EXPLORING PAST CLIMATE VARIABILITY IN THE GREATER ALPINE REGION

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Abstract: The presentation discusses the potential, the needs and the state of the art of climate variability data quality and analysis in the instrumental period. The greater alpine region is used as an example. Problems and solutions concerning the non climatic noise in time series is discussed (the homogeneity and outlier problem) and some first results based on the new HISTALP datasets are shown

Keywords: climate variability, instrumental period, data quality, Greater Alpine Region

During the past decade, the work of ZAMG's climate variability group has concentrated on data discovery, digitizing, quality improvement (homogenization, outlier correction and gap filling) in the "Greater Alpine Region" (GAR, 4 to 19deg E, 43 to 49deg N, 725.000km^2, 7 % of Europe). Thanks to intensive cooperation within international and national research projects (e.g. ALPCLIM, ALOCLIM, CLIVALP, ALP-IMP and others) but also thanks to a well established informal cooperation in the region, it was possible so far to create **high-resolution** (recent network densities 75 km (temperature) and 61 km (precipitation), **homogenized** (more than 1000 single inhomogeneities detected and removed), **outlier corrected** (several 1000 outliers detected and removed) and **gap-filled** (annual gap rate in the original data varying between 1 and 10 %) monthly **long-term** datasets (several series starting in the 18th century) for the climate elements temperature, precipitation and air pressure. Descriptions of the methods are given in e.g.: Aguilar et al., 2003, Auer et al., 2001, 2004, Böhm et al., 2001. Other elements like humidity, snow, sunshine and cloudiness are still under way. This presentation will focus on the three main climate elements. Other presentations of this session will describe other climate data and analysis activities in the GAR in which the "GAR-group" is involved (O7.1, E.1, E.4, E.6).

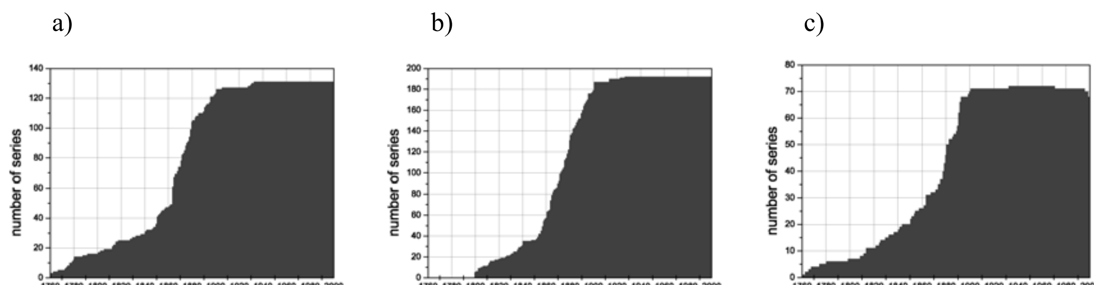

Figure 1. Temporal evolution of the HISTALP a) temperature, b) precipitation and c) air pressure networks 1760-2003 (timeseries of number of stations per year)

The GAR allows for studying the transition between three leading climate regions of Europe, Mediterranean – Atlantic – Continental. The transition from Mediterranean to the north is most accentuated here through the barrier of the Alps. Compared with the typical series of global coverage (starting not before 1850, in most cases for 20th century only or even shorter) the GAR provides another 100 years of early instrumental data in high quality (Fig. 1). All series are kept in a database called HISTALP in station-mode (original and homogenized versions, for the latter see e.g. Fig. 2) as well as in a medium resolution grid-mode-1 (1 to 1 deg lat-long, relative to 1901-2000 average). A second high-resolution grid-2 (10min resolution, absolute values) is envisaged for temperature and precipitation. The precip-10min-grid2 will be introduced in the next presentation by Efthimiadis et al.

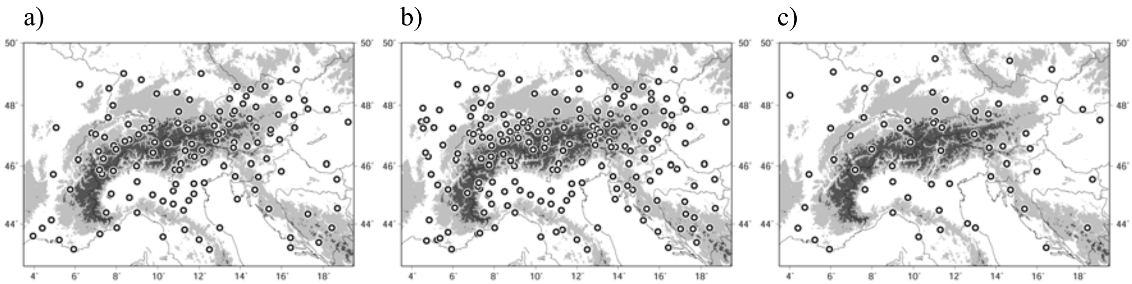

Figure 2. The recent HISTALP station-mode network in the GAR for a) temperature, b) precipitation and c) air pressure

Some selected results for temperature, precipitation and air pressure

For all 3 elements distinctive seasonally different evolutions are typical (e.g.: sharp recent wetting trends in autumn in the past 20 years, wet summers, autumns and winters versus dry springs in the 1800 to 1850 period, warm springs and summers versus cool winters near 1800, mild winters-cool summers in the 1910s, air-pressure seasonal features closely following those of temperature, some examples for temperature and precipitation are shown in Figs. 3 and 4).

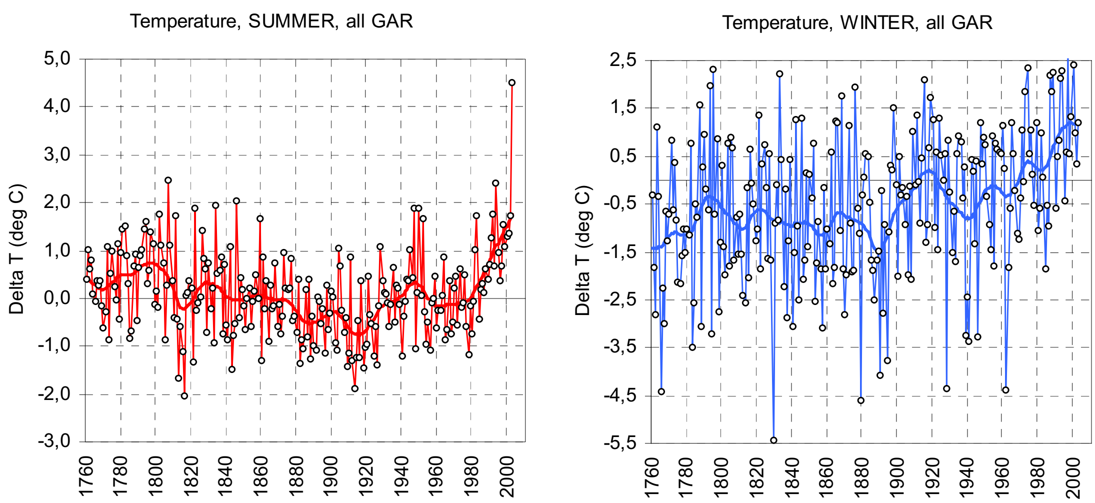

Figure 3. all GAR average temperature evolution 1760-2003 for summer (months 6to8, left) and for winter (months 12to2, right), single seasons and 30years low pass filtered, values are relative to 20th cent. mean

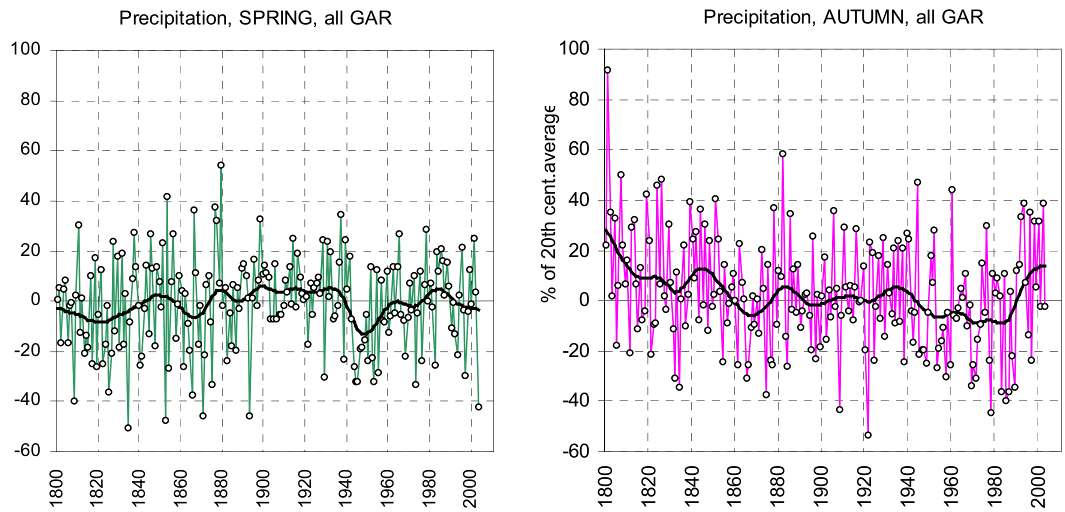

Figure 4. all GAR average precipitation evolution 1800-2003 for spring (3to5, left) and for autumn (9to12, right), single seasons and 30years low pass filtered, values are relative to 20th cent. mean in %

Concerning regional differences long-term temperature variability is regionally highly similar for the entire GAR: the Mediterranean parts not different to the Atlantic – continental sector, as well as a high similarity of high elevation (2000 to 3400m asl) vs. low elevation sites (Fig. 5). Long-term precipitation variability on the contrary shows several subregionally different features. Especially the Mediterranean part has sometimes even opposite trend signs versus the Atlantic subregion for several decades. Concerning interannual variability rotated EOF-based regionalisations produced 4 to 6 subregions – being typical also for different long-term precip-trends, not for temperature trends. Fig. 6 shows two regional examples of different annual precipitation trends.

The most striking regional air pressure differences are given for the low vs. high elevation subgroups (Fig. 7). Low elevation air pressure mimics air temperature very closely – thus indicating a strong respective advective forcing in the GAR. The stronger centennial air pressure increase of the high vs. the low elevation subgroup visible in Fig. 7 on the other hand has been used as an independent and "non-thermometric" proof for 19th-20th century warming of a "mean Alpine air column" in the region representative for the lower 3 km of the troposphere.

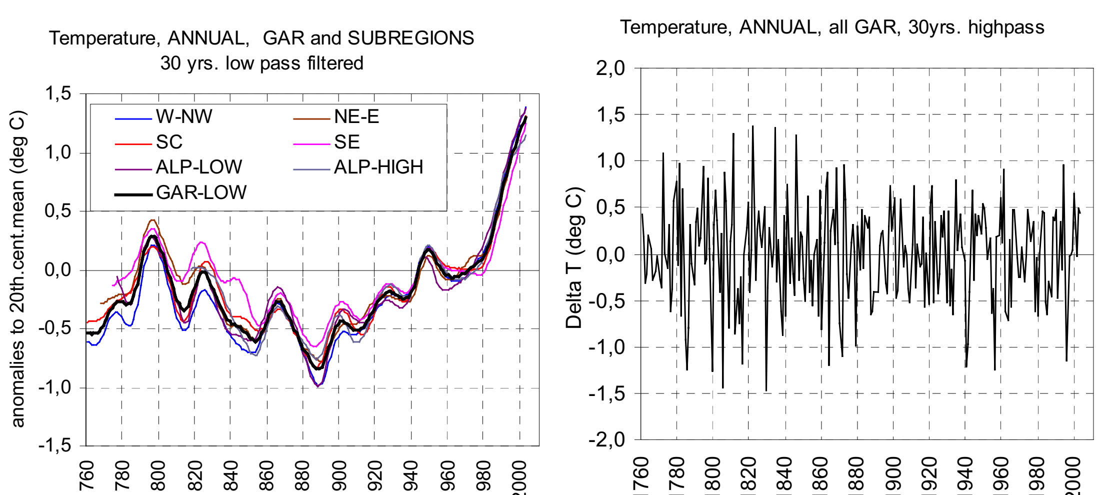

Figure 5. Smoothed subregional temperature series (left) and all GAR mean highpass (right) 1760-2003

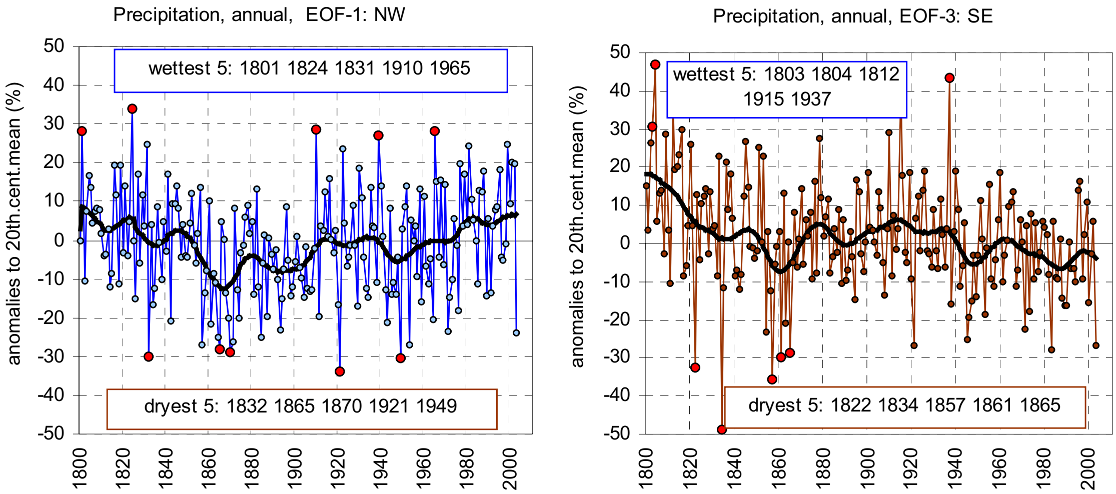

Figure 6. Subregional annual precipitation series 1800-2003 (single years and 30yrs. lowpass filtered)

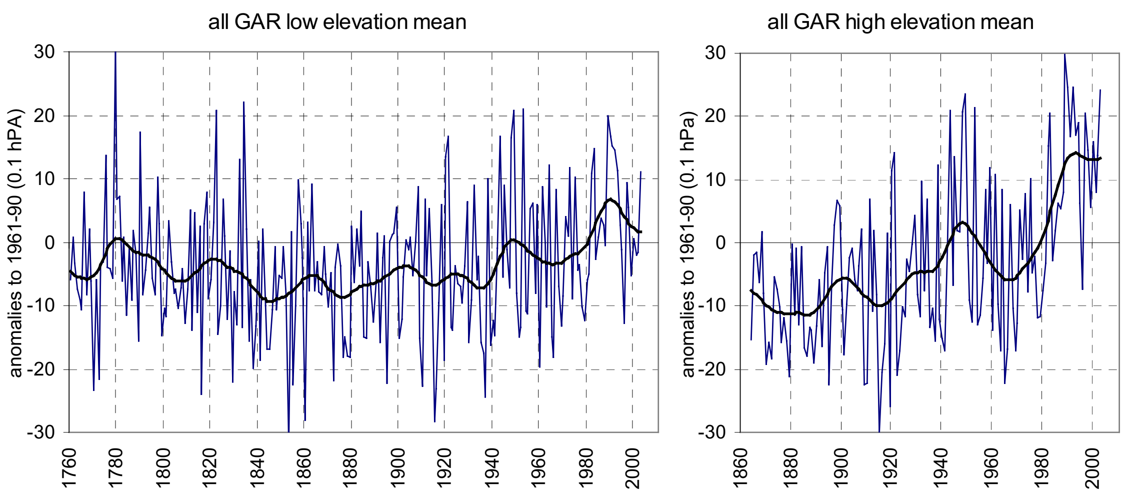

Figure 7. all GAR low (left) and high (right) elevation mean annual air pressure series (single years and 30yrs. lowpass filtered)

The extensive outlier detection and elimination work in the dataset (an interactive procedure based on monthly anomaly fields applied to each single month of the series) made them fit also to study an eventual increase of climate variability (based on time resolutions down to one month). In general the first analyses (based on detrended standard deviation time series in 30-yrs. moving windows) do not support this often heard argument in the recent climate change discussion. Temperature and precipitation series in the GAR typically show stable (precipitation) to decreasing (temperature) long term variability trends in all sub-regions of the GAR. Fig. 8 shows two examples, a 12 single series subset of temperature variability and a 36 series subset of precipitation variability.

We hope to have briefly illustrated the potential of the new HISTALP database of instrumental climate time series. The study region (GAR) well covers the northern border of the European Mediterranean – thus accentuating the typical features of mediterranean climate versus its northern neighbouring climates from Atlantic (NW) to Continental (NE).

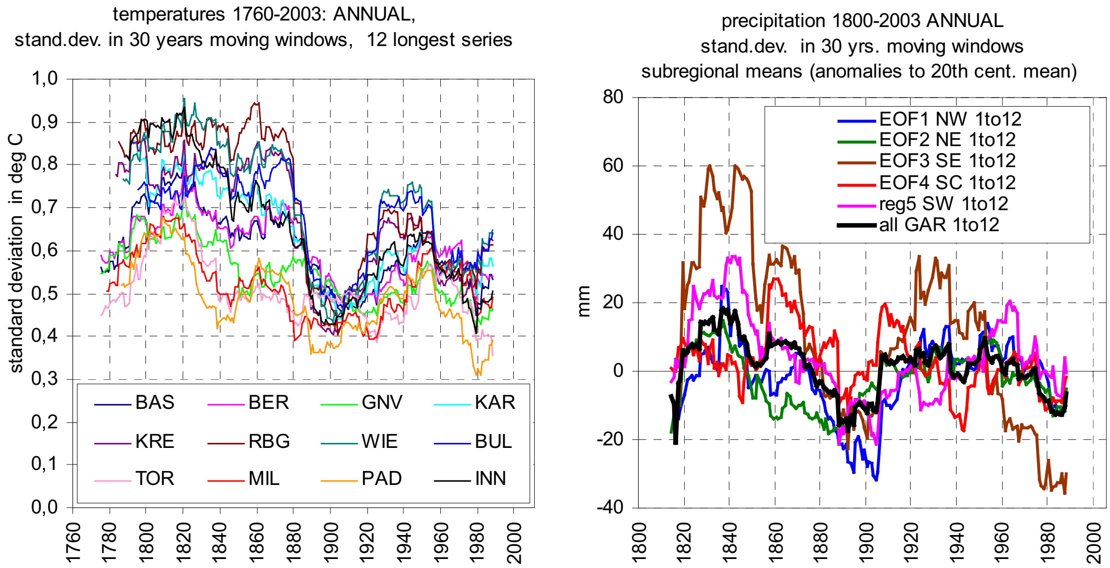

Figure 8. Has climate variability changed? Standard deviation series in 30years moving windows (after detrending through 30-yrs. highpass filtering) of annual temperature 12 longest single series, (left) and of annual precipitation (all GAR and subregional means, right)

In the near future a number of studies are planned which will concentrate on:

- the common analysis of different climate elements
- comparative subregional trend analysis in the GAR
- the vertical structure of climate variability (0 to 3400m asl)
- GAR-variability in the greater context of continental to global scale variability

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