Model Analysis Intercomparison Project for the Coordinated Enhanced Observing Period (CEOP)

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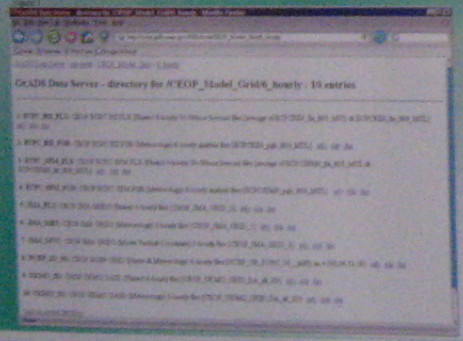
Introduction

The objective of this project is to examine multiple analysis data products in conjunction with in situ and satellite observations to evaluate the uncertainty of analyses in representing the water cycle, monsoons, and the surface energy budget. The project takes advantage of many new EOS platforms to provide independent global data for cross-comparison of the analysis systems. Water and energy cycle processes from the diurnal cycle to seasonal progression are studied. The analysis data is being collected in conjunction with the Coordinated Enhanced Observing Period (CEOP) under GEWEX. The main intensive observation period comprises two annual cycles (EOP3 and EOP4, October 1, 2002 – December 31, 2004). Twelve international data analysis centers have pledged to provide their model analysis output for this period. The various model analyses and the in situ and remotely-sensed observations are compared to NASA's next generation system, GEOS-5. This project will complement ongoing climate model intercomparisons and accelerate progress in understanding modeled physical processes and reanalyses.

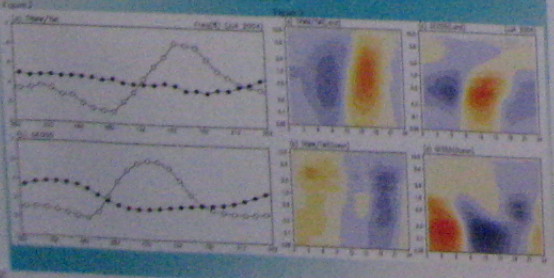
Data Gathering

The first step of this project is to accumulate the multiple analysis products. This step was made much easier by the contribution of international operational centers to the Coordinated Enhanced Observing Period (CEOP) model data center at Max-Planck Institute (MPI) in Germany. Additionally, the NASA/GSFC SIVO office has recently made available the Goddard optical lambda network for high-speed data downloads from MPI. Nonetheless, there is still a considerable effort in acquiring and preparing the various analyses for evaluation and intercomparison. 6-hourly, daily, and monthly data is available on an OpenDAP GrADS/DODS server to share among co-Is and other interested MAP researchers. The WWW address is http://voda.gsfc.nasa.gov:9090/dods/CEOP_Model (Figure 1).



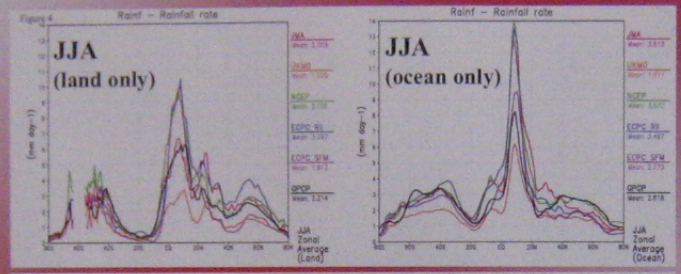
Rainfall Diurnal Cycle

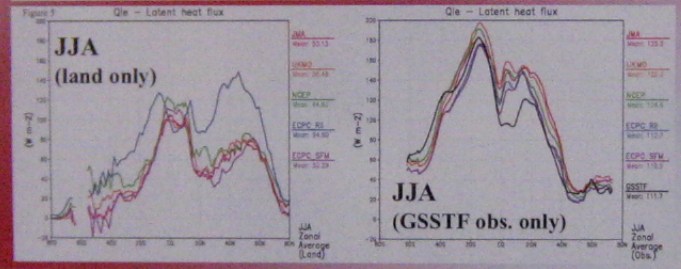
The diurnal cycles of rainfall were compared during JJA 2004 between GEOS-5 and TRMM/TMI. Figure 2 (left) shows the diurnal cycle frequency between land (open circles) and ocean (closed), and Figure 3 (right) shows a rainfall PDF (daily mean removed). GEOS-5 tends to produce maximum precipitation 3-4 hours earlier than TRMM over both land and ocean, likely relating to an over-abundance of light rain or drizzle in the model, particularly over the ocean.



Comparisons to Global Datasets

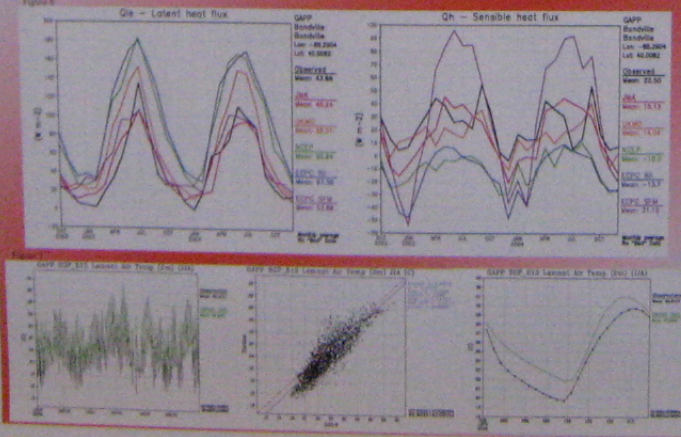
Monthly and zonal means of the model data were generated and compared to available global observations. Figure 4 (upper panels) shows the zonal JJA precipitation from the available analyses compared to the GPCP precipitation dataset. The models generally overestimate precipitation, particularly in the tropical oceans, though UKMO underestimates it. Figure 5 (lower panels) shows similar figures for the JJA evaporation, with the observations only available over the ocean over the extent of Goddard Satellite-Based Surface Turbulent Fluxes (GSSTF) dataset. The model analyses generally agree; however, ECPC Rit has too high evaporation over mid-latitude land areas.





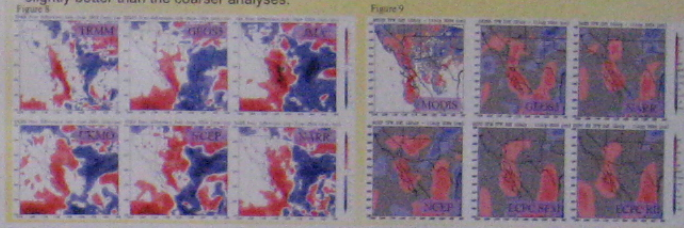
Comparisons to In Situ Datasets

Monthly means of the model data were generated at the CEOP reference site data points and compared to the observations. Examples at one of the sites – a monthly time-series of latent and sensible heat fluxes at GAPP Bondville in Illinois, USA – is shown in Figure 6 (upper panels). For the most part, the models have higher latent heat flux than observed at this site, particularly during the transitional spring and fall seasons. As expected, the models with high latent heat have low sensible heat, especially during the summer months. Some sample plots from comparisons between GEOS-5 and the reference site data for JJA 2004 is shown in Figure 7 (lower panels).



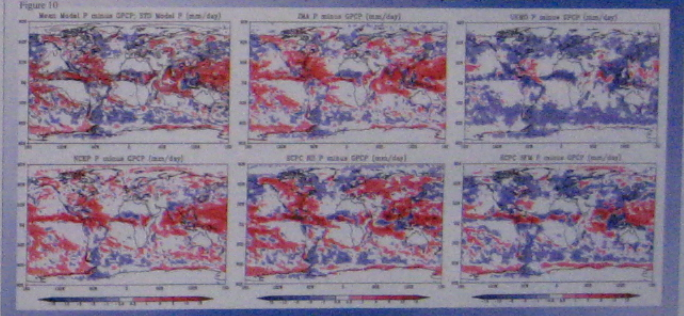
Monsoon Study

The North American monsoon during 2004 was examined in the analyses and observations. Figure 8 (left) shows the monsoon onset via precipitation difference from July to June, and Figure 9 (right) shows the difference of total precipitable water during a moisture surge event. While the analyses generally depict the surge event (compared to MODIS 1km observations), the finer-resolution GEOS-5 (1/2 degree) and NARR (32Km) appear to approximate the MODIS observations slightly better than the coarser analyses.

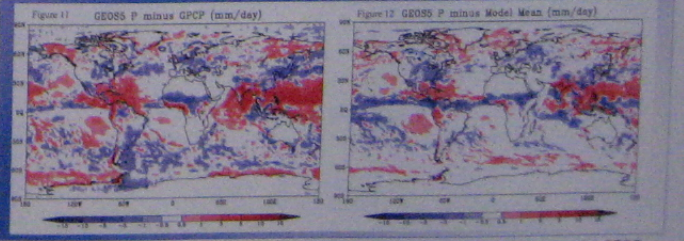


Ensemble of Analyses

An ensemble average of the available analyses is under development. Figure 10 shows the July 2004 monthly precipitation from 5 analyses minus GPCP observations. The upper left panel shows the mean of the 5 models (JMA, UKMO, NCEP, ECPC Rit, and ECPC SFM) minus GPCP, and also includes the standard deviation of the precipitation from the analyses (contours).



The GEOS-5 reanalysis precipitation was also compared for July 2004. Figure 11 (left) shows the difference between GEOS-5 and GPCP, while Figure 12 (right) shows the difference between GEOS-5 and the 5 analysis mean shown above. Figure 12 shows that adding additional models, such as GEOS-5, to the ensemble mean can help reduce the other analyses higher biases.



FUTURE WORK: Additional model analyses are being made available at MPI during the CEOP period. MSC (Canada) and CPTEC (Brazil) analysis data are downloaded and their processing is nearly complete. This and other data will be added to the ensemble analysis and the variance of the systems will be examined. The MERRA release of GEOS-5 will also be added to the study, with emphasis on the diurnal structure of precipitation and monsoon behavior. A cloud data study is also in development. Collaboration with other investigators are welcomed and invited.

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