Exceptional Event Analysis and WRF Modeling for Regulatory Applications in the Midwest

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LADCO’s Role on EE Demonstration

• EE WG: Monthly Call since July 2018
• Initial Notification Process: help narrowing the number of sites/days for EEs
• LADCO created diagnostics based on AirNow Tech data to distinguish non-event and potential EEs
  —HMS smk layer (manual inspection...!?)
  —Providing time series plots for O3, PM2.5 and CO for each state, NAA and interested areas
    —Standardized anomaly and residual ($x-(\mu +1\sigma)$) time series for each site
    —Average anomaly time series for each AQ variables for an area of interest
  —Removed year to monthly variability from time series based on 2013-2017 records

  (CO, PM$_{2.5}$, O$_3$ > 1$\sigma$) + (presence of smoke in the column) indicate potential EEs
When the Screening Model Works (May 23-24)

1. HMS smoke in the region on May 22
2. $O_3 > 2\sigma$ & CO and $PM_{2.5} > 1\sigma$
3. High pressure system on May 23-24
Discussion Points:

1. **Bring satellite data to site location**
   - Potential data sources
     - CALIPSO AOD
     - ISS CATS AOD Type Profile (aloft vs. sfc smk)
     - Hourly to daily cloud and smoke cover
     - ...  
     - Readily and easily accessible data in csv format
     - Temporal and spatial collocation (algorithms/scripts/footprint coverage)

2. **Knowledge on indicators and impacts of aged smokes on O3 and PM2.5**

Wish list: Consecutive cross section of AOD type profiles from CALIPSO/CATS over HMS smk layer

https://www.ssec.wisc.edu/mcidas/software/v/docs/SPIE%20Article%20on%20McIDAS-V_2008_07.pdf (Fig2, IDV)
2016 WRF Simulation for Regional Haze Planning

Finding the best performing Config:
- Physics options (PBL, LSM, mp, SL)
- Initialization data
- Nudging configuration
- SST over the Great Lakes

CASE1 = LADCO2016_WRFv39_YNT_GFS_gsa (d01-d03)
  - YSU PBL, Unified Noah LSM, Thompson's microphysics, MM5 Monin-Obukhov surface layer option
  - GFS Grid4 (~25km, 6hr fdda)
  - 3D grid (d02 and d03) and surface observation nudging (d02)
  - GLSEA SST over the Great Lakes

CASE2 = LADCO2016_WRFv39_YNT_NAM_gsa (d01-d03)
  - YSU PBL, Unified Noah LSM, Thompson's microphysics, MM5 Monin-Obukhov surface layer option
  - NAM218 (12km, 3hr fdda)
  - 3D grid (d02 and d03) and surface observation nudging (d02)
  - GLSEA SST over the Great Lakes

CASE3 = LADCO2016_WRFv39_APLX_NAM_gda_nd (d02, d03)
  - ACM2 PBL, Pleim-Xiu LSM, Morrison 2 moments microphysics, Pleim-Xiu surface layer option
  - NAM218 (12km, 3hr fdda)
  - 3D grid nudging
  - ICBC from USEPA’s 12km WRF output (ndown)
  - GHRSST over the domain
For 12 km grid, YNT_NAM (3hr fdda) had better performance for T and WD.
Discussion Points:

1. **Best WRF Configuration for LADCO region (Preliminary Results)**

<table>
<thead>
<tr>
<th>Met variable</th>
<th>12 km</th>
<th>4 km</th>
<th>1.33 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp</td>
<td>YNT_NAM</td>
<td>YNT_GFS/NAM</td>
<td>YNT_GFS or APLX_NAM</td>
</tr>
<tr>
<td>Wind Dir</td>
<td>YNT_NAM</td>
<td>YNT_GFS/NAM</td>
<td>YNT_GFS or APLX_NAM</td>
</tr>
</tbody>
</table>

2. **AMET Model Performance Statistics**
   - T, Q, WS, WD
   - Other variables: readily available and easily assessable in useful format?
     - Hourly cloud cover (cu_option and mp_option)