Assessment of Forecast Impact from JPSS Direct Readout Data for the Rapid Refresh Mesoscale Model System

Critical Weather, NWP and Data Assimilation Initiative

Yuanfu Xie, Haidao Liu,
Stephen Weygandt, Stan Benjamin
NOAA ESRL/GSD

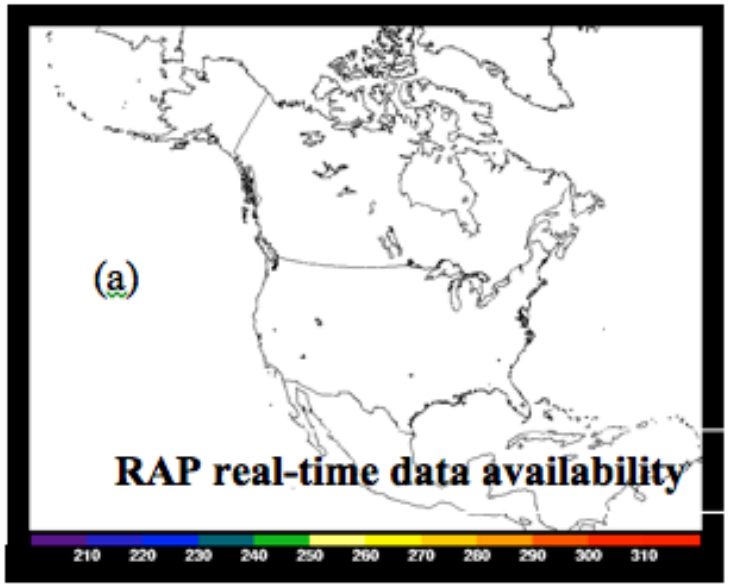
Outline

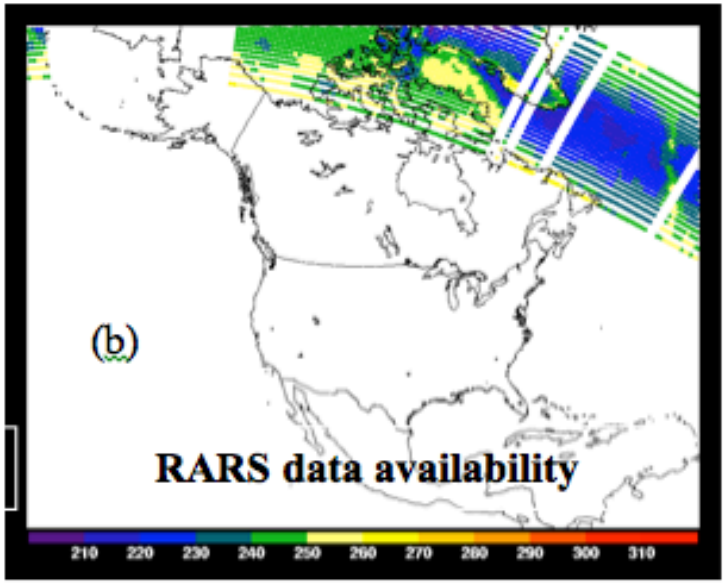
- Introduction
- Data Coverage and Channel Selection
- Retrospective Case Studies
- Evaluation
- Future Plan

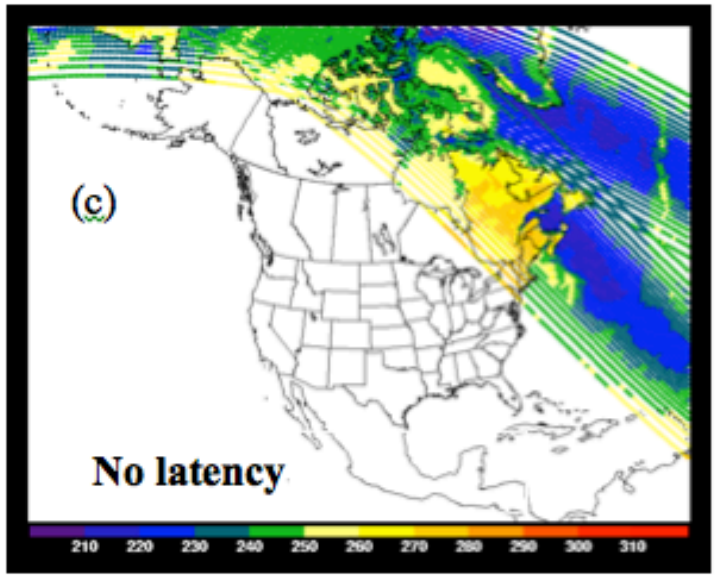
Introduction

- Brief Project Description
  - Use direct-readout global radiance data to improve forecasts for RAP and HRRR
- Goals/Objectives
  - Improve accuracy for better aviation and severe weather guidance
  - Improve the availability of S-NPP data (and future JPSS) latency
  - Provide experimental guidance with global rapid refresh model
- Targeted End Users and Affiliation
  - FAA, other transportation, AWC
  - Severe weather community – SPC, all NWS, WPC
- R2O Planning
  - via RAP/HRRR upgrades

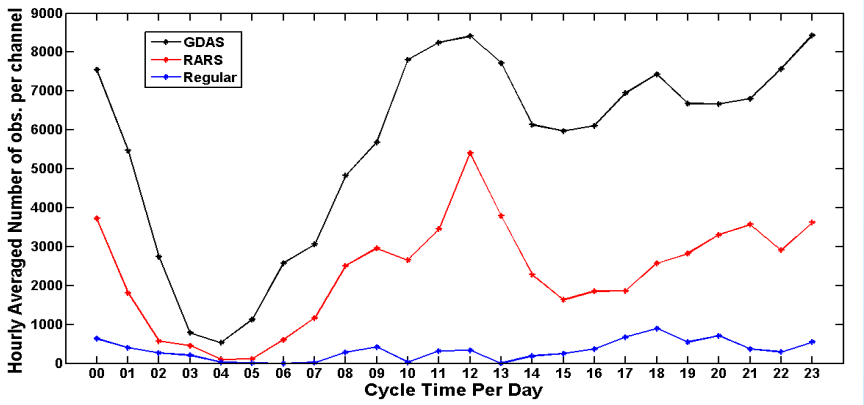
Direct RARS Data Coverage Impact





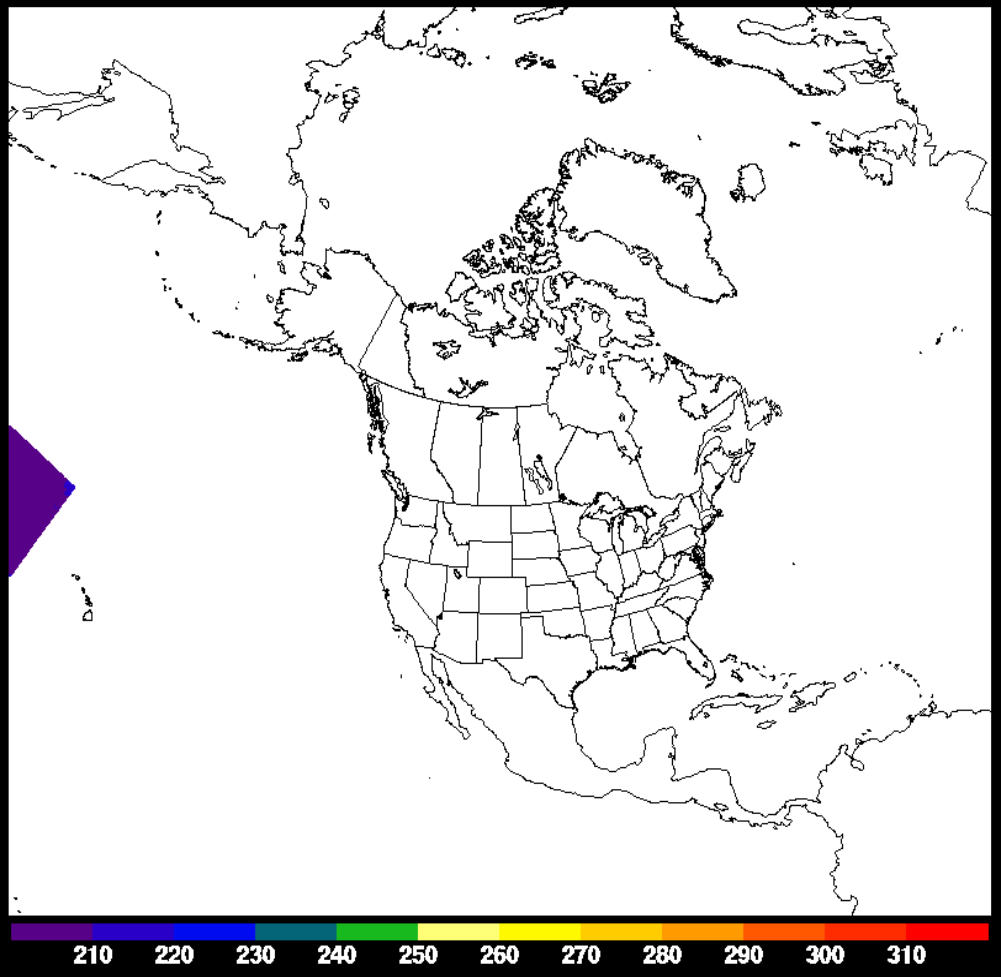


Hourly averaged observation number, for regular feed, RARS feed, and ideal condition GDAS conditions,

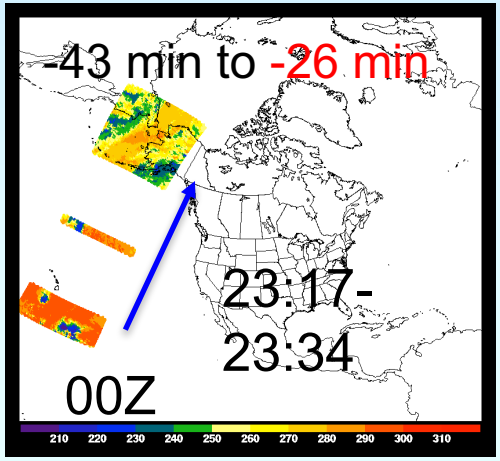


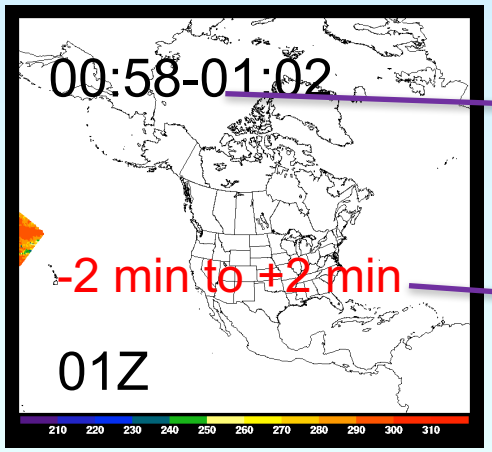
ATMS Data Coverage

Hourly ATMS data coverage on 8/25/2016.



SSEC CrIS data coverage (+/- 1.5 h) on 08/25/2016





From channel 311

Observed time

02Z
N/A

03Z
N/A

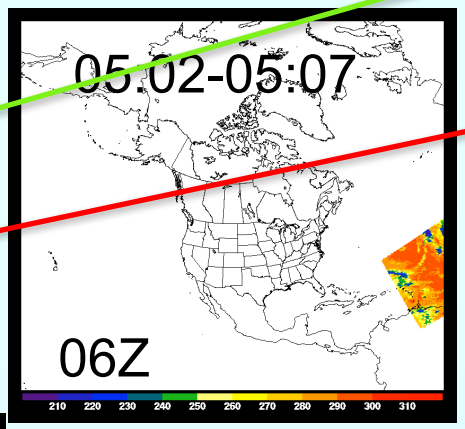
Observed time minus the the analysis time

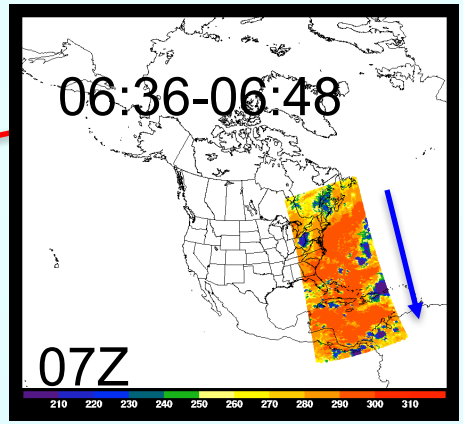
-58 min to -53 min

-24 min to -12 min

04Z
N/A

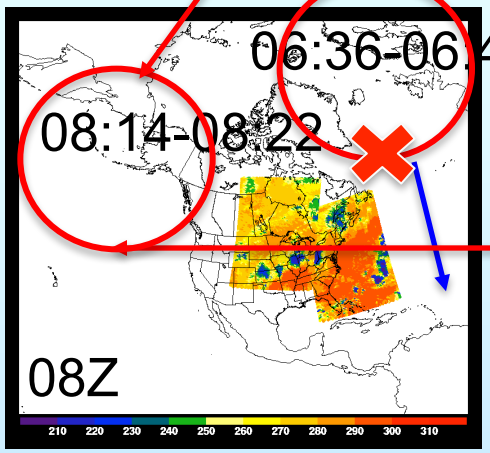
05Z
N/A

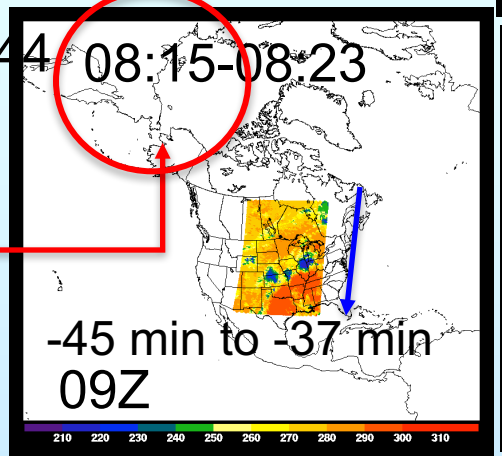


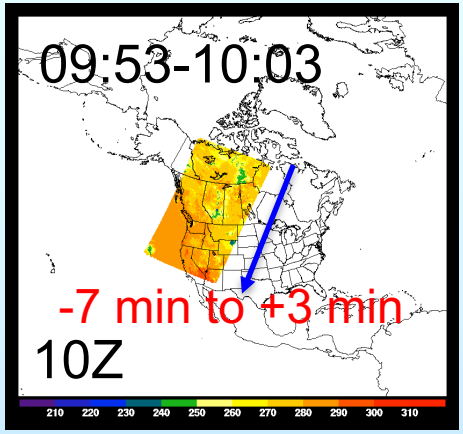


-84 min to -66 min

+14 min to +22 min

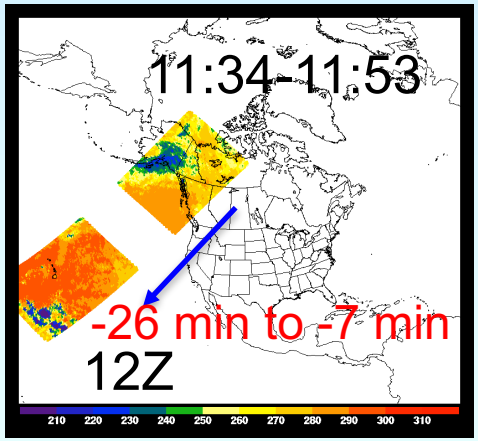




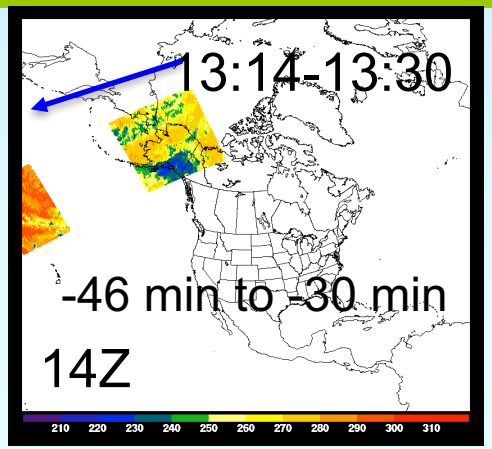


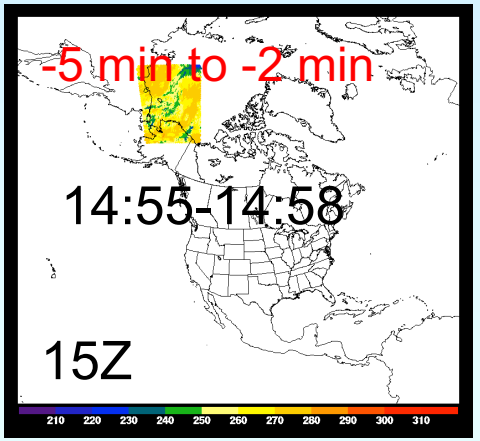
11Z
N/A

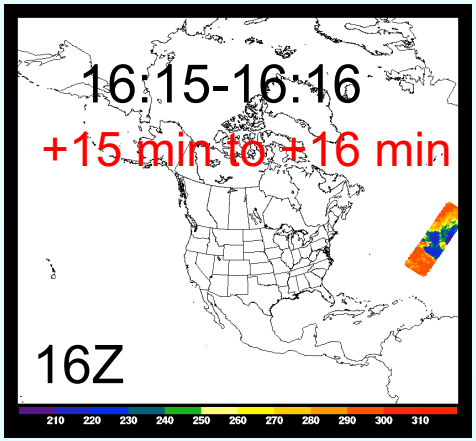
SSEC CrIS data coverage on 08/25/2016

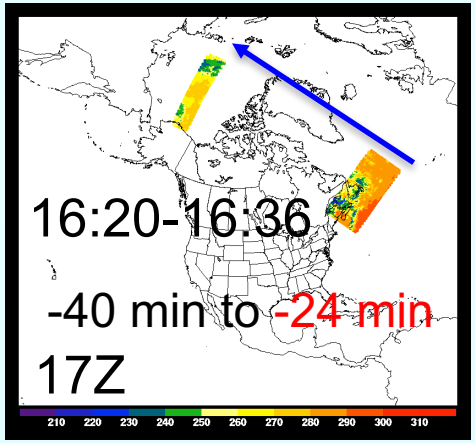


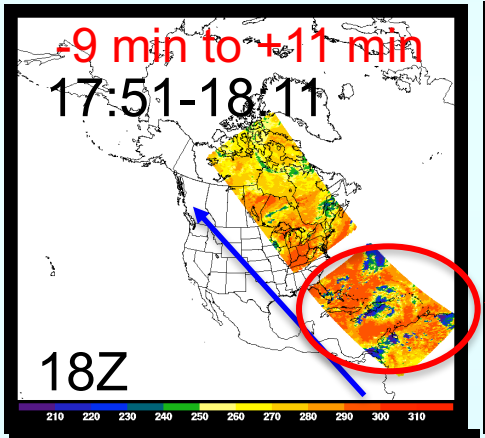
13Z
N//A

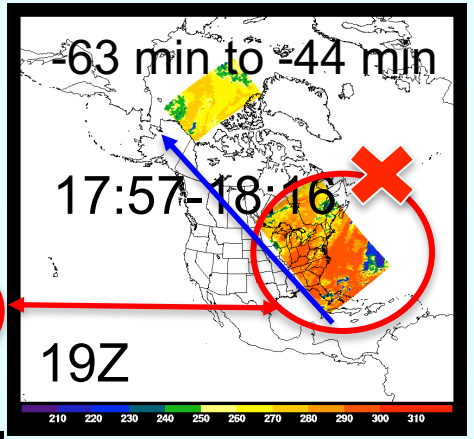


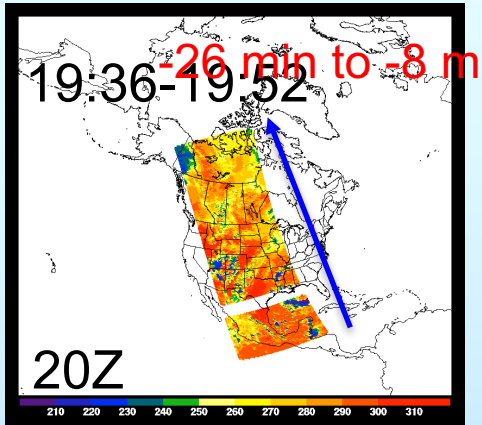




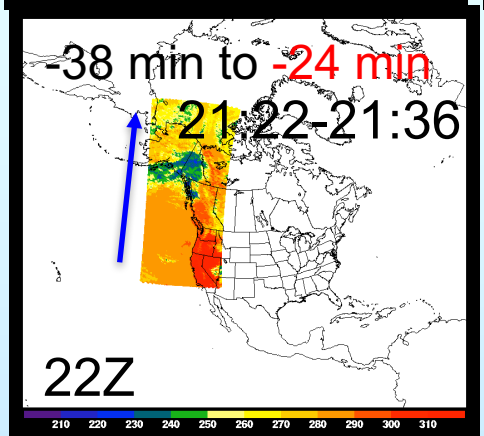


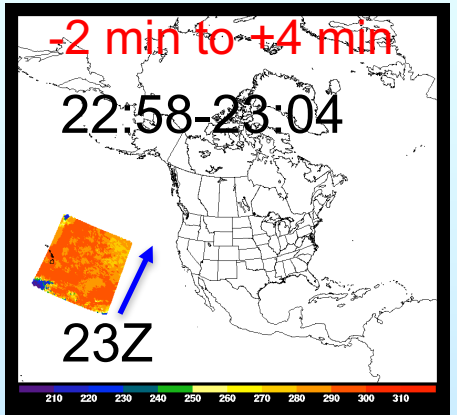




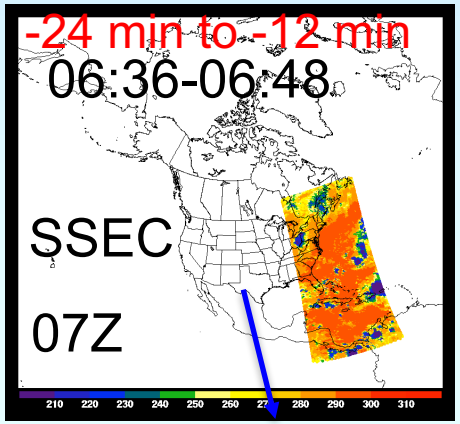


21Z
N/A

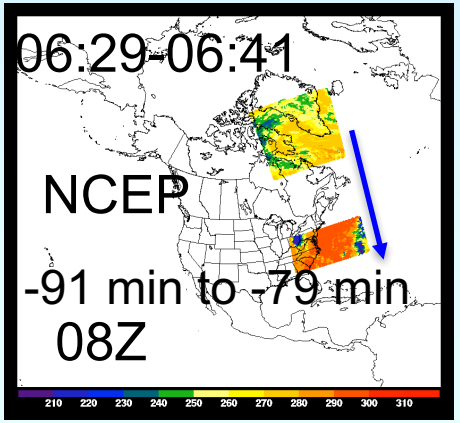


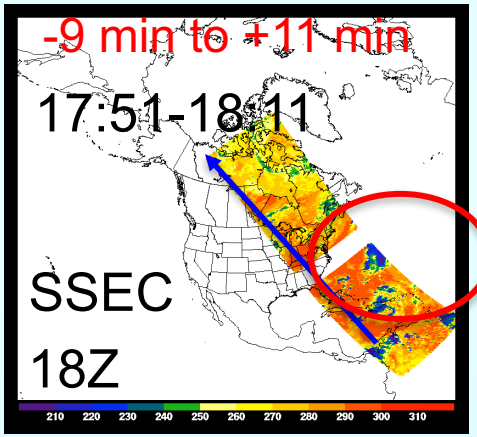


SSEC vs. NCEP (selected hours)

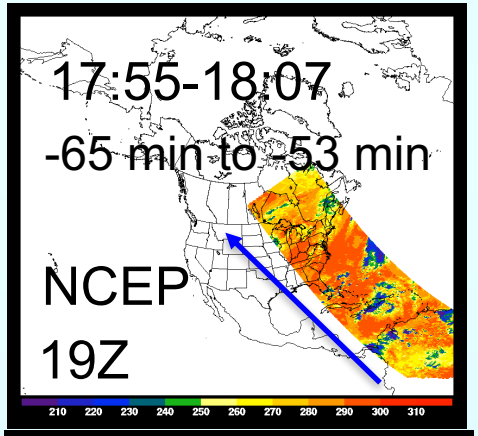


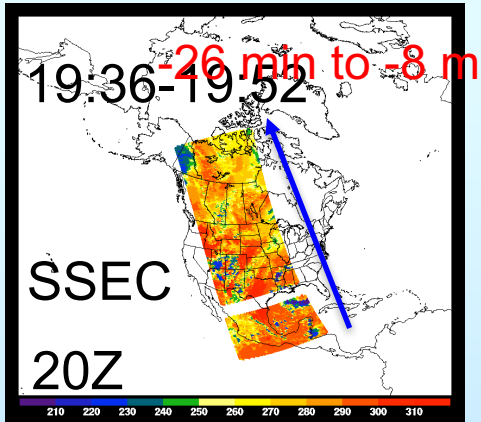
NCEP 07Z N/A



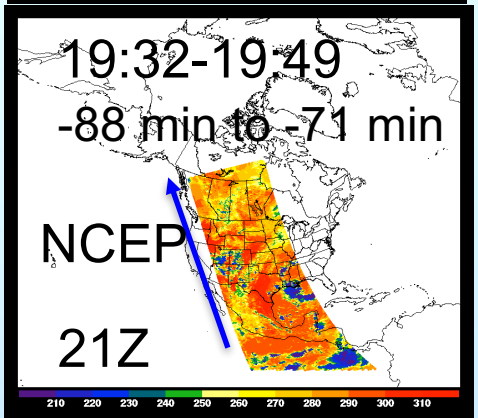


NCEP 18Z N/A





NCEP 20Z N/A



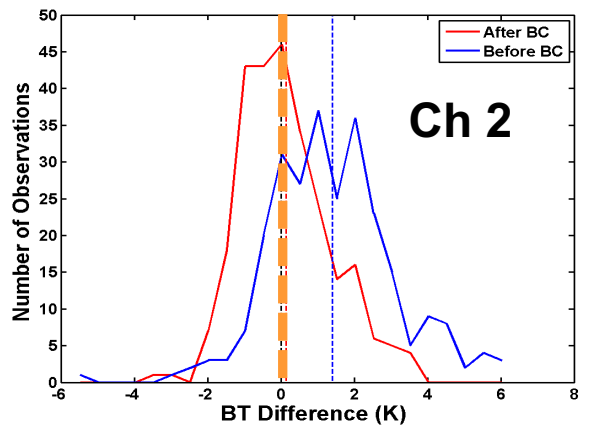
Channel Selection

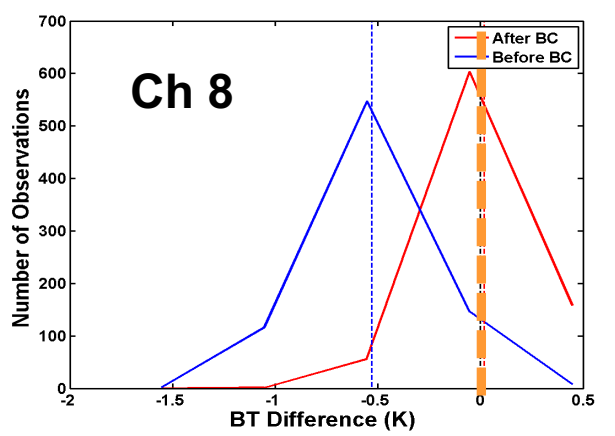
- Adopt some well accepted channel selection schemes:
- ATMS: channels 1-11, 16-22 (remove several high level channels (12-15) to fit RAP 10 hPa model top;
- CrIS: simply using NCEP GDAS selected channels (82 channels, since their peak weighting function heights are below 10 hPa, we will refine the channel selection in our future work);

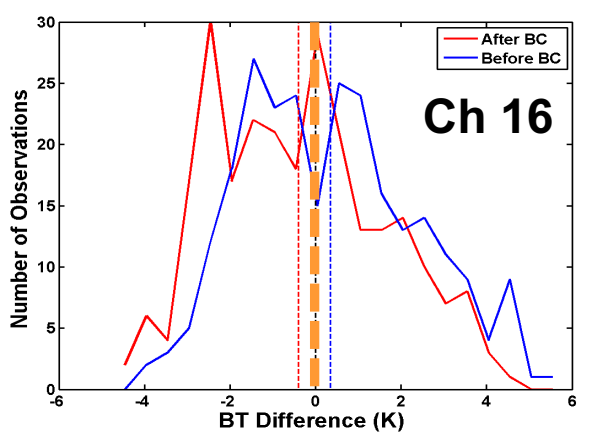
ATMS cycled bias correction

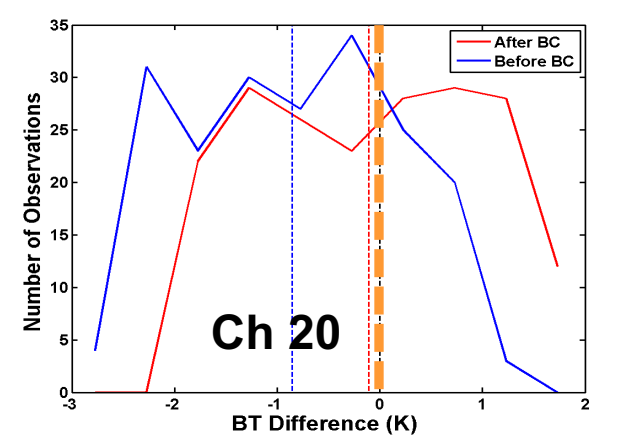
- Retro period from 1-7 Feb. 2016, hourly cycling
- Data from SSEC, +/- 1.5 hr data window, compare to EMC data
- Channel selection to remove high peaking channels (12,13,14)
- Cycled bias correction -- but no pre-retro spin-up of bias correction coefficients

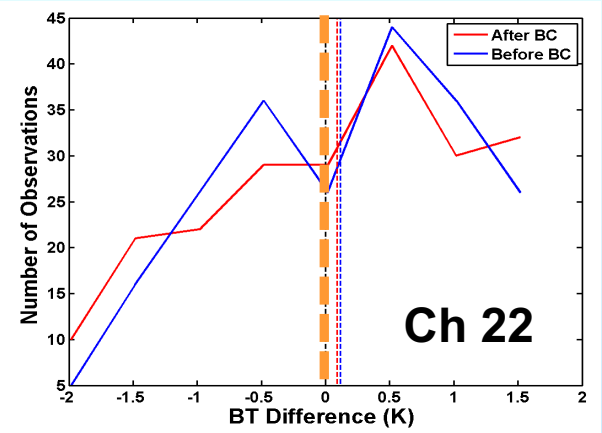
Sample bias Correction from 6z Feb 4, 2016











Ideal Direct Satellite Data vs. RAP Real Time Data Assimilated

We examine a particular time of the data feed for AMSUA and MHS, 20160826 15Z.

- Direct readout has twice as much as data
- On the direct readout experiment, CrIS and ATMS data are additional
- This is an ideal case from GDAS data

Satellite	Instrument	Direct Readout	RAP Real Time
NOAA 15	AMSUA	29712	0
NOAA 18	AMSUA	10266	0
NOAA 19	AMSUA	22149	11606
NOAA 18	MHS	5668	0
NOAA 19	MHS	4333	2056

Experiments

Several RAP direct readout experiments

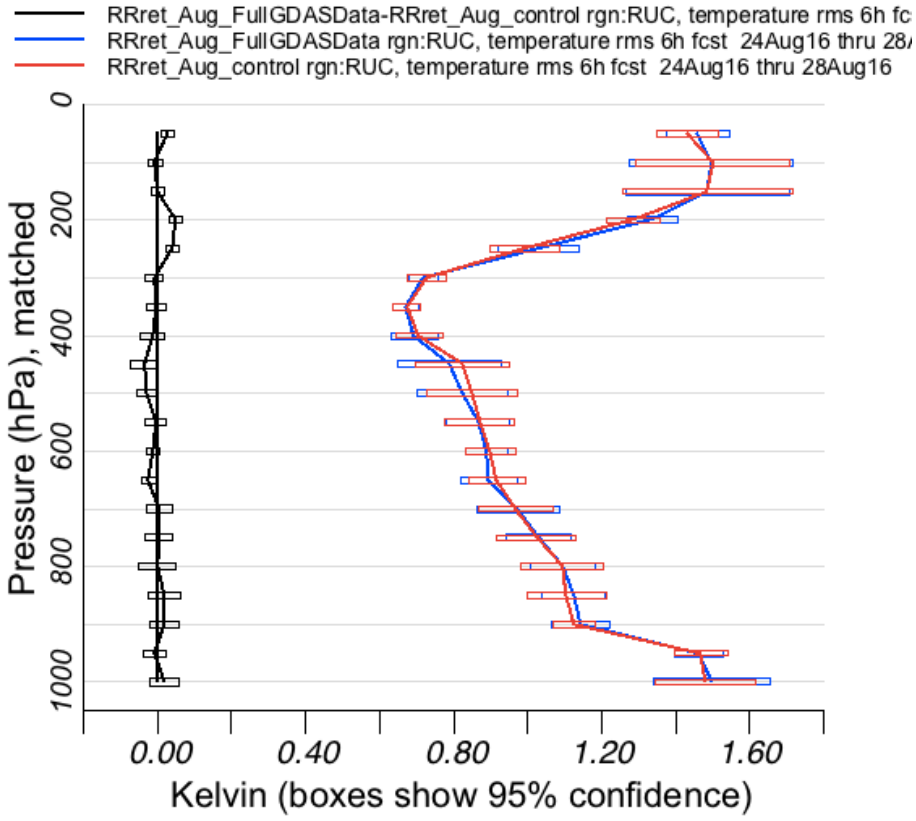
- Feb. 1-7, 2016 with ATMS data only
- August 23-31, 2016 with CrIS data only

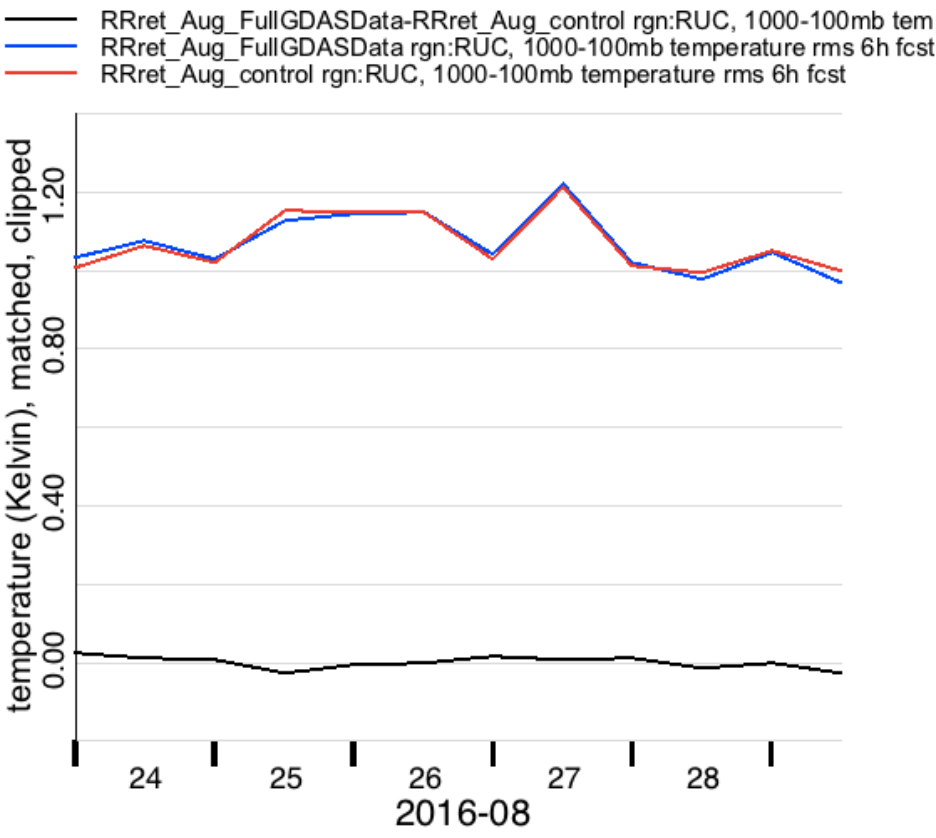
There are slight impact. So an ideal experiment is set with full archived GDAS data set which represents the best scenario for direct readout.

August 23-31, 2016 with full GDAS data

Full GDAS satellite with ATMS and CrIS impact: RMS

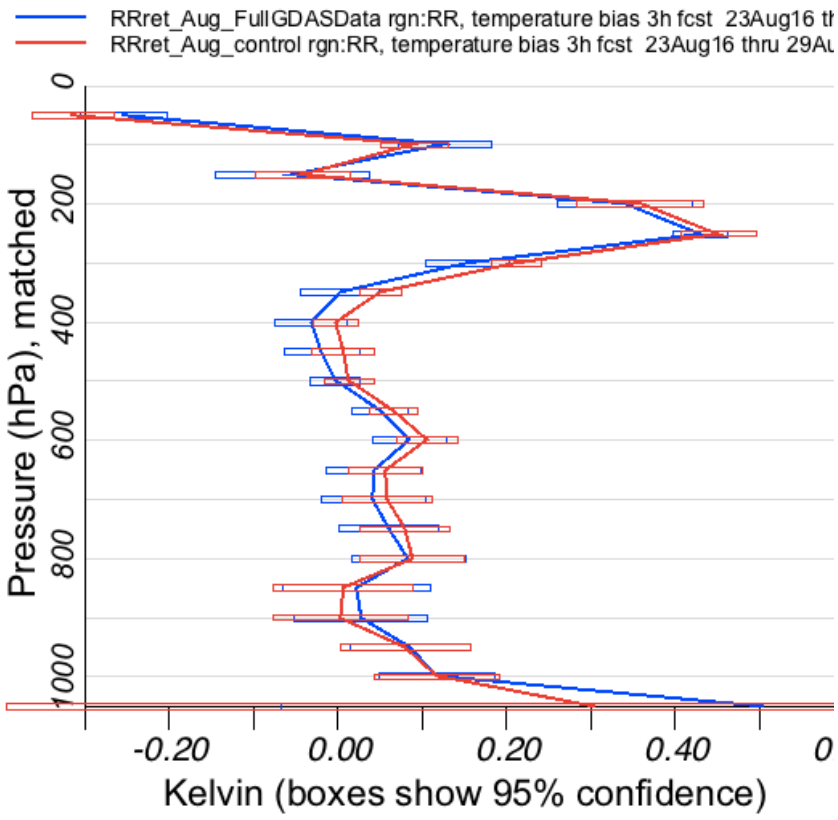
Slight improvement on 6h FCST RMS error in temperature

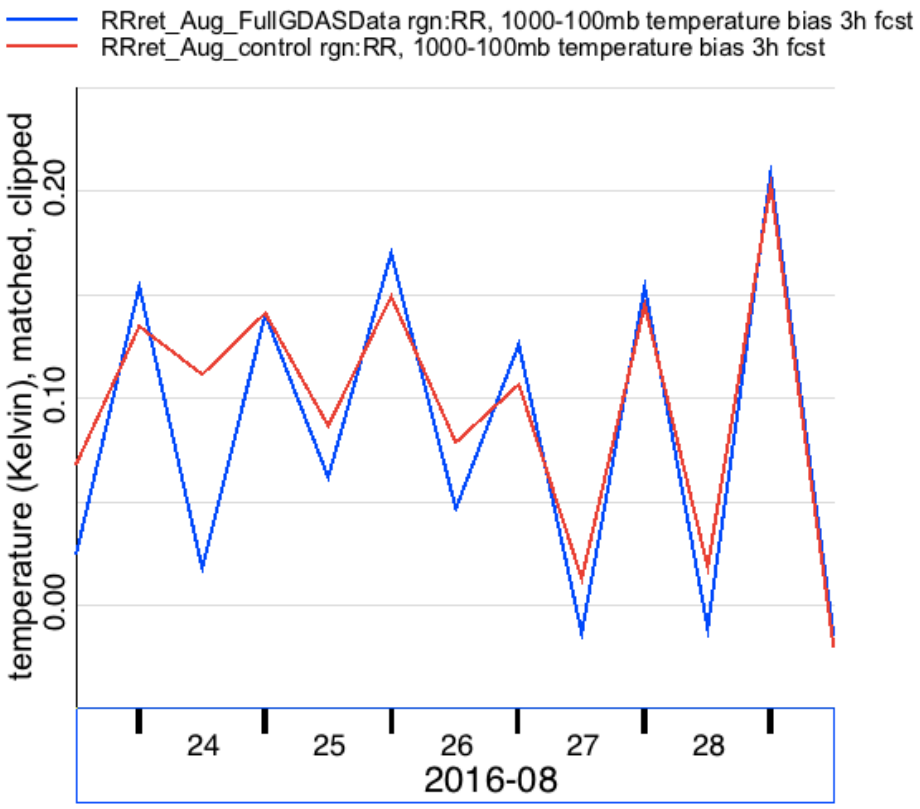




Full GDAS satellite with ATMS and CrIS impact: BIAS

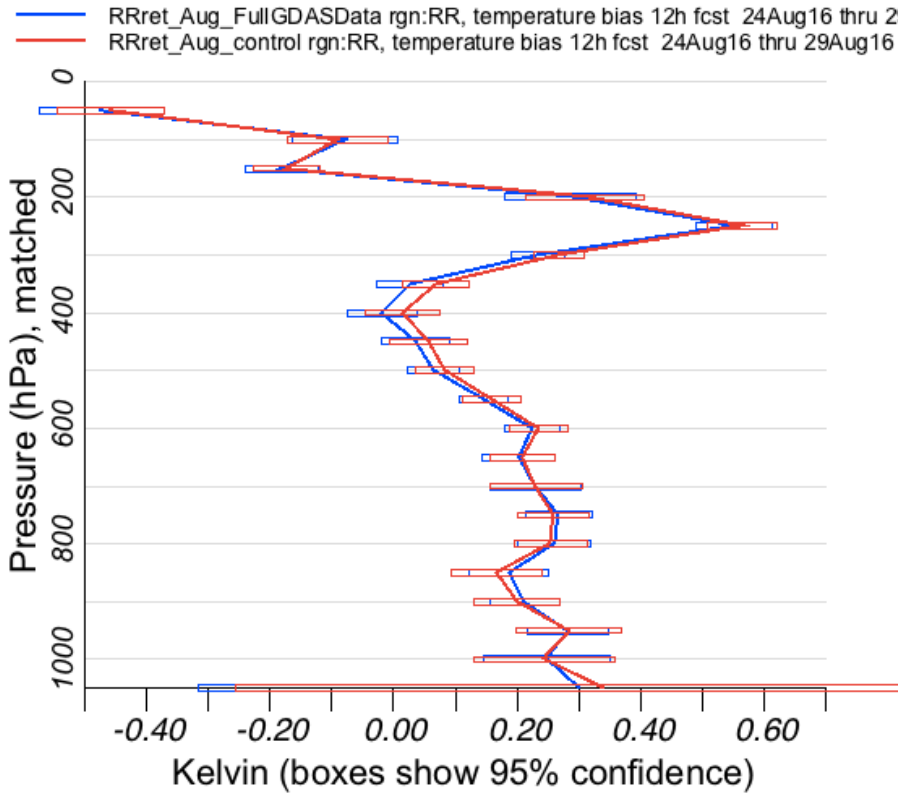
Slight improvement on 3h FCST RMS error in temperature

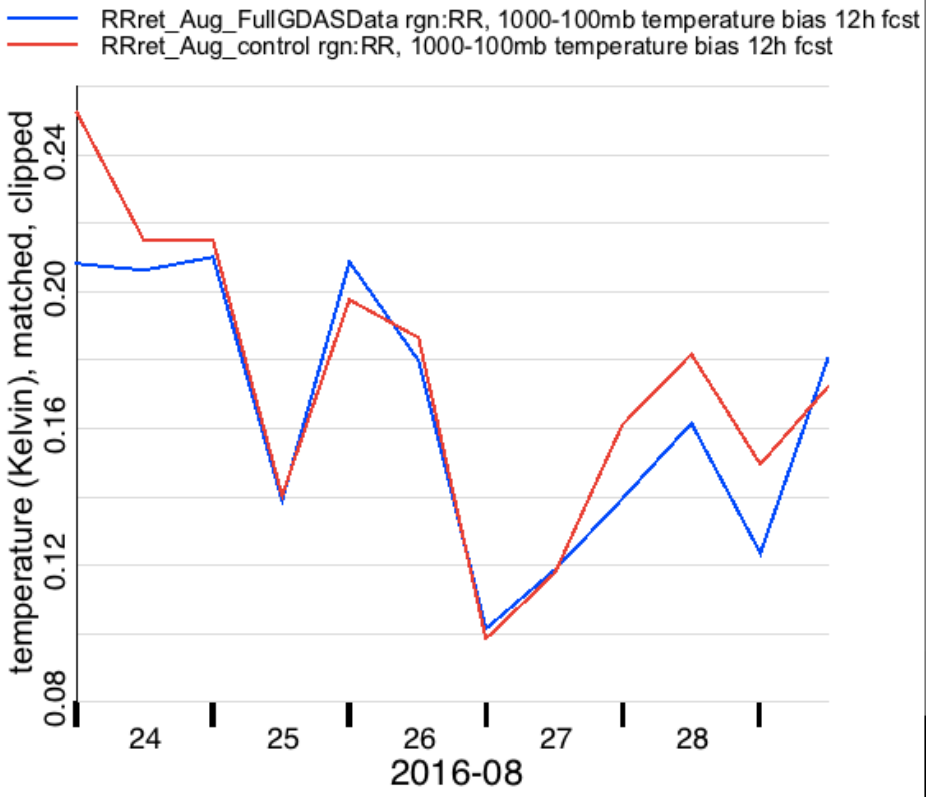




Full GDAS satellite with ATMS and CrIS impact: BIAS

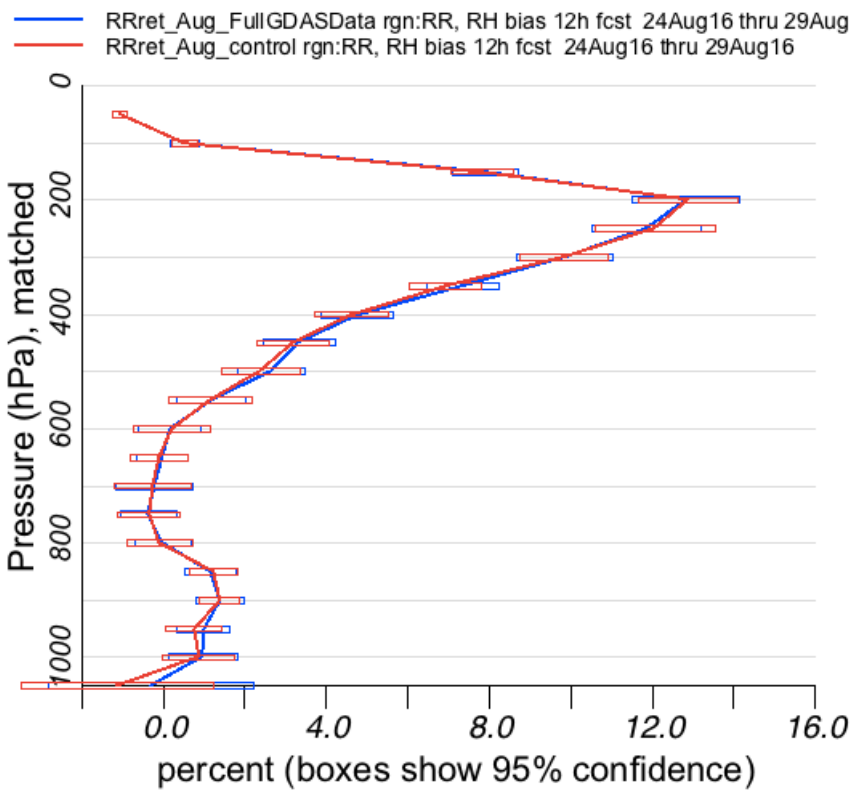
Slight improvement on 12h FCST RMS error in temperature

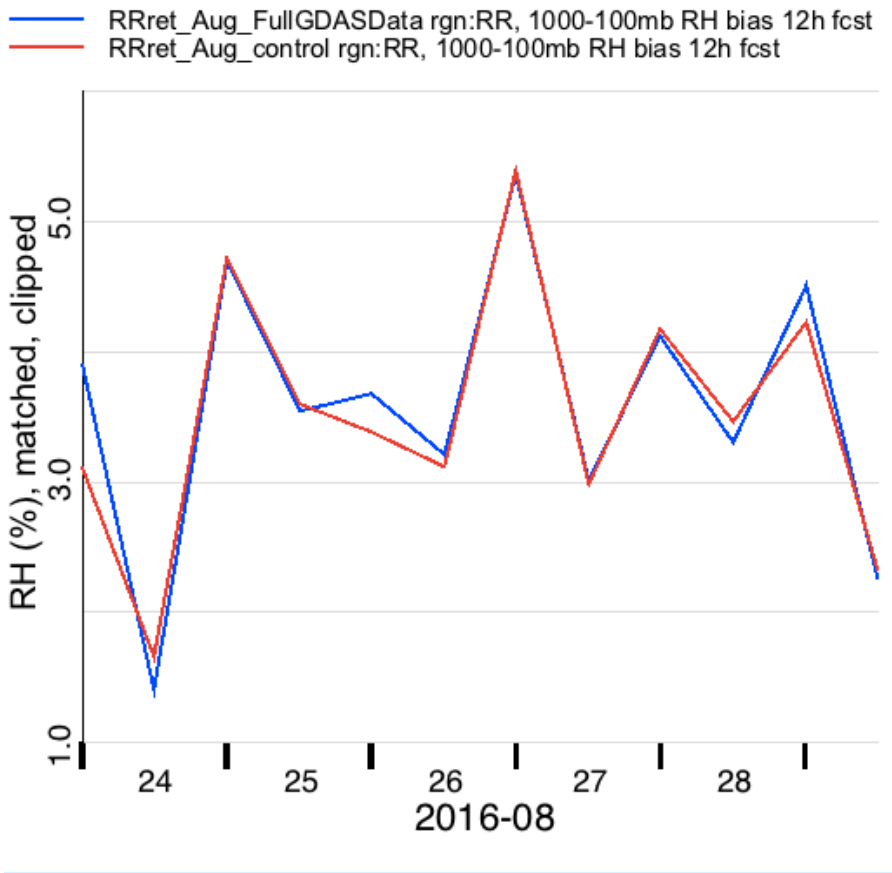




Full GDAS satellite with ATMS and CrIS impact: BIAS

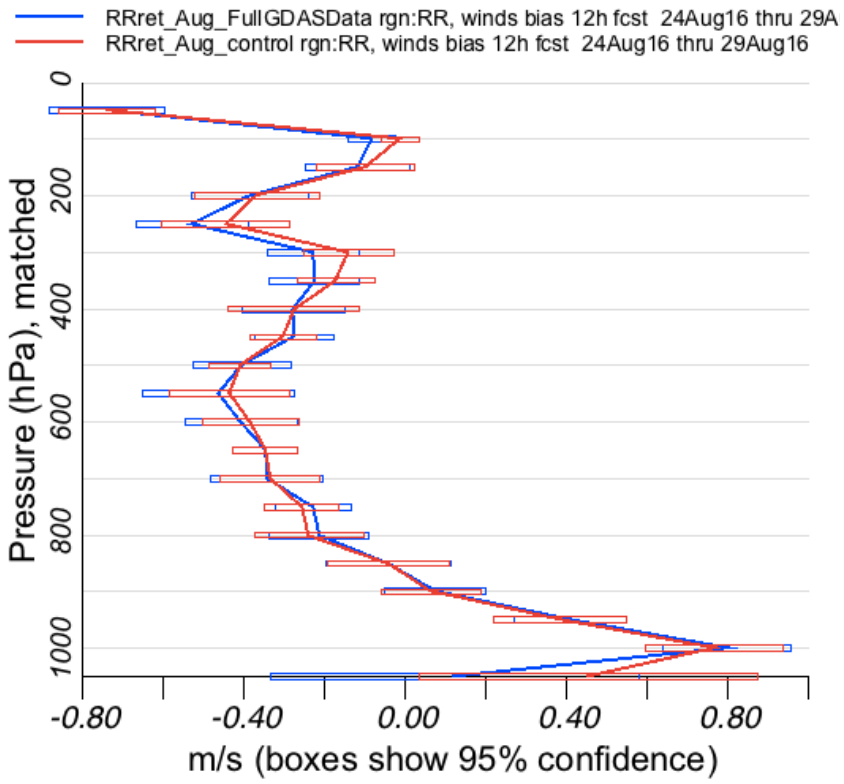
Slight improvement on 12h FCST RMS error in RH

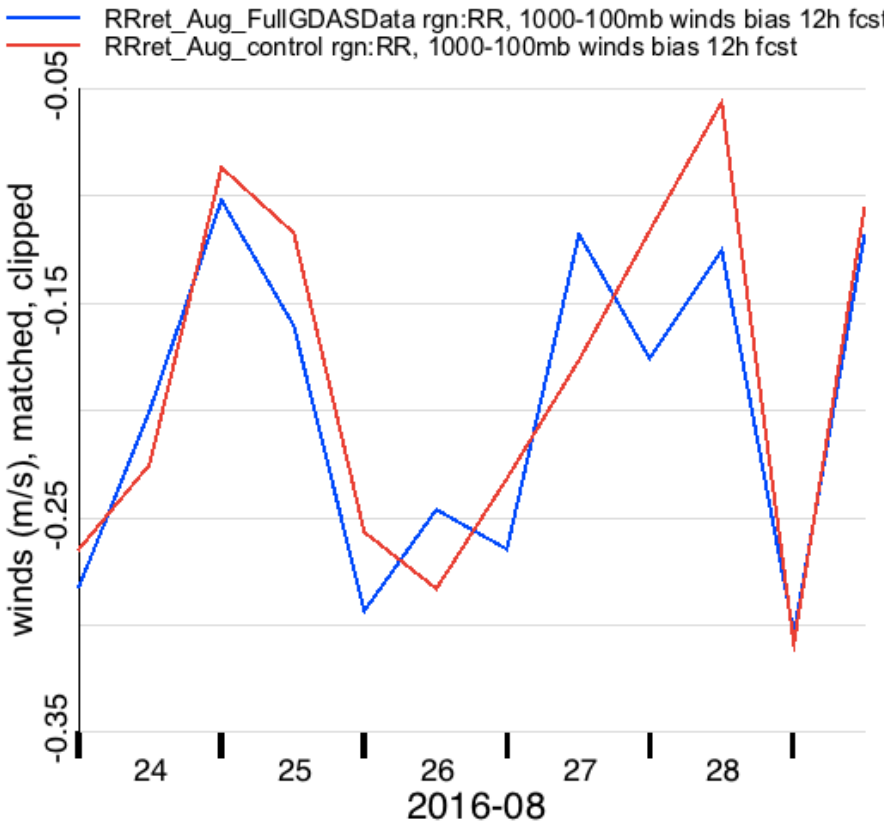




Full GDAS satellite with ATMS and CrIS impact: BIAS

Slight improvement on 12h FCST RMS error in wind





Summary/Discussion

1. SSEC, NCEP and ESRL/GSD worked closed resolving issues on data format, latency and transfer;
2. Different experiments performed to explore possible data impact;
3. The current validation is mainly on large scales, more careful study on finer scale impact should be focused in our future work, focusing on extreme weather events
4. Due to rich data source over RAP domain, the direct readout data has impact, particularly on bias improvement;
5. The direct readout data could have much significant impact on future large domains or global HRRR;


NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Thank you

Backup slides

Findings

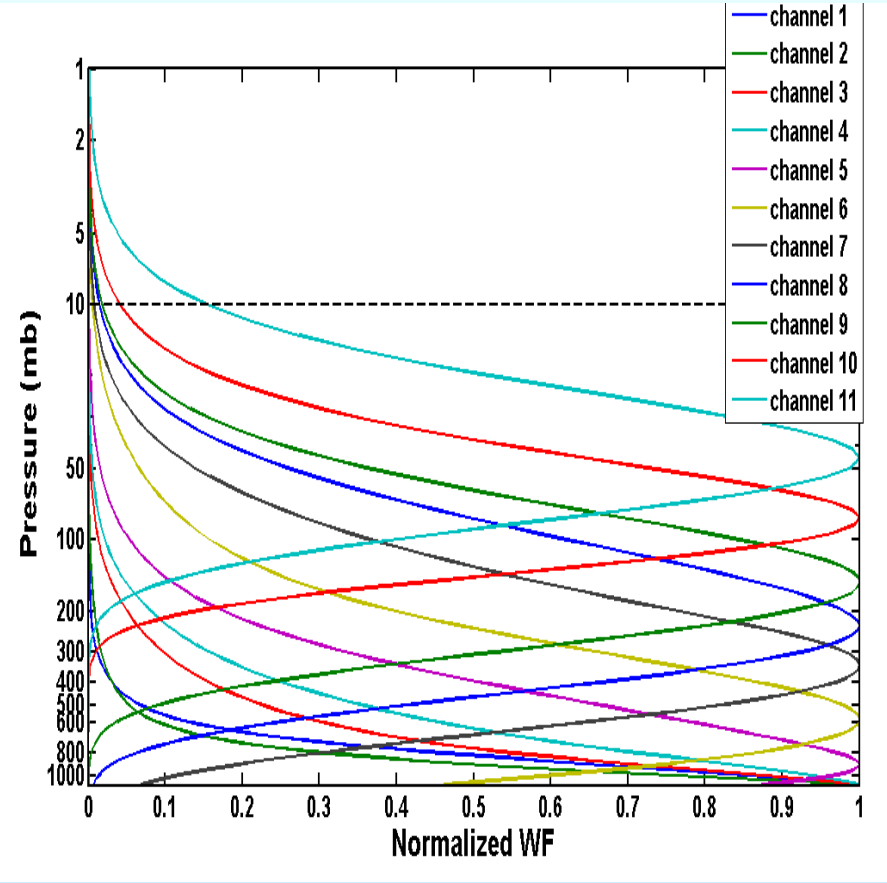
1. For descending: good data coverage with less latency on 07Z, 08Z, 09Z, 10Z, 12Z;
2. For ascending: good data coverage with less latency on 18Z, 19Z, 20Z, 22Z;
3. The least data latency: 08Z (+14 min to +22 min), and 18Z (-9 min to +11 min), close to Wisconsin area;
4. Data redundancy issues: Why 07Z data are repeated on 08Z again? Some data from 18Z are also repeated on 19Z? These data should only be included on 07Z or 18Z, should not be included on 08Z or 19Z. Need to check Bob's merging scripts and ssec data files to figure it out. Better remove the repeated data if possible;
5. Overall, good direct read out CrIS data coverage in a timely manner within the RAP domain. Much better (usually earlier and more coverage than the NCEP CrIS data (at least for this case).

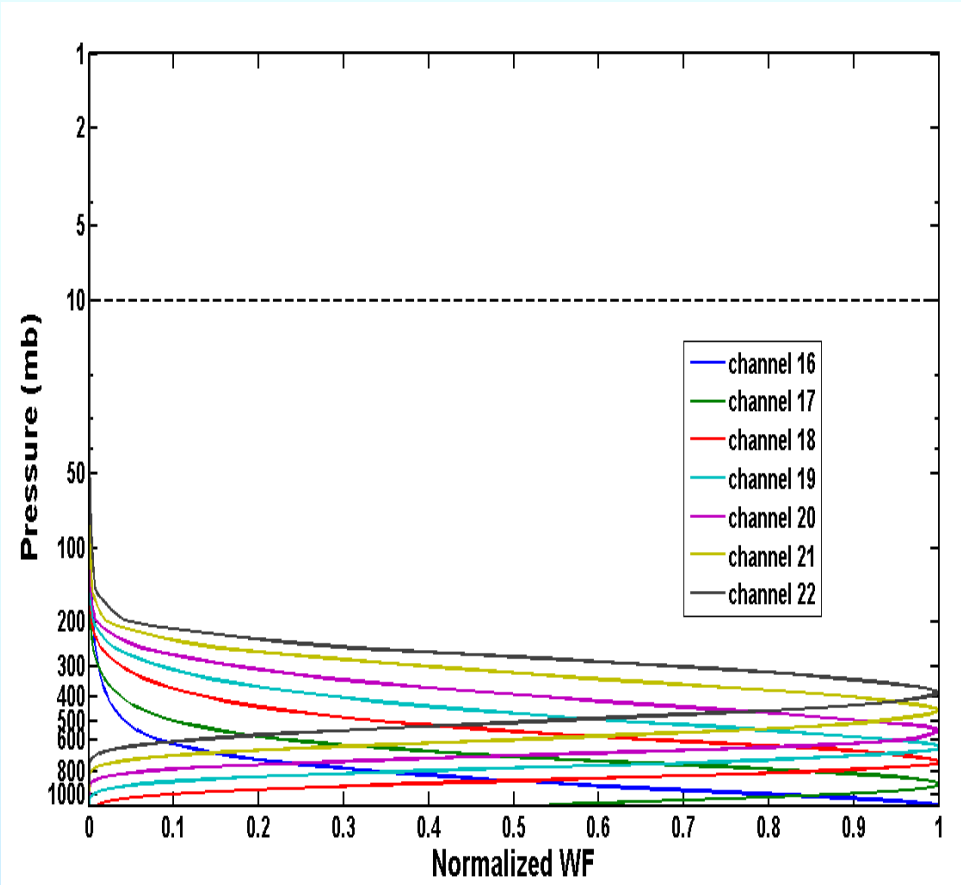
CrIS retrospective experiment

- Retro period from 23-31, August 2016, hourly cycling
  - A four week long period of data being collected
  - Due to computer resource and time limit, a preliminary run for 23-31, August 2016 has been performed.
- Data from SSEC, +/- 1.5 hr data window, compare to EMC data
- Channel selection
- Cycled bias correction, but no pre-retro spin-up of bias correction coefficients.

ATMS retrospective experiment

- Retro period from 3-8 Feb. 2016, hourly cycling
- Data from SSEC, +/- 1.5 hr data window, compare to EMC data
- Channel selection to remove high peaking channels (12,13,14)
- Cycled bias correction, but no pre-retro spin-up of bias correction coefficients





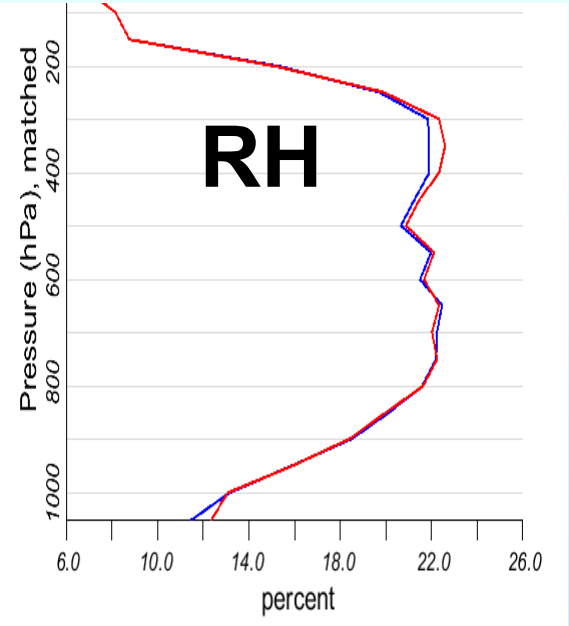
ATMS retro experiment verification

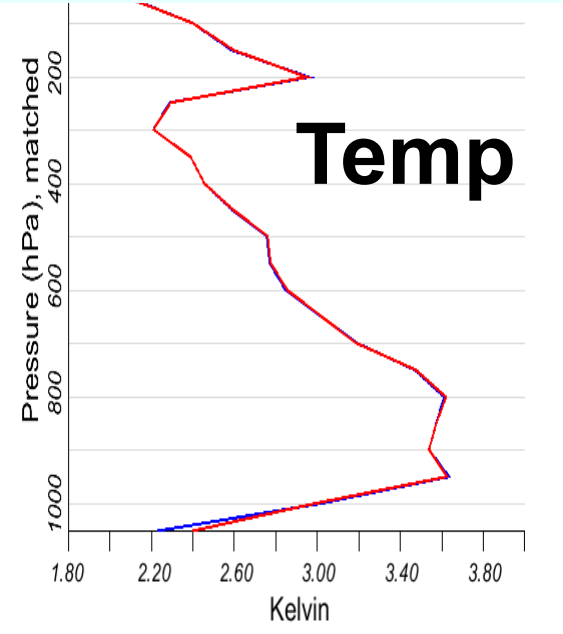
- Retro period from 3-8 Feb. 2016, hourly cycling
- Control run: all convention observations + following sat data:

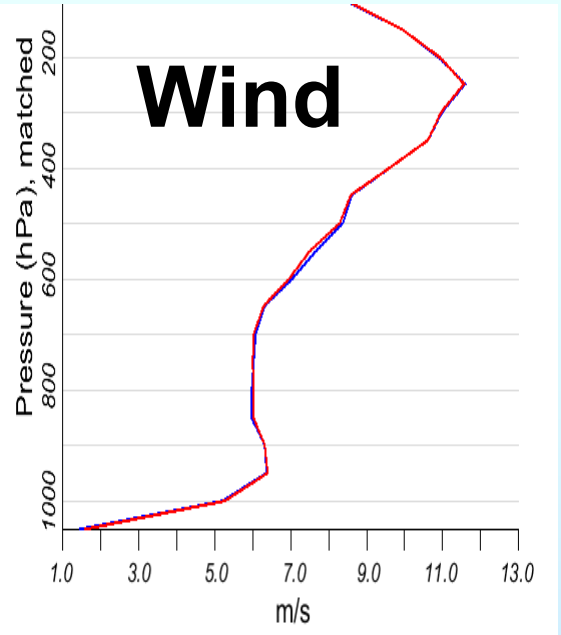
AMSU-A (remove high-peaking chs)
NOAA-15: channels 1-10, 15;
NOAA-18: channels 1-8, 10,15;
NOAA-19: channels 1-7, 9-10, 15;
METOP-A: channels 1-6, 8-10,15
METOP-B: channels 1-10, 15;

HIRS4 (remove high-peaking, O3 chs)
METOP-A: channels: 4-8, 10-15;
MHS – NOAA-18/19, METOP-A/B : chs 1-5
GOES (remove high-peaking, O3 chs)
GOES-15 (sndrD1,sndrD2,sndrD3,sndrD4): channels 3-8, 10-15.

+12h upper-air forecast verification against rawinsonde







Milestone Check-In

YEAR 1 TASKS

1. Examine the real-time hourly coverage from polar-orbiter direct readout data. Investigate statistics on data coverage using different data latency time Prepare all observation data files for future assimilation experiments.

-- In progress. Retro experiments ongoing with SSEC data, comparison with EMC

2. Set up and test the RAP retrospective system GSI based assimilation techniques.

-- Initial ATMS expt. completed, analysis of small impact being investigated. Examination of data coverage, channel selection, bias correction spin-up. CrIS retro work underway for new retro period. Work to test EMC data feed

3. Set up / test the Global Rapid Refresh (GRR) 1-h update cycle techniques.

-- Initial work to set up ensemble DA with FIM (scripts, file processing). Work will transition to new NGGPS core

4. Incorporate the advanced GSI cloud/precipitation techniques into RAP, GRR.

-- Progress on variational cloud analysis (separate project), results will be incorporated in RAP, GRRR

User Interactions

Items

1. Interaction with SSEC, NCEP on data feeds
2. Presentation, participation in JCSDA workshop
3. Discussions with other developers