



Microwave Sensors Subgroup (MSSG) Report

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CEOS OUTLINE

NSSE

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

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

■ Variation of sensors

■ Variation of products





Characteristics of Microwave Sensors



- Relatively low spatial resolution (km, tens of km, hundreds of km) for atmospheric, oceanic, large-scale terrestrial environmental applications
- Data dependent on sensor and processing (model, retrieval, algorithm, cal/val)
- Importance of processing and quality control



Requirements and Challenges

- Climate and global change applications
 - ✧ Higher requirements, especially for climate and global change applications: sensitivity, accuracy, stability, traceability;
 - ✧ Cross-calibration requirements of sensors flown for different missions;
- No traceable standards available for microwave sensors;
- New developed sensors
 - ✧ Polarized radiometers and scatterometers
 - ✧ Interferometric synthetic aperture radiometers
 - ✧ Scatterometers for terrestrial applications
 - ✧ Wide swath and SAR altimeters...



Many new techniques need to be developed for cal/val...



- High precision requirements:
 - ✧ Brightness temperature: 0.1K
 - ✧ Sea level: 1mm
 - ✧ Backscattering coefficient: 0.1dB
- Stability, traceability, historical data record
- Cross-calibration/validation requirements:
 - ✧ Traceable reference for processing or historical data
 - ✧ Small shift of sensor parameters (frequency, bandwidth, on-board calibrators,...)
 - ✧ Calibration models/algorithms for different sensors by different agencies



Priorities and focuses



■ Objectives

- ✧ Support CDR from microwave;
- ✧ Support CEOS VCs;
- ✧ Benefit member agencies and communities;

■ Priorities and focuses

MWR & SCAT Level 1 data

- ✧ Brightness temperature for MW radiometer
- ✧ Backscattering coefficient for radar scatterometer

MWR & ALT standards

- ✧ MWR Onboard calibrator (noise source, RAM blackbody)
- ✧ Prelaunch measurement and characterization
- ✧ GNSS-buoy references

Models and algorithms

- Preparation of joint meeting with GSICS Microwave Subgroup
- Identification of focus for standard of calibration of microwave sounder/imager
- Preparation of global water vapor CDR from microwave radiometry
- Discussions of calibration/validation of L-band radiometer/scatterometer for soil moisture and ocean salinity during IGARSS 2015, in the L-band Cross Comparison WG meeting
- Discuss with International Ocean Surface Wind Vector (IOSWV) Science Team and OSWV-VC during IOSWV meeting and ESA scatterometer science conference
- Other progresses



Discuss and coordination with GSICS MWG



- Further coordination with GSICS-MWSG
- Preparing an joint GSICS-MWSG and WGCV-MSSG Meeting in July 6-7, in Beijing, before IGARSS 2016
- Topics to be discussed:
 - ✧ Currently available calibration/inter-calibration algorithms and products at GSICS MWG
 - ✧ Currently available calibration/inter-calibration algorithms and products at WGCV MWSG
 - ✧ Microwave Standard procedure/definitions at GSICS MWG and WGCV MWSG
 - ✧ Exchange of ideas and collaborations between GSICS MWG and WGCV MWSG
 - ✧ New instruments and future directions for GSICS MWG and CEOS MWSG
 - ✧ Inputs to the standards of calibration of MW sounder/imager





Discuss and coordination with IOVWST & OSVW-VC



- Coordination and discussion in 2015 IOVWST meeting in May 19-21 in Portland, USA
- Further discussions on strategy during IGARSS 2015 invited sessions, July 29-30, 2015
- Workplan discussions in CMS in Barcelona (Dec 2015) and ESA Scatterometer Science Conference in ESTEC in Noordwijk (Feb 2016)
- Topics to be implemented:
 - ✧ Cal/X-cal for sigma 0 by NOC techniques
 - ✧ Quality control standardization for sigma 0 and OVW product





Progresses on MW radiometry



■ Focuses

- ✧ Standard of calibration of microwave sounder, with focuses on prelaunch and onboard calibration and characterization for CDR requirements
- ✧ CDR product of water vapor as portal
- ✧ Cross comparison/calibration of L-band radiometry/scatterometry for soil moisture and ocean salinity
- ✧ Calibration of innovative MWR (MIR, Microwave Interferometric Radiometer)

■ Progresses

- ✧ Initiative of standard drafting, Identifying sources of onboard calibration uncertainty and bias, identifying prelaunch requirements for CDR
- ✧ Group for water vapor CDR
- ✧ Discussion of cross-comparison/calibration of L-band radiometry/scatterometry
- ✧ Organizing focus group for calibration of MIR (UPC, CMS in Spain, LOCEAN in France and NSSC, CAS)





Water vapor CDR by microwave radiometer



■ Data source

- ✧ Jason/OSTM, HY-2A, FY-3B/C

■ Objectives

- ✧ The calibration and validation of the microwave sensors, including microwave imager, sounder are important to maintain the reliability and reproducibility of the sensor measurements.
- ✧ Focused on the Cal/Val of microwave sensors (18.7GHz, 23.8GHz, 36GHz, 50-60GHz, 89GHz, 118GHz, 150GHz, 183GHz), relevant products (like water vapor, precipitation, and snow cover over land and ocean).

■ Cal/Val of microwave sensors:

- ✧ For payload onboard satellite, thermal/vacuum calibration is aimed at ensuring that the sensor meets the performance specification requirements and at deriving the calibration parameters, particularly the nonlinearity parameter, which is needed for accurate in-orbit data processing.
- ✧ In-orbit cross-calibration and validation will be performed between various international passive microwave instruments.

■ Teams:

- ✧ European & Chinese teams identified
- ✧ US teams to be identified during the Joint GSICS/CEOS meeting in July





Calibration of Microwave Interferometric Radiometer (MIR)



■ MIR calibration challenges

- ✧ BT retrieval by interferometric measurement with designed base-line combinations
- ✧ BT uncertainty and bias from both measurement and imaging algorithms
- ✧ SMOS BT data shows big bias

■ Fostering focus group for MIR

- ✧ SMOS-BEC, LOCEAN and MiRS/CAS
- ✧ SMOS L1 data group coordinators : C. Ignasi (UPC), X. Yin (LOCEAN/CNRS & NSSC/CAS)
- ✧ SMOS L2 data group coordinators: M. Portabella (BEC),
- ✧ Chinese Ocean Salinity Mission team: H. Liu (NSSC/CAS), L. Wu

■ Main activities and processes

- ✧ Sharing calibration processing procedure and algorithms;
- ✧ Comparison and assessment of re-processed data.





Cross comparison/calibration of L-band radiometry/scatterometry for soil moisture and ocean salinity



- Ocean salinity and soil moisture
- Satellite/missions
 - ✧ Current/past: SMOS (ESA), Aquarius (NASA), SMAP (NASA)
 - ✧ Future: COSM (CNSA), WCOM (CAS)
- Challenges:
 - ✧ Difficulty in cold-sky calibration for very large antennas;
 - ✧ Extreme stability requirement for ocean salinity
- Objectives:
 - ✧ Promote cross-comparison/calibration
- Roadmap:
 - ✧ L-band WG
 - ✧ Plan for future (IGARSS 2016)



Identification of calibration uncertainty and bias of MWR for CDR



■ Requirements from CDR

- ✧ Long-term stability
- ✧ Consistency between different instruments
- ✧ Precision requirements

■ Focuses

- ✧ Procedure and processing of calibration
- ✧ Stability and characterization of On-board calibrators
- ✧ Prelaunch calibration requirements

■ Progresses

- ✧ Requirements discussed with GSICS-MWG
- ✧ Key topics identified
 - Antenna characterization
 - On-board calibrator characterization
 - Near-field characterization for emission and effect from satellite body structure

■ Future work plan

- ✧ Group for standard of calibration of microwave sounder/imager (GSICS/CEOS Microwave group joint meeting in July)
- ✧ Strategy for L-band cross-comparison/calibration (L-band group meeting in IGARSS 2016)
- ✧ Workplan for vapor CDR (before Dragon meeting in July)
- ✧ Reference replacement calibration for MIR
- ✧ Survey, characterization and mitigation of RFI and extraterrestrial emission impact for MIR



Progresses on radar scatterometry



■ Status:

- ✧ joint activities with IOVWST and OSVW-VC;
- ✧ HY-2 data open to European users via KNMI/ICM

■ Progresses

- ✧ Organizing focus group: KNMI (A. Stoffelen), ICM (M. Portabella), NSSC/CAS (R. Yun), ISRO, NOAA
- ✧ NOC (NWP ocean calibration) as reference for X-cal of L1 data
- ✧ Preliminary assessment had been made for HY-2 scatterometer, oceansat-2 scatterometer and METOP ASCAT data
- ✧ HY-2A L1/L2 data open to European research users



■ Future work plan

- ✧ Focus group meeting in IOVWST-2016 and IGARSS 2016
- ✧ Guideline of NOC for scatterometry L1 data
- ✧ Guideline for scatterometry data quality control for current and future OSVW missions (ASCAT, HY-2/SCAT, CFOSAT, OSCAT)

■ Requirements

- ✧ Climate and global change research requires long-term data with continuity;
- ✧ Sea level products related to orbit and algorithms (corrections) and requires x-cal and val
- ✧ Applications of radar altimetry data for ice

■ Priority focuses

- ✧ Cross calibration for different missions;
- ✧ Absolute reference (GNSS-buoy) calibration;
- ✧ Polar ice products from radar-altimetry

■ Recent progresses and status

- ✧ HY-2A altimeter with Jason-1/2 (NSOAS, CNES, ESA), cross comparison/calibration by NSOAS/SOA, CNES and ESA with very good encouraging results.
- ✧ Based on bilateral cooperation
- ✧ Initiation of polar ice application of radar altimetry

■ Future work plan

- ✧ Exchange cross-comparison
- ✧ Development of absolute validation (GNSS-buoy)
- ✧ Development of modeling for validation (satellite with in-situ data)
- ✧ Exchange of calibration site data
- ✧ Focus group for polar ice from radar altimetry



Summary



■ Progresses:

- ✧ Some focuses identified;
- ✧ Focus groups organized;
- ✧ Coordination and discussions with other groups (GSICS-MWG, IOVWST, L-band WG)

■ Future work plans

- ✧ MW radiometry: standard of calibration of microwave sounder/imager; water vapor CDR from microwave radiometer; MIR calibration;
- ✧ Radar scatterometry: NOC for L1 and L2 data; OSWV data quality control guidelines
- ✧ Radar altimetry: cross-calibration; GNSS-buoy reference; polar ice product





Future activities



- IOVWST meeting in May 17-19;
- Joint meeting with GSICS microwave subgroup in July 6-7;
- L-band meeting in IGARSS 2016;
- Group meeting for vapor;
- Group for Standard of calibration of mw sounder/imager.





Thanks !

