The global budget of Carbonyl Sulfide (COS): an inverse modelling approach

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OBJECTIVE

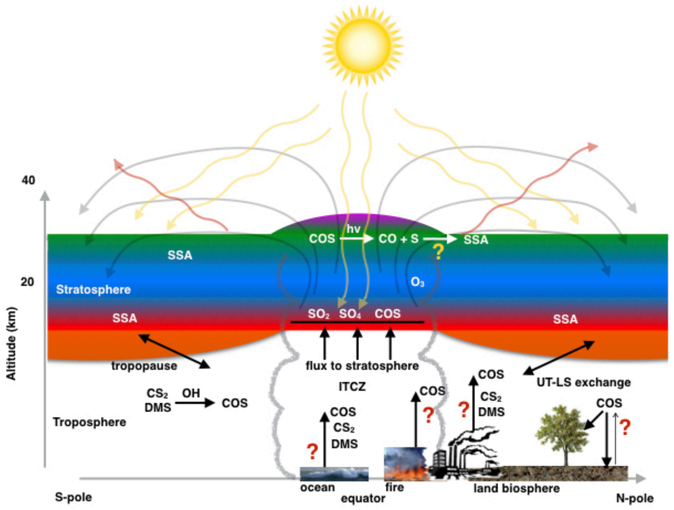
- Constrain global COS budgets with inverse modelling.
- Why?

(a) COS can inform about gross primary productivity (GPP)

(b) COS is contributing stratospheric sulfate aerosols.

- How?

We use TM5-4DVAR and implemented new anthropogenic emissions, updated the biomass burning emissions and biosphere sinks (SIB4). We also model CS_2. Table 1 compares our prior budget to Berry et al. (2013).

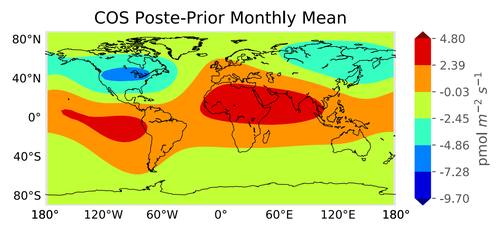


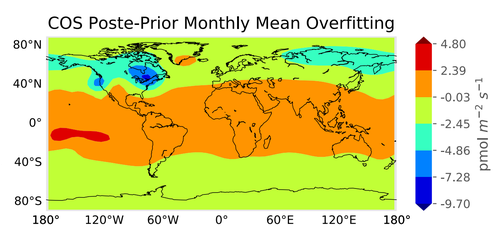
EMISSION BUDGETS

COS Global Budget (Gg S /year)	Berry2013	Prior of this study
Direct COS flux from oceans	39	40
Indirect COS flux as CS2 from oceans	81	81
Indirect COS flux as DMS from oceans	156	156
Direct anthropogenic flux	64	155
Indirect anthropogenic flux from CS2	116	188
Indirect anthropogenic flux from DMS	1	6
Biomass burning	136	152
Additional ocean flux	600	-
Anoxic soils and wetlands	-	-
Sources	1193	778
Destruction by OH	-101	-103
Destruction by O	-	-
Destruction by photolysis	-	-42
Uptake by plants	-738	-898
Uptake by soil	-355	
Sinks	-1194	-1043
Net total	-2	-265

WHERE ARE THE MISSING COS FLUXES?

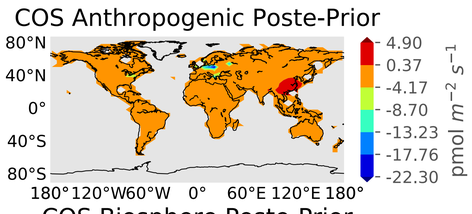
- We close the budget by adding 265 Gg S/year globally uniform
- Using TM5-4DVAR we optimize this term with NOAA observations
- Spatial correlation (left) 4000 km (right) 1000 km → overfitting

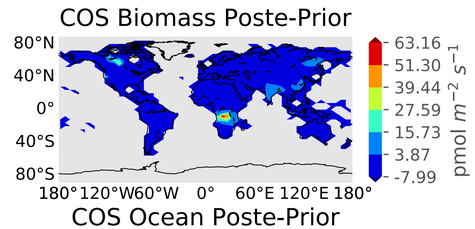


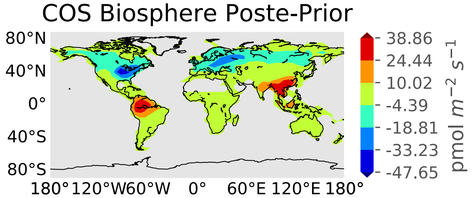


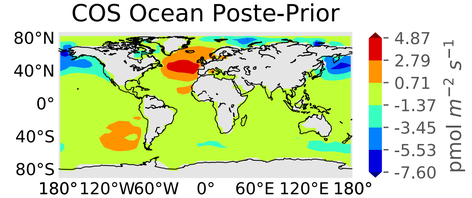
WHAT ARE THE MISSING COS FLUXES?

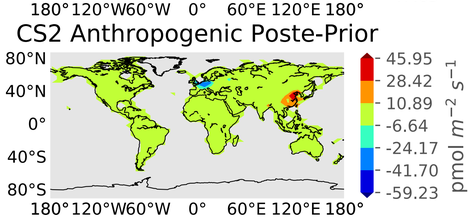
Next step: optimize different categories: anthropogenic, biomass burning, biosphere, and ocean.

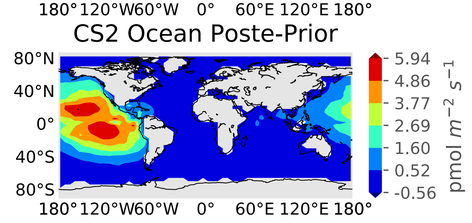












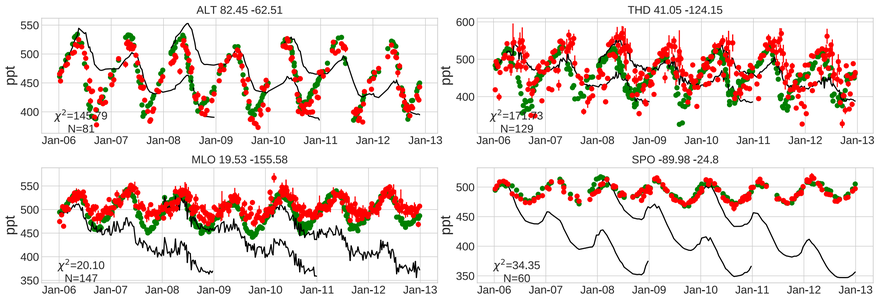
PRELIMINARY RESULTS

- Tropical sources needed (ocean, lower biosphere)
- NH high-latitude sink needed (lower anthropogenic, ocean, biosphere)
- Limited observation: risk of overfitting

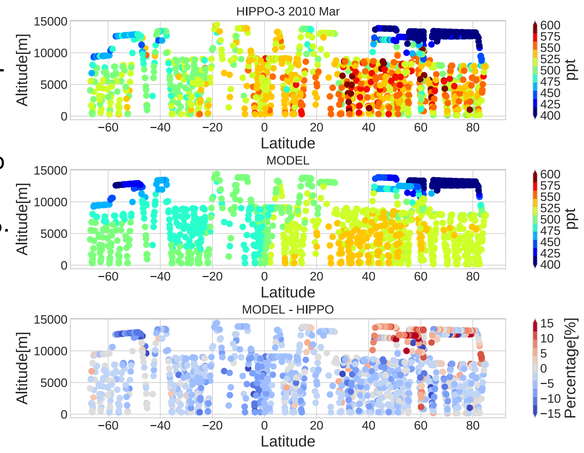
INVERSION RESULTS

Inversions were performed in three overlapping periods.

Red: observations & error; **Black**: prior; **Green**: posterior.



- Validation with HIPPO-3 campaign
- Posterior model: too low in troposphere, too high in stratosphere
- Remaining error <15%.



CONCLUSIONS

- TM5-4DVAR inverse model successfully implemented for multi-tracer inverse system linking CS_2 and DMS to COS
- Optimized emissions show the need for more tropical emissions (mainly CS_2 ocean & reduced biosphere) and more biosphere sinks at high latitudes. This is in line with recent findings concerning SIB4.
- The system is underdetermined, and more observations are needed

FUTURE PLANS

- Coupled COS-CO_2 inverse modelling, focusing on biosphere fluxes
- Assimilate additional observations, TES, TCCON, ACE-FTS

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