

GOES-R Progress Report for October - December 2005
University of Wisconsin-Madison
Cooperative Institute for Meteorological Satellite Studies

Project Title: CIMSS Participation in GOES-R Risk Reduction
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Date: January 2006
FY2005 Funding: \$910,000 (budget period through February 2006)
Remaining Funds: \$106,000

Topics Summary

Task 1. Algorithm Development

Program Management and Coordination

A dedicated internal web site has been developed and implemented for GOES-R Risk Reduction Algorithm Development team. Monthly work reports, group quarterly reports, meeting minutes, and announcements are uploaded to the site for use at monthly team meetings. The web site has improved the coordination among groups and efficiency in communication to meet project objective and deadlines. The web site address is http://cimss.ssec.wisc.edu/goes_r/internal/alg_dev/

Soundings Algorithm Development

In October – December, 2005 three cloudy sounding processing alternatives were developed: 1) cloud-clearing using spatially adjacent cloud contaminated radiance measurements, (2) retrieval based upon the assumption of opaque cloud conditions, and (3) retrieval or radiance assimilation using a physically accurate cloud radiative transfer model which accounts for the absorption and scattering of the radiance observed. Cloud-clearing using a combination of imager/sounder has been well investigated (Li et al. 2005). Work also has been done on cloudy sounding using an opaque cloud assumption and a cloudy radiative transfer model. Cloudy sounding retrieval using a radiative transfer model was successfully tested in NASTI data processing, especially when the cloud optical thickness is less 1. However, it is not very successful to date when applying the technique to AIRS data. This might be due to the large footprint size where clouds are more non-uniform within an AIRS footprint (13.5 km at nadir) than within NASTI (2 km). In order to investigate the difference between NASTI and AIRS on cloud property retrieval, simulated 10 km NASTI data will be used in algorithm testing.

(1) Cloudy sounding under partial cloud cover by opaque cloud assumption

We found sounding is retrievable when the radiances are contaminated by thin and single layer water clouds. The impact of spectral variation of cloud emissivity on the sounding retrieval will be investigated. Usually temperature is easier to retrieve than the moisture. Temperature and moisture information analysis under various cloudy skies will be performed.

(2) Synergy of MODIS/AIRS for direct cloudy sounding retrieval

Unlike the MODIS/AIRS cloud-clearing procedure, the direct cloudy sounding retrieval from MODIS/AIRS synergy uses the combined MODIS clear radiances and AIRS cloudy radiances within an AIRS footprint. Preliminary temperature retrieval results from a combination of MODIS and AIRS, MODIS alone and AIRS alone were produced. It can be seen that the

boundary layer is contaminated by clouds in AIRS cloudy sounding, with MODIS clear radiances, the boundary layer sounding is much improved.

(3) MODIS/AIRS cloud-clearing with angle effects taken into accounts

There are two ways to take into account the viewing angle effects in MODIS/AIRS cloud-clearing: (a) angle correction; and (b) using only along-track footprints. We found view angle correction is not a reliable way because the brightness temperature (BT) bias between a pair of footprints due to view angle is largely dependent on moisture. Since the moisture is highly variable spatially, it is difficult to estimate a universal BT bias for angle correction. Therefore the along track footprints are preferred in cloud-clearing. Using along track footprints in cloud-clearing will reduce the yield of successful cloud-clearing footprints by approximately 5%. For example, one case study shows the cloud-clearing successful rate is 15% (of all granule footprints) using along track footprints only, while that the successful rate is 20% when all the 9 footprints are used in the cloud-clearing. According to this study, the BT difference due to angle is small when the viewing angle is less than 30 degrees. Therefore, for a given AIRS footprint under partial cloud cover, it's 8 surrounding footprints can be used for cloud-clearing when the viewing angle is less than 30 degree, while only 2 along-track footprints should be used in cloud-clearing when the view angle is greater than 30 degrees.

In addition, handling surface pressure in regression was also investigated. Two ways of handling surface pressure in regression are: (a) regression is based on surface pressure classification, and (b) regression uses the surface pressure as additional predictor. Our study shows that using surface pressure as predictor performs better in the moisture retrieval.

Surface Emissivity Study & Modeling

In the last quarter, we have made progress toward an improved global emissivity database. The original inflection point/baseline fit approach is suitable for moderate spectral resolution applications; however there is limited information between the 8 inflection point wavelengths. A new approach that uses a principal component analysis (PCA) will allow for high spectral resolution. In the past three months, we have derived a new global gridded (0.05 degree spatial resolution), high spectral resolution emissivity database for 12 months. The approach is outlined below and is one of two methods based on PCA that we are currently investigating.

From the UCSB Emissivity Library (Dr. Zhengming Wan) and the JPL Aster Spectral Library, we selected 322 high spectral laboratory measurements and resampled them into 413 wavenumbers with resolution 5cm^{-1} . It was determined that 26 principal components are needed to explain the spectral variance to 0.999. Using the 26 PC's with randomly generated coefficients, 5000 simulated emissivity spectra were derived. The laboratory measurements were convolved with the MODIS spectral response functions beforehand. Then a least squares method was employed to find the simulated spectra that best matches the MOD11 emissivity at the 6 MOD11 wavelengths at each of the MOD11 latitude/longitude points (0.05 degree resolution). A comparison of the emissivity spectra at two global sites (SGP ARM site and a Sahara desert site) between this new database and the earlier, inflection point/baseline fit database was analyzed. Two regions, one between 5 and 6 microns and the other between 9 and 10 microns, need more attention. We expect that over these spectral regions we will get better results by using our third PCA/MOD11 regression method, which we are currently working on.

NWP Modeling for Geostationary hyperspectral resolution measurement simulation

During this quarter we are continuing to use the WRF model (ARW core) to generate a simulated atmospheric profile dataset for a case study referred to as the "FULLDISK" simulation. This simulation contains a single 1580×1830 grid point domain with 8-km horizontal grid spacing

that nearly covers the entire geographical region to be observed by GOES-R. The domain extends from the southern tip of South America northward into southern Canada with an east-west distance of $\sim 110^\circ$ degrees longitude. A dataset with 40-minute temporal resolution was generated for a 24-hour period during the simulation. A webpage containing a brief description of the WRF model simulation and gif images of various simulated and derived atmospheric fields has been constructed for the FULLDISK simulation. The webpage address is: <http://www.ssec.wisc.edu/~jasono/muri/fulldisk/index.html> .

Another task is to finish writing a journal article documenting the numerical modeling work performed at SSEC/CIMSS in support of forward model and retrieval algorithm development. The article describes how sophisticated mesoscale models, such as the MM5 and WRF, have been used to generate simulated atmospheric profile datasets with fine horizontal and vertical resolution. Model results from two prior case study simulations are presented. Representative examples illustrating the use of the simulated datasets, such as the generation of simulated TOA radiances, temperature and water vapor profiles, and atmospheric motion vectors are also included.

In an effort to better parameterize cloud microphysical processes in the WRF model, a recently developed double-moment microphysics scheme is being evaluated for use in future model simulations. This scheme, referred to as the Seifert and Beheng scheme, explicitly predicts the mixing ratios and total number concentrations for five microphysical species, including cloud water, rain water, cloud ice, snow, and rimed snow (graupel). It is anticipated that this scheme will be employed for several of our future model simulations.

The NCEP version of the WRF model (known as the NMM core) was released in November 2005. Numerous compilation issues were addressed before being able to successfully compile the WRF-NMM SI (standard initialization) and the WRF-NMM model. Test simulations using the WRF-NMM model will be run in early 2006 in order to evaluate the performance of the model.

Cloudy Fast Forward Model Development

In the last quarter four major tasks were conducted:

1. Develop reference models for the evaluation of fast model performance

Efforts were studies on ways to speed up reference model calculations by reducing the spectral resolution of (i.e., convolving) LBL gas optical depths. Results are encouraging:

- We have integrated the SOI model into the LBLDIS framework to allow direct comparisons with DISORT (which is the reference model used in LBLDIS).
- We have performed comparisons in clear sky between two reference models, LBLDIS and RTX model. At the highest spectral resolution, agreement was < 0.05 K. Also code was written to input Ping Yang's scattering databases into RTX and preliminary comparisons were done between LBLDIS and RTX in cloudy conditions.

2. Fast models improvement

- The cloud group agreed to compare two fast radiative transfer models, FIRTM2 (or two-layer model) and SOI model, in cloudy conditions. Analysis code was written that imports data cube files produced from WRF simulations, which are the source of atmospheric and cloud profiles for the comparison. In addition, the group leader has significantly reworked the FPLOD and FIRTM2 code (see below). The comparisons are on hold until Ping Yang completes the new reflection/transmission lookup databases for FIRTM2.

- We have improved the source function integration in FIRTM2 by replacing it with the method used in the SOI model, which is superior in areas of strong absorption. In clear sky, agreement between the models is $< 10^{-4}$ K.
- In a parallel effort, clear sky brightness temperature spectra from FIRTM2 (old code) was compared with LBLRTM and LBLDIS. Results will be presented in the upcoming AMS annual meeting.

3. Software development

- We are preparing for the integration of code into the CRTM standard by converting the fast model code to F95 while at the same time establishing a coding standard. Both FPLOD and FIRTM2 have been ported into F95 code. The code was simplified and generalized (FIRTM2 can now accept LBL data) and the coefficient and lookup databases are now loaded into memory.
- The tangent linear model for FPLOD in F95 was implemented and tested. The adjoint for FPLOD was written but has yet to be tested.

Recent publications:

Baum, B. A., P. Yang, A. J. Heidinger, and J. Li, 2005: Bulk scattering properties from ice clouds: high resolution spectral models from 100 to 3250 cm^{-1} , *Journal of Appl. Meteorology* (submitted).

Wu, X., J. Li, W. P. Menzel, H. L. Huang, K. Baggett, H. Revercomb, 2005: Evaluation of AIRS cloud properties using MPACE data, *Geophysical Research Letters*, 32, L24819, doi:10.1029/2005GL024400, 2005

Li, J., H.-L. Huang, C.-Y. Liu, P. Yang, T. J. Schmit et al., 2005: Retrieval of cloud microphysical properties from MODIS and AIRS. *J. Appl. Meteorol.*, 44, 1526–1543.

Zhou, D. K, W. L. Smith, X. Liu, A. M. Larar, H. -L. Huang, J. Li, M. J. McGill, and S. A. Mango, 2005; Thermodynamic and cloud parameter retrieval using infrared spectral data, *J. Geophysical Letter*, 32, doi: 10.1029/2005GL023211.

Wu, X., J. Li, W. Zhang, and F. Wang, 2005: Atmospheric profile retrieval with AIRS data and validation at the ARM CART Site, *Advances in Atmospheric Sciences*, 22, 647 – 654.

Plans for Next Three Months

- To generate the 24-hour dataset of higher spatial resolution CONUS and regional simulation using latest WRF model
- Continue to improve and verify two-layer cloudy forward model performance and prepare article for publication.
- Continue analyzing cloud-clearing and opaque cloudy sounding performance and revise cloudy sounding retrieval strategy.
- Continue to refine ATBD and use latest ATBD to guide algorithm development and implementation.
- Continue to refine approaches to improve high spectral resolution global gridded emissivity database.
- Adapt and implement the improved cloud microphysical property database.

Significant achievements in the last three months

- **HES sounding retrieval strategy is designed.**
- **An improved version of cloudy fast forward model is tested and delivered for TOA radiance simulation generation and to sounding team.**
- **A high spectral resolution gridded surface emissivity model is developed and under testing.**
- **Evaluating a double-moment microphysics scheme in future WRF model implementation.**
- **A 24 hours full disk dataset is generated.**

Task 2: GOES R Winds

A new dataset was recently provided by the GOES-R retrieval algorithm group for the ATReC case that includes AIRS cloud-cleared or flagged retrievals. This new set of cloud-cleared AIRS retrieval moisture fields was used by the winds group to re-derive the height-resolved winds and assess the quality. In Fig 1, wind vectors derived by tracking the constant-altitude moisture surface (343 hPa) over three consecutive 30-minute analyses (yellow vectors) are achieved in the clear sky region to the west of the cloud mass associated with a developing storm. For comparison, simultaneous operational GOES-12 water-vapor-tracked (imager, single channel) vectors are shown in beige. It can be seen the primary coverage of the GOES water vapor winds is in the cloudy regions, and the simulated GOES-R moisture retrieval winds are complementary by filling in data in the clear sky regions. While only one level (upper) is shown, similar wind vector coverage is achieved at other levels and essentially throughout the depth of the troposphere.

The simulated GOES-R winds will be validated against available rawinsonde observations, and this assessment will be covered in the next report.

Significant Accomplishments in the last three months

A new three-dimensional winds dataset was produced for the ATReC case using an updated retrieval algorithm that simulates HES soundings with cloud-masking.

Plans for Next Three Months

The ATReC dataset will be validated against collocated rawinsondes.

A new case is being prepared by the retrieval group with a goal to assess the ability to retrieve good wind coverage in the marine boundary layer.

A second new case is being prepared by the modeling group that will simulate full-disk GOES-R HES coverage over a 24-hour period. The winds group will attempt to derive vector fields from this case once we are provided with the retrieval moisture fields.

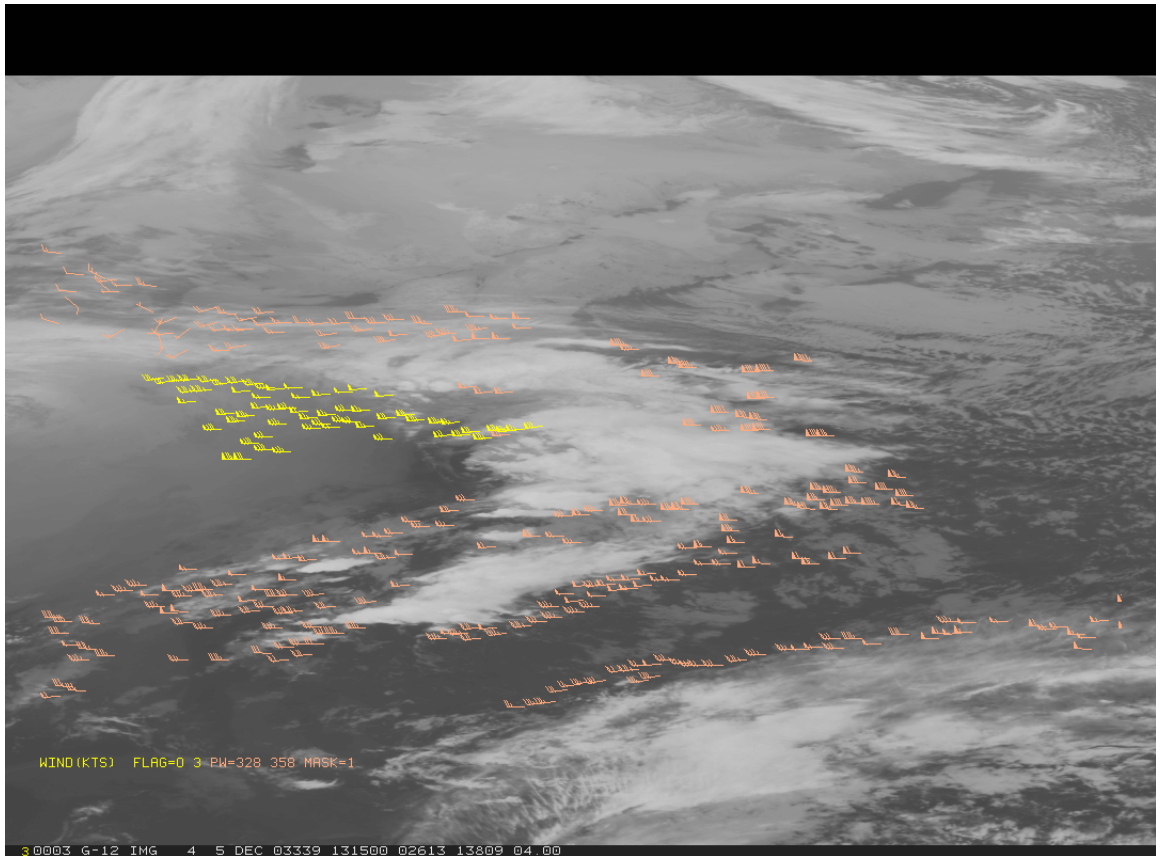


Fig 1. Wind vectors derived by tracking the constant-altitude moisture surface (343 hPa) over three consecutive 30-minute analyses (yellow vectors) in the clear sky region to the west of the cloud mass associated with a developing storm. For comparison, simultaneous operational GOES-12 water-vapor-tracked (imager, single channel) vectors are shown in beige

Task 3. Preparation for Data Assimilation

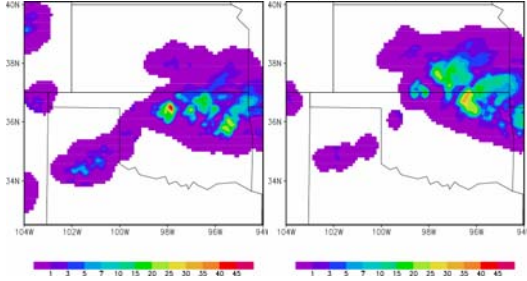
Topics Summary

It is well known that the quantitative precipitation forecast (QPF) is one of the most challenging tasks in NWP due to the lack of high-resolution data preceding the start of and during the storm for storm initialization and model development. The next generation GOES sounding instrument will provide infrared radiances with very high horizontal, temporal and spectral resolutions, leading to a revolutionary improvement in meteorological observations and forecasting at small-scales. Our study aims at preparing for GOES sounder data assimilation when future high spectral, spatial and temporal observations are made available. Having developed the tangent linear and adjoint models of the clear-sky radiative transfer model and conducted some adjoint sensitivity studies in the previous year, the remaining efforts involve those related to choosing observations that are to be included in data assimilation. To do so, a new high-resolution model simulation is generated and used for simulating hyperspectral measurements in a convective environment. Our research activities in the past three months can be summarized in the following four areas:

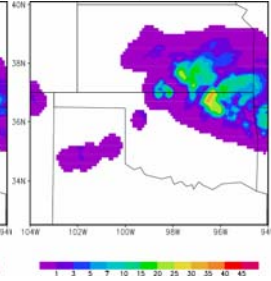
1. High-resolution model simulation

The 2002 convective activities that occurred over the Central Plains during 12-13 June 2002 are simulated using a larger 4-km domain (300 X 300 horizontal grid points and 54 vertical levels). The MM5 model for both domains was initiated at 0000 UTC 12 June, 2002. This new simulation captures the observed rainfall pattern from Texas to Oklahoma as well as the movement of the observed precipitation from the north of Oklahoma to the southeast of Oklahoma (Fig. 2) quite well, except that the model predicts the convective initiation two hours earlier than the observed time. An average score of 0.3 is achieved during the entire 15-h convective episode.

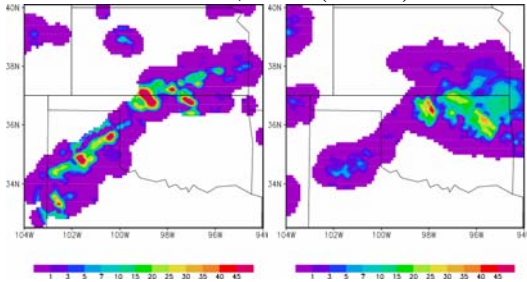
2200 UTC 12 June, 2002 (NCEP)



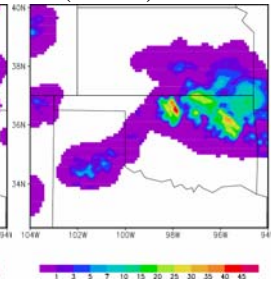
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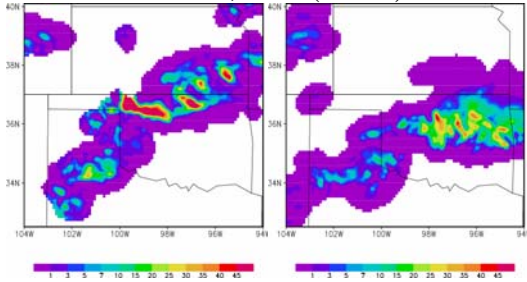
0000 UTC 13 June, 2002 (NCEP)



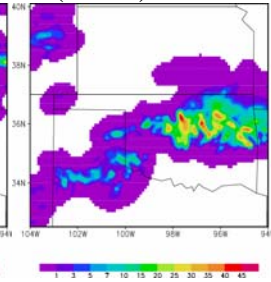
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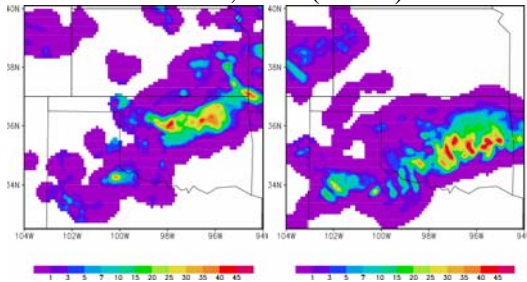
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0200 UTC 13 June, 2002 (MM5)



0400 UTC 13 June, 2002 (NCEP)



0400 UTC 13 June, 2002 (MM5)

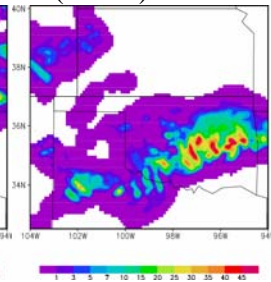


Figure 2. NCEP observed (left panels) and MM5 model simulated (right panels) 4-km 2-h accumulative precipitation ending at 2200 UTC 12, 0000 UTC, 0200, and 0400 UTC 13 June.

2. Spatial and temporal variations of atmospheric states within and near a convective storm

Unlike AIRS measurements for which the finite spatial foot print resolution is ~ 14 km at nadir, temporal resolution is 12 h, and less than 5% are not affected by clouds (i.e., clear-sky observations), Future GOES sounder will provide much more clear-sky observations due to its high horizontal and temporal resolutions. This is an attractive feature of GOES (or GIFTS) observations given the difficulties to properly account for the cloud effects in the so-called “forward radiative transfer model” that is required for GOES data retrieval and assimilation. The potential impact of clear-sky GOES-R or GIFTS observations to the prediction of convective initiation and development could be much more significant than AIRS measurements.

Small-scale features are found in clear sky atmosphere in convective cloud environment. Figure 3 shows the surface water vapor mixing ratio and temperature distributions for all the clear-sky points at the time when the convective initiation started. It can be seen that before the convective initiation, an area of maximum surface water vapor mixing ratio is found over the borders of Oklahoma and Kansas, where the convective initiation started. Fine-scale gradients of both water vapor and temperature fields are found in the immediate environment of convection.

Using the GIFTS clear sky forward radiative transfer model (RTM), which calculates clear-sky radiance based on input MM5 atmospheric temperature, mixing ratio, ozone, and pressure across its 101 standard vertical levels as input profiles, the distributions of clear-sky brightness temperature are deduced (Fig. 4). It is seen that the small-scale water vapor and temperature information are contained in GIFTS clear-sky radiance measurements in the immediate environment of convection. It is thus concluded that GIFTS high-horizontal measurements will be extremely valuable to short-range QPFs.

Abrupt vertical and temporal variations of the atmosphere are also observed (Figures omitted).

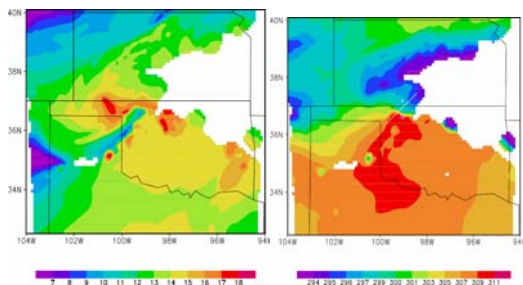


Figure 3. Surface water vapor mixing ratio (left, g/kg) and temperature (right, K) distribution for the clear sky points at 2200 UTC 12, 2002 from MM5 Model output. The white area indicates cloudy area. A straight line and three clear sky points used in the following sensitivity study are indicated in the right panel: A (plus symbol), point B (open circle symbol), point C (closed circle symbol).

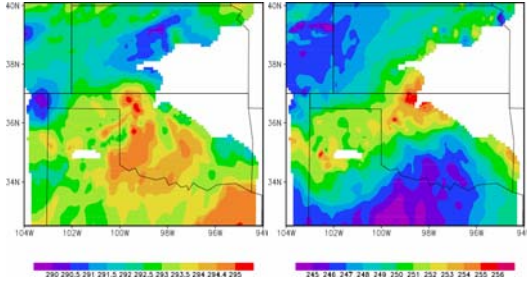


Figure 4. Simulated clear-sky brightness temperature distributions at channels 892.5818 cm^{-1} (left) and $1030.8287 \text{ cm}^{-1}$ (right) at 2200 UTC 12 June, 2002.

3. Quality control for clear-sky radiance assimilation

Infrared radiances are a very useful source of information for atmospheric data assimilation. The presence of clouds in a satellite's field of view (FOV) contaminates the radiance data such that valuable atmospheric information is not easily attainable. In order to handle this problem, some centers, such as the European Centre for Medium-Range Weather Forecasts (ECMWF), only clear-sky radiances are assimilated (McNally and Watts, 2003). As a result, only a small percentage of AIRS data is used by most of numerical weather prediction (NWP) models. While this method is effective for global forecasting purposes, its application for regional forecasting is limited due to the low number of clear-sky radiances for regional domains. In order to maximize the usefulness of the AIRS data for mesoscale model forecasts, a quality control procedure is developed that maximizes the usefulness of AIRS infrared data for regional, short-term QPFs. This quality control procedure consisting of two steps:

1) *A Cloud-Contaminated Data Removal Algorithm*

The weighting functions are calculated on each grid point. A cut-off pressure (COP) level for each channel is determined based on the vertical broadness of the corresponding weighting function profile. Only if a cloud is present above the COP level, the data is removed.

2) *A biweighting Residual Outlier Removal Procedure*

Additional data that is significantly different from the MM5 model forecasts is also removed by this second step.

Figure 5 shows the comparison of AIRS observed and SARTA simulated BTs for 18z 11 July, 2003 for channels $7.13 \mu\text{m}$. SARTA simulated BTs are calculated using MM5 18-hr forecast data from the test case used. Four distinct data types can be seen in top panel of this figure: 1) the data points flagged as cloud contaminated by the first step of the LCCDR algorithm and were removed (blue), 2) the data points identified by the biweight screening method as residual cloud contamination and removed (red), 3) the data points which have passed through both quality control checks and are considered to be uncontaminated AIRS data by the LCCDR algorithm (black), and 4) those points which are from entirely clear-sky points (green). The lower panel shows all clear-sky points (both LCCDR-identified cloud-uncontaminated data and completely clear-sky points) in black; the red line indicates the best-fit line for the remaining uncontaminated AIRS data. It is seen that for this water vapor channel, the observed BTs are lower than simulated values at low BTs. The proposed quality control procedure does an adequate job in identifying and removing practically all of the cloud contamination. The first step of the algorithm does a fine job identifying most of the cloud contamination using the MODIS cloud top pressures, as those data which are severely cloud-contaminated (indicated by those data which exhibit large discrepancies between AIRS and SARTA BT values) are completely removed from consideration. The data field is further thinned by the second step of the algorithm, as some additional data which deviates greatly from model simulations are flagged as outliers (either due

to residual cloud contamination, or some other as yet unidentified reasons such as model deficiencies) and removed. The data that remains for each channel exhibits excellent agreement between the AIRS observed and SARTA simulated BTs, as those points are tightly clustered along the $y=x$ line.

Figure 6 shows the total number of clear-sky data points (blue line) and the total number of LCCDR “clear-sky” data points (red line) of the 323 AIRS’s team selected NWP channels (grouped in decreasing maximum WF height). As can be seen here, the total number of useable points (red and blue lines combined) is dramatically increased for most channels when using the LCCDR algorithm (red versus blue) except for those channels whose peak WF is near the surface. As the maximum WF level lowers in the atmosphere by channel, the cut-off pressure level used by the LCCDR algorithm also decreases to a point where there are some channels (mainly window channels) which must be screened of any cloudiness to avoid contamination.

Although data is minimally removed, the root mean square error (RMSE) and mean absolute error (MAE) are both reduced and the correlation between AIRS and SARTA BTs is increased drastically after the quality control (Fig. 7), indicating far better agreement between the simulated and observed BT fields.

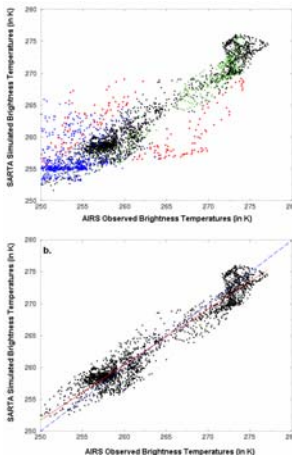


Figure 5—(a) AIRS versus SARTA BT comparison at 18z 11 July, 2003 for the 7.13 μm water vapor channel (channel 1583). SARTA data generated from 18-hr MM5 forecast data. Blue dots illustrate those points excluded by the first step of the algorithm; red dots indicate points excluded by second step (biweight method); black dots indicate those data points which successfully passed the quality control methods; green dots indicate completely clear-sky points. (b) Same comparison as (a), but only for those points which successfully passed through the first step of the algorithm and completely clear-sky points. Red line illustrates the best fit to the acceptable data distribution; blue dashed line indicates the $y=x$ line.

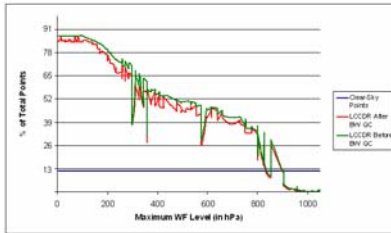


Figure 6—Total number of clear-sky points (blue line), LCCDR clear-sky points before biweight method (green line), and LCCDR clear-sky points after biweight method (red line) for all 323 NWP AIRS channels (grouped in decreasing maximum WF height) for 18z 11 July, 2003. Pressure levels in hPa.

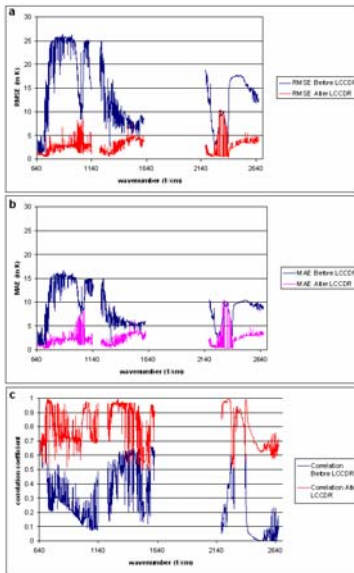


Figure 7—(a) RMSE for all 2378 AIRS channels at 18z 11 July, 2003, before and after applying LCCDR (in K); (b) MAE for all 2378 AIRS channels at 18z 11 July, 2003 before and after applying LCCDR (in K); and (c) Correlation coefficients for all 2378 AIRS channels at 18z 11 July, 2003 before and after applying LCCDR (correlation coefficient is dimensionless).

4. Channel selection

The GIFTS instruments will provide radiance measurements at many thousands of different channels. It is neither feasible nor efficient to assimilate all of the infrared channels. An effective channel selection is required that determines a subset of GIFTS channels that is sufficient for QPFs at convective scales. A substantial review of the existing methods of channel selection that were tested for the Atmospheric Infrared Sounder (AIRS, 2378 channels) and the Infrared Atmospheric Sounding Interferometer (IASI, 8461 channels) was made. Existing methods for channel selection include (i) Data Resolution Matrix (DRM) methods which select channels according to the relative importance of each observation on the analysis (Menke, 1984); (ii) Iterative methods maximizing the entropy reduction (ER) or the degree of freedom for the signal (DFS) (Rodgers 2000); and (iii) Jacobian methods which select channels based on the weighting functions (Aires et al. 2001).

It is felt that for convective QPFs applications, a new channel selection method based on observed and modeled vertical resolutions must be developed. Factors that must be considered

include information redundancy of GIFTS observations, sensitivity of QPFs to GIFTS measurements, the actual vertical variations of the atmosphere, the highest vertical resolutions the GIFTS measurements can possibly provide, and the required vertical resolution to model convection.

Plans for Next Three Months

- 1) Channel selection
 - Having completed a substantial reviews of all the existing channel selection methods, we proposed to do the following:
 - a) Determine the observed vertical variations of the atmospheric state using radiosondes, GPS radio occultation observations, and satellite retrievals.
 - b) Determine the highest vertical resolution for mesoscale models to capture the observed (both winter and summer) storm features.
 - c) Design a channel selection method which works best for APF applications.
- 2) Adapt GIFTS fast cloudy forward model in assimilation analysis work mentioned above.

Task 4: GOES-R Ground System Design and Studies

Under the ground data system task, we proposed to develop methods for creating, storing, processing, and distributing large datasets of the type anticipated during the GOES-R era from the HES sounder. The approach we are using is to take advantage of the sensor description of the NASA GIFTS instrument as a prototype for an instrument that could meet the HES specifications. Under continued NOAA funding we have developed a NWP simulation capability, a GIFTS top of atmosphere fast radiative transfer model, a GIFTS instrument simulator (radiance to interferograms), and a set of pipeline processing software for demonstration of parallel processing techniques.

In the current reporting period we were able to update the GIFTS radiative transfer model to include several important improvements, including an estimate of thermal reflection from the surface combined with a realistic geographic database of infrared land surface emissivity (also developed at UW-CIMSS). Moreover the 24 hour simulation of Earth atmospheric state parameters from the UW-CIMSS version of the WRF model was used to create top of the atmosphere radiances using the improved GIFTS radiative transfer model and then these radiances were converted to interferograms using the GIFTS simulation model. This is a very large and challenging computing task which creates a very large volume of output. Several technical computing issues have been raised and resolved in order to successfully create and store these data. The 24 hour dataset is being made available via web links to the science community in general and NOAA OSD in particular. A conference paper (Olson, et al., 2006) describing the GIFTS 24 hour dataset was written and submitted for the AMS 2006 annual meeting. The publication will be reported during the next quarterly report.

Progress on the GIFTS L0-L1 ATBD lead to the submission of a conference paper (Knuteson, et al., 2006) illustrating the application of the GIFTS calibration algorithm on simulated Earth scenes as they would be observed by the GIFTS sensor. This paper includes an example of the expected radiometric accuracy uncertainty for a typical GIFTS data cube. The software for the prototype implementation of the L0-L1 GIFTS ATBD was developed in parallel under NOAA OSD funding. The so called GIPS (GIFTS Information Processing System) pipeline was largely completed by the end of calendar year 2005. We anticipate with continued NOAA funding to be able to demonstrate realistic processing accuracy and throughput by running the 24 hour GIFTS

dataset of interferograms through the prototype GIPS ground processing software during the first quarter of 2006.

Meanwhile the actual NASA GIFTS instrument has entered thermal vacuum testing at the Space Dynamics Laboratory in Logan, Utah. Only preliminary cold test data has been available to date but we have been able to provide an early validation of some of the key NOAA ATBD algorithms as well as make an assessment of radiometric noise performance (under separate NASA contract). A subset of the GIFTS thermal vacuum test data will be pre-processed so that it can be used as input to the GIPS pipeline software. This activity is anticipated for the first quarter of 2006.

One of the proposed activity areas is the development of data storage, retrieval, and distribution techniques for the large HES-type datasets anticipated for the GOES-R era. No activity was conducted on this task during the last quarter of 2005, however now that the 24 GIFTS simulated dataset is available we anticipate creating a "GOES-like" data summary from the GIFTS dataset and a high spectral resolution "Summary" and then ingesting that into a relational database. We can then serve this data using OpenDAP over a local area network to highlight some of the new technologies for visualization and display of the hyperspectral data using tools built on VISAD/HYDRAE/MCIDAS-V.

CIMSS Finances Summary: GOES-R Funding and Spending Plan

GOES R Risk Reduction Funding

Through 2/2004	\$1,270K
Through 2/2005	\$ 750K
Through 2/2006	<u>\$ 910K</u>
Total funding to date	\$2,930K

GOES R Risk Reduction Spending

Through 2/2004	\$1,299K
3/2004 - 2/2005	\$ 880K
3/2005 – 12/2005	<u>\$ 645K</u>
Total spending thru 12/31/05	\$2,824K

For the next three months, spending is estimated to be:

January 2006	\$53K
February 2006	\$53K
March 2006	\$140K

end