



Institute of Remote Sensing and Digital Earth  
Chinese Academy of Sciences

# Assimilation of Tropical Cyclone Wind Field Retrieved from Sentinel-1

**Xiaofeng Yang**<sup>1</sup>, Boheng Duan<sup>1</sup>, Marcos Portabella<sup>2</sup>

<sup>1</sup>Institute of Remote Sensing and Digital Earth, CAS

<sup>2</sup>ICM/CSIC

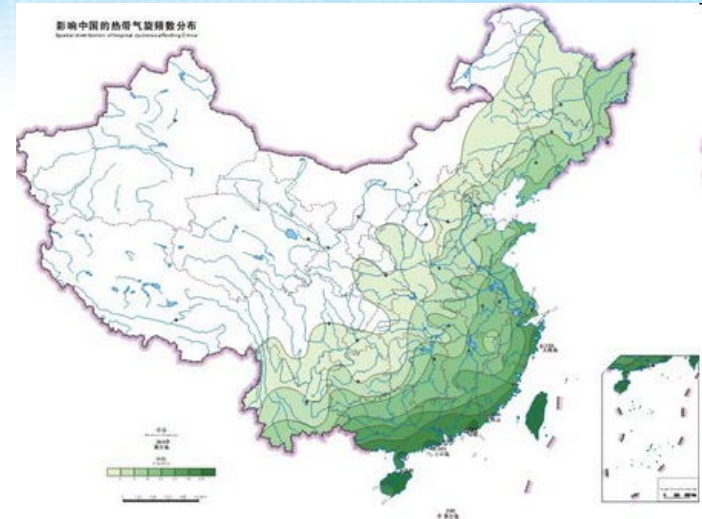
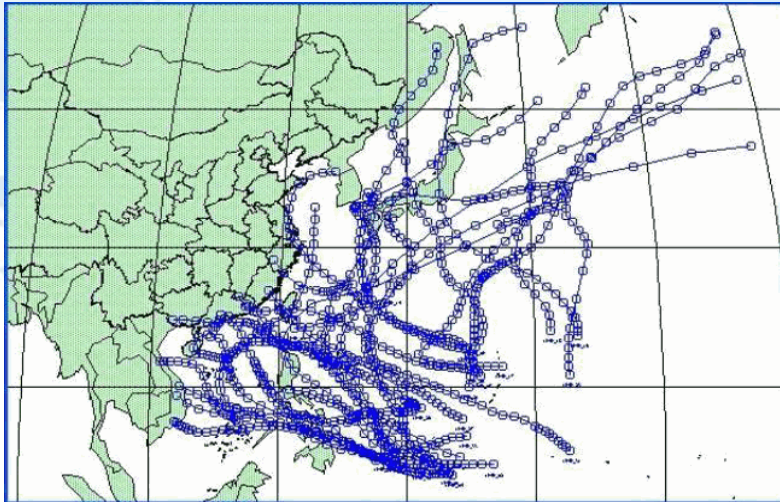




# Content

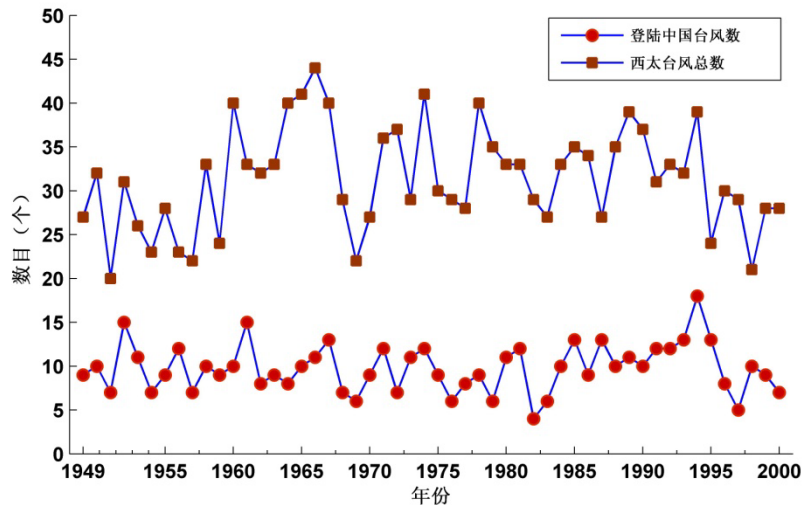
- × Research Background
- × Satellite Observations
- × WRF/3DVAR Experiments
- × Conclusions

# Background



## frequency of landfalling typhoons in China

- China is one of the countries than most frequently hit by tropical cyclones; Typhoon is also the most destructive natural disaster in China.
- More than 150 million people are under its threat every year.
- The typhoon track forecasting is still a big challenge, the 24h forecast error at CMA is ~94 km in 2012.



**Typhoon tracks and frequency over the western North Pacific (1949-2000)**

- More accurate observations and



# Motivation

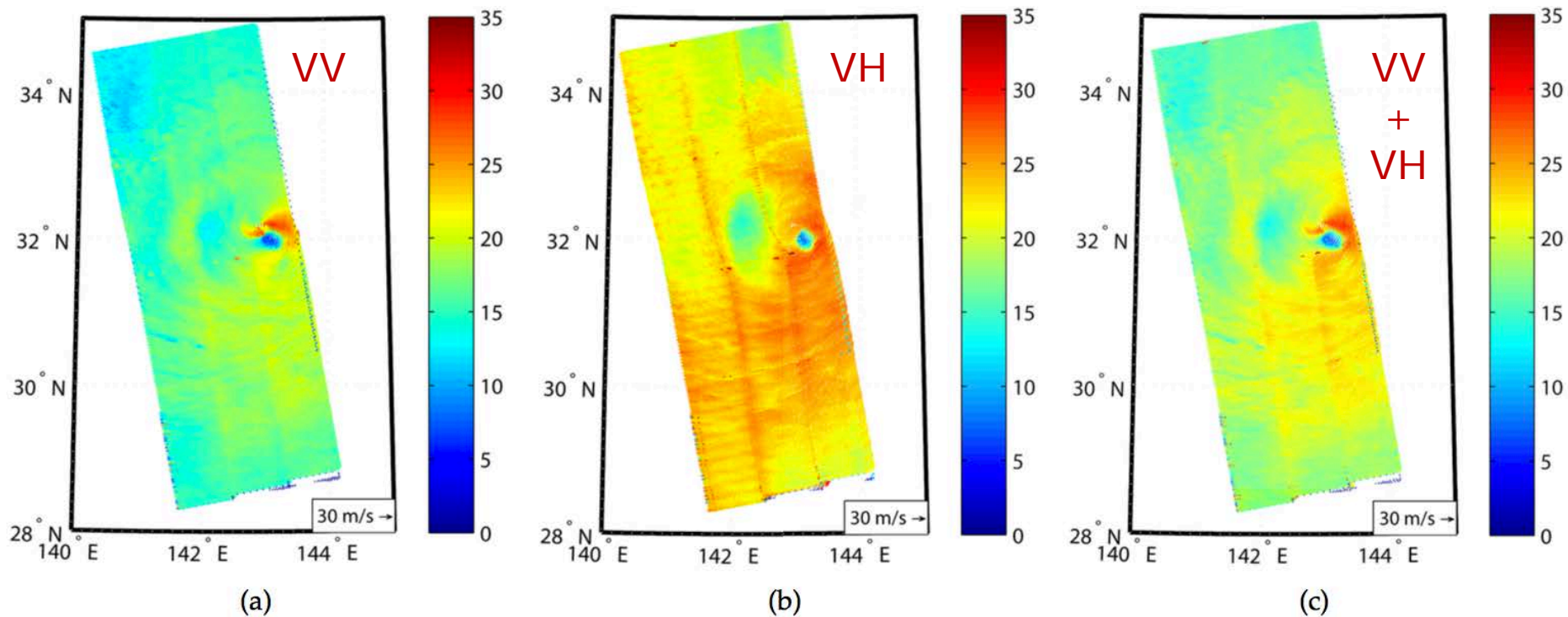
- ✓ Taking advantage of the high resolution winds observations (VV+VH) from SAR.
- ✓ Improve the quality control scheme of SAR wind assimilation under typhoon conditions.
- ✓ Investigate the impact of SAR wind assimilation on the typhoon track forecasting.



# SAR Winds

A simple linear weighted method is used to composite VV and VH wind retrievals.

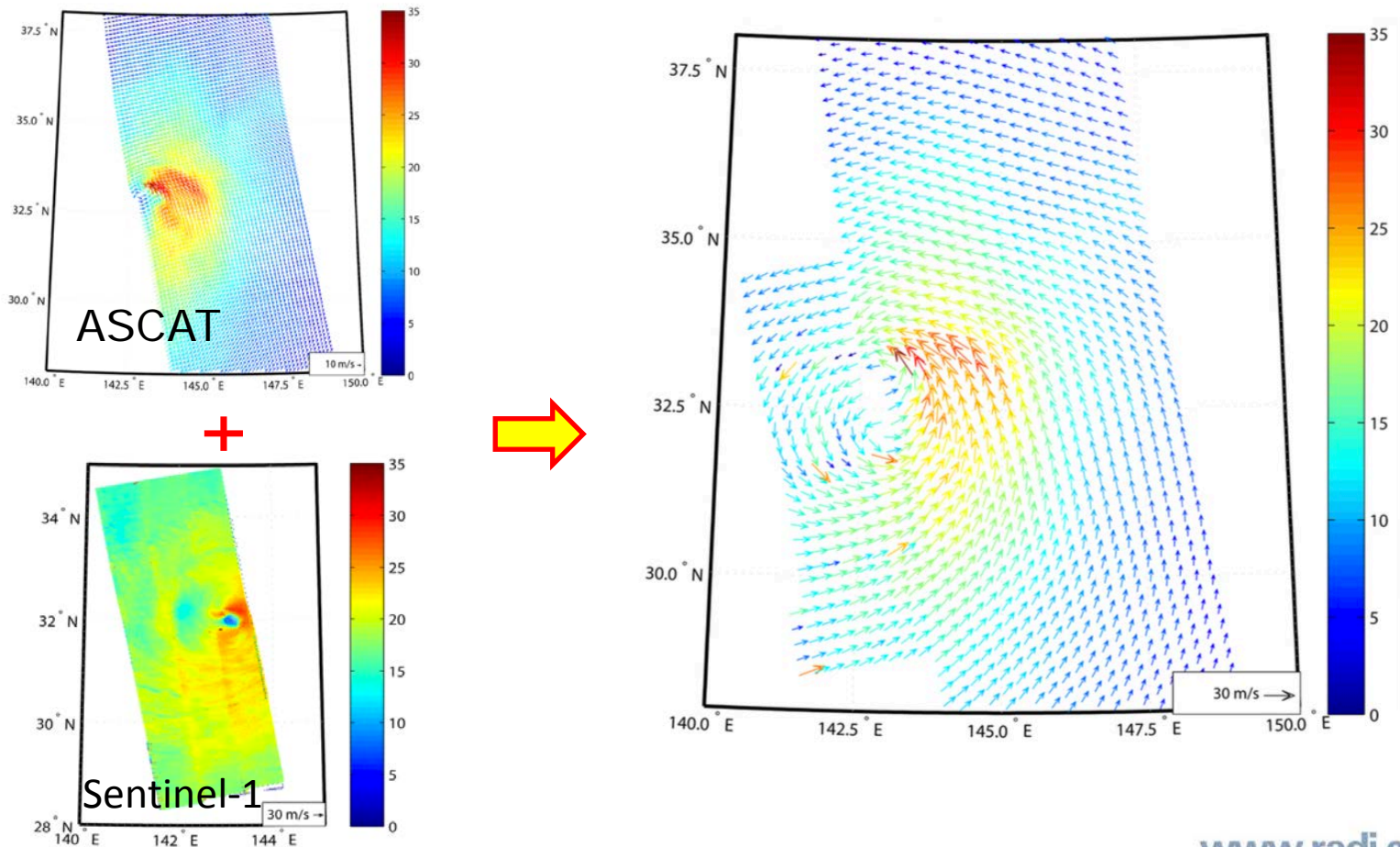
- VV wind is more accurate at low wind speed conditions;
- VH wind is more accurate at high wind speed conditions;



**Figure 2.** SAR wind field of satellite Sentinel-1 in typhoon "Lionrock (2016)" region with a resolution of 500m:(a) retrieved wind using VV polarization observation. (b) retrieved wind using VH polarization observation. (c) synthetic wind combined with VV and VH polarization retrieved wind.

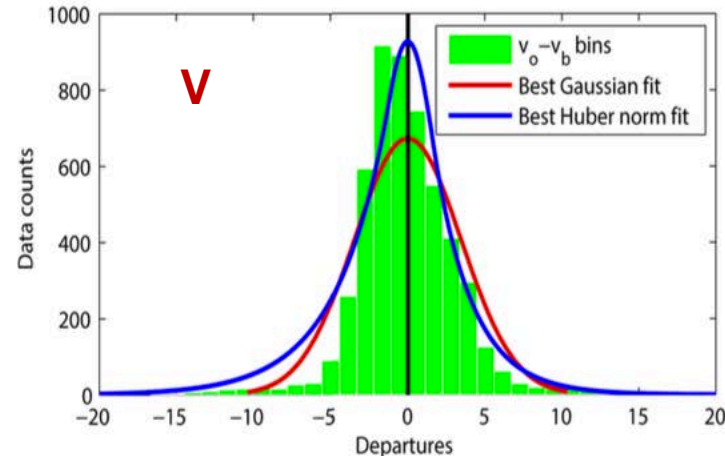
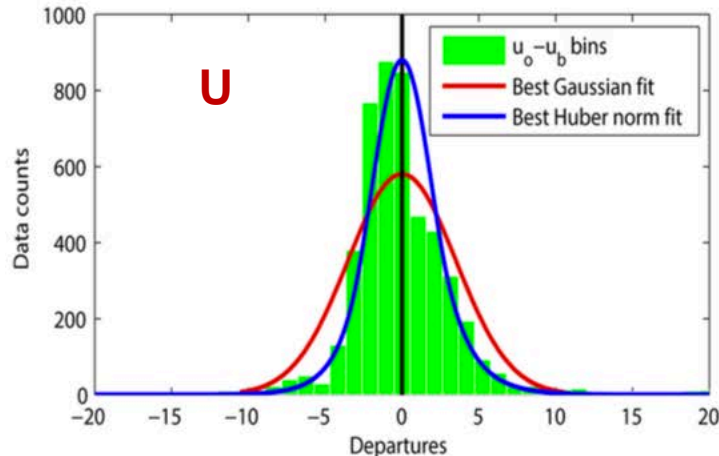
# SAR/ASCAT Joint Winds

We combine the ASCAT wind field with the Sentinel-1 SAR winds. The overlapped wind field of the SAR synthesis wind is removed and the joint wind field is sparse to 25 km.



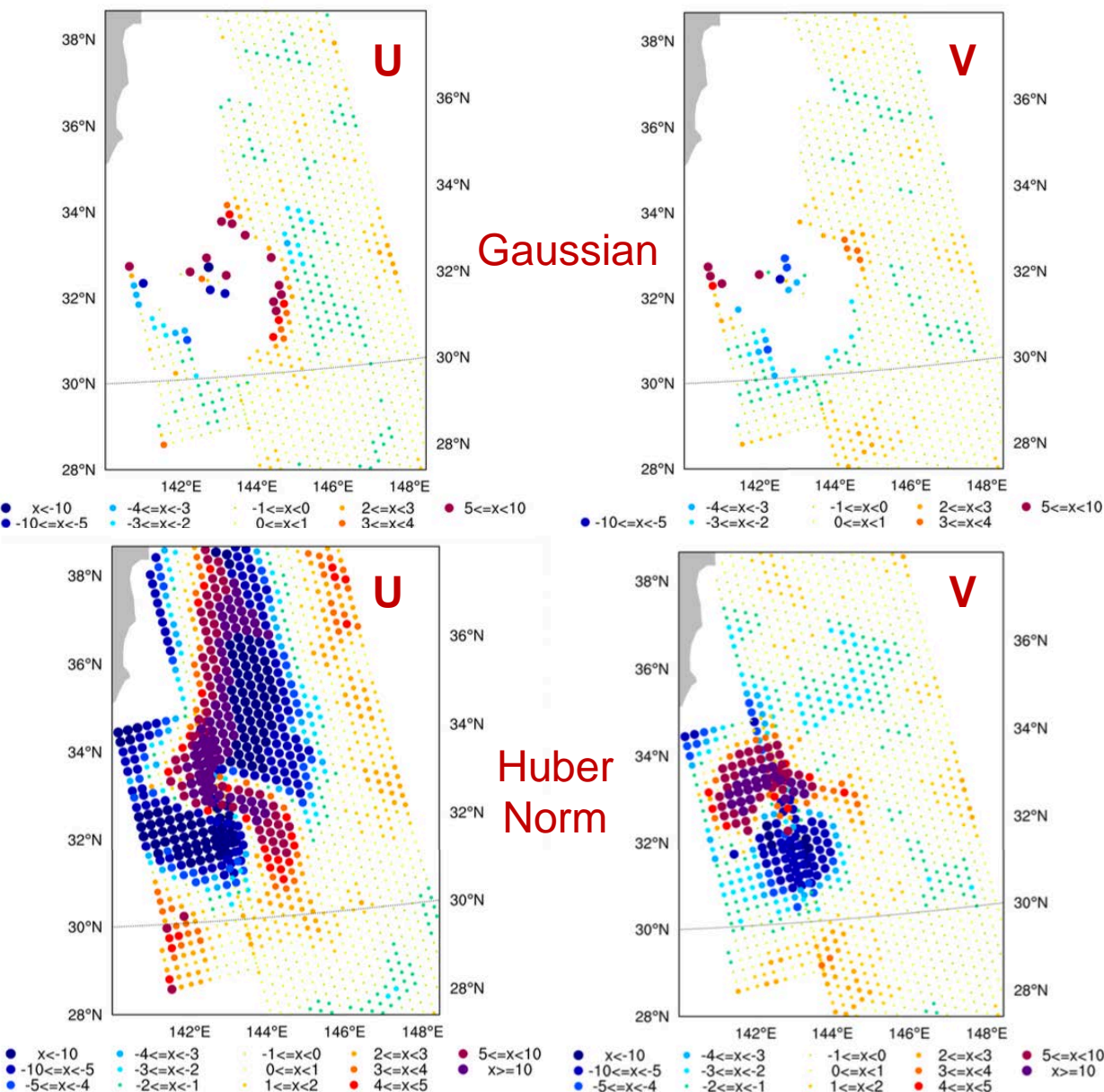
# Quality Control Scheme

- The traditional Gaussian distribution QC scheme gives equal weight to the observation satisfying the QC conditions.
- For the Huber norm distribution QC scheme, the main purpose is to give a more reasonable weight to observation. Observation with smaller deviation to the background is given a larger weight, while observation with bigger deviation is given a smaller weight. By this mean, it makes sure that observation with big deviation can still affect the final analysis, while ensuring the stability of the assimilation process.





# Observation residuals after QC



- ✓ Observation in the typhoon center area has bigger deviation to the background (O–B), thus has smaller weight using the Huber norm distribution QC scheme.
- ✓ Which means the analysis gets closer to the background or a bigger residual as shown in the Figure (c), (d), where the residual is much bigger in the center area of typhoon.
- ✓ the Huber norm QC scheme makes it possible for the assimilation of observations near the typhoon center.

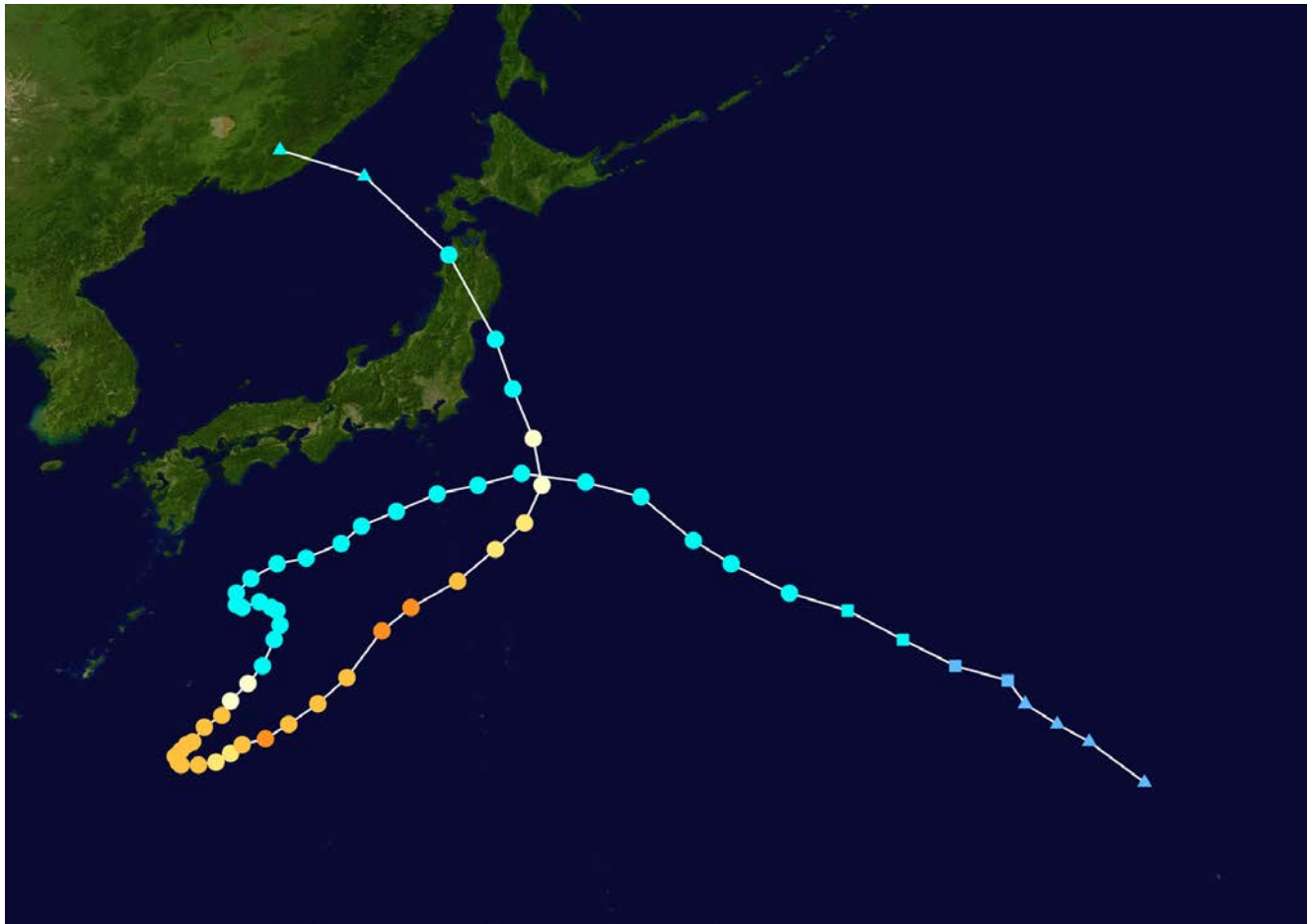


# Experimental design

Experiment name	QC scheme	Observation type
1	Huber norm distribution QC	SAR wind
2	Huber norm distribution QC	ASCAT wind
3	Gaussian distribution QC	SAR+ASCAT wind
4	Huber norm distribution QC	SAR+ASCAT wind

# Typhoon Lionrock (2016)

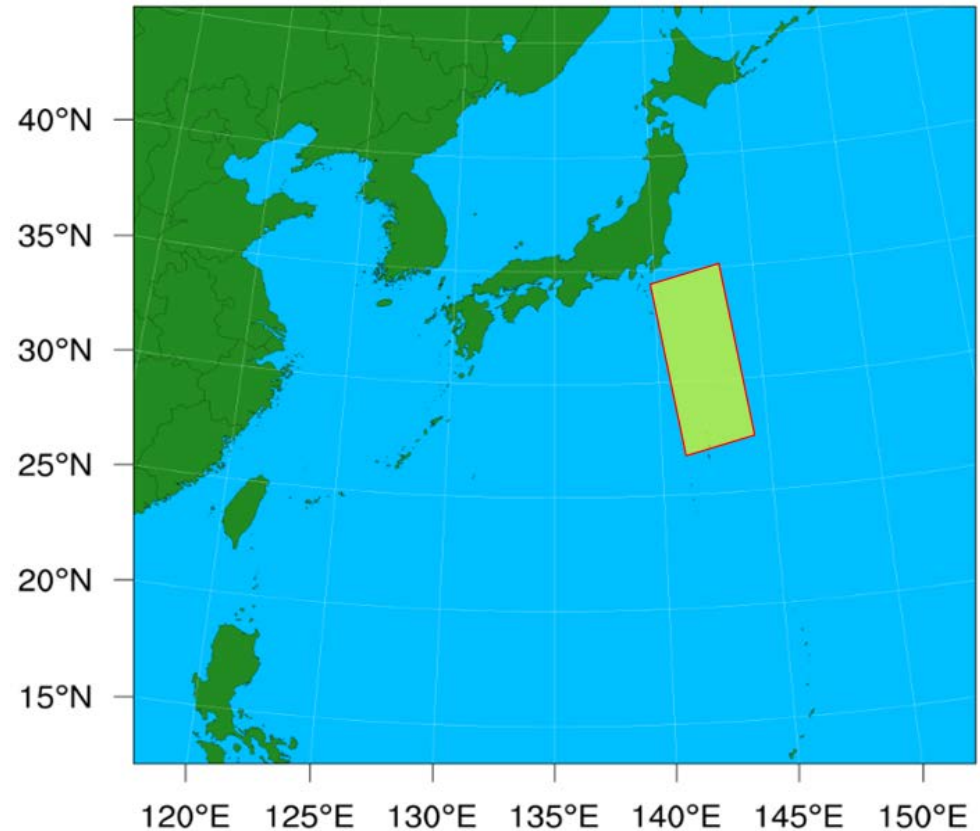
- ✓ Typhoon Lionrock was the 10<sup>th</sup> named storm in 2016 (15 Aug. to 2 Sep.).
- ✓ It was a powerful, long-lived, erratic tropical cyclone and caused remarkably flooding and casualties in North Korea and Japan .



# Model setup

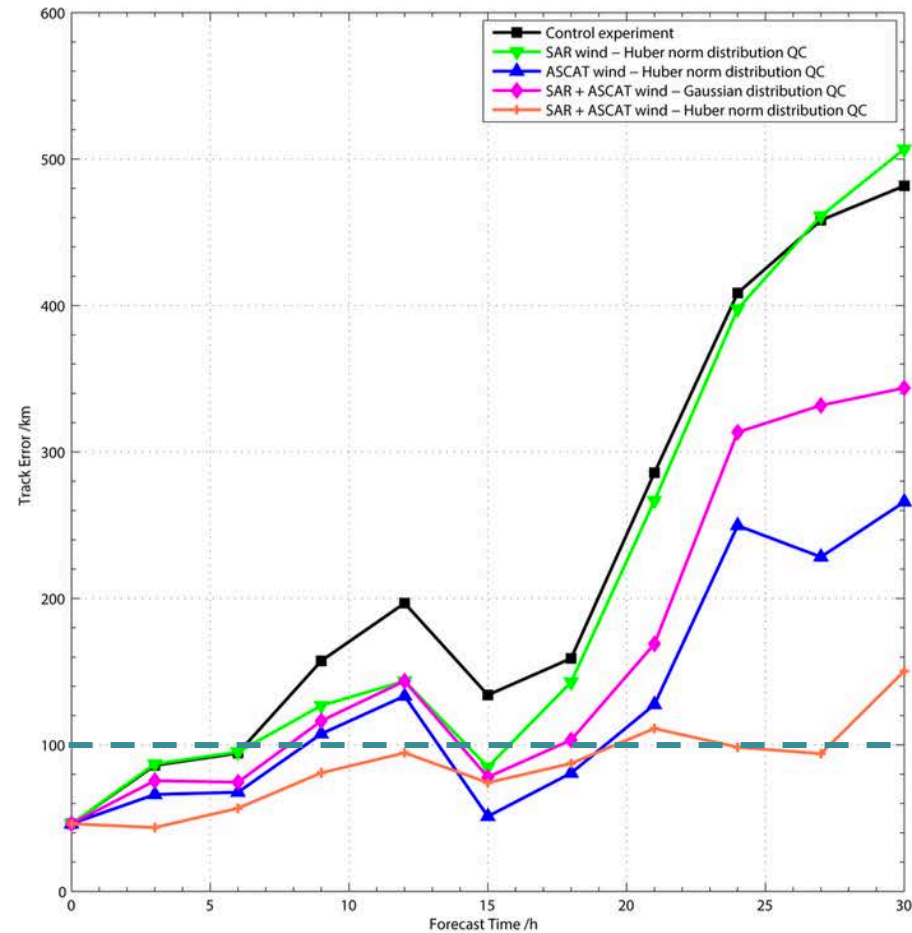
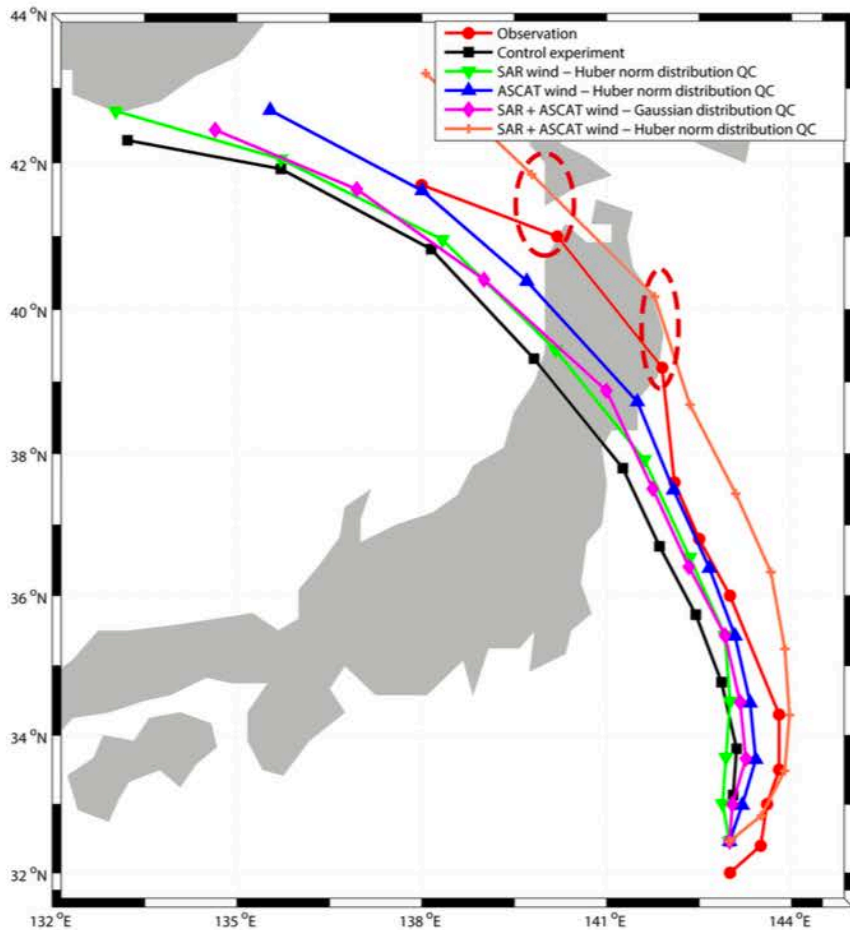
- ✓ WRF/3DVAR
- ✓ The grid size of the assimilation region is  $260 \times 250$ .
- ✓ the horizontal resolution is 15km, the vertical discretization is 30 layers.
- ✓ The NCEP global reanalysis data are used as the initial field and boundary conditions.
- ✓ A 30-hour forecast is made, which is a forecast to 0015 UTC 30 August 2016.

Lionrock Forecast Area



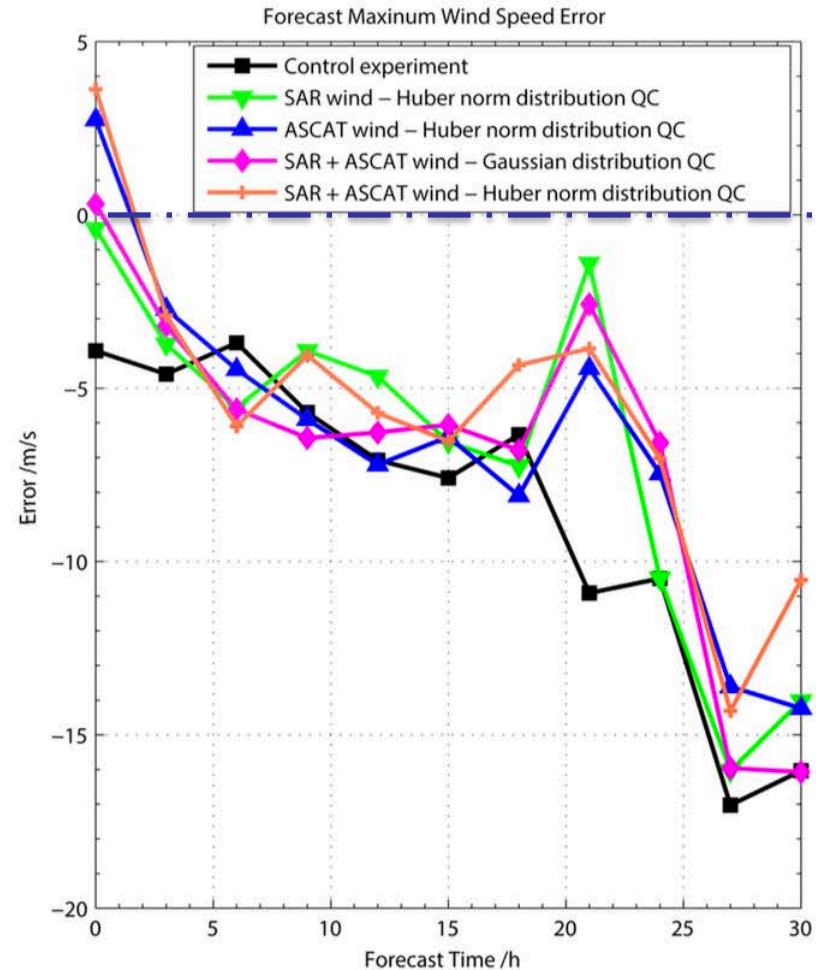
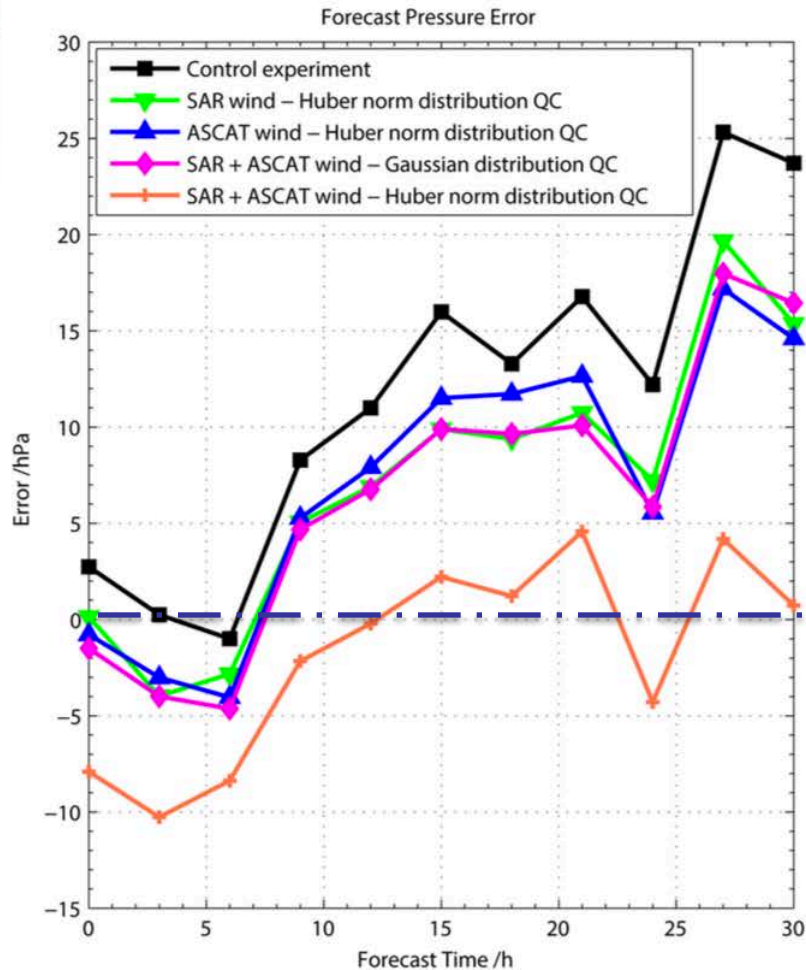


# Track Forecasting of Typhoon Lionrock



SAR+ASCAT winds with Huber norm QC scheme obtain the best forecast results.

# Pressure and maximum wind speed forecast errors



More accurate analyses were obtained when the Huber norm QC was applied.

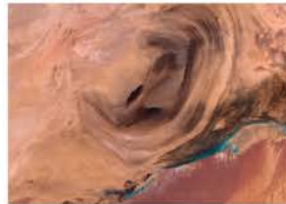
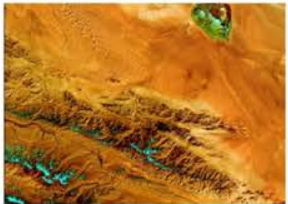


# Summary

- Using the NCAR's WRFDA system, we conducted a joint assimilation experiment of the Sentinel-1 winds and ASCAT winds for the typhoon Lionrock (2016).
- A new data quality control scheme is proposed based on Huber norm method.
- The results of assimilation experiments show that the joint assimilation could improve the typhoon track forecast.
- New algorithm to composite VV+VH wind speed map, and the improvement of parameterization of typhoon model are our future works.



# Thanks!



**Institute of Remote Sensing and Digital Earth  
Chinese Academy of Sciences**

Add: No.9 Dengzhuang South Road,Haidian District,Beijing 100094,China

Tel: 86-10-82178008 Fax: 86-10-82178009

E-mail: [office@radi.ac.cn](mailto:office@radi.ac.cn)

Web: [www.radi.cas.cn](http://www.radi.cas.cn)