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Evaluation of the oceanic component of the NCEP Climate Forecast System Reanalysis

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At National Centers for Environmental Prediction (NCEP), a reanalysis of the atmosphere, ocean, sea ice and land over 1979-2009 has been recently completed as the Climate Forecast System Reanalysis (CFSR). The oceanic component of the CFSR includes many advances: (a) the MOM4 ocean model with an interactive sea-ice, (b) a 6 hour coupled model forecast as the first guess, (c) inclusion of the mean climatological river runoff, and (d) high spatial (0.5o by 0.5o) and temporal (hourly) model output. The primary use of the CFSR is to provide initial conditions for a reforecast of the new operational Climate Forecast System (CFS.v2) over 1979-2009 for seasonal climate forecast. Since the CFSR will be used by many in initializing/validating ocean models and climate research, here we intend to inform the user community about the salient features in the CFSR ocean component. The net ocean surface heat flux of the CFSR has smaller biases than the NCEP/NCAR reanalysis (R1) and NCEP/DOE reanalysis (R2) in both the tropics and extratropics, when compared with the sum of the latent and sensible heat fluxes from the Objectively Analyzed air-sea Fluxes (OAFlux) and the shortwave and longwave radiation fluxes from the International Satellite Cloud Climatology Project (ISCCP-FD). However, the mean shortwave radiation is about 20 W/m≤ larger than observational analyses, which is consistent with the mean negative biases in cloudness and positive biases in the sea surface temperature. The evaporative latent heat flux appears to be 10-20 W/m≤ larger than other observational estimates in the tropical oceans. The ocean surface wind stress of the CFSR has smaller biases and higher correlation with the ERA40 than the R1 and R2, particularly in the tropical Indian and Pacific Ocean. The CFSR also has smaller biases compared to the QuickSCAT climatology than the R1 and R2. However, the trade winds of the CFSR in the central equatorial Pacific are too strong prior to 1999, and become close to observations once the ATOVS radiance data are assimilated in late 1998. A sudden reduction of easterly wind bias is related to the sudden onset of a warm bias in the eastern equatorial Pacific temperature around 1998/99. The CFSR has improved time-mean precipitation distribution over various regions compared to the ERA40, R1 and R2, leading to a better representation of freshwater flux (evaporation minus precipitation). For interannual variability, the CFSR shows improved precipitation correlation with observations over the Indian Ocean, the Maritime Continent, and western Pacific. The sea surface height and upper 300 m heat content (HC300) of the CFSR compare with observations better than the GODAS in the tropical Indian Ocean and extratropics, but worse in the tropical Atlantic, probably due to discontinuity in the deep ocean temperature and salinity caused by the six data streams in the CFSR. In terms of climate variability, the CFSR provides a good simulation of Tropical Instability Waves (TIW) and oceanic Kelvin waves in the tropical Pacific, and the dominant modes of HC300 that are associated with El Niño and Southern Oscillation, Indian Ocean Dipole, Pacific Decadal Oscillation and Atlantic Meridional Overturning Circulation.