Data quality of free of charge climate datasets: A comparison of NOAA temperature and precipitation data with validated sources

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Abstract

Many researchers have underpinned global climate change affecting especially spatial-temporal changes in precipitation and temperature in the Alps. However, the variability among the degree of changes is as high as the diversity of the datasets available. This paper explores precipitation and temperature datasets available from different sources: free of charge NOAA NCDC (National Oceanic and Atmospheric Administration, National Climatic Data Center) are compared with validated datasets from ZAMG (Austrian Weather Service), Austrian hydrographical surveys, data from the Ministry of Life Science, WorldClim (Global Climate Data), Histalp (Historical Instrumental Climatological Surface Time Series of the greater Alpine Region), HAÖ (Hydrological Atlas of Austria). Having pre- and post-processed the datasets, we use a spatial database to compare the data sources. Analysis have been done on datasets come from equal or closely related stations on a daily, weekly, monthly, and yearly basis. As a result, we conclude that free of charge datasets might be considered for e.g. climate change impact analysis and to be integrated in hydrological models, but one need to take into account the restrictions outlined in this paper.

Keywords: GIS, climate change, Alps

1 Introduction

Analysing the past climate change referring to changes in temperature and precipitation values are necessary to understand and to underpin climate change (Solomon et al., 2007; EEA, 2009). Global climate change impacts on water resources have been reported by numerous researchers (OECD, 2007). The most well-known climate change references on a global scale are the IPCC reports (Solomon et al., 2007) and the Millennium Ecosystem Assessment (Hassan et al., 2005). Even more dramatic are the reported climate induced changes on hydrology in the European Alps, with increasing temperatures twice the global average since the last century (EEA, 2009; Beniston, 2005; OECD, 2007). Local examples from Austria report on decreasing groundwater recharge of 25% within the last 100 years (Harum et al.,

2007). Also in Slovenia the measure of incoming and outgoing water is in a decreasing trend (Brancelj, 2009).

Even though for instance NOAA and HISTALP provide datasets for free of charge, there is still a lack of available data (Alpine Conference Action Plan, 2009) and the quality of the data is often uncertain and the pre-and post-processing steps of the real measurements a black box. Since present hydrological modeling tools and future climate change predictions rely on available datasets, we compare available climate parameters from different sources from equal meteorological stations or stations very close to it. We form the hypothesis that the daily measurements at one unique station but datasets coming from different sources share the same value or very close measurements. As a conclusion we will answer our research question about « How good perform the free of charge NOAA datasets in comparison to validated datasets from national data providers? » As a consequence we decide whether or not to use these datasets for spatio-temporal water scarcity analysis in the Alpine environment.

2. Methods

2.1 Data collection

The NOAA repository (http://gis.ncdc.noaa.gov/geoportal/) is a worldwide data pool, intending free and unrestricted access for research purposes, education, and other non-commercial activities for altogether 18 surface meteorological parameters (including temperature and precipitation). Historical data are generally available for 9000 stations from 1929 to the present, while data from 1973 to present is almost complete for every station.

The HISTALP database consisting of monthly homogenised temperature, precipitation and other records (air pressure, sunshine, etc.) for the Greater Alpine Region (Auer et. al, 2005) The longest temperature series extend back to 1760, precipitation to 1800. This dataset is a collection of quality improved, long-term instrumental climate data freely available (http://www.zamg.ac.at/histalp/).

The third used dataset in this study is the validated national Austrian Weather Service (ZAMG).

2.2 Statistical Analysis

For the analysis we used a free programming langue and software environment for statistical computing. R is widely used for statistical software development and data analysis.

An evaluation of the quality of the freely available (NOAA, HISTALP) datasets was carried out by comparing the daily measured values and the weekly, monthly, and annual average values against the daily measured ZAMG values and against respectively aggregated values.

3 Results

Having analysed the different datasets we achieved two main results as outlined in the following chapters.

3.1 Comparison between daily values of the ZAMG and NOAA datasets

In the first step we analysed the daily measured values between the same meteorological stations but data acquired from two different data providers: ZAMG and NOAA. As an example shown in Figure 1, the Salzburg Airport station (USAF ID Number 11150; lat: 47.80139, lon: 13.00167) shows some considerable differences up to one degree Celsius. The density of the two series is similar with little differences (Figure 2). Maximum and minimum values are more frequent in the ZAMG series. A difference larger than 2 °C is rare. For most of the months the mean difference are between 0.2 - 0.7 °C. As an example, Table 1 provides the summary statistics for September 2004.

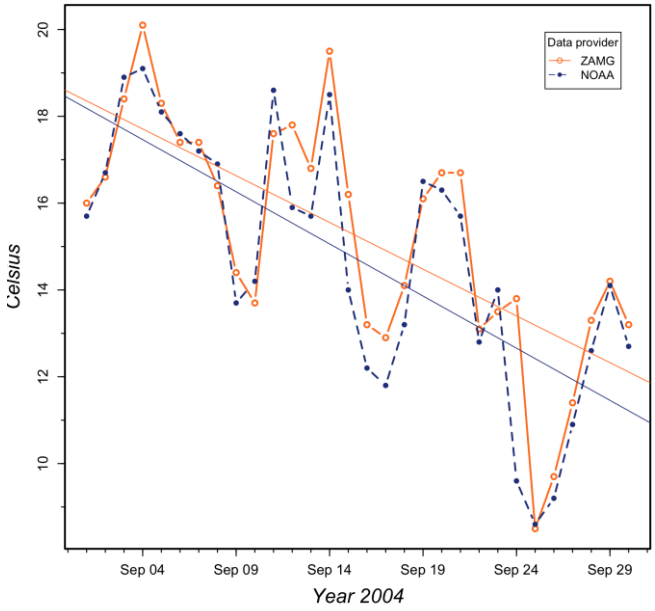

Figure 1. ZAMG vs. NOAA datasets at Salzburg airport

Table 1. Monthly mean values from NOAA and ZAMG for September 2004 at the station Salzburg airport

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
ZAMG	8.50	13.35	16.05	15.23	17.25	20.10
NOAA	8.60	12.72	14.95	14.70	16.85	19.10

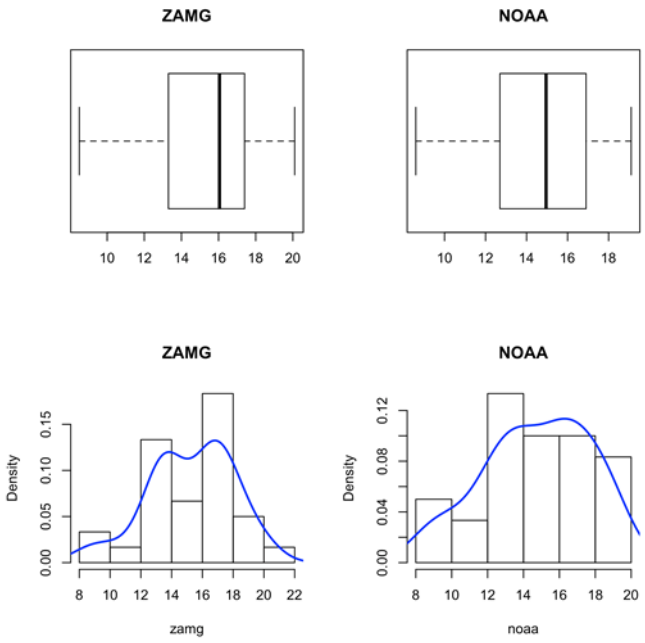

Figure 2. Boxplot and histogram results for 2004 September

3.2 Comparison between annual values of the ZAMG and HISTALP datasets

Because the HISTALP data is available only on a monthly basis we aggregated monthly and annual mean values in the ZAMG dataset. Analysing the annual temperature between the ZAMG and HISTALP we chose the same station (Salzburg Airport). The differences are larger compared to the daily-based comparison. The annual average temperature changes between 1981 and 2004 are depicted in Figure 3. The figure shows that the trends of the significant increasing temperature are stronger and the values are 1 °C Grad lower with the HISTALP data for most of the year. In terms of the increasing temperature trend, the daily NOAA series show a less significant increasing trend of approximate 0.5 °C. In contrast, the HISTALP series show an increasing trend of more than 1 °C considering the last 20 years.

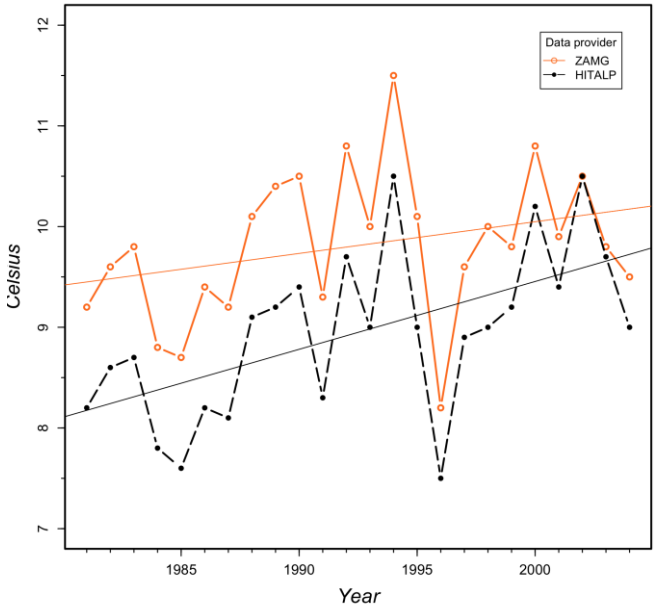

Figure 3. Annual mean temperatures for the Salzburg Airport meteorological station

4 Conclusion

As the results clearly show, the differences between the datasets from different data providers at one and the same meteorological stations are obvious. It was predictable between the NOAA and HISTALP because of the homogenisation of HISTALP data but unexpected for the same NOAA and ZAMG meteorological station for the same day.

The degree of the difference between the ZAMG and HISTALP annual mean temperature values for time interval chosen as example is around 1 °C.

Highlighting the benefits of daily resolution of and the less variance from the ZAMG data we expect that the NOAA climate time series are adequate for the potential use in climate change impact analysis on the hydrological cycle. The potential use of this dataset are promising but more study is needed to analyse the correlation between different datasets at a different time interval and place.

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