Assessing the need for heterogeneous production of small acids in GEOs-Chem using DC8 aircraft observations

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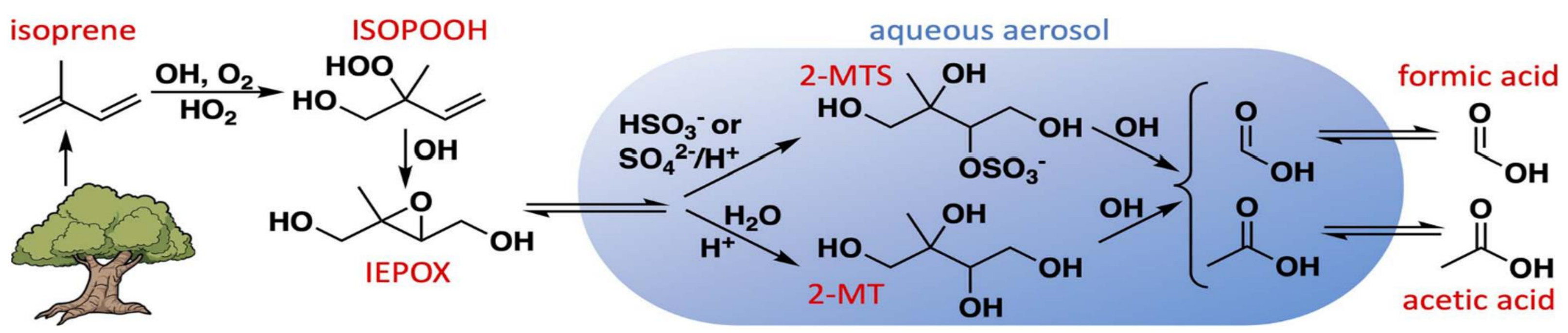
1. Background and motivation

Heterogeneous processing of IEPOX forms small acids



[Bates et al., 2023]

- FA and AA can contribute to atmosphere acidity, alter the oxidative capacity and impact the formation of cloud droplet.
- Via heterogeneous production of small acids, oVOCs are being underestimation in the GEOS-Chem model.
- Model need to be improved to better constrain IEPOX heterogeneous reactions, addressing oVOCs underestimation and refining global ozone budgets.

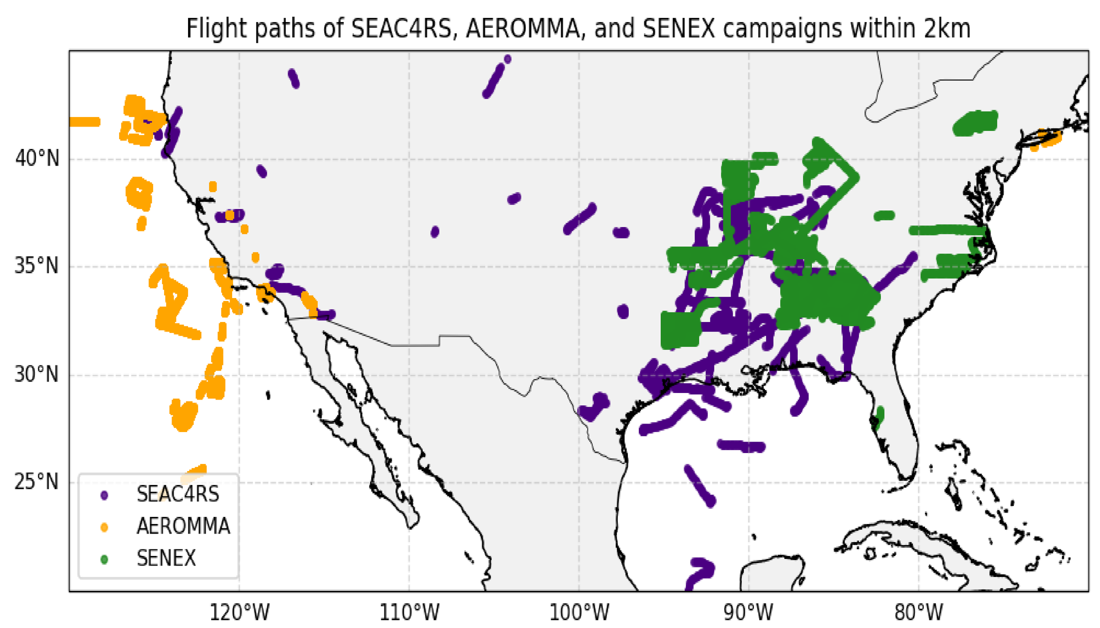
2. Research Method

This research will use:

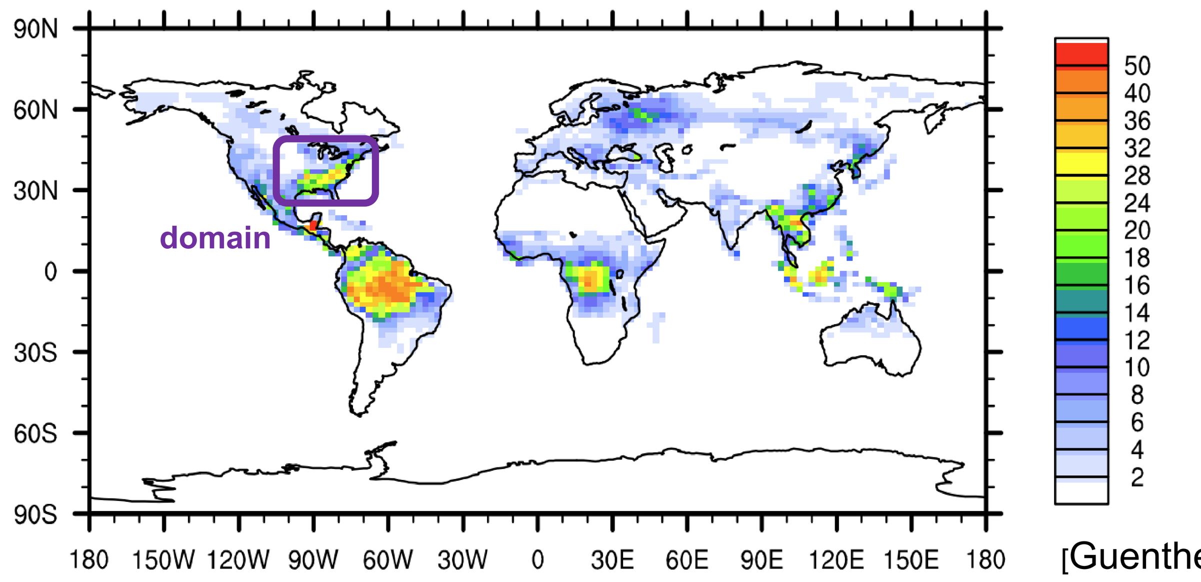
- GEOS-Chem model v14.5.0 nested grid simulations (0.25°×0.3125°) and global simulations (4°×5°)
- Satellite observations
- Aircraft observations from NASA aircraft campaigns (AEROMMA, SEAC[4]RS, SENEX)

Instruments for measurements:

- AMS
- CIT-CIMS
- NOAA Iodide CIMS



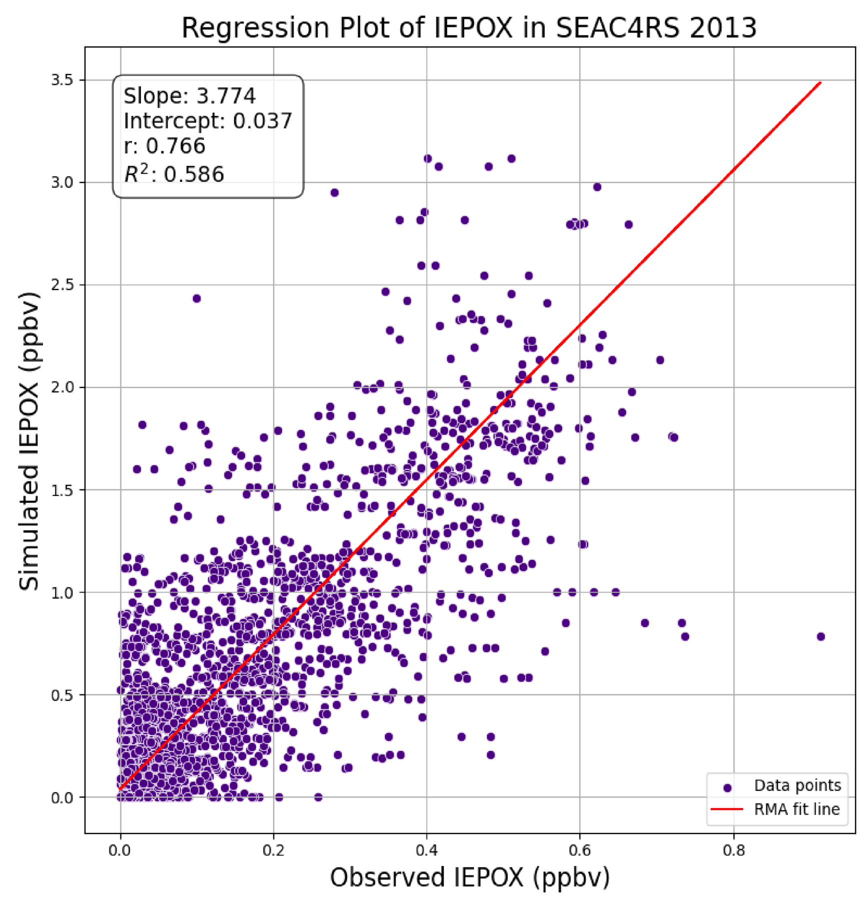
July 2000 global emission of ISOP simulated with MEGAN 2.1 using CLM4 (micro-moles/m^2/hr)

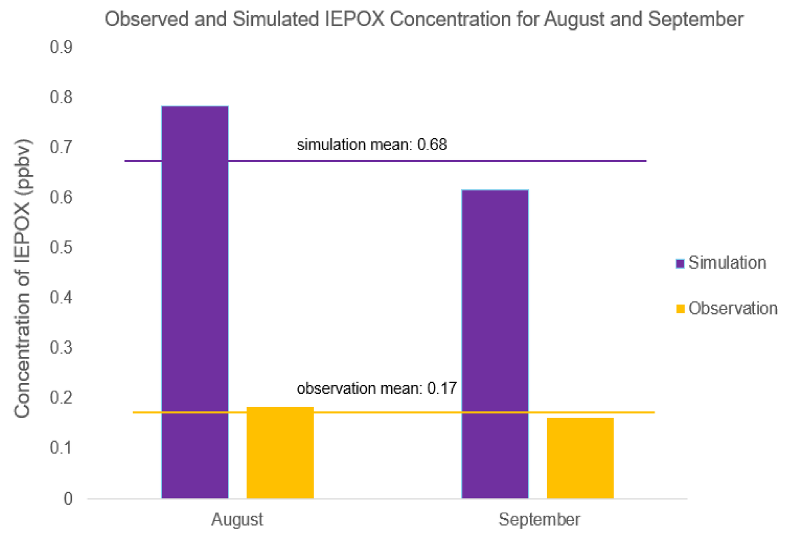


[Guenther et al., 2012]

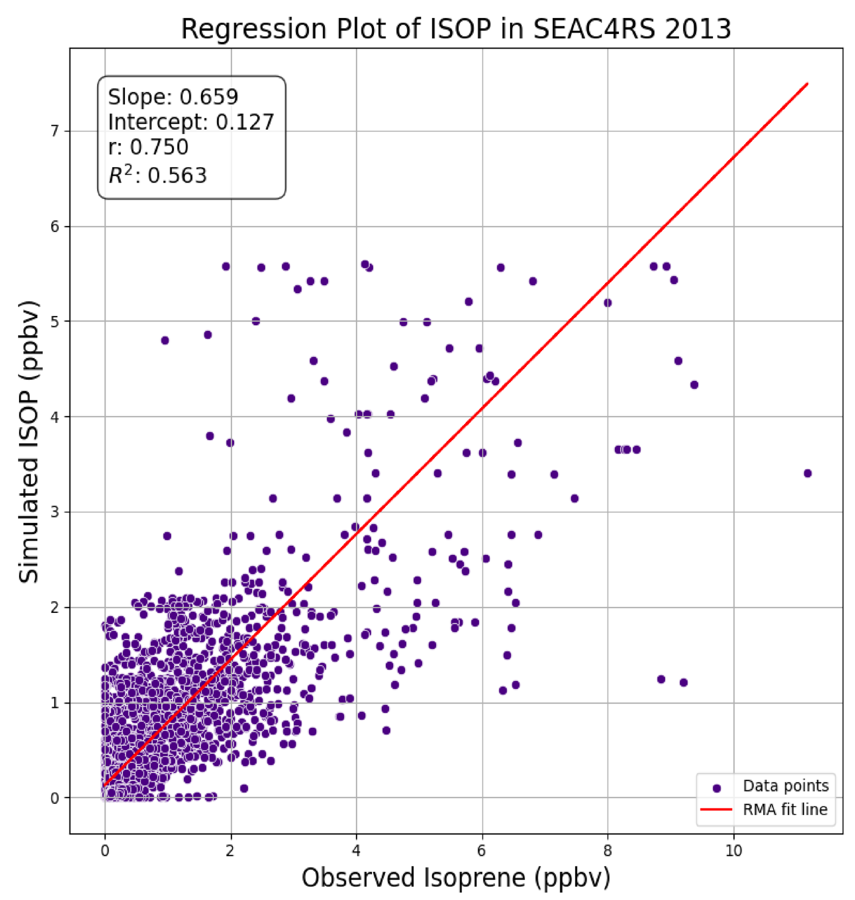
3. Preliminary results about comparison between observation and simulation from SEAC[4]RS

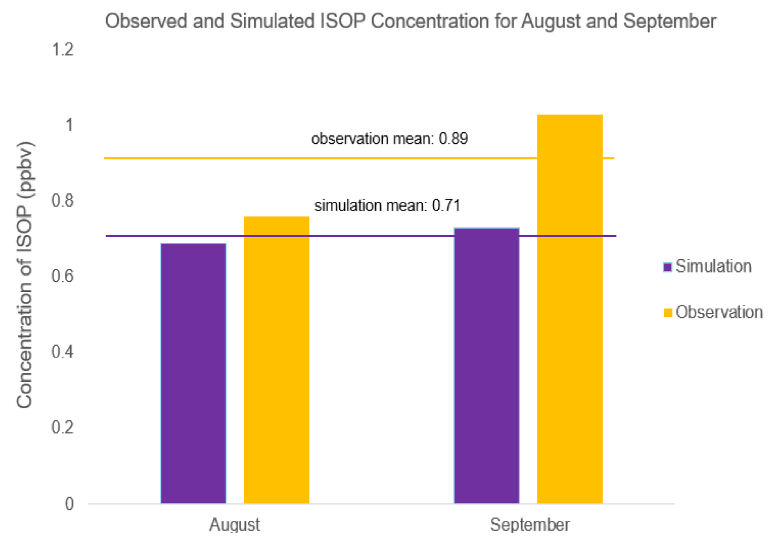
Use reduced major axis regression to plot the points with altitude within 2km and pressure over 800hPa.





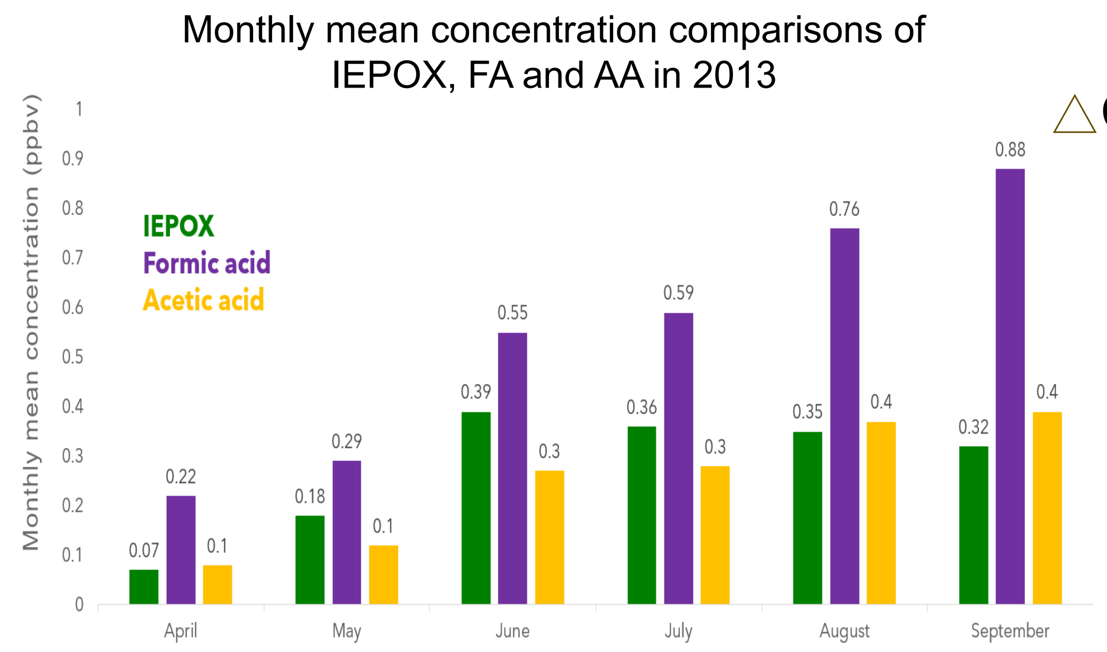
- For a single month, the model overestimates IEPOX, which consistent with the study of Vasilako in 2021.
- Based on the mean value of two months of IEPOX, the model overestimates 3.88 to 4.33 times..
- For ISOP, the model shows 10% difference in August, 29% underestimation in September.





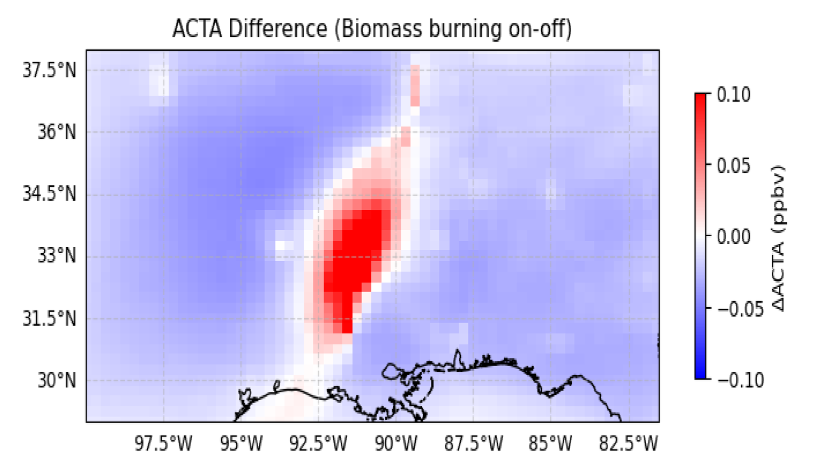
4. Preliminary results of biomass burning on small acids

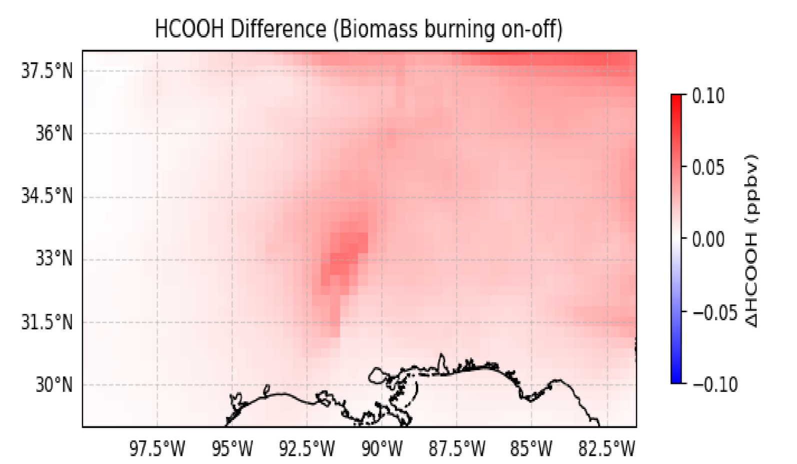
By turning off biomass burning emissions (GFED) in the model, we can quantify the contribution of fires to formic acid (HCOOH) and acetic acid (ACTA) concentrations in August 2013, and thus assess the relative importance of other sources.



$$\triangle \text{Concentration} = \frac{C_{on} - C_{off}}{C_{on}}$$

- AA reduces monthly mean by 5.1%.
- FA shows small change with biomass burning off (0.59%).





5. Conclusions and ongoing work

- For IEPOX, the model shows significantly overestimation compared to observations.
- For isoprene, the model shows slightly underestimation in August and shows underestimation in September.
- The model performs better in August than in September for both IEPOX and ISOP.

Next step:

- Adding the multiphase conversions of IEPOX to small acids may address the large model bias.
- Regrid observations to the GEOS-Chem 0.25°×0.3125° grid prior to comparison.

Reference

1. Bates, K.H., Jacob, D.J., Cope, J.D., Chen, X., Millet, D.B. and Nguyen, T.B. (2023).*Environmental Science Atmospheres*, 3(11), pp.1651–1664. 2. Vasilakos, P., Hu, Y., Russell, A. and Nenes, A. (2021b). *Atmosphere*, 12(6), p.707. 3. Guenther, A.B., Jiang, X., Heald, C.L., Sakulyanontvittaya, T., Duhl, T., Emmons, L.K. and Wang, X. (2012). Geoscientific Model Development, 5(6), pp.1471–1492

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