COMMITTEE ON EARTH OBSERVATION SATELLITES

Working Group on Calibration & Validation (WGCV)

MINUTES OF THE 24th WGCV MEETING

WGCV-24

November 7-11, 2005

Hosted by:

ESA/ESRIN, Frascati, Italy

November 7-11, 2005

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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-24 hosts (*Stephen Briggs, ESA/ESRIN*)

Stephen Briggs welcomed the WGCV-24 delegates on behalf of ESA/ESRIN. He stressed the importance of the calibration and validation activities in maintaining the accuracy of satellite data products. He hoped that all present would enjoy their stay in Italy and have a successful meeting.

Stephen Ungar thanked **S. Briggs** for his warm welcome. He also expressed his thanks to **Michael Rast** and to the **ESA/ESRIN staff** for their efforts in organizing the meeting.

2 Introduction and Approval of the WGCV-24 Agenda (*Stephen Ungar*)

Introduction (*Stephen Ungar*):

The WGCV Chair Stephen Ungar introduced all participants and presented to the WGCV members the new WGCV/MW Subgroup Chair Christopher Buck (ESA, Netherlands). The Chair recognised the participating for first time country/agency representatives of Russia/ScnEx and WMO. The logistics of the meeting and the needs of the participants were addressed.

The WGCV-24 Agenda (Annex A) was approved as presented.

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

Stephen Ungar presented the WGCV chair's report. The chair report included short introduction and background on WGCV since its establishment in 1984, an update on the WGCV subgroups structure and leadership, and focussed on the role, potential contributions of WGCV to GEOSS and presented a framework for the proposed activities.

The following achievements for 2006 were reported: 1) WGCV23 Plenary hosted by CONAE occurred jointly with WGISS, 8-11 March, 2005 in Cordoba, Argentina; 2) Immediately prior to the WGCV23 meeting was conducted a preliminary field campaign; 3) Progress was made on priority actions defined in CEOS 5 years plan for implementation in to the WGCV work plan.

The report focused on the current WGCV priority actions & activities, as follows: 1) The WGCV will support calibration and validation activities relating to the GEOSS and 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 CEOS WGCV website was reported to have been partially updated and re-hosted and is currently 508 Compliant and populated. Future upgrades will be conducted as necessary information becomes available.

CEOS WGCV Subgroups Chairs (update):

- Synthetic Aperture Radar (SAR) – Chair Dr. Satish Strivastava, CSA;
- Infrared Visible Optical Sensors (IVOS) - Chair Dr M.Rast, ESA;
- Microwave Sensors (MW) - **Appointment of new Chair - Dr C. Buck**, ESA;

- 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.

4 WGCV Secretariat update (*Petya Campbell*)

- Minutes from WGCV-23 were reviewed, approved and adopted as presented by Petya Campbell, WGCV Technical Secretariat.
- Open Action Items from previous meetings were reviewed and the following table reflects their current status.

WGCV23-4	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 Closed No longer relevant
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. Data sharing among PI's and collaborators	WGCV-24 Closed
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. Transitioning to an operational mode, in the process adding more sites.**	**WGCV-24 Open**
WGCV23-7	Ungar will contact Sergio Camacho to arrange WGEdu presentation at the next WGCV-24; 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.	WGCV-24 Completed

5 Joint WGCV/IVOS Session and IVOS report (*Michael Rast and IVOS members*)

Summary of IVOS subgroup meeting and recommendations to WGCV-24 was provided by the subgroup chair Michael Rast, with participation of the present IVOS members.

In order to establish reference datasets to support the understanding of climate change and quality assure operational services by E.O. satellites, data from different sensors and the resulting synergistic data products require a high level of accuracy which can only be obtained through continuous traceable calibration and validation activities. In this context, IVOS recommends to:

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 for specific vicarious calibration sites in a common format delivered by agencies responsible for their instruments. This database should also include site characteristics.

This activities should be supported for an active (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 provide the appropriate information and data in a timely manner.

6 The CEOS perspective on a productive relationship with GEO (*CEOS/SIT Briggs*)

The CEOS perspective on a productive relationship with GEO was presented by Stephen Briggs, CEOS/SIT and was followed by an open discussion.

- The need for WGCV actions relating to GEOSS was given highest priority. Plenary had requested that the WGCV23 develop recommendations to enable CEOS, and its working groups, to actively participate in GEOSS.
- New terms of reference for WGCV were proposed by CEOS/SIT, which in essence differed from the established WGCV terms of reference in the proposed terms for WGCV Chairmanship. CEOS/SIT proposed that the WGCV Chair serves for two years (3 years term currently). In addition, proposed was also the nomination of a Vice Chair with two years term, which to become the new Chair after two years.

7 Reports from the WGCV Subgroups

7.1 Atmospheric Chemistry Subgroup *(Ernest Hilzenrath)*

Ernest Hilzenrath gave the report from the AC subgroup. The Atmospheric Chemistry Satellite Timeline is: 19 instruments, 10 Missions by 2015.

ACSG Objectives-1 are to: Promote international collaboration and technical exchange to ensure sufficient use and maintenance of calibration/validation resources required for atmospheric chemistry missions; Verify accurate scientific products encouraging an end-to-end approach to the calibration and validation of Level 1 and Level 2 data products and subsequent re-calibration and reprocessing; Ensure that validation sensors are calibrated to traceable national standards with documented statements of accuracy and repeatability; and Encourage interaction between calibration scientists and data users to enable a better understanding of data uncertainties and user requirements.

ACSG Objectives-2 include: Develop comprehensive data validation methods that employ ground, aircraft, balloon, and satellite measurements and data assimilation with chemical transport models; Recommend a network of validation sites and to encourage continuous observation and quality control of data through the use of standard procedures and inter-comparisons; and Specify a comprehensive, consistent and quality- controlled multi-mission validation data base in an accepted format employing user friendly tools.

ACSG – Status: The current subgroup participants are (15 members): CNES, DLR, ESA, JAXA, NASA, KNMI, MSC, NOAA, IASB, EC, WMO, U. of Bremen, CSA (U of Toronto), Eumetsat, British National Space Center (BNSC).

Meetings: Four Subgroup meetings held: May ’02 (Ottawa), December ’02 (Frascati), July ‘03 (Toulouse), May ‘04 (Frascati).

Status of ACSG Projects: Collaboration between Aura and Envisat Validation Data Centers (*Approved*); Ground station cross calibration (*Approved*); Eureka (Canada) station re-opened (*Approved*); High latitude ozone campaign (*Planning*); and Collaboration on future missions: Metop, NPP, NPOESS, and post Metop (*Planning*).

Envisat Validation Status

ESA coordinated ground, aircraft, and balloon activities. The main phase was completed in the time period 2002-2004. Additional balloon soundings are planned for 2005: Brazil June/July, Fance Sept/Oct. More information available at
http://www.esa.int/esaLP/SEM76G6DIAE_LPcampaigns_0.html

Polar validation campaign is scheduled in Sweden for Jan/Feb 2006. Continued validation analysis by U. of Bremen (DL), BIRA (BE), RIVM (NL).

Future meetings: Next Aura/Envisat joint science team Meeting, is planned for Nov 7-11, 2005; The third ESA Validation Workshop is planned for June 2006, ESRIN IT.

EOS Aura - Atmospheric Chemistry

Background: Aura is the third large EOS Observatory following Terra and Aqua, it has four instruments (UV to microwave), polar orbit at 1:38 PM crossing, it is in it's second year of operations

Science Objectives: tracking ozone layer, global measurements of air quality, connecting atmospheric chemistry with climate, and synergy with A-Train.

Aura Validation Program – 63 data products,

Current and planned programs and activities include: nine aircraft field campaigns – 2007; ground based measurements and mobile trailer system for in situ and profile measurements focused on the troposphere; special high altitude instrumented balloon flights with additional H_2O and O_3 sondes (Costa Rica); high latitude ozone campaign; comparison with 5 other international satellites; and multinational collaboration, including: NASA, ESA, KNMI, FMI, NDSC.

Ozone Validation: All four Aura instruments measured ozone. Ozone amounts validated include: total column, troposphere and stratosphere column, troposphere and stratosphere profiles. The Aura ozone estimates were compared with: balloons and LIDAR, aircraft, other Aura instruments, other satellite instruments.

Aura Validation Data Center for inter-satellite data hosting and mission planning (AVDC, operational February 10, 2005): This is an active archive and distribution center for ground, balloon, aircraft, and some satellite data for Aura validation. It is a collaborative effort with ESA Envisat Cal/Val and Canadian ACE mission (data exchange).
Web access: http://avdc.gsfc.nasa.gov

As of October, 2005: 154 registered users, 100 Gb of validation data, 1.4 Tb of subsetted satellite data. In addition to Aura, AVDC supports ACE, OSIRIS, SBUV/2 subsets.

AVDC Functionality includes: Continuity in file format, AVDC/Envisat HDF, ASCII to HDF, IDL on-line, Linux, OSX, Windows; Numerous tools for end users: Collocation tools (Relational Database, Searchable (4-D, species, etc)); Aura Instrument Field of View prediction tool (Aircraft mission planning/scheduling, Ground based/Aura FOV coincidences); Aura instrument data subsetting (Aircraft flight path, Ground stations (Aeronet, NDSC)).

Sodankylä, Finland Campaign, hosted by the FMI April, 2006 for (Aura and Envisat): Results may be available for the next WGCV-25 meeting. Instruments to be included: Ground based: Lidar, Brewer, Dobson, SAOZ, balloon, DOAS; Satellites: Aura, Envisat, ERS-2. The campaign is supported by: NASA, FMI, ESA, KNMI, NDSC.

ACSG Action Items: Continue to lobby for stable funding from space agencies for ground based network to insure data quality and timely archiving; Coordinate Envisat (chemistry) and Aura validation – NASA/ ESA discussions continue for near term and long term coordination; Coordination of validation activities for next generation operational systems: Metop and NPOESS. Representatives are members of ACSG; Consider universal policy for publication, referencing and citation of validation data – AVDC is a test bed; and Respond to GEOSS, IGOS, and GMES requirements.

ACSG and GEOSS: ACSG deals with atmospheric constituents and responds to three GEOSS Societal Benefit Areas (SBAs). Not included in ACSG are: Aerosols, Greenhouse gases, Meteorological parameters (temp, winds, H_2O vapour). With these included an expanded Atmospheric Subgroup would respond to 6 of 9 GEOSS SBAs. Should ACSG expand or should WGCV include additional subgroups?

7.2 Land Product Validation (*Jeffrey Morisette*)

7.3 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 – focus on GEOSS application areas; 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 GEOSS "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 GEOSS member global land products (*possibly through the CEOS/WMO database*).

Reports from Recent LPV Activities:

LAI intercomparison: Topical meeting to establish data requirements (1998); Decide on Sites, Develop data sharing infrastructure (2001), Field Campaigns & individual product analysis (2004), Synthesis of results (Current work);

Albedo workshop: Topical meeting to establish data requirements (2002); Decide on Sites (2005), Develop data sharing infrastructure (Current), Current and future work - Field Campaigns & individual product analysis, Synthesis of results;

Land cover-best practices: Topical meeting to establish data requirements (2001); Decide on Sites (2004), Current and future work - Develop data sharing infrastructure, Field Campaigns & individual product analysis, Synthesis of results.

Manfredi results: K. Swanson, S. Garrigues, N.V. Shabanov, J. Morisette and R.B. Myneni, paper in progress. Analysis of Uncertainties of LAI Retrievals from LAI-2000, AccuPAR and DHP Optical Instruments over Croplands of Cordoba, Argentina.

Albedo/BRDF comparisons: In 2005 conduct virtual *experiments* (inter-compare 2002-2003 data for 5 sites) in 2006 conduct *real experiment*.

CEOS/LPV "best practices" document**:** *Global Land Cover Validation: Recommendations for Evaluation and Accuracy Assessment of Global Land Cover Maps*, Edited by: Strahler, Authors: Boschetti, Foody, Friedl, Hansen, Herold, Mayaux, Morisette, Stehman, Strahler, & Woodcock. In progress.

Harmonization/Validation initiative: Framework for joint GOFC-GOLD/CEOS cal/val activities.

Vegetation Continuous Fields: Global validation for the 2000 era **-** Use sampling IKONOS: ETM+/ASTER; Use JAXA's PRISM on ALOS - Request acquisition schedule and data access plan from JAXA.

Special Issue of IEEE Transactions on Geoscience and Remote Sensing: in progress (due March 2006). 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).

Potential upcoming meetings: FAO Agricultural monitoring (March '06); Validation of Vegetation index (TBD); Global Vegetation Monitoring (August 7th, or the week after IGARSS, Missoula Montana, US).

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

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.

Details on most points above are available at the LPV web site: http://lpvs.gsfc.nasa.gov/

7.4 Microwave Sensors (*Christopher Buck*)

The report for the Macrowave Sensors Sub Group was presented by ***Christopher Buck***, ESA/ESTEC, who succeeded Manuel Martín-Neira as MW Sensors chair.

CryoSat: Reported was that CryoSat was launched on 8 October 2005 from Rockot from Plesetsk Cosmodrome. It failed during separation of 2nd and 3rd stages. The failure was attributed to software error. The problem was reproduced on-ground and a go-ahead for future launches have been given.

CryoSat2: There is high motivation for building CryoSat 2. The programme will take 2-3 years. The experimental Campaigns with ASIRAS is set to continue.

SMOS (Soil, Moisture, Ocean, Salinity) 2nd mission within ESA's "Opportunity Missions in Earth Observation" programme. The mission objectives are to retrieve maps of: Soil, Moisture, Ocean Salinity. SMOS is a collaboration between CDTI (Spain), CNES (France) and ESA. The main mission elements include: Platform = PROTEUS (CNES); PLM - MIRAS (Microwave Imaging Radiometer with Aperture Síntesis), developed by ESA, EADS CASA Espacio as main contractor; VILLAFRANCA (Madrid), PLM operational centre; Eurockot - launcher. Anticipated launch date September 2007.

Sentinels

Sentinel-1 "Red" includes: C-band SAR, 100MHz BW, Quad-Pol.; Trade-off on platform: PRIMA or Snapdragon; Phase A KO April 2005; Prime: EADS Astrium

Sentinel-2 "Blue": Ocean mission; Radar Altimeter + Imaging Spectrometer + Radiometer; Trade-offs on: No of satellites, Type of altimeter (SIRAL, SRAL, RA-2), No of radiometer channels (up to 3); KO September 2005; Prime: Alcatel-Alenia Space.

Ice Sounding: P Sounder Demonstrator (TRP/EOEP): Reported was the development of a P-band (435MHz) radar for ice sounding capable of penetrating up to 4km of ice. Radar will be installed in a Twin Otter aircraft. The proof-of-concept flight is to be conducted over Greenland. Contractwas won by Oersted, DTU and DNSC but is start delayed until 2/1/06.

PARIS (Passive Reflectometry and Interferometry System)

PARIS Airborne Demonstrator (TRP – 1.75M)**:** Reported was that on the way is the development of a four-beam PARIS instrument for performing ocean altimetry using reflected GPS signals. The effort is split into four main parts: A – The overall project including Instrument Control Unit (Starlab) mounting into the aircraft (Do228) and flight – Astrium Portsmouth; B – Mutli-beam array – Q-Par Angus; C – Signal Processor – Austrian Aerospace, IEEC, D+T CNM; and D – Digital Beamforming Network and Receiver – Astrium Stevenage. Data processing will be done by Starlab including analysis of UK-DMC data for altimetric purposes provided by SSTL.

Further PARIS activities include: Support to SMOS MDPP-3 campaign by providing ocean roughness measurements (MSS) of the Coast of Norway, March/April 2006; and Passenger Instrument on CryoSat ASIRAS Campaign, Flights over sea-ice, Svalbard, Attempt to recover ice reflected GPS signals, April/May 2006.

PARIS on Ice – UK-DMC Summary: Reported was that 7 seconds of UK-DMC data have been collected over an ice-sheet near Alaska. Both direct and reflected signals were detected across the entire data set. Magnitude and phase of the reflected signal could be used to sense the ice surface.

ASAR Receiver Gain Droop: Use digital coded transponder developed by SEA/Qinetiq under ESA contract to repeat ASAR pulses across swath and so measures directly the receiver gain droop of the instrument. Paper on ASAR will be presented at EUSAR'06.

SurfSat: The instrument is based on modified version of SSTL's UK-DMC micro satellite. The idea is to trail or lead SMOS. Collected will be GPS ocean reflections from within SMOS swath. The goal is to determine ocean roughness (MSS) for those patches. The results will be fed into ocean roughness models. The intent is to improve the accuracy of ocean salinity measurements.

Forthcoming Subgrop Events

1. Workshop on RF Sensors for Earth Observation, Date: TBD/06, Location: ESTEC, The Netherlands.
2. Workshop on GNSS Reflections (applications and techniques), Date: TBD/06, probably June, Location: ESTEC, The Netherlands.

7.5 Terrain Mapping (*Jan-Peter Muller*)

Jan Peter Muller presented the Terrain Mapping Subgroup (TMSG) report.

7.4.1 Subgroup programmatic activities (2005):

Meetings: No Sub-group specific meetings have been held since 15 June 2004 (EDC).

PERS special issue dedicated to SRTM and application: In Feb06 will be published a Special Issue of Photogrammetric Engineering and Remote Sensing on "The Shuttle Radar Topography Mission – Data Validation and Applications". The call for papers have closed on 1 July 2005. The issue is edited by Dean Gesch (EDC), JPM (UCL) and Tom Farr (JPL). 53 papers were submitted, editors whittled this down to 15 to be sent out to 3 peer reviewers/paper. The overwhelming response has caused a few authors to complain that not all 53 papers were sent out to peer review but this was both impractical and would not meet PERS policy of only one special issue dedicated to SRTM and application.

SRTM conference was held at the USGS National Mapping Centre, Reston, Virginia, USA from 14-16 June 2005. The workshop was co-sponsored by USGS, NASA, NGA, ISPRS and CEOS-WGCV. Participated 183 attendees from 18 countries. Extremely positive feedback from attendees.
The conference web-site includes final program including all abstracts
http://edc.usgs.gov/conferences/SRTM/WorkshopProgram.html
A subset of all presentations, converted into PDF is available by anonymous ftp from
ftp://edcftp.cr.usgs.gov/pub/edcuser/gesch/outgoing/SRTM/Workshop/

WTF: A significant progress was reported on WTF (test site dossier). SRTM DEMs have been added to all test sites, where available. No progress have been made on obtaining 30m SRTM-DEMs for all TMSG test-sites.

EO Data Portal: Significant progress have been made on the EO Data Portal - CEOS-WGISS ICEDS. Reported was the addition of ASTER-stereo DEMs as WMS layer so all SRTM gaps (including above 60ºN, below 56ºS) can now be evaluated as to whether ASTER-DEMs are available

Future activities include:

Report on ISPRS meeting written by JPM (UCL) submitted to BNSC will shortly be posted on ICP2 web-site http://www.icp2.net/. This report will form the starting point for articles in AGU-EOS transactions (led by Dean Gesch), ISPRS Highlights (led by JPM) and if possible CEOS Newsletter (led by JPM, advice sought on mechanics of this).

TMSG working meeting is planned for the afternoon of 2/12/05 at ESA-ESRIN (immediately after FRINGE05). Discussed will be the following: TMSG test-sites: expansion to include sites in Africa, Asia and South America; Known issues web-site : planning issues; Best practice document revisited; Recent progress on spaceborne DEMs (SPOT5, X+ERS-tandem of Italy/Switzerland); Quality assessment of GETASSE30 DEM employed by ESA for all systematic EO processing; Global GCP extraction from EO high resolution datasets (e.g. Landsat, ERS-IQL, SPOT, SRTM-amplitude); TMSG working meeting planned for ISPRS Commission IV Symposium (Goa, India, September 2006); CEOS-WGISS EO Data Portal project currently working towards; Addition of edited 3" SRTM DEMs (both WMS and WCS); Addition of SRTM-derived land-water mask as vector layer (both WMS and WFS); Addition of NASA JPL-onearth cascaded SRTM backscatter mask mosaic (WMS); Addition of NASA-GSFC-cascaded ICESAT-GLAS profiles; In concert with ISPRS, plan to revisit international standards for specification of orbital elements.

7.4.2 Status of spaceborne DEMs
Coarse resolution production and validation

USGS-EDC-GTOPO30 and NOAA-NGDC/CEOS-GLOBE1 (30"≈1km) from Best Available Data (primarily US-NGA DTED1/0 and US-NGA-DCW) released in the mid-1990s. Detailed QA performed by NASA EOS-DEM Science WG. GTOPO30 operationally used for NASA-EOS processing.

ERS-derived Radar Altimetry Corrected Elevation (ACE) at 30" (≈1km) developed under ESA funding by P. Berry (de Montfort University). No independent or thorough validation yet performed.

SRTM30 - merger of unedited SRTM (averaged from 1->3->30") with GTOPO30. No independent or thorough validation yet performed.

GETASSE30 - ESA-ESTEC (M. Bouvet): merger of ACE-SRTM30-EGM96. No independent or thorough validation yet performed. Used operationally for MERIS data processing. See later for details.

ICESAT: major problems with 2 out of 3 lidars for global data acquisition. Data acquisition limited to 1-2 month acquisitions, 3 times/year. However, significant improvement in polar landmass heights for Greenland and Antarctica and substantial new data on vegetation/biomass.

Medium Resolution (30-90m)
Production**:**

ERS-tandem IfSAR: (raw data acquired primarily in 1995/6) global coverage. Few national DEMs have been produced (UK-LANDMAP, Switzerland-SARMAP, Italy-Telespazio). Limited by atmospheric WV refraction effects although PS solution feasible if sufficient scenes are available (mostly Europe). No dedicated DEM processing project.

SRTM: (X-: DLR/ASI; C- NASA/DoD). Near global coverage (80% of landmass).

ASTER: Stereo coverage based on individual requests and limited processing duty cycle. After 5 years, most of the Earth's surface is covered in cloud-free stereo acquisitions but limited processing capabilities at EDC (2-3 DEMs/day) have restricted available relative DEMs. Increasing number of low-cost ASTER-DEM commercial software. Cost (COFUS) of ASTER level 1 data still an issue for large-scale systematic DEM production. JPM will negotiate TMSG access to ASTER-DSMs for test sites.

SPOT-5 (and SPOT1-4): IGN/SPOT working on global commercial 10m DEM but no report since 6/04. JPM to negotiate access for TMSG to SPOT5-DSMs for TMSG test site areas.

ALOS (PRISM). There is and update on the launch-date (Q1/2006). GSI plan to contribute test sites in Asia. JPM will negotiate access for TMSG to PRISM-DSMs.

Validation:

ERS-tandem IfSAR: Validation results in the public domain are limited to the UK-LANDMAP project http://www.landmap.ac.uk and the TMSG web-site presentations.

SRTM: (X-: DLR/ASI; C- NASA/DoD). Consensus that SRTM-DEMs from X- and C- meet DTED-2 specification for height (Zrms≤8m) dependent on radar penetration of vegetation/built settlements.

ASTER: USGS tests indicate that RMSExyz<<30m with 9≤RMSEz≤20m depending on date of acquisition, accuracy of orbital modeling and quality of GCPs.

ICESAT: For flat, non-vegetated areas an intercomparison with (6-foot footprint) airborne lidar DEM shows: 0.1±0.22m.

Future requirements for validation

All global-scale products from NASA and ESA instruments are orthorectified using DIFFERENT DEMs with differences of up to several hundred meters. The GTOPO30 and SRTM3 DEMs have been extensively validated and this validation documented. However, no such validation has yet been performed of SRTM30, especially of the latest edited version of the DEM. No validations have yet been performed of GETASSE30 and this only includes the unedited SRTM30 which has many artifacts. There are no current "Known Issues" documentation of what impact the use of GTOPO30 or GETASSE30 artifacts has on derived global-scale land surface products.

There is an urgent need for NASA and ESA to validate these new DEMs and ensure interoperability between global-scale products in high relief areas (such as Greenland) as well as tropical areas to ensure that when data products may be merged in future, DEM artifacts will not dominate the signal

WGISS/WGCV Test Facility (WTF), status and issues:

A significant development of the WTF facility was reported. The Puget Sound test site is populated with 30m SRTM (finished NGA-supplied called SRTM-DTED2®), all other NASA and ESA datasets and airborne lidar datasets. All US WTF sites now have 1"(30m) SRTM-DTED2® and all non-US have 3"(90m) SRTM-DTED1®.

In near future the WG would like to extend WTF to include: Other spaceborne DEM products (e.g. GETASSE30) for Puget Sound (e.g. SPOT-5, ERS-tandem, ALOS-PRISM); Land cover information (US-NLCD at 30m, MODIS and GLC2000 at 1km and GlobCover at 300m); Add other TMSG test sites in Europe (North Wales, Barcelona, Aix-en-Provence). A question was raised, as to how this will be supported as there are no committed resources and the future of transitioning WTF to an operational service is not agreed.

This also applies to "Known Issues" which TMSG would like to kick-off using SRTM DEMs at EDC. However, it is hoped that if CEOS Plenary agree to the relevant Recommendation that this can go ahead.

SRTM workshop strongly endorsed recommendation for establishment of "Known Issues" web-pages for SRTM.

WGISS EO Data Portal Objectives and Update on ICEDS wrt TMSG

●Drill-down to anywhere on the planet to scales of 1:25 000 (30m) for colourised hill-shaded SRTM-DEMs (unedited at present)

●Find out what archived DEM data is available for anywhere (e.g. NASA ASTER, courtesy of EDC) to fill gaps in SRTM DEMs

●Explore change (e.g. Landsat 5 to 7) using transparency and flicker and context (e.g. rivers, transportation networks) including SRTM-derived water features

●Interactive exploration of geographical relationships at the continental and global scale (e.g. sea-level rise impact of global population)

http://iceds.ge.ucl.ac.uk

TMSG Recommendations to CEOS Plenary:

Background: It has previously been agreed that spaceborne DEMs will be used preferentially for georadiometric processing of other EO data products. The existence of ACE and SRTM global DEM products is acknowledged. Current georadiometric processing at NASA uses non-EO data sources of dubious quality containing many artifacts. Current georadiometric processing at ESA uses an unvalidated DEM (GETASSE30)

WGCV Requirement: Spaceborne DEMs should only be used for georadiometric processing if and only if their errors and artifacts have ben fully characterised

Recommendation: CEOS recommends member space agencies evaluate the impact of using different sources, especially space-based DEMs for georadiometric processing of EO data products. CEOS further recommends that quantitative evaluation of spaceborne DEM products be performed and published as part of any future web infrastructure for validation

WGCV Follow-up Activities: TMSG offer to provide, with suitable resourcing, the error characterisation required of these spaceborne DEMs as well as examples of "Known Issues" with downstream products caused by errors in the DEMs used for georadiometric processing.

7.6 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: Act as a forum for international technical interchange on the evolving methodologies, techniques and equipment of SAR data processing, calibration and validation, To determine standard definitions and calibration-validation requirements for SAR systems, To support changes in CEOS formats and user products as appropriate, To facilitate international cooperative programs in the calibration and validation of SAR systems, To educate the SAR community.

The CEOS SAR Subgroup Action Plan includes:
Annual Workshop/Meeting
Set up standard CAL/VAL sites – inter-sensor comparison
Calibration requirements and techniques for Polarimetry, Interferrometry, POLInSAR

Recent Annual Workshop/Meetings include:
2005 – Jointly Coordinated by DSTO and University of Adelaide in Adelaide, Australia;
2004 - Coordinated by ESA in Ulm, Germany;
2003 – Coordinated by CSA in Saint-Hubert, Canada;
2002 – Coordinated by BNSC in London, UK;
2001 – Coordinated by JAXA in Tokyo, Japan.

13th CEOS SAR Workshop/Meeting (2005)
The meeting was jointly coordinated by DSTO, Defence Science and Technology Organisation (DSTO), Australian Department of Defence and The University of Adelaide. It was held on September 28-30, 2005 in Adelaide, Australia. There were thirty five participants, seven presentation sessions (Calibration I, Calibration II, SAR & Signal Processing, Validation & Applications, Systems, Interferrometric SAR Cal/Val, and POLInSAR) and 29 presentations were made. Each presentation session concluded with a Discussion, Session Summary and Recommendations to WGCV. The workshop proceedings are being produced and then will be distributed on CD by DSTO.

Recommendations from SAR Subgroup: The 13th CEOS SAR Workshop/Meeting Concluded with a the following set of recommendations:

1. Agencies should provide both slightly under sampled and adequately sampled detected products.
2. Characterize boreal forest in Canada, and elsewhere, for use in antenna pattern measurements, at least as a secondary site.
3. Discuss calibration of polarimetric bistatic SAR systems at future CEOS SAR Workshops.
4. Discuss in a session at future SAR Wworkshops the issues associated with SAR processing for wide bandwidth.
5. Agencies should support development and use of physics-based modeling as a tool to aid in the design of future SAR systems
6. All papers supported the use of quad-polarisation for current and future applications and the recommendation is that agencies consider strongly the incorporation of quad-polarisation capability in future SAR programmes, even when the specific mission does not require fully polarimetric data. It is often possible to enhance the system to fully polarimetric capability at very little extra cost,

7. POLInSAR applications in forestry at low frequencies (P and L band) are now mature airborne applications. It is recommended that space agencies consider the exploitation of this new technology in future SAR missions aimed at vegetation mapping.

8. The problems of Faraday rotation and adaptation to terrain variations call for the use of QUADPOL systems and while there are some specific applications that can operate with dual polarisation from airborne sensors, space operation will be compromised by such restrictions. It is recommended that space agencies consider QUADPOL operation for all future L and P band systems.
Issues needing to be considered in optimum frequency of operation include limited spectrum allocation and severe Faraday rotation at P band balanced by wider bandwidth availability (higher resolution products), less Faraday rotation but increased temporal decorrelation at L band. It is recommended that agencies undertake studies of the comparative POLInSAR benefits at L and P band especially for space operation.

9. It is noted that POLInSAR also has important benefits at higher frequencies, C, X and Ku bands for short vegetation, urban structure, forest canopy studies and cryospheric applications. However the state of maturity of polinsar algorithms and techniques at these higher frequencies is lower than at the L and P frequency bands and so it is considered premature for CEOS to make any specific recommendations as yet. However, agencies are urged to consider POLInSAR modes in their future considerations for high frequency sensors, as it is expected that these applications will mature and develop into important new commercial and scientific applications over the next few years.

Forthcoming CEOS SAR Workshop/Meeting (2006): The next SAR workshop will be held towards the end of September or in early October, 2006 at the University of Edinburgh, Scotland. It will be hosted by the University of Edinburgh. The contact person for the meeting is Prof. Shane Cloude.

8 Country and Agency Reports

8.1 **Canada** *(Peter White)*

Peter White, the representative of Canada did not attend WGCV-24. He distributed a journal article (abstract included below, full paper available at http://wgcv.ceos.org/docs/plenary/wgcv24/Staenz_and_Hollinger1.pdf), describing the Canadian activities in hyperspectral remote sensing.

A Canadian Hyperspectral Spaceborne Mission - Applications and User Requirements[1]

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ABSTRACT

This paper outlines the mission performance requirements suggested by the User and Science Team for the Canadian Hyperspectral Spaceborne Mission. This civilian mission focuses mainly on sustainability and environmental issues including the key application areas: forestry, agriculture, geology, coastal and inland waters, and environment (wetlands, climate change, etc.). The mission is currently in its conceptual stage (phase A) to define different mission and instrument scenarios taking into account the established user requirements.

Keywords: Hyperspectral space mission, user requirements, sensor performance, operational requirements.

8.2 **Peoples Republic of China (PRC)** *(no representative)*

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

Michael Rast presented the ESA Calibration/Validation Report.

Introduction: The reporting period for the status report is from the last meeting of the CEOS Working Group on Calibration and Validation on 3-5 March 2005 (WGCV 23) to the next meeting on 8-11 November 2005 (WGCV 24). Calibration and validation activities of the European Space Agency during this period included routine calibration, performance monitoring and algorithm development for ERS-2 & Envisat, planning of calibration & validation for future missions and airborne simulation campaigns.

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. See http://www.knmi.nl/gome_fd/index.html.

ENVISAT

Three and a half year after its launch, the success of the Envisat Mission is well established. There is a constant increase of user demand for Envisat data and services. 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. See also http://envisat.esa.int/

The Envisat satellite is expected to continue its operations until 2010. The main limiting factor of the Envisat mission is the on-board hydrazine. Data access has been substantially improved: MERIS Reduced Resolution and AATSR near real time data are easily accessible on Internet (very soon applicable for MERIS archived data as well). Simplified Category 1 procedures are put in place for data systematically generated (i.e. MERIS RR and AATSR data).

Numerous validation activities have been carried out to confirm that the data received from its ten optical and radar instruments are as accurate as possible. As part of this ongoing commitment, commercial ships equipped with scientific equipment, so-called 'Ships of Opportunity', are now being used to monitor water conditions to compare in-situ data with data from Envisat., as for example the Norwegian Space Centre project validating MERIS (Medium Resolution Imaging Spectrometer) data products making use of the 'FerryBox' project using commercial ships such as ferries to monitor the environmental condition of European seas.

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 were presented at a dedicated workshop in March 2005.

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

Other future missions are currently being studied. See http://www.esa.int/export/esaLP/futuremissions.html

A major Cryosat validation experiment focused on land ice and time-varying penetration of Ku-band radar signal, density measurements in support of ice mass balance estimation and surface topographic effects. First sea ice data collected over the Bay of Bothnia, Finland, in March 2005. Further campaign activities are planned for spring 2006, despite launch failure, covering sea and land ice targets.

For the Soil Moisture and Ocean Salinity Mission SMOS various campaign activities are ongoing and planned to support the planned Soil Moisture and Ocean Salinity retrievals. In November 2005 the coSMOS-2 campaign is being carried out for validating the operation of SMOS and to provide data under varying geophysical conditions which are required for model parametrisation and validation of the L2 prototype processor. An airborne campaign dedicated to salinity retrieval procedure validation is under preparation to take place of the Norwegian coast in spring 2006.

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.

EgyptSAR – this is an initiative to join forces with a currently French national project exploring the surface penetration capability of long wave radar in P- and L-band. First results were already presented.

INDREX-2 (formally BioSAR) – the aim of the experiment is to estimate feasibility of biomass retrieval using P-Band backscatter and advanced interferometric techniques based on polarimetric L-Band data. The data analysis is close to completion.

SEN2FLEX – combines different activities in support of: fluorescence experiments (formally AIRFLEX) for observation of solar induced fluorescence signal over multiple surface targets; the GMES Sentinel-2 initiative for prototyping of spectral bands, spectral widths, and spatial/temporal resolutions to meet mission requirements; the EC Water Framework Directive (WFD) EO projects for the improvement of protection and management of Europe's water resources.

The Calibration Home Base (CHB) (DLR (D))- On behalf of ESA a new imaging hyperspectral spectrometer is being developed for airborne applications. The Airborne Prism Experiment (APEX) covers the entire spectral range from 380 to 2500 nm with a bandwidth under 10 nm at a ground resolution of 2 to 5 m. It should be ready for flight by mid-2006. A Swiss-Belgian consortium is responsible for its development and operation; DLR is providing the aircraft and a calibration laboratory. The laboratory, named the CHB (Calibration Home Base), is currently being installed in the cellar of the DFD's building in Oberpfaffenhofen.

8.4 **Italy** *(Victorio de Cosmo, Agenzia Spaziale Italiana)*

The report for the activities of the host country Italy was presented by *Victorio de Cosmo, ASI, IT*.

Earth Observation was reported to be the top priority of the Italian Space Agency. It is considered that a better understanding of the Complex Physical Systems, like the Earth System, will require more and more sophisticated - sensors with better spatial, temporal, radiometric and spectral resolution. It was reported that ASI

is promoting and funding the development of very challenging sensors for studying the Earth System, including: COSMO/SkyMed Mission; ROSA Radio Occultation Sounder for Atmosphere; and Imaging Spectrometers.

COSMO/SkyMed Mission, 2006-2013: This is a dual mission with global coverage, short re-visiting time, 4 LEO satellites, targeting the production of data for risk management, national security, environmental monitoring, agriculture, forestry, geology, etc.

ROSA (Radio Occultation Sounder for the Atmosphere) is the ASI Radio Occultation Instrument. Main objectives include: Meteorology/Climatology (temperature and Humidity profiles); Space Weather (electrons density profiles in the ionosphere); Solid Earth Physics (POD). The need for global and large number of occultations requires many instruments. ASI is looking to install ROSA on several missions: 2007: OCEANSAT-2, 2009: Aquarius/SAC D, 2010: BISSAT.

Imaging Spectrometers: A complete knowledge of the spectral signature of complex land ecosystem based on large number of spectral channels and contiguous spectral channels in many cases can be more useful than the knowledge of its very detailed geometrical property in many areas, including: security, land and sea operations, etc. Reported was that Fourier Spectrometers - the Mach-Zehnder and the Sagnac spectrometers are planned for a flight on the ASI Small Tecnological Mission. The anticipated launch date of this mission is the first quarter of 2008. Considered for missions are also dispersing spectrometers. In 2001 ASI decided to perform the Phase B activities of a demo and low cost hyperspectral mission called HypSEO (HyperSpectral Earth Observer, diagram of the sensor was presented), with main objectives to validate the Hyperspectral Sensor and testing of the hyperspectral data capabilities. In 2003, the interesting results achieved during the demonstrative program HypSEO convinced ASI to stop the activities in favour of an operational Hyperspectral Mission based on a new advanced payload CIA (Advanced Hyperspectral Camera). Decided was to investigate possible improvements of the HYC payload in terms of: Spatial coverage (Swath) of the hyperspectral channels; Spatial resolution (GSD) of PAN channel; Spectral coverage extension by means of auxiliary instruments (MIR and TIR); Simplification of the overall configuration by using agile satellite (no scanning mirror need).

Reported was that, based on the previous independently performed significant activities in the hyperspectral field (HypSEO,CIA, HERO etc.), the Presidents of CSA (Canadian Space Agency) and ASI (Agenzia Spaziale Italiana) on the 18th of October 2005 have signed an agreement on Cooperation in a Joint Definition Phase of a Hyperspectral Mission. The expected launch date for the joint mission is 2009.

8.5 JAXA *(Kazuo Ohta)*

The JAXA report was presented by ***Kazuo Ohta***, JAXA/EORC. The report focused on the Cal/Val plan for ALOS.

ALOS (Advanced Land Observing Satellite) is JAXA's High-Resolution Earth Observing Satellite. The ALOS mission goals include: Generation of Maps (1/25,000); Regional Environment Monitoring; Disaster Management Support; and Resources Survey.

Description: High-resolution (2.5m: PRISM), Global data collection by Data Relay Test Sat.; 4ton, 7kW; Scheduled to be launched in January 2006.

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.

For Cal/Val, research, application and science please see:
EORC/ALOS: Example of data utilization, RA, K&C, and the technical documents

http://www.eorc.jaxa.jp/ALOS/index.htm
ALOS Project Team site for satellite and sensors development status, **http://alos.jaxa.jp/index-e.html**
EOC/ALOS: For data search and general information after launch,
http://www.eoc.jaxa.jp/satellite/satdata/alos_e.html
HQ/Topics : General information **http://www.jaxa.jp/missions/projects/sat/eos/alos/index_e.html**

8.6 **NASA** *(Garik Gutman)*

Garik Gutman, Land-Cover/Land-Use Change Program, NASA Headquarters, presented the NASA agency report. The report focused on the Landsat program including current status, data gap issues and potential solutions.

Current Status: The GEOCOVER-2000 30-m orthorectified Landsat dataset is publicly available. A Global Mid-Decadal Land Survey is needed for studying changes since 2000. Landsat-7 coverage is global, but each scene has data gaps. Landsat-5 coverage is not global and the satellite is 20-yr old!

Future Prospects: In 3 years(2008-2009) - Landsat-5 will be out of fuel, Landsat-7 has high risk of a gyro failure, No firm plans for next Landsat. NPOESS/OLI is unlikely, LDCM free flyer is probable (cautious optimism). A strategy for a 2010 global dataset is needed. Landsat-7 data alone are insufficient for producing high-quality, regional-to-global LCLUC products (Scan Line Corrector failed the end of May 2003; L-7 composites from 2-3 consecutive images are still inadequate for LCLUC studies in areas with persistent clouds and/or significant seasonal changes.

Potential Solutions

1. Cobble together adequate-quality Landsat-7 composites with all available Landsat-5 scenes during 2004-2006 period for seasons compatible with the GEOCOVER-2000 data
2. Fill the gaps with other Landsat-like data (ASTER, ALI, SPOT, IRS, CBERS, etc.)
3. Principle of redundancy: for each pixel as much information as possible from Landsat-like sources: L-7, L-5, ASTER, ALI, etc. ALI, ASTER, SPOT May complement Landsat Scenes.

Summary of Goals

1) Develop a Global Mid-Decadal Dataset (circa 2005) with Landsat-like spatial resolution
2) Develop a strategy for the post-L5 period
3) Gain experience in utilizing non-US sources so that a global high-resolution 2010 dataset can be developed when L-5 is dead and the next Landsat is yet unavailable.

8.7 **NIST** *(Raju Datla for Carol Johnson)*

Raju Datla presented the NIST agency report for Carol Johnson. Reported was that NIST continues to collaborate with Earth observing programs to assess the accuracy of the radiometric characterization and calibration of flight sensors, as well as field equipment.

The presentation focused on the following activities/topics:

Robotic Lunar Observatory (ROLO) scale for radiance based on VEGA differs from NIST ROLO collimator based scale by more that expected. Tom Stone at USGS/ROLO and NIST staff addressing this problem.

Total Solar Irradiance Workshop: Hosted by NIST, July 18-20, 2005. Address the observed difference of 5 W/m^2 between the latest TIM and the old ACRIM series radiometers.

Upcoming NPOESS Calibrations: The NPOESS CrIS blackbody will be tested at the NIST MBIR Facility

New Collaborations : NIST and Utah State University (USU), Logan, Utah, signed a MOU; NIST and Space Dynamics Laboratory at USU started collaboration to work towards SI traceability for Space Based Sensors;

Upcoming meetings: CALCON meeting (October 2006); Achieving Satellite Instrument Calibration for Climate Change (ASIC3) Workshop (May 2006).

NIST Recommendations: Artefacts, such as filters and plaques for down-stream characterization as needed after launch, programs should produce and archive "witness samples"; "Witness samples" could be from the flight set, in order to ensure reproducibility of determined parameters.

8.8 NOAA *(Mitchell D. Goldberg)*

Mitchell D. Goldberg, NOAA/NESDIS, Office of Research and Applications/Satellite Meteorology and Climate Division presented the NOAA agency report.

Stated was that NESDIS/ORA is developing an integrated cal/val system to support GEOSS objectives. **NOAA N18 on-orbit calibration (ORA) activities** reported include: Monitor and quantify instrument noises though analyzing calibration target counts and channel space view measurements; Assess instrument geolocation biases and co-registration and provide recommended solutions for satellite raw, roll and pitch adjustments; Characterize other systematic biases in radiance through rigorous forward modeling and inter-satellite calibrations; Provide initial demonstration and assessments of NOAA-18 data for improving numerical weather prediction; Validate product algorithms (e.g. ATOVS and MSPPS, TOAST, UV index, NDVI, SST, AOD) for transition into operation; Communicate with NOAA-18 OV team, instrument vendors and users with timeliness diagnostics of instrument performances and provide root cause analyses.

Presented was an **update on the calibration/validation activities at NOAA/NESDIS** in prelaunch/postlaunch calibration, and validation of atmosphere, ocean, and land products. Introduced was the 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. Reported was that NOAA is adapting the current satellite intercalibration techniques to NPOESS and Metop.

In addition, a briefing on the development of the Integrate Sounding Retrieval Processing and Validation System was provided. 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.

The important role that NOAA/NESDIS plays in the calibration/validation of National Polar-orbiting Operational Environmental Satellite System (NPOESS) sensors was reiterated.

Some of the issues stated include: Sustained cal/val is needed and there is little funding; Pre-launch characterization is critical; Number of satellites are increasing rapidly; Resources needs to commensurate with number of sensors; Need reference sites for validation.

NOAA recommendations include: Encourage CEOS agencies to use the expertise of National standards laboratories such as NIST and NPL to help with the organisation and operation of post-launch comparison/calibration/validation activities. In particular, making use of their independence in the development of comparison protocols, analysis of results and uncertainties and the identification of instrument biases through the use of common SI traceable standards as part of the pre-comparison activities.

8.9 NPL (*Nigel Fox*)

The report for the NPL activities relevant to CEOS was presented by ***Nigel Fox***, Quality of Life Division, NPL.

Research programme 1: Focus on field spectroscopy: Reviewing error sources on field spectrometers (e.g. ASD), Aim to provide input for establishment of best practise by IVOS.

Research programme 2:
Design now estabished and work started to develop a field spectral-goniometer for surface BRDF (hemisphere) for NERC; Will also develop optimum calibration/characterisation strategy and standards; Evaluate uncertainties for different target types

Sponsoring Phd at Swansea University to perform sensitivity analysis on inputs needed to derive data products (e.g vegetation cover type, cover fraction, LAI, fAPAR, Leaf chlorophyll, albedo, aerosol optical thickness).

Goals: to identify uncertainty needed now and future; and to determine the potential accuracy possible and consequential demands on future sensors

Activities:
Some recent interest in the UK regarding TRUTHS + collaboration with NIST. Traceable Radiometry Underpinning Terrestrial- and Helio- Studies (TRUTHS) is a satellite mission to make SI traceable measurements of solar radiation incident from the Earth, and to transfer it's calibration accuracy to other satellite based EO instruments.

Starting to plan our prospective programme for post 2007

Promotion of Cal/val e.g. CCPR (Consultative Committee of Photometry and Radiometry (International committee of SI). CCPR & WMO planning to hold joint workshop on the importance of SI traceable measurements to monitor climate change

NCAVEO (Network for Calibration and Validation of Earth Observation data). This is an UK based "knowledge transfer network" led by Univ of Southampton, Surrey space centre and NPL, 3 yr funding for website and meeting organisation; Initial objectives/activities similar to IVOS / LPV and thus acts as a UK node for CEOS inputs and outputs to IVOS and LPV.www.ncaveo.ac.uk.

8.10 **UK** (*Gordon Keyte – not present*)

No UK country report at this time.

8.11 **USGS** (*John Dwyer*)

***John Dwyer*,** SAIC/U.S. Geological Survey, National Center for EROS Sioux Falls, SD presented the USGS agency report.

Mission Status of Landsat 7: Reported was Scan Line Corrector (SLC) malfunction (May 31, 2003). The SLC anomaly has not impacted the radiometric or geometric performance for existing pixels. New capability is being developed to improve the SLC-off data products. On May 5, 2004, Gyro #3 has been powered off due to anomalous gyro telemetry. The estimated end of the mission is January 2011, based on remaining fuel and assuming 9:30AM MLT crossing minimum criteria.

Mission Status of Landsat 5: Landsat 5 was switched to Bumper Mode operations in May, 2002. There have been an expansion of the International Ground Station (IGS) network. The estimated end of mission is December 2009, based on remaining fuel and assuming 9:30AM MLT crossing minimum criteria.

Reported was the development of Landsat5 new capability to improve the data calibration: Effective May 5, 2003, L5 TM data is processed and distributed by the USGS/EOS is radiometrically calibrated using a new procedure and revised calibration parameters; Definitive Ephemeris (DE) are generated from available satellite telemetry are now used to generate products. DE improves overall geolocation accuracy and reduces outliers.

Landsat Mission Data Gap: Reported was that the Earth observation community is facing a probable and pending gap in Landsat data continuity before OLI data arrive in 2010, due to: Landsat 5 limited lifetime/coverage, Degraded Landsat 7 operations, Either or both satellites could fail at any time: both beyond design life. Stated was that urgently are need strategy to reduce the impact of a Landsat data gap: Landsat data are used extensively by a broad and diverse community, A data gap will interrupt a 33-yr time series of land

observations during a critical time period. Reported was that Landsat Data Gap Study Team, chaired by NASA and the USGS, has been formed to analyze potential solutions. The objective is to recommend options, using existing and near-term capabilities, to populate the USGS National Satellite Land Remote Sensing Data Archive with science quality data. The approach considered includes the following steps: Identify data "sufficiently consistent in terms of acquisition frequency, geometry, spatial and spectral resolution, radiometric calibration, coverage characteristics, and spatial characteristics with previous Landsat data…".

EO-1 ALI Image Assessment System (ALIAS): ALIAS Goals include: Mitigate the risk associated with losing key knowledge, experience, and personnel before the LDCM mission fully commences; Generate an IAS prototype based on the algorithms and software used for EO-1 ALI and Landsat 7 ETM+ analyses; Reuse Landsat 7 IAS to the maximum extent possible. The ALI data and ALIAS prototype allow the LDCM Project to minimize risks of new technology and ground processing algorithms. It stimulates early research and development of needed calibration and correction algorithms. The effort prepares an instrument team for acceptance testing and On-orbit Initialization and Verification (OIV) Partners in this effort include: USGS/EROS, NASA/GSFC, MIT/Lincoln Laboratories and South Dakota State University.

LP DAAC Status: ASTER - ASTER corrections implemented include: Geometric errors (georeferencing), Earth nutation – correction implemented by GDS, Earth rotation (0-200m day, 0-700m night) - correction implemented by GDS, Height above sea level (0-500m) – to be implemented in ASTER L1A+ PGE in April, 2006, SWIR cross-talk, Stray light from band 4 to bands 5&9 – to be corrected in new delivery of Level-2 PGEs (Linux, S4PM). The LP DAAC will be generating in 2006 ASTER Level-1B and Level-2 products from any Level-1A data in the archive.

MODIS Direct Broadcast: The new geolocation processing code includes terrain correction – corrects artifacts identified in composite products. Data Products include: Calibrated radiances (Level-1B), Surface reflectance, Vegetation Indices (250m, 500m, 1000m), Swath-based and gridded products, HDF and Geotiff formats. Implemented are daily-incremented 7-day NDVI composites for conterminous U.S. using Aqua MODIS.

Commercial Providers and Cal/Val issues : USGS serves users having divergent requirements. Increasingly, these requirements are merging. Stated was an important question: How to maintain transparency required by science when using data provided by commercial providers?

8.12 ScanEx (*Vladimir Gershenzon)*

The ScanEx capabilities and activities were introduced by ***Vladimir Gershenzon***, ScanEx Chair.

ScanEx is a Private Russian company specializing in satellite remote sensing, including: Receiving stations (HW&SW – 39 ScanX, 7 AlliceSC, 81 Liana), Image processing software, Image archiving and distribution, Research in RS and thematic applications. ScanEx maintains a large on line image archive, primarily for Russia. They actively participate in Forest Watch.

9 WGCV Plenary Initiatives/Actions

9.1 WGCV white paper - "Data Quality Guidelines…"

A WGCV Draft White Paper entitled: "Data Quality Guidelines for Satellite Sensor Observations Relevant to GEOSS - *Calibration and Validation Issues*" was generated during the WGCV 23rd Plenary, held from 8 March to 11 March 2005 at CONAE in Cordoba, Argentina.

In response to the request from Plenary for developing recommendations to enable CEOS, and its working groups, to actively participate in GEOSS, WGCV-24 finalized this white paper, addressing the WGCV capabilities and framework for contribution toward GEOSS. The CEOS/WGCV focus is on defining standards and procedures aimed at allowing for the inter-comparison and ultimate utilization of data from all Earth observing platforms, both current and future. WGCV strives to establish common approaches to validation,

calibration and data exchange formats to ensure effective cooperative use of all CEOS member space assets in addressing important global scale problems.

The paper was discussed among all WGCV-24 participants and anonymously approved. A copy of the generated at WGCV-24 paper is provided in the appendix, while the most current version of the manuscript is available on the WGCV web site, at http://wgcv.ceos.org/docs/plenary/wgcv24/WGCV_paper_final_rev3a.pdf.

9.2 Current Action Items

During the WGCV-24 seven new action items were generated, in addition to one action item remaining open from WGCV-23, there are a total of eight open action items as listed in the following table.

CURRENT ACTION ITEMS

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. Transitioning to an operational mode, in the process adding more sites.**	**WGCV-25**
WGCV24-1	**Christopher Buck will jumpstart the activities of WGCV- MWSG on Microwave Activities in 2006 with a session as part of the "Workshop on Radio Frequency Sensors for Earth Observation", Date: TBD/06, Location: ESTEC, The Netherlands.**	**WGCV-25**
WGCV24-2	**Future WGCV-SAR Workshops will address: calibration of polarimetric *bistatic* SAR systems and issues associated with SAR processing for wide bandwidth**	**WGCV-25**
WGCV24-3	**Characterize boreal forest in Canada, and elsewhere, for use in antenna pattern measurements, at least as a secondary site.**	**WGCV-25**
WGCV24-4	**M. Rast and J. Morisette will serve on the organizing committee of the international workshop on: Long term global monitoring of vegetation variables using moderate resolution sensors, 8-10 August 2006, University of Montana, Missoula, Montana, U.S.A**	**WGCV-25**
WGCV24-5	**Define a standard for traceability: document a reference methodology to predict TOA radiance for which currently flying and planned wide swath sensors can be inter-compared.**	**WGCV-25**
WGCV24-6	In response to recommendation 1, raised by IVOS at the IVOS workshop and Committee meeting 14, ESA has undertaken a study activity developing a so-called Cal/Val Portal addressing the three components of the recommendation above.	**WGCV-25** completed

9.3 WGCV Terms of Reference

Recommendation to CEOS/SIT for WGCV Terms of Reference

The proposal by CEOS/SIT for new WGCV terms of reference (TOR) was carefully considered in a separate discussion session among all participants. The (TOR) proposed by CEOS/SIT differed from the TOF under which WGCV currently operates primarily in (1) the term of office for the WGCV Chair and (2) the introduction of a WGCV Vice Chair. Considered were three options:

1) The Chair serves for three years (present situation);

2) The Chair serves for two years with a Vice Chair who serves for two years subsequently succeeding to the Chair (Proposed by CEOS/SIT);

3) The Chair serves for 3 years but at the end of the second year a Vice Chair is added and succeeds to the Chair at the end of the current Chair's term in office.

The prevailing opinion of the group was in favour of the third option, which was voted and approved with a prevailing majority. The modified terms of reference, as approved by WGCV-24 are listed in the Appendix.

9.4 Recommendations to CEOS Plenary-19

After considerable discussion the Working Group unanimously adopted the following 6 Recommendations for consideration at the 19th CEOS Plenary.

Recommendation 1

Background

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

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

There is a need for 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 orthorectification 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

SAR subgroup has established a natural, homogeneous and international site in the Amazon Rainforest for radiometric calibration of SAR systems. The coordinates of the site are: UL: -5.03, -65.67; LR: -9.12, -69.64 deg. There is a strong need of a common man made calibration site with point targets (corner reflectors, transponders etc.) for use by different SAR missions. However, due to lack of funds, no common man made site has been built yet.

WGCV Requirement

It is important that data collected from different SAR satellites are intercomparable for absolute radiometry and therefore proper calibration is required using common reference targets.

Recommendation

Encourage CEOS agencies to use an international site within the Amazon Rainforest with coordinates of (UL: -5.03, -65.67; LR -9.12, -69.64 deg) as one of the radiometric calibration standards. In addition, encourage CEOS agencies to support efforts by the WGCV SAR subgroup to establish and maintain a common man made calibration site for use by different SAR missions.

WGCV Follow-up Activities

The SAR subgroup will acquire and analyse image data over the international site. The results will be presented and discussed at annual SAR workshops and it would be published in the workshop proceedings. The next SAR workshop will conduct activities and coordination required for establishing a man made calibration site.

Recommendation 5

Background

CEOS WGCV notes the growth in number of optical satellite sensors, and the diversity of their spectral and spatial characteristics. It notes that these sensors have been deployed, to meet the needs of both scientific and commercial applications and that the near "operational nature" of data provision from such sensors means that increasing reliance is put on the integrity and reliability of EO data, by governments, international agencies and the commercial sector.

It further notes:

- The needs of the GEOSS identified societal themes for data of guaranteed quality and long term reliability
- that much of this data will soon be the result of, synergistic combination of the products from more than one instrument and often more than one agency.
- that difficulties associated with both pre-flight calibration and more importantly "transference into orbit" means that unacceptably large biases between instruments (even on the same platforms) regularly occur requiring significant corrections to be applied.

- existing strategies for in-flight calibration can provide good long-term stability but not necessarily absolute accuracy, which is required to establish a reference baseline for long-term climate change studies and to secure such records for future generations.
- the specific activities identified in the recently developed strategy document on inter-satellite calibration prepared by WMO.

Recommendation

WGCV recommends that CEOS agencies ensure that all satellite pre-flight calibration activities should include not only an "end to end" system calibration but also of all appropriate sub-system components, and that these should all be made demonstrably traceable to SI units.

CEOS agencies should be encouraged to use SI traceable "benchmark" radiometric reference targets viewable by space based EO sensors to unequivocally quantify and remove biases between optical sensors. Such targets would probably include the Moon, Sun and a number of ground sites e.g. Deserts used by existing missions.

WGCV Follow-up Activities

In response to this recommendation by IVOS raised at the IVOS workshop and Committee meeting 14, ESA has undertaken a study activity developing a so-called Cal/Val Portal addressing the common format for information exchange on instrument characteristics, reference methodologies for radiative transfer procedures and vicarious calibration methods and associated metadata.

Recommendation 6

Background

It has previously been agreed that spaceborne DEMs will be used preferentially for georadiometric processing of other EO data products. The existence of ACE and SRTM global DEM products is acknowledged. Current georadiometric processing at NASA uses non-EO data sources of dubious quality containing many artifacts. Current georadiometric processing at ESA uses an unvalidated DEM (GETASSE30)

WGCV Requirement

Spaceborne DEMs should only be used for georadiometric processing if, and only if, their errors and artifacts have been fully characterised and documented.

Recommendation

CEOS recommends all member space agencies consider using validated space-based DEMs for georadiometric processing of EO data products. CEOS further recommends that quantitative evaluation of spaceborne DEM products be performed and published as part of any future web infrastructure for validation.

WGCV Follow-up Activities

TMSG offer to provide, with suitable resourcing, the error characterisation required of these spaceborne DEMs as well as examples of "Known Issues" with downstream products caused by errors in the DEMs used for georadiometric processing.

10 Date and Place of Next Meeting

The forthcoming WGCV-25 meeting will be held on 9 - 12 of May in Budapest, Hungary.

Annex A: CEOS/WGCV 24 Agenda

Tuesday, 08 November, 2005

13:00 Registration (lunch available in Café after 13:15)

14:00 Welcome from the ESA Host *(Stephen Briggs)*

14:15 WGCV Chair's Report

14:15 Introductions, Approval of WGCV 24 agenda (*Steve Ungar*)

14:25 Report from WGCV chair (*Ungar*)

14:55 WGCV Secretariat update: Approval of WGCV-23 minutes (*Petya Campbell*)

15:10 Review of action items from WGCV-23 (*Ungar, Campbell*)

15:30 Joint WGCV/IVOS Session

15:30 Summary of IVOS subgroup findings (*Michael Rast & IVOS participants*)

16:00 Break

16:20 Joint WGCV/IVOS Session Continues

16:20 CEOS perspective on a productive relationship with GEO (*Ungar*)

16:40 Open Discussion on WGCV contribution to this relationship (*ALL*)

17:45 Adjourn

18:00 Ice-breaker Cocktail

Wednesday, 09 November, 2005

9:00 Reports from Subgroups

9:00 Land Product Validation (*Jeff Morisette)*

9:30 Microwave Sensors (*Christopher Buck)*

9:50 SAR (*Satish Srivastava*)

10:10 Terrain Mapping (*Jan-Peter Muller*)

10:40 Break

11:00 Country and Agency Reports

11:00 Canada (*Srivastava)*

11:15 PRC *(Xiaolong Dong)*

11:30 ESA *(Rast)*

11:45 Italy *(Vittorio De Cosmo)*

12:00 JAXA *(Kazuo Ohta)*

12:15 NASA *(Garik Gutman)*

12:30 NIST *(Raju Datla)*

12:45 NOAA *(Mitch Goldberg)*

13:00 WMO Concept for Global Satellite Intercalibration System (*Goldberg)*

13:15 Lunch

14:00 Country and Agency Reports (continued)

14:00 NPL *(Nigel Fox)*

14:15 UK *(Fox)*

14:30 USGS *(John Dwyer)*

14:45 IPO "NPP/NPOESS calibration/validation" *(Steve Mango)*

15:00 ScanEx capabilities for establishing of decentralized networks *(Vladimir Gershenzon)*

15:15 Presentation on Education *(TBD)*

15:30 Break

16:00 Presentations on *Chris*/*Proba*, *CBERS-2* and *Disaster Monitoring Constellation* *(Rast and Dong, 20 min on each)*

16:45 Preparatory guidance for the working session (10 November) on "*WGCV contribution to GEOSS"*: Charge the group with assignments (*Ungar*)

17:30 Adjourn

Thursday, 10 November, 2005

9:00 **Reports from subgroups** (continued)

9:00 Atmospheric Chemistry (*Ernest Hilsenrath*)

9:20 **Working session on "*WGCV contribution to GEOSS"***

The CEOS perspective on the WGCV relevance/contribution to GEOSS *(Stephen Briggs, on behalf of the CEOS/BNSC Chair)*

Discuss *White Paper/Draft* identifying issues *(ALL, draft was e-mailed to participants*)

Assign participants to working groups

10:20 Break

10:40 **Break into working groups for discussions** *(ALL)*

12:30 **Reconvene as a plenary for reports from the working groups** *(ALL)*

13:15 Lunch

14:00 **Discussion of GEOSS white paper / draft** *(ALL, continued)*

14:00 *Break into working groups to finish discussing any remaining issues*

16:00 *Reconvene as a plenary for summary of the discussions*

17:00 **Review of WGCV-24 action items, Decision on the date and place of next WGCV25 meeting** *(Campbell, ALL)*

17:30 Adjourn

19:00 **Group Dinner**

Friday, 11 November, 2005

9:00 Discussion and finalizing of GEOSS white paper *(ALL, Ungar).*

11:00 Review of WGCV 24 recommendations to CEOS plenary *(Campbell, ALL).*

13:00 Close WGCV 24 Plenary

13:15 Lunch available in Cafe

14:00 Final editing of the WGCV report to CEOS plenary (*Ungar, Campbell, Volunteers welcomed*)

Annex B: WGCV White Paper

Data Quality Guidelines for Satellite Sensor Observations Relevant to GEOSS[1]

Calibration and Validation Issues, Recommendations by CEOS/WGCV to the CEOS Task Force

1. Introduction

Currently, many countries and organizations are collaborating to develop a 10 year plan enabling comprehensive and sustained Earth observations. This Plan, called "The Global Earth Observations System of Systems (GEOSS)", builds upon the existing Earth observation systems by coordinating their efforts. GEOSS addresses critical information gaps through the establishment of criteria for interoperability, sharing of information, reaching a common understanding of user requirements and improving delivery of information to users.

GEO will establish, within 10 years, a system of systems to provide timely data and products for local, national, regional, and international policy makers. In the implementation of GEOSS, harmonization of observations, real- or near real-time monitoring, integration of information from in-situ, airborne and space-based observations through data assimilation and models, and early detection of significant and extreme events is advocated. Integration of in-situ, airborne and space-based observations within the various societal benefit areas will be encouraged, as will the establishment of global, efficient, and representative networks of in-situ observation to support process studies, satellite data validation, and algorithm and model development, as well as the detection, documentation and attribution of change.

The success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata, and products. ***GEOSS interoperability will be based on non-proprietary standards, with preference to formal international standards.***

Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems other than where such affected systems have interfaces to the shared architecture **(from the GEOSS 10 yr. Implementation plan).**

The harmonization of operational data products and the creation of higher level information products such as global maps and time series (from different sensor sources) are required to satisfy the operational service requirements of the societal benefit areas as outlined in the GEOSS implementation plan. The CEOS/WGCV concentrates on defining standards and procedures aimed at allowing for the inter-comparison and ultimate utilization of data from all Earth observing platforms, both current and future. WGCV strives to establish common approaches to validation, calibration and data exchange formats to ensure effective cooperative use of all CEOS member space assets in addressing important global scale problems.

The WGCV Vision:

Empower the climate, environmental and weather analyses and prediction community with sustained high quality observations and associated error characteristics, "*in order to improve monitoring of the state of the Earth, increase understanding of Earth processes and enhance prediction of the behavior of the Earth system" (GEOSS 10 year Implementation Plan).*

2. Data quality assurance strategy

Operational services using data from different Earth Observing satellite sensors and the resulting synergistic data products require satellite measurements whose quality is well characterized and sufficient to produce a meaningful product. Accuracy assessment and reporting of measurement uncertainty is essential to assure product consistency and inter-operability (e.g. comparison/combination). This implies that the instrument calibration and product validation activities need to be continuously monitored and traceable to standards.

In this context, CEOS/WGCV recommends, that all GEOSS partners participate in the establishment of the following common practices:

- Document the methods used to derive and further process satellite measurements. Sensor signals are the starting point for all satellite derived information products. All current and planned Earth observing satellite sensors should be so documented, to enable product consistency and inter-operability (e.g. comparison/combination). Furthermore, standards for quality assurance of these products need to be defined.
- Create and maintain an internet-accessible information database containing, on an instrument or satellite basis, links to all instrument characteristics (including accuracy / precision / stability assessment) needed for ensuring inter-operability. CEOS-WGCV, in conjunction with CEOS-WGISS, will provide guidelines for the database content and format.
- Provide/publish reference methods in a readily accessible form. Calibration and validation material should address pre-flight characterization, vicarious calibration, geo-referencing, radiative transfer computation, data merging etc. The database should also include calibration and validation test-site characteristics and ancillary (meta-) data (see model case CEOS-WGISS-WGCV Test Facility).

Establishment of these practices should be phased in two steps as follows: 1) implementation period and 2) continuous maintenance and update (to accommodate new sensor information and data) throughout the GEOSS lifetime.

Participating countries and Agencies in GEOSS are asked to support these practices by providing adequate resources to produce and supply the appropriate information and data in a timely manner.

A structure for this activity is suggested in Figure 1. The elements needed to implement this system are described below. It is recognized that this activity will take place over the 10 year GEOSS implementation plan and will rely on the best efforts and available resources by all participating countries and agencies.

System Element 1 – Instrument Characteristics

System Element 1 contains the required information on the satellite sensor characteristics and performance, such as its spatial, radiometric, geometric/geo-referencing and spectral properties, as well as the spacecraft orbital characteristics.

Required information/activities include:

- Provision of instrument (system) characteristics and associated performance descriptions in common formats for all sensors and across all agencies,
- Use of common terminology (refer to CEOS/ISPRS Task Force Report) and methods to evaluate the sensor's characteristics,
- Instrument performance checks at regular intervals.

System Element 2 Sensor intercomparison Data

System Element 2 contains satellite and *in-situ* data collected to facilitate sensor inter-comparison and vicarious calibrations over Diagnostic Sites. These data must be incorporated into a readily accessible database available to all GEOSS participants.

Successful achievement of the above is contingent on:

- Agreement on a common, fixed set of diagnostic sites for atmospheric, ocean and land observations by all participants,
- Systematic satellite data acquisition over these sites by all participants,
- Frequent *in-situ* data collection over these sites by all participants,
- Common *in-situ* measurement protocols and site characteristics description,

- Web based distribution of satellite and *in-situ* data in a common format by all participants (currently addressed by CEOS/WGISS-WGCV Test Facility).

System Element 3 Reference Methods and Protocols

System Element 3 contains the documentation describing procedures and methods to establish Data Quality Assurance criteria.

Required documentation includes:
- Guidelines for performing:
  - vicarious calibration,
  - sensor inter-comparison and,
  - product validation
- In-situ measurement protocols
- Data merging guidelines

System Element 4 – Compliance with Interoperability Requirements

System Element 4 addresses the task of interoperability. Following the successful implementation of the first three basic system elements, System Element 4 will establish the requirements for interoperability of information from the different systems elements relevant to GEOSS. WGISS supports the metadata guidelines to ensure that all the ancillary data required for interoperability is ***supplied*** by the data providers. WGCV ensures that the data content of the various data sets can be made "integrable" by providing guidelines indicating which ancillary data needs to be ***acquired*** by the data provider. Thus WGISS sets interoperability guidelines and WGCV supplies harmonization and data/product integratability guidelines.

In this context it is required that:

- Satellite instrument-, diagnostic site- and methodology entries/data are available for the synergistic combination and merging of data from different optical sensors/sources.
- Differences in information products, due to the different observation techniques or system characteristics and different observing conditions (e.g. atmospheric influence), are understood and documented.

3. Detailed system element requirements to guarantee data quality

To allow accurate retrieval of geophysical parameters that meet mission goals it is essential that a comprehensive calibration strategy be built into the system throughout the mission lifetime from initial concept to end-of-life. Ideally instruments must meet thresholds for spectral coverage and resolution, and radiometric performance (accuracy, precision and long-term stability). Instruments meeting these thresholds can be used to anchor instruments that do not meet them.

The building blocks for a calibration / validation system shall include:

- Extensive pre-launch calibration tests to properly characterize instruments and ensure calibration traceable to SI standards
- On-board calibration devices (e.g., black bodies, solar diffusers) where appropriate
- Sustained post launch activities including:

  (a) In situ measurements of the state of the surface and atmosphere (e.g., the Cloud and Radiation Test-bed (CART) site, aircraft instruments with SI traceable calibrations)

  (b) Intercomparison with other satellite observations across the range of spatial and spectral scales
  - Radiative transfer models that enable comparison of calculated and observed radiances both for pre-launch and post-launch CAL/VAL activities
  - Full end-to-end simulation methods and systems
  - Data archive and documentation:

(a) Maintain long term open access to archives, accessible, possibly through 'CAL/VAL portals'

(1) Pre-launch activities:

(a) Full instrument cycle test (including instrument and environmental modeling) to ensure every element is traceable to SI standards where possible

(b) All calibration data and procedures should be documented and kept

(2) Onboard calibration devices:

(a) Should be concept proven and characterized

(b) Should be traceable to SI units

(c) The witness samples should be kept

(3) Post launch requirements include:

(a) Vicarious calibration of ground sites with temporally and spatially stable surface characteristics and generally clear skies, and where possible, observations of the Sun, Moon, and stars, are useful for characterizing calibration drifts of VIS and NIR instruments. If appropriately calibrated from benchmark instruments in space these can be used as reference standards.

(b) Space-based benchmark observations, with the required accuracy, spectral coverage and resolution and traceable to international standards as "gold" standards for validation and inter-calibration of other satellite sensors.

(c) Permanent reference sites and dedicated campaigns to collect in situ measurements of the state of the surface and atmosphere. All instruments used for in-situ measurements should be calibrated and traceable to SI standards.

(d) Satellite inter-calibration from simultaneous and collocated observations:

- Simultaneous observations from collocations between a LEO and all GEO sensors have also been demonstrated and can be used as a means to inter-calibrate GEO satellites. Conversely, an instrument with high accuracy, precision and stability in GEO orbit can be used as a means to inter-calibrate all LEO sensors;Collocated high spectral resolutions observations are important for validating and vicariously calibrating broader band radiometers.(4) Benchmark Radiative Transfer Models, as well as full end-to-end system simulation tools for all sensors must be documented, maintained and openly available.

(5) Data archive and documentation:

- All pre-launch instrument data must be archived with metadata and be freely and openly exchangedConsistent common file format and projection information or tools to perform related processing;
- All collocated observations for satellite inter-calibration must be archived with metadata and should be freely and openly exchanged;
- Special cal/val campaigns using aircraft and ground-based measurements are encouraged and resulting data must be archived with metadata and be readily accessible.
- Space Agencies should share responsibility in providing required sub-samples of satellite observations needed for inter-calibration. These data needs to be easily accessible and free.

All the information provided should be end-user oriented. All delivered products should have associated with them a statement of uncertainty and its level of confidence.

4. Current CEOS/WGCV activities for the generation and validation of data products

WGCV data product validation can benefit GEOSS in the following ways:

- promote quantitative validation of higher level products derived from remote sensing data and relay results so they are relevant to users;

- identify missing cal/val elements in preflight characterization, on orbit operations, and product generation;
- increase the quality, consistency and efficiency of satellite product validation *via* developing and promoting international standards and protocols for remote-and/or in situ sampling, scaling, error budgeting, data exchange for product validation;
- provide templates for mission-long validation and intercomparison programs for current and future earth observing satellites.

CEOS/WGCV specifically recommends that GEOSS use CEOS as follows:

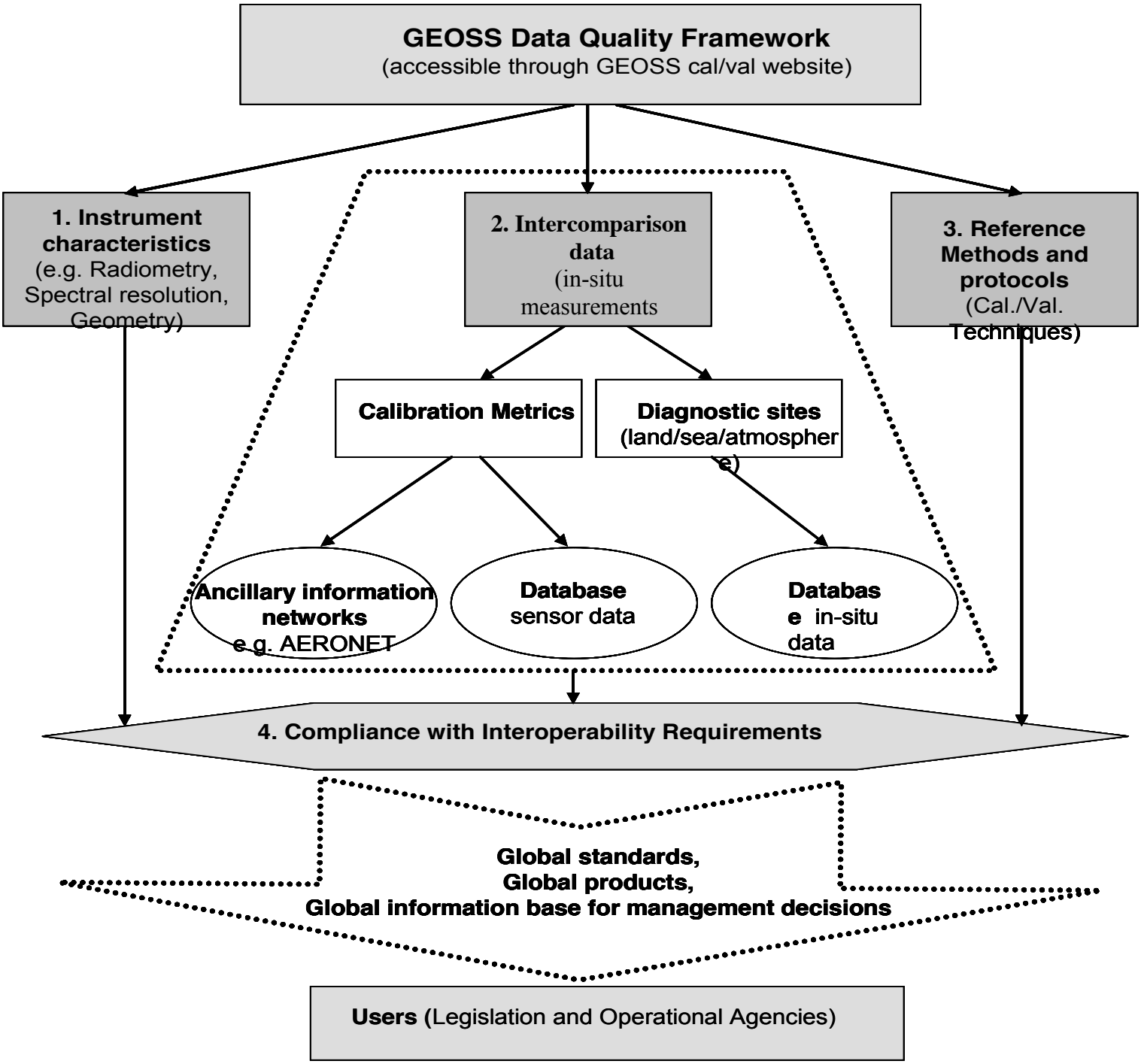
- GEOSS task CEOS/WGCV to serve as a clearinghouse for accuracy statements on CEOS member global satellite-derived products (via enhancements to the existing CEOS/WMO database).
- WGCV will participate in interactive forums, with GEOSS participants, to help determine the practical impact of uncertainty in the satellite-derived products used to support all application areas.

These recommendations will help CEOS WGCV quantify the accuracy of those products critical to the GEOSS focus areas and relay these accuracy figures to GEOSS participants. This, in turn, will set a context for proper use of these products and highlight the strengths and weaknesses of the existing suite of satellite-derived products used to support the focus areas. GEOSS can then advocate both the continued use of the strong components and further development of the weaker components.

5. Conclusion

The approach outlined above ensures the quality assessment of space-borne optical instrument data in the context of a service driven global operational Earth observation remote sensing system. It exploits ongoing work and available expertise among the CEOS working group members, and provides a mechanism for further development over the 10-year timescale of the GEOSS implementation plan.

Figure 1. GEOSS cal/val and data quality assessment framework system elements are highlighted



Acronyms

AERONET - **Ae**rosol **Ro**botic **Net**work

CEOS - Committee on Earth Observation Satellites

CEOS/WMO database - World Meteorological Organization

E.O. satellites – Earth Observing satellites

GEOSS - The Global Earth Observations System of Systems
GEO - Group on Earth Observations

ISPRS - International Society for Photogrammetry and Remote Sensing

Nilu (Norsk institutt for luftforskning) – Database of the Norwegian Institute for Air Research

Sade – Database for sensor inter-comparison for the **Sa**harian **De**sert (ESA/CNES)

SIMBIOS - Sensor Intercomparison for Marine Biological and Interdisciplinary Ocean Studies

WGCV - Working Group on Calibration and Validation within CEOS

WTF – CEOS / WGISS-WGCV Test Facility

Annex C: WGCV Terms of Reference

WORKING GROUP ON CALIBRATION AND VALIDATION (WGCV)

Mission Statement

To ensure long-term confidence in the accuracy and quality of Earth observation data and products, the WGCV provides a forum for calibration and validation information exchange, coordination, and cooperative activities. The WGCV promotes the international exchange of technical information and documentation, joint experiments, and the sharing of facilities, expertise and resources. The WGCV seeks to be the recognized first point of contact for the international user-community as far as calibration and validation is concerned. To this end, WGCV addresses the need to standardize ways of combining data from different sources to ensure the interoperability required for effective use of existing and future Earth observing systems.

Definitions

Calibration: The process of quantitatively defining the system responses to known, controlled signal inputs

Validation: The process of assessing, by independent means, the quality of the data products derived from the system outputs

Membership
Membership in the WGCV is open to all members of CEOS as defined in the CEOS Terms of Reference, including observers and affiliates. Members may include in their delegations to WGCV meetings any participants who have relevant expertise to contribute to the objectives of the WGCV.

Objectives
The objectives of the WGCV are to enhance coordination and complementarity, to promote international cooperation, and to focus activities in the calibration and validation of Earth observations for the benefit of the CEOS members and the international usercommunity. Meeting these objectives will include the promotion of:

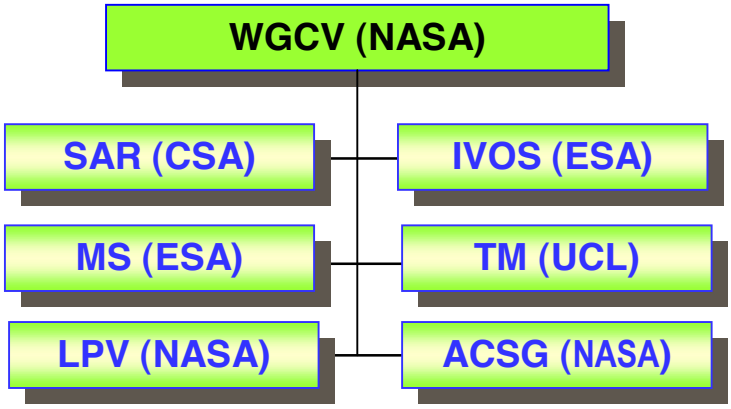
- exchange of technical information and documentation
- investigation of possibilities for technical coordination and cooperation for space and ground segments
- coordination of calibration and validation campaigns and programmes optimizing and sharing of available facilities, expertise, and resource as appropriate.

Specific objectives are:
Sensor-specific calibration and validation - To document and establish forums for the assessment and recommendation of current techniques and standards for pre- and post-launch characterizations and calibration.

Geophysical validation - To document and establish forums for the assessment and recommendation of techniques for validation of geophysical parameters derived from Earth observation satellite systems.

Structure and Procedures

The current WGCV structure is shown below:



- **Synthetic Aperture Radar (SAR)**
  Chair Dr. S. Srivastava, CSA
- **Infrared Visible Optical Sensors (IVOS)**
  Chair Dr. M.Rast, ESA
- **Microwave Sensors**
  Chair Acting - C. Buck, ESA
- **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

Selected Procedures:

- The WGCV shall meet when appropriate, but at least once per year, rotating venue among members. The chairman and secretariat for the WGCV, designated by the plenary, shall prepare and distribute minutes for each meeting. At each meeting of the WGCV, the time, place, and host for the next meeting shall be established. For each meeting of the WGCV, each member shall prepare a report on the member's current and planned calibration and validation activities.
- The CEOS WGCV shall coordinate its work with other international groups involved in related activities, as described in the CEOS Terms of Reference.
- Each CEOS member and affiliate shall designate a point of contact for WGCV correspondence.
- A WGCV Chair will be designated by the CEOS Plenary and will rotate among WGCV members every 3 years. A WGCV chair elect shall be designated by CEOS Plenary towards the end of the second year of the incumbent's term of office. The Chair Elect will serve as Vice Chair during the incumbent's last year in office and shall succeed the incumbent as Chair of the WGCV.
- Subgroups may be established by consensus of WGCV to perform detailed technical work in specific areas. Each Subgroup Chair will be appointed by WGCV, based on nominations from the Subgroup. The WGCV will approve Terms of Reference for each Subgroup. At each WGCV meeting, the Chairs of the Subgroups will report on the Subgroup's progress and plans.
- The WGCV shall work towards developing agreement on common terminology.
- The WGCV shall develop additional procedures as may be required.

List of Participants

	INITIAL	NAME	AFFILIATION	COUNTRY
1	H	BLOOM	NOAA	USA
2	M.	BOUVET	ESA-ESTEC	EU
3	P	CAMPBELL	NASA	USA
4	G	CHANDER	SAIC	USA
5	R	DATLA	NIST	USA
6	V	DE COSMO	ASI	IT
7	S.	DELWART	ESA-ESTEC	EU
8	J	DWYER	SAIC	USA
9	T	FEHR	ESRIN	IT
10	P	FEMENIAS	ESRIN	IT
11	N	FOX	NATIONAL PHYSICAL LABORATORY	UK
12	V	GERSHENZON	SCANEX	RUSSIA
13	N	GOBRON	EC-JRC	IT
14	M	GOLDBERG	NOAA	USA
15	P	GORYL	ESRIN	IT
16	Y	GOVAERTS	EUMETSAT	GERMANY
17	G	GUTMAN	NASA	USA
18	P	HENRY	CNES	FR
19	E	HILSENRATH	UNIVERSITY OF MARYLAND	USA
20	HLA	HUANG	UNIVERSITY OF WISCONSIN	USA
21	M.	KNEUBUEHLER	RSL	CH
22	R	KOOPMAN	ESRIN	IT
23	P	LECOMTE	ESRIN	IT
24	S	MANGO	NPOESS	USA
25	J	MORISETTE	NASA	USA
26	J.P.	MULLER	UNIVERSITY COLLEGE LONDON	UK
27	H	MURAKAMI	JAXA	JAPAN
28	K	OHTA	JAXA	JAPAN
29	B	PINTY	EC-JRC	IT
30	M.	RAST	ESA-ESTEC	EU
31	B	ROSICH TELL	ESRIN	IT
32	R	SANTER		FR
33	H	SCHWARZER	DLR	GERMANY
34	D	SMITH	RUTHERFORD APPLETON LAB	UK
35	S	SRIVASTAVA	CANADIAN SPACE AGENCY	CANADA
36	S	UNGAR	NASA	USA