Role of GOSAT total column CO_2 observations in the estimation of CO_2 surface fluxes

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GLOBAL ECOLOGY

Measuring CO₂ from space

Strength: spatial coverage expected to bring a quantum leap in carbon inversions

Atmospheric CO₂ observations



Measuring CO₂ from space

- Strength: spatial coverage expected to bring a quantum leap in carbon inversions
- Weakness: stringent precision and accuracy requirements for CO₂ retrievals



Source: Hungershoefer et al. [2010]

precision ∞ uncertainty reduction at regional scale

GOSAT Obs. Influence

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- Ability of transport models to link the variations in the column-averaged CO₂ concentrations to the changes in the surface fluxes
- How robust are CO₂ fluxes derived from satellite CO₂ observations?
- How influential are the satellite observations (relative to the surface observations) within such 'top-down' analyses?

Ensemble DA system – GEnSRF

Use an ensemble of analysis states to represent the full system state and its error statistics



Skipping Subtleties....

- Sequential
- Deterministic
- Smoother

Ζ

- Advanced algorithms to counter sampling error
- See Chatterjee et al. [2012], JGR-A

Source: J. Anderson, NCAR

- Leverage maximum information from the atmospheric data minimize assumptions regarding prior CO₂ flux patterns and distributions
- Fine spatiotemporal scales 1° by 1.25°, daily

Monthly averaged CO₂ fluxes at 1° by 1.25°



Uninformative prior

Any changes to the *constant but unknown mean flux in space and time* driven by observations

 Little variability at fine scales



Reduction in uncertainty at TransCom3 regions





Source : ODIAC (T. Oda); MsTMIP models - BIOME-BGC (W. Wang), CLM (D. Hayes), CLM4VIC (M. Huang), DLEM (H. Tian), GTEC (D. Ricciuto), LPJ-wsl (B. Poulter), VEGAS2 (N. Zeng), ORCHIDEE-LSCE (Gwenaëlle Berthier and Shushi Peng), TRIPLEX-GHG (Changhui Peng)



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Observational influence of GOSAT because of – spatial coverage, or more information content?

Analysis sensitivity with respect to observations

- Quantify the observational influence on the analysis
- □ Influence matrix =
 - covariance (analysis projected onto observation space)/ covariance (observations)
 - characterizes how the assimilation system uses the observations to pull the analysis away from the prior



Monitoring the observational influence in time

[WGGMS-9

GOSAT Obs. Influence



- Influence of the observations inversely proportional to the measurement error or the total modeldata mismatch error
- Total column vs. surface data interplay of modeldata mismatch error, atmospheric transport

Current utility of GOSAT observations is clearly in its spatial coverage

Summary

- GOSAT Obs. Influence
- GEnSRF provides a framework to use GOSAT observations to
 - (a) constrain fluxes at high spatiotemporal resolutions,
 - (b) independently reconcile top-down/bottom-up estimates,
 - (c) understand the role of GOSAT observations in influencing the analysis
- Closer examination of the analysis sensitivity demonstrates that current utility of GOSAT observations is likely due to its spatial coverage
- Ongoing work: how to detect, and account for the impact of systematic errors in the satellite observations?

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QUESTIONS?

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