# Towards a Regional Reanalysis over Northern High-Latitude Regions with the WRF model

**Zhiquan Liu**, Hui-Chuan Lin, Wei Wang,
Tae-Kwon Wee, Michael Barlarge and Bill Kuo
(NCAR)

David Bromwich, Lesheng Bai, Keith Hines and Sheng-Huang Wang
(Ohio State University)

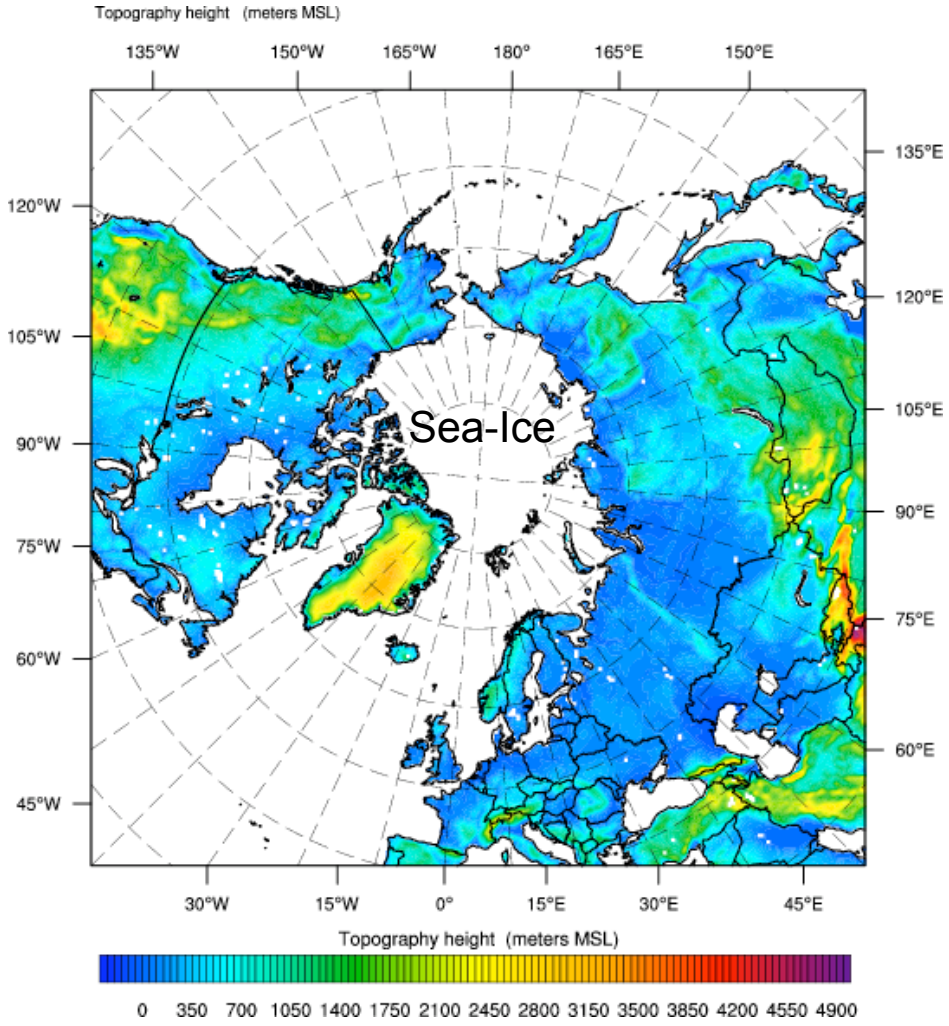
*NCAR is sponsored by the National Science Foundation

# Background

- Arctic System Reanalysis (ASR) project
  - Funded by NSF
  - University efforts: OSU, NCAR, UIUC, CU
  - 11 years reanalysis: 2000~2010
  - Currently testing for 30km, may go a finer resolution to 10km?
  - NCEP provided conventional and radiance data.

- Testing/Tuning the system for 2 months
  - Dec. 2007: use NCEP FNL (1°X1°, P levels) as LBC
  - Aug. 2008: use ERA-Interim (80X80km, model level) as LBC

# ASR domain




WRF model version 3.1:
30km*30km (360*360),
70 Levels (Top@10hPa)
40m-50m vertical spacing in PBL

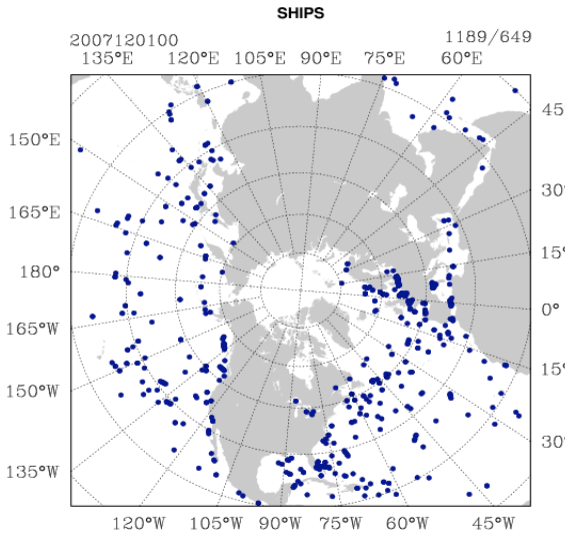
DFI, GWD, fractional sea-ice
WSM5 MP, new Grell,
MYNN2.5 PBL, sw/lw RRTMG,
Noah LSM.

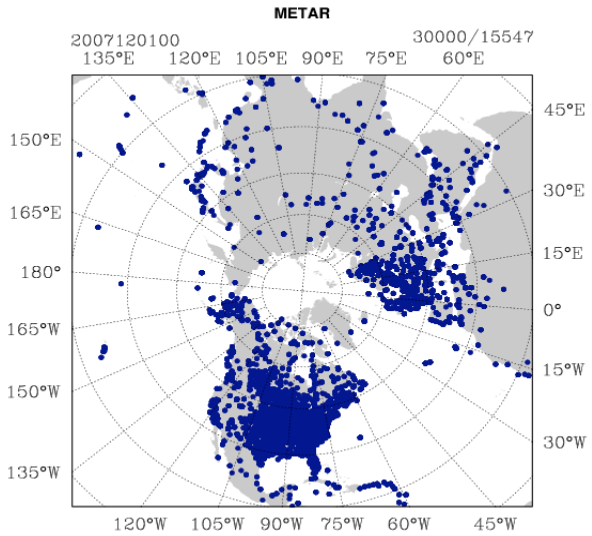
# WRFDA-3DVAR conf.

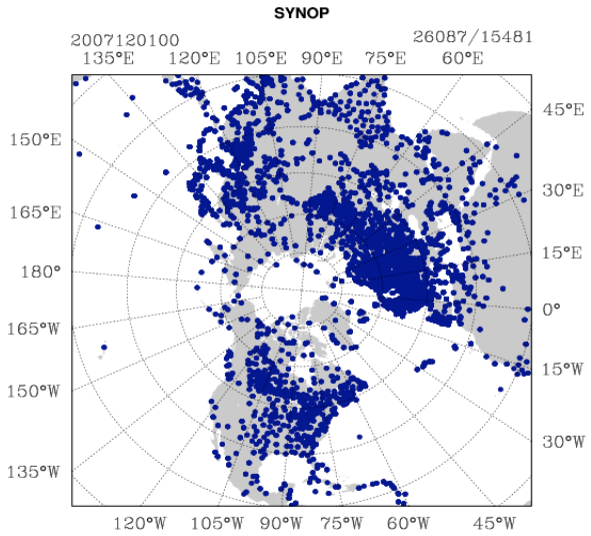
- 3-h continuous cycling regional DA
  - time window: ±1.5h
- Background error covariance statistics were obtained by the NMC method from a month cold-start forecasts.

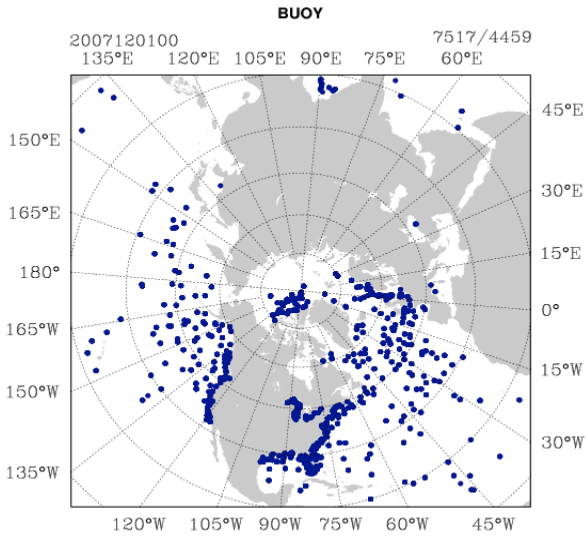
- Experiments
  - GTS: assimilate conventional obs
  - GTS+RAD: assimilate conventional obs plus MW radiances (AMSU/MHS)

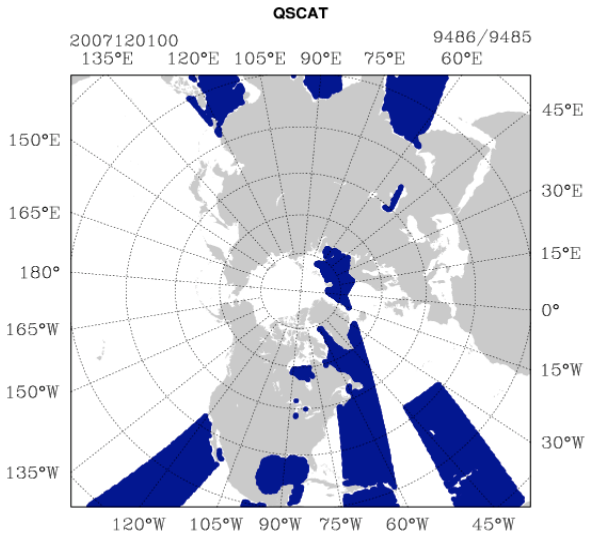
# NCEP PREPBUFR data (2007120100, +/-3h time window)

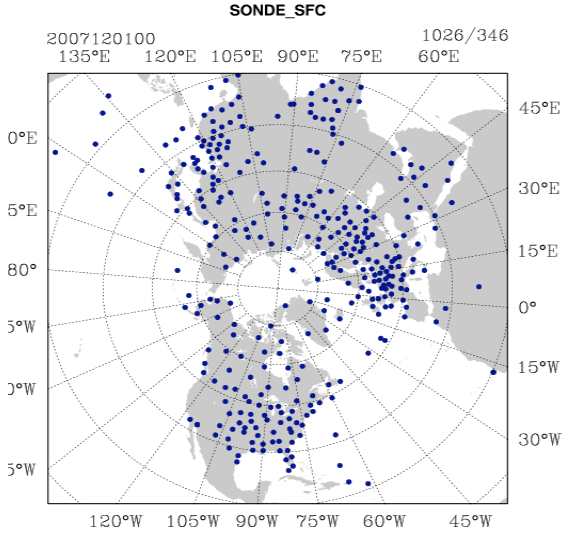


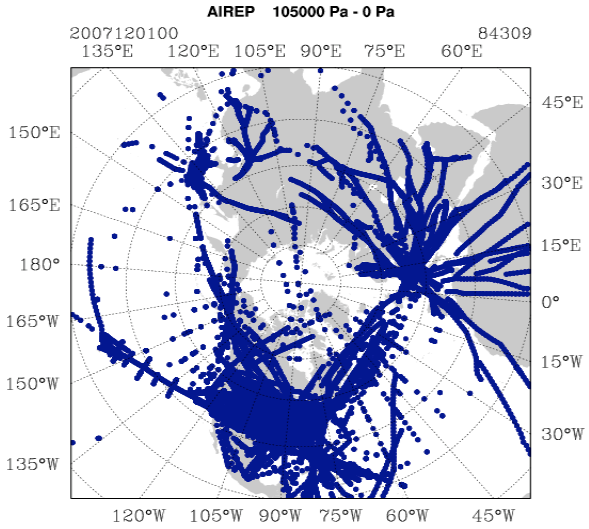



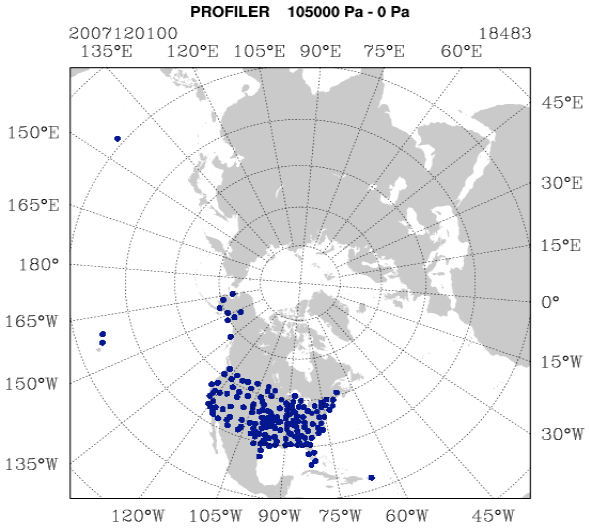



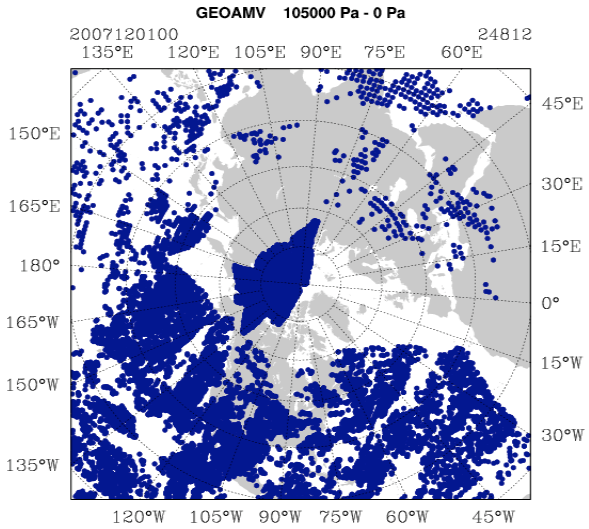



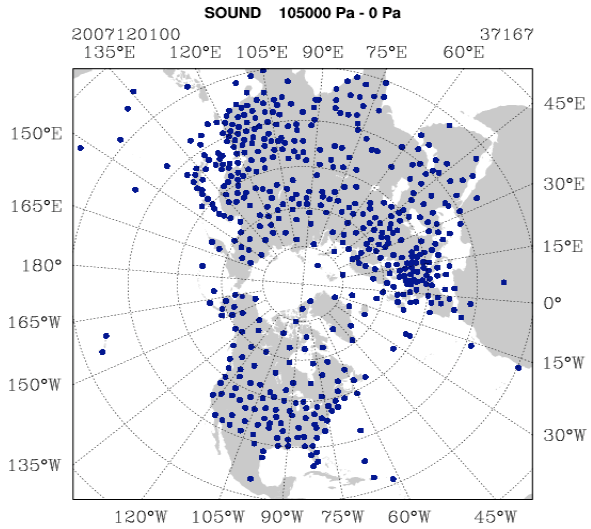




AIREP 105000 Pa - 0 Pa
2007120100
84309
135°E 120°E 105°E 90°E 75°E 60°E
150°E
165°E
180°
165°W
150°W
135°W
45°E
30°E
15°E
0°
15°W
30°W
120°W 105°W 90°W 75°W 60°W 45°W


PROFILER 105000 Pa - 0 Pa
2007120100
18483
135°E 120°E 105°E 90°E 75°E 60°E
150°E
165°E
180°
165°W
150°W
135°W
45°E
30°E
15°E
0°
15°W
30°W
120°W 105°W 90°W 75°W 60°W 45°W

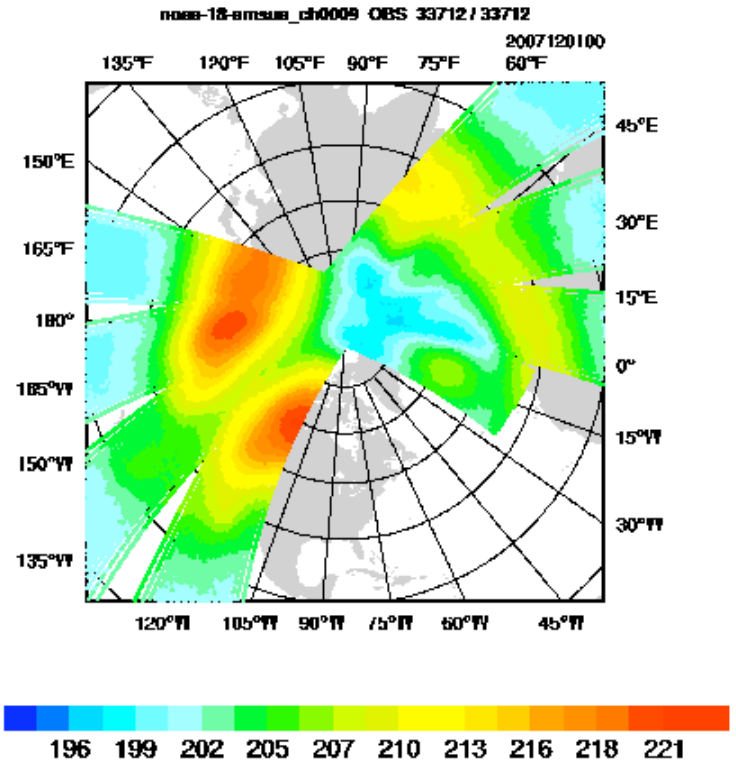

GEOAMV 105000 Pa - 0 Pa
2007120100
24812
135°E 120°E 105°E 90°E 75°E 60°E
150°E
165°E
180°
165°W
150°W
135°W
45°E
30°E
15°E
0°
15°W
30°W
120°W 105°W 90°W 75°W 60°W 45°W


SOUND 105000 Pa - 0 Pa
2007120100
37167
135°E 120°E 105°E 90°E 75°E 60°E
150°E
165°E
180°
165°W
150°W
135°W
45°E
30°E
15°E
0°
15°W
30°W
120°W 105°W 90°W 75°W 60°W 45°W

# Radiance data used

| | amsua | amsub | mhs |
|---|---|---|---|
| Noaa-16 | 5,6,7,8 | 3,4,5 | |
| Noaa-17 | | 3,4,5 | |
| Noaa-18 | 5,6,7,8 | | 3,4,5 |
| Metop-2 | 5,6,8,9 | | 3,4,5 |
| Aqua | 5,6,8,9 | | |

Thinning to 180km.
Use CRTM
Variational Bias Correction



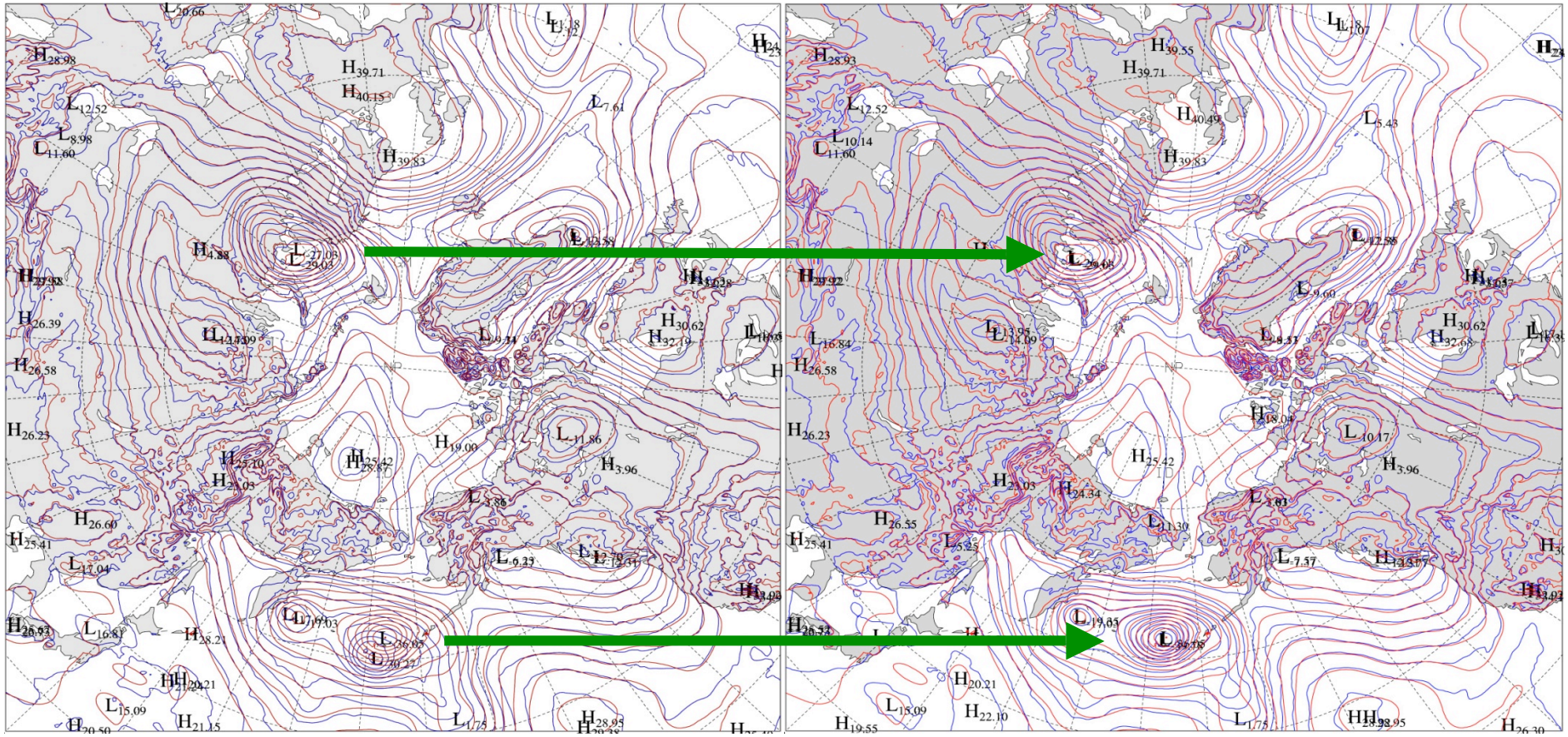
# Results from Dec. 2007 (OSU)

NCEP FNL as LBC

# Radiances better positioning Low Pressure centers

W/O Radiances

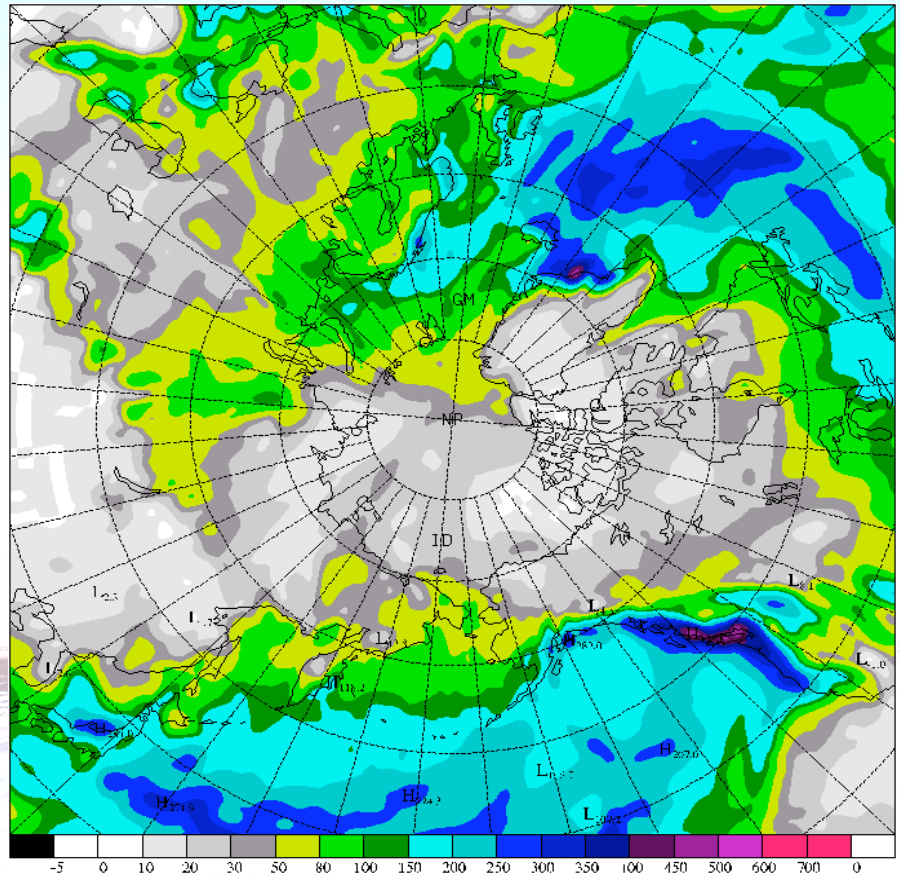
With Radiances

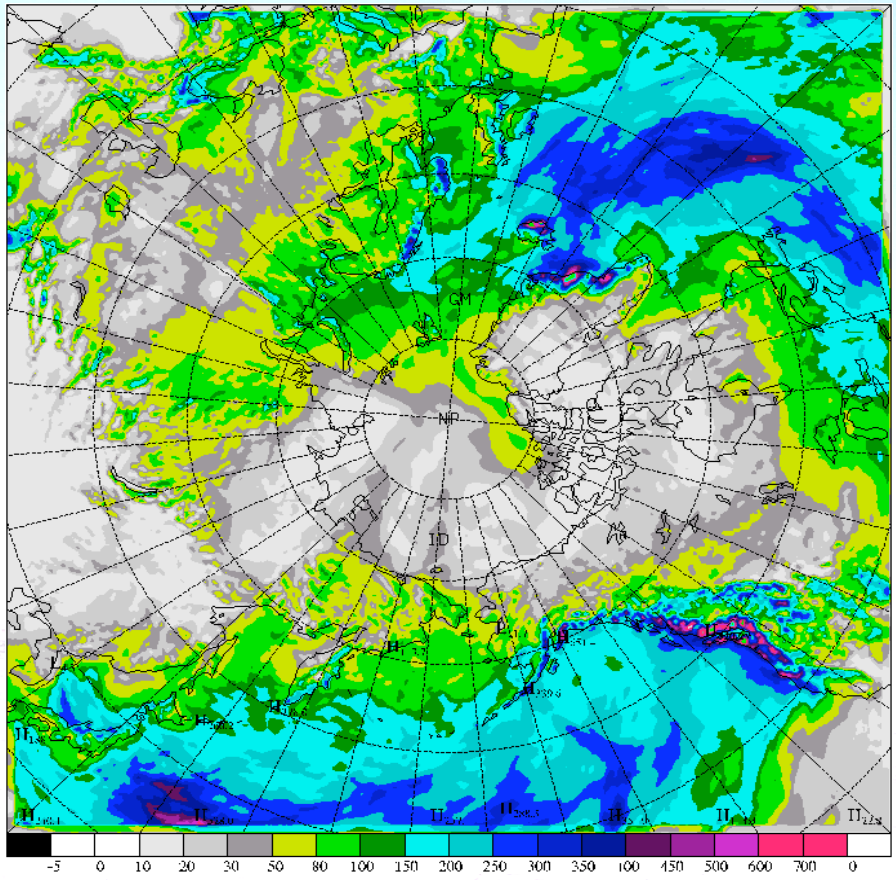


**ASR(blue) v. FNL(red): P'@model level-1 @day-20 in Dec. 2007**

# Precipitation (Monthly total in Dec 2007)

## (Unit: mm)




**ERA-Interim**

**ASR with Radiances**

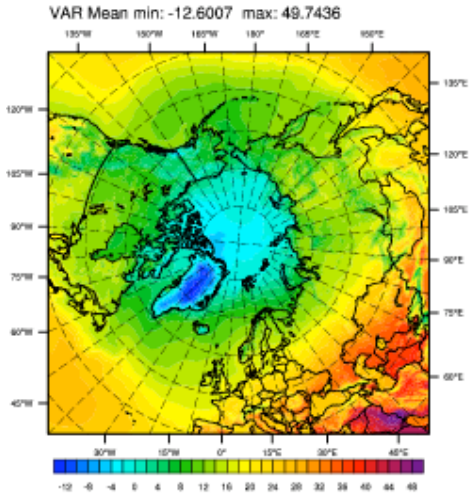
# Results from Aug. 2008

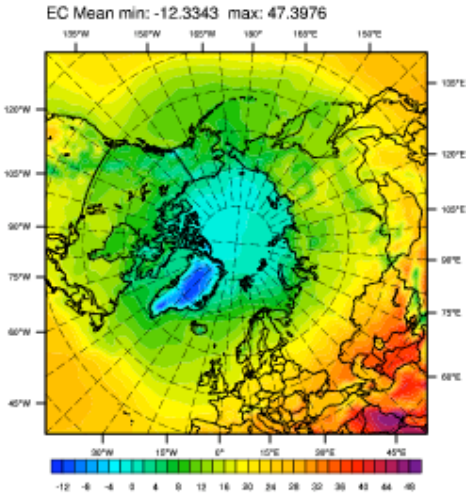
## ERA-Interim as LBC

# Monthly Mean T2m

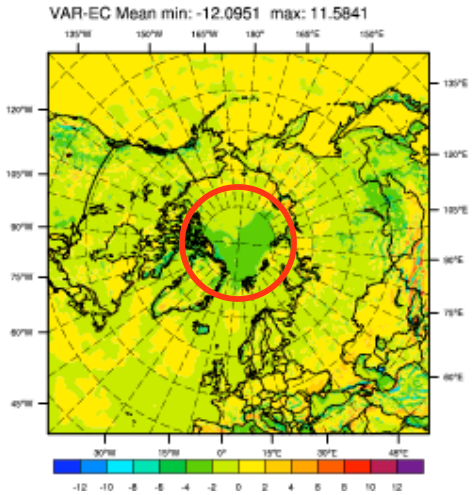
## W/O Radiances

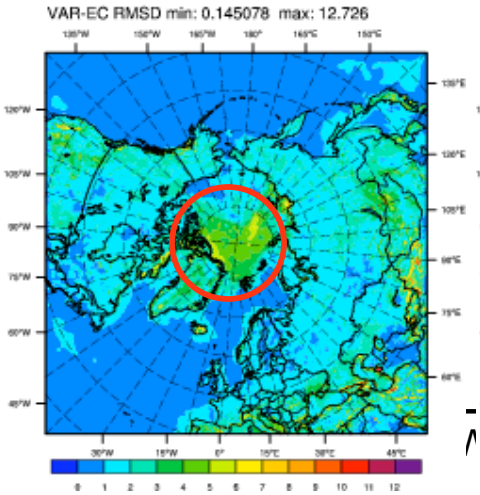
Monthly Map: T2 (C) at 12Z 08/2008



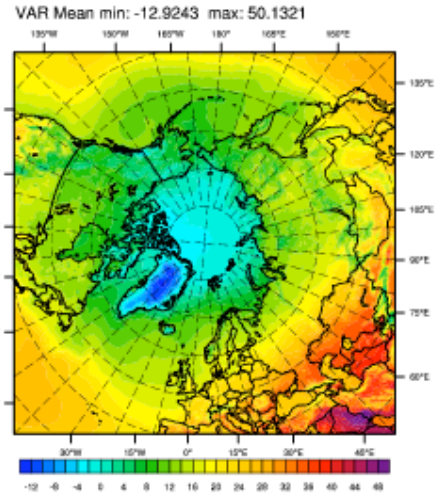

**4K colder than ERA**

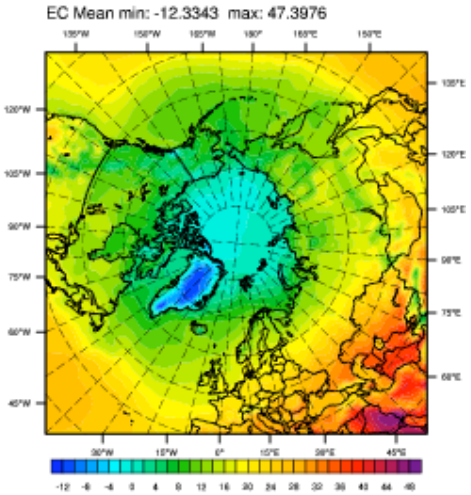


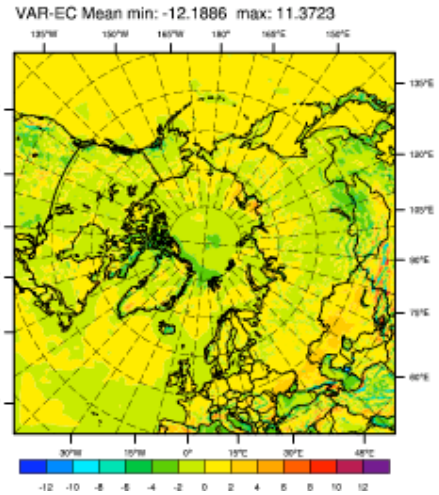



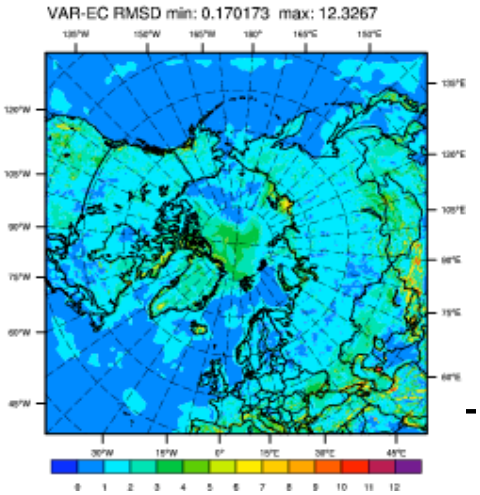

## With Radiances

Monthly Map: T2 (C) at 12Z 08/2008

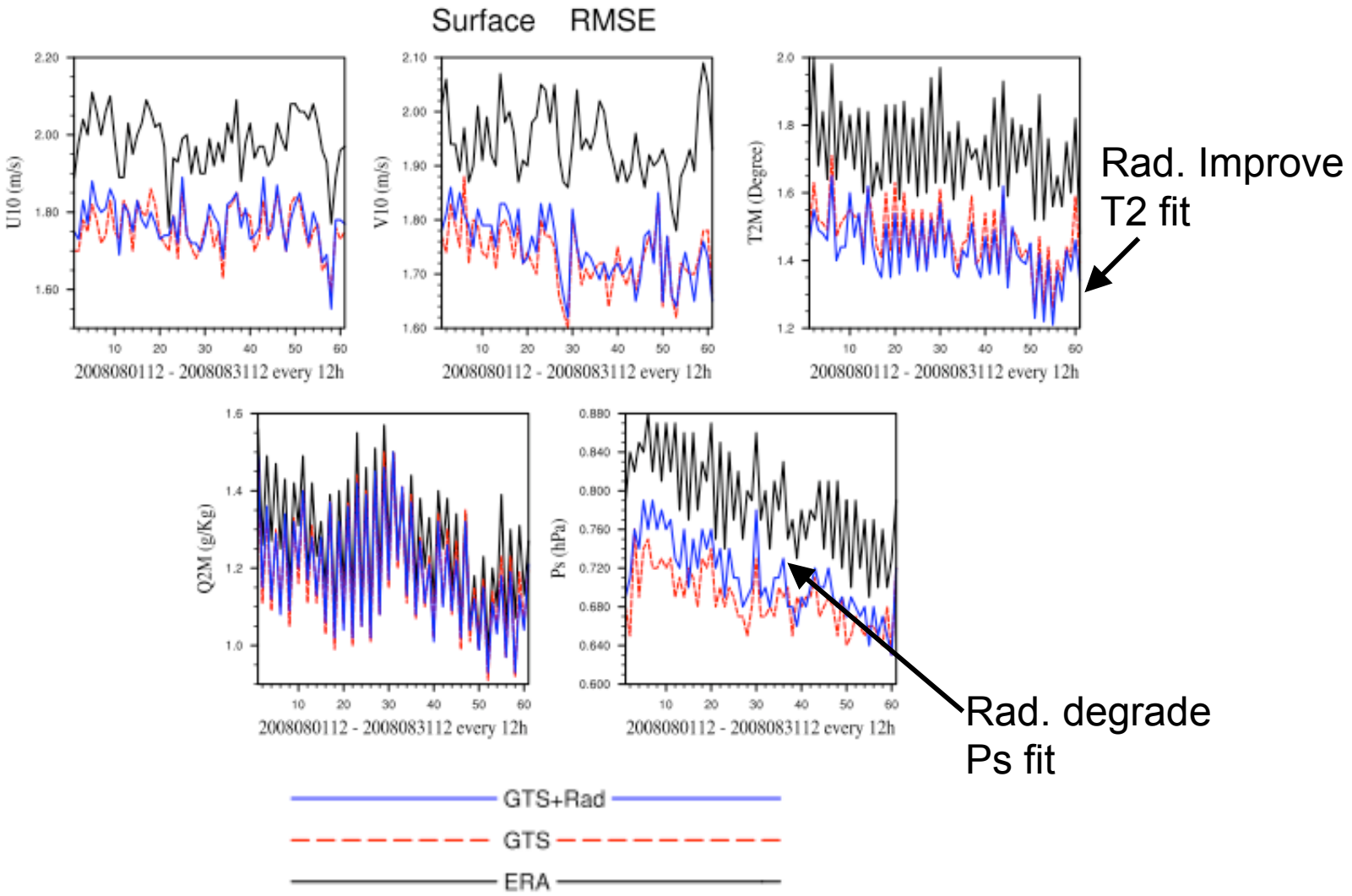


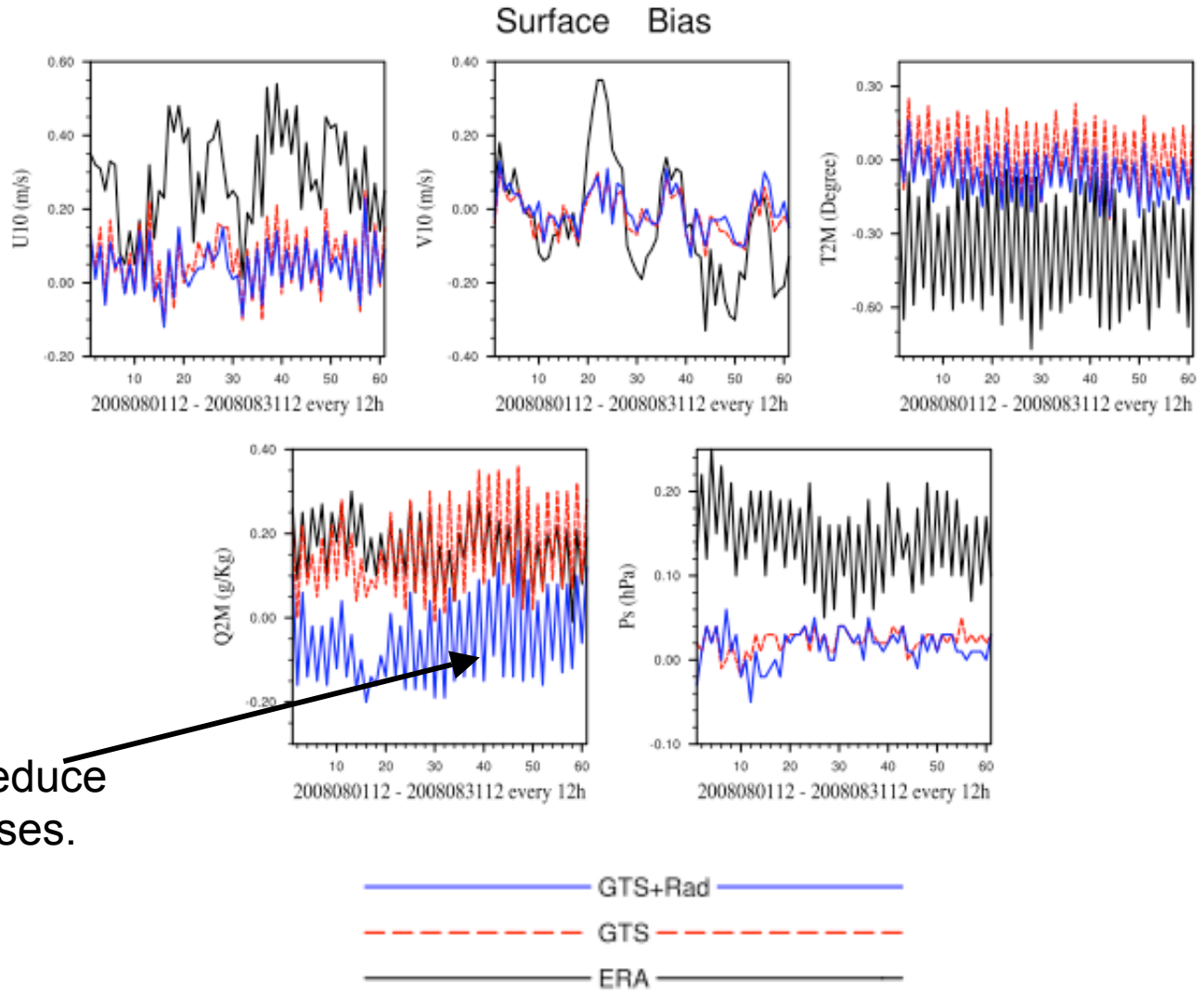



# Analyses vs. SYNOP (RMSE)

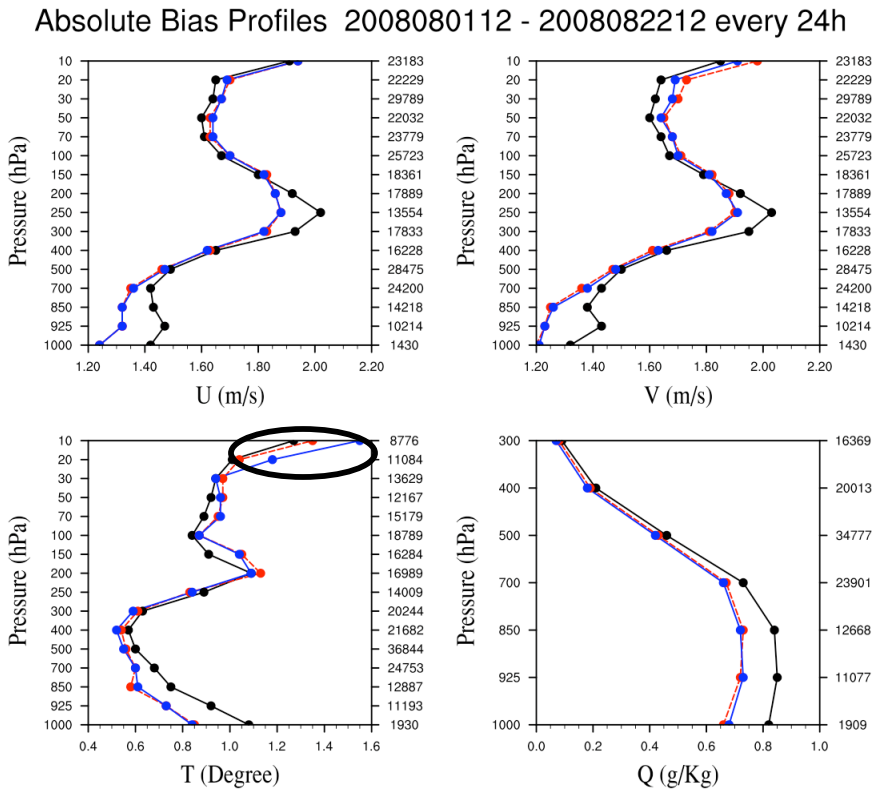


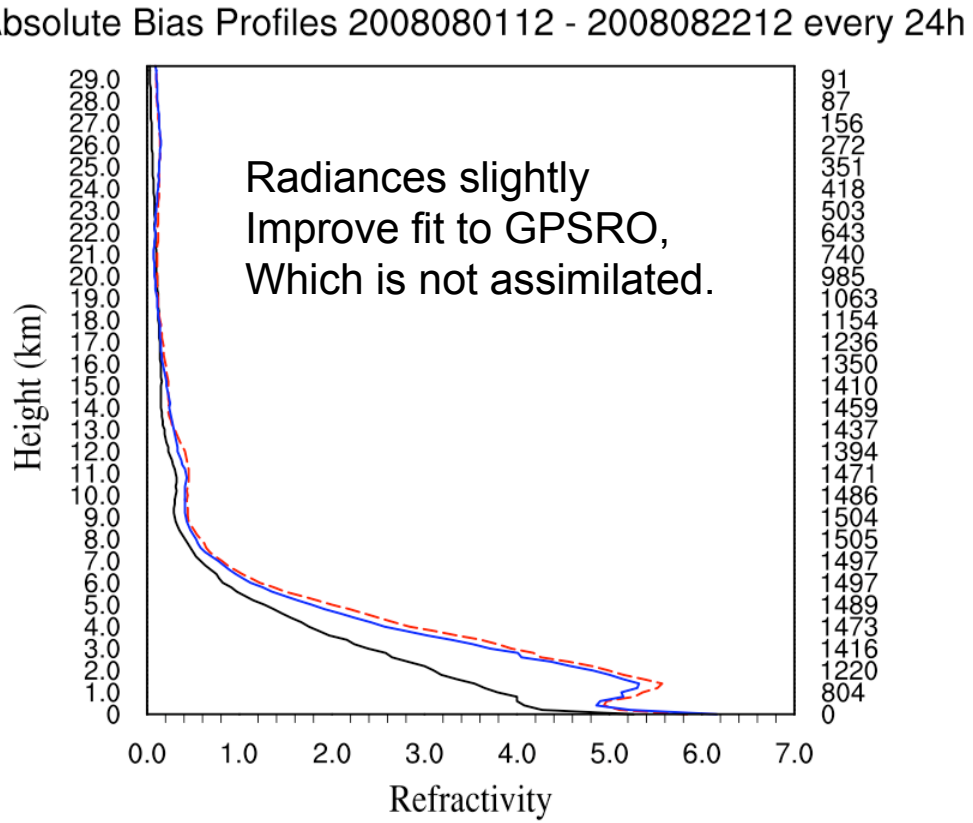
# Analyses vs. SYNOP (Biases)




Rad. reduce
Q2 biases.

# Analyses vs. SOUND & GPSRO



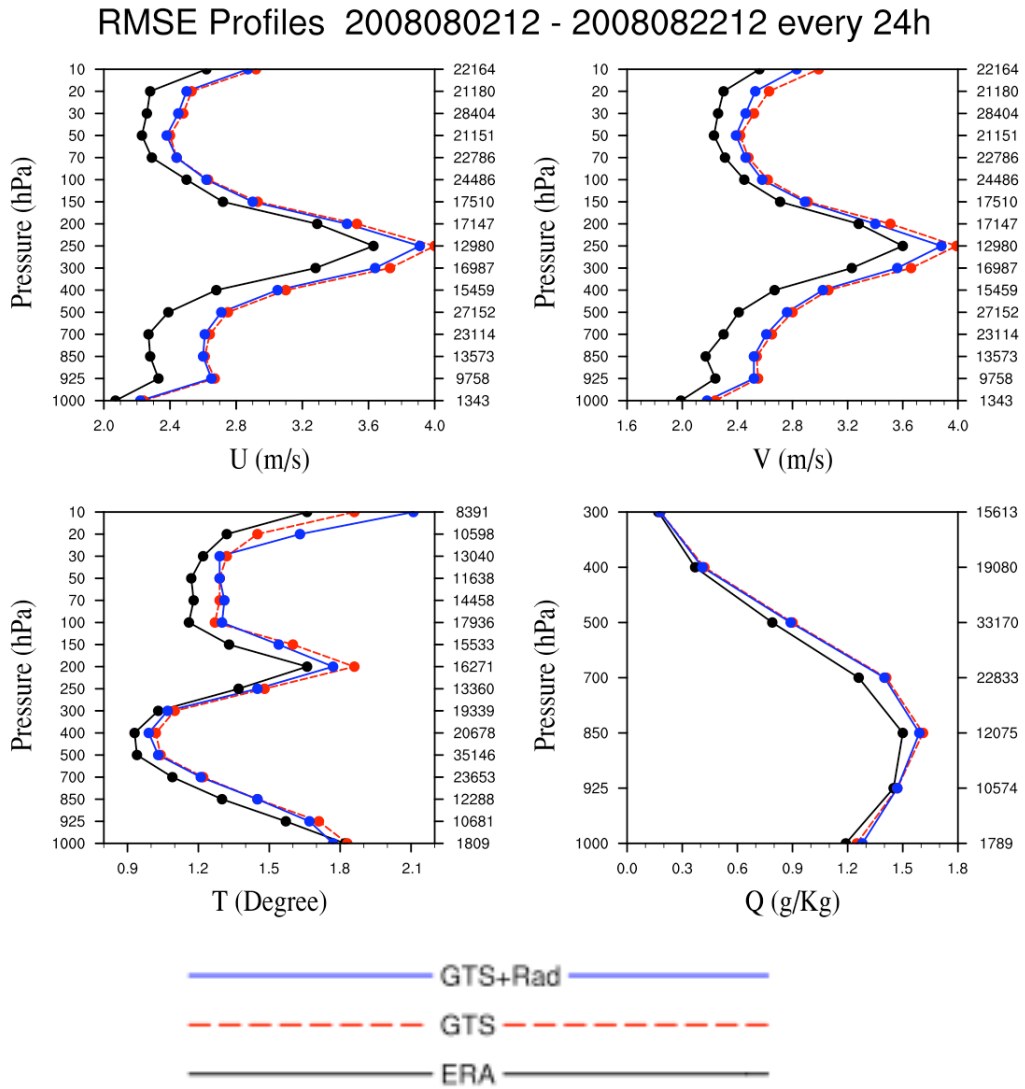




GTS+Rad

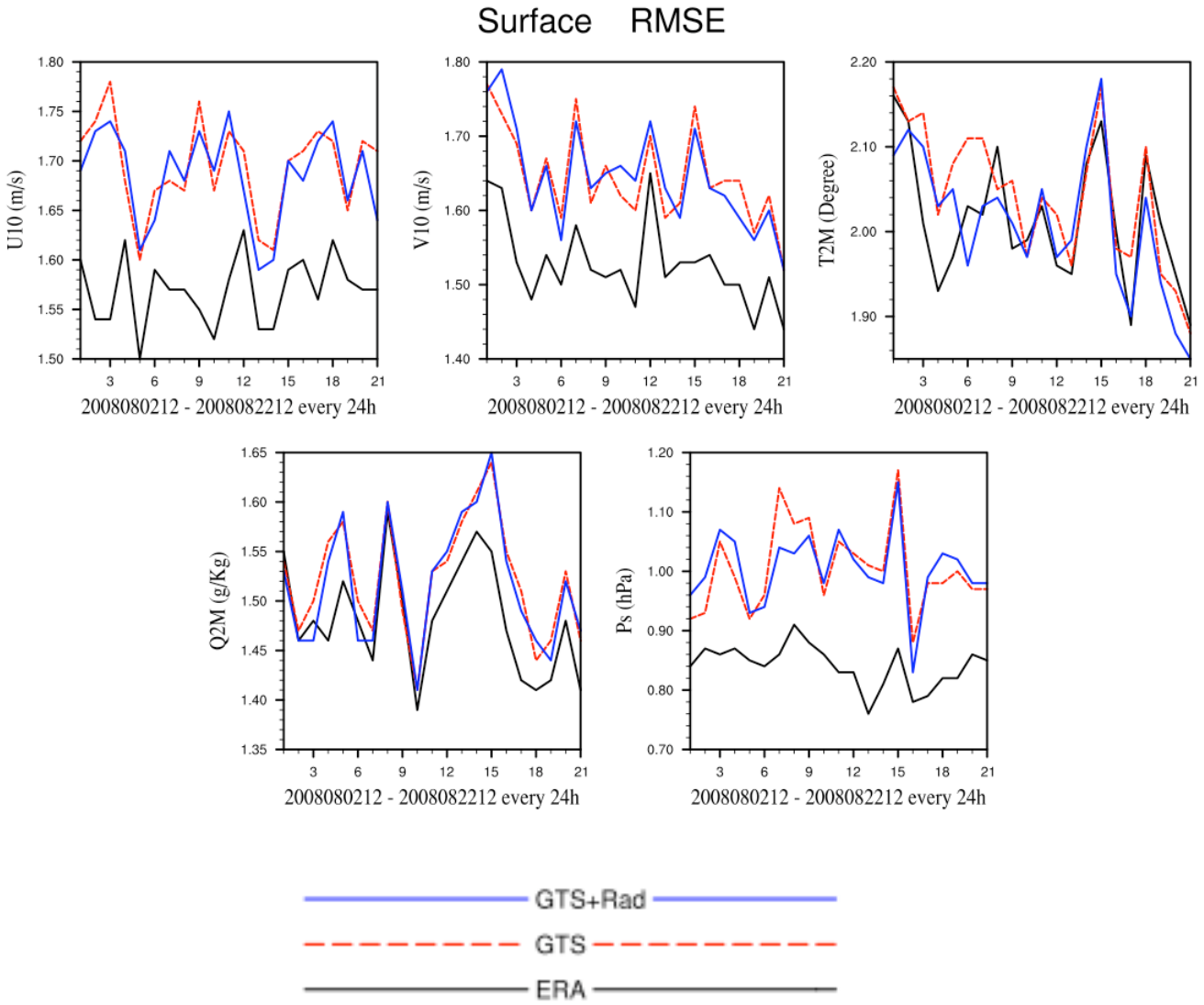
GTS

ERA

# 12h FC vs. SOUND (RMSE)



# 12h FC vs. SYNOP (RMSE)



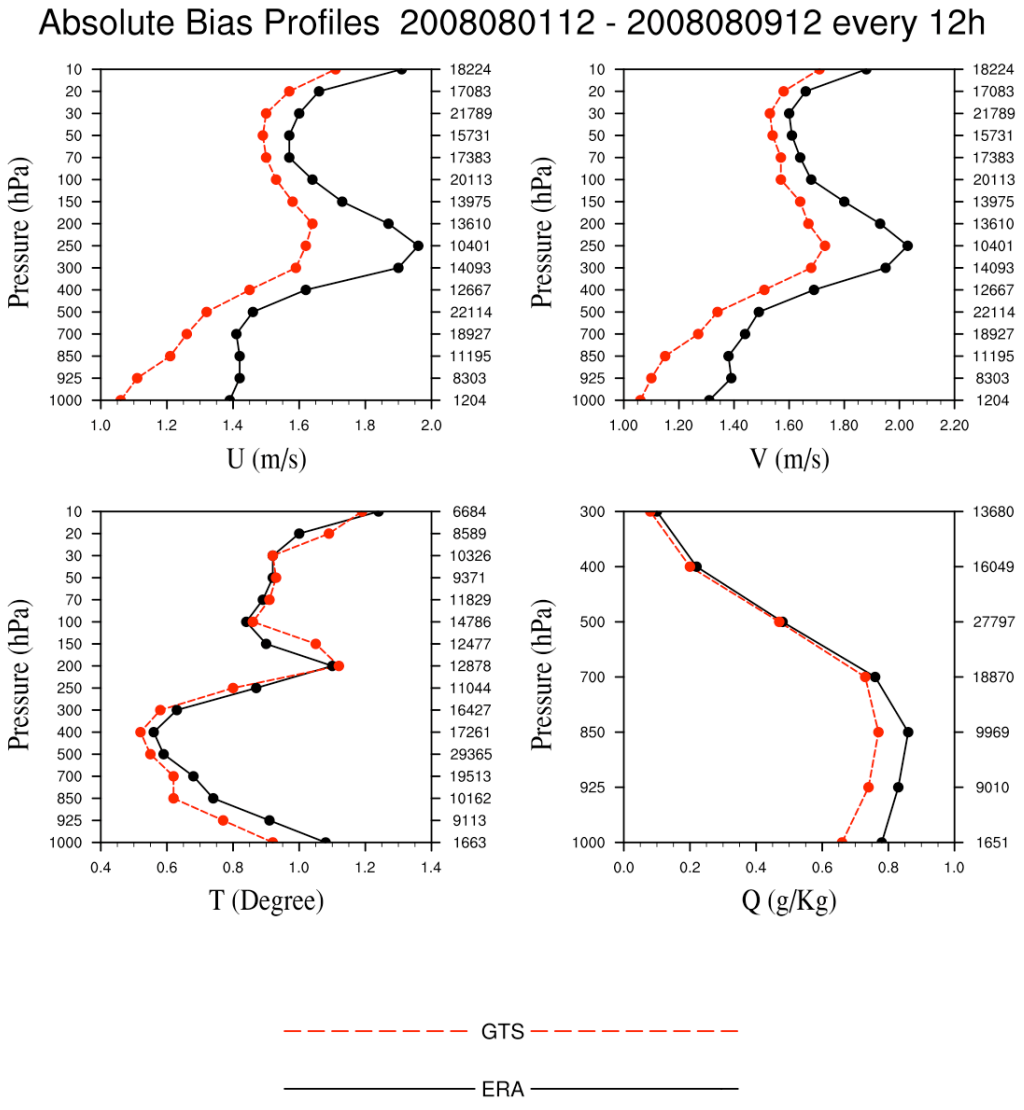
# Summary

- Encouraging side from initial ASR test results
  - Better fit to surface observations than ERA-Interim.
  - Better fit to radiosonde humidity observations than ERA-Interim.
  - Better fit to radiodonde wind and T below 200hPa.
- Drawback of current ASR analyses (vs. ERA-Interim)
  - Degrade fitting with upper air wind and T observations above 200hPa.
  - Degrade fitting with GSPRO (could be improved by assimilating GPSRO data)
- Radiance impact is mixed
  - Neutral impact on surface wind
  - Positive impact on T2m and Q2m.
  - Negative impact on Ps
  - Bigger errors on T above 20mb
  - Improve fitting with GPSRO observations
  - Better positioning Low pressure centers over ocean
- WRF forecast from ERA-Interim is still the best one.

# Future work

- More testing/tuning needed before production run
  - Background/Observation error tuning for wind field.
  - Add GPSRO data
  - Investigate issue of Ps and T (near the top) of assimilating radiances.
  - Nudging to global analysis near the top?
- Carry out one year run

# Analyses vs. SOUND




Impact of inflating background wind Error and reducing wind error lengthscale.