Assimilation of AIRS radiances using GSI/WRF for Short Term Regional Forecasts

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Overview

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2. Experimental Design
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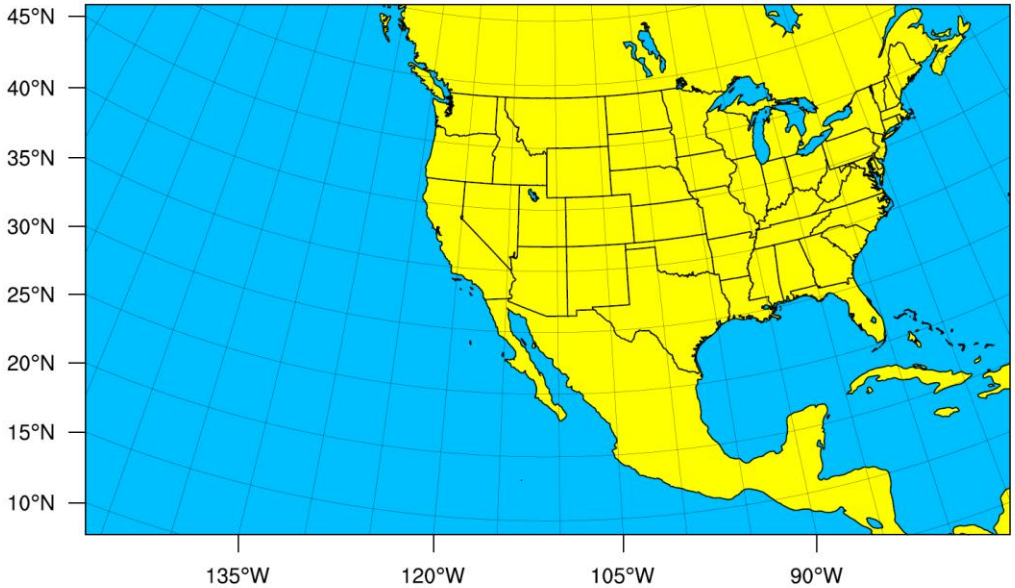
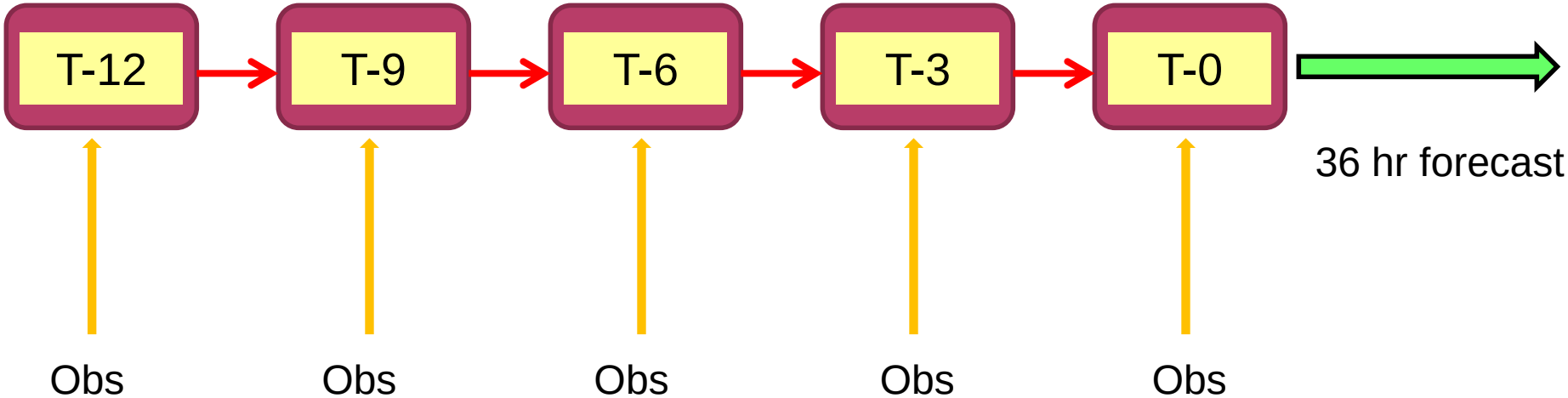
Introduction

- AIRS, hyperspectral sounder with 2378 channels.
- Increased vertical resolution (1km)
- NWP centers concluded that AIRS has a positive impact on global models.
- 12% forecast error reduction.
- Satellite radiance regional data assimilation using WRF and GSI.

Experimental Design



Initial condition and LBC: 1° GFS
Frequency : 3 hours
Horizontal Grid resolution = 13km
Domain size : 624 by 357 by 75
7 to 57°N and -170 to -53°E

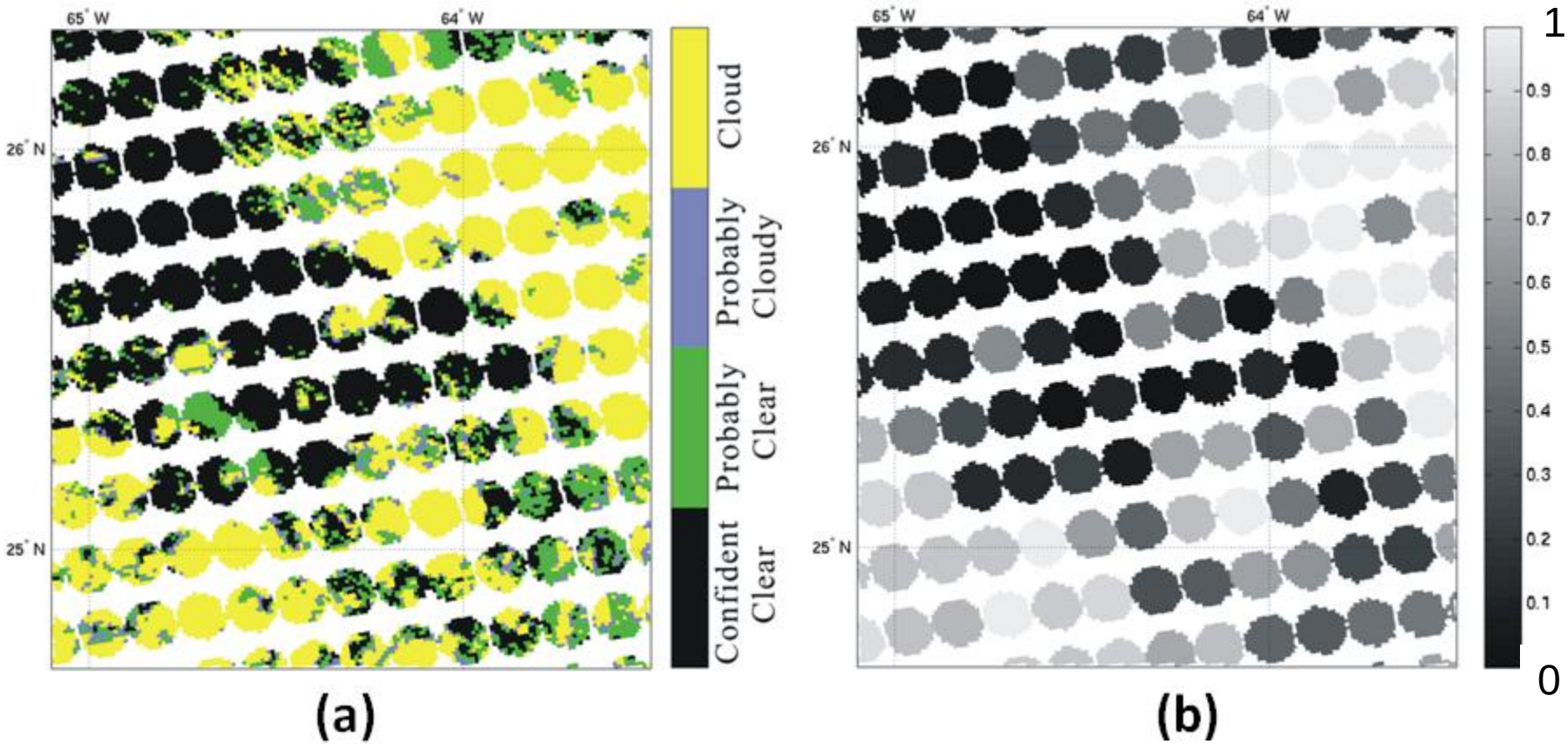


Data Assimilated

- All conventional data
- N15 : AMSU-A
- N18 : AMSU-A. MHS
- METOP-A : AMSU-A, MHS, HIRS-4
- AQUA : AIRS clear sky conditions

Control Run (CTRL) : all conventional + microwave/broadband IR data
Experiment Run (EXP) : Control Run + AIRS

Quality Control of AIRS radiances

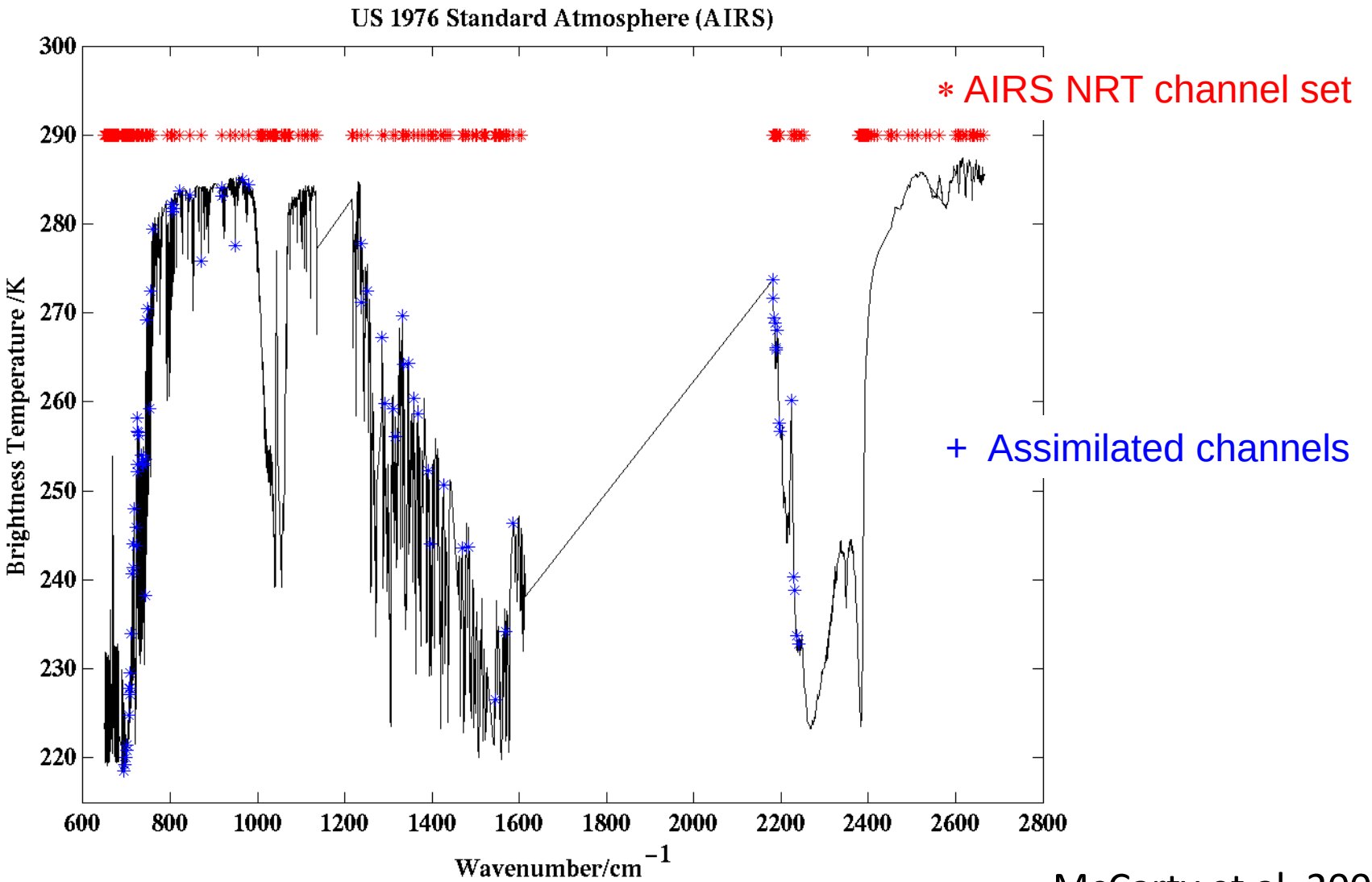


(a) MODIS cloud mask at 1km resolution superimposed with the AIRS footprint

(b) AIRS cloud fraction between 0 and 1.

Li et al, 2005

Channel Selection for AIRS

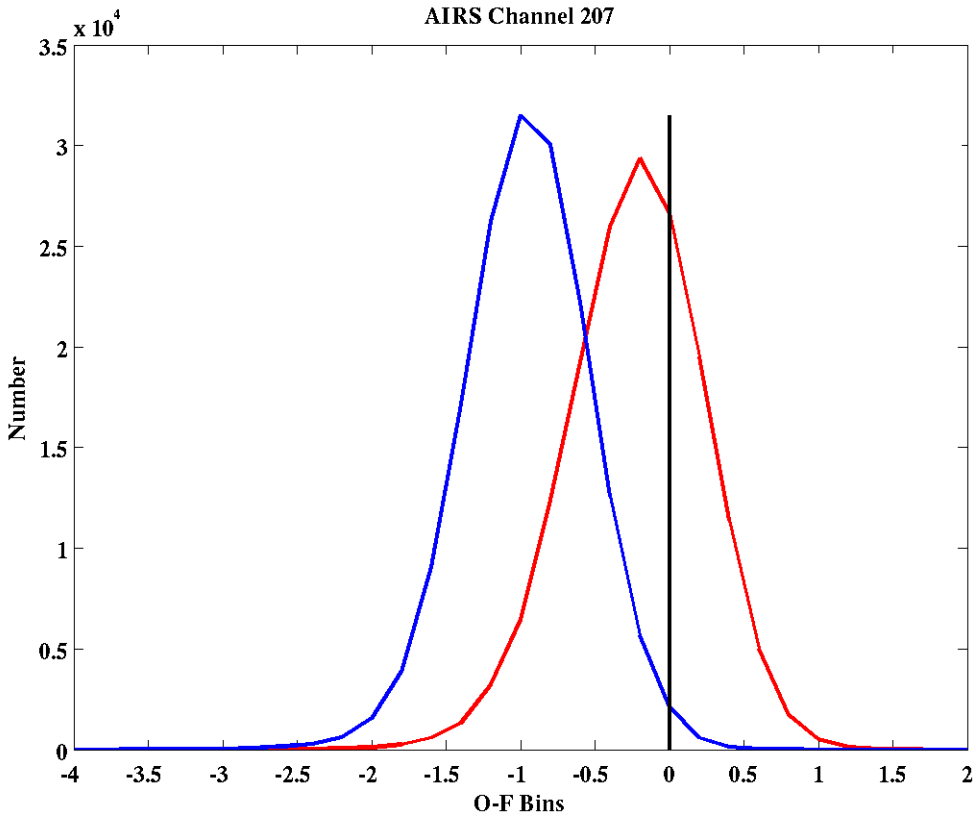


McCarty et al, 2009

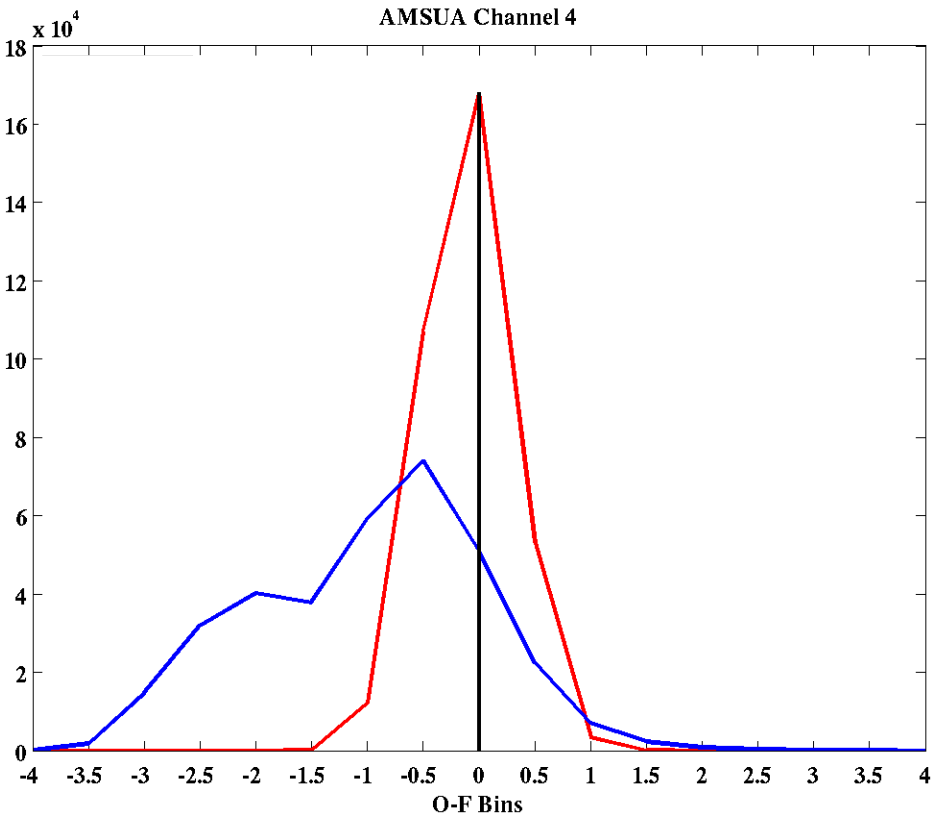
Histogram of O-F before and after BC

O = observation, F= first guess

AIRS Temperature channel



AMSU-A surface channel



Bias corrected

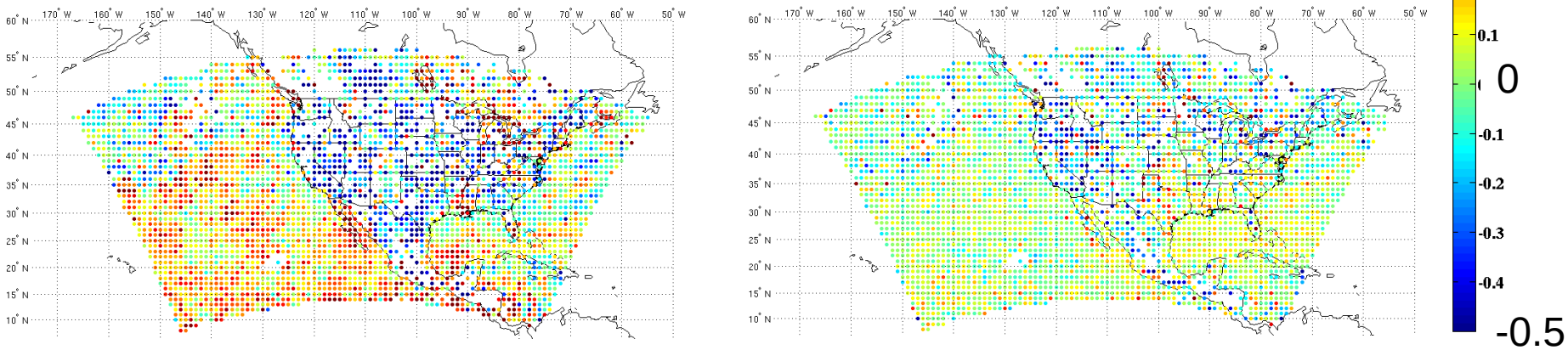
Not Bias corrected

Geographical Distribution of O-F / O-A

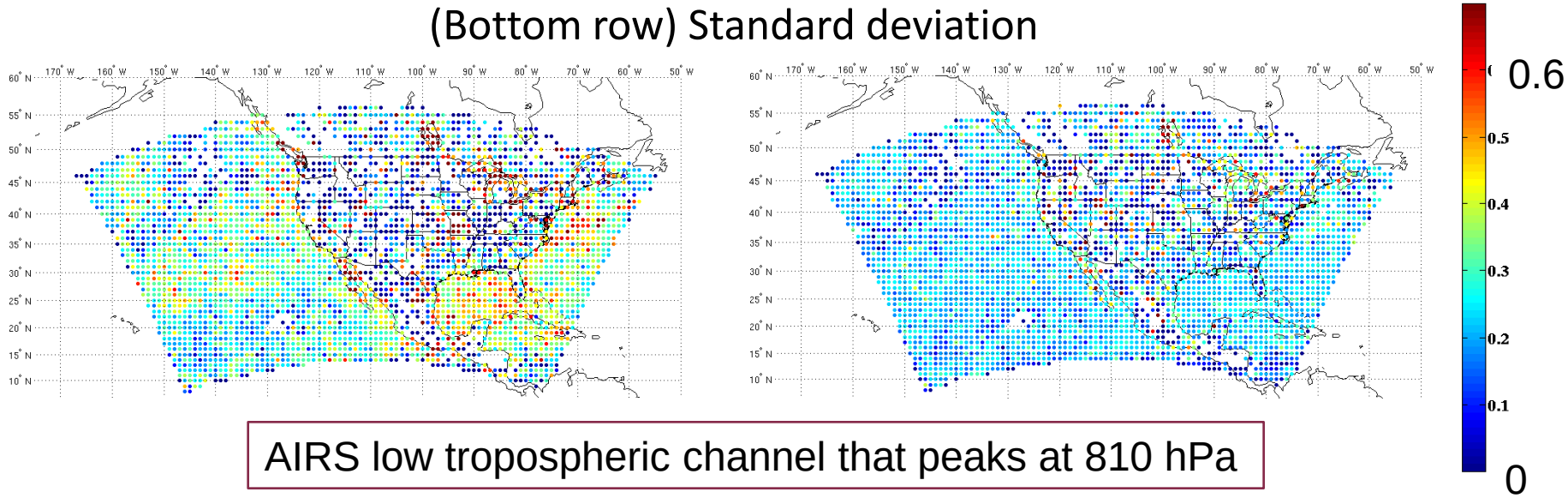
O = observation, F= first guess, A= analysis

(Top row) Bias

O-F [K] **O-A [K]**



(Bottom row) Standard deviation

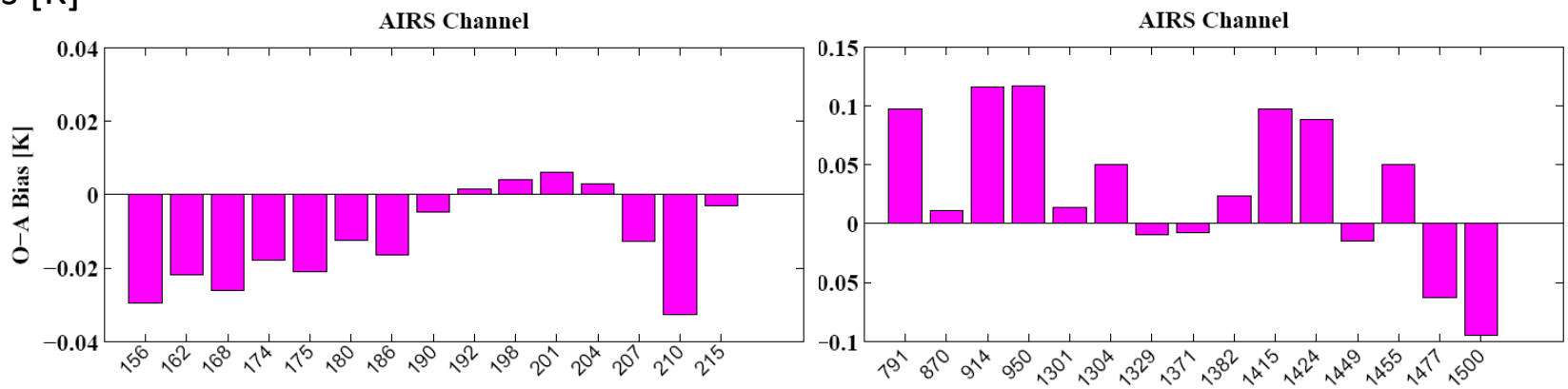


AIRS low tropospheric channel that peaks at 810 hPa

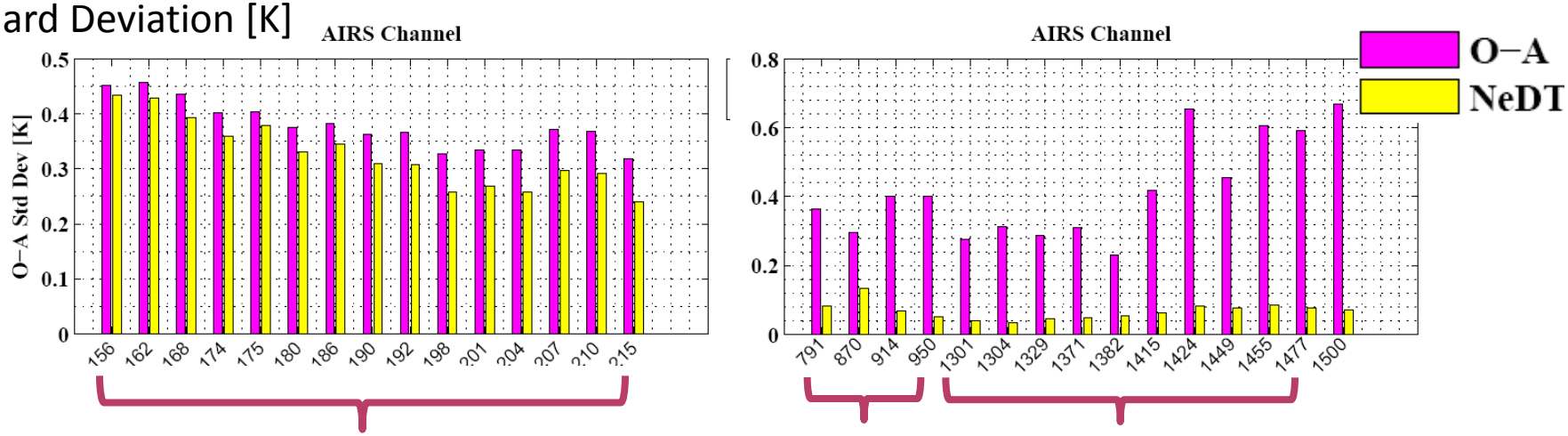
Statistics of O-A for AIRS channels

O = observation, A= analysis

Bias [K]



Standard Deviation [K]

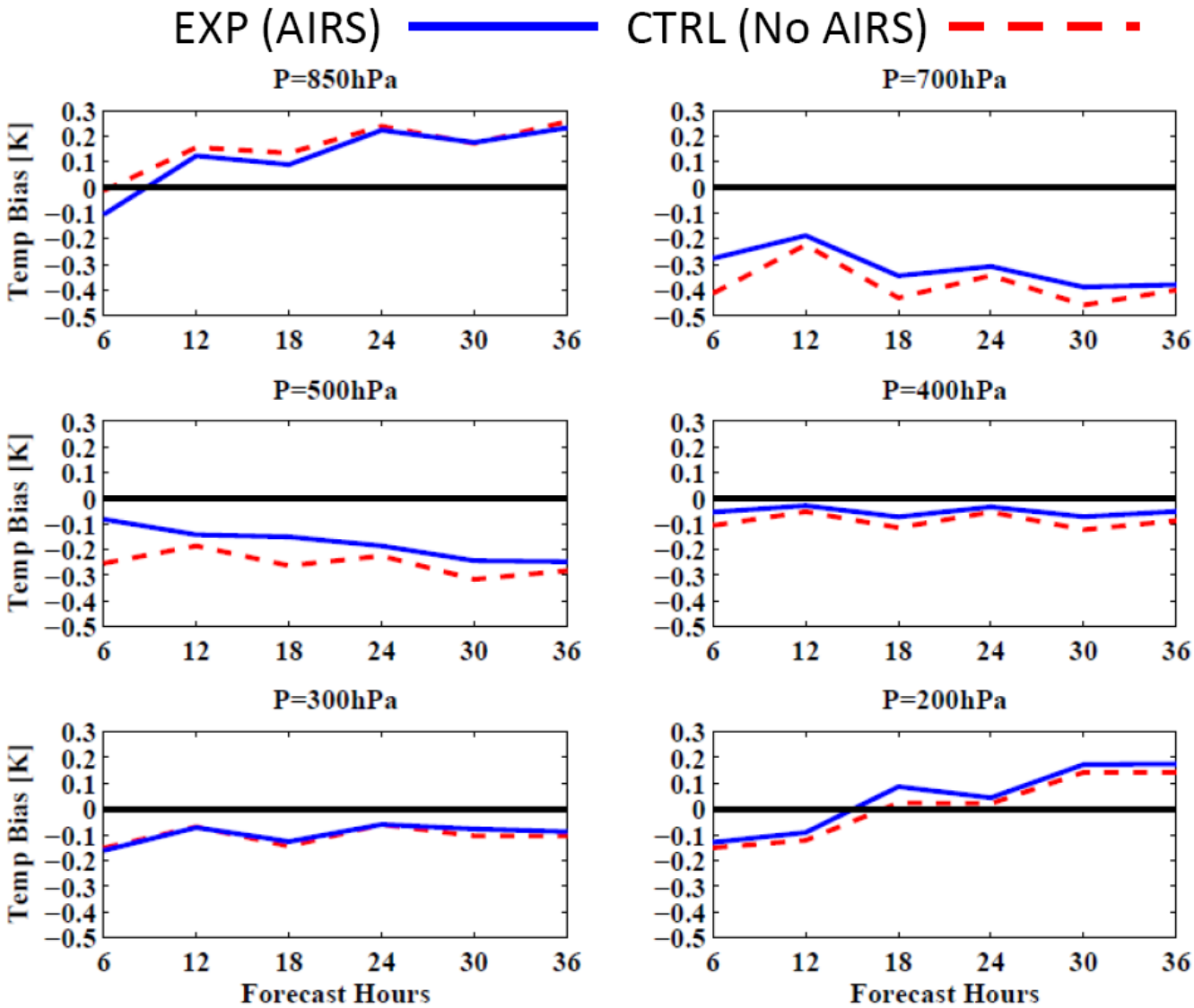


Temperature Sounding Channels

Surface Channels

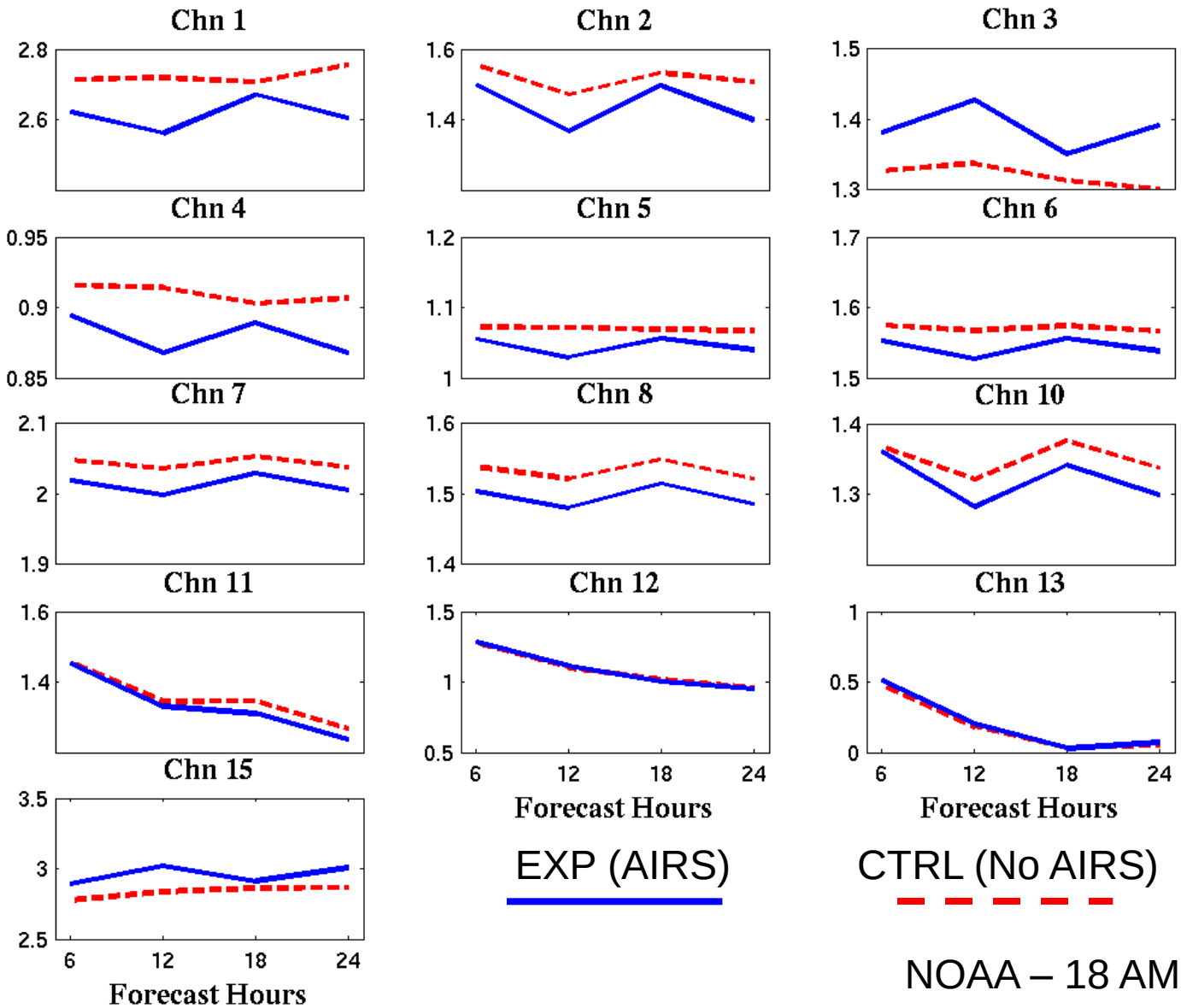
Water Vapor Channels

Verification against Radiosondes



Verification against Satellite Radiances

Absolute Bias

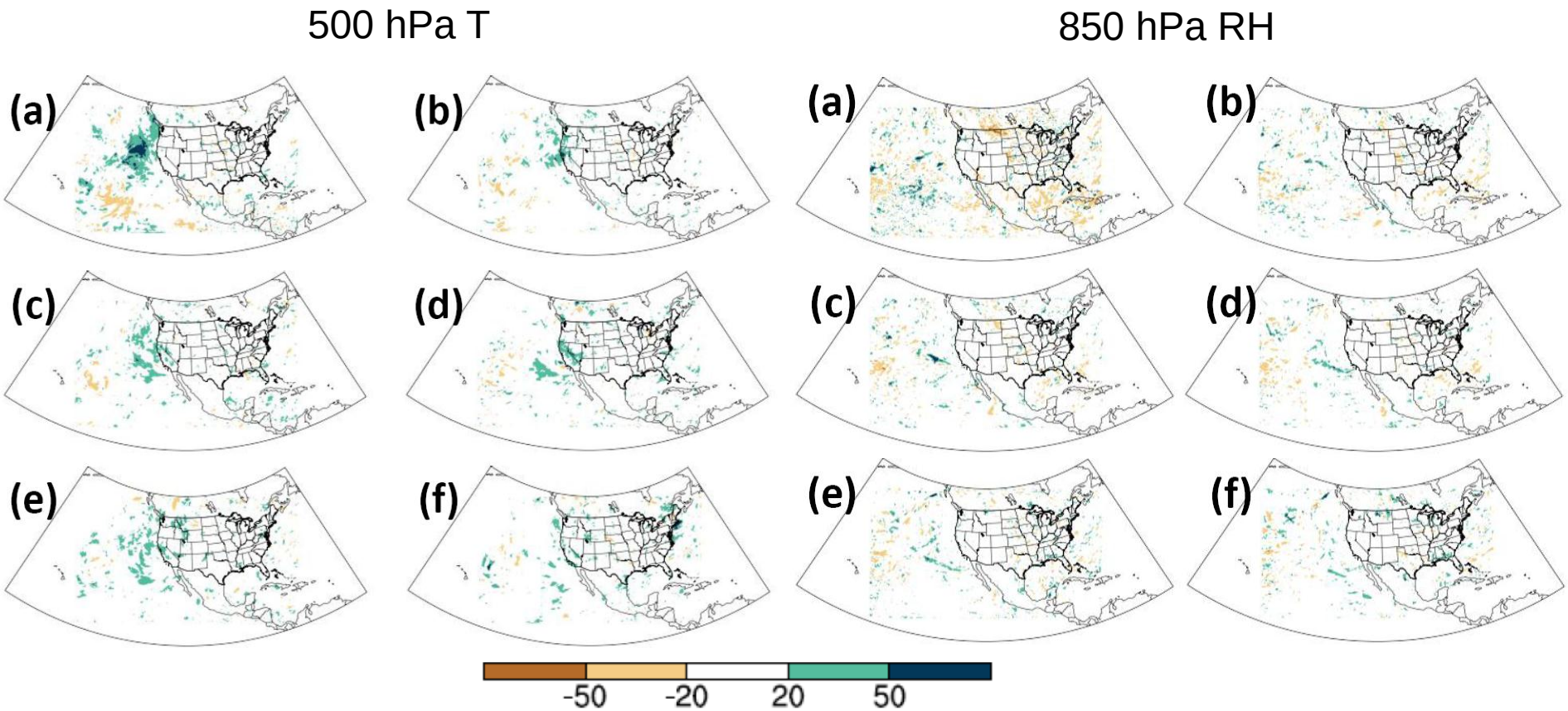


EXP (AIRS)

CTRL (No AIRS)

NOAA – 18 AMSU-A

Forecast Impact [%]



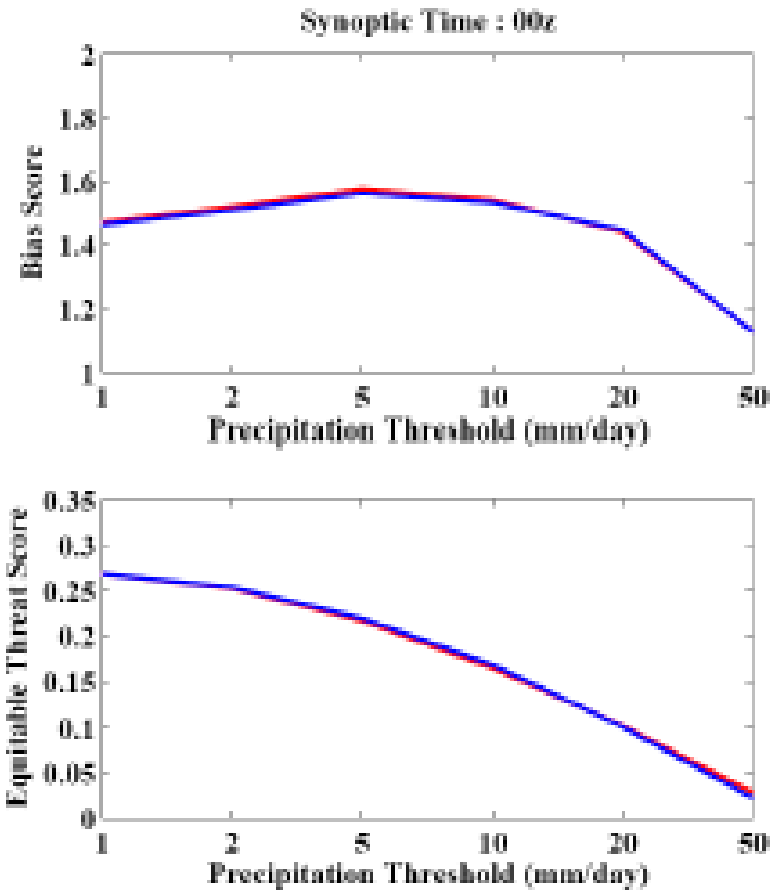
Forecast hours (a) 6, (b) 12, (c) 18, (d) 24, (e) 30 and (f) 36

- **Zapotocny et al, 2005**
- **Positive impact => forecast compared more favorable to the corresponding analysis with assimilation of AIRS radiances.**

Precipitation Forecast Skill Scores

- **NCEP Stage IV Precipitation Analysis**
- **Frequency bias**
  - **Ratio of forecast yes to observed yes**
  - **> 1 => overestimation**
  - **< 1 => underestimation**
- **Equitable Threat Score (ETS)**
  - **fraction of observed or forecast events that are correctly predicted and adjusted for hits associated with random chance**
  - **$-\frac{1}{3}$ to 1 where 0 => no skill**

Analysis Time = 00 UTC



No Airs **Airs**

Conclusion

- Limited Area NWP carry out using community models
- Assimilation of clear sky AIRS radiances.
- Results Summary
  - Present of bias in water vapor and surface channels
  - Significant bias exist in the 06/18 UTC analyses
  - Improvement in mean forecast errors for verification against radiosondes and BT
  - Near neutral impact for clear sky AIRS assimilation
- Future Work
  - More tuning is necessary
  - Re-run experiments on operational system
  - Assimilate single field of view cloud cleared AIRS radiances