1. FY08 –FY10 GOES-R3 Project Title

- Title: **Severe Weather**
- Project Type: Product Development Proposal
- Status: Final Year
- Duration: 3 years
- Leads:
  - » L. Grasso, Cooperative Institute for Research in the Atmosphere
  - » D. Lindsey, NOAA/NESDIS
- Other Participants:
  - » M. DeMaria, NOAA/NESDIS
  - » H. Gosden, CIRA
  - » J. Dostalek, CIRA
  - » R. Brummer, CIRA
  - » M. Sengupta, National Renewable Energy Laboratory

2. Project Summary

1) GOES-R Utilization Study
   - **Motivation: Explore satellite data assimilation with GOES-R data**
   - Explore the use data from the GOES sounder, AIRS, IASI, and COSMIC in an assimilation system for a severe weather case.

2) Application of GOES-R ABI to a Severe Thunderstorm Event
   - **Motivation: Use GOES-R data to improve severe weather nowcasts**
   - Simulate a severe thunderstorm event from 27 June 2005, generate the synthetic ABI imagery, and analyze the results for severe weather applications

3) Provide Synthetic Data to Aviation AWG
   - **Motivation: Assist with GOES-R Algorithm Development**
   - Deliver synthetic GOES-R Imagery for a convective case, so the Aviation AWG can test their Convective Initiation Algorithm

3. Major Milestones and Accomplishments

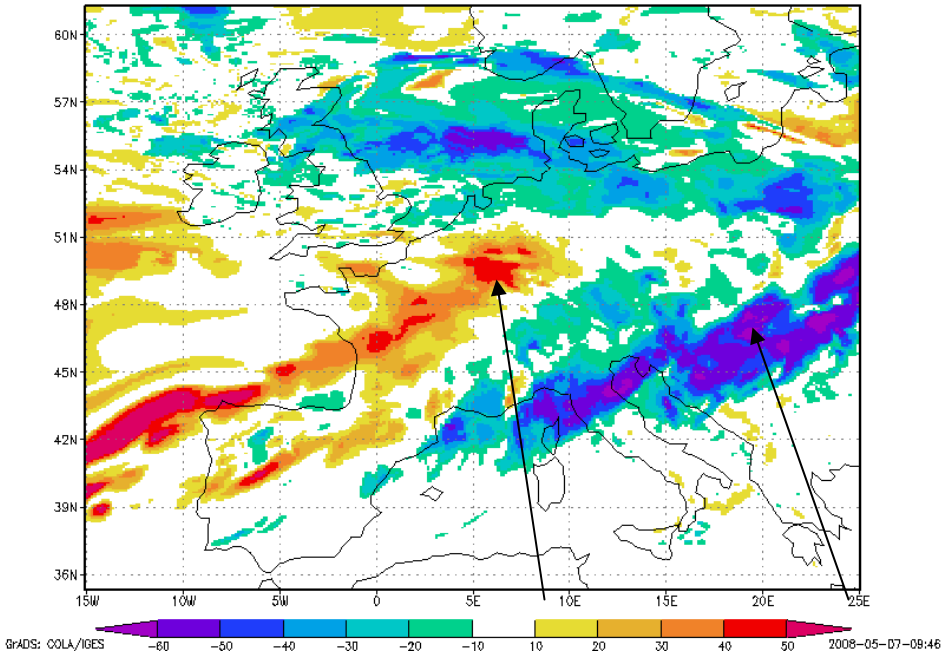
FY08-09 GOES-R3

GOES-R Utilization

- Kyrill storm over northern Europe 18 January 2007 was simulated.
- Acquired the Community Radiative Transfer Model version 1.1 (CRTM_V1.1). Received Help from Paul van Delst.
- Synthetic GOES-R imagery was generated and served as "observations".
- Synthetic GOES-R imagery was assimilated into WRF simulation of the Kyrill event.
- Results presented at the 3rd ICTP conference, Sept. 2008.
- Manuscript sent to the *Int. J. of Remote Sensing*; was accepted with minor revision.
- Assimilation experiments conducted with observed MSG-1.

3. Major Milestones and Accomplishments

Model minus Observations differences in brightness temperature



Large differences between model and observational data: +40K (red) and -60 K (violet)

- Additional information will be provided by Milija Zupanski who will present shortly.

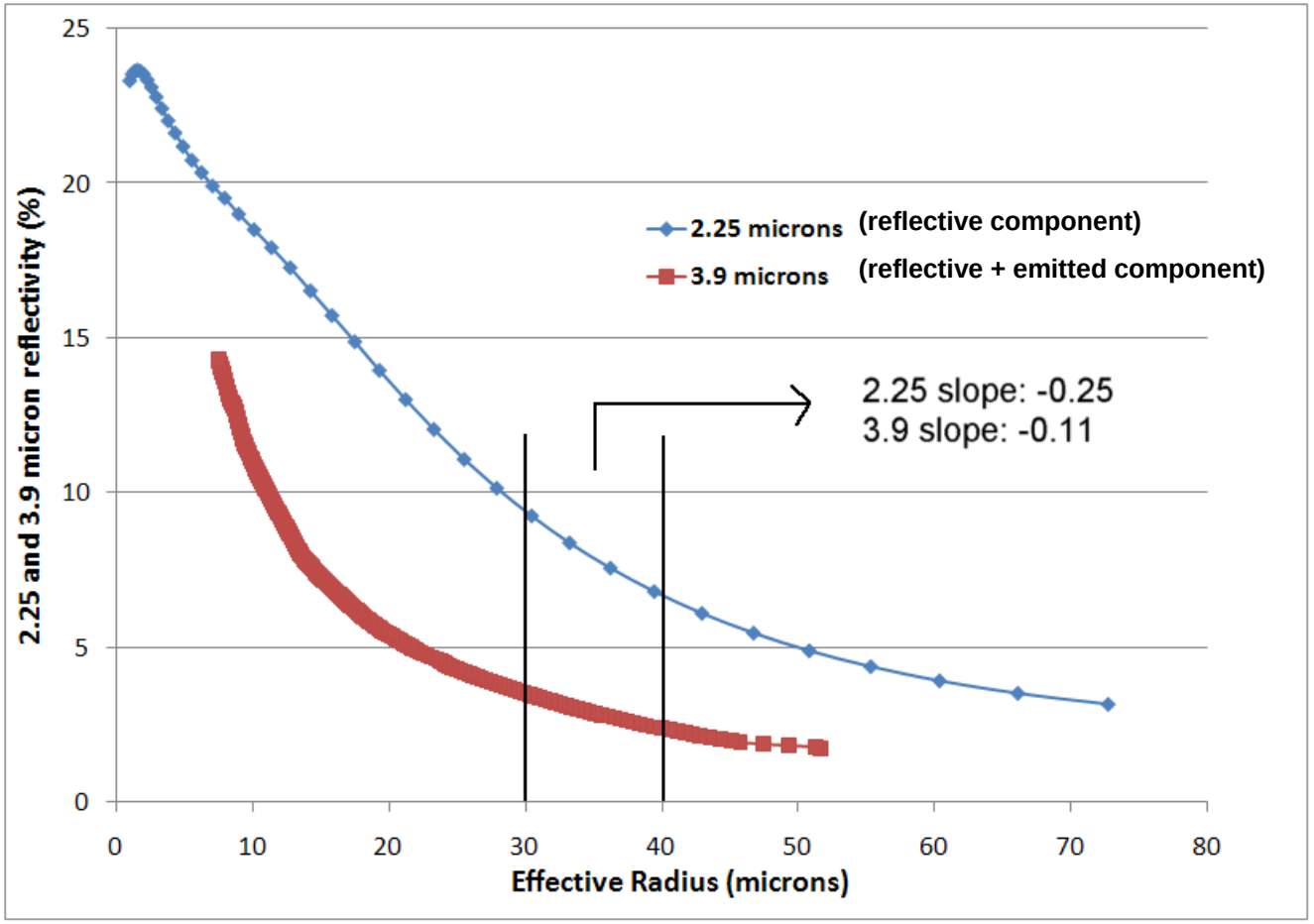
3. Major Milestones and Accomplishments

FY08-09 GOES-R3

Application to Severe Thunderstorm

- Simulation of 27 June 2005 thunderstorm event complete.
- Synthetic GOES-R imagery was generated from 2.25 µm to 13.3 µm.
- Analysis of synthetic imagery lead to discovery of microphysical error.
- Manuscript sent to the *Int. J. of Remote Sensing*. discussing the benefit of synthetic imagery of numerical model output.
- Oral presentation given at the 23rd conference on Weather Analysis and Forecasting and 19th conference on Numerical Weather Prediction.
- Developed ice particle size retrieval algorithm using 2.25 µm.

3. Major Milestones and Accomplishments



Plots of reflectivity verses effective radius at 2.25 µm (blue) and 3.9 µm (red). Graphs reveal smaller retrieval error at 2.25 µm compared to 3.9 µm.

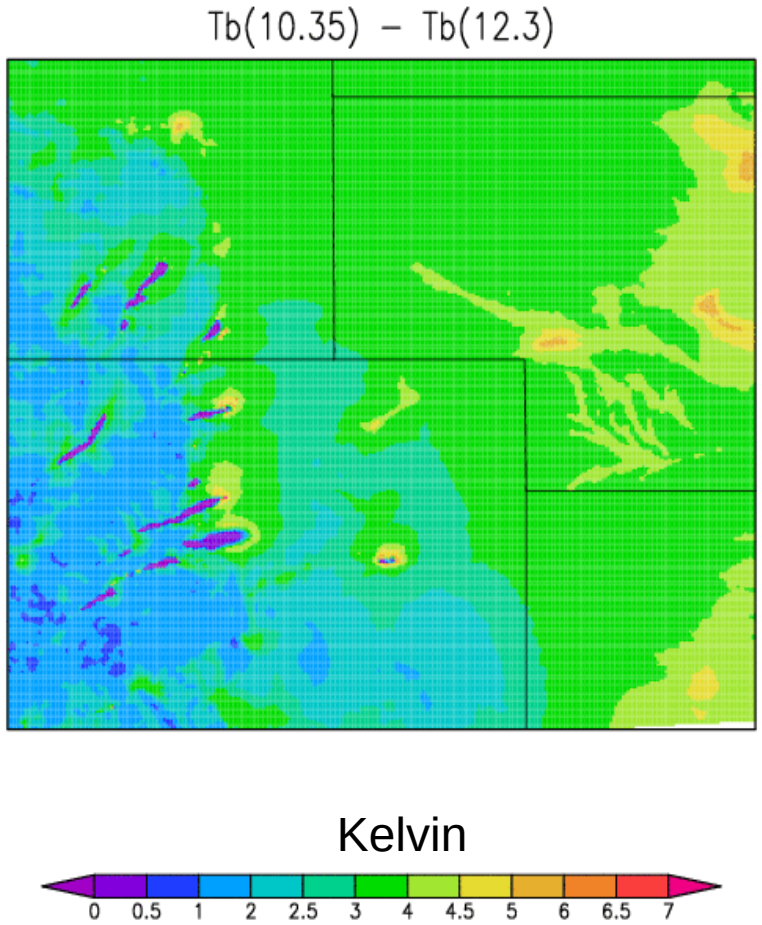
3. Major Milestones and Accomplishments

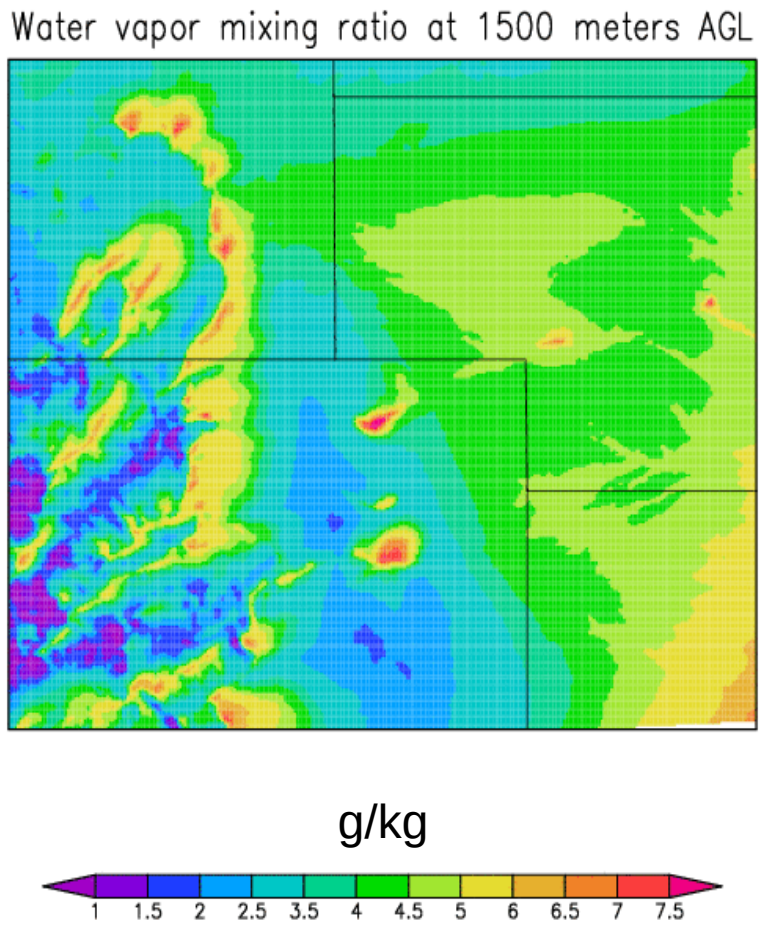
FY10 GOES-R3

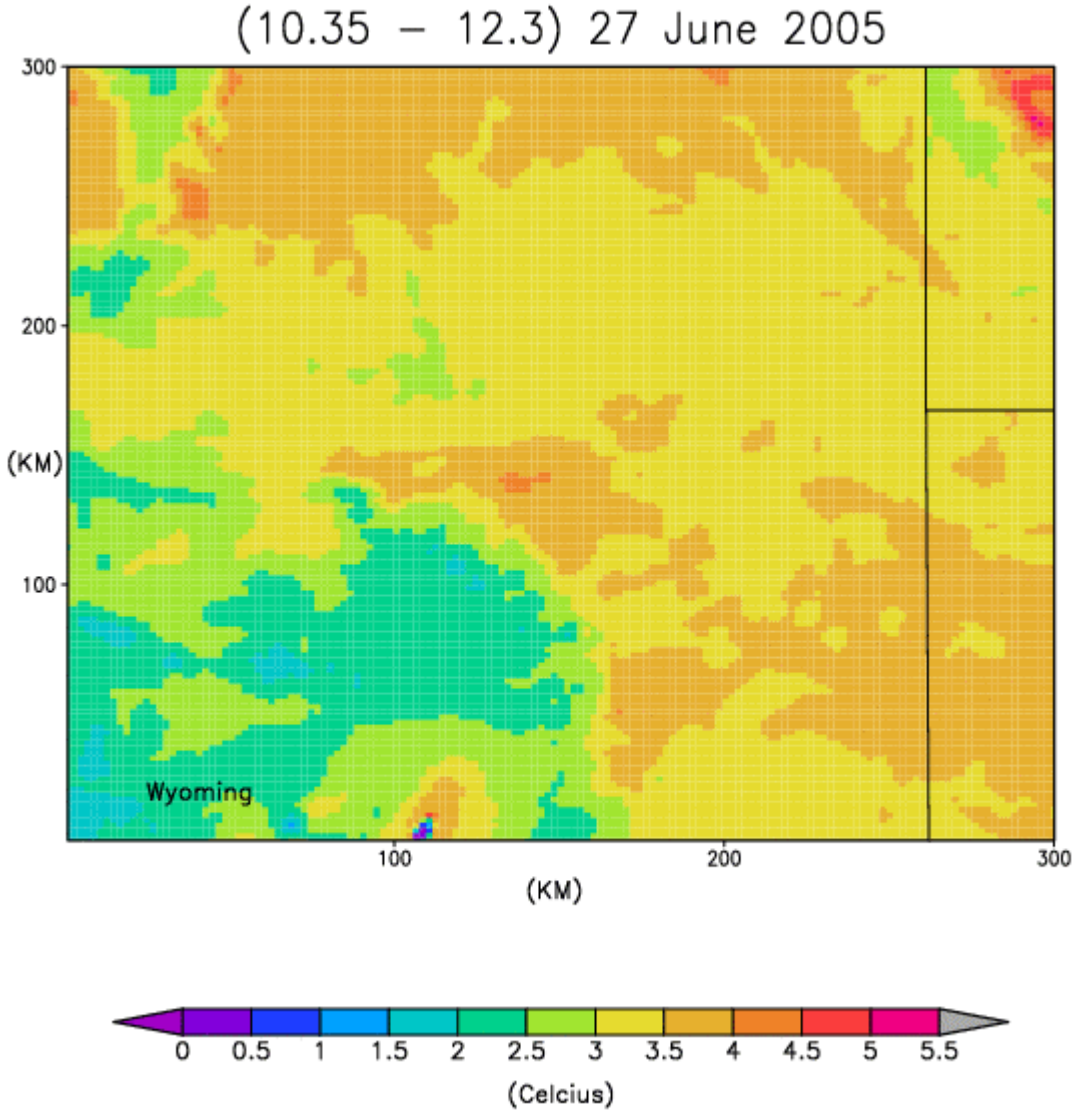
Application to Severe Thunderstorm

- Boundary layer moisture for 27 June 2005 simulation.
- Explore six possible channel differences in the window region of spectrum with 8.5, 10.35, 11.2, and 12.3 μm.
- Subjective analysis suggested optimal channel difference was that formed from 10.35 and 12.3 μm.

3. Major Milestones and Accomplishments






(10.35 – 12.3) 27 June 2005
300
200
100
(KM)
Wyoming
100
200
300
(KM)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
(Celcius)

3. Major Milestones and Accomplishments

FY08-10 GOES-R3 Publications Refereed

2 published (2008, 2010), 4 in press

Grasso, L. D., M. Sengupta, and **M. DeMaria**, 2010: Comparison between Observed and Synthetic 6.5 and 10.7 µm GOES-12 Imagery of Thunderstorms that occurred on 8 May 2003.
Int. J. Remote Sensing, ,Vol 31, Issue 3, April , 647-663.

Grasso, L. D., M. Sengupta, **J. F. Dostalek, R. Brummer**, and **M. DeMaria**, 2008: Synthetic satellite imagery for current and future environmental satellites.
Int. J. of Remote Sensing., Vol 29, No. 15, 4373-4384.

Lindsey, D., S. Miller, and **L. Grasso**, 2010: The impacts of the 9 April 2009 dust and smoke on convection. *Bull. Amer. Meteor. Soc.*, In press.

Setvak, M., **D. T. Lindsey**, P. Novák, P. K. Wang, M. Radová, J. Kerkmann, **L. Grasso**, S-H Su, R. M. Rabin, J. Šťástka, Z. Charvát, and H. Kyznarová, 2010: Cold-ring-shaped cloud top features atop convective storms. *Atmospheric Research*. In press.

Zupanski, D., **M. Zupanski**, **L. Grasso**, **R. Brummer**, I. Jankov, **D. Lindsey**, M. Sengupta and M. **DeMaria**, 2010: Assimilating synthetic GOES-R radiances in cloudy conditions using an ensemble-based method. *Int. J. of Remote Sensing.*, In press.

Grasso, L. D., **D. Lindsey**, 2010: An Example of the use of Synthetic 3.9 µm GOES-12 Imagery for Two-Moment Microphysical Evaluation.
Int. J. of Remote Sensing., In press.

FY10 AWG project

Aviation AWG

- This is new addition to the GOESR3 plan began in April 2009.
- A teleconference was held with Ken Pryor of the Aviation AWG group and Wayne MacKenzie of UAH.
- We agreed that synthetic imagery for the 27 June 2005 case will be delivered.
- Imagery was converted into the requested formats.
- Simulated radar reflectivity, based on the two-moment microphysics, was produced and delivered.
- A second case, 8 May 2003, is being prepared.

Unexpected Results

» Analysis of synthetic imagery lead to discovery of microphysical error. A direct comparison of synthetic GOES-R 3.9 µm imagery with observed GOES-12 imagery clearly showed a significant cold bias in the GOES-R data. An error was discovered in the two-moment microphysical package and was corrected. This unexpected result did demonstrate the value of synthetic imagery as a new tool to evaluate the performance of a numerical model.

Additional Activities Leveraged

- As a result of my oral presentation given at the 23rd conference on Weather Analysis and Forecasting and 19th conference on Numerical Weather Prediction (June 2009), Russ Schneider (SPC) invited me to participate in the Hazardous Weather Testbed 2010 spring and fall programs. During the spring program, my primary goal is to make synthetic GOES-R imagery of the 4 km WRF-ARW real-time model that is run at NSSL. This is part of the GOES-R proving ground program.

Recommendations for follow on research

- Results from the 27 June 2005 case, suggest that channel differencing Tb(10.35 μm) - Tb(12.3 μm) may have a use in forecasting regions where convective clouds, and eventually convective initiation may occur.
- Multi-group effort between CIMSS, CIRA, CREST, and U. of Alabama-Huntsville.
- Examine existing satellite integrated water vapor algorithms that use channel differencing. This could be used to identify “convective regions” prior to cloud formation.
- Combine the above with convective initiation algorithms.