Forecasting the Impact of Smoke from Mt McMurray Fires on U.S. Air Quality using S-NPP VIIRS Aerosol Products

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STAR JPSS Annual Science Team Meeting
August 10, 2016
Operational Air Quality Forecasting

- State, local, and tribal agencies issue **air quality forecasts** to protect the public from the adverse health effects of criteria pollutants
  - 43 states plus Washington, DC
  - O$_3$, PM$_{2.5}$, PM$_{10}$ most commonly forecasted pollutants
  - Based on EPA’s color coded Air Quality Index (AQI)
  - Forecasts typically issued by mid-afternoon (~3 PM) for next day; some agencies do morning updates
  - Forecasts available on state and local websites and EPA’s AirNow national website ([http://www.airnow.gov/](http://www.airnow.gov/))
Wildfire Smoke is a Problem for PM$_{2.5}$ Forecasts

- PM$_{2.5}$ is a mixture of solid and liquid particles with aerodynamic diameters $\leq 2.5\ \mu$m
- Smoke from major wildfires can be transported long distances, sometimes 100s of km downwind
- If smoke mixes to surface, it can impact local PM$_{2.5}$ conditions
  - Can cause exceedance of daily **National Ambient Air Quality Standard (NAAQS)**: $35\ \mu g/m^3$ (24-hr)
  - Observed Code Orange or higher PM$_{2.5}$ corresponds to exceedance of NAAQS
  - Forecasted Code Orange or higher PM$_{2.5}$: **Air Quality Alert (AQA)** issued
Very Difficult to Forecast Impacts of Smoke

- Forecasters have variety of tools they use as guidance to prepare PM$_{2.5}$ forecasts, but none are skillful in case of transported smoke
- Climatology: smoke events are rare for most locations
- Persistence: can’t account for first day of smoke event (but can be useful for multi-day smoke events)
- Numerical PM$_{2.5}$ models: don’t include transported smoke in boundary conditions
- So forecasters turn to satellite aerosol products to track smoke plumes and predict whether smoke will mix to surface
Case Study: Fort McMurray Fire, May 2016

• Ft McMurray fire began May 1, 2016
  – Burned for more than 1 month
  – Consumed > 600,000 hectares
  – Forced evacuation of > 88,000 residents from city in early May
Smoke Transported to Northern Plains, May 7

- Smoke from Ft McMurray fire traveled to N. Plains states and caused widespread exceedances of PM$_{2.5}$ NAAQS on May 7
- Event only lasted one day – PM$_{2.5}$ dropped to Code Yellow on May 8

<table>
<thead>
<tr>
<th>Quality Class</th>
<th>AQI Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>0 to 50</td>
</tr>
<tr>
<td>Moderate</td>
<td>51 to 100</td>
</tr>
<tr>
<td>Unhealthy for Sensitive Groups</td>
<td>101 to 150</td>
</tr>
<tr>
<td>Unhealthy</td>
<td>151 to 200</td>
</tr>
<tr>
<td>Very Unhealthy</td>
<td>201 to 300</td>
</tr>
<tr>
<td>Hazardous</td>
<td>301 to 500</td>
</tr>
</tbody>
</table>
Operational PM$_{2.5}$ Model Did Not Predict Smoke Impacts
VIIRS Aerosol Products Showed Smoke Transport

VIIRS AOT and RGB
May 7, 2016
Best Forecast Tool is 48-Hr Forward Trajectories

- Static example of 48-hr trajectories initiated at 12 UTC May 6
- Trajectories originated at areas of high observed AOT (> 0.4)
- Magenta/pink lines indicate transport of smoke S/SW into Plains states, remaining near the surface

Trajectory at 15 UTC May 7, 2016
eIDEA: New 1-Stop Fire and Smoke Imagery

http://www.star.nesdis.noaa.gov/smcd/spb/aq/eidea/

CONUS, Alaska, S/C Canada domain

calendar to select date of interest

animations and external links

main product overlay buttons
Importance of VIIRS Aerosol Products for Forecasting Impacts of Transported Smoke

• VIIRS RGB and AOD essential for identifying smoke plume transport upwind
  – Gives forecasters a heads-up when smoke may be heading toward forecast area
  – Use in conjunction with surface $\text{PM}_{2.5}$ measurements to determine when smoke is impacting surface air quality

• 48-hour aerosol trajectories critical tool for identifying when smoke will reach surface in forecast area
  – No other forecast tools can predict when transported smoke will move into forecast area and mix to surface

• New eIDEA website designed for operational users