Can satellite data of combustion products (CO, NOx, aerosols) provide constraints on megacity combustion (complementary to ground-based measurements)?

There is promise but current spatiotemporal coverage is insufficient to make robust multi-species characterization.

Fig. 9, Ch. 8, D. Parrish (lead)
WMO/IGAC Impacts of Megacities on Air Pollution and Climate, (2012)

Funding from NASA
Focus on Winter Data (NH: DJF, SH: JJA) across 2005-2014
On average, 5-10% of megacity are sampled per day by MOPITT & OMI
Used RCP emissions for later comparison with CAM-Chem/DART Reanalysis
Satellite Data Analysis over Megacities (2, e.g.)

A.) Regression Analysis

- Calculate linear regression (reduced Major Axis) between MOPITT CO/OMI NO\(_2\) for each year, each city across the winter period.
- Compare with other data (Emission-Based and Model-Based).

B.) CO/NO\(_2\) Diagrams

- Silva et al. (2013)
- Arellano et al. in prep
**Satellite-Based versus Emission-Based (Trends)**

RCP Emission-based (in red) was scaled down by 5.

While estimates are promising (some interesting trends), associated confidence intervals are large (due to lack of data).
Trends in CO–NO\textsubscript{x} relationships may provide insights on changes in combustion characteristics (on top of CO/NO\textsubscript{x} ratios). May be a useful diagnostic for models to capture?

There are obvious differences in trends between satellite-based and emission-based (sensitive to data selection & filters)

Need more data to ‘calibrate’ or ‘tune’ satellite-based approach.

Opportunity for multi-species inversions
**CHIME**

**CHemical Inverse Modeling system Experiments**

Inter-comparison activity on current data assimilation/inverse modeling systems (DAS) to elucidate key factors contributing to errors in emission estimates.

Similar to TransCom (for Carbon Cycle), we envision this to involve several groups in chemical DAS community, representing a range of modeling and assimilation approaches and assimilating different sets of chemical observations. Major focus will be on sensitivity of estimates to: 1) model transport, 2) model treatment of non-linear chemical processes and deposition, 3) prior distribution of emissions, 4) assimilation methods, 5) construction of observation operators, 6) observation types, and 7) other related DAS approximations.

Ensemble of Emission inventories (and characterization of uncertainties) would be critical.