An Assessment of the Surface Climate in CFSR

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This paper analyzes surface climate variability in the NCEP Climate Forecast System Reanalysis (CFSR). The CFSR represents a new generation of reanalysis effort and computes the first guess with a coupled atmosphere-ocean-sea ice-land model. Our analysis focuses on a set of surface variables including precipitation, surface air 2-meter temperature (T2m), and surface heat fluxes. None of these quantities are assimilated directly and thus an assessment of their variability provides an independent measure of the accuracy. The CFSR is compared with observational estimates and three previous reanalyses (the NCEP/NCAR reanalysis or R1, the NCEP/DOE reanalysis or R2, and the ERA40 produced by the European Centre for Medium-Range Weather Forecasts).

The CFSR shows improved time-mean precipitation distribution over various regions compared to the three previous reanalyses, leading to a better representation of freshwater flux (evaporation minus precipitation). For interannual variability, the CFSR also produces improved precipitation over the Indian Ocean, Maritime Continent, and western Pacific. T2m in the CFSR is more realistic in both interannual variability and long-term trend compared to R1 and R2. On the other hand, the CFSR overestimates downward solar radiation flux over the tropical Western Hemisphere warm pool, consistent with a negative cloudiness bias and a positive sea surface temperature bias. Meanwhile, the evaporative latent heat flux in CFSR appears to be larger than other observational estimates over most of the globe.

A few deficiencies in the long-term variations are identified in the CFSR. Firstly, dramatic changes are found around 1998-2001 in the global average of a number of variables, possibly related to the changes in the assimilated satellite observations. Secondly, the use of multiple streams for the CFSR induces spurious jumps in soil moisture between adjacent streams. Thirdly, there is an inconsistency in long-term sea ice extent variations over the Arctic regions between the CFSR and other observations with the CFSR showing smaller sea ice extent before 1997 and larger extent starting in 1997. These deficiencies may have impacts on the application of the CFSR for climate diagnoses and predictions.

Relationships between surface heat fluxes and SST tendency and between SST and precipitation are analyzed and compared with observational estimates and other reanalyses. Global mean fields of surface heat and water fluxes together with radiation fluxes at the top of the atmosphere are documented for the globe, and for the ocean and land separately.

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