February 18, 2011

Comments on the statistical form of Policy Relevant Background (PRB) of Ozone

EPA Clean Air Scientific Advisory Committee
Ozone Review Panel for the Reconsideration of 2008 NAAQS

Nicole Downey, Ph.D. - Supported by BP America Production Company

Slide 2: Policy relevant background (PRB) of ozone is defined as the concentration of ozone that would be present in the United States with zero anthropogenic emissions in North America (including Canada and Mexico). Currently, EPA defines PRB as 15-35 ppb based on modeling results from *Fiore et al.* [2002, 2003] using the GEOS-Chem chemical transport model. This range roughly represents an average across the entire United States over a year. More recent GEOS-Chem modeling work suggests that PRB is far higher than that estimated by *Fiore et al.* [2002, 2003], particularly during Spring and Summer in the Western US. Here, I argue that the current EPA definition of PRB is too restrictive to account for the influence of background ozone on ambient ozone, particularly in the Western United States. PRB should vary by season and by elevation. Additionally, an accurate and efficient set of tools to evaluate the influence of background on high-ozone events must be developed as the standard approaches background over large areas of the United States.

Slide 3: Recent modeling results from Dr. Lin Zhang and Dr. Daniel Jacob (Harvard) with a higher-resolution version of GEOS-Chem, show that in spring and summer, PRB over the entire Intermountain Western United States exceeds the maximum EPA PRB value of 35 ppb. As shown in the top set of figures, the contribution of background ozone is not constant across the United States, nor is it constant between seasons. PRB is generally higher with higher elevation, and there is significant seasonal variability depending on the location of interest.

The second row of figures shows the contribution of PRB to ambient ozone on days where the modeled MDA8 exceeds 60 ppb. Consistent with other studies, along the heavily populated eastern seaboard and in many urban areas, background is low during high ozone events. This is not the case, however, for the Western United States and Great Lakes area. In these areas, background increases with higher ozone, highlighting the pivotal role PRB plays in ambient ozone above 60 ppb.

The third row of figures shows the mean ozone enhancements due to anthropogenic activity in the United States. Here you see that in general, in the rural West domestic anthropogenic ozone is less than 20 ppb. This figure highlights the distinct differences between urban and rural ozone environments. In highly urbanized environments, domestic anthropogenic ozone accounts for a large portion of the observed ozone whereas in rural areas, there is a small component due to domestic emissions.

The fourth row of figures shows the domestic anthropogenic ozone signal for days with a modeled MDA8 greater than 60 ppb. Here again, the difference between the Western and Eastern United States ozone regimes is clearly visible. In the Intermountain West, the Denver and Salt Lake City metro areas contribute up to 30 ppb ozone, but in rural areas domestic anthropogenic ozone contributes 10-20 ppb ozone to high-ozone events (> 60 ppb).

These figures clearly show that the proposed levels of the ozone standard (60 – 70 ppb) are approaching background levels. Each of these figures represents a seasonal average, and on an event basis, PRB can be higher than what is shown here. Given that the form of the standard roughly allows for exceeding a maximum value four times per year, accurate modeling of event-level high-ozone days is critical.

Slide 4: Here we have plotted the number of days that 6 National Park sites in EPA Region 8 exceed a proposed standard of 60, 65, 70 and 75 ppb. As the standard approaches background (as shown in Slide 3), we see that the number of high-ozone days increases dramatically. Also notice that there is a significant amount of interannual variability in number of high ozone days. At 60 ppb, some sites exceed the standard 25% of the time (~80 days). All of these high-ozone days would need to be evaluated to determine the role of background, and an efficient and accurate system that states and agencies can readily access does not exist. Additionally, EPA has not adopted a formal protocol for flagging high-ozone events as 'background'.

Slide 5: In addition to varying by season and elevation, PRB can be significantly affected by exceptional events. These include stratospheric intrusions, streamers, folds etc…, mixing down of free tropospheric air, long range transport of Asian anthropogenic pollution plumes, and biomass burning emissions (both of North American and Asian origin). The most effective means for identifying exceptional events is using correlations between multiple co-located trace gas measurements. Correlations between carbon monoxide, methane, humidity, ozone, and mercury can be used to fingerprint the sources of high-ozone events. In the absence of experimental data, further model refinement and very detailed emission inventories will need to be developed to identify 'exceptional events'.

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- PRB is defined as the concentration of ozone that would be present in the United States with zero anthropogenic emissions in North America (including Canada and Mexico)

- Currently, policy relevant background (PRB) is defined as 15-35 ppb

- This is *roughly* an annual average of PRB across the entire United States from *Fiore et al.* [2002, 2003]

Policy Relevant Background

- varies by season
- varies by elevation
- varies by ozone concentration

The figures at right show that background ozone in the entire intermountain west exceeds the maximum of EPA's definition (35 ppb) during Spring and Summer

EPA's definition of PRB should vary seasonally and with elevation

Additionally, tools must be developed that can quickly and accurately evaluate the contribution of background to high-ozone events

Results from recent GEOS-Chem modeling at Harvard (Zhang and Jacob, 11/8/2010)

Spring **Summer**

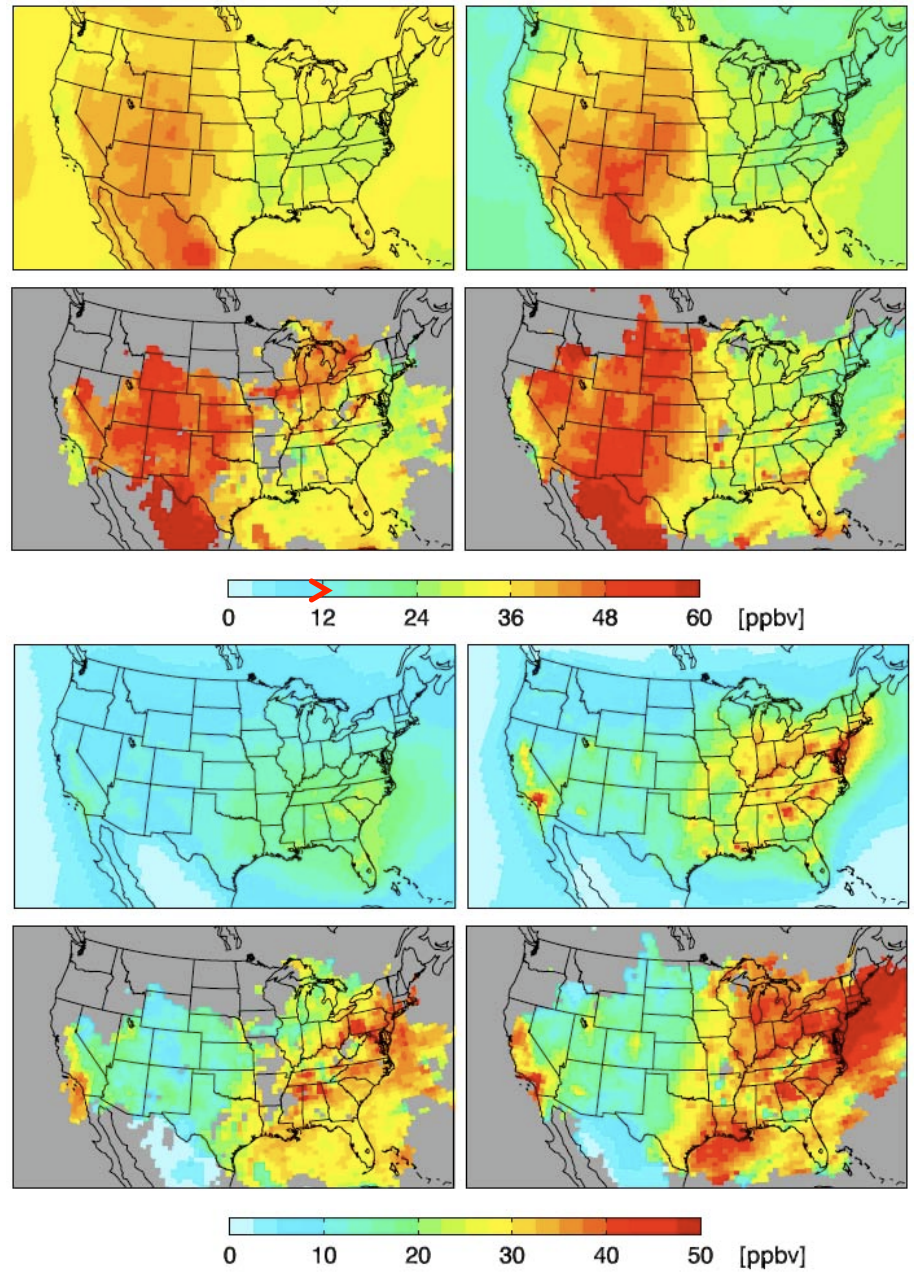
US background ozone concentrations estimated by a sensitivity study without US anthropogenic emissions

US background ozone for MDA8 ozone exceeding 60 ppbv

Current EPA PRB Range

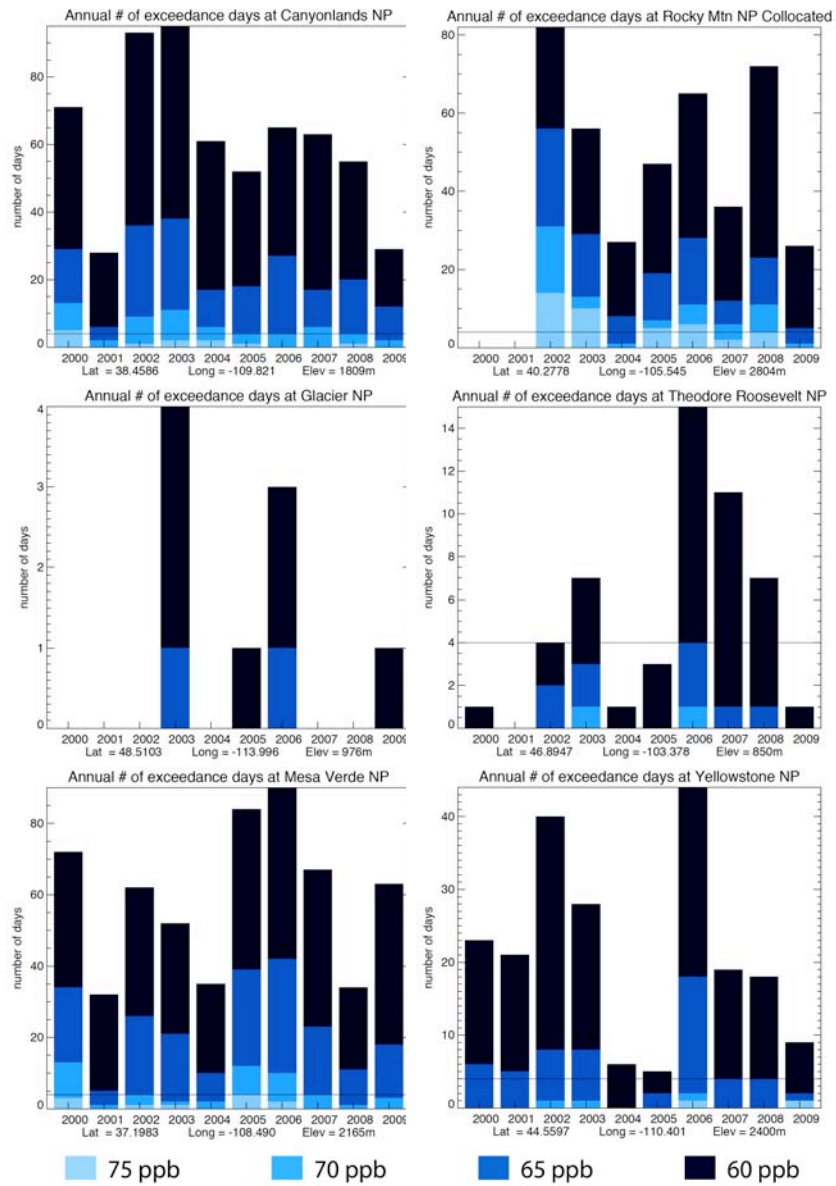
Mean ozone enhancements from US anthropogenic emissions.

Ozone enhancements from US anthropogenic emissions for MDA8 ozone exceeding 60 ppbv



National Parks Exceeding Proposed Standard

- As the standard approaches background, the number of days exceeding the standard at rural western National Park sites goes up dramatically.
- In some years, select sites exceed 60 ppb 25% of the time
- The current form of the standard allows for ozone to exceed the standard roughly 4 times per year



PRB Varies on Event Basis

- PRB can be strongly influenced by extreme events
  - Stratospheric intrusions, folds, streamers etc…
    - Recent CalNex field campaign (May 9 to June 26 2010) observed 8 stratospheric intrusions in 6 weeks in California (*Langford et al.* 2010)
  - Mixing down of free tropospheric air*
  - Asian pollution plumes (rising Asian emissions)*
  - Biomass burning plumes (Asian and North American)

- **The current definition of PRB is too restrictive to describe important variability in background ozone contribution to high ozone events**