

Forecast of hurricane track and intensity with advanced IR soundings

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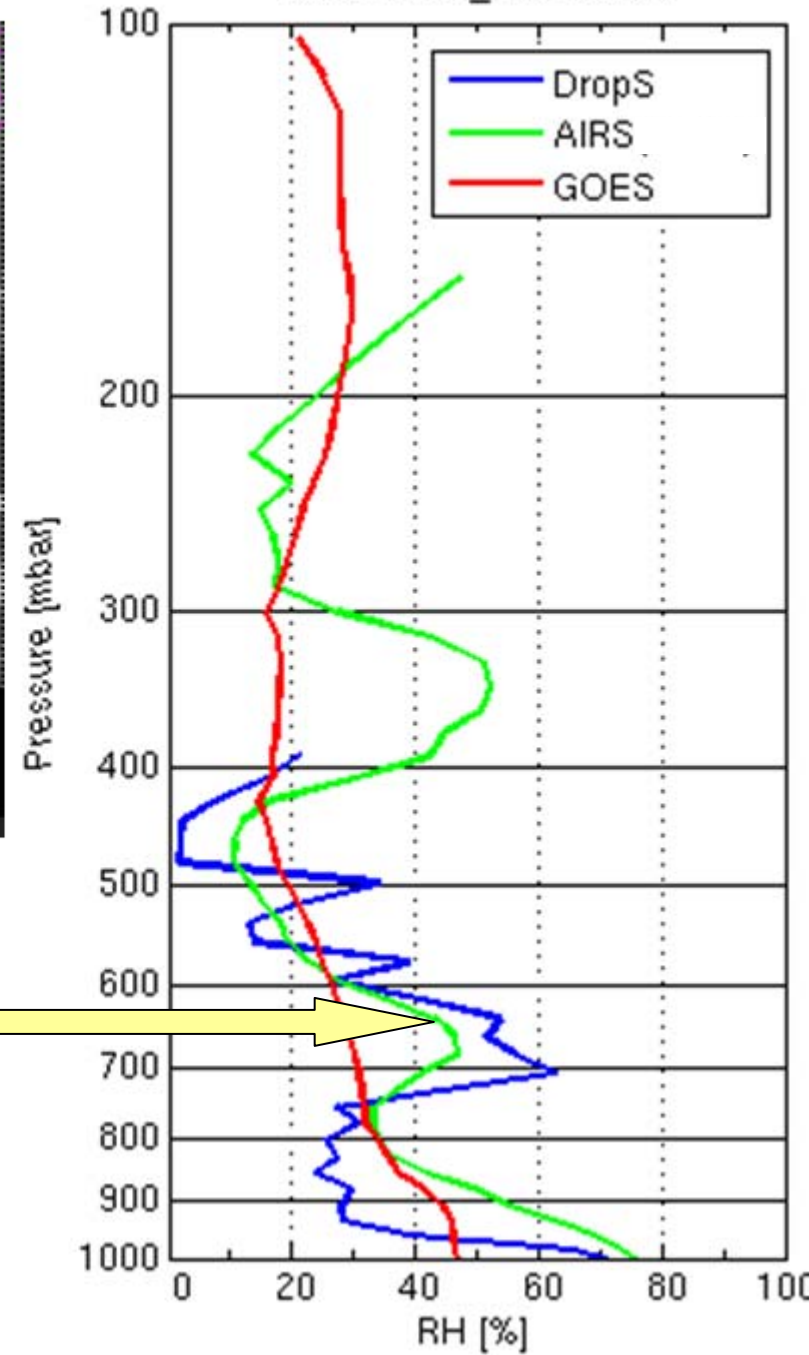
Monterey, CA



Using full spatial resolution hyperspectral IR soundings for tropical cyclone forecast

- Better use of water vapor measurements in global NWP satellites remains challenge (ΔR is always favorable for ΔT , not Δq)
- Full spatial resolution water vapor profiles in environmental region is critical for tropical cyclone forecast with a high resolution regional NWP model
- CIMSS Hyperspectral IR Sounding Retrieval (CHISR) algorithm has been develop for full spatial resolution temperature and moisture soundings from AIRS and IASI
- Forecast of various hurricanes and typhoons using advanced full spatial resolution IR soundings is studied with NCAR WRF/DART system

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* (27.05, 90.17)

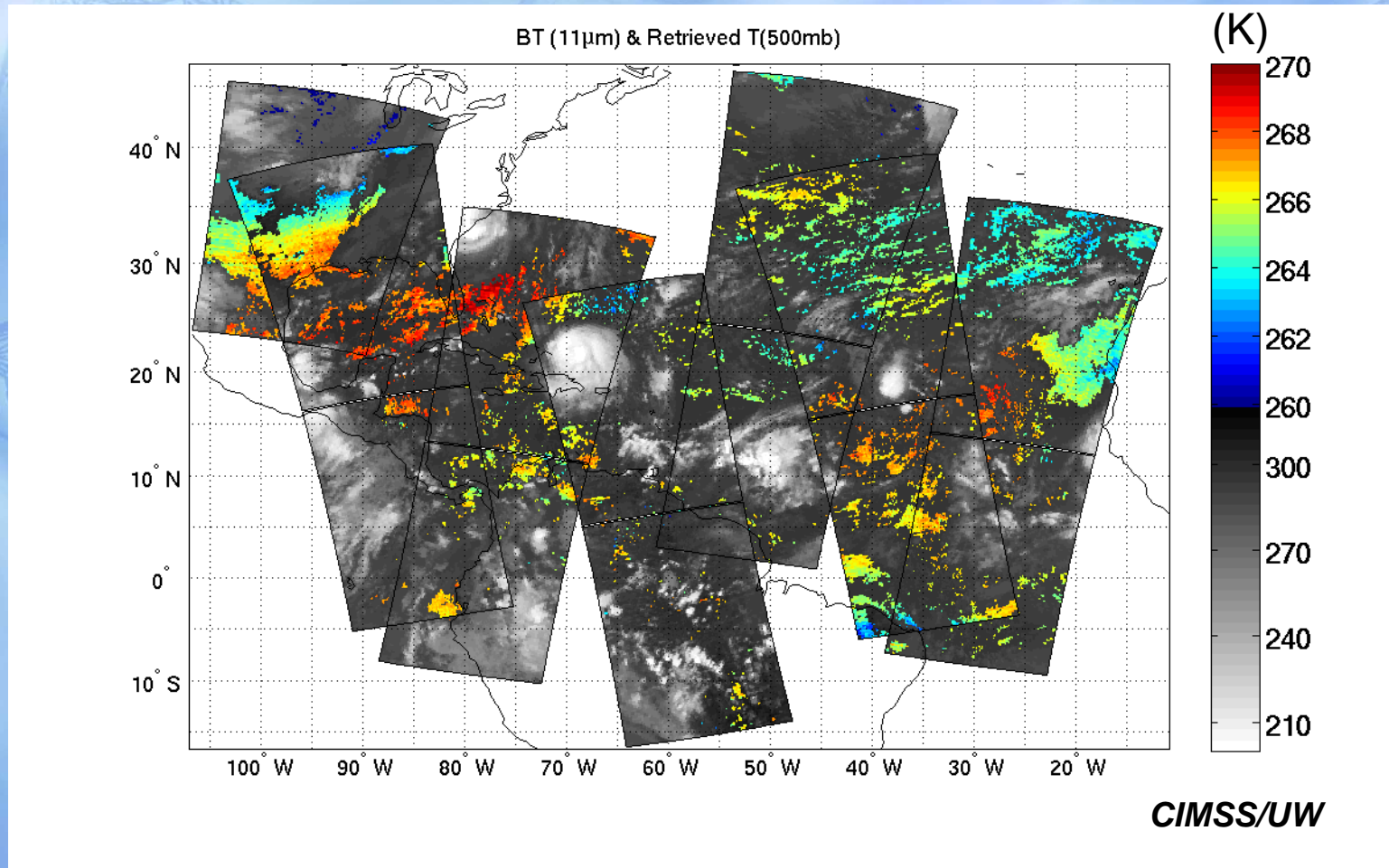
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AIRS SFOV Relative Humidity (RH) sounding depicts the vertical structure while the GOES sounding (independent of FCST) has limited vertical information

AIRS full spatial resolution soundings used for hurricane and typhoon forecast

- ~10 AIRS granules over the regional WRF domain
- Full spatial resolution AIRS soundings (13.5 km at nadir) are derived using CHSR algorithm
- Clear sky only soundings are used
- Ensemble assimilation of AIRS soundings followed by ensemble forecast (36 km resolution)
 - *CTL run*: Assimilate radiosonde, satellite cloud winds, QuikSCAT winds, aircraft data, COSMIC GPS refractivity, ship, and land surface data.
 - *Assimilation run*: Same as CTL run plus AIRS full spatial resolution T and Q soundings

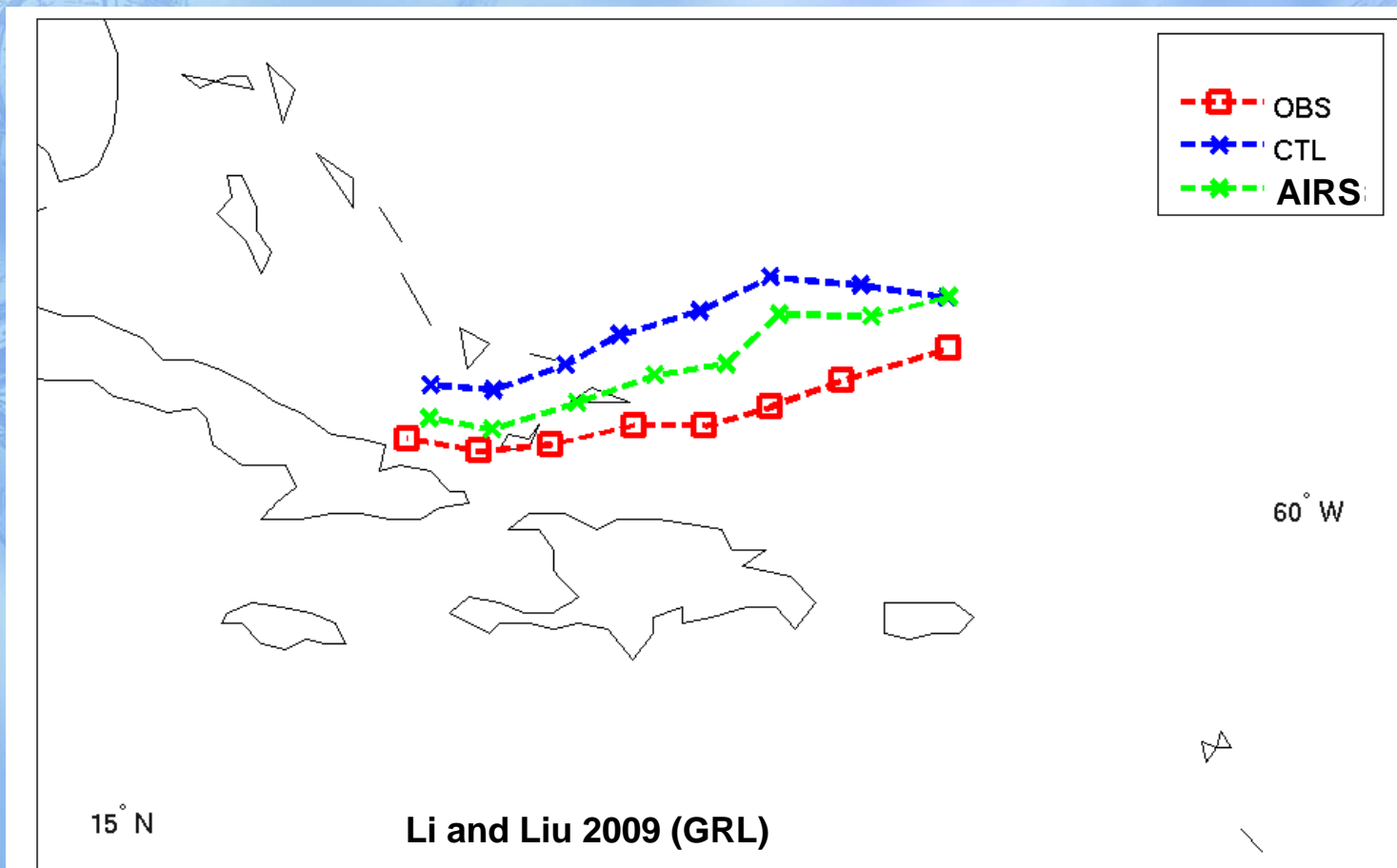
Hurricane Ike (2008) case: Retrieved 500mb temperature 2008.09.06 – **Used in assimilation**



Clear sky AIRS SFOV temperature retrievals at 500 hPa on 06 September 2008, each pixel provides vertical temperature and moisture soundings.

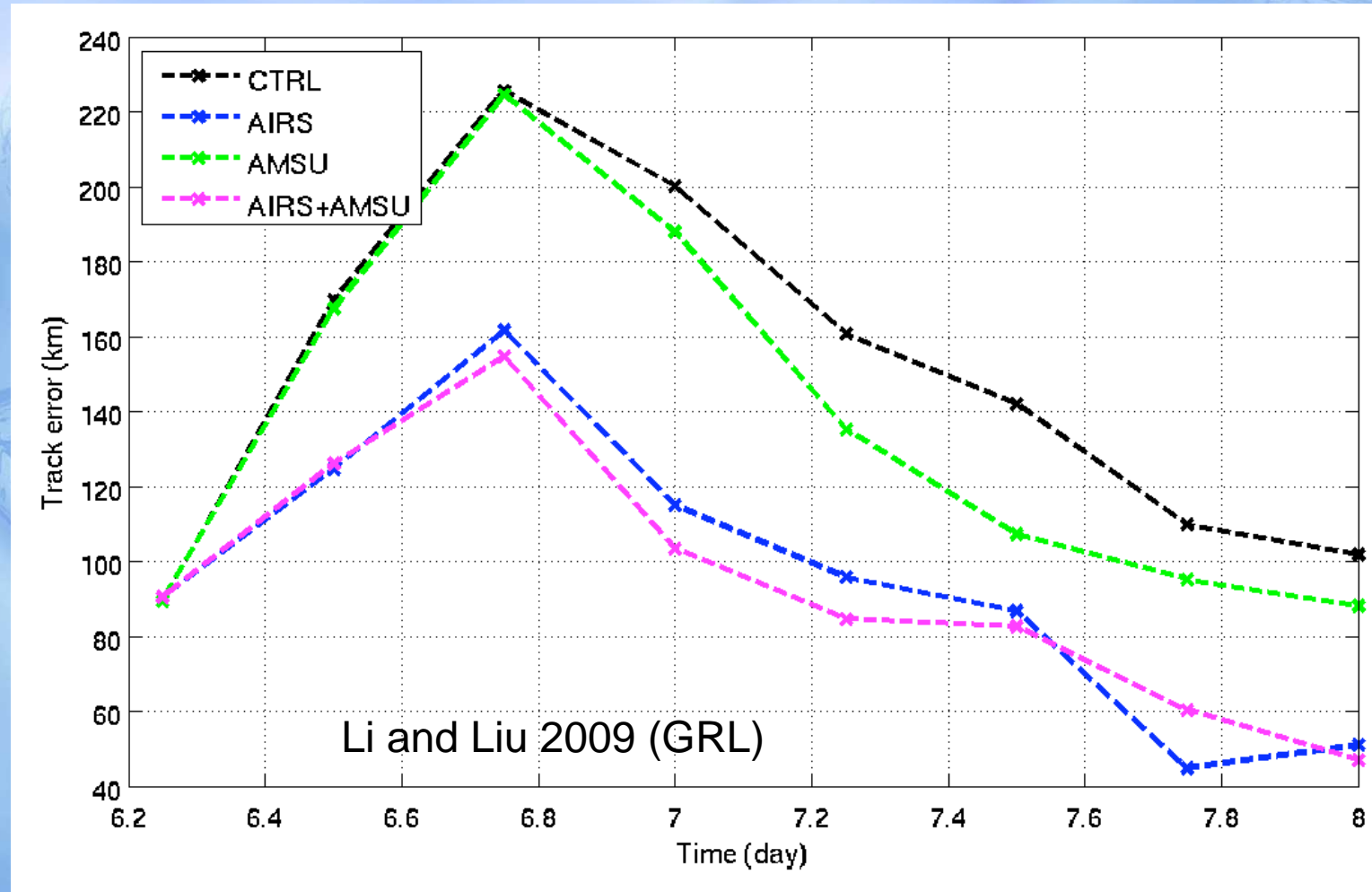
Tracks of ensemble mean analysis on Hurricane IKE

CTL run: Assimilate radiosonde, satellite cloud winds, aircraft data, and surface data.



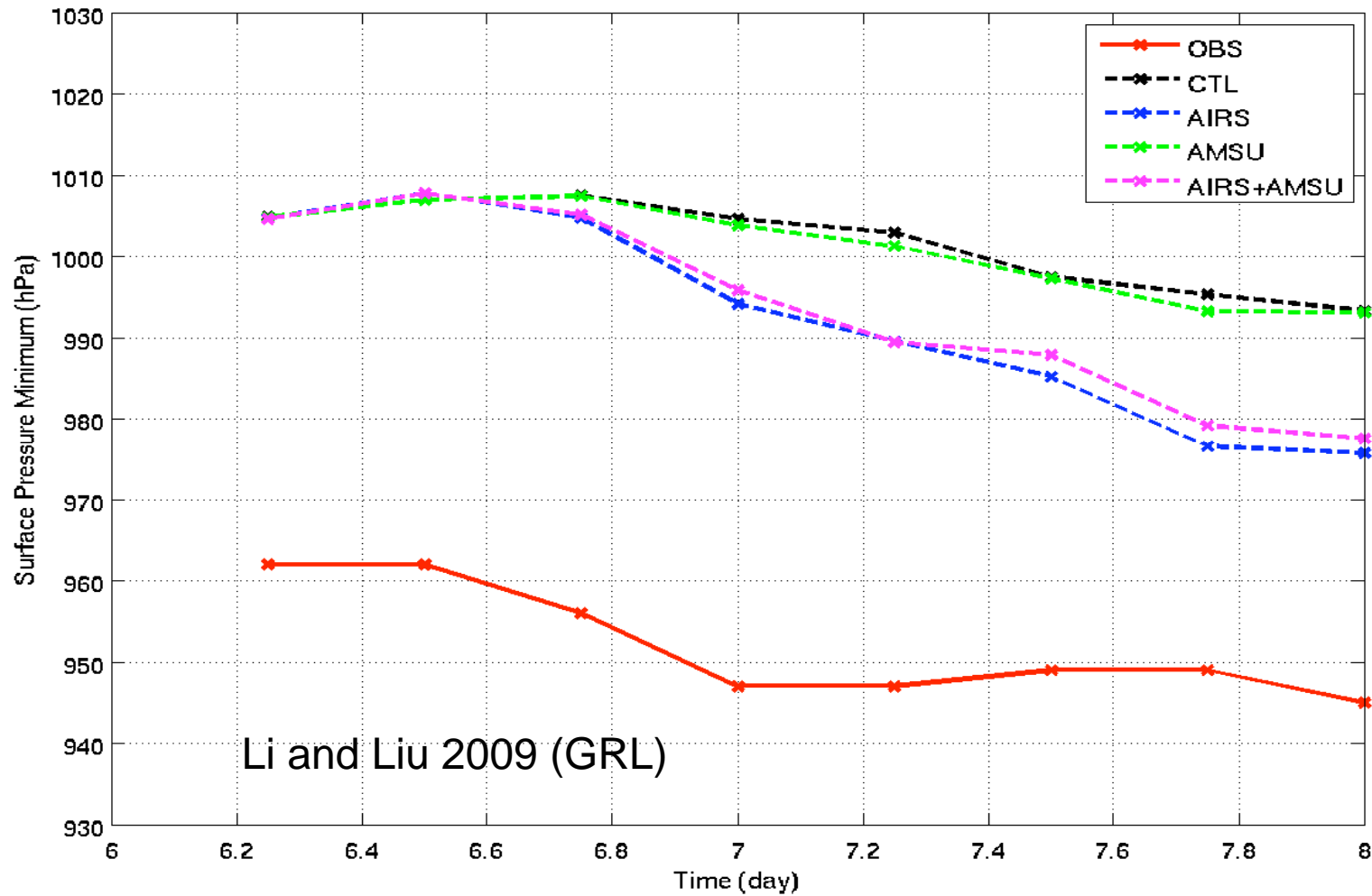
Analysis from 06 UTC 6 to 00UTC 8 September 2008

Track errors of on Hurricane IKE



Analysis from 06 UTC 6 to 00UTC 8 September 2008

SLP Intensity on Hurricane IKE

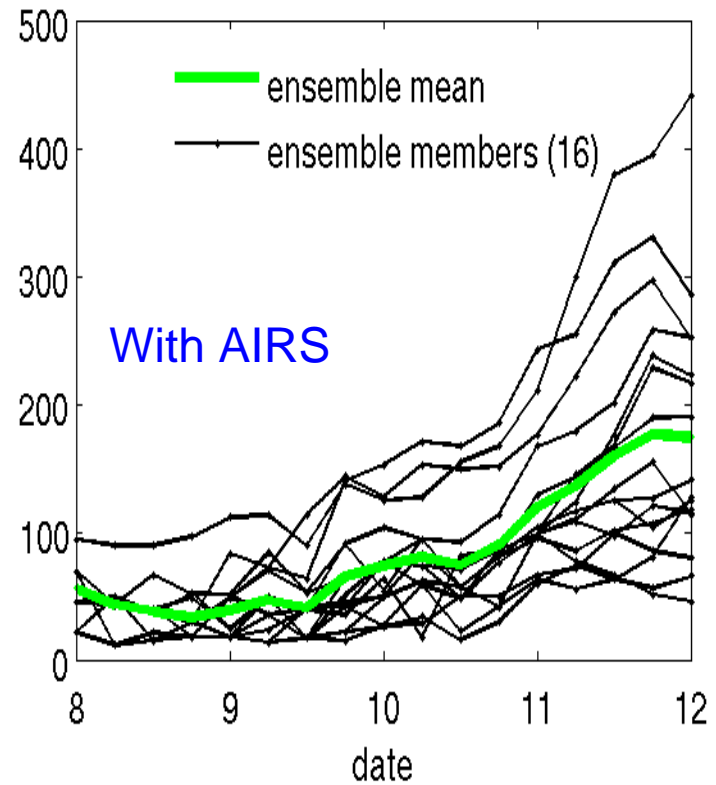
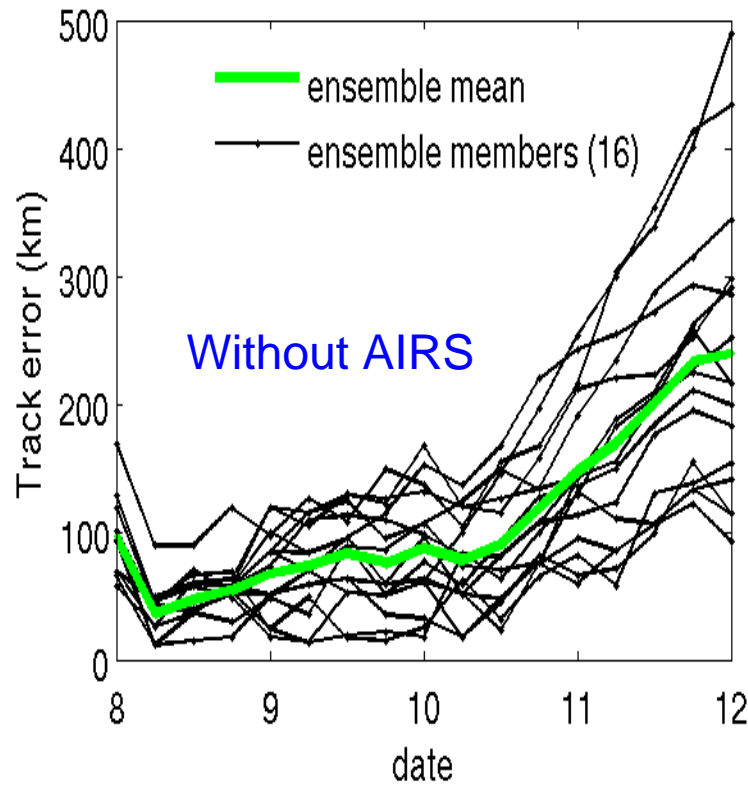


Analysis from 06 UTC 6 to 00UTC 8 September 2008

Forecast Experiments on Ike (2008)

- 4-day ensemble forecasts (16 members) from the analyses on 00UTC 8 September 2008.
- Track trajectory and hurricane surface central pressure are compared (every 6-hourly in the plots).

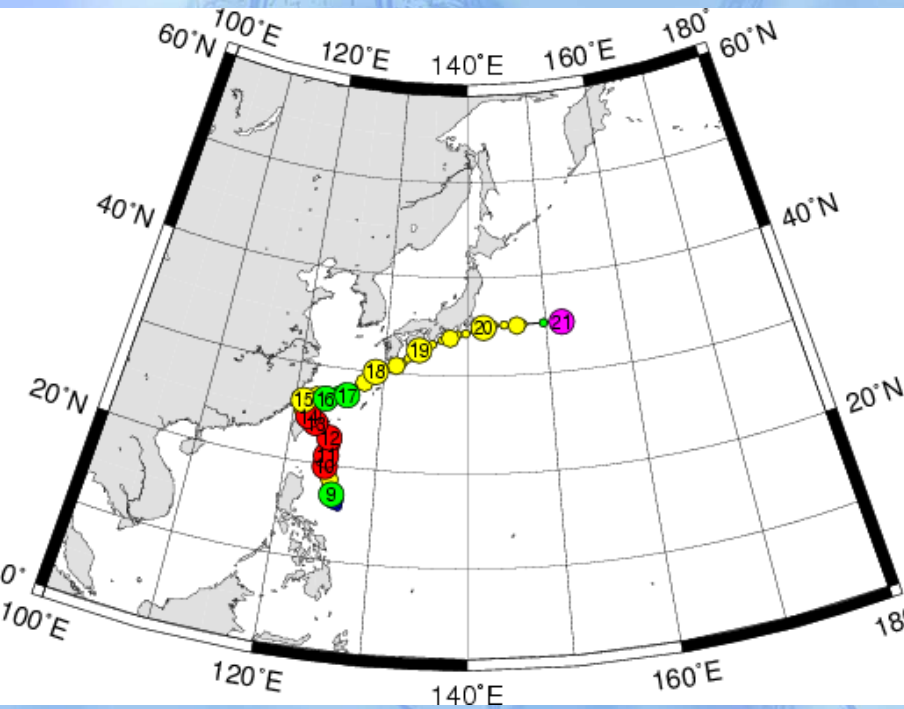
Track errors of 96 h forecasts



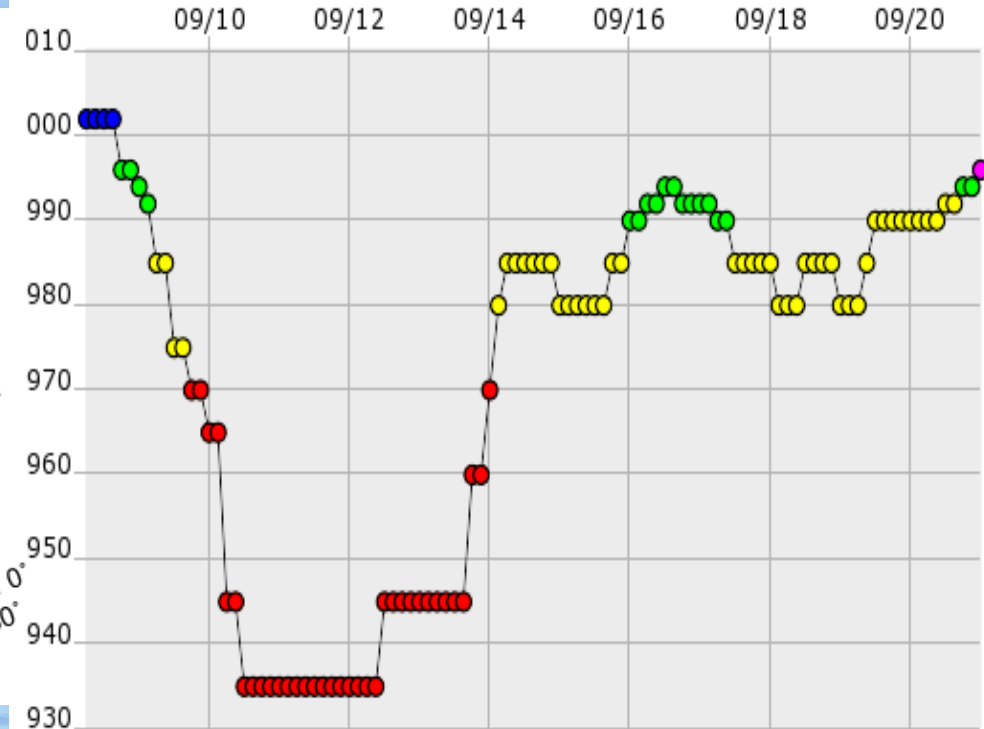
Li and Liu 2009 (GRL)

Forecasts start at 00 UTC 8 September 2008

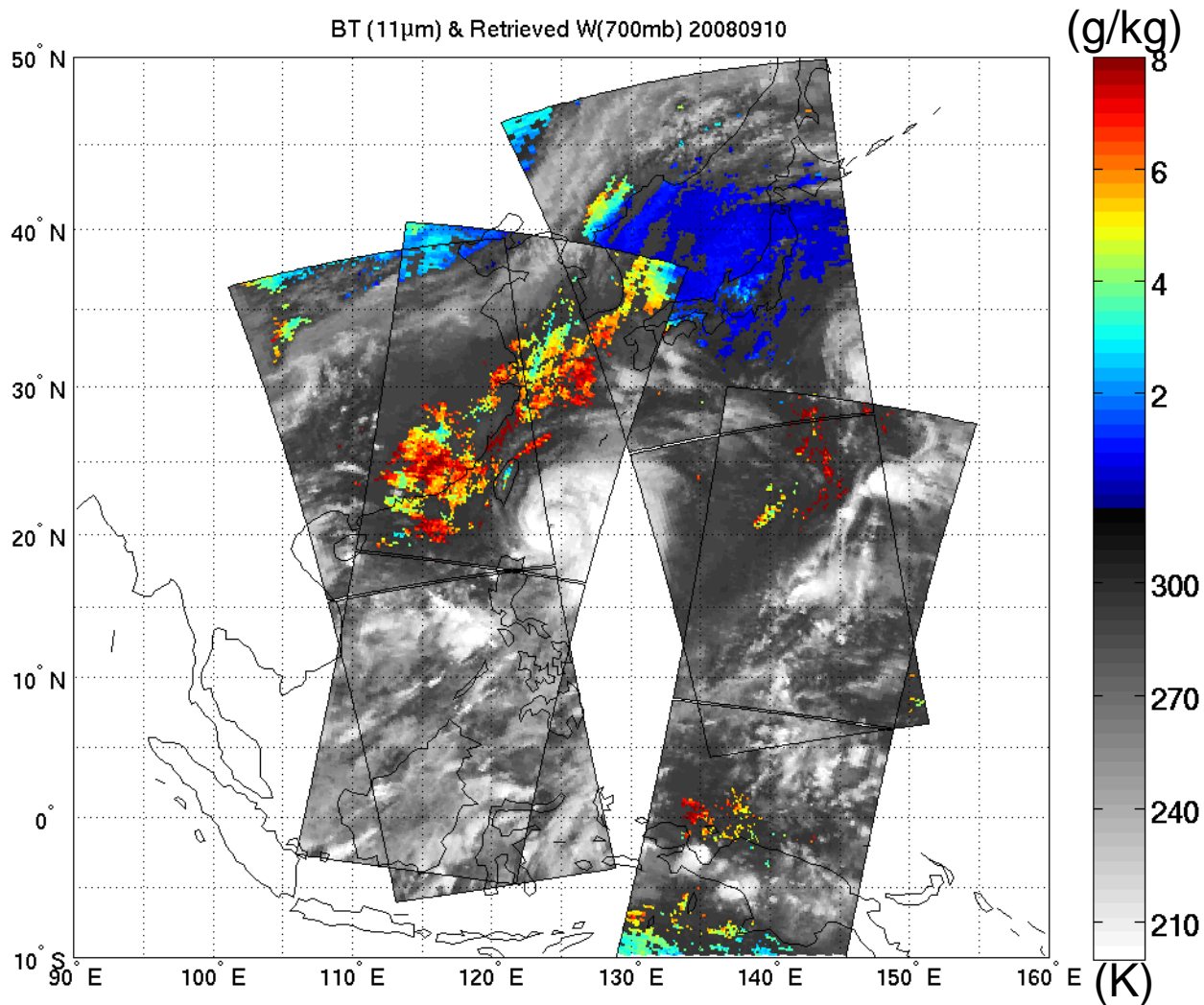
Typhoon Sinlaku (2008) Fact



Sinlaku Path



Sinlaku rapid intensification observed



700 hPa water vapor mixing ratio (g/kg) (Sinlaku – 10 September 2008)

GEO advanced IR sounder can provide more clear sky soundings
in south environment through frequent observations !

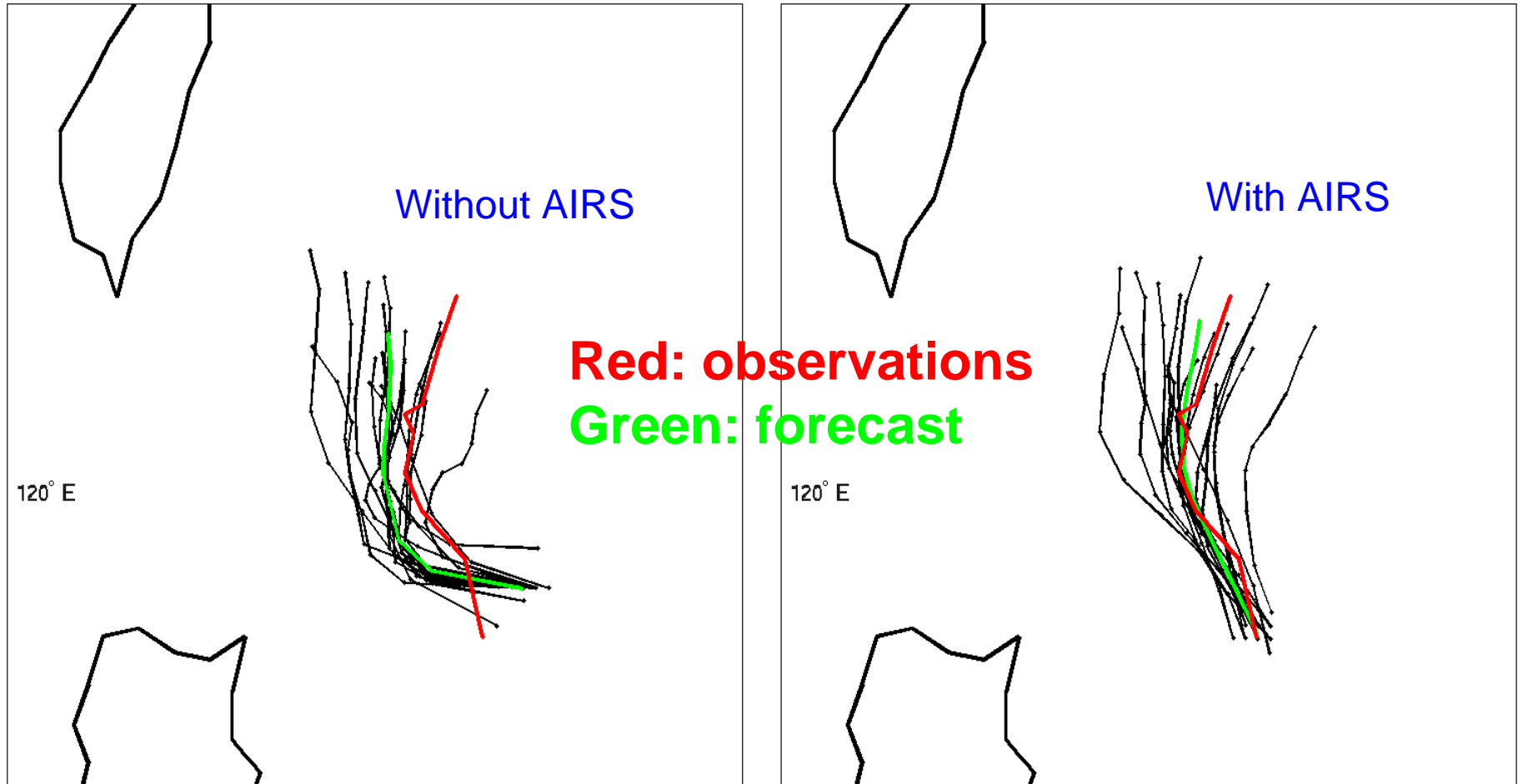
Forecast Experiments on Sinlaku

- 2-day ensemble forecasts (16 members) from the analyses on 12UTC 9 September 2008.
- Track trajectory and hurricane surface central pressure are compared (every 6-hourly in the plots).

Tracks of 48h forecasts on Sinlaku

Ensemble forecasts from 12UTC 9 Sept, CTL

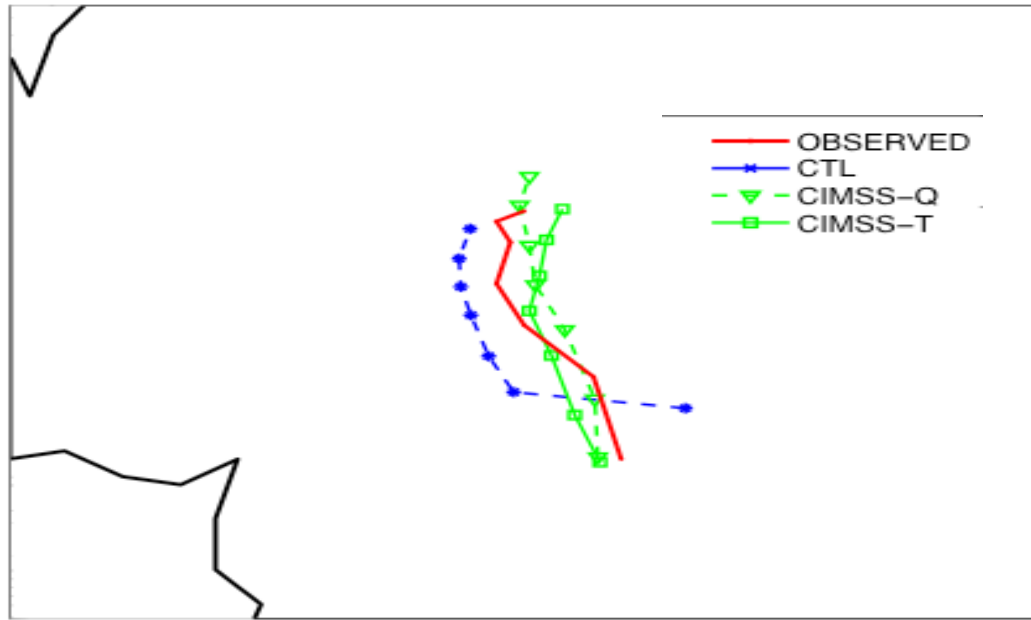
Ensemble forecasts from 12UTC 9 Sept, CIMSS



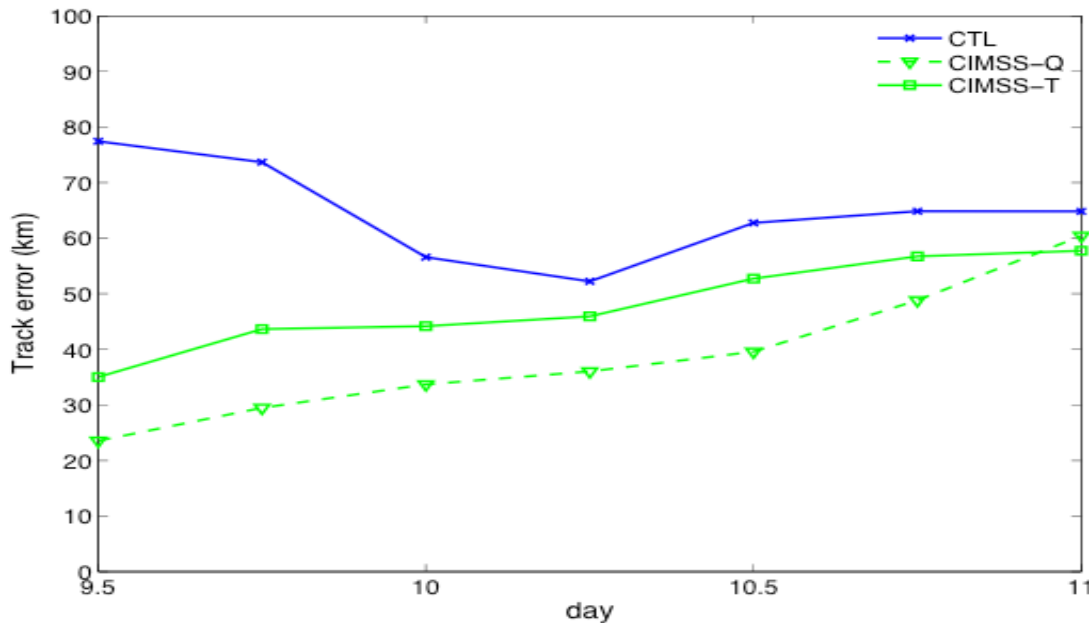
Liu and Li 2010 (JAMC)

Forecasts start at 12 UTC 9 September 2008

36 hours forecast from 12UTC September 9, 2008



Impact of AIRS on Typhoon Sinlaku (2008) track forecast with full spatial resolution temperature soundings and moisture soundings, respectively.

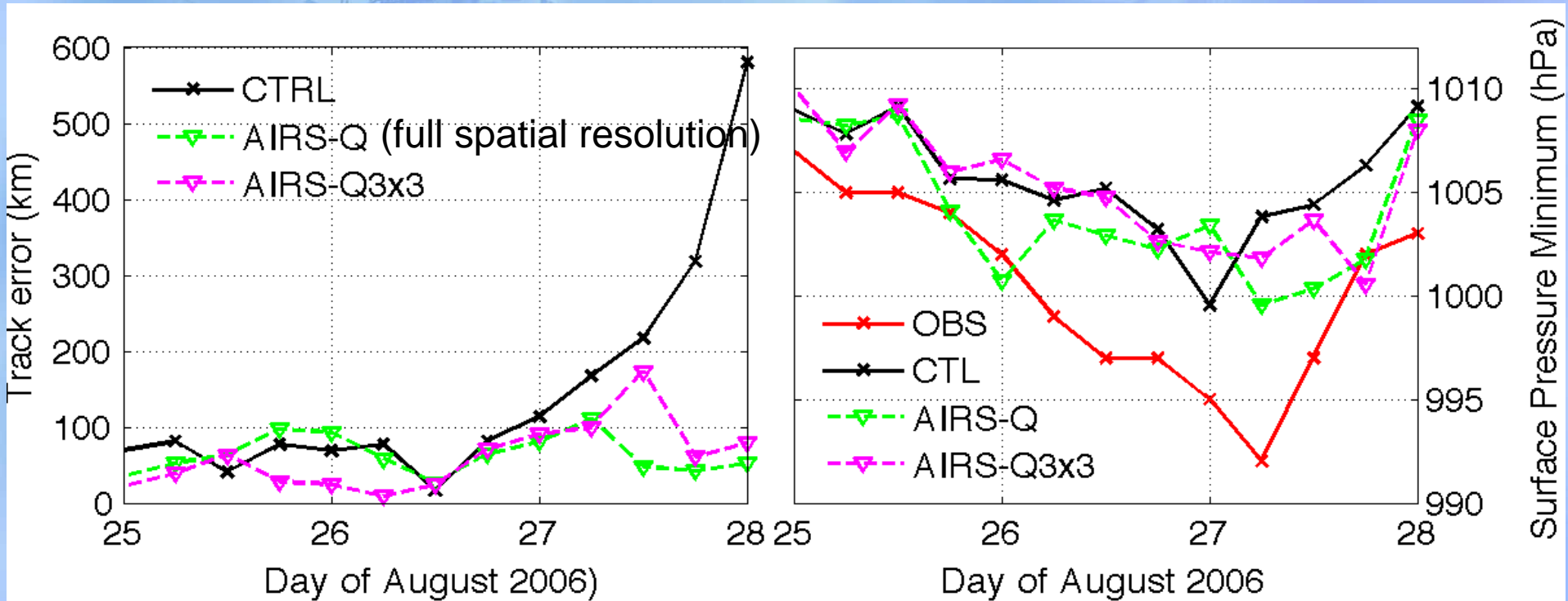


Typhoon Sinlaku (2008) track forecast error with AIRS full spatial resolution temperature soundings and moisture soundings, respectively.

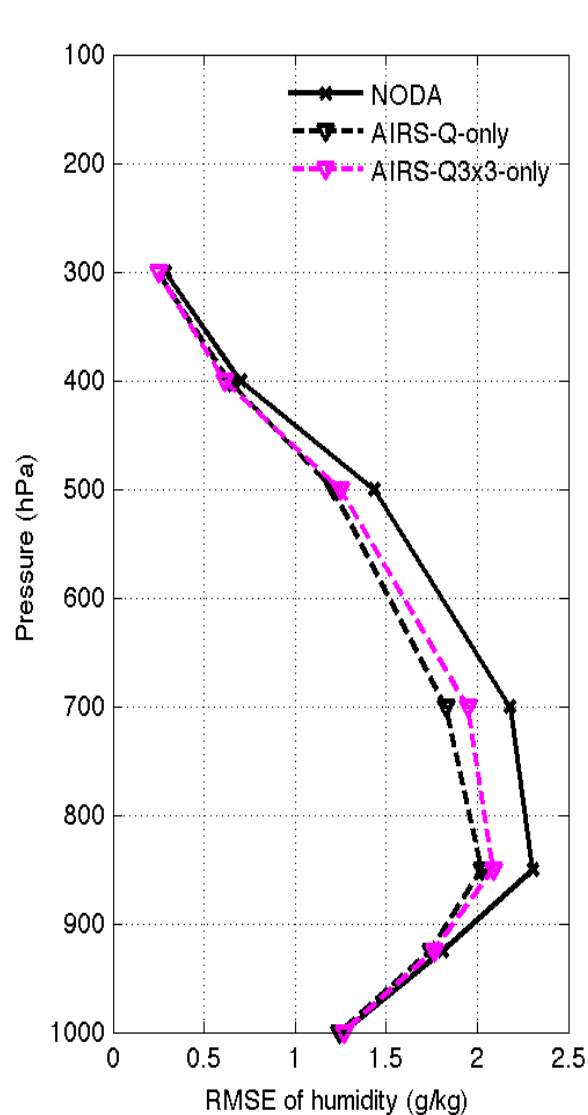
Ensemble mean analysis on Hurricane Ernesto (2006)

CTL run: Assimilate radiosonde, satellite cloud winds, aircraft data, and surface data.

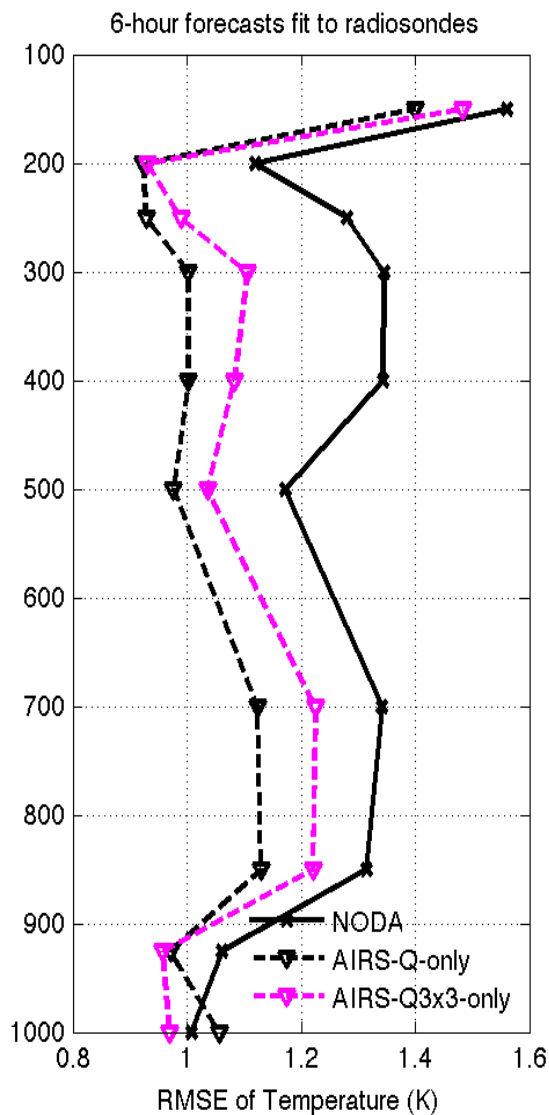
Analyses of Ensemble Mean, 25-28, 00Z, August 2006)



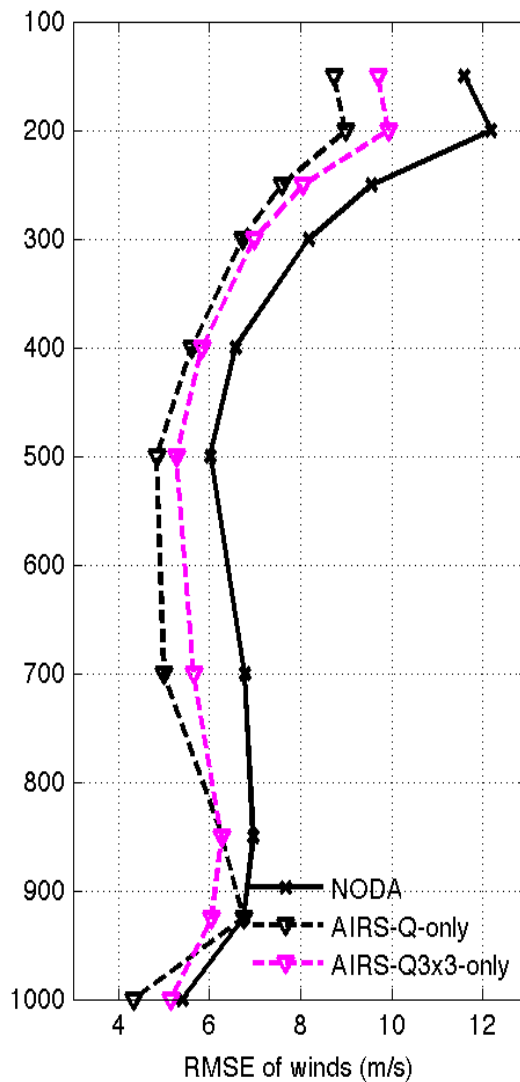
Comparisons between 6-hour forecasts and radiosondes (00 UTC, 22-28, August 2006, Hurricane Ernesto 2006)



AIRS Q-only: 13.5 km



AIRS Q 3x3 -only: 40 km



Summary

- Full spatial resolution temperature and moisture profiles from AIRS derived with CHISR algorithm have been used for Hurricane Ike, Hurricane Ernesto and Typhoon Sinlaku assimilation and forecast. Full spatial resolution CIMSS water vapor soundings improve forecasts (temperature, water vapor, and winds).
- The full spatial resolution AIRS soundings show positive impact on hurricane/typhoon track and intensity both in assimilation and forecast using the WRF/DART system.
- Full spatial resolution AIRS soundings significantly improve the definition of the typhoon vortex in the analysis and the forecast of the rapid intensification for Typhoon Sinlaku.
- Full spatial resolution IR soundings for regional forecast is promising. Future work includes using soundings in cloudy skies

References

- Li, J., H. Liu, 2009: Improved hurricane track and intensity forecast using single field-of-view advanced IR sounding measurements, *Geophysical Research Letters*, 36, L11813, doi:10.1029/2009GL038285.
- Liu, H., and J. Li, 2010: An improvement in forecast of rapid intensification of typhoon Sinlaku (2008) using clear sky full spatial resolution advanced IR soundings, *Journal of Applied Meteorology and Climate* (in press)

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Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,
Cooperative Institute for Meteorological Satellite Studies, 2011.