Land Surface Modelling at the UK Met. Office

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The surface parametrization group at the Hadley Centre develops improved representations of the land surface for the UKMO Unified Model (UM), which is used for both climate prediction and weather forecasting.

Recently, a new land surface scheme called "MOSES" has been introduced into the climate configurations of the UM. MOSES includes new modules representing soil water phase changes and the response of stomatal resistance to environmental variables (including CO_2). It is found to have a beneficial impact on the GCM simulation of the current climate, warming the high-latitudes in winter (due to the inclusion of soil water phase changes) and cooling the mid-latitudes in summer (due mostly to increased plant rooting depths). CO_2-induced stomatal closure within MOSES is also found to have significant impacts on the GCM climate senstivity to CO_2.

The new scheme is also being tested in the mesoscale NWP configuration of the UM, but here the constraints and targets are rather different. NWP applications of surface physics are dependent on initialisation and/or data assimilation for the "slow" surface variables (e.g. vegetation, soil moisture and soil temperature). Also, NWP puts more emphasis on a realistic simulation of the diurnal cycle in screen level variables (eg. temperature and humidity). Single column and mesoscale model tests suggest that MOSES over-estimates night-time minimum temperatures, as a result of an excessively strong coupling between the surface ("skin") temperature and the soil temperatures. A simple "thermal canopy" parametrization reduces this coupling and may be adapted to model urban heat island effects.

Although the emphasis is different, there are common processes which need to be modelled within both NWP and GCM land surface schemes. Sub-grid land surface heteorgeneity occurs on a wide range of space scales and is therefore a problem for both applications. One means of dealing with this is to calculate the surface fluxes for each different surface type (or "tile") within a gridbox. The gridbox mean fluxes can then be calculated explicitly as area weighted averages of the tile fluxes, rather than being approximated using "effective" parameters. Such a tile land surface scheme, "MOSES II", has been developed at the UK Met Office and is currently being tested in the GCM.

At the Hadley Centre, as elsewhere, the remit of land surface modelling is expanding to include CO_2 fluxes and interactive vegetation. MOSES II will provide accumulated carbon fluxes (and leaf turnover rates) to drive a Dynamic Global Vegetation Model ("TRIFFID"), which updates the area coverage and leaf area index of each of 5 vegetation tiles (broadleaf tree, needleleaf tree, C_3 grass, C_4 grass and shrub). TRIFFID will allow feedbacks associated with changes in vegetation structure and distribution to be included consistently within GCM climate predictions, and will form a key element of our first attempts at coupled climate-carbon cycle modelling.