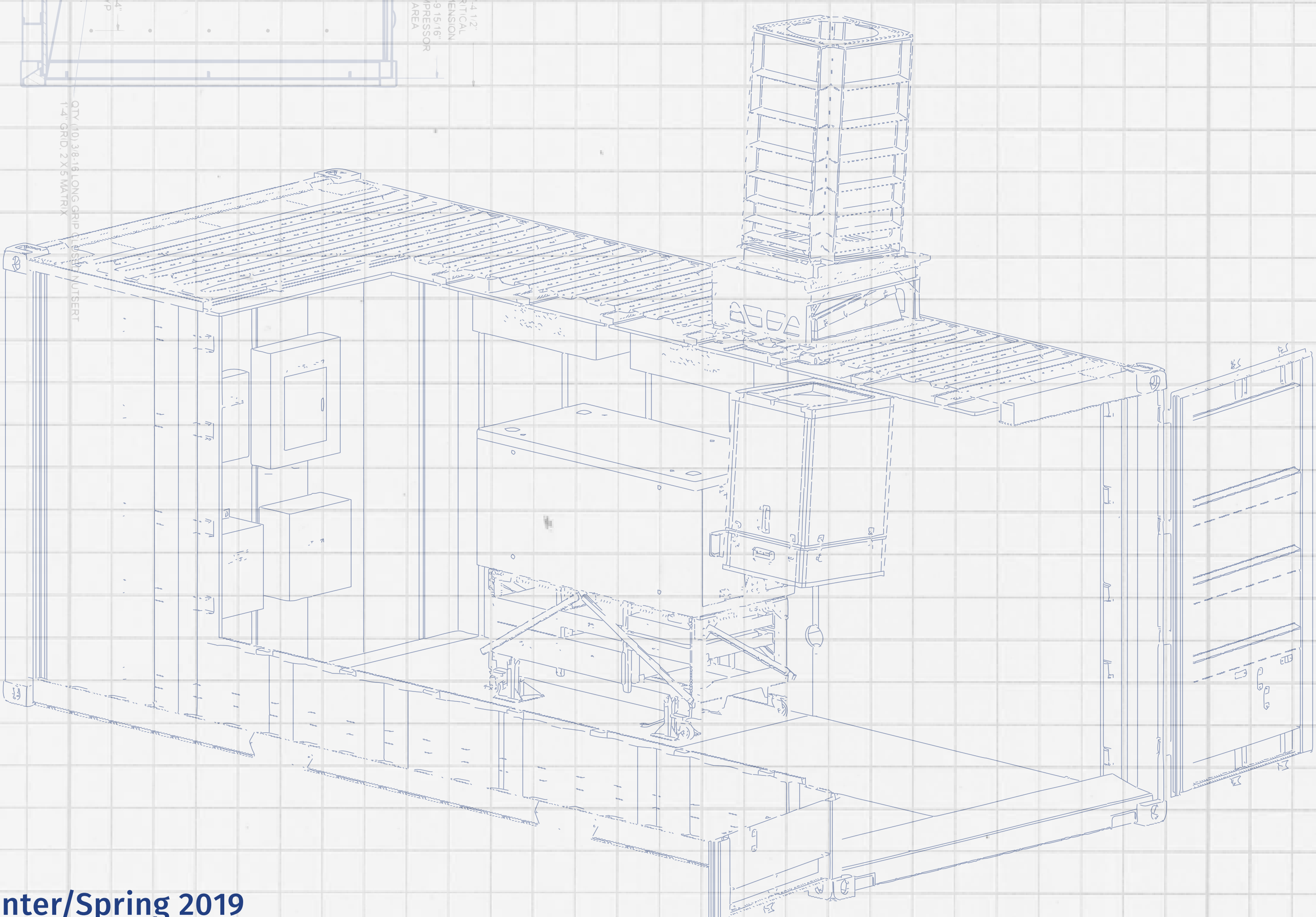
THROUGH *the* ATMOSPHERE

EYE IN THE SEA

SSEC INSTRUMENT ON SEAWARD JOURNEY



Winter/Spring 2019

Space Science and Engineering Center | Cooperative Institute for Meteorological Satellite Studies | University of Wisconsin–Madison

Director's note

This issue of *Through the Atmosphere* (TtA) highlights recent news from the Space Science and Engineering Center (SSEC) and the Cooperative Institute for Meteorological Satellite Studies (CIMSS). In the last six months we welcomed SSEC's new director, R. Bradley Pierce, listened to NOAA leadership's vision for future R&D, conducted research to mitigate the impact of droughts on farmers, voyaged the oceans to collect ground truth observations that pair with satellite measurements of clouds and aerosols and marked the history of satellite derived soundings.

On Oct. 1, Brad Pierce began serving as Director of SSEC. He is an alumnus of the UW-Madison who brings 25-plus years of experience as a scientist at the National Oceanic and Atmospheric Administration (NOAA) and NASA to his new role. Included in this issue is a conversation with Brad in which he discusses his goals for SSEC.

During his November visit to UW-Madison, Neil Jacobs, NOAA assistant secretary of commerce for environmental observation and prediction, shared his vision for increased use of cloud computing for R&D with a common interface to facilitate collaboration. Dr. Jacobs believes that cloud computing will enable testing of a "wide funnel" of ideas and approaches thus resulting in faster development of new capabilities. He further noted the importance of machine learning and automated information extraction for obtaining full value out of satellite measurements.

In support of America's Dairyland in Wisconsin and elsewhere, TtA reports on the work of CIMSS scientist Jason Otkin who has been conducting research on the effectiveness of the Evaporative Stress Index (ESI), which uses satellite thermal infrared imagery to estimate drought conditions. He has been talking with farmers on how to use the ESI, and other indicators, to help them prepare for drought.

TtA also introduces the SPARCLET, a downsized version of the SSEC Portable Atmospheric Research Center (SPARC), which carried the High Spectral Resolution Lidar (HSRL) on a research vessel in the Philippines this fall. Project manager Bob Holz led the team that adapted the HSRL to smaller quarters and sent graduate student Coda Phillips to help gather data that will improve our understanding of aerosols and how they interact with clouds to form convection.

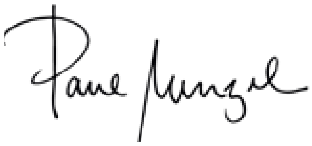
We note with pride that NOAA scientist Tim Schmit has been elected a Fellow of the American Meteorological Society. This is wonderful recognition for his tireless work to improve applications, utilization and awareness of GOES data and imagery. Tim is so pervasive in his GOES outreach that he is now known as "the GOES guy." Speaking of GOES, TtA also tracks the evolution of the sounders from leo and geo orbit, noting that the latter is still waiting for hyperspectral IR capabilities.

CIMSS is pleased to announce two new awards for 2019. The Verner E. Suomi Scholarship will be awarded to an outstanding high school senior and the William L. Smith Sr. Graduate Scholar Award to a new Ph.D. student entering the UW-Madison Department of Atmospheric and Oceanic Sciences (AOS). These awards honor the life works of Suomi and Smith, both of whom are recognized as remote sensing pioneers.

And finally, the CIMSS Board of Directors met on Dec. 5 and unanimously agreed to appoint AOS Professor Tristan L'Ecuyer (aos.wisc.edu/~tristan) as the new Director of CIMSS starting January 2019. TtA will feature him in an upcoming issue.

As these articles illustrate, SSEC and CIMSS scientists, along with their colleagues and students, continue their work to improve understanding of – and solve – our environmental challenges.

Paul Menzel
Interim CIMSS Director



THROUGH *the* ATMOSPHERE

WINTER/SPRING 2019

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Through the Atmosphere is a biannual publication featuring atmospheric, space science, and engineering research and education accomplishments of the University of Wisconsin–Madison's Space Science and Engineering Center (SSEC) and its Cooperative Institute for Meteorological Satellite Studies (CIMSS).

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SSEC Director
Brad Pierce

Interim CIMSS Director
Paul Menzel

Editorial Team
Jean Phillips
Leanne Avila
Eric Verbeten

Cover image: Blueprint drawings of the SSEC SPARCLET instrument

New SSEC Director

Brad Pierce shares his vision

by Jean Phillips

Brad Pierce began serving as Director of the Space Science and Engineering Center (SSEC) at the University of Wisconsin–Madison on Oct. 1, 2018. His background includes over 25 years as a scientist with the National Oceanic and Atmospheric Administration (NOAA) and NASA. Jean Phillips talked with him about his vision for SSEC, what he brings to the role and his ideas about how to meet current and future challenges and opportunities.

JP: What excites you about the role of director and how have you been preparing for it? What challenges do see for yourself?

BP: The most exciting aspect of this position is leading the Center at a time when we can play a key role in implementing the recommendations of the 2017 Decadal Survey for Earth Science and Applications from Space, very much in the same way we played a key role in the previous decadal survey.

This new survey is aimed at making sure there is an applications component to all of the missions right from the beginning and I think SSEC is in a strong position to bridge the gap between NASA and NOAA – that is, making sure that the NASA research capabilities developed as a result of this survey have real applications on the NOAA side. We have always had a very strong research-to-operations capability.

In terms of preparing for the role of director, I have been casually consulting with Steve Ackerman who served for two years as the interim director. Conversations with Steve and the leadership team at SSEC have helped me form a clearer picture of where we stand in terms of our transition to a new budget model within the university and any remaining issues associated with that transition.

I see this – resolving any remaining issues and reaching a balanced budget – as one of the biggest near-term challenges in my role as director.

JP: How would you characterize your leadership style?

BP: I think of myself as an open leader and one who seeks guidance from the rest of the staff. In particular, I see myself as someone who supports and facilitates the science of the center, fostering an open exchange of ideas and options. I think this is important to the health of SSEC. In fact, building interdisciplinary teams to tackle scientific problems is one of my strengths.

JP: SSEC is in the midst of organizational change. Leading SSEC might require additional change. Talk about your plan to address possible changes ahead, in terms of how you might manage competing priorities, if or how you would like to engage Center staff as a whole in this process, and how you plan to communicate along the way.

BP: I think being inclusive, especially during times of change, is critical because change can result in lots of uncertainty. Making sure that all staff – scientists and support staff – feel included in the process is going to be a very high priority for me.

The path that Steve Ackerman and the SSEC leaders charted during the last two years is the right one for SSEC. In fact, I do not plan to make any substantial changes in the next year.

That said, the new budget model is going to require a much more conservative approach to spending, and that includes our reserve funds. How to navigate and complete that transition is my first priority.

To address the gaps we have with the current budget model, I plan to announce an internal proposal competition that will provide seed money for

About Brad Pierce

- Born and raised in Minneapolis, Minnesota and attended high school in Wisconsin
- Researched laser wind measurements as a first year physics graduate student at UW–Madison
- Met with Department of Meteorology Chair John Young to ask about an atmospheric science department on campus doing LIDAR work. Young asked Pierce to define the difference between meteorology and atmospheric science, whereupon he applied to the meteorology graduate program
- Received Ph.D. in meteorology from UW-Madison in 1988 followed by a two-year postdoc with Professor Don Johnson
- Worked at NASA Langley Research Center for 17 years with Upper Atmosphere Research Satellite focusing on stratospheric chemistry and ozone depletion and Earth Observing System (EOS) program to continue to monitor climate science areas including atmospheric chemistry and aerosols
- Transferred to NOAA NESDIS in 2007 to work on the GOES-R program
- While at NASA and NOAA (stationed at SSEC), worked closely with SSEC researchers developing global numerical weather prediction models and began tackling global atmospheric chemistry problems and aerosol data assimilation in collaboration with SSEC

innovative research, demonstrations, or capabilities. The framework for this competition would be very similar to the UW2020 competition that funds research projects requiring development prior to applying for external funding.

My hope is that we can fund and develop some innovative ideas internally, putting them in a position to compete for other funds. We will need careful definition of scientific pursuits and budgets so that we can effectively manage the reserve fund.

The goal is to reduce, and eventually eliminate, our reliance on reserves through successful competition for other funds.

JP: What is your vision (or what is your big picture) for a strategic direction for SSEC and how will you advance it?

BP: My overall vision is that we develop an increased focus on numerical weather prediction and data assimilation. The atmospheric sciences – and the earth sciences in general – is moving towards integration of observations into modeling to improve decision making. SSEC has historically shown leadership in the observation side of this equation and I think we need to be building out capabilities for integration of those observations into prediction systems.

In addition, I think this is particularly important as we try to tap into funding through the Weather Research and Forecasting Innovation Act of 2017 that stresses the necessity of better observations and better modeling systems to improve, and extend, forecasts. If we are strategic in our thinking, we can be quite competitive with opportunities that emerge from The Weather Act, as well as the Decadal Survey and its emphasis on applications. We can contribute both on the observation side and on the information side well into the next decade.

We are already doing a fair amount in the area of numerical weather prediction and data assimilation, but it is not represented as an area of expertise in the Center's current organizational chart. As the nation moves more toward a community-based approach to the Next Generation Global Prediction System, we need to be poised to demonstrate our already strong capabilities.

Because of our relationship with NOAA, we have a super computer installed at SSEC. It has the capacity to assimilate the satellite measurements within new models and we need to be tapping into this as an additional selling point for our capabilities.

JP: How would you define a successful future for SSEC? How will you know you have succeeded?

BP: In the short term, I think the first step toward success will be when we have completed the transition to the new budget model and are functioning without the reliance on the reserve fund.

In the longer term, my goal is to expand SSEC's role in the research-to-operations pipeline. We are a unique research center with a long history of core funding from NOAA and NASA. In addition, our peers in the community perceive SSEC as a research-to-operations center. I think we can maintain these strengths while we explore opportunities through the Decadal Survey and other observational arenas in order to improve our predictive capabilities.

JP: What do you hope to accomplish in the first 12 months?

BP: I would like to see a 50 percent reduction in reserve spending. We have made significant changes over the last two years but this will be the first full year of the new budget model: the first year when we will see a full complement of 101 and 150 funds from the university. We still have a gap that needs to be filled, that is, we are still spending more than we are taking in, but this is where the internal proposal competition comes into play. I would like to reduce dependence on reserves by increasing our proposal success for science as well as education and outreach.

By the end of the year, I would like to have selected the first round of internal proposals, with input from the SSEC Advisory Council (SAC) on the proposal competition. They will be engaged in this process by helping to define focus areas and making the first selections of proposals to fund.

I will want to have conversations with team members of the various research groups to hear about their strengths and goals. My background as a NOAA and NASA scientist has allowed me to cultivate and maintain relationships with both organizations, relationships that will be ever more important to me as director of SSEC and to SSEC as a whole. We have an opportunity to be a partner in this new triad: NASA, NOAA, and SSEC.

▲ **SSEC's new director Brad Pierce collaborates with University of Wisconsin—Madison Atmospheric and Oceanic Sciences Professor Tracey Holloway on the NASA Health and Air Quality Applied Sciences Team (HAQAST) to use satellite data to help solve air quality and public health problems. Credit: SSEC**

So, yes. I will be knocking on people's doors and engaging with principal investigators when I see opportunities that SSEC could lead or where I think SSEC could make a strong contribution.

I also intend to have an open and ongoing dialogue about where the Center should be going as we consider NOAA, NASA and other announcements of opportunity.

In terms of industry, SSEC has had strong ties with various vendors and the private sector has always had a place in large satellite programs. In addition, the Weather Act clearly outlines a place for industry in future initiatives. As we are pursuing options with the Decadal Survey, having those industry contacts will continue to be important to us as we further develop relationships with NASA.

JP: Who are the leaders you most admire and why?

BP: I have two: Barack Obama and Kathryn Sullivan, the former administrator of NOAA. I admire each of them for the same reasons: first, they are humble leaders and second, they lead based on science. Those are two leadership qualities that I appreciate, admire and try to emulate.

JP: What do you see as the role of the SSEC Advisory Council (SAC)? How would you like to use their expertise and knowledge of the Center and its research?

BP: I agree with the charter of the SAC to be advisory to the director on how to navigate the landscape of the SSEC budget. They will also be crucial in helping to provide transparency to the director, and from the director, as we make decisions, especially throughout this transition process. They will be an important part of the SSEC management team.

Moving from the Transition Advisory Council to the SAC was a wise decision by the interim director Steve Ackerman. The Center staff had the opportunity to vote on a number of the seats on the council and the appointed members bring strong and varied backgrounds that will strengthen our ability to take advantage of opportunities across campus and beyond. I am very happy with their selection: Tracey Holloway (Nelson Institute for Environmental Studies), Tim Bertram (Chemistry Department), and Jim Hurley (Aquatic Sciences Center).

The SAC will be very engaged in the selection of internal proposals and they will be available as questions arise about the leadership of the Center.

I am honored to have the opportunity to lead SSEC in this next chapter of its history. I have a strong commitment to the continued success of SSEC as an international leader in the development and utilization of space-based Earth observations and look forward to working with everyone at SSEC as we continue to engage in research that benefits our state, the nation, and the world.

Credit: Bill Bellon

NOAA listening session

Plan to improve forecasting includes CIMSS

by Jean Phillips

Whether deciding to stock up on nonperishables or assessing energy needs ahead of a winter storm, weather is a billion-dollar industry that touches everyone — individuals and industry alike.

This is among the reasons Dr. Neil Jacobs, assistant secretary of commerce for environmental observation and prediction at the National Oceanic and Atmospheric Administration (NOAA), visited Madison for a listening session on Nov. 26, 2018. He was gathering input and laying out a vision to improve U.S. weather forecasts to better meet the needs of society.

Jacobs's visit emphasized the role of the NOAA cooperative institutes, like the University of Wisconsin–Madison Cooperative Institute for Meteorological Satellite Studies (CIMSS), in mitigating weather-related losses by increasing innovation and research opportunities.

"Severe weather impacts roughly 3 to 6 percent of GDP (gross domestic product) annually," Jacobs said at the event.

According to the NOAA National Centers for Environmental Prediction, from 1980 to October 2018, the U.S. experienced 238 events that exceeded $1.5 trillion in losses. In 2017 alone, the U.S. experienced 16 historic weather events, each exceeding $1 billion in direct losses.

"These numbers are derived from losses of insured assets," said Jacobs in a later interview, "but I have a feeling the number would be much larger if indirect impacts were factored into the equation, like delays in transportation, increased energy costs, or lost tourism revenue."

Industries, he said, are starting to incorporate forecast products into their planning. For example, stores may stock up on generators before a hurricane makes landfall, or on snow shovels ahead of a winter storm. These are the types of decisions that can improve public safety and business operations, which is why Jacobs continues to meet with private sector, industry and academic partners around the country.

Jacobs is working with each cooperative institute as their strengths dictate, but improving forecasts is the top priority, he said, and CIMSS is "at the top in this area," due to its expertise in satellite data assimilation.

For example, CIMSS scientists are incorporating satellite observations into numerical weather models to improve hurricane forecasts. Using a supercomputer housed on-site as part of a collaboration between UW–Madison and NOAA, they are also testing the forecast accuracy of a model that is a component of a new global prediction system.

The European Center for Medium-Range Weather Forecasts has developed a high preforming global model and the U.S. is striving to improve. Having university expertise working on innovative solutions to formatting satellite data and informing NOAA strategy is important.

Jacobs sees cooperative institutes like CIMSS as testbeds for this type of research and development. And CIMSS is no stranger to innovation.

In fact, the memorandum of understanding between UW–Madison and NOAA that formed CIMSS emerged out of a skunkworks type of arrangement that brought federal scientists to Madison to work alongside university researchers to experiment with and solve forecasting problems. The partnership has proven successful for nearly four decades.

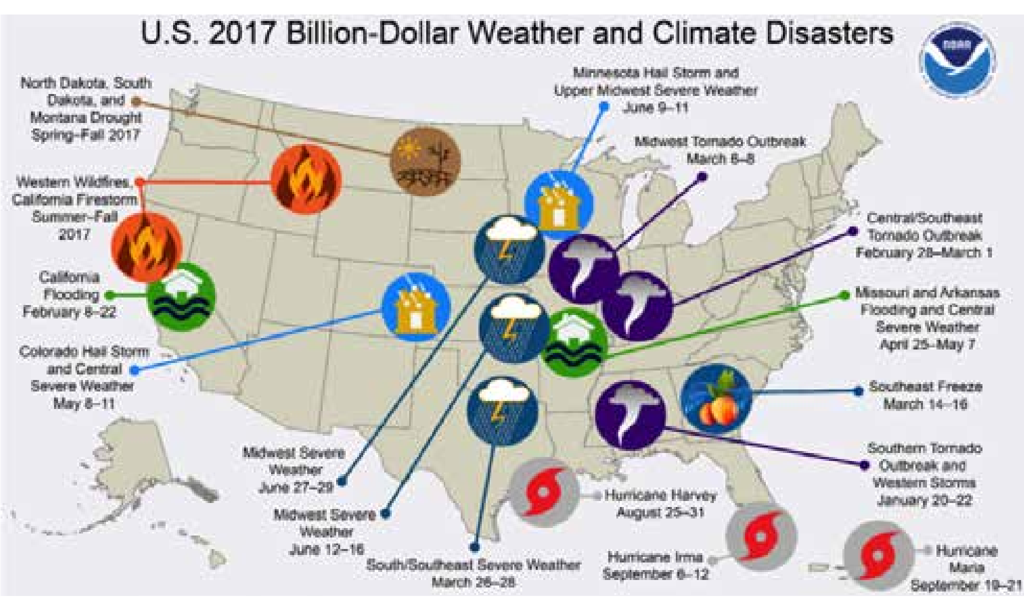
Jacobs envisions a return to this type of experimentation at the cooperative institutes and noted that other agencies, such as NASA and the Department of Defense, are already using this type of architecture to great advantage.

Jacobs noted that NOAA is also looking to improve the ways institutes cooperate with each other and with the federal government by erasing artificial barriers between them.

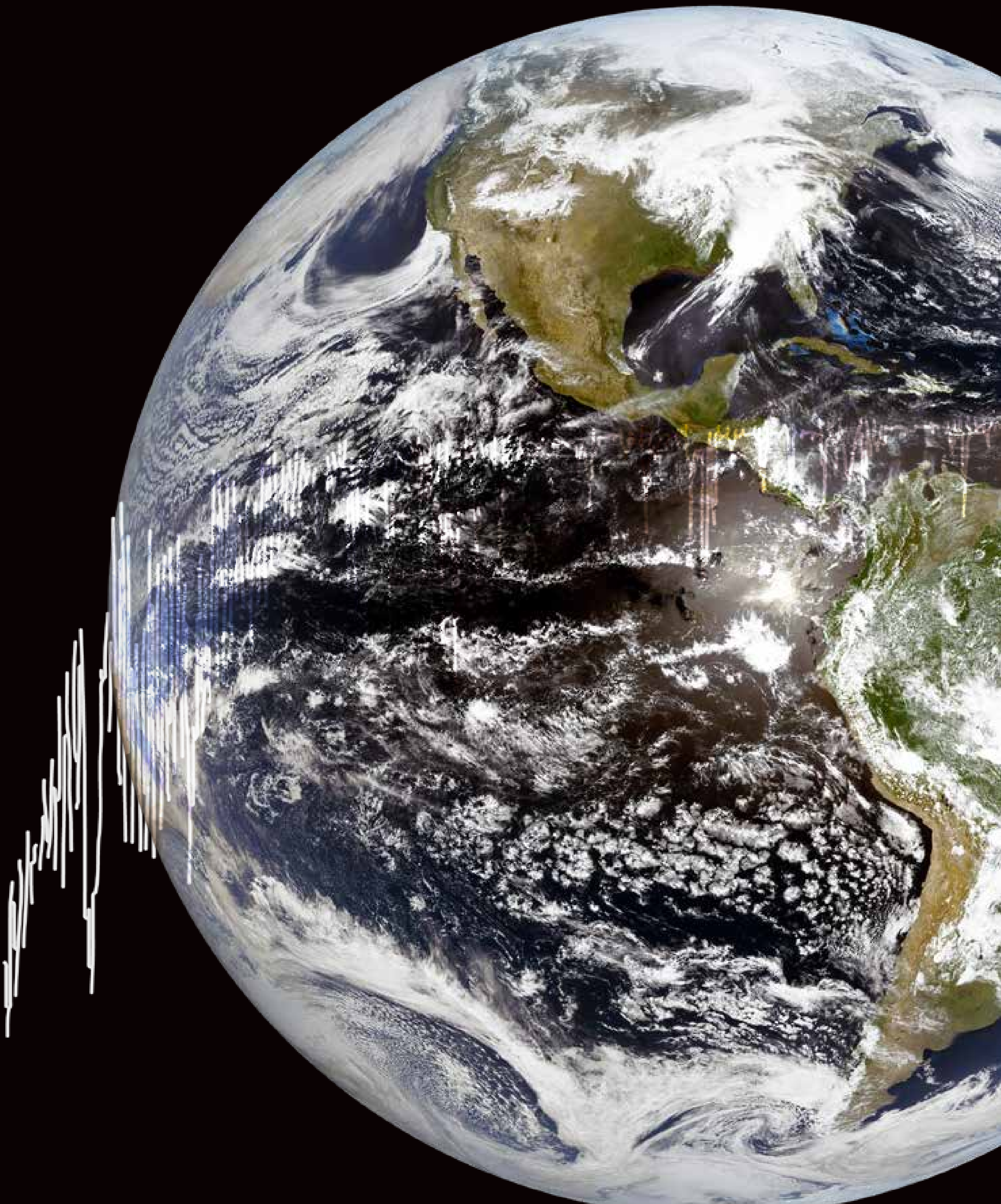
For example, a nonfederal entity like the UCAR (University Corporation for Atmospheric Research) Community Center in Boulder, Colorado could offer a cloud-based testbed where the cooperative institutes can conduct NOAA-funded research and testing.

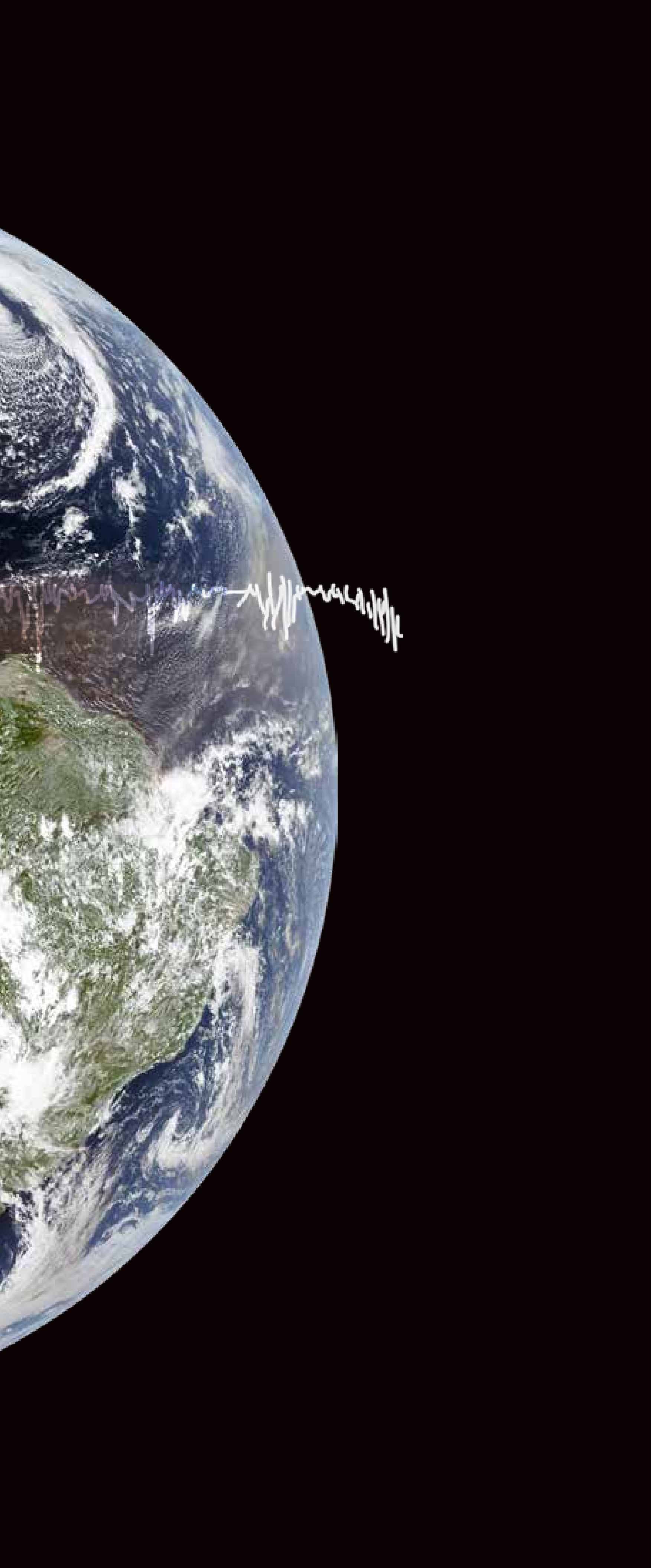
Jacobs hopes that creating a unified and transparent computing environment will help improve NOAA's approach to resource allocation and have the added benefit of bringing together researchers who may be working on similar problems.

"NOAA wants to be open to all innovation – from the cooperative institutes to industry," Jacobs said. "We do not want to restrict what may be a novel idea; if it works for our public service mission, then we will consider it."



◀ **This map depicts the general location of the 16 weather and climate disasters assessed to cause at least $1 Billion each in direct damages in 2017. Credit: NOAA.**





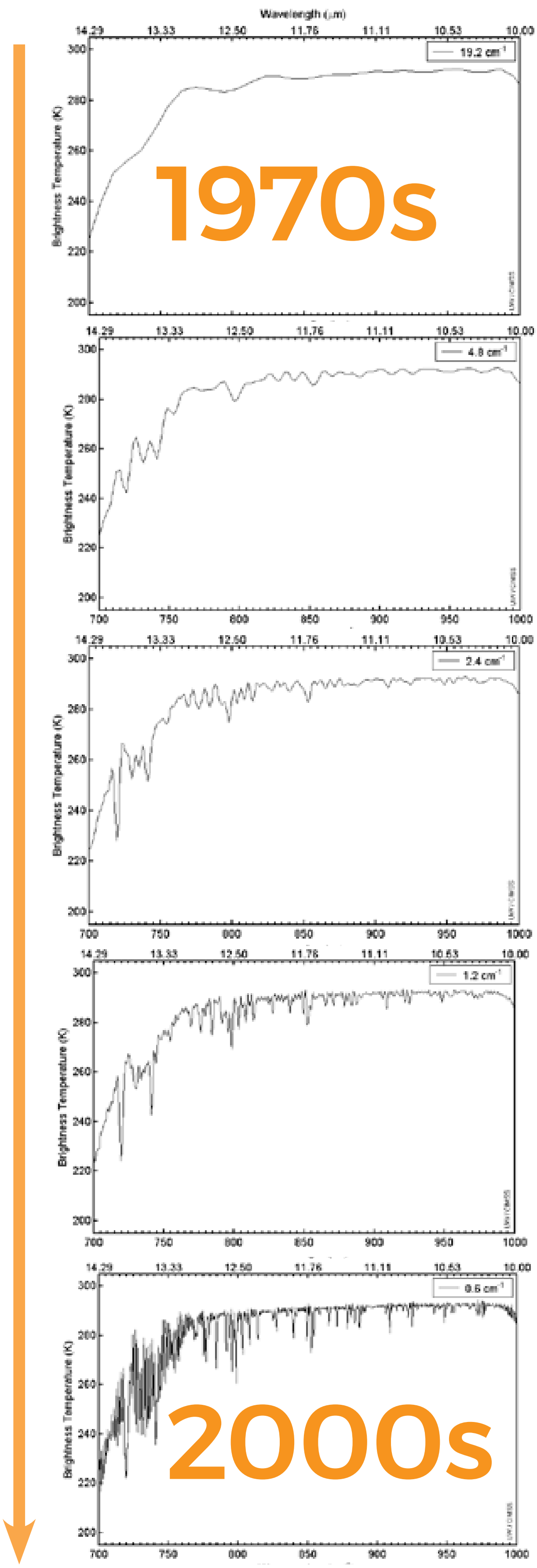
Satellite frontiers

Contributing to the next generation of geostationary sounders

by Eric Verbeten

Since the era of satellite meteorology began in the 1950s, the continued investment in remote sensing instrumentation has elevated the science and resulted in marked advancements in the understanding of the Earth's atmosphere, climate and weather. As the University of Wisconsin–Madison Space Science and Engineering Center (SSEC) looks to the future of satellite instrument development, geostationary-based hyperspectral infrared sounders represent the next frontier for improving global weather prediction and severe weather warnings.

For decades, most space-based IR sounders have been carried on polar orbiting satellites. While the current array of polar orbiting satellites provides strong global coverage, there are inherent drawbacks to the system, namely temporal coverage. A geostationary IR sounder on the other hand, excels at observing rapidly developing weather systems from a fixed location. Together, the two types of sounders can create a more accurate picture of weather system development.



A historic progression of IR sounder resolution improvements, beginning with the High Resolution Infrared Radiation Sounder (HIRS) in the mid-1970s, to the Atmospheric Infrared Sounder (AIRS) in the 2000s. Credit: Paul Menzel

But, unlike other countries, the United States has no formal plans to deploy an advanced geostationary IR sounder, says Paul Menzel, interim director of the UW–Madison Cooperative Institute for Meteorological Satellite Studies (CIMSS), housed within SSEC.

Infrared sounders (and modern hyperspectral IR sounders) play a major role in identifying the atmospheric state defined by temperature, humidity and cloud properties, he says. As a precursor to severe weather, changes in these conditions are vital to identifying atmospheric instability and improving weather forecasts.

As with any instrument array, technological diversity is key. Providing comprehensive coverage for something as large (and complex) as Earth's atmosphere cannot be achieved with any single satellite platform. Instead, a mix of sounders, imagers and other remote sensing devices are needed to provide the crucial data for severe weather prediction and global climate modeling. IR sounders complement other instruments by providing a continuous wide-angle view along with the ability to peer deep into the atmosphere – gathering data within a vertical profile.

In 2018, after conducting an Observing System Simulation Experiment, a team of CIMSS researchers, led by Dr. Jun Li, and the National Oceanic and Atmospheric Administration (NOAA) concluded that the inclusion of hyperspectral IR sounders on U.S. geostationary satellites could fill essential data gaps and lead to significant improvements in predicting local severe weather.

Looking back, SSEC's involvement with IR sounding technology can be traced to the late 1960s after the center was co-founded by Verner Suomi. He envisioned using satellites as a platform to observe Earth's weather. Quickly the utility of these space-based systems became apparent for the field of numerical weather prediction (NWP).

"The use of an infrared sounder from space got its start in 1969," says Menzel. "The development of the instruments (SIRS-A and IRIS-A) to fly aboard the Nimbus-3 satellite, which were the first IR sounders to fly in space, showed the way."

In the coming decades, major improvements would affect nearly every aspect of the IR sounding field, from improved spectral resolution, to new detection capabilities, to the analytical methods used for data assimilation in numerical models.

Among the wide-range of frequencies used to look at the Earth's weather, an IR sounder's strength comes from its multitude of spectral measurement channels to reveal a detailed vertical profile. As improvements in the detectors were realized, this would have a notable impact for the NWP community. In 1978 the launch of the polar-orbiting weather satellite TIROS-N marked a milestone with its IR sounder (HIRS-2) becoming the first to be used routinely for global NWP, transitioning the technology from an experimental era to an operational one.

"Around this time, these data were helping to create a truly connected and comprehensive view of Earth's atmosphere by measuring water vapor and temperature," says Menzel.

Until the late 1970s, IR sounders had only flown aboard polar orbiting satellites, but a growing interest expanded around the idea of fixing them to a geostationary platform. In 1980, with much of the instrument development, data analysis and processing conducted at SSEC in collaboration with NOAA and NASA, the Visible Atmospheric Sounder (VAS) aboard GOES-4 became the first experimental sounder to be used on a geostationary satellite. This initial experimental design proved successful, and later in 1994, through a separate mission, the technology became operational with the launch of GOES-7.

As a way to further improve the capabilities of IR sounders, SSEC researcher Hank Revercomb and his colleagues designed a new geostationary sounder called the High-resolution interferometer Sounder (HIS) and proof-of-concept interferometers for testing on high-altitude aircraft like the NASA ER-2, a converted former U2 spy plane. The aircraft served a new research purpose and could reach altitudes of 70,000 feet, high enough for instrument tests and satellite validation.

"From this elevation you could look down and see through almost all of Earth's atmosphere," says Revercomb. "This made for an accessible way to test IR sounding equipment without the high costs associated with satellite launches."

From these early test flights in the mid-1980s, the HIS program emerged as an innovative testbed for new IR sounder designs and techniques. One of which, would turn the sounding world upside down through a literal inversion of the instrument and using it for ground-based observations. An IR sounder's ability to peer through much of the atmosphere proved to be invaluable as a means to collect information about the boundary layer and higher altitudes. Since the early 1990s, SSEC's Atmospheric Emitted Radiance Interferometer (AERI) program has expanded to be part of a world-wide network of atmospheric monitoring stations.

SSEC continued to support the development and testing of IR sounders for other space-based missions included the Atmospheric Infrared Sounder (AIRS) aboard the Earth Observing System (EOS) Aqua satellite, the Infrared Atmospheric Sounder Interferometer (IASI) on the European Space Agency's MetOp, and most recently the Cross-track Infrared Sounder (CrIS) in orbit on two US polar satellites, Suomi NPP and NOAA-20.

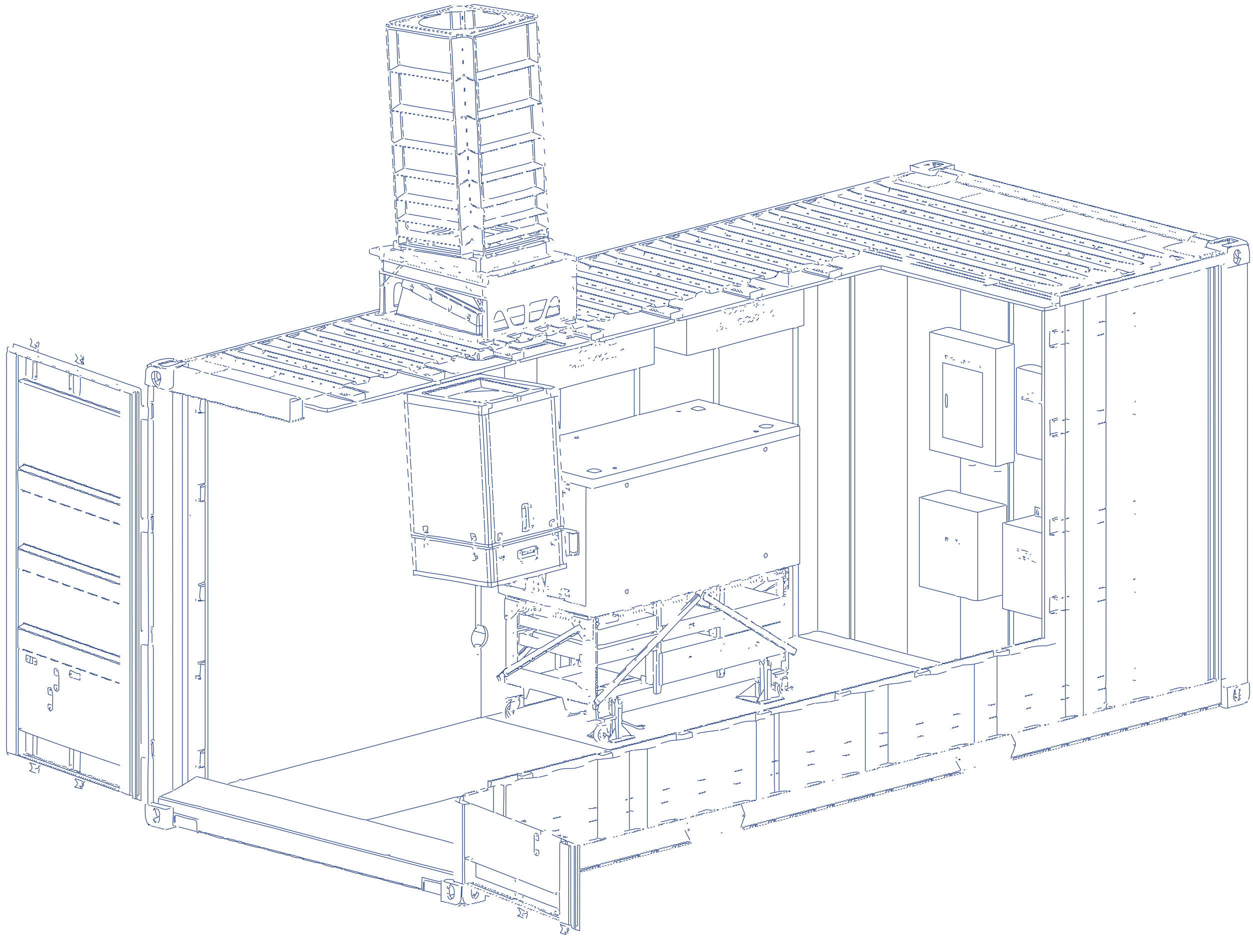
The first high spectral resolution geostationary IR sounder to go up, the Chinese Geostationary Interferometric Infrared Sounder (GIIRS), was launched on the FY-4 satellite in 2017. Future missions include the European Meteosat Third Generation satellite with its Infrared Sounder (IRS), scheduled to launch in 2022.

In addition, the World Meteorological Organization outlines in its "Vision for a Global Observation System in 2025," the need for at least six geostationary satellites equipped with advanced infrared sounding capabilities.

SSEC researchers and engineers are continuing to build better and more sensitive sensors with improved accuracy and spectral and spatial properties. As the evolution of sounding devices proceeds, Menzel and Revercomb remain hopeful that the US will launch its own geo-sounder, joining the international effort and improving NWP forecasting.

"We have come a long way to understand the improvements offered by IR soundings with spectral, spatial, and temporal sampling in balance," says Menzel. "It remains to realize these improvements in geostationary orbit."

Reference: Menzel, W.P., T.J. Schmit, P. Zhang, and J. Li, 2018: Satellite-Based Atmospheric Infrared Sounder Development and Applications. *Bull. Amer. Meteor.* Soc., 99, 583–603, https://doi.org/10.1175/BAMS-D-16-0293.1



EYE IN THE SEA

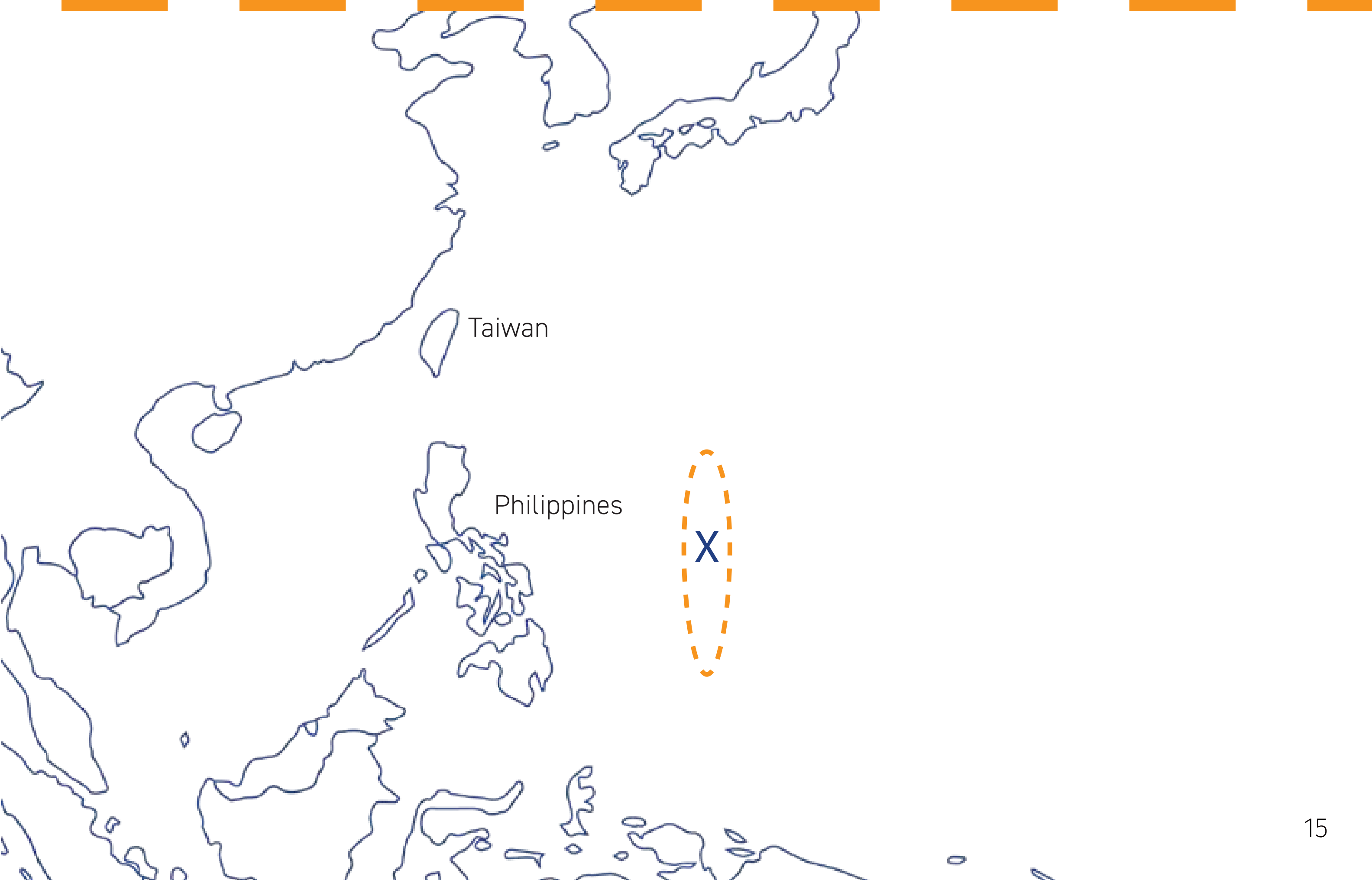
SSEC INSTRUMENT ON A SEAWARD JOURNEY

by Eric Verbeten

From a shipping port in Taiwan, the research vessel Thomas G. Thompson set out on a two-month voyage to study air/sea interactions and their impacts on the Southeast Asian monsoon season. Aboard the vessel, a crew of international collaborators used a robust set of instrumentation to capture everything from oceanographic measurements to detailed atmospheric observations.

The study, called the Propagation of Intra-seasonal Tropical Oscillations (PISTON), was designed to better understand the turbulent conditions over the Philippine Sea and to improve regional forecasts by learning more about aerosols (like pollution) and how they interact with clouds to form convection.


Credit: University of Washington School of Oceanography



The SSEC SPARCLET is a modified "seatainer," seen here when it was deployed during the PISTON field campaign over the Philippine Sea. Inside, the HSRL is used to measure and resolve thin aerosols and clouds using its telescoping lidar arm (right). Credit: Igor Razenkov

"SSEC engineers and scientists contributed to the ship's instrument fleet by building a portable research lab, called the SPARCLET. Its purpose is to provide a climate controlled and hardened portable lab that can be easily shipped and deployed anywhere in the world," says Bob Holz, SSEC scientist and collaborator for the PISTON campaign.

The SPARCLET is a downsized version of the original SSEC Portable Atmospheric Research Center (SPARC), a 17-foot towable laboratory used to make land-based atmospheric field observations. The SPARC carries two primary instruments designed and built at SSEC: The High Spectral Resolution Lidar (HSRL) and the Atmospheric Emitted Radiance Interferometer (AERI). The SPARCLET is designed to also support both instruments, but for the PISTON mission, was fitted for the HSRL.

To accommodate the maritime mission, SSEC engineers built the compact structure to house the HSRL using a standard metal shipping container used to transport goods worldwide. Engineers modified the SPARCLET "seatainer" which included insulation, adding temperature control, and mounting the HSRL to withstand the 22,000-mile journey while making it readily deployable from a ship's deck.

"Modifying the seatainer to fit the HSRL for field operations presented some engineering challenges," says Holz. "We needed to mount the HSRL in the container to fit the instrument's rotating telescope, and make sure it was still structurally sound."

The HSRL was first developed at SSEC nearly fifty years ago by Ed Eloranta, a scientist at SSEC and is capable of continuously measuring and resolving

▲ **A view from the stern of the R/V Thomas G. Thompson, a research vessel that carried an international crew of scientists to study oceanographic and atmospheric variables in the Philippine Sea. Credit: Igor Razenkov**

thin aerosols and clouds. Pollution like exhaust and smoke are found in high concentrations over the Philippine Sea and can impact weather through convective processes and cloud seeding. According to Holz, collecting accurate aerosol data is crucial to understanding the atmospheric conditions in the region. Eloranta's lidar system is one of the only lidars in the world with the required measurement sensitivity and capable of deploying on a ship.

The experiment ran from mid-August to mid-October 2018 and was designed to observe conditions during the boreal summer intraseasonal oscillation, a seasonal variation in the Earth's atmosphere that impacts different regions around the world. The topic of aerosols is of interest to researchers due to elevated levels of pollution coming from mainland areas like the Philippines.

As the crew collected data over the course of several hundred nautical miles, twice they were rerouted when tropical cyclones passed through their area of operation. Despite the disruption, however, the passing typhoons presented an opportunity to collect more data.

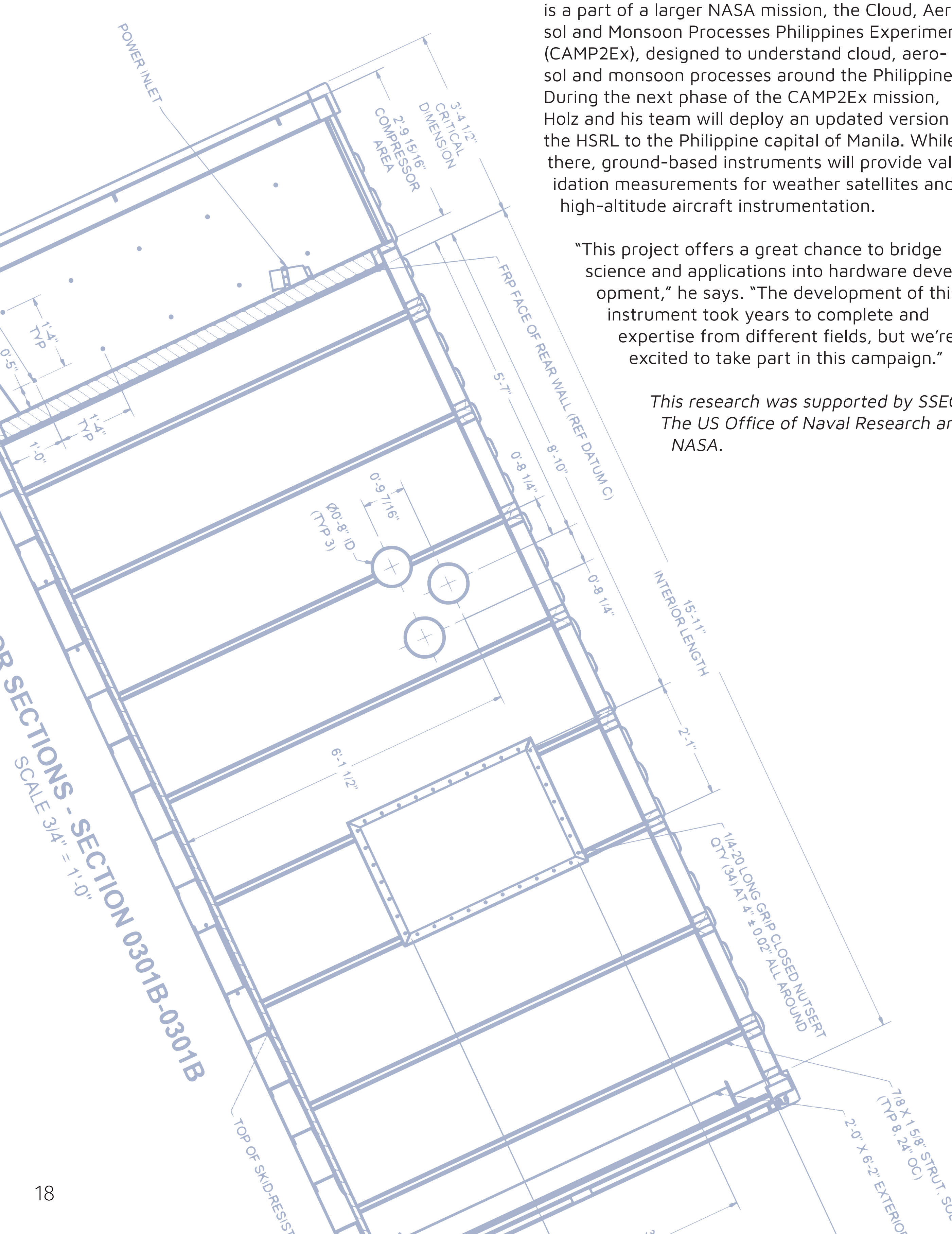
"The resulting ocean churning from the storm gave us a chance to observe the air and sea conditions in its wake," says Coda Phillips, a University of Wisconsin–Madison graduate student in the Department of Atmospheric and Oceanic Sciences.

Phillips was part of the deck crew for one month of the journey and operated the HSRL for daily measurements, as well as collecting particle samples. He says like many field campaigns, the conditions they observed were not as extreme or dynamic as they can be in the region, but the experiment was able to capture good observations of a suppressed phase in the inter-seasonal oscillation.

Following the end of the PISTON field campaign in October 2018, the SPARCLET began its journey back to Madison, Wisconsin with the data now being analyzed by Holz and his team. The PISTON project is a part of a larger NASA mission, the Cloud, Aerosol and Monsoon Processes Philippines Experiment (CAMP2Ex), designed to understand cloud, aerosol and monsoon processes around the Philippines. During the next phase of the CAMP2Ex mission, Holz and his team will deploy an updated version of the HSRL to the Philippine capital of Manila. While there, ground-based instruments will provide validation measurements for weather satellites and high-altitude aircraft instrumentation.

"This project offers a great chance to bridge science and applications into hardware development," he says. "The development of this instrument took years to complete and expertise from different fields, but we're excited to take part in this campaign."

This research was supported by SSEC, The US Office of Naval Research and NASA.



HSRL

High Spectral Resolution Lidar

More than 50 years of R&D at SSEC

SSEC LIDAR research and development goes back more than five decades to 1968 when the Italian physicist Giorgio Fiocco published a study demonstrating a technique to separate aerosol scattering from molecular scattering using lasers. This work laid the foundation for future LIDAR projects involving atmospheric aerosol detection, eventually leading to the development of SSEC's High Spectral Resolution LIDAR.

SSEC Senior Scientist Ed Eloranta has been working with the HSRL since the beginning and has helped shape each new generation. He says the program's formative years began in the 1970s and ran through the 1980s after his team was awarded several NASA grants to design HSRL technology for use on aircraft and during space missions.

The HSRL uses a high-powered green laser and an iodine absorption system to detect the backscatter from particles in the beam's path. The instrument can detect these particles throughout a large vertical profile, extending from the boundary layer to the upper atmosphere, nearly 30 kilometers high, with a resolution of 7.5 meters.

Beyond aerosol detection, Eloranta says that the HSRL also provides detailed information on cloud properties, cloud climatology, as well as uses for satellite validation. HSRL systems have been deployed around the world for various field campaigns, including in Antarctica, Alaska, the Great Plains and the Philippines.

Credit: John Lalande

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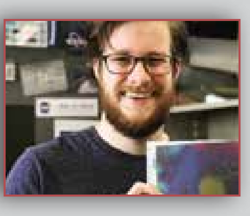
See all publications: go.wisc.edu/Lx74ac

AWARDS



KELTON HALBERT
Best Student Poster, AMS Conference on Severe Local Storms

BOB HOLZ
Permanent Principal Investigator, UW–Madison

JUN LI
Permanent Principal Investigator, UW-Madison

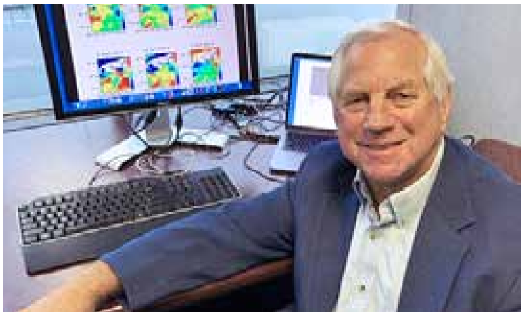
VERNER E. SUOMI SCHOLARSHIP

The Verner E. Suomi Scholarship is awarded by the University of Wisconsin–Madison Cooperative Institute for Meteorological Satellite Studies (CIMSS) to an outstanding high school senior who plans to attend a University of Wisconsin System school.

The $2000 scholarship honors Professor Suomi's lifelong commitment to undergraduate education, teaching undergraduate students throughout his tenure at UW-Madison. Suomi is widely known as the "father of satellite meteorology" for his transformational contributions to the field and is considered to be one of the most influential meteorologists of the 20th century.

The scholarship recipient must be interested in pursuing studies in meteorology, earth science, oceanography, physics, astronomy, science or math education or another physical science program.

For more information:
cimss.ssec.wisc.edu/education/Suomi_Scholarship/suomi_award.html



WILLIAM L. SMITH SR. GRADUATE SCHOLAR AWARD

The University of Wisconsin–Madison Cooperative Institute for Meteorological Satellite Studies (CIMSS) and the Department of Atmospheric and Oceanic Sciences (AOS) invite applications for the William L. Smith Sr. Graduate Scholar award available to a Ph.D. student entering the program in 2019.

The award honors the life works of Dr. Smith, an AOS graduate and emeritus professor, who developed and advanced the remote sounding capabilities of the global satellite observing system and their utilization over the past forty years.

The recipient will conduct research with a CIMSS investigator on problems related to the weather and climate prediction mission of the National Oceanic and Atmospheric Administration in areas such as radiation and remote sensing, cloud and atmospheric physics, oceanography, climate processes and climate change, synoptic and mesoscale meteorology, large scale dynamics, or data assimilation.

For more information:
cimss.ssec.wisc.edu/smith-award

CHRISTOPHER VELDEN
American Meteorological Society Banner I. Miller Award

ALLEN HUANG
Chair, Asia-Oceania Meteorological Satellite Users Conference

TIM SCHMIT
Fellow of the American Meteorological Society


Credit: Bill Bellon

When the rains stop

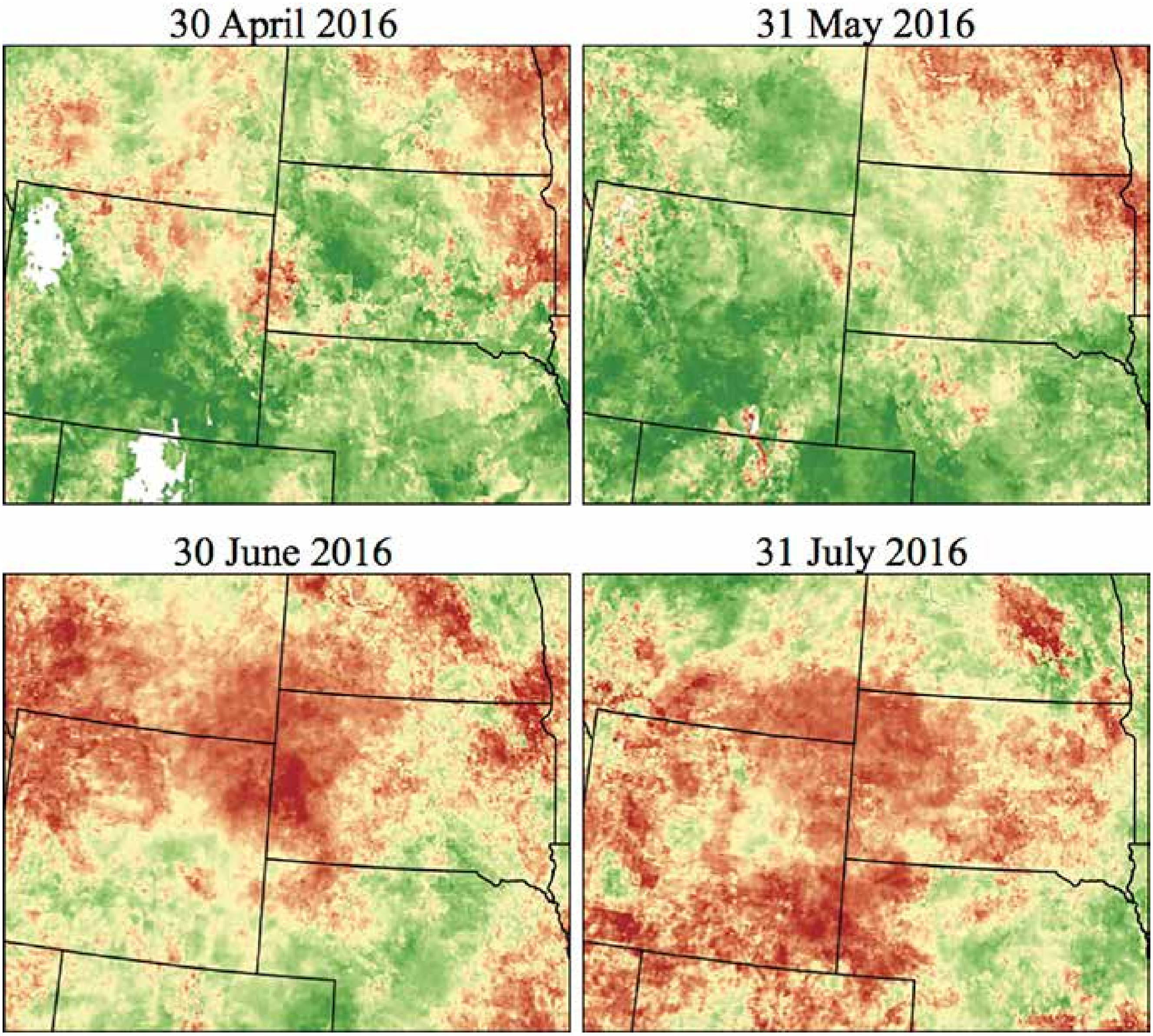
Flash drought research assists farmers and ranchers

by Leanne Avila

Droughts exact a significant toll on agriculture and the people who make it their livelihood. Crops can be damaged or even wiped out, the lack of rain can transform land into such poor condition that it cannot be used for planting or grazing livestock, and workers can lose their jobs – costing billions of dollars over the course of a year. Managing a farm or ranch through droughts requires additional planning and even a little luck in the form of unexpected but welcome rain.

Unfortunately, rapidly developing droughts take away time and opportunities for farmers and ranchers to make adjustments. So scientists have been working on developing tools and methods to provide them with information about conditions and trends to help mitigate the impact. The new twist is that scientists are going out into the field to discuss this work with farmers and ranchers, who then share their personal experiences with drought, including how and when they need to make decisions. The end result is that farmers and ranchers gain a better understanding of what is possible with the available data and scientists learn what information is vital to them.

For Jason Otkin, a researcher with the Cooperative Institute for Meteorological Satellite Studies (CIMSS), the effort began in early 2012 with a collaboration led by Martha Anderson of the U.S. Department of Agriculture (USDA) to investigate improved detection of rapidly developing droughts, known as flash droughts.



▲ Maps showing the Evaporative Stress Index at monthly intervals from the end of April until the end of July 2016. Red colors denote drier than normal conditions, whereas green colors indicate more favorable conditions. Credit: Jason Otkin

"Flash drought are droughts that develop very rapidly over the course of a few weeks to a few months," explains Otkin.

The timing of the collaboration would prove to be auspicious.

"That happened to be the same year that we had the 2012 drought across the central U.S., which was a classic flash drought," says Otkin.

Otkin and his colleagues are using satellite data to study flash drought conditions. Anderson and Chris Hain, a scientist from NASA, developed the Evaporative Stress Index (ESI) which uses satellite thermal infrared imagery from satellites such as GOES, MODIS, VIIRS, and SEVIRI to compare the "amount of moisture given off by vegetation and the land surface" – known as evapotranspiration – to the potential for evapotranspiration, using such factors as temperature, wind and dewpoint. Then they can compare that information with what they would expect for a particular area based on its climatology.

Using the ESI, Otkin has been investigating not only how to best detect flash droughts, but also to understand when and where they tend to occur most frequently.

More recently, Otkin has begun spending time away from the office meeting with ranchers and farmers in North and South Dakota as part of a collaboration with colleagues at the University of

Nebraska-Lincoln and the National Drought Mitigation Center.

One key component of their interactions is finding out how realistic and accurate the ESI tool is based on what the farmers and ranchers remember regarding actual conditions. In one case, ranchers in Rapid City, SD were able to help verify ESI maps that showed significant differences in conditions just miles apart – the luck of one small strip of land receiving rainfall that surrounding areas had missed.

While the verification is anecdotal, "their information is a very important source of ground truth," notes Otkin.

As another way to test their research results, the researchers gave a survey to farmers and ranchers who experienced a flash drought in western South Dakota, Wyoming, Nebraska and Montana in 2016. Questions focused on their recollections of when conditions began to decline, from plant health to soil moisture to water levels.

"We tried to use that like a crowd-sourced means of getting qualitative information to then verify these datasets… if you can use them in aggregate, they become very useful. You can start to see patterns, spatial patterns, temporal patterns," says Otkin.

Just as important has been learning from farmers and ranchers about how and when, and in what formats, information about drought conditions is most useful and relevant to them. As Otkin explained, it is a matter of perspective. Out of necessity, farmers and ranchers start making decisions during the winter, long before any of the drought prediction tools would be available. So the goal becomes looking at what decisions scientists can help inform during the growing season, giving farmers and ranchers the edge they need to survive the drought, let alone thrive.

Improving the resolution of the ESI product would help provide that edge with greater detail. The current resolution of the ESI is 4km, but a special version of it has 30m resolution that provides detailed information over a single field.

Otkin will also meet with specialty crop growers in Wisconsin, Iowa, and Missouri for the first time in early 2019 in a project led by Tonya Haigh from the University of Nebraska-Lincoln. Noting that specialty crop growers often get overlooked in drought discussions because of their smaller size, Otkin is

▲ **CIMSS researcher Jason Otkin has been working with farmers and ranchers to verify and improve the accuracy of flash drought prediction methods. Credit: SSEC**

eager to include them in his work. He'll share with them the current version of the 30m resolution ESI product to see how it might meet their particular needs.

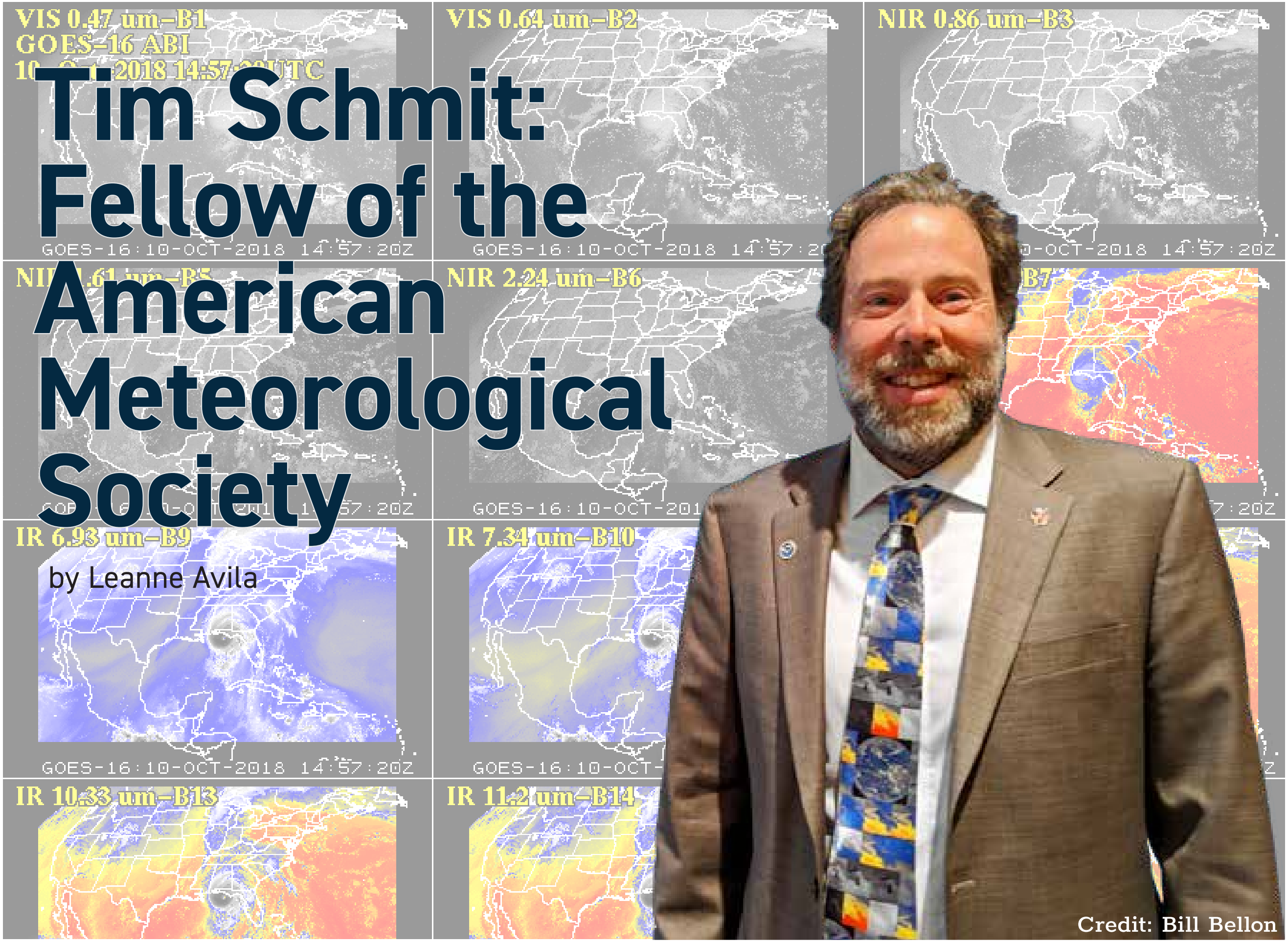
Through these efforts Otkin and his colleagues have begun developing long-term relationships that they hope will allow them to trade information to improve the drought products and improve outcomes for those who make their living in agriculture. Having grown up on a farm in Minnesota, Otkin remembers the complicated process and nature of managing crops and livestock, and he also understands that gaining the trust of farmers and ranchers takes time. His personal connection, enthusiasm and dedication to the work are clearly evident as he discusses his research and that of his colleagues.

"I've always liked the long game… droughts take a long time [compared to a tornado or other weather events]. So as [those conditions] slowly accumulate, one day at a time, it becomes very interesting."

This work was funded by the NOAA Climate Program Office Sectoral Applications Research Program (SARP).

Tim Schmit: Fellow of the American Meteorological Society

by Leanne Avila



Credit: Bill Bellon

As the saying goes, "it's an honor to be nominated." But it can also be rather humbling to receive an award because colleagues feel that you "have made outstanding contributions to the atmospheric or related oceanic or hydrologic sciences or their applications during a substantial period of years."

Tim Schmit, a National Oceanic and Atmospheric Administration (NOAA) scientist stationed at the Cooperative Institute for Meteorological Satellite Studies (CIMSS), has been elected as a Fellow of the American Meteorological Society (AMS) for 2019. He is one of 27 new Fellows to be honored at the 99th AMS Annual Meeting in Phoenix, Arizona.

Schmit has been making contributions to the atmospheric sciences since he began working for CIMSS in 1987. In 1996 he was hired by NOAA – keeping CIMSS as his duty station – for his growing expertise in the Geostationary Operational Environmental Satellite (GOES) program. Support letters for Schmit's AMS Fellow nomination note his instrumental role in the success of GOES, with the lead nominator Jeff Hawkins (retired, formerly with the Naval Research Laboratory, Marine Meteorology Division) lauding his wide-ranging knowledge and the general recognition of Schmit as the GOES expert within the community. Similarly, Dr. Steven Goodman (GOES-R Senior Program Scientist Emeritus and Fellow of the AMS) describes Schmit as "a leader in defining and executing the [GOES] mission requirements."

In recent years, Schmit has focused his efforts on the Advanced Baseline Imager (ABI) flying on the newest generation of GOES satellites. His involvement began long before launch, starting with advice on the spectral channels to be included on ABI, and continues post-launch. Goodman writes, "Tim has spent his career ensuring the quality of the visible and infrared imagery produced from GOES data, so that forecasters can accurately analyze and display the imagery and derived products."

Schmit has also made service to the AMS community a priority, whether serving on committees, taking on the role of a BAMS editor, or teaching AMS short courses. In fact, Schmit will be presenting on the ABI at a short course titled "GOES-R Series: Forecasting Applications" at the upcoming AMS Meeting.

Schmit's commitment to the community, writes Hawkins, "directly reflect[s] his passion to share his knowledge and skill with others in the profession."

Aurora over the US and Canada captured by the VIIRS nighttime sensor on polar-orbiting satellite Suomi-NPP
Credit: CIMSS

Credit: Pixabay

SatCam–The next generation

by Jean Phillips

First there was SatCam. Now there is VIIRS-Aurora-SatCam, a citizen science project at the Cooperative Institute for Meteorological Satellite Studies (CIMSS) that pairs the public's fascination with the Aurora Borealis and the scientific need to validate satellite imagery from polar-orbiting satellites, NOAA-20 and Suomi NPP.

How does it work? The original SatCam app, developed at SSEC for the iPhone, was programmed to know when one of the satellites would pass overhead. Once the satellite was in range, the app alerted users to snap a picture of the sky above them and a second one of the horizon to capture a view of the geography.

"The new VIIRS-Aurora-SatCam will operate in a similar way," says Margaret Mooney, co-investigator on the project and Director of Education and Public Outreach at CIMSS. "But instead of taking pictures of the sky during the day, citizen scientists will take pictures of the Aurora Borealis in the northern latitudes at night."

Over the last few years, SatCam users have been helping scientists validate and categorize what the satellite "sees," particularly when it comes to discerning cloud cover from snow cover.

Once again, SSEC is calling on the public to acquire ground-truth pictures of the Northern Lights that are coordinated with satellite overpasses so that scientists can compare the VIIRS satellite data to them.

The Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band is a nighttime sensor onboard NOAA-20 and Suomi NPP. It was designed to sense low-light emissions and display them as grayscale images.

Data collection was scheduled to coincide with the Aurora Summit, an annual conference for Northern Lights enthusiasts in the mid-latitudes, but app users can submit a photo at any time. The new app, named SatCamAurora, is freely available for iOS devices from the App Store.

"By leveraging people's passion for the Aurora, this citizen science project is a great way to raise awareness of NOAA's polar orbiting missions," says Mooney.

This work was supported by SSEC.

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