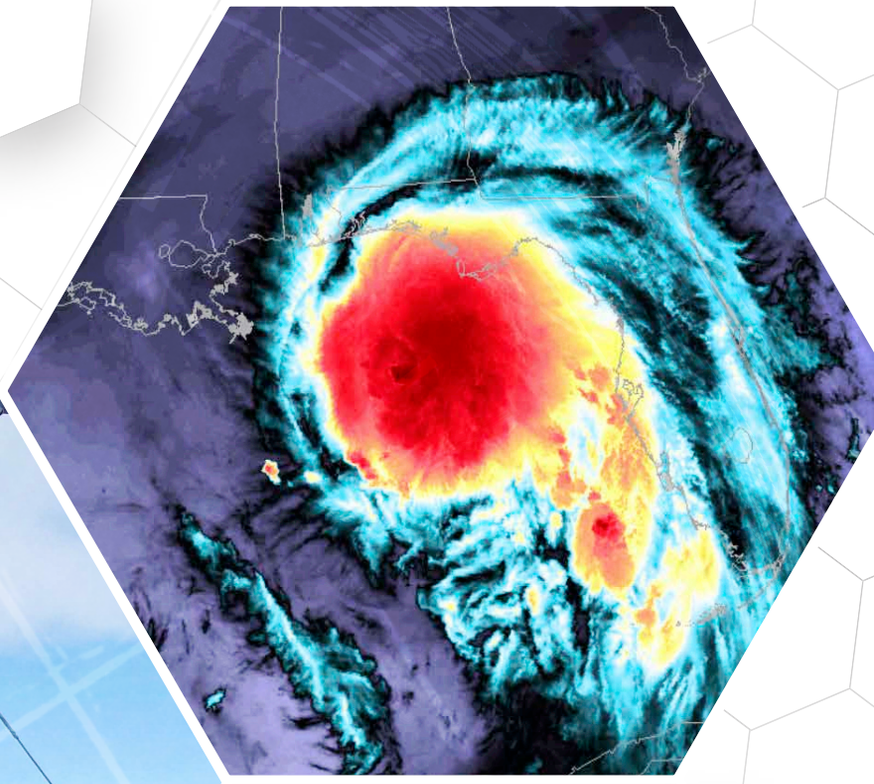
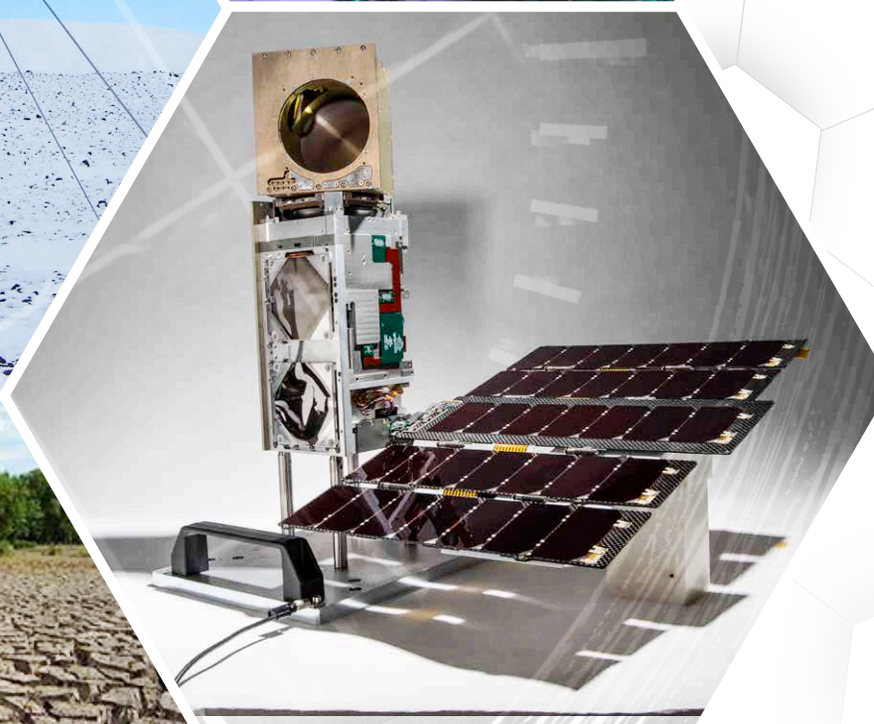
SSEC

Space Science and Engineering Center
University of Wisconsin–Madison

Biennial Report
2020-2021





From the director

Idea. Invest. Innovate.

Universities are incubators of new ideas. With the right investment, these ideas are realized as real-world innovations that improve, and save, people's lives.

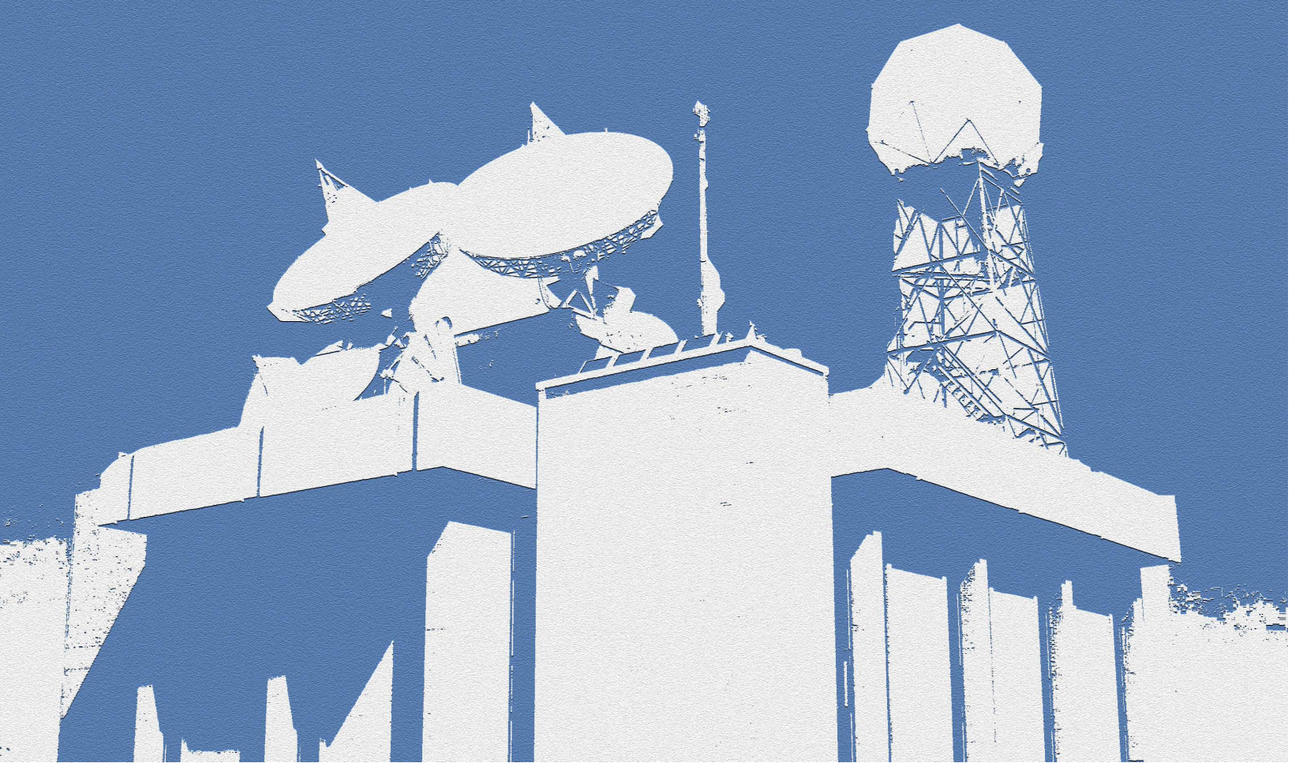
From our earliest beginnings, SSEC and CIMSS have been testbeds for basic and applied science research in environmental remote sensing; testing and refining ideas until they mature.

Central to the success of that research has been federal government investment and partnership.

New instruments designed to gather atmospheric data – like the CubeSats for the PREFIRE and TROPICS experiments – have evolved over decades and are now ready to deliver crucial and timely information about Earth's climate and weather. The investment in research for these two programs came largely from NASA, but similar support from our partner agencies like NOAA and NSF enables the research highlighted in this report.

Innovation builds on earlier research to push the field forward. Sustained investment in research at SSEC and CIMSS from our federal partners demonstrates our shared commitment to improving understanding of weather, climate and atmospheric processes for the benefit of all.

R. Bradley Pierce
SSEC Director



40 years and counting, NOAA renews partnership with UW

For more than 40 years, the National Oceanic and Atmospheric Administration has partnered with the University of Wisconsin–Madison to conduct critical research in satellite meteorology through its Cooperative Institute for Meteorological Satellite Studies.

In May 2020, NOAA announced that CIMSS will continue at UW–Madison for the next five years, recognizing the strength and value of their collaboration. The award brings up to $150 million to the institute.

CIMSS is recognized internationally for its satellite expertise, spanning geostationary and polar-orbiting platforms. This network of satellites forms the backbone of a global observing system developed to monitor our planet and ensure public safety.

Collaborating with NOAA scientists based at CIMSS, university researchers are helping design and demonstrate new satellite sensor technologies, develop products and data applications, and transition research into operational forecast models that benefit the public.

From developing better ways to detect and forecast severe weather to improving analyses of environmental and climate trends, CIMSS scientists are providing crucial information to decision makers at the city, state and national levels.

Four decades of collaboration have resulted in significant scientific achievements as CIMSS and NOAA staff have transformed the field of satellite meteorology.

Preserving data to unlock climate changes

Like the Arctic, changes in Antarctica's climate can be an indicator of much larger shifts in the Earth's climate.

The Antarctic Meteorological Research and Data Center is building a data hub to serve the global Antarctic research community as it studies those changes. The AMRDC is a collaboration between the University of Wisconsin–Madison Space Science and Engineering Center and Madison College that is funded by the National Science Foundation.

The AMRDC repository will enable discovery, sharing and preservation of open meteorological data collected in Antarctica. SSEC has amassed more than 40 years of data from weather stations, satellite sensors and other observational data that will support novel, longitudinal research into Antarctica's changing climate. External organizations will be invited to deposit datasets for long-term archiving.

Beyond establishing the repository, program scientists will conduct climate-related research and provide meaningful research experiences for undergraduates, a cornerstone of the UW and NSF's mission.

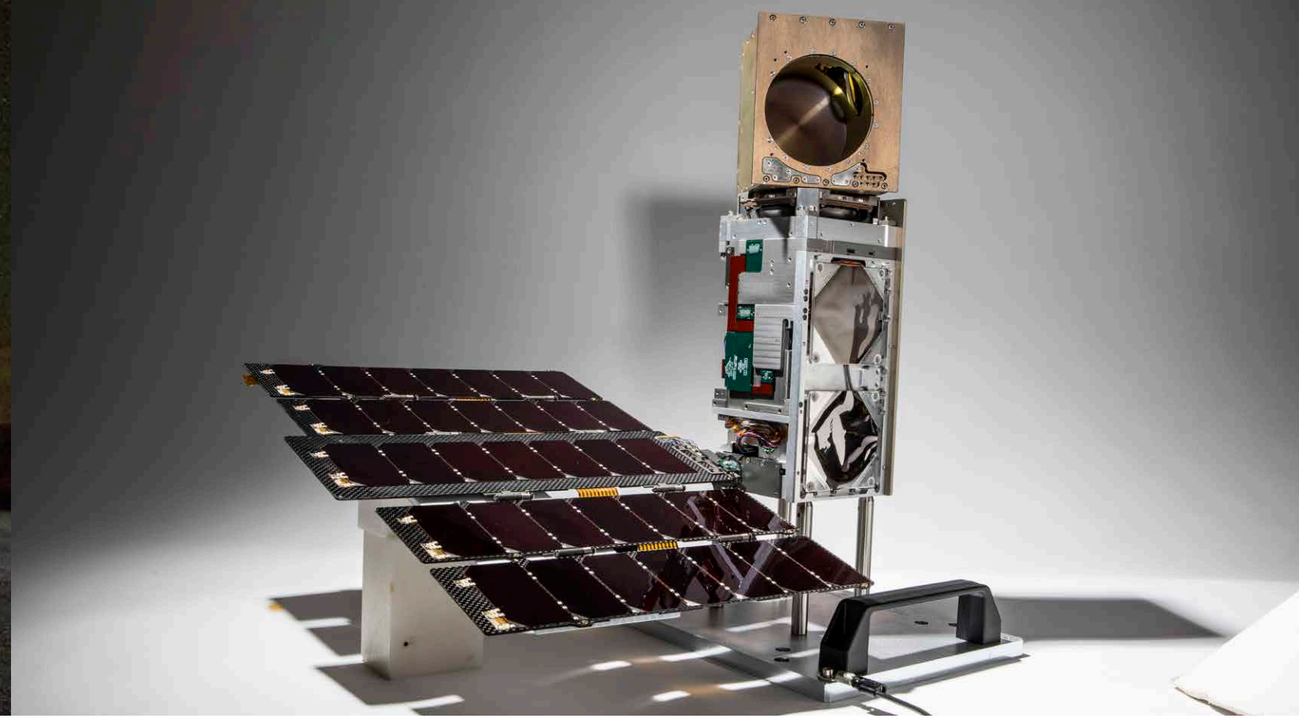
New opportunities for mobile atmospheric research lab

In 2021, the Space Science and Engineering Center Portable Atmospheric Research Center, or SPARC, became part of the National Science Foundation Community Instruments and Facilities Program.

Its incorporation into the CIF program will allow researchers from external institutions to apply to use the SPARC's unique instruments in new field experiments, expanding the facility's utility and reach within the atmospheric science community.

The SPARC vehicle is outfitted with a suite of instruments to make ground-based atmospheric measurements in high-resolution. The instruments include the Atmospheric Emitted Radiance Interferometer, the High Spectral Resolution Lidar, a Surface Meteorology station, a WindPro lidar system and a radiosonde receiving station. Also included in the CIF program is SPARC's sister facility, the SPARClet, which is a portable container capable of operating aboard seafaring research vessels.

Since its inaugural deployment in 2014, the SPARC has traversed the U.S. to support large-scale field campaigns and solo expeditions. The real-time, precision measurements from SPARC's instruments are leading to better understanding of atmospheric conditions that underpin severe weather forecasts, such as those that track development of damaging thunderstorms over the U.S. Great Plains, and climate studies.



Sneak preview of TROPICS mission with rare pathfinder launch

Space Science and Engineering Center researchers leading UW–Madison's involvement in the Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) investigation are getting a sneak preview of their mission to study hurricane development. NASA, with help from SpaceX, launched an engineering model version of the satellite instrument on June 30, 2021. TROPICS is one of the first CubeSat missions funded by NASA.

Part of what makes the mission so novel is what also makes it possible – in particular, being able to reduce the spacecraft down to the size of a shoebox. The satellite instrument makes observations in the microwave – frequencies that are new and unique to this mission – that allow for a much smaller signal receiving dish on the satellite. The pathfinder launch enables the team to test their observational and data processing approach.

TROPICS researchers will use the data to examine tropical cyclone warm cores. Understanding their characteristics and impacts on storm evolution will improve hurricane intensity and track forecasting.

Leveraging SSEC's infrastructure and expertise, the TROPICS Data Processing Center handles processing and reprocessing of all data – coordinating with the ground system and archive providers.

The six satellites of the main TROPICS mission will launch in 2022 – bringing new data and understanding of tropical cyclones to improve forecasts, saving lives and property.

PREFIRE CubeSat mission over poles fills missing data

The Arctic and Antarctic are important for regulating Earth's temperature. They respond to warming with glacial melt; resulting in sea level rise, shifts in mid-latitude weather patterns and changes in global temperatures – all harbingers of broader climate change.

To learn more, NASA partnered with the Space Science and Engineering Center on a mission called the Polar Radiant Energy in the Far-InfraRed Experiment. While 60 percent of radiation emitted into space over the Arctic is in the far-infrared region – and despite 50 years of satellite observations – scientists have little understanding of the processes that affect this key component of the polar energy budget. PREFIRE will address these missing data and help scientists better understand how the Arctic regions regulate Earth's temperature and climate.

Scheduled for launch in December 2022, two small CubeSats will carry a Thermal Infrared Sensor, or TIRS detector, to measure emissivities at various frequencies in the far-IR, with a focus on a range of 5–54 micrometers in wavelength. By filling the far-infrared observation gap and integrating these new observations into models, PREFIRE offers a pathway to improving polar climate predictions.

Identifying flash drought intensity

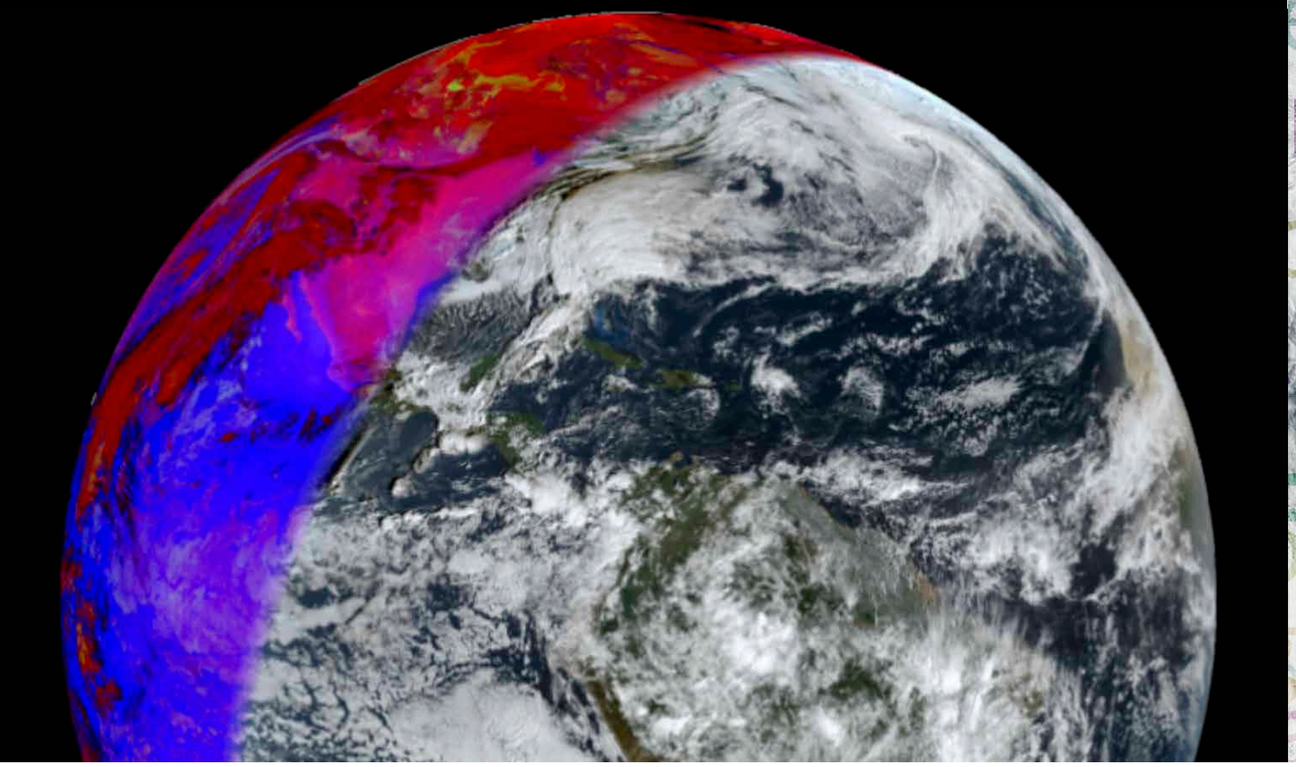
Dry weather compounded by hot temperatures can lead to drought. However, not all droughts follow the same pattern as they develop. Some, like flash drought, emerge rapidly and can have severe consequences depending on how long they last.

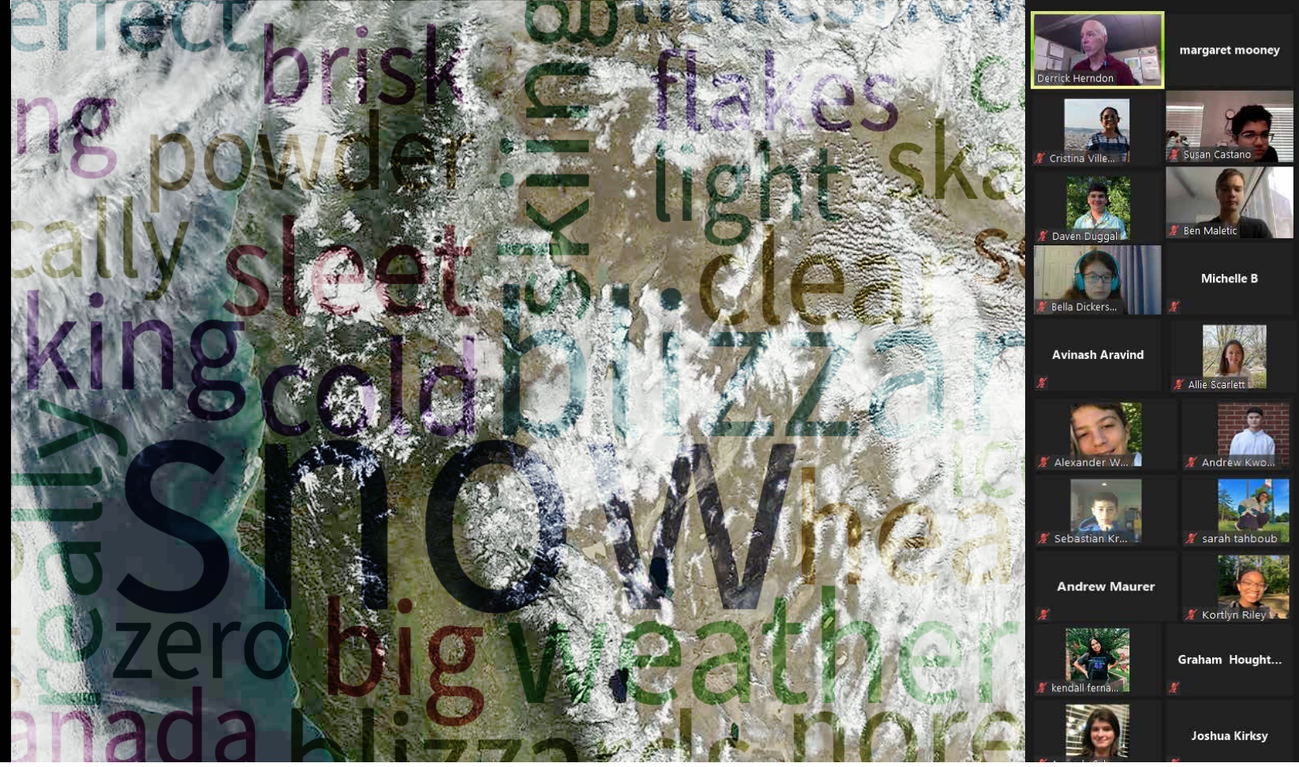
A new flash drought intensity index developed at the University of Wisconsin–Madison Cooperative Institute for Meteorological Satellite Studies, in partnership with researchers at NASA, the National Science Foundation, the Northern Australia Climate Program and the University of Southern Queensland, aims to clarify what a flash drought is and to quantify its severity. The new index considers how rapidly a drought intensifies as well as whether that intensification is followed by a prolonged period of drought.

The model is based on soil moisture data and characterizes land-surface interactions, or how much moisture has evaporated from the soil due to warming conditions.

While drought is a natural feature in Earth's climate, longer term drought can lead to devastating crop and livestock losses as well as increased wildfires, such as those that ravaged the Western United States and Pacific Northwest in 2021.

The new drought intensity index will provide critical information on changing conditions, such as reduced water supply, so that those most affected by drought can mitigate its costly — and deadly — impacts.





Leveraging cloud services to distribute satellite data

Alongside NASA and the National Oceanic and Atmospheric Administration, the University of Wisconsin–Madison Space Science and Engineering Center is piloting a new approach to satellite data acquisition, processing and distribution through the development of cloud services. The goal is to make data from weather satellites like GOES-16 and -17 more readily available and easier to access via the cloud so that users can improve weather forecasts where every minute matters.

SSEC's initiative has transitioned open-source software that was developed under the Community Satellite Processing Package to a cloud-based operation. Launched in 2021, the GeoSphere website is built on the CSPP platform and permits free access to near real-time data and imagery from the GOES-16 Advanced Baseline Imager. This shift in data delivery allows users to display imagery almost as soon as it is captured – as quickly as two minutes for mesoscale images and five minutes for full-disk images.

Future enhancements to the CSPP GeoSphere site include adding GOES-17 imagery and improving coverage of the Western U.S. and Pacific Ocean. These cloud-oriented techniques will inform the approach to algorithm development, data processing and product distribution in the GeoXO era that will usher in greater and more usable information to address Earth's environmental challenges.

Weather Camp inspires next generation of scientists

Developing a weather camp for high school students during a pandemic calls for creativity. Previous in-person field trips, including visits to a National Weather Service field office and a local TV station, had to be canceled, and a new virtual approach was needed. This brings advantages by helping to expand the reach of the program, making it accessible to more students across the U.S.

In June 2021, 42 high school students from more than 30 states, including Alaska and Puerto Rico, attended a one-week online Weather Camp hosted by the University of Wisconsin–Madison Cooperative Institute for Meteorological Satellite Studies. The agenda included an introduction to meteorology and remote sensing, as well as topics such as climate change, winter storms and tropical cyclones. By the end of the week students were ready for a forecast challenge and gave presentations to share what they had learned.

Each day also featured a "Weather Jobs Guest Speaker," providing a glimpse of what students might expect of a career in the atmospheric sciences. Some day one of them may be an undergraduate or graduate student at the UW–Madison or land a job at CIMSS. They would not be the first camp alumni to do so. And with our continued successful outreach, they won't be the last.

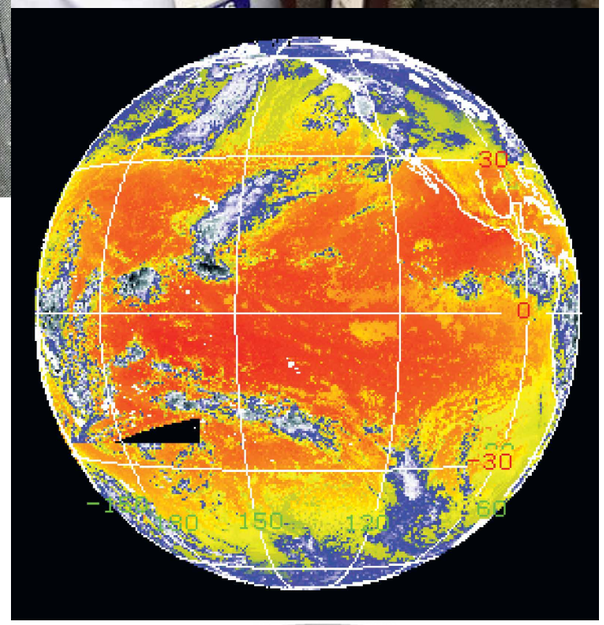
A commitment to student scholars

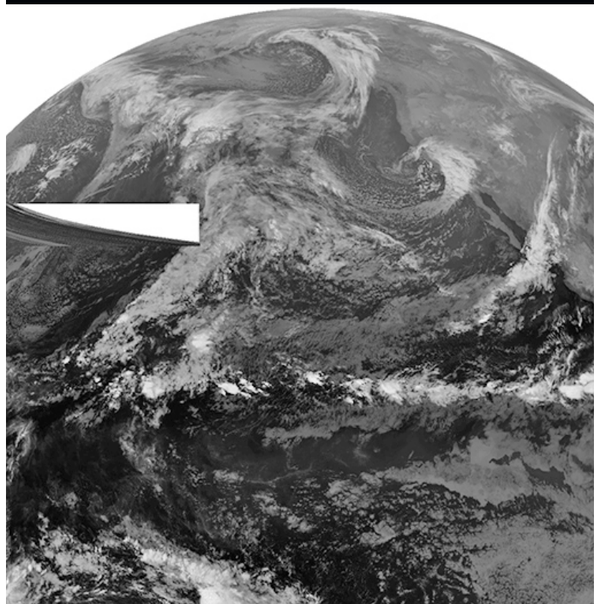
Three exemplary high school seniors were awarded the UW–Madison Cooperative Institute for Meteorological Satellite Studies Verner E. Suomi Scholarship for the 2021-2022 academic year.

They are: Emily Sautebin from Marshfield, Wisconsin, Hollyn Gaffner from Aledo, Texas, and Ikhbayar Khurelbaatar from Ulaanbaatar, Mongolia. While their hometowns may be scattered around the globe, all three students are freshmen at the University of Wisconsin–Madison and united in their pursuit to study environmental sciences.

The scholarship is named after the "father of satellite meteorology," Professor Verner Suomi, who was passionate about teaching undergraduate students. Scholarship recipients demonstrate outstanding performance in the physical sciences through school and extracurricular achievements.

"Like Suomi, Emily, Hollyn and Ikhbayar share a passion for the earth sciences and solving real problems that face our planet," says Tristan L'Ecuyer, director of CIMSS and chair of the Suomi Scholarship Committee. "They embrace the convictions of the next generation of change-makers to not only understand the physical environment but to use this knowledge to improve quality of life for all including those most vulnerable to the effects of a changing climate."





Solving real world problems through mentorship

Experiential learning opportunities in science are crucial for graduate students as they gain expertise in their fields.

To support this approach to learning, the NOAA Experiential Research and Training Opportunities internship provides funding for research fellows to work alongside a NOAA scientist. Graduate students gain hands-on experience designing and completing a research project that fits within NOAA's mission.

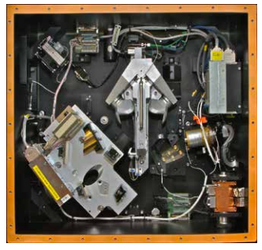
In 2021, Ronald Adomako, a master's student from City College of New York in the Center for Earth System Sciences and Remote Sensing Technologies, completed a 12-week internship with NOAA scientist Tim Schmit, who is based at the University of Wisconsin–Madison Cooperative Institute for Meteorological Satellite Studies.

Adomako's project involved automating the identification of "shark fins," so called because of their shape, in GOES-16 and -17 Advanced Baseline Imager data using machine learning. Shark fins are errors that emerge due to a processing anomaly. Adomako's tool will eventually be able detect these artifacts without human intervention and help fix the anomalies.

Adomako and Schmit intend to publish about their collaboration. Schmit is also encouraging Adomako to teach other CIMSS researchers about the benefits of the shark fin detection tool so that they can adapt the technique to identify and predict other types of artifacts in satellite data.

SSEC2022

New pathways to innovation



The goal of SSEC2022 is to stimulate transformative and innovative research and applications at SSEC that are consistent with the center's mission and the Wisconsin Idea to promote knowledge beyond the university.

This third and final year of seed funding, provided by SSEC, is opening new pathways to collaborative research, establishing strategic partnerships and improving infrastructure. Projects selected for funding in 2021-2022 are listed below.

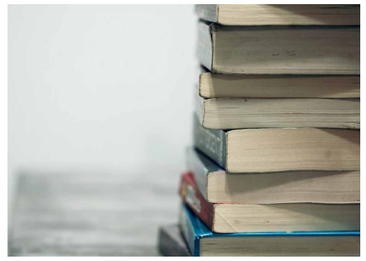
2021 projects	Principal investigator
Continuation of extending CAMEL emissivity database to far IR with ground-based ARI measurements	Eva Borbas
Development of a Low Cost Rubidium HSRL Suitable for Network Deployment	Ed Eloranta
SSEC Support of NOAA Next Generation IR Sounder Activities Prior to Phase-A Start-up	Bob Knuteson
CSPP Geo Cloud Demonstration and GeoSphere Website	Graeme Martin
Development of A Satellite All-Sky Correlated Observation Error Model for Data Assimilation	Jason Otkin
Augmenting Microphysical Remote Sensing Mixed-phase Capabilities for Precipitation Process Studies	Claire Pettersen
Satellite Data Services (SDS) LEO Satellite Data Repository (funded by FFS)	Jerry Robaidek
Continuing Python ADDE Server Development and Investigating Additional Python Interfaces to McIDAS	Becky Schaffer
Observation System Experiments Supporting Satellite Instrument and Development and Sounding Applications of the Data	Bill Smith Sr.
Hardware Testbed for the Next-generation Hyperspectral Infrared Imaging Sounder	Joe Taylor
A Synoptically-aware Bayesian Precipitation Retrieval Framework Incorporating VIIRS/ABI Cloud Information	Norm Wood

2020 projects	Principal investigator
Development of a Global Water Quality Portal Using the SSEC RealEarth™ Framework	Sam Batzli
Extending CAMEL Emissivity database to far IR with ground-based Absolute Radiance Interferometer measurements	Eva Borbas
An Exploratory Study of Stratiform Mixed-Phase Clouds using Multi- Sensor/Multi-Spectral Satellite Measurements	Tom Greenwald
Low Latency Reception, Processing, and Applications for Cross-track Infrared Sounder	Liam Gumley
Support NOAA BAA Study Awarded to GeoMetWatch, as a Teaming Partner, to Study Pricing Options for a GeoMetWatch Commercial Sounder	Liam Gumley
Summer internships and academic year student programmer pool	Denny Hackel
Satellite Detection of Sea Ice Leads Using Machine Learning	Jay Hoffman

Cloud-clearing for GEO-XO hyperspectral IR sounder cloudy radiances with collocated imager data using machine learning	Jinlong Li
A machine learning based quality control method for Advanced Baseline Imager water vapor band radiance assimilation	Zhenglong Li
Implementation of the convective scale Unified Model over CONUS at SSEC and the assimilation of GOES-16 ABI observations	Agnes Lim
Developing Convolutional Neural Network Methodologies for Denoising VIIRS Day-Night-Band and Cloud Layer Detection of GEO Imager Observations	Willem J. Marais
Leveraging the High Temporal Resolution of the Advanced Baseline Imager to Improve Daily Evapotranspiration Estimates over US	Jason Otkin
Digitizing the Applications Technology Satellite image collection	Jean Phillips
Satellite Data Services Satellite Data Archive Expansion (Part II)	Jerrold Robaidek
Observation System Experiments Supporting Future Satellite Sounding Instrument Development	Bill Smith Sr.
Enhancing capabilities to retrieve H2S distributions on Uranus and Neptune	Larry Sromovsky
International MODIS/AIRS Processing Package	Kathleen Strabala
Support of NOAA BAA Studies for Next Generation LEO and GEO IR Sounders	Joe Taylor
Optimizing ABI Clear Sky Radiance Assimilation in Regional NWP for Local Severe Storm Forecast	Pei Wang
Expanding GPU-enabled computing at SSEC	Anthony Wimmers

Publications

2021



Baines, K. H., and Coauthors, 2021: Investigation of Venus cloud aerosol and gas composition including potential biogenic materials via an aerosol-sampling instrument package. Astrobiology, 21.

Bendorf, J., S. Hubbard, C. J. Kucharik, and A. VanLoocke, 2021: Rapid changes in agricultural land use and hydrology in the Driftless Region. Agrosystems, Geosciences, & Environment, 4.

Boeckmann, G. V., C. J. Gibson, T. W. Kuhl, E. Moravec, J. A. Johnson, Z. Meulemans, and K. Slawny, 2021: Adaptation of the Winkie Drill for subglacial bedrock sampling. Annals of Glaciology, 62, 109-117.

Borbas, E., E. Weisz, C. Moeller, W. P. Menzel, and B. A. Baum, 2021: Improvement in tropospheric moisture retrievals from VIIRS through the use of infrared absorption bands constructed from VIIRS and CrIS data fusion. Atmospheric Measurement Techniques, 14, 1191–1203.

Borbas, E. E. and P. W. Menzel, 2021: Observed HIRS and Aqua MODIS thermal infrared moisture determinations in the 2000s. Remote Sensing, 13, 502.

Butterworth, B. J., and Coauthors, 2021: Connecting land-atmosphere interactions to surface heterogeneity in CHEESEHEAD19. Bulletin of the American Meteorological Society, 102, E421-E445.

Chen, R. and R. Bennartz, 2021: Rainfall algorithms using oceanic satellite observations from MWHS-2. Advances in Atmospheric Sciences, 38, 1367–1378.

Chen, W., and Coauthors, 2021: Land surface temperature from GOES-East and GOES-West. Journal of Atmospheric and Oceanic Technology, 38, 843-858.

Christian, J. L., J. B. Basara, E. D. Hunt, J. A. Otkin, J. C. Furtado, V. Mishra, X. Xiao, and R. M. Randall, 2021: Global distribution, trends, and drivers of flash drought occurrence. Nature Communications, 12, 6330.

Doak, A. G., and Coauthors, 2021: Characterization of ground-based atmospheric pollution and meteorology sampling stations during the Lake Michigan Ozone Study 2017. Journal of the Air & Waste Management Association, 71, 866-889.

Douglas, A. and T. L'Ecuyer, 2021: Global evidence of aerosol-induced invigoration in marine cumulus clouds. Atmospheric Chemistry and Physics, 21, 15103-15114

Dworak, R., Y. Liu, J. Key, and W. N. Meier, 2021: Blended Sea Ice Concentration product from AMSR2 and VIIRS. Remote Sensing, 13, 2982.

Dzambo, A. M., and Coauthors, 2021: Joint cloud water path and rainwater path retrievals from airborne ORACLES observations. Atmospheric Chemistry and Physics, 21, 5513-5532.

Gao, L., L. Chen, J. Li, C. Li, and L. Zhu, 2021: An improved dark target method for aerosol optical depth

67
grad and undergrad degrees awarded (since 2015)

retrieval over China from Himawari-8. Atmospheric Research, 250,105399.

Ghiz, M. L., R. C. Scott, A. M. Vogelmann, J. T. M. Lenaerts, M. Lazzara, and D. Lubin, 2021: Energetics of surface melt in West Antarctica. Cryosphere, 15, 3459-3494.

Gibson, C., G. Boeckmann, Z. Meulemans, T. Kuhl, J. Koehler, J. Johnson, and K. Slawny, 2021: RAM-2 Drill system development: an upgrade of the Rapid Air Movement Drill. Annals of Glaciology, 62, 99-108.

Griffin, S. M., J. A. Otkin, S. E. Nebuda, T. L. Jensen, P. S. Skinner, E. Gilleland, T. A. Supinie, and M. Xue, 2021: Evaluating the impact of planetary boundary layer, land surface model, and microphysics parameterization schemes on cold cloud objects in simulated GOES-16 brightness temperatures. Journal of Geophysical Research-Atmospheres, 126.

Henderson, D. S., J. A. Otkin, and J. R. Mecikalski, 2021: Evaluating convective initiation in high-resolution numerical weather prediction models using GOES-16 infrared brightness temperatures. Monthly Weather Review, 149, 1153-1172.

Hunt, E., and Coauthors: 2021: Agricultural and food security impacts from the 2010 Russia flash drought. Weather and Climate Extremes, 34.

Hyman, D. M. R., M. J. Pavolonis, and J. Sieglaff, 2021: A novel approach to estimating time-averaged volcanic SO2 fluxes from infrared satellite measurements. Remote Sensing, 13, 966.

Johnson, J. A., T. Kuhl, G. Boeckmann, C. Gibson, J. Jetson, Z. Meulemans, K. Slawny, and J. M. Souney, 2021: Drilling operations for the South Pole Ice Core (SPICEcore) project. Annals of Glaciology, 62, 75-88.

Khan, A. M., and Coauthors, 2021: Reviews and syntheses: Ongoing and emerging opportunities to improve environmental science using observations from the Advanced Baseline Imager on the Geostationary Operational Environmental Satellites. Biogeosciences, 18, 4117-4141.

Kuhl, T., C. Gibson, J. Johnson, G. Boeckmann, E. Moravec, and K. Slawny, 2021: Agile Sub-Ice Geological (ASIG) Drill development and Pirrit Hills field project. Annals of Glaciology, 62, 53-66.

Kulie, M. S., and Coauthors, 2021: Snowfall in the northern Great Lakes: lessons learned from a multisensor observatory. Bulletin of the American Meteorological Society, 102, E1317-E1339.

L'Ecuyer, T. S. and Coauthors, 2021: The polar radiant energy in the Far InfraRed Experiment: a new perspective on polar longwave energy exchanges. Bulletin of the American Meteorological Society, 102, E1431-E1449.

Lewis, W. E., T. L. Olander, C. S. Velden, C. Rozoff, and S. Alessandrini, 2021: Analog ensemble methods for improving satellite-based intensity estimates of tropical cyclones. Atmosphere, 12, 830.

Li, J., A. J. Geer, K. Okamoto, J. A. Otkin, Z. Liu, W. Han, and P. Wang, 2021: Satellite all-sky infrared radiance assimilation: recent progress and future perspectives. Advances in Atmospheric Sciences, Early access.

Li, X., and Coauthors, 2021: Tropical teleconnection impacts on Antarctic climate changes. Nature Reviews Earth & Environment, 2, 680–698.

Li, Z., T. J. Schmit, J. Li, M. M. Gunshor, and F. W. Nagle, 2021: Understanding the imaging capability of tundra orbits compared to other orbits. IEEE Transactions on Geoscience and Remote Sensing, 59, 8944-8956.

Limaye, S. S., and Coauthors, 2021: Venus, an astrobiology target. Astrobiology 21.

Loveless, M., E. E. Borbas, R. Knuteson, K. Cawse-Nicholson, G. Hulley, and S. Hook, 2021: Climatology of the Combined ASTER MODIS Emissivity over Land (CAMEL) Version 2. Remote Sensing, 13, 111.

Ma, Z., and Coauthors, 2021: Four-dimensional wind fields from geostationary Hyperspectral Infrared Sounder radiance measurements with high temporal resolution. Geophysical Research Letters, 48.

Ma, Z., Z. Li, J. Li, T. J. Schmit, L. Cucurull, R. Atlas, and B. Sun, 2021: Enhance low level temperature and moisture profiles through combining NUCAPS, ABI observations, and RTMA analysis. Earth and Space Science, 8.

Marcio Rocha, F., and Coauthors, 2021: WMO evaluation of two extreme high temperatures occurring in February 2020 for the Antarctic Peninsula Region. Bulletin of the American Meteorological Society, 102, E2053–E2061.

Mateling, M. E., C. Pettersen, M. S. Kulie, K. S. Mattingly, S. A. Henderson, and T. S. L'Ecuyer, 2021: The influence of atmospheric rivers on cold-season precipitation in the Upper Great Lakes region. Journal of Geophysical Research-Atmospheres, 126.

Milani, L., and Coauthors, 2021: Extreme lake-effect snow from a GPM microwave imager perspective: observational analysis and precipitation retrieval evaluation. Journal of Atmospheric and Oceanic Technology, 38, 293-311.

Milani, L. and N. B. Wood, 2021: Biases in CloudSat falling snow estimates resulting from daylight-only operations. Remote Sensing, 13, 2041.

Miller, S. D., S. H. D. Haddock, W. C. Straka III, C. J. Seaman, C. L. Combs, M. Wang, W. Shi, and S. Nam, 2021: Honing in on bioluminescent milky seas from space. Scientific Reports, 11, 15443.

Milojevic, T., A. H. Treiman, and S. Limaye, 2021: Phosphorus in the clouds of Venus: potential for bioavailability. Astrobiology, 21.

Mogul, R., S. S. Limaye, Y. J. Lee, and M. Pasillas, 2021: Potential for phototrophy in Venus' clouds. Astrobiology, 21.

Mogul, R., S. S. Limaye, M. J. Way, and J. A. Cordova, 2021: Venus' mass spectra

187
peer-reviewed publications 2020–2021

show signs of disequilibria in the middle clouds. Geophysical Research Letters, 48.

Nguyen, H., M. C. Wheeler, H. H. Hendon, E.-P. Lim, and J. A. Otkin, 2021: The 2019 flash droughts in subtropical eastern Australia and their association with large-scale climate drivers. Weather and Climate Extremes, 32.

Olander, T., A. Wimmers, C. Velden, and J. P. Kossin: 2021: Investigation of machine learning using satellite-based advanced Dvorak technique analysis parameters to estimate tropical cyclone intensity. Weather and Forecasting, 36, 2161-2186.

O'Neill, M. E., L. Orf, G. M. Heymsfield, and K. Halbert, 2021: Hydraulic jump dynamics above supercell thunderstorms. Science, 373.

Orf, L., 2021: Modeling the world's most violent thunderstorms. Computing in Science and Engineering, 23, 14-24.

Otkin, J. A., R. W. E. Potthast, and A. S. Lawless, 2021: Nonlinear conditional model bias estimation for data assimilation. Siam Journal on Applied Dynamical Systems, 20, 299-332.

Otkin, J. A., and Coauthors, 2021: Development of a flash drought intensity index. Atmosphere, 12, 741.

Pan, S., J. Gao, T. A. Jones, Y. Wang, and J. Li, 2021: The Impact of Assimilating Satellite-Derived Layered Precipitable Water, Cloud Water Path, and Radar Data on Short-Range Thunderstorm Forecasts. Monthly Weather Review, 149, 1359–1380.

Pettersen, C., and Coauthors, 2021: The precipitation imaging package: phase partitioning capabilities. Remote Sensing, 13, 2183.

Platnick, S., and Coauthors, 2021: The NASA MODIS-VIIRS continuity cloud optical properties products. Remote Sensing, 13, 2.

Proud, S. R. and S. Bachmeier, 2021: Record-low cloud temperatures associated with a tropical deep convective event. Geophysical Research Letters, 48.

Robinson, M. A., and Coauthors, 2021: Variability and time of day dependence of ozone photochemistry in western wildfire plumes. Environmental Science & Technology, 55, 10280-10290.

Ryglicki, D. R., C. S. Velden, P. D. Reasor, D. Hodyss, and J. D. Doyle, 2021: Observations of atypical rapid intensification characteristics in Hurricane Dorian (2019). Monthly Weather Review, 149, 2131-2150.

Shates, J. A., C. Pettersen, T. S. L'Ecuyer, S. J. Cooper, M. S. Kulie, and N. B. Wood, 2021: High-latitude precipitation: snowfall regimes at two distinct sites in Scandinavia. Journal of Applied Meteorology and Climatology, 60, 1127-1148.

Sledd, A. and T. L'Ecuyer, 2021: Uncertainty in forced and natural Arctic solar absorption variations in CMIP6 models. Journal of Climate, 34, 931-948.

Smith, W. L., H. Revercomb, E. Weisz, D. Tobin, R. Knuteson, J. Taylor, and W. P. Menzel, 2021: Hyperspectral satellite radiance atmospheric profile information content and its dependence on spectrometer technology. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 14, 4720-4736.

Sromovsky, L. A., K. H. Baines, and P. M. Fry, 2021: Evolution of Saturn's north polar color and cloud structure between 2012 and 2017 inferred from Cassini VIMS and ISS observations. Icarus, 362, 114409.

Stevens, B., and Coauthors, 2021: EUREC(4)A. Earth System Science Data, 13, 4067-4119.

Straka, W., S. Kondragunta, Z. Wei, H. Zhang, S. D. Miller, and A. Watts, 2021: Examining the economic and environmental impacts of COVID-19 using Earth observation data. Remote Sensing, 13, 5.

Thompson, G., J. Berner, M. Frediani, J. A. Otkin, and S. M. Griffin, 2021: A stochastic parameter perturbation method to represent uncertainty in a microphysics scheme. Monthly Weather Review, 149, 1481-1497.

Turk, F. J., and Coauthors, 2021: Applications of a CloudSat-TRMM and CloudSat-GPM satellite coincidence dataset. Remote Sensing, 13, 2264.

Wagner, T. J. and R. A. Petersen, 2021: On the performance of airborne meteorological observations against other in situ measurements. Journal of Atmospheric and Oceanic Technology, 38, 1217-1230.

Wang, P., Z. Li, J. Li, and T. J. Schmit, 2021: Added-value of GEO-hyperspectral infrared radiances for local severe storm forecasts using the hybrid OSSE method. Advances in Atmospheric Physics, 38, 1315–1333.

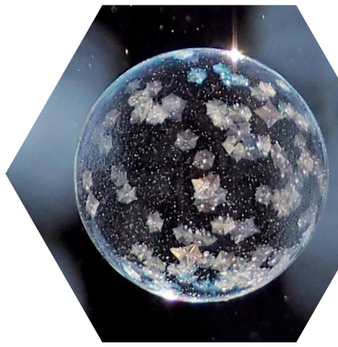
White, C. H., A. K. Heidinger, and S. A. Ackerman, 2021: Evaluation of Visible Infrared Imaging Radiometer Suite (VIIRS) neural network cloud detection against current operational cloud masks. Atmospheric Measurement Techniques, 14, 3371-3394.

Williams, S. S., T. J. Wagner, and R. A. Petersen, 2021: Examining the compatibility of aircraft moisture observations and operational radiosondes. Journal of Atmospheric and Oceanic Technology, 38, 859-872.

Wood, N. B. and T. S. L'Ecuyer, 2021: What millimeter-wavelength radar reflectivity reveals about snowfall: an information-centric analysis. Atmospheric Measurement Techniques, 14, 869-888.

Ye, X., and Coauthors, 2021: Evaluation and intercomparison of wildfire smoke forecasts from multiple modeling systems for the 2019 Williams Flats fire. Atmospheric Chemistry and Physics, 21, 14427-14469.

Zhao, D., L. Zhu, H. Sun, J. Li, and W. Wang, 2021: Fengyun-3D/MERSI-II Cloud Thermodynamic Phase Determination Using a Machine-Learning Approach. Remote Sensing, 13, 2251.



196
Research projects managed in 2021

14.0k
social media followers

See all publications: go.wisc.edu/lx74ac

Partners and Collaborators

SSEC has built key research and education partnerships with federal agencies as well as departments and centers across the University of Wisconsin–Madison campus and beyond. With our partners we are working towards understanding Earth-atmosphere processes to improve society's resilience to hazardous weather and climate events.

Federal Partners

National Aeronautics and Space Administration (NASA)
- Earth Science
- Planetary Science

Department of Commerce

National Oceanic and Atmospheric Administration (NOAA)
- National Environmental Satellite, Data, and Information Service (NESDIS)
- Center for Satellite Applications and Research (STAR)
- Advanced Satellite Products Branch (ASPB)
- NOAA Cooperative Institutes

National Science Foundation (NSF)
- Office of Polar Programs

Department of Energy (DOE)
- Office of Science
- Atmospheric Radiation Measurement (ARM) user facility

Department of Defense (DOD)
- Office of Naval Research
- Air Force

University of Wisconsin-Madison Campus Partners

College of Letters and Science (L&S)
Department of Atmospheric and Oceanic Sciences
Department of Astronomy
Department of Chemistry
Department of Geoscience
Center for Limnology
American Family Insurance Data Science Institute
Nelson Institute for Environmental Studies
Center for Climatic Research (CCR)
Center for Sustainability and the Global Environment (SAGE)
Aquatic Sciences Center
Energy Analysis and Policy
Office of the Vice Chancellor for Research and Graduate Education (OVCRGE)
Physical Sciences Laboratory
College of Engineering (COE)
Department of Civil and Environmental Engineering

Leadership

R. Bradley Pierce
SSEC Director

Brad Pierce began serving as Director of SSEC at the University of Wisconsin–Madison in October 2018 following a nationwide search. His background includes more than 25 years as a scientist with the National Oceanic and Atmospheric Administration and NASA. Pierce is also a professor in the Department of Atmospheric and Oceanic Sciences (AOS).

Tristan L'Ecuyer
CIMSS Director

Appointed by the CIMSS Board of Directors, AOS Professor Tristan L'Ecuyer assumed his role in January 2019. L'Ecuyer is well situated to lead CIMSS into the future, bringing more than 20 years of experience at the "intersection of satellite remote sensing and climate science" to the position.

SSEC's leadership also includes an executive director as well as associate directors for engineering, administration and science. Their combined experience is guiding SSEC and CIMSS into the future.

Mark Mulligan
Executive Director and Associate Director of Engineering

Chelsea Dahmen
Associate Director of Administration

Wayne Feltz
Associate Director of Science

SSEC Advisory Council

The SSEC Advisory Council provides advice and guidance to SSEC leadership. Council members are elected by their peers or appointed by the SSEC director and represent a diversity of expertise from principal investigators, staff, faculty and government scientists at UW–Madison.

SSEC Advisory Council members

Leanne Avila
Senior Editor – SSEC
Elected

Larissa Back
Associate Professor – AOS Associate Chair of Graduate Studies, designee

Tim Bertram
Associate Professor – Chemistry
Appointee

Tracey Holloway
Professor – Nelson Institute
Appointee

Jim Hurley
Director – Aquatic Sciences Center
Appointee

Jeff Key
NOAA ASPB Chief
Appointee

Angie Montgomery
Research Administrator – SSEC
Elected

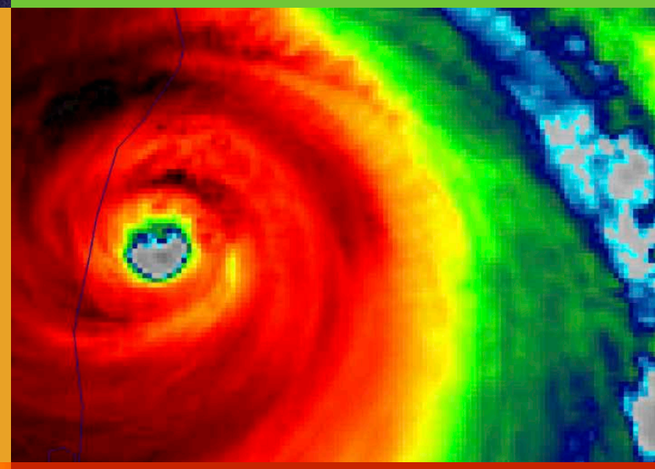
Krissy Slawny
Assoc. Instr. Innovator – SSEC
Elected (PI)

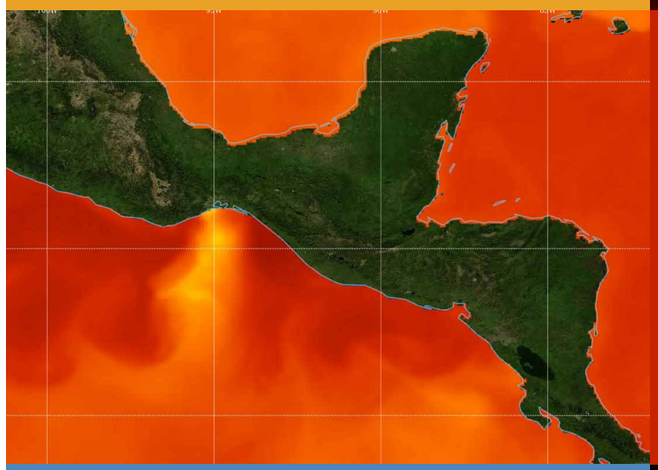
Kathy Strabala
Assistant Scientist – SSEC, Chairperson
Elected (PI)

Dave Tobin
Senior Scientist – SSEC
Elected (PI)

2.5
petabytes archived weather data

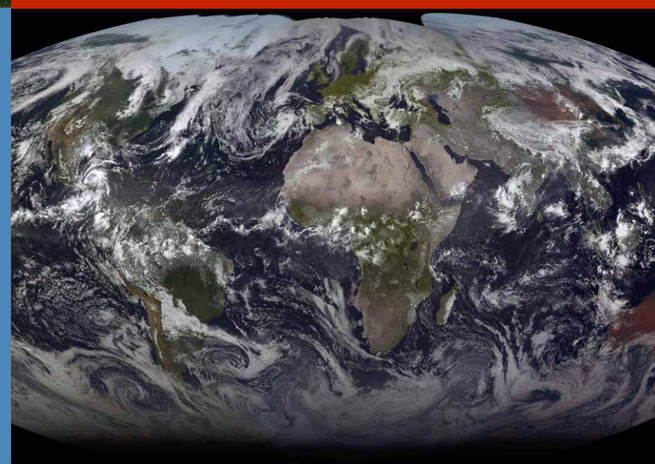
200
terabytes tropical cyclone data distributed worldwide





299
blogposts for analysis and training

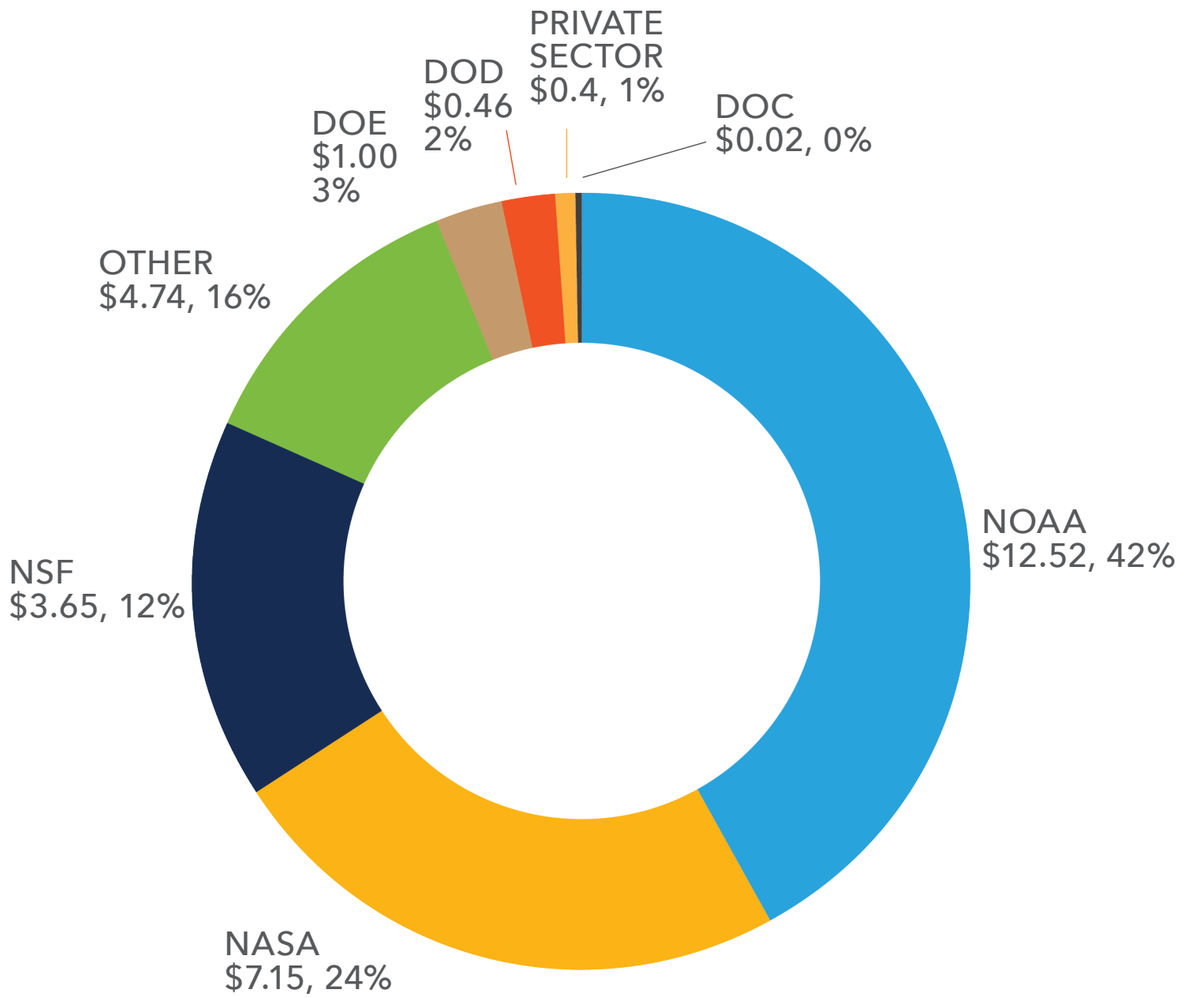
5.5
million
SSEC and CIMSS homepage visits



Spending

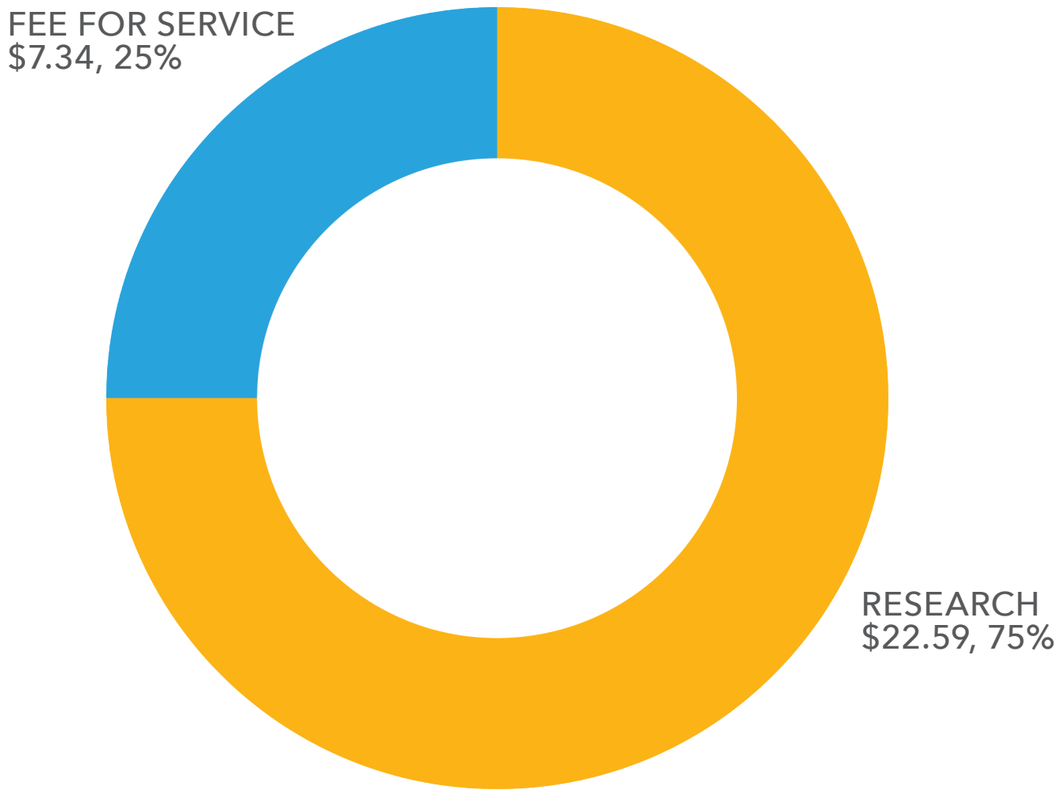
SSEC 2021
Spending by source
(in millions)

Total spending $29.9M



SSEC 2021
Research & Fee for service spending
(in millions)

Total spending $29.9M



Awards

2021

Jordan Gerth
NOAA Bronze Medal Award in Scientific or Engineering Achievement

Wei Han
International TOVS Study Conference-23 Best Oral Presentation

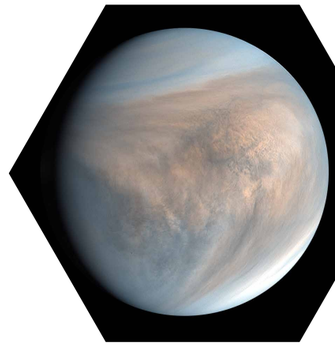
Jeff Key
NOAA Distinguished Career Award in Scientific Achievement

Tristan L'Ecuyer
Outstanding Alumni Award from the Department of Atmospheric Sciences at the Colorado State University

Scott Lindstrom
Joint Polar Satellite System Unseen Hero Award
National Environmental Satellite, Data, and Information Service Collaboration Award

David Tobin
International TOVS Study Conference-23 Best Poster Presentation

2020



Jay Hoffman
National Environmental Satellite, Data, and Information Service Outstanding Science and Research Employee

Tristan L'Ecuyer
American Geophysical Union Atmospheric Sciences Ascent Award

Jerry Robaidek
University of Wisconsin–Madison Chancellor's Award for Excellence in Research: Critical Research Support

Timothy Schmit
National Oceanic and Atmospheric Administration Administrator's Award

William Straka
Joint Polar Satellite System Innovation Award

Anthony Wimmers
National Environmental Satellite, Data, and Information Service Outstanding Science and Research Employee

Editorial team
Jean Phillips
Eric Verbeten
Leanne Avila
Callyn Bloch

Space Science and Engineering Center
Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin-Madison
1225 W. Dayton Street
Madison, WI 53706
ssec.wisc.edu

Photos

Bill Bellon, 22, 30; Gail Dengel, 19; Ed Eloranta, 21; Mathew Gunshor, 13; Jcrane, 1; Rick Kohrs, 25; Matthew Lazzara, 1, 5; David Mikolajczyk, 5; Margaret Mooney, 11; Hank Revercomb, 28; Bryce Richter, 2, 23; Tim Schmit, 13; Joe Taylor, 14; Eric Verbeten, 4, 18, 23, 25; Tim Wagner, 6; Blue Canyon Technologies, LLC, 1, 7; CIMSS, 10, 11, 13, 25; Free Vector Maps, 8; Planet-C Project Team, 29; University of Wisconsin-Madison, 24, 31

Give to SSEC

There are many ways to support SSEC and CIMSS. Gifts benefit our areas of greatest need and strengthen our areas of greatest opportunity. Targeted giving through the University of Wisconsin Foundation allows you to direct your contribution to a specific program.

To give please visit: **ssec.wisc.edu/give**

For more information on making a gift to SSEC or CIMSS, please contact:

Jean Phillips
Director of Communications
608.262.8164

Brad Pierce, Ph.D.
SSEC Director
608.890.1892