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Making direct use of canopy profiles in vegetation – atmosphere coupling

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Most coupled land-surface regional models use the 'big-leaf' approach for simulating the sensible and latent heat fluxes of different vegetation types. However, there has been a progression in the types of questions being asked of these models, such as the consequences of land-use change or the behaviour of BVOCs and aerosol. In addition, recent years has seen growth in the availability of in-canopy datasets across a broaded range of species, with which to calibrate these simulations. Hence, there is now an argument for transferring some of the techniques and processes previously used in local, site-based land surface models to the land surface components of models which operate on a regional or even global scale.

We describe here the development and evaluation of a vertical canopy energy budget model (Ryder, J et al., 2014) that can be coupled to an atmospheric model such as LMDz. Significantly, the model preserves the implicit coupling of the land-surface to atmosphere interface, which means that run-time efficiences are preserved. This is acheived by means of an interface based on the approach of Polcher et al. (1998) and Best et al. (2004), but newly developed for a canopy column. The model makes use of techniques from site-based models, such as the calculation of vertical turbulence statistics using a second-order closure model (Massman & Weil, 1999), and the distribution of long-wave and short-wave radiation over the profile, the latter using an innovate multilayer albedo scheme (McGrath et al., in prep.). Complete profiles of atmospheric temperature and specific humidity are now calculated, in order to simulate sensible and latent heat fluxes, as well as the leaf temperature at each level in the model.

The model is shown to perform stably, and reproduces well flux measurements at an initial test site, across a time period of several days, or over the course of a year. Further applications of the model might be to simulate mixed canopies, the light-stimulated emission of chemical species, or the ecological consequences of changes to temperature profile as a results of changes to stand structure.

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