The Tropospheric Emissions: Monitoring of Pollution (TEMPO) instrument will be the first NASA mission to make atmospheric composition observations from geostationary orbit and partially fulfills the goals of the Geostationary Coastal and Air Pollution Events (GEOCAPE) mission.

In that work, we quantified the spatial and temporal variability of column integrated and in-situ observations of trace gases over the Baltimore/Washington, DC area using output from WRF/Chem for the entire month of July 2011, coinciding with the first deployment of the NASA Earth Venture program mission DISCOVER-AQ (Deriving Information on Surface conditions from a satellite remote sensing observations from a network of ground sites and two research aircraft.)

Here, we expand that analysis to include the other three deployments of DISCOVER-AQ.

Maryland Analysis Highlights – Follette-Cook et al. (2015)

Follette-Cook et al. (2015) quantified the variability seen in the Maryland/DC DISCOVER-AQ P-3B trace gas data and found it compared well with our WRF/Chem simulation. Questions addressed in that analysis:

- How much does each species vary spatially and temporally throughout the campaign? (i.e. one month)
- How much of that variability would a TEMPO-like instrument see?
- Is the resolvable variability sufficient to answer the relevant science questions?

Precision Requirements (PR) for GEO-CAPE/TEMPO

The TEMPO instrument will make atmospheric composition observations from geostationary orbit and partially fulfills the goals of the Geostationary Coastal and Air Pollution Events (GEO-CAPE) mission.

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Structure Functions

Structure functions are a useful way to quantify variability in both space and time:

\[ f(x, y) = \langle \frac{1}{2} (x - y)^2 \rangle \]

- \( x \) = the average of data pairs separated by distance \( y \)
- \( Z \) = variable of interest at given location \( x \)
- \( q \) = scaling exponent (here \( q = 1 \))

Calculate structure functions using data from DISCOVER-AQ P-3B in-situ aircraft (14 flights for MD)

• Both points must be below 2 km (AGL)
• The points must be < 2 km apart (1.75 hrs for MD)
• The 1-second merge data was used for this analysis
• Model output was sampled along the P-3B flight track

Maryland – Jul/Aug 2014

Texas – Sep 2013

California – W. Appel

Coupled WRF/CMAQ v5.0.2

- 4 km

Colorado – G. Pfister

WRF/Chem – 3 km

The results from the MD analysis suggest that the PRs for TEMPO and GEO-CAPE are sufficient for addressing the science questions they are tasked to answer.

Can WRF/Chem capture the variability seen in the MD DISCOVER-AQ observations?

The results from the MD analysis suggest that the PRs for TEMPO and GEO-CAPE are sufficient for addressing the science questions they are tasked to answer.

Conclusions

• Results from an in-depth analysis of trace gas variability in MD indicated that the variability in this region was large enough to be observable by a TEMPO-like instrument
• The variability observed in MD is relatively similar to the other three campaigns with a few exceptions:
  - CO variability in CA was much higher than in the other regions; HCHO variability in CA and CO was much lower; MD showed the lowest variability in NO2
  - All model simulations do a reasonable job simulating O3 variability. For CO, the CACO simulations largely underestimate the variability in the other regions; the variability in HCHO is underestimated for every campaign. NO2 variability is slightly overestimated in MD, more so in CO. The TEMPO simulation underestimates the variability in each trace gas. This is most likely due to missing emissions sources (C. Loughner, manuscript in preparation).
  - Future Work: Where reasonable, we will use these model outputs to further explore the resolvability from space of these key trace gases using analyses of tropospheric column amounts relative to satellite precision requirements, similar to Follette-Cook et al. (2015).