

Working Group on Calibration and Validation Report to the 14th CEOS Plenary

Alan Belward

European Commission, DG Joint Research Centre
Space Applications Institute, 21020 Ispra (VA) Italy

1 Executive Summary

1.1 Highlights of 2000

- Release of the second WGCV three-year work plan.
- Completion of a report on traceability in sensor calibration.
- Publication of the proceedings of the ESA CNES sponsored SAR calibration workshop
- NASA sponsored Cal / Val dossier redesign, update and re-release
- The first inter-calibration and inter-comparison satellite radiometer validation pilot project
- Proposal for the second *in situ* radiometer inter-calibration and inter-comparison project
- Identification of potential vicarious calibration sites for satellite radiometers.
- New chairperson proposed for the WGCV.

1.2 Changes in Forward Planning

- New three-year plan reviewed and released
- The Cal / Val Dossier, maintained by NASA, has been redesigned and revitalised.
- ESA put forward Dr Yves-Louis Desnos as a nomination for the next Chair of WGCV. ISRO and CSIRO seconded the nomination and the ESA offer is presented for consideration at this 14th CEOS Plenary.

1.3 Commitments to implementation requested from Plenary: WGCV recommends that

1. All EO measurement systems should be verified traceable to SI units for all appropriate measurands.
2. Pre-launch calibration should be performed using equipment and techniques that can be demonstrably traceable to and consistent with the SI system of units, and traceability should be maintained throughout the lifetime of the mission.
3. A task force is established with ISPRS to standardise radiometric and geometric sensor parameter terms. CEOS agencies should nominate one person and support their participation in the task force.
4. CEOS Plenary should contact commercial operators of Earth observing satellites to ask them to agree to the free exchange of calibration and validation data as adopted by CEOS agencies.
5. CEOS Members should register their man made targets used for SAR calibration with the Cal/Val dossier. The targets should be made available to CEOS Members and CEOS Members should support an inter-comparison of the targets' performance.
6. Historical archives of spaceborne SAR data held by CEOS agencies should be opened to the scientific community at cost of reproduction.
7. Support for maintenance and development of the Cal/Val dossier should be continued. CEOS agencies should also provide a link to the CEOS dossier from their own web sites either directly or via a link to the CEOS web site. WGCV's web site would benefit from the involvement of a scientific journalist to collate all relevant activities by WGCV agencies and to present this in a suitable manner. CEOS agency sponsorship is sought.
8. CEOS Plenary should identify funding source(s) to support the second international infrared radiometer calibration and inter-comparison to calibrate and compare infrared radiometers used in the validation of the different surface temperature products derived from earth observation satellites. US\$41,400 are required for workshop infrastructure, setting up of equipment in laboratories and for access to a ship for deploying instruments

1.4 Future activities

WGCV-18 will be held in Frascati, Italy, hosted by the European Space Agency, June 2001.

2 Expanded report

2.1 WGCV plenary meetings

The Indian Space Research Organisation (ISRO) kindly hosted the 16th meeting of the CEOS Working Group on Calibration and Validation (WGCV) in Bangalore from 21st to 23rd February 2000. The work of India's National Resource Management System was introduced to the WGCV through technical visits to ISRO facilities and an excellent technical session on ISRO's applications research programme. Together these provided a stimulating and informative framework for the meeting.

WGCV16 identified ways in which WGCV could support the ISRO led CEOS initiative on education and training.

Dr George Joseph President of ISPRS Technical Commission I and ISRO Distinguished Professor at Space Applications Centre Ahmedabad opened a special session on traceability¹ by raising issues of standardisation and understanding. Discussion papers from the UK National Physical Laboratory and the US National Institute of Standards and Technology followed. Wide-ranging debate addressed questions of legal responsibilities arising out of the use of remotely sensed data, requirements for independent assessment, the value and necessity of independent audit, current institutional framework and institutional gaps, plus the costs to Agencies. A framework for a detailed report to Plenary was drafted and finalised at WGCV17.

Previous requests for assistance from the original 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 to address these issues was proposed to the 13th CEOS Plenary and received full support.

Discussion at WGCV16 acknowledged that land product validation is still in its infancy as there have been few operational products up to now, but highlighted potential overlap with the existing subgroup dealing with Infrared and Visible Optical Sensors (IVOS). A meeting to examine the issues surrounding the validation of land surface parameters, to identify areas of overlap, redundancy and gaps with the work of the existing IVOS sub group and to draw up a subsequent three-year work plan for presentation at WGCV17 was recommended. This subsequently took place in Ispra 23rd to 25th May 2000.

ESA put forward Dr Yves-Louis Desnos as a nomination for the next Chair of WGCV. ISRO and CSIRO seconded the nomination and the ESA offer is hereby formally presented to this CEOS Plenary.

WGCV17 was kindly co-hosted by the National Oceanic and Atmospheric Administration and the National Institute of Standards and Technology at Gaithersburg, Maryland, USA, from 25th to 27th October 2000.

The special session dealing with Earth Observation calibration activities at NOAA and NIST provided important ground setting for the WGCV's continued debate on the topic of traceability. The presenters too made considerable input to the drafting of the final report. This is given in annex 1. The recommendations have also been incorporated into the executive summary of this report to Plenary.

The new sub group on Land Product Validation, chaired by Dr Jeff Privette of NASA was formally accepted by the WGCV and the proposed work plan integrated into a revised three year plan for the group.

The revised three year work plan is given in annex 2. Key departures from the first work plan include the incorporation of the new sub group on land product validation, consolidation of communication and outreach activities along with revised expectations for the Cal Val dossier

¹ Traceability is defined by the International Vocabulary of Basic and General Terms in Metrology as "The property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties."

and the exclusion of education as a specific action. The latter is as a result of the existence of the ad hoc working group on Education. WGCV will of course work closely with the WGEdu as required.

Full minutes are available from the WGCV web site.

2.2 Land Product Validation sub group meeting, Ispra 23rd – 25th May 2000

This meeting aimed to examine the issues surrounding the validation of land surface parameters, to identify areas of overlap, redundancy and gaps with the work of the existing IVOS sub group and to draw up a subsequent three-year work plan for incorporation into the second three year plan of the WGCV.

There were 29 attendees at the meeting, including representation from 11 CEOS Member / Associates (BNSC, CCRS, CNES, CSIRO, DLR, EC, ESA, NASA, NASDA, NSC, OSTC), SPOT Image and a number of US and European research organisations. The goal of the new subgroup would be to promote the quantification and characterisation of satellite-based land surface parameter products, including better definition of the errors and uncertainties associated with these products. The meeting provided a forum to share experiences, develop basic standards for comparisons, and promote and co-ordinate international validation activities.

Consensus was reached on a set of objectives and a three-year work plan for a new WGCV sub group that would complement the IVOS. This involved slight modification to the IVOS work programme as agreed with the current IVOS chair, Dr Chris Mutlow. Dr Jeff Privette from NASA will chair the subgroup for the next 3-5 years. It was acknowledged that land product validation is still in its infancy, as there have been few operational products (i.e., Level 2 and above) up to now. The goal of the subgroup will be to develop standard practices on a 'per-product' basis, and to promote adherence to these standards by the various space agencies. Eventually, it is hoped that all EO missions will incorporate validation programs.

Based on the interests of the current membership, the subgroup's initial focus will be on products derived from optical sensors, starting with moderate/coarse resolution products. There were a number of suggestions for future workshops, several of which were related to the IGOS carbon theme, particularly to products promoted by the Global Observations of Forest Cover programme. Joint meetings with one or more of the existing WGCV subgroups were also recommended. The subgroup wants to be seen as providing valuable services, not only to the space agencies, but also to other scientists, including those currently outside the earth observation community. Attendees were urged to promote awareness of the subgroup among their colleagues.

2.3 Terrain Mapping sub group meeting, Gaithersburg 23rd – 24th October 2000

The Terrain Mapping sub group meeting addressed a number of developments concerning the Shuttle Radar Topography Mission (SRTM) which successfully covered a large proportion of the globe, much of this twice. The mission was marked by particular attention to complex calibration and validation issues. The resulting Digital Elevation Model is known to be accurate to +/- 16m.

The uses of ASTER on Terra for DEM derivation was debated and the TM sub group examined a number of DEMs derived from the commercially operated IKONOS system. Concern was expressed that users are sold DEMs and stereo data without QA, calibration and validation information.

The TM group also concluded that additional data are needed for validation. These include libraries of Ground Control Points, GPS profiles (for example road traverses) and the elevation of plane surfaces, including sea level. Agencies should be prepared to exchange this kind of data so as to permit the building of a global validation database for DEMs. This resulted in two resolutions brought forward to the WGCV Plenary and that in turn are brought forward to the CEOS Plenary. In particular the Terrain Mapping sub group highlights a concern that the lack of availability of calibration and validation data from the commercial Earth Observation satellite operators severely compromises the use of these data for scientific purposes.

Noting that widespread use of data from Earth observing satellites relies on users having confidence in the data, that valuable derived products must be able to sustain their credibility in the face of expert criticism and legal challenge and that lack of calibration and validation data discourages the development of new applications, recognising that not all satellite operators provide such data, WGCV recommends that CEOS Plenary should contact the commercial operators of Earth observing satellites to ask them to agree to the free exchange of cal val data as adopted by CEOS agencies.

Noting the disparate way in which Earth observing sensor parameters are specified and quoted, and that the extra terrestrial sensor community adopts a standard format, and recognising that proper use, understanding and intercomparison of sensor parameters depends on clear unambiguous definition, WGCV recommends that a task force be established with ISPRS to formulate a plan for standardisation of radiometric and geometric parameters of sensors. ISPRS are invited to identify the profile of participants required and in response to this CEOS agencies should nominate one person and support their participation in the task force.

At the conclusion of the meeting Professor Ian Dowman stood down as Chair. Sincere thanks are offered to him for his work in establishing an internationally recognised and highly productive group.

2.4 Inter –comparisons validation pilot project

Under the auspices of the Infra red and Visible Optical Sensors sub group a pilot project involving a number of CEOS Agencies has been run to develop a set of governing criteria for inter sensor calibration. The main achievement so far has been to develop a simple technique for the comparison and inter-calibration of a range of sensors. The motive for this is to be able to generate data that is extensive in both time and place (but especially time) for scientific study, especially of long-term changes. The objectives of the work are to permit the fusing of data from different sensors, to ensure traceability of the measurements made for QA and to assess the impact of algorithms on the error propagation from basic measurements to higher level products.

Potential vicarious calibration sites have also been identified through analysis of time series of measurements. The suitability of these sites with regard to invariance of reflectance properties over time was illustrated by reference to a set of time series of albedo for some of the sites, based on ATSR2 data. Structure visible in the data from some of the sites is due to seasonal variation but the long-term trend for all those illustrated is constant. Use of scattering angle measurements also suggests that the sites are fairly stable.

3 Conclusions and recommendations

The work outlined in the WGCV's three-year plan is needed by the international earth observation data providers and users. International co-operation is central to performing this work. Since its inception in 1984 the Working Group on Calibration and Validation has focused on ways in which the international co-operation can help ensure long term confidence in the accuracy and quality of Earth observation data and products from satellites.

The Working Group and its five technical sub-groups provide a forum for sustained debate, international co-operation and common actions too. This last attribute is being increasingly exploited. The sub groups are launching common pilot projects and examining cal val issues not in isolation but in the context of end to end "services". Traceability, product validation, demands on data providers and expectations / requirements of users are inextricably bound. WGCV's new structure and new work plan is ambitious, but is needed to address the cal val issues of this complex EO environment. The move to a more hands-on approach comes at a cost. Workshops, joint campaigns, pilot projects, the WGCV Cal Val dossier have all benefited from CEOS agency support in the past. The work plan cannot be implemented without support in the future.