Impacts of anthropogenic and biomass burning emissions on CAM-Chem model bias

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NCAR ACOM

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Research Premise

The NASA Atom flight campaign provides a unique and comprehensive dataset of the remote atmosphere.

How does the choice of emissions impact model bias when compared to these observations?

What is the spatial heterogeneity of these emissions impacts on model bias?
Observation Dataset

ATom I Flight Campaign

Observations taken from 2min merged record of TOGA and WAS measurements

CESM2 results interpolated (time and space) to match the observations.
Model Framework

CESM2.0 w/ full chemistry (beta06)
2016 March – September (GEOS5 SD runs)
0.92x1.25 degree resolution
MEGAN coupled CLM biogenic emissions

Three model iterations:
Run 002: HTAP anthropogenic emission with FINN v1.5 biomass burning
Run 003: CMIP6 anthropogenic emission with FINN v1.5 biomass burning
Run 006: CMIP6 anthropogenic emission with QFED biomass burning
### Results - Overall Statistics

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**Graph:**
- **Axes:** 0 ppb to 300 ppb on the x-axis and y-axis.
- **Legend:**
  - HTAP/FINN: Blue
  - CMIP/FINN: Green
  - CMIP/QFED: Pink

The graph shows the distribution of data points across different concentrations, with trends indicated by lines.
CMIP6 w/ FINN 1.5 (R003)  
CMIP6 w/ QFED (R006)  

50 ppb 150 ppb  
-20% 20%-15ppb 15ppb  

R002 - R006  
(R002 - R006) / R006  

-15ppb 15ppb  
-20% 20%
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The chart showing a scatter plot with the x and y axes ranging from 0 ppb to 1 ppb.
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The table above shows the overall statistics for different scenarios, including HTAP/FINN, CMIP/FINN, and CMIP/QFED. The variables are measured in parts per billion (ppb) for CO, O3, NO, NOy, ethane, propane, bigalk, HCN, CH3CN, benzene, HCHO, CH3CHO, acetone, CH3OH, and DMS.
Spatial Heterogeneity

Can we expand on this analysis to tell if different inventories are better resolved in different regions?

To do this we separate the comparison out into three different regions:

PAC-CONUS: Pacific, near the CONUS
PAC-REST: Other Pacific measurements
ATL-ARC: Atlantic flight data
Although CMIP6 has the lowest correlation, the regional analysis shows that it performs better near CONUS for CO.
Results - Overall Statistics

For NO, all of the regions show similar trends to the full flight correlation.
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HCN we do see regional differences, other work has show an underestimate of South American BB.
Conclusions and Future Work

We have shown that emissions inventories have a large effect on model bias vs. observation in remote areas.

This impact is regionally dependent and does not always follow global model biases.

Future work includes testing of additional regional inventories (DICE, MEIC/MIX/KORUS) and improved speciation (EDGAR v4.3.2).

Once optimal model framework is found we will also test the impact of model resolution and chemistry.

This will be done using CAM-SE and implemented parameterizations from other work (Becky Schwantes, Siyuan Wang, etc.).

Observations comparison for Atom NO$_\gamma$ (collaboration with NOAA).