# Working Group on Calibration and Validation
# Report to the 13th CEOS Plenary

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## 1 Executive Summary

### 1.1 Highlights of 1999

- A framework for community wide involvement of the National Standards Laboratories to ensure traceability in sensor calibration was established. (Traceability - refers to an auditable route describing and confirming the calibration chain and attributed accuracy back to an internationally agreed reference, usually SI as maintained by a national standards laboratory)
- Land Surface Parameter Validation in the light of IGOS developments was discussed in depth and plans for future activities in this area established.
- A strategy for supporting the atmospheric chemistry community in Cal/Val was outlined.
- The third report setting international standards for SAR Calibration was published, and a fourth report is in preparation.
- Validation of the microwave sensor on-board the Tropical Rainfall Mapping Mission began.
- Results of vicarious calibration exercises for a number of optical sensors were compared.
- A review of the state of the art of digital elevation model validation was completed.

### 1.2 Changes in Forward Planning

- *Two new groups will be established* to maintain impetus on the issues of traceability and validation of land surface products. To examine traceability an *ad hoc study group* with a life of one year is planned. For Land surface parameter validation a *new WGCV sub-group* with a long-term perspective is envisioned.
- The year's WGCV activities emphasised the importance of CEOS Associate involvement, especially in the sub-groups. Special effort to contact appropriate Associates prior to sub group meetings will be made through the CEOS Plenary secretariat.
- The Test Site Dossier, maintained by NASA, should be redesigned to contain only pointers to the test site descriptions rather than the out-of-date descriptions themselves. It should contain information on (i) what test sites are available and (ii) points of contact.

### 1.3 Commitments to implementation requested from Plenary

- Members and Associates are asked to nominate at least one representative for the *ad hoc study group* to examine issues of traceability (not necessarily the formal WGCV member) and to support their nominee(s) attendance at two meetings during 2000.
- CEOS Members are also asked to nominate a “partner" National Standards Laboratory from their geographical region. Nomination of a National Standards Laboratory partner does not imply the need to support their attendance in the *ad hoc study group* though CEOS Members may choose to provide such support.
- Members and Associates are asked to nominate at least one representative for the *new WGCV sub-group* on Land Surface Parameter Validation and to support their nominee(s) attendance at at-least one meeting during 2000.
- Members and Associates are asked to identify individuals leading their atmospheric chemistry validation programmes.
- Members and Associates are asked to participate in one vicarious sensor calibration campaign results intercomparison workshop in 2000.

Nominations should be made by the end of the year to the WGCV Secretariat.

### 1.4 Future activities

WGCV-16 will be held in February 2000, in Bangalore hosted by ISRO. The ad hoc group on traceability will run as a parallel session. WGCV-17 will be held in September 2000. NIST and NASA have offered to co-host the meeting in Washington D.C. A validation intercomparison workshop will be held early 2000. CNES have offered to host this.

# 2 Expanded report

## 2.1 Activities

- All four sub-groups met at least once. The WGCV held its 15th meeting in April 1999 at the Andøya Rocket Range Norway, kindly hosted by the Norwegian Space Centre. WGCV also held an *ad hoc* meeting on land surface parameter validation as a joint activity with ISPRS WGII/4, WGIII/6 and the Terrain Mapping sub group, London May 1999.

  Discussion on the roles and work of the WGCV at these meetings were guided by the keynote address from Dr Tillmann Mohr, Chair of CEOS who provided directions to the Working Group and a detailed update on the IGOS initiative at WGCV15. Dr Mohr emphasised the need for continued effort on calibration, the need for greater efforts concerning product validation, and stressed the importance of validation to IGOS.

## 2.2 Traceability

Representative National Standards laboratories (notably the USA's NIST and the UK's NPL) have been regular contributors to the WGCV over the last three years. These laboratories have no formal representation in CEOS but are making valuable contributions to our thinking. In particular they have raised the issue of traceability. Key points to emerge include:

- All agencies should ensure SI measurements are traceable to international standards.
- There is a perception that calibration is generally performed to SI standards. A list of projects/sensors should be made for those that are and those that are not calibrated to SI standards, with an action on the CEOS Members to either make the sensors traceable or to declare that they will not do so.
- CEOS Members should demonstrate and confirm claimed accuracy, not just by a simple declaration but by independent verification through either peer or auditor review.
- WGCV is not an accredited independent auditing body.

It is not just the instrument compliance that needs to be addressed but all the steps in the chain. Traceability and error budgets are needed for every sensor, and creators of higher level products should show how errors propagate through processing chains. In the context of IGOS the end-users need to have confidence in the data at all levels (spectral radiance to products), and this can be achieved by accountability through independent assessment. It is important for the future that the quality of data products is traceable to SI standards.

Practical steps may be the inter-comparison of diffusers at the National Standards Laboratories and using the National Standards Laboratories to make benchmark targets for calibration sites used in inter-comparison vicarious calibration exercises. If the ground instruments for the test sites are properly calibrated then inter-comparisons can be made and other problems in the data can be identified. Yearly validation of all sensors of a similar type using common sites will allow the provision of up to date calibration coefficients and allow problems of long term sensor degradation to be accounted for.

Some agencies involve National Standard Laboratories. There needs to be a framework of traceability to take the process forward from early users to mainstream data users. Those agencies with experience should share that experience with those who do not. Not all agencies were represented during the discussion (NASA, NASDA and CNES were unable to attend WGCV15) yet such developments would have considerable ramifications for future mission planning. The full consequences are not clear at this time, but WGCV has a responsibility to develop this discussion.

- WGCV will convene a special *ad-hoc* group, with a life of 1 year, to look in depth at the issue of traceability and its long-term consequences.
- This calls for a representative from each major instrument group and any other interested CEOS Member/Associate.
- Each CEOS Member is also asked to identify and suggest a "partner" National Standards Laboratory.

- The *ad-hoc* group will meet in a special side session to WGCV-16 in India, results will be fine-tuned at WGCV-17 in Washington, and the Chair of WGCV will make a detailed report at CEOS Plenary in 2000.
- Nominations for representatives to the *ad-hoc* group should be made by the end of the year to the WGCV Secretariat.

**2.3 Response to IGOS; New work on Land Surface Parameter Validation**

In response to requests from the Global Observation of Forest Cover IGOS Pilot Project made during last year's WGCV/IGOS projects meeting, and from a perceived need to expand our validation work a combined WGCV / ISPRS WGII/4, WGIII/6 workshop was held May 26th – 28th on Production and Validation of DEMs and Terrain Parameters from Spaceborne Sensors. The meeting, held at University College London examined issues including existing validation activities, the role of terrain models in validation of land surface related parameters, gaps in collaborative activities related to calibration and validation for land surface related parameters, validation protocols for land surface related parameters and the role for WGCV.

The workshop identified a trend towards producing higher level products, and that it is harder to validate these than it is to generate them, especially as the costs of obtaining field data for validation are high, particularly in proportion to the non-satellite budget of the observing systems. The workshop concluded that co-ordinated international validation initiatives would be beneficial to multiple space agencies, maximizing limited resources for land product validation.

- A recommendation was made to the WGCV to convene a new sub-group to examine Land Surface Parameter Validation, and the terms of reference for such a group was drafted.

Following the meeting Jeffrey Privette, EOS MODIS Land Validation Program, NASA/Goddard Space Flight Center and Stefan Dech, German Aerospace Center (DLR) German Remote Sensing Data Center (DFD) Oberpfaffenhofen agreed to co chair a new WGCV sub group with the following objectives:

- promote the quantification and characterisation of satellite land product accuracy
- share land product validation past experience and lessons learned
- move towards the generation of 'standardised products with known accuracy' from similar sensing systems in the context of data continuity
- establish relationships between like products - e.g. Vegetation Indices
- develop in-situ validation measurement standards, protocols and traceability
- co-ordinate international validation activities
- improve access to validation data sets

NASA and DLR have kindly agreed to support them in their roles as joint co-chairs. A first meeting is planned for spring 2000 where the focus will be on validation of products associated with the Global Observations of Forest Cover project.

**2.4 Atmospheric Chemistry**

A special session on Norwegian Space Activities described the work of the Norwegian Space Centre, the Nansen Centre, the Andøya Rocket Range, the ALOMAR Facility, and Norway's work on SAR Wind Cal/Val for ENVISAT. The proximity to the ALOMAR facility was a catalyst for a special session on Atmospheric Chemistry led by Evert Attema of ESA concerning the lessons learned from GOME and the plans for ENVISAT.

The key points to emerge were that harmonisation is essential for atmospheric chemistry as there are many parameters measured. Also the limited presentations on atmospheric chemistry activities at WGCV-15 indicate a need for more co-ordination. However, there is international co-operation in atmospheric chemistry at present (eg stimulated through ENVISAT) and improvements through the actions of WGCV are not altogether clear. The following actions were proposed to develop the discussion further:

- WGCV will ask CEOS Plenary Members/Associates to identify individuals leading their atmospheric chemistry groups so that WGCV can write to identified points of contact asking if further help in co-ordination is wanted
- If such a need is identified then WGCV would get involved. A model for future consideration was considered to be that of the IOCCG

**2.5 Sub-group activities**

***2.5.1 The SAR subgroup*** (chaired by Yves-Louis Desnos) met in Toulouse, October 1999. Main actions:

The workshop hosted by CNES and jointly organised by CNES and ESA invited specialist papers to review the performance of existing and planned airborne and spaceborne SAR sensors. A technical report will follow as part of the SAR SG series, now recognised as reference standards in the field of SAR Cal/Val.

- To further broaden the international nature of these annual events SAR SG is seeking a host from Asia for next years events. Offers from Plenary Organisations are welcomed.

Support by the SAR subgroup was also given to NOAA for its Symposium on Emerging Coastal and Marine Applications of Wide Swath SAR, held at APL, Maryland, USA on 23-25 March 1999

***2.5.2 The Microwave Sensors subgroup*** (chaired by Elena Lobl) met in Huntsville, April 1999 and in El Segundo, September 1999. Main actions:

Validation of the TMI sensor on-board TRMM launched in November 1997 has been a key focus for the group. TMI had a one-channel calibration glitch immediately following launch, and this is still present to some extent. It affects < 0.5% of some data over short time periods. Ground validation continued in summer 1999 with rain gauges and an aircraft over-flights.

Investigation of the small glitch on the AMSU-B water vapour sounder on-board the NOAA-15 launched in May 1998 has also been discussed.

***2.5.3 Infrared and Visible Optical Sensors subgroup*** (chaired by Christopher Mutlow) met in Andøya April 1999. Main actions:

Presentations from NPL and NIST on the current activities in the standards laboratories and the practical ways these can be applied to field and space calibration, which led to the issue of traceability of standards as debated by the WGCV in plenary session (see section 2.2).

Presentation of vicarious calibrations and sensor inter-comparisons highlighted the need for inter-comparison. If rigorous inter-comparison does not occur then calibration will continue to be *ad hoc*. Owing to the continuing inconsistencies in the vicarious and on-board calibration of visible and near-IR sensors, IVOS recommends that a rigorous inter-comparison of the results already obtained by CEOS Members and Associates takes place.

- A dedicated workshop to address this issue should be convened. The support and participation of CEOS Members and Associates for this is requested. The result would be a report containing recommendations for future work and a significant step forward in the improved convergence of sensor calibrations.

***2.5.4 The Terrain Mapping subgroup*** (chaired by Ian Dowman) met in London May 1999. Main actions:

The focus was a joint meeting with ISPRS WGII/4, WGIII/6 and the WGCV on land surface parameter validation. Specialist papers were invited to provide a state of the art review concerning the production and validation of Digital Elevation models. As a result the Terrain Mapping subgroup will

- prepare recommendations for the establishment of a global GCP network.
- consider how orbit validation could be developed.
- update current status of sensors.
- produce a statement of DEMs available.
- produce DEM requirements document with a science rationale, taking into account the output from SRTM.

## 3 Conclusions and recommendations

The IGOS developments have conditioned much of the discussion within WGCV over the last twelve months. Emphasis on future operational uses of Earth Observation data has lead to wide ranging debate and to significant changes in the Working Group's forward planning; we now have a fifth sub group. This though still only exists on paper (or perhaps in electronic form). A decision to operate with co-chairs was taken to further promote exchange of ideas across geographical regions, and both our new co-chairs (and their sponsoring agencies) deserve our thanks for their future efforts. In common with the other sub groups this new venture will only succeed if people participate. *We need the right people to come to the right meetings*.

This is particularly true of the intercomparison workshop on calibration results. The point of the workshop would be to look at specific data sets and their problems not at general issues. CNES (through their representative at the IVOS subgroup meeting) have made an initial offer to host the workshop. Others should attend. The result will be more uniform approaches to vicarious calibration, better calibration and therefore better products and happier users.

The *ad hoc* group on traceability is another example. Traceability could play a major role in moving Earth Observation onto broader operational footings by instilling confidence in EO products. Anticipating the results of any group is unwise, but it is probably safe to guess that the costs of establishing full traceability will be large. Someone has to discuss all the benefits and assess the costs before Plenary Members and Associates are able to make that all-important comparison between the costs and the benefits. *The* ad hoc *group won't work without broad participation by Plenary Organisations and their potential National Standards Laboratory partners.*

WGCV's recommendations to the 13th Plenary are therefore that Plenary Organisations fully support WGCV activities by nominating appropriate participants and providing their nominees with the means to attend. We specifically request that

- Members and Associates nominate a representative(s) for an *ad hoc* group to examine issues of traceability (not necessarily the formal WGCV member) and support their nominee(s) attendance at two meetings during 2000.
- CEOS Members identify a “partner" National Standards Laboratory.
- Members and Associates nominate a representative for the new sub-group on Land Surface Parameter Validation and support their nominee's attendance at at-least one meeting during 2000.
- Members and Associates identify individuals leading their atmospheric chemistry validation programmes.
- Members and Associates are asked to participate in a vicarious sensor calibration campaign results intercomparison workshop.

Full minutes of all meetings can be found on the WGCV web site http://wgcv.ceos.org/.

**Thanks go to all individuals who participated in the WGCV and sub group meetings and to the CEOS Members and Associates who supported them.**