Technology At Work

Raising the Bar on Air Quality Modeling

Research Collaboration Improves Accuracy, Efficiency, and Speed

By Matthew Hirsch

The electric power industry is emitting fewer air pollutants as new plants are constructed and current plants install emissions controls. Simulating how power plant emissions disperse in the atmosphere is needed to help understand their impacts on air quality—and the extent to which controls mitigate those impacts. Such modeling is not easy. Models must account for variable wind speeds and directions as well as reactions with atmospheric chemicals, requiring complex calculations to quantify the transport and transformation of emissions.

The U.S. Environmental Protection Agency (EPA) has several established tools for modeling primary pollutants and secondary pollutants. Nevertheless, Southern Company researcher Justin Walters says that there are opportunities to advance the science in air quality modeling.

Walters is participating in an EPRI research project to develop tools that could advance air pollutant modeling in the United States. As EPA reviews and updates its air modeling guidelines, it can consider these and other publicly available tools that have undergone rigorous evaluation.

Modeling Primary Pollutants in 10-Minute Increments

Since 2005, AERMOD has been EPA's preferred model for simulating dispersion of the primary pollutants sulfur dioxide (SO_2) and nitrogen dioxide (NO_2). AERMOD is versatile and works on a range of terrain, but it does not perform well in low-wind conditions and has difficulty simulating short-term periods, such as one-hour averages, which are relevant to air quality standards.

The EPRI tool Sub-Hourly AERMOD Run Procedure (SHARP) operates along with AERMOD, improving the accuracy of results by enabling simulations of primary pollutants under low-wind speeds in time increments as small as 10 minutes. The resulting simulations can be used to calculate one-hour average concentrations, consistent with the National Ambient Air Quality Standards.

Research from Duke Energy, a project collaborator, demonstrated the effectiveness of SHARP's continuous 10-minute simulations. The utility compared emissions data directly from the stacks of its 3,145-megawatt Gibson Station plant with AERMOD's hourly analysis and SHARP's 10-minute methodology. "We found AERMOD over-predicted hourly concentrations by 50% or more compared to measured values. SHARP results were generally within 10% of measured values," said Patrick Coughlin, a Duke Energy senior environmental specialist.

Faster Modeling of Secondary Pollutants

Secondary pollutants have been regulated since 1971, but regulatory air quality models to simulate those pollutants from single sources were not always available. In 2012, EPA granted a Sierra Club petition requesting that the agency establish regulatory air quality models for ozone and fine particulate matter, known as $PM_{2.5}$. Southern Company's Walters worked with EPRI to provide guidance toward the development of the Second-Order Closure Integrated Puff Model with Chemistry (SCICHEM) for consideration by EPA. SCICHEM uses data on primary pollutants to predict the formation and behavior of secondary pollutants. While simulations from

EPA-proposed models can take up to two weeks using supercomputing, SCICHEM requires just a few days on a single computer. The team analyzed ambient data to confirm that the model matches measured atmospheric conditions.

“SCICHEM provides a one-stop solution to modeling dispersion of secondary pollutants from any point source that emits pollution,” said Eladio Knipping, a principal technical leader in EPRI’s Environment Sector.

According to Walters, SCICHEM can provide “a technically sound model for assessing secondary pollutant formation in the atmosphere that is more cost-effective and efficient than other models being considered by EPA.”

Informing Regulations

To inform EPA’s review of its air quality modeling guidelines, EPRI submitted public comments based on these modeling efforts. The agency will review comments from diverse stakeholders regarding simulating low-wind conditions and secondary pollutants.

Using a preferred model can provide certainty to plant operators that EPA will accept the results. Alternatives may provide more accurate results, but they must demonstrate good performance and comply with other EPA and state requirements. “That’s one of the reasons we’ve published these results in peer-reviewed literature,” said Knipping. Plant operators can petition to use non-preferred models.

Great River Energy, another project collaborator, is now seeking state approval in North Dakota to use alternative methods for simulating SO_2 dispersion in low-wind conditions at one power station. The electric cooperative is using an EPRI peer-reviewed paper among other resources to support the request.”

Key EPRI Technical Experts

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