January 14, 2013

An Open Letter to the Ozone Docket and EPA SAB

To Whom It May Concern:

The estimation of background ozone concentrations is extremely important in order to adequately fulfill the Agency's goal of assessing the risk associated with ozone exposures. Too low an estimate of background concentrations can result in (1) unreliable statistical significance outcomes associated with controlled laboratory exposure studies whose results are used in the clinical health risk analyses; (2) overestimated human health risk predictions for both FEV_1 and epidemiological outcomes, and; (3) optimistic policy expectations of the levels to which hourly average ozone concentrations can be lowered as a result of emission reduction requirements (i.e., attainability of proposed revised ozone standards).

In its November 2012 letters to the EPA Administrator commenting on the third version of the ISA and the second versions of the REA and PA, CASAC has indicated to the Agency that the stratosphere is not an important contributor to the troposphere. Furthermore, the letters from CASAC imply that high ozone background concentrations at higher-elevation monitoring sites are not associated with stratospheric influence and intercontinental transport. In its letters, CASAC notes that atmospheric chemistry rather than stratosphere-troposphere exchange is responsible in the mid-latitudes for background ozone peaking in the spring and exhibiting low concentrations during the summer. It also notes that placing the stratosphere in a prominent role gives the “misleading” impression that the stratosphere is a large source of ozone for the troposphere; CASAC has requested that the EPA modify Figures 2-1 and 3-1 so that greater emphasis can be placed on ozone photochemistry.

The goal of the ISA, as well as the REA and PA, is to reflect the most current scientific knowledge and the application of this knowledge in the standard-setting process. It is important that several statements contained within the November 2012 letters be reevaluated by EPA in light of recent scientific findings to fully reflect the weight of this evidence and appropriate corrections be made. Although CASAC implies that stratospheric contributions to surface ozone concentrations are minimal at both high- and low-elevation monitoring sites in the US, policymakers, as well as many atmospheric researchers who are actively involved in assessing the importance of the stratosphere, have not come to this conclusion. For many years, State and Federal Officials have identified the importance of the stratosphere affecting surface ozone concentrations. For example, in October 2012 at a workshop in Reno, NV, recognizing the importance of the stratosphere to affect attainment of the ozone NAAQS, state air quality agency science and regulatory staff, as well as Federal scientists, formally discussed the scientific

evidence available for understanding natural background concentrations and the role that background ozone concentrations play in attainment. EPA scientists indicated there is compelling evidence that stratospheric ozone intrusion affects surface ozone concentrations and that these intrusions can contribute to frequent enhanced ozone concentrations. Several states in the Intermountain West (e.g., Wyoming and Colorado) routinely document the importance of stratospheric ozone intrusion in enhancing surface ozone levels and note in the EPA's Air Quality System (AQS) database when these intrusions contribute to enhanced surface ozone levels. Currently, EPA actively participates in the Ozone Stratospheric Intrusion Workgroup, whose participants include, besides the EPA, state agencies and NOAA, NCAR, and NASA researchers.

Based on our published research (e.g., Lefohn et al., 2011, 2012), as well as other recent publications (e.g., Lin et al. 2012; Langford et al., 2011; Ambrose et al., 2011; Cooper et al., 2011; Langford et al., 2009), a better balanced perspective reflecting the importance of the stratosphere in affecting background ozone concentrations should have been presented in the CASAC November 2012 letters to the EPA Administrator. There is considerable evidence published in the literature that the stratosphere is affecting surface ozone concentrations during the springtime as well as other times of the year at both high- and low-elevation monitoring sites. In October, we provided CASAC with summary abstracts that described published papers supporting the importance of stratospheric intrusions and background ozone influencing hourly average ozone concentrations ≥ 50 ppb. CASAC has decided to ignore the published information and evidence indicating that state air quality science and regulatory staff and policymakers recognize that the stratosphere is an important contributor to enhancing surface ozone levels.

While stressing the lack of importance of stratospheric ozone in affecting surface ozone concentrations, CASAC refers in its November 14, 2012 letter on the third version of the ISA to the paper authored by McDonald-Buller et al. (2011) as the closest thing to a consensus statement from the atmospheric chemistry community on the magnitudes and sources of background ozone. We (Sam Oltmans and Allen Lefohn) are co-authors of the McDonald-Buller et al. (2011) paper. The paper notes that the GEOS-Chem model, which the EPA utilizes for assessing background ozone levels, as well as other global models, have difficulty representing the fine structures of ozone events, including events for which the contribution of background ozone is likely important. The paper notes that stratosphere-troposphere exchange can contribute to background ozone at low altitude and, in particular, at elevated sites. For example, Figure 4 in McDonald-Buller illustrates a high ozone event at Gothic, Colorado in April 2006. An in-depth analysis of this episodic ozone event was described in the Supplemental Material in Emery et al. (2012), with the authors attributing the event at Gothic to a stratospheric intrusion. The in-depth analysis presented by Emery et al. (2012) complements the material described in McDonald-Buller et al. (2011) about the importance of the stratosphere in affecting surface ozone concentrations. While referring to the McDonald-Buller et al. (2011) paper in its letter, CASAC

apparently overlooked the description of the importance of the stratosphere in affecting surface ozone concentrations.

McDonald-Buller et al. (2011) also note the importance of considering tropospheric ozone measurements collected at sites, such as Trinidad Head, California for evaluating North American background ozone levels. Observations indicate that models, such as GEOS-Chem, underestimate background ozone at Trinidad Head (Fig. 5 in McDonald-Buller et al., 2011). Unfortunately, the third version of the ISA minimizes the usefulness of using empirical data collected at Trinidad Head for establishing background ozone values and testing the adequacy of models.

While the letters to the Administrator minimize the role of transport of ozone from the stratosphere in enhancing background ozone, new results suggest that the stratosphere plays a larger role than acknowledged by CASAC. Recently published work by Lin et al. (2012) dramatically reinforces the important contribution of North American background ozone (NAB), including a very significant stratospheric component, on 8-hour maximum daily average ozone (MDA8) at or near current air quality standards. In particular, during the spring and early summer, background ozone over the western U.S. is routinely elevated by input from the stratosphere. The work of Lin et al. (2012) represents a major advance within the modeling framework in the ability to quantify the contributions to background ozone. Unlike prior GEOS-Chem work, the AM3 model explicitly simulates ozone variability in the lower stratosphere and its dynamic coupling with the troposphere. CASAC incorrectly notes in its letters that the model used by Lin et al. (2012) does not account for ozone originating from production in the troposphere followed by transport to the lowermost stratosphere. In the AM3 model, the dynamic e90 tracer is sensitive to the direct influence of upward mixing of tropospheric air near the tropopause and does not account such ozone as "stratospheric". The AM3 model indicates tropospheric air only slightly influences baseline ozone levels that have their origin in the stratosphere, especially under the circumstances of deep stratospheric intrusion events. Thus, unlike the GEOS-Chem model, the AM3 model indicates that the ozone originating in the stratosphere is important in influencing surface ozone concentrations.

Based on the AM3 model, estimates of stratospheric impacts on springtime surface ozone over the western U.S. are generally higher on average and up to 2–3 times greater during the intrusions than previous model estimates (e.g., Fiore et al., 2003). This finding is in notable contrast to prior work concluding that stratospheric influence on high surface ozone events is rare (US EPA, 2006, 2007). The analyses described by Lin et al. (2012) imply that stratospheric intrusions may pose a challenge for springtime ozone over the U.S. Mountain West to remain below the ozone NAAQS with domestic emission controls, particularly if a threshold value in the 60–70 ppb range were to be adopted (US EPA, 2010). Although ozone produced from local emissions can dominate ozone pollution in urban areas, in lower elevation US regions, and

during the summer, it is possible for stratosphere-to-troposphere transport to influence surface ozone over mid-latitude regions prone to deep intrusions, including during periods when there is ozone enhancement from pollution sources. These intrusion events are most frequent in the spring but may occur during other seasons.

The work of Lin et al. (2012) utilizing AM3, a more advanced model than GEOS-Chem, shows that stratospheric intrusions can increase surface MDA8 ozone by 20-40 ppb above baseline levels and generally make a larger contribution to background levels than transported Asian pollution. AM3 model simulations of the total ozone concentrations and background ozone (eliminating NA anthropogenic influence) reproduce observed ozone enhancements both in surface air and aloft during stratospheric intrusions. The conclusions reached in recent work by Lin et al. (2012), as well as numerous published results by others, are in strong contrast with the conclusions currently reached by CASAC. It is our opinion that a more balanced view than currently recognized by CASAC should be contained within the ISA, REA, and PA. The current state of scientific information indicates the importance of the stratosphere in affecting contributions to surface background ozone concentrations.

Sincerely,

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