

CEOS

Working Group on Calibration and Validation

Organisation and current activities

CGMS is informed on the organisation of the CEOS Working Group on Calibration and Validation and on its major activities.

1. INTRODUCTION

2. WGCV STRUCTURE

The WGCV is chaired / vice-chaired by elected experts and is supported by a technical secretariat. The current post-holders are as follows:

Chair:	Mr Pascal Lecomte,	ESA
Vice Chair:	Mr Gregory Stensaas,	USGS
Technical Secretariat:	Dr Marie-Claire Greening,	Greening Consulting

The WGCV supports six subgroups that operate as individual entities and that focus on specific technical areas related to calibration and validation. The WGCV subgroups and their current chairs / vice-chairs are as follows:

CEOS WGCV Subgroups			
Synthetic Aperture Radar	SAR	Dr Satish Srivastava	CSA
Infrared Visible Optical Sensors	IVOS	Dr Nigel Fox	NPL
Microwave Sensors	MWS	Dr Christopher Buck	ESA
		Dr. Xiaolong Dong	CSSAR
Terrain Mapping	TMSG	Prof. Jan-Peter Muller	UCL
Land Product Validation	LPV	Dr Frederick Baret	INRA,
		Dr Sébastien Garrigues (VC)	CNES
Atmospheric Chemistry	ACSG	Dr Bojan Bojkov	ESA,
		Dr Jean-Christopher Lambert (VC)	IASB/BIRA

The terms of references of the various sub groups are described in the paragraphs here after.

2. THE CEOS WGCV SUBGROUPS

2.1. The Synthetic Aperture Radar Subgroup

The mission of the Synthetic Aperture Radar Subgroup is to foster high-quality synthetic aperture radar imagery from airborne and spaceborne systems through precision calibration in radiometry, phase, and geometry, and validation of higher level products

The objectives of the Synthetic Aperture Radar subgroup, beyond those of the WGCV, are to:

- Act as a forum for international technical interchange on the evolving methodologies, techniques, and equipment of SAR calibration and validation
- Determine standard definitions and calibration-validation requirements for synthetic aperture radar imaging systems
- Support changes in CEOS formats and user products as appropriate
- Facilitate international cooperative programs in the calibration and validation of SAR systems
- Educate the SAR community

The major activity of the SAR subgroup in recent years has centred on the annual meetings. This is expected to continue. In the 2002 meeting, it was agreed to set up calibration and validation reference sites (to include both natural and man made targets) for the purposes of providing an easily accessible source of reference calibration data to data providers, showing the mutual compatibility between different SAR systems, and demonstrating the total quantitative and qualitative quality of SAR data. The 2003 meeting of the SAR subgroup should focus on the problem of full polarimetric SAR calibration, both establishing requirements and techniques.

2.2. The Infrared and Visible Optical Sensors Subgroup

The mission of the Infrared and Visible Optical Sensors Subgroup is to ensure high quality calibration and validation of infrared and visible optical data from Earth observation satellites and validation of higher level products

The objectives of the Infrared and Visible Optical Sensors subgroup, beyond those of the WGCV, are to:

- Promote international and national collaboration in the calibration and validation of all IVOS and, thus, to assist in the improved application of data from satellite sensors
- Address all sensors (ground based, airborne, and satellite) for which there is a direct link to the calibration and validation of satellite sensors
- Identify and agree on calibration and validation requirements and standard specifications for IVOS
- Identify test sites and encourage continuing observations and intercomparison of data from these sites
- Encourage the timely and unencumbered release of data relating to calibration and validation activities including details of pre-launch and in flight parameters

After a period of inactivity, the IVOS subgroup is revitalised, and improving, its membership. The subgroup plan to review the ongoing activities of CEOS member agencies and institutions. Opportunities for coordination / cooperation will be actively sought. Recommendations with respect to solar irradiance, radiative transfer codes, and protocols for calibration and validation will be devised and put forward. The subgroup will meet at least once each year.

2.3. The Land Product Validation Subgroup

The Land Product Validation subgroup arose out of the recognition in the late nineties that standardized approaches to global product validation were essential for wide acceptance and use of proposed global land products. Several programs at the time were aimed at global monitoring of Earth processes, many with plans to distribute higher level data products. A common approach to validation would encourage widespread use of validation data, and thus help us to more toward standardized approaches to global product validation. With the high cost of in-situ data collection, the potential benefits from international cooperation are considerable and obvious.

Previous requests for assistance from the original International Global Observing Strategy (IGOS) pilot projects and two subsequent ad hoc meetings of the WGCV identified a clear need for improved international collaboration concerning the validation of land products derived from Earth observing satellites. A new subgroup within the WGCV was proposed to the CEOS Plenary in Stockholm at the end of 1999, receiving full support. The LPV was officially adopted as a subgroup at the WGCV-17 meeting in October of 2000.

The LPV subgroup activities are divided up into four themes that compliment the research agenda of the Global Observations of Forest and Land Cover Dynamics (GOFC/GOLD) program, namely biophysical products, fire/burn scar detection, and land cover mapping. In addition to the GOFC/GOLD themes, the LPV subgroup includes an Albedo/Surface Radiation thematic group. Working with GOFC/GOLD, who seek the common goal of coordinated validation of land cover and fire products by standardized protocols, LPV aims for similar coordination for all land products.

2.4. The MicroWave Sensors Subgroup

The mission of the Microwave Sensor 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.

The objectives of the Microwave Sensors subgroup, beyond those of the WGCV, are to:

- Facilitate international cooperation and co-ordination in microwave sensor Cal/val activities by sharing information on sensor development and field campaigns

- Promote accurate calibration and validation of microwave sensors, through standardization 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 cal/val

The plan of action for the Subgroup is based on spaceborne microwave sensors. The Subgroup is concerned mainly with passive sensors at the present; however, it is envisioned that there will be a gradual increase of attention to active sensors, especially towards the end of the three-year period of this plan. The Subgroup will approach its objectives by starting from currently operating sensors, such as those flying aboard the DMSP and NOAA platforms, and extending to the next generation of sensors. A focal point will be sensors aboard the EOS platforms of ESA, Japan, and the United States, as there will be both active and passive sensors covering a large part of the microwave spectrum.

2.5. The MicroWave Sensors Subgroup

The mission of the Atmospheric Composition Subgroup is to ensure accurate and traceable calibration of remotely-sensed atmospheric chemistry radiance data and validation of higher level products, for application to atmospheric chemistry and climate research

The Atmospheric Composition subgroup was approved at CEOS Plenary 15 in November 2001. The objectives of the Atmospheric Composition subgroup, beyond those of the WGCV, are to:

- Promote international collaboration and technical exchange to ensure the efficient use and maintenance of calibration/validation resources required for atmospheric chemistry missions
- Verify accurate scientific products by encouraging an end-to-end approach to the calibration and validation of Level 1 and Level 2 data products, and any subsequent re-calibration and reprocessing
- Ensure that validation sensors are calibrated to traceable national standards, with documented statements of accuracy and repeatability
- Encourage interaction between calibration scientists and data users to enable a better understanding of data uncertainties and user requirements
- Recommend a network of validation sites and to encourage continuous observation and quality control of data through the use of standard procedures and inter-comparison
- Develop comprehensive data validation methods that employ ground, aircraft, balloon, and satellite measurements and data assimilation with chemical transport models
- Specify a comprehensive, consistent and quality-controlled multi-mission validation database in an accepted format and employing user-friendly tools

The membership of the subgroup will be completed by including relevant agencies and organisations who are not yet represented. The subgroup will initiate and support

the process of approaching agencies, through CEOS, for partial sustained support for ground validation networks and the maintenance of these networks between missions. Data validation archival and retrieval for the long term and across present and future mission applications is seen as very important and this will be actively pursued. The subgroup will meet regularly to review and coordinate upcoming validation activities, discuss results and pursue its main objectives. These objectives will be reviewed and updated as required.

2.6. The MicroWave Sensors Subgroup

The mission of the Terrain Mapping Subgroup is to ensure that characteristics of digital terrain models produced from Earth Observation sensors at global and regional scale are well understood and that products are validated and used for appropriate applications

The objectives of the Terrain Mapping subgroup, beyond those of the WGCV, are to:

- Develop specifications for the generation of "standardised terrain surface products with known accuracy" from similar sensing systems in the context of data continuity
- Specify evaluation methods and statistics which give transparent information about the quality and heritage of terrain models
- Update the current dossier of test sites and identify new sites, particularly to satisfy the cal/val requirements of future missions and generally improve access to validation data sets
- Prepare recommendations for the establishment of a global ground control point network
- Consider how orbit validation could be developed
- Keep an up to date record of the current status of sensors which produce data for terrain mapping and of the DEMs available
- Produce a DEM requirements document with a science rationale, taking into account the output from SRTM

The objectives will be achieved through the following activities:

- Liaise with CEOS Members and Associates activities, especially the IGOS in order to determine the DEM requirements of the user community to ensure that cal/val procedures are in place to satisfy that need
- Collaborate with other groups to ensure that common activities are co-ordinated and enhanced by collaboration
- Hold one meeting a year to review progress, plan future action and discuss results.
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3. WGCV CURRENT ACTIVITIES

The WGCV undertake a variety of activities related to the calibration and validation of Earth Observation data. Current activities are mainly focused on the requirements

identified by the Group on Earth Observations (GEO) and their goal to achieve a Global Earth Observation System of Systems (GEOSS). To this end, GEO have identified a series of tasks and the WGCV are taking a lead role in those related to calibration and validation. The following are the group's current activity interests.

- QA4EO
- Dome C Experiment
- Cal/Val Portal and Post-Launch Test Sites
- Radiometric Standards
- Benchmark Mission Coordination
- Ground Based Cal/Val Campaign
- Reference Test Site Data Collaboration and Comparison
- ASTER DEM Validation

3.1. Quality Assurance Framework for Earth Observations (QA4EO)

CEOS has established a quality assurance (QA) strategy to facilitate interoperability of Global Earth Observations systems. This strategy is based upon a set of key operational guidelines derived from "best practices" for implementation by the community. The QA4EO has been completed and endorsed by CEOS and is recommended for implementation and use throughout the GEO community.

Specific implementation tasks:

Develop and initiate an implementation plan for QA4EO (the latest version of the QA4EO framework and its 10 associated key guidelines can be found via the QA4EO website).

Organise a community workshop to address the implementation of QA4EO

Work with CEOS WGISS on cal/val data access

Establish outreach activities to promote QA4EO within the user community.

A specific paper has been produced regarding QA4EO.

3.2. DOME C Experiment

That activity consists in conducting a multi-sensor comparison to evaluate the size of any biases using the Dome C site as a reference standard. This will serve as a pilot for future regular CEOS comparisons over this and other reference sites to ensure data interoperability and to underpin the LSI constellation. The results of the comparison will allow an assessment to be made of the site's suitability for climate quality calibration.

The study of the Dome C site stability using the SeaWiFS observations has been completed. All historical SeaWiFS observations of the Dome C have been used in the analysis to evaluate the stability of the site. The Snow BRDF model developed by Warren et al has been used in correcting the BRDF effects. Our results show that the Dome C is indeed stable since the SeaWiFS launch and the stability/variability is estimated to be better than 0.8% (1sigma) per decade. The analysis procedure is being documented and has been made available on the DOME C website. Further

work has been done comparing the SeaWiFS and MODIS/Aqua observations in collaboration with NASA MODIS team. It has been found that the SeaWiFS and MODIS now agree at the 1% level once the sensor view angle is taken into account. This is better than the previous reported results which did not take into account of the SeaWiFS off-nadir view angle effect. Comparisons of the MODIS and AVHRR/MetOP solar bands show that the difference can be as much as 10%. This discrepancy is due to a known traceability issue in the vicarious calibration of AVHRR. Separately, the Dome C has been used for the on-orbit verification of NOAA-19 which was launched recently. The Dome C calibration has been compared with Deep Convective Clouds calibration using the HIRS (High Resolution Infrared Radiation Sounder) visible band in sensor degradation assessment. The results show that the Dome C calibration is very promising and the results have been presented at the AMS conference. We have coordinated with NASA and acquired additional Hyperion data sets over the Dome C site. The next step is to analyse the spectral characteristics of the site. A website has been established for the Dome C study, where the sample datasets, presentations, and sample programs can be found at:

<http://www.star.nesdis.noaa.gov/smcd/CEOS/WGCVProjects/DomeC/DomeCStudy.html>.

At NOAA the focus has been the study of low resolution instruments such as MODIS/SeaWiFS/AVHRR/HIRS, IVOS have made good progress on the high resolution instruments for the Dome C study.

3.3. Cal/Val Portal and Post-Launch Test Sites (reference standards)

That activity consisted in the development a consolidated worldwide Cal/Val test site database and an appropriate subset of CEOS endorsed reference standards, based on community agreed criteria, to be included in the CEOS Cal/Val portal, and to further expand the Cal/Val portal in both content and functionality by adding links to QA4EO information and data.

Test Site Catalog: http://calval.cr.usgs.gov/sites_catalog_map.php

An online catalog of prime candidate test sites for the post-launch characterization and calibration of space-based optical imaging sensors has been established. The online catalog provides easy public Web site access to this vital information for the global community. The layout is set up to help the user quickly locate the needed information available on the site. Drop-down menus list locations so the user may go straight to a specific site. A map with clickable links provides another way to go to sites. The maps include a world map, where the user selects a continent, and a map of each major continent. All of these maps are accessible throughout the catalog. Each of the calibration site pages contains the same fields for easy review. These fields include location, terrain elevation, center latitude/longitude, Worldwide Reference System 2 (WRS-2) path/row, size of usable area, owner, researcher, purpose, description, support data, suitability, and limitations. Other features include a small image of the globe depicting the position of the site and a satellite image of the test site. Additional images are also available. Through greater access to and

understanding of these vital test sites and their use, the validity and utility of information gained from Earth remote sensing will continue to improve.

CEOS Reference Standard Test Sites

Recently, members of the IVOS subgroup worked with collaborators around the world to establish a core set of CEOS-endorsed, globally-distributed, reference standard test sites for the post-launch calibration of space-based optical imaging sensors. These CEOS reference standard test sites consist of eight instrumented and five pseudo-invariant sites. The CEOS instrumented sites are provisionally being called "LANDNET". These instrumented sites are primarily used for field campaigns to obtain radiometric gain and these sites can serve as a focus for international efforts, facilitating traceability and cross-comparison to evaluate biases of in-flight and future sensors in a harmonized manner. The pseudo-invariant desert sites have high reflectance and are usually made up of sand dunes with low aerosol loading and, practically, no vegetation. Consequently, these pseudo-invariant reference standard test site can be used to evaluate the long-term stability of a sensor and to facilitate cross-comparison of multiple sensors.

The WGCV is now working towards establishing optimum methodologies for the characterization and use of these reference standard test sites and integrating these sites on the Cal/Val portal. We have prepared a questionnaire to get comprehensive information on these sites to enable potential users to select an appropriate site or group of sites to meet their needs. A questionnaire is currently getting reviewed by the test sites point of contact (POC).

The work is now progressing to expand the catalogue to sites for other applications and other sensor domains and also to allow storage of associated satellite imagery by USGS. Agencies are requested to regularly observe these sites and to provide data to the database. CNES are working towards making available easy access to the SADE database of pseudo-invariant sites for cal/val purposes for CEOS members and ESA are nearing completion of a revamped Cal/val portal which will have a new look and also increased functionality including wikki based input and edit capability.

3.4. Radiometric Standards

Identify fundamental radiometric reference standards and application methods "best practices" for use in EO (WGCV subgroups).

Develop a CEOS/WGCV standards and recommendations handbook as a summary of appropriate QA4EO guidelines and reference standards for instrument calibration. (WGCV subgroups).

Following the establishment of CEOS reference standards for post-launch Cal/Val, including the moon, standard deserts and LANDNET test sites, WGCV/IVOS will ensure that the accompanying operational guidelines and coordinates are made available through the GEO/CEOS Cal/Val portal. This list of standards will be increased to encompass other application areas, e.g. water bodies, following approval by the IVOS team.

Standards for post-launch cal/val have been established and procedures established including some for new OC sites (from JRC) and methods for example rayleigh scattering for radiometric gain (CNES).

3.5. Benchmark Mission Coordination

Maintain dialogue between UK and USA relating to collaboration and coordination of the benchmark measurement/calibration missions (TRUTHS and CLARREO).

Subject to resourcing, an optimisation study will be carried out to define operational and detailed mission/instrument specifications of TRUTHS to establish “strawman” requirements as a basis for identification and collaboration of other CEOS space agencies.

3.6. Ground Based Cal/Val Campaign

This activity consist in initiating and plan an international cross-comparison of ground Cal/Val support techniques and instrumentation for both IR emitted radiance (SST) and VIS/SWIR reflected radiance (Land).

Two Intercomparison Campaigns have been organised in Miami (USA) and Tuz Golu (Turkey).

These IR Radiance comparison exercises were both highly successful.

The first one, organised in May 2009, saw nine participant institutes supported by NPL and NIST bringing together 30 radiometers (13 viewing the ocean). The first results show generally good agreement with some surprises!

The second campaign consisted in a pilot comparison of land surface reflectance and took place in August in Turkey. It was organised by NPL with DLR, CNES, ONERA and TU taking part and INPE and CSIR as observers.

Simultaneous Aircraft and satellite measurements were made by various agencies (including a coordinated activity by GSICS) following a formal invitation to participate. The results for all the comparisons are now being processed.

The invitation for participation in a full CEOS comparison will be sent out shortly. It is hoped that agencies will support participation of key ground teams and provide satellite/aircraft imagery.

3.7. Reference Test Site Data Collaboration and Comparison

This task complements the one described in paragraph 3.3. That task consists in initiating, with the support of the WGCV subgroup chairs, a dialogue with instrument owners relating to the collection of calibration data over CEOS-endorsed sites, and to ensure collaboration and coordination for the evaluation of the data and the development of the results over comparative sites as a prototype for an operational EO calibration network.

The principle is based on peer-review of the results, before posting them on the Cal/Val portal, on presenting the information via CEOS/GEO venues and workshops and publishing significant results.

3.8. ASTER DEM Validation

This activity consist in uupdating the ICEDS information server to provide OGC-compliant access to ASTER 30m DEM data (when it becomes available), together with localized validation DEM data and associated quality information (e.g. gap locations; number of ASTER observations per pixel, etc.).