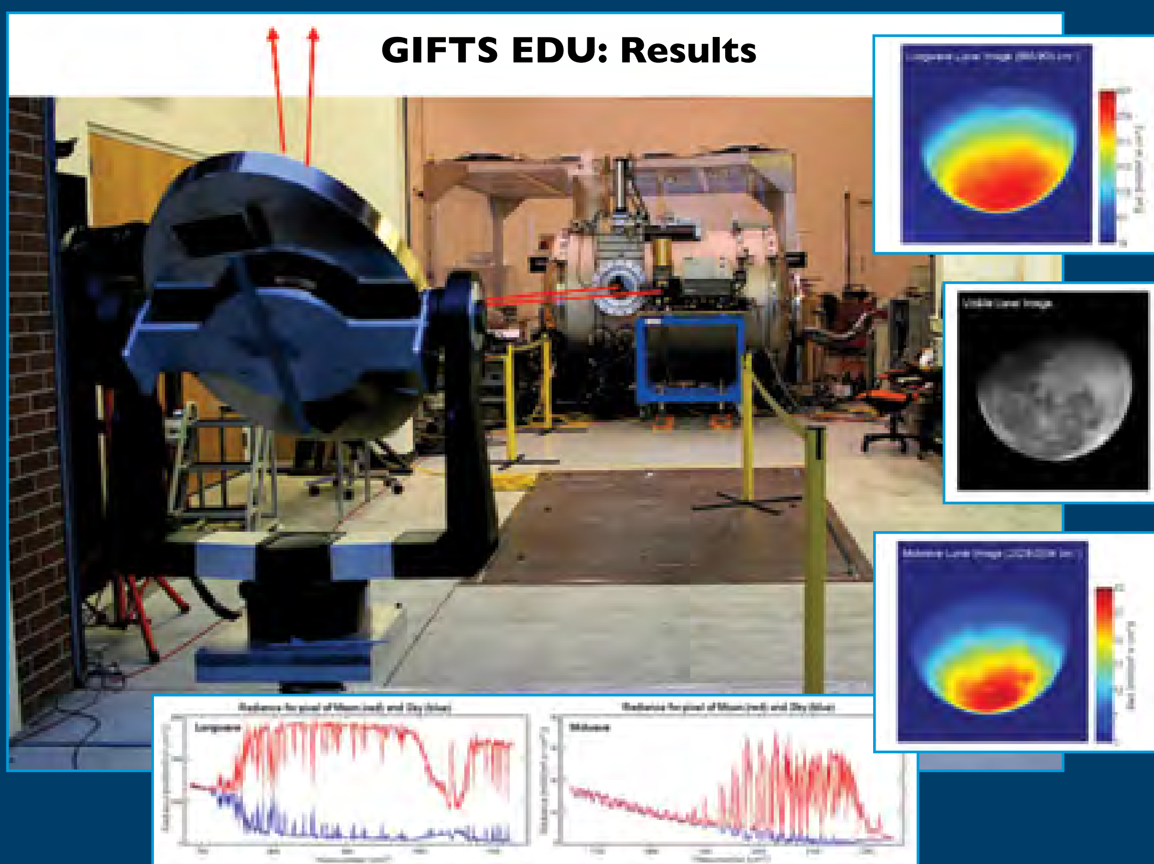
University of Wisconsin-Madison
Space Science and Engineering Center
Cooperative Institute for Meteorological Satellite Studies

through the atmosphere

Summer 2007



Inside this issue...

Director's Note

Welcome to the inaugural issue of *Through the Atmosphere*. This biannual newsletter publicizes atmospheric and space science research and engineering projects and accomplishments at UW-Madison's Space Science and Engineering Center (SSEC) and its Cooperative Institute for Meteorological Satellite Studies (CIMSS).

SSEC and CIMSS are looking ahead to shape the development of future satellite instruments. The first article in this newsletter outlines our active role in the NASA/NOAA Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) project and makes the case that the technology is ready for flight demonstration. GIFTS will revolutionize space-based observations of the Earth's atmosphere, leading to significant weather forecasting improvements.

In addition to preparing for upcoming satellite technology, SSEC/CIMSS scientists continue to expand the use of data from current satellites. This issue of the newsletter provides two examples of this research: using data from CALIPSO to validate cloud properties and providing experimental satellite data products for use in operational forecasting at the National Weather Service.

SSEC also participates in more direct measurements of the Earth and its atmosphere. For example, SSEC's Ice Coring and Drilling Services have designed and built a new Deep Ice Sheet Coring drill. This fall the drill will procure a core from the West Antarctic Ice Sheet that will illuminate the climate record in Antarctica over the past 100,000 years.

In this issue of *Through the Atmosphere*, we also welcome newcomers in the Environmental Remote Sensing Center and announce our plans for the Verner Suomi Science Museum.

Since the early 1960s, the SSEC has conducted critical research in atmospheric and space sciences. Strengthening collaborations with NOAA and NASA, our cooperative institute has put us in a position to advance applications of observations made by remote sensing instruments. The following articles highlight our efforts to measure and understand our physical environment using current instruments, and to explore and realize potential of future instruments. §

Hank Revercomb
Director, SSEC

Through the Atmosphere

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Cooperative Institute for Meteorological Satellite Studies

SSEC CIMSS

Revolutionary observing opportunity:

GIFTS demostrates significant improvements in imaging and sounding

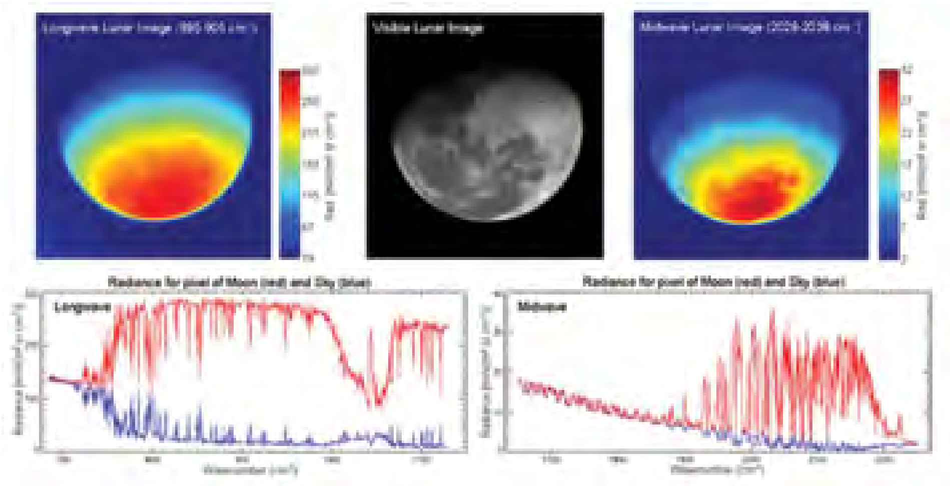


Figure 1. GIFTS moon viewing images and on-moon spectra compared to an off-moon sky view.

The new millennium ushered in an exciting opportunity to modernize severe weather observing from geosynchronous orbit. The NASA/NOAA Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) project was formally initiated during the holiday season of December 1999. In the nearly eight years since that announcement, the GIFTS program has persevered through the successful completion of the Engineering Development Unit and gained new life as more and more scientists in the community advocate and support flying the sensor. The opportunity ushered in by the new millennium may finally be realized and not a moment too soon. When the GIFTS Imaging sounder capability gets into orbit, we expect to see significant improvements in the quality and timeliness of severe weather warnings from a combination of better nowcasts and numerical model forecasts.

GIFTS offers a very real observing revolution with 100 times more detail in space and time coverage than the current GOES sounder. The factor of 100 improvement comes from a combination of more imaging detail, more vertical detail, and greater temporal coverage frequency. Specifically, the two order-of-magnitude improvement stems from the use of a 16,000 detector array (128 x 128 pixels) to image with 4 km footprints through a Fourier Transform Spectrometer (FTS) or Michelson interferometer (4 km pixel spacing replaces 10 km, yielding more than a factor of six in combined x and y horizontal detail). The FTS divides the observed infrared emission spectrum from the earth into more than 2000 spectral elements. This spectral detail translates into three times more information about how temperature, water vapor, and other greenhouse gases vary with altitude in the atmosphere. In addition, GIFTS can cover the same domain on the earth five to six times faster than the GOES sounder. Even faster spatial coverage (40 times GOES) is possible in its reduced spectral resolution imaging modes.

The GIFTS development initially faced a number of technical challenges, with some considered potentially significant. All of these have been successfully addressed by the Engineering Development Unit (EDU) and the partners involved in its design and manufacture, including (1) longwave detector/read out development (BAE Systems), which yielded high sensitivity of the 15-micron carbon dioxide band and high operability (96% good pixels), while providing the desired sampling characteristics for imaging FTS operation, (2) a long-lived, stable laser (TESAT, Germany), the onboard FTS spectral reference, (3) a Michelson interferometer designed for imaging (Utah State University's Space Dynamics Laboratory, SDL; University of Wisconsin-Madison, UW-Madison) with alignment and velocity monitoring, (4) cryogenic thermal design (SDL), using a pulse tube mechanical cooler (Lockheed-Martin) and multiple radiative coolers to maintain the detector package at <60 K and the spectrometer at 150 K, (5) light weight and thermally stable optics (SSG Precision Optronics, Inc.), (6) high speed analog to digital converters (Raytheon), and (7) internal calibration references (UW-Madison), which in combination with a space view provide highly accurate absolute calibration with low mass and volume. All elements demonstrated high probability for a 9-year lifetime. In addition, NASA LaRC has developed a control module for EDU control and spacecraft interface. The technology is ready for a flight demonstration!

In April 2006, following thorough thermal-vacuum testing with laboratory sources, GIFTS was exercised with a set of novel tests looking at the atmosphere and the natural environment. GIFTS was configured in the thermal vacuum

(ctd. on page 4)

GIFTS

(continued from page 3)

chamber at SDL, but arranged so it could view outside the laboratory. A large mirror (19” diameter) was used to point the field of view toward the moon, distant mountains, and the zenith atmosphere. Images of the moon created by the two GIFTS infrared sounding bands (111 microradian/pixel) and its visible imager (28 microradian/pixel) are shown in Figure 1, along with a single spectrum. The full data cube (2-D image x spectral channel) includes spectra from all 16,000 image pixels and images can be made from any of the 2000 spectral channels. It must contain lots of interesting information about the moon, but that application has not yet been pursued. The mountain views are used as a stationary target for testing geometrical stability. Both the moon and the zenith views provide atmospheric absorption and emission spectra, similar to those encountered in viewing the earth from space.

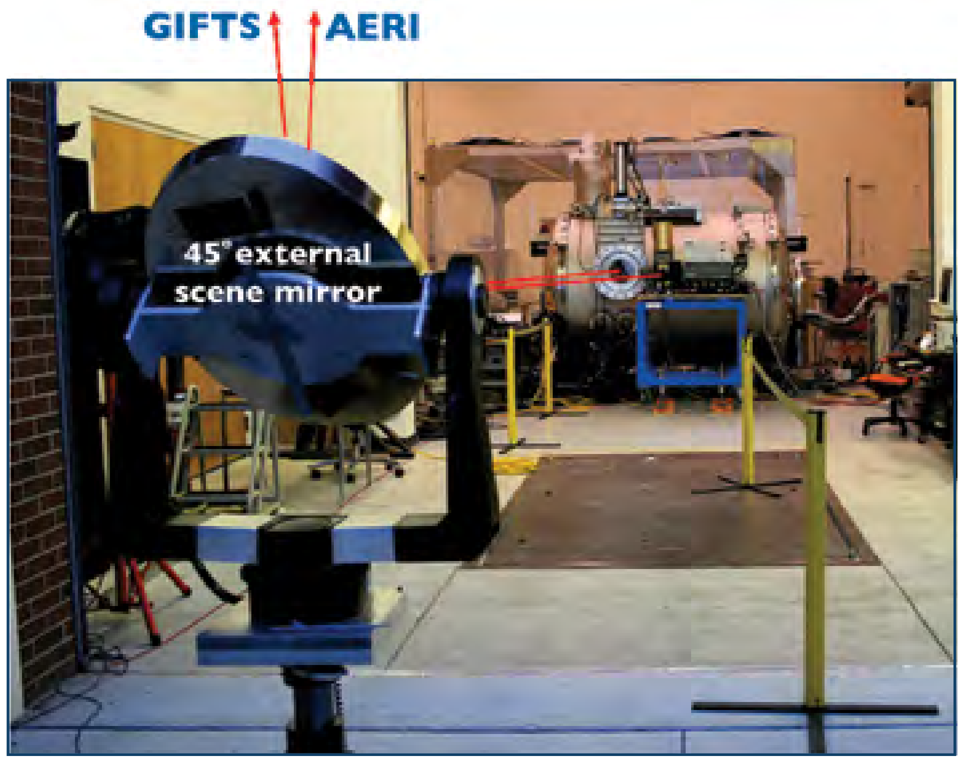


Figure 2. Zenith sky viewing configuration showing the GIFTS chamber and view port with AERI sitting along side (blue rectangle is AERI cart). The radiance intercomparison includes about 40 feet of horizontal path.

The zenith views provide a valuable quantitative test of radiometric and spectral calibration. For this application, Atmospheric Emitted Radiance Interferometer (AERI) instruments from SSEC were used as comparison standards. One AERI was placed very close to the GIFTS chamber window, and both were pointed at the same large mirror aimed to zenith (see Figure 2). This arrangement gave GIFTS and AERI nearly identical views of the downwelling radiance spectrum plus approximately 40 feet of horizontal air path. The AERI-bago instruments (including a second AERI, radiosonde launches, ceilometer, and in situ observation) were used to characterize atmospheric conditions and to independently measure the downwelling spectrum, thereby providing the information needed to calculate spectra for comparison. To allow accurate comparisons, the GIFTS and the thermal-vacuum chamber window were calibrated together using very large, high emissivity, external blackbodies. These blackbodies are the same ones used without a window for accurate GIFTS EDU sensor module radiometric calibration testing.

Comparisons of one GIFTS and one AERI spectrum are shown in Figure 3. More detailed analyses are needed to produce a complete interpretation of these comparisons, but these first atmospheric comparisons are generally excellent and evoke a great deal of excitement for getting GIFTS in orbit as soon as possible.

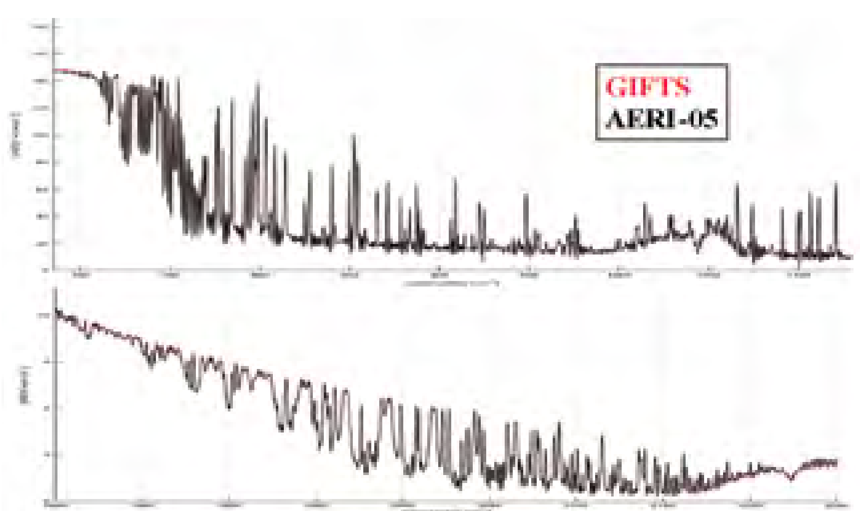


Figure 3. Representative GIFTS zenith spectrum compared to AERI spectrum.

Launch the future:
Plans for the Verner Suomi Science Museum

The Verner Suomi Science Museum, now in its initial planning stages, will capture over 40 years of breakthroughs in the atmospheric sciences. Named for the “Father of Satellite Meteorology,” the museum will showcase pioneering work in remote sensing technology and the integral role of SSEC in advancing weather and climate research. The Suomi Science Museum will evolve through collaboration with the University of Wisconsin–Madison’s Department of Atmospheric and Oceanic Sciences (AOS), other groups on campus and our federal partners.

UW–Madison has a well-deserved reputation as one of the premier research and education institutions in the world. In particular, UW-Madison researchers have used environmental satellites to revolutionize the way we view the Earth and its atmosphere. The success of Suomi’s spin-scan cloud camera and its continuous observations of cloud motions led to the development of a specific satellite devoted to monitoring the weather from geostationary orbit. This event marked an important scientific advance that has led to improved weather forecasts, cutting edge research on climate change and the development of better models for understanding weather and climate.

The museum will offer visitors a unique perspective on the history and future of satellite meteorology and other topics. Public education and information are integral to the University of Wisconsin, upholding the tradition of the Wisconsin Idea. This “Idea” rests on a general principle: the influence of university education should extend beyond the classroom. For more than a century, the Wisconsin Idea has guided university outreach efforts throughout Wisconsin and beyond.

The Suomi museum will communicate scientific progress, technological advances and related concepts in lively and engaging ways to various audiences. Telling this story through a museum offering interactive exhibits and outreach programs is a perfect expression of the Wisconsin Idea. The story is rich and interesting, and telling it well is essential to maintaining public understanding and support.

Located at street level of SSEC, the museum and accompanying auditorium will occupy approximately 6000 square feet of renovated space. When complete, the Suomi Science Museum will allow visitors of all ages and backgrounds to explore and understand our planet through interactive exhibits and dynamic content. §

Jean Phillips and **Tom Achtor**

museum.ssec.wisc.edu/

So, what are the steps needed to get GIFTS in orbit? At the request of NASA Headquarters, NASA LaRC has submitted a plan and estimated costs for building a flight model for launch in 2011. The complete plan requires a partnership with NOAA as recommended in the National Research Council report entitled “Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond,” informally known as the Decadal Survey. Herein lies a serious problem, also identified in the Decadal Survey: NASA support for NOAA applications is not identified as one of its primary responsibilities. In decades past this cooperation was crucial to our international leadership in the field. It is clear that this type of cooperation between the development and operational agencies is essential to the timely advancement of our operational capabilities consistent with the incumbent benefits to the nation. §

Hank Revercomb

www.ssec.wisc.edu/gifts/

Passive satellite cloud property retrievals

MODIS cloud detection and height evaluation using CALIPSO lidar observations

Because clouds modulate the Earth's energy balance, accurate long-term global measurements of cloud properties are needed to determine the impact of clouds on climate. Passive satellite cloud property retrievals have been operational for over thirty years with CIMSS/SSEC at the forefront in identifying the necessary spectral bands and developing cloud retrieval algorithms. In this article we present initial results from a one-month comparison of Moderate Resolution Imaging Spectroradiometer (MODIS) cloud top pressure and cloud mask using measurements from the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) on Cloud Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO).

Evaluating the performance of passive cloud property retrievals has proven challenging as until recently, comparisons were limited to a small number of collocated lidar and radar measurements from ground and aircraft platforms. Because of a lack of global evaluation measurements, it has been difficult to access the global quality and sensitivity of the satellite retrievals. The Geoscience Laser Altimeter System (GLAS), launched on board the Ice, Cloud and Land Elevation Satellite (ICESat) platform in January 2003 provided the first autonomous lidar measurements from space. While GLAS measurements have proved to be a valuable resource for evaluating passive IR cloud retrievals, the infrequent coincidence with IR measurements results in a relatively small number of coincident Advanced Very High Resolution Radiometer (AVHRR) and MODIS retrievals.

On 28 April 2006 our evaluation capability took a significant leap forward with the launch of the NASA CALIPSO mission as part of the A-Train system of satellites. The near coincident orbits of CALIPSO and Aqua provide global, continuous, and near coincident active and passive cloud retrievals for the first time.

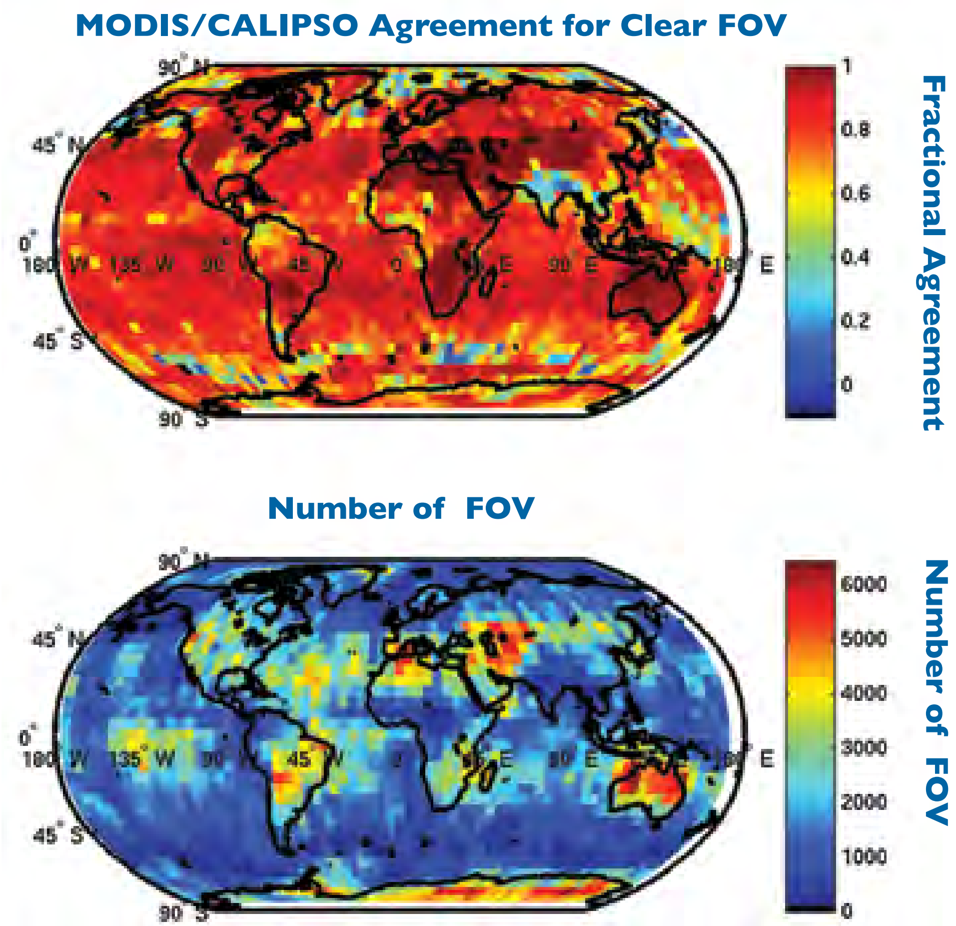


Figure 1. The fractional agreement between the MODIS and CALIOP cloud mask for clear FOV is presented in the top image. The fractional agreement is calculated at 5-degree resolution in the figure. A grid cell with perfect MODIS agreement will have a fractional agreement of 1 (red) while regions of poor agreement are colored blue. The bottom figure presents the number of MODIS FOV for each grid cell used to generate the fraction agreement.

In order to conduct the comparison and achieve accurate results, we accounted for the different spatial sampling characteristics of the CALIOP and MODIS measurements. We developed an accurate collocation algorithm designed to match corresponding active nadir satellite measurements with imager data. The CALIPSO orbit oscillates across the MODIS swath requiring the collocation to both identify the MODIS pixel transected by CALIOP and identify the CALIOP shots within each MODIS Individual Field of View (IFOV). Processing the collocation and combining the measurements requires significant computational and storage resources. The SSEC/CIMSS Atmosphere Product Evaluation and Algorithm Test Element (PEATE) effort funded by NASA as part of the NPOESS Preparatory Project (NPP) provided the processing capability to evaluate one month of collocated global CALIOP and MODIS cloud mask and cloud top height retrievals for August 2006.

	Clear	Cloudy
Day/Night	0.83	0.91
Day	0.86	0.95
Night	0.80	0.87

Table 1. Global MODIS/CALIOP cloud mask agreement for clear and cloudy scenes during the month of August 2006. The results are separated into total, day, and night results.

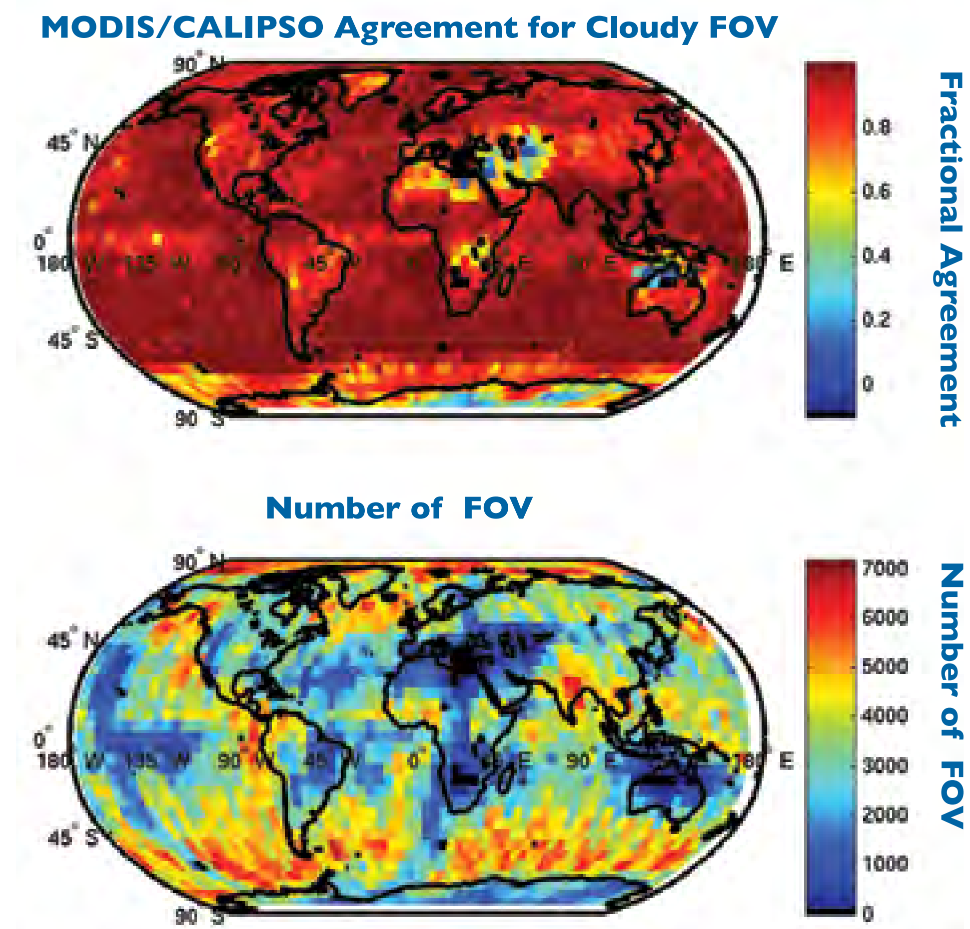


Figure 2. The fractional agreement between the MODIS and CALIOP cloud mask for cloudy FOV is presented in the top image. The fraction agreement is calculated at 5-degree resolution in the figure. A grid cell with perfect MODIS agreement will have a fractional agreement of 1 (red) while regions of poor agreement are colored blue. The bottom figure presents the number of MODIS FOV for each grid cell used to generate the fraction agreement.

Cloud Detection

The MODIS 1 km cloud mask was evaluated using the collocated CALIOP L2 cloud detection retrievals. The MODIS 1 km resolution results in approximately four coincident CALIOP measurements within each MODIS IFOV. In this study a MODIS IFOV is only considered for comparison when the CALIOP shots within the IFOV were all returned clear or cloudy. The sensitivity of MODIS cloud mask to partially cloud-filled IFOV will be investigated in future research. The global results of the cloud mask comparison are presented in Table 1. In this table the left column presents the agreement clear between MODIS and CALIOP while the right column is the agreement cloudy. A value of one would represent perfect agreement while a value of zero would indicate no agreement. The results have been separated into day and night, day, and nighttime agreement. For both day and nighttime cloud detection the MODIS cloud mask is in closer agreement with CALIOP for cloudy scenes compared to clear IFOV. This result is not unexpected as the MODIS cloud mask was designed to be clear sky conservative; if there is uncertainty in the spectral tests, MODIS will determine the field of view cloudy. When the results are separated by day and night, the daytime agreement with CALIOP improves. The daytime MODIS cloud mask utilizes reflectance channels that are not available at night; the additional information should improve the MODIS cloud mask sensitivity, which CALIOP confirms.

The MODIS cloud mask retrieval is sensitive to both surface and atmospheric properties that can have significant regional variation. To investigate the regional performance of the cloud mask, the results in Table 1 were divided into five-degree grid cells with the results presented in Figures 1 and 2. The figures confirm that over much of the world CALIOP and MODIS are in good agreement, but there is considerable regional variation in results. For clear IFOVs, MODIS shows significant disagreement with CALIOP north of the coast of Antarctica, the northern portion of South America, along the inter topical convergence zone (ITCZ) at around 10 N latitude, and in the northern Pacific and Atlantic oceans.

(ctd. page 8)

CALIPSO/MODIS

(continued from page 7)

Cloud Top Height

The L2 MODIS cloud top pressure retrieval is produced using 5 km average MODIS IR radiances. To investigate the MODIS cloud top pressure retrievals, the collocation was adapted to the larger IFOV resulting in an average of 15 CALIOP measurements collocated within one MODIS 5 km IFOV. To compare the MODIS cloud top pressure to the CALIOP cloud top height retrieval, the MODIS cloud pressure retrievals were converted to cloud top height using a model pressure profile. For each cloudy MODIS IFOV the mean collocated cloud top height was calculated using the collocated CALIOP retrievals. The MODIS/CALIOP cloud top height differences were then calculated using the converted MODIS cloud top height and the mean of the collocated CALIOP cloud top heights within the MODIS 5km IFOV. The distribution of MODIS/CALIOP global results from the comparison is presented in Figure 3. A negative difference occurs if the MODIS cloud top height is beneath CALIOP while a positive difference results if the MODIS cloud top height is above CALIOP. For the month of August 2006 the mean cloud height difference, excluding the polar regions (-60 > Latitude <-60) is found to be -1.28 km. In Figure 3 the distribution is separated into low and high clouds using the CALIOP derived cloud heights. For low clouds (CALIOP cloud top height < 5 km) the global cloud height difference has a mean of -0.19 km. There is a small but significant "bump" in the low cloud distribution (MODIS cloud height greater then CALIOP). For high clouds (CALIOP cloud top height >5 km) the mean difference is significantly larger (-2.48 km) and the distribution wider (STD = 3.9 km). There is a significant tail in the high cloud distribution with differences larger than 15 km.

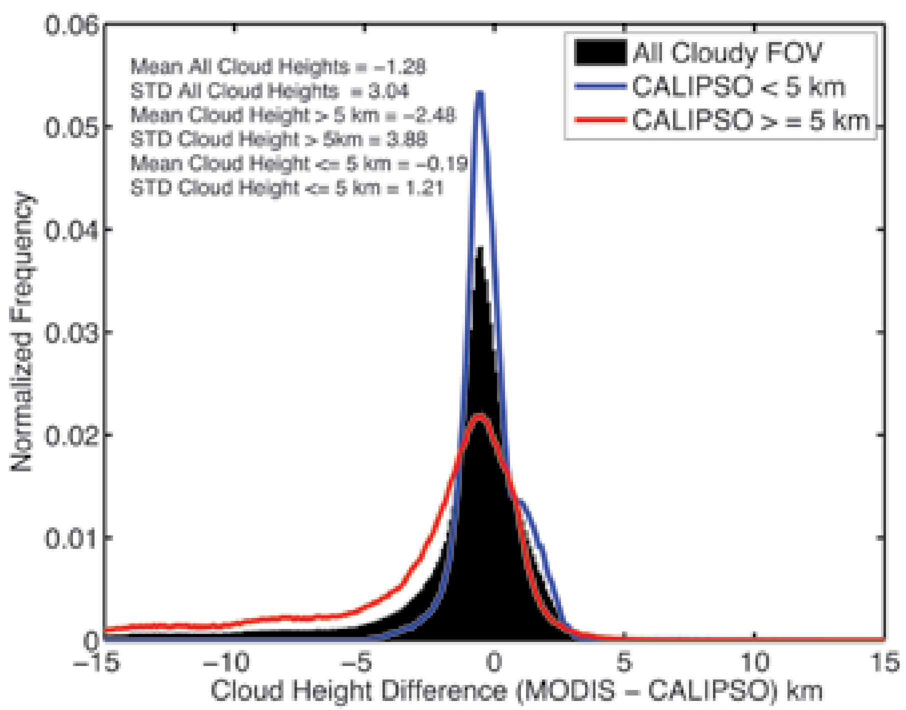


Figure 3. The histogram of the global cloud height differences between MODIS and CALIOP is presented. The polar regions (-60 < Latitude < 60) have been excluded from the comparison. A negative difference occurs if the MODIS cloud top height is below CALIOP. The solid black distribution includes both high and low clouds. The red and blue distribution have been separated into high and low clouds, respectively.

The MODIS cloud top retrieval performance is sensitive to the cloud properties and uncertainties in the atmospheric profile used in the retrieval. Because of the significant regional variation in both the cloud characteristics and model atmospheric profile uncertainty, a regional dependency on the performance of the MODIS cloud top pressure retrieval would not be unexpected. To investigate the regional cloud height differences, MODIS/CALIOP mean cloud height differences were separated into 5-degree grid boxes for August 2006 with the results presented in Figure 4. A regional dependence of MODIS cloud top height retrievals was found with MODIS consistently underestimating the cloud top heights compared to CALIOP along the ten degrees latitude region (ITCZ), a region with considerable thin cirrus. The MODIS overestimation of the cloud top height for low clouds (the "bump" in Figure 3) occurs in regions of marine stratus (northern United States Pacific coast, western coast of South America and western coast of southern Africa). The systematic overestimation of the cloud height has been identified. A modified retrieval is currently in development and will be re-evaluated using CALIOP.

To summarize, the one-month comparison demonstrates that over much of the world there is good agreement between the MODIS and CALIOP cloud detection with global differences of 17% and 9% respectably for clear and cloudy detection. At regional scales, cloud detection differences can be significantly larger with the largest disagreement in the polar and desert regions. For cloud height retrievals the comparison reveals significant disagreements with a strong regional dependence between MODIS and CALIOP. Over ocean stratocumulus, there is a systematic high bias of 1-2 km in the MODIS retrievals while for regions with significant cirrus, MODIS tends to underestimate the cloud height relative to CALIOP with differences often greater then 3 km. Future research will investigate the source of these differences with a focus on improving the MODIS cloud retrievals. §

Bob Holz and Steve Ackerman

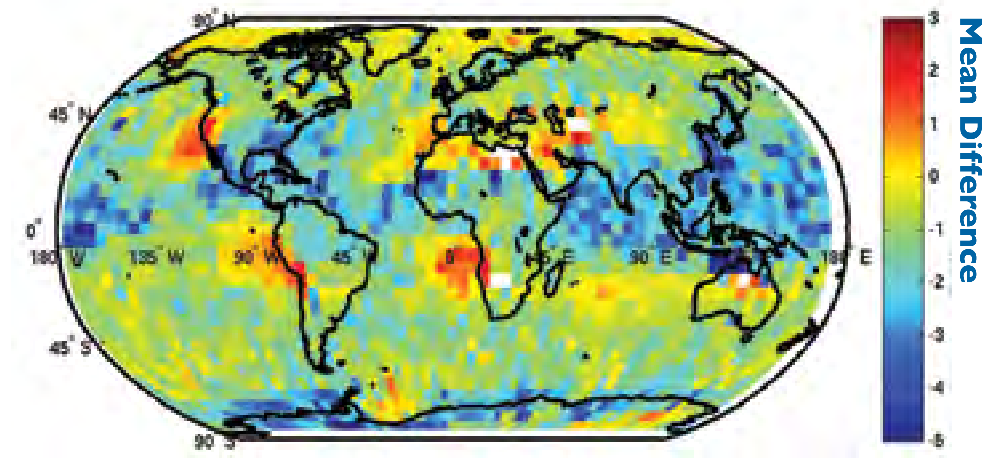
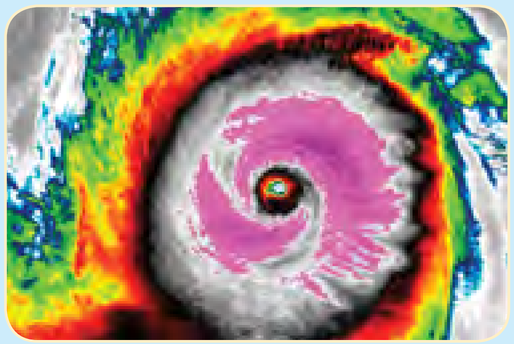


Figure 4. The mean cloud top height difference. For each 5-degree grid box the mean cloud height difference (MODIS – CALIOP) is calculated. A negative difference (blue) results when mean MODIS cloud height is below the CALIOP. If less than 50 fov are found within a 5-degree box, a mean cloud height difference is not presented.

CIMSS Satellite Blog:

After 10 years, the popular CIMSS GOES Gallery passed the baton to the CIMSS Satellite Blog. The Gallery debuted in 1996 when I started working at CIMSS. As was the original mission of its predecessor, the Blog showcases examples of some of the meteorological satellite images and products that are available to (or created by) scientists and researchers at CIMSS, and serves as a diverse collection of interesting cases that demonstrate the utility of satellite images and products in various aspects of weather analysis and forecasting.



In early June, super cyclone Gonu gathered strength in the Arabian Sea. Find details about this storm in the 05 June entry of the CIMSS Satellite Blog.

Initially, the GOES Gallery was nothing more than a simple repository for interesting cases to which I might later refer in my ongoing work with the Virtual Institute for Satellite Integration Training (VISIT) program. However, as the GOES Gallery continued to grow, those involved in satellite meteorology training, myself included, began to rely on this resource. The Gallery's popularity led me to keep it going through the years.

Using blog software to create more professional-looking HTML page layout, I can easily add new images and analyses. Posts are also cross-referenced so users can find quickly find related images and information. Frequent the CIMSS Satellite Blog to learn more about the role of satellite data in meteorology and to see impressive views of Earth from space. §

Scott Bachmeier

cimss.ssec.wisc.edu/goes/blog/

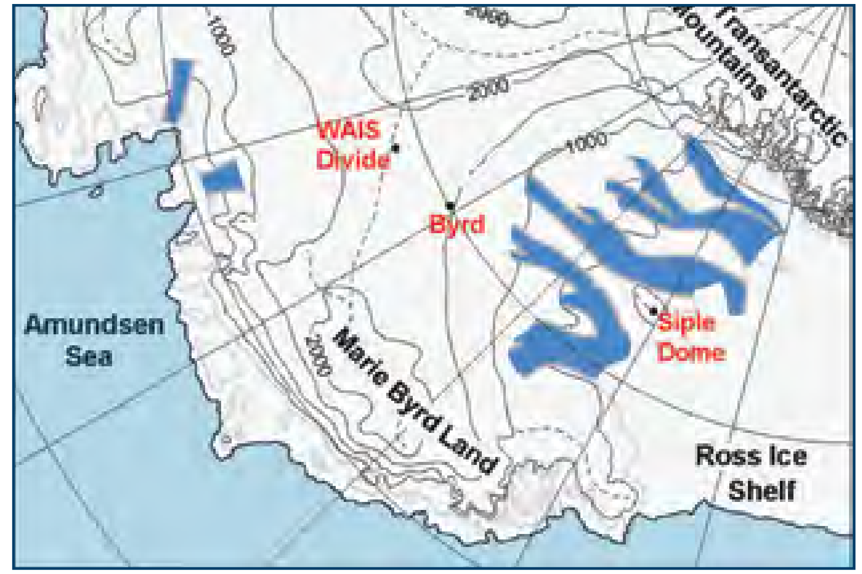
Retrieving ice cores for climate research

Ice cores play an important role in the study of the history of Earth's climate. By analyzing the gases, dust, ash, and other substances trapped in the layers of ice formed from annual snowfall in the Earth's cold regions such as Greenland and Antarctica, scientists can reconstruct Earth's climate thousands of years into the past. The Space Science and Engineering Center assists in this research through its Ice Coring and Drilling Services (ICDS) group, which provides the tools and field support to retrieve ice cores for scientific investigation.

ICDS will soon deploy its new Deep Ice Sheet Coring (DISC) drill and a drilling crew to collect ice cores in support of the West Antarctic Ice Sheet (WAIS) Divide Ice Core Project. Funded by the National Science Foundation, the main objective of the project is to retrieve continuous core to a depth of approximately 3,500 meters below the surface. The core will provide a climatic record for Antarctica for the past 100,000 years with a resolution that will allow scientists to determine conditions on an annual basis for the last 40,000 years.

The DISC drill replaces the PICO 5.2-Inch drill, which has been the primary drill for US deep coring projects. ICDS began detailed design and fabrication of the drill in June 2003 after a one-year conceptual design phase during which ICDS personnel worked closely with representatives of the ice coring community to define requirements and find means to meet those requirements. The DISC drill was successfully tested in Greenland during the Northern Hemisphere summer of 2006 and modifications to the drill are currently being completed before the drill goes to West Antarctica in September 2007.

The DISC drill is a "tethered" electro-mechanical drill that consists of a 16-meter down-hole portion (sonde) raised and lowered in the fluid-filled borehole by a winch via a cable approximately 15 mm in diameter. The sonde consists of six distinct and separable sections: (1) the cutter head assembly that actually cuts the ice, (2) the core barrel in which up to 4 meters of core is collected, (3) the screen section in which chips of ice resulting from the cutting operation are separated from the drilling fluid and stored, (4) the motor/pump section that houses a pump to circulate the drilling fluid and motors to drive the pump and rotate the lower portions of the drill that cut the ice, (5) the instrumentation section that contains controls for the pump and cutting motors as well as numerous sensors to monitor the drilling operation, and (6) the upper section that provides for the termination of the cable and "anti-torques" that center the drill and provide a torque reaction point to prevent the entire sonde from rotating. The cutter head, core barrel and screen section rotate while the sections above are restrained.



The cable that will be used at WAIS Divide is 3800 meters long and has multiple functions. First, it provides the support for lowering and raising the sonde. Second, the cable provides the electrical conductors to transmit power from the surface to the motors and instruments in the sonde. Finally, the cable houses optical fibers through which data are sent between the sonde and the surface control system.

The cable winch is electrically driven and is designed to have the smallest "footprint" possible. As the borehole becomes deeper, a substantial amount of time is required to raise and lower the sonde. Consequently, ICDS engineers designed the winch to be operated at the fastest practical speeds. The DISC drill winch is capable of raising the sonde at a speed of 3 meters per second.

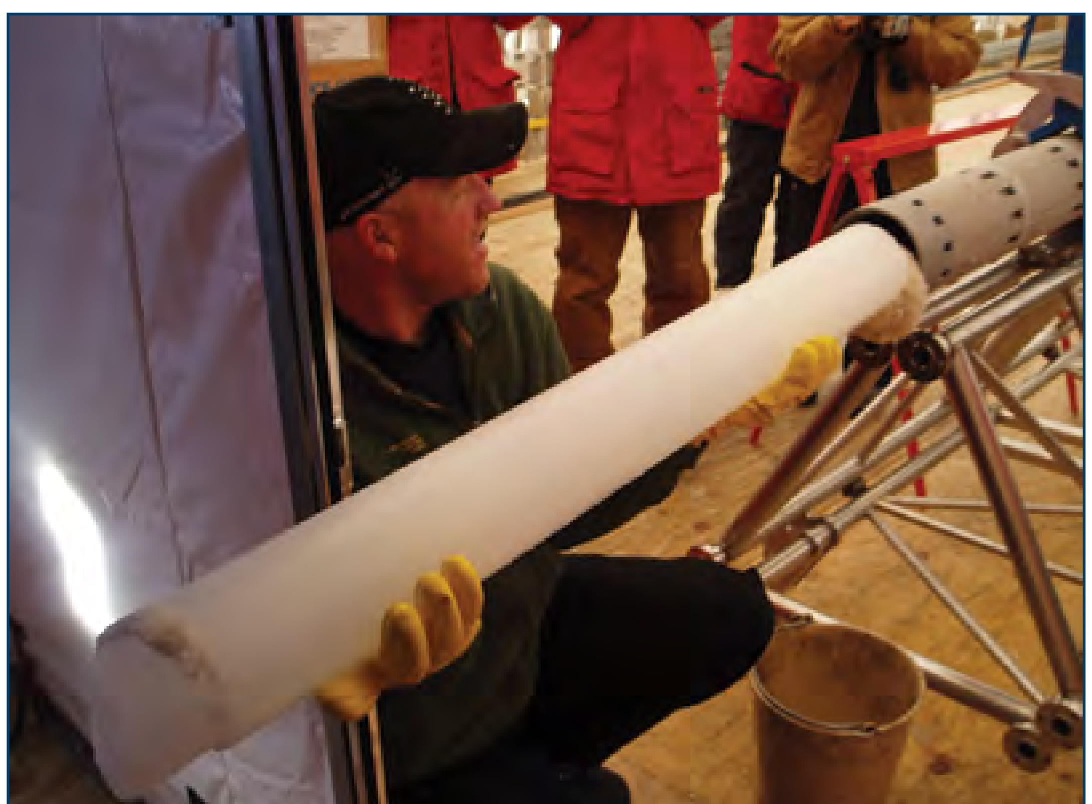
Another important component of the DISC drill system is the drill tower. The tower provides a structure above the entrance of the borehole from which cables can raise the drill sonde. The tower is designed so that it can be tilted to allow easy access to the drill sonde for removing ice core and chips, and servicing the sonde. A "slot" approximately 1.2 m x 9.5 m x 9.1 m deep must be dug into the ice to allow the drill to be moved from the horizontal to vertical position.

ICDS's work at WAIS Divide began during the austral summer of 2005-2006 when a drill crew cored several shallow holes to provide cores from the site before it was disturbed by construction activities. ICDS crews were also at the site during the 2006-2007 Antarctic field season to obtain additional shallow cores, to drill and case a pilot hole for the deep core, and to install gantry canes that will be used to set up the DISC drill. The DISC drill will be shipped from Madison in mid-September 2007 for installation at WAIS Divide in December. Actual coring is scheduled to begin in late December 2007 and will continue for up to six seasons. The ICDS drilling crew will consist of 10 people and will be a mix of full-time SSEC employees and seasonal personnel. §

Don Lebar

ICDS:
www.ssec.wisc.edu/icds/

WAIS project:
waisdivide.unh.edu/



An ICDS team tested the DISC drill in Greenland during summer 2006. In the image on the left, an ICDS technician removes the DISC drill's first core from the core barrel. On the right, the drill sonde sits on the tower. When upright, the tower supports the sonde as it descends into the hole and later returns to the surface. The map shows the WAIS Divide site.

From research to operations

SSEC/CIMSS support for National Weather Service forecast offices

In pursuit of a shared goal of improved weather prediction, research scientists at CIMSS have forged a strong collaboration with operational forecasters at the National Weather Service (NWS). Working closely with NWS forecast offices, CIMSS researchers have integrated several satellite and model products into the Advanced Weather Interactive Processing System (AWIPS) that NWS forecasters use to view satellite, radar, models, and other meteorological data.

In the summer of 2006, a team of CIMSS researchers began integrating two product streams into AWIPS: satellite data and products from the Moderate resolution Imaging Spectroradiometer (MODIS), and model forecast fields from the CIMSS Regional Assimilation System (CRAS). To facilitate the operational use of MODIS and CRAS images and products, the CIMSS team formatted the data to be compatible with the Display 2 Dimensions (D-2D) component of AWIPS workstations.

Less than one year after project inception, the efforts of the CIMSS team members have produced favorable results. The data are now being distributed to the NWS Central, Southern, Western, and Eastern Region AWIPS servers. As of June 2007, eight NWS offices are ingesting MODIS data into their local AWIPS workstations, and four offices are ingesting CRAS forecast imagery. The following MODIS images and products are being distributed to AWIPS: visible channel, snow/ice detection channel, shortwave IR channel, water vapor channel, IR window channel, cirrus detection channel, fog/stratus product, cloud phase product, cloud top temperature product, and sea surface temperature. The CRAS products include IR and water vapor channel forecast satellite imagery.

Recently, the CIMSS team also began distributing additional satellite products derived from the sounding instruments aboard Geostationary Operational Environmental Satellites (GOES) to the Central Region. The Milwaukee/Sullivan forecast office currently uses these GOES sounder products (total column ozone, and Convective Available Potential Energy, or CAPE) in making their forecasts.

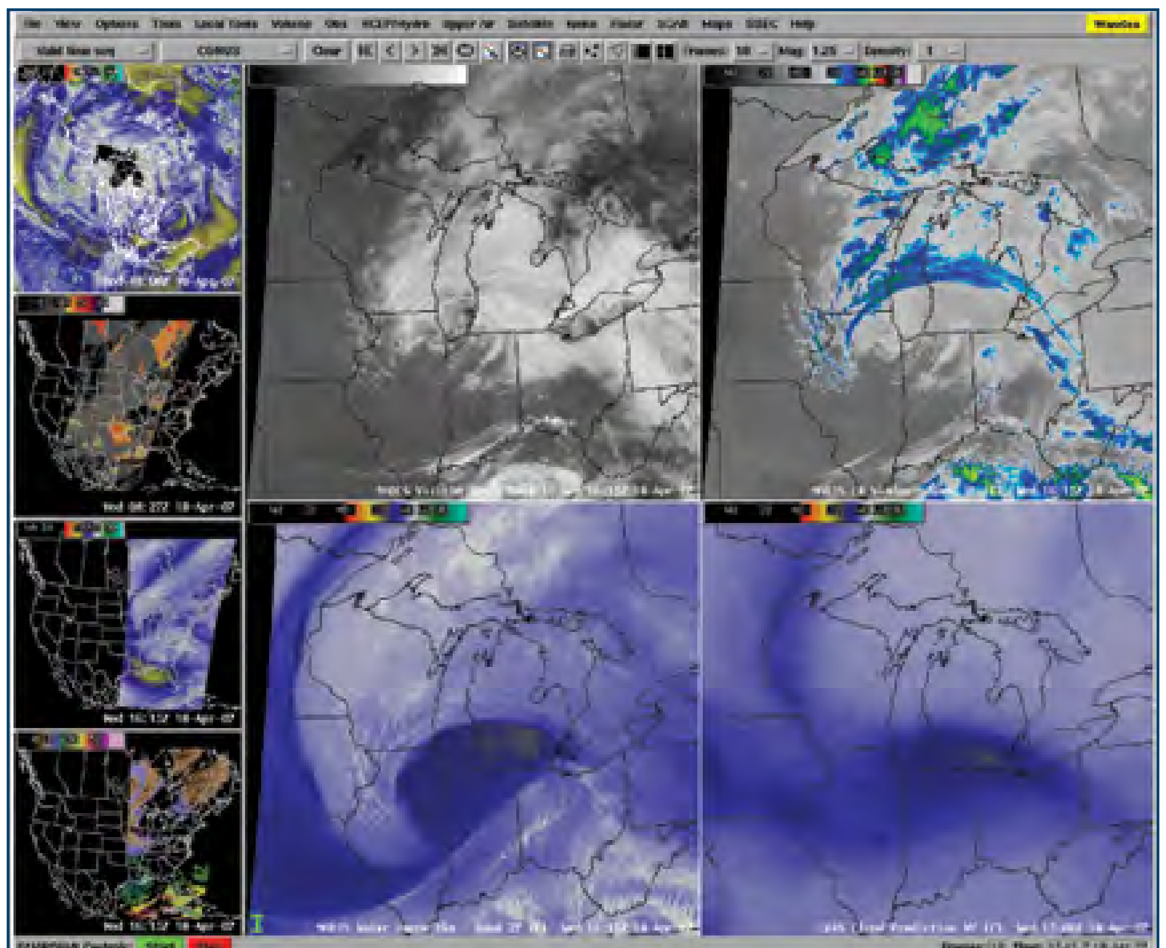


Figure 1. Screen capture of the D-2D component of AWIPS, showing some of the MODIS and CRAS products that are currently available to NWS forecasters.

NWS offices using MODIS data: La Crosse and Milwaukee, WI; Davenport, IA; Indianapolis, IN; Riverton, WY; Aberdeen, SD; Springfield, MO; Billings, MT

NWS offices using CRAS data: Indianapolis, IN; Milwaukee, WI; Riverton, WY; Springfield, MO

Due to its close proximity, the team selected the Milwaukee/Sullivan forecast office as the initial testing and installation site, and setup was completed during June/July 2006. Jordan Gerth, a CIMSS undergraduate researcher, leveraged his AWIPS experience gained at the Milwaukee forecast office in the Student Career Experience Program, and played a key role in developing the necessary AWIPS scripts and working with personnel at both the local NWS offices and the various NWS Regional Headquarters.

Forecasters at the Milwaukee/Sullivan office have found SSEC/CIMSS data useful and frequently reference these images and products in their daily forecast discussions. MODIS direct broadcast data has proven to be particularly useful because it has higher spatial resolution than the satellite imagery available from GOES, and SSEC/CIMSS has the ability to process and distribute the data quickly. Using these new satellite products today helps NWS forecasters prepare for the next generation of GOES and POES satellites. Scheduled for launch in 2009, the NPOESS preparatory satellite (NPP) will carry an instrument similar to MODIS. Scheduled for launch in 2014, GOES-R will include many of the satellite channels and products that are currently available using MODIS.

In addition to formatting and distributing SSEC/CIMSS satellite data products, the CIMSS team developed a new Virtual Institute for Satellite Integration Training (VISIT) distance learning lesson titled "MODIS Products in AWIPS." The first tele-training session was offered on November 1, 2006. To date, 14 "MODIS Products in AWIPS" VISIT lessons have been conducted with a total of 41 NWS offices participating. The "CRAS Forecast Imagery in AWIPS" lesson debuted in December 2006, and four CRAS lessons have been given with 11 NWS offices participating.

The CIMSS collaboration with NWS forecast offices continues as members of the project team visit new sites and follow up with current users. The team made a site visit to the forecast office at Milwaukee/Sullivan, WI in January 2007 to discuss the MODIS and CRAS products as well as the availability of more products. A similar site visit was made to the La Crosse, WI forecast office in March 2007. These site visits have helped to perpetuate a strong collaboration between SSEC/CIMSS and the local NWS forecast offices. §

Scott Bachmeier

Remembering Tom Zapotocny

The University of Wisconsin and the atmospheric science community as a whole recently lost a valuable scientist. Tom Zapotocny, long-time SSEC researcher and UW-Madison graduate, passed away on March 6, 2007.

During his time at SSEC, Tom participated in studies to ascertain the benefit of satellite data to numerical weather prediction models. This data impact research extended to a strong collaboration with Jim Jung and other scientists at the Joint Center for Satellite Data Assimilation. Together, Zapotocny and Jung did the initial and significant subsequent work to integrate data from the MODerate-resolution Imaging Spectrometer (MODIS) and the Atmospheric InfraRed Sensor (AIRS) into numerical weather prediction models. The results indicated substantial improvement in NCEP's Global Forecast System.

Zapotocny worked on developing and improving the global UW Hybrid Model. He also contributed to the combination of the UW Hybrid Model with a chemical modeling system developed at NASA to create the Real-time Air Quality Modeling System.

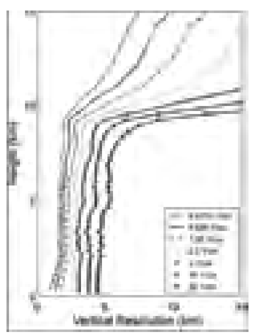
Colleagues will remember Zapotocny's dedication to his work and his important scientific contributions to numerical weather prediction and satellite data impact studies. §

Highlights of recent publications

Kossin, J. P.; Knapp, K. R.;Vimont, D. J.; Murnane, R. J. and Harper, B. A.. **A globally consistent reanalysis of hurricane variability and trends.** Geophysical Research Letters, Volume 34, 2007, Doi: 10.1029/2006GL028836, 2007.

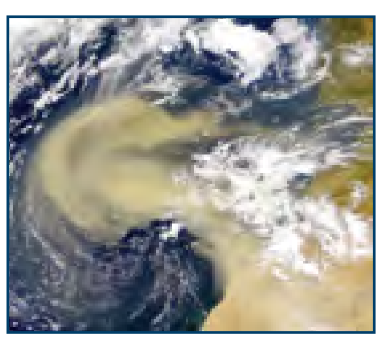
Upward trends in global hurricane activity have been identified in the existing historical records, but the fidelity of these records is uncertain and this ambiguity has cast broad doubt on the veracity of the trends. To address this issue, we constructed a homogeneous global record of hurricane intensity by applying a new algorithm to a large archive of carefully reanalyzed satellite imagery, and found that previously documented global trends are inflated and potentially spurious. Our findings imply that consideration of increasing tropical sea surface temperature alone is not sufficient for understanding or predicting hurricane variability in our warming climate.

Wang, Fang; Li, Jun; Schmit, Timothy J. and Ackerman, Steven A.. **Trade-off studies of a hyperspectral infrared sounder on a geostationary satellite.** Applied Optics, Volume 46, Issue 2, 2007, pp.200-209.



This paper summarizes trade-off studies on spectral coverage, spectral resolution, and signal-to-noise ratio for the hyperspectral infrared sounder on a geostationary satellite. We investigate the effects of spectral coverage, spectral resolution, and signal-to-noise ratio on vertical resolution and retrieval accuracy. With the appropriate spectral coverage, we find that a hyperspectral IR sounder with appropriate signal-to-noise ratio can achieve the required science performance (1 km vertical resolution, 1 K temperature, and 10% relative humidity retrieval accuracy).

Evan, Amato T.; Heidinger, Andrew K. and Knippertz, Peter. **Analysis of winter dust activity off the coast of West Africa using a new 24-year over-water advanced very high resolution radiometer satellite dust climatology.** Journal of Geophysical Research, Volume 111, 2006, Doi: 10.1029/2005JD006336, 2006.



In this paper, we describe a new 24-year satellite dust dataset and use it to understand what causes the year-to-year changes in wintertime dust loadings over the tropical North Atlantic. Our results corroborate previous research that found a strong relationship connecting dust activity, the North Atlantic Oscillation, and Sahelian rainfall. We also use satellite observations of 'greenness' to suggest that vegetation density across the Sahel is also an important control on dust activity observed over the Atlantic, which has been implied by modeling results but yet observed.

Zapotocny, Tom H.. **Publications of Tom H. Zapotocny**. University of Wisconsin-Madison, Space Science and Engineering Center, Schwerdtfeger Library, Madison, WI, 2007.

SSEC welcomes the Environmental Remote Sensing Center

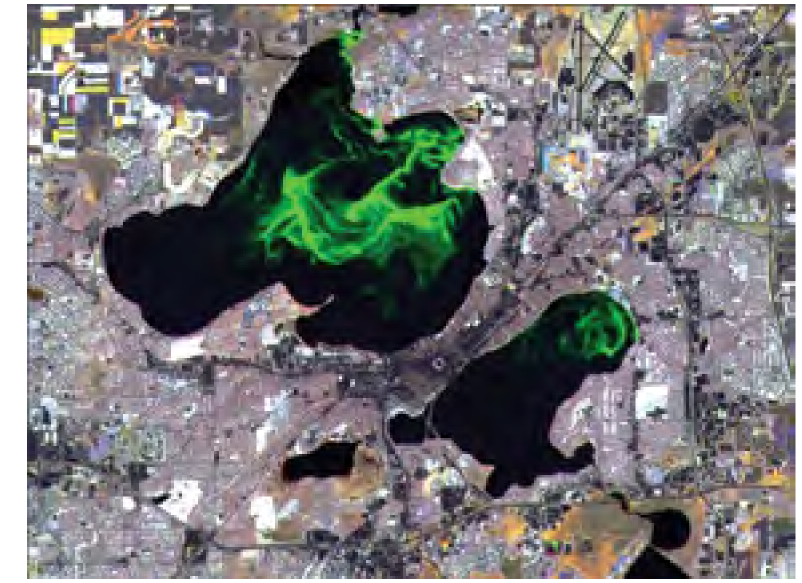
Integrating studies of the Earth with those of the atmosphere and beyond, the Environmental Remote Sensing Center (ERSC) joined SSEC in January 2007. This union facilitates unique opportunities to study interactions between the Earth and its atmosphere.

The ERSC team uses remote sensing technologies to explore the Earth in various ways, including: mapping tornado damage tracks; monitoring algal blooms in lakes; mapping wetlands; quantifying urban sprawl; assessing agricultural land use; and supporting environmental management, transportation planning, and emergency management.

Supported by NASA, the latest ERSC initiative involves studying and monitoring water levels and biophysical conditions in large lakes around the world with data from a variety of satellite-based instruments.

In addition to research activities, ERSC also engages the public through education and outreach programs. Among these efforts are "WisconsinView," a remote sensing data distribution and education consortium funded by the U.S. Geological Survey; and the "MapTEACH" geospatial education and outreach project in Alaska, funded through a collaborative grant from the National Science Foundation.

A collaborative pilot study has already resulted in new techniques for displaying real-time weather data in geographic mapping applications. Working together across the disciplines creates new avenues for advancing understanding of our Earth and its systems. §



This image of the Madison lakes was created using a variety of digital image processing techniques to enhance three separate Landsat-7 images from different dates in 1999-2000 and combine them into a single composite image. The results provide a dramatic view of an algal bloom that was occurring on Lakes Mendota and Monona in late October, 1999.

Sam Batzli

www.ersc.wisc.edu/

Honors and Awards

Paul Menzel

NESDIS Distinguished Career Award "for innovative contributions and international leadership in the field of satellite remote sensing, resulting in improved measurements, applications, and understanding of global weather and climate"

University of Wisconsin-Madison Department of Physics Distinguished Alumni Fellow Award

Tim Schmit

NOAA Bronze Medal "for reducing costs and increasing satellite earth science global data distribution and archiving through world-leading R&D in data compression"

Allen Huang

Named the first Distinguished Scientist in the University of Wisconsin-Madison's Graduate School

Elected by his peers to be co-chair of the International TOVS Working Group

Larry Sromovsky

University of Wisconsin-Madison's Chancellor's 2007 Award for Excellence in Research by an Independent Investigator

Suomi Scholarship Winner

Michael Phillips of Fond du Lac High School won the 2007 Verner E. Suomi Scholarship Award for Outstanding Achievement in the Physical Sciences. Phillips hopes to attend either UW-Madison or UW-Platteville and plans to major in Math.

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

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