



DEVELOPMENT AND VALIDATION OF AMSR2 ALL-WEATHER SEA SURFACE WIND SPEED

MISAKO KACHI¹, TAKASHI MAEDA¹, AKIRA SHIBATA² AND NAOTO EBUCHI^{3*}

¹EARTH OBSERVATION RESEARCH CENTER, JAPAN AEROSPACE EXPLORATION AGENCY (JAXA)

²REMOTE SENSING TECHNOLOGY CENTER OF JAPAN (RESTEC)

³INSTITUTE OF LOW TEMPERATURE SCIENCE, HOKKAIDO UNIVERSITY



GCOM-W AND AMSR2

The Advanced Microwave Scanning Radiometer 2 (AMSR2) on board the Global Change Observation Mission – Water (GCOM-W) was launched in May 2012.

- Multi-channel passive microwave radiometer
- Successor of AMSR-E on Aqua and AMSR on ADEOS-II
- Deployable main reflector system with 2.0 m diameter where AMSR-E has 1.6 m
- Frequency channel set that is identical to that of AMSR-E except additional 7.3-GHz channel for RFI mitigation

GCOM-W/AMSR2 characteristics		AMSR2 Channel Set				
Scan and rate	Conical scan at 40 rpm	Center Freq.[GHz]	Band width [MHz]	Pol.	Beam width [deg] (Ground res. [km])	Sampling interval [km]
Antenna	Offset parabola with 2.0m dia.	6.925/7.3	350	V and H	1.8 (35 x 62)	10
Swath width	1450km (> 1600km effective)	10.65	100		1.2 (24 x 42)	
Incidence angle	Nominal 55 degrees	18.7	200		0.65 (14 x 22)	
Digitization	12bits	23.8	400		0.75 (15 x 26)	
Dynamic range	2.7-340K	36.5	1000		0.35 (7 x 12)	
Polarization	Vertical and horizontal	89.0	3000	0.15 (3 x 5)	5	

AMSR2 STANDARD PRODUCTS

Products	Areas	Res.	Accuracy			Range
			Release	Standard	Goal	
Brightness Temperature	Global	5-50 km	±1.5K	±1.5K	±1.0K(systematic) ±0.3K(random)	2.7-340 K
Integrated water vapor	Global, over ocean	15 km	±3.5 kg/m ²	±3.5 kg/m ²	±2.0 kg/m ²	0-70 kg/m ²
Integrated cloud liquid water	Global, over ocean	15 km	±0.10 kg/m ²	±0.05 kg/m ²	±0.02 kg/m ²	0-1.0 kg/m ²
Precipitation	Global, except cold latitude	15 km	Ocean±50% Land±120%	Ocean±50% Land±120%	Ocean±20% Land±80%	0-20 mm/h
Sea surface temperature	Global, over ocean	50 km	±0.8°C	±0.5°C	±0.2°C (zonal mean)	-2-35°C
Sea surface wind speed	Global, over ocean	15km	±1.5 m/s	±1.0 m/s	±1.0 m/s	0-30 m/s
Sea ice concentration	Polar region, over ocean	15 km	±10 %	±10 %	±5 %	0-100 %
Snow depth	Land	30 km	±20 cm	±20 cm	±10 cm	0-100 cm
Soil moisture	Land	50 km	±10 %	±10%	±5 %	0-40 %

List of AMSR2 standard products with their pre-defined accuracies. Release accuracy is minimum accuracy required for data release. Standard accuracy is criteria for mission success. Target accuracy is challenge for extra mission success.

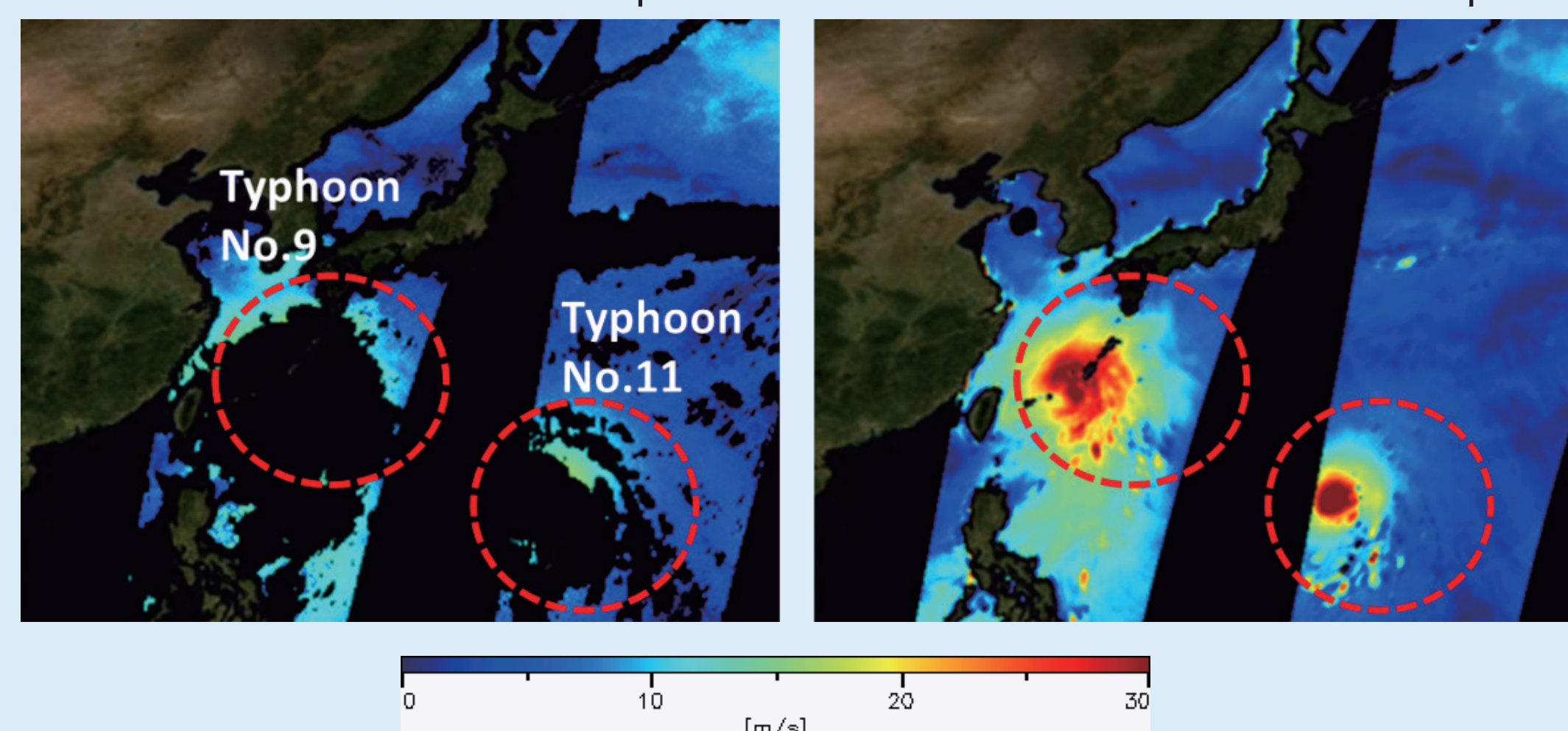
AMSR2 RESEARCH PRODUCTS

Products	Areas	Res.	Target accuracy	Range
All-weather sea surface wind speed	Ocean	60 km	± 7 m/s (for more than 15 m/s range)	0 - 70 m/s
10-GHz SST	Ocean	30 km	± 0.8 °C	9 - 35 °C
Soil moisture and vegetation water content based on the land data assimilation	Africa, Australia	25 km	soil moisture: ± 8 % vegetation water: ± 1 kg/m ²	0 - 100 % 0 - 2 kg/m ²
Land surface temperature	Land	15 km	forest area: ± 3 °C nondense vegetation: ± 4 °C	0-50 °C
Vegetation water content	Land	10 km	± 1 kg/m ²	0 - 4 kg/m ²
High resolution sea ice concentration	Ocean in high latitude	5 km	± 1 %	0 - 100 %
Thin ice detection	Okhotsk sea	15 km	± 80 %	N/A
Sea ice moving vector	Ocean in high latitude	50 km	2 components: 3 cm/s	0 - 40 cm/s

List of AMSR2 research products that was defined in March 2015. Although those products has many challenges in development or difficulty in validation, target accuracy is defined for data release. 10-GHz SST has been incorporated to the standard SST products Ver. 2 since March 2015. All-weather sea surface wind speed (ASW) has been released in Oct. 2015.

ALL-WEATHER SEA SURFACE WIND SPEED

Standard Sea Surface Wind Speed All-weather Sea Surface Wind Speed

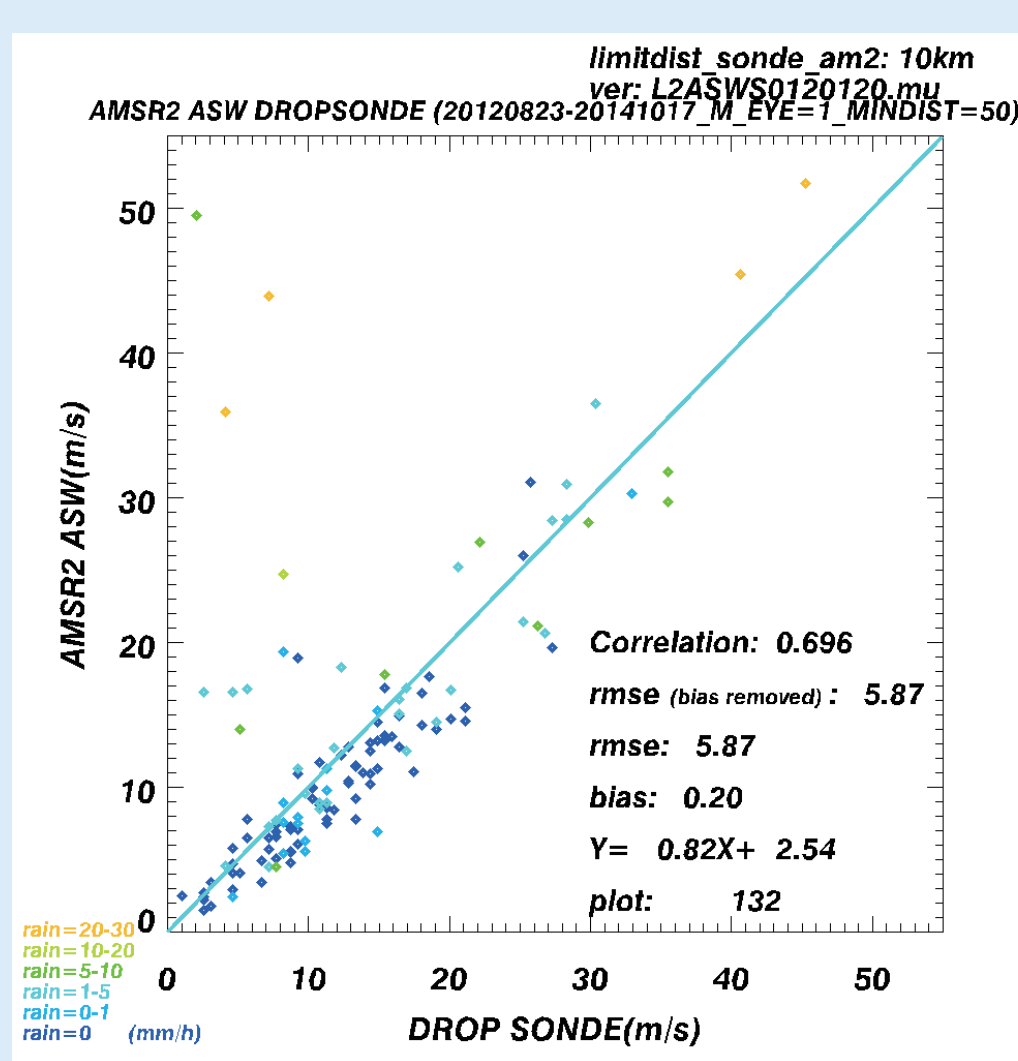


The All-weather sea surface wind speed can estimate wind speed under tropical cyclones or heavy rainfall regions by using both 6-GHz and 10-GHz channels instead of 36-GHz, and originally developed for AMSR-E (Shibata, 2006). Figure shows comparison of AMSR2 standard sea surface wind speed (SSW) and all-weather sea surface wind speed (ASW) for the same observation on July 1, 2015, descending orbits. Typhoon No.9 and 11 in 2015 (within red dashed circles) were located in the south of Japan. While SSW cannot retrieve wind speed under the typhoons, ASW can retrieve but with coarse horizontal resolution.

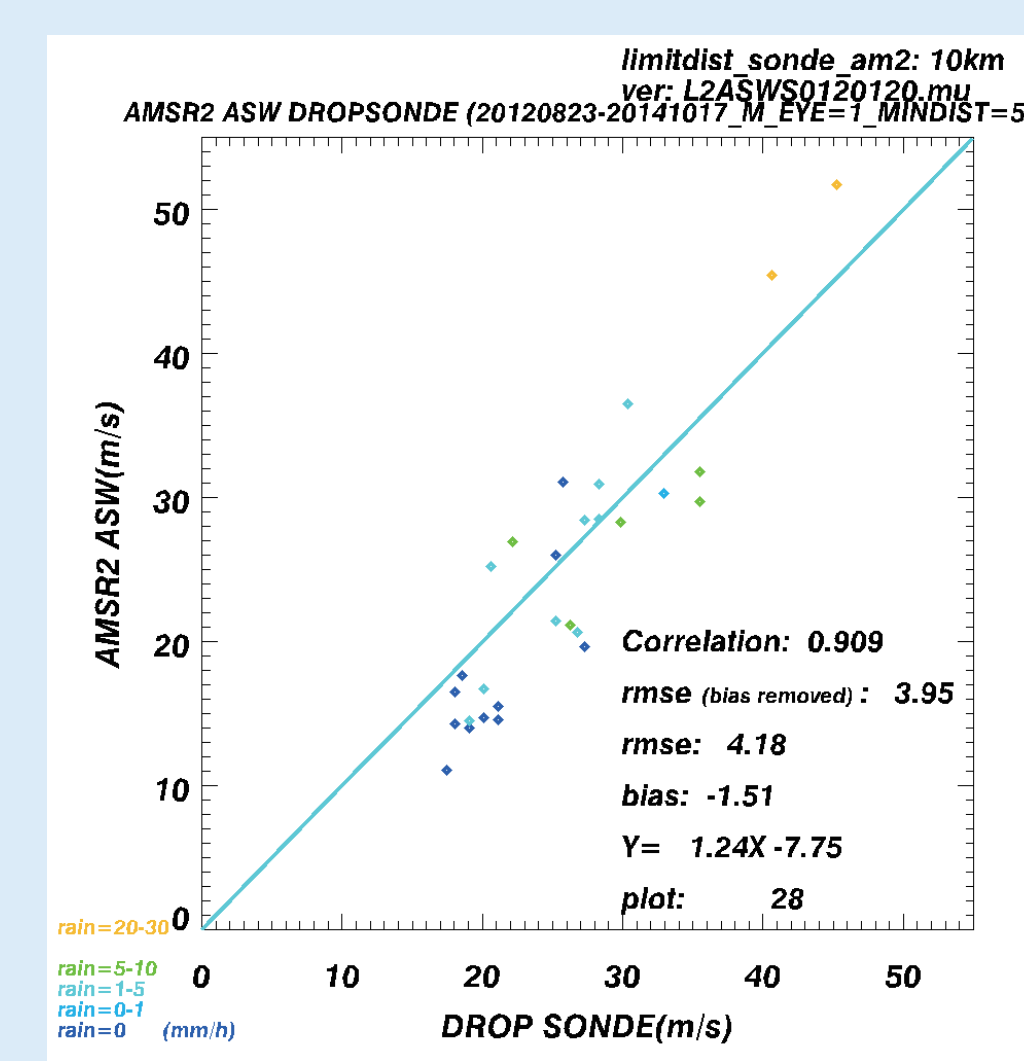
VALIDATION BY DROPSONDE

Validation of ASW is not simple because of lack of available in-situ observations in strong wind speed area. Archives of dropsonde for hurricane observations, provided by US National Hurricane Center (NHC), 1628 samples from June 2002 to December 2006, were used in validation of AMSR-E all-weather sea surface wind speed, and RMSE is 3.2 m/s (Saitoh and Shibata, 2010). Result shows good agreement, but there is no dropsonde observations stronger than 35 m/s.

For AMSR2 ASW, we apply similar method to Saitoh and Shibata (2010). NOAA GPS-dropsonde wind speed data at bottom layer from July 2012 to October 2014 are matched up to AMSR2 ASW observation within 10km in distance and 90 minutes in time differences. Dropsonde data indicated as EYE_EYEWALL and data within 50 km to the best track was removed from validation data.



(Left) Scatter plot between AMSR2 ASW and dropsonde for all wind speed range. RMSE is 5.87 m/s and bias is 0.20 m/s.



(Right) Same as left figure but for wind speed stronger than 17 m/s. RMSE is 4.78 m/s and bias is -1.51 m/s.

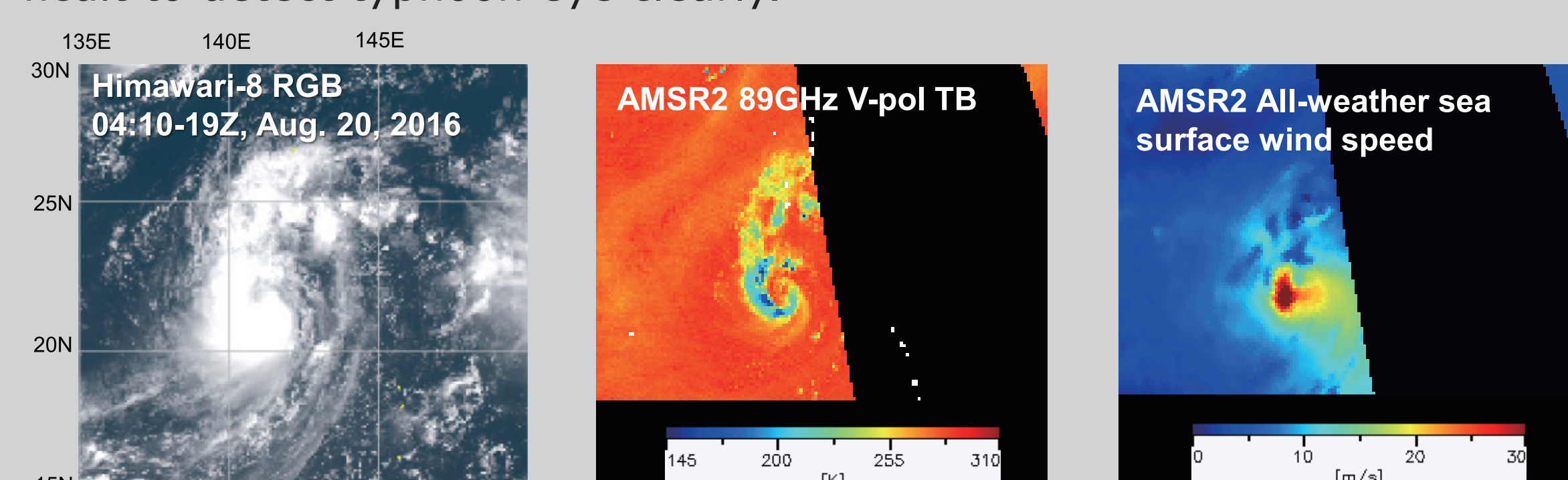
Colors in figures indicate AMSR2 rain rate at each match-up pixel.

GPS-dropsonde data are provided courtesy of the NOAA/AOML/Hurricane Research Division in Miami, FL (USA).

UTILIZATION IN TYPHOON ANALYSIS

AMSR2 ASW research product is released to public in March 2015. Current version has a negative bias about -1.51 m/s in AMSR2 ASW in wind range around 20-30 m/s. We would like to improve the algorithm in future update.

The Japan Meteorological Agency (JMA) uses AMSR2 ASW for their typhoon analysis, and also provides its images over typhoon area to national weather services in Asia to be utilized in their typhoon monitoring to complement cloud images by the geostationary satellite when it is difficult to detect typhoon eye clearly.



Himawari-8 RGB image of Typhoon 11, at 04:10-19Z on August 20, 2016 (left), and AMSR2 89-GHz V-pol. TB (middle) and AMSR2 ASW (right) over the same area at 04:15Z on August 20, 2016.

TO GET ASW DATA

AMSR2 ASW research product has been distributed from the GCOM-W Research Product Distribution Service (left). ASW product for AMSR-E is currently planning to release in near future.

Quick look images of AMSR2 are also available at JASMES for Water Cycle for global area (<http://kuroshio.eorc.jaxa.jp/JASMES/WC.html>).

Match-up images of tropical cyclones are available at the JAXA Tropical Cyclone Real-time Monitoring (http://sharaku.eorc.jaxa.jp/TYPHOON_RT), and images and data are available from the JAXA Tropical cyclone Database (http://sharaku.eorc.jaxa.jp/TYP_DB).

Research Product: http://suzaku.eorc.jaxa.jp/GCOM_W/research/resdist.html
Standard Product: <https://gcom-w1.jaxa.jp/>

