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THE LONG-TERM TEMPERATURE TIME-SERIES OF CENTRAL BELGIUM (1767-1999)

„*No sustainable development is possible without knowledge of the past*"
Thomas McGovern, North Atlantic Biocultural Organization coordinator

Abstract: The paper describes in a concise way the sources of historical climatology. It discusses further the early instrumental meteorological observations in Belgium, among them, those records which were thereupon used in the European Union's IMPROVE project to produce the daily Central Belgian Temperature (1767-1999) time-series. This series enables to better assess the climatic variability over a 230-year time span in Belgium.

Key words: temperature, Central Belgium, long-term series, IMPROVE project.

1. The Sources of Historical Climatology

The late H.H. Lamb (1972), the well-known British climatologist and meteorologist (1913-1997), was among the pioneers of phrasing climatic research by the motto

„*Past, present, and future climate*"

In this way, Lamb stressed the importance of the knowledge of the past climate, the monitoring of the present climate and the forecast/prediction of the future climate. The tools for historical climatology are historical sources or documents. The documents currently used, are annals or chronicles (for the West-European region since the 8th century), brief annotations in parish registers, or notes in newspapers (from the 16th century onwards), or clerical sources (bookkeeping registers, reports and inquiries at the occasion of natural catastrophes), as well as meteorological diaries.

A critical catalogue of medieval climatic data for West-Europe was produced by Pierre Alexandre (1987). More recently, Jan Buisman (1995), has started publishing „One Thousand Years of Weather, Wind and Water in the Low Countries", of which already three volumes are published with Aryan van Engelen as the Editor. In contrast

to the more scholarly approach of Alexandre, the latter author presents comprehensive material in a lively way and is therefore more accessible for a broad public. Furthermore, the climatic information filtered by the method of source analysis can be combined into a time-series; then, statistical analyses can made inferences about climatic changes (Buisman 1995; van Engelen 1995; Yan, Alexandre, Demarée 1997; Ogilvie, Farmer 1997; Pfister 1999).

2. The Instrumental Meteorological Observations

The main meteorological instruments were invented at the end of the 16th century but underwent considerable development in the course of next centuries. The first thermometer was constructed around 1590 by Galileo Galilei and the barometer by Torricelli in 1643 (Maracchi 1991; Moberg, Demarée 1999).

In France, following outbreaks of epidemics in the 1770s, the neo-Hippocratic hypothesis according to which the physical affections are directly connected with the weather, became a leading idea in medicine. In 1776, a Correspondence Society for Epidemics was founded at Paris. The Society strove to unravel the hypothesized links between the quality of the air and the state of human health, this is, between weather, climate, health, location and to a lesser extend the environment (Hippocrates 1800; Demarée 1996). Rapidly, the *Société Royale de Médecine*, also established in 1776, founded a nationwide medico-meteorological network and a large meteorological enquiry took place from 1778 till 1794 (Desaive et al. 1972). Several prominent Belgian physicians, among them Jean Demeste at Liège, J.B.L. Planchon at Tournai, Robert de Limbourg at Theux, N.F.J. Eloy at Mons, and the agro-meteorologist, E.-J. de Poederlé, took part in this endeavour and medico-meteorological reports were sent to the General-Secretary Felix Vicq-d'Azyr in Paris.

In 1780, the Elector, Carl Theodore, founded the Palatine Meteorological Society at Mannheim (Traumüller 1885). The Society established a worldwide network of meteorological stations, most of them in Europe, but also in North America, in Greenland, as well as in the tropics, like at the Isle of Bourbon (now named La Réunion). In eastern Europe, the stations of Sagan (now Żagań in Poland), St. Petersburg, Moscow, and shortly Pychminsk (near Perm) in the Ural mountains, reported to J.J. Hemmer, secretary of the Palatine meteorological society and editor of the Ephemerides.

The 18th century instrumental meteorological observations are of utmost importance for climatic change studies since they allow for calibration of historical climatological information which spans a much larger period. Although during the 18th century, the meteorological instruments were steadily improving, it remains a difficult task to compare 18th century observations with those of the second half of the 19th and of the 20th centuries.

Besides the instrumental differences, the observational procedures were not standardized (hours of observation, the number of observations per day, thermometers hanging at a northerly exposed wall). Moreover, it frequently occurs that long-term daily observational records are lost, or that only a maximum and a minimum value of

a climatological variable per month, or even worse, the arithmetic average of those two data, are known. In the latter case, all statistical inferences and the elaboration of time-series are excluded.

3. The Ancient Instrumental Meteorological Observations in Belgium

The earliest known instrumental climatological reading in the meridional Low Countries is an isolated thermometer datum at Namur during the remarkable cold winter of 1708-1709 (Galliot 1790; Mann 1792):

„Le froid qui s'étoit fait sentir dès la veille des Rois [5 January] ... La Meuse fut gelée à Namur à 5 pieds [1.62 m] de profondeur. Le thermomètre de Réamur fut à 15 degrés et un quart [-19°C]."

It is Abbott Jean-Baptiste Chevalier (1722-1801) who is generally credited to have carried out, from 1763 onwards, the first instrumental meteorological observations in Belgium. However, several naturalists did precede him but their observations are considered as being lost.

The earliest long-term daily instrumental records presently known at the moment belong to Guillaume-Lambert Godart (1721-1794), a physician at Verviers. His account books of medical consultations contain daily morning meteorological observations of temperature, atmospheric pressure, wind direction and state of the sky for the period from January 1767 till February 1794 (Demarée 1990, 1993). For this reason, G.-L. Godart is duly recognised as the deacon of the Belgian meteorologists. Godart was a scion of a rich textile bourgeois family which exported even to Gdańsk as can be witnessed in the account books. As a physician and natural scientist, Godart published in the leading scientific journals of his time.

Baron Eugène-Joseph de Poederlé (1742-1813), a well-known botanist and probably motivated by the estimates of agronomical yields, carried out meteorological observations over a long-lasting period covering the end of the *Ancien Régime* and the French era in Belgium. These observations are done at his manor in Saintes (south of Brussels) in Summer and at Brussels in Winter. Extracts of his meteorological observations are published in newspapers in France and in Liège. De Poederlé maintained close contact with Father Louis Cotte (1740-1815), one of the leading meteorologists of his time. Fortunately, his manuscript with daily meteorological observations for the years 1785, 1786 and 1787 is kept at the Royal Library *Albertina* in Brussels. It constitutes a precious overlap and even a completion when the Brussels series of the Palatine Meteorological Society presents deficiencies in various ways.

A great impetus was given to sciences in the Southern Low Countries when the Imperial and Royal Academy of Brussels founded by the Empress Maria-Theresia in 1773, accepted to participate in the work of the Palatine meteorological Society. Firstly, J.B. Chevalier, and afterwards Theodore Augustin Mann (1735-1809), were charged to carry out the programme of meteorological observations. Within the Academy several

scientists were carrying out meteorological observations. Unfortunately, the intellectual activity diminished with the start of the revolutionary period in 1789, and ceased completely later on when the French abolished the learned societies of the *Ancien Régime*.

With the avenge of the 19th century, when Belgian was a part of the French Empire, a new branch of sciences, the statistical sciences, made its entry. Among the statistical data of a country, information related to the topography, the territorial divisions, the climate, the meteorological phenomena and the reigning illnesses, are listed. The French botanist and meteorologist Lamarck developed the meteorological aspects in the „*Annales de Statistique*", a journal edited by L.J.P. Ballois. Within the same framework, the Minister of the Interior, Jean Chaptal, requested the prefects to collect meteorological information within their departments.

The prefects of the nine Belgian Departments made efforts to implement the request. In a first instance, they transmitted the request to the professors of physics at the Central Schools in their county-towns. Several „*Mémoires statistiques*" of the Belgian Departments contain meteorological information. Unfortunately, these initiatives remained often too short-lived, the results too concise and dealing with a short-term period in order to matter scientifically. Furthermore, the daily records are mostly not preserved.

It remains a difficult enterprise to bridge the gap of meteorological information during the French (1794-1815) and the Dutch (1816-1830) eras. The manuscripts of the bourgeois Guillaume Schamp (1764-1846) at Gent, of the French printer Louis Antoine Charles Le Poitevin de la Croix (LPX) (1739-1839) at Antwerp, and of the physician Victor François (1790-1868) at Mons, Hainault, provide highly interesting daily meteorological information but, unfortunately, do not allow us to cover the entire period. Daily meteorological records carried out by LPX, being also head of the customs office in the harbour of Antwerp, were published in the newspaper „*Journal du Commerce d'Anvers*". This initiative is demonstrative of a mercantile and maritime interest in meteorology.

At last, the gap from the French and Dutch era to the beginning of the modern instrumental data of Quetelet could be bridged using the long-term record of the meteorological observations by the florist Simon Veen at Haarlem in The Netherlands (Geurts, van Engelen 1992). The distance from Haarlem to Brussels is approximately the same as from Brussels to Verviers. The climate at Haarlem is somewhat more maritime while the climate at Verviers is more continental, the Brussels climate being in the middle.

4. The Modern Meteorological Observations in Belgium

It is an acknowledged fact that the modern era of meteorological observations started on January 1st, 1833, date at which Adolphe Quetelet begun his climatological observations at the Royal Observatory of Brussels (Vincent 1901/02/03; Malcorps 1994; Alexandre, Denoyelle 1996; Quiet 2000). These observations are continuing until today in spite of a certain number of changes. Around 1890, the Royal Observatory

moved from its location at the Schaerbeek Gate, more and more perturbed by the development of the town of Brussels, to the Plateau of Uccle, south of Brussels. At that time, the latter side was an open area swept by the winds, with very few constructions in its neighbourhood. Today, it is part of a residential area certainly influenced by the urban heat island of Brussels. A correction which would take into account this development could be made, comparing climatological data from the station of Uccle with those of a rural site (Vandiepenbeeck 1998).

5. Preliminary Results of the IMPROVE Project

The European Union Project IMPROVE (Improved Understanding of Past Climatic Variability from Early European Instrumental Sources), co-ordinated by Prof. Dario Camuffo at Padova, Italia, to which several European Climatic Research Units have collaborated, had the aim to construct long-term daily meteorological time-series. The Belgian participants were the Royal Meteorological Institute of Belgium and the Department of Medieval History at the University of Gent, Belgium. All constructed European time-series within the framework of the IMPROVE Project start in the 18th century.

As has been shown already above, it will be impossible in Belgium to construct a time-series consisting at one single location like various other participants were doing. Therefore, a Central Belgian Temperature (CBT) time-series is considered combining pieces of sufficient long-term and partly overlapping records. All data of the time-series are reduced to the present conditions and observing procedures at the Plateau of Uccle. The 19th and 20th centuries part of the Brussels time-series consists, of course, of the daily maximum and minimum temperatures observed at Brussels and at Uccle. In particular, François' observations at Mons (1818-1838), long-term records of Simon Veen at Haarlem, The Netherlands, from 1788 till 1841, and finally Godart's observations at Verviers (1767-1794), allow for the reconstruction of an unique CBT time-series since 1767 (Geurts, van Engelen 1992; Verhoeve et al. 1999; Lachaert, Thoen 1999).

This time-series, a true innovation, describes the long-term daily history of the Belgian climate whereas until now, at the most, one-hundred and sixty five years were available at a monthly time-basis. The new time-series will allow for a more precise assessment of climatic events like the occurrence and frequencies of hot and cold spells, the number of days with a maximum temperature above 25°C, or < 0°C, the number of days with a minimum temperature < 0°C, etc. The time-series will allow also for assessing the changes in these frequencies, and hence provide first-class information on the long-term climatic variability.

Figure 1 represents the annual minimum temperature since the year 1767 based upon daily temperature data as well as the annual maximum and mean temperatures since 1794 also based upon daily temperature data. The daily mean temperature is defined as the arithmetic average of the daily maximum and minimum temperature.

The minimum temperatures of the 18th century are among the coldest of the whole time span of the nearly 250 years. In the 19th and 20th centuries several distinct

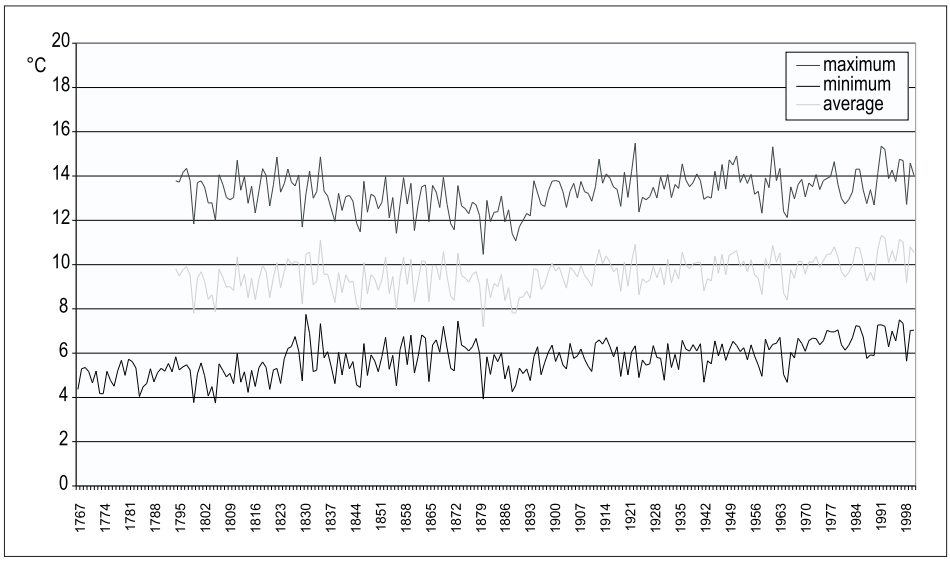

Fig. 1. Yearly averages of the maximum, minimum and average air temperature at Brussels under the present day conditions at the Plateau at Uccle over the time span 1767-1998.

periods are noticed. The first three decades of the 20th century, the maximum temperature is high while the minimum temperature rises and reaches levels comparable with the present values. It follows more or less a temperate period from 1833 onward till the 1880s, followed by a very cold period in the 1880s and 1890s, and finally by a slow temperature rise in the 20th century and finishing with the present warm state of the climate. The increase in temperature is mainly due to the increase in the minimum temperature since the early 20th century, and to a lesser degree, to an increase in the maximum temperature.

Climatologists, following the work of the IPCC (Intergovernmental Panel on Climatic Change), define this warm epoch as the greenhouse climate of the 21st century. The question to be answered is to know if the present warm signal is an integral part of the natural climatic variability or not, or to which extent. A potential key to answer this pertinent question is contained in the approach of the historical climatology.

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