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DEFORESTATION AND CLIMATE IMPACT IN THE PANTANAL OF NHECOLÂNDIA
A statistical analysis with the contribution of GIS and Remote Sensing

Master's dissertation in Physical Geography – Environment and Spatial Planning, supervised by Nuno Ganho Gomes da Silva, PhD and co-supervised by Arnaldo Yoso Sakamoto, PhD, presented to the Geography Department of the Faculty of Letters of the University of Coimbra

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DEFORESTATION AND CLIMATE IMPACT IN THE PANTANAL OF NHECOLÂNDIA

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This dissertation is dedicated to my
parents Milton and Ione for believing in me,
and to my loving wife, Eliane, who was
always on my side in the difficult times. She
was the light to my darkened path. To all
of you, thank you very much.

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ABSTRACT

The Pantanal is a region of distinct landscapes and fauna of great importance being considered by UNESCO as a World Natural Heritage Site and Biosphere Reserve. The Pantanal of Nhecolândia is regarded as the region that suffered most deforestation among other Pantanal regions. The Nhecolândia is one of the regions of Brazil with high meat production, leading the farmers to continuously deforest large areas of trees and “cordilheiras” to increase the pasture for livestock.

Deforestation has taken place since the dawn of humanity. This practice leads to consequences to the surrounding environment beyond just logging, as changing and impacting the whole dynamic of the ecosystem in question.

Studies related to a geographical character of an area has been supported by the geographic information systems and remote sensing, especially when it comes to map the changes in land use and occupation.

The use of new technologies in such old problems as the practice of deforestation has increased considerably, thus being able to consider it as the era of the Geotechnology.

Using the available tools of the highest existing technologies in our planet, this dissertation aimed at seeking a relationship between deforestation in the Pantanal region of Nhecolândia with a climate impact caused by this activity through statistical techniques applications looking for a correlation between the variables provided by the Brazilian Institute of Meteorology and the techniques of geographic information systems along with the science of remote sensing.

Maps were performed to show the evolution of land use for the region of Nhecolândia in a quadrangle layer, where are located the Firm and Nhumirim farms, responsible for studies in micro scale for climate impacts caused by deforestation and the meteorological data, respectively.

Various multiple and linear regressions were made in the study focused onthree variables: maximum and minimum temperatures and rainfall.

The preliminary results showed the importance of studies in a micro scale level and raised the importance of the influence of the atmospheric circulation in the region as the most influential in changing the local dynamicsas well as causing both beneficial and/or harmful implications to the study region.

Keywords: Deforestation; Climate impact; Statistical Analysis; Remote Sensing; Pantanal of Nhecolândia

RESUMO

O Pantanal é uma região de distintas paisagens e rica biodiversidade sendo considerado, pela UNESCO, como Patrimônio Natural Mundial e Reserva de Biosfera. O Pantanal da Nhecolândia é considerado como a região que mais sofreu desmatamento dentre as outras regiões do Pantanal. A Nhecolândia é uma das regiões do Brasil com maiores produções de carne, o que acarretou que seus fazendeiros continuamente desmatassem grandes áreas de árvores e "cordilheiras" para aumentar a pastagem para o gado.

O desmatamento acontece desde os primórdios da humanidade. Essa prática leva a consequências para o ambiente envolvente para além da derrubada de árvores, mas modificando e impactando toda a dinâmica do ecossistema em questão.

Estudos relacionados ao cartáter geográfico de uma área tem sido auxiliados pelos sistemas da informação geográfica e detecção remota, especialmente em se tratando em cartografar as alterações no uso e ocupação do solo.

A utilização de novas tecnologias em problemas tão antigos como a prática do desmatamento tem aumentado consideravelmente, podendo assim entender como a era das geotecnologias.

Utilizando-se das ferramentas disponíveis no contexto das mais altas tecnologias, o dispor das investigação em geociênciasdesta dissertação visou buscar uma relação entre o desmatamento na região do Pantanal da Nhecolândia com os impactos climáticos causados por essa atividade através de aplicações de técnicas estatísticas procurando uma correlação entre as variáveis fornecidas pelo Instituto de Meteorologia brasileiro e com as técnicas dos sistemas da informação geográfica juntamente com a ciência da detecção remota.

Foram realizadas mapas para mostrar a evolução da ocupação do solo para a região da Nhecolândia em um quadrângulo onde estava inserida as fazendas Firme e Nhumirim, responsáveis por estudos em escala micro para os impactos climáticos causado pelo desmatamento e pelos dados meteorológicos, respectivamente.

Foram feitas várias regressões lineares e múltiplas a três variáveis em que o estudo se focou: temperatures máxima e mínima e precipitação.

Resultados preliminares mostraram a importância dos estudos em escala micro e elevou a importância da influência da circulação atmosférica na região como maior influente nas mudanças ocorridas, quer causadoras de impactos quer benéficas para a região de estudo.

Palavras-chave: Desmatamento; Impacto climático; Análise Estatística; Detecção Remota; Pantanal da Nhecolândia

TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

INDEX OF GRAPHICS

INDEX OF APPENDIX

INTRODUCTION

In the past few decades the geographic information system along with various disciplines has been a constant in various studies, especially those with a geographical nature theme.

With the advent of satellite images and the development of informatics, a greater increase in the reading possibilities of geographical space in various degreesresulted in a sophisticated developed tool focused on spatial analysis and for such case, we can call it today the era of geoprocessing.

As technology nowadays progressively updates and upgrades almost as fast as the speed of light, they also “walk” beside and jointly with the human’s interventions in our planet. In order to fulfil the needs of our society, the industry of every kind fulfils the society’s needs, most of the times,in a no-matter-what-are-the-consequences attitude. Deforestation is among the variety of consequences.

Deforestation is no fresh news for humankind. The consequences of such activity is beyond its border. Affects widely the environment where it is being practiced. In every environment in the world deforestation happens and it’s most likely due to economic reasons.

The Pantanal is not off of this threat. The Pantanal is worldly known for its environmental singularities and wonderfulness, being considered by UNESCO a World Heritage Site and Biosphere Reserve. (Figure 1)

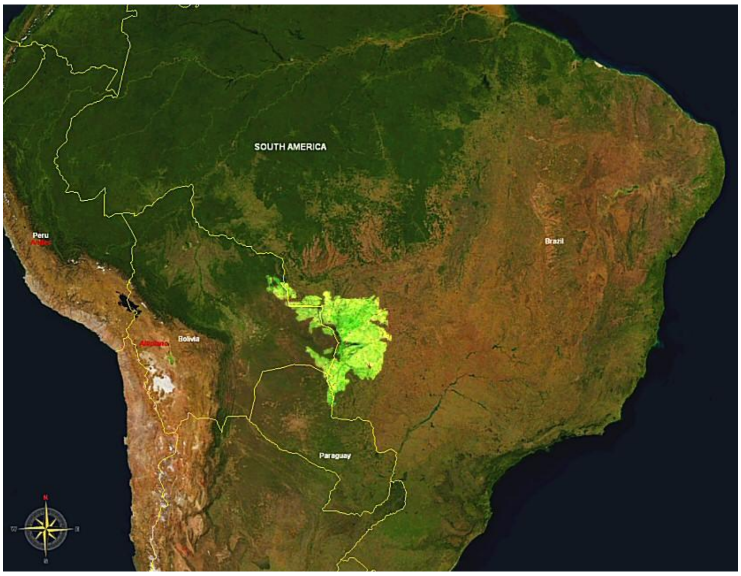

Figure 1: Location of the Pantanal in the South American continent
Source: Wikipedia

Extensive beef-cattle raising is considered the main economic activity in the Pantanal and it demands major land use with vast pasture areas culminating in huge farms throughout the entire Pantanal. One of the most important regions for livestock in Brazil is the sub-region of "Nhecolândia", located in the alluvial fan of the Taquari River in the Mato Grosso do Sul state of Brazil. (RODELA*et al.,* 2007)

This area has a very unique system of vegetation distribution with its units arranged in mosaic, alternating "cerradões" (savannah like environment) and seasonal forests in the "cordilheiras", seasonal and humid fields, flooded in parts or/and in the surrounding ponds;seasonal forest in the intermediate parts of the environment, etc.

1 - Characterization of the problem

Since the early 1970's, local farmers progressively deforested their land in order to increase their pasture land by replacing the native pasture and "cordilheiras" introducing exotic forage, predominantly *Brachiara ssp* resulting in vast deforested areas within their farms. (BODDEY*et al.*, 2004).PADOVANI*et al.* (2004) presented in their article that the Nhecolândia area is the most deforested of all the Pantanal's sub-regions.

Deforestation of "cordilheiras"not only has negative impacts on the Pantanal's flora, it also contributes: to the reduction of a number of timber species; has negative repercussions on wildlife, hampering the nesting of thejacaré-do-pantanal (*Caiman yacare*); decreases the refuge areas in times of major floods for several species such as the pampas deer (*Ozotocerosbezoarticus*) (BACANI*et al.*, 2010). Nesting of jabiru (*Jabiru mycteria*) and many other bird species is also impacted negatively. The habitat loss is the major cause of species extinction (PIMM*etal*, 1995*apud*BACANI*et al.*, 2010).

In addition to the negative impacts appointed to the biotic environment, it is important to evaluate others, such as the climate impact caused in recurrence of deforestation as is well-known studied by several scientist all over the world.

Many articles about the climate impact caused by deforestation and also its impact in the Pantanal had been written. Many relate to the soil transformation, the increase of acidity in the saline water ponds in the Nhecolândia region due to landscape transformation, depletion of the sandy boundaries facilitating the entrance of fresh water to the saline pond environment altering the alkalinity and, thus, altering the surrounded environment.

As little introduced, the impacts in the climate and due to the climate within the Pantanal are well known and documented, but not entirely understood. Many methodologies are tested and new results are produced.

2 - Objectives

2.1 - General objectives

This dissertation aims to study the impacts caused in the regional climate of the Pantanal of Nhecolândia due to the deforestation that it has happened since the years 1970's throughthe analyse of a time series meteorological data such as temperature (maximum and minimum) and precipitation from 1985 until 2011. It will have the contribution of GIS and Remote Sensing as mapping the progression of deforestation from 1984 until 2014 utilizing LANDSAT imagery. It will also analyse if there is a correlation between deforestation and the impacts in the regional climate.

2.2 - Specific objectives

- To understand the dynamics of the climate of the Pantanal of Nhecolândia;
- To introduce a brief historical of the study area;
- To analyse the meteorological data;
- To map the evolution of the deforestation;
- To verify about the impacts caused in the regional climate due to deforestation;

3 - Methodology

3.1 - Meteorological and satellite data

The USGS (*U.S. Geological Survey*) Landsat Mission and INPE (*Instituto Nacional de Pesquisas Espaciais*) provided most of the imagery used in this dissertation. It was used images from the Landsat 5 and 8 and the Chinese-Brazilian satellite CBERS2.

The Meteorological data were acquired for free in the BDMEP (*Banco de Dados Meteorológicos para Ensino e Pesquisa*) of SADMET.

Images from Landsat 5 and 8 satellites dates from September2nd, 1984, until September 21st, 2014, orbit 226/073 for both satellites;the images will assess the deforestation progression in the Nhumirim and Firme Farms. It was chosen the Nhumirim Farm to do the studies simply because the meteorological station is located within the property and the Firme Farm because many authors study the area and its natural features.

The meteorological data is from the Nhumirim Station from INMET (*Instituto Nacional de Meteorologia*) dating from January 1st, 1985, until December31st, 2011. They were analysed, hourly, daily and monthly. However, only the years with a complete set of data for every day and every month of the year were used. The climatological station is located at latitude 18°59'S and longitude 56°39'W, about 97 meters above sea level in the Nhumirim Farm that belongs to EMBRAPA (*Empresa Brasileira de Pesquisa Agropecuária*); the precipitation (mm), air temperature (minimum, maximum and mean - °C), relative humidity (%), evaporation (%), insolation (hours) and evaporation of the tank "Class A" (mm) data are collected daily at 08, 14 and 20 hours.

The land use map area was elaborated with the analysis of the imagery (from 1984 to 2014) provided by the Landsat program, using the technique of "Supervised classification" which it'll be compared among each other.

The "Supervised Classification" was applied after thecomposition of the bands of the Landsat satellite to assess the coverage of the vegetated area utilizing the open-source software QGIS and its plugin "Semi-Automatic Classification Plugin" and also the proprietary software ArcGIS 10.1.

3.2 - Linear and multiple regression

It will be explored the impacts on the climate by using the linear regression model to seek the correlation with the variables minimum temperature and precipitation and maximum temperature and precipitation, also a multiple regression model with the variables precipitation and maximum and minimum temperatures.

4 - Structure of the dissertation

This dissertation structures in 5 chapters.

The first chapter introduces the theory that supports the study. The second chapter addresses a brief history of the Pantanal of Nhecolândia and its geographical characteristics. The third chapter analyses the characteristics of the regional climate. The fourth chapter analyses the thermal and hygrometric topoclimate variability. The fifth and last chapter finalise the dissertation with the results obtained with the theory, the statistical and GIS techniques and the remote sensing science.

CHAPTER 1 – THEORETICAL FOUNDATION

1 - General aspects of deforestation and climate impact

Since the dawn of civilization that deforestation occurs. In the early days the capacity of regeneration of the natural resources was able to follow the slow pace of consumerism. With the growth of the population in exponential scale, natural resources and the environment have been degraded to maintain the global needs for raw materials. As the result of this process are many direct and indirect effects in our days, such as disappearance of species, induced mutation, desertification and climate change (RÊGO&HOEFLICH, 2001). Direct actions are represented by deforestation, exploration of soil resources, urbanization and industrialization. Indirect actions are felt in the form of impacts aroused from lower production, susceptibilities caused by climate change, and diseases caused by mutagenic agents. (INOUE, 1992 *apud*RÊGO&HOEFLICH, 2001).Deforestation is the process of removing a forest or stand of trees, mainly caused by human activities in order to convert to a non-forest use. There are many reasons why forests gets cleared, as they are used as timber or charcoal for industries, while cleared areas are used as settlements, pasture for livestock, plantations of commodities, etc. Deforestation causes a great impact in the global environment as well as in the human life causing negative effects in the economy, society, culture and biological aspects, affecting virtually every living-being in our planet, directly or indirectly (COMISSÃODASCOMUNIDADESEUROPEIAS, 2008).

The consequences of deforestation are numerous, as cited above, because not only affects the biodiversity but also affects the climate. According to DUBREUIL*et al.* (2011, p. 1) in an article about the Brazilian Amazon, "[...] the forest promotes the maintenance of strong humidity and a range of high temperatures (30 °C to 34 °C during daytime and 15 °C to 20 °C during the night, on average). Major modifications in vegetation cover have consequences on hydrology and climate (LEAN&WARRILOW, 1989; ICHII*et al.,* 2003)." As trees transpire, they release a great deal of water back to the atmosphere regulating the cycle of rain regionally and globally. Forests purify the water, regulate the level of the groundwater and are responsible for the regulation of about 57% of the freshwater (ADAMOWICZ*et al.*, 2005).

Deforestation can contribute to the decrease of precipitation. The decrease of precipitation degrades other parts of the forest leading it to the savannah expansion and semi-desertification (OYAMA&NOBRE, 2003), erosion of the soil, loss of fertility of the soil by leaching in periods of rainy season, laterites (ESPINDOLA&DANIEL, 2008), damaging crops and pastures from regions that can be far away from the deforested area (DUBREUIL*et al.*, 2011), and also reducing the amount of renewable freshwater sources for human consumption. Hence, changes of surface cover have implications that broaden well further than the lower layers and influence all the climate parameters such as temperature, humidity, rainfall, etc.

1.1 - The influence of deforestation in the climate

According to THE WORD BANK (2012), forests cover 31% of the land on our planet producing vital oxygen, also acting as a carbon dioxide sink, as it would otherwise be free in our atmosphere playing a critical role in mitigating the climate change scenario (WWF, 2014). Lost or degraded forests set off a sequence of changes that distress life both locally and around the world.

As put by DUBREUIL*et al.* (2011, p. 3), "The synthesis of deforestation (substitution of forest by pasture) and climate presents a systematic decrease in evaporation allied to an increase in albedo (less energy absorbed), and decrease in rugoses, root system and foliar surface (PIELKE, 2001; VONRANDOW*et al.*, 2004; SHEIL&MURDIYARSO, 2009). The decrease in evaporation is linked with an increase in surface temperatures. The majority of the models (but not all) predict a decrease in precipitation linked to a reduction in convection due to albedo increase and low rugoses. Moreover, latent and sensible heat fluxes vary little above the forest (the Bowen ratio has a year-round stable value around 0.3-0.4), while above pastures, these fluxes are variable throughout the year."

Complex exchanges among the dynamical processes in the atmosphere and thermodynamic processes at the Earth-atmosphere boundary determine the equilibrium climate. Therefore, estimating quantitatively, the effects that hefty changes in terrestrial ecosystems can have on temperature, circulation and rainfall has been a complex task. (NOBRE*et al.*, 1991).

Changing the land use, as deforestation, alters the land cover of the globe, causing all sorts of problems. However, it also produces greenhouse gases (GSGs, notably CO_2, CH_4 and N_2O) and aerosols (e.g. smoke and dust particles), thus being responsible for important effects on climate in which they affect by reflecting and absorbing radiation. Indeed, "landscape transformation and particularly land changes from tropical forest to pastures or crops contribute to sensibly modify the radiative exchanges in local scale" (DUBREUIL*et al.*, 2011)

Anthropogenic changes in the physical aspects of the Earth's surface can arouse climatic disturbances such as exerting alterations of the albedo – the albedo of forested land is lower than deforested areas because of "the greater leaf area of a forest canopy and multiple reflections within the canopy result in a higher fraction of incident radiation being absorbed" (IPCC, 2007) inducing "radiative forcing"[1] by perturbing the shortwave radiation budget. Changes in the land use can also affect the emissivity, fluxes of moisture through evaporation and transpiration, also the surface energy balance by altering the water cycle (e.g. irrigation), the ratio of latent and sensible heat and the rugoses of the terrain exerting frictional drag in the atmosphere altering the turbulent transfer of heat and moisture affecting the air temperature near the ground modifying humidity, precipitation and the velocity of the wind (IPCC, 2007; ONÇA, 2011). MARENGO (2006, p. 2) states "Changes in land use patterns due to deforestation might produce changes in latent heat and can ultimately influence precipitation in two important ways. First, an increase in evapotranspiration adds moisture to the atmosphere, which, if recycled, directly increases rainfall. Second, increased latent heating associated with this increased rainfall can drive an intensified circulation (e.g. the Hadley cell), resulting in changes to the moisture convergence from remote sources. Land-use practices, such as agriculture or urbanization often disrupt the supply of fresh water through changes in the surface water balance and the partitioning of precipitation into evapotranspiration, runoff and groundwater flow".

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[1] (IPCC, 2007) "Anthropogenic greenhouse gases and aerosols affect the climate system by altering the balance between absorbed solar radiation and emitted infrared radiation. The imbalance is quantified as the "radiative forcing", which is defined as the change in net downward radiation (combined solar and infrared) at the tropopause when, for example, greenhouse gas or aerosol amounts are altered, after allowing for the adjustment of stratospheric temperatures only. The surface climate responds to the initial change in net radiation at the tropopause rather than at the surface itself or at the top of the atmosphere because the surface and troposphere are tightly coupled through heat exchanges, and respond as a unit to the combined heating perturbation. The adjustment of the stratosphere is included in the radiative forcing because the stratosphere responds quickly and independently from the surface-troposphere system."

1.2 - The use of Remote Sensing and GIS in the deforestation and climateimpact studies

The use of geotechnologies is growing within the geographical analysis and its responsibilities. Outcomes and outputs have been of fundamental importance to the scientific research and technical documents in the area of counselling and environmental consulting (CARDOSO, 2011).

Geotechnologies solutions consist of a set of technologies for collecting, processing, analysing and delivering information with geographic references that together constitute tools for decision-making (ROSA, 2003).

In this perspective, GIS and Remote Sensing has been an important tool to analyse and visualize spatial data, being used extensively in different applications such as cartography for land use (urban planning), analysis and transporting management (input network and emergencies), geodemographic analysis (service locations), cartography of infrastructure networks (gas, water, electricity) and multiple applications for natural resources (CARDOSO, 2011).

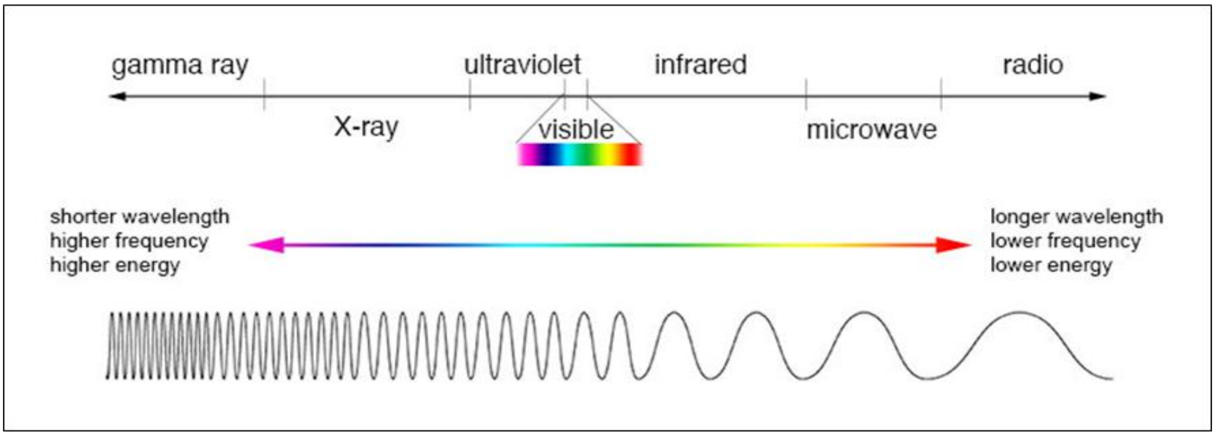
Remote Sensing and GIS has been used in many fields of expertise and climate impacts and deforestation studies are one of them(DUBREUIL*et al.*, 2009). As ZAKARIA (2010, p.8) well elucidated, "remote sensing data are capable of capturing changes in vegetation cover by multi-temporal monitoring through time series. Remote sensing is also one of the most reliable devices having high capability in research work for spatial information and data collection concerning different fields. As remote sensing has routinely provided a newly quality of imagery of the Earth's surface, it has become intertwined with GIS as a means to constantly and inexpensively updates some of the data such as land use and land cover".

2 - Remote Sensing

The set of methods for data acquisition of targets on Earth's surface (objects, areas, events) through the exchange of electromagnetic radiation with the surface performed by distant or remote sensors is known as Remote Sensing (Figure 2).

There are many definitions for Remote Sensing. As put by LILLESAND (1987), it is the science that obtains the information from a determined object, area or phenomena through the analysis of the data acquired without direct contact with the object investigated.

The absorption, the incidence, the reflection and emission of the electromagnetic waves from Earth's surface and the interpretation of its reflectance patterns are part of the Remote Sensing activities with various applications to different sciences subjects and human activities, which among them are the deforestation studies and climate change (CARDOSO, 2011; ROSA, 2003).



Source:http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html

Figure 2: Electromagnetic spectrum

Before Remote Sensing, it was common to use aerial photography and yet some of the photos are irreplaceable to many applications. According to CARDOSO (2011, p.52), "there are many data acquisition systems such as airborne cameras, satellites, radar systems, sonar or microwave (Table 1). The systems can be active, as the microwave systems, which record the difference in their frequency between the signal emitted by them and the rec eiv ed signal from the surface (the Doppler effect), or passive and active, such as photographic cameras, which record the reflectance or emittance of a surface".

The level of acquisition of data in Remote Sensing thoroughly connects with the sensor's height. Depending on its height, there will be differences in the data acquired such as the dimension of the detected area, in the environmental factors and in the

Electromagnetic Radiation registered by the sensor as with the level of information. (MAZZOCATO, 1998 *apud*RODRÍGUEZ, 2005)

The satellites used in Remote Sensing have evolved since 1970's in many temporal and spatial scales offering diverse use in any area of expertise. Depending on the needs of one, such images acquired from a certain satellite and with a proper spectral sign, it would allow the perfect discrimination of the target and its neighbours being a fast, inexpensive and an efficient way to detect the many diverse environments in our planet (RIBEIRO, 1998).

Table 1: Reference table of the types of systems in Remote Sensing

<table>
<tr><th colspan="6">Taxonomy of remote sensing systems</th></tr>
<tr><th>Platform of recording</th><th>Record Mode</th><th>Ways of Recording</th><th>Spectral Coverage</th><th>Spectral Resolution</th><th>Spatial Resolution</th></tr>
<tr><td rowspan="3">Satellite /Shuttle</td><td rowspan="4">Passive (Visible)</td><td rowspan="4">Analogic</td><td rowspan="2">Visible /Ultraviolet</td><td rowspan="2">PAN 1 Band</td><td>Very Low >250m</td></tr>
<tr><td rowspan="2">Low 50-250m</td></tr>
<tr><td rowspan="2">Infra-red reflected</td><td rowspan="2">Multi-Spectral 2-20 Bands</td></tr>
<tr><td rowspan="3">Airplane /Balloon</td><td>Medium 10-50m</td></tr>
<tr><td rowspan="4">Active (Radar, Laser)</td><td rowspan="4">Digital</td><td rowspan="2">Infra-red thermal</td><td rowspan="2">Hyper-Spectral 20-250 bands</td><td>High 4-10m</td></tr>
<tr><td rowspan="2">Very High 1-4m</td></tr>
<tr><td rowspan="2">Stationary</td><td rowspan="2">Microwave</td><td rowspan="2">Ultra-Spectral >250 bands</td></tr>
<tr><td>Ultra-High <1m</td></tr>
</table>

Source: CARDOSO, 2011. **Translation:** Author

2.1 - Spectral behaviour in land use

The basis for interpretation remote sensing images is the interaction of radiation with matter. According to GIRARD&GIRARD (2003, p. 72), "An object situated in a given geographic position at a given moment, viewed under a given field of view and receiving a given radiation, exhibits a spectral behaviour that is specific to it. Hence, some authors use the term spectral signature. This term is inappropriate since a signature implies constancy whereas, in reality, the spectral behaviour of an object varies with time, place, mode of data acquisition and incident radiation."

Remote Sensing image bases on general laws of physics and the spectral behaviour of objects is quite important when we are dealing with analysis and interpretation (GIRARD&GIRARD, 2003).

Although there are many objects we can study, it normally reduces to a few broad circumstances such as vegetation (organic matter), soils (mineral matter), water, snow and ice.

2.1.1- Spectral behaviour in vegetation

The spectral characteristics of the vegetation relates to the leaf composition chemistry, morphology and internal structure, as it has been the largest contributor to detect the electromagnetic radiation sign (VERONESE, 2000).

In the visible region, healthy vegetation has a high interaction because of the high absorption rate in the visible region due to the presence of pigments in the vegetation leavessuch as chlorophyll which absorbs a large amount of energy in the regions that are concentrated in the 0.45 and 0.67µm. Due to this fact, we are able to colourize the image of the healthy vegetation in the green colour. Because vegetation suffers hydric stress, thus producing low amount of chlorophyll, the absorption decreases in the visible region leaving a yellowish colour (CARVALHO, 2005; COURA, 2007 *apud*VILELA, 2009).

In the near infrared region, the reflectance of healthy vegetation can reach values close to 50% of the incident energy (CARVALHO, 2005 apud VILELA, 2009) due to internal structure of leaves (THIAM&EASTMAN, 1999 *apud*VILELA, 2009). According to VILELA (2009, p. 11) "Wavelengths greater than 1.3 microns the incident energy on the vegetation is usually absorbed or reflected occurring low or no transmittance. For wavelengths of about 1.4, 1.9 and 2.7 microns, the increase in absorption is due to the presence of water in the leaves(CARVALHO, 2005)."

2.1.2- Spectral behaviour in water

Water provides distinct spectral behaviour due to its physical state. The liquid form emits a low reflectance (less than 10%) in the range between 0.38and 0,7µm, absorbing all radiation with values higher than 0,7µm. According to VERONESE (2000, p. 36), "[...] Nevertheless, this behaviour is affected by the concentration of suspended materials and dissolved in water and by the depth of the water body. The increase in concentration of suspended material implies an increase of the reflectance in the red range." Clouds have high reflectance (approximately 70%) throughout the optical spectrum. The smooth waves in the spectral curve are due to light absorption on 1.3 and 2µm (VERONESE, 2000; VILELA, 2009).

2.1.3- Spectral behaviour in soil

The presence of organic matter and moisture and the mineral formation determine the spectral behaviour of soils. The reflectance has lower values in the blue wavelength, positively increasing in the red, near infrared and near mid-infrared wavelengths. The iron oxides and hydroxides increase the spectral range from green to near infrared and reduce the reflection in the blue wavelengths. Reduced reflectance at all wavelengths is occasioned by the high moisture content in the soil and an increase in organic matter leads to the reduction of the reflectance. The level of organic material is better detailed in the visible and infrared (VERONESE, 2000; VILELA, 2009).

2.2 - Spectral, spatial, radiometric and temporal resolution

2.2.1- Spectral resolution

Spectral resolution defines as the capacity of the sensor to distinguish spectrally similar bodies. The resolution relates to the number of spectral channels and their thickness. Different objects may have similar spectral response within a certain range of wavelength and provide different responses in another portion of the spectrum. Thus, a larger number of spectral channels imply a higher spectral resolution. (VILELA, 2009)

2.2.2- Spatial resolution

Spatial resolution relates to the ability of a sensor to distinguish objects that are close spatially (VERONESE, 2000; VILELA, 2009). A reference to this resolution is the pixel size. Normally, only objects bigger than the pixel size can be identified, although it depends on its reflectance and contrast between the nearby objects.

Spatial resolution is one of the most important factors when one chooses to work on getting information about the terrestrial resources. (VERONESE, 2000)

2.2.3- Radiometric resolution

According to VERONESE (2000, p. 19) "Grey levels of the pixels are represented by integers that fall within a certain range". The larger the value number, the higher the radiometric resolution. The number of Grey levels is usually expressed in terms of the number of binary digits (bits) needed to store in digital form the value of the maximum level. The value in bits is always a power of 2. Thus, *n* bits expresses 2^n values of Grey levels.

2.2.4- Temporal resolution

Temporal resolution is defined as the frequency at which a sensor revisits a given area. According to FONSECA (2000), the appropriate temporal resolution is essential in the process of identification studies that dynamically change such as atmospheric flow, growing crops, and land use.

2.3 - LANDSAT satellite

LANDSAT stands for Land Remote Sensing Satellite. The program was first initiated in mid-1960s. The satellite was conceived exclusively to the observation of terrestrial natural resources. The first of the LANDSAT satellite to be launched was the LANDSAT 1 in July 23rd, 1972. The last update in the program was the LANDSAT 8, launched in February 11th, 2013.

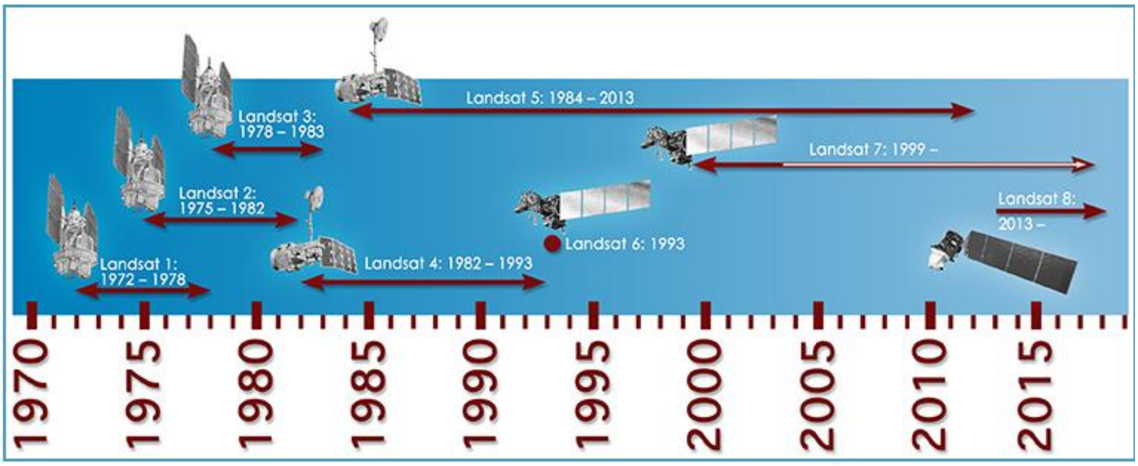


Figure 3: LANDSAT program time series.
Source: http://landsat.gsfc.nasa.gov/?p=3166

The LANDSAT satellites orbit our planet from North to South in a geocentric orbit, polar and sun-synchronous. LANDSAT 1, 2 and 3 satellite images the entire Earth every 18 days and LANDSAT 5, 7 and 8 every 16 days.

Our knowledge of diverse things such as coral reefs, tropical deforestation, and Antarctica's glaciers for example, increased with the advent of the LANDSAT program. Since it collects data from all over the world in a regular basis and from a considered period of the 20th century, LANDSAT have helped to improve our understanding of Earth. The 30 meters spatial resolution and 185 kilometres swath of LANDSAT are detailed enough to characterize human-scale processes such as urban growth, agricultural irrigation, and deforestation allowing scientists to evaluate environmental change over time (NASA, 2014).

2.4 - Digital processing of images

The main purpose of the digital processing of images is to take the digital data and computers and to manipulate them in order to obtain parameters of correction and highlights enabling them to promote the identification and extraction of the image's data (VILELA, 2009).

2.4.1- Pre-processing

It is common to images coming from remote sensors be subject to a number of spatial distortion mainly caused by the platform of instability as well as by scenic effects related to the acquisition geometry and the curvature and rotation of the Earth (VILELA, 2009). According to VERONESE (2000), it is necessary to submit images to a geometric correction when such distortions are present in order to provide mapping accuracy in the placement of objects depicted therein, utilizing the ground control points for example. There are other techniques of correcting geometrically as image registering, elimination of noises, interpolation correlation, etc. Also MATHER (2004) *apud*VILELA (2009, p. 22) refers that "geometric correction of images is required in various situations, such as when you want to match an image and a map; locate points of interest on the map and image; overlapping temporal sequences of images relating to the same area, as they may be obtained by different sensors".

Thus, pre-processing is the technique applied on raw data, providing the proper rectification and correction of the distortions in remote sensed images.

2.4.2- Digital classification of images

Digital classification of images is the process of extraction of information from images enabling the user to identify the patterns and homogeneous objects. The end product obtained results in a thematic map.

During the process of digital classification, the user chooses different classes according to one's project and gives a pattern recognition based on pixels information.

According to FONSECA (2000) the classification is implemented based on differences in behaviour of materials throughout the electromagnetic spectrum.

There are two groups of training in the automatic classification which are called supervised and non-supervised.

3 - Statistics

Statistics is a tool to processdata in an investigation through a set of methods. Therefore, it is a set of tools to collect, explore, discuss and interpret data.

Statistics is not a science, because it is a set of methods, analysis tools and does not has a theory. It alone does not explain anything. Need something to explain it, such as geography, economics, medicine, etc., in an appropriate scientific framework.

When we have many observations, we make a successive reduction and thus there is a loss of conditioned specificity and individuality. It is important to have several observations in statistics, but there is also a gain of generality.

3.1 - Linear and multiple regression

Regression analysis is a statistical process to calculate and assess the relationship among variables. According to JOHNSON&WICHERN (2013, p. 360), "Regression analysis is the statistical methodology for predicting values of one or more *response* (dependent) variables from a collection of *predictor* (independent) variable values. It can also be used for assessing the effects of the predictor variables on responses". Indeed, regression analysis assists one to interpret how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed.

The association between a single dependent variable Y and a collection of predictor variable z_1, z_2, …, z_r is one of the concerns of the classical linear regression model (JOHNSON&WICHERN, 2013). Specifically, the methods that establish linear relations to the parameter of a model between two or more variables are denominated as methods of linear regression. We can establish a functional relation between a random variable Y (dependent) and another independent variable, which can be either random or fixed. A fixed variable is the one that the user controls its reactions (FERREIRA, 2009). When one independent variable is used, we call a simple linear regression. As we need more than one independent variable, we call it a multiple linear regression (WALPOLE*et al.*, 2009).

CHAPTER 2 – GEOGRAPHICAL CHARACTERIZATION OF THE STUDY AREA

I - Brief historical of the Pantanal Mato-Grossense and the Nhumirim and Firme Farms

ASSINE (2003) states that the Pantanal is a sedimentary basin tectonically active with changes in its landscape happening since the Pleistocene caused by climatic and tectonic changes.

According to GODOI FILHO (1986), the Pantanal Mato-Grossense covers an area of approximately 140.000 km², with 65% of its territory in the State of Mato Grosso do Sul and 35% in the State of Mato Grosso. It has an average elevation of 100m, being an integral part of the Paraguay River Basin (500.000 km²), also representing the centre of South America. The Planalto Cristalino surrounds it with altitudes varying from 600 to 700m, which represents the area of water and sediment sources. (BACANI, 2007).

CALHEIROS & OLIVEIRA (1996) consider the Pantanal as a mosaic of aquatic ecosystems. It is a remarkable interspace of transition and contact influenced by four other large Brazilian biomes: Amazonian, Savannah, Chaco and Atlantic Forest. As AB'SABER's (1988, p. 9) said, "In the category of a large and relatively complex alluvial detritic coalescing plain, the Pantanal Mato-Grossense includes savannah and Chaco ecosystems, biotic components of the dry North-east and peri-Amazon regions. From the phytogeoGraphical point of view, this is an old regional 'complex', which vegetation maps elaborated from documents of remote sensing images turned into a perfectly understandable mosaic of natural organization of space, somewhat 'complex'".

According to FRANCO & PINHEIRO (1982) *apud*BACANI, (2007), the usual designation of the Pantanal is based on the fact that the area is often flooded by surface water. However, most researchers agree that the term is not appropriate because "the area does not present characteristics of a swamp genesis" (SÁNCHEZ, 1977 *apud*BRASIL, 1982, *apud*BACANI, 2007, p. 35).

The Pantanal is formed by extensive surface of accumulation of modern alluvium in a continuous sedimentation process experiencing annual periodic flooding. It has relatively flat topography and low topographic gradient ranging from 0.3 to 0.5m/km East to West and from 0.03 to 0.15m/km in the North-South direction (ALMEIDA, 1965; FRANCO&PINE, 1982; ALVARENGA*et al.*, 1984, *apud*GRADELLA*et al.*, 2010). As an active sedimentary basin, its landscape ismoulded by successive depositional events and it is mainly formed by fluvial plains.

The Pantanal Mato-Grossense has many sub-regions (Figure 4) and the Pantanal of Nhecolândia situates between the Taquari River, in the North and the Negro River, in the South (Figure 5).

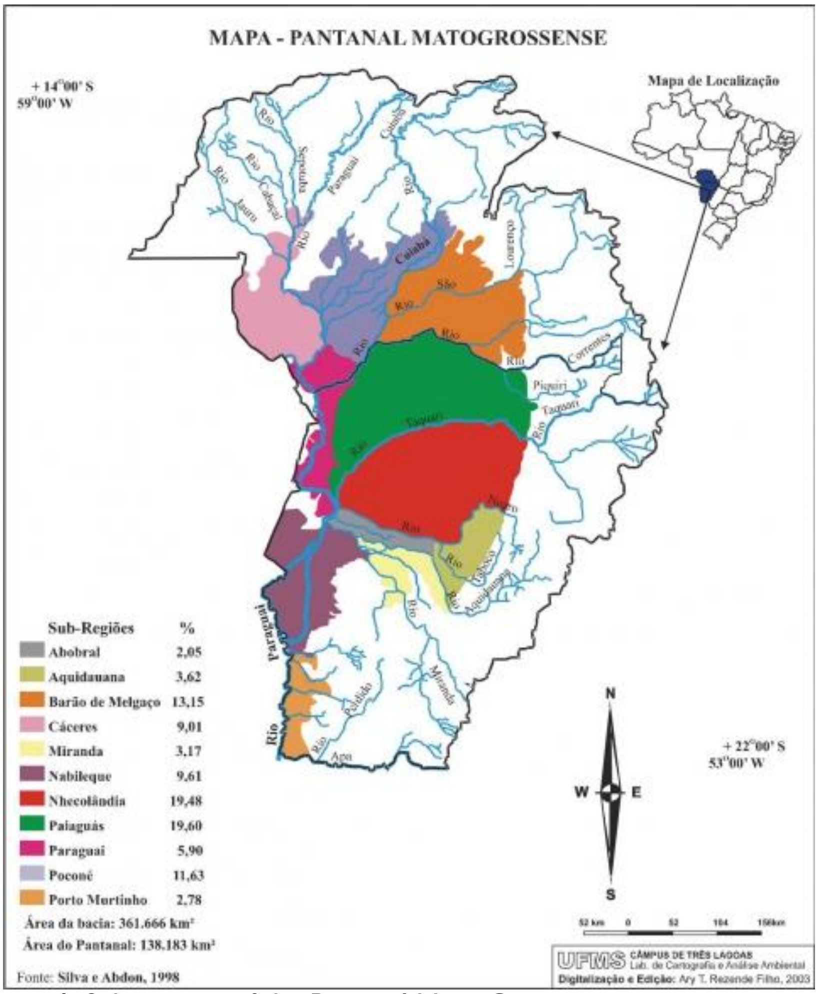


Figure 4: Sub-regions of the Pantanal Mato-Grossense
Source: SILVA*et al.*, 2015

This sub-region characterizes by the presence of rivers, bays, saline, ebbs, streams, "cordilheiras", tropical grassland, savannah, forests and seasonal forests (BRASIL, 1982 *apud*SAKAMOTO, 1997). FERNANDES (2007) mentioned that some characteristics of spatial patterns are popular terminologies for particular hydrological and morphological features that became widely known. However, it has been adapted to the scientific literature, such as "cordilheiras", anelongated elevation that does not exceed 3 meters above the level of the lakes, but only 1-2 meters above the bays and ebbs.

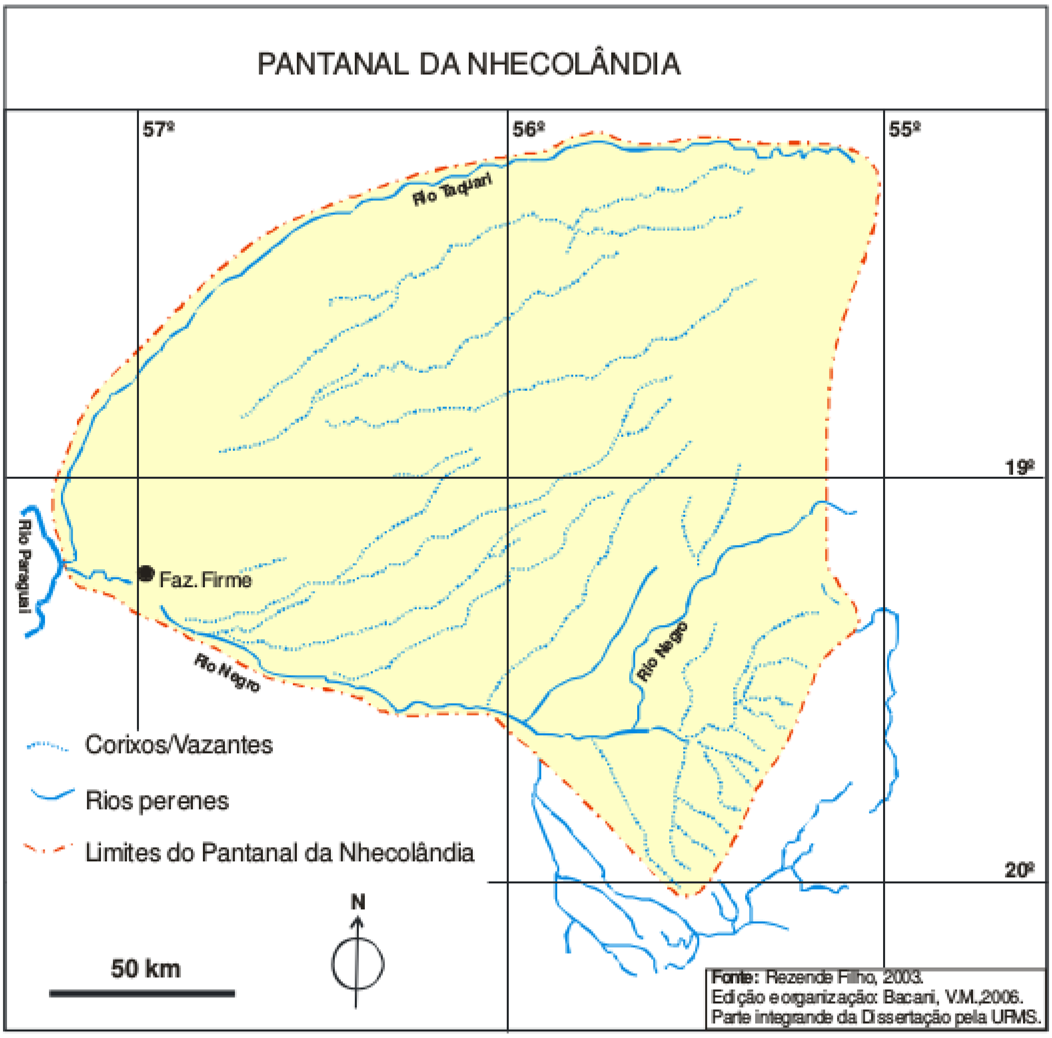


Figure 5: Pantanal of Nhecolândia
Source: BACANI, 2007

The Brazilian Agricultural Research Corporation (EMBRAPA), installed in 1975 a research unit in the Pantanal region that could investigate ways of producing and developing technologies and innovations to the activities performed in the biome. The company had as main objective to conduct research in cattle ranching subject, investigating topics such as health, reproductive and nutritional management of beef cattle, as well as native and cultivated pastures (EMBRAPA, 2015).

In 1982, the institution acquired the Nhumirim Farm, located about 160 km from Corumbá (18°59'S and 56°39'W), in the Mato Grosso do Sul state, Brazil, with an area of over 4300 hectares, which it was used as the base of climate, soil, limnology, ichthyology, fauna, flora, environmental impacts and conservation nucleus "in situ" of Pantanal's breeds and horses studies (EMBRAPA, 2015).

The Firme Farm situates in the western portion of the Pantanal of Nhecolândia (Figure 6);

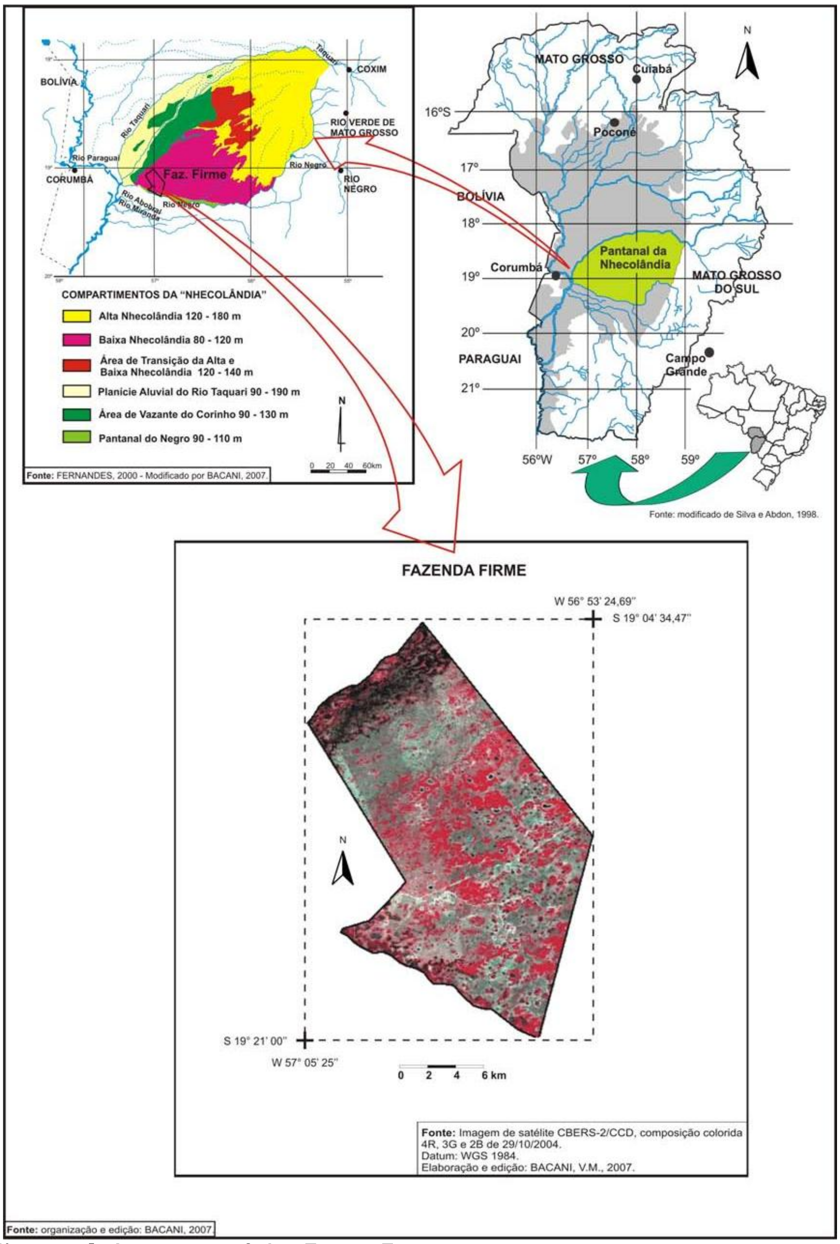


Figure 6: Location of the Firme Farm
Source: BACANI, 2007

It bounds in the North by the ebb tide of "Corixão" and South by the Negro River, with an area of 34229.7 hectares (SAKAMOTO, 1997). This region is known regionally as "Curva do Leque".

The Firme Farm was the first farm in Pantanal to raise cattle, founded in 1847 by Joaquim José Gomes da Silva (Baron of Vila Maria), by the banks of the Paraguay River (SAKAMOTO, 1997).

2 - Climatology

According to the Köppen climate classification, which is based on systematic thermal and rainfall regimes and distribution of plant associations (VIANELLO&ALVES, 1991), the Pantanal Mato-Grossense can be classified as belonging to the climate type Aw (tropical savannah climate), mega thermic (average temperature of the coldest month is above 18 °C), with dry winter and rainy summer (SORIANO, 1997). TARIFA (1986) classifies the climate of the Pantanal region by high temperatures and by the highest thermal amplitudes in Brazil. Mainly the tropical latitude and its geographic area, also related to orographic and low altitudes, determine the mega thermic character. The rainfall follows the tropical regime, with annuals ranging from 800 mm to 1400 mm, presenting the rainy season from October to March (80% of the annual rainfall) and the dry season from April to September. The rainy trimester comprehend December until February, being January the rainiest. July is the driest month of the year. The evaporation exceeds the precipitation in the dry season (CADAVIDGARCIA, 1984, *apud,* ALLEM&VALS, 1987, *apud*, BACANI, 2007). The mean annual temperature is 25,5 °C, with the mean annual minimum and maximum temperatures, respectively, 20 °C and 32 °C. The maximum absolute temperature is over 40 °C between September and January and the minimum absolute occurs between May and August, being common cooling under 10 °C, also been registered minimum absolute temperatures close to 0 °C (SORIANO, 2002).

According to SAKAMOTO (1997, p. 135), "the climate and hydrology of the Pantaneira plain is known in general terms by studying the flow of the main rivers and rainfall conditions (DNOS, 1974; SANCHES, 1977; ADÁMOLI, 1986, CADAVIDGARCIA, 1984; CARVALHO, 1986; TARIFA, 1986; TUCCI, 1995)".

According to DNOS (1974) *apud* BACANI (2007), the infiltration of rainfall in wetlands is moderate, according to the observation of the water level in wells. The differentiated rate of infiltration in similar soils is the saturation index these soils may present. Part of the area between the Taquari and Negro rivers, transition area between the Chaco and the Savannah, provides about 40 to 50% of the rainfall to the groundwater.

Currently, the existing network of weather stations in the Alto Paraguay Basin are poor because many of the stations are disabled and others have their records incomplete. In the Pantanal, the density of these stations is very low due to the difficult access at certain times of the year and the shortage of qualified staff that are willing to reside at the place of station to make observations (SORIANO & GALDINO, 2002).

3 - Hydrology

The hydrological regime is tropical, with the maximum in February or March and the minimum in August or September, although the behaviour of the tributary rivers presents, often, gaps with the main river and among each other, causing various effects on the volume of water transported in various sectors of the Paraguay River (DNOS, 1974 *apud*SAKAMOTO, 1997).

The Paraguay River has its flow slower when it runs from North to South and faster towards the East-West direction, which is the general orientation of most of its tributaries (ALVARENGA*et al.*, 1986).

According to DNOS (1974 *apud*SAKAMOTO, 1997), it was estimated that the flood of the tributaries rivers can take up to 10 to 30 days to cross the entire Pantanal and the flooded area may vary from 10.000 to 30.000 km^2 from one year to another. Ebb tides, streams and lakes with various lengths and extensions cause considerable losses of great volume of water. The precipitation in the North sector may increase the runoff during the rainy season.

The seasonal alluvial regime of the Great Pantaneira Depression is the greatest contributor to the major floods in the Pantanal. The Paraguay River is considered the main watercourse of the Pantanal, with meandering, angular and straight sectors.

The Pantanal is largely covered by small ponds, old abandoned meanders, even old riverbeds, partially or completely covered by vegetation ("water hyacinth" or "beach grass"). The ponds and the abandoned meanders usually have permanent water with little depth and vegetation growing in the water rooted at the bottom or floating on the surface. Water can flow from one pond to another during floods. During periods of low discharges, ponds and meanders seem independent, although erstwhile abandoned channels covered with grass assisted by soil permeability maintain the connection. The water flows very slowly, about 1 to 5 m^3/s on these channels because of the low slope and the resistance opposed by the vegetation; as a result, there is a longer period of time for filling or emptying in the high or low discharges occasions of the Paraguay River and its tributaries (DNOS, 1974 *apud* BACANI, 2007).

According to GRADELLA (2008, p. 22), "ASSINE (2003) states that the Paraguay River has a very complex partitioning due to the fact it runs through different geomorphological areas where outside the Pantanal it has erosive characteristics and in the Pantaneira plain features a strong decrease in the topographic gradient, becoming sedimentary and receiving waters of several alluvial fans."

4 - Geology and geomorphology

The Pantanal is mainly formed by metamorphic rocks of low-grade and neo-Proterozoic magmatic rocks (Cuiabá Group); on the western edge, inconsistent with the Cuiabá Group, occur Proterozoic sub-horizontal rocks slightly deformed from the Corumbá Group, slightly leaning to South-West, forming the Maciço do Urucum (Planalto Residual do Urucum-Amolar). At its eastern edge of the Precambrian crystalline rocks occur Palaeozoic and Mesozoic sequence of the Paraná Basin, constituting the Taquari-Itiquira and Maracajú-Campo Grande plateaus (ASSINE, 2003).

The Pantanal is a depositional area formed by sediments of the Formação Pantanal, known as the Sedimentary Basin of the Pantanal. OLIVEIRA&LEONARDOS (1943 *apud*ALMEIDA, 1964) describes the sediment as fine and silt-clay sandy, rarely presents gravel, usually handled by the current drain (GRADELLA, 2008).

Wells drilled by PETROBRAS (*Petróleo Brasileiro S.A*) of 412,5m deep did not reach the foundation. The stratigraphy shows that in the bottom predominates coarse sandstones and conglomerates, while at the top occurs quartz sands mainly fine to medium. From bottom to top, the sediments tend to get thinner. In some parts, there is the presence of iron oxide, sometimes forming laterites (ASSINE, 2003). USSAMI*et al.* (1999, *apud*ASSINE, 2003) inferred through earthquakes an approximate depth of 550m.

It is assumed that the sedimentation of the Pantanal might have occurred during the Pliocene era after the uplift and dismantling of the South American continent and the tectonic subsidence of the Pantanal region (ASSINE, 2003).

The geomorphological unit “Planície and the Pantanal Mato-Grossense” is an extensive accumulation surface formed by modern alluviums in continuous process of accumulation. This unit is relatively flat causing annual periodic flooding in result of the weak topographic gradient ranging from 0.3 to 0.5m/km in the East-West and 0,03 to 0,15m/km in the North-South direction, and altimetry ranging between 80-150m (ALMEIDA, 1965; FRANCO&PINHEIRO, 1982;. ALVARENGA*et al.*, 1984 *apud* GRADELLA, 2008)

One of the most remarkable geomorphological features of the Pantanal is the mega alluvial fan Taquari, with approximately 50,000 km² and about 37% of the total area of the Pantanal. Its altitude varies from 85-190m with topographic gradient of 36 cm/km (ASSINE, 2003 *apud*GRADELLA, 2008).

5 - Biogeography

In the Pantanal Mato-Grossense’ soils there is a large dominance of Hydromorphic soils as in the northern portion of the Pantanal prevails soils with clayey subsurface horizon such as: Hydromorphic Laterite, Planosols, red-yellow Podzolic, Glei with little humidity and Alluvial soils (AMARALFILHO, 1986 *apud* BACANI, 2007); towards the centre of the plain, it is possible to find sandy sediment carried out by the Taquari river, such as Hydromorphic Podzol with highest occurrence, followed by Hydromorphic Quartz Sand, Planosols, Hydromorphic Laterite and Glei with little humidity (CUNHA, 1981 *apud*AMARALFILHO, 1986 *apud*BACANI, 2007) (Figure 7)

The E and N portion of the Pantanal of Nhecolândia present ancient alluvial deposits, with sandy surface materials and the presence of thinner materials in abandoned pits and beds, also presenting sparse bays and divergent and semi-active streams and ebb, Hydromorphic Podzolic soils and dystrophic Planosols with vegetation of seasonal forest and tropical grassland with little humidity in the NE and N and humid in the S and NW (BRAUN, 1977; FRANCO&PINHEIRO, 1982. In: BRAZIL RADAMBRASIL *apud*SAKAMOTO, 1997).

The S and SW portion of the Pantanal of Nhecolândia in the river-lake plain is characterized by the presence of a large number of lakes, surrounded by the “cordilheiras” and ebbs, linked to intermittent and diffluent watercourses of the Taquari river and subject to the flooding of the Paraguay and Negro rivers, also presenting Hydromorphic Podzolic soils and vegetation of grassland and seasonal forest (BRAUN, 1977; FRANCO&PINHEIRO, 1982. In: BRAZIL RADAMBRASIL *apud*SAKAMOTO, 1997).

In the lower flat lands, it is found grassy vegetation in large areas and savannah interspersed with woody vegetation, with palm trees in the higher lands of the “cordilheiras” (LOUREIRO*et al.*, 1982. In: BRASIL. RADAMBRASIL *apud*SAKAMOTO, 1997).

The contrast between the qualities of the water of the lakes is one of the peculiarities of the Pantanal, which goes beyond the intermittent character of flooding in low waters and bays. CUNHA (1943 *apud*SAKAMOTO, 1997) had pointed out that perennial ponds would present alkaline water, bicarbonate, or chlorinated sodic, with a pH close to 10 while other ponds, ebbs and streams would be acidic, just as CUNHA (1980, 1981, 1985 *apud*SAKAMOTO, 1997) and ORIOLLI*et al.* (1982 *apud*SAKAMOTO, 1997) found about the soils of the region.

The constancy of the permanence of the water table near the surface causes a low percolation of the water in the soils of the Pantanal, making the leaching of the salt that exists in the sediments difficult. Hence, the soils in the most flooded areas are found to be acidic (DELL'ARCO*et al.*, 1982 In: BRASIL. RADAMBRASIL *apud*SAKAMOTO, 1997).

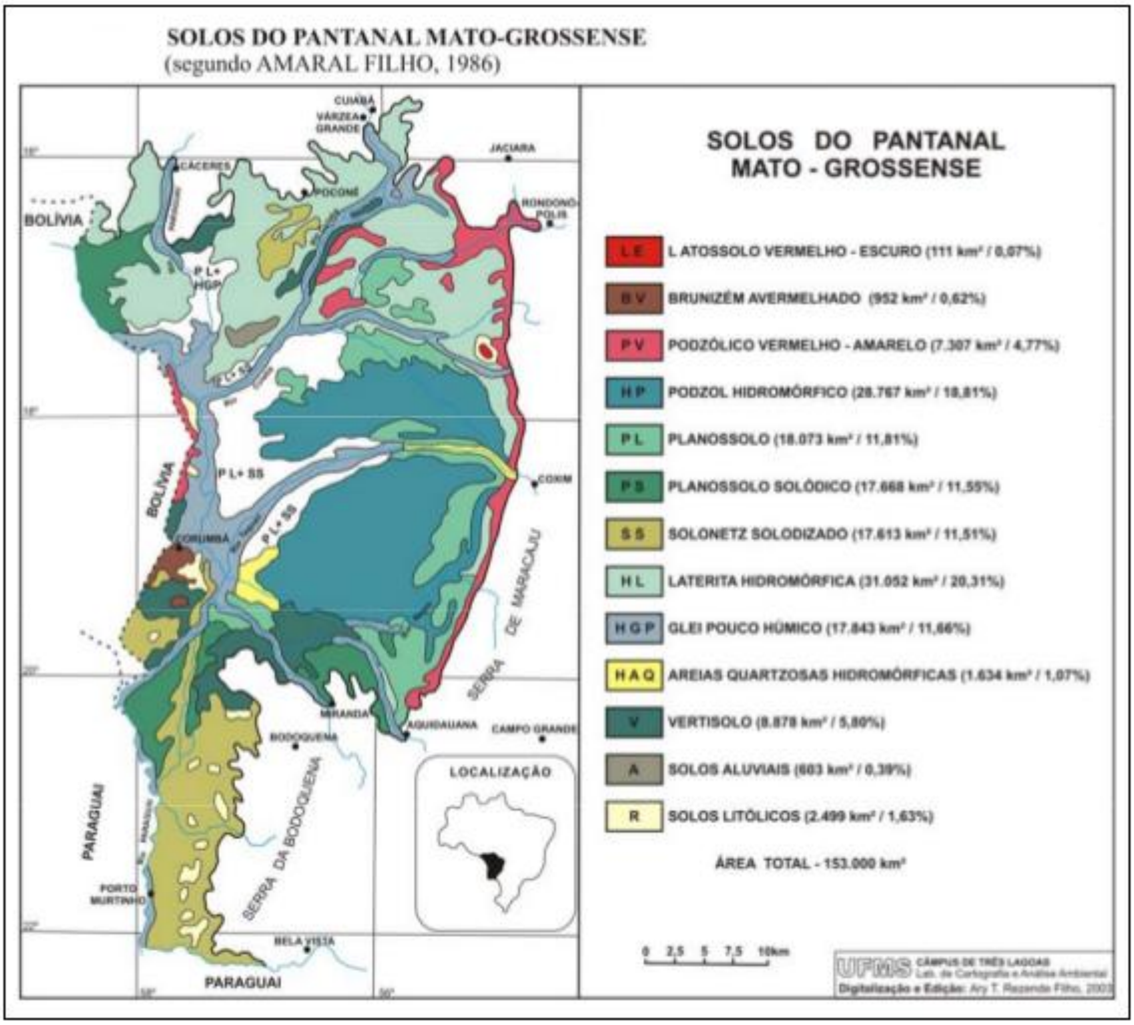


Figure 7: Pedology of the Pantanal Mato-Grossense

Source: BACANI, 2007

CHAPTER 3 – THE CLIMATE OF THE PANTANAL OF NHECOLÂNDIA

1 - Characteristics of the regional climate

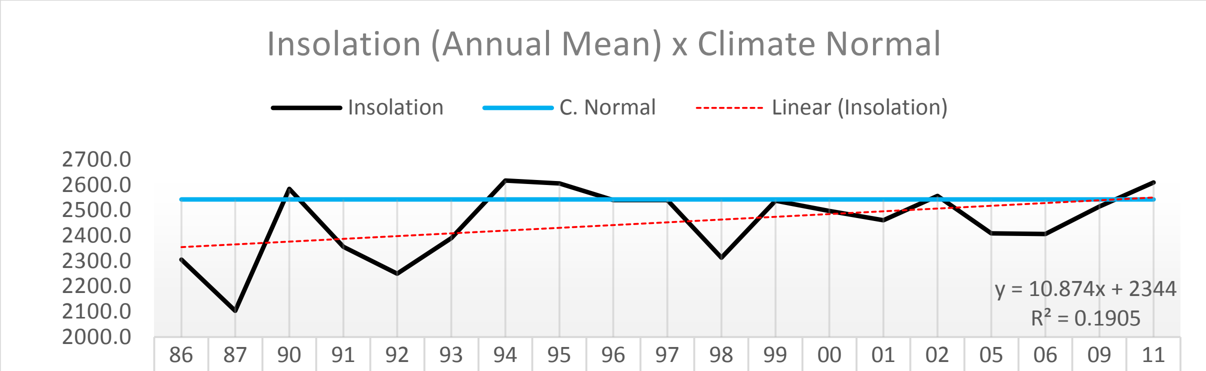
The Pantanal has a typical tropical climate of Aw in the Köppen classification, characterized by two distinct seasons as it is dry in winter and rainy in the summer (GARCIA, 1984), with annual averages of the temperature around 25 °C and the relative humidity around 82% (SORIANO, 1996).

1.1 - Insolation and cloudiness

It was analyzed only the years with a complete set of data of every month to be compared with the climatological normal (1961-1990), being 19 years analyzed. Only 5 years (1990, 1994, 1995, 2002 and 2011) had a total of insolation hours higher than the climatological normal (2542,50 hours) (Graphic 1, Appendix 1). In addition, the Graphic showed a positive tendency, but not a strong correlation though. April was the month with most averages above the climatological normal with a total of 8 years out of 19, also with most insolation hours; February and September were the months that presented the lesser numbers of hours of insolation in a total of 7 years out of 19.

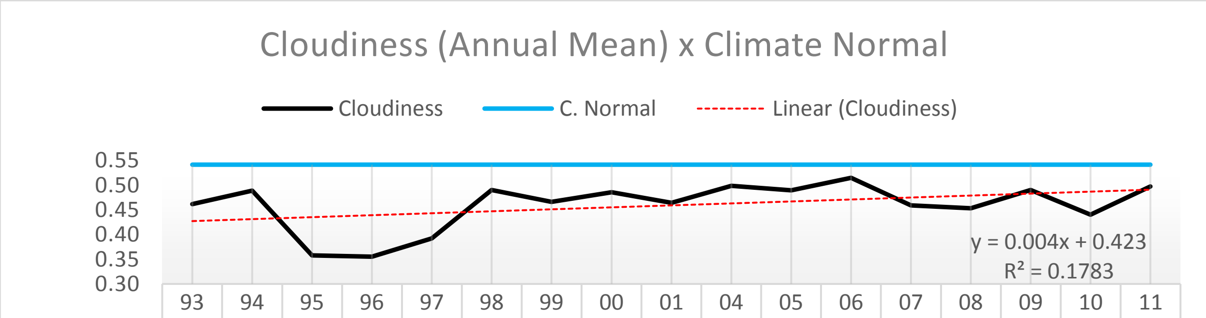
The cloudiness data analyzed consisted in 17 years of a complete set of data of every month (Graphic 2). The whole period analyzed showed that it never went over the total of the CN (Climate Normal). The year 1996 was the lowest of cloud coverage and 2006 was the highest. Even though the tendency of the data showed a positive line, the correlation is not strong. The cloudiest month was February and August had the lowest cloud coverage (Appendix 2).

Graphic1: Insolation compared with the Climate Normal



	86	87	90	91	92	93	94	95	96	97	98	99	00	01	02	05	06	09	11
Insolation	2305	2103	2585	2356	2249	2390	2617	2605	2539	2541	2313	2538	2498	2460	2556	2409	2406	2514	2609
C. Normal	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542

Graphic2: Cloudiness compared with the Climate Normal



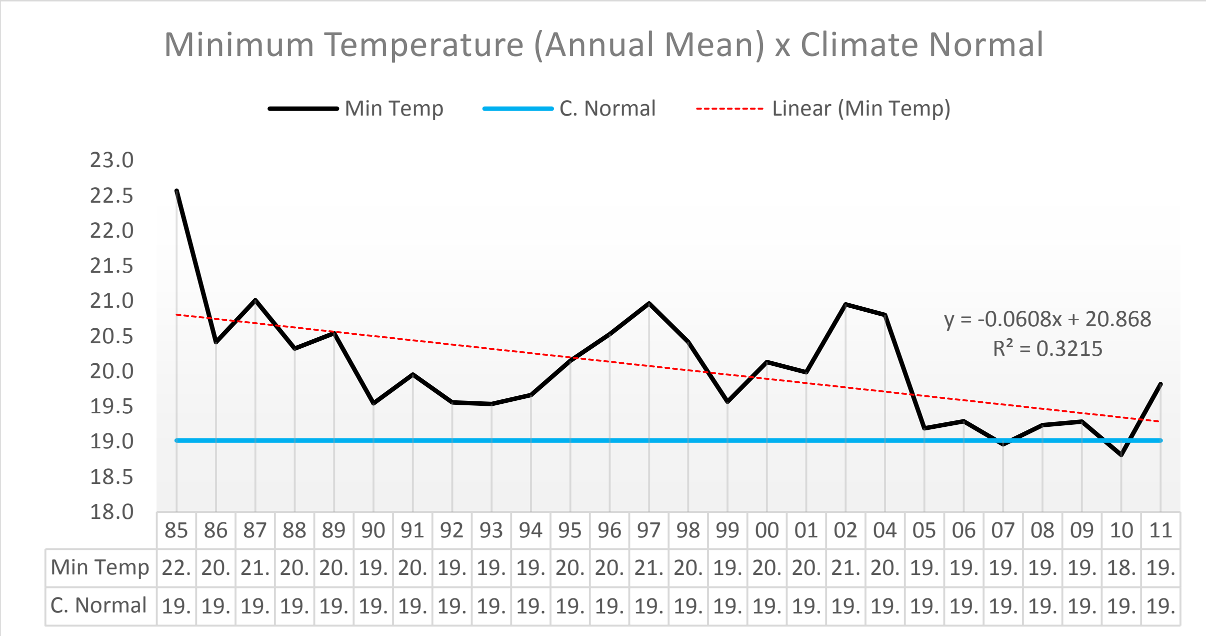
	93	94	95	96	97	98	99	00	01	04	05	06	07	08	09	10	11
Cloudiness	0.46	0.49	0.36	0.35	0.39	0.49	0.47	0.49	0.46	0.50	0.49	0.51	0.46	0.45	0.49	0.44	0.50
C. Normal	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54

1.2 - Temperature

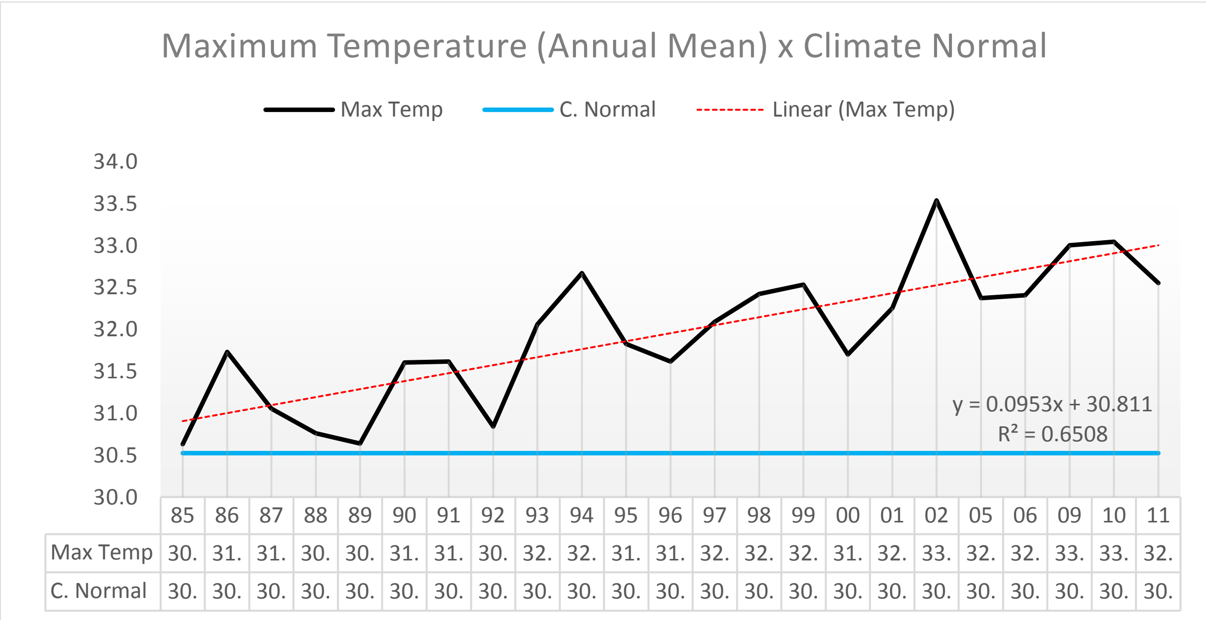
It was analysed 27 years of a complete set of data of every month for the minimum temperature (Graphic 3). Only the years 2007 and 2010 were not over the CN. The year 1987 was with the highest minimum temperature and 2010 the lowest. The tendency of the data is negative, but it hasn't a strong correlation. After the year 2002, the average dropped significantly when compared to the previous years with most of the years around the average of the CN, some of them lower and others just a little bit over, with the exception of the year 2011. July had the lowest minimum temperature for 18 years and February had the highest for 10 years (Appendix 3).

For the maximum temperature, it was analysed 23 years of a complete set of data of every month and all of them had their yearly average over the CN (Graphic 4). 1985 was the year with the lowest yearly average and 2002 was the highest. The tendency of the data is positive with a strong correlation (R^2= 0.65). The averages seem to grow each year, as after 1993, they always stayed at least 1,1 °C over the CN. June and July had for 10 years the lowest averages and September had for 7 the highest (Appendix 4).

Graphic3: Minimum temperature compared with the Climate Normal



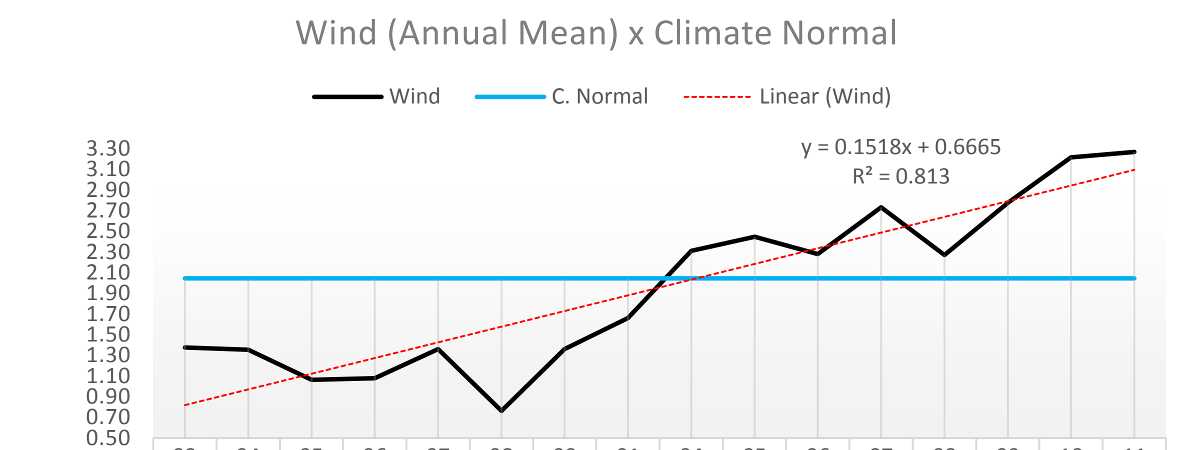
Graphic4: Maximum temperature compared with the Climate Normal



1.3 - Wind

It was analysed 16 years and half of them went over the CN (Graphic 5). The year 1998 had the lowest average and 2011 had the highest. The month of March had the lowest average for 7 years and the months of August and September both had the highest averages for 5 years(Appendix 5). The tendency for the data has a positive line with a strong correlation.

Graphic5: Wind intensity compared with the Climate Normal

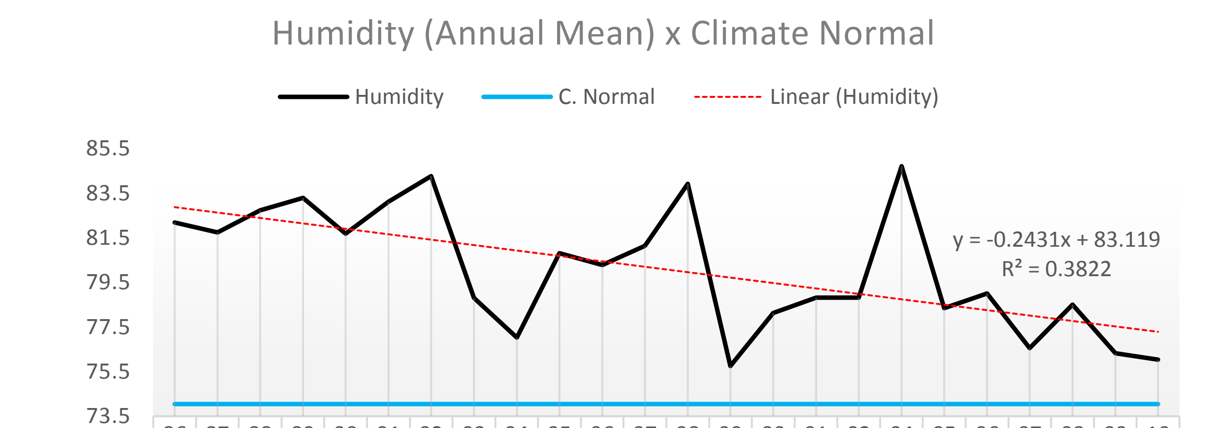


	93	94	95	96	97	98	00	01	04	05	06	07	08	09	10	11
Wind	1.38	1.35	1.06	1.08	1.36	0.76	1.36	1.66	2.31	2.45	2.28	2.73	2.27	2.77	3.22	3.27
C. Normal	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04

1.4 - Humidity

A total of 24 years were analysed and all of them are over the CN (Graphic 6). The year with the lowest average is 1999 and with the highest, 1992. September had the lowest average for 11 years and March had the highest for 8 (Appendix 6)with negative tendency.

Graphic6: Humidity compared with the Climate Normal

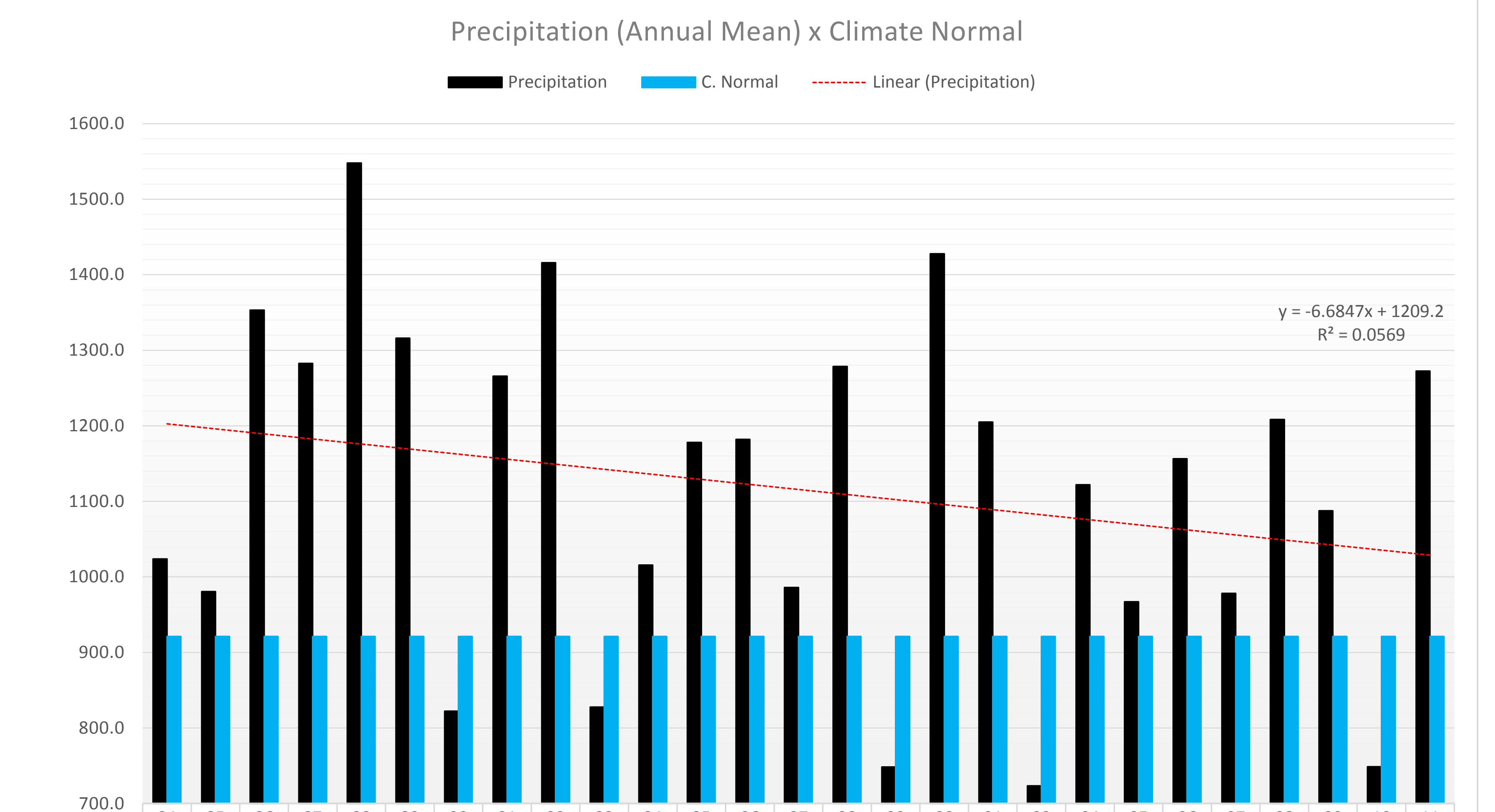


	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	04	05	06	07	08	09	10
Humidity	82.	81.	82.	83.	81.	83.	84.	78.	77.	80.	80.	81.	83.	75.	78.	78.	78.	84.	78.	79.	76.	78.	76.	76.
C. Normal	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.	74.

1.5 - Precipitation

27 years were analysed with a complete set of data of every month and 5 years are under the CN(921 mm) (Graphic 7). The year with the lowest average of precipitation is 2002 and with the highest is 1988. The tendency of the data shows a negative line with a very weak correlation. The months of June and August had for 10 years the lowest monthly average when compared to the CN, also July had for 9 years. January was the month with the highest average for 11 years (Appendix 7).

Graphic7: Precipitation compared with the Climate Normal



	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	04	05	06	07	08	09	10	11
Precipitation	1023.	980.7	1353.	1282.	1548.	1316.	822.2	1265.	1416.	827.6	1015.	1178.	1182.	986.1	1278.	748.3	1427.	1205.	723.5	1121.	967.2	1156.	978.2	1208.	1087.	748.7	1272.
C. Normal	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0	921.0

2 - Dynamic factors of the climate - Action centres and atmospheric circulation

The Mato Grosso do Sul State situates in the confluence of the main atmospheric systems of the South American continent, with more than one rain regime. The air masses operating in the region are unstable and very humid having relevant factors in the dynamics of the rainfall and temperature. Although the geomorphology is considered limited, the height of the mountains also has significant effects on the climate (BRASIL, 1979).

Equatorial air masses formed on the Atlantic Ocean precipitates its moisture over the South American continent from East to West at low latitudes; they are resupplied by water intake arising from the Amazon forest (SALATI*et al.,* 1978 *apud*DUBREUIL*et al.*, 2006). These air masses bring rainfall to the Central–Southern Brazil, Northern Argentina and Paraguay (Chaco). When they reach the Andes, they change to a Southward path, also known as "Rios Voadores" (Flying Rivers) because of its estimated volume of water transported through this "corridor" is close to that flowing in the Amazon River (MARENGO 2006; DUBREUIL*et al.*, 2006). The Atlantic Subtropical Anticyclone produces NE-NW winds deflecting the Continental Equatorial air mass in the Pantanal. The moist air-mass coming from the south of the Amazon basin is deflected by the winds produced by the low temperatures in the summer at the eastern part of the Andes located at the Tropic of Capricorn, latitude 30° South. The winds are generally weak in the lowlands, except during storms. The cold fronts, which its origin comes from the instability of polar fronts in Antarctic, do not reach the entire biome, only further South and Southeast. The warm fronts are frequent and very important, inducing the ascent of the continental Equatorial air-masses over the polar air, resulting in a wet weather with rainy summer (October to April, as the wettest months are December, January and February) and dry winter (May to September, as the driest months are June, July and August)(DNOS, 1974; GARCIA, 1984; SALVI-SAKAMOTO, 2004; ALMEIDA&LIMA, 1959; CAMPOS, 1969 *apud*TOZATO*et al.*, 2013) (Figure 8).

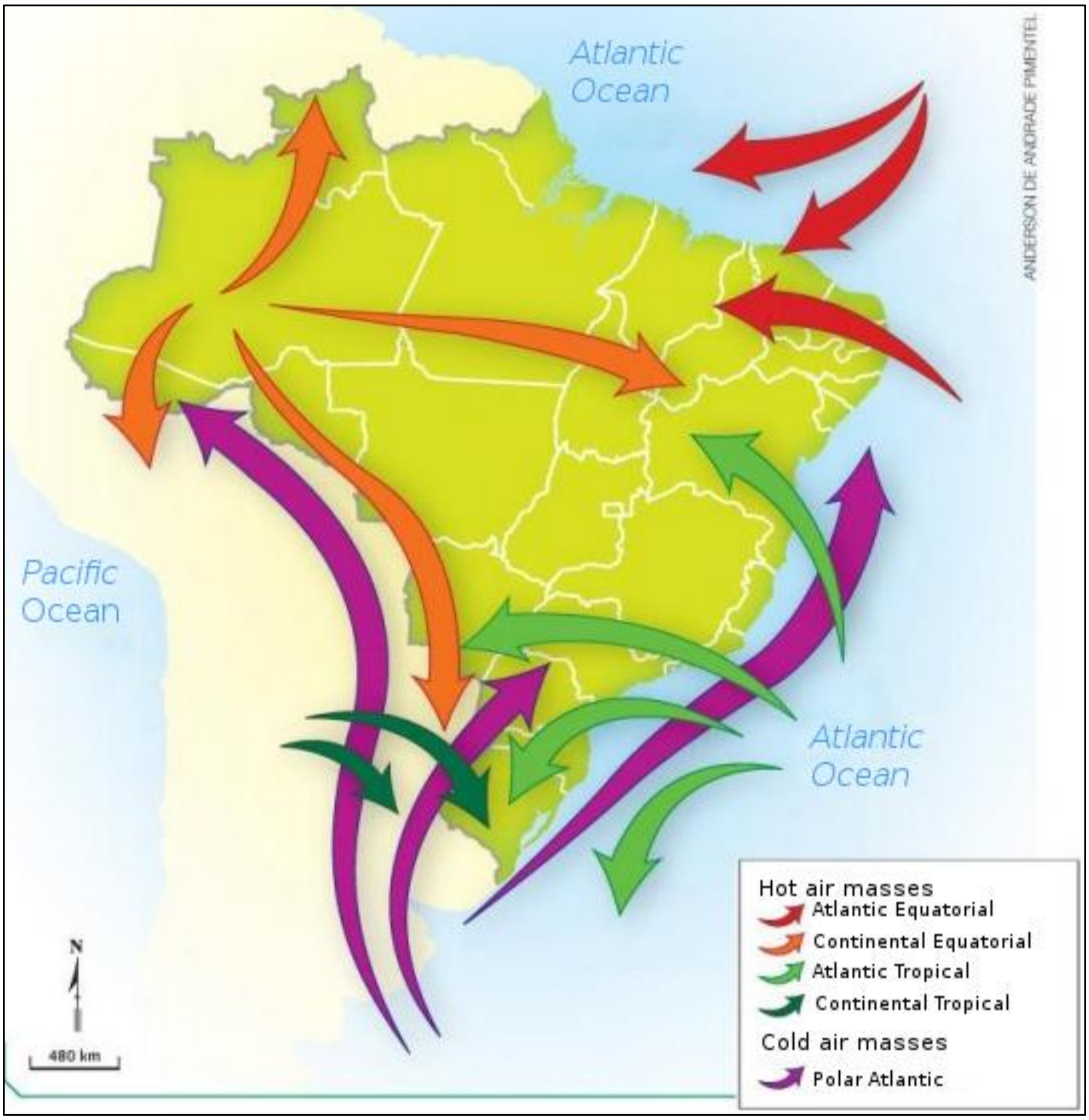


Figure 8: Brazilian air masses
Source: Anderson de Andrade Pimentel. **Adaptation**: The author.

ENSO (El Niño Southern Oscillation), South Atlantic Convergence Zone (SACZ) and the Intertropical Convergence Zone (ITCZ) act directly and indirectly in the Pantanal's air-masses (DUBREUIL, 2008; SETTE, 2000 *apud*TOZATO*et al.*, 2013) as the Atlantic anticyclone acts regulating with its high pressure resulting in a dry season (autumn and winter), and the convection in Amazon regulates the rainy season (spring and summer) (ZAVATINI, 1990; SETTE, 2000 *apud*TOZATO*et al.*, 2013).

CHAPTER 4 – THERMAL AND HYGROMETRIC TOPOCLIMATE VARIABILITY ANALYSIS

I - Maximum and minimum temperatures regarding absolute values

The maximum temperature series shows us that none of the years had mean values under the Climate Normal mean value (Table 2, Graphic4).

The years 1985 and 1989 have the lowest mean values for the series. Although they have the lowest values, they are notnecessarily the mildest. When applying statistics techniques such as variances and standard deviation, we rapidly see that those years had a lot of variation among the months and a great value of amplitude between the maximum and minimum temperatures (Graphic8).

Comparing the years with the second lowest mean values, the years 1988 and 1992 are quite milder than the years above. The statistics shows a high value for variance and standard deviation for the year 1988 and high amplitude of maximum and minimum temperatures for both years, but the maximum and minimum temperatures for 1988 are lower than the above years, also it has both the second lowest maximum and minimum temperature for the series (Graphic9).

The statistics shows that the year 1992 has a high variance and standard deviation with a high amplitude between maximum and minimum temperatures, but comparing with the other years, it is noticed that the temperatures are lower (it has the lowest value for maximum temperature and the fifth place for minimum temperature), being considered the mildest year for the series (Table 2).

It is also noticed that the year 2002 has the highest value for maximum temperature and the third highest minimum value for maximum temperature, which we can easily assume that it is the hottest year of the series (Table 3).

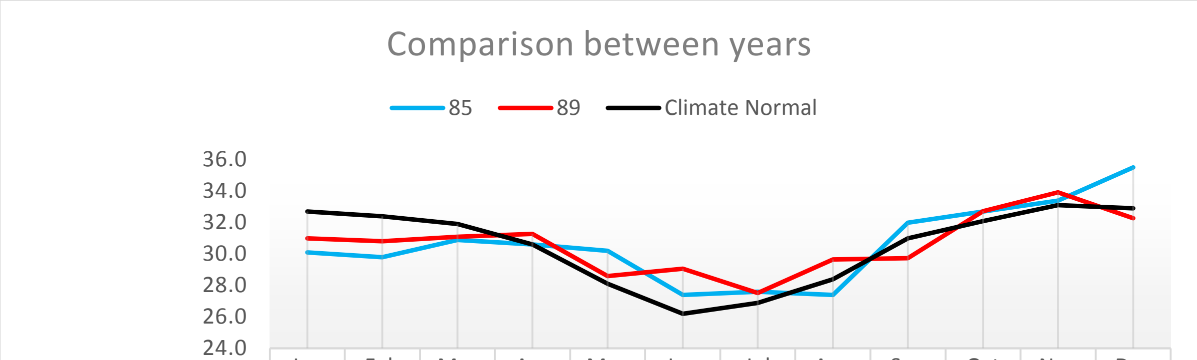
Analysing it seasonally (rainy and dry seasons, as in the tropical world it is appropriate to consider them instead of spring, autumn, winter and summer),the rainy season is the season that had the most quantity of years that had the maximum temperature above the Climate Normalcomparing with the other seasons. Considering the rainy seasonfrom October until March. November and December had both 18 years, out of 23, of mean maximum temperature over the Climate Normal mean value.January had 13 years and

February had 14.March had 16 years of mean maximum temperature above the Climate Normal.October had all the years of the series above the Climate Normal.

The dry season starts inApriland ends in September. Aprilhad 21 years and May 22 years above the Climate Normal.June had none of the years under the Climate Normal, only in 1996 that the mean maximum temperature was the same as the Climate Normal. July had 19 years of maximum temperature above the Climate Normal and August, 21 years. September had 15 years over the Climate Normal.

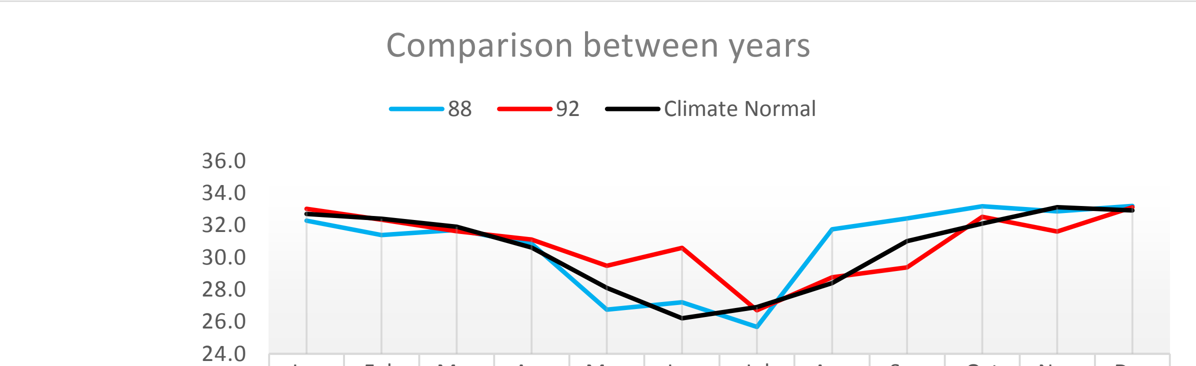
In 1985, February had the lowest mean value (29.8 °C) of maximum temperature for the rainy season and October of 2002 had a scalding 38 °C as the highest mean value. July of 1990 had 25.6 °C as the lowest mean value for the dry season and September of 2010 had the highest mean value, 35.2 °C.

Graphic 8: Graphic comparing the years 1985 and 1989 for maximum temperature



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
85	30.1	29.8	30.9	30.6	30.2	27.4	27.6	27.4	32.0	32.7	33.4	35.5
89	31.0	30.8	31.1	31.3	28.6	29.1	27.5	29.7	29.7	32.7	33.9	32.3
Climate Normal	32.7	32.4	31.9	30.6	28.1	26.2	26.9	28.4	31.0	32.1	33.1	32.9

Graphic9: Graphic comparing the years 1988 and 1992 for maximum temperatures



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
88	32.3	31.4	31.7	30.8	26.8	27.2	25.7	31.7	32.4	33.2	32.9	33.2
92	33.0	32.3	31.6	31.1	29.5	30.6	26.7	28.8	29.4	32.5	31.6	33.1
Climate Normal	32.7	32.4	31.9	30.6	28.1	26.2	26.9	28.4	31.0	32.1	33.1	32.9

Table 2: Monthly values for maximum temperatures series with statistics techniques applied

Maximum Temperature																							
Months	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**05**	**06**	**09**	**10**	**11**
Jan	30.1	32.4	32.8	32.3	31.0	32.5	32.8	33.0	32.9	33.5	31.8	32.6	32.2	34.6	33.4	35.1	32.7	34.0	32.5	33.3	33.8	33.2	33.8
Feb	29.8	32.2	31.4	31.4	30.8	32.2	33.0	32.3	31.9	33.2	32.0	33.5	32.2	33.1	33.8	32.7	33.4	32.7	33.7	33.3	33.7	34.1	32.5
Mar	30.9	32.2	32.1	31.7	31.1	33.8	31.7	31.6	33.7	32.4	32.6	32.5	32.2	33.7	32.2	31.7	33.2	33.6	33.5	33.3	33.7	35.2	31.2
Apr	30.6	32.5	31.8	30.8	31.3	32.7	31.4	31.1	31.9	32.5	30.5	31.9	30.8	32.2	32.2	32.9	32.8	33.8	32.4	32.1	34.3	33.1	32.3
May	30.2	30.4	27.5	26.8	28.6	28.0	29.8	29.5	30.0	31.0	29.0	30.0	29.2	31.1	30.2	30.3	28.9	31.9	31.1	28.6	31.5	28.6	29.7
Jun	27.4	29.9	27.0	27.2	29.1	27.4	28.2	30.6	29.4	29.5	29.4	26.2	27.4	30.5	29.9	29.0	27.8	29.2	31.1	30.9	28.5	30.9	29.2
Jul	27.6	28.9	29.8	25.7	27.5	25.6	29.4	26.7	28.4	29.2	30.2	29.8	31.0	33.7	29.5	26.4	30.5	29.2	28.3	31.6	30.0	29.2	30.0
Aug	27.4	30.8	28.3	31.7	29.7	32.1	31.0	28.8	29.5	32.9	31.9	32.9	30.5	30.7	32.6	31.7	34.1	33.8	33.3	32.9	32.5	33.3	31.9
Sep	32.0	30.5	30.8	32.4	29.7	30.6	32.8	29.4	32.4	34.8	33.9	30.9	35.1	30.8	34.8	30.4	34.2	34.0	31.0	32.9	33.1	35.2	34.5
Oct	32.7	32.5	33.3	33.2	32.7	34.8	33.3	32.5	34.7	35.7	32.7	33.0	35.1	32.9	35.1	34.7	33.6	38.0	33.9	33.5	35.5	34.4	34.3
Nov	33.4	35.1	34.8	32.9	33.9	34.7	33.2	31.6	35.8	34.8	33.9	32.5	35.1	33.4	32.2	32.8	33.7	37.6	34.2	33.8	35.4	33.8	35.9
Dec	35.5	33.4	33.1	33.2	32.3	34.9	33.0	33.1	34.0	32.5	34.0	33.4	34.3	32.5	34.5	33.0	32.1	34.6	33.5	32.6	34.0	35.6	35.4
Mean	**30.6**	**31.7**	**31.1**	**30.8**	**30.6**	**31.6**	**31.6**	**30.8**	**32.1**	**32.7**	**31.8**	**31.6**	**32.1**	**32.4**	**32.5**	**31.7**	**32.3**	**33.5**	**32.4**	**32.4**	**33.0**	**33.0**	**32.6**

Table 3: Comparison among years with the lowest values for the maximum temperature series

1985		1989		1988		1992	
Mean	30.63	**Mean**	30.64	**Mean**	30.76	**Mean**	30.84
Standard Deviation	2.50	**Standard Deviation**	1.83	**Standard Deviation**	2.66	**Standard Deviation**	1.95
Variance	6.26	**Variance**	3.34	**Variance**	7.09	**Variance**	3.79
Range	8.10	**Range**	6.40	**Range**	7.51	**Range**	6.41
Minimum	27.4 °C	**Minimum**	27.52 °C	**Minimum**	25.67 °C	**Minimum**	26.7 °C
Maximum	35.5 °C	**Maximum**	33.92 °C	**Maximum**	33.18 °C	**Maximum**	33.11 °C

Table 4: Statistics results organized according to the lowest to the highest values for the maximum temperatures series

Years	Mean		Variance		Std Deviation		Max Temperature		Min Temperature		Range Temperatures	
	Years/CN	30.5	Years/CN	5.6	Years/CN	2.4	Years/CN	33.1	Years/CN	26.2	Max - Min	Years/CN
1	85	30.6	98	1.7	98	1.3	92	33.1	90	25.6	4.1	98
2	89	30.6	06	2.0	06	1.4	88	33.2	88	25.7	5.0	95
3	88	30.8	86	2.6	86	1.6	91	33.3	96	26.2	5.0	91
4	92	30.8	91	2.7	91	1.6	96	33.5	00	26.4	5.2	06
5	87	31.1	05	2.7	05	1.6	06	33.8	92	26.7	5.5	99
6	90	31.6	95	2.8	95	1.7	89	33.9	87	27.0	5.8	05
7	91	31.6	89	3.1	89	1.8	95	34.0	85	27.4	6.2	86
8	96	31.6	99	3.3	99	1.8	05	34.2	97	27.4	6.4	89
9	00	31.7	92	3.5	92	1.9	01	34.2	89	27.5	6.4	92
10	86	31.7	94	3.7	94	1.9	98	34.6	01	27.8	6.4	01
11	95	31.8	01	4.0	01	2.0	87	34.8	91	28.2	6.5	94
12	93	32.1	09	4.0	09	2.0	90	34.9	05	28.3	6.7	11
13	97	32.1	96	4.1	96	2.0	99	35.1	93	28.4	7.0	09
14	01	32.3	11	4.6	11	2.2	00	35.1	09	28.5	7.1	10
15	05	32.4	10	4.9	10	2.2	97	35.1	10	28.6	7.3	96
16	06	32.4	93	5.0	93	2.2	86	35.1	06	28.6	7.4	93
17	98	32.4	00	5.5	00	2.3	09	35.5	86	28.9	7.5	88
18	99	32.5	87	5.6	87	2.4	85	35.5	95	29.0	7.7	97
19	11	32.6	97	5.6	97	2.4	10	35.6	11	29.2	7.9	87
20	94	32.7	85	5.7	85	2.5	94	35.7	02	29.2	8.1	85
21	09	33.0	88	6.5	88	2.6	93	35.8	94	29.2	8.7	00
22	10	33.0	02	6.6	02	2.6	11	35.9	99	29.5	8.8	02
23	02	33.5	90	8.8	90	3.0	02	38.0	98	30.5	9.3	90

The minimum temperature series had only the year 2010 with the total mean value under the Climate Normal mean value (Graphic3).

The years with the lowest total mean values are 2005, 2006, 2009 and 2010. (Table 5) The years 2010 and 2005 have the lowest total mean values, respectively. The statistic shows that both years had high values for variance and standard deviation, as well as one of the highest range for the series. However, 2005 have the second lowest mean minimum temperature of the series, but the second highest range. 2010 did not have the lowest minimum temperature, but the Graphic 10 shows that its means values followed the Climate Normal line closely, also having 5 years under the line.

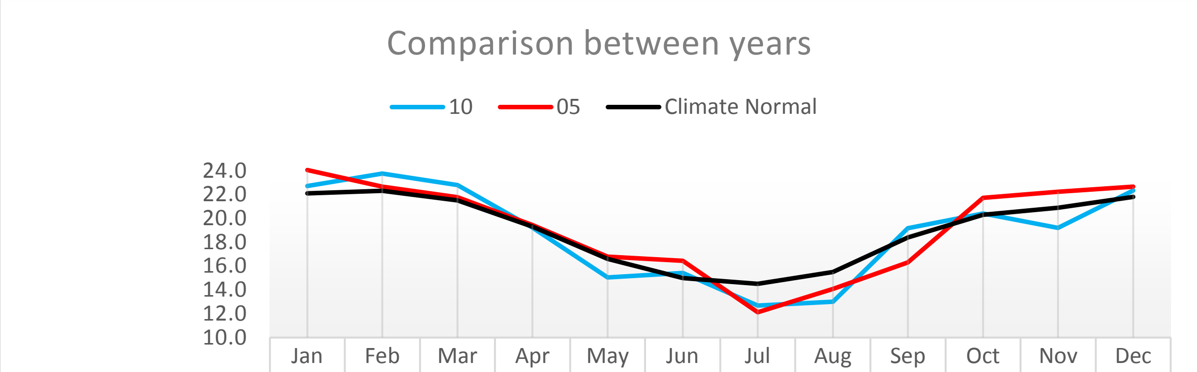
As for 2009 and 2006, they are in the third and fourth position of years with lowest total mean minimum temperatures, respectively. The year 2009 has the lowest variance and standard deviation in comparison with the years 2005, 2006 and 2010. It's ranked 4th in maximum temperature for the minimum temperature series and has, also, the highest minimum temperature compared with the mentioned years. However, it has the lowest range. As for 2006, variance and standard deviation is the highest of the whole series and ranks the 3rd position of the highest range values. As for the minimum temperature mean value, 2006 has the lowest the value of the whole series. (Graphic 11)

Even though 2006 has the lowest minimum temperature mean value, it is not the mildest of the years. The range and variation of temperatures are the highest of the series. As for 2010 and 2009, both years present mild transitions in the mean temperatures over the months. (Table 6)

The years 1987, 1997 and 2002 have equally the highest mean minimum temperature of the series. Their variance and standard deviation are lower than the above-analysed years. Also, they all present high values for the maximum and minimum mean temperature. Although they present range value as well lower than the years with the lowest total mean values, they are easily considered the warmest of the series, with 1997 being considered the warmest. (Table 7)

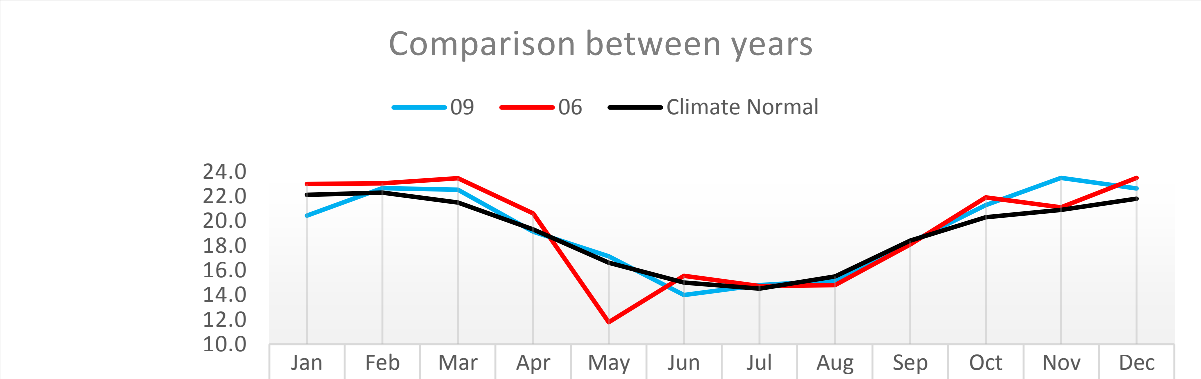
The year 2004 was taking out of the statistical analysis table since the maximum temperature series does not have a full set of data for this year.

Graphic10: Graphic comparing the years 2010 and 2005 for minimum temperatures



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10	22.7	23.8	22.8	19.2	15.1	15.4	12.7	13.0	19.2	20.4	19.2	22.3
05	24.1	22.7	21.8	19.4	16.8	16.4	12.1	14.1	16.3	21.7	22.2	22.7
Climate Normal	22.1	22.3	21.5	19.3	16.6	15.0	14.5	15.5	18.4	20.3	20.9	21.8

Graphic11: Graphic comparing the years 2009 and 2006 for minimum temperatures



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
09	20.4	22.7	22.5	19.1	17.1	14.0	14.8	15.2	18.2	21.3	23.5	22.6
06	23.0	23.0	23.5	20.6	11.8	15.5	14.7	14.8	18.1	21.9	21.1	23.5
Climate Normal	22.1	22.3	21.5	19.3	16.6	15.0	14.5	15.5	18.4	20.3	20.9	21.8

Table 5: Monthly values for minimum temperatures series with statistics techniques applied

Months	Minimum Temperature																									
	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	04	05	06	07	08	09	10	11
Jan	22.9	23.4	23.5	24.5	23.4	22.9	23.5	22.8	23.5	22.6	23.9	23.4	25.0	23.4	24.1	23.4	23.7	23.5	22.9	24.1	23.0	23.9	22.7	20.4	22.7	22.6
Feb	22.9	24.1	22.9	23.4	23.2	22.1	23.5	22.8	22.6	23.4	24.4	23.2	24.5	23.9	24.1	23.7	23.6	23.5	22.5	22.7	23.0	23.4	23.0	22.7	23.8	23.1
Mar	24.2	23.6	24.9	25.2	23.5	22.7	22.9	21.9	23.3	21.7	24.2	23.3	22.2	23.2	23.7	22.4	22.8	23.9	21.6	21.8	23.5	22.5	22.8	22.5	22.8	23.0
Apr	22.9	23.3	22.4	23.8	23.3	22.0	21.4	19.3	21.6	20.2	20.2	22.3	20.4	23.0	20.1	22.3	20.9	21.9	21.5	19.4	20.6	20.9	20.2	19.1	19.2	22.4
May	20.5	20.6	18.9	19.1	18.4	17.1	19.4	19.7	16.2	18.2	17.2	19.5	18.4	16.6	16.4	18.6	16.8	19.5	16.3	16.8	11.8	15.5	16.7	17.1	15.1	17.9
Jun	15.7	15.8	17.0	16.4	18.7	15.2	17.4	17.7	15.2	16.0	16.8	15.4	18.1	16.3	15.5	17.2	13.8	15.5	15.8	16.4	15.5	13.7	14.8	14.0	15.4	15.7
Jul	15.7	14.5	18.6	13.1	14.8	12.5	13.6	12.7	13.3	13.6	16.4	14.1	15.1	16.3	14.4	12.1	15.9	15.4	14.1	12.1	14.7	12.3	14.3	14.8	12.7	15.4
Aug	15.8	18.5	15.5	16.4	18.1	15.8	14.5	14.8	14.1	13.8	15.3	18.4	16.1	18.0	14.3	17.0	16.7	18.4	13.9	14.1	14.8	12.6	16.7	15.2	13.0	15.5
Sep	22.0	17.7	17.7	18.6	18.2	16.9	19.3	17.4	18.1	19.2	18.6	17.4	21.7	18.1	18.8	18.8	19.2	18.2	17.2	16.3	18.1	17.9	16.0	18.2	19.2	18.6
Oct	21.3	18.1	24.9	20.3	20.2	21.7	19.7	21.8	20.9	21.7	20.4	22.0	22.8	21.1	21.6	21.8	21.6	23.1	20.1	21.7	21.9	21.3	21.2	21.3	20.4	20.8
Nov	22.8	22.4	23.5	20.6	21.9	22.8	21.5	21.1	22.5	21.8	21.4	22.8	23.8	22.0	19.4	21.9	22.3	24.1	20.8	22.2	21.1	21.1	21.3	23.5	19.2	20.9
Dec	22.7	23.2	22.4	22.3	23.0	22.9	22.8	22.8	23.2	23.8	22.9	24.6	23.5	23.1	22.4	22.5	22.5	24.5	22.2	22.7	23.5	22.4	21.2	22.6	22.3	21.9
Mean	**20.8**	**20.4**	**21.0**	**20.3**	**20.5**	**19.5**	**20.0**	**19.6**	**19.5**	**19.7**	**20.2**	**20.5**	**21.0**	**20.4**	**19.6**	**20.1**	**20.0**	**21.0**	**20.8**	**19.2**	**19.3**	**19.0**	**19.2**	**19.3**	**18.8**	**19.8**

Table 6: Comparison among years with the lowest values for the minimum temperature series

2010		2005		2009		2006	
Mean	18.8	**Mean**	19.2	**Mean**	19.3	**Mean**	19.3
Standard Deviation	3.9	**Standard Deviation**	3.9	**Standard Deviation**	3.4	**Standard Deviation**	4.1
Variance	15.3	**Variance**	15.3	**Variance**	11.5	**Variance**	17.1
Range	11.1	**Range**	12.0	**Range**	9.5	**Range**	11.7
Minimum	12.7	**Minimum**	12.1	**Minimum**	14.0	**Minimum**	11.8
Maximum	23.8	**Maximum**	24.1	**Maximum**	23.5	**Maximum**	23.5

Table 7: Table 4: Statistics results organized according to the lowest to the highest values for the minimum temperatures series

Years	Mean		Variance		Std Deviation		Max Temperatures		Min Temperatures		Range Temperatures	
	Years/CN	19.0	Years/CN	7.9	Years/CN	2.8	Years/CN	22.3	Years/CN	14.5	Max - Min	Years
1	10	18.8	89	7.6	89	2.8	92	22.8	06	11.8	7.6	98
2	05	19.2	11	8.6	11	2.9	90	22.9	05	12.1	7.7	11
3	09	19.3	98	8.9	98	3.0	11	23.1	00	12.1	8.5	85
4	06	19.3	85	9.3	85	3.0	93	23.5	90	12.5	8.6	89
5	93	19.5	87	9.7	87	3.1	89	23.5	10	12.7	9.1	02
6	90	19.5	95	9.9	95	3.1	06	23.5	92	12.7	9.1	95
7	92	19.6	97	10.1	97	3.2	09	23.5	88	13.1	9.4	87
8	99	19.6	92	10.2	92	3.2	91	23.5	93	13.3	9.5	09
9	94	19.7	91	10.3	91	3.2	00	23.7	94	13.6	9.5	86
10	11	19.8	86	10.4	86	3.2	01	23.7	91	13.6	9.8	99
11	91	20.0	01	10.4	01	3.2	94	23.8	01	13.8	9.9	01
12	01	20.0	02	10.5	02	3.2	10	23.8	09	14.0	9.9	91
13	00	20.1	09	10.6	09	3.3	98	23.9	96	14.1	9.9	97
14	95	20.2	00	10.9	00	3.3	86	24.1	99	14.3	10.1	93
15	88	20.3	96	11.1	96	3.3	05	24.1	86	14.5	10.2	92
16	86	20.4	94	11.7	94	3.4	99	24.1	89	14.8	10.2	94
17	98	20.4	99	12.6	99	3.5	85	24.2	97	15.1	10.3	90
18	96	20.5	88	12.9	88	3.6	95	24.4	95	15.3	10.5	96
19	89	20.5	90	13.0	90	3.6	02	24.5	11	15.4	11.1	10
20	85	20.8	93	13.8	93	3.7	96	24.6	02	15.4	11.6	00
21	02	21.0	05	14.0	05	3.7	87	24.9	87	15.5	11.7	06
22	97	21.0	10	14.0	10	3.7	97	25.0	85	15.7	12.0	05
23	87	21.0	06	15.6	06	4.0	88	25.2	98	16.3	12.1	88

In order to evaluate the maximum and minimum temperature series, the table 8 consists of the sum of the mean values of both series showingan increasing order the years with the lowest to the highest mean values. This table provides the coldest and the hottest year of the series.

Table 8: Increasing order of the mean of the maximum and minimum temperatures mean values

Years	Max Temp	Min Temp	Mean
C. Normal	**30.5**	**19.0**	**24.8**
85	30.6	20.8	**25.7**
86	31.7	20.4	**26.1**
87	31.1	21.0	**26.0**
88	30.8	20.3	**25.5**
89	30.6	20.5	**25.6**
90	31.6	19.5	**25.6**
91	31.6	20.0	**25.8**
92	30.8	19.6	**25.2**
93	32.1	19.5	**25.8**
94	32.7	19.7	**26.2**
95	31.8	20.2	**26.0**
96	31.6	20.5	**26.1**
97	32.1	21.0	**26.5**
98	32.4	20.4	**26.4**
99	32.5	19.6	**26.1**
00	31.7	20.1	**25.9**
01	32.3	20.0	**26.1**
02	33.5	21.0	**27.2**
05	32.4	19.2	**25.8**
06	32.4	19.3	**25.8**
09	33.0	19.3	**26.1**
10	33.0	18.8	**25.9**
11	32.6	19.8	**26.2**

Years	Mean
C. Normal	**24.8**
92	25.2
88	25.5
90	25.6
89	25.6
85	25.7
05	25.8
91	25.8
93	25.8
06	25.8
00	25.9
10	25.9
95	26.0
87	26.0
99	26.1
86	26.1
96	26.1
01	26.1
09	26.1
94	26.2
11	26.2
98	26.4
97	26.5
02	27.2

As the previous tables of maximum and minimum temperatures showed, the year 1992 was the mildest year for the maximum temperature series, but in the minimum temperature series, 1992 stood out as only having the lowest value for the maximum temperature. The years 2010 and 2009 had the lowest mean values in the minimum temperature series, but in the maximum temperature series, they had high mean values, which in the end of the analysis, they are not, in fact, the mildest years of the series.

2 - Precipitation values regarding absolute values

The precipitation series is the longest in terms of years with complete data. It was analysed from 1984 until 2011, except the year 2003 because of lacking information (Table 9). The year with the highest mean total value is 1988 and the year with the lowest is 2002.

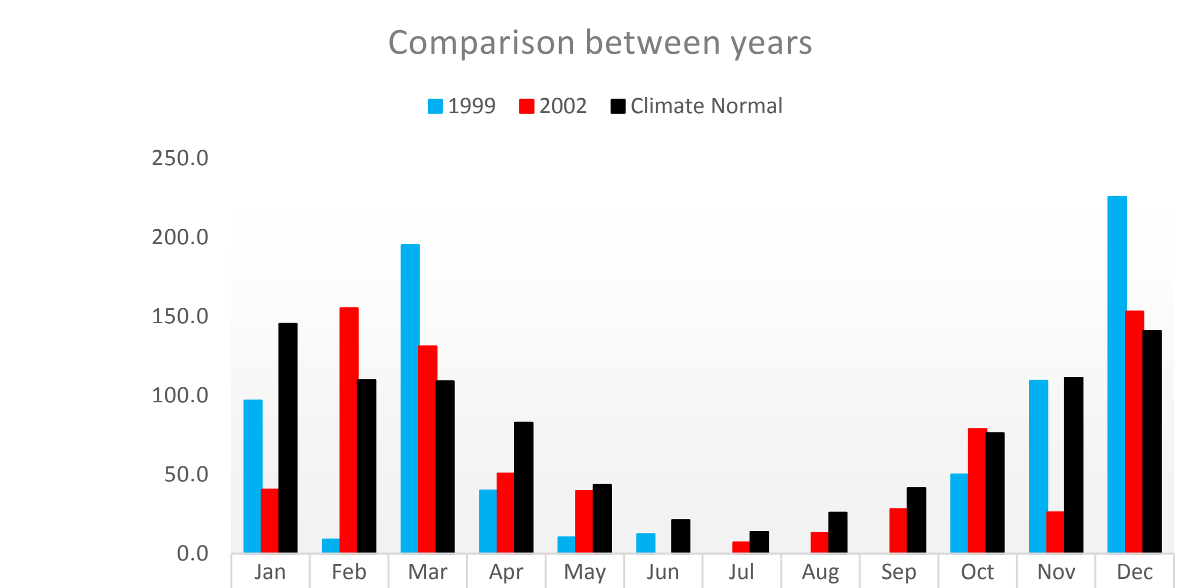
Only 5 years of the series had a mean total value under the Climate Normal mean total value. The years are 1990, 1993, 1999, 2002 and 2010 (Graphic7). Even though they have the lowest mean values, the year of 1999 had the most years under the Climate Normal totalling 10 months. It also had 3 straight months without a drop of water and February had the lowest mean value of precipitation of the rainy season. Considering the low amount of precipitation of the whole year, it is easily noticeable that the year 1999 is the driest of the series if analysed continuously. The year 2002 had the lowest total mean value for the series, but only 8 months under the Climate Normal. It also had a constancy of precipitation during the months, having the second lowest variance and standard deviation and the lowest value of range (Graphic 14).

Although the year 1988 had the highest mean value, it also has the highest variance and standard deviation of the series. In the dry season, it had about 4 months with no rain, assuming that the month of September did not rain enough to consider it. The year of 1992 had the most constancy of precipitation over the months. The months of June, July and August were the only ones under the Climate Normal. June was the month that rained the least, only 2 mm. July rained 8.8 mm and August 24.2 mm. All the other months rained at least 92.2 mm of rain.Even though the year 2000 rained more than the year 1989, the latterkeeps a very good constancy of precipitation over the months(Graphic 15).However, its variance, standard deviation and range are higher than the year 1992, but lower than the year 2000.

Analysing the statistical techniques of the series, we can easily notice that the rainiest years had the highest variances and standard deviations and the driest years had the lowest values of variances and standard deviation, also the lowest ranges, except for the year 1999. (Table 10)

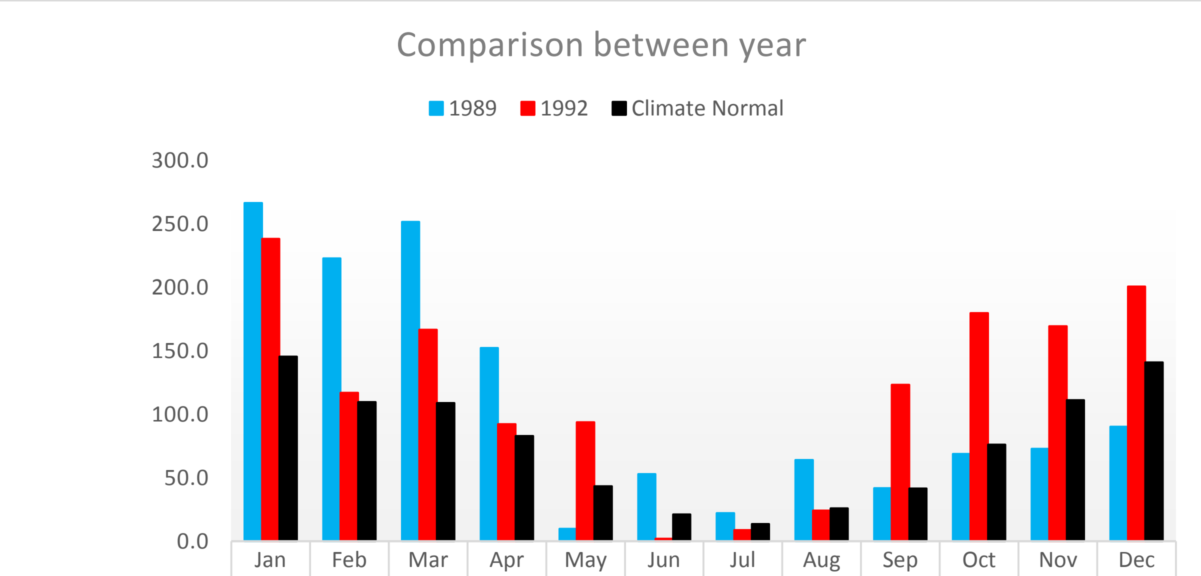
The minimum mean value for the rainy season happened in February of 1999 with 9 mm and maximum mean value was in March of 2011 with 455.2 mm. As for the dry season, several years and months had no precipitation whatsoever and the highest mean value happened in August of the year 2000 with 124 mm.

Graphic12: Comparison between the driest years of 1999 and 2002



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	96.8	9.0	195.0	40.0	10.3	12.3	0.0	0.0	0.0	50.0	109.3	225.6
2002	40.6	155.1	131.1	50.6	39.6	0.0	7.0	13.2	28.1	78.8	26.2	153.2
Climate Normal	145.4	109.7	109.0	82.9	43.5	21.3	13.7	25.9	41.6	76.1	111.1	140.8

Graphic13: Comparison between the rainiest years, 1989 and 1992



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1989	266.5	222.8	251.5	152.3	10.0	53.0	22.3	64.0	41.8	68.8	72.8	90.3
1992	238.2	117.1	166.6	92.2	93.8	2.0	8.8	24.2	123.2	179.8	169.4	200.7
Climate Normal	145.4	109.7	109.0	82.9	43.5	21.3	13.7	25.9	41.6	76.1	111.1	140.8

Table 9: Monthly values for precipitation series

	Precipitation																										
Months	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**
Jan	182.3	255.6	296.2	346.5	297.7	266.5	112.2	227.4	238.2	94.2	67.5	264.9	154.0	225.2	97.3	96.8	88.1	168.2	40.6	63.4	275.4	162.2	282.2	392.8	193.4	181.4	187.9
Feb	114.6	99.9	222.2	58.9	308.7	222.8	173.8	93.1	117.1	110.5	188.9	240.7	41.6	110.4	283.0	9.0	245.3	74.4	155.1	182.2	99.4	165.6	211.7	167.6	146.4	64.4	153.9
Mar	97.2	109.0	158.1	80.2	331.6	251.5	62.8	182.5	166.6	170.9	102.1	136.4	219.0	82.6	108.4	195.0	340.9	67.4	131.1	56.2	37.4	152.2	31.8	123.0	190.2	67.8	455.2
Apr	59.1	81.7	33.5	175.2	146.9	152.3	107.4	253.9	92.2	79.4	39.6	56.4	101.4	140.8	159.4	40.0	127.0	113.6	50.6	75.5	41.6	54.6	10.4	27.0	1.4	10.4	168.8
May	27.7	89.5	92.7	104.6	37.7	10.0	116.7	55.6	93.8	7.8	64.4	11.6	59.9	54.6	71.1	10.3	1.4	88.2	39.6	158.7	44.2	52.5	85.4	86.0	54.9	71.8	2.5
Jun	0.0	0.0	0.3	34.4	0.0	53.0	18.0	21.3	2.0	4.3	45.9	3.7	0.0	103.2	9.5	12.3	3.0	11.0	0.0	21.9	33.6	2.6	0.0	22.3	11.1	7.4	1.0
Jul	0.0	98.2	7.1	9.0	0.0	22.3	17.2	5.2	8.8	14.5	12.2	18.2	7.4	0.0	1.0	0.0	9.0	10.4	7.0	8.0	27.4	14.2	12.0	0.0	32.3	0.0	3.2
Aug	112.2	9.0	67.4	24.0	0.0	64.0	24.2	0.0	24.2	4.4	0.0	0.0	25.8	11.5	30.0	0.0	124.0	10.0	13.2	0.5	0.0	16.4	0.0	4.6	56.6	0.0	2.0
Sep	53.4	22.1	60.5	4.7	1.0	41.8	28.4	36.1	123.2	1.3	1.1	3.2	119.5	52.6	66.5	0.0	21.0	124.9	28.1	17.0	45.6	31.0	0.0	43.3	1.5	18.5	30.0
Oct	14.0	104.2	13.3	109.0	78.4	68.8	22.6	47.4	179.8	44.7	100.3	126.0	95.8	57.6	159.2	50.0	51.0	219.6	78.8	200.0	64.2	112.4	76.6	85.9	101.8	96.3	150.1
Nov	182.5	79.4	113.2	125.8	111.5	72.8	58.9	151.6	169.4	37.3	158.9	187.4	161.4	66.8	127.3	109.3	223.4	141.1	26.2	278.0	126.5	183.4	176.7	116.6	81.8	108.9	50.2
Dec	180.9	32.1	288.8	210.2	234.5	90.3	80.0	191.7	200.7	258.3	234.8	129.6	196.4	80.8	165.8	225.6	193.8	176.3	153.2	60.4	171.9	209.3	91.4	139.2	216.2	121.8	67.8
Total	**1023.9**	**980.7**	**1353.3**	**1282.5**	**1548.0**	**1316.1**	**822.2**	**1265.8**	**1416.0**	**827.6**	**1015.7**	**1178.1**	**1182.2**	**986.1**	**1278.5**	**748.3**	**1427.9**	**1205.1**	**723.5**	**1121.8**	**967.2**	**1156.4**	**978.2**	**1208.3**	**1087.6**	**748.7**	**1272.6**
Mean	**85.3**	**81.7**	**112.8**	**106.9**	**129.0**	**109.7**	**68.5**	**105.5**	**118.0**	**69.0**	**84.6**	**98.2**	**98.5**	**82.2**	**106.5**	**62.4**	**119.0**	**100.4**	**60.3**	**93.5**	**80.6**	**96.4**	**81.5**	**100.7**	**90.6**	**62.4**	**106.1**
Total CN	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**	**921.0**
Variance	4943	4558	11259	9844	17342	8200	2541	8317	5961	6358	5737	9320	5419	3578	6365	6183	12395	4834	3162	8014	6044	5701	8974	11519	6148	3324	17300
Std Dev	70.31	67.5	106.1	99.22	131.7	90.56	50.4	91.2	77.21	79.7	75.74	96.54	73.62	59.8	79.78	78.6	111.3	69.53	56.2	89.52	77.7	75.5	94.7	107.3	78.41	57.7	131.5
Max	182.5	255.6	296.2	346.5	331.6	266.5	173.8	253.9	238.2	258.3	234.8	264.9	219.0	225.2	283.0	225.6	340.9	219.6	155.1	278.0	275.4	209.3	282.2	392.8	216.2	181.4	455.2
Min	0.0	0.0	0.3	4.7	0.0	10.0	17.2	0.0	2.0	1.3	0.0	0.0	0.0	0.0	1.0	0.0	1.4	10.0	0.0	0.5	0.0	2.6	0.0	0.0	1.4	0.0	1.0
Range	182.5	255.6	295.9	341.8	331.6	256.5	156.6	253.9	236.2	257.0	234.8	264.9	219.0	225.2	282.0	225.6	339.5	209.6	155.1	277.5	275.4	206.7	282.2	392.8	214.8	181.4	454.2
Season	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**
Rainy	771.5	680.2	1091.8	930.6	1362.4	972.7	510.3	893.7	1071.8	715.9	852.5	1085.0	868.2	623.4	941.0	685.7	1142.5	847.0	585.0	840.2	774.8	985.1	870.4	1025.1	929.8	640.6	1065.1
Dry	252.4	300.5	261.5	351.9	185.6	343.4	311.9	372.1	344.2	111.7	163.2	93.1	314.0	362.7	337.5	62.6	285.4	358.1	138.5	281.6	192.4	171.3	107.8	183.2	157.8	108.1	207.5
January	182.3	255.6	296.2	346.5	297.7	266.5	112.2	227.4	238.2	94.2	67.5	264.9	154.0	225.2	97.3	96.8	88.1	168.2	40.6	63.4	275.4	162.2	282.2	392.8	193.4	181.4	187.9
July	0.0	98.2	7.1	9.0	0.0	22.3	17.2	5.2	8.8	14.5	12.2	18.2	7.4	0.0	1.0	0.0	9.0	10.4	7.0	8.0	27.4	14.2	12.0	0.0	32.3	0.0	3.2

Table 10: Statistical techniques of the precipitation series

Quantity of Years	Total		Mean		Variance		Standard Deviation		Maximum Precipitation		Minimum Precipitation		Range	
	C. Normal	921.0	C. Normal	76.8	C. Normal	2011.3	C. Normal	44.8	C. Normal	145.4	C. Normal	13.7	Years	Max - Min
	Years	Value	Years	Value	Years	Value	Years	Value	Years	Value	Years	Value		
1	02	723.5	02	60.3	90	2540.9	90	50.4	02	155.1	84	0.0	02	155.1
2	99	748.3	99	62.4	02	3161.6	02	56.2	90	173.8	85	0.0	90	156.6
3	10	748.7	10	62.4	10	3324.2	10	57.7	10	181.4	88	0.0	10	181.4
4	90	822.2	90	68.5	97	3577.9	97	59.8	84	182.5	91	0.0	84	182.5
5	93	827.6	93	69.0	85	4557.7	85	67.5	06	209.3	94	0.0	06	206.7
6	05	967.2	05	80.6	01	4834.1	01	69.5	09	216.2	95	0.0	01	209.6
7	07	978.2	07	81.5	84	4943.4	84	70.3	96	219.0	96	0.0	09	214.8
8	85	980.7	85	81.7	96	5419.3	96	73.6	01	219.6	97	0.0	96	219.0
9	97	986.1	97	82.2	06	5700.9	06	75.5	97	225.2	99	0.0	97	225.2
10	94	1015.7	94	84.6	94	5736.9	94	75.7	99	225.6	02	0.0	99	225.6
11	84	1023.9	84	85.3	92	5960.8	92	77.2	94	234.8	05	0.0	94	234.8
12	09	1087.6	09	90.6	05	6044.1	05	77.7	92	238.2	07	0.0	92	236.2
13	04	1121.8	04	93.5	09	6147.7	09	78.4	91	253.9	08	0.0	91	253.9
14	06	1156.4	06	96.4	99	6183.0	99	78.6	85	255.6	10	0.0	85	255.6
15	95	1178.1	95	98.2	93	6357.9	93	79.7	93	258.3	86	0.3	89	256.5
16	96	1182.2	96	98.5	98	6364.5	98	79.8	95	264.9	04	0.5	93	257.0
17	01	1205.1	01	100.4	04	8014.2	04	89.5	89	266.5	98	1.0	95	264.9
18	08	1208.3	08	100.7	89	8200.3	89	90.6	05	275.4	11	1.0	05	275.4
19	91	1265.8	91	105.5	91	8316.6	91	91.2	04	278.0	93	1.3	04	277.5
20	11	1272.6	11	106.05	07	8974.1	07	94.7	07	282.2	00	1.4	98	282.0
21	98	1278.5	98	106.5	95	9319.6	95	96.5	98	283.0	09	1.4	07	282.2
22	87	1282.5	87	106.9	87	9844.1	87	99.2	86	296.2	92	2.0	86	295.9
23	89	1316.1	89	109.7	86	11259.1	86	106.1	88	331.6	06	2.6	88	331.6
24	86	1353.3	86	112.8	08	11519.5	08	107.3	00	340.9	87	4.7	00	339.5
25	92	1416.0	92	118.0	00	12394.8	00	111.3	87	346.5	89	10.0	87	341.8
26	00	1427.9	00	119.0	11	17300.1	11	131.5	08	392.8	01	10.0	08	392.8
27	88	1548.0	88	129.0	88	17341.7	88	131.7	11	455.2	90	17.2	11	454.2

CHAPTER 5 – DEFORESTATION AND CLIMATE IMPACT

1 - Deforestation – Land use imagery time series

The area of the study has approximately 2318 square kilometres in the Pantanal of Nhecolândia with both Firme and Nhumirim farms inserted in the quadrangle layer in the Landsat image. Its geographic coordinates are, for the left superior corner, 57° 3' 14" W and 18° 55' 41" S; right superior corner, 56° 36' 45.8" W and 18° 56' 6" S; left inferior corner, 57° 3' 44" W and 19° 22' 41" S and for the right inferior corner, 56° 37' 11" W and 19° 23' 6" S. It was chosen both farms mainly because they are the sources of data presented here. The meteorological data belongs to the Nhumirim farm, where all the meteorological equipment are located. The other data and studies are from the Firme farm as well as from neighbouring farms.

The deforestation process in the Firme farm are diverse. Nevertheless, the main reason to deforest the areas is to transform the dense vegetated areas ("cordilheiras") into pastures for cattle raising. From 1962 until 1974, the deforestation was modest since it was a dry period for the region exposing native pastures. From 1974 forth, the flood seasonality was back in its normal regularity reducing the native pasture area for the cattle, inducing the farmers to deforest areas such as the "cordilheiras" and planting new species of exotic pasture such as the *Brachiaria* ssp (the *B. humidicola, B. decumbens, B. ruziziensis* and *B. brizantha* covers about 85% of the cultivated pasture in Brazil) (BODDEY*et al.*, 2004; PADOVANI*et al.*, 2004; BACANI, 2007; SILVA*et al.*, 2013). This situation reduced the amount of cattle in the region between the years 1970s and 1980s. Other reasons why the farmers deforested the native vegetation to introduce the cultivated pastures, as cited above, is the fact that the cattle has a smaller proportion of available food during the year (seasonal floods) when compared to other regions of the country which this variability in the availability of food affects the growth of the cattle. Such situation triggered a competition among the meat producers in the Pantanal while compared to the rest of the country producers, which it was an incentive to expand the areas deforesting great portions to increase the production of meat and, thus, enabling the farmer's to compete outside the Pantanal (PADOVANI*et al.*, 2004).

The time series analysis of the deforestation comprises 3 selected images. The date of the images are September 02nd, 1984 (Figures 11, 12 and 13), September 12th, 1999

(Figures 14, 15 and 16) and September 21st, 2014 (Figures 17, 18 and 19). It was made 3 images as false colour, here used as the guide image for the 3 supervised classification images. Another 3 images were done to assess the radiative temperatures of the surface region.

The process of creation of the band set for the false colour, the supervised classification and the radiative temperatures were all done with the open source GIS software QGIS utilizing a plugin called "Semi-Automatic Classification Plugin". The assembling of the end-map were done with the proprietary GIS software ArcGIS 10.1, available for the University of Coimbra's students.

It is important to mention here that the accuracy presented by the supervised classification is not 100 % accurate to the real world. The classes assigned for the classification had some errors where the object of one class is also recognized in the region of interest by the training plugin in another class, thus, disturbing the reality. As the main focus of this study is to assess the deforestation using the remote sensors of the satellites, the "high vegetation" class was the only one with high precision of accuracy. The "high vegetation" class represents the dense forested areas of the region, mainly "cordilheiras" and some sparse dense aggregate of trees. Still, the "high vegetation" class did not have 100 % of accuracy.

All the supervised classification presented a classification report containing the size of the areas occupied by each pre-determined class. For the year 1984, the class high vegetation covered approximately 18.78 % of the quadrangle, which it represents around 32909.4 hectares (table 11).

Table 11: Classification report for the supervised classification image of September 02, 1984

Class	PixelSum	Percentage (%)	Area (m^2)
High Vegetation	365525	18.77251071	329093969.1
Water	164371	8.441710847	147988522.8
Low Vegetation	1032083	53.00537355	929217675.7
Burned Areas	179512	9.219317261	161620454.4
Saline	3280	0.168453143	2953089.99
Macrophyte	202358	10.39263449	182189446.4

The false colour image showed the presence of a great amount of water in the surface. It was possible to distinguish the areas where fire had happened from the bare soil/grass/low vegetation areas. Some alkaline ponds and fresh water ponds where macrophytes were growing also is shown in the image. The thermal image showing the radiative temperature of the surface went through a process called *pan-sharpening* to get a better resolution of the pixels. The original image has a pixel resolution of 120 meters. After the *pan-sharpening* process, the pixel resolution is now 30 meters. It is interesting to see the radiative temperature for the areas where water and vegetation is present. It is clear that they are cooler than the bare soil/grass/low vegetation areas. It also proves the cooling effect that high vegetation plays in the environment.

The year 1999 presented in the false colour major areas of bare soil because of the use of fire to clear the biomass. The image presents either new and/or past fires.As for the classification report of the supervised classification, the area of the "high vegetation" had a loss of almost 2%, but it also had a major increase of burned areas when comparing both years. The total "high vegetation" area in hectares is approximately 29717.1 hectares. (Table 12). For the radiative temperature image, we clearly see the rise of the surface temperature due to less high vegetation and the increase of burned area, which this year it accounts as a larger area than the "high vegetation".

Table 12: Supervised classification report for September 12, 1999

Class	PixelSum	Percentage (%)	Area (m^2)
High Vegetation	330068	16.95152196	297170886.3
Water	55471	2.848861067	49942333.8
Low Vegetation	1194938	61.36922618	1075841295
Burned Areas	342994	17.61537114	308808581.7
Saline	1005	0.051614454	904833.9757
Macrophytes	22653	1.163405198	20395227.91

For the last series of images, the year 2014 presented, at a first glance, in the false colour image, a higher presence of the red colour, which it represents the "high vegetation" class in the supervised classification.It also present huge areas of burned areas and bare soil. The classification report for the supervised classification image presented an increase of the "high vegetation" area (Table 13). It is possible to see throughout the region deforested chunks of "cordilheiras" and some parts where trees had grown in the past 15 years. This is possible to be identified with the open source software Google Maps, either using it as the software itself or as a QGIS plugin called "Openlayers". This plugin is very useful when one needs to verify the real situation of the area. But also it is possible whenever one has the financial resource to purchase images from commercial satellites. Brazil provides free imagery from its satellites CBERS. The satellite has a high resolution panchromatic camera with a resolution pixel of 2.7 meters, ideal to identify objects remotely. Unfortunately, these images were only available from January 2007 until June 2010. (Figures9 and 10)

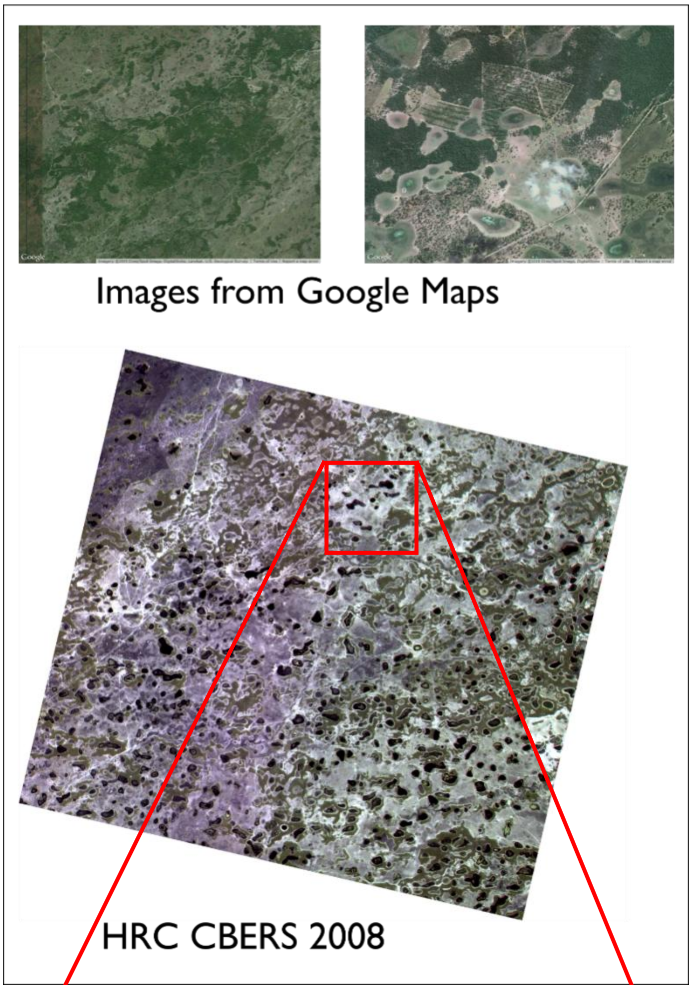


Figure 9: Re-forested and deforested areas. Google Maps and HRC Camera from CBERS satellite.

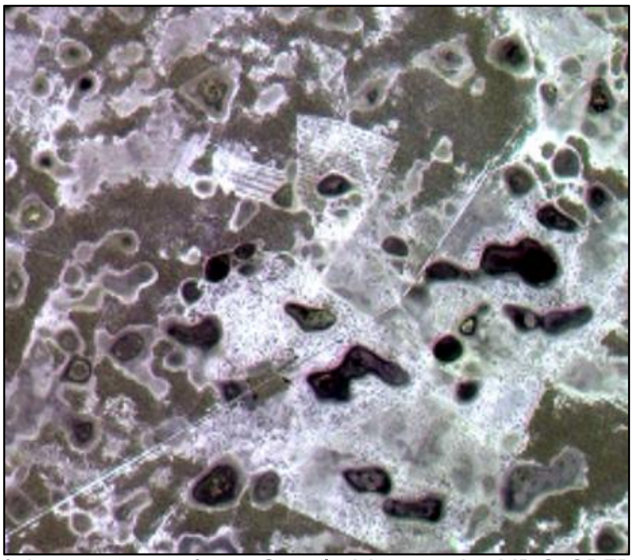


Figure 10: Zoom of the same area from Google Maps in the HRC CBERS image. True Color composition

Table 13: Classification report for September 21, 2014

Class	Pixel Sum	Percentage (%)	Area (m2)
High Vegetation	484352	24.87518803	436077757
Water	58912	3.025582794	53040377.29
Low Vegetation	1160694	59.61053428	1045010315
Burned Areas	202817	10.41620766	182602699
Saline	3433	0.176310866	3090840.834
Macrophytes	36921	1.89617637	33241169.37

The increase of "high vegetation" was quite significant, almost 6 %. The burned area also had a major decrease. The radiative temperature image shows as previously images had proven, the hotter spots are where bare soil/burned areas are and the cooler sports, the water and vegetation. It is important to mention that the increase of "high vegetation" is quite significant, but it didn't happened where "cordilheiras" where cut down. The increase happened in different areas of the region and the cut down of "cordilheiras" continued to happened.

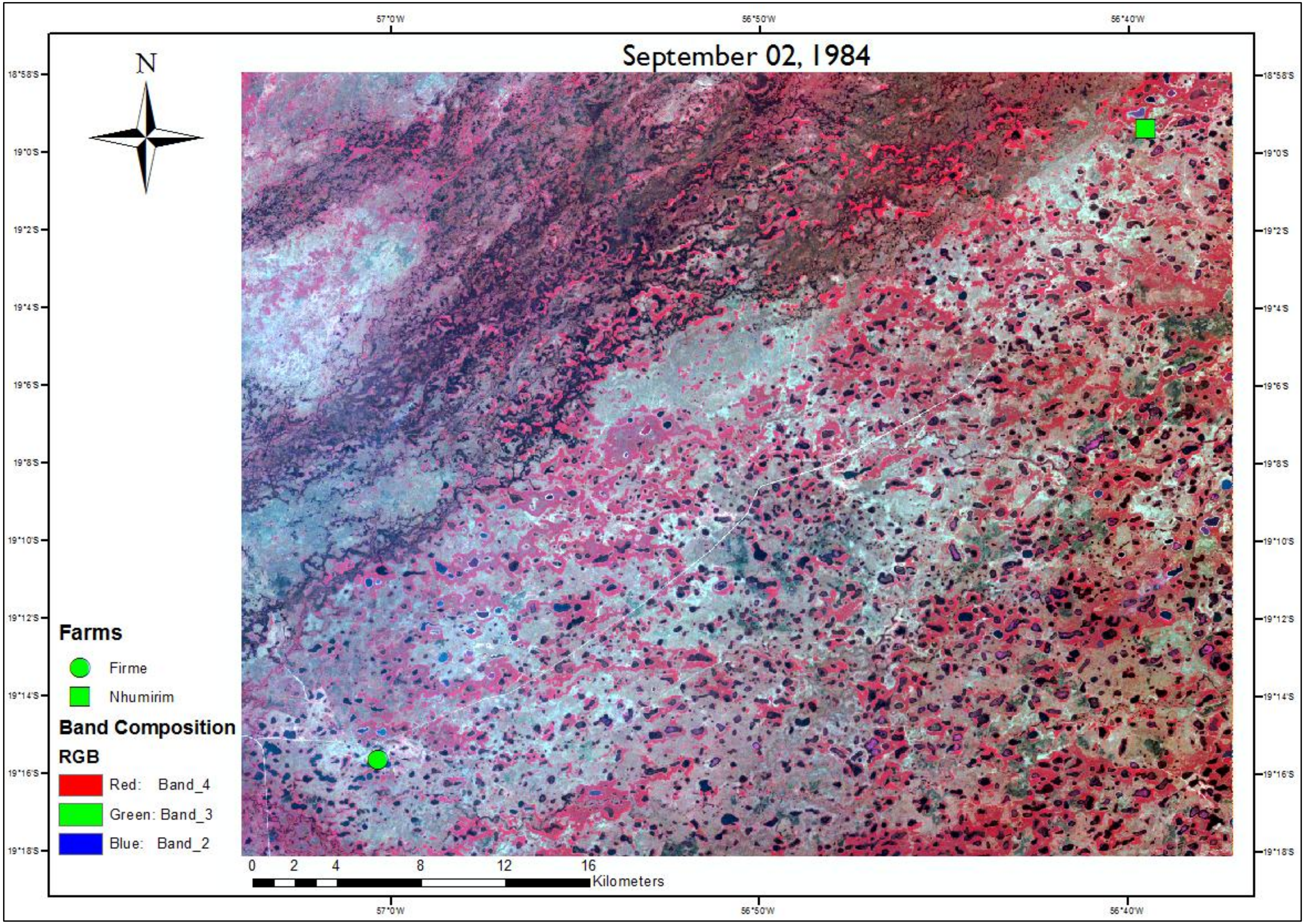


Figure 11: False colour - September 02, 1984

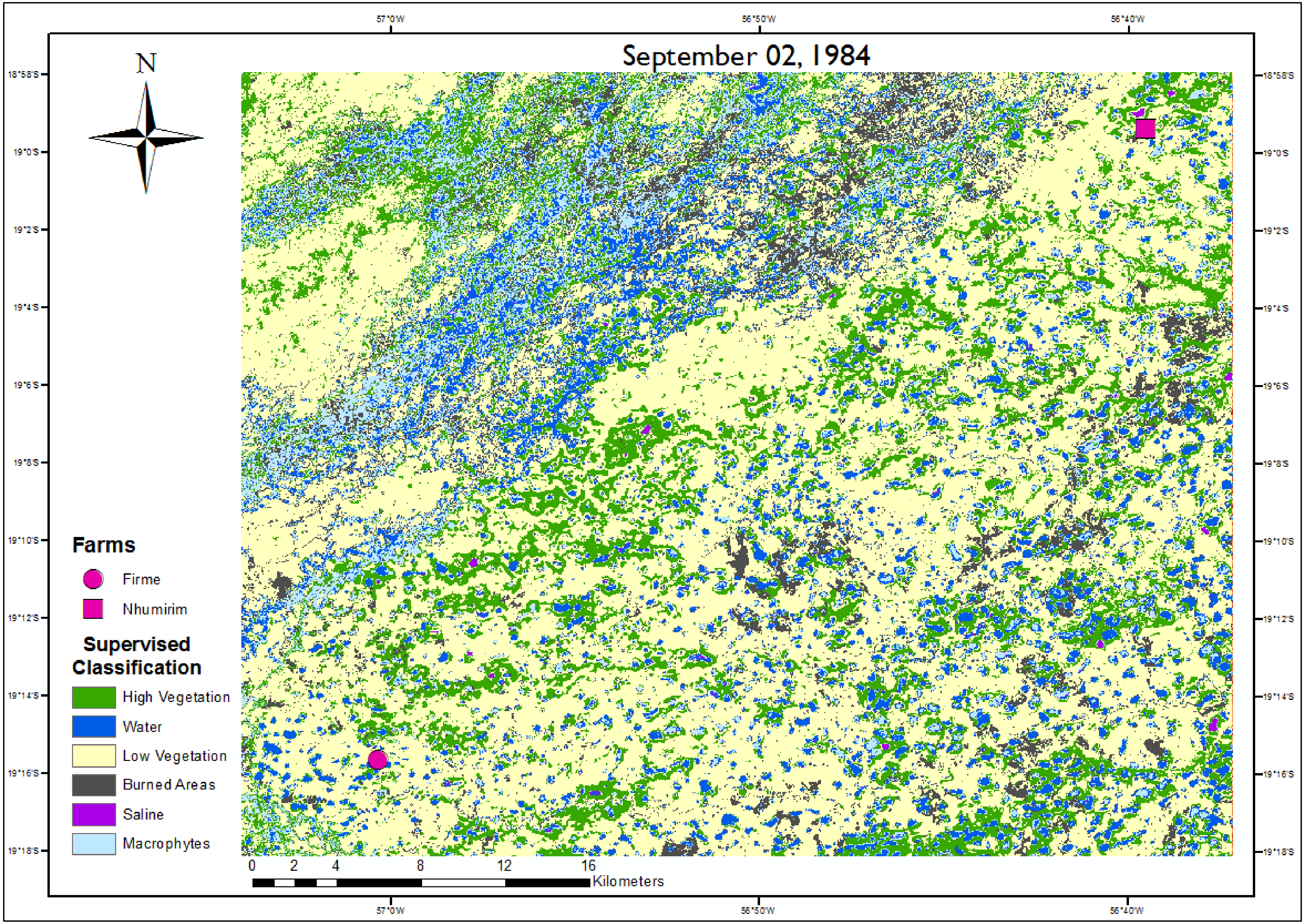


Figure 12: Supervised classification - September 02, 1984

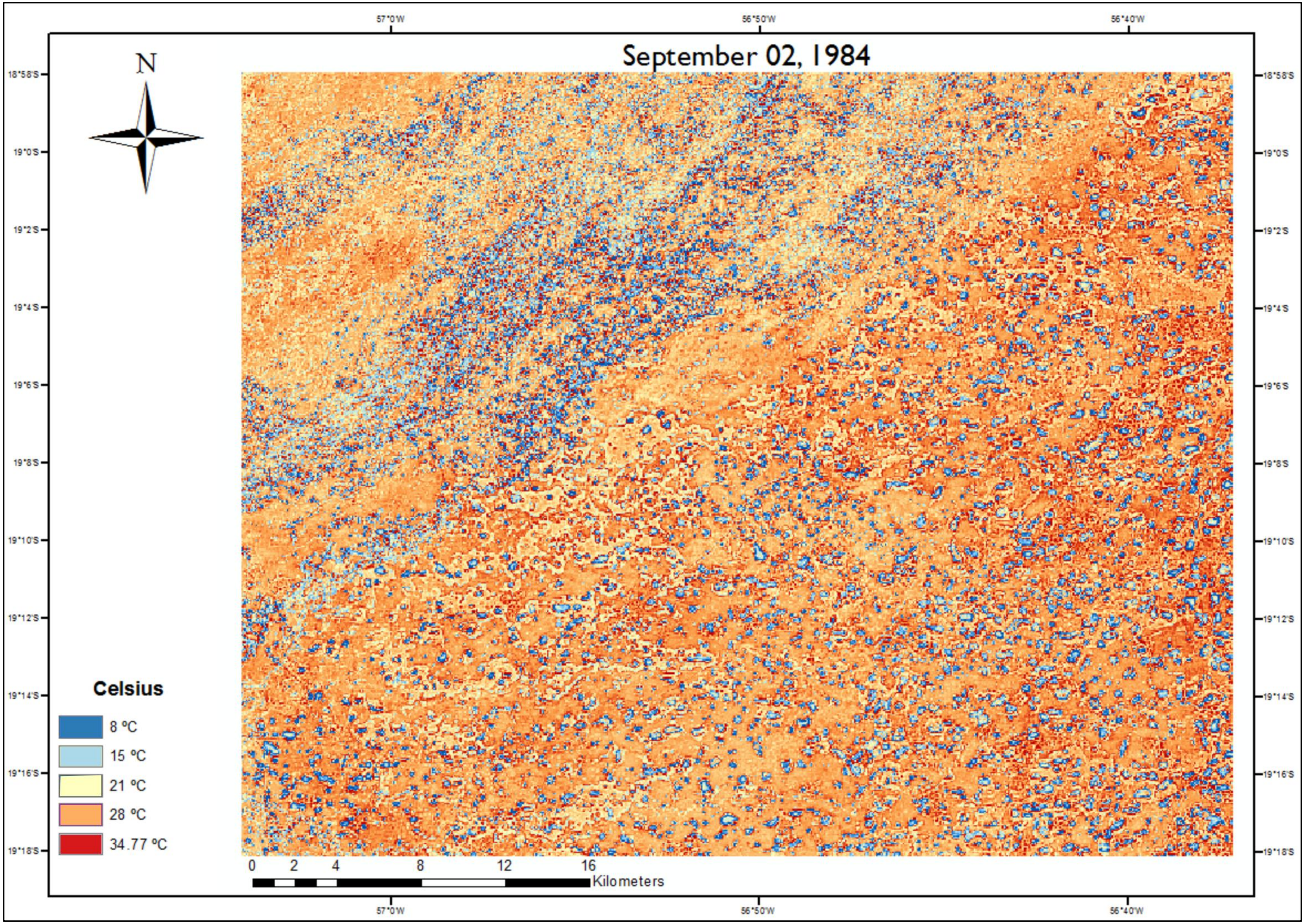


Figure 13: Radiative temperature - September 02, 1984

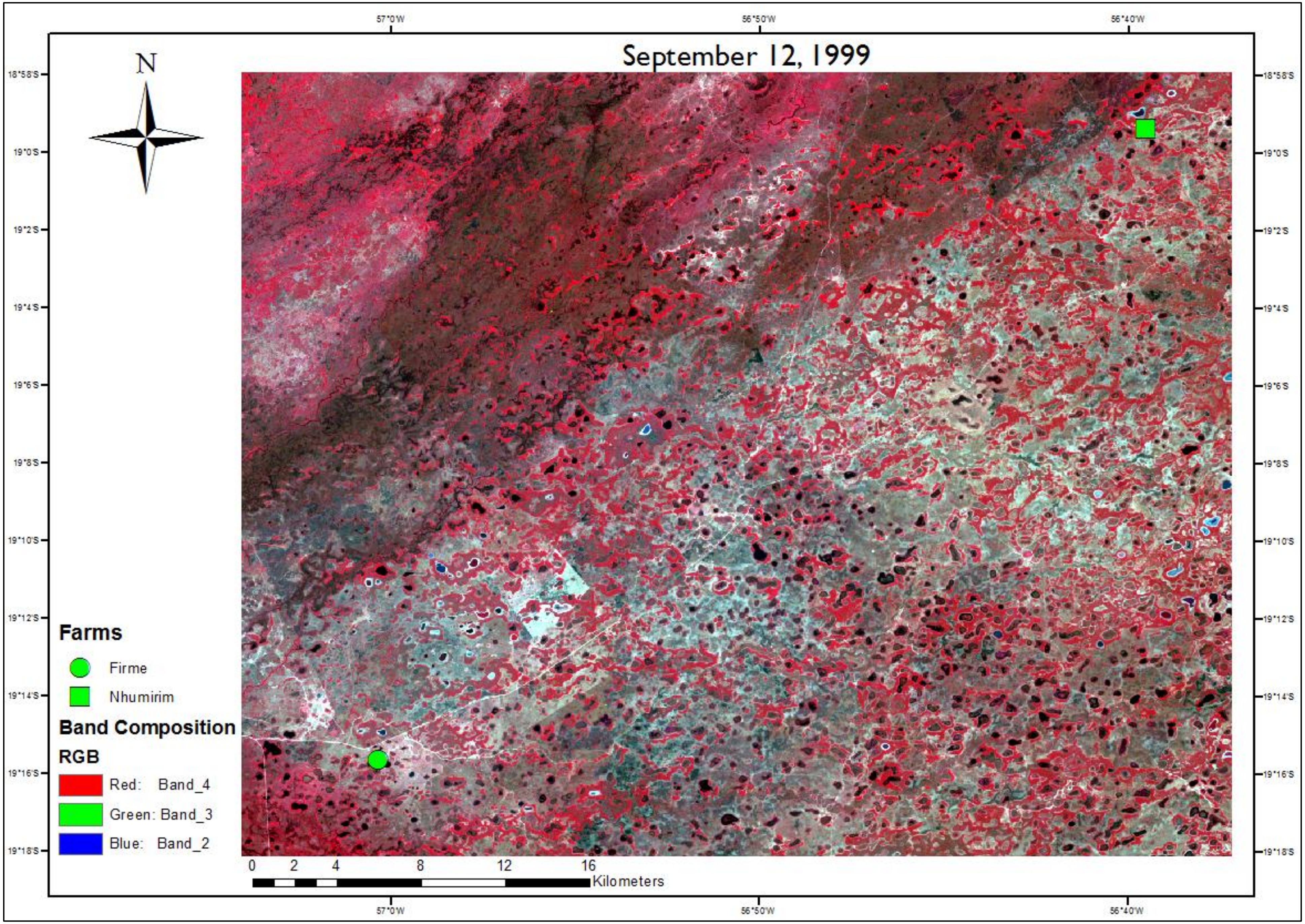


Figure 14: False colour - September 12. 1999

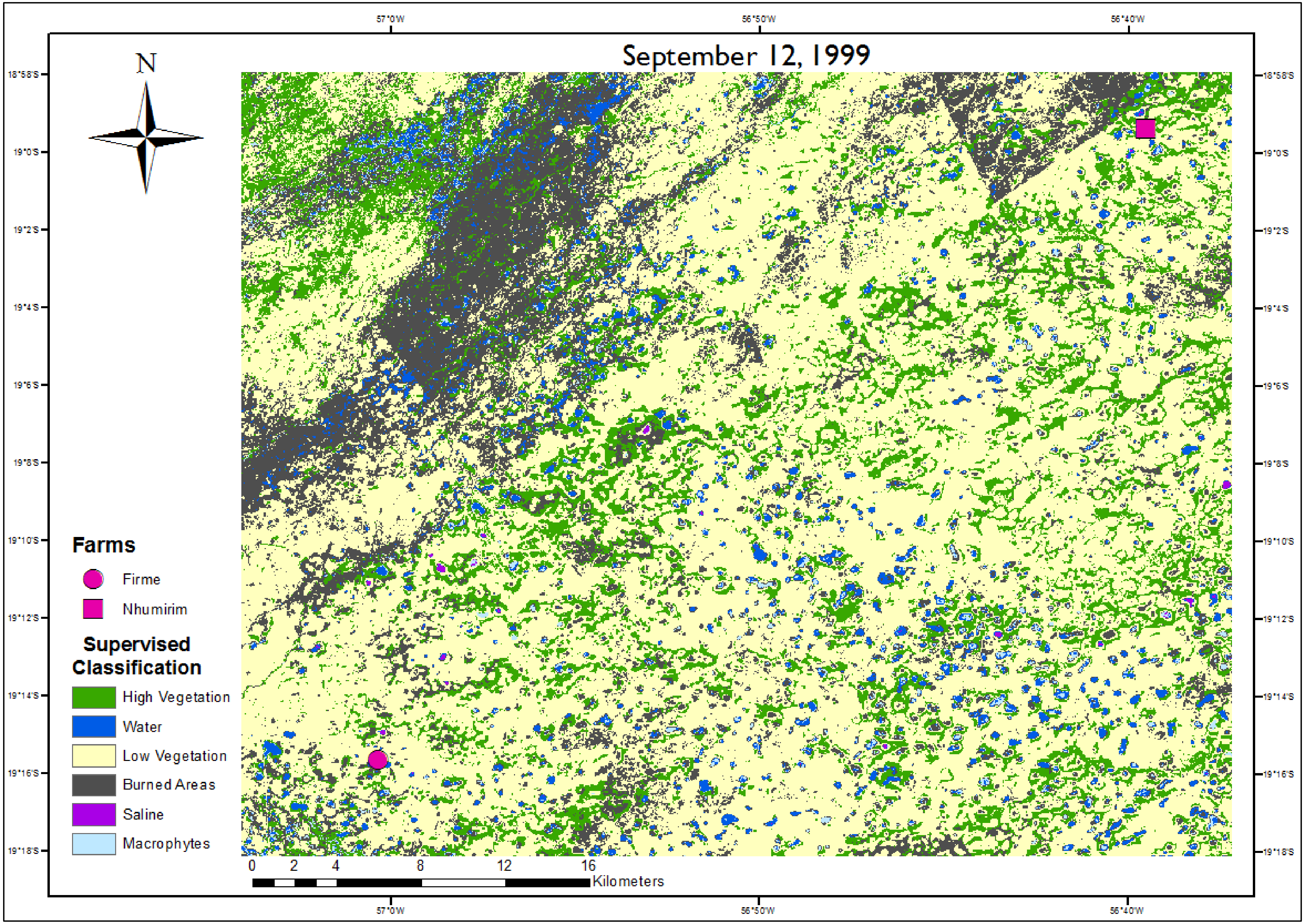


Figure 15: Supervised Classification - September 12, 1999

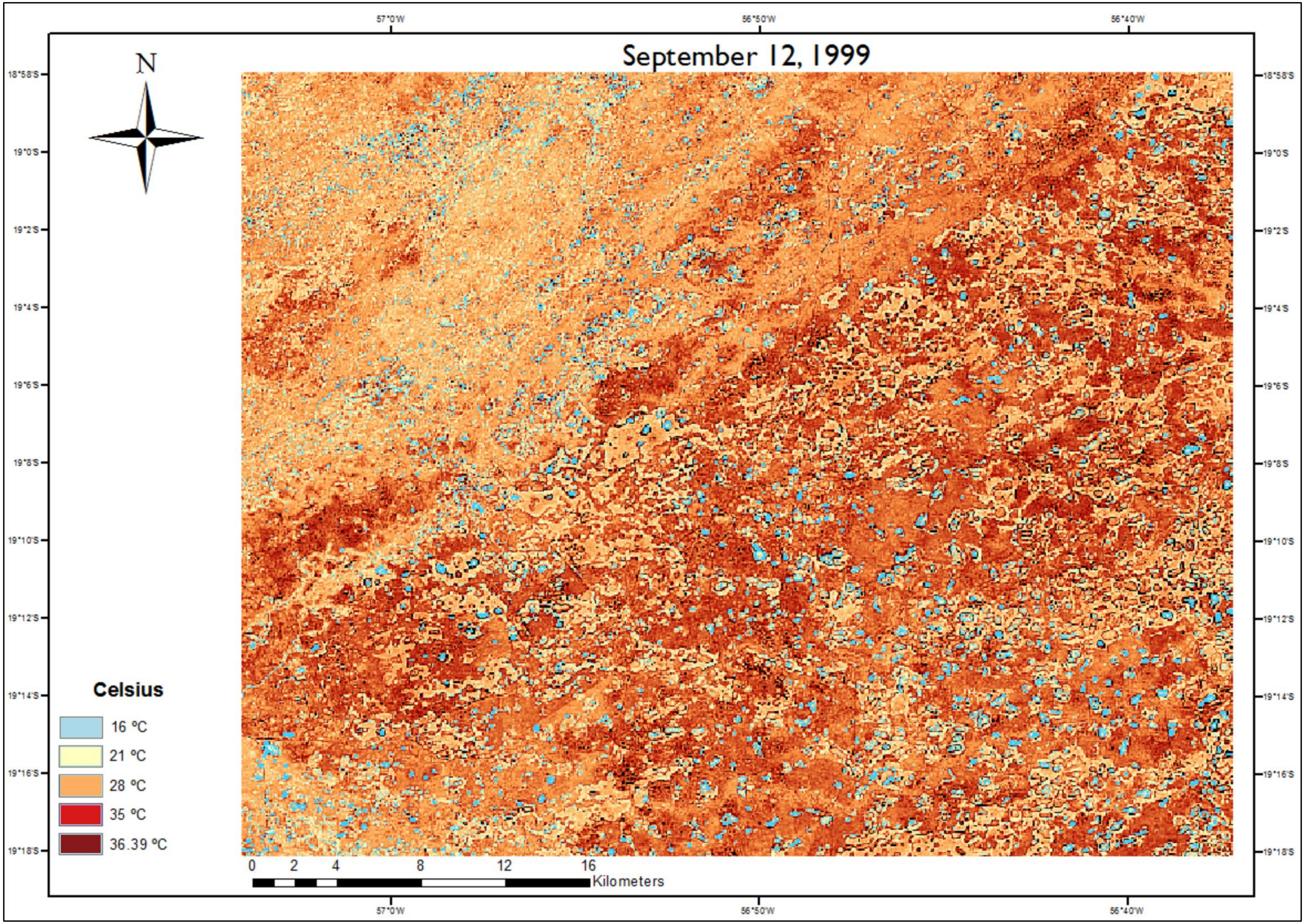


Figure 16: Radiative temperature - September 12, 1999

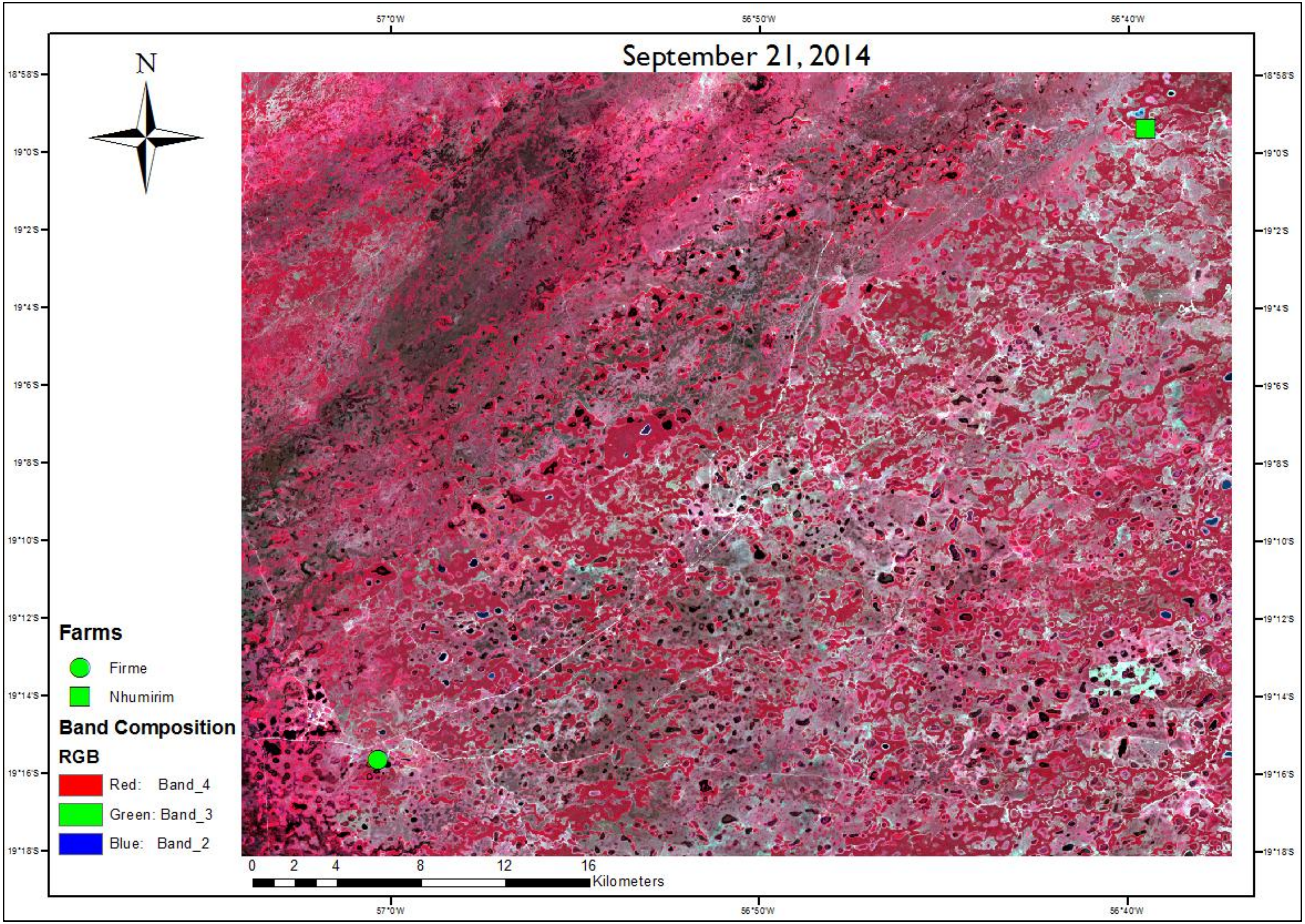


Figure 17: False colour - September 21, 2014

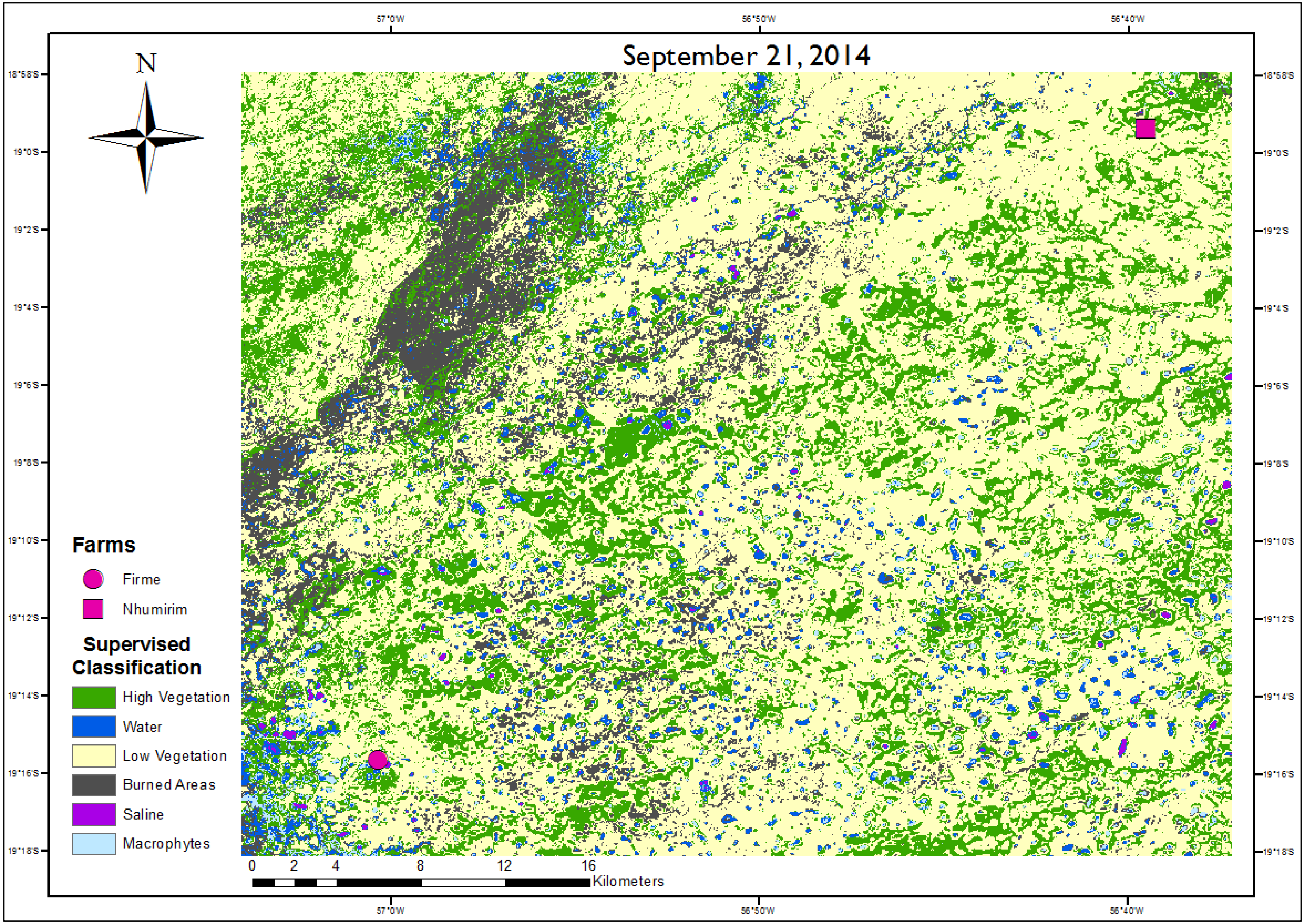


Figure 18: Supervised classification - September 21, 2014

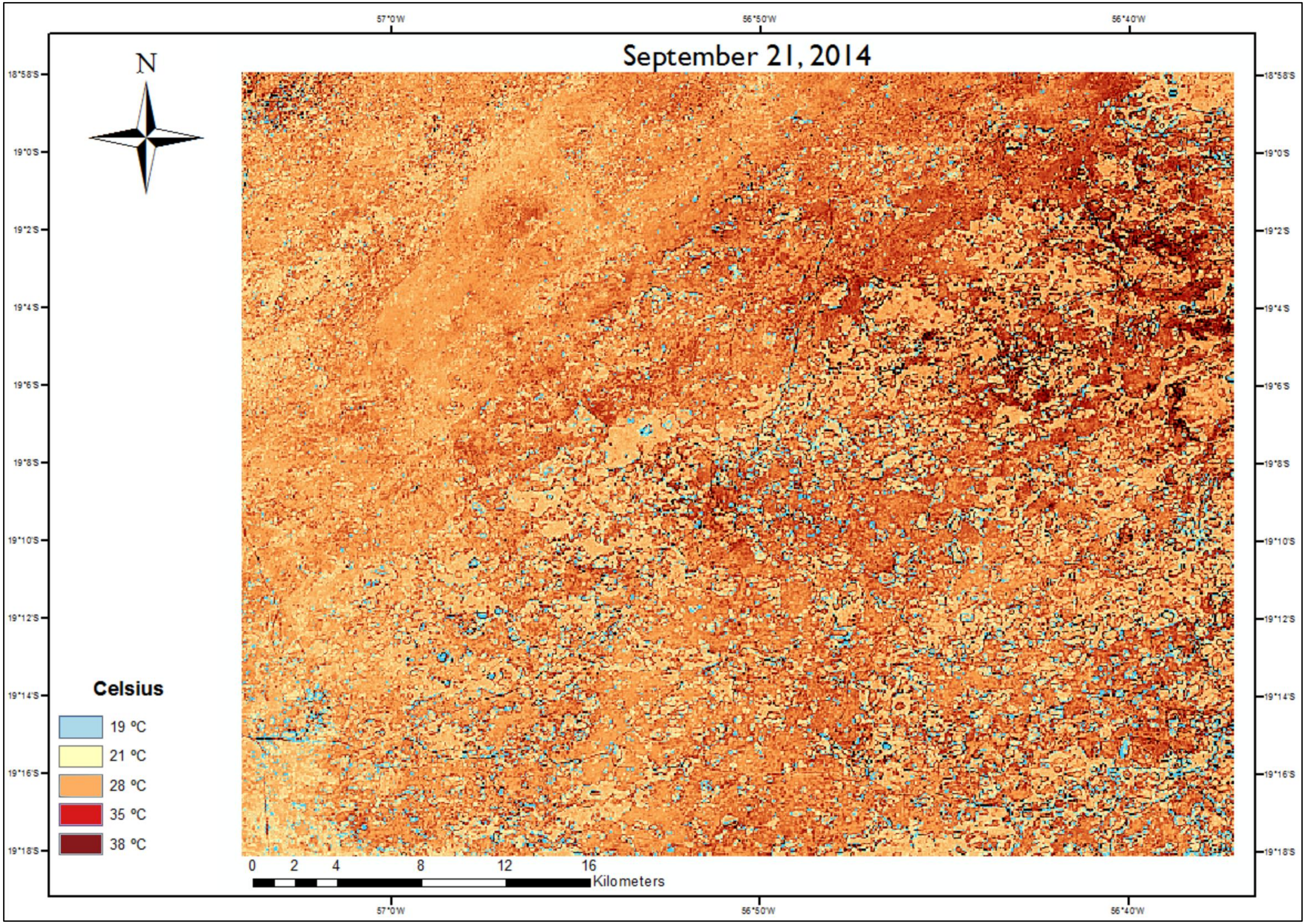


Figure 19: Radiative temperature – September 21, 2014

2 - Statistical analysis

On a regional scale, the average annual temperature of the Pantanal is a quantity related to the local balance of radiation, air masses, topography and exchange of energy of natural areas such as the mosaic of vegetation and altered areas.

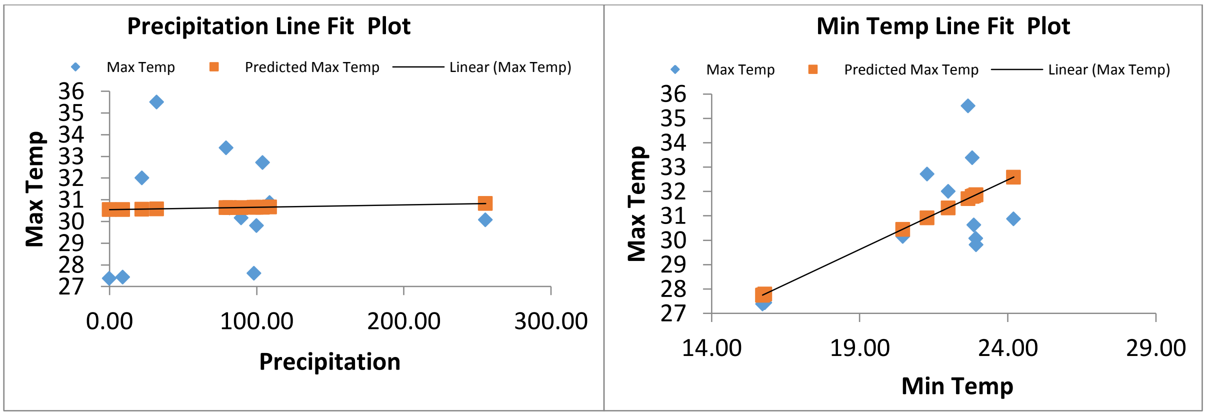
As far as this study goes, this dissertation relied on the statistical results obtained from the meteorological data, which was gathered from the INMET-BDMEP website and from EMBRAPA-Pantanal,also from articles, bachelor's degree monographies, master's degree dissertations, PhD thesis, and all the other sources of information available. It also had the help of the Remote Sensing science and GIS techniques to support the decision making of the results here presented.

The statistical analysis was based on the years with the lowest and highest mean values for precipitation and maximum and minimum temperatures only in order to seek a correlation with the deforestation previously presented. The years analysed were 1985, 1987, 1988, 1989, 1992, 1997, 1999, 2000, 2002, 2005, 2009, and 2010. To support the statistical results, thermal imagery from the Landsat series were used in order to enhance them. Also, the same statistics techniques were applied to the Climate Normal data.

Several years had both the highest and lowest mean values for the variables. 1989 had the lowest mean value for maximum temperature and the highest mean value for precipitation. 2009 had the highest mean value for the maximum temperature and the lowest mean value for the minimum temperature. The year 2002 had the highest mean value for the maximum and minimum temperature variables and the lowest mean value for precipitation. 2010 had the highest mean value for the maximum temperature and the lowest mean value for the minimum temperature and precipitation variables.

1985 had only the precipitation and the maximum and minimum temperatures data available. The Climate Normal data is from the Corumbá station from INMET dating from 1961 to 1990. As far as the statistical analysis, a single regression with the variables maximum temperature as the independent variable and the precipitation as the dependent variable, the results showed a weak R^2 of 0.0009 and a very high value for the Sig-F of 0.92. The coefficient is insignificant, 0.001.The *p*-value clearly shows that this regression is not statistically significant. When the regression had as the dependent variable the minimum temperature, the scenario changed drastically where we can clearly see that the correlation is strong and one variable explains the other. We definitely can reject the null hypothesis for this regression. The R^2 is 0.52, the Sig-F is 0.007 and the coefficient is 0.57. Those are strong values what we can assume that the minimum temperature plays a vital role in the maximum temperature changes. As a multiple regression, the results are straightforward. The precipitation is not a strong variable here, hence, it should be removed since we cannot reject the null hypothesis and is more likely it will jeopardise the study(Appendix 8).The overall for the 1985 regressions is that the minimum temperature does affect the maximum temperature and the precipitation has no response in the changes of maximum temperature, even when analysed together with the minimum temperature. But one thing that stood out this year was the fact that in all the years analysed, July 1985 was the month that most rained, especially when it was in the dry season, more specifically, considered the driest month. In 2 days rained 95.7 mm (01/07/1985 – 35.4 mm; 02/07/1985 – 60.3). The maximum and minimum temperatures for these days almost didn't change,having a little amplitude (01/07/1985 – maximum temperature= 19.1 °C and minimum temperature= 19 °C; 02/07/1985 – maximum temperature= 21.5 °C and minimum temperature= 18 °C). Due to the lack of availability of detailed data of the weather conditions and weather satellite imagery for the region, unfortunately it will not be possible to do a detailed analysis of the synoptic conditions for those days.

Graphic14: Linear Regression - Max Temp (Y) and Precipitation (X) and Minimum Temperature (X)



1987 had the highest mean value of the minimum temperature series along with the years of 1997 and 2002. The regression between minimum temperature (Y) and the precipitation (X) showed a R^2 value of 0.32 and a Sif-F of 0.05 with a coefficient value of 0.01. A medium strength of correlation and a low coefficient value. It is prudent to say that the p-value is over 0.05, what we can assume that the variable precipitation does not associate to the changes in the minimum temperature. The linear regression between the minimum temperature and maximum temperature presents a strong correlation with a R^2 of 0.69, Sig-F 0.0007 and a coefficient value of 1.10. The maximum temperature has a huge influence in the minimum temperature. As far as the insolation and the relative humidity influencing in the minimum temperature numbers, they both lack of correlation presenting results close to zero to the R^2 values (0.05 and 0.01, respectively) and a very high value for Sig-F (0.45 and 0.66, respectively) as well the coefficient values (0.02 and 0.09, respectively). A multiple regression was done in order to assess the influence of the response variables in the predictor. The results show a strong correlation between the variable when analysing only the R^2 (0.86) and the Sig-F (0.003). Moreover, the *p*-value gives us a different approach. Only the maximum temperature and relative humidity have acceptable values (0.002 and 0.02, respectively), forcing the other variables to be taken out due to no statistical significance(Appendix 9). Hence forth, another multiple regression was done to properly assess the results obtained from the previous regression and it confirmed a very strong correlation among the variables [minimum temperature (Y) – maximum temperature and relative humidity (X)]. The R^2 has a value of 0.81 and Sig-F of 0.0004. The coefficient are 0.25 for relative humidity and 1.21 for maximum temperature. Both variables presented strong *p*-values under 0.05.

1988 had the third lowest mean value for maximum temperature and also it is the year that rained the most of all the years in the series withonly four months with no rain whatsoever. As this year had two variables among the highest and lowest values of the whole data here presented, it was produced linear regression for both variables. The maximum temperature (Y) and the precipitation (X) regression showed a R^2 of 0.21 and a Sig-F of 0.12. The coefficient value is 0.009, very low. This variable should not be used since it does not present a statistical significance. The regression with the minimum temperature, as the X, presented a R^2 of 0.37, a Sig-F of 0.03 and a coefficient value of 0.43. It has a good correlation. The relative humidity regression shows a poor value for R^2 of 0.08, Sig-F of 0.35. The *p*-value is over 0.05, forcing us to eliminate this variable. As a multiple regression, the result is interesting. It has a high value for R^2, 0.85 and Sig-F of 0.001. The *p*-value for the variables are valid only for the minimum temperature and relative humidity variables. The precipitation went over 0.05. An even stronger multiple regression with the minimum temperature and relative humidity was done to observe the results and it was concluded that, when these variables are together, the changes in the maximum temperature values are highly responsive to the variables analysed, the minimum temperature and relative humidity.

It presented a R^2 of 0.85, a Sig-F of 0.0001 and extremely low *p*-values. The coefficient values are reasonably high, as 0.71 for minimum temperature and -0.45 for relative humidity.Its residual output shows how little the prediction were off the real values. For the precipitation linear regression as it being the independent variable, the minimum temperature variable here is the X. The results showed a R^2 of 0.78, a Sig-F of 0.0001 and a coefficient value of 31.08. It presented a very strong correlation between the variables, assuming valid changes that the minimum temperature do to the precipitation. As for the relative humidity, the R^2 is 0.31, but the Sig-F is 0.056 and high coefficient value of 15.74. But this is a classic misinterpretation of the R^2value since it shows a good value of correlation, but the Sig-F and the *p*-value is over 0.05, which we will not use this variable since we cannot reject the null hypothesis; in other words, it is not a meaningful addition to our study since the changes in the predictor's value are not associated with changes in the response. A multiple regression with the precipitation being the Y and the rest of the variables the X, it shows the same situation as the linear regression of the relative humidity, good value of R^2 (0.80), but high *p*-values for all the variables (all of them are over 0.05 – Appendix 10).

The year 1989 had the second lowest mean value for maximum temperature and was the most constant in precipitation, having only one month with low precipitation (10 mm in May). The maximum temperature (Y) and precipitation (X) regression showed a weak R^2 value of 0.10 and a high Sig-F value of 0.29. The coefficient value was a poor 0.006. This regression should not be used since the *p*-value was over 0.05. As for the maximum temperature as Y and the minimum temperature as X, the correlation is very strong, with a R^2 of 0.52 and a very low value for Sig-F of 0.007. The coefficient value is good, 0.45. As far as the relative humidity variable as X and the maximum temperature Y, the regression analysis showed a good correlation with a R^2 of 0.18 with a Sig-F of 0.18 and coefficient of -0.17. This variable is not valid as far as statistical significance. The multiple regression for the maximum temperature as Y and all the other variables showed a very strong correlation between them, but the precipitation variable went over the *p*-value, being excluded of the analysis. The next multiple regression done was only with the minimum temperature and relative humidity and it definitely showed the strongest correlation for this year of all the regression done. Not only had a high value for R^2 of 0.93 and Sig-F 5.15358^{-06}, but for the *p*-values as well.The variables are, indeed, major players in the changes on the maximum temperature(Appendix 11).

1992 had the third highest mean value for precipitation. The regression between precipitation (Y) and the maximum temperature (X) presents a strong correlation of the variables. The R^2 has a good value of 0.64 and the Sig-F value is also very good, 0.001 showing us that changes in the predicator's value (X) are related to changes in the response variable (Y). The coefficient value is 31.75. The minimum temperature and precipitation regression is stronger than the previous regression, with a R^2 of 0.70 and a Sig-F of 0.0005 and also a poor coefficient of 0.03.Analysing the insolation influence in the precipitation, the results show no correlation whatsoever when taking the value of the R^2 0.03 and the Sig-F 0.56. The coefficient value is negative (-0.68). This regression is not appropriate to be used when seeking the correlation between insolation and precipitation (Appendix 12). As for the relative humidity influencing the precipitation, the regression shows us no correlation with a value of R^2 of 0.02, Sig-F of 0.65 and coefficient of -5.73. As the previous regression, this one cannot be accounted in the study since its*p*-value is very high and, therefore, we cannot reject the null hypothesis and is not statistically significant. The multiple regression results shows a very strong correlation, with a R^2 of 0.84 and a Sig-F of 0.006. Although the numbers seem very straightforward, the *p*-values for the variables show another scenario where the changes in predicator's value (X) are not related to changes in the response variable (Y) for most of the variable, except for the minimum temperature. We should not considered this regression because it is not statistically significant and we cannot reject the null hypothesis.

1997 had the second highest mean value for minimum temperature(Appendix 13).This year had its values a little over the Climate Normal in most of the variables with complete data. Only the insolation, average wind speed and cloudiness were under. Analysing the linear regression with the precipitation being the X and the minimum temperature being the Y, the results showed a medium correlation with the value for R^2 of 0.38, Sig-F of 0.03 and coefficient of 0.03. A little stronger correlation presented when the X variable was the maximum temperature. The R^2 has a value of 0.41, Sig-F of 0.024 and the coefficient of 0.86. An even stronger correlation is noticed with the results of the linear regression with the cloudiness being the X variable with a R^2 of 0.43, Sig-F 0.02 and coefficient of 1.95. For the insolation variable as X, the results showed a weak correlation, with a R^2 of 0.10 and a high Sig-F value of 0.3 with a negative coefficient of -0.04. As the *p*-value for it has a value over 0.05, we are not going to consider this linear regression due to statistical insignificance. For the relative humidity and the average wind speed values, the linear regression for both showed a very poor correlation, having the R^2 for both variables the value of 0.00, both having also high values for Sig-F, 0.88 and 0.79, respectively, and both had *p*-values over 0.05. The multiple regression results are very interesting since it shows highs values for R^2 and Sig-F, 0.94 and 0.004, respectively. But, as previously presented in the other multiple regressions, the *p*-values for the variables over 0.05 making them, for this study, not statistical significant, hence, the only variable under the 0.05 value was the maximum temperature. It is interesting because this variable, in the linear regression, did not havethe strongest results. The cloudiness variable had better results, showing more correlation and influence in the minimum temperature variable. For this matter, another multiple regression was done in order to see if the correlation gets better with the all the variable that had statistical significant results. The X variables this time were maximum temperature, cloudiness and insolation. Indeed, the results presented were very promising. But the insolation variable, this time, had the *p*-value over 0.05. The other variable had great values. A final multiple regression was done with the maximum temperature and cloudiness as the X variable and the results were really good. The correlation got a lot stronger. The R^2 has a value of 0.77 and Sig-F of 0.001. The *p*-values are both 0.00 for the X variables.

1999 had the second lowest mean value for precipitation(Appendix 14).Of all the linear regression and the multiple regression done for this year, only when the minimum temperature was the X variable in a linear regression that the results showed a little correlation. All the other variables, cloudiness, maximum temperature, insolation and relative humidity showed very weak correlation, very high values for Sig-F and *p*-values. For the minimum temperature linear regression results, the R^2 has a value of 0.36, Sig-F of 0.03 and coefficient 12.85.

2000 had the second highest mean value for precipitation. The maximum temperature series acting as the variable X and the precipitation, always as the Y variable for this year, showed a weak result. The R^2 value is only 0.17 and the Sig-F is 0.18. The coefficient is 18.8. But the *p*-value is over 0.05. For the minimum temperature, the values aren't high, but they do show better results and stronger correlation. The R^2 is 0.38, the Sig-F is 0.03 and the coefficient is 20. It proves the influence on the changes of precipitation by the minimum temperature rise. For the insolation variable, the results aren't good since it shows a weak value for R^2 of 0.17, Sig-F of 0.17 and a negative coefficient value of -1.4. The *p*-value is over 0.05. As for the relative humidity, the value of R^2 is 0.40 and Sig-F is 0.02. The coefficient value is 17.45. The cloudiness variable presented the best results so far, is a R^2 of 0.52, Sig-F of 0.00 and coefficient of 623. It is the variable with the strongest correlation. Finally, the average wind speed is not statistical significant since its *p*-value is over 0.05. The multiple regression showed exciting results with a R^2 0.73, but the Sig-F is very high, 0.18, and all the variables had the *p*-value over 0.05. Another multiple regression was done to seek the correlation with all the variables that had positive results regarding *p*-value-wise, and it also failed with all the variables (minimum temperature, relative humidity and cloudiness) having the *p*-value over 0.05(Appendix 15).

2002 was a year with extreme ranges for precipitation, maximum and minimum temperatures. It had the lowest mean value for precipitation, the highest mean value for maximum temperature and the third highest mean value for minimum temperature. Summarizing, it was the hottest and driest year of the series. The first linear regression was done with the precipitation being the Y variable and the minimum temperature as the X variable. They presented very good correlation with a R^2 of 0.52 and Sig-F of 0.007. The coefficient value is 11.99. Good relation of the minimum temperature with the precipitation. All the other variables (insolation, relative humidity and maximum temperature) presented not as good results as the minimum temperature. In fact, all of them had their *p*-values over 0.05. Those variables are not good as far as significance for the statistics here applied, as we can see in the multiple regression (appendix 16). A linear regression was also done to assess the influence of the variables in the maximum temperature. The X variable this time was the minimum temperature and the Y variable the maximum temperature. The results showed excellent correlation between the variables: R^2 of 54%, Sig-F of 0.005 and coefficient 0.58. It definitely has bidirectional influence. The insolation as the X variable and the maximum temperature as the Y, it does not present correlation. The *p*-value is over 0.05 and the R^2 is very low. For the relative humidity variable as X, it also went over 0.05 of the *p*-value. Analysing the multiple regression, we can see that only the minimum temperature and relative humidity variables had the *p*-value under 0.05 and the rest (precipitation and insolation) over. Another multiple regression was done with the variables minimum temperature and relative humidity. The results definitely shows that they are strong together. The R^2 is 0.86 and the Sig-F is 0.0001. And lastly, the linear regression for the minimum temperature variable as Y. For both insolation and relative humidity variables the results are not statistically significant. In the multiple regression results shows that the only variable worth analysing is the maximum temperature since it is the only one with the *p*-

value under 0.05. But, when the maximum temperature and precipitation are together, even though the precipitation presented a *p*-value over 0.05 in the previous analysis (precipitation *p*-value= 0.053718822), in this case, the multiple regression gets stronger and the *p*-values for both variables are very low, suggesting that these variables are very important when explaining the changes in the minimum temperature.

The year 2005 had the second lowest mean minimum temperature value of the series. Most of variables analysed for this year had good correlation, being only 2 out 6 not statistically significant. The 2 variables are the insolation and average wind speed. The other 4 (maximum temperature, precipitation, relative humidity and cloudiness) all had high values for R^2, especially the cloudiness (R^2 0.82) and also very low values for Sig-F (Appendix 17). As for the multiple regression, the results weren't so great the linear regressions. Only 2 variables had *p*-values under 0.05, maximum temperature and cloudiness. Now, for the multiple regression with those variables, the results are excellent, showing an excellent correlation. The R^2 is 95%, the Sig-F 9.30562^{-07}. In a final analysis, the maximum temperature and cloudiness definitely influence the most of all the variables the changes in the minimum temperature values.

2009 had both the third highest mean value for maximum temperature and the third lowest mean value for minimum temperature.(Appendix 18) This year had interesting results. A linear regression with the maximum temperature as the Y variable and the minimum temperature as the X variable was done. The results shows excellent correlation between the variables. As for the rest of variables available for this year (insolation, relative humidity, average wind speed, cloudiness and precipitation), they all presented *p*-values under 0.05. None of them had significant results. Nevertheless, as multiple regression, they present different and satisfactory results. The variables minimum temperature, relative humidity and average wind speed showed excellent correlation with a R^2 of 0.97 and Sig-F of 1.86819^{-06}. None of them went over the *p*-value. Most of the variables may not be passive of changes when analysed alone, but as a group, they definitely show important influence. As for the minimum temperature as the Y variables, the results were quite different from the linear regression of the maximum temperature. 3 out of 6 variables were worthy analysing. The variables are maximum temperature, cloudiness and precipitation. They had good correlation values basing on the R^2 and Sig-F. As a multiple regression, the *p*-values, again, were over 0.05, exception of the 3 previous variables mentioned. A multiple regression with them were done and the result couldn't be better, with very high R^2 and very low Sig-F meaning a great influence of those variables in the minimum temperature.

The last year of the series to be analysed is the 2010. This year had the third lowest precipitation values, the second highest mean value for maximum temperature and the lowest value for minimum temperature. Starting with the minimum temperature as the X variable, the results showed that for insolation and relative humidity, these variable did not influenced the minimum temperature since their R^2 were not valuable and also had *p*-values over 0.05. The maximum temperature variable had the highest value for R^2 0.53 of the other variables with high correlation (cloudiness= 0.45, precipitation= 0.43). As a multiple regression, all the variables made the R^2 rise, but 2 of them were over 0.05 for the *p*-value. The multiple regression with only the variable with significant statistical showed a very strong correlation with a value of R^2 of 96% and very low values for Sig-F and *p*-values. For the maximum temperature being the Y variable, the linear regression that stood out of the pack was the only one with the minimum temperature being the X variable. All the rest had values not significant as far as statistics significance. As a multiple regression, 3 out of 5 had interesting results: the minimum temperature, relative humidity and cloudiness variables. A multiple regression with those variables was done and the results were excellent comparing to the linear regression. The R^2 was 94%, the Sig-F was 2.57532^{-05} and the *p*-values were very low. The variables are much more powerful and more influential when they are together. Lastly, the precipitation variable as the Y. The variables that had values under the *p*-value were the minimum temperature and cloudiness. All the rest had very low R^2 and high Sig-F values. The multiple regression with all the variables presented all the variables with very high values for *p*-value. Another multiple regression was done only with the minimum temperature and cloudiness variables to check their correlation together and also presented *p*-values higher than 0.05(Appendix 19).

The frequency of the linear regressions with *p*-values under 0.05 and over 0.05 is shown in the table 14. As for the multiple regressions, every year had different variables to be compared, but 5 years had the same variables for its multiple regression. The years are the following with their respective variables:

- 1987 and 2002, minimum temperature as the Y variable and the precipitation, maximum temperature, insolation and relative humidity as the X variable;

- 1988 and 1989 had two multiple regressions with the same variables. The first multiple regression had the maximum temperature as the Y variable and the precipitation, minimum temperature and relative humidity as the X variable; the second multiple regression had also the maximum temperature as the Y variable and the minimum temperature and the relative humidity as the X variable;
- 1997, 2005 and 2009, minimum temperature as the Y variable and the precipitation, maximum temperature, cloudiness, insolation, relative humidity and the average wind speed as the X variable;
- 1997 and 2005, minimum temperature as the Y variable and the maximum temperature and cloudiness.

The results for the multiple regression of 1987 and 2002 had different values for their *p*-values. 1987 had 2 variables under 0.05, maximum temperature and relative humidity. 2002 had 1 variable under 0.05, maximum temperature.Although they had the same variables for their multiple regression, the years are quite different weather-wise. 1987 had the highest mean value for minimum temperature. 2002 had the lowest mean value for precipitation and the third highest mean value for minimum temperature and the highest mean value for maximum temperature. 1987 rained a lot more than 2002, it was more humid and had a lower mean value for maximum temperature. Also it had about 453 hours less insolation. 1987 has a stronger correlation when analysed with the maximum temperature and relative humidity together and 2002 has a stronger correlation when analysed with the maximum temperature and precipitation.

For the years 1988 and 1989, their regression had the same results. Their differences are that 1988 had the highest mean for precipitation and the third lowest mean for maximum temperature and 1989 had the second lowest mean for maximum temperature. The biggest difference between these years is that 1988 not only rained a lot more than 1989, but it, also, had 3 months without a single drop of rain.

The reason why the years 1997, 2005 and 2009 having the same variables for their multiple regression is only because they all had the same set of data and also being in the top 3 of lowest and highest mean values for the series here studied. 1997 has the second highest mean value for minimum temperature. 2005 has the second lowest mean value for minimum temperature and 2009 has the third lowest mean for minimum temperature and the third highest mean value for maximum temperature. As for the years 1997 and 2005, they had their strongest multiple regression with the minimum temperature as the Y variable and the maximum temperature and the cloudiness as the X variable.

Table 14: Frequency of linear regressions with p-values under 0.05 and over 0.05

Linear Regressions	**Quantity of Years**			
	***p*-value**		**Frequency - Variables**	
	<0.05	**>0.05**	**<0.05**	**>0.05**
Max Temp - Precipitation	0	6	0%	100%
Max Temp - Min Temp	6	0	100%	0%
Max Temp - Cloudiness	0	2	0%	100%
Max Temp - Insolation	0	2	0%	100%
Max Temp - Relative Humidity	0	5	0%	100%
Max Temp - Wind	0	2	0%	100%
Total	**6**	**17**	**17%**	**83%**
Min Temp - Precipitation	5	1	83%	17%
Min Temp - Max Temp	6	0	100%	0%
Min Temp - Cloudiness	4	0	100%	0%
Min Temp - Insolation	0	5	0%	100%
Min Temp - Relative Humidity	0	6	0%	100%
Min Temp - Wind	0	4	0%	100%
Total	**15**	**16**	**47%**	**53%**
Precipitation - Max Temp	1	5	17%	83%
Precipitation - Min Temp	6	0	100%	0%
Precipitation - Cloudiness	2	1	67%	33%
Precipitation - Insolation	0	4	0%	100%
Precipitation - Relative Humidity	0	6	0%	100%
Precipitation - Wind	0	2	0%	100%
Total	**9**	**18**	**31%**	**69%**

Analysing the frequency table 14, we easily see that of all the variables, the minimum temperature is the one that excels from the others. The 6 years analysed that had the lowest and the highest mean value for maximum and minimum temperature and precipitation, the linear regression with the minimum temperature variable being either the Y or the X had 100% of statistical significance. The maximum temperature linear regressions had almost no variables that explained their changes, except by the minimum temperature variable explaining 100% of the 6 years analysed. As far as the minimum temperature being the Y, the linear regressions showed that the insolation, relative humidity and average wind speed has no statistical significance and the cloudiness, maximum temperature and precipitation are representative of changes. And the last variable of the table, the precipitation as the Y, the variables of insolation, relative humidity and average wind speed also are not statistical significant, but in this case, the variable that are more suitable to the analysis are the cloudiness and minimum temperature.

3 - Climate impact

A mixture of various analyses including articles, dissertations, the fields of GIS, remote sensing and statistics techniques supports the results gathered in this topic.

The pressure to develop more pasture in the region resulted in a total ignorance of the cultural and environmental values that the Pantanal has to offer to the world resulting in great impacts in every part of the ecosystems, such as the dendro-phytophysiognomy (SALIS&CRISPIM, 1999 *apud*BACANI, 2007); the "Pantaneira" fauna contributing to the extinction of some species (ALHO*et al.*, 1988; CAMPOS, 1993; PIMM*et al.*, 1995 *apud* BACANI, 2007); the ponds and lakes there within (SAKAMOTO, 1997); the pedology (SAKAMOTO, 1997) as well as the micro-climate within the region (GRADELLA*et al.*, 2004; SALVI-SAKAMOTO*et al.*, 2004; QUÉNOL*et al.*, 2005; BACANI, 2007; BACANI*et al.*, 2010; TOZATO*et al.*, 2013); to name a few.

Many are the ways to deforest an area, but a common one among the farmers of the Pantanal is the controlled burning of the aerial biomasses of aboveground herbaceous (CARDOSO*et al.*, 2003). Such technique is applied in various countries of the world. The idea is to prevent and to reduce the quantity of flammable material in areas subject to long periods of dryness decreasing the risk of wild intense fire (FERNANDEZ*et al.,* 1997 *apud*CARDOSO*et al.*, 2003) and also to contain the expansion of undesirable species and promote the rebirth of the forages with low acceptability. Although the fire acts as selective element over the vegetation, it provides the appearance of the indicator flora by stimulating rapid formation of green shoots, regardless of rainfall, through its pruning effect on these plants, using stored reserves in the root system. (COUTINHO, 1990 *apud*CARDOSO*et al.*, 2003) However, when this technique is applied to the Pantanal, it did not result in a good technique, as shown by CARDOSO*et al.* (2003) in his study. CARDOSO shows us that it takes about 7 months to recover the values of an area where the burning techniques was not applied. It also exposed the soil to weathering, compromising it. In a long term, the periodic burning would affect the soil mainly because the Pantanal soil is characterized by low natural fertility and sandy textures.

The impacts in the climate of the Pantanal are, yet, not conclude in a regional scale since the area suffers of lots of influences from distance such the Amazon forest, possibly the glaciers in Peru and the Andes. (DUBREUIL*et al.*, 2011; SALVI-SAKAMOTO*et al.*, 2004; GRADELLA*et al.*, 2004; ZAVATINI, 2009). As for a micro scale analysis, many were the articles published regarding the subject, which we are going to cover some. SILVA&SAKAMOTO(2002) and SILVA(2003) had published an article and a monography, respectively, assessing the differences among different landscape unities: old meanders, salted pond, "cordilheiras" and beach. Their results showed a similar behaviour between the salted pond and the beach and the old meander with the bay. They all presented higher thermal amplitude and temperature, while the "cordilheiras" presented lower temperature and lower thermal amplitude. In constructed areas, the temperatures were higher. During the autumn, there were low cloudiness and scarce winds. The beach area had 6 °C of temperature higher than the "cordilheiras" and the latter presented higher humidity. The article and the monography showed the importance of the "cordilheiras" in terms of maintenance of a standard pattern of temperature and humidity range.

The main problems that the Pantanal of Nhecolândia suffer is the fact that these "cordilheiras" are cut down to broaden the cattle area for pasture which the consequences are detect, as showed above. As put by LAWTON*et al.* (2001, p. 584) "Deforestation and conversion of land to pasture or cropland generally increase surface albedo, reduce aerodynamic roughnesslength and mechanically turbulent mixing in theboundary layer, reduce evapotranspiration,and increase the ratio of convective sensibleheat transfers to latent heat transfers from the surface to the atmosphere. Conversion offorest to grassland or cropland also commonlyalters surface soil structure by compaction and thus reduces infiltration of rainfall and increases runoff, with the end result of reducingsoil moisture. Because grasses and crops usually have shallower roots than do forest trees,the volume of water available for transpirationand latent heat transfer is greater for forests thanfor agricultural land developed from them".

GRADELLA*et al.*(2004) also found, yet, little differences between the beach and the "cordilheiras" in his study while analysing the temperature ranges. The author also measured the input and output of the radiative energy in both areas and concluded that in the beach, the gain and loss of energy is a lot faster than the "cordilheiras". The study emphasized the importance of a vegetal coverage to the area and its influence.

QUÉNOL*et al.* (2005) had as objective of the study to determine the climatic conditions of a saline pond and to assess the influence of its evaporation process since a study conduct by BARBIÉRO*et al.* (2002) (in QUÉNOL*et* al, 2005) showed that this process is responsible for 90% of the geochemical transformations in the Pantanal of Nhecolândia. After fixing 7 meteorological determined points in a transect trajectory crossing the landscape unities (beach, saline pond and "cordilheiras"), the authors observed that there are a strong spatial variability of the temperatures and relative humidity among the points and, also, an alternated breeze system established between the beach and the "cordilheiras" showing a specific local climatic system in the saline environment. They were able to measure the speed of these breezes and their directions, which later was compared to the alternation of lake breezes with land breezes phenomenon, but in a much finer scale. They also found out that the temperature within the "cordilheiras" were considerable lower when compared to the other environments which is explained by the limitation of solar radiation input of the "cordilheira's" vegetation. They concluded that the strong heterogeneity of the land cover (water, bare soil, grass, forest) and a closed environment (saline pond and beach, which its form is oval and surround by the "cordilheiras" vegetation of about 15 meters of height) are responsible for the localized thermodynamics phenomena.

In BACANI's(2007) master's degree dissertation, the author researched the use of Remote Sensing science to assess the land use and land occupation in the Pantanal of Nhecolândia using as example, the Firme farm. The author did an exhaustive study of the land use process and evolution from the year 1987 until 2004 identifying the areas with high anthropogenic alteration following an analysis of the microclimate behaviour and the morphology of the soils there within. It was concluded that an intensification of the deforestation occurred during the years analysed and oscillations on the hydrology regime configured by the different flood levels. The microclimate behaviour and the morphology of the soil showed profound alterations due to the deforestation (from "cordilheiras" to pasture). His studies proved that the consequences of deforestation affects this micro-region and all its environmental aspects, thus the importance of proper and sustainable use of it.

Many of the above studies proves the relation between the deforestation and its impacts in their area of interest for their studies.

Although the studies showed the impacts, they also are studied in small areas of the Nhecolândia region. They presented impacts in a micro-climate scale. In this study, the data analysed had a region of interest much bigger and with only one meteorological station to collect the data.

The methodology here applied intended to seek a climate impact caused by the correlation of the deforestation, proven by the satellite imagery, with the statistical analysis of the meteorological data.

Although the deforestation had happened and the above mentioned studies had showed results where the climate impact occurred, the study here did not presented a conclusive and, yet, real correlation. The deforestation results showed an increase of the deforested area from 1984 to 1999. As for 1999 to 2014, it showed an increase of the vegetated area. The fact that the area of vegetated area had grown does not exclude the results presented in the studies mentioned here as the impact problem were solved. The vegetated area had grown not where the "cordilheiras" were cut-down. Instead,they actually grew where old "cordilheiras" were not deforested. And even though the vegetated are had grown, the deforestation kept going around the saline/fresh water ponds where the "cordilheiras" are located. The impacts are still happening for those areas.

As for the statistical analysis, they do not show a trend regarding the deforestation. Their changes are not direct related to the deforestation. The variable that had more statistical representability was the minimum temperature influencing both the maximum temperature and the precipitation. They present great statistical significance. But they do not explain any climate impact in the region.

The impacts are caused not by direct factors such the deforestation, but by indirect factors. The explanation for its changes is certainly the atmospheric circulation. Many are the actors that participate in this scenario. As previously mentioned in this topic and in chapter 3, topic 2, the Pantanal is on the influence of the ENSO (El Niño Southern Oscillation), South Atlantic Convergence Zone (SACZ), the Intertropical Convergence Zone (ITCZ), the

Atlantic anticyclone, responsible forthe dry season (autumn and winter), and the convection in Amazon, which regulates the rainy season (spring and summer) (ZAVATINI, 1990; SETTE, 2000 *apud*TOZATO*et al.*, 2013)

CONCLUSION

The results here presented are important to understand that the climate is not influenced by a direct system, but, instead, by indirect systems.

Deforestation is a problem that has been affecting humanity since the beginning of the civilization. But, yet, alone it does not explain the alterations of the climate in a regional level as far as this dissertation methodology observed. It does explain the impacts and alterations in a micro-scale level, as presented in this dissertation by several studies.

The initial hypothesis of this dissertation was to seek whether deforestation could affect and cause a climate impact in the Pantanal of Nhecolândia through the statistical techniques applied to the meteorological data and the Remote Sensing science.

The initial results were obtained through the Remote Sensing science with the study of a time series deforestation cartography from the years of 1984 and 2014. It was proven that the deforestation happens, but it also presented a growth in the vegetated area. The cartography for the Nhecolândia presented difficulties while doing a supervised classification technique since the targets are easily mismatched with each other. New techniques and methodology are greatly advised.

The statistical results are very straightforward depending on the analyses. In this study, it was focused on the *p*-values results since they present the statistical significance of a variable to the given regression. It is clear that the influence of the deforestation is not entirely impactful as far as the regional analysis of the area. The deforestation has a negative impact in a micro scale level, where it shows changes in the surrounding dynamics of the area, as shown by some studies here presented. As for this study, the results does not present ambiguous direct relation of the deforestation and the climate impact. It shows, mostly, the influence of the analysed variables in each variable.

It is concluded that the climate impact in the region does not seem to be caused by the deforestation, but the changes in the regional climate is, therefore,caused by the atmospheric circulation.

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APPENDIX

Appendix 1: Insolation data from 1986 until 2011

Insolation																			
Months	**86**	**87**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**05**	**06**	**09**	**11**
Jan	169.5	158.7	208.3	180.7	187.8	205.5	234.7	172.6	191.5	178.1	198.0	229.5	242.3	217.9	211.9	138.9	156.7	222.6	174.0
Feb	161.8	185.0	191.7	197.3	205.0	185.6	192.5	197.6	205.5	177.3	150.3	161.1	154.9	98.0	159.7	206.3	197.2	171.2	133.2
Mar	196.4	176.4	240.2	201.7	186.1	220.9	224.8	242.6	194.9	220.8	201.4	167.5	152.5	226.1	240.2	224.2	181.0	168.9	150.0
Apr	244.7	177.9	211.1	222.3	203.3	196.3	247.0	223.1	261.0	226.7	192.3	210.1	253.3	225.3	254.0	202.2	194.1	260.6	225.0
May	152.5	158.6	194.0	217.3	179.9	216.5	241.0	218.1	201.7	214.4	186.3	267.9	226.1	200.6	236.3	215.9	235.7	212.0	262.3
Jun	238.2	167.0	194.1	177.2	220.9	229.4	226.4	213.0	207.3	185.2	213.9	217.9	210.9	214.3	222.8	215.4	208.6	207.9	204.3
Jul	231.7	239.3	230.4	239.0	207.6	188.7	222.5	267.5	260.6	253.5	262.1	227.7	218.0	234.8	196.2	228.1	253.8	196.3	231.7
Aug	160.0	148.9	212.3	204.4	150.3	170.8	235.5	233.6	181.0	207.2	147.9	216.5	231.3	264.8	207.8	221.9	253.9	243.6	248.4
Sep	162.8	130.4	190.9	119.0	151.2	172.0	152.2	165.8	196.0	188.1	116.9	182.4	187.8	224.6	185.6	174.7	184.9	195.3	240.5
Oct	229.2	161.1	241.5	208.9	183.3	228.1	215.2	197.1	226.2	230.6	203.7	213.0	179.4	191.6	192.6	190.2	201.7	233.4	249.2
Nov	213.5	229.5	243.1	187.5	185.3	195.1	240.6	233.7	203.2	212.5	227.4	227.2	225.8	181.3	209.3	181.1	202.1	225.2	265.9
Dec	145.1	170.8	227.5	201.0	188.6	181.2	185.3	241.0	210.9	246.6	213.3	217.2	215.7	181.6	240.5	210.4	136.9	177.8	225.3
Total	**2305.4**	**2103.6**	**2585.1**	**2356.3**	**2249.3**	**2390.1**	**2617.7**	**2605.7**	**2539.8**	**2541.0**	**2313.5**	**2538.0**	**2498.0**	**2460.9**	**2556.9**	**2409.3**	**2406.6**	**2514.8**	**2609.8**
Mean	**192.1**	**175.3**	**215.4**	**196.4**	**187.4**	**199.2**	**218.1**	**217.1**	**211.7**	**211.8**	**192.8**	**211.5**	**208.2**	**205.1**	**213.1**	**200.8**	**200.6**	**209.6**	**217.5**

Appendix 2: Cloudiness data from 1993 until 2011

Cloudiness																	
Months	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**
Jan	0.51	0.53	0.70	0.45	0.54	0.48	0.73	0.55	0.56	0.51	0.68	0.79	0.81	0.64	0.55	0.76	0.68
Feb	0.46	0.71	0.60	0.40	0.53	0.63	0.77	0.66	0.63	0.56	0.66	0.67	0.61	0.65	0.72	0.73	0.77
Mar	0.49	0.59	0.36	0.41	0.44	0.55	0.74	0.76	0.48	0.42	0.56	0.50	0.45	0.43	0.48	0.41	0.69
Apr	0.43	0.49	0.32	0.26	0.36	0.49	0.51	0.41	0.45	0.43	0.50	0.53	0.35	0.45	0.42	0.48	0.48
May	0.36	0.43	0.30	0.36	0.36	0.44	0.33	0.36	0.46	0.66	0.42	0.32	0.45	0.54	0.41	0.51	0.36
Jun	0.40	0.45	0.29	0.33	0.37	0.41	0.45	0.53	0.32	0.39	0.41	0.45	0.29	0.42	0.44	0.23	0.36
Jul	0.43	0.36	0.18	0.19	0.24	0.27	0.32	0.41	0.30	0.42	0.36	0.24	0.38	0.15	0.49	0.32	0.21
Aug	0.32	0.22	0.19	0.30	0.36	0.51	0.18	0.32	0.19	0.30	0.19	0.36	0.27	0.26	0.37	0.12	0.28
Sep	0.35	0.38	0.17	0.33	0.21	0.51	0.24	0.42	0.29	0.21	0.34	0.36	0.13	0.33	0.42	0.18	0.26
Oct	0.52	0.48	0.39	0.35	0.33	0.47	0.38	0.39	0.55	0.49	0.49	0.68	0.47	0.60	0.49	0.44	0.45
Nov	0.60	0.58	0.40	0.43	0.55	0.52	0.42	0.49	0.64	0.57	0.64	0.60	0.68	0.47	0.54	0.58	0.44
Dec	0.65	0.66	0.39	0.46	0.42	0.60	0.53	0.53	0.68	0.52	0.63	0.68	0.63	0.50	0.53	0.53	0.49
Total	**5.54**	**5.87**	**4.29**	**4.26**	**4.71**	**5.88**	**5.59**	**5.82**	**5.57**	**5.48**	**5.88**	**6.18**	**5.51**	**5.44**	**5.88**	**5.28**	**5.47**
Mean	**0.46**	**0.49**	**0.36**	**0.35**	**0.39**	**0.49**	**0.47**	**0.49**	**0.46**	**0.50**	**0.49**	**0.51**	**0.46**	**0.45**	**0.49**	**0.44**	**0.50**

Appendix 3: Minimum temperature data from 1985 until 2011

Minimum Temperature																										
Months	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**
Jan	22.9	23.4	23.5	24.5	23.4	22.9	23.5	22.8	23.5	22.6	23.9	23.4	25.0	23.4	24.1	23.4	23.7	23.5	22.9	24.1	23.0	23.9	22.7	20.4	22.7	22.6
Feb	22.9	24.1	22.9	23.4	23.2	22.1	23.5	22.8	22.6	23.4	24.4	23.2	24.5	23.9	24.1	23.7	23.6	23.5	22.5	22.7	23.0	23.4	23.0	22.7	23.8	23.1
Mar	24.2	23.6	24.9	25.2	23.5	22.7	22.9	21.9	23.3	21.7	24.2	23.3	22.2	23.2	23.7	22.4	22.8	23.9	21.6	21.8	23.5	22.5	22.8	22.5	22.8	23.0
Apr	22.9	23.3	22.4	23.8	23.3	22.0	21.4	19.3	21.6	20.2	20.2	22.3	20.4	23.0	20.1	22.3	20.9	21.9	21.5	19.4	20.6	20.9	20.2	19.1	19.2	22.4
May	20.5	20.6	18.9	19.1	18.4	17.1	19.4	19.7	16.2	18.2	17.2	19.5	18.4	16.6	16.4	18.6	16.8	19.5	16.3	16.8	11.8	15.5	16.7	17.1	15.1	17.9
Jun	15.7	15.8	17.0	16.4	18.7	15.2	17.4	17.7	15.2	16.0	16.8	15.4	18.1	16.3	15.5	17.2	13.8	15.5	15.8	16.4	15.5	13.7	14.8	14.0	15.4	15.7
Jul	15.7	14.5	18.6	13.1	14.8	12.5	13.6	12.7	13.3	13.6	16.4	14.1	15.1	16.3	14.4	12.1	15.9	15.4	14.1	12.1	14.7	12.3	14.3	14.8	12.7	15.4
Aug	15.8	18.5	15.5	16.4	18.1	15.8	14.5	14.8	14.1	13.8	15.3	18.4	16.1	18.0	14.3	17.0	16.7	18.4	13.9	14.1	14.8	12.6	16.7	15.2	13.0	15.5
Sep	22.0	17.7	17.7	18.6	18.2	16.9	19.3	17.4	18.1	19.2	18.6	17.4	21.7	18.1	18.8	18.8	19.2	18.2	17.2	16.3	18.1	17.9	16.0	18.2	19.2	18.6
Oct	21.3	18.1	24.9	20.3	20.2	21.7	19.7	21.8	20.9	21.7	20.4	22.0	22.8	21.1	21.6	21.8	21.6	23.1	20.1	21.7	21.9	21.3	21.2	21.3	20.4	20.8
Nov	22.8	22.4	23.5	20.6	21.9	22.8	21.5	21.1	22.5	21.8	21.4	22.8	23.8	22.0	19.4	21.9	22.3	24.1	20.8	22.2	21.1	21.1	21.3	23.5	19.2	20.9
Dec	22.7	23.2	22.4	22.3	23.0	22.9	22.8	22.8	23.2	23.8	22.9	24.6	23.5	23.1	22.4	22.5	22.5	24.5	22.2	22.7	23.5	22.4	21.2	22.6	22.3	21.9
Mean	**22.6**	**20.4**	**21.0**	**20.3**	**20.5**	**19.5**	**20.0**	**19.6**	**19.5**	**19.7**	**20.2**	**20.5**	**21.0**	**20.4**	**19.6**	**20.1**	**20.0**	**21.0**	**20.8**	**19.2**	**19.3**	**19.0**	**19.2**	**19.3**	**18.8**	**19.8**

Appendix 4: Maximum temperature data from 1985 until 2011

Maximum Temperature																							
Months	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**05**	**06**	**09**	**10**	**11**
Jan	30.1	32.4	32.8	32.3	31.0	32.5	32.8	33.0	32.9	33.5	31.8	32.6	32.2	34.6	33.4	35.1	32.7	34.0	32.5	33.3	33.8	33.2	33.8
Feb	29.8	32.2	31.4	31.4	30.8	32.2	33.0	32.3	31.9	33.2	32.0	33.5	32.2	33.1	33.8	32.7	33.4	32.7	33.7	33.3	33.7	34.1	32.5
Mar	30.9	32.2	32.1	31.7	31.1	33.8	31.7	31.6	33.7	32.4	32.6	32.5	32.2	33.7	32.2	31.7	33.2	33.6	33.5	33.3	33.7	35.2	31.2
Apr	30.6	32.5	31.8	30.8	31.3	32.7	31.4	31.1	31.9	32.5	30.5	31.9	30.8	32.2	32.2	32.9	32.8	33.8	32.4	32.1	34.3	33.1	32.3
May	30.2	30.4	27.5	26.8	28.6	28.0	29.8	29.5	30.0	31.0	29.0	30.0	29.2	31.1	30.2	30.3	28.9	31.9	31.1	28.6	31.5	28.6	29.7
Jun	27.4	29.9	27.0	27.2	29.1	27.4	28.2	30.6	29.4	29.5	29.4	26.2	27.4	30.5	29.9	29.0	27.8	29.2	31.1	30.9	28.5	30.9	29.2
Jul	27.6	28.9	29.8	25.7	27.5	25.6	29.4	26.7	28.4	29.2	30.2	29.8	31.0	33.7	29.5	26.4	30.5	29.2	28.3	31.6	30.0	29.2	30.0
Aug	27.4	30.8	28.3	31.7	29.7	32.1	31.0	28.8	29.5	32.9	31.9	32.9	30.5	30.7	32.6	31.7	34.1	33.8	33.3	32.9	32.5	33.3	31.9
Sep	32.0	30.5	30.8	32.4	29.7	30.6	32.8	29.4	32.4	34.8	33.9	30.9	35.1	30.8	34.8	30.4	34.2	34.0	31.0	32.9	33.1	35.2	34.5
Oct	32.7	32.5	33.3	33.2	32.7	34.8	33.3	32.5	34.7	35.7	32.7	33.0	35.1	32.9	35.1	34.7	33.6	38.0	33.9	33.5	35.5	34.4	34.3
Nov	33.4	35.1	34.8	32.9	33.9	34.7	33.2	31.6	35.8	34.8	33.9	32.5	35.1	33.4	32.2	32.8	33.7	37.6	34.2	33.8	35.4	33.8	35.9
Dec	35.5	33.4	33.1	33.2	32.3	34.9	33.0	33.1	34.0	32.5	34.0	33.4	34.3	32.5	34.5	33.0	32.1	34.6	33.5	32.6	34.0	35.6	35.4
Mean	**30.6**	**31.7**	**31.1**	**30.8**	**30.6**	**31.6**	**31.6**	**30.8**	**32.1**	**32.7**	**31.8**	**31.6**	**32.1**	**32.4**	**32.5**	**31.7**	**32.3**	**33.5**	**32.4**	**32.4**	**33.0**	**33.0**	**32.6**

Appendix 5: Wind data from 1993 until 2011

Wind																
Months	**93**	**94**	**95**	**96**	**97**	**98**	**00**	**01**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**
Jan	1.18	1.19	0.96	1.09	1.28	1.61	0.18	1.57	2.30	4.06	1.73	2.97	2.69	2.09	3.15	3.27
Feb	1.05	1.23	1.11	1.18	1.15	1.23	1.14	0.70	1.84	1.81	1.98	2.46	2.55	2.24	3.64	3.04
Mar	0.60	1.11	0.74	0.67	0.65	0.96	1.01	1.23	1.45	1.73	1.72	1.96	1.49	1.33	2.05	3.33
Apr	1.20	1.20	1.00	0.96	0.89	1.02	0.88	1.28	3.06	2.08	1.73	1.69	2.17	0.98	2.94	2.70
May	1.38	1.26	0.71	0.76	0.84	0.75	0.92	1.49	2.11	2.30	2.15	2.23	2.51	2.32	3.20	2.22
Jun	1.32	1.26	1.23	1.03	1.80	0.64	1.67	1.50	2.26	1.86	1.72	2.76	1.84	2.62	2.17	3.40
Jul	1.70	1.83	1.11	0.73	1.24	0.36	1.74	2.26	2.61	2.28	2.43	2.46	1.92	3.01	3.59	2.94
Aug	1.44	1.25	1.26	1.09	1.61	0.43	1.56	2.53	2.22	2.91	3.46	4.10	2.39	2.75	2.96	4.62
Sep	1.90	1.49	1.29	1.31	1.52	0.55	2.80	2.14	2.77	3.79	2.82	3.12	3.08	4.46	4.52	4.09
Oct	1.82	1.49	1.33	1.24	1.68	0.49	1.38	1.94	2.41	2.58	2.40	2.69	3.00	3.90	2.84	3.28
Nov	1.54	1.39	1.07	1.17	1.94	0.96	1.49	1.64	2.71	2.07	2.50	3.42	1.86	4.33	3.80	4.02
Dec	1.39	1.55	0.96	1.71	1.72	0.14	1.54	1.66	2.01	1.88	2.72	2.96	1.75	3.27	3.72	2.31
Mean	**1.38**	**1.35**	**1.06**	**1.08**	**1.36**	**0.76**	**1.36**	**1.66**	**2.31**	**2.45**	**2.28**	**2.73**	**2.27**	**2.77**	**3.22**	**3.27**

Appendix 6: Humidity data from 1986 until 2011

Humidity																								
Months	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**04**	**05**	**06**	**07**	**08**	**09**	**10**
Jan	84.9	86.4	87.3	86.7	83.7	86.0	84.5	86.3	81.7	85.3	83.6	84.7	82.3	83.9	75.0	81.8	81.8	78.2	86.8	82.9	86.8	87.9	76.1	80.8
Feb	85.6	83.2	86.9	87.9	82.6	85.0	84.1	86.3	83.8	85.8	80.7	85.7	85.1	85.4	82.1	84.0	84.0	83.3	83.6	83.4	85.4	81.8	82.9	80.7
Mar	86.2	84.7	86.8	86.9	82.6	86.4	86.2	86.8	82.3	86.4	86.1	83.3	84.9	86.0	86.3	85.0	85.0	83.3	86.3	85.8	79.5	87.0	86.9	83.1
Apr	84.2	85.5	87.4	86.7	85.5	87.4	86.4	84.3	82.3	83.7	83.0	86.2	84.7	76.5	81.6	81.9	81.9	85.6	80.0	85.6	81.7	82.5	79.4	76.2
May	86.5	86.6	87.3	84.4	86.4	85.7	87.7	83.2	81.8	85.1	86.8	83.5	85.0	79.2	80.2	80.2	80.2	85.4	78.7	80.8	79.8	80.5	79.6	80.3
Jun	83.8	85.3	84.6	85.5	88.6	87.3	86.0	81.4	80.3	81.8	82.5	84.8	86.3	78.0	80.1	79.3	79.3	79.9	81.5	80.7	79.0	81.6	78.8	86.8
Jul	81.4	82.0	80.4	83.0	81.4	83.9	82.7	77.5	75.5	81.3	74.5	80.3	82.9	74.7	73.4	76.7	76.7	79.7	73.2	76.5	74.7	74.0	77.2	75.3
Aug	82.2	77.7	79.3	84.8	77.4	75.9	83.3	74.0	67.8	73.3	72.1	77.4	87.0	62.2	76.0	67.8	67.8	68.5	66.1	62.2	69.4	72.3	69.7	65.7
Sep	78.1	73.0	76.5	78.4	75.2	78.4	81.7	67.0	64.7	70.9	77.2	75.5	84.2	65.5	73.0	70.8	70.8	62.3	67.4	70.0	57.6	64.8	66.7	68.9
Oct	74.7	75.0	74.2	75.6	78.5	78.3	82.2	69.3	70.4	76.9	76.8	75.5	80.3	66.9	74.4	76.3	76.3	73.4	78.4	78.6	70.4	75.6	67.4	69.9
Nov	74.4	77.7	79.1	76.6	78.1	80.6	82.5	71.3	72.8	78.1	80.3	76.8	80.9	72.5	78.0	80.7	80.7	75.8	77.5	76.4	75.8	77.6	72.7	72.1
Dec	84.2	83.7	83.0	83.0	80.3	82.6	83.8	78.4	80.9	81.1	80.0	80.1	83.7	78.3	77.3	81.3	81.3	76.3	80.6	85.2	78.7	76.3	78.8	72.6
Mean	**82.2**	**81.7**	**82.7**	**83.3**	**81.7**	**83.1**	**84.3**	**78.8**	**77.0**	**80.8**	**80.3**	**81.1**	**83.9**	**75.8**	**78.1**	**78.8**	**78.8**	**84.7**	**78.3**	**79.0**	**76.6**	**78.5**	**76.3**	**76.0**

Appendix 7: Precipitation data from 1984 until 2011

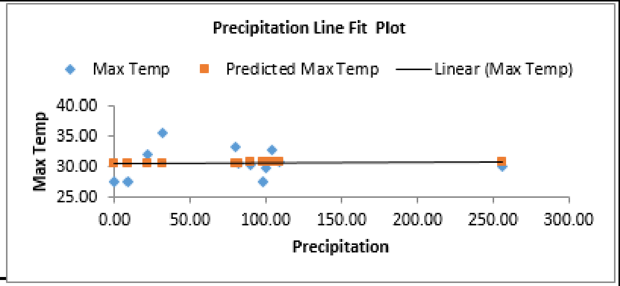
Precipitation																											
Months	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**
Jan	182.3	255.6	296.2	346.5	297.7	266.5	112.2	227.4	238.2	94.2	67.5	264.9	154.0	225.2	97.3	96.8	88.1	168.2	40.6	63.4	275.4	162.2	282.2	392.8	193.4	181.4	187.9
Feb	114.6	99.9	222.2	58.9	308.7	222.8	173.8	93.1	117.1	110.5	188.9	240.7	41.6	110.4	283.0	9.0	245.3	74.4	155.1	182.2	99.4	165.6	211.7	167.6	146.4	64.4	153.9
Mar	97.2	109.0	158.1	80.2	331.6	251.5	62.8	182.5	166.6	170.9	102.1	136.4	219.0	82.6	108.4	195.0	340.9	67.4	131.1	56.2	37.4	152.2	31.8	123.0	190.2	67.8	455.2
Apr	59.1	81.7	33.5	175.2	146.9	152.3	107.4	253.9	92.2	79.4	39.6	56.4	101.4	140.8	159.4	40.0	127.0	113.6	50.6	75.5	41.6	54.6	10.4	27.0	1.4	10.4	168.8
May	27.7	89.5	92.7	104.6	37.7	10.0	116.7	55.6	93.8	7.8	64.4	11.6	59.9	54.6	71.1	10.3	1.4	88.2	39.6	158.7	44.2	52.5	85.4	86.0	54.9	71.8	2.5
Jun	0.0	0.0	0.3	34.4	0.0	53.0	18.0	21.3	2.0	4.3	45.9	3.7	0.0	103.2	9.5	12.3	3.0	11.0	0.0	21.9	33.6	2.6	0.0	22.3	11.1	7.4	1.0
Jul	0.0	98.2	7.1	9.0	0.0	22.3	17.2	5.2	8.8	14.5	12.2	18.2	7.4	0.0	1.0	0.0	9.0	10.4	7.0	8.0	27.4	14.2	12.0	0.0	32.3	0.0	3.2
Aug	112.2	9.0	67.4	24.0	0.0	64.0	24.2	0.0	24.2	4.4	0.0	0.0	25.8	11.5	30.0	0.0	124.0	10.0	13.2	0.5	0.0	16.4	0.0	4.6	56.6	0.0	2.0
Sep	53.4	22.1	60.5	4.7	1.0	41.8	28.4	36.1	123.2	1.3	1.1	3.2	119.5	52.6	66.5	0.0	21.0	124.9	28.1	17.0	45.6	31.0	0.0	43.3	1.5	18.5	30.0
Oct	14.0	104.2	13.3	109.0	78.4	68.8	22.6	47.4	179.8	44.7	100.3	126.0	95.8	57.6	159.2	50.0	51.0	219.6	78.8	200.0	64.2	112.4	76.6	85.9	101.8	96.3	150.1
Nov	182.5	79.4	113.2	125.8	111.5	72.8	58.9	151.6	169.4	37.3	158.9	187.4	161.4	66.8	127.3	109.3	223.4	141.1	26.2	278.0	126.5	183.4	176.7	116.6	81.8	108.9	50.2
Dec	180.9	32.1	288.8	210.2	234.5	90.3	80.0	191.7	200.7	258.3	234.8	129.6	196.4	80.8	165.8	225.6	193.8	176.3	153.2	60.4	171.9	209.3	91.4	139.2	216.2	121.8	67.8
Total	**1023.9**	**980.7**	**1353.3**	**1282.5**	**1548.0**	**1316.1**	**822.2**	**1265.8**	**1416.0**	**827.6**	**1015.7**	**1178.1**	**1182.2**	**986.1**	**1278.5**	**748.3**	**1427.9**	**1205.1**	**723.5**	**1121.8**	**967.2**	**1156.4**	**978.2**	**1208.3**	**1087.6**	**748.7**	**1272.6**

Appendix 8: 1985

Months	Precipitation	Min Temp	Max Temp
Jan	255.60	22.93	30.08
Feb	99.90	22.93	29.82
Mar	109.00	24.20	30.88
Apr	81.70	22.86	30.63
May	89.50	20.46	30.16
Jun	0.00	15.73	27.38
Jul	98.20	15.74	27.62
Aug	9.00	15.81	27.44
Sep	22.10	21.99	32.02
Oct	104.20	21.28	32.72
Nov	79.40	22.81	33.39
Dec	32.10	22.66	35.51
Total/Mean	**980.70**	**20.78**	**30.64**

Max Temp (Y) - Precipitation (X)

Regression Statistics	
Multiple R	0.030222225
R Square	0.000913383
Adjusted R Square	-0.098995279
Standard Error	2.622214449
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.062861702	0.0628617	0.00914218	0.925715496
Residual	10	68.76008616	6.87600862		
Total	11	68.82294786			

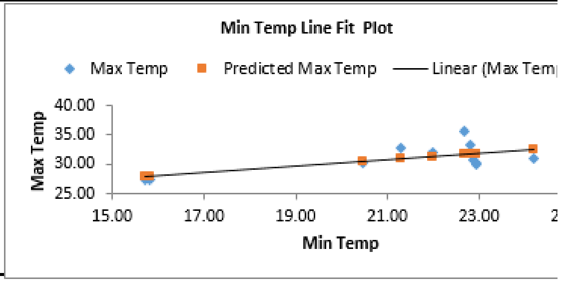
	Coefficients	*Std Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	30.546	1.220	25.032	0.000	27.827	33.265
Precipitation	0.001	0.012	0.096	0.926	-0.025	0.027

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	30.83222744	-0.754808081
2	30.65788153	-0.840640146
3	30.6680713	0.212573862
4	30.63750198	-0.004168644
5	30.64623607	-0.481719941
6	30.54601796	-3.162684631
7	30.65597794	-3.039848909
8	30.55609576	-3.120611891
9	30.57076456	1.445902109
10	30.66269647	2.059884172
11	30.63492654	2.758406793
12	30.58196211	4.927715308

Max Temp (Y) - Min Temp (X)

Regression Statistics	
Multiple R	0.723713184
R Square	0.523760772
Adjusted R Square	0.47613685
Standard Error	1.810419497
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	36.04676033	36.0467603	10.9978503	0.007795973
Residual	10	32.77618754	3.27761875		
Total	11	68.82294786			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	18.76600822	3.617697163	5.18728002	0.00040875	10.70527662	26.82
Min Temp	0.571229377	0.17224897	3.31630069	0.00779597	0.187434756	0.9

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	31.86190235	-1.784483
2	31.86685852	-2.049617137
3	32.58975914	-1.70911398
4	31.82240768	-1.189074345
5	30.45225567	-0.287739537
6	27.74954222	-0.366208887
7	27.75457887	-0.138449834
8	27.79511773	-0.359633855
9	31.32924632	0.687420351
10	30.92029522	1.802285425
11	31.79575031	1.597583026
12	31.71264565	3.797031773

Max Temp (Y) - Precipitation, Min Temp (X)

Regression Statistics	
Multiple R	0.79163163
R Square	0.626680638
Adjusted R Square	0.54372078
Standard Error	1.689606758
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	2	43.13000889	21.5650044	7.55402254	0.011867584
Residual	9	25.69293897	2.854771		
Total	11	68.82294786			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	17.27019529	3.507283948	4.92409384	0.00081997	9.33616779	25.2042228
Precipitation	-0.013235422	0.008402474	-1.5751815	0.14966758	-0.032243138	0.0057723
Min Temp	0.695251473	0.179000607	3.88407327	0.0037083	0.290323968	1.10017898

RESIDUAL OUTPUT

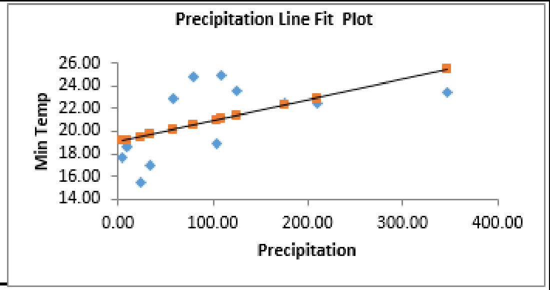
Observation	Predicted Max Temp	Residuals
1	29.82642225	0.250997103
2	31.8932096	-2.07596822
3	32.65261999	-1.771974828
4	32.07999252	-1.446659186
5	30.30912455	-0.144608424
6	28.20418346	-0.820850124
7	26.91059524	0.705533796
8	28.14053526	-0.705051394
9	32.26858987	-0.251923204
10	30.68422151	2.03835913
11	32.07798892	1.315344414
12	32.60287648	2.906800937

Appendix 9: 1987

Months	Precipitation	Humidity	Max Temp	Insolation	Min Temp
Jan	346.50	86.42	32.83	158.70	23.46
Feb	58.90	83.18	31.44	185.00	22.88
Mar	80.20	84.68	32.08	176.40	24.85
Apr	175.20	85.50	31.81	177.90	22.43
May	104.60	86.55	27.47	158.60	18.93
Jun	34.40	85.27	26.96	167.00	17.02
Jul	9.00	82.03	29.83	239.30	18.61
Aug	24.00	77.74	28.30	148.90	15.49
Sep	4.70	73.00	30.76	130.40	17.71
Oct	109.00	75.03	33.31	161.10	24.90
Nov	125.80	77.67	34.82	229.50	23.49
Dec	210.20	83.74	33.05	170.80	22.39
Total/Mean	**1282.50**	**81.73**	**31.05**	**2103.60**	**21.01**

Min Temp (Y) - Precipitation (X)

Regression Statistics	
Multiple R	0.566335984
R Square	0.320736447
Adjusted R Square	0.252810091
Standard Error	2.815947364
Observations	12



ANOVA

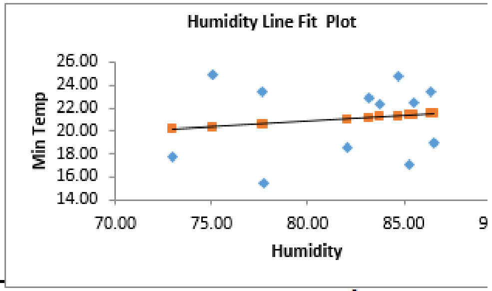
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	37.44200233	37.4420023	4.72182623	0.054893227
Residual	10	79.29559557	7.92955956		
Total	11	116.7375979			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	19.02527582	1.223612786	15.5484448	2.4748E-08	16.29889663	21.751655
Precipitation	0.018594911	0.008557346	2.17297635	0.05489323	-0.00047204	0.03766187

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	25.46841233	-2.007122011
2	20.12051605	2.761626805
3	20.51658765	4.328573643
4	22.28310415	0.143562515
5	20.97030347	-2.041271207
6	19.66494074	-2.648274076
7	19.19263001	-0.586178401
8	19.47155367	-3.978005286
9	19.1126719	-1.399338565
10	21.05212107	3.844653122
11	21.36451557	2.122151097
12	22.93392602	-0.540377635

Min Temp (Y) - Relative Humidity (X)



Regression Statistics	
Multiple R	0.139952721
R Square	0.019586764
Adjusted R Square	-0.078454559
Standard Error	3.383062017
Observations	12

ANOVA

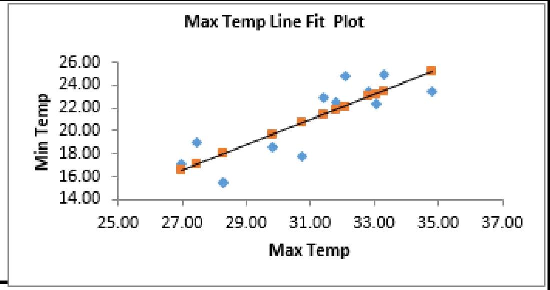
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.286511806	2.28651181	0.1997807	0.664422646
Residual	10	114.4510861	11.4451086		
Total	11	116.7375979			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	13.04046791	17.86274283	0.73003726	0.48211888	-26.7602034	52.84
Humidity	0.097537863	0.218220964	0.44696834	0.66442265	-0.38868875	0.583

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	21.46962709	1.991663237
2	21.153528	1.728614859
3	21.29972242	3.545438869
4	21.37995518	1.046711487
5	21.48221262	-2.553180358
6	21.35719634	-4.340529678
7	21.04171904	-2.435267429
8	20.62325015	-5.12970176
9	20.16073189	-2.447398561
10	20.358954	4.537820191
11	20.61590859	2.870758079
12	21.20847732	1.185071063

Min Temp (Y) - Max Temp (X)



Regression Statistics	
Multiple R	0.83526205
R Square	0.697662692
Adjusted R Square	0.667428961
Standard Error	1.878673231
Observations	12

ANOVA

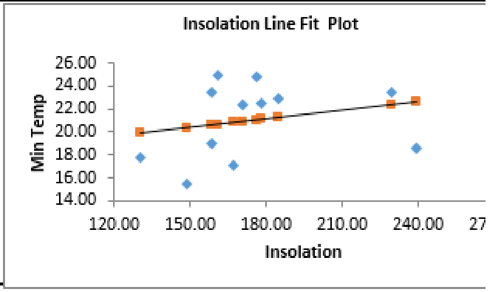
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	81.44346681	81.4434668	23.0756401	0.000719608
Residual	10	35.29413109	3.52941311		
Total	11	116.7375979			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-13.25491439	7.154137085	-1.8527621	0.09362015	-29.1953252	2.6854964
Max Temp	1.103484666	0.229715036	4.80371108	0.00071961	0.591647668	1.61532166

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	22.96785967	0.493430652
2	21.43391428	1.448228576
3	22.14558561	2.699575678
4	21.85061111	0.576055557
5	17.06243689	1.866595364
6	16.49135392	0.52531275
7	19.6609653	-1.054513688
8	17.97370165	-2.480153264
9	20.69195221	-2.978618877
10	23.49824424	1.398529958
11	25.16474339	-1.678076723
12	23.20991437	-0.816365984

Min Temp (Y) - Insolation (X)



Regression Statistics	
Multiple R	0.237993117
R Square	0.056640724
Adjusted R Square	-0.037695204
Standard Error	3.318516173
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	1	6.612102025	6.61210202	0.60041519	0.456350767
Residual	10	110.1254959	11.0125496		
Total	11	116.7375979			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	16.6536394	5.706441699	2.91839298	0.01534263	3.938894941	29.36
Insolation	0.024865759	0.032090455	0.77486463	0.45635077	-0.04663623	0.096

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	20.59983529	2.861455029
2	21.25380475	1.628338112
3	21.03995922	3.805202069
4	21.07725786	1.349408807
5	20.59734872	-1.66831646
6	20.80622109	-3.789554424
7	22.60401544	-3.997563826
8	20.35615086	-4.862602472
9	19.89613432	-2.182800991
10	20.65951311	4.237261079
11	22.360331	1.126335662
12	20.90071097	1.492837414

Min Temp (Y) - Precipitation, Max Temp, Insolation, Relative Humidity (X)

Regression Statistics	
Multiple R	0.931351806
R Square	0.867416186
Adjusted R Square	0.791654006
Standard Error	1.486967959
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	4	101.2600819	25.3150205	11.4491979	0.003425021
Residual	7	15.47751598	2.21107371		
Total	11	116.7375979			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-63.03727077	20.25895106	-3.1115762	0.01704354	-110.942078	-15.132464
Precipitation	-0.013458252	0.009086968	-1.4810498	0.18214309	-0.03494552	0.00802901
Max Temp	1.68668883	0.352712876	4.78204496	0.00200752	0.85265541	2.52072225
Insolation	-0.026083649	0.019254254	-1.3546954	0.21760891	-0.07161273	0.01944543
Humidity	0.461038183	0.167470237	2.75295593	0.02838273	0.065033998	0.85704237

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	23.36951323	0.091777094
2	22.7153287	0.166814161
3	24.43181114	0.413350148
4	23.04252094	-0.615854275
5	17.66065584	1.268376422
6	16.9224936	0.094173065
7	18.73208645	-0.12563484
8	16.33117041	-0.837622022
9	19.04212568	-1.328792348
10	22.06405973	2.832714464
11	23.8156653	-0.328998638
12	24.02385162	-1.630303231

Min Temp (Y) - Relative Humidity, Max Temp (X)

Regression Statistics	
Multiple R	0.905247767
R Square	0.819473519
Adjusted R Square	0.779356524
Standard Error	1.530222486
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	95.66337019	47.8316851	20.4270909	0.000451268
Residual	9	21.07422771	2.34158086		
Total	11	116.7375979			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-37.238099	11.34341169	-3.2827953	0.00948683	-62.898679	-11.5
Humidity	0.250452641	0.101632328	2.46430094	0.03590441	0.020544343	0.480
Max Temp	1.216602171	0.192656443	6.31487924	0.00013852	0.780783019	1.652

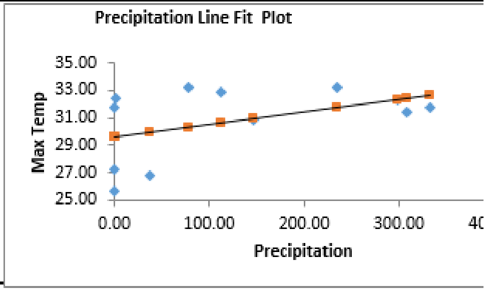
RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	24.34180403	-0.880513704
2	21.83895212	1.043190741
3	22.99896684	1.846194449
4	22.87977219	-0.453105519
5	17.86333662	1.065695638
6	16.91270203	0.10396464
7	19.59716206	-0.990710452
8	16.66241548	-1.168867093
9	18.4716819	-0.758348563
10	22.07462951	2.822144679
11	24.57175502	-1.085088352
12	23.93810485	-1.544556464

Appendix 10: 1988

Months	Precipitation	Min Temp	Humidity	Max Temp
Jan	297.70	24.54	87.32	32.28
Feb	308.70	23.43	86.93	31.37
Mar	331.60	25.21	86.77	31.70
Apr	146.90	23.82	87.37	30.84
May	37.70	19.12	87.29	26.75
Jun	0.00	16.43	84.63	27.19
Jul	0.00	13.13	80.39	25.67
Aug	0.00	16.40	79.32	31.73
Sep	1.00	18.58	76.47	32.41
Oct	78.40	20.30	74.19	33.16
Nov	111.50	20.60	79.07	32.86
Dec	234.50	22.32	83.00	33.18
Total/Mean	**1548.00**	**20.32**	**82.73**	**30.76**

Max Temp (Y) - Precipitation (X)



Regression Statistics	
Multiple R	0.467118504
R Square	0.218199697
Adjusted R Square	0.140019666
Standard Error	2.470140265
Observations	12

ANOVA

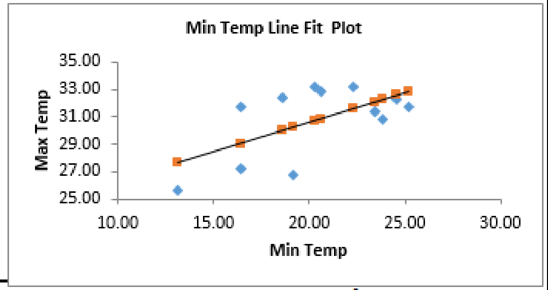
	df	SS	MS	F	Significance F
Regression	1	17.02948594	17.0294859	2.79099018	0.125749426
Residual	10	61.01592931	6.10159293		
Total	11	78.04541525			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	29.54199097	1.020168793	28.9579442	5.6211E-11	27.26891325	31.81
Precipitation	0.009448412	0.005655613	1.67062568	0.12574943	-0.00315308	0.02

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	32.35478321	-0.077363854
2	32.45871574	-1.093198499
3	32.67508437	-0.971858567
4	30.92996269	-0.093296021
5	29.8981961	-3.153034814
6	29.54199097	-2.348657641
7	29.54199097	-3.874249038
8	29.54199097	2.183815478
9	29.55143939	2.855227281
10	30.28274647	2.881769659
11	30.59548891	2.267844428
12	31.75764357	1.423001587

Max Temp (Y) - Min Temp (X)



Regression Statistics	
Multiple R	0.611969623
R Square	0.374506819
Adjusted R Square	0.311957501
Standard Error	2.209454119
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	1	29.22854023	29.2285402	5.98738453	0.034439205
Residual	10	48.81687502	4.8816875		
Total	11	78.04541525			

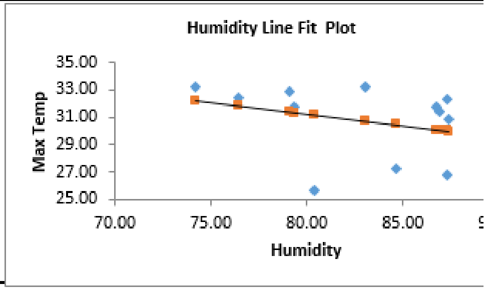
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	21.91819477	3.669648067	5.97283292	0.00013699	13.74170934	30.0946802
Min Temp	0.435096892	0.177814595	2.44691327	0.03443921	0.038901284	0.8312925

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	32.59631462	-0.318895261
2	32.11446538	-0.748948135
3	32.88544352	-1.182217711
4	32.28220273	-1.445536064
5	30.23837017	-3.493208879
6	29.06828702	-1.874953689
7	27.6305959	-1.96285396
8	29.05238025	2.673426197
9	30.00229502	2.40437165
10	30.75066167	2.413854458
11	30.87974042	1.983592918
12	31.62927668	1.551368476

Max Temp (Y) - Relative Humidity (X)

Regression Statistics	
Multiple R	0.294867701
R Square	0.086946961
Adjusted R Square	-0.004358343
Standard Error	2.669449448
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	6.785811695	6.78581169	0.95226627	0.352158251
Residual	10	71.25960355	7.12596036		
Total	11	78.04541525			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	44.56556039	14.16745781	3.14562859	0.01041005	12.9984972	76.13
Humidity	-0.166865685	0.170996741	-0.9758413	0.35215825	-0.54787017	0.21

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	29.99441817	2.283001188
2	30.05975379	1.305763456
3	30.08592516	1.617300651
4	29.98706172	0.849604944
5	29.99980093	-3.254639641
6	30.44316126	-3.249827928
7	31.15171243	-5.483970498
8	31.32934365	0.396462806
9	31.80589769	0.600768979
10	32.18520313	0.979313003
11	31.37204691	1.491286426
12	30.71570855	2.464936615

Max Temp (Y) - Precipitation, Min Temp, Relative Humidity (X)

Regression Statistics	
Multiple R	0.924157452
R Square	0.854066996
Adjusted R Square	0.79934212
Standard Error	1.193178627
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	3	66.65601335	22.2186711	15.6065587	0.001048862
Residual	8	11.38940189	1.42367524		
Total	11	78.04541525			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	55.48734001	8.220984513	6.74947628	0.00014513	36.52971572	74.4449643
Precipitation	0.002470754	0.006141385	0.40231213	0.6979896	-0.01169131	0.01663281
Min Temp	0.646539677	0.205616045	3.14440284	0.0137138	0.172388226	1.12069113
Humidity	-0.46156545	0.092475246	-4.9912325	0.00106443	-0.67481375	-0.2483171

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	31.78513219	0.49228716
2	31.27702254	0.088494703
3	32.55164333	-0.848417519
4	30.92543402	-0.088767351
5	27.65379751	-0.908636221
6	27.04831945	0.145013888
7	26.87187378	-1.204131847
8	29.47594247	2.249863986
9	32.20814655	0.198520118
10	34.56062399	-1.396107863
11	32.58494968	0.278383655
12	32.18714787	0.993497293

Max Temp (Y) - Min Temp, Relative Humidity (X)

Regression Statistics	
Multiple R	0.922558669
R Square	0.851114497
Adjusted R Square	0.818028829
Standard Error	1.136262436
Observations	12

ANOVA

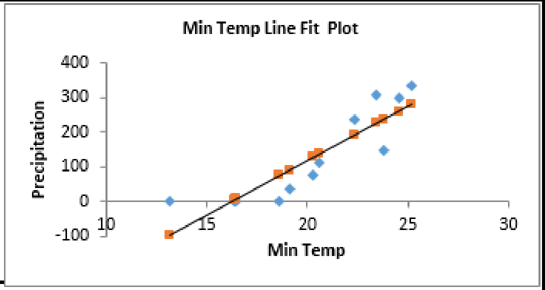
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	66.42558433	33.2127922	25.7245679	0.000189599
Residual	9	11.61983092	1.29109232		
Total	11	78.04541525			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	53.45182634	6.170546955	8.66241303	1.166E-05	39.49307935	67.41
Min Temp	0.716258619	0.105385418	6.79656289	7.9361E-05	0.477860242	0.9
Humidity	-0.450235569	0.083881123	-5.3675434	0.00045182	-0.63998785	-0.26

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	31.71446737	0.562951981
2	31.09753282	0.267984418
3	32.43733615	-0.734110348
4	31.17752577	-0.340859099
5	27.84733149	-1.102170199
6	27.11740599	0.075927344
7	26.6624786	-0.994736662
8	29.48230995	2.243496503
9	32.3318983	0.074768362
10	34.58730183	-1.422785702
11	32.60574071	0.257592627
12	32.06870439	1.111940775

Precipitation (Y) - Min Temp (X)



Regression Statistics	
Multiple R	0.88424894
R Square	0.781896187
Adjusted R Square	0.760085806
Standard Error	64.50205904
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	149153.3438	149153.344	35.8497257	0.000134337
Residual	10	41605.1562	4160.51562		
Total	11	190758.5			

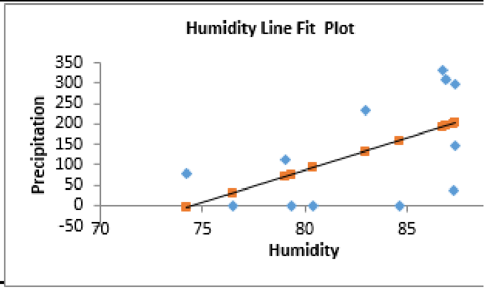
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-502.6768265	107.1304691	-4.6921929	0.0008516	-741.378387	-263.97527
Min Temp	31.08128138	5.191059376	5.98746405	0.00013434	19.5148803	42.6476825

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	260.1179759	37.58202414
2	225.6969261	83.00307391
3	280.7719886	50.82801135
4	237.6792959	-90.77929595
5	91.67748323	-53.97748323
6	8.092230834	-8.092230834
7	-94.60968064	94.60968064
8	6.955925924	-6.955925924
9	74.81338153	-73.81338153
10	128.2731855	-49.8731855
11	137.4939656	-25.99396564
12	191.0373214	43.46267856

Precipitation (Y) - Relative Humidity (X)

Regression Statistics	
Multiple R	0.562925564
R Square	0.316885191
Adjusted R Square	0.24857371
Standard Error	114.1533864
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	60448.54363	60448.5436	4.63882771	0.056700365
Residual	10	130309.9564	13030.9956		
Total	11	190758.5			

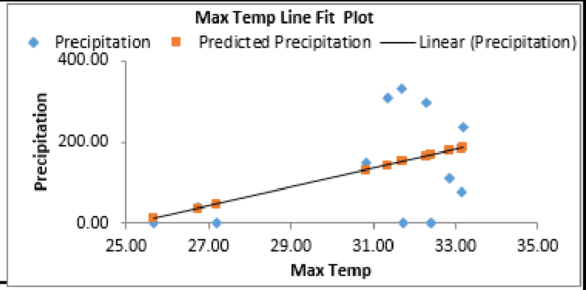
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-1173.926016	605.8415109	-1.9376784	0.0813933	-2523.82502	175.9
Humidity	15.74922017	7.312315697	2.15379379	0.05670037	-0.54363453	32.04

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	201.3365322	96.36346776
2	195.1699855	113.5300145
3	192.6998631	138.9001369
4	202.0308527	-55.13085269
5	200.8284929	-163.1284929
6	158.9829842	-158.9829842
7	92.10806977	-92.10806977
8	75.34277088	-75.34277088
9	30.36435285	-29.36435285
10	-5.435487408	83.83548741
11	71.31232529	40.18767471
12	133.259258	101.240742

Precipitation (Y) - Max Temp (X)

Regression Statistics	
Multiple R	0.467118504
R Square	0.218199697
Adjusted R Square	0.140019666
Standard Error	122.1208636
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	41623.44685	41623.4469	2.79099018	0.125749426
Residual	10	149135.0531	14913.5053		
Total	11	190758.5			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-581.3844703	426.6794559	-1.362579	0.20291178	-1532.08554	369.316603
Max Temp	23.09379588	13.82344118	1.67062568	0.12574943	-7.70675048	53.8943422

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	164.0236638	133.6763362
2	142.9643825	165.7356175
3	150.7633552	180.8366448
4	130.7512153	16.1487847
5	36.26282529	1.437174707
6	46.61281897	-46.61281897
7	11.38112263	-11.38112263
8	151.284828	-151.284828
9	167.0084748	-166.0084748
10	184.5100956	-106.1100956
11	177.5546416	-66.05464162
12	184.8825762	49.6174238

Precipitation (Y) - Min Temp, Relative Humidity, Max Temp (X)

Regression Statistics	
Multiple R	0.897801457
R Square	0.806047456
Adjusted R Square	0.733315253
Standard Error	68.00560297
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	153760.4037	51253.4679	11.0824011	0.003200327
Residual	8	36998.09628	4624.76204		
Total	11	190758.5			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-1252.856225	1128.508294	-1.1101879	0.29917016	-3855.20102	1349
Min Temp	22.46887411	15.61954446	1.43851021	0.18823703	-13.54986	58.48
Humidity	8.199260717	10.28999978	0.79681836	0.44855604	-15.5295213	31.92
Max Temp	8.026161878	19.95008688	0.40231213	0.6979896	-37.978821	54.03

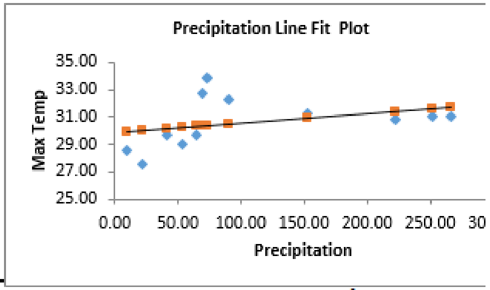
RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	273.6178317	24.08216832
2	238.2051528	70.49484723
3	279.4438218	52.15617822
4	246.1945127	-99.29451266
5	107.183739	-69.483739
6	28.57113351	-28.57113351
7	-92.7334355	92.7334355
8	20.58380786	-20.58380786
9	51.68674467	-50.68674467
10	77.77794118	0.622058815
11	121.9823326	-10.48233257
12	195.4864178	39.01358218

Appendix 11: 1989

Months	Precipitation	Min Temp	Humidity	Max Temp
Jan	266.50	23.36	86.68	31.00
Feb	222.80	23.18	87.86	30.81
Mar	251.50	23.47	86.94	31.10
Apr	152.30	23.27	86.70	31.28
May	10.00	18.43	84.42	28.60
Jun	53.00	18.65	85.53	29.07
Jul	22.30	14.83	83.03	27.52
Aug	64.00	18.09	84.77	29.65
Sep	41.80	18.19	78.37	29.73
Oct	68.80	20.17	75.61	32.73
Nov	72.80	21.86	76.57	33.92
Dec	90.30	23.00	83.03	32.28
Total/Mean	**1316.10**	**20.54**	**83.29**	**30.64**

Max Temp (Y) - Precipitation (X)



Regression Statistics	
Multiple R	0.330254124
R Square	0.109067786
Adjusted R Square	0.019974565
Standard Error	1.809622279
Observations	12

ANOVA

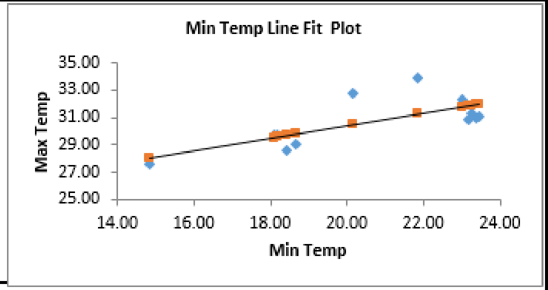
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4.008922907	4.00892291	1.22419848	0.294444193
Residual	10	32.74732792	3.27473279		
Total	11	36.75625083			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	29.90981888	0.842365739	35.5069271	7.4515E-12	28.03291105	31.78
Precipitation	0.006666574	0.006025274	1.10643503	0.29444419	-0.00675857	0.020

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	31.68646095	-0.689686757
2	31.39513165	-0.580845936
3	31.58646234	-0.489688142
4	30.92513816	0.354861844
5	29.97648462	-1.373258814
6	30.26314732	-1.189813986
7	30.05848349	-2.542354453
8	30.33647964	-0.681640928
9	30.18848169	-0.461815019
10	30.36847919	2.360553064
11	30.39514549	3.524854508
12	30.51181054	1.768834618

Max Temp (Y) - Min Temp (X)



Regression Statistics	
Multiple R	0.722592434
R Square	0.522139826
Adjusted R Square	0.474353808
Standard Error	1.325305566
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	19.1919024	19.1919024	10.9266236	0.007938819
Residual	10	17.56434843	1.75643484		
Total	11	36.75625083			

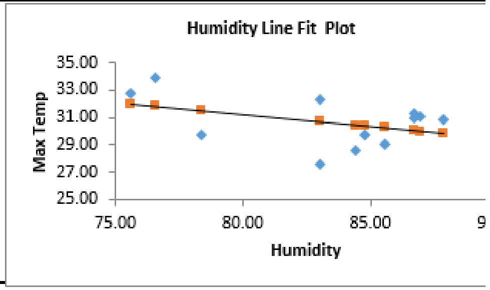
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	21.21135891	2.87820728	7.36964257	2.3982E-05	14.79831344	27.6244044
Min Temp	0.459085417	0.138883453	3.30554437	0.00793882	0.149633799	0.76853703

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	31.93766753	-0.940893336
2	31.85066344	-1.036377724
3	31.98653791	-0.889763719
4	31.89274627	-0.612746268
5	29.67037794	-1.067152133
6	29.77177164	-0.69843831
7	28.01915136	-0.503022328
8	29.51636219	0.138476523
9	29.56059235	0.166074315
10	30.47155604	2.25747622
11	31.24543583	2.674564169
12	31.76884257	0.511802592

Max Temp (Y) - Relative Humidity (X)

Regression Statistics	
Multiple R	0.409879589
R Square	0.168001277
Adjusted R Square	0.084801405
Standard Error	1.748746801
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	6.175097093	6.17509709	2.01924922	0.185740042
Residual	10	30.58115374	3.05811537		
Total	11	36.75625083			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	45.490701	10.46235879	4.34803488	0.00144803	22.1791129	68.80
Humidity	-0.17828448	0.12546384	-1.4210029	0.18574004	-0.45783534	0.101

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	30.03746237	0.959311819
2	29.82713598	0.987149731
3	29.99145348	1.105320717
4	30.0334366	1.246563404
5	30.44004023	-1.836814426
6	30.24143516	-1.168101823
7	30.68733806	-3.171209027
8	30.376778	-0.721939288
9	31.5191406	-1.792473929
10	32.01009388	0.71893838
11	31.84005266	2.079947341
12	30.68733806	1.593307102

Max Temp (Y) - Precipitation, Min Temp, Relative Humidity (X)

Regression Statistics	
Multiple R	0.967220105
R Square	0.935514732
Adjusted R Square	0.911332757
Standard Error	0.544315703
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	3	34.38601415	11.4620047	38.6864479	4.14414E-05
Residual	8	2.370236679	0.29627958		
Total	11	36.75625083			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	41.03483304	4.842615355	8.47369242	2.8796E-05	29.867742	52.2019241
Precipitation	-0.001957479	0.003636374	-0.5383052	0.60501578	-0.01034297	0.00642801
Min Temp	0.622298722	0.099226983	6.27146669	0.00024007	0.393480887	0.85111656
Humidity	-0.275669993	0.049489217	-5.5703041	0.00052826	-0.38979233	-0.1615477

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	31.15850978	-0.161735587
2	30.8009016	0.013384115
3	31.18297603	-0.086201832
4	31.31493748	-0.034937484
5	29.20973106	-0.606505257
6	28.95591005	0.117423283
7	27.32976705	0.186361985
8	28.79743763	0.857401082
9	30.66721136	-0.940544689
10	32.60831739	0.120714864
11	33.3865718	0.533428198
12	32.27943384	0.001211323

Max Temp (Y) - Min Temp, Relative Humidity (X)

Regression Statistics	
Multiple R	0.966011892
R Square	0.933178975
Adjusted R Square	0.918329859
Standard Error	0.522397288
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	2	34.30016049	17.1500802	62.8440736	5.15358E-06
Residual	9	2.456090342	0.27289893		
Total	11	36.75625083			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	42.95911382	3.135318264	13.7016756	2.4699E-07	35.86653115	50.05
Min Temp	0.579545684	0.057087606	10.1518652	3.1559E-06	0.450404546	0.708
Humidity	-0.290807282	0.039083999	-7.4405713	3.9311E-05	-0.37922143	-0.20

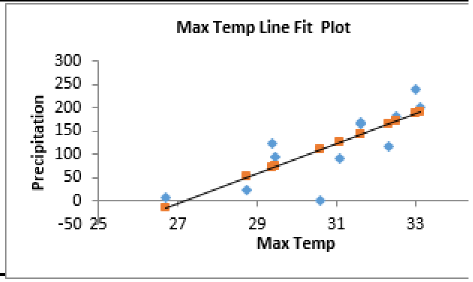
RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	31.29349355	-0.296719355
2	30.84058811	-0.026302395
3	31.28014008	-0.183365888
4	31.2302187	0.049781301
5	29.08794728	-0.484721469
6	28.8919928	0.181340531
7	27.40683016	0.109298873
8	28.79032937	0.864509344
9	30.70952064	-0.982853976
10	32.66032823	0.068704029
11	33.35990641	0.560093589
12	32.14040975	0.140235416

Appendix 12: 1990

Months	Precipitation	Max Temp	Min Temp	Insolation	Humidity
Jan	238.20	33.00	22.83	187.80	84.48
Feb	117.10	32.33	22.84	205.00	84.10
Mar	166.60	31.61	21.85	186.10	86.19
Apr	92.20	31.09	19.28	203.30	86.43
May	93.80	29.47	19.68	179.90	87.71
Jun	2.00	30.58	17.72	220.90	86.03
Jul	8.80	26.70	12.68	207.60	82.71
Aug	24.20	28.75	14.81	150.30	83.29
Sep	123.20	29.37	17.35	151.20	81.70
Oct	179.80	32.51	21.78	183.30	82.16
Nov	169.40	31.59	21.08	185.30	82.47
Dec	200.70	33.11	22.81	188.60	83.81
Total/Mean	**1416.00**	**30.84**	**19.56**	**2249.30**	**84.26**

Precipitation (Y) - Max Temp (X)



Regression Statistics	
Multiple R	0.800044884
R Square	0.640071816
Adjusted R Square	0.604078998
Standard Error	48.57985499
Observations	12

ANOVA

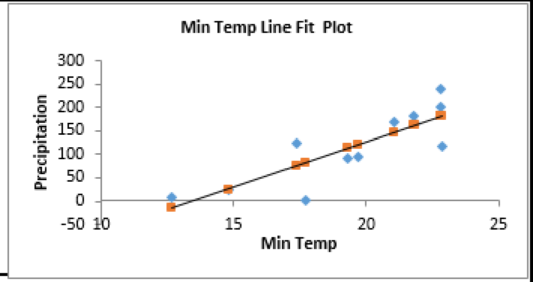
	df	SS	MS	F	Significance F
Regression	1	41968.67689	41968.6769	17.7833203	0.001779985
Residual	10	23600.02311	2360.00231		
Total	11	65568.7			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	-861.3848669	232.6683344	-3.70220068	0.00409361	-1379.80222	-342.9
Max Temp	31.75469111	7.530112554	4.21702742	0.00177999	14.97655477	48.53

RESIDUAL OUTPUT

Observation	Predicted Precipitation	Residuals
1	186.4175052	51.78249483
2	165.3866452	-48.28664523
3	142.3706756	24.22932443
4	125.8684796	-33.66847964
5	74.35417591	19.44582409
6	109.6735872	-107.6735872
7	-13.43217983	22.23217983
8	51.51128521	-27.31128521
9	71.25041094	51.94958906
10	170.8474631	8.952536923
11	141.8516742	27.54832583
12	189.9002777	10.79972226

Precipitation (Y) - Min Temp (X)



Regression Statistics	
Multiple R	0.841860474
R Square	0.708729058
Adjusted R Square	0.679601963
Standard Error	43.70155265
Observations	12

ANOVA

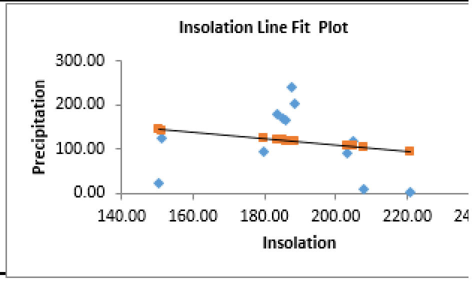
	df	SS	MS	F	Significance F
Regression	1	46470.44296	46470.443	24.3322953	0.000593493
Residual	10	19098.25704	1909.8257		
Total	11	65568.7			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-262.4368439	78.14924311	-3.35814953	0.00726492	-436.564209	-88.3094791
Min Temp	19.451368	3.943289036	4.93277764	0.00059349	10.66517249	28.2375635

RESIDUAL OUTPUT

Observation	Predicted Precipitation	Residuals
1	181.6190635	56.58093647
2	181.9263043	-64.82630427
3	162.5441736	4.055826373
4	112.5206932	-20.32069316
5	120.3786275	-26.57862752
6	82.17655909	-80.17655909
7	-15.78094845	24.58094845
8	25.56889513	-1.368895129
9	74.97955293	48.22044707
10	161.2892467	18.51075334
11	147.5979934	21.80200656
12	181.1798391	19.52016091

Precipitation (Y) - Insolation (X)



Regression Statistics	
Multiple R	0.186076797
R Square	0.034624574
Adjusted R Square	-0.061912968
Standard Error	79.56029894
Observations	12

ANOVA

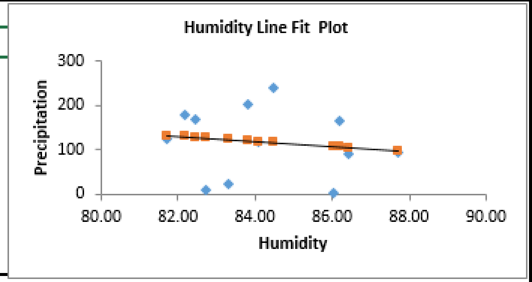
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2270.288323	2270.28832	0.35866434	0.562569174
Residual	10	63298.41168	6329.84117		
Total	11	65568.7			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	246.1056965	215.1361271	1.14395337	0.27928735	-233.247467	725
Insolation	-0.683443008	1.141190647	-0.59888592	0.56256917	-3.22617423	1.85

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	117.7550996	120.4449004
2	105.9998798	11.10012015
3	118.9169527	47.6830473
4	107.161733	-14.96173296
5	123.1542994	-29.35429935
6	95.13313602	-93.13313602
7	104.222928	-95.42292802
8	143.3842124	-119.1842124
9	142.7691137	-19.56911369
10	120.8305931	58.96940687
11	119.4637071	49.93629289
12	117.2083452	83.49165482

Precipitation (Y) - Relative Humidity (X)



Regression Statistics	
Multiple R	0.143821592
R Square	0.02068465
Adjusted R Square	-0.077246885
Standard Error	80.13266149
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1356.265631	1356.26563	0.21121542	0.655645502
Residual	10	64212.43437	6421.24344		
Total	11	65568.7			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	600.8131294	1050.803519	0.57176543	0.58010495	-1740.52302	2942.14928
Humidity	-5.730200346	12.46829289	-0.45958179	0.6556455	-33.5112882	22.0508875

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	116.7036227	121.4963773
2	118.883521	-1.783520972
3	106.9068286	59.69317141
4	105.5328128	-13.33281281
5	98.21910549	-4.419105487
6	107.8248929	-105.8248929
7	126.8701072	-118.0701072
8	123.5428941	-99.34289411
9	132.6557611	-9.455761114
10	130.0124751	49.78752485
11	128.2626075	41.13739248
12	120.5853714	80.11462865

Precipitation (Y) - Max Temp, Min Temp, Insolation, Relative Humidity (X)

Regression Statistics	
Multiple R	0.917737912
R Square	0.842242876
Adjusted R Square	0.752095947
Standard Error	38.4409186
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	55224.77044	13806.1926	9.34300139	0.006156333
Residual	7	10343.92956	1477.70422		
Total	11	65568.7			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	788.8342957	794.6419464	0.99269149	0.35392742	-1090.19532	2667
Max Temp	-5.384724607	20.5875921	-0.26155194	0.80119573	-54.0666442	43.2
Min Temp	24.08568615	12.05423098	1.99811055	0.08585824	-4.41804076	52.58
Insolation	-0.736309007	0.623118574	-1.18165151	0.27592698	-2.2097503	0.737
Humidity	-9.943538074	7.094141628	-1.40165486	0.20376684	-26.7185174	6.831

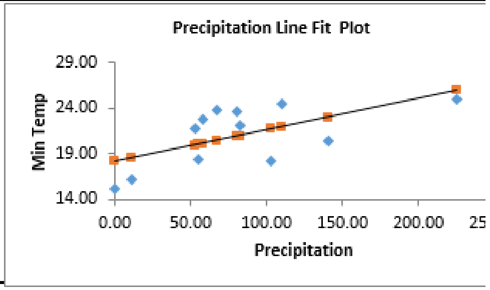
RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	182.6612407	55.53875935
2	177.7261716	-60.62617156
3	150.762346	15.837654
4	76.57018899	15.62981101
5	99.57395589	-5.773955885
6	32.76110486	-30.76110486
7	-24.81775824	33.61775824
8	51.78795726	-27.58795726
9	124.7743205	-1.574320521
10	186.5361255	-6.736125509
11	169.9906614	-0.590661443
12	187.6736856	13.02631444

Appendix 13: 1997

Months	Precipitation	Max Temp	Cloudiness	Insolation	Humidity	Wind Mean	Min Temp
Jan	225.20	32.22	5.44	178.10	84.69	1.28	25.00
Feb	110.40	32.16	5.31	177.30	85.68	1.15	24.49
Mar	82.60	32.20	4.43	220.80	83.34	0.65	22.16
Apr	140.80	30.75	3.58	226.70	86.16	0.89	20.35
May	54.60	29.24	3.57	214.40	83.51	0.84	18.37
Jun	103.20	27.41	3.69	185.20	84.81	1.80	18.12
Jul	0.00	31.03	2.35	253.50	80.28	1.24	15.14
Aug	11.50	30.50	3.62	207.20	77.35	1.61	16.14
Sep	52.60	35.11	2.09	188.10	75.48	1.52	21.69
Oct	57.60	35.12	3.31	230.60	75.46	1.68	22.77
Nov	66.80	35.09	5.51	212.50	76.77	1.94	23.84
Dec	80.80	34.26	4.15	246.60	80.08	1.72	23.52
Total/Mean	**986.10**	**32.09**	**3.92**	**2541.00**	**81.13**	**1.36**	**20.97**

Min Temp (Y) - Precipitation (X)



Regression Statistics	
Multiple R	0.622473263
R Square	0.387472963
Adjusted R Square	0.32622026
Standard Error	2.72412703
Observations	12

ANOVA

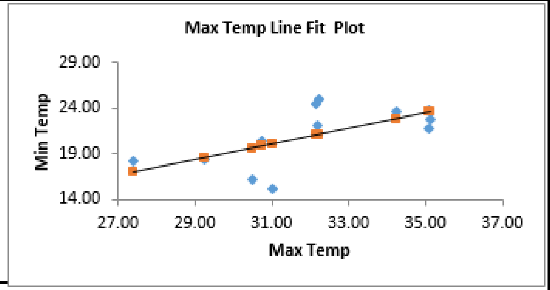
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	46.94300128	46.9430013	6.32580997	0.03064275
Residual	10	74.20868078	7.42086808		
Total	11	121.1516821			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	18.12829588	1.375374485	13.1806254	1.2031E-07	15.06377056	21.1S
Precipitation	0.034536242	0.013731469	2.51511629	0.03064275	0.003940622	0.065

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	25.90585762	-0.905857622
2	21.94109702	2.548188981
3	20.98098949	1.177075514
4	22.99099878	-2.637665782
5	20.01397471	-1.639780705
6	21.69243608	-3.572436075
7	18.12829588	-2.992811882
8	18.52546267	-2.383527667
9	19.94490222	1.741764779
10	20.11758343	2.656610568
11	20.43531686	3.40468314
12	20.91882425	2.60375675

Min Temp (Y) - Max Temp (X)



Regression Statistics	
Multiple R	0.642775067
R Square	0.413159787
Adjusted R Square	0.354475765
Standard Error	2.66639605
Observations	12

ANOVA

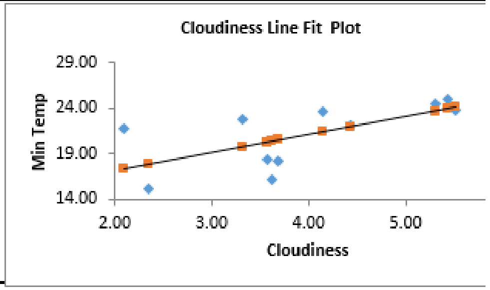
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	50.05500313	50.0550031	7.04041368	0.0241725
Residual	10	71.09667893	7.10966789		
Total	11	121.1516821			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-6.674183044	10.4454961	-0.6389532	0.53721295	-29.9481987	16.5998326
Max Temp	0.861345608	0.324622303	2.65337779	0.0241725	0.138042043	1.58464917

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	21.08059556	3.919404435
2	21.03038342	3.458902578
3	21.05836682	1.099698182
4	19.81219439	0.541138612
5	18.51322922	-0.139035225
6	16.93242919	1.187570806
7	20.05253738	-4.917053376
8	19.59685799	-3.454922987
9	23.56479037	-1.878123372
10	23.57294042	-0.798746425
11	23.54756346	0.29243654
12	22.83385077	0.688730233

Min Temp (Y) - Cloudiness (X)



Regression Statistics	
Multiple R	0.657133781
R Square	0.431824806
Adjusted R Square	0.375007287
Standard Error	2.623649757
Observations	12

ANOVA

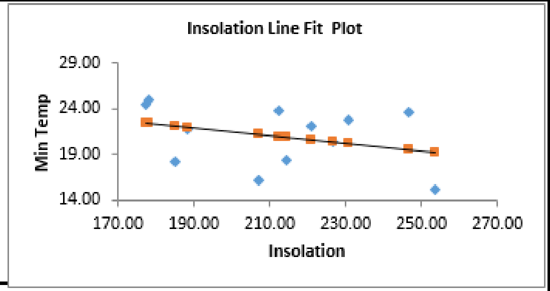
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	52.31630159	52.3163016	7.60020519	0.020239016
Residual	10	68.83538047	6.88353805		
Total	11	121.1516821			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	13.28686291	2.886718995	4.60275591	0.00097599	6.854852166	19.71
Cloudiness	1.958229264	0.710314823	2.75684697	0.02023902	0.37554921	3.540

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	23.94131419	1.058685813
2	23.68412819	0.805157812
3	21.96203004	0.196034959
4	20.29297249	0.060360507
5	20.2775299	-1.903335897
6	20.5105533	-2.390553304
7	17.89817755	-2.762693554
8	20.38281213	-4.240877135
9	17.37738648	4.309280518
10	19.77218142	3.00201258
11	24.07888175	-0.238881751
12	21.41777155	2.104809451

Min Temp (Y) - Insolation (X)



Regression Statistics	
Multiple R	0.320524596
R Square	0.102736017
Adjusted R Square	0.013009618
Standard Error	3.29704475
Observations	12

ANOVA

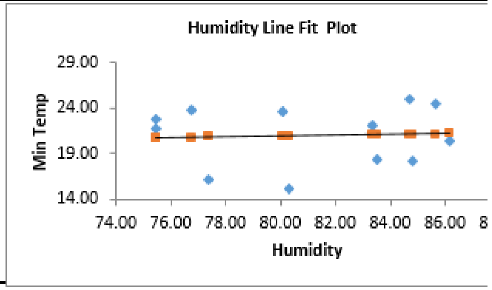
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	12.44664123	12.4466412	1.14499209	0.309747122
Residual	10	108.7050408	10.8705041		
Total	11	121.1516821			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	29.75212261	8.265688306	3.59947309	0.00485215	11.33502136	48.1692239
Insolation	-0.041491433	0.038775481	-1.070043	0.30974712	-0.12788859	0.04490572

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	22.36249832	2.637501682
2	22.39569146	2.093594535
3	20.59081411	1.567250889
4	20.34601465	0.007318346
5	20.85635928	-2.482165285
6	22.06790914	-3.947909141
7	19.23404424	-4.098560238
8	21.15509761	-5.013162605
9	21.94758398	-0.260916984
10	20.18419806	2.589995937
11	20.93519301	2.904806992
12	19.52033513	4.002245871

Min Temp (Y) - Relative Humidity (X)



Regression Statistics	
Multiple R	0.046475751
R Square	0.002159995
Adjusted R Square	-0.097624005
Standard Error	3.476923856
Observations	12

ANOVA

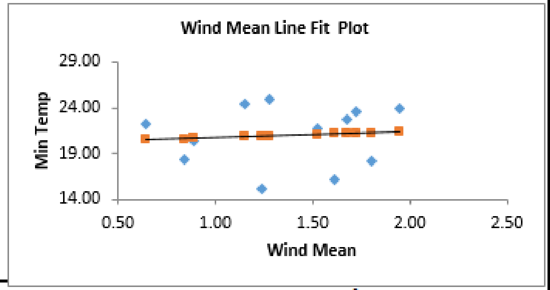
	df	SS	MS	F	Significance F
Regression	1	0.261687074	0.26168707	0.02164671	0.885954839
Residual	10	120.889995	12.0889995		
Total	11	121.1516821			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	17.88834299	20.94437901	0.85408801	0.41304841	-28.7786416	64.55
Humidity	0.037936973	0.257849751	0.14712821	0.88595484	-0.53658807	0.612

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	21.10105389	3.898946112
2	21.1387286	3.350557398
3	21.04996136	1.108103641
4	21.15692932	-0.80359632
5	21.05638618	-2.682192175
6	21.10571441	-2.985714407
7	20.93400882	-5.798524823
8	20.82295141	-4.681016409
9	20.75195214	0.934714863
10	20.7510547	2.0231393
11	20.80063794	3.039362056
12	20.92636024	2.596220764

Min Temp (Y) - Wind Mean (X)



Regression Statistics	
Multiple R	0.083770282
R Square	0.00701746
Adjusted R Square	-0.092280794
Standard Error	3.468450734
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.850177093	0.85017709	0.07067053	0.795763329
Residual	10	120.301505	12.0301505		
Total	11	121.1516821			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	20.06204552	3.545851929	5.65789151	0.00021015	12.16139507	27.962696
Wind Mean	0.664812715	2.500806836	0.26583929	0.79576333	-4.90733216	6.23695759

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	20.91271992	4.087280078
2	20.82974598	3.659540023
3	20.49095675	1.667108248
4	20.65372883	-0.300395833
5	20.61963059	-2.245436589
6	21.2587084	-3.138708404
7	20.88412566	-5.748641663
8	21.13432394	-4.992388939
9	21.07403806	0.612628943
10	21.177215	1.596979004
11	21.35473661	2.485263388
12	21.20580926	2.316771744

Min Temp (Y) - Precipitation, Max Temp, Cloudiness, Insolation, Relative Humidity, Wind Mean (X)

Regression Statistics	
Multiple R	0.973022122
R Square	0.946772051
Adjusted R Square	0.882898511
Standard Error	1.135663296
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	114.7030265	19.1171711	14.822602	0.004764226
Residual	5	6.448655605	1.28973112		
Total	11	121.1516821			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-51.28913788	28.26768923	-1.8144086	0.12933646	-123.953546	21.37
Precipitation	0.009767937	0.011547644	0.84588141	0.43621834	-0.01991623	0.03
Max Temp	1.273378716	0.284493	4.47595798	0.00654311	0.542066177	2.004
Cloudiness	0.632844808	0.436680015	1.44921862	0.20695529	-0.48967691	1.755
Insolation	-0.023059966	0.016965845	-1.3591994	0.23217459	-0.06667206	0.020
Humidity	0.39513998	0.262461357	1.50551679	0.1925345	-0.27953842	1.069
Wind Mean	0.685314979	1.248420607	0.54894558	0.60665617	-2.52385236	3.894

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	25.61791949	-0.617919494
2	24.66453691	-0.175250914
3	21.6009056	0.557159403
4	20.93359953	-0.580266533
5	17.36753577	1.006658234
6	17.42649826	0.693501745
7	16.43727959	-1.30179559
8	16.84776734	-0.705832341
9	21.78278541	-0.096118407
10	21.73456726	1.039626744
11	24.29554644	-0.455546439
12	22.88679741	0.635783593

Min Temp (Y) - Max Temp, Cloudiness, Insolation (X)

Regression Statistics	
Multiple R	0.903675815
R Square	0.816629978
Adjusted R Square	0.74786622
Standard Error	1.666417812
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	98.93609546	32.9786985	11.8758776	0.002569805
Residual	8	22.2155866	2.77694832		
Total	11	121.1516821			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-5.693175393	7.677021089	-0.7415865	0.47953977	-23.3964178	12.010067
Max Temp	0.848954316	0.208992726	4.06212375	0.00362275	0.367016225	1.33089241
Cloudiness	1.511373094	0.493847676	3.06040337	0.01557306	0.372558311	2.65018788
Insolation	-0.030745771	0.021658775	-1.4195526	0.1935079	-0.080691	0.01919945

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	24.40967151	0.590328488
2	24.18628064	0.30300536
3	21.54729477	0.610770229
4	18.84946106	1.503871936
5	17.93543706	0.438756938
6	17.45500373	0.664996265
7	16.41404274	-1.278558736
8	19.30610378	-3.164168785
9	21.48459229	0.202074714
10	22.03424694	0.739947055
11	25.88967065	-2.04967065
12	22.08393381	1.438647186

Min Temp (Y) - Max Temp, Cloudiness (X)

Regression Statistics	
Multiple R	0.877747506
R Square	0.770440684
Adjusted R Square	0.719427503
Standard Error	1.757886903
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	93.34018478	46.6700924	15.1027766	0.001330538
Residual	9	27.81149728	3.09016636		
Total	11	121.1516821			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-11.19296046	6.991490308	-1.6009406	0.14385414	-27.0088103	4.622
Max Temp	0.783457961	0.215024648	3.64357281	0.00537095	0.297038414	1.269
Cloudiness	1.789609427	0.478166963	3.74264549	0.00460665	0.707920606	2.871

RESIDUAL OUTPUT

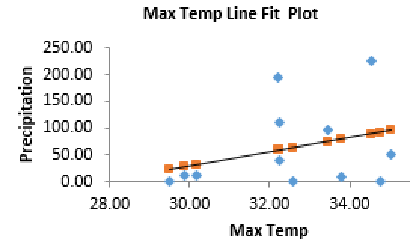
Observation	*Predicted Min Temp*	*Residuals*
1	23.78909149	1.210908507
2	23.50837967	0.980906333
3	21.96002149	0.198043514
4	19.30119707	1.052135926
5	18.10557868	0.268615315
6	16.88068151	1.239318488
7	17.33122375	-2.195739753
8	19.18743629	-3.045501285
9	20.04993273	1.636734272
10	22.24592897	0.528265029
11	26.15870432	-2.318704322
12	23.07756302	0.445017977

Appendix 14: 1999

Months	Precipitation	Max Temp	Min Temp	Insolation	Humidity	Cloudiness
Jan	96.80	33.45	24.10	229.50	83.89	7.30
Feb	9.00	33.80	24.05	161.10	85.43	7.71
Mar	195.00	32.20	23.66	167.50	86.01	7.42
Apr	40.00	32.25	20.12	210.10	76.53	5.07
May	10.30	30.17	16.39	267.90	79.22	3.30
Jun	12.30	29.86	15.53	217.90	77.99	4.47
Jul	0.00	29.51	14.40	227.70	74.67	3.23
Aug	0.00	32.58	14.33	216.50	62.15	1.83
Sep	0.00	34.77	18.83	182.40	65.53	2.36
Oct	50.00	35.05	21.59	213.00	66.86	3.83
Nov	109.30	32.24	19.36	227.20	72.53	4.16
Dec	225.60	34.54	22.43	217.20	78.27	5.28
Total/Mean	**748.30**	**32.54**	**19.57**	**2538.00**	**75.76**	**4.66**

Precipitation (Y) - Max Temp (X)

Regression Statistics	
Multiple R	0.310453673
R Square	0.096381483
Adjusted R Square	0.006019631
Standard Error	78.39487321
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6555.167711	6555.16771	1.06661696	0.326041388
Residual	10	61457.56146	6145.75615		
Total	11	68012.72917			

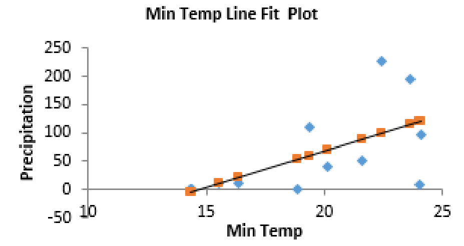
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-354.3484004	404.1181188	-0.87684364	0.40114539	-1254.77968	546.
Max Temp	12.80795247	12.40153564	1.03277149	0.32604139	-14.8243909	40.4

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	74.07760985	22.72239015
2	78.56039321	-69.56039321
3	58.06766926	136.9323307
4	58.70806688	-18.70806688
5	32.06752574	-21.76752574
6	28.09706047	-15.79706047
7	23.6142771	-23.6142771
8	62.93469119	-62.93469119
9	90.98410711	-90.98410711
10	94.5703338	-44.5703338
11	58.57998735	50.72001265
12	88.03827804	137.561722

Precipitation (Y) - Min Temp (X)

Regression Statistics	
Multiple R	0.605898321
R Square	0.367112776
Adjusted R Square	0.303824053
Standard Error	65.60822158
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	24968.34178	24968.3418	5.80060335	0.036781045
Residual	10	43044.38739	4304.43874		
Total	11	68012.72917			

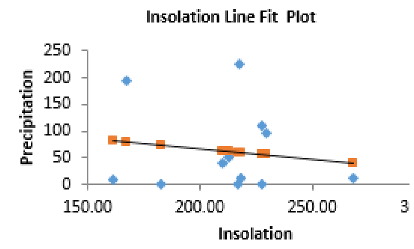
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-189.1600578	106.1354044	-1.7822522	0.10504194	-425.644476	47.3243604
Min Temp	12.85497974	5.337462195	2.40844418	0.03678104	0.962372854	24.7475866

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	120.644954	-23.84495398
2	120.002205	-111.002205
3	114.9887629	80.0112371
4	69.48213461	-29.48213461
5	21.53306017	-11.23306017
6	10.47777759	1.822222413
7	-4.048349522	4.048349522
8	-4.948198104	4.948198104
9	52.89921074	-52.89921074
10	88.37895483	-38.37895483
11	59.71235	49.58765
12	99.17713781	126.4228622

Precipitation (Y) - Insolation (X)

Regression Statistics	
Multiple R	0.142499365
R Square	0.020306069
Adjusted R Square	-0.077663324
Standard Error	81.62821693
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1381.071177	1381.07118	0.20726952	0.658640752
Residual	10	66631.65799	6663.1658		
Total	11	68012.72917			

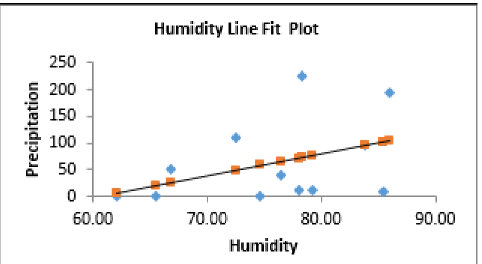
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	143.2573881	179.2508082	0.79920079	0.44274273	-256.138302	542.6
Insolation	-0.382501441	0.840166488	-0.45526862	0.65864075	-2.25450903	1.48

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	55.4733074	41.3266926
2	81.63640595	-72.63640595
3	79.18839673	115.8116033
4	62.89383535	-22.89383535
5	40.78525207	-30.48525207
6	59.91032411	-47.61032411
7	56.16180999	-56.16180999
8	60.44582613	-60.44582613
9	73.48912526	-73.48912526
10	61.78458117	-11.78458117
11	56.35306071	52.94693929
12	60.17807512	165.4219249

Precipitation (Y) - Relative Humidity (X)

Regression Statistics	
Multiple R	0.405741113
R Square	0.164625851
Adjusted R Square	0.081088436
Standard Error	75.37643913
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	11196.6534	11196.6534	1.97068404	0.190660001
Residual	10	56816.07577	5681.60758		
Total	11	68012.72917			

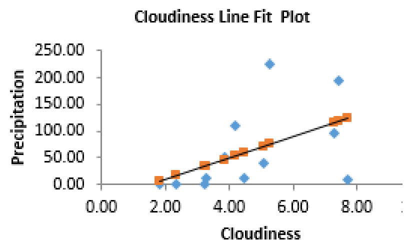
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-247.5119847	221.8050262	-1.1158989	0.29056194	-741.724381	246.700412
Humidity	4.090337282	2.913738822	1.40381054	0.19066	-2.40187739	10.582552

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	95.6264099	1.173590103
2	101.9255293	-92.92552931
3	104.2979249	90.70207506
4	65.5215275	-25.5215275
5	76.52453479	-66.22453479
6	71.49341993	-59.19341993
7	57.91350015	-57.91350015
8	6.702477378	-6.702477378
9	20.52781739	-20.52781739
10	25.96796598	24.03203402
11	49.16017837	60.13982163
12	72.63871437	152.9612856

Precipitation (Y) - Cloudiness (X)

Regression Statistics	
Multiple R	0.506638438
R Square	0.256682507
Adjusted R Square	0.182350758
Standard Error	71.10207544
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*	
Regression	1	17457.67785	17457.6779	3.45320149	0.09277665	
Residual	10	50555.05131	5055.50513			
Total	11	68012.72917				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-32.03287639	54.78521419	-0.5846993	0.57170515	-154.101941	90.03
Cloudiness	20.24114576	10.89241382	1.85827917	0.09277665	-4.02866466	44.51

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	115.7274877	-18.92748765
2	124.0263574	-115.0263574
3	118.1564251	76.84357486
4	70.58973261	-30.58973261
5	34.76290461	-24.46290461
6	58.44504515	-46.14504515
7	33.34602441	-33.34602441
8	5.008420349	-5.008420349
9	15.7362276	-15.7362276
10	45.49071187	4.509288133
11	52.17028997	57.12971003
12	74.84037322	150.7596268

Precipitation (Y) - Max Temp, Min Temp, Insolation, Relative Humidity, Cloudiness (X)

Regression Statistics	
Multiple R	0.651703148
R Square	0.424716993
Adjusted R Square	-0.054685514
Standard Error	80.75329444
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*	
Regression	5	28886.16179	5777.23236	0.88592985	0.543159217	
Residual	6	39126.56738	6521.09456			
Total	11	68012.72917				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	98.68031146	1759.005639	0.05610005	0.9570836	-4205.45143	4402.81205
Max Temp	-18.38308606	48.80102402	-0.37669468	0.71936274	-137.79489	101.028718
Min Temp	29.27325141	35.43292224	0.82615967	0.44032122	-57.4279859	115.974489
Insolation	0.31054449	1.150826147	0.26984483	0.79632049	-2.50542565	3.12651463
Humidity	0.289404	11.7860081	0.02455488	0.98120629	-28.5499189	29.1287269
Cloudiness	-21.14115943	60.09598584	-0.35178988	0.73702123	-168.190739	125.908421

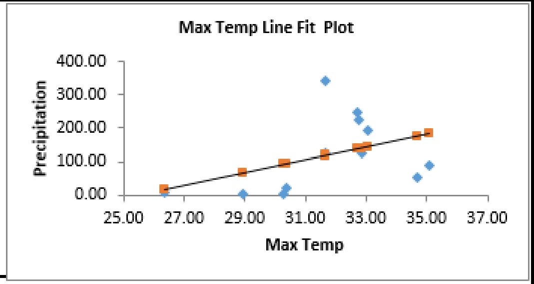
RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	130.46904	-33.66904002
2	93.10786099	-84.10786099
3	119.3905059	75.60949407
4	75.01141166	-35.01141166
5	60.20682338	-49.90682338
6	0.112235876	12.18776412
7	1.765094322	-1.765094322
8	-34.22392064	34.22392064
9	36.43055615	-36.43055615
10	90.88753031	-40.88753031
11	76.33872131	32.96127869
12	98.8041407	126.7958593

Appendix 15: 2000

Months	Precipitation	Max Temp	Min Temp	Insolation	Humidity	Cloudiness	Wind Mean
Jan	88.10	35.09	23.40	242.30	75.02	0.55	0.18
Feb	245.30	32.69	23.67	154.90	82.05	0.66	1.14
Mar	340.90	31.68	22.39	152.50	86.35	0.76	1.01
Apr	127.00	32.87	22.30	253.30	81.58	0.41	0.88
May	1.40	30.27	18.60	226.10	80.24	0.36	0.92
Jun	3.00	28.96	17.15	210.90	80.14	0.53	1.67
Jul	9.00	26.36	12.12	218.00	73.40	0.41	1.74
Aug	124.00	31.66	16.99	231.30	76.04	0.32	1.56
Sep	21.00	30.37	18.85	187.80	73.03	0.42	2.80
Oct	51.00	34.68	21.77	179.40	74.37	0.39	1.38
Nov	223.40	32.76	21.86	225.80	78.02	0.49	1.49
Dec	193.80	33.03	22.50	215.70	77.30	0.53	1.54
Total/Mean	**1427.90**	**31.70**	**20.13**	**2498**	**78.13**	**0.49**	**1.36**

Precipitation (Y) - Max Temp (X)



Regression Statistics	
Multiple R	0.414178247
R Square	0.17154362
Adjusted R Square	0.088697982
Standard Error	106.2800316
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	23388.81798	23388.818	2.07064155	0.180713926
Residual	10	112954.4512	11295.4451		
Total	11	136343.2692			

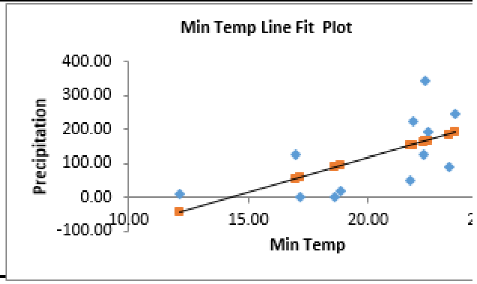
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-480.1521096	417.4980157	-1.1500704	0.27687518	-1410.39566	450.09144
Max Temp	18.89936272	13.13393002	1.43897239	0.18071393	-10.364857	48.1635825

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	182.9716635	-94.87166355
2	137.7267026	107.5732974
3	118.5918916	222.3081084
4	141.0069516	-14.00695157
5	91.94989465	-90.54989465
6	67.11044332	-64.11044332
7	17.99852155	-8.998521547
8	118.2870638	5.712936225
9	93.82153634	-72.82153634
10	175.3057796	-124.3057796
11	139.0540048	84.34599517
12	144.0755466	49.7244534

Precipitation (Y) - Min Temp (X)

Regression Statistics	
Multiple R	0.620970573
R Square	0.385604453
Adjusted R Square	0.324164898
Standard Error	91.52524104
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	52574.57169	52574.5717	6.27615963	0.031166498
Residual	10	83768.69747	8376.86975		
Total	11	136343.2692			

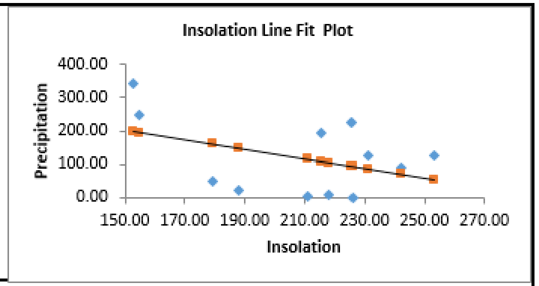
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-283.9151608	162.9823262	-1.74199968	0.11212181	-647.062414	79.23
Min Temp	20.01176319	7.988005673	2.50522646	0.0311665	2.2133774	37.8

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	184.4246557	-96.32465575
2	189.8115823	55.48841774
3	164.0901228	176.8098772
4	162.3471583	-35.34715829
5	88.30363449	-86.90363449
6	59.33008343	-56.33008343
7	-41.45005652	50.45005652
8	56.15569749	67.84430251
9	93.23987608	-72.23987608
10	151.8224517	-100.8224517
11	153.4752833	69.92471672
12	166.3495109	27.45048907

Precipitation (Y) - Insolation (X)

Regression Statistics	
Multiple R	0.420695546
R Square	0.176984743
Adjusted R Square	0.094683217
Standard Error	105.9304445
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	24130.67843	24130.6784	2.15044304	0.173257048
Residual	10	112212.5907	11221.2591		
Total	11	136343.2692			

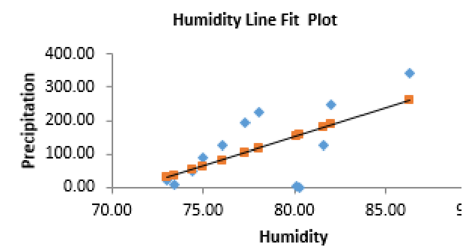
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	417.8279532	206.0652453	2.02764883	0.07007936	-41.3140259	876.969932
Insolation	-1.435562626	0.978944728	-1.4664389	0.17325705	-3.61678741	0.74566216

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	69.99112904	18.10887096
2	195.4593025	49.84069747
3	198.9046528	141.9953472
4	54.19994016	72.80005984
5	93.24724358	-91.84724358
6	115.0677955	-112.0677955
7	104.8753008	-95.87530085
8	85.78231793	38.21768207
9	148.2292921	-127.2292921
10	160.2880182	-109.2880182
11	93.67791237	129.7220876
12	108.1770949	85.62290511

Precipitation (Y) - Relative Humidity (X)

Regression Statistics	
Multiple R	0.635156127
R Square	0.403423306
Adjusted R Square	0.343765636
Standard Error	90.18825688
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	55004.05238	55004.0524	6.76230416	0.026471365
Residual	10	81339.21678	8133.92168		
Total	11	136343.2692			

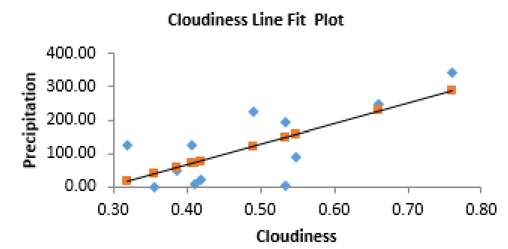
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-1244.68314	525.0468352	-2.37061355	0.03923613	-2414.56039	-74.8
Humidity	17.45422079	6.712018039	2.60044307	0.02647136	2.498912624	32.4

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	64.664939	23.435061
2	187.4657675	57.83423246
3	262.4325186	78.46748144
4	179.2903676	-52.29036761
5	155.8773107	-154.4773107
6	154.1272109	-151.1272109
7	36.51297392	-27.51297392
8	82.54144721	41.45855279
9	30.05677983	-9.056779833
10	53.39371884	-2.393718839
11	117.0369918	106.3630082
12	104.499974	89.30002596

Precipitation (Y) - Cloudiness (X)

Regression Statistics	
Multiple R	0.725257859
R Square	0.525998962
Adjusted R Square	0.478598858
Standard Error	80.39082727
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	71716.41807	71716.4181	11.0970002	0.00760226
Residual	10	64626.8511	6462.68511		
Total	11	136343.2692			

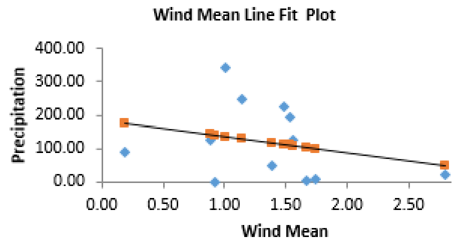
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-183.3586488	93.68261965	-1.9572323	0.07879734	-392.096533	25.3792359
Cloudiness	623.0389624	187.030489	3.33121603	0.00760226	206.3090634	1039.76886

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	157.6379272	-69.53792721
2	227.7038297	17.59617025
3	290.2849783	50.61502168
4	70.01055004	56.98944996
5	38.3896405	-36.9896405
6	148.4621209	-145.4621209
7	72.55628724	-63.55628724
8	15.61183446	108.3881655
9	77.62545685	-56.62545685
10	57.39594247	-6.395942475
11	122.6227014	100.7772986
12	149.5987309	44.20126913

Precipitation (Y) - Wind Mean (X)

Regression Statistics	
Multiple R	0.277716535
R Square	0.077126474
Adjusted R Square	-0.015160879
Standard Error	112.1728994
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	10515.6756	10515.6756	0.83572095	0.382136972
Residual	10	125827.5936	12582.7594		
Total	11	136343.2692			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	185.6461488	79.77916861	2.32700029	0.0422657	7.887083644	363.4
Wind Mean	-48.99335986	53.59281617	-0.91417775	0.38213697	-168.405596	70.4

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	176.7430754	-88.64307545
2	129.7261567	115.5738433
3	136.1259633	204.7740367
4	142.3686973	-15.36869726
5	140.3404701	-138.9404701
6	103.6543403	-100.6543403
7	100.3029005	-91.3029005
8	109.2586417	14.74135829
9	48.4647412	-27.4647412
10	117.9022462	-66.90224623
11	112.7004742	110.6995258
12	110.3122929	83.48770709

Precipitation (Y) - Max Temp, Min Temp, Insolation, Relative Humidity, Cloudiness, Wind Mean (X)

Regression Statistics	
Multiple R	0.857251264
R Square	0.73487973
Adjusted R Square	0.416735405
Standard Error	85.02630696
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	100195.9048	16699.3175	2.3098942	0.188192878
Residual	5	36147.36437	7229.47287		
Total	11	136343.2692			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2876.716263	1782.541392	-1.61382859	0.16748448	-7458.88479	1705.45226
Max Temp	51.04437208	43.05389724	1.18559237	0.2890517	-59.6291941	161.717938
Min Temp	-24.30606064	32.00442877	-0.75945929	0.48182841	-106.576064	57.9639426
Insolation	0.56129338	1.235805975	0.45419216	0.66872685	-2.61544701	3.73803377
Humidity	17.19338246	11.61044211	1.4808551	0.19872844	-12.6522091	47.0389741
Cloudiness	627.6697203	405.2720955	1.54876126	0.18212206	-414.115367	1669.45481
Wind Mean	75.07619474	70.80696161	1.06029397	0.33751958	-106.938895	257.091284

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	128.3986142	-40.29861416
2	214.1986437	31.10135626
3	319.4980691	21.40193092
4	125.355678	1.644321978
5	15.71399932	-14.31399932
6	140.6691734	-137.6691734
7	-52.77417327	61.77417327
8	81.25401596	42.74598404
9	49.65123335	-28.65123335
10	90.06350529	-39.06350529
11	152.5641502	70.83584984
12	163.3070908	30.4929092

Precipitation (Y) - Min Temp, Relative Humidity, Cloudiness (X)

Regression Statistics	
Multiple R	0.805011502
R Square	0.648043519
Adjusted R Square	0.516059839
Standard Error	77.44909395
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	88356.37193	29452.124	4.91002764	0.031982683
Residual	8	47986.89723	5998.36215		
Total	11	136343.2692			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-783.4642161	520.4915921	-1.50523895	0.17067957	-1983.71998	416.7
Min Temp	10.04821531	7.910039773	1.2703116	0.23967109	-8.19236911	28.28
Humidity	6.769299394	7.52895727	0.89910185	0.39485445	-10.5925072	24.1
Cloudiness	352.9359691	248.9705033	1.41758146	0.19406331	-221.191041	927.0

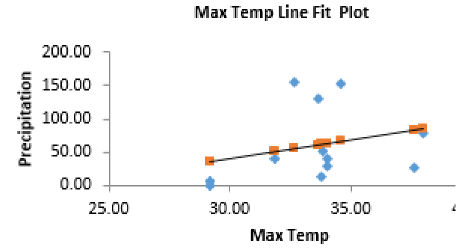
RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	152.6690948	-64.56909475
2	242.6905818	2.609418207
3	294.3005726	46.59942739
4	136.4002978	-9.400297759
5	72.22912308	-70.82912308
6	119.3556151	-116.3556151
7	-19.86092774	28.86092774
8	14.74212125	109.2578787
9	48.13660842	-27.13660842
10	75.14311474	-24.14311474
11	137.6052285	85.79477152
12	154.4885697	39.31143027

Appendix 16: 2002

Months	Precipitation	Min Temp	Insolation	Humidity	Max Temp
Jan	40.60	23.51	211.90	76.43	34.04
Feb	155.10	23.46	159.70	84.63	32.68
Mar	131.10	23.89	240.20	83.06	33.63
Apr	50.60	21.90	254.00	82.79	33.84
May	39.60	19.54	236.30	81.58	31.85
Jun	0.00	15.46	222.80	82.63	29.19
Jul	7.00	15.42	196.20	74.09	29.20
Aug	13.20	18.41	207.80	70.45	33.80
Sep	28.10	18.20	185.60	66.88	34.00
Oct	78.80	23.10	192.60	70.10	38.00
Nov	26.20	24.07	209.30	67.68	37.60
Dec	153.20	24.50	240.50	75.00	34.60
Total/Mean	**723.50**	**20.96**	**2556.90**	**76.28**	**33.54**

Precipitation (Y) - Max Temp (X)



Regression Statistics	
Multiple R	0.274054295
R Square	0.075105757
Adjusted R Square	-0.017383668
Standard Error	56.71509276
Observations	12

ANOVA

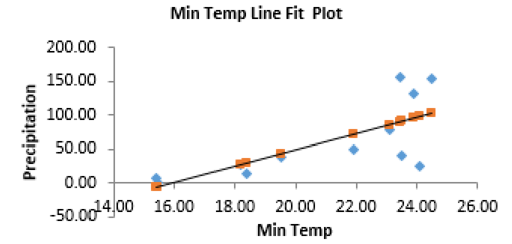
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2612.031703	2612.0317	0.81204697	0.388703294
Residual	10	32166.01746	3216.60175		
Total	11	34778.04917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-132.0281578	214.0462641	-0.61682066	0.55113703	-608.952955	344.8
Max Temp	5.734697094	6.363849616	0.90113649	0.38870329	-8.44484348	19.91

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	63.17353356	-22.57353356
2	55.35306978	99.74693022
3	60.84265445	70.25734555
4	62.0339919	-11.4339919
5	50.63119474	-11.03119474
6	35.38676415	-35.38676415
7	35.44349751	-28.44349751
8	61.80460401	-48.60460401
9	62.95154343	-34.85154343
10	85.89033181	-7.090331807
11	83.59645297	-57.39645297
12	66.39236169	86.80763831

Precipitation (Y) - Min Temp (X)



Regression Statistics	
Multiple R	0.722352614
R Square	0.521793299
Adjusted R Square	0.473972629
Standard Error	40.78124097
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	18146.95302	18146.953	10.9114594	0.007969638
Residual	10	16631.09615	1663.10961		
Total	11	34778.04917			

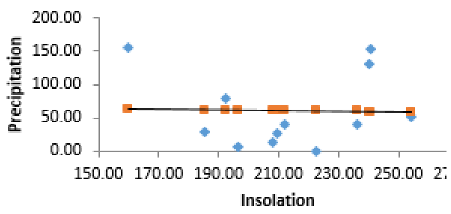
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-191.093896	77.0076792	-2.48149143	0.03245981	-362.677698	-19.510094
Min Temp	11.99638402	3.631691414	3.30324982	0.00796964	3.90447128	20.0882968

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	90.9372174	-50.3372174
2	90.30699937	64.79300063
3	95.54228133	35.55771867
4	71.58693002	-20.98693002
5	43.29997235	-3.699972348
6	-5.66978306	5.66978306
7	-6.078691806	13.07869181
8	29.75565891	-16.55565891
9	27.28027705	0.819722954
10	86.02257479	-7.222574789
11	97.69905123	-71.49905123
12	102.8175124	50.38248759

Precipitation (Y) - Insolation (X)

Regression Statistics	
Multiple R	0.0148627
R Square	0.0002209
Adjusted R Square	-0.09975701
Standard Error	58.96640289
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	7.682465488	7.68246549	0.00220949	0.963434596
Residual	10	34770.3667	3477.03667		
Total	11	34778.04917			

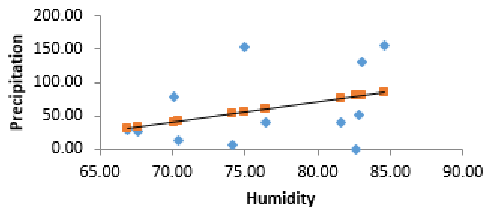
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	66.8343941	140.2286204	0.47661022	0.64388303	-245.614443	379.2
Insolation	-0.030706218	0.653251864	-0.04700517	0.9634346	-1.48624208	1.424

RESIDUAL OUTPUT

Observation	Predicted Precipitation	Residuals
1	60.32774647	-19.72774647
2	61.93061106	93.16938894
3	59.4587605	71.6412395
4	59.03501469	-8.435014688
5	59.57851475	-19.97851475
6	59.9930487	-59.9930487
7	60.8098341	-53.8098341
8	60.45364197	-47.25364197
9	61.13532001	-33.03532001
10	60.92037648	17.87962352
11	60.40758264	-34.20758264
12	59.44954863	93.75045137

Precipitation (Y) - Relative Humidity (X)

Regression Statistics	
Multiple R	0.363733217
R Square	0.132301853
Adjusted R Square	0.045532039
Standard Error	54.93345866
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	4601.200365	4601.20037	1.52474514	0.245129867
Residual	10	30176.8488	3017.68488		
Total	11	34778.04917			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-178.9630261	194.4068296	-0.92055936	0.37895259	-612.128436	254.202384
Humidity	3.136693806	2.540232669	1.23480571	0.24512987	-2.5232973	8.79668491

RESIDUAL OUTPUT

Observation	Predicted Precipitation	Residuals
1	60.76638567	-20.16638567
2	86.47968722	68.62031278
3	81.58492672	49.51507328
4	80.72908295	-30.12908295
5	76.93047775	-37.33047775
6	80.23243768	-80.23243768
7	53.43057163	-46.43057163
8	42.022112	-28.822112
9	30.80337216	-2.703372158
10	40.91920968	37.88079032
11	33.3127272	-7.112727203
12	56.28900933	96.91099067

Precipitation (Y) - Min Temp, Insolation, Relative Humidity, Max Temp (X)

Regression Statistics	
Multiple R	0.841235311
R Square	0.707676849
Adjusted R Square	0.540635048
Standard Error	38.10967054
Observations	12

ANOVA

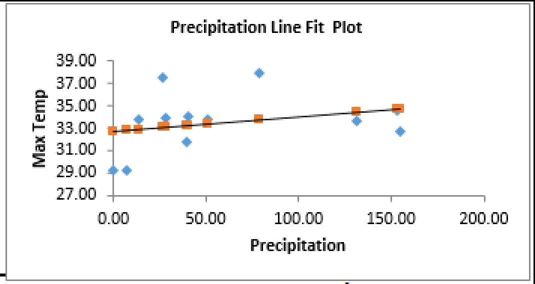
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	24611.62025	6152.90506	4.23652551	0.046957997
Residual	7	10166.42892	1452.34699		
Total	11	34778.04917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	45.27448387	477.6720526	0.09478152	0.92714449	-1084.24044	117
Min Temp	18.46249358	7.97210099	2.31588807	0.05371882	-0.38852975	37.31
Insolation	-0.42455647	0.453584072	-0.93600392	0.38042985	-1.49711237	0.647
Humidity	0.926119425	3.411710971	0.27145307	0.79387378	-7.14129508	8.993
Max Temp	-10.49746359	11.86531794	-0.88471827	0.40567051	-38.5544821	17.5

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	102.8190273	-62.21902726
2	145.9184014	9.181598576
3	108.3047546	22.79524543
4	63.1450178	-12.5450178
5	46.87737046	-7.277370459
6	6.124302416	-6.124302416
7	8.770999209	-1.770999209
8	7.372531028	5.827468972
9	7.57619639	20.52380361
10	56.00586497	22.79413503
11	68.83907202	-42.63907202
12	101.7464625	51.45353754

Max Temp (Y) - Precipitation (X)



Regression Statistics	
Multiple R	0.274054295
R Square	0.075105757
Adjusted R Square	-0.017383668
Standard Error	2.710346253
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5.965278215	5.96527822	0.81204697	0.388703294
Residual	10	73.45976812	7.34597681		
Total	11	79.42504634			

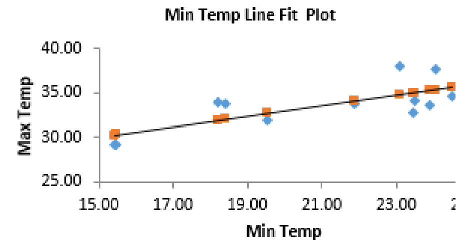
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	32.74655489	1.174727135	27.8758819	8.1914E-11	30.12909972	35.3640101
Precipitation	0.013096726	0.014533565	0.90113649	0.38870329	-0.01928608	0.04547953

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	33.27828197	0.76042803
2	34.7778571	-2.102857102
3	34.46353568	-0.831277677
4	33.40924923	0.43075077
5	33.26518524	-1.413572244
6	32.74655489	-3.553221892
7	32.83823197	-3.635005974
8	32.91943168	0.880568324
9	33.11457289	0.885427106
10	33.7785769	4.221423095
11	33.08968911	4.510310886
12	34.75297332	-0.152973323

Max Temp (Y) - Min Temp (X)

Regression Statistics	
Multiple R	0.739478482
R Square	0.546828425
Adjusted R Square	0.501511268
Standard Error	1.897186688
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	43.43187303	43.431873	12.0666974	0.005983785
Residual	10	35.99317331	3.59931733		
Total	11	79.42504634			

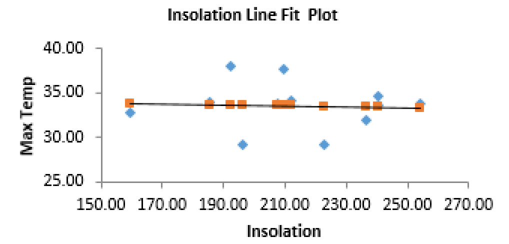
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	21.23794427	3.582479111	5.9282814	0.00014542	13.25568338	29.22
Min Temp	0.586884692	0.168950146	3.47371521	0.00598379	0.210440308	0.963

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	35.03541382	-0.996703818
2	35.00458242	-2.329582417
3	35.26070183	-1.628443831
4	34.08876294	-0.248762941
5	32.70491407	-0.853301073
6	30.30922552	-1.115892525
7	30.28922097	-1.085994973
8	32.04230189	1.757698111
9	31.92120175	2.078798246
10	34.79498066	3.205019342
11	35.3662149	2.233785105
12	35.61661923	-1.016619226

Max Temp (Y) - Insolation (X)

Regression Statistics	
Multiple R	0.049129021
R Square	0.002413661
Adjusted R Square	-0.097344973
Standard Error	2.814841758
Observations	12



ANOVA

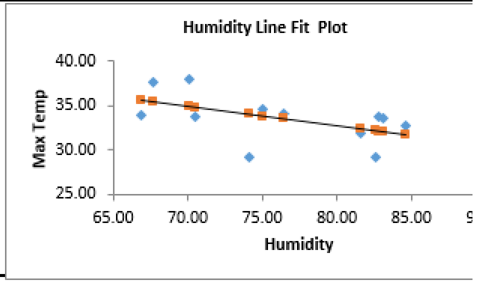
	df	SS	MS	F	Significance F
Regression	1	0.191705117	0.19170512	0.02419501	0.879484798
Residual	10	79.23334122	7.92333412		
Total	11	79.42504634			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	34.56971377	6.694004668	5.1642799	0.0004226	19.65454189	49.4848856
Insolation	-0.004850571	0.03118387	-0.15554744	0.8794848	-0.07433256	0.06463142

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	33.54187775	0.496832246
2	33.79507757	-1.120077566
3	33.40460659	0.227651408
4	33.33766871	0.502331289
5	33.42352382	-1.57191082
6	33.48900653	-4.295673529
7	33.61803172	-4.414805721
8	33.5617651	0.238234904
9	33.66944777	0.330552226
10	33.63549378	4.364506223
11	33.55448924	4.045510761
12	33.40315142	1.196848579

Max Temp (Y) - Relative Humidity (X)



Regression Statistics	
Multiple R	0.525746583
R Square	0.276409469
Adjusted R Square	0.204050416
Standard Error	2.397315404
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	21.95383489	21.9538349	3.81997079	0.079158698
Residual	10	57.47121145	5.74712115		
Total	11	79.42504634			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	50.06264793	8.48398223	5.90084309	0.00015089	31.1591575	68.96
Humidity	-0.216666491	0.110856645	-1.95447456	0.0791587	-0.46367049	0.030

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	33.50338721	0.535322786
2	31.7272461	0.947753898
3	32.06535069	1.566907305
4	32.12446793	1.71553207
5	32.38685582	-0.535242818
6	32.1587736	-2.965440602
7	34.01010709	-4.806881087
8	34.79814413	-0.998144133
9	35.57307632	-1.573076322
10	34.87432689	3.125673112
11	35.39974313	2.200256871
12	33.81266108	0.78733892

Max Temp (Y) - Precipitation, Min Temp, Insolation, Relative Humidity (X)

Regression Statistics	
Multiple R	0.939776108
R Square	0.883179132
Adjusted R Square	0.816424351
Standard Error	1.151303784
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	70.14654351	17.5366359	13.2302003	0.002229279
Residual	7	9.278502829	1.3255004		
Total	11	79.42504634			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	34.68155322	6.056370365	5.72645844	0.00071554	20.36051298	49.0025935
Precipitation	-0.009580625	0.010829013	-0.88471827	0.40567051	-0.03518717	0.01602592
Min Temp	0.722832213	0.166746969	4.33490467	0.00341729	0.328538287	1.11712614
Insolation	0.00058389	0.014533464	0.04017556	0.96907502	-0.03378229	0.03495007
Humidity	-0.207656003	0.067637615	-3.07012604	0.01806431	-0.36759355	-0.0477185

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	35.53924566	-1.500535657
2	32.67153484	0.003465163
3	33.58796445	0.044293548
4	32.98051129	0.859488713
5	31.62263202	0.228980977
6	28.82491311	0.368419888
7	30.49202106	-1.288795058
8	33.35382854	0.446171459
9	33.79166793	0.208332065
10	36.1797955	1.820204501
11	37.9006096	-0.300609603
12	35.489416	-0.889415998

Max Temp (Y) - Min Temp, Relative Humidity (X)

Regression Statistics	
Multiple R	0.931501537
R Square	0.867695113
Adjusted R Square	0.838294027
Standard Error	1.08055139
Observations	12

ANOVA

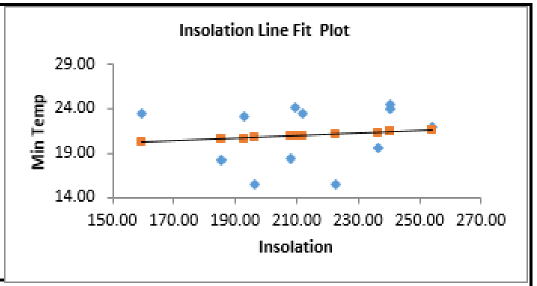
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	68.91672459	34.4583623	29.5123492	0.000111453
Residual	9	10.50832175	1.16759131		
Total	11	79.42504634			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	38.56108339	4.23225857	9.11123051	7.721E-06	28.98704935	48.1
Min Temp	0.611164877	0.096366571	6.34208385	0.00013412	0.393168547	0.82
Humidity	-0.233781471	0.050039673	-4.67192248	0.00116542	-0.34697907	-0.1

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	35.06205778	-1.02334778
2	33.1135083	-0.438508298
3	33.74503595	-0.112777951
4	32.58839946	1.251600539
5	31.43041347	0.421199533
6	28.68951321	0.50381979
7	30.66625558	-1.46302958
8	33.34214963	0.457850374
9	34.05218527	-0.05218527
10	36.29091091	1.709089091
11	37.45269792	0.14730208
12	36.00101253	-1.401012528

Min Temp (Y) - Insolation (X)



Regression Statistics	
Multiple R	0.117644427
R Square	0.013840211
Adjusted R Square	-0.084775768
Standard Error	3.52634779
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.745202051	1.74520205	0.14034451	0.715760915
Residual	10	124.3512873	12.4351287		
Total	11	126.0964894			

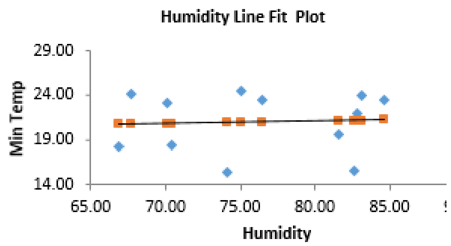
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	17.83671453	8.386044615	2.12695202	0.05932507	-0.84855729	36.5219863
Insolation	0.014635207	0.0390662	0.37462583	0.71576092	-0.07240971	0.10168012

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	20.93791496	2.571762035
2	20.17395714	3.283185859
3	21.35209133	2.541456668
4	21.55405719	0.342609806
5	21.29501402	-1.756304024
6	21.09743872	-5.640771725
7	20.70814221	-5.285561209
8	20.87791061	-2.468233615
9	20.55300901	-2.349676012
10	20.65545546	2.444544537
11	20.89986343	3.173469574
12	21.35648189	3.143518105

Min Temp (Y) - Relative Humidity (X)

Regression Statistics	
Multiple R	0.053929942
R Square	0.002908439
Adjusted R Square	-0.096800717
Standard Error	3.545839047
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.366743905	0.36674391	0.02916922	0.867795108
Residual	10	125.7297455	12.5729745		
Total	11	126.0964894			

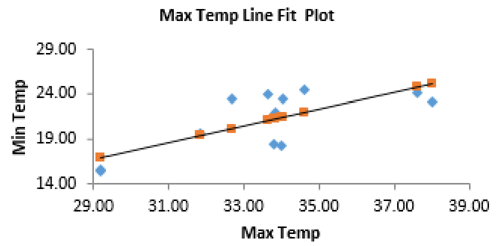
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	18.81908627	12.54855136	1.4997019	0.16458333	-9.14082855	46.77
Humidity	0.028003867	0.163966668	0.17079	0.86779511	-0.33733664	0.393

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	20.95934954	2.550327456
2	21.18891351	2.268229489
3	21.14521393	2.748334075
4	21.1375731	0.759093902
5	21.1036598	-1.564949799
6	21.13313913	-5.676472134
7	20.89385665	-5.471275648
8	20.79200387	-2.382326867
9	20.69184487	-2.488511873
10	20.78215734	2.317842656
11	20.71424797	3.359085034
12	20.91937629	3.580623708

Min Temp (Y) - Max Temp (X)

Regression Statistics	
Multiple R	0.739478482
R Square	0.546828425
Adjusted R Square	0.501511268
Standard Error	2.390467415
Observations	12



ANOVA

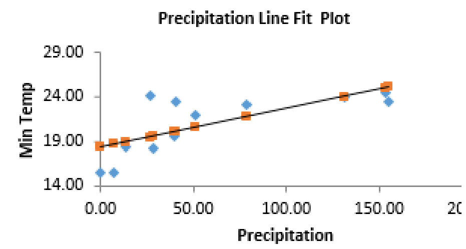
	df	SS	MS	F	Significance F
Regression	1	68.95314475	68.9531447	12.0666974	0.005983785
Residual	10	57.14334464	5.71433446		
Total	11	126.0964894			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-10.29214362	9.021771718	-1.1408118	0.28053258	-30.3939037	9.80961646
Max Temp	0.931747638	0.268227987	3.47371521	0.00598379	0.33409844	1.52939684

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	21.42334403	2.086332973
2	20.15271046	3.304432545
3	21.04463334	2.848914664
4	21.23819645	0.658470546
5	19.38552156	0.153188437
6	16.90867545	-1.452008452
7	16.91789323	-1.495312231
8	21.20092655	-2.791249548
9	21.38727608	-3.183943076
10	25.11426663	-2.014266628
11	24.74156757	-0.668234573
12	21.94632466	2.553675341

Min Temp (Y) - Precipitation (X)



Regression Statistics	
Multiple R	0.722352614
R Square	0.521793299
Adjusted R Square	0.473972629
Standard Error	2.455609622
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	65.79630324	65.7963032	10.9114594	0.007969638
Residual	10	60.30018616	6.03001862		
Total	11	126.0964894			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	18.33267214	1.064318351	17.2248013	9.1952E-09	15.96122307	20.7C
Precipitation	0.043495882	0.013167603	3.30324982	0.00796964	0.014156634	0.072

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	20.09860493	3.411072069
2	25.07888338	-1.621740378
3	24.03498222	-0.141434219
4	20.53356375	1.363103253
5	20.05510905	-0.516399049
6	18.33267214	-2.876005136
7	18.63714331	-3.214562308
8	18.90681777	-0.497140774
9	19.55490641	-1.35157341
10	21.76014761	1.339852391
11	19.47226424	4.601068765
12	24.9962412	-0.496241203

Min Temp (Y) - Insolation, Humidity, Max Temp, Precipitation (X)

Regression Statistics	
Multiple R	0.947307403
R Square	0.897391315
Adjusted R Square	0.83875778
Standard Error	1.359547981
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	113.1578944	28.2894736	15.3050865	0.001432966
Residual	7	12.93859498	1.84837071		
Total	11	126.0964894			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-28.25150016	13.29433818	-2.12507759	0.07118575	-59.6876146	3.1846143
Insolation	0.007488708	0.016929223	0.44235392	0.67157818	-0.03254254	0.04751996
Humidity	0.162448063	0.105828707	1.53500944	0.16865622	-0.08779706	0.41269319
Max Temp	1.007967924	0.232523666	4.33490467	0.00341729	0.458136825	1.55779902
Precipitation	0.023496818	0.010145921	2.31588807	0.05371882	-0.00049447	0.04748811

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	21.0147419	2.4949351
2	23.27132219	0.185820807
3	24.02162731	-0.128079307
4	22.39855113	-0.501884133
5	19.80657751	-0.267867514
6	16.26655213	-0.80988513
7	14.85374459	0.568836406
8	19.12885526	-0.719178259
9	18.93328826	-0.729955258
10	24.73276457	-1.632764572
11	22.82476966	1.24856334
12	24.20854148	0.29145852

Min Temp (Y) - Max Temp, Precipitation

Regression Statistics	
Multiple R	0.915884121
R Square	0.838843722
Adjusted R Square	0.803031216
Standard Error	1.502636233
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	105.7752486	52.8876243	23.4232064	0.000270777
Residual	9	20.32124084	2.25791565		
Total	11	126.0964894			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-5.825079195	5.777917329	-1.00816243	0.33971112	-18.8956363	7.245
Max Temp	0.737718866	0.175319039	4.20786511	0.00228	0.341119647	1.134
Precipitation	0.03383418	0.008378287	4.03831733	0.00293602	0.014881179	0.052

RESIDUAL OUTPUT

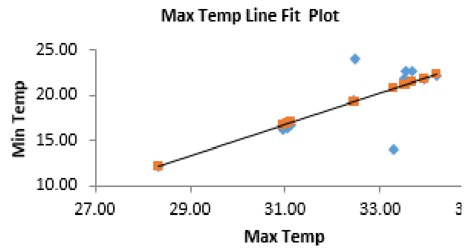
Observation	*Predicted Min Temp*	*Residuals*
1	20.65958703	2.850089965
2	23.52756602	-0.070423022
3	23.42173299	0.471815006
4	20.85133672	1.045330283
5	19.01229014	0.526419863
6	15.71139331	-0.254726312
7	15.95553082	-0.532949824
8	19.55642964	-1.146752639
9	20.20810269	-2.004769691
10	24.87437107	-1.774371067
11	22.79960567	1.273727334
12	24.8833899	-0.383389897

Appendix 17: 2005

Months	Min Temp	Max Temp	Precipitation	Insolation	Humidity	Wind Mean	Cloudiness
Jan	24.06	32.47	275.40	138.90	86.79	4.06	6.82
Feb	22.66	33.68	99.40	206.30	83.64	1.81	6.60
Mar	21.77	33.49	37.40	224.20	86.29	1.73	5.56
Apr	19.44	32.43	41.60	202.20	79.96	2.08	5.03
May	16.78	31.13	44.20	215.90	78.74	2.30	4.15
Jun	16.43	31.05	33.60	215.40	81.52	1.86	4.11
Jul	12.11	28.33	27.40	228.10	73.18	2.28	3.57
Aug	14.08	33.28	0.00	221.90	66.10	2.91	1.87
Sep	16.31	30.97	45.60	174.70	67.37	3.79	3.43
Oct	21.73	33.92	64.20	190.20	78.37	2.58	4.90
Nov	22.23	34.17	126.50	181.10	77.49	2.07	6.38
Dec	22.66	33.53	171.90	210.40	80.60	1.88	6.34
Total / Mean	**19.19**	**32.37**	**967.20**	**2409.3**	**78.34**	**2.45**	**4.90**

Min Temp (Y) - Max Temp (X)

Regression Statistics	
Multiple R	0.758923114
R Square	0.575964294
Adjusted R Square	0.533560723
Standard Error	2.670628427
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	96.87686296	96.876863	13.5829197	0.004207979
Residual	10	71.32256193	7.13225619		
Total	11	168.1994249			

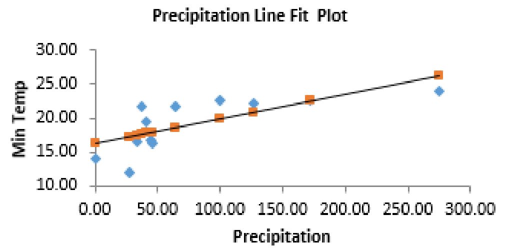
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	-36.78790326	15.2080215	-2.41898022	0.03612454	-70.6734868	-2.90
Max Temp	1.729244703	0.469202036	3.68550128	0.00420798	0.683797418	2.774

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	19.36234616	4.69571884
2	21.45058725	1.206555749
3	21.12506039	0.649133606
4	19.29726604	0.139400964
5	17.04181044	-0.26439144
6	16.91090835	-0.477575346
7	12.19434673	-0.087894728
8	20.76805437	-6.684183367
9	16.76104162	-0.447708624
10	21.87254025	-0.140282251
11	22.29462467	-0.061291674
12	21.19199773	1.472518272

Min Temp (Y) - Precipitation (X)

Regression Statistics	
Multiple R	0.721850497
R Square	0.521068141
Adjusted R Square	0.473174955
Standard Error	2.838240006
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	87.64336159	87.6433616	10.879797	0.008034454
Residual	10	80.5560633	8.05560633		
Total	11	168.1994249			

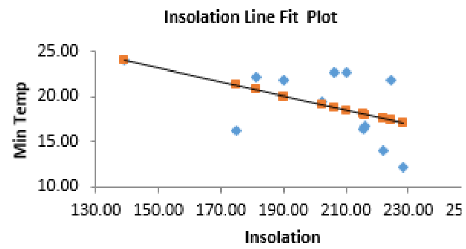
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	16.26281614	1.207654879	13.4664435	9.8105E-08	13.57199339	18.9536389
Precipitation	0.036307682	0.011007486	3.29845373	0.00803445	0.011781476	0.06083389

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	26.26195184	-2.203886835
2	19.87179976	2.78534324
3	17.62072346	4.15347054
4	17.77321573	1.663451274
5	17.8676157	-1.090196699
6	17.48275427	-1.049421268
7	17.25764664	-5.151194638
8	16.26281614	-2.178945144
9	17.91844645	-1.605113455
10	18.59376934	3.138488656
11	20.85573795	1.377595051
12	22.50410672	0.160409277

Min Temp (Y) - Insolation (X)

Regression Statistics	
Multiple R	0.520758367
R Square	0.271189277
Adjusted R Square	0.198308204
Standard Error	3.501221851
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	45.61388038	45.6138804	3.72098362	0.082572933
Residual	10	122.5855445	12.2585545		
Total	11	168.1994249			

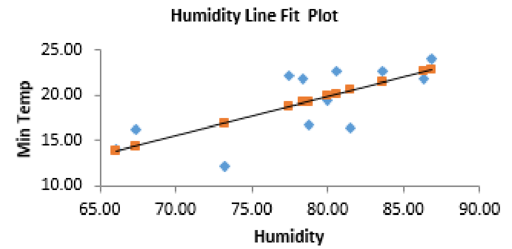
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	35.04163997	8.279932488	4.23211663	0.00173796	16.59280071	53.49
Insolation	-0.078956168	0.040931455	-1.92898513	0.08257293	-0.17015713	0.01

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	24.07462823	-0.016563232
2	18.7529825	3.904160495
3	17.3396671	4.434526903
4	19.07670279	0.359964206
5	17.99500329	-1.217584291
6	18.03448138	-1.601148375
7	17.03173804	-4.925286041
8	17.52126628	-3.437395283
9	21.24799742	-4.934664415
10	20.02417681	1.708081189
11	20.74267794	1.49065506
12	18.42926222	4.235253784

Min Temp (Y) - Relative Humidity (X)

Regression Statistics	
Multiple R	0.728818477
R Square	0.531176372
Adjusted R Square	0.484294009
Standard Error	2.808128641
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	89.34356024	89.3435602	11.329983	0.007169484
Residual	10	78.85586465	7.88558646		
Total	11	168.1994249			

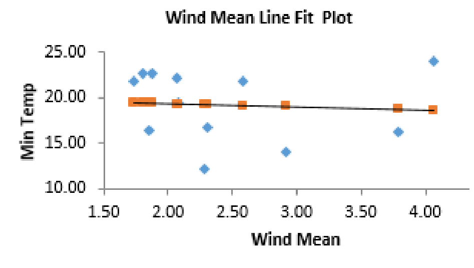
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-14.66428391	10.0900904	-1.45333524	0.17678086	-37.1464064	7.81783854
Humidity	0.432152133	0.12838729	3.366004	0.00716948	0.146087424	0.71821684

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	22.84233931	1.215725687
2	21.48215517	1.174987833
3	22.62626325	-0.852069246
4	19.88988026	-0.453213261
5	19.36421127	-2.58679227
6	20.56331762	-4.129984623
7	16.95949381	-4.853041811
8	13.89957797	0.18429303
9	14.44836494	1.864968061
10	19.20389709	2.52836091
11	18.82390529	3.409427713
12	20.16717802	2.497337976

Min Temp (Y) - Wind Mean (X)

Regression Statistics	
Multiple R	0.064370912
R Square	0.004143614
Adjusted R Square	-0.095442024
Standard Error	4.092706578
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.696953541	0.69695354	0.04160855	0.842459154
Residual	10	167.5024714	16.7502471		
Total	11	168.1994249			

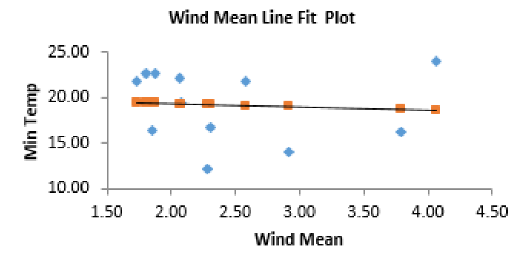
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	19.98559838	4.079036213	4.89958837	0.0006235	10.89693932	29.07
Wind Mean	-0.325551602	1.595983994	-0.20398175	0.84245915	-3.88162555	3.230

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	18.66238869	5.395676313
2	19.39650494	3.260638056
3	19.42200898	2.352185018
4	19.30859918	0.128067825
5	19.23647973	-2.459060729
6	19.38151915	-2.948186153
7	19.24348072	-7.137028716
8	19.03694818	-4.953077175
9	18.75139612	-2.438063122
10	19.14546527	2.586792733
11	19.31279163	2.920541371
12	19.37300142	3.291514579

Min Temp (Y) - Wind Mean (X)

Regression Statistics	
Multiple R	0.064370912
R Square	0.004143614
Adjusted R Square	-0.095442024
Standard Error	4.092706578
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.696953541	0.69695354	0.04160855	0.842459154
Residual	10	167.5024714	16.7502471		
Total	11	168.1994249			

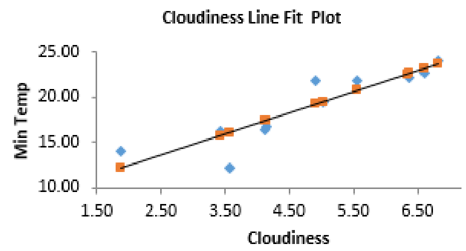
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	19.98559838	4.079036213	4.89958837	0.0006235	10.89693932	29.0742574
Wind Mean	-0.325551602	1.595983994	-0.20398175	0.84245915	-3.88162555	3.23052234

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	18.66238869	5.395676313
2	19.39650494	3.260638056
3	19.42200898	2.352185018
4	19.30859918	0.128067825
5	19.23647973	-2.459060729
6	19.38151915	-2.948186153
7	19.24348072	-7.137028716
8	19.03694818	-4.953077175
9	18.75139612	-2.438063122
10	19.14546527	2.586792733
11	19.31279163	2.920541371
12	19.37300142	3.291514579

Min Temp (Y) - Cloudiness (X)

Regression Statistics	
Multiple R	0.908548675
R Square	0.825460694
Adjusted R Square	0.808006764
Standard Error	1.713400445
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	138.842014	138.842014	47.293685	4.31349E-05
Residual	10	29.35741085	2.93574109		

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	7.773406922	1.732110592	4.48782368	0.00116483	3.914024017	11.63
Cloudiness	2.331110805	0.33897006	6.87704042	4.3135E-05	1.575838445	3.086

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	23.66506483	0.39300017
2	23.14763749	-0.490494489
3	20.73237825	1.041815755
4	19.50666387	-0.069996866
5	17.4487709	-0.671351902
6	17.3568622	-0.923529197
7	16.09522074	-3.988768738
8	12.13484064	1.949030356
9	15.77688658	0.536446423
10	19.20337003	2.528887968
11	22.64071413	-0.407381133
12	22.56217435	0.102341652

Min Temp (Y) - Max Temp, Precipitation, Insolation, Relative Humidity, Wind Mean, Cloudiness (X)

Regression Statistics	
Multiple R	0.993524597
R Square	0.987091124
Adjusted R Square	0.971600473
Standard Error	0.65897883
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	166.0281594	27.6713599	63.7217328	0.000146362
Residual	5	2.171265493	0.4342531		
Total	11	168.1994249			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-34.44639937	10.60374329	-3.24851314	0.02273336	-61.7041893	-7.1886095
Max Temp	1.02074779	0.139087099	7.33891064	0.00073691	0.66321302	1.37828256
Precipitation	-0.006570079	0.00683685	-0.96098042	0.38069693	-0.02414476	0.0110046
Insolation	0.003221331	0.025646424	0.12560546	0.90493842	-0.0627049	0.06914756
Humidity	0.106721534	0.05693584	1.87441749	0.11973212	-0.0396367	0.25307977
Wind Mean	1.343688741	0.908586607	1.478878	0.19923323	-0.99190749	3.67928497
Cloudiness	1.802817594	0.538743634	3.3463367	0.02041045	0.417932995	3.18770219

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	24.35032868	-0.292263676
2	23.1903644	-0.533221405
3	21.7725974	0.001596596
4	19.43960989	-0.002942886
5	16.7116307	0.065788301
6	16.32879839	0.104534614
7	12.33037299	-0.223920986
8	14.5852943	-0.501423301
9	15.89914879	0.414184207
10	21.04197395	0.690284055
11	22.72637565	-0.493042645
12	21.89408887	0.770427126

Min Temp (Y) - Cloudiness, Max Temp (X)

Regression Statistics	
Multiple R	0.976893297
R Square	0.954320514
Adjusted R Square	0.944169517
Standard Error	0.923956666
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	160.5161616	80.2580808	94.0124919	9.30562E-07
Residual	9	7.683263285	0.85369592		
Total	11	168.1994249			

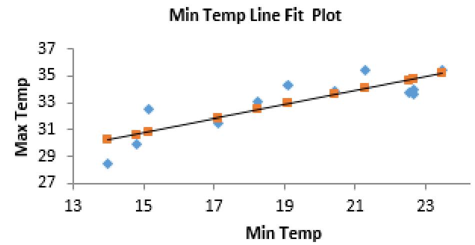
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-20.0793729	5.606118698	-3.58168886	0.00591511	-32.7612945	-7.39
Cloudiness	1.811795944	0.209844791	8.63398101	1.1976E-05	1.337094047	2.286
Max Temp	0.93899128	0.186355472	5.03871054	0.00070101	0.517425914	1.360

Observation	*Predicted Min Temp*	*Residuals*
1	22.76196547	1.296099532
2	23.49373706	-0.836594057
3	21.43977567	0.334418328
4	19.49461629	-0.057949288
5	16.67044462	0.106974378
6	16.52793024	-0.094597242
7	12.98622778	-0.879775784
8	14.56370397	-0.479832972
9	15.21855619	1.094776807
10	20.65727984	1.074978161
11	23.5580618	-1.324728798
12	22.89828506	-0.233769064

Appendix 18: 2009

Months	Max Temp	Min Temp	Insolation	Humidity	Wind Mean	Cloudiness	Precipitation
Jan	33.84	20.43	222.60	76.06	2.09	5.53	193.40
Feb	33.66	22.65	171.20	82.87	2.24	7.20	146.40
Mar	33.74	22.53	168.90	86.90	1.33	4.85	190.20
Apr	34.32	19.12	260.60	79.36	0.98	4.24	1.40
May	31.50	17.13	212.00	79.56	2.32	4.12	54.90
Jun	28.50	13.99	207.90	78.84	2.62	4.36	11.10
Jul	29.96	14.79	196.30	77.15	3.01	4.94	32.30
Aug	32.47	15.17	243.60	69.68	2.75	3.69	56.60
Sep	33.12	18.25	195.30	66.65	4.46	4.17	1.50
Oct	35.47	21.28	233.40	67.36	3.90	4.95	101.80
Nov	35.42	23.49	225.20	72.72	4.33	5.41	81.80
Dec	34.03	22.64	177.80	78.81	3.27	5.33	216.20
Total / Mean	**33.00**	**19.29**	**2514.8**	**76.33**	**2.77**	**4.90**	**1087.60**

Max Temp (Y) - Min Temp (X)



Regression Statistics	
Multiple R	0.849691329
R Square	0.721975354
Adjusted R Square	0.69417289
Standard Error	1.16022854
Observations	12

ANOVA

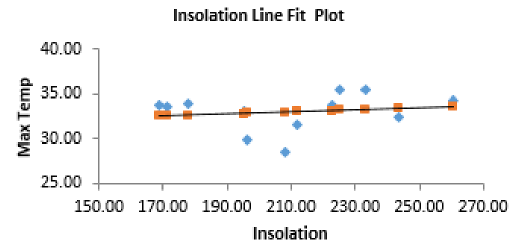
	df	SS	MS	F	Significance F
Regression	1	34.95635694	34.9563569	25.9680343	0.000466824
Residual	10	13.46130266	1.34613027		
Total	11	48.4176596			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	22.88437245	2.013865754	11.3634051	4.8694E-07	18.39719992	27.3
Min Temp	0.524641347	0.102953941	5.09588406	0.00046682	0.295245671	0.754

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	33.6039798	0.237955199
2	34.76749895	-1.106784951
3	34.70403414	-0.962099136
4	32.91376637	1.406233632
5	31.87097086	-0.367744865
6	30.22585352	-1.722520519
7	30.64229493	-0.677778933
8	30.84199704	1.632196962
9	32.4573284	0.662671604
10	34.05077119	1.423422808
11	35.20644905	0.210217948
12	34.76157575	-0.73576975

Max Temp (Y) - Insolation (X)



Regression Statistics	
Multiple R	0.166439113
R Square	0.027701978
Adjusted R Square	-0.069527824
Standard Error	2.169709535
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	1	1.341264954	1.34126495	0.28491242	0.605160341
Residual	10	47.07639465	4.70763946		
Total	11	48.4176596			

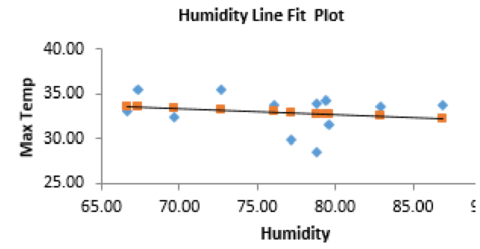
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	30.48281202	4.76446168	6.39795512	7.853E-05	19.86692984	41.0986942
Insolation	0.012029893	0.022537518	0.53377188	0.60516034	-0.03818683	0.06224661

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	33.16066628	0.681268723
2	32.54232976	1.118384241
3	32.514661	1.227273996
4	33.61780222	0.702197777
5	33.03314941	-1.529923407
6	32.98382684	-4.480493844
7	32.84428008	-2.879764082
8	33.41329404	-0.939100037
9	32.83225019	0.287749812
10	33.29058912	2.183604875
11	33.191944	2.224723001
12	32.62172705	1.404078945

Max Temp (Y) - Relative Humidity (X)

Regression Statistics	
Multiple R	0.201749084
R Square	0.040702693
Adjusted R Square	-0.055227038
Standard Error	2.155154994
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	1.970729133	1.97072913	0.42429696	0.529484784
Residual	10	46.44693047	4.64469305		
Total	11	48.4176596			

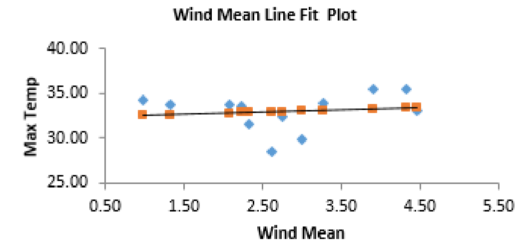
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	38.24138543	8.064657891	4.74184844	0.0007899	20.27220786	56.2
Humidity	-0.068617287	0.105341279	-0.65138081	0.52948478	-0.30333228	0.166

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	33.02204469	0.819890311
2	32.55534044	1.105373565
3	32.27887521	1.463059791
4	32.7960319	1.523968099
5	32.78188418	-1.278658183
6	32.83185877	-4.328525771
7	32.94734036	-2.982824362
8	33.46030996	-0.986115959
9	33.66804324	-0.548043238
10	33.61912577	1.855068232
11	33.25176501	2.164901995
12	32.83390048	1.191905521

Max Temp (Y) - Wind Mean (X)

Regression Statistics	
Multiple R	0.14122312
R Square	0.01994397
Adjusted R Square	-0.078061633
Standard Error	2.17834844
Observations	12



ANOVA

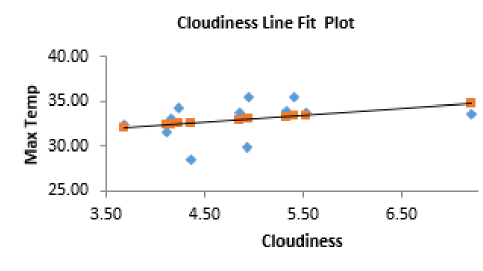
	df	SS	MS	F	Significance F
Regression	1	0.965640336	0.96564034	0.20349826	0.661536214
Residual	10	47.45201927	4.74520193		
Total	11	48.4176596			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	32.25134151	1.782779645	18.0904811	5.7105E-09	28.27906092	36.2236221
Wind Mean	0.27120051	0.60118779	0.45110781	0.66153621	-1.06832936	1.61073038

RESIDUAL OUTPUT

Observation	Predicted Max Temp	Residuals
1	32.81707174	1.024863256
2	32.85831402	0.802399981
3	32.61235902	1.129575978
4	32.51651541	1.803484594
5	32.88122667	-1.378000665
6	32.96248946	-4.459156457
7	33.06669283	-3.102176829
8	32.9978719	-0.523677903
9	33.45969057	-0.339690573
10	33.3098984	2.164295605
11	33.42654363	1.990123367
12	33.13784635	0.887959649

Max Temp (Y) - Cloudiness (X)



Regression Statistics	
Multiple R	0.326522118
R Square	0.106616694
Adjusted R Square	0.017278363
Standard Error	2.079796356
Observations	12

ANOVA

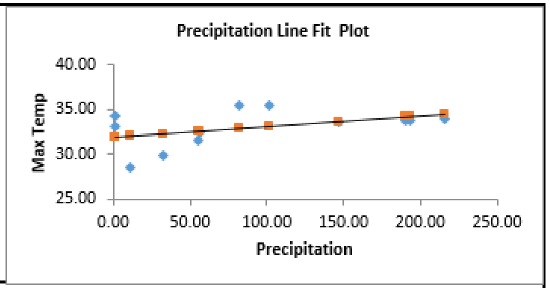
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5.16213078	5.16213078	1.19340369	0.300262755
Residual	10	43.25552882	4.32555288		
Total	11	48.4176596			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	29.39177864	3.360546036	8.74613183	5.3481E-06	21.90401545	36.87
Cloudiness	0.737438662	0.675044206	1.09243018	0.30026275	-0.76665356	2.241

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	33.46751511	0.374419892
2	34.70309285	-1.042378848
3	32.96795941	0.773975591
4	32.52179575	1.798204255
5	32.42875753	-0.925531534
6	32.60373403	-4.10040103
7	33.03139536	-3.066879358
8	32.11157927	0.362614734
9	32.46443998	0.655560022
10	33.03932504	2.434868964
11	33.3821411	2.034525904
12	33.32478459	0.701021408

Max Temp (Y) - Precipitation (X)



Regression Statistics	
Multiple R	0.447601803
R Square	0.200347374
Adjusted R Square	0.120382111
Standard Error	1.967671432
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	9.700350945	9.70035095	2.50543007	0.144536632
Residual	10	38.71730866	3.87173087		
Total	11	48.4176596			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	31.91838071	0.89047365	35.8442731	6.7837E-12	29.93428178	33.9024796
Precipitation	0.011976785	0.007566571	1.58285504	0.14453663	-0.00488259	0.02883616

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	34.23469094	-0.392755945
2	33.67178205	-0.011068047
3	34.19636523	-0.454430232
4	31.93514821	2.384851787
5	32.57590621	-1.072680214
6	32.05132303	-3.547990028
7	32.30523087	-2.340714872
8	32.59626675	-0.122072749
9	31.93634589	1.183654108
10	33.13761743	2.336576567
11	32.89808173	2.518585268
12	34.50776164	-0.481955644

Max Temp (Y) - Min Temp, Insolation, Humidity, Wind Mean, Cloudiness, Precipitation (X)

Regression Statistics	
Multiple R	0.990649338
R Square	0.981386111
Adjusted R Square	0.959049445
Standard Error	0.424556457
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	47.51641868	7.91940311	43.9361046	0.00036243
Residual	5	0.901240926	0.18024819		
Total	11	48.4176596			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	39.6309125	6.39498769	6.19718355	0.00159666	23.1920733	56.06
Min Temp	0.698841362	0.063165048	11.0637352	0.00010508	0.536470438	0.861
Insolation	0.004239841	0.008517564	0.49777618	0.63975826	-0.01765526	0.026
Humidity	-0.227729927	0.058505318	-3.89246544	0.01149629	-0.37812263	-0.077
Wind Mean	-0.86173232	0.296716982	-2.90422313	0.03362496	-1.6244676	-0.098
Cloudiness	-0.21549127	0.202877966	-1.06217188	0.33674446	-0.73700569	0.306
Precipitation	-0.001831301	0.002768917	-0.66137815	0.53762517	-0.00894903	0.005

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	34.18868034	-0.34674534
2	33.56565427	0.095059731
3	33.76215873	-0.020223728
4	34.26327782	0.056722182
5	31.39157841	0.111647593
6	29.1195664	-0.616233396
7	29.51346809	0.45104791
8	32.12544888	0.348745124
9	33.29215542	-0.172155419
10	35.53815838	-0.063964376
11	35.38939698	0.027270018
12	33.8969763	0.128829702

Max Temp (Y) - Min Temp, Relative Humidity, Wind Mean (X)

Regression Statistics	
Multiple R	0.985085721
R Square	0.970393879
Adjusted R Square	0.959291583
Standard Error	0.423299407
Observations	12

ANOVA

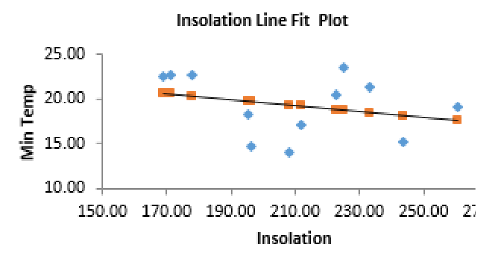
	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	46.9842005	15.6614002	87.4047965	1.86819E-06
Residual	8	1.433459104	0.17918239		
Total	11	48.4176596			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	44.58469944	2.851297663	15.6366345	2.7908E-07	38.00959524	51.1598036
Min Temp	0.641663006	0.040491495	15.846859	2.5155E-07	0.548289452	0.73503656
Humidity	-0.27610338	0.034236465	-8.06459965	4.121E-05	-0.35505281	-0.19715395
Wind Mean	-1.038880257	0.190107519	-5.46469842	0.00059819	-1.47726898	-0.60049153

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	34.52652649	-0.684591487
2	33.91365152	-0.252937523
3	33.66575844	0.076176564
4	33.92425922	0.395740785
5	31.19485026	0.308375743
6	29.07258567	-0.569252668
7	29.64742244	0.317093556
8	32.21939425	0.254799751
9	33.26183119	-0.141831194
10	35.58766245	-0.113468447
11	35.07609314	0.340573857
12	33.95648494	0.069321061

Min Temp (Y) - Insolation (X)



Regression Statistics	
Multiple R	0.285682227
R Square	0.081614335
Adjusted R Square	-0.010224232
Standard Error	3.415176212
Observations	12

ANOVA

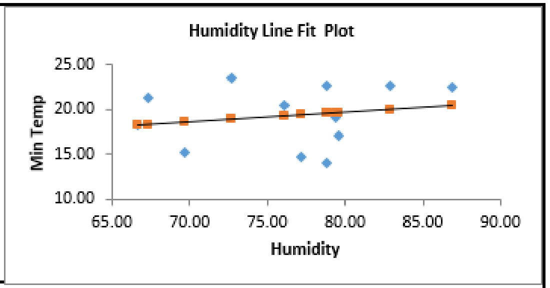
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	10.36495885	10.3649588	0.8886717	0.368054175
Residual	10	116.6342856	11.6634286		
Total	11	126.9992445			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	26.29668751	7.499379956	3.50651489	0.00566453	9.587027666	43.0(
Insolation	-0.033441695	0.035474608	-0.94269385	0.36805418	-0.11248405	0.045

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	18.85256624	1.579691756
2	20.57146936	2.078530642
3	20.64838526	1.880646744
4	17.58178184	1.534885159
5	19.20704821	-2.078016209
6	19.34415916	-5.350826158
7	19.73208282	-4.944985818
8	18.15029065	-2.982548653
9	19.76552451	-1.518857513
10	18.49139594	2.79247506
11	18.76561784	4.721049162
12	20.35075417	2.287955828

Min Temp (Y) - Relative Humidity (X)



Regression Statistics	
Multiple R	0.191516235
R Square	0.036678468
Adjusted R Square	-0.059653685
Standard Error	3.497729359
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4.658137781	4.65813778	0.38075001	0.550992053
Residual	10	122.3411067	12.2341107		
Total	11	126.9992445			

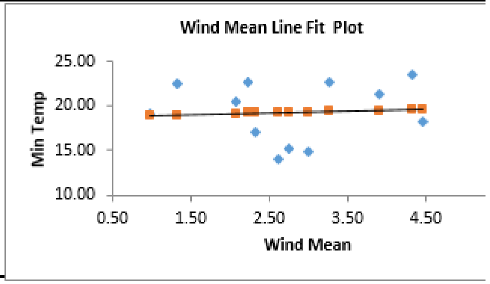
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	11.23616911	13.08861347	0.85846902	0.41073815	-17.9270791	40.3994173
Humidity	0.105493631	0.170964633	0.61704944	0.55099205	-0.27543931	0.48642657

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	19.26049111	1.171766892
2	19.97801184	2.671988157
3	20.40305518	2.125976823
4	19.60796782	-0.491300824
5	19.62971882	-2.500686817
6	19.55288686	-5.559553856
7	19.37534308	-4.58824608
8	18.58669305	-3.418951053
9	18.26731963	-0.02065263
10	18.34252636	2.941344644
11	18.90731436	4.579352639
12	19.54974789	3.088962107

Min Temp (Y) - Wind Mean (X)

Regression Statistics	
Multiple R	0.062943567
R Square	0.003961893
Adjusted R Square	-0.095641918
Standard Error	3.55662884
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.503157374	0.50315737	0.03977652	0.845915167
Residual	10	126.4960871	12.6496087		
Total	11	126.9992445			

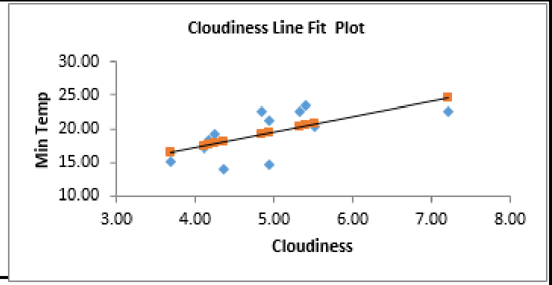
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper*
Intercept	18.74520893	2.910776525	6.43993407	7.4428E-05	12.25959466	25.23
Wind Mean	0.195764853	0.981570163	0.19944051	0.84591517	-1.99130976	2.382

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	19.15357872	1.278679283
2	19.18334927	3.466650734
3	19.00580777	3.523224229
4	18.93662349	0.180043507
5	19.19988865	-2.070856655
6	19.25854783	-5.265214831
7	19.33376656	-4.546669561
8	19.28408849	-4.116346489
9	19.61745019	-1.370783193
10	19.50932339	1.774547608
11	19.59352323	3.893143774
12	19.38512841	3.253581593

Min Temp (Y) - Cloudiness

Regression Statistics	
Multiple R	0.641231127
R Square	0.411177358
Adjusted R Square	0.352295094
Standard Error	2.734593765
Observations	12



ANOVA

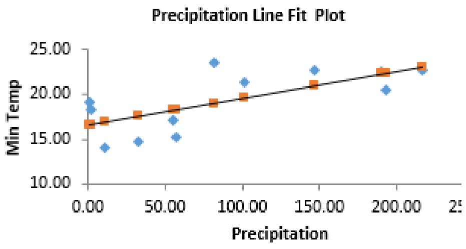
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	52.21921386	52.2192139	6.98304259	0.024626176
Residual	10	74.7800306	7.47800306		
Total	11	126.9992445			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	7.800006001	4.418571179	1.76527789	0.10797616	-2.04518411	17.6451961
Cloudiness	2.345452089	0.887573282	2.64254472	0.02462618	0.367815575	4.3230886

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	20.76304293	-0.330784933
2	24.69284556	-2.042845562
3	19.17418678	3.354845221
4	17.75514605	1.361520953
5	17.45923443	-0.330202429
6	18.01575392	-4.022420919
7	19.37594726	-4.588850258
8	16.45043672	-1.282694722
9	17.57272382	0.67394318
10	19.4011679	1.882703095
11	20.4915076	2.995159401
12	20.30908303	2.329626974

Min Temp (Y) - Precipitation (X)



Regression Statistics	
Multiple R	0.697079328
R Square	0.485919589
Adjusted R Square	0.434511548
Standard Error	2.55514821
Observations	12

ANOVA

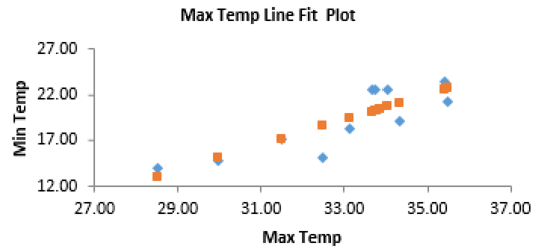
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	61.7114207	61.7114207	9.45220979	0.01175143
Residual	10	65.28782376	6.52878238		
Total	11	126.9992445			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	16.55052504	1.156337443	14.3128852	5.4819E-08	13.97404466	19.12
Precipitation	0.03020851	0.00982568	3.07444463	0.01175143	0.00831553	0.052

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	22.39285088	-1.960592877
2	20.97305091	1.676949093
3	22.29618364	0.232848355
4	16.59281696	2.523850041
5	18.20897224	-1.079940243
6	16.88583951	-2.892506506
7	17.52625992	-2.739162917
8	18.26032671	-3.09258471
9	16.59583781	1.65082919
10	19.62575136	1.658119638
11	19.02158116	4.465085838
12	23.0816049	-0.442894904

Min Temp (Y) - Max Temp (X)



Regression Statistics	
Multiple R	0.849691329
R Square	0.721975354
Adjusted R Square	0.69417289
Standard Error	1.879066789
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	91.6903245	91.6903245	25.9680343	0.000466824
Residual	10	35.30891996	3.530892		
Total	11	126.9992445			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-26.12924319	8.929109384	-2.92629892	0.01513636	-46.0245387	-6.23394765
Max Temp	1.376131254	0.270047599	5.09588406	0.00046682	0.774427707	1.9778348

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	20.44170127	-0.009443265
2	20.19231738	2.457682617
3	20.30408814	2.22494386
4	21.09958145	-1.982914453
5	17.22333072	-0.094298716
6	13.0950842	0.8982488
7	15.10586379	-0.318766794
8	18.55951013	-3.391768128
9	19.44822395	-1.201556948
10	22.68790389	-1.40403289
11	22.60873919	0.877927813
12	20.6947319	1.943978105

Min Temp (Y) - Insolation, Relative Humidity, Wind Mean, Cloudiness, Precipitation, Max Temp (X)

Regression Statistics	
Multiple R	0.992995306
R Square	0.986039678
Adjusted R Square	0.969287292
Standard Error	0.59547465
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	125.2262942	20.871049	58.8596564	0.000177741
Residual	5	1.772950296	0.35459006		
Total	11	126.9992445			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-55.31108025	9.302645083	-5.94573691	0.00192267	-79.2242907	-31.39
Insolation	-0.00391819	0.012112918	-0.32347201	0.7594291	-0.03505544	0.027
Humidity	0.321973384	0.080029423	4.02318765	0.01008892	0.116251204	0.527
Wind Mean	1.245786606	0.393658078	3.16464129	0.02496465	0.233856302	2.257
Cloudiness	0.345090589	0.274632496	1.2565541	0.26442366	-0.36087472	1.05
Precipitation	0.003578038	0.003720428	0.96172736	0.380356	-0.00598563	0.01
Max Temp	1.374783328	0.124260325	11.0637352	0.00010508	1.055361994	1.694

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	20.03081406	0.401443937
2	22.77247077	-0.122470767
3	22.40533265	0.123699345
4	19.08950396	0.027163041
5	17.29708408	-0.16805208
6	13.25290207	0.740430934
7	15.51993869	-0.732841693
8	15.71823579	-0.550493792
9	17.90996373	0.336703269
10	21.1665373	0.117333705
11	23.46803323	0.018633767
12	22.83025967	-0.191549667

Min Temp (Y) - Relative Humidity, Wind Mean, Max Temp (X)

Regression Statistics	
Multiple R	0.986626829
R Square	0.9734325
Adjusted R Square	0.963469687
Standard Error	0.649427868
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	123.625192	41.2083973	97.7065959	1.21293E-06
Residual	8	3.374052445	0.42175656		
Total	11	126.9992445			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-67.60868077	5.711770769	-11.8367287	2.3796E-06	-80.7800478	-54.4373138
Humidity	0.426637182	0.049356486	8.64399419	2.4908E-05	0.31282092	0.54045344
Wind Mean	1.616407016	0.275713557	5.86263161	0.00037734	0.980610413	2.25220362
Max Temp	1.510335822	0.095308214	15.846859	2.5155E-07	1.290554687	1.73011696

RESIDUAL OUTPUT

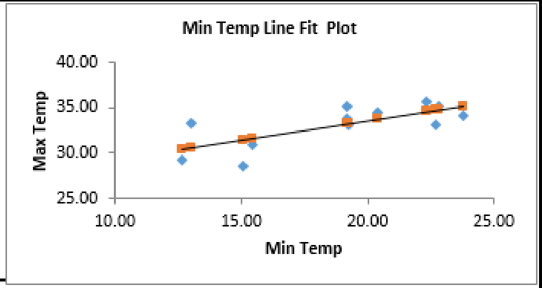
Observation	*Predicted Min Temp*	*Residuals*
1	19.32781727	1.104440732
2	22.20172082	0.448279181
3	22.57741249	-0.048380487
4	19.66374739	-0.547080387
5	17.67118705	-0.542155051
6	13.31395931	0.679373694
7	15.42388613	-0.636789131
8	15.61469958	-0.446957578
9	18.05100179	0.195665214
10	21.01798616	0.265884844
11	23.91044382	-0.423776823
12	22.68721421	-0.048504209

Appendix 19: 2010

Months	Min Temp	Humidity	Wind Mean	Cloudiness	Precipitation	Max Temp
Jan	22.71	80.84	3.15	7.57	181.40	33.19
Feb	23.76	80.71	3.64	7.35	64.40	34.08
Mar	22.80	83.08	2.05	4.08	67.80	35.17
Apr	19.21	76.21	2.94	4.79	10.40	33.08
May	15.05	80.27	3.20	5.13	71.80	28.57
Jun	15.41	86.83	2.17	2.33	7.40	30.88
Jul	12.67	75.31	3.59	3.19	0.00	29.24
Aug	12.99	65.65	2.96	1.17	0.00	33.32
Sep	19.18	68.89	4.52	1.76	18.50	35.20
Oct	20.42	69.89	2.84	4.38	96.30	34.40
Nov	19.19	72.08	3.80	5.78	108.90	33.78
Dec	22.34	72.62	3.72	5.30	121.80	35.63
Total / Mean	**18.81**	**76.03**	**3.22**	**4.40**	**748.70**	**33.05**

Max Temp (Y) - Min Temp (X)

Regression Statistics	
Multiple R	0.730361358
R Square	0.533427713
Adjusted R Square	0.486770485
Standard Error	1.652948847
Observations	12



ANOVA

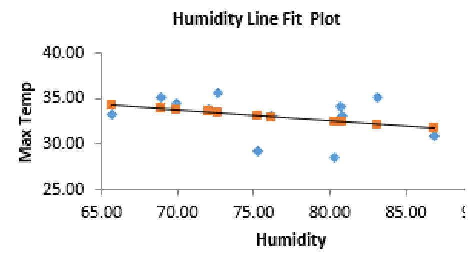
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	31.23744207	31.2374421	11.4329061	0.006987806
Residual	10	27.3223989	2.73223989		
Total	11	58.55984097			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	24.9396264	2.444204987	10.203574	1.3211E-06	19.49359831	30.3856545
Min Temp	0.430891566	0.127435279	3.38125806	0.00698781	0.146948069	0.71483506

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	34.72503468	-1.534711683
2	35.17637895	-1.097807948
3	34.7639541	0.410239898
4	33.21848954	-0.138489543
5	31.4252395	-2.851045495
6	31.58110159	-0.701101592
7	30.39943964	-1.160729643
8	30.53843664	2.777692355
9	33.20412663	1.999206366
10	33.73815425	0.665071749
11	33.20699939	0.569667612
12	34.56379808	1.062007924

Max Temp (Y) - Humidity (X)



Regression Statistics	
Multiple R	0.351347046
R Square	0.123444747
Adjusted R Square	0.035789221
Standard Error	2.265633162
Observations	12

ANOVA

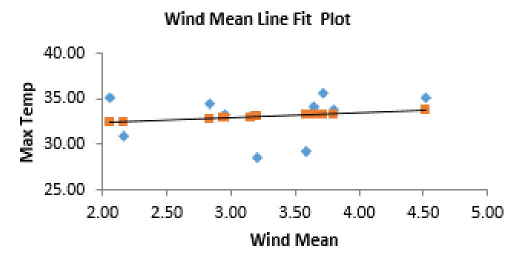
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.228904732	7.22890473	1.40829396	0.262767055
Residual	10	51.33093624	5.13309362		
Total	11	58.55984097			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	42.64493527	8.115814703	5.25454767	0.00037095	24.56177321	60.72
Humidity	-0.126262793	0.106396841	-1.1867156	0.26276705	-0.36332973	0.110

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	32.43801398	0.75230902
2	32.4537241	1.624846898
3	32.15494101	3.019252994
4	33.02265831	0.057341688
5	32.51030966	-3.936115656
6	31.68216829	-0.802168286
7	33.13653233	-3.897822326
8	34.3553756	-1.0392466
9	33.94648099	1.256852005
10	33.82079522	0.582430777
11	33.54454448	0.23212252
12	33.47560904	2.150196965

Max Temp (Y) - Wind Mean (X)



Regression Statistics	
Multiple R	0.158405166
R Square	0.025092197
Adjusted R Square	-0.072398584
Standard Error	2.389360708
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.469395052	1.46939505	0.2573802	0.622925853
Residual	10	57.09044592	5.70904459		
Total	11	58.55984097			

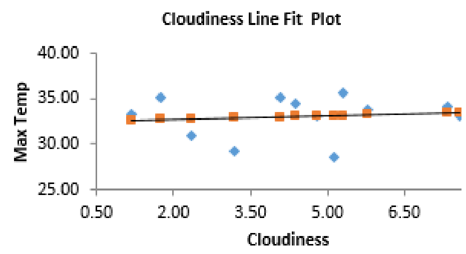
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	31.36160656	3.389282191	9.25317067	3.2223E-06	23.80981523	38.9133979
Wind Mean	0.523498924	1.031877693	0.50732652	0.62292585	-1.77566785	2.8226657

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	33.01090982	0.179413185
2	33.26863828	0.809932718
3	32.43674928	2.737444717
4	32.90301983	0.176980172
5	33.03905469	-4.464860688
6	32.49585441	-1.615854406
7	33.24169955	-4.00298955
8	32.90958712	0.406541878
9	33.72898491	1.474348088
10	32.84766819	1.555557807
11	33.34973926	0.426927742
12	33.30924766	2.316558336

Max Temp (Y) - Cloudiness (X)

Regression Statistics	
Multiple R	0.103856133
R Square	0.010786096
Adjusted R Square	-0.088135294
Standard Error	2.406827972
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.631632083	0.63163208	0.10903705	0.748056714
Residual	10	57.92820888	5.79282089		
Total	11	58.55984097			

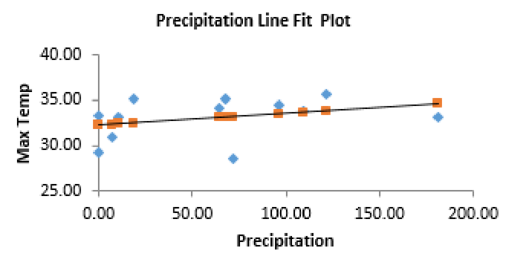
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	32.52570854	1.719531332	18.9154498	3.6988E-09	28.69435397	36.35
Cloudiness	0.118002403	0.357358249	0.33020758	0.74805671	-0.6782414	0.91

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	33.41897398	-0.228650983
2	33.39246427	0.686106729
3	33.00660007	2.167593929
4	33.09080895	-0.010808946
5	33.13094664	-4.556752637
6	32.80104744	-1.921047437
7	32.90255487	-3.663844874
8	32.66401243	0.652116574
9	32.73286836	2.470464638
10	33.04212764	1.361098356
11	33.20750022	0.569166776
12	33.15124812	2.474557875

Max Temp (Y) - Precipitation (X)

Regression Statistics	
Multiple R	0.317973774
R Square	0.101107321
Adjusted R Square	0.011218053
Standard Error	2.29431934
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5.920828631	5.92082863	1.12479858	0.313830696
Residual	10	52.63901234	5.26390123		
Total	11	58.55984097			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	32.25117252	0.999519104	32.2666894	1.9254E-11	30.02410517	34.4782399
Precipitation	0.012724833	0.011998162	1.06056522	0.3138307	-0.01400874	0.0394584

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	34.55945731	-1.369134307
2	33.07065179	1.007919209
3	33.11391622	2.060277776
4	32.38351078	0.696489217
5	33.16481556	-4.590621558
6	32.34533628	-1.465336283
7	32.25117252	-3.012462515
8	32.25117252	1.064956485
9	32.48658193	2.716751066
10	33.47657398	0.926652022
11	33.63690688	0.13976012
12	33.80105723	1.824748768

Max Temp (Y) - Min Temp, Relative Humidity, Wind Mean, Cloudiness, Precipitation (X)

Regression Statistics	
Multiple R	0.974452515
R Square	0.949557705
Adjusted R Square	0.907522459
Standard Error	0.701651953
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	55.60594819	11.1211896	22.5895599	0.000794963
Residual	6	2.953892777	0.49231546		
Total	11	58.55984097			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	36.37966313	4.417042278	8.23620442	0.00017307	25.57155003	47.18
Min Temp	0.693573949	0.0768154	9.02910023	0.00010337	0.505613436	0.881
Humidity	-0.167226629	0.048480863	-3.4493327	0.01364413	-0.28585503	-0.048
Wind Mean	-0.356133859	0.400570906	-0.8890657	0.40819559	-1.33629556	0.624
Cloudiness	-0.566279287	0.207544461	-2.7284722	0.03425538	-1.07412229	-0.058
Precipitation	-0.00046869	0.006413998	-0.073073	0.94412316	-0.01616318	0.01

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	33.11841187	0.071911128
2	33.87243617	0.206134828
3	35.22892083	-0.054726829
4	33.19612852	-0.116128518
5	29.31715902	-0.742965024
6	30.45408737	0.425912627
7	29.48721382	-0.248503823
8	32.69589428	0.620234715
9	35.5485681	-0.345235101
10	35.32068363	-0.917457627
11	32.95878257	0.817884427
12	35.3428668	0.282939197

Max Temp (Y) - Cloudiness, Min Temp, Relative Humidity (X)

Regression Statistics	
Multiple R	0.970973394
R Square	0.942789332
Adjusted R Square	0.921335331
Standard Error	0.647132874
Observations	12

ANOVA

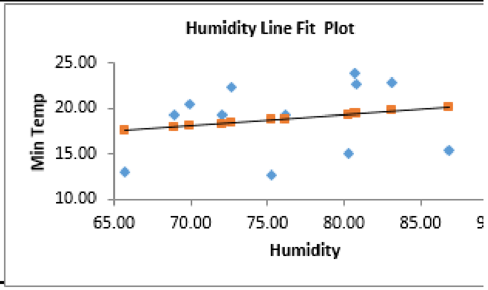
	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	55.20959332	18.4031978	43.9446864	2.57532E-05
Residual	8	3.350247648	0.41878096		
Total	11	58.55984097			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	33.37022598	2.57761539	12.9461618	1.1999E-06	27.42623423	39.3142177
Cloudiness	-0.624707898	0.13719207	-4.5535278	0.0018657	-0.94107338	-0.30834242
Min Temp	0.696736803	0.067719902	10.2885087	6.8615E-06	0.540574429	0.85289918
Humidity	-0.140492638	0.032717763	-4.2940783	0.00263678	-0.21593994	-0.06504534

RESIDUAL OUTPUT

Observation	*Predicted Max Temp*	*Residuals*
1	33.10667882	0.083644185
2	33.99431071	0.084260288
3	35.0377534	0.1364406
4	33.05849569	0.02150431
5	29.37629172	-0.802097719
6	30.45333751	0.426662487
7	29.62351898	-0.384808977
8	32.46732966	0.848799342
9	35.95815615	-0.75482315
10	35.04458284	-0.641356843
11	33.00285259	0.773814406
12	35.41784493	0.20796107

Min Temp (Y) - Relative Humidity (X)



Regression Statistics	
Multiple R	0.20385121
R Square	0.041555316
Adjusted R Square	-0.054289153
Standard Error	4.015626069
Observations	12

ANOVA

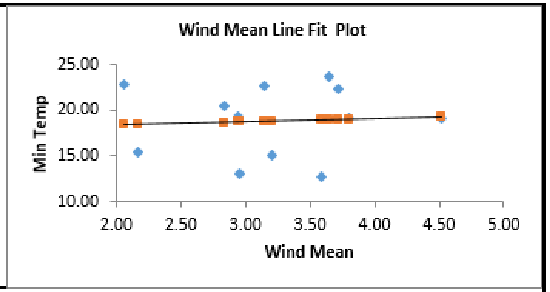
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6.991430808	6.99143081	0.43357031	0.525111562
Residual	10	161.2525273	16.1252527		
Total	11	168.2439581			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	9.370084537	14.38453393	0.65139994	0.52947294	-22.6806544	41.42
Humidity	0.12417157	0.188578599	0.65846056	0.52511156	-0.29600773	0.544

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	19.40795408	3.301722921
2	19.39250416	4.364638845
3	19.68633867	3.113661332
4	18.8329929	0.380340103
5	19.3368558	-4.285242797
6	20.15128111	-4.737948107
7	18.72100492	-6.050036917
8	17.52234869	-4.528800689
9	17.92447099	1.255529008
10	18.0480751	2.371279902
11	18.31975045	0.866916551
12	18.38754415	3.947939848

Min Temp (Y) - Wind Mean (X)



Regression Statistics	
Multiple R	0.059709096
R Square	0.003565176
Adjusted R Square	-0.096078306
Standard Error	4.094436942
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.59981935	0.59981935	0.03577932	0.8537559
Residual	10	167.6441387	16.7644139		
Total	11	168.2439581			

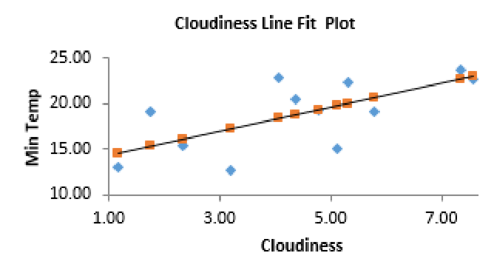
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	17.73532533	5.807914294	3.05364791	0.0121757	4.794485842	30.6761648
Wind Mean	0.334469671	1.768237894	0.18915423	0.8537559	-3.60540988	4.27434922

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	18.78908474	3.920592262
2	18.95375051	4.803392488
3	18.42224676	4.377753235
4	18.72015255	0.493180455
5	18.80706683	-3.755453831
6	18.46000973	-3.046676728
7	18.93653904	-6.265571037
8	18.72434847	-5.730800467
9	19.24787143	-0.067871433
10	18.68478773	1.734567271
11	19.00556689	0.181100113
12	18.97969633	3.355787673

Min Temp (Y) - Cloudiness (X)

Regression Statistics	
Multiple R	0.674612225
R Square	0.455101654
Adjusted R Square	0.400611819
Standard Error	3.027802082
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	76.56810358	76.5681036	8.35204689	0.016107425
Residual	10	91.67585449	9.16758545		
Total	11	168.2439581			

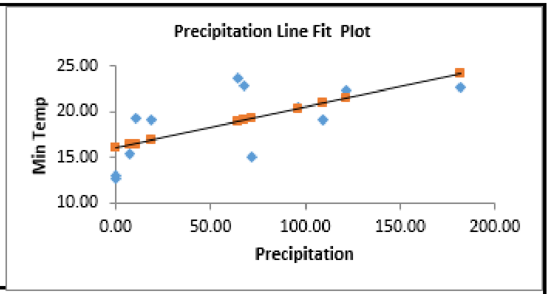
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	13.09241012	2.163179341	6.05239236	0.00012322	8.272546188	17.91
Cloudiness	1.299220028	0.449558532	2.88999081	0.01610743	0.297541196	2.300

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	22.92736542	-0.217688417
2	22.63549044	1.121652559
3	18.38708123	4.412918774
4	19.31423062	-0.100897622
5	19.75615122	-4.70453822
6	16.12392309	-0.710590087
7	17.24153164	-4.570563644
8	14.61515186	-1.621603861
9	15.37326364	3.806736363
10	18.7782439	1.641111104
11	20.59901502	-1.412348016
12	19.97967293	2.355811069

Min Temp (Y) - Precipitation (X)

Regression Statistics	
Multiple R	0.660107242
R Square	0.435741571
Adjusted R Square	0.379315729
Standard Error	3.081121085
Observations	12



ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	73.31088667	73.3108867	7.72237594	0.019486859
Residual	10	94.93307139	9.49330714		
Total	11	168.2439581			

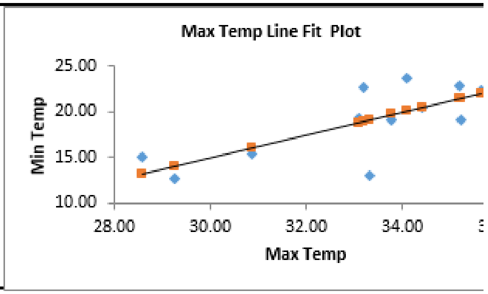
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	16.01727874	1.342288902	11.9328102	3.0798E-07	13.02647269	19.0080848
Precipitation	0.04477598	0.016112748	2.77891633	0.01948686	0.008874539	0.08067742

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	24.13964148	-1.429964478
2	18.90085184	4.856291157
3	19.05309017	3.746909826
4	16.48294893	2.730384066
5	19.23219409	-4.180581093
6	16.34862099	-0.935287995
7	16.01727874	-3.346310744
8	16.01727874	-3.023730744
9	16.84563437	2.33436563
10	20.3292056	0.090149402
11	20.89338294	-1.706715943
12	21.47099308	0.864490917

Min Temp (Y) - Max Temp (X)

Regression Statistics	
Multiple R	0.730361358
R Square	0.533427713
Adjusted R Square	0.486770485
Standard Error	2.801748886
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	89.74598986	89.7459899	11.4329061	0.006987806
Residual	10	78.49796821	7.84979682		
Total	11	168.2439581			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	-22.09767171	12.12563633	-1.8223927	0.0983916	-49.1152731	4.919
Max Temp	1.237962763	0.366124898	3.38125806	0.00698781	0.422185653	2.053

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	18.99071227	3.718964735
2	20.09033021	3.666812787
3	21.44667069	1.35332931
4	18.8541365	0.359196501
5	13.27611645	1.775496547
6	16.13061842	-0.71728542
7	14.09876252	-1.427794517
8	19.14645541	-6.152907408
9	21.48274369	-2.302743687
10	20.49224101	-0.072886014
11	19.7165843	-0.529917303
12	22.00574953	0.329734471

Min Temp (Y) - Relative Humidity, Wind Mean, Cloudiness, Precipitation, Max Temp (X)

Regression Statistics	
Multiple R	0.982855007
R Square	0.966003965
Adjusted R Square	0.937673936
Standard Error	0.976356105
Observations	12

ANOVA

	df	SS	MS	F	Significance F
Regression	5	162.5243306	32.5048661	34.0982342	0.000248048
Residual	6	5.719627459	0.95327124		
Total	11	168.2439581			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-47.9388925	9.047885575	-5.2983531	0.00183271	-70.0782709	-25.799514
Humidity	0.225169271	0.071593079	3.14512623	0.01993768	0.049987317	0.40035122
Wind Mean	0.476013972	0.56023119	0.84967417	0.4281018	-0.89482237	1.84685031
Cloudiness	0.813250296	0.276880191	2.93719205	0.02604248	0.135748875	1.49075172
Precipitation	0.002263651	0.008881165	0.25488218	0.80732552	-0.01946778	0.02399508
Max Temp	1.342968382	0.148737786	9.02910023	0.00010337	0.97902013	1.70691663

RESIDUAL OUTPUT

Observation	Predicted Min Temp	Residuals
1	22.90359855	-0.193921552
2	23.85527473	-0.098131728
3	22.45145532	0.348544684
4	18.96598023	0.24735277
5	14.36782132	0.683791685
6	16.02799164	-0.614658645
7	12.59117896	0.079789038
8	13.94743681	-0.95388881
9	18.47258195	0.707418052
10	19.1282972	1.291057801
11	20.40426518	-1.217598178
12	22.61523912	-0.279755116

Min Temp (Y) - Max Temp, Cloudiness, Relative Humidity (X)

Regression Statistics	
Multiple R	0.980745598
R Square	0.961861927
Adjusted R Square	0.94756015
Standard Error	0.895579442
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	161.8274578	53.9424859	67.2547132	5.12631E-06
Residual	8	6.416500295	0.80206254		
Total	11	168.2439581			

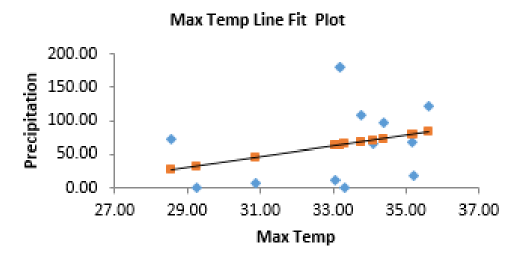
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-43.459139	6.575061509	-6.6096931	0.00016768	-58.621258	-28
Max Temp	1.33441237	0.129699299	10.2885087	6.8615E-06	1.035325249	1.633
Cloudiness	0.927363475	0.148247249	6.25551895	0.00024425	0.585504705	1.269
Humidity	0.185352816	0.049810681	3.721146	0.00586175	0.07048918	0.300

RESIDUAL OUTPUT

Observation	*Predicted Min Temp*	*Residuals*
1	22.83416248	-0.124485485
2	23.78805335	-0.030910351
3	22.65622773	0.143772274
4	19.24969209	-0.036359087
5	14.30464893	0.746964066
6	16.00462106	-0.591288056
7	12.47720004	0.193767963
8	14.25423586	-1.260687863
9	17.91392703	1.266072972
10	19.46118317	0.95817183
11	20.33026778	-1.143600776
12	22.45690149	-0.121417488

Precipitation (Y) - Max Temp (X)

Regression Statistics	
Multiple R	0.317973774
R Square	0.101107321
Adjusted R Square	0.011218053
Standard Error	57.33146769
Observations	12



ANOVA

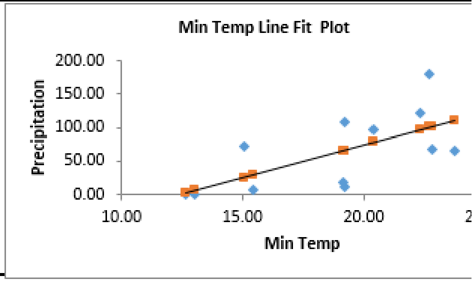
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3697.097288	3697.09729	1.12479858	0.313830696
Residual	10	32868.97188	3286.89719		
Total	11	36566.06917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-200.1737446	248.1237812	-0.80674953	0.43857667	-753.027982	352.680492
Max Temp	7.945669474	7.49191973	1.06056522	0.3138307	-8.74736795	24.6387069

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	63.54559175	117.8544083
2	70.60331676	-6.203316765
3	79.30877499	-11.50877499
4	62.66900165	-52.26900165
5	26.86735646	44.93264354
6	45.18852881	-37.78852881
7	32.14738096	-32.14738096
8	64.54520464	-64.54520464
9	79.54030385	-61.04030385
10	73.18291809	23.11708191
11	68.20448737	40.69551263
12	82.89713467	38.90286533

Precipitation (Y) - Min Temp (X)



Regression Statistics	
Multiple R	0.660107242
R Square	0.435741571
Adjusted R Square	0.379315729
Standard Error	45.42324595
Observations	12

ANOVA

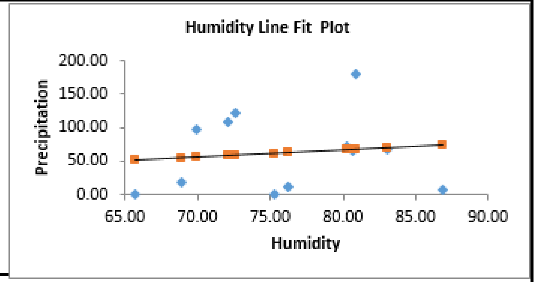
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	15933.35644	15933.3564	7.72237594	0.019486859
Residual	10	20632.71273	2063.27127		
Total	11	36566.06917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	-120.6685996	67.16706601	-1.79654415	0.10262821	-270.326149	28.98
Min Temp	9.731592105	3.501937794	2.77891633	0.01948686	1.92878845	17.53

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	100.3327138	81.06728618
2	110.5262257	-46.12622568
3	101.2117004	-33.41170041
4	66.30772015	-55.90772015
5	25.80755866	45.99244134
6	29.32767015	-21.92767015
7	2.640092568	-2.640092568
8	5.779309549	-5.779309549
9	65.98333699	-47.48333699
10	78.04423433	18.25576567
11	66.04821752	42.85178248
12	96.69122018	25.10877982

Precipitaiton (Y) - Relative Humidity (X)



Regression Statistics	
Multiple R	0.114904906
R Square	0.013203137
Adjusted R Square	-0.085476549
Standard Error	60.06936185
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	482.7868336	482.786834	0.13379793	0.722145428
Residual	10	36083.28233	3608.32823		
Total	11	36566.06917			

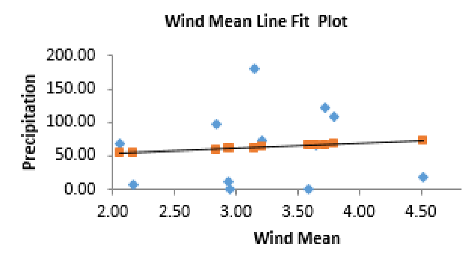
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-16.06058559	215.1768514	-0.074639	0.94197394	-495.504488	463.383317
Humidity	1.031850667	2.820929021	0.36578399	0.72214543	-5.25357088	7.31727222

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	67.35289126	114.0471087
2	67.22450428	-2.824504277
3	69.66623339	-1.86623339
4	62.57503367	-52.17503367
5	66.76207318	5.037926823
6	73.5298486	-66.1298486
7	61.64442716	-61.64442716
8	51.68373947	-51.68373947
9	55.02532697	-36.52532697
10	56.05246208	40.24753792
11	58.31005125	50.58994875
12	58.8734087	62.9265913

Precipitation (Y) - Wind Mean (X)

Regression Statistics	
Multiple R	0.08611835
R Square	0.00741637
Adjusted R Square	-0.091841993
Standard Error	60.24523355
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	271.1875073	271.187507	0.07471784	0.790149871
Residual	10	36294.88166	3629.48817		
Total	11	36566.06917			

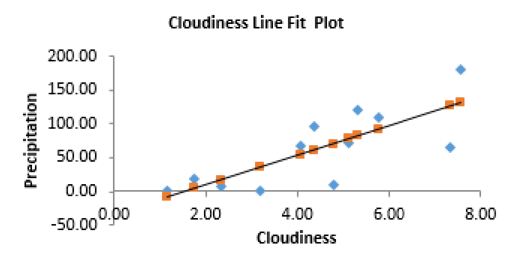
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Uppe
Intercept	39.5211503	85.45720891	0.46246713	0.65364536	-150.889377	229.9
Wind Mean	7.111829661	26.0177178	0.27334564	0.79014987	-50.8592582	65.08

RESIDUAL OUTPUT

Observation	Predicted Precipitation	Residuals
1	61.92723989	119.4727601
2	65.42852876	-1.028528758
3	54.12716291	13.67283709
4	60.46153447	-50.06153447
5	62.30959319	9.490406811
6	54.93011693	-47.53011693
7	65.06256112	-65.06256112
8	60.55075237	-60.55075237
9	71.68242285	-53.18242285
10	59.70957227	36.59042773
11	66.53030052	42.36969948
12	65.98021472	55.81978528

Precipitation (Y) - Cloudiness (X)

Regression Statistics	
Multiple R	0.76965791
R Square	0.592373299
Adjusted R Square	0.551610629
Standard Error	38.60739067
Observations	12



ANOVA

	df	SS	MS	F	Significance F
Regression	1	21660.76302	21660.763	14.5322497	0.003417335
Residual	10	14905.30614	1490.53061		
Total	11	36566.06917			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-33.79089031	27.58261856	-1.22507913	0.24861786	-95.2487944	27.6670137
Cloudiness	21.85222366	5.732303966	3.81211879	0.00341733	9.07985448	34.6245928

RESIDUAL OUTPUT

Observation	Predicted Precipitation	Residuals
1	131.6280828	49.77191725
2	126.7188933	-62.3188933
3	55.26279935	12.53720065
4	70.8569832	-60.4569832
5	78.28986411	-6.489864113
6	17.19762428	-9.79762428
7	35.99523486	-35.99523486
8	-8.179144533	8.179144533
9	4.571912051	13.92808795
10	61.84195759	34.45804241
11	92.4664068	16.4335932
12	82.04938623	39.75061377

Precipitation (Y) - Max Temp, Min Temp, Relative Humidity, Wind Mean, Cloudiness (X)

Regression Statistics	
Multiple R	0.820377922
R Square	0.673019935
Adjusted R Square	0.400536548
Standard Error	44.63999639
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	24609.6935	4921.9387	2.46994851	0.150828399
Residual	6	11956.37566	1992.72928		
Total	11	36566.06917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Uppe*
Intercept	215.7229392	981.8601748	0.21970841	0.83338238	-2186.80236	2618
Max Temp	-1.897100978	25.96172973	-0.07307298	0.94412316	-65.4231651	61.62
Min Temp	4.731961724	18.56529087	0.25488218	0.80732552	-40.6956685	50.1
Humidity	-2.913966905	5.192662595	-0.56117008	0.59500301	-15.6199545	9.792
Wind Mean	-14.09858743	26.49358905	-0.53215091	0.61374083	-78.9260644	50.72
Cloudiness	19.81951168	18.03364429	1.09902976	0.3138868	-24.3072263	63.94

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	130.2709692	51.12903076
2	122.5114745	-58.11147448
3	66.60310305	1.19689695
4	75.21597528	-64.81597528
5	55.32441278	16.47558722
6	-7.230837201	14.6308372
7	13.4331038	-13.4331038
8	4.232474313	-4.232474313
9	9.986970363	8.513029637
10	90.14666399	6.153336013
11	93.3810338	15.5189662
12	94.8246561	26.9753439

Precipitation (Y) - Cloudiness, Min Temp (X)

Regression Statistics	
Multiple R	0.79296932
R Square	0.628800343
Adjusted R Square	0.54631153
Standard Error	38.83485309
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	22992.75684	11496.3784	7.62285603	0.011567355
Residual	9	13573.31233	1508.14581		
Total	11	36566.06917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-83.69579398	59.91370619	-1.39693902	0.19591733	-219.230014	51.8384256
Cloudiness	16.89993071	7.811288588	2.16352661	0.05872931	-0.77043172	34.5702931
Min Temp	3.811743079	4.055964856	0.93978701	0.37186327	-5.36348687	12.986973

RESIDUAL OUTPUT

Observation	*Predicted Precipitation*	*Residuals*
1	130.7983104	50.60168956
2	130.9943447	-66.59434468
3	72.08371195	-4.283711948
4	70.47238739	-60.07238739
5	60.35737311	11.44262689
6	14.48903743	-7.089037433
7	18.57342052	-18.57342052
8	-14.36028183	14.36028183
9	19.08221303	-0.582213035
10	68.09745148	28.20254852
11	87.08289903	21.81710097
12	91.02913276	30.77086724