IMPACT AND APPLICATIONS OF GCOM-W OCEAN PRODUCTS AT NOAA

NOAA/NESDIS/STAR

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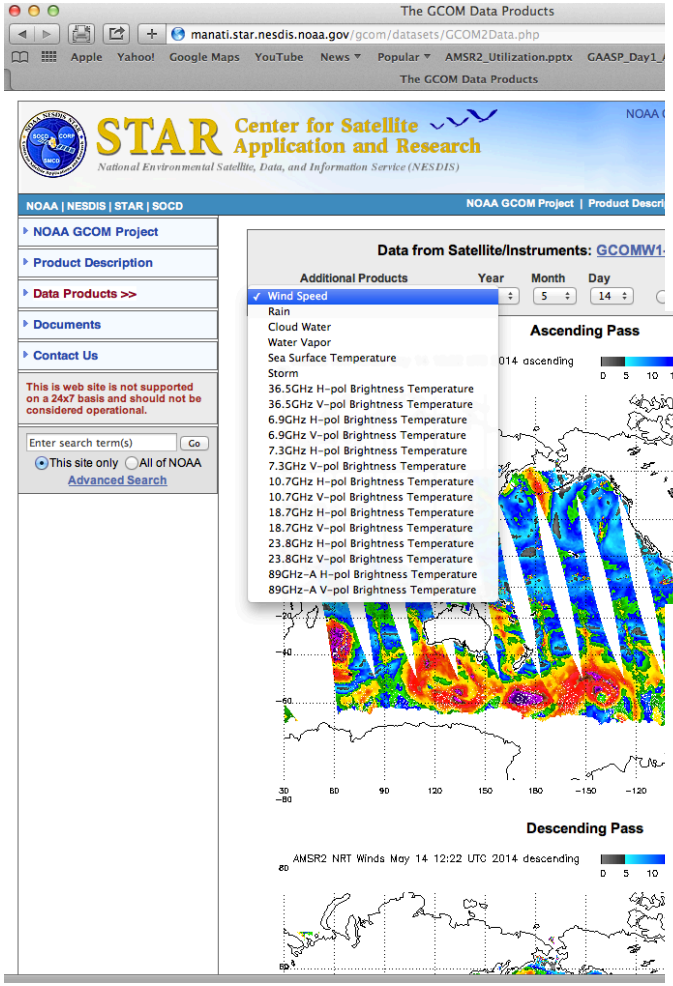
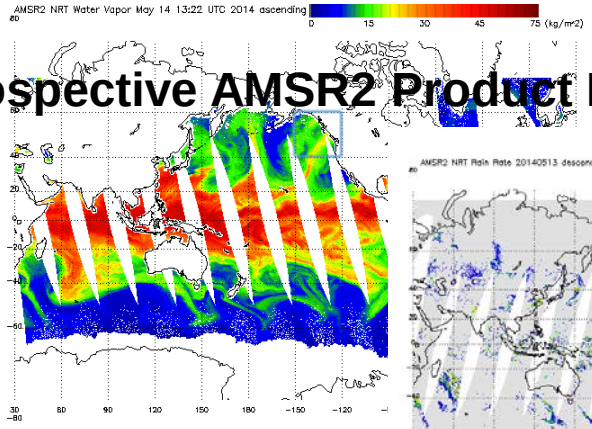
Outline

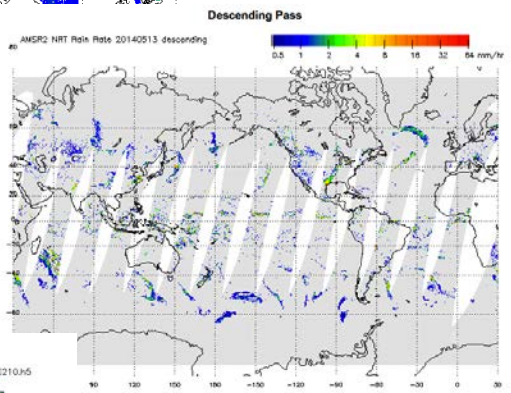
- AMSR-2 Ocean Products Introduction
- AMSR-2 Utilization Examples:
  - Near-real time tropical cyclone forecasting: Tropical cyclone structure, location and intensity analysis
  - Near real time and research impact: SST measurements indicating the onset of rapid intensity decay in a tropical cyclone
  - Extratropical (ET) transition process and ET cyclone structure analysis
- Conclusions

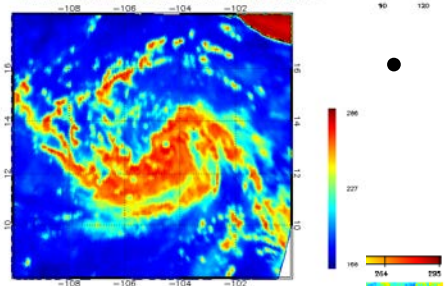
STAR GCOM-W AMSR2 Ocean Products Web Page

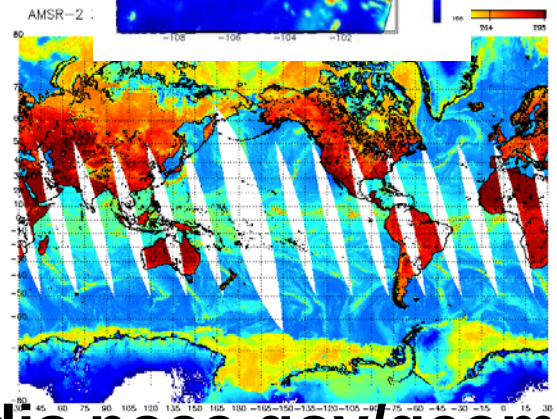
Near Real-Time and Retrospective AMSR2 Product Portal











- Ocean NRT Products
  - **MW brightness temperature**
    - Tropical Cyclone forecasting
    - Data assimilation
  - **SST, Wind Speed ,Cloud liquid water, Water Vapor, Rain Rates**
    - Blended Products
    - NWP Model validation
    - Climate studies
    - Research

http://manati.star.nesdis.noaa.gov/gcom

Current Users of Near Real-time GCOM – W Data

- US NOAA National Weather Service
  - Tropical Cyclone Monitoring and Forecasting
  - Numerical Weather Prediction Model Assimilation
  - Marine Forecasting and Monitoring
  - Hydrological and Precipitation Forecasting and Monitoring
  - Seasonal and Climate Forecasting
- US National Ice Center
- US Department of Defense
  - AFWA
  - FNMOC
  - NAVO
  - Naval Research Laboratory
    - Joint Typhoon Warning Center
    - Oceanographer of Navy
- Leading Numerical Weather Prediction Centers outside US including: Japan, ECMWF

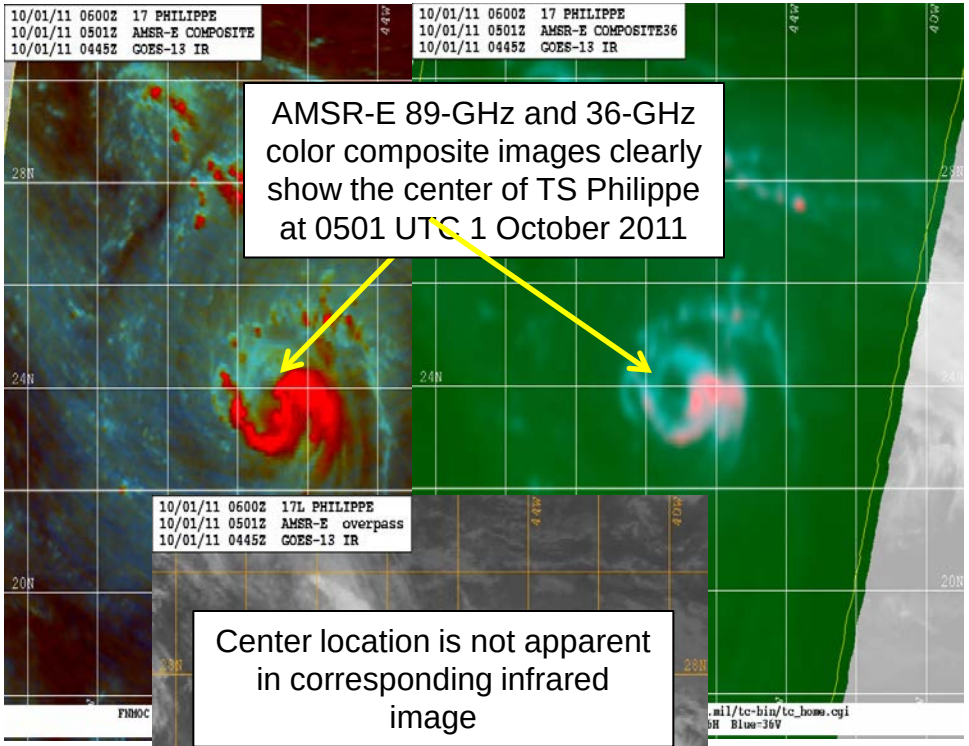
US NWS GCOM Data Product Priorities (initial) for AWIPS2

AMSR-2 Imagery (36H, 36V, 89H, 89V, GHz)
AMSR-2 Cloud Liquid Water
AMSR-2 Precipitation (Type/Rate)
AMSR-2 Precipitable Water
AMSR-2 Sea Surface Wind Speed
AMSR-2 Snow Cover/Depth
AMSR-2 Snow Water Equivalent
AMSR-2 Soil Moisture
AMSR-2 Sea Ice Characterization
AMSR-2 Sea Surface Temperature (SST)
AMSR-2 Surface Type

AMSR-2 MICROWAVE IMAGERY FOR TROPICAL CYCLONE FORECASTING

Uses of Microwave Imagery
Overview

- Determining if a formative system has a well-defined center, a requirement to initiate advisories
- Locating the center of TCs when the center is not apparent in conventional visible or infrared imagery, especially for weaker systems at night
- Assessing trends in TC structure and intensity, such as eyewall formation and eyewall replacement cycles



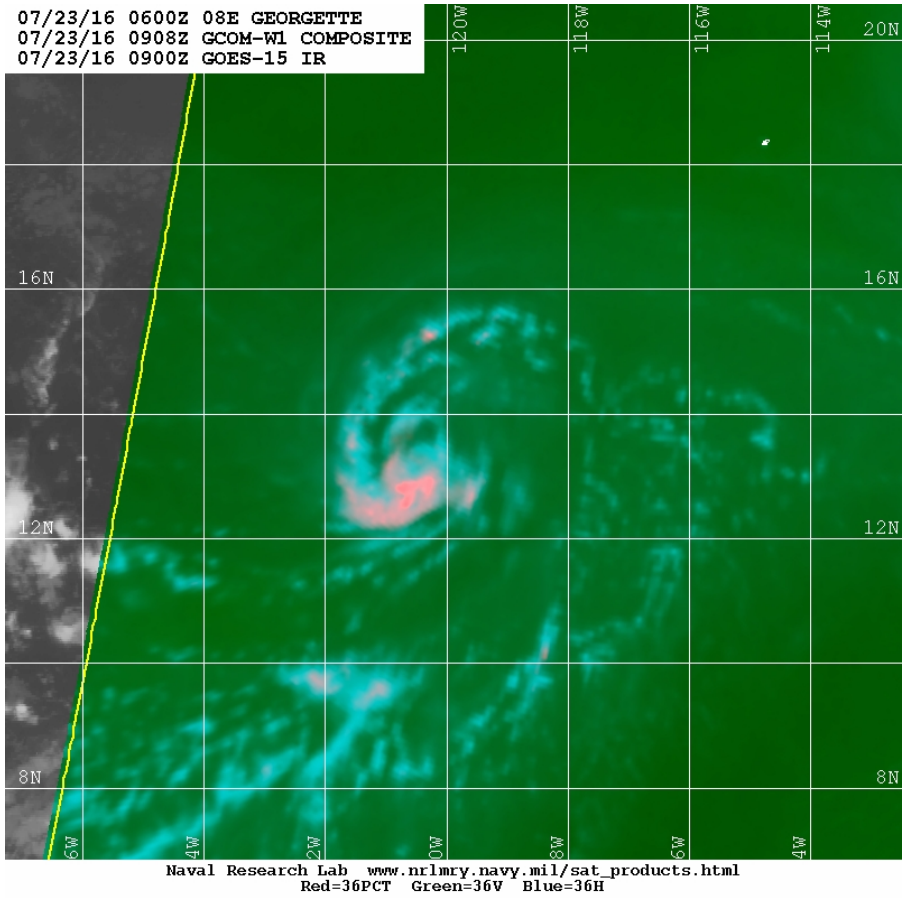
Tropical Storm Georgette 23rd July 2016

ZCZC MIATCDEP3 ALL TTAA00

KNHC DDHHMM TROPICAL STORM GEORGETTE

DISCUSSION NUMBER 8 NWS NATIONAL HURRICANE CENTER MIAMI FL EP082016 800 AM PDT SAT JUL 23 2016

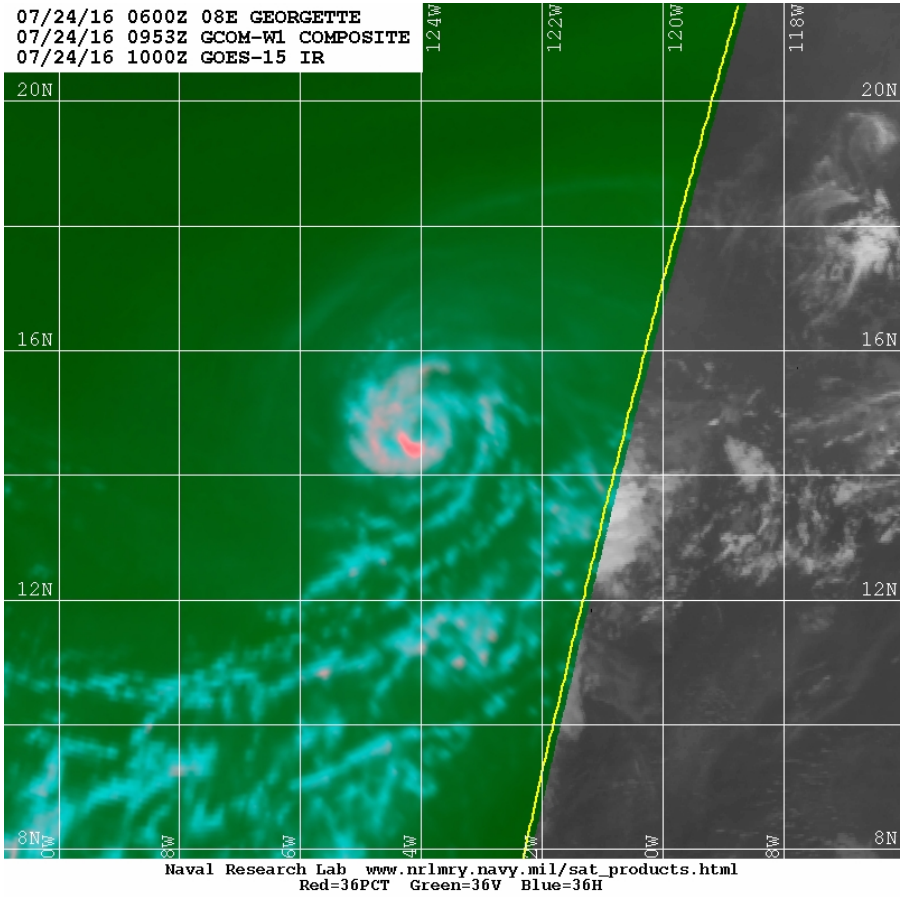
With the help of the above-mentioned AMSR pass, the initial motion is estimated to be 290/11. There is no change to the track forecast reasoning, as Georgette will be steered by a strong mid-level ridge to the north that will weaken and shift westward during the next several days.



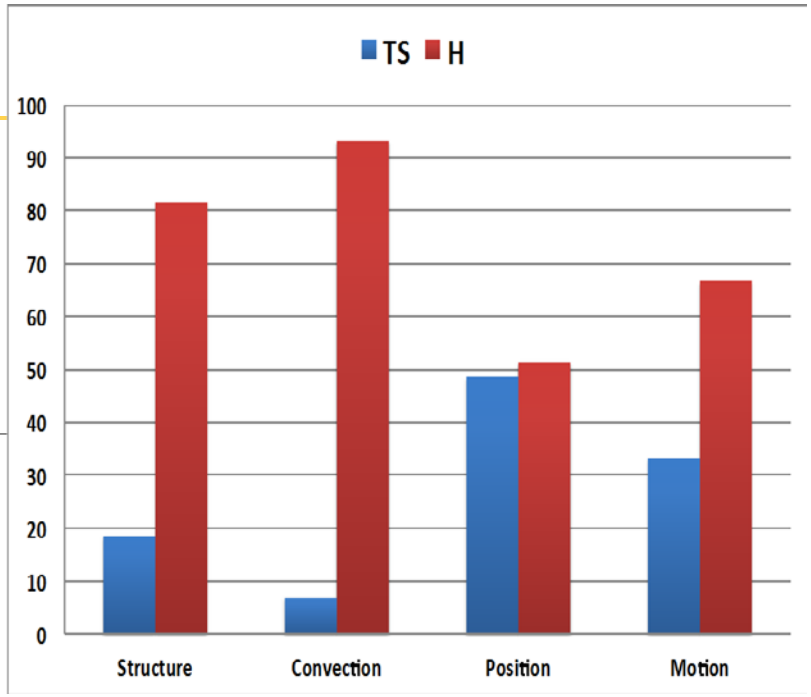
Hurricane Georgette 24th July 2016

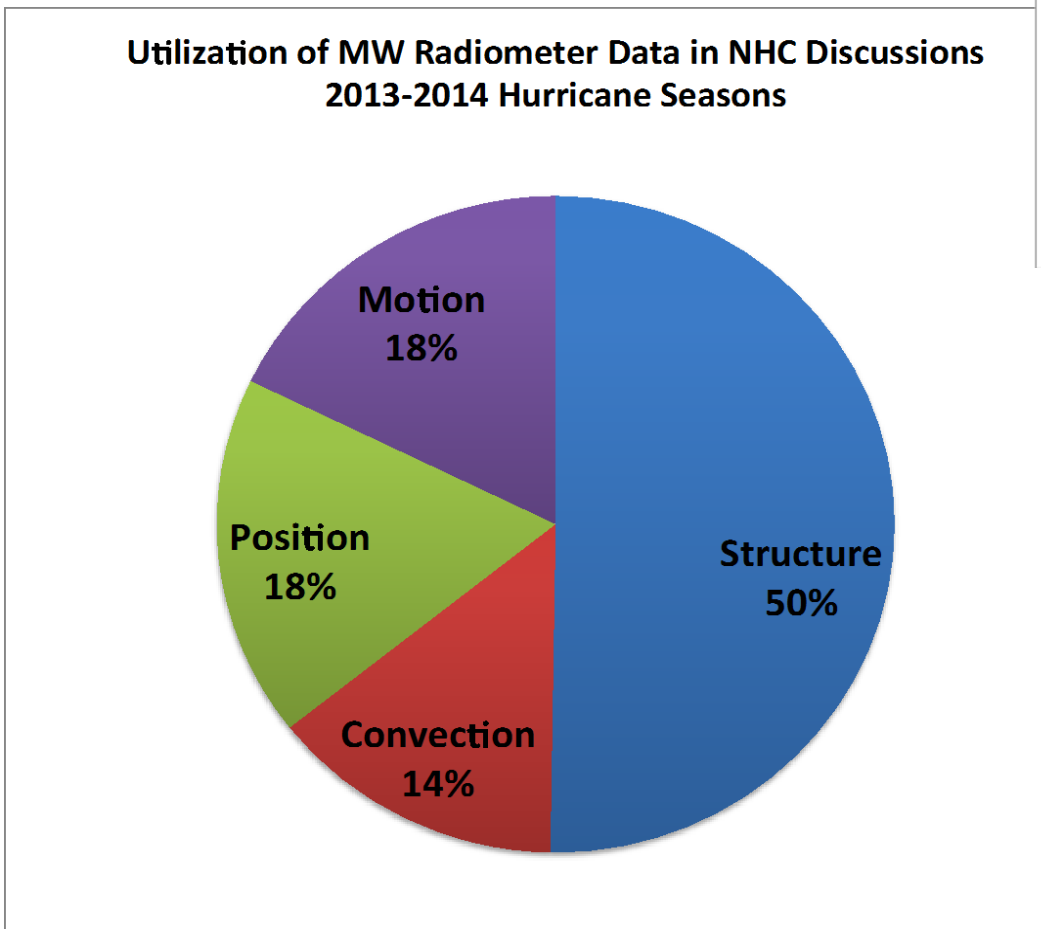
ZCZC MIATCDEP3 ALL TTAA00 KNHC DDHHMM HURRICANE GEORGETTE DISCUSSION NUMBER 12 NWS NATIONAL HURRICANE CENTER MIAMI FL EP082016 800 AM PDT SUN JUL 24 2016

The coverage of cold convective tops has increased over the past few hours **and a 0921Z GPM pass and 0935Z AMSR pass showed that the center of Georgette was near the middle of the CDO feature**. Based on the improved convective organization, the initial intensity has been set to 75 kt, which is close to the latest Dvorak estimates from SAB and UW-CIMSS. The hurricane has an opportunity to strengthen a bit more in the short term before SSTs cool below 26C by 24 hours.



AMSR2 Utility at NHC

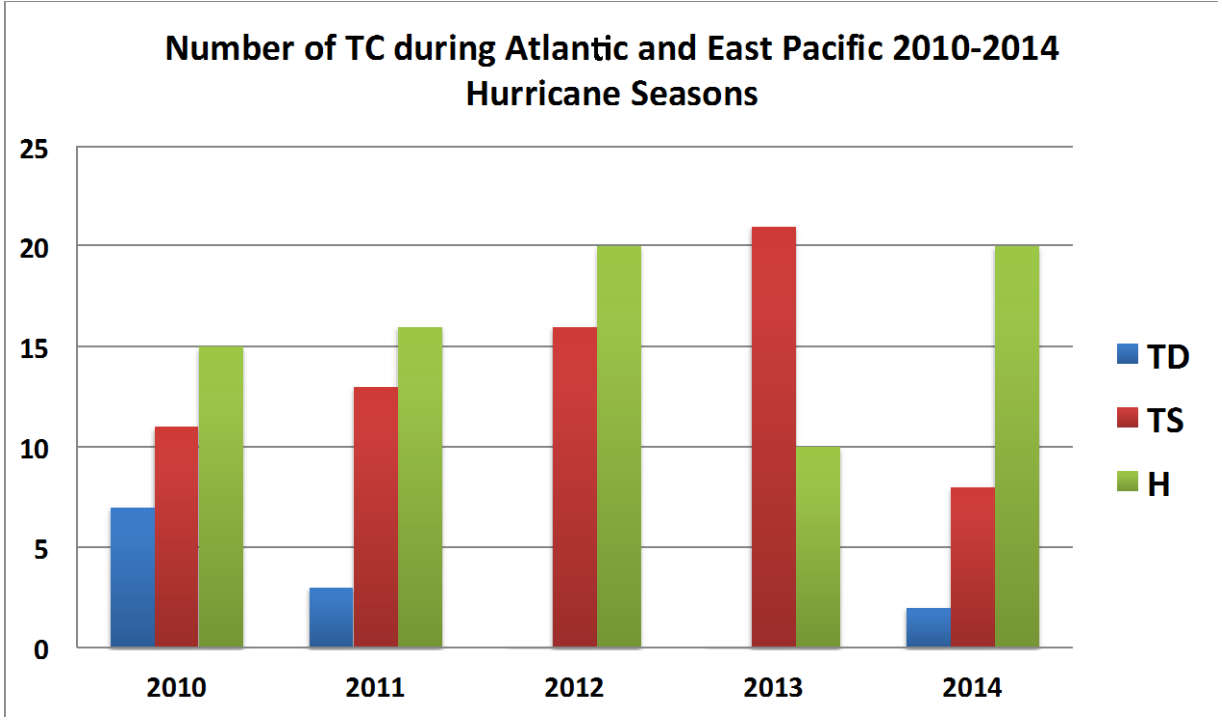


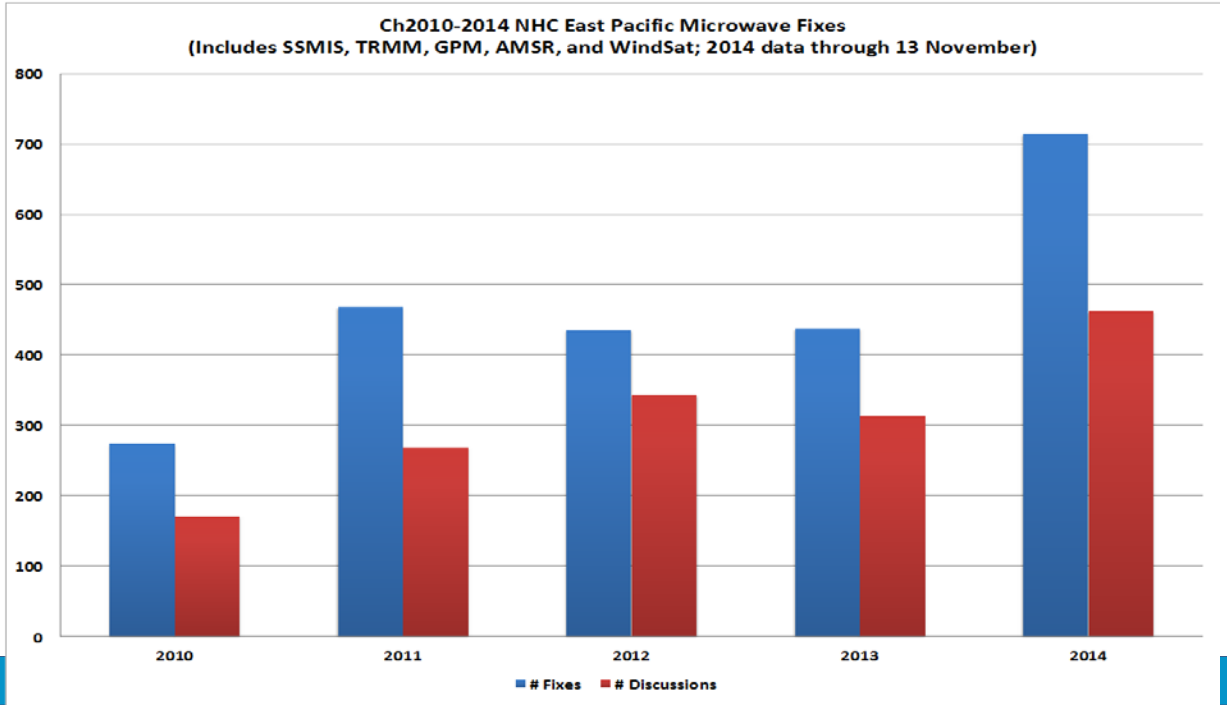


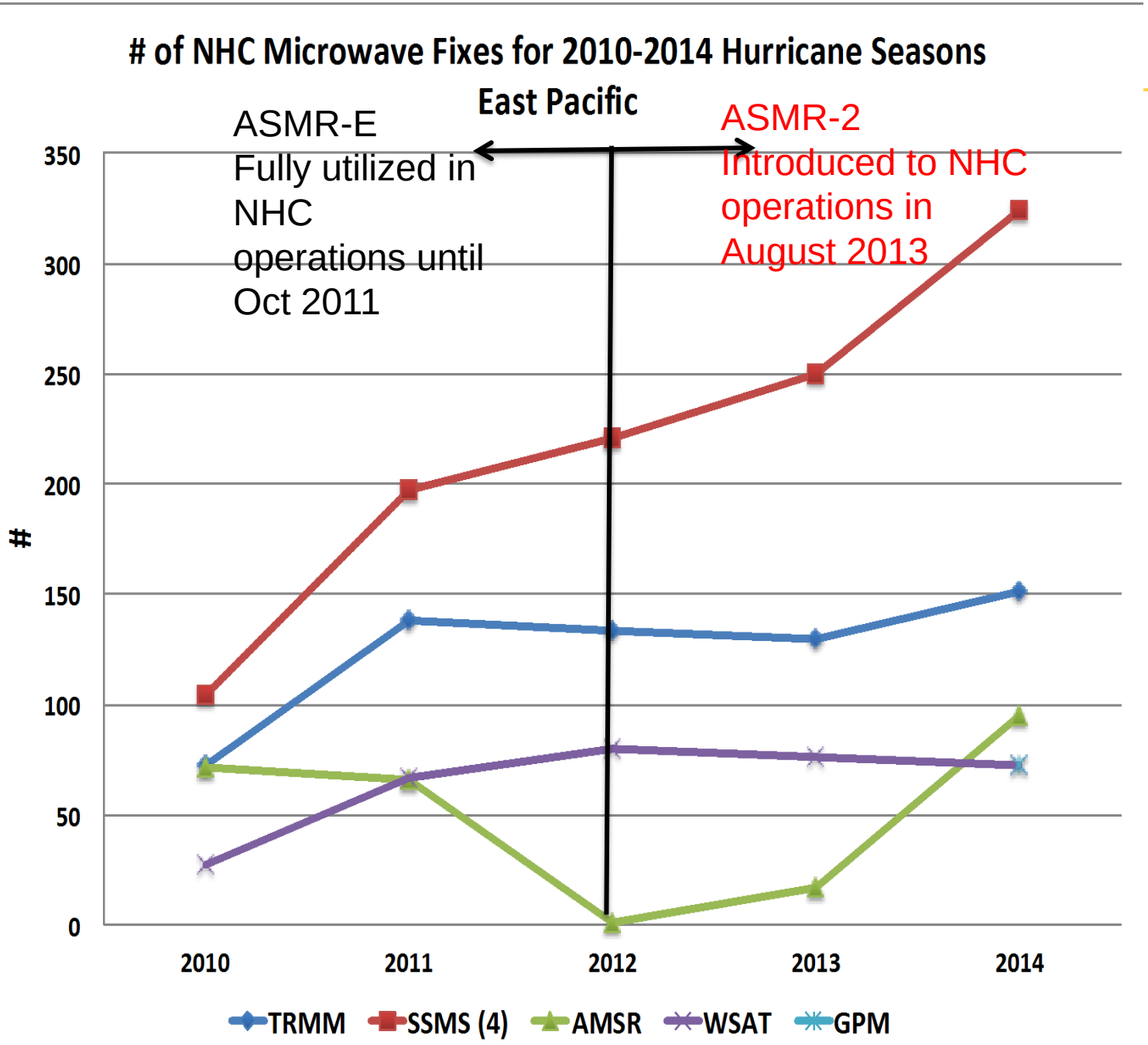
- MW data is most useful for monitoring changes in storm convection and structure and within 2013-2014 season data has been used almost 50% of time in this purpose

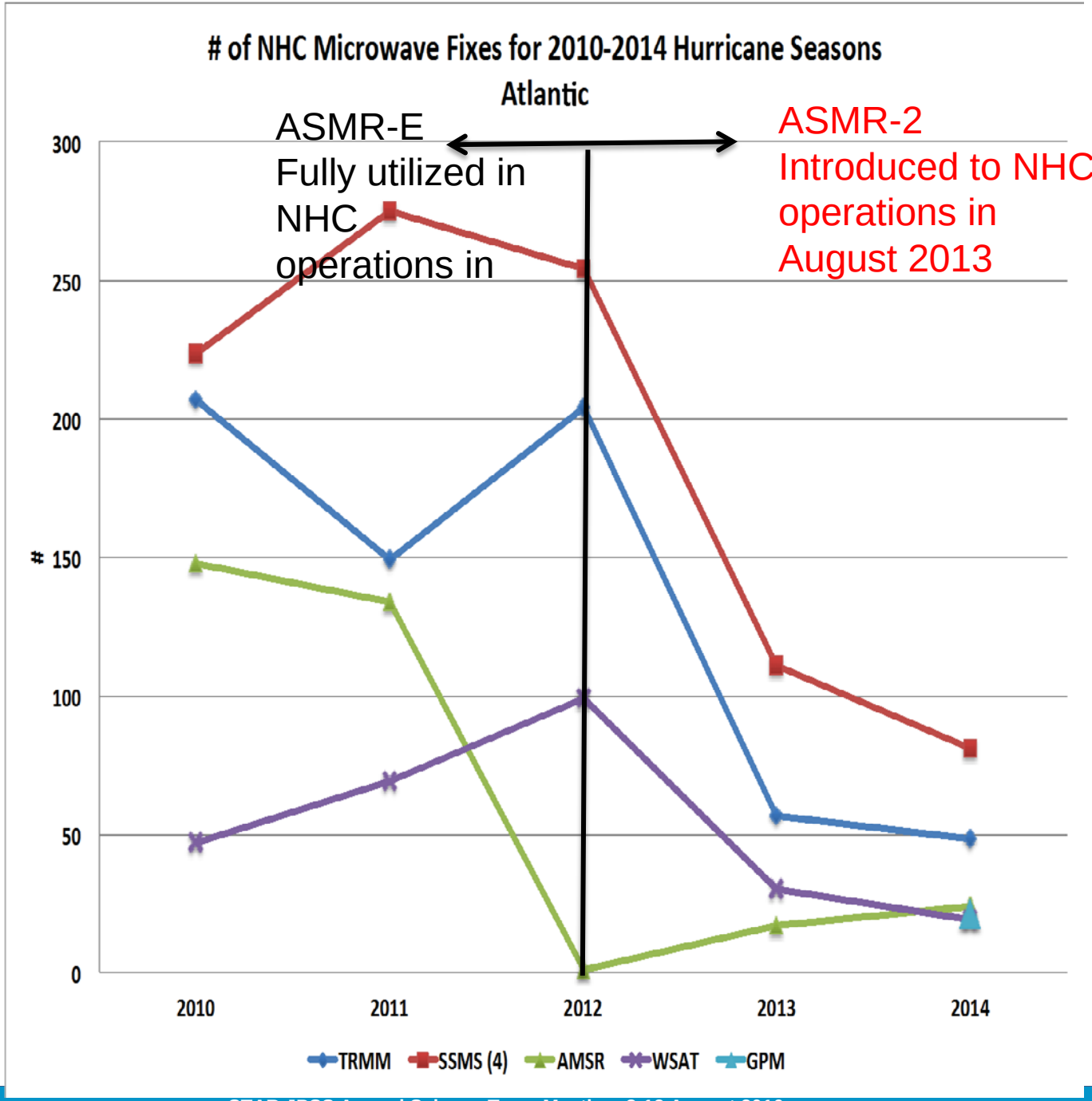
Quantifying Impact of Microwave Data on TC Forecasting

- To asses impact of MW radiometer on NHC operations we examined usage of MW data during 2010-2014 Atlantic and East Pacific hurricanes seasons in Automatic Tropical Cyclone Forecast system
- We have also examined NHC discussions issued 4 times a day during TC event
- MW radiometers used are TRMM, DMSP SSMIS (F16,17 and 18) and SSMI (F15), and AMSR-E and AMSR2


Number of TC during Atlantic and East Pacific 2010-2014 Hurricane Seasons
25
20
15
10
5
0
2010
2011
2012
2013
2014
TD
TS
H


Ch2010-2014 NHC East Pacific Microwave Fixes
(Includes SSMIS, TRMM, GPM, AMSR, and WindSat; 2014 data through 13 November)
800
700
600
500
400
300
200
100
0
2010
2011
2012
2013
2014
Fixes
Discussions

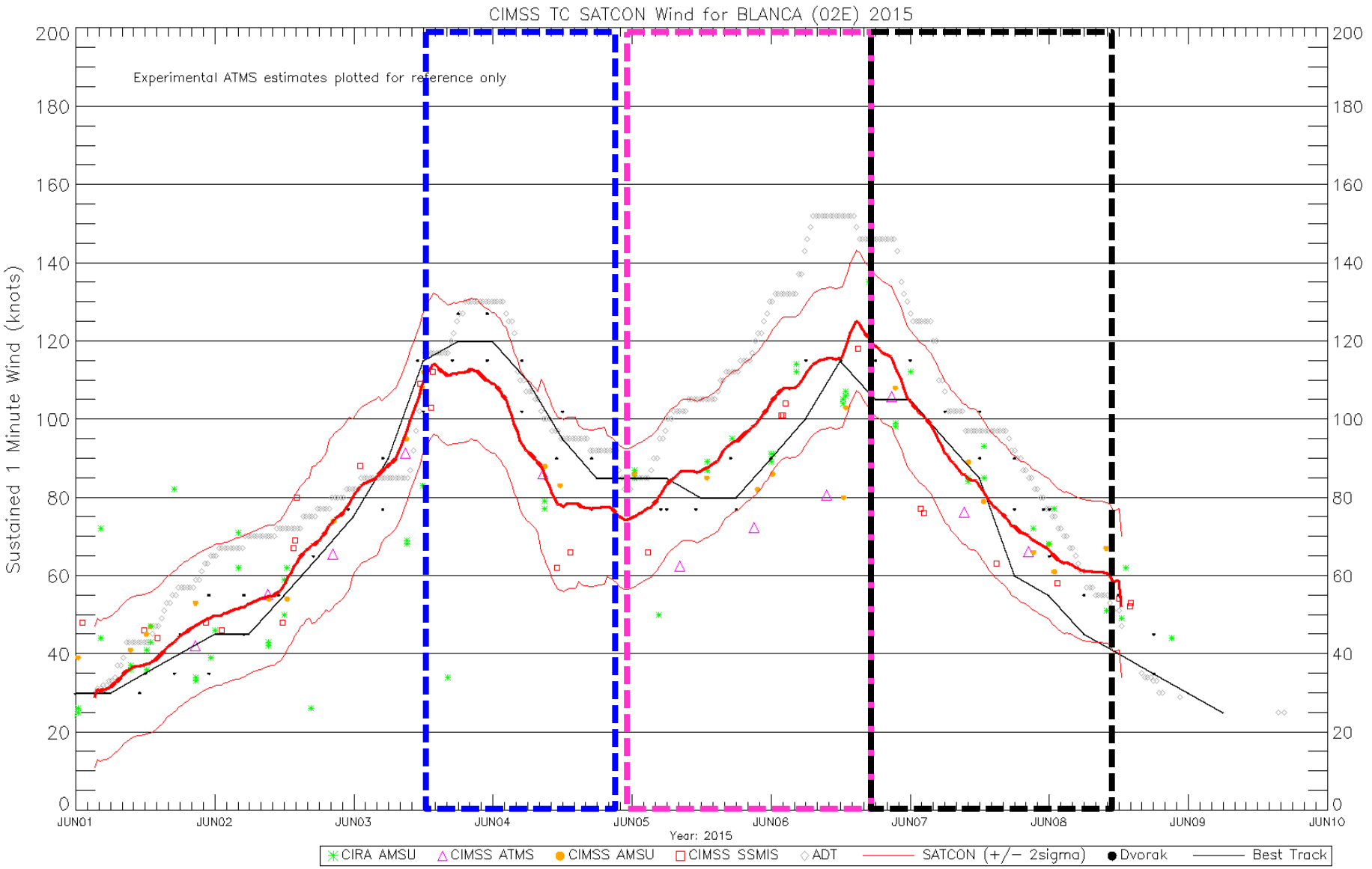

# of NHC Microwave Fixes for 2010-2014 Hurricane Seasons
East Pacific
ASMR-E
Fully utilized in NHC operations until Oct 2011
ASMR-2
Introduced to NHC operations in August 2013
350
300
250
200
150
100
50
0
#
2010
2011
2012
2013
2014
TRMM
SSMS (4)
AMSR
WSAT
GPM


# of NHC Microwave Fixes for 2010-2014 Hurricane Seasons
Atlantic
ASMR-E Fully utilized in NHC operations in
ASMR-2 Introduced to NHC operations in August 2013
300
250
200
150
100
50
0
#
2010
2011
2012
2013
2014
TRMM
SSMS (4)
AMSR
WSAT
GPM

EXAMPLE OF AMSR-2 IMPACT ON NEAR REAL TIME FORECAST AND RESEARCH: EAST PACIFIC HURRICANE BLANCA JUN 2015

Plots courtesy of Michael Brennan, NHC

Peter Black, NRL


CIMSS TC SATCON Wind for BLANCA (02E) 2015
Experimental ATMS estimates plotted for reference only
Sustained 1 Minute Wind (knots)
0
20
40
60
80
100
120
140
160
180
200
JUN01
JUN02
JUN03
JUN04
JUN05
JUN06
JUN07
JUN08
JUN09
JUN10
Year: 2015
CIRA AMSU
CIMSS ATMS
CIMSS AMSU
CIMSS SSMIS
ADT
SATCON (+/- 2sigma)
Dvorak
Best Track

Tropical Storm Blanca
2 June 2015

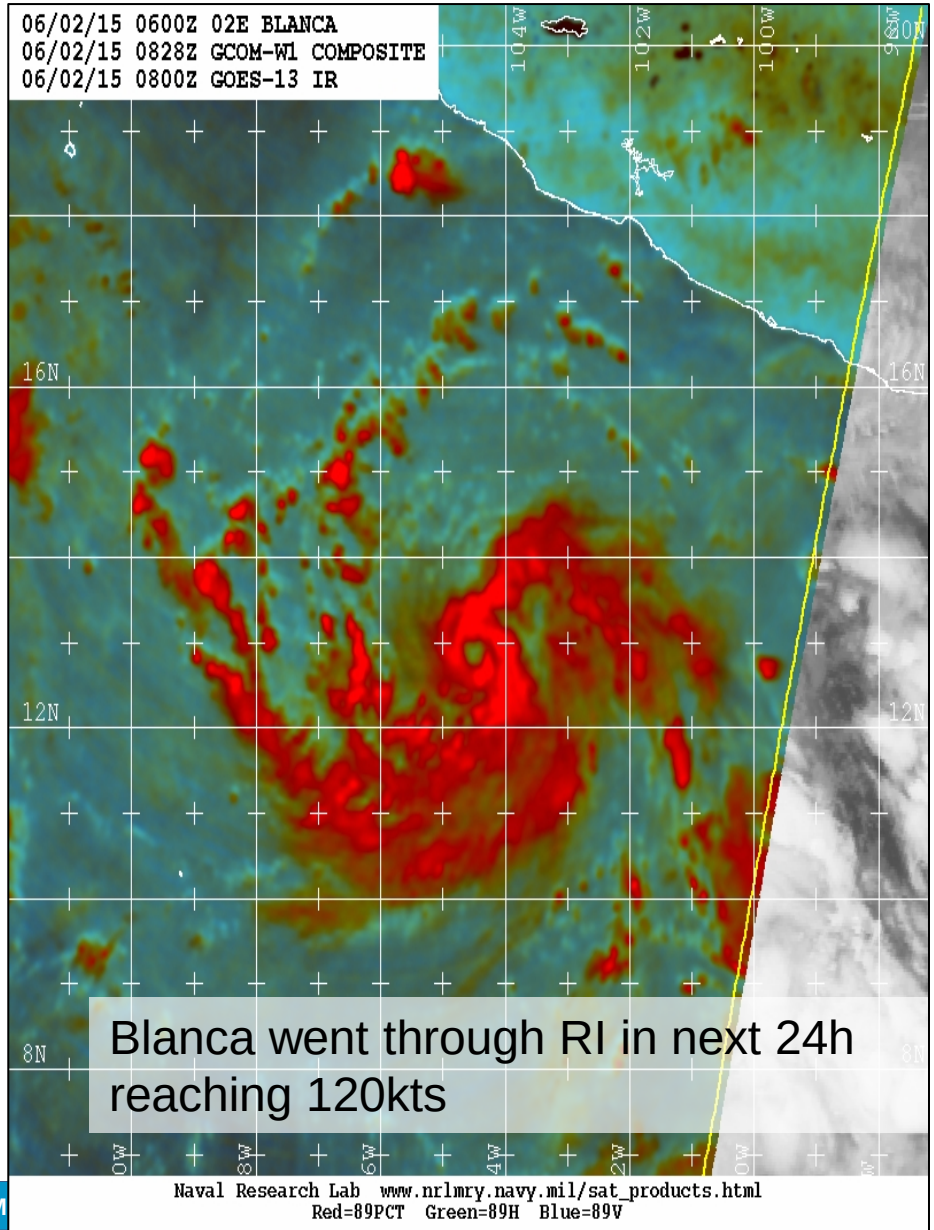
TROPICAL STORM BLANCA DISCUSSION NUMBER 8

NWS NATIONAL HURRICANE CENTER MIAMI FL EP022015

1000 AM CDT TUE JUN 02 2015

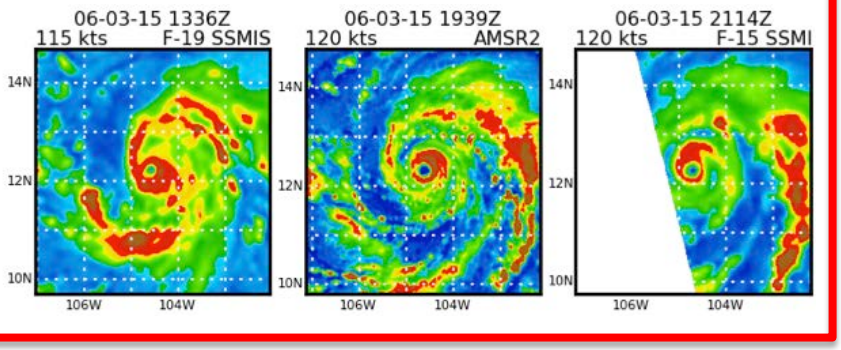
Blanca is intensifying. Geostationary imagery shows a CDO and prominent banding features, and a **0828Z AMSR-2 image from GCOM-W1 showed a low- and mid-level eye feature.** The latest Dvorak estimates from TAFB and SAB are T3.5/55 kt, and the latest ADT is T4.5/77 kt. The initial intensity is set to 60 kt for this advisory. **Given that Blanca has developed the inner-core features seen in microwave imagery and the shear is now below 10 kt, the cyclone appears to be poised for a period of rapid intensification.**

The NHC forecast is near the highest guidance, showing Blanca becoming a major hurricane tomorrow, and conditions appear favorable for continued strengthening through 72 hours, when the SHIPS, LGEM and FSU Superensemble all show a peak near 120 kt. However, even this forecast could be conservative given that the SHIPS RI index shows a 95 percent chance of a 40-kt increase in the first 24 hours.

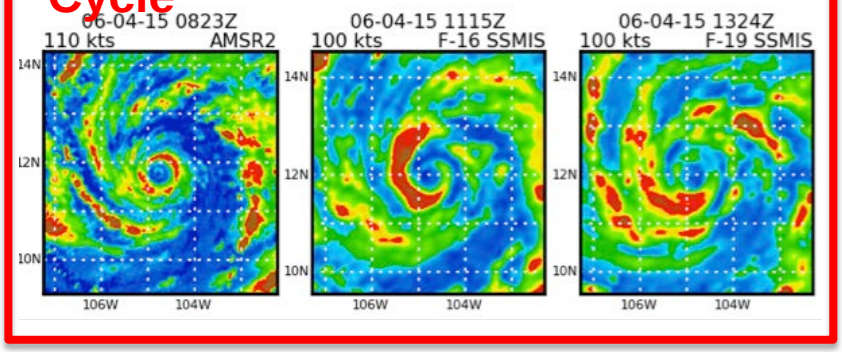


Blanca's Development through MW Imager Eyes

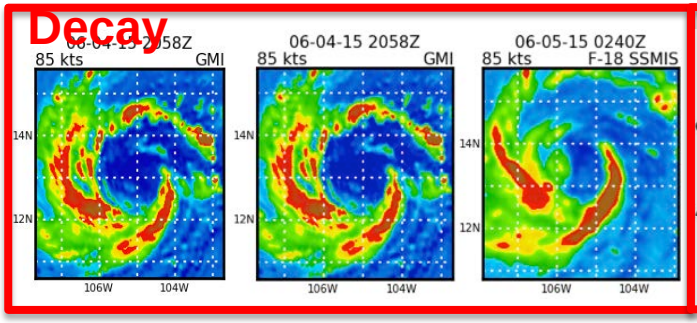
Pinhole Eye Development



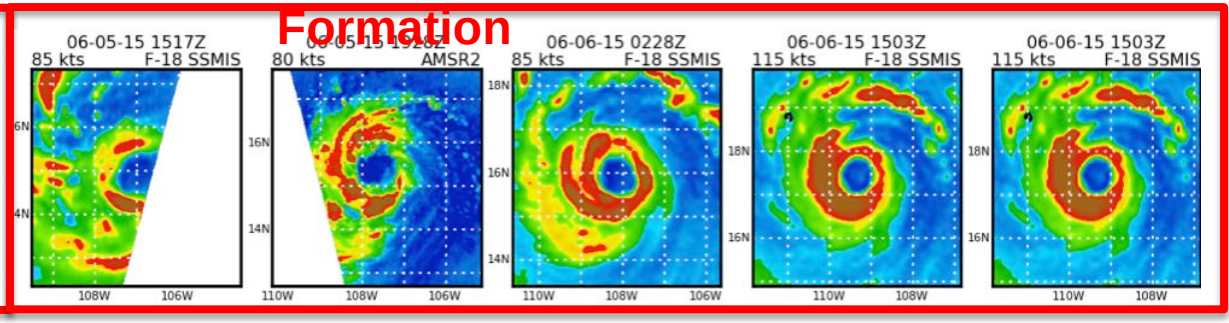
Eyewall Replacement Cycle



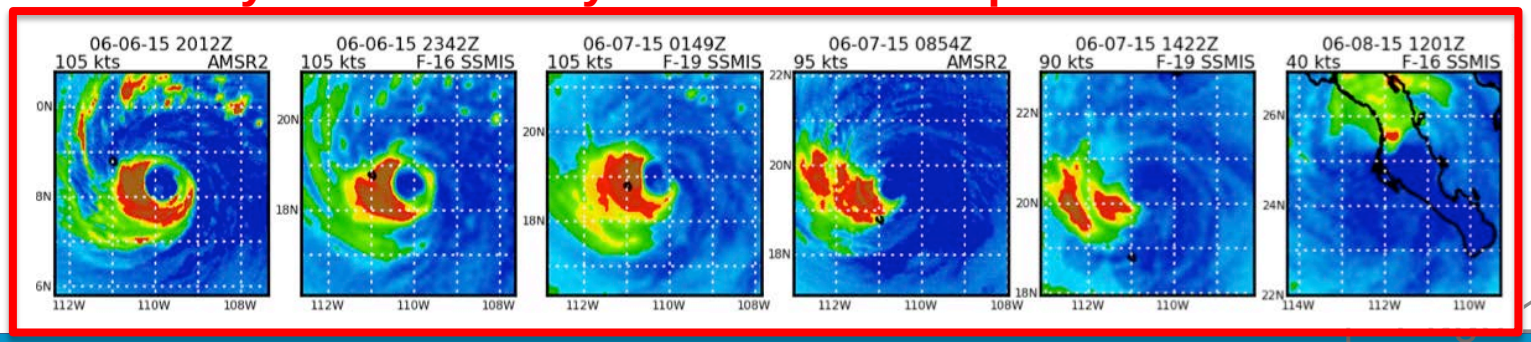
Eyewall Collapse during Rapid Decay

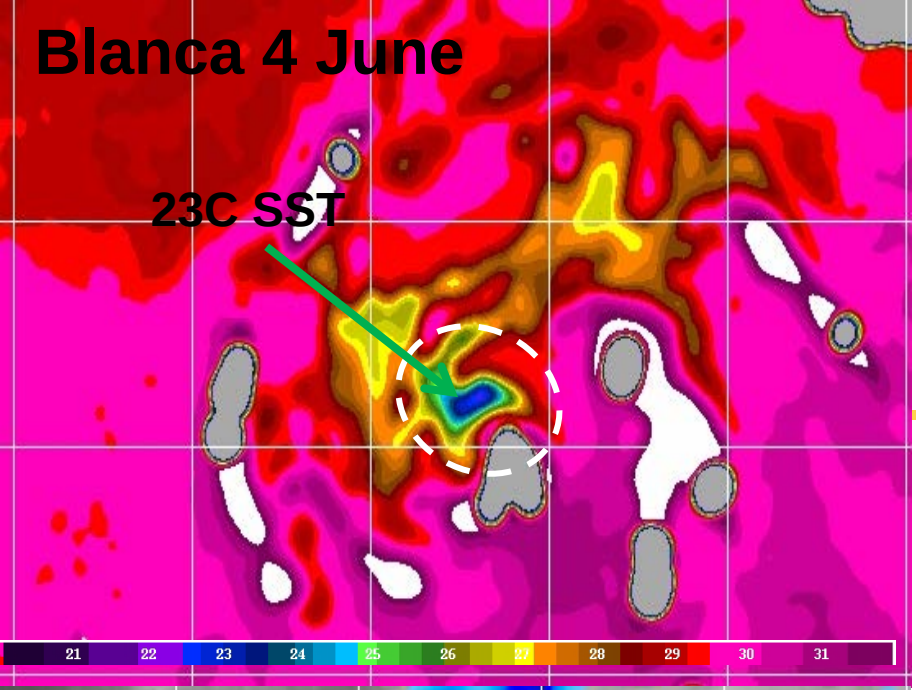


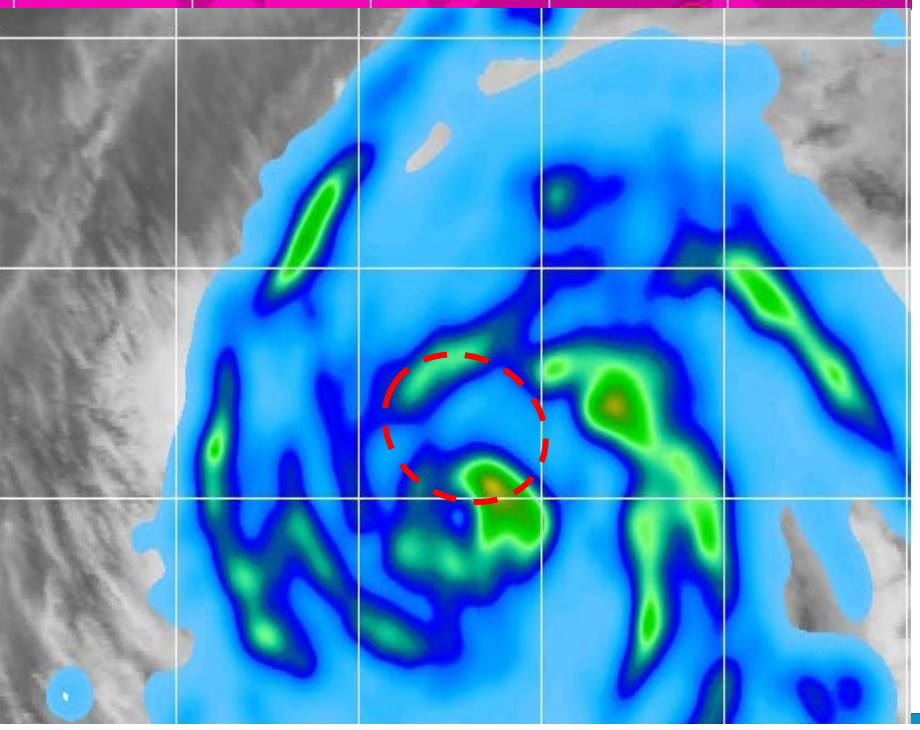
Second RI with Single Eye Formation

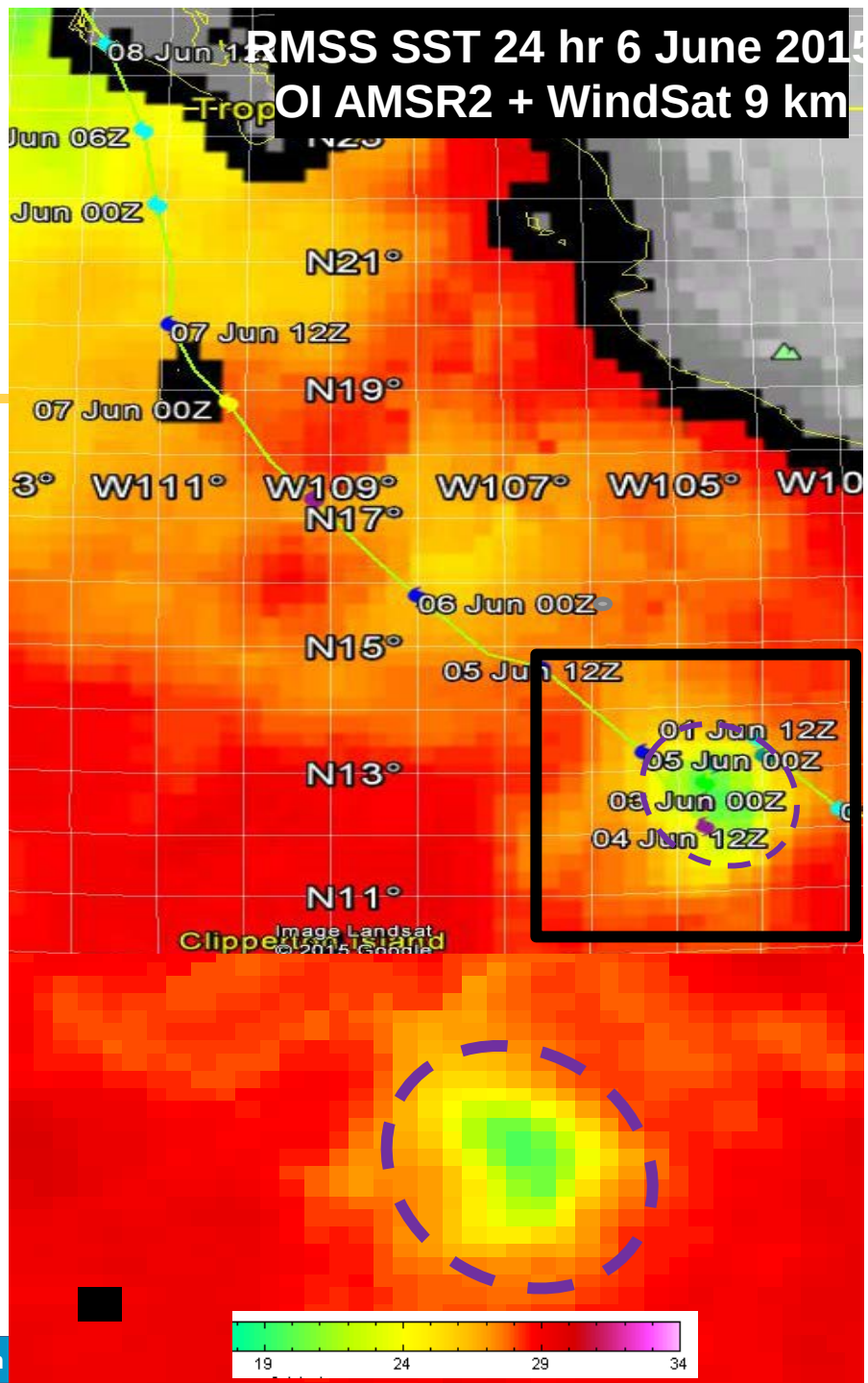


Asymmetric Decay over cold water prior to Landfall




Blanca 4 June
23C SST
21
22
23
24
25
26
27
28
29
30
31

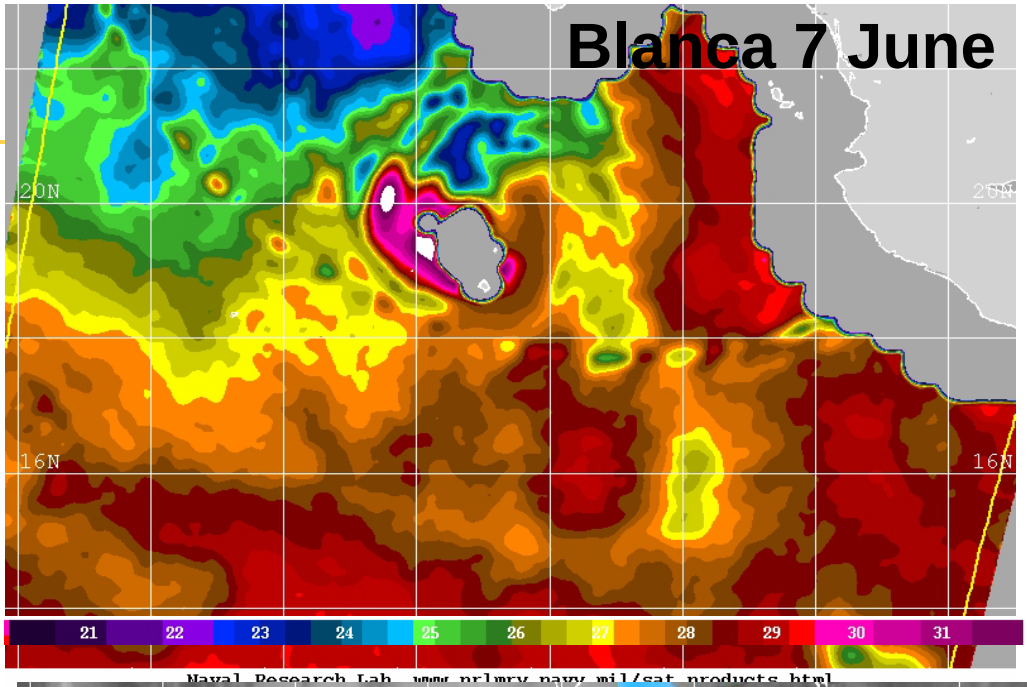

5
10
15
20
25
30
35

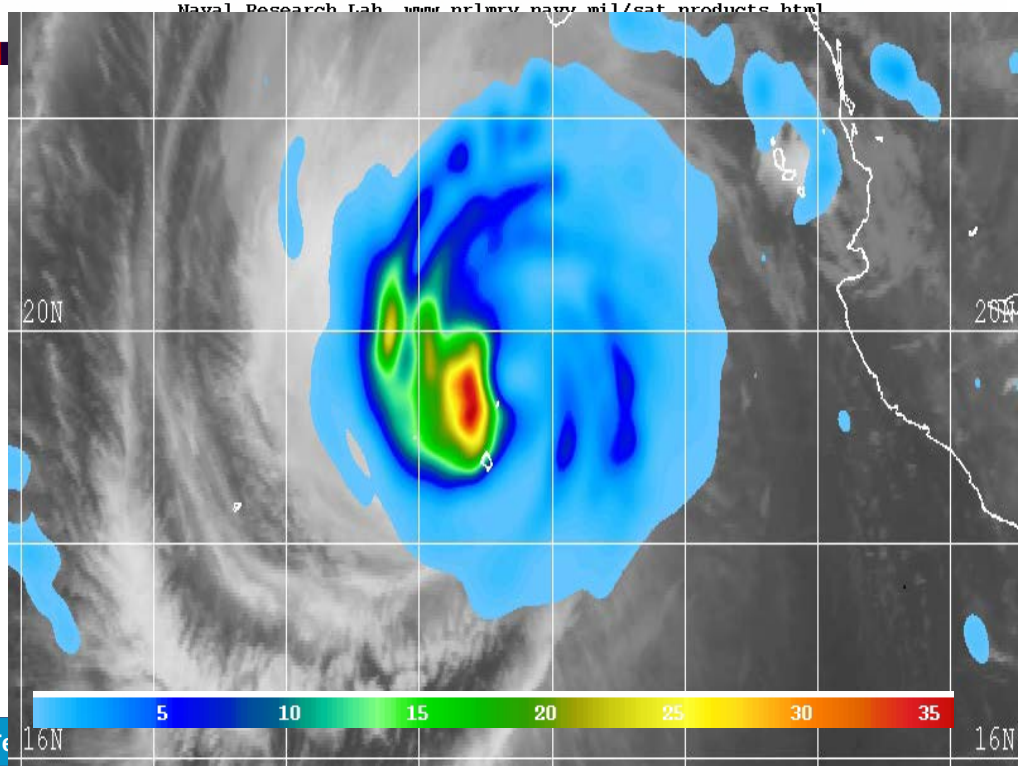

RMSS SST 24 hr 6 June 2015
OI AMSR2 + WindSat 9 km
08 Jun 12Z
Trop
Jun 06Z
Jun 00Z
N21°
07 Jun 12Z
N19°
07 Jun 00Z
3°
W111°
W109°
W107°
W105°
W10
N17°
06 Jun 00Z
N15°
05 Jun 12Z
01 Jun 12Z
05 Jun 00Z
03 Jun 00Z
04 Jun 12Z
N13°
N11°
Image Landsat
19
24
29
34

ASMR-2 SST indicate possibility of Rapid Decay

- Second radip decay occurred as Blanca crosses San Lucas front into cold SSTs < 26C and landfall on Baja detected by AMSR-2 SST

- "Only rain rates greater than about 10 mm/hr (dark blue) impair SST estimation"
  - Flagging scheme doesn't need to be too conservative for forecasting uses as required by data assimilation

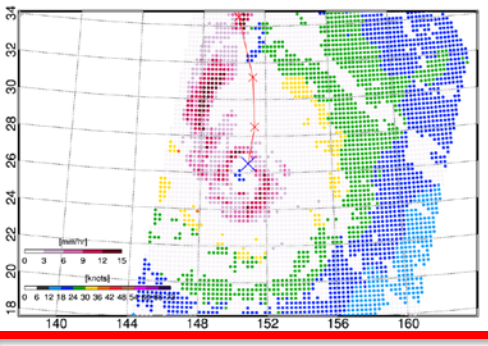




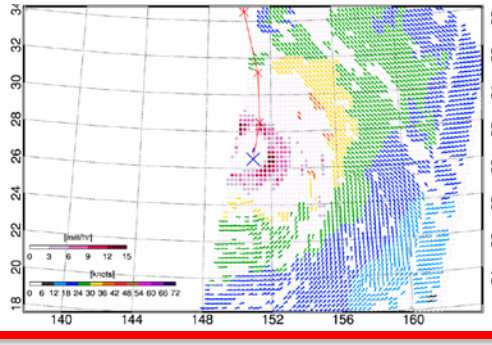
MONITORING EXTRATROPICAL TRANSITIONS

ExtraTropical Transition
West Pacific 06-08 October 2015
Radiometer Observations – Wind and Rain Fields

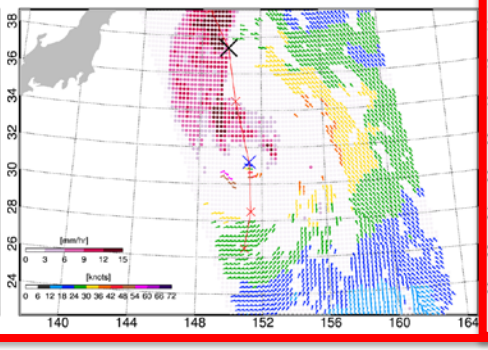
AMSR2 10061528



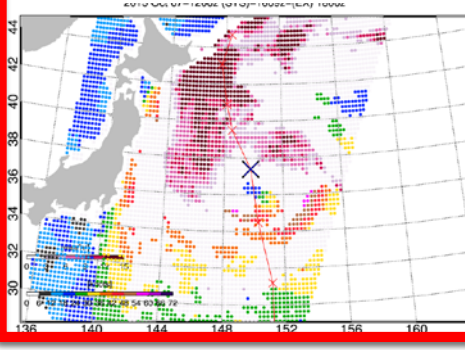
WINDSAT 10062004



WINDSAT 10070720



AMSR2 10071609



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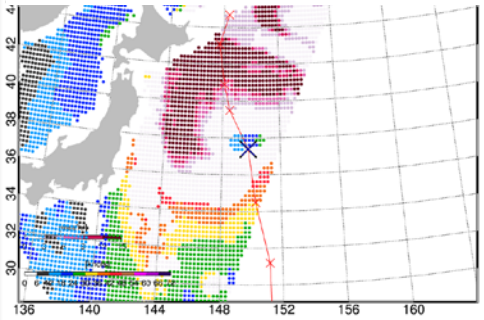
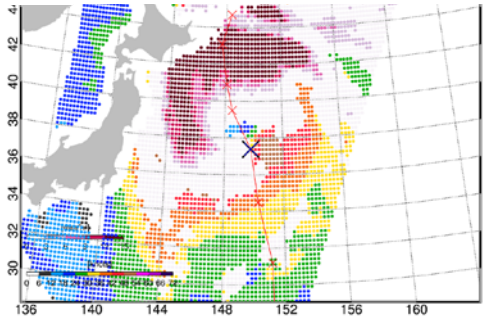
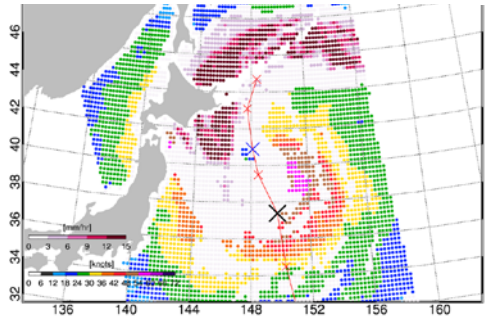


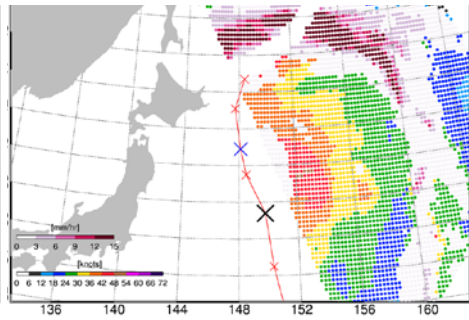
SSMIF17 10072053



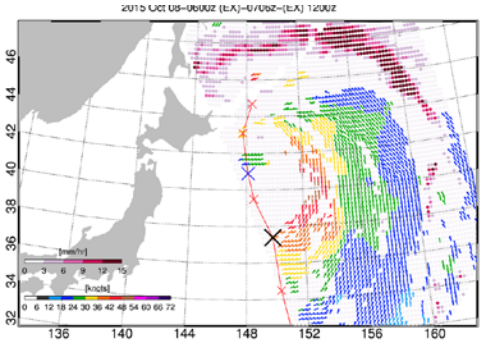
AMSR2 10080313



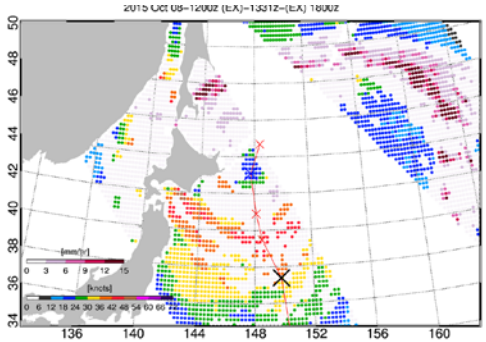
SSMIF16 10080501



WINDSAT 10080706



GMI 10081331



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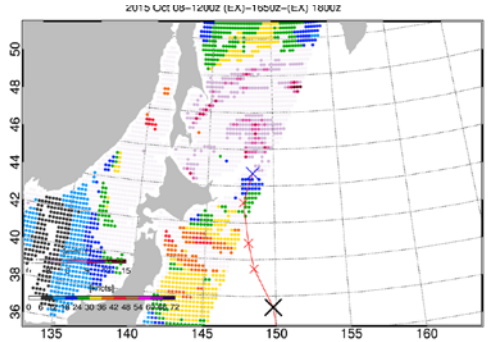
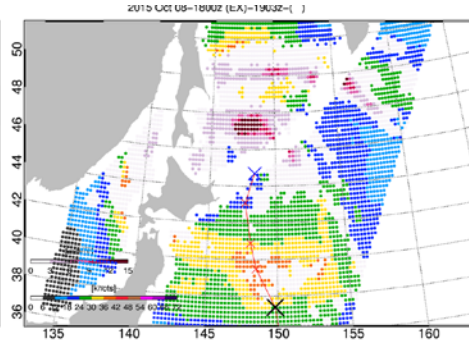
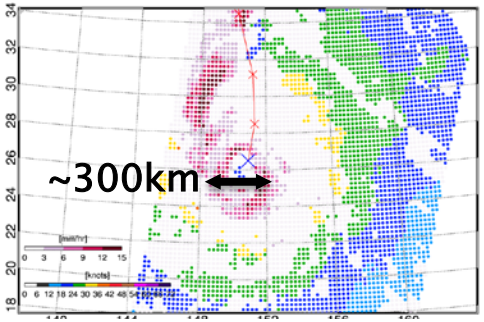


SSMIF16 10081903



ExtraTropical Transition
West Pacific 06-08 October 2015
Scatterometer + Radiometer Observations

AMSR2 10061528



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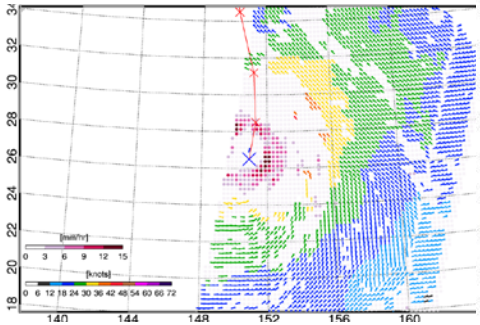
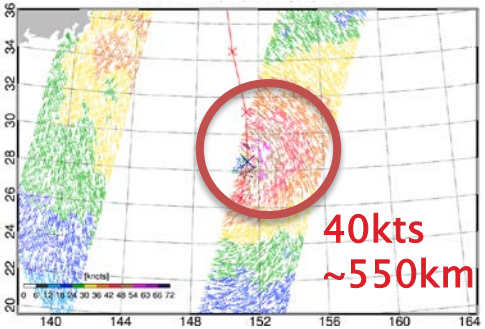
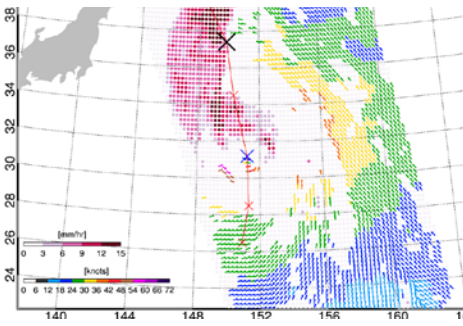


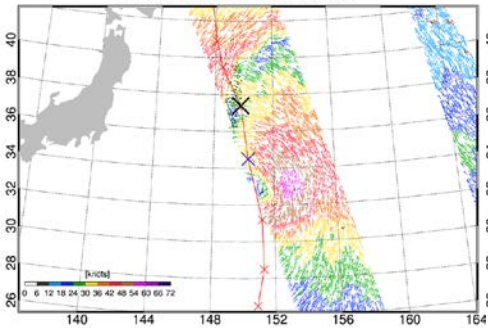
ASCAT-B 10070002



WINDSAT 1007072



ASCAT-A 10071024



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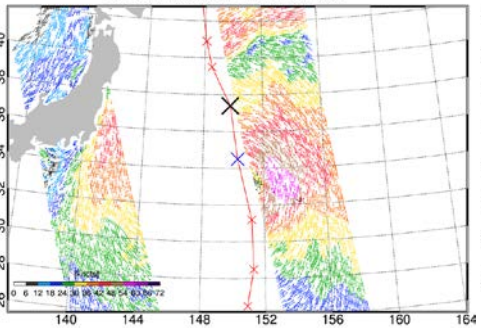
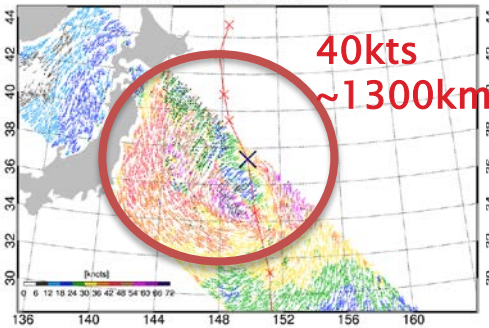
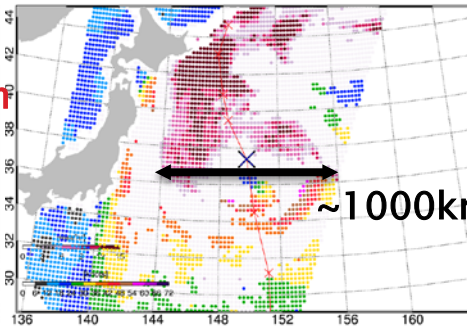


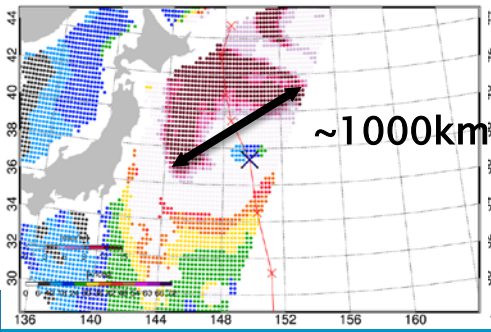
RapidScat 10071503



AMSR2 10071609



SSMIF16 10071907



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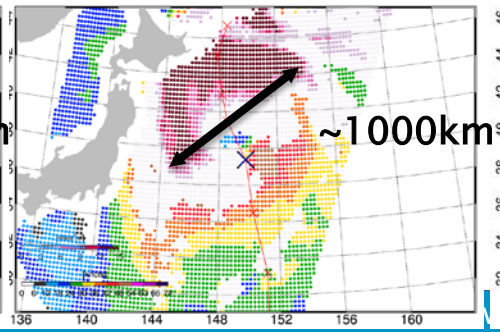

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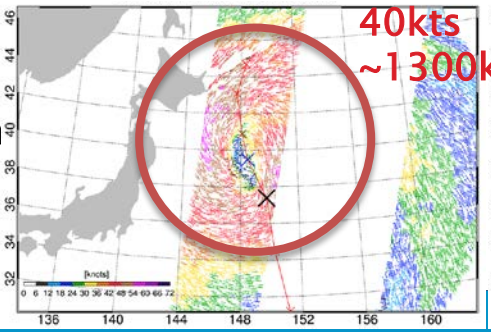

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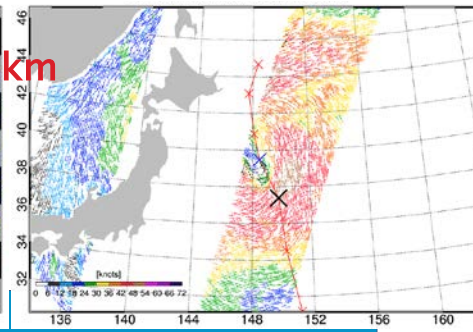
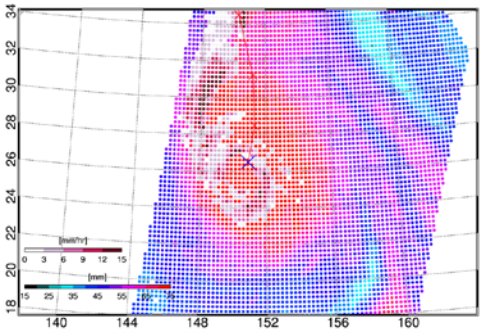
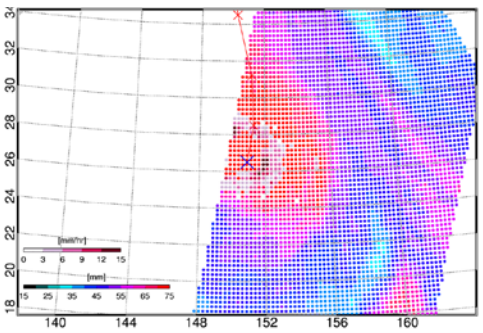


ExtraTropical Transition
West Pacific 06-08 October 2015
Radiometer Observations – Water Vapor and Rain Fields

AMSR2 10061528



WINDSAT 10062004



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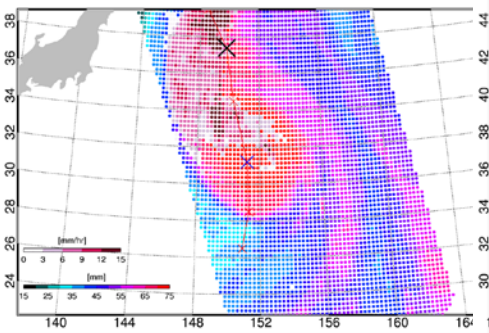

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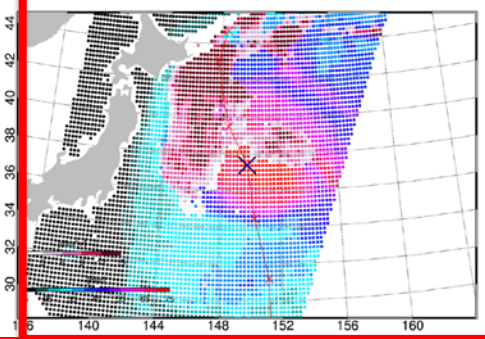

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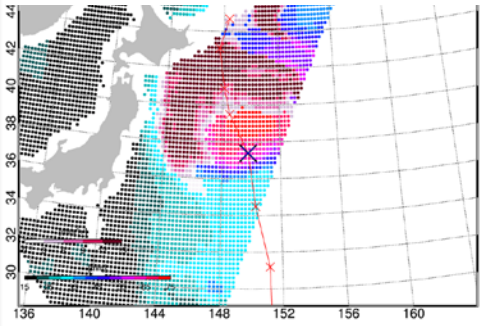

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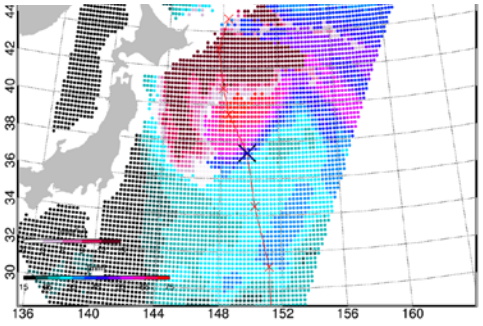

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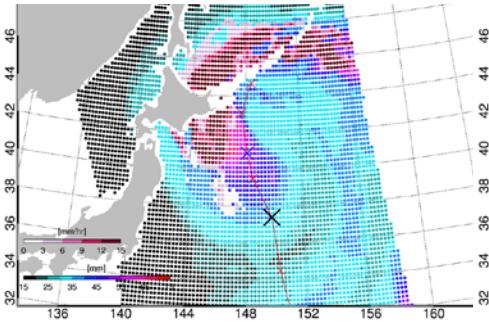

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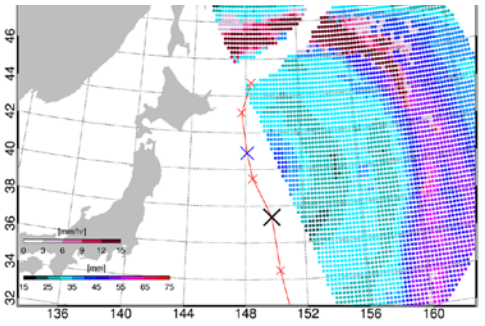
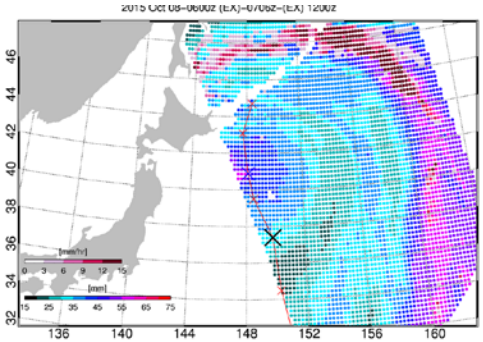
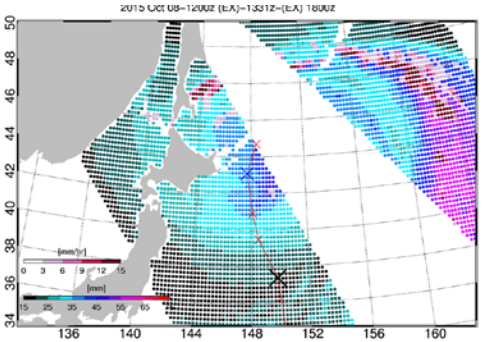


WINDSAT 10080706



GMI 10081331



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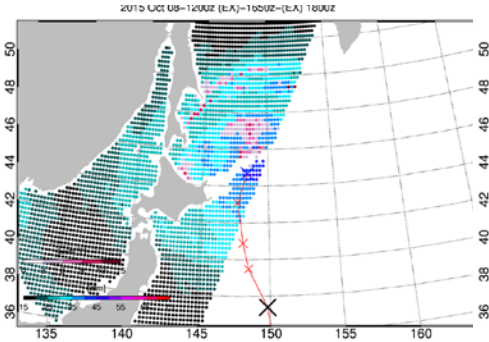

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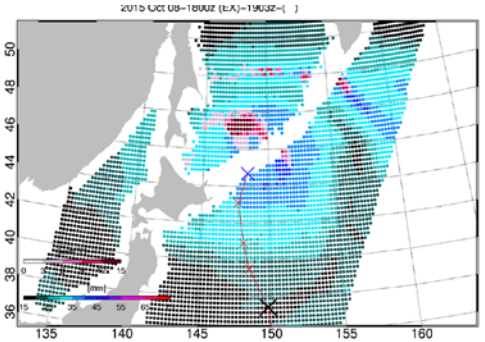

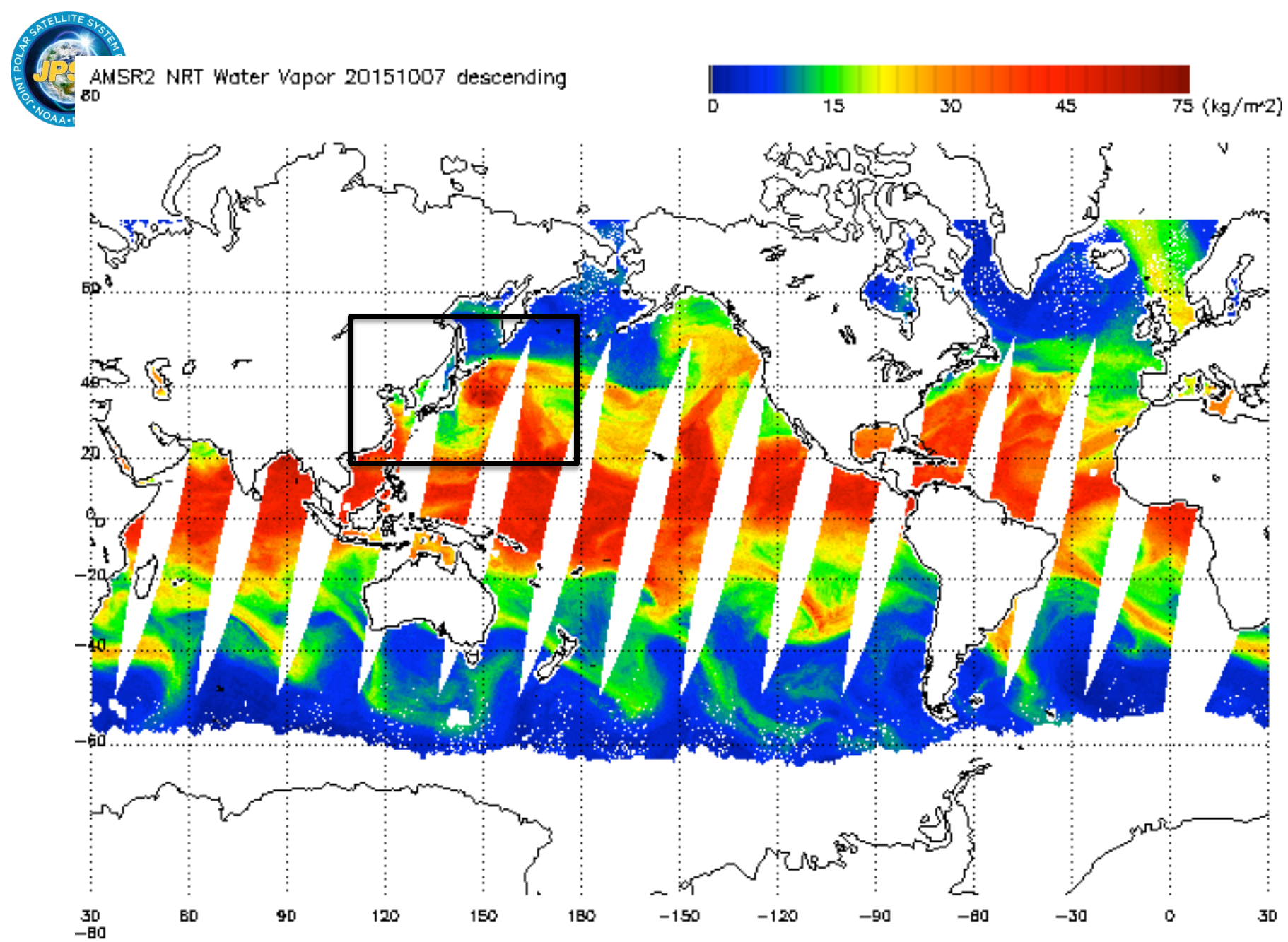
AMSR2 NRT Water Vapor 20151007 descending
0
15
30
45
75 (kg/m^2)
60
40
20
0
-20
-40
-60
30
60
90
120
150
180
-150
-120
-90
-60
-30
0
30
-80

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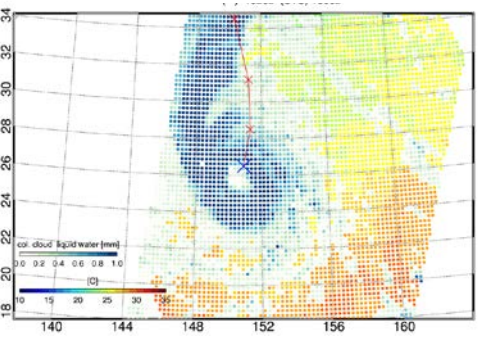
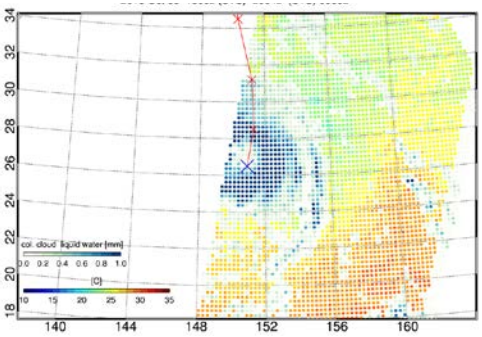
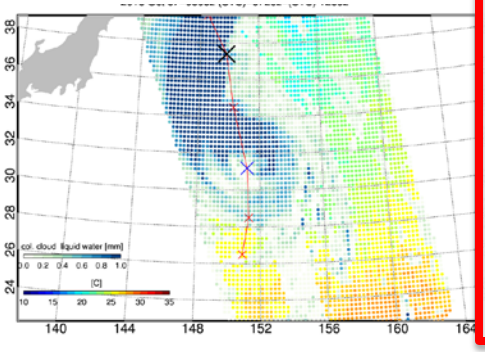
AMSR2 10061528



WINDSAT 10062004



WINDSAT 10070720



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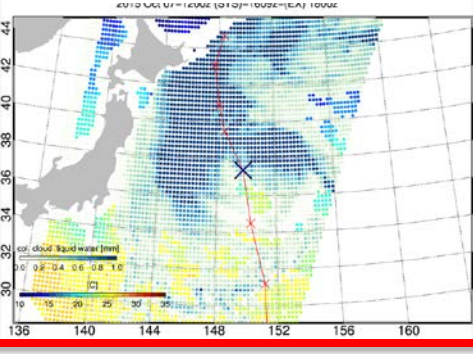

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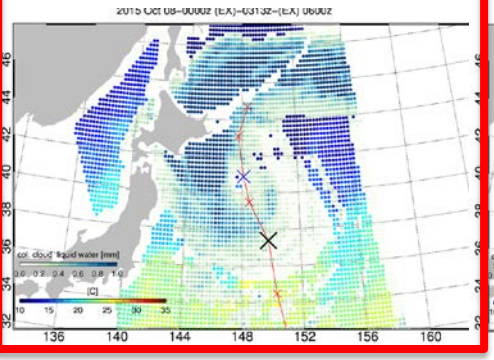

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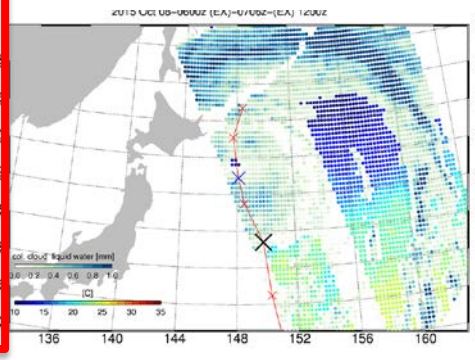
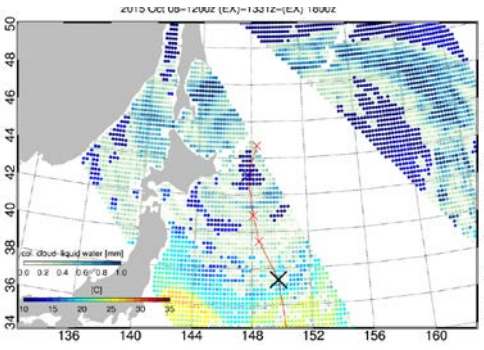


GMI 10081331



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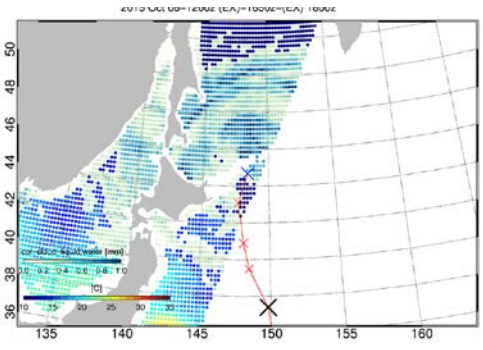

Conclusions

- AMSR2 provides all-weather information critical for tropical cyclone forecasting, hydrological applications such as extreme precipitation, flash flood forecasting and drought forecasting, and marine environmental weather information (wind speed, which contributes to wave height forecasting, and sea surface temperature).
- NOAA's JPSS program's level 1 requirements for microwave imagery are met by GCOM-W1 AMSR2. JPSS provides real-time access via Svalbard to meet NOAA and Japan's latency requirements.
- Microwave imager observations from AMSR2 are routinely used by NOAA, DoD, Japan, EUMETSAT, and other environmental agencies for weather forecasting and environmental monitoring applications.
  - Importance of AMSR2 data for tropical cyclone forecasting is evident in many forecast discussions from the National Hurricane Center and Joint Typhoon Warning Center.
  - Continuity of AMSR2 type observations are important to the operational weather and research communities.