

**CIMSS Participation in the
GOES-R Risk Reduction Program**

**Quarterly Progress Report for
1 April – 30 June 2007**

**from the
University of Wisconsin-Madison
Cooperative Institute for Meteorological Satellite Studies (CIMSS)**

Project Title: CIMSS Participation in GOES-R Risk Reduction

Principle Investigator: Steve Ackerman

Topics/Lead Investigators:

1. Algorithms
 - 1.1 Sounding Algorithm Development - Jun Li, Allen Huang
 - 1.2 Winds – Chris Velden
 - 1.3 Ozone - Jun Li
 - 1.4 Radiative Transfer Modeling - Steve Ackerman, Tom Greenwald
 - 1.5 Surface Properties - Bob Knuteson
 - 1.6 Biomass Burning-Elaine Prins, Chris Schmidt
 - 1.7 SATCAST / CI - Wayne Feltz
 - 1.8 Tropical Cyclones - Jim Kossin, Chris Velden
 - 1.9 Visualization (HYDRA integration) - Tom Rink
2. Nowcasting - Ralph Petersen
3. Data Assimilation / Simulations - Jason Otkin, Allen Huang
4. Validation - Dave Tobin
5. Ground System – Maciej Smuga-Otto, Bob Knuteson

Program Manager: Tom Achtor

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1. Algorithms

1.1 Sounding Algorithm Development Task Leads: Jun Li, Allen Huang

Summary on sounding algorithm development

We have reported that CIMSS is developing the IR alone cloudy sounding algorithm, which deals with the challenge of using IR data in cloudy region (see previous reports for more information). The radiosonde and ECMWF analysis data are used for algorithm evaluation. Alternatively, NASA EOS (Earth Observing System) A-Train satellites provide excellent data for GOES-R algorithm testing and evaluation. We have used the CloudSat and CALIPSO data to evaluate our infrared (IR) alone cloudy sounding algorithm. See section 1.1A for details.

We are applying the IR alone single field-of-view (SFOV) cloudy sounding approach to hurricane cases, for example, the Hurricane Isabel case that Mark DeMaria had studied using operational AIRS/AMSU (3 by 3 AIRS FOV size) soundings for studying the hurricane eye temperature anomaly. The question we posed was, does AIRS alone provide the same hurricane eye temperature anomaly? Our study found that hyperspectral IR alone SFOV soundings provide high spatial and vertical resolution temperature and moisture structures for the hurricane eye and its environment in all sky conditions. See section 1.1B for details.

A GEO/LEO synergy study was carried out; the idea is to combine the hyperspectral IR data from LEO orbit and high temporal and spatial resolution ABI from GOES-R to produce the best possible profiles from future available data. For example, CrIS can be used together with ABI for soundings at the NPOESS overpass time, and the combined CrIS/ABI soundings can be used as the first guess for next time ABI alone profiles, and so on until the next NPOESS overpass. This approach takes advantages of high vertical resolution and accurate sounding information from polar orbiting, and high temporal and spatial information from GOES-R ABI. SEVIRI and AIRS are used for the concept study. Preliminary result shows the combination is helpful for sounding evolution but geostationary hyperspectral IR data is still needed for quality mesoscale soundings. More studies on GEO/LEO sounding evolution will be presented in our next report.

In our last quarterly report, we have presented an advanced algorithm that retrieves the surface IR emissivity spectrum simultaneously with the temperature and moisture sounding. The emissivity study deals with the challenge of using IR data over land. A manuscript entitled "Physical retrieval of surface emissivity spectrum from hyperspectral infrared radiances" by Jun Li et al. has progressed through the review processing and will be published in Geophysical Research Letters after minor revisions. We are applying the same approach for SEVIRI/ABI surface emissivity retrievals. Furthermore, the advantage of time continuity of SEVIRI/ABI can be uniquely taken into account in the emissivity retrieval. For example, ABI radiances from many time steps can be used to retrieve temporally invariable emissivity and variable surface skin temperatures. Results on SEVIRI emissivity and skin temperature retrieval using time continuity is expected in next quarterly report.

1.1A. Using A-train data for algorithm testing and evaluation

One big challenge in the application of IR data is handling clouds. Usually only clear radiances are used. Recently an infrared alone cloudy sounding algorithm was developed to retrieve sounding (temperature and moisture profiles) and cloud properties (cloud-top pressure, cloud optical thickness and cloud particle radius) from cloudy radiances. The cloudy soundings are reasonable when compared with radiosondes and ECMWF analysis. A manuscript describing this work is being published in the Geophysical Research Letters. In order to further evaluate the cloudy sounding algorithm, EOS A-train data were used; CloudSat and CALIPSO data were used to evaluate the cloud-top retrievals from AIRS retrievals using cloudy sounding approach. The operational MODIS cloud-top product is also included in the comparisons. Results (see Figure 1) show that AIRS and MODIS agree well, cloud-top heights from both AIRS and MODIS are closer to the values obtained by CloudSat than the ones obtained by Caliop. AIRS shows slightly smaller mean differences with respect to CloudSat's CPR and Caliop than MODIS. This demonstrates that the cloudy sounding approach also provides reasonable cloud-top properties. There is a more detailed analysis about the comparisons in the manuscript (Weisz et al. 2007) submitted to GRL recently.

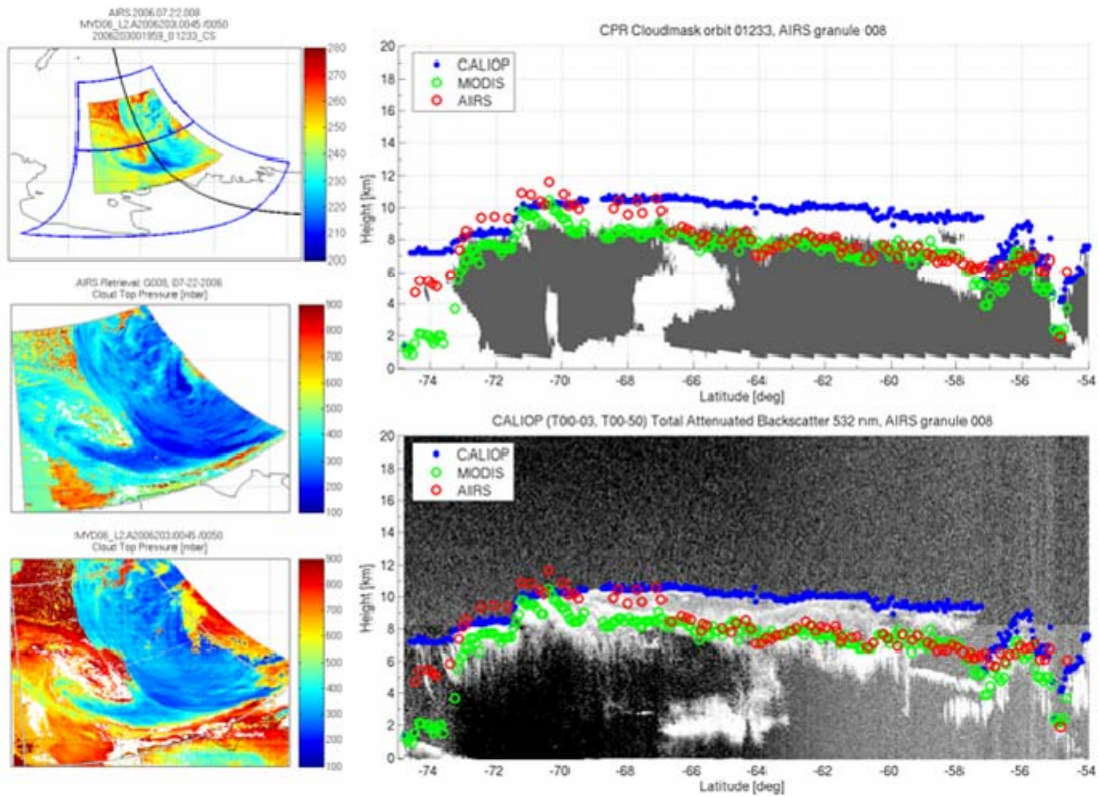


Figure 1. Left column shows AIRS BT at wavenumber 911 cm^{-1} (upper), AIRS cloud-top pressure (CTP) (middle) and operational MODIS CTP (lower) on July 22, 2006 located off the coast of Antarctica southeast of New Zealand. The top image in right panel shows CloudSat's L2 CPR Cloud Mask product (i.e., the geometric distribution of the clouds) in gray. The bottom image in right panel shows CALIPSO's 532 nm total attenuated backscatter per km per steradian. The MODIS and AIRS cloud heights are plotted.

1.1B. Hurricane structures depicted by hyperspectral infrared data

We applied the hyperspectral IR alone single FOV cloudy sounding approach to a hurricane case. Our study shows that with hyperspectral infrared alone data, high vertical and spatial resolution moisture and temperature structures can be obtained for the hurricane eye and its environment in both clear and cloudy sky conditions. The cloud-top structure of the hurricane can also be well depicted. The study on hurricane Isabel (13 September 2003) with AIRS shows that the hurricane eye temperature anomaly can be as large as 20 K when compared with its environment, while the NCEP analysis only shows an anomaly of 5 K and less (see Figure 2). This might be caused by the large forecast error in hurricane eye region due to lack of observations. The AIRS alone soundings are verified with dropsonde data. See the attached Fig. 2 details. Combination of ABI and hyperspectral IR data from polar orbits will provide a better picture of the hurricane. MODIS/AIRS combination will be used for a CrIS/ABI hurricane sounding study.

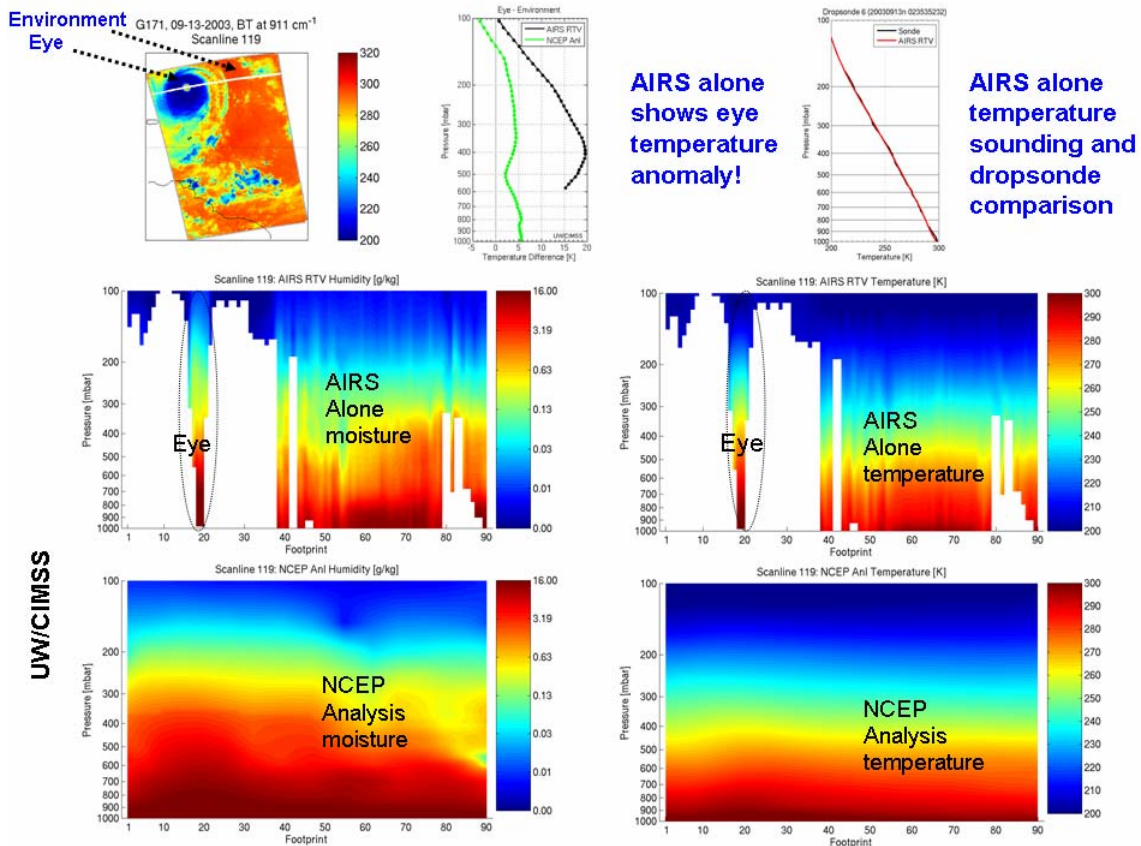


Figure 2. The AIRS brightness temperature image at 11 μm channel (top left), hurricane eye temperature anomaly from AIRS alone single footprint soundings and NCEP analysis (top middle), AIRS validation with dropsonde (top right), AIRS moisture (lower left) and temperature (lower right) single footprint (~ 13.5 km) sounding cross-section along the scan line across the eye, along with the NCEP analysis (bottom panels).

Publications

Li, Jun, Jinlong Li, Elisabeth Weisz, and Daniel K. Zhou (2007), Physical retrieval of emissivity spectrum from hyperspectral IR radiances. *Geophysical Research Letters*. (conditionally accepted)

Weisz, E., Jun Li, Jinlong Li, D K. Zhou, H.-L.Huang, M. Goldberg, and P. Yang, (2007), Cloudy sounding and cloud-top height retrieval from AIRS alone single field-of-view radiance measurements. *Geophysical Research Letters* (in press).

Weisz, Elisabeth, Jun Li, W. Paul Menzel, Andrew Heidinger, and Brian Kahn, 2007: Comparison of AIRS, MODIS, CloudSat and CALIPSO cloud top height retrievals, *Geophysical Research Letters* (submitted).

Conference presentations

Jun Li attended the GOES-R Algorithm Working Group (AWG) meeting held from 15 to 18 May 2007 at the National Conference Center and gave a presentation entitled “Research on All Sky Single field-of-view Infrared Only Sounding”.

1.2 Winds

Task Lead: Chris Velden

Summary

Previous GOES-R winds work concentrated on demonstrating the ability to target and track features from WRF model moisture fields and simulated moisture retrievals. The ATReC and Ocean Winds datasets were used to successfully demonstrate the concept.

The next dataset being investigated (FULLDISK) dwarfs the previous two cases in the number and size of files. WRF simulations run on a full-disk domain simulating the expected GOES-R coverage are broken up into “cubes” to simulate HES sounding blocks. These cubes are written as Unidata network Common Data Form (NetCDF) files. Each NetCDF file contains the moisture field information. New data staging code using Jython stitches the cubes together into a McIDAS AREA file as preparation for the winds retrievals. Jython is an implementation of Python integrated with the Java platform.

The Winds Group has now received retrieved moisture fields from the FULLDISK case, and the processing of winds can be tested. We plan to refine the cloud mask and derive multi-level winds from simulated hyperspectral sounder retrieved moisture fields on the FULLDISK case. This will mark the completion of the demonstration of winds from hyperspectral sounder retrieved fields. Future efforts will be focused on ABI winds risk reduction.

Accomplishments in the last three months

No major accomplishments during this reporting period. Spending and labor time on this project was low, as most efforts of the Winds group were focused on the GOES-R AWG workshop. There was some initial development of a cloud mask, which will need additional work before winds can be attempted (next reporting period).

1.3 Ozone

Task Lead: Jun Li

Summary on ABI ozone algorithm improvement

ABI total column ozone spatial resolution studied. In order to increase the ABI total column ozone (TCO) retrieval coverage, clear radiances within 5 by 5 field-of-views (FOVs) area were

averaged for a total column ozone (TCO) retrieval. In such a way, the spatial resolution of the TCO product will be 10 km, which is the same as that of the current GOES Sounder research TCO product (Li et al. 2001-JTECH; Li et al. 2007 – GRL). The question raised is: does the 10 km ABI TCO preserve the spatial gradient of TCO when compared with the ABI single FOV TCO product with 2 km spatial resolution? In order to answer this question, SEVIRI (Spinning Enhanced Visible and InfraRed Imager) 3 km radiances were used for this study. SEVIRI TCO with approximate 10 km spatial resolution from radiances averaged within a 3 by 3 FOV area were compared with the SEVIRI single FOV TCO product with 3 km spatial resolution. Results show that the 10 km TCO keeps the needed spatial gradient information. The 10 km TCO has more retrieval coverage than the 3 km TCO. In addition, since the signal-to-noise ratio of radiances averaged from 3 by 3 FOV area is much better than that of single FOV; the 10 km TCO will have better quality than that of single FOV. Figure 3 shows the 10 km and 3 km TCO products derived from SEVIRI radiances at 1200 UTC on 14 February 2006. Note that, the total ozone observation derived once each day from the Ozone Monitoring Instrument (OMI) onboard the NASA’s EOS (Earth Observing System) Aura platform has a much larger spatial resolution (13 km by 25 km). Therefore, ABI 10 km TCO should be able to meet the science requirement in term of spatial resolution.

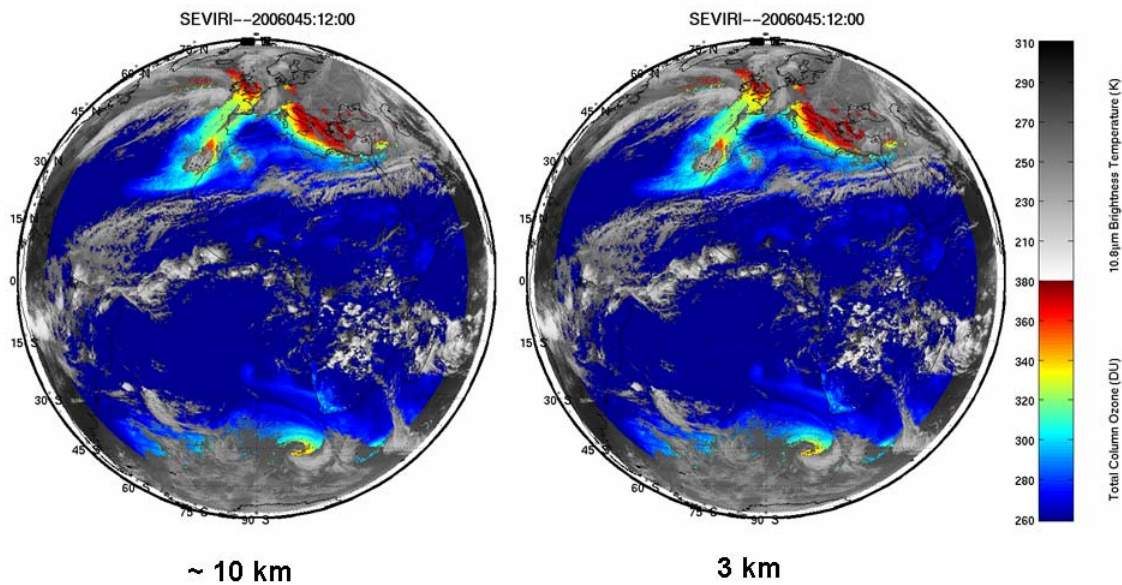


Figure 3: The 10 km and 3 km TCO products derived from SEVIRI radiances at 1200 UTC on 14 February 2006.

Manuscript on ABI ozone retrieval further revised. The manuscript entitled “Retrieval of Total Column Ozone from Imagers Onboard Geostationary Satellites” by Xin Jin, Jun Li, Christopher C. Schmidt, Timothy J. Schmit, and Jinlong Li, has gone through the second review process, minor revision is further needed. The co-authors are working on the final improvement

on the paper, and will compare the SEVIRI TCO with the AIRS operational ozone product, according to the reviewers' comments.

Publications during April 01 – June 30, 2007

Jin, Xin, Jun Li, Christopher C. Schmidt, Timothy J. Schmit, and Jinlong Li, 2007: Retrieval of Total Column Ozone from Imagers Onboard Geostationary Satellites, *IEEE Transactions on Geosciences and Remote Sensing* (conditionally accepted).

1.4 Radiative Transfer Modeling

Task Leads: Steve Ackerman, Tom Greenwald

Proposed work:

To build full solar capability into the Successive Order of Interaction (SOI) radiative transfer model (RTM) and to compare the SOI RTM with other RTMs.

Accomplishments:

1. Acquired FIRTM-AD RTM from Zhibo Zhang at Texas A&M
2. Acquired a preliminary solar version of the SOI RTM from Chris O'Dell at CSU. This version of the model will be extended to include azimuthal variation of the radiance field.
3. Ran Mie calculations for the purpose of creating high-spectral-resolution scattering property tables needed by the models. Calculations were performed at 1 inverse cm resolution from 100 to 3250 inverse cm and for 16 effective droplet diameters from 2 microns to 175 microns.

1.5 Surface Properties

Task Lead: Bob Knuteson

Proposed Work

The CIMSS GOES-R Risk Reduction activity in 2006 related to land surface properties was focused on the development of a global gridded high spatial resolution multi-year infrared emissivity database for use by 1) the AWG proxy data team for simulation of realistic Earth emitted radiation, 2) the sounder team for temperature and water vapor retrieval algorithm development, and 3) for data assimilation in numerical weather prediction models. A paper was submitted in late 2006 to the *Journal of Applied Meteorology and Climate (JAMC)* by lead author Suzanne Wetzel Seaman that describes the methodology used to create this database from a combination of MODIS observations and laboratory measurements. This development was conducted in collaboration with the MODIS land products team and has been used for the comparison of against AIRS products produced by NOAA/STAR. We proposed to continue this work in 2007 with an emphasis on deriving land surface temperature and surface emissivity for the ABI sensor.

Our approach is to collaborate with the EUMETSAT Land Satellite Applications Facility (LAND SAF) in Portugal, esp. Dr. Isabel Trigo, in an algorithm for using the temporal change of the SEVIRI instrument measurements to determine infrared emissivity for the SEVIRI infrared channels. We will create a prototype algorithm for ABI that takes advantage of the time change of surface temperature to separate surface temperature and surface emissivity. We will apply this algorithm to the SEVIRI observations over Africa and Europe for a case study. The independent emissivity product created from the SEVIRI infrared channels will be used to validate the CIMSS

emissivity database. This CIMSS database is being used by the EUMETSAT Climate SAF in the profile retrieval of temperature and water vapor over land. We will collaborate with Ralf Bennartz (UW-AOS) on the impact of improvements in the land surface emissivity on profile retrievals SEVIRI as a proxy for ABI.

Accomplishments April - June 2007

1. Diurnal signatures of land surface emission are being investigated using SEVIRI data from August 2006. The diurnal change of observed brightness temperature is shown for seven sites near the Eastern Mediterranean in the Figure 4. These geostationary observations are being used to develop an inversion method for obtaining land surface emissivity from the SEVIRI data that takes advantage of the time variation of the measurements. The data were obtained from M. Pavalonis using GEOCAT.

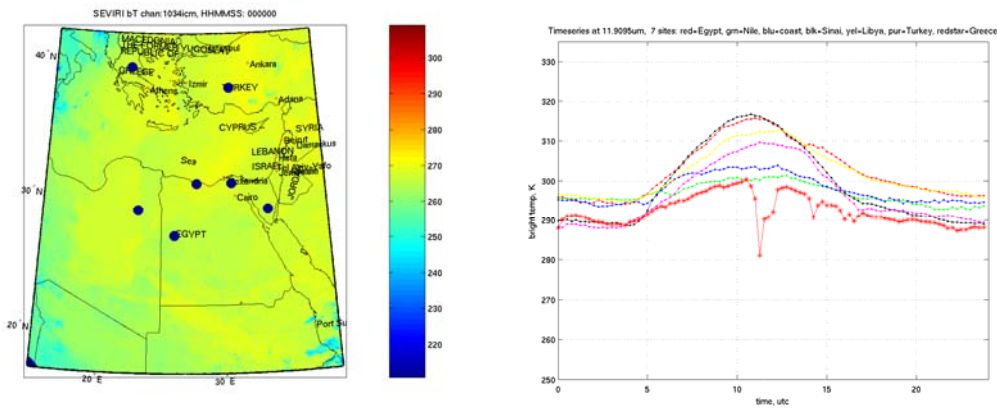


Figure 4. Diurnal change in the observed SEVIRI brightness temperature (right) at the seven sites shown as dots on the map (left) representing a range of land cover types.

2. The applicability of the UW MODIS Best Fit (UW BF) global emissivity database is being evaluated for use with the SEVIRI retrieval algorithm. The UW MODIS BF product will be used in a forward model comparison with SEVIRI brightness temperatures using the EUMETSAT Land SAF skin temperatures. The UW BF emissivity extracted at the seven sites shown in the previous map is shown in Figure 5 below showing a wide range of measured emissivity values.

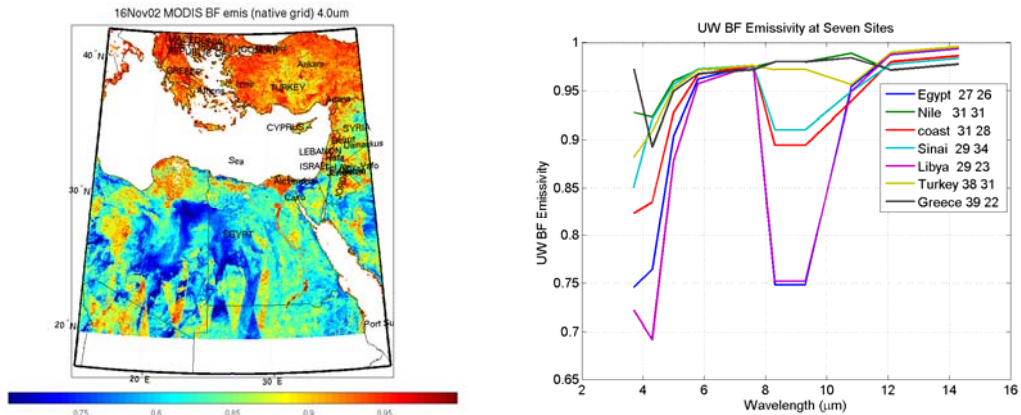


Figure 5. UW BF gridded database is plotted at 4 microns for the evaluation region at 5 km resolution (left) and as emissivity spectra at the seven selected sites (right).

1.6 Biomass Burning- Task Leads: Elaine Prins, Chris Schmidt

GOES-R ABI biomass burning research and development activities for 2007 focuses on active fire detection and sub-pixel characterization utilizing simulated and current global geostationary multi-spectral data. CIMSS is investigating application of the dynamic Baseline Emissivity dataset which contains monthly estimates of spectral band emissivities derived from MODIS data to improve sub-pixel fire characterization. CIMSS will utilize 15-minute MSG SEVIRI data and the MSG WF_ABBA product over Africa to investigate how to exploit high temporal data to identify and monitor small fast-burning agricultural and grass fires. CIMSS will continue to investigate fire characterization using both Dozier estimates of instantaneous sub-pixel fire size and temperature and fire radiative power (FRP) as derived from both MODIS simulated ABI data and other sensors as appropriate. Collaborations will continue with NRL-Monterey and NESDIS on emission studies and data assimilation into the NAAPS model. Although initial efforts by NOAA/NESDIS to obtain 2 km MTSAT-1R JAMI data have not been successful, CIMSS is eager to utilize this data if it is made available. These risk reduction activities will ensure enhanced future fire detection, monitoring and characterization.

Accomplishments:

Work to create simulated ABI data from MODIS data continued from 2006 and the first quarter of 2007. The CIMSS technique that properly accounts for the viewing geometries of the two satellites and the spatial response function of the ABI when generating the simulated imagery replaced the straightforward averaging and the simplified remapping techniques that have been used in the past. This remapped data is being used as proxy data for the GOES-R ABI WFABBA development effort. An example is shown in Figure 6 below.

CIMSS comparisons of FRP calculated from Dozier instantaneous sub-pixel fire characteristics with FRP calculated from the 3.9 micron radiances were extended to include several years worth of data (2004-2006). Previously there had proven to be a 1:1 correlation between the two for relatively large fires with Dozier fire temperatures between 650 K and 1200 K. For small and cool, large and cool, or small and hot fires (size and temperature as determined by the Dozier technique), the two techniques diverged markedly. Validation of FRP from an independent source is necessary to determine if either technique is effective in those cases.

Work to utilize the Baseline Emissivity (formerly referred to as the SeeBor) dataset and the collaborations with NRL-Monterey and NESDIS on emission studies and data assimilation into the NAAPS model have continued.

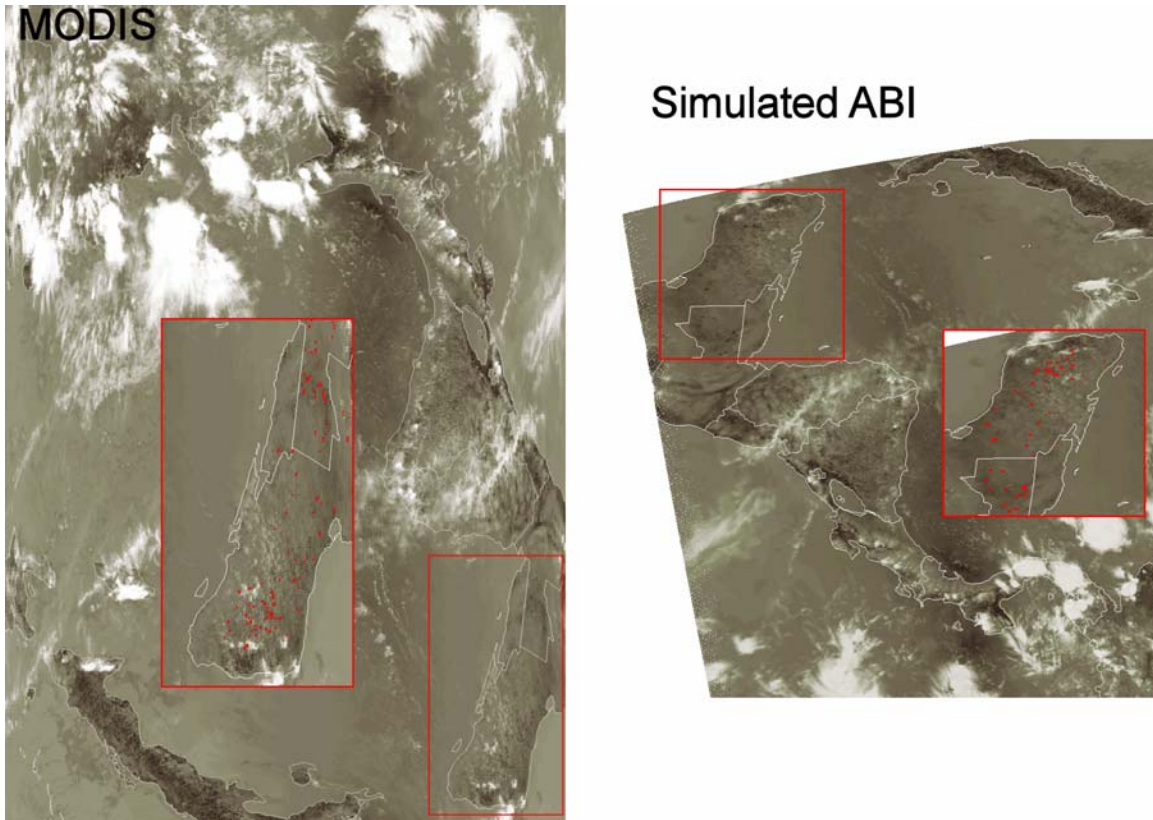


Figure 6. Original MODIS data from 24 April 2004 18:45 UTC AQUA overpass over Central America. ABI simulated data was remapped from source 1 km data to 2 km ABI with ABI navigation. Some points near the limb are not remapped properly due to issues with handling the overlap between sweeps of the MODIS push-broom sensor. Fires are highlighted in insets in red.

Conference Publications:

Schmidt, Christopher C., Elaine M. Prins, Jay P. Hoffman, Jason C. Brunner, Scott Lindstrom, Matthew Gunshor, Dave Santek, and Graeme Martin, 2007: GOES-R Fire Detection and Characterization, Algorithm Working Group Annual Meeting, National Conference Center, Landsowne, VA, 14-18 May 2007.

1.7 SATCAST / Convective Initiation

Task Lead: Wayne Feltz

Work Proposed

This research seeks to adapt SATCAST for use with MSG SEVIRI imager radiance data in anticipation of application on the GOES-R ABI imager. The CIMSS Satellite Nowcasting and Aviation Applications (SNAAP) team will conduct this research.

We proposed to take advantage of the current Convective and Orographically-induced Precipitation Study (COPS) being conducted in Southern Germany and Eastern France in the Summer of 2007. Collaboration is currently underway between CIMSS, Dr. Volker Gaertner (EUMETSAT), Dr. Marianne Koenig (EUMETSAT), and Dr. Volker Wulfmeyer (U of Stuttgart) to transition the SNAAP/ASAP convection initiation and mesoscale atmospheric motion vector applications to using SEVIRI radiance inputs. This experiment is providing an

opportunity to use a current imager containing more ABI channels than currently possessed by GOES imager. New radiance channels can be used to optimize the convective initiation algorithm.

Accomplishments

The GOES imager SatCAST algorithm has been successfully adapted to use SEVIRI radiances as the input data stream. Additional channels including 8.5 and 12.0 μm have been used to optimize algorithm performance. This additional radiance information has reduced the False Alarm Rate (FAR) when compared to the GOES imager version of SATCAST algorithm. SATCAST has been implemented at EUMETSAT in collaboration with Marianne Koenig and Volker Gaertner and is currently in operation at CIMSS in support of the COPS. A near real-time web site supporting these products are located at:

<http://cimss.ssec.wisc.edu/snaap/cops/quicklooks.php>

The convective initiation datasets are being archived for further study and Dr. Marianne Koenig has requested that members of our SNAAP team return to Darmstadt after COPS has ended to review possible cases of interest for study. Figure 7 shows an example of nowcasting products shown at the above website.

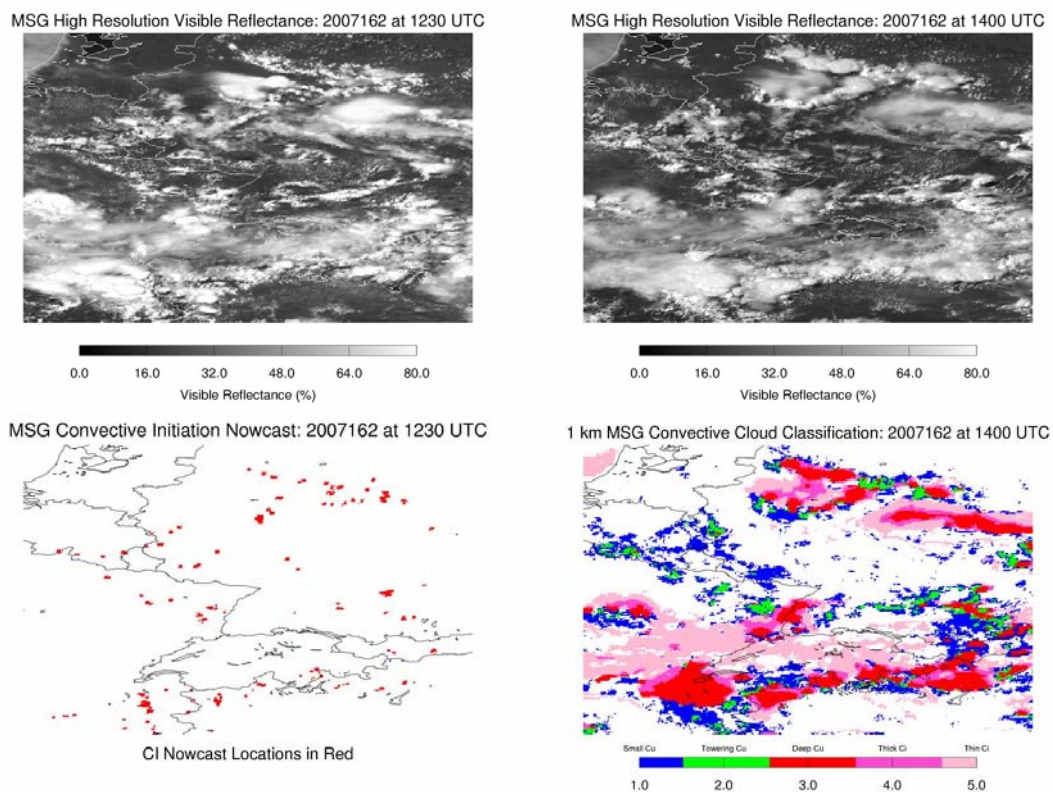


Figure 7: Convective initiation nowcast (bottom-left) compared to MSG 1 km Visible channel imagery at the time of the nowcast (upper-left) and imagery 1.5 hours later, illustrating that many of the cumulus identified by the nowcast later developed into deep convection (bottom-right).

The SATCAST algorithm is currently using 15-minute resolution SEVIRI data, however a special 5-minute temporal resolution mode has been invoked over the COPS domain during intensive operational periods. This 5-minute SEVIRI data is being archived at EUMETSAT and is accessible for case study use. Currently, a new methodology for calculating cooling rate by taking advantage of higher temporal resolution SEVIRI and GOES imager data is being investigated since the current SATCAST algorithm requires calculation of mesoscale winds which will most likely not be needed for 30-sec or 5-minute resolution ABI modes of operation. Mesoscale winds will not be needed for these higher temporal resolution mode which removes computational expense and improved temporal latency of satellite derived convective fields.

In the 3rd quarter, preliminary validation of the SATCAST SEVIRI CI products will be conducted in collaboration with EUMETSAT and new box-average CI cooling rate will be investigated, taking advantage of higher temporal resolution expected from ABI.

1.8 Tropical Cyclones

Task Leads: Jim Kossin, Chris Velden

Chris Velden Lead - Project Description

One of the objectives of our GOES-R risk reduction work is to demonstrate what will be achievable with the availability of the ABI. One way to do this is to employ currently existing GOES observing strategies that mimic what will be possible with ABI. Specifically, in regards to tropical cyclones, the upper-level outflow is thought to be important toward understanding intensity change. Atmospheric motion vectors (AMVs), derived from special GOES five-minute rapid-scan (r/s) imaging operations, can be effective at simulating what will be available on a routine basis once GOES-R is launched.

As a demonstration of this capability, GOES-11 AMVs were derived from 5-min. r/s imagery during a special observing period as NASA's Tropical Cloud Systems and Processes (TCSP) experiment was taking place in July of 2005. Hurricane Emily traversed the sampling domain and provides a good case study, as the intensity fluctuated during the period of observation. Examples of the GOES-11 r/s AMVs and selected kinematic analyses for a time period during Emily were shown in previous QRPTs. High-resolution data such as this will be routinely possible from the GOES-R ABI, and our intent is to see what we can observe and learn from current GOES capabilities (special observing modes) in advance of this deployment.

Accomplishments in the last three months

We are in the process of creating time series of upper-level quantities derived from the GOES r/s AMVs over other TCs cases. From these we hope to identify systematic trends and potentially associations with the hurricane's structure and intensity fluctuations. We expanded our dataset to include analyses from other 2005 storms, namely Katrina, Rita, Wilma, and Ophelia and Eugene. These analyses have been sorted by storm maximum wind and azimuthally averaged. Figure 8 shows the azimuthal averages for storm-relative tangential wind, relative vorticity, storm-relative radial wind, and divergence. These profiles show the stronger cyclonic rotation (seen in the vorticity and tangential wind plots) in the more intense systems, even at upper-levels. One can also see the heightened divergence for lower-strength storms (cat-1 to cat-3), probably due to increased convective vigor in strengthening storms. By the time the storms are at cat-4 or -5 strength, the upper-level divergence over the core region is actually shown to be weaker. For further analysis, it may be worth normalizing many of these quantities by some size parameter to take into account the differing spatial structures of each storm.

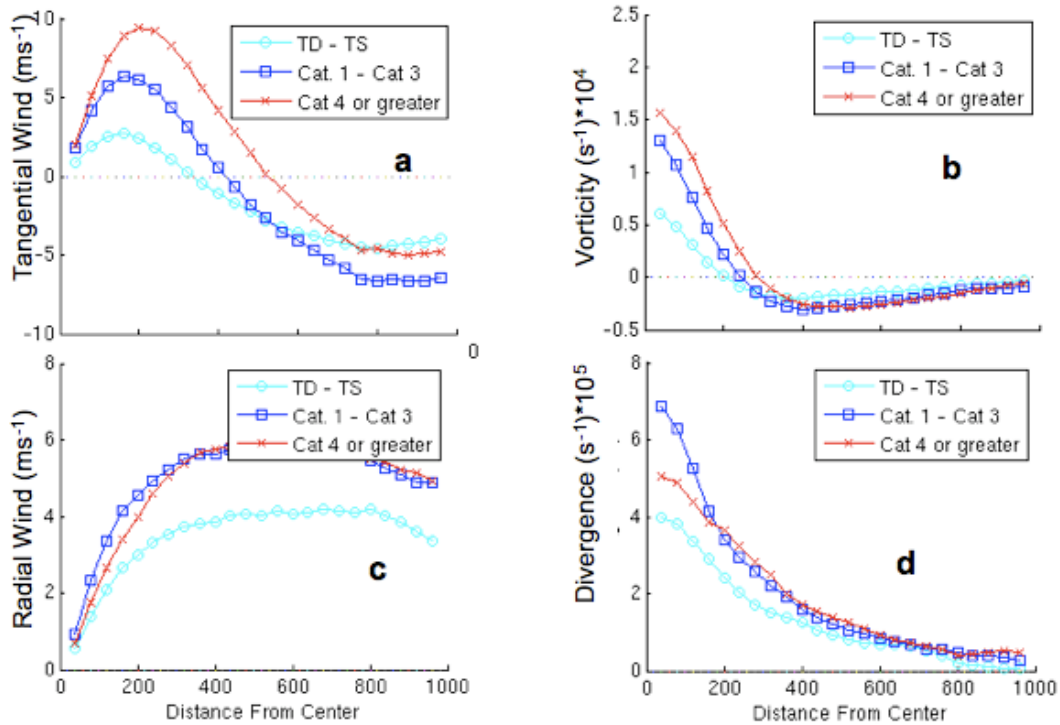


Figure 8: Azimuthally averaged profiles of upper-level: a) SR Tangential Wind b) Relative Vorticity c) SR-Radial Wind d) Divergence binned by intensity. These profiles suggest that the upper level kinematics are sensitive/related to storm intensity.

Jim Kossin Lead - Project Description

A major goal of this project is to explore the relationships between GOES IR imagery and structure and size of the low-level wind fields of hurricanes. Information about storm structure/size is presently very limited but is a priority item for the NOAA National Hurricane Center forecast office.

Another major goal is the application of GOES satellite imagery and environmental fields (from reanalysis data) to form an objective index to diagnose the occurrence of secondary eyewall formation (SEF).

An earlier overarching goal related to risk reduction for the HES platform was considerably scaled back (in lieu of the addition of goals 1 and 2 above) due to uncertainty in the present mission planning. However, we still continue to be active in achieving the originally stated goal of comparing soundings in the hurricane environment and have been involved in the testing and validation portions of this retrieval development by examining algorithm performance and impacts in the unique and challenging environments around tropical cyclones (TCs).

Accomplishments in the last three months

No labor was charged to this project in this quarter with the exception of the 12-day period at the end where a new student began contributing (described below), but a number of accomplishments were made.

One milestone in our previous Quarterly Report was the construction of a new dataset constructed by Kossin and colleagues at the NOAA National Climatic Data Center (NCDC) that significantly extended the record of critical wind radii in hurricanes for the period 1983–2005. In this quarter we have further extended the record back to 1981 and forward to 2006. Additionally, we have also fixed some erroneous data that was identified by various users of the data in the previous release. Some of the data work performed here overlaps with Kossin's GIMPAP project.

We have recently brought a new Ph.D. student into the project (Matt Sitkowski, M.S. in Atmospheric Science from the U. of Hawaii) to work with us on the GOES-R Risk Reduction project. Matt started on June 18th and has made remarkable progress in the very short time since then. We are scrutinizing datasets comprising microwave satellite imagery, aircraft measurements, and written reports, among other data sources, in order to construct/extend a database of secondary eyewall formation (SEF) occurrences. The SEF database we are constructing covers tropical cyclones worldwide and begins in 1997. Presently, the list is being updated from 2003 through 2006 and is near completion. Over 3,000 microwave images have been examined during the update. The ten years of data will include over 75 tropical cyclones that have undergone SEF at least once during their existence. Investigation of several environmental factors associated with SEF tropical cyclones have been examined prior to the update with encouraging results. These findings will be revisited with a larger sample size upon completion of the database. When the database is completed, we will explore relationships between SEF and the GOES imagery and reanalysis fields. The occurrence of SEF is an important factor in estimating and predicating the intensity of a tropical cyclone. Based upon our findings, a SEF prediction algorithm will ultimately be created to aid forecasters with tropical cyclone intensity forecasts. This algorithm is expected to be combined with an algorithm constructed by CIRA personnel for identifying annular hurricane formation (Knaff, J. A., T. A. Cram, A. B. Schumacher, J. P. Kossin, and M. DeMaria, 2007: Objective identification of annular hurricanes. *Wea. Forecasting*, accepted pending minor revision.)

The CIMSS Sounding Group has utilized *in situ* data collected by aircraft reconnaissance missions into TCs to make formal comparisons to retrieved products. We have been peripherally involved in this study and have obtained and provided the necessary aircraft dropsonde data, while sharing our respective expertise of TC thermodynamic structure. A more formal description of this research will be found in the Quarterly Report from the Sounding Group.

1.9 Data Analysis and Visualization: HYDRA integration

Task Lead: Tom Rink

This work seeks to develop powerful data analysis and visualization tools for multi- and hyper-spectral data. A primary goal of this work is to advance the current HYDRA application by using the IDV (Integrated Data Viewer) development framework to take advantage of IDV capabilities that current HYDRA users would like to have, (e.g. time animation and a state-saving persistence mechanism) while maintaining important aspects of the current HYDRA, such as the data centric user interface and customization for efficient access and display of multi- and hyper-spectral data. This new development of HYDRA using the IDV brings new display, data sources and analysis capabilities to both the IDV and McIDAS-V (the next-generation McIDAS) communities. Current HYDRA users may prefer an improved, domain specific application, while McIDAS-V and IDV users may prefer the HYDRA functionality as a plug-in: some of this is to

be determined, and will play out over time during the course of development and interaction with current and new users.

Quarterly progress report:

Most of the work this past quarter, and next, is focusing on the integration of HYDRA's abstract, extensible model for representing multi- and hyper-spectral data to the data source hierarchy of the IDV, and the mechanism in which the HYDRA analysis tools will be accessed and improved in the new environment. Basically, we'll take lessons learned and expand and improve upon what has been successful. Much progress has already been made on adapting HYDRA data to the IDV/McIDAS-V display environment, and this process was expedited by the fact that both HYDRA and the IDV have their own adapters to the VisAD data model. The goal of the current work is to more cleanly integrate the functionality of both applications. An example of HYDRA integration into McIDAS-V is shown in Figure 9.

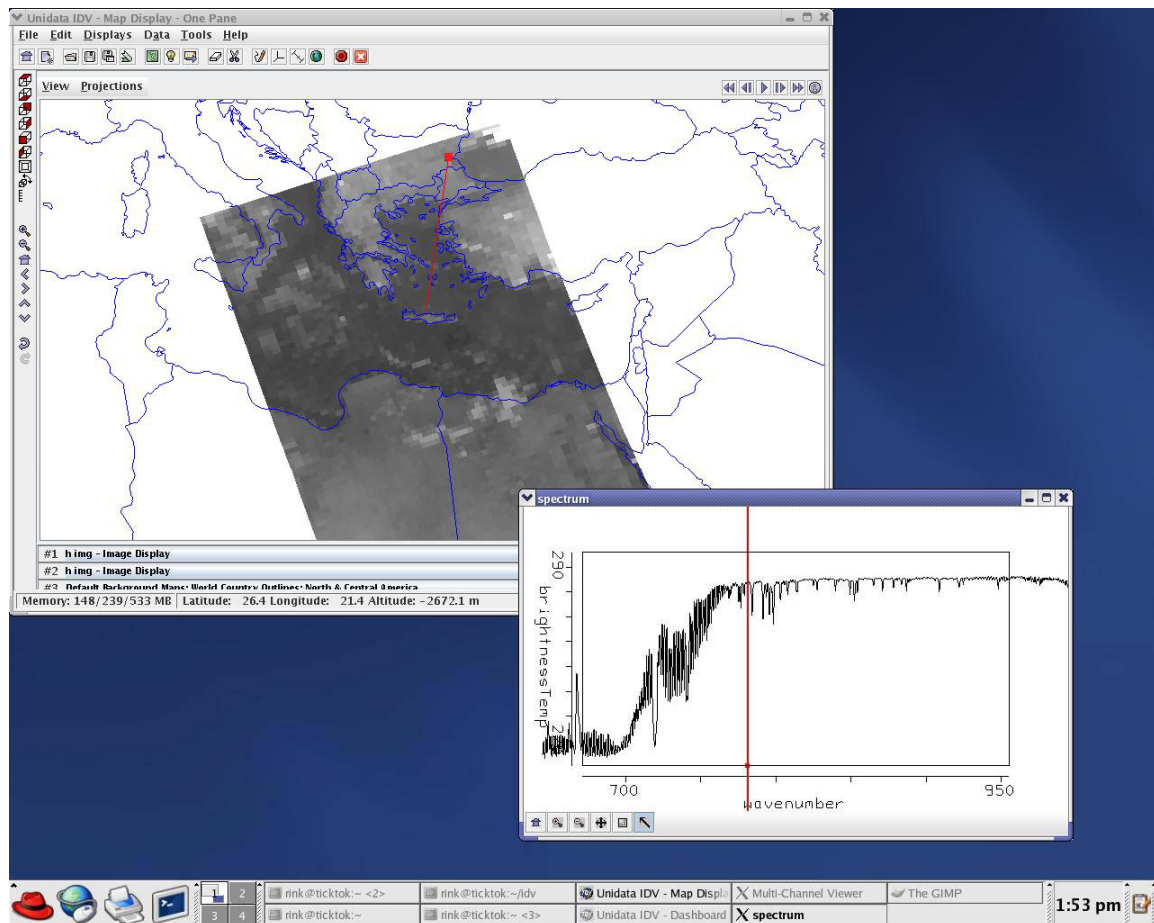


Figure 9: Sample of HYDRA capabilities integrated into the McIDAS-V environment showing METOP-A: IASI sounder data, Level 1C, over the Mediterranean Sea and North Africa.

2. Nowcasting

Task Lead: Ralph Petersen

The overall goal of this project is to provide and test new tools to identify areas of convective destabilization 3-6 hours in advance of storm development using moisture data from current and future GOES satellites.

1)

Goal: Test Lagrangian Nowcasting System running in real time

Task: Transfer the nowcasting system from the developmental to fully automated Linux computers.

Progress: Porting the codes from the current research-based computer has continued as described in last report. The goal for this task is to have the systems ported, tested and running 24/7 before the NWS Great Lakes Forecasting Workshop in early September 2007.

2)

Goal: Determine the optimal predictor for DPI nowcasts

Task: Testing the nowcasting system using both TPW and θ_e as conservative tracers.

Progress: θ_e profilers have been obtained for the 13 April 2006 hail storm case and will be tested in Q3 as a truer definition of convective instability. Before the θ_e tests are run, significant effort has been placed in removing undesirable, small-scale 'noise' from the initial wind fields obtained from the RUC-II. Tests showed that significant smoothing was necessary to eliminate small-scale imbalances from the initial wind fields, which contain excessive divergence and deformation which can be amplified in the later 2-3 hours of the nowcasts. This smoothing approach is currently being used. Alternatives based on partial geostrophic and/or semi-geostrophic balance are also being assessed.

3)

Goal: Determine utility of Nowcasting products in WFOs

Task: This most important work will be initiated with local WFOs in educating and training of forecasters on the concept of the GOES nowcasting systems and then getting real-time nowcasting products into the WFOs for their evaluation and feedback. The objective of this evaluation would be to improve forecasts of the timing and location of hard-to-predict isolated thunderstorms, and would take into account the utility of the DPI predictions of both 'event' and 'non-event' forecasts.

Progress: Based upon feedback from forecasters and attendees at the AMS Annual Meeting, a change has been made to the nowcast displays before training can begin at WFOs (see Figure 10). A new procedure has been incorporated into the display production which adds 'cloud obstruction' based upon whether any observations had been projected into an area during the past several nowcast cycles. An additional change was also included to account for the increasing in uncertainty in the longer range nowcast by increasing the 'radius of influence' assigned to each nowcast trajectory parcel with projection times. The change produces fields which retain full observation details at the initial times, but show less detail at longer prediction time. -- CIMSS will present the Nowcasting Model at the NWS Great Lakes Forecasting Workshop being held in Milwaukee in September 2007 and recruit volunteers to participate in the assessment process.

Additional Task: No response from JCSDA on joint CIMSS-NOAA/ESRL/GSD Nowcasting Proposal.

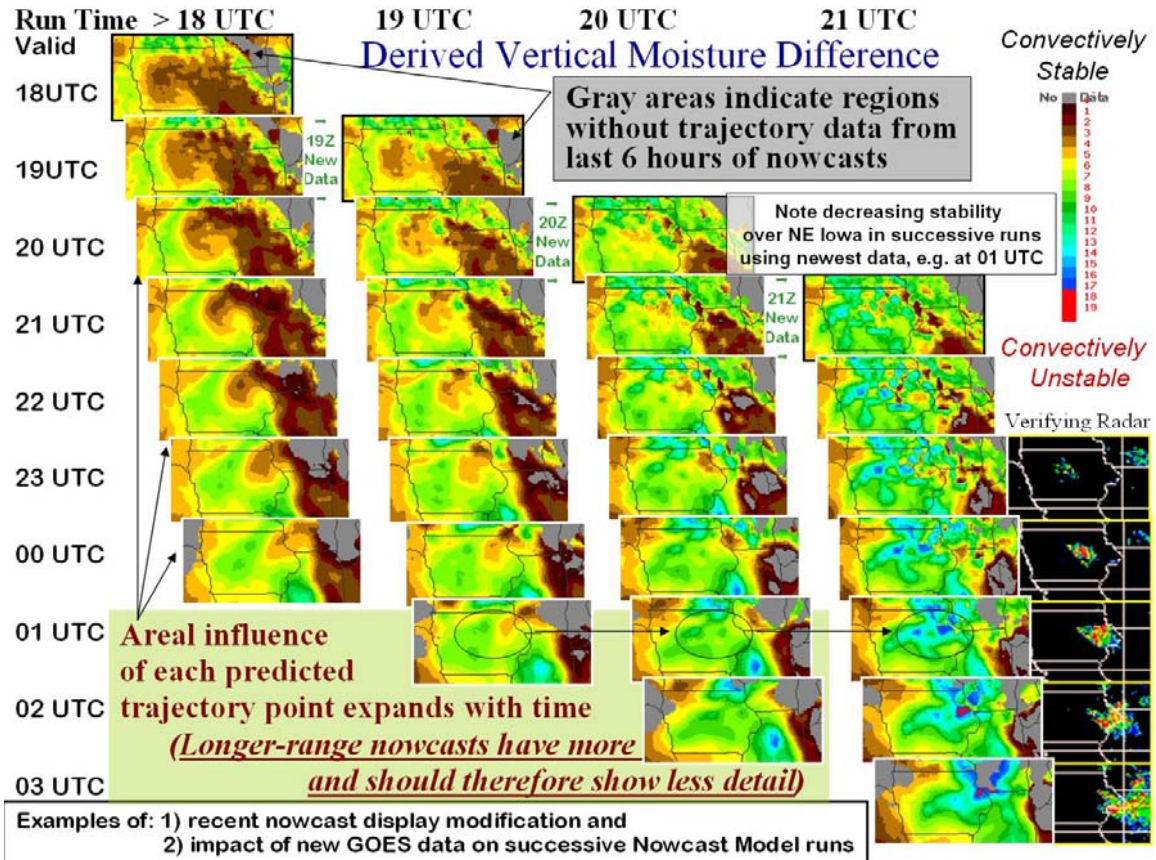


Figure 10.

Presentations/Publications:

An invited oral presentation was made at the CCNY-CREST: An Objective Nowcasting Tool that Optimizes the Impact of Satellite Derive Sounder Products in Very-Short-Range Forecasts, by Ralph Petersen and Robert Aune. **NOTE:** In response to this presentation, CCNY-CREST has request that a graduate student from CREST be trained on the use of the model at CIMSS this summer, with the goal of integrating the moisture prediction capabilities of the Nowcasting Model with the hydrological prediction efforts developing at CCNY.

Oral presentation abstracts have been accepted for:
AMS Satellite Conference in September, 2007
IUGG Annual Meeting in July 2007.

Oral presentation abstract being submitted for:
NWS Great Lakes Forecasting Workshop, September 2007 - This workshop will be used as a venue for exposing a large number of NWS/WFOs to the capabilities of the Nowcasting Model and recruit volunteers to participate in assessing the model output.

3. Data Assimilation / Simulations

Task Leads: Jason Otkin, Allen Huang

In order to support GOES-R Risk Reduction activities, a high-resolution Weather Research and Forecasting (WRF) model simulation was recently performed at the National Center for Supercomputing Applications (NCSA). The simulation contained three nested domains designed to represent the anticipated GOES-R scanning regions (i.e. full disk, CONUS, and mesoscale) with the appropriate spatial and temporal resolution. Proxy atmospheric profile and ABI radiance datasets are currently being generated for each domain. Figure 11 shows the simulated $8.5 \mu\text{m}$ brightness temperatures for the full disk domain valid at 18 UTC on 04 June 2005.

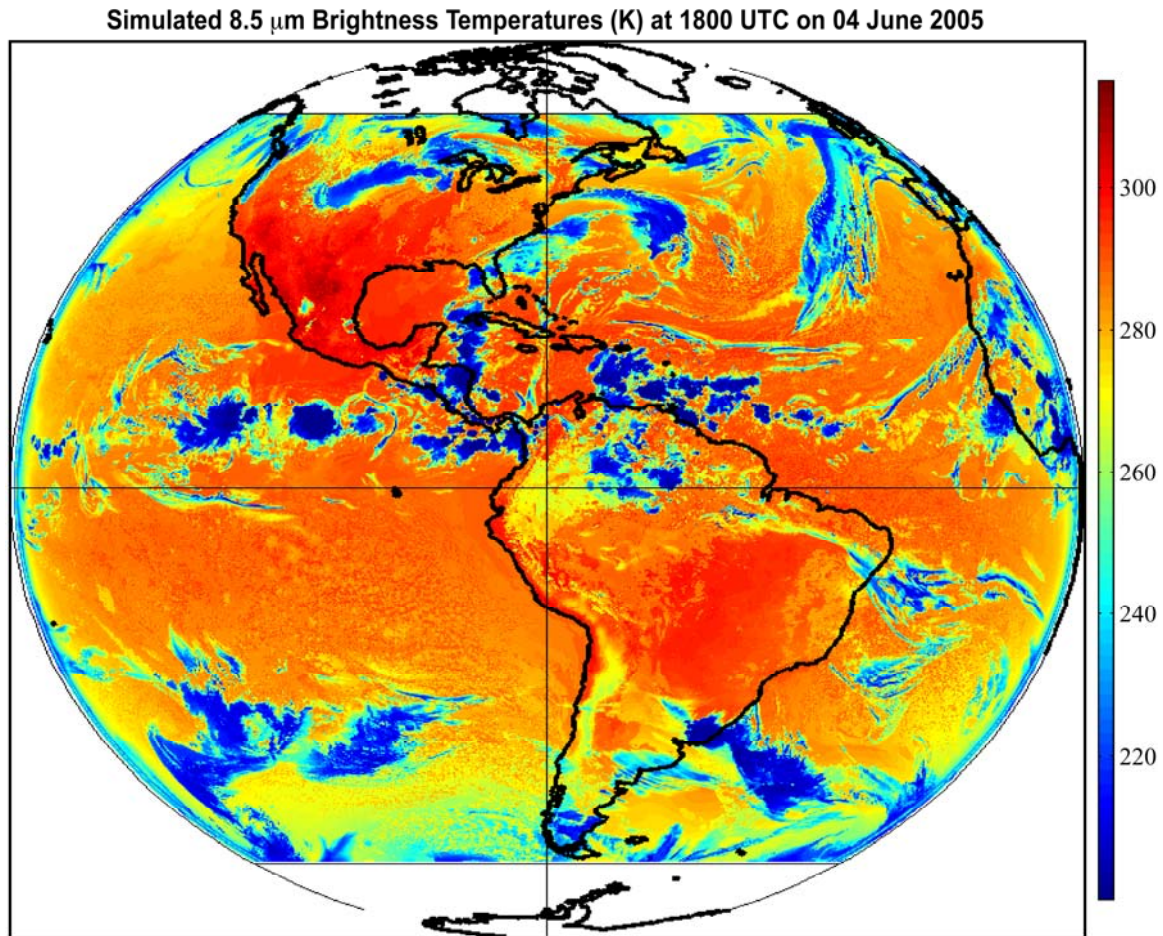


Figure 11 Simulated $8.5 \mu\text{m}$ brightness temperatures (K) valid at 1800 UTC on 04 June 2005.

Since the accuracy of proxy cloudy-sky radiances is strongly dependent upon the ability of the WRF model to realistically simulate cloud morphology, a detailed comparison of model simulated and MODIS-derived cloud data was recently completed for a case study containing a wide assortment of cloud types. An ensemble of eight high-resolution model simulations was constructed for this case using four cloud microphysical and two planetary boundary layer (PBL) parameterization schemes characterized by different levels of sophistication. Inspection of the simulated datasets revealed that the PBL and microphysics schemes both exert a strong influence on the spatial distribution and physical properties of the simulated cloud fields. Overall, the simulated cloud properties were broadly similar to the MODIS observations, although several

large discrepancies were also identified. A journal article describing the results of this study was recently submitted to the *Monthly Weather Review* (see below).

Publications during 01 April – 30 June 2007

Otkin, J. A., and T. J. Greenwald, 2007: Comparison of WRF model-simulated and MODIS-derived cloud data. *Mon. Wea. Rev.*, submitted for publication.

Conference presentations during 01 April – 30 June 2007

Otkin, J. A., and T. Greenwald, 2007: An intercomparison of MODIS-derived and WRF-simulated cloud data for an intense extratropical cyclone. *18th Conf. on Numerical Weather Prediction*, Park City, UT.

Otkin, J. A., and H.-L. Huang, 2007: Large-scale high-resolution WRF model simulations used for GOES-R research activities. *8th Annual WRF User's Workshop*, Boulder, CO.

Otkin, J. A., H.-L. Huang, E. R. Olson, and T. Greenwald, 2007: WRF-simulated atmospheric profile datasets used to support GOES-R research activities. *GOES-R AWG Annual Meeting*, Leesburg, VA.

4. Validation

Task Lead: Dave Tobin

Proposed Work

The proposed validation/demonstration activities include 1) efforts to validate the accuracy of combined Geo/Leo temperature and water vapor soundings and 2) Geo/Leo radiance inter-calibration efforts related to GSICS.

Accomplishments

Major accomplishments this quarter relate to the proposed Geo/Leo radiance inter-calibration work.

Aircraft based validation of IASI spectral radiances

IASI data from the recently launched METOP-A platform is expected to contribute significantly to the Geo/Leo intercalibration efforts. In contrast to AIRS, IASI has continuous spectral coverage in the thermal IR, and therefore is expected to provide a more accurate reference when simulating broadband sensor response functions. With funding from the Integrated Program Office, the UW/SSEC Scanning-HIS and NASA Langley NAST-I sensors participated in the Joint Airborne IASI Validation Experiment (JAIVEx), an aircraft-based campaign conducted in April-May 2007 aimed at providing detailed validation of IASI. The Scanning-HIS and NAST-I provide a NIST traceable reference for the on-orbit satellite observations. Figure 12 below shows a preliminary comparison of Scanning-HIS, NAST-I, and IASI mean spectra obtained as part of the JAIVEx field campaign; further analyses and intercomparisons are required but these initial results are very encouraging and suggest that IASI will continue the record begun by AIRS and will be a valuable resource to the Geo/Leo intercalibration efforts.

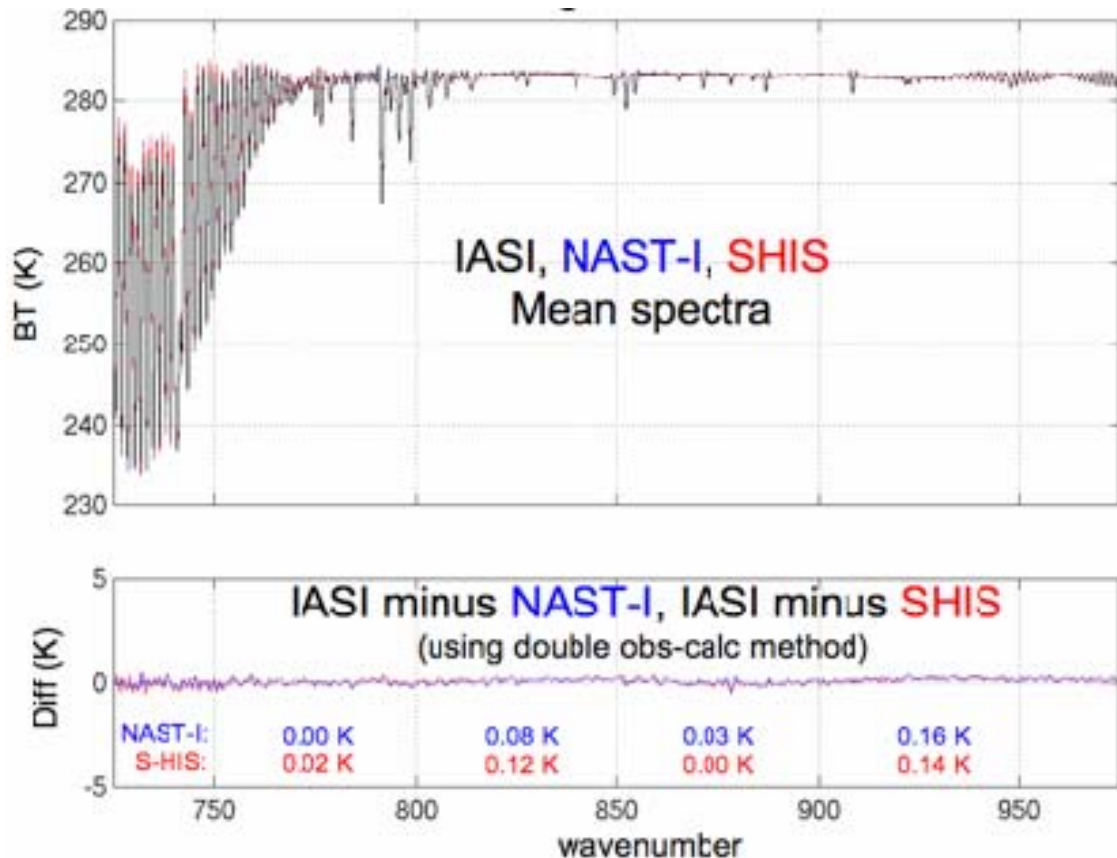


Figure 12. Preliminary validation of IASI radiance observations using Scanning-HIS and NAST-I data collected on 19 April 2007 over the SGP ARM site as part of the Joint Airborne IASI Validation Experiment (JAIVEx). Mean differences for 50 cm⁻¹ regions, listed for Scanning-HIS and NAST-I, are typically less than 0.1K.

SNO Intercomparison Uncertainty Study

We have conducted a controlled experiment using MODIS and SEVERI data to characterize the spatial and temporal collocation errors encountered when intercalibrating two sensors via Simultaneous Nadir Overpasses (SNOs). The results are being used to assess the ability of a hypothetical climate benchmark sensor to serve as an accurate calibration transfer for weather sensors on various other platforms. Initial results suggest that spatial and temporal collocation errors can be made very small (< 0.05K uncertainty in mean bias) when intercalibrating a sun-synchronous weather satellite (e.g. CrIS, IASI) with a large footprint (~100 km diameter) nadir viewing benchmark sensor in a 90 degree precessing orbit.

AIRS Noise Characterization paper accepted:

A paper describing a novel approach to characterize hyperspectral sensor noise using Earth scene data was accepted the Journal of Atmospheric Remote Sensing: Tobin, D. C., P. Antonelli, H. Revercomb, S. Dutcher, D. Turner, J. Taylor, R. Knuteson, K. Vinson, Hyperspectral Data Noise Characterization using Principle Component Analysis: Application to the Atmospheric Infrared Sounder, Journal of Applied Remote Sensing, 2007, in press.

5. Ground Systems

Task Leads: Maciej, Smuga-Otto, Bob Knuteson

Last year, the SSEC demonstrated a lightweight web-oriented system for distributed processing, management and visualization of hyperspectral data, nicknamed Origami. Extensions to Origami proposed for 2007 involved integration of new algorithms to the Origami framework, the packaging of Origami for distribution across multiple projects, and development of the infrastructure itself to make the Origami framework more robust.

In Q2 of 2007, several candidate algorithms slated for integration into Origami were moved to an XML (eXtensible Markup Language)-based interface description standard, and tools were developed to generate Origami-compatible source language interface files from this XML description. This task was necessary for two reasons: First, it is much easier to automatically generate a new source language (C/C++, Fortran, Java, etc.) interface file from an XML description than it is to translate an interface file written in one source language into another. The algorithms in question, used for calibration Level 1 of raw data from potential hyperspectral imaging sounder, already had well-established interfaces to very specific coding frameworks within which they were developed, and needed to be adapted to Origami. The XML interface files provided the cleanest way to do this, as they assured the least coupling between the algorithm code and the surrounding environment. The flexibility of this approach was further demonstrated when this approach was adapted, with few changes, to a similar challenge in deploying Level 2 candidate algorithms for Advanced Baseline Imager (ABI) work under separate funding.

Second, the Origami task dispatcher, in order to fulfill its task, needs to know the interface to each algorithm, and can most easily obtain this information by parsing the XML algorithm interface file. Since this is the same file that was used to ultimately generate the executables, this guarantees that Origami has access to the most current version of the interface, and is thus aware of all currently implemented interface conventions for the algorithm in question.

Since the goal of Origami was to allow lightweight deployment of various algorithms in a distributed system as independent executables (outside of any previously constructed framework), the conversion of their interfaces to a format compatible with Origami, and the development of a matching XML-driven code generator is a major milestone in integration activity.

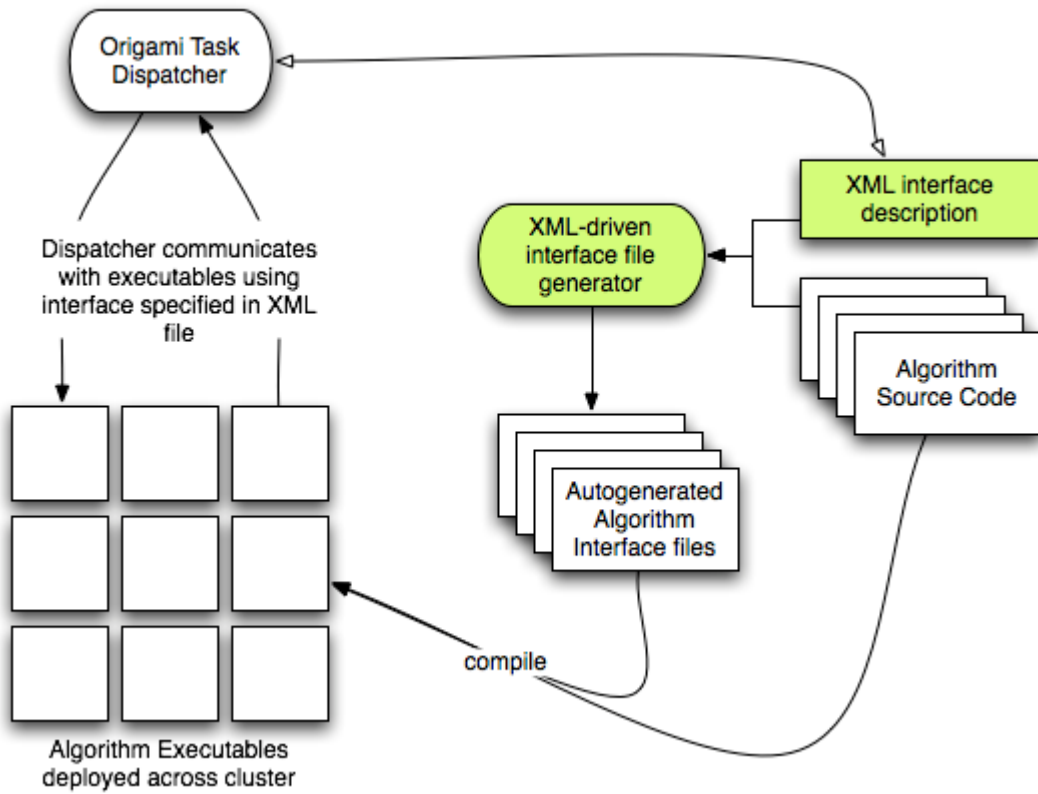


Figure 13. Role of XML interface and code generator in developing algorithms slated for Origami.