A HIGH RESOLUTION TEMPERATURE CLIMATOLOGY FOR THE GREATER ALPINE REGION (GAR)

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Abstract: The Greater Alpine Region (the GAR) covering the area between 4-19°E and 43-50°N and an altitude range between 0 and more than 4000 m asl. offers a challenging climate worth to be studied in any detail. However, it is surprising that up to now no comprehensive Alpine Temperature Climatology covering the whole region is existing. To overcome this deficiency as a first step we want to produce monthly temperature maps for this region in spatial resolution as high as possible. The period under investigation will be 1961-1990. In this paper we will describe the first steps of our initiative as well as the further plans.

Keywords *- Greater Alpine Region (GAR), monthly Temperature Climatology ,high spatial resolution, 1961-1990*

1. INTRODUCTION

The study region GAR comprises 12 countries as there are: France, Switzerland, Liechtenstein, Italy, Germany, Czech Republic, Slovakia, Hungary, Austria, Slovenia, Croatia and Bosnia-Herzegovina. The number of data holders (national and/or regional meteorological and hydrographical services etc.) is somewhat higher. For precipitation a supra-national Alpine Climatology covering a major part of GAR over the period 1971–1990 was prepared by Frei and Schär 1998, however for temperature a comparable investigation is still missing, although a number of national and/or regional investigations are existing (compare examples cited in the list of references). With our joint initiative described in the following - the partnership combines Weather Services as well as some sub-national data providers - we want to reduce this deficiency by setting up a first step to be described in the following. The final goal is to produce 12 high resolution 1961–1990 monthly temperature fields for GAR in a resolution of approximately 1km or 1 min. A second value (the local vertical lapse rate) for each grid-cell will allow corrections of still existing sub-grid effects due to steep orography.

2. DATA COLLECTION AND DATA QUALITY

Up to now we collected the monthly climatological normals for the period 1961–1990 of 1723 stations (Fig. 1) plus the most relevant metadata (longitude, latitude, altitude, algorithms for the calculation of mean temperature) provided by 20 data holders. For most of the stations the normals were based on complete 30years observations. To enlarge the spatial coverage, additionally also sites with at least 20 years were included (>=15y for high elevations), however only adjusted to 1961-90 using „climatologically nearby sites“.

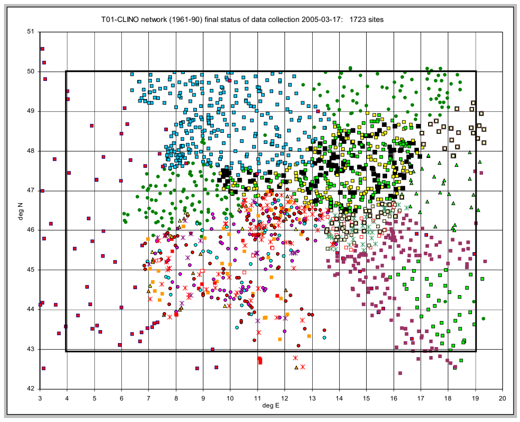

Figure 1. The network of 1723 temperature stations in GAR

The activities of quality testing, gap filling and adjusting to the common 30 years period have nearly been finished and we can conclude that the overall data quality was quite high. Only single cases required the correction of errors respecting to double station information (two different values for in fact one station), mixtures of temperature maximum and mean as well as minimum and mean, outliers, non-precise geographical information, shown in Figure 2.

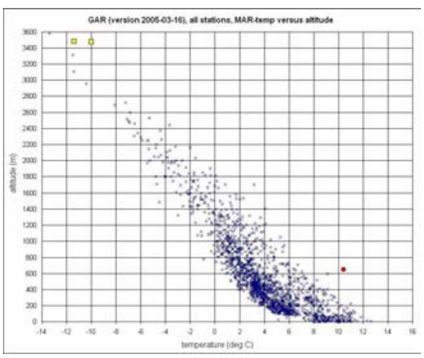

Figure 2. Example for data errors in respect to double station information (yellow) and outliers (red), plot of mean March temperature of all stations versus altitude (1961-1990)

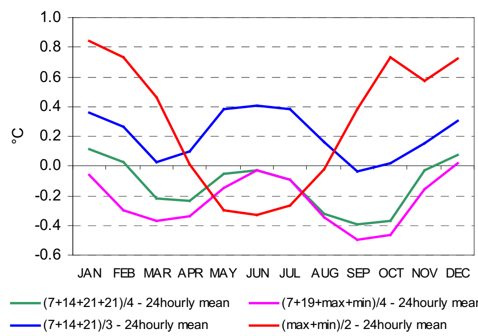

Figure 3. Comparison of the mean monthly temperature obtained by using different algorithms to calculate the monthly mean at the Austrian station Puchberg, all values are shown as differences from the “true” (24hours) mean

A greater number of errors occurred concerning metadata, especially the specification of geographical longitude and latitude turned out to be adequate for the pre-GIS period, but seem to be unusable to check the modelled climatographies versus station values in GIS. In 98 of 100 cases lat-long-errors were responsible for intolerable differences between station altitudes and model altitudes.

For further proceeding we have to adjust the data -derived from different data sources- to a common algorithm of mean calculation., as there have been several in use for the period 1961-1990, e.g.(7+14+2*21)/4, (7+19+Max+Min)/4, (Max+Min)/2, (7.30 + 13.30 + 2x21.30)/4. This topic is still under investigation, but preliminary results for single stations show biases up to 1 K (Figure 3).

4. FURTHER PROCEEDING

Soon we will be able to start with temperature analyses. At this time we only can present examples of our preliminary results (Figure 4 and 5). A comparison of the residuals after each single or mixed method will be the basis to decide upon the method to be used.

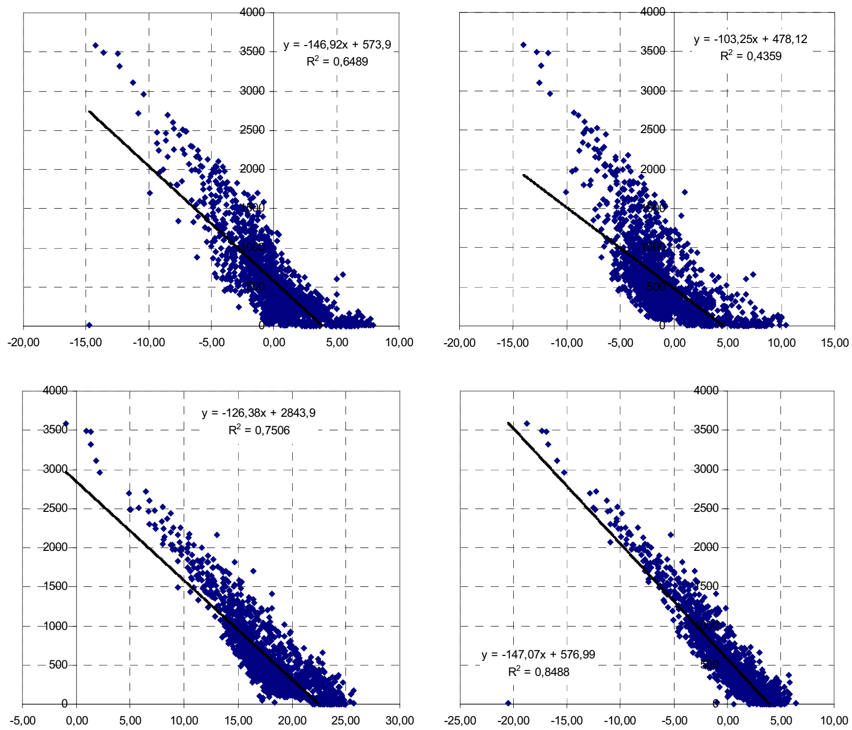

Figure 4 Regression of air temperature with altitude for January (upper row) and July (lower row) for the entire GAR. Left side: after detrending with latitude and longitude, right side: without detrending.

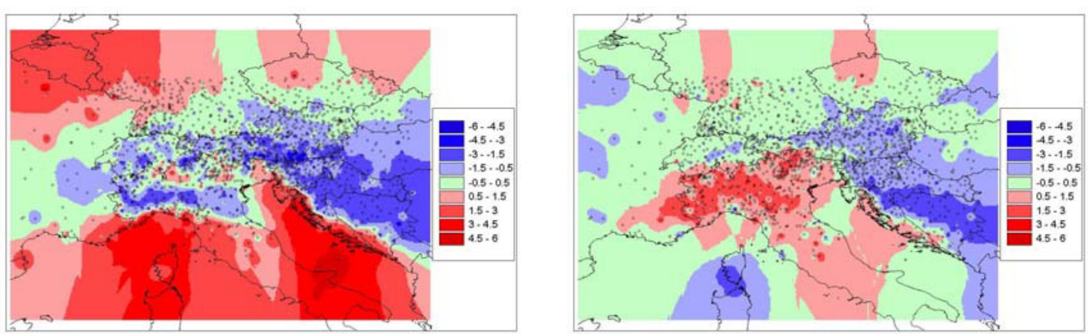

Figure 5 Spatial distribution of Residuals from regression of air temperature with altitude (detrended) for January (left) and July (right) in GAR 1961-1990.

Several methods have been described and have been used for national approaches. For the greater region of GAR the best solution has to be determined by validation procedures. Vertical effects, maritime influences, latitude and longitude effects, urban and rural land-use, slope orientation and others have to be taken into account.

REFERENCES

Auer I, R. Böhm, H. Mohnl, R. Potzmann, W. Schöner, P. Skomorowski 2001: Öklim – Digitaler Klimaatlas Österreichs, CD Zentralanstalt für Meteorologie und Geodynamik.

Auer I, R. Böhm, M. Leymüller, W. Schöner, 2002: Das Klima des Sonnblicks. Klimaatlas und Klimatographie der GAW Station Sonnblick einschließlich der umgebenden Gebirgsregion. *Österreichische Beiträge zu Meteorologie und Geophysik*. **Heft 28**.

Böhm R, R. Potzmann, 1999: Systematic Climate Mapping in Complicated Terrain – Part one: from Point Measurement to Maps of Means (a GIS-Supported Procedure including quantitative Error Analysis). *ÖGM bulletin* **99/1**, 21-30.

Frei C, C. Schär, 1998: A precipitation climatology of the Alps from high-resolution rain-gauge observations. *Int. J. Climatol*., **18**, 873-900.

Gajic-Capka M, M.P. Tadic, M. Patarcic, 2003: Digitalna godisnja oborinska karta hvvatske. *Hvartski meteorolologki casopis* **38**, 21-33.

Hidrometeoroloski zavod Republike Slovenije, 1995. Klimatografija Slovenije 1961-1990.

Meteo France. Le climat de la France.

Meteo France. 2004 : Climate Atlas of Europe.

Schwarb M. 2001: The Alpine Precipitation Climate. Evaluation of a high Resolution Analysis Scheme Using Comprehensive Rain gauge data. Diss. ETHZ 13'911. *Zürcher Klimaschriften*, **Heft 80**, Institut für Klimaforschung ETH, Verlag Institut für Klimaforschung ETH Zürich

SMS 2003: Atlante climatico della Valle d'Aosta.

Tveito OE, E. Foerlan, 1998: Spatial interpolation of temperatures in Norway applying a geostatistical model and GIS. *DNMI, Report* **No 26/98**

Tveito O.E., E. Foerland, R. Heino, I. Hanssen-Bauer, H. Alexandersson, B. Dahlström, A.. Drebs, C. Kern-Hansen, T. Jonsson, E. Vaarby Laursen, Y. Westman, 2000: Nordic temperature maps. *DNMI, Report* **No. 09/00**

Ungersböck M, A. Orlik, A. Jurkovic,. 2003: HISTALP – eine Datenbank zur kombinierten Erfassung von historischen Klimazeitreihen und deren Metadaten. *Terra Nostra* **2003/6**, 450-452.