Estimating global carbon fluxes with GOSAT observations

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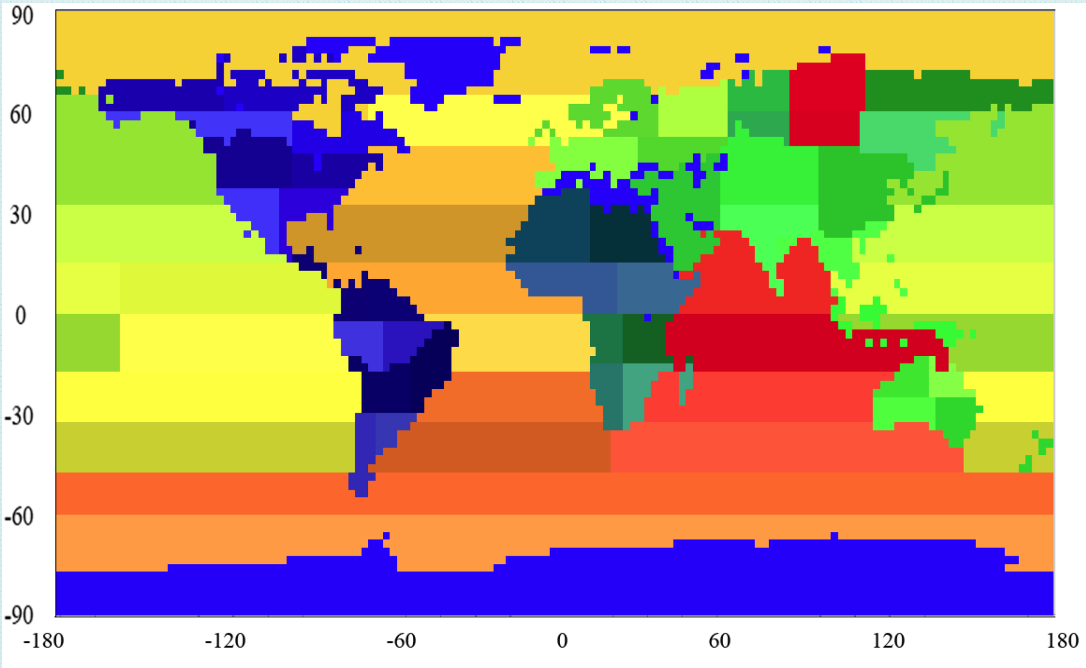
Contents

Basic procedure for standard GOSAT Level 4 product:
Estimations of monthly CO_2 regional fluxes by using existing surface network and GOSAT observations.

- Expected GOSAT data and its use in flux estimation
- Inverse estimation with total column CO_2 data
- Inverse model estimates of the flux uncertainty
- Summary

Inverse model of the regional CO_2 fluxes.



Map of inverse model regions

1. Monthly emission pulse of 1GtC/year is prescribed for each region and each month, then inverse problem is solved to find optimal flux distribution that fits to observations
2. Estimated CO2 flux uncertainty is dependent on (1) Observation errors (2) transport sensitivity (3) prior constrains on fluxes

Problem: $\boldsymbol{x} - \mathbf{T}\boldsymbol{F} = \min$

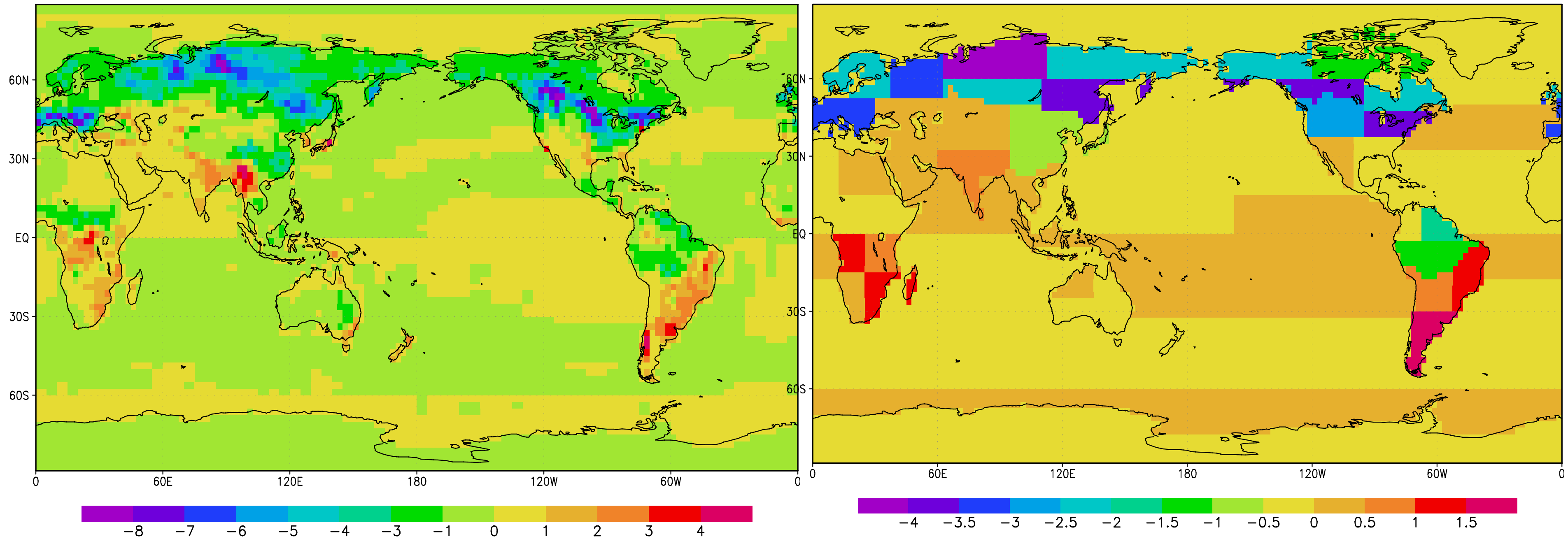
x *concentration,* ***F*** *fluxes,* ***T*** *- transport matrix*

Flux solution: $\boldsymbol{F} = \boldsymbol{F_0} + [\mathbf{T}^T \mathbf{C_x}^{-1} \mathbf{T} + \mathbf{C_{F0}}^{-1}]^{-1} \mathbf{T}^T \mathbf{C_x}^{-1} [\boldsymbol{x} - \mathbf{T}\,\boldsymbol{F_0}]$ (2')

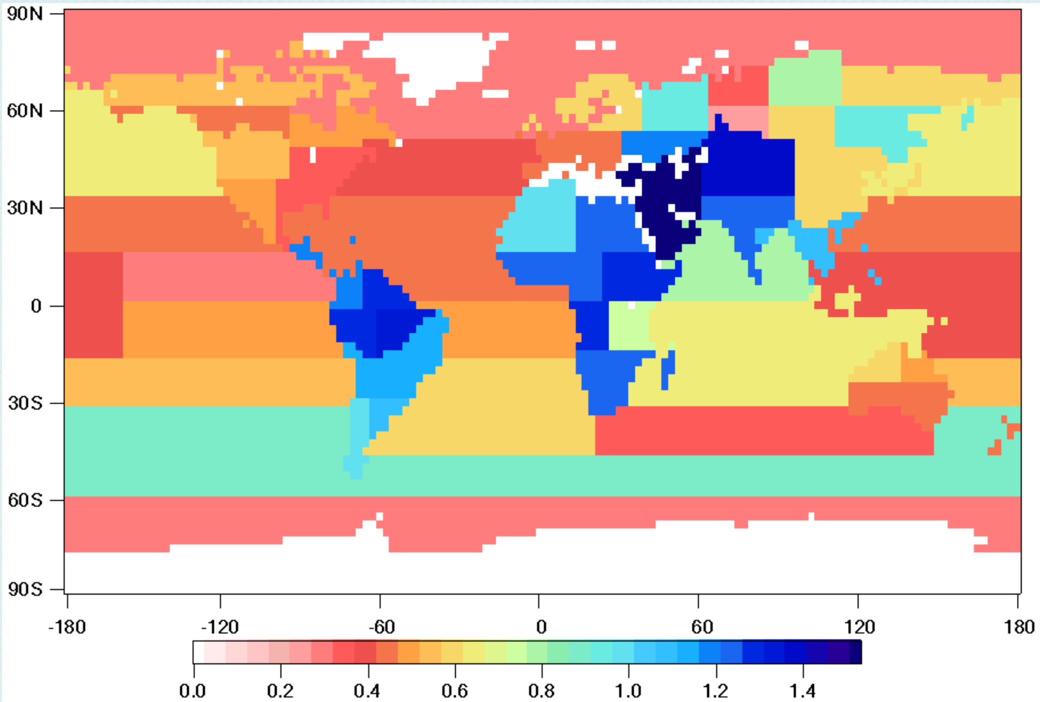
Flux error covariance: $\mathbf{C_F} = [\mathbf{C_{F0}}^{-1} + \mathbf{T}^T \mathbf{C_x}^{-1} \mathbf{T}]^{-1}$

Inverse model fluxes, with 64 region model

left model grid, right region average

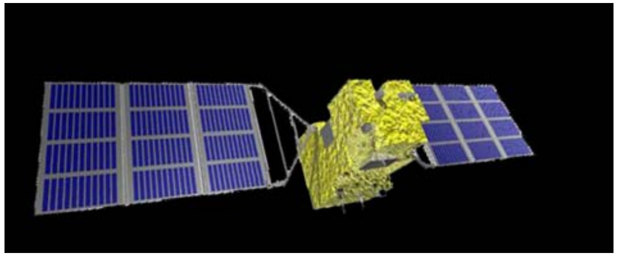


CO2 flux uncertainties (GtC/year) without using GOSAT data

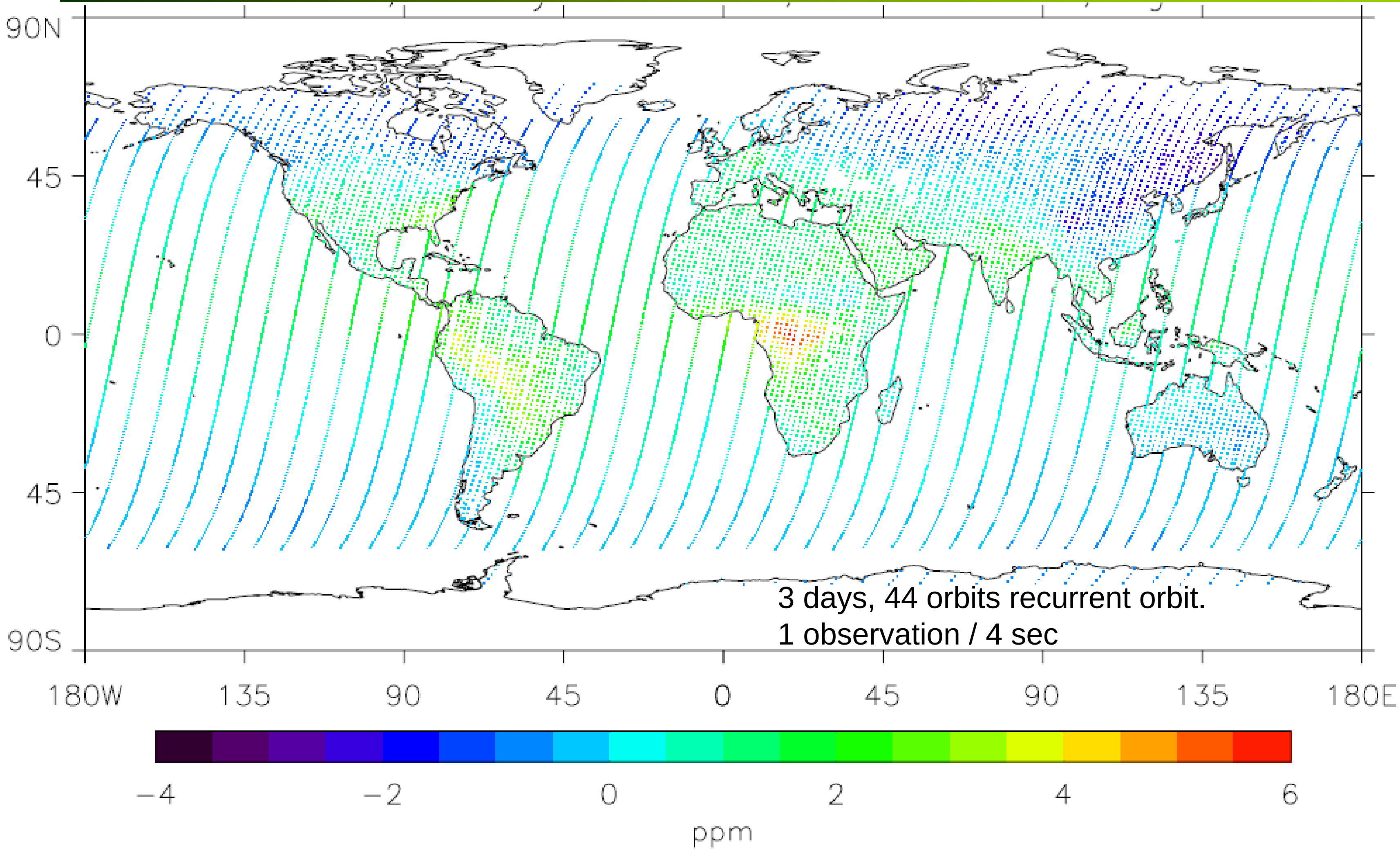


Large uncertainties exist in the regions of poor observational coverage

Estimated: monthly mean flux uncertainties for each region during 1 year (flux climatology)

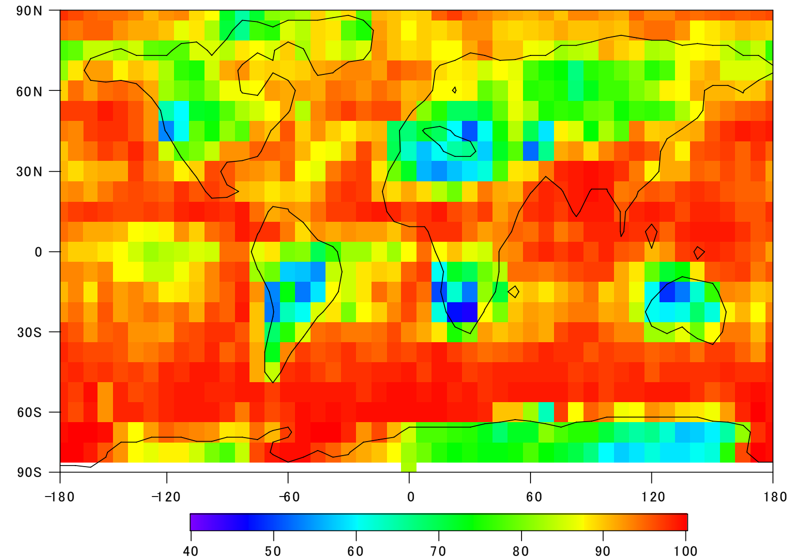


GOSAT simulation

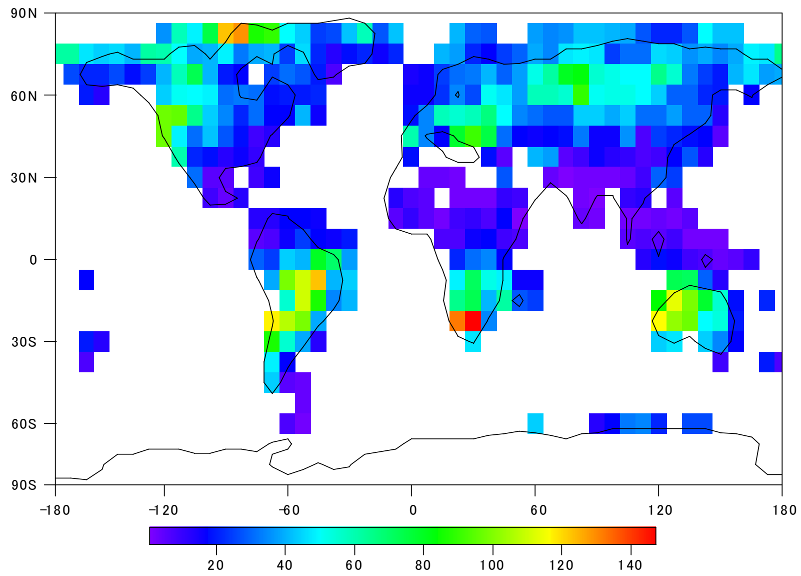


Monthly mean (July) CO_2 concentration along GOSAT orbit, with global offset subtracted

Average number of observations per month and monthly mean cloud cover

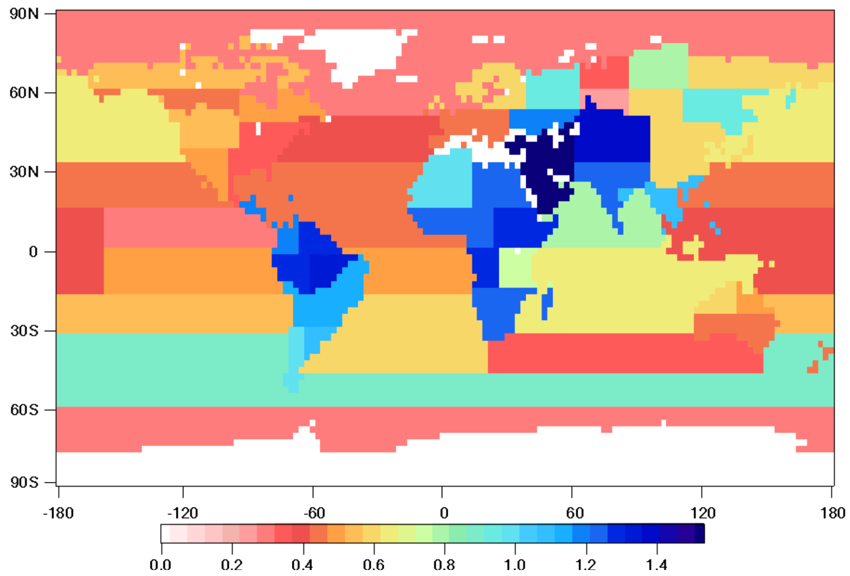


- Average cloud cover (%) per month for July. 7.5x7.5 degree grid

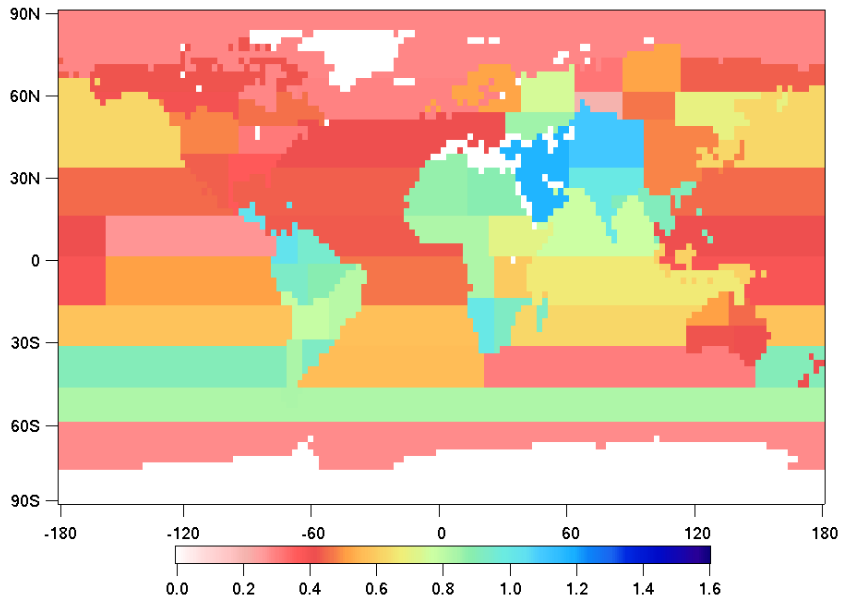


- Average number of observations over land in July. 7.5x7.5 degree grid

Regional CO2 flux uncertainties



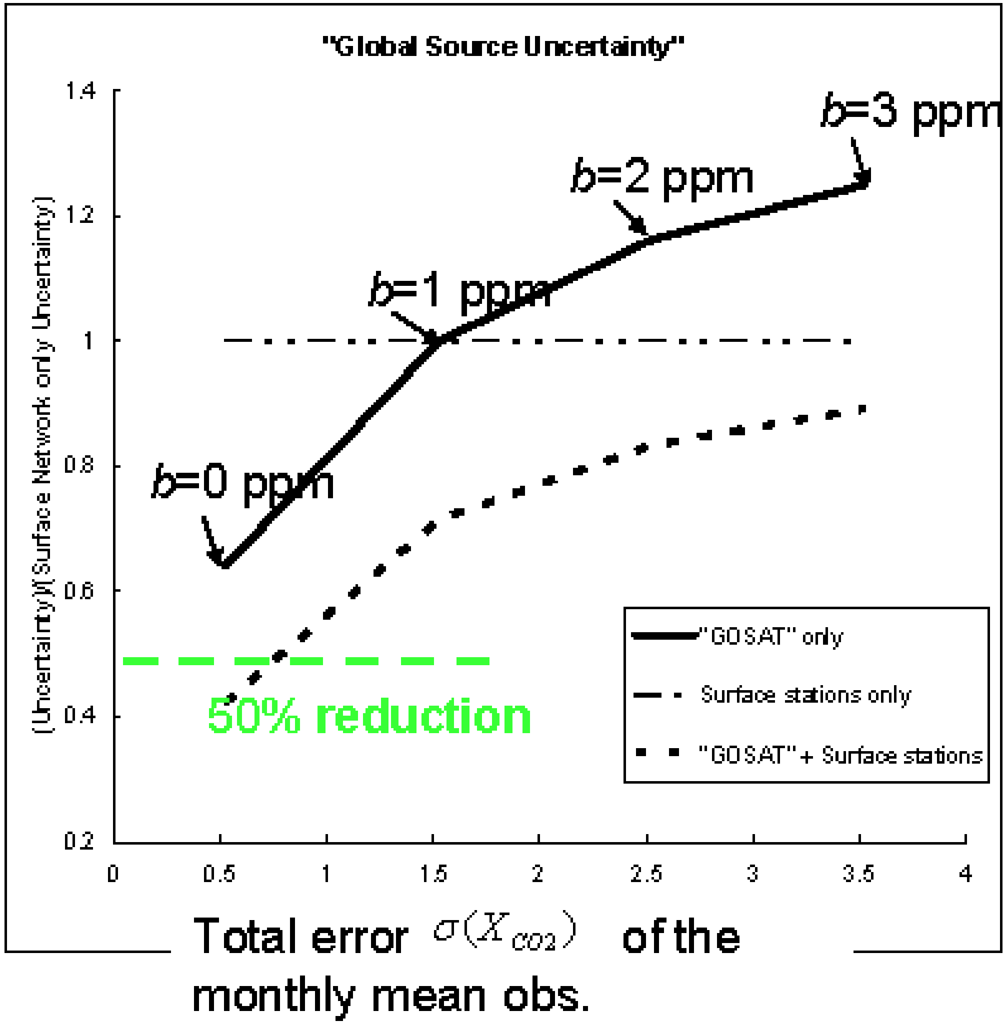
- CO2 flux uncertainties for 2005. Surface stations <u>only</u> were used in inversion.



- CO2 flux uncertainties for 2005. Surface stations <u>AND</u> simulated GOSAT data were used in inversion.

<u>GtC/year/region</u>

Mean regional flux uncertainty (relative to surface network) against the precision of column CO2 data.



Error model:

$$\sigma(X_{CO2}) = \sigma_s(X_{CO2}) + \frac{\sigma_r(X_{CO2})}{\sqrt{N}}$$

where

$$\sigma_{sigle\_shot}(X_{CO2}) = \sigma_s(X_{CO2}) + \sigma_r(X_{CO2})$$

$$\sigma_r(X_{CO2}) - random\_error$$

$$b = \sigma_s(X_{CO2}) - systematic\_error$$

To approach to 50% reduction target bias (*b*) should be reduced below 0.5 ppm

Summary

Evaluation of the expected contribution by GOSAT CO2 observations

- Inverse model was used to estimated CO2 flux uncertainty reduction due to use of the CO2 (column average) observations with TANSO-FTS (SWIR) sensor on GOSAT. Realistic cloud frequency and orbit are used in estimation

- Conclusion: average 50% flux uncertainty reduction is possible for many regions to achieve if the systematic retrieval error is kept below 0.5 ppm and single shot random error of 2.5 ppm (0.6%)