Geophysical Research Abstracts,
Vol. 11, EGU2009-8129, 2009
EGU General Assembly 2009

A method to estimate daily maxima and minima from single daily surface air temperature readings

M. Andrighetti, M. de Franceschi, and D. Zardi
University of Trento, Civil and Environmental Engineering, Trento, Italy (Dino.Zardi@ing.unitn.it, +39 0461 882672)

A problem specifically affecting temperature series obtained from measurements taken before the introduction of modern standards about observation timing and instruments (e. g. maximum and minimum thermometers, Middleton, 1969) is the availability of only one single daily observation, often taken at varying hours (described e.g. as "one hour after sunrise"). The present work proposes a method to estimate daily temperature maxima and minima when only such single daily readings are available, taking advantage of all the available information.

Indeed in many cases the observers used to record at least the daily hour at which measurements were recorded, but nevertheless the effective diurnal timing of measurements has to be reconstructed if the adopted timing system was an older one. This is the case of the Italian or French timing conventions which were adopted in Italy by various observers, often without explicitly mentioning which one was chose for the observations.

On the contrary, indications about the state of the weather at the time of observations were usually recorded as side information as well, which are a very useful reference to classify the days into some weather categories (Geiger, 2003). This is relevant for the estimation method presented in the following.

The method requires the availability of a representative diurnal temperature cycle (for each weather category), determined for instance on the basis of a sample of high frequency temperature measurement in the same area (of course, in more recent times) by suitable averaging over subsets taken from days falling within the same category, or by means of proper fitting procedures.

Based on linear regression, a best fit line is obtained, which provides the basis for the relationship between the single-hour reading and daily extremes: the regression parameters provide the basis for the evaluation of maxima and minima from single daily readings. Furthermore, the method provides also an estimate for the intrinsic error of the estimate.

A preliminary application of the method to the series of data from temperature measurements taken in Verona (Italy) from 1768 to 1774 by Giuseppe Maggi is presented. Maggi used to be lecturer in the Military Academy of Verona in the castle of Castelvecchio, where he used to take daily measurements from the main tower. In his records he used to write every day the main meteorological variables, such as air pressure, temperature, wind direction, precipitation, water level in the Adige river and the state of the weather (Andrighetti et al., 2008). For air temperature he used the mercury-in-glass thermometer made by A. M. Lorgna for previous measurements at the same premises (Lorgna, 1765). The registers of observations also reported that he used to take measurements at sunrise: as previously mentioned, this is a very important piece of metadata in order to infer daily temperature extrema. Indeed the hour of sunset can be easily evaluated for each day of the year through suitable algorithms (Bird and Hulstrom, 1981). The notes about the state of the weather recorded by Maggi allow to classify the days of his dataset in three main categories (namely fair weather, partly overcast and overcast) for each season, resulting in a total of 12 subsets containing homogeneous days so as to weather and season.

Starting from recent (2003-2006) time series of air temperature taken every 1 min in Verona, suitable average daily cycles have been evaluated for each of the above subsets. Comparison of each daily cycle with the corresponding average cycle provides useful information about deviation of that cycle from the average.

In particular the differences between maximum and minimum temperature of each day with respect to the corresponding extrema of the average cycles has been evaluated, as well as similar differences between the temperature

at a given hour between the single daily cycle and the average. Suitable linear correlation between the above differences can be evaluated by scatter plot and best fit lines. The resulting slope and intercept, along with their uncertainties provide the coefficients for the algorithm that allows to estimate extrema starting from a single daily reading taken at a known hour.

REFERENCES

Andrighetti, M., Zardi, D., de Franceschi, M., 2008, History and analysis of the temperature series of Verona (1769 – 2006), Meteor. Atmos. Phys. (in press).

Bird R. E., Hulstrom R. L., A simplified Clear Sky Model for Direct and Diffuse Insolation on Horizontal Surfaces, Solar Energy Research Institute, 1981.

Geiger R. et al., The Climate near the ground, Rowman & littlefield publishers, inc., Oxford, United Kingdom, 2003.

Lorgna A. M., Della graduazione de' Termometri a Mercurio, e della rettificazione de' Barometri semplici: Dissertazione di A. M. Lorgna, Professore di Matematiche nel Pubblico Collegio Militare di Verona. Stamperia di Marco Moroni, Vol. IV, pag. 70. Verona 1765.

Middleton W. E. K., Meteorological Instruments, Johns Hopkins Press, Baltimora, 1969.