Microwave Sensors Subgroup (MSSG) Report

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DONG, Xiaolong, MSSG Chair

CAS Key Laboratory of Microwave Remote Sensing
National Space Science Center
Chinese Academy of Sciences
(MiRS,NSSC,CAS)
Email: dongxiaolong@mirslab.cn
Tel: +86-10-62582841, Fax: +86-10-62528127

OUTLINE

- Missions and objectives
- Recent 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:
  - ✧ Spaceborne weather radars: Cloud and Precipitation Radars (e.g PR, CPR)
  - ✧ GNSS and GNSS-Reflected signal applications
  - ✧ Ice sounders and GPR

Characteristics of Microwave Sensors

- Diversity in types and applications
- Low spatial resolution (km, tens of km, hundreds of km)
- Atmosphere, ocean, large-scale environmental applications
- Data dependent on processing (statistics, sensor parameters, algorithms…)
- Importance of process control and quality control

Recent Requirements and Challenges

- 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
  - ✧ …

Climate applications of ocean wind vector

- Different sensors (frequency, antennas, scanning…)
- Differences in…
  - Calibration
  - Processing
  - Geophysics
- Therefore, differences of
  - L1b products (bias, definitions…)

(P. Lecome, ESRIN/ESA, 2011)

- Climate application requirements…
  - Long-term geophysical parameter with consistency
  - Cross comparable
- Therefore
  - Standardization of system terminology
  - Standardization of processing
  - Cross-cal references

What needs to/can do for microwave sensors…

- General considerations
- Passive microwave sensors
- Active 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.

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.

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;
- Identify cross-cal/comparison of PR with other sensors (Alt, etc)

Focus areas for passive sensors

- Radiometric standard of MW, MMW passive sensor calibration
  - NIST/US;
  - BIRMM,CSSAR/China;
  - FSUE «VNIIFTRI», Kosmonit/Russia;
  - UK (NPL), etal
- 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
  - US, Japan, Europe, China, Russia, etal
- Methodologies and standardization for in-orbit cal/val
  - Real-aperture (imager, sounder)
  - Synthetic aperture

Focus areas 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

Focus areas 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
- Space based weather radars
  - Cross-cal with other sensors (Alt, MW imager…)
  - Collaborate with GPM team

Status and recent progresses

- **Status**
  - ✧MSSG does not have fixed group member
  - ✧MSSG does not actively participate in tasks
- **Recent progresses**
  - ✧Discussion 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 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: next step work

- Coordinate with OSVW VC and IOVWST to determine areas for x-cal of Ku-band data;
- Work out standard processing algorithms for x-cal purpose;
- Collect data for specified areas;
- X-cal of L1b data and OSW data;
- Initiate tasks with OSVW VC.

Cross-calibration of altimetry 1: requirements and progresses

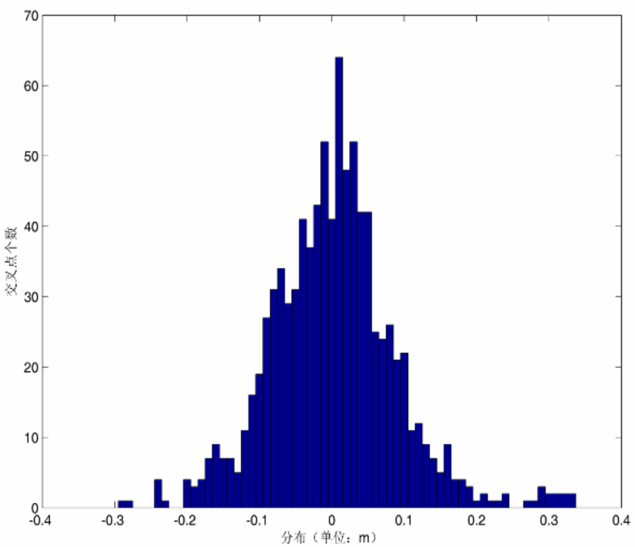
- Climate and global change research requires long-term data with continuance;
- Sea level products related to orbit and algorithms (corrections) and requires x-cal and val
- HY-2A altimeter with Jason-1/2 (NSOAS, CNES, ESA)
- Based on bilateral cooperation, no OST involvement.

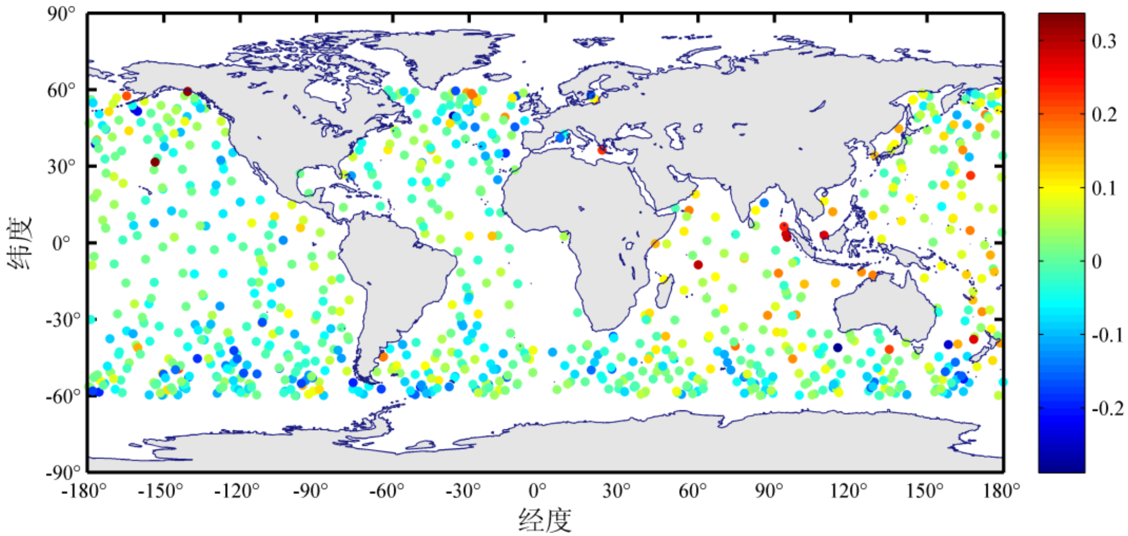
Cross cal/val of HY-2A altimeter data with Janson-1/2

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

Sea level

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





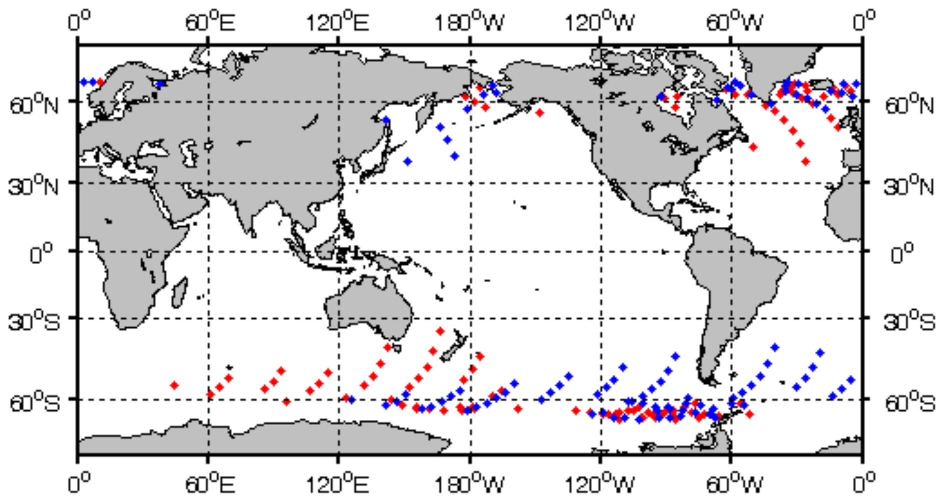
Statistics of coincidence locations

Absolute RMS deviation with average offset correction:

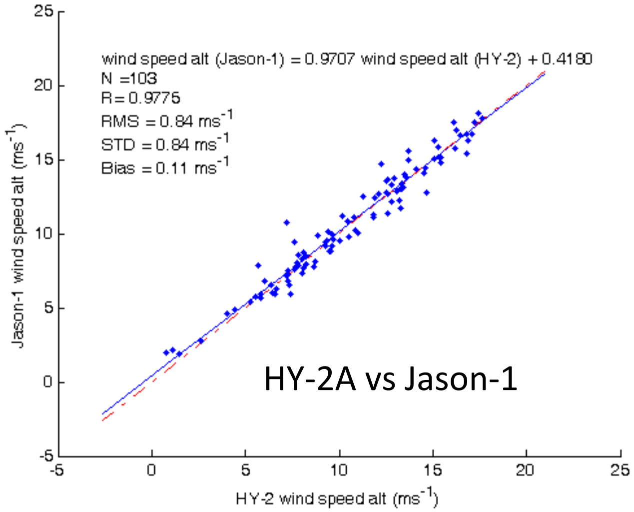
8.3cm, with correlation coefficient of 0.978.

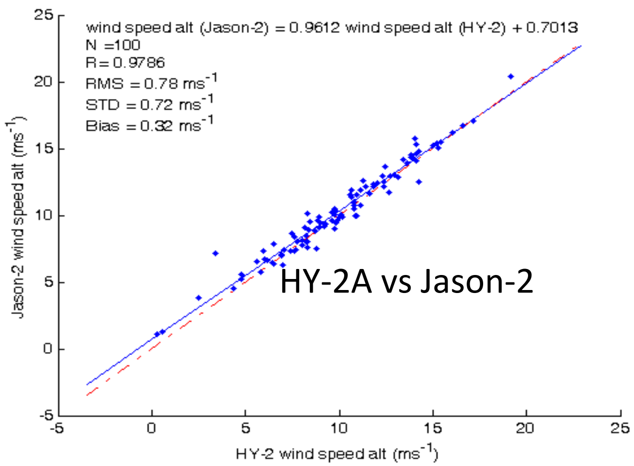
Wind speed

- 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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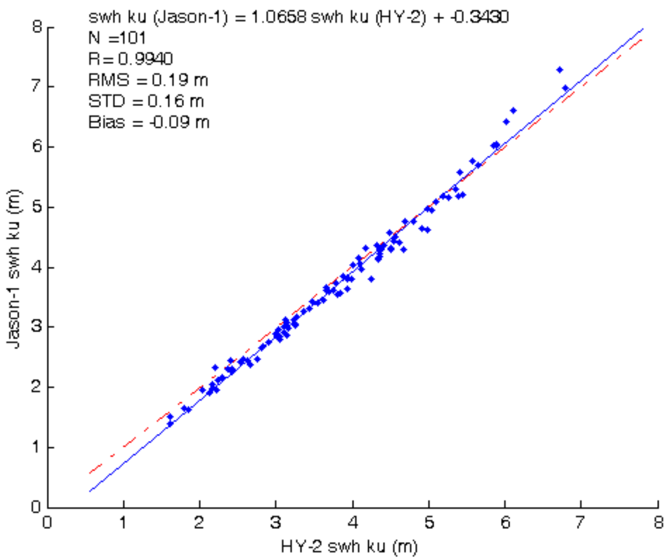
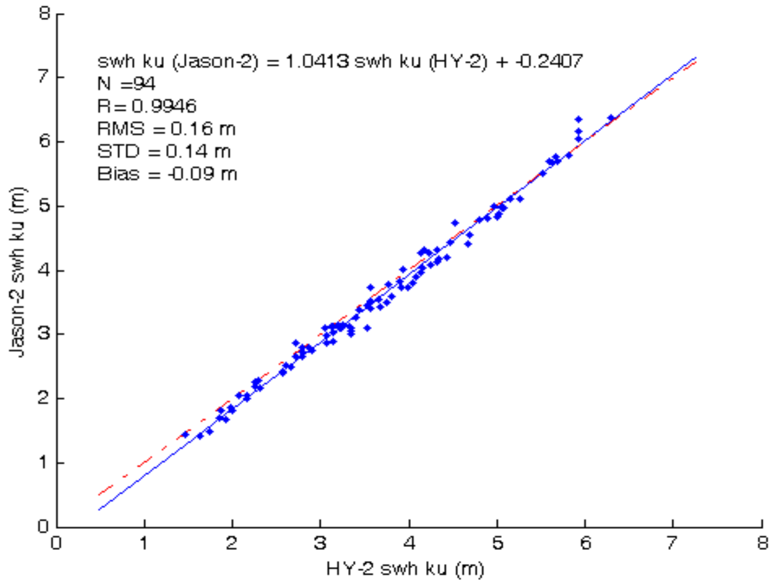
Significant wave height

- 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

Cross-calibration of altimetry 2: next step work

- X-cal and val with ocean;
- Connection with OST VC.

Future work

- Next CEOS Microwave Sensor Calibration and Validation Workshop (before WGCV-37);
- X-cal of L1b data and data quality control standards for ocean vector wind vector data (with IOVWST and virtual constellation)
- Cross calibration/comparison of radar altimetry data (NSOAS/SOA, CNES, ESA)
- Standardization of calibration of microwave radiometry
- Coordination of data for cal/val purpose
  - ✧ NSOAS/SOA began to release HY-2A data (L2 and L3);
  - ✧ JPL cannot provide data and communicate with China;
  - ✧ 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 GEOSS.
- Based on the quality assurance requirements for applications, prelaunch test and calibration requirements should be identified, with collaborated work by payload manufacturer, operational service agencies and application communities.
- Cross-calibration and validation is important for microwave data applications in climate and global change 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.

Other proposal

- A vice-chair for MSSG is expected to focus on passive microwave sensors.
  - ✧Dr Richard Dudley (NPL, UK)

The End!