Applications of JPSS Imagers and Sounders to Tropical Cyclone Track and Intensity Forecasting

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Program: JPSS RR/PG

Introduction

Project goal:

to improve tropical cyclone forecasts by utilizing new capabilities provided by JPSS SNPP (launched Oct, 2011)

- **Two basic methods exists for improving tropical cyclone forecasts with S-NPP:**
  - assimilate data in numerical forecast models
  - improve analysis and statistical post-processing forecast products
- **Our group is developing two applications focusing on the 2nd approach**
  1. Multi-spectral center fix algorithm
     - Use data from ATMS, CrIS, and VIIRS
  2. Maximum intensity estimation method
     - Generalization of operational AMSU methods

Methodology/Expected Outcomes

1. **Improve center location estimates**
   - Image processing techniques will be used to develop an objective center fixing algorithm from the VIIRS visible and IR data
   - Separate algorithms will be used during the day and night
   - Start with ATMS T,q retrievals
   - Use hydrostatic and nonlinear balance equations to diagnose geopotential height (Z) and wind fields
   - Estimate center from Z and wind fields
   - Refine using VIIRS IR, visible and DNB imagery
2. **Intensity analysis and forecast improvements**
   - Hydrostatic integration of ATMS soundings to give P_{min} and V_{max}
   - Use MIRS ATMS to statistically adjust CIRA AMSU algorithm
   - Estimate Maximum Potential Intensity (MPI) from ATMS and SST (Emanuel 1988, Bister and Emanuel 1998)
   - Incorporate improved MPI estimates into Logistic Growth Equation Model (LGEM) (DeMaria 2009)

Available ATMS MIRS retrievals

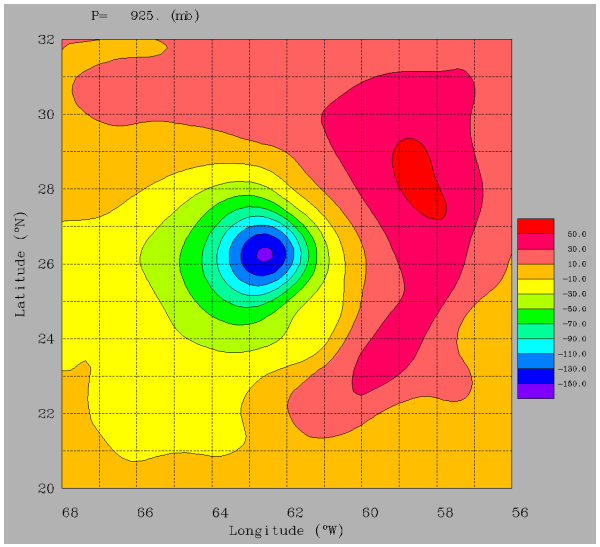
#	TC	Name	#days
1	AL07	Helene	4
2	AL08	Gordon	6
3	AL09	Isaac	12
4	AL10	Joyce	3
5	AL11	Kirk	5
6	AL12	Leslie	3
7	**AL18**	**Sandy**	**8**
8	AL19	Tony	4
9	IO01	Murjan	4
10	IO02	Nilam	4

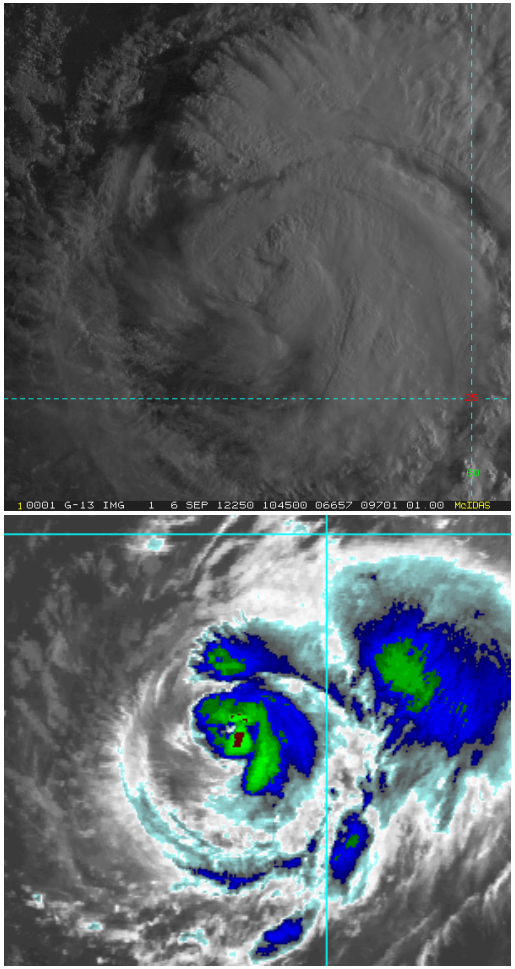
#	TC	Name	#days
11	WP14	Kai-Tak	4
12	WP15	Tembin	12
13	WP16	Bolaven	10
14	WP23	Maria	1
15	WP24	Son-Tinh	8
16	WP26	Bopha	1
17	EP08	Hector	2
18	EP09	Ileana	6
19	EP17	Rosa	4

Data collected for active TC periods, 2012:
08/15 - 09/01, 10/20 - 11/01, 12/02

- 19 different storms in AL,EP,WP,IO
- 101 "storm" days

Example of Center Fix Algorithm



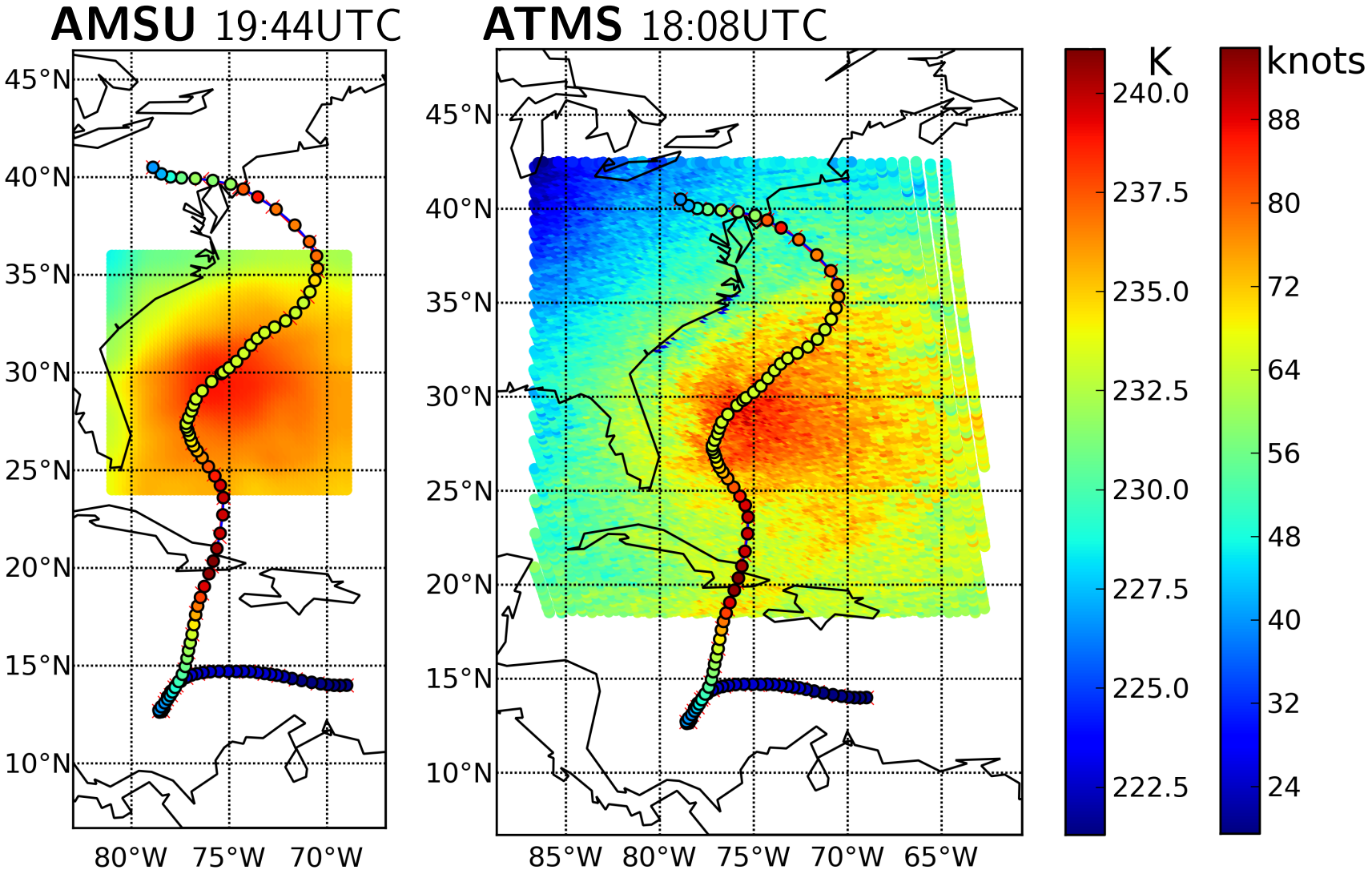


Machine Learning Algorithm to give final lat/lon of low–level circulation center

1. First guess from pressure minimum from hydrostatic integration of MIRS temperature retrievals
2. Extract features (pressure gradients, etc) near first guess position
3. Add features from high-res Vis/DNB and IR near first guess position

Example from Hurricane Leslie 06 Sept 12 10 UTC

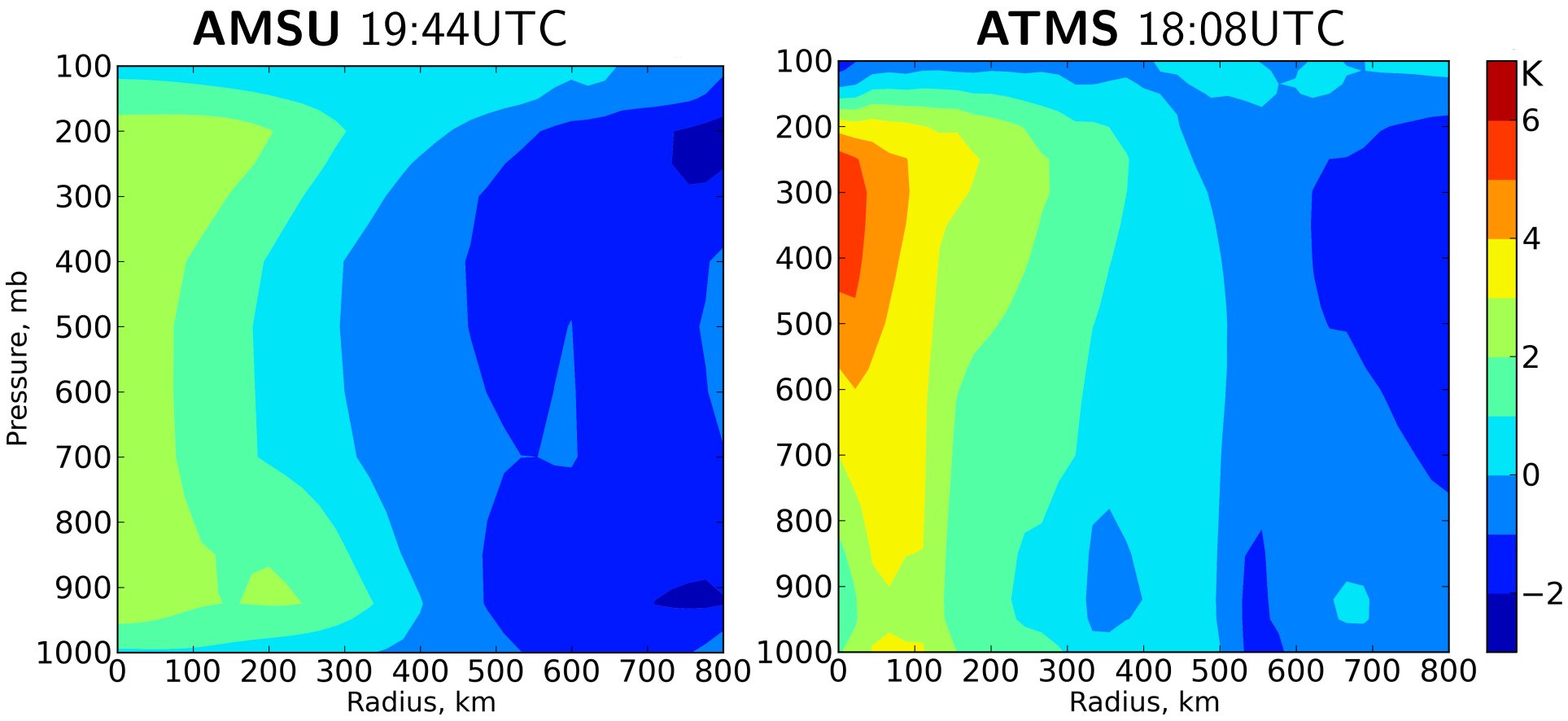
MPI estimation method: SANDY 250mb T, Oct 27, 2012



ATMS:

- higher resolution
- wider swath
- more frequent observations

MPI: SANDY azimuthally averaged T profile, 2012 Oct 27



ATMS:

- better resolves warm core
- does not require T correction at low levels

Possible Path to Operations

- **Center fix algorithm**
  - Needs similar input to intensity/structure algorithm
  - Could be added as extension on NDE system
- **Intensity forecast algorithm**
  - MPI estimates with ATMS and modified LGEM could be implemented as part of NHC operational SHIPS/LGEM model run
  - Work with NCO to make MIRS available on NCEP supercomputer
- **ATMS intensity/structure estimation**
  - Related project leveraging JPSS-PG/RR work
  - AMSU version of CIRA algorithm already operational
  - ATMS version being implemented in NDE system under PSDI support
  - CIMSS also converting their AMSU algorithm to ATMS

Future Plans

- Continue collection of ATMS/VIIRS data during 2013 hurricane season
- Continue development of center fix, MPI algorithms
- Test ATMS-based MPI in LGEM
- Possible tests in NHC Proving Ground in 2014
- Coordination with CIRA and CIMSS intensity/structure estimation algorithms

Publications List

1. **References:**

Bister, M. and Emanuel, K. A.,1998: Dissipative heating and hurricane intensity. *Meteorol. Atmos. Phys.*, **65**, 233-240

DeMaria, M.,2009: A simplified dynamical system for tropical cyclone intensity prediction. *Mon. Wea. Rev.*, **137**, 68-82

Emanuel, K.,1988: The maximum intensity of Hurricanes. *J. Atm. Sci.*, **45**, 1143-1155

2. **Project Publications:**

Chirokova G, M. DeMaria, R. DeMaria and J. Dostalek. Applications of JPSS imagers and sounders to tropical cyclone track and intensity forecasting, 2013: *Abstract submitted to 2013 EUMETSAT Meteorological Satellite Conference & 19th AMS Satellite Meteorology, Oceanography, and Climatology Conference. 16-20 September 2013, Vienna, Austria*