

1. Introduction

- LEO hyperspectral IR sounder
 - AIRS/IASI/CriS
 - Great success in global forecast
- GEO hyperspectral IR sounder
 - EUMETSAT: IRS/MTG (2020)
 - China: FY4 (2016)
 - USA: GOES-R HES withdrawn
 - High temporal/vertical/ resolution
 - Ideal for regional weather forecast
- Observing System Simulation Experiment (OSSE)
 - Study the value added impacts compared to existing instruments
 - Simulate observations for existing and future instruments
 - Validate the simulations
 - Synthetic observations
 - Nature run (NR)
 - Quick regional OSSE (r-OSSE) on Hurricane Sandy (2012)
 - Are high temporal hyperspectral IR measurements worthy?

2. ECMWF T1279 (NR)

The sample NR data provided by ECMWF for Hurricane Sandy

- 144 hours from 10/27 2012 00 UTC to 11/1 23 UTC
- Hourly output for the first 90 hours
- One of the better NWP models to successfully forecast Hurricane Sandy's track and landfall

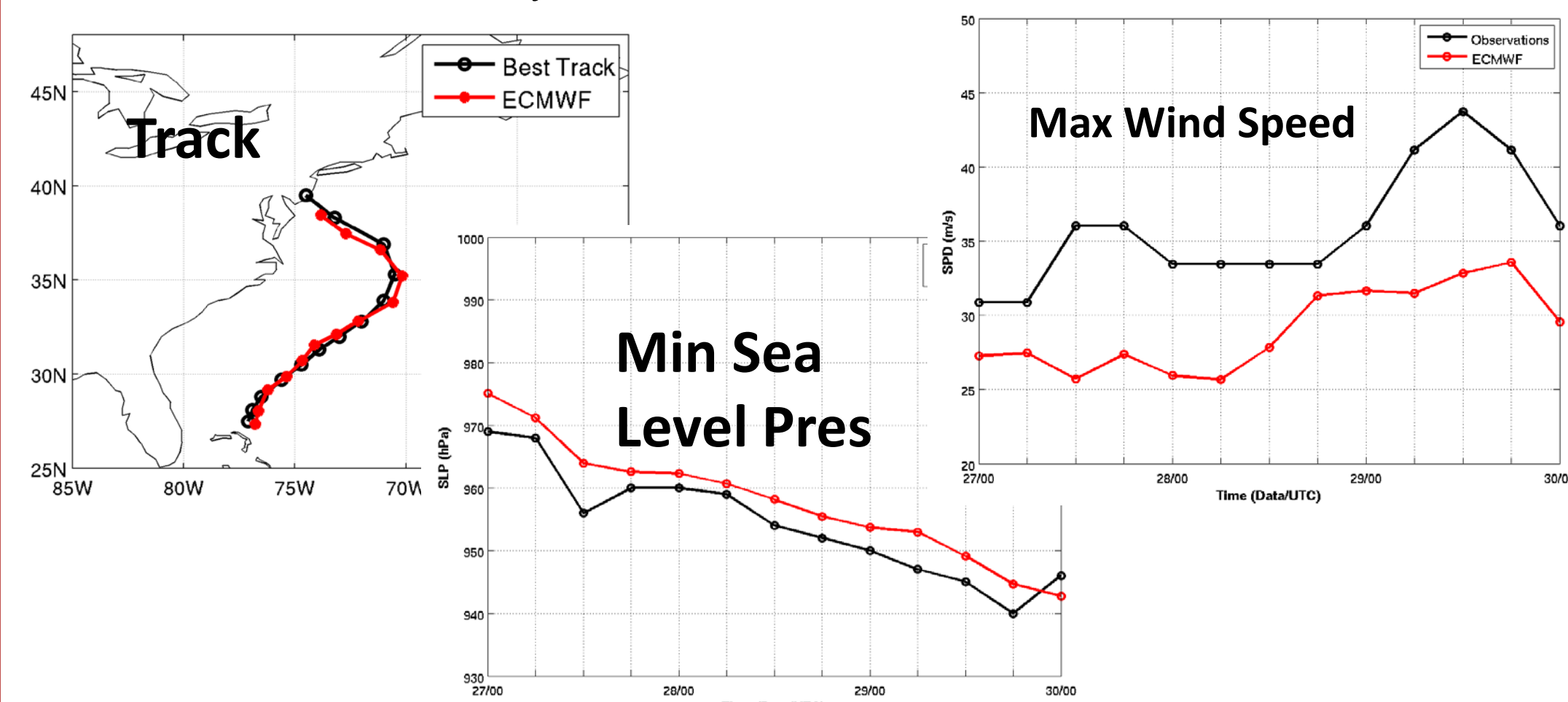


Figure 1. Validation of ECMWF T1279 NR for Hurricane Sandy, which was successfully predicted for track, maximum wind speed and minimum sea level pressure, although the forecast is a bit weaker compared with observations.

3. Examples of synthetic observations and validations

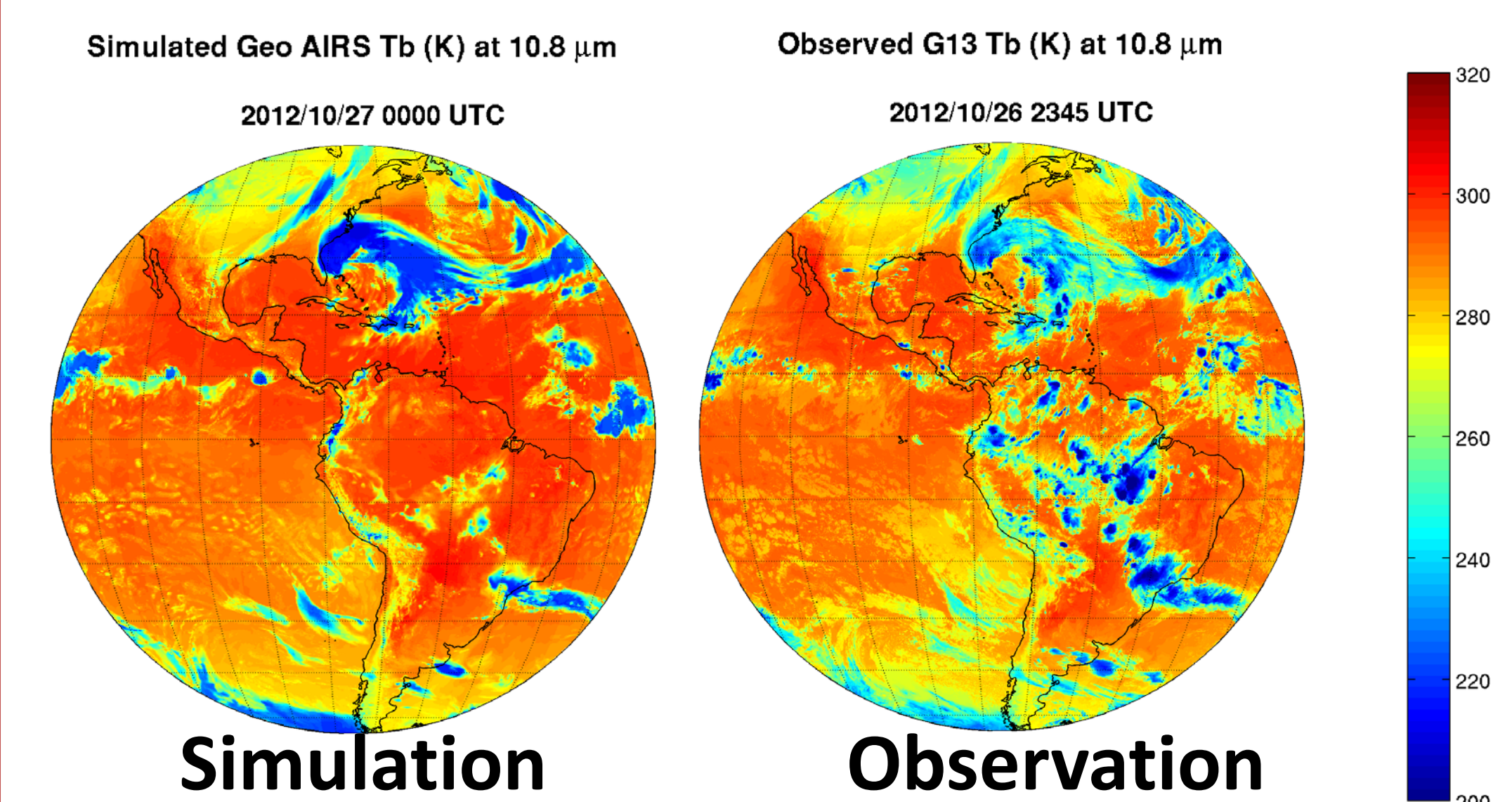


Figure 2. The simulated (left) GEO AIRS Tb at 10.8 micron at 0000 UTC on October 27 2012 and the observation (right) from the GOES-13 Imager. The GEO AIRS radiances are convolved with GOES-13 Imager spectral response function to generate left figure.

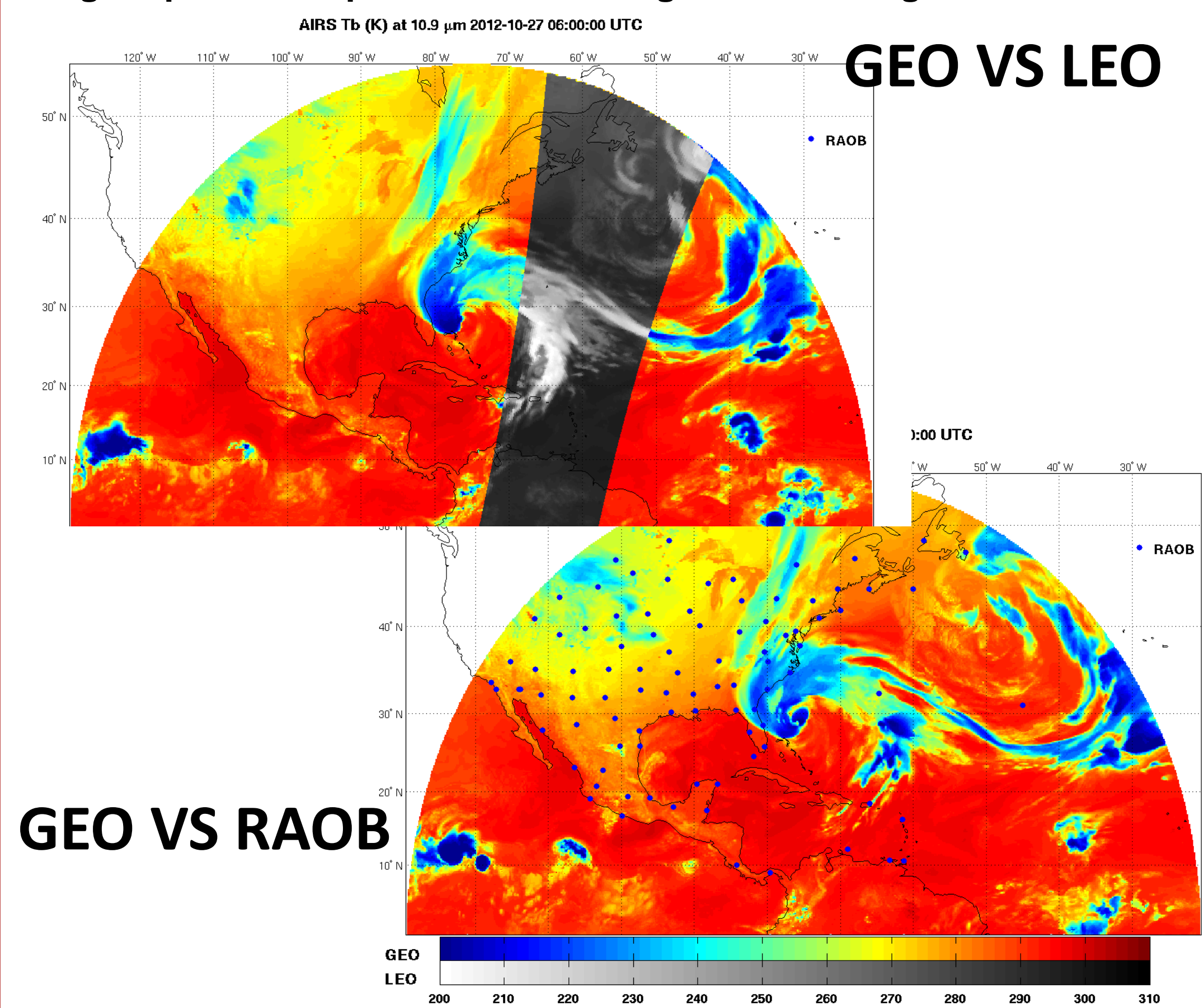
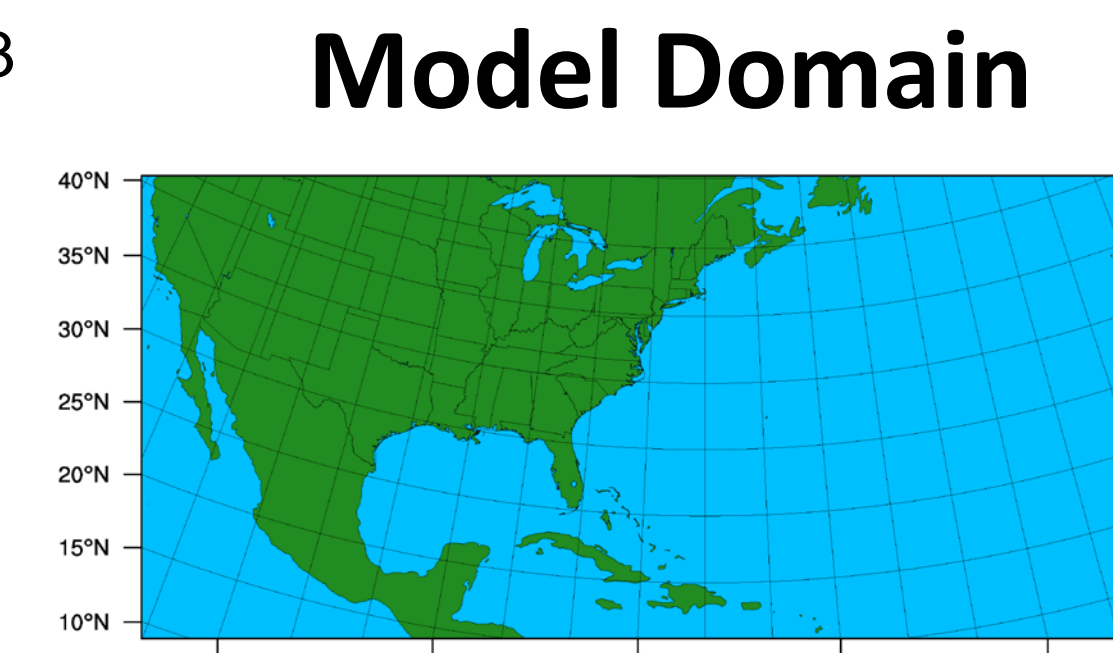


Figure 3. Data coverage of three types of synthetic observations: continuously GEO (hourly, colored), snapshot LEO (twice a day, gray), and scattered RAOB (twice a day, blue dots).

4. Quick r-OSSE configuration

- Forecast model: WRF-ARM V3.6.1
- Assimilation system: GSI V3.3
- Horizontal resolution: 16 km
- Vertical levels: 75
- Model top: 10 hPa
- Time steps: 50 s
- Physics scheme
 - Microphysics: WSM6
 - Longwave/shortwave Radiation: RRTMG
 - Planetary Boundary layer: Yonsei University
 - Cumulus Parameterization: Grell
- Initialization and background come from NCEP Final Analysis (FNL)
- Synthetic radiosonde observations (RAOBs) as conventional obs
- Assimilate atmospheric sounding (t/q) retrievals (both GEO and LEO) instead of radiances



5. Experiment results

5.1 GEO VS LEO

3h cyc: initialization time -> DA 1 -> DA 2 -> DA 3 -> end of forecast
 6h cyc: initialization time -> DA 1 -> DA 2 -> end of forecast

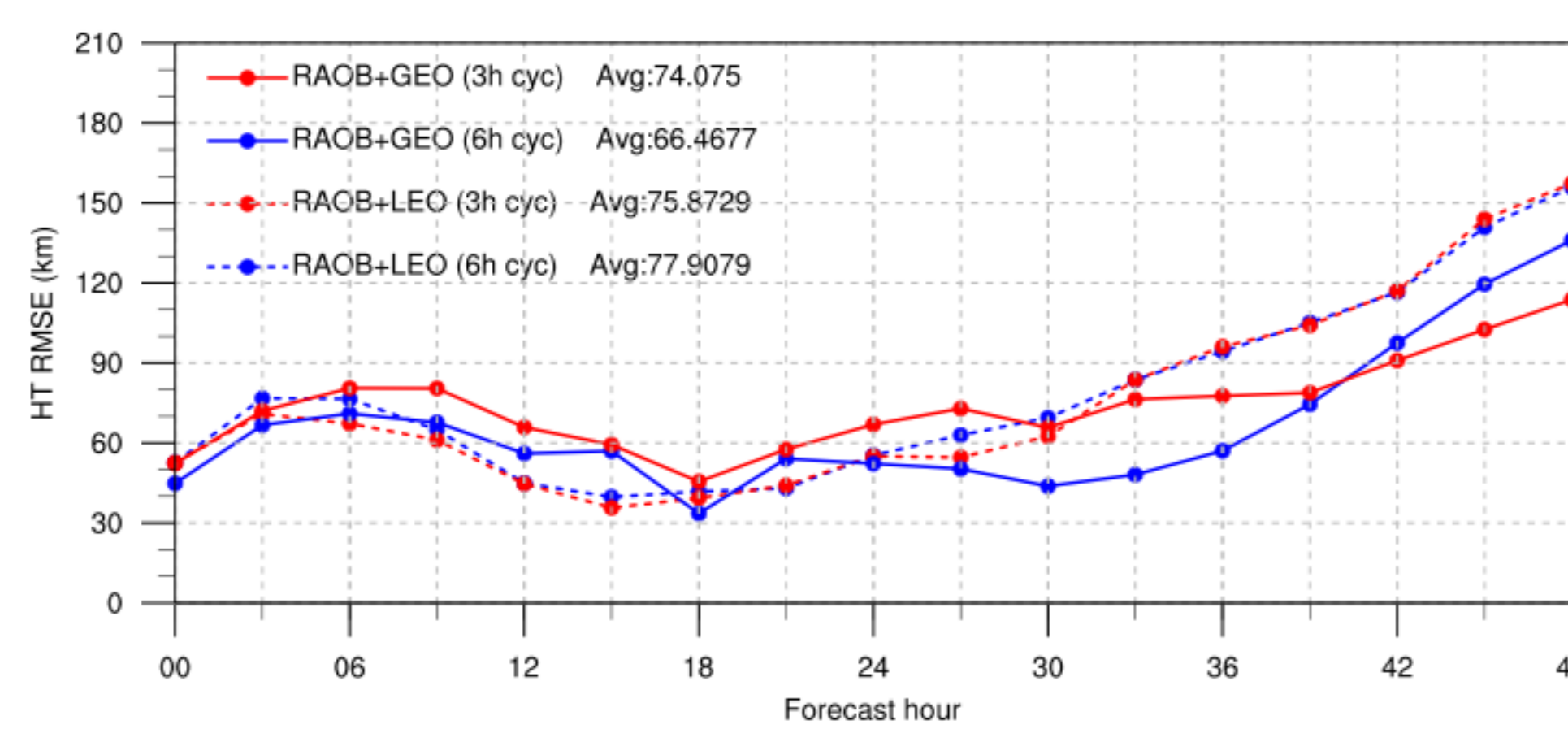


Figure 4. Impact of GEO AIRS on Hurricane Sandy track forecast versus that of LEO AIRS. Notice the improvement by GEO AIRS for the last 18 hours of forecast.

5.2 GEO High temporal cycling

1h cyc: initialization time -> DA 1 -> DA 2 -> DA 3 -> DA 4 -> DA 5 -> DA 6 -> DA 7 -> end of forecast

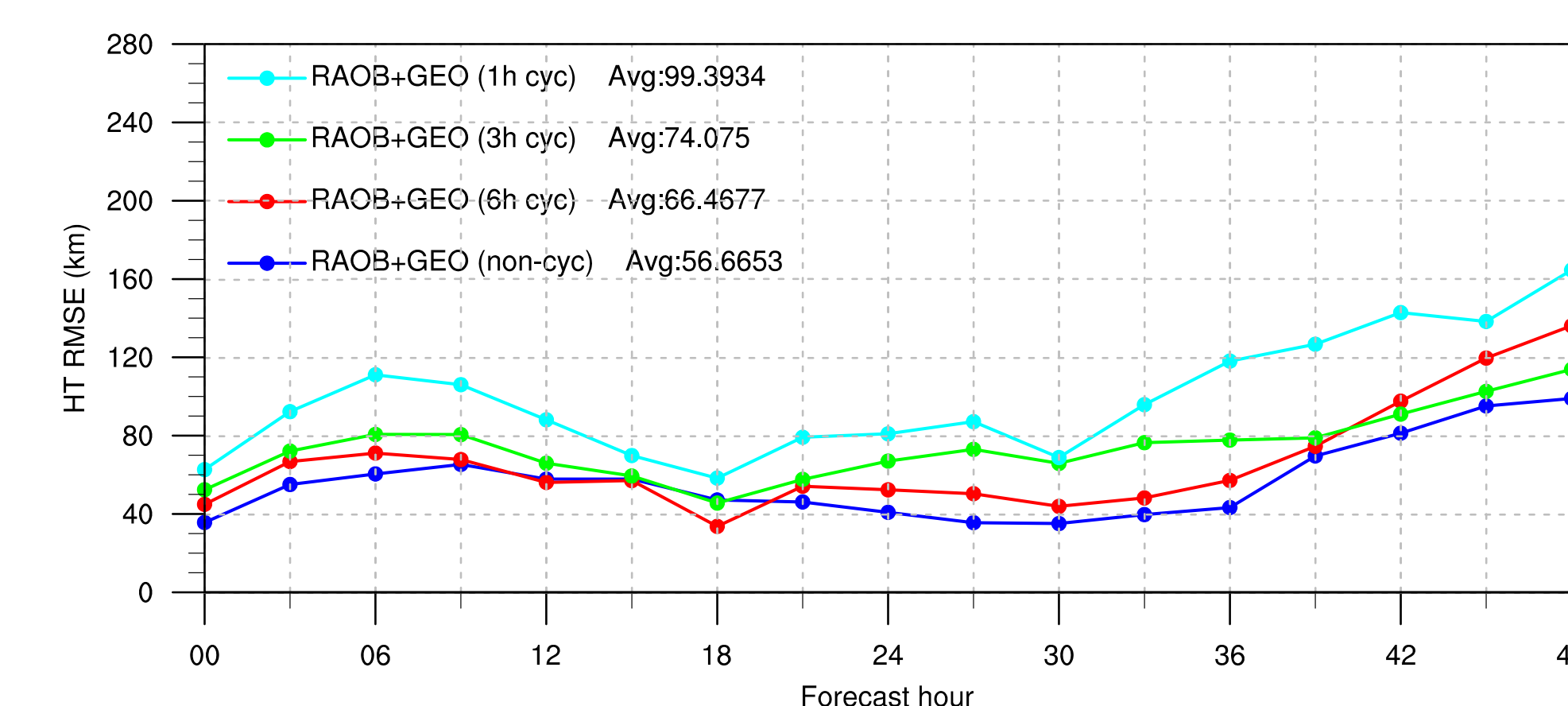


Figure 5. Impact of GEO AIRS on Hurricane Sandy track forecast using different cycling schemes. Note more frequent DA leads to worse forecast.

5.3 Thinning

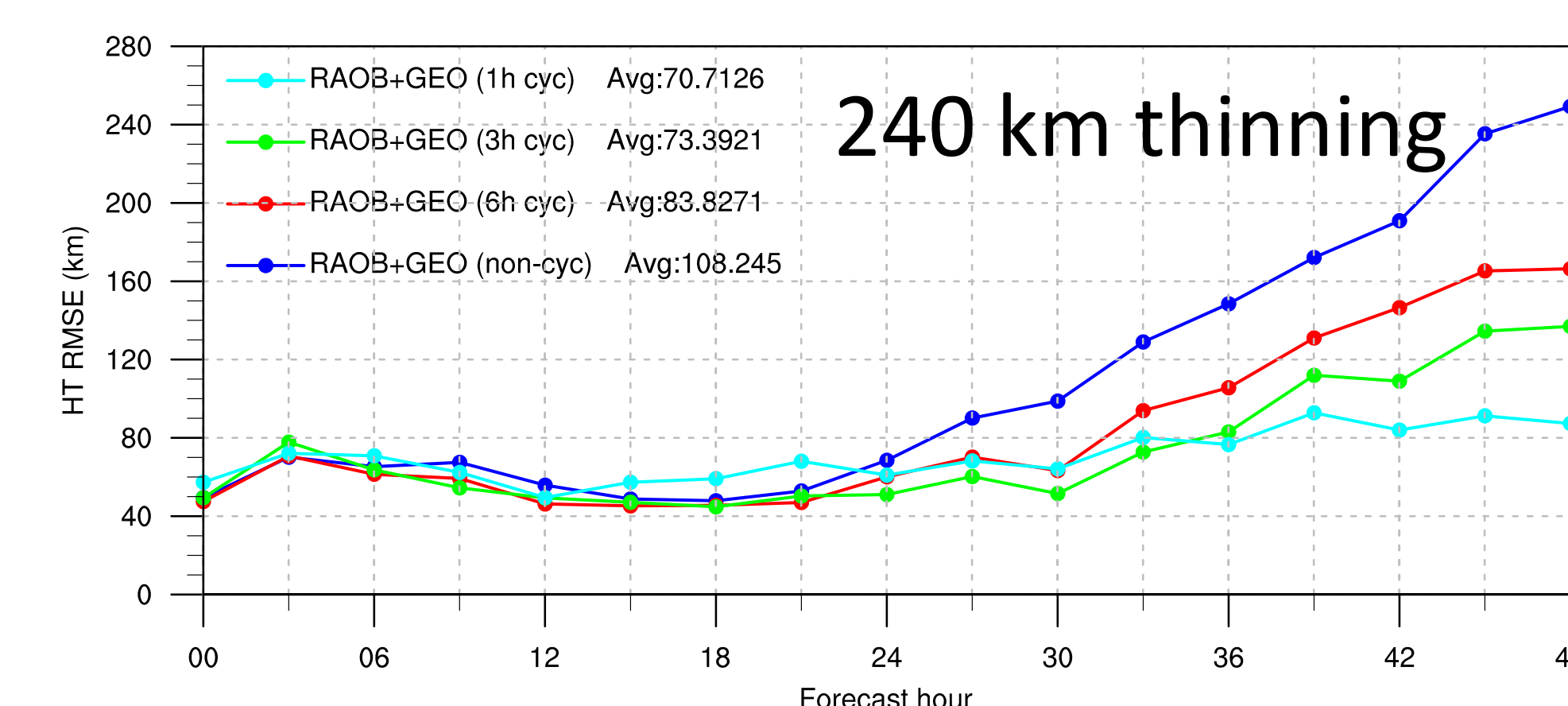


Figure 6. Impact of data thinning on different cycling schemes. Note thinning significantly helps 1h cycling, but not others.

5.4 Imbalance btwn thermodynamic and dynamic fields in analysis

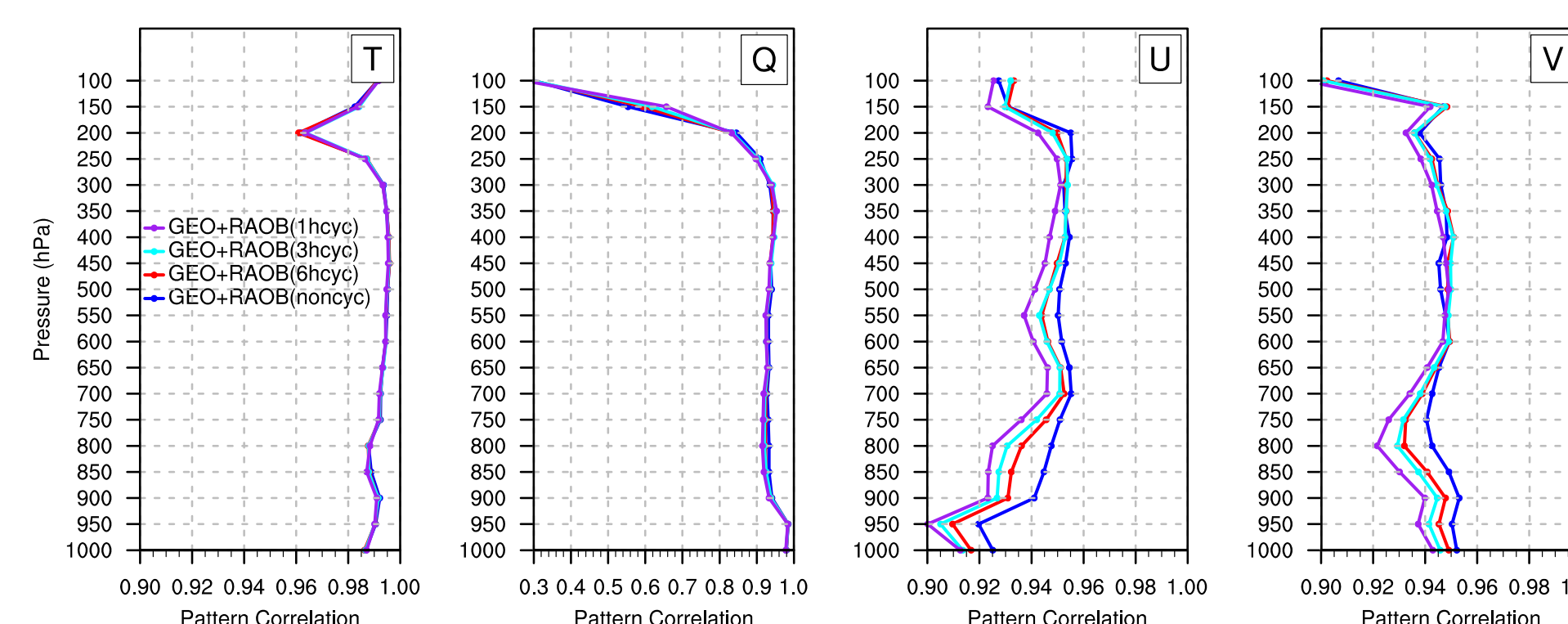


Figure 7. Pattern correlation between analysis and NR for different cycling experiments. More frequent DA leads to larger imbalance between thermodynamic and dynamic fields.

5.5 Reducing observation weight through B matrix

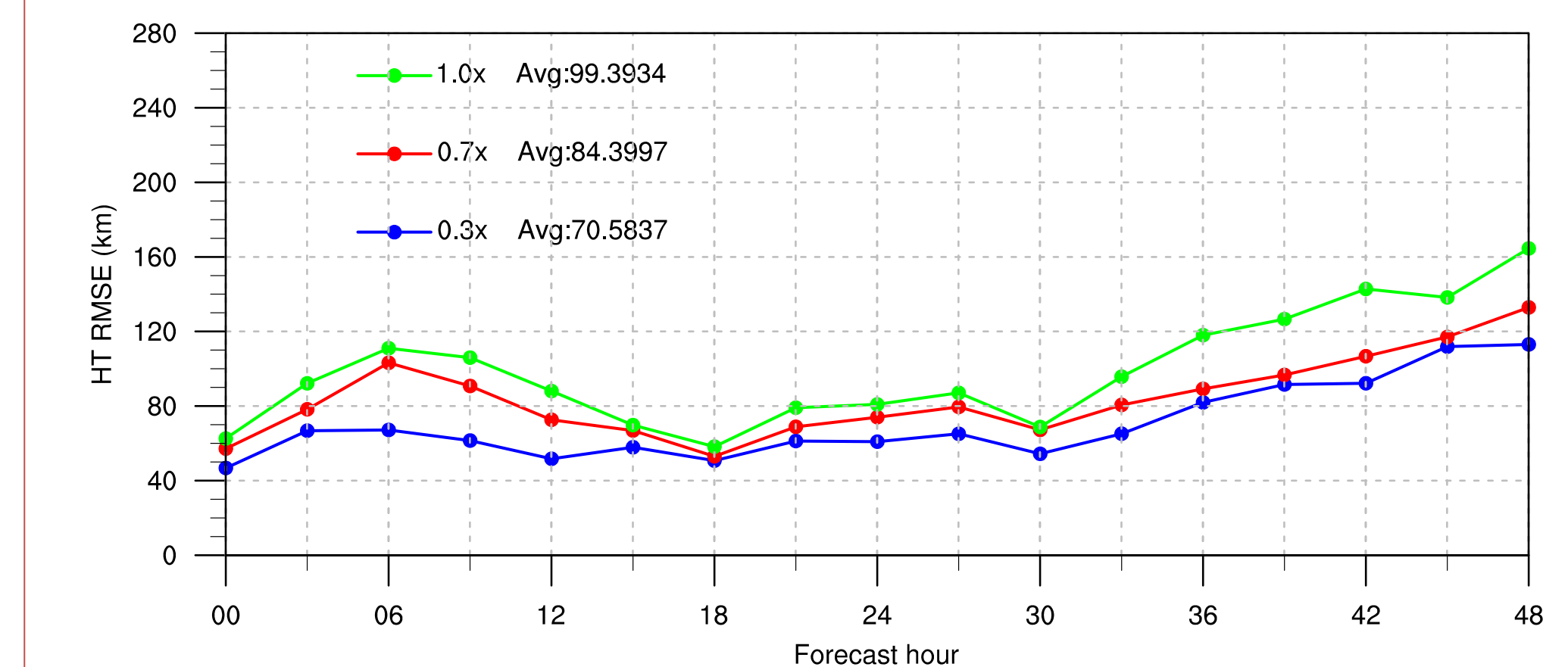


Figure 8. Impact of reducing the influence of data by lowering weight on observation. Helps but still not as good as none cycling.

5.6 Reducing observation weight through observation impact radius

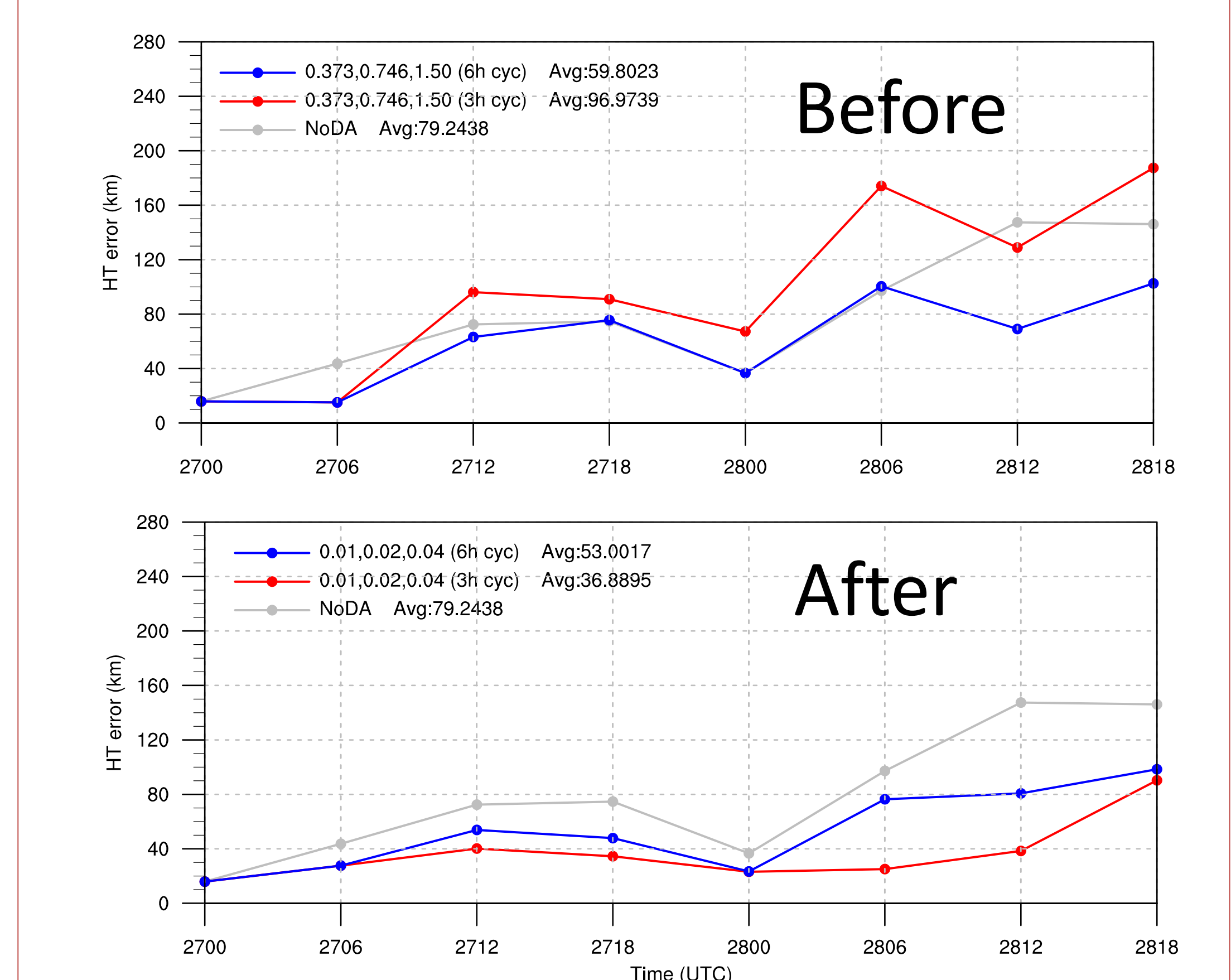


Figure 9. Impact of adjusting obs impact radius on analysis.

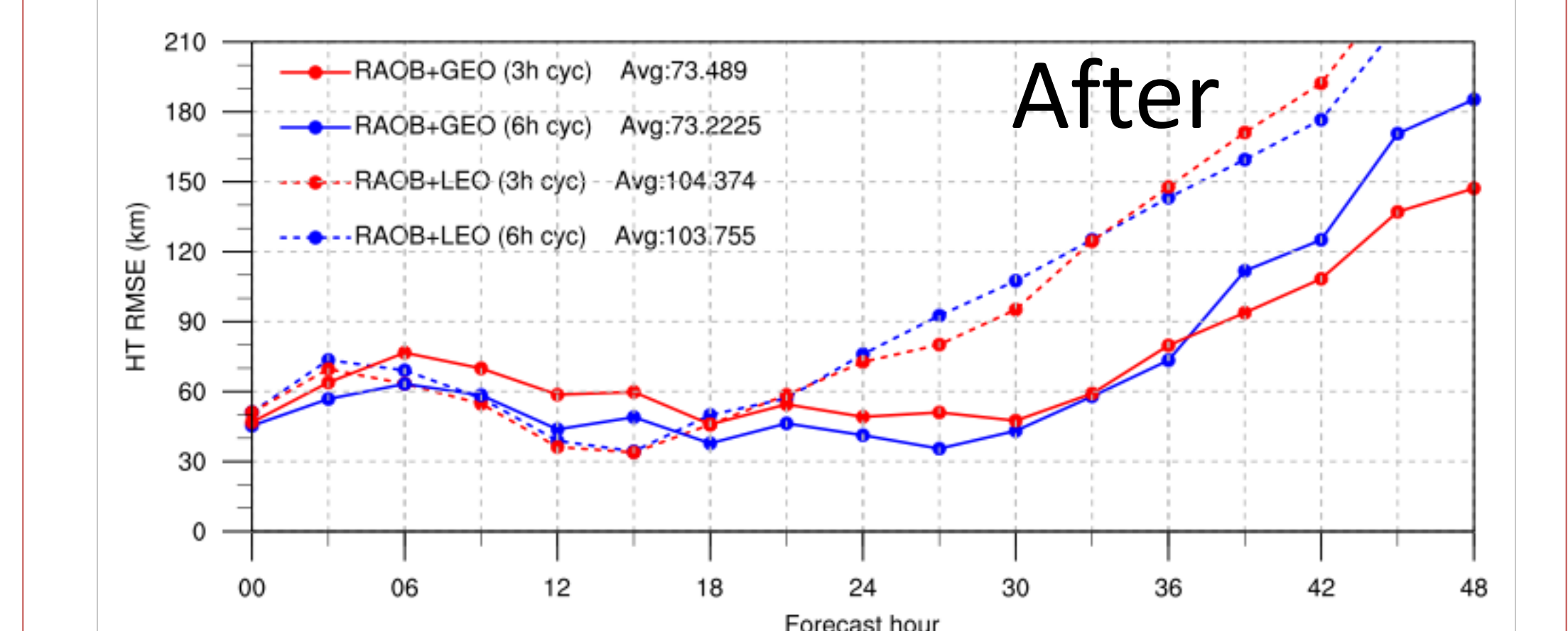


Figure 10. Impact of adjusting obs impact radius on forecast.

6. Summary

- Generated and validated simulated synthetic GEO AIRS radiance observations from ECMWF T1279 NR.
- Atmospheric sounding profiles were retrieved from both GEO and LEO AIRS synthetic radiances, validated, and converted to PREPBUFR format.
- Experiments show that
 - GEO AIRS provides additional improvements of Hurricane Sandy track forecast over LEO AIRS
 - More frequent DA of GEO AIRS leads to worse forecast, possibly due to imbalance between thermodynamic and dynamic fields
 - Thinning, tuning B matrix and obs impact radius help 1h cycling, but still no advantage over 3h and 6h cyclings
- Ongoing work
 - Is track forecast/analysis representative of all validation?
 - Can combining different strategy help to show the value of high temporal GEO AIRS?
 - How to maintain observation influence but reduce imbalance between thermodynamic and dynamic fields? 4-D?

7. Acknowledgement

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