Emission Data Assimilation for Air Quality Forecasting

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Emission Data Assimilation

Emission data assimilation (EDA): Assimilate satellite observations to reduce emission uncertainty (temporal trends, spatial distribution, source strength, etc).

EDA provides rapid emission refresh for air quality forecasting.

(Source: Tong et al., 2012)
NO$_x$ Emissions During Great Recession

**Atlanta**

Comparison to 2005 values

- OMI (Space)
- AQS (Ground)
- NAQFC (Model)

**Philadelphia**

OMI = Ozone Monitoring Instrument on NASA’s Aura Satellite

AQS = Air Quality System

(Source: Tong et al., 2015; 2016)

State-level NOx Adjustment

Satellite-adjusted – EPA Project.

Surface Ozone Change
Can satellite data be used to adjust emission pixel by pixel?

1) Emission contribution >= 75%;
2) Transport <= 25%;

Applications of Hi-Res satellite data need to consider chemical budget when adjusting emissions.
SO$_2$ Emission from Kilauea Eruption

(REUTERS/Terray Sylvester)

SO$_2$ Forecasting

SNPP/OMPS

(Li Can and Nickolay Krotkov, NASA GSFC)

New SO$_2$ Forecasting
Rising Dust Storms

(Source: Tong et al., 2017)

Fast rising dust in Southwest, economic losses of 3 billion dollars per year, approximately half from health effects.

(Kondragunta et al., 2018)
Emission data assimilation, air quality forecasting and reanalysis

- Ammonia Emissions from Biomass Burning
  - Fire NH$_3$ emissions derived from MODIS Fire Radiative Power (FRP) [Bray et al., 2018];
- Chemical data assimilation of MODIS AOD into the National Air Quality Forecast Capability (NAQFC) [Tang et al., 2017];
- High-resolution long-term North America Chemical Reanalysis;
  - Combined model prediction and observations for PM$_{2.5}$ and composition, O$_3$, NO$_2$, CO and SO$_2$ (12km resolution over US, 2009-2018);
- Dust storm and human health;
  - Used NASA data to link ocean changes to dust storms and Valley fever [Tong et al., 2017].
  - Tracking dust storms with GOES-16 Advanced Baseline Imager [Kondragunta et al., 2018].
- Outreach: Eight presentations; 20+ media interviews; New documentary “Dust Rising” (Lauren Swartzman).

Tiger Team Participation

- Co-Lead with Brad Pierce: NOx emissions
  - Developed rapid emission refresh application;
  - Supported chemical data assimilation work by Peirce and NOAA.
- TT Fiore: Satellite Data in SIPS.
  - Worked with NASA GIS DISC to create a recipe to derive long-term satellite NO$_2$ trend over your city.
- TT Duncan and West: Emission Efficacy.
  - Generated long-term air quality reanalysis data for West’s health analysis.
- TT Kinney and Freeman: High Resolution
  - Developed multi-year dust observations to cross-validate high-resolution prediction.