Dust, Fire, and Stagnation
Terry Keating and John Dawson
U.S. Environmental Protection Agency
Air Quality Management is, at least partly, about managing for “extreme” weather.

<table>
<thead>
<tr>
<th>NAAQS</th>
<th>Averaging Time</th>
<th>Form</th>
<th>Non-Attainment Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>1 hour</td>
<td>Not to be exceeded more than once per year</td>
<td>0</td>
</tr>
<tr>
<td>NO₂</td>
<td>1 hour</td>
<td>98th percentile, averaged over 3 years</td>
<td>0</td>
</tr>
<tr>
<td>SO₂</td>
<td>1 hour</td>
<td>99th percentile of 1-hour daily maximum concentrations, averaged over three years</td>
<td>38</td>
</tr>
<tr>
<td>SO₂</td>
<td>3 hours</td>
<td>Not to be exceeded more than once per year</td>
<td>9</td>
</tr>
<tr>
<td>CO</td>
<td>8 hour</td>
<td>Not to be exceeded more than once per year</td>
<td>0</td>
</tr>
<tr>
<td>O₃</td>
<td>8 hour</td>
<td>Annual fourth highest daily maximum 8-hour concentration, averaged over 3 years</td>
<td>227</td>
</tr>
<tr>
<td>PM₂·₅</td>
<td>24 hour</td>
<td>98th percentile, averaged over 3 years</td>
<td>104</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>24 hour</td>
<td>Not to be exceeded more than once per year, averaged over three years</td>
<td>33</td>
</tr>
<tr>
<td>Pb</td>
<td>3 month</td>
<td>Not to be exceeded</td>
<td>22</td>
</tr>
<tr>
<td>NO₂</td>
<td>1 year</td>
<td>annual mean</td>
<td>0</td>
</tr>
<tr>
<td>PM₂·₅</td>
<td>1 year</td>
<td>annual mean, averaged over 3 years</td>
<td>135</td>
</tr>
</tbody>
</table>
“Extreme Weather” from an Air Quality Perspective

• High Winds
  ➢ PM$_{10}$
• Surface Temperature Inversions
  ➢ CO, NO$_2$, SO$_2$, PM$_{2.5}$
• Stagnant High Pressure Systems
  ➢ O$_3$, PM$_{2.5}$
• Stratospheric Intrusion
  ➢ O$_3$
Location of Bermuda High and Jet Stream Are Drivers of O$_3$ Extremes in Eastern U.S.

Correlation between Bermuda High Index and Summertime Average MDA8 Ozone (1993-2008)

Under climate change scenarios (RCP 4.5 and RCP8.5 to 2100),

- jet stream migrates northward, leading to
- more interannual variability in ozone in North
- and less interannual variability in ozone in South.

Zhu and Liang, J Clim, 2013

Barnes and Fiore, GRL, 2013
Impact of Climate Change on U.S. Ozone

Different models and climate scenarios yield different changes in ozone.

However across these models, changes in extremes appear more pronounced than changes in averages.

Difference in 95th Percentile MDA8 Ozone in 2050

Weaver et al., BAMS, 2009
PM$_{2.5}$: Averages are only part of the story

Change in PM due 2000 to 2050 Climate (A1B)

Dawson et al., JGR, 2009

“Julys” in which PM$_{2.5}$ exceeds 24 hr NAAQS

Pye et al., JGR, 2009

Pye et al., JGR, 2009
Exceptional Events Rule

• States can petition EPA to exclude observations from attainment status determinations if the event:
  – Affects air quality
  – Is not reasonably controllable or preventable
  – Is caused by human activity that is unlikely to recur at a particular location, or is a natural event
  – Is associated with a measured concentration in excess of normal historical fluctuations, including background.
  – Has a clear causal relationship with a measured exceedance that would not have occurred but for the event.

• Guidance and examples are available at http://www.epa.gov/ttn/analysis/exevents.htm

• Most applications are related to dust and fires. New applications are being considered for stratospheric ozone intrusion.
PM due to Wildfires in a 2050 Climate
Is exceptional becoming commonplace?

Changes in the Western U.S. in
• Organic Carbon
• Black Carbon
• Visibility

Yue et al., Atmos Env, 2013

Change in Organic Carbon
2000 to 2050

Change in Black Carbon
2000 to 2050

Change in Visibility
2000 to 2050
USGCRP Special Report on Climate and Health

- Coordinated by Climate Change Human Health Working Group
- Lead by NIH, CDC, NOAA, EPA with USDA, DOE, and others
- Building upon current 3rd National Climate Assessment and the 2008 CCSP SAP 4.6

Assessment of literature on:
- Thermal Extremes: Heat and Cold Waves
- Air Quality Impacts
- Vectorborne and Zoonotic Disease
- Waterborne and Foodborne Diseases
- Food Safety
- Extreme Weather and Climate Events
- Mental Health and Stress-Related Disorders
- Other Health Threats

Efforts to quantify national-scale impacts related to:
- Extreme Heat
- Air Quality
- Vectorborne Disease (Lyme)
- Waterborne Disease (Vibrio)

- Public Review Draft expected May 2015, Final Publication expected Late 2015