Problems Found in CFSR and Solutions Tested for CFSRL

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When NCEP undertook the CFSR project the NCEP Climate Forecast System (CFS) and the assimilation component, had undergone large changes in comparison with what was available in the prior NCEP global reanalyses, NCEP/NCAR Global Reanalysis 1&2. The changes included much higher spatial resolution, more highly resolved stratosphere and surface layers, atmosphere-ocean-land coupling, direct assimilation of satellite radiance, assimilation of ozone, and use of the operational NCEP Gridpoint Statistical Interpolation assimilation (GSI). Following an intense effort to complete the reanalysis of 1979 through 2010 with the new system, in a very restricted timeframe, a number of problems became evident in the results. Some of the problems were serious enough that a lower resolution rerun of CFSR (named CFSRL), was proposed to address and correct them for the record. The presentation will describe the diagnosis of several of these problems affecting the atmospheric component of the CFSR, and how they are resolved in the CFSRL system. Also, additions/improvements made to the observation datasets available for CFSRL are briefly described.

An important problem affecting the CFSR is seen in discontinuities in time series located at “stream boundaries”, points in time where multi-processed CFSR 5-10 year segments were joined, even with more than a one year overlap between streams. We look at some of the satellite time series to illustrate the problem. Although a potential source of discontinuities caused by different satellites entering the analysis was partially avoided by pre-computed bias correction spin ups for those events, we found severe discontinuities in some of the satellite time traces at stream boundaries because of mismatched bias correction parameters, especially in the stratosphere. The solution for this is simply running a single stream reanalysis for this period. There are other issues to address concerning the transitioning of satellites into and out of the reanalysis, which will require more work to resolve in a better way.

Examination of the CFSR radiosonde record reveals jumps in the time series of radiosonde radiation bias corrections corresponding to times when the NCEP operational radiation correction tables changed. We show several examples of this, and describe the development of an adaptive method of radiosonde bias correction which eliminates these discontinuities from the CFSRL.

Finally, it was apparent from a number of CFSR diagnostics, and inter-comparisons with other reanalyses, that forecast error structure functions derived for the GSI assimilation system in the 21st century timeframe were not suitable for reanalysis of the 1980’s and early 1990’s. In particular, analysis of the data sparse tropical atmosphere prior to the mid 1990’s, were biased by model errors and clearly deficient compared to other reanalysis results. We show new structure functions developed for the earlier period in comparison with those used later. The impact of the new structure functions in the early 1980’s is illustrated by improvements in the analysis of temperatures in the tropical upper troposphere, and wind patterns in the tropical stratosphere, in particular the Quasi Biennial Oscillation of the U wind component. Additional factors affecting the QBO representation in CFSR turned out to be problems with the radiance assimilation of SSU channels, including observation error levels and bias correction methodology. The complete set of improvements to the analysis of the tropical stratosphere for the CFSRL also included developing a method to enhance the influence of sparse tropical radiosonde observations in time, as an adjunct to the extension of spatial influence of the observations provided by the enlarged forecast error structure functions.

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