Intercomparison of remote sensing measurements at a rural site in China: Implications for satellite measurement uncertainty and production of HONO and HCHO from fires

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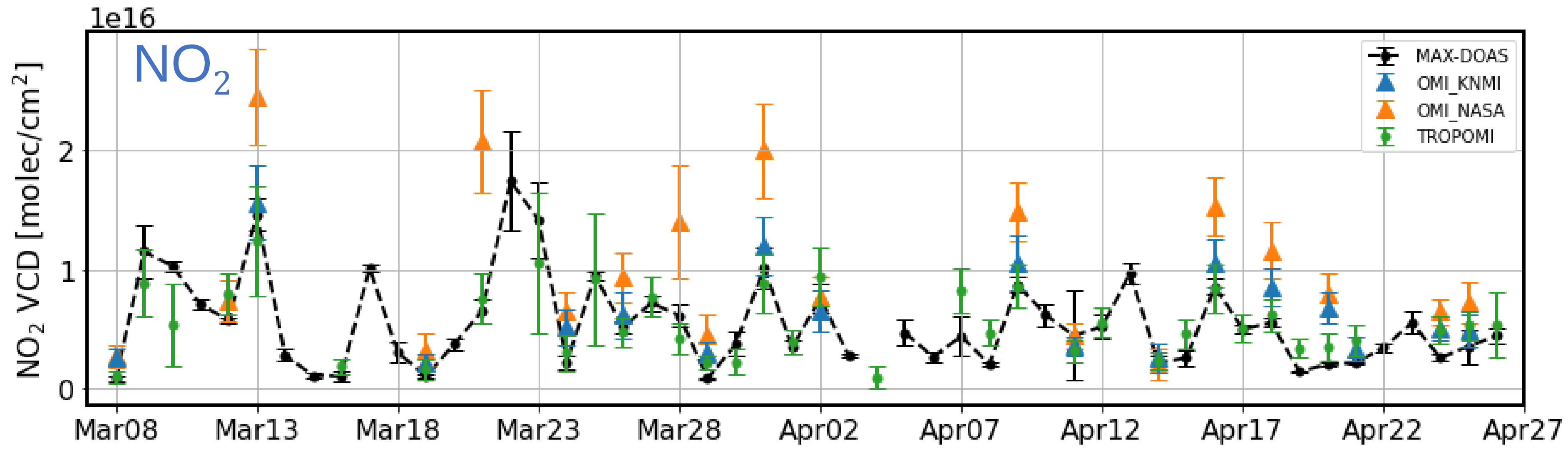
Data: Ground based MAX-DOAS

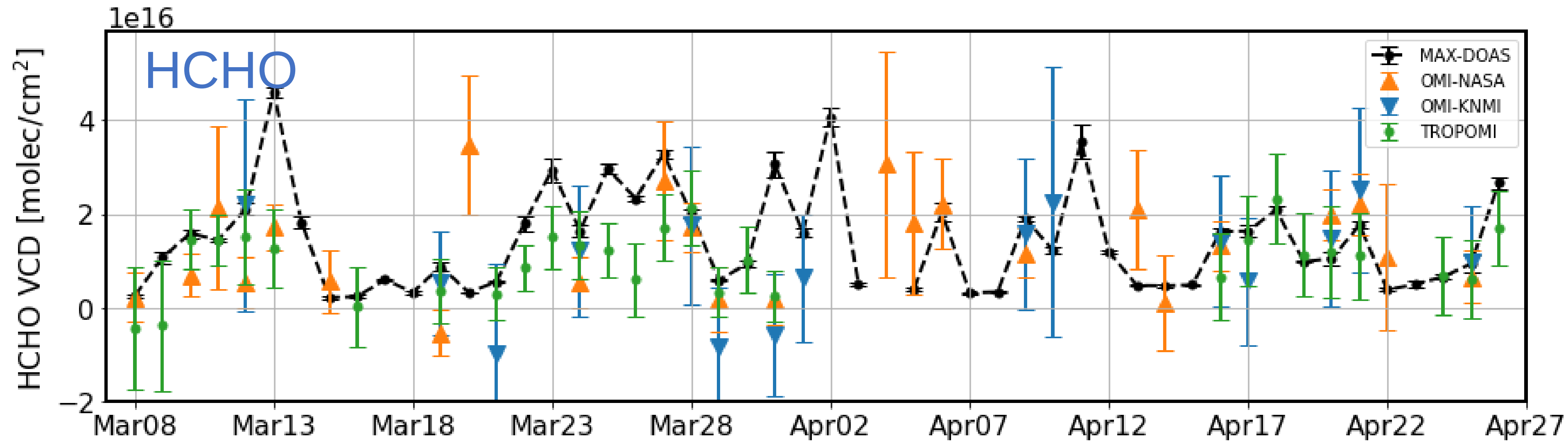
Ozone Photochemistry and Export from China Experiment (OPECE)

- March to April 2018
- Rural site in Dongying, Shandong, China.
- Downwind from megacities in the North China Plain (NCP)

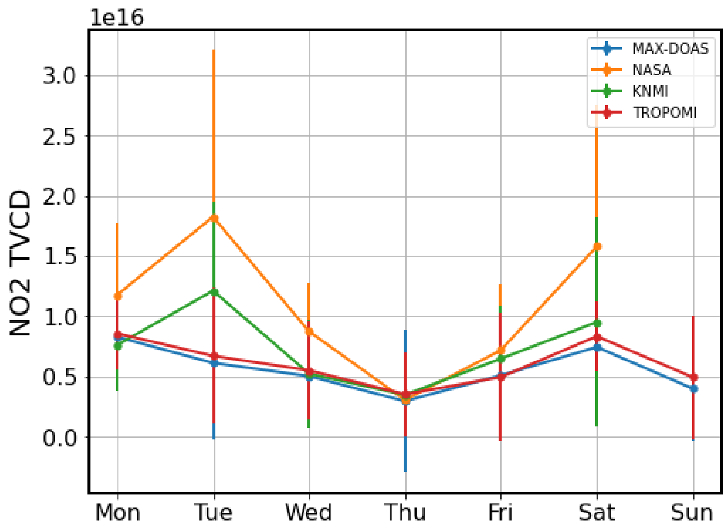
- Ground based MAX-DOAS
- Satellite data (OMI and TROPOMI)

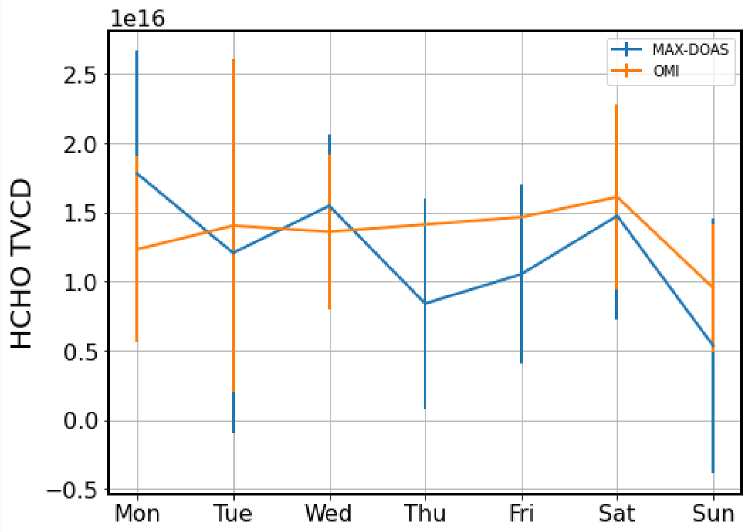
Daily Evolutions of observed TVCDs

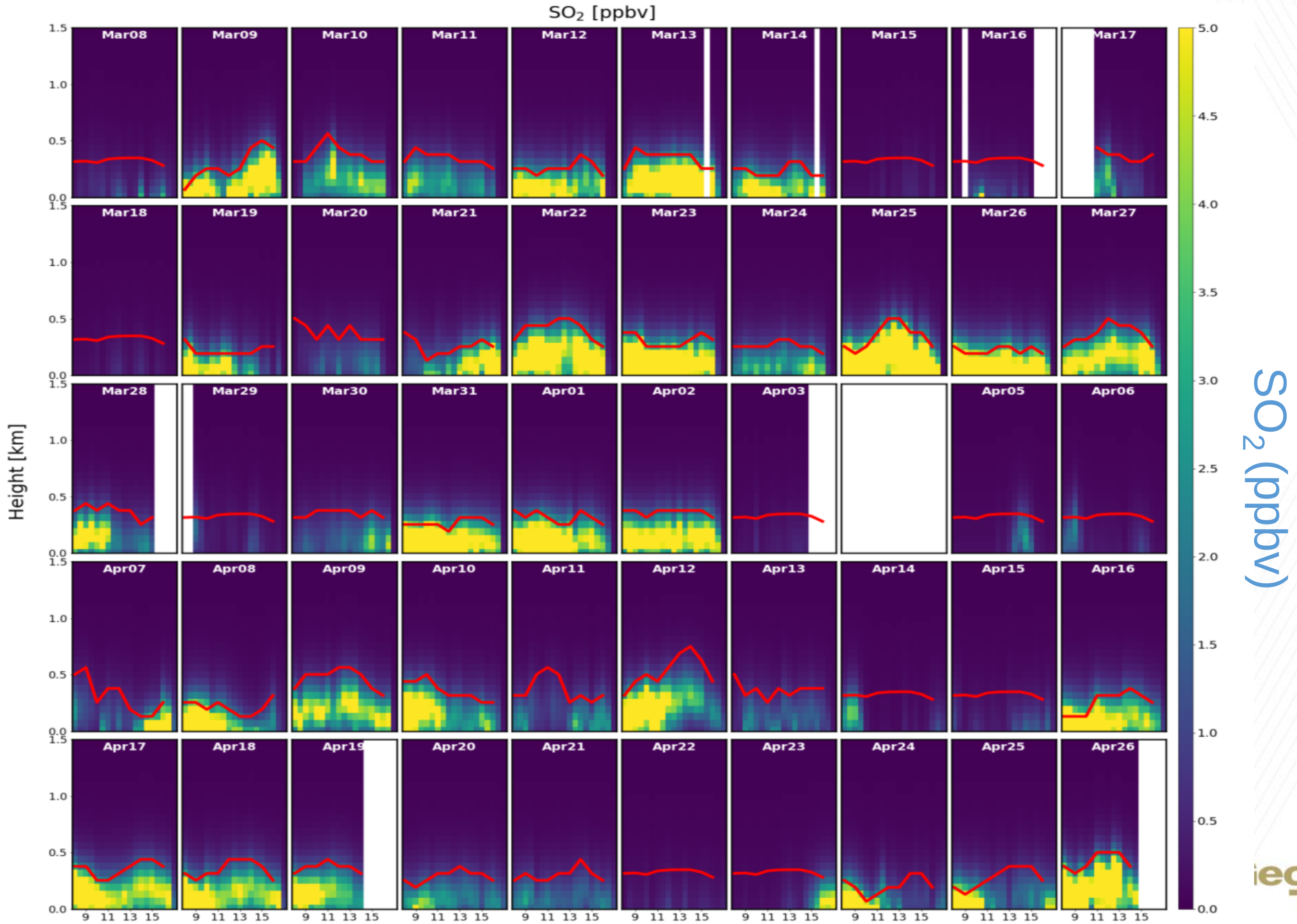




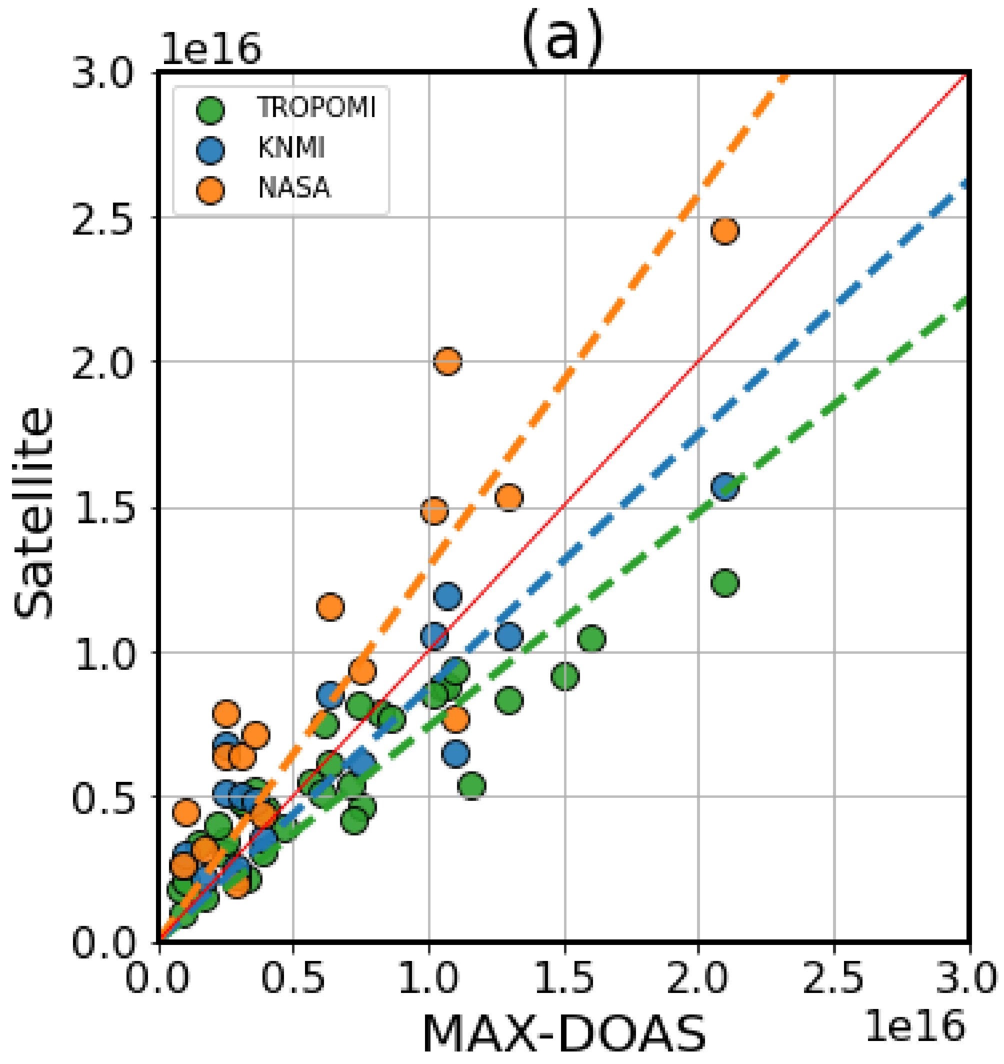
Weekly cycle is insignificant due to pollutant transport







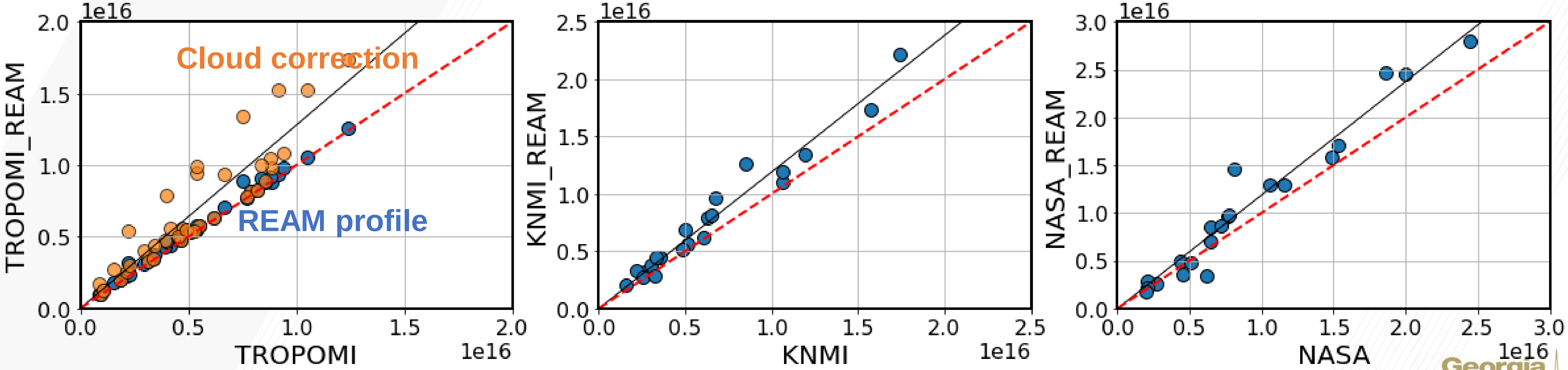
Comparison of OMI and TROPOMI NO_2 TVCDs to MAX-DOAS



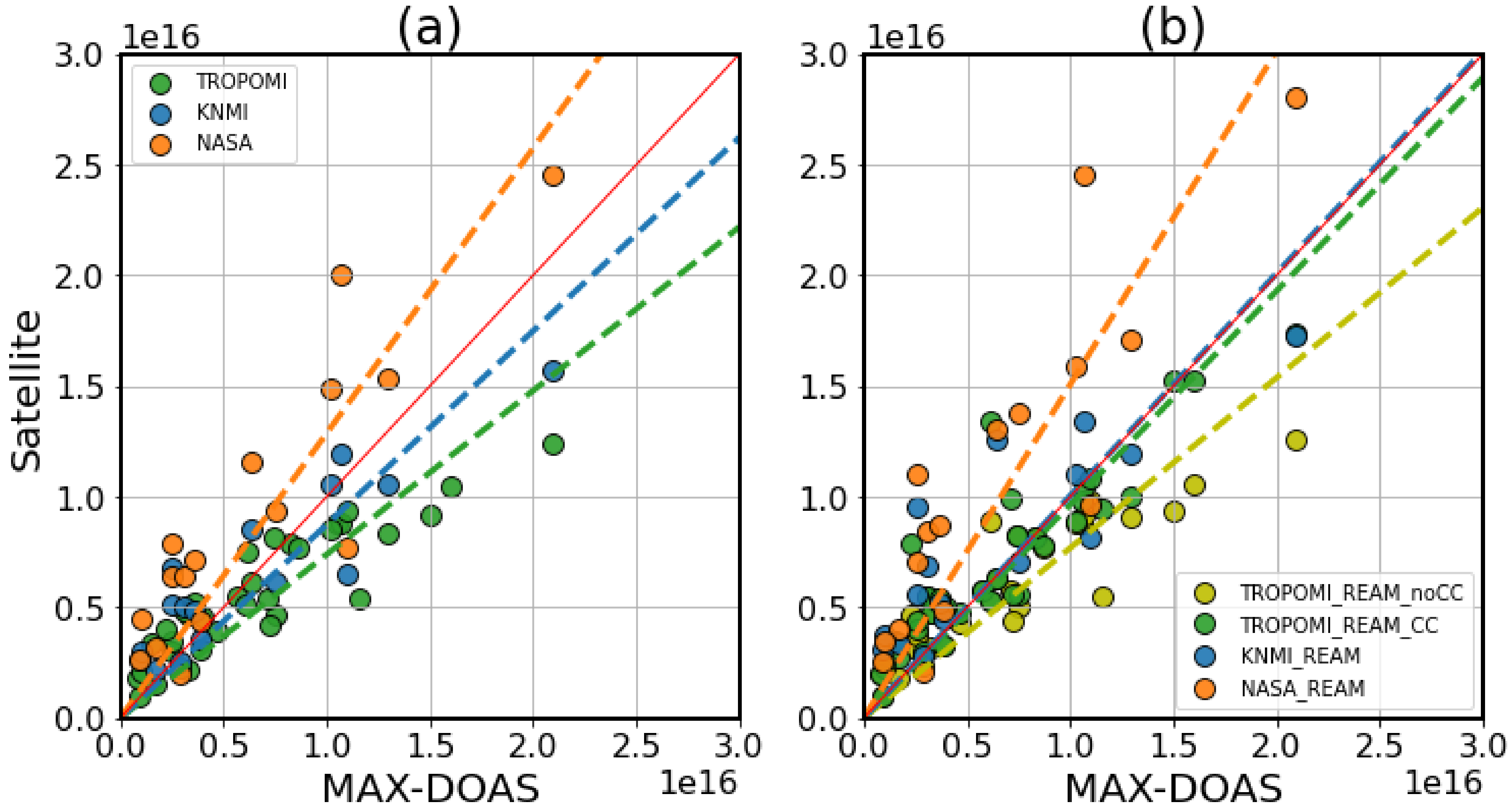
TROPOMI: too low
KNMI-OMI: low
NASA-OMI: too high

Method: calculate AMF based on REAM profiles

- Regional chemical transport model (REAM)
  - 36km × 36km, 30 layers in troposphere
  - Driven by meteorological conditions from the Weather Research and Forecasting version 4.0 (WRFv4.0)
  - Chemicla boundary conditions from GEOS-Chem simulation

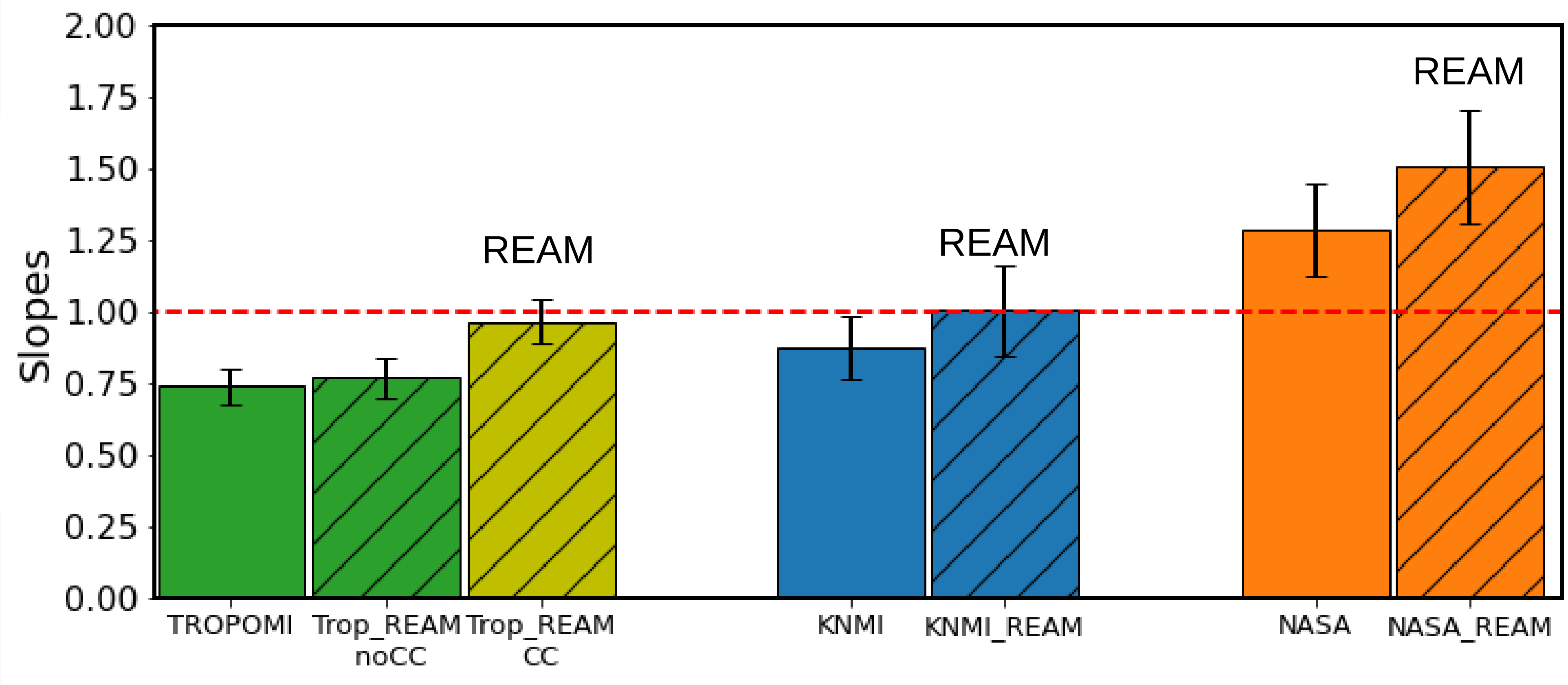


Comparison of OMI and TROPOMI NO$_2$ TVCDs to MAX-DOAS



TROPOMI:
good
TROPOMI_noCC:
too low
KNMI-OMI:
good
NASA-OMI:
too high

Comparison of OMI and TROPOMI NO_2 TVCDs to MAX-DOAS



TROPOMI:
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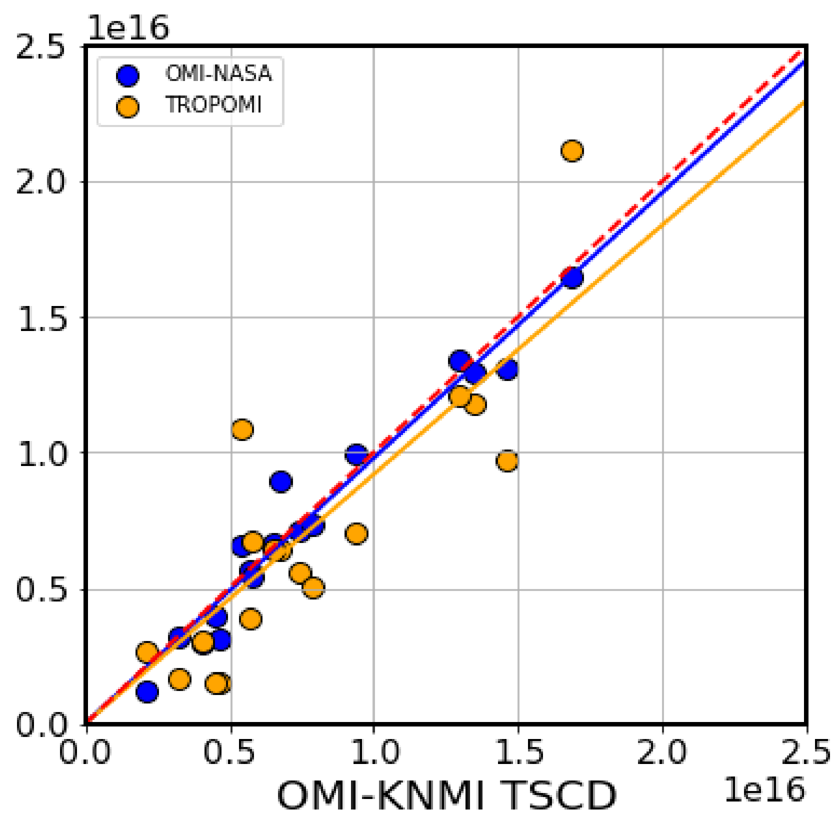
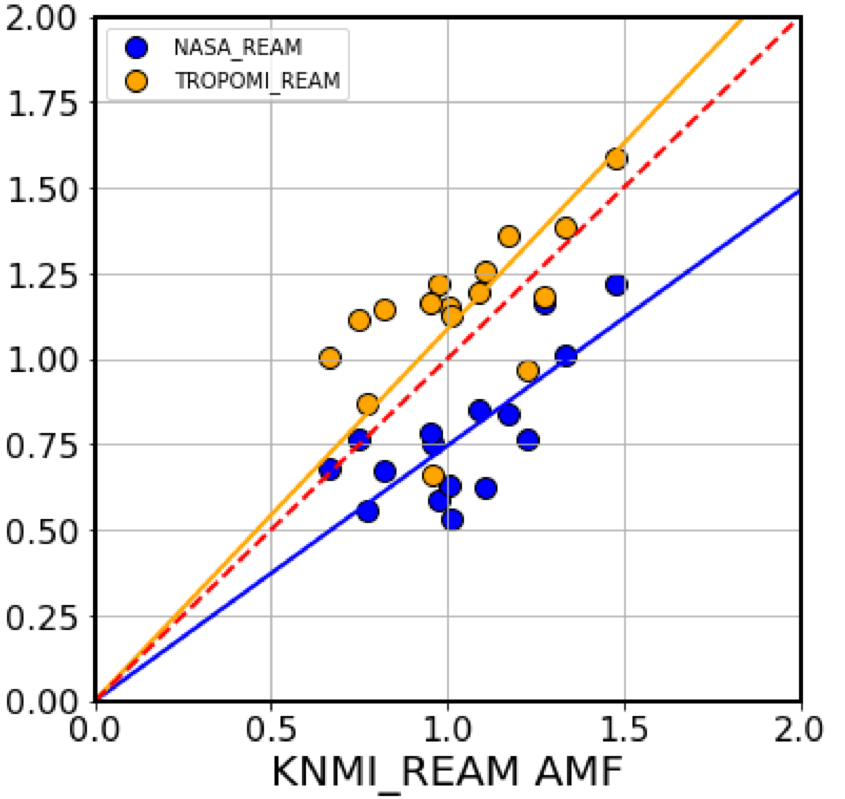
Intercomparisons of TROPOMI with OMI

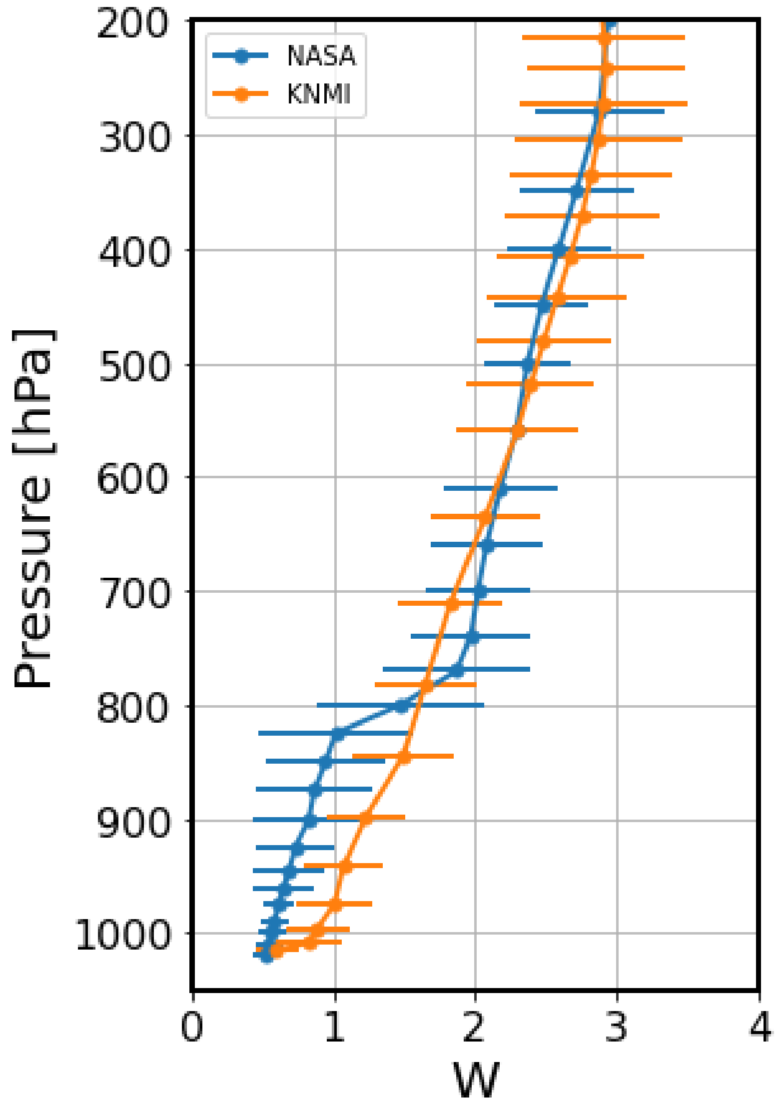


NASA OMI and TROPOMI vs. KNMI OMI TSCDs



NASA OMI and TROPOMI vs. KNMI OMI AMFs

OMI scattering weight vertical profiles from NASA and KNMI

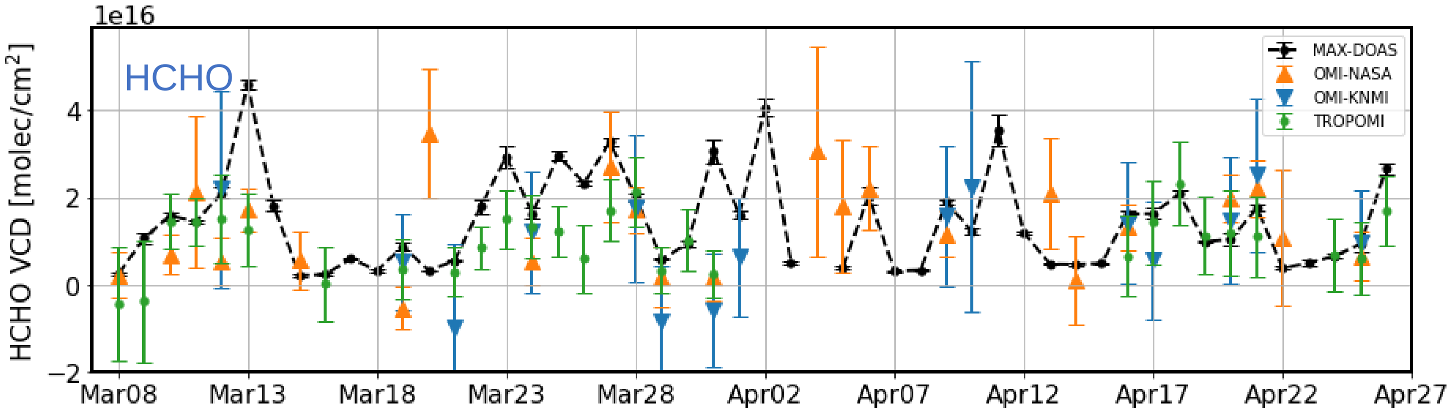


$$\mathrm{TVCD_{REAM}} = \frac{\mathrm{SCD}}{\mathrm{AMF_{REAM}}}$$

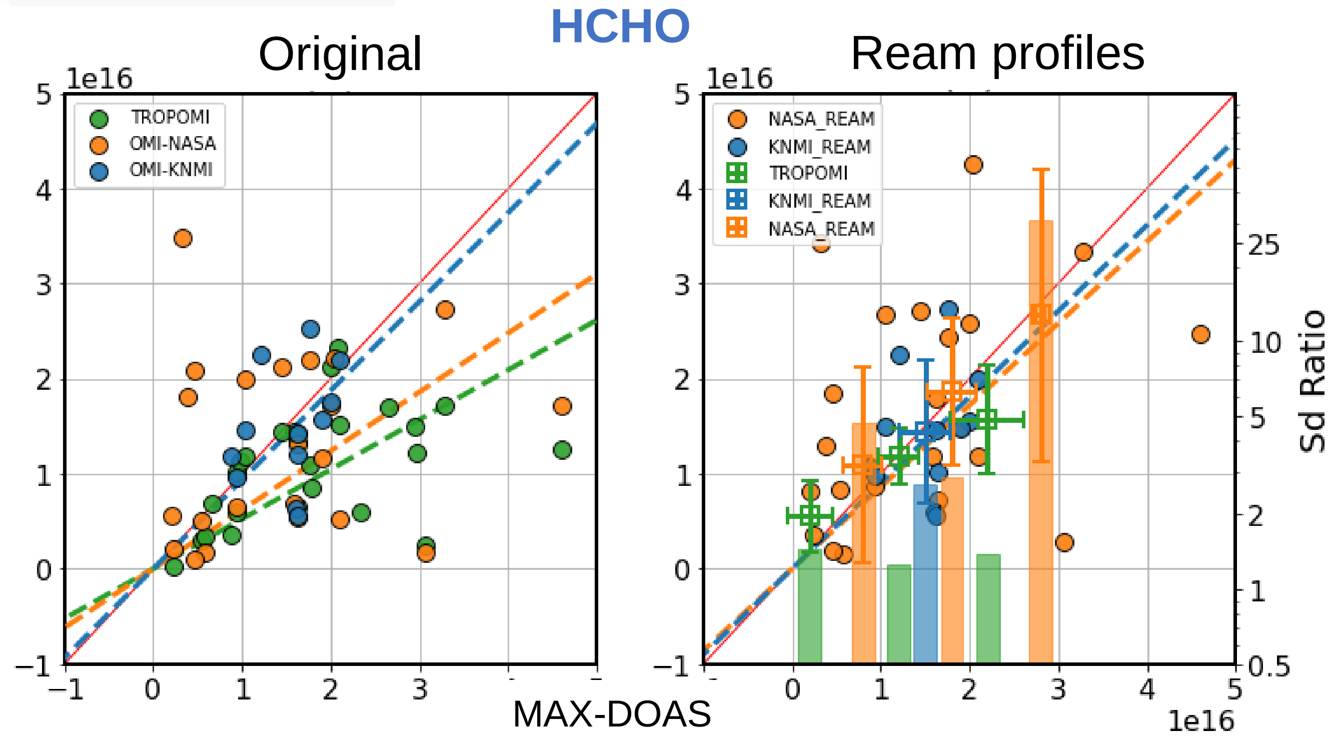
$$\mathrm{AMF_{REAM}} = \frac{\sum_i V_{i,\mathrm{REAM}} W_i}{\sum_i V_{i,\mathrm{REAM}}}$$

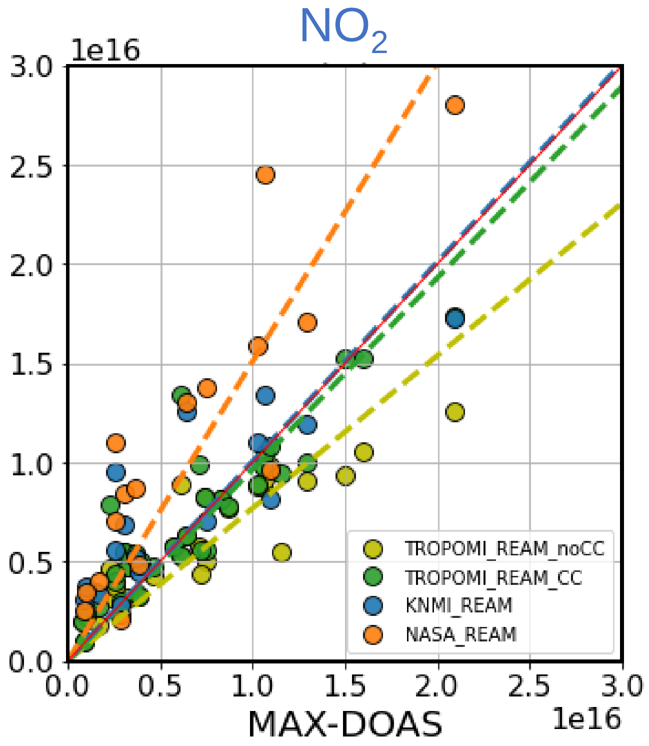
Below 800hP, w from NASA is 30% lower than that from KNMI.

Intercomparison of HCHO TVCDs



The comparisons for OMI and TROPOMI HCHO TVCDs are considerable worse than those of NO$_2$

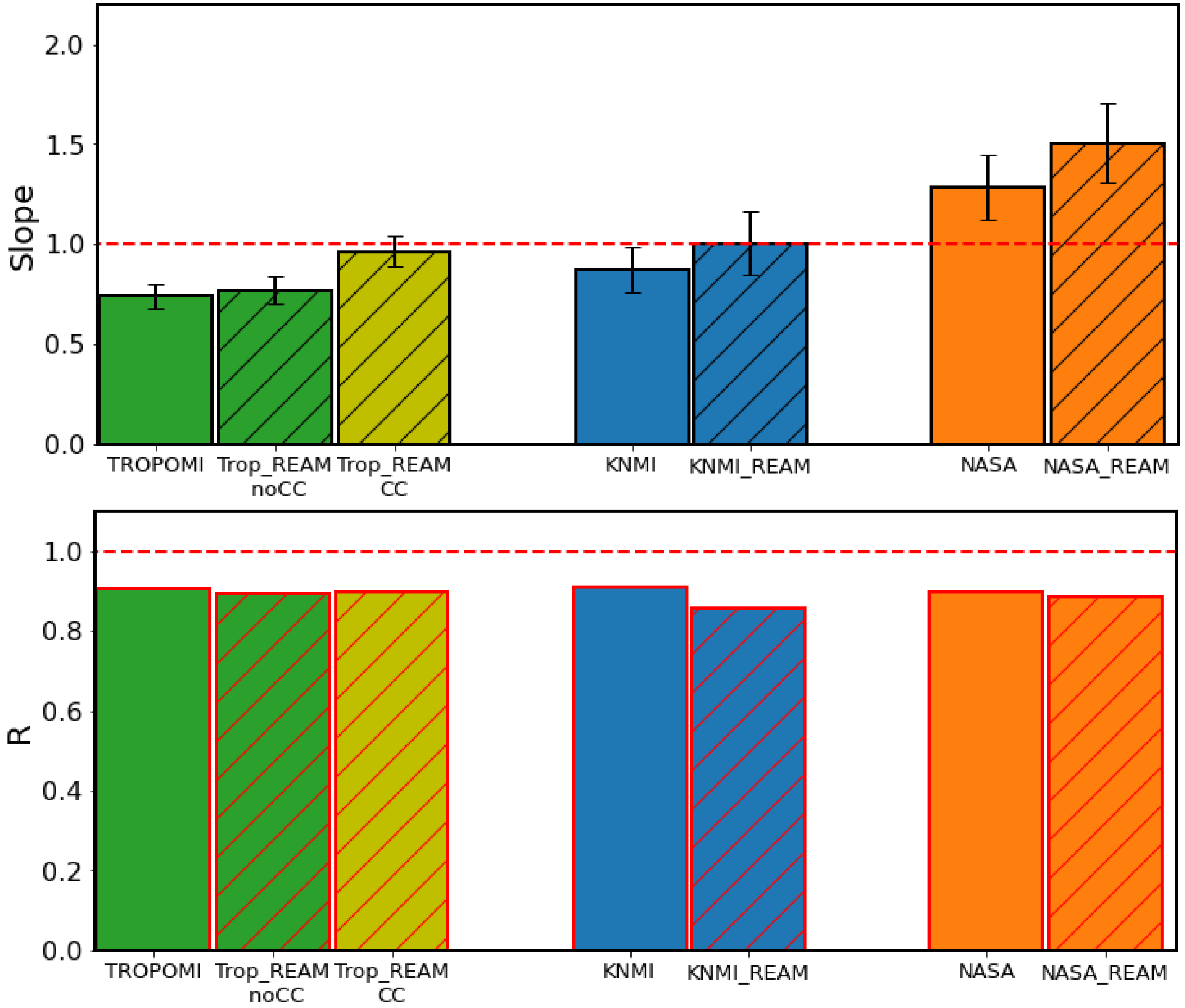




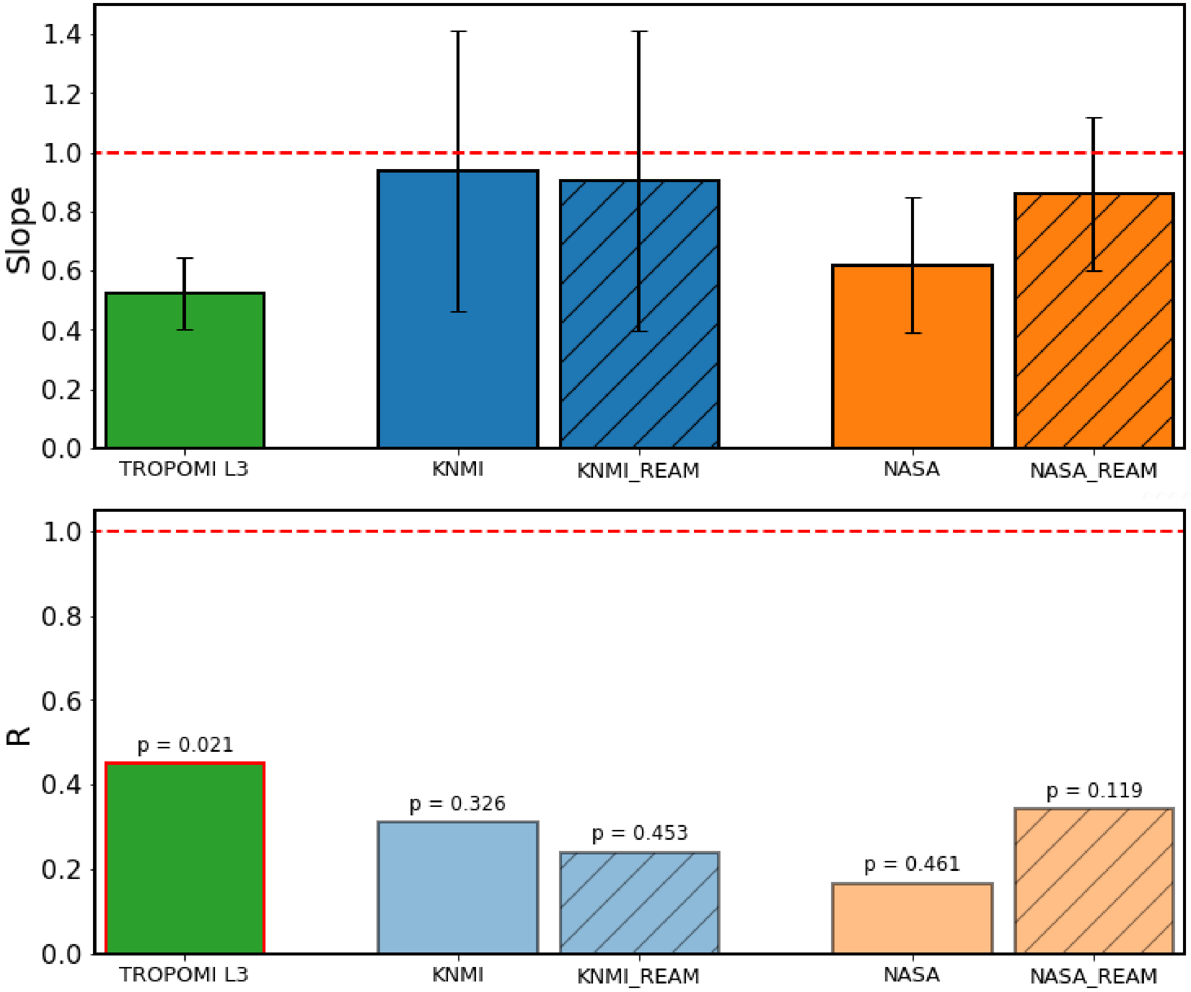
Intercomparisons of NO_2 vs. HCHO TVCDs

Slope

correlation coefficients



NO_2



HCHO

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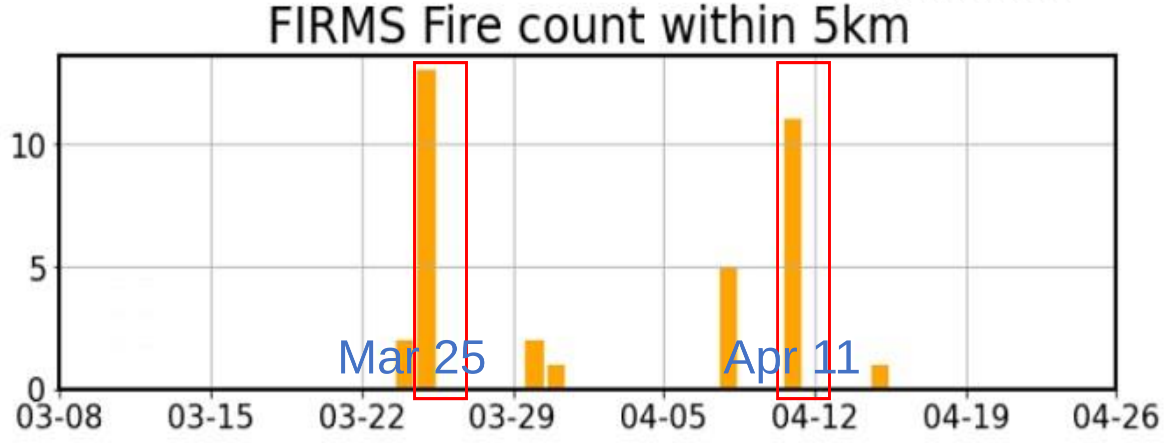
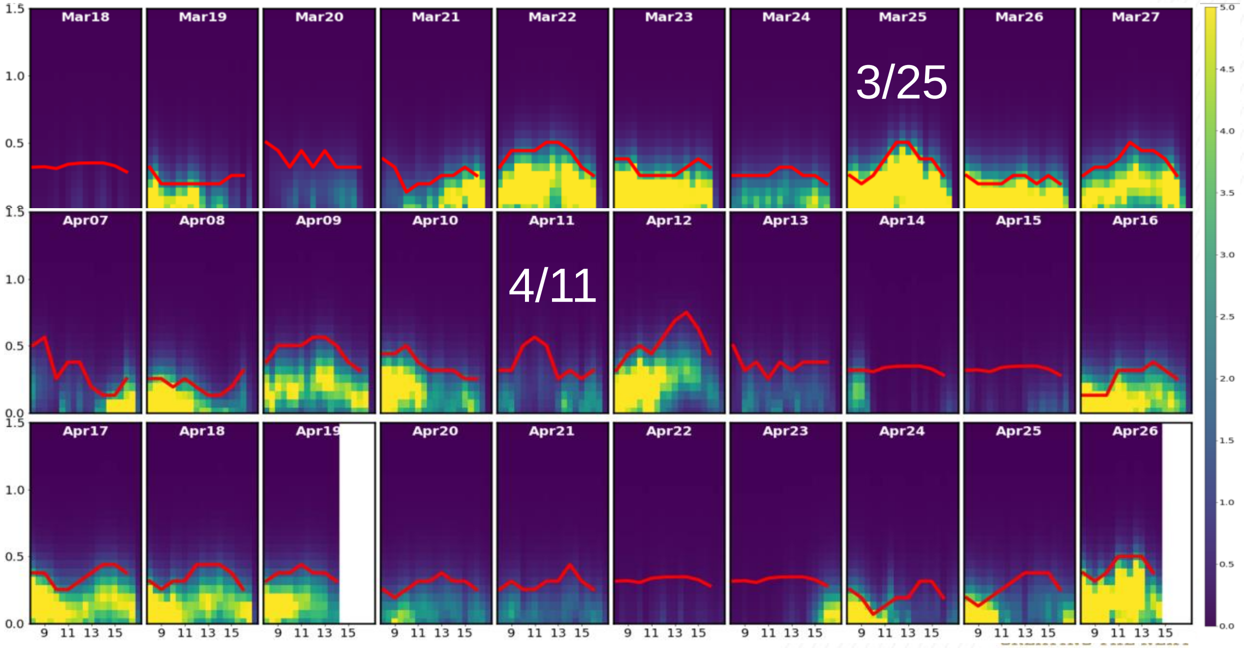
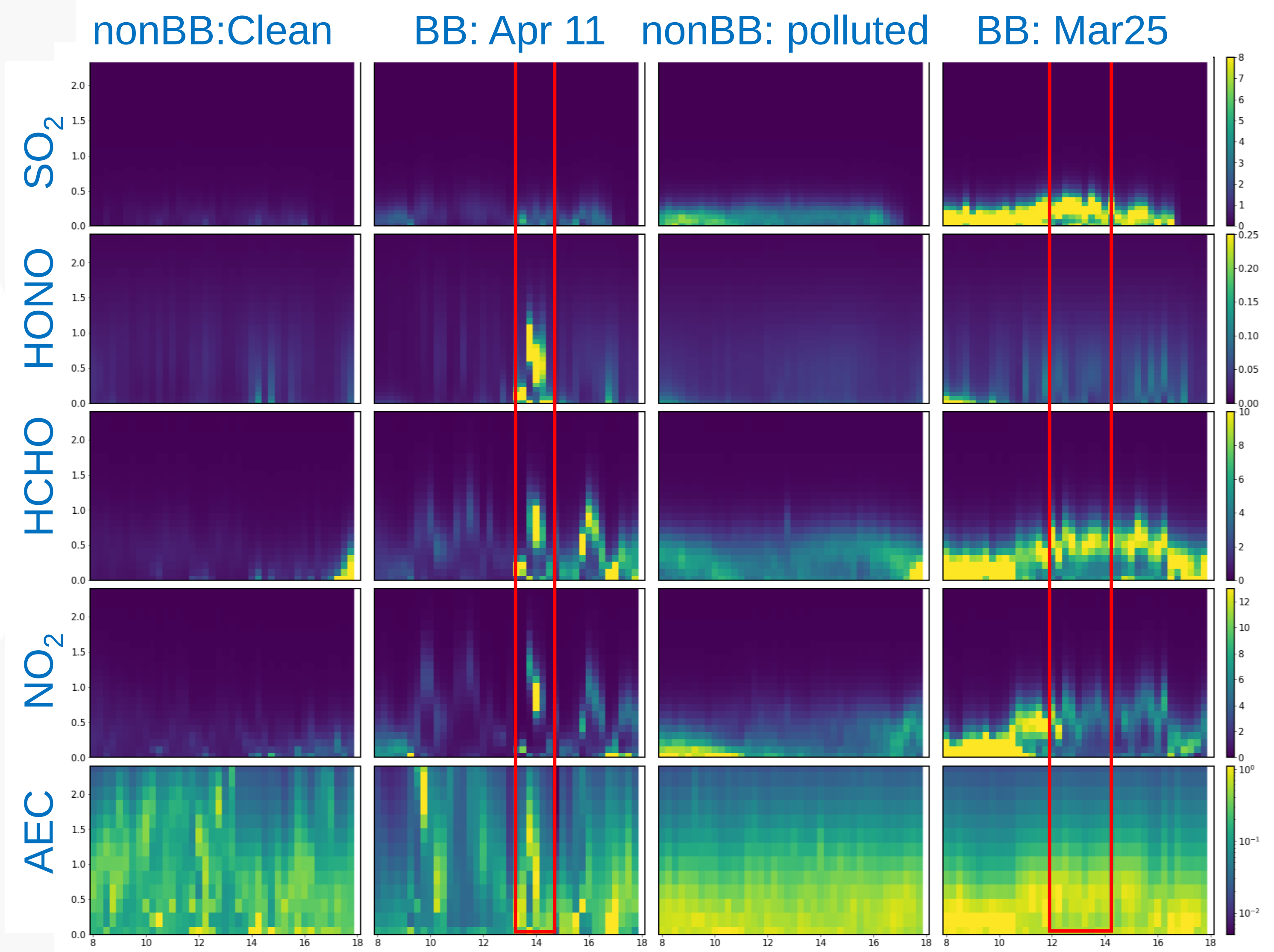
Biomass burning impacts on HONO and HCHO

FIRMS observed fire hotspots



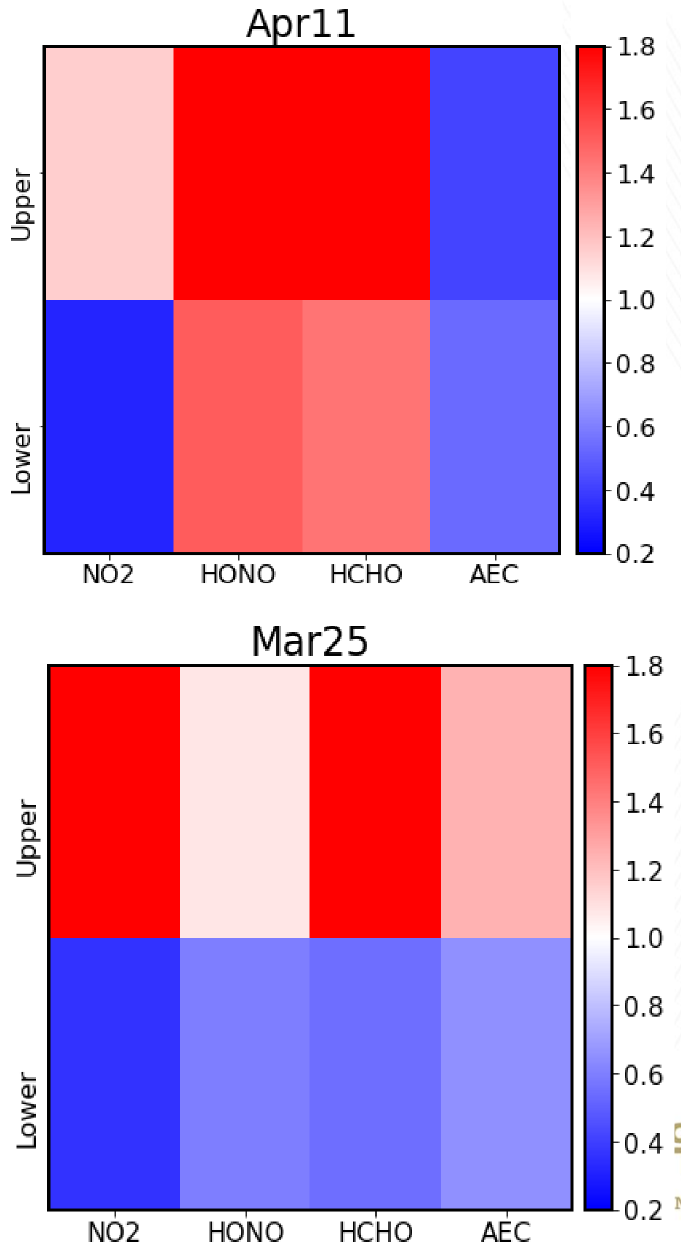
Fire count within 5km





Measured species concentrations with and without biomass burning (BB) in clean and polluted days

Enhancement ratios over background



Conclusions

- Unifying prior profiles improves the consistency among satellite NO_2 and HCHO TVCD products
- OMI and TROPOMI NO_2 TVCD data are in good agreement with MAX-DOAS
- In comparison, OMI and even TROPOMI HCHO daily TVCD products are not as well correlated with MAX-DOAS as NO_2; TROPOMI data have a higher correlation coefficient and less scattering than OMI data
- Biomass burning can significantly enhance HONO and HCHO above the surface layer, which will significantly enhance photochemical oxidation. Fire production of HONO is more variable than HCHO