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Microwave Sensors Subgroup (MSSG) Report

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OUTLINE

- Missions and objectives
- Recent requirements and challenges
- Focuses and progresses
- Future work

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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.

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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

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Characteristics of Microwave Sensors

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

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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. 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
 - ...

MHS/MWHS (microwave Humidity Sounders) calibration requirements for climate applications- precision, accuracy & stability

- Requirements for weather applications
 - Accuracy: 1.0K
 - Precision (NEDT): 0.25~1.2K
 - Stability: None
- Requirements for climate applications
 - Accuracy: 0.5K
 - Precision(NEDT): <0.1K (long term average)
 - Stability: <0.04K (long term average)
- Error sources for calibration
 - Calibration references (emissivity, temperature...)
 - Antenna (sidelobe, spillover, spacecraft...)
 - Temperature (calibration references, receiver,...)
 - Nonlinearity
 - Processing
- Quality control: standardization of ...
 - Radiometric standards
 - Calibration procedure
 - Calibration data processing

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Climate applications of ocean wind vector

- Different sensors (frequency, antennas, scanning...)
- Differences in...
 - Calibration
 - Processing
 - Geophysics
- Therefore, differences of
 - L1b products (bias, definitions...)
- Climate application requirements...
 - Long-term geophysical parameter with consistency
 - Cross comparable
- Therefore
 - Standardization of system terminology
 - Standardization of processing
 - Cross-cal references

(P. Lecomte, ESRIN/ESA, 2011)

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What MSSG needs to/can do...

- General considerations
- Passive microwave sensors
- Active microwave sensors

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General considerations

- Many groups/organizations (MicroRAD, GCICS, 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.

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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.

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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)

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Priorities 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

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Priorities for active sensors (1)

- Scatterometers
 - Evaluation of L1b (σ_0);
 - Prelaunch calibration requirements
 - Antenna, internal cal, data processing
 - After launch cal/val
 - Identify and characterization of extended-area target
 - Amazon, Antarctic, ocean
 - 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 σ_0 for sharing wind retrieval models
 - Ocean wind vector
 - Soil moisture

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Priorities 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

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Action plan for next five years

- Identification and characterization of reference sites for passive and active sensor, especially for L1b data product, collecting data on these sites;
- Identification and standardization of calibration procedure and calibration data processing of microwave sensors, for both prelaunch and in-orbit, to ensure the consistency of data for different sensors on different satellites and developed by different agencies;
- Standards or recommended guidelines for cross-calibration of in-orbit microwave sensors;
- Standards or recommended guidelines for quality assurance of microwave data for climate and global change applications;
- Standardization of radiometric references for passive sensors;
- The subgroup will meet periodically to discuss results and new developments;
- The subgroup implements its action plan by participation of concerned agencies and other groups.

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Recent progresses

- Many talks with concerned people, focus priorities identified;
 - Radiometric standards;
 - In-orbit cal/val of MW radiometers;
 - Scatterometer data quality control;
 - Extended area target data collection;
 - Cross-cal of altimeter data
- The CEOS Microwave Sensors CAL/VAL workshop was held on October 26-27, 2011 in Beijing, China

2011 CEOS Microwave Sensors CAL/VAL Workshop

- October 26-27, Beijing, China. Hosted by CAS Key Laboratory of Microwave Remote Sensing.
- 36 attendees from US, Netherlands, Russia and China, providing 22 presentations.
- Presentations focused on passive sensors and radar scatterometry.



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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.
- 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.

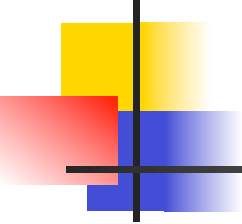
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Proposal and recommendations from the workshop (2)

- 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.
- 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.

Participation in International Ocean Vector Wind Team and Coordination with OVW Virtual Constellation

- 2012 International Ocean Vector Wind Science Team Meeting (IOVWST 2012, Utrecht, Netherlands, June 12-14) and Virtual Constellation Meeting during IOVWST 2012.
- Some results from the meeting:
 - IOVWST focuses on science and applications;
 - VC focuses on data;
 - WGCV focuses on coordination of Cal/Val;
- Proposals for Cal/Val of ocean vector wind
 - NWP global ocean model as a reference for long term calibration and stability;
 - Cross-calibration/calibration of sigma 0 data (level 1b) (IRSO, JPL/NASA, NSOAS/SOA)

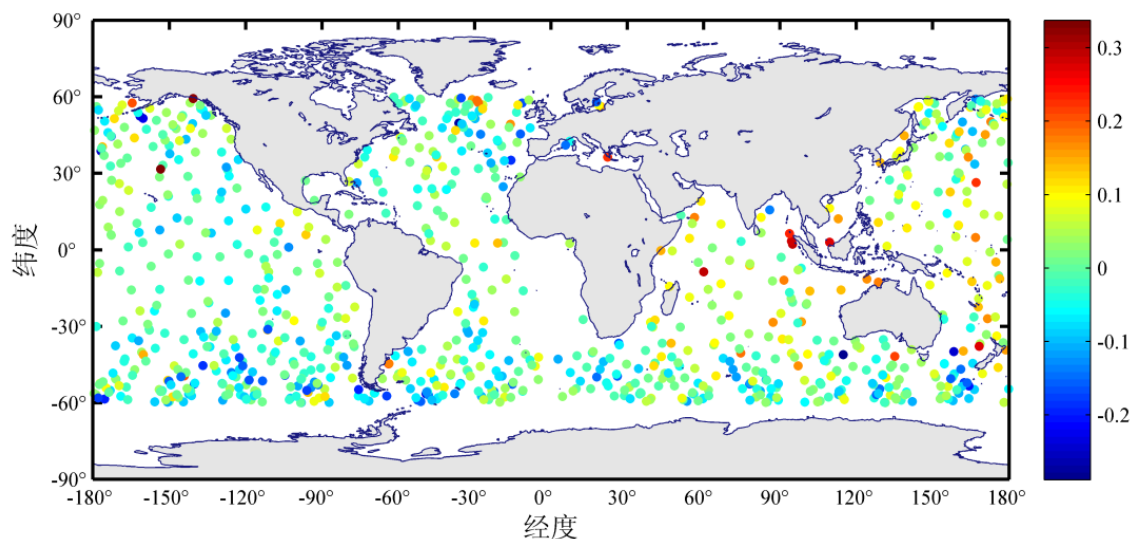
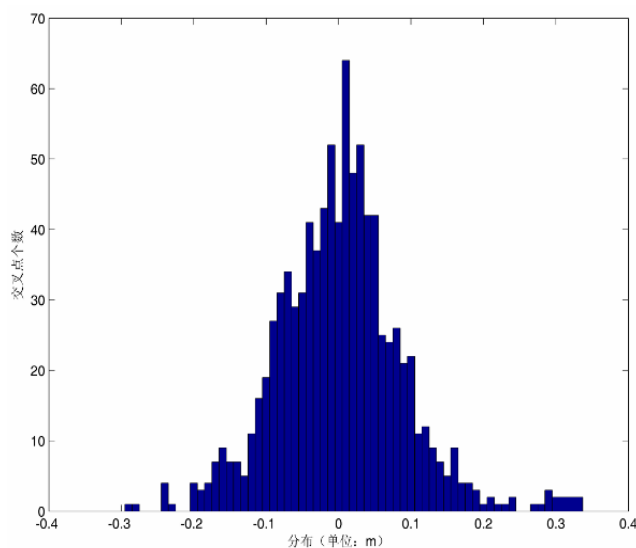
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Cross cal/val of HY-2A altimeter data with Janson-1/2

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

Sea level

Cross-comparison with Janson-2

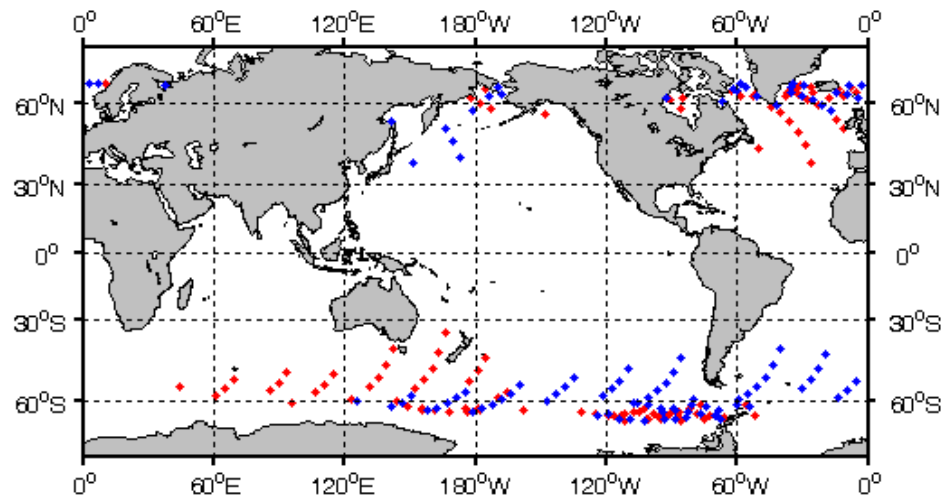


Statistics of coincidence locations

Absolute RMS deviation with average offset correction:
8.3cm, with correlation coefficient of 0.978.

Wind speed

● Cross-comparison with Jason-1/2

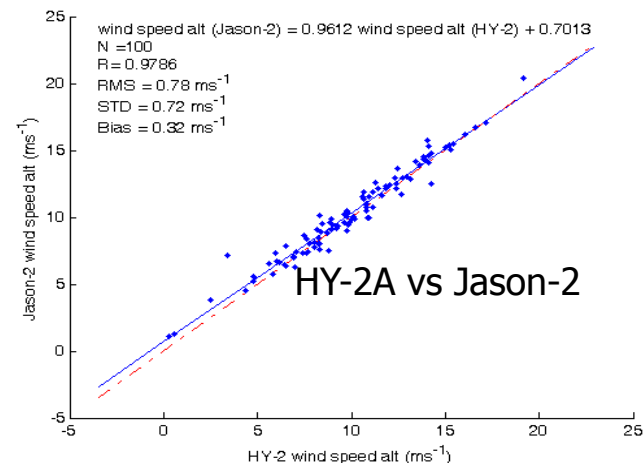
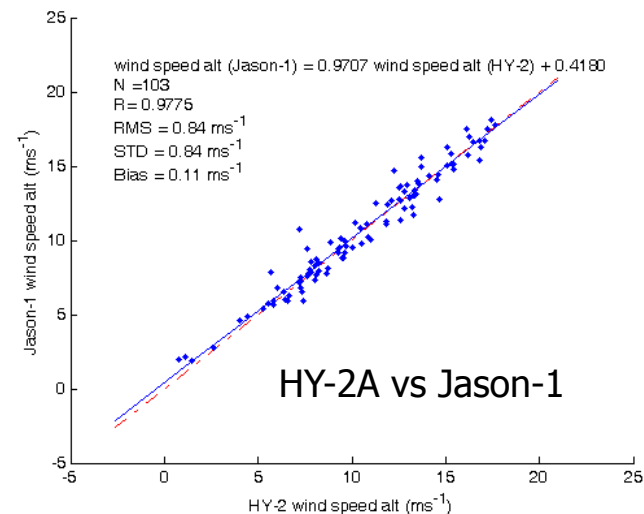


Coincidence point distribution of HY-2A and Jason-1/2

RMS deviation:

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

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



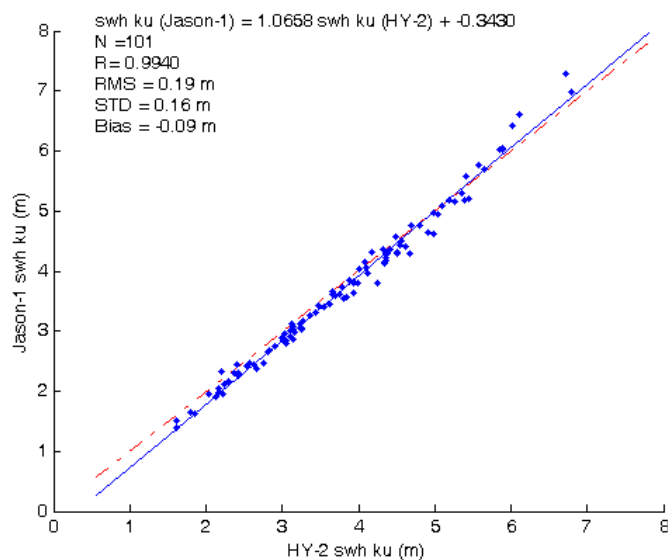
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Preparation for standardization of cal/val of microwave radiometry

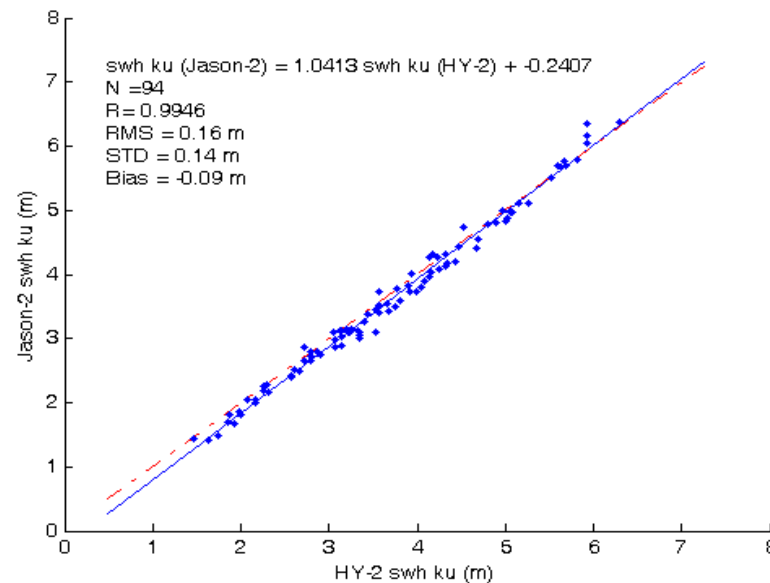
- Standards for microwave calibrators (blackbody and noise source)
- Standards for calibration procedure (Thermal/Vacuum test, transfer,...)
- Cross comparison/calibration

Significant wave height

- Cross-comparison with Jason-1/2



HY-2A vs Jason-1



HY-2A vs Jason-2

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

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Future work

- Next CEOS Microwave Sensor Calibration and Validation Workshop (March, 2013);
- 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)
- Standardization of calibration of microwave radiometry
- Coordination of data for cal/val purpose
 - NSOAS/SOA began to release HY-2A data;
 - JPL cannot provide data and communicate with China;
 - Concerned agency participation is needed.



The End!
