

HURRICANE MATTHEW

Remote Sensing Systems
www.remss.com

EXTREME WINDS AND PRECIPITATION FROM SPACE

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INTERNATIONAL WORKSHOP ON MEASURING
HIGH WIND SPEEDS OVER THE OCEAN
November 2016, UK MET OFFICE, Exeter, UK

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RSS SATELLITE OBSERVATIONS FOR HURRICANE MATTHEW

Sensor	Dataset	Obs. Local Time	Latency
SMAP	Wind speed	6 am/pm	~ 6-8 hours
ASCAT	Wind vector	9:30 am/pm	No NRT, manual processing
WindSat	All-weather Wind vector, Rain, Water Vapor, SST	6:00 am/pm	6-12 hours
GMI, AMSR2, SSMIS	Rain rates, WV, SST	Variable	3-12 hours
MW Radiometers	Blended SST	Variable	24 hours

- Analysis of almost NRT wind and precipitation data from RSS
- Comparison with:
 - NHC best track data, max 10-min sustained winds (0.88 scaling from 1-min)
 - SFMR (from HRD, NOAA flights; US Air-force flights to be done when available)
 - NCEP GFS wind fields, 0.25 deg

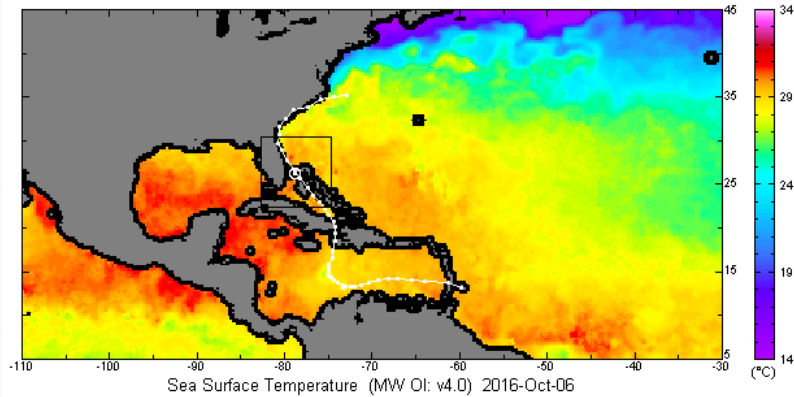


PRECONDITIONING OF HURRICANE MATTHEW

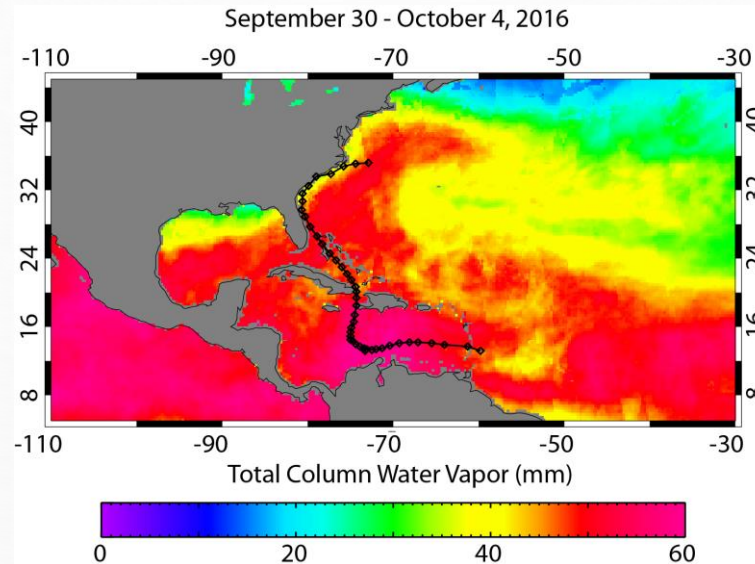
1. Very warm SSTs over all tropical Western Atlantic
2. More moisture → potential for feeding the storm intensity
2. No significant cold wake → missed opportunity for weakening
3. Eyewall travelling just off-shore the US coast for several days → No weakening until landfall on Oct 9

All of this led to a storm that hit Haiti and the US, with Cat. 3-4 winds for more than a week and continuous wide-spread extreme precipitation

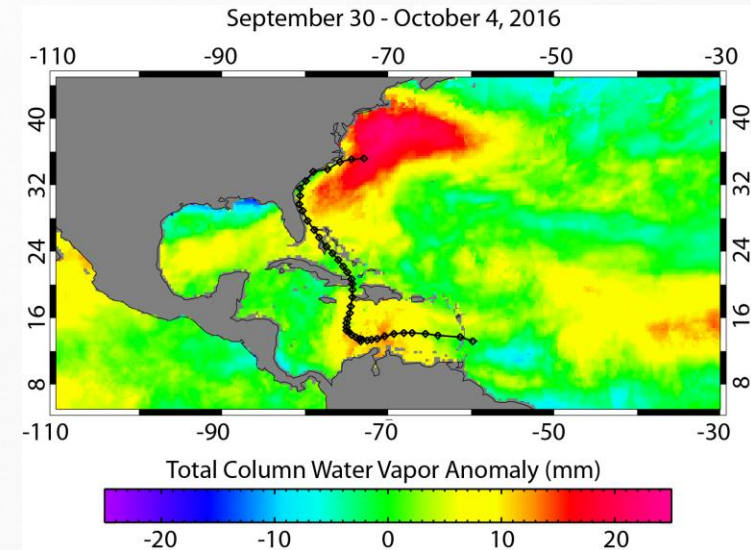
SST



Water Vapor



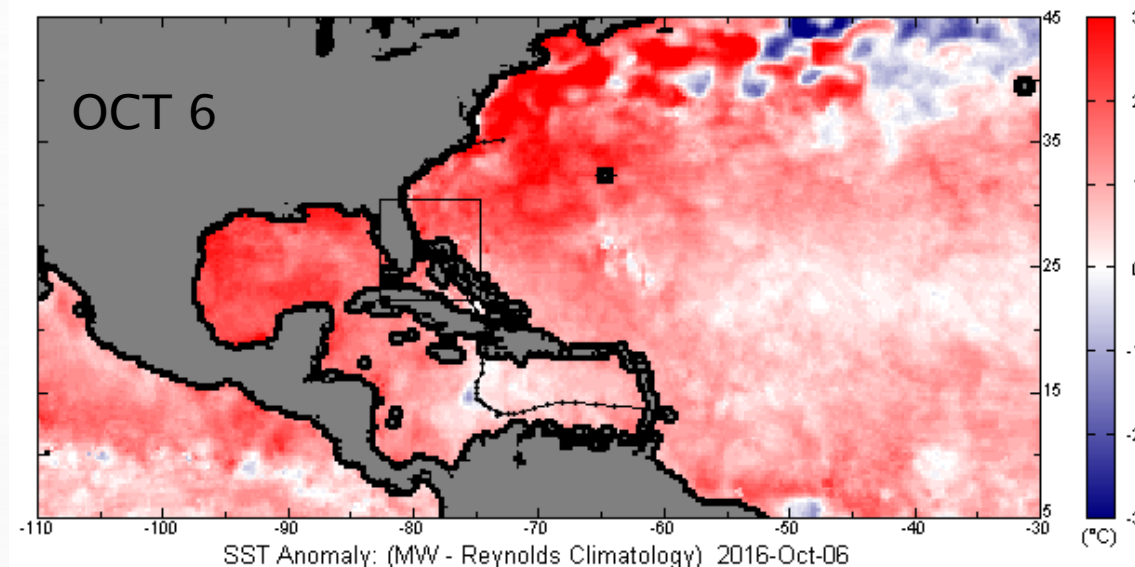
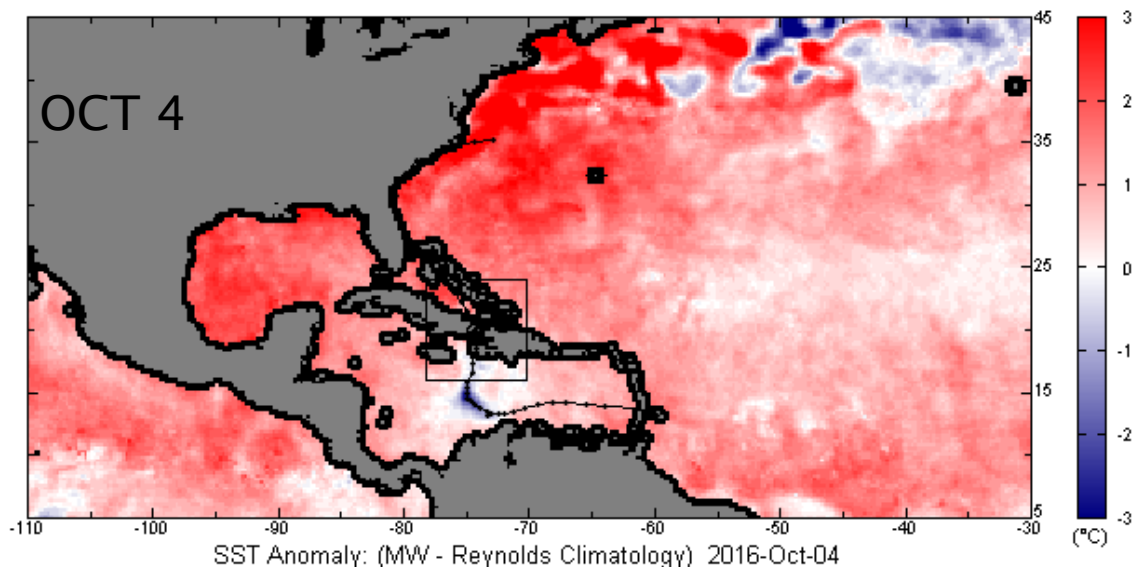
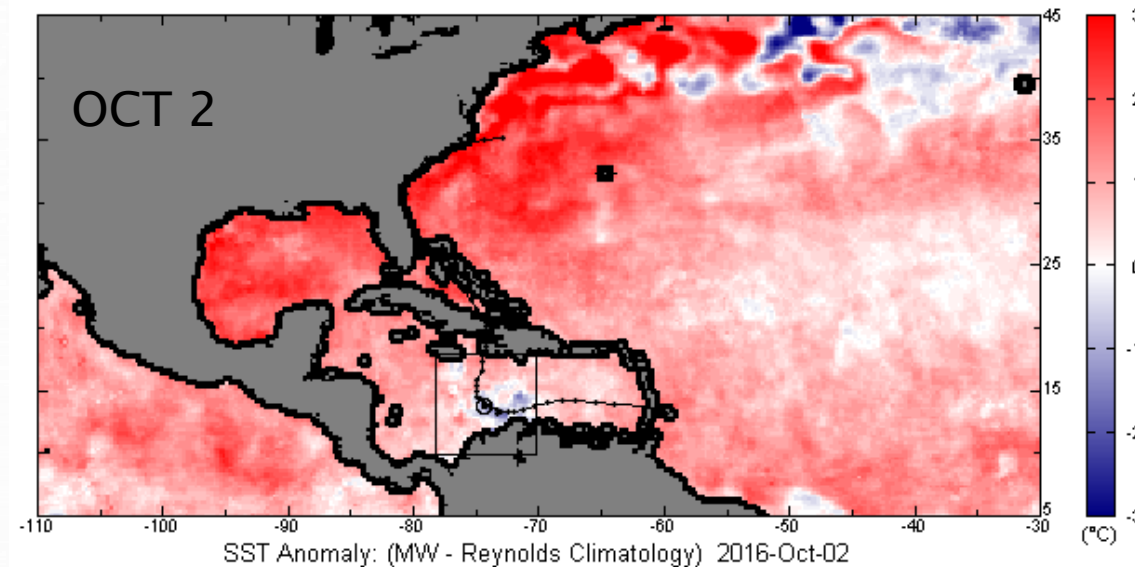
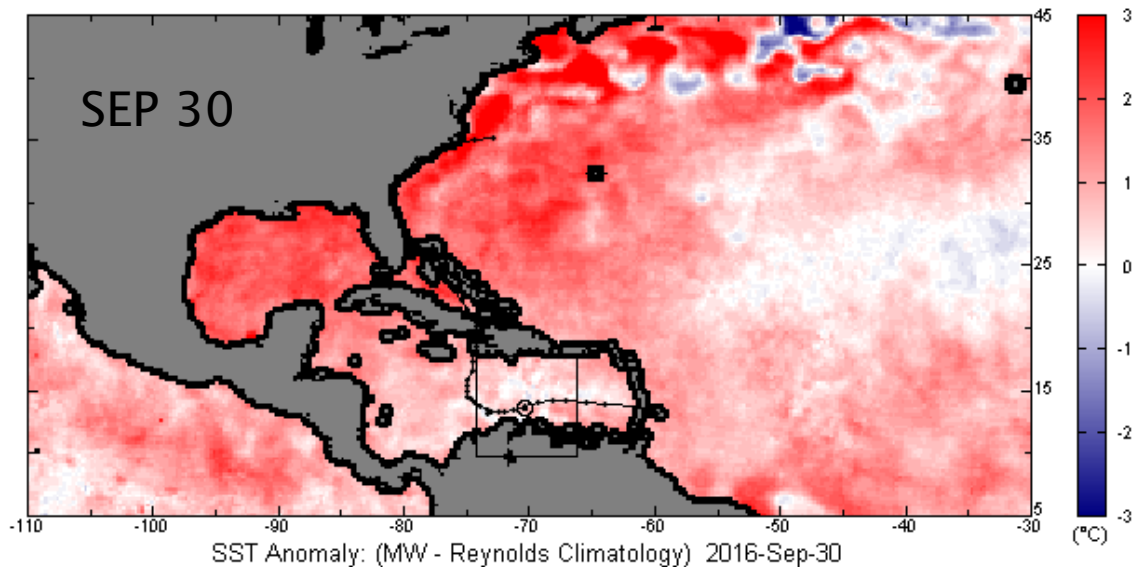
Water Vapor anomaly





SST ANOMALIES

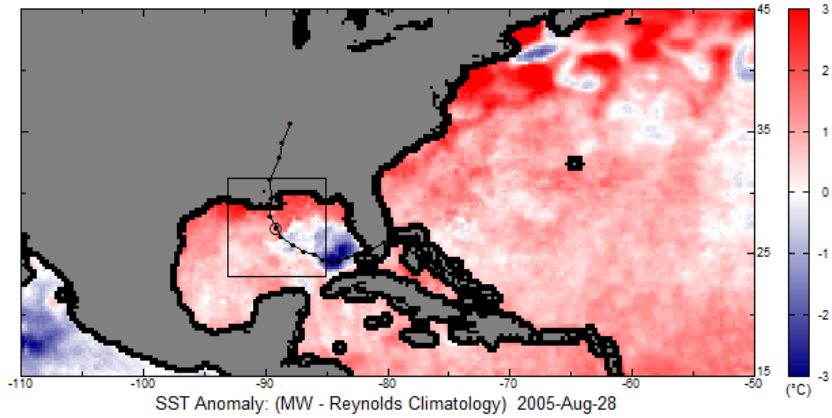
Very warm SSTs, no significant cold wake



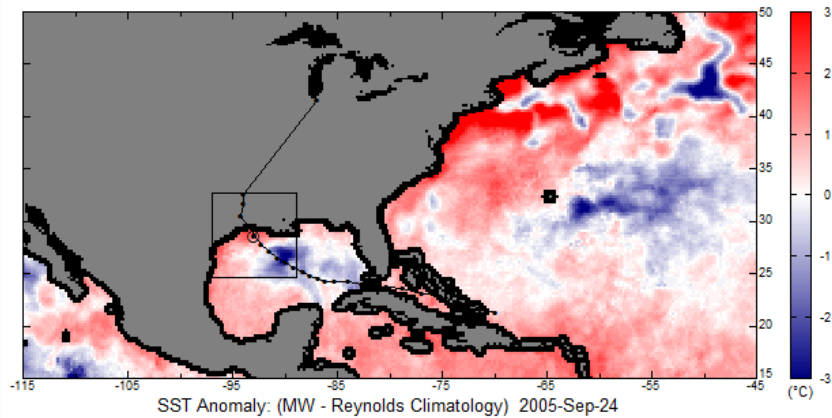


COLD WAKE FOR OTHER STORMS

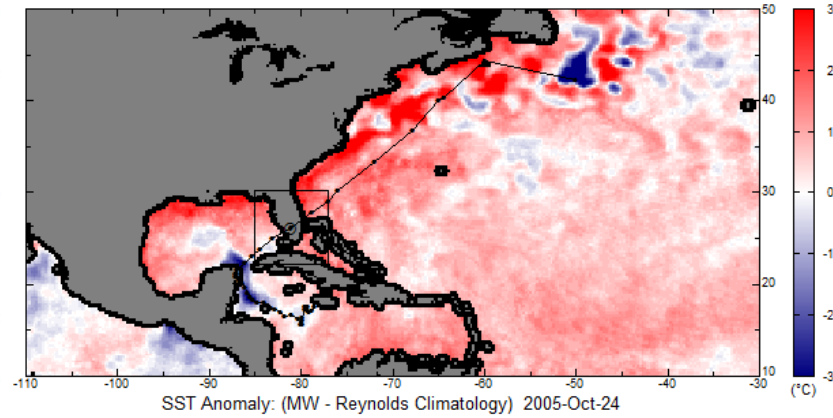
Katrina, Aug 28, 2005



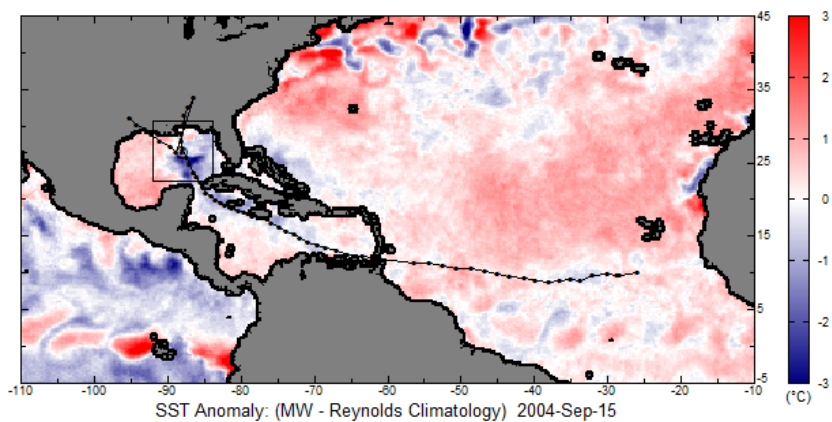
Rita, Sep 24, 2005



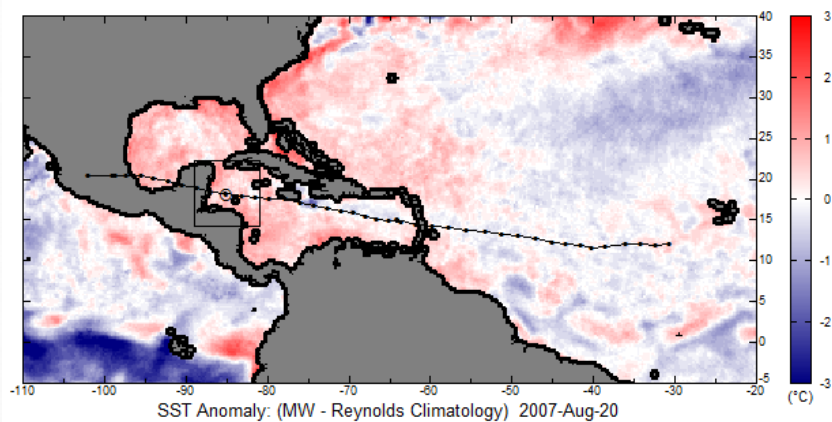
Wilma, Oct 24, 2005



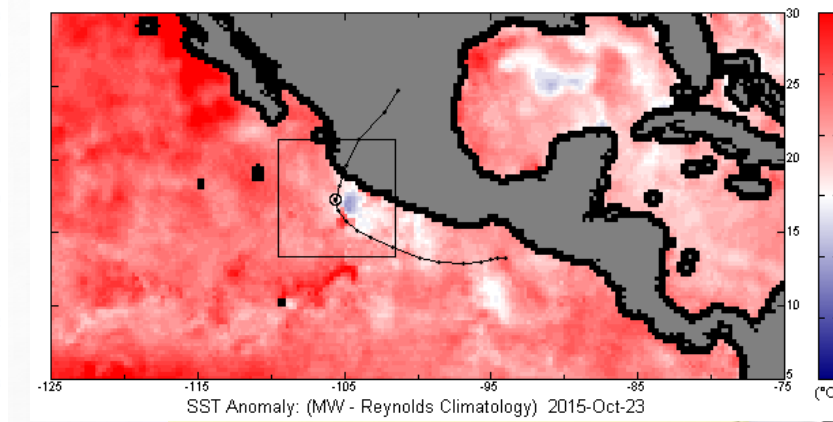
Ivan, Sep 15, 2004



Dean, Aug 20, 2007



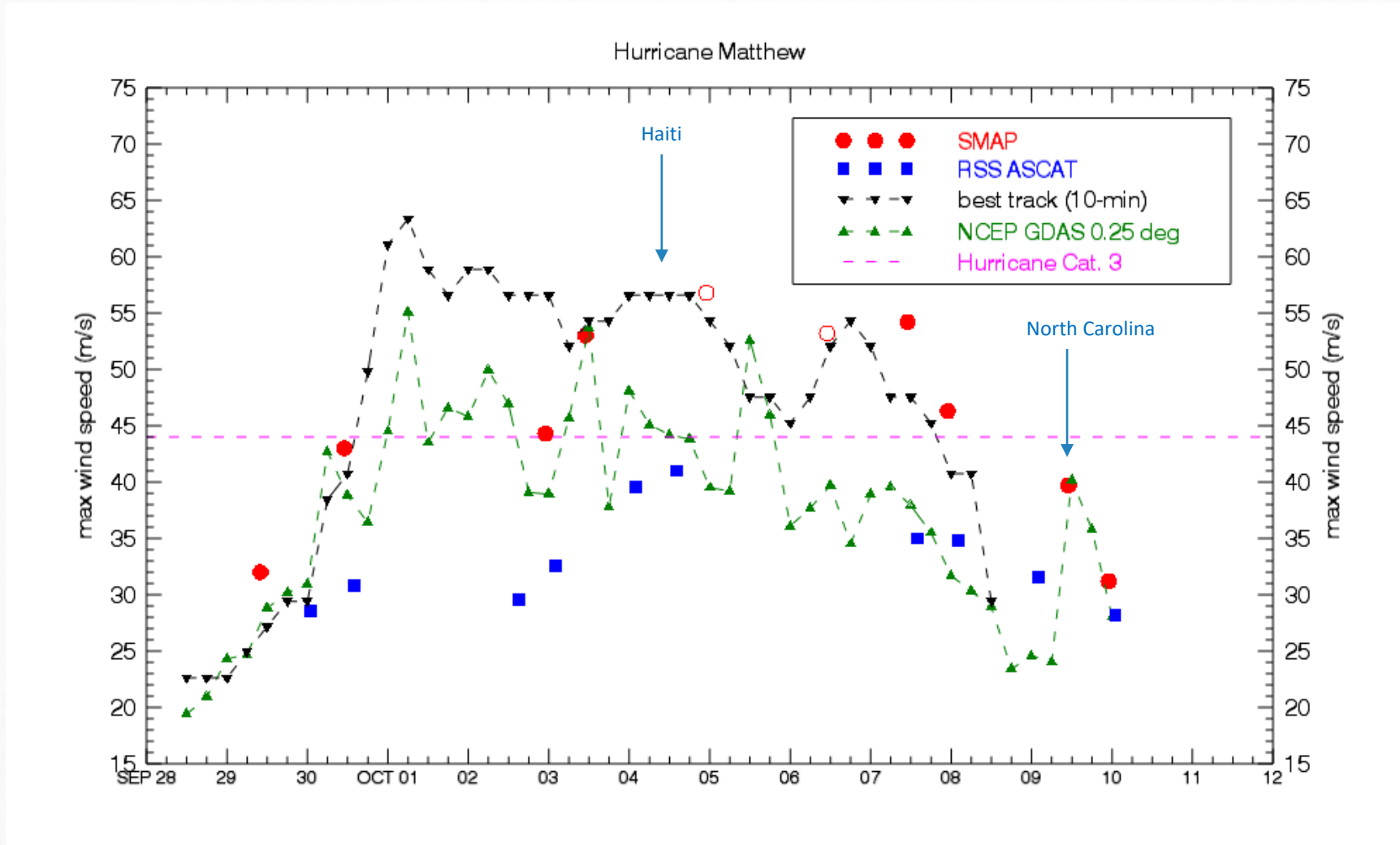
Patricia, Oct 23, 2015



El Nino → Deep thermocline
 Very warm SST & No cold wake
 Very intense hurricane



TRACKING MATTHEW'S MAXIMUM WINDS TIMESERIES



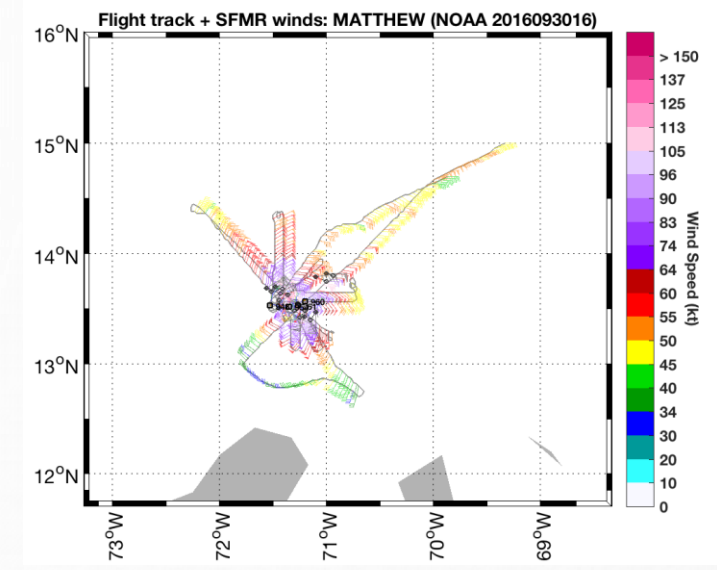
○ Possible land contamination in SMAP



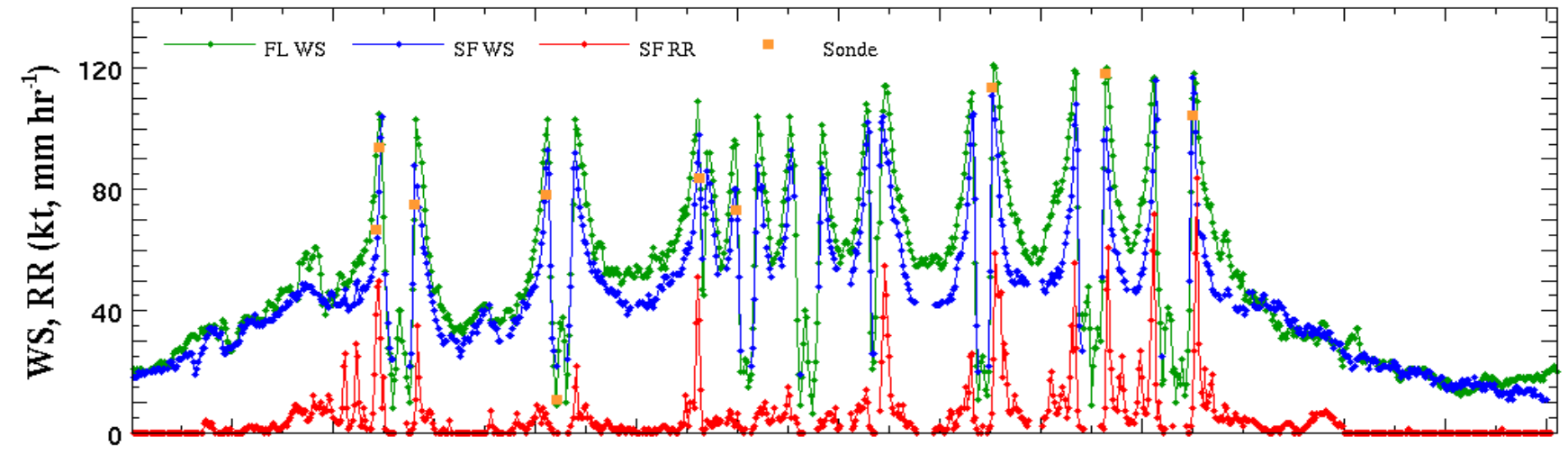
WIND VALIDATION WITH AIRBORNE OBSERVATIONS

What do we use to validate satellite hurricane-force winds?

- NOAA flights with SFMR and GPS dropsondes during Matthew available at the NOAA/HRD website
http://www.aoml.noaa.gov/hrd/Storm_pages/matthew2016/sfmr.html
- US Air Force flights not yet available.
- SFMR surface winds consistent with dropsondes scaled at surface
- Extensive validation dropsondes vs SFMR in Klotz and Uhlhorn (JAOT, 2014)



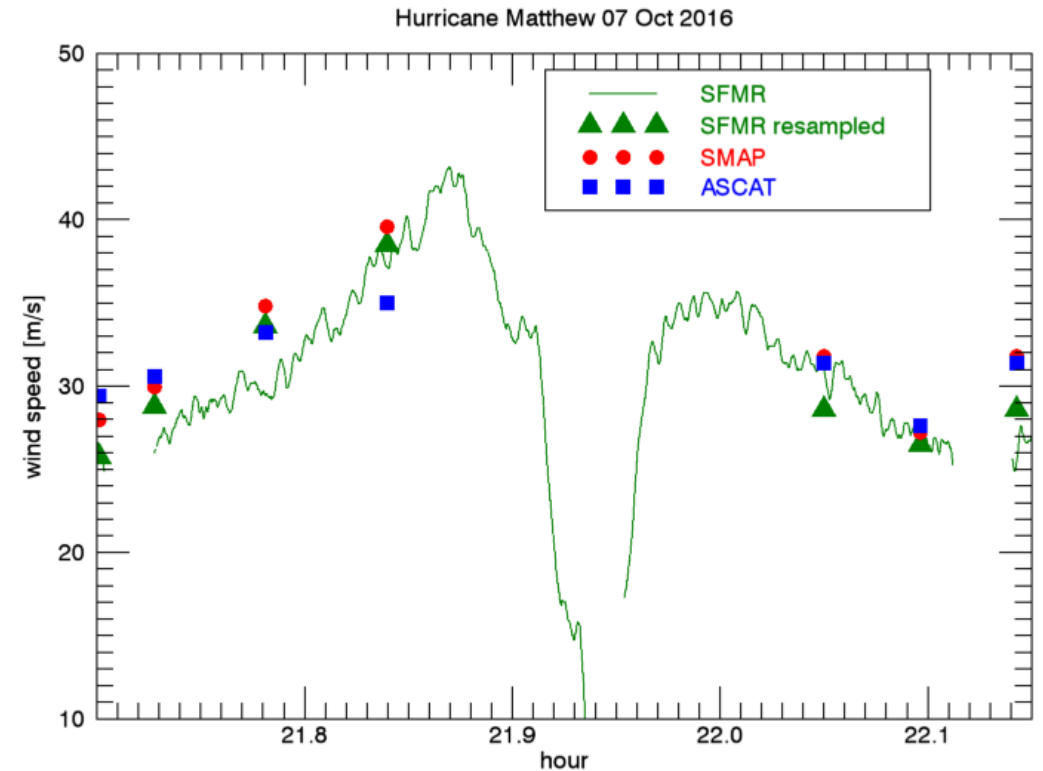
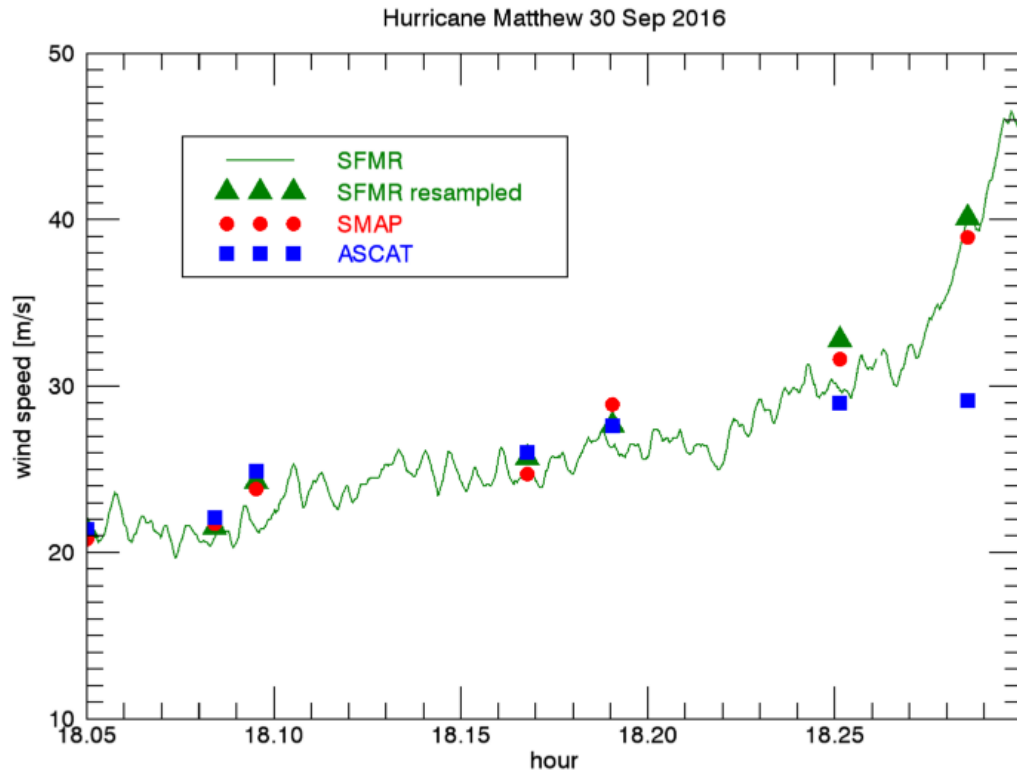
Wind speed and rain rate (NOAA 2016093015)





SATELLITE WINDS VS SFMR

- Under the assumption that SFMRs accurately measure surface winds, SMAP Hurricane-force winds are proven to be very realistic.
- ASCAT underestimates surface hurricane-force winds → rain, low sensitivity, or scatterometer model function?





MATTHEW: SATELLITE SURFACE WINDS

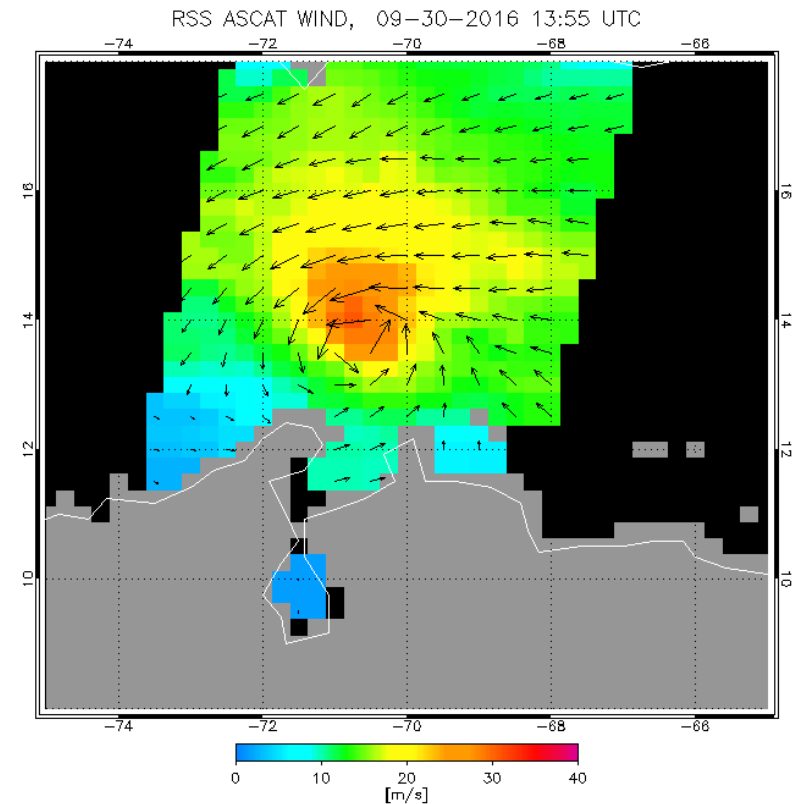
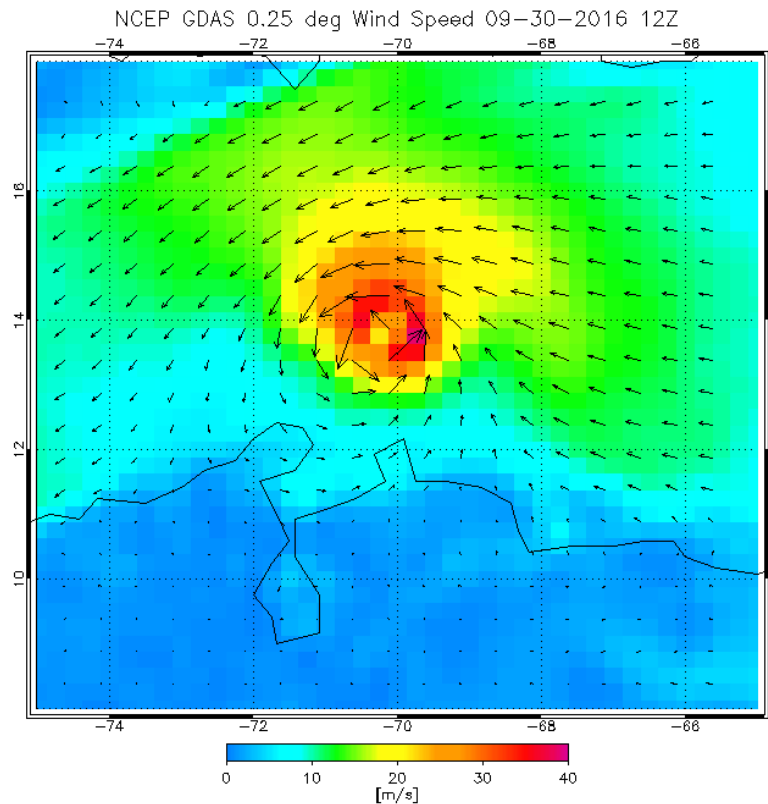
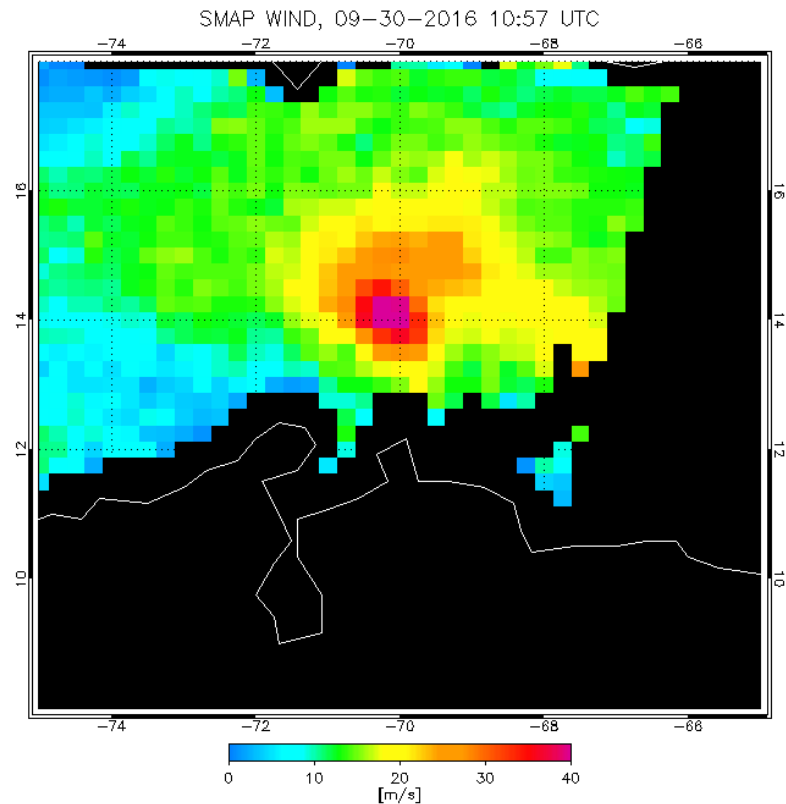
SEPTEMBER 30, AM:

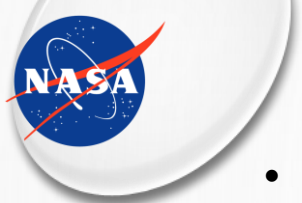
- NHC reported Category 3
- SMAP Category 2/3
- ASCAT too low

SMAP 11 UTC

NCEP 12 UTC

ASCAT 14 UTC

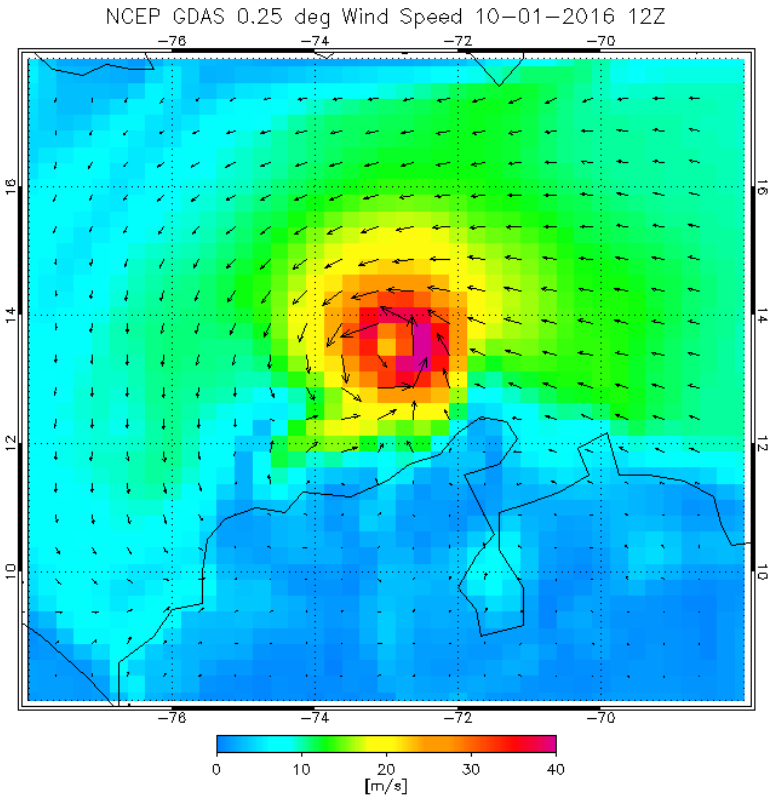




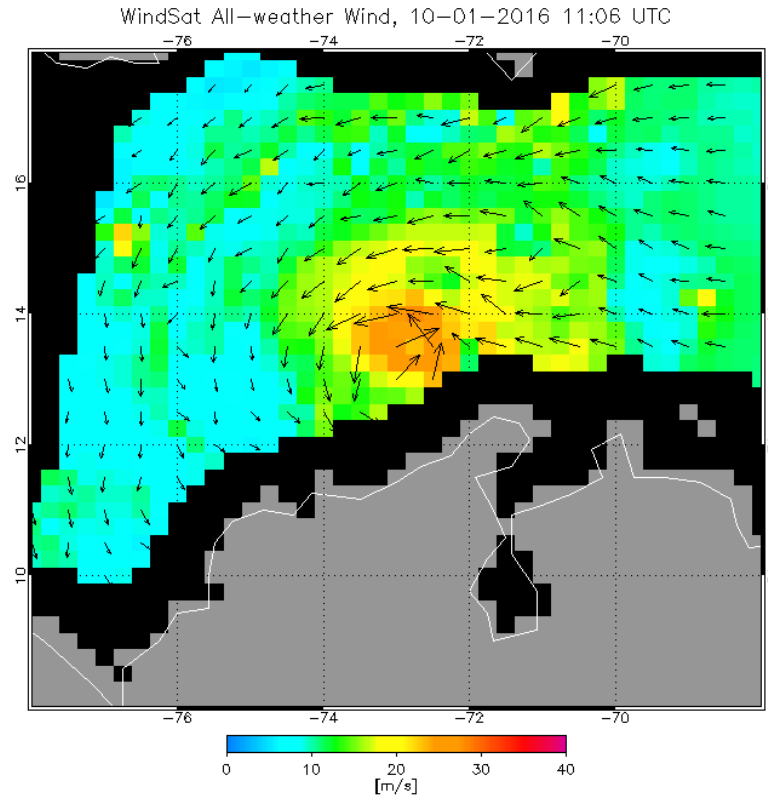
OCTOBER 1:

- NHC reported Category 5
- WindSat all-weather winds too low (rain impact)
- no SMAP or ASCAT (satellite gaps or partial view)

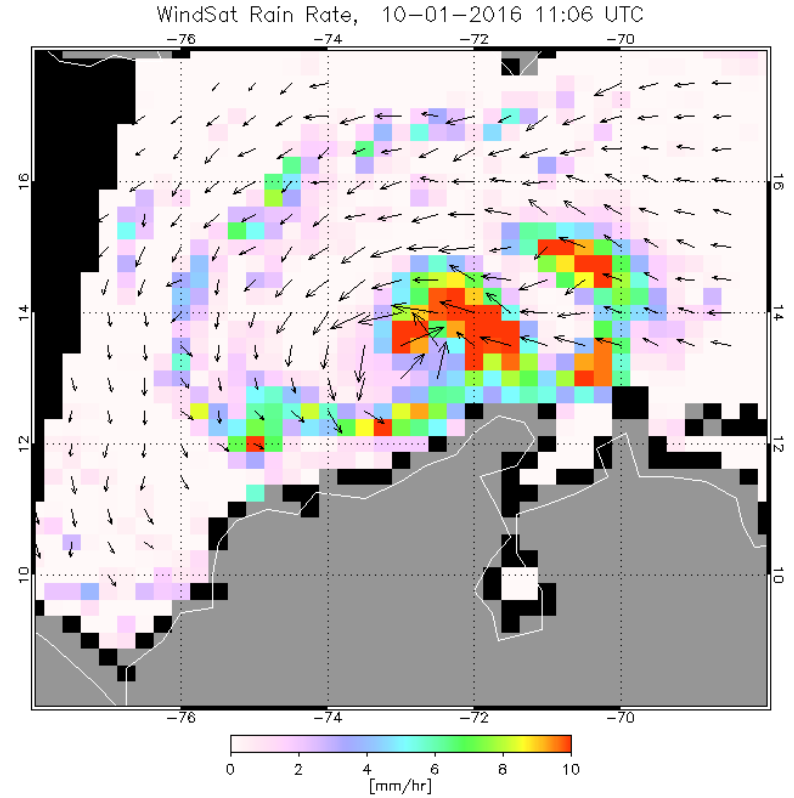
NCEP GFS



WINDSAT AW WINDS



WINDSAT RAIN

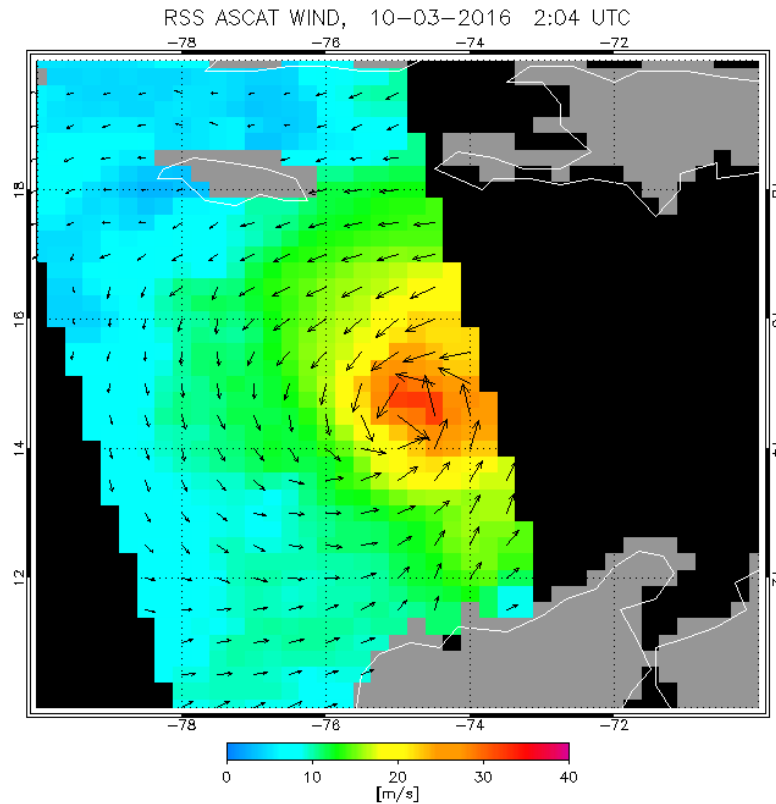




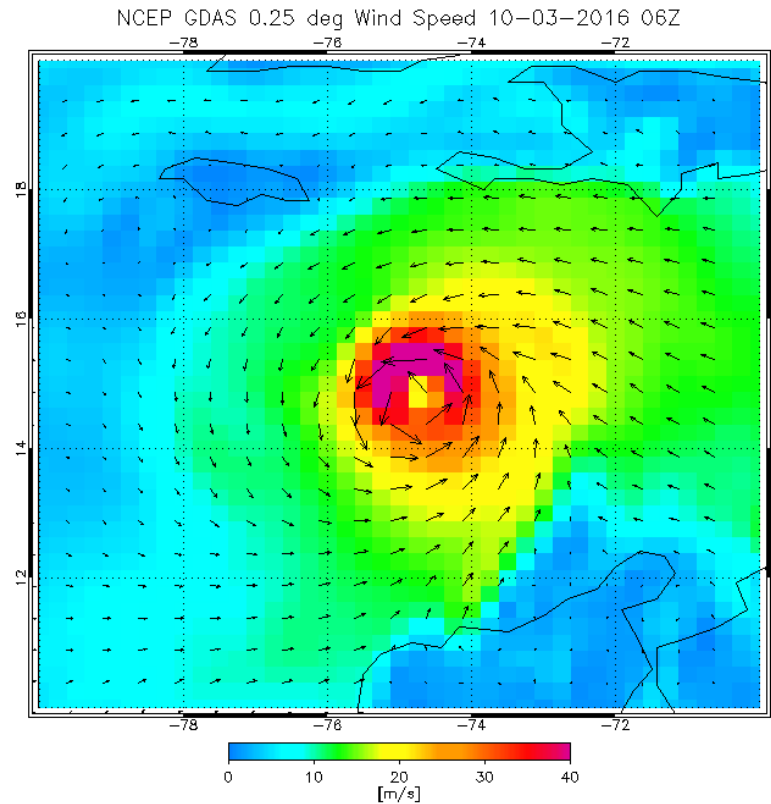
OCTOBER 3: APPROACHING HAITI

- NHC reported Category 4
- SMAP Category 4
- ASCAT wind speed too low (Category 1) , good wind direction

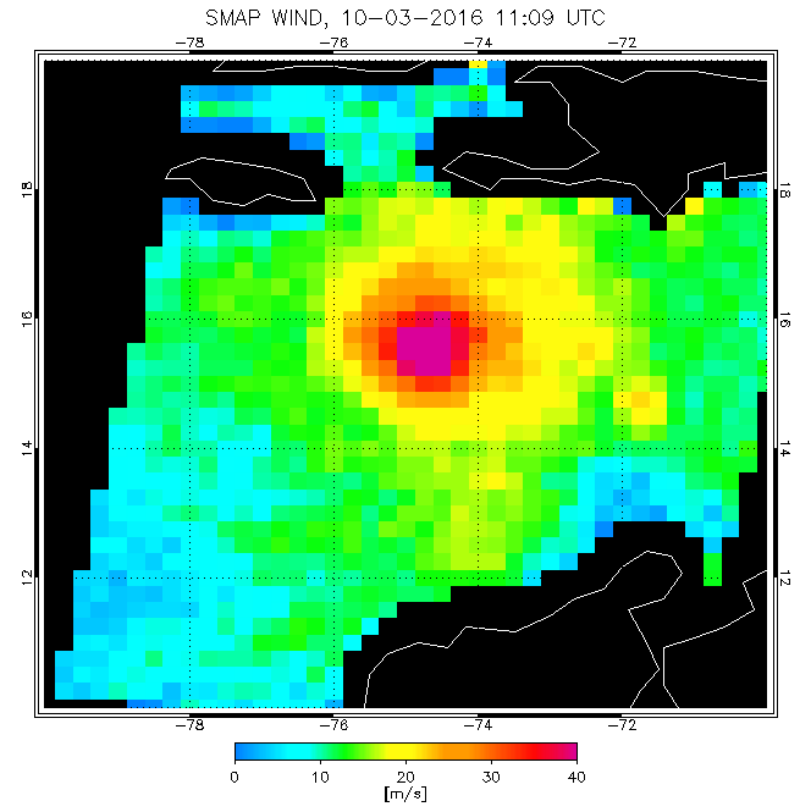
ASCAT 2 UTC

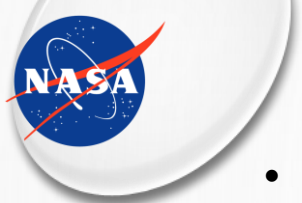


NCEP 6 UTC



SMAP 11 UTC

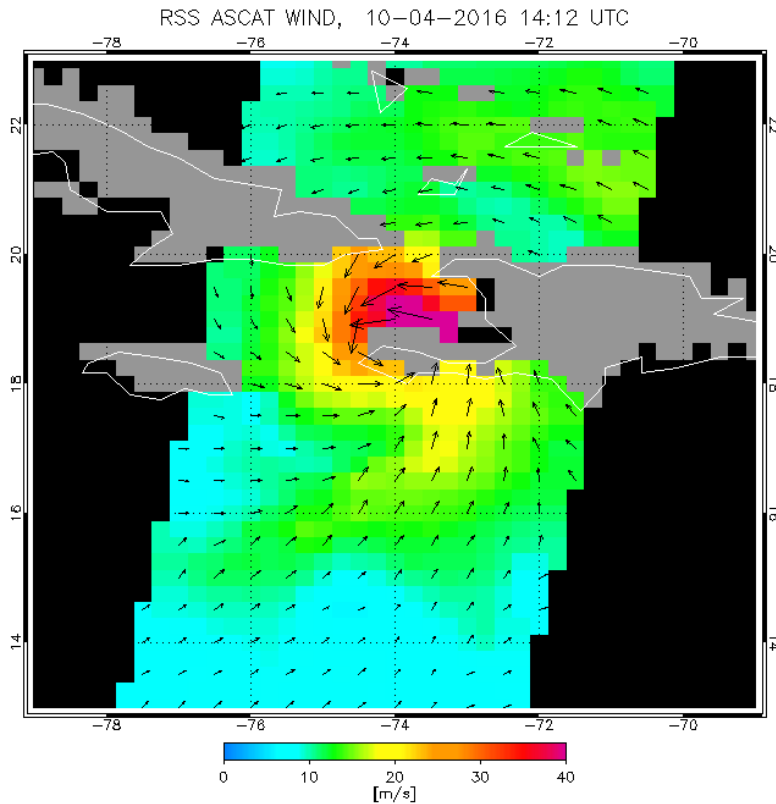




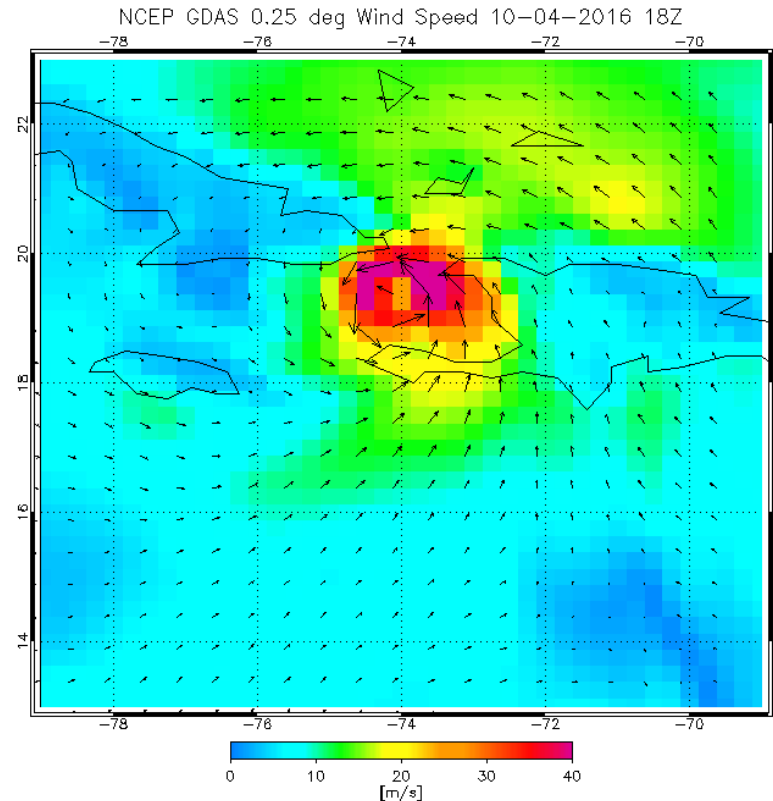
OCTOBER 4: HAITI LANDFALL

- NHC Category 4
- SMAP Category 4, but possible land contamination
- ASCAT Category 2, good wind direction

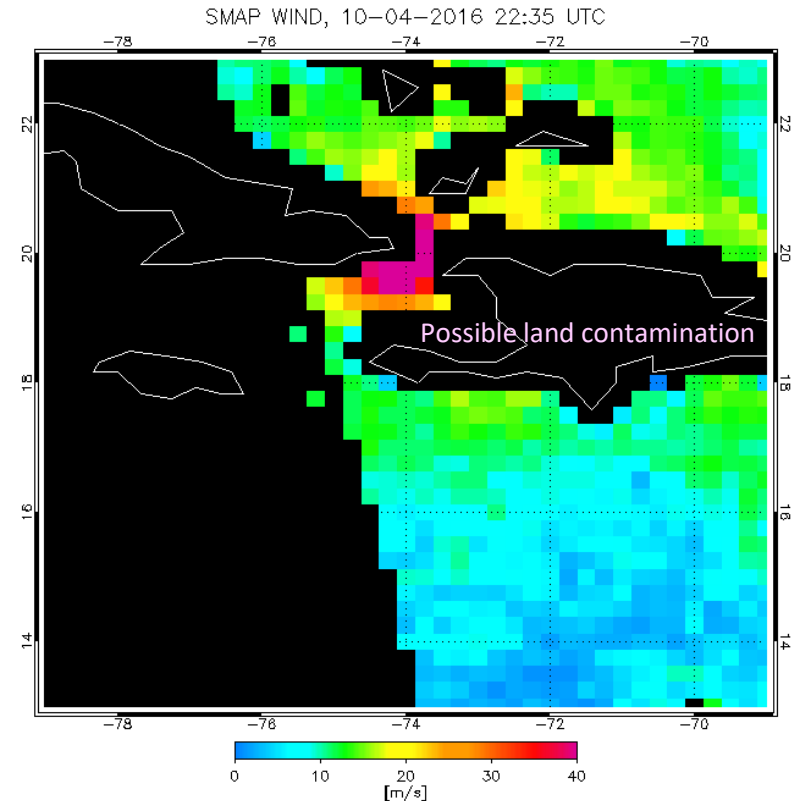
ASCAT 14 UTC



NCEP 18 UTC



SMAP 22 UTC

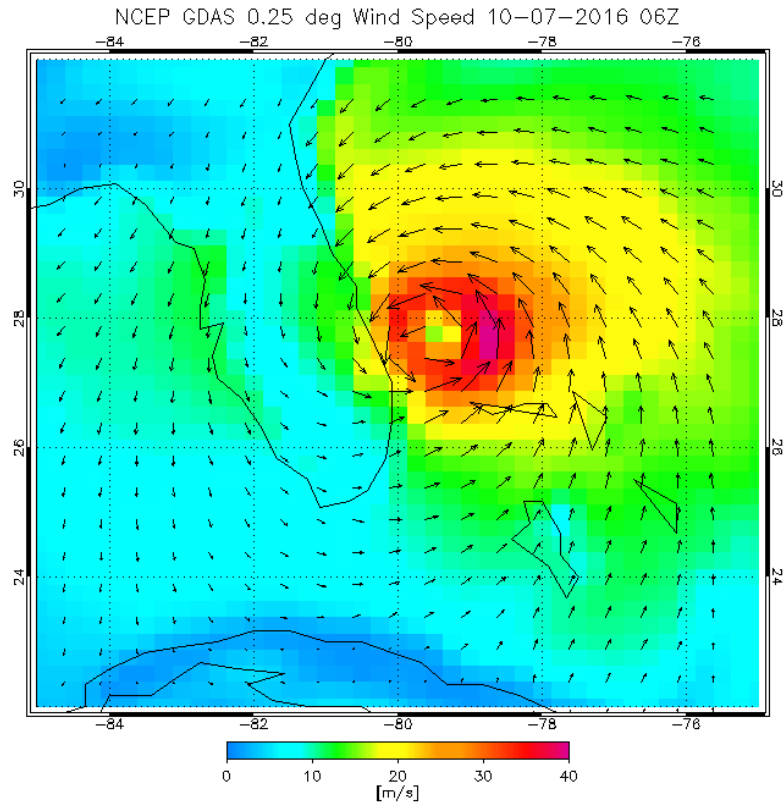




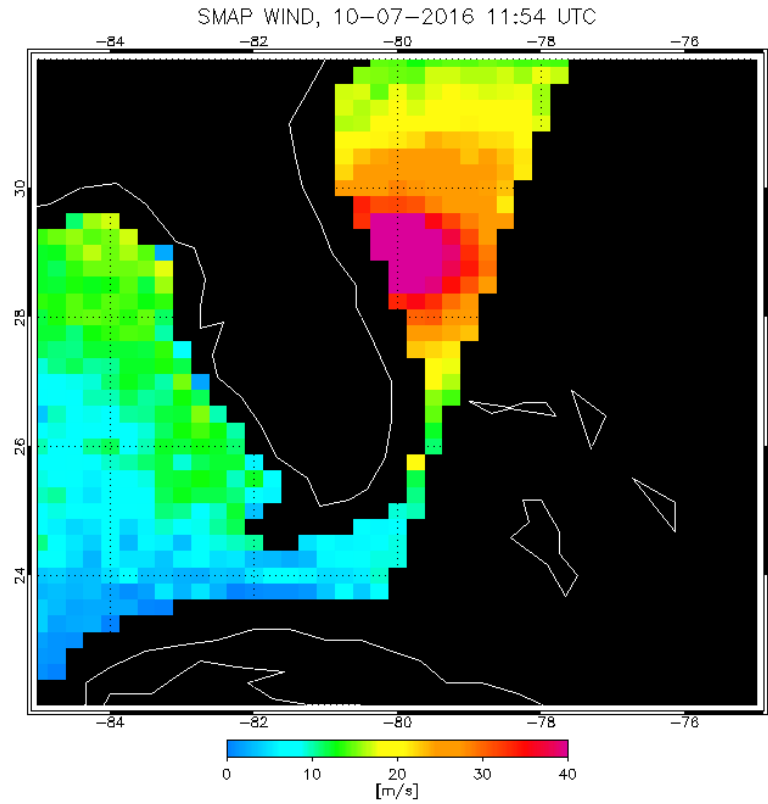
OCTOBER 7: OFF FLORIDA

- NHC Category 3-4
- SMAP Category 3-4
- ASCAT Category 1

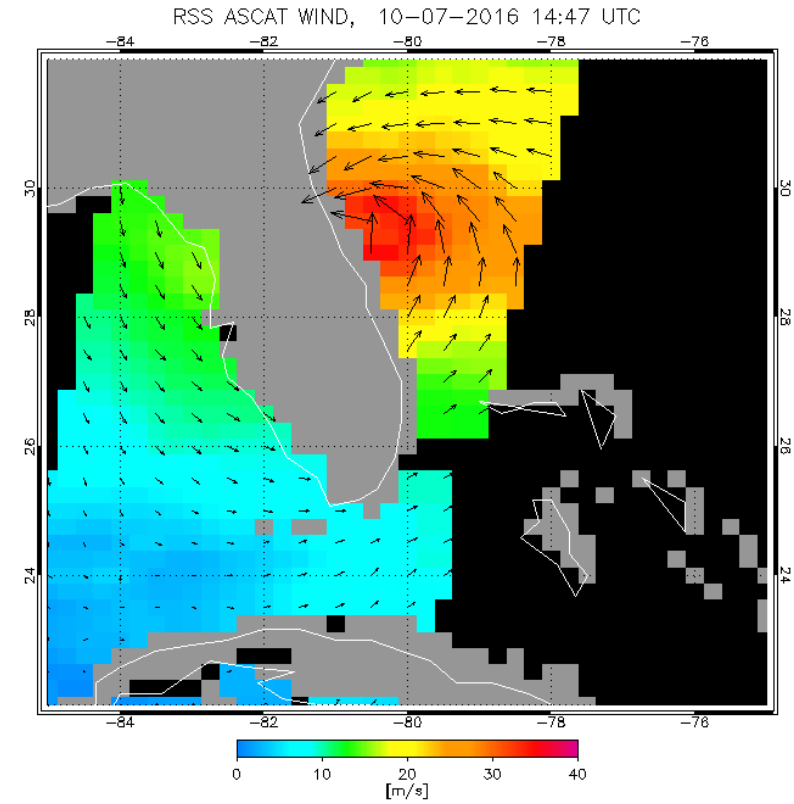
NCEP 6 UTC



SMAP 12 UTC



ASCAT 14 UTC

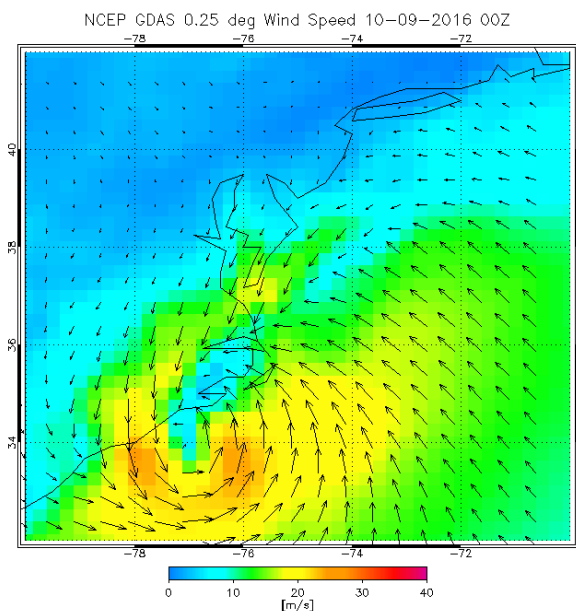




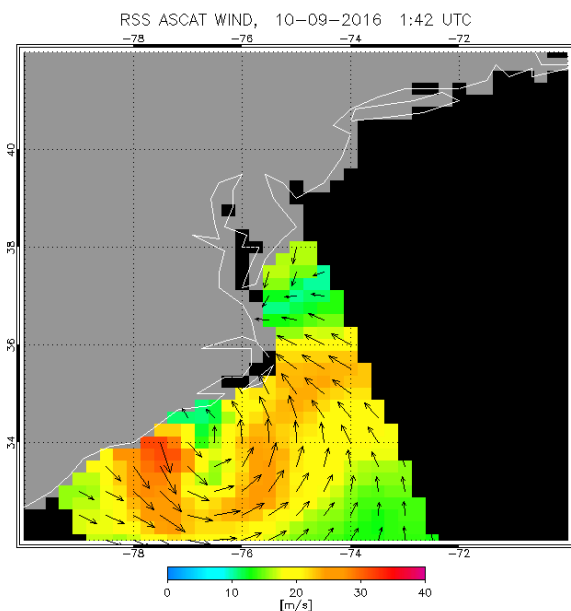
OCTOBER 9: LANDFALL SOUTH CAROLINA, POST-TROPICAL STORM

- NCEP ~ 40 m/s
- SMAP hurricane force winds (max 40 m/s)
- ASCAT ~ 32 m/s, but 10 hours earlier, before re-intensification

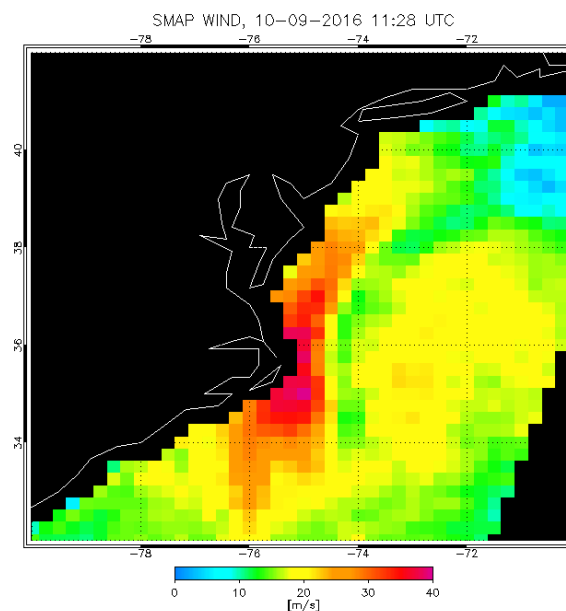
NCEP 00 UTC



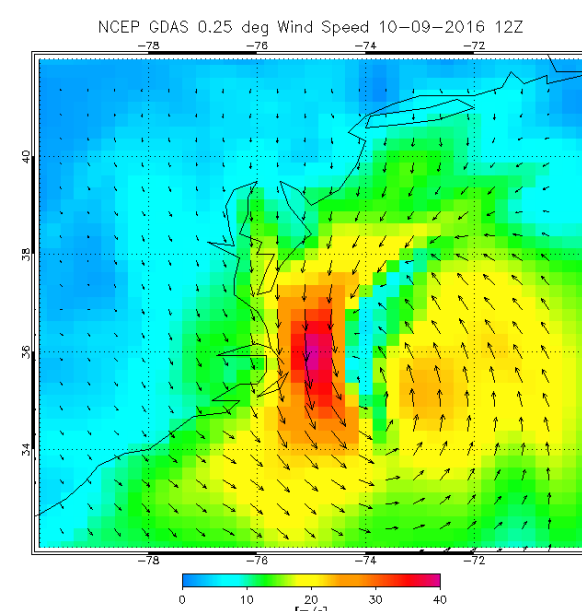
ASCAT 2 UTC



SMAP 12 UTC



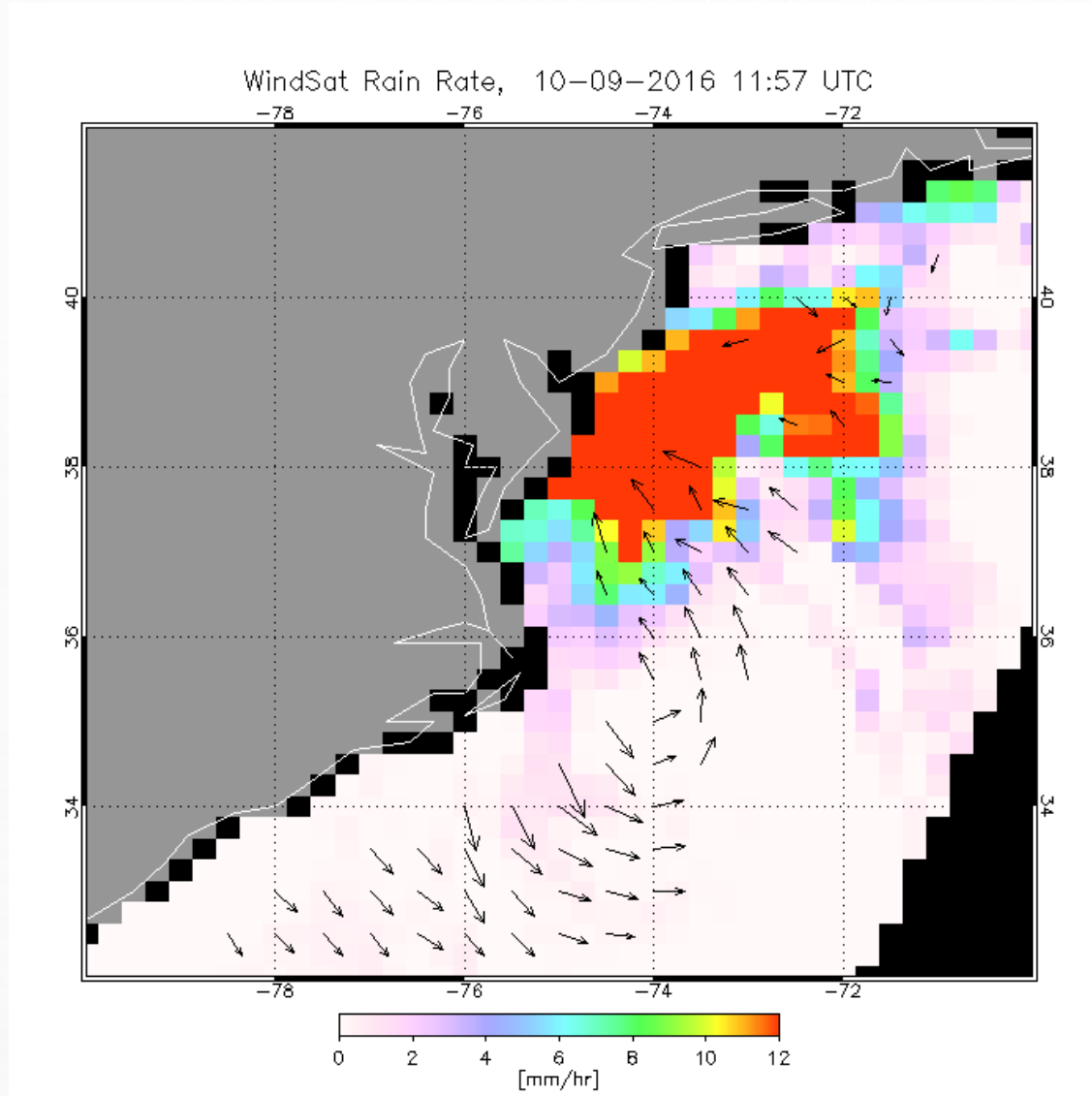
NCEP 12 UTC





OCTOBER 9: PRECIPITATION AT LANDFALL

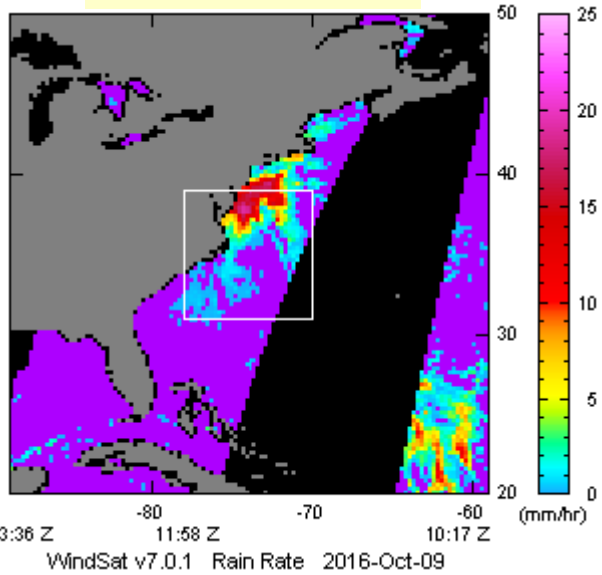
Extreme precipitation in area as wide as 300 Km



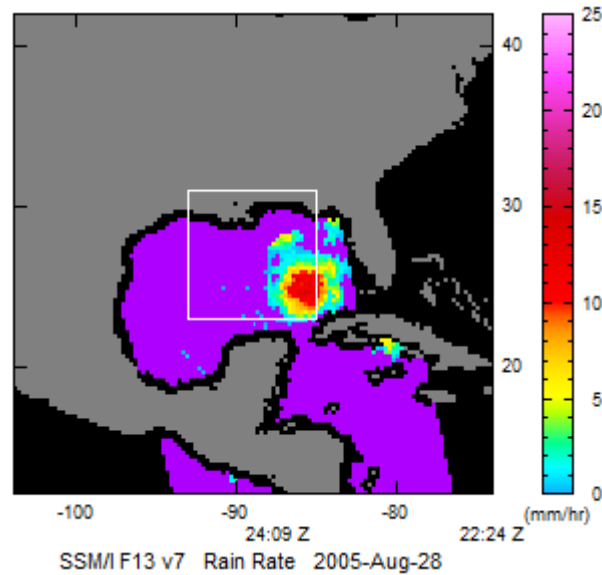


RAIN INTENSITY: COMPARISON TO OTHER HURRICANES

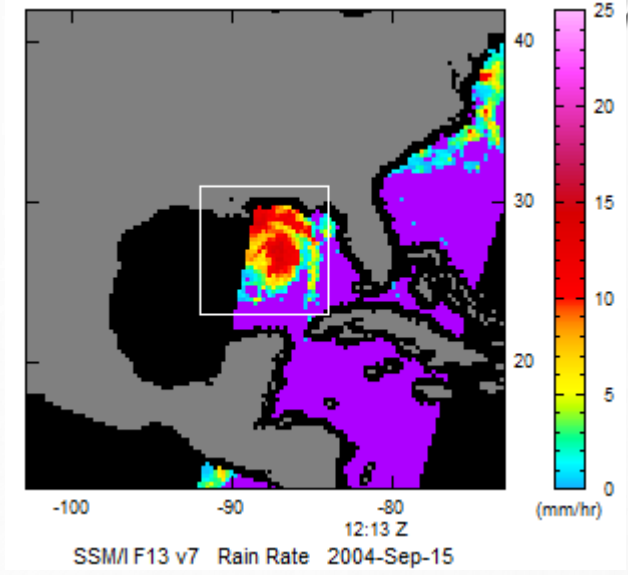
Matthew, 2016



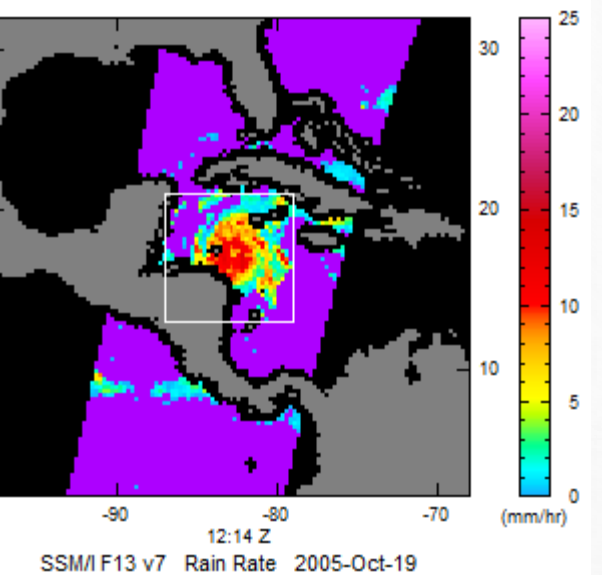
Katrina, 2005



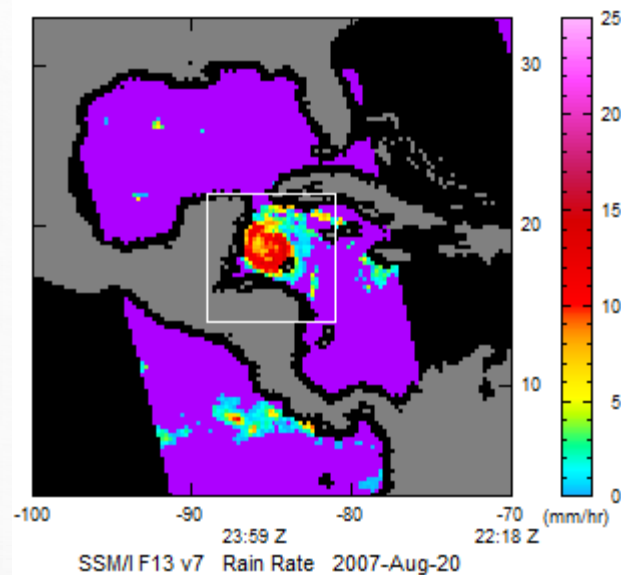
Rita, 2005



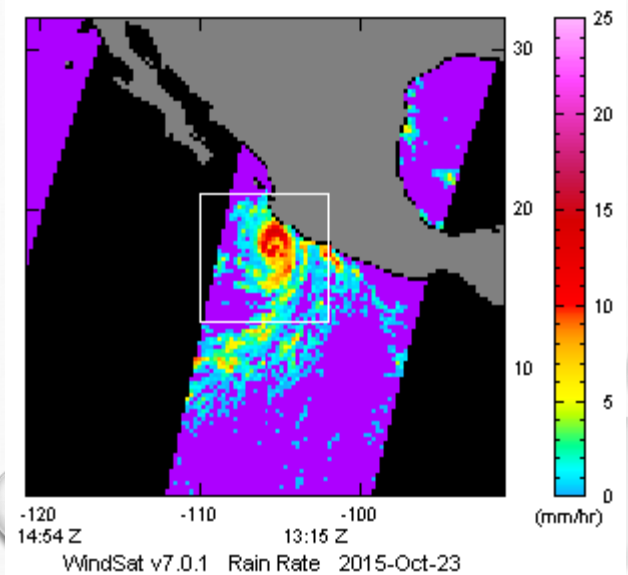
Wilma, 2005



Dean, 2007



Patricia, 2015





SUMMARY

- Review of Satellite MW observations of winds/rain/SST during Matthew
- Validation of satellite hurricane-force winds with SFMR (→ dropsondes)
- Matthew extreme winds and precipitation fueled by anomalously high SST, high moisture, lack of cold wake, late landfall.
- ASCAT correlates to SMAP and NHC best track below 35 m/s, underestimates hurricane-force winds. Never reached Category 3.
- SMAP winds are consistent with SFMR and NHC best track 10-min max winds, through the whole period (Sep 30-Oct 9)
- Potential benefit of SMAP in NWP