The ORCA2 West Coast Regional NACP Project

An Inverse Modeling Approach to Constrain Regional Scale Carbon Fluxes

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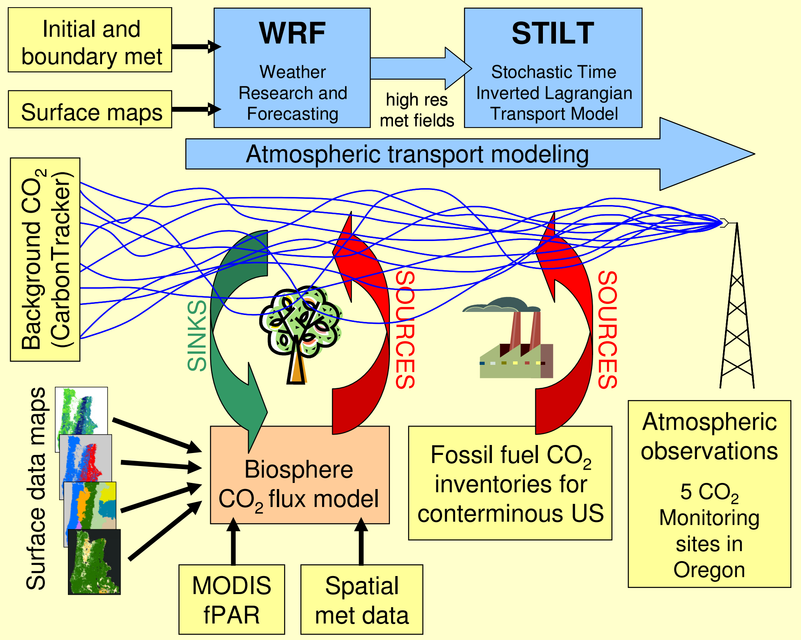
Objectives

- Apply top-down modeling to constrain the regional carbon balance of the US West Coast Region (CA, OR, WA). The presented results focus on the state of Oregon
- Integrate atmospheric, inventory and RS data sources to improve results (see Figs. 1 & 2)
- Analyze the role of climate variability, disturbance history, and stand age on regional scale carbon fluxes and pools
- Compare top-down and bottom-up approaches, combine both to reduce output uncertainty

Model design



Simulate transport by coupling mesoscale model (WRF) to Lagrangian backward trajectories (STILT)

Background and fossil fuel data taken from external databases, not optimized

Compare simulated CO_2 concentrations with atmospheric observations, optimize by improving biosphere flux model parameters (Fig.2)

Find optimum set of baserates for the flux model through Bayesian inversion

Fig.1: Conceptual overview on top-down modeling setup.

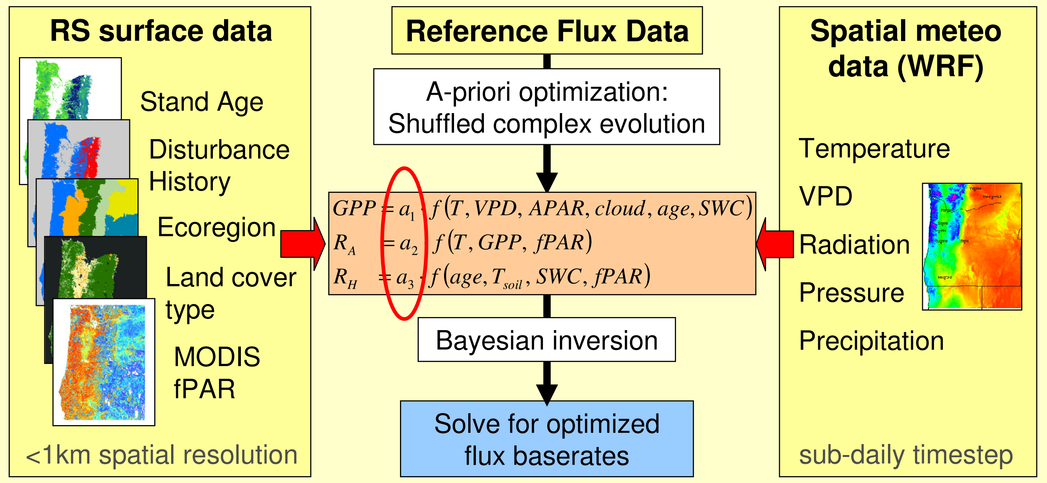


Fig.2: Data sources and optimization strategy for the ORCA diagnostic biosphere flux model.

Atmospheric CO_2 monitoring

5 monitoring sites arranged in West-East transect through the state of Oregon, from Pacific coast to central high desert (Fig.3). The accumulated source weight function (Fig.4) covers most of the state, with some gaps in the far East and lower coverage in the Southwest

Similar instrumentation at all sites. Comparison to reference gases in ~4hr intervals to provide well calibrated CO_2 concentration data

Continuous monitoring, averaged in 1hr bins, since summer 2006. Only data from 2007 used for the presented results

Quality screening of data to identify well-mixed atmospheric conditions

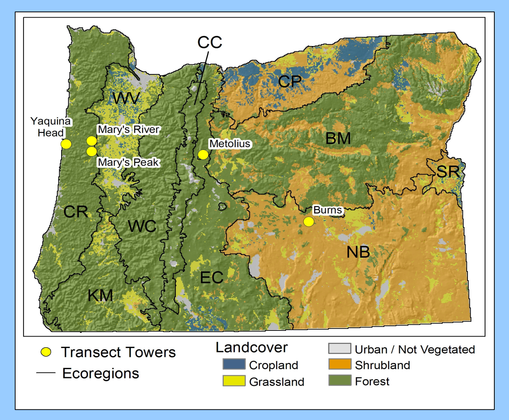


Fig.3: Site locations and land use.

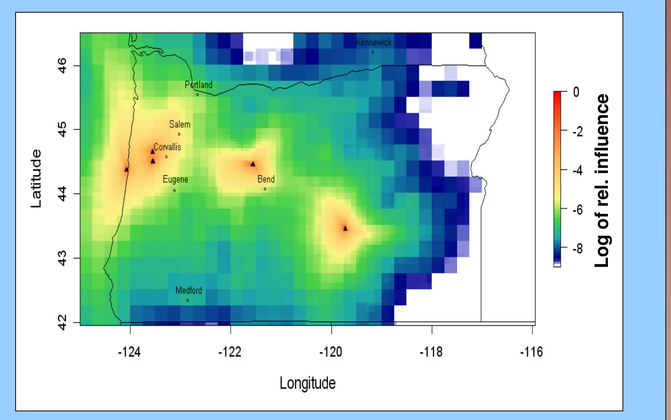


Fig.4: Cumulative source weight for 2007.

RESULTS

- Even prior model version (trained with eddy-covariance data and bottom-up references, not optimized against CO_2 data) produces high correlation between modeled and measured CO2 concentrations (Fig. 5)
- Significant improvements for the easternmost site (Burns) after optimization (Fig.6), indicating biased prior setup for the high desert ecosystems
- Largest flux modifications assigned to autotrophic respiration (RA) in western half of the state (Fig.7), while heterotrophic respiration (RH) reduced in most areas
- Net ecosystem exchange (NEE) increases and decreases moderately on the statewide level (Figs. 8 and 9). Increased sink strength found mostly in the East Cascade forests and high desert grass- and shrublands, decreases focus on the humid western conifer forests and northern agricultural areas
- 9% increase in net carbon uptake within the state of Oregon after optimizing the fluxes with the inverse modeling framework. Statewide budget still preliminary, since some components of the data quality screening and optimization procedure still need to be fine-tuned

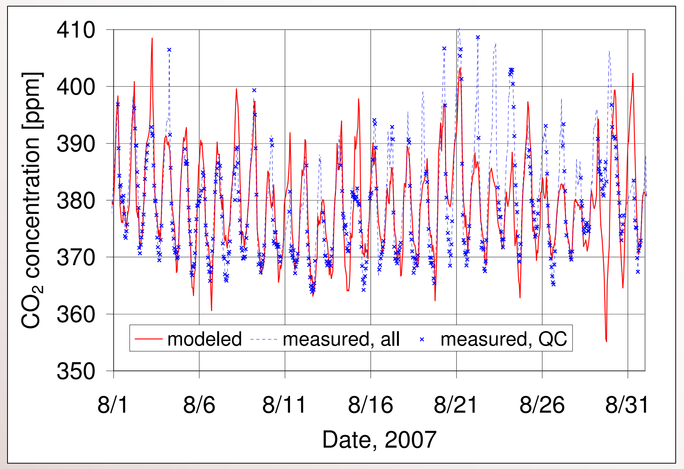


Fig.5: Measured vs. modeled (a priori) CO_2 concentrations at the Mary's River site.

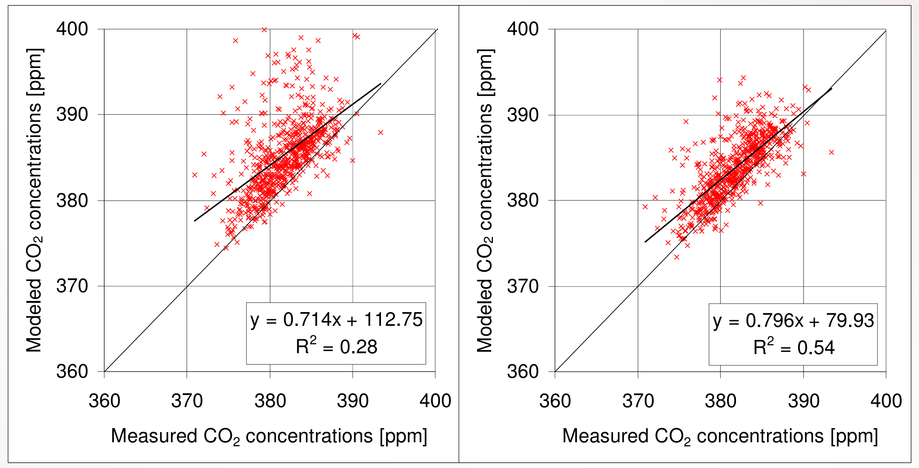


Fig.6: Measured vs. modeled CO_2 concentrations (4hr averages) at the Burns site before (left) and after (right) optimization.

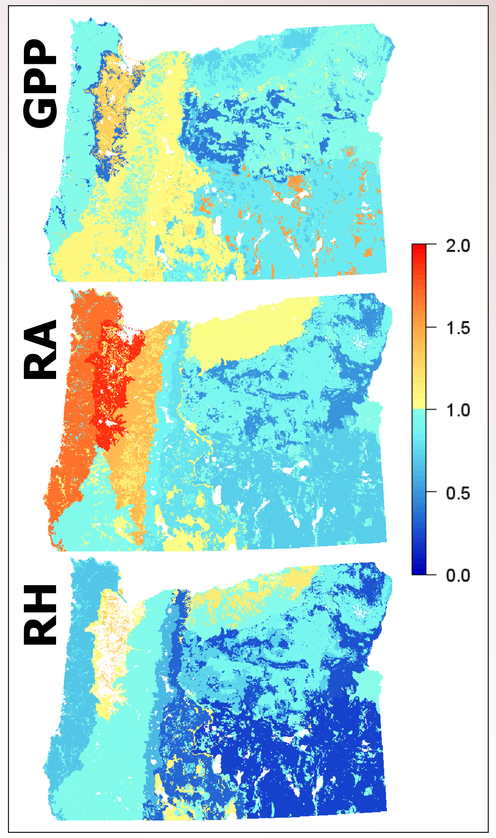


Fig.7: Scaling ratios between posterior and prior fluxes. Warm colors indicate higher fluxes in the optimized flux model version.

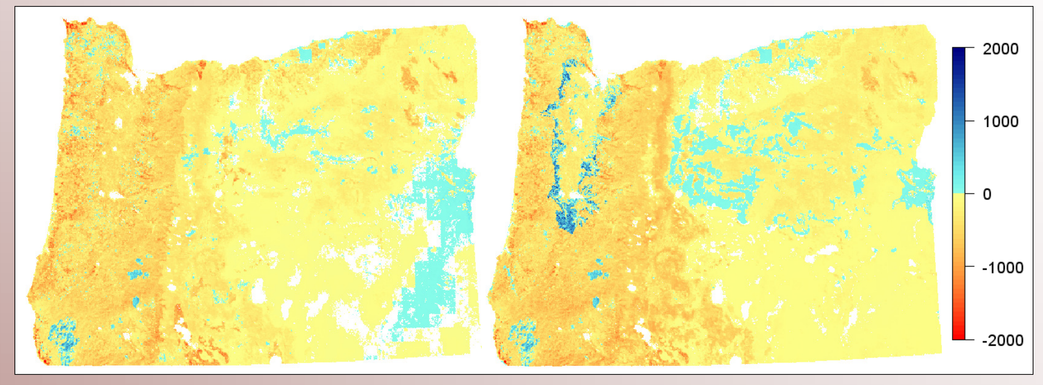


Fig.8: Annual NEE fluxes [gC m^{-2}] before (left) and after (right) optimization. Warm colors indicate a net terrestrial carbon sink.

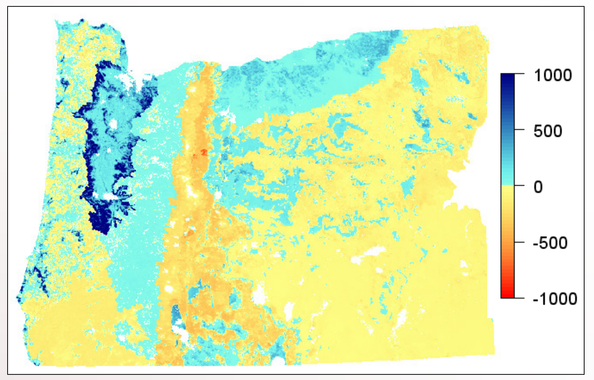


Fig.9: Annual NEE differences [gC m^{-2}], optimized – initial flux model. Warm colors indicate higher uptake in posterior version.

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