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Appalachian researchers to monitor air quality and climate change

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An interdisciplinary team of researchers from Appalachian State University will soon be monitoring air quality and atmospheric conditions and their impact on ecosystems and climate in the area. The project is called AppalAIR (Appalachian Atmospheric Interdisciplinary Research).

A monitoring station and 30-meter tower has been located behind the Broyhill Inn and Conference Center on campus. It is the only monitoring station east of Illinois that has been invited to collaborate with the National Oceanic and Atmospheric Administration's (NOAA) global network of aerosol monitoring stations. NOAA has loaned equipment to the university to assist with the collection of data related to air quality and climate change.

"This monitoring station will let us see how pollutants move across the country, how they age and affect the climate and vegetation," said Patrick Sheridan with NOAA's Earth System Research Laboratory in Boulder, Colo., and who recently installed some new instrumentation at the AppalAIR facility. He said partnerships, such as the one with Appalachian, are important in NOAA's ability to monitor climate conditions across the United States.

The monitoring station may also become part of AERONET (AErosol RObotic NETwork), a network of ground-based remote sensing aerosol instruments established by NASA to collect data related to the optical, microphysical radiative properties of natural and manmade particles in the atmosphere.

The idea for the interdisciplinary research project began nearly two years ago when Brett Taubman, an assistant professor of chemistry, and Ryan Emanuel, an assistant professor of geology, began discussing their common research interests related to atmospheric processes. James Sherman, a colleague of Taubman's from Pennsylvania, joined Appalachian's Department of Physics and Astronomy, adding his research expertise. They learned of others already at Appalachian who also shared their interests.

"I talked to my department chair about the critical mass of faculty on campus working on atmospheric research and suggested we establish some type of interdisciplinary effort. It snowballed from there and we all began working together," Taubman said.

The group received $50,000 in start up funds from the College of Arts and Sciences. They have spent the past 18 months developing and outfitting the Broyhill monitoring station, and fostering relationships with NOAA and other research partners.

Taubman recently received $15,000 from the N.C. Space Grant and $15,000 in matching funds from the university to purchase equipment that will be used at AppalAIR to study the effects aerosols, or particles, in the atmosphere have on the amount of sunlight reaching the earth's surface, which influences climate and weather. The grant also will provide stipends for student researchers.

"Plants emit volatile organic compounds that react with the atmosphere and ultimately form particles. The blue-grey haze of the Blue Ridge and Great Smoky mountains was historically from the natural aerosols that form as a result of these emissions," Taubman said. "We are going to collect manmade and naturally occurring or biogenic aerosols and look at the size and number of particles and their chemical and optical properties. The effect of biogenic aerosols on the climate is a huge source of uncertainty especially here in the Southeast."

Taubman said the region's higher temperatures plus the number of trees result in high biogenic emissions. At the same time, anthropogenic emissions, such as sulfur, have decreased. "We don't know yet what the impacts to the climate will be as that ratio of inorganic to organic emissions changes," he said.

Sherman also will study the effects of atmospheric pollutants and natural aerosols. “I plan to investigate the roles of aerosols, water vapor and clouds on regional solar radiation budget, and hence regional weather and climate,” he said. Radiation budget refers to the balance the Earth’s climate attempts to maintain between the amount of solar energy reaching earth and the amount of energy radiated back into space.

Sherman will apply optical techniques and laser remote sensing to measure aerosol properties, water vapor and clouds up to the top of the troposphere. Included in this research is a plan to develop the next generation of an aerosol/water vapor LIDAR (laser radar) that Sherman helped develop at the Air Force Research Laboratory in Boston. LIDAR is able to make high-resolution measurements of clouds, water vapor and aerosols and determine their effects on electromagnetic radiation, such as light from the sun, high-energy laser beams and microwave sources and can potentially be used to predict clouds.

“Improved understanding of regional aerosol properties, distributions and variability will be incorporated into regional climate models, along with measurements made by fellow AppalAIR researchers, with the goal of better predictions of future regional climate,” Sherman said.

Emanuel will study interactions between land and the atmosphere. “I’m interested in how much carbon dioxide the region’s landscapes are removing from the atmosphere,” Emanuel said. “This monitoring station will provide data to help understand how factors such as climate change and air pollution affect the ability of southern Appalachian ecosystems to sequester carbon dioxide. Rising levels of atmospheric carbon dioxide load the dice toward more extreme weather events across the globe. This kind of research is needed to understand how rapidly carbon dioxide is added to or removed from the atmosphere by different types of ecosystems.”

He also will study the amount of water vapor these ecosystems release back into the atmosphere through evaporation and transpiration. “These are important components of the water cycle. Much of our precipitation returns to the atmosphere through these processes,” Emanuel said. “I’m also interested in the role of land use change in all of this. As we see our land across the southern Appalachians being converted for other purposes, how does that affect relationships between water, carbon and climate?”

Baker Perry, an assistant professor in the Department of Geography and Planning, is also part of the AppalAIR researchers. His research interests include synoptic climatology, orographic precipitation, snow, high winds, and tropical glacier responses to climate variability and change. His recent research activities have focused on improving snowfall forecasts in the southern Appalachian Mountains, particularly related to northwest flow snowfall. He will continue use of surface-based and balloon-borne meteorological measurements to study the impact of the region’s diverse mountain topography on climate and precipitation.

Professor Rahman Tashakkori from the Department of Computer Science will supervise data acquisition, management and visualization.

“There is a real need for an atmospheric research facility in northwest North Carolina capable of collecting the atmospheric data that are currently lacking. Appalachian’s location and mission make it the ideal place for doing this type of atmospheric research,” said Biology Professor Howard Neufeld, a member of the research project. Neufeld’s research focuses on the physiological effects of air pollution on native plant species.

Data collected at the site will be posted to a Web site for the public to access. Future plans call for offering educational outreach programs to the public at the AppalAIR site.