

Reactive Nitrogen in the Global Upper Troposphere from Aircraft Campaigns and GEOS-Chem



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<u>Major Finding</u>: We identified that missing loss processes in GEOS-Chem for the PAN-like compound PPN accounts for almost 50% of the model underestimate in NO₂ in the upper troposphere compared to NASA DC8 aircraft observations.

1. Motivation and Approach

 \geq Reactive nitrogen (NO_v) in the upper troposphere (UT; 8-12 km) impacts global climate, air quality, and atmospheric oxidants.



2. Proportion of UT NO_v measured during DC8 campaigns



- \succ There are large uncertainties in NO_v in the UT, evidenced by discrepancies between state-of-science models and observations.
- > We use NASA DC8, MOZAIC, and IAGOS aircraft observations and GEOS-Chem v13.0.2 to identify and quantify these errors.
- > Aircraft observations are screened for stratospheric influence and aircraft plumes
- \succ Most (68-100%) UT NO_v contributed by a handful of species (NO_x, PANs, HNO₃, HNO₄ and organic nitrates). No NO_2 during SONEX NO₂. KORUA-AQ influenced by biomass burning.

3. Consistent between aircraft observations of total UT NO_v from DC8, MOZAIC and IAGOS

> MOZAIC and IAGOS commercial aircraft campaigns have multiple years of observations of total NO_v at cruising altitude, so can be used to assess whether DC8 measurements offer a climatology of reactive nitrogen in the UT. Comparison requires accounting for different vertical sampling of UT.

Spatial distribution of UT NO_v during DC8 and MOZAIC



Vertical sampling extent of aircraft campaigns



DC8 less than MOZAIC (by 19%) and than IAGOS (by 41%; not shown). Difference is consistent with altitude sampled (commercial aircraft at higher altitude where NO_v more abundant).

4. GEOS-Chem skill at simulating UT reactive nitrogen



5. Concluding Remarks

- 1. Most total measured reactive nitrogen in the upper troposphere is from a few individual components.
- 2. DC8 is roughly consistent with MOZAIC and IAGOS climatology after accounting for different altitudes sampled.
- 3. GEOS-Chem v13.0.2 underestimates UT NO_v due to an underestimate in NO_x .

4. The model overestimates the PAN-like PPN compound

due to missing loss processes in the model.

5. Next: Evaluate DC8 against NO₂ obtained from cloudslicing TROPOMI partial columns.

References

Hudman et al., 2007, doi:10.1029/2006jd007912 Stevenson et al., 2013, doi:10.5194/acp- 13-3063-2013

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