Land Surface Water and Energy Flux Evaluation from the North American Regional Reanalysis (NARR) and Land Data Assimilation Systems (LDAS) for Water Resources Applications

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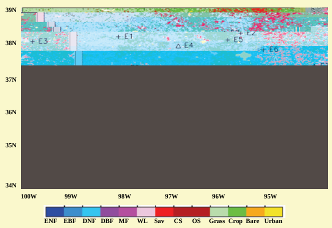
Abstract

The joint analysis of independent North American Regional Reanalysis (NARR) data, North American Land Data Assimilation System (NLDAS) data and In-situ measurements using Southern Great Plains (SGP) reference sites provides a unique look at the water and energy flux estimation from different model approaches. Comparison shows that large biases are found on the partitioning between sensible heat and latent heat fluxes in most models during spring and summer season. Possible factors, such as model forcing, parameterized surface albedo, land cover classifications and model physics, affecting the energy fluxes are investigated at a high spatial resolution through NASA Land Information System (LIS) over the SGP reference sites for the period from October 2002 to December 2004. It was found that the model forcing data, land cover classifications and model physics had significant influences on the energy flux estimation. This study will suggest the optimal forcing data and model for the future operational predictions.

DATA and MODELS



1) The North America Regional Reanalysis (NARR) was computed at the National Centers for Environmental Prediction (NCEP) and initially covers the period 1979-2003. The highest resolution output is at 32 km spatially with 30 pressure levels including surface level and every three hours temporally. Domains span all of North America including 186 variables. 2) NLDAS_Noah model at NCEP and NLDAS_Mosaic model at Goddard are real-time and retrospective hourly, uncoupled, land surface simulation system providing outputs of land surface water and energy balance featuring 0.125º spatial resolution (Cosgrove et al., 2003; Mitchell et al., 2004) . 3) The powerful Land Information System (LIS) is a high performance land surface modeling and data assimilation system capable of modeling global land-atmosphere interactions at spatial resolutions down to 1km (Peter-Lidard et al., 2004).

4) The third and fourth Coordinated Enhanced Observing Period (CEOP3&4) data were measured at half-hour frequency from October 2002 to December 2004. The GEWEX Americas Prediction Project - Atmospheric Radiation

Assessment of the Model Energy Budget

The outgoing LW radiation at the surface is well predicted from three models with correlation coefficient above 0.96 and relative RMS errors below 6%. Although the reflected SW radiation has large relative RMS errors (83% for MOSAIC, 55% for Noah, and 69% for NARR) due to the inconsistent estimates of the incoming SW radiation, its magnitude is much less than other radiation components (nearly ten times less than outgoing longwave radiation). Thus, the difference in outgoing shortwave radiation estimates can be ignored in the consideration of the energy budgets.

Although the differences of the net radiation between the field measurements and the model output have been reduced significantly through our analysis in the golden days (b), the large RMS errors were still found in the estimates of sensible heat and latent heat fluxes separately (c and d). It is encouraging that the

Evaluate the model energy fluxes with LIS

1. Effects from the forcing data

E15, located in grassland region, is selected to derive the "observed" albedo replacing the albedo in the LIS Mosaic model. The OS/IS ratio is very high up to 0.4 at station E15 in the winter due to snow effect. However, ratio and albedo from model for both stations are around 0.2 all year round from MOSAIC. Thus, the in-situ based albedo is assimilated by direct replacement into the land surface models.

The utility of in-situ based albedo has significantly improved the accuracy of estimations on the outgoing short wave radiation with no bias and less RMS errors on the site E15. The RMS errors in net radiation and the combine sensible and latent heat fluxes have been largely reduced, especially in winter.

Among the selected SGP sites, there are 3 sites (E4, E7 and E20) that the UMD land cover specifications do not match the in-situ observations. The dominant land cove types in NLDAS from UMD land cover map are grass/cropland for E4 at Plevna, KS, and wooded grassland for E7 at Elk Falls, KS and for E20 at Meeker, OK, while the field measurements at the three sites for CEOP3&4 periods were taken on the ungrazed rangeland for E4, and pasture for E7 and E20.

The monthly RMS errors of the simulated sensible flux were largely reduced over all three models, especially in the spring and summer seasons. The maximum reductions of the monthly RMS errors are 28 W/m^2 for Mosaic, 22 W/m^2 for Noah, and 31 W/m^2 for CLM2. The CLM2 model has its monthly RMS errors of sensible heat flux reduced among all 27 months, and the new RMS curves don't show any seasonal variations. The monthly RMS errors of latent heat flux and the combined sensible and latent heat fluxes just are slightly reduced for all three models. Both Mosaic and CLM2 models are more sensitive to land cover classification than

Summary

We used LIS to investigate the possible factors affecting the estimation of the energy fluxes, and found that the model forcing data, land cover classifications and model physics had significant influences on the energy flux estimation. This study used the accurate representation of forcing data, surface albedo and land cover type to largely improve the flux estimation among different models.

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