Estimation of the sea surface wind in the vicinity of typhoon using Himawari-8 low-level AMVs

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13th International Winds Workshop
June 27 – July 1, 2016
@Monterey, California, USA

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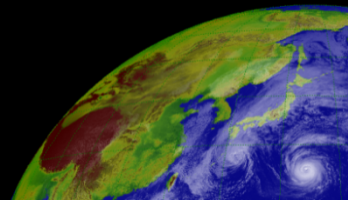
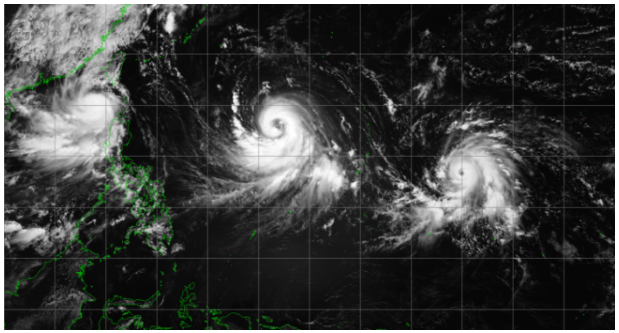


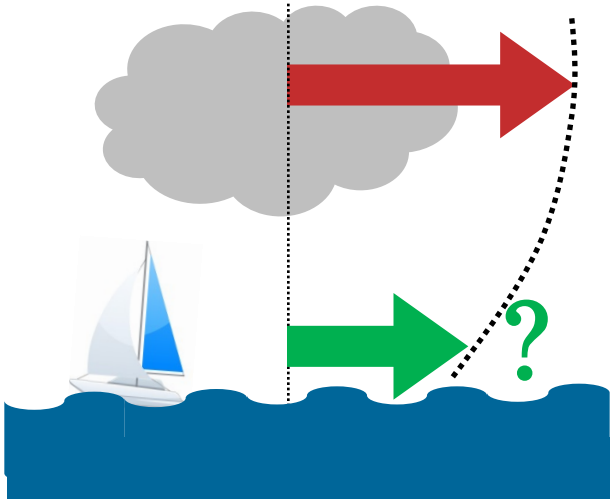
- Usefulness of Himawari-8 AMV for typhoon analysis
- Comparison low-level AMV with ASCAT and RapidScat and estimation of sea surface wind from AMV
- Accuracy of the estimated sea surface wind
- Future plans
- Summary

Typhoon analysis

Analysts and forecasters estimate the tropical cyclone intensity using wind data over the ocean. But in situ observations such as ships and buoys are sparse.
ASCAT and RapidScat sea wind data are very helpful and are mainly used for the analysis, but the amounts of data are not so enough.

If we can evaluate surface winds over the ocean from AMVs that assigned to low level, they are also very helpful for analysts and forecasters.

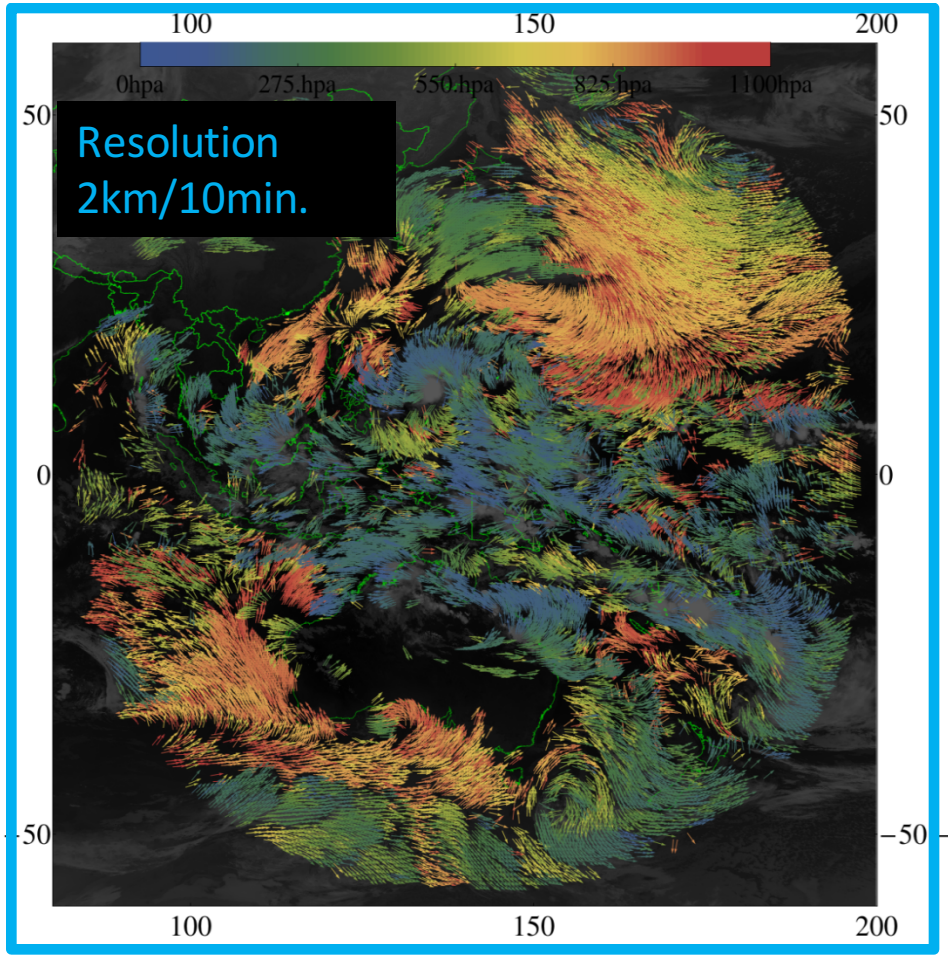


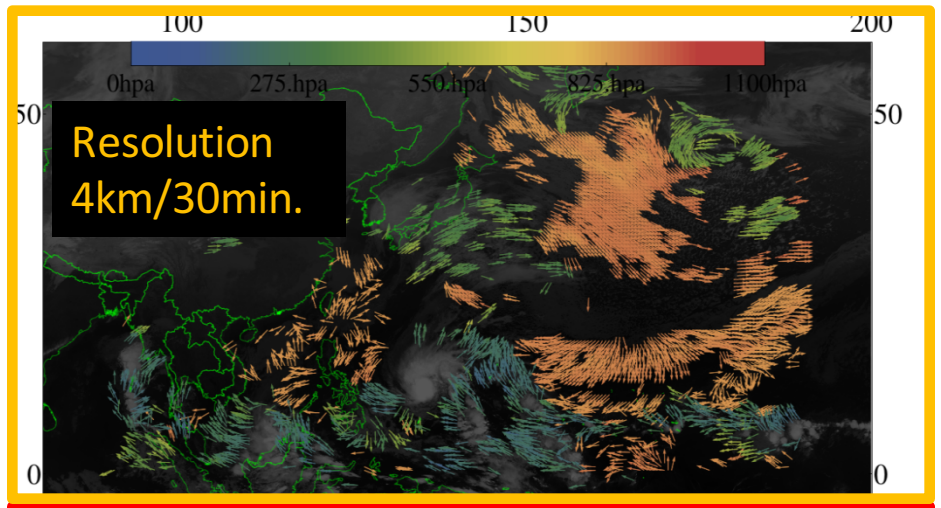


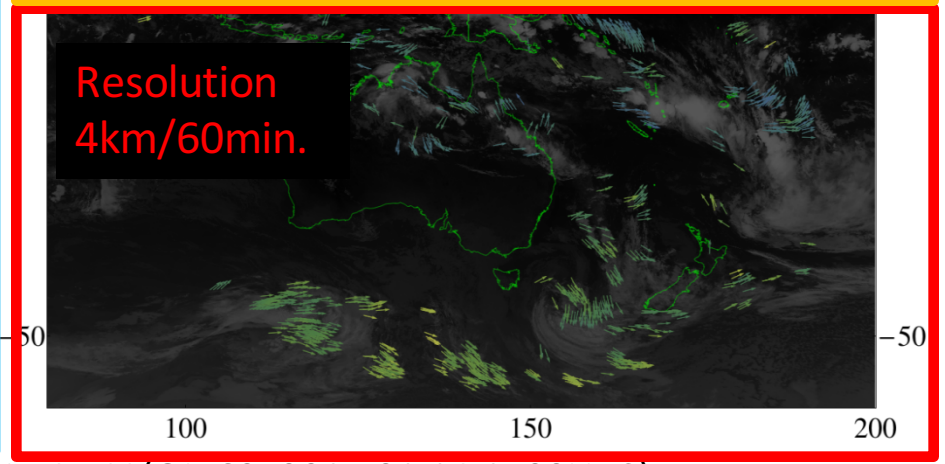
Improvement in AMVs Retrieval

Himawari-8 AMVs derived from Himawari-8 imagery with new algorithm

MTSAT-2 AMVs derived from MTSAT-2 imagery and heritage algorithm

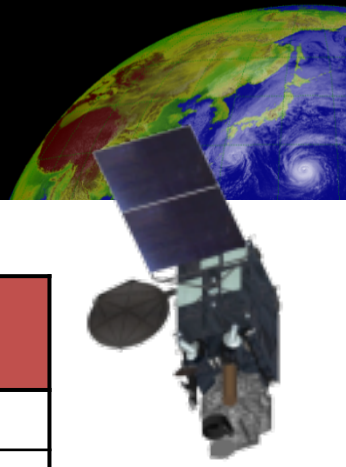






Himawari-8 and MTSAT-2 IR AMV (QI>60, 2015 01 14 1700UTC)

AHI spectral bands

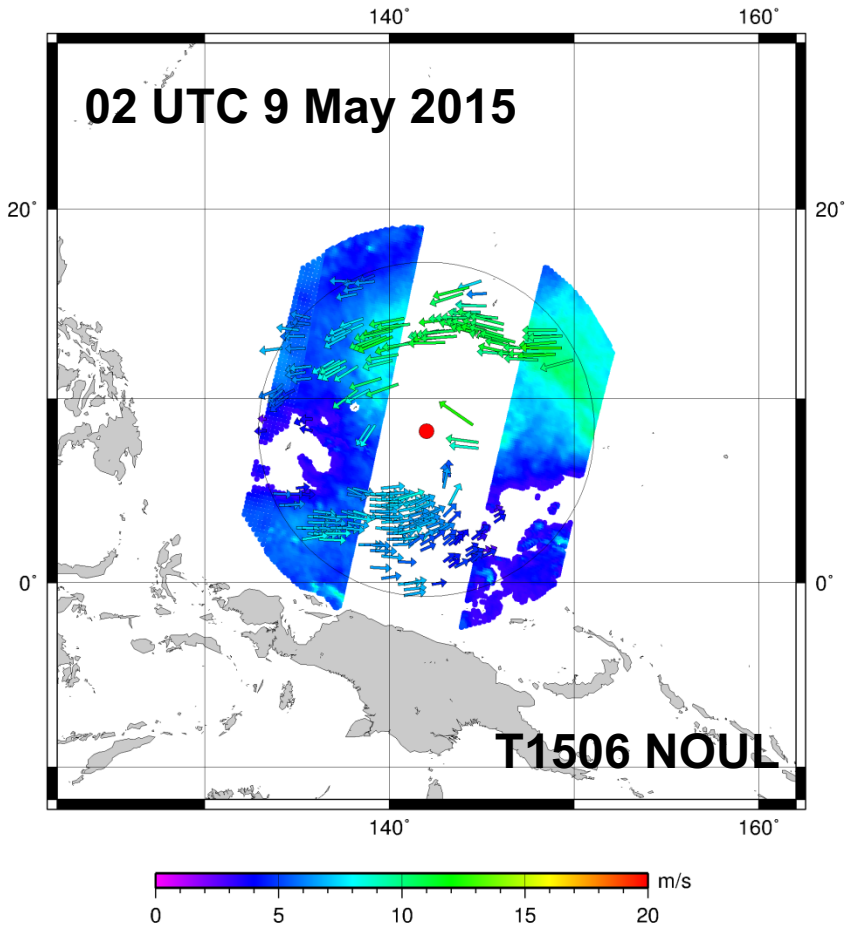


Himawari-8/9 Imager (AHI)

Band		Spatial Resolution	Central Wavelength	Primary Use
1	Visible	1 km	0.47 μm	vegetation, aerosol
2			0.51 μm	vegetation, aerosol
3		0.5 km	0.64 μm	Vegetation, low cloud, fog
4	Near Infrared	1 km	0.86 μm	vegetation, aerosol
5		2 km	1.61 μm	cloud phase
6			2.26 μm	particle size
7			3.9 μm	low cloud, fog, forest fire
8	Infrared	2 km	6.2 μm	mid- and upper-level moisture
9			6.9 μm	mid-level moisture
10			7.3 μm	mid- and lower-level moisture
11			8.6 μm	cloud phase, SO_2
12			9.6 μm	Ozone content
13			10.4 μm	cloud imagery, information of cloud top
14			11.2 μm	cloud imagery, sea surface temperature
15			12.4 μm	cloud imagery, sea surface temperature
16			13.3 μm	cloud top height

Comparison with ASCAT/RapidScat

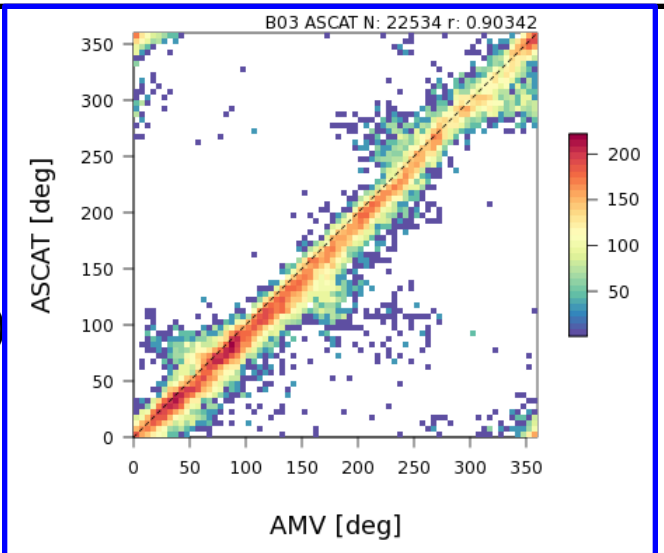
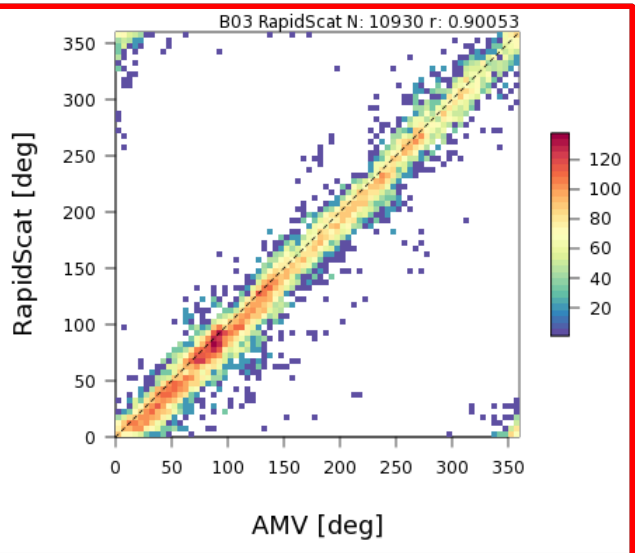
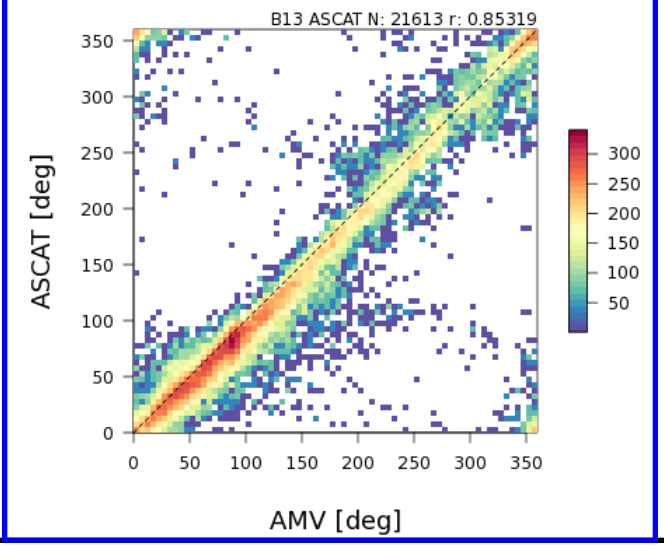
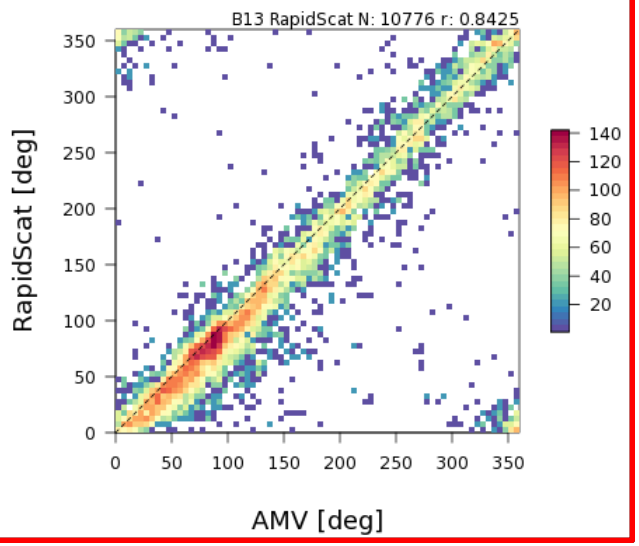
Collocation Himawari-8 AMV with ASCAT/RapidScat sea wind within 1000 km radius from center of typhoon.



- Low-level AMV : AMVs that of height are estimated below 700hPa and for QI (w/o forecast) >= 80%
- Collocated sea winds that are within 0.2 degrees (lat/lon) from low-level AMVs and also selected ones that are the temporally nearest within 1 hour before AMV observation time.
- Used the best-track data (2015) determined by JMA for tropical cyclone center position.
- Analyzed typhoons formed on March to December, 2015 (T1506 – T1527).

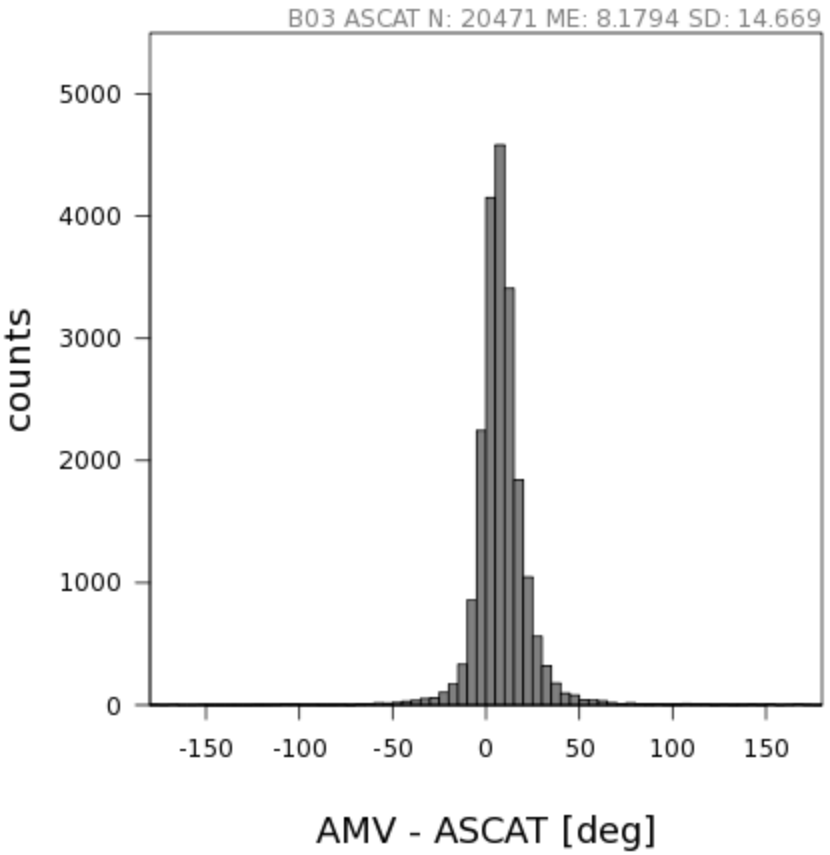
← low-level AMVs (vectors) and ASCAT seawind speed (shading) (T1506 Noul)
Radius of the circle is 1000 km from the center of Typhoon Noul.

Comparison between low-level AMV and Sea wind - wind direction -

	ASCAT	RapidScat
band 3 (0.64 um)		
band 13 (10.4 um)		

Differences between low-level AMV and sea winds - wind direction -

Differences between low-level AMV and sea winds of the scatterometers (ASCAT / RapidScat).



Wind direction differences between low-level AMV and ASCAT

Differences between ASCAT and low-level AMV

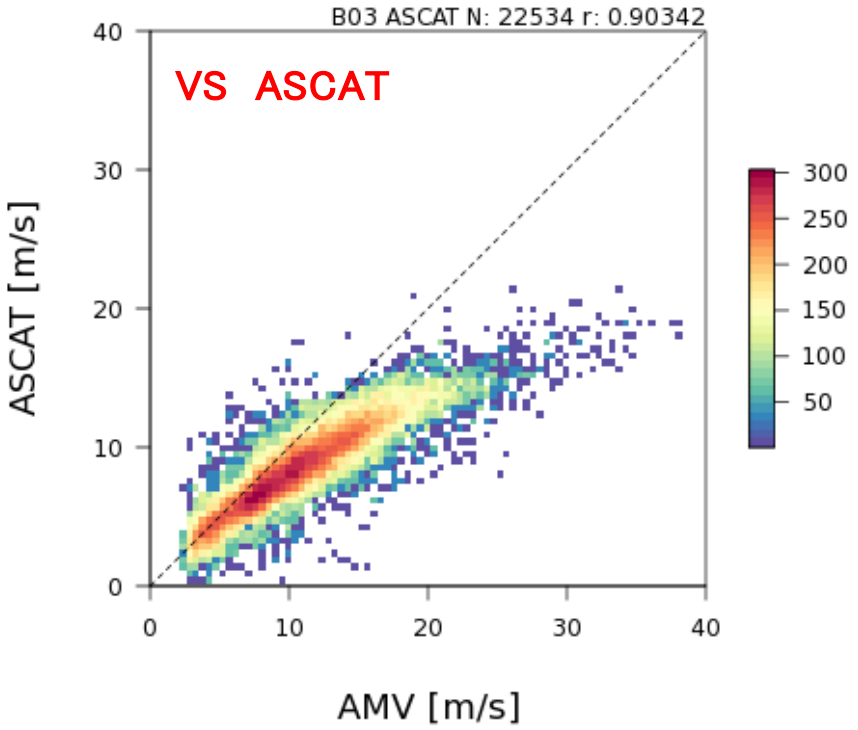
AMV>=5m/s	SD [deg]	Bias [deg]
B3 (0.64um)	14.7	8.18
B7 (3.9um)	17.2	9.23
B13 (10.4um)	18.6	8.57

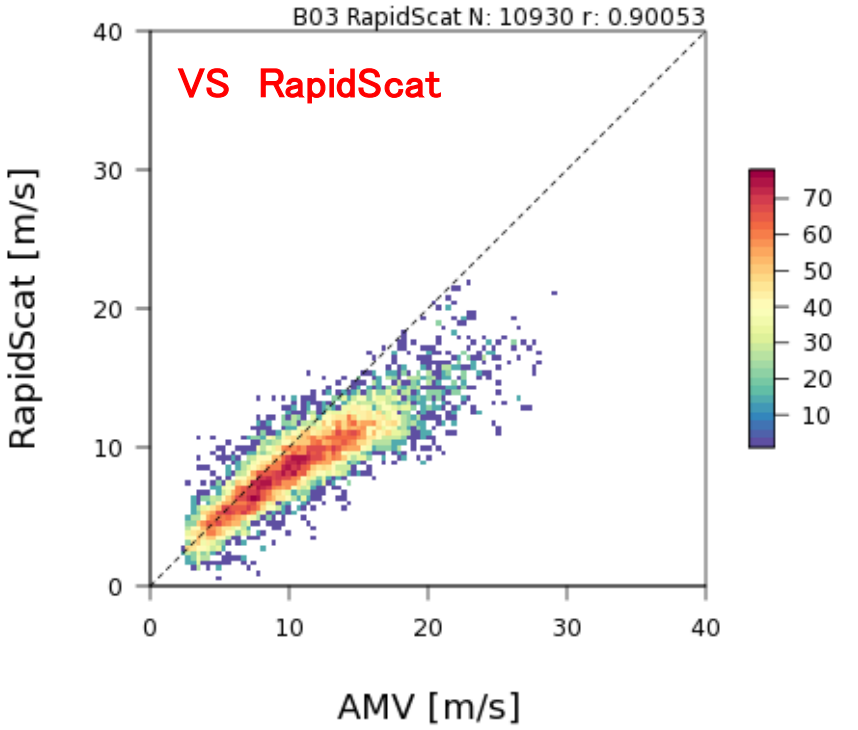
Differences between RapidScat and low-level AMV

AMV>=5m/s	SD [deg]	Bias [deg]
B3 (0.64um)	13.1	8.65
B7 (3.9um)	16.9	9.70
B13 (10.4um)	18.7	9.22

These values are calculated for low-level AMVs that speed are more than 5m/s , QI(w/o forecast) ≥ 80%

Comparison between low-level AMV and sea wind
- wind speed -



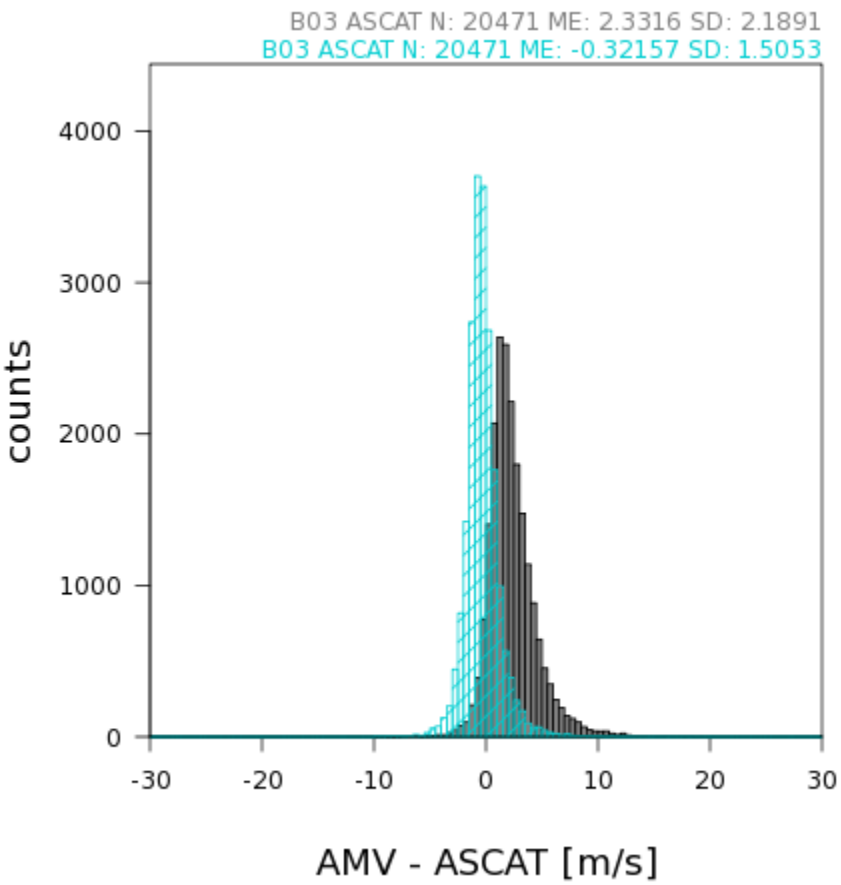


AMV height ≥ 700hPa , QI(w/o forecast) ≥ 80%

- Between ASCAT/RapidScat sea wind and low-level AMV, there are good correlations (r~0.9).
- Adjusting low level AMVs to sea winds with using linear regression equation, wind speed over the ocean is estimated with reducing factor 0.76 (0.7~0.8). We can simply evaluate the sea surface wind speed by the following,

ASCAT sea wind ~ 0.76 x Low-Level AMV

Accuracy of the estimated sea surface wind



Speed difference between low-level AMV and ASCAT

Speed difference between estimated sea surface wind and ASCAT

Using the factor 0.76 for low-level AMV and estimated sea surface wind. Its error with ASCAT / RapidScat is following.

accuracy of speed differences between ASCAT and estimated sea surface wind

AMV>=5m/s	RMSE [m/s]	Bias [m/s]
B3 (0.64um)	1.54	-0.322
B7 (3.9um)	1.63	-0.441
B13 (10.4um)	1.72	-0.630

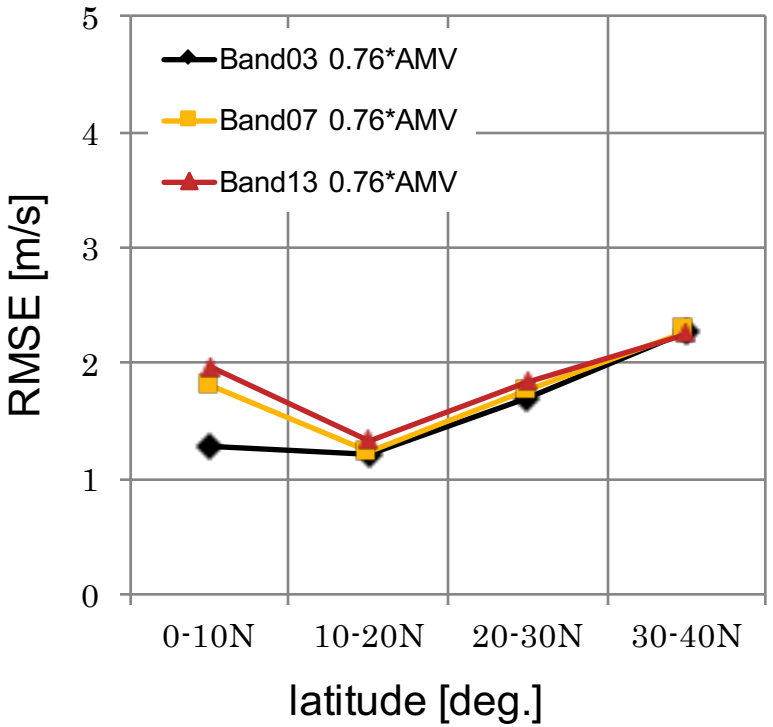
between RapidScat and estimated surface wind

AMV>=5m/s	RMSE [m/s]	Bias [m/s]
B3 (0.64um)	1.57	-0.623
B7 (3.9um)	1.90	-0.765
B13 (10.4um)	1.96	-0.844

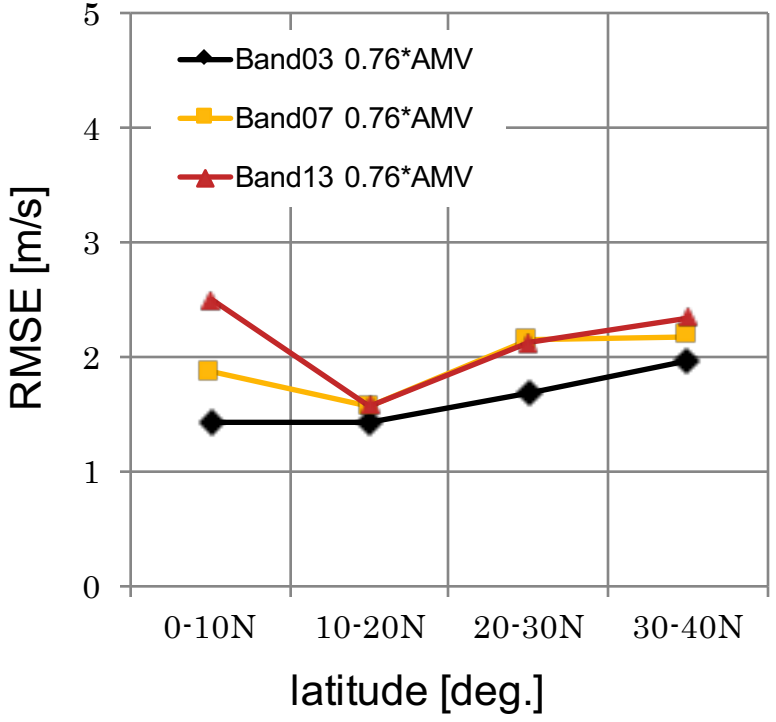
RMSEs are calculated for low-level AMVs that speed are above 5m/s , QI(w/o forecast) ≥ 80%

Latitude dependency of the accuracy

The accuracy of speed differences between ASCAT and reduced AMV

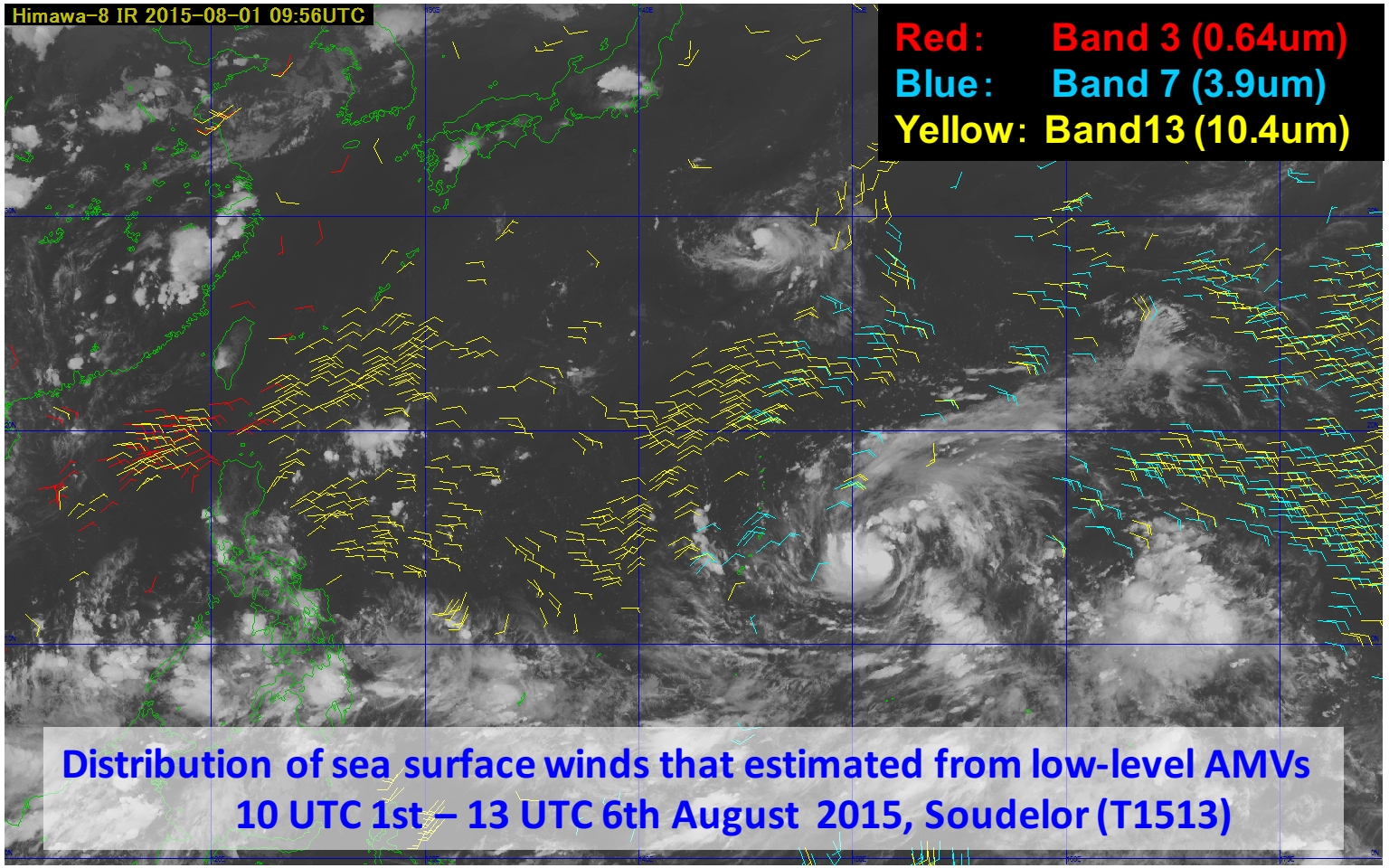


The accuracy of speed differences between RapidScat and reduced AMV



RMSE is calculated for Low-level AMVs ≥ 5m/s, QI(w/o forecast) ≥ 80%

- Sea surface wind speed that estimated with reduced factor, the errors are approximately 1.2 to 2.5 m/s (RMSE) for three bands AMVs (band 3, 7 and 13) in comparison with ASCAT and RapidScat for each latitude.
- The accuracy tends to be worse on higher latitude.

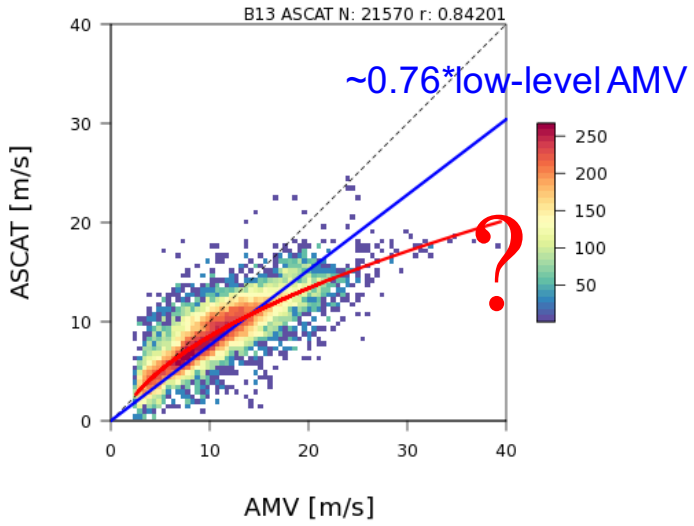


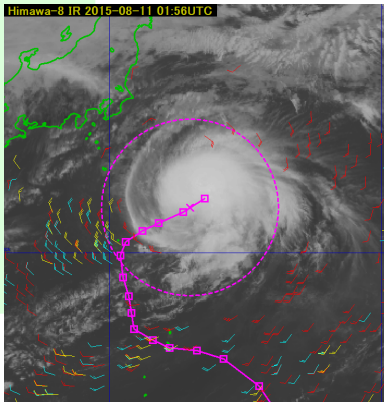
Visible band AMVs are the most numerous of the three bands AMVs.

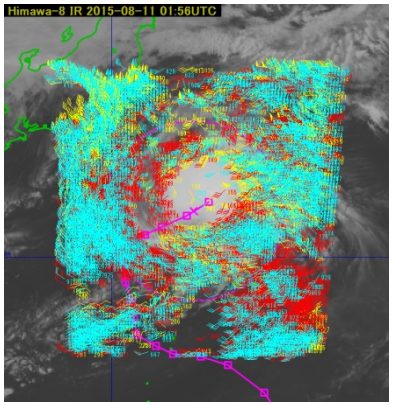
Future Plans

1 To optimize more relevant regression equation for higher wind region. (Statistics of over 20 m/s are not frequent.)

2 To use AMVs that calculated from AHI's typhoon target observation images.

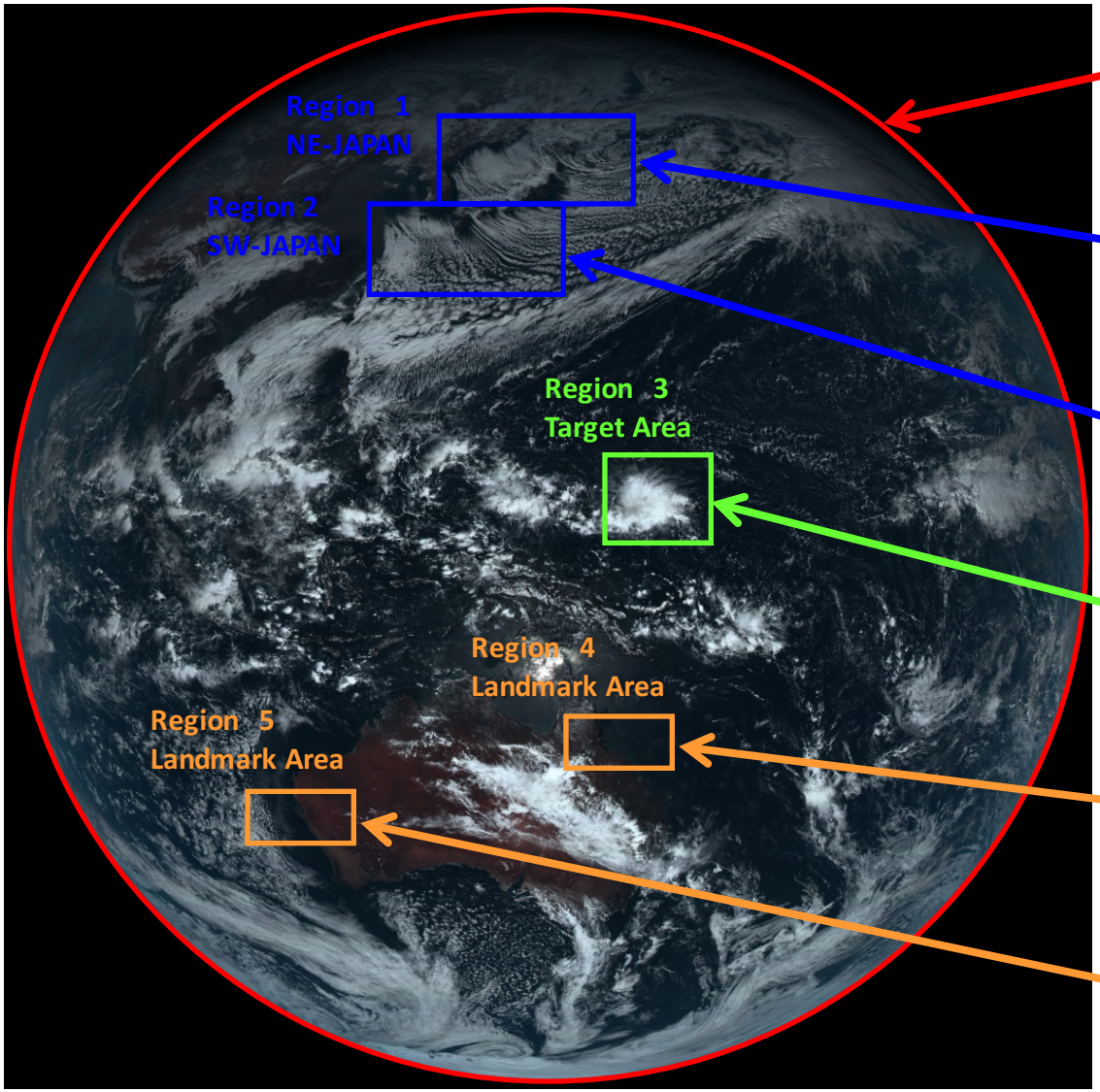






MSC/JMA

AHI Observation Modes



Full disk

Interval : **10 minutes** (6 times per hour)

Region 1 JAPAN (North-East)

Interval : **2.5 minutes** (4 times in 10 min)

Dimension : EW x NS: 2000 x 1000 km

Region 2 JAPAN (South-West)

Interval : **2.5 minutes** (4 times in 10 min)

Dimension : EW x NS: 2000 x 1000 km

Region 3 Target Area

Interval : **2.5 minutes** (4 times in 10 min)

Dimension : EW x NS: 1000 x 1000 km

Region 4 Landmark Area

Interval : **0.5 minutes** (20 times in 10 min)

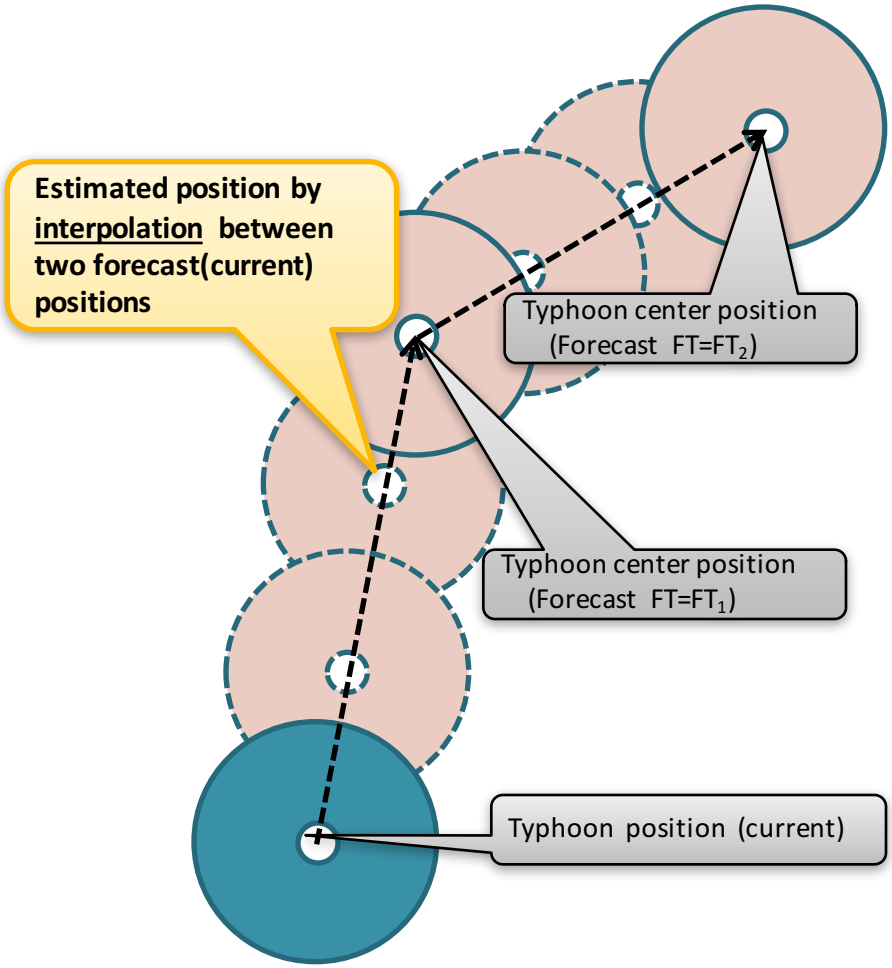
Dimension : EW x NS: 1000 x 500 km

Region 5 Landmark Area

Interval : **0.5 minutes** (20 times in 10 min)

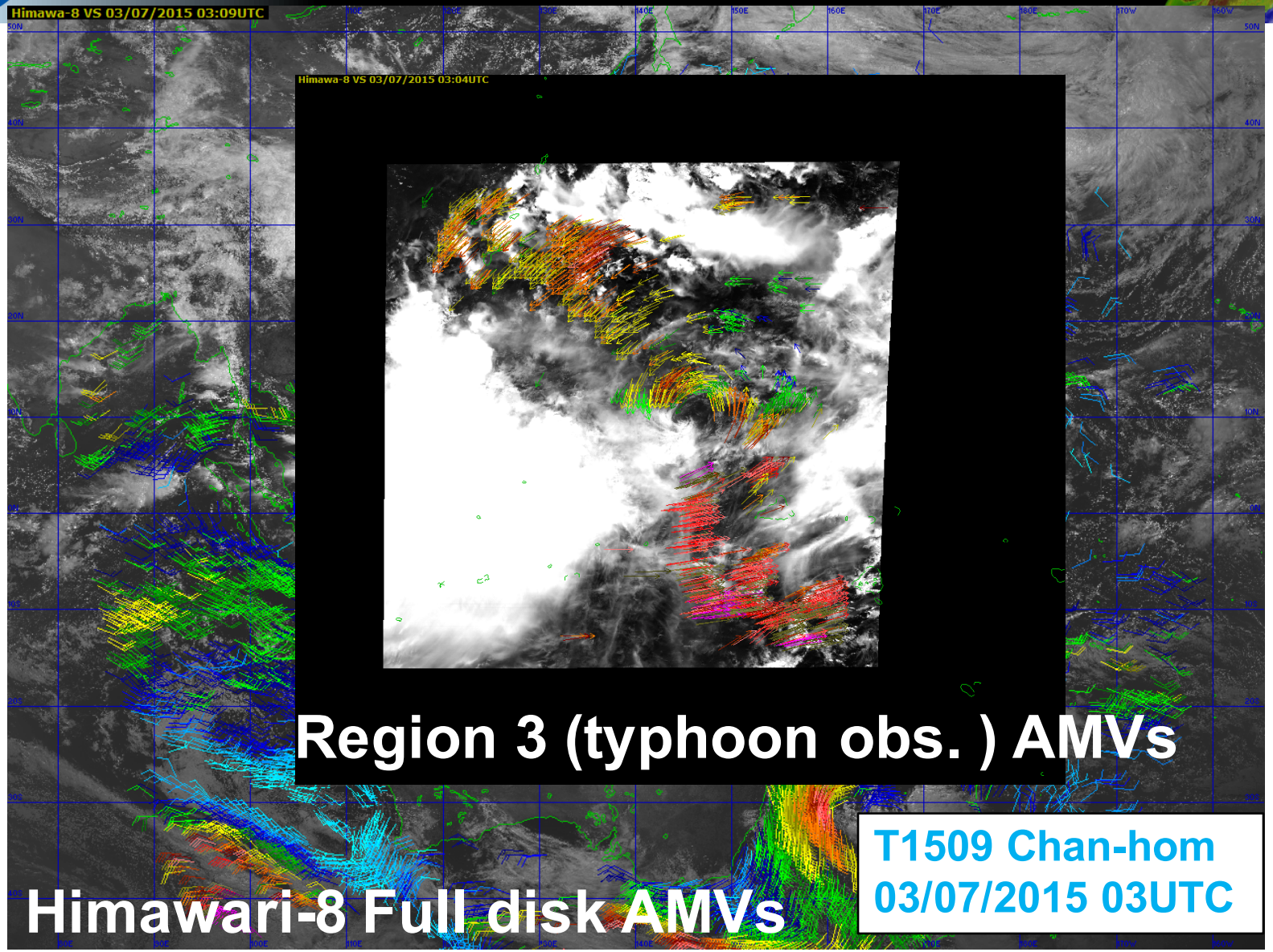
Dimension : EW x NS: 1000 x 500 km

Target Area Observation (Typhoon)



21UTC on 9th – 10UTC on 10th, May 2015
Typhoon Noul (2015) Band 03

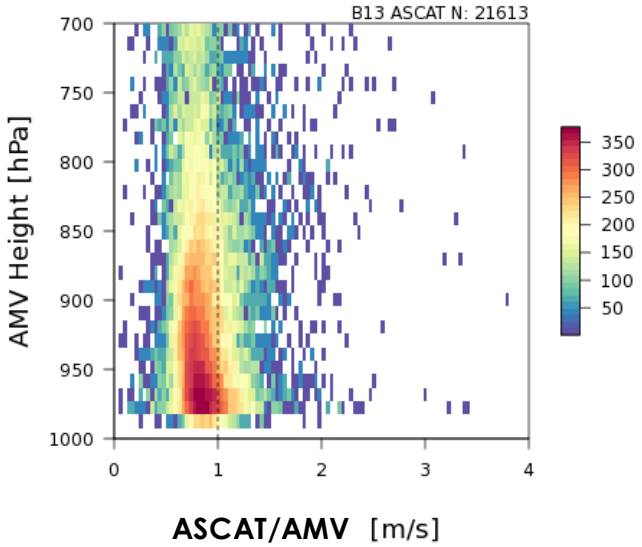
Future plan 2 - AHI region 3 observation



Summary

- Wind speed around a tropical cyclone that estimated from Himawari-8 low level AMV with the reduced factor is simple but helpful for typhoon analysis especially over the ocean.
- Accuracy of the sea surface wind evaluated from AMV will be improved by optimization for high speed region.
- AMVs that derived from AHI's flexible observation imagery will provide more information on the vicinity wind of tropical cyclones and will be more helpful for typhoon analysis.

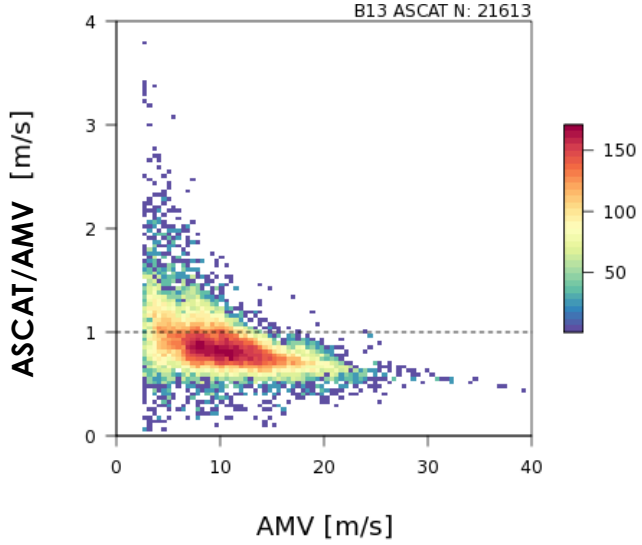

Thank you for your kind attention !

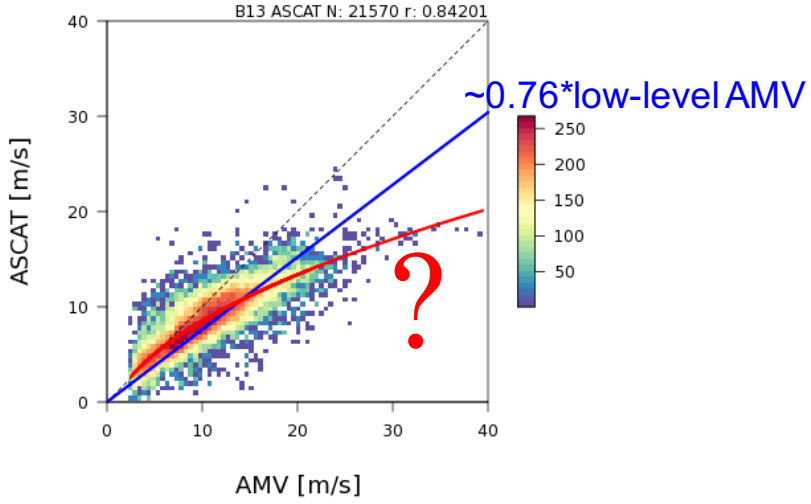


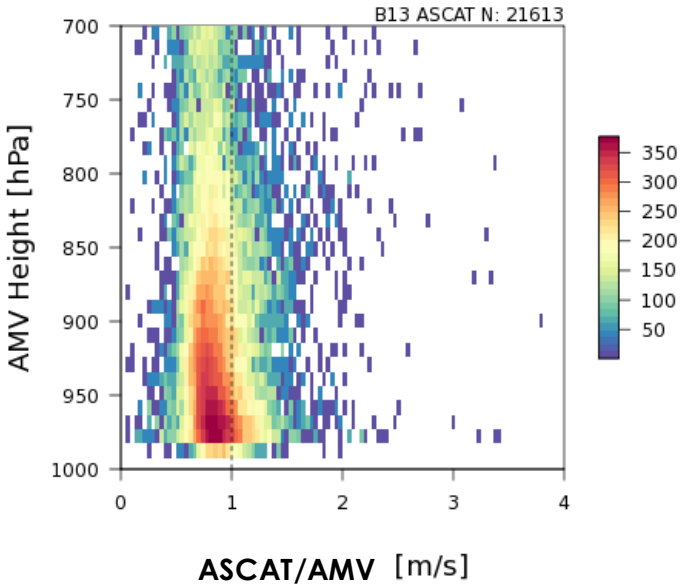
- Correlation between speed ratio and AMV height is not so clear.
- Correlation between AMV speed and speed ratio is recognized.

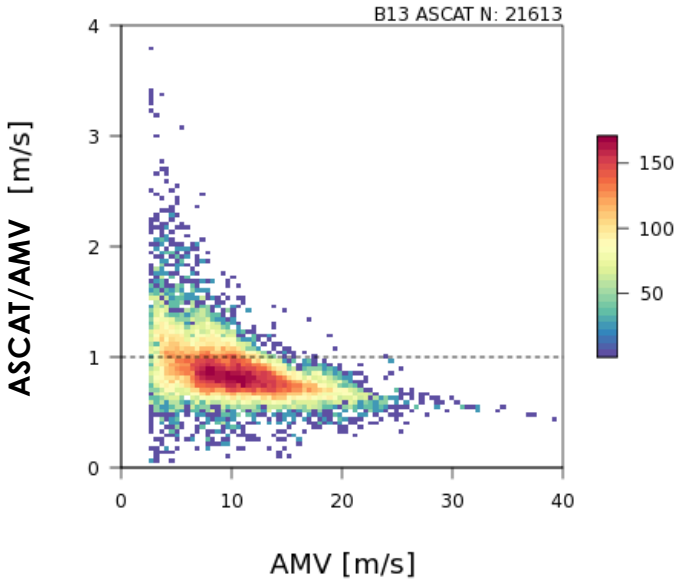
- To optimize more relevant regression equation for more high speed data using with AMV speed (and height) .

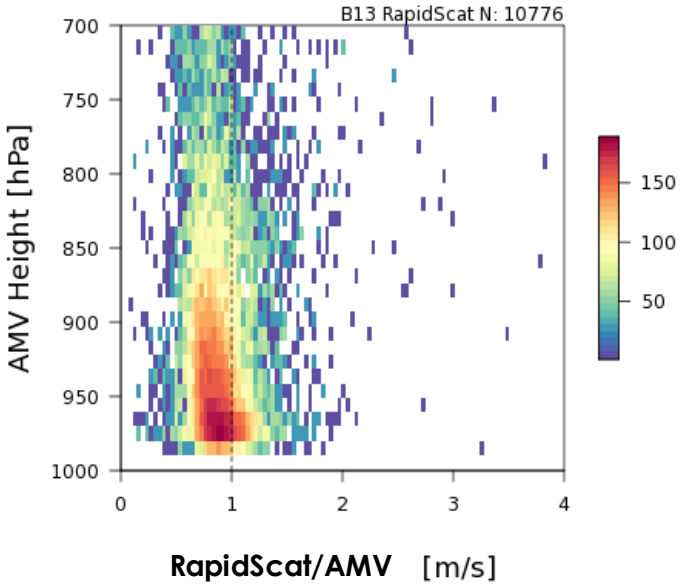
  sea wind ~ f(speed, height) ?

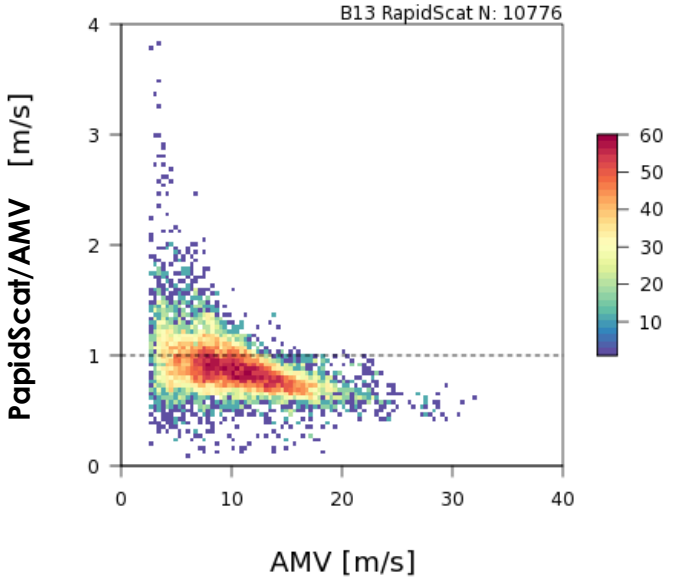


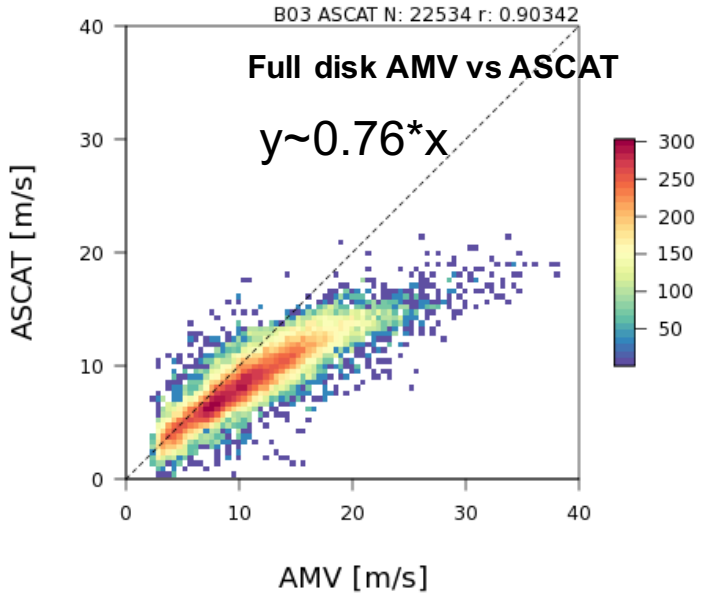


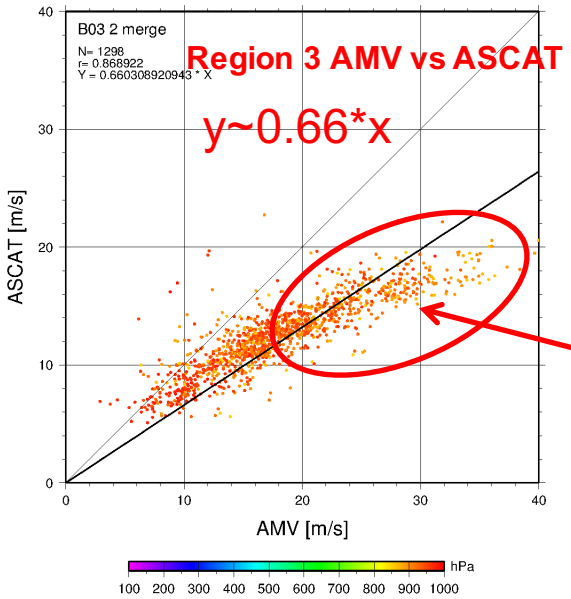

B13 ASCAT N: 21613
AMV Height [hPa]
700
750
800
850
900
950
1000
0
1
2
3
4
ASCAT/AMV [m/s]
350
300
250
200
150
100
50


B13 ASCAT N: 21613
ASCAT/AMV [m/s]
4
3
2
1
0
0
10
20
30
40
AMV [m/s]
150
100
50

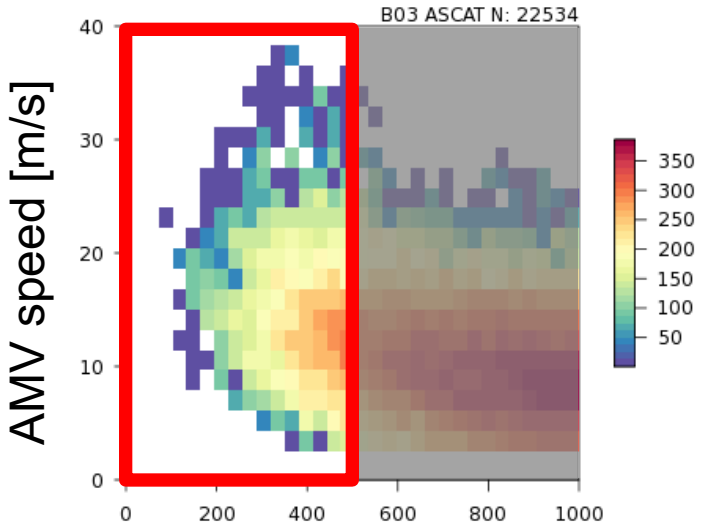

B13 RapidScat N: 10776
AMV Height [hPa]
700
750
800
850
900
950
1000
0
1
2
3
4
RapidScat/AMV [m/s]
150
100
50


B13 RapidScat N: 10776
PapidScat/AMV [m/s]
4
3
2
1
0
0
10
20
30
40
AMV [m/s]
60
50
40
30
20
10





Region 3 (typhoon obs. area) :
within about 500km from center of typhoon



Higher speed wind data will be increased.

If we use region-3 AMVs, the number of low level AMVs near typhoon's eye are increased.