An Examination of the Radiative Fluxes in Various Reanalyses with an Emphasis on the Global Budget

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Most of the reanalysis projects are based on the forecast models and data assimilation systems used in the numerical forecasting of weather. In the weather prediction problem, accurate modeling and prediction of the radiative fluxes are wanted but are not a critical parameter. Instead forecast model development is driven by improving the forecast skill. In this presentation, the radiative fluxes from the available reanalyses (CFSR, ERA-40, ERA-interim, JRA-25, MERRA, NCEP/NCAR Reanalysis. R2) are examined as well as some experimental test reanalyses (CFS-lite test runs). In one test case, the latest GFS model was used and this system produced 5-day skill scores that were better than the CFSR (equivalent to several years of model development). However, the radiative fluxes were further from observations and this had unsatisfactory consequences on the land and ocean components of the system. This could be expected as the net radiative flux at the surface is a major forcing that is driving the land and ocean models. On the other hand, the global short and long wave fluxes only differed by 15 W/m/m from the CFSR. One might consider a 15 W/m/m difference to be not bad as it is within the range of estimates given by various reanalyses. In another test run, a version of the CFSR atmospheric model with marine stratus was tested. In this model, the global fluxes were better than the CFSR. Evaluation of this run was more favorable even though the forecast skill of the model was worse than the former test run. The differences in the free tropospheric analyses were small and the their monthly means were even smaller. This an example of how a “weather prediction” optimized forecast model may not be reanalysis optimized.

This study will show the radiative fluxes from various reanalyses and CFSR-lite test runs. Then we will compare them to the satellite-based analyses such as ERBE and CERES. For example, the global outgoing long-wave radiation (OLR) ranges from 236 W/m/m (N/N Reanalysis) to 255 W/m/m (JRA-25). Most of the reanalyses have more OLR than the 239 W/m/m that was estimated by Trenberth et al (BAMS, 2001). The outgoing short-wave flux (OSR) at the top of the atmosphere was estimated to be 109 W/m/m by Trenberth et al. and was within the range of the various reanalyses estimates. The range of reanalyses fluxes were about 20 W/m/m for both the OLR and OSR fluxes. The test runs had different fluxes. The first run had 10 W/m/m more OLR and 20 W/m/m too little OSR. The second run was close to estimates by Trenberth et al.

The global radiative fluxes are not critical in the weather forecasting problem. However, incoming solar flux should balance the outgoing short and long wave fluxes and the changes in the heat storage term. With an annual average, the changes in the heat storage term are going to be small (unless there is a secular trend in the ocean). Assuming no secular trend, the imbalance in the global radiation budget will have to be balanced by the observational increment. The two test runs provide an example of two similar assimilations where one is in radiative balance and the other is not.

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