**VERA-QC**: operational application, challenges, and how to cope with them

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1. **Objective**

The "VERA-Quality Control" is a model independent algorithm that checks for the quality of meteorological measurements by using the content of data self-consistency. As an essential preprocessing step, VERA-QC is applied to a continually increasing number of hourly available synoptic reports. These constitute the fundamentals for the operational analysis of basic meteorological parameters carried out at the Department of Meteorology and Geophysics in Vienna, called VERA (Vienna Enhanced Resolution Analysis) - thus the abbreviation VERA-QC. The scope of this poster is to present the results of the operational application of VERA-QC. Special challenges related to measurements in complex terrain are addressed and solutions are proposed.

2. **Mathematical background**

VERA-QC is based on the assumption that the error free analysis field \( v_i \) should be smooth. Thus, a cost function \( J \) consisting of the squared curvature \( C \) of the analysis field is minimized (eq. (1)). The unknown analysis field is approximated by a Taylor series around the curvature of the observation field (eq. (2)). Note the two different local neighborhoods.

\[
J(v_i) = \sum_{i=1}^{N} \frac{1}{2} \left( C_{v_i} v_i^2 \right) \rightarrow \min \text{ (1))}
\]

\[
\frac{\partial^2 \Psi}{\partial x^2} + \frac{\partial^2 \Psi}{\partial y^2} + \frac{\partial^2 \Psi}{\partial z^2} = \Delta \Psi \text{ (2)}
\]

3. **Data**

Every hour, approx. 2000 GTS-measurements all over Europe are operationally checked by the VERA-QC. The controlled parameters are:

- precipitation, wind components, MSL-pressure, potential temperature and equivalent potential temperature.

Note that the VERA-QC is only applicable to measurements featuring a high degree of redundancy. However, the scale of (convective) precipitation events is small compared to the mean distance between the observation points. Thus, the QC of precipitation is basically restricted to a Limit- and a Gross Error check. Prior to the quality control, a station selection algorithm excludes stations that are not representative regarding valleys and lowlands. It is based on the concept of the Minimum Topography, as visualized in Fig.1.

4. **Add-Ons**

Operationally, the proposed corrections (called deviations) are stored for all measurements and can be used to compute a bias correction for each station (see Fig.2). The spatially uncorrelated distribution of daily bias corrections for MSL-pressure is visualized in Fig.3.

For potential temperature, the bias correction is highly depending on the individual station height (see Fig.4). This behavior is stronger pronounced in summer. For reducing temperature values to potential temperature, the dry-adiabatic lapse rate is used. However, the local actual lapse rate is smaller than the dry-adiabatic one and, additionally, strong local heating in valleys and above elevated plains influences higher stations and those in valleys.

Thus, the higher the station, the higher the computed potential temperature values, which get adjusted by negative bias corrections. Therefore, relative values compared to the standard atmosphere are considered for the quality control by VERA-QC.

5. **Results**

Monthly mean of the analyzed hourly MSL-pressure observations for July 2011

- a) Without quality control
- b) With quality control including bias correction

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6. **Conclusions**

Since the VERA-QC is a model independent quality control method that does not require any prior knowledge, it can be used in many different fields of application:

- it is applicable to data collected during field campaigns as e.g. COPS
- it can be used for case studies
- it can be applied in the field of model validation
- it can be used for defining analyses uncertainties
- it can also be employed for the homogenization of time series and it proved itself as valuable preprocessing for the operational real time VERA analyses that support the forecasters of the Austrian aviation weather service (ACG, AustroControl GmbH).

References:

3) Wellmeier, V. et al., 2011: The Convective and Orographically-induced Precipitation Study: the scientific strategy, the field phase, and research highlights. Quarterly Journal of the Royal Meteorological Society, 137, 3-30.

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