NCEP Satellite Data Assimilation Overview

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# Outline

I. **2009-2010 satellite data implementations**

II. **Data assimilation development**

III. **GFS implementation – June 2010**

I. 2009-2010 Satellite Data Implementations

- December 2009
  - NOAA19 hirs/4,AMSU-A, & MHS brightness temp obs
  - NOAA18 sbuv/2 and OMI ozone
  - Monitor N19 GOME
  - RARS (currently only EARS) 1B data
  - EUMETSAT-9 atm motion vectors
  - [Tropical storm pseudo sea-level pressure obs]
  - Improved use of GPS RO observations
    - Refractivity forward operator
    - Allow more observations, in particular in the tropical latitudes, due to better QC checks for COSMIC data
    - Better QC procedures
- February 2010 – GPSRO GRAS & GRACE [Cucurull]
- March 2010 – complete RARS data feed
- April 20, 2010
  - JASON-2 Altimetry

Differences between RTOFS SSH analysis and Ssalto/Duacs (independent) SSH analysis

left panel: with JASON-1/JASON-2/ENVISAT, right panel : without JASON-2
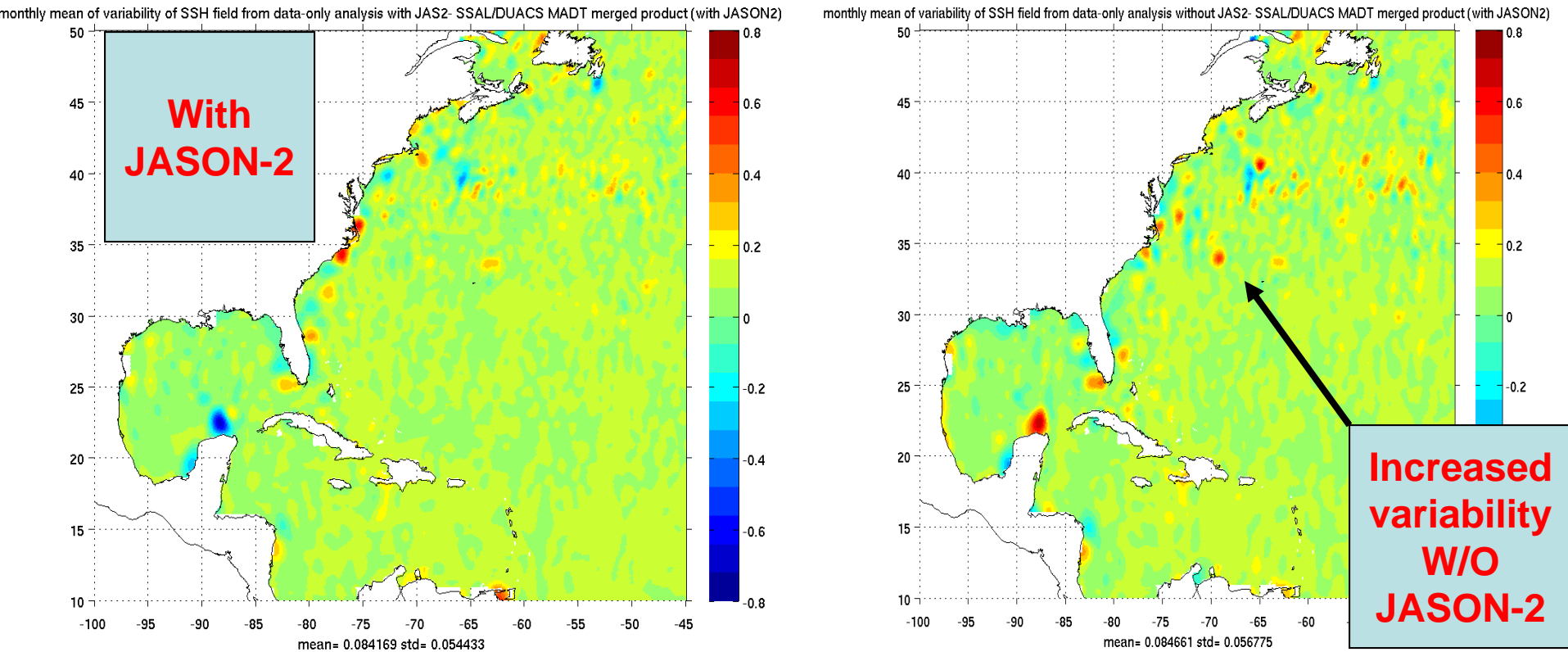
The right panel shows presence of larger differences in the Gulf Stream region which may lead to formation of spurious mesoscale features.

II. 2009-2010 Data Assimilation Development

- December 2009 data assimilation upgrades
  - Merge GMAO & EMC codes (4d-var capable, GMAO)
  - Update background error covariance
  - Proper use of different spectral truncation between background and analysis

- March 2010
  - Commitment to develop Hybrid Variational-Ensemble system
  - EMC, GMAO, ESRL, U. Oklahoma project
  - EnKF-based ensemble covariance estimates
  - Applicable to 3d and 4d-var

III. GFS implementation – June 2010

- Eulerian T574L64 for fcst1 (0-192hr) and T190L64 for fcst2 (192-384 hr)
  - Dynamics upgrade
    - Using a positive-definite tracer transport scheme in the vertical to replace the operational central-differencing scheme to eliminate computationally-induced negative tracers
- Physics upgrades
  - Gravity-Wave Drag parameterization upgrade
  - Radiation
    - Changing SW routine from ncep0 to RRTM2
    - Changing longwave computation frequency from three hours to one hour
    - Adding stratospheric aerosol SW and LW and tropospheric aerosol LW
    - Changing aerosol SW single scattering albedo from 0.90 in the operation to 0.99
    - Changing SW aerosol asymmetry factor. Using new aerosol climatology.
    - Changing SW cloud overlap from random to maximum-random overlap
    - Using time varying global mean CO_2 instead of constant CO_2
    - Using the Yang et al. (2008) scheme to treat the dependence of direct-beam surface albedo on solar zenith angle over snow-free land surface

III. GFS implementation – June 2010 (cont'd)

- Physics upgrades (cont'd)
  - New shallow convection
    - Convection starting level is defined as the level of maximum moist static energy within PBL
    - Detrain cloud water from every updraft layer
    - Entrainment rate is given to be inversely proportional to height and detrainment rate is set to be a constant as entrainment rate at the cloud base.
    - Mass flux at cloud base is given to be a function of convective boundary layer velocity scale.
  - Deep convection upgrade
    - Convective overshooting
    - Eliminate Random cloud top, and cloud water is detrained from every cloud layer of the single cloud.
    - Finite entrainment and detrainment rates for heat, moisture, and momentum are specified.
    - Similar to shallow convection scheme, entrainment rate is given to be inversely proportional to height in sub-cloud layers and detrainment rate is set to be a constant as entrainment rate at the cloud base.
    - Above cloud base, an organized entrainment is added, which is a function of environmental relative humidity
    - Increased momentum background diffusivity for winds only
    - Increased cloud water detrainment in upper cloud layers
  - PBL upgrade
    - Include stratocumulus-top driven turbulence mixing
    - Redefined PBL height (bulk Richardson number)
    - Enhance stratocumulus top driven diffusion when condition for cloud top entrainment instability is met.
    - Use local diffusion for the nighttime stable PBL.
    - Background diffusion in inversion layers below 2.5km over ocean is reduced by 70% to decrease the erosion of stratocumulus along the costal area.
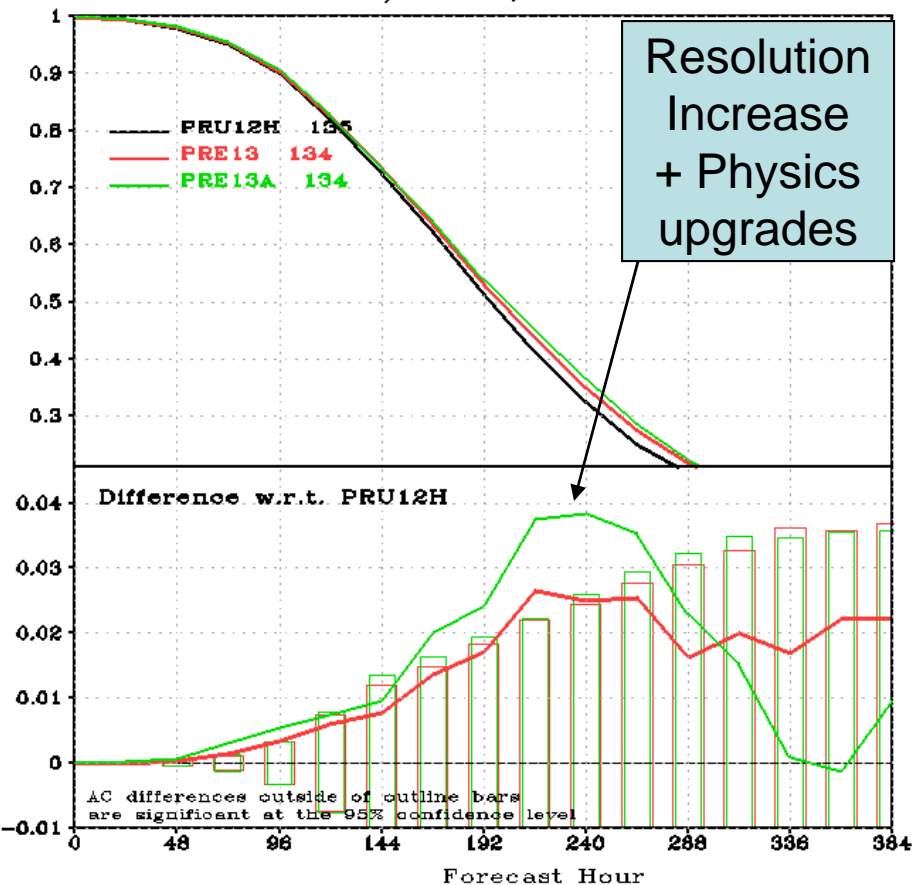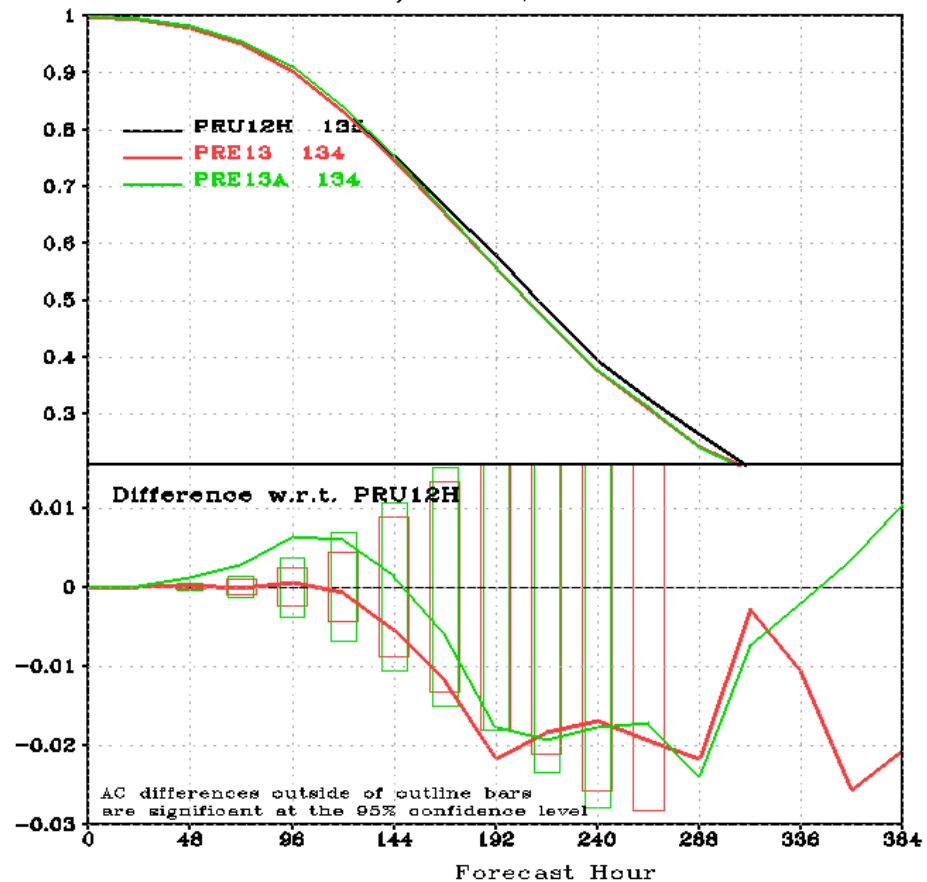
Results
500 MB Anomaly Correlation
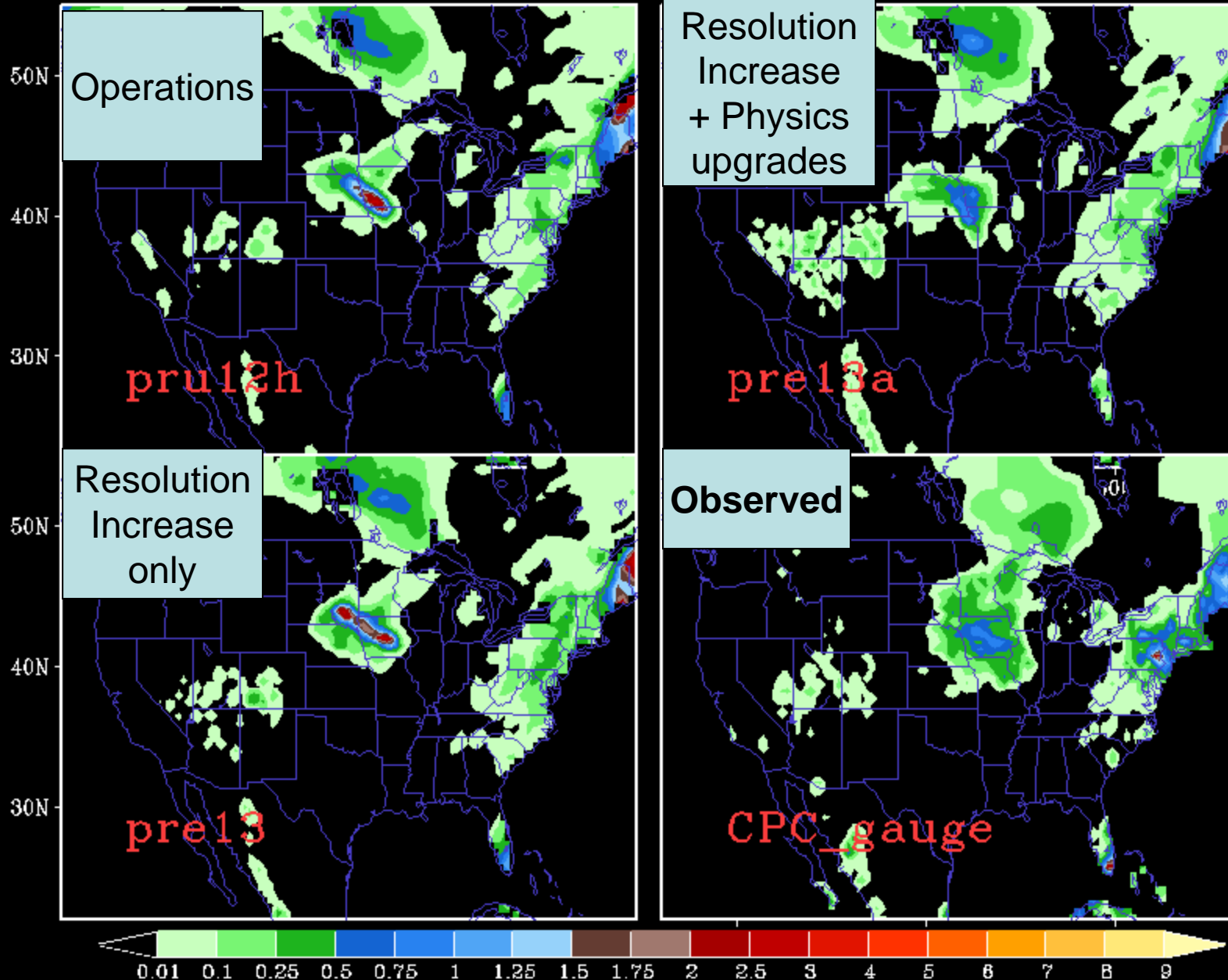
Northern Hemisphere

Southern Hemisphere

Resolution Increase + Physics upgrades

24-Hour Rainfall Endding at 2008092912 (0.5-deg, inch)
Forecast Cycle 2008092700, Fcst Hour: 36 from 60

Operations — pru12h

Resolution Increase + Physics upgrades — pre13a

Resolution Increase only — pre13

Observed — CPC_gauge

0.01 0.1 0.25 0.5 0.75 1 1.25 1.5 1.75 2 2.5 3 4 5 6 7 8 9

Results
Precipitation Scores

CONUS Precip Skill Scores, f12-f36, 20jun2008-01nov2008

Differences outside of the hollow bars are 95% significant based on 10000 Monte Carlo Tests
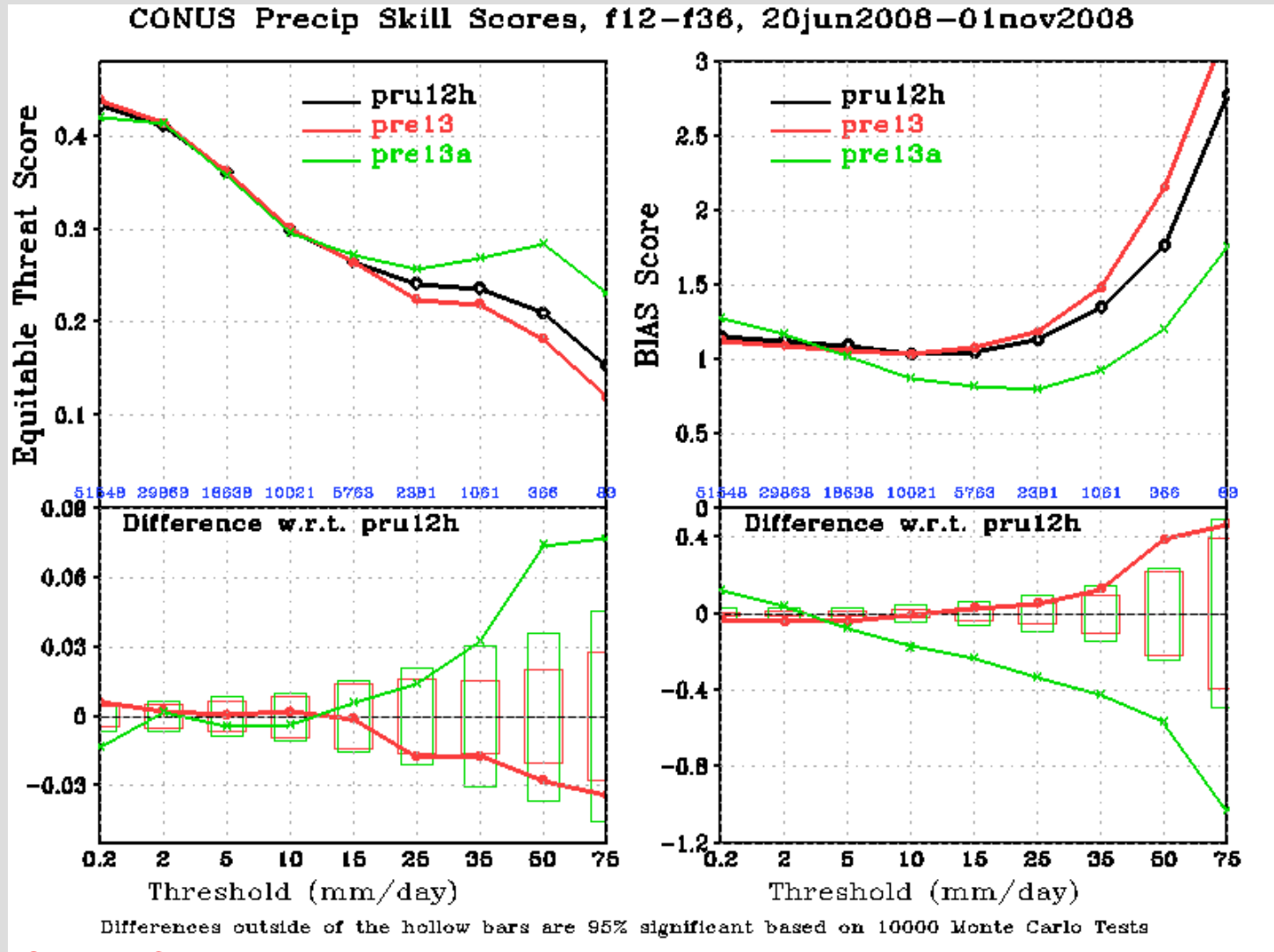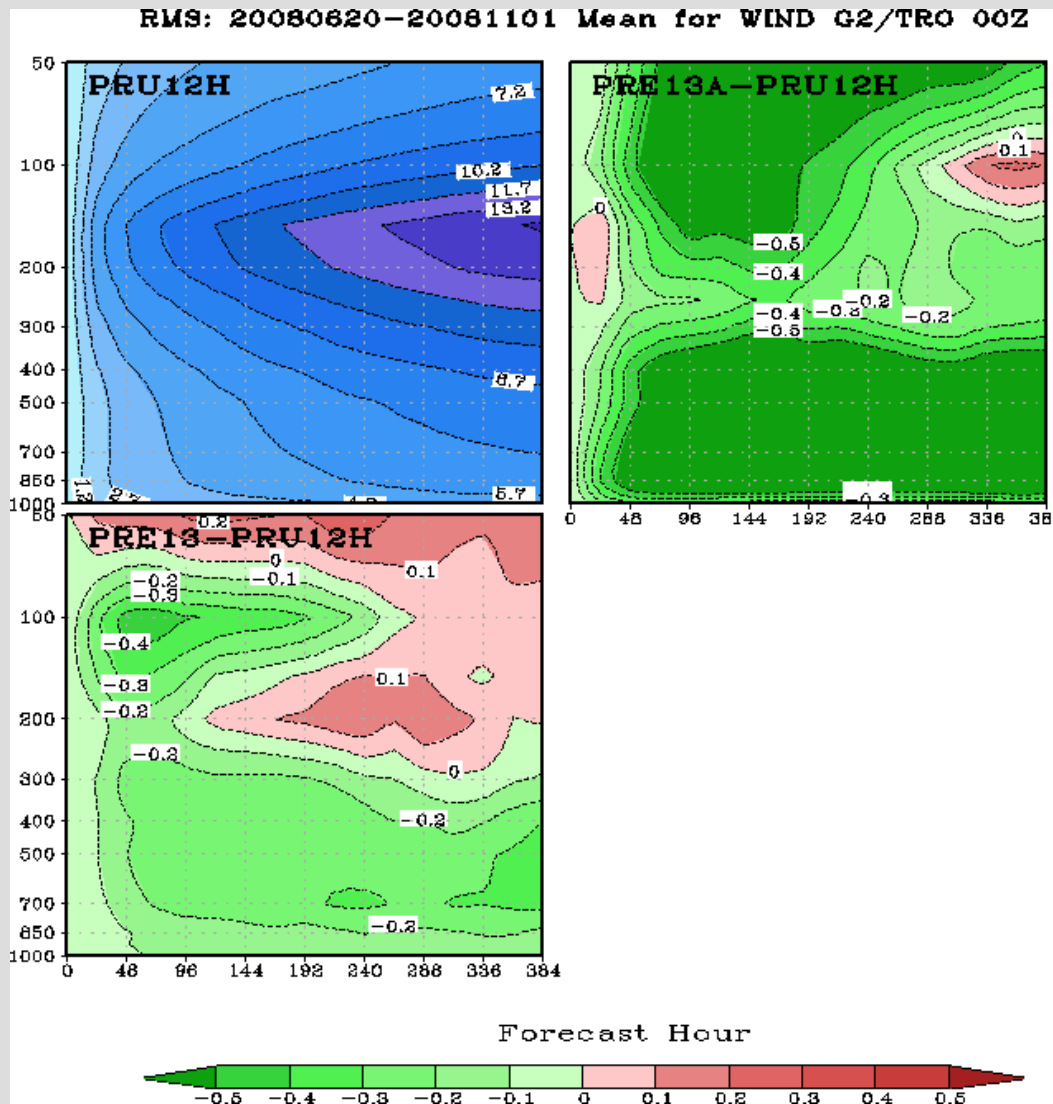
Red – without Shallow Conv
Green – With SC

Results
Tropical Wind Scores

With
Shallow Conv

Without
Shallow Conv