Microwave Sensors Subgroup (MSSG) Report

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OUTLINE

- Missions and objectives
- Requirements and challenges
- Focuses and progresses
- Future work

Missions & Objectives of MSSG

- Missions:
  - The mission of the Microwave Sensors subgroup is to foster high quality calibration and validation of microwave sensors for remote sensing purposes. These include both active and passive types, airborne and spaceborne sensors.
- Objectives
  - Facilitate international cooperation and co-ordination in microwave sensor calibration / validation activities by sharing information on sensor development and field campaigns.
  - Promote accurate calibration and validation of microwave sensors, through standardisation of terminology and measurement practices.
  - Provide a forum for discussion of current issues and for exchange of technical information on evolving technologies related to microwave sensor calibration / validation.
  - Provide calibration/validation support to CEOS virtual constellations and data application groups/communities by coordination of reference sites for both passive and active microwave sensors, and standardization of quality assurance of microwave remote sensing data.

MSSG covers passive and active…

All EO sensors operated in microwave spectrum, except SAR

- Works currently focuses on:
  - Microwave Radiometers (sounders, imagers)
  - Radar Scatterometers
  - Radar Altimeters
- Other related aspects:
  - GNSS and GNSS-Reflected signal applications
  - Spaceborne weather radars: Cloud and Precipitation Radars (e.g PR, CPR)
  - Ice sounders and GPR

Characteristics of Microwave Sensors

- Diversity in types and applications
- Low spatial resolutions (km, tens of km, hundreds of km), but generally large swath with prompt global coverage
- Atmosphere, ocean, large-scale environmental applications
- Data dependent on processing (statistics, sensor parameters, algorithms...)
- Importance of process control and quality control

Requirements and Challenges

- Quantitative assimilation in numerical prediction models
- Climate and global change applications
  - ✧ Higher requirements, especially for climate and global change applications: sensitivity, accuracy, stability;
  - ✧ Cross-calibration requirements of sensors flown on different spacecrafts and developed by different agencies;

  (e.g. ASCAT/METOP of Eumetsat, OSCAT of ISRO, India; SCAT/HY-2 of SOA, China)
- No traceable standards available for microwave sensors;
- New developed sensors
  - ✧ Polarized radiometers and scatterometers
  - ✧ Interferometric synthetic aperture radiometers
  - ✧ Wide swath and SAR altimeters
  - ✧ ...

What needs to/can do for microwave sensors...

- General considerations
- Active microwave sensors
- Passive microwave sensors

General considerations

- Many groups/organizations (MicroRAD, GSICS, IOVWST,...) had worked on different aspects involving microwave sensors, including Cal/Val, most from aspects of science and applications, WGCV can provide Cal/Val support from sensors by concerned agencies.
- MSSG will emphasize on data quality of microwave sensors, by provide a platform for exchange and sharing of prelaunch calibration standards/schemes for different agencies and standardization of prelaunch and post launch calibration of microwave sensors.
  - ✧ Standardization of calibration of passive microwave sensors;
  - ✧ Collecting information of cal/val sites for microwave imagers,
  - ✧ Coordinating microwave data on selected sites for cal/val applications;
  - ✧ Coordinating with other groups and organizations.
- Priorities will be on L1b level data, i.e. BT for passive and Sigma 0 for active sensors.

Active microwave sensors

- Identify the post-launch cal/val procedures for different type of scatterometers (fixed beam, scanning beam, etc)
- Coordinating scatterometer data (C band and Ku band) for potential proposed calibration site (Amazon forest, Antarctic, etc), setup database for cal/val and cross-cal of scatterometer on these sites;
- Collecting information of artificial calibration facilities/sites for scatterometers;
- Identify information of calibration sites for radar altimeters, collaboration for cross-instrument cal/val;
- Identify cross-cal/comparison of PR with other sensors (Alt, etc)

Passive microwave sensors

- For radiometric standards
  - ✧ Identify references for standardization of radiometric references in microwave spectrum
- For prelaunch calibrations
  - ✧ Identify reference standards for pre-launch calibration of microwave radiometers from existing standards or specifications, to promote the cross-comparison of microwave radiometers developed by different agency and flown on different satellites;
  - ✧ Develop CEOS/WGCV standards and recommendations as proposed guidelines and reference standards for calibration of passive microwave sensors.
- For post-launch cal/val
  - ✧ Identify cross-calibration and validation methodology for cal/val of microwave sounders;
  - ✧ Identify appropriate calibration sites (Amazon forest, Antarctic ice shell, desert, etc) for cal/val of microwave imagers, setup database of these sites.

Focuses for active sensors (1)

- Scatterometers
  - ✧ Evaluation of L1b (sigma 0);
  - ✧ Prelaunch calibration requirements
    - ➢ Antenna, internal cal, data processing
  - ✧ After launch cal/val
    - ➢ Identify and characterization of extended-area target
      - ☐ Amazon, ocean, ice
    - ➢ Antenna pattern cal
      - ☐ Extended target, ground calibration station and transponders
      - ☐ Rotating and fixed, pencil-beam and fan-beam
    - ➢ After launch cal/val
      - ☐ Cross cal of sigma 0 for sharing wind retrieval models
      - ☐ Ocean wind vector
      - ☐ Soil moisture

Focuses for active sensors (2)

- Radar altimeter
  - ✧ Prelaunch calibration
    - ➢ Antenna, transmitted signal, receiver
  - ✧ After launch cal/val
    - ➢ Ground calibration stations
    - ➢ Cross cal/val for application of ALT data from different satellites
      - ☐ Sea level
      - ☐ Significant wave height
      - ☐ Surface wind speed

Recent progresses

- Recent progresses
  - ✧ Collaboration with OSVW VC and IOVWST to formulate MSSG priorities on scatterometer
  - ✧ NSOAS, CNES and ESA cooperation for cal/val of radar altimeter: cross-cal and cal with ocean
  - ✧ Progresses on cal/val of passive microwave atmospheric data with GNSS measurements
  - ✧ Progresses on microwave emission standard

Cross-calibration of scatterometry 1: requirements and difficulty

- Climate data record (CDR) of ocean surface wind (OSW) become important new requirement for scatterometer data, in addition to weather applications;
- Consistency of OSW data from different missions requires cross-cal;
- L1b data (sigma 0) bias plays essential role;
- Difficulties in direct sharing of sigma 0 data (US, China, India) due to data policy;
- OSVW VC and MSSG coordinate in international, multilateral frame.

Cross-calibration of scatterometry 2: Progresses and next step work

- Coordinate with OSVW VC, IOVWST and agencies to determine areas for x-cal of Ku-band data; (June 2-4, 2014 IOVWST meeting)
- Survey of sites for X-cal and val of microwave scatterometry data
- Multilateral joint campaigns to avoid data share difficulties (X-cal with Amazon for QSCAT, OSCAT and HY-2 SCAT
- Work on standard processing algorithms for x-cal purpose;
- X-cal of L1b data and OSW data;
- X-cal with global ocean NWP models

Cross-calibration of altimetry 1: requirements and progresses

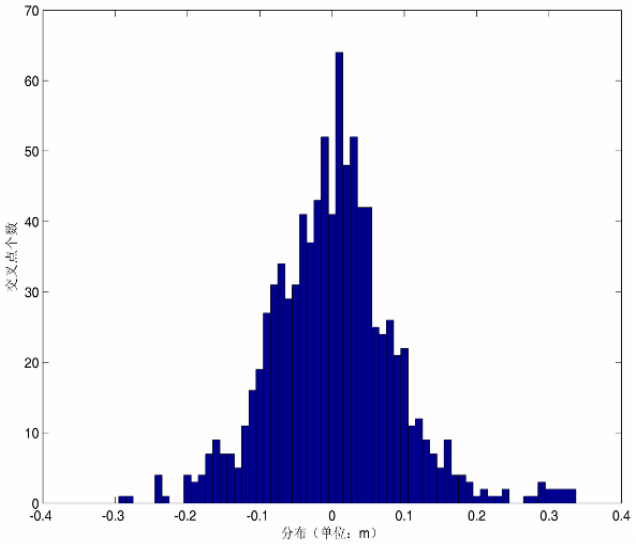
- Climate and global change research requires long-term data with continuance;
- Sea level products related to orbit and algorithms (corrections) and requires x-cal and val
- HY-2A altimeter with Jason-1/2 (NSOAS, CNES, ESA)
- Multimission altimetry data validation in the Baltic Sea (NSOAS, DTU Space)
- Based on bilateral cooperation, no OST VC involvement.

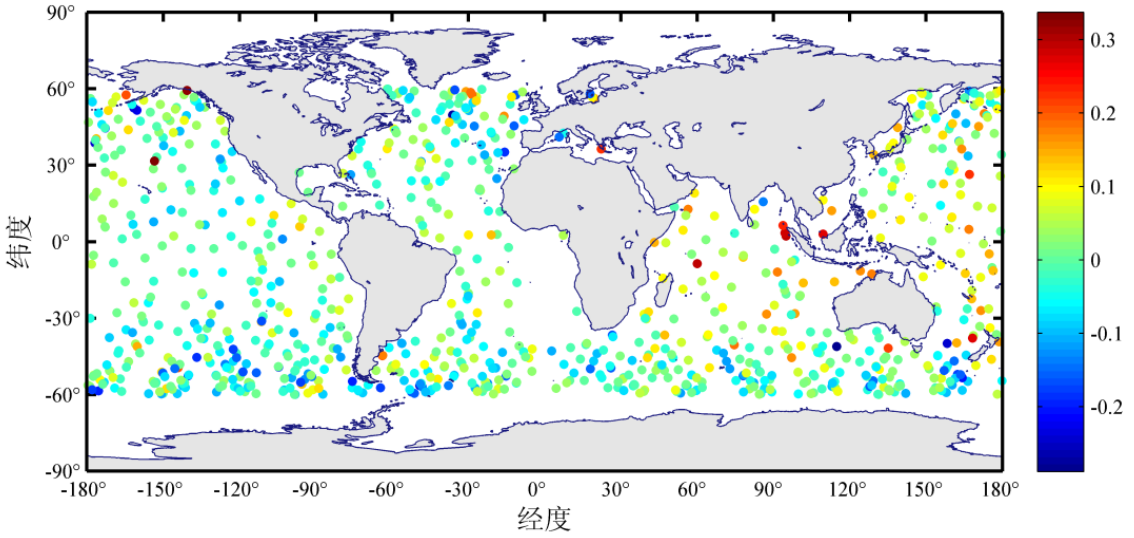
Cross cal/val of HY-2A altimeter data with Janson-1/2

- Participation by NSOAS/SOA, CNES and ESA;
- Very good encouraging results.

Sea level

- Cross-comparison: HY-2A with Janson-2





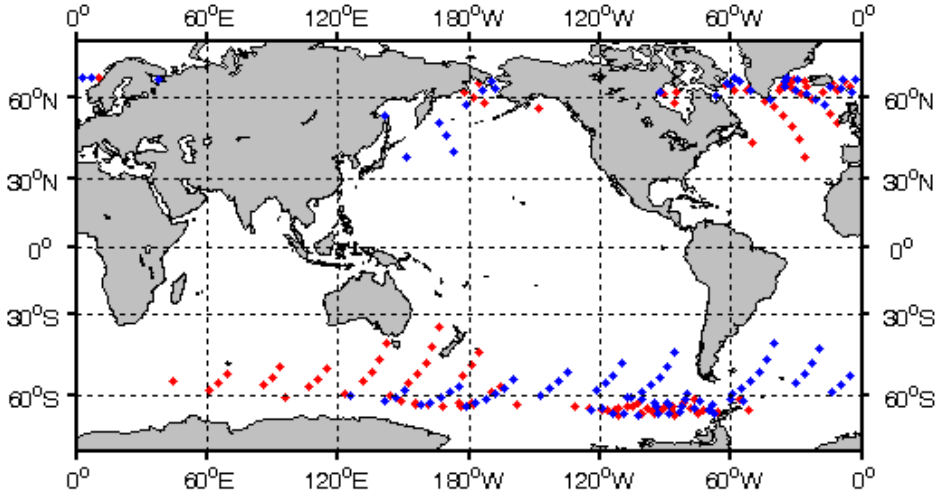
Statistics of coincidence locations

Absolute RMS deviation with average offset correction:

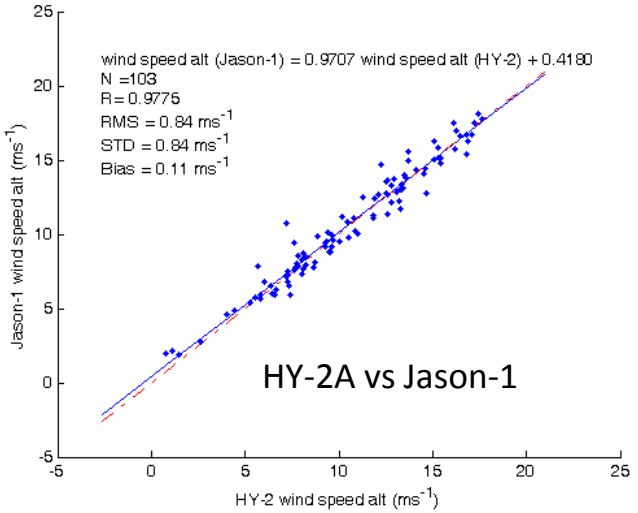
8.3cm, with correlation coefficient of 0.978.

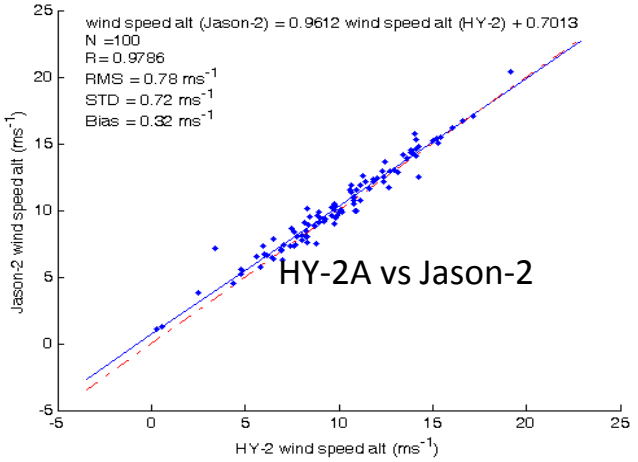
Wind speed

- Cross-comparison with Janson-1/2



Coincidence point distribution of HY-2A and Jason-1/2





RMS deviation:

HY-2A vs Jason-1: 0.84m/s

HY-2A vs Jason-2: 0.78m/s

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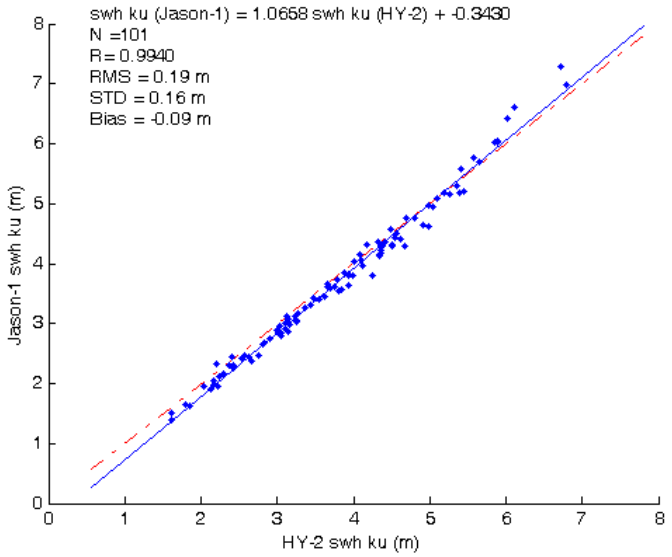
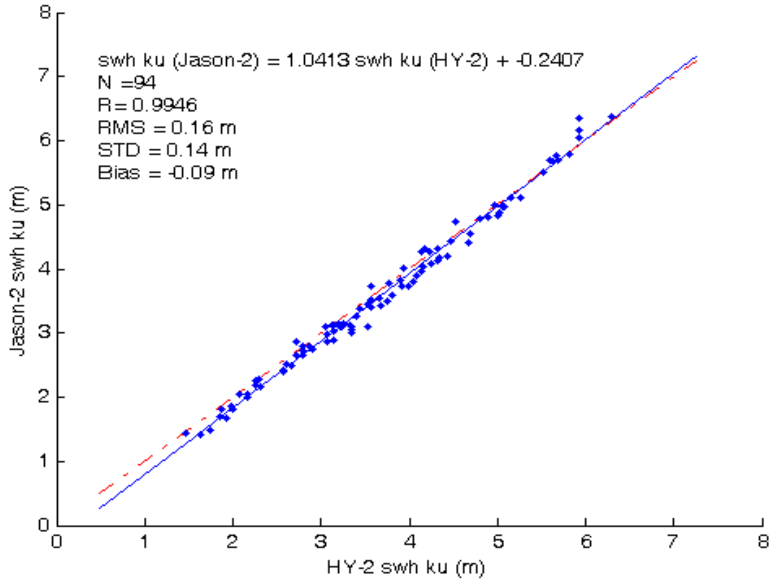
Significant wave height

- Cross-comparison with Janson-1/2



HY-2A vs Janson-1



HY-2A vs Jason-2

RMS deviations: vs Jason-1: 0.19m; vs Jason-2: 0.16m

Recent focuses and progresses for passive sensors

- Clarification of climate requirements for passive microwave data (with GCICS)
- Validation of microwave atmospheric data with GNSS-O
- Standardization for prelaunch calibrations to characterize data quality
  - ✧ Radiometric references (calibration target)
  - ✧ Standard of calibration procedure and calibration error source identification
  - ✧ Standard for cal data processing
  - ✧ Evaluation of system specifications
- Methodologies and standardization for in-orbit cal/val
  - ✧ Real-aperture (imager, sounder)
  - ✧ Synthetic aperture

Future work

- Next CEOS Microwave Sensor Calibration and Validation Workshop (before end of 2014);
- X-cal of L1b data and data quality control standards for ocean vector wind vector data (with IOVWST and OSVW VC)
- Cross calibration/comparison of radar altimetry data (NSOAS/SOA, CNES, ESA, TUD space and TUC)
- Standardization of calibration of microwave radiometry
- With availability of GNSS-O data, x-cal/val of passive microwave atmospheric data becomes more feasible, collection of coincident data and development of X-comparison algorithms and standard are important for future
- Coordination of data for cal/val purpose
  - ✧ NSOAS/SOA began to release HY-2A product data;
  - ✧ Concerned agency participation is needed.
- Further coordination with other groups: GSICS, MicroRAD,...

Proposal and recommendations from the workshop (1)

- In order for long-term stability and traceability of data from passive microwave sensor, development of standard for passive microwave calibrator is necessary, including measurement method, and criteria for characterization uncertainty of the emissivity. Concerned agencies are encouraged to participate, under the framework of CEOS and GEO.
- Clarification of cal/val requirements for microwave sensors from WGClimate is necessary;
- Based on the quality assurance requirements for applications, prelaunch test and calibration requirements should be identified, with collaborated work by payload and algorithm team, operational service agencies and application communities.
- Cross-calibration and validation is important for microwave data applications in climate purposes, a database should be setup with participation of agencies with capability. The database should include temporal and spatial information of overpasses of satellites with similar payloads or data products. Related agencies are encouraged to participate and provide information and data.

Proposal and recommendations from the workshop (2)

- Ground replace calibration is important to ensure long-term stability of passive microwave sensors, it is recommended for the community to identify some certain cold references (such as calm ocean surface, arctic ocean ice, etc.) and warm references (such as Amazon forest, desert, etc.) and collect data, including data from satellite payloads and in-situ measurements.
- The importance of quality assurance of L1b level data of spaceborne radar scatterometer is identified. It is suggested to setup a working mechanism to coordinate the agencies with capability to participate, including identification of ground reference sites and providing data for these sites, for the purpose of climate record data.
- Calibration with global ocean can play an important role in the quality assurance of microwave scatterometry data, it is suggested community to provide in-situ measurement data and participate in development of models.

The End!