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EVALUATION OF A HOMOGENIZATION METHOD BASED ON GEOSTATISTICAL SIMULATION USING A BENCHMARK TEMPERATURE DATA SET

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EVALUATION OF A HOMOGENIZATION METHOD BASED ON GEOSTATISTICAL SIMULATION USING A BENCHMARK TEMPERATURE DATA SET

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EVALUTATION OF A HOMOGENIZATION METHOD BASED ON GEOSTATISTICAL SIMULATION USING A BENCHMARK TEMPERATURE DATA SET

ABSTRACT

Historical climate records are relevant since they provide significant information in different environmental studies. However, few climate records are free of non-natural irregularities that imply a problem in the quality of climate data. Considering this problem, many methods have been developed to homogenize climate data. The present project focused on the evaluation of the GSIMCLI (geostatistical simulation for the homogenization of climate data) homogenization method, which is based on a geostatistical stochastic approach, the direct sequential simulation (DSS). The GSIMCLI method was used to homogenize simulated monthly temperature data. This project also included the study of different alternatives for the modelling of the empirical variogram that is part of the parameters in the DSS algorithm. The efficiency of the method was assessed through the calculation of performance metrics, in order to be compared with other homogenization procedures. The literature review on variography was a relevant contribution for the challenging task of modelling small networks' data. Nonetheless, the results provide evidence that the artificial data of the benchmark data set used lacks a spatial autocorrelation structure. Hence, it was not surprising that GSIMCLI underperformed other homogenization methods. Annual temperature data sets achieved better homogenization results than monthly data sets.

KEYWORDS

Direct Sequential Simulation

Geostatistical Simulation

Homogenization

GSIMCLI

Simulated temperature data

ACRONYMS

CRMSE – Centred Root Mean Square Error

DSS – Direct Sequential Simulation

EDA – Exploratory Data Analysis

ESDA – Exploratory Spatial Data Analysis

GSIMCLI – Geostatistical simulation with local distributions for the homogenization and interpolation of climate data

HOME – Advances in Homogenization Methods of Climate Series: an Integrated Approach

MULTITEST – Multiple verification of automatic software homogenizing monthly temperature and precipitation series

PDF's – Probability Density Functions

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1 INTRODUCTION

1.1 Theoretical Framework

There are many weather stations with climate records since the 19th century, but instrumentation, data collection and methodologies have evolved during the years (Cowtan et al., 2015). Since climate records are often used in different perspectives, their quality plays an important role in order to obtain robust results. However, climate time series are not free from non-natural irregularities (Ribeiro et al. 2016a). On the one hand, climate data have natural irregularities due to variations in weather and climate (Venema et al., 2012). On the other hand, non-natural irregularities may cause inhomogeneities during the process of collecting, processing, transferring and transmitting climate data; changes in instruments, station location, and so on (Petterson et al., 1998; Aguilar et al., 2003).

There are three types of inhomogeneities such as breakpoints, point errors and trends (Guijarro, 2006). As a solution, many techniques have been developed to detect inhomogeneities and homogenize climate data including geostatistical techniques which have potential advantages (Aguilar et al., 2003; Costa and Soares, 2009; Ribeiro et al., 2016a).

Homogenization is a process of identifying and rectifying non-natural irregularities in climate data (Aguilar et al., 2003). Taking into account the importance of homogenization, it has a long tradition since there is an historical development of methods to achieve it (Domonkos et al, 2012; Venema et al., 2012; Ribeiro et al. 2015a). The most recent advances in homogenization of climate series have been done by the European initiative (COST Action ES0601) "HOME" (Advances in Homogenization Methods of Climate Series: an Integrated Approach, 2008-2011), being the main goal the evaluation of statistical homogenization methods' performance (Domonkos et al., 2012; Venema et al., 2012; Ribeiro et al., 2016b).

Venema et al. (2012) recommend the following algorithms ACMANT, Craddock, MASH, PRODIGE and USHCN due to their superior performance (Ribeiro et al., 2016b). However, there is no a specific method to solve all non-natural irregularities. Therefore, many experiments try to evaluate the performance of several homogenization methods in order to identify the adequate method for a specific purpose (Domonkos, 2011a; Domonkos, 2011b).

Costa et al. (2008) proposed a new homogenization method based on geostatistical simulation. So, in order to make its application more useful, it was turned into a software package (GSIMCLI- Geostatistical simulation with local distributions for the homogenization and interpolation of climate data) (Caineta et al., 2015a; Caineta et al., 2015b). The direct sequential simulation (DSS) allows calculating the probability density functions (PDFs) at candidate stations, using spatial and temporal neighboring observations. Afterwards, a statistic value from the PDF is used to identify and correct irregularities (Ribeiro et al., 2015a; Ribeiro et al., 2015b; Ribeiro et al., 2016c, Caineta et al., 2015a; Caineta et al., 2015b).

Most of the historical climate records need a homogenization process to obtain accurate observations over the record's period. Therefore, this project will evaluate a geostatistical homogenization method that uses simulated temperature data, using the package software GSIMCLI.

One of the limitations during this project will be the challenging task of the variography study due to the number of stations, since each data set only contains 10 stations. The literature review regarding this topic will be helpful to define the most satisfactory variogram's parameters.

Although there are many methods and approaches to estimate the parameters and to fit a variogram model, there is no specific approach or method that allows estimating reliable parameters for a wide range of data types and conditions (Gribov et al., 2000). The project will analyze some of the approaches to get the best variogram's parameters.

1.2 Motivation

Historical climate records are relevant since they provided significant information in different perspectives for monitoring environmental impacts, weather forecasting, making decisions about climate changes and so on. However, few climate records are free of non-natural irregularities; which implies a problem in the quality of climate data. Taking into consideration the relevance of quality of climate records, many methods have been developed to homogenize climate data with non-natural irregularities. Nevertheless, there is no a specific homogenization method to be applied in a general way since there are several climatic elements and patterns.

The present project will focus on the evaluation of the geostatistical homogenization method GSIMCLI using simulated monthly temperature data. Afterwards, once the temperature data are homogenized, the next step will be to calculate performance metrics in order to assess the method's efficiency.

The main motivation for this research is two folded: (1) this technique is novel in its incorporation of spatial correlation metrics; and, (2) the technique was only assessed for networks from a few regions of the HOME project, and mainly for precipitation data (Ribeiro et al., 2016c).

1.3 Objectives

The principal aim of this project is the evaluation of a geostatistical homogenization method using the package software GSIMCLI to homogenize simulated temperature data. In order to accomplish with the principal aim, the project contemplates the following specific objectives:

- To prepare the climate time series in a specific format in order to be recognized by GSIMCLI.
- To do the respective Exploratory Data Analysis and Exploratory Spatial Data Analysis of the simulated temperature data.
- To determine the GSIMCLI parameters to homogenize the simulated temperature data set.
- To homogenize the simulated temperature data set using the GSIMCLI.
- To calculate performance metrics of the homogenization tests.

2 LITERATURE REVIEW

2.1 Importance of climate data

Climate data have been representative input to be used in different perspectives since impacts almost all aspects of human endeavour (Peterson et al., 1997). For instance, climate data is useful in the following application fields: forest engineering, hydrology, environmental sciences, ecology, agricultural sciences, meteorology and climatology, and so on. Therefore, examination of climate change and climate variability requires climate data free of irregularities. So in order to get robust results, the data should have high quality.

Considering that climate data is an outstanding input, there are many weather stations with climate records since the 19th century. Consequently, instrumentation, data collection and methodologies have evolved during the years (Cowtan et al., 2015). This evolution has allowed obtaining data that are more accurate; however, it does not imply to get complete homogeneous climate data since there are many factors, which play a prominent role to influence in climate data's quality.

Based on the aforementioned, climate records are not free from non-natural irregularities, but for long-term climate analyses, climate data must be homogeneous.

Taking into account the relevance of climate data' quality, the birth of statistical homogenization was as early as 19th century with the correction of local biases of observed time series (Domonkos et al., 2012), and later many methods and approaches have been developed to get homogeneous climate records.

Even though there are several homogenization methods, their application is still not completely sufficient to be known as unique solution to homogenize climate time series.

2.2 Homogenization

Homogenization is the process of identifying and rectifying non-natural irregularities in climate data (Aguilar et al., 2003). Once this process is applied, the obtained climate time series contain variations that are caused only by weather or climate (Venema et al., 2012).

Since there is no single technique to homogenize climate data, (Aguilar et al., 2003) recommend the following steps:

- Analyze metadata and quality control
- Create reference time series
- Detect breakpoints
- Data adjustment

Depending on the type of irregularities, some procedures have been proposed in order to remove inhomogeneities from climate data. Nevertheless, there is no proper procedure to be applied immediately since it depends on different factors, such as the temporal resolution of the observations (yearly, monthly, hourly, etc.), type of elements (precipitation, temperature, etc.), availability of metadata and spatial resolution (Costa and Soares, 2009).

2.3 Types of irregularities

Climate data might not be free of irregularities, which may affect the reliability of the data, thus compromising the time series continuity and in that sense to hide the true climatic signal and patterns (Ribeiro et al., 2016b).

On the one hand, climate data with natural irregularities have variations due to weather and climate (Venema et al., 2012). On the other hand, non-natural irregularities may cause inhomogeneities during the process of collecting, processing, transferring and transmitting climate data; changes in instruments, station location, and so on (Petterson et al., 1998; Aguilar et al., 2003). There are three types of inhomogeneities such as breakpoints, point errors and trends (Guijarro, 2006).

- ***Breakpoints***

Breakpoints are the most frequent kind of irregularities. They correspond to shifts in the mean or change-points. These irregularities can be a product of land use surroundings, changes of location or instrumentation (Ribeiro et al., 2016a). In addition, a breakpoint in a time series can be a starting point of inhomogeneities (Aguilar et al., 2003).

- ***Points errors***

Point errors are not outliers since the values could not differ significantly; however, they are induced errors from the observation to transmission and mechanization processes.

- ***Trends***

This type of inhomogeneities are kind of difficult to identify since they may be considered as true climate trend (Ribeiro et al., 2016a). Trends could be product of sensor decalibration or urban growth (Guijarro, 2006).

2.4 Homogenization approaches

Considering that the relevance of climate data's quality has been notorious to be used in different perspectives, homogenization has a long tradition since there is an historical development of methods to achieve it (Domonkos et al, 2012; Venema et al., 2012; Ribeiro et al., 2015a).

Therefore, there are groups of homogeneity testing techniques. Each group has different requirements due to each approach has specific philosophy regarding data adjustments (Aguilar et al., 2003; Ribeiro et al., 2016a). The most well-known approaches will be mentioned below.

2.4.1 Direct methods

Direct methods are mathematical algorithms that are able to deal with inhomogeneous time series since they can detect multiple breakpoints in a direct way (Venema et al., 2012). In these methods are included the use of metadata, analysis of measurements, and study of instrument changes. Important information can be provided by metadata, which indicates where and what causes the discontinuity in the climate data series (Ribeiro et al., 2016a).

2.4.2 Indirect methods

Indirect methods are well known to use graphical and statistical techniques to identify irregularities and to adjust the data. Most of these techniques use metadata as recommended by Aguilar et al. (2003).

These methods include subjective and objective approaches. On the one hand, subjective approaches are based on experts' judgment, which are useful to do the exploratory analysis. On the other hand, objective methods do not need to apply subjective methods since they are applied in an automatic way.

2.4.3 Absolute methods

To identify and adjust the climate data, absolute methods use only the time series of a single station. Absolute methods require station's history records to identify if the irregularity is natural or artificial. These methods have a limitation to distinguish irregularities from true climate signals.

2.4.4 Relative methods

Relative methods consider data from the surrounding stations in order to homogenize the candidate station. These methods are more appropriate with climate data that have spatial density and coherence. Therefore, relative methods are more effective if the surrounding weather stations are homogeneous (if the weather stations just have natural irregularities).

2.4.5 Multiple breakpoint techniques

Climate data series does not have just one breakpoint; usually there are multiple breakpoints in the candidate time series. Therefore, most homogenization methods have applied single-breakpoint techniques multiple times to test segments of the time series. However, the multiple breakpoints methods are the most efficient techniques to identify and correct multiple change-points (Ribeiro et al., 2016a).

2.4.6 GSIMCLI approach

The Direct Sequential Simulation (DSS) is a geostatistical simulation method that reproduces the covariance and the histograms of the variable (Soares, 2001). This method has been very used in different perspectives specially air and water pollution, health and water.

Costa et al. (2008) proposed a new homogenization method for inhomogeneities detection based on DSS. The DSS algorithm allows calculating the probability density functions (PDFs) at candidate stations, using spatial and temporal observations from close stations without taking into consideration the candidate's data (Figure 1). In other words, for every unit of time, the DSS algorithm generates a set of realizations of each candidate station using a reference time series (Ribeiro et al., 2016b). Consequently, the empirical PDF is useful to identify and correct irregularities (Costa and Soares, 2008; Ribeiro et al., 2016c).

When there are irregularities in the candidate station, the adjustment of the time series implies the replacement of irregular values with the mean or median of the PDF calculated at the candidate station's location (Costa and Soares, 2008). Later, Ribeiro et al. (2016c) proposed the GSIMCLI algorithm, which is an extension of the geostatistical approach proposed by Costa and Soares (2008). The GSIMCLI method uses a local radius parameter to better infer the PDF, and allows using other statistics from the empirical PDF to detect and correct irregularities. Furthermore, a semi-automatic approach for the adjustments stage was also proposed (Ribeiro et al., 2016c).

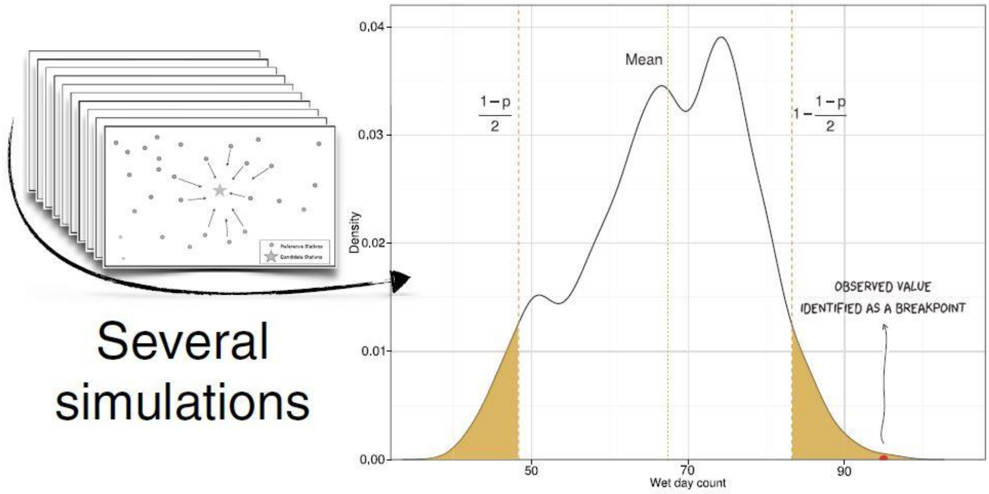

Figure 1.- DSS schema and local pdf for a candidate station (Ribeiro et al., 2016b)

2.5 GSIMCLI software

The homogenization method proposed by Ribeiro et al. (2016c) was turned into a software package (GSIMCLI - Geostatistical simulation with local distributions for the homogenization and interpolation of climate data) in order to make its application more useful (Caineta et al., 2015a; Caineta et al., 2015b).

2.5.1 Homogenization parameters

The GSIMCLI software has two sets of parameters. The first one is related with the geostatistical simulation, and the second one with the homogenization process.

The parameters related with simulation are:

- Number of simulations: number of simulated images per candidate station
- Kriging type: the kriging estimator to be used for simulation
- Maximum number of nodes: maximum number of data points to be used in kriging system.
- Number of CPU cores: depending on the CPU cores, more than one simulation can run at the same time

- Simulation grid: related with the grid dimension, cells size, and origin point's coordinates. Depending on the simulated grid, the computational time increases or decreases. In other words, more number of grid cells, more computational time.
- Semivariogram: useful tool to build continuity structural model.

The homogenization process has the following parameters:

- Candidate order: it is the order in which the candidate stations will be homogenized.
- Detection probability: useful value to build the detection interval located in the local pdf.
- Tolerance radius: the detection interval could consider all nodes located in a radius around the candidate station.
- Correction method: the mean, median, skewness and percentile values of the local pdf can replace the detected inhomogeneous values.

2.5.2 Running the homogenization process

Once the parameters are defined, the process starts without any additional interaction. Depending on the data set size, the process can take several hours or days. It also depends on the selected parameters. For instance, the process will take more time if the number of simulations is higher.

It is possible to run the homogenization process with multiple networks choosing the option batch. For example, the data time series can be split in decades and all of them are homogenized in the same process.

2.5.3 Gathering the results

After the homogenization process, spreadsheet files save the results. These files contain the homogenised time series in a tabular structure organised by station and year, as well as a summary of the homogenisation process, with the number of irregularities detected and missing data filled in.

There is also an additional option to save files with the simulated maps. However, those maps demand a considerable disk space in the computer, so in case it is necessary those maps as a result; the disk space should be considered.

2.5.4 Performance metrics

GSIMCLI software has an option to calculate performance metrics, namely the Centred Root Mean Square Error (CRMSE) by station and network, and also the Improvement measures as proposed by Venema et al. (2012). The station CRMSE quantifies the efficiency of homogenization process for each station and the network CRMSE measures the efficiency of homogenization process of the network. Hence, for simulated time series, it is possible to calculate the performance metrics by using the homogenized and the original data (i.e., artificial data without inhomogeneities).

2.6 Variography

Taking into account that a variogram describes the spatial autocorrelation of a phenomenon, it has a huge importance in most of the geostatistical techniques since a variogram is an essential input for most of geostatistical estimation and simulation algorithms. However, there is no reliable approach or method that allows estimating the variogram parameters for a wide range of data types and conditions (Gribov et al., 2000).

The variography study is considered as a challenging task due to the variability of climate data, number of stations and so on. The literature review regarding this topic is useful to define the most satisfactory variogram's parameters (Ribero et al., 2015).

2.6.1 Variogram models' parameters

The best way to obtain a variogram that estimates the spatial dependence is having a deep variogram analysis. Several parameters such as sill, nugget and range are an important part of the variogram models. Figure 2 illustrates the parameters on a generic variogram.

- ***Sill***

In the absence of spatial correlation, the sill value represents the variability. The value of the partial sill could be equal at the variance value but as recommendation, this value should not be higher than variance.

- ***Range***

This value represents the distance where there is no more spatial correlation. In other words, the distance at which variogram scopes the sill value. Therefore, the spatial dependence is zero beyond the range.

- ***Nugget***

The nugget value represents variability at distances that are smaller than the usual sample spacing. The lack of accuracy in the sampling process can be a reason to obtain high variability at short distances. Before collecting data, it is necessary to have a precious knowledge about the scale of spatial variations depending on the project's interest.

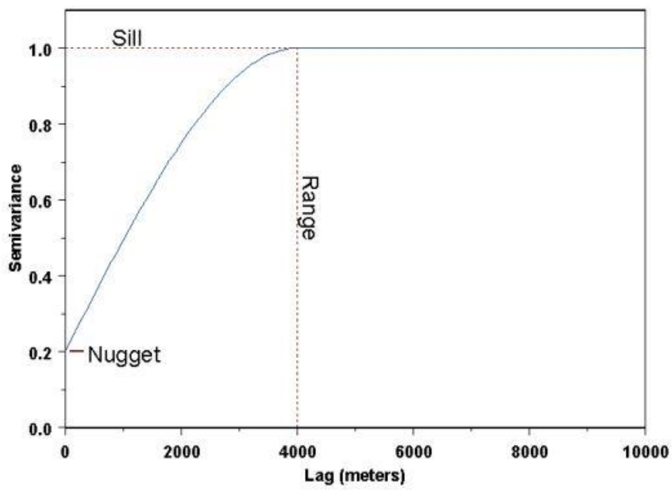

Figure 2.- Variogram's models' parameters (Bohling, 2005)

2.6.2 Types of variogram models for kriging

The selected variogram model can influence the kriging predictions, particularly when the curve's shape differs considerable in the origin. The most usual variogram models authorized for kriging are illustrated in Figure 3, and described below (Johnston et al., 2001).

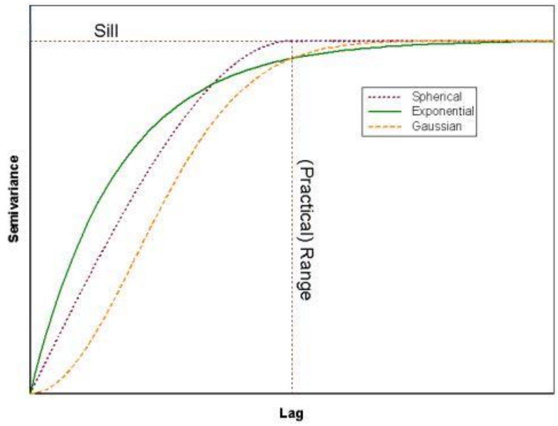

Figure 3.- Variogram's model for Kriging (Bohling, 2005)

- ***Spherical***

This model characterizes the decrement of spatial dependence at considerable distance, after that distance the autocorrelation is zero. It is important to mention that at the same moment that the decrement appears, the semivariance increases. This model is one of the most well-known and used models.

- ***Exponential***

This type of model is useful to apply when spatial dependence decreases exponentially with increment of distance. The autocorrelation disappears completely only at infinite distance. As well as spherical model, exponential model is commonly used.

- ***Gaussian***

Gaussian model represents smoothly varying properties. This model presents a parabolic behavior at the origin while spherical and exponential models have a linear behavior at the origin.

2.6.3 Variogram modelling approaches and limitations

The study of variography of climate data is a challenging task since it depends on the variability of data and the number of stations of the time series (Ribeiro et al., 2015). The variogram reliability depends on the number of points (Soltani-Mhammadi and Safa, 2016). However, depending on the purpose of the project, the data and other factors, the sample size may vary. When assessing the rank correlation coefficient, O'Brien and Griffiths (1965) considered the sample size small when it varied between 10 and 100 observations. Actually, in the context of estimating the parameters of variogram models, a small sample has less than 30 values (Pardo-Igúzquiza and Dowd, 2013).

Since Direct Sequential Simulation requires Kriging, it is essential to consider some issues regarding Kriging. One of the principal issues is that Kriging requires at least 100 of samples (Webster and Oliver, 1992). It would imply a limitation for small samples; however, this limitation can be overcome with Restricted Maximum Likelihood (REML) variogram. REML variograms were more accurate and adequate for small samples (50 observations) (Kerry and Oliver, 2007).

Another concern is regarding the assumption of a common variogram model throughout all data points by Ordinary Kriging. Hence, initial data set may satisfy the common variance assumption. However, temporal average data might not satisfy this requirement if the sample frequencies oscillate in different sites (Eberly, S., et al., 2004).

Variogram modelling is critical in geostatistical studies; hence, variogram uncertainty need to be quantified. It is possible to know if the estimated variogram is accurate for kriging by estimating variogram uncertainty (Marchant and Lark, 2004). Therefore, several authors such as Ortiz and Deutsch (2002), and Pardo-Igúzquiza and Dowd (2001) presented approaches to calculate the uncertainty in the variogram, who suggested similar expressions for experimental variogram uncertainty.

The use of automatic or manual fitting procedures to choose variogram models and estimate their parameters is controversial (Goovaerts, 1997, pp. 97-107). In fact, it is not recommendable to use automatized methods for calculating the experimental variograms since data spacing and orientation may be artefact (Larrondo et al., 2003).

The software package VARFIT reduces the time for variogram modelling by performing nonlinear minimization of the weighted squared differences between experimental variogram and model (Pardo-Igúzquiza, 1999). Nonetheless, the user has to calculate the experimental variogram (Larrondo et al., 2003). Another software product based on Weighted Least Squares is SAGE 2001 developed by Isaaks (2001). Kushavand (2005) proposed WinVAM, which is a program for modelling variograms using Least Square and Weighted Least Square.

R contains useful packages for modelling, prediction and simulation of geostatistical data. For instance, "*Gstat*" can deal with several issues in Geostatistics like variogram modelling using Generalized Least Squares, Restricted Maximum Likelihood (just for direct variograms) and Levenberg-Marquardt depending on the case (Pebesma, 2001). Another package is "*Automap"*, which contains the tool "Autofitvariogram" for variogram fitting. However, "Autofitvariogram" requires the "absolute minimum" recommended number of spatial points needed for variogram modelling and fitting (30 observations). Moreover, it does not fit anisotropic variogram models (Hiemstra, 2013).

Using the Geostatistical Analyst tool from ArcGIS developed by ESRI, the variogram is fitted to the variance points based on Levenberg-Marquardt Method of nonlinear least square approximation (ESRI, 2011).

Desassis and Renard (2013) proposed a method for automatic variogram modelling by iterative least squares; however, the method has a main limitation trying to fit a periodic variogram. The proposed method can be found in RGeostat, which was developed by Renard and Desassis (2014).

3 STUDY AREA AND DATA

3.1 Study Area

Spain is a transcontinental country located in the South-West of Europe and North of Africa. Moreover, it occupies the majority part of the Iberian Peninsula for this reason this country is well known as Peninsular Spain. This country has a mean altitude of 650 meters; hence, Spain is one of the most mountainous countries in Europe and this is one the factors which determines its weather conditions.

The 100 stations are located in Spain, specifically in the North-Center of the country (Figure 4). Spain has 19 autonomous communities; but the weather stations are located in the following communities: Castilla y Leon, Pais Vasco, Comunidad Foral de Navarra, Rioja, Castilla-La Mancha and Comunidad Madrid. The majority of the stations have their locations in Castilla y Leon, which has continental Mediterranean climate.

The spatial distribution of mean temperature in Spain is kind of anarchic since there are local factors around the area that determine the temperature. The factors to be taken into account are the following:

- **Latitude -** the maritime areas located in the South part of the region have higher temperatures than in the North due to the descent of temperature.
- **Sea action -** the most affected areas are located in the littoral and its influence is limited inside of Spain due to the mountains. The Atlantic winds do not have to overcome big obstruction so Ebro valley can be affected by those winds.
- **Relief -** the altitude introduces strong modifications in the temperature values (thermal gradient 0.5/100 m).

All of these factors interact together; however, there are other factors that contribute in the variability of the thermal levels, such as high insolation of large regions located in Solana, and absence of clouds, which increase the night cooling in winter, the fog, etc.

The temperature values can vary along the year. The maximum temperatures are registered in July and few cases in August but in general the mean summer temperatures are high and the difference between regions is minimal. Only in the mountain sectors, North and Northeast regions have low values; thereby, they are considered as soft summers. Meanwhile in Guadalquivir Valley are located the highest temperatures.

On the other hand, in winter, low temperatures are related with the frequency of clear sky and short days. In the mountain areas, the mean temperatures are really low and they can be negative in Pyrenees or Iberic System. The coast region has higher temperatures, which means that the winter is soft with 8 degrees Celsius. Finally, in the middle of Spain, there is an increment from North-South and East-West in both plateaus due to altitude and proximity to maritime influence.

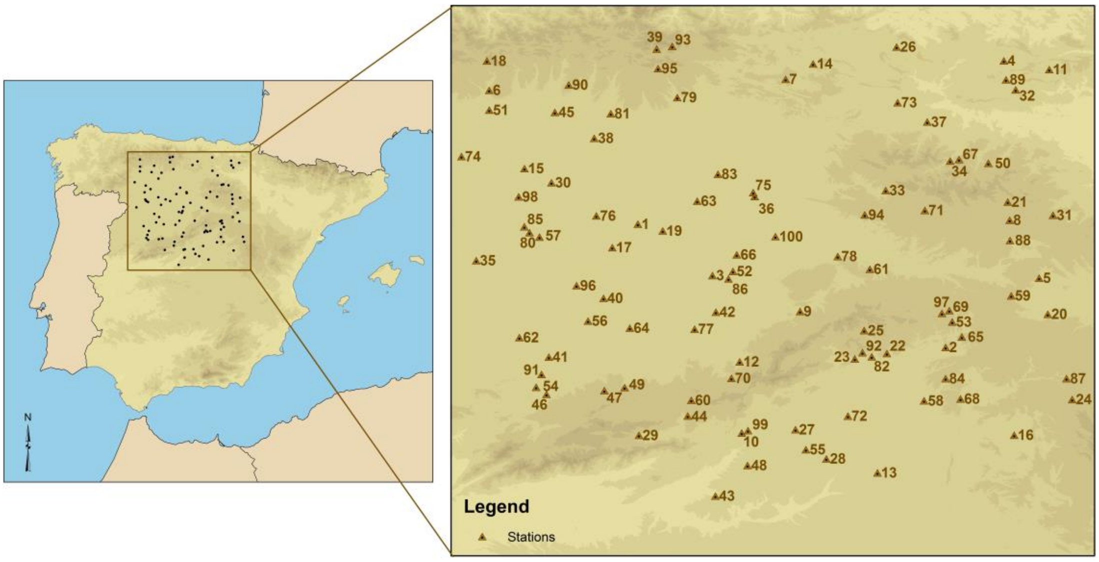

Figure 4.- Location of the 100 stations in the north-center of Spain

3.2 Data

For this project, the input data[1] are simulated temperature data from Spain, which correspond to a subset of the benchmark being developed by the MULTITEST (Multiple verification of automatic software homogenizing monthly temperature and precipitation series) project. This data set is mentioned in the text as "inhomogenized". The data belong to North-Center region of Spain, mainly in the autonomous community Castilla y Leon. The temperature (Tm) series contain three files. The first one with station coordinates (*.est), the second with benchmark data (*.series) and the third one with selected series (*-index.txt).

The *.est file contains the coordinates of the 100 stations in decimal degree (ETRS89 30 N) which were converted in UTM coordinates. Also, in the second file (*.series) contains the benchmark data which consist in 1000 lines with 720 data each. Every line is a series of 60 years (720 months), and each group of ten lines corresponds to each data sets so there are 100 data sets in total.

The *-index.txt file contains the selected series in every test. Each line represents one data set that contain 10 stations. The first line of *-index.txt contains the ranks of the 10 stations randomly selected from the 100 stations in the *.est file, which corresponds to the first 10 lines --10 series-- of the file *.series; and so on with the following lines until to complete the 100 data sets.

There are three kind of temperature data mentioned in the text:

1. **Inhomogenized -** simulated data set, which have irregularities.
2. **Homogenized -** inhomogenized data set after the GSIMCLI homogenization process.
3. **Original -** data set with artificial data that was used to introduce the inhomogeneities. Hence, the "original data set" was used to do the comparison with the homogenized data set, and to assess the GSIMCLI

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[1] Provided by Dr. Jose A. Guijarro (Meteorological Studies of the Mediterranean-State Meteorological Agency) http://www.aemet.es/en

efficiency based on the performance metrics. This artificial data set is supposed to have the characteristics of real observations in the study region.

4 METHODOLOGY

The methodology was organized in three general sections as it is shown in Figure 5. The first section was regarding data pre-processing which implied to gather the data series based on the required format by GSIMCLI. Therefore, 15 macros were created in order to automatize the steps during the pre-processing part. Once data were organized, it was possible to analyze the data based on Exploratory Data Analysis and Exploratory Spatial Data Analysis.

Before starting the homogenization process, grid parameters were defined. Moreover, the variography study was an essential step to define variogram's parameters, which were required parameters to homogenize the data.

The homogenization process by GSIMCLI had four steps, which were the definition of parameters, running the homogenization process, gathering the results and calculation of performance metrics to assess the GSIMCLI efficiency.

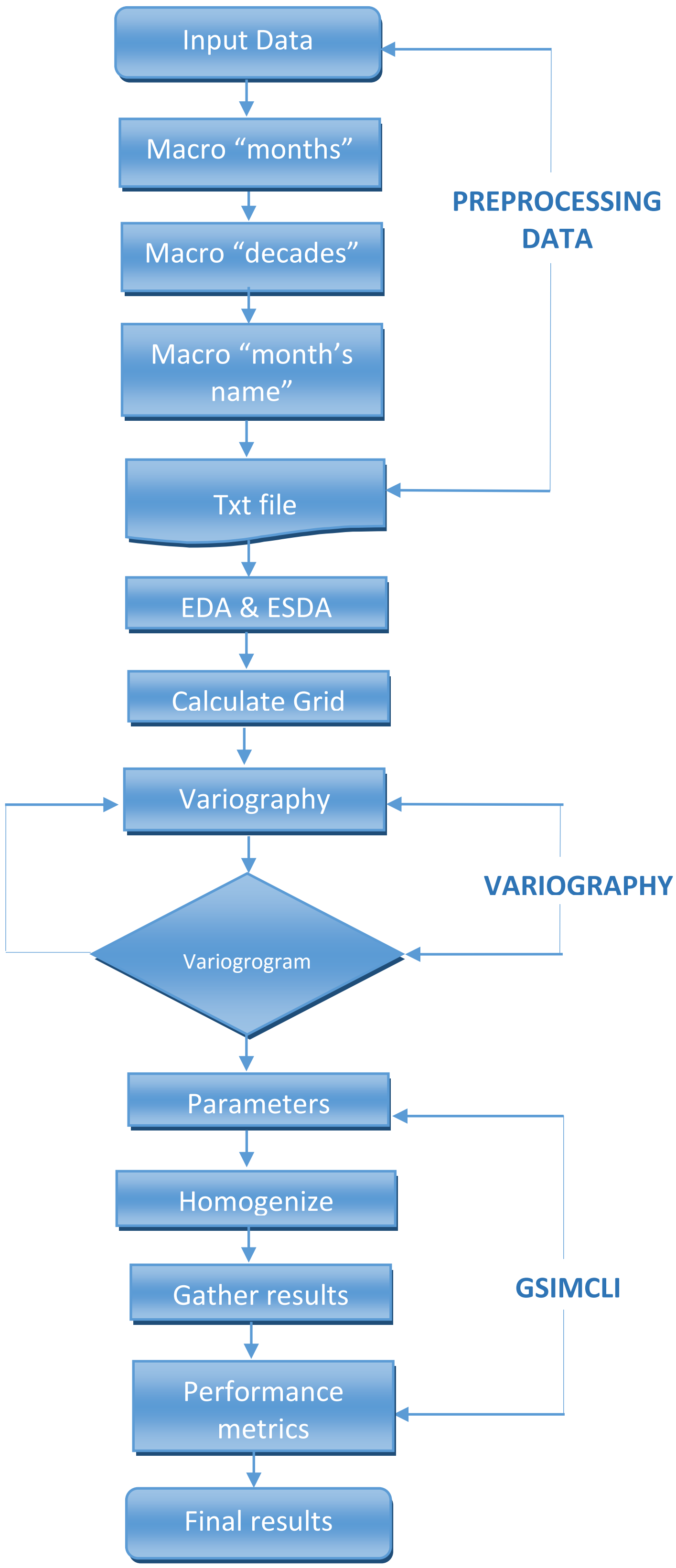


Figure 5.- Flowchart of methodology

4.1 Data pre-processing

Since GSIMCLI requires a specific format to homogenize the data, it was necessary to gather the data series based on the required format which implies a folder with the data by month per decade as *.txt file. Moreover two *.csv files, one file with the grid's parameters and another file with variograms' parameters. Therefore, it was prepared an Excel file per data set, which contains the ID stations, coordinates X and Y, month, year and temperature value.

With the *.est file, the coordinates were converted in UTM using the tool Project in ArcGIS. Taking into consideration each line from *-index.txt, the stations were selected from *.est file in order to prepare the file per data set. The *.series file provides the temperature value per station per month during six decades (1951-2010), so the tests are performed splitting this file in groups of 10 lines which means 10 series for every test.

4.2 Macros

For this project was required to create 15 macros which automatized the steps during the pre-processing part. The code of each macro is in Appendix G to Appendix J.

The flowchart of the application of macros is illustrated in Figure 6. The macro "months " selected the data from the principal Excel file per month and each one was exported as a new file with its specific month's name. After this step, using the macro "decades" in each month file, it selected and copied the data by decades in a new sheet.

There were 12 macros (one per month); therefore, each one organized the headers in one column, specified the name of the file (decade, month and data set) and exported it as *.txt file in the specific month's folder located at the desktop. The last macro "variography" was useful to prepare each file per month with the corresponding information about the variograms per decade.

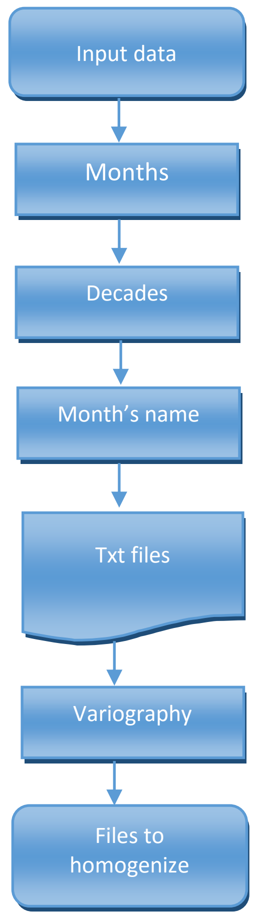


Figure 6.- Flowchart of macros

4.3 Grid

Since one of GSIMCLI's requirements is the grid's parameters, they were determined using the tool Fishnet in ArcGIS. A relevant factor regarding the number of cells was to take a minimum of three cells around the extreme stations. This factor decreased the time during the homogenization process. Each data set had its own grid, so the parameters were calculated per data set which included X min, Y min, X max, Y max, X nodes, Y nodes, and the cells size.

Depending on the area, the values in X and Y could change between data set; however, in Table 1 the coordinates were similar but not equal. Therefore, it was mandatory to calculate a grid per data set.

data set	x min	y min	x max	y max	x nodes	y nodes	x size	y size
1	230000	4420000	550000	4780000	32	36	10000	10000
2	260000	4470000	600000	4800000	34	33	10000	10000
3	260000	4390000	610000	4700000	35	31	10000	10000
4	220000	4430000	540000	4760000	32	33	10000	10000
5	260000	4410000	600000	4770000	34	36	10000	10000

Table 1.- Grids of data set 1 ,2, 3, 4 and 5

4.4 Variography

The study of variography is a challenging task and one of the reasons can be the sample size. One of the limitations during this project was the number of stations since each data set contains 10 stations. Based on the literature review, the minimum recommendable number of stations is thirty or more. That minimum number of points is recommended for variogram modelling and fitting. There are many methods in order to estimate the parameters for fitting the variogram. Nevertheless, there is no specific approach or method that estimates the semivariogram exactly (Gribov et al., 2000).

After doing the literature review and having many attempts using different tools, it is not recommendable to use automatized methods for calculating the experimental variograms since data spacing and orientation may be artefact (Larrondo et al., 2003). Based on the points aforementioned, the most useful tool during this project was the Geostatistical Wizard from ArcGIS to estimate the variograms' parameters manually. The considerations in Eberly et al. (2004) were useful. After evaluating all the possibilities regarding the experimental variograms, the most satisfactory was the estimation of a variogram per month and decade in each data set, as also recommended by Ribeiro et al. (2016c).

We considered two approaches. The first one was using the 100 stations with inhomogenized series (simulated data with irregularities) in order to evaluate if the variogram parameters were similar with the ones obtained in networks of 10 stations. Given that the results were not satisfactory, we also investigated the variograms of the 100 stations belonging from original data (artificial dataset that have the characteristics of real observations in the study region).

As a starting point, the value of the partial sill has not to be higher than the variance. In some cases, the sill has equal value as variance. In other words, if there is no nugget variance, the value of the partial sill is the same as the variance. (Watson, 1997)

To select the value of the range was taken into consideration the minimum distance and the maximum distance in order to have a reference the most adequate range and in that sense giving importance to this aspect in the fitting variogram's steps, therefore avoiding short distances in range.

Finally, regarding the chosen models, the exponential and spherical model were the ones that provided a better fitting for this project, considering the behavior of the data by month. On the one hand, the exponential model was considered when the experimental variogram leveled out, but was "curvy" all the way up. On the other hand, when the experimental variogram started out straight, then bent over sharply and leveled out, the spherical model was the best choice. However, the most predominant model was the exponential.

4.5 GSIMCLI

4.5.1 Homogenization Parameters

The homogenization process was performed in two phases. The first one using annual data from the first data set with the following parameters: probability of detection = 0.95, percentile of correction = 0.975, grid cell size = 10 km, 200 and 500 simulations, and 2 nodes. The parameters were determined based on previous studies (Caineta et al., 2015a; Ribeiro et al., 2015a, 2015b and 2016b).

On the other hand, since the project was more focus on monthly data, the homogenization process was done with each data set. Each data set had the same parameters as annual data but the number of simulations were 200. The number of simulations were different since the amount of data were quite considerable.

4.5.2 Running the homogenization process

Once the parameters were defined, the homogenization process was launched by data set. The process of detecting inhomogeneities was practically automatic. In order to guarantee the homogenization, the option “batch processing” was used since it was monthly data by decade.

4.5.3 Gathering results

The results were located in several folders, one folder per month and decade, which made arduous to analyse. Taking into consideration monthly data, a spreadsheet files saved the results of homogenization in per month and decade. These file structure was organized by month and station illustrating the homogenized time series. Each file contained one spreadsheet with a summary of the homogenize process which indicates the number of irregularities being useful to get a general idea of the existing irregularities.

4.5.4 Calculating performance metrics

Once the homogenize process was done, it was possible to calculate the performance metrics. Taking into consideration that this project used simulated data, original data were used to do the calculations due to original data is artificial data without inhomogeneities. The original data were organized based on COST-HOME format. This specific format implied to organize the data in one file by months and specifying the decade (Venema and Mestre, 2010).

5 RESULT

5.1 EDA & ESDA

Exploratory Data Analysis (EDA) is an approach for analysis data where most of the techniques are simple and graphical such as plotting simple statistics, raw data, etc. On the other hand, Exploratory Spatial Data Analysis (ESDA) techniques have been developed from Exploratory Data Analysis. ESDA is used to identify spatial patterns in the data which are representative characteristics (Bivand, 2010).

5.1.1 Annual Data

As part of the analysis, annual data from data set 1 was analyzed. Thereby, the mean temperature was calculated based on the daily values per month during the six decades (1951-2010). In Figure 7 is illustrated the location of each station, so it is visible the distance between them with the minimum is 50 km and the maximum is around 80 km. Also, the stations located in the upper left corner are more spread than the other points located in the lower right corner.

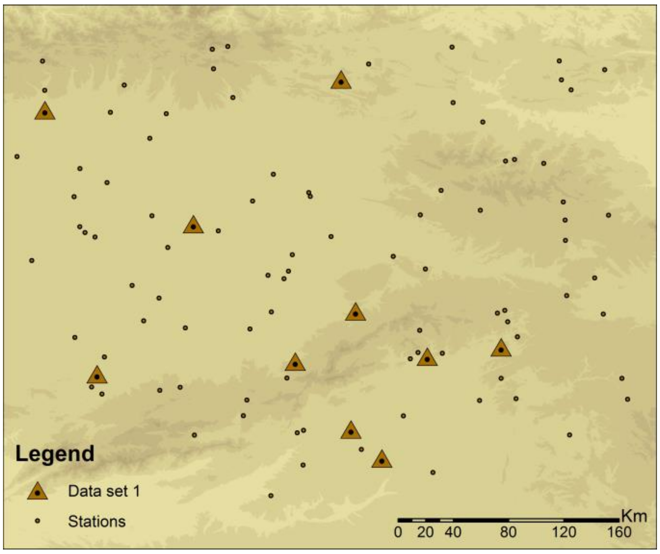


Figure 7.- Location of weather stations of Data Set 1

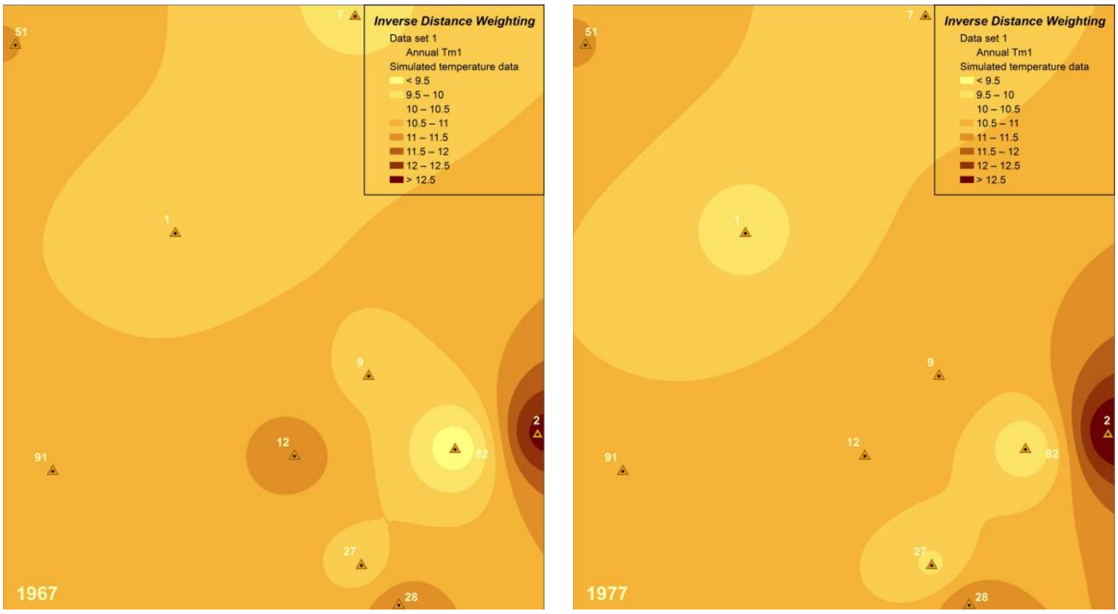
As result of the Exploratory Data Analysis, the mean value oscillated 10.4 to 11.6 °C depending on the month. The lowest minimum value was in the decade

1951-1960 with 7.81 °C and the highest maximum temperature value was in the decade 1981-1990 with 14.98 °C.

The skewness characterizes the degree of asymmetry of a distribution around its mean. In this case, the majority had a positive skew that indicated that the tail on the right side was longer or fatter than the left side (Appendix A). Just in the decade 1951-1960 the skewness was negative. Analysing the mean and the median in each decade, it was possible to get the same conclusion. These values showed that mean>median; therefore, it has a positive skew.

Regarding the Exploratory Spatial Data Analysis, the Inverse Distance Weighting interpolation was done in three years of the data set 1 (1967, 1977 and 2001). Regarding the Figure 8, the high temperature values were in the right lower corner which belonged to station 2.

On the other hand, the lowest values were in stations 1, 27, and 82 but the majority were in station 82. Also in the IDW of the three years, there was no overall trend in any of them. As a conclusion, analysing the whole area there was no anisotropy. So, there was no need to do the directional variograms in the next step of the analysis.



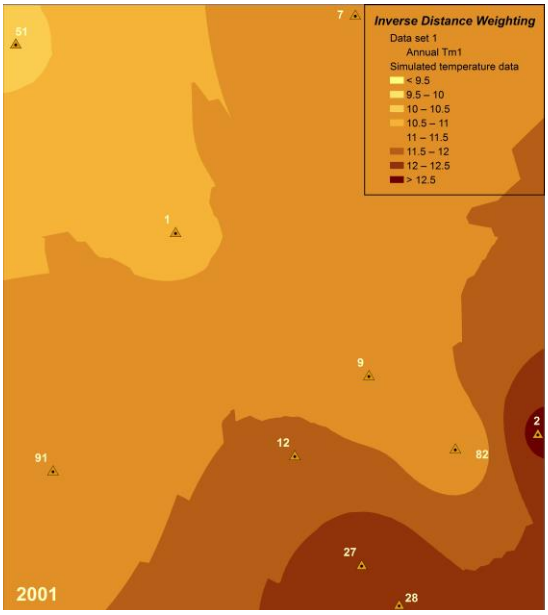
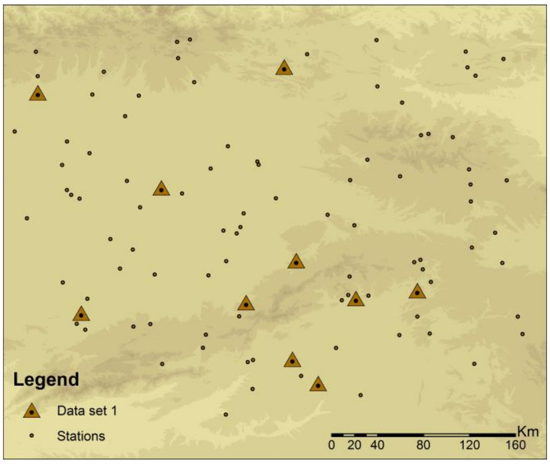
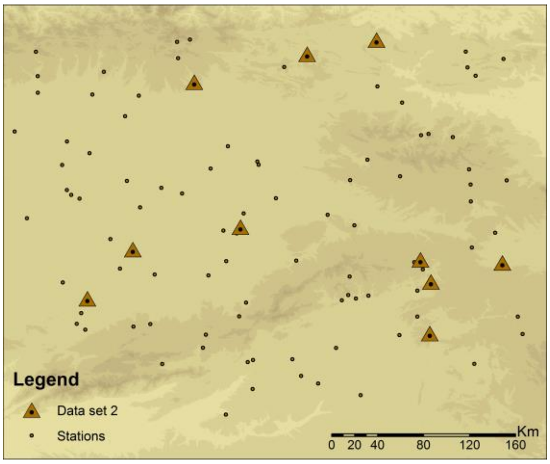


Figure 8.- IDW from Data Set1 (1967, 1977 and 2001)

5.1.2 Monthly Data

Since the objective was to work with monthly data, Exploratory Data Analysis was done with monthly data. In Figure 9 is illustrated the location of stations in each data set, so the distance between them oscillated among 50 km and 100 km. Comparing the location of stations in each data set, they are widespread without any pattern of location.





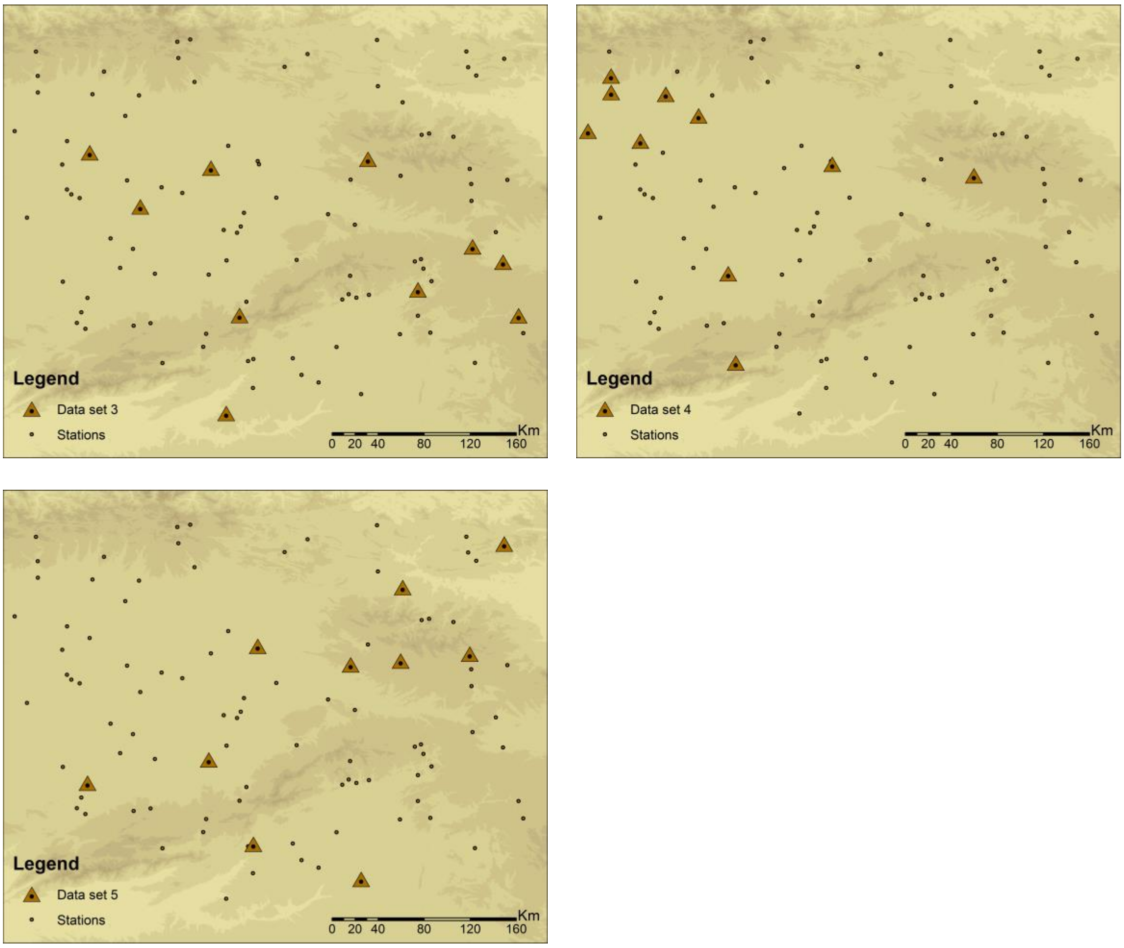


Figure 9.- Location of weather stations of Data Set 1, 2, 3, 4 and 5

As part of the Exploratory Data Analysis (Appendix B to Appendix F), the mean temperature value was analyzed. This value oscillated 2.21 to 20.9 °C where the lowest mean value belonged to data set 2 and the highest mean value belonged to data set 3 (Appendix C & Appendix D). The lowest minimum value in each data set was prominent in January and February with negative values since the lowest temperatures were consequence of winter season. The lowest value was in February from data set 1 with –6.4 °C (Appendix B). Regarding maximum temperature was prominent in July and August since the influence of summer season (Appendix B). The highest maximum temperature value was in data set 5 in July with 27.5 °C (Appendix F).

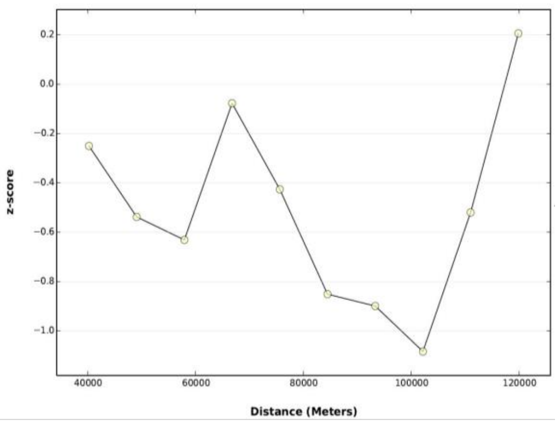
Since the skewness characterizes the degree of asymmetry of a distribution around its mean, it was possible to conclude that the majority had negative skew that indicated that the tail on the left side is longer or fatter than the right side. Just in data set 5, the skewness was positive in the majority of the months (Appendix F). Also, it could be concluded analysing the mean and the median in each data set. If mean>median means positive skew; on the other hand, if mean<median means negative skew. Based on that criteria, data set 4 had 11 months with negative skew (Appendix E).

5.1.3 Local and Global Moran's I analyses of original dataset

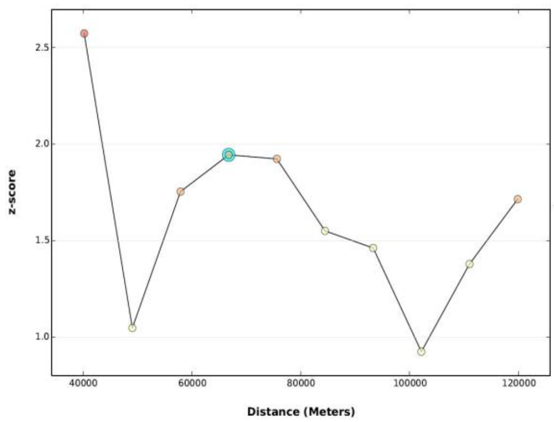
In order to analyze the spatial autocorrelation of original temperature data, the Local and Global Moran's I statistics were calculated for the set of 100 artificial series which had the characteristics of real observations in the study region. This analysis aimed at verifying if the spatial dependence could be affected by the inhomogeneities inserted in the artificial temperature series.

Figure 10 displays a line graph with the z-scores of the Global Moran's I statistic computed for a series of distances. Statistically significant peak z-scores indicate distances where spatial processes promoting clustering are most pronounced. Figure 10 highlights the existence of peaks in July 1972 (66764 meters), April 1988 (111034 meters) and November 2005 (66764 meters). In July 1972 and November 2005, there was a peak at the same distance value. On the other hand, in January 1954 there was no peak.

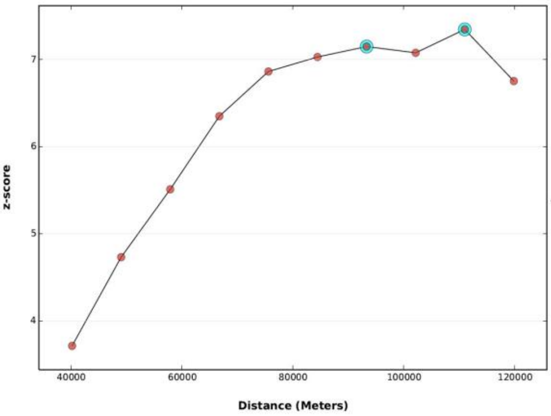
January 1954



July 1972



April 1988



November 2005

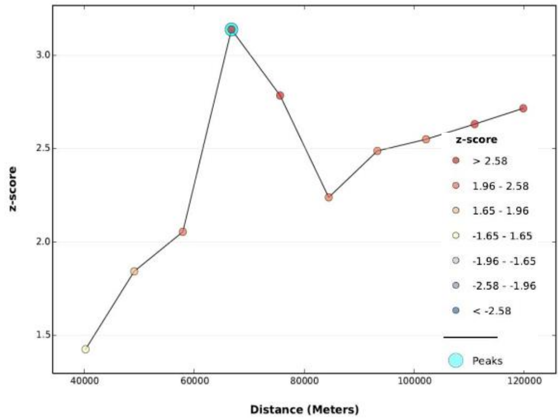


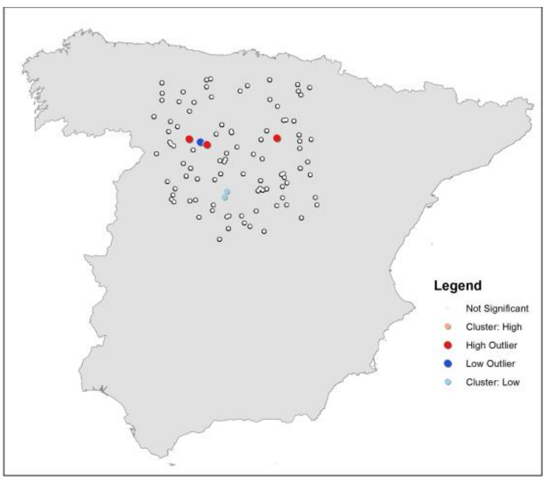
Figure 10.- Spatial Autocorrelation of original data, for January 1954, July 1972, April 1988 and November 2005

The Local Moran's I statistics (Figure 11) show that there were low and high spatial outliers in January 1954 and November 2005 in the same locations. There was a low outlier located in Valladolid, also there were two high outliers located in the same area. Moreover, there was one high outlier located in Soria. On the other hand, there were two clusters of low values located in Segovia in January 1954.

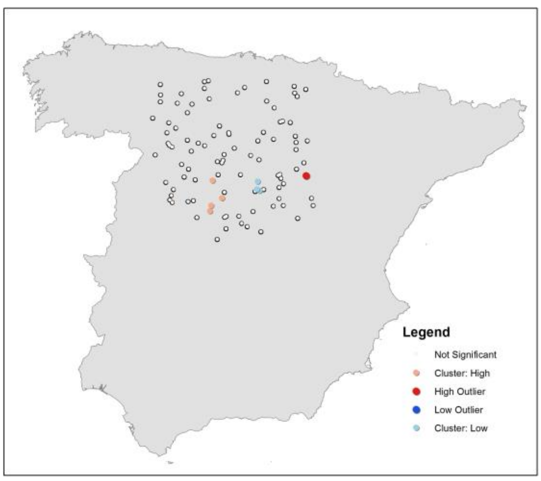
There was high cluster in July 1972 (Leon, Soria and Guadalajara), April 1988 (Segovia and Avila) and November 2005 (Salamanca, Avila and Valladolid).

The other remaining points were not statistically significant, so there was no evidence to reject the hypothesis with 95% confidence.

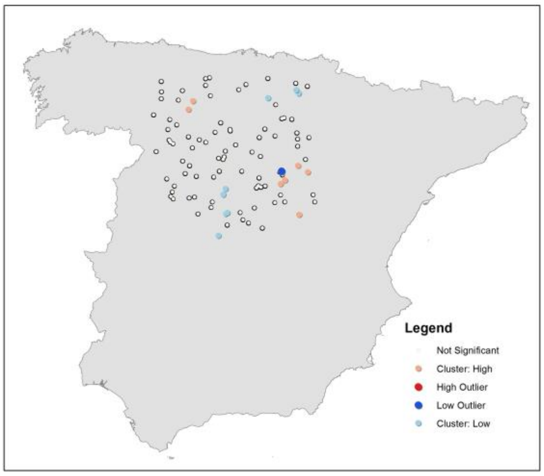
January 1954



July 1972



April 1988



November 2005

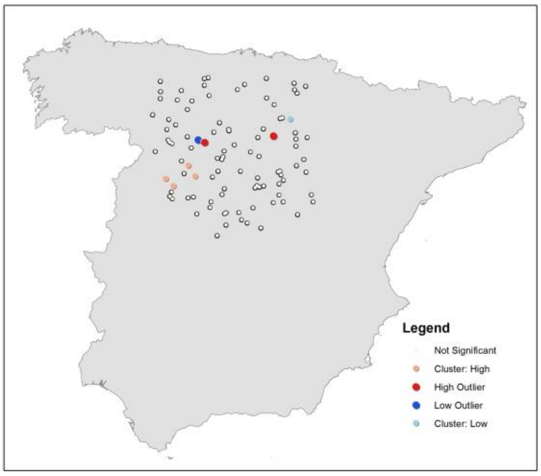


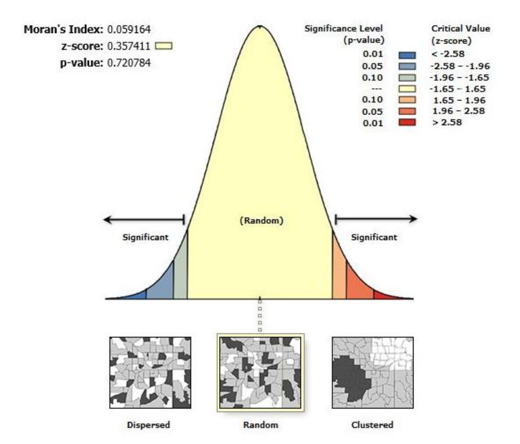
Figure 11.- Anselin's Local Moran's I map for January 1954, July 1972, April 1988 and November 2005

The Global Moran's I statistic was also calculated by month considering the whole study region, using the Spatial Autocorrelation tool from ArcGIS. Since the original data set had 100 stations, the results were reliable. The given z-score value in January 1954, July 1972 and November 2005 (Figure 12) meant that the pattern did not appear to be significantly different than random.

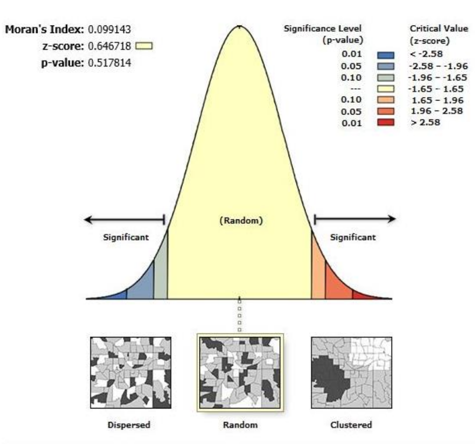
On the other hand, the z-score value in April 1988 meant that there was less than 10% likelihood that the clustered pattern of high values and/or low values could be the result of random chance. In other words, there is evidence of spatial autocorrelation in April 1988 with a 90% degree of confidence.

Therefore, based on the previous analysis, one can conclude that data were organized without any specific spatial dependence since the distribution was more random than clustered.

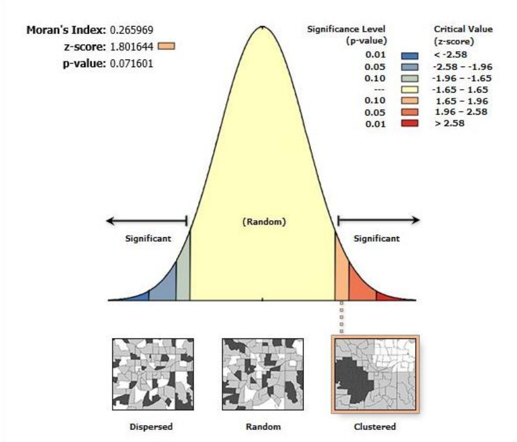
January 1954



July 1972



April 1988



November 2005

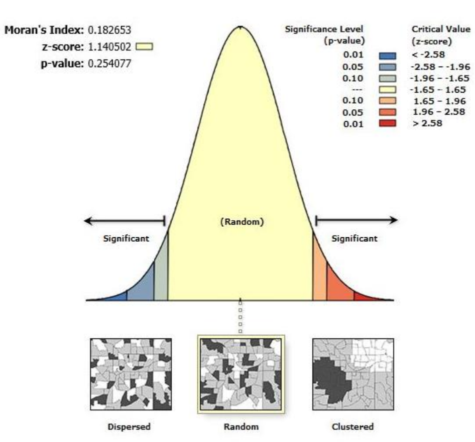


Figure 12.- Global Moran's value of original data, for January 1954, July 1972, April 1988 and November 2005

5.1.4 Local and Global Moran's I analyses of inhomogenized data

Using the set of 100 inhomogenized series (simulated data with irregularities), the Local and Global Moran's I were calculated, for January 1966, 1990, and 2005. The aim of this analysis is to verify verifying if the difficulties in the variogram modelling of the simulated networks were due to the small number of the stations in the networks (10 stations), or if the spatial processes promoting the observed pattern of simulated values (inhomogenized series) was random chance.

The line graph with the z-scores of the Global Moran's I statistics (Figure 13) illustrates that there was no existence of peaks in any of the three years.

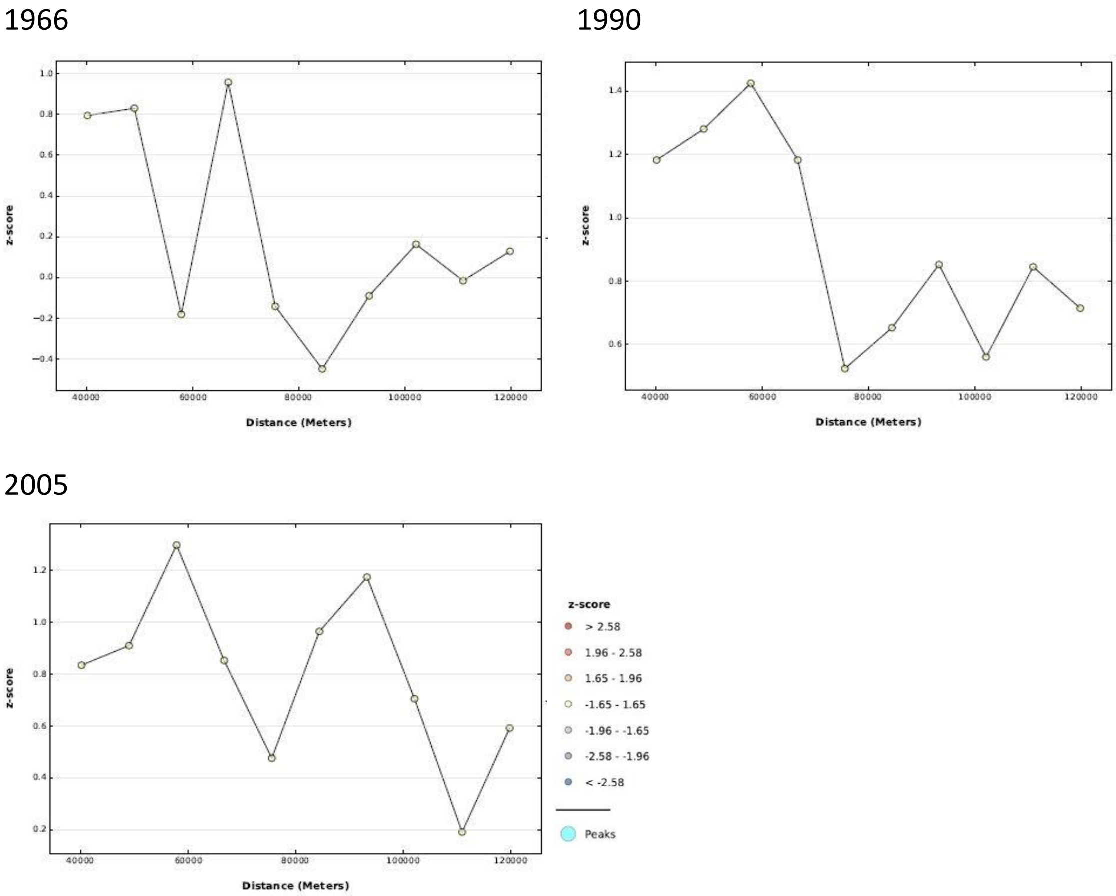


Figure 13.- Spatial Autocorrelation of inhomogenized data, for January 1966, 1990, 2005

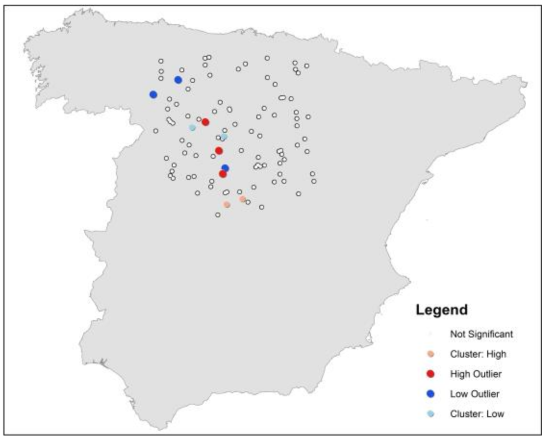
The Local Moran's statistics (Figure 14) illustrate the existence of low and high spatial outliers in January 1966, 1990, and 2005. There was one low outlier having the same location in the three years. The location was in the Autonomous Community Castilla y Leon specifically in the province Leon.

In January 1966, the high outliers were located in Valladolid and Segovia. On the other hand, in Leon and Palencia were located the outliers with high values for January 1990. Additionally, the high outliers in January 2005 were located in Palencia and Valladolid.

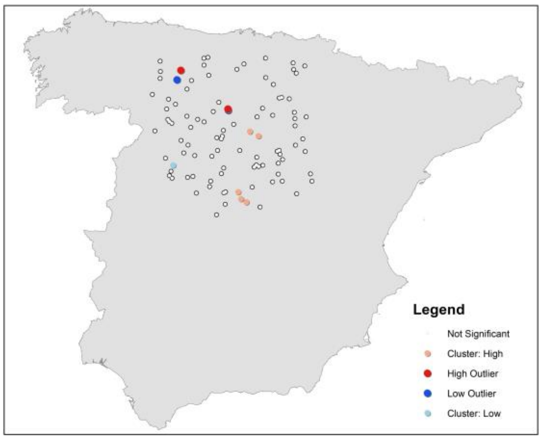
Moreover, there was the existence of cluster with low values in the three years (1966, 1990, 2005).

The remaining points were not statistically significant. In other words, there was no evidence to reject the hypothesis with 95% confidence.

1966



1990



2005

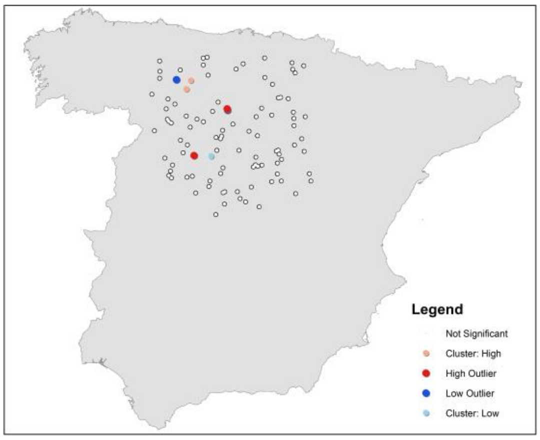
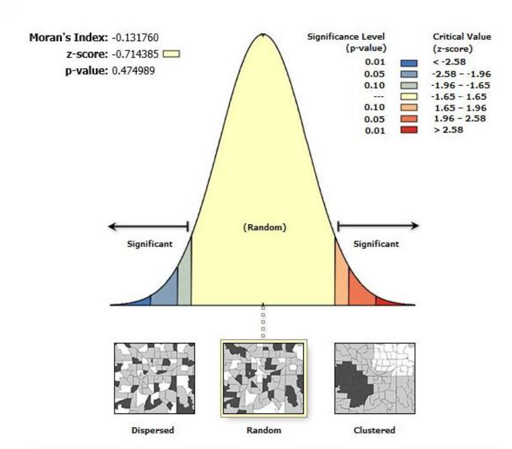


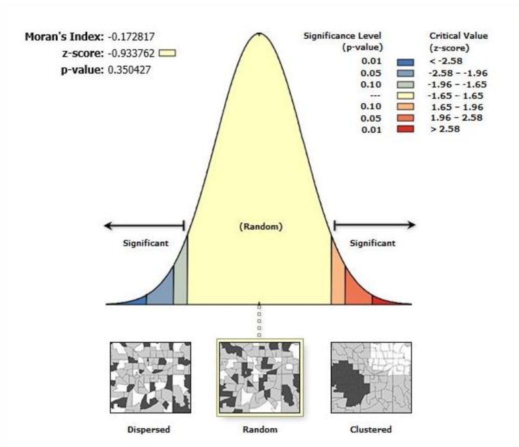
Figure 14.- Anselin's Local Moran's I map for January 1966, 1990, 2005

The Global Moran's I statistic was calculated using the set of 100 inhomogenized series for January 1966, 1990 and 2005. The given z-score value in the three years (Figure 15) meant that the pattern did not appear to be significantly different than random. Hence, the data do not have spatial dependence since the distribution was random.

1966



1990



2005

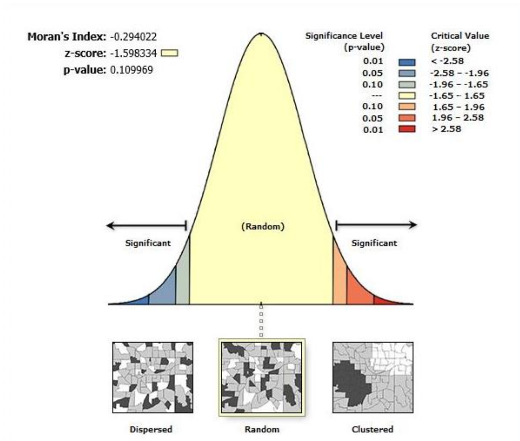


Figure 15.- Global Moran's value of inhomogenized data, for January 1966, 1990, 2005

5.2 Variography

5.2.1 Annual Data of Data Set 1

In Table 2 the variograms' parameters are illustrated from annual data of data set 1. The exponential model fit better in the majority of the decades; however, in decade 1971-1980 the best model was spherical. Regarding the lag size of the experimental variograms, they did not have considerable difference. Just in 1971-1980 the range was differed from the others. Another point to mention is that the partial sill value was not higher than the variance.

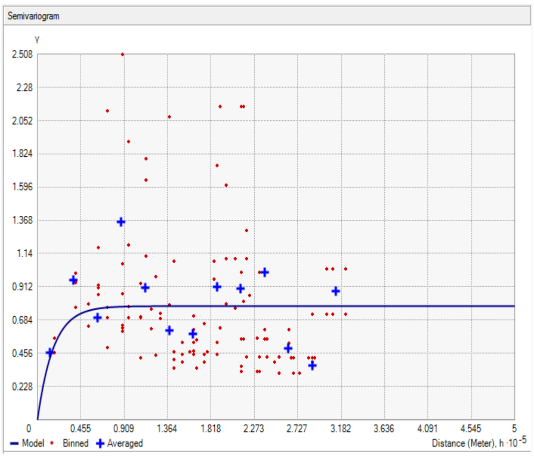
Moreover, the nugget parameter was considered equal to zero. The inclusion of a nugget effect to a variogram model implies that samples located close together are more dissimilar in value than if no nugget effect was assumed, which is not realistic for temperature data. The addition of a nugget effect would result in overly smoothed estimates of temperature, because it would imply a greater distribution of the available kriging weight to data values further away (Morgan, 2005, p. 171).

variance	Decade	Model	Nugget	Range	Partial Sill	Lag size	# Lags	nugget_nor	psill_norm	sill_norm
0.795753	1951-1960	Exponentia	0	55000	0.79	25000	20	0	0.99277	0.99277
1.100401	1961-1970	Exponentia	0	55000	1.1	19000	18	0	0.999636	0.999636
0.98593	1971-1980	Spherical	0	55000	0.98	16000	20	0	0.993986	0.993986
1.214624	1981-1990	Exponentia	0	55000	1.2	25000	17	0	0.98796	0.98796
0.934625	1991-2000	Exponentia	0	55000	0.93	20000	18	0	0.995052	0.995052
0.51154	2001-2010	Exponentia	0	55000	0.44	31000	15	0	0.860148	0.860148

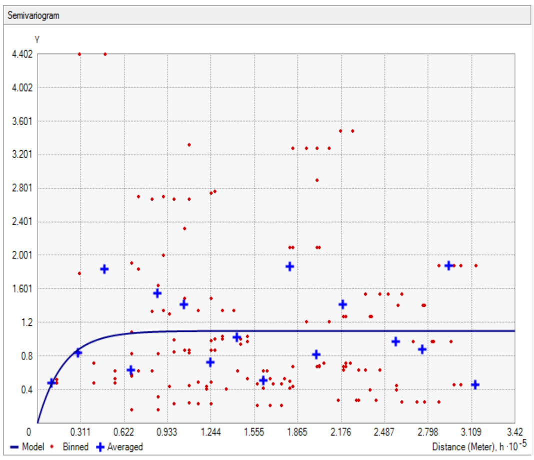
Table 2.- Variogram's parameters from Data Set 1 Tm1 Annual Data

In Figure 16 is highlighted each variogram per decade. Based on the variograms, the majority fit much better with the Exponential model and the parameters selected beforehand were the most adequate by decade; however, the parameters were somewhat similar in the six decades.

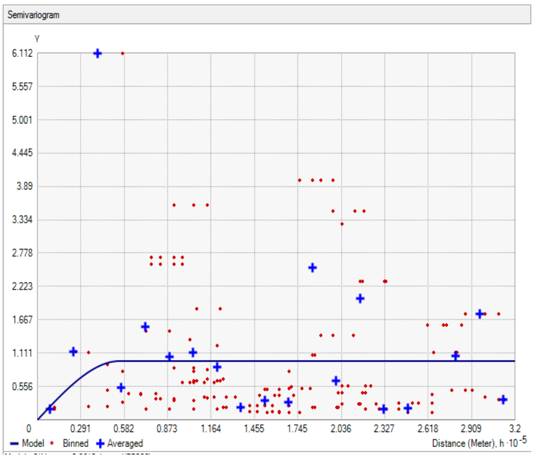
1951-1960



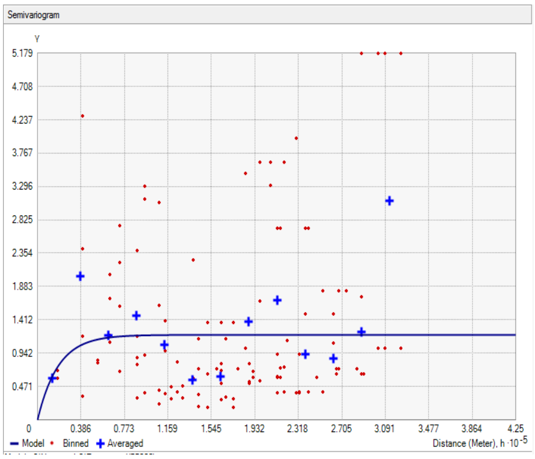
1961-1970



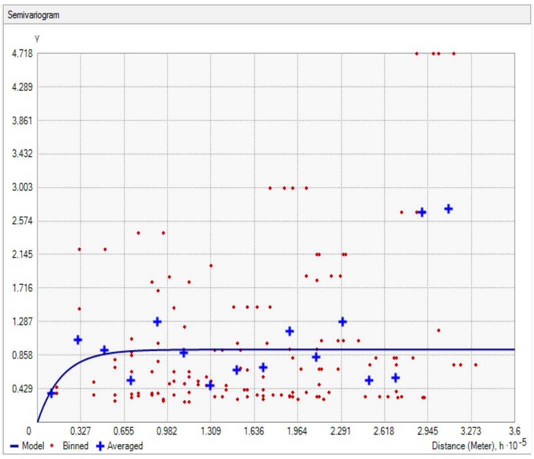
1971-1980



1981-1990



1991-2000



2001-2010

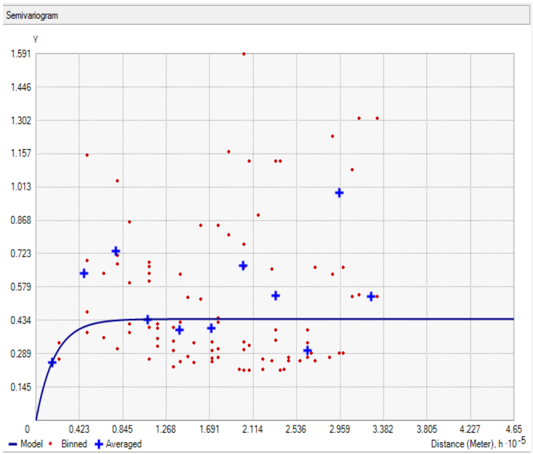


Figure 16.- Variograms by decade from Data Set 1 Tm1 Annual Data

5.2.2 Monthly Data of 100 stations (inhomogenized dataset)

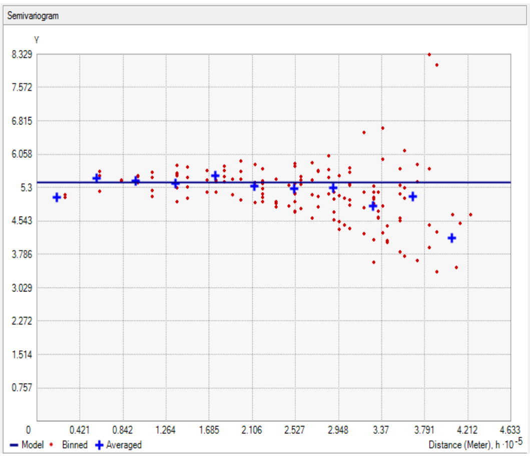
The 100 stations were taken into consideration in order to create a new data set. So it was possible to obtain a more reliable experimental variogram. It was necessary to create Table 3 to assign the position of each station in the *.series file, so it allowed taking each one without repeating.

St_id	Series num	St_id	Series num	St_id	Series num	St_id	Series num
1	2	26	16	51	3	76	120
2	4	27	8	52	19	77	47
3	156	28	1	53	355	78	102
4	134	29	38	54	384	79	11
5	58	30	22	55	433	80	192
6	31	31	79	56	151	81	118
7	5	32	153	57	529	82	9
8	225	33	21	58	71	83	101
9	7	34	92	59	23	84	99
10	84	35	96	60	214	85	85
11	45	36	36	61	271	86	115
12	10	37	46	62	125	87	26
13	50	38	32	63	30	88	242
14	20	39	209	64	35	89	566
15	39	40	14	65	17	90	110
16	211	41	13	66	62	91	6
17	28	42	52	67	130	92	81
18	78	43	27	68	12	93	67
19	143	44	256	69	18	94	43
20	15	45	40	70	25	95	93
21	48	46	77	71	37	96	646
22	187	47	202	72	154	97	138
23	63	48	53	73	112	98	203
24	291	49	59	74	33	99	49
25	180	50	74	75	41	100	90

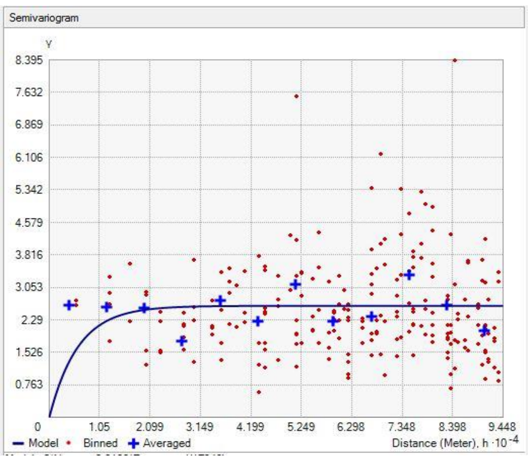
Table 3.- Station ID and series number of each of the 100 stations

Once the data were correctly organized, the following variograms were obtained in ArcGIS (Figure 17). The variogram belonging to January illustrated the existence of pure nugget effect. Moreover, in order to obtain other results, it was obtained one variogram per year (1966, 1990, 2005). However, the results were quite unsatisfactory, as expected from the ESDA results regarding the Global Moran’s I statistic.

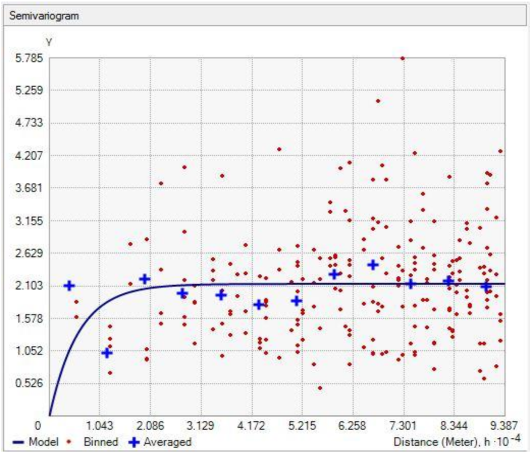
1951-2010



1966



1990



2005

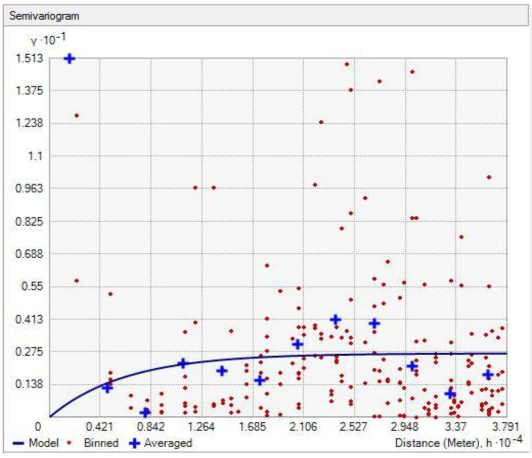


Figure 17.- Variogram from January using 100 stations (1951-2010, 1966,1990, 2005)

5.2.3 Coding in R (autofitVariogram)

In order to automatize the process of obtaining the variogram's parameters, it was used the Programming Language R (Appendix K). Monthly data from data set 1 was used as input data; however, the result was quite unsatisfactory since the number of points was 10, which meant that this number was far below the "absolute minimum' recommended number of spatial points needed for variogram modelling and fitting. The result (Figure 18) was discussed with Prof. Edzer Pebesma, so he mentioned that the amount of points should be minimum 30 in order to get acceptable results using autofitVariogram tool in R.

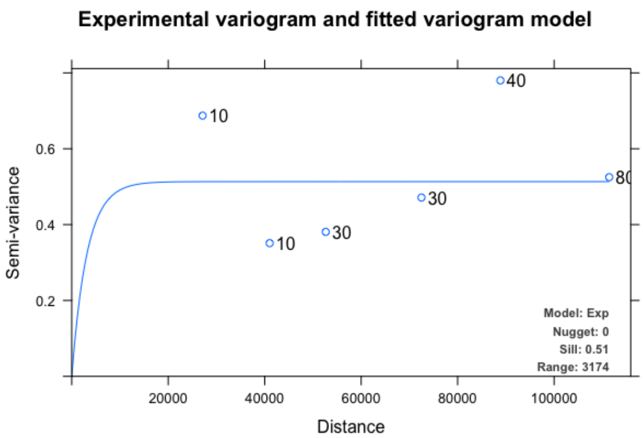


Figure 18.- Variogram obtained using autofitVariogram tool in R

5.2.4 Monthly Variogram per month and decade

Another option to obtain variograms was one variogram per month per decade. Since the variograms in the same month but in different decades had similarities, it was possible to use the parameters variogram for the six decades. Therefore, each month had the description of the variogram's parameters by decade in folders, which were used to homogenize the data in GSIMCLI.

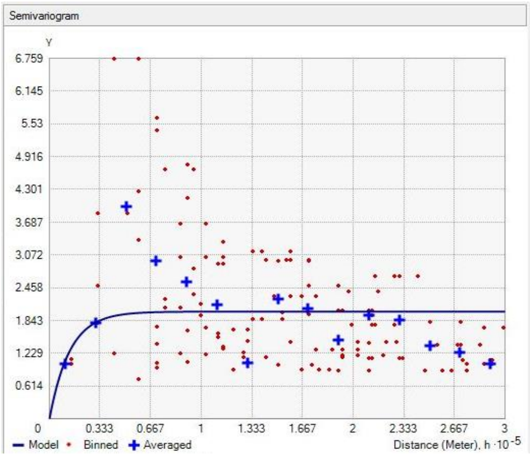
As an example, in Table 4 is illustrated the variograms's parameters of data set 2 of month July, so the most predominant model was Exponential. The range was selected based on the minimum and maximum distance between the stations. Regarding the partial sill, this values was not superior than the variance as it is illustrated in the column 10 of Table 4.

Decade	Model	Nugget	Range	Partial Sill	Lag size	# Lags	nugget_norm	psill_norm	sill_norm
1951-1960	Exponential	0	70000	3.38	20000	15	0	0.999106	0.999106
1961-1970	Exponential	0	70000	3.38	20000	15	0	0.999106	0.999106
1971-1980	Exponential	0	70000	3.38	20000	15	0	0.999106	0.999106
1981-1990	Exponential	0	70000	3.38	20000	15	0	0.999106	0.999106
1991-2000	Exponential	0	70000	3.38	20000	15	0	0.999106	0.999106
2001-2010	Exponential	0	70000	3.38	20000	15	0	0.999106	0.999106

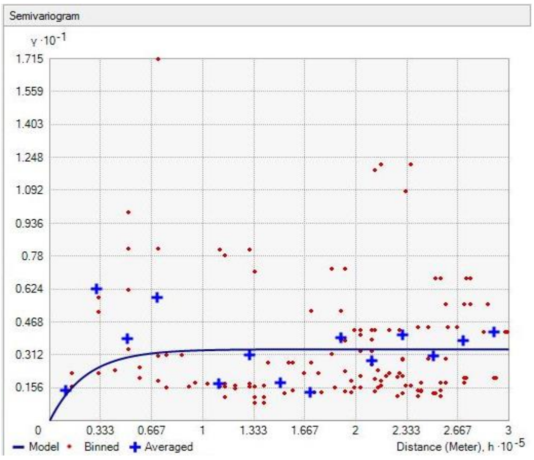
Table 4.- Variograms' parameters from Data Set 2 month July

In the Figure 19 is highlighted the variograms obtained in the five data sets that correspond to July of the first decade (1951-1960). Between all of them had similarities. For instance, the Exponential model fit better instead of Spherical or Gaussian model. In addition, the range oscillated between 65000 – 80000 meters. The value of partial sill was always lower than the variance in all cases. Therefore, even though they had similar parameters, it was better to have variograms' parameters per data set in order to guarantee robust results.

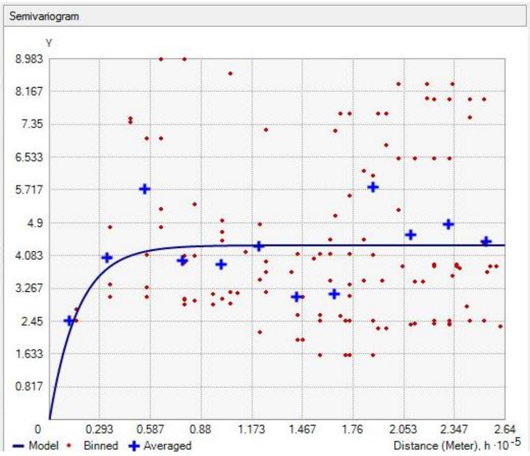
Data Set 1



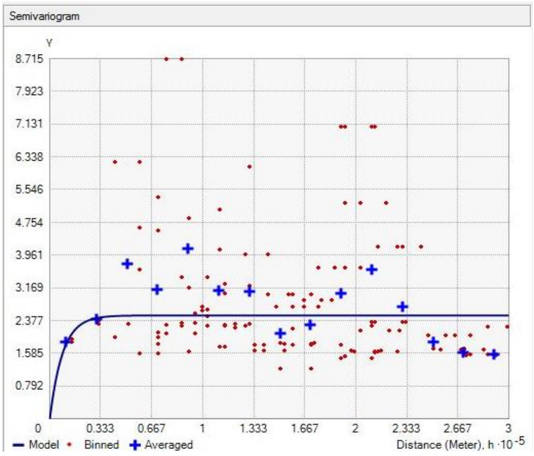
Data Set 2



Data Set 3



Data Set 4



Data Set 5

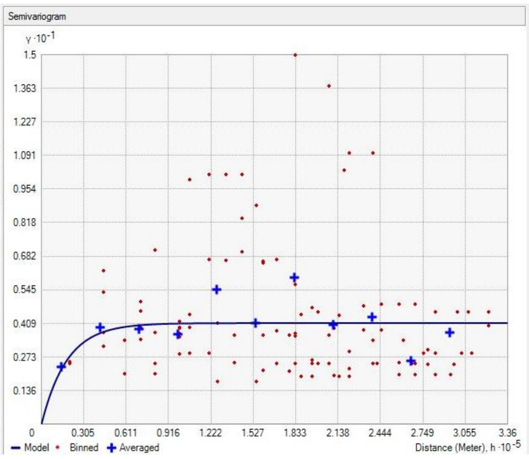


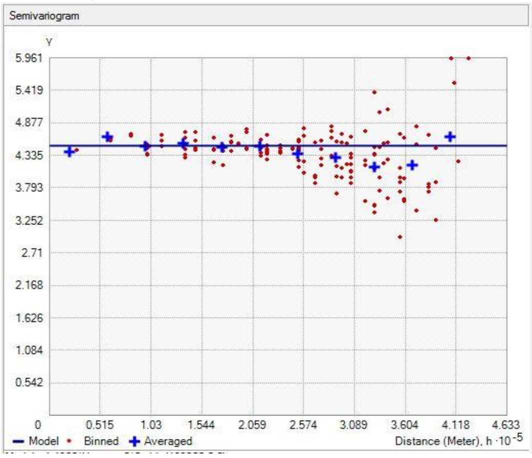
Figure 19.- Variograms from month July of decade 1951-1960 of Data Sets 1,2,3,4 and 5

5.2.5 Monthly Data of 100 stations (original dataset)

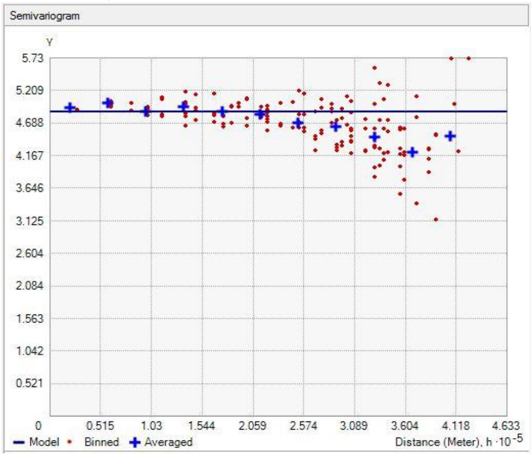
In order to verify if the absence of spatial dependence was caused by the inhomogeneities inserted in the artificial temperature series, a monthly artificial data set was analysed. Hence, taking the 100 stations to create a new data set, it was possible to obtain variograms of January and February (1951-1960); in addition, variograms of January and February in 1954.

Figure 20 illustrates that the two first variograms clearly highlight a pure nugget effect. On the other hand, the variograms belonging to 1954 do not show a pure nugget effect, but almost. Hence, they are quite unsatisfactory, as expected from the ESDA results regarding the Global Moran's I statistic.

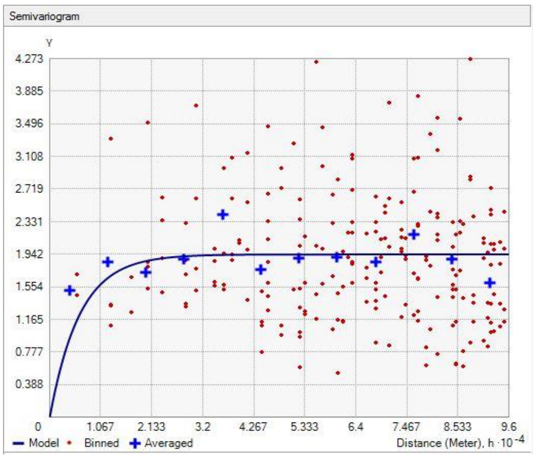
January 1951-2010



February 1951-2010



January 1954



February 1954

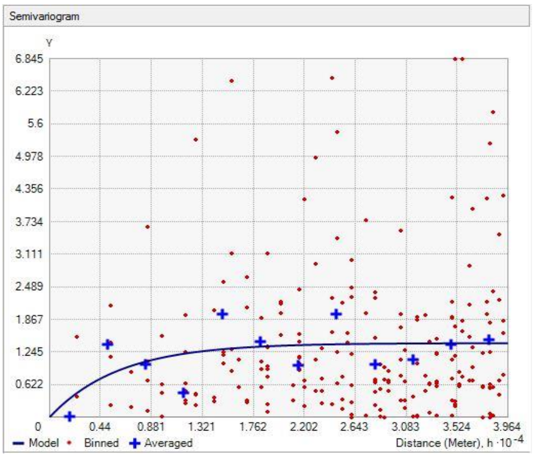


Figure 20.- Variograms from January and February with six decades and year 1954

5.3 Homogenization of annual data

The data set 1 was used to test the data, so at the beginning the data were gathered by year in order to be homogenized with GSIMCLI considering 200 and 500 simulations. A high number of simulations implied more time to homogenize the data.

In Table 5 is illustrated the irregularities detected in each station by decade. Therefore, the number of irregularities with 200 and 500 simulations is almost similar. For instance, in station 4 in decade 1961-1970, there were 3 irregularities detected with 200 simulations and 4 irregularities detected with 500 simulations.

In some cases, more simulations imply a higher number of detected inhomogeneities. The reason could be explained by the minor irregularity of the PDF due to high number of simulations. However, comparing the results obtained in Ribeiro et al. (2016b), they were different since in that case low number of simulations implied higher number of detection of irregularities. The possible fact of different results may be that higher number of irregularities could imply the detection of false positive (Ribeiro et al., 2016b). Hence, the performance metrics were the way to verify it.

	st 1	st 2	st 3	st 4	st 5	st 6	st 7	st 8	st 9	st 10	
500 SIM	1	2	0	1	0	0	0	0	0	3	1951-1960
200 SIM	1	2	0	1	0	0	0	0	0	3	
500 SIM	0	0	4	7	1	0	0	0	0	0	1961-1970
200 SIM	0	0	3	7	0	0	0	0	0	0	
500 SIM	10	0	0	0	0	7	0	3	0	0	1971-1980
200 SIM	10	0	0	0	0	7	0	2	0	0	
500 SIM	1	4	0	9	0	0	0	2	0	0	1981-1990
200 SIM	1	4	0	7	0	0	0	2	0	0	
500 SIM	6	1	0	0	0	0	5	0	2	0	1991-2000
200 SIM	6	1	0	0	0	0	6	0	2	0	
500 SIM	5	1	1	2	0	2	1	0	0	0	2001-2010
200 SIM	5	0	1	2	0	2	2	0	0	0	

Table 5.- Irregularities detected with 200 and 500 simulations-Data set 1 annual temperature data

5.3.1 Performance metrics of annual data

After the homogenization process of data station 1 (annual data), it was possible to calculate the performance metrics. In order to identify the efficiency of homogenization process with 200 and 500 simulations, the calculation of performance metrics was done for both results.

The station CRSME and network CRSME value are illustrated in Table 6. The lowest value of performance metrics corresponds to the test with the best parameters. In other words, in this project the result of the performance metrics revealed that the parameter 200 simulations had similar performance achieved in the homogenization process as 500 simulations.

Considering that higher number of simulations implies more time, 200 simulations was the best option since this project focus on monthly data.

Simulations	CRSME station	CRSME network
200	0.6106	0.5929
500	0.6107	0.593

Table 6.- Performance metrics of annual data

5.4 Homogenization of monthly data

Considering the previous results and the time to get homogenized data, the number of simulations was 200 to homogenize temperature monthly data. All of the results were analyzed based on the calculation of performance metrics proposed by Venema et al. (2012).

5.4.1 Summary of irregularities of monthly data

Being quite considerable the amount of data, the analysis was not straightforward. The results were organized in a spreadsheet file for each month of each time series, making a total of 60 files. These files contain the homogenized time series, in a tabular structure organized by station and year. In addition, a summary of the homogenization process with the number of irregularities detected and number of missing values.

For instance, Table 7 is the summary of the homogenization of data set 4 for August. Table 7 shows that station 1 had more irregularities detected and station 8 did not have any irregularity detected. Regarding missing data, any station had missing values.

Station ID	Irregularities detected	Missing data
1	15	0
2	5	0
3	7	0
4	4	0
5	4	0
6	3	0
7	4	0
8	0	0
9	3	0
10	4	0

Table 7.- Summary of the homogenization in data set 4 for August

5.4.2 Summary of irregularities in data sets with same stations.

In several cases, the same station was part not only of one data set but also of another data set, but the time series were different. For instance, in Table 8 is illustrated the stations which are repeated in two data sets. In each data set the station had a number of irregularities detected and missing values, for July.

The number of irregularities detected were not the same even though it was the same station but in different data set. For instance, in station 71, the irregularities detected in data set4 were 2 and in data set5 were 12. In addition, there are no missing values in any station, which is correct since in this data there are no missing values.

Station ID	Data set	Irregularities detected	Missing data
51	dt1	4	0
	dt4	5	0
2	dt1	7	0
	dt3	2	0
41	dt2	2	0
	dt5	9	0
20	dt2	3	0
	dt3	12	0
71	dt4	2	0
	dt5	12	0

Table 8.- Irregularities detected in stations 51, 2, 41, 20 and 71 in different datasets, for July

5.4.3 Comparison of temperature values of repeated stations and original temperature values.

The number of irregularities detected were not the same even though the station was the same but located in different data set (Table 8). Therefore, Table 9 was elaborated in order to verify the values of the repeated stations in different data sets to analyze the difference in Table 8.

In Table 9, the temperature values were not the same in any case and had different values compared with original temperature values (artificial temperature data that were used to introduce the inhomogeneities). Therefore, since temperature values were different, the number of irregularities detected by GSIMCLI differed due to distinct inhomogeneous temperature values.

Station ID	Data Set	Temperature value
51	dt1	21.42812
	dt4	23.2781
	original	22.6
2	dt1	26.4522
	dt3	20.26377
	original	25.8
41	dt2	23.11323
	dt5	20.95038
	original	21.1
20	dt2	24.2
	dt3	24.2
	original	24.9
71	dt4	22.6417
	dt5	24.37885
	original	21.9

Table 9.- Inhomogeneous and original temperature values of st 51,2,41,20,71, for July 1990

5.4.4 Performance metrics of monthly data

Considering that this project used simulated data with irregularities and original data (artificial data that was used to introduce the inhomogeneities), it was possible to calculate the performance metrics proposed by Venema et al. (2012). The data set 1 obtained the lowest value of Station CRMSE and Network CRMSE with 0.69 and 0.19 respectively. On the other hand, data set 2 had the highest values, 1.57 in Station CRMSE and 0.48 in Network CRMSE.

The homogenization process was performed with the following parameters in all data sets: probability of detection = 0.95, percentile of correction = 0.975, grid cell size = 10 km, 200 and 500 simulations, and 2 nodes. However, the results had a difference that may be due to station's locations. In data set 1, the stations' location was not quite widespread compared with the other data sets. Hence, a possible reason for this difference could be the location of stations since the range parameter of the variogram represents the distance from where there is no more spatial correlation.

Comparing the values of Table 10 with the CRMSE values from Venema et al. (2012), it was notorious that Climatol (0.69) has a lower value than the ones illustrated in Table 10. This might be due to the lower number of stations (Ribeiro et al., 2016c). However, the lack of spatial autocorrelation structure in the data could be the main reason, as discussed in the Variography section. In fact, data seem to be temporally correlated but not spatially correlated.

Data set	Station CRMSE	Network CRMSE
1	0.65	0.19
2	1.57	0.48
3	1.51	0.27
4	1.29	0.4
5	1.35	0.53
Average	1.274	0.374

Table 10.- Results of performance metrics of monthly data set 1, 2, 3, 4 and 5

6 CONCLUSIONS

The principal aim of this project was the evaluation of the geostatistical homogenization method GSIMCLI using simulated monthly temperature data. Hence, specific objectives were accomplished such as prepare climate time series in a specific format, do Exploratory Data Analysis and Exploratory Spatial Data Analysis of the simulated temperature data, determine the GSIMCLI parameters, homogenize the simulated temperature data set, and calculate performance metrics of the homogenization tests.

In reference to the achieved objectives, previous training and knowledge before performing homogenization is quite important to understand the process systematically.

Based on Exploratory Spatial Data Analysis (ESDA) of temperature data, it can be concluded that the original data were organized without any specific spatial distribution since the distribution was more random than clustered. Hence, the same conclusion was obtained for the inhomogenized and homogenized data sets.

For this project, the variography study was an essential part of the GSIMCLI's parameters to homogenize the data. The study of variography was a challenging task since the number of stations of the networks was 10. Therefore, literature review about the several methods and approaches regarding variography was relevant to decide the best technique to estimate the parameters to fit a variogram model. Many attempts were undertaken using different tools to model the variograms.

Most experimental variograms exhibited a nugget effect or an erratic pattern. The small number of points used to infer the variogram models could have caused this lack of evidence of spatial autocorrelation. However, the ESDA results indicate that it can also be caused by the lack of spatial dependence in whole data set.

The homogenization efficiency was evaluated using performance metrics. In annual data, the minimum error revealed that 200 and 500 simulations had similar performance in the homogenization process. However, taking into account that this project used monthly data, it was better to choose 200 simulations since it implied less computational time than using 500 simulations.

Regarding the performance metrics of monthly data, data set 1 presented the lowest value of Station CRMSE and Network CRMSE. Nevertheless, the performance metrics of data set 1 had difference compared with the other data sets. The difference may be due to station's locations since the variogram's parameters depends on spatial correlation.

Comparing the CRMSE values obtained in this project with the CRMSE values in Venema et al. (2012); the CRMSE value is higher in this project. One reason may be due to low number of stations, which contributes to model of the spatio-temporal structure (Caineta et al., 2015a). Another reason would be the variograms' parameters since data are temporally correlated but does not seem to be spatially correlated. This factor is quite important since Ordinary Kriging is required by Direct Sequential Simulation algorithm.

Moreover, comparing the CRMSE values of monthly and annual data, annual temperature data sets achieved better homogenization results than monthly data sets. The increase of variability in monthly data is the most likely reason of this result.

6.1 Future work

The results were compared with the ones obtained in Venema et al. (2012), who describe the homogenization of the benchmark data set of the HOME project. The comparison aims to get an idea about the CRMSE values. For future work, it would be important to compare these results with another method using the same data in order to analyze which method has better performance.

Regarding variography study, for future research would be meaningful to use real data from the monitoring stations or the E-OBS gridded dataset. The latter are European daily high-resolution observational gridded dataset of surface temperature that can be found on the website of the European Climate Assessment & Dataset project.

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APPENDIX A: HISTOGRAMS DATA SET 1 ANNUAL DATA

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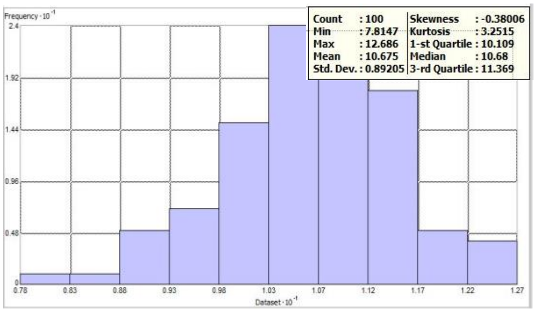

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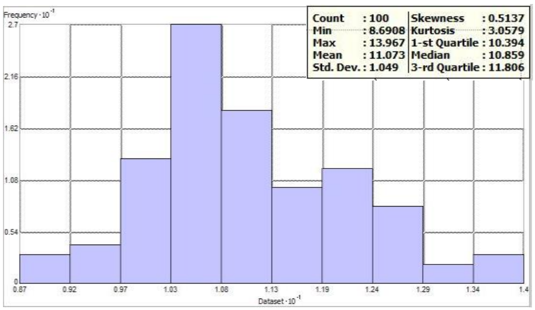
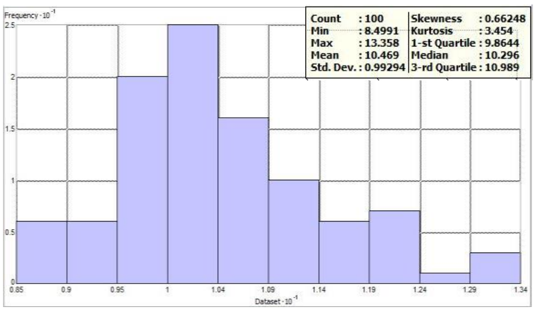
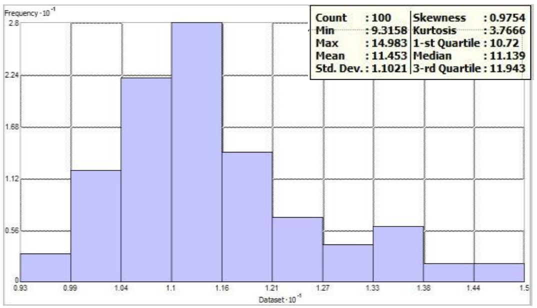


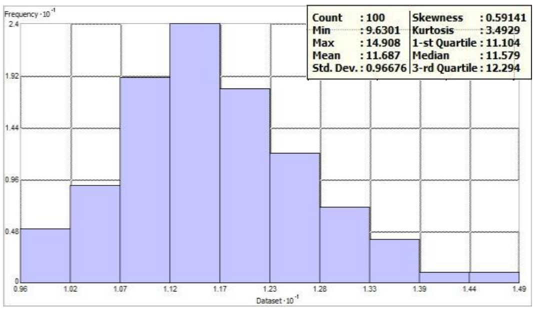
1971-1980



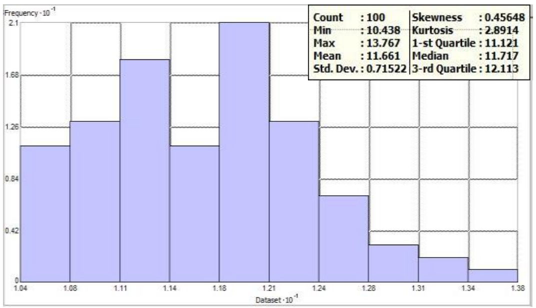
1981-1990



1991-2000



2001-2010



APPENDIX B: HISTOGRAMS DATA SET 1 MONTHLY DATA

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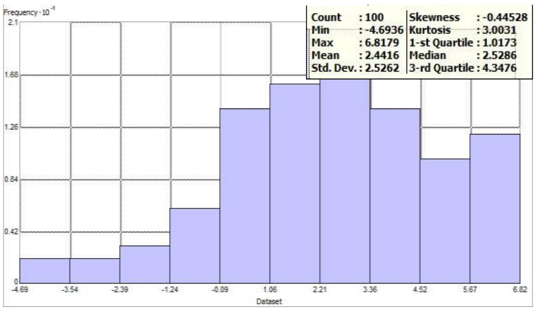

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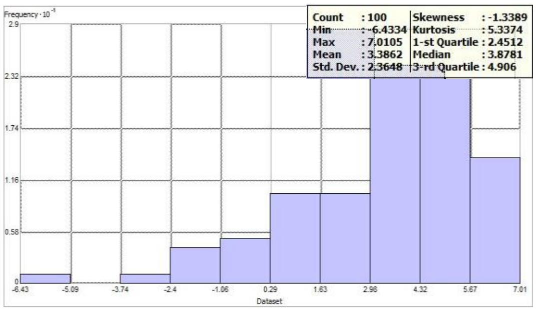

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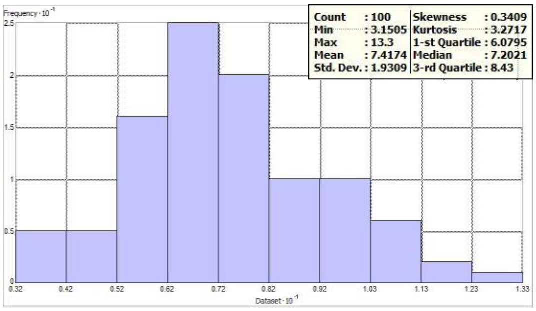
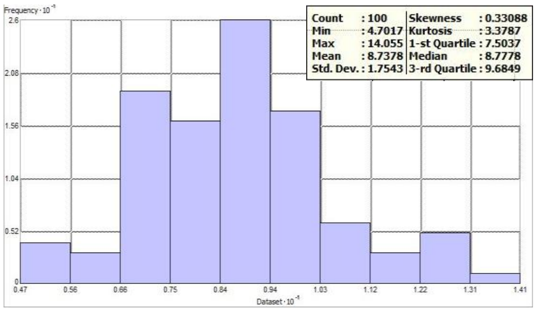


April



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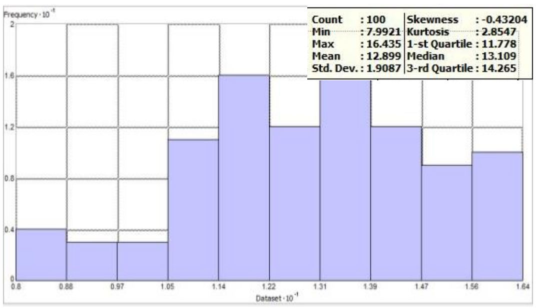

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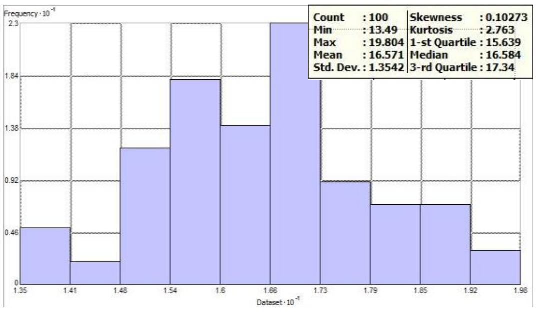

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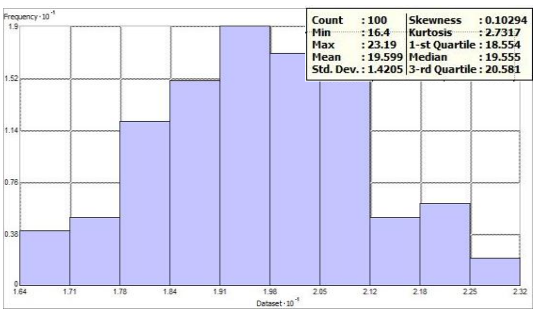

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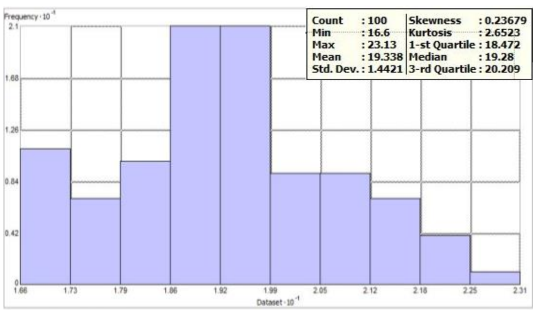

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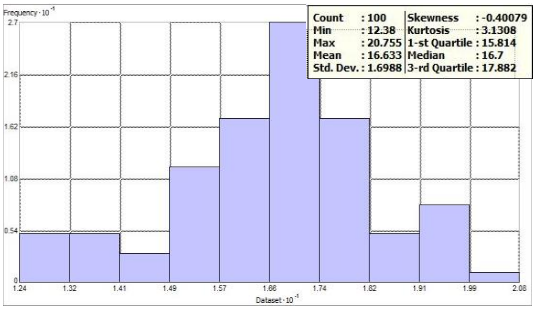

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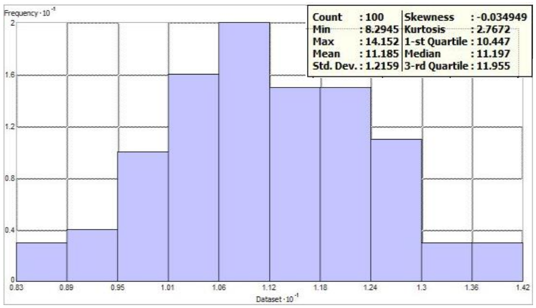

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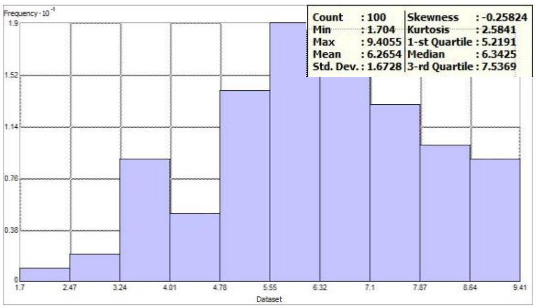
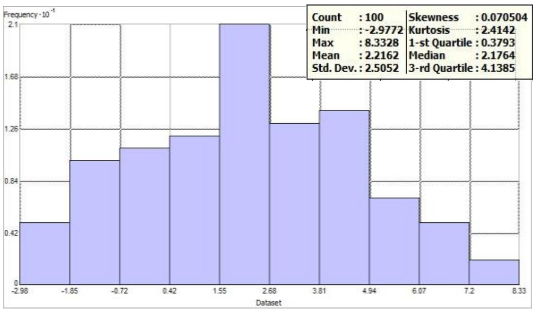


December

APPENDIX C: HISTOGRAMS DATA SET 2 MONTHLY DATA

January



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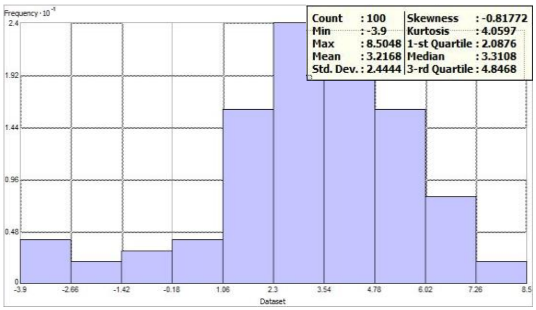

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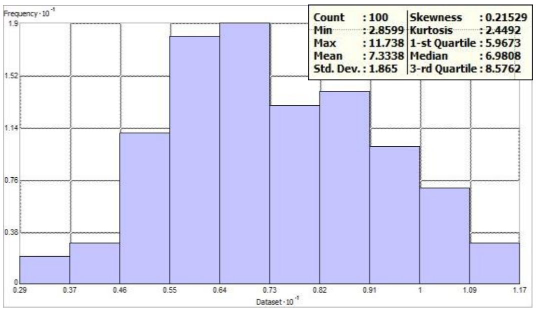

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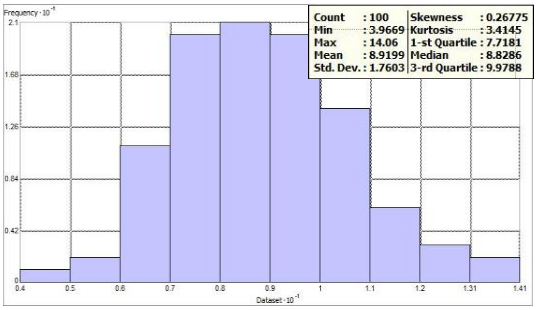

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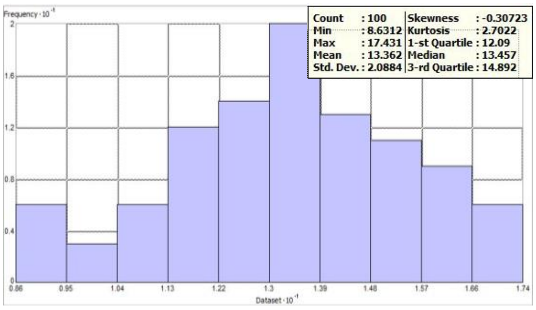

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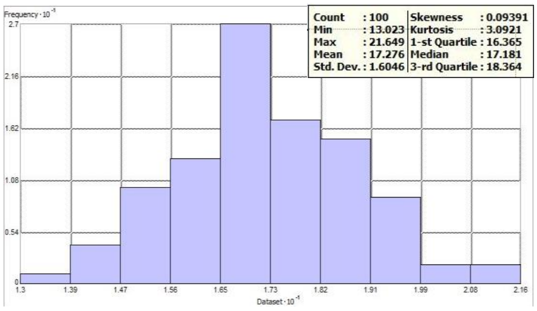

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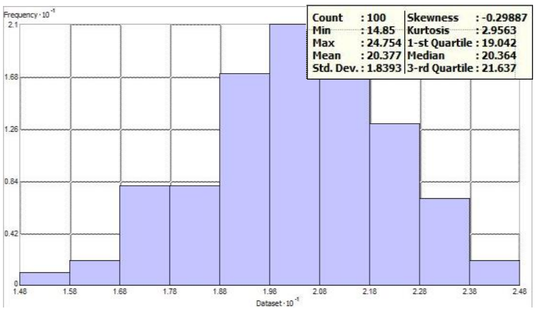

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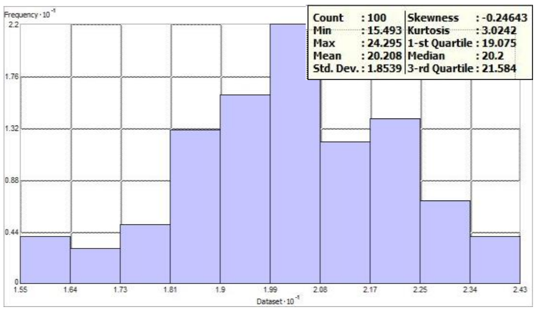

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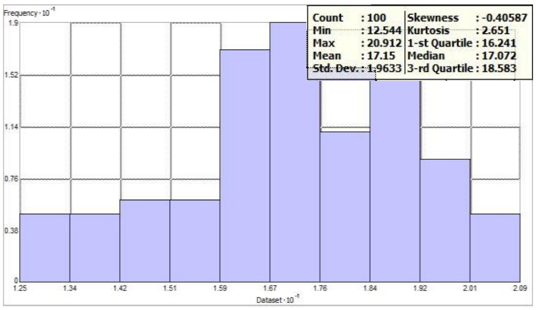

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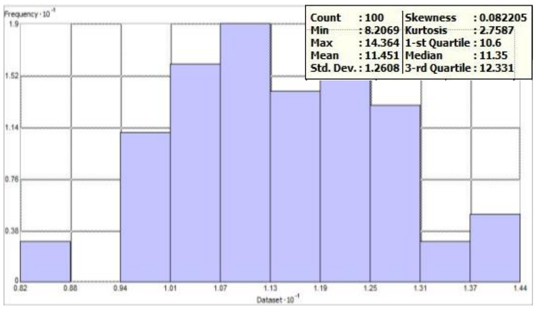

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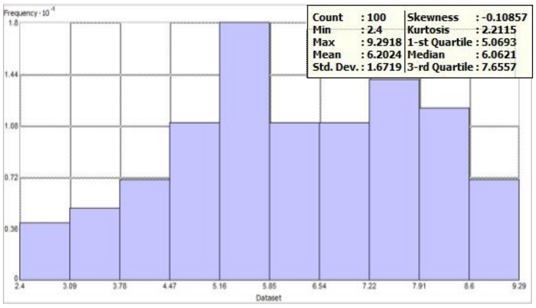

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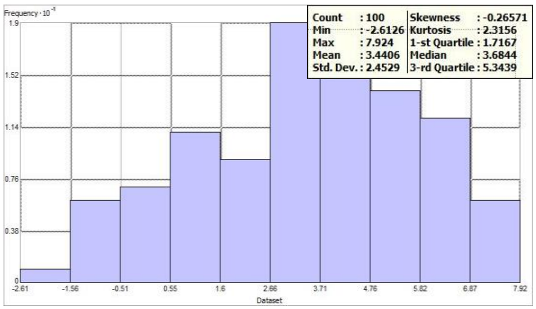
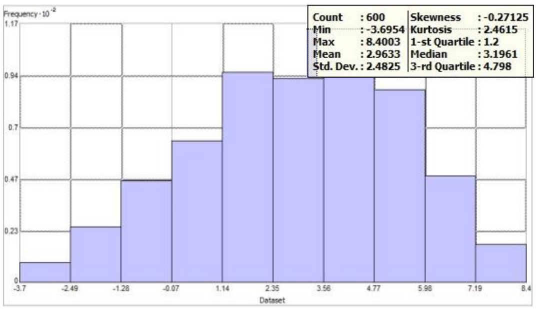


APPENDIX D: HISTOGRAMS DATA SET 3 MONTHLY DATA

January



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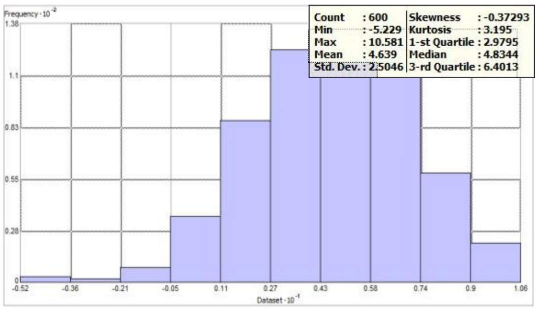

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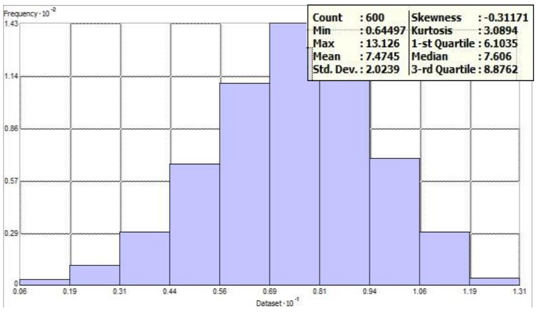

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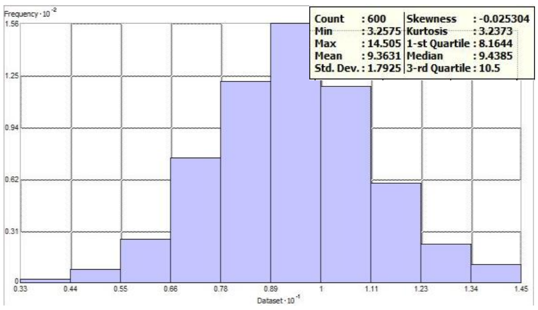

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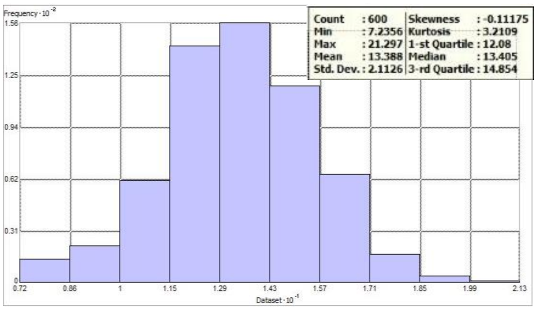

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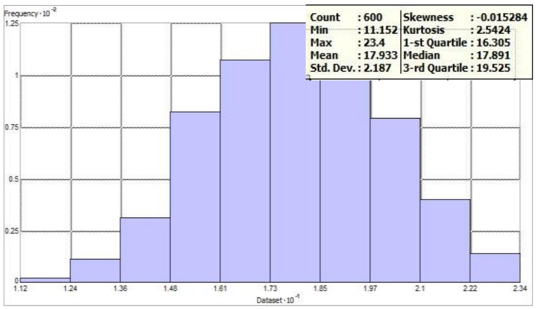

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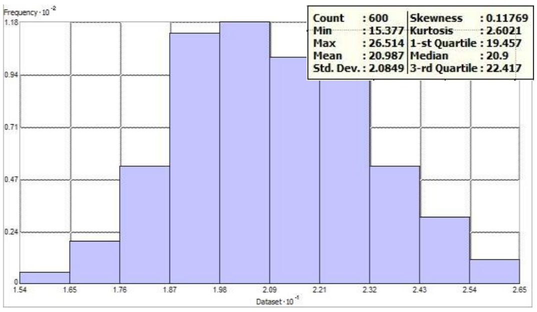

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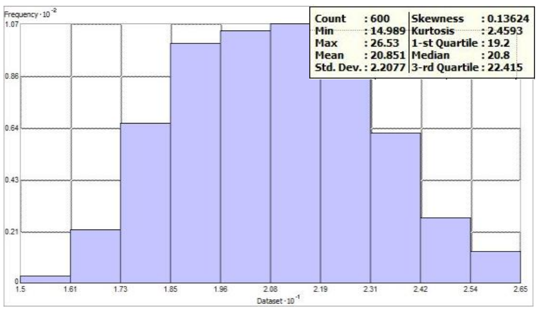

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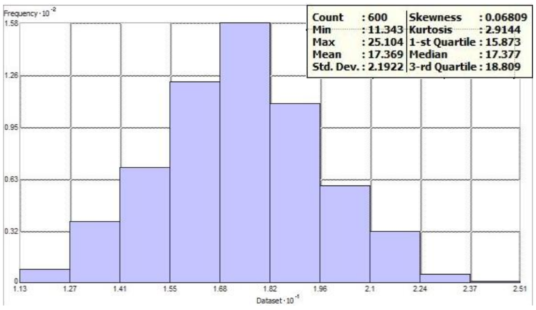

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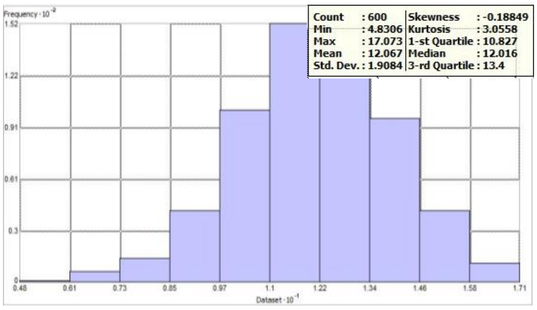

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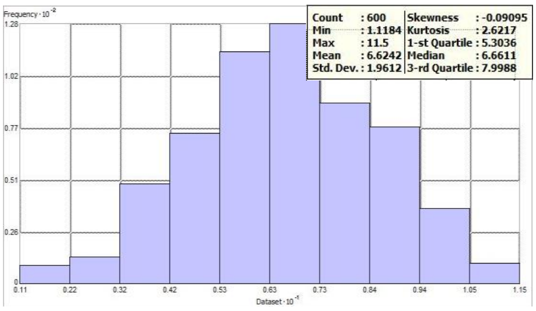

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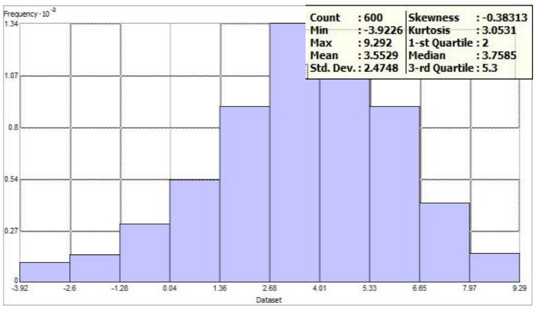
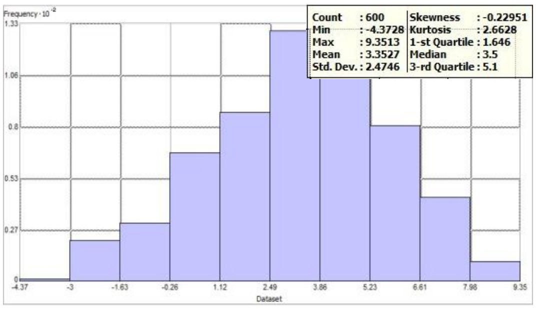


APPENDIX E: HISTOGRAMS DATA SET 4 MONTHLY DATA

January



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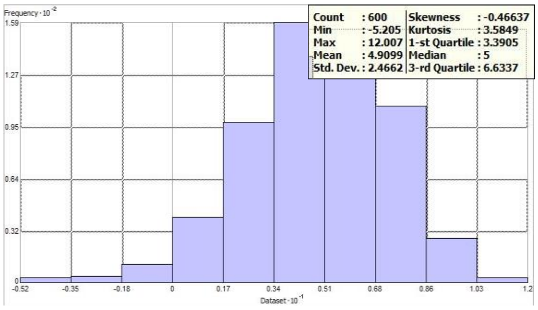

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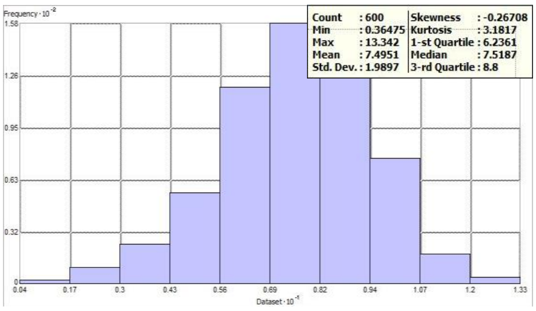

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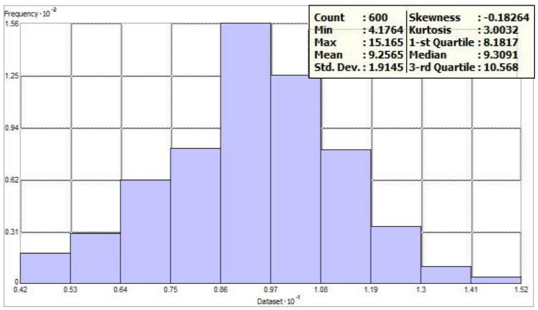

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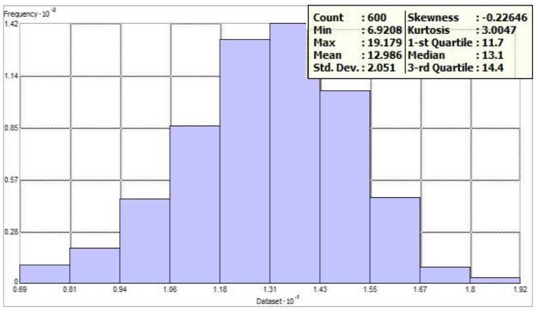

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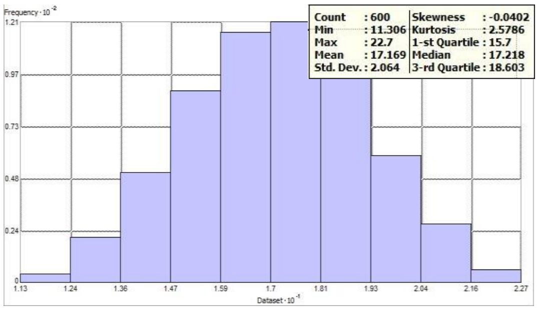

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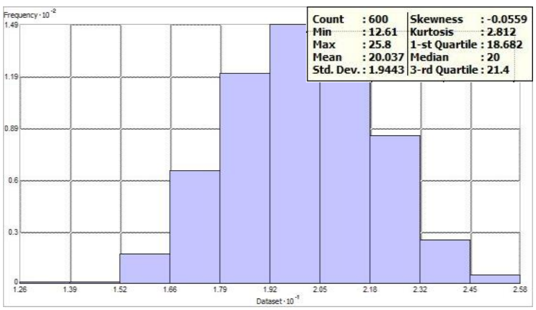

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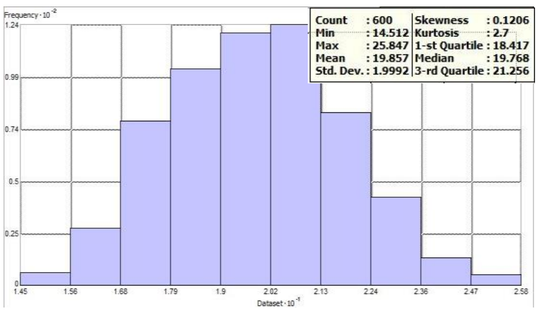

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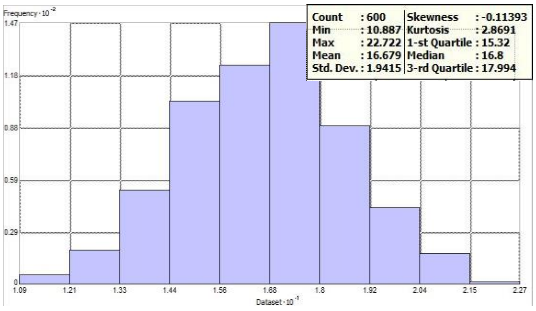

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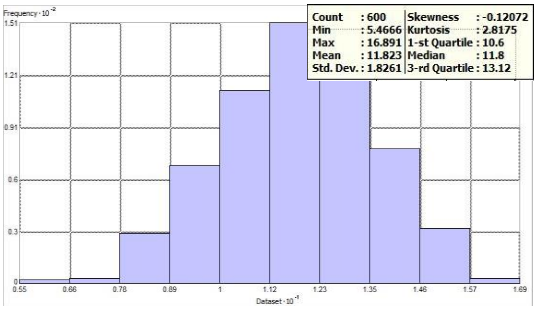

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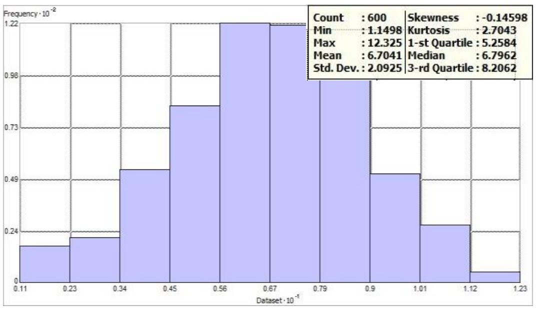

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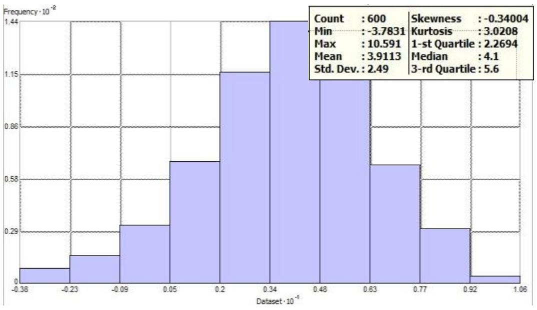
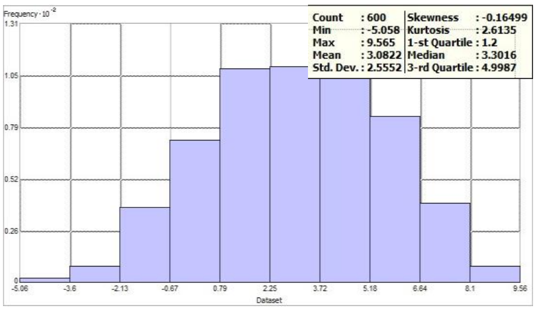
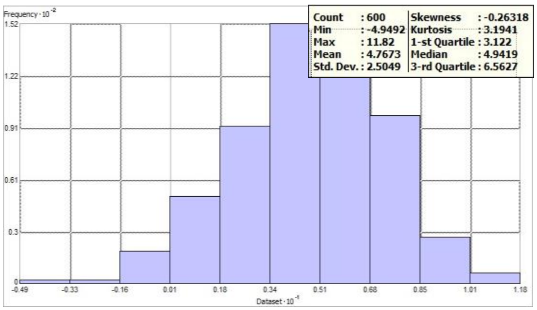


APPENDIX F: HISTOGRAMS DATA SET 5 MONTHLY DATA

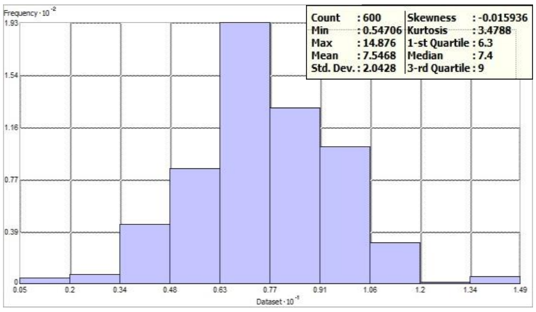
January



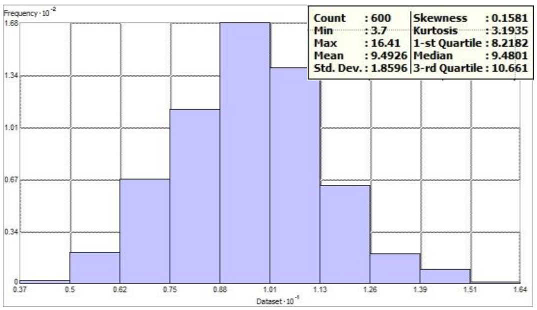
February



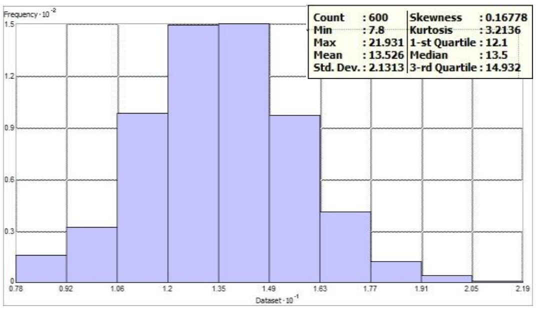
March



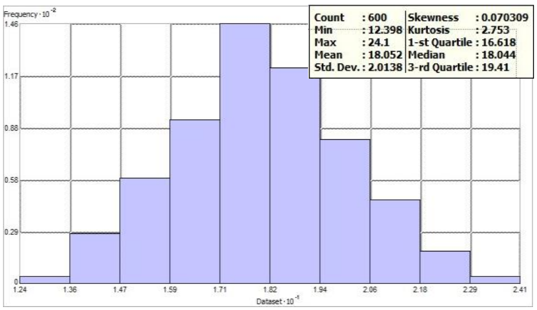
April



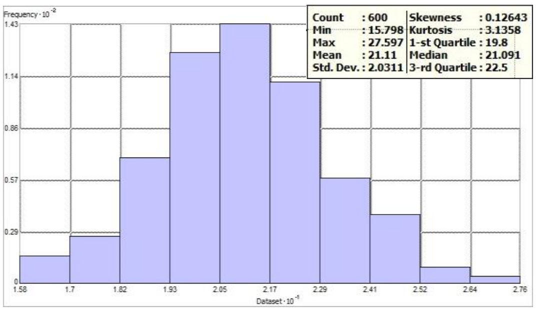
May



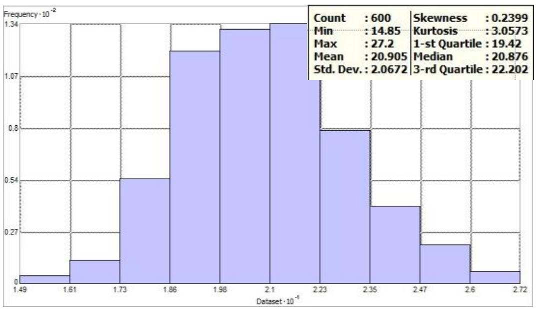
June



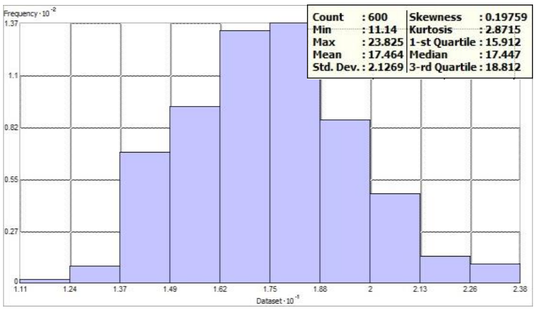
July



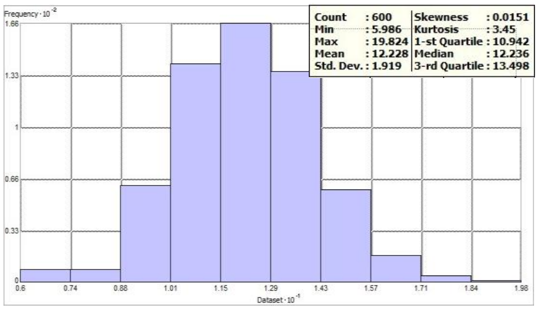
August



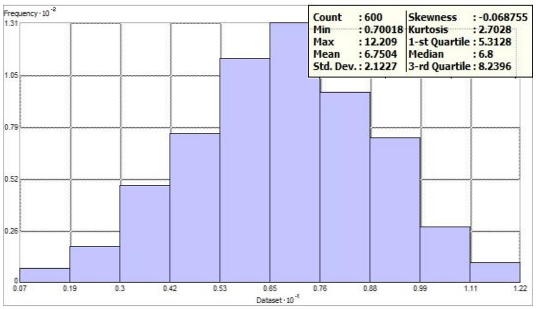
September



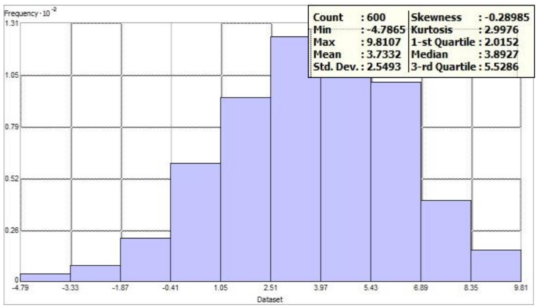
October



November



December



APPENDIX G: MACRO TO SPLIT DATA BY MONTH

```
Sub Months()
' Months Macro
' Keyboard Shortcut: Ctrl+m
'
    Selection.AutoFilter
    ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="1"
    Columns("B:F").Select
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet2").Select
    Application.CutCopyMode = False
    Sheets("Sheet2").Move
    Sheets("Sheet2").Select
    Sheets("Sheet2").Name = "Sheet2"
    Sheets("Sheet2").Select
    Sheets("Sheet2").Name = "Sheet1"
    ChDir "C:\Users\Nova\Desktop\months"
    ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\jan.xlsx", _
        FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
    ActiveWindow.Close

    ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="2"
    Columns("B:F").Select
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet3").Select
    Application.CutCopyMode = False
    Sheets("Sheet3").Move
    Sheets("Sheet3").Select
    Sheets("Sheet3").Name = "Sheet1"
    ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\feb.xlsx", _
        FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
    ActiveWindow.Close

    ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="3"
    Columns("B:F").Select
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet4").Select
    Application.CutCopyMode = False
    Sheets("Sheet4").Move
    Sheets("Sheet4").Select
    Sheets("Sheet4").Name = "Sheet1"
    ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\march.xlsx", _
        FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
    ActiveWindow.Close

    ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="4"
    Columns("B:F").Select
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet5").Select
    Application.CutCopyMode = False
```

```
Sheets("Sheet5").Move
Sheets("Sheet5").Select
Sheets("Sheet5").Name = "Sheet1"
ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\april.xlsx", _
    FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
ActiveWindow.Close

ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="5"
Columns("B:F").Select
Selection.Copy
Sheets.Add After:=ActiveSheet
ActiveSheet.Paste
Sheets("Sheet6").Select
Application.CutCopyMode = False
Sheets("Sheet6").Move
Sheets("Sheet6").Select
Sheets("Sheet6").Name = "Sheet1"
ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\may.xlsx", _
    FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
ActiveWindow.Close

ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="6"
Columns("B:F").Select
Selection.Copy
Sheets.Add After:=ActiveSheet
ActiveSheet.Paste
Sheets("Sheet7").Select
Application.CutCopyMode = False
Sheets("Sheet7").Move
Sheets("Sheet7").Select
Sheets("Sheet7").Name = "Sheet1"
ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\june.xlsx", _
    FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
ActiveWindow.Close

ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="7"
Columns("B:F").Select
Selection.Copy
Sheets.Add After:=ActiveSheet
ActiveSheet.Paste
Sheets("Sheet8").Select
Application.CutCopyMode = False
Sheets("Sheet8").Move
Sheets("Sheet8").Select
Sheets("Sheet8").Name = "Sheet1"
ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\july.xlsx", _
    FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
ActiveWindow.Close

ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="8"
Columns("B:F").Select
Selection.Copy
Sheets.Add After:=ActiveSheet
ActiveSheet.Paste
Sheets("Sheet9").Select
Application.CutCopyMode = False
Sheets("Sheet9").Move
Sheets("Sheet9").Select
Sheets("Sheet9").Name = "Sheet1"
ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\aug.xlsx", _
    FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
```

```
    ActiveWindow.Close

    ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="9"
    Columns("B:F").Select
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet10").Select
    Application.CutCopyMode = False
    Sheets("Sheet10").Move
    Sheets("Sheet10").Select
    Sheets("Sheet10").Name = "Sheet1"
    ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\sep.xlsx", _
        FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
    ActiveWindow.Close

    ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="10"
    Columns("B:F").Select
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet11").Select
    Application.CutCopyMode = False
    Sheets("Sheet11").Move
    Sheets("Sheet11").Select
    Sheets("Sheet11").Name = "Sheet1"
    ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\oct.xlsx", _
        FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
    ActiveWindow.Close

    ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="11"
    Columns("B:F").Select
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet12").Select
    Application.CutCopyMode = False
    Sheets("Sheet12").Move
    Sheets("Sheet12").Select
    Sheets("Sheet12").Name = "Sheet1"
    ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\nov.xlsx", _
        FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
    ActiveWindow.Close

    ActiveSheet.Range("$A$1:$F$7201").AutoFilter Field:=1, Criteria1:="12"
    Columns("B:F").Select
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet13").Select
    Application.CutCopyMode = False
    Sheets("Sheet13").Move
    Sheets("Sheet13").Select
    Sheets("Sheet13").Name = "Sheet1"
    ActiveWorkbook.SaveAs Filename:="C:\Users\Nova\Desktop\months\dec.xlsx", _
        FileFormat:=xlOpenXMLWorkbook, CreateBackup:=False
    ActiveWindow.Close
End Sub
```

APPENDIX H: MACRO TO DIVIDE THE DATA BY DECADES

```
Sub decades()
' decades Macro
' Keyboard Shortcut: Ctrl+t
'
    Range("C1").Select
    Sheets("Sheet1").Select
    ActiveSheet.Range("$A$1:$E$601").AutoFilter Field:=3, Criteria1:=">=1951", _
        Operator:=xlAnd, Criteria2:="<=1960"
    Columns("A:E").Select
    Application.CutCopyMode = False
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet2").Select
    Sheets("Sheet2").Name = "1951-1960"

    Sheets("Sheet1").Select
    ActiveSheet.Range("$A$1:$E$601").AutoFilter Field:=3, Criteria1:=">=1961", _
        Operator:=xlAnd, Criteria2:="<=1970"
    Columns("A:E").Select
    Application.CutCopyMode = False
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet3").Select
    Sheets("Sheet3").Name = "1961-1970"

    Sheets("Sheet1").Select
    ActiveSheet.Range("$A$1:$E$601").AutoFilter Field:=3, Criteria1:=">=1971", _
        Operator:=xlAnd, Criteria2:="<=1980"
    Columns("A:E").Select
    Application.CutCopyMode = False
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet4").Select
    Sheets("Sheet4").Name = "1971-1980"

    Sheets("Sheet1").Select
    ActiveSheet.Range("$A$1:$E$601").AutoFilter Field:=3, Criteria1:=">=1981", _
        Operator:=xlAnd, Criteria2:="<=1990"
    Columns("A:E").Select
    Application.CutCopyMode = False
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet5").Select
    Sheets("Sheet5").Name = "1981-1990"

    Sheets("Sheet1").Select
    ActiveSheet.Range("$A$1:$E$601").AutoFilter Field:=3, Criteria1:=">=1991", _
        Operator:=xlAnd, Criteria2:="<=2000"
    Columns("A:E").Select
    Application.CutCopyMode = False
    Selection.Copy
    Sheets.Add After:=ActiveSheet
```

```
    ActiveSheet.Paste
    Sheets("Sheet6").Select
    Sheets("Sheet6").Name = "1991-2000"

    Sheets("Sheet1").Select
    ActiveSheet.Range("$A$1:$E$601").AutoFilter Field:=3, Criteria1:=">=2001", _
        Operator:=xlAnd, Criteria2:="<=2010"
    Columns("A:E").Select
    Application.CutCopyMode = False
    Selection.Copy
    Sheets.Add After:=ActiveSheet
    ActiveSheet.Paste
    Sheets("Sheet7").Select
    Sheets("Sheet7").Name = "2001-2010"
End Sub
```

APENDDIX I: MACROS TO GATHER DATA IN GSIMCLI FORMAT BY MONTH

JANUARY

```
Sub january()
'
' january Macro
'
' Keyboard Shortcut: Ctrl+Shift+j
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\january\dec_jan_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\january\dec_jan_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
```

```
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\january\dec_jan_1951_2010\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\january\dec_jan_1951_2010\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
```

```
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
    "C:\Users\Nova\Desktop\set_1951_2010\january\dec_jan_1951_2010\1971_1980.txt" _
    , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
    "C:\Users\Nova\Desktop\set_1951_2010\january\dec_jan_1951_2010\1961_1970.txt" _
    , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
```

```
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\january\dec_jan_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

FEBRUARY

```
Sub february()
'
' february Macro
'
' Keyboard Shortcut: Ctrl+Shift+F
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\february\dec_feb_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
      "C:\Users\Nova\Desktop\set_1951_2010\february\dec_feb_1951_2010\2001_2010.txt" _
      , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\february\dec_feb_1951_2010\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\february\dec_feb_1951_2010\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\february\dec_feb_1951_2010\1971_1980.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\february\dec_feb_1951_2010\1961_1970.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\february\dec_feb_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

MARCH

```
Sub march()
'
' march Macro
'
' Keyboard Shortcut: Ctrl+Shift+H
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\march\dec_march_1951_1960"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\march\dec_march_1951_1960\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\march\dec_march_1951_1960\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\march\dec_march_1951_1960\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\march\dec_march_1951_1960\1971_1980.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\march\dec_march_1951_1960\1961_1970.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\march\dec_march_1951_1960\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

ABRIL

```
Sub april()
'
' april Macro
' encabezado de cada archivo (decadas)
'
' Keyboard Shortcut: Ctrl+Shift+A
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\april\dec_april_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\april\dec_april_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
```

```
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\april\dec_april_1951_2010\1991_2000.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\april\dec_april_1951_2010\1981_1990.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
```

```
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\april\dec_april_1951_2010\1971_1980.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\april\dec_april_1951_2010\1961_1970.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
```

```
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\april\dec_april_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

MAY

```
Sub may()
'
' may Macro
'
' Keyboard Shortcut: Ctrl+Shift+M
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\may\dec_may_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\may\dec_may_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\may\dec_may_1951_2010\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\may\dec_may_1951_2010\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\may\dec_may_1951_2010\1971_1980.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\may\dec_may_1951_2010\1961_1970.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\may\dec_may_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

JUNE

```
Sub june()
'
' june Macro
'
' Keyboard Shortcut: Ctrl+Shift+e
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\june\dec_june_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\june\dec_june_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\june\dec_june_1951_2010\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\june\dec_june_1951_2010\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\june\dec_june_1951_2010\1971_1980.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\june\dec_june_1951_2010\1961_1970.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\june\dec_june_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

JULY

```
Sub july()
'
' july Macro
'
' Keyboard Shortcut: Ctrl+Shift+y
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\july\dec_july_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\july\dec_july_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\july\dec_july_1951_2010\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\july\dec_july_1951_2010\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\july\dec_july_1951_2010\1971_1980.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\july\dec_july_1951_2010\1961_1970.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\july\dec_july_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

AUGUST

```
Sub august()
'
' august Macro
'
' Keyboard Shortcut: Ctrl+Shift+U
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\august\dec_aug_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\august\dec_aug_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\august\dec_aug_1951_2010\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\august\dec_aug_1951_2010\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\august\dec_aug_1951_2010\1971_1980.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\august\dec_aug_1951_2010\1961_1970.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\august\dec_aug_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

SEPTEMBER

```
Sub september()
'
' september Macro
'
' Keyboard Shortcut: Ctrl+Shift+S
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\september\dec_sep_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\september\dec_sep_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\september\dec_sep_1951_2010\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\september\dec_sep_1951_2010\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\september\dec_sep_1951_2010\1971_1980.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\september\dec_sep_1951_2010\1961_1970.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\september\dec_sep_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

OCTOBER

```
Sub october()
'
' october Macro
''
' Keyboard Shortcut: Ctrl+Shift+A
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\october\dec_oct_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\october\dec_oct_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\october\dec_oct_1951_2010\1991_2000.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\october\dec_oct_1951_2010\1981_1990.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\october\dec_oct_1951_2010\1971_1980.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\october\dec_oct_1951_2010\1961_1970.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\october\dec_oct_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

NOVEMBER

```
Sub november()
'
' november Macro
'
' Keyboard Shortcut: Ctrl+Shift+N
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\november\dec_nov_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\november\dec_nov_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\november\dec_nov_1951_2010\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\november\dec_nov_1951_2010\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\november\dec_nov_1951_2010\1971_1980.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
  "C:\Users\Nova\Desktop\set_1951_2010\november\dec_nov_1951_2010\1961_1970.txt" _
  , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\november\dec_nov_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close
End Sub
```

DECEMBER

```
Sub december()
'
' december Macro
'
' Keyboard Shortcut: Ctrl+Shift+D
'
    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_2001_2010_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("2001-2010").Select
    Sheets("2001-2010").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\december\dec_dec_1951_2010"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\december\dec_dec_1951_2010\2001_2010.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Rows("1:6").Select
    Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "dt5_1991_2000_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
```

```
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1991-2000").Select
Sheets("1991-2000").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\december\dec_dec_1951_2010\1991_2000.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1981_1990_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1981-1990").Select
Sheets("1981-1990").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\december\dec_dec_1951_2010\1981_1990.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1971_1980_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
```

```
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1971-1980").Select
Sheets("1971-1980").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\december\dec_dec_1951_2010\1971_1980.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
ActiveCell.FormulaR1C1 = "dt5_1961_1970_Tm1"
Range("A2").Select
ActiveCell.FormulaR1C1 = "5"
Range("A7").Select
Selection.Cut
Range("A3").Select
ActiveSheet.Paste
Range("B7").Select
Selection.Cut
Range("A4").Select
ActiveSheet.Paste
Range("C7").Select
Selection.Cut
Range("A5").Select
ActiveSheet.Paste
Range("D7").Select
Selection.Cut
Range("A6").Select
ActiveSheet.Paste
Range("E7").Select
Selection.Cut
Range("A7").Select
ActiveSheet.Paste
Sheets("1961-1970").Select
Sheets("1961-1970").Move
ActiveWorkbook.SaveAs Filename:= _
   "C:\Users\Nova\Desktop\set_1951_2010\december\dec_dec_1951_2010\1961_1970.txt" _
   , FileFormat:=xlText, CreateBackup:=False
ActiveWorkbook.Save
ActiveWindow.Close

Rows("1:6").Select
Selection.Insert Shift:=xlDown, CopyOrigin:=xlFormatFromLeftOrAbove
Range("A1").Select
```

```
    ActiveCell.FormulaR1C1 = "dt5_1951_1960_Tm1"
    Range("A2").Select
    ActiveCell.FormulaR1C1 = "5"
    Range("A7").Select
    Selection.Cut
    Range("A3").Select
    ActiveSheet.Paste
    Range("B7").Select
    Selection.Cut
    Range("A4").Select
    ActiveSheet.Paste
    Range("C7").Select
    Selection.Cut
    Range("A5").Select
    ActiveSheet.Paste
    Range("D7").Select
    Selection.Cut
    Range("A6").Select
    ActiveSheet.Paste
    Range("E7").Select
    Selection.Cut
    Range("A7").Select
    ActiveSheet.Paste
    Sheets("1951-1960").Select
    Sheets("1951-1960").Move
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\december\dec_dec_1951_2010\1951_1960.txt" _
        , FileFormat:=xlText, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

End Sub
```

APPENDIX J: MACRO TO GATHER VARIOGRAPHY PARAMETERS

```
Sub variography()
'
' variography Macro
' Variograms by month
'
' Keyboard Shortcut: Ctrl+Shift+V
'
    Sheets("Hoja1").Select
    Sheets("Hoja1").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\january"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\january\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja2").Select
    Sheets("Hoja2").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\february"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\february\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja3").Select
    Sheets("Hoja3").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\march"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\march\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja4").Select
    Sheets("Hoja4").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\april"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\april\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja5").Select
    Sheets("Hoja5").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\may"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\may\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja6").Select
    Sheets("Hoja6").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\june"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\june\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
```

```
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja7").Select
    Sheets("Hoja7").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\july"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\july\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja8").Select
    Sheets("Hoja8").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\august"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\august\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja9").Select
    Sheets("Hoja9").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\september"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\september\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja10").Select
    Sheets("Hoja10").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\october"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\october\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja11").Select
    Sheets("Hoja11").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\november"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\november\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

    Sheets("Hoja12").Select
    Sheets("Hoja12").Move
    ChDir "C:\Users\Nova\Desktop\set_1951_2010\december"
    ActiveWorkbook.SaveAs Filename:= _
        "C:\Users\Nova\Desktop\set_1951_2010\december\dt4_resumo_variografia.csv" _
        , FileFormat:=xlCSV, CreateBackup:=False
    ActiveWorkbook.Save
    ActiveWindow.Close

End Sub
```

APPENDIX K: CODE IN R (AUTOFITVARIOGRAM)

```
#Working Directiry
setwd("~/Decades")

#Loading packages
require(openxlsx)
require (automap)

#Import data
library(openxlsx)
dataset = read.xlsx("/Users/juliavelastegui/Decades/1951_1960.xlsx", sheet="decade1", startRow = 1, colNames
= TRUE)

#Variogram fitting
coordinates(dataset) =~ coordx+coordy
variogram = autofitVariogram(value~year,dataset,model = "Exp",fix.values=c(0,NA,NA),dX=.5)
plot(variogram)
```