

Data processing and application of HY-2A microwave scatterometer

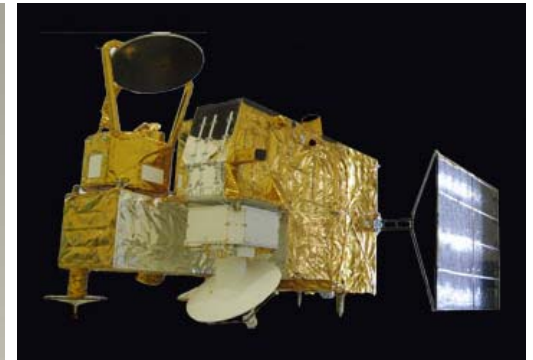
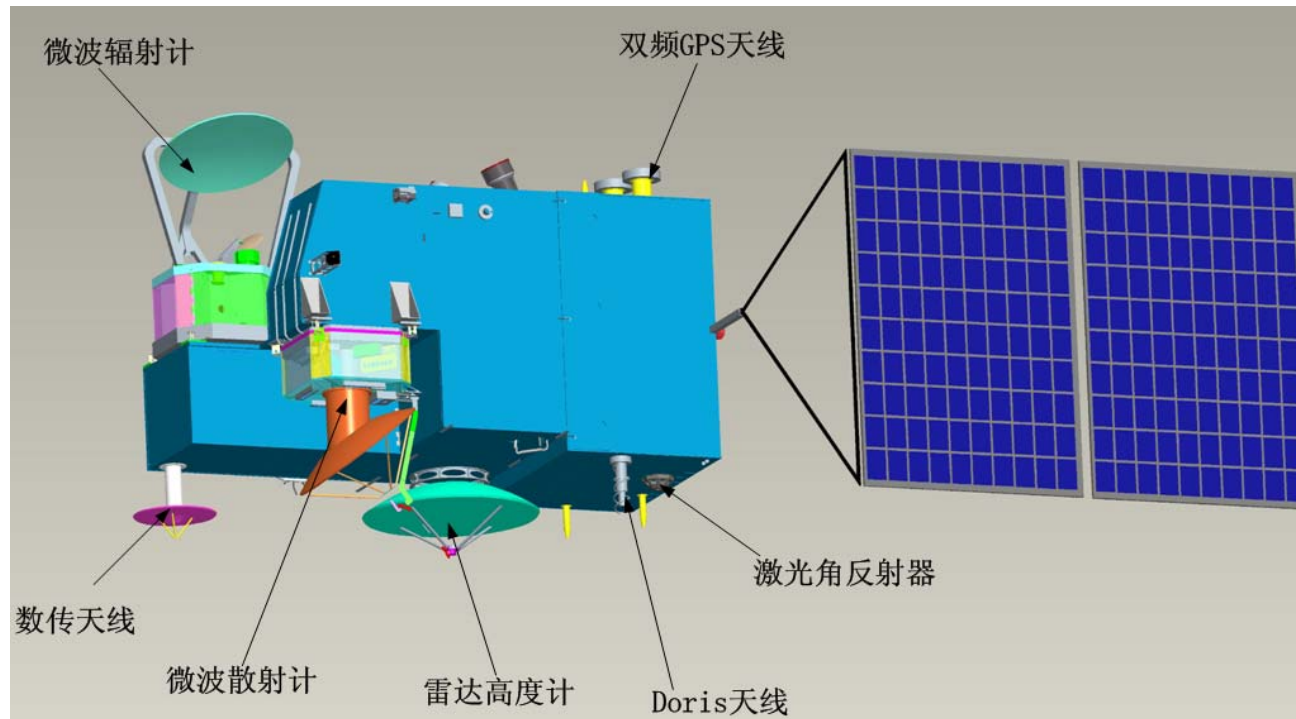
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National Satellite Ocean Application Service(NSOAS)

May, 2016
Sapporo

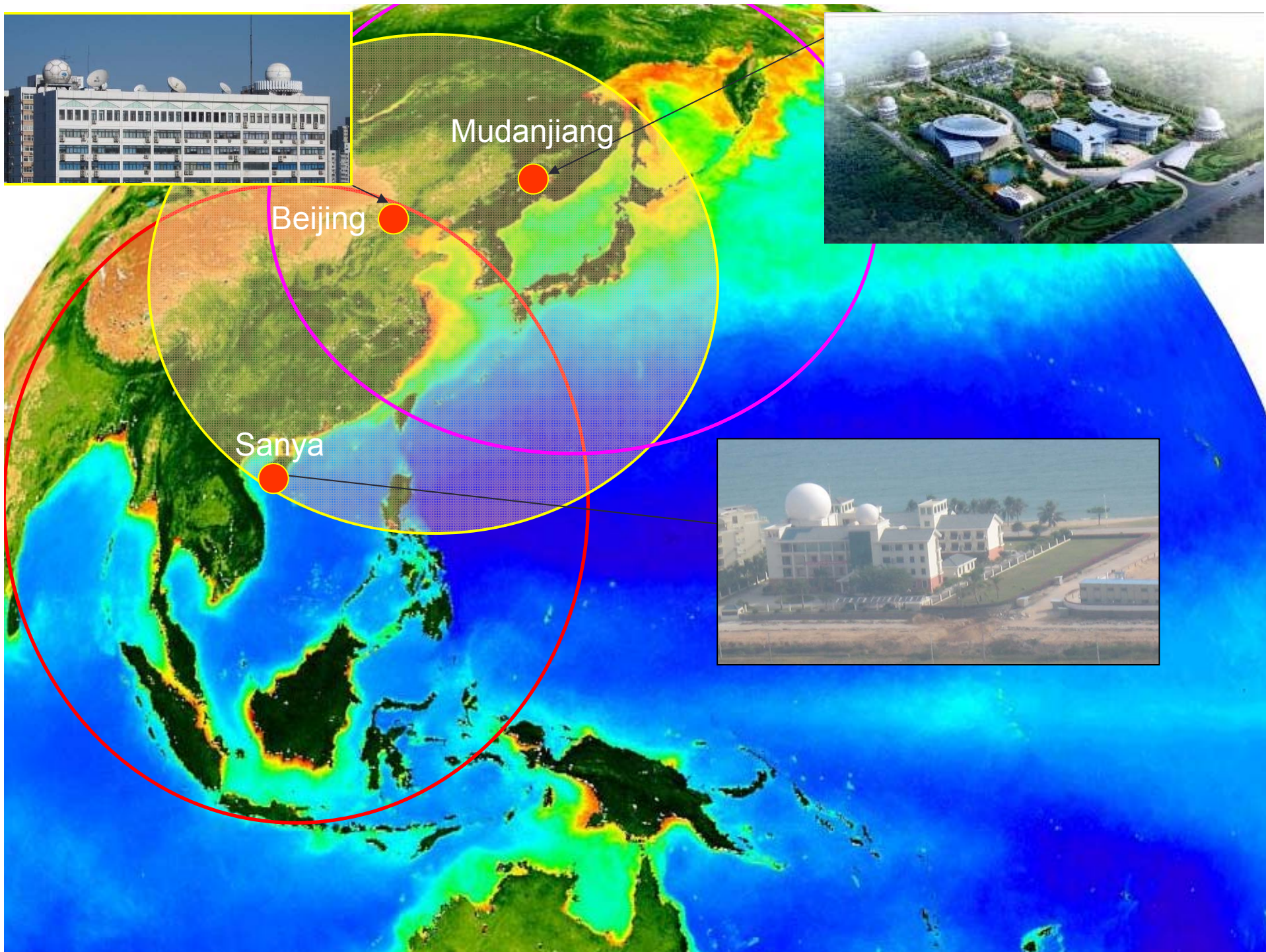
Outline

- **HY-2A Satellite**
- **HY-2A Microwave Scatterometer(HSCAT)**
- **HSCAT Data Processing**
- **Application of HY-2A Ocean Wind Vector**

HY-2A Satellite



- Launched in August 16, 2011, Taiyuan, ShanXi by CZ-4B carrier rocket.
- HY-2A main payloads are Scatterometer, Altimeter, Radiometer.
- The HY-2A satellite is in a 971km height sun-synchronous orbit, Local time of descending node is 6:00 am, repetition period is 14 days.
- Designed for 3 years of life time.

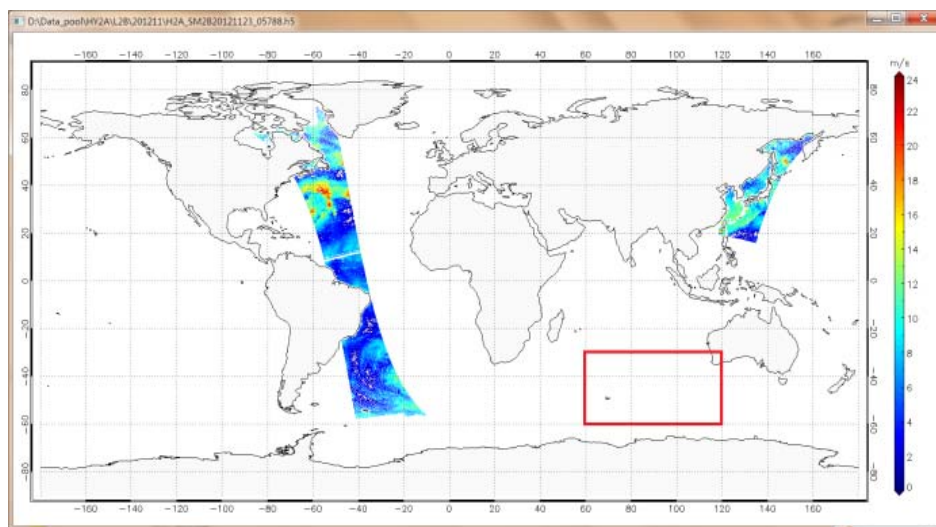


The data receiving strategy of HY-2A satellite ground stations

HY-2A satellite downloads 2 times of observation data, 6:00am & 6:00pm respectively. Each time almost 7-8 cycles data are received by the ground stations.

There are seven cycles data received in Nov. 24, 2012 :

H2A_SM2B20121123_05782
H2A_SM2B20121123_05783
H2A_SM2B20121123_05784
H2A_SM2B20121123_05785
H2A_SM2B20121123_05786
H2A_SM2B20121123_05787
H2A_SM2B20121123_05788

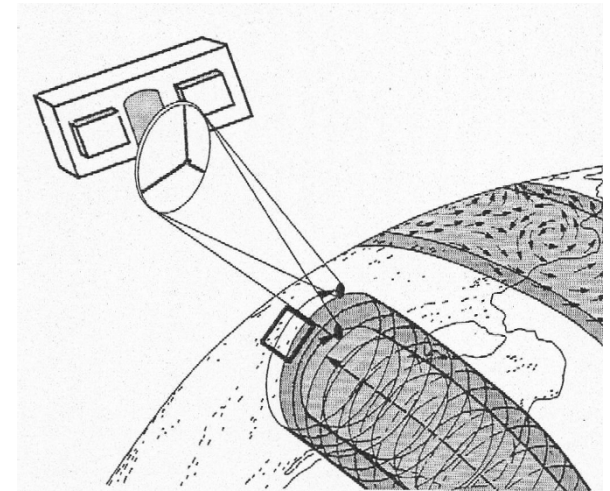
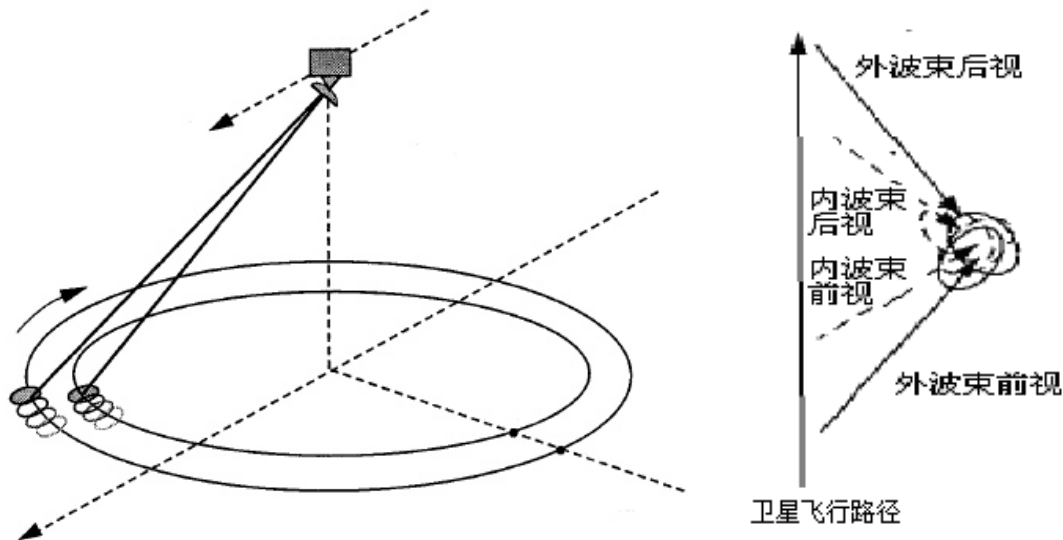


Orbit : H2A_SM2B20121123_05788

There are about four cycles of near real time data downloaded to the ground station every time, but some applications such as Numerical Weather Prediction needs a regular time spacing of data input, so NSOAS is now trying to build ground stations in the polar regions.

HY-2A Microwave Scatterometer(HSCAT)

HSCAT observation features



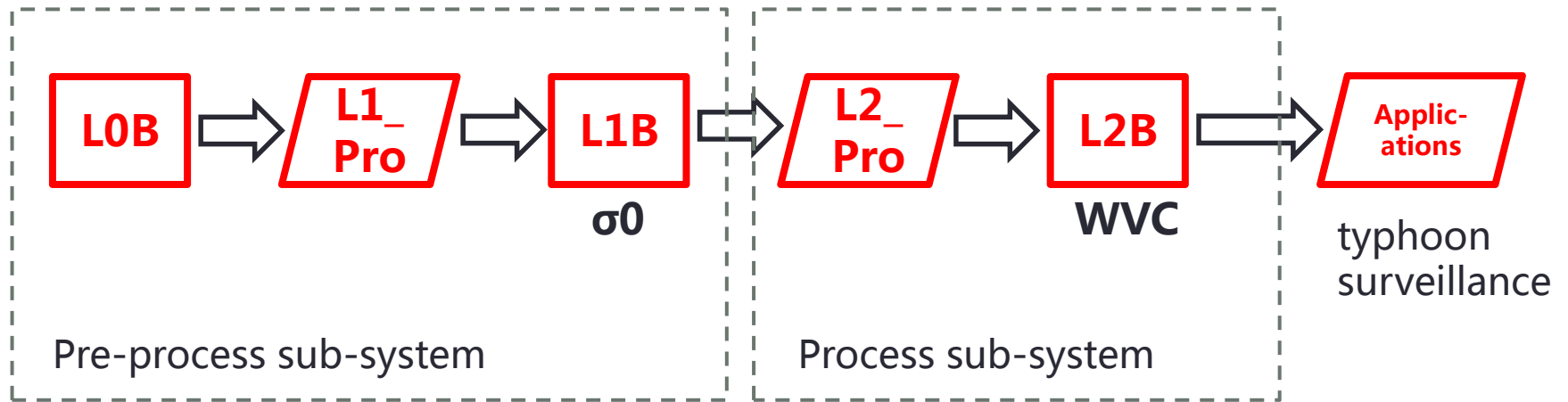
HSCAT employs a single 1-meter parabolic antenna dish with twin offset feeds for vertical and horizontal polarization. The antenna spins at a rate of 18 rpm, scanning two pencil-beam footprint paths at incidence angles of 41.5° (H-pol) and 48.6° (V-pol).

The main feature of the HSCAT is described in the table below:

Working frequency		13.256GHz
Polarization mode		HH, VV
Ground footprint		≤50km
Swath	H-polarization	>1350km
	V-polarization	>1700km
Wind speed measuring range		2~24m/s
Wind speed measuring accuracy		2m/s
Wind measuring direction accuracy		20°

HSACT Data Processing

Data processing flow of HSCAT

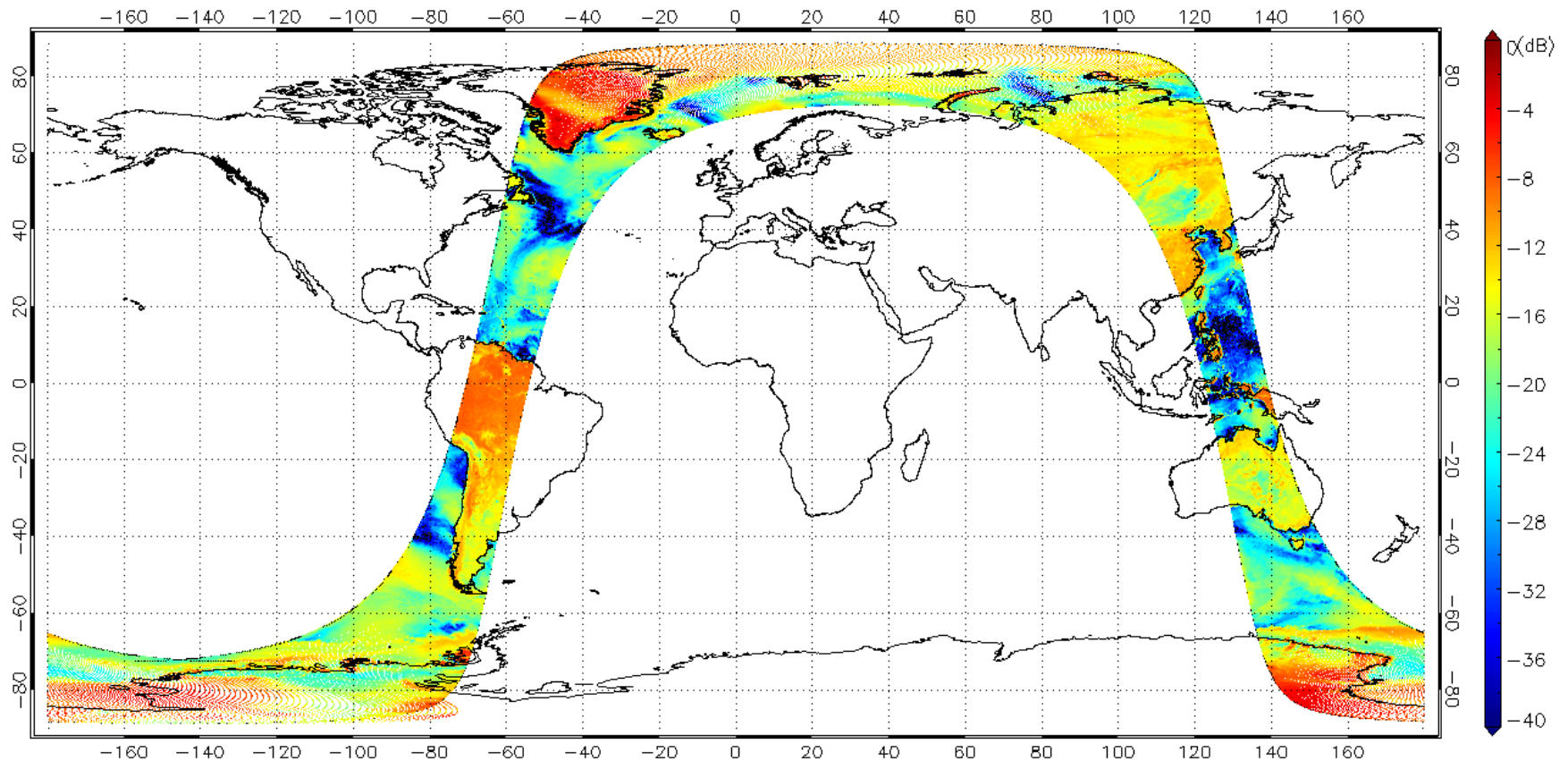


- Divided into two parts: Pre-process & Process
- Data unpacking
- Geometric positioning
- Calculating physical parameters
- Ocean wind retrieval

The normalized radar backscattering coefficient

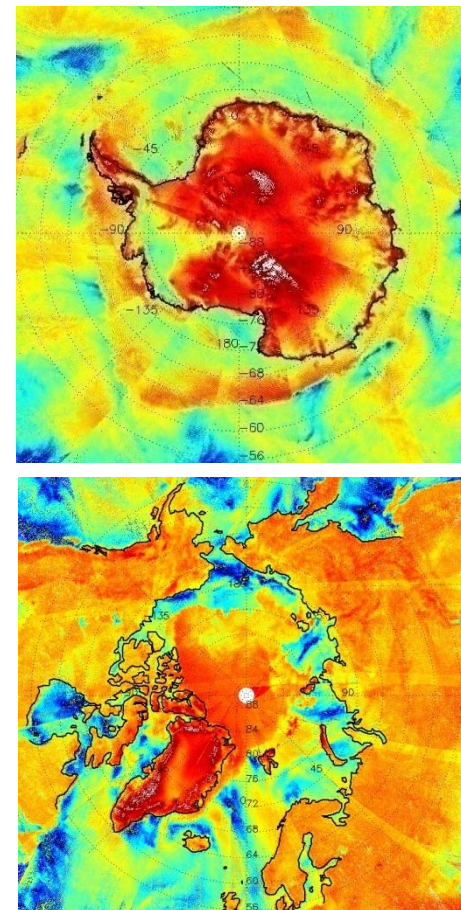
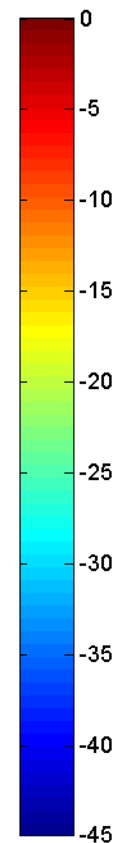
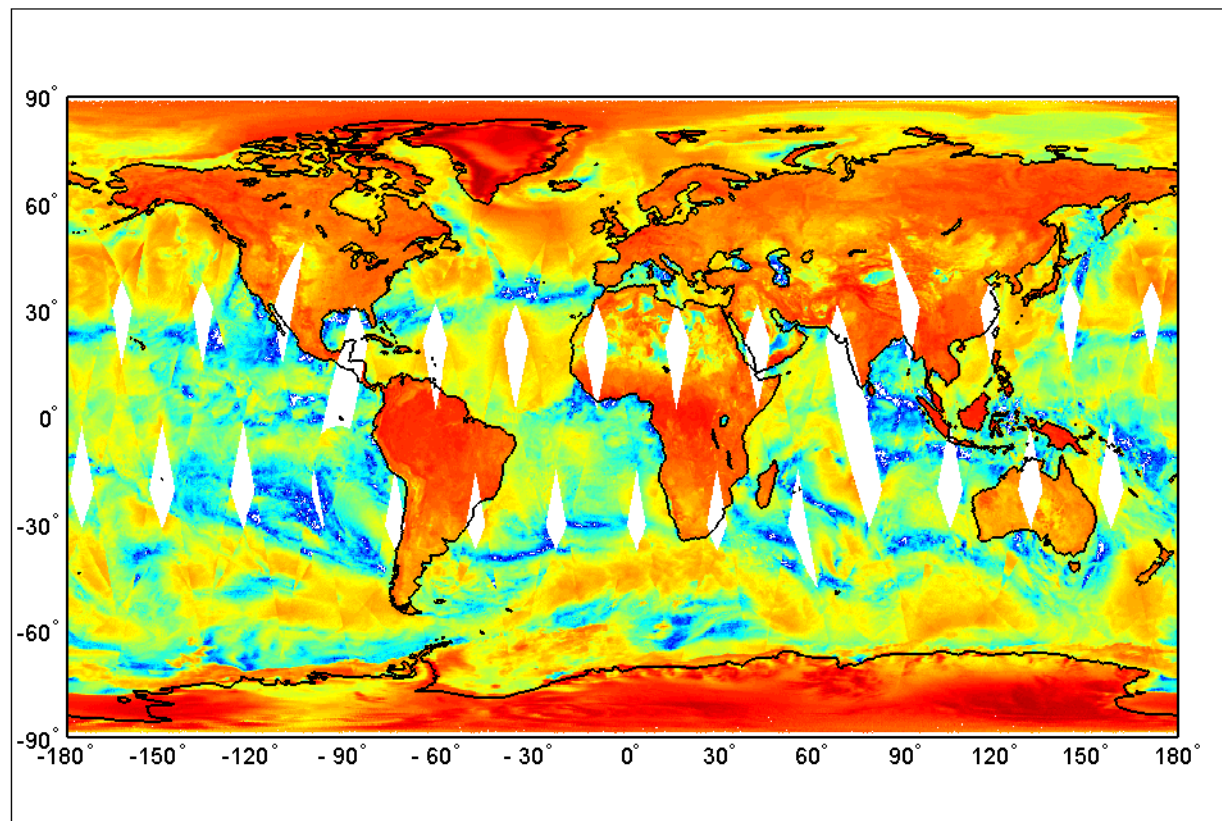
According to the radar equation, the normalized radar backscattering coefficient can be expressed as follows:

$$\sigma^0 = \frac{(4\pi)^3 L_a^2 L_w^2}{\lambda^2 I} \cdot \frac{P_s}{P_t} = \frac{(4\pi)^3 L_a^2 L_w^2}{\lambda^2 I} \cdot \frac{P_{os} L_f}{P_{os,c}} \cdot \frac{G_c}{G_{e,AGC}}$$

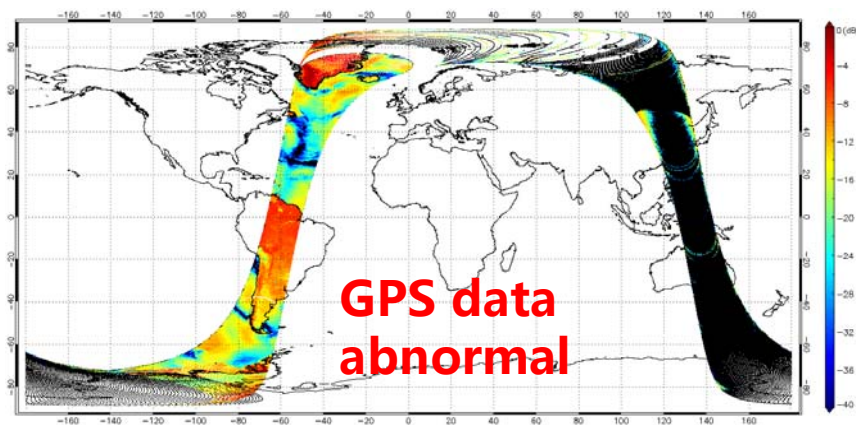
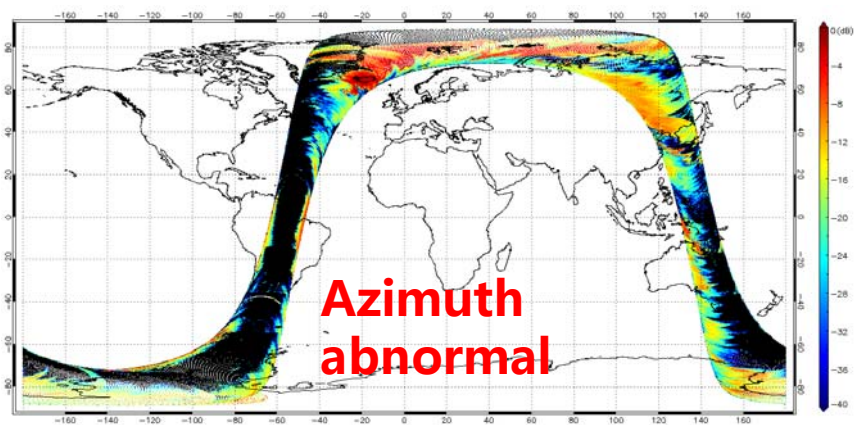
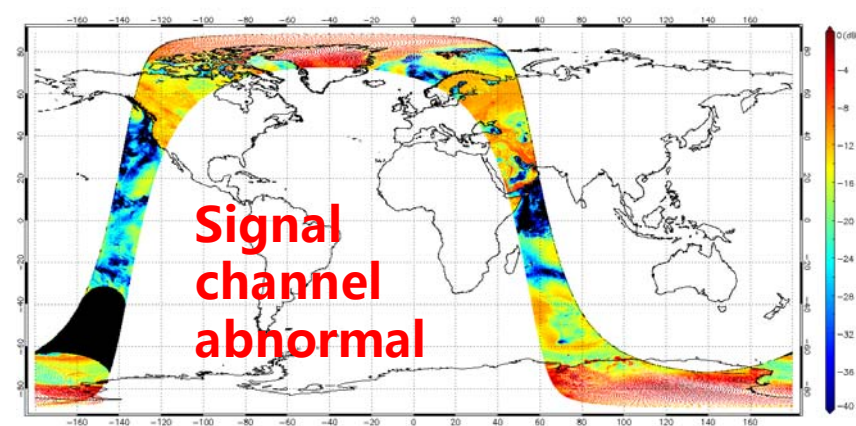
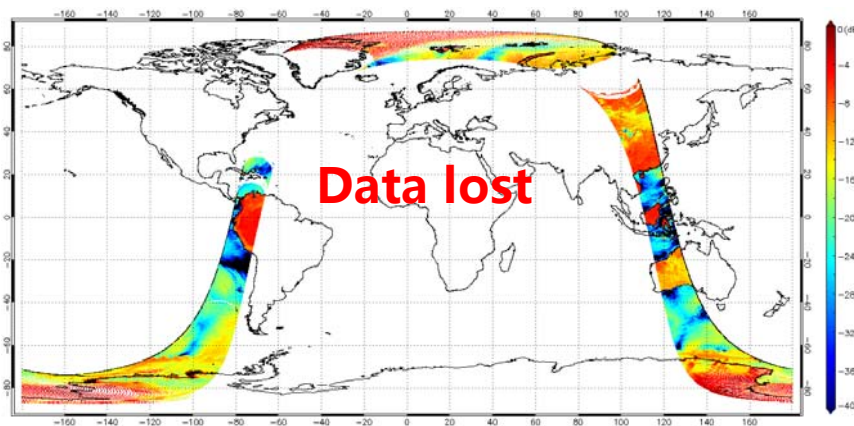
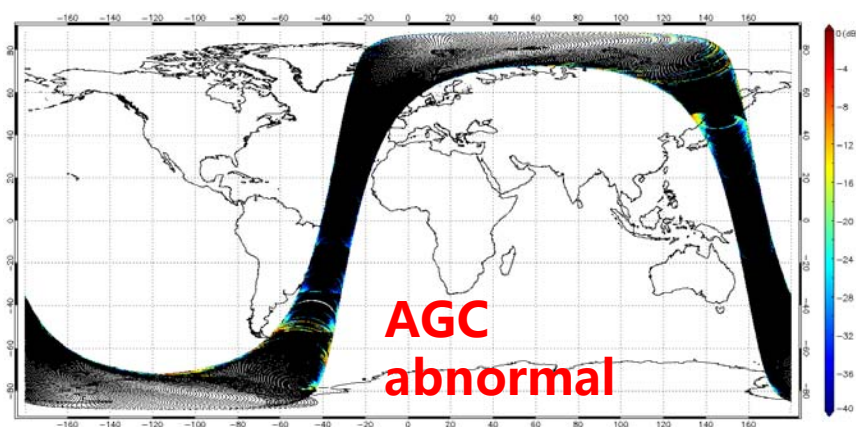
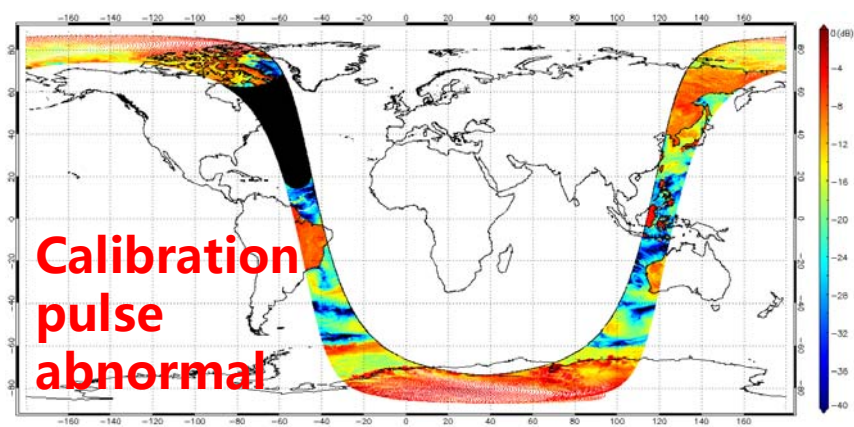


One cycle of the normalized radar backscattering coefficient of HSCAT

sigma0, 20120101, full, VV, forward_and_afterward



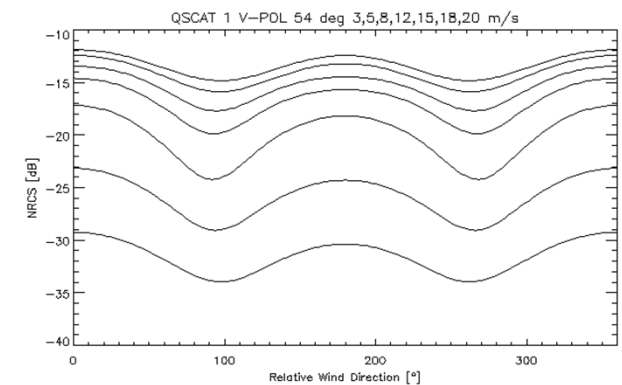
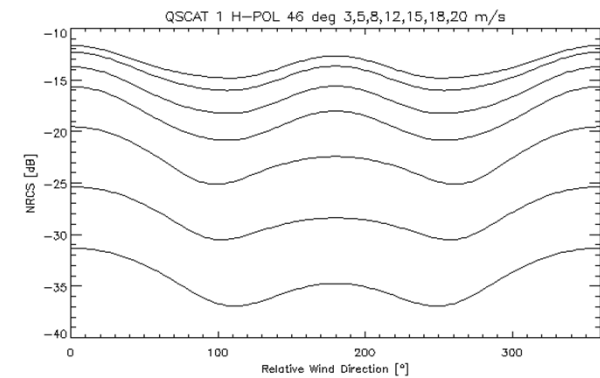
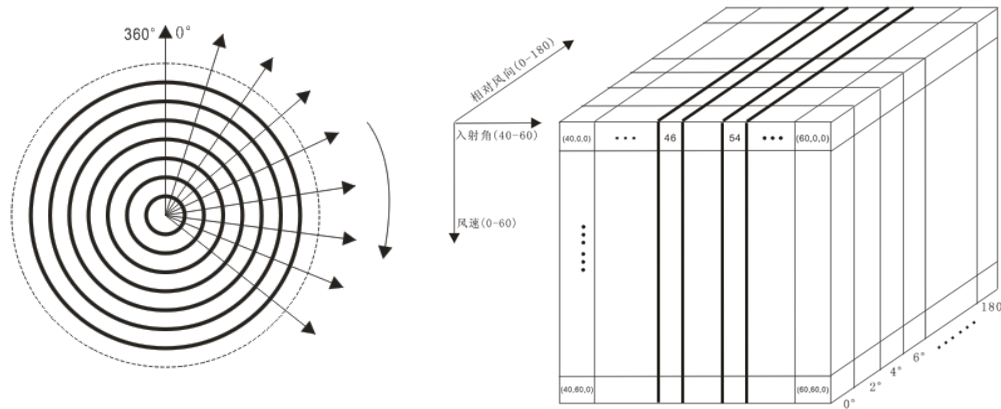
Global distribution of HSCAT **sigma0**



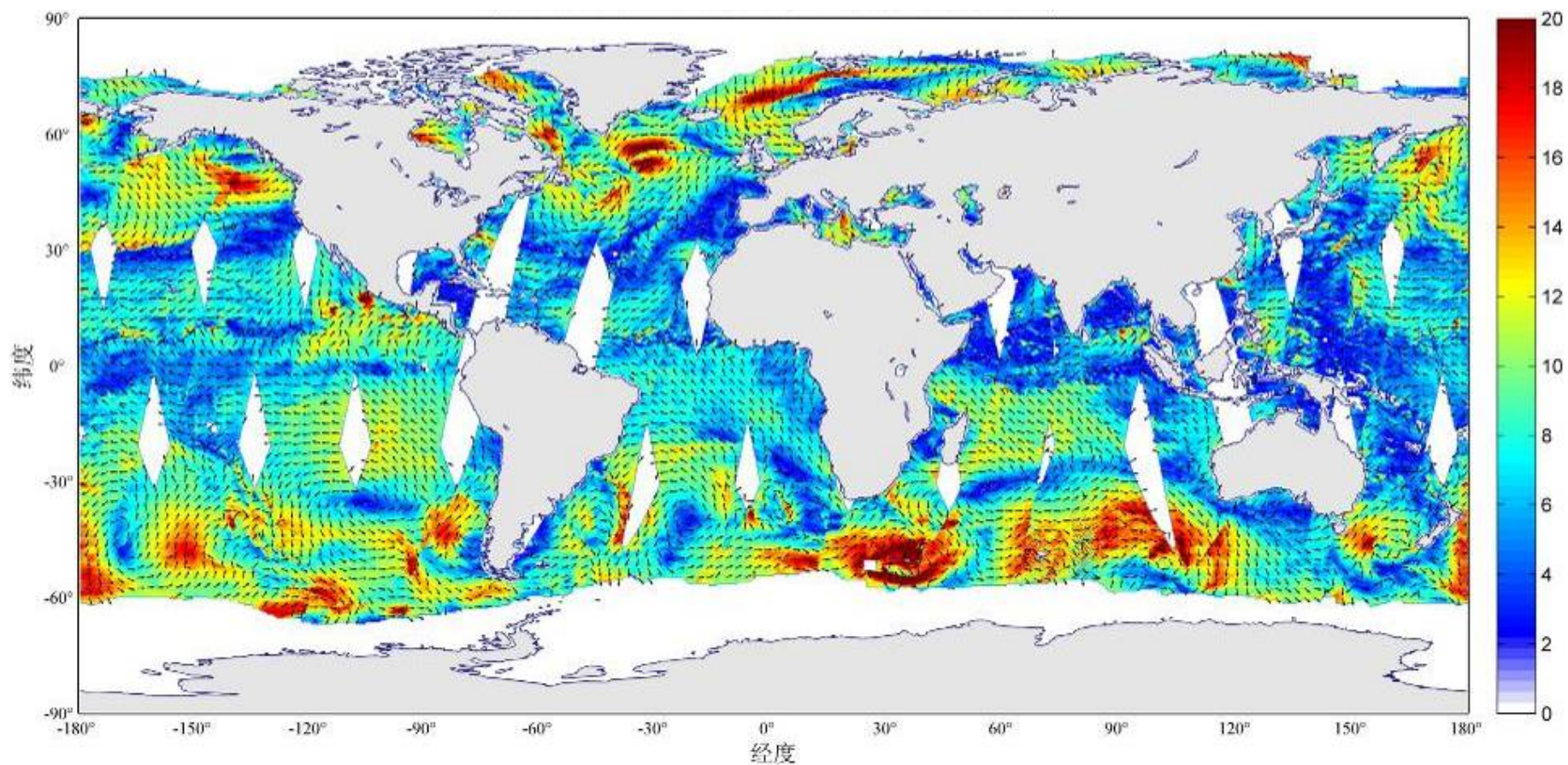
The HSCAT wind retrieval

The HSCAT wind retrieval algorithm uses a maximum-likelihood estimator (MLE) as the objective function for determining wind vector solutions. The MLE is defined by:

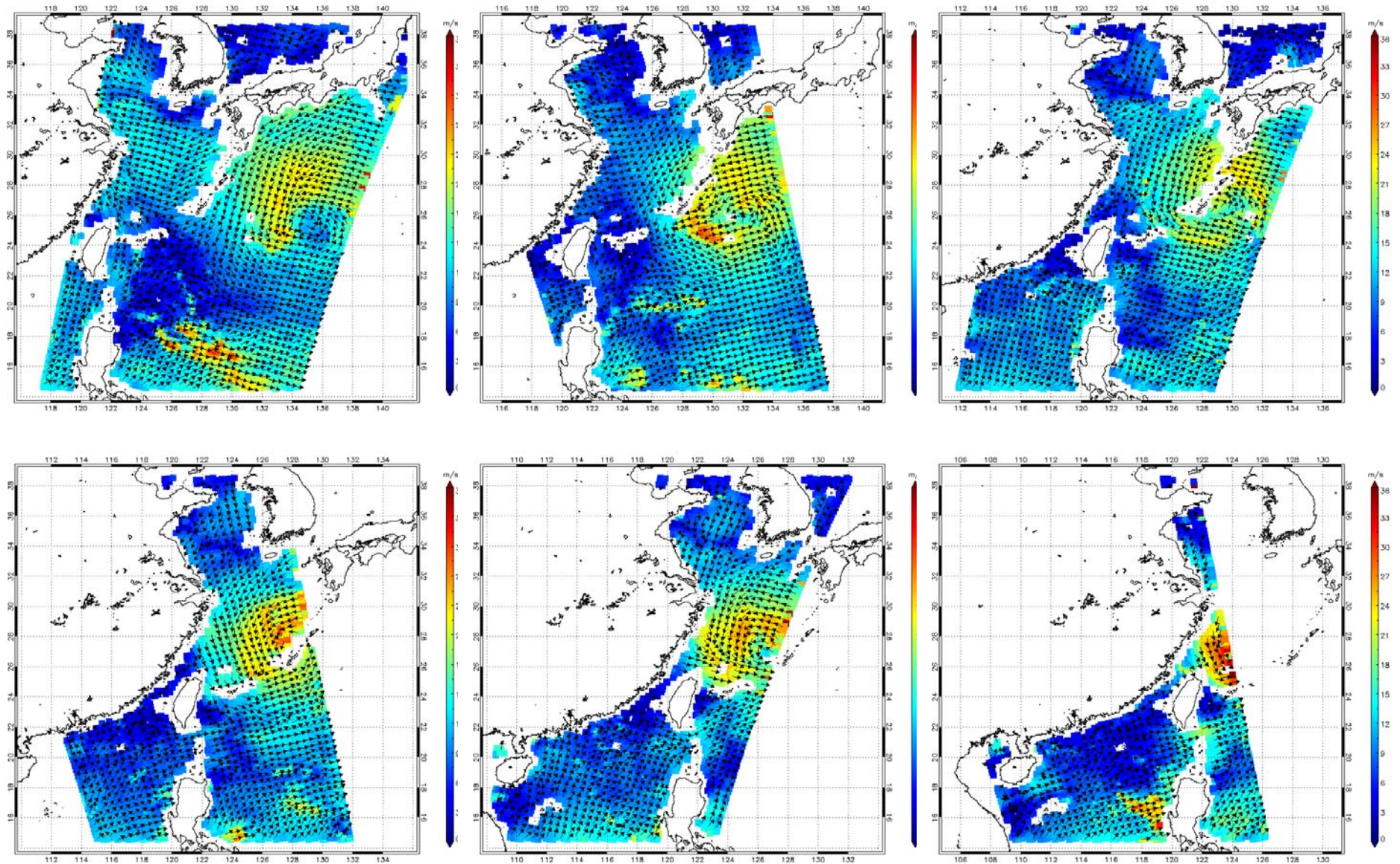
$$J_{MLE}(U_{trial}, \Phi_{trial}) = -\sum_{i=1}^N \left(\frac{(z_i - M(U_{trial}, \Phi_{trial} - \phi_i, \theta_i, p_i))^2}{2V_{R_i}} \right) + \frac{1}{2} \ln V_{R_i}$$

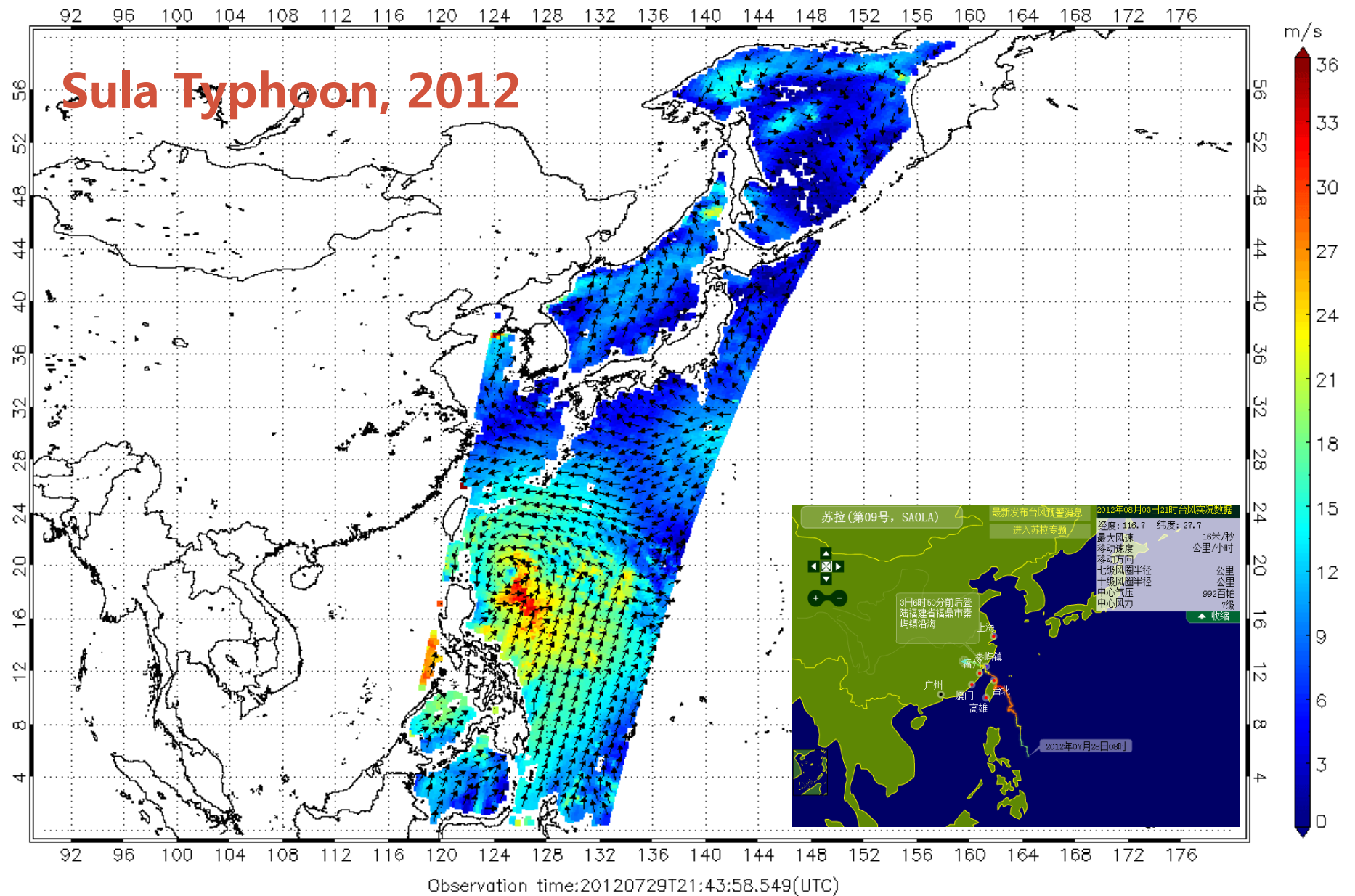


The global ocean wind vector data



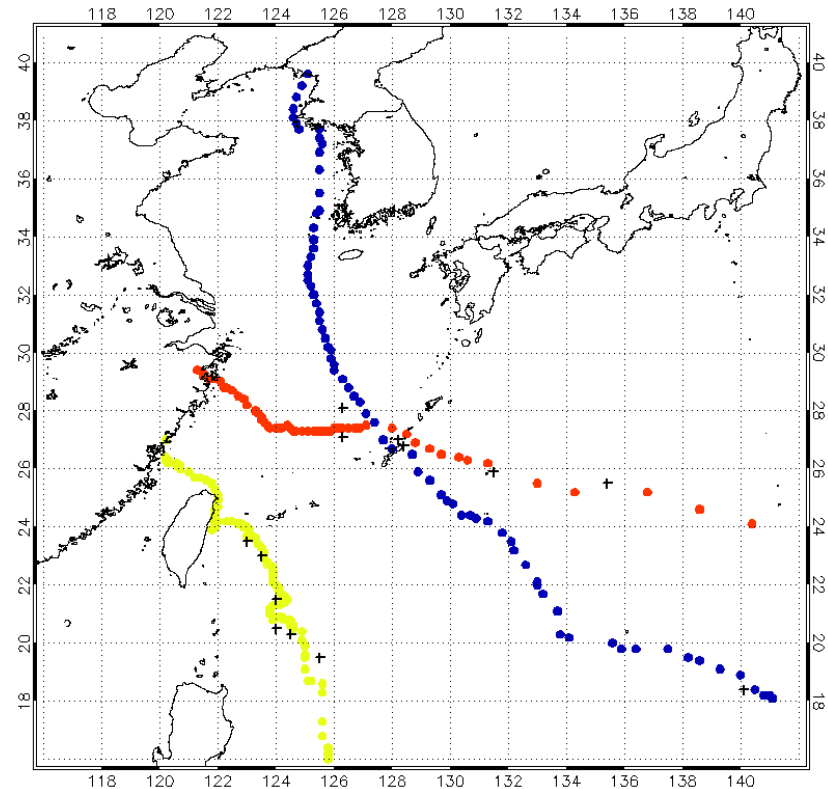
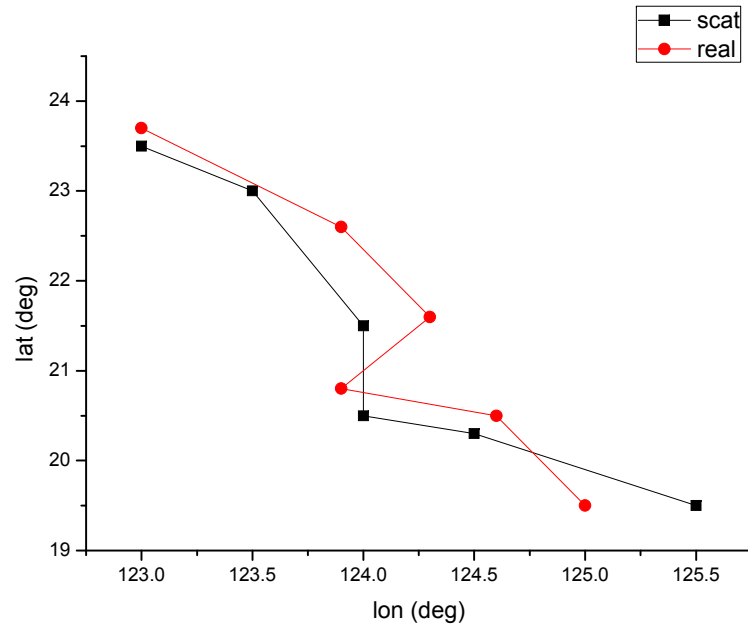
Application of HY-2A Ocean Wind Vector





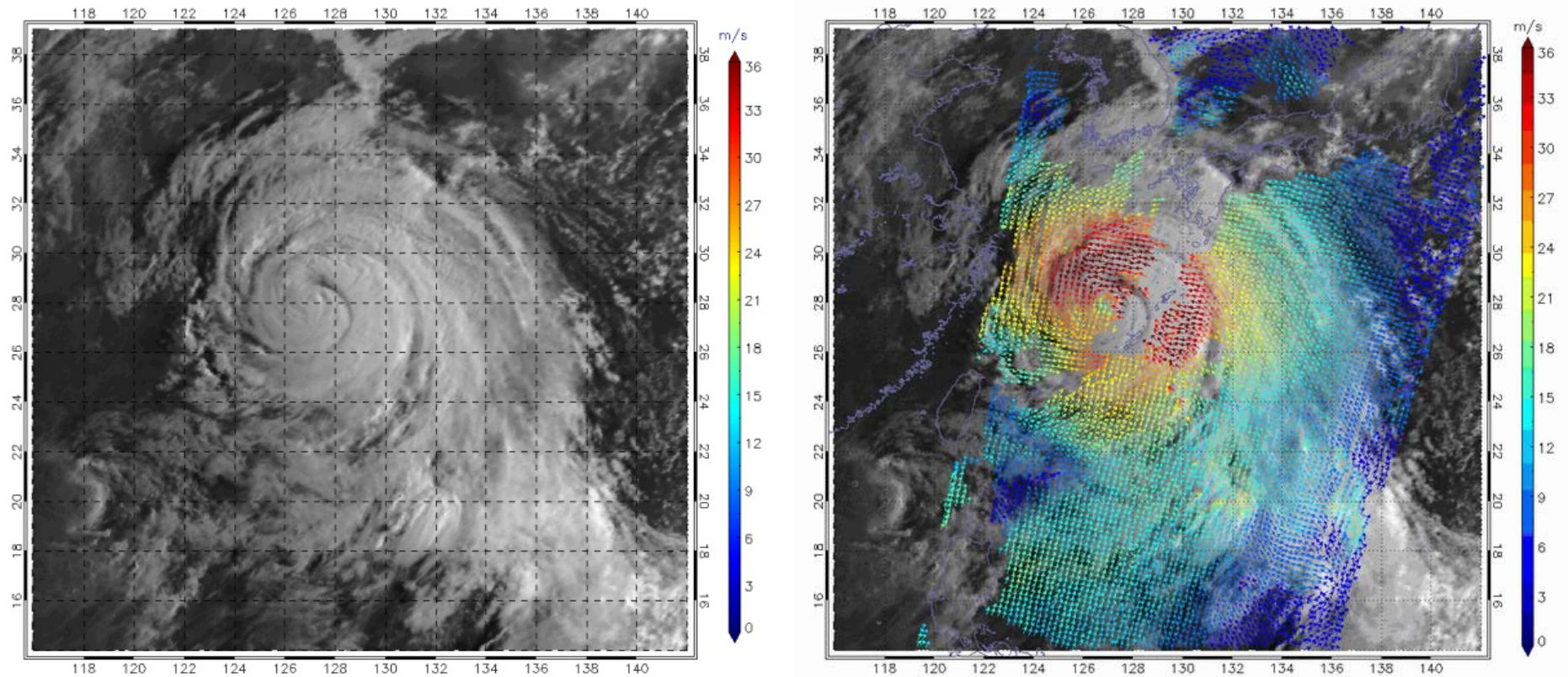
Animation used to demonstrate the moving of typhoon Sula

The route of tropical cyclones



The centers of tropical cyclones determined by HSCAT are validated by the near real time data provided by the Central Meteorological Station of China. It shows that the HSCAT observation is useful in the route analysis.

2、 Comparison between HSCAT and FY-2E



The FY-2E geostationary satellite's optical observation with a 5km resolution is overlapped by the HSCAT ocean wind fields. The overall structures of these two kinds of data are coincided well.

Conclusion

- More than four years and nearly 22,000 cycles data has been collected by the HSCAT;
- The ocean surface wind, sea surface temperature, sea surface height, etc. can be inferred from the HY-2A observation data simultaneously, which gives a great convenient to the research of oceanic and atmospheric phenomena such as tropical cyclone;
- More in-depth and extensive research is needed for understanding the mechanism of the formation of tropical cyclones, and HSCAT data is useful;
- The performance and the stability of HSCAT should be improved in the fellow-on sensor.



THANKS !