Data Collection and Analysis for GNSS-R Experiment in China

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ICG International Committee on Global Navigation Satellite Systems

Guideline

I. Introduction

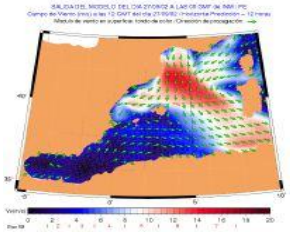
II. GNSS-R receiver Description

III. Data Process and Analysis

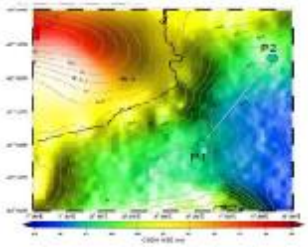
IV. Summary

I. Introduction

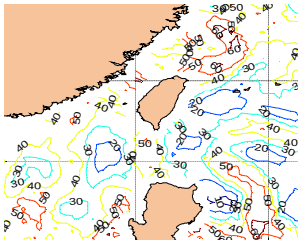
Applications of GNSS-R



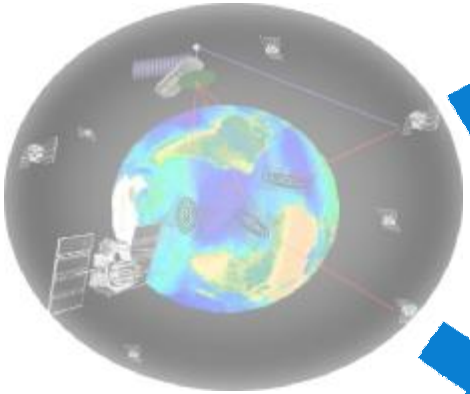
Ocean wind



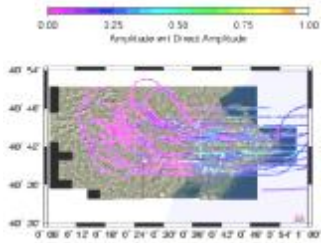
Altimetry



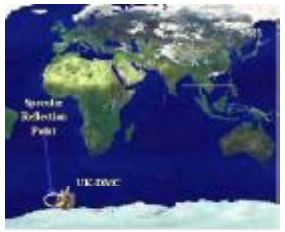
Significant Wave Height



GNSS-R



Soil moisture



Sea ice

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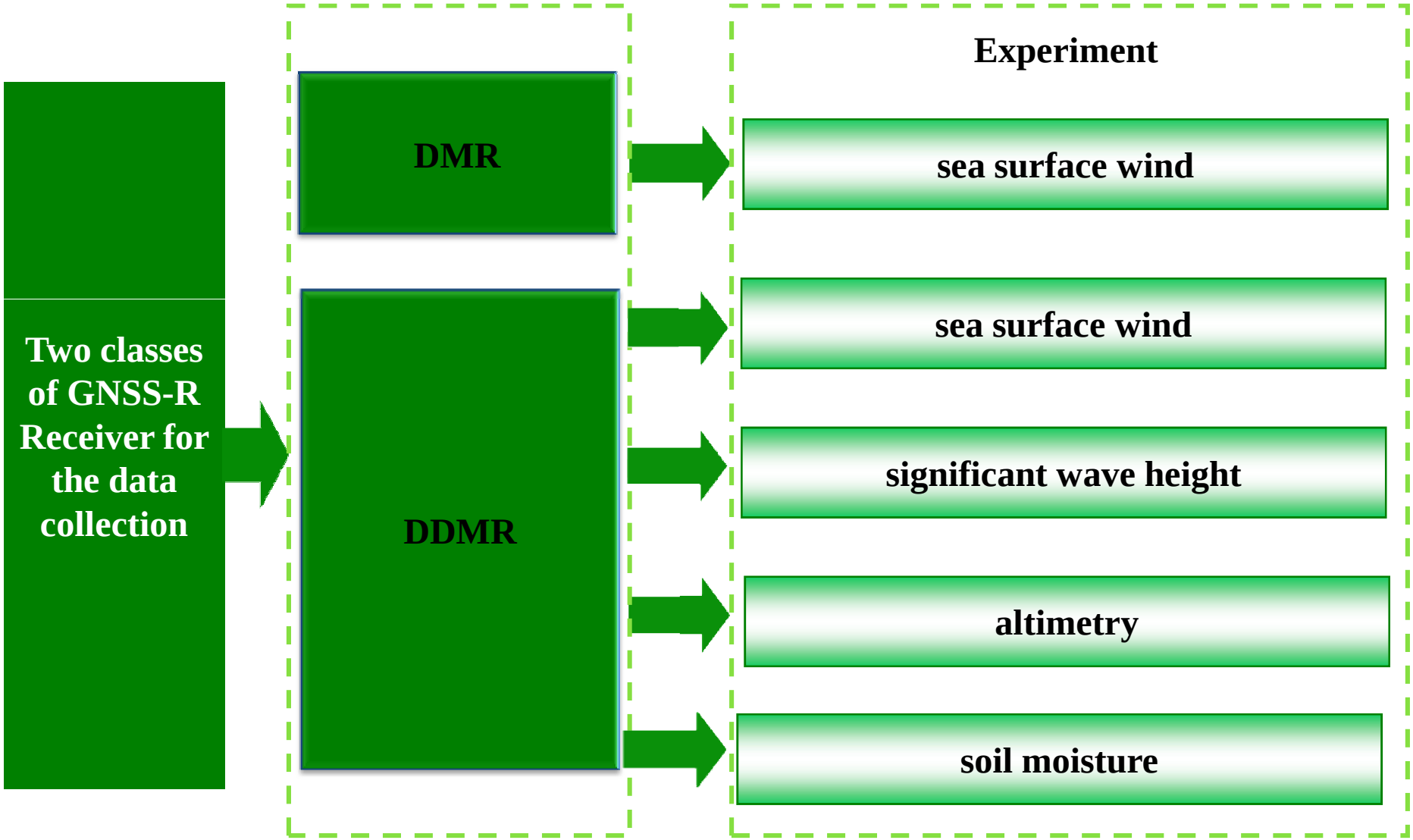

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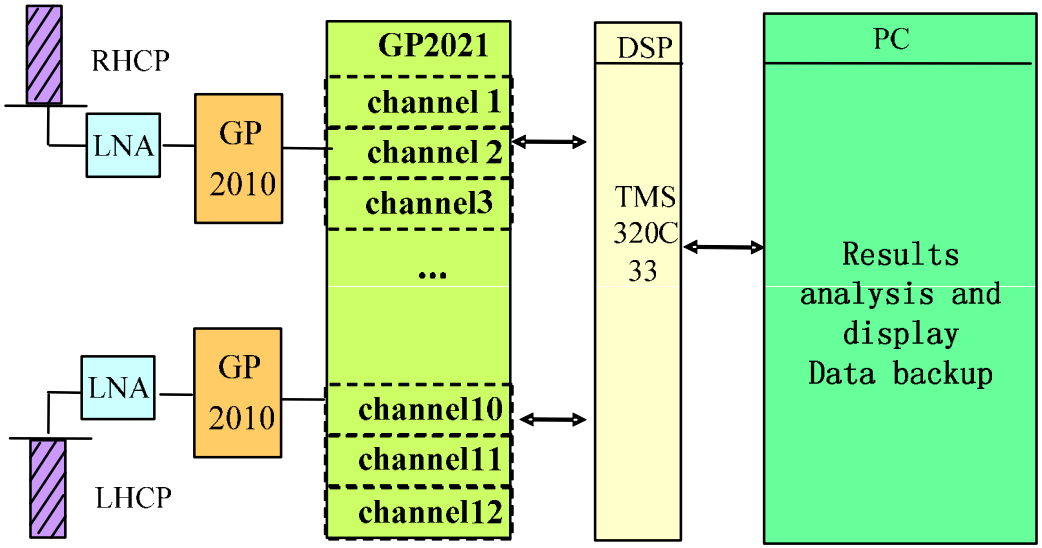
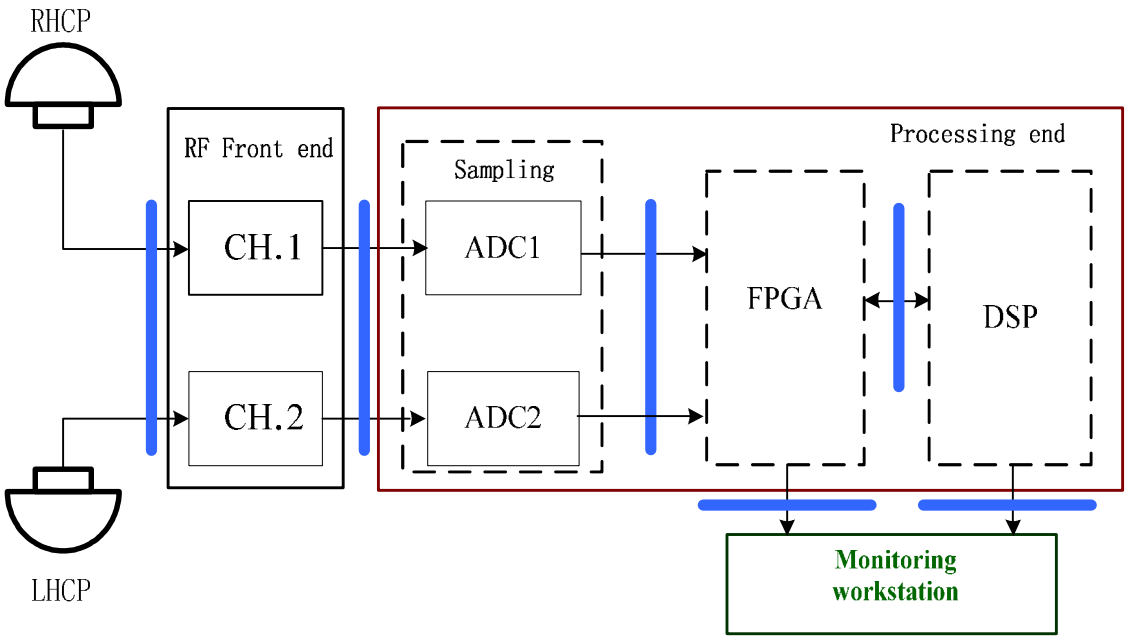
II. GNSS-R receiver Description

1.DMR (Delay Mapping Receiver)



- Commercial GNSS correlator and RF chipset from Zarlink
- Commercial RHCP, Custom-built LHCP @3dB gain
- Data backup for the result replay
- Not configurable for the time delay resolution (half C/A code chip)
- One dimension reflection correlation

2.DDMR(Delay-Doppler Mapping Receiver)



- Custom-built RF front end and correlator
- Commercial RHCP, Custom-built LHCP @12dB gain
- Data backup for both the result replay and the post-processing with different algorithm
- Configurable for the time delay and the Doppler resolution
- Primitive digital data from ADC could be used GNSS-R software receiver
- Two dimension reflection correlation

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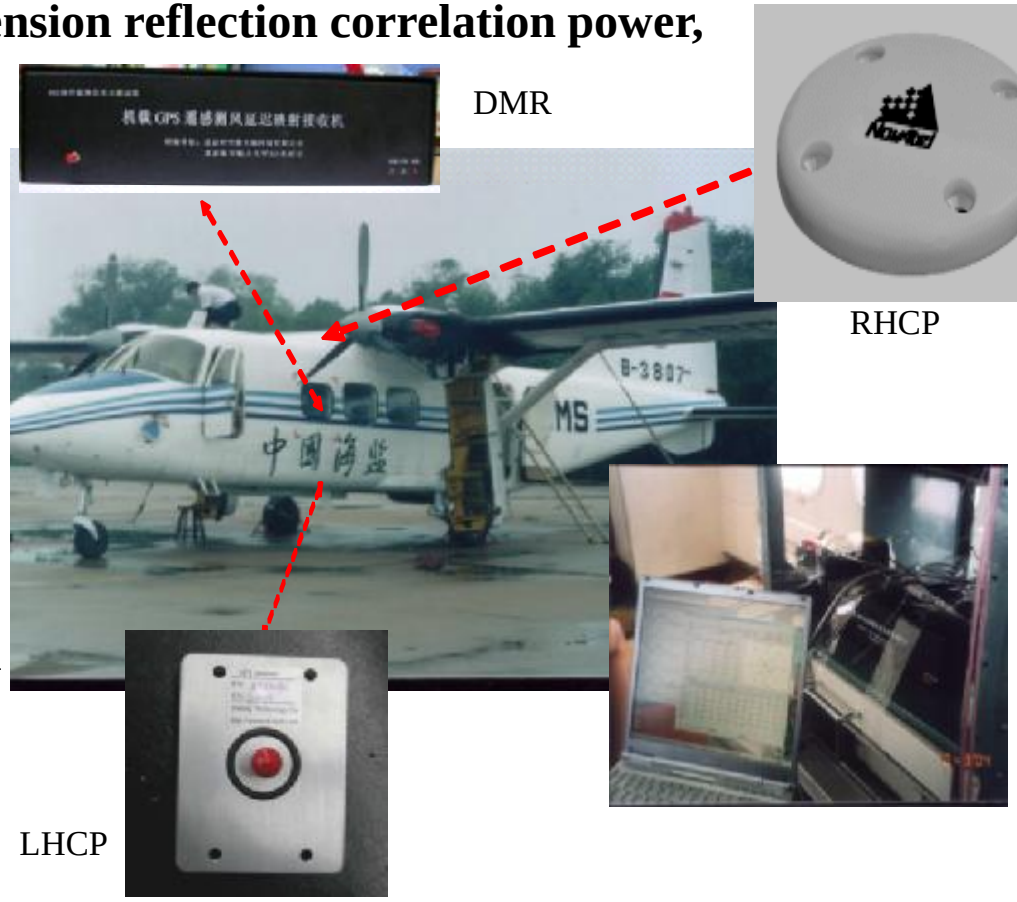
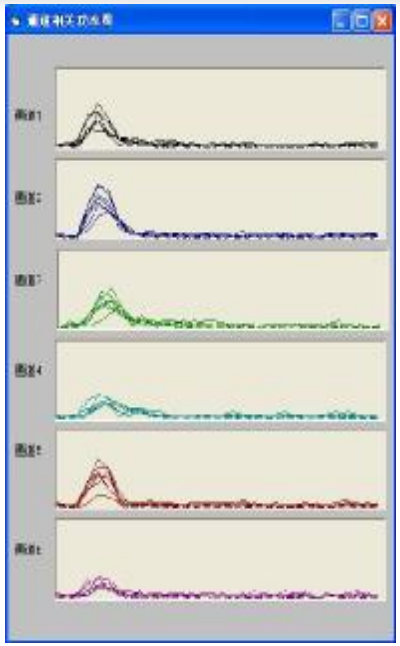
III. Data Process and Analysis

1. Airborne experiments for sea surface wind using DMR

- Shan Dong, Bohai area, from Aug, 2004 to Sep, 2004
- Delay Mapping Receiver, one dimension reflection correlation power,
- 3 flights were performed
- Maximum flight height is about 3000 meters
- 3dB Gain LHCP antenna was used



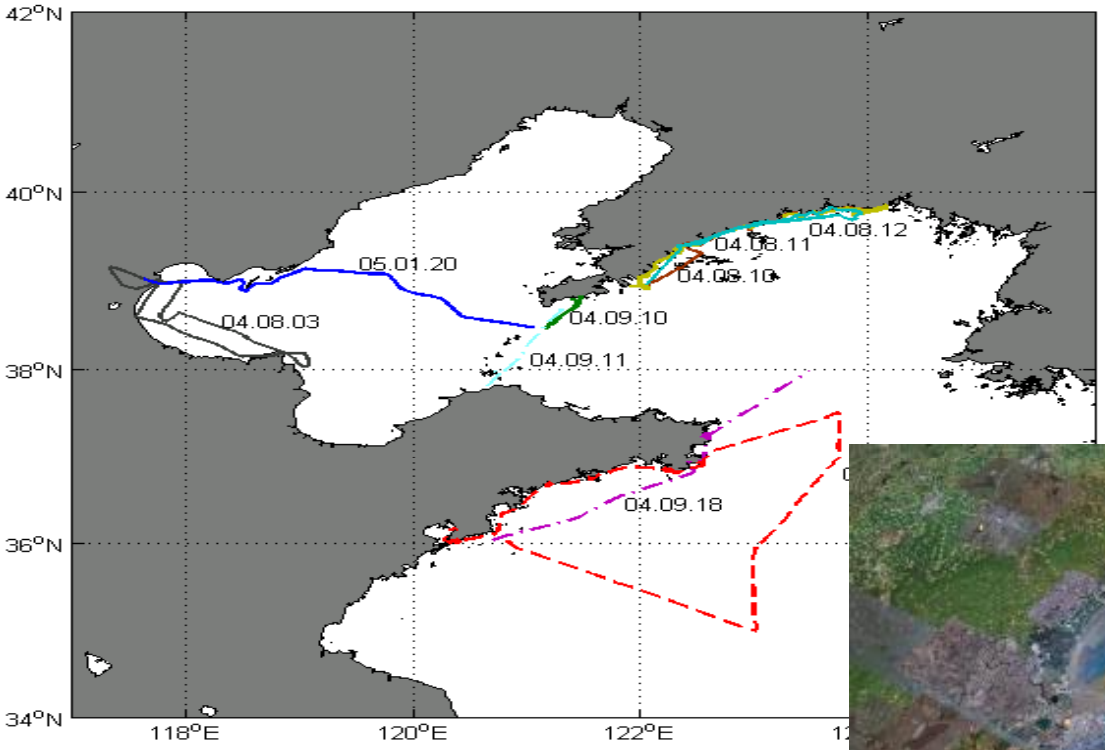


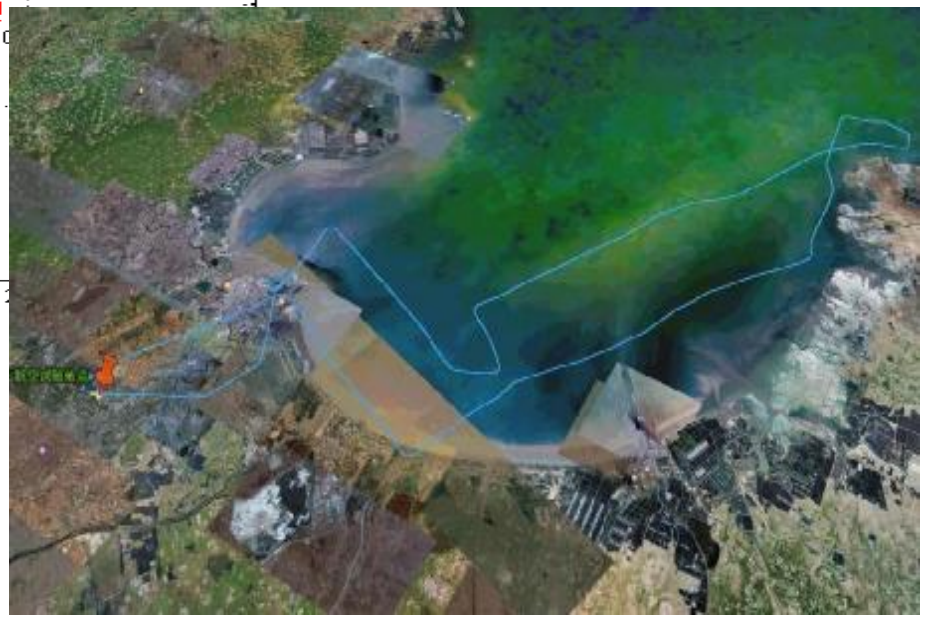
•The power curve is also shown in real time with dynamic mode

•Graphical User Interface

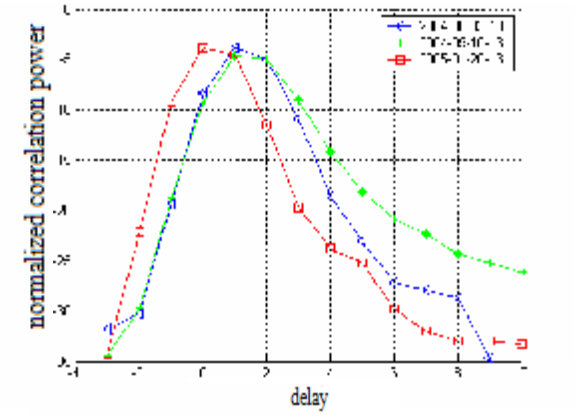
•6 direct channels to display the visible satellite information

•6 reflect channels to show the reflection correlation power over different time delay from -3 to 6, the time resolution is half chip



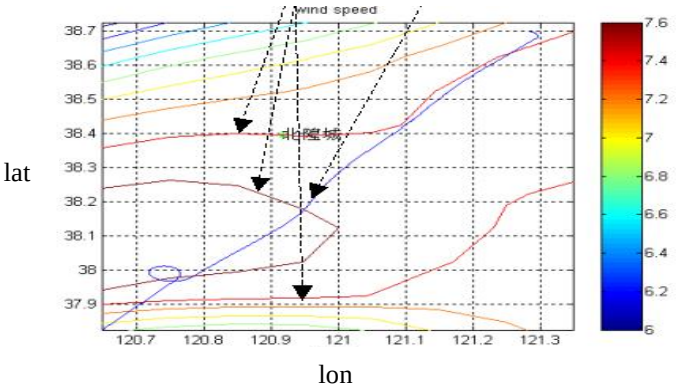


The flight areas and the trajectory @ Google map

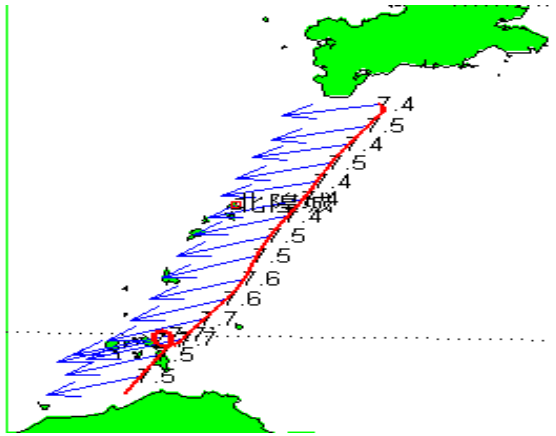


- 3 examples for the normalized correlation power curve at different wind speed
- The declining data are used to get the wind speed
- less than 2m/s deviation from the scatterometer data

Wind speed contour line **airline**



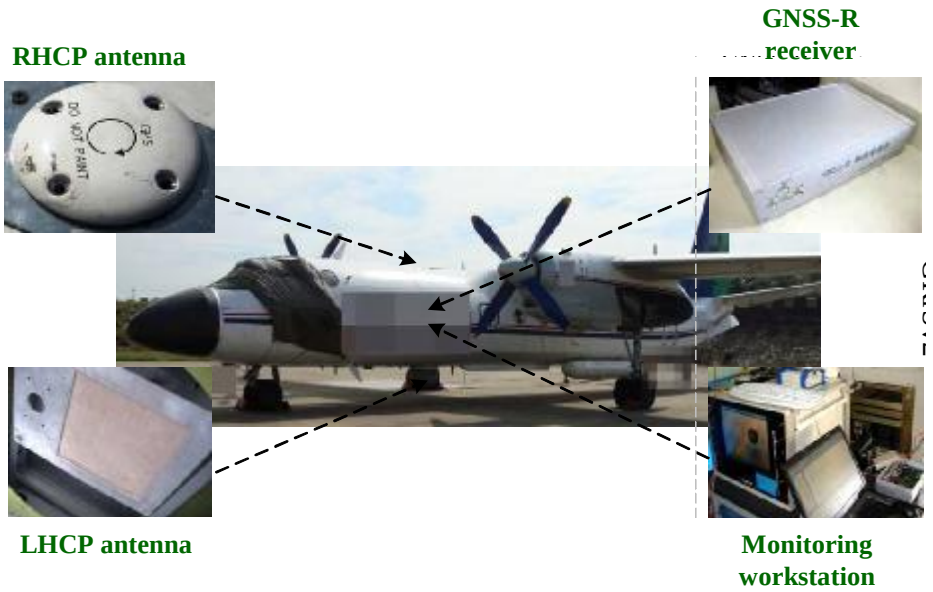
Scatterometer Measured wind speeds

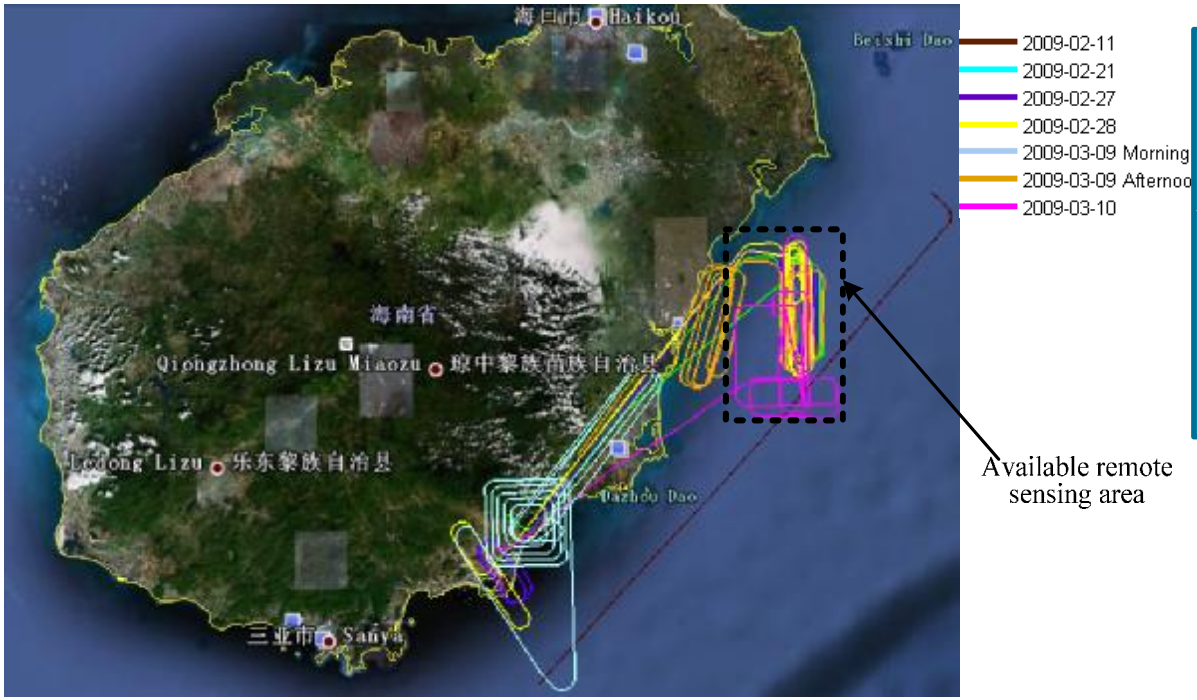


Measured and *in-situ* wind speeds

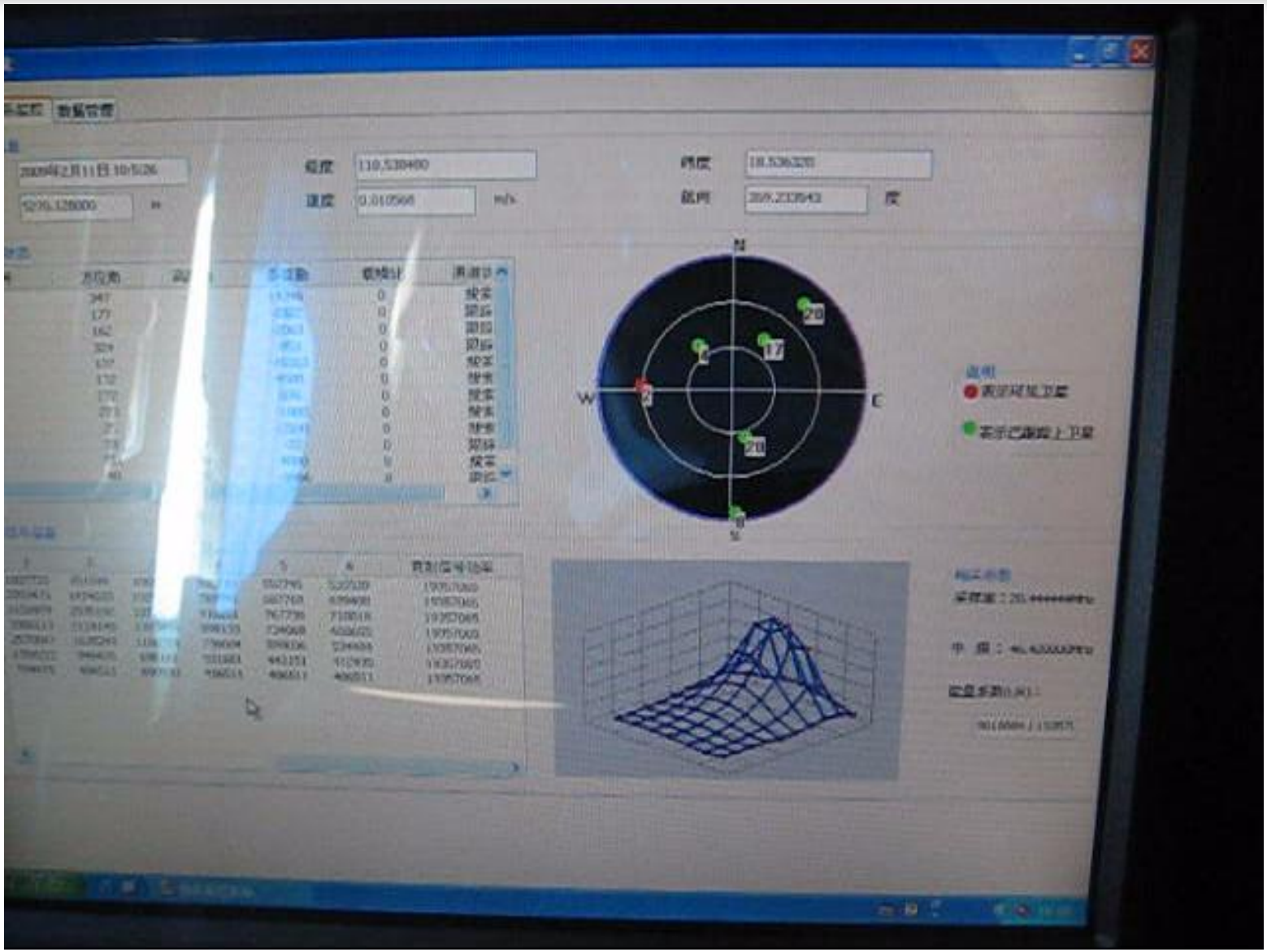
2. Airborne experiments for sea surface wind using DDMR

- Hainan, from Feb. 30, 2009 to Mar. 5, 2009
- 12dB Gain LHCP antenna was used

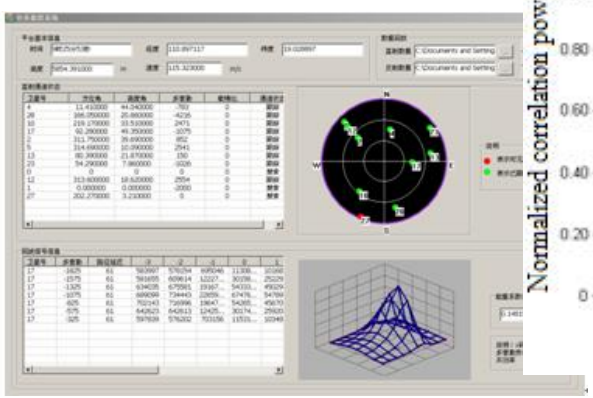


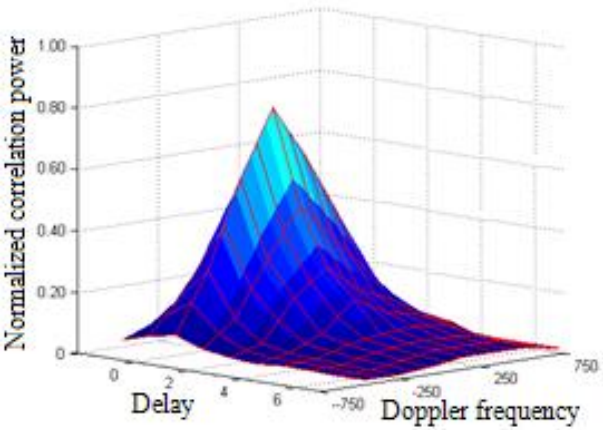


- 7 flights trajectory @ Google map
- Maximum flight height is about 5000 meters

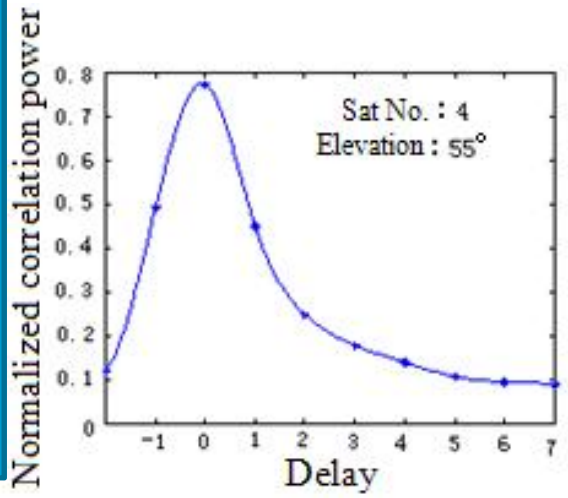


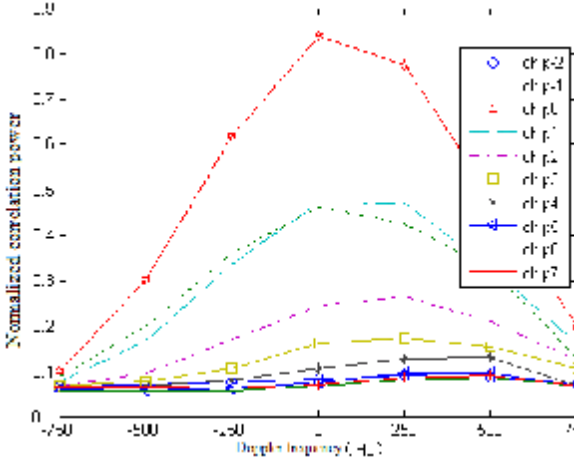
- The flight information including location, satellite sky view…
- Two dimensional reflection correlation power over time delay and Doppler
  - -1~+3 C/A code Chip with half chip resolution
  - -750~+750Hz Doppler with 250Hz resolution
- Data output is real time and dynamic , 1Hz





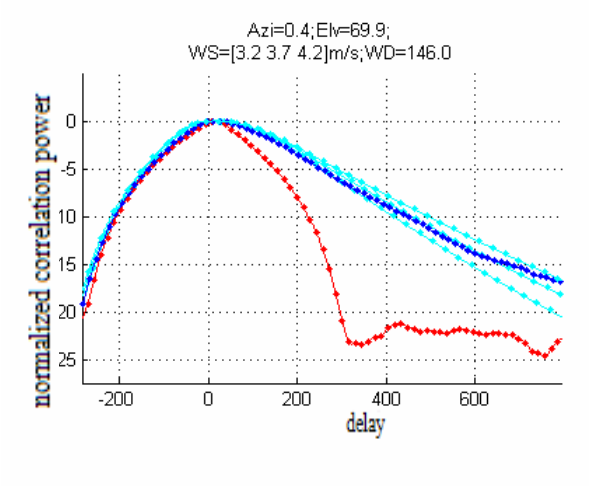
Geographical User Interface

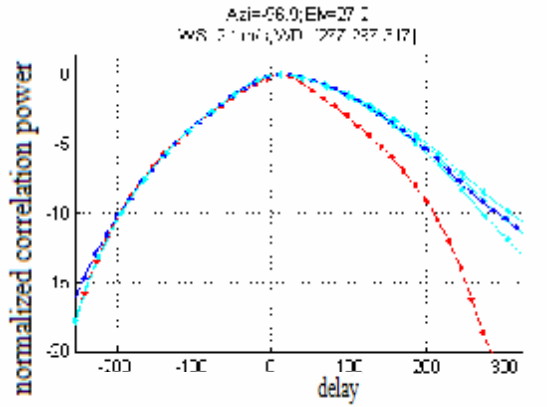


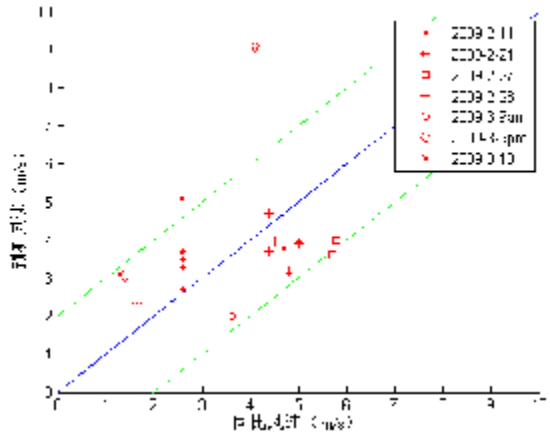


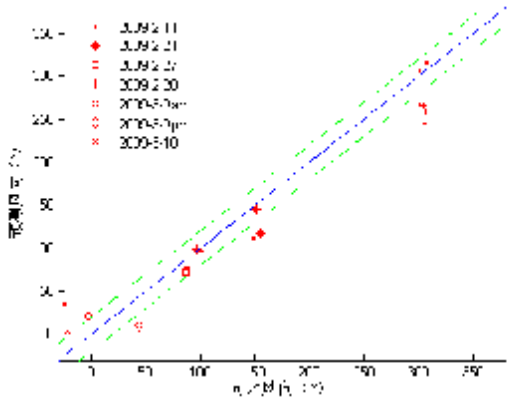
•Examples for the wind retrieval

- •Elfouhaily spectrum model was used
- •Theory curve and test data matching method
- •Wind speed deviation is within ±2m/s
- •Wind direction deviation is within ±10°

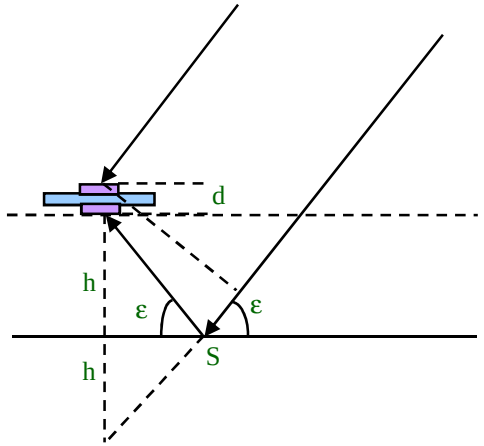






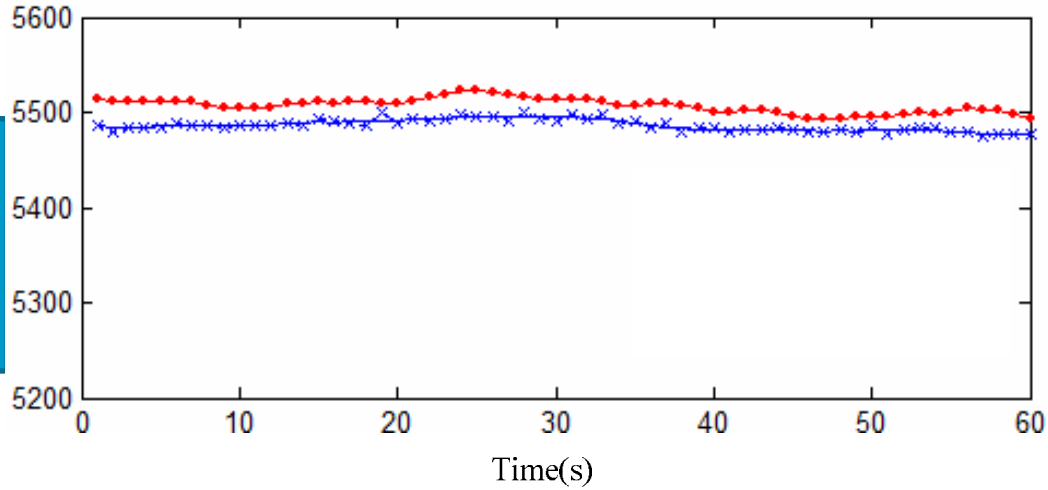


•Examples for altimetry based on the collected data



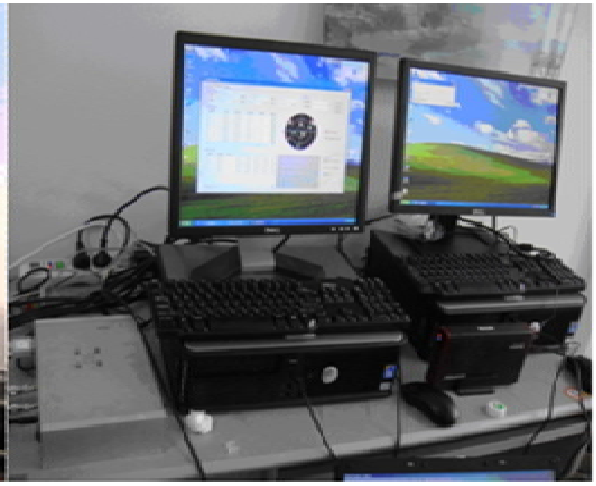
•Geographical model for the altimetry

- **60 seconds data were selected**
- **Standard deviation is about 6meters**



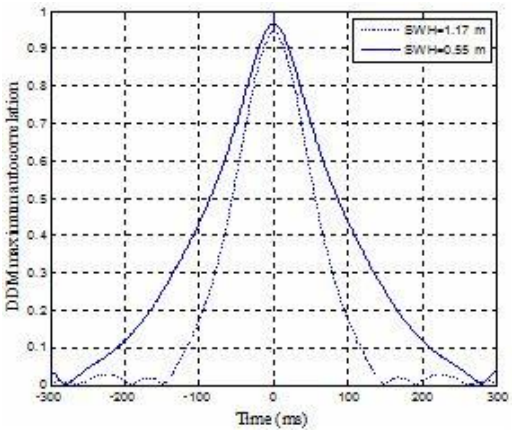
3. Experiments to Significant Wave Height

•The GNSS-R DDMR receiver was equipped in Bohe, Guangdong province in Nov. 2009.



•Continuously observation

•Data processing is ongoing



4. Experiments for Soil Moisture

•Data collection in Hailaer Neimenggu, May 2009

•Experiment was performed for the land surface with and without grass

•Data processing results show that the GNSS reflection signal changes over the soil moisture, which has the same trend with the hygrometer

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Through the static and dynamic test on sea surface, soil moisture, it is shown that the collected data is effective, and the real-time output of the results can be used to retrieve various physical parameters.

- In the design of GNSS reflected signal processing receiver, the future work will be towards multiple system, high-precision, high resolution and in the direction of software defined receiver.

- Cooperation with related organization or departments on ocean, weather and other applications to promote GNSS-R techniques application in routine observation.

- More applications such as surface imaging, target detection would be expanded.

Thank you!

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