Radiance Assimilation over Northern High Latitude Regions

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(NCAR/MMM)

Acknowledgements:

Collaborators from Ohio State University

Outline

- Background: Arctic System Reanalysis (ASR) Project
- Preliminary Results from 2 test periods
- Summary and future work

Background

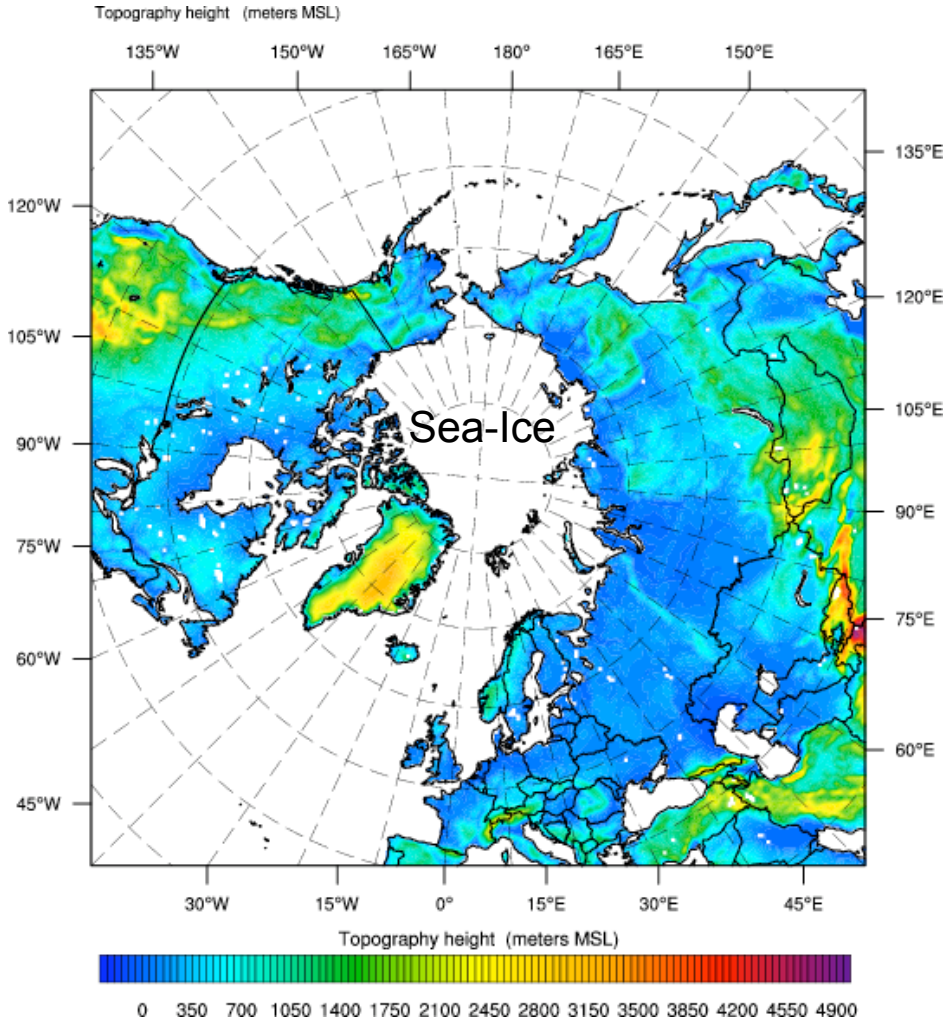
- Arctic System Reanalysis (ASR) project
  - Funded by US NSF
  - University efforts: OSU, NCAR, UIUC, CU
  - 11 years reanalysis: 2000~2010
  - Currently testing for 30km, may go up to 10km?
  - NCEP provided conventional and radiance data.

- 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

WRFDA-3DVAR

- WRFDA includes 3D/4DVAR and Hybrid VAR/Ensemble scheme
- 3DVAR is adopted for ASR for computational efficiency
  - 3-hr cycling regional DA, time window: ±1.5h
- Control variables: stream function, unbalanced velocity potential, unbalanced T, pseudo RH, unbalanced Ps.
- NMC method to generate background error covariance statistics.
  - Domain-averaged statistics.
- Recursive filter in horizontal, EOF in vertical for covariance modeling.

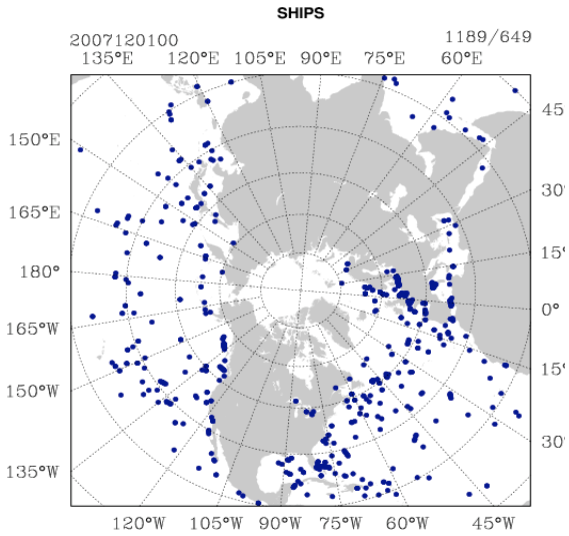
ASR domain

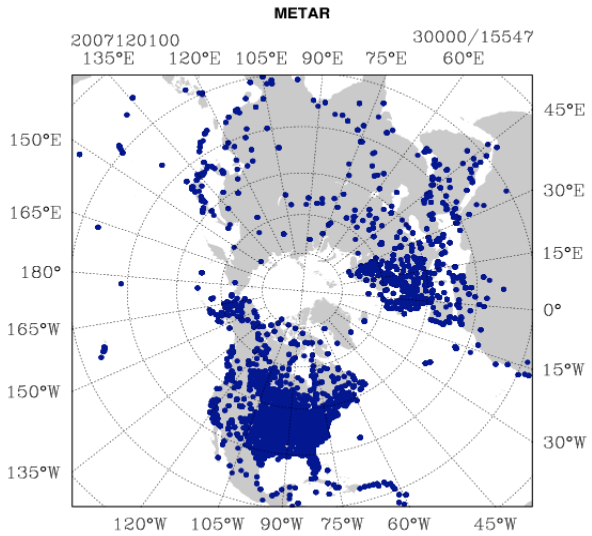


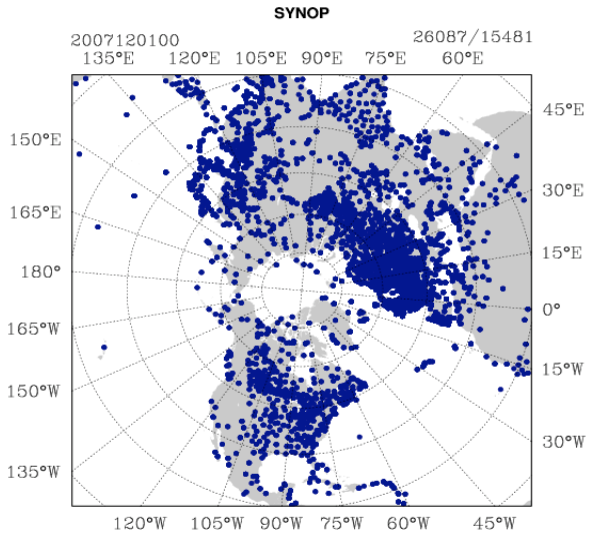
WRF model version 3.1:
30km*30km (360*360),
70 Levels (Top@10hPa)
40m-50m vertical spacing in PBL

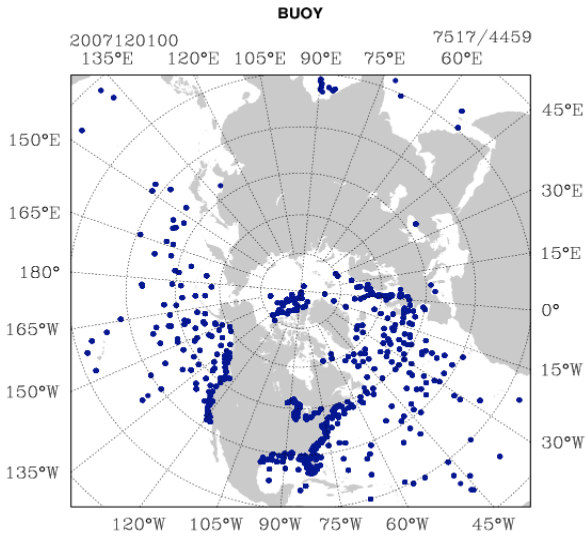
DFI, GWD, fractional sea-ice
WSM5 MP, new Grell,
MYNN2.5 PBL, sw/lw RRTMG,
Noah LSM.

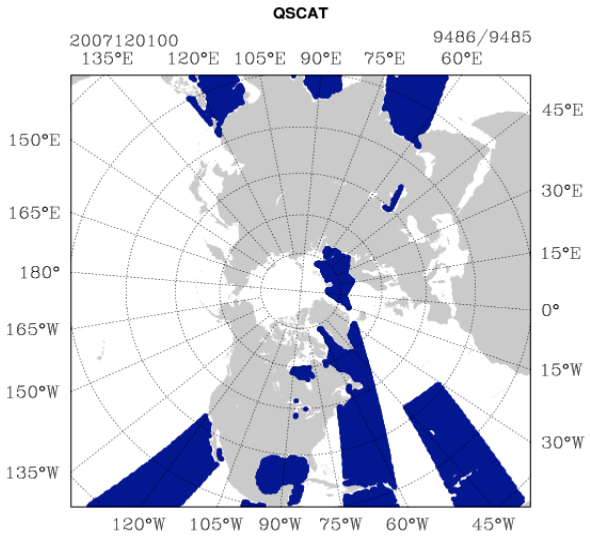
NCEP PREPBUFR data (2007120100, +/-3h time window)

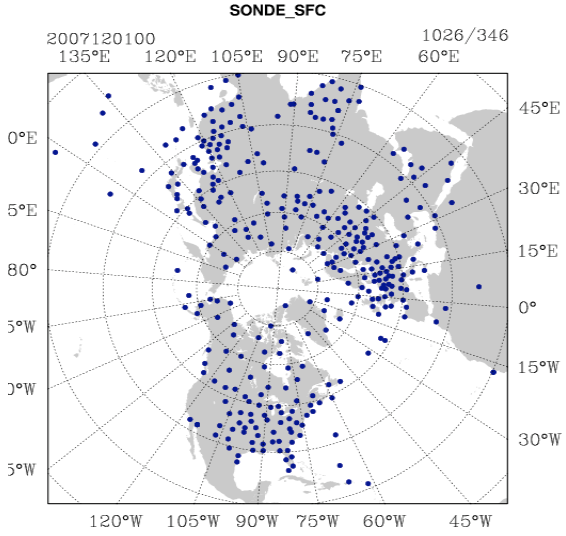


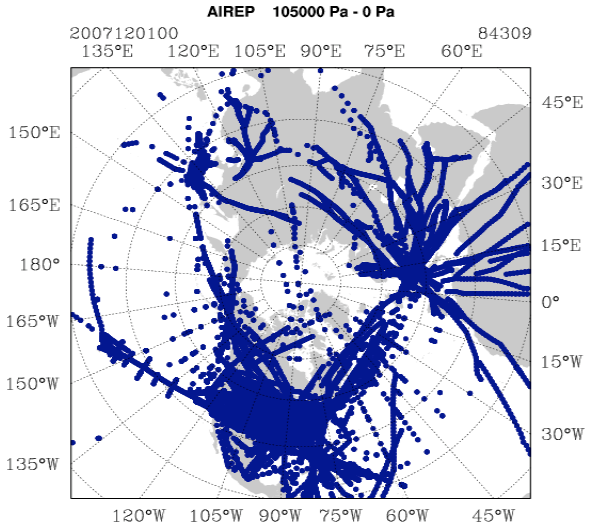


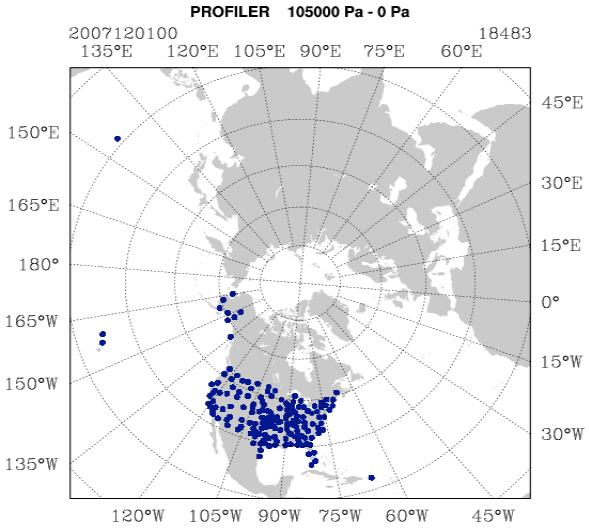


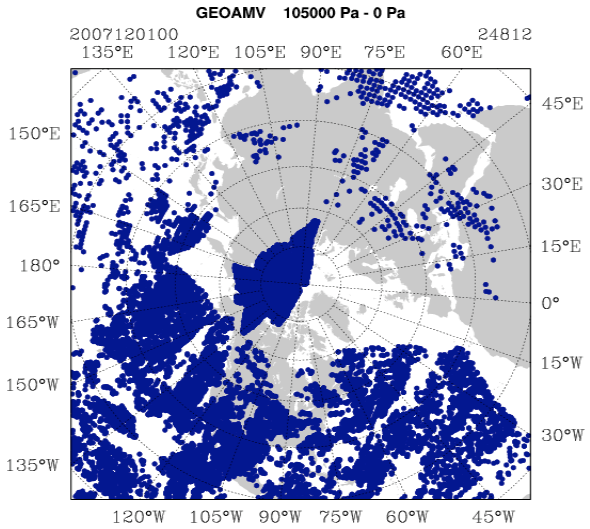


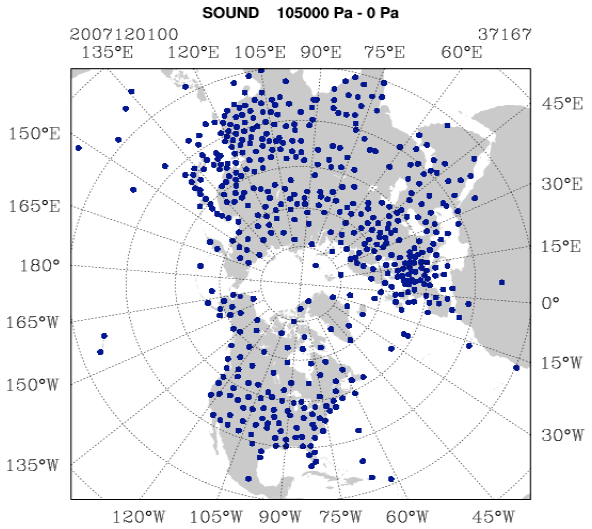










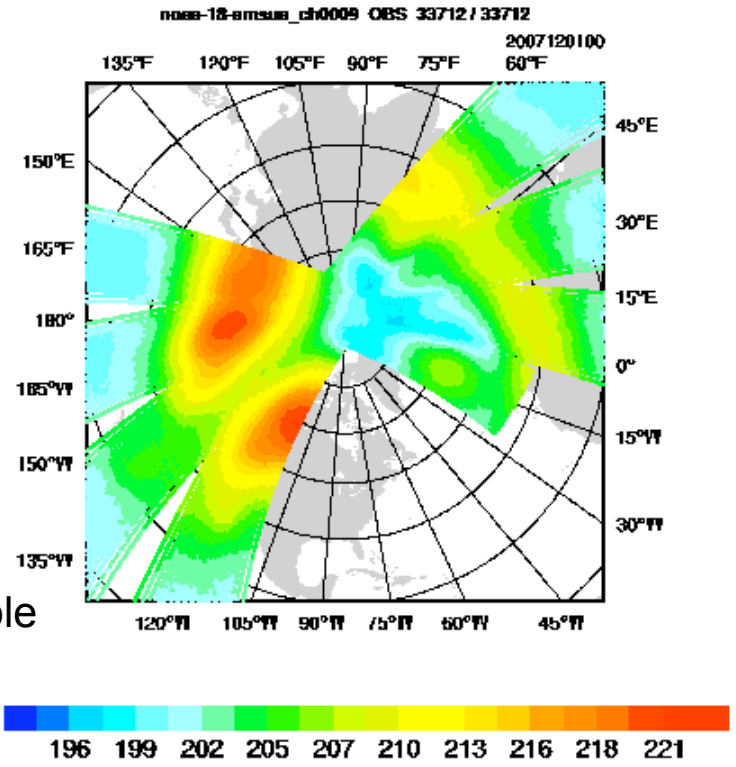


GPSRO data caused large cold biases near model top due to bad quality control (data above 30km not rejected).

Will re-include in future exps. with refined QC.

Radiance data used

	amsua	amsub	mhs
Noaa-15	4,5,6,7,8,9	3,5	
Noaa-16	4,5,6,7,8	3,4,5	
Noaa-17		3,4,5	
Noaa-18	4,5,6,7,8		3,4,5
Metop-2	4,5,6,8,9		3,4,5
Aqua	4,5,6,8,9		



Follow NCEP provided instrument/Channel availability table
AMSU-A ch4 only over sea
Thinning to 90km.
CRTM, Variational Bias Correction

AIRS new cloud detection scheme was found instable.
May include it in future runs.

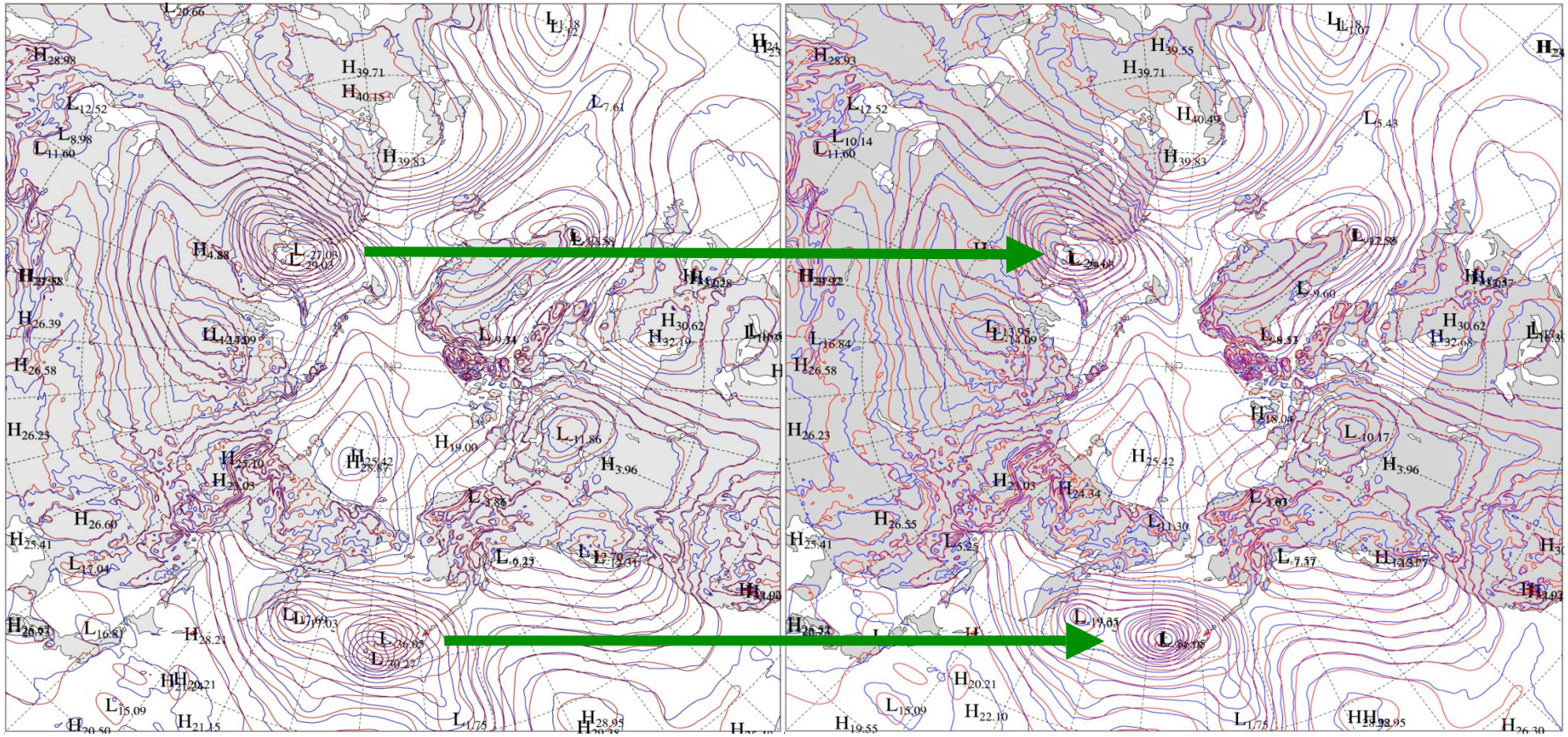
Results from Dec. 2007

NCEP FNL as LBC

Radiances better positioning Low Pressure centers

W/O Radiances

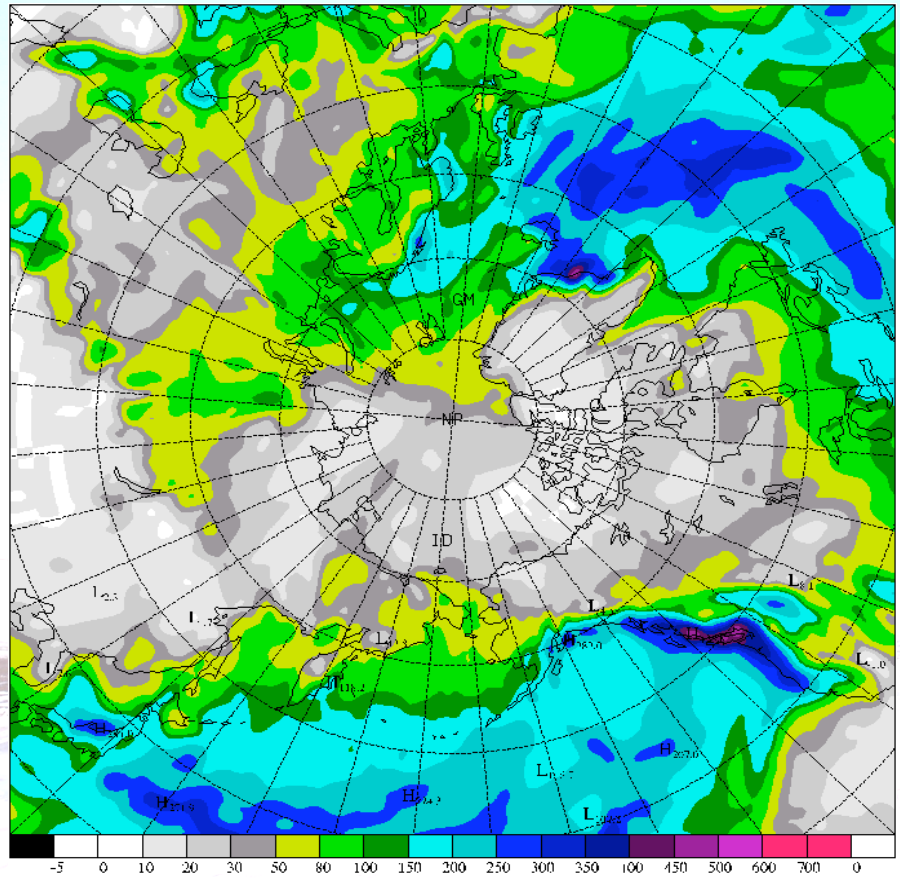
With Radiances

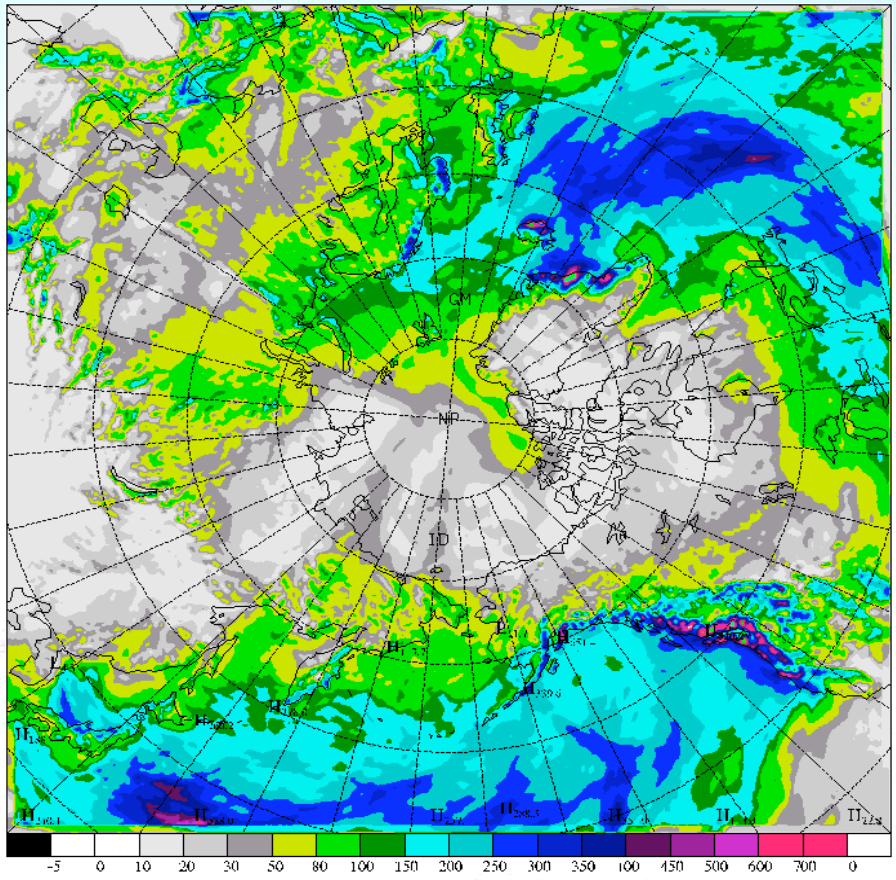


ASR(blue) v. FNL(red): P'@model level-1 @day-20 in Dec. 2007

Precipitation (Monthly total in Dec 2007)

(Unit: mm)



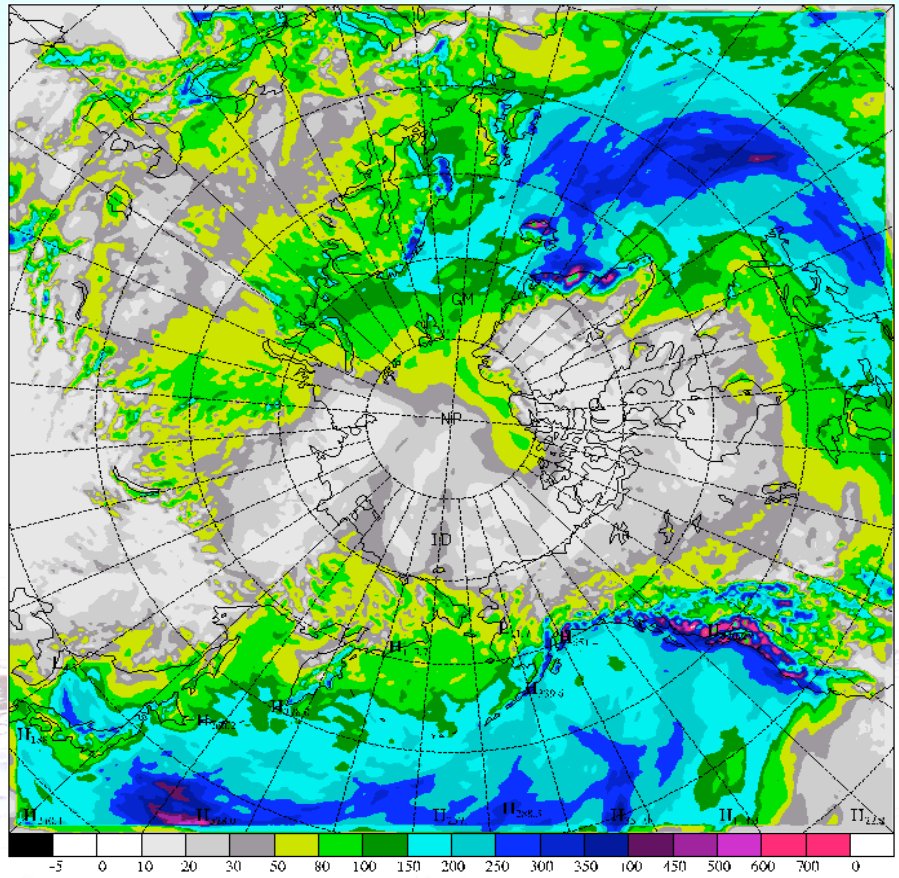


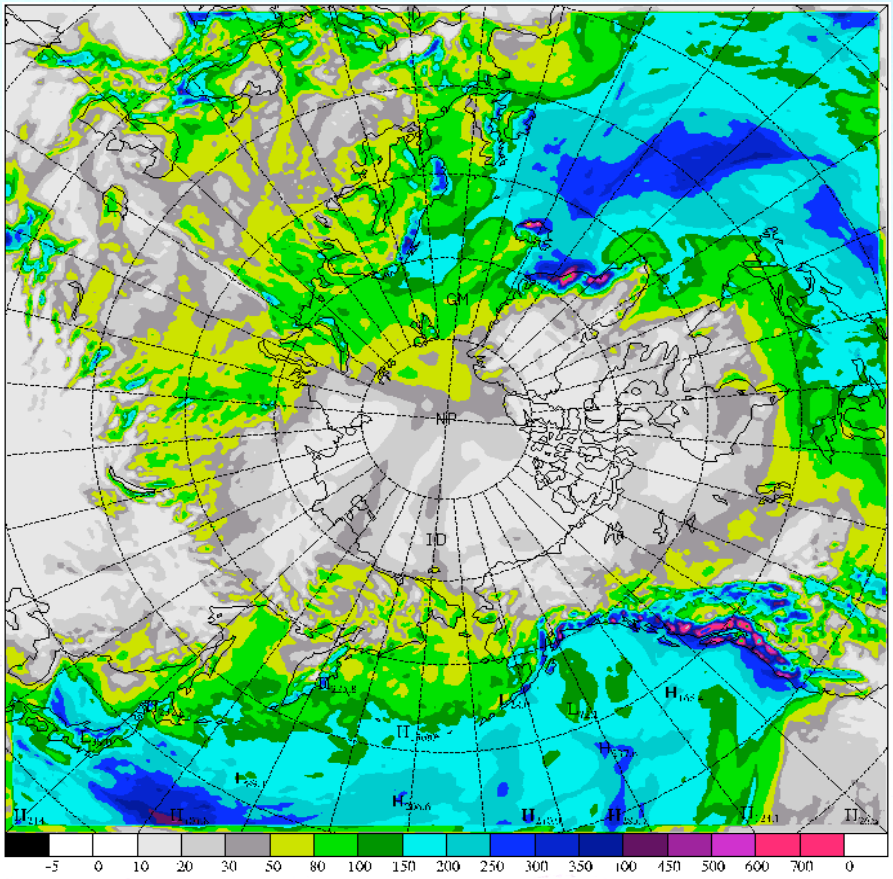
ERA-Interim

ASR with Radiances

Precipitation (Monthly total in Dec 2007)

(Unit: mm)





ASR with Radiances

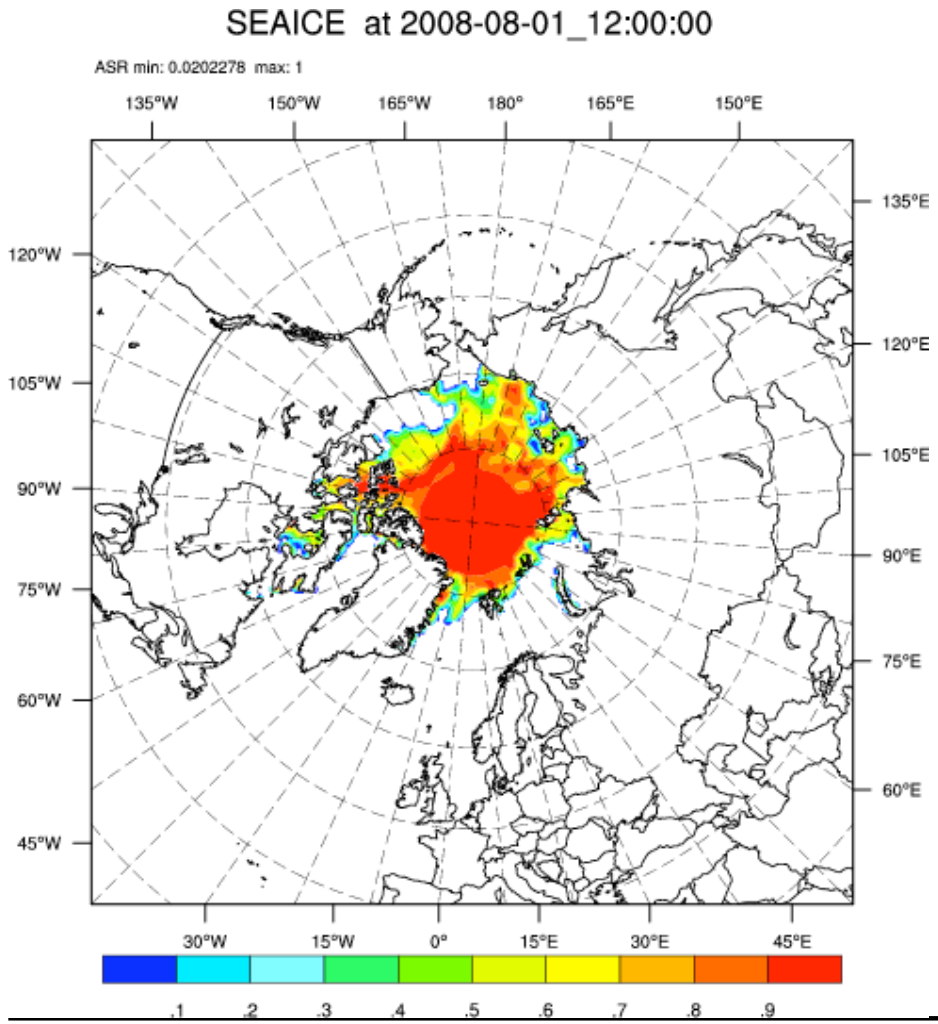
ASR w/o Radiances

Results from Aug. 2008

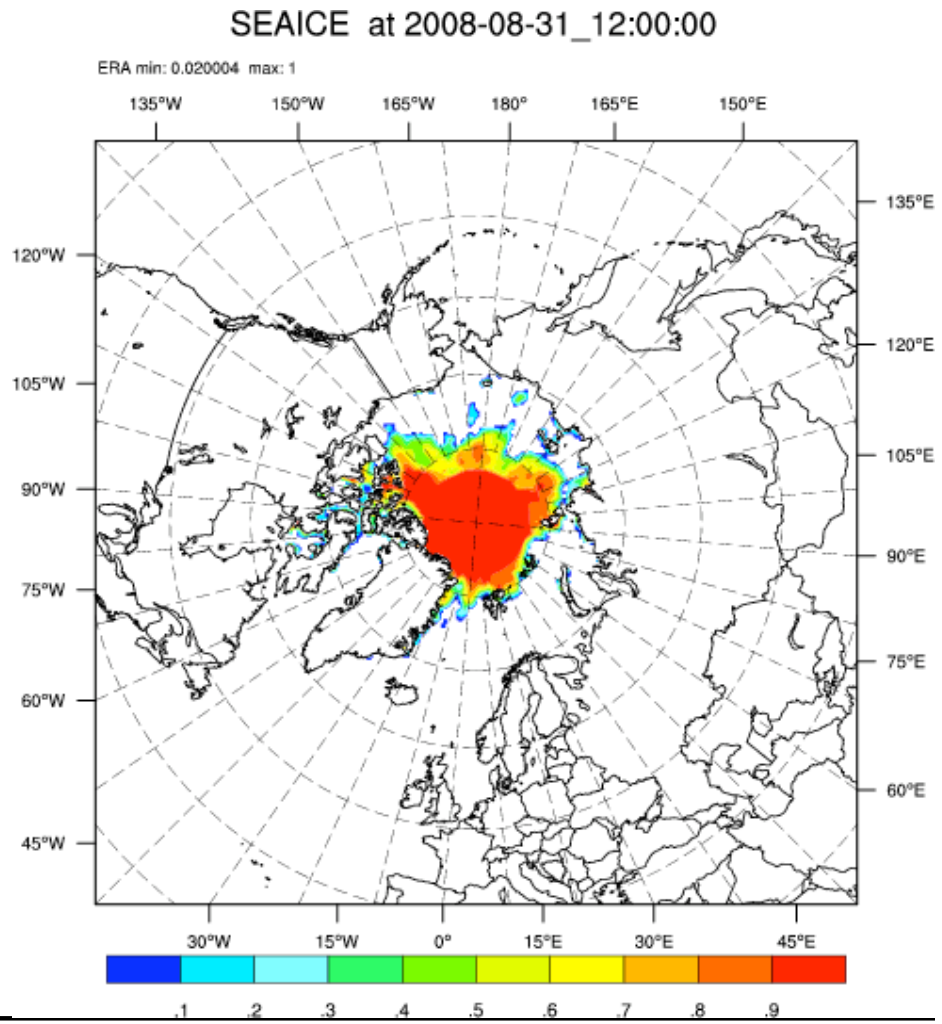
ERA-Interim as LBC

ERA-Interim Fractional Sea-Ice

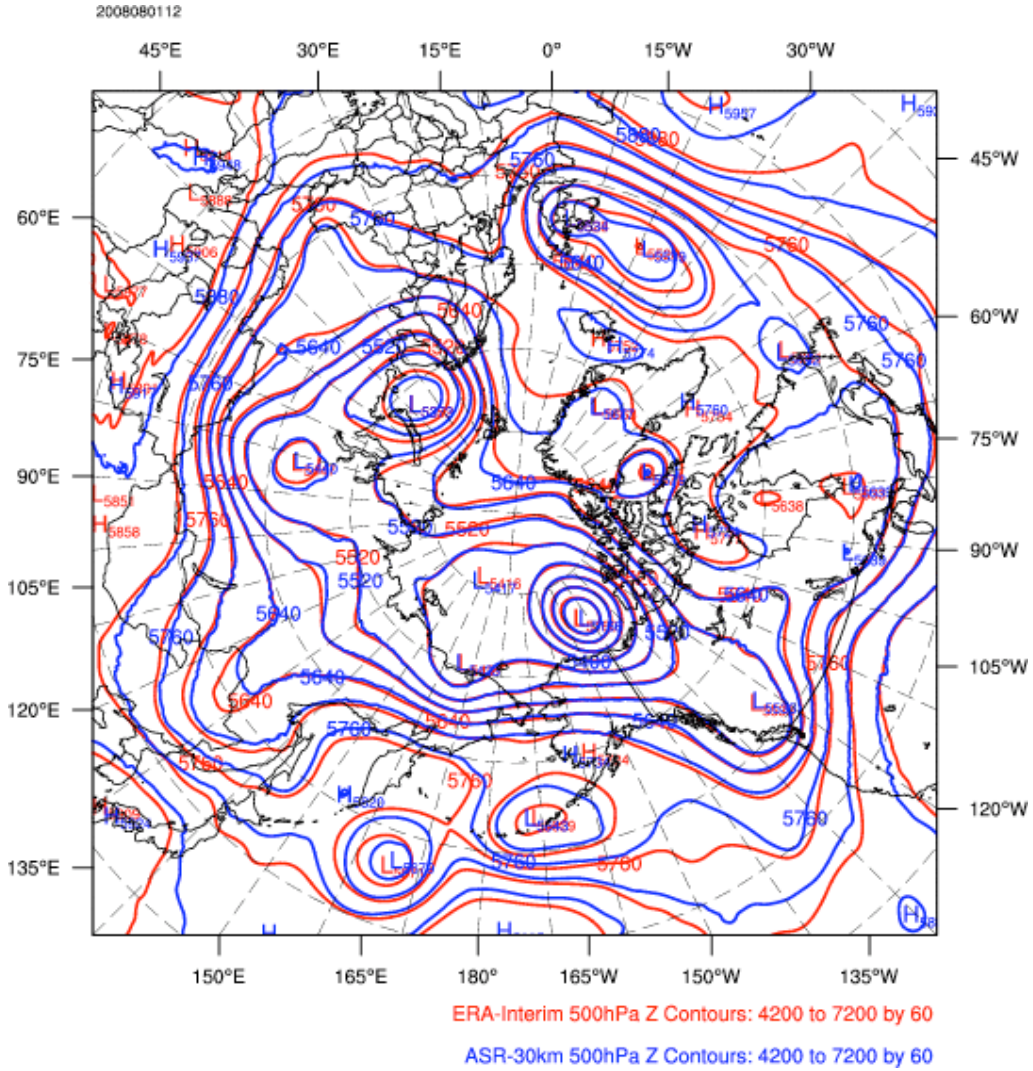
Beginning of August



End of August



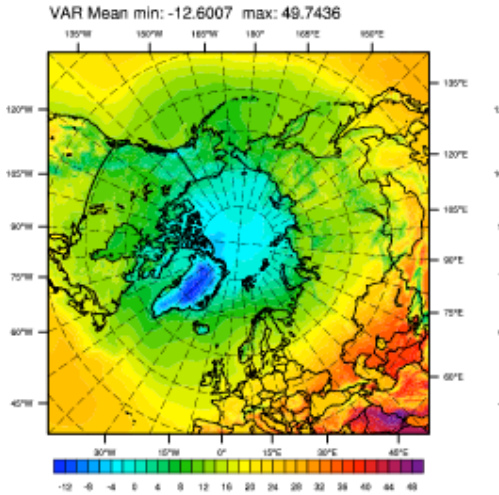
500hPa Height Analyses

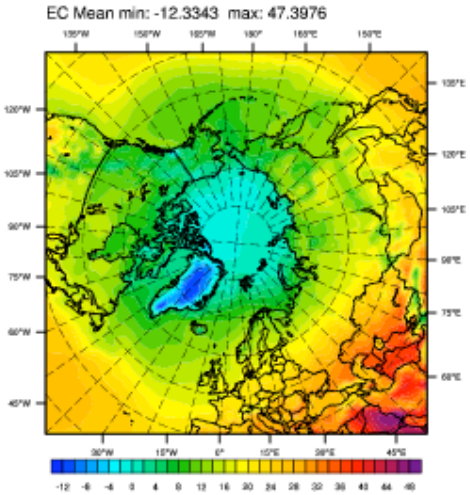


Monthly Mean T2m

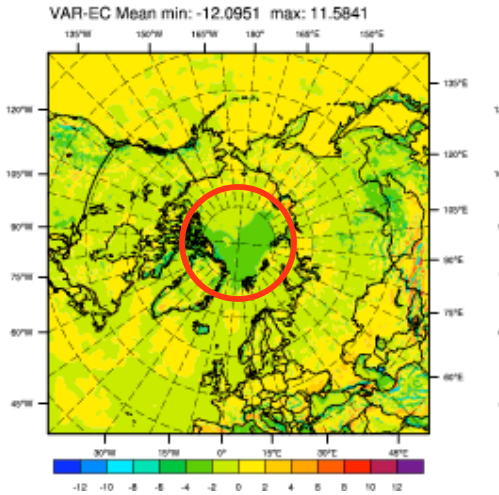
W/O Radiances

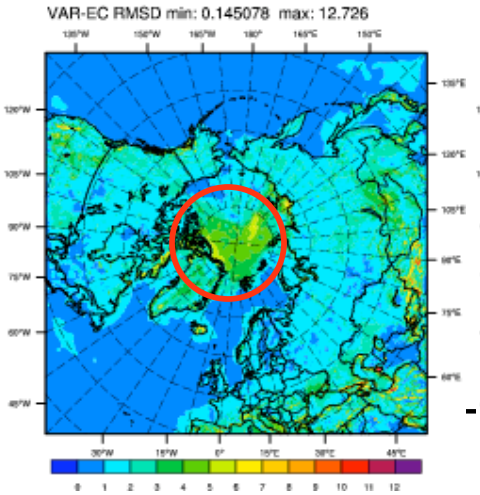
Monthly Map: T2 (C) at 12Z 08/2008





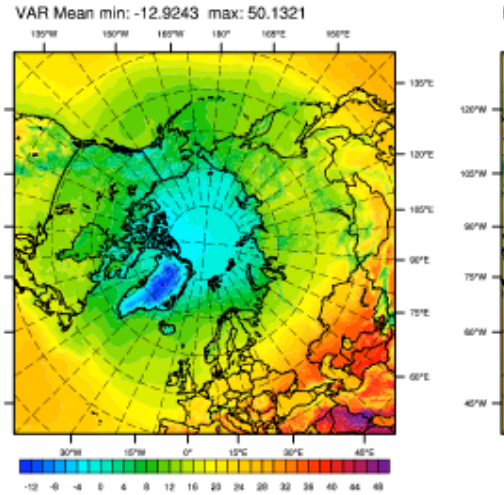
4K colder than ERA

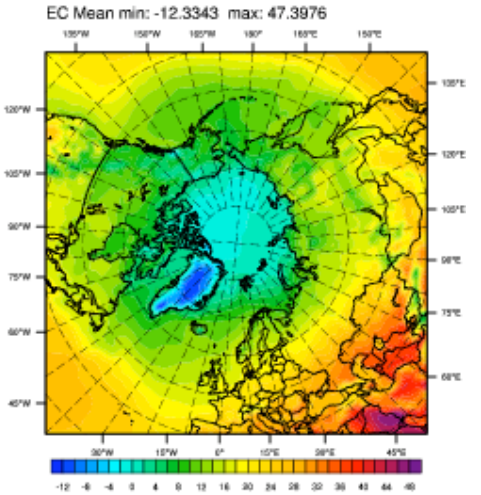


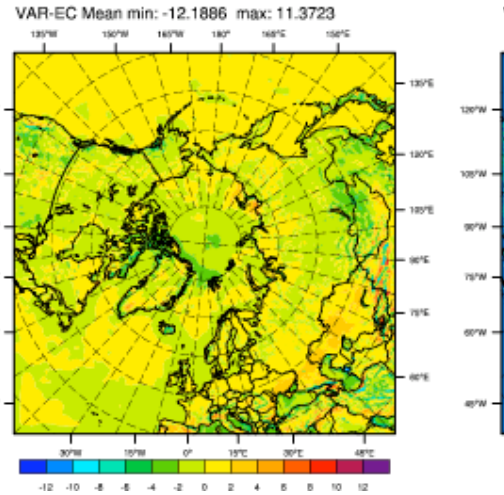


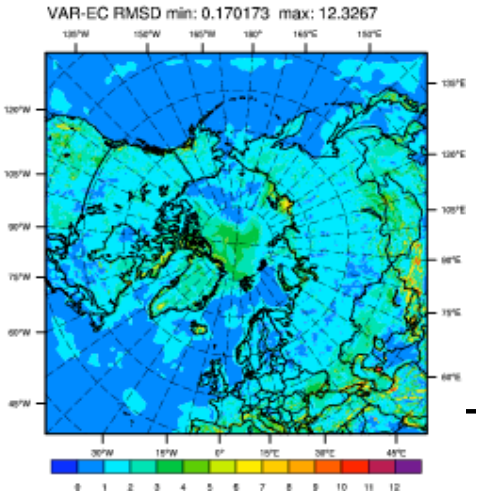
With Radiances

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

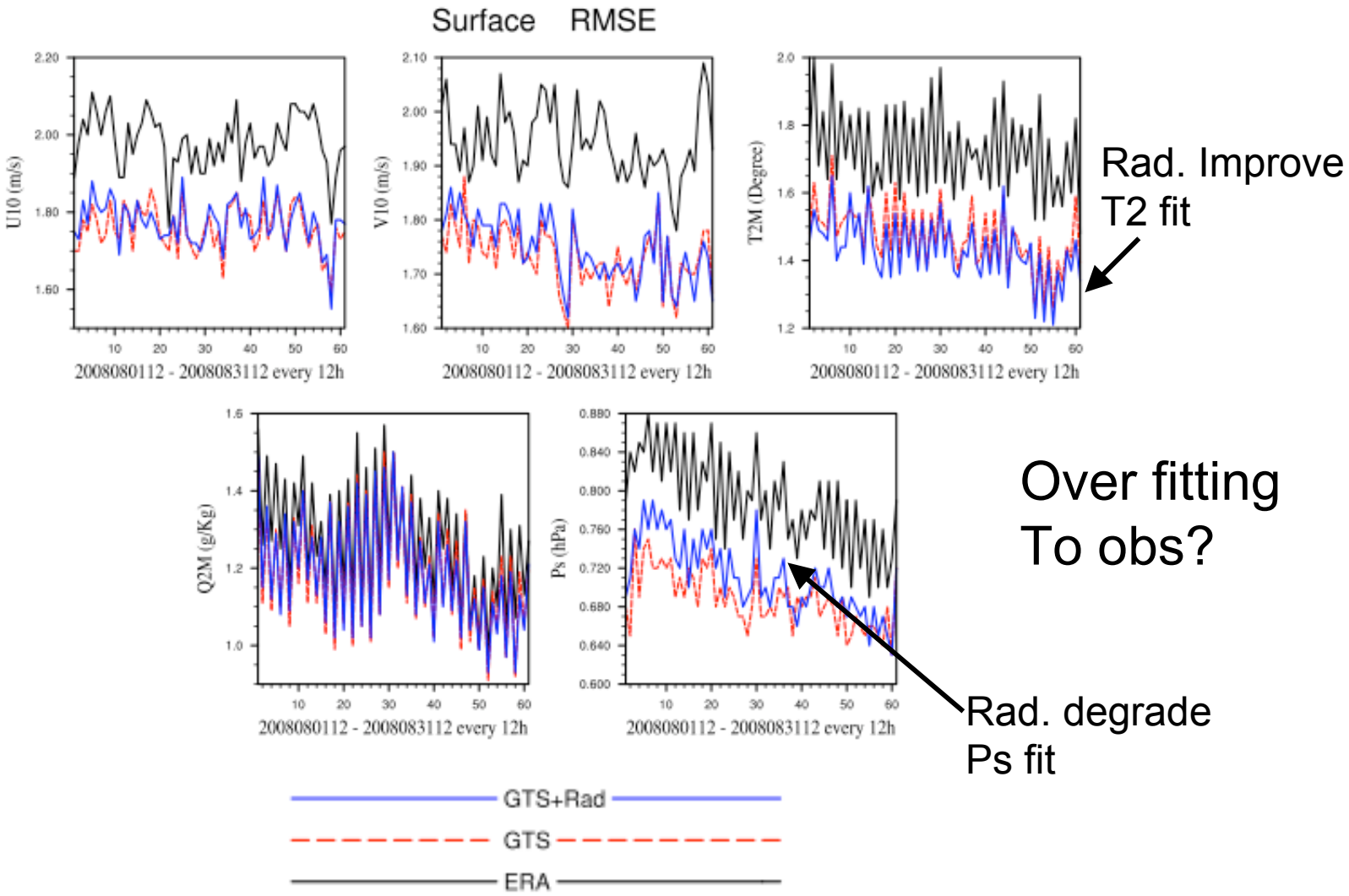




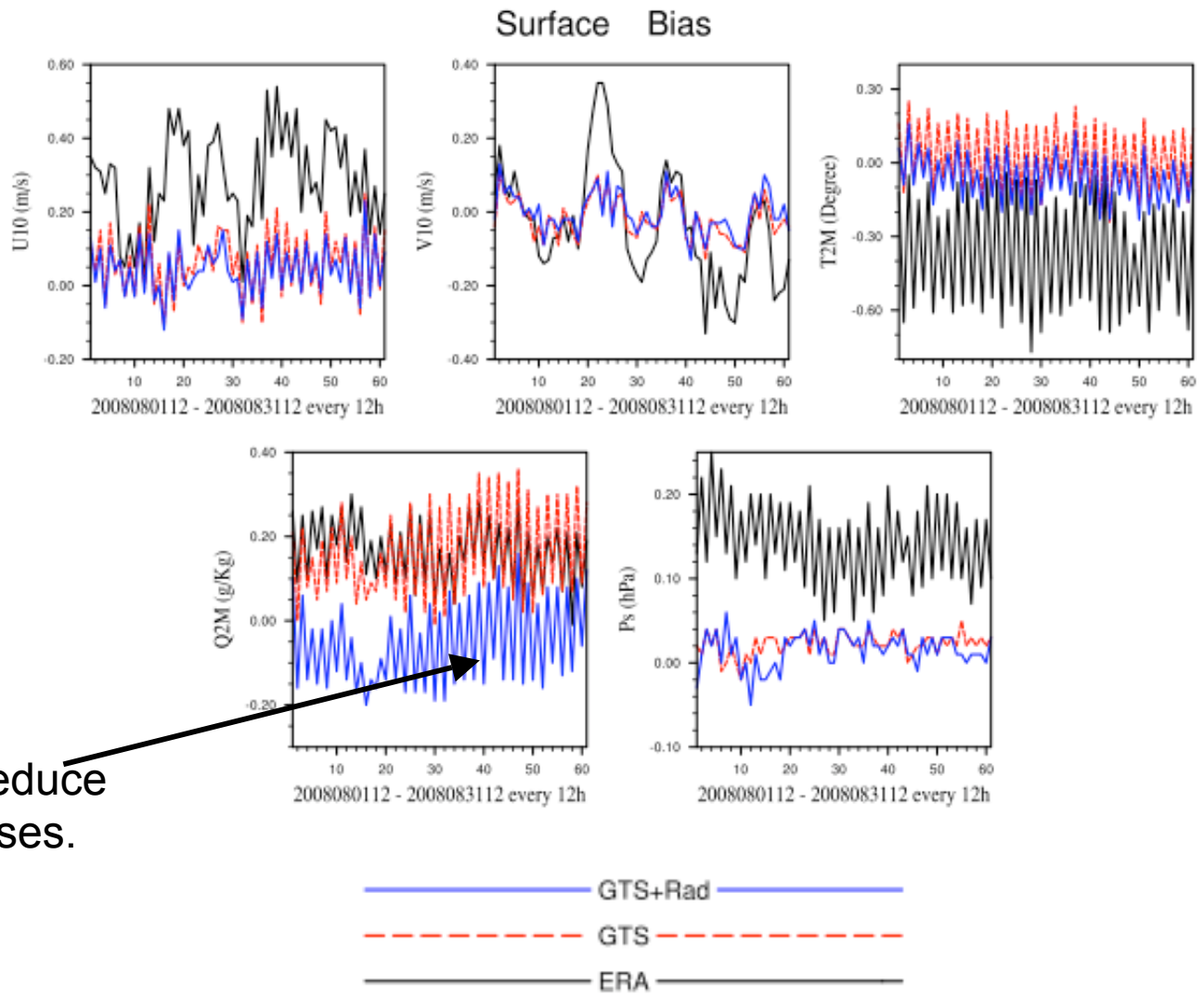




Analyses vs. SYNOP (RMSE)



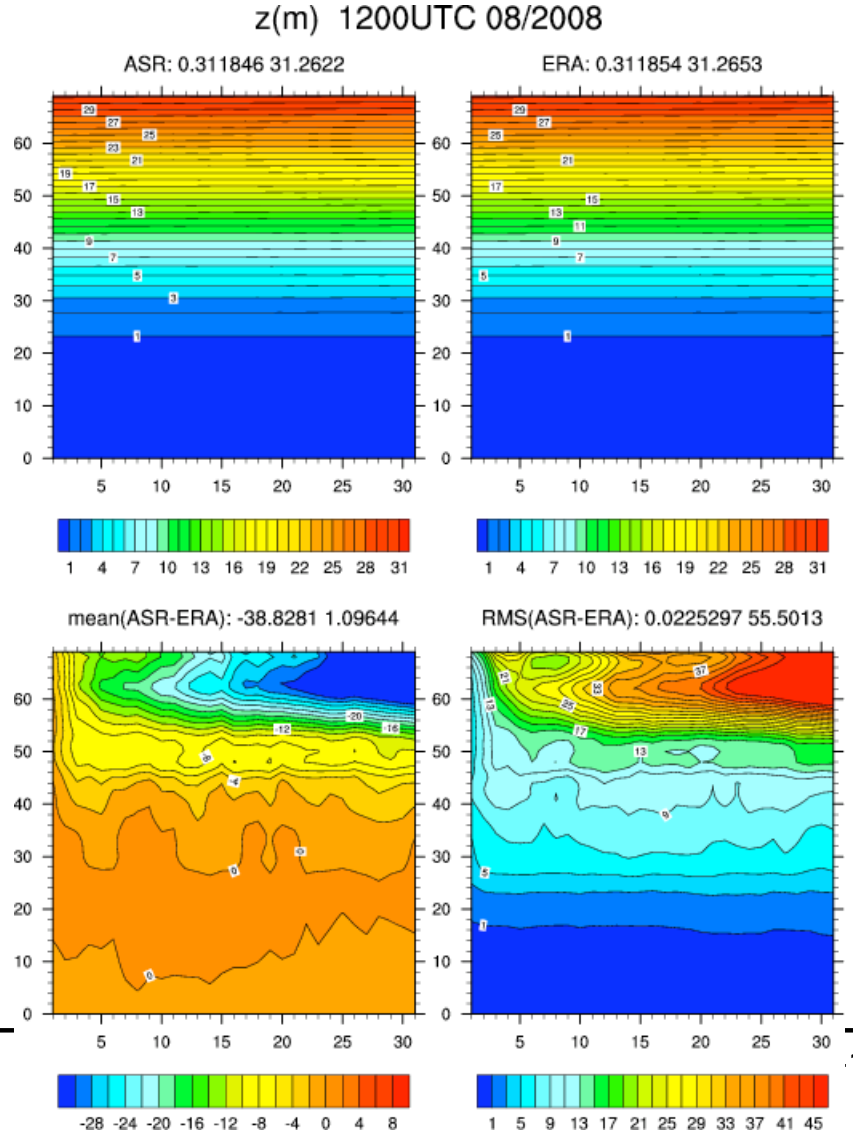
Analyses vs. SYNOP (Biases)



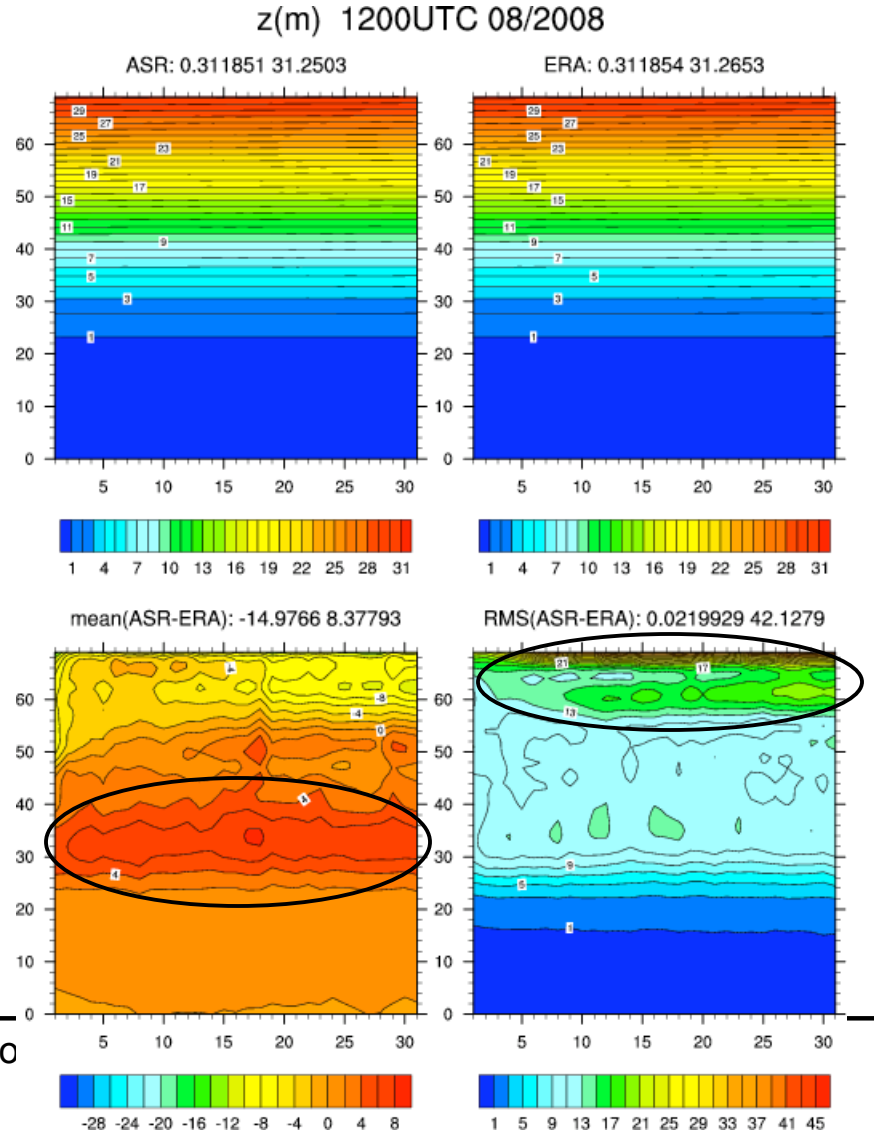
Rad. reduce
Q2 biases.

Z: ASR vs. ERA-Interim

W/O Radiances



With Radiances



Summary

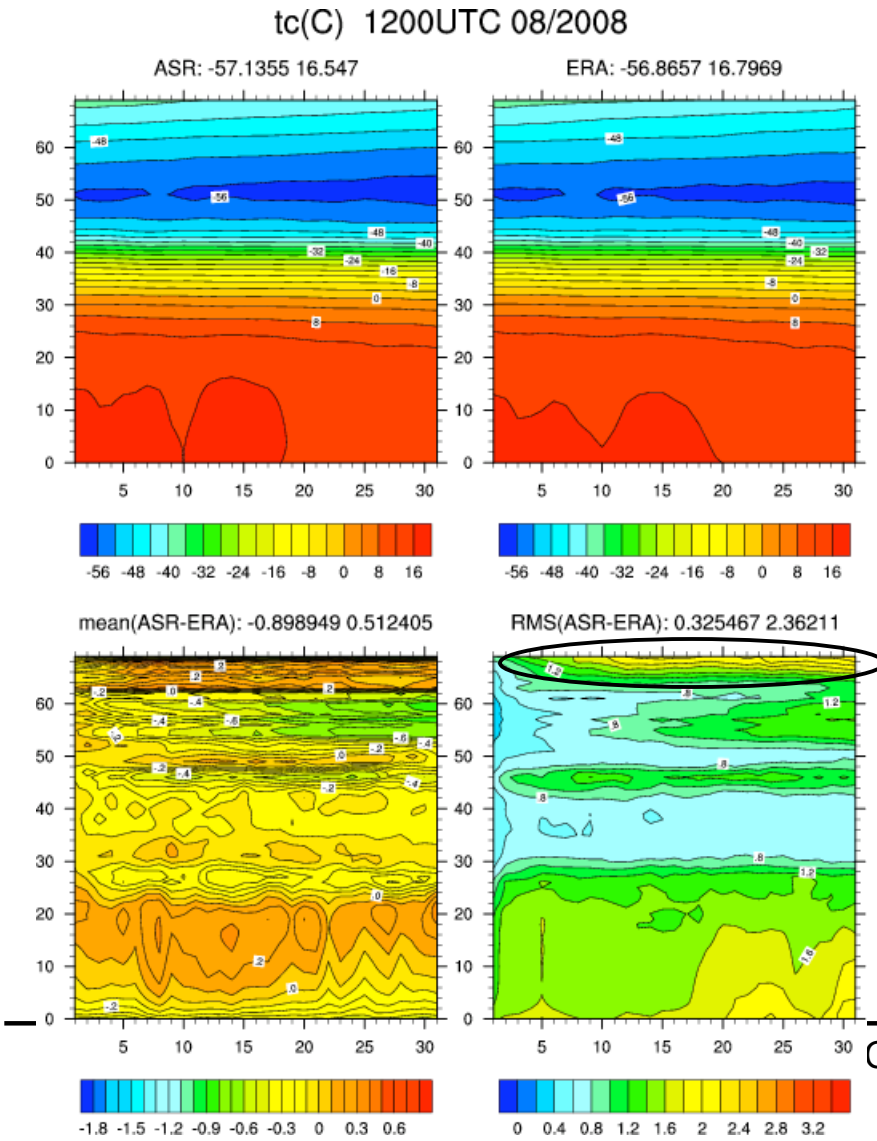
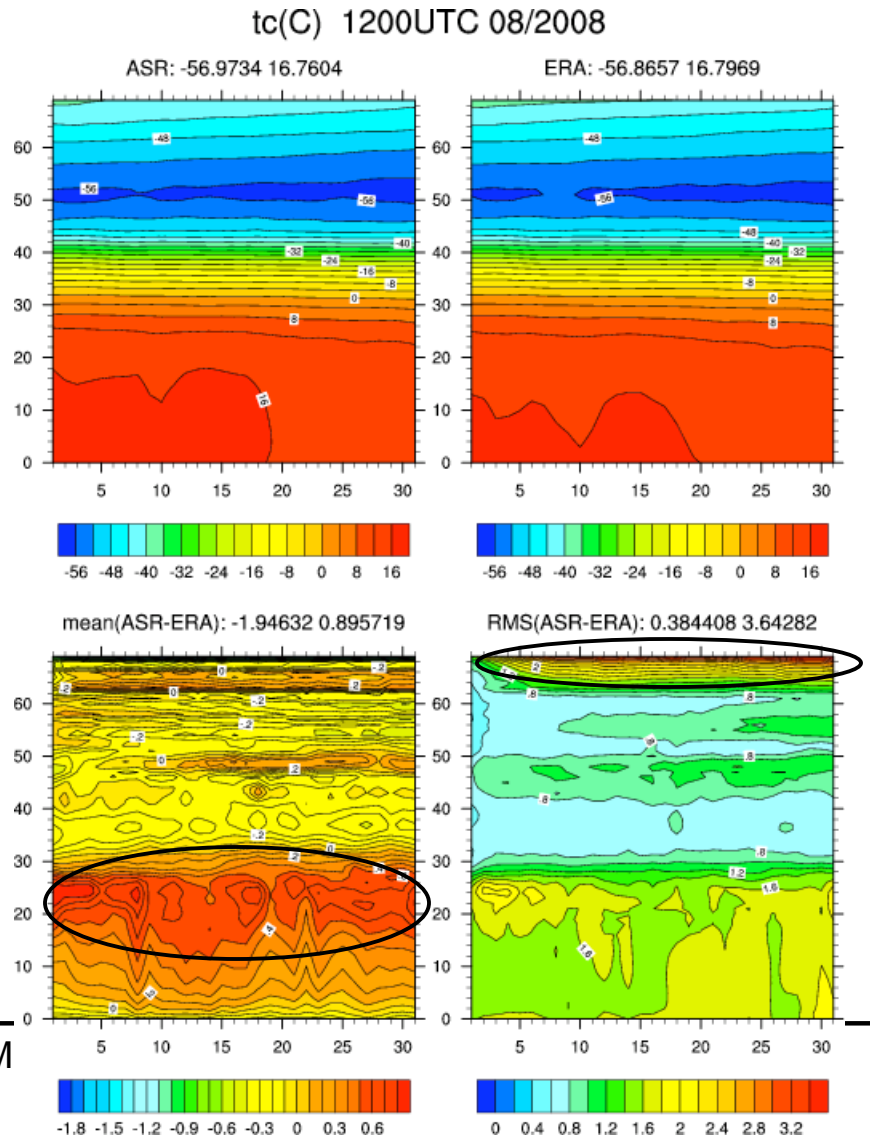
- Several issues in WRFDA were found during testing
  - GPSRO QC, AIRS cloud detection scheme.
  - Errors near the model top increasing with the time.
  - Other issues not listed/mentioned in this talk ….
- Radiance impact is mixed
  - Adding radiances tends to produce more precip. over ocean.
  - Better positioning Low pressure centers over ocean
  - Radiances apparently improve T2m/Q2m.
  - But larger Ps error.
  - Mixed impact for upper air. Model top biases make things complicate.
- Difficulties to do reanalysis for university.
  - Computational resource limitation, limited man power
  - Data collection/processing
  - Lack detailed obs monitoring information (usually available in operational NWP centers. e.g., blacklist of various obs types)

Future work

- More testing/tuning needed before production run
  - Diagnose HBH^T and compare to R
  - Use observation sensitivity tools to identify impact from different obs types (& individual radiance channel)
  - Model top issue: nudging global fields at top levels? increase model top? Add O3?
- Need run forecasts to judge analysis performance.

T: ASR vs. ERA-Interim

W/O Radiances



With Radiances