Global carbonyl sulfide (COS) budgets constrained by NOAA surface network and MIPAS satellite

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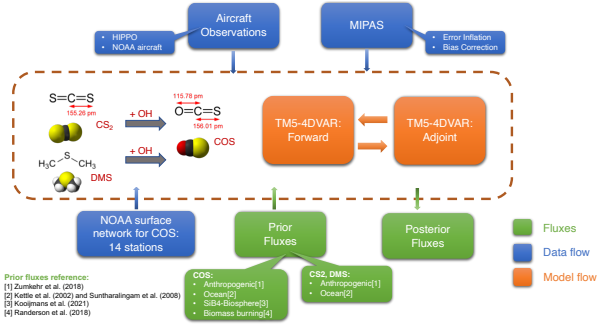
1. Motivation

COS is a trace gas around 480 ppt in the troposphere and becomes a diagnostic tool to better trace CO_2 footprint and estimate gross primary production (GPP)[1]. It is also important for its contribution to the stratosphere sulfur aerosols. However, COS comes from various sources and uptake by plants, soil, and oceans. Therefore, accurate quantification of COS global budgets is challenging. We use inverse model to better constrain COS surface fluxes, and enhance the understanding of its sources and sinks.

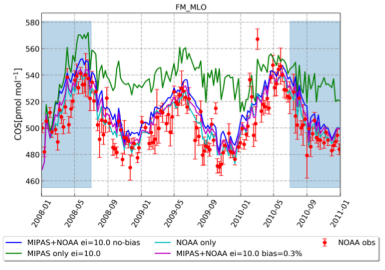
2. Method

Inverse system within TM5-4DVAR is extended to optimize the COS fluxes [2-3]. In this work, NOAA surface network and MIPAS satellite data are co-assimilated in the modelling framework[4][5].



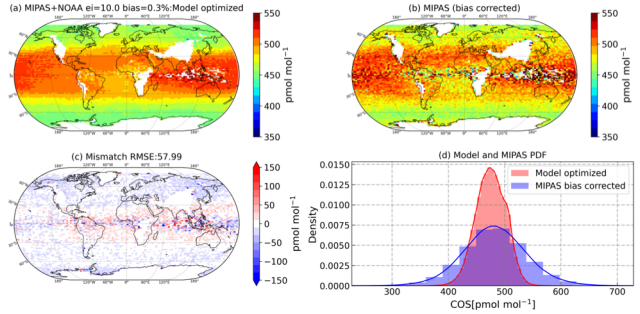
3a. Performance : Ground Fitting at Mauna Loa(3397 m a.s.l.)

Inversions performed in 2008-2011 by 4 cases: NOAA only, MIPAS only NOAA+MIPAS no bias, and NOAA+MIPAS with bias correction 0.3%. MIPAS only overestimates COS at ground. Other cases are close to observations.



3b. Performance: Tropospheric Fitting

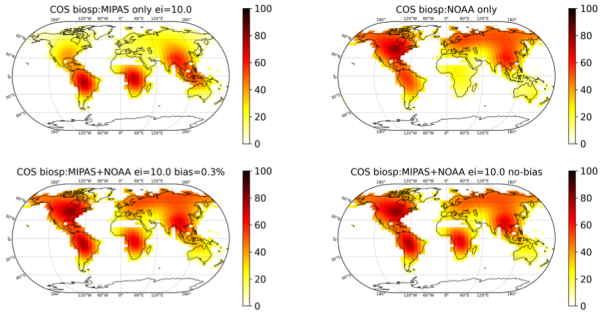
In this case MIPAS+NOAA with slight bias correction annual mean is shown. MIPAS observation is slightly reduced to fit model. Model can match MIPAS with bias correction well. Note that panel C shows mismatch is close to 0.



4. Error Reduction for COS Biosphere Sink

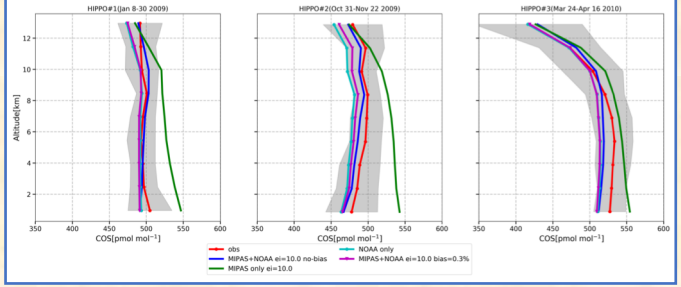
$$ER = 1 - \frac{err_{posterior}}{err_{prior}}$$

ER is enhanced over where observations are available. MIPAS+NOAA co-assimilation can gain improved error reduction, as shown in bottom panels.



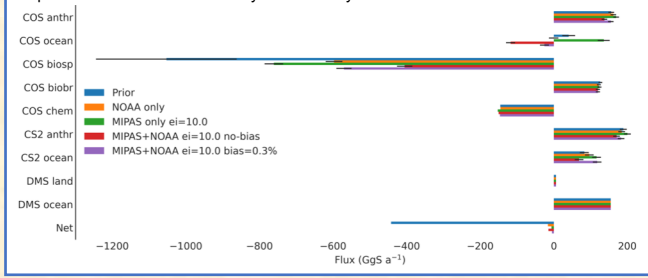
5. Model Evaluation against HIPPO Flights #1-3

MIPAS only case overestimates COS in troposphere. Other cases underestimates but bias is within 20 ppt.



6. Global Budgets of COS, CS_2 and DMS

Net global budgets are balanced due to the relative chemical equilibrium of COS, and biosphere generally gains reduction after optimization. DMS is not optimized due to its uncertainty of chemistry and a lack of measurements.



7. Outlook

- Future work could focus on improvement of prior fluxes implementation.
- COS isotope modelling is a new route to differentiate its sources and sinks.

References:
[1] Berry et al. (2013), JRG-B.
[2] Krol et al. (2005), ACP.
[3] Ma et al. (2021), ACP.
[4] Montzka et al. (2007), JGR-A. NOAA data available at: https://gml.noaa.gov/dv/data/
[5] Glatthor et al.(2017), ACP.

Poster presentation time: July 12-13 2022, 15:00-16:00 JST

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http://cos-ocs.eu/