New possibilities for geophysical parameter retrievals opened by GCOM-W1 AMSR2

Zabolotskikh Elizaveta[1], Mitnik Leonid[2], Reul Nicolas[3], Chapron Bertrand[3]

[1] Russian State Hydrometeorological University, Russia, St. Petersburg, Russia,
[2] Pacific Oceanological Institute RAS, Vladivostok, Russia
[3] IFREMER, Brest, France

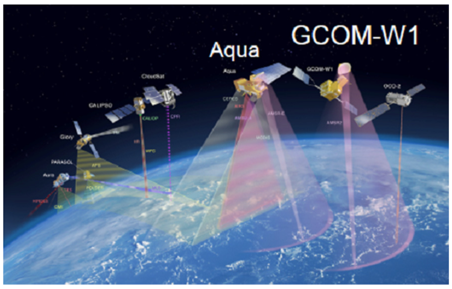
Additional channels — Better than AMSR-E

AMSR2 Channel Set

Center Freq. [GHz]	Band width [MHz]	Polarization	Beam width [deg] (Ground res. [km])	Sampling interval [km]
6.925 / 7.3	350	V & H	1.8 (35 × 61)	10
10.65	100		1.2 (24 × 41)	
18.7	200		0.65 (13 × 22)	
23.8	400		0.75 (15 × 26)	
36.5	1000		0.35 (7 × 12)	
89.0(A&B)	3000		0.15 (3 × 5)	5

Same as AMSR-E

The great success of AMSR-E (2002-2011) revolved to the design of its successor AMSR2, launched on the Japanese GCOM-W1 satellite on 18 May 2012. The new AMSR2 instrument has two additional channels in C-band intended for removing from data the pixels, contaminated by radio-frequency interference (RFI). Measurements in C and X bands are not saturated up to high rain rates hence they can be used in ocean parameter and rain rate retrievals.

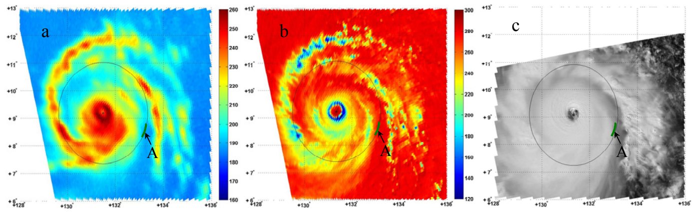


GCOM-W1 AMSR2 rain free algorithms for Sea Surface Wind Speed (SWS) retrievals

- Are based on numerical experiment and physical modeling of AMSR2 brightness temperatures;
- Use Neural Networks as an inversion function;
- Are validated against matched-up AMSR2-buoy measurement data;
- Two SWS algorithms are developed – 1) using low frequency AMSR2 channels (LF algorithm - higher accuracy, lower resolution) and 2) using higher frequency AMSR2 channels (HF algorithm - lower accuracy under optically thick atmospheres, higher resolution);
- Use newly developed atmospheric filtering based on the value of total atmospheric absorption $\tau_{10.65}$ as a criterion for weather masking

(Zabolotskikh E.V., L.M. Mitnik, B. Chapron, (2013). New approach for severe marine weather study using satellite passive microwave sensing. *Geophys. Res. Lett.*, doi:10.1002/grl.50664)

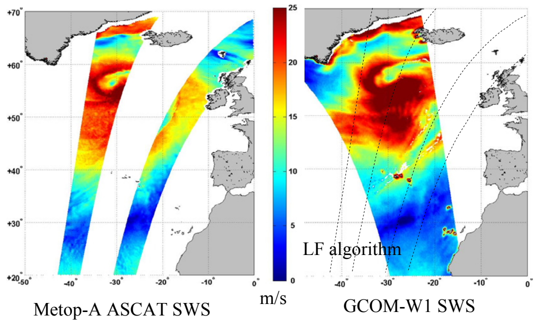
GCOM-W1 AMSR2 all weather algorithms for SWS and Rain Rate (RR) retrievals



Brightness temperature fields measured by AMSR2 on 7 November 2013 at ~ 4:20 UTC over the typhoon Haiyan (a) at 10.65 GHz, vertical polarization and (b) at 89 GHz, vertical polarization and (c) Aqua MODIS visible image at ~ 4:23 UTC . Area A, marked by dark green line, corresponds to rain-free region. The black dot corresponds to the typhoon center

Validation of GCOM-W1 AMSR2 rain-free SWS algorithms:

1) using Metop-A ASCAT for extratropical cyclones over the North Atlantic



26 January 2013 ~ 12:00 -14:00 UTC

2) using Norwegian and North Sea oil platform high wind speed measurements

root mean square error for about 6500 match-ups σ = 1.4 m/s

(Zabolotskikh E.V., L.M. Mitnik , B. Chapron, (2014). GCOM-W1 AMSR2 and MetOp-A ASCAT wind speeds for the extratropical cyclones over the North Atlantic. Remote Sensing of Environment, doi:10.1016/j.rse.2014.02.016)

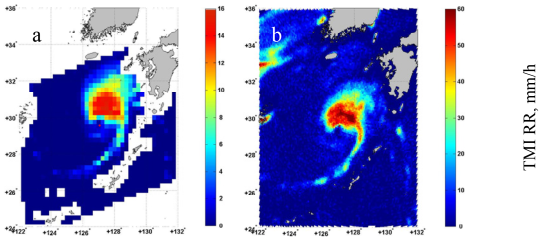
under rain:

- Microwave brightness temperatures over the oceans under rain conditions (T_B) increase towards a maximum and then drop off as rainfall rate (RR) increases further due to scattering on rain particles;
- Lower frequency T_B (in C- and X-bands) tends to increase through most of RR range without saturation up to more than 30 mm/h (depending on freezing level) , thus making them suitable for being used in oceanic parameter retrievals;
- Areas with high RR (> 30 mm/h) decrease with RR increase. Averaging over large spatial areas, typical for C- and X-bands, leads to much lower RR to be considered than for higher frequency measurements;

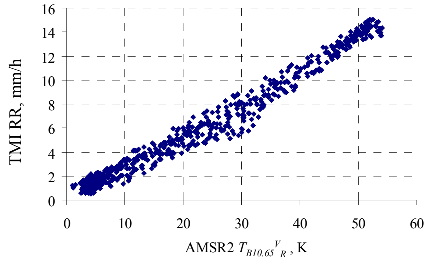
two assumptions are done for A part of the circle

- Atmospheric parameter variations influencing T_B in C- and X-bands are negligible for the area of equal distance from the cyclone center which does not relate rain (A section);
- Though wind speed variations influencing T_B in C- and X-bands cannot be priori considered negligible (wind field can be significantly asymmetric), wind dependency in C- and X-bands is very similar. So to some extension $\Delta T_B{}^V{}_{7.6} = T_{B\,7.3}{}^V - T_{B\,6.9}{}^V$ and $\Delta T_B{}^V{}_{10.7} = T_{B\,10.65}{}^V - T_{B\,7.3}{}^V$ do not depend on the sea state but rather the functions of rain rate;

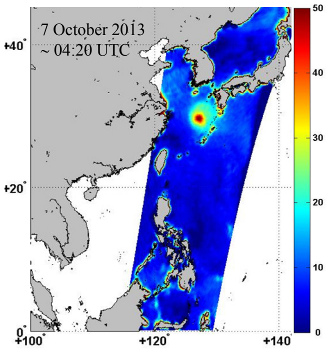
So we postulate that over most rainy atmospheres rain emission in C- and X-bands can be parameterized in terms of $\Delta T_B{}^V{}_{7.6}$ and $\Delta T_B{}^V{}_{10.7}$. and related to rain rate (RR). After subtraction of the rain emission part from the total T_B rain-free SWS can be applied. SWS can be retrieved even over hurricanes.



(a) TMI rain rate field (mm/h) for the typhoon Danas on 7 October 2013 (http://www.remss.com/) at ~ 18:36 UTC; (b). AMSR2 derived rain brightness temperature (K) at 10.65 GHz vertical polarization at ~ 17:14 UTC. Red dots indicate the center of the typhoon at ~ 17:14 UTC

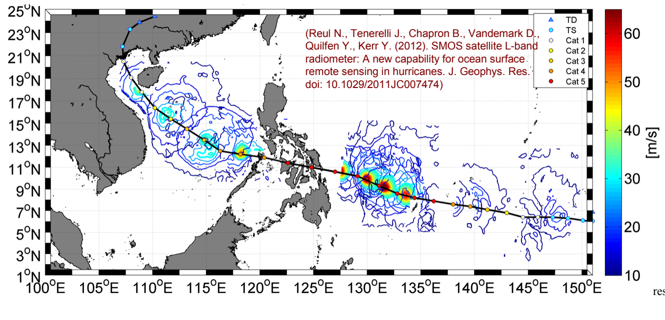


TMI RR as a function of AMSR2 derived rain brightness temperature at 10.65 GHz vertical polarization $T_{B10.65}{}^V{}_R$

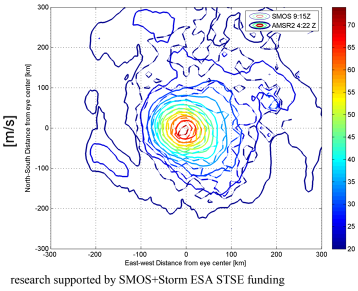


Typhoon Danas. SWS fields derived from AMSR2

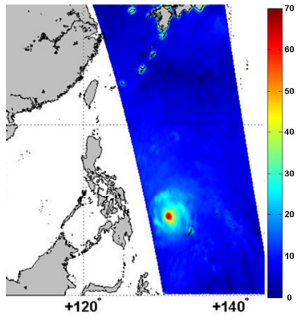
SMOS-AMSR2 for supertyphoon Haiyan (3-11 November 2013)



(Reul N., Tenerelli J., Chapron B., Vandemark D., Quilfen Y., Kerr Y. (2012). SMOS satellite L-band radiometer: A new capability for ocean surface remote sensing in hurricanes. J. Geophys. Res. doi: 10.1029/2011JC007474)



research supported by SMOS+Storm ESA STSE funding



Typhoon Haiyan. SWS fields derived with AMSR2 LF algorithm.

7 November 2013 ~ 04:20 UTC