COMMITTEE ON EARTH OBSERVATION SATELLITES

Working Group on Calibration & Validation (WGCV)

MINUTES OF THE 25th WGCV MEETING

Including the 2nd Joint Session of
the CEOS Working Groups on
Information Services and Systems (WGISS)
and Calibration & Validation (WGCV)

WGCV-25

Hosted by:

Hungarian Association for Geo-information and EOGEO Hungary

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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	Commission Nacional de Actividades Espaciales
COSPAR	Committee on Space Research
CRT	CEOS Review Team
CSA	Canadian Space Agency
CSSAR	Centre 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 Centre
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
GNSS Reflections	Global Navigation Satellite System Reflections

1 Welcome from the official WGCV-25 hosts (*Prof. Ivan Almar, President of Scientific Council on Space Research Hungary*)

Prof. Ivan Almar, President of Scientific Council on Space Research Hungary (specialties in astronomy and space research) welcomed the WGCV-25 delegates. He stressed the importance of the calibration and validation activities in maintaining the accuracy of satellite data products for Earth observations as well as for other planets. He hoped that all present would enjoy their stay in Budapest and have a successful meeting.

Stephen Ungar thanked Prof. Almar for his warm welcome. He also expressed his thanks to **Victor Pusztai** and to the **HUNAGI and EOGEO members and staff** for their efforts in organizing the meeting.

2 Introduction and Approval of the WGCV-25 Agenda (*Stephen Ungar*)

Introductions (*Stephen Ungar*)

The WGCV Chair Stephen Ungar introduced all participants and presented to the WGCV members the new: WGCV/IVOS Subgroup Chair *Nigel Fox* (NPL, UK) and ESA representative *Pascal Lecompte* (ESA/ESRIN). The Chair recognised the *CEOS/SIT* representative *Ron Birk (NASA/HQ)* and the participating for first time country/agency representative of JAXA *Keiji Imaoka*. The logistics of the meeting and the needs of the participants were addressed.

The WGCV-25 Goals and Agenda (Annex A) were approved as presented.

3 WGCV-25 Chair's Report (*Stephen Ungar*)

Stephen Ungar presented the WGCV Chair Report. The Chair's Report included short introduction and background on WGCV since its establishment in 1984, an update on the WGCV subgroups, structure and leadership. It focussed on the role, potential contributions of WGCV to GEOSS and IGOS, and presented background and framework for the current and planned activities.

The following activities were reported: 1) The WGCV report was presented to the CEOS 19th Plenary. The report included 6 recommendations (included as Annex B), which were approved and accepted; 2) The WGCV White Paper, entitled "*Data Quality Guidelines for Satellite Sensor Observations Relevant to GEOSS - Calibration and Validation Issues"*, finalized at WGCV-24, was introduced to the CEOS 19th Plenary; 3) The WGCV goals and terms of reference were reviewed; 4) Progress was made on priority actions defined in CEOS 5 years plan for implementation into the WGCV work plan.

The report focused on the current WGCV priority actions, which are 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 contribute/lead a number of GEO tasks (Annex C), to facilitate the establishment and application of uniform 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 recently updated. Future upgrades will be conducted as necessary information becomes available.

CEOS WGCV Subgroups Chairs (update):

- Atmospheric Chemistry (ACSG) – Dr. E. Hilsenrath, NASA;
- **Infrared Visible Optical Sensors (IVOS) – New Chair Dr. N. Fox, NPL/UK;**
- Land Product Validation (LPV) – Dr. J. Morisette, NASA;
- Microwave Sensors (MW) – Dr. C. Buck, ESA;
- Synthetic Aperture Radar (SAR) – Dr. Satish Srivastava, CSA;
- Terrain Mapping (TM) – Prof. J. Peter Muller, UCL.

4 WGCV Secretariat update (*Petya Campbell*)

- Minutes from WGCV-24 were reviewed, approved and adopted as presented by P. Campbell, WGCV Technical Secretariat.
- Open Action Items from previous meetings were reviewed and the following table reflects their current status.

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.	WGCV25 closed
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.	WGCV25 closed
WGCV24-2	Future WGCV-SAR Workshops will address: calibration of polarimetric bistatic SAR systems and issues associated with SAR processing for wide bandwidth	WGCV25 closed
WGCV24-3	Characterize boreal forest in Canada, and elsewhere, for use in antenna pattern measurements, at least as a secondary site.	WGCV25 closed
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	WGCV25 closed, opened WGCV25-1
WGCV24-5	Define a standard for traceability - NPL document a reference methodology to predict TOA radiance for which currently flying and planned wide swath sensors can be inter-compared.	WGCV25 closed
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.	WGCV25 completed

5 The CEOS perspective on a productive relationship with GEO (*CEOS/SIT Ronald Birk*)

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.

6 Reports from the WGCV Subgroups

6.1 Atmospheric Chemistry Subgroup *(Ernest Hilsenrath)*

Ernest Hilsenrath, the Chair of the Atmospheric Chemistry subgroup presented the report from the AC subgroup.

The current ACSG goals included: Insure accurate and traceable calibration of remotely sensed atmospheric chemistry radiance data and validation of higher level products, for application to atmospheric chemistry and climate research, from Earth Observing satellite missions; and Support the calibration/validation recommendations of WMO/CEOS #140.

In support of these goals it is anticipated that 19 instruments on 10 missions for observing atmospheric chemistry will be flown by 2015.

ACSG Objectives-1 include: 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 include 15 members: CNES, DLR, ESA, NASDA, 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), July ’06 (Beijing)

Update on the Status of Current and Planned ACSG Projects: Collaboration between Aura and Envisat Validation Data Centres (*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*).

ACSG Activities
The Aura validation program is underway.
Envisat Validation Status: Conducted Envisat ACVT Workshop, NASA AO has selected validation team, ESA/Aura/OMI AO validation team is selected, Aura Validation Data Center, B-57 AVE missions are underway, The DC-8 Intex missions are underway.

Operational Metop and NPOESS Chemistry instruments: Cal/Val program underway, NOAA process GOME-2 chemistry data products, Validation Data Center (based on Aura Validation Data Center) is being considered, Post Metop (>2019) planning for atmospheric chemistry.

Envisat Validation

ESA Coordinated: Ground, aircraft, and balloon, main phases are complete; All three chemistry instruments continue operating near nominal; ESA has sponsored the following Validation Workshops: Dec 2002, May 2004., Aura/Envisat joint science team meeting, Netherlands, Nov 2005; Follow on Envisat Validation Workshop is scheduled for December 2006.

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, launched on July 15, 2004.

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

Aura Validation Program – Current and planned programs and activities include: Nine aircraft field campaigns in 2007, which target different environments and seasons to exercise the algorithms - Three major tropical UT/LS campaigns, Two tropospheric campaigns (transcontinental), Polar mini-campaign, Regular mini-aircraft missions (AVE). Ground based measurements for in situ and profile measurements focused on the troposphere. Special high altitude instrumented balloon flights with additional H_2O and O_3 sounds. Aura Validation Data Center (AVDC) for inter-satellite data hosting and mission planning. And Multinational collaboration, including: NASA, ESA, KNMI, FMI, NDSC.

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

As of April, 2006: 220 national and international registered users, 200 + Gb of validation data, 2.5 Tb of subsetted satellite data. In addition to Aura, AVDC supports ACE, OSIRIS, NOAA-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)).

Cal/Val plans for Metop and NPOESS Atmospheric Composition Measurements

GOME-2: Planned is performance verification and long term tracking. Level-1 and Level-2 will be validated with feedback. Revision of algorithm data base is planned for QC. Validation data center planned. The current commitment to reprocessing is not clear.

IASI: The Level 1 validation is executed at the Technical Expert Center at CNES. The Level 2 validation is to be determined (TBD): AIRS heritage, Distributed responsibility.

OMPS: An instrument contractor provides post launch calibration to system contractor with government oversight. The instrument tracking and NRT calibration update is conducted by the contractor. Thee is a Level 2 validation responsibility of the user (NOAA, NASA, DoD). At the present the Cal/Val formulation and implementation is immature.

Chinese BUV ozone instrument

The Chinese National Meteorological Satellite Center (NMSC) plans to fly BUV ozone instrument on FY-3 polar orbiter in 2007. It is a copy of NASA's SBUV/TOMS. NMSC requests NOAA's support for data processing algorithms. ACSG has contacted NMSC about cal/val. A meeting with NMSC has been planned for July 21, 2006 (to discuss algorithms with NOAA/NASA, review US and European cal/val activities, and plan cal/val coordination between US and NMSC).

Sodankylä, Finland Intercomparison
The purpose of the campaign is to resolve the persistent 5-10% differences between satellites and ground stations in polar regions and high SZA where ozone trends appear are the largest. The campaign was supported by: NASA, FMI, ESA, KNMI, NDACC(NDSC). The campaign was hosted by the FMI in April, 2006. The list of participants included Canada, Spain, USA, Germany, Belgium, Netherlands, and France. The ground based instruments included: Ground based: Lidar, Brewer, Dobson, SAOZ, balloon, DOAS; Satellites: Aura, Envisat, and ERS-2.

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. Include aerosol and met sounding validation in ACSG or form new subgroup – No consensus yet by Subgroup. Include CO2 (NASA and JAXA initiatives) in ACSG – under consideration by ACSG. Consider universal policy for publication, referencing and citation of validation data – on going by ACSG. Continue discussions with WGCV for GEOSS involvement.

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?

ACGS Recommendations to WGCV-25:
1. Establish uniform data protocols (nomenclature and formats) for collecting, archiving, and accessing validation data across Earth science disciplines. Aura and Envisat (chemistry) have agreed to maintain validation data protocol uniformity for their respective archives. Validation data are a global resource and cost effective archiving and access must be a high priority. WGISS-WGCV project
2. Consider the role of CEOS Cal/Val in upcoming operational systems (NPP/NPOESS and Eumetsat). The operational EO systems will be the major user for validation data. US and European operational systems are in support of establishing validation requirements and insuring resources.
3. To consider the roles of CEOS Cal/Val in the context of IGOS, GEOSS, and GMES. The next generation EO systems require validation and the sharing global resources. The CEOS WGCV has experience and should play a role.

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

IVOS report (*Michael Rast*)

The Infrared Visible Optical Systems IVOS sub-group to the CEOS Working Group on Calibration and Validation (WGCV) changed its chairman during the 25th meeting of the WGCV in May 2006 in Budapest, Hungary. Nigel Fox of NPL, UK took over the IVOS chairmanship. Michael Rast, the former IVOS Chair, presented the report from the previous 16th IVOS subgroup meeting taking place at ESA-ESRIN in November 2005. The report focused on the elements of satellite systems calibration, which were addressed as part of the White Paper: Data Quality guidelines for Optical satellite sensor observations relevant to GEOSS, which had been initiated by IVOS following the 24th WGCV in Cordoba. He further introduced the subject of *IVOS – GEO – Long-term datasets.*

The objectives of the 16th IVOS meeting were: a) to begin establishing the status of data quality guidelines for optical sensors (mainly imagers) in view of GEOSS; b) to detail the status of current cal/val and data quality procedures/guidelines at instrument level; c) to define the minimum quality requirements of all Agencies and Instrument providers for generic optical imager interoperability relevant for GEOSS; and d) to establish the IVOS Work plan for the 2006-2009 time period.

It was also reported that ESA has initiated a project to develop a web based "Cal/Val portal" as an interface (and depository) for all necessary information to support cal/val and inter-comparison of EO sensors.

Recommendations to CEOS Plenary

The formulation of the Cal/Val requirements for space-borne Earth Observation systems globally was developed by IVOS in support of the WGCV whitepaper entitled "Data Quality Guidelines for Satellite Earth Sensor Observations Relevant to GEOSS *Calibration and Validation Issues*". One of IVOS' main foci during the IVOS 16th subgroup meeting was advancing the "White paper", which was finalized and adapted by WGCV at the WGCV-24 meeting.

In the context of GEOSS it was noted that the interoperability of observing and data systems can only be built on quality assured remote sensing and in-situ data, which are the basis for deriving higher level products and from there information on a global level and for long time series. In the context of GEOSS, IVOS highlights 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. In further notes: 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.

In conclusion IVOS recommends that CEOS develops a collaborative inter-agency program/mission to establish a set of SI traceable standard 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 used by existing missions. Traceability to SI and the assignment and maintenance of a high accuracy radiometric value could be obtained through the support of a dedicated mission.

6.3 Land Product Validation (*Jeffrey Morisette*)

Jeff Morisette, the outgoing Chair of LPV presented the subgroup report.

Chairmanship transfer: Fred Baret has agreed to be the new LPV chair, while Sebastien Garrigues has will be vice-chair.

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. LPV operates under this definition, with the understanding that validation activities should consider user accuracy needs and feedback to algorithm improvements.

Mission statement and goals: to foster quantitative validation of *higher level global land products* derived from remote sensing data and relay results so they are relevant to users; to 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; to advocate mission-long validation and intercomparison programs for current and future earth observing satellites.

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*).

The LPV activities for LAI inter-comparison was addressed by S. Garrigues. The scientific community investigating the associated processes at the regional to global scales is increasingly utilizing high level products corresponding to estimates of state biophysical variables such as leaf area index (*LAI*). Understanding the uncertainty in a given product, and differences between products, is critical for their proper use. Direct validation is required to establish the absolute accuracy of a given product. Product inter-comparison would provide understanding of their differences and would bring an insight on the products and their relative accuracy and help define how multiple products can be used in combination, and how consistent time series can be constructed from different sensors. In addition, inspection of the smoothness of the time series of the products at a given site can yield key information on the sensor and the algorithms performances with regards to cloud screening, atmospheric correction, bidirectional effects, and soil background or understory variations.

Benchmark Land Multi-site Analysis and Inter-comparison of Products (BELMANIP). The goal is to improve the representativeness of the land surface types. It is built from several networks of sites: direct validation sites (VALERI, BIGFOOT…) for which ground measurement of Leaf Area Index or other biophysical variables were available. Site characteristics of importance: sites have some degree of homogeneity within a window of 10 km*10km centered over the site; less than 20% of water bodies

Reports addressing recent LPV activities:

CEOS/LPV "best practices" document completed**:** *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, & Woodcock. The primary findings include: Call for global inter-comparisons, "Hybrid" statistical sampling using fixed sites, Confidence layers (model-based accuracy). Available at the WGCV and LPV web sites.

Special Issue of IEEE Transactions on Geoscience and Remote Sensing *(Morisette, Baret, and Liang guest editors)*, completed March 2006. Papers have been submitted covering land cover, burned area, biophysical (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). Special Issue: describing the state of the art research on both protocol and results for validation and accuracy assessment of global land products. The issue includes three "framework" papers, 19 "validation results" and four "user response" papers - an attempt to solicit "user feedback". It will be available by July, 2006.

The LPV web site has been continuously maintained and updated.

Upcoming LPV meeting/workshop: Global Vegetation Monitoring (August 7th, or the week after IGARSS, Missoula Montana, US). The goals of the meeting include: Increasing knowledge through combined products; Realizing efficiency by avoiding redundancy; and developing near- and long-term plans to avoid gaps in our understanding of critical global vegetation information. Preliminary program: Day 1: program and sensor overview, Day 2: Pilot studies and product-specific break-out sessions, Day 3: Reaction to break-outs and plan development. On August 7th in scheduled, as part of the conference, an LPV workshop on long-term VI (vegetation indices) record.

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 for membership from CEOS. Multi-sensor products offer great potential. The associated algorithms will require an understanding of the accuracy of each sensor's input.

LPV recommends that CEOS WGCV considers both the radiometric comparison (through IVOS) as well as the implication for higher-order, derived products (through LPV). The initial step could be to encourage CEOS

members to provide repeat and continued coverage from the CEOS sensors at the CEOS Land Validation Core Sites.

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

6.4 Microwave Sensors (*Christopher Buck*)

The report for the Microwave Sensors Sub Group was presented by ***Michael Rast*** for ***Christopher Buck*** (WGCV/MW Subgroup Chair, ESA/ESTEC, not present).

CoSMOS-OS

The goals of the campaign were: to use TUD developed radiometer in preparation for SMOS, and to fly out of Stavanger, Norway over a region of the North Sea with sharp temperature gradient. The aircraft is SkyVan operated by Helsinki University of Technology. The aircraft was tasked to fly circles and "sun glint" flights close to: Stavanger/ Newcastle ferry route, and North Sea oil platforms. Sea state is determined using: PARIS receiver for GPS reflections, and coincident ASAR data where available. Circles are difficult to fly perfectly due to wind. The campaign that has been just completed reported difficulties encountered due to: Poor weather, Minor equipment problems and Interruption of ENVISAT services. Nevertheless, invaluable dataset was collected. The collected data will be processed during coming months.

CryoVEx

CryoSat-2 is now approved and the launch is planned in approximately 3 years. The CryoSat Validation Experiment (CryoVEx) is continuing. The current campaign is now underway (May 2006). The equipment consists of: ASIRAS (airborne version of SIRAL = CryoSat radar altimeter), Laser profiler, and PARIS instrument to collect GPS reflections off ice (piggyback experiment). The campaign is based initially on Svalbard, the aircraft will fly out over Greenland collecting measurements over both sea and land ice

Sentinel 3

PCR was held in March. Selected was a dual-frequency Ku- and C-band altimeter (as Jason), with the argument for heritage with S-band second channel of RA-2 outweighed by improved accuracy obtainable with C-band (twice available bandwidth). The current efforts are now concentrated on determining relative benefits of dual or triple frequency radiometers for troposphere correction

PARIS Airborne Demonstrator

CDR was successfully held in April and now the instrument is being built. The first TRRs will be in July. The plan is for completion on schedule for February 2007. The test flight likely to be over "hole" in floor of the Irish Sea. The plan for the campaign is to repeatedly "image" an ocean eddy over a period of a week

PARIS on Vega

The first launch of Vega scheduled for December 2009. PARIS could be a candidate payload – a stripped down version with single wide beam suitable for PROBA platform or a full version with 12 beams on a larger platform (e.g. MicroSat 100).

Forthcoming Events

Workshop on GNSS Reflections (applications and techniques) is scheduled for 14-15 June, 2006 at ESTEC, The Netherlands.

Workshop on RF Sensors for Earth Observation: The workshop is planned for 5-7 of December, 2006 at ESA/ESTEC, The Netherlands. At this workshop is scheduled a dedicated CEOS WGCV Microwave Sensors Subgroup session.

6.5 Terrain Mapping (*Jan-Peter Muller*)

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

1. Terrain Mapping Sub-Group (TMSG) Mission: To ensure that characteristics of digital terrain models produced from Earth Observation sensors at global and regional scale are well understood and that products are validated and used for appropriate applications.

2. S**pecific objectives:** To develop specifications for the generation of '*standardised terrain surface products with known accuracy'* from similar sensing systems in the context of data continuity; to specify evaluation methods and statistics which give transparent information about the *quality and heritage of terrain models*; To update the current dossier of test sites and identify new sites, particularly to satisfy the cal/val requirements of future missions and generally improve access to validation data sets; To keep an up to date record of the current status of sensors which produce data for terrain mapping and of the DEMs available; To produce a DEM requirements document with a science rationale, taking into account the output from SRTM.

3. Relevance of TMSG to GEO and the GEOSS 10-year Implementation Plan: Six out of the Nine Societal Benefit areas state an urgent need for global topographic information of the highest possible quality, reliability and in some cases resolution (particularly disasters). It could be argued that the other 3 areas (weather, biodiversity, ecosystems) have not yet realised the role of topography. Most of the mapping requirements are NOT explicitly discussed but need to be included in future GEO activities.

4. Subgroup programmatic activities (2005/6):

Meetings: Sub-group meeting held on 2 December 2005 at ESRIN immediately following the FRINGE 2006 (technical material available from Prof. Muller)

Special Issue of *Photogrammetric Engineering and Remote Sensing* on "The Shuttle Radar Topography Mission – Data Validation and Applications". Edited by Dean Gesch (EDC), Jan Peter Muller (UCL), Tom Farr (JPL) in March 2006.

SRTM conference (of the same title) was held at the USGS National Mapping Centre, Reston, Virginia, USA from 14-16 June 2005. Workshop co-sponsored by USGS, NASA, NGA, ISPRS and CEOS-WGCV. 183 attendees from 18 countries. Extremely positive feedback from attendees. Conference web-site includes final program, all abstracts and presentations http://edc.usgs.gov/conferences/SRTM/

Significant progress on EO Data Portal - CEOS-WGISS ICEDS: Addition of SRTM land-water mask and global C-SAR amplitude masks. Addition of inter-comparison pull-down menu facilities

WTF: No progress yet achieved on obtaining 30m SRTM-DEMs for all TMSG test-sites for WTF.

5. Future activities include:

CEOS-WGISS EO Data Portal project currently working towards: Addition of edited 3" SRTM DEMs (both WMS and WCS); Addition of NASA-GSFC-cascaded ICESAT-GLAS profiles; Addition of Landsat 5 mosaic (Dr Nevin Bryant, JPL) for North America; Extraction of GCP WFS-WCS database (subject to funding) for GRID-enabled automated geocoding and orthocorrection.

This is in concert with ISPRS, plan to revisit international standards for specification of orbital elements; in concert with the Global Mapping project, plan to co-ordinate the validation of 1:1M scale digital mapping using satellite data; and in concert with the relevant national and international bodies, plan to make a push on the creation of an OGC-compliant global Ground Control Points from global mosaiced Landsat and SPOT5 datasets.

6. 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. Not validated
ERS-derived Radar Altimetry Corrected Elevation (ACE) at 30" (≈1km) developed under ESA funding by P. Berry (Montfort University). No independent or thorough validation yet performed. Not validated
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. Not validated
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. Validation started!

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. No dedicated DEM processing project. Limited validation.
SRTM: (X-: DLR/ASI; C- NASA/DoD). Near global coverage (80% of landmass). Extensive validation performed and current status reported in AGU-EOS 2 May 06.
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. Hopes that WGCV-WGISS Plenary discussions can move this (stalled) process forward.

Medium Resolution (30-90m) 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.

7. An update/overview of the following research projects was presented, addressing the current status and future plans and potential issues.

- ESA merged DEM (GETASSE30) for MERIS/AATSR land processing - Marc Bouvet, ESA-ESTEC
- ICESAT-GLAS assessment - Bob Schutz (UTA) and Dave Harding (NASA-GSFC)
- ASTER DEM status and issues - Bryan Bailey (USGS-EDC)
- C- and X-band SRTM issues - Paul Salamonowicz (NGA) and Marian Werner (DLR)
- HRS onboard SPOT 5 - Marc Bernard
- DEM Production with ERS Tandem and X-SRTM Data in Italy and Switzerland - Frank Martin Seifert, ESA; Mario Costantini, Telespazio; Paolo Pasquali, Sarmap; Rob Verhoeven, Synoptics

8. Report on the TMSG Working Meeting held on the afternoon of 2/12/05 at ESA-ESRIN (immediately after FRINGE05). The TMSG Chair reported that at the meeting were discussed the following topics: 1) TMSG test-sites - expansion to include sites in Africa, Asia and South America; 2) Known issues web-site - planning issues; 3) Best practice document revisited; 4) Recent progress on spaceborne DEMs (SPOT5, X+ERS-tandem

of Italy/Switzerland); 5) Quality assessment of GETASSE30 DEM employed by ESA for all systematic EO processing; and 6) Global GCP extraction from EO high resolution datasets (e.g. Landsat, ERS-IQL, SPOT, SRTM-amplitude).

9. 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 is 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

10. 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.

11. WGISS EO Data Portal Objectives and Update on ICEDS with TMSG: 1) Drill-down to anywhere on the planet to scales of 1:25 000 (30m) for colorized hill-shaded SRTM-DEMs (unedited at present). 2) Find out what archived DEM data is available for anywhere (e.g. NASA ASTER, courtesy of EDC) to fill gaps in SRTM DEMs. 3) Explore change (e.g. Landsat 5 to 7) using transparency and flicker and context (e.g. rivers, transportation networks) including SRTM-derived water features. 4) 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, Agreed at Nov05 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 artefacts. 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 artefacts have been 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. *A question was raised with regard to the progress since 12/05 especially with regard to resourcing*. JPM reported that no significant resourcing had yet been established.

6. 9. 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 is 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

6. 10. 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.

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6. 12.TMSG Recommendations to CEOS Plenary, Agreed at Nov05 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 artefacts. 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 artefacts have been 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 resorting, 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. *A question was raised with regard to the progress since 12/05 especially with regard to resorting.*

6.6 SAR (*Satish Srivastava*)

The SAR subgroup Chair, Dr. Satish Srivastava, presented the report from the subgroup (SG) activities and reviewed the SAR SG 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.

Next CEOS SAR CAL/VAL Workshop/Meeting (14th) will be coordinated by the University of Edinburgh and held in Edinburgh, Scotland, 3rd–6thOctober 2006. It is planned as a 3-day Workshop (4th–6th) and a SAR Tutorial day on 3rd of October. LOC Chairman –Dr. Iain H Woodhouse, School of GeoSciences. The timetable for the workshop is as follows: Abstract Submission 17thMay, 2006; Author Notification 5thJuly, 2006; Presenting Author Pre-registration 14thJuly 2006; Presentation Submission 21stSeptember 2006; Paper Submission 4thOctober 2006; Workshop 4th–6thOctober 2006; Distribution of Proceedings 7thNovember 2006. The Presentation Themes include: Geometry and Radiometry, Calibration Requirements, Calibration Instrument and Site, Calibration Methodology and Tool, Polarimetric and Interferometric (POLIn) SAR, Bistatic SAR, Validation and Application, New Space borne SARs launched in 2006 (e.g., TerraSAR-X, ALOS, RADARSAT-2), Future SAR Missions. For more information please visit the website http://www.geos.ed.ac.uk/research/eeo/events/ceos2006/

SAR Calibration sites

International Amazon Rainforest Site: Recommendation was made and accepted at the 19thCEOS Plenary to encourage CEOS agencies with SAR missions to use the international site as established by the SAR subgroup for calibration. Currently, data is collected and analyzed for calibration monitoring of SAR satellites including RADARSAT-1. Radiometry of the site remains stable as observed from RADARSAT-1. Baseline data is acquired for full polarimetric calibration of RADARSAT-2.

Canadian Boreal Forest (Hearst Region): Since January 2003, RADARSAT-1 data is routinely collected and analyzed for radiometric characterization of the site. Major progress has been made in characterization for summer and winter months for a wide range of incidence angles at C-band. Initial results indicate that it can be used as a secondary site for calibration but with a reduced accuracy compared to the Amazon site.

Multi-Transponder Site in Ottawa: Discussion has significantly advanced for relocation of an ENVISAT ASAR Transponder to a site in Ottawa where a RADARSAT-1 Transponder is located. Relocation is expected to occur in the Summer/Fall 2006 timeframe. Both Transponders can be used simultaneously by C-band SAR satellites (e.g., RADARSAT-1 and 2, ENVISAT) for inter-sensor comparisons.

Recommendations from SAR Subgroup: The next 14th CEOS SAR Workshop/Meeting will review the current activities and plans of the group and generate a set of recommendations for WGCV and CEOS Plenary.

7 Country and Agency Reports

7.1 Canada *(Satish Srivastava)*

The Canada report was presented by ***Satish Srivastava***.

Regarding the **RADARSAT-1 program** was reported that: The program completed successfully ten years of operation; Data is received and processed at 32 ground stations with 22 archive facilities globally, covering real time 80% of world's landmass; As of March 2006, completed 54,255 orbits, planned 230,730 user requests corresponding to a total acquisition of 404,174 minutes of SAR data; Average system performance is maintained better than 95%; and Product quality and calibration are fully maintained. As a member of International Charter Space and Major Disasters, Canada provided SAR data for about 104 Charter emergencies to date. The on board recorder (OBR)2 is not operational, and OBR1 is showing aging effects. An extensive global radar data archive has been built. I-STOP (Integrated Satellite Tracking of Oil Polluters) project for Canadian waters have was made operational in collaboration with other government departments. Spacecraft health and resource utilization appear to indicate a continuation of operation at least until RADARSAT-2 becomes operational in 2007, preferably until March 2009 to support IPY (operational funding an issue).

SCISAT-1 Program Status update was presented. SCISAT-1 was launched in August 2003. SCISAT-1 satellite measures numerous trace gases, thin clouds and aerosols in the stratosphere, thereby enabling a more comprehensive understanding of the several chemical processes that play a role in stratospheric ozone depletion. The satellite has the capacity to receive science data was augmented from 1.1 GB (gigabytes) to 2.9 GB per day by employing two Canadian stations and those of US and European partners. Last year alone the amounts of science data collected were: FTS: 903 GB, Imager: 113 GB, MAESTRO: 22 GB. Data routinely is being provided to the science team.

RADARSAT-2 Program Status
This is the most advanced commercial C-band SAR satellite, with multi-polarization, ultra fine resolution (3 m), swath width range: 20 to 500 Km, and right- and left-looking modes. The launch is scheduled for December 2006. The goal of the mission is to provide data continuity to RADARSAT-1 users.

RADARSAT Constellation (RSATC)
The constellation will consist of 3 satellites in the same orbital plane, equally spaced 15 to 30 minutes apart. The plan is for 5 year development. The plan is that 1 satellite will be launched every year, starting 2011. It will provide on an average daily and complete coverage of Canada's land and oceans at 50 m resolution.

SWIFT and Chinook
The development is continuing, in collaboration with ESA, of an instrument called SWIFT (Stratospheric Wind Interferometer for Transport) to validate complex climate and weather models. SWIFT is to fly on Canadian small satellite bus under a CSA mission called Chinook. Launch is planned for 2009.

International Collaboration
Some of the international collaborations discussed include: CEOS as member since its creation; Canada – USA (RADARSAT-1); Canada – ESA (Associate member of ESA, TIGER Initiative - Canadian investment of $3.4 million for seven R&D projects for water management in Africa under CSA's EOADP (Earth Observation Applications Development Program); Canada – China (MOU CSA – CCRS - Chinese Academy of Sciences (CAS), MOU CSA – CCRS – Institute of Remote Sensing Applications (IRSA)); Canada – Norway; Canada – Finland; International Charter "Space and Major Disasters".

7.2 Peoples Republic of China *(*PRC, *Xiaolong Dong, Heguang Liu, Jingshan Jian)*

The PRC report was presented by ***Xiaolong Dong***, NMRSL/CSSAR/CAS.

Past, current and future missions with Microwave/MMW Sensors were discussed. Past: Multi-mode Microwave Remote Sensor (SZ-4, 2002-2003). Current: Polar-orbit meteorological satellite (2007-2010); Chang'e-1 lunar satellite (2007-2008), Microwave sounder is one of the main payloads of Chang'e-1). Future: HJ-1C Environment Satellite: S Band SAR. (2007); HY-2 ocean dynamic environment measurement mission (~2009); FY-4 geostationary meteorological satellite (>2010).

Re-calibration and validation of MMV data by *in situ* data from ship borne microwave sensors was discussed. Objectives: Calibration, Correction of BT retrieval formula, and Application. Future plans for CAL/VAL of spaceborne MW/MMW sensors: With development of technologies, more and more Chinese missions of earth observation satellites with microwave/MMW sensors are being proposed or being carried into execution. For operational or experimental/operational applications, CAL/VAL becomes an essential requirement for these missions. CAL/VAL is the demerit of Chinese EO satellites. China is now implementing a comprehensive plan for spaceborne microwave/MMW earth observation sensors.

Some of the current and near future tasks/plans (2006~2007) were described. They include the development of CAL/VAL technologies for: 1) passive microwave/MMW sensors; 2) active microwave/MMW sensors; and 3) Research about the construction requirements of the CAL/VAL experiments.

The recent progresses of the Earth Observation Programs with Spaceborne Microwave Remote Sensors was discussed. Background on China's Earth Observation Satellites Series of Meteorological Satellites was presented. Satellites with odd number (1, 3) are in polar orbit. Those include: optical, infrared sensors and since 2003 microwave/mmw sensors. Satellites with even number (2, 4,…) are on Geostationary Orbit. Those include: optical, infrared sensors and microwave/mmw sensors. The ZY-Series (Resources Satellite: Optical Imaging) include CBERS (China-Brazil Earth Resources Satellite); the HY-Series (Oceanic Satellite) include: HY-1 (Water Colour Satellite), HY-2 (Ocean Dynamic Environment Satellite), HJ-Series (Environment Monitoring and Disaster Mitigation Satellite), Optical imager and SAR.

Some of the considerations about the CAL/VAL sites selection and construction for Spaceborne Microwave Remote Sensors were discussed. As part of the implementation of earth observation program with microwave sensors and in a preparation for CAL/VAL, sites selection and consideration had been started and researches had been conducted since 2004. For the Cal/Val sites over land and ocean the polarization difference for the emissivity with different frequencies, and the brightness temperature precision for the different sites were compared.

Calibration and Validation over the Takelimgan Desert
The main rationale for the selection of this site is that: The desert is of large area, which fits well with the large FOV of spaceborne low frequency microwave radiometer. Its stability and homogeneous characteristic from a viewpoint of microwave radiometric. The radiometric behavior can be predicted may be predicted with a significant level of accuracy. It is relatively easy to access a Sand Desert road. Airborne and field experiments can be carried out without too many difficulties.

The need for vicarious calibration of low frequency spaceborne microwave radiometer by monitoring large areas of uniform, stable and known characteristics was addressed. This is especially true for the ongoing L band mission such as ESA SMOS. In tradition, tropical rain forest and calm ocean are used as two-point external calibration sites. But at lower frequency, especially L band, the stability and predictability of rain forest at spaceborne scale are in challenge. In this context, we therefore put forward a proposal to ESA SMOS mission to use the Takelimgan Sand Desert as another choice of vicarious calibration of MIRAS onboard SMOS. The proposal is approved and the desert has been selected as one of the two vicarious calibration sites of the mission (another is Dome C, which is taken care by Italian scientists; rain forest is still under investigation).

7.3 **ESA** *(Pascal Lecompte)*

The European Space Agency Report was presented by the new ESA representative ***Pascal Lecompte***.

Cal/Val Portal

The WGCV/IVOS recommendation for a Cal/Val portal aiming at easing the work related to the calibration and inter-calibration of optical sensors, as well as supporting the validation of their products was taken up by ESA and is currently under implementation. The portal will contain a description of the currently used methodologies, a centralized access to EO satellite data for vicarious calibration and validation, access to in-situ data and a sensor description geared towards those involved in calibration experiments.

On going Studies, a number of investigations are currently on the way: to determine the influence of various parameters on vicarious calibration, for identification of required tools, and for gathering sensor characteristics.

The Cal/Val portal aims at providing:

- a Description of methodologies,
- a Description of instrument characteristics (SensorML),
- an Access to in-situ data, either in a Local database or in External databases (link to Nilu type of Database)
- an Access to tools and Calibration and Validation Results
- a User management, a Forum and an Help

The current status is: The documentation of reference methodology to predict Top of Atmosphere (TOA) radiance for intercomparison of currently flying and planned wide swath sensors is completed (Richard Santer). The instrument characteristics are completed for MERIS/AATSR. There is an existing database of instrument data – MERIS/AATSR/ALOS (Optical).

The Cal/Val portal will be open for ALOS ADEN team only in June, 2006 as a test case. The 1st version will be opened in September, 2006.

Plan for the Cal/Val Portal evolution: The continuation of the WGISS Test Site Facility (WTF) and the evolution of the portal to manage the cal/val data requires: user specific sites, cruise concept, temporal window, data quality criteria, user capacity to edit, Orbit propagator for campaign planning. The integration of KOMPSAT-2 – TBC is pending.

An update on the following ESA on-going projects was reported:

Definition of Quality Products & Cal/Val data centre: This is actually the combination of projects described previously as separate activities - Definition of Quality Products, Third generation Cal/Val Data Centre, The Cal/Val Portal is a third element of that suite.

Test Site characterization study: Test Sites are needed for calibration or validation and those Test Sites need to be perfectly characterized. The selection of test sites depends on the products type we need to calibrate and validate. The study will consist in selecting Test Sites for specific product type and to perfectly characterize subset of selected sites.

Requirement Definition for Multi-Mission Generic Quality Control Standards: So far Quality Control, Calibration, and Validation activities have been setup as dedicated to single missions. The scope of this project is to define the requirements of standards in the context of multi-mission infrastructure.

A summary/report on the following recent ESA campaigns was presented:

- AQUIFEREX,
- BACCHUS-DOC,
- INDREX-II - Indonesian radar experiment,
- SENT2FLEX - Sentinel 2 – Airborne fluorescence experiment
- NezerPyla Experiment

- ESABC 2004: Envisat Balloon campaigns in Kiruna (Sweden), Aire sur l'Adour and Gap (France) and Teresina (Brasil)
- DOMEX - Dome C Experiment
- VAMP
- CRYOVEX - CryoSat Validation Experiments
- WALEX-3 - Wales Experiment
- SISTER - Validation of ENVISAT AATSR Geophysical Products in Opportunity Cruises using the SISTeR Precision Radiometer
- Validation of MERIS marine products at the Aqua Alta Oceanographic Tower (AAOT)
- CoSMOS-2 - Campaign for Validating the Operation of SMOS
- BOUSSOLE - Validation of MERIS marine products
- AMIRAS - Campaign for Validating the Operation of SMOS
- EQUAL – Lidar experiments
- TASTE - Technical ASsistance To Envisat

A short description of each campaign is available in the CEOS-WGCV website

Meetings:

The Second working meeting on MERIS and AATSR Calibration and Geophysical Validation (MAVT) occurred 22-24th March 2006. The proceedings are soon to be published.

The next Atmospheric Chemistry meeting (ACVT) will be held 23-27th October 2006 at ESRIN.

7.4 JAXA *(Keiji Imaoka)*

The JAXA report was presented by ***Keiji Imaoka***, 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**

7.5 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 - updates and potential solutions.

Landsat-7 data alone are insufficient for producing high-quality, regional-to-global LCLUC products: The data is seriously degraded since 6/1/2003, Scan Line Corrector failed (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.

Goals: Develop a global high-res. dataset for 2004-2006 based mostly on Landsat data, Develop a strategy for the post-L5 period, Gain experience in utilizing non-US sources so that a global **decadal** high-resolution 2010 dataset can be developed when L-5 (and maybe L-7) is (are) dead and the next Landsat is yet unavailable.

Comparison of Landsat 5 versus Landsat 7: L-5 allows "consistent", "full-scene" coverage, but will be challenging in coordinating acquisition from a constellation of ground stations; L-7 allows high quality data in non-gap portions of image and a readily accessible archive, but may present problems for change detection and other analyses.

Mid-Decadal Global Land Survey (MDGLS)
Components: Landsat-5 ground stations data where available, Landsat-7 composites, ASTER to fill the gaps, EO-1/ALI over islands, if necessary fill the gaps with foreign data.
USGS leads Phase I – data compilation: satellite tasking, ground station coordination, scene selection, data transfer, ingest into the USGS archive.
NASA leads Phase II – data processing, Process the collected data into an ortho-rectified dataset compatible with previous surveys.
Phase III – development of LCLUC products.

Coverage
Past Surveys' Coverage of Unique Coverage: 1970's: 6,976 path/rows; 1990: 7,037 path/rows; 2000: 8,209 path/rows.
MDGLS will include 9,500 scenes: Better accounting of islands and reefs; Inclusion of the Antarctic continent; Full coverage of Arctic area in 'ascending' orbit.
L5/L7 Combined Coverage: Almost 2/3rds through the imaging opportunity, 87% of the globe has been covered. EO-1 acquisitions over islands and reefs provide some additional coverage

Future
In 3-4 years (2009-2010) Landsat-5 will be out of fuel, Landsat-7will also be out of fuel, and there is a high risk of a gyro failure before that. The next Landsat (LDCM) is likely to occur after 2010. There is a need to develop a strategy for the Landsat-less years. Negotiations with foreign sensor data owners would provide some of the data required. MDGLS could provide a prototype for GEOSS.

Role of the CEOS Cal/Val Group
Phase I: Develop a strategy to intercalibrate non-Landsat sources of information for the mid-decadal project, Assist with access to foreign sensor data sources, Intercalibration of these data, "Stitching" exercises. Phase III: Validation of land cover classification using in situ data. End-of-decade activities: Verification of new sensors data quality, Inter-calibration.

The following issues were raised for discussion:
Two major datasets are being targeted: the mid-decadal (2004-2006) dataset; and a "gap filler" dataset to fill in the data gap between L-7/5 and LDCM. Change detection often presents difficulties when a mix of sensors is used so a heavy emphasis is on one-sensor approach, e.g. Landsat alone. However, now an opportunity exists to prepare to fill the data gap for the Landsat-less period that will likely require a multisensor approach, which in turn is strongly dependent on international cooperation, knowledge/inventory of international data, assets and future plans, and sensor intercalibration. Note that data policy is an issue, which may override availability,

technical issues, and availability. Experimental multi-sensor acquisitions and analysis are required. The link to GEOSS is crucial!

7.6 NIST *(Carol Johnson)*

Carol Johnson presented the NIST agency report. 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.

National Polar-orbiting Operational Environmental Satellite System (NPOESS) & NPOESS Preparatory Project (NPP)

Karen St. Germain and Steve Mango are the prime leads. The major efforts in FY06 include: CrIS blackbody at NIST with TXR, VIIRS reflectance scale, publication of TXR verification of SBRS VIIRS blackbody radiance.

NPP/NPOESS CrIS blackbody: The calibration study is being planned at the NIST MBIR Facility. A preparatory experiment is in progress with NIST blackbody in the MBIR Facility. The CrIS ECT blackbody testing is expected to take place in FY07. The CrIS ICT blackbody testing is planned for FY08.

Test is in preparation for NPOESS CrIS Calibration Blackbody (ICT). The goal of the test is to validate vendor's radiance scale.

Characterization Support for VIIRS (Visible/Infrared Imager/Radiometer Suite): Half An angle Mirror will be used for the infrared reflectance scale comparison. The NIST instrument will be updated with a BIB detector. The bi-directional reflectance distribution function (BRDF) includes: Measurements of samples (UV, Vis, Near IR) and Consultation on reflectance scales. System testing through the solar view aperture aims at the determination of the "Apparent" BRDF of the VIIRS solar diffuser target.

Ocean Colour (NOAA/NESDIS)

This project is conducted by the team of Menghua Wang, NOAA/NESDIS, Ken Voss, UM, Carol Johnson & Dennis Clark, NIST. The FY06 primary efforts include: MOBY operations, Instrument development for vicarious calibration NPP/NPOESS & GOES-R.

Geostationary Operational Environmental Satellite (GOES)

GOES and GOES-R are led by Michael Weinreb, NOAA/NESDIS. The FY06 primary efforts include: Plan for ABI calibration verification efforts; application of TXR measurements of the GOES Imager blackbody source; novel source development.

Novel Sources for GOES-R: The report reviewed the principle design of the spectral platform. The Spatial Light Modulator (SLM) in the design represents new technology. A brief description of the principles of operation of the SLM was presented.

Collaborations

NIST participated with NOAA in meetings with WMO (July 05, March 06) for the developing the draft Implementation Plan for a Global Space-Based Inter-Calibration System (GSICS).

NIST and Space Dynamics Laboratory at USU started collaboration to work towards SI traceability for Space Based Sensors. Some of the activities planned include: CALCON meeting (October 2006), and a workshop on "Achieving Satellite Instrument Calibration for Climate Change" (ASIC3) (May 2006).

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.

Recommendations

Artefacts for down-stream characterization (programs should produce and archive "witness samples")

"Witness samples" could be from the flight set, in order to ensure reproducibility of determined parameters.

7.7 NOAA *(Chiangyoung Cao)*

The NOAA agency report was presented by *Changyong Cao.*

NOAA reported significant progress in recalibration to support climate change detection studies, identified several challenges in climate quality instrumentation, and prelaunch and postlaunch calibration. An integrated cal/val system has been developed for both polar-orbiting and geostationary operational environmental satellites. A GOES-R cal/val working group is formed to support this important future mission.

Recalibration for climate change detection:
NOAA has completed inter-satellite bias quantification for MSU, AVHRR, and HIRS from 1980 to 2003 using the SNO (Simultaneous Nadir Overpass) method in support of climate change detection studies. Scientists begin to use the SNO calibrated data sets to construct time series (e.g., MSU Ch2 mid-troposphere temperature trend reanalysis), and to evaluate the impact of recalibration on products (e.g., aerosols). Recalibration also reveals discrepancies in calibration traceability (e.g., MODIS vs. AVHRR VIS/NIR channels).

Extensive study has been demonstrated with the SNO method. Examples included the impact of SNO calibration on NDVI analysis between N16/N18 AVHRR; Evaluation of the MODIS/Aqua and AVHRR/N16 inter-calibration (at 0.63um) which suggests that the discrepancies are probably caused by differences in on-orbit calibration traceability. Similar discrepancies are also observed at the Libyan and Taklimakan desert sites.

Calibration challenges and opportunities:
With requirements as stringent as ~0.1 K/decade, climate change detection is challenging the state of calibration science and technology. SNO allows us to quantify biases but not to find the root cause.

Understanding the root cause of intersatellite biases is critical for proper bias correction and better future instrumentation. Required are: Climate quality instrumentation - long term stability and degradation in the piece parts of the calibration system; Radiometric quality - PRT, blackbody paint, nonlinearity postlaunch and long term change, prelaunch nonlinearity measurement accuracy, orbital dependency of blackbody performance; Spectral issues - Spectral response functions (SRF): long term SRF shift, SRF cloning; Possible frequency drift in microwave; On-orbit calibration traceability (especially in the VIS/NIR); Improved knowledge of the SNO sites and desert sites; and Using VIS/NIR hyperspectral data for site characterization.

Questions were raised with regard to characterization of calibration sites using hyperspectral data sets: Hyperion: what's the calibration accuracy; AVIRIS: data availability.

GOES-R Cal/Val Working Group and the Integrated cal/val system:
NOAA will take the lead in GOES-R cal/val working group, with members from NASA, Vendors, NIST, MIT/LL, other labs and universities to include pre&postlaunch calibration, long term monitoring of instrument performance, and validation of products. NOAA will leverage on the integrated cal/val system developed for the POES/NPOESS. A comprehensive cal/val plan will be developed during the next year.

NOAA's Cal/Val capability expansion was reported through the Development of an Integrated Cal/Val System, which includes: prelaunch calibration, automated on-orbit instrument performance monitoring, inter-satellite and inter-sensor calibration, cal/val at ARM and desert sites with RTM, Spectral and Spatial calibration, and cross-platform calibration. A web interface has been developed for the Integrated Cal/Val System. SNO is a core component in the Integrated Cal/Val System. Long term time series are to be established at all ARM and desert sites. Example ARM site overpass showed good agreement between RTM and AIRS, but discrepancies in the shortwave Non-LTE, Long wave CO2, and window channels due to surface emissivity need to be addressed with JCSDA.

Concluding remarks / Summary
Recalibration of MSU, AVHRR, HIRS, and SSMI begins to show the usefulness of the SNO/SCO time series for climate change detection studies. Experience as well as lessons learned in recalibration helps NOAA in assessing the GCOS implementation plan and related tasks. GOES-R Cal/Val Working Group is being formed. NOAA is planning to expand the cal/val capabilities with an integrated system to support current and future operational instruments.

7.8 NPL (*Nigel Fox*)

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

The NPL representative summarized the agencies goals and objectives as follows:
Goals: to identify uncertainty needed now and future; and to determine the potential accuracy possible and consequential demands on future sensors.
Research programme 1: Focus on field spectroscopy, especially reviewing error sources on field spectrometers (e.g. ASD) with the aim to provide input for establishment of best practise by IVOS; and
Research programme 2: The design is now established and work has started to develop a field spectral-goniometer for surface BRDF (hemisphere) for NERC. NPL will also develop optimum calibration/characterisation strategy and standards and will evaluate the uncertainties for different target types.

The following current NPL activities were addressed:
ESA Study to improve Quality of EO data:
1. Identification of a set of (if possible) generic "quality reporting indicators" and/or a means of "certification" of data products and their production, appropriate to the needs of their application and those of all stakeholders in the EO sector – data producer and user.
2. Establish a baseline specification of QA /QC tools and procedures needed to ensure implementation of "best practise" for operations of future sensors/missions in the "multi-mission" environment: via analysis of existing missions, to meet needs of applications as specified by users, appropriate adoption/adaptation of practises of non EO industrial sector, for all sensor types.
Validation of data products: require all processing steps (listed below) and data to be QA – "certified".
Pre-flight: User specification, Instrument build compliance, and Calibration. Post-launch: In-flight checks, Ground "Truth" comparison, and Inter-sensor cross calibration. Processed data released: "validated", Uncertainty statement.
NCAVEO (Network for Calibration and Validation of Earth Observation data). This is an UK based "knowledge transfer network" led by University 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.
Comparison/validation exercise through NCAVEO
UK multi-sensor comparison will be conducted June 13-20, 2006. Participating sensors/data include: Spot, DMC, Chris/Proba, Casi, Lidar, Ground spectrometers + BRDF. Location: Chilbolton site, Southern England - Mixed land cover site, 6 X 9 km, Aeronet site.
Objectives: To compare results and techniques from different teams: Traceability and reflectance calibration - all ground spectrometers will be calibrated to NPL standards on site. Validation of biophysical products based on the VALERI protocols. Validation of land cover. Validation of vegetation index products.

7.9 USGS (*John Dwyer*)

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

Stated was that the Landsat Program provides for and updates a national archive of land remote sensing data for distribution to the U.S. Government, international community, and the general public (Public Law 102-555, the Land Remote Sensing Policy Act of 1992, Presidential Decision Directive/NSTC-3 (5/5/94; amended 10/16/00), Management Plan for the Landsat Program). Since land cover change is occurring at rates unprecedented in human history, the Landsat program is of critical importance to science. The Landsat program provides the only medium resolution inventory of the global land surface over time at a scale where human vs. natural causes of change can be differentiated and on a seasonal basis. No other satellite system is capable/committed to even annual global coverage at this scale

U.S. Landsat Archive: An overview of the up to date archive and capability was provided by sensors. ETM+ Landsat 7: 603,112 scenes, 535 TB RCC and L0Ra Data, Archive grows by 260 GB Daily. TM Landsat 4 & Landsat 5: 643,181 scenes, 307 TB of RCC and L0Ra Data, Archive Grows by 40 GB Daily. MSS Landsat 1 through 5: 641,555 scenes, 14 TB of Data.

Mission Status of Landsat 5: Landsat 5 was switched to Bumper Mode operations in May, 2002. There has 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 are processed and distributed by the USGS/EOS are 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.

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.

Landsat Mission Data Gap: Reported was that the Earth observation community is facing a probable gap in Landsat data continuity before LDCM data arrive in 2011. A data gap will interrupt a 34+ yr time series of land observations. Landsat 5 has a limited lifetime/coverage while Landsat 7 has degraded. Either or both satellites could fail at any time: both are operating beyond their design life. **There is an urgent need of a strategy to reduce the impact of a Landsat data gap.** Landsat Program Management must determine utility of alternate data sources to lessen the impact of the gap & feasibility of acquiring data from those sources in the event of a gap. A Landsat Data Gap Study Team, chaired by NASA and the USGS, has been formed to analyze potential solutions. The Landsat Data Gap Study Team is developing a strategy for providing data to the National Satellite Land Remote Sensing Data Archive for 1-4 years. A Technical Committee is considering issues that must be resolved to support strategy (data characteristics & quality, data availability and coverage, data processing and archiving requirements, etc.). A Programmatic Committee is considering project issues and compiling a final strategy document ("GEOSS" data exchange vs. commercial purchase, licensing, project funding, MOUs, data policy, etc.). The possibility of using data from the following systems is considered : IRS ResourceSat – 1, 2 (India); CBERS – 2, 2A, 3, 4 (China & Brazil); Rapid Eye – 1, 2, 3, 4, 5 (Germany); DMC (Algeria, Nigeria, UK, China); Terra/ASTER (US & Japan); High-resolution U.S. commercial systems: IKONOS, Quickbird, OrbView-3; ALOS (Japan); SPOT – 4, 5 (France); EO-1/ALI (US). Reported was on the formation of a USGS-sponsored Landsat Science Team, which would address a range of topics including**:** Applications: with emphasis on those applications that have historically been reliant on Landsat data. Technical needs: especially those of large operational customers (e.g., global change studies, agricultural surveys, disaster assessment, etc.). Instrument functions: including long-term calibration and image geometry and radiometer performance. Data issues: including acquisition strategies, data access requirements and specifications, product characteristics, data management capabilities, data archiving. The Science Team Responsibilities are to: Provide science-based feedback on critical design issues, including instrument and data systems; Contribute to the specification and design of the data acquisition strategy and data access systems; Conduct experiments on science and applications elements of program; Represent the breadth of user perspectives and their requirements on product formats and product generation issues; Provide insights on long-term issues (e.g., gap-filling options, future missions); Consider interoperability of Landsat with other systems currently in orbit or planned for launch within the LDCM operational timeframe; Participate in representation tasks (e.g., provide data for demos or presentations and represent mission in selected forums including scientific meetings).

EO-1 Mission Status: After 5 years on orbit EO-1 is fully functional. Currently it is operating in a lowered orbit extended mission since Sept 27, 2005. It will use all remaining fuel to lower orbit in a controlled manner while maintaining the current Mean Local Time (MLT). The orbit perigee is lowered 5-6 km. EO1 have ceased formation flying with Landsat 7 and left the WRS-2 worldwide grid and it is drifting across WRS-2. It is using 35-day predicted ephemeris for scheduling and maintaining a Mean Local Time (MLT) crossing ~ 10AM. It is

continuing to lower perigee by 1 km every 5-6 weeks. There is a potential to run until 2011 based on remaining fuel.

Status of ASTER L1B On-Demand: Reported was that last year, Japanese and U.S. ASTER partners have agreed to develop and implement on-demand production of ASTER L1B data both by ASTER GDS and the LP DAAC. The approach will leverage the entire L1A archive, increasing the number of L1B scenes available to the user from 400,000 to over 1 million. The system will be implemented during summer 2006.

CBERS-2 Test Downlink: Reported was that the CBERS-2 test downlink at USGS EROS ground station was very successful. This is the first time that the CBERS-2 satellite data was down linked in a country other than China and Brazil. "CBERS in a box" works: The CBERS-2 capture and processing system is a small computer that can perform the following tasks - ingest the raw data, show the image data in a "moving window" display, record the raw data in the computer's hard disk, process the raw data to level 1 products, generate quick looks to populate the Data Catalog of the system and make the level 1 data available to the users.

Long Term Archiving of EOS Data
The issue is addressed by NASA – USGS MOU. A variety of Version0 data sets were transitioned in 2004 (e.g., GLCC, GTOPO30, NALC, SIR-C). For MODIS and ASTER, a pilot project is being investigated to build capacity for: On – demand processing of L2 or higher products from L0 data and product distribution via GLOVIS or Earth Explorer. Options for the LTA product suite are being considered by the USGS Archive Advisory Committee data sieve process and the EOSDIS land products review process.

8 Joint WGISS/WGCV Session

The joint work of the WGISS and WGCV working groups occurred on May 10-11, 2006 and produced the following (below) recommendation to the CEOS Plenary:

Joint WGCV25/WGISS21 Recommendation on WTF/Cal/Val
WGISS Test Facility (WTF) has exceeded its objective and has reached a level of functionality that would qualify pursuing it towards an operational system. Likewise, the ESA Cal/Val portal and the EOS land validation core site infrastructure have grown with a strong perspective towards an operational setup.

Linking operationally the functionalities of WTF and the Portal will serve as a pathway to an interactive Cal/Val. In order to further contribute towards an operational Cal/Val Portal for EO users in a GEOSS environment, the review of the original requirements and mandate for both activities (WTF and Cal/Val Portal) as well as the agreements for sharing of responsibilities and resources are required.

Both WGCV and WGISS are asking CEOS Plenary to play an active role in soliciting support and commitments from the member agencies for sharing the responsibilities for the establishment of an operational Cal/Val portal. To this end, we request the endorsement of a joint CEOS WGCV/WGISS workshop (organized in the June 2007 timeframe) as well as an offer of sponsorship by one of the members, to address the new topics around the WTF, the Portal and their operationalization. WTF and the Portal are to continue activities in 2006 and 2007.

9 Current WGCV 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

WGCV25-1	M. Rast/J. Morisette to report on 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.	WGCV26
WGCV25-2	LPV, NOAA, NIST to post relevant Cal/Val materials and populate the WGCV suggested cal/val practices web site.	WGCV26
WGCV25-3	NIST to generate for the CEOS best practices a description of the Total Solar Irradiance model adopted at WGCV-21 in Beijing (2003).	WGCV26
WGCV25-4	NOAA to participate on the WTF telecoms. Cao will provide a representative.	WGCV26
WGCV25-5	IVOS chair (Nigel Fox) - to address the issue of biases introduced into values calculated from observations due to use of different solar spectral models. Results (spectra and papers) to be posted on WGCV site.	WGCV26
WGCV25-6	WGCV secretariat to post all recommendations on the WGCV site.	WGCV26
WGCV25-7	Pascal Lecompte and the Fred Baret (LPV Chair) to serve as a WGCV organizing panel for organizing in 2007 a WTF portal workshop.	WGCV26
WGCV25-8	Keiji Imaoka (JAXA) to report on the status of ALOS and make test data available for Cal/Val studies.	WGCV26
Action items transferred to WGCV from WGISS or shared by both WGs:		
WGISS21-9 transferred	Pascal Lecompte to develop plans for a Cal/al Portal workshop in June 2007 timeframe.	
WGISS21-10 shared	Jeff Morisette and Lin Olson to report to WGISS-22 with a transition plan for the WTF Core Sites activity (WGISS22).	
WGISS21-11 transferred	WGCV to verify that the CEOS-WGCV Terrain Mapping validation activities are incorporated in the 2007-2009 GEO work plan.	

10 Review of 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.

11 Recommendations to CEOS Plenary-20

After considerable discussion the Working Group unanimously adopted the following Recommendations for further consideration for submission to the 20th CEOS Plenary.

Recommendation 1: Encourage all CEOS members to provide representative data from appropriate sensors over the CEOS Land Validation Core Sites on a continuous basis. These data are to be used for inter-comparison of sensor performance/characteristics and product validation.

Recommendation 2: CEOS to establish and populate a CEOS "best practices" Cal/Val Core Reference Internet Site, to be used for posting WGCV approved documents and procedures, contributing to harmonizing space segment data acquired in support of GEO.

12 Date and Place of Next Meeting

The forthcoming WGCV-26 meeting will be held on October 31-November 3, Chiang Mai, Thailand.

Annex A: CEOS/WGCV 25 Agenda

Tuesday, May 9, 2006

8:30 Registration

9:00 Welcome Address *(Prof. Ivan Almar, President, Scientific Council on Space Research Hungary)*

9:10 Introductions, Logistics and Adoption of Agenda for WGCV-25, Minutes and Status of Action Items from WGCV-24 *(Ungar, Campbell)*

9:45 WGCV Chair Report, WGCV-25 Goals, Contributions to CEOS/SIT for GEO 2006 WP and CEOS Response to GCOS *(Ungar)*

10:30 Break

11:00 Subgroup Reports

11:00 Atmospheric Chemistry - Highlights *(Ungar for Hilsenrath)*

11:15 Land Product Validation *(J. Morisette / S. Garrigues / I. Csiszar)*

12:00 Lunch

13:00 Subgroup Reports *(Continued)*

13:00 Infrared and Visible Optical Sensors *(Michael Rast)*

13:30 Microwave Sensors *(M. Rast for Christopher Buck)*

14:00 Terrain Mapping *(Jan Peter Muller)*

14:30 SAR *(Satish Srivastava)*

15:00 Break

15:30 Country and Agency Reports

15:30 China *(Xiaolong Dong)*

15:50 ESA *(Paskal Lecompte)*

16:10 JAXA *(Keiji Imaoka)*

16:30 NASA *(Garik Gutman)*

17:00 WGCV preparation for the Joint WGISS/WGCV Session

Discussion on the WGCV contributions to CEOS/SIT, toward: 1) GEO 2006 WP and 2) CEOS response to GCOS; Generate items for joint WGISS/WGCV discussion *(All)*

18:00 Adjourn

Wednesday, May 10, 2006

8:30 Host Workshop (for WGCV/WGISS): *Hungarian Activities in Remote Sensing*

08:30 Welcome address **Dr. E. Both** Director, Hungarian Space Research Office

Session A

08:40 **Dr. S. Mihály** Chair, DG FÖMI (with introductory words), Co-Chair/Rapporteur: D.Szendrő (DLAG MoARD)

08:50 **G.Csornai** et al (FÖMI) Operational use of Earth Observation in agriculture

09:20 **G.Büttner** – G.Maucha – B.Kosztra: (FÖMI) Application of Earth Observation in Land Cover Mapping and Change Assessments

09:50 **G. SIPOS** - P. Kacsuk (MTA SZTAKI) Grid Application Support by the P-GRADE Portal

10:20 Coffee Break

Session B

10:50 **Dr. P. Bozó** Chair, MoEnvironment and Water (with introductory words), Co-Chair/Rapporteur: K.Brezsnyánszky (MÁFI)

11:00 **Dr. A.A. Takács** – T.Lőrincz - A.Révész (MoEW) et al: Applicability of Satellite Imageries int he Information System for Nature Protection

11:30 **C. Bíró** et al (Kiskunság National Park) Use of Earth Observation Data in the Kiskunság National Park, Hungary

12:00 Biró M., **MOLNÁR Zs**. and Horváth F.: In-door and out-door interpretation of satellite images by botanists

12:30 Closing Words (**Dr. K. Brezsnyánszky**, on behalf of the Geosciences Committee, Hungarian Academy of Sciences chaired by Prof. J. Ádám)

12:40 Lunch

13:30 Joint WGISS/WGCV Session

13:30 WGISS/WGCV Joint Session Objectives and Agenda *(Petiteville, Ungar)*

13:40 CEOS SIT Requirements for the WGs *(JL Fellous, CEOS SIT / ESA)*

14:00 Evaluation of CEOS Response to GCOS requirements *(Petiteville, Ungar)*

14:45 CEOS Constellation *(CEOS/SIT, Stephen Ward)*

15:05 WGISS/WGCV Contributions to GEO *(Petiteville, Ungar)*

15:45 Break

15:50 Joint WGISS/WGCV Session *(Continued)*

15:50 CEOS Implementation Plan for GEO, WG Actions *(Ron Birk, CEOS/SIT)*

16:30 Further Discussion of WG's Roles in GEO Era *(CEOS/SIT, WGs)*

17:30 Adjourn

19:00 Joint WGISS/WGCV Dinner (No-host)

Thursday, May 11, 2006

8:30 Joint WGISS/WGCV Projects *(WGISS/WGCV Session Continued)*

8:30 WTF-CEOP *(Ochiai/Aizawa, McDonald)*

9:15 WGISS-WGCV WTF Core Test Sites *(Foundeen, Morisette, Dwyer and Muller)*

10:00 CEOS/EO Data Portal Project - update *(Cudlip, Czaran, Muller)*

10:45 Break

11:00 Wrap-up discussions/formulate Joint Recommendation to Plenary *(Petiteville, Ungar)*

12:00 Lunch, Reconvene to WGISS-21 and WGCV-25

13:00 WGCV-25 Country and agency Reports *(Continued)*

13:00 Canada *(Satish Srivastava)*

13:20 NIST *(Carroll Johnson)*

13:40 NOAA *(Changyong Cao)*

14:00 NPL *(Nigel Fox)*

14:20 UK *(Nigel Fox)*

14:40 USGS *(John Dwyer)*

15:00 Break

15:30 Review WGCV open Action Items and generate new Action Items *(All)*

16:00 Generate WGCV Recommendations to Plenary *(All)*

17:00 Discuss date/location for WGCV-26 and candidate for WGCV Chair *(All)*

17:30 Adjourn

Friday, May 12, 2006

9:00 WGCV Reporting to Plenary *(All)*

Finalize the WGCV contributions to CEOS/SIT for GEO 2006 WP and CEOS Response to GCOS

10:30 Break

10:45 WGCV Reporting to Plenary *(Continued)*

Further discussion of *WGCV Terms of Reference* and Potential candidates for WGCV Chair *(All)*

12:00 Close WGCV Plenary *(All)*

12:00 Lunch

13:00 WGCV/WGISS Task Teams – Working sessions

13:00 Wrap-up and write-up *(Ungar, Campbell, **others welcome**)*

Annex B:

WGCV Recommendations approved and accepted by 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 a 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 shape files, 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.

Annex C:

Tasks selected from the GEO 2006 Work Plan for participation by WGCV (as of May 2006)

Task #	GEO'06 Specific Tasks by Societal Benefit Area	WGCV Role	WGCV Responsibility/Action	WGCV Subgroup / Agency	Point of Contact
Disasters					
DI-06-01	Encourage agencies to acquire data over tsunami regions	PARTICIPATE	Participate (CEOSS)	Subgroup Collaboration	Ungar
DI-06-05	Planning production for coastal zones: bathymetry, LU/LC high res. maps and DEM	SECONDARY ROLE	Participate and suggest appropriate LU classes and sources for DEM	LPV/TM; NASA, NPL	Morisette, Muller, Fox
Health					
HE-06-01	Define requr. RE: Human Health, Environment and EO	CONTRIBUTE	Serve as consultants on data quality guidelines	NASA	Ungar, Morisette, Gutman
HE-06-02	WS (workshop) in Geneva	PARTICIPATE	Participate in WS providing guidance with regard to data uncertainty and cal/Val for satellite data	NASA	Ungar, Morisette, Gutman
HE-06-03	Formation of consortia for pilot-projects integrating EO, health and epidemiological as well as socio-economic data	PARTICIPATE	Provide guidance on requir. for integrating EO, by using CEOS cal\Val protocols	NASA	Ungar, Morisette, Gutman
Task #	**GEO'06 Specific Tasks by Societal Benefit Area**	**WGCV Role**	**WGCV Responsibility/Action**	**WGCV Subgroup / Agency**	**Point of Contact**
Climate					
CL-06-01	Mechanism for reanalysis and reprocessing climate data	PARTICIPATE, PROVIDE EXPERTISE AS NEEDED	Provide guidance for, and assistance in, the retrospective calibration of Earth RS data	NASA, NOAA	Ungar, Cao & Goldberg
CL-06-02	Establish actions securing the provision of key data for climate studies and forecasting from satellite systems.	PARTICIPATE, PROVIDE EXPERTISE AS NEEDED	Establish the set of cal/Val procedures needed to meet the objectives	NASA, NOAA	Hilsenrath, Cao & Goldberg

CL-06-03	Establish framework for the preparation of guidance materials, standards for terrestrial EOS for climate. Coordinate mechanisms for terrestrial climate observations.	PARTICIPATE, PROVIDE EXPERTISE AS NEEDED	Determine the cal/Val procedures and information, which must be included in the metadata to meet the objectives	WGCV:	Hilsenrath
CL-06-05	Coordinate with IPY to enhance the utilization of EO	PARTICIPATE, PROVIDE EXPERTISE AS NEEDED	Establish the set of cal/Val procedures needed to meet the objectives	ACSG	Hilsenrath
Water					
WA-06-04	Global data set mapping catchments	WGCV PROVIDE INPUT, SECONDARY ROLE	Participate and suggest appropriate LU classes and sources of data	LPV; USGS	Morisette, Dwyer
WA-06-05	Coordination mechanism for global in situ water obs.	PARTICIPATE, PROVIDE EXPERTISE AS NEEDED	Establish the set of cal/Val procedures needed to meet the objectives	NOAA, USGS	Cao & Goldberg, Dwyer
Ecosystems					
EC-06-01	Support IGCO develop global C observations, particularly *in-situ* CO_2	SUBSTANTIAL ROLE	Determine the cal/Val procedures and information, which must be included in the metadata. Provide guidance for, and assistance in, the retrospective calibration of data.	ACSG	Hilsenrath
EC-06-02	Establish Ecosystems Classification Task Force to create a globally agreed class. scheme	CO-LEAD	Build on the WGCV LC scheme used for cal/Val as a straw man model for meting wider community needs.	LPV, NASA	Morisette, Gutman
EC-06-03	Harmonization of observing methods	TERRESTRIAL PORTION	Establish the EOS/terrestrial set of cal/Val procedures needed to meet the objectives	LPV, NASA and USGS	Morisette, Gutman and Dwyer
EC-06-07	Global network of organizations for ecosystems	PARTICIPATE, PROVIDE EXPERTISE AS NEEDED	Establish the set of cal/Val procedures needed to meet the objectives	LPV: NASA	Morisette, Gutman
Agriculture					
AG-06-03	Begin production of products based on HR global land cover change data set. Propose mechanism. for regular analysis/reporting of LCC.	CONTRIBUTE	Establish the set of cal/Val procedures needed to meet the objectives	LPV, NASA	Morisette

AG-06-04	Assessment effort on forest/forest changes; Ensure appl. of standardized classifications and harmonization of existing datasets.	CONTRIBUTE	Provide expertise as needed, to determine the cal/Val procedures and information, which must be included in the metadata. Provide guidance for, and assistance in, the retrospective calibration of data.	LPV, NASA	Morisette
Biodiversity					
BI-06-05	Facilitate interoperability obs. network	CONTRIBUTE	Establish the EOS set of cal/Val procedures needed to meet the objectives	Subgroup Collaboration	Ungar
Data Management					
DA-06-02	Develop GEO data quality assurance strategy, beginning with space-based observations and evaluating expansion to *in-situ* observations.	WGCV LEADING ROLE	Develop GEO data quality assurance strategy, beginning with space-based observations and evaluating expansion to *in-situ* observations.	IVOS + Others	Rast
DA-06-04	Facilitate development and harmonization of data, metadata, and products for basic maps, LC products	CONTRIBUTE	Participate and suggest appropriate LU classes and sources for DEM	Subgroup Collaboration	Ungar
DA-06-09	Establish GEOSS Best Practices Registry	PARTICIPATE	Establish a cal/Val best practices registry consistent with the GEOSS Best Practices Registry	Subgroup Collaboration	Ungar

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