Quantifying the influence of climate and land use change on primary production using carbonyl sulfide measurements

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Relationship of CO_2 to Carbonyl Sulfide

While regional-scale analysis of atmospheric CO_2 measurements is useful for determining CO_2 fluxes, additional tracers are helpful in determining the underlying processes. Regional analysis of the atmospheric carbonyl sulfide tracer over North America suggests a strong relationship to primary production [Campbell et al., *Science*, 2008]**. Here we show how COS could be applied to deconvolve processes that underlie net carbon fluxes.**

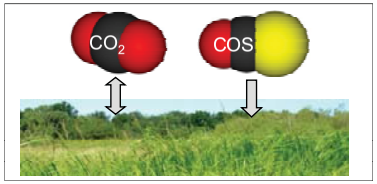
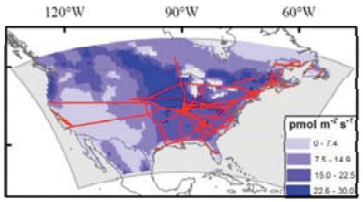


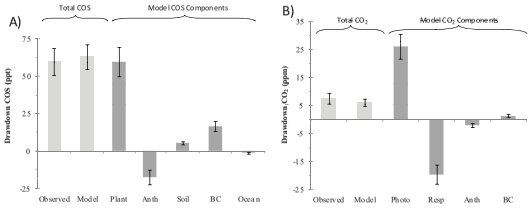
Fig. 1. The dominant land fluxes of CO_2 are photosynthesis and respiration while OCS uptake is influenced by a process linked to photosynthesis.

Plant Uptake of Carbonyl Sulfide

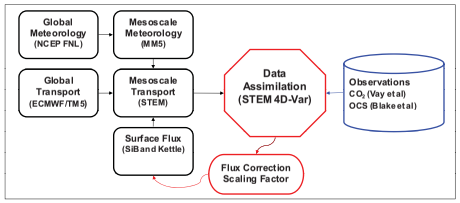
$$F = GPP \cdot \frac{[COS]}{[CO_2]} \cdot V_{COS/CO2}$$

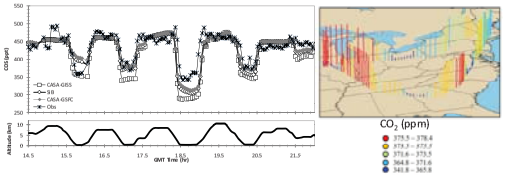


- ❑INTEX-NA observations and regional model are quantitatively consistent with GPP-based plant uptake
- ❑Plant uptake of COS is dominant over other COS surface fluxes for the continental growing season
- ❑Relative uptake of COS to CO_2 is consistent between atmospheric measurements made from different labs and for different years
- ❑C4 plants have a low value for GPP/NEE or leaf-scale relative uptake

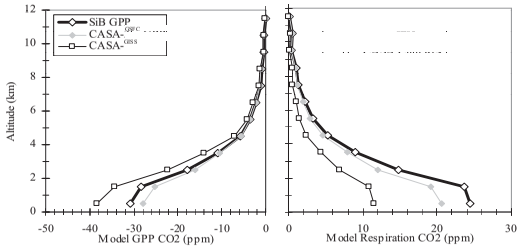


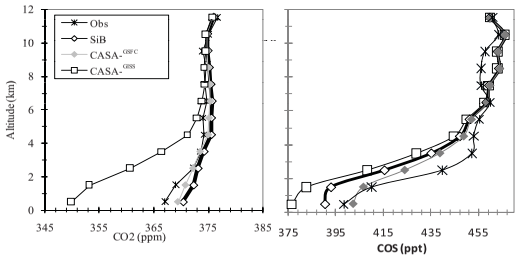
Top-Down Primary Production Assessment



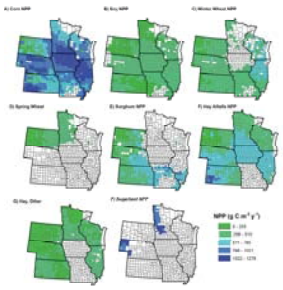


- ❑Top-down CO_2 analysis provides constraint on net CO2 flux
- ❑GPP and respiration components are large relative to net flux, suggesting the need for a tracer
- ❑Three flux models show variability in the GPP estimate with the CASA-GISS flux as the largest
- ❑The large flux from CASA-GISS also appears to overestimate the COS drawdown, but looking at CO2 also , its clear that respiration is underestimated.

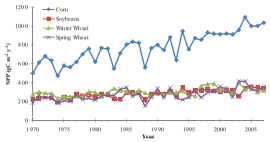




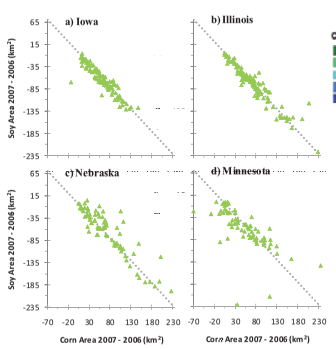
Primary Production During Biofuel Crop Surge

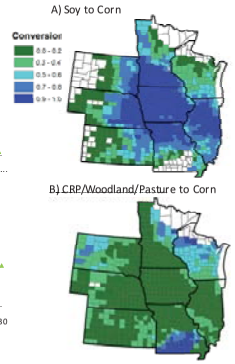


- ❑NPP for corn is roughly three times the NPP of other widespread crops in the Midwest
- ❑Corn NPP increasing at faster rate than other crops
- ❑Other biofuels crops (e.g. Miscanthus) may have higher NPP



- ❑High yields of corn relative to other crops (above) and rapidly expanding corn area (below) can influence regional NPP
- ❑New flux estimates account for crop yields and expansion
- ❑Assessing these surface flux estimates may be supported by the simultaneous analysis of CO_2 and COS.





References

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Montzka, S. A., et. al. (2007). "On the global distribution, seasonality, and budget of atmospheric carbonyl sulfide (COS) and some similarities to CO_2." *Journal Of Geophysical Research-Atmospheres* 112(D9): doi:10.1029/2006JD007665.

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