



**COMMITTEE ON EARTH OBSERVATION SATELLITES  
WORKING GROUP ON CALIBRATION AND VALIDATION**

**MINUTES OF THE SEVENTEENTH MEETING**

**WGCV 17**

**25-27 October 2000**

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**and**

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**at**

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**ACRONYMS and ABBREVIATIONS**

AMSU	Advanced Microwave Sounding Unit
ASTER	Advanced spaceborne thermal emission and reflection radiometer
ATSR	Along-Track Scanning Radiometer
AVHRR	Advanced Very High Resolution Radiometer
AVIRIS	Airborne Visible/Infrared Imaging Spectrometer (NASA)
BNSC	British National Space Centre
CCRS	Canadian Center for Remote Sensing
CEO	Centre for Earth Observation (EC)
CEOS	Committee on Earth Observation Satellites
CERES	Clouds and Earth's Radiant Energy System
CHRIS/PROBA	Compact High-Resolution Imaging Spectrometer / PROject for On-Board Autonomy
CNES	Centre National d'Etudes Spatiales (France)
CSA	Canadian Space Agency
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DEM	Digital Elevation Model
DERA	Defence Evaluation and Research Agency (UK)
DLR	Deutsches Zentrum für Luft- und Raumfahrt (Germany)
EC	European Commission
ECT	External calibration target
EPIC	Earth Polychromatic Imaging Camera
EO	Earth Observation
EOS	Earth Observing System (NASA)
ERS	European Remote Sensing Satellite
ESA	European Space Agency
ESRIN	European Space Research Institute (ESA)
ESTEC	European Space Research & Technology Centre (ESA)
FAO	Food and Agriculture Organisation (of the United Nations)
GCP	Ground control point
GLOBE	Global Land One-km Base Elevation DEM (CEOS/WGISS)
GOES	Geostationary Operational Environmental Satellites
GOFC	Global Observation of Forest Cover
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GSFC	Goddard Space Flight Center (NASA)
HIRS	High Resolution Infrared Sounder
HQ	Headquarters
HRTI	High resolution terrain information
IFOV	Instantaneous Field of View
IGOS	Integrated Global Observing Strategy
IGOS-P	IGOS Partnership
IR	Infrared
IRS	Indian Remote Sensing (satellite)
ISPRS	International Society for Photogrammetry & Remote Sensing
ISRO	Indian Space Research Organisation
ISS	International Space Station

**ACRONYMS and ABBREVIATIONS**

ITC	International Institute for Aerospace Survey and Earth Sciences (The Netherlands)
IVOS	Infrared and Visible Optical Sensors Subgroup
LAI	Leaf Area Index
LBIR	Low Background Infrared Facility (NIST)
LISS	Linear Imaging Self-Scanner
LPV	Land Products Validation Subgroup
MODIS	Moderate Resolution Imaging Spectrometer
MOS	Modular Optoelectronic Scanner
MRA	Mutual Recognition Agreement
MS	Microwave Sensors Subgroup
MSMR	Multifrequency Scanning Microwave Radiometer
MSU	Microwave Sounding Unit
MOBY	Marine Optical Buoy
MTF	Modulation Transfer Function
NASA	National Aeronautics and Space Administration (USA)
NASDA	National Space Development Agency (Japan)
NDVI	Normalised Difference Vegetation Index
NESDIS	National Environmental Satellite Data and Information Service
NIMA	National Image and Mapping Agency
NIR	Near infrared
NIST	National Institute of Standards and Technology (USA)
NISTAR	NIST Advanced Radiometer
NMI	National Metrology Institute(s)
NOAA	National Oceanic and Atmospheric Administration (USA)
NPL	National Physical Laboratory (UK)
NRA	NASA Research Announcement
OCM	Ocean Colour Monitor
ORA	Office of Research and Applications (NESDIS)
PAD	
POES	Polar-orbiting Operational Environmental Satellites
POL-IN-SAR	Polarimetric SAR interferometry
QA	Quality assurance
QC	Quality control
S/N	Signal to Noise Ratio
SAR	Synthetic Aperture Radar
SBUV	Solar Backscatter Ultraviolet
SCANSAR	
SeaBASS	SeaWiFS bio-optical archive and storage system
SI	Système International (International System of Units)
SIMBIOS	Sensor intercomparison and merger for biological and interdisciplinary oceanic studies (NASA)
SIT	CEOS Strategic Implementation Team
SLC	Scan line corrector
SPICE	Spacecraft, planet (or other target), instrument, pointing (C-matrix), and event database.

**ACRONYMS and ABBREVIATIONS**

SRTM	Shuttle Radar Topographic Mission
SSM/I	Special Sensor Microwave / Imager
SSMIS	Special Sensor Microwave Imager / Sounder
SST	Sea Surface Temperature
SWIR	Short-wave infrared
SXR	SeaWiFS Transfer Radiometer (NIST)
TIR	Thermal infrared
TM	Terrain Mapping Subgroup
ToR	Terms of Reference
UCL	University College London (UK)
USGS	United States Geological Survey
WGCV	CEOS Working Group on Calibration and Validation
WGISS	CEOS Working Group on Information Systems and Services
WiFS	Wide Field Sensor
Y2K	Year 2000 Compliance

## 1. WELCOME AND ADMINISTRATION

**Saunders** initiated the meeting with a brief description of the administrative arrangements including the location of the restaurant, rest rooms and arrangements for travel to and from NIST. He pointed out that NIST was an open campus and that participants were free, time allowing, to visit with participants from NIST without security restrictions.

**Belward** welcomed the participants on behalf of the CEOS WGCV. He pointed out that the meeting was a little unusual in have two co-sponsors, NIST and NOAA and he extended particular thanks to **Saunders** and his team for making the arrangements for the meeting at NIST.

Dr Katherine **Gebbie**, Director of the Physics Laboratory, NIST, welcomed the participants on behalf of NIST. The working group meeting is likely to be one of the more interesting of those hosted by the organisation in the recent past both from a technical point of view and also because of its importance. She described the mission of the Physics Laboratory at NIST to support all of industry, government and science through its activities in measurement science covering the full range of applications. The activities are vertically integrated addressing the immediate needs of users as well as fundamental issues. She also extended an invitation to the participants to visit activities of the laboratory that are of interest to them.

Dr. Marie **Colton**, Deputy Director NOAA/NESDIS Office of Research and Applications, welcomed the participants on behalf of the NESDIS Office of Research Applications (ORA). ORA responsibilities range from satellite development and launch through all the intermediate steps to data processing and user services. These require calibration and validation (but especially the former) at nearly all the steps of the process of getting data and information to the end user and the activities of the WGCV are therefore of considerable interest. ORA is especially interested in international co-operation and partnerships. The main challenges facing the organization are to maximize the use of data, develop applications in coastal and ocean remote sensing, and to take on board the implications for their work of Internet communications which represent a revolution in the way information including images is disseminated.

**Colton** expanded further on the role of calibration and validation in the work of ORA. Climatic studies require long time-series data with a consequent great importance attached to calibration of the sensors used to measure parameters relevant to climate change. The technical approach is end-to-end with attention being given to calibration not only during design and pre-launch testing but also in later stages of the data gathering process including responding to user queries. She showed examples of NOAA sensor performance over time (generally good but with at least one example of degradation revealed by the calibration data) to illustrate the point "if you don't know the instrument, you don't know the data". The publication of calibration and validation data and activities are not well enough publicized and the WGCV offers a route for the wider dissemination of ORA work on these topics.

**Belward** thanked the speakers for their welcomes. Following some preliminary remarks concerning the validation of land parameters, he proposed a small change to the order of the agenda so as to bring forward the presentation of the subgroup reports to accommodate those in the audience who had to leave early, which was accepted by the meeting.

## 2. SUBGROUP REPORTS

### 2.1. SAR Calibration (Yves-Louis Desnos)

**Desnos** provided information the objectives, achievements and plans of the SAR subgroup. The presentation is available on the WGCV web-site.

The objectives of the subgroup are to:

- provide a forum for the exchange of information on SAR calibration
- support co-ordinated changes in SAR format
- promote co-operation among SAR cal/val workers
- provide education about these topics to the SAR user community.

The main activity in the past year was the SAR workshop held at CNES also reported on at the 16<sup>th</sup> WGCV. The recommendations arising from this workshop include:

- Assess the performance of future systems using standardized radar cross-section models.
- SAR image ambiguity requirements need to be properly assessed for future missions
- Utility and feasibility of wide band low frequency SAR has to be demonstrated and documented.
- There is a need for a QA authority to validate calibration processes by the data providers and to provide a system of man-made targets for international reference.
- There is a need for continued co-operation between the agencies to optimize spatial and temporal SAR coverage for ocean and ice studies.
- The historical archive of SAR images should be open to the user/scientific community.
- There is a need for a permanent validation test site for POL-INSAR science and application development.
- There is a need for a CEOS standard for SAR image compression.
- There is a need for INSAR coverage in addition to that provided by SRTM for DEM generation.
- Provide users with tools to support calibration of archived products.
- Develop/provide tools to predict orbit baseline relative to data already acquired.
- Explore quantitative benefits of high resolution versus full and partially polarimetric imagery.
- Compare DEM recovered from INSAR, POL-SAR and POL-IN-SAR data takes.
- Improve polarisation purity and channel isolation of future SAR systems.
- Set up a task force for POL-IN-SAR image formatting in WGISS.
- Develop phase preserving processed products for the the SCANSAR modes of existing and future SAR.

The subgroup workplan includes the following activities:

- Promote technical exchanges
- Promote joint field campaigns
- Develop test sites for cal/val
- Exchange data sets for independent validation between group members
- Ensure SAR data products are calibrated and validated.

The next meeting of the SAR Calibration Subgroup is planned for 2-5/4/01 at NASDA/EORC, Tokyo, Japan, to be organized by NASDA and ESA. The topics to be covered include

- Science and applications requirements
- Geometry and radiometry
- Polarimetry
- Interferometry
- Instrument design and new concepts
- Low frequency imaging
- High resolution imagery
- Processing and calibration
- Data compression techniques

The meeting will consist of a plenary session with prior discussion of key topics, selected technical papers and posters. Further information is available on [www.eorc.nasda.go.jp/JERS-1/conference/ceos-sar/index.htm](http://www.eorc.nasda.go.jp/JERS-1/conference/ceos-sar/index.htm).

**Belward** said that the proposal to set up a task force within WGISS (Recommendation xv) needs further discussion before being taken to CEOS plenary. **Barton** asked about the future chair of the subgroup. **Desnos** replied that some candidates were in the room. **Dowman** asked if polarimetric SAR for DEM generation was based on a specific instrument particularly with regard to canopy penetration, to which **Desnos** responded that no particular instrument was in mind.

## 2.2. Microwave Sensors (Jim Shiue)

The subgroup generally plans to have one meeting per year. The next meeting will be in December 2000 at GSFC. The other main event is the First International Microwave Radiometer Calibration Workshop on 30-31/10/00 at the University of Maryland Inn and Conference Center. Its objectives are to gather together for discussion an international group of scientists and engineers from industry, government and academia with an interest in microwave radiometer calibration, to provide a forum for discussion of state-of-the art in this topic and to identify future calibration requirements to serve as a guide for the research efforts of the microwave radiometer calibration community. Topics to be discussed include missions, standards, assessments and measurements, airborne and ground-based systems and correlation radiometers.

**Calton** asked how the outputs from this very relevant workshop were to be integrated within the CEOS reporting structure. **Shiue** replied that the method envisaged was through the normal course of dissemination of information from scientific workshops, ie publication and through the presence of people from CEOS at the workshop. **Belward** asked Shiue to take formal responsibility for reporting back to the Microwave subgroup (especially important in view of the imminence of CEOS plenary), report to include a participants list, to which he agreed.

## 2.3. Infrared and Visible Optical Sensors

**Belward** reported that IVOS had not met during the course of the year and that the Chairman, **Mutlow** had resigned. He passed on the thanks of the former chairman for the support he had received during his tenure from ESA and BNSC. **Belward** also mentioned that some further thought had gone into the responsibilities of the subgroup in view of the proposed inclusion of LPV as an addition WGCV subgroup. These are incorporated in the draft IVOS workplan to be discussed in the afternoon (see Section 5).

## 2.4. Terrain Mapping (Ian Dowman)

**Dowman** reported on some recent activities of the subgroup. These included collaboration with ISPRS on the production of a book on global terrain databases ([www.geocarto.com/B001.htm](http://www.geocarto.com/B001.htm)) which has now been published. A new edition is planned and contributions are invited. (Ideas for contributions to Hastings: david.a.hastings@noaa.gov). **Hastings** mentioned that he and another from NOAA had received an award for their work on the GLOBE DEM and extended his thanks to those in WGCV who had contributed but not been acknowledged, as the award is limited to NOAA staff.

**Dowman** reported on the subgroup meeting held prior to the WGCV plenary. A full report will be placed on the WGCV web-site.

## Developments

The Shuttle Radar Topography Mission (SRTM) successfully covered a large proportion of the globe, much of this multiple times. The mission was marked by particular attention to complex calibration and validation issues. The resulting DEM is expected to be accurate to +/- 16m.

ASTER on Terra has been launched.

Ikonos. Concern is expressed that users are sold DEMs and stereo data without QA, calibration and validation information.

**New sensors**

Vegetation canopy LIDAR. The sensor maps both the top of the canopy and the ground surface beneath which raises a number of new validation issues.

ICESat (laser altimeter) measures ice elevation. Cal/val issues include the accuracy of sensor pointing for repeat data collection.

GeoSAR, an airborne X and P Band SAR that measures elevation of both canopy top and ground surface.

**Current DEMs and Future Requirements**

Current global coverage is satisfied by GTOPO30 and GLOBE data. Reference was also made to the US National Elevation Dataset which consists of 1" elevation postings with an accuracy of +/- 6m but is restricted to the US. DEMs in progress include that derived from SRTM. A requirement for High Resolution Terrain Information (HRTI) with 1m accuracy has been identified within NIMA. It raises an issue with regard to canopy height and the way in which the data can be calibrated and validated.

**Dowman** also reported on some of the main conclusions of the meeting;

Specification of accuracy. This is hard to present in a consistent way that the user can understand – it can't be represented by a single figure. Visualization of the data is useful for users to evaluate accuracy but a means is required for the errors also to be visualized.

CEOS dossier is out of date with regard to DEM test sites. New sites are needed for HRTI and some sites are available in the US from the USGS. Good cal/val test sites need airborne data and need to permit those undertaking validation to be able to take account of the vegetation canopy.

Additional data are needed for validation. These include GCPs, 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.

**Belward** asked if WGCV should approach Agency representatives on CEOS Plenary to provide test site data to be added to the WGCV dossier. There was general discussion from which it emerged that a more cautious and considered approach was favoured: first to find out which agencies hold such test site data; second to consider which organisation should host a database of it.

**Dowman** also reported on the issues that had arisen during the meeting and recommendations following from it.

Space Imaging are unwilling to share cal/val data for Ikonos stereo imagery because of a perceived commercial disadvantage in doing so. **Morisette** reported evidence of some softening of this attitude because of a realisation that it was damaging the scientific credibility of Ikonos products.

There is a requirement for the standardisation of EO sensor parameters both geometric and radiometric comparable to that in place for extra terrestrial sensors (SPICE)

Co-ordination of WGCV activities with those common to ISPRS. In a later remark, **Dowman** emphasised that now is a good time to initiate participation and co-ordination of activities with ISPRS since the organisation is currently setting up working groups and preparing ToRs.

**Dowman** indicated his intention to tender his resignation because of new heavy responsibilities. **Belward** thanked him for the hard work completed by the Terrain Mapping subgroup under his leadership and his own substantial contribution. **Shiue** remarked that standardisation of terminology is mundane but is fundamental to the tasks of calibration and validation and is the foundation on which success is built.

## 2.5. Land Product Validation (Jeff Privette)

**Belward** introduced the presentation by reminding the meeting of the discussions that had taken place concerning the proposal to include this subgroup at Bangalore and the overlaps identified with IVOS.

**Privette** presented the vision, context, issues to be addressed and proposed organisation of LPV. The presentation has been posted on the WGCV website.

The vision of the LPV stems from the need of users to understand the accuracy of the products they use and the fact that this understanding comes through validation of the products. There is currently a lack of expectation among users that they can make use of accuracy expressions because they have long been denied them. Therefore:

- (i) henceforward, all missions should have on-going validation based on standard packages
- (ii) validation activities should be used to improve product generation algorithms iteratively
- (iii) global change issues are vital, therefore a global validation strategy is required. The GOFC will be the focus for LPV activities.

The GOFC was described as was the context and reporting structure of the proposed group.

The issues identified at the foundation of the group were:

- (i) Consistency in definitions, to permit meaningful cross validation
- (ii) Input from users about their accuracy requirements
- (iii) Information and data exchange
- (iv) Validation test sites with regard to their quantity, spatial distribution relative to each product to be validated, temporal distribution, size and range of solar angles accommodated.

The current approach to the test site issue is based on establishing networks with those managing existing sites viz:

- Canadian LAI network (11 sites)
- VALERI (6 sites)
- EOS core site network (23 sites)
- LPSIM site inventory (comprehensive list)
- Miscellaneous project sites, eg ASTER
- WGCV site inventory (56+ sites)

Current issues with regard to validation measurements include:

- Experimental design including working towards a manual of "best practice"
- Field instrumentation including estimation of products from surrogate parameters, specification and calibration.

Current issues with regard to understanding and using results include:

- the mismatch in both area and timing of the product being validated and the validation data
- aggregation and scaling methods
- reporting results in a way the user can understand.

Current activities include:

- fast track LAI product intercomparison
- fire product validation

- land cover product validation.

Recommendations to WGCV from the Ispra meeting of the group include:

- creation of CEOS core sites
- sharing of validation data
- open (free) release of imagery over the core sites
- sponsorship of forums, workshops, a website and a CEOS-sponsored field instrument loan programme for users.

The current organization consists of 2 co-chairs (Dech and Privette) appointed for a period of 3-5 years. Plans for specific information-sharing activities include an annual workshop around a specific topic that involves the user community.

**Rao** emphasised the point that high-level products are only as good as the basic measurements from which they are derived, in most of the cases considered, the radiance measurements. Proper validation requires that the way in which errors in radiance estimation are propagated into higher level products be understood. There is a need for a description of this link. There are additional uncertainties in deriving the properties of surface materials from EO measurements, for example the radiative transfer model used to extrapolate irradiance to the base of the atmosphere. **Privette**, in responding, agreed that these were important matters but that the models and assumptions can only be improved by undertaking validation exercises. **Morisette** emphasised that users were more interested in the accuracy of high level products than that of primitive fundamental measurements. **Hastings** commented that the discussion was of exactly the kind required to clarify the validation that should be undertaken by the agencies in order to improve the utility of products derived from their data. **Belward** added that if LPV encourages the agencies to include these kinds of validation then it should be adopted by WGCV.

**Attema** asked if WGCV should adopt the group and expressed concern about overlap with IVOS. Further discussion was deferred until Item 5.7.

### 3. WGCV CHAIR'S REPORT (ALAN BELWARD)

#### 3.1. Preparations for 14<sup>th</sup> Plenary

**Belward** emphasised the need for speedy preparation of WGCV recommendations to Plenary which must be completed within the week. There are 2 main sets of recommendations relating to the 2000-2003 workplan, the issue of LPV and IVOS, and traceability. In response to a question he also said that recommendations from subgroups to be carried forward to Plenary must also be agreed within this timeframe. These matters are reported in Section 10.3.

#### 3.2. IGOS update and status report

**Belward** informed the meeting that the CEOS-IGOS partnership has been formalised. IGOS "Projects" have been replaced by "Themes" which have a broader scope. They include an Ocean and a Carbon theme. The latter has been extended to include the whole carbon cycle although there will be a terrestrial component that will replace GOFD.

#### 3.3. Action Items from WGCV 16

These represent the consolidation of action items from several previous WGCV plenary meetings. **Belward** noted that several actions remain open or incomplete. The following includes those that attracted comment. The action numbers are referenced in the minutes to WGCV 16.

16.3 Some actions to involve the private sector have been taken – witness the involvement of a representative of Spotimage at the meeting.

16.5 Complete.

16.6 Some parts completed but not enough material was received for preparation of the newsletter.

16.10 to 6.16. These items relate to the educative efforts of WGCV. All are incomplete. **Barton** said that the problem was that education and information dissemination have no champion and that one is required in order to get the inputs from members required to generate these products. Support and a budget from sponsors are also required. **Attema** said that if the work of the WG is important (and it is) then we should let people know about its successes. There was discussion about whether the brochure was worthwhile or the same results could be achieved via the newsletter or website. **Attema** pointed out that whatever medium was used, the material still had to be got together. **Belward** asked if more time and resources should be devoted to these activities and there followed a general discussion of their purpose and their position in the workplan. It was subsequently agreed that Activity 6 in the Work Plan (Education and Outreach) should be merged with Activity 3 (Communication with the Community). With regard to the brochure, **Desnos** expressed the view that the work of the WG merited publicity in this form and undertook to produce it.

16.19 Complete

16.20 Complete

16.21 Complete

16.22 Complete

15.23 Complete

16.25 Complete

#### 4. REPORT FROM WGISS: ACTIVITIES AND SERVICES (ALAN BELWARD)

**Belward** illustrated the WGISS Test Environment. It consists of a menu of tools for functions (eg interoperability, catalogue management) developed by WGISS and put at the disposal of projects, currently mainly GOF. **Hastings** extended the discussion to include WGISS task team and there was discussion of the direction of the WGISS activities between **Hastings** and **Belward**.

#### 5. WGCV WORK PLAN REVIEW ISSUE 2.3

Copies of the latest version of the Workplan (Issue 2.3) were distributed for those who had not been able to download the text from the website. **Belward** reviewed the changes made in the text as a result of discussion at the Bangalore meeting.

##### 5.1. WGCV Plenary

**Attema** questioned whether WGs do or indeed should disseminate issues discussed at CEOS Plenary. There followed a discussion during which it was pointed out that WGs often rejected directions from CEOS plenary. **Shiue** said that directions from CEOS Plenary should be accompanied by support and/or resources to carry them out. **Barton** stressed the "conduit" aspect of the functions of the WGs, their responsibility to act as the interface between the agencies and the science community and their function to co-ordinate the activities of the agencies. **Attema** said such a role was somewhat hollow since plans are often decided before WGs (and WGCV in particular) have time to discuss them.

**Hutchins** suggested that the section on Plenary needs more information on management but this was countered by the argument that this information was in the WGCV ToR and that was adequate.

##### 5.2. Communications with the Community

**Belward** asked by way of initiating the discussion "Should we continue to sustain the newsletter". **Teillet** stressed that the WG must have outreach if it is serious about the stated importance of its work. **Attema** stressed the need for staff dedicated to this task which cannot be done properly

without a consistent effort. **Belward** asked **Desnos** if the sponsor of the new chair might be prepared to provide this dedicated support and received a positive response. He also said that past experience was not encouraging. Therefore, after further discussion, it was agreed that an approach should be made to Plenary to find a champion for communications and outreach work among the sponsoring agencies.

### 5.3. Activity 4: CEOS Communication

**Hastings** asked if this activity could be folded in with the new education CEOS group but **Belward** responded that this subgroup was not permanently established and its responsibilities were somewhat different from those required by WGCV.

### 5.4. Activity 5 Test Site Dossier (Jim Butler)

**Butler** set out the history, purposes, recent activities and current status of the Test Site Dossier. The purpose of the dossier is to provide users with a database of calibration laboratories, validation test sites and cal/val instrumentation and to promote collaboration and comparisons. After an enthusiastic start, the dossier languished somewhat. NASA funding, started in 1995, led to the distribution of questionnaires to potential providers of information in 1997-98 and the updating of the content and functionality of the database in 1999-2000.

The main recent activities include an amplified covering letter, an expanded distribution list of 300+, the provision of near real-time support for users filling in the questionnaire, the incorporation of user suggestions, backups, Y2K compliance, improved functionality that includes automatic incorporation of data sent electronically and the initiation of efforts to incorporate other databases (eg Claire Jacobs' land test site database).

The current status is marked by a low rate of response to the questionnaire. There have been 277 hits on the site by users seeking information but these represent only 17 separate users. NASA funding ends on 30-10-00.

**Attema** asked what the database was for and who uses it. From a personal perspective, he has not been obliged to use it to find a suitable test site. The point was made that 17 unique hits is not many and the question asked whether it is worth continuing to make the effort to maintain the database. If so, then it needs to be better publicized with more links from CEOS, Agency and regional RS community websites and perhaps also test site managers' websites.

**Belward** asked if the WGCV should make a recommendation to Plenary for continued support from Agencies and ISPRS. The response of the meeting was affirmative, the request to emphasize recent enhancements and the need for better links and to include requests to WGISS for related information.

**Rao** wondered about the quality of the information in the database. **Hastings** mentioned the pressure on those supplying data to make it accurate. **Dowman** indicated a need for a cal/val member to be responsible for liaison with ISPRS. **Barton** explained the need for continuing support extending to at least 3 years rather than annual support. **Attema** returned to the point that there is not yet enough evidence that the information in the dossier is used and further enhancement is needed. In the following discussion about improving access to the dossier, **Moreau** mentioned the importance of establishing links with the regional organisations of remote sensing scientists.

### 5.5. Activity 6: Education and outreach

Discussion centered around two aspects of the activity: description, whether the work described could be construed as a complete description of the education and outreach task and whether the description of the bibliographic database conformed with what was intended. With regard to the first, it was agreed that education and outreach went beyond what was set out in the draft and that **Belward** would attempt a recasting of the activity description in the workplan. With regard to

the second, it was agreed that the words “comprehensive bibliography” in Section 7.2 should be replaced by “list of key references”. **Attema** also made the point, noted against other educative and information dissemination activities, that the activity had no “owner” so not much got done.

**Dowman** made a brief presentation of current ISPRS activities and plans. It is formulating a 4 year plan with the following themes common to those of CEOS:

- identification of a common set of sensor parameters
- promotion these among sensor manufacturers
- collaboration with WGISS
- Liaison with CEOS over IPSAR and LIDAR
- Spectral signatures
- Disaster monitoring

The means of collaboration might include members of WGCV on relevant ISPRS WGs and vice versa and the setting up of joint task forces. Specific mention was made of Stan Lorraine, President of ISPRS Commission I, Standardization and the president of Commission VII, Applications. **Belward** put forward a plea for formal representation of ISPRS on WGCV. **Tieller** supported this but urged CEOS members to smooth co-ordination by attending ISPRS conferences. **Dowman** agreed to take CEOS cal/val report to ISPRS and said thought should be given to an invitation from the Plenary Chair to ISPRS members to sit on CEOS WGs.

#### 5.6. Activity 7: Validation Pilot Projects

**Belward** introduced the idea of collaboration in projects based around the representatives of Agencies in WGCV. **Morisette** made a very rapid presentation of several land product validation projects, based on presentations made at the May meeting of LPV. If/when the LPV subgroup is formally accepted it could use the infrastructure and lessons learned from these projects for a LPV pilot project on the validation of GOCF products. **Belward** agreed to amend the text of this section of the work plan by deleting the points including and following “Additional pilot projects under discussion...” and replacing with “Pilot projects will be developed to support particular cal/val activities and to address specific cal/val issues of importance to the user communities “ or similar text.

The presentation is available on the WGCV website.

#### 5.7. Activity 8: Sub Group missions, objectives and action plans

**Belward** suggested that the meeting concentrate initially on the IVOS and LVP subgroups, the relationship between them and whether the LVP subgroup should be adopted by WGCV. He indicated that the revised text in Section 9.3 of Issue 2.3 of the Work plan was provided by **Mutlow** in order to accommodate the inclusion of an LPV subgroup.

**Attema** stressed that subgroups are mostly based on sensors and that the inclusion of LVP cuts across this logical arrangement with potentially serious consequences for overlap of responsibilities and objectives. He said the inclusion of the words “provide support for the validation of higher level products” in the IVOS mission statement was objectionable on the grounds that IVOS has and does validate such products, eg SST. The comment was made that the SAR community is more homogeneous than the optical and thermal and it is more natural that both calibration of basic measurements and validation of higher level products go hand in hand. **Privette** stressed that the user communities that seek calibration of sensors and those that require validation of high level products tend to belong to different groups in the optical and thermal fields. **Barton** and **Teillet** supported the inclusion of this vigorous new group and there was unanimous agreement among the speakers that much would be lost if they were excluded. There was however, reservation about the inconsistency and overlap with IVOS that would be introduced by their inclusion. **Shiue** said that WGCV should accept LPV and live with the inconsistency represented by overlap with IVOS. However, there was a strong feeling that any

steps taken should not damage the viability of IVOS which it was agreed had an essential role, though currently at a low ebb.

**Belward** canvassed opinion concerning the inclusion of LVP and it was agreed that it should be accepted as a WGCV subgroup subject to reservations, and that the word "proposed" in the subgroup title in the draft workplan should be struck out.

The reservations are;

- the issue of co-chairs
- the wording of the IVOS action plan.

It was also agreed that it is essential to maintain support for IVOS and that the priority is to find a new chair for the subgroup.

It was agreed therefore that **Belward** would revise the wording of the IVOS action plan, reverting to the original text of Mutlow, pending the appointment of a new IVOS chair and the reworking by him/her of the text.

There was some discussion also of the mission statements for the Terrain Mapping and Microwave Sensor subgroups. **Dowman** agreed to email **Belward** with replacement text for the former. **Shiue** undertook to rework the text of the latter and email to **Belward** also. **Hutchins** suggested merit in a more standardised format and content for each of the subgroup entries.

## 6. SPECIAL SESSION ON CALIBRATION ACTIVITIES AT NIST AND NOAA

**Belward** introduced this and the following session which together make up a day of work devoted to traceability. He expressed the anticipation of the meeting in hearing about calibration and validation work that have a real impact on Earth observation data and affect the way in which they are used. He drew attention particularly to the two papers prepared for the session on traceability by **Rao** and by **Fox** and **Saunders** that would form the basis of the discussion in Session 7.

### 6.1. Welcome (Dr Albert Parr, Chief, Optical Technology Division, NIST)

**Dr Parr** expressed the welcome of the Optical Technology Division to the meeting and provided the context for the subsequent presentations and an overview of the organisation's divisions and their activities. The NIST measurement strategy for remote sensing is based on addressing the full range in time and space, encompassing space sensors (including those for the International Space Station), airborne sensors and ground observations, with traceability to SI. Particular attention was drawn to the Low Background Infrared Facility (LBIR) used for calibrating black body sources and transfer standard radiometers and the development of portable radiation sources for calibrating instruments *in situ*.

### 6.2. Overview of calibration activities at the NOAA/NESDIS Office of Research Application (Mike Wienreb)

The presentation is available on the WGCV website.

**Weinreb** presented a summary of the functions of the current NOAA sensors and their platforms which include the sounding of atmospheric properties, and the measurement of Earth surface properties and radiation budget. The information is required in near real time for forecasting (some radiance measures go directly into weather forecasting models) and with a somewhat longer time scale, for climate studies. These applications require good calibration and early attention to this aspect. Calibration activities extend from design of sensors through to trouble-shooting on operational satellites.

Current activities include the investigation of solar contamination of AVHRR data and the vicarious calibration of a number of spaceborne sensors in the visible and near infrared (see presentation by Rao, Section 6.3) including HIRS and GOES.

Long time series MSU data indicate no temperature changes in the troposphere, an unexpected result. Improved calibration methods have highlighted differences between the sensors and the next step is to use these improved methods to revise historical temperature estimates.

The SBUV/2 sensor measures atmospheric ozone and is designed to provide results in near real time. The instrument is self-calibrating but a problem has been encountered and new calibration parameters have been developed by NASA that provide better correspondence with "ground truth". This will require the reprocessing of historical data to derive accurate long-term trends in atmospheric ozone.

Work has been undertaken in the pre-launch calibration of the IR channels on POES and GOES. The manufacturers provide a two-point calibration but the relationship between output and spectral radiance is not linear. The method depends on determining the value of the coefficients of the (quadratic) regression equation that represents the relationship more accurately and then evaluating the confidence that can be placed on the internal calibration target. Traceability is established through the calibration of the thermistors used to measure the temperature of the calibration target. There are unexpected errors in the pre-launch calibration of the GOES instrument which may be traceable to an error in the target temperature measurements.

Discrepancies between the observed and calculated brightness temperatures recorded by the NOAA 14 HIRS may be caused by an error in the spectral response function supplied by the manufacturers in the bands concerned. The error occurs in both the HIRS and GOES sounders. NIST was approached to help resolve the problem by tracing the temperatures to a common standard.

**Barnes** reported similar problems with information supplied by instrument manufacturers. The observed problems with the ECT may be related to differences between the bulk temperature of the black bodies and that recorded by the thermistors. **Barton** asked about the origin of the shift in the spectral response curve between different instances of the same sensor.

### **6.3. NOAA Site survey for vicarious calibration and inter-sensor calibration (C.R.Nagaraja Rao)**

**Rao** reviewed the achievements so far with regard to inter-sensor calibration and described the objectives, methods used and some of the results of this work as well as describing the results of the site survey.

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.

The principle and method were outlined. They depend on the calculation of a test site albedo at the top of the atmosphere for a reference instrument and the instrument being calibrated, the comparison of these albedos and the derivation of a simple calibration equation that links the response of the reference to the tested sensor. The method requires that a consistent radiative transfer model through the atmosphere is used, that the test site has constant reflectance properties over a range of timescales and that the surface materials are Lambertian reflectors with reflectance independent of wavelength over the spectral range of the sensor channels.

Examples of intercalibration data were presented for several sensor pairs. The results for example of GOES 8 Imager visible band and AVHRR Channel 1, are satisfactory and give confidence that the method works. Comparison of ATSR and AVHRR data demonstrates that bands of different spectral widths can be accommodated by the method. Variation in pixel size between different sensors, and the reflectance properties of the test site have a measurable but acceptable effect. Comparison of AVHRR Channels 1 and 2 shows that the method breaks down for sensors with different bandpasses.

**Rao** also presented a list of potential vicarious calibration sites developed in collaboration with the Rutherford Appleton Laboratory, Didcot. 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.

The presentation is available on the WGCV website.

**Belward** asked if the test site list will be made available. Teillet described spectral band difference effects that affect radiometric cross-calibration between Landsat 5 and 7 sensors, as reported in P.M. Teillet, J.L. Barker, B.L. Markham, R.R. Irish, G. Fedosejevs and J.C. Storey: "Radiometric Cross-Calibration of the Landsat-7 ETM+ and Landsat-5 TM Sensors Based on Tandem Data Sets" in Remote Sensing of Environment, Special Issue on Landsat 7 Science. **Privette** emphasised the importance of having sites with ground measurements to monitor seasonal and annual changes. He asked which sites had been visited or were instrumented. **Rao** replied that the Chinese ones were but that the instruments had been changed from time to time.

Several participants, while congratulating Rao on the progress made, also expressed their appreciation of the continued support given by NOAA to vicarious instrument calibration and this sentiment was generally endorsed by the meeting.

**Hastings** raised the matter of seasonal and annual time variations at the sites. **Rao** replied that the top of the atmosphere measurements matched seasonal variations but that these were due more to seasonal changes in atmospheric water vapour than to surface effects. **Barnes** remarked that CEOS dossier had recorded a test site in Egypt and there were several other groups known to be using desert test sites.

#### 6.4. The SeaWiFS program (Bob Barnes and Chuck MacClain)

The presentation concentrated on calibration and validation activities within the SeaWiFS program. These responsibilities include the provision of processing algorithms, the tracking of instrument performance and post-launch calibration, the verifying of processing code and the QC of products. **Barnes** mentioned that SeaWiFS has a bilinear gain that permits the collection of useful data over both land and sea.

SeaWiFS products include measurements of chlorophyll, aerosol, NDVI, coccolithophores, cloud fraction, smoke and others. The complex effects to be accounted for in order to arrive at the water-leaving radiance were described.

The Ocean colour community infrastructure has had to be rebuilt because of the long gap since the deployment of the previous ocean color instrument. It now includes measurement protocols, calibration round robins, data archiving, networks and collaboration and instrumentation.

The calibration of sensors includes pre-launch laboratory calibration at NIST, post launch maintenance of calibration based on lunar observations with interpolated solar calibration to

identify steps, vicarious calibration using an instrumented buoy (MOBY), both leading to operational adjustments and product checks. The relationship between these methods was illustrated. Barnes remarked that the lunar calibrations had indicated that the visible instruments had been stable since launch but that some drift had been detected in the NIR channels. These results were illustrated by time-series data for each band and comparison with ship-borne measurements.

The second part of the presentation concentrated on SIMBIOS which is essentially an intercalibration campaign for SeaWiFS. Its objectives are to ensure consistent research data products, develop cross-comparison and data merger methods and encourage collaboration and information dissemination. The activities include comparison within SeaBASS, a QC archive/database, data processing, cross calibration and sun photometry.

**Teillet** asked whether SeaWiFS produced any atmospheric products over land. Barnes replied yes but no aerosol data. There followed a general discussion of other SeaWiFS derived land products. **Sakamoto** asked if AVIRIS was included in the cross calibrations but it is not. **Wienreb** enquired about the account taken of lunar variation in the post-launch calibration method and a description was provided.

#### **6.5. Remote sensing support at NIST (Carol Johnson)**

**Johnson** started her presentation by describing the particular motivation for the support from NIST which arises because of the need for accurate measurement of radiant flux to support EO science and especially multi-sensor and long time series data generation but also to demonstrate state-of-the-art and act as a check on the information provided by manufacturers. She described the programs and partners in the work and mentioned in particular NISTAR, the first instrument to be built by NIST for use in space.

The main task of the program is to verify the calibration of sensors used in EO for spectral radiance traced to NIST standards. The presentation is a review of the way and how well this is done for the visible and IR through current activities at NIST. The principles underlying the task for both sensors and sources were illustrated with particular reference to the LBIR (Low background Infrared Facility) used for calibrating sensor black bodies that can be transported to NIST.

This was followed by a discussion of the accuracies required to satisfy the science goals of some of the projects and the implications this has for the methods and equipment to be used for calibration. This in turn was linked to the technical response by NIST to meet the requirements of the projects including the development of a range of portable transfer radiometers, radiance sources and black bodies, sensor calibration, including MOBY, SeaWiFS and EPIC, sensor development and calibration (NISTAR), training and comparisons. Further details of some of this work was provided including descriptions of the instruments developed, the results of EO sensor calibrations and radiometer comparisons. The presentation was concluded with a valuable summary of guidelines for successful calibration in the context of EO programs.

The presentation is available on the WGCV website.

#### **6.6. EPIC (Ted Early)**

EPIC stands for Earth Polychromatic Imaging Camera. It will be mounted on Triana and observes the sunlit earth from an altitude of  $1.6 \times 10^6$  km. The camera has a resolution of 8km, a 2048 by 2048 sensor array and 10 channels in the UV to SWIR range with variable bandwidth. The wide spectral range and variable bandwidth pose particular calibration problems.

Following this brief description, **Early** went on to describe the construction and functions of the instrument and the calibration goals to be aimed at both on the contractor's site and at GSFC. These are:

5% consistency  
3% absolute radiance  
1% band to band (better than absolute radiance because some products are generated by band to band comparison)  
0.1% pixel to pixel.

The calibration procedures include inbuilt QC and tests for each of offset, linearity, dark signal, exposure time and responsivity.

**Weinreb** asked how the channels were chosen but this was not known to the calibration team. **Barton** asked what other instruments there are on Triana. There are two additional instruments.

#### **6.7. Expression of Thanks.**

Belward, on behalf of the WGCV, thanked the presenters for the valuable information provided during the session. Many of the presentations contained examples where calibration had made a direct contribution to the improvement of the resulting EO data products and clearly demonstrated the value of calibration and validation activities in the avoidance of error.

#### **6.8. Presentation to the Chair**

On behalf of the WGCV, Mr Nagaraja **Rao** made a presentation to Alan Belward in recognition of his hard work over his years as chair of the group, now sadly coming to an end, and to thank him for his leadership which has contributed significantly to the current high standing of WGCV in calibration and validation matters.

### **7. SPECIAL SESSION: TRACEABILITY**

**Belward** introduced the session by describing the outcome required from it, the moulding together of the two documents previously circulated on the website and at the meeting, produced as a result of discussions at the 16<sup>th</sup> WGCV Plenary, Bangalore ("Improving the traceability to SI of the high level data products of Earth Observation measurements" and "Traceability of satellite radiometer measurements to national standards") into a single agreed submission to CEOS Plenary. In addition, he invited participants to consider also the draft resolutions on this topic contained in the Notes to the Agenda of the 20<sup>e</sup> Conference Generale des Poids et Mesures 1995, also circulated at the meeting. He then invited **Fox** to run through the main points in the first of these papers.

#### **7.1. Improving the traceability to SI of the high level data products of Earth Observation measurements: presentation of the draft report (Nigel Fox)**

The main points emphasised in the presentation were:

- Traceability requires a fully integrated strategy; it depends on an unbroken chain of measurements that provide an assured link between the EO product for which traceability is being established and the SI standard to which it is linked and the measurements must be carried out using accepted methods and protocols.
- The terminology used should be standard so that there is no opportunity for misunderstanding between the partners establishing the link.
- The task requires setting up a small group of specialist laboratories, which are likely to be national standards laboratories, to ensure that all primary measurements made in support of EO missions can demonstrate traceability to SI units. They would be responsible for maintaining a database recording the level of equivalence of each data provider's measurement capability for the key primary measurands.

## 7.2. Response from the WGCV members (chaired by Alan Belward)

Wide-ranging discussion of the points made in the presentation and in the source documents followed and partly overlapped the presentation. With regard to standard terminology, and more specifically to a prohibition on the use of precision which is not recognised by the metrology community, **Attema** asked what should be used in its place and whether any substitute would be as well understood by EO scientists. **Weinreb** challenged the assertion that traceability would necessarily lead to improved EO products through its impact on accuracy. For some products, for example those related to change monitoring, reproducibility is more important than absolute accuracy. **Attema** and other cited numerous examples where the absolute accuracy of measurements is poor or unknown but repeatability is good and useful products can be and have been made on this basis. **Fox** accepted that this is the case where measurements were made by a single sensor or by sensors that overlapped in time but the argument would break down when this was not the case and then traceability would be required to validate the accuracy of the measurements used.

**Hastings** pointed out that lack of accuracy is a constraint on users and improving accuracy is a worthwhile goal. **Belward** emphasised that some agencies have accepted that traceability is worth establishing and are making good progress in this direction— witness the papers in Session 6 – but that others have not. Plenary wants from WGCV an opinion, supported by argument and information that helps them decide if establishing traceability for some EO measurements merits their support.

**Johnson** and **Zalewski** stressed that traceability is an essential foundation for achieving and demonstrating levels of accuracy. **Shiue** said that it is not the only way of improving accuracy. **Fox** agreed but maintained that the accuracy of measurements of fundamental parameters, to which traceability contributes, is the foundation on which good products are based.

From this discussion, a consensus was reached that at this time, strict traceability is not feasible for high level products because their generation requires inputs and assumptions other than traceable measurements (eg models). **Attema** however wished that the concept could be extended to high level products, perhaps by incorporating cross-comparison, on the basis that it is improvement in the quality of high level products that mainly interests users. **Johnson** made reference to the SIMBIOS program as an example of traceability best practice that supports the quality assurance of high level products.

**Attema** and **Shiue** pointed out that improving the accuracy of Level 2 products may be more important for users than traceability and that some products, for example, those based on ratios including several radar products do not need traceability. **Fox** agreed that the practical consequences of the introduction of traceability were more likely in products based on optical and infrared measurements.

**Attema** suggested that it would be more fruitful to restrict the discussion to traceability of calibration measurements rather than the broader issues of how to improve accuracy and **Belward**, making reference to the request from Plenary for a submission on this topic, agreed that this would be helpful in taking matters forward.

**Attema** inquired whether it was true that National standards laboratories must be involved in the calibration of EO sensors in order to establish traceability. **Zalewski** emphasised that their key role is to ensure the assessment of the accuracy of measurements made by others and part of the way this is done is through traceability to SI with which view **Johnson** concurred.

With regard to the need to establish a subset of laboratories with expertise in the measurands of interest to the EO community, **Attema** and **Zalewski** indicated that agencies would go to the laboratories they thought would do the best work which might not be a national standards laboratory in some cases. Consequently, **Attema** thought that few agencies would support the

idea. **Barnes** drew a comparison between SIMBIOS and this organisation but **Shiue** pointed out that SIMBIOS dies with SeaWiFS while the proposed organisation is intended to be permanent. However, **Fox** reiterated that such an organization might be required in order to make global traceability possible. **Johnson** indicated that there are viable alternative methods that do not require a special organisation. **Teillet** looked forward to the establishment of a small network of super test sites, fully instrumented and automated, somewhat similar to MOBY but on land, that could be used to calibrate sensors post-launch and establish the traceability of suitable measurands to SI through a laboratory like NIST.

The main topics of the discussion and its principal conclusions may be summarised as follows:

- (i) Whether or not to include a recommendation for establishing traceability to SI of high-level data products derived from EO measurements to CEOS Plenary. The conclusion was that in spite of its utility to users, establishing traceability for these products is not feasible at this time and the recommendation should be restricted to the traceability of fundamental measurements.
- (ii) Whether or not to recommend establishing an international organisation for the assessment of traceability of EO data to CEOS Plenary. It was concluded that the need for such an organisation was not yet clear, especially in view of the more restricted scope of (i), that it was therefore unlikely to be accepted by CEOS plenary and should not be put forward at this time.

### 7.3. Recommendations to Plenary (chaired by Alan Belward)

It was agreed that, rather than go through the draft document (“Improving the traceability to SI of the high level data products of Earth Observation measurements”) line by line, the main changes resulting from the discussions described in Section 7.2 would be agreed and that **Belward** would prepare a revised draft for circulation on the website. Participants would have just one week in which to register their comments and further suggestions since the report has to be presented to CEOS Plenary at the beginning of November.

Attention was focussed initially on the key recommendations in italics on page 4 of the draft document. **Rao** expressed the view that the recommendations appeared to be dictating to member organisations rather than advising them, especially in the case where the members are the agencies that carry out the calibrations. After consideration of a number of proposals, the following text was agreed for the first recommendation:

“ All Earth observation systems should be verified traceable to SI units for all appropriate measurands.”

The following alternatives were discussed for the second paragraph:

“Pre- and post-launch calibrations should be performed with equipment and techniques that can be demonstrably traceable to and consistent with the SI system of units.”

or

“Pre-launch calibrations 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 each mission.”

Attention then turned to the rest of the document.

**Overview:** minor amendments were agreed including the deletion of specific references to reflect the fact that the paper is being put forward to CEOS Plenary.

**Background:** it was agreed that this should be condensed.

**User demand:** the need for post-launch calibration should be stressed. Therefore Section 3.3 from Rao's paper headed "Post-launch calibration of satellite radiometers" should be incorporated into this section.

The section **Position of the Space Agencies** should be merged with **Current Best Practice**.

In view of the decision not to recommend setting up an organisation devoted to the assessment of traceability of EO data, the sections following the main recommendations need not be included.

**Belward** thanked the participants for their help in revising the text and NIST for providing the environment and expertise that had allowed the work to be taken forward so effectively.

#### 7.4. Review of TM subgroup recommendations

Since time allowed, there followed a review of recommendations from the Terrain Mapping subgroup reported in Section 10.3.

#### 7.5. IVOS Chair

**Barton** proposed **Kiran Kumar** as a possible new IVOS chair pointing out that he is from an agency with a strong programme and his appointment would demonstrate the global reach of WGCV leadership. **Belward** pointed out that it is up to the IVOS subgroup to select candidates for their chair; WGCV has a supporting role. **Barton** moved that a letter of invitation be sent to Kumar, **Rao** seconded and the motion was passed.

### 8. NEWSLETTER

Before the start of the session, **Belward** thanked **Saunders** for the hospitality of NIST and especially for entertaining WGCV members at his home the previous evening. He made a presentation on behalf of WGCV to the NIST support team, thanking them for their efficient administration of the domestic arrangements for the participants and secretarial support for the meeting.

Returning to the newsletter, **Belward** reminded the meeting that it had been touched on under Item 3.3, the review of actions from the 16<sup>th</sup> WGCV Plenary. There was a discussion of the relative merits of passive distribution on the web or active distribution through email and hard copy. **Hutchins** said that in the past all three had been used, including the distribution of some 200 copies on paper and that this could be accomplished for the next newsletter. It was decided that distribution would be mainly through publication on the website with more limited distribution by email and as hard copy.

**Hutchins** raised the matter of content. The newsletter typically consists of between 8 and 16 pages. There was agreement that there was abundant material of interest available for a newsletter of this size. The following were suggested for inclusion:

Terrain Mapping meeting report (already received)  
Hand over of the chair to Yves-Louis Desnos (**Secretariat**)  
LVP (**Morisette**, full page article in color)  
Traceability document (in preparation)  
Material already provided by Teillet

A deadline for receipt of material was set for 24-11-00.

**Hutchins** reported that because of changed responsibilities in about a month's time, he would no longer be able to continue as newsletter editor. **Belward** accepted with regret and proposed a vote of thanks to Hutchins for his excellent work as editor.

## 9. COUNTRY REPORTS

### 9.1. ESA.

The report has already been received and is published on the WGCV website. Attema mentioned in addition to the report, a PowerPoint presentation on the ESA website and suggested that a link be established from the WGCV website ([http://earth.esa.int/ers1\\_overview](http://earth.esa.int/ers1_overview)). He also mentioned upcoming ESA projects, in particular ENVISAT and CHRIS/PROBA and stated that WGCV members interested in investigation or collaboration would be welcome and should contact him. Finally, he drew attention to the vegetation hotspot described in the ESA report and said that collaborators to investigate this would also be welcome.

### 9.2. NOAA.

The report was circulated at the meeting and will be posted on the WGCV website.

### 9.3. Australia (Ian Barton)

A shortened version of the presentation is available on the WGCV website.

The presentation started with a description of the main cal/val test sites used by CSIRO in Australia and adjacent regions. The main site for sea surface height is at Burnie in the Bass Strait. It and others are equipped with acoustic height equipment and are surveyed from time to time with GPS; there are plans for permanent installation of GPS receivers. The Burnie site is close to the Topex/Poseidon cross-over and has other advantages with respect to satellite cross-overs. The expected total error for sea height measurement with the existing equipment is +/- 8mm.

Calibration for land surface temperatures is supported by 3 instrumented sites with in addition special campaigns. Special mention was made of the effect of view angle on the proportion of vegetation visible in the IFOV.

Sea surface temperature measurements are supported by deployment of radiometers and other equipment on 2 tourist ferries and one research vessel. The Townsville ferry has radiometer(s), logging equipment for bulk SST and is supported by a radiosonde at a nearby site. SST measurements include those derived from coral bleaching. The work based on these data includes the development of algorithms. The Peth ferry is equipped with radiometers and bulk SST equipment. Sky radiance measurements are available from an adjacent site and buoy deployment is under development. **Barton** showed comparisons of ATSR, radiometer and bulk temperatures derived from data collected here.

The research vessel at Hobart is used for radiometer comparison and for training, teaching and co-operation.

The radiometers are calibrated through black body sources either in-built or portable and these are themselves calibrated against laboratory standards. Examples of comparison of different black bodies was given with agreement to +/- 0.1 C. Intercomparison of radiometer measurements also showed good agreement after taking account of the correction required for sky radiance.

**Belward** asked about co-operation with other investigators for land temperatures and a brief description was supplied. **Privette** asked if the TASCOS radiometer is actively cooled. The response was no, but internal heating is controlled by fans.

## 10. SUMMARY

### 10.1. Summary

**Belward** in reviewing the work of the meeting said that much had been achieved, in particular in taking forward the adoption of the LPV subgroup and agreeing the form that the WGCV recommendation on traceability to Plenary should take. He was impressed by the technical presentations which showed the growing impact of calibration on the quality of EO data products.

### 10.2. Action Items

Following the practice at WGCV 16, open actions from that meeting have been included in the following action list. However, it was agreed that those relating to IVOS should be deferred until the appointment of a new IVOS chair and that those relating to education and outreach should be rolled up into a single action.

<b>WGCV-17 Actions</b>	
WGCV17-1	<b>Secretariat</b> to provide link from WGCV to forthcoming SAR workshop website at <a href="http://www.eorc.nasda.gov.jp/JERS-1/conference/CEOS-SAR/index.htm">www.eorc.nasda.gov.jp/JERS-1/conference/CEOS-SAR/index.htm</a>
WGCV17-2	<b>Shiue</b> to report back to WGCV Microwave Sensors subgroup on the proceedings of the 1 <sup>st</sup> International Radiometer Calibration Workshop, 30 to 31-10-00, University of Maryland, including a participants list.
WGCV17-3	<b>WGCV Members</b> to provide to Secretariat cal/val case studies for inclusion on the website (previously WGCV 16-8 to 16-16).
WGCV17-4	<b>Secretariat</b> to draft recommendations to Plenary seeking support for outreach activities.
WGCV17-5	<b>Dowman</b> to circulate WGCV report to colleagues at ISPRS
WGCV17-6	<b>Shiue</b> to rework mission statement of Microwave Sensors subgroup and send to Belward asap.
WGCV17-7	<b>Barton</b> to send letter of invitation to Kumar reference the vacant IVOS chair.
WGCV17-8	<b>Rao</b> to email copy of the NOAA report to Secretariat asap.
WGCV17-9	<b>Secretariat</b> to provide links from WGCV website to those of subgroups.
WGCV17-10	<b>Desnos</b> to request WGISS to provide task team for POL-INSAR data formatting
WGCV17-11	<b>Privette</b> to advise SAR subgroup chair of the location and characteristics of test sites suitable for POL-INSAR calibration and validation

WGCV17-12
<b>Secretariat</b> to forward to Hutchins TM subgroup report by 24-11-00
WGCV17-13
<b>Secretariat</b> to forward to Hutchins report of hand over of WGCV to Yves-Louis Desnos and traceability document by 24-11-00
WGCV17-14
<b>Morisette</b> to forward full page article in colour to Hutchins by 24-11-00.
WGCV17-15
<b>Secretariat</b> to advise Belward of the number of hits on WGCV website.

### 10.3. Recommendations and Reporting to Plenary

**Belward** said that a draft of the report will be prepared by 30-10-00 and posted on the website shortly thereafter for comment. The report will contain recommendations and the meeting led by Belward then went on to consider what these should be and their form. The recommendations for taking forward to Plenary are available in the WGCV17 report on the WGCV website.

(i) Establishment of a database of co-ordinated control points for validating DEMs (TM Subgroup).

**Attema** said that the agencies might send this recommendation back to the TM subgroup for action. **Belward**, noting the mood of the meeting, said that it should not be taken forward to Plenary in its present form. **Hastings** noted that it could perhaps be included in other database recommendations.

(ii) Standardisation of sensor parameters by setting up a task force with ISPRS (TM Subgroup)

**Hastings** pointed out that implementation of the recommendation would not represent very much work for the agencies but **Belward** said that in its present form, it might result in no action. **Privette** stressed that the objective was very worthwhile. **Belward** agreed but some tightening of the text was required before submission. The wording was modified to imply the recommendation of the setting up of the task force under ISPRS leadership.

(iii) Ca/val data to be provided for all sensors including those operated by the private sector.

**Attema** said the recommendation was unlikely to be accepted as it stands. **Belward** concurred but emphasised that it contained a message that was important to communicate to Plenary although perhaps not in the form of a recommendation. After further discussion it was agreed to take the resolution forward stressing the compromising effect of the lack of calibration data for scientific work and possible legal consequences and recasting the action requested from the agencies.

(iv) Use of standard radar cross-section models to assess performance of future systems (SAR Subgroup)

It was agreed to take the recommendation forward.

(v) Recommend that CEOS agencies register their man-made targets for SAR calibration with the cal/val dossier and that these targets are made available to CEOS Plenary members and that the agencies encourage a comparison of the targets' performance (SAR Subgroup).

(vi) Historical archives of spaceborne SAR data should be opened to the scientific community at the cost of reproduction (SAR Subgroup).

There was discussion of whether the word opened was correct. It was agreed to take the recommendation forward.

(vii) Support for the cal/val dossier (WGCV Plenary)

The following form of words was agreed. Recognising the benefits of a common database documenting test sites, instruments and laboratories to the work of all subgroups, WGCV recommends that support for the maintenance and development of the cal/val dossier be continued and that all CEOS agencies provide a link to the CEOS dossier either directly or via a link to the CEOS website.

(viii) Support for WGCV outreach functions (WGCV Plenary)

There was agreement that in view of the work involved, a recommendation be put to Plenary for support for WGCV outreach functions. The case would be strengthened if supported by evidence of the level of use of the existing website. An action was placed on the secretariat to find out the number of hits on the website over the last few months.

(ix) Taking forward LPV recommendations to Plenary.

**Belward** suggested that these might not yet be specific enough to be taken forward. In many cases they require co-ordinated effort from several WGCV subgroups, for example a specific list of test sites needs to be drawn up. **Privette** agreed that this was the case and it was decided not to take these recommendations forward pending them being made more specific.

(x) Support for the Second International Calibration and Intercomparison Workshop (WGCV Plenary)

The funding is required for workshop infrastructure – the setting up of equipment in laboratories – and for access to a ship for deploying instruments. The recommendation was supported by a detailed costing and the meeting agreed to take it forward to Plenary.

## 11. DATE AND PLACE OF NEXT MEETING

**Desnos** offered ESRIN at Frascati as a possible venue that could also accommodate subgroup meetings. June-September was suggested as a suitable time slot. The view was expressed that July-September, while suitable in some respects clashed with the launch of ENVISAT and AQUA and an earlier date would be more suitable. **Rao** suggested a possible beneficial link with a climate conference in June-July. **Teillet** mentioned conflicts in June and July while IGARSS is being held in July in Australia.

It was agreed to hold the meeting at ESRIN, Frascati in late May/early June, subject to confirmation.

**Teillet** indicated that CCRS would be prepared to act as host 2 to 3 meetings hence.

## 12. FORMAL HANDING OVER OF CHAIR TO ESA.

**Alan Belward** formally handed over the chair to **Yves-Louis Desnos**. The meeting congratulated Desnos on his appointment. **Belward** expressed his personal thanks and that of all the participants to NOAA and NIST for hosting the meeting and looked forward to the next one. **Saunders** responded by expressing his appreciation of the sentiments and an invitation to the participants to attend a number of related meetings scheduled for the future at NIST.

The meeting was closed at 11-15am.

## APPENDIX A. AGENDA

**Wednesday, 25<sup>th</sup> October 2000 1000 hrs onwards**

Lecture Room A, Admin Building 101

1. Welcome from the official WGCV 17 hosts
  - 1.1. Dr. Katharine Gebbie, Director of the Physics Laboratory National Institute of Standards and Technology
  - 1.2. Dr. James Purdom, Director, NOAA/NESDIS Office of Research and Applications National Oceanic and Atmospheric Administration
2. WGCV Chair's report (Alan Belward)
  - 2.1. Preparations for the 14<sup>th</sup> Plenary
  - 2.2. IGOS update and status report
  - 2.3. Action items from WGCV 16
3. Reports from Subgroups (including proposed sub group on land product validation)
  - 3.1. SAR Calibration (Yves-Louis Desnos)
  - 3.2. Microwave Sensors (Elena Lobl)
  - 3.3. Infrared and Visible Optical Sensors (Christopher Mutlow)
  - 3.4. Terrain Mapping (Ian Dowman)
  - 3.5. Land Product Validation (Jeffrey Privette)
4. Report from WGISS: activities and services (Alan Belward)
5. WGCV Action Plan Review Issue 2.3
  - 5.1. Activity 1 - WGCV Plenary
  - 5.2. Activity 2 - WGCV Subgroups meetings and technical work
  - 5.3. Activity 3 - Communication with the Community
  - 5.4. Activity 4 - CEOS Communication
  - 5.5. Activity 5 - Test Site Dossier
  - 5.6. Activity 6 - Education and Outreach
  - 5.7. Activity 7 - Validation Pilot Projects
  - 5.8. Activity 8 - Subgroup missions, objectives and action plans

**Thursday 26<sup>th</sup> October 2000**

*Lecture Room A; Admin Building 101*

6. Special session on calibration activities at NIST and NOAA
  - 6.1. Welcome. Dr. Albert Parr, Chief Optical Technology Division
  - 6.2. Overview of calibration activities at the NOAA/NESDIS Office of Research Applications (Mike Weinreb)
  - 6.3. NOAA site survey for vicarious calibration, and inter-sensor calibration. (Nagaraja Rao)
  - 6.4. The SeaWiFS Program (Bob Barnes and Chuck McClain)
  - 6.5. An overview of the EOS Program at NIST (Carol Johnson)
  - 6.6. EPIC (Ted Early)
  
7. Special Session: Traceability
  - 7.1. Improving the traceability to SI of the high level data products of Earth Observation measurements: Presentation of the draft report (Bob Saunders & Nigel Fox)
    - 7.1.1. User demand
    - 7.1.2. Current best practice
    - 7.1.3. Traceability to SI and the Mutual Recognition Arrangement (MRA)
    - 7.1.4. Improving traceability for primary EO quantities on a global scale
    - 7.1.5. International Organisation for the Assessment of Traceability of Earth Observation Data (IOATEOD).
    - 7.1.6. Practicalities and Resource implication
  - 7.2. Response from the CEOS Members (Round-table discussion: the views of all CEOS Members represented in WGCV are welcomed and expected)
  - 7.3. Discussion of possible elements of a strategy: Recommendations to Plenary.
  
8. Dinner hosted by NIST

**Friday 27<sup>th</sup> October 2000**

*Lecture Room A; Admin Building 101*

9. Newsletter
10. Country Reports
11. Summary
  - 11.1. Summary
  - 11.2. Review of action items
  - 11.3. Recommendations and reporting to Plenary
12. Date and place of next meeting
13. Hand over of Chair of WGCV to ESA
14. Close of meeting

**APPENDIX B PARTICIPANTS LIST WGCV-17****17th WGCV Plenary Meeting: Participants List**

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