Coupled Inverse Modeling of CO_2 and CH_4 in the Troposphere Using Novel Constraints

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Understanding the budgets of carbon dioxide and methane is critical to predicting climate change. Carbon dioxide and methane directly impact earth's radiative balance as greenhouse gasses. Additionally, methane plays a crucial role as a reactant in earth's photochemistry. Any future attempts to manage carbon reservoirs depend fundamentally on quantitative improvement of source and sink estimates.

Inverse modeling is a class of techniques that uses observations of atmospheric trace gases and a global transport or general circulation model to estimate sources and sinks. While inverse models are powerful methods to recover sources and sinks on a global scale, there are still many limitations to their accuracy. Some areas are largely under-sampled because of logistical, political, or financial difficulties associated with making regular measurements. As a result, these regions are poorly constrained, increasing the error in inversion estimates for sources in the area. Additionally, sampling is often done preferentially near oceans which causes under-estimation of continental sources. Limitations in the model can also cause inaccuracy. For example, because of limited model resolution, small-scale spatial and temporal variability cannot be resolved.

By introducing additional constraints into the inversion, the noise associated with these problems might be significantly reduced. Measured relationships between the trace gases, source specific emission ratios, and temporal gradients might be used to couple trace gases and further constrain the inversion. In this talk use of these constraints will be explored through coupled inversions of methane and carbon dioxide.

These preliminary experiments, using only one constraint, have demonstrated the potential of coupling trace gases to significantly improve estimation of trace gas sources and sinks.