# NOAA NESDIS
## Center for Satellite Applications and Research

# Satellite Meteorology and Climatology Division
# FY07 Report: Year in Review

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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 2007 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 2007 Fiscal Year.

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

- **High quality calibrated observations and products from NOAA, METOP, The National Polar-orbiting Operational Environmental Satellite System (NPOESS) and the Geostationary Operational Environmental Satellite (GOES-R) satellite observations**, such as, the Global Space-based InterCalibration System (GSICS), the NOAA Integrated Sounding Product Validation System, and the SNO technique for satellite intercalibration, etc.
- **Improved utilization of satellite observations and demonstration of new products from NOAA and non-NOAA satellites to support NOAA mission goals**: For example, Greenhouse gas products from AIRS, new GOME-2 $NO_2$ products, GOES Aerosol Products which improve Community Multiscale Air Quality (CMAQ) model prediction of aerosols, the Satellite-derived biomass burning PM2.5 emission database for improving PM2.5 predictions, and a demonstration of our Vegetation Health time series that showed its efficacy in drought monitoring, estimating regions of malaria outbreaks, and crop yields.
- **Development and enhancement of product processing systems for transition to Operations**: These include the Infrared Atmospheric Sounding Interferometer (IASI), the Microwave Integrated Retrieval System (MIRS), the Automatic Smoke Detection Algorithm (ASDA), and the ATOVS Sounding Product, etc. All were transitioned to NESDIS Office of Satellite Data Processing and Distribution (OSDPD).
- **Leadership and development of new algorithms and applications for future satellite observing systems (NPOESS and GOES-R)**: For example, the Algorithm Working Group (AWG) for GOES-R Algorithm Development, leading development of NPOESS Data Exploitation (NDE) NOAA unique products, and moving towards CMMI level three maturity for algorithm and systems development.
- **National and International Collaborations**: We continued to work closely with many NOAA Programs for example, Air Quality, Climate, and Weather and Water. In addition, we had some international collaboration with NWP centers, the China bilateral agreement, Japan (JAX and JMA) bilateral agreement, Korea (KMA) bilateral agreement, India MOU, CEOS Cal/Val, CEOS SIT, CGMS, and WMO GSICS, AOPC, etc.
- **Education, Outreach and Training**: JCSDA Data Assimilation Training Workshop, and the SMCD Student Mentorship Program.

To help us achieve our future work program, I am pleased to welcome five new employees who joined us earlier this year. “Who we are” gives more details. The range of their experience will bring new insight and expertise to our team, and complement our existing strengths. I would like to say goodbye to three long serving team members: Dan Tarpley, Dave Brown and Art Neuendorffer. I wish each one of them a long and happy retirement, and I particularly want to thank Dan Tarpley for his support in operating the Division. His help and support to me as Chief has been invaluable.

I hope you enjoy reading about our accomplishments as 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 with our team and partners as we continue to improve in FY08.

# 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, and access to Cooperative Institutes via grants, which provides scientists and software specialists to support the SMCD investigators. 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 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 Operational Products Development Branch 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 manages the NOAA line item budget, which supports the JCSDA Executive Office, STAR researchers working on JCSDA Directed Research programs, and the extramural community through a Federally Funded Opportunity.

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 a numerical weather prediction community empowered to effectively assimilate increasing amounts of advanced satellite observations. The goals of the JCSDA are to:

- Reduce from two years to one year the average time for operational implementation of new satellite technology
- Improve and increase uses of current and future satellite data in NWP models
- Assess 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.

**CHIEF**
Goldberg, Mitch

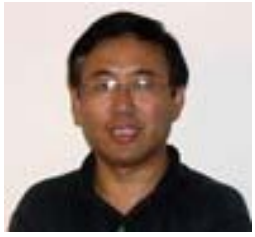
Thompson, Patricia

East, Tina

Jackson-Jones, Staci

## SENSOR PHYSICS BRANCH

**Branch Chief**



Weng, Fuzhong

Barnet, Chris

Beck, Trevor
JOINED March

Boukabara, Sid
JOINED May

Cao, Changyong

Flynn, Larry

Han, Yong

Kleespies, Tom

Kondragunta, Shobha

Mo, Tsan

Neuendorffer, Art
RETIRED September

Wu, Fred

## ENVIRONMENTAL MONITORING BRANCH

**Acting Branch Chief**


Laszlo, Istvan

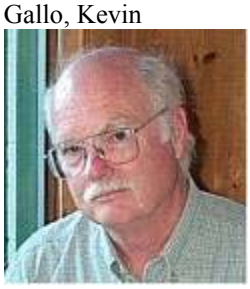

Forsyth, Dave


Gallo, Kevin


Kogan, Felix


Kuligowski, Bob


Li, Xiaofan


Tarpley, Dan
RETIRED August


Sullivan, Jerry
RETIRED October


Vargas, Marco
JOINED May


Yu, “Bob” Yunyue
JOINED November


Zhan, “Jerry” Xiwu
JOINED October


Zou, Cheng-Zhi

## OPERATIONAL PRODUCTS DEVELOPMENT BRANCH

**Branch Chief**


Hank Drahos


Brown, Dave
RETIRED June


Chalfant, Mike


Daniels, Jaime


Pryor, Ken


Reale, Tony


Weldon, Roger


Wolf, Walter
JOINED April

# New Staff Profiles

**Xiwu "Jerry" Zhan** joined us in 2006 as a Physical Scientist. Jerry received his B.S. and M.S. degrees from Nanjing Institute of Meteorology in China. He obtained his Ph.D. degree in Atmospheric Sciences from Cornell University in 1994. He worked at the Hydrology Lab of USDA-ARS for two years as a postdoctoral scientist. In 1996, he joined the research faculty of the Department of Geography at University of Maryland College Park. He started working in the Hydrological Sciences Branch of NASA Goddard Space Flight Center as a contractor of UMBC Goddard Earth Science and Technology Center in 2002. He returned to USDA-ARS as a civil servant remote sensing specialist in 2005. Jerry worked on various research fronts of land surface modeling and remote sensing. He has published refereed papers on land surface water, energy and carbon flux simulation models, MODIS land cover classification and land cover change detection algorithms, soil moisture retrieval algorithms, land data assimilation system development, and land remote sensing and modeling data applications for agricultural efficiency. He will continue his research interests in these areas.

**Trevor Beck** joined our Sensor Physics Branch (SPB) as an Air Chemistry Scientist. Trevor received his BA degree in physics and mathematics at the University of Colorado, Boulder in 1994. Prior to joining NESDIS he worked at NCAR Climate and Global Dynamics and NCEP CPC. His research interests are in remote sensing using UV and VIS radiances, radiative transfer, and atmospheric chemistry.

**Yunyue "Bob" Yu** joined our Environmental Monitoring Branch (EMB) as a physical scientist. Yunyue received his BS degree in physics in 1982, from the Ocean University of Qingdao, Qingdao (now renamed Ocean University of China). He also completed MS degree courses in advanced physics at Peking University, China, during 1984-86, and MS courses in remote sensing at University of Dundee, UK, during 1987-88. He received his PhD degree from the University of Colorado, Boulder, in 1996. After completing his PhD, he worked in satellite remote sensing at NASA Goddard Space Flight Center as a principal scientist with Raytheon ITSS, and then as a senior research scientist at George Mason University, Fairfax, VA. His research interests are in remote sensing of land and ocean surface.

**Walter Wolf** joined us as the Product Development Leader in our Operational Products Development Branch (OPDB). Walter received his B.S. in Atmospheric Science from the State University of New York at Albany in 1989. Later he obtained his M.S. in Atmospheric & Oceanic Sciences from the University of Wisconsin-Madison in 1994. He has extensive experience creating operational processing systems in the field of atmospheric science. He is currently leading the development and transition of the IASI near real time processing and distribution system, the CrIS/ATMS processing and distribution system, and the development of the GOES-R Algorithm Working Group product processing systems. He designed, developed, and implemented the near real-time AIRS, AMSU, and HSB processing and distribution system. The AIRS processing system is running 24/7 and is distributing data to the global Numerical Weather Prediction (NWP) Centers. Mr. Wolf also designed, developed and implemented the International ATOVS Processing Package (IAPP), a direct broadcast software package that processes ATOVS satellite data to produce temperature and water vapor retrievals and is currently being used around the world.

**Sid-Ahmed Boukabara** received the /Ingénieur/ degree in electronics and signal processing from the National School of Civil Aviation (ENAC), in Toulouse, France (1994), the M.S. degree from the National Polytechnic Institute of Toulouse, France (1994) and the Ph.D. degree in remote sensing from the Denis Diderot University, Paris, France (1997). His principal areas of interest are atmospheric and surface radiative transfer modeling, spectroscopy and retrieval processes. Sid started his career in Europe, on ESA's ERS projects, and then joined AER Inc. located in Cambridge, MA as a staff scientist in 1998, to work on the next generation polar orbiting satellite programs NPP/ATMS and NPOESS/CMIS & CrIS, as well as on the NASA scatterometers SeaWinds/QuikSCAT. He became a NOAA contractor in 2005 where he started working on the Microwave Integrated Retrieval System (MIRS) before becoming an SMCD staff member in May 2007.

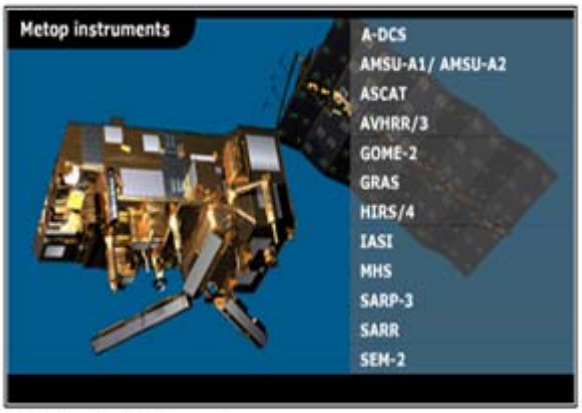
**Marco Vargas** came on board as a Research Scientist in our Environmental Monitoring Branch (EMB). Marco received a B.E. degree in Electrical Engineering in 2002, an M.S. in 2004, and a PhD in Electrical Engineering in 2007, specializing in remote sensing, all from the City University of New York. He joined NOAA/NESDIS in 2006 through the NOAA Graduate Sciences Program.

# Accomplishments

## Assuring 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 2007, our calibration scientists made a number of breakthroughs.

### Record Breaking Rapid Checkout of MetOp



MetOp's suite of instruments

We completed a full characterization of NOAA instruments on the MetOp-A satellite within 45 days after satellite launch. The on-orbit verification and calibration included the three NOAA instruments (AMSU-A, AVHRR/3, HIRS/4) on board MetOp-A as well as assistance to EUMETSAT colleagues on calibration of several other several other instruments: ASCAT, IASI, MHS, and GOME-2. More rapid checkout permits earlier use of the data, thus maximizing benefits from the satellite.

### Global Space-based Intercalibration System (GSICS) Five-Year Priority Plan: Achieving Comparability of Satellite Measurements

The first GSICS Five-year Priority Plan, emphasizing rapid integration of newly-calibrated satellite instrument data into the operational environment, was presented to the GSICS Executive Panel in Geneva, Switzerland, April 23-27 2007. GSICS, an international program under the World Meteorological Organization, will ensure the comparability of satellite measurements provided at different times by different instruments and programs, and tie these measurements to absolute references and SI standards. Initial projects include inter-calibrating current operational satellite data and coordinating with national standards laboratories to research and develop methods of ensuring standards-traceable calibration transfer before and after spacecraft launch. GSICS contributes to achieving the goals of the Global Earth Observation System of Systems (GEOSS). Rapid integration into operations will allow early testing of the impact of GSICS inter-calibrations on environmental products and applications. SMCD is playing a leading role in GSICS.

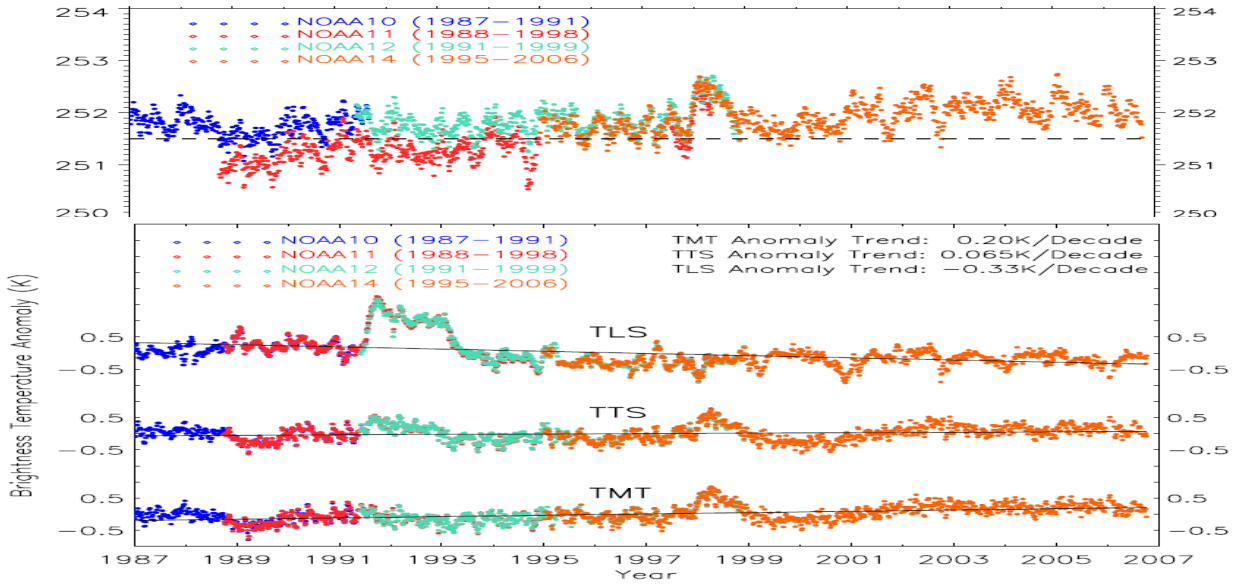
Global Space Based Inter-calibration System
Five-Year Program Plan

World Meteorological Organization

Draft, April 2007

## Improved MSU Calibrations: Accurate Estimates of Global Warming Rates Now Possible

Accurate decadal scale atmospheric temperature trends can now be computed from the time series of overlapping MSUs on NOAA's POES satellites over the past two decades. This capability results from intercalibration of the MSU atmospheric channels for NOAA 10 to 14 using the Simultaneous Nadir Overpass technique. Temperature trends are of the order of a few tenths of a degree Celsius per decade, and detecting such tiny changes requires very stable measurements and removal of inter-instrument biases. The upper panel in the accompanying figure shows the time series of the globally averaged brightness temperatures for channel 2 of the MSUs on NOAA 10 to NOAA 14 prior to intercalibration. Note that intersatellite differences can be as large as $1^0$ C. The lower panel illustrates the time series of MSU channels 2 (TMT: Temperature of Middle Troposphere), 3 (TTS: Temperature of Tropopause and Lower Stratosphere), and 4 (TLS: Temperature of Lower Stratosphere). The data show that the troposphere is warming at a rate of $0.2^0$ C/decade and the lower stratosphere is cooling at $0.33^0$/decade, consistent with climate model predictions. The merged MSU radiance data set produced by our scientists is well suited for assimilation in reanalysis systems.



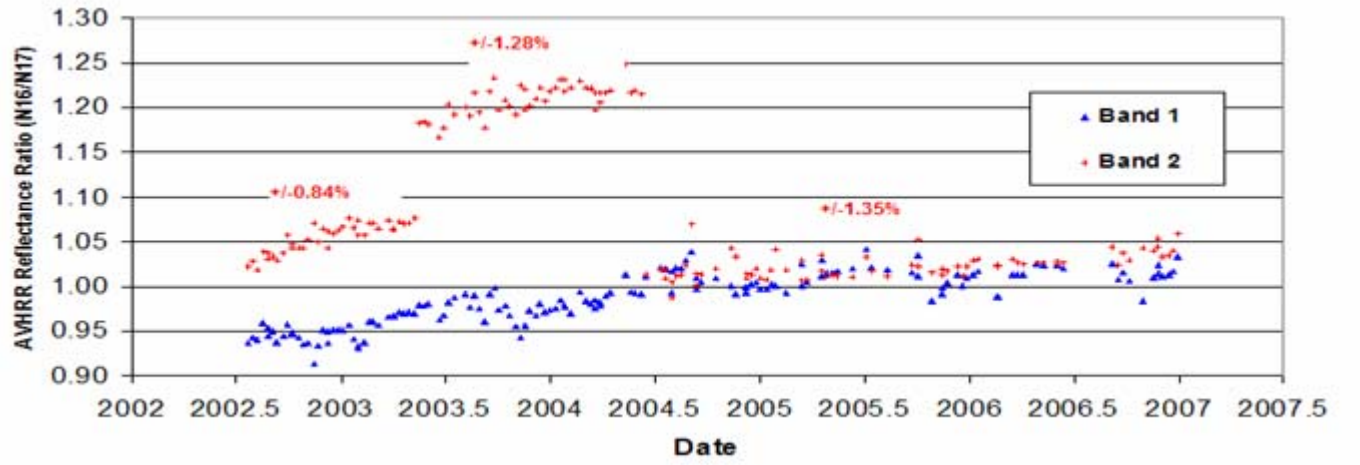

***Upper panel: Ocean-averaged MSU channel 2 time series for NOAA 10, 11, 12, and 14 for 1987-2007 before intercalibration with the Simultaneous Nadir Overpass technique; Lower panel: Anomaly time series for MSU channels MSU channels 2 (TMT: Temperature of Middle Troposphere), 3 (TTS: Temperature of Tropopause and Lower Stratosphere), and 4 (TLS: Temperature of Lower Stratosphere) after the SNO recalibration.***

## The Moon as a Calibration Reference for GOES-R

The Moon is a very stable source of reflected sunlight, as are many stars. This property makes these objects excellent standards for checking the drift of satellite imagers in the visible and near infrared regions of the spectrum. The GOES-R cal/val working group has recommended to the GOES-R program office that Lunar and Stellar calibration requirements be included in the GOES-R/Advanced Baseline Imager (ABI) ground system operations to ensure instrument performance compliance. The recommendations are currently being considered at the GOES-R program level. GOES-R/ABI calibration stability and accuracy requirements are critical for the quality of higher level products. Without Lunar/Stellar calibration, calibration drift is difficult to account for.

## Inter-calibration Accuracy for AVHRRs: Now Less than 1%

We developed the capability to quantify intersatellite biases for the solar bands of NOAA's AVHRRs with uncertainties to less than 1% (see figure – uncertainty value in red). By introducing a new procedure into the Simultaneous Nadir Overpass (SNO) Intercalibration method, our scientists have been able to achieve increased accuracies, which permit tracking of more detailed characteristics of the operational vicarious calibration, including calibration improvements, drifts and uncertainty changes. Intersatellite comparison using the SNO method is vital for generating Fundamental Climate Data Records (FCDRs).




***Time series of AVHRR reflectance ratio (NOAA-16/ 17) during Simultaneous Nadir Overpasses not only detects large jumps due to coefficient adjustments, but also reveals calibration drifts, variability changes, and relative degradation rate.***

## SMCD to Manage GSICS Coordination Center (GCC)

Our division was chosen to manage and operate the GSICS Coordination Center (GCC). The GCC coordinates the specifications for collocated data requirements (satellite-to-satellite, satellite-to-reference sites), specifications on collocation criteria, sampling frequency, formats, reporting times, methodology for instrument inter-comparisons, and archiving and access of collocated data. The GCC also publishes a GSICS Quarterly designed to disseminate news on inter-calibration activities to GSICS partner agencies, satellite data users, and policy makers. In addition, the GCC has developed a website to allow for timely communication among GSICS partners, and posting of major meeting presentations.


GSICS Quarterly
No. 1, Spring 2007
Global Space-based Inter-Calibration System
Introducing GSICS

## NIST/NOAA Meeting on MSU Calibration

On September 19, 2007, a joint National Institute of Standards and Technology (NIST)/NOAA calibration meeting was held at the NIST main campus in Gaithersburg, Maryland. The primary purpose of the meeting was to share information about outstanding calibration issues related to developing long-term climate data records from NOAA Microwave Sounding Unit (MSU) observations, and to exchange ideas for improving the quality of such data records. Three NOAA/STAR scientists including Cheng-Zhi Zou, Changyong Cao, and Bob Iacovazzi Jr. and 13 NIST scientists attended the meeting. At the meeting, Cheng-Zhi provided a presentation describing inter-calibration techniques using simultaneous nadir overpasses to generate high-quality climate data

records from the MSU observations. Cheng-Zhi's presentation generated a very lively and fruitful discussion, and stimulated thinking about next steps. His presentation was followed by a laboratory tour of some of the NIST facilities that provide optical calibration standards for radiometers. The meeting initiated a potentially long-term collaborative effort between NOAA and NIST to resolve the existing MSU calibration issues and possibly that of other instruments.

## GOES-R Cal/Val Plan: Focus on On-orbit Radiance Quality Assurance

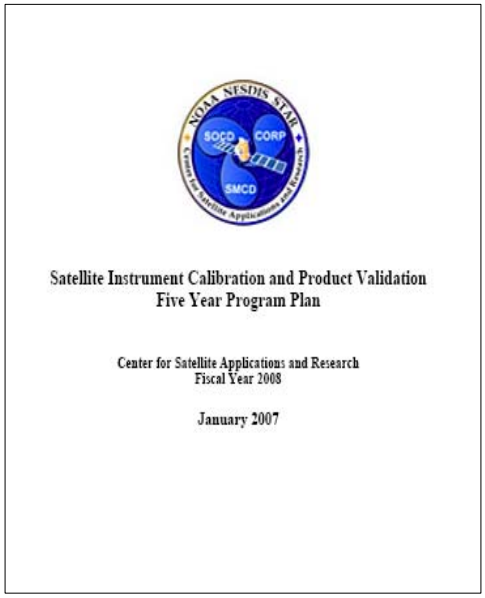

The first volume of a calibration and validation plan for the NOAA's next geostationary satellite series was completed and distributed. GOES-R Volume 1 addresses pre-launch characterization and calibration; ground processing system and operational calibration; as well as post-launch activation and checkout, radiance verification, long-term instrument performance monitoring, and calibration anomaly resolution. The GOES-R Calibration/Validation Plan focuses on on-orbit radiance quality assurance – e.g., radiance performance analyses, sensor parameter trending, inter-satellite/inter-sensor calibration, lunar and stellar calibration, vicarious calibration, and radiative transfer simulation of instrument radiances – during the entire life of the GOES-R radiometers. The plan is a collaborative effort amongst NOAA, NIST, NASA, and the instrument vendors. It is developed based on the experience and lessons learned from the heritage GOES and POES systems, as well as other programs. The methodologies described in the plan encompass both the traditional approach and the current state of the art in Cal/Val.

The GOES-R Cal/Val Plan is an important part of GOES-R data quality assurance, which is essential to GOES-R mission success. It supports NOAA goals associated with the GOES-R program and the Global Earth Observing System of Systems (GEOSS) concept. It does this by laying out a strategy to assure the accuracy and stability of GOES-R data throughout the pre- and post-launch life of the satellite instruments.

## STAR Five Year Satellite Cal/Val Plan: Towards a National Center for Calibration

We also completed the first version of STAR's Five Year Satellite Cal/Val Plan, which was developed under the leadership of SMCD. The plan formulates the activities that STAR must undertake to insure the quality of the observations and products from NOAA's fleet of operational satellites. The plan calls for leveraging other agency – NASA and NIST - cal/val capabilities and working toward the establishment of a National Center for Calibration. Implementation of the plan will produce the following benefits:

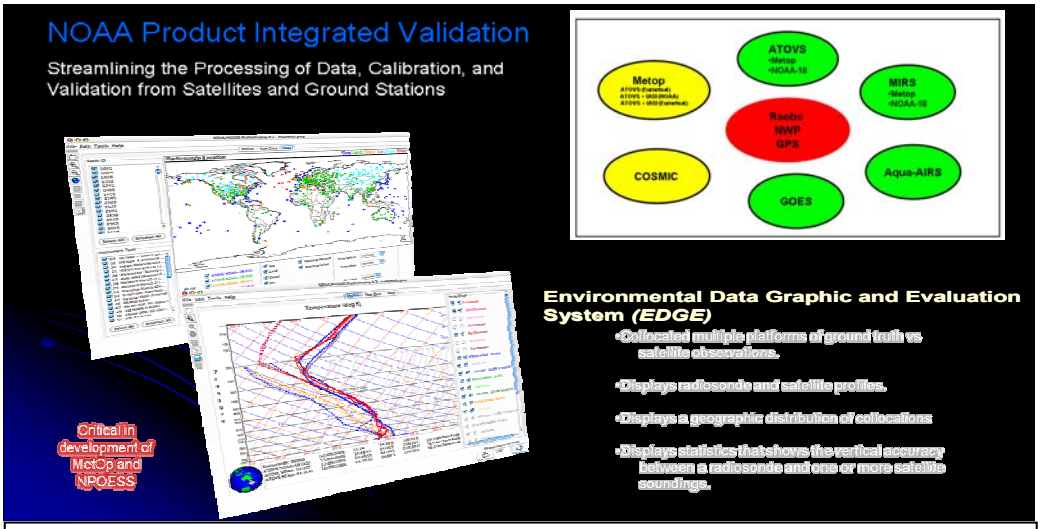
- Early, irrefutable detection of climate change
- Facilitation of accurate climate data and estimates of climate trends to underpin policy decisions
- Verification of climate model predictions
- Improved weather prediction
- More reliable short term climate forecasts
- Achieving the nine societal benefit goals of the Global Earth Observation System of Systems (GEOSS)
- Ability to make sound policy decisions based on accepted accurate information



## NOAA Products Integrated Validation System

The National Environmental Satellite Data and Information Service (NESDIS) has been responsible for the generation and validation of satellite based surface and atmospheric weather products since the deployment of the TIROS Operational Vertical Sounder (TOVS) in 1979. These systems have expanded over the past 25+ years, to include products from multiple polar and geostationary space platforms, leading up to the current advanced microwave and hyper-spectral infrared sounders that will be the mainstay of the planned next generation NPOESS systems.

During this time the problem of inter-sensor and product validation has become a growing concern for the scientific community of users and research tasked with utilizing these observations to provide the public with real-time weather and long-term climate information. The lack of a centralized, consistent approach to monitor and validate the respective suites of satellite observations has led to ambiguous and in some cases conflicting results as well as costly duplication of effort among the respective satellite and product programs within NOAA.




***This panel shows the basic components of NPIV. The current suites of NOAA polar satellite products from ATOVS and Microwave Integrated Retrieval System (MIRS), geostationary (GOES) products and experimental Aqua-AIRS from NASA/EOS are shown in green. Planned expansions to include products from the ATOVS and hyper spectral Infrared Atmospheric Sounding Interferometer (IASI) sounders onboard the polar orbiting MetOp satellite and GPS observations from the recently deployed constellation of COSMIC satellites (and receivers) are also shown in yellow. Ground truth observations consisting of radiosonde, numerical weather prediction (NWP) and surface based GPS data that are collocated with the respective suites of satellite observations are indicated in red. Available analytical tools using the Environmental Data Graphics and Evaluation (EDGE) system are critical for developing and troubleshooting NPIV system software and ultimately for validating the respective product suites using the NPIV collocation database.***

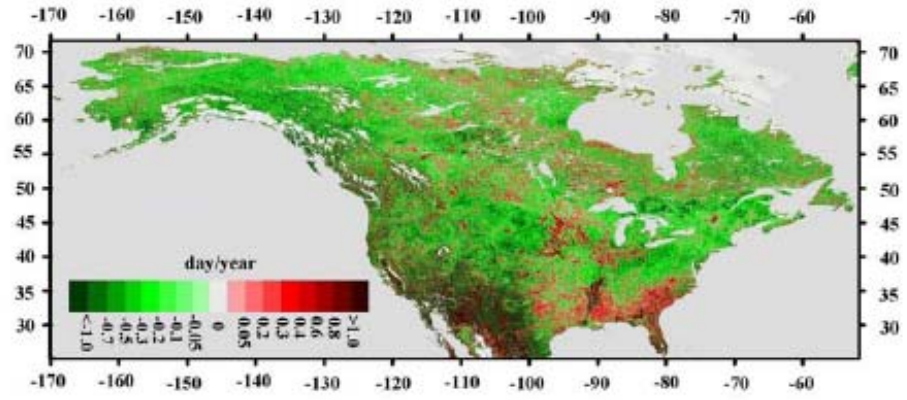
The NOAA Product Integrated Validation System (NPIVS) is establishing an integrated satellite data collection and ground truth collocation system with the goal of providing consistent monitoring and validation of NOAA spaced based weather products. NPIVS protocols include carefully designed strategies for collocating satellite observations from both polar and geostationary platforms with selected sets of ground truth observations. The program includes screening of the ground truth used for validation, and graphical evaluation systems for complete scientific monitoring, analysis and research support.

# 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.

## Global Warming and Spring Greenup: Surprising Results

One would expect that global warming would lead to earlier spring green-ups. We have found that this is not always the case. Analyzing annual cycles of the AVHRR Normalized Difference Vegetation Index (NDVI) over the North America since 1982, they found that green-up is occurring earlier north of 40 degrees latitude, but later south of this latitude. The algorithm, developed by Xiao Yang Zhang of ERT, automatically detects the phenological transition date in the onset of the vegetation green-up for each annual cycle of NDVI. Use of the phenological approach treating each year's NDVI individually overcomes residual errors in the satellite intercalibrations of the many AVHRRS used in the study. North of 40 degrees, green-up has advanced by 0.32 days/year, while south of 31 degrees, green-up has been delayed by 0.15 days/year. A possible explanation: Some plants need to be exposed to a short cold snap to sprout. Plants at northern latitudes still get this, but those at lower latitudes do not, causing them to sprout later as the climate warms. A similar pattern emerges when records of lilac bloom dates are analyzed.




***Rate of change (days/year) of green-up onset from 1982 to 2005, where negative values (green areas) represent earlier green-ups and positive values (red areas) denote later green-ups. The white color indicates the areas without good data or no changes.***

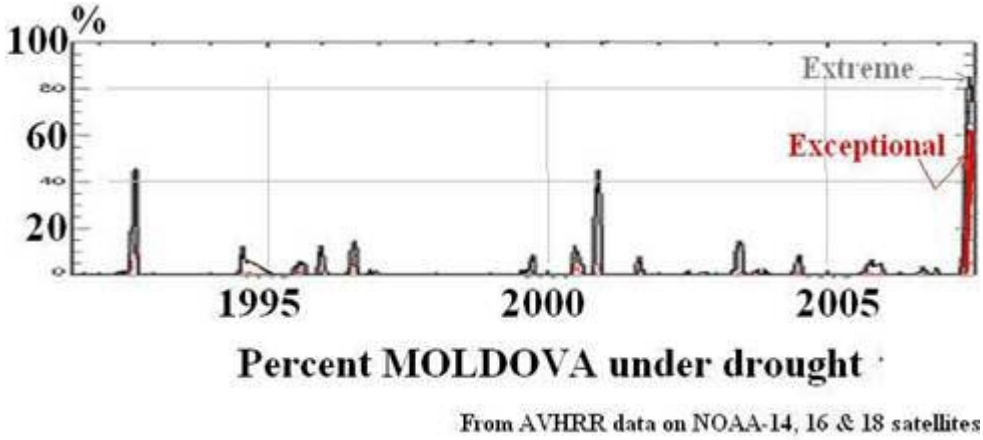
## NOAA Responds to US Embassy in Ukraine: "Once in a Lifetime Drought in Moldavia"

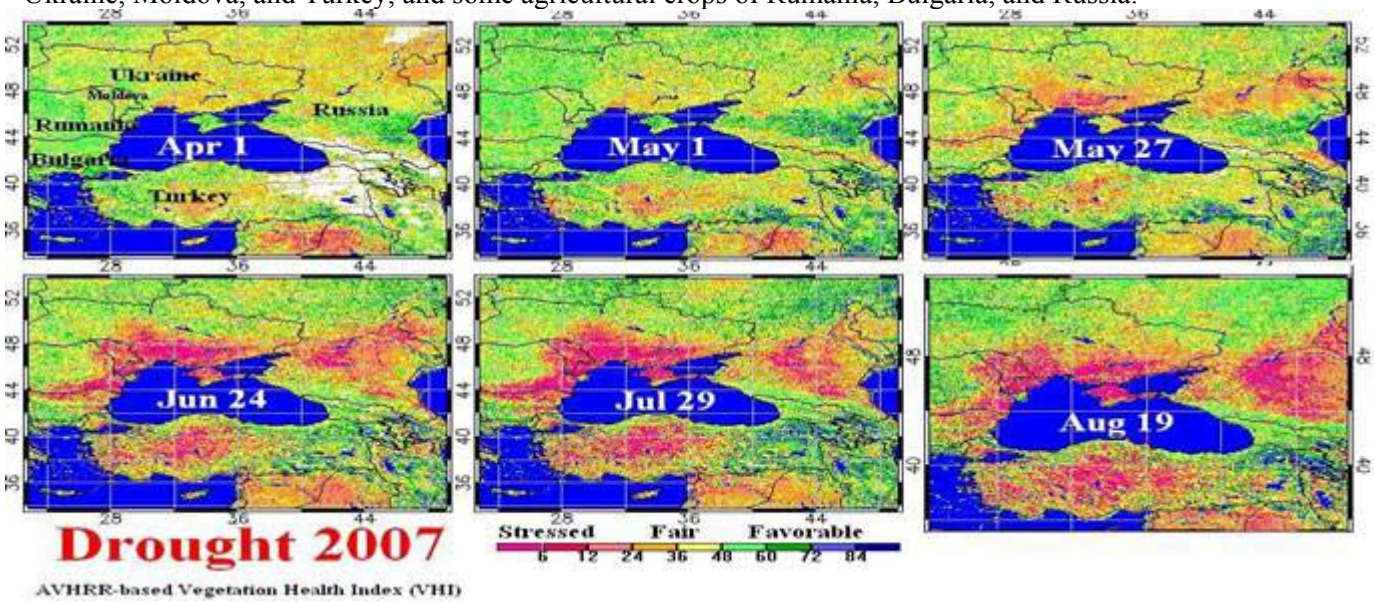
Mr. Matt Habinowski, Economic Officer of the U.S. Embassy in Kiev, Ukraine, sent NOAA/NESDIS/STAR the following in a letter:

> "We are hearing reports that the drought that has been affecting the northern Black Sea countries and has, in fact, intensified in the past couple of weeks. Moldova has even declared a state of emergency due to crop losses. We are concerned that Ukraine might be similarly affected. Does NOAA have any data imagery to confirm this?"

Our scientists sent the following information to the U.S. Embassy in Kiev, Ukraine, and to the Ministry of Ecology and Natural Resources of Moldova.

Global analyses of the Advanced Very High Resolution Radiometer (AVHRR)-based vegetation health indices (VHI) indicate that ninety percent of the Moldova territory is covered by extreme drought, including 60 percent by exceptional (once per 50-80 years) drought. In the Ukraine, the 2007 drought is much more intense than the 2003 severe drought, which caused huge crop losses. In the Black Sea area, the drought started in April-May 2007. During June-August, the drought expanded and intensified so much that we could not find a similar condition in the entire 27-year of archived satellite data. The drought was particularly severe during the wheat heading period, which started in May and is a critical time for the wheat crop. The drought affects major agricultural areas of Ukraine, Moldova, and Turkey, and some agricultural crops of Rumania, Bulgaria, and Russia.

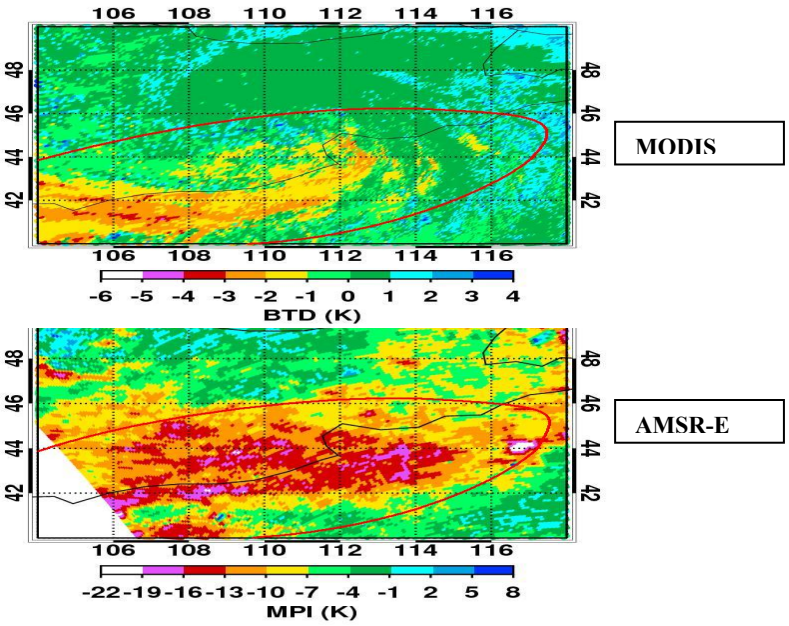



***Vegetation Health deteriorated (red areas) in the main growing regions of the Winter Wheat crop during the critical heading period.***

## Microwave Sensor Improves Dust Storm Monitoring

Observations from satellite infrared sensors (e.g. AVHRR, MODIS) provide good, relatively high horizontal resolution monitoring of dust storms for cloud-free conditions, under which the dust particles can attenuate the radiation emitted from surface. For cloudy conditions, the effect of the aerosols is swamped by the infrared absorption by the clouds. Lower horizontal resolution microwave radiation passes through clouds and is sensitive to dust particles that may contain silicon, sandstones, and graphite, which produce scattering and decrease the microwave emission from surface. Thus, combined IR and microwave observations can monitor dust storms for all conditions. Asian dust storms affect the air quality around the world because the storms are associated with mid-latitude frontal systems, and the dust particles travel thousands of miles away from their

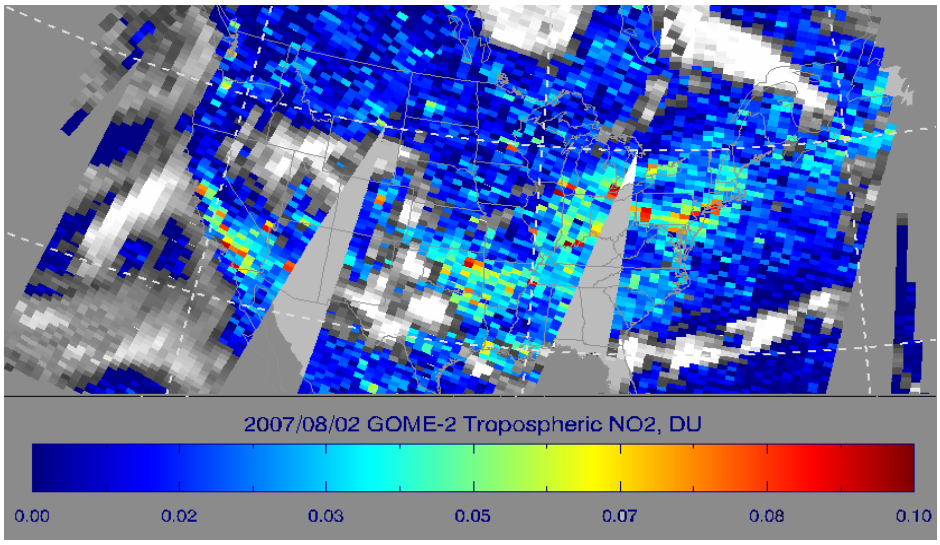



origin. The US is in the downstream of the Asian dust storms and is constantly affected in spring season. The combined IR/microwave technique will improve global air quality forecasts.

***Comparison of dust storm areas identified by infrared algorithm from MODIS (upper panel) and microwave algorithm using AMSR-E (lower panel) for the dust storm case 5 (March 27, 2004). The microwave observations agree quite well with the dust storm region (within red line) determined by surface observation.***

## Air Pollutant and Acid Rain Precursor $NO_2$ Detected from Global Ozone Monitoring Experiment-2 (GOME-2) Observations

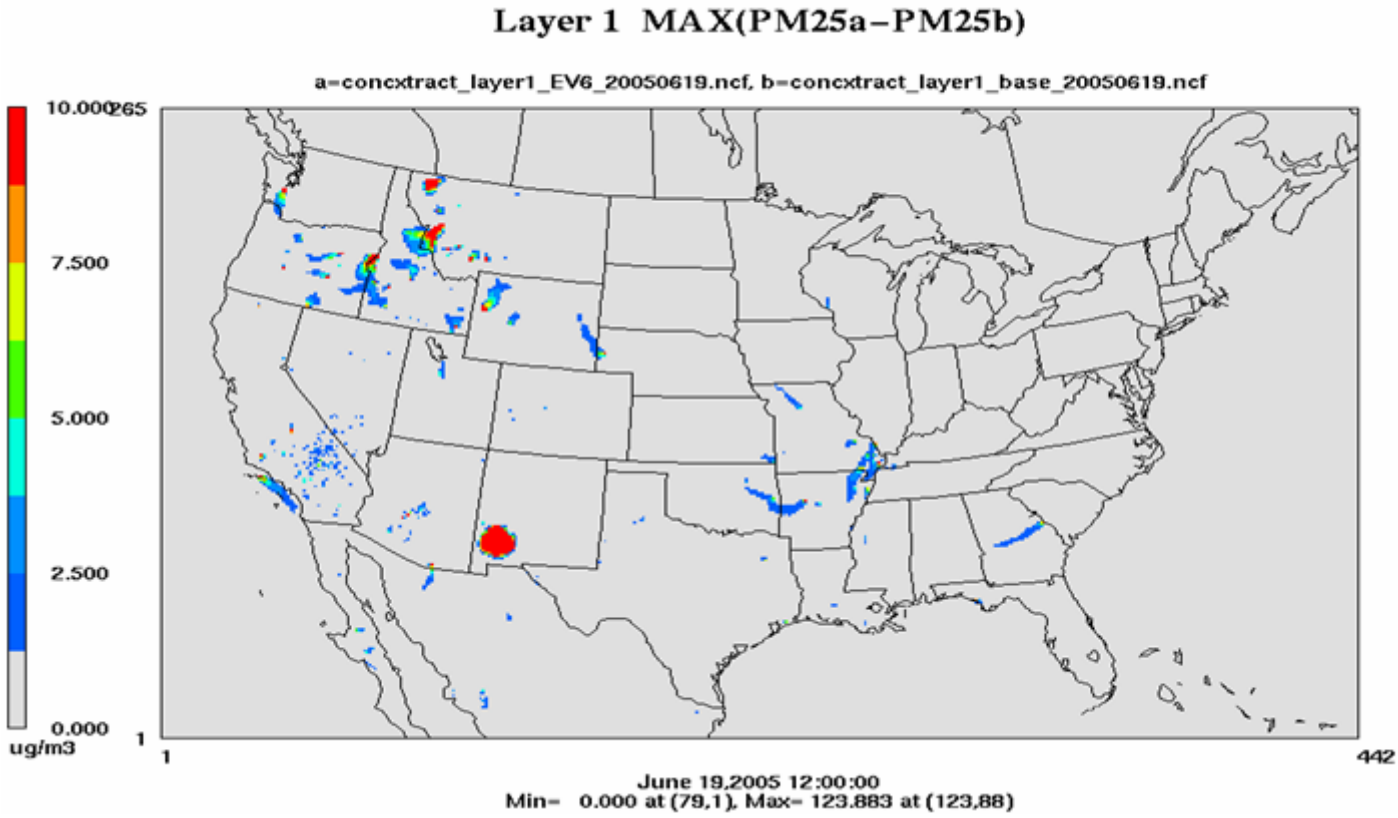
We are developing an algorithm to generate tropospheric $NO_2$ column amounts from observations of the GOME-2 instrument. GOME-2 is Europe's 2nd generation ozone monitoring instrument and is flying on EUMETSAT's MetOp satellite. Nitrogen Dioxide ($NO_2$) pollutes the air mainly as a result of road traffic and energy production. Apart from giving rise to acid rain and other air pollutants, current levels of $NO_2$ may affect our health. The EPA and NWS will use the tropospheric $NO_2$ product when it becomes operational. Applications will include verifications of the Clean Air Interstate Rule, which permanently caps emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx) in the eastern United States, and improving air quality model forecasts by constraining $No_x$ emissions in air quality model predictions. These results are preliminary and research is ongoing. – *Trevor Beck*




***Estimated tropospheric $NO_2$ for the Continental US, 2 Aug. 2007. The regions of enhanced $NO_2$ are indicative of enhanced air pollution. The grey scale pixels are cloud covered.***

## Assimilation of Satellite-Derived Forest Fire Smoke Amounts Improves Air Pollution Predictions

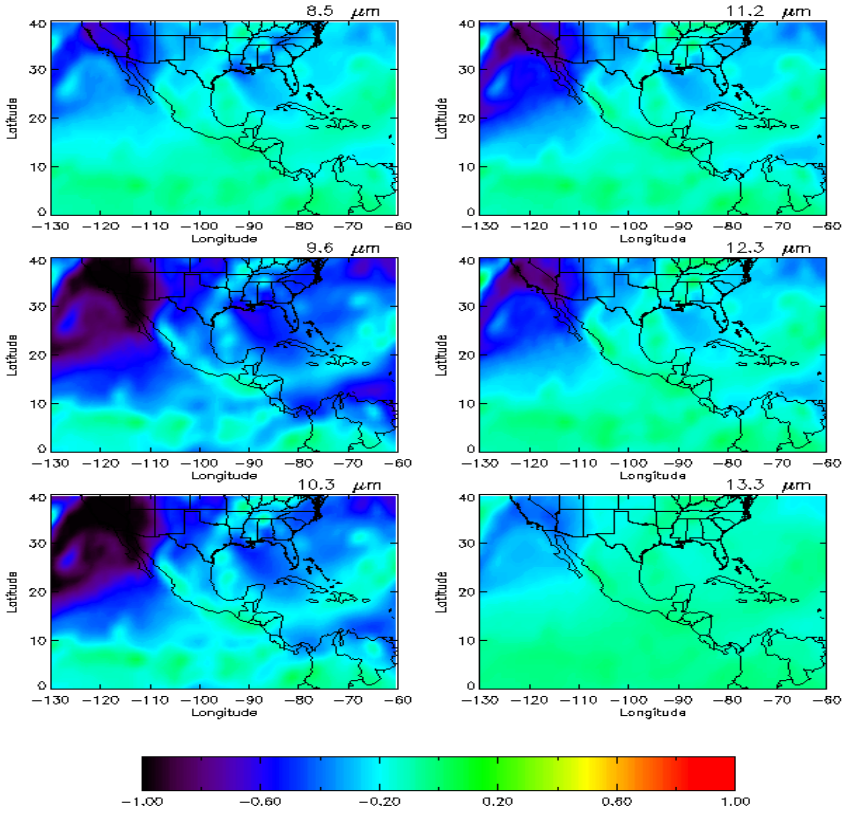
Our scientists, in collaboration with NOAA/OAR scientists, assimilated satellite-derived biomass burning smoke (particles smaller than 2.5 microns , PM 2.5) emissions into the Community Multiscale Air Quality (CMAQ) model and simulated air quality over the Continental United States (CONUS) for a 10-day time period in June 2005 when there were multiple fires in the central and western U.S. Preliminary results show that assimilation of satellite derived PM2.5 emissions from forest fires could impact surface PM2.5 concentrations by up to 10µg/$m^3$. This is significant because concentrations greater than 35µg/$m^3$ are harmful to human health, and if biomass burning emissions are not included, air quality predictions will underestimate particle amounts. Primary sources of PM2.5 include fuel combustion from automobiles, power plants, wood burning, industrial processes, and diesel powered vehicles such as buses and trucks. However, prescribed and wildfires events contribute substantially to this pollution episodically by emitting tens of tons of particles into the atmosphere. Because these particles are very small, they are able to penetrate to the deepest parts of the lungs and cause upper respiratory problems including death caused by asthma. Therefore, accounting for these emissions in air quality forecast models will alert the public to take preventative measures.




***Difference in surface PM2.5 concentrations between two model runs (with and without assimilated satellite-derived biomass burning emissions). Red spots are areas where concentrations are 10 µm/$m^3$ greater as a result of assimilating the satellite data.***

## Community Radiative Transfer Model (CRTM) Expanded to Include Aerosol Radiative Processes

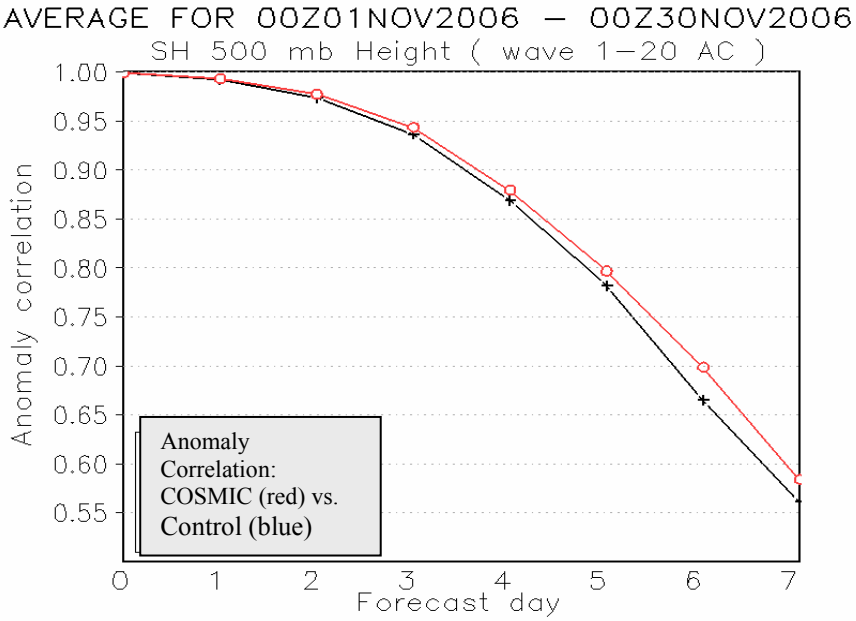
With the implementation of an aerosol component, the CRTM is now applicable for air-quality forecasts and assimilation of satellite radiances – for example, infrared sea surface temperature observations - affected by aerosols. The new version of the CRTM has been tested by utilizing aerosols from the Goddard Chemistry Aerosol Radiation and Transport (GOCART) model in the data assimilation. The aerosol type, concentration, and aerosol particle size are the inputs for the CRTM to compute aerosol absorption and scattering as well as the multiple scattering among aerosols, clouds, and the surface. The NASA GOCART model simulates major tropospheric aerosol components, including dust, sulfate, black carbon (BC), organic carbon (OC), and sea-salt aerosols, globally. Aerosols depress the brightness temperature in general because of their absorption in the infrared spectrum.




***Brightness temperature difference (with minus without aerosols) in CRTM simulations for several IR wavelengths.***

## Joint Center for Satellite Data Assimilation (JCSDA) Impact Studies


Before the data from a new instrument are assimilated operationally, a set of experimental forecasts is conducted to determine whether forecast skill is increased when the new data are assimilated. Two series of parallel forecasts are run, one series containing the new data and the other – the control – without the new data. The skill of the forecasts is generally measured by the anomaly correlation coefficient, which is defined as the correlation between the deviations of the forecast field from the climatological field and the deviations of the observed, or verifying, field, from the climatological field. Most major forecast centers focus on the 500 mb geopotential height field, and provide separate results for the Northern and Southern Hemispheres. The results are displayed as anomaly correlation falloff curves, which show how the skill of the forecasts decreases with forecast range. When the anomaly correlation falls below 0.6, which usually occurs at a range of 6 to 7 days, forecasts are basically useless. During 2007, the JCSDA conducted a number of such forecast impact experiments for new instruments - the Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC), Special Sensor Microwave Imager/Sounder (SSMIS), and WINDSAT – all yielding positive impacts. These results are summarized below.




***Anomaly correlation scores (Red: With COSMIC; Blue: without COSMIC) for the 500 mb height field in the Southern Hemisphere as a function of the forecast length. In this test, useful forecast ranges was extended by about 6 hours.***

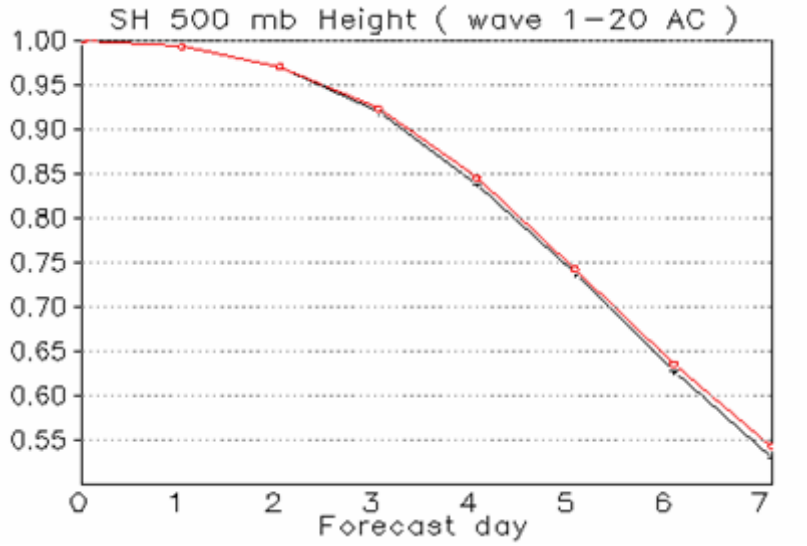
## COSMIC Data Extend Forecast Range; Operationally Implemented Only One Year after Launch

After successful testing at the JCSDA, Global Positioning System (GPS) radio occultation (RO) soundings from the COSMIC mission went into operational use with the implementation of the Gridpoint Statistical Interpolation (GSI)/Global Forecast System (GFS) system at NOAA/NCEP on May 1st 2007.

Impact tests indicate that the assimilation of GPS RO observations improves the fit to rawinsonde observations by reducing the mean and root-mean-square differences in the upper troposphere and stratosphere. The anomaly correlation (AC) scores for both the Northern and Southern Hemispheres also improved with the use of COSMIC data for the test period, November 2006. The Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) was launched in April 2006. It consists of 6 Radio Occultation Sounders. Over 1500 profiles of refractivity and bending angle from COSMIC are delivered to the JCSDA daily. These profiles provide information on temperature and humidity at high vertical resolution (~100 m) low horizontal resolution (100s of km) in the troposphere and stratosphere.

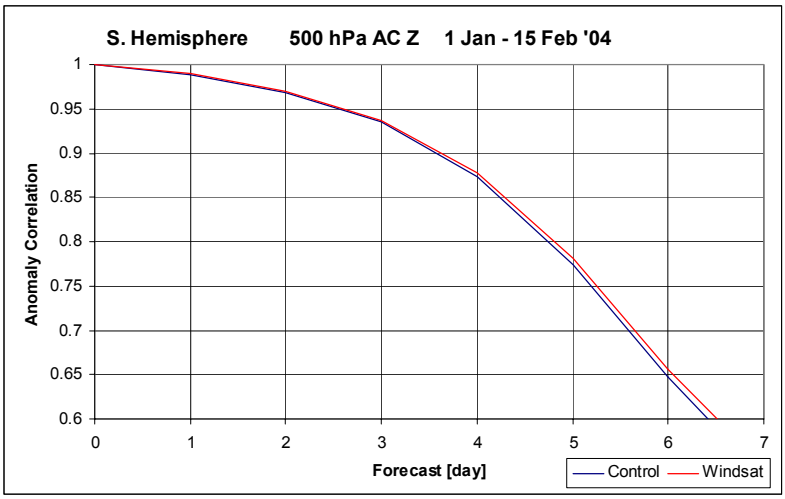
## Positive Impact of Special Sensor Microwave Imager/Sounder (SSMIS) Radiances in the Global Forecast System (GFS)

Preliminary impact assessment of SSMIS radiances in NCEP's Global Forecast system indicates improved predictions at all forecast ranges. To achieve these positive results, SMCD researchers, working with JCSDA colleagues at the Naval Research Laboratory and with scientists from the UK MetOffice, overcame a number of instrumental problems that introduced significant systematic errors in the observations. The multi-agency team characterized the errors and developed methods for accounting for them so that the data could be assimilated. The SSMIS is a conical scanning microwave sensor developed by the US Navy. It is a pre-cursor of a conical-scanning microwave sensor planned for NPOESS.




***The GFS Anomaly Correlation in the Southern Hemisphere is improved slightly at all forecast times by adding SSMIS radiances (red curve) to the set of observations assimilated.***

## Positive Impact of WINDSAT on Forecasts: Good News for NPOESS

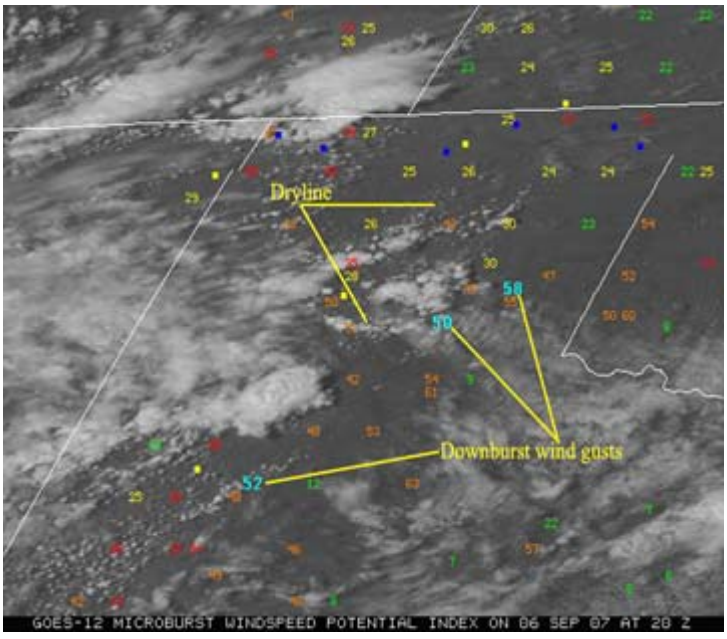



***The GFS Anomaly Correlation in the Southern Hemisphere is increased significantly by adding WindSat ocean surface wind vectors to the control data set, especially for longer range forecasts.***

Parallel forecasts with and without WINDSAT observations in NCEP's Global Forecast System indicate increased accuracy in the Southern Hemisphere with the added WINDSAT data. WINDSAT is a joint NPOESS-Integrated Program Office/DoD/NASA risk reduction project intended to demonstrate that ocean surface *wind speed* and *wind direction* can be measured from space using a polarimetric, microwave radiometer. These JCSDA tests indicate the polarimetric radiometer concept is viable and that the measured wind vectors have forecast impacts comparable to scatterometer winds. This is good news for NPOESS, for which similar measurements with a conically scanning microwave instrument are planned.

## New Geostationary Operational Environmental Satellite (GOES) Microburst Product Demonstrates Capability for Forecasting Downburst Potential

A new GOES sounder-derived downburst nowcasting product, the Microburst Windspeed Potential Index (MWPI), was developed and implemented experimentally during Spring, 2007. The MWPI algorithm incorporates relevant parameters for downburst potential, including convective available potential energy (CAPE) and boundary layer temperature and dew point depression gradients. Validation during the 2007 convective season produced favorable results including a statistically significant correlation (r = 0.78) between MWPI values and measured downburst wind gusts and a high confidence level (97%) that this correlation represents a physical relationship between index values and downburst magnitude. The MWPI image product demonstrated effectiveness in the assessment of downburst wind gust potential over western Texas during the afternoon September 6, 2007.



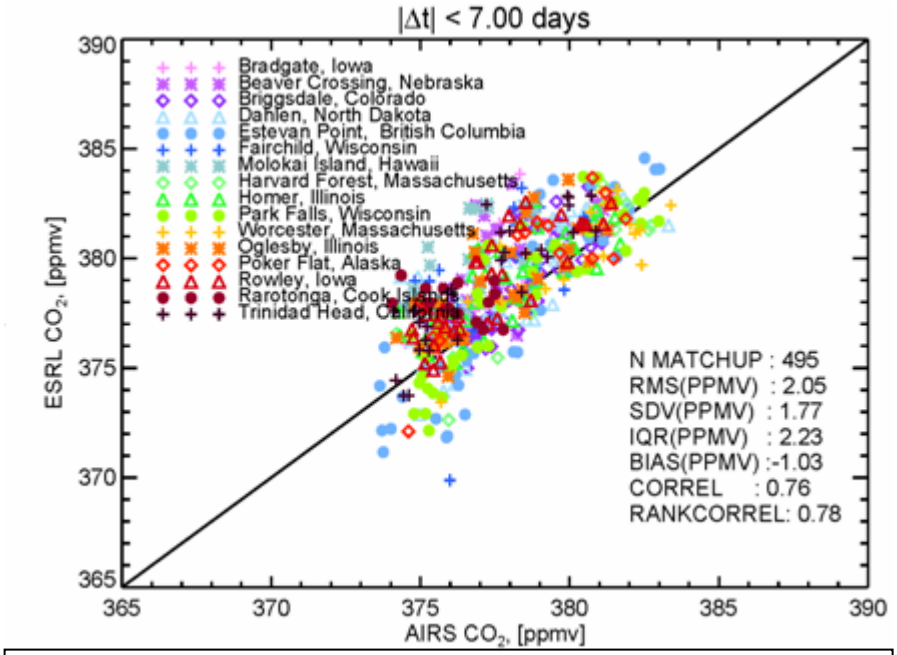

***This image is a GOES MWPI product at 2000 UTC September 6, 2007. Apparent in the product image is convective storm activity, developing along the dryline over western Texas, that propagated eastward during the following three-hour period. Downburst wind gusts of 52, 50, and 58 knots were observed by Slaton, Clarendon, and McLean (West Texas) mesonet stations, respectively, between 2040 and 2220 UTC. Comparison of the 2000 UTC MWPI values to the location of observed downbursts revealed that the MWPI effectively indicated the potential for strong wind gusts of 45 to 55 knots, based on linear regression. Note that the strongest downburst, 58 knots, occurred near a local maximum (55) in MWPI values. The MWPI algorithm is intended for implementation in the GOES-R Advanced Baseline Imager (ABI).***

## Atmospheric Carbon Products from AIRS and IASI

We continued to improve the trace gas products from the Aqua AIRS instrument and also made significant progress towards these products being operational within the NASA AIRS processing system and the NOAA-unique processing of the MeTOP-A IASI instrument. We used our 3x3 degree gridded AIRS radiance product to develop a 48 month (Sep. 2003 to Aug. 2007) global climatology of carbon monoxide (CO), methane (CH4), and carbon dioxide (CO2) along with simultaneously retrieved profiles of temperature, water, ozone, nitric acid, surface products, cloud products, and derived products such as OLR, CAPE, and LI. In addition, a significant quantity of full spatial resolution AIRS was re-processed near validation sites.

The NOAA methane product became operational within the AIRS science team product produced at the NASA/GSFC DAAC in July 2007. This product was validated with respect to NOAA/ESRL in-situ measurements of methane (Xiong 2007), and two papers are in preparation related to methane emissions near the Tibetian plateau and Siberian permafrost regions.

In order to properly use the trace gas products derived from a thermal sounder a user needs to not only know the concentration derived but also the region of the atmosphere that the sounder is sensitive to. This sensitivity function is called an averaging kernel. We installed software into the AIRS version 5 system at the NASA DAAC to provide users an estimate of the vertical sampling in the AIRS product for temperature, moisture, ozone, carbon monoxide, and methane. A paper describing the theoretical basis for averaging kernels in the AIRS science team algorithm along with estimates of the AIRS product vertical resolution and degrees of freedom was accepted (Maddy et al., 2007a).




***Correlation diagram of all NOAA ESRL/GMD site measurements, vertically weighted using AIRS Jacobians between 2.5 km and 8 km, compared to AIRS CO2 retrievals (6km to 8km) with a temporal matchup of 14 days and spatial average of 200 km. The total number of matchups (N MATCHUP), Root-mean-squared error (RMS), standard deviation (SDV), interquartile range (IQR), bias, correlation (CORREL), and rankcorrelation (RANKCORREL) are summarized on the plot.***

Significant progress has been made to characterize the AIRS CO2 product. A validation study of the AIRS CO2 product was submitted for publication and accepted (Maddy et al., 2007b) and Eric Maddy also successfully defended his dissertation topic that described a detailed comparison of the AIRS product with both in-situ measurements and model products. In particular, the comparison of AIRS measured CO2 gradients with the NOAA/ESRL CarbonTracker model was insightful and shows that while we have achieved the theoretical expectation of performance in the AIRS CO2 product, there may not be enough accuracy to significantly constrain carbon budget models. Quantification of the utility of the AIRS and IASI CO2 product will be the focus of our activities in FY08.

Through these efforts we have demonstrated that AIRS and IASI instruments have the capability to simultaneously measure a number of stratospheric and tropospheric tracers of interest to the carbon, climate, and chemistry communities. In FY07 we made significant progress towards using trace-tracer correlations to define regions of interesting atmospheric chemistry – such as ozone production in biomass burning regions and stratospheric-tropospheric exchange of ozone and nitric acid. In addition, Antonia Gambacorta used the AIRS re-processed dataset to look into

temperature-moisture correlations for her PhD topic at UMBC. This work is an important contribution to understanding the water vapor climate feedback. In the figure below we show the correlation of temperature and moisture derived from AIRS as a function of altitude (pressure) and latitude. Regions of highest correlations (red) are found in the sub-tropical and mid latitude lower and upper troposphere. Negative minima are found over the subtropical northern free troposphere (blue region). A paper has been submitted on this topic and Antonia expects to defend her dissertation in spring of 2008.

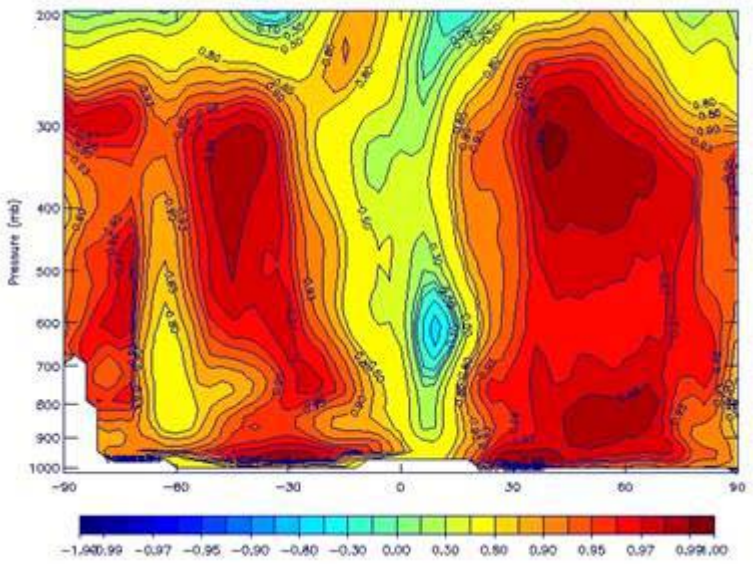



***Fig. above shows zonal cross-section of the correlation of temperature and moisture derived from AIRS products from 9/2003-4/2007. Regions of highest correlations are found in the sub-tropical and mid latitude lower and upper troposphere. Negative minima are found over the subtropical northern free troposphere.***

We have participated in a couple of intensive field campaigns (e.g., WAVES and START07, AEROSE) to test our algorithms and inter-compared our work with developers of algorithms of other missions (e.g., Aura TES algorithm developers). In particular, a number of papers were published this year with regard to the validation of ozone (Monahan et al. 2007, Pan et al. 2007, Divakarla et al. 2007) and validation campaigns in the Saharan air layer (Nalli et al., 2007). We hope to continue to develop these concepts and are looking towards making some of these atmospheric chemistry products operational in the coming year. We expect to make further improvements to the AIRS trace gas products and to have operational IASI trace gas products by April of 2008.

# 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. During the year, SMCD also formed an Integration Team 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 FY07

**Product Processing Systems Transitioned to NESDIS/OSDPD**

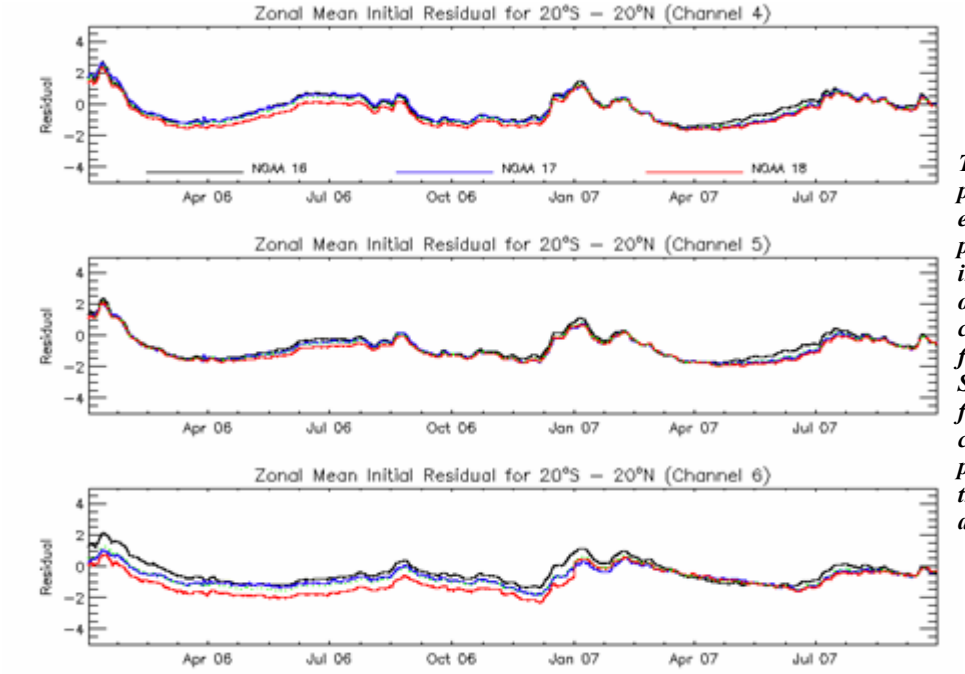
Solar Backscatter Ultraviolet Spectral Radiometer (SBUV/2) Version 8 Processing System
NESDIS Smoke Forecast Tool
AIRS Version 5 Algorithm Processing System
ATOVS Sounding Products for METOP
Microwave Integrated Retrieval System (MIRS)
Infrared Atmospheric Sounding Interferometer (IASI) Processing System
Total Ozone Estimates from MetOP GOME-2

**Data Assimilation Systems Transitioned to NWS/NCEP**

COSMIC Assimilation System
AIRS (all FOVs) Assimilation System
METOP AMSU, HSB, HIRS Assimilation System
GOES 1 km x 1 km FOV Sounder Radiance Assimilation System

## Solar Backscatter Ultraviolet Spectral Radiometer (SBUV/2) Version 8 Declared Operational: First Major Algorithm Change since 1990

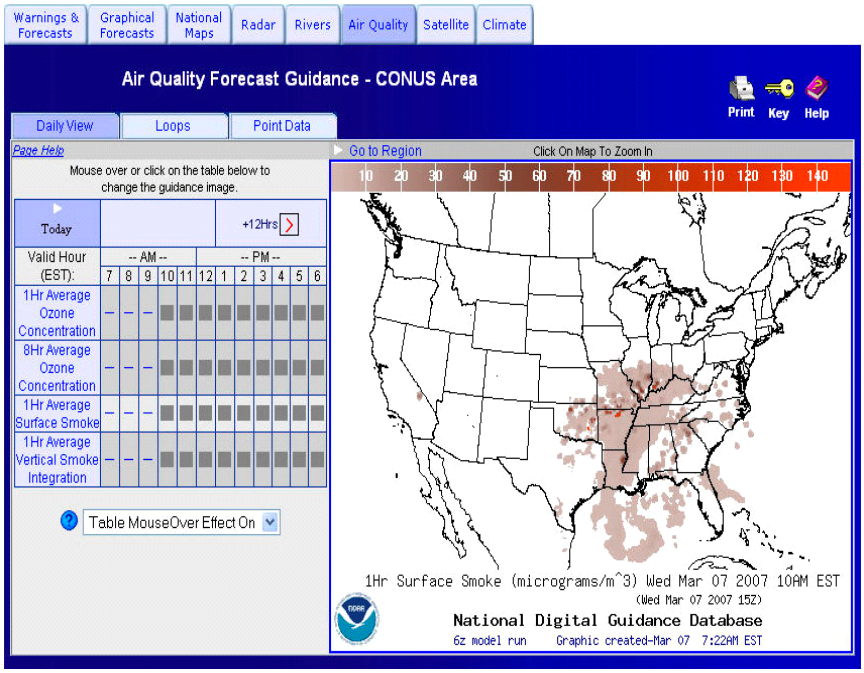
On February 21, 2007, the NESDIS Satellite Products and Services Review Board (SPSRB) declared the new Version 8 SBUV/2 product operational. This is the first new algorithm to be implemented since the Version 6 algorithm in 1990 and represents a major advance. It uses better a priori information, better diagnostics, and provides an averaging kernel for use in data assimilation. Significant improvements are expected in total and profile ozone, which is now provided at 21 levels instead of the previous 12. The current Version 6 products will be distributed in parallel until December 1, 2007, to allow environmental modeling centers enough time to switch their operations to the new products. V8 products, containing total and profile ozone information, are created orbitally and daily in binary and BUFR format.




***The Version 8 SBUV/2 algorithm provides measurement residuals for easier trending of instrument performance. Time series of the initial residuals (differences between observed radiances and those computed fro a climatological ozone field) for the three operational SBUV/2s (on NOAA-16, -17 and -18) for three of the ozone profiling channels are shown in the three panels. The agreement among the three instruments indicates that they are all well calibrated.***

## NESDIS Air Quality Products Used by NWS to Improve Air Quality Forecasts

On March 7, 2007, NOAA deployed its smoke forecast tool into operations, following successful experimental testing over a period of 10 months. The smoke forecast tool leverages capabilities both within and outside NOAA to forecast smoke concentrations in the air we breathe. It integrates the NESDIS operational GOES Imager detected location of wildfires with NOAA National Weather Service weather inputs from the North American Mesoscale model and smoke dispersion simulations from the NOAA research HYSPLIT model to produce a 48-hour prediction of smoke transport and concentration, updated daily. The model also incorporates U.S. Forest Service estimates for wildfire smoke emissions based on vegetation cover. The smoke predictions are verified in near real time using NESDIS operational Automatic Smoke Detection and Tracking Algorithm that provides observed column smoke amounts associated with fires.




***The figure above is an output from the NWS hourly surface smoke concentration (micrograms per cubic meter) forecasts from the NOAA HYSPLIT model***

## AIRS Version 5 Algorithm Prepared For Delivery

Our scientists played a significant role in defining, developing, and implementing a number of improvements to the AIRS science team algorithm. Changes to the AIRS Version 5 algorithm included the computation of empirical bias adjustments for 2378 AIRS channels relative to the "best estimate" sonde database (dedicated launches within AIRS overpass). These calculations used the NOAA gridded reprocessing set to mitigate incorrect bias corrections due to trace gases and the atmospheric state above the sonde burst height. All the changes were incorporated into the JPL version of the code and were delivered to the NASA/GSFC DAAC on March 22, 2007. SMCD was responsible for a number of significant components of this algorithm, including:

- The replacement of all ad-hoc error estimate terms that had been installed after launch with scientifically defensible error terms, such as those due to CO2 errors, etc.; and
- Major modifications to the ozone retrieval were made including a new first guess, removal of the ozone regression step, and optimization of the physical algorithm. All changes were based on intensive validation campaigns that NOAA/NESDIS has played a pivotal role in, including START, WAVES, and validation with the operational WOUDC network.

## ATOVS Sounding Product Declared Operational for MetOp

The ATOVS sounding products from the MetOp instrument were declared operational May 23, 2007. The MetOp Spacecraft provides ATOVS with the AMSU-A, MHS, AVHRR/3 and HIRS/4 for generation of 110 atmospheric attributes. This is the first spacecraft since 2001 to have a completely healthy HIRS instrument, for generation of cloud, ozone and radiation atmospheric products.

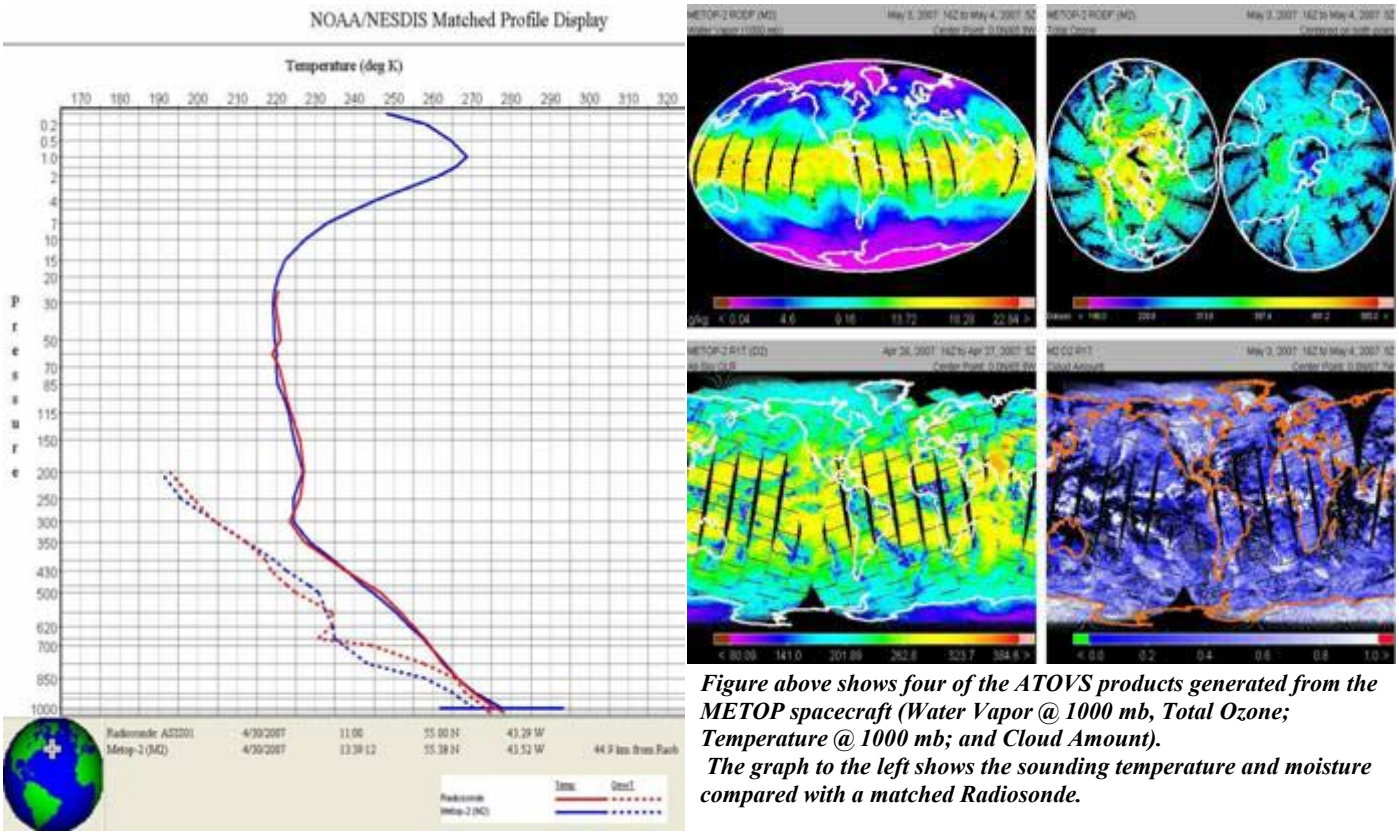
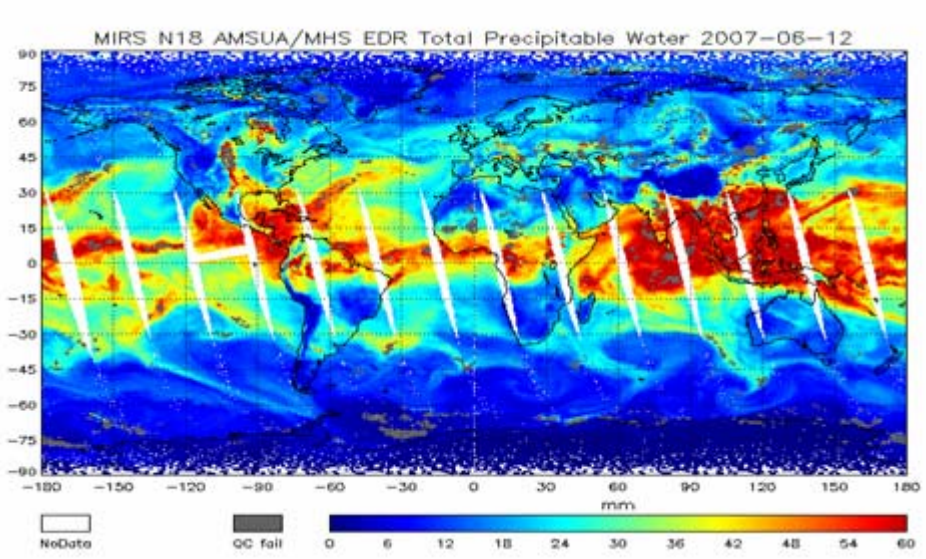



***Figure above shows four of the ATOVS products generated from the METOP spacecraft (Water Vapor @ 1000 mb, Total Ozone; Temperature @ 1000 mb; and Cloud Amount).***
***The graph to the left shows the sounding temperature and moisture compared with a matched Radiosonde.***

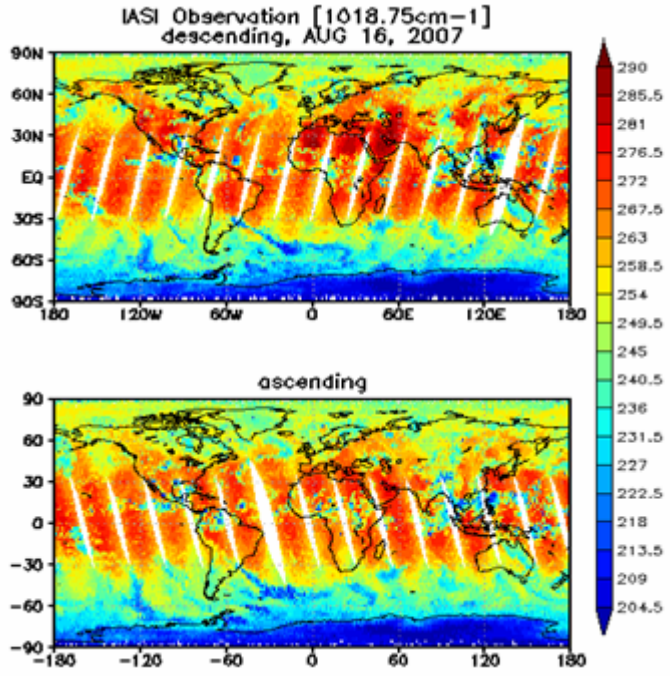
## Microwave Integrated Retrieval System (MIRS) Goes Operational

The MIRS went into operational production in August 2007. The MIRS includes scientifically upgraded algorithms that are applicable to all operational microwave sensors (currently for NOAA-18 and MetOp-A AMSU/MHS). The product suite consists of extended atmospheric temperature and moisture profiles, and expansion of coverage for precipitable water, skin temperature and emissivity to all surfaces and weather conditions. Having a state-of-the-art operational retrieval system that is adaptable to all microwave sensors will ensure physical consistency and minimal bias of products from various sensors, and, therefore, higher quality for climate data records. These improved/advanced operational products will also improve the assimilation of microwave data and the validation of NWP models, and enhance NOAA's weather forecasting and climate monitoring capability.




***The figure above shows the first map of the total precipitable water retrieved from MIRS over land and oceans. This product was requested by forecasters to estimate hurricane potential rainfall after landfall. Red represents high water vapor amounts, blue low amounts.***

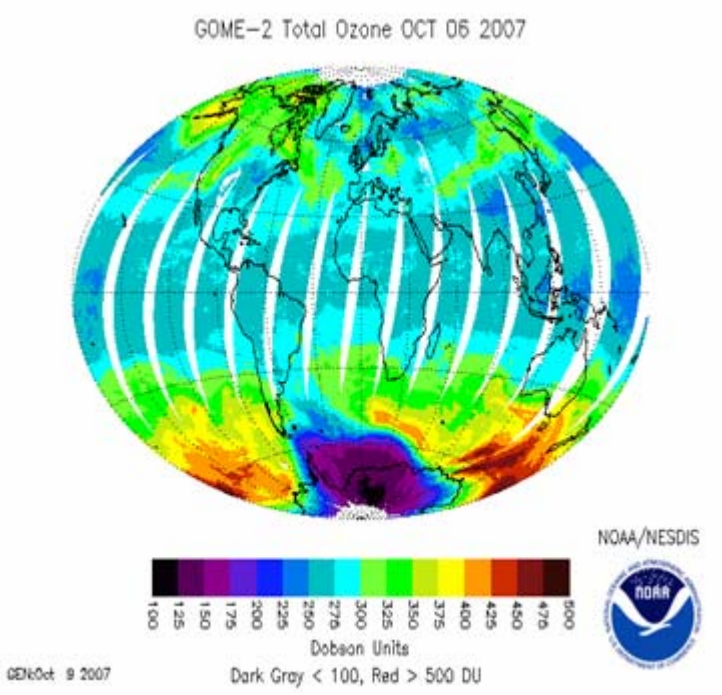
## Infrared Atmospheric Sounding Interferometer (IASI) Processing System Approved for Operational Implementation




***Global grid of the IASI radiances for a channel at 1018.75 cm-1. The global grid is a daily product from the IASI processing and distribution system.***

At its September meeting, the NESDIS SPSRB approved the MetOp IASI radiance product processing system for operational implementation at OSDPD. The system produces thinned (sampled) radiances, principal component scores, and reconstructed radiances using IASI level 1C data. These products will be made available to both real-time users and climate users. The system will be distributing IASI calibrated and navigated radiances to the United States Numerical Weather Prediction (NWP) Centers as well as to the Department of Defense (DoD). The radiances have been spatially and spectrally subset to reduce the file size to enable near-real time distribution. IASI, which flies on the MetOp satellite, is an advanced hyperspectral infrared interferometer with 8461 observing channels.

## Operational Total Ozone Estimates from MetOp GOME-2




***False-color image of the global column ozone field from retrievals using the GOME-2 measurements for October 6, 2007. The purple, violet and black regions show the extent of the Antarctic Ozone Hole conditions on that day.***

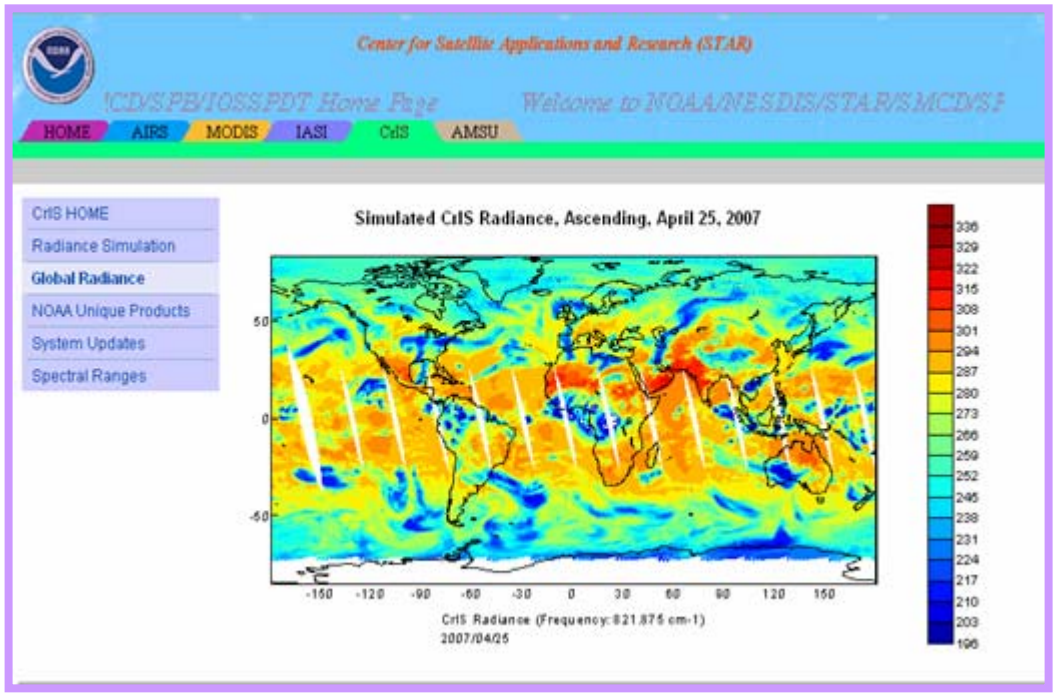
The MetOp GOME-2 product processing system was approved for operational implementation. By the end of November, NOAA began producing operational total ozone estimates from the Version 8 algorithm applied to the MetOp GOME-2 instrument as part of the Initial Joint Polar-Orbiting Operational Satellite System (IJPS). The primary mission objective of the IJPS is to collect and exchange polar satellite environmental data between NOAA and EUMETSAT and disseminate the data to users in support of operational meteorological and environmental forecasting and global climate monitoring. With a GOME-2 scan-width of 1920 km, global coverage can be achieved within one day. The advanced GOME-2 observes four times smaller ground pixels (80 km x 40 km) than GOME on ERS-2 and has better polarisation and improved calibration processes. NOAA will use the data in Weather and UV forecast models. The data will cover most of the globe each day representing a significant increase over current nadir-only SBUV/2 products.

# 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.

## NPOESS Sounder Processing System Passes Milestone

The product processing system for the NPOESS (CrIS)/Advance Technology Microwave Sounder (ATMS) passed its Preliminary Design review (PDR) on May 9, 2007. The PDR is a significant step in the Satellite Product and Services Review Board (SPSRB) process that will bring the CrIS/ATMS subset and NOAA Unique products to operations.



## GOES-R Algorithm Working Group (AWG) Annual Meeting

The GOES-R AWG held a very successful annual meeting in May 2007, at the National Conference Center. The meeting kicked off with the AWG Cal/Val workshop and later an AWG developers retreat.

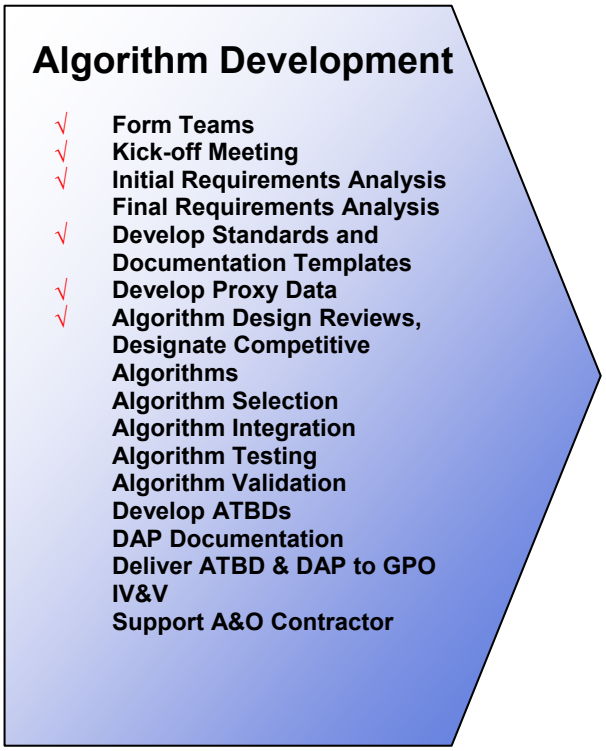
SMCD leads the GOES-R AWG, whose mission is to develop, provide, and demonstrate algorithm development and user readiness for end-to-end capabilities for the GOES-R Ground Segment and to provide sustained life cycle validation and product enhancements. The AWG is responsible for the selection, development, and demonstration of GOES-R Level-2 product algorithms that will support GOES-R implementation and operations preparations.

The AWG includes about 100 scientists from NOAA, NASA, DOD, EPA, and Cooperative Institutes. Its activities leverage other programs, such as GOES, MODIS, AIRS, IASI, and NPOESS. It facilitates algorithm consistency across platforms -- prerequisite for GEOSS (maximize benefits and minimizes integration).

## GOES-R AWG Algorithm Design Reviews

Algorithm Design Reviews (ADRs) are a crucial deliverable in the development of the next generation of algorithms to be implemented on the GOES-R series weather satellite system. STAR, through its Algorithm Working Group (AWG), has been directed to provide Government Furnished Information (GFI) algorithms for the GOES-R satellite series. The ADR is the first scheduled deliverable of the Application Teams

The ADR defines the candidate algorithms, the method for testing and validation, proxy data requirements and the schedule for delivery to the AWG integration team.



# National and International Collaborations

## Global Space-based Inter-Calibration System (GSICS) Executive Panel Meeting


The Global Space-based Inter-Calibration System (GSICS) Executive Panel kicked off with a meeting, chaired by Mitch Goldberg, in Geneva, Switzerland, October 11-13, 2006. The Panel approved initial steps to implement a new international initiative to ensure the comparability of satellite measurements provided at different times, by different instruments under the responsibility of different satellite operators. Sponsored by the World Meteorological Organization and the Coordination Group for Meteorological Satellites, GSICS will inter-calibrate the instruments of the international constellation of operational low earth orbiting (LEOs) and geostationary (GEOs) environmental satellites and tie these to common reference standards. The inter-comparability of the instruments will result in more accurate observations for assimilation in numerical weather prediction models, the construction of more reliable climate data records, and achieving the societal goals of the Global Earth Observation System of Systems. The United States, the European Organization for the Exploitation of Meteorological Satellites, the Russian Federation, Japan, and China will participate in the undertaking. NOAA is taking a leading role in implementing the System: Mitch Goldberg, Chief of the Satellite Meteorology and Climatology Division in the NESDIS Center for Satellite Applications and Research, chairs the GSICS Executive Panel, and NESDIS will operate a major component of the System, the GSICS Coordination Center.

## 5th Annual Workshop and Science Steering Committee (SSC) Meeting

The Joint Center for Satellite Data Assimilation (JCSDA) hosted the 5th annual workshop on satellite data assimilation, May 1-2, 2007, at the University of Maryland University College (UMUC). This workshop was attended by over 100 scientists. It also hosted the Science Steering Committee meeting, May 30-31, 2007 at the same location. The Joint Center for Satellite Data Assimilation basic reporting and scientific guidance cycle is completed by the annual workshop and reports to the Science Steering Committee.

## SMCD's Changyong Cao Appointed Chair, Committee on Earth Observation Satellites (CEOS) Working Group on Calibration/Validation (WGCV)

Dr. Changyong Cao became the Chair of the Working Group on Calibration/Validation (WGCV) of the Committee on Earth Observation Satellites (CEOS), succeeding Dr. Stephen Ungar of NASA. The overarching goal of the WGCV is to ensure long-term confidence in the accuracy and quality of Earth observation data and products. WGCV has two specific tasks:

1. sensor-specific calibration and validation, and
2. geophysical parameter and derived product validation.

NOAA plays a leading role in CEOS, which is charged with coordinating international civil spaceborne missions designed to observe and study planet Earth. Comprising 26 Members (most of which are space agencies) and 20 Associates (associated national and international organizations), CEOS is recognized as the major international forum for the coordination of Earth observation satellite programs and for interaction of these programs with users of satellite data worldwide.

## The First GSICS Research Working Group Meeting


The GSICS Research Working Group (GRWG) met for the first time on 22-23 January 2007 at NOAA Science Center in Camp Springs, Maryland. Attending the GRWG-I were representatives from the World Meteorological Organization (WMO), the sponsoring organization of the GSICS, and delegates from member organizations including China Meteorological Administration (CMA), Centre National d'Etudes Spatiales (CNES), European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), Korea Meteorological Administration (KMA), Japan Meteorological Agency (JMA), and NOAA. By improving the satellite data quality through inter-calibration of critical components of the global observing system, the GSICS is an important contribution to the GEOSS. From the sound foundation laid out by the GSICS Executive Council Meeting in October 2006 in Geneva, the GRWG-I is a solid first step to realize the many objectives set forth by the GSICS.

## NESDIS Delegation Visits India in Support of Collaborative Program

A delegation from STAR (Al Powell, Felix Kogan, Shobha Kondragunta, and Bob Kuligowski, along with Stephen Mango of the Integrated Program Office (IPO) and Becky Chacko of NESDIS International Affairs (IA)) went to India in support of the Indo-U.S. collaborative satellite research program. Progress in Indo-U.S. collaborative efforts were discussed and future directions were planned, and a Memorandum of Understanding (MOU) was signed regarding the planned NPOESS ground station in India.

Scientific collaboration between the USA and India is being guided by a MOU which was first signed in 1997 and extended in 2002. The ensuing collaboration has resulted in significant improvements to the navigation and registration of data from India's Kalpana-1 meteorological satellite, the real-time production of satellite rainfall estimates from Kalpana-1 at NESDIS (with transition to operational production in India underway), and collaboration in other projects such as air quality and vegetative health. This trip provided an opportunity to further strengthen these collaborative ties and to establish directions for continued mutually beneficial research and cooperation.

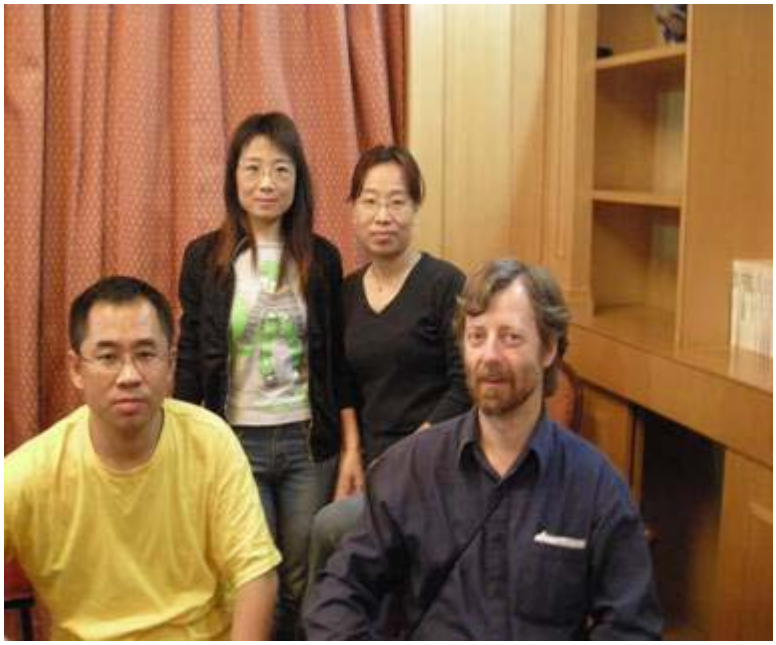
## National Space Agency of Ukraine (NSAU)/NOAA Cooperation

A NOAA delegation to the Ukraine (Al Powell, Felix Kogan (STAR)), and (Leonid Roytman, Reza Khanbilvardi (NOAA/CREST)) hosted by Dr. Oleg Fedorov, NSAU's Chief of Directorate for Space Programs and Scientific Research, representative of GEOSS-Ukraine, met with Mr. Valery Komarov, First Deputy Director General of NSAU to discuss Cooperation under the auspices of the Global Earth Observing System of Systems (GEOSS). Among the activities selected for further collaboration were: Early drought detection, flashflood and rainfall monitoring, vegetation health for agriculture and food security, the health of the Black Sea ecosystems & fisheries, invasive species, and recreation, and the Microsatellite Youth Project.

## The 4th International Geostationary Laboratory Geo-Microwave Focus Group Meeting


The meeting was organized by the WMO, hosted by the China Meteorological Administration (CMA), and held in Beijing, China on April 12-13, 2007. The purpose of the IGeoLab-Microwave meetings is to reach a set of recommendations that will ultimately lead to flying a microwave sensor on a geostationary orbit. IGeoLab is a concept of international partnership fostered by the WMO to prepare and implement demonstration missions of innovative instruments on geostationary orbit.

## United States of America – People's Republic of China Joint Working Group on Cooperation in the field of Atmospheric Science and Technology



***Working session on the FY-3 SatelliteFront: (L) Wang Weihe (the total ozone product lead) - a member of Fuxiang's team, (R) Larry Flynn – NOAA; Back (L) Liu Ruxia (the cloud product validation lead) - a member of Chunxiang's team, (R) Shi Chungxiang (the validation lead)***

As part of U.S.- P.R.C Joint Working Group on Cooperation in the field of Atmospheric Science and Technology, SMCD's Dr. Larry Flynn was invited to visit the Chinese National Satellite Meteorological Center (NSMC), Beijing, China from May 28th to June 9th, 2007. Dr. Flynn provided Huang Fuxiang, NSMC ozone product lead and his team with a detailed description of the algorithms and processes for creating NOAA Solar Backscatter UltraViolet Instrument (SBUV/2) and NASA Total Ozone Mapping Spectrometer (TOMS) total ozone and ozone profile products. Assisting NSMC in the development of measurements and products will help to integrate Solar Backscatter Ultraviolet Sounder (SBUS) and Total Ozone Unit (TOU) instruments on the soon-to-be launched FY-3 Polar satellite into GEOSS.

## The Committee on Earth Observation Satellites (CEOS) / Working Group on Calibration/Validation (WGCV) 27th Plenary Meeting

CEOS/WGCV27 was held at the National Physical Laboratory (NPL) in London from June 12-15, 2007, with more than 40 participants from 30 space agencies/countries. This meeting sought to align the activities of this working group with the CEOS implementation plan and tasks developed by the CEOS Strategic Implementation Team (SIT), in support of the GEOSS/GEO tasks, CEOS climate actions, CEOS constellations, and GSICS. It also signified the transition of CEOS/SIT chair from Volker Liebig of ESA, to Mary Kicza of NOAA/NESDIS.

## Achieving Satellite Instrument Calibration for Climate Change (ASIC$^3$)


Achieving Satellite Instrument Calibration for Climate Change (ASIC3)

Report of a Workshop Organized by

National Oceanic and Atmospheric Administration
National Institute of Standards and Technology
National Aeronautics and Space Administration
National Polar-orbiting Operational Environmental Satellite System-Integrated Program Office
Space Dynamics Laboratory of Utah State University

At the National Conference Center, Lansdowne, VA, May 16-18, 2006

Edited by George Ohring

Global climate change is probably today's most compelling issue since it is the single issue that will impact all of humanity. Its global aspect requires information from satellites. One hundred satellite instrument calibration experts, metrology scientists from national standards institutes, remote sensing specialists, and climate data analysts met at Lansdowne, VA., May 16-18, 2006 to discuss how data from satellite sensors can best be used to answer two key questions about climate change:

What is the current rate of climate change?
What will the climate be like in the future?

The ASIC$^3$ Workshop overarching recommendations called for the flight of satellite benchmark instruments and the establishment of a national center for calibration. NOAA was a sponsor of the workshop, SMCD edited the Workshop, and STAR will publish the hard copy version.

# Education, Outreach and Training

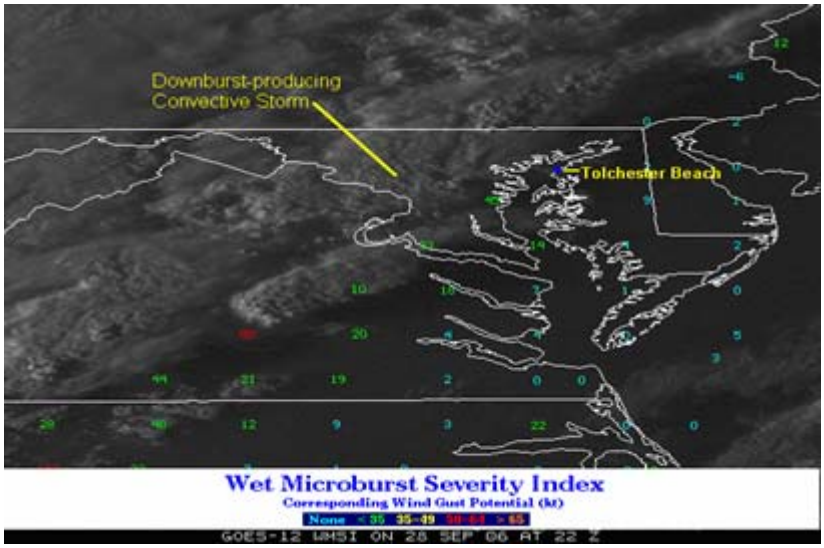
## Summer Training Program at University of Maryland on Satellite Data Assimilation

A summer training program sponsored by the JCSDA was held at the, July 23 to August 10, 2007. Five STAR scientists provided 10 lectures to 30 graduate students and young scientists. The lectures covered important aspects of assimilation of satellite remote sensing observations, from basic theory to practical techniques applied in the current operational systems.

## SMCD Student Mentorship Program

The SMCD mentorship program supports NOAA's cross-cutting priority of Environmental Literacy, Outreach, and Education.

Ken Pryor hosted Derek Mason from Thomas Jefferson High School for Science and Technology (TJHSST) in Alexandria, Virginia, from September 2006 to January 2007. The student, presented a research paper tilted "Investigation of Convective Downburst Hazards to Marine Transportation," in a STAR seminar.

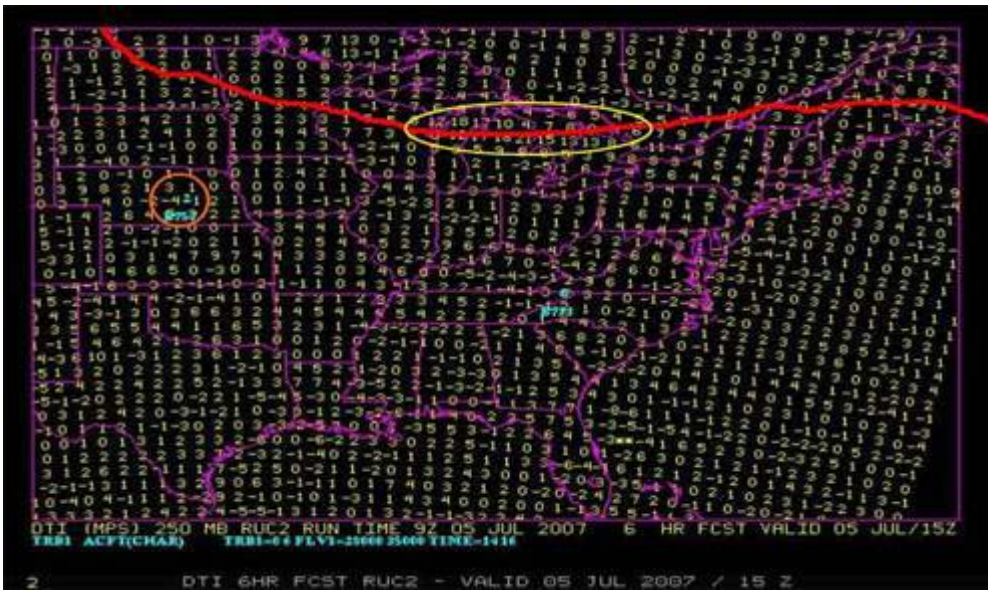



***GOES WMSI September 28, 2006: The WMSI values were collected at 22:00 GMT. The closest value to the location of the downburst was 45. The downburst occurred while a large storm passed over the northern Chesapeake Bay region.***

The next mentorship program began on June 25, 2007. Ms. A. Nagirimadugu, a student from Thomas Jefferson High School for Science and Technology (TJHSST) in Alexandria, Virginia, successfully completed the mentorship program under the instruction of K. Pryor.

She validated the Ellrod Divergence-Trend-Deformation-Vertical Shear Index (D-DVSI) product by comparing pilot reports of jet stream turbulence to index values at the nearest grid points.

Her accomplishments included, research activities involving the NWP-model derived turbulence product data collection and image analysis; presentation of her project at a STAR seminar on August 29, 2007; the completion of a research paper titled "An Initial Assessment of a Clear Air Turbulence Forecasting Product" that discusses validation results of comparing the Ellrod Deformation-Vertical Shear Index (D-DVSI) product to pilot reports of jet stream turbulence. Her research results were published in ArXiv.org and are available at the following URL: http://arxiv.org/abs/0708.3362.




***The image above, generated by Ms. Nagirimadugu, is an NWP model-derived turbulence index. The location of the jet stream is drawn in red. Especially high TI values are outlined in yellow and pilot reports of turbulence are plotted in blue (code 2= light to moderate turbulence).***

***Note: regions of high TI values in close proximity to the jet stream.***

## Visiting Scientists

Seung-Hee Sohn, visiting scientist from Korea Meteorological Administration (KMA), started her two-year visit at STAR on Jan. 15, 2007. She will work with X. Wu and others on issues related to GOES Imager calibration, in preparation for the launch of Korea's Communication, Ocean, and Meteorology Satellite (COMS) in 2008.

Koji Kato, visiting scientist from Japan Meteorological Agency (KMA), started his one-month visit at STAR on Feb. 26, 2007. He worked with X. Wu and others to develop algorithms for the Global Space-based Inter-Calibration System (GSICS) and the related issues.

Dr. Mark Green from Desert Research Institute began his sabbatical work at STAR on July 9, 2007. He is investigating the performance of GOES aerosol optical depth retrievals over the West Coast (specifically CA) using ground observations of speciated aerosol measurements from National Park Service IMPROVE network and NASA AERONET optical depth measurements. His work will have implications regarding the usability of satellite data for monitoring air quality and visibility in the U.S.

Ran You from CMA/National Satellite Meteorological Center is visiting SMCD for six months. This is part of exchanging visit in FY07 US-China Bilateral.

## Achievements

Dr. Sid Boukabara won the Best Oral Presentation Award at the 15th International TOVS Studies Conference (15th ITSC), where he presented the MIRS algorithm theoretical base, system architecture, system performance and products validation and monitoring system.

The 2006 Bronze and Distinguished Career Award Ceremony was held in Washington DC at the DAR (Daughters of American Revolution) Constitution Hall on May 11, 2007. A group bronze medal was awarded to Dr. Fuzhong Weng and his team, including C. Cao, T. Mo, X. Wu, J. Sullivan, T. Kleespies, M. Chalfant, A. Reale, A. Ignatov, and L. Flynn, for developing an integrated system for accurately calibrating NOAA-18 instruments that lead to a high quality of operational satellite products.

Dr. Zou is honored for developing an innovative and unique satellite instrument intercalibration technique, which allowed data from several NOAA satellites to be merged into a single consistent, long-term, climate-quality record. He analyzed this 25-year record to determine the global trends in atmospheric temperature. His result, a global temperature increase of 0.20 degrees C per decade, is consistent with trends observed from surface weather stations. His work adds substantially to the robustness of observed atmospheric temperature trends.

# Journal Articles


Alexander, J., and C. Barnet, 2006: "Using Satellite Observations to Constrain Parameterizations of Gravity Wave Effects for Global Models", *J. Atmos. Sci.* 64, p.1652-1669, (May 2007).

Barnet, C.D., M. Goldberg, E.S. Maddy, and X. Xiong, 2007: "Observing trace gases from spectrally resolved infrared radiances". FTS/HISE, *OSA Technical Digest (Optical Soc. Amer.)* 3 pgs.

Boukabara, S.-A., F. Weng**,** and Q. Liu, 2007: "Passive Microwave Remote Sensing of Extreme Weather Events Using NOAA-18 AMSUA and MHS", *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 45, Issue 7, pp. 2228-2246, doi:10.1109/TGRS.2007.898263.

Cao, C., K. Jarva, and P. Ciren, 2007: "An Improved Algorithm for the Operational Calibration of the High-Resolution Infrared Radiation Sounder (HIRS)". *Journal of Atmospheric & Oceanic Technology*, Vol. 24, 169-181, (February 2007).

Chahine, M.T., T.S. Pagano, H.H. Aumann, R. Atlas, C.D. Barnet, L. Chen, E.J. Fetzer, M. Goldberg, C. Gautier, S. Granger, F.W. Irion, R. Kakar , E. Kalnay, B.H. Lambrigtsen, S.Y. Lee, J. Le Marshall, W. McMillan, L. McMillin, E.T. Olsen, H. Revercomb, P. Rosenkranz, W.L. Smith, D.Staelin, L.L. Strow, J. Susskind and W. Wolf. 2006: "The Atmospheric Infrared Sounder (AIRS): Improving Weather Forecasting and Providing New Insights into Climate". *BAMS*, 87, p.911-926, doi:10.1175/BAMS-87-7-911.

Crow, W., and X. Zhan, 2007: "Continental-Scale Evaluation of Remotely Sensed Soil Moisture Products". *IEEE's Geoscience and Remote Sensing Letters,* Vol. 4 No 3. (July 2007).

Cucurull, L., J. Derber, R. Treadon, and J. Purser, 2007: "Assimilation of Global Positioning System Radio Occultation Observations into NCEP's Global Data Assimilation System", *Mon. Wea. Rev.* Vol.135, pp 3174-3193.

Han, Y., F. Weng, Q. Liu, and P. van Delst, 2007: "A Fast Radiative Transfer Model for SSMIS Upper-Atmosphere Sounding Channels"*, Journal of Geophysical Research*, D11121, doi:10.1029/2006JD008208 (June, 2007).

Iacovazzi, Jr., R. A., and C. Cao, 2007: "Quantifying EOS-Aqua and NOAA POES AMSU-A Brightness Temperature Biases for Weather and Climate Applications Utilizing the SNO Method". *J. Atmos. and Ocean. Tech*., 24, 1895-1909.

Iacovazzi, Jr., R. A., and C. Cao, 2007: "Reducing Uncertainties of SNO-estimated AMSU-A Brightness Temperature Biases at Surface-sensitive Channels". *J. Atmos. and Ocean. Tech*., (in press).

Kleespies, T. J., 2007: "Relative Information Content of the Advanced Technology Microwave Sounder, and the Advanced Microwave Sounding Unit and the Microwave Humidity Sounder Suite", *IEEE Trans. Geoscience and Remote Sens.*, 45, 7, pp 2224-2227.

Kleespies, T.J., and P. Watts, 2007: "Comparison of Simulated Radiances, Jacobians and Linear Error Analysis for the Microwave Humidity Sounder and the Advanced Microwave Sounding Unit–B". *QJRMS,* 132, pp 3001-3010, (August 2007).

Kleespies, T. J., R. Smith-Dearring, J. Woodward, J. Shepherd, C. Gliniak, W. Chadwick, J. Walters and D. Han, 2007: "Evaluation of the Microwave Sounding Unit by a Pitch Maneuver", *Geophysical Remote Sensing Letters,* (September 2007).

LeMarshall, J., L. Uccellini, F. Einaudi, M. Colton, S. Chang, F. Weng, M. Uhart, S. Lord, L.P. Riishijgaard, P. Phoebus, and J.G. Yoe, 2007: "The Joint Center for Satellite Data Assimilation", *Bull Amer Meteor, Soc,* pp 329-340, (March 2007).

Li, X., W. Zheng, W.G. Pichel, C-Z. Zou, P. Clemente-Colon: 2007: "Coastal Kabatic Winds Imaged by Synthetic Aperture Radar (SAR)", *Geophysical Research Letter, Vol. 34*, L03804, 5 pp, doi:10.1029/2006GL028055 (March, 2007).

Liu, Q. and Weng, F, 2006: "Advanced Doubling-Adding Method for Radiative Transfer in Planetary Atmospheres", *Journal of Atmospheric Science, American Meteorological Association,* pp 3459-3465, (December 2006).

Liu, Q., and F. Weng, 2006: "Combined Henyey-Greenstein and Rayleigh (HG-Rayleigh) Phase Function", *Applied Optics*, Vol. 45, 7475-7479.

Liu, Q., and F. Weng, 2006: "Detecting Warm Core of Hurricane from the Special Sensor Microwave Imager Sounder", *Geophysical Research Letters*, 33, L06817.

Liu, Q., and F. Weng, 2006: "Radiance Assimilation in Studying Hurricane Katrina", *Geophysical Research Letters, Vol. 33*, 5pp, L22811, doi:10.1029/2006GL027543 (November 2006).

Liu, Q., and F. Weng, 2007: "Uses of NOAA-16 and -18 Satellite Measurements for Verifying Limb-Correction Algorithm", *J. Appl. Meteorol. Climatology*, 46, 544-548.

Liu, Q., M. Kazumori, Y. Han, and F. Weng, 2007: "Calculating Antarctic Stratospheric Temperature from Special Sensor Microwave Imager and Sounder", *Journal of Geophys. Res. Lett.,* 34, L15812, August, 2007, doi:10.1029/2007GL030646

McMillin, L.M., J. Zhao, M.K. Rama Varma Raja, S.I. Gutman, and J.G. Yoe, 2007: "Radiosonde Humidity Corrections and Potential Atmospheric Infrared Sounder Moisture Accuracy", *Journal of Geophysical Research,* Vol. 112, D13S90, (July 2007).

Meijer,Y. J., D. P. J. Swart, R. J. van der A, F. Baier, P. K. Bhartia, G.E. Bodeker, K. Chance, T. Erbertseder, L.E. Flynn, F. del Frate, S. Godin-Beekmann, G. Hansen, O. P. Hasekamp, A. Kaifel, H.M. Kelder, B.J. Kerridge, J.-C. Lambert, J. Landgraf, X. Liu, I.S. McDermid, M.D. Müller, R.F. van Oss, Y. Pachepsky, V. Rozanov, R. Siddans, S. Tellmann, M. Weber, and C. Zehner, 2006: "Evaluation of Nine Different GOME Ozone Profile Algorithms", *Journal of Geophysical Research,* 111 (D21), D21306, 10.1029/2005JD006778, 2006.

Mo, T., 2007: "Diurnal Variation of the AMSU-A Brightness Temperatures over the Amazon Rain Forest", *Institute of Electrical Engineers (IEEE) Transactions on Geoscience & Remote Sensing*, *Vol. 45, No.4, pp.958-969,* (April, 2007).

Mo, T., 2007: "Post-Launch Calibration of the NOAA-18 Advanced Microwave Sounding Unit-A", *IEEE Transactions on Geoscience & Remote Sensing, Vol. 45, No. 7*, 1928-1937, (July 2007).

Mo, T. and S. Kigawa, 2007: "A Study of Lunar Contamination and On-orbit Performance of the NOAA-18 Advanced Microwave Sounding Unit-A", *Journal of Geophysical Research,* (In press, 2007).

Monahan, K.P., L.L. Pan, A.J. McDonald, G.E. Bodeker, J. Wei, S.E. George, C.D. Barnet, and E. Maddy, 2007: "Validation of AIRS v4 Ozone Profiles Using Ozonesondes from Lauder, NZ and Boulder, USA." *Journal of Geophysical Research*, 112 D17304 doi:10.1029/2006JD008181.

Nalli, N., P. Clemente-Colón, and M. Goldberg, 2006: "Measuring Trans-Atlantic Aerosol Transport from Africa", *EOS December issue.*

Nalli, N. R., P. Clemente-Colon, V. Morris, E. Joseph, M. Szczodrak, P. J. Minnett, J. Shannahoff, M. D. Goldberg, C. Barnet, W. W. Wolf, W. F. Feltz and, R. O. Knuteson, 2005: "Profile Observations of the Saharan Air Layer During AEROSE 2004", *Geophys. Res. Lett.*, 32, doi:10.1029/2004GL022028, (In press).

Ohring, G., J. Tansock, W. Emery, J. Butler, L, Flynn, F. Weng, K. St. Germain, B. Wielicki, C. Cao, M. Goldberg, J. Xiong, G. Fraser, D. Kunkee, D. Winker, L. Miller, S. Ungar, D. Tobin, J. G. Anderson, D. Pollock, S. Shipley, A. Thurgood, G. Kopp, P. Ardanuy, and T. Stone, 2007: "Achieving Satellite Instrument Calibration for Climate Change", *Eos Trans. AGU, 88*(11), 136.

Pan, L.L., K.P. Bowman, M. Shapiro, W.J, Randel, R. Gao, T. Campos, A. Cooper, C. Davis, S. Schauffler, B.A. Ridley, J.C. Wei, and C. Barnet, 2007: "Chemical Behavior of the Tropopause Observed During the Stratosphere-Troposphere Analyses of Regional Transport (START) Experiment". *Journal of Geophysical Research*, 112 D18110 doi:10.1029/2007JD008645, (May 2007).

Pielke, R. Sr., J. Nielsen-Gammon, C. Davey, J. Angel, O. Bliss, N. Doesken, M. Cai, S.Fall, D. Niyogi, K. Gallo, R. Hale, K.G. Hubbard, X. Lin, H. Li, and S. Raman. 2007. "Documentation of Uncertainties and Biases Associated with Surface Temperature Measurement Sites for Climate Change Assessment". *Bul. Amr. Meteorol. Soc.* 88:913-928 (June 2007).

Prabhakara, C., R. Iacovazzi, Jr., J.-M. Yoo, K.-M. Kim, and T. Bell, 2007: "A Method to Estimate Rain Rate over Tropical Oceans with the TRMM Microwave Imager Radiometer". *J. Met. Soc. Japan*, in press.

Prados, A., S. Kondragunta, P. Ciren, K. Knapp, "GOES Aerosol/Smoke Product: Comparisons with MODIS and AERONET", *Journal of Geophysical Research*, 2007.

Pu, R., Z. Li, P. Gong, I. Csiszar, R. Fraser, W.-M., Hao, S. Kondragunta, and F. Weng, 2007: "Development and Analysis of a 12-year Daily 1-km Forest Fire Dataset Across North America from NOAA/AVHRR Data". *Remote Sensing of Environment*, Volume 108, Issue 2, 198-208, (30 May 2007).

Rama Varma Raja, M. K., S. I. Gutman, J. G. Yoe, L. M. McMillin,and J. Zhao, 2007: "The Validation Of AIR Retrievals Of Integrated Precipitable Water Vapour Using Measurements From A Network Of Ground Based Gps Receivers Over the Contiguous United States", *J. Atmos. Oceanic. Tech*, 2007,

Tuleya, R. E., M. DeMaria, and R. J. Kuligowski2007: "Evaluation of GFDL and Simple Statistical Model Rainfall Forecasts for U.S. Landfalling Tropical Cyclones". *Weather and Forecasting*, 22 (1), 56-70, (January 2007).

Wang, L., C. Cao, and P. Ciren, 2007: "Assessing NOAA-16 HIRS Radiance Accuracy Using Simultaneous Nadir Overpass Observations from AIRS". *J. Atmos. Oceanic Technol.*, 24, 1546-1561.

Warner, J. , M. McCourt-Comer, C. Barnet, W.W. McMillan, W. Wolf, E. Maddy, G. Sachse, 2006: "A Comparison of Satellite Tropospheric Carbon Monoxide Measurements from AIRS and MOPITT during INTEX-A". *Journal of Geophysical Research,* doi:10.1029/2006JD007925 (June 2007).

Wu, A., X. Xiong, and C. Cao. "Terra and Aqua MODIS Inter-Comparison of the Reflective Solar Bands Using AVHRR aboard the NOAA-KLM Series of Satellites", *International Journal of Remote Sensing*, (In press).

Zapotocny, T., J. Jung, J. LeMarshall, and R. Treadon, 2007: "A Two-Season Impact Study of Satellite and In Situ Data in the NCEP Global Data Assimilation System", *Weather and Forecasting,* (August, 2007).

Zou, C.-Z., M.D. Goldberg, Z. Cheng, N.C. Grody, J.T. Sullivan, C. Cao, and D. Tarpley, 2006: "Recalibration of Microwave Sounding Unit for Climate Studies Using Simultaneous Nadir Overpasses", *Journal of Geophysical Research*, 111, D19114, doi:10.1029/2005JD006798 (October, 2006).

**ACCEPTED**

Cao, C., X. Xiong, A. Wu, and X. Wu, 2007: "Assessing the Consistency of AVHRR and MODIS L1B Reflectance". *Journal of Geophysical Research*, Accepted September 2007.

Divakarla, M, C. Barnet, M. Goldberg, E. Maddy, B. Irion, M. Newchurch, X. Liu, W. Wolf, L. Flynn, G. Labow, X. Xiong, J. Wei, and L. Zhou, 2007: "Evaluation of Atmospheric Infrared Sounder (AIRS) Ozone Profiles and Total Ozone Retrievals with Matched Ozonesonde Measurements, ECMWF Ozone Data, and Ozone Monitoring Instrument (OMI) Retrievals.", *J. Geophys Res*. Accepted w/ revisions Nov. 2007

Kondragunta, S et al., 2007: "Air Quality Forecast Verification using Satellite Data". *Journal of Atmos. Sci.*

Laszlo, I., P. Ciren, H. Liu, S. Kondragunta, J.D. Tarpley, and M. Goldberg, 2007: "Remote Sensing of Aerosol and Radiation from Geostationary Satellites", *Advances in Space Research*.

Maddy, E.S., and C.D. Barnet, 2007: "Vertical Resolution Estimates in Version 5 of AIRS Operational Retrievals". *Institute of Electrical Engineers (IEEE) Transactions on Geoscience & Remote Sensing*, Accepted May 4, 2007.

Maddy, E.S., C. D. Barnet, M. Goldberg, C. Sweeney, and X. Liu, 2007: "CO2 Retrievals from the Atmospheric Infrared Sounder: Methodology and Validation". *Geophys. Res. Lett.,* Accepted August 2007.

McMillan, W.W., J.X. Warner, M.L. McCourt-Comer, E.S. Maddy, A. Chu, L. Sparling, E. Eloranta, R. Hoff, G. Sachse, C.D. Barnet, I. Razenkov and W. Wolf, 2006: "AIRS Views of Transport from 12-22 July 2004 Alaskan/Canadian Fires: Correl. of AIRS CO and MODIS AOD with Forward Trajectories and Comparison of AIRS CO Ret's with DC-8 In-Situ Measurements During INTEX-A/ICARTT". *Journal of Geophysical Research.*

Mo, T., 2007: "Calibration of the Advanced Microwave Sounding Unit-A for NOAA-N". *NOAA Technical Report, NESDIS 124*

Nalli, N, P. van Delst, and P. Minnett, 2007: "Emissivity and Reflection Model for Calculating Water Surface Leaving Radiance in the Infrared. 2: Validation Using Fourier Transform Spectrometers", Accepted September 2007.

Xiong, X., C. Barnet, E. Maddy, C. Sweeney, X. Liu, L. Zhou, M. Goldberg, 2007: "Characterization and Validation of Methane Products from the Atmospheric Infrared Sounder (AIRS)", *JGR-B special section on methane*.

Zhan, X., W.T. Crow, T.J. Jackson & Peggy O'Neill, 2007: "Improving Space-Borne Radiometer Soil Moisture Retrievals with Alternative Aggregation Rules for Ancillary Parameters", *Geoscience and Remote Sensing Letters*. Accepted October 2007.

Zhang, X, and S. Kondragunta, 2007: "Temporal and Spatial Variability in Biomass Burned Areas across the USA Inferred from GOES Fire Products", *Remote Sensing of Environment,* Accepted August 2007.

Zhou, L., M. Goldberg, C. Barnet, Z. Cheng, F. Sun, W. Wolf, T. King, X. Liu, H. Sun, and M. Divakarla, 2007: "Regression of Surface Spectral Emissivity from Hyperspectral Instruments". *IEEE TGARS*

**IN REVIEW**

Gambacorta, A, C.D. Barnet, B. Soden, L. Strow. "An Assessment of the Tropical Humidity-Temperature Covariance Using AIRS", submitted to *Geophys. Res. Lett*. Oct. 2007.

Kumar, S.V. R.H. Reichle, C.D. Peters-Lidard, R.D. Koster, X. Zhan, W.T. Crow, J.B. Eylander, and P.R. Houser, 2007: "A Land Surface Data Assimilation Framework using the Land Information System: Description and Applications", in review by *Advances in Water Resources*, 2007.

## Other

Flynn, L.E., 2007: "Comparing Two Sets of Noisy Measurements". NOAA Technical Report *NESDIS 123, U.S. Department of Commerce, Washington, DC*, (April 2007).

Flynn, L.E., "NOAA Southern Hemisphere Winter Summary 2006" Winter Bulletin, (Contributor to NOAA Bulletin: Stratosphere), http://www.cpc.ncep.noaa.gov/products/stratosphere/winter_bulletins/sh_06/.

Flynn, L.E., 2006: "Scientific Assessment of Ozone Depletion", Global Ozone Research and Monitoring Project, Report No. 50, (Contributor to Chapter 3), *World Meteorological Organization*.

Flynn, L.E., C., Seftor, J., Larsen, and P., Xu, 2007: "The Ozone Mapping and Profiler Suite" in Qu, J., W. Gao, M. Kafatos, R. Murphy and V. Salomonson (eds), *Earth Science Satellite Remote Sensing, Science and Instruments, Volume I*, Co-published by Tsinghua University Press, Beijing and Springer-Verlag GmbH Berlin Heidelberg, pp. 279-296.

Goldberg, M., and F. Weng, 2007: "Advanced Technology Microwave Sounder" in Qu, J., W. Gao, M. Kafatos, R. Murphy and V. Salomonson (eds), *Earth Science Satellite Remote Sensing, Science and Instruments, Volume I*, Co-published by Tsinghua University Press, Beijing and Springer-Verlag GmbH Berlin Heidelberg, pp. 243-253.

Ho, B., C. Zou, and B. Kuo, 2007-2009: "Validation and Calibration of MSU/AMSU Measurements and Radiosonde Observations Using GPS RO Data for Improving Stratospheric and Tropospheric Temperature Trend Analysis", *NOAA/Climate Program Office*.

Pryor, K.L., 2006: A Numerical Model-derived Boundary Layer Turbulence Product. arXiv:physics/0612189v3 [physics.ao-ph]

Pryor, K. L., 2007: "The GOES Microburst Windspeed Potential Index". *ArXiv*, physics/0703162. (Revision 23 Apr 2007).

Pryor, K. L., 2007: An Initial Assessment of the GOES Microburst Windspeed Potential Index. arXiv:0710.0603v2 [physics.ao-ph]

Weng, F., 2007: "Conically Scanned Microwave Imager Sounder" in Qu, J., W. Gao, M. Kafatos, R. Murphy and V. Salomonson (eds), *Earth Science Satellite Remote Sensing, Science and Instruments, Volume I*, Co-published by Tsinghua University Press, Beijing and Springer-Verlag GmbH Berlin Heidelberg, pp. 224-242.

## Conference Proceedings

Barnet, C.D., M. Goldberg, E. Maddy, and X. Xiong, " Observing Trace Gases from Spectrally Resolved Infrared Radiances," in Fourier Transform Spectroscopy/ Hyperspectral Imaging and Sounding of the Environment (*FTS/HISE),* OSA Technical Digest Series (CD) (Optical Society of America, 2007), paper HWA3.

Bolten, J., W.T. Crow, X. Zhan, T.J. Jackson, C. Reynolds and B. Doorn, 2006: Assimilation of AMSR-E Soil Moisture Retrievals into the USDA Global Crop Production Decision Support System. AGU 2006 Fall Meeting, San Francisco, CA. Dec. 11-15, 2006

Cao, C., A. Wu, X. Wu, and X. Xiong, 2007: Inter-calibrating MetOp/AVHRR and Aqua/MODIS with Improved SNO accuracy, *IGARSS Conference proceedings, Barcelona, Spain.*

Cao, C., X. Wu, A. Wu, and X. Xiong, 2007: Improving the SNO calibration accuracy for the solar reflective bands of AVHRR and MODIS, *SPIE conference proceedings, San Diego, CA.*

Divarkarla, M., Barnet, C., Goldberg, M., Maddy, E., Wolf, W., Flynn, L., Xiong, X., Wei, J., Zhou, L., Liu., X., 2007: Intercomparison of AIRS Ozone Profiles and Total Ozone Retrievals with Matched Ozonesonde Measurements and ECMWF Forecast Data, *HISE/OSA Santa Fe, New Mexico*

Flynn, L.E., M.T. DeLand, L.-K. Huang, and E. Beach, 2006: "Characterization of Operational Solar Backscatter Ultraviolet Instruments at NOAA," Proceedings of the Third Workshop on the Atmospheric Chemistry Validation of Envisat (ACVE-3), 4-7 December 2006, ESR

Goldberg, M. D., 2007: "Global space-based inter-calibration system (GSICS)", Atmospheric and Environmental Remote Sensing Data Processing and Utilization III: Readiness for GEOSS, Mitchell D. Goldberg; Hal J. Bloom; Allen H. Huang; Philip E. Ardanuy, Eds.

Kleespies, T. J., 2007: Relative Information Content of the Advanced Technology Microwave Sounder, and the Advanced Microwave Sounding Unit and the Microwave Humidity Sounder Suite, *ITSC-15*, Maratea, Italy.

Kleespies, T. J., 2007: Results from the NOAA-14 Microwave Sounding Unit Pitch Test, *ITSC-15*, Maratea, Italy.

Kleespies, T. J., 2007: The Use of Google Earth in Meteorological Satellite Visualization, *ITSC-15*, Maratea, Italy.

Kuligowski, R. J, 2006: Satellite rainfall estimates for global flood monitoring and prediction. Preprints, *5th Asia-Pacific Remote Sensing Symposium,* SPIE, Goa, India.

Kuligowski, R. J. and J. C. Davenport, 2007: The new NESDIS Hydro-Estimator algorithm. Preprints, *21st Conference on Hydrology*, American Meteorological Society, San Antonio, TX, CD-ROM, 3.2.

Kuligowski, R. J., 2006: Satellite precipitation estimation and nowcasting plans for the GOES-R era. Preprints, *3rd International Precipitation Working Group Workshop*, Melbourne, Australia.

Kuligowski, R. J., 2007: The GOES-R Hydrology Algorithm Team: Progress and plans. Preprints, *3rd Symposium on Future Operational Environmental Satellites*, American Meteorological Society, San Antonio, TX, CD-ROM, P1.5.

Mo, T., 2007: "AMSU-A Measurements of Brightness Temperatures over Amazon Rain Forest," *Joint Assembly*, 22-25 May 2007, Acapulco, Mexico.

Morris, V. R., M. Hawkins, N. Nalli, E. Joseph, M. Goldberg, P. J. Minnett, and L. Roldan, 2007: AEROSE: Ongoing field investigations of downwind transport of aerosols from Saharan and Sub-Saharan Africa across the Tropical Atlantic, P1.4, 9th Conference

Nalli, N. R., and Coauthors, 2007: On the derivation of hyperspectral infrared emission from the sea-surface, Fourier Transform Spectroscopy/Hyperspectral Imaging and Sounding of the Environment Topical Meetings (The Optical Society of America, Washington

Pryor, K.L., 2006: Electrical Behavior of Downburst-Producing Convective Storms over the High Plains. Preprints, *23rd Conf. on Severe Local Storms*, St. Louis, MO, Amer. Meteor. Soc.

Pryor, K. L., 2008: An Initial Assessment of the GOES Microburst Windspeed Potential Index. Preprints, 5th GOES Users' Conf., New Orleans, LA, *Amer. Meteor. Soc*.

Rama Varma Raja, M.K., Y. Yu, D. Tarpley, J. Privette, and H. Xu. Developing Split Window Algorithm for Land Surface Temperature Measurement from GOES-R ABI Sensor: Part 3, Ground Measurement Comparisons, *GOES-R Annual Working Group Meeting*, Lans

Reale, A. L., and E.G. Dutton, 2007: "A candidate GCOS Atmospheric Reference Observations Network (GARON) Consisting of ARM, BSRN and WMO Reporting Sites and Satellite / In-situ Data Collection Strategies", *14th Symposium on Meteorological Observations and Instrumentation*.

Ryu, D., W.T. Crow and X. Zhan, 2006: Improving Flood Prediction Through the Assimilation of AMSR-E Soil Moisture Retrievals into a Hydrologic Model. AGU 2006 Fall Meeting, San Francisco, CA. Dec. 11-15, 2006.

Scofield, R., and R. J. Kuligowski, 2007: Satellite Precipitation Algorithms for Extreme Precipitation Events. Measuring Precipitation from Space – EURAINSAT and the Future (eds. V. Levizzani, P. Bauer, and F. J. Turk), Springer Publishing, pp. 485-496

Wang, L., and C. Cao, 2007: Inter-calibration of geostationary imagers with IASI high spectral resolution measurements. 2007 GOES-R Cal/Val Workshop and the Algorithms Working Group Annual Meeting, Lansdowne, VA.

Wang, L., and C. Cao, 2007: On-orbit verification of infrared sounders on MetOP-A. 14th Symposium on Meteorological Observation and Instrumentation, San Antonio, TX.

Wang, L., and C. Cao, 2007: Radiance comparison of IASI and AVHRR on MetOp-A. SPIE Optics & Photonics 2007- Optical Engineering and Applications, San Diego, CA.

Wang, L., and C. Cao, On-orbit Verification of Infrared Sounders on MetOP-A, 2007 AMS, San Antonio, TX.

Yu, Y., D. Tarpley, J. Privette, M. K. R.-V. Raja, and H. Xu. Developing Split Window Algorithm for Land Surface Temperature Measurement from GOES-R ABI Sensor: Part 1, Regression Analysis, *GOES-R Annual Working Group Meeting*, Lansdowne, VA, May 1

Yu, Y., D. Tarpley, J. Privette, M. K. R.-V. Raja, and H. Xu. Developing Split Window Algorithms for Land Surface Temperature Measurement from GOES-R ABI Sensor: Part 2, Sensitivity Analysis, *GOES-R Annual Working Group Meeting*, Lansdowne, VA, May

Zhan, X., W. Crow, S. Kumar, P. Houser and C. Peters-Lidard, 2007: Impact of Observational Data Preprocessing on their Assimilation in NASA's Land Information System Using Ensemble Kalman Filter. 21st Conference on Hydrology. AMS Annual Meetings, San Antonio, TX. Jan. 15-18, 2007.

Zhan, X., T.J. Jackson, M. Cosh, S. Boukabara, D. Tarpley, M. Goldberg, and F. Weng. Calibration of AMSR-E soil moisture retrieval algorithm using MIRS and LDAS simulations. IGARSS 2007, Barcelona, Spain. July 21-28, 2007.

Zhou, L., Z. Cheng, F. Sun, W. Wolf, T. King, C. Barnet, and M. Goldberg. Regression of Surface Emissivity from Hyper-Spectral Measurements, *2007 AMS meeting in Amsterdam.*