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VERA-QC, an approved Data Quality Control based on Self-Consistency

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Nowadays it is understood that the quality of processed meteorological observations influences the performance of every forecast, analysis, reanalysis or verification study to a high degree. Therefore, many different QC methods have been developed. Most of them are directly embedded in the data assimilation process; others are stand-alone applications using model information (as first guess field) or prior knowledge (such as error statistics). But there are only few elaborated model independent QC methods which can be used on an operational basis without the need of prior knowledge.

This last special category of quality control methods may be very valuable to the fields of model verification, analysis and re-analysis of observations, field campaigns or could even be used as a preprocessing tool for data assimilation systems.
The Department of Meteorology and Geophysics at the University of Vienna developed such a quality control method called VERA-QC. It is based on the spatial and temporal consistency of meteorological observations and hence it is applicable to measurements featuring a high degree of autocorrelation (with regard to the resolution of the observational network in space and time). In consideration of a conventional synoptic network, the VERA-QC is applicable to parameters like mean sea level pressure, potential and equivalent potential temperature or wind speed.

Mathematically, the VERA-QC algorithm is expressed as an optimization problem minimizing the curvature of the (initially unknown) analysis field. This can be achieved by formulating a cost function, allowing the deviations (differences between the observation field and the analysis field) to vary.
Besides the time efficient numerical formulation (as a matrix equation that can be solved at once without the need of converging iterations), the VERA-QC can convince with the following special features:

•The definition of neighboring stations adapts automatically to inhomogeneous or varying station distributions.
•A special weighting method (which is based on the reduction of the analysis field's curvature achieved by each deviation) allows refining the proposed deviations.
•An elaborated cluster treatment takes care of stations that are located close to each other.
•Random errors of high magnitude are identified by a gross error recognition that is based on the mentioned weighting factor as well as on station specific variable thresholds.
•Systematic errors are adjusted by a bias correction.
•Especially for potential temperature, there is the possibility to check the departures from the corresponding values of the standard atmosphere instead of the actual measurements which allows reducing the influence of the station height.

Besides the implementation as preprocessing tool for the operational VERA-analysis (see contribution 'Objective high Resolution Analysis over Complex Terrain with VERA' by Dieter Mayer), the VERA-QC method has already been successfully employed even for non-obvious applications such as the homogenization of time series or the creation of ensemble analysis.