3rd International Conference on Earth System Modelling
Vol. , 3ICESM-328, 2012
3rd International Conference on Earth System Modelling

Data assimilation experiments in coupled systems: Applicability to the land surface for the initialization of long-range simulations

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At their lower boundary, climate models are usually coupled to land-surface models by the exchange of heat and moisture fluxes. Soil temperature and soil moisture are known to have a strong influence on screen level variables. Particularly the deeper soil has a long-term memory, and this low-frequency variability is assumed to have a potential of seasonal and decadal predictability.

To exploit this potential, a climate prediction should be initialized with an optimal estimate of the soil state. Additionally, the parameters used to describe soil properties, such as hydraulic conductivity or root depth, are another major source of uncertainty in a land-surface model, which are known to have significant influence on climate simulation results. Both issues can be adressed by the means of data assimilation, where state and parameters are dynamically adjusted by combining model predictions and observations. Within the MiKlip project, this is planned to be performed on global (A-8, PASTLAND) and regional (e.g. C-29, DEPARTURE & C-18, DECREG) scales.

More generally, the land-surface model itself can be interpreted as a coupled system: The upper soil is influenced by fast processes (the influence of the atmosphere), while the deeper soil is characterized by a rather slow variability. The coupling within the model results from the vertical transport of energy and soil moisture.

This work investigates the impact of data assimilation (by ensemble methods) in coupled systems and concentrates on the information transfer between observable and unobservable parts. We show results from two different experimental setups:

- A coupled slow/fast Lorenz model is used to gain insight into more general aspects.
- The land-surface model TERRA is run in an ideal environment at Lindenberg, where highly-resolved boundary conditions as well as observations of soil temperature and moisture are available.