P2-30

Improving Tropical Cyclone Intensity Forecasting with JPSS ATMS-MIRS Retrievals

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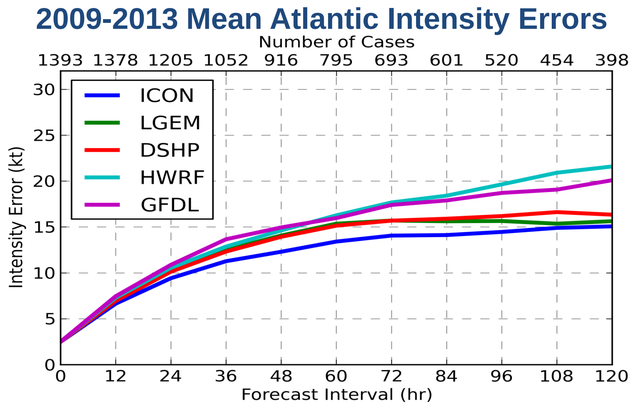
Introduction

While tropical cyclone track errors have improved dramatically over the past few decades, the ability to forecast intensity changes has improved much more slowly. An especially difficult but very important forecast problem is predicting rapid changes in tropical cyclone intensity. Improving these forecasts is one of the highest priorities within NOAA. The possibility of improving the Rapid Intensification Index (RII) as well as SHIPS and LGEM forecasts with the use of JPSS Advanced Technology Microwave Sounder (ATMS) data is investigated. Preliminary statistics show that using ATMS-based Maximum Potential Intensity (MPI) as input to RII results in the improvement of the Brier Skill Score and bias for RII forecast for both Atlantic and West Pacific basins, with up to 3.1% bias decrease for the Atlantic basin.

2009-2013 Mean Atlantic Intensity Errors

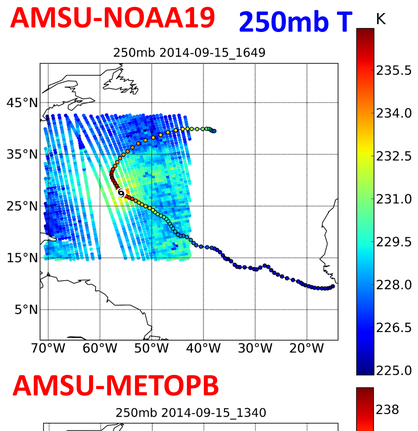


- In the last 5 years statistical intensity forecast models, the Statistical Hurricane Intensity Prediction Scheme (SHIPS) and the Logistic Growth Equation Model (LGEM), have generally outperformed dynamical models in intensity prediction.
- The accuracy of SHIPS, LGEM, and RII, critically depends on the accuracy of the MPI estimate.
- An MPI estimate algorithm that uses T, q retrievals from the ATMS in the near storm environment is being developed.
- The use of that MPI estimate as input to SHIPS/LGEM and RII to improve their forecast is being investigated.

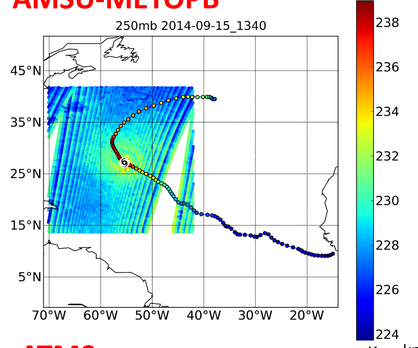
AMSU-MIRS vs. ATMS-MIRS

2014AL06 EDOUARD

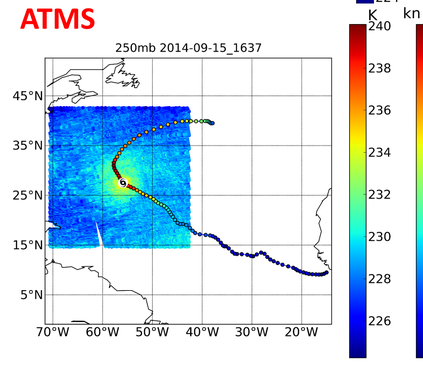
AMSU-NOAA19 **250mb T**



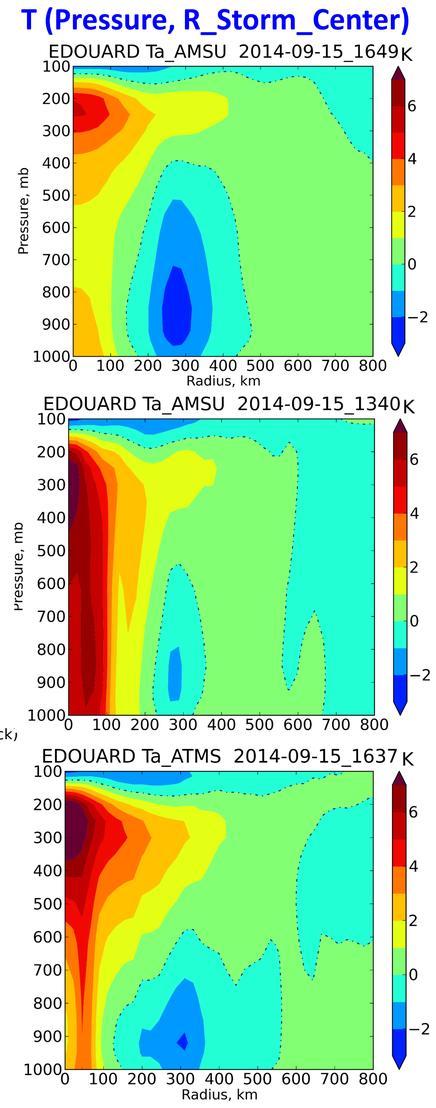
AMSU-METOPB



ATMS



T (Pressure, R_Storm_Center)



ATMS is one of the five instruments onboard the Joint Polar Satellite System (JPSS) Suomi National Polar Orbiting Partnership satellite (SNPP). The successor to the Advanced Microwave Sounding Unit (AMSU), ATMS provides high-resolution sounding data with very small gaps between consecutive orbits. In addition, ATMS data are processed with the new Microwave Integrated Retrieval System (MIRS) which provides simultaneous temperature and moisture profile retrievals. This makes it possible to obtain from the data MPI estimates which previously could only be done using model fields.

Resolution ATMS:

- ✓ Much smaller gaps between passes
- ✓ Higher resolution and wider swath

Temperature ATMS - more realistic TC warm core:

- ✓ Larger magnitude in the upper levels
- ✓ AMSU often too warm in the lower levels

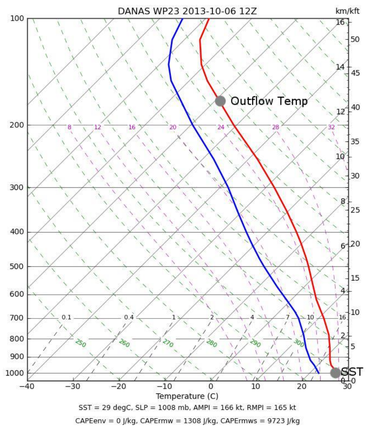
Maximum Potential Intensity (MPI) Estimates

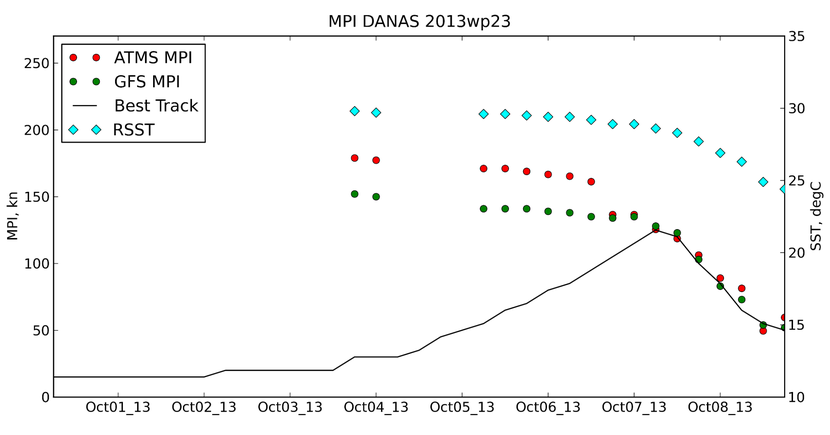
- **Statistical models, SHIPS and LGEM, use MPI as one of the key parameters**
- Operational versions of SHIPS, LGEM, RII use MPI statistically calculated from SST only
- **Use ATMS-MIRS T, q, SLP retrievals** together with SST **to estimate MPI** from using algorithm by Emanuel (1988), Bister and Emanuel (1998):

$$(MPI)^2 = \frac{T_s - T_o}{T_o}\frac{C_k}{C_D}(k^* - k)$$

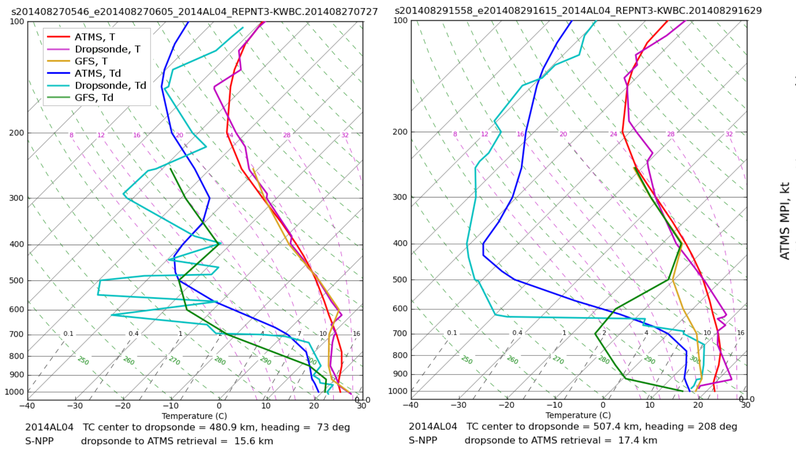
- T_s, T_o, k^*, and k: estimated from SST, sounding
- C_k/C_D: specified ratio of surface exchange coefficients

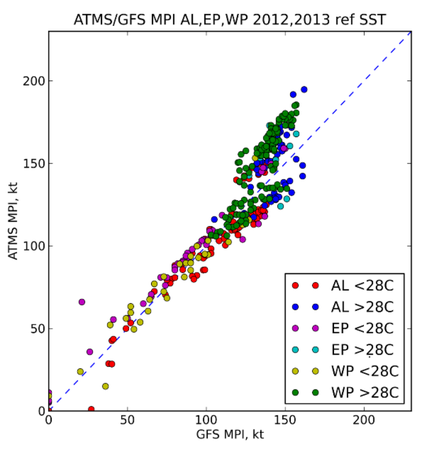
- MPI calculation from ATMS:
  1. Average T, RH between r = 200 to 800 km to get $\overline{T}(p), \overline{RH}(p)$
  2. Input $\overline{T}(p), \overline{RH}(p)$ environmental profiles to Emanuel (1988) MPI algorithm
  3. Replace empirical MPI with ATMS MPI in RII and models





MPI: ATMS vs. GFS Profile





ATMS vs dropsondes

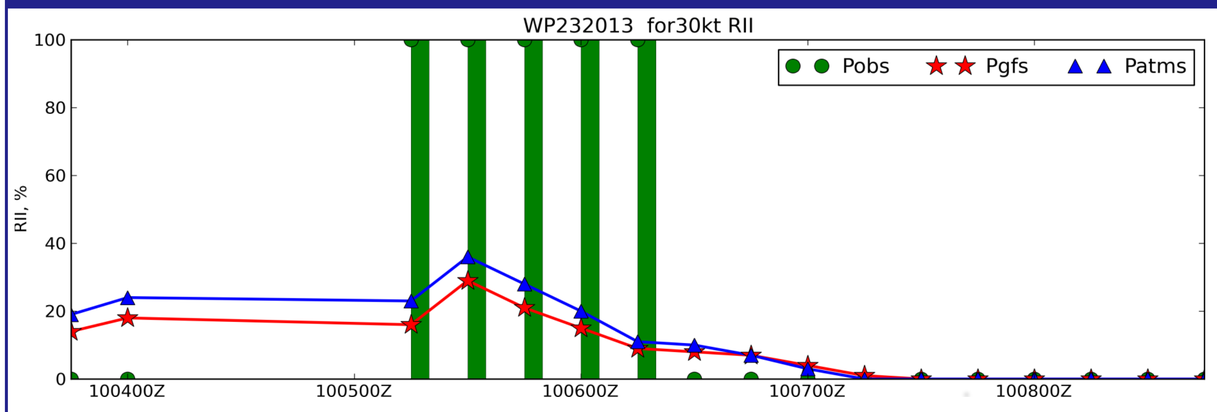
- ATMS profiles differ significantly from dropsondes close to the storm center (0-50 km)
- ATMS profiles look better away from the storm center (> 350 km)
- ATMS is lacking vertical resolution (could miss shallow dry/moist levels)
- ATMS has dry and cold bias at the surface

A more formal analysis is being conducted to obtain the best possible sounding from a combination of GFS and ATMS soundings.

ATMS vs GFS:

- T profiles usually very similar; q profiles – rather different
- The lowest sounding point (1000 mb) usually matches for dropsondes and GFS; thus the GFS lowest point could be used to replace ATMS data at the lowest level
- No obvious dependence on distance from TC center
- The ATMS MPI is similar to GFS MPI for weaker storms for AL, EP, and WP storms.
- For MPI > 100 kt, in some cases the GFS MPI is larger than ATMS MPI, and in some cases that relationship is reversed.

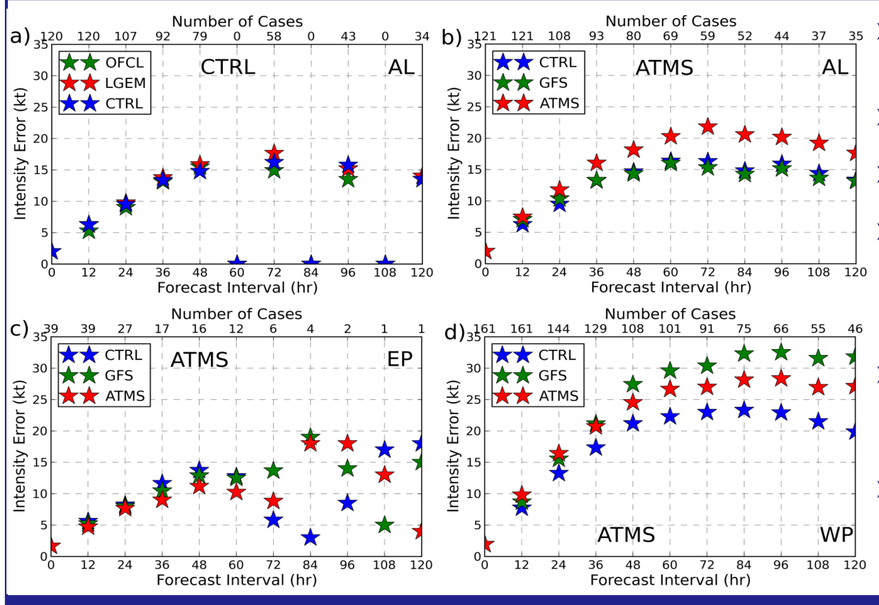
RII: GFS vs. ATMS



1) Statistics are preliminary: based on very small number of cases
2) **AL:**
   - Brier Score: ATMS < GFS
   - Brier Skill Score: ATMS/GFS > 0
   - Bias: ATMS better than GFS
3) **EP:** only 1 (one) RI cases available, unable to calculate statistics
4) **WP:**
   - Brier Score: ATMS < GFS
   - Brier Skill Score: ATMS/GFS > 0
   - Bias: ATMS better than GFS

Basin		BS GFS	BS ATMS	BS Mean	BSS A/G	BSS G/M	BSS A/M	Bias GFS	Bias ATMS	# Cases	#RII
AL	25kt	964.55	957.98	854.27	0.68	-12.91	-12.14	1.63	1.44	130	13
	30kt	723.53	718.46	667.83	0.70	-8.34	-7.58	1.30	1.15	130	10
	35kt	477.11	467.65	413.10	1.98	-15.49	-13.20	1.26	1.00	130	6
	40kt	248.40	243.55	211.88	1.95	-17.24	-14.95	1.63	1.37	130	3
WP	30kt	1044.39	996.30	1586.00	4.60	34.15	37.18	0.56	0.61	176	31

LGEM: GFS vs. ATMS



- LGEM is rerun with the same settings as operational version (CTRL)
- Empirical MPI is replaced by GFS MPI (GFS)
- Empirical MPI is replaced with ATMS MPI (ATMS)
- AL: The best results are produced by the control run for 0-24 hr forecast and by GFS run for longer range forecast. Use of ATMS MPI does not improve the forecast
- EP: ATMS MPI improves 0-48 hr forecast relative to both control and GFS runs. More data are needed.
- WP : ATMS MPI improves forecast relative to GFS run. The best results are produced by the control run.

Conclusions

- ATMS data provide more realistic TC structure than AMSU
- RII: for AL, EP, WP forecast is slightly improved with ATMS MPI
- LGEM, SHIPS Intensity forecast: AL - worse; WP, EP - better in some cases
- The possibility of using a combination of ATMS and GFS data to obtain the most realistic sounding and the best possible MPI estimate is investigated

References

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