Data Assimilation for Reanalysis

Dick Dee
European Centre for Medium-Range Weather Forecasting (ECMWF)

For historical and practical reasons, most atmospheric reanalysis data sets have been generated with model-based data assimilation systems that were originally developed for numerical weather prediction. In theory, a forecast model combined with observation operators for data assimilation makes it possible to reconcile and integrate information from many different types of observations in a single, physically consistent data set. In practice, reanalysis involves many pitfalls related to data quality, model defects, and, ultimately, lack of information.

Data assimilation requirements for reanalysis are different from those for initializing the best possible forecast. The most obvious example is the need for temporal homogeneity in reanalysis, which is only partly achieved by construction (i.e., by using a single configuration of the data assimilation system). At the same time one should take full advantage of the richness and diversity of the observing system in order to obtain the most accurate and complete description of the state of the atmosphere. There is a tension between these two key requirements - homogeneity and maximum information from observations - which is manifested, for example, by inconsistent mass and energy budgets in reanalysis data sets.

It must be recognized that some degree of inconsistency is unavoidable when imperfect models are combined with incomplete observations; however no better alternative is available. This is precisely the challenge that makes data assimilation for reanalysis especially interesting: To make sense of the complete instrumental record while meeting essential climate requirements. This presentation reviews some aspects of data assimilation that are key to this challenge, and outlines opportunities and practical approaches for meeting it. These include: to make better use of prior information about observations, to improve observational bias corrections, and to develop methods for controlling the effects of model biases.

Corresponding Author:

Name: Dick Dee
Organization: European Centre for Medium-Range Weather Forecasting (ECMWF)
Address: Shinfield Park, Reading Berks RG2 9AX
UK