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Scaling up of carbon exchange dynamics from AmeriFlux sites to a super-region in eastern North America

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We are presenting a strategy to use in-situ observations from about 40 long-term AmeriFlux sites in eastern North America to scale up carbon exchange dynamics to a large region of North America between ˜28° and 50° N, and from ˜90° W to the east coast. This region contains over 40 carbon flux measurement sites (mostly of the AmeriFlux network) in a variety of climatic and landuse settings, from upland forest, agricultural areas, to urban development. The core of the scaling strategy uses measured fluxes of CO2, energy, water, and other biophysical and biometric parameters to train and calibrate surface-vegetation-atmosphere models, in conjunction with satellite derived drivers.

It is a major problem of bottom-up scaling that in-situ flux observations are in general spatially limited and disparate. Thus, to achieve valid regional exchange rates, models must be used to interpolate and extrapolate spatial domain covered by these observations. Observed and modeled fluxes can only be linked if they represent exchange over the same ecosystem. Because most long-term flux stations are not situated in spatially extensive homogeneous locations, this requirement is often a problem, but can be satisfied by selecting observation periods whose flux footprints are statistically representative of the type of ecosystem identified in the model. The flux footprint function indicates the time-varying surface “field-of-view” (or spatial sampling window) of an eddy-flux sensor, oriented mostly in upwind direction. For each observation period, the modeled flux footprint window is overlaid over a high reso-

lution vegetation index map (derived from Landsat or a better resolution platform), to determine a footprint-weighted vegetation index for which the observation is representative. To achieve matching of measured and modeled fluxes, the ecosystem parameters of the models will be adjusted to those contained in the dynamically variable flux-tower footprints. Calibrated models are used in conjunction with MODIS data, atmospheric re-analysis data, and digital land-cover databases to derive ecosystem exchange fluxes over the study domain. Meteorological conditions at canopy level and high temporal and spatial resolution are coupled to tropospheric re-analysis data by a one-dimensional boundary-layer slab-model, which is also trained and calibrated against LIDAR data at select flux sites.

To integrate across the large range of spatial scales (from 102 m for a site to several 106 m for the domain), and over time scales from hourly fluxes to annual net ecosystem exchange (NEE) we follow a multi-tiered and multi-scale nesting approach. To simulate a future prognostic mode of our strategy, meteorological variables to drive the models are derived from standard re-analysis fields. To address the problem of their low spatial resolution and unreliability of surface values, we use data from levels higher than about 200 mb above the surface elevation. Canopy level temperatures and other fields are derived from these iteratively, by inversion with a mixed layer slab-model and using local surface parameters.