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Editorial

Bay Region Atmospheric Chemistry Experiment (BRACE)

The Bay Region Atmospheric Chemistry Experiment (BRACE) was conceived in response to persistent increasing trends of nitrogen oxide emissions in Florida, a far-sighted effort to assess its potential effects on air quality and the ecological health of Tampa Bay and its surroundings. BRACE goals were to:

- improve estimates of nitrogen deposition to Tampa Bay, Florida,
- apportion atmospheric nitrogen between local, regional and remote sources, and
- assess the impact of utility controls on nitrogen deposition to Tampa Bay.

Answers to these questions provide the technical basis for development of effective community control strategies to reduce loading of biologically active (fixed) nitrogen to Tampa Bay.

The 104,000 ha Tampa Bay estuary had from 1950 to 1980 lost 40% of its seagrass as a consequence of dredging activities, re-suspension of sediments, and nutrient-induced algal growth. Seagrass serves as a protective nursery to fish and shellfish, as food for manatees, and to stabilize bottom sediments. Reducing the flux of fixed nitrogen to Tampa Bay should mitigate algal blooms, improve water clarity, and increase seagrass coverage. Local, state and federal agencies charged with the management of Tampa Bay have adopted the restoration of seagrass coverage to 1950s levels and the associated reduction of nitrogen loading necessary to support seagrass recovery as long-term goals for bay restoration.

In response to an initial estimate that the direct deposition of atmospheric nitrogen contributed ~30% to the total nitrogen load to Tampa Bay the Tampa Bay Estuary Program in 1996 began monitoring rainfall and ambient air concentrations of nitrogen at an urban bayside location. Flux calculations from observational data supported the initial estimate of the direct atmospheric nitrogen flux and raised important questions about the contribution from indirect atmospheric nitrogen deposition and the sources of nitrogen to the "airshed". Regional acid rain deposition modeling by the USEPA defines the airshed as the region within which 67% of the nitrogen emitted from Tampa is re-deposited. Model predictions describe this region as centered over peninsular Florida, roughly elliptical, and roughly three times the size of the bay region. The Tampa Bay Estuary Program and Florida Department of Environmental Protection saw the need for nitrogen fate and transport modeling and developed from this need the BRACE.

The BRACE began in 2000 and has included both long-term and short-term intensive measurement campaigns, as well as concurrent special studies. BRACE planners sought experimental designs that balanced project resources between measurements that would support mesoscale modeling and those that would offer direct evidence of source contributions and nitrogen deposition rates; designs that took advantage of new technologies and explored new theoretical constructs.

BRACE participants included managers, scientists, engineers, and technicians from the Argonne National Laboratory, Environmental Protection Committee of Hillsborough County, Florida Department of Environmental Protection, National Oceanic and Atmospheric Administration, Pinellas County Department of Environmental Management, Tampa Bay Estuary Program, Texas Tech University, United States Environmental Protection Agency, University of Maryland, University of Miami, University of Michigan, University of South Florida, and URG, Inc. The project was supported

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by the Florida Department of Environmental Protection, by the Tampa Electric Company, and by in-kind contributions from BRACE participants.

Within the framework established by the project goals, BRACE researchers sought to improve nitrogen deposition estimates by expanding the air pollutant monitoring network, by deploying state-of-the-art sensors and monitors, and by analyzing and interpreting meteorological and air pollutant concentration data with sophisticated atmospheric chemistry and physics models.

Coupled with the meteorological and emissions data, BRACE measurements enable researchers to reconstruct a four-dimensional image of nitrogen emissions, dispersion, transport and transformation; to analyze the role in nitrogen processing and transport of the land–sea breeze and regional (wind) convergence zones; to identify deficiencies, if any, in nitrogen emission inventory; and to infer (calculate) total nitrogen deposition rates over the Tampa Bay watershed, including the direct total nitrogen deposition rate to Tampa Bay. The nitrogen species of interest are NO, NO_2, HNO_3, HNO_2, NO_z (i.e., NO_y–NO_x), NO_3^-, NH_3, NH_4^+, and organic amines. NO, NO_2, HNO_3, HNO_2, PAN and other organic nitrates, $NO_3^\bullet$, and N_2O_5 comprise NO_y.

The pollutants of interest, the models, and the modeling objectives dictate the best temporal and spatial scales of the observations. Measurements on shorter time scales, for example, allow better resolution of regional air pollution plumes and improved agreement with equilibrium and kinetic assumptions inherent in many model algorithms. New technologies make possible near real-time monitoring of solar radiation, actinic flux, wind speed and direction, temperature, relative and specific humidity; and concentrations of NO and NO_2, HNO_3 total oxidized nitrogen species (NO_y), NO_3^-, NH_3, NH_4^+, O_3, CO, SO_2, mercury, organic carbon (OC), black carbon (EC), volatile organic compounds (VOCs), metals, and aerosol mass and number. From these measurements, we have a better understanding of the magnitude and composition of gaseous and aerosol nitrogen species; of nitrogen deposition velocities and fluxes, both to the watershed and directly to the bay surface; of source emissions and the contributions of those emissions to regional air quality; and of the limitations on instrument and model performance. With this volume we present the research results that underpin the decision making and assist with interpretation of community multi-scale modeling now in progress.

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