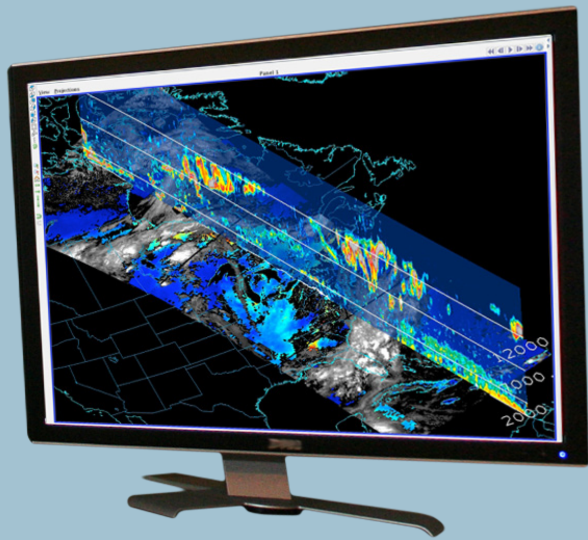
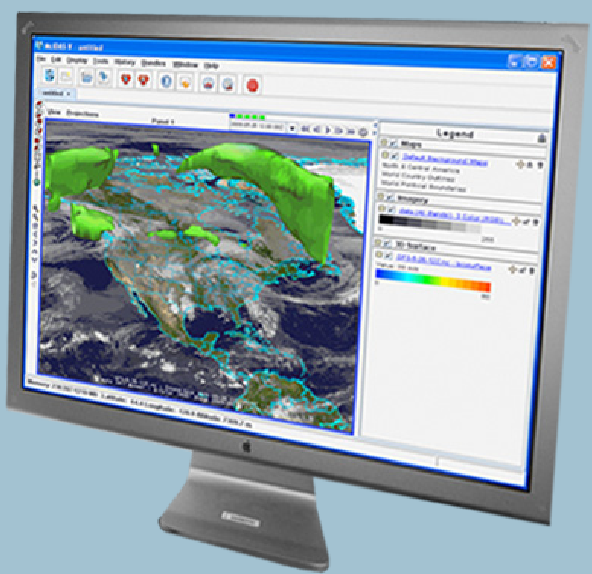
University of Wisconsin-Madison
Space Science and Engineering Center
Cooperative Institute for Meteorological Satellite Studies

Summer/Fall 2010



McIDAS-V 1.0 Released



- Java-based
- Open source
- Powerful, multi-dimensional display
- VisAD/IDV visualization capability
- Display radiance spectra, multi-band imagery, scatterplots and transects
- HYDRA integrated

Inside this issue...

and more...

Director's Note

This issue of "Through the Atmosphere" is filled with articles that celebrate some of the Space Science and Engineering Center's (SSEC) recent successes. After months of intensive efforts, McIDAS-V Version 1.0 has been released. The McIDAS visualization tool has long been used by scientists here at SSEC and throughout the world. This new version brings McIDAS software into the 5-D visualization system needed for the next generation of weather analysis.

Congratulations also go out to Scott Bachmeier for being recognized by NOAA in October as the NESDIS Team Member of the Month. An interview with him covers his education work through the GOES Gallery, SHyMet, VISIT, and the Cooperative Institute for Meteorological Satellite Studies (CIMSS) Satellite Blog, which are wonderful examples of how to effectively use e-learning tools to teach complex topics associated with satellite meteorology.

In addition to these web-based tools for explaining satellite observations, CIMSS researchers work directly with National Weather Service (NWS) forecasters to better understand their needs and discover how satellite observations might help. An article in this publication describes collaborations with NWS offices in Sullivan, WI, and Norman, OK.

Activities throughout SSEC also address public outreach and K-12 teacher training. An overview of the Climate Literacy Program provides just one example of these education and outreach activities.

Climate science is more than just an outreach topic at SSEC. Two articles look at how SSEC scientists are learning about the Earth's climate system, one through assisting the analysis of air bubbles suspended in ice and the other ice particles suspended in air – each working at opposite ends of the world.

Beyond our scientific expertise, the first SSEC photo competition demonstrates that there are many of us with an artistic eye. Congratulations to all who submitted images. You can see these excellent photographs via the link in the article or posted outside the Schwerdtfeger Library at SSEC.

Finally, congratulations also go out to everyone for successfully completing, and winning, the re-competition for CIMSS.

Steve Ackerman
Director, CIMSS

Through the Atmosphere

Fall 2010

University of Wisconsin-Madison
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McIDAS-V 1.0 Software Released

After more than three years in development, SSEC's latest rendition of the Man-computer Interactive Data Access System (McIDAS) has left the "beta" designation and is now an operationally supported software toolkit. This fifth generation of McIDAS is a Java-based, open-source system designed to support new environmental satellite observations, as well as the multispectral and hyperspectral researchers and algorithm developers working with them.

McIDAS-V provides powerful new data manipulation and visualization tools to work in this data rich environment. Unlike most other two-dimensional weather display tools, a new, powerful multi-dimensional display capability brings weather data into the three-dimensional world. This new data analysis and visualization system will support both researchers and operational users of the advanced measurement systems on GOES-R, JPSS, and Metop.

McIDAS had its origins in the early 1970s. The data analysis and visualization capabilities of this system were state-of-the-art for many years and continue to provide powerful tools even 35 years later. Used by many atmospheric scientists in research, operations and industry, McIDAS offers support through the McIDAS Users Group (MUG), a group with over 50 members. Keeping this legacy in mind, McIDAS-V continues to provide full support for current McIDAS users.

McIDAS-V integrates several software tools and new ideas. The foundation of McIDAS-V is the Visualization for Algorithm Development (VisAD), an open-source Java library for building interactive and collaborative data analysis and visualization tools. Developed by Bill Hibbard at SSEC in the 1990s, VisAD combines several important attributes, including the use of Java for platform independence, a powerful mathematical data model that embraces virtually any numerical data set, and a general display model that supports 2-D and 3-D displays, including multiple data views with direct manipulation.

The Integrated Data Viewer (IDV) is also an open-source, Java-based software framework developed at Unidata that builds upon the VisAD library to provide a versatile data analysis and visualization toolkit

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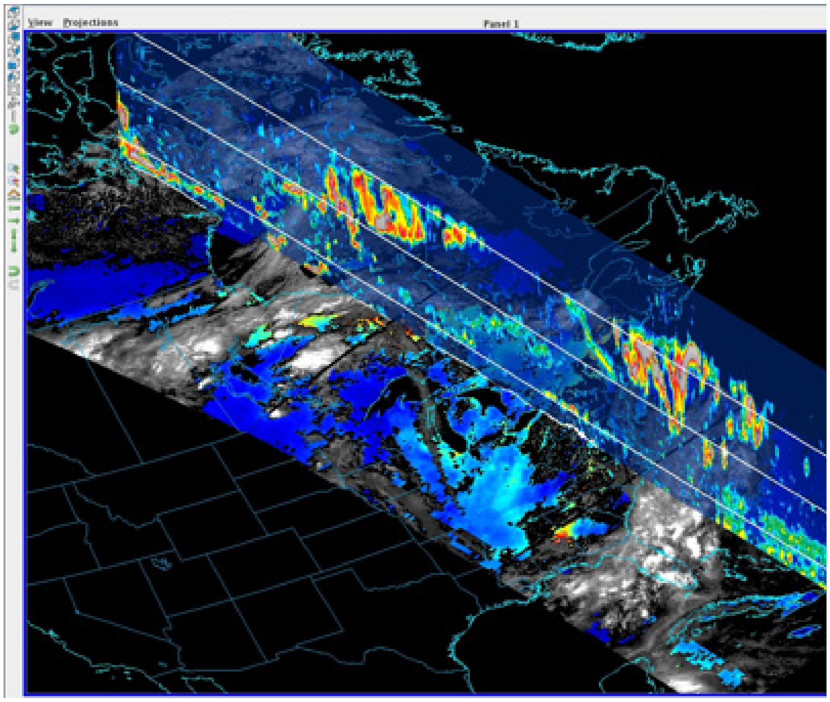
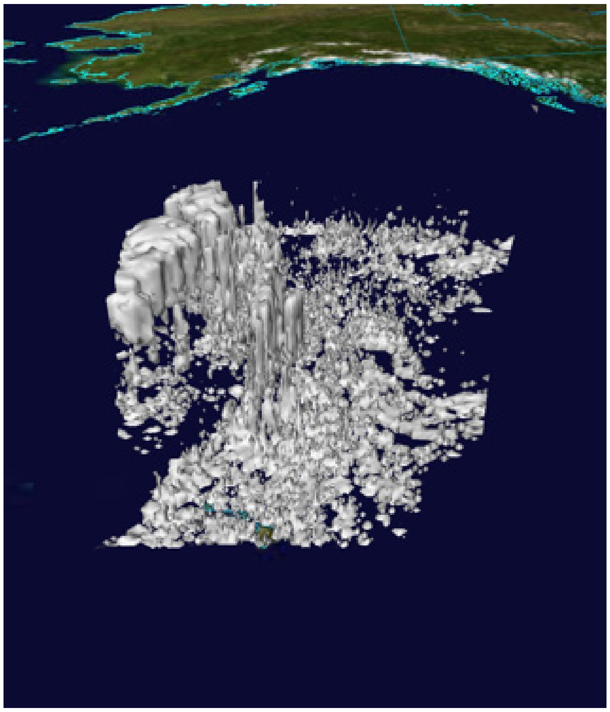
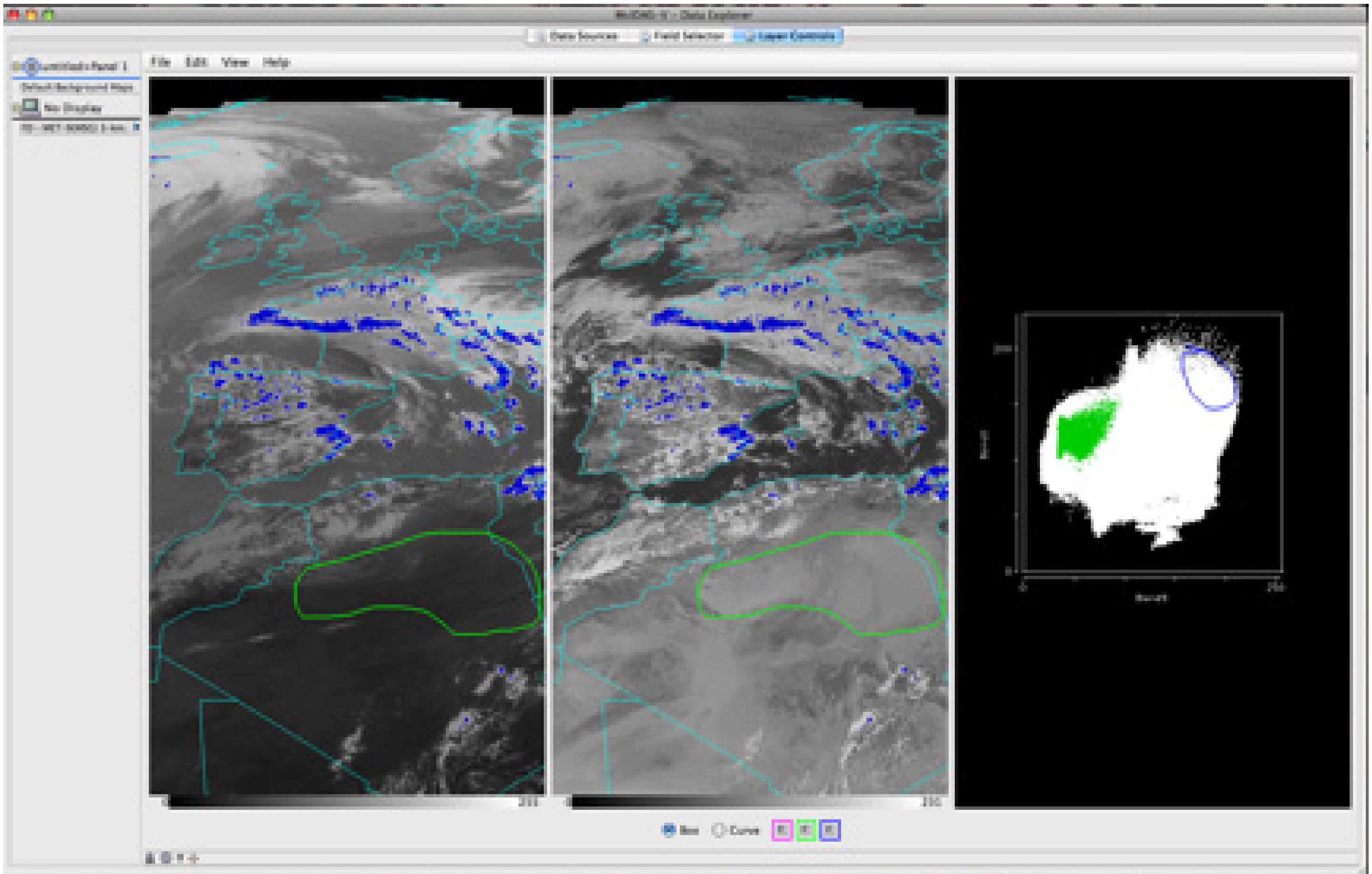


Imagery from MODIS (horizontal) and Calipso (vertical) demonstrate McIDAS-V's capability to display distinctly different coordinate systems in its 3-D data model.



This 3-D multi-layer cloud retrieval from AIRS allows algorithm developers to quickly and visually inspect the output from their retrieval algorithms.

McIDAS-V 1.0 Software Released (cont.)



Using the HYDRA component of McIDAS-V a user can display multi-band imagery (SEVIRI band 9, left, band 1, center) and a scatterplot of radiance vs reflectance (right). The user can then use a mouse to draw on the scatterplot or image to create a color display of the data points selected.

for geoscience data. The IDV brings together the ability to display satellite observations, surface and upper air (radiosonde) observations, gridded data, and radar and profiler data, all within a unified interface. The VisAD/IDV visualization capability provides 3-D views of the atmosphere and allows users to interactively slice and probe the data, creating cross-sections, profiles, animations and value read-outs of multi-dimensional data sets.

The final key component of McIDAS-V is the Hyperspectral Data Research Application (HYDRA). Developed by SSEC scientists to interrogate multi- and hyperspectral satellite data, this tool allows scientists to work interactively with the data, displaying radiance spectra, multi-band imagery, scatterplots and transects. By supporting the forthcoming GOES-R and JPSS programs in the U.S., the HYDRA data interrogation capability is an integral addition to the McIDAS-V toolkit.

McIDAS-V is a software ensemble containing many features. It builds upon several years of VisAD and IDV development to enhance functionality. McIDAS-V will integrate the multi- and hyperspectral satellite data capabilities from HYDRA and allow a two-way dialog with a McIDAS-X session to make those data and products available. In addition to these powerful attributes, McIDAS-V offers improved data and server management and a friendly, user-configurable interface. Finally, since the software is freely available and open source, we will add our own and our collaborators' improvements to continue to evolve the capabilities of the software.

To learn more about McIDAS-V and download the software, user manuals, and training materials, see our new Web site: http://www.ssec.wisc.edu/mcidas/software/v/.

Tom Achtor

Bringing Spaceborne Hazardous Weather Information Down to Earth

To the average person, forecasting the weather often appears to be more guesswork than actual science. Meteorologists discuss the probability of severe weather; watches and warnings can cover seemingly significant areas, which may dilute their impact. Compounding the problem is the sheer difficulty of accurately predicting the weather (with all its uncertainty) as everyone notices when the forecast is wrong.

While we may not change these perceptions over night, CIMSS researchers are working with weather forecasters at the National Weather Service (NWS) to add new decision support products and information from weather satellites to the forecasting tools already available in an effort to improve their forecasts, particularly in the area of convective initiation.

CIMSS collaborations with the NWS have increased and become more focused in recent years. Scientists have sought greater understanding of the needs and tools of the forecasters, going so far as to install an AWIPS work station at CIMSS four years ago in order to replicate their forecasting environment; at the same time the forecasters have been able to see the positive impact of incorporating information from weather satellites and how they might augment their current (and future) forecasting system.

This research has been conducted in conjunction with CIMSS's efforts on the GOES-R Proving Ground program, which is designed to prepare NWS forecasters for the next generation of geostationary forecast products. CIMSS researchers have focused on several opportunities to help bridge the gap between research and forecasting: working one-on-one with forecasters from NWS Milwaukee/Sullivan and in particular working with forecasters during their shifts as they observe the day's conditions and prepare forecasts (see accompanying article on page 8); participating in the Hazardous Weather Testbed experiment; and creating a Weather Event Simulator DVD and guide.

Hazardous Weather Testbed Experiment

For the past two summers CIMSS scientists have contributed to the Hazardous Weather Testbed experiment held in Norman, OK. In addition to providing products, CIMSS researchers have traveled to Oklahoma to collaborate with and train forecasters at NOAA's Storm Prediction Center. In 2010 the experiment focused on official GOES-R baseline and Option-2 products, including the following CIMSS products: cloud and moisture imagery, enhanced-V and overshooting tops, and convective initiation (CI).

To detect areas of convective initiation, CIMSS researchers look at changes in infrared window brightness temperatures with cloud-top cooling indicating areas of possible severe weather. They also look at cloud microphysics to see if these areas have clouds transitioning from water phase to supercooled, mixed phase or thick ice, indicating possible precipitation and lightning.

A case from 10 June 2010 demonstrated the significance of accurate CI detection. At 2132 UTC the UWCI indicated an area of "Pre-CI Cloud Growth" near Boulder, CO. Approximately 30 minutes later (2204 UTC) this area was flagged by radar imagery for possible convection and was later noted for golf ball sized hail by storm spotters.

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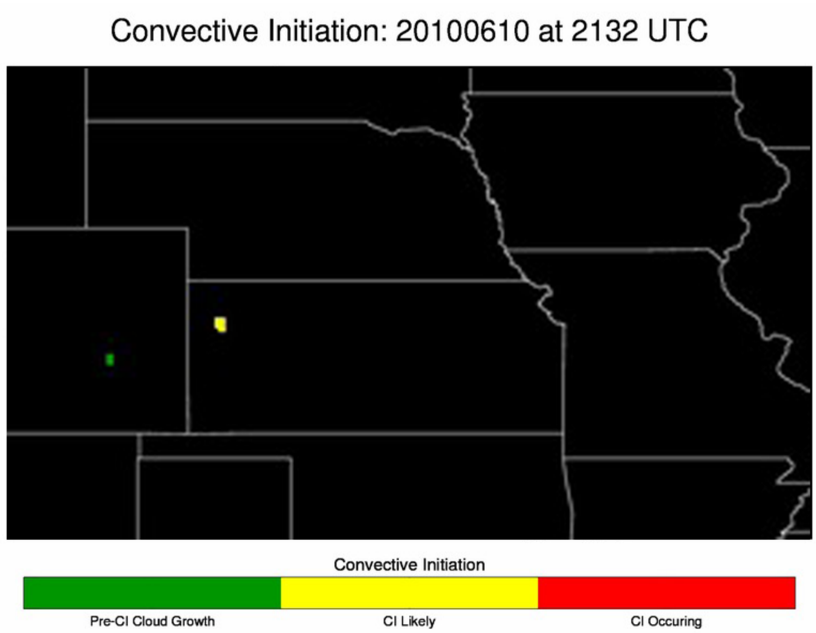


UWCI detects Pre-CI Cloud Growth near Boulder, CO more than 30 minutes before radar imagery.

Bringing Spaceborne Hazardous Weather Information Down to Earth (cont.)

In the final evaluation report of the Hazardous Weather Testbed, the evaluators noted the usefulness of the CIMSS products. Forecasters found the convective initiation products particularly helpful in the early stages of severe weather development to detect areas that would warrant further, more detailed monitoring. In fact, forecasters often noted that they were able to identify developing storms with satellite data anywhere from 5 to 30 minutes before they could identify the same storms on radar. Though they also pointed out that as the storms continued to develop, the satellite imagery was not nearly as useful, given time constraints and limited temporal resolution during consecutive full-disk and calibration scans.

Melissa Kreller, Regional Training Officer at NWS Southern Region Headquarters, left, and Angela Lese, a lead forecaster at the NWS field office in Louisville, Kentucky, right, practice issuing severe weather warnings based on new radar and satellite products evaluated as part of the Hazardous Weather Testbed Experimental Warning Program at the National Weather Center in Norman, Oklahoma.

In addition, because high cloud contamination can be an issue for the thunderstorm initiation product, forecasters suggested including cloud typing output alongside this initiation signal within AWIPS, as this information would clear up any confusion whenever high clouds are not obvious within the image. Finally, given the benefit of seeing cloud top temperature cooling rates, forecasters noted that the addition of a cloud-top cooling rate track would better allow them to follow any changes (or lack thereof) in storm development.

To detect severe thunderstorm features and overshooting thunderstorm tops and their relative magnitudes, forecasters relied on another product from CIMSS: the OTTC (for Overshooting Top and Thermal Couplet) product. As with CI, CIMSS researchers look at satellite infrared window brightness temperature differences. One distinction is the OTTC product's reliance on spatial tests, which can pose difficulty due to a satellite instrument's coarse IR resolution, such as that on GOES-13, and the small size of the features to be detected; the OTTC product does work better with the higher spatial resolution on polar-orbiting satellites. Temporal resolution was also an issue, except when the satellite was in rapid scan mode. However, despite its limitations, forecasters were keen to use the OTTC product to identify the strongest storm within a particular scene or an overshooting top within a strong thunderstorm complex.

For more information on the Hazardous Weather Testbed, visit the experiment's blog at: http://goesrhwt.blogspot.com/

GOES-R ABI Weather Event Simulator

The GOES-R ABI Weather Event Simulator (WES) has been in development at CIMSS to help forecasters discover what data and information will be available with the future GOES-R ABI. The WES (beta 01 version) made its debut at the National Weather Association Annual Meeting in October 2009.

The DVD includes simulated GOES-R ABI data with 1 km spatial resolution for some visible near IR bands and 1 minute temporal resolution; these data are part of a CONUS and mesoscale simulation for a convective outbreak from June 2005. Users can examine differences in specific bands (such as between bands at 6.19 μm and 11.2 μm) to detect possible overshooting tops or to study vegetation (using a Normalized Difference Vegetation Index between bands at 0.86 μm and 0.64 μm).

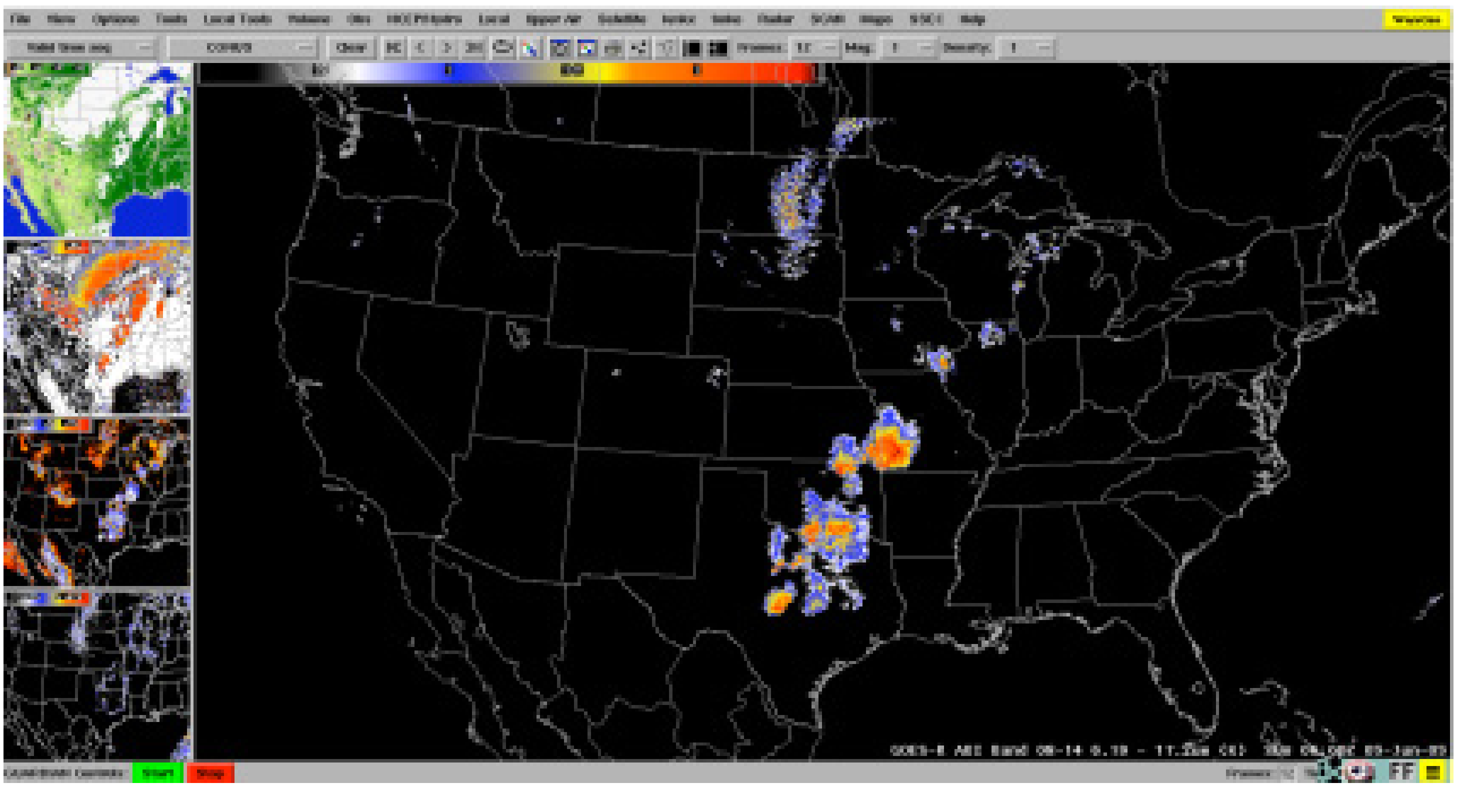
To assist users in examining the ABI data, a WES guide is included on the DVD, along with short videos detailing the GOES-R ABI bands. CIMSS researchers continue to improve the WES based on feedback from NWS forecasters. Copies of the WES (beta 01 version) DVD are available upon request.

Bringing Spaceborne Hazardous Weather Information Down to Earth (cont.)

The WES was also integrated into the Hazardous Weather Testbed experiment as a way to provide additional training. Using an archived case simulated in real-time, forecasters were to issue warnings based on CIMSS's convective initiation products. Following the conclusion of the simulation, forecasters discussed their experiences, noting the pros and cons of the CI product.

CIMSS researchers are continuing their efforts to promote the use of satellite data in weather forecasting and to prepare forecasters for the upcoming changes with the GOES-R ABI. Visits to and interactions with NWS forecast offices, and with the Milwaukee/Sullivan office in particular, remain vital to understanding the specific needs of forecasters, to sharing our research results, and to gaining the valuable feedback that will guide our future work.

Leanne Avila



Band differences used to detect areas with the greatest potential for convection.

Honors and Awards

Steve Ackerman
Received NASA's Exceptional Public Service Medal.

Chris Velden
Named to the AMS Committee on Hurricanes.

Margaret Mooney
Chair of the Education Committee of the Federation of Earth Science Information Partners.

Jean Phillips
Serving on AMS History of Meteorology Committee.

Charles R. Stearns
Awarded (posthumous) Goldthwait Polar Research Medal from Byrd Polar Research Center at Ohio State University.

Scott Bachmeier
Named NESDIS Team Member of the Month.

CIMSS Scientists and NWS Forecasters Prepare for the Future of Forecasting

Forecasters at the National Weather Service Milwaukee, WI, forecast office have been working closely with scientists at CIMSS to bring the latest in satellite-derived research products to operations. Twice a week this summer, a forecaster at the office sat down with a scientist to actively evaluate the algorithms that will eventually be applied to remote observations collected from the Geostationary Operational Environmental Satellite (GOES) R-Series.

Jeff Craven, science and operations officer, helped organize the local testbed after learning about new satellite products and algorithms under development that could help the office's operations. He believed early forecaster evaluation would make for a better operational product in the future. "It was a good interaction overall," Craven said in summary of the effort. "The forecasters enjoyed it."

Two products were evaluated as part of the testbed this year. The first was a convective initiation and cloud top cooling product, which detects microphysical and temperature changes at cloud tops between two consecutive infrared satellite images from GOES to determine whether a cloud was increasing in height, indicating a likely thunderstorm.

The second was a multi-layer Lagrangian nearcasting model, which moves point observations of moisture from the GOES Sounder forward in time, out to nine hours, based on winds from the Rapid Update Cycle model. This technique can be used to identify broader areas of instability based on varying moist and dry air advection in the lower and middle levels of the troposphere, filling a gap where traditional numerical weather prediction methods are lacking in skill.

Both products are set for more extensive evaluation at the NWS's Aviation Weather Center and Storm Prediction Center in the near future.

As part of the interaction, forecasters completed a survey at the end of their evaluation shift, noting the lead time of the products, as well as determining a subjective probability of detection and false alarm ratio. Forecasters also noted strengths and weaknesses, and whether it would be a likely candidate for use on shift now or in the future.

"We are really at the mercy of the GOES satellite and its temporal and spatial limitations," wrote Marcia Cronce, a forecaster at the Milwaukee forecast office who helped in organizing the testbed.

Just as the forecasters are evaluating the products, CIMSS scientists are able to examine how well our research products meet the needs of these users. We can not only see firsthand how forecasters are using the products, but we can also explain our development logic to them. With both sides working together, we can help them to better interpret what they are seeing, and the forecasters can provide us with better feedback.

In fact, the forecasters from this summer underscored some of the shortcomings we already anticipated. For example, our radar validation standard came under scrutiny because there are other indications of convective initiation on radar which are useful to forecasters.

Formal results of the testbed were presented at the upcoming National Weather Association annual meeting in October. Additional products are under development for evaluation in a possible testbed next summer.

To increase the use of satellite data in operations, CIMSS has provided experimental satellite imagery and products, accompanied by training, to the Milwaukee forecast office since 2006, including data from polar-orbiting satellites equipped with the MODerate resolution Imaging Spectroradiometer, or MODIS, which has aided in determining Lake Michigan surface water temperatures. Since that time, CIMSS has interacted with around 50 additional NWS field offices and regional headquarters across the country, and has become a leader in transitioning satellite research to operations.

Jordan Gerth

UW-Madison Wins the CIMSS Recompetition

Following 10 months of proposal preparation, submission, and peer review that started on 12 August 2009 and ended on 9 June 2010, CIMSS was awarded a new 10-year partnership with NOAA.

Despite not knowing the requirements of the Announcement of Opportunity (AO), CIMSS Director Steve Ackerman was proactive in beginning preparations for the proposal that would keep CIMSS located at UW-Madison/SSEC. In August 2009 Steve held an “all hands” meeting to discuss the plans for proposal development. He asked the CIMSS scientists to write two-page summaries of their current research projects, material that he knew would find its way into the proposal. The writing team of Steve, Tom Achtor and Paul Menzel (with help from Maria Vasys and Leanne Avila) would later integrate these two-pagers throughout the proposal as examples of CIMSS expertise in satellite meteorology.

The AO was formally released on 1 December 2009. Proposals were due to NOAA no later than 25 February 2010. Expermentation with content in December led to serious organizing work in early January. An “extended outline” of the proposal was completed in late January. By the 1st week of February the extended outline was turned into a solid draft, which was delivered to a “Red Team” for review. This group conducted a thorough review of the proposal, which left one more week for finalizing the proposal. Having addressed the comments of the Red Team, the UW-Madison/SSEC proposal to host CIMSS was submitted to NOAA on 23 February.

The proposal reviews and notification of award took another two months. Finally, on 9 June, Steve was informed that we had won the recompetition.

With this award CIMSS will continue to live within SSEC for at least 10 more years (with a review after the first four years). We are looking forward to continuing our work with NOAA and the NOAA scientists who work at CIMSS, providing exciting research and enormous benefit to the country.

Tom Achtor

CIMSS Director Steve Ackerman

CIMSS continues to follow three mission goals:

- Foster collaborative research among NOAA, NASA, and the University in those aspects of atmospheric and earth system science that exploit the use of satellite technology;
- Serve as a center at which scientists and engineers working on problems of mutual interest can focus on satellite-related research in atmospheric and earth system science; and
- Stimulate the training of scientists and engineers in the disciplines involved in atmospheric and earth sciences.

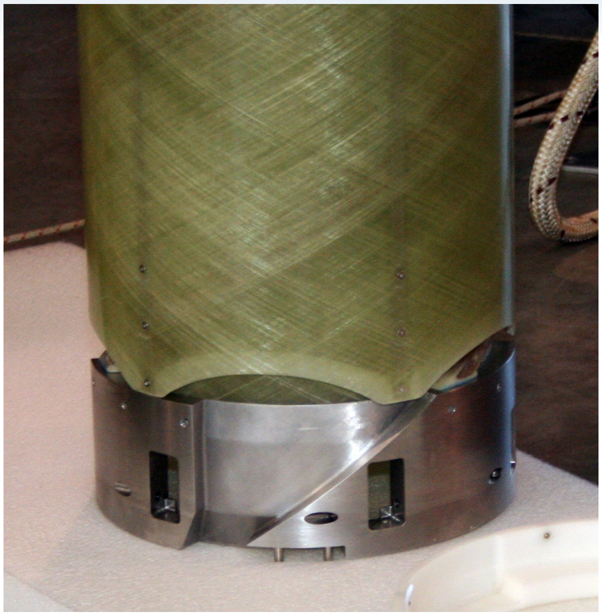
SSEC Engineers Explore Ti

Approximately 10,000 to 20,000 years ago our planet shifted from glacial to interglacial conditions – the most profound shift in climate in the past 100,000 years. What caused this drastic shift?

The Antarctic ice shelf, a spectacularly unwelcoming wind-swept expanse, holds frozen in its depths a remarkable archive of the Earth's climate and environmental changes. Though Antarctica is literally a desert, the slight precipitation it receives never melts. Each year another thin layer is deposited and, through the millennia, deepens to thousands of meters thick. Pristine atmospheric samples only months old lie near the surface; dig deeper into the ice and find material tens or even hundreds of thousands of years old.

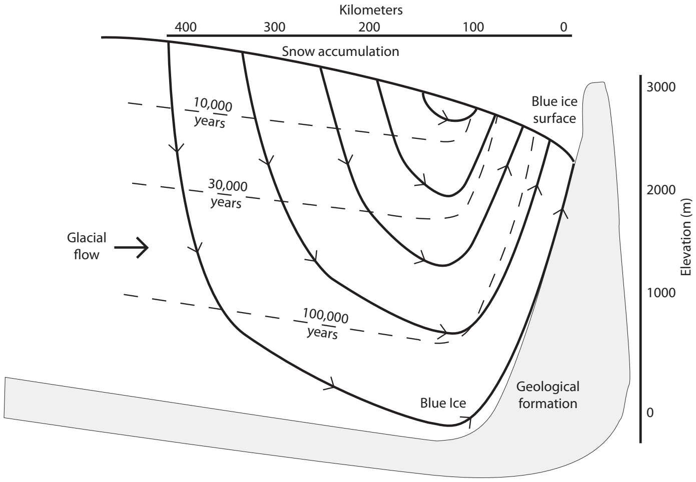
Into the Blue: Dri

Professor Emeritus and ICDS Principal Investigator Charles Bentley examines the Blue Ice Drill barrel.



Most of the Antarctic ice sheet is covered by snow and firn (the intermediate stage between older snow and glacial ice) to a depth of up to 100 meters. However, there are areas known as "blue ice" where clear hard ice lies exposed on the surface.

Blue ice, formed by the unimaginable pressures deep in the ice fields and characterized by its dense, crystalline structure, emerges into the light when a glacier's inexorable flow is obstructed by a geological feature such as mountains. Squeezed between the irresistible force driving the glacier and an immovable geographical object, the deepest, oldest ice is squeezed to the surface.



Scientists funded by the National Science Foundation (NSF) want to examine the methane carbon-14 levels from millennia ago in an effort to further understand the role that CO_2 plays in climate change. This study requires a large amount of blue ice from between 5 and 6 meters deep at most locations and from 5 and 12 meters at several others. In order to accomplish this sampling, it was determined that a light-weight, large diameter, easily transported coring drill was required.

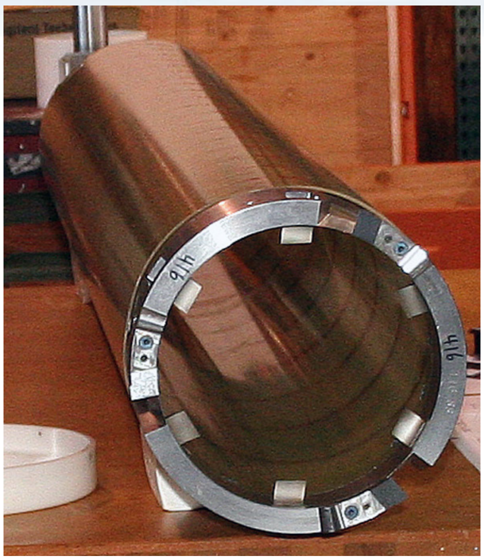
SSEC's Ice Coring and Drilling Services (ICDS) group rose to the challenge – designing, building, and testing a new Blue Ice Drill. Required to produce a core free of contamination from oils, greases, exhaust fumes and any carbon-containing lubricants or fluids, and with a mammoth 24cm core diameter, the drill meets those requirements and can bore 12 meters down into the ice and produce 7 sample cores per day.

me and Space in Antarctica

The stratified nature of the Antarctic ice provides an extremely high temporal resolution for past environmental samples, enabling scientists to evaluate the systems that drive the planet's climate and examine what impacts them.

Sophisticated drills bore into the ice and bring out cores filled with remnants of atmospheric history – bubbles of air trapped thousands of years ago. Volcanic ash and gas emissions, micrometeorite dust, and aerosol particles can be brought to the surface and analyzed. Researchers can compile detailed records of past climate changes and try to discern what caused them. They can see, in detail, how today's atmosphere differs from those ancient times. What impact has humanity had on the planet's atmosphere and how important is that impact? We find ourselves in a relatively recent interglacial period. What caused it?

lling the Blue Ice



Blue Ice Drill with six core dogs exposed.

Jeff Severinghaus (Principal Investigator - kneeling) accepted delivery of the Blue Ice Drill from the ICDS group. From left to right: Josh Goetz, Fred Best, Kristina Dahnert, Jay Johnson, Tony Wendricks, Tanner Kuhl, Tom Demke, Alex Shturmakov (Project Manager), Charles Bentley, Chris Gibson. Not pictured: Michael Gerasimoff and Don Lebar.

Disassembled, the drill is small and light enough (at most 500kg/1100lbs) to fit into a Bell 212 helicopter.

The drill was designed with simplicity in mind. Generally, three scientists and two drillers will be present on site for the drilling, but as few as two people can operate the device.

Perhaps the biggest challenge facing the Blue Ice Drill was the sheer size of the core sample. With a sample nearing 10 inches in diameter, consisting of dense, hardened ice, how was the core to be snapped free of its glacier?

Four core dogs are typical, but for the Blue Ice Drill six core dogs are used. In addition, new, larger core dogs were developed, with an improved geometry that optimized engagement with the ice core. Spring-loaded and ground to near razor sharpness, the core dogs lie flat against the drill housing while the meter-long core is cut. Then the drill is raised slightly, allowing the dogs' sharp edges to engage and break the core. A second piece of equipment, the Core Recovery Tool (CRT) was designed and built to break the core in case it can't be cracked and broken by the core dogs. A piston on the side of the CRT drives the sample horizontally, snapping it free. The core dogs then hold the sample in place as it is brought to the surface.

At the 17 September 2010 Final Acceptance Review, Jeff Severinghaus (University of California, San Diego), Principal Investigator, delivered an enthusiastic "thumbs up" to the SSEC Blue Ice Drill and the engineering/design team responsible for its innovations. The drill will be deployed this season in Antarctica.

Mark Hobson

Revolutionary Replicate Coring Drill to Examine Important Climate Events

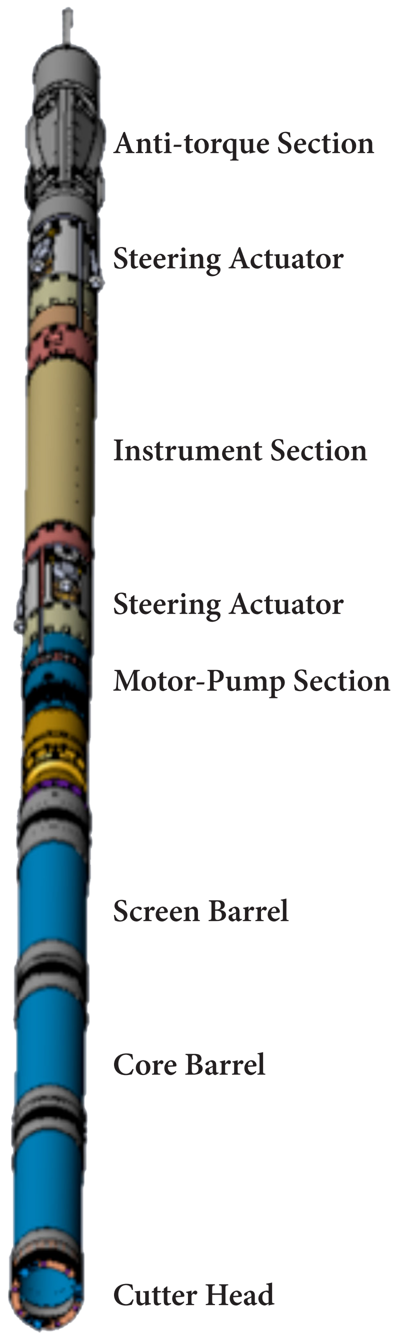
Ice cores that provide accurate records of past glacial transition periods are rare. Until recently, the practice of taking a single deep ice core from one area made verification of the sample's validity very difficult. Total understanding of the spatial relationships so far beneath the surface was elusive, increasing the chances of misinterpreting the atmospheric record. In one case, an anomaly that was observed between two cores drilled near to one another was read as a record of climate instability, but was finally resolved as a stratigraphic disturbance in the ice itself. The pressures of the shifting ice cap had misaligned the layers of ice.

Led by Principal Investigator Charles Bentley, SSEC's Ice Drill Design and Operations (IDDO) group is revolutionizing ice drill technology and sample recovery with their new Replicate Coring Drill.

Project Manager Alex Shturmakov says, "The Replicate Drill can collect additional samples at points of high interest by deploying into an existing borehole and then deviating from it, essentially creating a separate borehole at depth."

The Replicate Coring Drill design uses two steering actuator sections that make it possible to deflect the drill in the borehole by applying sidewards force, thus angling out of the parent borehole and creating a replicate borehole.

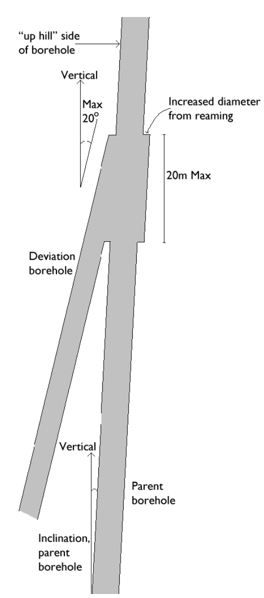
Deeper strata are more compressed by the weight of the ice above them, decreasing the sample availability. Multiple extractions from the same, contiguous strata can be made without needing to re-locate the drill in order to bore another hole and without needing to document and store an entire new core.

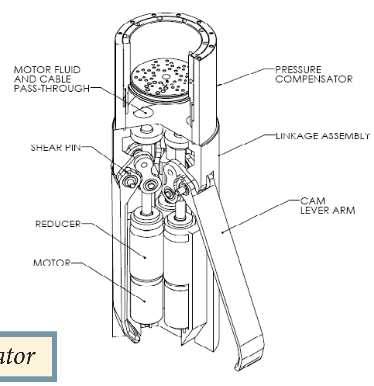


Of particular interest to scientists studying environmental changes that may affect humanity are climate events that occurred 11,600, 14,700, and 38,000 years ago, as well as many suspected volcanic incidents in the past. With the Replicate Coring Drill, reliable atmospheric gas records and local climate records that span these times of transition from glacial to interglacial periods may be obtained. Researchers will be able to measure and interpret the timing of changes in methane, CO_2, nitrogen, krypton, xenon, and their isotopes – measurements that require large sample volumes. This extended core collection capability will be used to improve climate models and predictions of how the Earth's climate responds to ongoing human influence.

The ability to obtain additional ice samples from "intervals of interest" at the West Antarctic Ice Sheet (WAIS) Divide and other deep core sites is vital to climate scientists. Because of the unique quality of the gas record in the WAIS Divide and the large samples needed, efforts to acquire a detailed record of the past 100,000 years of atmospheric history will benefit greatly from using Replicate Coring Drill technology.

Mark Hobson





Steering Actuator

SSEC Photo Contest Winners

Earlier this year SSEC invited scientists, faculty, staff and students from the Atmospheric Oceanic and Space Sciences Building (of which SSEC is a part) to participate in a photo contest showcasing Wisconsin weather. Nearly two dozen images from 11 photographers – capturing simple, yet striking moments that speak to more than just the beauty of Wisconsin and its weather – were submitted.

1st Place: Hank Revercomb for *Mammatus Clouds*

The photos showcase the way these photographers view the natural world… through the lens of both an artist and scientist. Appreciating not only the beauty but also the forces that created the picturesque scene, the photographers recorded Wisconsin weather throughout the year.

To view the rest of the entries, either visit the exhibit located on the third floor of the AOSS Building, west corridor, outside the Schwerdtfeger Library or check out the online slideshow: http://library.ssec.wisc.edu/photocontest.php.

Leanne Avila

2nd Place: Tom Achtor for *Autumn Fog*

3rd Place: Bill Bellon for *Contrail Cloud at Sunset*

Scanning the Arctic Sky With LIDAR

Fifteen hundred kilometers due north of Hudson Bay, at 80 degrees north latitude, Ellesmere Island is the second-closest piece of land to the North Pole itself. Since 2005, SSEC has operated a LIDAR (Light Detection and Ranging) station at the outpost station of Eureka on the remote, forbidding island.

Global climate models suggest that the arctic climate may be particularly sensitive to changes caused by the build up of greenhouse gases and air-borne pollutants. Increases in the amount of CO_2 in the Arctic can trigger a disproportionate temperature response in the arctic climate – perhaps as much as 2 to 3 times more than the global mean. Small changes in radiation balance may induce large changes in ice cover.

Although arctic clouds strongly affect this balance, only very sketchy records of the clouds and their composition have been available. With few residents in the frigid wilderness and the sky dark for half of the year, accurate observations are scarce. Satellite observations are difficult, both because of the darkness in the winter, and because of the white ground cover which blends with the clouds when viewed from space. Also, satellite-mounted infrared detectors determine altitude by measuring temperature in the clouds, but the arctic weather systems are so volatile that those measurements cannot be precise.

The High Spectral Resolution LIDAR (HSRL), built at SSEC and permanently installed on Ellesmere Island, solves these problems. Operated remotely via the internet, and able to gather information in the months-long midnight, the HSRL perpetually scans the polar skies.

A more difficult problem was the study of cirrus clouds which, on average, cover 40% of the sky. Floating high in the upper troposphere and composed of ice, cirrus clouds are one of the first modulators of incoming radiation and one the final barriers as heat radiates from the surface into space. These clouds are high in the atmosphere, quite thin and are often composed of irregularly shaped ice crystals making them hard to measure. Any instrument seeking to accurately determine their composition must be extremely sensitive and able to resolve vertical variations in the clouds' optical properties.

Though similar in its operating principles to radar, LIDAR equipment uses much shorter wavelengths (in the ultraviolet, visible, or near infrared ranges). Minute aerosols and cloud particles missed by the broader bands are visible to the LIDAR. While LIDAR technology itself is not new, the SSEC team, led by Edwin Eloranta, uses techniques not found elsewhere. Other systems may run at 10 or 20 very powerful pulses per second. The laser beam is transmitted through one telescope and the return signal is received in another one. The returning signal is large, necessitating analog detectors for processing.

The UW-Madison system replaces the large pulses with many small pulses. At 4,000 pulses/second, the system measures data 200 times more often than previous systems. The smaller pulses make the laser system "eye-safe," an important feature if the system is distributed world-wide to less-experienced operators.

The small, frequent pulses are transmitted through a large telescope with as many as a hundred precisely designed and engineered optical surfaces (lens, mirrors, filters, polarizers, etc.) and then received and recorded via the same telescope, eliminating the alignment problems of the earlier two-telescope systems.

This arrangement creates a small field of view. Special filters narrow the bandwidth and the colors acquired even further. The system currently operating in the Arctic works at 40

The LIDAR with the environmental housing removed.

micro-radians, which provides very little expansion in the field of view over distance.

Such a tightly controlled signal enables the system to use photon-counting detectors, five times as sensitive as their analog predecessors. Its wider dynamic range makes changing the gain on the receiver because of a bright cloud or clear sky unnecessary. The system doesn't require the constant presence of an operator to tweak settings.

LIDAR has long been used to investigate cirrus clouds, but single channel LIDAR instruments, which combined both molecular and cloud scattered photons into one field of view, did not have sufficient information to accurately measure their exact composition.

The solution was to separate the returned signal into its molecular and aerosol backscattered components.

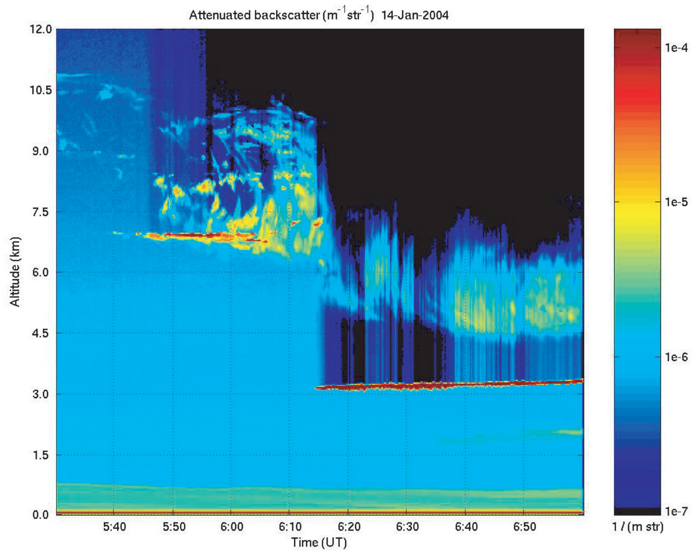
Because the molecular LIDAR return is Doppler-broadened by the thermal motion of the molecules and the more massive, slowly moving aerosol particles remain spectrally unbroadened, the HSRL can distinguish between the two and yield distinct returns.

Targeting clouds and aerosols year-round, with high accuracy and dependability, the HSRL gathers highly detailed atmospheric measurements that are used in imaging a two-dimensional structure of the atmosphere over time. Small-scale atmospheric features that last only half an hour can be put into forecast models, increasing model accuracy.

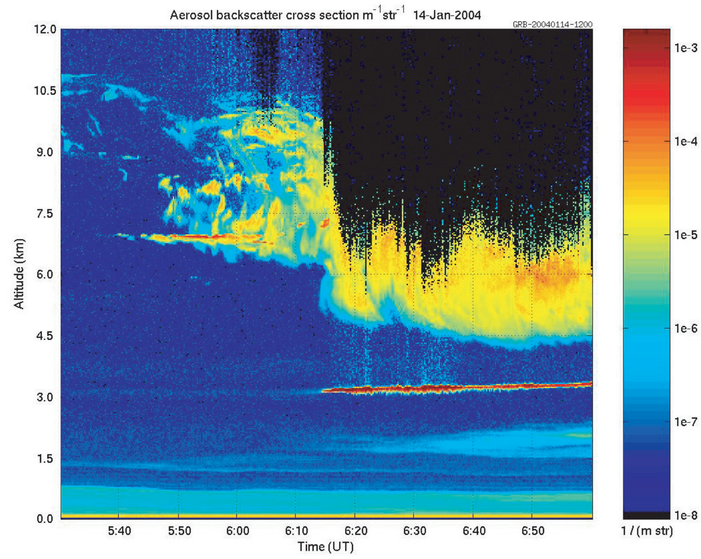
The UW-Madison system is unique in its approach of high-repetition rate, common telescope, narrow field of view, narrow band path, and continuously operating photon counting. It offers unique advantages, such as robust calibration, no unstable inversions, eye-safe operation, and a large dynamic range.

Mark Hobson

The HSRL has been adapted to be mounted in a NASA Gulfstream V (GV) aircraft with windows in the top and bottom bulkhead to permit scanning while in the air. The GV-mounted LIDAR, flying as high as 45,000 feet, supplies vertical cross-sections of atmospheric data that is collected and then downloaded from the airplane's internal network. The airplane-mounted device achieves an arc of 100 micro-radians.



Upper layer cloud structure is shadowed by lower clouds in the standard LIDAR image. Any attempt to correct for attenuation requires questionable assumptions about the scattering properties of the obscuring clouds. Fine details of aerosol layers are masked by strong molecular scattering.



The HSRL image of backscatter cross section rigorously corrected for attenuation; shadows artifacts are removed. Obscured areas are objectively determined from the strength of the molecular signal. Also notice the enhancement of tenuous aerosol layers after removal of the molecular scattering.

The CIMSS Satellite Blog:
How a Storage Solution Became a Tool for Training and Outreach

CIMSS's Scott Bachmeier just needed a place to put a few interesting case studies so that they wouldn't get lost on his hard drive. The simple question of "Where am I going to put all this stuff?" was answered in the form of the CIMSS GOES Gallery, a simple HTML page that could serve as a catalog of cases.

Over time what originally was designed as a pet project became a showcase of the satellite products CIMSS has and what these products can do. It also became an asset for training, allowing Scott to point users to specific examples – with many of the cases being used in various VISIT and SHyMET satellite training modules.

"The GOES Gallery evolved into more than I thought it would be," noted Scott.

Then in 2004 while working on the IDEA project, Scott got his first taste of blogging. For once there was no need to worry about the HTML structure – it was all about the content. Which led Scott to wonder "Why don't I move to this?"

Soon enough Scott was working with Bill Bellon, SSEC's Webmaster, who helped set up The CIMSS Satellite Blog using WordPress. Once he has selected images and with the words already writing themselves in his head, Scott can create a blog post in only 10 minutes, compared to the 30 minutes or more he needed for a CIMSS GOES Gallery entry (often due to all the little, or large, HTML edits necessary to create it). Not only does the blog style make for a faster approach, but a more professional look in the end.

Scott noted the appeal of the blog format, which by its very nature turned it into what he called a "just in time" training tool, allowing him to write about weather events shortly after they happen. Unlike publishing a manuscript of a case study, which may not appear for a year or more, Scott can write about weather events that are still fresh in the reader's mind and allow them to see or be reminded of what types of satellite imagery are useful in a particular situation.

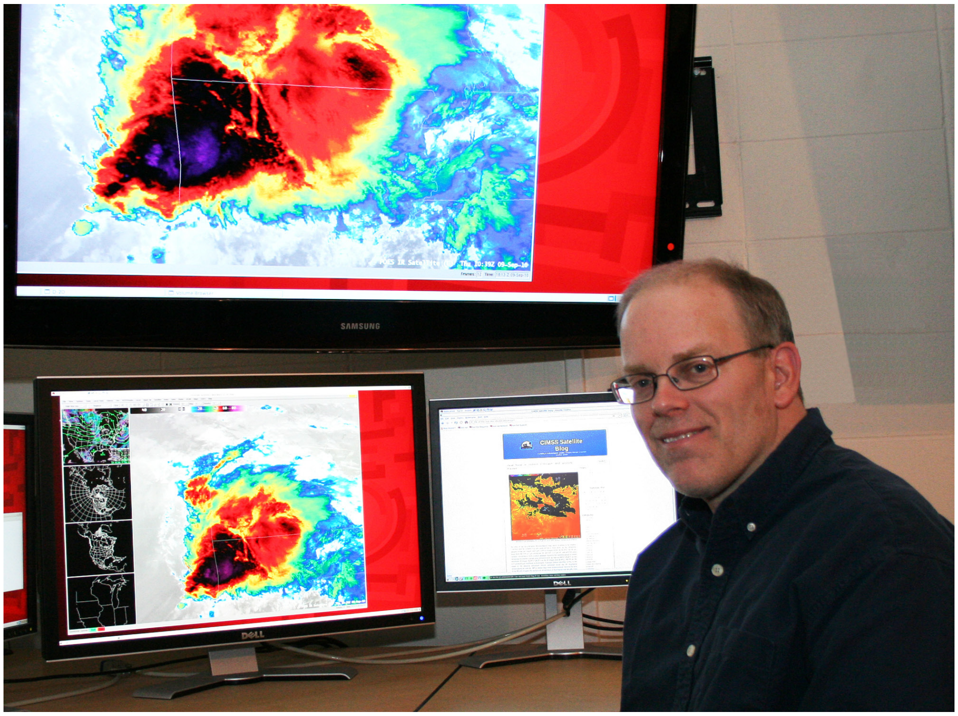
Given the number of cases Scott may be looking at on a particular day, he chooses to blog about those that may be the most timely or interesting (such as a hurricane approaching land). He also will create posts highlighting a product that he may not have shown in a while, to remind users of its utility. Mostly, "the meteorological gems get put on the Blog." Though Scott confessed to having too many good cases to possibly include them all.

In creating posts for the blog, Scott aims to appeal to as a wide an audience as possible. He pointed out that the text isn't particularly technical so that even younger users, whether they are in college or high school or perhaps still in junior high, could understand and learn something.

It was during junior high school when Scott himself first became interested in meteorology. He had attended an open house of the National Weather Service Forecast Office in Sioux Falls. That day he was handed his very first paper copy of a weather satellite image.

"At that point I was hooked," remarked Scott. Regular visits to the forecast office soon followed, with the forecasters sharing what they knew and Scott seeing firsthand the ins and outs of operational forecasting.

And Scott isn't done tweaking the Blog. He still has a few plans for improvements. He'd like to restore the ability to accept comments. Comments were initially allowed - that is, until spammers took them over. He'd like to see more immediate feedback

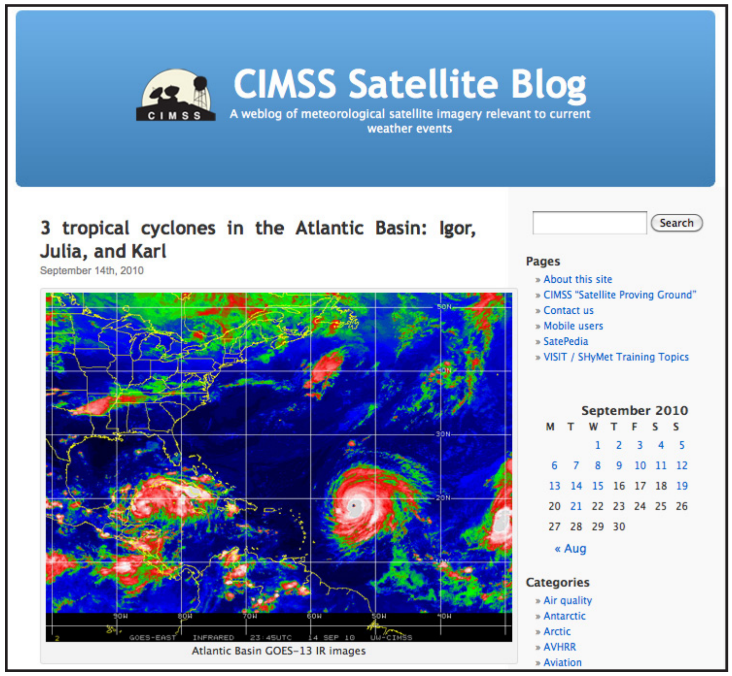


and interaction from readers that comments more easily allow.

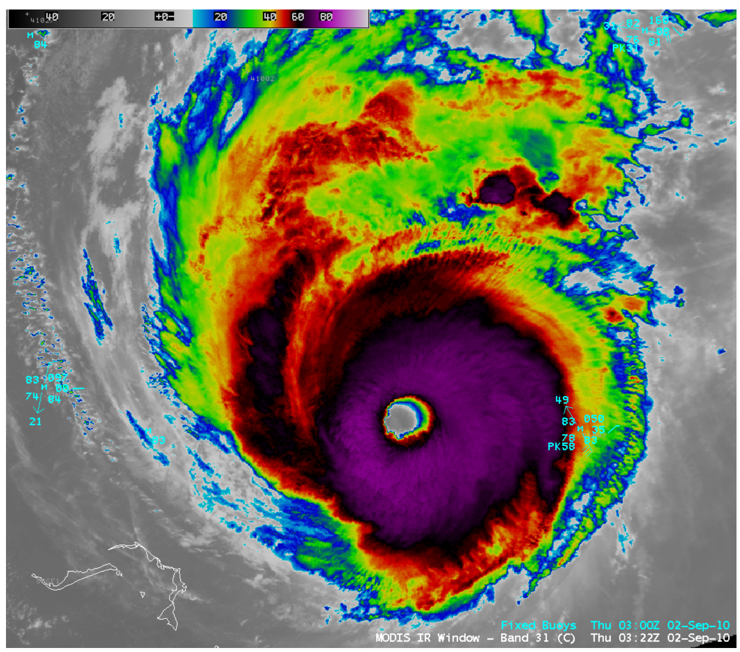
Scott would also love to include even more cases on the Blog and to include more variety, looking to adding cases from not just the U.S. but from around the world as well, especially given SSEC's access to global data. In order to accomplish this goal, though, either Scott would need to spend more of his working day on the Blog or find more in-house contributors. Though Scott was quick to note that SSEC's Scott Lindstrom has been a major contributor.

On some days, Scott currently spends as much as 50-75% of his working hours (and then some, as he said his wife might argue) gathering images for potential Blog entries. While originally it wasn't a part of his official job description, it soon became something that took on a life of its own. Fortunately, Scott noted, his supervisors saw the positive aspects of the Blog and have encouraged him to continue.

Scott has also given consideration to how the Blog could work better on mobile devices, such as iPods and iPads. Currently, some of the animations are rather long and not mobile-device friendly. Though Scott also wondered how useful that would be, as much of what he is showing requires seeing subtle image details and knowing how much easier those are to see on larger screens.



The CIMSS Satellite Blog highlights CIMSS satellite products and interesting weather phenomena.



MODIS IR image of Hurricane Earl approaching the US East Coast.

Looking to the future, Scott is excited about "preparing people for all the products and channels coming up on GOES-R." He noted how the Blog could serve "to whet their appetite" for future improvements. As CIMSS products and imagery continue to make their way into AWIPS, Scott can include cases on the Blog to allow forecasters to see how these new products and imagery may be used.

"I'm very proud of what we do here," said Scott, and he is keen to share that enthusiasm, as well as the results of our work, with others.

Visit the CIMSS Satellite Blog at http://cimss.ssec.wisc.edu/goes/blog/.

Leanne Avila

Highlights of Recent Publications

Suomi: Pragmatic Visionary.

Bulletin of the American Meteorological Society, v.91, no.5, 2010.

Lewis, J. M., D. W. Martin, R. M. Rabin, and H. MoosMuller

Despite a most unusual path into scientific research, Verner Suomi used his keen physical insight and pragmatic engineering skills to develop the innovative radiometers that flew aboard Explorer VII in 1959. Suomi became the recognized world leader in satellite meteorology, often referred to as the “father of satellite meteorology.” He gained world acclaim during the 1960s and 1970s in response to his scientific leadership, both nationally (at the Space Science and Engineering Center at the University of Wisconsin-Madison) and internationally as a member of the Joint Organizing Committee (JOC) of the Global Atmospheric Research Program (GARP).

Climate modulation of North Atlantic hurricane tracks.

Journal of Climate, v.23, no.11, 2010.

Kossin, J. P., S. J. Camargo, and M. Sitkowski

The variability of North Atlantic tropical storm and hurricane tracks, and its relationship to climate variability, is explored. Tracks from the North Atlantic hurricane database for the period 1950–2007 are objectively separated into four groups using a cluster technique that has been previously applied to tropical cyclones in other ocean basins. General climatologies of the seasonality, intensity, landfall probability, and historical destructiveness of each cluster are documented, and relationships between cluster membership and climate variability across a broad spectrum of time scales are identified.

Objective satellite-based detection of overshooting tops using infrared window channel brightness temperature gradients.

Journal of Applied Meteorology and Climatology, v.49, no.2, 2010.

Bedka, K., J. Brunner, R. Dworak, W. Feltz, J. Otkin, and T. Greenwald

Deep convective storms with overshooting tops (OTs) are capable of producing hazardous weather conditions such as aviation turbulence, frequent lightning, heavy rainfall, large hail, damaging wind, and tornadoes. This paper presents a new objective infrared-only satellite OT detection method called infrared window (IRW)-texture. This method uses a combination of 1) infrared window channel brightness temperature (BT) gradients, 2) an NWP tropopause temperature forecast, and 3) OT size and BT criteria defined through analysis of 450 thunderstorm events within 1-km Moderate Resolution Imaging Spectroradiometer (MODIS) and Advanced Very High Resolution Radiometer (AVHRR) imagery.

Using CALIPSO to explore the sensitivity to cirrus height in the infrared observations from NPOESS/VIIRS and GOES-R/ABI.

Journal of Geophysical Research, v.115, 2010.

Heidinger, A. K., M. J. Pavolonis, R. E. Holz, Bryan A. Baum, and S. Berthier

This paper demonstrates how the availability of specific infrared channels impacts the ability of two future meteorological satellite imagers to estimate cloud-top pressure. The geostationary imager, the Advanced Baseline Imager (ABI), will be flown first on the GOES-R platform. The polar-orbiting imager, called the Visible/Infrared Imager Radiometer Suite (VIIRS) and flown on the National Polar-Orbiting Environmental satellite Suite (NPOESS), has spectral channels in window regions only. This paper investigates the impact on the ability of a satellite imager such as VIIRS to confidently estimate cloud-top pressure due to the absence of infrared absorption channels.

Errors in cloud detection over the Arctic using a satellite imager and implications for observing feedback mechanisms.

Journal of Climate, v.23, no.7, 2010.

Liu, Y., S. A. Ackerman, B. C. Maddux, J. R. Key, R. A. Frey

Arctic sea ice extent has decreased dramatically over the last 30 years, and this trend is expected to continue through the twenty-first century. Changes in sea ice extent impact cloud cover, which in turn influences the surface energy budget. The accuracy of cloud detection using observations from space varies with surface type, complicating any assessment of climate trends as well as the understanding of ice–albedo and cloud–radiative feedback mechanisms. Cloud amounts from the Moderate Resolution Imaging Spectroradiometer (MODIS) are compared with those from the CloudSat and Cloud–Aerosol Lidar and Infrared Pathfinder (CALIPSO) satellites in both daytime and nighttime during the time period from July 2006 to December 2008.

Climate Literacy Ambassadors:
A NASA Global Climate Change Education Project

What does it mean to be climate-literate? It means that you understand your impact on the Earth's climate and climate's influence on you, your environment and society. Being climate literate is critical to understanding and interacting with our environment.

To become climate literate we need to know how to assess scientifically credible information about climate and communicate about climate change in meaningful ways. To be climate literate means that your decision-making process considers the impact of your actions on climate.

For the past few years, NSF, NASA, and NOAA have been collaborating to build programs that address the climate literacy of our nation. Many of CIMSS's outreach and education programs support this literacy goal – from our summer workshops, to the weather and climate presentations on a 3D globe display system, to radio and internet programs.

Beginning in the early 1990s, CIMSS has sponsored and hosted teacher and student workshops on the Earth sciences. These workshops cover some of the essential principles of climate literacy. The 3D display system shows not only real-time satellite imagery, but also historical weather and animations of climate variables.

A new kiosk in the lobby is a collaboration with the Science Museum of Minnesota and includes examples of satellite observations of human effects on the environment, effects that are so pervasive that some are saying we are entering a new era of environmental history: the "anthropocene period."

One of our latest education initiatives is the Climate Literacy Ambassadors program. This NASA-funded project is a three-tiered program to prepare Grade 6-12 teachers to be Ambassadors of Climate Literacy in their local schools and communities. Teachers are recruited through our web pages, the Earth Science Information Partners (ESIP), the Climate Literacy Network, and the Madison Metropolitan School District. The complete training involves participation at a teacher workshop combined with distance learning education, followed by a technology-supported virtual community of climate change educators.

Teachers at the May 2010 workshop held at CIMSS.

The workshops provide an overview on climate change and demonstrate NASA climate resources. Workshops were held in May 2010 at CIMSS, and at a second Climate Literacy Ambassadors workshop held at the Federation ESIP July 2010 meeting in Knoxville, Tennessee.

The second tier is a distance learning curriculum which utilizes e-learning technology to clarify graphs and concepts from the 2007 Intergovernmental Panel on Climate Change Summary for Policy Makers, with the report content intricately linked to the Essential Principles of Climate Literacy. UW-Madison faculty and staff from multiple departments contributed to the development of the course. The virtual community, hosted on our network, will provide support for teachers exploring climate literacy in their classrooms. Participating teachers progress through the program and become climate education resource agents. We seek to have teachers who will undertake capstone projects that engage students in research projects investigating regional climate system topics.

The science of climate includes numerous disciplines and therefore a wide background of subject matter to teach. Integrating climate science into a science curriculum will require a cooperative effort of scientists working with teachers who possess varied experiences and expertise. We invite you to join us in this endeavor. Check out CIMSS on Facebook to find out more about our research and outreach.

Margaret Mooney
Steve Ackerman

If you would like to be added to our mailing list for *Through the Atmosphere*, please contact Maria Vasys at maria.vasys@ssec.wisc.edu.

***Through the Atmosphere* online:**
www.ssec.wisc.edu/media/newsletter/

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