Evaluation of Observing and Modeling requirements for the Balanço Atmosférico Regional de Carbono na Amazônia (BARCA) Project

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A study of basin-wide carbon balance for Amazonia (Balanço Atmosférico Regional de Carbono na Amazônia -- BARCA) is being planned, involving systematic observations of variations of trace gas mixing ratios, simulation analysis of atmospheric transport, and regional flux estimation by inverse methods. In addition to proposed campaign observations to be made by aircraft, a longer-term program of ongoing trace gas measurements may provide information about the time-mean carbon budget. We have conducted a series of observing system simulation experiments using a coupled model of meteorology, atmospheric transport, and surface exchanges of energy/water/carbon (SiB-BRAMS). Observations of atmospheric trace gas mixing ratio were simulated in the model by releasing imaginary "particles" into an adjoint of the simulated transport field using a Lagrangian Particle Dispersion Model (LPDM) driven from the SiB-BRAMS meteorology. Backward-in-time transport was calculated by the LPDM from each hypothetical sample according to model parameterizations of advection, turbulence, and vertical motion associated with both deep and shallow convective clouds. Samples were specified hourly from each LBA eddy covariance site, twice weekly as profiles from two locations (Santarem and Fortaleza) using light aircraft, and weekly from the existing global flask network. Results show that time-mean fluxes over much of the Amazon Basin can be strongly constrained by such a sampling network, but highlight uncertainties associated with model transport and the treatment of diurnal and synoptic variations of surface fluxes. An analytical framework is recommended in which surface fluxes are divided into components due to photosynthesis, ecosystem respiration, and a time-mean flux by unspecified processes. Balanced component fluxes due to photosynthesis and respiration can be constrained using eddy covariance data, satellite imagery, and regional meteorology, and time-mean fluxes constrained by observed variations in atmospheric composition. Transport model error, especially related to turbulent and convective processes, must also be treated in the analysis.

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