Amazonian GPP Estimated from Satellite-Observed Carbonyl Sulfide Mixing Ratios

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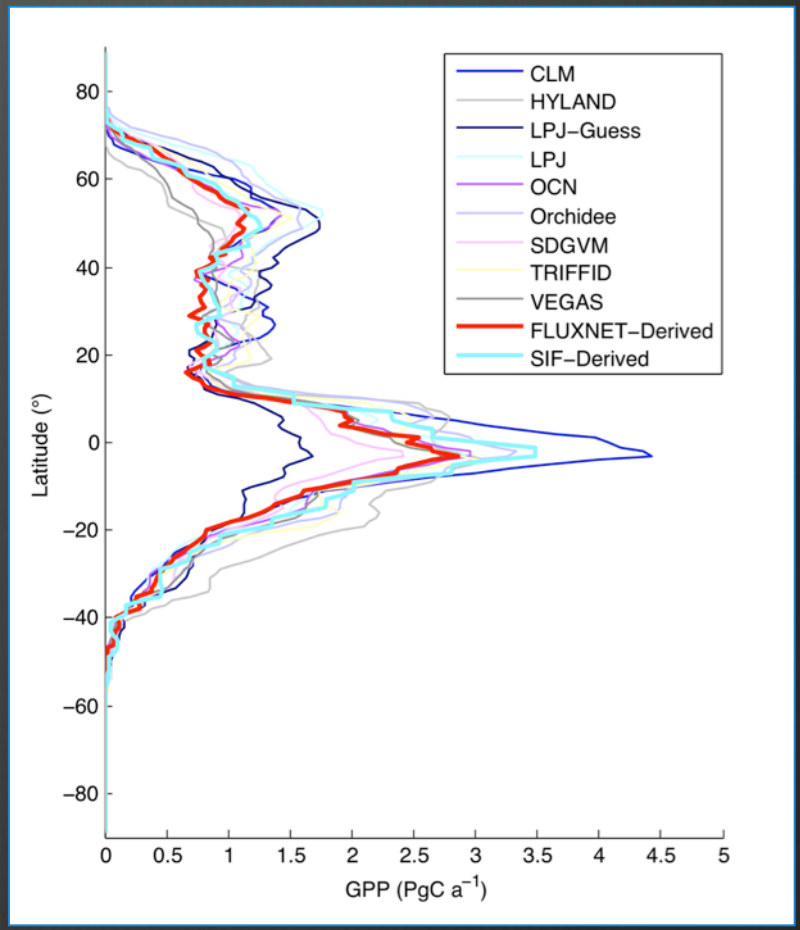
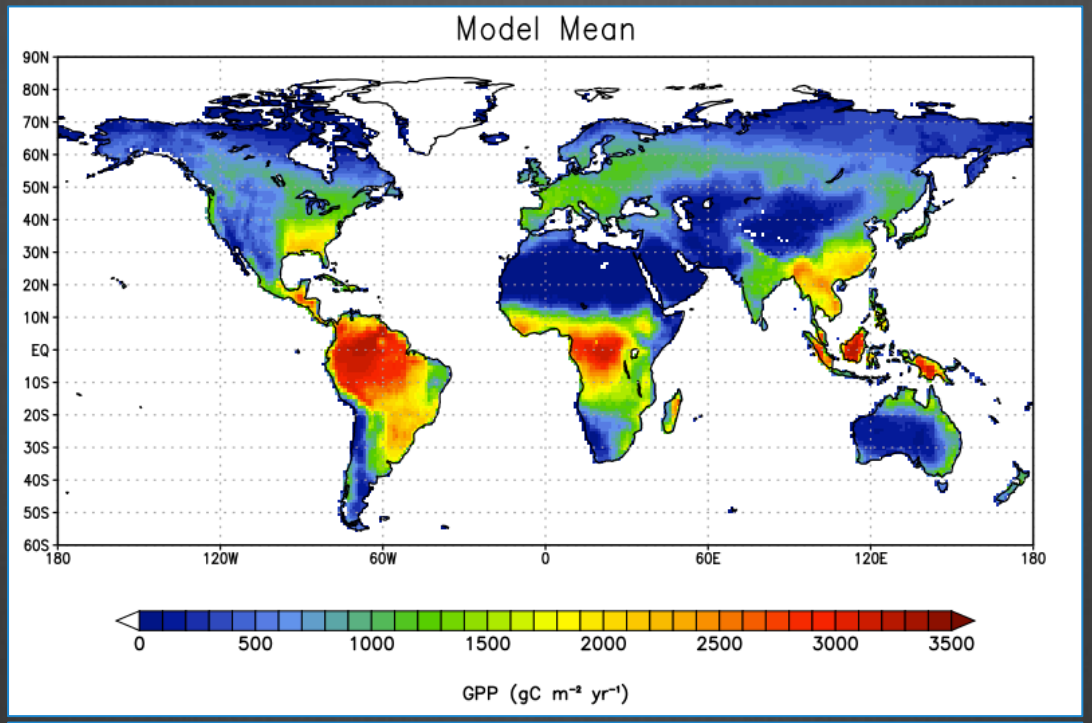
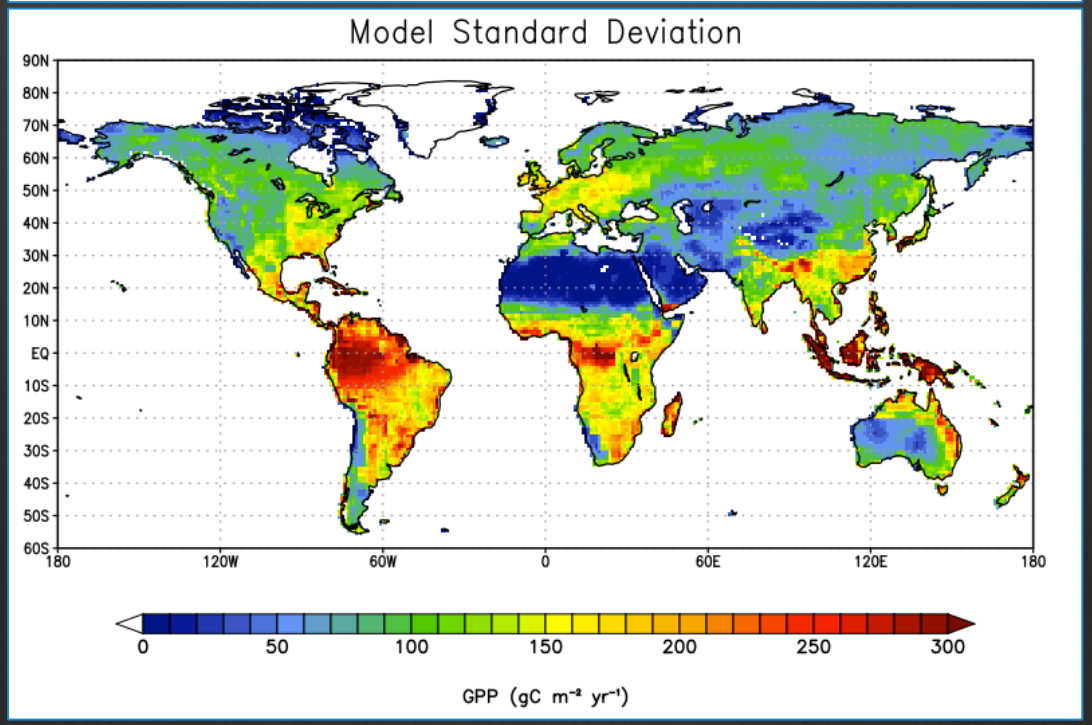
Background

- GPP estimates are highly variable in the tropics.
- 2.5x difference between low and high members of TRENDY project in tropics
- Approach:
  1. Using TRENDY as a guideline, scale COS plant fluxes in SiB up/down.
  2. Compare GEOS-Chem output to satellite COS observations (MIPAS).



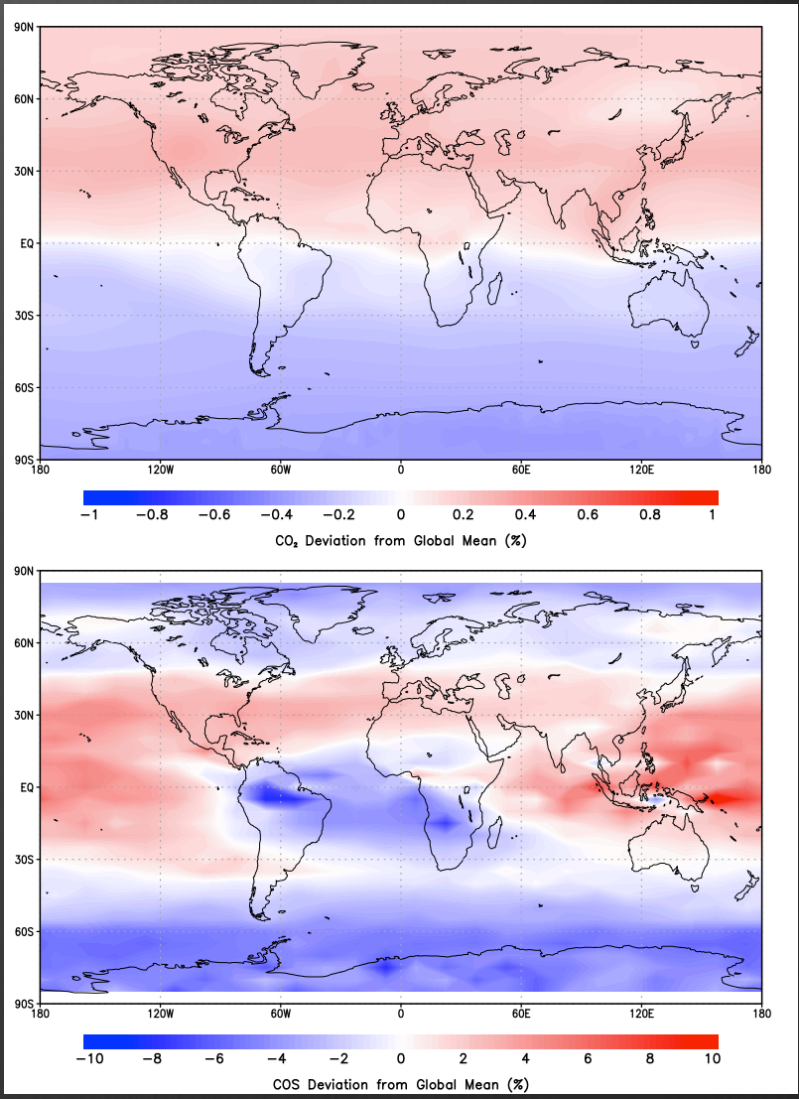
TRENDY Model Ensemble





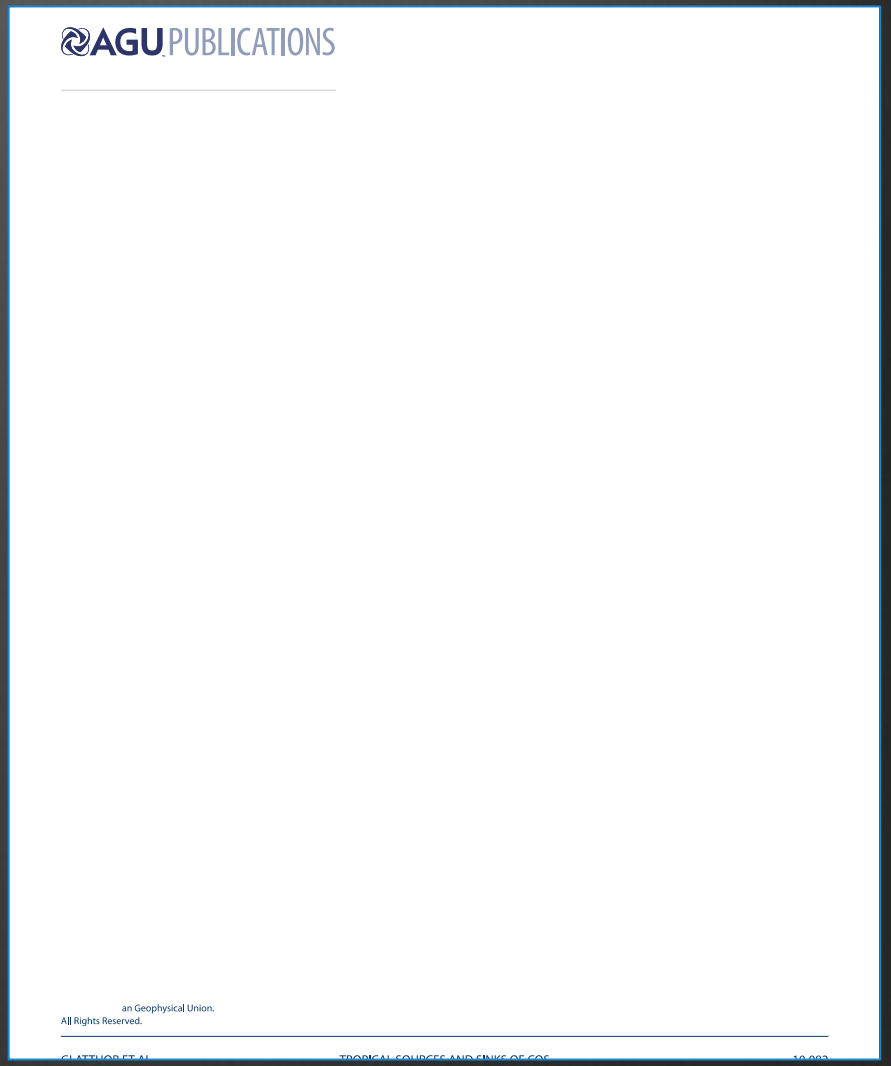
COS vs. CO_2

- GOSAT CO_2 at 250hPa
  - ±1% from global mean
  - Competing signals from photosynthesis and respiration over land.
- MIPAS COS at 250hPa
  - ±10% from global mean
  - No competing respiration signal over land!

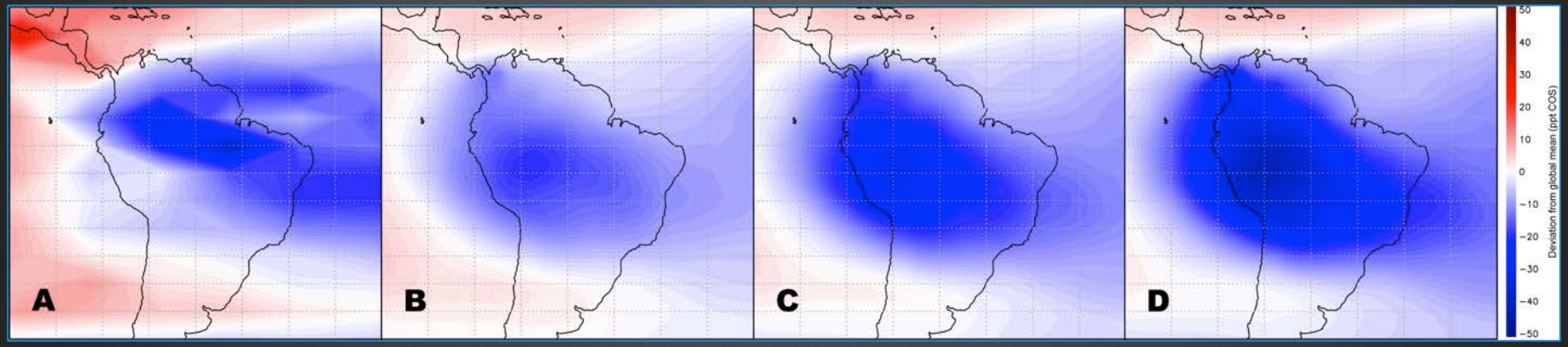


MIPAS

- Michelson Interferometer for Passive Atmospheric Sounding onboard ENVISAT (now inactive)
- COS retrievals 2002-12.
- Approximately 250hPa
- See Glatthor et al., 2015 (GRL) for details. 10.1002/2015GL066293



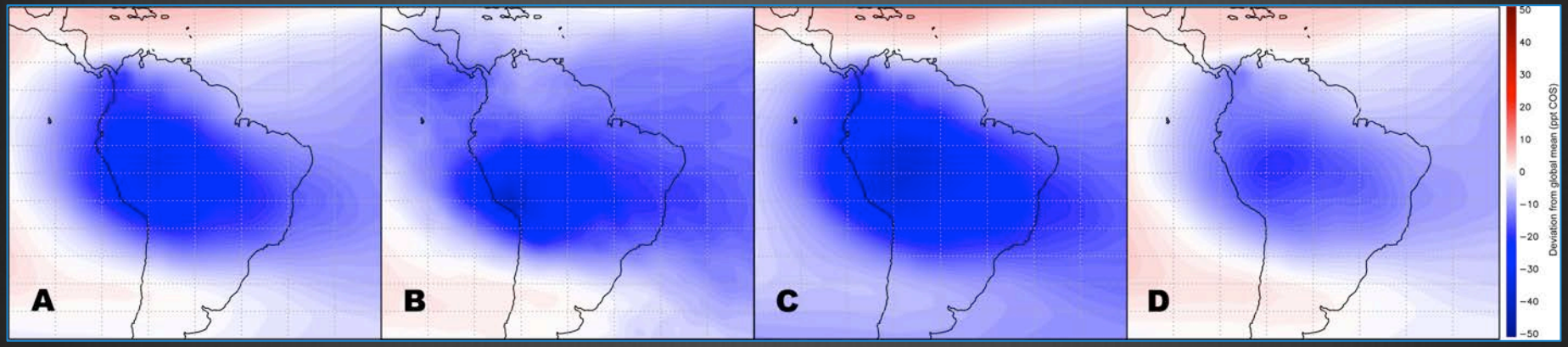
GEOS-Chem Model Output



(A) MIPAS Annual mean deviation from global mean (ppt COS)
(B) GEOS-Low model output
(C) GEOS-Med model output
(D) GEOS-High model output

➔ GEOS-Med and GEOS-High seem to be in the appropriate range.

GEOS-Chem Model Output



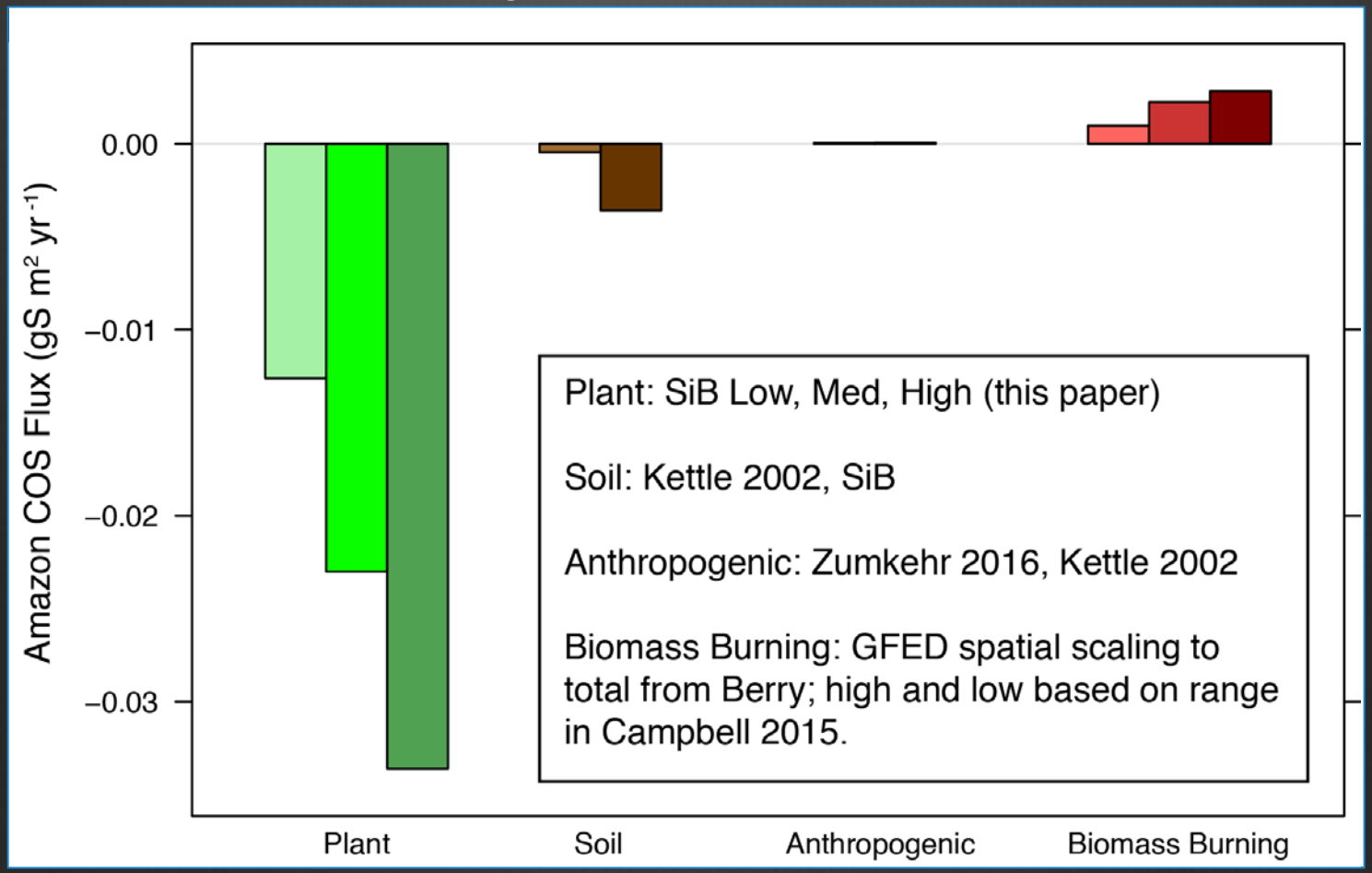
(A) GEOS-Med model output
(B) PCTM model output (using GEOS-Med fluxes)
(C) GEOS-Med with increased anthropogenic, decreased ocean
(D) GEOS-Low model output

(A)-(C) relatively similar, even with large changes.
Low is significantly lower.

➔ Changes to plant fluxes have strong effect, relative to changes to other fluxes or choice of transport model

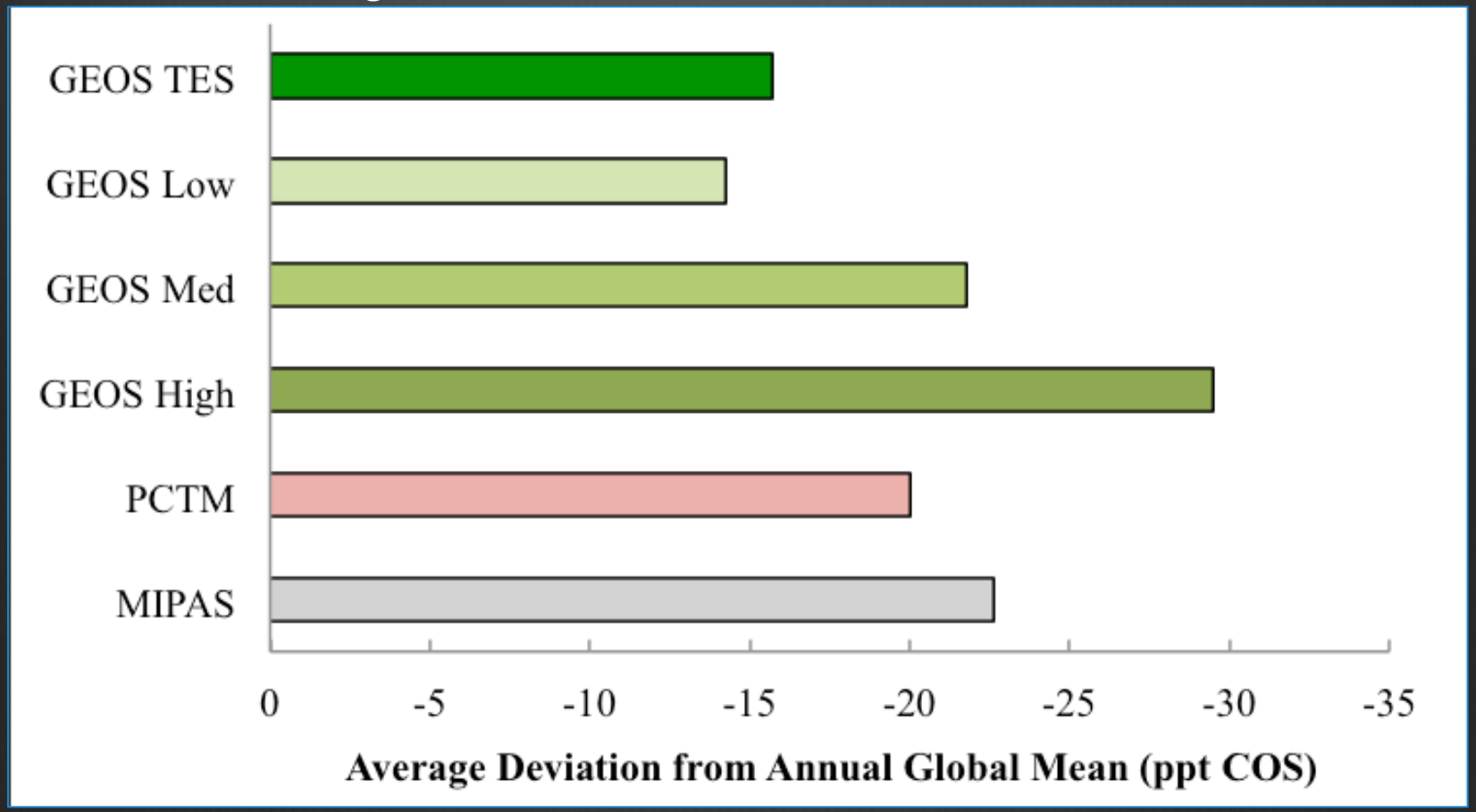
Amazon Flux Uncertainty

Average annual COS flux in box 5N-15S, 75W-50W



Amazon Depression, 250hPa

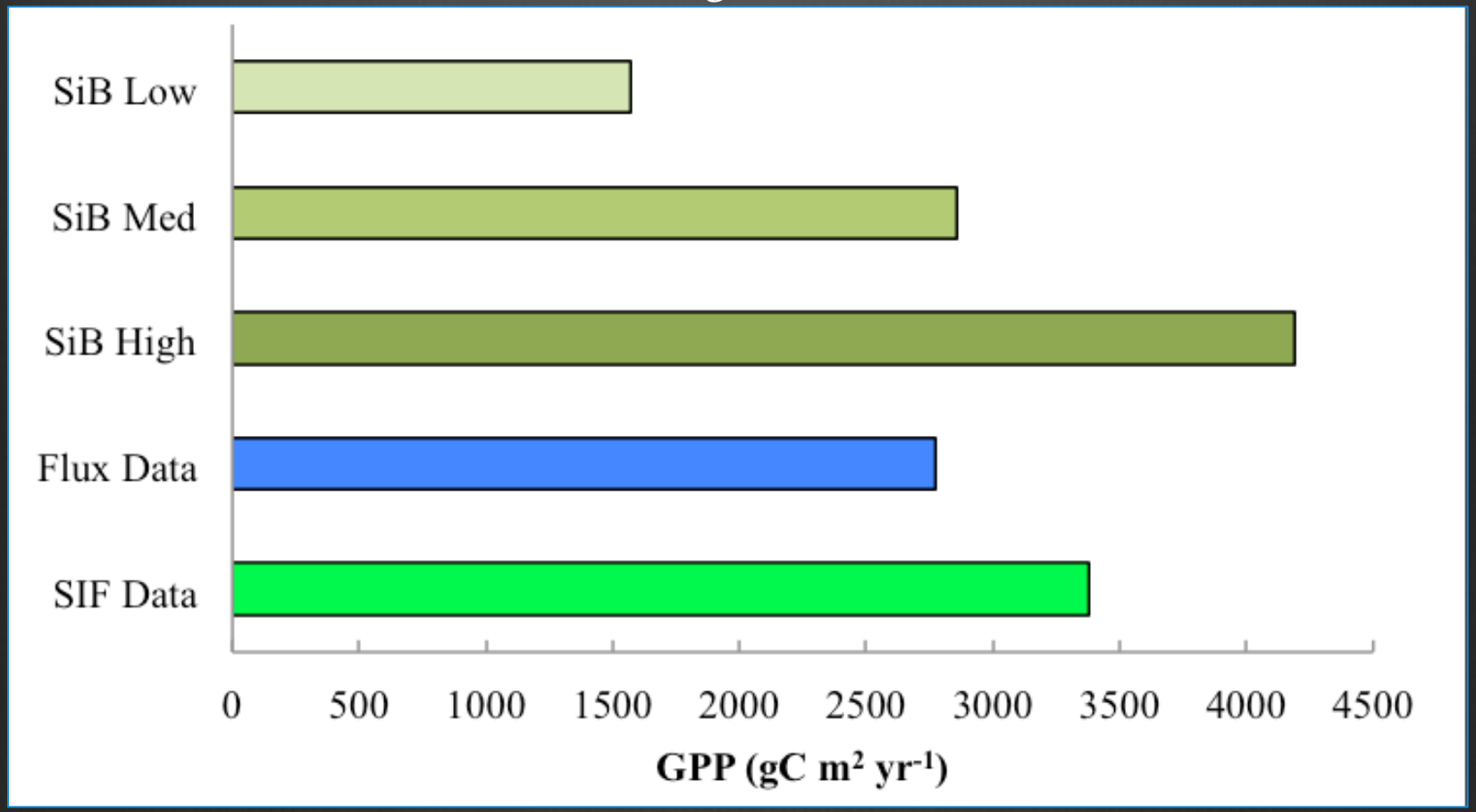
Average annual concentration difference in box 5N-15S, 75W-50W



GEOS TES is a run optimized using TES retrievals over ocean.

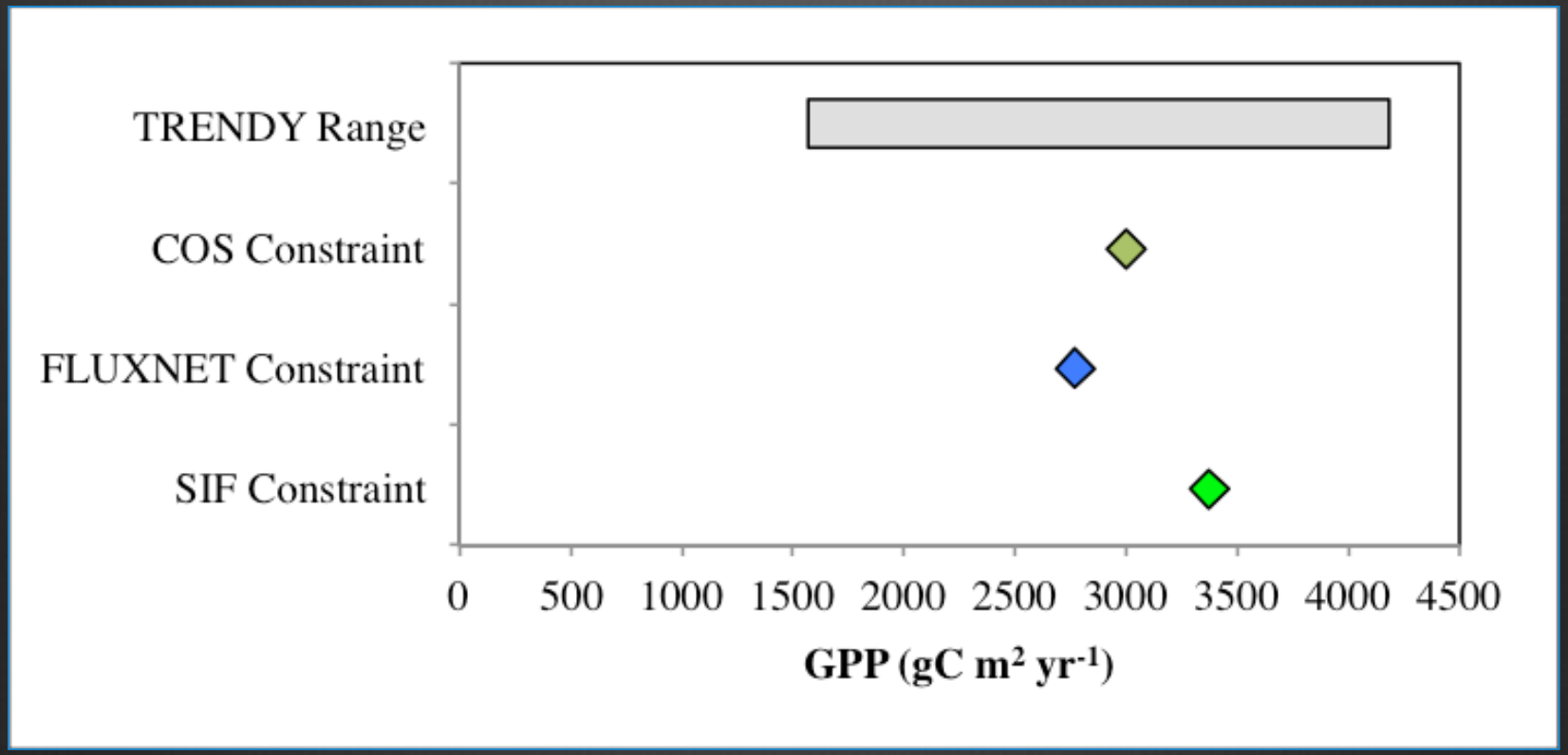
Implications for GPP

Average annual GPP in box 5N-15S, 75W-50W



Eddy Flux-constrained GPP from Beer 2010. SIF-constrained GPP from Parazoo 2014.

Put differently…



Crude optimization still yields a constraint close to other metrics!

Conclusions

- Remotely-sensed COS concentrations are a promising tracer for terrestrial gross primary production.
- Using MIPAS COS observations yields Amazonian GPP estimate close to other independent metrics, and near the median of the TRENDY model ensemble.
- Future work:
  - Investigating convective transport scenarios
  - Magnitude and timing of seasonal cycles
  - Collection and assimilation of airborne and flux-tower data
  - 4D variational inverse modeling

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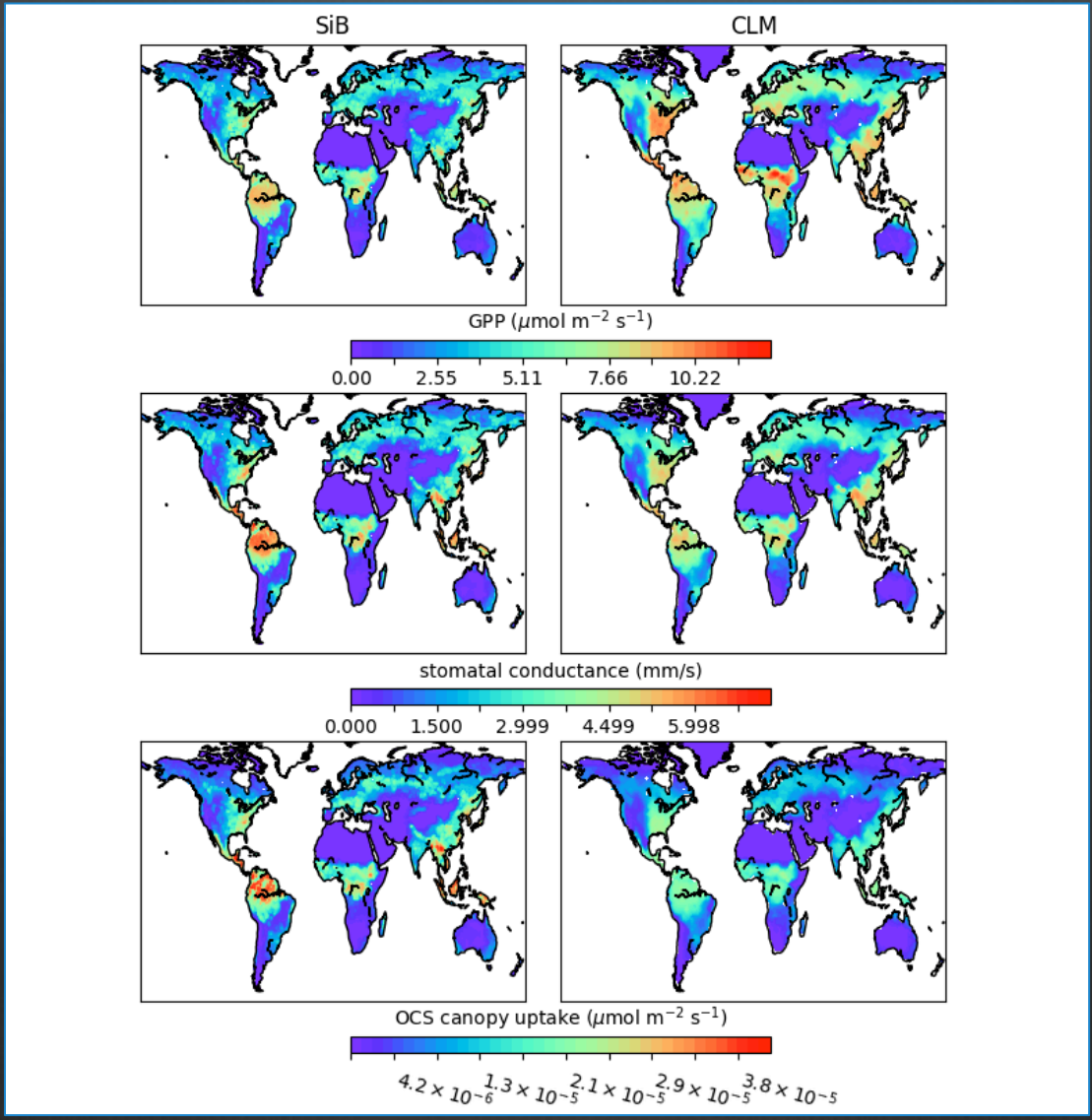
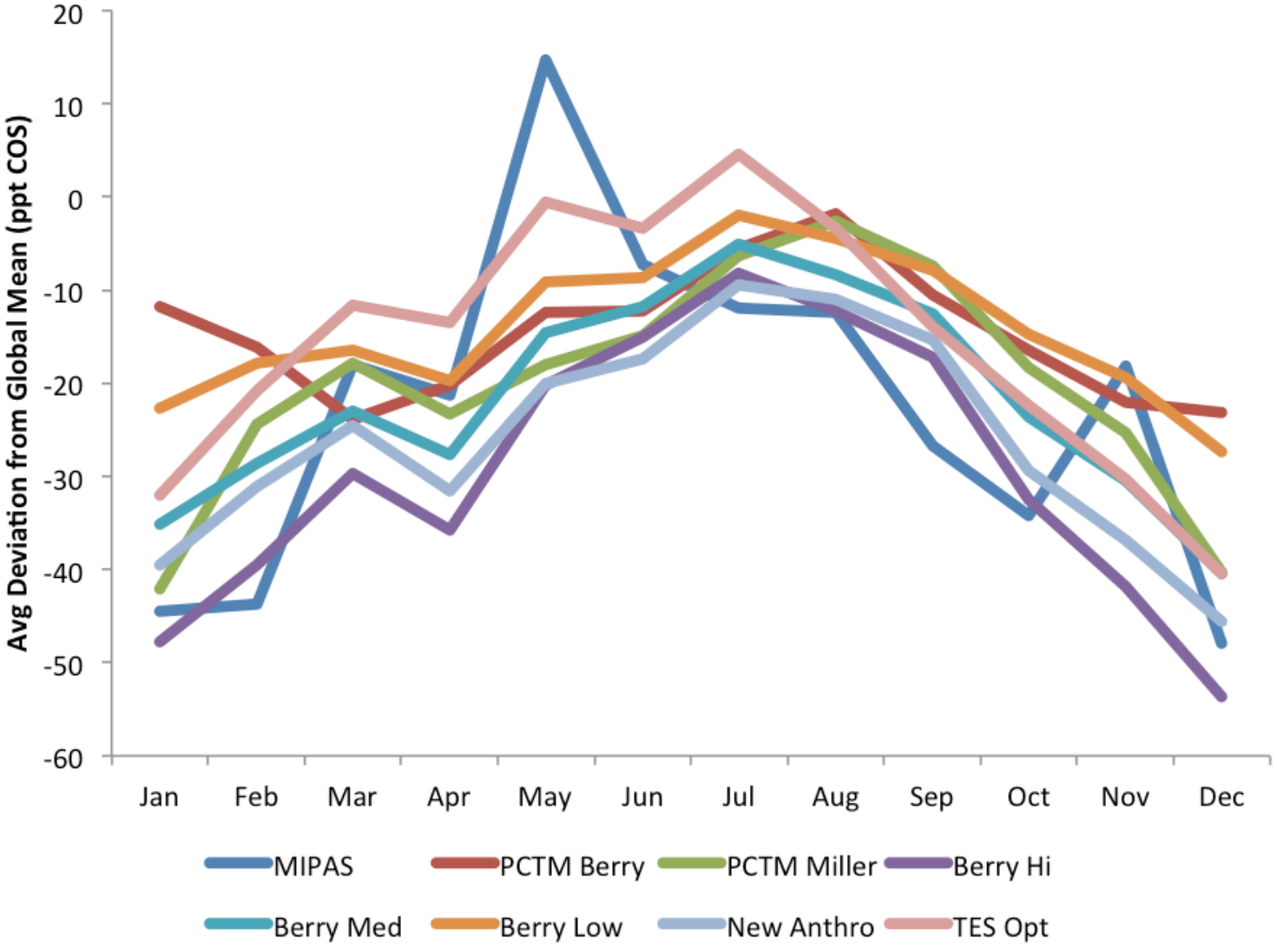
Stomatal Conductance and GPP

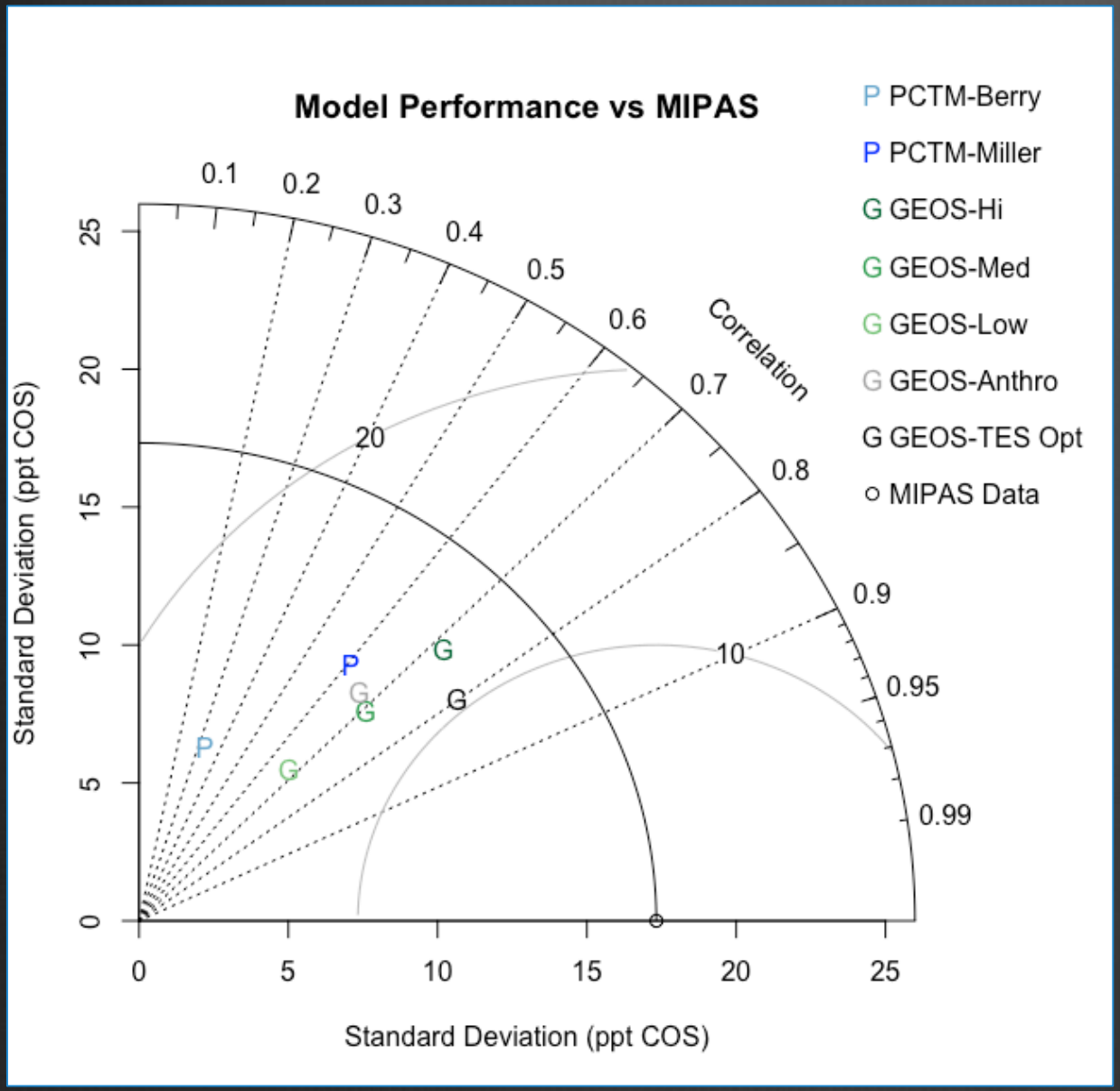


GEOS-Chem Setup

Flux (GgS COS)	Berry 2013	This Study	Notes
Ocean COS	39	43.5	Kettle
Ocean DMS	81	90	Kettle
Ocean CS2	156	156	Kettle
Anthropogenic	180.5	180.5	Kettle
Biomass Burning	136	136	GFED, scaled to 136 GgS/yr
Addl Ocean Source	600	269 to 619	Same approach and scaling factors as in Berry
OH Radical	-101	-111	GEOS-Chem OH
Canopy Uptake	-738	-793 to -948	SiB, adjusted
Soil Uptake	-355	-166	SiB

Amazon COS Depression





Comparison of monthly concentration difference from global mean between all models compared to MIPAS observations.

TES-optimized is best, but GEOS-Med and GEOS-High are close seconds.