Data assimilation system for ECMWF surface observations-only reanalysis of the 20th Century (ERA-20C)

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Inspired by the highly successful 20th Century Reanalysis (20CR), the ERA-CLIM project, funded by European Union FP7 DG Environment, will attempt to produce a similar reanalysis as part of a capacity building effort. This pilot product, covering the 20th century and assimilating only surface observations, is to be called ERA-20C. This reanalysis should be seen as a first attempt to produce a century-long global reanalysis record at ECMWF. The goal is to repeat this iterative exercise at a later date, when additional observations have been recovered by the various partners of the ERA-CLIM project from historical archives and from satellite data reprocessing, when increased computing power make it possible to create a higher resolution dataset, and when additional components of the Earth system have been incorporated in the reanalysis framework (e.g., ocean and ice).

The ERA-20C reanalysis will essentially ingest the same datasets as 20CR, namely observations from the International Surface Pressure Databank (ISPD) and the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). Particular efforts, to be separately reported by Hersbach et al., were made to use forcing datasets throughout the century. Overall, the atmospheric model and the data assimilation system will differ between 20CR and ERA-20C.

This paper focuses on the configuration of the data assimilation system to be used in ERA-20C. The core of the atmospheric component of the data assimilation system remains a four-dimensional variational (4D-Var) analysis, but with several dedicated modifications. These modifications all come from the fact that this exercise takes the ECMWF data assimilation system in uncharted territories, away from the well-observed recent time period. Also, the ambitious planned production schedule, using ideally few parallel streams, poses additional constraints.

The choice of the resolutions for the atmospheric model and assimilation resulted mostly from computing constraints. The length of the analysis window was subject to a comparison study to determine an optimal configuration, based on scientific grounds, but still meeting technical limits. We will report on such a study, comparing 12-hour 4D-Var, 24-hour 4D-Var, and overlapping 24-hour 4D-Var.

We will also describe a new variational scheme developed for ERA-20C, to correct for biases in surface pressure observations. This new scheme resembles that used for satellite radiances in ERA-Interim. The predictors are much simpler in the case of surface pressure, and the basis for correction is by individual station.

We will discuss our approach towards making adaptive adjustments of the background errors via an ensemble of data assimilations. A total of 10 members will be used, and background “errors of the day” will be computed to allow for larger errors in fast-moving systems or regions of greater uncertainty.

We will present our assessment of the observation error estimates for use in the assimilation using a now commonly applied method. Without surprise, but reassuringly, these estimates reflect generally accepted limitations of the observing network or reporting practices. By this approach, we hence do not claim to have estimated the absolute level of observation error, but we will have made an attempt to incorporate knowledge about variations in observation error in the reanalysis.

To conclude, we will present a preliminary assessment of the overall efficiency of the data assimilation method, both scientifically and technically, given the production constraints for ERA-20C.

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