Specification of Background Errors in the ECMWF 20th Century Reanalysis Using Surface-Only Observations (ERA-20C)

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Reanalyses apply data assimilation to estimate the atmospheric state from an incomplete set of observations over long time periods. For example, Compo et al. [1] produced the NOAA 20th Century Reanalysis, assimilating surface pressure observations into an atmospheric model forced by sea-surface boundary conditions. However, the surface pressure observing system improves greatly throughout the course of the 20th century, with a near 50-fold increase in the number of observations, yet with immense disparities between Northern and Southern hemispheres. This represents a challenge to reconstruct a global weather history that is coherent in time.

Denying this observational fact by considering averages in a climatological fashion, or arbitrarily discarding observations so as to sub-sample them to a daily global constant number of observations does not really address the problem. Indeed, the global observing network is a sum of regional networks which evolved in their geographical coverages, their local reporting times, and also their instrumental qualities.

One way to envision an optimal data assimilation system for reanalysis is to extract varying amounts of information depending on the prior knowledge of the atmospheric state and to reflect this information in the uncertainty estimates that should accompany the reanalysis products. The great challenge posed by observing system changes appears then as an opportunity to develop and evaluate new data assimilation methods.

To this effect, ECMWF is producing, with funding from the European Union FP7 ERA-CLIM project, a reanalysis of the 20th century (ERA-20C). It assimilates atmospheric surface pressure observations over land and ocean, and atmospheric surface wind observations over ocean. The data assimilation system in ERA-20C is a hybrid ensemble of four-dimensional variational analyses (4D-Var). We will describe how the ensemble provides a set of background realizations that enable to update the local background error variances. This allows for geographic variations, representative of regional network disparities. We will also present how the full set of global background error covariances are updated automatically at regular intervals as the production advances. We will finally illustrate how this scheme performs in ERA-20C, based on production results, and how effectively it captures the slow improvement over time in reanalysis quality that results from an increasing number of observations.

References

[1] G. P. Compo and Co-authors. "The Twentieth Century Reanalysis Project", *Q.J.R. Meteorol. Soc.*, vol. 137, pp. 1-28, 2011. DOI: 10.1002/qj.776