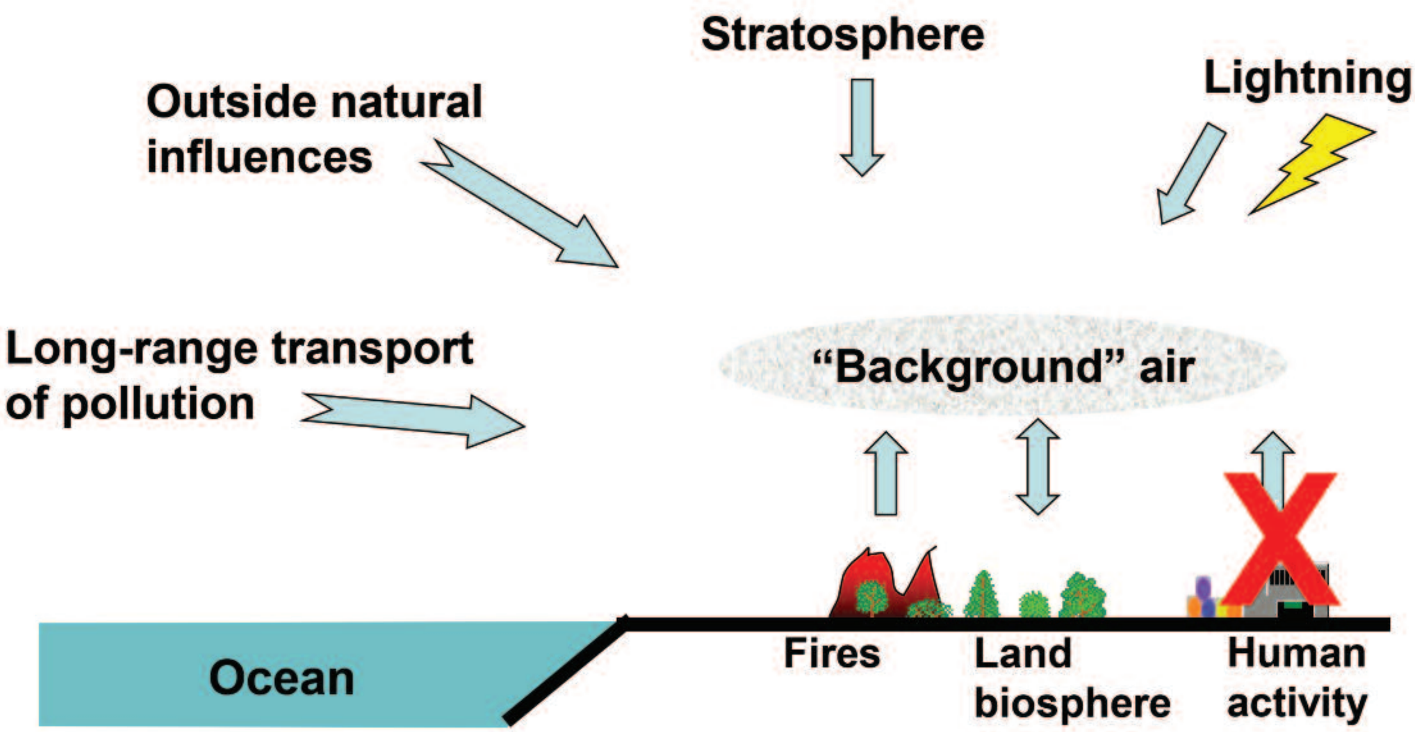


*Schematic overview of background ozone concentrations.*
*Source: Figure 3-7, 2013 Ozone ISA, U.S. Environmental Protection Agency.*

# Strengths and Limitations of Current Tools to Characterize Background Ozone

A key aspect of air quality management is identifying the driving sources of air pollution. In the United States, the U.S. Environmental Protection Agency (EPA) uses the concept of "background ozone" to describe ozone ($O_3$) coming from sources other than anthropogenic emissions of $O_3$ precursors. EPA has identified provisions in the U.S. Clean Air Act that provide regulatory relief to local jurisdictions that are unduly impacted by background $O_3$. Each of these provisions relies on technical tools—including photochemical models, monitors, satellite data, and ozonesondes—to accurately quantify $O_3$ originating from controllable, anthropogenic sources versus background $O_3$. The articles in this month's *EM* explore the strengths and limitations of current tools used to quantify background $O_3$.

A key aspect of air quality management is identifying the driving sources of airpollution.

To begin, Hogrefe, et al. delve into the details of air quality models that are critical for characterizing source contributions to $O_3$ concentrations at different locations across the United States. The authors describe the interplay between large-scale hemispheric or global models with higher resolution regional models. The hemispheric and global models are well-suited to capture long-range intercontinental $O_3$ transport, as well as vertical exchange between the stratosphere and the troposphere. Regional-scale models often use a horizontal grid spacing of 12-km or finer to capture $O_3$ formation that is dependent on spatial gradients near urban areas and other large emissions sources. It is crucial to couple these two types of models to fully capture the full suite of processes that lead to $O_3$ formation. Hogrefe, et al. identify improvements needed in both types of modeling systems to quantify the magnitude of background $O_3$ contributions more definitively across space and time.

Second, Neu, et al. describe how satellite data are being used to inform air quality models. The authors identify satellites as an important tool for constraining air quality models because, unlike surface monitors, they can provide more complete spatial coverage. They show how model assimilation of satellite data improves model estimates of total $O_3$ and increases estimates of the magnitude of background $O_3$. The authors also describe recent outputs developed as part of NASA's Health and Air Quality Applied Science Team (HAQAST). That effort specifically resulted in a new dataset of "satellite-informed boundary conditions" that could be used by U.S. state and local governments to couple global-scale information with regionally focused regulatory model simulations.

Next, Stauffer, et al. couple statistical analysis of zonesonde measurements at Trinidad Head, CA, with routine $O_3$ surface monitors in California, satellite-derived carbon monoxide surfaces, and meteorology data. The authors identify four types of ozonesonde vertical profiles, each associated with a different set of $O_3$ sources. The types are ordered based on the magnitude of $O_3$ aloft from lowest (type 1) to highest (type 4). Stauffer, et al. demonstrate the additional nuanced information that can be gleaned when vertical profiles of $O_3$ are available. One important finding is that conditions leading to higher $O_3$ aloft in California do not appear to necessarily correspond to conditions leading to high surface $O_3$.

Finally, Jaffe, et al. describe the uncertainties associated with each of the tools addressed in the other three articles and identify the need for targeted investment to address current shortcomings. The authors describe how models are necessary for characterizing source contributions and quantifying background $O_3$ since ambient surface $O_3$ measurements cannot be used alone to quantitatively distinguish between sources of $O_3$. They further describe how models are used to make demonstrations for regulatory purposes and present a case study comparing model results from two U.S. regions with different source signatures. They show that while the source contributions vary dramatically between these regions, the model had a similar positive bias in both cases. It is necessary to not only constrain total $O_3$ in the model, but also to properly attribute the source(s) of the biases. If bias is incorrectly attributed evenly across sources or conversely incorrectly attributed to a single source or group of sources, a constrained model may not appropriately apportion total $O_3$ between controllable and uncontrollable source categories. Jaffe, et al. conclude by suggesting key areas of investment that would provide the ambient data necessary to improve modeling capabilities most effectively. **em**

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