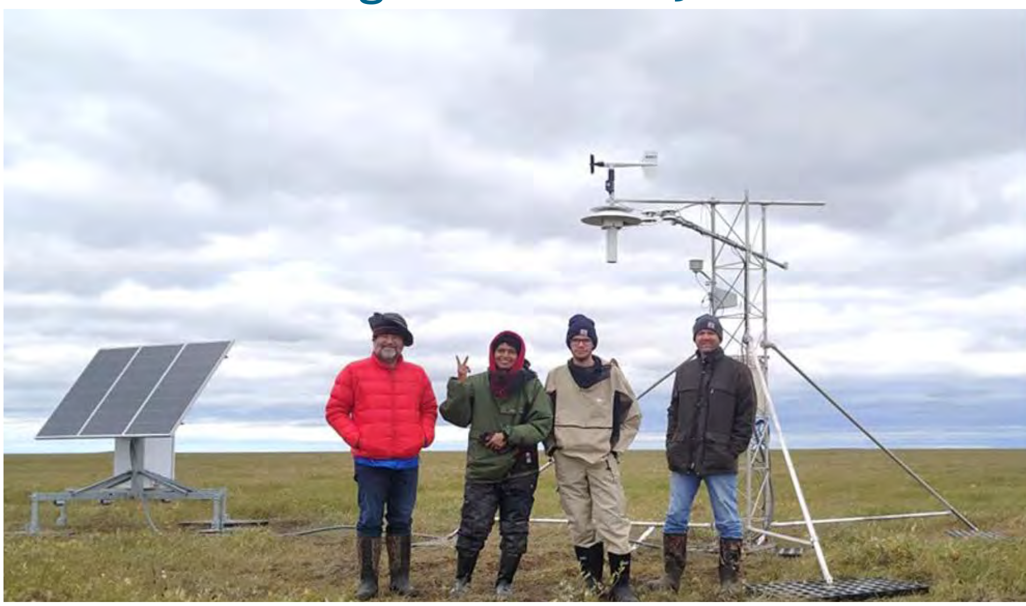
SUMMER 2022 AIR RESOURCES LABORATORY

Boundary Matters

Linking Earth and Sky



FOCAL Team Installs Towers in Alaska

In August, a team from ARL traveled to Prudhoe Bay, Alaska, to begin tower installations that support observations of greenhouse gas (GHG) emissions over northern Alaska. ARL collaborates with the Flux Observations of Carbon from an Airborne Laboratory (FOCAL) campaign to measure greenhouse gases and water vapor over this region of Alaska from a small aircraft operating at low altitudes.

More Inside....

Although the calendar indicated summer, temperatures in Prudhoe Bay rarely rose above 55°F with gusty winds in early August. ARL's Praveena Krishnan is a principal investigator for FOCAL, which is funded by the National Science Foundation's Office of Polar Programs. Mark Heuer, Dominick Christensen, and Tom Wood of ARL's Atmospheric Turbulence and Diffusion Division (ATDD) conducted the installation of the ground tower and information technology support for the project. The north slope has many different land types and ecologies, although it is dominated by permafrost.

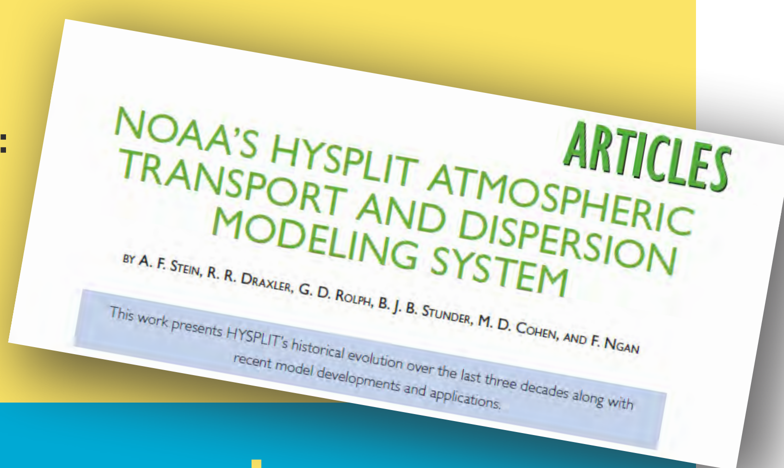
FOCAL will help identify the late summer and autumn net flux of methane and carbon dioxide from the north slope and adjoining Arctic waters. Scientists will use this data to establish benchmarks that tracks the complex process of carbon flux around the Arctic Circle. This data can tell local citizens of the seasonal changes in their environment and to predict likely changes in temperatures, sea ice, and permafrost.

Continued on page 6

HYSPLIT by the Numbers

1 Most read papers in the Bulletin of the American Meteorological Society:

A. Stein, R. Draxler, G. Rolph, B. Stunder, M. Cohen, and F. Ngan (2015). NOAA's HYSPLIT Atmospheric Transport and Dispersion Modeling System. Bulletin of the American Meteorological Society, 96: 2059 doi: 10.1175/BAMS-D-14-00110.1


ARTICLES

NOAA'S HYSPLIT ATMOSPHERIC TRANSPORT AND DISPERSION MODELING SYSTEM

BY A. F. STEIN, R. R. DRAXLER, G. D. ROLPH, B. J. B. STUNDER, M. D. COHEN, AND F. NGAN

This work presents HYSPLIT's historical evolution over the last three decades along with recent model developments and applications.

Emergency support

Nuclear power plants in Ukraine

5

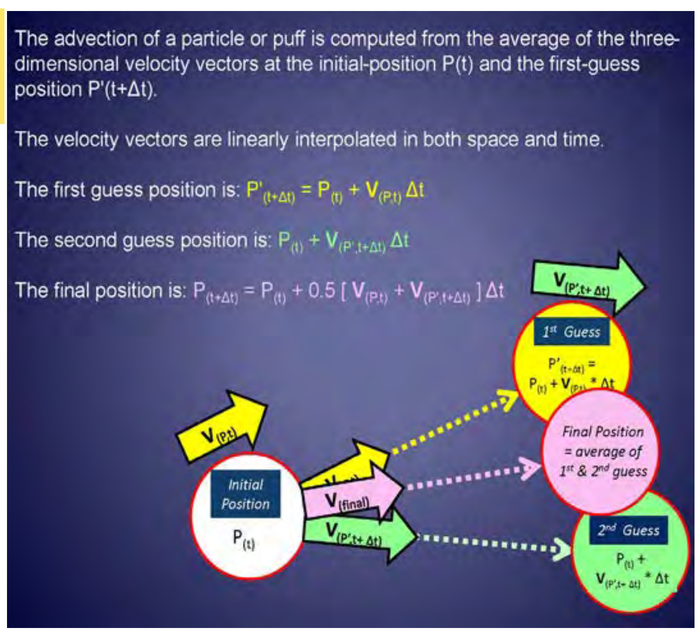
Since March 2022, the HYSPLIT team has been working to establish a set of computational systems to be able to forecast impacts from potential releases from nuclear power plants in Ukraine.

No releases have been reported; the work has been hypothetical to prepare systems in the event they might be needed, should releases of radionuclides occur.

HYSPLIT Training

49 Countries represented in the June 2022 HYSPLIT workshop

200 Attendees in the HYSPLIT workshop



READY

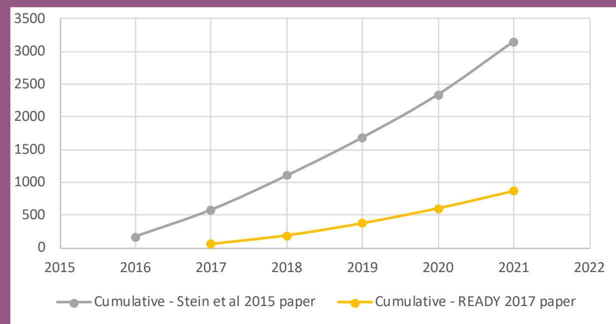
Apr to June 2022

HYSPLIT Runs (public users):	387,183
HYSPLIT Runs (registered users):	1,444
NWS HYSPLIT Runs:	991
Locust web application runs:	1,035
Meteorological analysis tools:	562,189

3156

Cumulative Citations in 2021

A. Stein, R. Draxler, G. Rolph, B. Stunder, M. Cohen, and F. Ngan (2015). NOAA's HYSPLIT Atmospheric Transport and Dispersion Modeling System. Bulletin of the American Meteorological Society, 96: 2059 doi: 10.1175/BAMS-D-14-00110.1



871

Cumulative Citations in 2021

G. Rolph, A. Stein, and B. Stunder (2017). Real-time Environmental Applications and Display sYstem: READY. Envr. Modelling and Software 95: 210 doi:10.1016/j.envsoft.2017.06.025

HYSPLIT's Annual Workshop Held in June

ARL's annual four-day HYSPLIT was held online from June 14 to 17, 2022. Other resources, information and advanced tutorials are available on the READY website. The 2022 session was conducted by an ensemble of ARL HYSPLIT team members and covered a range of HYSPLIT applications. Approximately 200 people participated in the event from around the world.

This training session used HYSPLIT's new default graphical output options, which have proven popular with users. The default output is now SVG (Scalable Vector Graphics) which can be displayed through any browser, and does not require other graphic utilities to be installed. The HYSPLIT version 5.2.2 graphics upgrade also simplifies the installation process for most end users.

With the event recordings and all workshop materials available on the workshop page, anyone can access the Workshop content if they wish to learn about the HYSPLIT model. The workshop remains a successful way to engage and train new users. On our website, HYSPLIT Tutorials are available. Questions or issues posted in the HYSPLIT Forum are answered by the HYSPLIT team.

HYSPLIT Time of Arrival Graphics Now Available

As part of the implementation of HYSPLIT (v8), the Time of Arrival (ToA) graphics have been added for the Regional Specialized Meteorological Centre (RSMC) operational products. The ToA indicates the forecast period for which any emitted and transported radiological material concentration will first reach an area downwind of the source. The HYSPLIT ToA products are generated following the guidelines provided to the RSMCs by the International Atomic Energy Agency (IAEA). ARL, together with NOAA's National Center for Environmental Prediction, are designated by the World Meteorological Organization (WMO) as the Washington RSMC, one of ten worldwide for emergency environmental response related to potential radionuclide sources.

Currently, three ToA plots are generated for the periods of 0-24, 25-48, and 49-72 hours after the nearest synoptic time (TINT) prior to or equal to the start of the release time, similar to the concentration and deposition plots. In the ToA plots, colored areas are used to present the arrival time of the radiological plume predicted by non-zero 3-hr averaged radionuclide concentrations (Becquerel per meter cubed or Bq/m3).in 6 hour time intervals. The first plot (for the first 24 hours period after TINIT) contains four areas in different colors (with 6-hour steps). The second plot shows the plume arrival time for the next 24 hours. It contains five colored areas and the gray area shows the area where the plume already arrived during the first 24 hours. The third ToA plot shows the plume arrival time in the third 24-hour period and the area the plume already passed over in the first 48 hours is represented as a gray area. A zero threshold for concentration is used and it is indicated in the ToA plots. As The initial time of the ToA is defined as the model start time and it may differ from the pollutant release time. This initial time (TINT) is indicated in all the ToA plots.

In three time period simulations shown at right, the release is identical to the model start time. Time-integrated ToAs which are based on time-integrated concentrations (with units of Bq s /m3) are planned to be added in the future. An appropriate threshold will need to be defined for time-integrated ToAs.

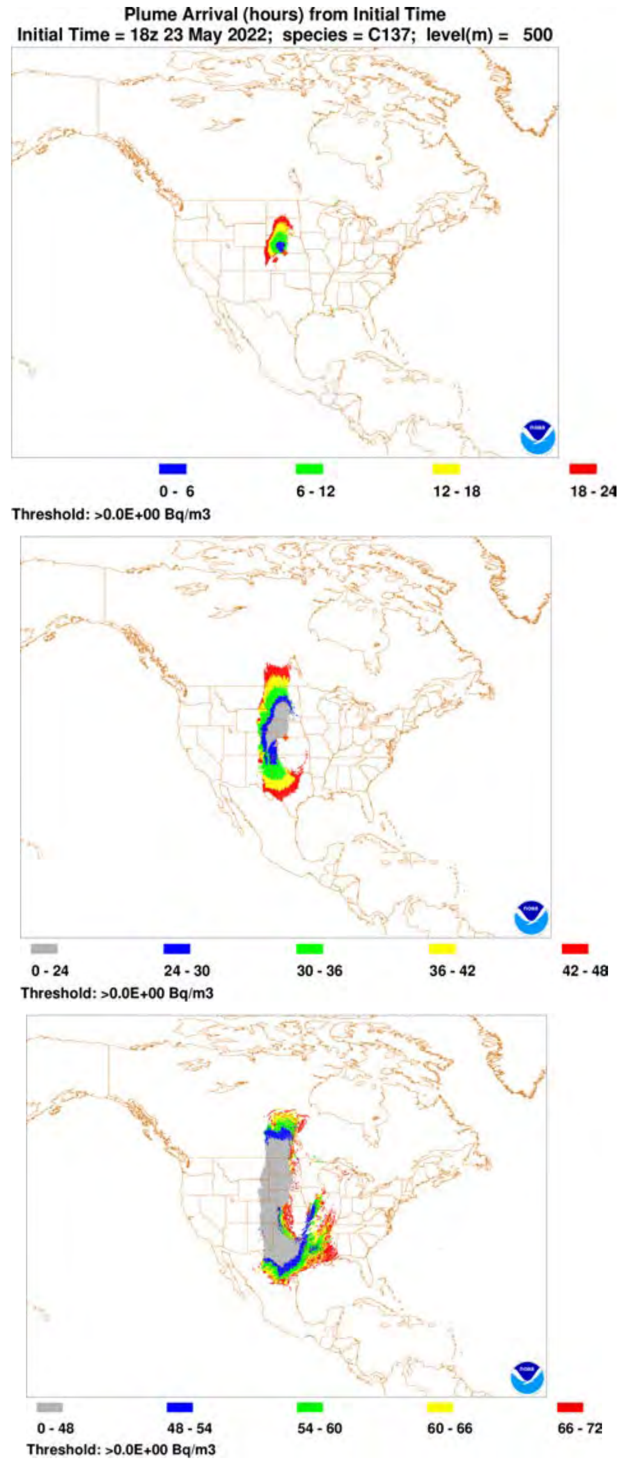


Figure at right: Time of Arrival of Cs-137 plume based on 3-hr average air concentration within the layer 500 meters above the ground predicted from HYSPLIT model for a unit release of 1Bq over 6 hours starting from 18:00Z on May 23, 2022. The top plot shows the plume arrival time in 6-hour intervals during the first 24 hours from the prediction starting time which is the same as the release time. The middle plot shows the plume arrival time for the next 24 hours. The gray area shows the area where the plume arrived during the first 24 hours. The bottom figure shows the plume arrival time in the third 24-hour period and the area already hit by the plume in the first 48 hours (gray area). The "+" symbol indicates the assumed release location (100°W, 40°N).

ARL Leadership Takes Shape

Ariel Stein

Dr. Ariel Stein is appointed the Director, Air Resources Laboratory (ARL) effective May 8, 2022. Dr. Stein is currently Director of NOAA's Global Monitoring Laboratory (GML). Ariel has agreed to serve as Acting Director of GML until the position is filled.

In January 2022, Ariel was selected to the Senior Executive Service and appointed as the Director of NOAA's GML in Boulder, Colorado. Dr. Stein became Acting Deputy Director of ARL in 2017. In his career at ARL, Ariel led the development of hybrid dispersion modeling techniques, including the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model, a widely utilized atmospheric transport and dispersion model. His research with atmospheric transport and dispersion modeling includes the simulation of atmospheric tracer release experiments, radionuclides, smoke originated from wildfires, volcanic ash, and wind-blown dust.

With a permanent director now appointed, ARL is better equipped to meet the atmospheric research and development needs of NOAA as well as our Nation. "Ariel Stein is a proven leader and we look forward to having him at ARL to help us address pressing issues such tracking greenhouse gas emissions and improving our nation's air quality forecasting capability," said Cisco Werner, Acting Assistant Administrator of NOAA Research.

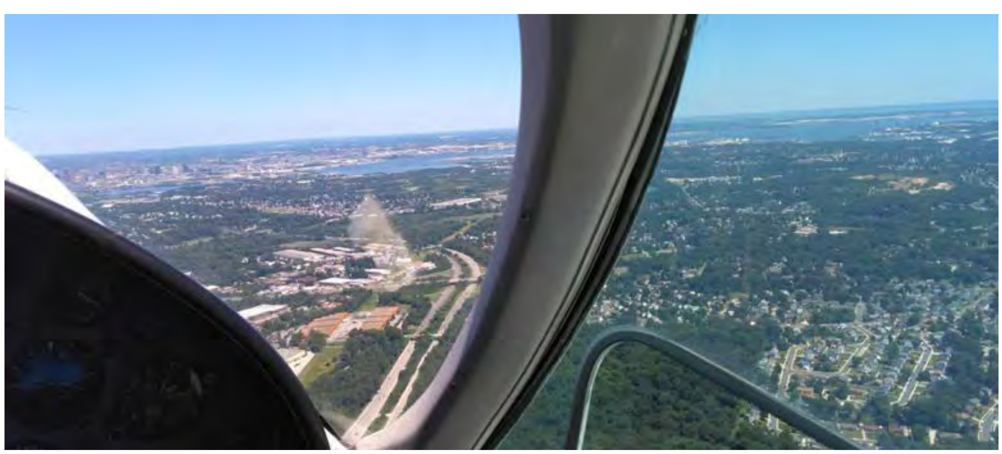
LaToya Myles

Dr. LaToya Myles is Acting Deputy Director at ARL, a role she has held since January 2022. Dr. Myles is an environmental chemist and has previously led ARL's Atmospheric Turbulence and Diffusion Division in Oak Ridge, TN as Director.

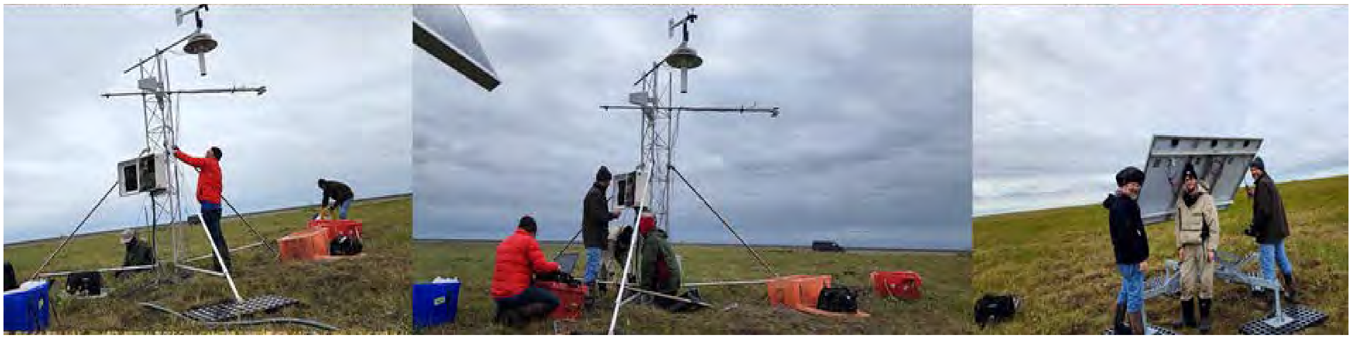
LaToya has demonstrated leadership of boundary layer R&D efforts, including observational campaigns and modeling of physical and chemical processes in the atmosphere. She began her 20-year tenure at ARL as a fellow of the NOAA Educational Partnership Program and is a subject matter expert, invited speaker, and published author in surface-atmosphere exchange and biogeochemical cycling of reactive nitrogen.

Dr. Myles has been recognized for her academic achievements with scholarships, fellowships, and awards. She was recognized as a 2016 Technology All-Star at the 21st Women of Color STEM Conference. She is also a member of the American Geophysical Union and has served as AGU Honors & Recognition Committee Chair since 2020.

"LaToya brings a wealth of leadership experience and innovative thinking that can help advance ARL's existing research and development programs and identify new opportunities," said Ariel Stein.



Summer days also mean high ozone events in the Baltimore Washington metropolitan area. Phil Stratton and Xinrong Ren, along with their research partners, use a Cessna 402 research aircraft to measure ozone, nitrogen oxides, volatile organic compounds, carbon monoxide, and greenhouse gases such as carbon dioxide and methane. This image was taken by ARL's Phil Stratton on a flight headed toward Baltimore.



The ATDD team at work installing a tower and supporting equipment.

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"The FOCAL project will help us to understand the changes in Arctic carbon emissions," said ARL's Praveena Krishnan. "The climate at northern latitudes is warming at a rapid rate, and data from this project at the local, landscape and regional scales will help us to understand the key processes that control the carbon emissions (carbon dioxide and methane) and how they respond to the changing climate conditions of the Arctic."

In recent decades, warming in the Arctic region has been much faster than the rest of the globe. Known as arctic amplification, this phenomenon has been observed by instruments, climate models and in paleoclimate records. Northern latitudes are warming at twice the global mean; carbon trapped in permafrost is now increasingly vulnerable to decomposition microbes, which could yield large increases in methane (CH_4) and carbon dioxide (CO_2) emissions, both important greenhouse gases.

Accurate forecasts of greenhouse gas emissions are critical inputs to global models that predict changes to temperature and to sea level. Our regional and global scale climate models require a better understanding of methane and carbon dioxide sources to gain insight into how the change will vary in a warming Arctic.

"The FOCAL project will help us to understand the changes in Alaska's carbon emissions"

– ARL's Praveena Krishnan

The complex terrain of the North Slope offers a wide range of greenhouse gas sources, such as wetlands or thawing permafrost. But scientists have a knowledge gap between ground based studies and large-scale regional estimates from remote sensing data or inversion-model results. FOCAL will fill in missing data on the sources of emissions by providing more insight into ground based measurements and their scalability over the ecosystem. Observations of various molecules reveal clues about the greenhouse source processes at local, landscape, and regional scale, a feature unique to this project.

Limited infrastructure for ground-based equipment means that a small aircraft is the best option for large scale measurements. Airborne measurements, especially from low-flying aircraft, can correlate the emissions with the larger landscape. For FOCAL, flux measurements from aircraft are coordinated with tower surface measurements, enabling detailed surface-flux measurements to be used over a larger regional scale by mapping the correspondence to the flux in larger areas. Comparing aircraft measurements to local tower measurements and land classification maps allows for the determination of which landforms or mechanisms contribute to the variations in emissions.

One of the FOCAL towers after installation.

The Arctic is changing at a rapid pace, and it is important to understand all the complex interactions of biology, weather, ocean and climate in that unique landscape.
– Ariel Stein, ARL Director

FOCAL is made possible by the convergence of three unique systems: the "Best" Aircraft Turbulence (BAT) developed by NOAA; the carbon isotopologue instrument developed at Harvard University; and the DA-42 aircraft operated by Aurora Flight Sciences. The project is led by Harvard University, with a number of collaborators. Regional data on the contributions of key sources of greenhouse gasses at a local, landscape, and regional scale are a featured element of this research.

The ground towers installed by ARL's FOCAL team capture resolved emissions and correlates the underlying sources to map out the ecosystem and its emissions profile. Using the eddy covariance measurements from the aircraft, scientists can extrapolate the local data to the regional scale.

"The Arctic is changing at a rapid pace, and it is important to understand all the complex interactions of biology, weather, ocean and climate in that unique landscape," said Ariel Stein, Director of NOAA's Air Resources Laboratory. "FOCAL is an excellent example of making multiple measurements of the boundary layer over complex land areas."

FOCAL enables accurate measurements of the sources of Alaskan greenhouse gases to improve bottoms-up (or source based) estimates of Alaskan carbon flux, which helps improve our models and understanding of the Arctic processes. This experiment design captures a combination of in situ measurements with regional fluxes calculated using a transport model that is tuned for the geography of Alaska and widely applicable to other circumpolar areas.

Interns kick off summer at ARL

Annabelle Pham

Annabelle is a student at The George Washington University (GWU), School of Business Washington, DC working on a Bachelor of Arts in Business Economics & Public Policy, with a minor in Statistics. Her interests include altruism, corporate social responsibility, education, ethics, public service, and volunteerism. Her mentor is Michelle Howard in ASMD and the internship is through the Partnership for Public Service.

Norman Urbanek

Norman Urbanek began a NOAA Pathways Internship working with the HYSPLIT modeling team at ASMD. Norman will be entering his senior year at North Carolina State University next fall majoring in Environmental Technology. For the past 2 years, he has been conducting research on assessing disparities in hazardous air pollutant emission exposures across the US among different demographic groups. In his work at ARL, he plans to extend this research to include dispersion modeling using the HYSPLIT model. The HYSPLIT team is looking forward to working with Norman in this important Environmental Justice research.

Chuck Baker

Chuck currently is a PhD student in the Department of Atmospheric Sciences at UMD. With expertise in mathematics, his research interests include the development and application of planetary boundary layer parameterizations, computational fluid dynamics in extreme weather events, and improving the accuracy level of low-cloud and precipitation predictions. Chuck serves at the Earth System Science Interdisciplinary Center (ESSIC) focusing on the regional Climate-Weather Research and Forecasting (CWRF) model as part of the Earth System Modeling group (EaSM) at the University of Maryland-College Park. Chuck is a rated aviation and drone pilot, a dedicated weather enthusiast, and an avid outdoorsman.

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Nicholas Clark

Nicholas Clark, an M.S. candidate from Texas Tech University, began an internship at ATDD, working under the direction of Temple Lee and Travis Schuyler. During his internship, Nicholas will work on the development and implementation of a small uncrewed aircraft systems (sUxS) motion-removal algorithm. The development of this algorithm is required to correct for errors associated with the motion of sUxS to provide the required fidelity in vertical wind speed measurements to enable reliable sensible and latent heat fluxes from sUxS. The ability to retrieve this information is critical for using sUxS to scale surface point observations to model-relevant scales and for developing new surface-layer and boundary-layer parameterizations.

Ella Hunter

Ella Hunter began a federal Pathways internship at ARL in August 2022. Ella is a junior at the University of Tennessee, Knoxville, majoring in mathematics and geography. She has assisted in analyzing the urban heat island effect in Knoxville and has worked with the Knoxville Heat Equity Coalition to create local heat adaptation and mitigation plans. Ella has also interned at the National Weather Center through the NSF-funded REU Program, where she studied snow events with sudden visibility drops. She will be working on various administrative tasks at ATDD for the next year.

Faria Panwala

Faria is a rising senior at Georgia Tech at the school of Earth and Atmospheric Sciences, with a focus on meteorology. She is working at ATDD with Dr. Rick Saylor, Dr. Temple Lee, and Dr. Travis Schuyler to analyze the output of the HRRR model during severe weather events. These outputs are cross-referenced with storm watches/warnings to assess the effectiveness of warnings issued during tornadic activity. She looks forward to working with the ATDD over the next year on this important project.

Jenifer Vivar

Jenifer Vivar is currently pursuing a master's degree in data science at the City College of New York (CUNY). She has been a NOAA-CESSRST fellow researcher for the last year focusing on Mixing Layer Height (MLH) and pollutant transmissions. During the NERTO internship at ARL, Jenifer is working on comparing different algorithms that calculate MLH with Alice Crawford, Nebila Lichiheb, and Christopher Loughner. She is also attempting a machine learning algorithm implementation to determine MLH and expects to graduate in the Spring of 2023.

About ARL

NOAA's Air Resources Laboratory (ARL) conducts research on the lowest part of the atmosphere, the boundary layer, the area where we live and breathe.

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