



Microwave Sensors Subgroup (MSSG) Report

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CEOS WGCV-39
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CEOS OUTLINE

NSSE

- Focuses and progresses
- Future work and recommendations



MSSG covers...



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



- 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



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 on different spacecrafts and developed by different agencies;
- **New developed sensors**
 - ✧ Interferometric synthetic aperture radiometers
 - ✧ Polarized radiometers and scatterometers
 - ✧ 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



Recent progresses



- Identify priorities and focuses
- Organize focus groups
- Formulate implementation plans





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





Updates from WGCV-38



- Discuss with GSICS Microwave Subgroup for potential coordination and prepare for joint meeting and activities
- Discuss with International Ocean Surface Wind Vector (IOSWV) Science Team and prepare for next meeting (May 19-21)
- Progresses on MW radiometry
- Progresses on radar scatterometry
- Progresses on radar altimetry





Discuss and coordination with GSICS MWG



- Discussed in NOAA NESDIS during WGCV-38
- Preparing an joint GSICS-MWG and WGCV-MSSG Meeting in November 2015 or May 2016
(tbc in GSICS-MWG meeting on May 13, 2015)
- 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 MSSG
 - ✧ Microwave Standard procedure/definitions at GSICS MWG and WGCV MSSG
 - ✧ Exchange of ideas and collaborations between GSICS MWG and WGCV MSSG
 - ✧ New instruments and future directions for GSICS MWG and CEOS MSSG





Discuss and coordination with IOVWST & OSVW-VC



- Discussion during 4th CFOSAT Science Workshop in Guangzhou in Feb 3-5, 2015
- More coordination will be done in 2015 IOVWST meeting in May 19-21 in Portland, USA
- Strategy and preliminary results to be discussed during IGARSS 2015 invited sessions
- 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

- ✧ Calibration of innovative MWR (MIR, Microwave Interferometric Radiometer)
- ✧ Prelaunch and onboard calibration and characterization for CDR requirements

■ Progresses

- ✧ Organizing focus group for calibration of MIR (UPC, Spain and NSSC, CAS)
- ✧ Identifying sources of onboard calibration uncertainty and bias, identifying prelaunch requirements for CDR
- ✧ Identifying elements of cal/val of MW products





Calibration of Interferometric MWR



■ 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 L1 data group: C. Ignasi (UPC), X. Yin (LOCEAN/CNRS & NSSC/CAS)
- ✧ Chinese Ocean Salinity Mission team: H. Liu (NSSC/CAS), X. Yin

■ Main activities and processes

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



■ Future work plan

- ✧ Guideline for onboard calibration of MIR
- ✧ Reference replacement calibration for MIR
- ✧ Survey, characterization and mitigation of extraterrestrial emission impact for MIR



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

- ✧ Joint WGCV MSSG-GSICS MWG meeting (Nov 2015 or May 2016);
- ✧ Identify cal/val focuses for CDR requirements
- ✧ Organize focus group for several topics
- ✧ Guidelines for prelaunch calibration and characterizations



New elements of cal/val of microwave data



- Discussed during WGCV-38 (Oct 2014) and WGCV planning meeting (Feb 2015) (B. Bojkov, C. Cao and X. Dong)
- Water vapor by nadir-looking MWR identified;
- Further steps:
 - ✧ Organize focus group during Dragon Meeting in June, 2016; (ESA, EUMETSAT, CNES, NSSC, NSOAS...)
 - ✧ Draft pre-task plan
 - ✧ Cross-cutting development: combination of GNSS-RO data with MWR data
 - ✧ MWR vapor can be first microwave cal/val portal element





Progresses on radar scatterometry



■ Status:

- ✧ joint activities with IOVWST and OSVW-VC;
- ✧ Cross bilateral collaborations to avoid political difficulties (EUMETSAT and KNMI as connection)

■ Progresses

- ✧ Organizing focus group: KNMI (A. Stoffelen), NSSC/CAS (NSSC/CAS), 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



■ Future work plan

- ✧ Focus group meeting in IOVWST-2015 and IGARSS 2015
- ✧ Guideline of NOC for scatterometry L1 data
- ✧ Guideline for scatterometry data quality control for current and future OSVW missions (ASCAT, OSCAT, HY-2/SCAT, CFOSAT)
- ✧ Direct support to OSVW-VC

■ 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

■ Priority focuses

- ✧ Cross calibration for different missions;
- ✧ Absolute reference (GNSS-buoy) calibration;

■ 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

■ 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
- ✧ Coordination with and support to OST VC



Summary



■ Progresses:

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

■ Future work plans

- ✧ MW radiometry: MIR calibration; guidelines for prelaunch calibration (with GSICS-MWG); vapor product with nadir looking MWR;
- ✧ Radar scatterometry: NOC for L1 and L2 data; support to OSVW-VC and community
- ✧ Radar altimetry: cross-calibration; GNSS-buoy reference; support to OST-VC and community

