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# VERA-QC, a new Data Quality Control based on Self-Consistency

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A nowadays continually increasing number of meteorological observation sites is producing larger and larger amounts of data. This extensive quantity of measurements suggests information benefits only if their quality meets the implied requirements for the intended applications. Considering applications like model validation most of the conventional quality control (QC) methods are not suited because they depend on model output. Even by analyzing data over complex terrain without having the knowledge of model information (such as first guess fields) a special model independent QC method is required. Optimum interpolation, Bayesian and variational QC are based on model output like background fields. More simple spatial consistency checks using inverse distance or spatial regression interpolation do not deliver a satisfying performance considering a complex terrain and an inhomogeneous station distribution.

At the Department of Meteorology and Geophysics at the University of Vienna a new QC method was developed, the so called VERA-QC. Its name originates from its application as preprocessing tool for VERA (Vienna Enhanced Resolution Analysis), the department's operational analysis system. It analyzes the GTS observations of basic meteorological parameters and is carried out on an hourly basis. The presented self-consistent and model independent QC does not necessarily need any prior knowledge and makes use of the spatial and temporal consistency of meteorological parameters. It is applicable to measurements featuring a high degree of autocorrelation with regard to the resolution of the observational network in space and time. Considering a conventional synoptic network these requirements are fulfilled by parameters like mean sea level pressure, potential temperature, equivalent potential temperature or wind speed.

The VERA-QC procedure can mathematically be expressed as an optimization problem minimizing the curvature of the analyzed field. This can be formulated with the help of a cost function where the differences between the observation field and the analysis field (deviations) are allowed to vary. As result, a matrix equation which can be solved at once without the need of converging iterations is derived. The obtained deviations are weighted according to the effect that an applied deviation would have on the cost function or the local curvature respectively. Depending on the weighted deviations, station values are accepted, corrected or identified as outliers and hence dismissed. Furthermore it is pointed out that this method is able to handle complicate station distributions, such as closely adjacent (clustered) stations or inhomogeneous station densities. VERA-QC also automatically adapts to different densities of observation networks by using the concept of natural neighborhoods (Delaunay triangulation) and does not require the definition of a user defined circle of influence.

With the help of some 1, 2 and 3 dimensional analytic examples the performance of VERA-QC handling typical challenges such as the correct recognition of random or gross errors or the treatment of clustered stations is presented. Furthermore VERA-QC is compared to two other spatial consistency checks using inverse distance and spatial regression interpolation by applying them on artificial but realistic observation fields. Their performances are evaluated based on their ability to recognize random and gross errors. As a result VERA-QC has proven itself advantageous and eligible.