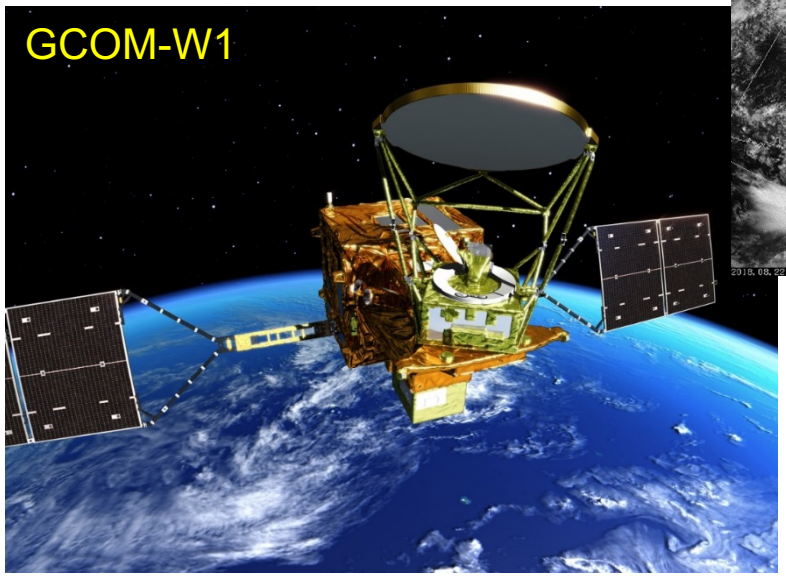
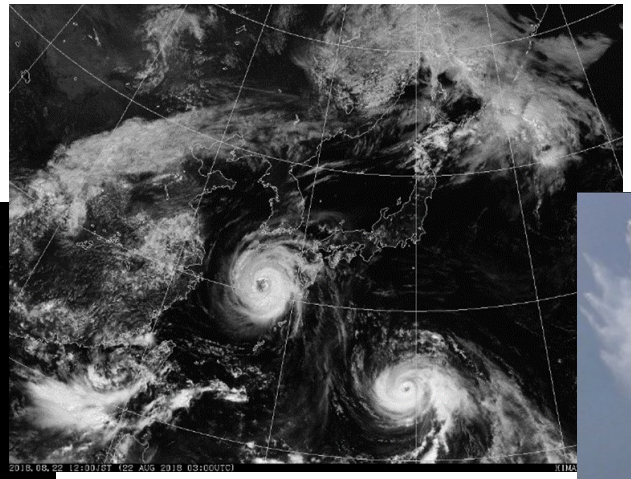
Evaluation of All-weather Sea Surface Wind Speed Product from GCOM-W/AMSR2





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Outline

- Introduction of GCOM-W and AMSR2
- AMSR2 All-weather Sea Surface Wind Speed Product (AWS)
- Comparison with Airborne Stepped-Frequency Microwave Radiometer (SFMR)
- Comparison of 50-kt radii with typhoon best track data
- Summary

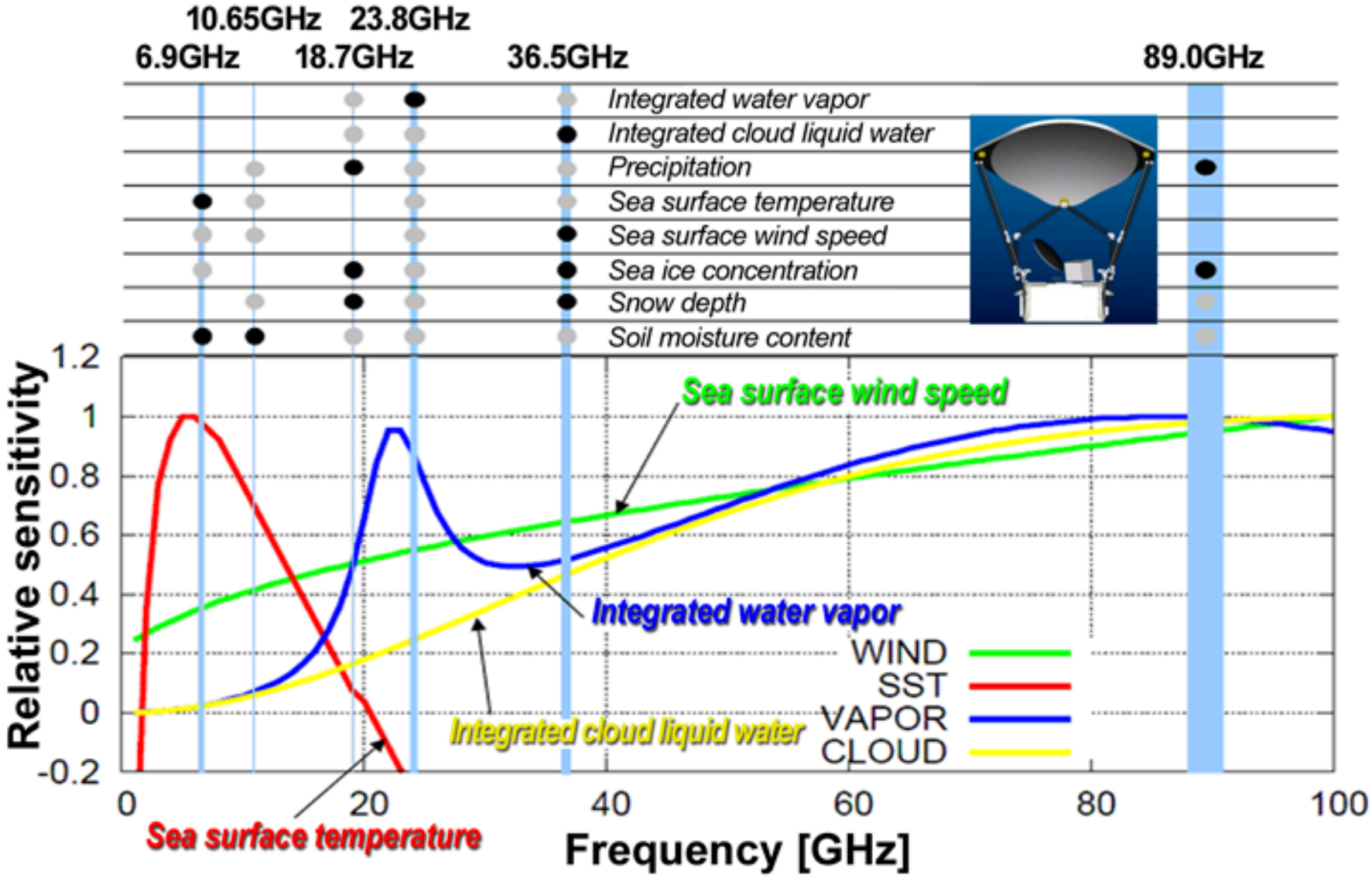
AMSR2 Instrument

- ✓Successor of AMSR-E on Aqua and AMSR on ADEOS-II. Launched in May 2012.
- ✓Deployable main reflector system with 2.0 m diameter (1.6 m for AMSR-E).
- ✓Frequency channel set is identical to that of AMSR-E except 7.3GHz channel for RFI mitigation.
- ✓Two-point external calibration with improved HTS (hot-load).
- ✓Add a redundant momentum wheel to increase reliability.

GCOM-W1/AMSR2 characteristics	
Scan and rate	Conical scan at 40 rpm
Antenna	Offset parabola with 2.0m dia.
Swath width	1450km (effective > 1600km)
Incidence angle	Nominal 55 degrees
Digitization	12bits
Dynamic range	2.7-340K
Polarization	Vertical and horizontal

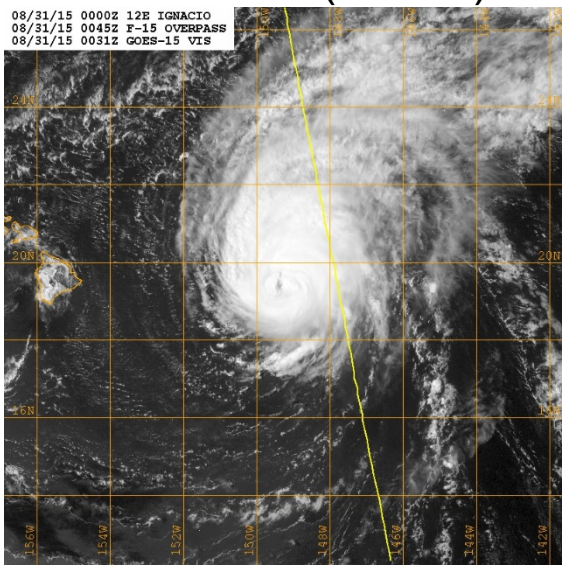
AMSR2 Channel Set				
Center Freq. [GHz]	Band width [MHz]	Pol.	Beam width [deg] (Ground res. [km])	Sampling interval [km]
6.925/ 7.3	350	V and H	1.8 (35 x 62)	10
10.65	100		1.2 (24 x 42)	
18.7	200		0.65 (14 x 22)	
23.8	400		0.75 (15 x 26)	
36.5	1000		0.35 (7 x 12)	
89.0	3000		0.15 (3 x 5)	5

Frequencies utilized by AMSR2

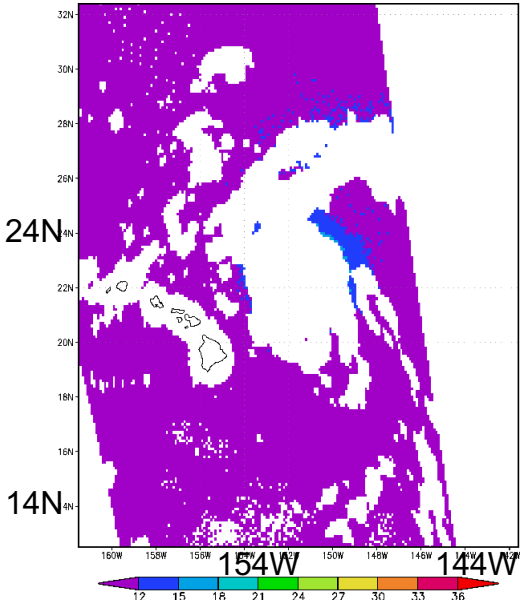


Ignacio (Aug 31, 2015)

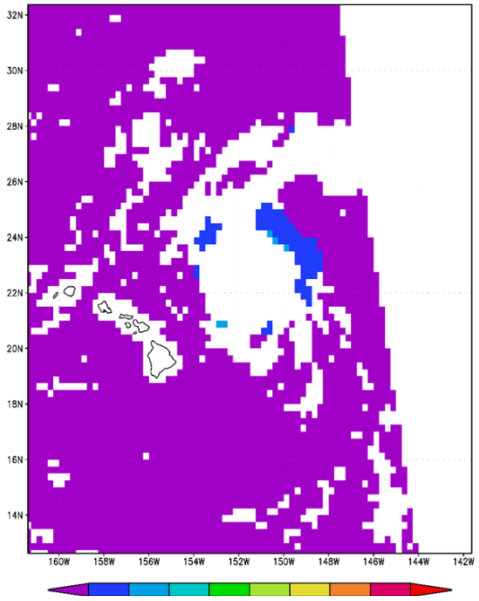
GOES-15 (0031Z)



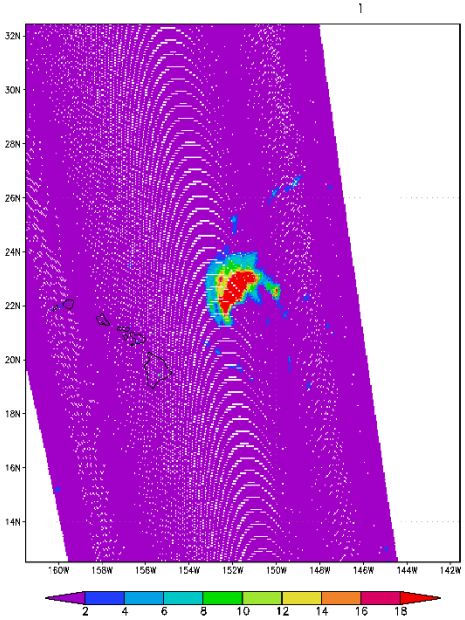
Standard Wind (2301Z)



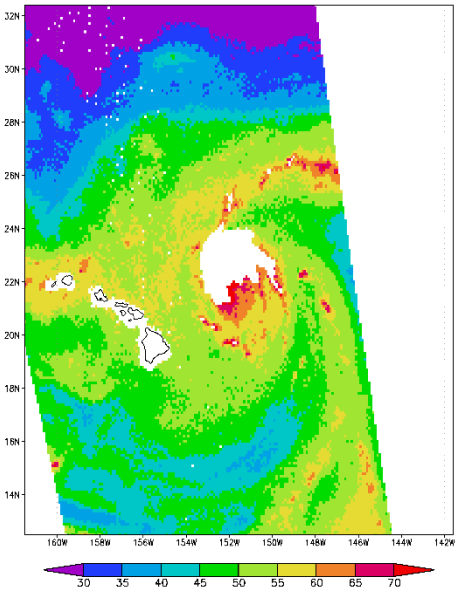
RSS LF Wind



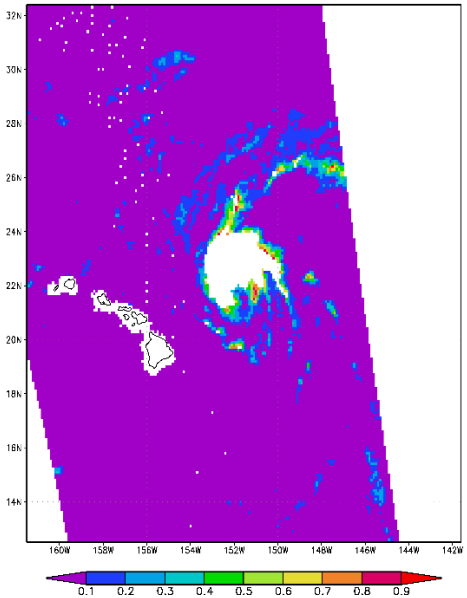
Rain Rate



Integrated Water Vapor



Cloud Liquid Water

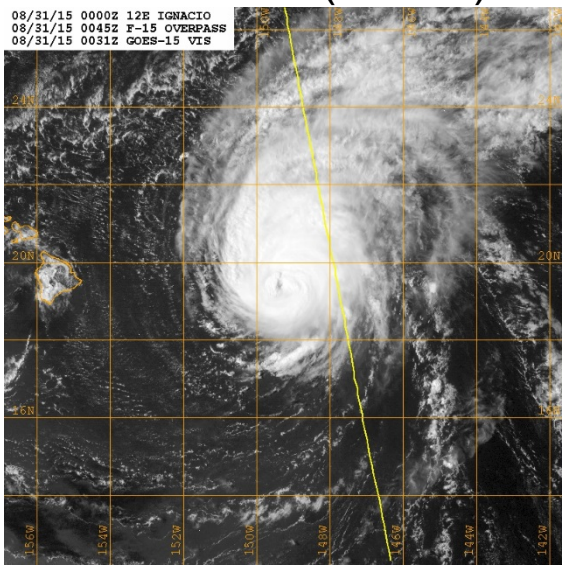


AMSR2 All-weather Sea Surface Wind Speed (AWS) Product (ver. 3.0)

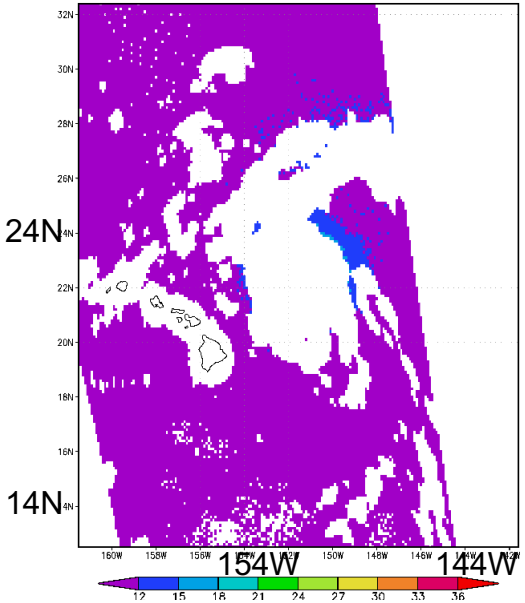
- Research product of marine wind speed under high-wind and heavy rain conditions (e.g., tropical cyclones) developed by JAXA.
- Based on brightness temperatures at 7 and 10 GHz, which are less affected by rain. (Standard wind speed product mainly utilizes 36 GHz)
- Spatial resolution is 50 km. (15 km for standard product)
- Goal of accuracy is 7 m/s. (1.0 m/s for standard product)
- AWS products is available at https://suzaku.eorc.jaxa.jp/GCOM_W/research/resdist.html

Ignacio (Aug 31, 2015)

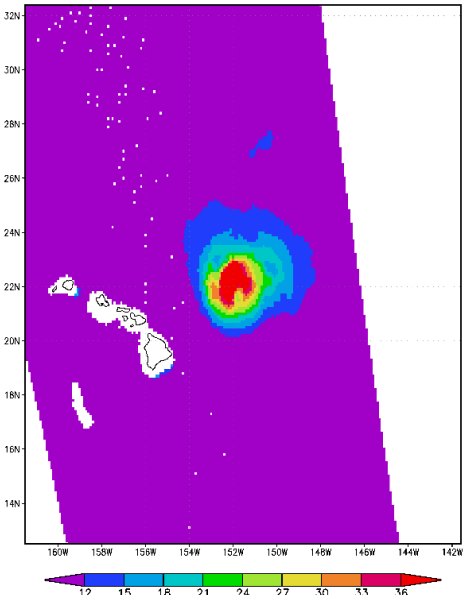
GOES-15 (0031Z)



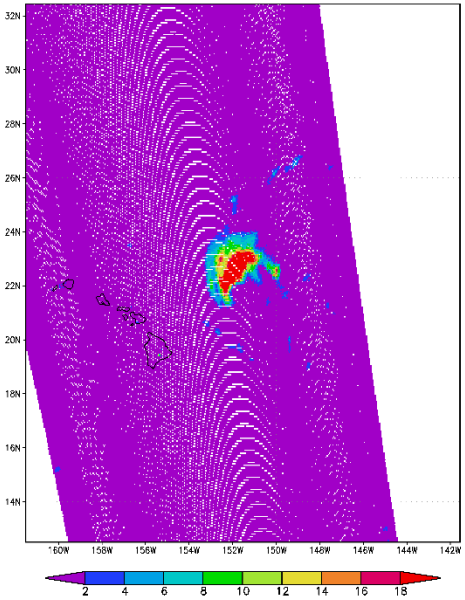
Standard Wind Speed (2301Z)



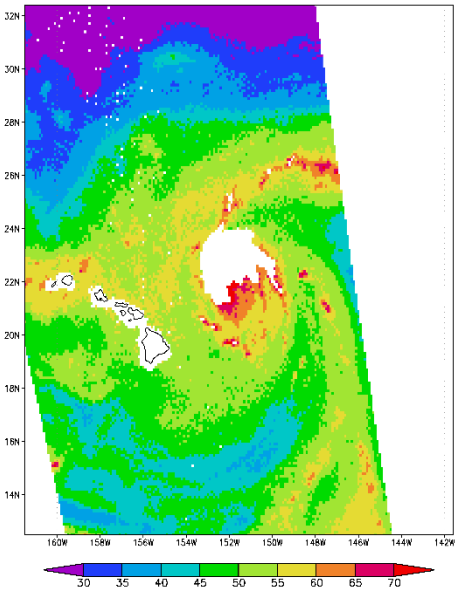
All-Weather Product



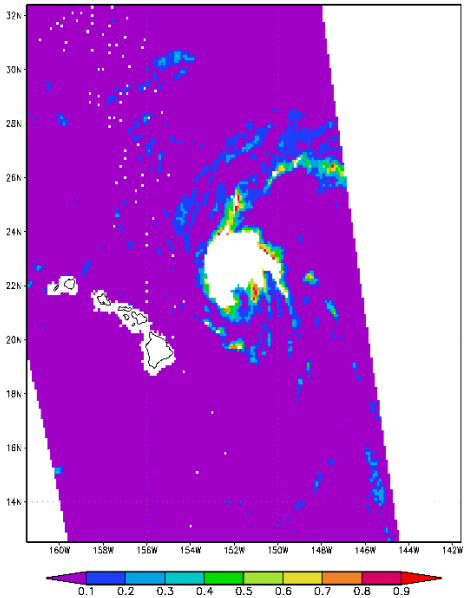
Rain Rate



Integrated Water Vapor



Cloud Liquid Water



Issues concerning Microwave Remote Sensing of Marine Wind under High-wind and Heavy-rain Conditions

- Lack of reliable in-situ measurements

  Buoy: Low anemometer height, motion and flow separation by high waves

  Ship, Tower: Distortion of air flow by big structures

  NWP output: Low spatial and temporal resolutions, inaccurate parameterization of surface boundary layer

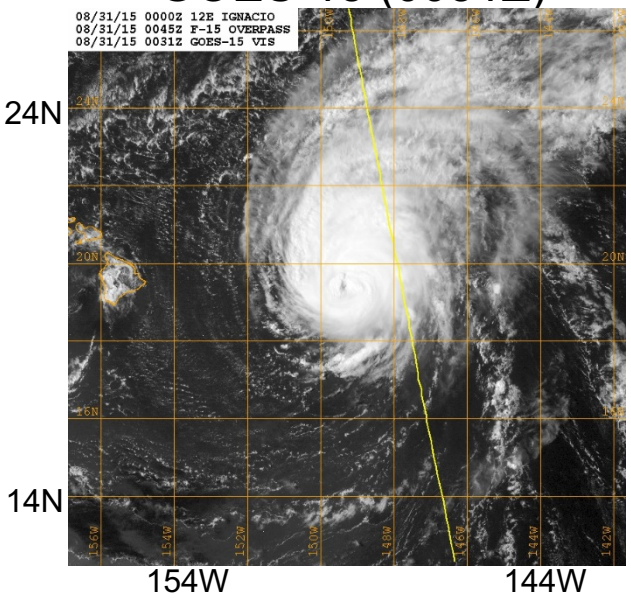
- Low numbers of data points for validation
- Saturation of sensitivity to wind speed at high frequencies
- Attenuation by heavy rain
- Most of wind retrieval algorithms has been developed and validated by reference data in low-mid wind speed ranges

Comparison of AMSR2 AWS wind speed with SFMR data

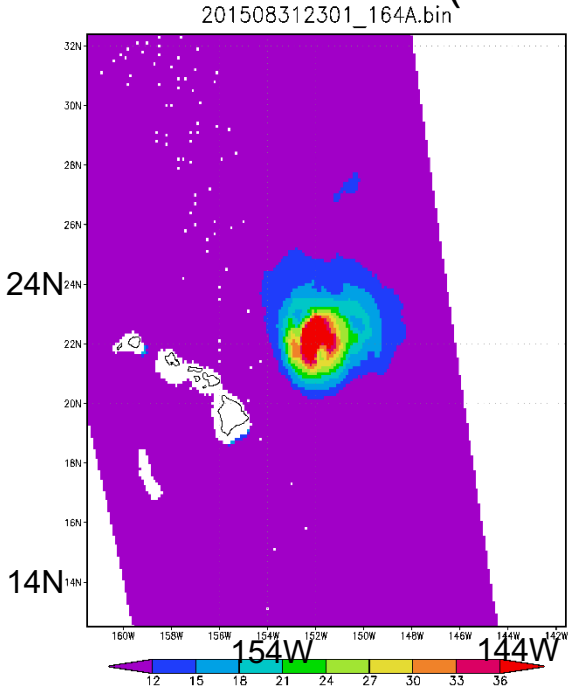
- SFMR data, calibrated by dropsonde observations, were provided by the NOAA/NESDIS/ STAR.（Thanks to Drs. Paul Chang, Zorana Jelenak, Joe Sapp, Mark Romer）
- The SFMR data were smoothed along the flight track over 30 km.
- Data of standard deviation greater than 5 m/s in the 30 km section were discarded.
- Collocate the SFMR data with AMSR2 observations allowing temporal difference of 15 min. and temporal separation of 30 km.
- Cases of 12 hurricanes from 2012 to 2016 were selected.

Ignacio (Aug 31, 2015)

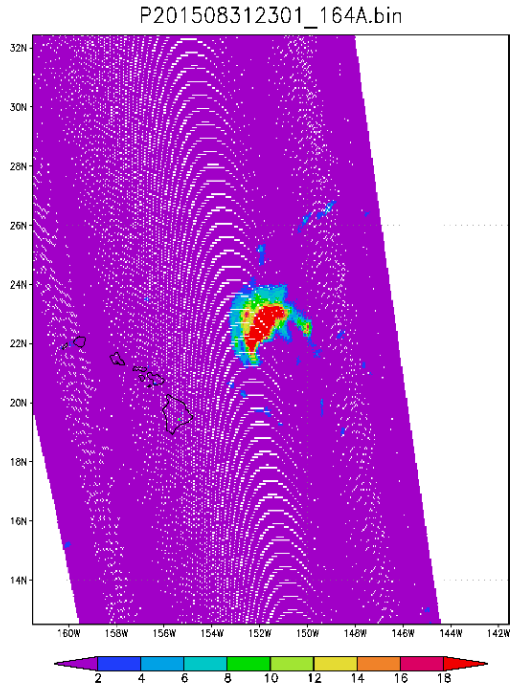
GOES-15 (0031Z)

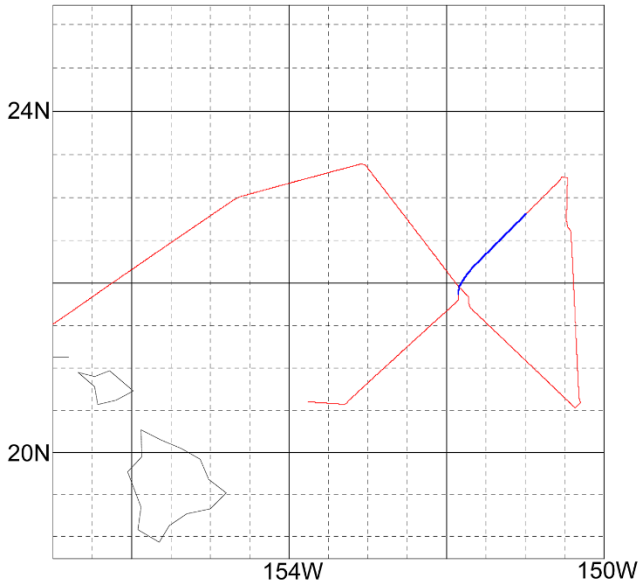


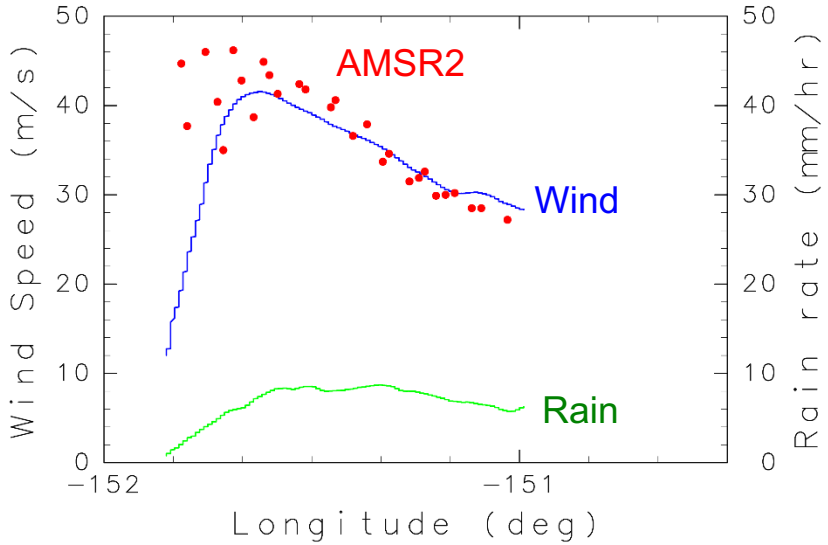
AMSR2 All Weather (2301Z)



AMSR2 Rain Rate

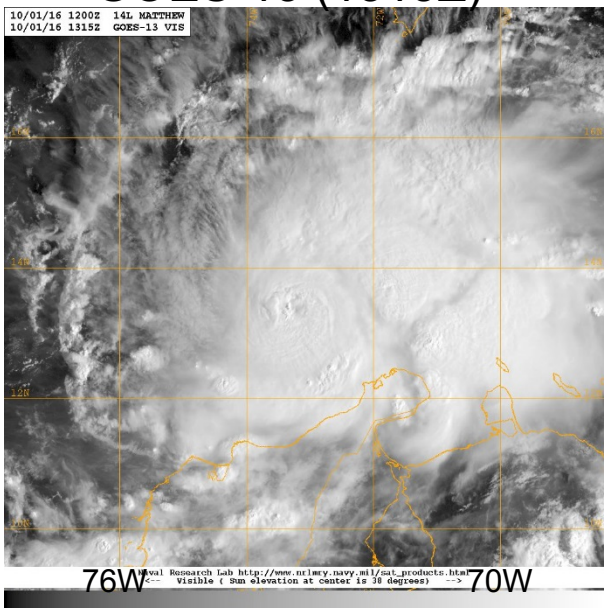




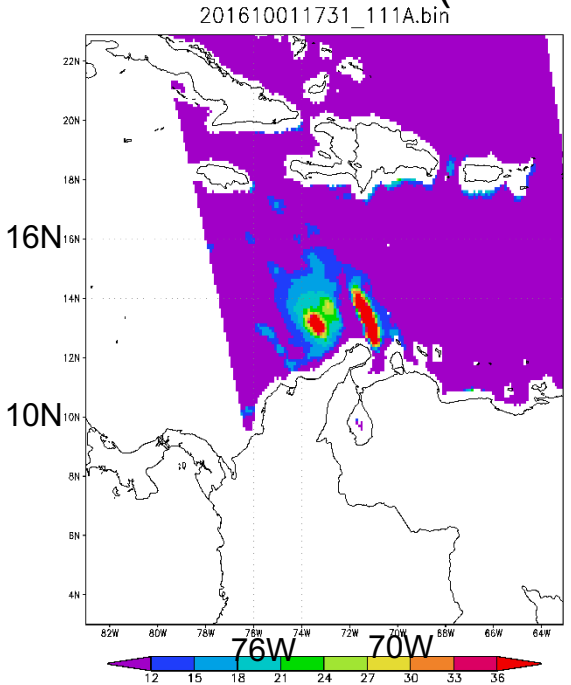


Matthew (Oct 1, 2016)

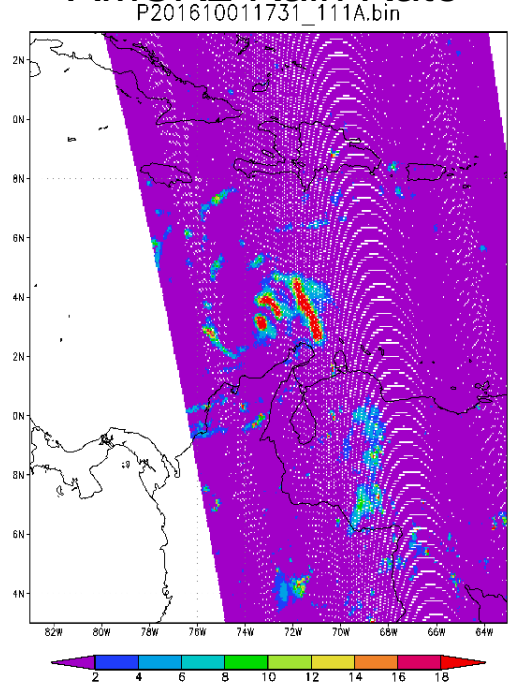
GOES-13 (1315Z)

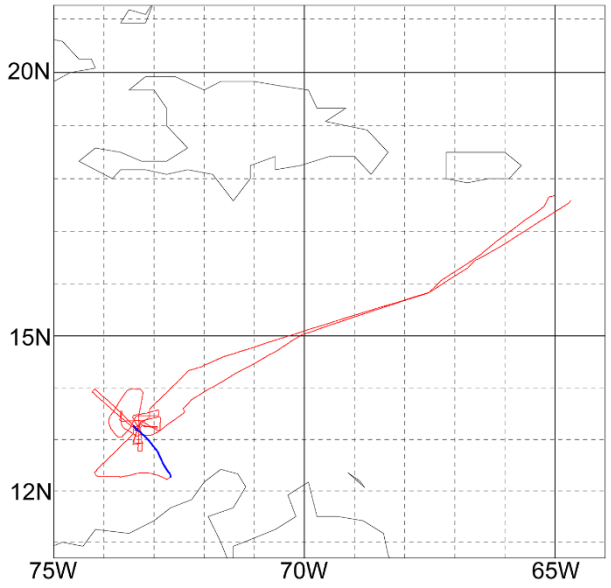


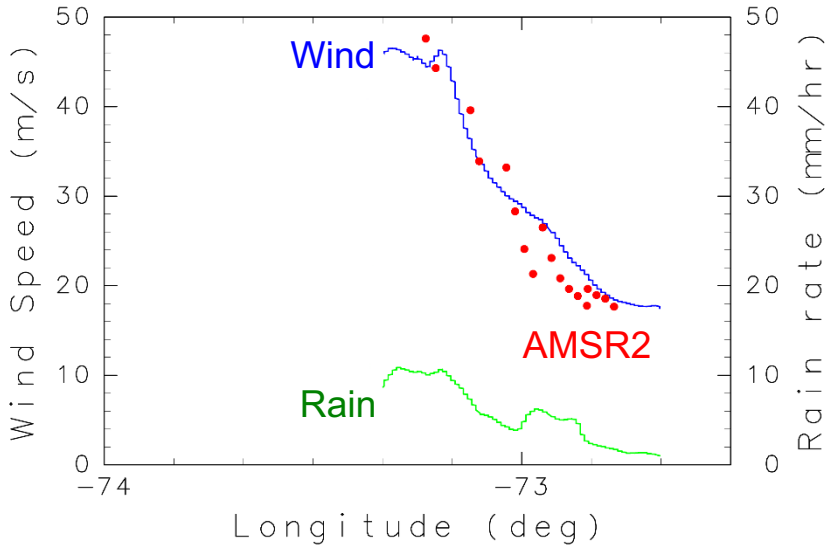
AMSR2 All Weather (1731Z)



AMSR2 Rain Rate

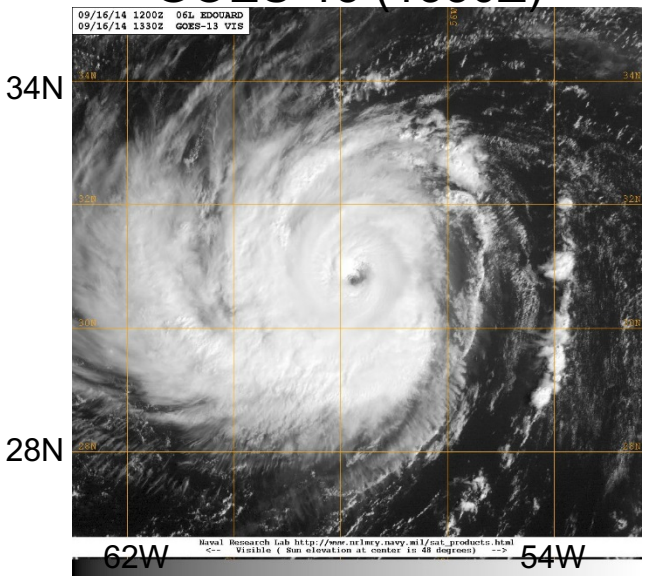




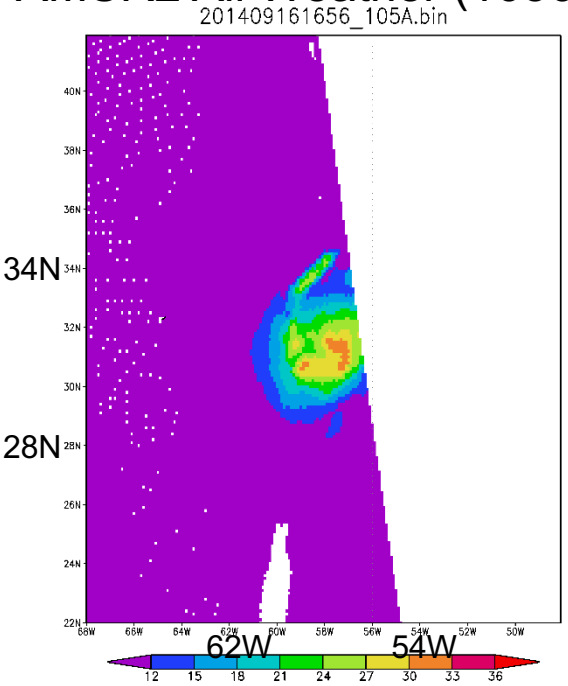


Edouard (Sep 16, 2014)

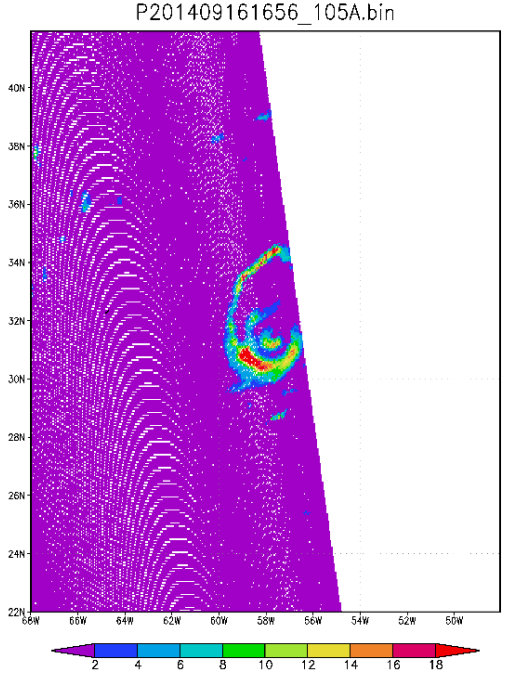
GOES-13 (1330Z)

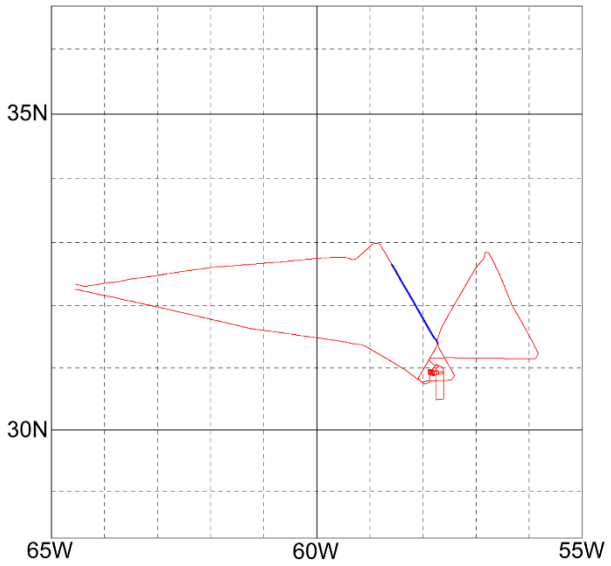


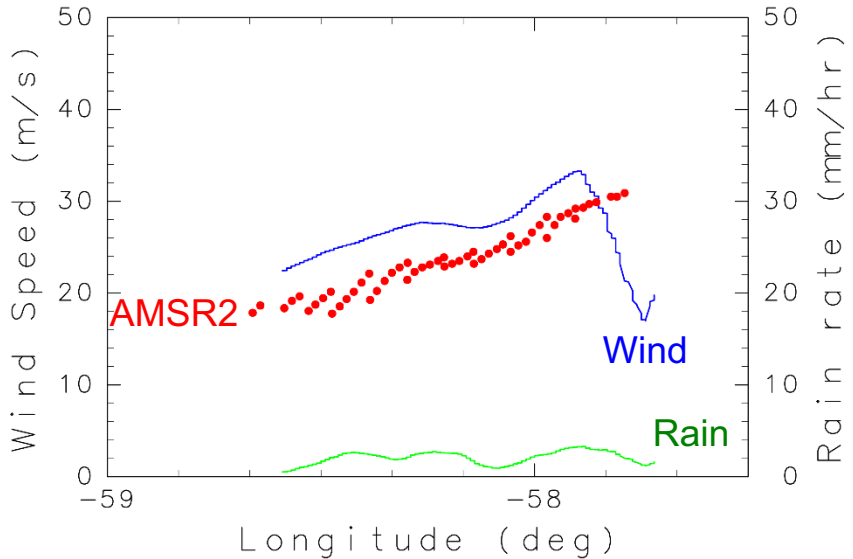
AMSR2 All Weather (1656Z)



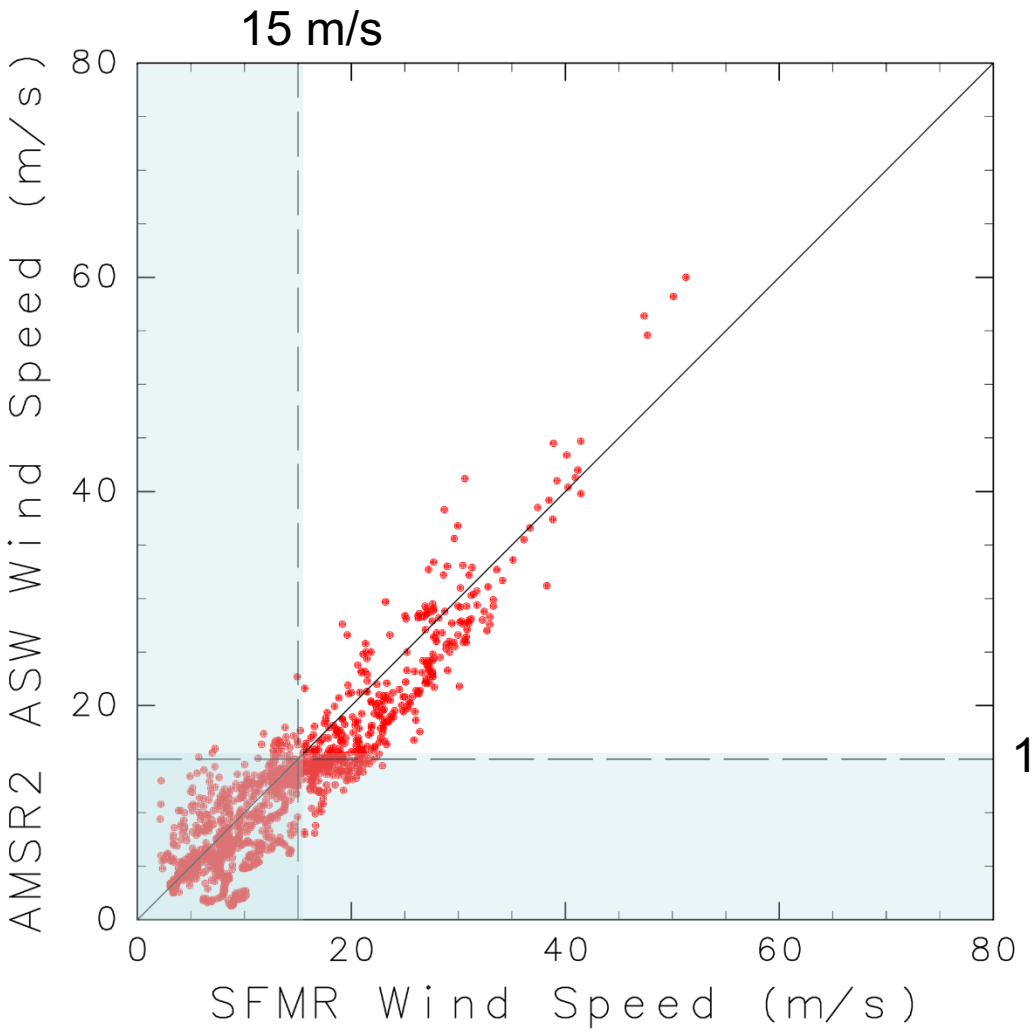
AMSR2 Standard







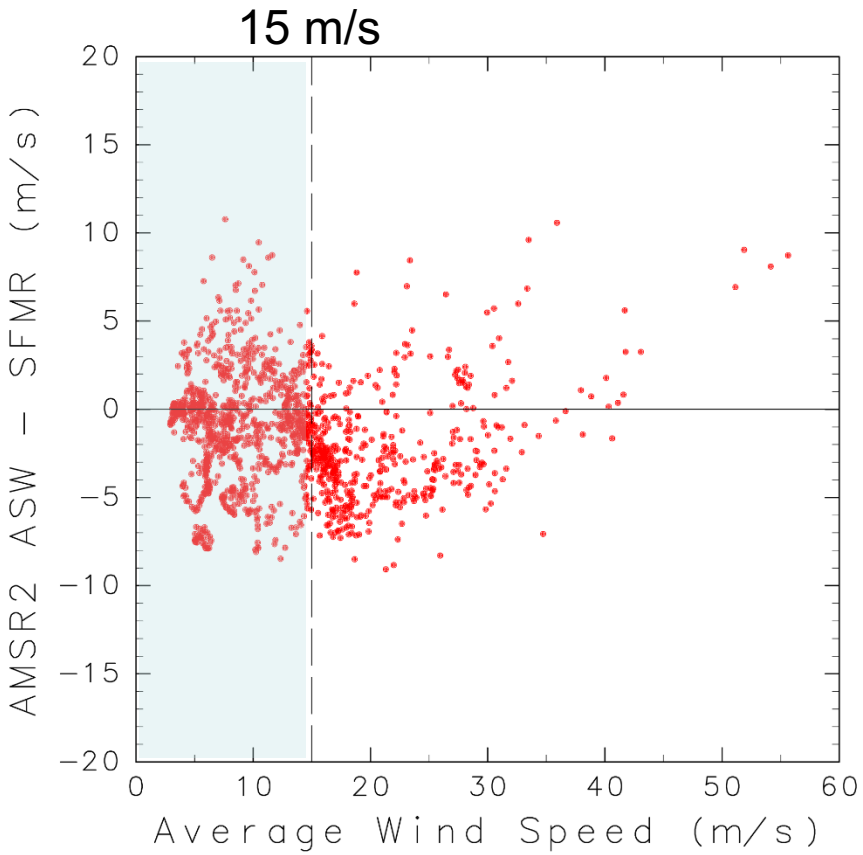
Comparison of AMSR2 AWS Wind Speed with SFMR

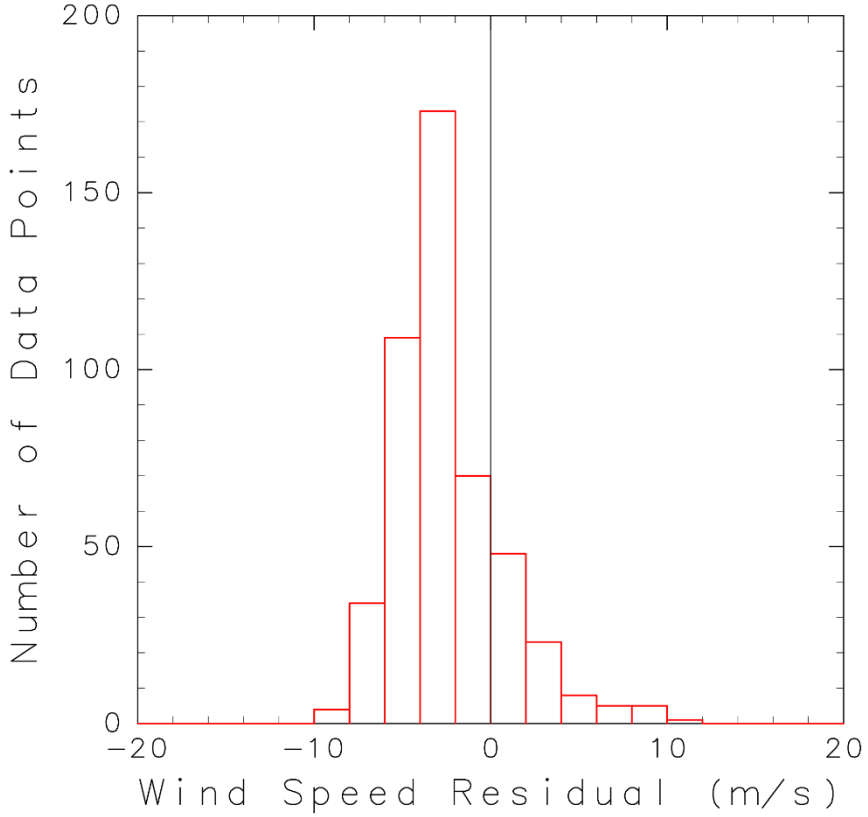


For data points of wind speed higher than 15 m/s.

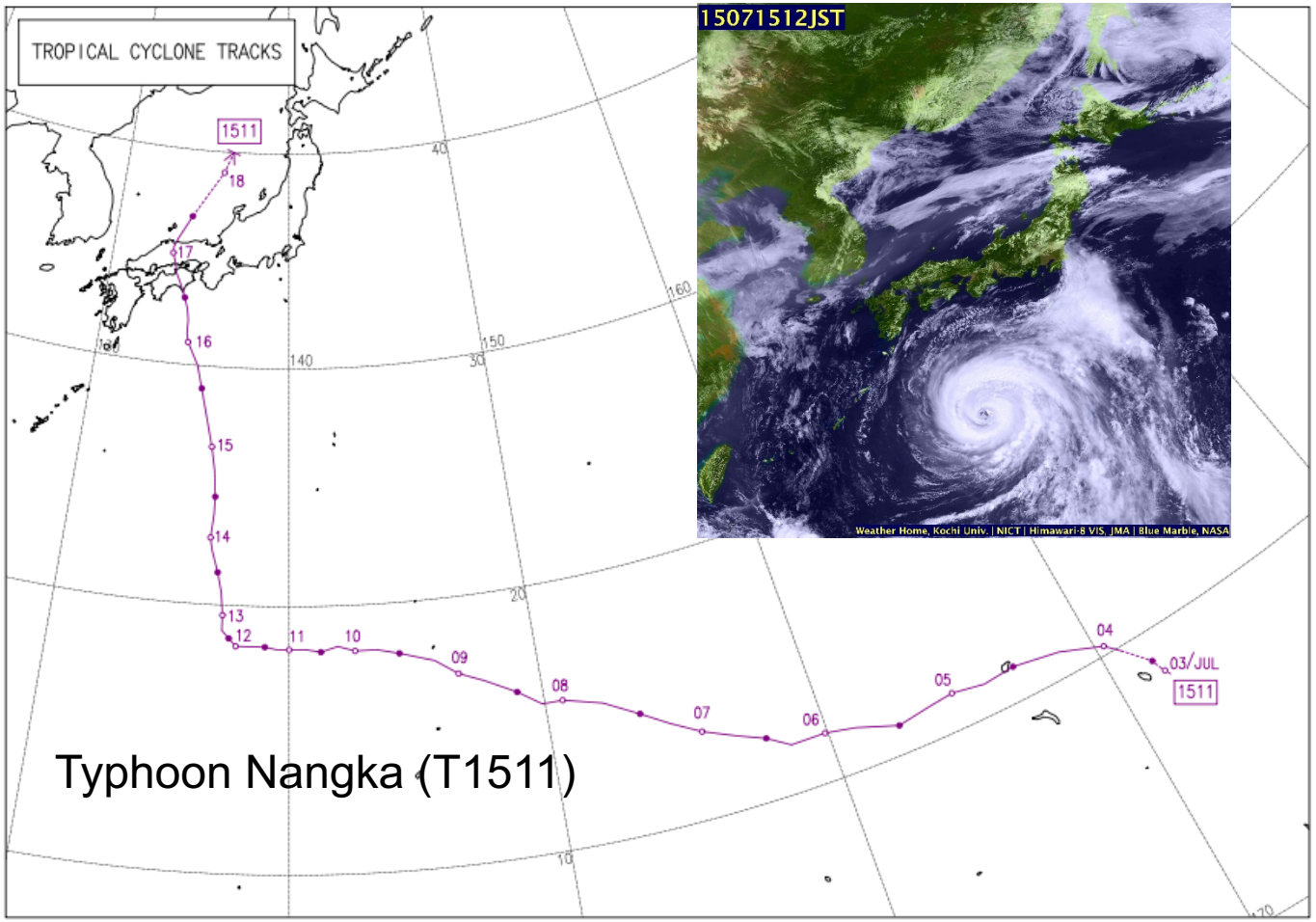
Number of data points	347
Bias	-1.94 m/s
RMS difference	3.26 m/s

Wind Speed Residual (AMSR2 AWS – SFMR)



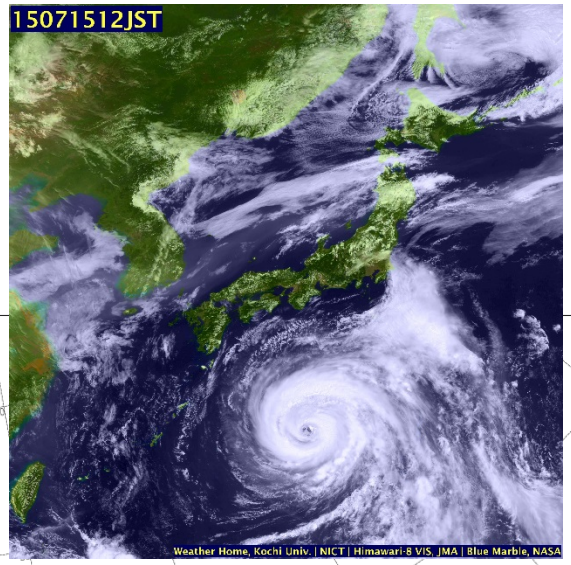


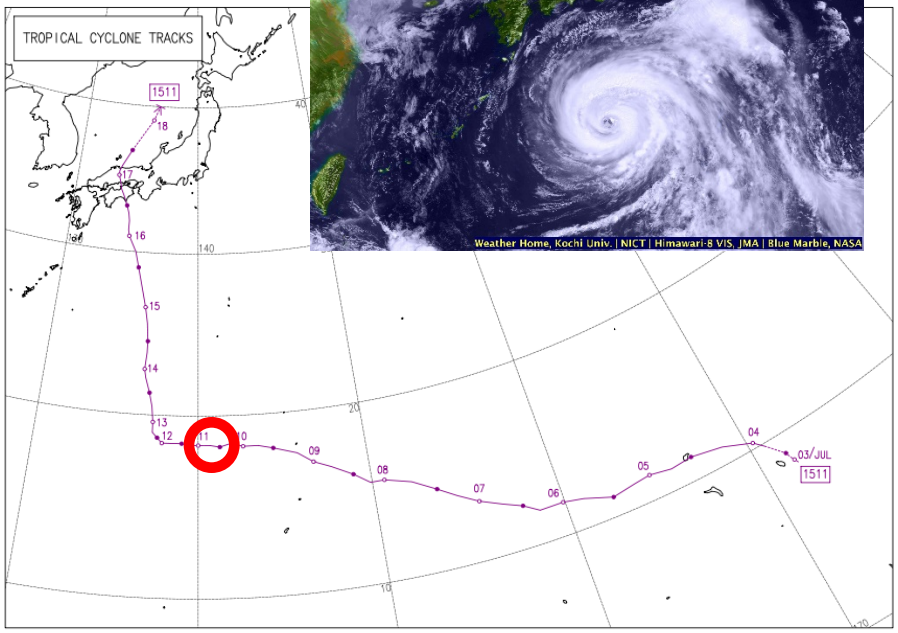
Comparison with JMA Typhoon Best-Track Data

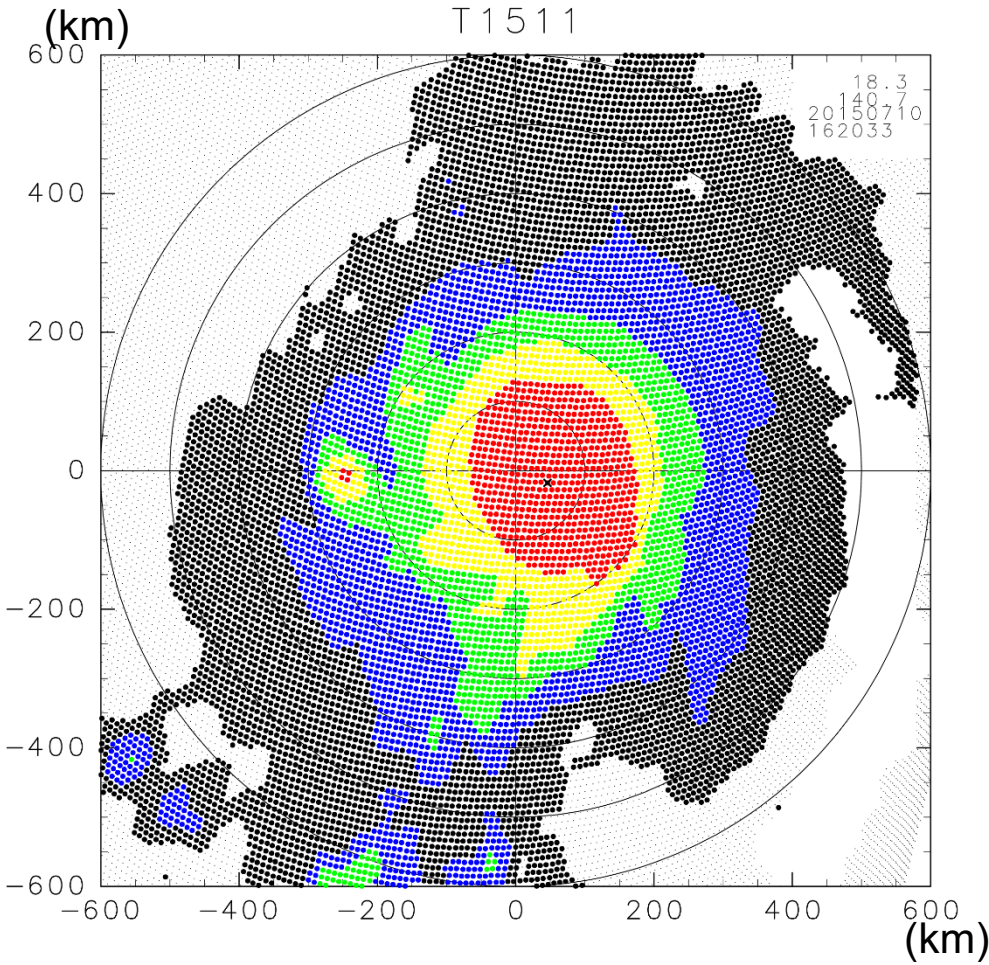


Evaluation comparing spatial distribution of extreme wind area (50-kt radius)

Typhoon Nangka (T1511)

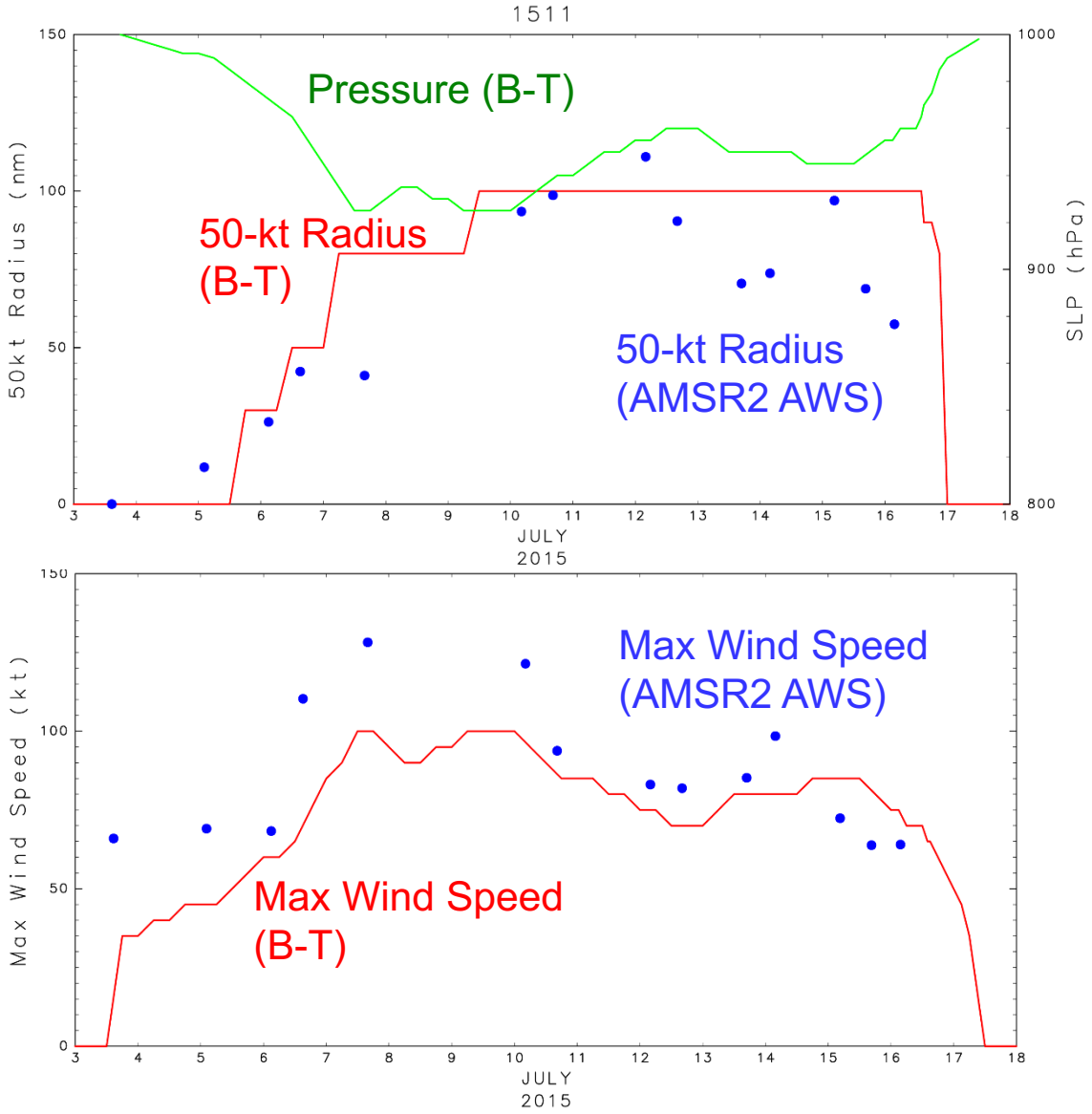




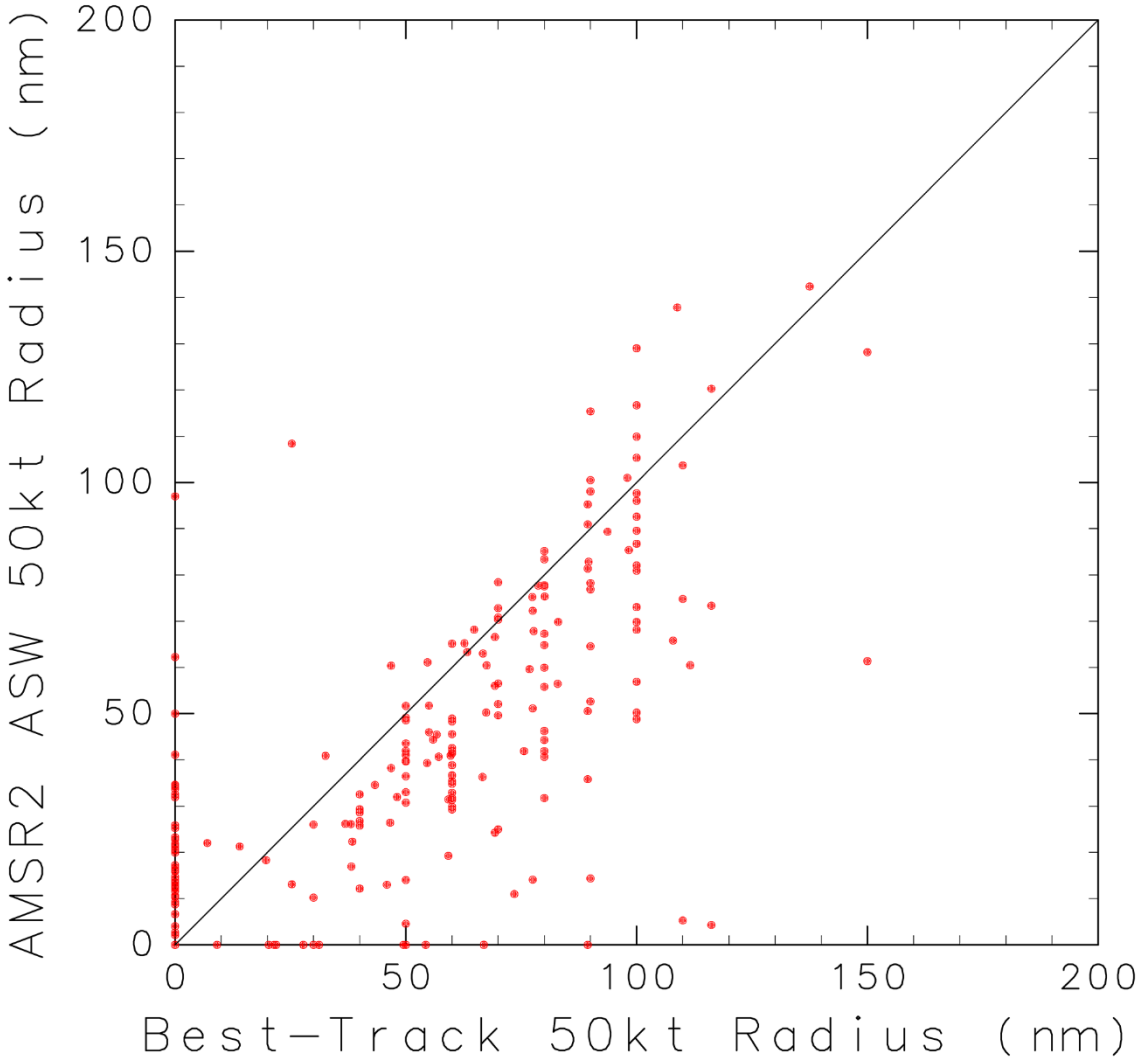


10-15, 15-20, 20-25, 25-30, 30- m/s

Time Series of 50-kt Radius and Max Wind Speed (T1511)

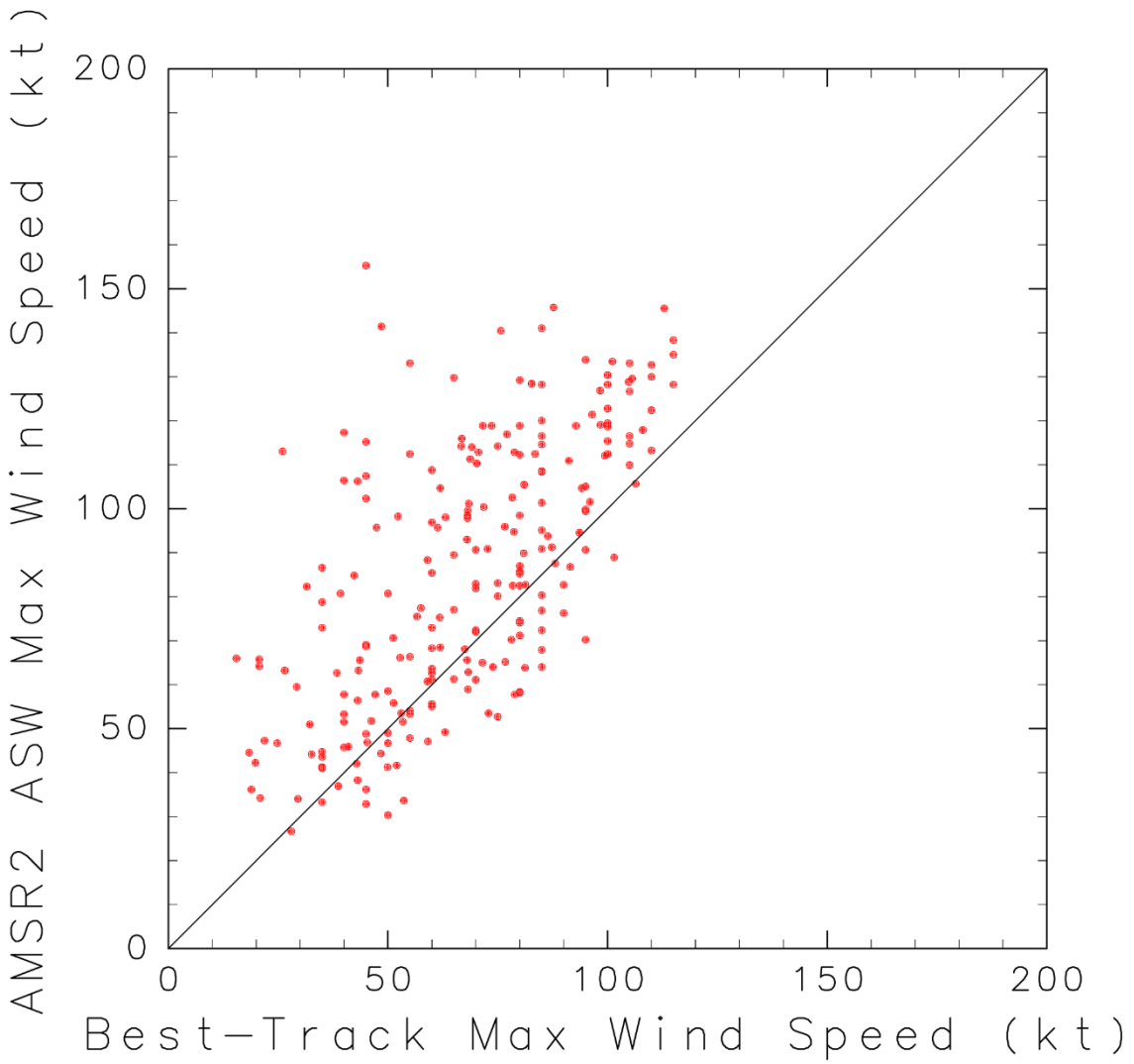


Comparison of 50-kt Radius (28 Typhoons in 2012-2017)



Number of data points	154
Bias	-16.3 km
RMS difference	28.2 km
Correlation	0.650

Comparison of Maximum Wind Speed (28 Typhoons in 2012-2017)



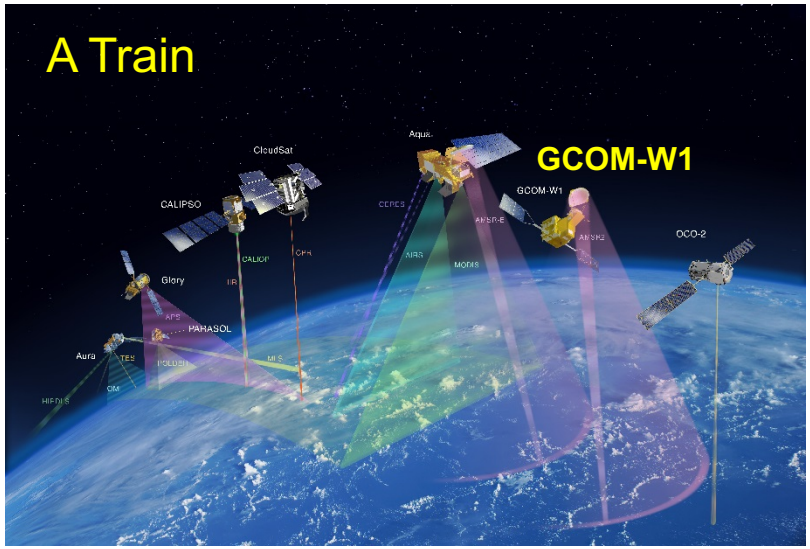
Number of data points	179
Bias	+18.4 m/s
RMS difference	29.4 m/s
Correlation	0.646

Summary

- JAXA developed the AMSR2 All-weather Sea Surface Wind Speed (AWS) Product for high-wind and heavy-rain conditions.
- To validate the AWS product, airborne SFMR data, calibrated with dropsonde observations, were smoothed along flight tracks.
- The AWS wind speed agreed well with the SFMR data with RMS difference of 3.26 m/s in the wind speed range higher than 15 m/s.
- However, systematic negative bias were discernible. Further investigations are needed for improvements.
- Spatial distribution of high-wind area of the AWS is evaluated by comparisons of the JMA Typhoon Best-track data.
- Comparison of 50-kt radius around 28 typhoons during a period from 2012 to 2017 showed reasonable correlation (correlation coefficient = 0.650) , although the AMSR2 AWS tends to underestimate the 50-kt radius compared to the best-track data.
- It is exhibited that AMSR2 AWS product is useful to monitor wind speed around tropical cyclones under extreme wind and rain conditions.

AMSR2/GCOM-W

(Advanced Microwave Scanning Radiometer 2 on Global Change Observation Mission – W)



GCOM-W/Main Specifications of AMSR2

Scan and rate	Conical scan at 40 rpm
Antenna	Offset parabola with 2.0m dia.
Swath width	1450km
Incidence angle	Nominal 55 degrees
Digitization	12bits
Dynamic range	2.7-340K
Polarization	Vertical and horizontal

AMSR2 Channel Set

Center Freq.	Band width	Pol.	Beam width	Ground res.	Sampling interval
GHz	MHz		degree	km	km
6.925/7.3	350	V/H	1.8	35 x 62	10
10.65	100		1.2	24 x 42	
18.7	200		0.65	14 x 22	
23.8	400		0.75	15 x 26	
36.5	1000		0.35	7 x 12	
89.0	3000		0.15	3 x 5	5

Deployed (observation)

Stowed (during launch)

Launched on May 18, 2012, and still in operation

Recommendations from the International Workshop on Measuring High Wind Speeds over the Ocean (2016)

- Dropsonde is the most reliable in-situ measurement under high-wind conditions.
- However, the pointwise measurements by dropsondes cannot be directly compared with spaceborne microwave measurements (10-100 km).
- Calibrate Airborne Stepped-Frequency Microwave Radiometer (SFMR) with dropsondes.
- Smooth the calibrated SFMR data along the flight track over 10-100 km.
- Discard data around eye wall, where wind speed rapidly changes.

INTERNATIONAL WORKSHOP ON MEASURING HIGH WIND SPEEDS OVER THE OCEAN

15-17 November 2016

Ifremer oceandatalab SOLab Лаборатория спутниковой океанографии Met Office esa

logobar.png (©ifremer)

15-17 November 2016 | Met Office,

A three day workshop on the science and applications of remotely-sensed ocean surface winds, with a focus on high or extreme wind speeds. The workshop will be held at the Met Office headquarters in the cathedral city of Exeter.

Suggested topics include:

Status of monitoring ocean-surface winds from space: current and future instruments

Methods and models for retrieving high winds from satellite observing systems

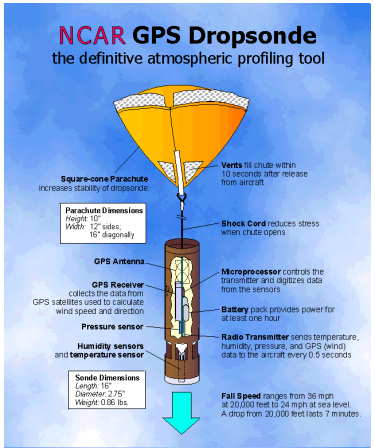
Ocean surface wind products, synergies, and validation of high wind speeds

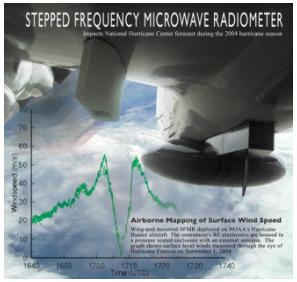
Applications for ocean-atmosphere interactions

Applications for numerical weather prediction (NWP)

Applications for tropical cyclone and extra-tropical storms-Climate applications

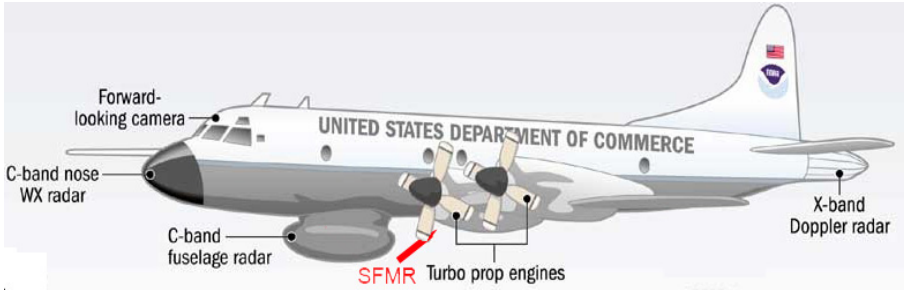
For registration and abstract submission please visit the web links given below:

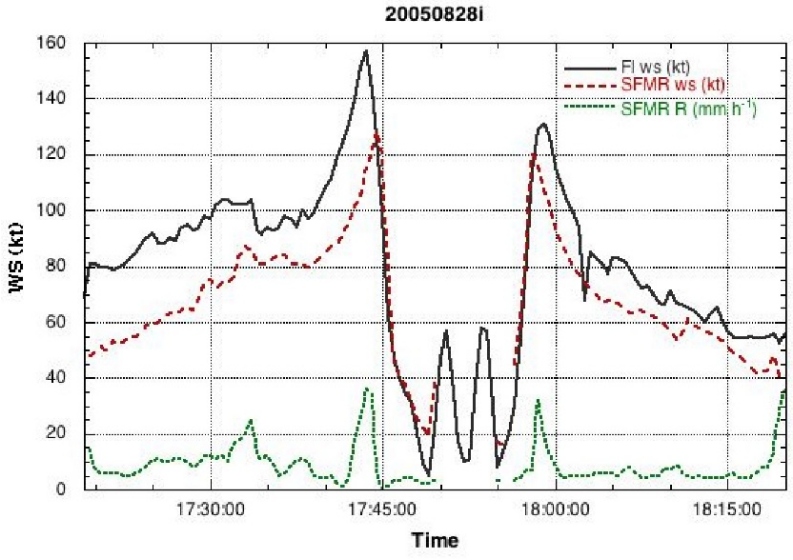


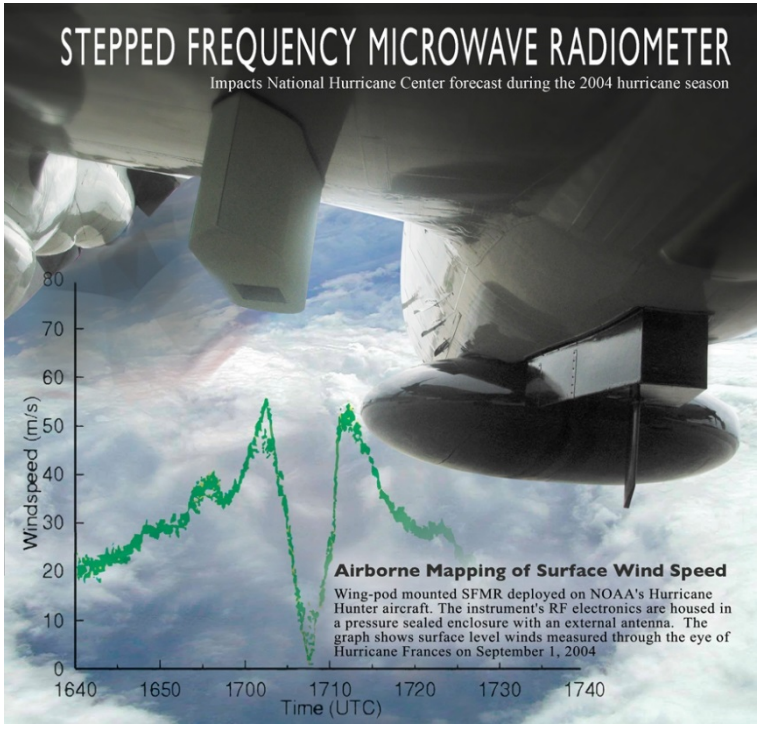


Stepped-Frequency Microwave Radiometer (SFMR)

- Airborne microwave radiometer operated at 6 frequencies from 4.6 to 7.2 GHz with vertical incidence
- Measures wind speed and rain rate simultaneously.







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