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Reconstructing the climate of the 250 years of instrumental records at the northern border of the Mediterranean (the Alps)(*)

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Summary. — The paper provides a selection of first results based on a newly developed instrumental climate database for the European Alps and their wider surroundings. After an outline on data availability, network density, series durations and quality aspects some examples for the two main climate elements temperature and precipitation show some principal features of climate variability and trends in the region. Regional as well as seasonal differences are discussed. The overview closes with examples dealing with changes of climate variability: For temperature as well as for precipitation (the former stronger, the latter weaker and with regional modifications) inter-annual (-seasonal, -monthly) variability has not increased but decreased during the past two centuries of well-proved instrumental data in the study region.

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1. – Data aspects

During the past decade, the work of ZAMG's climate variability group (Ingeborg Auer, Wolfgang Schöner, Reinhard Böhm plus project-associates) has concentrated on data discovery, digitizing, quality improvement (homogenization, outlier correction and gap filling) in the "Greater Alpine Region" (GAR, 4° to 19° E, 43° to 49° N, 725000 km^2, 7% of Europe). It was possible so far to create *high-resolution* (recent network densities 75 km (temperature) and 61 km (precipitation), *homogenized* (more than 1000 single

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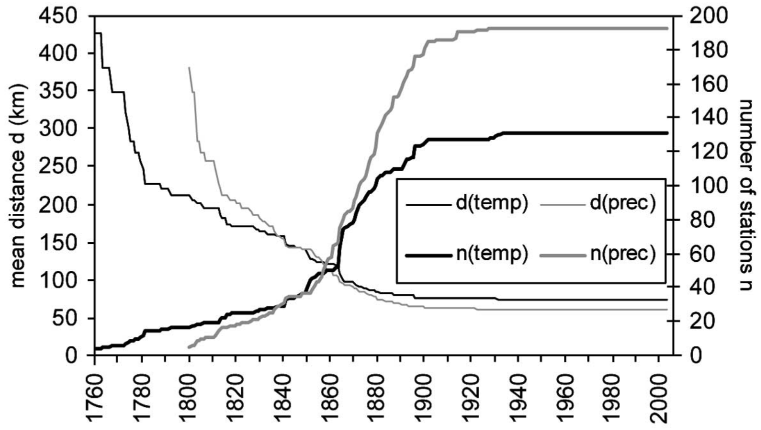

Fig. 1. – Temporal evolution of the HISTALP temperature and precipitation networks 1760-2003 (bold: number of stations per year, thin: mean network density.

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.*, [1-4]. Other elements like humidity, snow, sunshine and cloudiness are still under way.

The GAR allows to study the transition between three leading climate regions of Europe, Mediterranean-Atlantic-Continental. The transition from Mediterranean to the

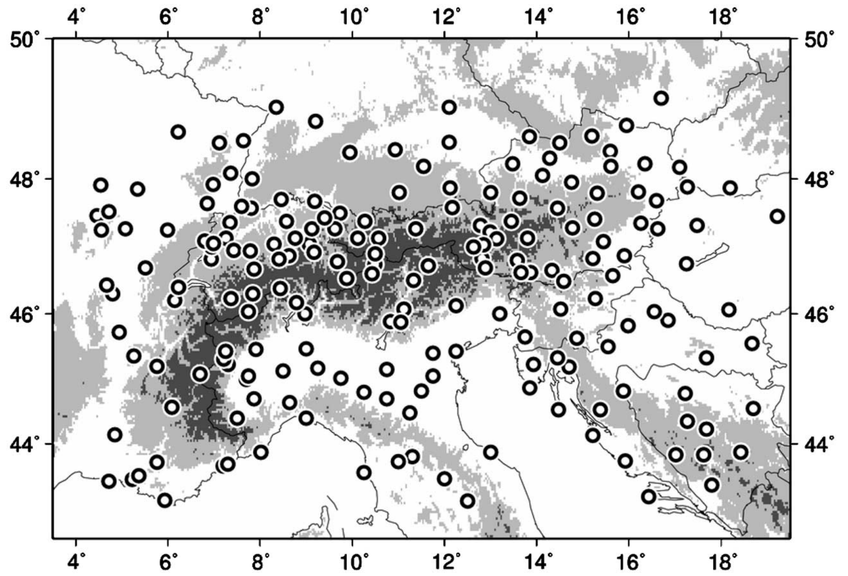

Fig. 2. – The recent HISTALP precipitation network in the GAR.

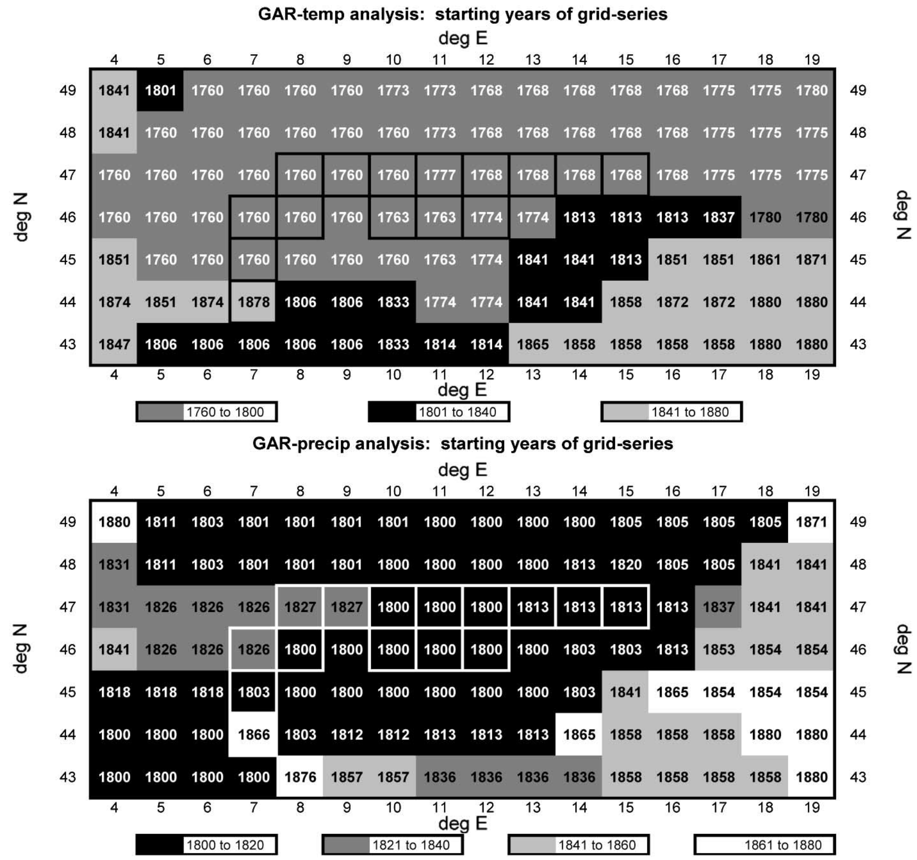

Fig. 3. – Starting years of the grid-mode temperature and precipitation series of HISTALP.

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 the 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 grid-mode (1 to 1° lat-long, relative to 1901-2000 average, for temperature and precipitation, see, *e.g.*, fig. 3).

2. – Some first analysis results

The following examples of first analyses on the HISTALP data-set deal with temperature and the precipitation variability in the region. For both 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 *vs.* dry springs in the 1800 to 1850 period, warm springs and summers *vs.* cool winters near 1800, mild winters-cool summers in the 1910s, some examples in figs. 4 and 5). 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

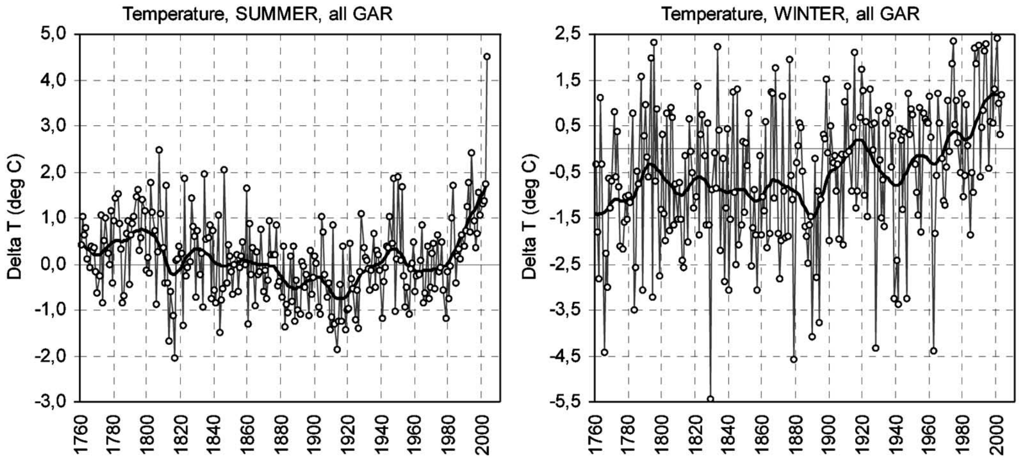

Fig. 4. – All GAR average temperature evolution 1760-2003 for summer (months 6 to 8, left) and for winter (months 12 to 2, right), single seasons and 30-year low-pass filtered, values are relative to the 20th century mean.

high similarity of high-elevation (2000 to 3400 m a.s.l.) *vs.* low-elevation sites (fig. 6). 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 precipitation-trends, not for temperature trends. Figure 7 shows two regional examples of different annual precipitation trends. The extensive outlier detection and elimination work in the dataset (an interactive procedure based on monthly anomaly

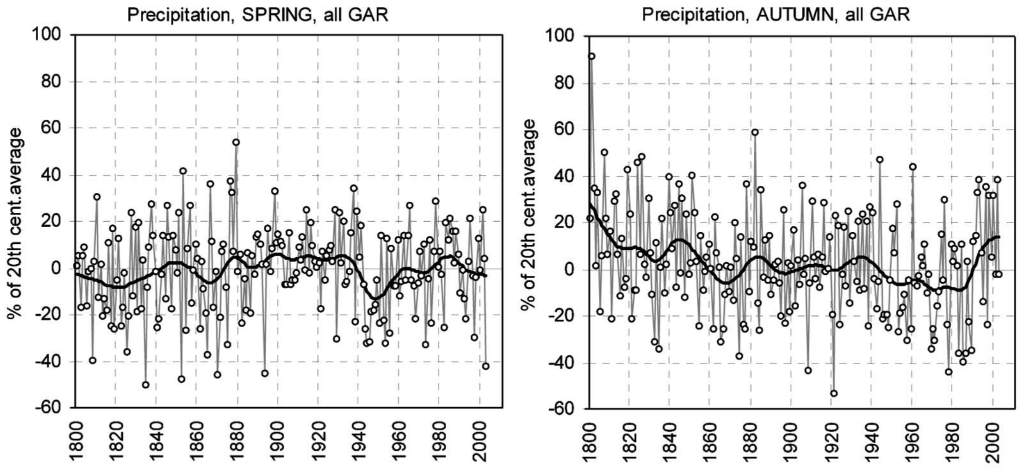

Fig. 5. – All GAR average precipitation evolution 1800-2003 for spring (3 to 5, left) and for autumn (9 to 12, right), single seasons and 30-year low-pass filtered, values are relative to the 20th century mean in %.

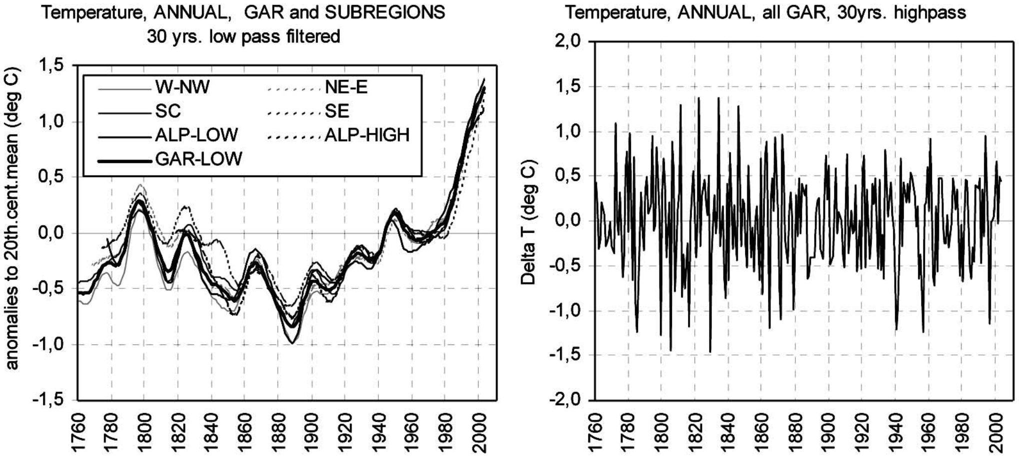

Fig. 6. – Smoothed subregional temperature series (left) and all GAR mean high-pass (right) 1760-2003.

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-year 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. Figure 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

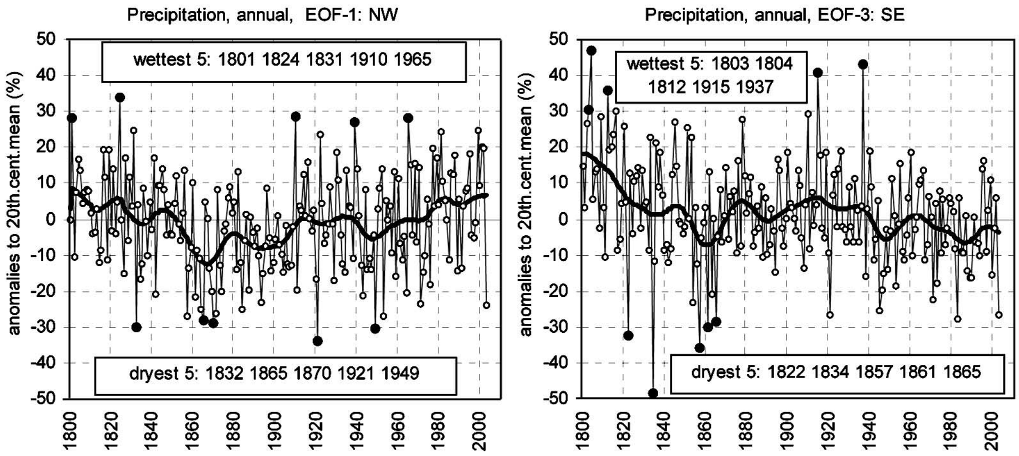

Fig. 7. – Subregional annual precipitation series 1800-2003 (single years and 30-year low-pass filtered).

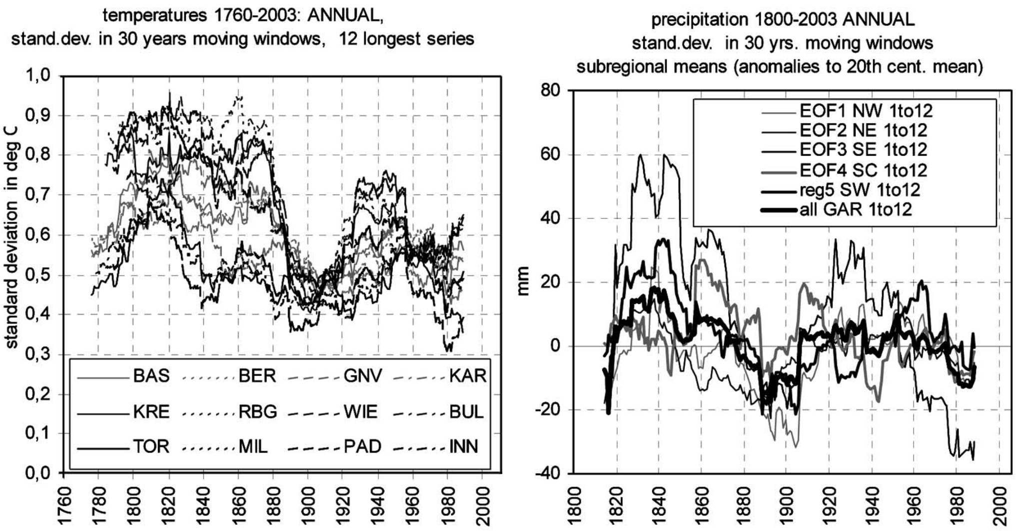

Fig. 8. – Has climate variability changed? Standard deviation series in 30-year moving windows (after detrending through 30-year high-pass filtering) of annual temperature 12 longest single series, (left) and of annual precipitation (all GAR and subregional means, right).

of the European Mediterranean—thus accentuating the typical features of Mediterranean climate *vs.* its northern neighbouring climates from Atlantic (NW) to continental (NE).

3. – Conclusions and outlook

The paper showed some highlights of first studies on the new and quality improved HISTALP-database of instrumental climate time series in the GAR. HISTALP is a "workshop in progress" with the goal to develop and maintain a database of high-quality long-term instrumental climate data. "Climate" is understood in its full meaning, thus covering not only main elements like temperature but also less well available and studied data like humidity, cloudiness and others. This increasingly opens new fields of research on the interactions of different climate elements thus hopefully increasing our understanding how climate variability works—not only at the typical time-scale of maximum 50 years (given by the reanalysis datasets) but at longer time scales of 100 to 200 years. Such data are available in certain regions (like in the GAR) but are not fully processed yet. For the GAR—being an interesting transition-region between three principal climate regimes (Mediterranean-Atlantic-Continental)—HISTALP intends to increasingly close the remaining data and quality deficits soon. In the near future a number of studies are planned which will concentrate on: 1) the common analysis of different climate elements, 2) comparative subregional trend analysis in the GAR, 3) the vertical structure of climate variability (0 to 3400 m a.s.l.), 4) GAR-variability in the greater context of continental to global scale variability.

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REFERENCES

[1] Aguilar E., Auer I., Brunet M., Peterson T. C. and Wieringa J., Guidlines on Climate Metadata and Homogenization. World Climate Programme Data and Monitoring WCDMP-No.53, WMO-TD No. 1186, WMO, Geneva (2003).

[2] Auer I., Böhm R. and Schöner W., Austrian Long-term Climate 1767-2000, Multiple instrumental climate time series from Central Europe, *Österreichische Beitr. Meteorol. Geophys.*, **25** (2001) 1 (plus data and metadata-CD).

[3] Auer I., Böhm R., Jurkovic A., Orlik A., Potzmann R., Schöner W., Ungersböck M., Brunetti M., Nanni T., Maugeri M., Briffa K., Jones P., Efthymiadis D., Mestre O., Moisselin J-M., Begert M., Brazdil R., Bochnicek O., Cegnar T., Gajic-Capka M., Zaninovic Majstorovic Ž., Szalai S., Szentimrey T. and Mercalli L., A new instrumental precipitation dataset for the greater alpine region for the period 1800-2002, *Int. J. Climatol.*, **25** (2005) 139.

[4] Böhm R., Auer I., Brunetti M., Maugeri M., Nanni T. and Schöner W., Regional temperature variability in the European Alps 1760-1998 from homogenized instrumental time series, *Int. J. Climatol.*, **21** (2001) 1779.