CEOP-based Diagnosis of Prediction Skill of Current Operational General Circulation Models and Land Data Assimilation Systems

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Abstract: Based on the platform of the Coordinated Enhanced Observing Period (CEOP) project, this study evaluated forecast skill of four operational models (BMRC, JMA, NCEP, and UKMO) and NASA global land data assimilation system (GLDAS) through comparisons with in situ data of CEOP/EOP 3. This evaluation not only directly contributes to improving forecast skill but also provides a reference for data users to choose appropriate data for hydrological and agricultural applications since these model forecasts/reanalysis products are the major data sources of those studies. Based on the comparisons, several findings are suggested. (1) These models usually have good skill in estimating air temperature, humidity, and total downward radiation, but it is still hard to predict surface temperature, downward radiation, surface energy budget, and precipitation. (2) All the models significantly under-predicted the diurnal range of surface skin temperature in arid and semi-arid regions, indicating that current land models may over-predict turbulent transfer capability for bare soil and sparsely vegetated surfaces. (3) Downward shortwave radiation was over-predicted in all the models, and downward longwave radiation was under-predicted by NCEP and JMA while its prediction is much better in BMRC and UKMO. JMA and UKMO models gave the maximum and minimum biases for both components, respectively. (4) JMA and UKMO shows better skill to estimate surface energy budget, NCEP tends to over-predict latent heat fluxes because of over-prediction of precipitation. BMRC uses a simple bucket hydrological model without explicit vegetation, which yielded incorrect surface energy budget. As a result, BMRC predicted too warm summer in Amazon and Baltic Sea regions while too cold winter in the Polar region. (5) JMA tends to over-predict the intensity of heavy rainfall events while BMRC and UKMO tends to under-predict it. Composite diurnal cycle of precipitation shows an afternoon peak and a nighttime peak of precipitation intensity in summer season. In tropical regions, the afternoon peak is stronger than the nighttime peak. In other regions, both peaks are strong, but the onset time of the nighttime rainfall is more variable. In addition, a low intensity around 18pm was observed at many sites. These

characteristics are not well predicted in all the models. JMA and NCEP models predict the late-afternoon peak time better than BMRC and UKMO, which predicted the peak 3-4 hours earlier. No model reproduced the nighttime peak and the 18pm low intensity. (6) Three GLDAS products with different land surface show noticeable differences in the surface energy partition among these models and also between land surface models and observations, suggesting the essential role of land processes studies and model calibrations in land data assimilation systems.