NOAA NESDIS
Center for Satellite Applications and Research

Satellite Meteorology and Climatology Division
Annual Report

Photo courtesy of Lockheed Martin

Artist's rendering of GOES-R Spacecraft

2009

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Message from Mitch Goldberg, Chief,

Satellite Meteorology and Climatology Division

On behalf of the Satellite Meteorology and Climatology Division (SMCD), it is my pleasure to present the Fiscal Year 2009 Report. This report summarizes the major activities and accomplishments within my division throughout the year.

As an organization focused on the research and development of new satellite products, SMCD is actively engaged and committed to improve and expand the use of satellite data for monitoring global meteorological, environmental and climatological conditions.

I am very proud to share this report on our accomplishments, which include the Division's completed tasks, highlights from workshops and meetings attended, published papers, and training provided during the 2009 Fiscal Year.

We contributed to the Center for Satellite Applications and Research's (STAR) mission through the following outcomes:

- **Ensuring high quality calibrated observations and products**
  - Intercomparison of SeaWiFS, MODIS and AVHRR/MetOP using the Dome C Radiometric Reference Standard
  - Completion of NOAA-19 Validation
  - AVHRR Lunar NDVI for Climate Change Detection
  - Twenty Nine Year MSU Radiance and Deep-Layer Temperature CDRs
  - NPROVS Archive Products
  - GSICS Routine Inter-Calibration of AIRS and IASI with all GEOs
  - Microwave Sounding Unit (MSU) Calibration
  - GSICS Microwave Intersensor Calibration Baseline Algorithm
- **Improved utilization of satellite observations**
  - Improved Microwave Sea Surface Emissivity for Better Radiance Assimilation
  - First operational Greenhouse Gas Products
  - Monitoring Atmospheric Carbon Dioxide
  - Mapping Nitrogen Dioxide (NO2) Pollution over the Globe
  - Extending the Community Radiative Transfer Model to the UV/Visible Spectrum
  - Correcting Satellite Vegetation Measurements for Effects of Volcanic Dust
  - Extending the Range of Weather Forecasts
  - Microburst Prediction
  - Aerosol Correction to NDVI
  - Assimilated Soil Moisture products
- **Transition to Operations**: **Products below were transitioned to NESDIS Office of Satellite Data Processing and Distribution (OSDPD)**
  - MTSAT – IR Winds
  - Microwave Integrated Retrieval System for DMSP-F16
  - Full-disk GOES Imager Surface and Insolation Product (GSIP-fd)
  - NOAA – 19 Launch support and transition to operations
  - Hydro-Estimator
- **Leadership and Development of new Algorithms and Applications for Future Operational Satellite Observing Systems (NPOESS and GOES-R)**

- AWG Algorithm Development and GOES-R instrument Cal/Val
- Vegetation Health from GOES-R
- NPP Ozone Mapping and Profiler Suite (OMPS) Cal/Val Program
- GOES-R Land Products Validation
- A Multi-year MSG SEVIRI Dataset for GOES-R Algorithm Development and Testing
- Version 2 Software Package for GOES-R Rain Rate Algorithm
- Validation plan for GOES-R ABI Active Fire Product

— **National and International Collaborations**:
- CEOS (Committee on Earth Observations Satellites) WGCV (Working Group on Calibration/Validation) Meeting
- CEOS Land Surface Imaging Constellation
- Advanced Research Workshop on Using Satellite and in Situ Data to Improve Sustainability in Kyiv, Ukraine
- GSICS, CEOS, and CGMS
- Cooperative Work on Feng-Yun-3 Satellite Ozone Instruments: Total Ozone Unit (TOU) and Solar Backscatter Ultraviolet Sounder (SBUS)
- GTOS Assessment Report on the Fire Disturbance Essential Climate Variable (ECV) for UNFCCC
- USGEO Health Task Force

— **Education, Outreach and Training**:
- The 2nd Workshop on Remote Sensing and Modeling of Surface Properties
- JCSDA 7th Science Workshop on Satellite Data Assimilation
- Workshop on AVHRR and HIRS Climate Data Records
- Instructor at South Dakota State University
- Membership on Graduate Committees and Research Supervision at CREST
- Guest Lectures and Membership on Graduate Committees at the University of Maryland, Department of Geography
- VISIT Training, 11 Sessions, 58 NWS Students & 1 Spanish Meteorological Agency (Agencia Estatal De Meteorología, AEMET), 19 Offices

I would like to say goodbye and congratulations to Sid Boukabara and Patricia Thompson. Sid was promoted as a Senior Data Assimilation Scientist within STAR and appointed as the Deputy Director of the Joint Center for Satellite Data Assimilation (JCSDA). Patricia is currently a stay-at-home mom. In the past year she became an integral part of the support staff at SMCD. Her help and support to me as Chief has been invaluable. You both will be dearly missed. Congratulations on all you have done and much success in the future.

Please join me in welcoming Danette Warren who joined us earlier this year. “Who we are” gives more details. Ms Warren’s experience will bring new insight and expertise to our team, and complement our existing strengths.

I hope you enjoy reading our accomplishments. Although these are a representative sample of my Division’s scientific activities in FY09, they demonstrate the dedication of the hard-working staff in SMCD. I am confident that our highly talented staff and our commitment to investment in research and development will continue to support further progress in the year ahead. I look forward to working closely with our team and partners for many years to come.

Mission

SMCD conducts research and develops new satellite products to improve and expand the use of satellite data for monitoring global meteorological, environmental and climatological conditions. The Division conducts an end-to-end program ranging from planning new satellite instruments to developing new satellite products and applications and transitioning these developments to operations in NOAA's weather, climate, and environmental monitoring and prediction systems. Most of the Division's research and development falls in the following discipline areas:

- Atmospheric variables - temperature, humidity, winds
- Land surface variables - vegetation, snow and ice cover
- Hydrological Cycle variables - precipitation, clouds, water vapor
- Environmental hazards - aviation hazards, air quality, fires, heavy rainfall and flash floods, drought
- Climate variables - ozone, Earth radiation budget, aerosols, greenhouse gases

In addition to developing new and improved products, we conduct the following crosscutting activities:

- Calibrating satellite instruments
- Transitioning research products to operational production
- Developing radiative transfer models for the National Weather Service (NWS) Numerical Weather Prediction (NWP) satellite data assimilation systems
- Developing and analyzing long-term satellite data sets for studying and assessing climate change
- Planning and preparing for new satellite instruments

To execute its activities, SMCD has an active visiting scientist program, an extensive task order contract support system - which provides scientists and software specialists to support the SMCD investigators – and access to Cooperative Institutes via grants. Its scientists also collaborate with colleagues both nationally and internationally.

Who We Are

Setting within NOAA

SMCD is one of three units in the NESDIS Center for Satellite Applications and Research (STAR). The other units are the Satellite Oceanography and Climatology Division (SOCD) and the Cooperative Research Program (CoRP). STAR is the science arm of NOAA's National Environmental Satellite, Data and Information Service (NESDIS) and provides leadership, guidance, and direction for NESDIS research, development, and applications activities with respect to satellites and satellite data. The main objectives of STAR are to ensure that satellite remote sensing data and information products are of the highest quality possible and to enhance their utilization to enable NOAA to fulfill its mission to understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs. STAR conducts research and develops satellite products for meteorological, climatological, oceanographic, and land surface applications by NOAA's operational and research components. STAR is a vital link in NOAA’s research to operations pathway.

Key development activities include the NPOESS Data Exploitation (NDE), GOES-R, Climate Data Records (CDRs), and the GSICS.

Organization

Sensor Physics Branch

The Sensor Physics Branch oversees the calibration of all of NOAA's Earth observing satellite instruments and develops many of the atmospheric products derived from satellite observations. It researches state-of-the-art algorithms for profiling atmospheric temperature and water vapor, ozone, air quality, carbon cycle and hydrological products from operational and research satellite instruments. It develops, upgrades, and maintains the Community Radiative Transfer Model, which is used for data assimilation in the numerical weather prediction models of the NWS, NASA, and DoD. It develops and tests advanced retrieval algorithms for current and future satellite observing systems. The Branch also strongly supports the NOAA climate goal through its retrospective reprocessing of satellite observations of ozone and other important constituents to produce long term Climate Data Records. It also participates in the design, planning, and preparation for next generation satellite systems.

Environmental Monitoring Branch

The Environmental Monitoring Branch develops satellite-based land surface, climate, and environmental hazards products. Its vegetation, snow and ice cover products are used as initial or boundary conditions for NWS weather prediction models. The Branch's Earth Radiation Budget, cloud, and aerosol products help scientists to better understand critical climate processes. Its heavy rainfall, fire, and drought products provide early warnings for destructive environmental hazards. The Branch also constructs long-term satellite-based data sets of Earth Radiation Budget, clouds, aerosols, vegetation, and atmospheric temperature for monitoring global climate change. It also participates in the design, planning, and preparation for next generation satellite systems.

Operational Products Development Branch

The Operational Products Development Branch (OPDB) is the main conduit for transferring new science into NESDIS operations for both geostationary and polar satellites, and provides support in training NWS and DoD forecasters to correctly utilize and interpret satellite products. The OPDB transitions research products to operations. The Branch transitions the science algorithms developed by SMCD for atmospheric sounding, wind, and convection intensity products to operational processing systems for the NESDIS Office of Satellite Data Processing and Distribution (OSDPD). It also develops satellite products for use by the aviation sector, such as aircraft icing, volcanic ash hazards, and fog and low ceiling events.

NOAA-NASA-DoD Joint Center for Satellite Data Assimilation (JCSDA)

SMCD provides support to the JCSDA through its staff who work on JCSDA Directed Research programs and also through collaboration with the extramural community through a Federally Funded Opportunity to develop advanced data assimilation sciences.

The JCSDA was established by NOAA, NASA, and DoD to accelerate and improve the quantitative use of research and operational satellite data in weather and climate analysis and prediction models. It is part of the Environmental Modeling Program, under NOAA's Weather and Water Goal, which provides model-based estimates of current and future states of the environment at multiple time scales. These estimates are based upon a wide array of observational data and ever more refined modeling techniques. The program maintains a suite of operational models to meet current needs as well as a research and development program for improved performance and new capabilities in future generations of environmental models.

The vision of the JCSDA is an interagency partnership working to become a world leader in applying satellite data and research to operational goals in environmental analysis and prediction. The major short term goal of the JCSDA is:

- Contribute to making the forecast skill of the operational NWP systems of the JCSDA partners internationally competitive by assimilating the largest possible number of satellite observations in the most effective way.

Additional goals include:

- Reducing from two years to one year the average time for operational implementation of new satellite technology
- Improving and increasing uses of current and future satellite data in NWP models
- Assessing the impacts of data from advanced satellite instruments on weather and climate predictions

Staff

SMCD's most important asset is its employees. Thus, our organization works diligently to attract and maintain a staff of highly qualified and motivated professionals. Our staff members are accustomed to working on projects and problems requiring close team work, and innovative solutions. Their record of research and publications, their product maintenance, validation, improvement and development, and also their scientific collaboration and leadership is evidence of the Division's success. Below are photos of the civil servant staff members and a list of the contract support staff.

CHIEF
Goldberg, Mitch

Tammie Herrin

Danette Warren
JOINED - August

SENSOR PHYSICS BRANCH

Branch Chief

Weng, Fuzhong

Barnet, Chris

Beck, Trevor

Cao, Changyong

Flynn, Larry

Han, Yong

Kleespies, Tom

Kondragunta, Shobha

Mo, Tsan

Wu, "Fred" Xiangqian

ENVIRONMENTAL MONITORING BRANCH

Branch Chief


Ivan Csiszar


Gallo, Kevin


Kogan, Felix


Kuligowski, Bob


Laszlo, Istvan


Li, Xiaofan


Vargas, Marco


Yu, “Bob” Yunyue

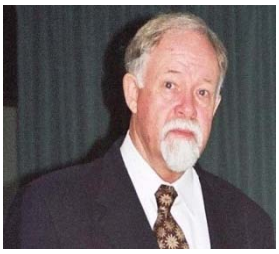

Zhan, “Jerry” Xiwu


Zou, Cheng-Zhi

OPERATIONAL PRODUCTS DEVELOPMENT BRANCH

Branch Chief


Hank Drahos


Chalfant, Mike


Daniels, Jaime


Pryor, Ken


Reale, Tony


Weldon, Roger


Wolf, Walter

New Staff Profiles

Danette Warren comes to us after 12 years with the contracting office of the Federal Aviation Administration, where she was a Project Assistant. She was responsible for the Division's Travel and TOSM budgets, webmaster for the Division, Knowledge Services Network (KSN) Administrator for several projects, and various other duties.

Contract Support Staff (listed alphabetically)

Mitch Goldberg, Chief, SMCD
Adams, Delshaun
Dowling, Deborah
Lowe, Ken
Ohring, George/ JCSDA
Price, Julie
Valenzuela, Tess

Fuzhong Weng (Sensor Physics Branch)

Beach, Eric
Chen, Ruiyue / U-MD
Chen, Wanchun
Chen, Yong
Cheng, Zhaohui
Cucurull, Lidia
Darnel, Jonathan
Divakarla, Murty
Fu, Gang
Gambacorta, Antonia
Garrett, Kevin
Grassotti, Christopher
Grotenhuis, Michael
Guo, Guang
Guo, Qingzhao
Hanna, Rafik
Hao, Yan
Iacovazzi, Bob
Iturbide-Sanchez, Flavio
Kim, Min-Jeong/ CIRA
King, Tom
Kongoli, Cezar
Koval, Larisa
Krasowski, Greg
Li, Yaping
Liang, Ding (Ellen)
Liu, Xingpin
Maddy, Eric
Nalli, Nick
Niu, Jianguo
Pachepsky, Yakov
Padula, Frank
Qian, Haifeng
Qiu, Shuang
Rowland, William
Sampson, Shanna
Sindic-Rancic, Gordana
Song, Yi
Sun, Fengying
Sun, Haibing
Sun, Ninghai
Swales, Dustin
Uprety, Sirish
Varma Raja, M. K. Rama
Vogel, Ronald
Wang, Likun
Wei, Jennifer
Xie, Hua
Xiong, Xiaozhen
Xu, Chuanyu
Yan, Banghua/ JCSDA
Yang, Hu (Tiger)
Yu, Fang Fang
Zeng, Jian
Zhang, Kexin
Zhang, Wendy
Zhao, Qiang
Zhao, Yunhui
Zhou, Mi
Zhu, Tong/ JCSDA

Ivan Csiszar (Environmental Monitoring Branch)

Chen, Ming	Liu, Hongqing
Ciren, Pubu/ U-MD	Liu, Jicheng
Davenport, Clay	Romanov, Peter/ CICS
Ellicott, Evan	Schroeder, Wilfrid / CICS
Guo, Wei	Tarpley, Dan
Hale, David / UCAR	Tian, Yuhong
Jelenak, Aleksandar/ UCAR	Xu, Hui
Kim, Hye-Yun	Zhang, Xiaoyang

Hank Drahos (Operational Products Development Branch)

Allegrino, Rico	Keehn, Peter
Appel, Igor	Liu, Quanhua 'Mark'
Atkins, Tom	Pettey, Michael
Bailey, Andrew	Sun, Bomin
Bresky, Wayne	Tilley, Frank
Brown, Charlie	Wang, Wenhui
Jensen, Ken	Zhang, Chen
Jung, Jim / CIMSS	Zhang, Zhaohui

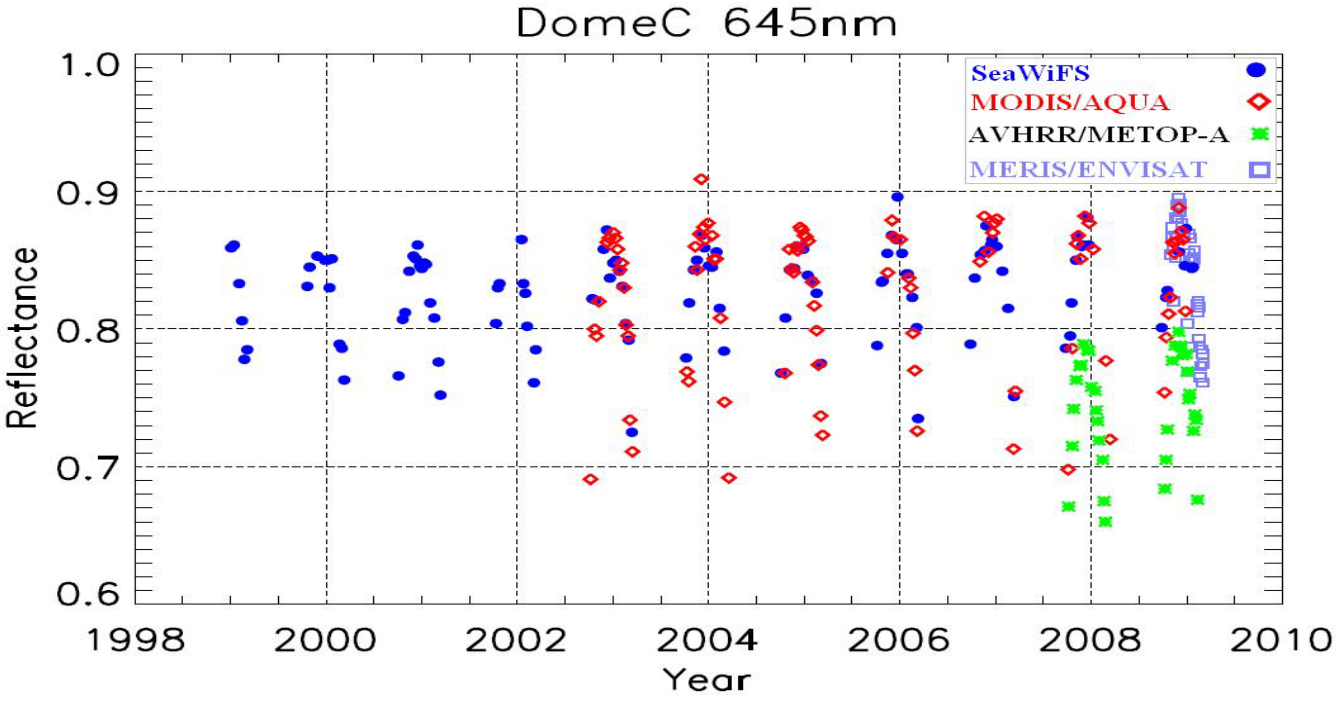
Accomplishments

Ensuring High Quality Calibrated Observations and Products

Good instrument calibration is critical to good products. Requirements for more accurate satellite information products are rapidly growing. As numerical weather prediction models become more reliable, their appetite for more accurate data input steadily increases. As the requirements for monitoring global climate become clearer – temperature changes as tiny as a few tenths of a degree Celsius per decade, ozone trends as small as 1%/decade – the measurements become more demanding. To create the stable long-term data sets needed for monitoring climate change it becomes vital to inter-calibrate sensors on different satellites. These are major challenges, but in 2009, our calibration scientists made a number of breakthroughs.

Looking at an Ice Sheet in Antarctica to Compare Satellite Instruments

P. Jing and C. Cao



Inter-comparison of satellite measurements of the reflectivity of Antarctic ice in the visible 640 nm band shows good agreement (+/-2%) between SeaWiFS, MODIS, and MERIS. AVHRR observations are consistently lower by ~10% due to uncertainties in the desert standard used for AVHRR calibration. Gaps in the record are caused by the darkness of winter, during which solar reflectivity observations cannot be performed. The consistent shape of the curves each year is due to snow bi-directional reflection effects is and can be removed by applying a Bidirectional Reflectance Distribution Mode (BRDF)

The ideal way to intercalibrate satellite instruments would be to bring them into the same room, have them view the same object, and intercompare the readings. Not so easy with orbiting satellites. But if one can find a place on the surface of the Earth whose characteristics do not change with time, perhaps one can intercompare satellite measurements of this location. Such a place is Dome C, a permanent ice sheet in Antarctica whose reflectivity is stable over time. Moreover, the atmosphere over Antarctica is very clear - very few aerosols and little water vapor – and thus does not interfere with the surface reflected sunlight. Inter-comparison of AVHRR, MODIS, MERIS, and SeaWiFS visible reflectances at Dome C reveal the instrument calibration differences, and also show the potential use of this site as a standard to establish consistency. SeaWiFS, MODIS, and MERIS

measurements are consistent with each other; AVHRR observations have a negative bias of about 10% with respect to the other measurements. Such on-orbit radiometric standards are highly desirable for establishing consistency across satellites, as well as developing long-term time series from a sequence of satellites. The Dome C site will enable the accurate re-calibration of the visible/near infrared channels of satellite radiometers (AVHRR, HIRS etc.) for climate change detection. This work is a continued joint effort by NOAA, NASA, CNES, and other CEOS agencies.

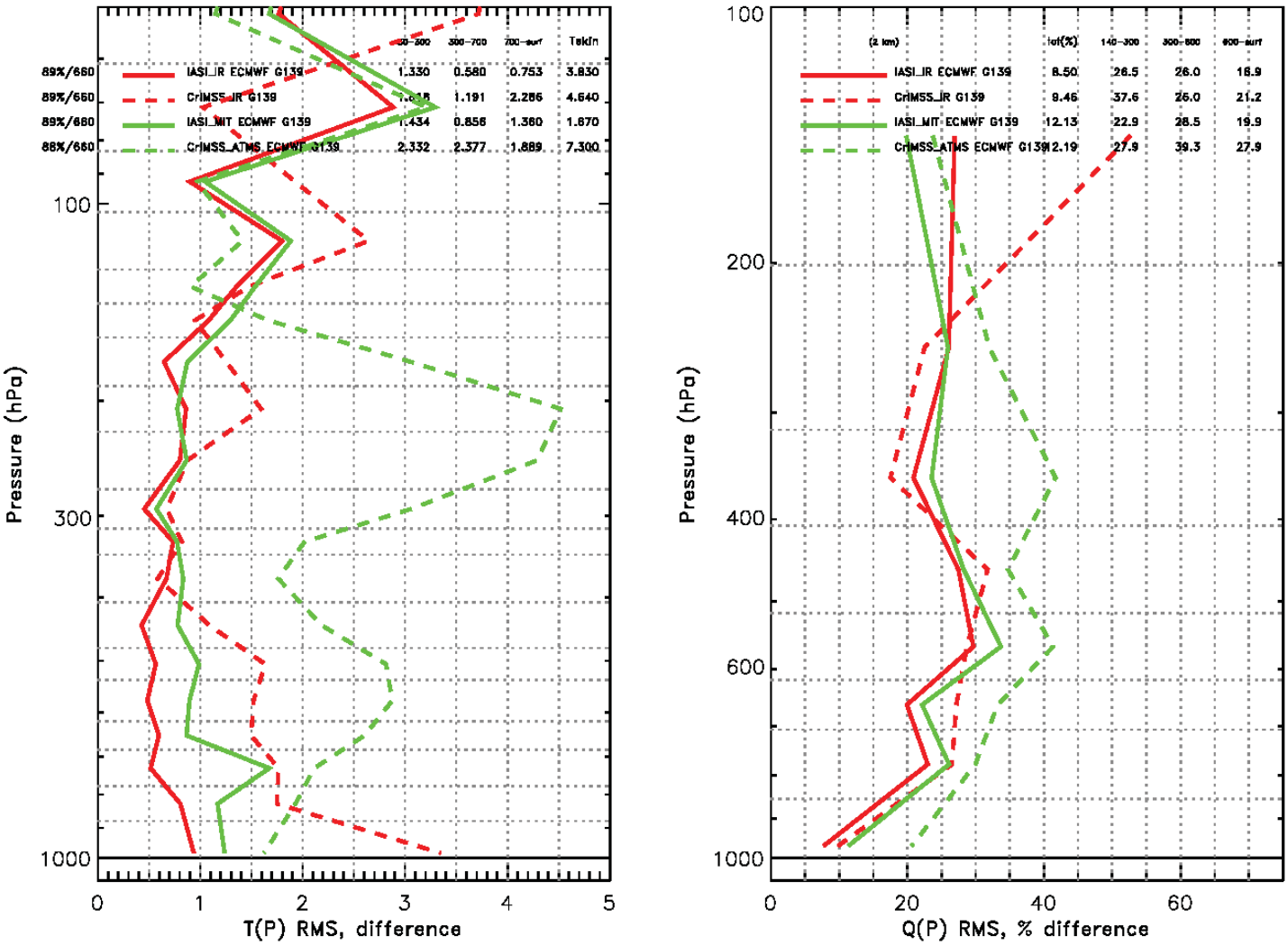
SMCD to Lead NPP CrIS/ATMS Temperature and Moisture Cal/Val Program

C. Barnet

STAR/SMCD will lead the validation plan for the NPP satellite Atmospheric Vertical Moisture profiles (AVMP) and Atmospheric Vertical Temperature Profiles (AVTP) Environmental Data Products (EDR). Activities in STAR include the development and utilization of proxy datasets, derived from existing sounders, that can be used to demonstrate, prior to the launch of NPP, that we have a viable calibration and validation plan for the Cross-track Infrared Sounder (CrIS) and Advanced Technology Microwave Sounder (ATMS) instruments. These proxy datasets have been made available to the cal/val team and are used by STAR to test the operational Northrop Grumman Aerospace Systems (NGAS) CrIS/ATMS EDR algorithm. These activities should ensure a rapid and accurate transition to operations of these advanced infrared and microwave instruments for use by NWP centers.

The NPP mission is introducing new instrument concepts (CrIS and ATMS) along with a new a EDR algorithm that utilizes a new forward model (Optimal Spectral Sampling algorithm). The ability to inter-compare with heritage sounding systems, such as AIRS/AMSU and IASI/AMSU/MHS, is a strong component of the cal/val plan. At STAR we plan on utilizing our NOAA-Unique CrIS/ATMS Processing System (NUCAPS), which utilizes the heritage AIRS and IASI algorithm and forward model, to facilitate direct comparisons of CrIS/ATMS products with AIRS/AMSU, IASI/AMSU/MHS, and ATOVS products - all generated at OSDPD. In this way, the performance characteristics of the new CrIS/ATMS instruments can be directly compared with heritage products and we can isolate algorithm and forward model issues from instrument issues.
In the figure we show preliminary statistics for retrieval errors based on our simulations. We expect that NGAS algorithm is not performing as well as IASI because empirical bias corrections (a.k.a. tuning) have not been employed in this experiment; however, the ability to inter-compare systems using the same source radiances is proving to be a valuable diagnostic of system performance.

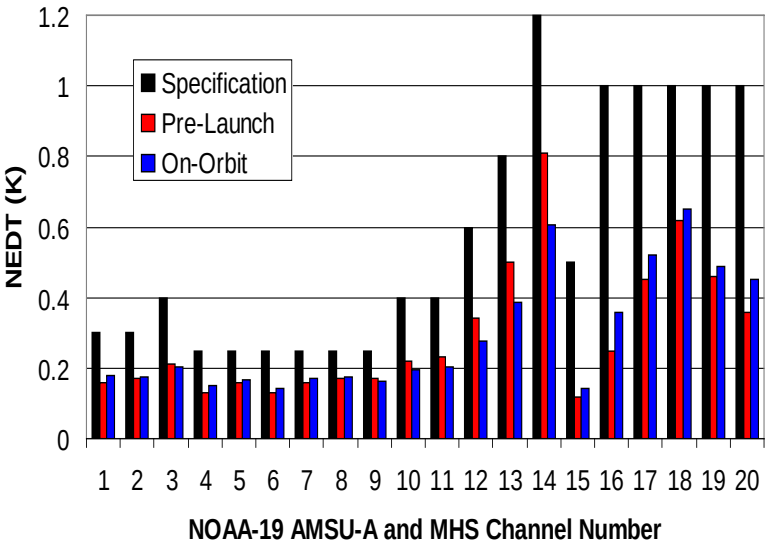
The cal/val program is a collaboration with team members from industry (Northrop Grumman Aerospace Systems), other government agencies (NASA Langley Research Center and Goddard Space Flight Center) and universities (Univ. of Maryland Baltimore County and University of Wisconsin, Massachusetts Institute of Technology) as well as Numerical Weather Prediction (NWP) partners (NCEP, UKMet, ECMWF) and the NASA NPP Product Evaluation and Algorithm Test Element (PEATE) teams.



Retrieval errors for temperature (left panel) and moisture (right panel). The solid lines are root mean squared differences from ECMWF for the IASI product system and the dashed lines are for the NGAS CrIS/ATMS product. Red lines are the coupled infrared and microwave algorithms and the green lines are the microwave-only product.

Checking Out NOAA's Newest Polar Orbiting Satellite

T. Mo



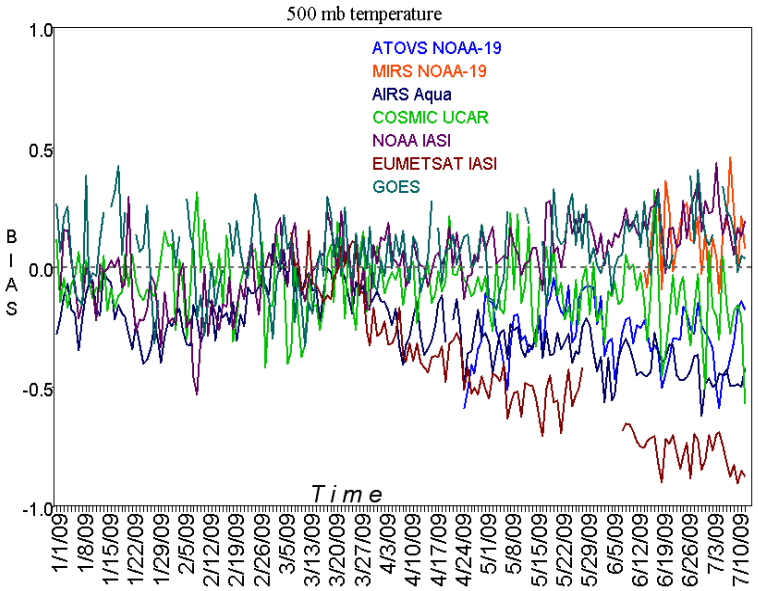
Comparison of noise (NEΔT) values derived from on-orbit data to those from pre-launch and specification. Channels 1-15 are from AMSU-A and channels 16-20 from MHS

NOAA-19 became NOAA's newest polar orbiter after its successful launch from Vandenberg Air Force Base at about 2:22 a.m. PST, February 06, 2009. Prior to their use, all instruments must be checked out to assure that they are performing satisfactorily. One example of the checkout results is shown in the figure, which compares the specification, pre-launch, and on-orbit values of the noise (NEDT; sometimes referred to as temperature sensitivity) of the two microwave instruments - AMSU-A and MHS – as a function of observing channel. For AMSU-A channels 1 – 10, the noise is less than 0.2 K. For all channels of both instruments the noise is well within the specifications and high quality data can be expected during the mission's lifetime. SMCD scientists also validated the performance of the other earth observing instruments on NOAA-19: HIRS, AVHRR, and SBUV/2.

Drifting Satellite Temperature Sensors

A. Reale

The NOAA PROducts Validation System (NPROVS) provides real-time monitoring of satellite product systems. Building on this system, SMCD has developed the NPROVS ARChive Summary System (NARCSS) for detecting erroneous long term drifts in satellite observations. The satellite temperature observations are compared to ground truth as represented by co-located radiosonde measurements and the differences are trended. The long term drifts of several different satellite instruments over the first half of 2009 are shown in the figure. The system can also detect time varying bias in the product processing system as indicated by the curves for NOAA's and EUMETSAT's IASI temperatures.

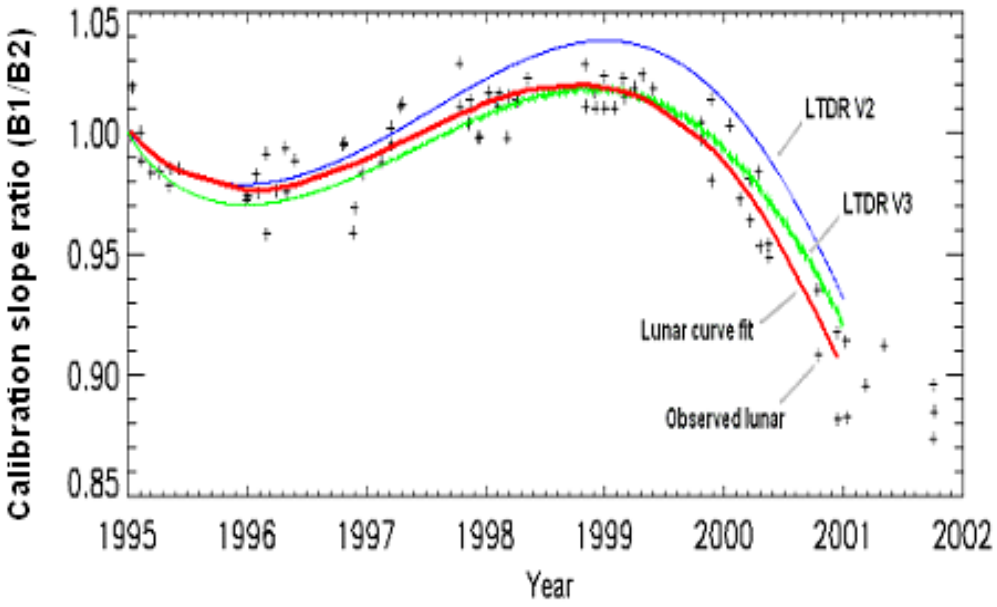


Respective trend plots of satellite-minus-radiosonde 500mb temperature differences for denoted satellite product systems from January to July 2009

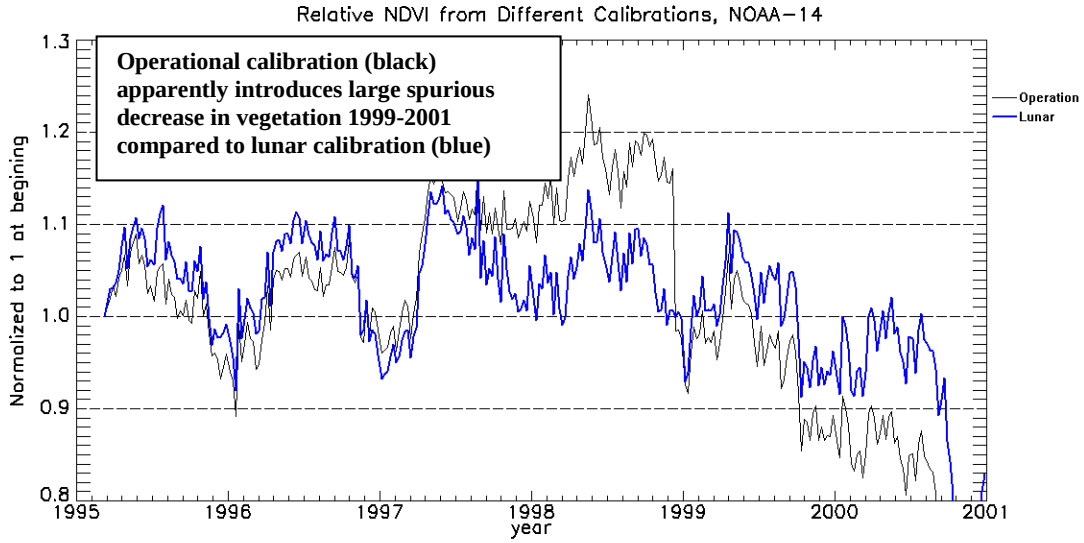
How the Moon Helps us to Monitor Vegetation on Earth

C. Cao

SMCD scientists have developed a novel method to use AVHRR lunar observations to help monitor long term changes in vegetation on the Earth. Satellite measurements of vegetation amount are derived from the Normalized Difference Vegetation Index (NDVI). The NDVI depends on the difference between the near-infrared (ch 2) and visible channels (ch.1) of the AVHRR. If the sensitivity of these channels did not change with time, the ratio of the slopes of their calibration formulas would be unity for all time. By computing this ratio when the AVHRR views the Moon - an irrefutable stable reference body without vegetation - and recording the time series, one can see how stable the AVHRR NDVI measurements would be. The figure shows the results for the NOAA-14 AVHRR, which compare favorably with competing methods developed by the NASA LTDR (Long-Term Data Record) program. A comparison of vegetation index trends derived using the operational calibrations – based on viewing the reflection from stable desert regions on Earth- and the lunar data is shown below.



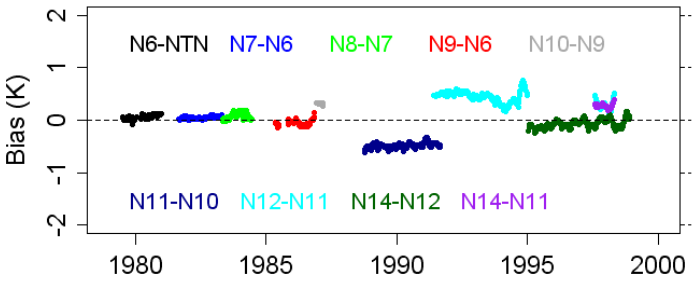
AVHRR/NOAA-14 normalized long-term slope ratio (determines the NDVI trend) comparison between lunar and NASA LTDR (red=lunar curve fit; + = lunar observation; green = LTDR version 3; and blue = LTDR version 2).



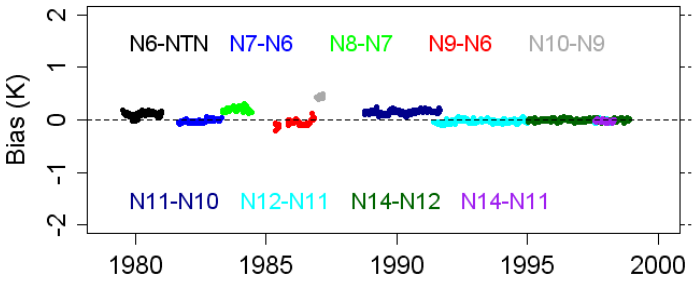
Intercalibrating Almost Three Decades of MSU Observations

C. Zou, M. Goldberg, and W. Wang

NOAA's Microwave Sounding Units (MSUs) are arguably the most important source of data on global atmospheric warming over the last few decades. Atmospheric temperature trends derived from the MSUs are central to the UN Intergovernmental Panel on Climate Change's (IPCC) conclusions about the rates of global climate change. While the individual MSUs are very stable instruments, the small systematic differences (biases) between instruments can overwhelm the slow persistent pace of global warming and lead to unreliable results. Thus, it is imperative to minimize these small systematic differences prior to analyzing the data for trends. Exploiting STAR's innovative Simultaneous Nadir Observation (SNO) technique for intercomparing satellite instruments, SMCD scientists have intercalibrated nine different MSUs covering almost three decades of observations. Global biases between instruments before and after recalibration are shown in the figure. Differences of up to 0.5 C between instruments from 1987 to 1995 are clearly eliminated, and the recalibrated observations provide a firm foundation for deriving trusted data on greenhouse warming.



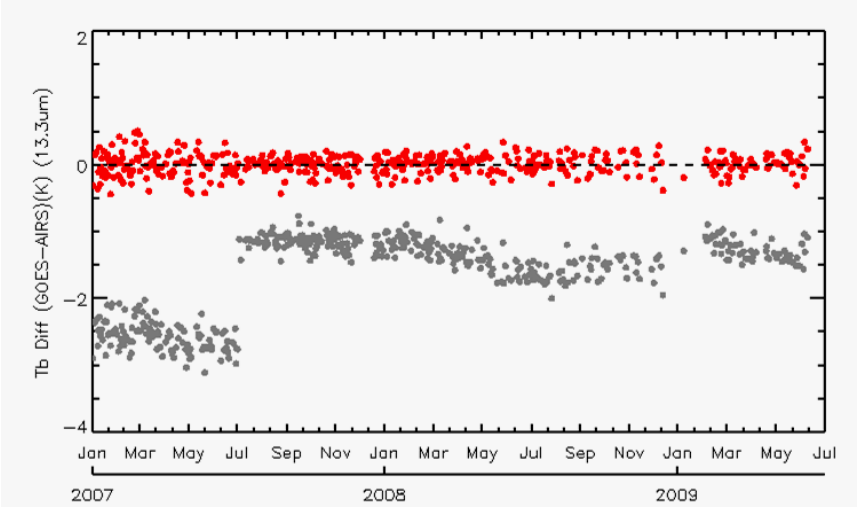
Intersatellite biases for NOAA operational calibration (ch2 global ocean-mean); time-varying intersatellite biases were found



Intersatellite biases after SNO climate calibration (ch2 global ocean-mean); time-varying biases minimized

The GSICS Correction- IR Eliminates Jump in GOES Readings

F. Wu

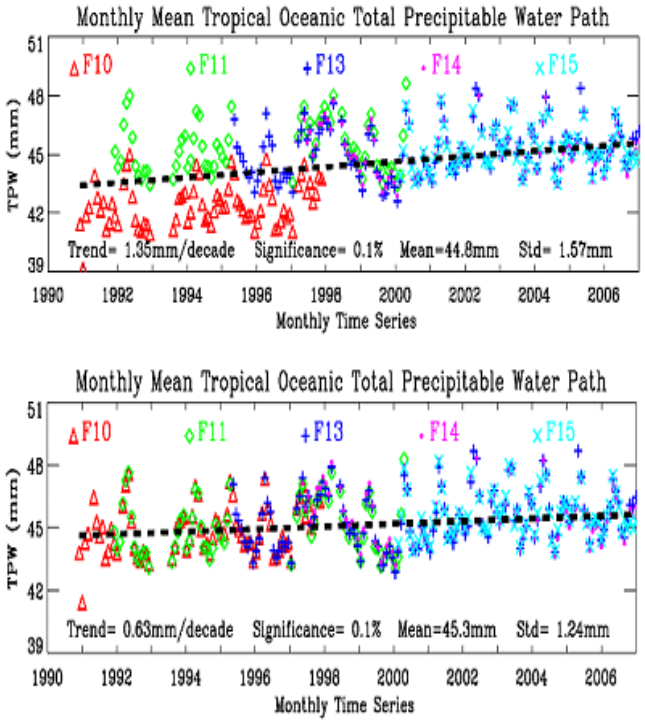


30 months time series of GOES-12 Channel 4 (10.7 μm) bias, as evaluated by AIRS, before (gray) and after (red) GSICS Correction.

SMCD plays a leading role in the Global Space-Based Inter-Calibration System (GSICS), whose goal is to intercalibrate the instruments on the global constellation of operational satellites while they are in flight. Intercalibrations are performed using a number of methods, including simultaneous matchups of operational and well calibrated research/advanced operational instrument observations, viewing stable reference sites such as deserts, deep convective clouds, and the moon, model calculations, and aircraft underflights. The intercalibration results in a bias correction, which is then applied to the operational instrument. Implementation of the GSICS Correction to GOES IR imager observations is shown in the figure.

The GSICS Correction- Microwave Cuts Water Vapor Trend in Half!

F. Weng



Total precipitable water from SSM/I before (upper panel) and after (lower) intersensor calibration. An increase in TPW may be a result of SST increase in past two decades

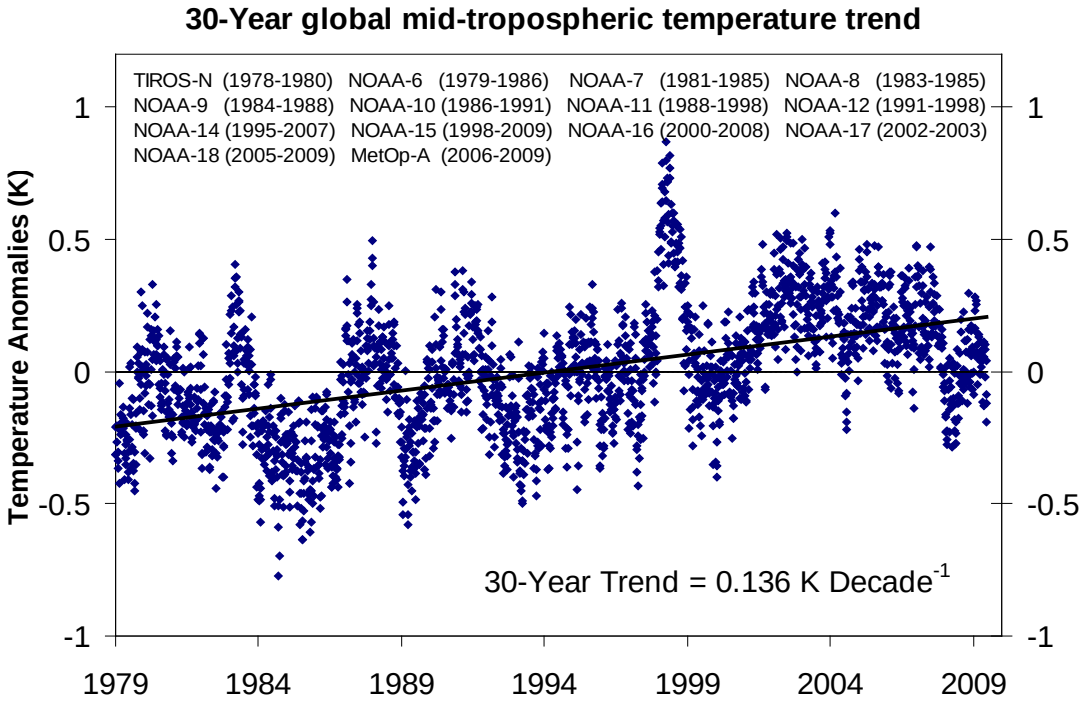
As part of the GSICS program, SMCD scientists developed a microwave intersensor calibration algorithm for the Defense Meteorological Satellite Program (DMSP) series of satellites. Simultaneous overpasses of pairs of the conically scanning Special Sensor Microwave Imagers (SSM/I) are used to quantify the systematic differences between instruments and to correct the observations. During the work, several major instrument anomalies and scan dependent biases were detected and accounted for. After application of the GSICS correction to the SSM/Is, the data are processed into long term data sets of environmental variables as a project of the WMO's Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) program. The figure shows time series of Total Precipitable Water (TPW) before (upper panel) and after (lower panel) applying the GSICS Correction. The TPW trend of 0.63 mm/decade is less than half of the original value!

Improved Utilization of Satellite Observations

Our researchers are constantly developing new applications of and products from satellite observations. This activity includes developing new applications for existing satellite observations as well as for the advanced instruments as they come online. As part of these activities, SMCD scientists contribute to the JCSDA's mission of accelerating and improving the quantitative use of research and operational satellite data in weather, ocean, climate and environmental analysis and prediction systems.

What the MSU and AMSU Tell us about Global Warming

C. Zou and W. Wang

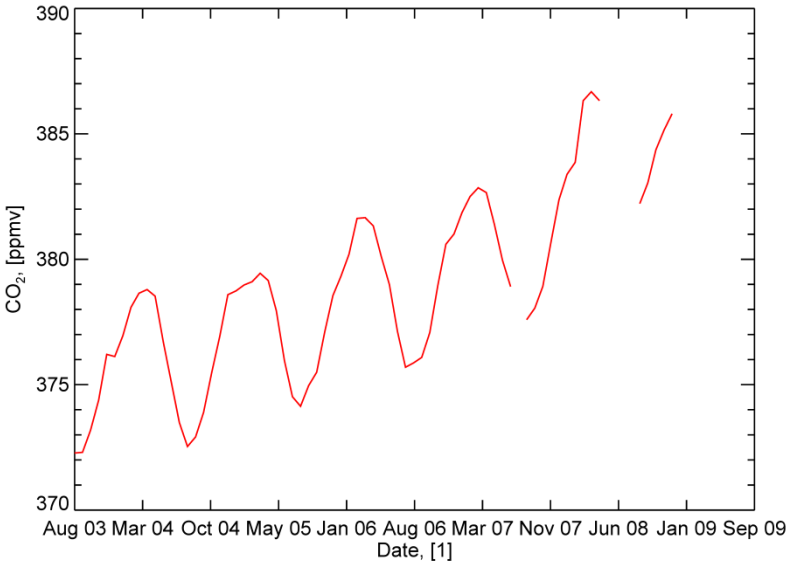


The Microwave Sounding Unit (MSU) and the Advanced Microwave Sounding Unit (AMSU) measure atmospheric temperatures with a high degree of accuracy under both clear and cloudy conditions. MSUs were manifested on NOAA POES from 1979 to 2007 and the first AMSU was launched in 1998. Their high accuracy, all-weather observing capability, and long term record make them ideal for monitoring global warming. As the graph shows, over the past 30 years the atmosphere has warmed at a rate of about 0.14 deg C per decade. Deriving such a small trend is not a trivial matter. It involved intercalibrating the instruments of 14 different satellites while they were in space (see section on Ensuring High Quality Calibrated Observations and Products), and correcting for incident angle errors, and diurnal drift errors. The plot show global, monthly mean temperature anomalies based on MSU ch.2 and AMSU ch. 5 observations, which are sensitive to the mean temperature of the mid-troposphere - the atmospheric layer between 2 and 8 km.

Monitoring Atmospheric Carbon Dioxide

C. Barnet

Looking remarkably similar to the iconic Keeling time series of atmospheric CO_2 concentrations at the surface of the Earth, the curve at the right shows the increasing concentration of CO_2 in the free atmosphere superimposed on its seasonal cycle as derived from NASA's Atmospheric InfraRed Sensor (AIRS). As opposed to the surface observations which can be performed at only a few locations, the satellite measurements are global, providing a true worldwide picture. This information on this major man-made greenhouse gas will acquire increasing importance as the nations of the world put limits on CO_2 emissions and look for robust verification systems.



Northern Hemisphere (40N to 80N) Carbon Dioxide Derived from AIRS from 2003 to 2009.

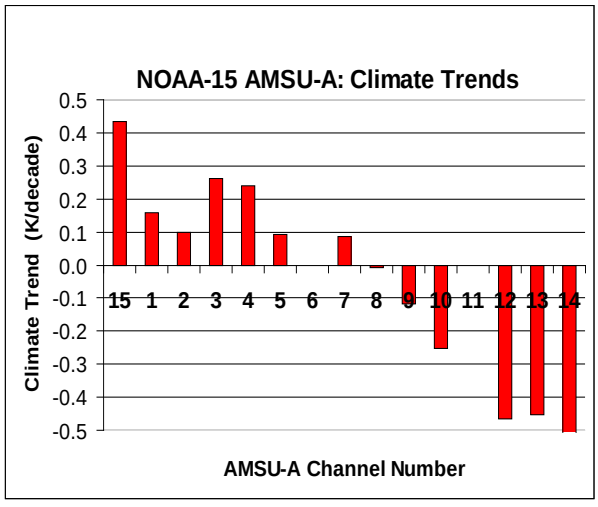
How Does Greenhouse Warming Vary with Altitude?

T. Mo

NOAA's AMSU sounding channels sense different layers of the atmosphere. Plotting the brightness temperature trends derived from each of the channels provides an interesting perspective on the variation of the rate of global warming with altitude.

- Channel 15 measurements are closest to the Earth's surface
- Channel 9 measurements are near the tropopause.
- Channels 15 and 1-8 measurements are at multiple levels in troposphere
- Channels 10-14 measurements are at multiple levels in stratosphere

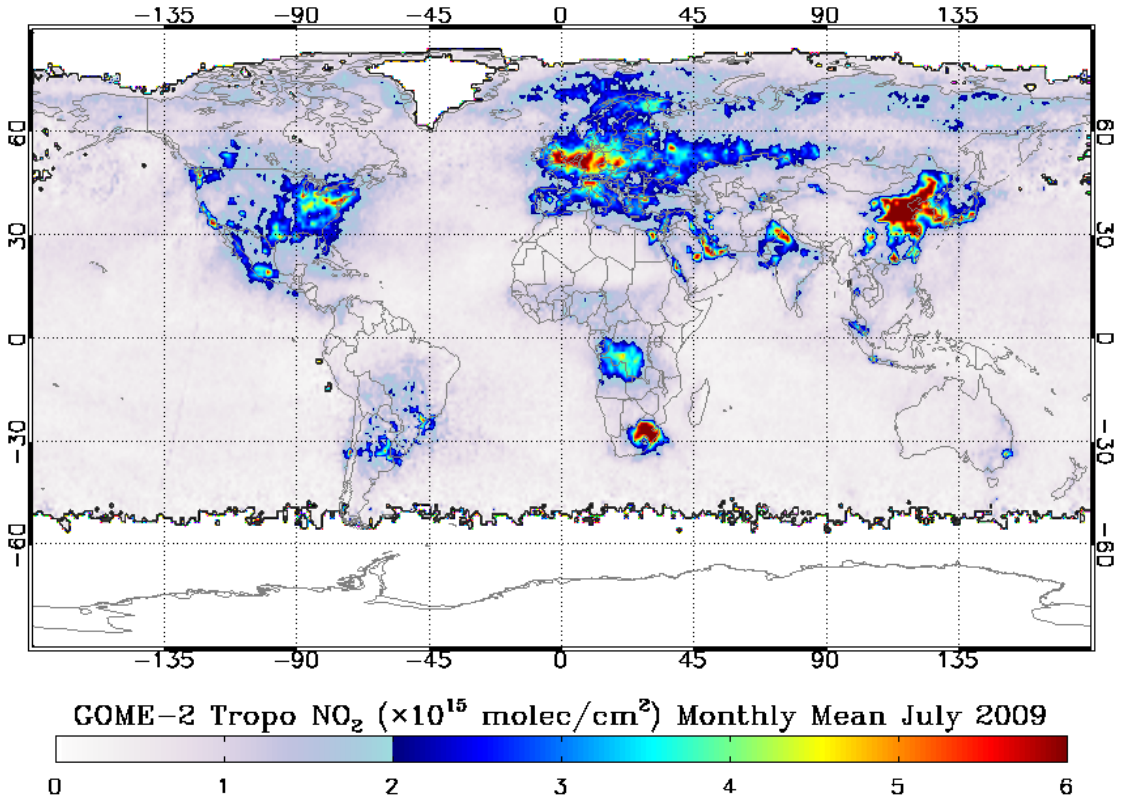
The chart on the right shows the global temperature trends at multiple levels of atmosphere from 0 to 50 km. These results demonstrate that the troposphere is warming and that the stratosphere is cooling and reconfirm results obtained from other studies. Only nadir observations were used in the study.



NOAA-15 AMSU-A Data from May 1998 through Dec. 2007 are used to derive these temperature trends. Data at Channels 6 and 11 are not used due to channel failures

Mapping Nitrogen Dioxide (NO_2) Pollution over the Globe

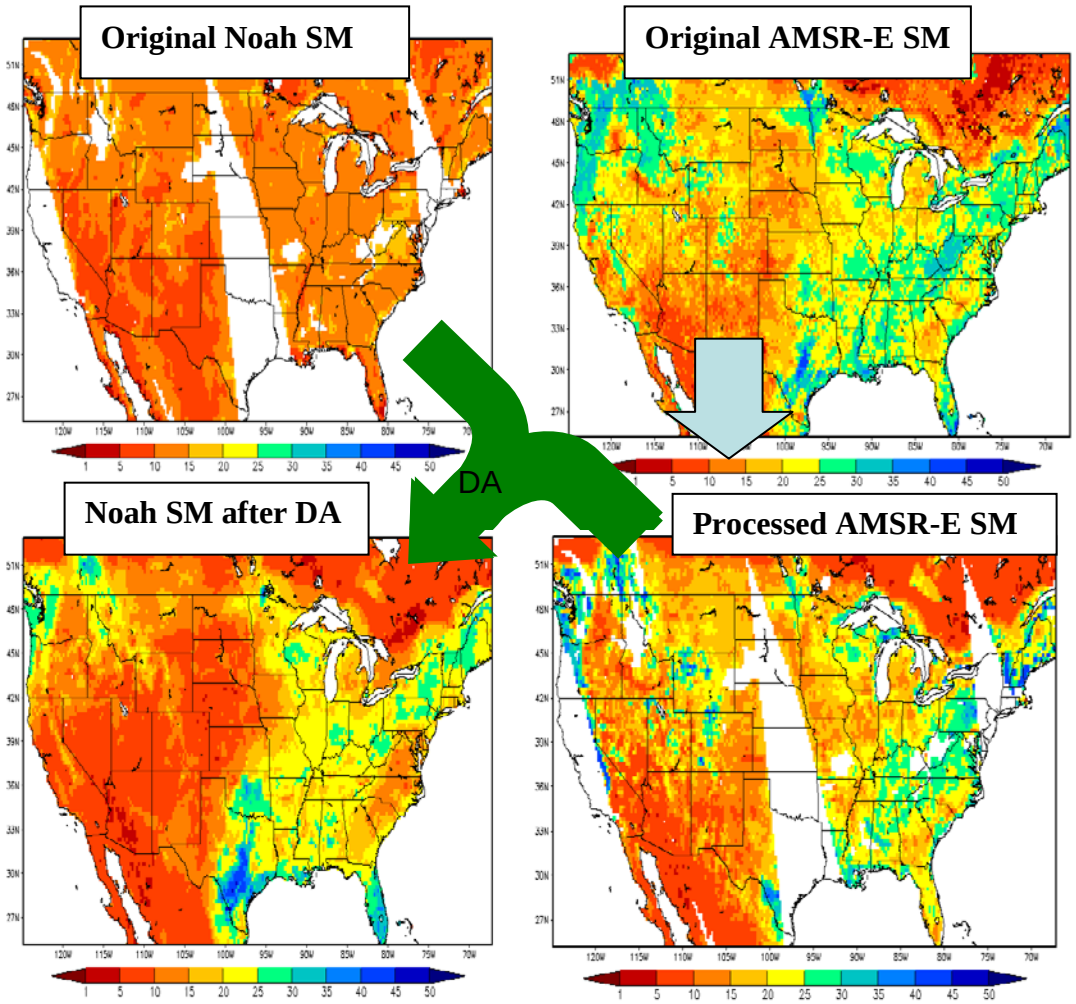
S. Kondragunta



NO_2 is injected into the atmosphere by urban/industrial sources such as cars and power plants and is a major pollutant that leads to smog formation. Estimates of the amount of NO_2 in the atmosphere can be determined for observations of the GOME-2 instrument on the MetOP-1 satellite. By measuring hyper-spectral measurements in the Ultraviolet-Visible wavelength region, the tropospheric concentration of this pollutant is obtained. Continuous monitoring of tropospheric NO_2 amounts from GOME-2 enables EPA to track various pollution events and develop emissions reduction control strategies. The map shows the monthly mean amounts for tropospheric NO_2 in units of molecules/cm^2. Major hotspots of NO_2 pollution are seen over the eastern U.S., southern California, the biomass burning regions of South America and Africa, Western Europe, and China.

AMSR-E Soil Moisture (SM) Assimilated into Land Surface Model

X. Zhan and J. Meng

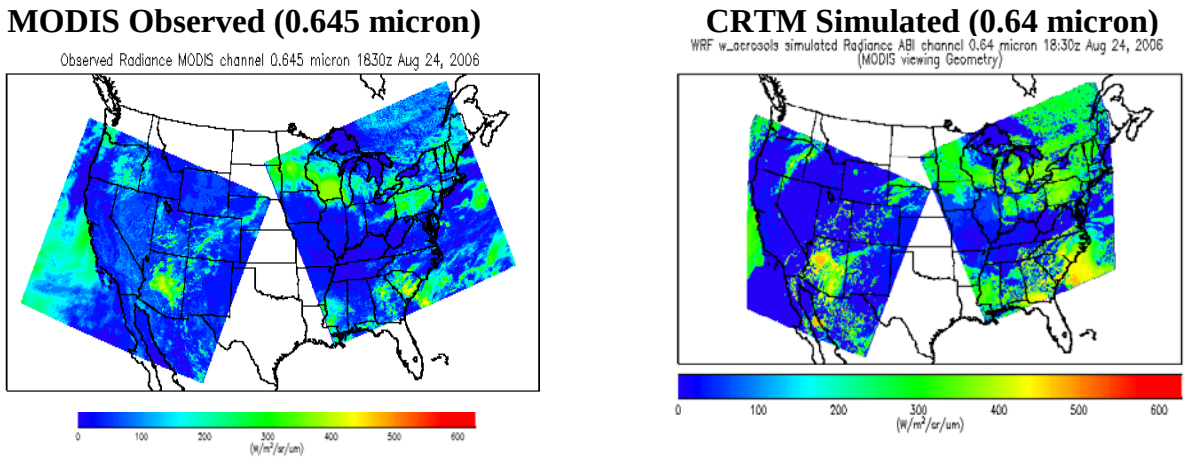


Soil moisture is arguably the most important environmental variable not currently routinely observed. Through its control of surface evaporation, it influences the hydrological cycle and precipitation and thus plays a major role in both weather and climate processes. The global soil moisture (SM) data product generated from the NASA Advanced Microwave Scanning Radiometer (AMSR-E) has been assimilated into the National Centers for Environmental Prediction (NCEP) **Land Surface Mode**l (Noah LSM). The Noah LSM SM field after the data assimilation (DA) demonstrates significantly different spatial and temporal patterns from the original Noah LSM SM.

Assimilating these satellite soil moisture observations will improve numerical weather predictions and other applications.

Extending the Community Radiative Transfer Model to the UV/Visible Spectrum

M. Liu, Y. Han, R. B. Pierce, et al.



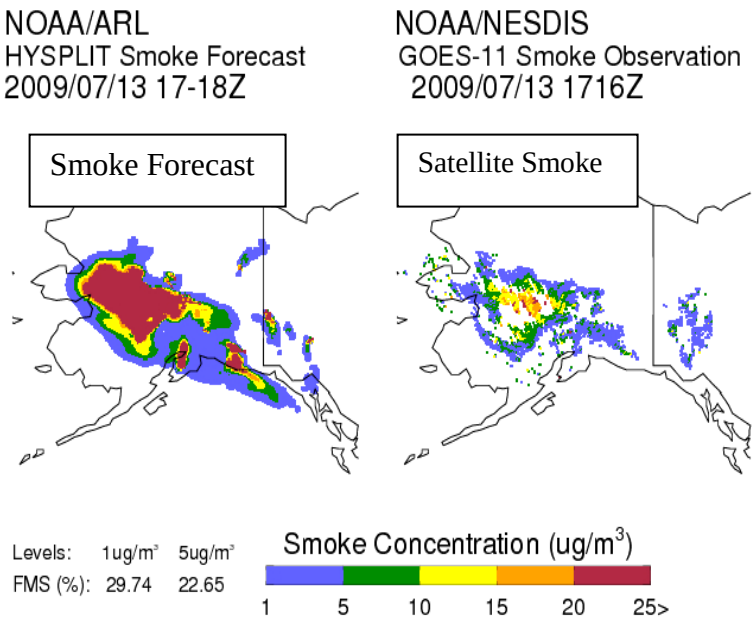
Comparison of the 0.645 micron band MODIS Terra and Aqua L1 radiances (left panel) and 0.64 micron band CRTM simulated radiances (right panel) using MODIS Terra and Aqua viewing geometry for 18:30Z on August 24th, 2006 (W/m2/sr/um)

The Joint Center for Satellite Data Assimilation's (JCSDA) Community Radiative Transfer Model (CRTM), developed primarily by SMCD scientists, has enabled the JCSDA partner agencies – NOAA, NASA, and DoD – to use a common, advanced radiative transfer code for their NWP data assimilation systems. The current CRTM covers the Earth's emission spectrum – the infrared and microwave regions – but not the Earth's solar reflectance region – the UV, visible, and near-IR regions. Closing this gap is critical to developing assimilation systems for clouds, natural aerosols and air pollution, ozone, and surface albedo. The CRTM has recently been extended to these spectral regions. A test of the performance of the extended model is illustrated in the figure. The left panel shows visible radiances observed by NASA's MODIS instrument, the right panel radiances calculated with the extended CRTM applied to atmospheric conditions prevailing at the time of the MODIS observations as obtained from the regional Weather Research and Forecasting (WRF) model. The agreement is encouraging and the large differences are due not to the CRTM but to incomplete knowledge of deep convective clouds from the WRF model.

Satellite Smoke Observations Verify NWS Smoke Forecasts

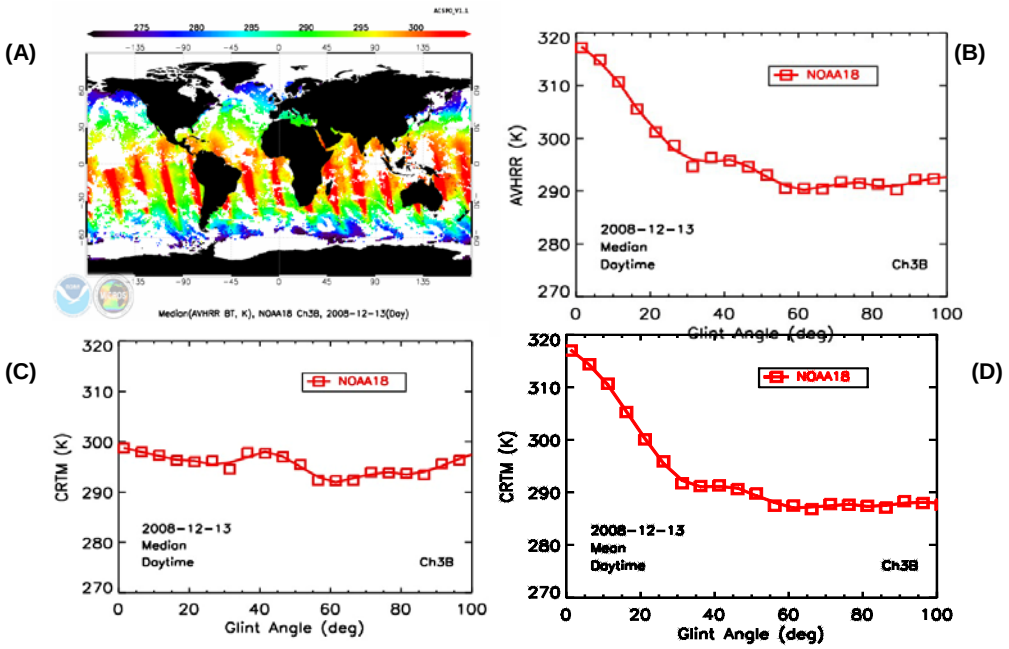
S. Kondragunta, J. Zeng

The GOES Automated Smoke Detection Algorithm (ASDA) has been implemented for the western GOES-11 satellite so smoke from wildfires in Alaska can be captured. Plume area overlap calculations show that observations and predictions agree to 30%. This algorithm is currently operational and the National Weather Service (NWS) is preparing to use it to verify operational smoke forecasts in Alaska. The NWS has made the NOAA/Air Resource Lab (ARL) Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model smoke forecasts operational and will require the NESDIS ASDA product to verify all its smoke forecasts.



Accounting for Sunlight in the Communiity Radiative Transfer Model

Y. Han



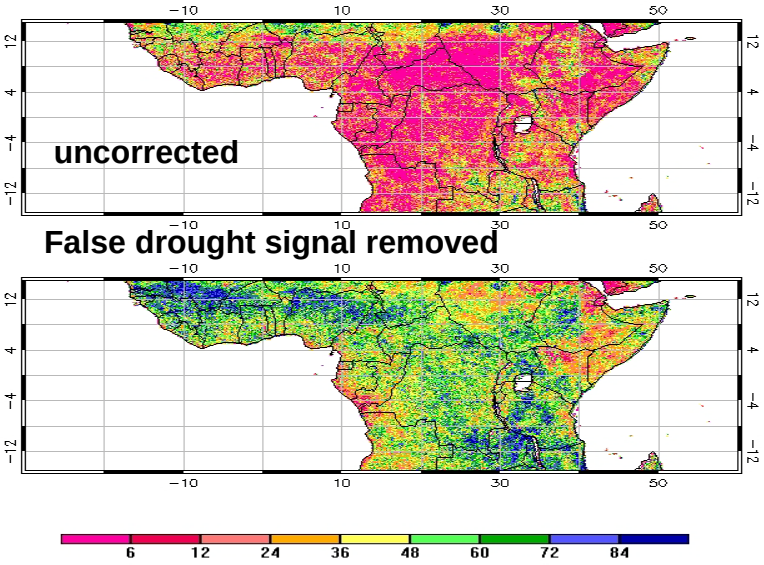
A – measured radiance in brightness temperature (note the sun glint area with the red color); B – measured radiance as a function of glint angle; C – CRTM simulations before the use of the BRDF model; D – CRTM simulations with the BRDF model.

AVHRR channel 3B can be used to derive sea surface temperature (SST) with the Community Radiative Transfer Model (CRTM). This channel is sensitive to sun light as reflected by the sea surface as Figures A and B show. Before this work, the CRTM did not model the reflection correctly, resulting in large errors in the sun glint areas, as the differences between Figures B and C show. A Bi-directional Reflection Distribution Function (BRDF) model has recently been implemented into the CRTM, which treats the sea surface roughened by the wind. Significant improvement has been made in radiance simulations in the sun glint areas, as the smaller differences between Figures B and D reveal. The work will improve the SST retrievals and radiance assimilation using channels sensitive to the sun light reflection over the ocean surface.

Correcting Satellite Vegetation Measurements for Effects of Volcanic Dust

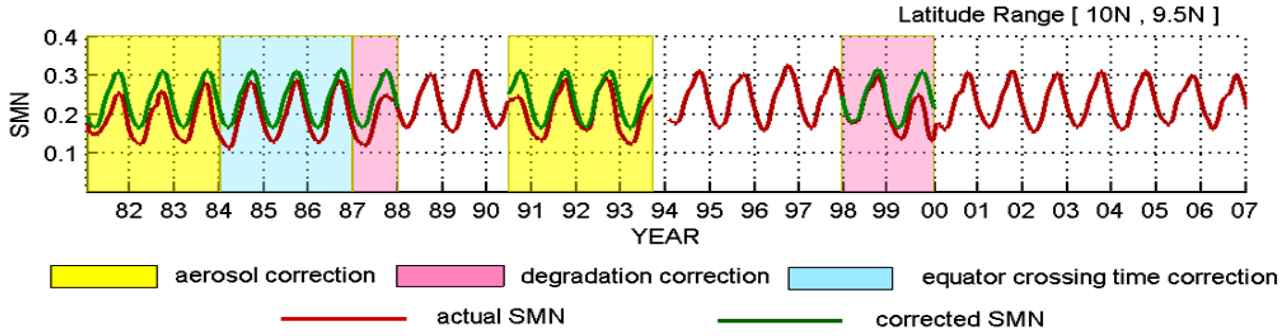
F. Kogan

Maps of Vegetation Condition Index (VCI)



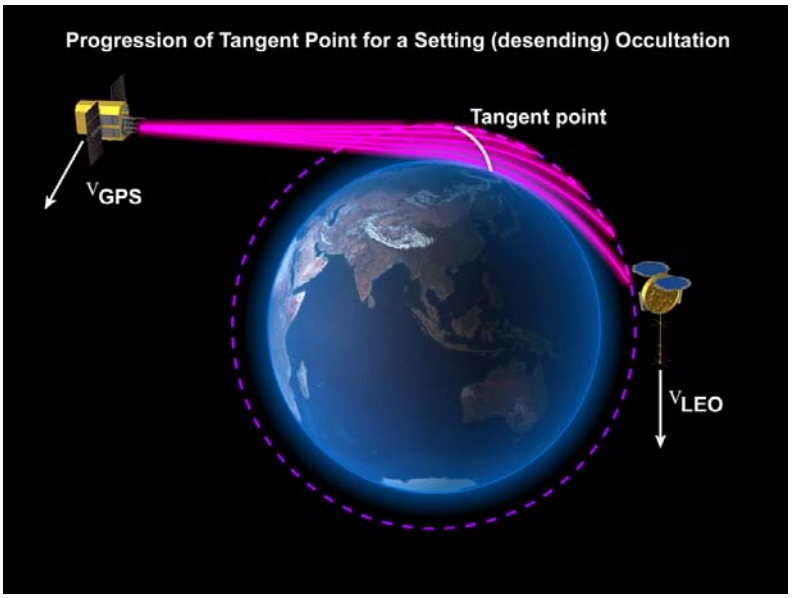
Strong volcanic eruptions inject huge amounts of aerosols into the stratosphere where they are transported horizontally and after a month or so are distributed globally. The slowly fall out over the course of a year or two, but during that time they reflect additional sunlight back to space at the same wavelength bands used to measure vegetation from satellites. As a result the AVHRR based Normalized Difference Vegetation Difference Index (NDVI) time series has artifacts induced by volcanic aerosols of the two major eruptions of the past few decades - El Chichon and Mt. Pinatubo. A statistical method was developed and applied to correct for these errors. The method also corrects for orbital drift of the POES satellites, which causes readings to occur later and later in the afternoon during satellite lifetime. The NDVI correction allows for improved applications such as vegetation health, fire risk, malaria risk, and agricultural yield. The effects of the corrections on long term time series of vegetation and on drought detection in Africa are shown in the accompanying figures.

Time Series of Uncorrected and Corrected Smoothed NDVI (SMN)



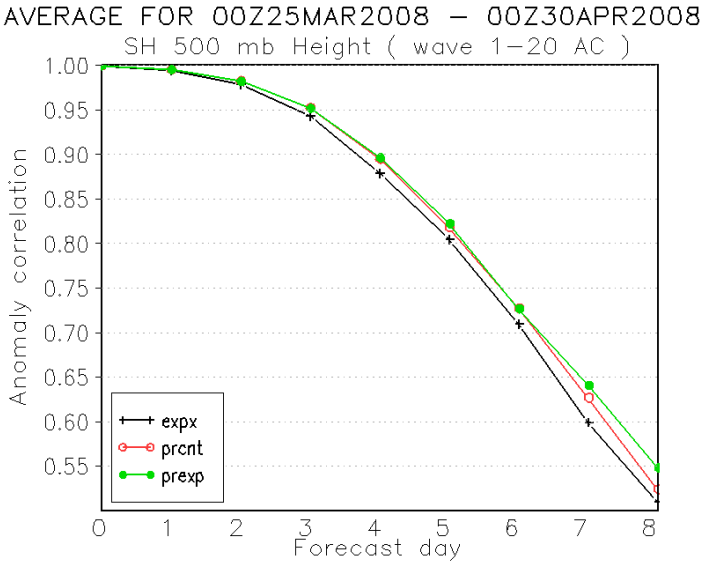
Extending the Range of Weather Forecasts

L. Cucurull



SMCD's scientists working on projects of the NASA-NOAA-DoD Joint Center for Satellite Data Assimilation (JCSDA) have made several contributions toward the Center's near-term goal of contributing to making the forecast skill of the operational NWP systems of the JCSDA partners internationally competitive by assimilating the largest possible number of satellite observations in the most effective way. One example is the assimilation of COSMIC GPS-Radio Occultation (RO) observations. GPS-RO observations are based upon the transmission of radio signals through the atmosphere from high altitude GPS satellite low earth orbiters (LEOs). The refraction of the signals by the atmosphere provides data on temperature and water vapor with high vertical resolution as the LEO descends with respect to the GPS satellite (see figure). These data have been used operationally by the NCEP since 2007. Recent work by SMCD scientists has resulted in still further gains in forecast accuracy and extension of forecast skill beyond that achieved in the original implementation.

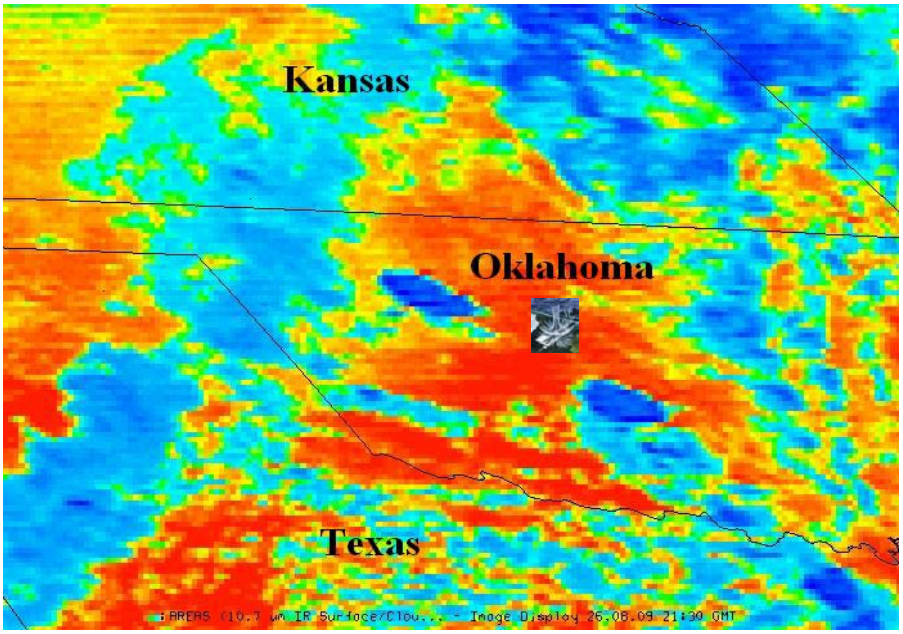
The latest results (see figure) show that the range of skillful forecasts (anomaly correlation greater than 0.6) is extended by about 11 hours to 7.5 days in the Southern Hemisphere. To put this achievement in context, such an extension normally takes about 3 years of development work by NCEP!



Anomaly correlation scores as a function of the forecast length for the geopotential heights at 500 hPa for the Southern Hemisphere (20S-80S) with the NCEP GDAS system. The results correspond to prcnt (initial results with COSMIC), prexp (current results with COSMIC) and expx (results without COSMIC).

Microburst Prediction

K. Pryor



GOES-11 imager microburst product at 2130 UTC 26 August 2009. Red shading indicates a high potential (risk) of microbursts. Microburst icon marks the location of wind damage that occurred at Kingfisher, Oklahoma at 0020 UTC 27 August.

A microburst is a strong downdraft that induces an outburst of damaging winds on or near the ground. The intense downdraft is driven by a combination of the weight of precipitation (loading) in a thunderstorm and the cooling that occurs due to the melting of ice and evaporation of rain when the precipitation descends beneath the base of the storm cloud. The small size (about 4 km) and short time duration (about 5 minutes) of the microburst is a major factor in generating the low-level wind shear that is a hazard to aviation (see sidebar). SMCD scientists are developing a suite of products derived from the GOES imager and sounder to predict microburst potential. The color coded map of GOES microburst potential (red indicates high potential) was verified by reports of wind damage (icon) at Kingfisher, OK.

Microburst Airline Disasters

Between 1970 and 1990, there were several noteworthy aircraft accidents related to microbursts. Three of these events were major disasters. The crash of Eastern flight 66 at John Kennedy International Airport, resulting from intense wind shear caused by concentrated strong downdraft on June 24, 1975, killed 112 out of 124 people on board. The crash of Delta flight 191 at Dallas-Fort Worth International Airport on August 2, 1985 killed 135 out of 163 people on board. The Delta 191 crash was again the result of intense microburst-induced wind shear and hurricane-force winds produced by a small but intense thunderstorm. The crash of Pan American flight 759 at New Orleans International Airport on July 9, 1982 in which 153 people were killed was a take-off disaster. These three events underscore the importance of detecting hazardous winds produced by isolated and intense thunderstorms during take-off and landing when aircraft are most vulnerable to wind shear.

Transition to Operations

Transition to operations is the ultimate step in the development of a new product system. During the year, SMCD and the JCSDA transitioned a number of product systems to the NESDIS Office of Satellite Data Processing and Distribution and assimilation systems for new instruments to the NWS National Centers for Environmental Prediction. These are listed below; more detail on some of these transitions follows. SMCD's Integration Team continues to standardize STAR product systems and reduce the time it takes to transition new systems to operations.

List of Product Processing/Assimilation Systems Transitioned to Operations in FY09

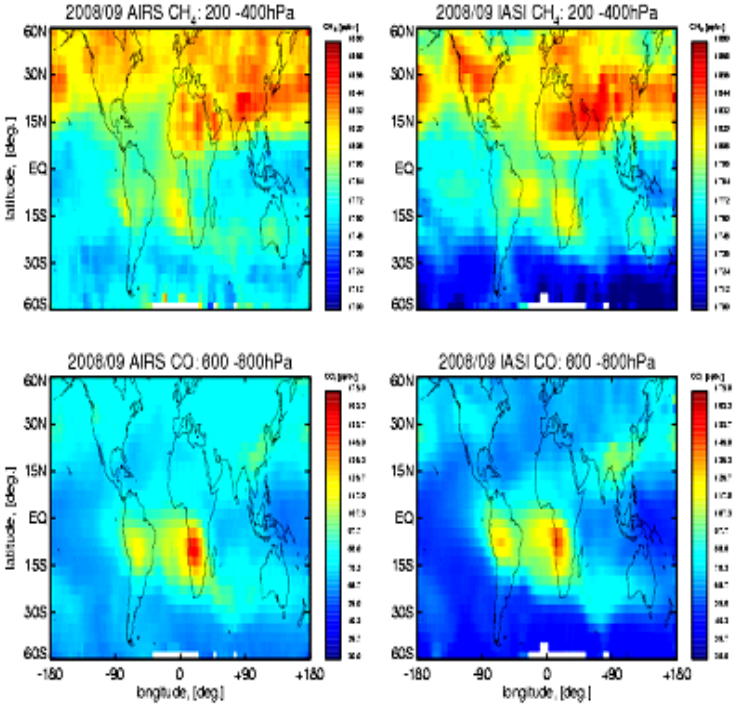
Microwave Integrated Retrieval System (MiRS) v3.0 Products
Full-disk GOES Imager Surface and Insolation Product (GSIP-fd)
Advanced Very High Resolution Radiometer (AVHRR) Polar Winds Product
Blended TPW Products
MTSAT-1R Winds
GOES-W Biomass Burning Emission Product
MIRS v4.0 products

World's First Operational Greenhouse Gas Products

E. Maddy and C. Barnet

Greenhouse gasses are essential to maintaining the temperature of the Earth and in excess can raise temperatures. Measurements include carbon dioxide (CO2), carbon monoxide (CO), and methane (CH4). STAR scientists developed the first operational greenhouse gas products. These products, which became operational in August 2008, are derived from data taken by the Infrared Atmospheric Sounding Interferometer (IASI) aboard the European Metop-A satellite. The products derived from IASI utilize the same algorithm as that used with the Atmospheric Infrared Sounder launched in 2002 aboard the NASA Aqua satellite. With this information NOAA will be able to provide accurate mid-troposphere greenhouse gas concentrations well into the next decade and beyond.

Monitoring these greenhouse gases is essential for understanding sources and sinks and when integrated with ground-based measurements and models will provide better monitoring of regional and global trends as well as sources. This new operational product also responds to the 2005 Energy Bill. Increasing atmospheric concentrations of heat-trapping greenhouse gases, leads to increasing severe weather conditions, such



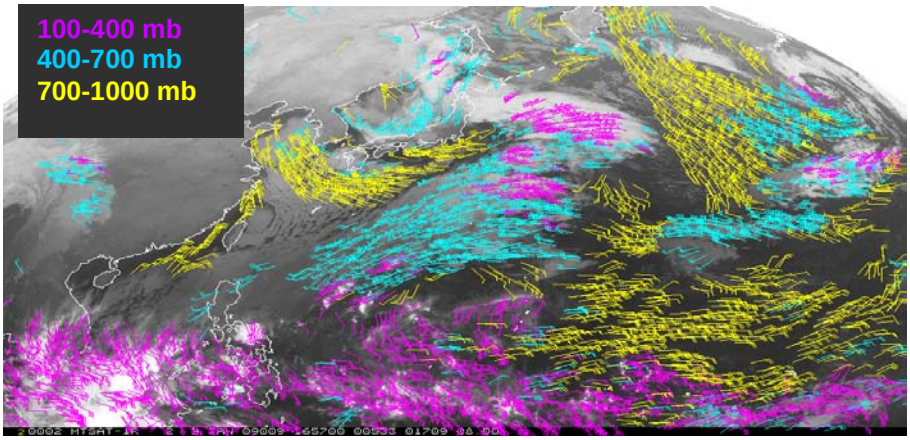
Examples of the first operational greenhouse gas products from the IASI instrument on the EUMETSAT's METOP satellite as compared to a more mature product from NASA's AIRS instrument. Upper tropospheric methane between 200-400hPa (top panels) and middle tropospheric carbon monoxide between 600 - 800hPa (bottom panels) from AIRS (left panels) and IASI (right panels). Apparent in both top panels is the increased abundance of CH4 in the N. Hemisphere due to rice production in Asia and the large vertical transport associated with Asian summer monsoon. Further illustrating the agreement in the two CO products, the bottom panels show pollution outflow from Asia and biomass burning outflow from Africa and S. America.

as droughts and intense hurricanes. Information on the seasonal and geographic distribution of greenhouse gases will provide critical data on the sources of these gasses and how best to mitigate the risks.

Winds from Japan's Geostationary Satellite Transitioned to Operations

J. Daniels

A wind product generated from observations of Japan's Multi-functional Transport Satellite-1R (MTSAT)-1R has been transferred to operational production. The near real-time wind information over the Western Pacific is primarily used by NWS forecasters responsible for providing watch, warning, and advisory support to the US trust territories in the Western Pacific and aviation route forecasts over the Western Pacific for the aviation community.



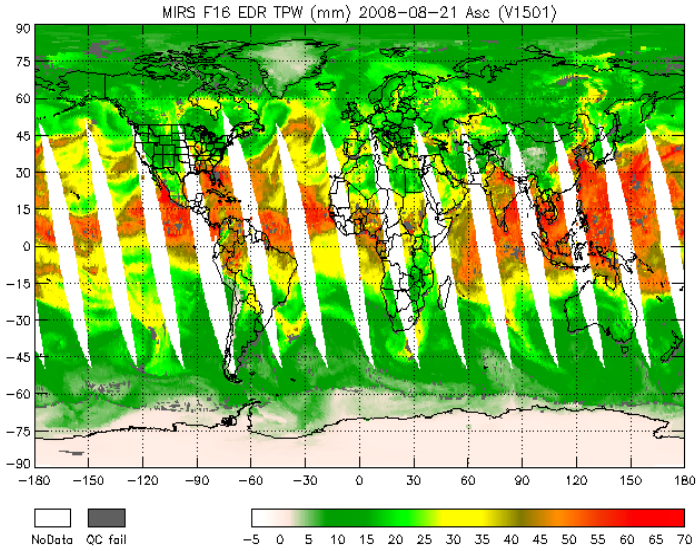
Example of MTSAT-1R cloud-drift winds derived from the long-wave (11um) infrared channel at 18 UTC on 09 January 2009. Yellow: Lower troposphere; Blue: Middle troposphere; Pink: Upper troposphere

Operational Implementation of the Microwave Integrated Retrieval System for DMSP-F16

S. Boukabara

The Microwave Integrated Retrieval System (MiRS) was extended to produce four new products from DMSP SSMI/S that were declared operational October 27, 2008:

- Total precipitable water (TPW)
- Land emissivity spectrum
- Land surface temperature
- Land surface type



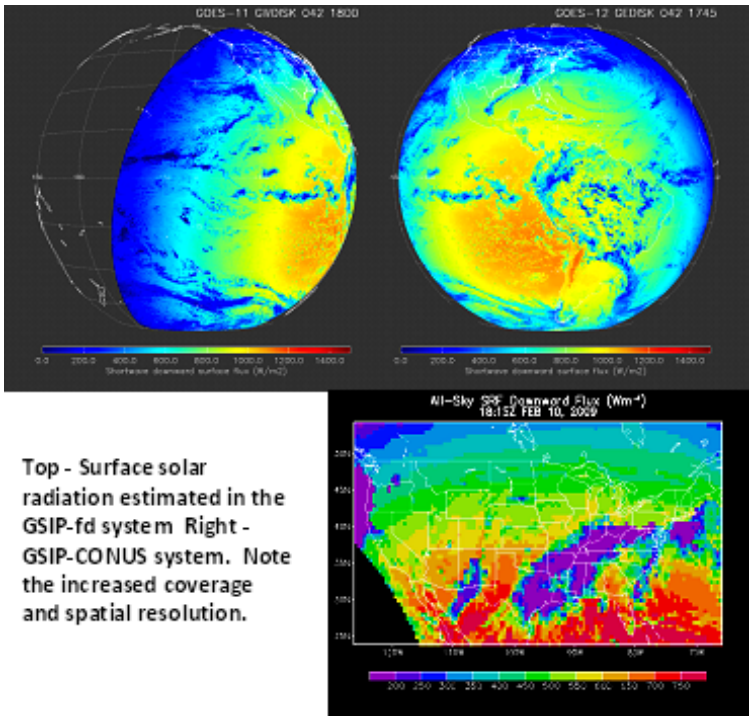
F16 SSMIS

Example of Total Precipitable Water (TPW) from SSMI/S

Extension of MiRS to SSMI/S increases the time and spatial coverage. The improved coverage of sounding and land products is important to the study of water cycle, hydrology and land processes. The objectives of MIRS include: (1) an improved temperature and moisture profiles retrieval, (2) the extension of the retrieved products to non-standard surfaces including sea-ice and snow-covered land, (3) the retrieval in all-weather conditions including cloudy and precipitating conditions and (4) an improved set of retrieved surface properties whose derivation is based on the retrieved emissivities instead of directly from the brightness temperatures. MiRS is routinely running on NOAA-18 and METOP-A AMSU and MHS, DMSP-F16/F17 SSMIS and planned to be applied to NPP/NPOESS ATMS, NPOESS MIS, etc.

Full-disk GOES Sunlight Product Transitioned to Operations

I. Laszlo and the GSIP-fd Team



Top - Surface solar radiation estimated in the GSIP-fd system Right - GSIP-CONUS system. Note the increased coverage and spatial resolution.

One of the earliest quantitative products from GOES satellites was the amount of sunlight, or surface solar radiation. The basis for measurement is easy to grasp: GOES observes the reflected sunlight; what's not reflected reaches the surface. But the product was limited to North America and has poor spatial resolution. The new operational implementation (GSIP-fd) extends the product to the full disk of the earth observed by GOES and increases the spatial resolution. The figure illustrates the greater spatial coverage of the new product (upper panel) compared to the old product (lower panel). Surface solar radiation is one of the forcing functions for the coupled ocean-atmosphere models and the new product will provide this information. The data will also be used by NOAA's Coral Reef Watch Program studies of coral health. A unique feature of GSIP-fd is the near real-time continuous evaluation of the solar radiation estimates with ground observations.

Future Operational Satellite Observing Systems (NPOESS and GOES-R)

SMCD plays a key role in preparing for the next generation of operational satellites – NPOESS and GOES-R. Our scientists assist satellite procurement programs in defining instrument calibration requirements, developing product processing algorithms, and planning data exploitation.

The Geostationary Operational Environmental Satellite-R Series (GOES-R) Algorithm Working Group (AWG)

J. Daniels and K. Lowe

The Geostationary Operational Environmental Satellite-R Series (GOES-R) program is a key element of NOAA's operations. The GOES-R series of satellites will be comprised of improved spacecraft and instrument technologies, which will result in more timely and accurate weather forecasts, and improve support for the detection and observations of meteorological phenomena that directly affect public safety, protection of property, and ultimately, economic health and development. The first launch of the GOES-R series satellite is scheduled for 2015.

NESDIS STAR has partnered with the GOES-R Ground Segment and created the Algorithm Working Group (AWG) to develop, test, demonstrate and validate product algorithms and sustained life cycle validation and product enhancements. The AWG is responsible for providing recommended algorithms and to collaborate with the Harris Ground System contractor over the life cycle of the satellite system. AWG algorithms will be encoded in operational software that will automatically calibrate, produce, and validate GOES-R data.

AWG Background

Developing 56 product algorithms across 14 different science teams

Leverages more than 100 scientists from NOAA, NASA, DOD, EPA, and NOAA's Cooperative Institutes (University partners)

Apply first-hand knowledge of algorithms developed for POES, GOES, DMSP, AIRS, MODIS, MetOP and Space Weather

Leverage other programs & experience (GOES, MODIS, AIRS, IASI, NPOESS and other prototype instruments and international systems)

Facilitate algorithm consistency across platforms -- prerequisite for GEOSS (maximize benefits and minimizes integration)

STAR AWG is also supporting the development of the GOES-R Algorithm Proving Ground. This is a joint effort by the GOES-R Program Office, STAR, and its cooperative institute partners to leverage existing test-beds in Norman, Oklahoma; Huntsville, Alabama; Boulder, Colorado; and elsewhere. The offices will incorporate simulated GOES-R products under local field conditions. Objectives of the proving ground include the following:

Preparing forecasters for Advanced Weather Interactive Processing System (AWIPS)-focused GOES-R products
Providing real-world experience by leveraging existing resources in preparation for the GOES-R era
Providing product tailoring for NOAA operations
Establishing critical coordination with NWS Weather Forecast Offices (WFOs), River Forecast Centers (RFCs), and national centers (e.g., Storm Prediction Center)

STAR AWG met all of its FY09 deliverables to the GOES-R Ground System Project on schedule and within its budget. This included delivery of the 80% baseline algorithms, 4 Algorithm Design Reviews, 12 Critical Design Reviews, 16 Test Readiness Reviews and successfully holding its annual meeting in Madison, Wisconsin. Additionally, STAR AWG was recognized with a GOES-R Program Award for its performance, Algorithm Integrated Development Team performance award and 2 members of the Algorithm Integrated Development Team received the GOES-R Ground System team member of the month awards.

STAR AWG supported the GOES-R Program initiative of externally reviewing the AWG's 80% algorithm theoretical Basis Documents (ATBDs). An Algorithm Development Executive Board (ADEB) was formed to: independently peer review ATBDs and reports received from more than 30 external algorithm scientists; assess the overall AWG algorithm development process; and determine the readiness of the algorithms for implementation. The ADEB results:

> The ADEB summary finding: *"Overall the Board found the briefings were very professional, orderly, and complete. The Board commends the work of the STAR/AWG and recommends delivery of the 80% algorithms and their ATBDs to the GOES-R Program Office"*.

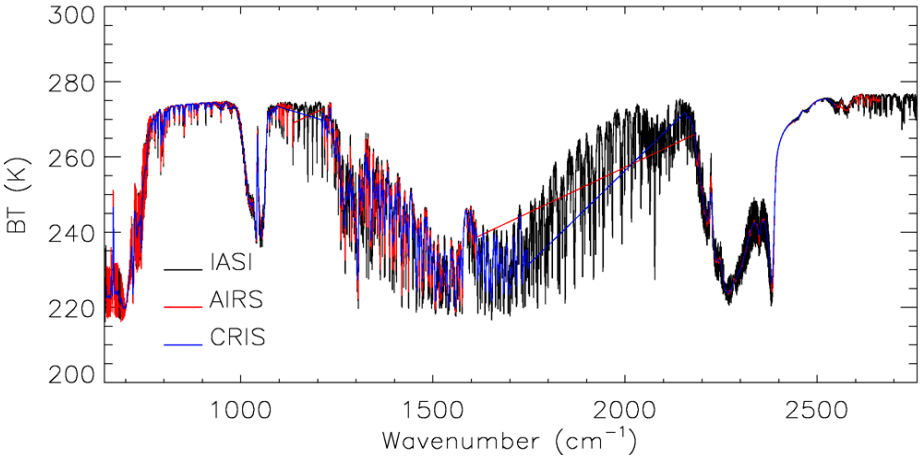
The STAR AWG is a recognized leader that consistently delivers world class science algorithm products and processes on time and within its budget.

CRTM Ready for NPP, NOAA N' and DMSP Sensors

Y. Chen, Y. Han, P. van Delst, and F. Weng

The Community Radiative Transfer Model (CRTM) Team of the Joint Center for Satellite Data Assimilation (JCSDA), led by SMCD scientists, has extended the CRTM to cover the spectral observations of a host of new and future sensors. The CRTM is the glue that connects satellite radiance observations to NWP model variables and is the core of data assimilation systems. Especially noteworthy is the extension to the NPP which will be launched within the next few years. The list of recently added CRTM-ready sensors includes:

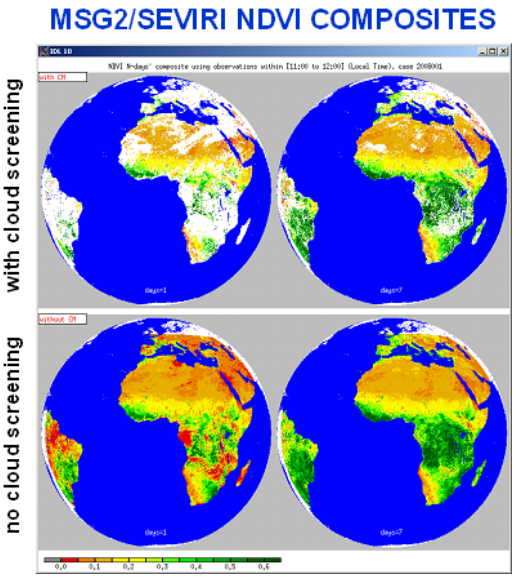
- AVHRR/3 on NOAA-N'
- HIRS/4 on NOAA-N'
- AMSU-A on NOAA-N'
- MHS on NOAA-N'
- SSMIS on DMSP-17
- SSMIS on DMSP-18
- SSMIS on DMSP-19
- CrIS on NPP
- ATMS on NPP



CRTM simulated brightness temperature (BT) spectrum for hyper-spectral infrared sensor IASI (black line), AIRS (red line), and CrIS (blue line).

Vegetation Health from GOES-R

F. Kogan

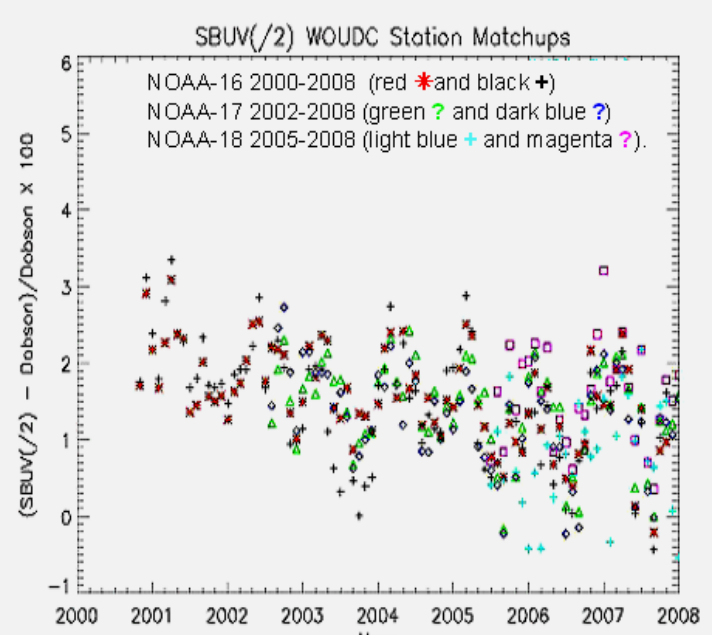


NOAA's current satellite vegetation product is based on POES AVHRR observations. Extension of this product to geostationary satellites (GEOs) would be extremely beneficial. By providing many views of the each location during the course of a day, GEOs have a greater chance of obtaining a cloud-free observation of the surface than do the POES satellites, which get one peak daily. Current GOES satellites do not have the requisite spectral bands for measuring vegetation, but the GOES-R ABI will include these channels. SMCD scientists have developed and tested procedures for GOES-R vegetation using Meteosat-2 SEVIRI data as a proxy. The GOES-R Vegetation Health product will. With less impact from cloud cover, the GOES-R vegetation product will be much more reliable than the current AVHRR-based product.

Comparison of daily (left) and weekly (right) composites of SEVIRI NDVI data. White in upper panel represents cloudy pixels. Weekly compositing removes most of the residual cloud contamination. Residual clouds in lower panel reduce NDVI in cloudy areas.

SMCD to Lead NPP OMPS Ozone Cal/Val Program

L. Flynn



Validation of total column ozone estimates for SBUV/2 by comparisons to ground-based data. Time series show percent differences between SBUV/2 and match-up values from Dobson stations.

Under an Act of Congress, NOAA is charged with operational monitoring of the Earth's ozone layer. The legislation was passed in the 1980s to assure long term ozone measurements in the wake of the Montreal Protocol to phase out use of ozone destroying chemicals. The SBUV/2 instruments on NOAA's POES satellites have performed this function since the mid-1980s. The NPP Ozone Monitoring and Profiling Suite (OMPS) will continue and improve upon the SBUV/2 measurements. SMCD will lead the OMPS Calibration and Validation activities for the NPP products. The OMPS cal/val plan exploits the synergy of the SBUV/2 and GOME-2 algorithms, and their extension to OMPS Nadir Profiler and Nadir Mapper instruments. Existing relationships with Subject Matter Experts in NESDIS/OSDPD, NWS/NCEP, and OAR/ESRL are being extended to form an experienced team. The OMPS Nadir Mapper and Nadir Profiler will provide the next generation of ozone monitoring products for NOAA. Early and reliable validation of these products will smooth their acceptance in applications and ozone assessments. A primary source of validation data for the satellite measurements is ground-based ozone observations. The figure shows that the SBUV/2 measurements were quite stable and generally within 2% of the surface observations over the period 2000-2008.

Validating GOES-R Land Products

Kevin Gallo

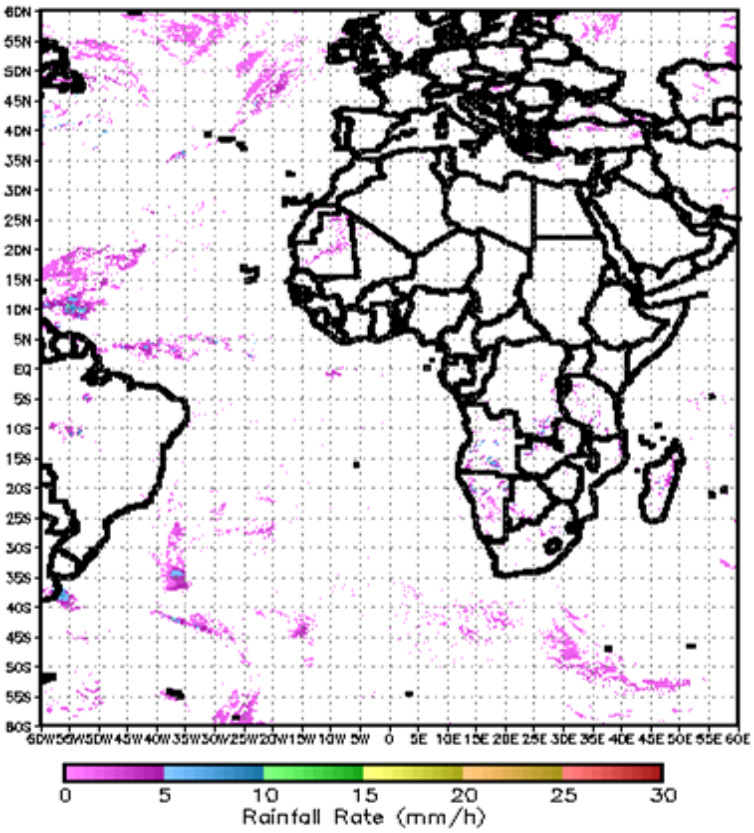
In the past, satellite based land surface products have suffered from lack of a robust validation observation program. Recognizing the importance of such a capability, the GOES-R program is supporting the selection of validation targets. SMCD has developed a plan to assess proposed validation sites for GOES-R land products such as vegetation, surface temperature, solar radiation, snow, and fires. The Plan, entitled "Protocol for Assessment of GOES-R Land Product Validation Targets, provides:

- Proposed methodology for assessment of potential GOES-R validation targets (*in situ* or satellite),
- Documentation of satellite-derived measures of spatial variation associated with the validation targets (targets that fail spatial variation tests may be dismissed from use for validation of GOES-R Land products).

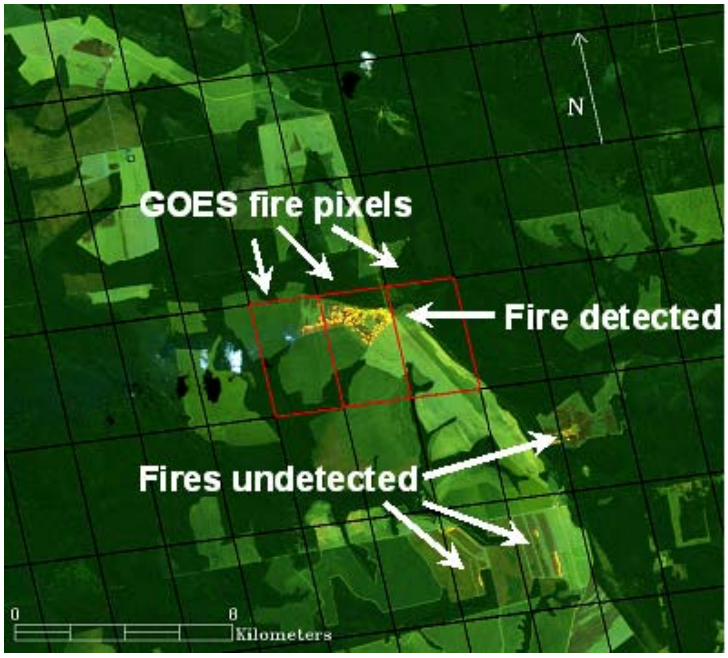
GOES-R Rain Rate Algorithm Delivered

B. Kuligowski

Rain gauges provide a direct measurement of rainfall; however, the spatial density of rain gauge networks (especially of gauges whose data are available in real time) is typically far too coarse to capture the spatial variability of rainfall at small scales. Radar provides an indirect measurement of rainfall, but only for regions within a few hundred km of a radar unit – and even less in mountainous regions due to blockage of the beam. Estimates of rainfall from satellite data are less direct and less accurate than either gauges or radar, but have the advantage of high spatial resolution (4 km) and complete coverage over oceans, mountainous regions, and sparsely populated areas where other sources of rainfall data are not available. Since flash flood events often originate with heavy rainfall in sparsely instrumented areas that goes undetected, satellite-derived rainfall can be a critical tool for identifying hazards from smaller-scale rainfall and flood events. NESDIS has produced GOES real-time estimates of rainfall for decades. The algorithms are being updated and improved for application to GOES-R. Taking advantage of GOES-R capabilities, the GOES-R Rain Rate algorithm will provide estimates of rainfall rate every 15 minutes in support of flood forecasting and other applications. Algorithm code is delivered to the GOES-R Algorithm Integration Team (AIT) in stages: the recently delivered second stage is code that meets AIT coding standards and successfully runs on a test data set.



Sample Rainfall Rate product created using proxy data from the Spinning Enhanced InfraRed Visible Imager (SEVIRI).



Active fires (in yellow) detected by Landsat-7 on 17 May 2003 1315 UTC at 55.8W 11.3S. The grid denotes the nominal GOES-12 imager pixels. Red contours are pixels flagged as "fire" by the current operational GOES product. GOES-R ABI, with its finer spatial resolution, will increase fire delectability.

Validation Plan for GOES-R ABI Active Fire Product

I Csiszar, W. Schroeder and C. Schmidt

GOES-R ABI, with finer spatial resolution than its predecessor the GOES Imager, will increase detestability of active fires. The ABI fire detection and characterization algorithm builds on the Wildfire Automated Biomass Burning Algorithm (WF-ABBA) which was designed and implemented for the GOES imager series starting with GOES-8. The WF-ABBA product provides routine detection and characterization of sub-pixel active fires serving the fire management community as well as the scientific community, therefore demanding quality data with well characterized sources of errors. The validation plan developed for the GOES-R fire product includes: pre- and post-launch activities and methods for detection and characterization products. Proposed reference data include high spatial resolution Landsat-class satellite imagery, imagery from airborne sensors, other validated fire products, and simulated proxy ABI data. The detailed plan will also quantify the improved detection capabilities of GOES-R ABI compared to the current GOES Imager. The approach is consistent with proposed NPP/NPOESS VIIRS fire product validation plans.

National and International Collaborations

CEOS (Committee on Earth Observations Satellites) WGCV (Working Group on Calibration/Validation) Meeting

C. Cao

- The 29th CEOS/WGCV meeting was held in Avignon, France, sponsored by INRA (French Institute of Agricultural Applications)/CNES (Centre National d'Etudes Spatiales).
- The meeting reviewed the CEOS/WGCV 2008 Actions and completed all six Category 1 actions with major deliverables, including the data quality assurance guidelines, and the Dome C calibration experiment.
- C. Cao of NOAA completed his two year term and stepped down as the Chair.
- P. Lecomte of ESA became the Chair, with the newly elected vice Chair Greg Stensaas from USGS.

CEOS/WGCV Group Photo at INRA, Avignon, France

The CEOS/WGCV has made significant contributions to the CEOS 2008 actions with major deliverables

CEOS Land Surface Imaging Constellation

K. Gallo

- Report completed entitled "*Update on CEOS Land Surface Imaging Constellation contribution to GEO/GEOSS."*
- An internet portal for information and data access related to the mid-resolution satellite systems is being created.
- Satellite data have been contributed to *Forest Resource Assessment 2010* project and plans for 2009 include contributions to the *Global Land Survey* dataset.

Documentation of the activities of the CEOS Land Surface Imaging (LSI) Constellation group related to GEO and GEOSS activities

Advanced Research Workshop on Using Satellite and in Situ Data to Improve Sustainability in Kyiv, Ukraine

B. Kuligowski

- The workshop was sponsored by the North Atlantic Treaty Organization (NATO) and co-directed by Dr. Al Powell of STAR.
- The Workshop addressed issues of environmental security and improving sustainability for countries of the former Soviet Union.
- Approximately 85 representatives attended from North America, Europe, and Asia.
- NOAA offered selected real-time satellite product to the Ukrainian Hydromet service in exchange for data and collaboration to help NOAA validate and improve these products.

Dr. Al Powell making opening remarks.

The Workshop follows up on a MOA between NOAA and NSAU established in June 2008 under the auspices of the Global Earth Observing System of Systems (GEOSS).

Cooperative Work on Feng-Yun-3 Satellite Ozone Instruments: Total Ozone Unit (TOU) and Solar Backscatter Ultraviolet Sounder (SBUS)

L. Flynn

Drs. Huang, Wang, Flynn, Li, and Zhang examine the SBUS Engineering Design Unit's chopper wheel and grating drive cam mechanisms in operation.

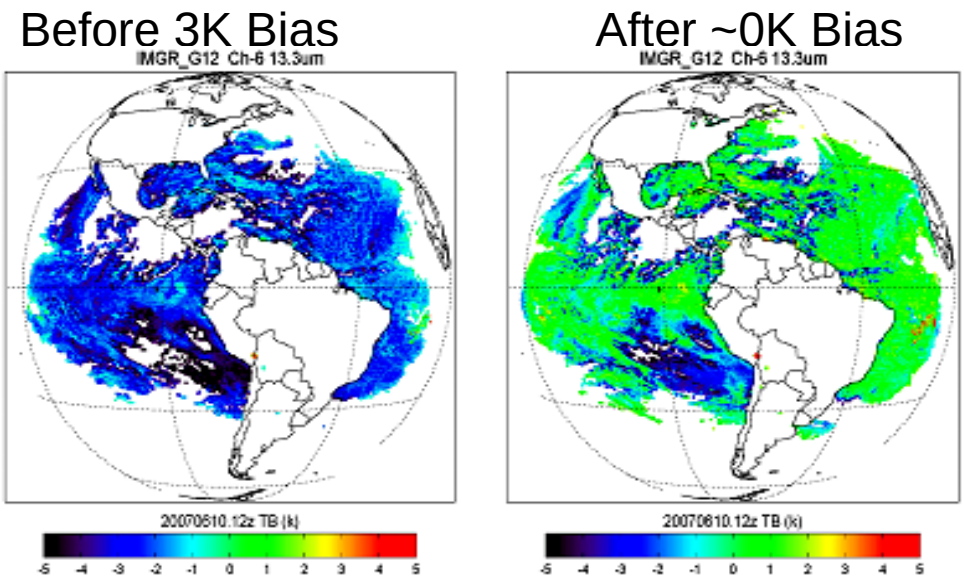
- Dr. Larry Flynn spent three weeks working in collaboration with personnel from the Chinese Meteorological Agency (CMA) and the Chinese Academy of Science (CAS) Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP).
- The CMA is working on a second generation of atmospheric chemistry instruments similar to the Ozone Mapping Instruments (OMI) and the Ozone Mapping and Profiler Suite (OMPS).

Coordination of international efforts and resources will lead to more efficient systems

The 6th GSICS Executive Panel Meeting

F. Weng, M. Goldberg

- The 6th GSICS Executive Panel Meeting was held in College Park, MD on June 3-4, 2009
- Participants from WMO, NOAA, NIST, USGS, NASA, EUMETSAT, CNES, JMA and KMA.
- NASA GPM project scientist, Dr. Arthur Hou, was also invited to give an overview on NASA GPM cross-calibration requirements and recent accomplishments
- GSICS user community from NCEP and STAR also reported their progresses on uses of GSICS data set in reanalysis projects.
- GSICS First Users Workshop – September 22, 2009 in Bath UK (at the EUMETSAT Satellite Conference)



The first major deliverable to the user community is the GSICS correction algorithm for geostationary satellites. The user applies the correction to the original data using GSICS provided software and coefficients.

The above figure shows the difference between observed and calculated brightness temperatures for GOES-12 channel 6 before and after the correction, respectively. The bias is reduced from 3 K to nearly zero. Significant improvement for both weather and climate users.

GSICS is now engaging a broader community to cross-calibrate satellite measurements for a strong environmental data stewardship

Education, Outreach and Training

The 2nd Workshop on Remote Sensing and Modeling of Surface Properties

F. Weng

- The workshop was attended by 80 participants from 12 countries.
- Seven presentations from STAR and EMC were given on emissivity model developments and improvements, impacts of the emissivity models on land data assimilation, global forecasts and satellite derived products
- Major NWP centers reported their planning and significant progresses on uses of surface sensitive sounding channels in their global forecast systems

The 2nd Workshop on Remote Sensing and Modeling of Surface Properties, Toulouse, France, on June 8-12, 2009

Accurate knowledge on land surface emissivity can reduce the biases in data assimilation and improve uses of satellite sounding data in NWP model

JCSDA 7th Science Workshop on Satellite Data Assimilation

F. Weng

Advances in data assimilation science and preparation of upcoming satellite sensors result in earlier uses of satellite data in computer forecast models and improve the forecast skills

- The Joint Center for Satellite Data Assimilation (JCSDA) held its 7th Annual science workshop at the University of Maryland, Baltimore County, on May 12-13, 2009
- About 100 participants representing both internal and external JCSDA projects attended the workshop.
- JCSDA partner agencies also reported their advances in uses of satellite data in NWP models. Some of the major advances reported were 1) operational uses of IASI data at NCEP, 2) improved uses of microwave data sensitive to surface, and 3) CRTM preparation for new instruments

Visiting Scientists

Wilfrid Schroeder, University of Maryland, CICS

Awards and Honors

SMCD Scientist Honored with Department of Commerce (DOC) Gold Medal

Gold medals are the highest forms of recognition that can be awarded by the Department of Commerce. They are granted by the Secretary, for rare and distinguished contributions of major significance to the Department, the nation, or the world. Dr. Changyong Cao was among the recipients of this year's DOC Gold medal awards. Dr. Cao was honored for his leadership in developing and implementing an international framework for generating high-quality satellite data for climate monitoring. SMCD congratulates Dr Cao for this prestigious recognition of his efforts and achievements.

Two SMCD Scientists among Recipients of 2009 Administrator's Awards

On August 28, 2009, Dr. Jane Lubchenco announced the winners of the 2009 Administrator's and Technology Transfer Awards. The Administrator's Award recognizes significant contributions to NOAA programs in equal employment opportunity, diversity, scientific research, public service, engineering development, environmental conservation, policy development, administrative support, public affairs, and information systems. We're excited to congratulate this year's winners and very proud of their accomplishments.

Yong Han

Fuzhong Weng

For improving the accuracy of weather forecasts by developing new and powerful radiative transfer models and techniques to assimilate advanced satellite data.

The current weather conditions are the starting point for all computer weather prediction models, and satellite observations provide most of the needed data. But satellites do not measure weather variables directly. They measure reflected sunlight and emitted heat radiation from the earth at different spectral wavelengths. The intensity and spectral distribution of this radiation depends on important weather variables, for example, atmospheric temperature, humidity, cloudiness, precipitation, and surface properties. A radiative transfer model is the glue that connects the remote satellite observations to the weather conditions. It is a complex numerical model that, given surface and atmospheric conditions, permits calculation of the radiation, and, given measurements of the radiation, enables extraction of information on the surface and atmosphere. The radiative

transfer model must not only be accurate but must be fast enough to enable assimilation of millions of satellite observations in a matter of minutes.

The nominees were challenged to develop new and powerful radiative transfer models and techniques to assimilate advanced satellite data into the NWS/NCEP global forecast system to meet NOAA's mission goals for serving society's need for weather and water information.

With strong collaboration between NESDIS and NWS, as well as support from JCSDA and external community scientists, the nominees developed, tested and implemented the community radiative transfer model (CRTM) into the NWS/NCEP global forecast system (GFS) in the extraordinarily short period of 1-2 years. The new capabilities to assimilate the advanced hyperspectral IR observations and more atmospheric observations over land have resulted in large positive impacts on weather forecasts, increasing forecast accuracy and extending the useful range of medium range predictions by almost half a day. This translates to improved accuracy, lead time, and false alarm rates in tornado warnings, flash flood warnings, winter storm warnings, Atlantic hurricane forecasts, 3-day precipitation, marine wind and wave forecasts.

SMCD Scientist among the 2009 Bronze Medal Awardees

Dr. Lawrence Flynn was selected as one of the 2009 Bronze Medal recipients in recognition of his exemplary engineering support and outstanding efforts in recovering the NOAA-18 SBUV Instrument. Ms. Mary E. Kicza, NOAA Assistant Administrator for Satellite and Information Services, delivered a congratulatory message to the award recipients. In it she stated “these prestigious awards affirm our employee’s dedicated service and significant contributions to our agency’s success”. The Bronze Medal is the highest honor award granted by the Under Secretary of Commerce for Oceans and Atmosphere.

Dr. Peter Romanov Named NOAA Team Member of the Month

Dr. Peter Romanov was the recipient of the January 2009 NOAA Team Member of the Month Award. He was recognized for developing operational algorithms for fully automated snow and ice cover maps, based upon optical data from a variety of NOAA and NASA satellites, and microwave data from the DMSP (Defense Meteorological Satellite Program) satellites. Dr. Romanov has also been very innovative in developing automated methods of validating the snow products with ground truth data.

A major milestone in Dr. Romanov's product development activities occurred in February 2008 when his automated product for the Southern Hemisphere was transitioned to full operations. The 4-km spatial resolution of this new product is 8-12 times higher that the resolution of existing microwave-based global products over the Southern Hemisphere.

Dr. Romanov has been a cooperative institute scientist at SMCD since 1998. He is currently affiliated with the Cooperative Institute for Climate Studies, University of Maryland, as an Associate Research Scientist. A web-based data visualization and distribution system of Dr. Romanov's products is available at http://www.star.nesdis.noaa.gov/smcd/emb/snow/HTML/snow.htm.

SMCD Recognition Luncheon

On October 21, 2009, Dr. Mitch Goldberg hosted a Recognition Luncheon for the Satellite Meteorology & Climatology Division, with the sponsorship of contractors I.M. Systems Group, Inc (IMSG), Short & Associates, Inc., Earth Resources Technology, Inc. (ERT), QSS, and ECG. Dr. Goldberg gave certificates of appreciation to each contractor team member who rendered notable services to the Division in the past year.

"While there are a number of ways to reward the outstanding efforts of federal employees at STAR, it is more difficult to get formal recognition for contractors," Dr. Goldberg said to the group. "This luncheon is a step towards sharing recognition with contractor team members, whose efforts are indispensable to SMCD and to STAR."

Here are some pictures from this event.

Dr. Goldberg congratulated Lori Brown for extending the new innovative design of the STAR website to individual Division projects.

Lori Brown & Mitch Goldberg

Dr Goldberg presented the GOES-R AWG team members with certificates for their exemplary work, and contributions towards the first major AWG delivery of the GOES-R Baseline products. He commended the team members for completing this four-year effort on time and within budget, and also in achieving the required performance for the 80% Algorithm Theoretical Basis Documents (ATBDs).

Kenny Lowe, Tess Valenzuela, Tong Zhu, Ming Chen (IMSG), Konstantin Vinnikov (UMD), Dan Tarpley (Short and Associates, Inc.), Hui Xu (IMSG), Wayne Bresky (IMSG), Mi Zhou (IMSG), Pubu Ciren (QSS), Hongqing Liu, Peter Romanov, Tim Mavor, Zhaohui Cheng, Larisa Koval, Hua Xie, Shuang Qiu, Qingzhao Guo, Shanna Sampson, Xingpin Liu, Gang Fu, Zhaohui Zhang, Yunhui Zhao, Haibling Sun, Wendy Zhang

George Ohring and Julie Price were presented certificates in recognition and appreciation for their notable contributions to the SMCD annual report and the Committee on Earth Observations Satellite (CEOS) climate progress report to the United Nations Framework Convention on Climate Change.

George Ohring & Mitch Goldberg, not pictured: Julie Price (Short and Associates, Inc.)

Ken Jensen & Mitch Goldberg

Ken Jensen was presented with a certificate of appreciation for his notable contributions in the development of the STAR Enterprise Product Lifecycle

Quanhua Liu, Yong Chen, Banghua Yan, and Ron Vogel received certificates for the support they provided to **Fuzhong Weng, and Yong Han**, in developing new and powerful radiative transfer models and techniques to assimilate advanced satellite data, which led to improvements in the accuracy of weather forecasts.

Ron Vogel, Banghua Yan, Yong Chen, Mitch Goldberg, Yong Han, Fuzhong Weng; not pictured: M. Liu

The following is a listing of some of the recognition that SMCD and many of its civil servant staff members received this year. In this section, the civil servant staff member's name is in bold, followed by the SMCD project that was recognized with Gold, Silver, and/or Bronze Medals, and other awards in the past year, and a list of the contract team members that contributed to the project.

Felix Kogan: In support of developing space-based, worldwide drought early warning and vegetative health monitoring systems and transferring the technology to users in more than ten nations. This is the first operational use of NOAA's satellite instruments for monitoring vegetative health and correctly portraying drought onset and extent and an innovative use of a current NOAA Advanced Very High Resolution Radiometer (AVHRR) sensor. The system has been used to successfully monitor drought and affect agriculture and livestock policy in the U.S., Kazakhstan, and Georgia (Caucasus).
Guo Wei
Le Jiang
Aleksandar Jelenak

Sid-Ahmed Boukabara, Christopher Barnet, Mitchell Goldberg, Fuzhong Weng, Ralph Ferraro, Walter Wolf, Limin Zhao, Tom Schott, Awdhesh Sharma, Huan Meng: In support of implementing processing systems that create Metop products and make them available for assimilation into U.S. forecast systems in record time.
Thomas King (system)
Haibing Sun (simulation system)
Lihang Zhou (system, planning, coordination)
Zhaohui Cheng (system, coordination, etc.)
Peter Keehn (porting code, etc.)
Wen Zhou (system work, since departed)
Xingpin Liu (regressions in beginning)
Kexin Zhang (regressions)
Chen Zhang (system)
Larisa Koval (documentation)

Science and validation
Antonia Gambacorta (overall science lead)
Murty Divakarla (val)
Eric Maddy (trace gases, CO2)
Xiaozhen Xiong (CH4)
Jennifer Wei (O3, validation)
Fengying Sun (convective parameters, emissivity)
Nick Nalli (AEROSE validation)
Bormin Sun
Mike Petty
Frank Tilley
Kevin Garrett
Flavio Iturbide-Sanchez
Chris Grassotti
Wanchun Chen
Cezar Kongoli
Banghua Yan
Quanhua Liu

Changyong Cao: In support of developing and implementing an international framework for generating high-quality, satellite data for climate monitoring.
Ping Jing (IMSG)
Likun Wang (QSS)
Bob Iacovazzi (ERT)
Sirish Uprety (QSS)
Ruiyue Chen (IMSG)

Xiangqian Wu: In support to the chair of the WMO GSICS Research Working Group (GRWG), and coordinating and integrating all the calibration research with GSICS partner agencies.
Fangfang Yu
Likun Wang
Yaping Li
Ninghai Sun

Mitch Goldberg: In providing superior support to the Chief of the Satellite Meteorology and Climatology Division, with notable contributions to the GSICS Coordination Center and the development of the GSICS product acceptance and data archiving procedures.
Robert Iacovazzi
Aleksandar Jelenak

Shobha Kondragunta: In support of the development of critical new smoke and dust observation products for verification of real-time pre-operational testing of new National Weather Service smoke predictions
Jian Zeng

Journal Articles

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Gao, S., and X. Li. 2008. Responses of tropical deep convective precipitation systems and their associated convective and stratiform regions to the large-scale forcing, *Quarterly Journal of the Royal Meteorological Society*, **134**, 2127-2141

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