

## CS8 - Time series information

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### Background

Datasets including long time series of meteorological variables form the basis for studies into climate change and its effects. Unfortunately those datasets are scarce. This especially holds when one is interested in extremes because these require high quality data. The Netherlands is one of the few countries for which data of sufficient length and spatial and temporal resolution are available. However, a large proportion of the data is only available as hard copy and therefore not readily available to researchers and the wider public. The CS8 project aims to rectify this situation. In CS8 three data sources are being digitized, checked for quality and, where necessary, homogenized. Relevant statistical parameters are also determined and used to describe the present climate, including extremes.

### Data sources

#### Daily rainfall 1850-1950

KNMI measures daily rainfall since about 1850. In the 1850-1950 period, the network gradually increased to its present density of about 300 rain gauges. The measurements are taken by voluntary observers every morning. In the first decade of the 20<sup>th</sup> century a standardization of the measurements was implemented. In contrast to the post-1950 period, where all observations are digitally available, only about 10% of the observations were digitally available in the 1850-1950 period. In the years 2005 and 2006 we digitized all pre-1951 daily data, amounting to about 4.7 million observations (13500 station-years). It took two man-years of typing in the data. The data will become available in 2008 after quality control and homogeneity testing.

#### Rainfall strip charts and paper rolls

Self-recording rain gauges (Figure 1) have been applied for continuous rainfall measurements at a selected set of KNMI stations since the end of the 19<sup>th</sup> century. At first, rainfall was recorded on daily (Figure 2) and sometimes weekly



Figure 1. Example of a self-recording rain gauge (without lid).

rainfall strip charts.

Thereafter, from about 1980 through 1993, paper rolls were used to register rainfall for about 10-20 days per roll. From 1994 onwards, rainfall measurements are transferred electronically and operationally stored at 10-minute resolution (for some selected stations at 1-minute resolution). Until now, the strip charts and paper rolls have been used mainly for extracting hourly values. In infrastructural design (e.g. sewer systems, tunnel drainage) there is, however, a need for long rainfall series with much higher resolution than 1 hour. Fortunately, the charts and rolls can be used to extract rainfall with a time resolution of about 5 to 10 minutes.

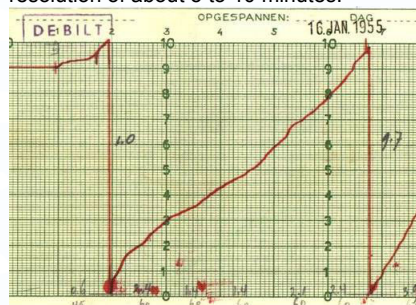


Figure 2. Part of the daily rainfall strip chart of De Bilt of 16 January 1955.

We are developing a procedure that largely automates the labor-intensive extraction work for rainfall strip charts and paper rolls. Although developed for rainfall, it can be applied to other elements as well. The procedure consists of four basic steps: (1) scanning of the charts and rolls to high-resolution digital images, (2) applying automatic curve extraction software in a batch process to determine the coordinates of cumulative rainfall lines on the images, (3) visually inspecting the results of the curve extraction, (4) post-processing of the curves that were not correctly determined in step (3). Although KNMI is still perfecting the software, several tens of station-years have successfully been digitized. The time resolution is about 5 minutes. In total 321 station-years are being digitized using the stations De Bilt, Eelde, Den Helder/De Kooy, Vlissingen, Beek and Amsterdam. When the digitisation is completed, the number of station-years with digital 5-minute rainfall series will be increased by a factor of 25. The data will become available in 2009.

#### Pre-1850 meteorological measurements

We are also digitizing part of the old pre-1850 measurements in the Netherlands. Figure 3 shows an example of an 18th century hardcopy data source available in the archive of KNMI. The digitisation of this kind of data is a labour-intensive. The data

is digitised by making an electronic copy (jpeg-images), which is used to type the data into a spreadsheet. Both the images and the data are made accessible via the internet after quality control.

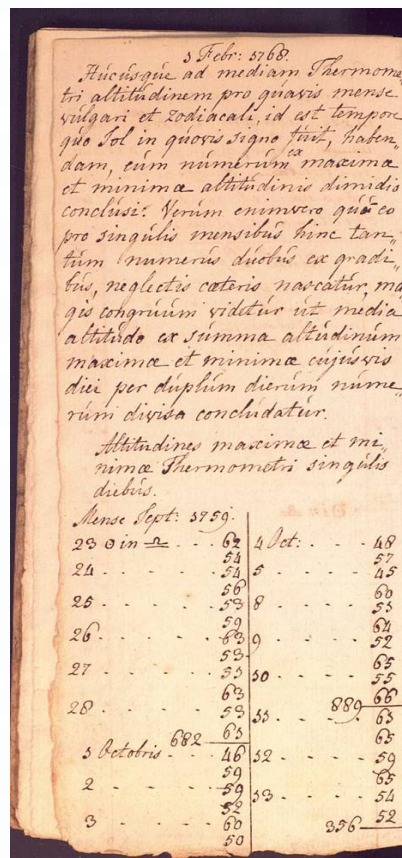


Figure 3. Example page from the weather diary of Jan Carel van der Muelen. The weather observations (partly in Latin) and measurements are taken partly in Utrecht and partly in Driebergen and cover the period 1759-1810.

## Results

The project produces new datasets of historical climate data which at the moment are only available as hard copy documents. The datasets contain long series of high-resolution observations from a dense network in the Netherlands. The new datasets will be used in the CS6 and CS7 project for model evaluation and as baseline climate. The datasets will be made available free to everyone. Where relevant, they will be linked to the corresponding modern digital data in the Netherlands. The goal is also to make the latter datasets freely available, particularly for the scientific and impact communities in the field of climate change and its consequences.