The Impact of Assimilating Retrieved Total Precipitable Water and Sounding Data from AIRS and MODIS on Severe Weather Simulations

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Introduction

1. **Initial condition problems.**

2. **The proper and effective assimilation of retrieved satellite data may have potentials of improving the initial conditions.**

3. **Assess the impact of assimilating MODIS and AIRS retrieved data on hurricane simulations.**

AIRS retrieved data

1. **Atmospheric Infrared Sounder (AIRS)**
2. **AIRS + AMSU are onboard Aqua (2002)**
3. **AIRS-IR/AMSU-Microwave retrieval stages of the AIRS algorithm.**
4. **Soundings- temperature and mixing ratio**

   - 45 km

   - Temp: 28 pressure levels ranging from 1100 hPa to 0.1 hPa

   - Mixing ratio: 14 layers ranging between 1100 hPa and 50 hPa.
5. **Total precipitable water (TPW)**

   - 45 km

MODIS retrieved data

1. Moderate Resolution Imagine Spectroradiameter (MODIS)
2. Onboard Terra (2000) and Aqua (2002)
3. Total precipitable water (TPW)

   a. NIR: 1 km

   - Available over cloud free areas and cloud-top over both land and ocean, but only in daytime.
   - Reduced resolution from 1 km to 5 km, requiring a minimum of 10 cloud free pixels in a 5x5 matrices

   b. IR: 5 km

   - Day and night

4. Soundings- temperature and dew point

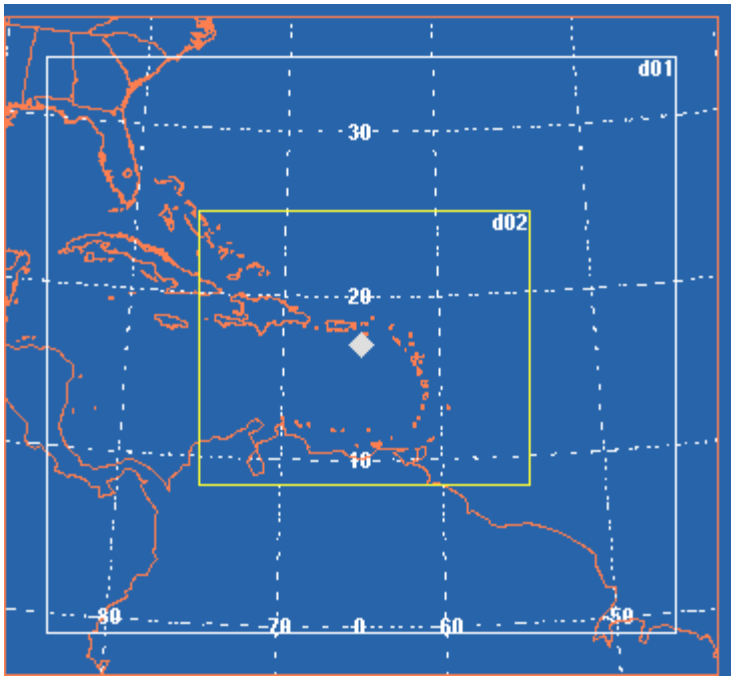
   a. IR: 5 km

   - 20 pressure levels ranging from 1000 hPa to 5 hPa
   - Daytime and nighttime.

Model setting

1. **The Advanced Research WRF model (ARW), version 2.1.2 and its 3DVAR were utilized in this study.**

2. **Hurricane Emily 2005**

3. 

D01: 30 km, 144x 132

D02: 10 km, 226x187

Physic: Purdue microphysics

New Kain-Fritsch

RRTM long wave

Dudhia short wave

YSU PBL

Experiment Designs

G:GTS; M: MODIS; A: AIRS

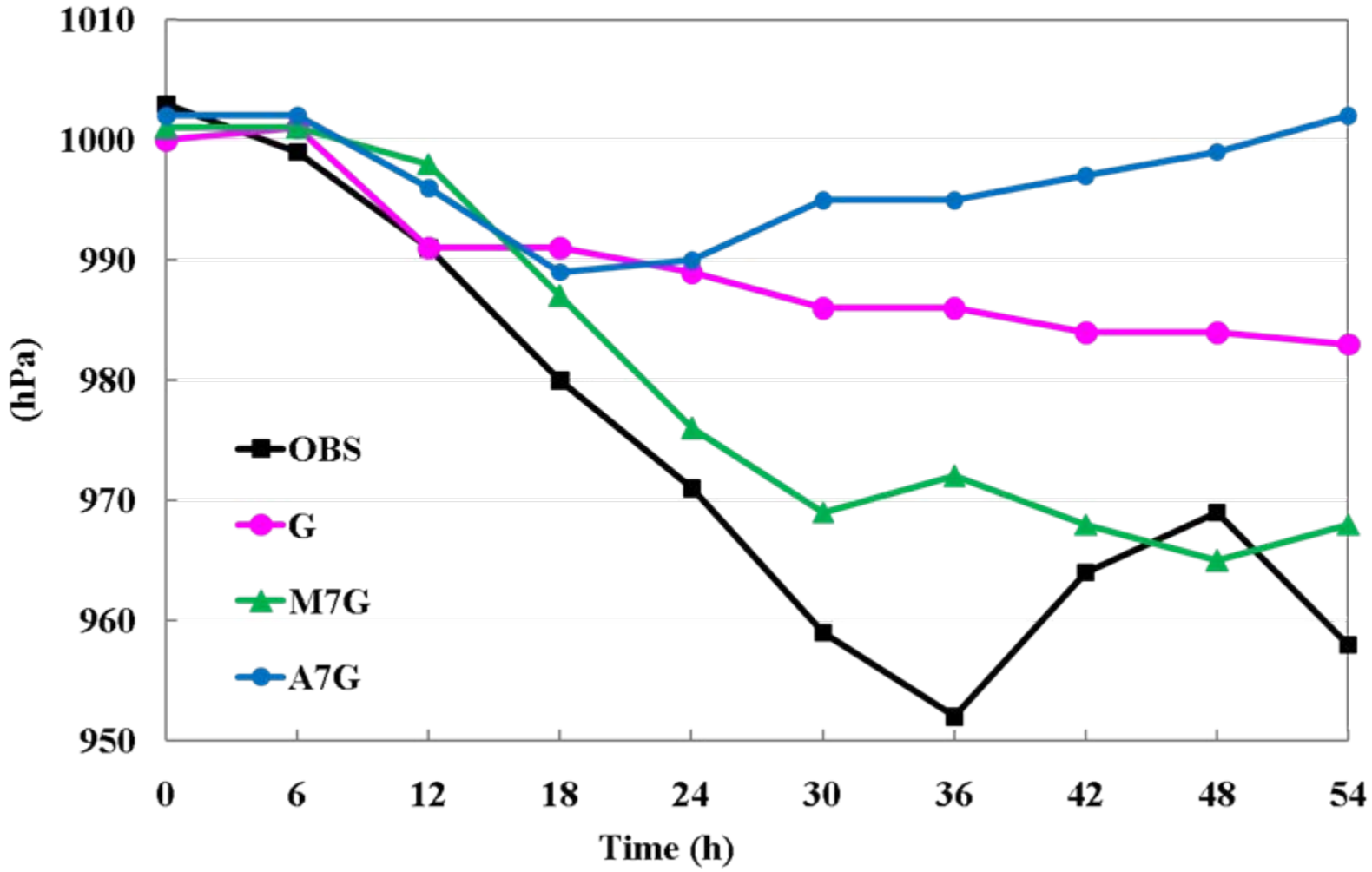
Exp. Sounding	Assimilating data
G (CONTROL)	GTS
M7G	MODIS Sounding Temp + Dew point + GTS
A7G	AIRS Sounding Temp + mixing ratio + GTS

Exp. TPW	Assimilating data
G (CONTROL)	GTS
MNG	MODIS NIR TPW + GTS
MIG	MDOIS IR TPW + GTS
AG	AIRS TPW + GTS

Ave. Error	
G	14.44
M7G	7.1
A7G	22.3

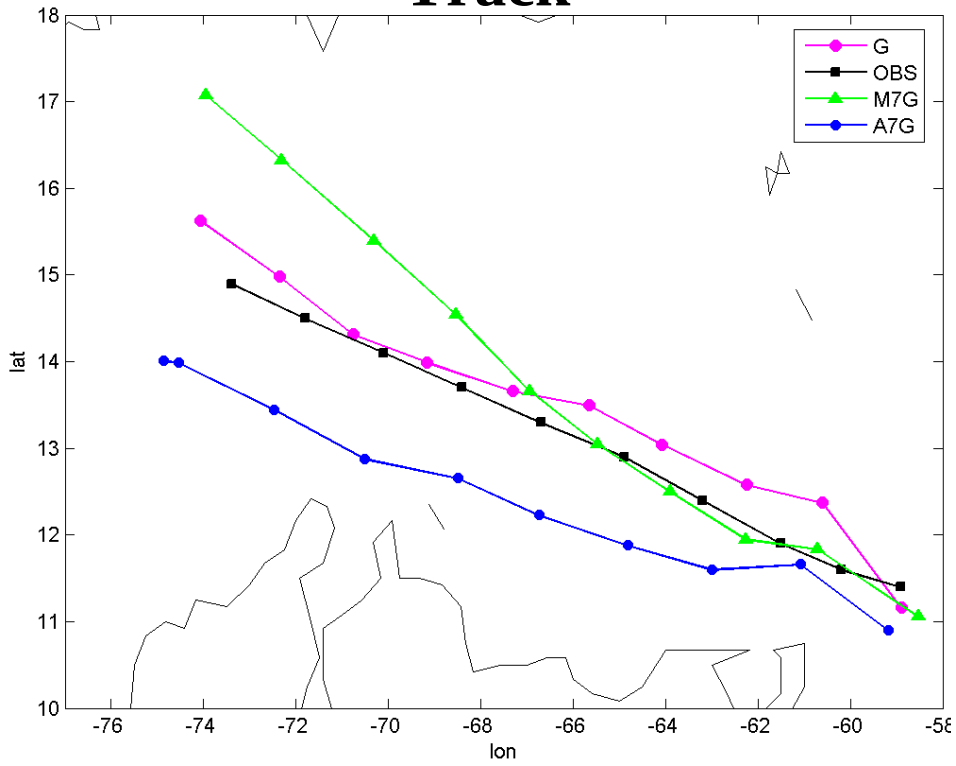
Sounding Experiment

Center Pressure

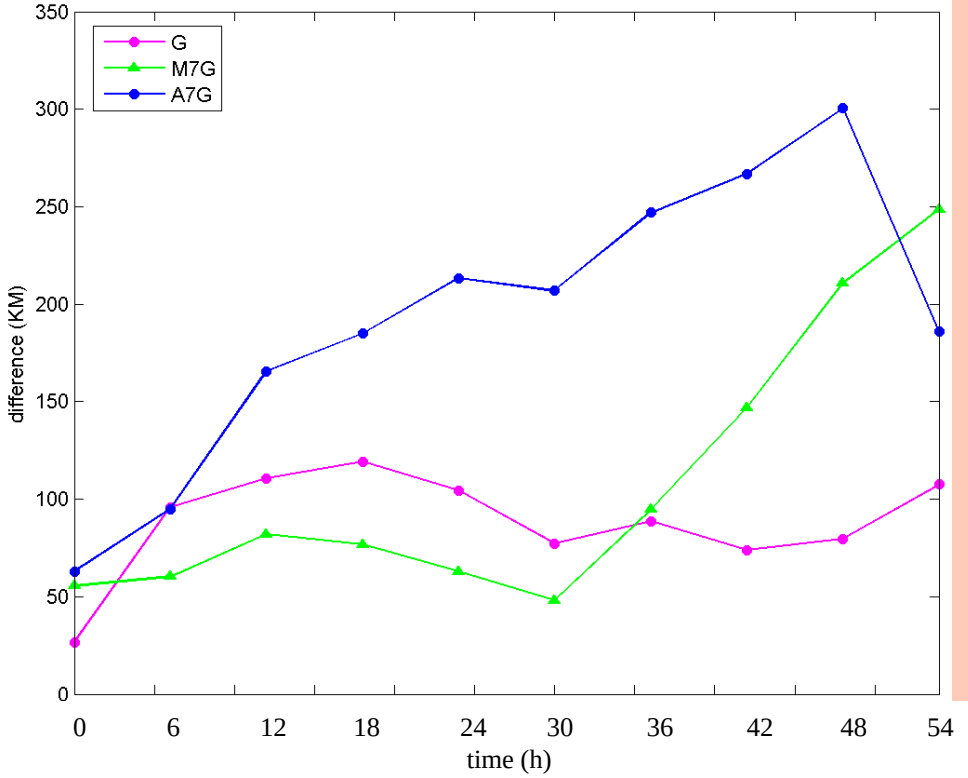


Sounding Experiment

Track



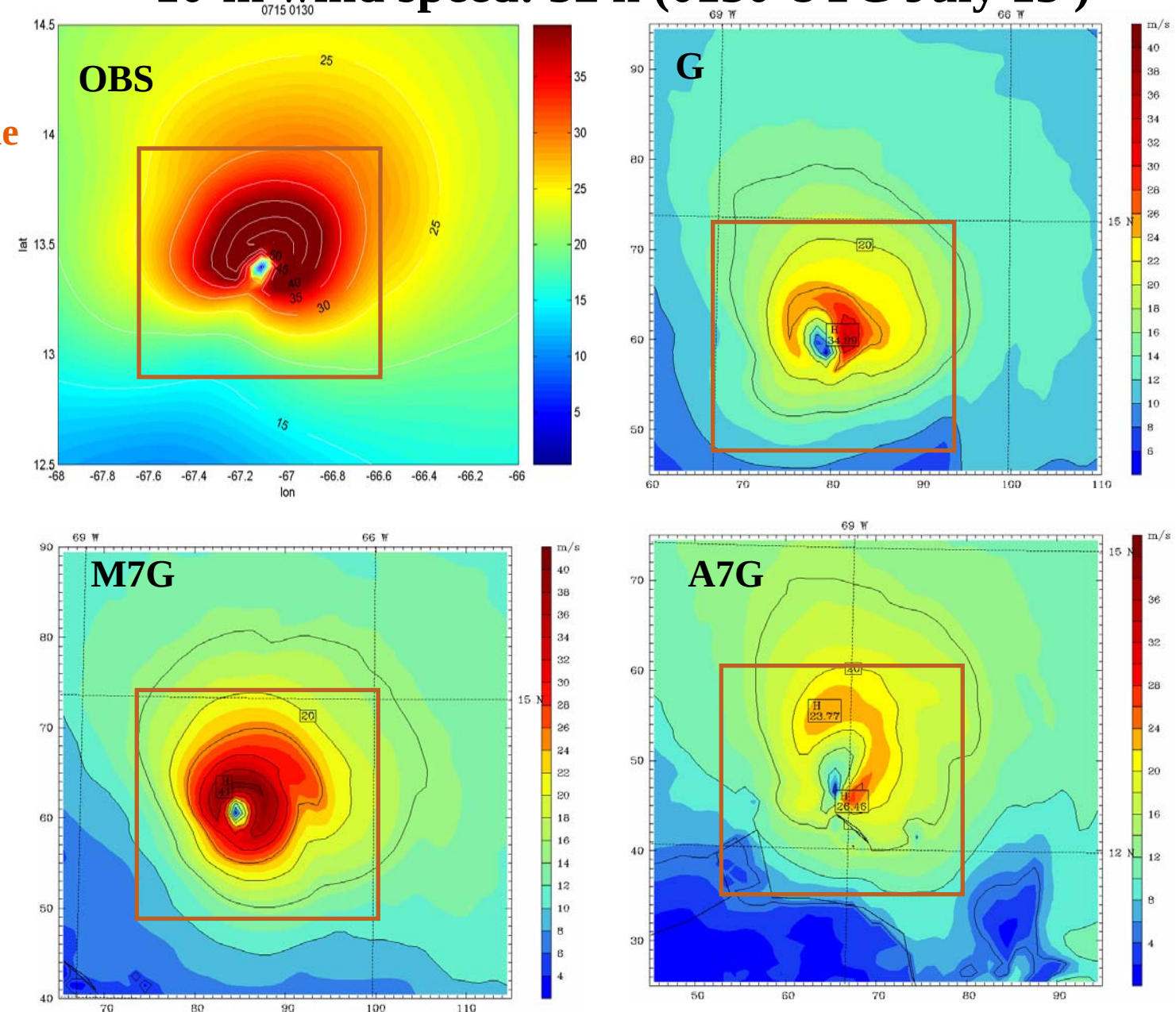
Track Error



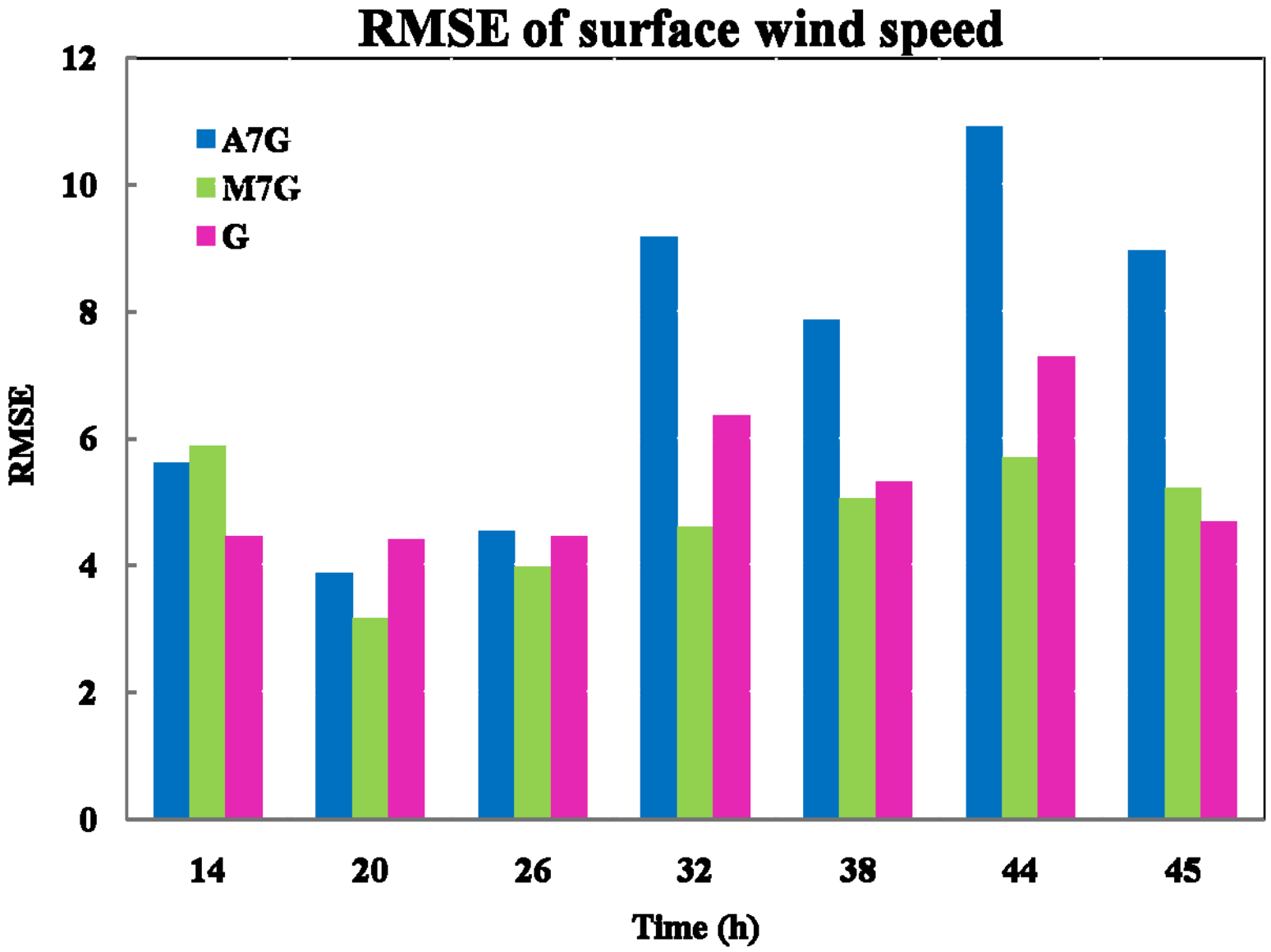
Sounding Experiment

10-m wind speed: 32 h (0130 UTC July 15)

Source: NOAA's Hurricane Research Division



Sounding Experiment



Summary

1. **Sounding experiment:**

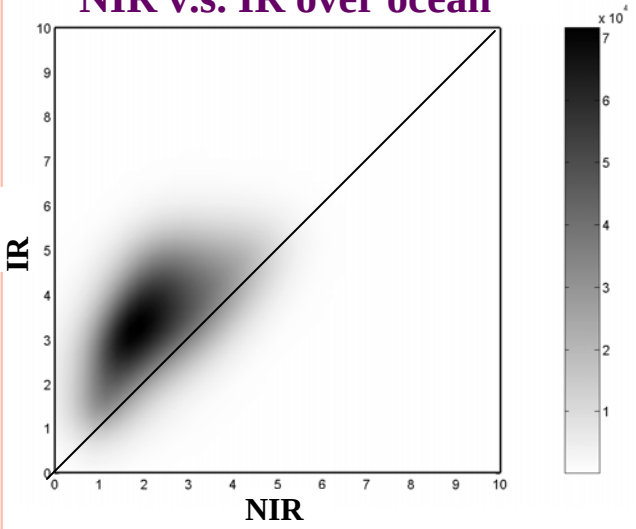
   a. **After assimilating MODIS retrieved temperature and dew point vertical profiles, the simulation has been improved in terms of hurricane intensity, track in early stage, and surface wind pattern.**

   b. **After assimilating AIRS retrieved vertical profiles, the simulation results became worse than G and MIG.**

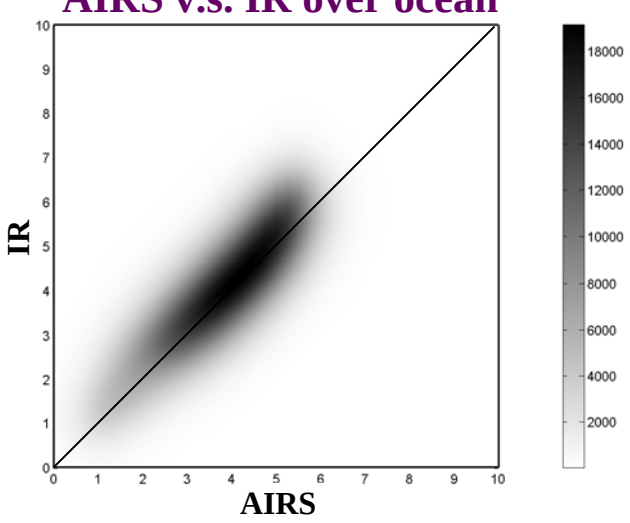
Observed TPW Comparisons

(Sep. 2002, Jul.-Sep 2005 over the Pacific and Atlantic Oceans)

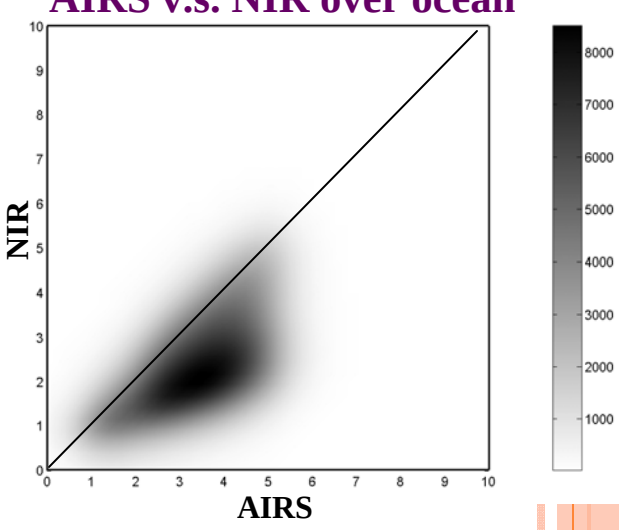
NIR v.s. IR over ocean



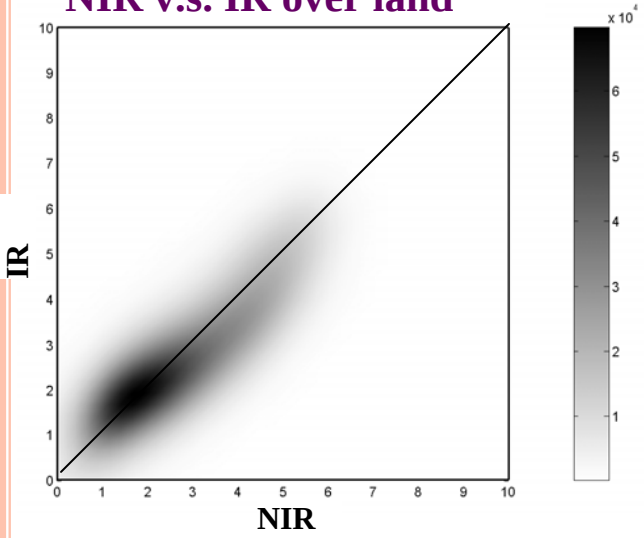
AIRS v.s. IR over ocean



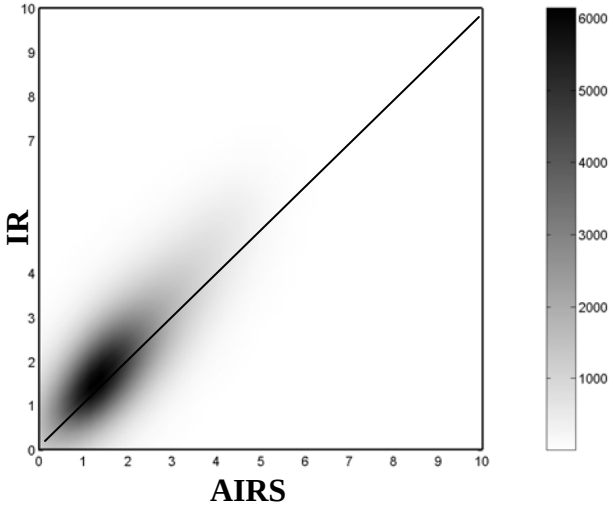
AIRS v.s. NIR over ocean



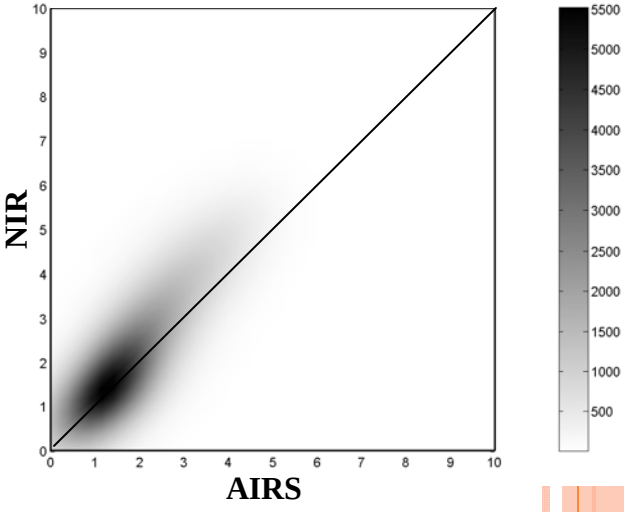
NIR v.s. IR over land



AIRS v.s. IR over land

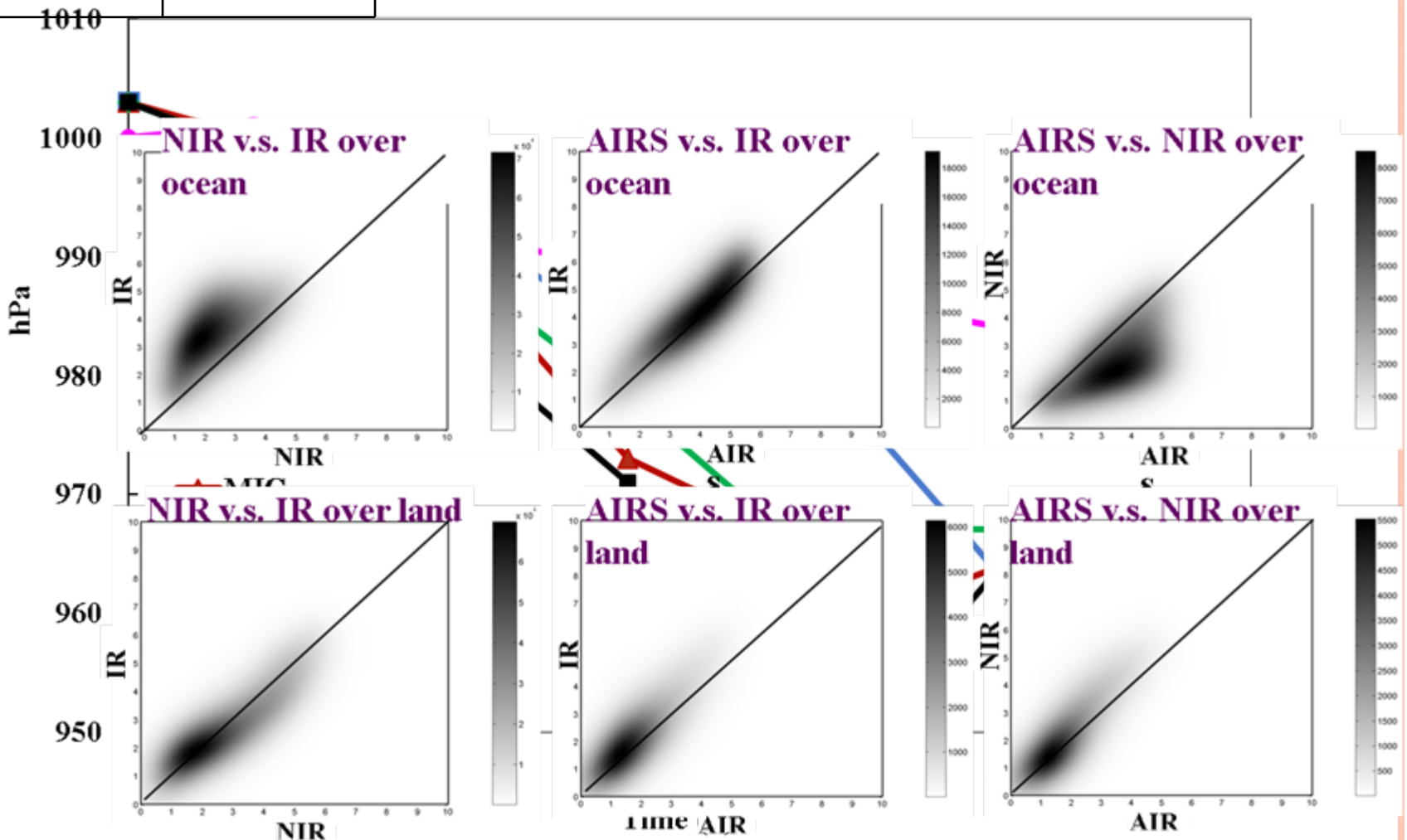


AIRS v.s. NIR over land



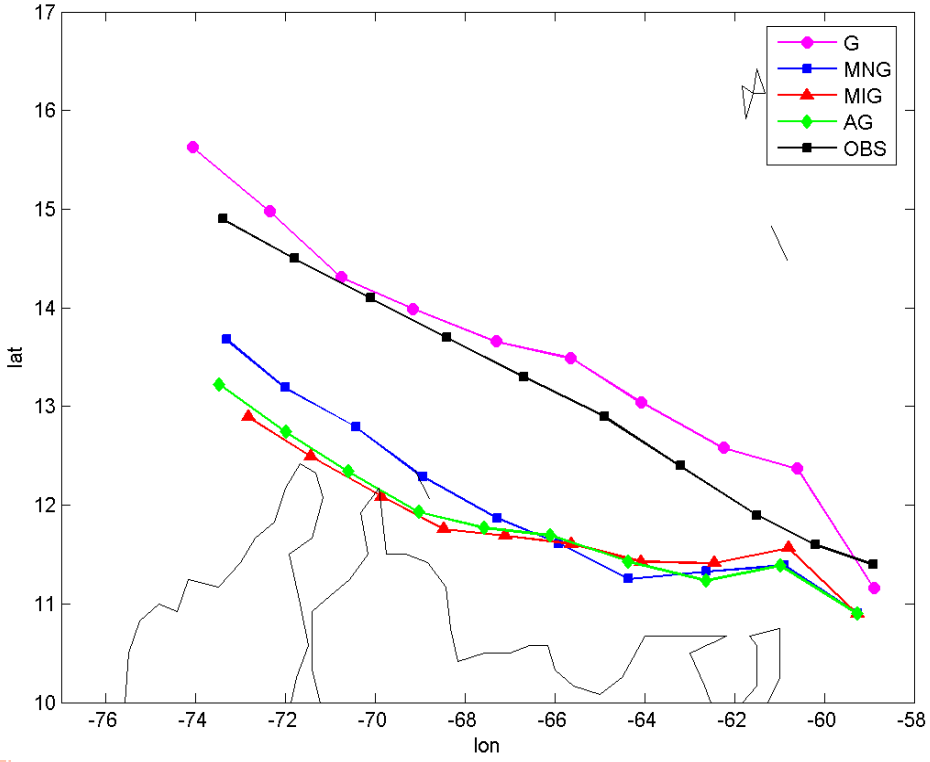
Ave. Error	
G	14.44
MNG	9.1
AG	5.3
MIG	3.8

TPW Experiment

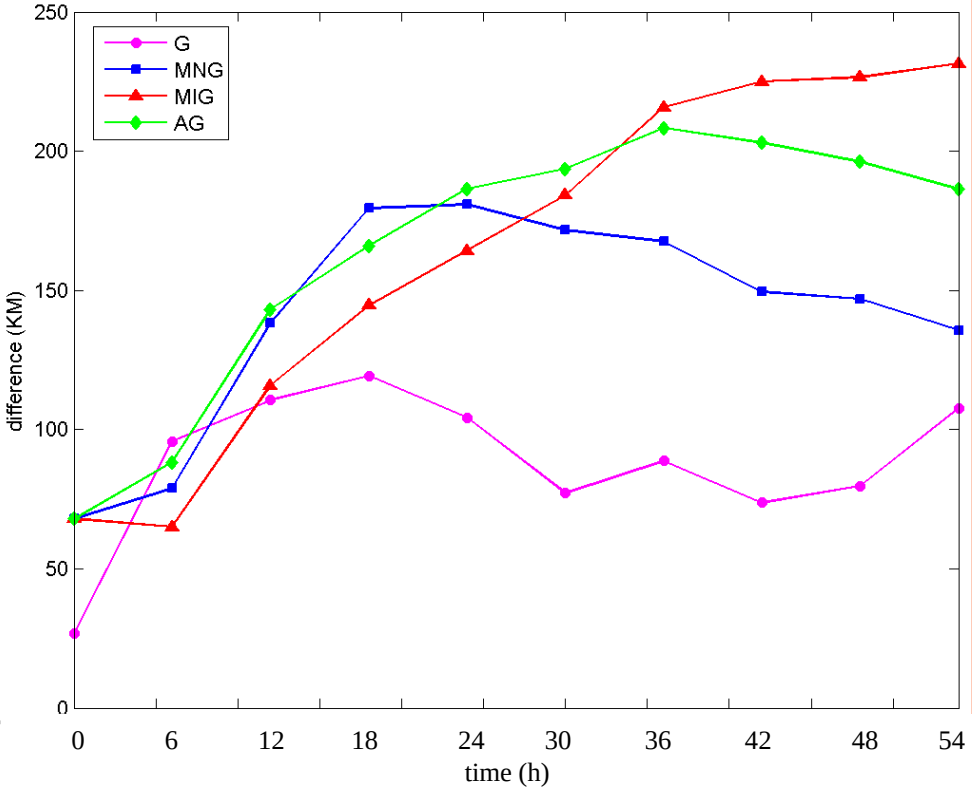


TPW Experiment

Track



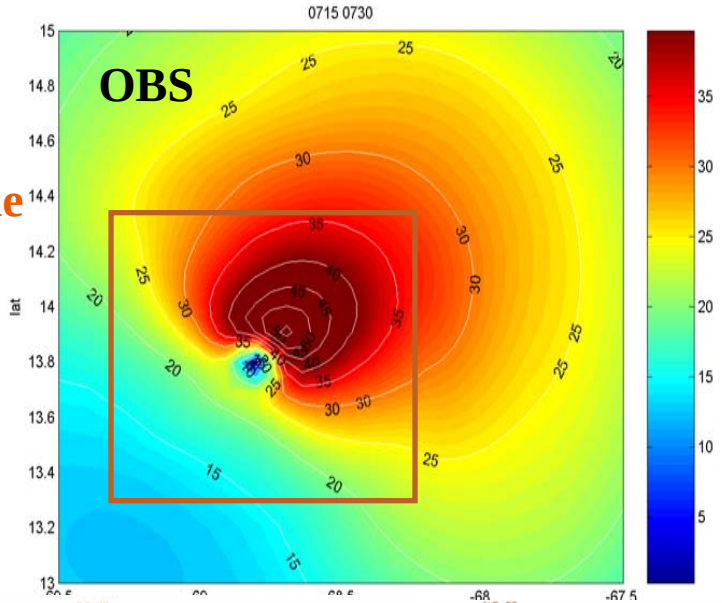
Track Error

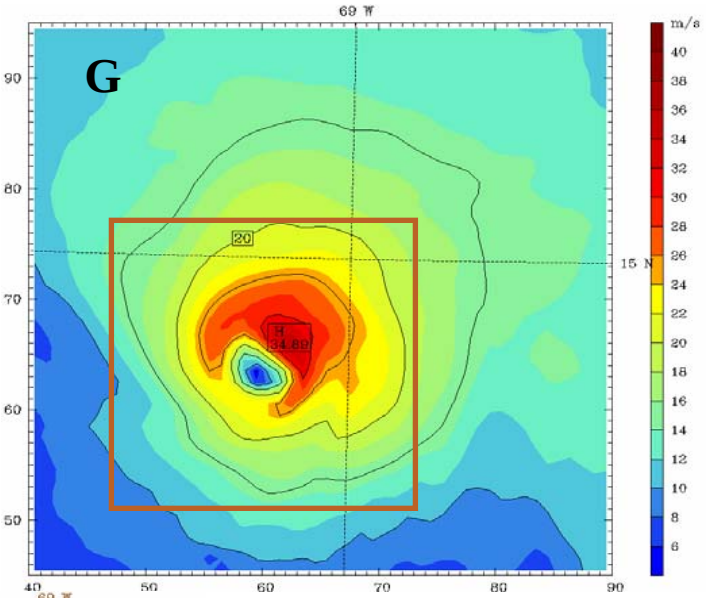


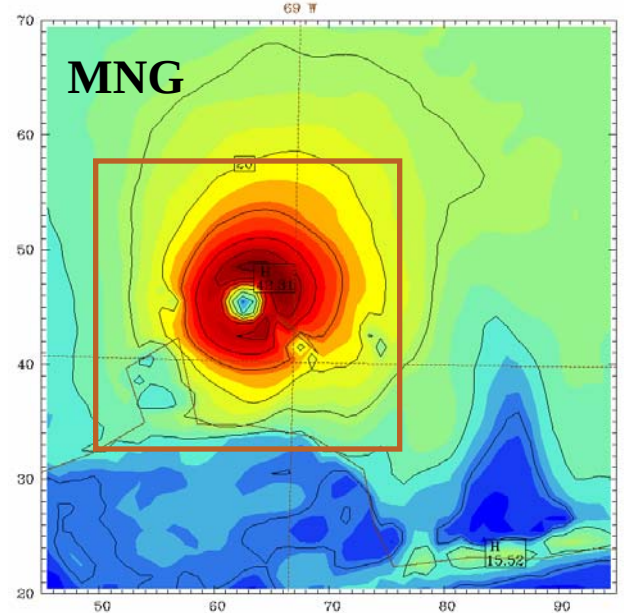
TPW Experiment

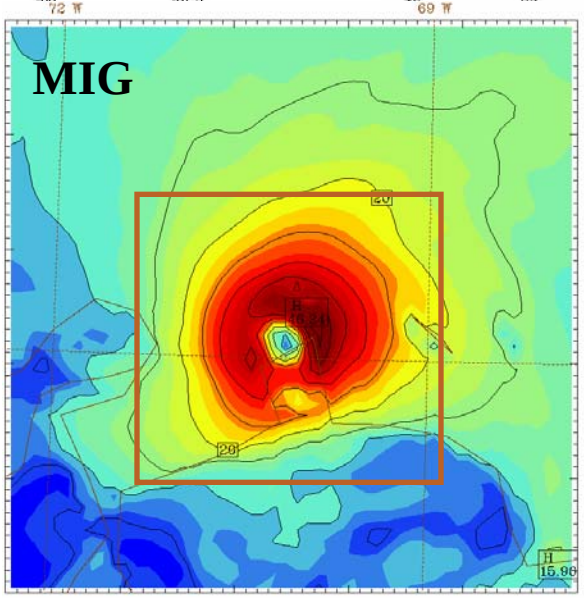
10-m wind speed: 38 h (0800 UTC July 15)

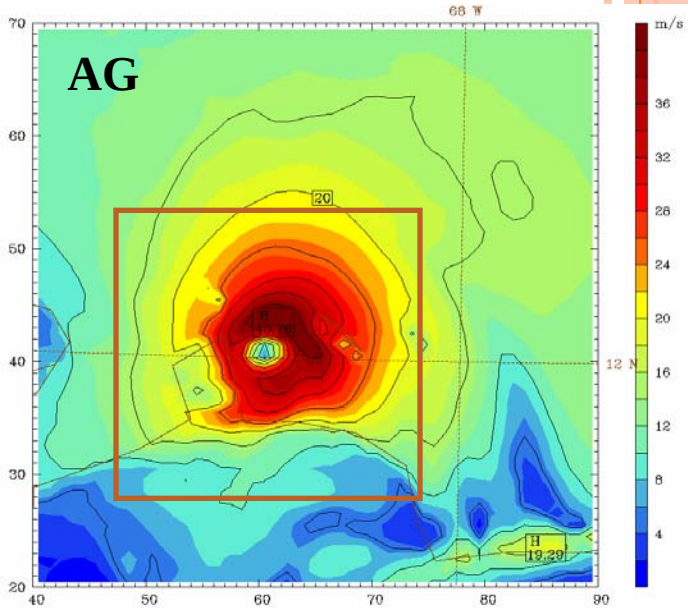
Source: NOAA's Hurricane Research Division

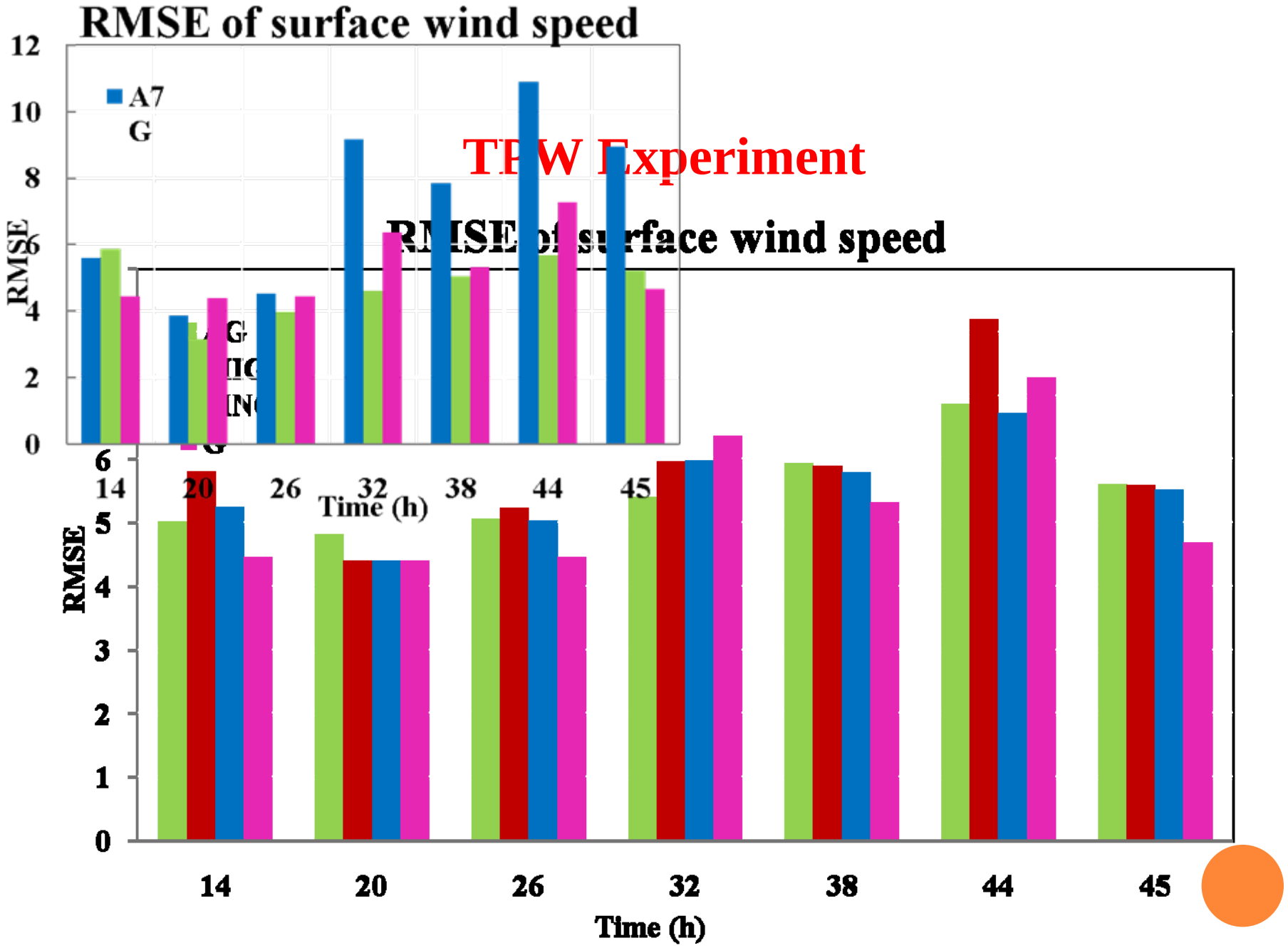











RMSE of surface wind speed
A7
G
RMSE
Time (h)
TPW Experiment
RMSE of surface wind speed
RMSE
Time (h)

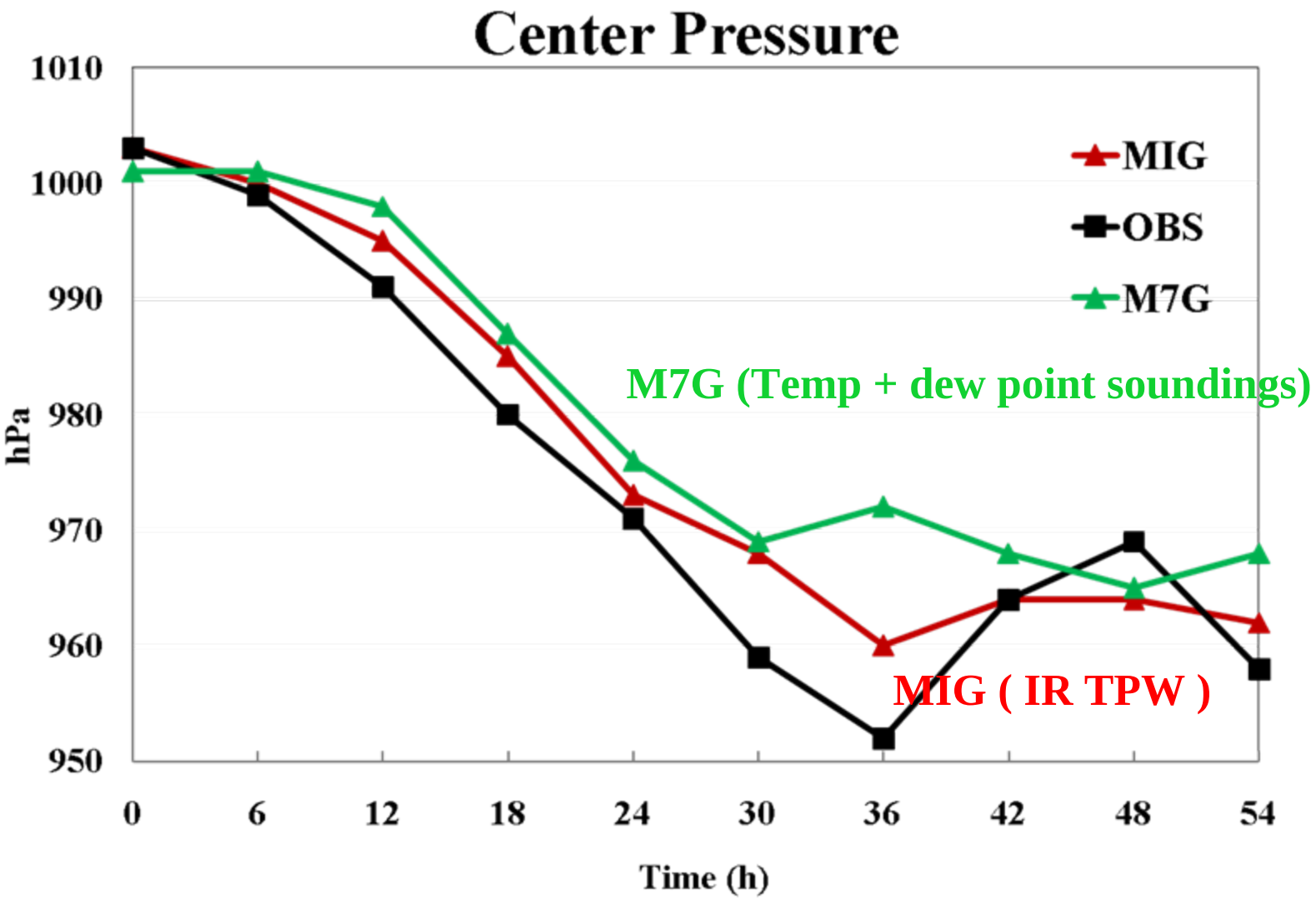
Summary

2. TPW experiment:

a. **After assimilating retrieved TPW, the hurricane intensities of MIG, MNG, and AG have improved. In particular, MIG has the smallest simulated intensity errors.**

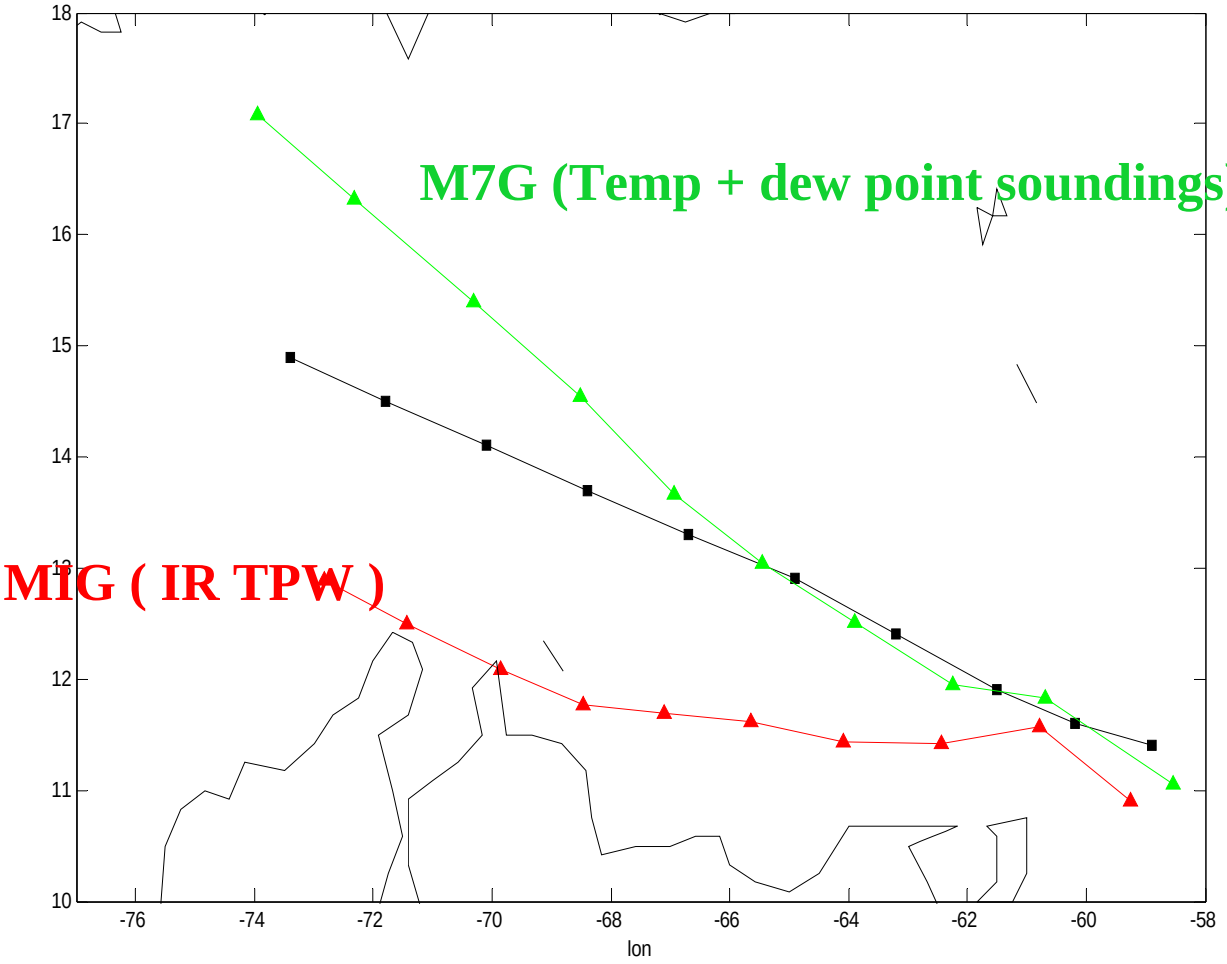
b. **Unfortunately, the tracks of MIG, MNG, and AG shifted to the south.**

MODIS IR TPW and sounding comparison

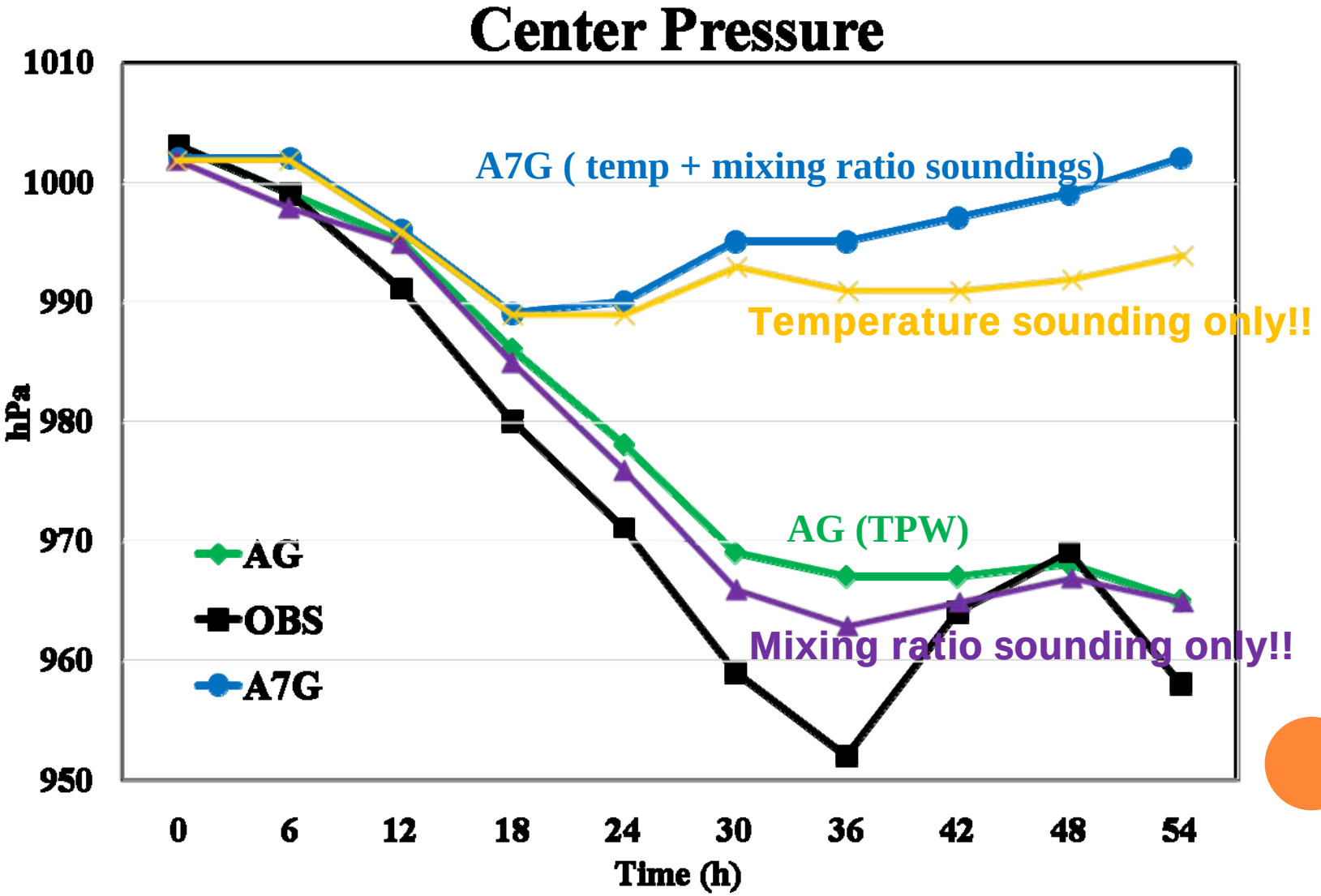


MODIS TPW and sounding comparison

Track



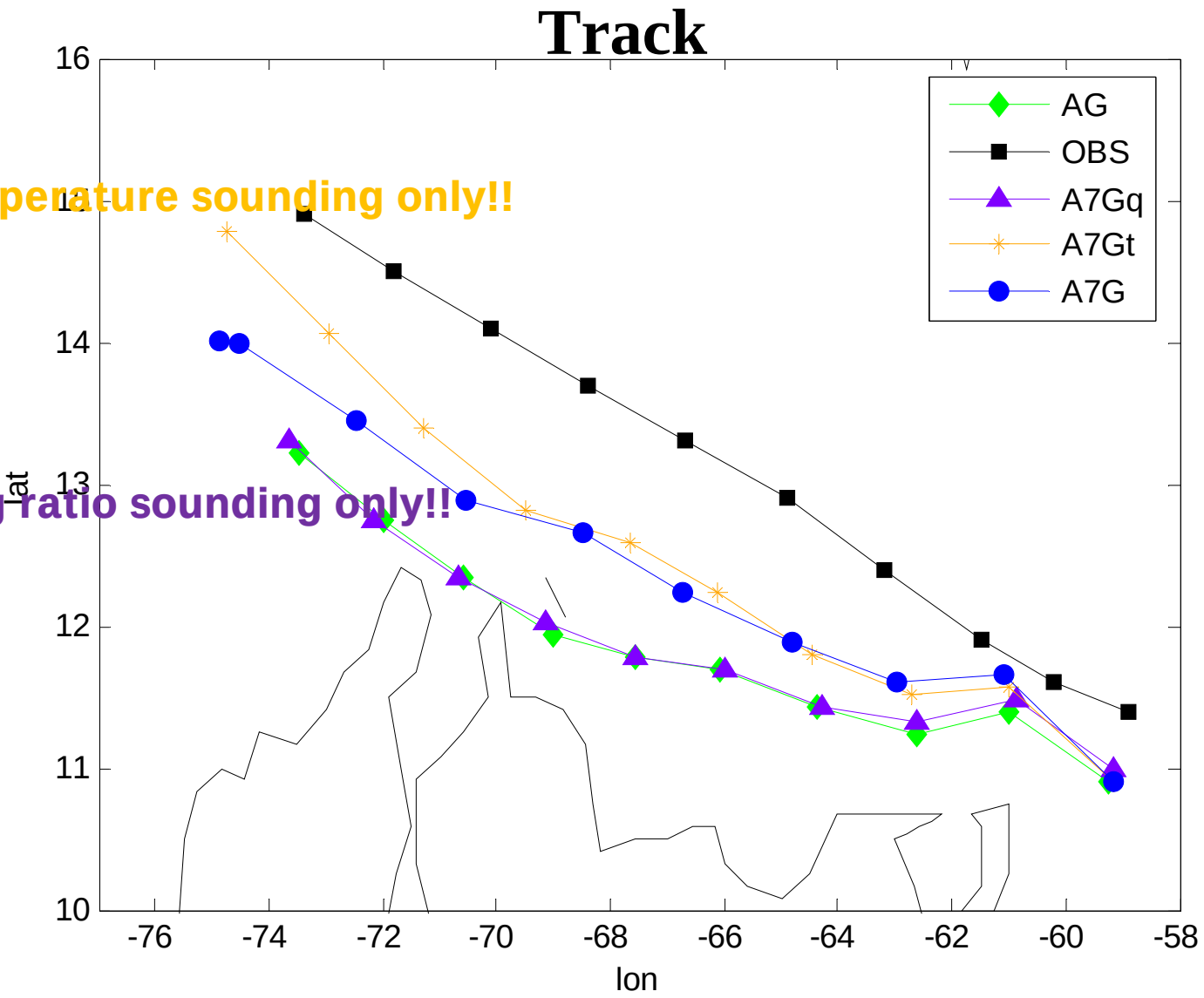
AIRS TPW and sounding comparison



AIRS TPW and sounding comparison

Temperature sounding only!!

Mixing ratio sounding only!!



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