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Title: IMPROVING THE PROCESSES OF LAND-ATMOSPHERE INTERACTION IN CCSM 2.0 AT HIGHER RESOLUTION AND BETTER SUB-GRID SCALING

Brief Description of Research Project

Our CCPP project consists of the development and testing of a systematic sub-grid scaling framework for the CLM. It consists of four elements: i) a complex vegetation tiling representation; ii) an orographic tiling system; iii) a tiling system to describe a distribution of water table parameters intended to provide a realistic statistical model of wetlands; and iv) improvements of past developed treatments of precipitation intensity.

Most Recent Results to Date:

Vegetation tiling: We have advanced the vegetation tiling system through work on the required 3-D treatment of canopy radiation. Two papers were developed to provide the conceptual framework needed (Dickinson et al., 2008; Dickinson. 2008). These papers provide analytic solutions for the idealized case of a spherical bush with leaves treated as homogeneous scatters, and an underlying black surface. The required parameterization needs to extend these solutions by accounting for leaf orientation effects, bushes characterized by an aspect ratio , close enough together depending on their fractional coverage that their shadows have some overlap, and a reflecting underlying surface. Much of the structure of the parameterization can be understood in terms of what fraction of the surface is covered by shadows. Bush overlap is accounted for with a statistical model that insures total shadow coverage is less than 100%. The canopy radiation model also needs development of the global data sets required to support the numerical specifications of the model parameters. For the latter, Shaikh has obtained from NCAR and is working with the current high resolution vegetation data set supporting CLM 3.5. Initial implementation is on low resolution versions of CAM/CLM of T42 and T85 but plans are to also test at T170 (0.7 deg.) and T341 (0.35 deg.).

Orographic tiling system: Yan Huang implemented a version of the WRF mesoscale model (40 km grid) at Georgia Tech and repeated earlier simulations by Shaikh run with CAM to determine how to scale model parameters with elevation. She found little dependence on various options available for running WARF (e.g. , convection scheme or boundary layer scheme) but some substantial differences with the earlier results from CAM. Presumably these results depend on differences between the CLM and the WRF land scheme. As our project has nobody sufficiently knowledgeable about the latter, it is not possible to trace them back to model differences but they provide some idea of uncertainty. Huang has a paper in preparation but its progress is slow as she has taken a position elsewhere.

Water table: We concentrated our efforts in supporting the implementation of a water table scheme in CLM as part of CLM 3.5 working with Niu at UTA and Oleson at NCAR. The Niu et al. (2007) paper describes the underlying concepts and initial implementation, and Oleson et al, the overall new version of CLM. We have been contributing analysis and consequent suggestions to resolution of the current issue of too rapid exchange between the ground water reservoir and the overlying soil column.

Most recent products delivered (above mentioned papers)

Dickinson, 2008: Determination for climate models of the multi-scattered solar radiation from a canopy with leaves modeled as a 3D distribution of homogeneous isotropic scatters, *J. of Computational Physics*, **227**, 3367-3677.

Dickinson, R. E., Y. Tian, Q. Liu and L. Zhou, 2008: Dynamics of leaf area for climate and weather models, *J. Geophys. Res.*, accepted.

Oleson, K.W., G.-Y. Niu, Z.-L. Yang, D.M. Lawrence, P.E. Thornton, P.J. Lawrence, R. Stockli, R. E. Dickinson, et al., 2008: Improvements to the Community Land Model and their impact on the hydrological cycle. *J. Geophys. Res.* **113,** *G01021, doi:10.1029/2007JG000563.*

Niu, G.-Y., Z.-L. Yang, R.E. Dickinson, L.E. Gulden, and H. Su, 2007: Development of a simple groundwater model for iuse in climate models and evaluation with GRACE data. *J. Geophys. Res.*, **112,** D07103, doi:10.1029/2006JD007522.