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Time-varying biophysical properties of terrestrial ecosystems: Their use in regional climate modeling

E. Hugo Berbery†; Domingo Alcaraz-Segura; Omar Muller
† University of Maryland, USA
Leading author: berbery@atmos.umd.edu

Including the interannual variability of vegetation functioning into land-surface models is a necessary element to account for land-use and land-cover change effects on climate models. However, many land-surface models use land-cover classifications that do not have year-to-year variability. Changes in land cover do occur, for example, in the form of land-use shifts, fires, floods, droughts, and insect outbreaks. These changes also imply changes in the land surface's biophysical properties, a source of variability that is thus not taken into account in the simulations. The properties may influence near surface variables, the boundary layer, the atmosphere's convective instability, the low level moisture fluxes, and ultimately, their manifestation in changes of precipitation and temperature. A consistent set of time-varying biophysical properties has been produced by taking advantage of the concept of ecosystem functional types (EFTs), seen as patches of the land surface that have homogeneous exchanges of mass and energy with the atmosphere. It is already known that climate is the main regional driver of ecosystem structure and functioning, as it determines the timing and amount of water and energy that is available in the ecosystems. In turn, ecosystems also influence climate primarily by determining the energy, momentum, and water exchanges between the land-surface and the atmosphere. Once EFTs are defined, they are assigned biophysical properties that are consistent with those already in use for land cover types. However, as EFTs change from year to year so do the properties. Some land-surface properties exhibit greater interannual variability than others across the entire study area. Large interannual variability was found for surface roughness, stomatal resistance, and minimum leaf area index. Low interannual variability was observed for emissivity, and radiation stress. Rooting depth, background albedo, Green vegetation fraction, and maximum leaf area index showed intermediate variability. Numerical experiments with a regional climate model employing EFTs in place of land cover types show that a representation of the land surface that takes into account realistic conditions during anomalous periods reduces the model biases in precipitation and better represents extremes like floods and droughts.