COMMITTEE ON EARTH OBSERVATION SATELLITES

1st Joint Meeting of the CEOS
Working Group on Information Services and Systems (WGISS)
and
Working Group on Calibration & Validation (WGCV)

MINUTES OF THE 23th WGCV MEETING

WGCV-23

March 7-11, 2005

Hosted by:

Comisión Nacional de Actividades Espaciales / CONAE

Teofilo Tabanera Space Center

Falda del Carmen, Province of Córdoba

Argentina

Contents

Acronyms

AATSR	Advanced Along Track Scanning Radiometer
AMSU	Advanced Microwave Sounding Unit
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR	Advanced Very High Resolution Radiometer
BNSC	British National Space Centre
Cal/Val	Calibration / Validation
CAS	Chinese Academy of Science
CBERS	China Brazil Earth Resources Satellite
CCRS	Canada Centre for Remote Sensing
CEOP	Coordinated Enhanced Observing Period
CEOS	Committee on Earth Observation Satellites
CGMS	Coordinating Group for Measuring Satellites
CHRIS/PROBA	Compact High-Resolution Imaging Spectrometer / Project for On-Board Autonomy
CONAE	Comision Nacional de Actividades Espaciales
COSPAR	Committee on Space Research
CRT	CEOS Review Team
CSA	Canadian Space Agency
CSSAR	Center for Space Science and Applied Research
DEM	Digital Elevation Model
DGVM	Digital Global Vegetation Models
DN	Data Number
EDC	Earth Resource Observing Systems (EROS) Data Center
ENVI	ENvironment for Visualizing Images
Envisat	Environmental Satellite
EOS	Earth Observing Satellite
ERS	Earth Resources Satellite
ESA	European Space Agency
ESRIN	European Space Research Institute
ESSAC	Earth Systems Science Advisory Committee
ESSP	Earth System Science Pathfinder
ESTEC	European Space Research and Technology Centre
FAO	U.N. Food and Agriculture Organisation
FAPAR	Fraction of Absorbed Photosynthetically Active Radiation
GCM	Global Circulation Models
GCMD	Global Change Master Directory
GCOS	Global Climate Observing Systems
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GHz	Gigahertz
GIFTSS	Government Information From The Space Sector
GMES	Global Monitoring for Environment and Security
GOFC	Global Observation of Forest Cover
GOFC/GOLD	Global Observation of Landcover Dynamics
GOME	Global Ozone Monitoring Experiment
GTOS	Global Terrestrial Observing System
HIRS	High Resolution Infrared Radiation Sounder
IGOS	Integrated Global Observing Strategy
IGOL	IGOS Land Theme
ISPRS	International Society for Photogrammetry and Remote Sensing
IPO	Integrated Program Office
ISSMAP	*In situ* Sensor Measurement Assimilation Programme
IVOS	Infrared and Visible Optical Sensors
JAXA	Japan Aerospace Exploration Agency
JERS	Japanese Earth Resources Satellite
LAI	Leaf Area Index

LCCS	Land Cover Classification System
LPV	Land Product Validation
MOBY	Marine OPtical BouY
MERIS	Medium Resolution Imaging Spectrometer
MHz	Megahertz
MODIS	MOderate-Resolution Imaging Spectro-radiometer
NASA	National Aeronautics and Space Administration, USA
NDVI	Normalized Difference Vegetative Index
NESDIS	National Environmental Satellite, Data, and Information Service
NIST	National Institute of Standards and Technology, USA
NOAA	National Oceanic and Atmospheric Administration, USA
NPL	National Physical Laboratory, UK
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NWP	Numerical Weather Prediction
OCG	Observations Coordination Group
PILPS	Programme Intercomparing Land Process Schemes
RADARSAT	Radar Satellite
ROLO	RObotic Lunar Observatory
SAR	Synthetic Aperture Radar
SIRCUS	Spectral Irradiance and Radiance responsivity Calibrations using Uniform Sources
SIT	Strategic Implementation Team
SNO	Simultaneous Nadir Observations
SPOT	Systeme Probatoire pour l'Oberservation de la Terre
SRTM	Shuttle Radar Topography Mission
TGARS	Transactions on Geoscience and Remote Sensing
TIFRI	Technology Innovations for Radiometer Instruments
TM	Terrain Mapping
TOPC	Terrestrial Observation Panel for Climate
UK	United Kingdom
UNEP	United Nations Environment Programme
USGS	United States Geological Survey
WGCV	Working Group on Calibration and Validation
WGEdu	Working Group on Training and Education
WGISS	Working Group on Information Systems and Services
WMO	World Meteorological Organisation
WTF	WGCV / WGISS Test Facility

1 Welcome from the official WGCV-23 hosts (*Laura Frulla on behalf of Dr. Conrado Varotto*)

Laura Frulla welcomed the WGCV-23 delegates on behalf of Dr. Varotto, Comisión Nacional de Actividades Espaciales (CONAE) principal representative to CEOS. She stressed the importance of the calibration and validation activities in maintaining the accuracy of satellite data products. She hoped that all present would enjoy their stay in Argentina and have a successful meeting.

Stephen Ungar thanked **L. Frulla** for her warm welcome. He also expressed his thanks to **Anna Medico** and the **CONAE staff** for their efforts in organizing the meeting.

1.1 Introduction (*Stephen Ungar*):

- Introduction of new members and participants, discussion of logistics, and reflection on the Calibration and Validation field effort, preceding the meeting.
- Recognising the appointment the new chair of the SAR subgroup – Satish Strivastava (CSA, Canada).

1.2 **Role of CONAE in Earth Observing from Space** (*Juan Bratina, Argentina Country Report*).

Juan Bratina presented the CONAE Report reviewing the calibration and validation activities for SAC-C. Intercomparison of SAC-C data with simultaneous EO-1, Landsat-7, and Terra observations was explored. The results of several field campaigns conducted jointly with NASA scientists over the past 3 years were presented.

The significant influence of CEOS, preceding CONAE by about 20 years, on the Argentinean space program was emphasized.

While, in 2003-2004 the idea for global integrated systems was strongly supported by all countries. At the present, there is a need to consider possibilities and decide on the methods for participation of CEOS/WGCV in the Global Earth Observation System of Systems (GEOSS). While CEOS as organization is a member of GEOSS, the role of CEOS and its working groups needed to be defined at this meeting.

2 Approval of the Agenda

The agenda (Annex A) was approved as presented.

3 WGCV Chair's Report (*Stephen Ungar*)

Stephen Ungar presented the WGCV chair's report and updates. The chair report included short introduction and background on WGCV since its establishment in 1984. The following achievements for 2004 were reported: 1) WGCV Plenary 22nd hosted by USGS in Sioux Falls – June 2004; 2) Finalized plans for joint WGISS/WGCV meeting in Cordoba; 3)Inaugurated preparations for International field campaign; 4) Progress on priority actions defined in CEOS 5 years plan for implementation in to the WGCV work plan: a) Liaison with WGISS: augmentation of Cal/Val Test Facility phase 1; b) Liaison with ISPRS: evaluation of joint Workshop on Geometric and Radiometric

Standards. The report focused on the current WGCV priority actions & activities, as follows: 1) The WGCV will support calibration and validation activities relating to the IGOS themes, particularly through the focused work of the WGCV subgroups; 2) The WGCV will actively co-operate with the ISPRS in the definition of radiometric and geometric standards; 3) The WGCV will encourage traceability to international standards; 4) The WGCV will propose joint calibration and validation campaigns to CEOS Members and will seek CEOS support for these campaigns; 5) The WGCV will cooperate with other CEOS Working Groups to focus efforts and to ensure the best use of resources.

- The need for WGCV actions relating to GEOSS, and in cooperation with ISPRS was given highest priority. Plenary is requested that this workshop develops recommendations to enable CEOS, and its working groups, to actively participate in GEOSS.

Funding issues and questions were discussed. The CEOS WGCV website was reported to have been re-hosted and is currently 508 Compliant and populated.

CEOS WGCV Subgroups Chairs (update):

- Synthetic Aperture Radar (SAR) – **appointment of new** Chair Dr. Satish Strivastava, CSA, Canada (2005 - current); previous Chair Dr. M. Shimada, JAXA.
- Infrared Visible Optical Sensors (IVOS) - Chair Dr M.Rast, ESA;
- Microwave Sensors - Chair Dr M. Martin-Neira, ESA (absent);
- Terrain Mapping (TM) - Chair Prof. J. Peter Muller, UCL;
- Land Product Validation (LPV) - Chair Dr J. Morissette, NASA;
- Atmospheric Chemistry (ACSG) - Chair Dr E.Hilsenrath, NASA.

Minutes from WGCV-22 were reviewed, approved and adopted as presented.

The latest CEOS Newsletter, No. 24, was distributed to the members.

The group suggested issuing of a certificate to Stuart Frye for his efficient service and in recognition of his contribution to furthering WGCV goals.

Status of Action Items from WGCV-22

WGCV19-5	**Martin-Neira / Hilsenrath** to identify existing education material and channel this to WGEdu through secretariat. OPEN	**Dec 2004**
WGCV20-8	**Martin-Neira** to re-work the Microwave Sensors subgroup recommendations and report back to WGCV-21. CLOSED Instead item WGCS23-10 was opened.	**WGCV-23**
WGCV20-13	**Muller** to provide the Secretariat with a copy of, or a link to, the best practise dossier for the WGCV website. CLOSED	**WGCV-23**
WGCV20-18	**Hilsenrath** to ask the NGST (system contractor for NPOESS) to be represented on the joint ISPRS / WGCV taskforce. CLOSED Replaced by items WGCV23-1 and WGCV23-2 were opened.	**Aug 2004**
WGCV21-10	**SAR subgroup** to document analysis over the Amazon using SAR data, in particular noting any differences at C-band HH polarisation (examples from Radarsat and Envisat). CLOSED	**WGCV-23**

WGCV21-13	**Liu & Morisette** to explore the possible incorporation of Chinese FY-1 (and maybe FY-2), CBERS-1 and CBERS-2 data into the WTF within the 2005 phase of WTF. OPEN	**Dec 2004**
WGCV21-14	**Morisette, Dwyer & Rast** to work on getting MERIS data available within the WTF. CLOSED	**WGCV-23**
WGCV21-15	**Morisette & Dwyer** to explore the feasibility of getting MODIS swath data available within the WTF. CLOSED	**WGCV-23**
WGCV21-16	**Morisette, Dwyer, Gesch & Muller** to work on getting SRTM data available within the WTF. CLOSED	**WGCV-23**
WGCV21-17	**Morisette, Dwyer & Shimada** to explore the feasibility of getting SAR data available within the WTF. CLOSED	**WGCV-23**
WGCV22-1	**Ungar** to request **WGCV members** to review the GEO terms of reference and scrutinise the cal/val aspects. CLOSED	**Aug 2004**
WGCV22-2	**Rast** to clarify the status of validation for Envisat derived terrain data. CLOSED	**WGCV-23**
WGCV22-3	**Ungar** to word a funding action item. CLOSED	**WGCV-23**
WGCV22-4	**Belward,** as official WGCV representative, to coordinate with GCOS an international validation activity for global albedo, fAPAR, and LAI products with the objective of providing recommendations for deriving products that meet the Global Climate Observing System requirements. CLOSED As a follow up opened WGCV23-4.	**WGCV-23**
WGCV22-5	**Belward** to coordinate an interaction between the WGCV and the Programme Intercomparing Land Process Schemes (PILPS) to ensure that the climate modelling community are able to access the most appropriate albedo product for each model. CLOSED As a follow up opened WGCV23-4.	**WGCV-23**
WGCV22-6	**Frye** to forward GEO Plan to members for comment back to WGCV Chair. CLOSED	**July 2004**
WGCV22-7	**Hilsenrath/Rast** to solicit and decide where best to provide representation from the atmospheric sounder community in WGCV (IVOS or ACSG). OPEN	**WGCV-23**
WGCV22-8	**Zanoni** will work with **Morisette** to figure out how to get the Quikbird and IKONOS data for cal/val of WTF sites purchase going. CLOSED Replaced by WGCV 23-5.	**WGCV-23**

4 Reports from Subgroups

4.1 Atmospheric Chemistry (*Ernest Hilsenrath*)

Ernest Hilsenrath, the ACSG chairman, reviewed the goals and objectives of the subgroup and summarized its most recent activities. He noted that 19 instruments on 10 missions measuring atmospheric chemistry will be in orbit by 2015. Nearly all the space agencies and science institutions

involved in atmospheric chemistry observations from space are members of the ACSG. The fourth subgroup meeting since its creation in May 2002 was held in Frascati Italy in May 2004.

ACSG projects approved and action items closed include establishing agreements between Aura and Envisat validation data centers to share validation data. Establishing support for Dobson ground station intercomparisons, reopening of the Canadian Eureka ground station and developing a forum for collaboration of validation activities between METOP and NPOESS. Other ACSG activities include participation in Envisat validation workshops and coordinating the Aura validation program. Hilsenrath noted the strong links between between IGOS IGACO Theme (atmospheric chemistry). Hilsenrath also reviewed the Envisat validation program which is coming to an end, and Aura validation program, which is just starting up. There are plans to coordinate validation activities where they overlap. At a minimum, validation data will be shared between the respective data centers. Hilsenrath then described the Aura Validation Center capabilities which could grow to include the international A-Train. The concept of a uniform validation data formats among Earth science disciplines was proposed with the idea to involve WGISS which was meeting jointly with WGCV. This did not happen since there was intense pre occupation with the role of CEOS in the GEOSS framework.

Hilsenrath reviewed six action items for ACSG. Five are ongoing with one needing resolution. The open action item is to consider including aerosols, met soundings and CO2 in ACSG.

Three recommendations were proposed to WGCV. 1) Establish uniform data protocols for Earth science validation data using the Envisat and Aura approaches. 2) Consider the role of CEOS Cal/Val in the upcoming US and Eumetsat operational systems. 3) Consider the role of CEOS Cal/Val in context of IGOS, GEOSS, and GMES.

4.2 Infrared and Visible Optical Sensors (*Michael Rast*)

Michael Rast reported on IVOS Status and the IVOS Workshop on *Inter-Comparison of large Scale Optical and Infrared Sensors*, conducted at ESA-ESTEC, Noordwijk, The Nederlands, October 12-14, 2004.

The IVOS Workshop main topics/contributions include: 1) operational in-flight calibration, including MODIS, MISR, MERIS, Sciamachy, Landsat, EO-1, CERES, GERB, GLI; 2) vicarious calibration using instrumented and/or stable targets; 3) diagnostic for cross-calibration/inter-comparison; 4) traceability of radiometric and spectral measurements (NIST, NPL); 5) intercomparison of geophysical products (albedo, atmospheric constituents). One of the topics at the Workshop was the initiation of a large-scale sensor intercomparison campaign for the 2005/2006 timeframe. Such campaign should focus on the intercomparison of satellite sensor outputs and instruments used for *in-situ* characterisation over a limited set of vicarious targets. This would provide the first step towards ensuring validity and consistency of measurements and resulting data products from different sensors and thus reduce uncertainties in continuous and global satellite monitoring. The participation of CEOS partners in this campaign and specifically the support for the subsequent data analysis is encouraged.

The IVOS recommendations include: To establish reference datasets, in support the understanding of climate change and quality assure operational services by E.O. satellites, IVOS recommends to initiate the following activities: 1) Document a reference methodology to predict TOA radiance for which currently flying and planned wide swath sensors can be inter-compared, i.e., define a standard for traceability; 2) Create and maintain a fully accessible web page containing, on an instrument basis, links to all instrument characteristics needed for inter-comparisons as specified above, ideally in a common format; 3) Create and maintain a database (e.g.: SADE) of instrument data and site characteristics for specific vicarious calibration sites in a common format delivered by agencies responsible for their instruments. This activity should be supported for an implementation period of 2 years and a maintenance period over 2 subsequent years. An amount of 500 K-euro/$ is estimated to be

required for this activity. Agencies are asked to support this activity by providing appropriate information and data in a timely manner.

Related Action Items include: 1) Create and distribute an *orbit propagator* tool for large scale optical sensor inter-comparison planning purposes (ESA); 2) Specify data format to be used for a database for sensor inter-comparison purposes such as SADE (ESA/CNES); 3) Contact instrument teams to and request that they provide instrument descriptions and inter-comparison data in a common format (IVOS to establish white paper containing rationale, benefit and intended use); 4) Encourage the use of diagnostic sites as established by international cal/val teams (IVOS in cooperation with WTF).

The proposed at the WGCV22 sensor inter-comparison campaign (Large-scale Optical Sensor Inter-comparison -LOSI) was not recommended for the 2005/6 timeframe. IVOS is planning a potential field experiment for 2006/2007, based on the field campaign in March 2005 in Argentina, with the goals of: 1) Bringing international teams together to develop best practice and agreed protocol for future vicarious calibration activities and evaluating the potential of this technique as a means of improving calibration and validation; 2) Comparing all field radiometers against the same source before the field experiment; 3) Comparing radiative transfer models in the context of the experiment.

The Atmospheric Chemistry Subgroup and the IVOS will coordinate a resolution concerning the treatment of sounders relative to the WGCV. The IVOS is not currently considering sounders within the infrared/visible sensor category, these should, however, be covered within the WGCV subgroups.

4.3 Land Product Validation (*Jeffrey Morisette*)

Jeff Morisette gave the report from the LPV subgroup. The working definition of LPV for **validation is:** the process of assessing by independent means the quality of the data products derived from the system outputs, considering user accuracy needs and feedback to algorithm improvements.

LPV goals: 1) Foster quantitative validation of global land cover products derived from remote sensing data and relay results so they are relevant to users; 2) Increase the quality and economy of global satellite product validation *via* developing and promoting international standards and protocols for field sampling, scaling, error budgeting, data exchange for global land product validation; 3) Advocate mission-long validation and intercomparison programs for current and future earth observing satellites.

LPV objectives: 1) Work with users to define uncertainty objectives; 2) Identify opportunities for coordination and collaboration through product Inter-comparisons and global test sites for systematic measurements; 3) Develop consensus "best practice" protocols for data collection and description through workshops, case studies and publications *(with CEOS WGCV "endorsement*"); 4) To develop procedures for validation, data exchange and management - with a focus on land product validation core sites (done in conjunction with WGISS); 5) To serve as a clearinghouse for accuracy statements on CEOS member global land products (*possibly through the CEOS/WMO database*).

Reports from LPV workshops:
Leaf area index: The LAI workshop occurred on 16 August 2004, University of Montana, Missoula, USA. Established was an agreement for data sharing and a paper was submitted to the special issue (on-line at http://eospso.gsfc.nasa.gov/eos_observ/pdf/Sept-Oct04.pdf).

Fire and logging disturbance in Brazil: The workshop was conducted as a part of the Large scale study of the Biosphere and atmosphere in Amazonia (LBA), 26 July 2004, Brasilia (available on-line at http://eospso.gsfc.nasa.gov/eos_observ/9_10_01/Sept_Oct01.pdf).

Land cover harmonization: GOFC-GOLD/FAO Workshop on Harmonization of Global Land Cover Product occurred 15-16 July 2004, FAO in Rome, Italy. A manuscript on this issue has been submitted to the special issue (Morisette, Privette, Strahler, Mayaux, Justice, 2004, "Validation of Global Land-

Cover Products by the committee on Earth Observing Satellites", Geospatial Data Accuracy Assessment, Lunetta and Lyon eds.).

Ongoing LPV activities

NASA funding for LPV activities: Three years of support (2004-2006) for LPV workshops, web infrastructure, collection of data for "Core Sites" and a post-doc research position (Sebastien Garrigue).

Web site update: Last updated on February 22, 2005. Matches CEOS and WGCV page layout and graphics, can be found at http:landval.gsfc.nasa.gov/LPVS

CEOS Core Sites (with WGISS):

Special Issue of IEEE Transactions on Geoscience and Remote Sensing: in progress (due March 2006). Over 20 papers have been submitted, covering land cover, burned area, biosphysical (VI, LAI, fAPAR, GPP). Several members from the user community have agreed to write a note for each section on the implication for the uncertainty/validation of the products (land cover, fire/burn). Still is needed an article on biosphysical parameters.

LPV future chair: it have been decided that the new LPV chair will be Fred Barret.

Together with GOFC/GOLD, LPV supports the technical feasibility and research utility of an integrated, global high temporal resolution fire monitoring system from geostationary platforms. Such a system will be achieved if products from different geostationary platforms can be combined in a relatively seamless fashion. Coordination on validation activities would results in cost sharing and ensure consistency of methods, so the LPV recommends that the validation of system components should be coordinated through the Land Product Validation (LPV) subgroup. GLC2000 and MODIS land cover should be integrated into the CEOS Land Validation Core Sites and the core sites should be coordinated with the GOFC/GOLD land cover reference data "clearinghouse". Using this infrastructure, the LPV will lead an intercomparison of year 2000 MODIS data and GLC2000.

LPV recommendations: 1) Continue with "recommendation 3" on the convergence to LCCS, perhaps explicitly listing some of the steps documented in the GOFC/GOLD/LPV harmonization of land cover. 2) CEOS WGCV develop a plan to share background information and data acquisition and access for new satellite data (CHRIS/PROBA, CBERES-2, Disaster Monitoring Constellation) – related to WTF. 3) CEOS members should continue to provide mechanism for field-data sharing (example: the NASA-sponsored MERCURY system).

LPV concluding remarks: Defining user accuracy requirements remains a challenge, because there are no established standards on how to relay product accuracy to users. LPV covers many satellite and many land products. Membership is not well defined, LPV could benefit from a call from membership from CEOS. Multi-sensor products offer great potential. The associated algorithms will require an understanding of the accuracy of each sensor's input. Perhaps WGCV has not been consistent among subgroups ("land"/ "atmosphere" or "biophysical"/"atmospheric chemistry").

- Strong interest was expressed in Chris/Proba, CBRES2 and the Disaster monitoring constellation. WGCV23-8 new action item was generated: Rast and Dong to arrange a presentations for the next meeting.
- It is proposed that LPV provide a validation service to GEOSS. The implications of that are to be considered.

4.4 Microwave Sensors (*Manuel Martin-Neira* - not present)

New action item was generated for Ungar to find the status of the MSG (see WGCV23-10).

4.5 Terrain Mapping (*Jan-Peter Muller*)

Peter Muller presented the Terrain Mapping Subgroup (TMSG) report. **Prof. Muller** reported that the next workshop on "SRTM validation and applications" would take place at the USGS National Mapping Center, Reston, Virginia from 14-16 June 2005. For more details, please visit http://edc.usgs.gov/conferences/SRTM/index.html.
It was agreed by the plenary that Dr Steve Ungar, Chair-WGCV, could act on behalf of the WGCV (subject to any guidance received from CEOS management) to sign a MoU with NGA which NGA required for co-sponsorship of a meeting with any non-US agencies. In addition to this SRTM workshop, Muller also reported that a special issue of the ASPRS "Photogrammetric Engineering and Remote Sensing" journal was due for publication in Feb06 (6 years after the mission date) with a closing date for call for papers of 30/6/05. This was to be edited by Dean Gesch (USGS-EDC), Tom Farr (JPL) and Muller.

Muller reported on the current status of spaceborne DEM production, distribution and validation. This included a report on ASTER, ERS, ICESAT-GLAS and SPOT-5. Muller raised the issue that a new version of the ACE-GDEM fused with GTOPO30 and SRTM30 had been generated at ESA and requested that the TMSG be given access either to information on its validation or to perform validation themselves to ensure that no spaceborne DEM was employed for systematic data processing which had not been subject to peer review. Michael Rast (ESA) agreed to let Muller know what the status of this merged DEM was with regard to validation and availability. Muller reported that there was great confusion with at least four different SRTM products made available through different mechanisms.

Muller reported on the significant progress that has been made with the addition of DEM information on some of the CEOS-WTF core test sites (Puget Sound - TMSG special site, Harvard forest, Railroad valley) and requested that NLCD for the US core sites be added in future, especially for sites for significant topography for aid in interpreting differences between "bare earth" and spaceborne DEMs.

Recommendations:
The TMSG recommended that space agencies be requested to provide any internal quality metrics or external validation information with a web-link on each of these different distribution mechanisms to this information together with a moderated "Known Issues" page in a similar fashion to the one produced by MODIS at
http://landweb.nascom.nasa.gov/cgi-bin/QA_WWW/newPage.cgi?fileName=terra_issues.

The TMSG also recommended that subsidiary products (such as orthorectified SAR amplitude mosaics and water body masks for SRTM) be made available, if possible as OGC-compliant data layers (WMS/WCS/WFS formats) for use in understanding and interpreting the data.

4.6 SAR (*Satish Srivastava*)

The SAR subgroup Chair, Dr. Satish Srivastava, presented the subgroup mission and objectives.

Mission: to foster high-quality synthetic aperture radar imagery from airborne and space borne SAR systems through precision calibration in radiometry, phase, and geometry, and validation of high level products.

Objectives: 1) Act as a forum for international technical interchange on the evolving methodologies, techniques, and equipment of SAR calibration and validation; 2) To determine standard definitions and calibration-validation requirements for synthetics aperture radar imaging systems; 3) To support

changes in CEOS formats and user products as appropriate; 4) To facilitate international cooperative programs in the calibration and validation of SAR systems; and 5) To educate the SAR community.

The 12th CEOS SAR Annual Workshop/Meeting was coordinated by ESA and conducted on May 27-28, 2004 in Ulm, Germany. The meeting coincided in part with EUSAR 2004 conference and had eighty participants and six presentation sessions (Geometry and Radiometry, Oceans and Atmosphere, Calibration Methodology, Polarimetry and Interferrometry, Instrumentation Calibration Concepts, Land). The meeting produced a set of recommendations.

The CEOS SAR subgroup made the following recommendations:

1) Recommendations addressing the establishment of new calibration and validation sites:

- The SAR Subgroup should set up International Calibration sites with man-made targets. There is an ongoing discussion and funding is an issue. The idea of joint ESA-CSA Transponder Sites in Canada is currently being considered.
- Tentatively agreed an international site within the Amazon Rainforest with coordinates of (UL: -5.03, -65.67 - LR -9.12, -69.64 deg). This natural site should be used as one of the radiometric calibration standards and it should be regularly monitored. The Amazon stability dataset (gamma, sigma-zero, incidence angle, polarization) should be uploaded at CEOS WGCV website.

2) Recommendations to Space Agencies:

- To make their best efforts to generate high quality SAR products, considering that the achievable geometric accuracy is the order of 25 m or less, and radiometric accuracy is significantly less than 1.0 dB.
- To consider generation of more user friendly SAR products, for example to add image quality information (i.e., ambiguity, saturation, shadow) to the current SAR products.
- To continue to improve the quality of single and full polarization SAR data by technical exchange of information on the development of SAR calibration and imaging techniques and algorithms. This is being conducted through several international technical conferences and CEOS SAR Workshops.
- To produce Single Look Complex (SLC) product for preserving phase information for Pol-In-SAR data.

The SAR subgroup Chair announced that the next or 13th CEOS SAR Workshop will be held in Adelaide, Australia, September 28-30, 2005 and will be conducted as a *"Joint Workshop: CEOS/SAR & Advanced Imaging Radar Technology Workshop 2005"*. The workshop will be coordinated by the Centre of Expertise in Microwave Radar (CoEMR), University of Adelaide and it will provide an open forum for the presentation and discussion of current and future issues related to the calibration and validation of SAR imagery. Two advanced SAR courses are also planned. Visit http://www.plevin.com.au/CEOS_SAR2005/.

5 Country / Agency reports

5.1 Canada *(Peter White and Satish Srivastava)*

Peter White and Satich Srivastava presented some of the activities being pursued by or in conjunction with Natural Resources Canada, related to calibration and validation.

In this report we talk on some activities being pursued by or in conjunction with the Canada Center for Remote Sensing and with the Canadian Space Agency, related to Earth Observation missions with a

focus calibration and validation. Past reports covering previous material are not be reviewed in this report.

PRESENT ACTIVITIES

5.1.1 1-km Resolution Products, LAI and Clumping Index (Canada-wide, NRCan Contacts: Wenjun Chen & Richard Fernandes): In support of climate, weather, and ecological studies, Canada-wide LAI maps are routinely derived using Advanced Very High-Resolution Radiometer (AVHRR) imagery every 10 days at 1-km resolution. Similar maps are now being produced using the SPOT VEGETATION sensor. The process of calibration – validation – calibration continues with field measurements being performed at various sites across Canada (in deciduous, conifer, mixed forests, and cropland), and using Landsat TM scenes to facilitate spatial scaling to 1-km pixels. Accuracy assessment and validation continues with new site activity each year. Influences, such as terrain and BRDF continue to be evaluated.

Clumping (Canada-wide, NRCan Contacts: Sylvain Leblanc & H. Peter White): In addition to LAI, vegetation canopy heterogeneity provides complementary information. Using radiative transfer models (Five-Scale and FLAIR), national mapping of the clumping index are being derived. A methodology to incorporate a calibration – validation stage as part of the LAI mapping effort are being evaluated.

5.1.2 **Landsat**

Time Dependant Calibration (NRCan Contacts: Phil Teillet): A coordinated effort on the part of several agencies has led to the specification of a definitive time-dependent radiometric calibration record for the Landsat-5 thematic mapper (TM) for its lifetime since launch in 1984. This has been implemented in the National Landsat Archive Production Systems (NLAPS) in use in North America. The specifications of this calibration include (i) anchoring of the Landsat-5 TM calibration record to the Landsat-7 ETM+ absolute radiometric calibration, (ii) new time-dependent calibration processing equations and procedures applicable to raw Landsat-5 TM data, and (iii) algorithms for recalibration computations applicable to some of the existing processed datasets in the North American context. The cross-calibration between Landsat-5 TM and Landsat-7 ETM+ was achieved using image pairs from the tandem-orbit configuration period that was programmed early in the Landsat-7 mission. The time-dependent calibration for Landsat-5 TM is based on a detailed trend analysis of data from the on-board internal calibrator. The new lifetime radiometric calibration record for Landsat-5 will facilitate the quantitative examination of a continuous, near-global dataset at 30-m scale that spans almost two decades.

5.1.3 FLUX-NET Canada (NRCan Contacts: Werner Kurz & Robert Fraser): Changes in land use and cover and natural disturbance are thought to be major controls of the dynamic sink/source balance for the immense boreal terrestrial carbon stock. Fluxnet-Canada is a national research network developed to study the influence of climate and disturbance on terrestrial carbon cycling along an east-west transect of Canadian forest and peat lands. The purpose of the present work was to create large-area land cover classifications from satellite imagery to support Fluxnet scaling and modeling studies. The methodology presented in [9] was implemented on seven Fluxnet monitoring sites across Canada. A Landsat ETM+ image covering each site was clustered to 150 classes using unsupervised K-Means classification prior to 50-cluster merging through classification by generalization (CPG). The resulting clusters were merged to 16-class landcover maps through interactive labeling using cluster bitmaps to create spatial context for the 50 clusters. The bitmaps aided the analyst when ground data was scarce or nonexistent. The products were sent to Fluxnet-Canada site managers for ground validation and the classifications were refined according to the feedback provided. The final landcover maps were used in the calculation of leaf area index (LAI) for the Landsat ETM+ scenes, thus allowing for upscaling of carbon flux measurements based on the correlation of LAI to carbon flux.

5.1.4 Calibration of National Forest Fire Impacts (NRCan Contact: Robert Fraser): Satellite-based mapping can provide a timely and efficient means of identifying burned vegetation at continental scales for estimating greenhouse gas emissions and its effects on the terrestrial carbon budget. In this study, we used a sample of 55 Landsat Thematic Mapper (TM) scenes distributed across Canada to validate and calibrate 1998 and 1999 national-level burned areas maps produced using coarse resolution (~ 1-km) SPOT VEGETATION and NOAA AVHRR imagery. Commission and omissions errors, based on fire events > 200 ha, were found to be small in the coarse resolution maps (4% and 1%, respectively). However, the coarse resolution burned area estimates were 72 percent larger than the crown fire burned area mapped at 30 m using Landsat TM (11,039 vs. 6,403 ha average area). This bias was attributed to spatial aggregation effects in which the coarse resolution product included the tree crown fire, partial burn, and unburned fractions of a pixel. A regression calibration model (R2=0.95, p< 0.0005, RMS=3,015 ha, n=155) based on a VGT/TM double sampling approach was derived to correct for the aggregation bias and to provide Canada-wide estimates of crown fire burned area.

5.1.5 CHRIS/PROBA. Processing of CHRIS Hyperspectral Data (NRCan Contacts: Karl Staenz): Processing for northern geological applications has been performed using the ISDAS Hyperspectral Calibration Procedure (HCP - see below). The processed data set was acquired over Nanisivik, Nunavut, Canada on July 9, 2003 using mode 5. The nadir image (GSD = 17 m) was selected for the data quality assessment. Landcover in this Arctic environment (N73°) consists mainly of exposed bedrock and tundra vegetation. Using the ISDAS-HCP, the following sensor and calibration artifacts were investigated: striping (incl. dead pixels), random noise, keystone, smile, and radiometric calibration. The at-sensor radiance data were converted to surface reflectance using look-up tables generated with MODTRAN V4.3 to calculate the reflectance on a pixel basis.

5.1.6 EO-1 Hyperion, Forestry Applications (NRCan Contacts: David Goodenough): In cooperation with NASA, The Pacific Forestry Centre (PFC) of Natural Resources Canada are conducting the Evaluation and Validation of EO-1 for Sustainable Development of forests (EVEOSD) project. NASA's Hyperion, ALI and Landsat-7 ETM+ data were collected over the Greater Victoria Watershed (GVWD) test site on Vancouver Island on September 10, 2001. Concurrent ground reflectance measurements were made of calibration sites. Canopy and ground cover chemistry samples were also collected. Several publications on this work can be found in the literature.

5.1.7 Hyperspectral Applications

FLAIR (NRCan Contacts: H. Peter White): As space-borne sensors are increasingly being designed to provide off-nadir imagery (to increase the potential of target application frequency and acquisition success), the bi-directional reflectance characteristics of scenes need to be assessed for information extraction. The FLAIR Model (Four-Scale model for Anisotropic Reflectance) is being evaluated with leaf level reflectance models to allow for the extraction of vegetation properties. In this case, the spectral imagery provides the means of separating reflectance characteristics of scene components from the architectural structure and distribution of the components.

HUST (NRCan Contacts: Karl Staenz & H. Peter White): In order to advance the application of hyperspectral remote sensing, a Hyperspectral User and Science Team (HUST) has been created to serve as an advisory body. This advisory team will focus on the development of appropriate products and highlight their usefulness to the user community. Application development sections includes i) Geology/Soil; ii) Forestry; iii) Agriculture; iv) Environment (including wetlands, snow/ice, and climate change) and v) Coastal/Inland Waters. As part of the HUST applications development plan, core test sites are being considered where application products (LAI, soil moisture, snow depth, etc.) can be evaluated on a continual basis. This will facilitate the calibration and validation of procedures and methodology development. A plan to call for candidate sites is being prepared.

Proposed Missions

HERO (CSA Contact: Allan Hollinger): NRCan Contacts: Karl Staenz & H. Peter White The Hyperspectral Environment and Resource Observer (HERO) is a proposed space-borne hyper-spectral instrument. The proposed HERO mission will provide unique capabilities to discern physical and chemical properties of Earth surface features not possible using current broadband multi-spectral sensors. The HERO instrument will acquire data anywhere globally and at low cost to the end user. This program will coordinate with the HUST in the definition of mission requirements and the trade-off decisions that must be made during the development work in order to best serve the user community. This mission is presently in the planning stage. The mission statement is as follows: *The Hyperspectral Environment and Resource Observer (HERO) will be a Canadian optical Earth Observation mission that will address the stewardship of natural resources for sustainable development within Canada and globally. Through targeted imaging mapping and regular monitoring of the Earth's surface, HERO will acquire and deliver high-quality hyperspectral data that will support decision-making in the management of sensitive ecosystems and valuable natural resources.*

SAR Constellation (CSA Contact: Guy Seguin): CSA is working with industry for many years to develop new technologies in support of Canada's SAR program. It is proposed to have a SAR constellation of 6 satellites to be developed over a period of five years. The present proposal is for a launch of 2 satellites every 2 years, starting in 2009/10. A preliminary science program covers a number of applications of interest to Canada, including disaster management, ice/glacier monitoring, coastal surveillance, DEM and global biomass estimates.

CHINOOK (CSA Contact: Rejean Michaud): The proposed mission will carry a Stratospheric Wind Interferometer for Transport Studies (SWIFT). The instrument will be designed to measure wind profiles in the stratosphere and will simultaneously provide profiles of ozone density. This mission is aimed at furthering our knowledge of atmospheric circulation and will help explain how pollutants are transported within the atmosphere and explain the way in which ozone is distributed in the stratosphere.

HYDROS (CSA Contact: Marie-Josse Bourassa): NRCan Contact: Terry Pultz.

CSA is a partner with NASA in the proposed HYDROS mission, which will focus on providing the first global view of the Earth's changing soil moisture and surface freeze/thaw conditions.

CASSIOPE (CSA Contact: Berthier Desjardins): This proposed mission will carry an Enhanced Polar Outflow Probe (ePOP) that would investigate atmospheric and plasma flow processes in the topside polar ionosphere.

Ongoing and New Missions

RADARSAT-1 (CSA Contact: Satish Srivastava): RADARSAT-1 is the first Canadian Earth observation satellite launched in November 1995. The mission has completed successfully 5.25 years of design life in early 2001 and presently it is in extended mission. Data is received and processed at 29 ground stations with 19 archive facilities globally. The SAR imagery has variety of applications encompassing monitoring of sea ice, ocean and environment to resource management in forestry, agriculture, geology and off-shore oil exploration to disaster management and to surveillance of vast Canadian coast. The application has advanced to interferrometry and DEM generation.

RADARSAT-2 (CSA Contact: Luc Brule): RADARSAT-2 is a follow on program to RADARSAT-1 with an advanced SAR instrument. This is a MDA mission in partnership with CSA. The system is presently being built, integrated and tested. Expected launch date is Fall 2005. At present there is a Science and Operational Applications Research (SOAR) data access program. For more information, visit http://RADARSAT2.info

Scisat-1 (CSA Contact: Rejean Michaud): The satellite was launched in 2003 and it is presently in operational phase. It carries the Atmospheric Chemistry Experiment (ACE), which consists of a

Fourier Transform Spectrometer (FTS) and the MAESTRO instrument (measurements of aerosol extinction in the stratosphere and troposphere). Both instruments are designed to gather information on the chemical process occurring in the ozone layer, between 8 and 50 km above the Earth's surface.

MOPITT: Canada's MOPITT (measurements of pollution in the troposphere) instrument is flying aboard NASA's Terra spacecraft, measuring the global distributions of carbon monoxide and methane in the troposphere.

NASA's CloudSat: This mission will, for the first time, provide global survey of the general characteristics and seasonal variations of the vertical structure and frequency of occurrence of clouds. It will provide significant improvements to characterization of cloud processes and validation of climate models. Canada is contributing key radar components to the mission's cloud profiling radar.

In-situ (NRCan Contacts: Phil Teillet): In Situ Sensor Measurement Assimilation Program (issmap) The objective of this program is to make significant advancements in the practical use of Earth observation data by developing intelligent in situ measurement capabilities that open new pathways towards the generation of quantitative and validated geophysical and biospheric information products. This will allow for the real-time monitoring of remote environments, hazards and disasters, and natural resources.

CCRS In-Situ Sensorweb Prototype Demonstrations

Flood Hazard Monitoring: Red River Watershed, Manitoba: Satellite-based soil moisture maps and strategically deployed in situ sensorwebs can monitor soil moisture changes in space and time without ongoing field work. Measurements include: Global radiation, relative humidity and precipitation, air and soil temperature, rainfall, wind speed and direction, and soil moisture (Adcon C-Probes with sensors at multiple depths to match soil core sampling locations).

Groundwater Monitoring: Oak Ridges Moraine, Ontario. Deployment of a sensorweb to monitor spatial patterns in climate and evaporation.

Drought Severity and Vegetation Monitoring: Alberta. Deployment to detect the onset of drought and, more generally, support the prediction and assessment of rangeland productivity and crop yields. In this demonstration, each sensor node provides soil moisture, precipitation, and soil temperature information via wireless communication to a central server in real time.

5.2 **Peoples Republic of China (PRC)** *(Dong Xiaolong, Liu Heguang, Jiang Jingshan)*

Background on China's Earth Observation Satellites Series of Meteorological Satellites was presented. Satellites with odd number (1,3,) are in polar orbit. Those include: optical, infrared sensors and since 2003 microwave/mmw sensors. Satellites with even number(2,4,…) are on Geostationary Orbit. Tose include: optical, infrared sensors and microwave/mmw sensors are considered for 2005. The ZY-Series (Resources Satellite: Optical Imaging) include CBERS (China-Brazil Earth Resources Satellite); the HY-Series (Oceanic Satellite) include: HY-1 (Water Color Satellite), HY-2 (Ocean Dynamic Environment Satellite), HJ-Series (Environment and Disaster Reduction Satellite), Optical imager and SAR.

Past, Current and Future Missions with Microwave/MMW Sensors were discussed. Past: Multi-mode Microwave Remote Sensor (SZ-4, 2002-2003). Current: Polar-orbit meteorological satellite (2006-2007); Chang'e-1 lunar satellite (2006-2007, Microwave sounder is one of the main payloads of Chang'e-1). Future: HJ-1C Environment Satellite: S Band SAR. (2006); HY-2 ocean dynamic environment measurement mission (~2008); FY-4 geostationary meteorological satellite (~2010).

Re-calibration and validation of MMV data by *in situ* data from shipborne microwave sensors was discussed. Objectives: Calibration, Correction of BT retrieval formula, and Application. Future plans for CAL/VAL of spaceborne MW/MMW sensors: With development of technologies, more and more

Chinese missions of earth observation satellites with microwave/MMW sensors are being proposed or being carried into execution. For operational or experimental/operational applications, CAL/VAL becomes an essential requirement for these missions. CAL/VAL is the demerit of Chinese EO satellites. China is now implementing a comprehensive plan for spaceborne microwave/MMW earth observation sensors.

Current and near future tasks/plans (2003~2005) were described. They include the development of CAL/VAL technologies for: 1) passive microwave/MMW sensors; 2) active microwave/MMW sensors; and 3) Research about the construction requirements of the CAL/VAL experiments.

5.3 **ESA** *(Michael Rast for Evert Attema)*

Michael Rast presented the status and plans for the group from ESA for Evert Attema. Calibration and validation activities of the European Space Agency during the period June 2004 (WGCV 22) – March 2005 (WGCV 23) included routine calibration, performance monitoring and algorithm development for ERS-2 & Envisat, planning of calibration & validation for future missions and airborne simulation campaigns.

5.3.1 Missions in Orbit

ERS-2: The high quality of the ERS data products under reduced attitude stability was maintained. It is planned to stretch ERS operation as much as possible to avoid gaps in data provision between ERS, Envisat and METOP. For examples of routine scatterometer data freely available on the see

http://www.knmi.nl/onderzk/applied/scattmtr/ers_prod/.

ENVISAT: ESA's advanced Earth observing satellite Envisat is now in its operational exploitation phase following successful calibration and initial validation programmes. Data were released for distribution. The quality of Envisat 's data products is being ensured with the support of data quality working groups for each instrument as well as with validation teams for level-2 data products (geophysical variables). The scientific and commercial exploitation of ERS and Envisat 's data is being reviewed during a series of dedicated workshops. The Envisat/ERS symposium held on 6 to 10 September 2004 in Salzburg, Austria attracted over 1000 participants. See also **http://envisat.esa.int/**.

PROBA: PROBA (PROject for On-Board Autonomy) is a highly manoeuvrable small satellite. It was successfully launched into a sun-synchronous polar orbit on 22 October 2001. For Earth Observation the main scientific interest of this mission relates to the use of the imaging spectrometer CHRIS (Compact High-Resolution Imaging Spectrometer) on-board PROBA. The data acquisition plans include vicarious calibration sites (see **http://www.rsacl.co.uk/chris/**). The project has completed its first full-scale science programme and further extension of the operations during 2005 has been approved. Achievements and project plans will be presented at a dedicated workshop. See also **http://www.estec.esa.nl/conferences/**

5.3.2 Future Missions

METOP: METOP is a joint project of Eumetsat and ESA. For details on calibration and validation see **http://www.eumetsat.de**.

Earth Explorer Missions: The following missions are part of ESA 's Earth Explorer Programme. (See **http://www.esa.int/livingplanet/**). Their calibration and validation requirements are currently under review. Airborne campaigns were executed for these missions as a proof-of-concept experiment or to test calibration/validation approaches. In-orbit campaigns are planned.

GOCE -- http://www.esa.int/export/esaLP/goce.html

CryoSat -- http://www.esa.int/export/esaLP/smos.html

ADM-Aeolus -- http://www.esa.int/export/esaLP/aeolus.html

SMOS -- http://www.esa.int/export/esaLP/smos.html

SWARM -- http://www.esa.int/export/esaLP/swarm.html

For other missions under consideration see **http://www.esa.int/export/esaLP/futuremissions.html**

During the reporting period a measurement campaign was executed in Antarctica to verify the stability radiometric signature of the Dome Concordia area as a natural target for instrument calibration.

Earth Watch Missions: Earth Watch mission are operational missions under development by ESA as part of the Earth Observation Programme. This programme also responded to the GMES (Global Monitoring of Environment and Security) initiative taken jointly by ESA and the European Union. See **http://www.gmes.info/**. The GMES space segment comprises of a number of Sentinel missions currently being defined. Calibration and validation will be an essential part of GMES.

ESA Simulation Campaigns

The main objective of the ESA simulation campaigns is to provide support for the preparation of future space programmes and their users (see http://www.esa.int/export/esaLP/campaigns.html) Currently high priority is given to pre-launch and validation campaigns for the Earth Explorer Missions and Earth Watch Missions. During the reporting period the INDREX-2 campaign as announced in the previous report was flown in Indonesia. The experiment was designed to ascertain the best requirements for a space-borne mission that will contribute towards the sustainable management of tropical forests and to support global biomass estimation. The preliminary results confirm the capability of estimating forest height from space using L-band polarimetric synthetic aperture radar.

5.4 JAXA *(Takeo Tadono and Masanobu Shimada for Masanobu Shimada)*

Takeo Tadono gave the JAXA report. The launch results and satellite status of MTSAT-1R/H-IIA F7 were reported. The H-IIA Launch Vehicle Number 7 (H- IIA F7) was successfully launched at 6:25 p.m. on February 26, 2005 (Japan local time) from Tanegashima Space Center, Japan.

ALOS Cal/Val: JAXA will be launchinge next Advanced Land Observing Satellite (ALOS).

The current status of ALOS is as follows: End-to-End test was carried out on January. Integrated Space Chamber test was to be completed by the end of March. The ground segments are almost completed, and will be under internal review in April. The transportation to Tanegashima Space Center is planned for May. The launch is scheduled for September 2005.

The sensors on board include: PRISM, Panchromatic Remote-sensing Instrument for Stereo Mapping; AVNIR-2, Advanced Visible and Near Infrared Radiometer type 2; and PALSAR, Phased Array type L-band Synthetic Aperture Radar. Details on the calibration of the instruments were presented (see presentation for the details). The plans for sensors cross calibration were described as well. The instruments will be cross-calibrated 1) against calibrated satellite data *i.e*, Terra/ASTER, SPOT; 2) by using the well known and homogeneous test sites, and 3) using calibrated reflectance model, or via a vicarious calibration.

ALOS Research Announcements (RA): With the 1st RA were approved 166 proposals. JAXA will release a 2nd RA, targeting data utilization research, about one year after the launch.

5.5 NIST *(Robert D. Saunders for Carol Johnson)*

Robert Saunders presented the NIST agency report for Carol Johnson.
Examples of Heritage Activities were presented:

North American Interagency Intercomparison of Ultraviolet Monitoring Spectroradiometers. Purpose: Assess accuracy of downwelling surface irradiance measurements in the UV; and Perform limited field characterization and calibration using NIST standards

SeaWiFS Intercalibration Round-Robin Experiments (SIRREXs). Purpose: Ensure that radiometric standards used by institutions involved in the validation of SeaWIFS measurements were consistently calibrated with the values traceable to stated reference standards (e.g., SI); Clear articulation, demonstration, and training related to the community-accepted Ocean Optics Protocols

1997 Lunar Lake, Nevada Surface Reflectance to Top of the Atmosphere Radiance. Purpose: Laboratory characterization of field radiometers

Ideas & suggestions for future comparisons were presented. They included the following:

Common Broadband Source for Intercomparison: Field radiometers are used outdoors and in remote locations, which may result in operation on 1) battery power; 2) very short warm-up times; and 3) extreme values for ambient (air) temperature and relative humidity. Solar-illuminated reflectance standards are not usually viewed simultaneously, so there is no way to intercompare radiometers or assess their radiometric stability during field exercises it follows that the comparison results can be no better than those obtained in a laboratory under more ideal conditions. **NIST propose to assess this uncertainty component by pre (or pre and post) laboratory comparisons. S**table source (e.g. integrating sphere with monitor detectors) and/or external NIST monitor radiometer (the source does not have to be calibrated) and field radiometers will be used to measure the source under controlled conditions. The use of standard sources in the field and of Novel sources were discussed.

NIST Recommendations: NIST is available to help with laboratory component, including planning and execution, of any CEOS/IVOS sponsored field comparison activity. This activity would be coordinated with our collaborators at NASA, IPO, and NOAA and the level of our involvement would depend on the interest and enthusiasm of CEOS / IVOS as well as these agencies.

5.6 **NOAA** (*Changyong Cao*)

Changyong Cao presented the NOAA agency report with an update on the calibration/validation activities at NOAA/NESDIS in prelaunch/postlaunch calibration, and validation of atmosphere, ocean, and land products. He introduced the novel Simultaneous Nadir Overpass (SNO) method developed by NOAA scientists for the intersatellite calibration of polar-orbiting radiometers in the infrared, microwave, and visible/near-infrared. The progress made in using this method for the operational monitoring of instrument performance, intersatellite calibration of historical data for climate trending studies, and linking the calibration to that of the next generation operational polar-orbiting and geostationary radiometers were presented. The accuracy and uncertainties of this method were evaluated.

In addition, he gave a briefing on the development of the Integrate Sounding Retrieval Processing and Validation System. Other activities included the marine optical buoy (MOBY) project, validation of AIRS retrievals with GPS integrated precipitable water, sea surface temperature retrievals, ozone time series, and validation of GOES aerosol and AVHRR NDVI.

He reiterated the important role that NOAA/NESDIS plays in the calibration/validation of National Polar-orbiting Operational Environmental Satellite System (NPOESS) sensors, and the need for including the calibration/validation of atmospheric sounders on the CEOS/WGCV agenda, which is currently being considered by the subgroups.

5.7 **NPL** (*Nigel Fox*)

Nigel Fox provided the report from NPL. At the present, NPL is concentrating its research effort towards ground based cal/val systems. It is evaluating the radiometric performance of a number of

field spectrometers with a view to determining optimum calibration strategies. It has also now received funding for the development of a new field gonio-spectrometer for surface BRDF has now been obtained and the design for a 35 angle, near simultaneous sampling hemisphere is underway and has submitted a project proposal to the EU in conjunction with others to establish best practise for surface BRDF and spectral signature libraries. In addition, it is part of a new UK based Knowledge transfer network called NCAVEO (Network for CAlibration and Validation of Earth Observation data) www.ncaveo.ac.uk which seeks to exchange information on cal/val issues but currently limited to the optical domain and largely the remit of IVOS and LPV sub-groups of WGCV.

5.8 UK (*Gordon Keyte – not present*)

No UK country report at this time. UK is mostly involved in utilizing data instead of building and flying satellites.

5.9 **USGS** (*David Meyer*)

David Meyer provided the USGS agency report.

5.10 GISS-WGCV WTF Core Test Sites (Jeff Morisette, John Dwyer and Peter Muller)

6 Current WGCV Action Items:

OPEN ITEMS REMAINING FROM PREVIOUS MEETINGS

WGCV19-5	**Martin-Neira / Hilsenrath** to identify existing education material and channel this to WGEdu through secretariat. **OPEN**	**WGCV-24**
WGCV21-13	**Xiaolong Dong & Morisette** will collaborate to explore the possible incorporation of Chinese FY-1 (and maybe FY-2), CBERS-1 and CBERS-2 data into the WTF within the 2005 phase of WTF. Negotiations with the CBERS data centre. **OPEN.**	**WGCV-24**
WGCV22-7	**Hilsenrath/Rast** to solicit a representative and decide where best to provide representation from the atmospheric sounder community in WGCV (IVOS or ACSG). Needed are temperature and passive macro-wave experts. Hilsenrath will seek GSFC aerosol specialist. **OPEN.**	**WGCV-24**

NEW ACTION ITEMS, ACCEPTED DURING THE WGCV-23 MEETING

WGCV23-1	**Hilsenrath and Cao** will collaborate to consider the best approach for including aerosol validation in the WGCV subgroup.	**WGCV-24**
WGCV23-2	**Hilsenrath** to contact IPO to solicit NPOESS representative to WGCV. The item was taken to resolve WGCV20-18 (WGCV20-18: Hilsenrath to ask the NGST (system contractor for NPOESS)	**WGCV-24** completed

	to be represented on the joint ISPRS / WGCV taskforce).	
WGCV23-3	**Xiaolong Dong** will suggest a CBERS expert, representative from China, to participate in the WTF teleconference.	**WGCV-24**
WGCV23-4	**Ungar**, as a follow up to WGCV22-4 and WGCV22-5, will query Belward and report the findings to the WGCV-24. **WGCV22-4:** Belward will coordinate with GCOS an international validation activity for global albedo, fAPAR, and LAI products with the objective of providing recommendations for deriving products that meet the Global Climate Observing System requirements. **WGCV22-4:** Belward will coordinate an interaction between the WGCV and the Programme Intercomparing Land Process Schemes (PILPS) to ensure that the climate modelling community are able to access the most appropriate albedo product for each model.	**WGCV-24**
WGCV23-5	**Morisette** will follow up on WGCV22-8 to determine the Quikbird and IKONOS data costs and payment possibilities. Potentially, NASA resources will be allocated and this will be a part of NASA data request.	**WGCV-24**
WGCV23-6	**Morisette (with Dwyer and Faundeen)** will follow with CEOP (Coordinated Enhanced Observing Period) to add a water/hydrology site to the WTF on CEOS Core Sites.	**WGCV-24**
WGCV23-7	**Ungar** will contact Sergio Camacho to: discuss the location of the next meeting and potentially arrange WGEdu presentation at the next WGCV24; and invite an Italian member to participate in the WGCV group.	**WGCV-24** completed
WGCV23-8	**Rast** and **Dong** will arrange for the next meeting presentations on: Chris/Proba, CBRES-2 and Disaster monitoring constellation.	**WGCV-24** completed
WGCV23-9	**White** will comment on the Canadian document on RS requirements at the next meeting.	**WGCV-24** completed
WGCV23-10	**Ungar** will contact Manuel Martin-Neira to establish the current status of the Microwave Sensors subgroup.	**WGCV24** completed

7 Recommendations

Recommendation 1

Background

Recommended by LPV. This recommendation is a continuation of WGCV recommendation number 3 to CEOS 18 plenary. It is suggested to explicitly list some of the steps documented in the GOFC/GOLD/LPV harmonization of land cover.

Global land cover maps at coarse resolution pose significant problems for accuracy assessment because of the high frequency of mixed pixels, difficulty in precise geolocation of map products and reference materials, and logistical difficulties associated with field data collection. Validation of land cover is critical in that without proper validation, land cover maps can be misleading.

WGCV Requirement

To produce land cover maps that integrated and utilize the complimentary efforts of the GOFC/GOLD Land Cover Implementation Team's effort to coordinate land cover reference data.

Recommendation

Request all CEOS members that produce land cover maps to use CEOS Land Validation Core Sites and either use the FAO/UNEP Land Cover Classification System (LCCS) or relate their legends to the FAO/UNEP LCCS.

WGCV Follow-up activities

The LPV, in conjunction with the WTF, will expand their core validation sites to encompass new sites of interest to contributing CEOS members and will develop a proper statistical sampling strategy to maximize use of non-randomly selected sites to derive accuracy figures.

Recommendation 2

Background

It has been agreed by CEOS agencies that global DEMs employed for radiometric and geometric processing of their spaceborne data should preferably be sourced from spaceborne sources of DEMs.

WGCV Requirement

To be able to utilize these spaceborne DEMs, a full error characterization is required which should include inter-comparisons with *in situ* validated data as well as inter-comparisons with other DEM sources (spaceborne and airborne) all of which should be intrinsically and verifiably more accurate.

Recommendation

Request that CEOS participating space agencies provide any and all internal quality metrics (e.g. Terrain Height Error Data) or external validation information via a web-link on each product page. In addition, the CEOS participating space agencies should provide a moderated "Known Issues" page in a similar fashion to the one produced by MODIS at

http://landweb.nascom.nasa.gov/cgi-bin/QA_WWW/newPage.cgi?fileName=terra_issues.

WGCV Follow-up Activities

The TMSG, in conjunction with the WTF, will provide an example set of results for external validation information as well as a few “Known Issues” for some sample DEM datasets. The TMSG will liaise with WGISS about the creation of the “Known Issues” pages for DEMs.

Recommendation 3

Background

Global cartographic data, derived from existing spaceborne datasets are an unique resource for mapping the "state-of-the-planet". The optimum method for providing such data is through the use of OGC standards which web browsers around the world can recognize and use directly within Web Map Server browsers. Global orthorectified and mosaiced products have a number of helpful applications regarding image geocoding, change detection and scene interpretation.

WGCV Requirement

To encourage CEOS participating space agencies to provide such cartographic and image map data, either generated within the agency or via third parties in OGC-compliant formats (e.g. ARC shapefiles, GML for vector data and geotiff for image map data)

Recommendation
Request that subsidiary products (such as orthorectified SAR amplitude mosaics and water body masks for SRTM) produced by CEOS participating space agencies be made available as OGC-compliant data layers (WMS/WCS/WFS formats) for use in understanding and interpreting the data and for quality control of orthoerctification and geocoding of any spaceborne dataset.

WGCV Follow-up Activities

The EO Data Portal project, ICEDS, will provide a demonstration of the utility of vector data derived from SRTM and it's inter-comparison with other public domain coastline and water body datasets.

Recommendation 4

Background

Recommended by the SAR subgroup. (Currently being developed)

WGCV Requirement

Recommendation

Encourage CEOS agencies, participating in the SAR subgroup, to support the establishment of new calibration and validation sites. All CEOS agencies should take responsibility for making validation data gathered to support their observing systems available in the most efficient manner for WGCV access.

WGCV Follow-up Activities

The SAR Subgroup should set up International Calibration sites with man-made targets. There is an ongoing discussion and funding is an issue. The idea of joint ESA-CSA Transponder Sites in Canada is currently being considered.

Tentatively agreed an international site within the Amazon Rainforest with coordinates of (UL: -5.03, -65.67 - LR -9.12, -69.64 deg). This natural site should be used as one of the radiometric calibration standards and it should be regularly monitored. The Amazon stability dataset (gamma, sigma-zero, incidence angle, polarization) should be uploaded at CEOS WGCV website.

Recommendation 5

Background

In situ measurements of reflected solar and thermally-emitted spectral radiance are used to validate radiometrically-derived satellite-based products, to calibrate the satellite sensors post-launch, or to supply data for algorithm product activities. A variety of commercial and custom field instruments are used to supply these data, and the results are critically dependent on instrument factors (robustness of the radiometric characterization, traceability of the results, etc.), environmental factors (suitability of the site, variability of conditions, etc.), the experience of the personnel, and the measurement protocols and procedures.

WGCV Requirement

See the IVOS terms of reference presented, for example, at the ESA Workshop "Inter-comparison of Large Scale Optical and Infrared Sensors," 12-14 October 2004, ESTEC, Noordwijk, the Netherlands. At the workshop, it was proposed to organize a field campaign to perform surface and atmospheric measurements for vicarious calibration in the 2006/2007 timeframe to allow for diligent preparation and cross-calibration of in-situ sensors.

Recommendation

Encourage CEOS agencies to use NIST (or other appropriate NMI resources) to help with the laboratory component, including planning and execution, of any CEOS / IVOS sponsored field comparison activity. This activity would be coordinated with our collaborators at NASA, IPO, and NOAA. NIST's impartial position and extensive experience with instrument performance and comparison protocols can be used to great benefit. For example, a laboratory component consisting of simple experiments with novel sources can be used to place all the participants instruments on a common radiometric scale, as well as to reveal the nature of observed biases. A successful example was the TIR comparison held at the Univ. Miami for sea surface temperature.

WGCV Follow-up Activities

NIST observed the two day field exercise that was held in Argentina in March 2005. A copy of our report can be made available.

8 Date and Place of Next Meeting

The forthcoming WGCV-24 meeting will be held on 8 - 11 of November in Frascati, Italy.

Annex A: CEOS/WGCV 23 Agenda

Monday, March 7, 2005

8:15 Bus departs from hotels to meeting site

8:30 Registration

9:00 Welcome from the official WGCV-23 hosts *(Laura Frulla for Dr. Conrado Varotto).*

9:20 Introductions, logistics, WGCV agenda *(Steve Ungar).*

10:00 Break

10:30 CONAE activities *(Juan Bratina).*

10:45 WGCV Chair's report (*Steve Ungar*).

11:15 Update from WGCV Secretariat (Petya Campbell, Steve Ungar)

11:35 Action items from WGCV-22 (*Steve Ungar)*

12:00 Lunch

13:00 Joint WGISS/WGCV Welcoming Session (*Dr. Conrado Varotto*).

13:20 Special session on LPV field effort (*Jeffrey Morisette*).

14:40 Break

15:00 Special session on LPV field exercise continued (*Jeffrey Morisette*).

16:00 Tour of CONAE Facilities

17:00 Welcome Reception by CONAE

18:30 Return to Hotels

Tuesday, March 8, 2004

8:15 Bus departs from Hotels to meeting site

9:00 Reports from Subgroups

9:00 Atmospheric Chemistry (*Ernie Hilsenrath*)

9:40 Infrared and Visible Optical Sensors (*Michael Rast*)

10:20 Break

10:40 Reports from Subgroups (continued)

10:40 Land Product Validation (*Jeffrey Morisette*)

11:20 Microwave Sensors (*TBD*)

12:00 Lunch

13:00 Reports from Subgroups (continued)

13:00 Terrain Mapping (*Jan-Peter Muller*)

13:40 SAR (*Satish Srivastava*)

14:20 Country and agency Reports

14:20 Canada *(Peter White and Satish Srivastava)*

14:40 PRC *(Dong, Xiaolong)*

15:00 ESA (*Michael Rast*)

15:20 Break

15:40 JAXA *(Takeo Tadono)*

16:00 NIST *(Robert Saunders for Carroll Johnson)*

16:20 NOAA (*Changyong Cao*)

16:40 NPL *(Nigel Fox)*

17:45 UK *(Nigel Fox for Gordon Keyte)*

17:20 USGS *(Dave Mayers)*

17:40 Return to Hotels

Wednesday, March 9, 2005

8:15 Bus departs from Hotels to meeting site

9:00 Joint WGISS/WGCV Session

9:00 Welcome, Objectives, & Agenda Review *(For CONAE Laura Frula, Steve Ungar, John Faundeen*)

10:30 Break

10:40 Report on the Beijing CEOS exhibition –November 18, 2004 (*John Faundeen)*

10:45 Summary of Plenary 18 (*Steve Ungar, John Faundeen*)

11:30 WGISS-WGCV WTF Core Test Sites (*John Faundeen*)

12:00 Lunch

13:00 WGISS-WGCV WTF Core Test Sites (*Jeff Morisette, John Dwy and Peter Muller*)

14:00 WGCV Argentina Cal/Val Exercise (*Jeff Morisette and Steve Ungar*)

14:30 SensorWeb Prototyping Activities (*Steve Ungar for Dan Mandl)*

15:00 CEOS EO Data Portal Project (*Wyn Cudlip, Lorant Czaran, Jan-Peter Muller*)

15:30 Break

15:45 GeoWall Technology Demonstration (*Stu Doescher, John Faundeen*)

16:15 WGCV-WGISS Collaboration *(All-Hands Discussion)*

17:00 USGS presentation *(Dave Mayers)*

17:30 Adjourn

19:00 Group Dinner

Thursday, March 10, 2005

8:15 Bus departs from Hotels to meeting site

9:00 **Discussion of Topics from Joint Session** *(all).*

9:45 **Recommendations and Reporting to Plenary**

10:30 Break

10:50 Review of action items *(all).*

11:20 Decission on the date and place of next meeting *(all).*

11:40 Close WGCV Plenary

12:00 Lunch

13:00 Open IVOS Sub-group Meeting

18:00 Return to Hotels

Friday, March 11, 2005

08:15 Bus departs from hotel to meeting site

08:40 Open IVOS Sub-group Meeting PART II

11:40 Close of IVOS Sub-group Meeting

Annex B: Participants

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