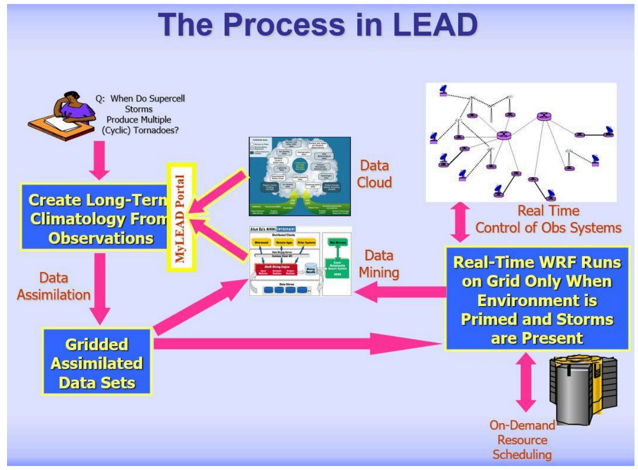
Millersville Meteorology Celebrates 30 Years of Research

In 1995, a MU meteorology alumnus working for a California company, Tim Dye, needed atmospheric profiles to validate the derived winds from an acoustic sodar, which happened to be located near Gettysburg at the time. Coincidentally, Millersville had recently received funding from the National Science Foundation-Instrumentation for Laboratory Improvement Program (NSF-ILI) for the acquisition of a tethered atmospheric sounding system and a suite of trace gas analyzers for the purpose of getting students into the field. That 1995-96 study put us in touch with Dr. Bruce Doddridge, an atmospheric chemist then at the University of Maryland, and Dr. C. Russell Philbrick, a physicist, electrical engineer, and Lidar expert then at Penn State University, which resulted in our tethersonde/air-chemistry group being invited to participate in the **North American Research Strategy for Tropospheric Ozone (NARSTO) - Northeast Oxidant and Particle Study (NEOPS)**. NARSTO-NEOPS was conducted in the summers from 1998 through 2002 in the greater Philadelphia region to study the transport of trace gases and particles across the urban airshed. Over 40 students were directly involved in NARSTO-NEOPS, operating two tethered balloons for 20 hours each day. The blimp in the photo was used in the 2001 study and carried a payload up to 130 lbs to 1000 feet over NE Philly.

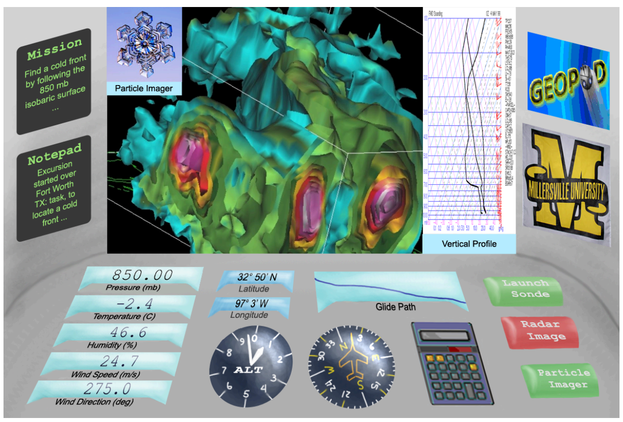
In 1996, during a sabbatical and funding from NSF, Dr. Clark took three students to Ponca City, Oklahoma where they conducted research, which was an extension of his dissertation research investigating mesoscale horizontal pressure gradients with high fidelity, and the Low-Level Jet that establishes at night in summer over the Great Plains as a consequence of these warm season gradients. **NSF deployed the University of Wyoming T-200 King Air** (right photo) where it studied the convective boundary layer by day under the scientific supervision of Dr. Roland Stull, and my LLJ by night.

The connections fostered during NARSTO-NEOPS led to an invitation to conduct research that required obtaining vertical profiles of atmospheric aerosol size distribution in winter. Millersville was the sole participant, setting up a field station on a farm 2.5 miles from Millersville. The project, funded by the **Mid-Atlantic Northeast Visibility Union (MANEVU)** involved 18 students in the winter of 2003-04, juggling class schedules to operate two tethered balloons with payloads of meteorological instruments and particle detectors, operating day and night weather permitting during the 10th coldest January on record - and we didn't miss a byte of data (left photo).

The **Linked Environments for Atmospheric Discovery (LEAD)** project, funded by the National Science Foundation from 2003 to 2008, involved nine collaborative institutions, 107 scientists including Drs. Yalda and Clark along with a dozen students from Millersville. LEAD created an integrated cyberinfrastructure to advance mesoscale meteorology, particularly real-time severe weather forecasting. The goal was to overcome rigid IT frameworks that limited research by developing a system that could dynamically adapt to unfolding weather events. Ultimately, LEAD created a scalable and integrated framework that addressed significant IT challenges in mesoscale meteorology, laying the groundwork for more advanced real-time weather forecasting and research. LEAD was transformative and set the stage for a decades-long investment by NSF in complex dynamically adaptive frameworks for other disciplines through the EarthCube initiative.



Flying through the jet stream was never more fun! From 2009-2014, a collaboration of meteorology and computer science faculty and students at Millersville created the Geosciences Probe of Discovery **(GEOpod)**, a virtual environment that enabled users to probe a 3-D immersion world of authentic geophysical data, actuate virtual devices to collect data and record



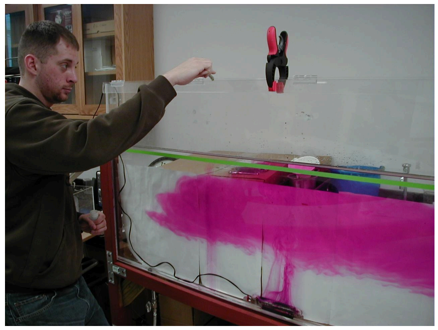
observations, while guided by instructional design strategies that were customized for undergraduate learners. Because the data consist of real observations and imagery, and simulated data from numerical models based on actual physics, the exploration environment naturally exhibits technical accuracy, scientific soundness, physical consistency, authenticity, and high fidelity; attributes that are otherwise enormously challenging and costly for synthetic simulations targeted for education. GEOpod had the feel of a computer game.

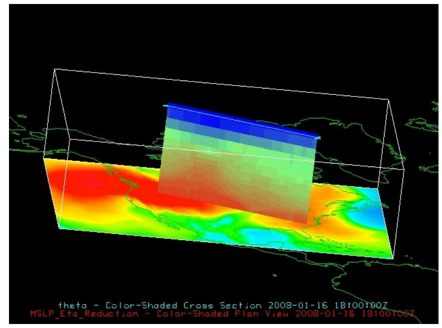
Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ) was a four-year campaign (2011-2015) conducted in collaboration between NASA Langley and Ames Research Centers, NASA Goddard Space Flight

Center, and several universities to improve the use of satellites to monitor air quality for public health and environmental benefit. Over 40 Millersville meteorology undergraduates participated in field research during four separate campaigns from Edgewood, MD, Smith Point, TX, Huron, CA, and Golden, CO, where they established a site that included Sodar, Lidar, and flux tower, rawinsonde support and tethered balloon activities in support of DISCOVER-AQ NASA P3B aircraft measurements of pollution plumes from upstream urban areas. [DISCOVER AQ - NASA Science](). In addition to research, Millersville students assembled and installed the instruments and built the Quonset hut on site for each DISCOVER-AQ location, and engaged middle school students from Huron, CA in learning about meteorology, air pollution, and the field project.

While larger projects provided scores of students with the opportunity for multi-institutional field research and analysis, several smaller projects, funded internally, provided additional students with opportunities that could be conducted during the semester and serve as independent study or honors projects. Here on the left is John Dougherty downloading data from a suite of instruments measuring heat and moisture flux off a vegetated roof in Lancaster, PA. John determined that a vegetated roof reduces the sensible heat flux by 40% compared to a vinyl/rubber roof, and has the potential to significantly reduce the urban heat island effect if more buildings were constructed with vegetated roofs.

In November 2012, Dr. Clark secured a contract to participate in a two-week study to obtain vertical profiles of atmospheric variables and particle-size distribution in and around a desolate area in the Mojave Desert near Fort Irwin, CA in support of satellite validation studies. The project, named **Galactica**, provided funding for eight MU meteorology students to accompany Clark on a cross-country excursion to lift an aerodynamic particle-sizer to several hundred meters on a tethered balloon to gather data during training exercises. By knowing the amount and size distribution of particular matter kicked up by the surface activities, algorithms could be derived that would essentially allow the satellites to account for the dust and reach emissions from ammonia released at the surface.





Tanks and numerical models exposed students to the utility of controlled geophysical fluid dynamics experiments in a laboratory setting. Millersville, along with colleagues from MIT, Dartmouth, and Johns Hopkins, collaborated on developing learning modules using a rotating tank (above, left) to enhance the undergraduate science classroom experience (see https://weathertank.mit.edu/). Our in-house Weather Research and Forecast (WRF) numerical model (above, right) was employed by students to study atmospheric phenomena in diagnostic and prognostic modes.

During the winter of 2013-2014, 23 Millersville students and two faculty embarked on an arduous study of **Ontario Winter Lake-effect Systems (OWLeS)**, which involved rawinsonde and tethered balloons, aircraft, radar and a plethora of ground-based instrumentation spread across the U.S. and Canadian shores of Lake Ontario to study cross-lake and along-lake fetches resulting in lake-effect snowfalls. Climatology estimated that we should see eight events; we had intensive operational periods for 26 events. Millersville supported a variety of efforts from near Geneva, NY, where we established basecamp, to the Tug Hill area where we encountered blizzard conditions, blowing snow and lightning on the drive there and astounding snowfall rates and accumulations as one can infer from the photos. In addition to the measurements and observations that we normally carried out, the Millersville crew took over the responsibility of photographing ice crystals for a study being conducted by the University of Wyoming. A sample is shown here.

SPECIAL
PECAN
COLLECTION

Nocturnal Destabilization Associated with the Summertime Great Plains Low-Level Jet

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Most of the precipitation that occurs in summertime across the Great Plains (LLJ) of the United States happens at night when isolated convection and areas of instability, remnants of daytime heating, are reinvigorated and organized into mesoscale convective systems (MCS). Millersville Meteorology was one of several groups participating in a project, which became known as **Plains Elevated Convection At Night (PECAN)**. The MU meteorology group of 13 students set up their instruments, which included rawinsondes, Lidar, Sodar, and tethered balloon, in Ellis, KS, as part of an observing network that extended from Oklahoma to Nebraska, and Colorado to Iowa to capture the structure and behavior of these systems. We pulled all-nighters, capturing the atmospheric conditions downstream of the MCS and recording the passage of undulating bores, but mostly concentrating on the the development and evolution of the nocturnal GP Low-Level Jet (LLJ), a wind system carrying warm, moist air from the Gulf of Mexico into the central plains of the U.S., and an important recurring feature of the MCS environment.

Winter snowstorms are frequent on the eastern seaboard and cause major disruptions to transportation, commerce, and public safety. Snowfall within these storms is frequently organized in banded structures that are poorly understood by scientists and poorly predicted by current numerical models. The capabilities of remote sensing technologies and numerical weather prediction models have advanced significantly, making **The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS**, https://espo.nasa.gov/impacts) a well-equipped study to identify key processes and improve remote sensing and forecasting of snowfall. This multi-institutional study

involved a network of surface and airborne operations, including the NASA P3B and the ER-2 aircraft, to capture the synoptic, mesoscale, and cloud microscale physics of these systems. Several Millersville meteorology students and faculty were assigned to obtaining atmospheric profiles using multiple rawinsonde systems, one fixed and one mobile, as well as providing in-situ surface observations. Nothing beats the thrill of a winter snowstorm!

Millersville University Meteorology Project **TILTTING (Thermodynamic Investigation into LCL Thresholds during Tornadogenesis and its Influence in the Northeast and Great Plains)** is a student-led project investigating the atmospheric conditions, specifically cloud base heights (the LCL or Lifted Condensation Level), that accompanies tornado formation and compares the LCL found in the Great Plains with that in the Northeast. TILTTING started with a few students crowdsourcing the funds needed to carry-out the field exercises. Funds donated by a variety of organizations and individuals (e.g., AccuWeather, WeatherWorks, Millersville's Center for Disaster Education and Research, etc.) helped these students raise over $30,000 to obtain instrumentation and support their deployments. Using the funds, Millersville meteorology students built their own Mobile Mesonet to observe the surface winds of nearby storms and constructed prototype instruments to measure storm environments by drone. Students also organized training exercises for radiosonde data collection and deployments out in the field. During the spring of 2024, Dr. Greg Blumberg and seven Millersville meteorology students deployed to the Great Plains for two weeks. During that time, they collected data on evolution of the near-storm environment over five different observing periods. While in Norman, Oklahoma, the students connected with individuals in the Storm Prediction Center and National Severe Storms Laboratory. Following the data collection, several of the students involved in the project presented their own analyses at the 2025 American Meteorological Society conference in New Orleans studying lightning trends and environmental differences between tornadic and non-tornadic storms.

It is fitting to end this narrative with our most recent field project, which was instigated by Millersville alumnus Adam Jacobs. In Fall 2024, Dr. Blumberg and seven Millersville students worked with Adam and Georgia Tech Research Institute to develop a system of launching, tracking, and recovering balloon-borne payloads. Students assisted in the testing of this system. That November, we traveled to Bridgewater, VA to participate in an event in which hyperspectral imagers were used to track and map the signature of various airborne targets. For a week, Millersville students coordinated with several other groups to launch balloons and recover them.

More to come!

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