

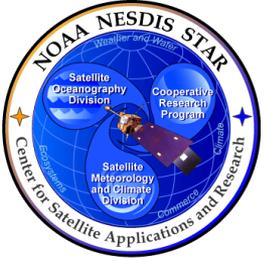
# Toward Operational Uses of Geostationary Imager Radiance Data in the GSI Analysis System

## Participants

- Project Title: Toward Operational Uses of Geostationary Imager Radiance Data in the GSI Analysis System
- Funding Period: 3 years
- Principal Investigator: Fuzhong Weng
- EMC Technical POC: Andrew Collard and Steve Lord
- FSU Technical POC: Xiaolei Zou
- Support Scientists:  
Tong Zhu, Greg Krasowski (STAR)  
Haixia Liu (EMC), Zhengkun Qin (FSU)

## Tasks

- Implementation of SEVIRI and GOES imager Data in GFS
- Assimilation of SEVIRI and GOES Data through Uses of AWG LSE/LST Products.
- Uses of GOES and SEVIRI Cloud-Affected Radiances in GFS.
- Assimilation of High Temporal Resolution Data from GOES and SEVIRI Using the NCEP Four Dimensional Data Assimilation (4DDA) System



# Major Accomplishments

- Impacts of GOES imager radiance data assimilation on precipitation forecasts in the presence of other observations
  - *Finding: GOES imager data greatly compliments all types of satellite data*
  - *MHS and GSN data degraded the precipitation forecasts*
- SEVIRI radiance data are ingested at NCEP GFS and experiments were conducted
  - *Finding: SEVIRI data in GFS resulted in small to neutral impacts on forecasts and detection of clouds maybe a problem*
- Two IR land surface emissivity datasets are tested in GFS forecast (CIMSS vs. NASA LaRC)
  - *Finding: Both emissivity data sets improve forecast score and more data are being assimilated*
- Preparation of a high resolution GOES BUFR data for NWP

# Data Assimilation on Precipitation Cases in Gulf Coast

## NCEP GSI 3D-Var Data Assimilation System

<b>Observations:</b>	Conventional data AMSU-A, AIRS, HIRS/3, HIRS/4, MHS, GSN GOES imager radiances
<b>DA period:</b>	1200 UTC May 22 to 0000 UTC May 23, 2008
<b>DA Runs:</b>	Different Combinations of Satellite Observations

# Forecast Model

## Advanced Research WRF (ARW) Model

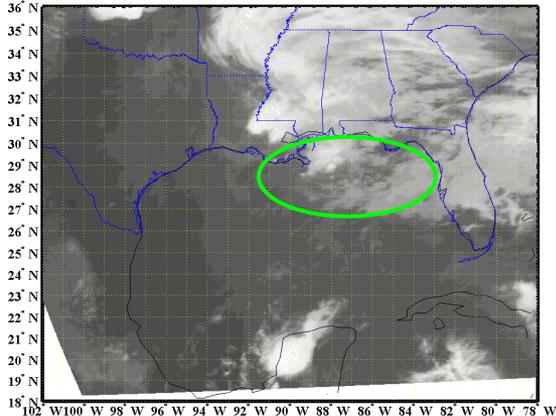
Resolution:	10 km, 27 layers
Domain size:	250x200x27
Microphysics:	WRF single-moment 3-class scheme
PBL:	Yonsei University scheme
Cumulus:	Kain-Fritsch scheme
Radiation:	Dudhia scheme

Forecast Period: 0000-2400 UTC May 23, 2008

# GOES-11 Channel 5 (May 23, 2008)

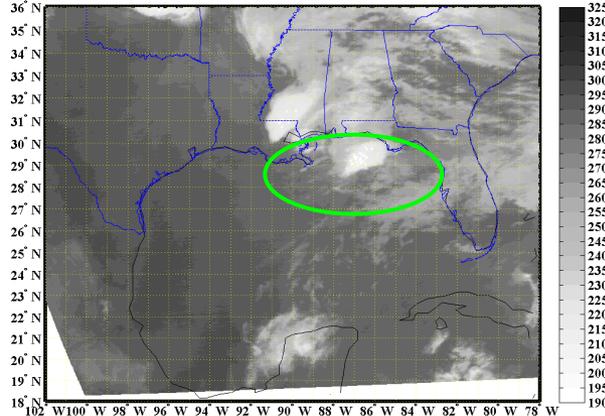
0300-0306 UTC

GOES-11, ch.5 ( $\lambda = 12.0 \mu\text{m}$ ), 0300-0306 UTC, May 23, 2008



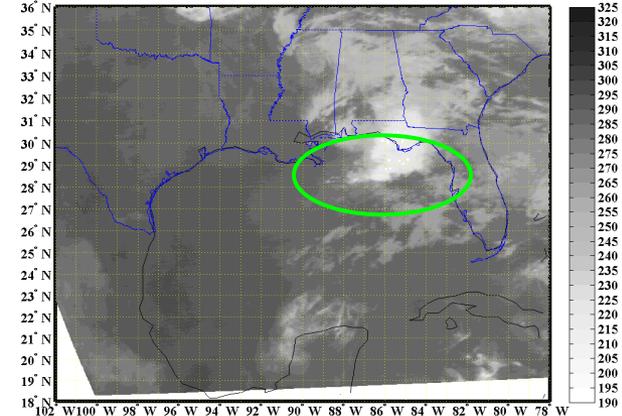
0600-0606 UTC

GOES-11, ch.5 ( $\lambda = 12.0 \mu\text{m}$ ), 0600-0606 UTC, May 23, 2008



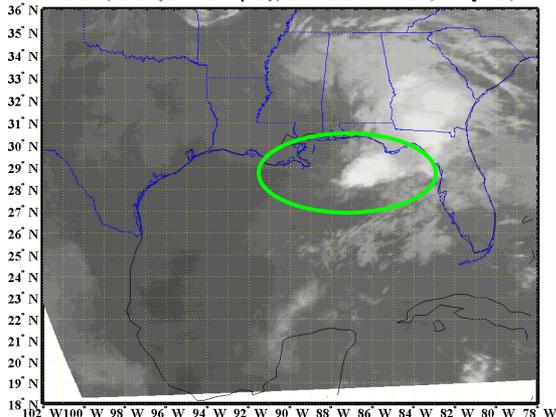
0900-0906 UTC

GOES-11, ch.5 ( $\lambda = 12.0 \mu\text{m}$ ), 0900-0906 UTC, May 23, 2008



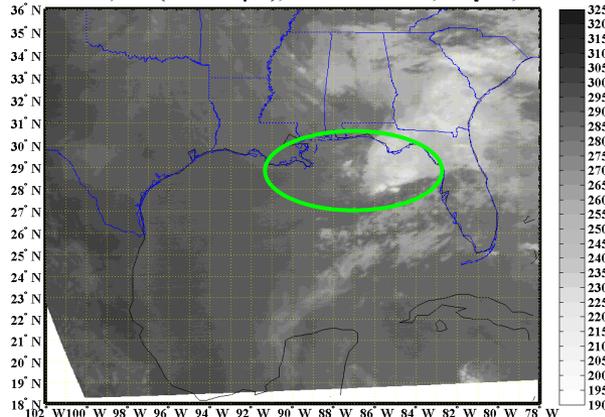
1200-1206 UTC

GOES-11, ch.5 ( $\lambda = 12.0 \mu\text{m}$ ), 1200-1206 UTC, May 23, 2008



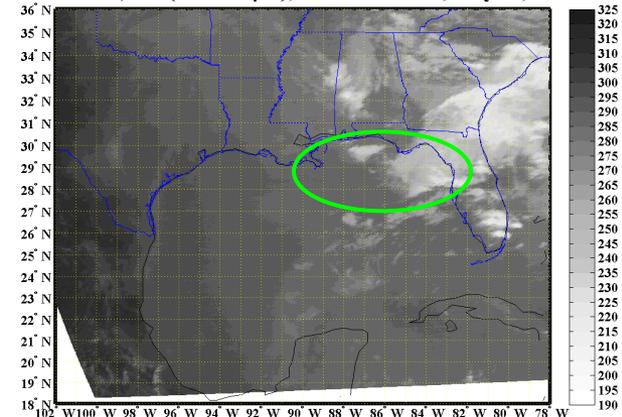
1500-1506 UTC

GOES-11, ch.5 ( $\lambda = 12.0 \mu\text{m}$ ), 1500-1506 UTC, May 23, 2008

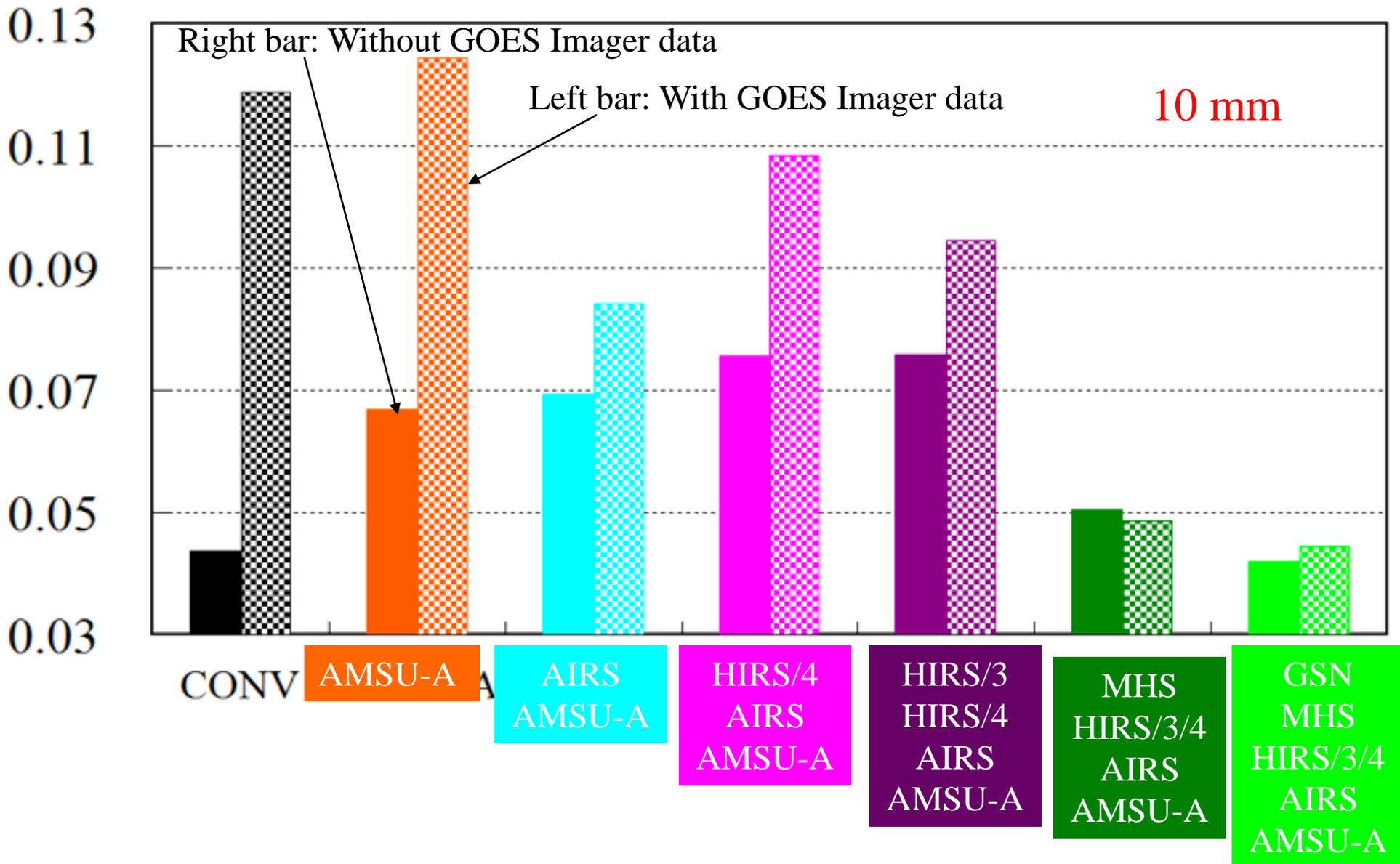


1800-1806 UTC

GOES-11, ch.5 ( $\lambda = 12.0 \mu\text{m}$ ), 1800-1806 UTC, May 23, 2008



# Threat Scores of 3-h Accumulative Rainfall



# NCEP MSG SEVIRI CSR Assimilation in GFS

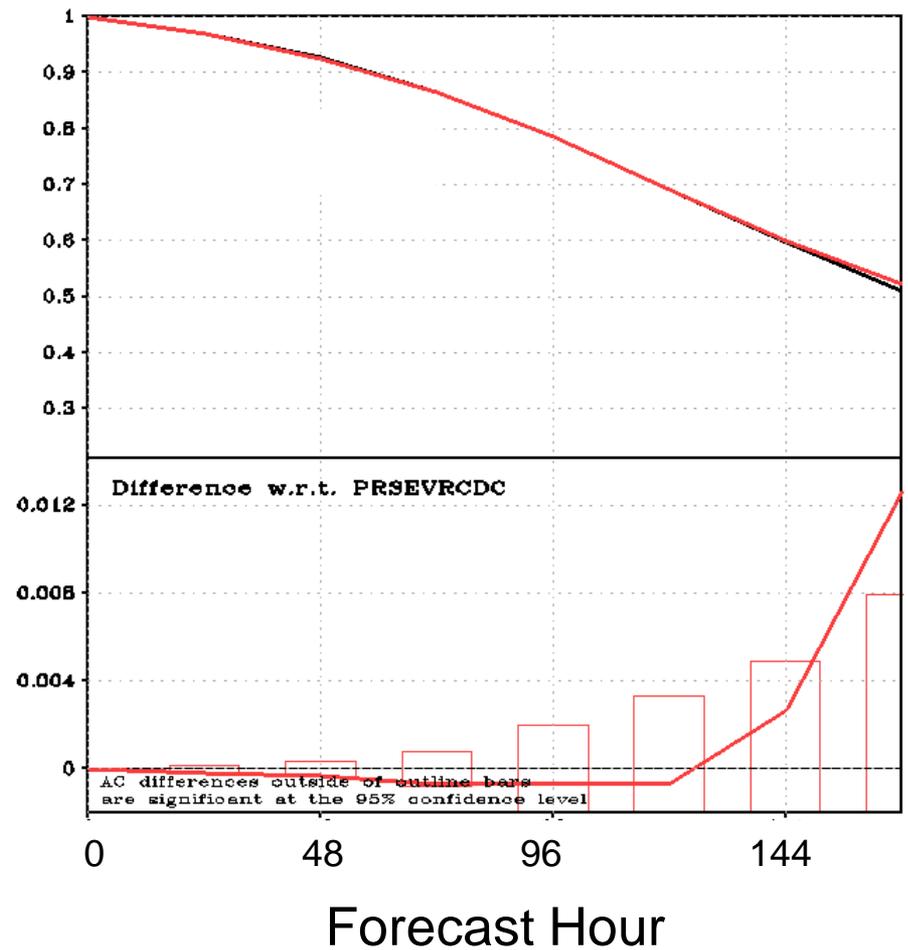
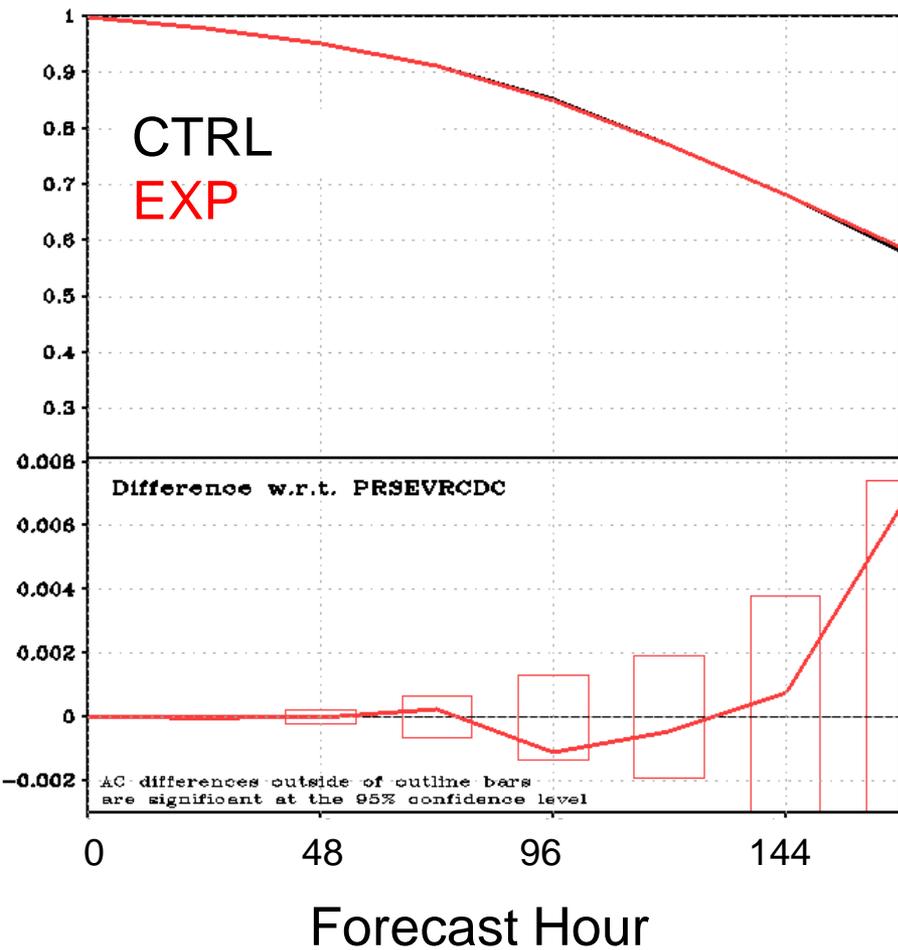
- **SEVIRI Data**
  - ✓ thinning
  - ✓ gross check
  - ✓ bias correction
- **CTRL DA Experiment**
  - ✓ T382 resolution
  - ✓ March 9 to April 30, 2011
  - ✓ 10 days bias correction spin up
  - ✓ All operational data
- **EXP DA Experiment**
  - ✓ SEVIRI CSR two WV channels added to CTRL

# Impact on 5-Day Forecasts

## Geopotential Anomaly Correlation Coefficient

500 hPa

250 hPa



# Two New IR Land Surface Emissivity Data Bases in CRTM

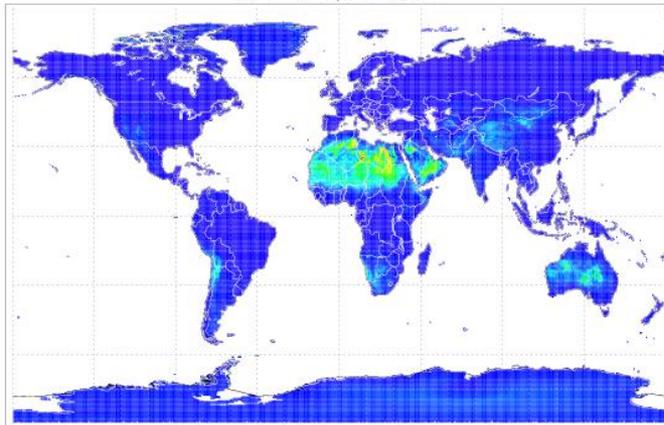
## NASA/LARC IASI Emissivity

– by Dan Zhou et al.

- 8461 IASI channels
- 645 – 2760 ( $\text{cm}^{-1}$ )
- $0.5^\circ \times 0.5^\circ$  lat/lon
- Monthly 07/2007 – 06/2008
- Combined, Daytime, Nighttime

IASI Emissivity – July  
SEVIRI Ch7 8.7  $\mu\text{m}$

IASI Emissivity at 8.70 $\mu\text{m}$



Emissivity  
0.60 0.64 0.68 0.72 0.76 0.80 0.84 0.88 0.92 0.96 1.00

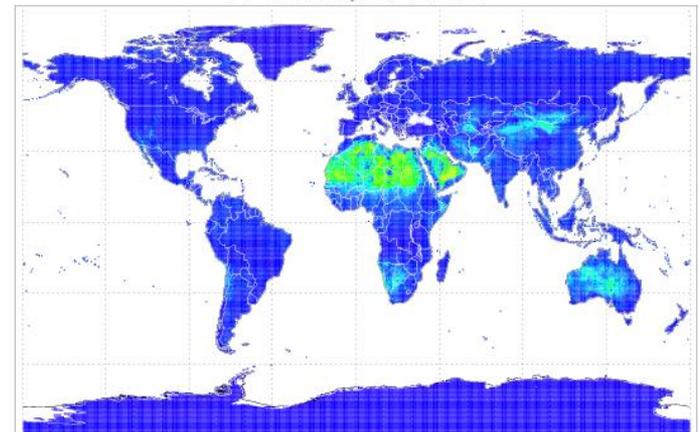
## UWiremis-RTTOV module

– by Eva Borbas and Ben Ruston

- 10 hinge points of UW/CIMSS BF global IR land
- Eigenfunction represents for the laboratory measurements
- From 3.6 to 14.3  $\mu\text{m}$
- $0.1^\circ \times 0.1^\circ$  lat/lon .

UW Emissivity – July  
SEVIRI Ch7 8.7  $\mu\text{m}$

UW Emissivity at 8.70 $\mu\text{m}$



Emissivity  
0.60 0.64 0.68 0.72 0.76 0.80 0.84 0.88 0.92 0.96 1.00

# Data Assimilation and Forecast Experiments in GFS Using STAR IR Land Surface Emissivity

GSI latest trunk version in June 2011 (SEVIRI is not used)  
GFS, with updated skin temperature scheme (Zheng)

**CTL:** March 10 – April 12, 2011, Emis LUT

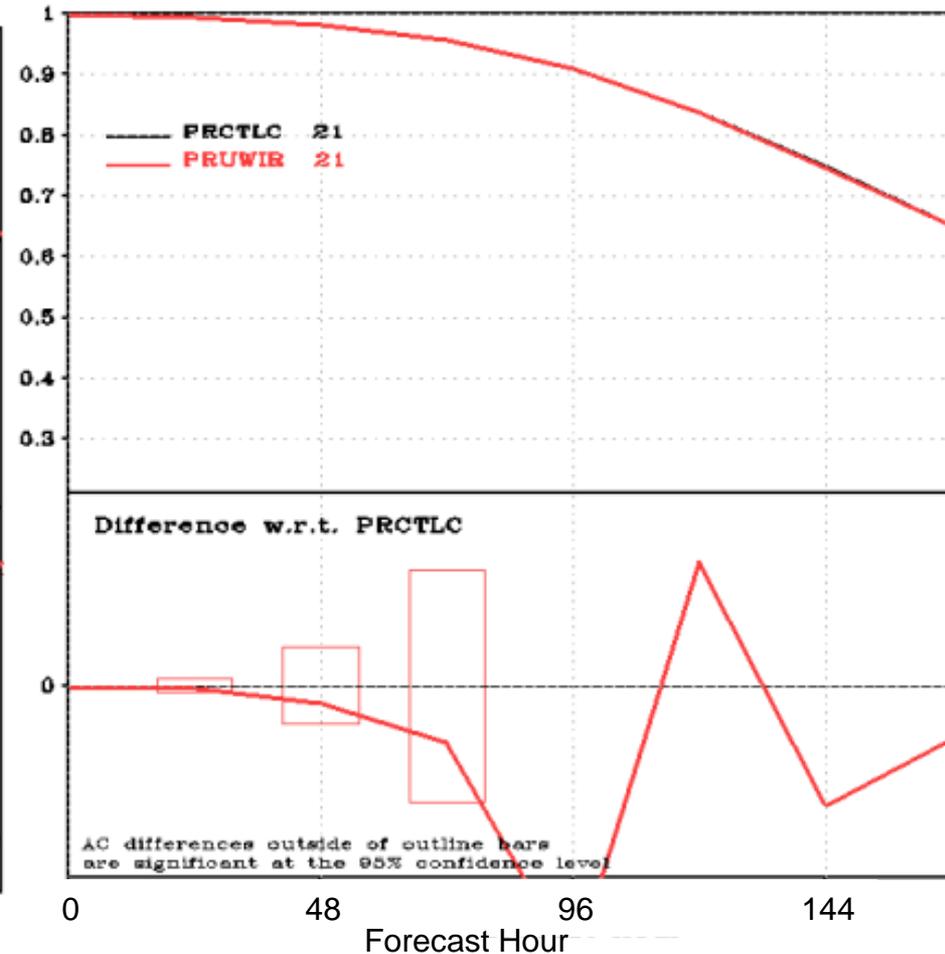
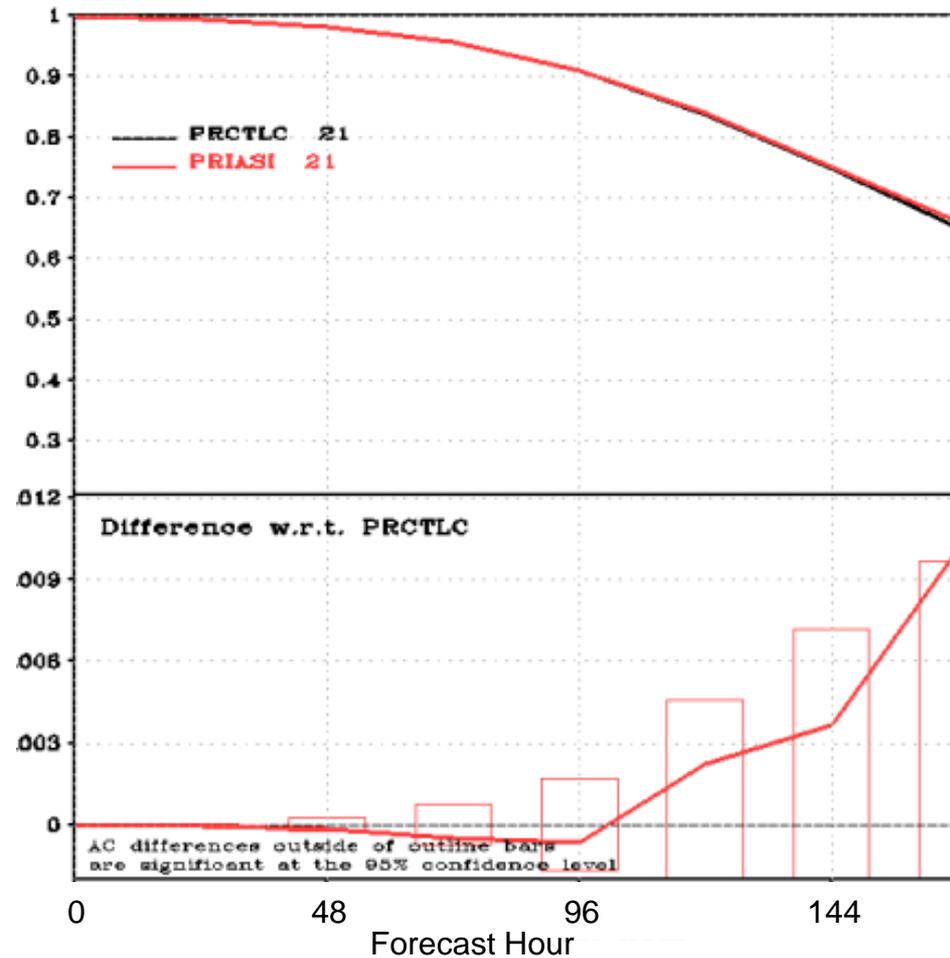
**Exp1:** March 10 – April 17, 2011, Emis IASI

**Exp2:** March 10 – April 17, 2011, Emis UW-RTTOV

# GFS Anomaly Correlations for 500hPa

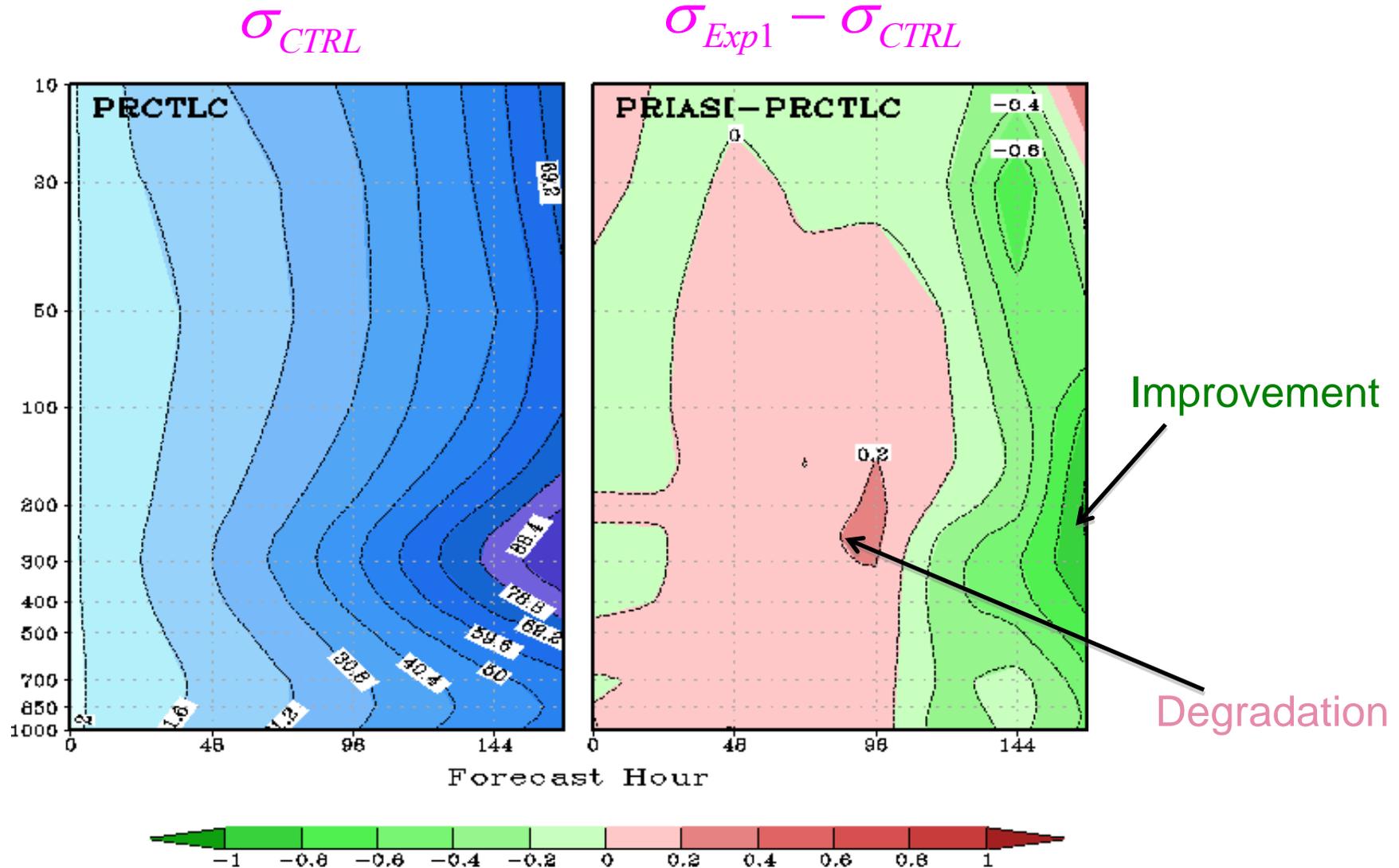
Exp1 (IASI Emis)

Exp2 (UWIR Emis)



1. A notable positive impact on GFS forecast by using IASI land surface emissivity.
2. A neutral to small positive impact on GFS forecast by using UW IR land surface emissivity.

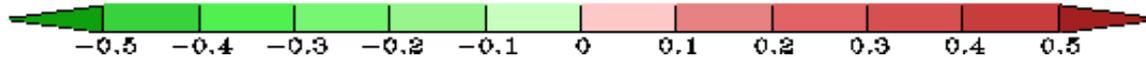
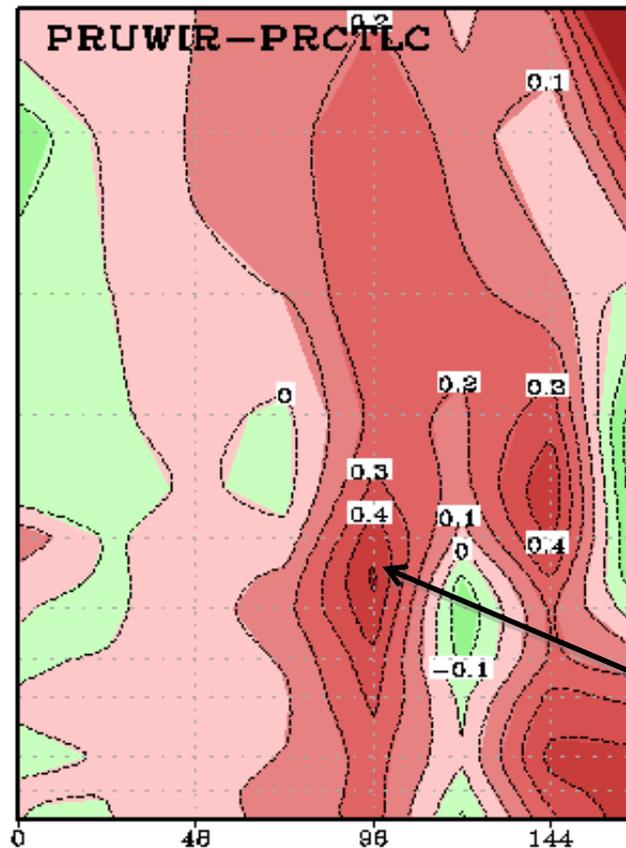
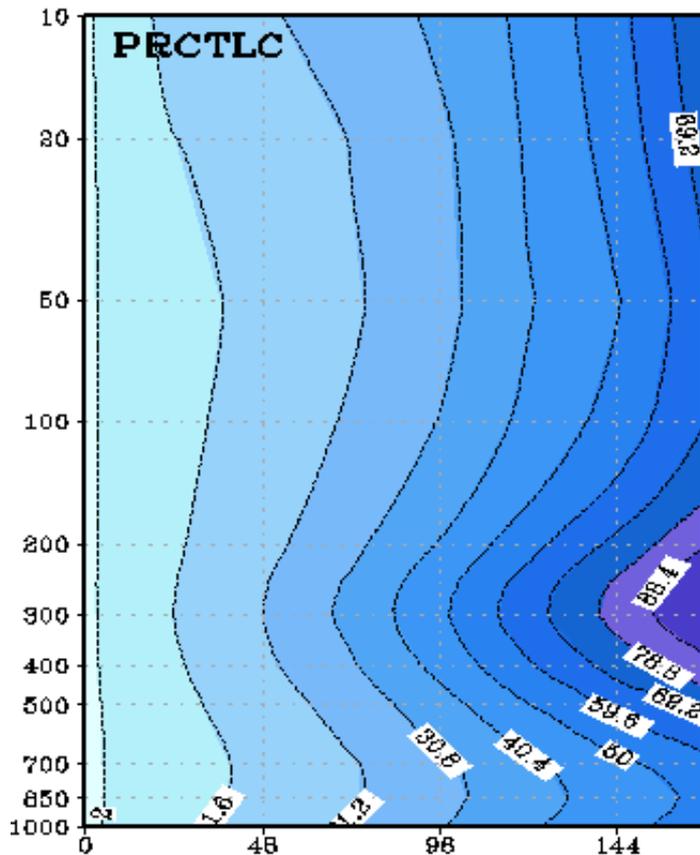
# IASI Emis Impact on RMSE for Geopotential Height

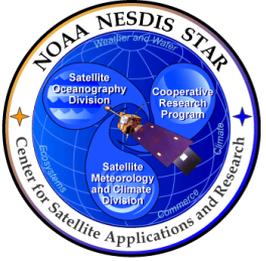


# UWIR Emis Impact on RMSE for Geopotential Height

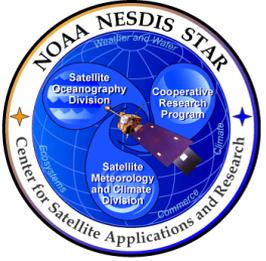
$\sigma_{CTRL}$

$\sigma_{Exp2} - \sigma_{CTRL}$





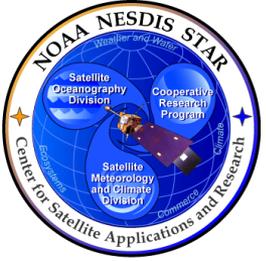
# Backup Slide



# Project Milestones and Deliverables (2011-2012)

- Complete studies of assimilation of SEVIRI and GOES imager data. EMC/STAR
- Continue the evaluation of infrared land surface emissivity databases in comparison with the current baseline CRTM emissivity. STAR/FSU
- Investigate the GOES-R AWG and Met Office SEVIRI cloud algorithms for pixel level cloud detections and implement improved algorithm in GSI for the high resolution data. EMC/STAR/FSU
- Suggest possible strategies to use efficiently all the SEVIRI or GOES data, given the possibility of limited resources at NCEP to use this data stream. This may include intelligent thinning or super-obbing. EMC
- Convert the high resolution of MSG SEVIRI imager data into BUFR format STAR

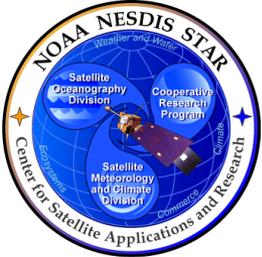
***By the end of the first year, we deliver assessment reports on uses of IR land surface emissivity data bases and recommend a best emissivity data set for operational implementation to CRTM. Also, an improved cloud detection algorithm will be interfaced into GSI for experiments.***



# Project Milestones and Deliverables (2012-2013)

- Refine the cloud retrieval algorithm and use the retrieved cloud properties with background cloud parameters from GFS in forward models to simulate high resolution IR imager radiances **STAR** (This may be in conflict with on-going direct radiance assimilation efforts.)
- Begin tests of using IR cloudy radiances with hybrid cloud information **STAR**
- Begin assimilation tests on preferred IR emissivity databases. **STAR/EMC**
- Develop strategy to use high resolution operational GOES, MSG and GOES-R imager data in GSI analysis system. **EMC**
- Incorporate the new GSICS inter-sensor calibration algorithms for new GOES and MSG imagers *Incorporate into what?* **STAR**

***By the end of the second year, we deliver assessment reports on uses of GOES and SEVIRI IR clouds-affected radiances and on experimental results of the high resolution data in GFS/WRF.***



# Project Milestones and Deliverables (2013-2014)

- Complete SEVIRI data assimilation with the new emissivity model **STAR/EMC**
- Complete testing of use of IR cloudy radiances **STAR/EMC**
- Complete system to use high resolution data and test on operational GOES imager data (MSG imager data is not available in near real time) **EMC**
- Ensure all positive developments are incorporated in the NCEP test and evaluation system **All**

***By the end of third year, we will deliver the overall improved methodology and algorithms for assimilation of SEVIRI and GOES imager observations.***