Geophysical Research Abstracts,
Vol. 11, EGU2009-6493, 2009
EGU General Assembly 2009

Constraining regional scale carbon budgets at the US West Coast using a high-resolution atmospheric inverse modeling approach

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The study presented is embedded within the NACP (North American Carbon Program) West Coast project ORCA2, which aims at determining the regional carbon balance of the US states Oregon, California and Washington. Our work specifically focuses on the effect of disturbance history and climate variability, aiming at improving our understanding of e.g. drought stress and stand age on carbon sources and sinks in complex terrain with fine-scale variability in land cover types.

The ORCA2 atmospheric inverse modeling approach has been set up to capture flux variability on the regional scale at high temporal and spatial resolution. Atmospheric transport is simulated coupling the mesoscale model WRF (Weather Research and Forecast) with the STILT (Stochastic Time Inverted Lagrangian Transport) footprint model. This setup allows identifying sources and sinks that influence atmospheric observations with highly resolved mass transport fields and realistic turbulent mixing. Terrestrial biosphere carbon fluxes are simulated at spatial resolutions of up to 1km and subdaily timesteps, considering effects of ecoregion, land cover type and disturbance regime on the carbon budgets. Our approach assimilates high-precision atmospheric CO2 concentration measurements and eddy-covariance data from several sites throughout the model domain, as well as high-resolution remote sensing products (e.g. LandSat, MODIS) and interpolated surface meteorology (DayMet, SOGS, PRISM).

We present top-down modeling results that have been optimized using Bayesian inversion, reflecting the information on regional scale carbon processes provided by the network of high-precision CO2 observations. We address the level of detail (e.g. spatial and temporal resolution) that can be resolved by top-down modeling on the regional scale, given the uncertainties introduced by various sources for model-data mismatch. Our results demonstrate the importance of accurate modeling of carbon-water coupling, with the representation of water availability and drought stress playing a dominant role to capture spatially variable CO2 exchange rates in a region characterized by strong climatic gradients.