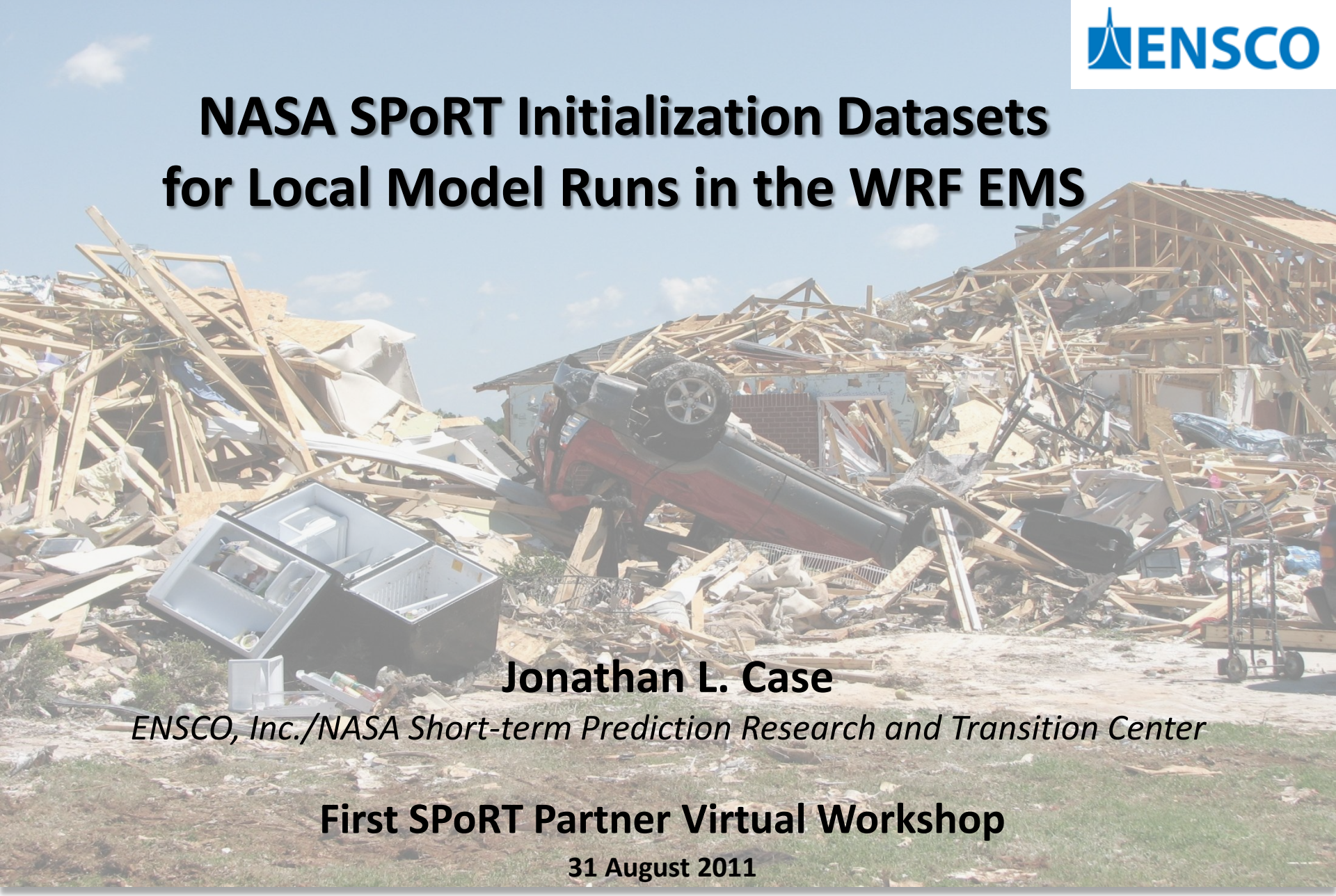
NASA SPoRT Initialization Datasets for Local Model Runs in the WRF EMS



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ENSCO, Inc./NASA Short-term Prediction Research and Transition Center

First SPoRT Partner Virtual Workshop

31 August 2011

Outline

WRF EMS High-level Overview

SPoRT datasets for use in WRF EMS

- Multi-sensor sea surface temperature (SST)
- Great Lakes lake surface temperature (LST)
- Great Lakes ice cover (winter only for obvious reasons)
- Land Information System (LIS) land surface fields
- SPoRT Daily MODIS Greenness Vegetation Fraction (GVF)

Some examples of Model Impact

Instructions on incorporating data into EMS

Summary and Conclusions

Brief Overview of the WRF EMS

Weather Research and Forecasting (WRF) model

- Community numerical weather prediction (NWP) system
- Contains two distinct NWP models
  - Advanced Research WRF (ARW, NCAR)
  - Non-Hydrostatic Mesoscale model (NMM, NCEP)

Environmental Modeling System (EMS)

- NWS SOO/Science and Training Resource Center (STRC)
- End-to-end system that runs ARW or NMM models in real time
- Manages acquisition and interpolation of initial/boundary conditions
- Automated post-processing can produce graphical output and display forecasts in AWIPS

Simple Changes to WRF EMS Enables Use of SPoRT Datasets

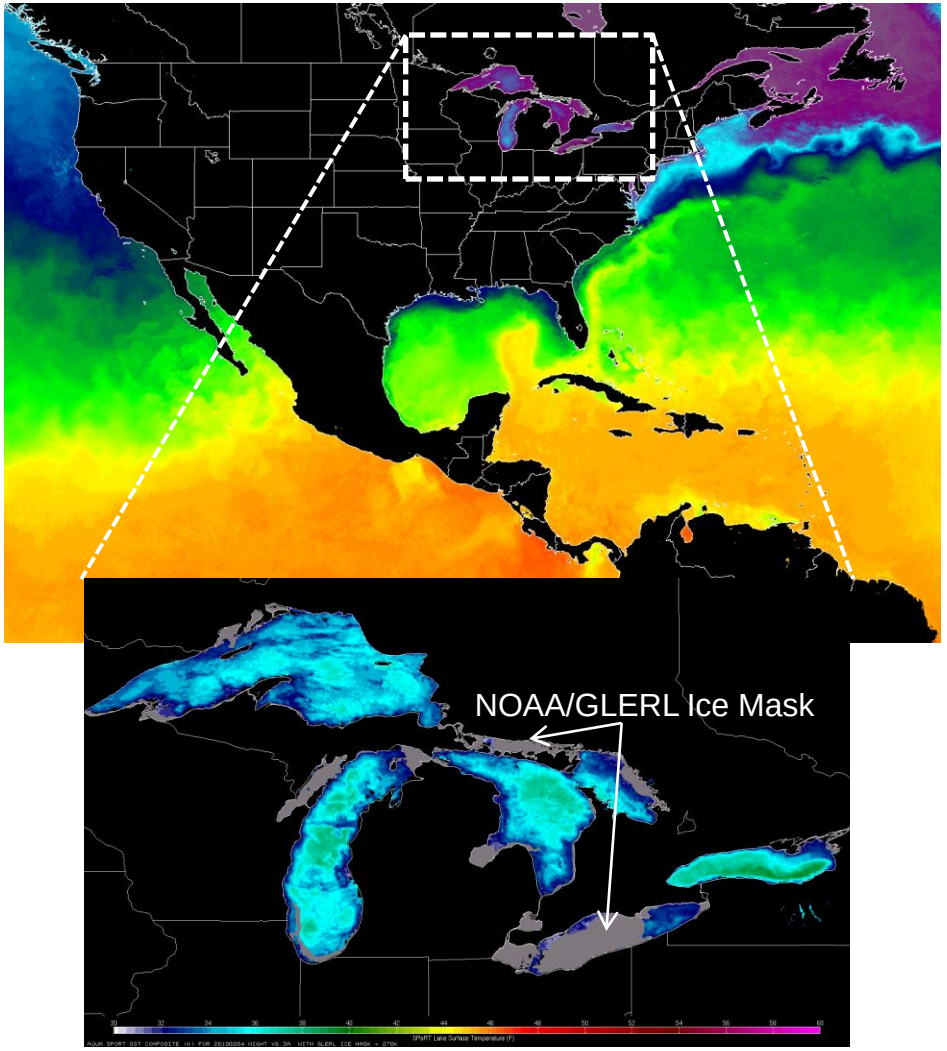
SPoRT SST (Great Lakes LST & Ice)

SPoRT SST composites

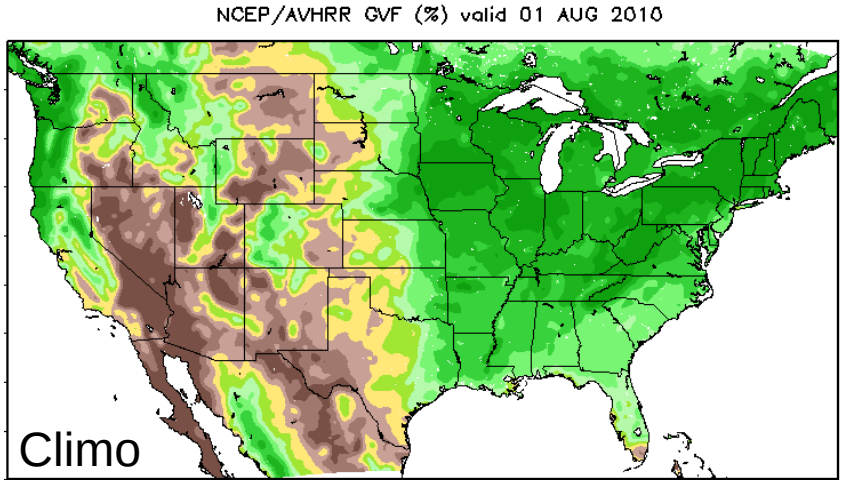
- Time latency-weighted blend of MODIS, AMSR-E, and global OSTIA
- 1-km resolution; 04z/07z/16z/19z
- Highly detailed compared to operational NCEP SST

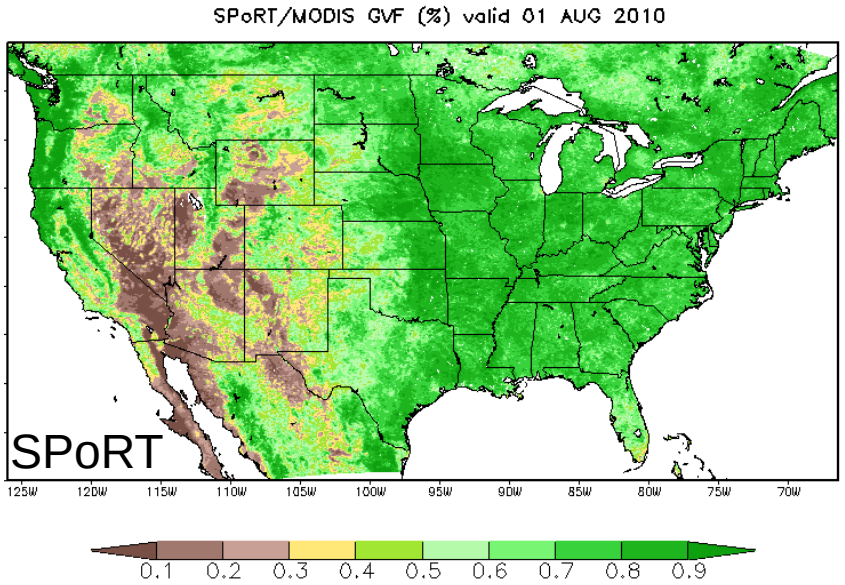
Great Lakes LSTs and Ice Cover

- Blend of MODIS and Remote Sensing Systems (REMSS) LST analysis
- Lake ice cover incorporated from NOAA Great Lakes Environmental Research Laboratory (GLERL) analysis, 90% fractional threshold (ice > 90%)
- LSTs set to 270K where ice occurs



SPoRT/MODIS Real-time GVF





SPoRT GVF Composite Product

- GVF: Percent coverage of healthy green vegetation at a given model grid pixel
- MODIS swaths of Normalized Difference Vegetation Index (NDVI) mapped to CONUS grid
- Latency-weighted composite of NDVI, similar to SST compositing technique
- Updated daily with new MODIS swaths
- NDVI converted to GVF by vegetation type following Zeng et al. (2000); Miller et al. (2006)

Benefits over default GVF

- Default GVF in WRF/EMS is a monthly climo
  - Represents GVF the same from year to year
  - Cannot account for anomalies caused by weather extremes, wildfires, urbanization, etc.
- Much higher spatial resolution (1 km vs. 16 km)

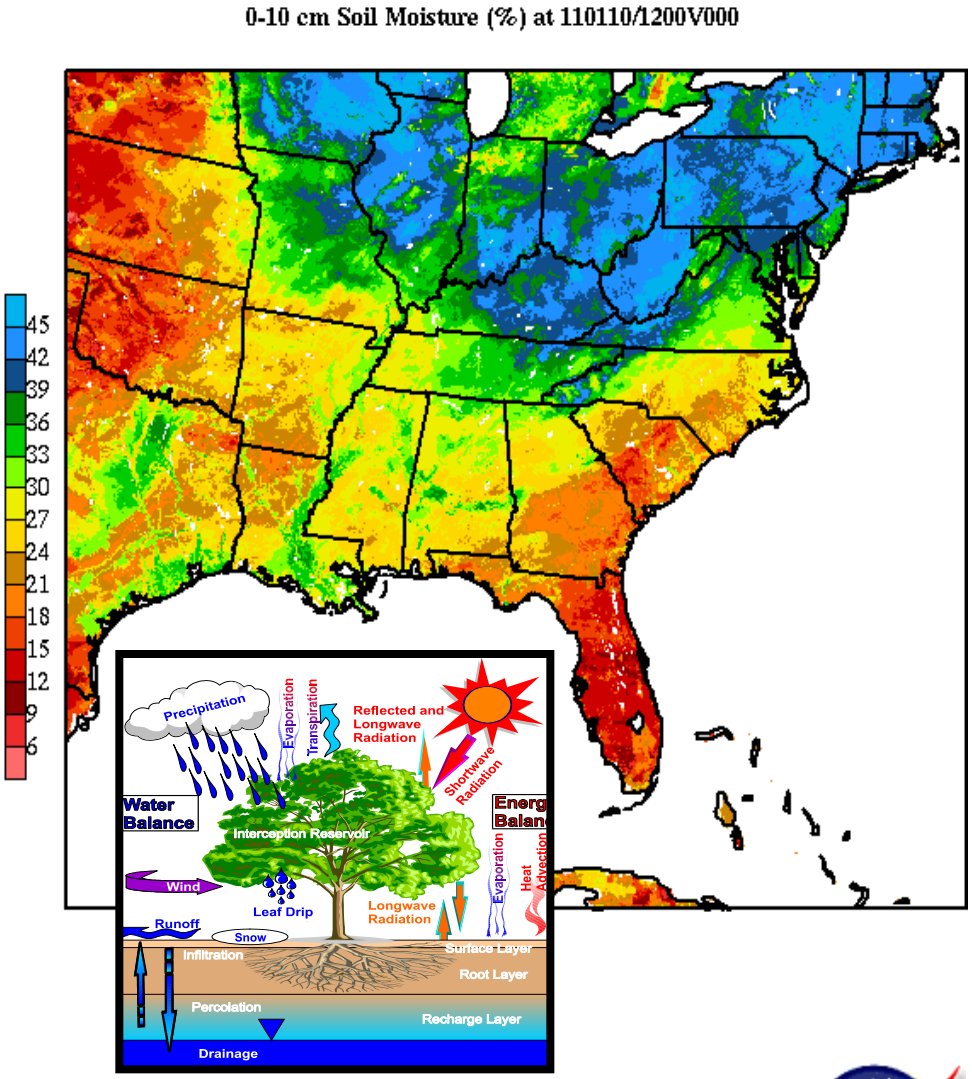
LIS Land Surface Initialization

Land Information System (LIS)

- NASA system to perform land surface modeling & assimilation of land datasets
- Runs variety of Land Surface Models (LSMs)
- Uses satellite, ground, and reanalysis data to integrate LSMs apart from NWP model
- Can run coupled to Advanced Research WRF

SPoRT Real-Time LIS Run

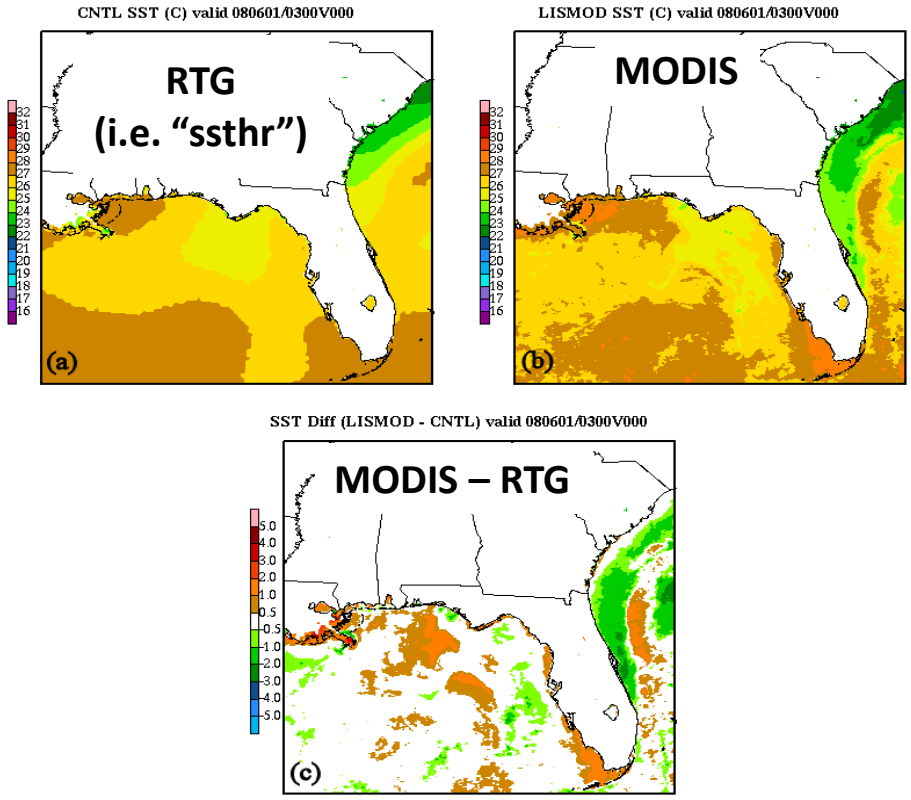
- Runs operational Noah LSM on 3-km grid over eastern/southern U.S.
- High-resolution spin-up ensures soil fields are consistent with local model runs
- NCEP operational analyses drive LSM
  - GDAS and Stage IV precipitation
- Incorporates new MODIS GVFs every day
- Output every hour for initializing WRF EMS



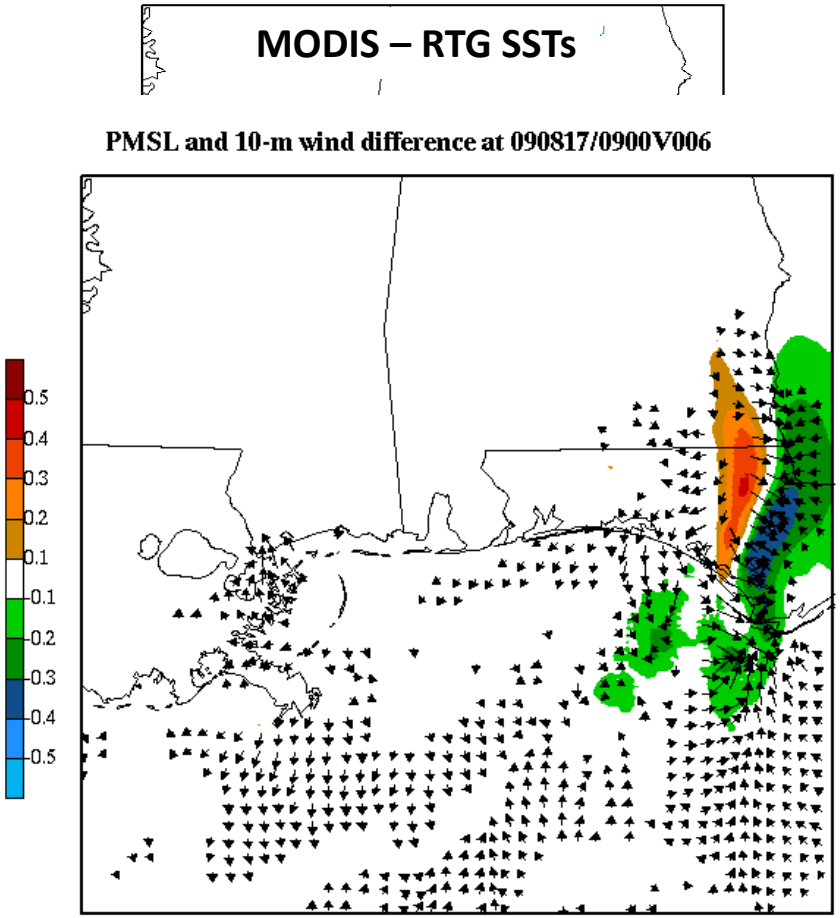
WRF Model Sensitivity/ Impact Examples

Impact of SPoRT SSTs

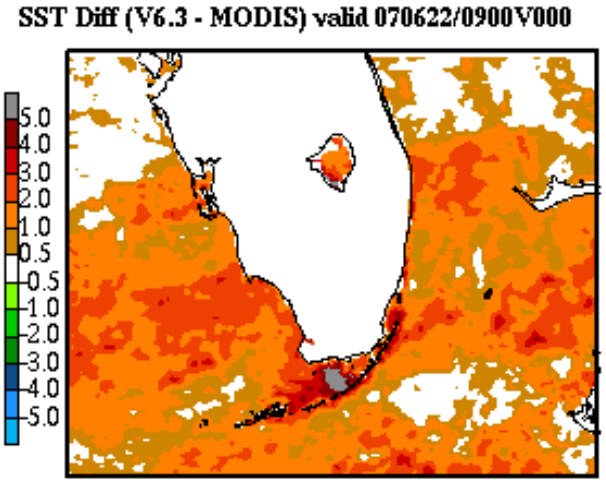
Can capture much more detail in SST horizontal variations

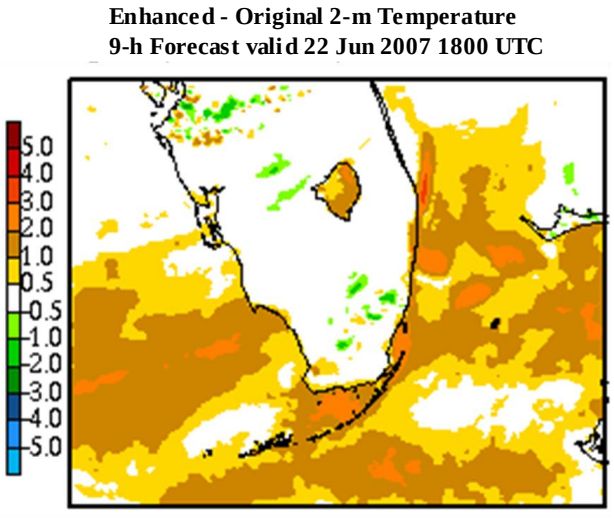


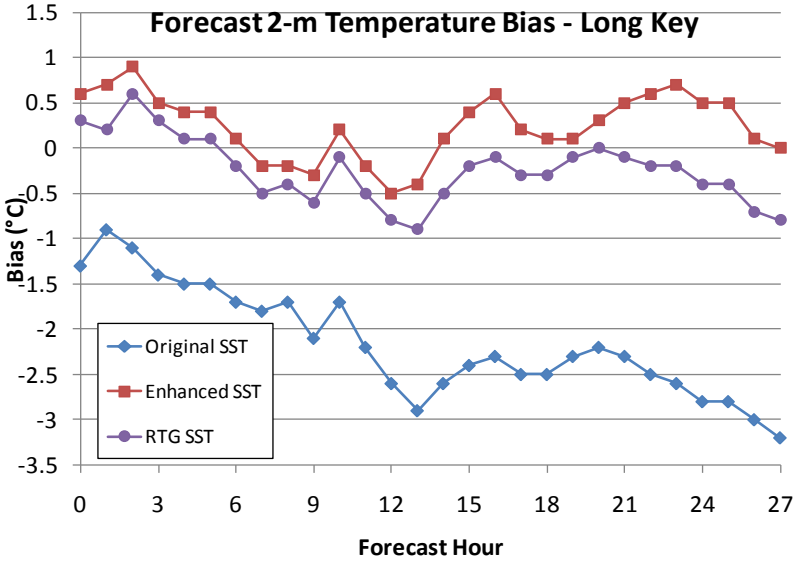
Enhanced cyclonic development in land-falling, Tropical Cyclone (Claudette 2009)



Impact of SPoRT SSTs: Improving original MODIS product with multi-sensor approach





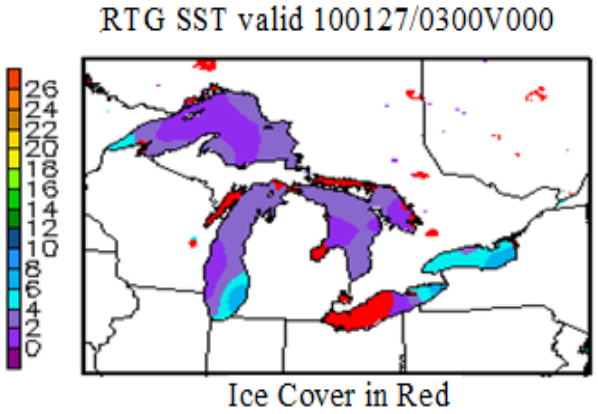


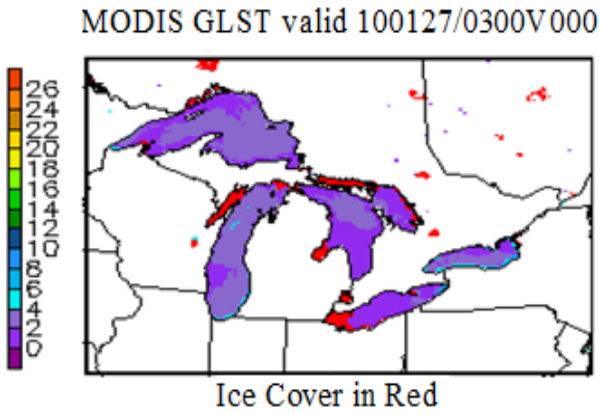
(Top-Left) Enhanced SST minus MODIS-only SST;

(Top-Right) Difference in WRF 2-m temperature for the 9-h forecast valid 1800 UTC 22 June 2007.

(Bottom) Verification of 2-m Temp at Long Key, FL C-MAN observation

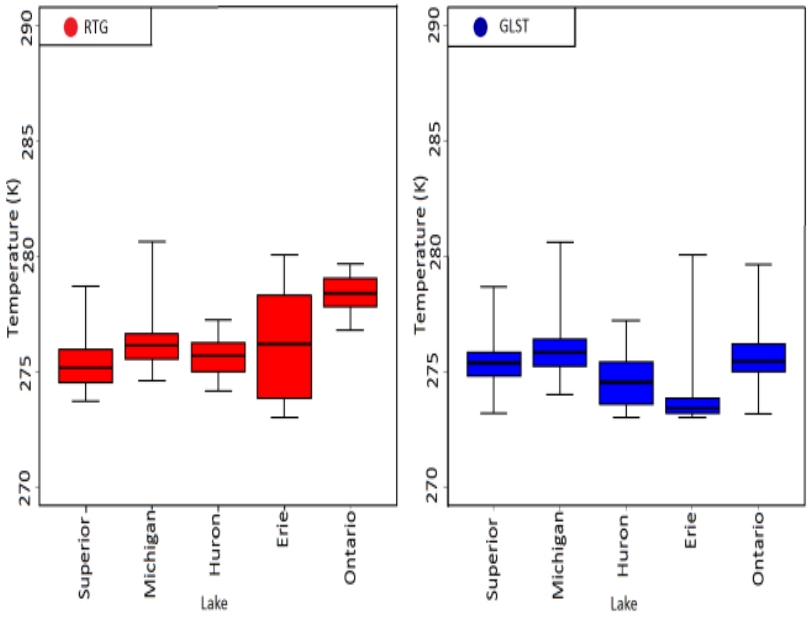
Impact of Great Lakes LST and Ice Cover

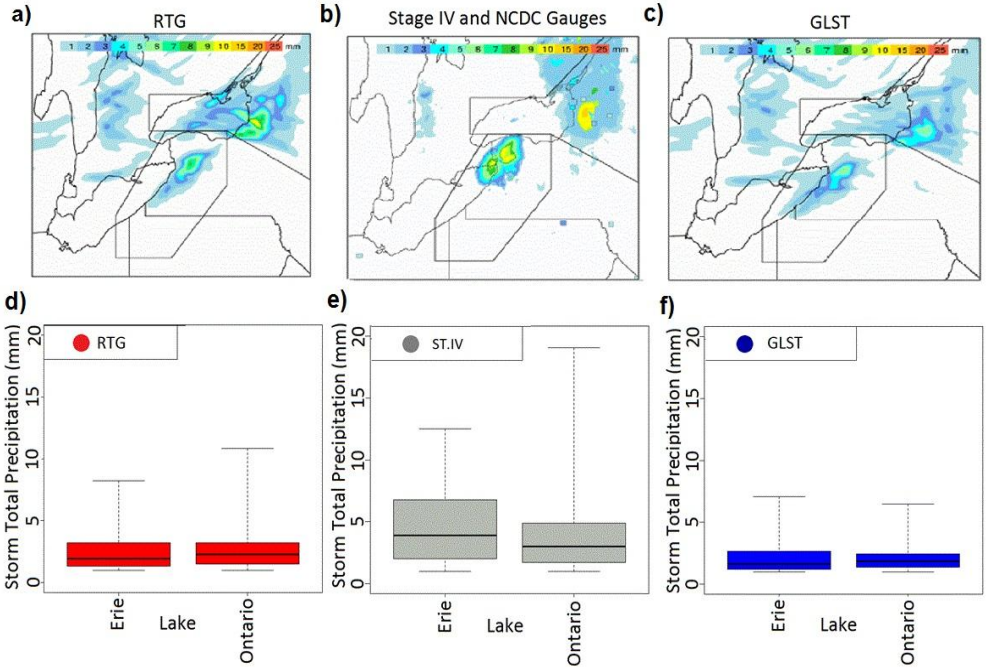




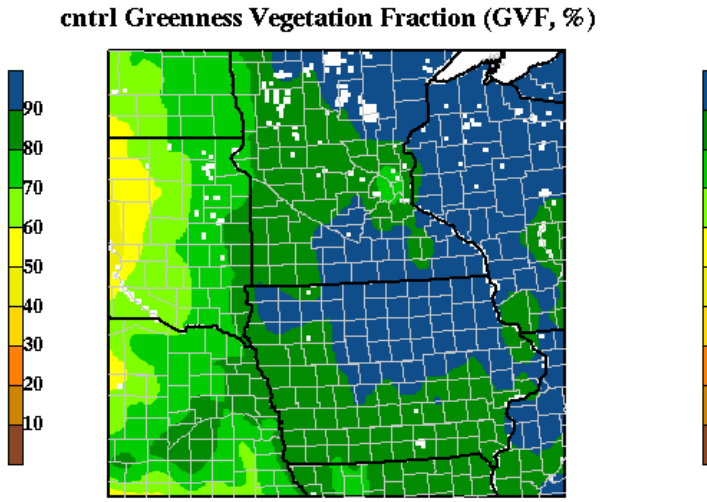
Fairly substantial differences between RTG LST/ice cover and SPoRT product, esp. eastern lakes.

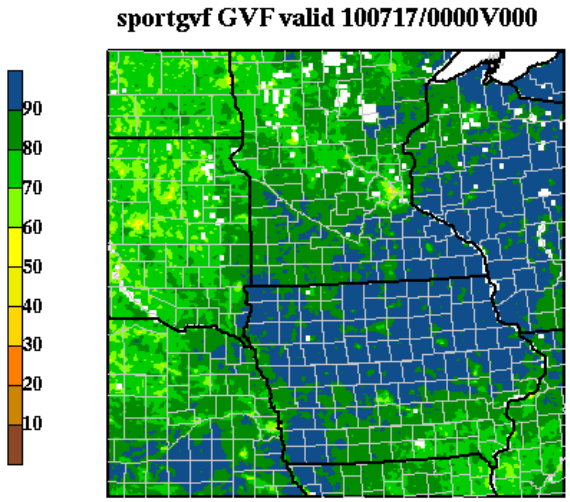
Changes to heat fluxes and QPF amounts.



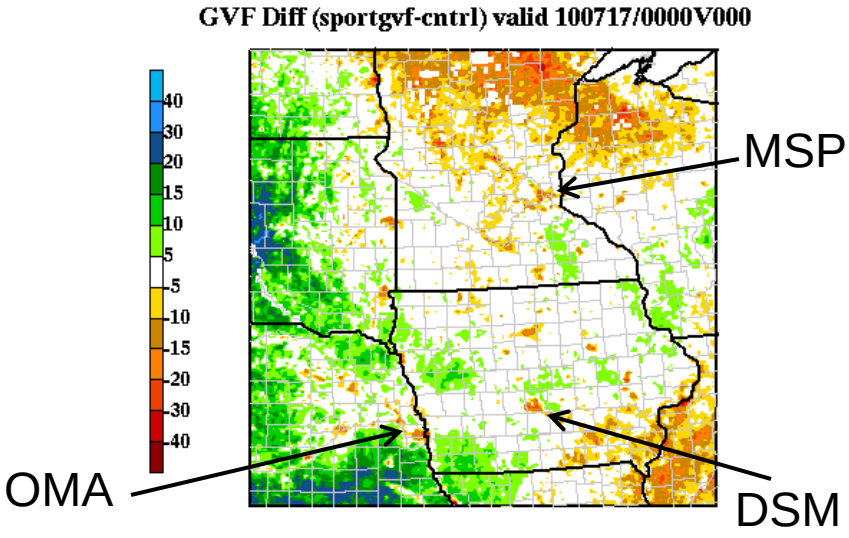


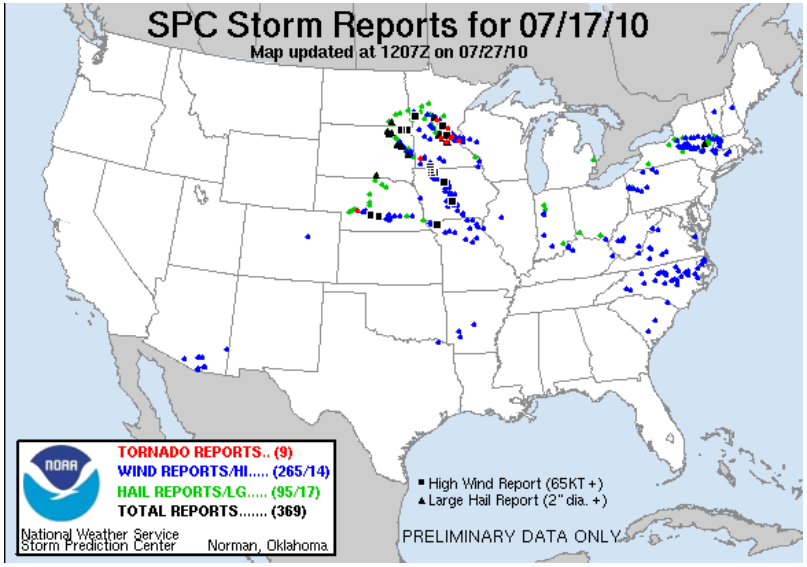
GVF Impact on 17 July 2010 Case





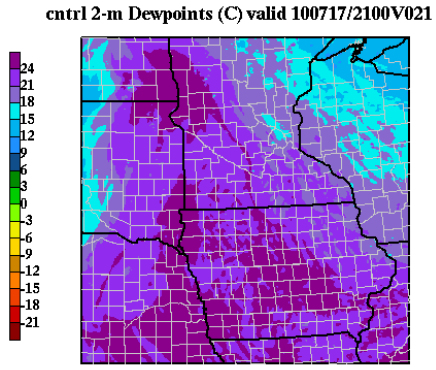
- "Control" WRF run uses NCEP climo GVFs
- "sportgvf" run uses SPoRT daily GVFs for 16 July 2010

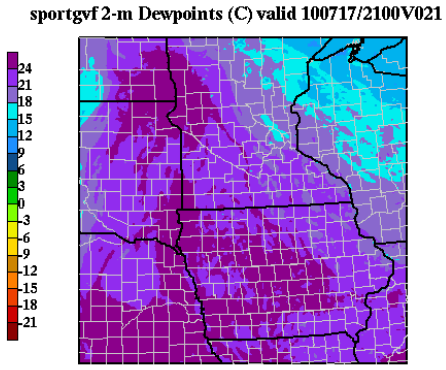


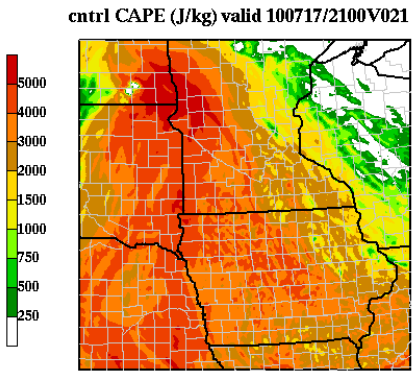


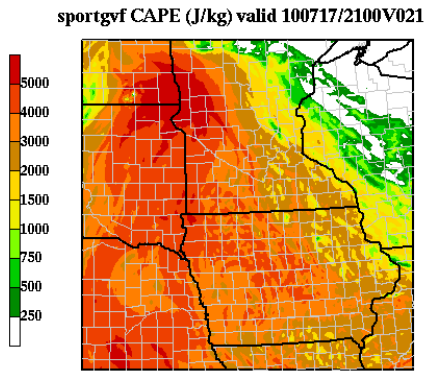
- Urban areas can be resolved much better by the SPoRT GVF.
- Higher GVFs prevail from NE to ND.

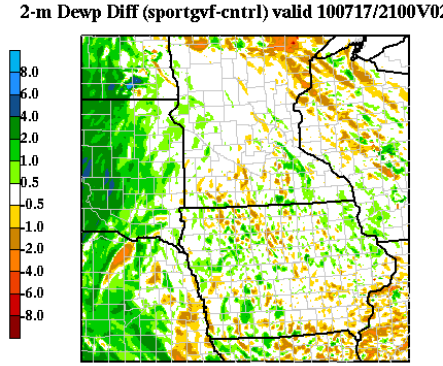
GVF Impact on 17 July 2010 Case, cont.
WRF Run 21-h fcst: 2-m Dewp/CAPE

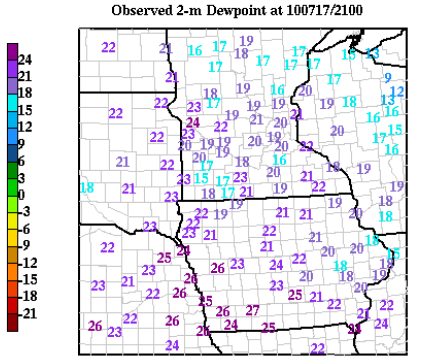


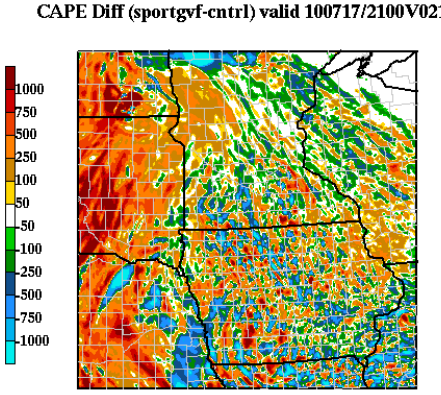






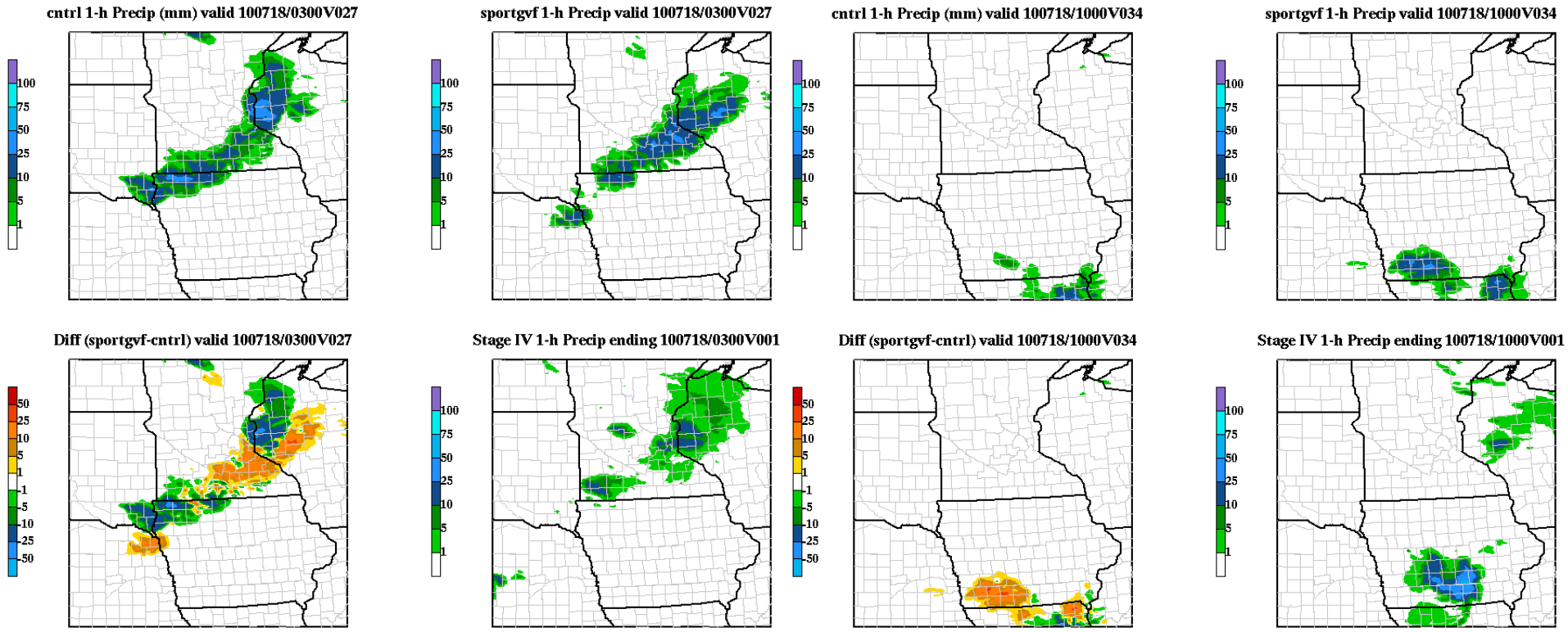






- Higher GVF values by 10–30% from NE to ND increase evapotranspiration, leading to higher 2-m dewpoints
- Net result is increase in CAPE up to 1000 J kg^{-1}
- Some improvements to 2-m T/Td verification stats (not shown)

GVF Impact on 17 July 2010 Case, cont.
Forecast 1-h precip: 27-h/34-h forecasts

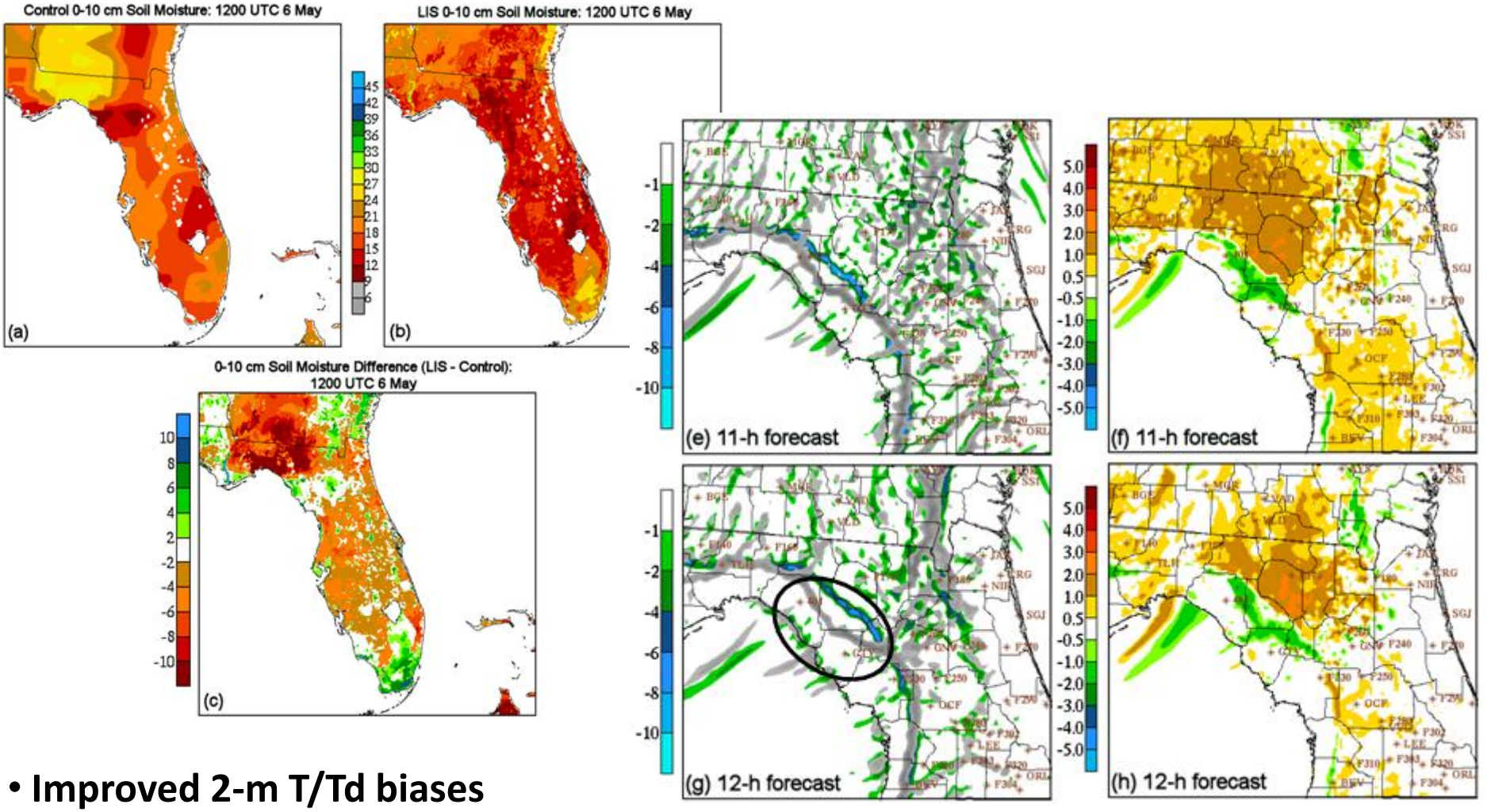


- Both model runs similar on placement
- Variation in intensity
- SPoRTGVF run suggests more discrete convective mode, similar to obs. (Stage IV)

- Control run moves convection through domain too fast
- SPoRTGVF run is still closer on intensity and placement
- Improved threat scores (not shown)

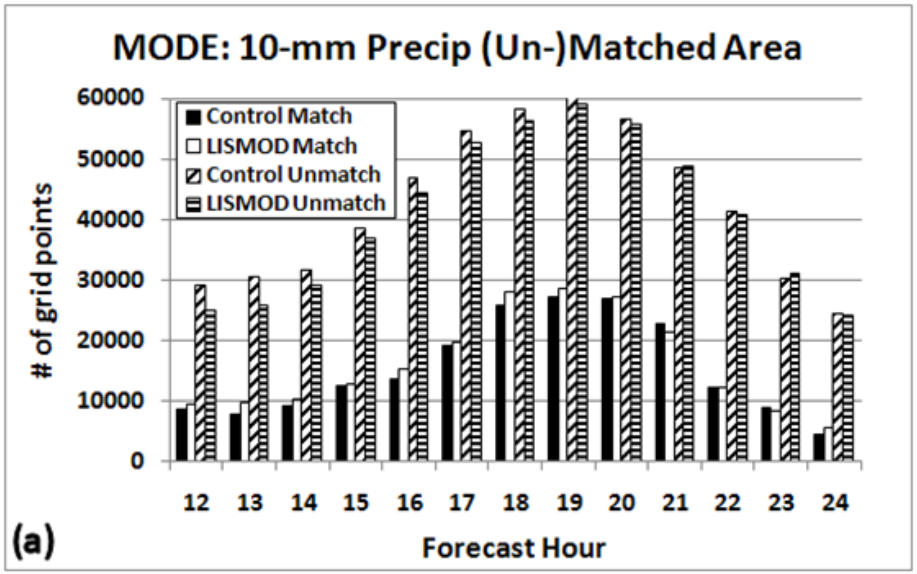
LIS Initialization Impact Studies:

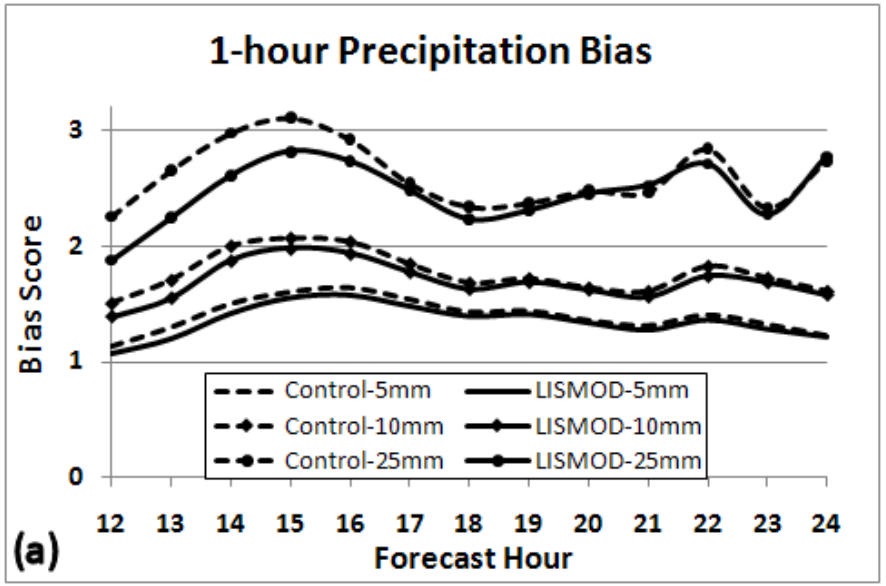
May 2004 Study over Florida

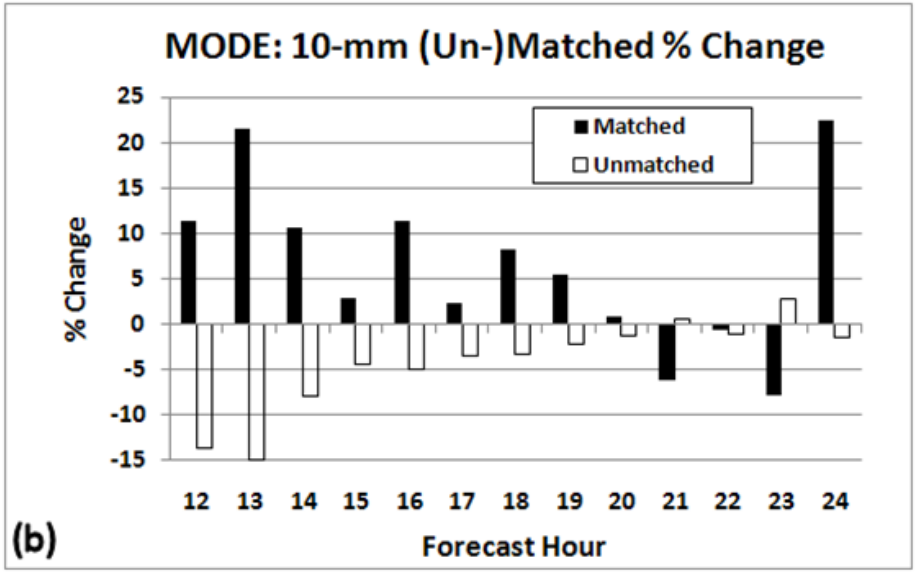


- **Improved 2-m T/Td biases**
- **Better timing of sea breeze passage**
- **Case et al. (2008), *J. Hydrometeor.***

LIS Initialization Impact Studies:
SE U.S. Summer 2008 Precip Study







- **Better correlation with observed soil moisture (not shown)**
- **Small improvements in verification of daytime summer precip**
- **Case et al. (2011), *Wea. Forecasting* (In Press)**

“How to” Section for WRF EMS Users

How do I use SPoRT SSTs?

ems_prep:

- Add "--sfc sstsport,ssthr" to your ems_prep entry
- Example: "ems_prep --dset namptile --sfc sstsport,ssthr"
- SPoRT recommends the "--besthr sstsport" option to best match the SST hour with the model initialization hour
  - SSTs can have a diurnal signal, depending on atmospheric conditions
  - This option will often result in using yesterday's SST data
  - SSTs don't change much from day-to-day, however, so that's OK

ems_autorun:

- Edit the *<rundir>/conf/ems_auto/ems_autorun.conf* file
- Set "SFC = sstsport,ssthr" and "BESTHR = sstsport"

How do I use Great Lakes LSTs?

See Previous slide

(Great Lakes LSTs blended into the SST composite)

How do I use Great Lakes Ice Cover?

Recommended method: (configuration file entry)

- Edit the *<rundir>/conf/ems_run/run_physics.conf* file
- Ensure that "SEAICE_THRESHOLD" is < 273 K and > 270 K
  - WRF initialization routine (real.exe) changes open water points to ice points when SST < SEAICE_THRESHOLD
  - Land use changes from water to land/ice
- Ensure that "FRACTIONAL_SEAICE = 0"
- Default values in *run_physics.conf* should suffice

How do I use SPoRT LIS?

ems_prep:

- Add "--lsm lis" to your ems_prep entry
- Example: "ems_prep --dset namptile --lsm lis"
- A backup lsm option should be available in EMS v3.2.1
  - e.g. "ems_prep --dset namptile --lsm lis,namptile"

ems_autorun:

- Edit the *<rundir>/conf/ems_auto/ems_autorun.conf* file
- Set "LSM = lis" or "LSM = lis,namptile"

Important Notes:

- Must use Noah LSM physics option because the SPoRT/LIS runs the standard operational Noah and its soil layers
- If using a backup LSM option, use namptile for Noah LSM consistency with the Noah LSM

How do I use SPoRT Daily GVFs?

More involved than other datasets, but in a nutshell:

- Create new directory in $EMS/data/geog, called “sportgvf”
- Obtain “index” file from SPoRT to define the new GVF data
- Modify “GEOGRID.TBL” file to support new dataset
- Download compressed file from SPoRT’s ftp site each day
- Re-localize domain by running the “ems_domain” script
- You’re all set!

SPoRT instructions document available

- Detailed instructions available for those interested
- Sample script provided as well

Summary of SPoRT Data for EMS

SPoRT has three main products for use in the WRF EMS

- MODIS/AMSR-E/OSTIA 1-km resolution SSTs
  - Includes REMSS Great Lakes LSTs and GLERL ice cover
- Real-time, daily MODIS Greenness Vegetation Fraction
- 3-km resolution land surface initialization data through LIS, incorporating the MODIS GVF

Possible Future SPoRT Capabilities in Modeling/EMS

- Full 3D cube analyses containing AIRS profiles
- Verification toolkit using NCAR's Model Evaluation Tools

Questions?