Evaluation of the Relative Contribution of Observing Systems in Reanalyses: Aircraft Temperature Bias and Analysis Innovations

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Reanalyses have become important sources of data in weather and climate research. While observations are the most crucial component of the systems, few research projects consider carefully the multitudes of assimilated observations and their impact on the results. This is partly due to the diversity of observations and their individual complexity, but also due to the unfriendly nature of the data formats. Here, we discuss the NASA Modern-Era Retrospective analysis for Research and Applications (MERRA) and a companion dataset, the Gridded Innovations and Observations (GIO). GIO is simply a post-processing of the assimilated observations and their innovations (forecast error and analysis error) to a common spatio-temporal grid, following that of the MERRA analysis fields. The data includes insitu, retrieved and radiance observations that are assimilated and used in the reanalysis. While all these disparate observations and statistics are in a uniform easily accessible format, there are some limitations. Similar observations are binned to the grid, so that multiple observations are combined in the gridding process. The data are then implicitly thinned. Some details in the meta data may also be lost (e.g. aircraft or station ID). Nonetheless, the gridded observations should provide simplified access to all the observations input to the reanalysis.

To provide an example of the GIO data, a case study evaluating observing systems over the United States and statistics is presented, and demonstrates the evaluation of the observations and the data assimilation. The GIO data are used to collocate Radiosonde and Aircraft temperature measurements from 1979-2012. Using the observed residuals from the MERRA data assimilation, we statistically infer the contextual bias and effective gain for various observing systems.

A known warm bias of the aircraft measurements is apparent compared to the radiosonde data forecast departures. However, when larger quantities of aircraft data are available, they dominate the analysis and the radiosonde data become biased against the forecast. When AMSU radiances become available the radiosonde and aircraft analysis and forecast residuals take on an annual cycle. While this supports results of previous work that recommend bias corrections for the aircraft measurements, the interactions with AMSU radiances will also require further investigation. This also provides an example for reanalysis users in examining the available observations and their impact on the analysis. GIO data is presently available alongside the MERRA reanalysis.