Estimating Flux Perturbations Using Simulated ASCENDS Observations

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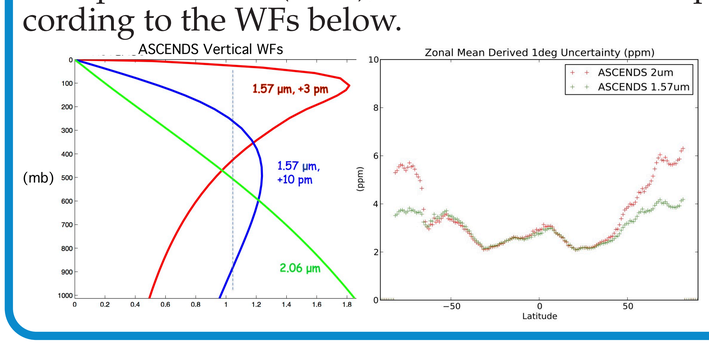
Overview

- The Active Sensing of Carbon Emissions over Days, Nights and Seasons (ASCENDS) mission will measure atmospheric carbon dioxide concentration using a differential absorption lidar (DIAL) technique.
- In this project, we assessed the information content of simulated ASCENDS retrievals of column integrated CO_2 (XCO_2) on realistic perturbations to a baseline set of fluxes, described in detail in Hammerling et al (2014).

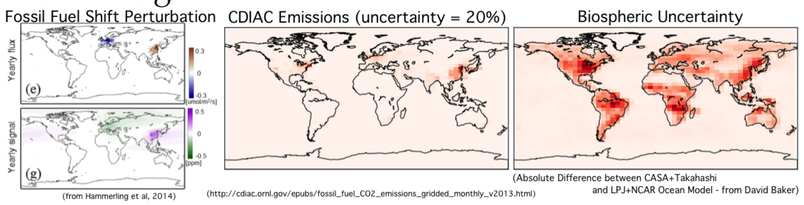
Observations

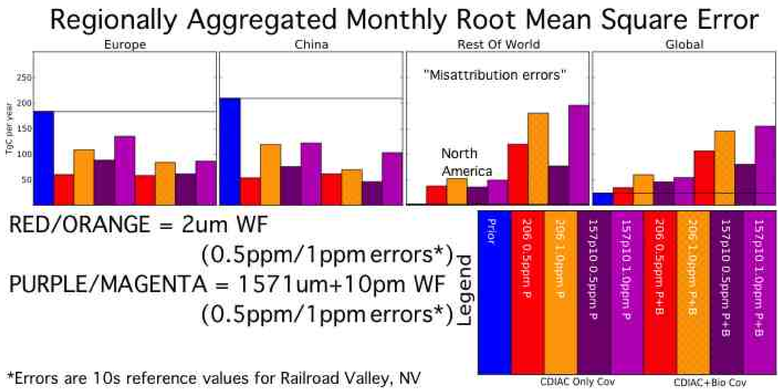
- ASCENDS will retrieve XCO_2 using differential absorption in the weak ($\sim 1.57\mu m$) and/or strong ($\sim 2\mu m$) CO_2 bands. The choice of line determines the vertical weighting function (WF), which quantifies the sensitivity of the retrieval to a particular atmospheric layer.
- To create pseudo-observations, a set of "truth" fluxes are propagated into concentrations using a transport model (TM5), which are then sampled according to the WFs below.



Fossil Fuel Emission Shift

- In this scenario, fossil fuel emissions shift from Europe to China in a largely neutral way, meaning no change would be detected in the global background. This is already happening in reality due to carbon controls put into place in the EU and accelerated economic growth in China.



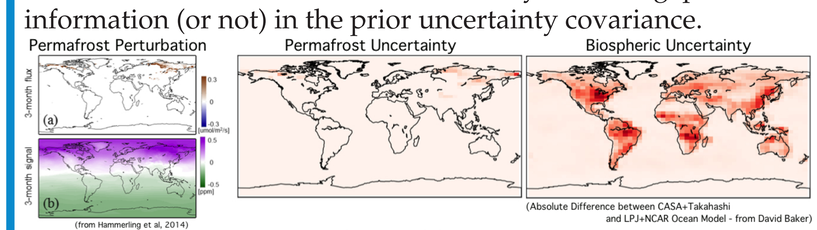


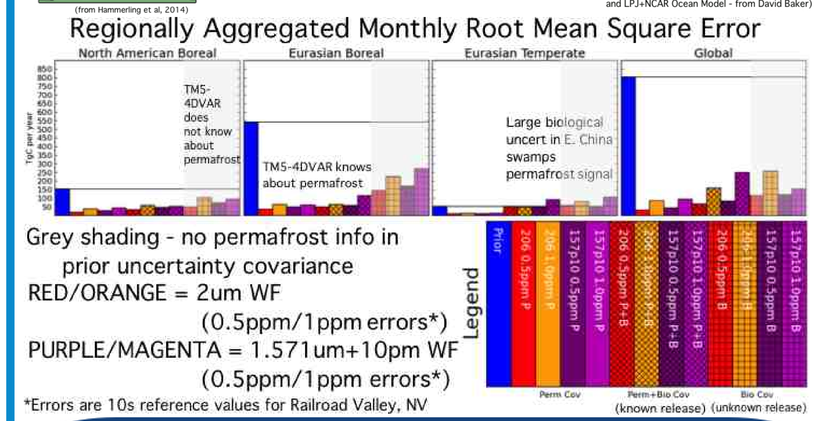
RESULTS:

- ASCENDS observations reduce errors in monthly emissions by at least 30%
- Increased measurement precision leads to improved flux estimates
- Magnitudes are sensitive to prior uncertainty covariance

Permafrost Release

- This scenario draws upon work by Schaefer et al (2011), wherein the authors used the SiB-CASA model driven by output from GCMs using the A1B scenario from the IPCC AR4 to investigate potential warming impacts on permafrost at high latitudes in North America and Eurasia. We assessed the ability of ASCENDS observations to diagnose permafrost release if the community were aware or unaware of a release by including permafrost information (or not) in the prior uncertainty covariance.

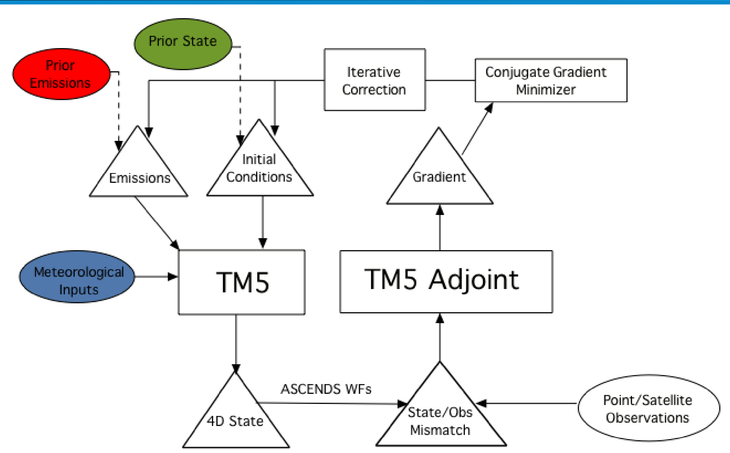




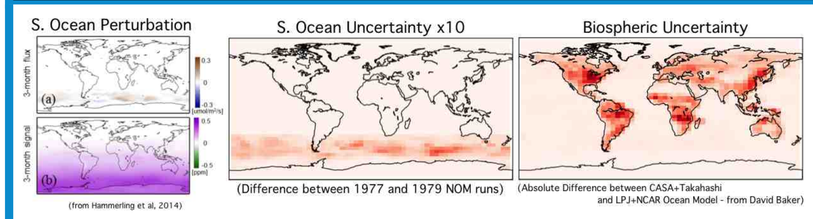
RESULTS:

- ASCENDS observations predict elevated boreal source even when no permafrost information is included in the prior uncertainty
- Eurasian Temperate signal is overwhelmed by biological uncertainty in East China - may not be detectable

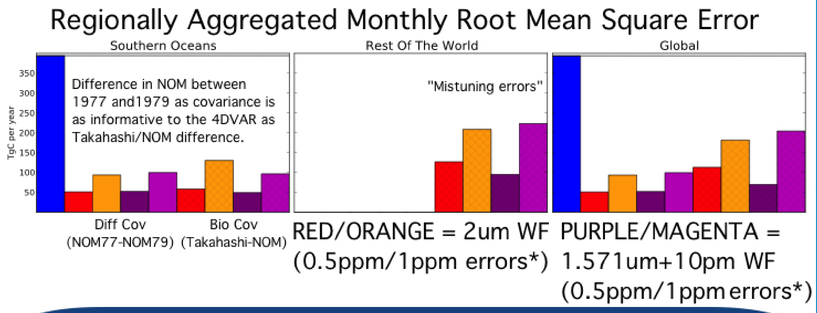
TM5-4DVAR



Southern Ocean Interannual Variability



- In Doney et al (2009), the CCSM Ocean Biogeochemical Elemental Cycle model was shown to produce different regimes of behavior for the Southern Ocean (SO). In 1977, the SO was primarily a source of CO_2, while in 1979, it was primarily a sink. We attempted to estimate the difference between these two years for SO, which is especially challenging due to regular large scale cloud cover.



RESULTS:

- ASCENDS observations should be able to significantly reduce uncertainty in the Southern Ocean to atmosphere CO2 flux at the regional scale
- The regional result was similar for two choices of prior uncertainty