Study measures impacts of nitrogen deposition on coastal waters

October 7 2014, by Douglas Martins

Penn State researchers Douglas Martins (left) and Raymond Najjar (4th from left) look on as ship's crew retrieve a drifter using a grapple. Credit: Stephanie Mack/Penn State

Scientists have a good understanding of how air pollution impacts human health and the terrestrial biosphere, but what impact does air pollution

have on oceans? To help answer this question, this past August, researchers from Penn State's department of meteorology embarked on a three-week, NSF-funded field project to catch and analyze rainwater at sea.

"The atmospheric deposition of nitrogen to coastal waters is one of many ways in which humans influence the ocean," says Raymond Najjar, professor of meteorology, and a principal investigator on the project. "This study is important because it is the first to directly measure the impact of nitrogen deposition on the productivity of coastal waters."

Nitrogen is a naturally-occurring element essential for the growth of all living organisms; however, in aquatic systems, excess nitrogen can stimulate an explosive growth of plants and algae, which deplete oxygen levels when they die and decompose.

As a byproduct of combustion, nitric oxide (NO) from cars, trucks, biomass burning and energy production is emitted to the atmosphere. Additionally, a substantial amount of nitrogen enters the atmosphere as ammonia from agricultural activity. Given a general west-to-east flow of meteorological systems across the United States, the coastal marine systems of the eastern seaboard receive significant atmospheric nitrogen loadings, yet the biological impact of these loadings remains poorly understood.

Penn State researchers Raymond Najjar (2nd from left) and Douglas Martins (4th from left) retrieve a drifter from the Atlantic Ocean with the help of the ship's crew. Credit: Bettina Sohst/Penn State

The nitrogen that falls in rainwater can be a nutrient for some biological processes. It can be taken up by phytoplankton and other biomass and used for the production of amino acids and proteins. Since nitrogen is often a limiting nutrient in the open waters of oceans, the deposition from the atmosphere can be a stimulant to the system.

For "Deposition of Atmospheric Nitrogen to Coastal Ecosystems," or DANCE, the NSF-funded project, the researchers collected air and water samples in the coastal waters located between the Delaware Bay and the coastal Carolinas to investigate whether atmospheric nitrogen loadings from precipitation following summer storms stimulate primary

productivity and accumulation of algal biomass in coastal waters.

The Penn State team, in collaboration with researchers from Old Dominion University and the College of William & Mary's Virginia Institute of Marine Science, collected their measurements on board the R/V Hugh R. Sharp, operated by the University of Delaware out of Lewes, DE.

A sunset on the Atlantic Ocean from the research vessel Hugh R. Sharp. Credit: Bettina Sohst

Meteorological forecasts, developed on board by doctoral candidate Daniel Tomaso, directed the ship to intercept rain events. The challenge of marine forecasting is the lack of real-time data from established weather stations, which meteorologists have become accustomed to over land. Despite the challenges, the ship intercepted numerous rain events.

"I now have a new appreciation for weather at sea in addition to the vastness of the ocean," says Tomaso.

Air quality measurements, collected by research associate Douglas Martins, characterized the pollution coming from terrestrial air masses.

A group of dolphins following the research vessel Hugh R. Sharp. Credit: Bettina Sohst

"The measurements will be used to calculate the amount of dry deposition of nitrogen to the ocean surface as well as to improve numerical models that predict the impacts of nitrogen deposition," says Najjar.

"This project highlights the interdisciplinary nature of earth system science," says Martins. The atmosphere touches everything we can see.

Even in remote locations such as the middle of the ocean, we can still see impacts from humans."

Provided by Pennsylvania State University