Ambient Air Monitoring Networks Supporting Secondary Standards and Air Quality Model Improvement

This background piece provides some context for the following charge questions:

What are the panel's view of the broader consideration of using CASTNET, complemented by rural NCore, to serve as a framework for the nation's rural monitoring of important gases and aerosols in support of secondary standards and evaluating the behavior of regional air quality models?

What are the panel's views on establishing a suite of NOy species measurements at 2- 5 locations in different atmospheric and ecological regions for the purpose of evaluating air quality model and NOy instrument behavior?

The NOx/SOx secondary standard provides an opportunity to consider the state of the nation's ambient air monitoring networks with regard to addressing environmental welfare concerns and supporting a multiple pollutant multiple media (MPMM) air quality management framework. The design of ambient air monitoring networks to support NAAQS implementation has focused primarily on human population exposure, resulting in a largely urban-oriented landscape of air measurements. Network design, whether focused on urban-oriented human population exposure or more rural-oriented environmental welfare objectives, historically also has been based on either a single pollutant or single program focus. Examples include all of the individual urban NAAQS networks and the more rural based IMPROVE and CASTNET. The concept of a multi-purpose network may run the risk of losing focus on meeting primary information objectives. However, the coupling of so many atmospheric processes that influence various pollutant categories (and programs) suggests that a more generalized multipurpose design could more effectively leverage the resources available for routine measurement programs. The additional interest in environmental welfare protection, particularly effects related to atmospheric deposition, creates a multipurpose umbrella potentially linking multiple pollutants and multiple environmental media.

The current design of ambient air monitoring networks to support NAAQS implementation has focused primarily on human population exposure, resulting in a largely urban-oriented landscape of air measurements. In addition to being traditionally urban oriented, monitoring networks have also tended to focus on a single pollutant. The problem with this approach is that existing atmospheric conditions and behaviors of pollutants do not follow the same guidelines. To successfully implement regulatory policies to limit the emissions and regulate the concentrations of a specific pollutant, one must first understand the factors that influence its concentration in the environment.

The concept of a multi-faceted network addresses the need to understand simultaneous atmospheric processes that influence pollutant concentrations and thus will enable the development and implementation of more effective regulatory policies. In addition, a multi-faceted network would be more effective in leveraging the resources available for routine measurement programs, and in linking information on multiple pollutants with a range of different environmental locations and conditions. Atmospheric deposition is a great example of a field in which this approach would be most effective, because of the complexity of the influencing factors.

The benefits of the multi-faceted networks described above were outlined in recommendations by the National Academy of Science (NAS) in a 2004 report on Air Quality Management. The development of the NOx/SOx secondary standard is the first major EPA regulatory action that adheres to those recommendations. Specifically, the use of a multi-pollutant air management framework that integrates both human and environmental health concerns. The agency's NCore multi-pollutant network also meets many of the tenets stated by the NAS recommendations, however, it is largely uncoupled from mainstream regulatory planning efforts and has a dominant urban area focus.

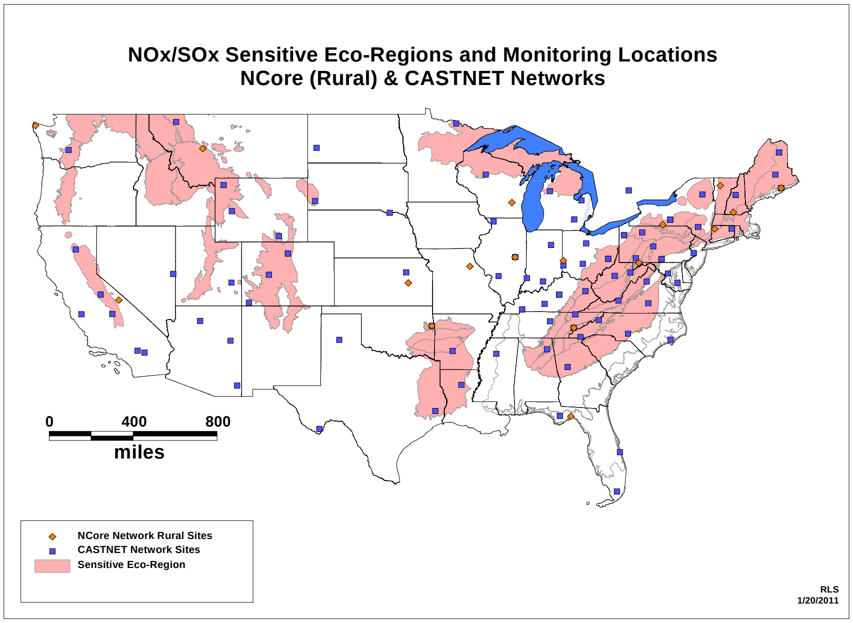
The role of networks in model evaluation and improvement is included here for CASAC consideration for the following reasons. First, modern air quality models like CMAQ must simulate co-dependent relationships across atmospheric species because of their shared emission precursors, atmospheric chemistry reactions, mass transport, and removal mechanisms. As models are evaluated and improved using observational databases, simultaneous observations of related pollutants significantly improves upon the diagnostic power of single-pollutant observations. Measurements in rural locations are highly valued for model evaluation because they are generally further removed from significant impacts of nearby emission sources, relative to urban locations, and provide measurements that are more spatially representative of the volumetric grid cell averaging incorporated in air quality models. Second, two of the most important primary NAAQS, those for ozone and $PM_{2.5}$, are strongly influenced by the same regional transport processes and emission precursors that influence the spatial and temporal patterns of NOy and SOx deposition. Coupling these related influences will lead to improved regional air quality model formulation, benefitting both primary and secondary NAAQS compliance programs. Third, the form of the NOx/SOx standard is based on the coupling of atmospheric (air concentration and deposition) and ecosystem biogeochemical processes. This linkage incorporates explicit outputs from air quality models as part of the form of the standard. Consequently, observations which enable air quality model evaluation and improvement are of direct interest to the secondary standard review process.

The CASTNET and IMPROVE networks (Figures 1 and 2) effectively serve as the national infrastructure for rural and regional ground-based ambient air monitoring networks. CASTNET is the most relevant network with respect to the NOx/SOx secondary standard as it was designed partly in response to the NAPAP study and CAA Title IV provisions, both of which addressed acidification associated with atmospheric deposition of NOx and SOx species. Over the last two decades, CASTNET has evolved into a multi-purpose network with measurements of ozone and aerosol and gaseous nitrogen and sulfur species.. These monitors have served as an important surface-based complement to NOAA's ozonesondes, which capture vertical profiles of ozone, in the evaluation of global air quality models such as GEOSchem, which has provided EPA background levels of ozone used in EPA's ozone risk assessments. Similarly, several of the IMPROVE sites have been used to identify episodes of trans-Pacific transport of aerosols to the continental U.S. These examples illustrate the basics of leveraging programs designed for other uses, and that the siting design criteria deployed in rural networks are well suited for delineating signals associated with transport and making improved assessments of regional air quality.

This AMMS committee will be advising EPA on a number of topics over the next few years. Originally, the deployment of the PM2.5 monitoring network was the driver for the

AMMS committee to advise EPA as a complement to the NAS panel on *Research Priorities on Airborne Particulate Matte*r. Shortly after the PM2.5 networks were deployed around 2000, , the AMMS evolved to advise the EPA on a comprehensive national air monitoring strategy The NCore multiple pollutant network is being deployed as a component of that strategy. However, over the last five years the AMMS has been charged by EPA to focus on one pollutant more or less coincidient with each NAAQS review. Until now, EPA has not requested CASAC to advise on broadly-based monitoring topics of interest with important leveraging opportunities. In particular, the original EPA monitoring strategy and NCore were primarily focused on urban rather than rural network design, as it was motivated by heightened interest in fine particle exposure and epidemiology assessments. As stated above, the multi-faceted nature of the NOx/SOx standard would benefit from considering the role of observations beyond the indicators, recognizing that measurements of indicators always will be a priority in supporting EPA rules and standards. Clearly, the emphasis on specific indicator methods in the charge questions reflects the priority on indicator observations. Nevertheless, EPA, and the ambient monitoring community in general, stand to benefit from scientific advice not only on specific methods but also on the broader design and growth elements intrinsic to national monitoring programs.

Accompanying this white paper is draft report that was developed by the Air Quality Research Subcommittee (AQRS) of the Committee for Environment and Natural Resources (CENR) that explores very similar leveraging and information gap themes.


NOx/SOx Sensitive Eco-Regions and Monitoring Locations
NCore (Rural) & CASTNET Networks
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CASTNET Network Sites
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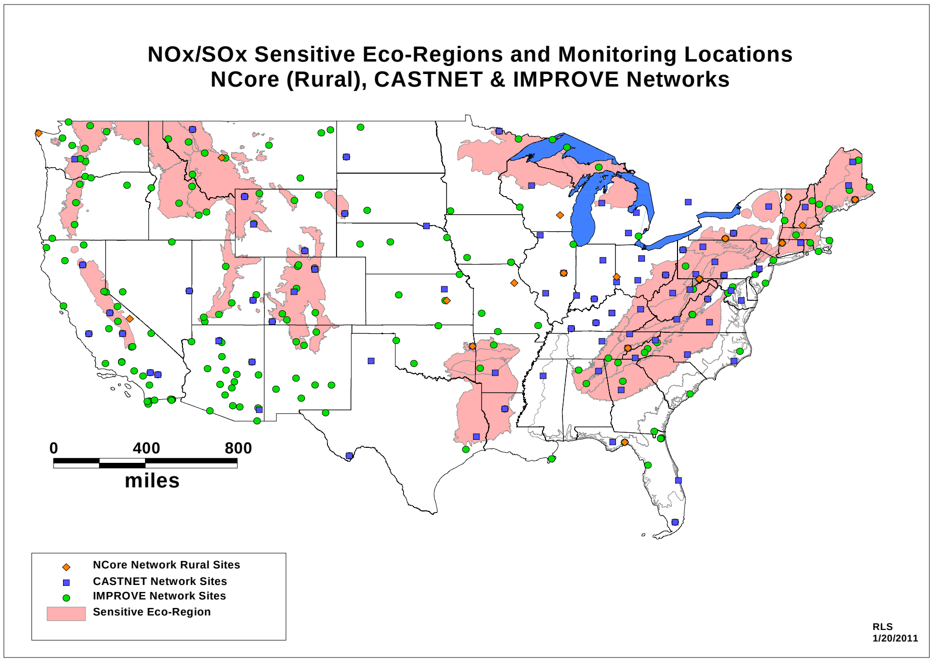
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