COMMITTEE ON EARTH OBSERVATION SATELLITES

Working Group on Calibration & Validation (WGCV)

MINUTES OF THE 27th WGCV MEETING

WGCV-27

London, United Kingdom, June 12th –15th, 2007

Hosted by:

National Physics Laboratory (NPL)

and

British National Space Centre (BNSC)

at the

National Physics Laboratory (NPL), Teddington, United Kingdom

Contents

Acronyms

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

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

1 Introduction, Logistics and Adoption of Agenda for WGCV-27 (Changyong Cao and Petya Campbell)

The WGCV Chair Changyong Cao introduced the participants and the new chairs and members, including the WGCV/ACSG Subgroup Chair Bojan Bojkov (NASA/UMBC) and the WGCV/TMSG Vice-Chair Jean-Christopher Lambert, and the new members from Turkey and Thailand. The logistics of the meeting and the needs of the participants were addressed.

A change in the traditional WGCV meeting agenda was proposed. In addition to the traditional sessions on reports and WGCV contributions to GEOSS, the WGCV27 agenda includes also: panel discussions with moderators in some session; and invited keynote speakers, leading experts/scientists on specific issues/tasks. The goal is to establish the connection between decision makers and leading experts for specific action items/tasks.

The WGCV-27 Goals and Agenda (Annex A) were approved as presented.

Session 1: Welcome, Country and Agency Reports

2 Welcome from the official WGCV-27 hosts (Dr Martyn Sene, Director, Quality of Life Division, NPL and Dr. Arwyn Davies, Director, Earth Observation, BNSC)

Dr. Martyn Sene, Director, Quality of Life Division, NPL and Dr. Arwyn Davies, Director, Earth Observation, BNSC welcomed the WGCV group and expressed their pleasure in meeting the WGCV27 participants. **Dr. Sene** presented an overview of NPL and discussed some of the agency goals, programs, instruments and capabilities. **Dr. Daves** provided a report on the satellite programs, agencies and plans of the United Kingdom.

The **WGCV Chair, Changyong Cao** thanked the hosts for their kind remarks, informative presentations and for organizing the meeting.

3 WGCV-27 Chair's Report (*Changyong Cao*)

Changyong Cao presented the WGCV Chairman Report. The Report included short introduction and background on WGCV since its establishment in 1984, an update on the WGCV subgroups, structure and leadership. It emphasized the new role of CEOS/WGCV in the GEOSS era, and the associated changes in the WGCV agenda and plans.

CEOS WGCV Subgroups Chairs (update):

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

The report addressed the traditional WGCV priorities, which are as follows: 1) The WGCV will support calibration and validation activities in support of the GEO tasks, particularly through the focused work of the WGCV subgroups; 2) The WGCV will actively contribute/lead a number of GEO tasks such as DA-06-02, 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 seek CEOS endorsement for joint calibration and validation campaigns to CEOS Members and will seek CEOS support for these campaigns.

In addition to the traditional WGCV objectives, the Chair reiterated the CEOS/SIT call for working group alignment with CEOS IP: Better link between strategic objectives, Plenary and WG actions; and *"A rationale and purpose for the meeting in the context of the CEOS IP & Constellations, in the spirit of WP6000 of the 2007 CEOS Work Plan "*.

The following major events and developments since WGCV26 were reported/discussed:

Summary of the CEOS 20th Plenary was held in Buenos Aires, Nov. 14-15, 2006. At the meeting was approved the turning of CEOS into the space arm of GEO. The minister of Foreign Affairs of Argentina, Jorge Taiana addressed the participants and Barbara Ryan of USGS became the new CEOS chair for 2007, succeeding Conrado Varotto of CONAE. Tubitak Uzay (Space Technology Research Institute of Turkey) became the latest member of CEOS. Changyong Cao became the Chair of WGCV, with Vice chair Pascal Lecomte, succeeding Stephen Ungar

WGCV Recommendations accepted by the CEOS 20th Plenary:

1) Request that CEOS members ensure that all future missions include a quality assurance component, stating the accuracy of the data and all derived products;

2) CEOS requests that member space agencies coordinate efforts with existing cal/val archives and that member agencies supply the necessary resources to implement the requirement to establish uniform data protocols for collecting, archiving, and accessing validation data across Earth science disciplines;

3) CEOS requests that their operational member agencies (e.g. WMO, NOAA, EUMETSAT, USGS, etc.) devise a comprehensive cal/val plan that meets the needs of the extended (e.g. research) user community; and

4) CEOS requests that all member agencies: provide support to perform additional ground measurements for direct validation, taking advantage of already existing networks; prepare subsets of data/products for global land product inter-comparisons, as described by CEOS/WGCV/LPV; and support the actual processing of these data sets and the dissemination of the corresponding validation results.

The following **Joint WGCV25&WGISS21 Request/Recommendation** was also approved: CEOS endorsement of a joint GEO/CEOS Workshop on Cal/Val Processes (to be held in October 2007 at the GEO Secretariat in Geneva). Recommend CEOS encourage continued support by appropriate members to address issues associated with the operationalization of capabilities developed by the CEOS WTF and the ESA Cal/Val Portal.

The **work of WGCV toward GEOSS and GEO tasks** was addressed (see list of GEO Tasks with WGCV contribution in Appendix B). Significant progress on the GEO DA-06-02 tasks was reported. WGCV has developed strategy, listed preliminary actions and established timeframe and milestones to accomplish the task. The task lead Stephen Ungar was highly prized. Other GEO tasks that WGCV is contributing were also reviewed. New action item (WGCV27-01) was generated for the subgroup chairs, i.e., to report the subgroup activities contributing to the GEO tasks.

The **Global Climate Observation System Implementation Plan** (GCOS IP; 59 Action Items) was introduced. Reported was that action items have been assigned to the CEOS working groups and member agencies, with JLF as a point of contact for all action items. WGCV was assigned 15 action items including absolute measurements, recalibration of historical data, and cal/val sites. The action items were to be discussed at a separate session at which experts for each action item were to be identified.

WGCV Support to CEOS Constellations: The new CEOS initiative "CEOSS Virtual Constellations" was introduced. Reported was that WGCV is presently contributing to the Atmospheric Composition constellation led by Dr. Ernest Hilsenrath (WGCV/NASA); and Land Surface Imaging (LSI). WGCV has identified Dr. Stephen Ungar as the LSI team member representing both WGCV and NASA. It was believed that WGCV has a lot more to offer to the Constellations, such as the development of standards, calibration/Validation Sites, and inter-satellite calibration using the SNO method.

The **CEOS/WGCV Joint Experiment** was addressed. The experiment includes simultaneous Nadir Overpass between EOS/Hyperion and MetOP/AVHRR. It is conduced as a coordination among NOAA, USGS, and NASA. Reported was that the first data set has been acquired at 23:47UTC on May 19, 2007. The experiment is anticipated to be very useful for resolving spectral issues in the intercomparison between AVHRR and MODIS. It can also prove potentially useful for the CEOS constellations as well.

Upcoming events in 2007-2008:

1. CEOS Meetings at Frascati, June 18-20, 2007: LSI Constellation Workshop and CEOS/SIT-20 meeting;
2. Co-sponsorship of GEOSS Workshop at IGARSS 2007 (Barcelona);
3. GEO/CEOS Cal/Val Workshop, October 2007 in Geneva;
4. CEOS 21th Plenary in November 2007.

4 WGCV Secretariat update (*Petya Campbell*)

- Minutes from WGCV-26 were reviewed, approved and adopted as presented.
- Open Action Items from previous meetings were reviewed and the following table reflected their status.

WGCV Current Action Items

WGCV25-3	**NIST to generate for the CEOS best practices: a description of the Total Solar Irradiance Workshop.**	WGCV26 in progress
WGCV26-1	**WGCV Secretariat to generate a "WGCV suggested cal/val practices" web page and populate it with the materials generated by WCV25-2&5.** The materials will be transferred to the Cal/Val Portal	WGCV27
WGCV26-2	**Chair to request that for cal/val purposes, JAXA acquires and provides to CEOS/WGCV/TMSG cloud-snow free stereo PRISM data over the TMSG test sites: 1) USA: Puget Sound; 2) France: Aix-en-Provence; 3) Spain: Barcelona; 4) UK: North Wales; and 5) P.R. China: Three Gorges area.**	WGCV27
WGCV26-3	**Chair to request that JAXA provide to CEOS/WGCV/TMSG a list of the global set of DEM QA sites.**	WGCV27
WGCV26-4	**The WGCV Subgroup Chairs (SG) to review with the SG members the list of GEO tasks in which WGCV is participating and generate a list of the activities which their SG is conducting toward the listed GEO tasks.**	WGCV27
WGCV26-5	**WGCV Subgroup Chairs to review with the SG members the *seed questions* (web link below) describing QC and cal/val processes, focus of the GEO/CEOS Cal/Val Portal Workshop, and prepare to address them. In addition, similar request to be made to the wider WGCV membership.** http://wgcv.ceos.org/docs/plenary/wgcv26/Greening_CEOS_workshop.pdf	WGCV27

The CEOS WGCV website was reported to have been recently updated. Future upgrades will be conducted as necessary information becomes available.

5 Reports from the WGCV Subgroups

5.1 Atmospheric Chemistry Subgroup *(Bojan Bojkov)*

Bojan Bojkov, the new Chair of the Atmospheric Chemistry subgroup presented the report from the AC subgroup. The report included summaries of the recent subgroup meetings, focussed on the current ACGS cal/val issues, and provided recommendations to WGCV and CEOS for resolving some of the issues.

Subgroup Meetings: Two ACSG meetings were held: *ACSG-6 December 2006, Frascati* (in conjunction with Envisat ACVE-3); and *Topical meeting April 2007, Montreux* (in conjunction with Envisat Symposium) with good attendance by the sub-group members. Guests of ACSG at both meetings were the Envisat Cal/Val team (ESA/ESRIN), and at Montreux - GOSAT team representative (JAXA).

At the December 2006, ACSG-6 meeting at Frascati E. Hilsenrath stepped-down as Chairman. He was succeeded by Bojan Bojkov as chairman, with Jean-Christopher Lambert (BelSPO/IASB-BIRA) as vice chair of the group. Overview of the AC missions was presented and their cal/val status was addressed. The coordination of missions and discussions on pressing cal/val issues focused on X-sections, Air quality, aerosols, etc. At this meeting the sub-group mission was discussed: Atmospheric Chemistry vs. Atmospheric Composition. A decision was made to continue with the broader mission and Atmospheric Composition.

April 2007, Montreux: Discussed were the preparations for the upcoming GEO/CEOS Cal/Val Workshop. The main focus was on "methodology", "quality issues" and "site accreditation". Discussions were also held regarding the contributions of the research members to the Atmospheric Composition Constellation (ACC). The ACC was presented by E. Hilsenrath. It was underlined that cal/val is and integral component to the ACC missions. The collaboration between ESA and NASA on cal/val data sharing and SAUNA campaigns is identified as and example and can serve as a model contribution to ACC, as well as to WGCV and CEOS.

The next ACSG meeting will be held in Darmstadt, September 12, 2007 (in conjunction with 2nd AC Constellation meeting). ACSG is inviting the participation of the following atmospheric composition teams: For aerosols: B. Holben (Aeronet, NASA), and O. Torres (advanced aerosol retrievals, NASA); and for greenhouse gases: OCO (JPL) and GOSAT (JAXA) val team leads, and M. de Maziere (NDACC IR working group Chair, IASB).

Current ACSG cal/val issues: The "Hot" cal/val items for the ACSG include *Ozone column* measurement discrepancies (from the ground and from space), *Air quality* validation capabilities and *Data assimilation*.

The ozone column issues are driven by the following questions: Total column trends (i.e. detection of the turnaround and recovery), Development of new tropospheric ozone products, and the Input to satellite UV products and studies. Currently the satellite measurements agree within 2-3% globally, with higher differences at low sun, high column amounts, high reflectivities, etc. Similar issues exist for ground-based measurements. In an attempt to better understand the column issues, NASA, ESA and FMI conducted two field campaigns with a focus of measurements during high column, low sun periods in Northern Finland. These were SAUNA, March-April 2006 and SAUNA 2, February-April 2007. During the campaigns was employed a combined network instruments: Dobsons, Brewers, DOAS, sondes and LIDAR. Included were World and European standard instruments. Involved were more than 30 Scientists from 12 institutes in 10 countries. SAUNA (column) summary: SAUNA behavior have been seen at other high and mid-latitude sites. The state of the network calibration (Brewer and Dobson) is uncertain (at best) and requires improvements. An updated and systematic calibration transfers are required especially when considering tropospheric ozone products. It is necessary to identify key players to implement this across networks. With the improved GB calibration the differences most probably due to ozone X-sections uncertainties. High spectral resolved X-section is required which can be used by both satellites and ground-based instruments.

Air quality: Air quality is an increasing priority with space agencies and has clear Societal Benefits. Envisat-Sciamachy, Aura-OMI, MetOp-GOME/2 are already measuring many key tropospheric air quality constituents (NO2, HCHO, CHOCHO, SO2, etc.) and other species retrievals are under development. There are however limited and/or limiting validation capabilities. For example the in-situ measurements (from established networks) are not necessarily suitable for validation and/or are very difficult to interpret. New (and modifications of the existing) ground-based remote sensing methods are under development. SAUNA-style intercomparison is needed ASAP to quantify instruments and algorithms.

Data assimilation: An overview of the current and future data assimilation capabilities as related to atmospheric chemistry/composition cal/val is needed. ACSG initiated a workshop on "Use of data assimilation in satellite validation". It was organized by W. Lahoz (U. Reading), C. Zehner (ESA) and B. Bojkov (NASA) and co-sponsored by NASA, ESA and U. Maryland (Baltimore County). This workshop will be held in Baltimore, MD,

June 3-5, 2008. It is expected to include ~35 invited participants, with five keynote speakers/themes. The plan is that the workshop will produce peer reviewed proceedings, which will be published during the Summer of 2008.

Cal/val data: Data sharing is essential to enhance validation. The sharing between Envisat and Aura enabled the use of ~7,000 sondes for OMI tropospheric column validation (instead of the only 2,000 available through WOUDC and NASA field experiments). The plan is that the Envisat/Aura model will continue with GMES, but it is also encouraged for other missions. Ensuring homogeneity in data content reporting is essential. A set of common Key (and mandatory) variables must be reported to facilitate an interpretation of the validation measurements. This could be achieved in close coordination with NDACC (through the Aura Validation Data Center). While for profiling instruments (MWR, LIDAR, sondes) the reporting is synchronized, for other network instrumentation homogenization is ongoing.

ACSG Recommendations
The ACSG proposes 3 recommendations to WGCV and 2 to CEOS.
Recommendation # 1
ACSG recommends that WGCV promotes the improvement of TOZ calibration of Brewer and Dobson networks among the member agencies.
Background: This is essential for establishing trends and for the development of new tropospheric ozone products. The side by side Dobson and Brewer (incl. reference instruments) operation and calibration transfer will result in a "homogeneous" network.
Timeline: ASAP (preferably Sept. 2007 for European campaign at Huelva, Spain).
Recommendation # 2
Background: This recommendation addresses the Ozone X-sections issues. X-sections are thought to be the major remaining uncertainty in ozone retrievals. The goal is to have a common X-section reference baseline. Therefore,
ACSG recommends that WGCV expresses, and encourages among the member agencies, support of the on-going activities at U. Bremen for highly resolved GOME/GOME-2 X-section work on O3, NO2 and SO2.
Timeline: ASAP.
Recommendation # 3
It is recommended that for air quality ground instrument intercomparison are quantified the state of validation assets, and SAUNA-like effort is deployed to include classical instrumentation, plus DOAS/SAOZ, direct-sun CCD and complimentary measurements (ultra-light gas sampling) and LIDAR (NO2 + aerosol).
Timeline Summer 2008
Recommendation # 4 (CEOS, Extend WGCV-26 Recommendation 2)
Addresses Cal/Val data sharing across missions.
Encourage new missions: to follow Envisat/Aura data exchange across existing and future AC missions (incl. greenhouse gas missions), and to follow homogeneous data reporting by leveraging on existing efforts such as undertaken by NDACC.
Timeline: ASAP
Recommendation # 5 (CEOS)
Validation requires use of "overlapping" information to meet actual product quantification (for example aerosol effect on NO2 retrievals)
Propose to extend ACSG mission/mandate to encompass atmospheric composition (atmospheric chemistry, air quality, aerosols, greenhouse gases).

Timeline: formal change after report to WGCV-28.

5.2 Infrared and Visible Optical Sensors (*Nigel Fox*)

The IVOS Chair, ***Nigel Fox***, presented the report from the IVOS subgroup. The report focussed on the IVOS 18th SG meeting. The IVOS 18th IVOS meeting was held at NPL 11 June, 2007. There were ~35 attendees,

representing the various IVOS areas, including: Land, Ocean colour, Sea surface temperature, field spectroscopy, Standards labs, test site owners, satellite/instrument builders and calibrators. 13 agency reports were presented.

The objectives of the 18th IVOS meeting were: 1. Information exchange on agency and country activities and progress report on ongoing IVOS activities. 2. Review of the sub-group mission and terms of reference in light of GEO. 3. Review actions/progress on the work for the development of Data Quality strategy for GEO. This GEO task is central for IVOSs work. The discussions included considerations and proposals for: calibration reference test sites, best practise for data base (web portal), and comparisons. 4. Review and prioritisation of activities (work plan): review of activities outstanding from 17th meeting; Best practise for data base (web portal); Need for 2nd (follow-on) workshop; Establishment, operation and use of cal/val reference test sites. 5. Agree on communication strategy – discussed were the advantages of using the IVOS web-site / Wikki, meetings and the forthcoming workshop. 6. Develop recommendations to CEOS WGCV.

IVOS Mission statement: To ensure high quality calibration and validation of infrared and visible optical data from Earth observation satellites and validation of higher level products.

IVOS Terms of Reference: 1. Promote international and national collaboration in the calibration and validation of all IVOS member sensors. 2. Address all sensors (ground based, airborne, and satellite) for which there is a direct link to the calibration and validation of satellite sensors; 3. Identify and agree on calibration and validation requirements and standard specifications for IVOS members; 4. Identify test sites and encourage continuing observations and inter-comparison of data from these sites; 5. Encourage the preservation, unencumbered and timely release of data relating to calibration and validation activities including details of pre-launch and in flight parameters.

The following country and agency reports were presented: CNES, DLR, ESA, JAXA, JPL, JRC, NCAVEO, NOAA, NIST, NPL, RAL, Tubitak Space, USGS, Univ Valencia (see WGCV web site for more details).

IVOS Work Plan:

1) Establish best practise for calibration/validation (identification of intercomparison targets, site characterisation and sensor comparisons): identification of key characteristics for calibration site and then obtain list to prioritise/categorise, Education of community, Understanding of sensor biases / inter-team consistency of activities, CEOS members to identify contacts for key in-situ teams groups and sensor cross calibration, Collate existing documents of "best practise" to discuss/contrast differences; Review of Cross-comparison protocols and add guidance from NPL/NIST; Encourage existing planned activities - communicating outputs to IVOS members; Goal of comparison in ~ 5 yr timeframe.

The critical importance of long term instrument performance monitoring, inter-satellite/ inter-sensor calibration and cross comparisons for the generation of long term data records was stated and relevant research findings illustrated this point. Sensor drift and models were discussed and the VGT2 calibration monitoring over deserts and generation of a new VGT2/B2 calibration were presented. The results from two years of PARASOL calibration over clouds to establish a calibration model were presented. The calibration over clouds was compared to other methods (e.g. vicarious calibration such as rayleigh, desert and sunlight) and the results were consistent within 1%. The advantages of stellar and lunar methods for monitoring drift and "calibration" were discussed and relevant results were presented.

Pre-flight calibration does not match real conditions, because in the laboratory light sources are uniform, when real scenes are spatially not uniform. To address this problem there are a few project on the way, using Digital Light Processing projectors (DLP) and the Hyperspectral Image projector (HIP) prototype.

Presented was the Aeronet Ocean Color (OC) network, supporting ocean color validation with highly consistent time series of standardized measurements and their success and issues were discussed. A

recommendation was made to: Put in place ways to reinforce extensive (space and time) field activities through state-of-the-art measurement protocols, for ocean color products validation and merging (specifically support and extend AERONET-OC).

The reprocessing plan for ASTR was presented. The plan is to produce high quality data set in a common format from 15 years of coverage, including 3 overlapping missions.

2) Communication of QA Relevant data: The "CEOS" Web Portal (ESA activity) was presented and it's current status was discussed. The IVOS information will be first to populate the portal. Recognised were the existing issues, and the discussions addressed the folowing: when information from the other sub groups is introduced, the structure of the portal may have to be altered; maintenance and updating of links and information; QA of inputs, the need to define a format.

To identify a set of CEOS "certifiable" reference cal/val test sites the following steps were considered: Utilise existing pre-cursor activities of IVOS/USGS/ESA; Define set of essential criteria (e.g. homogeneity, size, reflectance, accessibility, level of maintenance); Request data/list from CEOS members (GEO auspices); and Categorise / classify sites for "CEOS certification". The leading organisations in this effort are USGS in conjunction with ESA. It is expected that a framework for the activity will be completed in the Autumn of 2007. http://calval.cr.usgs.gov/satellite_catalog_map.php

A discussion on test sites stated the importance of common cal/val sites. Presented were the proposed new site in Turkey; the site in Chilbolton, Hampshire; and the ALOS optical cal/val sites across the world.

Sites and comparisons are conducted to understand the biases among instruments and NOT to state who is right/wrong. The ultimate aim is to have a comprehensive list of sites, but only a few "prioritised". The methodologies used for site characterisation may be of more use than sites themselves, so they need to collated for the best practises registry.

The discussions addressing terminology included the following issues/questions: Is a natural target used for validation or calibration? If the status of "calibration" is attached does this risk miss use? It was agreed that we needed to be clear in terms and in describing uses and in particular different targets would be limited in scope. Uncertainty in targets parameters and its traceability at point of use (TOA) is critical and it has to be significantly smaller than that of sensor for calibration.

The discussion on establishing best practise for calibration/validation (target of intercomparison, site characterisation and sensor comparisons) addressed the following issues: Education of community, Understanding of sensor biases / inter-team consistency of activities, CEOS members to identify contacts for key in-situ teams groups and sensor cross calibration, Collate existing documents of "best practise" to discuss/contrast differences, Review of Cross-comparison protocols and add guidance from NPL/NIST, Encourage existing planned activities – communicating outputs to IVOS members – Goal of comparison in ~ 5 yr timeframe. The following action was assigned to the IVOS members: All to provide existing protocols methodologies as basis for discussion. It is needed to confirm that such documents can be released. There is a possible need for recommendation to CEOS to encourage member agencies to allow release of all documentation associated with calibration to members.

3) IVOS operational logistics: Establish password protected document store and workspace; Update of intro page on WGCV website; Encourage attendance through development of key policy items; Consider bi-annual "conference/workshops" linked to existing meetings.

In conclusion: The IVOS membership is very active in a wide range of disciplines, so the source of debates at the meetings. The large breadth and diversity are providing potential to pilot concepts envisaged in the Geo strategy. There is a need to ensure discussion between meetings and this is strongly encouraged.

5.3 Land Product Validation *(Frederic Baret, Jeffrey Morisette & Sebastien Garrigues)*

Frédéric Baret, the Chair of LPV presented the subgroup report. Fred Baret is the new LPV chair, while Sebastien Garrigues is the 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 efficiency* of global satellite product validation *via* developing and promoting international standards and protocols for field sampling, scaling, error budgeting, data exchange; to provide feed-back to international structures (GEO/GEOSS) for: requirements and achievements on product accuracy and definitions of future mission.

The LPV web site has been continuously maintained and updated by Jaime Nickeson, NASA GSFC.

The land products currently targeted include: Land cover (including change detection); Fire (active/ scars); Energy (LST/ albedo/ PAR/ SWR/ LWR); Vegetation (LAI/ fAPAR/ fCover/ VIs/ biomass); Soil (moisture, soil type, etc.).

Higher level products not yet considered (Evapotranspiration, Net Primary Productivity, Vegetation Phenology).

Some of LPV's accomplishments include:

- Web site initiated and maintained,
- Davos March 2007 LPV meeting, .
- Validation and intercomparison of MODIS c4 and CYCLOPES v3 LAI and fAPAR products (Weiss, M., F. Baret, S. Garrigues, R. Lacaze, and P. Bicheron. 2007. LAI, fAPAR and fCover CYCLOPES global products derived from VEGETATION. part 2: Validation and comparison with MODIS Collection 4 products. Remote sensing of Environment, 110:317-331).

Future plans include:

- Contributions to GEO/GEOSS and future meetings.
- Preparation of a global validation exercise publication,
- Preparation of a paper showing an approach to build up a virtual constellation for MR products.
- Preparation of a paper on fAPAR definition, ground measurement and validation of current products (MODIS, CYCLOPES, JRC)
- Development of devices for continuous ground monitoring of fAPAR and LAI.
- Organization of the WGCV 29th meeting in Avignon, September 2008.

Previous LPV workshops: 1) First Workshop - LAI Intercomparison 7-8/6/2001, ESA Frascati, Italy ; 2) CEOS/WGCV Land Product Validation Workshop on Surface Albedo 10/23/2002 - 10/24/2002, Boston University, Boston, MA USA; 3) CEOS LAI Intercomparison Activity Results 16/8/2004 University of Montana, Missoula, MT USA; 4) Global Vegetation Continuous Fields (VCF) Validation Workshop 27-28/10/2005 Geographic Information Science Center of Excellence Brookings, SD USA; 5) LPV workshop on albedo - April 27-28, 2005, Vienna, EGU; Reported in NASA EOS "Earth Observer" *http://eospso.gsfc.nasa.gov/eos_observ/pdf/ May-Jun05.pdf;* 6) LPV workshop on long-term VI record - Aug 7, 2006 University of Montana, Missoula Montana; Reported in NASA EOS "Earth Observer"; *http://eospso.gsfc.nasa.gov/eos_observ/pdf/ Nov-Dec06.pdf*; and most recent 7) Long term global monitoring of vegetation variables using moderate resolution satellites (GVM)- Aug 8-10, 2006 University of Montana, Missoula Montana; Accepted to AGU's EOS Transactions; Presentations and posters from both meetings are posted on-line at //www.ntsg.umt.edu/VEGMTG/. 8) LPV workshop on LAI and fAPAR products March07:

Presentations are posted on line at the LPV site. Report to be submitted to NASA EOS Observer. In addition to that, conducted were also a number of GOFC-GOLD-FIRE meetings.

Report from the LPV Davos meeting/workshop on LAI and fAPAR: The workshop was attached to the ISPMSRS. It was held in Davos, 12-14 March 2007. The LPV workshop on LAI and fAPAR products included 23 participants from different countries, but missing were Asian participants.

Reported were the following current LPV Validation activities: Estonia (Jarvelsja, mixed forest); Estonia, Finland, VALERI; VALERI: (Africa (2) Europe (2) South America (1); China: (2 sites: Belgium (VITO)-China); England: NCAVEO (crops); Spain: (Valencia Anchor station, Univ. Valencia, EOLAB) crops; and Canada: (CCRS: boreal forest, crops). Sample results were presented to illustrate some of the findings. The cal/val included two types of efforts: indirect validation: to establish self consistency and for comparison with other products (Temporal continuity (and spatial!), Temporal consistency, Statistical distributions, Scatter plots, Transects, Maps); and/or direct validation: a comparison with ground measurements. The BELMANIP of sites (demonstrates possibilities for direct validation) includes 397 sites representing the global variability over surface types and latitudes. The following issues were discussed: Methodological aspects for ground measurements, Comparison of devices: LAI2000/TRAC DHP: DHP becoming widely used; Sampling strategy: Size of ESUs, Number and position for ESUs; Definitions of fAPAR/fIPAR, of LAI; and the Design easy to use intruments for continuous monitoring.

Recommendations from the workshop: Sharing data requires improvements, It is desirable to get more sites for validation, Particular focus needs to be put on temporal evolution; More investigations are needed on clumping; No validation is conducted under 3x3km² - a consequences on the size of the sites; It is necessary to keeping the row ground data for further processing (LAI2000-fAPAR); Take attention to land cover (for validation of classifications); Characterize (even qualitatively the background); Evaluation of methodology on simulated scenes; Document the achieved progresses (accuracy/efficiency) since FIFE, BOREAS, HAPEX; a Discussion on resampling/projection is required.

The following **Objectives for Global Vegetation Monitoring** were stated:

1. Advances in products validation - good progress have been achieved, need validation exercise as independent as possible from the producer teams, systematic community evaluation of available products every 2-3 years.

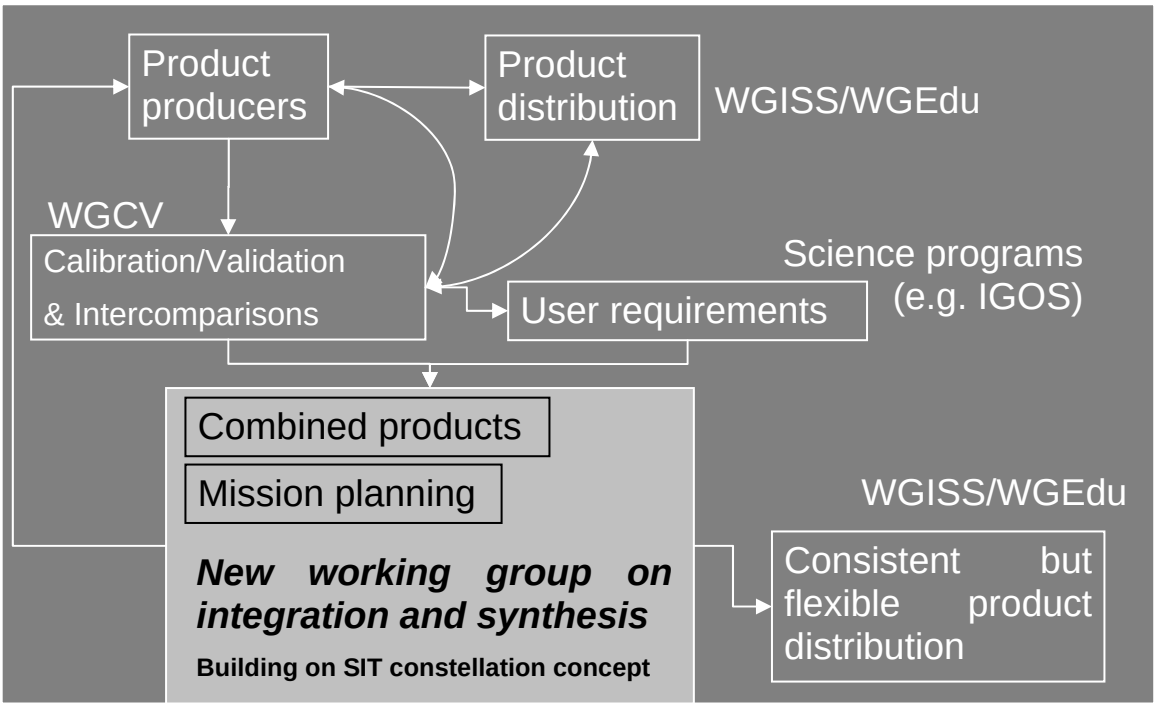
2. Intercomparison: Global network of sites representative of the global biomes for intercomparison: BELMANIP; Cut outs by each producers to be available to the whole community; Data support and archiving is required for this activity with possible use of the MERCURY system for developing of automatic intercomparison interface.

3. Direct validation: Improvements of representativeness of the included sites to get to stage 3 of the validation; More sites; Encourage synergy between ground measurements at fluxnet sites and RS validation; *Need seasonality description* particularly for key phenological periods; Standard protocols for measurements and data formatting are now well documented; Encourage individual groups to advertise their ground observations at the LPV web site.

The **LPV User requirements** determined, are as follow: 1) All products should be associated to quantitative uncertainties, traceable to up-scaled field measurements with published and reproducible protocols; 2) No missing data: procedures should be developed to fill the gaps for obtaining long and consistent time series (Strong support of the reprocessing/benchmarking of past AVHRR data (1981…); No gaps between actual series and the next ones (VIIRS, sentinel 2-3); Overlap between 2 sensors necessary for the intercomparison/calibration; Backward compatibility); 3) Data should be freely available; 4) Spatial resolution: large improvement expected 10-50m (clouds, water bodies, heterogeneity, size fields, Use 'texture' metrics); 5) Temporal resolution 4 to 10 days.

Global Vegetation Monitoring: Outputs Continuing validation and intercomparison are essential and proper support by the agencies is need to answer the need for quantitative uncertainties. The need for proper data fusion was stated: should build on validation exercise. The results from the workshop need to be brought forward and integrated in other programs and plans. Generating and maintaining long and consistent time series

is critical. Large improvements in the spatial resolution are needed for future missions: multi-agency satellite constellation and receiving/processing systems. CEOS should initiate a pilot working group on sensor constellations (for combined products and mission planning): **Virtual constellations.** A new working group within CEOS was proposed on "integration and synthesis" to better take in charge questions associated with the development and exploitation of virtual constellations.



Contribution to GEO/GEOSS

Identify opportunities for coordination and collaboration (Capitalize on field data networks coordinated through GEOSS); 2) Develop consensus "best practice" protocols for data collection and description (GEOSS could "approve/publish" related document). 3) To develop procedures in support to the validation exercise, based on data exchange and management - with a focus on land product validation core sites (done in conjunction with WGISS, GEOSS could "approve" related activities). 4) To contribute to inter-calibration between products/sensors and accuracy assessment for data fusion (virtual constellation).

Future meeting:

- GEO/CEOS/WGCV Quality Assurance of Calibration and Validation Processes (05 May 2008 Washington),
- A workshop on albedo from medium resolution products jointly organized with G. Schaepam and C. Schaaf will be attached to the fall AGU meeting in San-Francisco.

LPV recommendations:

Recommend to exploit currently existing ground networks to increase the efficiency of validation activities, with special emphasis on seasonality;

Recommend agencies to support the continuity and expansion of product validation activities to be able to quantify the associated uncertainties and allow fusion between similar products; and

Encourage agencies and producers to prepare subsets of data/products for global product intercomparison activity as described by CEOS/WGCV/LPV.

5.4 Microwave Sensors *(Christopher Buck)*

Not present.

5.5 Terrain Mapping (*Jan-Peter Muller*)

Jan Peter Muller, Chair WGCV-TMSG; presented the Terrain Mapping Subgroup (TMSG) report.

The TMSG Chair introduced the TMSG vice chair *Veljko Jovanovic* (NASA/JPL, TG *Supervisor* - Processing Algorithms & Calibration Engineering, Instrument Software Systems Section). The current Chair plans to step down in 2008/9 and Veljko Jovanovic (JPL) will serve as TMSG chair with support from JPL and NASA.

1) Review of the Terrain Mapping Sub-Group (TMSG) mission and objectives, and discussion of the relevance of the subgroups work to GEO and GEOSS:

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.

Specific 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.

Relevance of TMSG to GEO and the GEOSS 10-year Implementation Plan: Six out of the Nine Societal Benefit areas (SBA) state an urgent need for global topographic information of the highest possible quality, reliability and in some cases resolution (particularly disasters). Most of the mapping requirements are NOT discussed but need to be included. Some of the GEO tasks that include DEM components are: DA-07-01 global DEM interoperability, DA-06-04 Data Management, DA-06-05 GIS data, and DA-06-07 Web portal. TMSG is making a significant contribution in 2007 to GEO task DA-07-01. The task is to ensure DEM interoperability and it is led for GEO by the TMSG Chair. The most urgent, short-term need for DEMs comes from Disasters SBA. The Georadiometric processing of any land products require global DEM (e.g. global land cover). Therefore it could be argued that the other 3 areas (weather, biodiversity, ecosystems) have not yet recognised the importance of topography. CEOS Plenary and WGCV have previously agreed that global DEM should be sourced from spaceborne sources and be fully VALIDATED.

2) Subgroup programmatic status

2.1 2007 activities

There were no TMSG meetings held or planned during 2007. The subgroup meeting planned at USGS did not go ahead as proposed due to other activities overtaking events. The regular monthly inputs from the SG members to the GEO Task DA-07-01 are replacing much of the need for a dedicated meeting.

The TMSG chair reported that Global Topography (including bathymmetry) appear to have significantly risen up in the political priorities and agenda in both NASA and the GEO Secretariat (at last!).

No progress was reported on obtaining 30m SRTM-DEMs for all non-US TMSG test-sites. This task is now subsumed into the larger task of trying to obtain a global 30m DEM from whatever source is feasible. However, a significant progress has been made on obtaining ALOS-PRISM data for TMSG test-sites and a list of global Terrain mapping sites chosen by JAXA.

Significant progress was reported on the EO Data Portal - CEOS-WGISS ICEDS: Addition of SRTM edited DEMs as well as SRTM land-water mask (local) and global C-SAR amplitude masks (via the JPL Onearth server); Addition of inter-comparison mechanisms using pull-down menu facilities.

No progress has been made on obtaining resourcing from national or international sources for: web reporting on "Known Issues - Errors in SRTM DEM" on a public web-site; Quality assessment of ESA GETASSE30 DEM; and Updating of a "best practice" technical document.

2.2 Future TMSG plans and activities include:

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

2) As part of GEO Task DA-07-01, working on several different options to obtain global topography and bathymetry for continental shelves at 30m. Need to ensure that validation is included as part of these plans

3) In concert with the relevant national and international bodies, starting to make a push on the creation of an OGC-compliant global Ground Control Points from global mosaiced Landsat and SPOT5 datasets

4) Plan to invite groups to participate in "Evaluation of DEMs from new sensors (ALOS-PRISM, COSMO-SKYMED) " once data secured

5) Plan to hold TMSG-sponsored workshop as part of the ISPRS Congress in Beijing, July 2008

2.3 Follow-up on WGCV26 Action Items (thanks to Murakami, JAXA)

WGCV26-2: Chair to request that for cal/val purposes, JAXA acquires and provides to CEOS/WGCV/TMSG cloud-snow free stereo PRISM data over the TMSG test sites. The following data was obtained: 1) USA: Puget Sound - PRISM L1B1, 2006/09/12 triplet 2 scenes. 2) France: Aix-en-Provence - PRISM L1B1, 2006/07/25 triplet 1 scene; PRISM L1B1, 2007/03/12, triplet 1 scene . 3) Spain: Barcelona: data have been prepared in the FTP site - PRISM L1B1, 2006/12/03-1, triplet; PRISM L1B1, 2006/12/03-2, triplet. 4) UK: North Wales: JAXA needs the location latitude /longitude. 5) P.R. China Three Gorges area: JAXA needs the location latitude /longitude. A question from JAXA: does the item refer solely to 1B1 data or DEM by PRISM data? Answer: it would be preferred to have both (if DEM is a "standard" product of ALOS but 1B1 would be excellent in the first instance

WGCV26-3: Chair to request that JAXA provide to CEOS/WGCV/TMSG a list of the global set of DEM QA sites. The possible sites, at which JAXA has the reference DEM and can be made open include: Mt. Ibuki, Shiga Pref., Japan, and Mt. Tsukuba, Ibaraki Pref., Japan.

3) Scientific status of DEM production & validation activities

3.1 GTOPO30: This is a Global 30-arc-second (1-km) elevation model. It is derived from multiple source datasets, generated from the best available data (primarily US-NGA DTED1/0 and US-NGA-DCW) and was released in 1997. Detailed QA performed by NASA EOS-DEM Science WG. GTOPO30 operationally used for NASA-EOS processing. Widely used for climate modeling, land cover characterization, hydrologic modeling, and EOS satellite image product generation. Some QA performed for NASA in 1999. Not fully validated. The production of a second version (with NGA) including SRTM is due to start in July 2007.

3.2 The National Elevation Dataset (NED): This is a seamless national coverage of "best available" raster elevation data. NED is the elevation layer of *The National Map* (US). It is in Geographic "projection", resolution: 1-arc-second (30-meter), 1/3-arc-second (10-meter), and 1/9-arc-second (3-meter) grid spacing (Alaska: 2-arc-second grid spacing). Datum: NAD 83 horizontal; NAVD 88 vertical; Elevation units: decimal meters. NAD is updated bi-monthly to incorporate all new USGS DEM production and other newly available source data**.** The NED April 2007 release has over 70% 10-meter DEM source, or better (3m).

3.3 HRS onboard SPOT 5 (contributed by Marc Bernard): The HRS stereo sensor was launched on board SPOT 5 (May 2002). The system is funded under a Public Private Partnership (46% military – 54% civilian). HRS pairs are used to produce the Reference3D® product (DTED level 2 DEM + orthoimage), with a 9m CE90 (assessed by NGA in 2006). The IGN France & Spot Image production of Reference3D® is currently in progress. One of the largest customers currently for Reference3D® products is the US NGA. 23 Mkm² have been completed by June 2007 and 30 Mkm² are expected by mid 2008 (N.B. Total land area is 150 Mkm²). An expansion to a world-wide coverage by 2013 is currently under discussion. JRC Ispra (European Commission) and FÖMI (Hungarian Mapping) have performed an in-depth assessment of Reference3D over Hungary, using

"official" Hungarian data and report: RMSEz = 3.4m and RMSExy = 5.75m. Currently the validated SPOT-5 HRS coverage includes most of Asia, Europe, Central and South America, Australia and New Zealand.

3.4 Fusion of ASTER and SRTM (thanks to Nick Austin, UCL-MSSL): The study explores different methods of how to fuse DEMs together to get advantages of all - coverage vs. reliability vs. resolution. ASTER DEMs were supplied by USGS under a NASA data grant. An ASTER DEM mosaic of the Three Gorges Reservoir Region was then created in ER Mapper and presented hill-shaded in ArcMap, with 30° altitude and 330° azimuth for the light direction, using ICEDS custom hill-shading colour scheme. The ASTER DEM Mosaic contains a number of artefacts (clouds in the original data). An elevation difference image was generated: SRTM DEM – ASTER DEM Mosaic, mean = -29.79m, min = -3178m, max = 545m, std. deviation = 176.45m. The conducted height assessment campaign reported: for the 30m ASTER DEM, a mean=1.64m and St Dev=22.05m; for the 90m SRTM DEM, a mean=4.52m and St Dev=20.20m; and for the combined SRTM + ASTER, 30m fused DEM mean=1.74m and St Dev=19.72m.

3.5 COSMO-SkyMed: A Summary of Characteristics & SAR Products Performances, (Thanks to Ettore Lopinto (ASI)

COSMO-SkyMed (*COnstellation of small Satellites for Mediterranean basin Observation*) is the largest Italian investment to date in Space Systems for Earth Observation. It is commissioned and funded by the Italian Space Agency (ASI) and the Italian Ministry of Defense (MoD). It is "natively" conceived as a Dual-Use (Civilian and Defence). The long term goal is to establish a global service for a wide range of applications, such as Risk Management, Scientific and Commercial Applications and Defence/Intelligence Applications. The system consists of a constellation of 4 Low Earth Orbit mid-sized satellites, each equipped with a multi-mode high-resolution Synthetic Aperture Radar (SAR) operating at X-band with an antenna electronically steerable in both elevation and azimuth, capable to acquire SAR images in: 1) A Spotlight mode, for metric resolutions over small images; 2) Two Stripmap modes, for metric resolutions over tenth of km images; one mode is polarimetric with images acquired in two polarizations; 3) Two ScanSAR for medium to coarse (100 m) resolution over a large swath.

The interferometric configuration is aimed to produce three-dimensional DEMs by combining two radar measurements of the same point on the ground using interferometry. Such configurations are characterized by the two satellites placed in different orbital planes with 20 seconds of time separation, corresponding to an along-track separation of 151 Km on ground. The SAR data is anticipated to become available in December 2007, while the full constellation (4 satellites) is expected by December 2008.

ASI is encouraging scientific researchers and the development of applications using COSMO products. Please refer to: https://cosmo-skymed-ao.asi.it where you will find detailed information on the AO itself and on COSMO-SkyMed in general. (AO is now closed)

3.6 WGISS EO Data Portal Objectives and Update on ICEDS wrt TMSG: 1) Drill-down to anywhere on the planet to scales of 1:25 000 (30m) for colourised 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). For more information visit: http://iceds.ge.ucl.ac.uk. UK JISC plans to support ICEDS as a national service for the academic community. There is a plan to include a key Cal/Val element.

4) Summary of TMSG action items: 1) Continue being pro-active in GEO tasks and try to link across WGISS-WGCV Terrain mapping (and other cartographically) related activities. 2) Transfer over to the new chair including agreeing on job specification and agree preliminary program. 3) Question: should we add any further test sites to the one at Puget Sound to WTF and promote their use in the terrain mapping community in terms of: setting QA/QC standards, developing new techniques in QA/QC, inter-comparison of different research and commercial DEM production systems, Developing the "Known Issues" web-site at the WTF site (or elsewhere). It needs to be considered how to add TMSG links to the CEOS-WGCV "web portal" at ESA.

5) The way forward - GLOBETOP 2.0: Requirements (updated after discussions with NOAA-NGDC): DEM available by 2010 at the very latest; DEM must be free of ©, cost and 3rd party issues; DEM should be at least 3 arc-seconds (≈90m) without any gaps; DEM should preferably be 1 arc-seconds (≈30m); DEM should include improved coastline (≈30m); DEM should include bathymmetry of continental shelves. Current status of DEMs: C-SRTM provides ≈80% coverage of region from 60ºN-56ºS; X-SRTM could be employed to fill in many gaps (© and cost issues); ERS-tandem could be employed to fill in remaining gaps but need remains to correct for atmospheric effects; ASTER stereo can be employed to fill in many gaps but cloud coverage is still an issue although planimetric offsets have now been resolved with SRTM; Unknown status of ALOS-PRISM global topography project described at ISPRS 1996. Unknown status of ©, cost and 3rd party IPR issues. No plans to produce global DEM at present; DLR-Astrium TANDEM-X has been approved but DEM at 10m will be ©, very high cost and many 3rd party issues. Working progress: 1) GDTT has to find a champion who will provide co-ordination of GLOBETOP 2.0 including promotion of the fusion of these different input data sources, develop documentation, provide final fused DEM, develop OGC-compliant distribution (USGS approached but no status as of this time). 2) GDTT needs to produce a requirements (or "gap") document in association with GEO Secretariat (no progress on this yet, awaiting feedback from USGS as to whether they will become the champion for this project). 3) GDTT have to issue a call for proposals for participation in GLOBETOP 2.0 with participants bringing their own funding and providing products freely without © restrictions or any 3rd party issues. 4) TMSG is proposing a joint workshop on GLOBETOP 2.0 in mid 2007 at USGS Reston (USGS approached but no status as of this time, since confirmed that this will need to be delayed with no date yet agreed). 5) TMSG is proposing to provide validation, with suitable resourcing of individual input and fused products.

6) TMSG Recommendation to CEOS Plenary (same):
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
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.* No progress was reported since 12/05 especially with regard to resourcing and finding champion.

5.6 SAR (*Satish Srivastava*)

The SAR subgroup Chair, ***Dr. Satish Srivastava***, presented the report for the subgroup activities.

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:** an annual Workshop/Meeting, setting up of standard CAL/VAL sites for inter-sensor comparison, and the determination of calibration requirements and techniques for Polarimetry, Interferrometry, POLInSAR.

Recent Annual Workshops/Meetings include: 2006 – Coordinated by University of Edinburgh in Edinburgh, UK; 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.

The next CEOS SAR Workshop/Meeting (2007) will be held September 11-13, in Vancouver, Canada. It will be hosted by the Canadian Space Agency (CSA), and held jointly with CSA's ASAR Workshop 2007. The organizing committee includes: Canadian Space Agency, CEOS WGCV SAR Subgroup, Defense Research and Development Canada, Canada Centre for Remote Sensing and MacDonald, Detwiller & Associates (MDA). The deadline for final paper submission is October 12, 2007 with the plan for distribution of the proceedings in December 2007. The ASAR 2007 Workshop will include the following topics: Next Generation SAR Systems, New SAR Missions, Innovative SAR Concepts, SAR Hardware and on-board Processing, Polarimetry and Interferrometry, Signal Processing Techniques, SAR User Requirements, SAR Calibration, Validation, Emerging SAR Applications, SAR Data Formats, Calibration Targets, Calibration Performance of on-going Missions, and RCS Models and Scatterometers. For more information, please visit the workshop web-site, at

http://www.space.gc.ca/asc/eng/events/2007/asar.asp.

14th CEOS SAR Workshop/Meeting (2006): The workshop was coordinated by the University of Edinburgh, Scotland. It was held 4–6 October 2006 in Edinburgh and forty participants from thirteen countries attended. The program included six presentation sessions (ALOS-PALSAR, ERS & ENVISAT, RADARSAT, TerraSAR-X & TANDEM-X, Future Systems and POLInSAR & INSAR) with a total of 31 presentations. Each presentation session concluded with a session discussion and recommendations to WGCV. The workshop was preceded by a tutorial on calibration and validation of radar for snow and ice studies on October 3, 2006. The workshop proceedings are being produced and then distributed on CD by *The Edinburgh Earth Observatory*. For more information please visit
http://www.geos.ed.ac.uk/research/eeo/events/ceos2006/ .

SAR Calibration sites

International Amazon Rainforest Site: Data is routinely collected and analyzed for calibration monitoring of SAR satellites including RADARSAT-1. Radiometry of the site remains stable as observed from RADARSAT-1. NASA/JPL polarimetric data and RADARSAT-1 data have been analysed by MDA in preparation to use the site for full polarimetric calibration of RADARSAT-2.

Canadian Boreal Forest Site**:** The site is located in the Hearst Region, Northwestern Ontario landmass, Hudson Bay basin. The eco-type is Boreal Forest-Barrens transition, including the following species: boreal spruce, balsam fir, jack pine, poplar, birch, tamarack, and cedar. 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 complimentary site to Amazon site for calibration but with a reduced accuracy.

Multi-Transponder Sites in Canada: In the Fall 2006, ESA relocated an ENVISAT ASAR Transponder in Resolute Bay, in the vicinity of a RADARSAT Transponder. Currently both Transponders are used simultaneously by ENVISAT. Another ENVISAT ASAR Transponder was recently relocated in Ottawa, again in vicinity of another RADARSAT Transponder. There are two potential sites in Canada for inter-sensor comparisons for C-band SARs (e.g., RADARSAT-1 and 2, ENVISAT).

Recommendations from SAR Subgroup: 14th CEOS SAR Workshop/Meeting in Edinburgh concluded with a set of recommendations as follows: 1) In order to reduce the extent of the commissioning phase of space borne SARs, effort should be invested as much as possible into pre-launch calibration (e.g. antennas, TR modules, etc). 2) In order to facilitate the use of calibrated SAR data (and to avoid the problem of continuously changing data formats), the data providers should provide: a reader on the data CD itself, and a Look-Up-Table (LUT) of calibration conversion factors for each pixel across a swath to covert DNs to sigma nought, beta nought and gamma. 3) CEOS/WGCV should co-ordinate a central database to log the characteristics, location and

availability of calibration targets, in order to increase the availability of these targets to other agencies for appropriate SAR sensors. 4) Future SAR Missions should be capable of full polarimetric imaging and at different frequencies. 5) CEOS agencies should investigate new product types from their SAR satellites that provide complex data in which the noise has been removed

6 Country and Agency Reports

6.1 Canada *(Satish Srivastava)*

Satish Srivastava presented a summary of the current activities in Canada.

RADARSAT-1 Program Status

The satellite has completed successfully 5.25 years of design life in early 2001, presently is in its twelfth year of operation. Data is received and processed at 35 ground stations with 22 archive facilities globally. As of 30 April 2007, it has completed 59,957 orbits, planned 274,534 user requests corresponding to a total acquisition of 426,688 minutes of SAR data. The average system performance maintained is better than 95%. Spacecraft health and resource utilization appear to indicate a continuation of operation until March 31, 2009 (another extension recently granted by the Government of Canada)

The product quality and calibration are fully maintained. The international network of RADARSAT-1 data receiving stations is covering 80% of the world's landmass. This satellite has provided Canada's 1st space data for use in support of operations with near real-time delivery (typically less than 90 minutes) for the Canadian Ice Service.

Multiple coverage campaigns have been completed under baseline Background Mission, including: multi-season ScanSAR coverage of continents and polar caps; radargrammetric coverage of world's landmass using two independent imaging beams; site-specific data acquisitions of most of the world's remote oceanic islands, tropical deltas, capitals and major cities. Currently providing ongoing four-season coverage of Arctic Basin

Canada participates the international space-based disaster management (International Charter "Space and Major Disasters"), and has provided RADARSAT-1 data for **107** Charter emergencies to date. I-STOP (Integrated Satellite Tracking of Oil Polluters) monitoring for Canadian waters is now an operational program of the Canadian Ice Service. The program has met the mission objectives and continues to establish new benchmarks of excellence and success. RADARSAT-1 data is being supplied to clients in 60 countries, and as a result significant economic benefits have been realized from RADARSAT-1.

SCISAT Program Status

SCISAT was launched in August 2003 The 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.

SCISAT's 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. During the last fiscal year alone (Apr. 1, 2006 – Mar. 31, 2007) the amount of science data collected was - FTS: 650.7 GB, Imager: 95.3 GB, MAESTRO: 22.5 GB. The collected data is routinely provided to the science team.

RADARSAT-2 Program Status

RADARSAT-2 is the most advanced commercial C-Band SAR satellite, developed in a partnership between Canadian Space Agency (CSA) and MacDonald Dettwiler & Associates (MDA). It is scheduled for launch in the summer of 2007. The MDA MOC was installed at CSA in St-Hubert in May 2006. The spacecraft is completing testing at DFL in Ottawa. RADARSAT-2 characteristics: 7 years design life, C-band (5.405 GHz) imaging frequency used, expected spatial resolution of 3-100m, polarization modes: single (HH, VV, VH, HV), Dual (HH/HV, VV/VH) and Polarimetric, right and left looking.

RADARSAT Constellation Program (RSATC)

The plan is for a constellation of 3 satellites (RSATC-1, 2 and 3), which will be positioned in the same orbital plane, equally spaced 15 to 30 minutes apart. Each of the satellites will take ~5-year development and starting

in 2011 one satellite will be launched every year. The goal is to provide daily and complete coverage of Canada's land and oceans at 50 m resolution.

Project DELTA

Recently there was an announcement of opportunity (AO) for Project DELTA (Differential Elevations, Levees and Terrain Assessment) - a collaborative effort between CSA, USGS and NASA. The project calls for innovative research and development into the application of RADARSAT-1 interferometric data for subsidence mapping in New Orleans. 23 Proposals were accepted from PIs in 11 countries and the first progress reports from the PIs are expected in June 2007.

Canadian GEO Secretariat (CGEO)

The interdepartmental CGEO Secretariat was established in 2005, with the following functions: i) Administer Canada's engagement in International GEO (30%) - correspondence, official comments, delegation support, etc.; ii) Coordinate the development of a Canadian Strategy for Earth Observation (70%) - advance the principles of GEO/GEOSS within Canada, coordinated EO data collection, data policies and infrastructure to support improved data access and interoperability; facilitate the transformation of EO data into information for decision support; and ensure the engagement of the end users to realize societal benefits. Currently CGEO is in an early development and consultation stage. It is targeted for completion in 2007. The participants include: 1. EO network operators – EC, NRCan, AAFC, CSA, DFO, HC, DND, and in the future: provinces and municipalities; 2. EO data and product users – all of the above departments plus others consumer departments and agencies.

6.2 Peoples Republic of China, PRC *(Xiaolong Dong)*

The PRC report was presented by ***Xiaolong Dong***, NMRSL/CSSAR/CAS. The report focused on the evaluation and selection of sites for Microwave Radiometer Calibration**.**

Past, current and future missions with Microwave/MMW Sensors were reviewed. 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). Some of the current and near future tasks/plans (2006~2007) were described, including 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.

1) Considerations about the CAL/VAL Sites Selection and Construction for Spaceborne Microwave Remote Sensors

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. Presented was a plan for future CAL/VAL of spaceborne MW/MMW sensors. China is now implementing a comprehensive plan for spaceborne microwave/MMW earth observation sensors. With development of new 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 Chinese EO satellites. 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 research 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 are compared.

2) Evaluation and Selection of Sites for Spaceborne Microwave Remote Radiometers

Calibration and Validation over the Takelimgan Desert -The main rationale for the selection of this site is that the desert is a large area, which fits well with the large FOV of spaceborne low frequency microwave radiometer. It is stabile and homogeneous from a viewpoint of microwave radiometry. Therefore, it's radiometric behavior can be predicted with a significant level of accuracy. It is relatively easy to access via a

Sand Desert road. Airborne and field experiments can be carried out without too much difficulty. 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).

DUNHUANG Gobi - Gansu Province (for details see PRC presentation at WGCV26).

Amazon Forest - Surface temperature is obtained using AQUA-MODIS 5km Average; Atmospheric humidity/temperature contour is determined using ground based sounding; Surface Emissivity is well defined (for details see PRC presentation at WGCV26).

The stability of long-time series of SSMI data was addressed. Stated was that: the stabilities of channels of V-pols are better than H-pols; with frequency channels like SSMI, there are stable high BT areas in Amazon region; in China, south area of Yunnan Province and costal area of Fujian Province are the most stable with high BT; besides the desert area and the Amazon region, southern Yunnan province and the coastal area of Fujian Province have good BT image with high BT. Due to the removal of seasonal variations to some extent, more stabilities have been obtained for the Amazon region and Southern Yunnan Province and Coastal area of Fujian Province. From time series of BT image, the seasonal variations of Amazon area are very small, even for the 85GHz channels, which have the biggest variations, the lowest and highest BT difference is less than 10K. After sliding average of 20days, very stable (STD <0.8K) high BT target can be obtain in Amazon region. From BT image time series analysis, some area of southern Yunnan Province has small seasonal variations, but the stability is less than the Amazon region. After sliding average, high BT target with stability about 1K can be obtained. With in situ sounding data corrections, high BT target with stability better than 1K is possible. Considering the standard variation of 19V data of ocean surface emission after scattering processing (May-Oct, 1999: 0<SEA_wind<10m/s), even after sea surface wind speed threshold control, the stability (STD) of cold target with low BT on the ocean is twice or more than STD of Amazon region for more than one time.

3) Conclusions and suggestions: 1) For the atmospheric transparent channels, Amazon rain forest can be very good warm target with high BT for microwave radiometry performance evaluations and validations; 2) Southern Yunnan Province and Coastal region of Fujian Province can be good transient calibrations sites after in situ atmospheric sounding corrections; and 3) *In Situ* observation facilities are necessary to provide cold target with low BT for microwave calibration sites on the ocean.

6.3 ESA *(Pascal Lecomte)*

The ESA report was presented by ***Pascal Lecomte***. The report focused on products and processes harmonisation, discussing a number of activities in this context. The GMES Space Component: Sentinel-1, -2 and -3 were presented and discussed in detail.

Product Harmonization Projects

1) Data Harmonization - Project description: "Data Harmonization" is considered a prerequisite for interoperability among spatial information systems; it will allow Europe to realize its objectives for a sustainable and interoperable functioning of GMES. Tasks: Classification of sensors/products per GMES applications; gathering the sensors/products which give similar information; survey of existing programs/projects RISE Glob-program (ex: Globcover) Medspiration; coordination among projects and the need of harmonization; according to the classification products, identification of parameters that can be harmonized across products/missions); format harmonization (generic). Project status: To be initiated in 2007.

2) IPF sentinels - Project description: Procurement of the data processing facility in the case of Sentinel-1 and of the processing prototypes in the case of Sentinel-2&3; Definition of the Sentinel-1/2/3 missions Products and Algorithms. Project status: see below.

3) Amalfi Multi-Mission (ANGLE) - Project description: Implement a multi-mission facility for the systematic end-user product quality control. The scope is to ensure that all data provided to users independently of the distribution process (media on-request, NRT on line, subscriptions, etc) has been quality checked before delivery. For this purpose, AMALFI MM shall become an integrated element in the multi-mission ground segment. AMALFI MM will also provide the means to monitor the quality of the products distributed to the users at any ESA facility AMALFI MM will initially cover the following missions: ERS SAR, ENVISAT, ALOS, Cryosat. Project status: To be initiated in early 2007.

4) Operational & Centralized Auxiliary Data Access (OCADA) - Project description: An EO centralized multi-user/multi-purpose system to solve the problem of optimizing the handling of Auxiliary Data. This Multi-Mission component will represent the EO reference Auxiliary Data handling system, by providing (automatically) a common internal source for Auxiliary Data received from multiple sources (e.g., data providers). Project status: Initiated in 2007.

5) Multi-Mission Processing (GAMME) - Project description: Engineering support environment for verification and software validation of operational and prototype processors. Mimics facilities behind operational ground-segment interfaces. Project status: End contract in 2007.

Summary and current status of the GMES Space Component activities

Activity	Schedule
Multi-Mission Processing (GAMME)	End contract by April 2007
ANGLE	End contract by July 2007
GECA (Cal/Val DC & Quality Product)	Planned start in Sept. 2007
Certification Non-ESA centres	Postponed 2008
Operational & Centralized Auxiliary Data Access (OCADA)	Planned start in Sept. 2007
Multi-Mission Systematic QC	1 Year – End contract by March 2007
Cal/Val Portal	2 Years – End contract by July 2007
Cal/Val sites	Planned start in late 2007
GMES generalisation: Product Harmonization study	Planned start in Sept. 2007
Sentinel IPFs	Planned start in Sept. 2007

Sentinel Satellites and GMES (tanks to *Peter G. Edwards, GSC Space Segment Programme Manager ESTEC, Noordwijk)*: The Sentinel-1, -2 and -3 satellites are being developed as part of the Space Component of the GMES system, and will provide dedicated services alongside national and other missions which contribute to GMES. Their goals are as follows: Sentinel-1: C-band interferometric radar, Sentinel-2: Multispectral optical imaging, Sentinel-3: Wide-swath, low-medium resolution optical and infrared radiometers and a radar altimeter package. To fulfill revisit and coverage requirements, to provide a robust operational service and to be affordable, each Sentinel mission is based on a constellation of 2 satellites in the same orbital plane. The life time of the individual satellite is specified as 7 years (with consumables for 12). The life-cycle of the space segment is planned to be in the order of 15-20 years. The strategy for Sentinel procurement and replacement over this period is being elaborated, but will likely result in a need for 4 or 5 satellites of each type if the desired robustness for the service that GMES will provide is to be achieved.
The key technical elements for the Sentinels include: Minimum technical risk, maximum schedule reliability and maximum cost efficiency by robust, state-of-the art technologies; Maximum continuity with established (pre-)operational sensors, enabling availability of long term data sets; Use and extension of existing ground segment facilities, the multi-mission concept in ESRIN and the ESOC Flight operations facilities; Harmonisation of key spacecraft elements where possible by sharing: Avionics (sharing of high development

costs, sharing units with very similar specifications, using serial production), Software, Ground segment interfaces, and Tools and ground support equipment.

The Sentinel 1 Services were summarized as follows:

GMES Consolidated Service	Sentinel-1 Contribution	
Polar Environment Services	Glacier and Snow Monitoring Iceberg Monitoring Sea Ice Monitoring Oil Discharge Monitoring	Near Shore Ice Complex Land Monitoring Lake Ice Monitoring River Ice Monitoring
Marine & Coastal Environment	Sea surface winds, currents & waves Oil spill information services (surveillance, drift forecasting) Ship detection services for fisheries and security	
Land Information Services	Basic Land Cover Soil Sealing Map	
Forest Monitoring Services	Green house gas reporting Sub-National Forest Information Updates Mapping and Monitoring of Disturbances (Clearing, Fires) Land Cover & Forest Indicators	
GMES Consolidated Service	Sentinel-1 Contribution	
Polar Environment Services	Glacier and Snow Monitoring Iceberg Monitoring Sea Ice Monitoring Oil Discharge Monitoring	Near Shore Ice Complex Land Monitoring Lake Ice Monitoring River Ice Monitoring
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Land Information Services	Basic Land Cover, Soil Sealing Map	
Forest Monitoring Services	Green house gas reporting Sub-National Forest Information Updates Mapping and Monitoring of Disturbances (Clearing, Fires) Land Cover & Forest Indicators	

Sentinel 2 will have a Multispectral imaging capability to provide continuity of Landsat, SPOT & Vegetation-type data; and Continuity to services for multi-spectral high-resolution optical observations over global terrestrial surfaces. The Sentinel 2 services are summarized below:

GMES Initial Service	S-2 Features
Global Change - Land	mapping services for monitoring urban areas in Europe (urban sprawl, urban planning modelling & forecasting, changes in urban land use, environmental monitoring and enforcement of urban planning discipline
Land cover & Land use change	Comprehensive information services for European users with respect to mainly European policies (Water, Soil, Integrated Coastal Zone Management, Urban Environment, Spatial Development)
Forest Monitoring	Forest area / forest area change map, Forest type map, Forest fragmentation
Food Security early warning	Support to Crop and Food Supply Assessment, Agricultural mapping Crop Yield assessment
Humanitarian Aid	Appropriate and reliable application of geographic information for humanitarian organizations
Risk Management (flood and fires)	Monitoring of floods, forest fires, volcano eruptions, subsidence and landslides

Sentinel-3 has the following objectives: Consistent, long-term collection of remotely sensed marine and land data; Operational ocean state analysis, forecasting and service provision; Advanced Radar Altimeter concept; and Multi-channel optical imager (VIS, IR). A summary of the S-3 services is included below.

GMES Initial Service	S-3 Features
Marine and Coastal Environment	sea-surface topography, mesoscale circulation, water quality, sea-surface temperature, wave height and wind, sediment load and transport, and eutrophication
Polar Environment monitoring	sea-ice thickness and ice surface temperature
Marine Security	ocean-current forecasting, water transparency, wind and wave height
Global Change - Ocean	global sea-level rise, global ocean warming, ocean CO2 flux
Global Change - Land	forest cover change mapping, soil degradation mapping
Land cover & Land use change	land use mapping, Vegetation indices
Forest Monitoring	forest cover mapping
Food Security early warning	regional land-cover mapping, drought monitoring
Humanitarian Aid	land use mapping
Air Pollution (local/regional)	aerosol concentration
Risk Management (flood/fires)	burned scar mapping, fire detection

The current schedule for the Sentinels 1-3 is summarized below:
Sentinel-1: Phase B2 start in April 2007; Preliminary Design Review is scheduled for February 2008 and Critical Design Review for March 2009; Flight Acceptance Review is planned for August 2011, and Launch for November 2011; the Commissioning Review is planned for February 2012.
Sentinel-2: Industrial proposals TEB selection process will take place in May-July 2007; Phase B2 starts in October 2007; Preliminary Design Review is planned for October 2008 and Critical Design Review for Mid 2010; Flight Acceptance Review is planned for January 2012, and Launch for April 2012; the Commissioning Review is planned for July 2012.
Sentinel-3: Industrial proposals TEB selection process: would take place in May-July 2007; Phase B2 starts in October 2007; Preliminary Design Review is scheduled for August 2008 and Critical Design Review for February 2010; Flight Acceptance Review is planned for April 2012 and Launch for August 2012; the Commissioning Review is planned for January 2013.

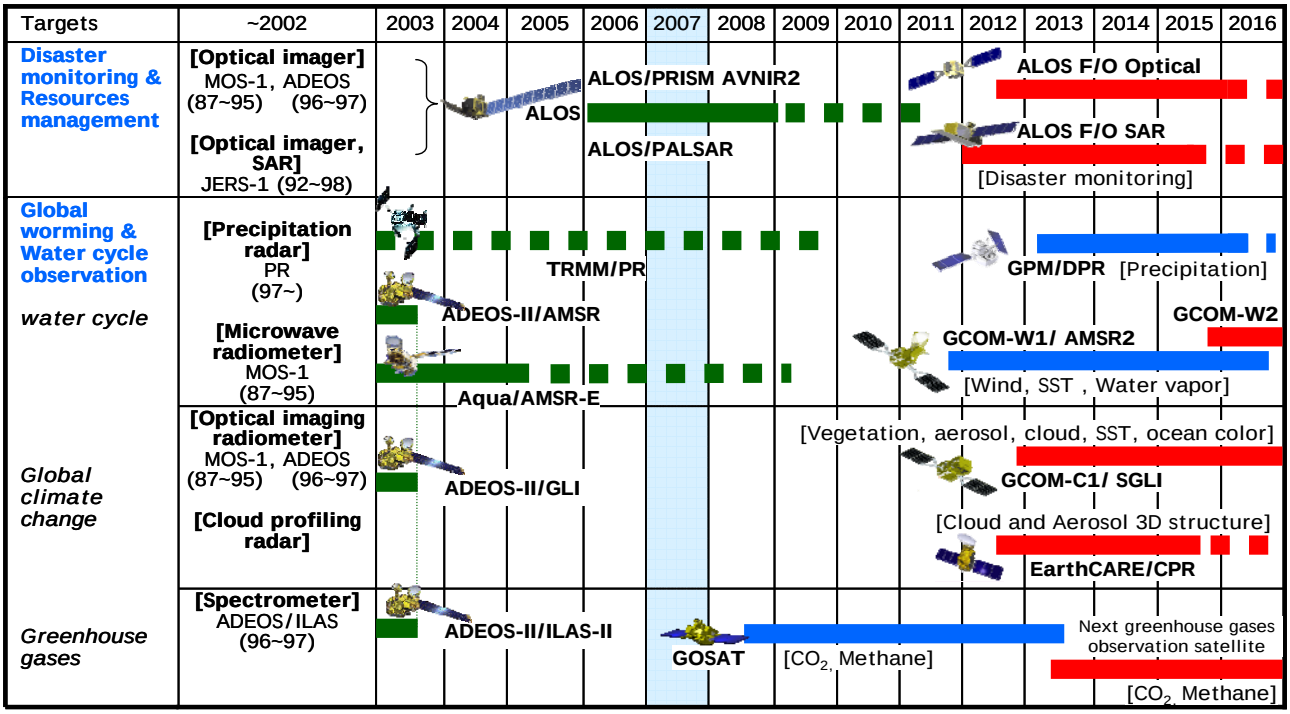
6.4 JAXA *(Murakami)*

The JAXA report was presented by ***Hiroshi Murakami,*** Japan Aerospace Exploration Agency (JAXA), Earth Observation Research Centre (EORC). The report focused on JAXA's Earth Observation plan The recent, current and future JAXA EO missions were presented (summary table is provided on the next page) and their status was discussed.

Status of the Current Missions

1. Advanced Land Observing Satellite (ALOS). ALOS mission objectives are follows: (1) Provide and update maps for Japan and other countries including those in the Asian-Pacific region (Cartography); (2) Perform regional observation for "sustainable development," harmonization between Earth environment and development (Regional Observation); (3) Conduct disaster monitoring around the world (Disaster Monitoring); (4) Survey natural resources (Resources Surveying); and (5) Develop technology necessary for future Earth observing satellites (Technology Development).

2. Advanced Microwave Scanning Radiometer for EOS (AMSR-E), mission objectives include: Multi-frequency, dual-polarized passive microwave radiometers for observing global climate and hydrology. Higher spatial resolution compared to existing instruments (e.g., SSM/I). Addition of 6.9-GHz channels for estimating SST and soil moisture.



3. Tropical Rainfall Measuring Mission (TRMM): TRMM was launched in November 1997 to understand the global energy and water cycle by providing quantitative measurement of rainfall in the tropics.

4. Japan Meteorological Agency (JMA) geostationary satellites: The Multi-functional Transport Satellite (**MTSAT**) series fulfils two functions: a meteorological function by the Japan Meteorological Agency and an aviation control function by for the Civil Aviation Bureau of the Ministry of Land, Infrastructure and Transport. The MTSAT series succeeded the **Geostationary Meteorological Satellite series** (GMS-1~5).

Future Missions

1 GCOM-W/ AMSR2 - GCOM: Global Change Observation Mission; and AMSR2: Advanced Microwave Scanning Radiometer-2: Multi frequency and dual polarized passive microwave radiometer. Targets of GCOM-W are water-energy cycle, and will carry AMSR-follow on, AMSR-2. AMSR-2 will continue AMSR-E observations (water vapour, cloud liquid water, precipitation, SST, wind speed, sea ice concentration etc.).

2 GCOM-C/ SGLI; SGLI (Second Generation Global Imager): Targets of GCOM-C are carbon cycle and radiation budget, and will carry SGLI.SGLI will continue almost of the GLI observations (sea surface temperature, ocean colour, aerosols, cloud, vegetation, snow/ ice, and so on). The new SGLI features (250m (VN) and 500m (T) channels and two polarization/ multi-direction channels (P)) will enable improvement of land and coastal monitoring and retrieval of land aerosols.

3 Greenhouse gases Observing SATellite (GOSAT): The GOSAT aims to contribute to international treaties by monitoring the distribution of the density of greenhouse gases. GOSAT has been developed by JAXA, Japan's Ministry of the Environment (MOE), and National Institute for Environmental Studies (NIES). GOSAT carries Thermal and Near infrared Sensor for carbon Observations (TANSO) consists of the Fourier Transform Spectrometers (FTS) and the Cloud and Aerosol Imager (CAI).

4 Global Precipitation Measurement (GPM): The Global Precipitation Measurement (GPM) is a follow-on and expanded mission of the Tropical Rainfall Measuring Mission (TRMM) mainly initiated by NASA, JAXA, and the National Institute of Information and Communications Technology (NICT). The major sensors on the GPM core satellite are the Dual-frequency Precipitation Radar (DPR) and the GPM Microwave Imager (GMI). DPR radar will measure intense rain in tropics by 14GHz, and weak rain & snow in mid/ high-latitudes by 35GHz. The goal is for obtaining highly sensitive precipitation measurement and a calibration for constellation radiometers and sounders.

Constellation Satellites: Microwave Radiometers or Sounders will be installed on each satellite for frequent precipitation measurements.

1. EarthCARE/ CPR: EarthCARE has been defined with the specific scientific objectives of quantifying aerosol-cloud-radiation inter-actions. EarthCARE is a joint project between ESA and JAXA-National Institute of Information and Communications Technology (NICT). JAXA-NICT is responsible for: Cloud profiling Radar (CPR) development; CPR science data processing; Promotion of the science and application

Program Status: Mission Definition Review (MDR) / System Requirement Review (SRR) in the last month; A phase up review in this summer (TBD); System Definition Review (SDR) and JAXA Management Level Review by the end of 2007 (TBD).

2. ALOS Follow-On Concept (for disaster monitoring)

Current System Concept: Monitoring disaster area affected by earthquake, volcano, flood, etc. Observing the disaster affected area within 3 hr (6 hr in night). A satellite constellation of two optical sensor satellites and two SAR satellites; Higher spatial resolution: 1-2m (pan), 3-5m (multi), 5m (SAR).

ALOS Cal/Val status "Daichi" (Advanced Land Observing Satellite): Jan. 24, 2006: Launch by H-IIA #8 from TKSC ; Jun. 11, 2007: 1.4 year (503 days) after launch.

Mission objectives: Cartography (1:25,000 scale), Regional environment observation, Disaster monitoring, and Resources surveying.

The instruments 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.

The geometric conditions of AVNIR-2 (Nadir) are similar to geometry in 16 days MODIS observations. AVNIR-2 and MODIS TOA radiance can be compared on satellite zenith angle θ (cross track angle).

The Latest ALOS calibration result can be find, in English, at:

http://www.eorc.jaxa.jp/hatoyama/satellite/data_tekyo_setsumei/alos_hyouka_e.html

6.5 NASA *(Stephen Ungar)*

Stephen Ungar, NASA EO-1 Mission scientist, presented the NASA agency report. The report focused on the Landsat Continuity Mission Program including current status, data gap issues and potential solutions.

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

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

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

Summary of Goals

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

6.6 NIST *(Raju Datla)*

Raju Datla, Optical Technology Division, Physics Laboratory, National Institute of Standards and Technology presented the NIST report.

Earth Observing System (EOS)

Reported was that NIST continues to collaborate with Earth observing programs to assess the accuracy of the radiometric characterization and calibration of flight sensors, as well as field equipment. The following NIST activities for the EOS program were reported: aperture area comparison – it is at a final set of measurement activities, continuing (with JPL/ACRIM); preparations are underway for Laboratory comparison for Total Solar Irradiance (TSI) between NIST, TIM, ACRIM, DIARAD, PMO6V in irradiance mode; preliminary characterization of SIM Instrument at the SIRCUS facility resolves most of the discrepancy between the SIM measurements and the Thullier/SOLSPEC measurements; limited comparison between NIST and TIM, and only in power mode is scheduled for November 17th, 2006.

Characterization of SIM on SIRCUS: The characterization team includes: LASP - Jerry Harder, Erik Richard, and Nate Miller; NIST - Keith Lykke, Steve Brown, Robert Bousquet, and Joe O'Connell

Future Work on SIM – there are plans for repeating the following measurements: SIM: Extend slit scatter function measurements into the UV & IR, looking more closely at baseline scatter level; ESR: Extend the spectral coverage to UV & IR, Establish the uncertainty in the measurements. The measurements are currently planned for December 06-January 07, but TBD.

TSI Instrument Comparison at NIST: This is a direct system-level comparison with representative TSI radiometer in a vacuum chamber. The beam expander for variable beam diameters is up to 15 mm: both irradiance and power modes. The homogenizer produces a top-hat profile: simulates solar irradiance geometry. The beamsplitter ratio (transmittance/reflectance) is measured in a separate step.

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

Calibration Support for CrIS (Cross-track Infrared Sounder): A study of NPP/NPOESS CrIS blackbody is being planned at the NIST MBIR Facility. A preparatory experiment has been completed with NIST blackbody in the MBIR Facility and the data is being analyzed. The CrIS ECT blackbody testing is expected to take place in FY07. The CrIS ICT blackbody testing is planned for FY08.

Test for NPOESS CrIS Calibration Blackbody (ICT): The goal is to validate vendor's radiance scale. TXR is a filter radiometer. FTXR is an FTIR spectroradiometer. Both CrIS blackbody and TXR are in vacuum. The FTXR views the blackbody thru a window. The ICT is controlled over its temperature range and radiometers measure emitted radiance. Separately, by widely varying temperature of the Scene Plate in front of the ICT, reflected radiance from the ICT is measured and used to infer ICT emissivity.

Characterization Support for VIIRS (Visible/Infrared Imager/Radiometer Suite): An infrared reflectance scale comparison of the Half Angle Mirror: NIST instrument upgrade with BIB detector to cover the LWIR range is completed. Characterization of bi-directional reflectance distribution function (BRDF), includes measurements of samples (UV, Vis, Near IR), and continuing consultation on reflectance scales. System testing has been conducted through the solar view aperture for determination of the "Apparent" BRDF of VIIRS solar diffuser target.

Geostationary Operational Environmental Satellite (GOES)

NIST is developing novel sources for GOES-R to replace the lamps in the lamp/monochromator systems - Supercontinuum Sources for Metrology: power (SCF < 1 mW/4 nm, SCS > 4 mW/1 nm), stability (~ 0.1 % over several hours), the resolution is determined by entrance/exit slit, SCF: 1 mm, SCS – single mode fiber: 10 um. The spectral range of the novel sources is from 450 nm to 2000 nm (commercial), and from 380 nm to 3000 nm (demonstrated). This is an emerging technology, which originally has been developed for the telecommunications industry.

Collaborations: NIST and Space Dynamics Laboratory at USU started collaboration to work towards SI traceability for Space Based Sensors. A joint proposal was developed at the workshop on "Achieving Satellite Instrument Calibration for Climate Change" (ASIC3) (May 2006) for LUSI (LUnar Spectral Irradiance) - a new program to reduce the uncertainty in the absolute lunar spectral irradiance.

Project Summary

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.

EOS: Jim Butler, NASA/GSFC cal/val lead; Primary efforts, FY07: TSI, TIM, SIM, stray light algorithms, prepare for lunar radiometry scale validation.

NPOESS and NPP: Karen St. Germain and Steve Mango, IPO; Primary efforts, FY07: CrIS blackbody at NIST with TXR, VIIRS reflectance scale, publication of TXR verification of SBRS VIIRS blackbody radiance.

Ocean Color (NOAA/NESDIS): Menghua Wang, NOAA/NESDIS, Ken Voss, UM, Carol Johnson & Dennis Clark, NIST; Primary efforts, FY07: MOBY operations, Instrument development for vicarious calibration NPP/NPOESS & GOES-R.

GOES and GOES-R: Michael Weinreb, NOAA/NESDIS; Primary efforts, FY07: Plan for ABI calibration verification efforts; application of TXR measurements of the GOES Imager blackbody source; novel source development, Participate in GOES-R reviews.

Reported was that NIST collaborates with NOAA for participating in the implementation of GSICS, and with USU/SDL for SI traceable Space based Radiometry.

NIST Recommendation: CEOS agencies to incorporate MOON irradiance measurements for VIS/NIR instruments in remote sensing space satellites for their calibration and stability monitoring.

6.7 NOAA *(Changyong Cao and Mitch Goldberg)*

NOAA Calibration/Validation Update: The report was prepared by Changyong Cao and Mitch Goldberg and given by Changyong Cao, as a representative of NOAA/NESDIS/ORA.

Global Space-based Inter-Calibration System (GSICS): GSICS is sponsored by WMO and CGMS, GSICS will inter-calibrate operational LEO and GEO satellites, and tie these to common reference standards. Chaired by Mitch Goldberg, the Executive panel kicked off in Geneva, Switzerland Oct. 11-13, 2006. Inter-comparability will result in more accurate observations for weather, water, and climate applications. Current members include: Eumetsat, Russian Federation, Japan, China, and the US. NOAA/NESDIS becomes the GSICS Coordination Center. The GSICS Calibration Support for climate studies will be carried out by participating satellite agencies, national standards laboratories, major NWP centers, and national research laboratories. CSS activities include: Earth-based reference sites**,** such as stable desert areas, long-term specially equipped ground sites, and special field campaigns, will be used to monitor satellite instrument performance; Extra-terrestrial calibration sources**,** such as the sun, the moon, and the stars, will provide stable calibration targets for on-orbit monitoring of instrument calibration; Model simulations will allow comparisons of radiances computed from NWP analyses of atmospheric conditions with those observed by satellite instruments; Benchmark measurements of the highest accuracy by special satellite and ground-based instruments will help nail down satellite instrument calibrations. WMO, CGMS, satellite agencies, national standards institutes, national data centers, major NWP centers, and national research laboratories will carry out the GSICS.

The first GSICS meeting was held at NOAA Jan 22-23, 2007. The attendees included representatives from WMO, EUMETSAT, CNES, CMA, KMA, JMA, NASA, and U. of Wisconsin. The meeting focused on methodology for intercalibration between LEO and GEO satellites. The second meeting was held at EUMETSAT, June 12-14, 2007

MetOP: The NOAA instruments on MetOP-A include: AVHRR, HIRS, and AMSU. MetOP-A Cal/Val has been conducted at NOAA. SNOs between MetOP-A and NOAA-18 are routinely produced for intercalibration.

METOP On-orbit Verification: The on-orbit verification is a major milestone for the Joint mission for EUMETSAT, ESA, and NOAA. NOAA has completed independent On-orbit verification for the NOAA instruments on MetOP. All instruments are working well. The MetOP/HIRS EMI noise issue has been resolved. The system experienced a shutdown for the first acquisition of MetOP/AVHRR and EO-1/Hyperion SNO data.

GOES-R: The GOES-R first launch is scheduled for the 2012. GOES-R payloads include: Advanced Baseline Imager (ABI) with 16 channels (0.47 – 13.3 um) - on schedule; Hyperspectral Environmental Suite (HES) – cutback; GEO Lightning Mapper (GLM); Space Environment In-Situ Suite (SEISS) ; Solar Imaging Suite (SIS); and Extreme Ultraviolet Sensor (EUS). A major risk reduction for GOES-R is the use of current GOES for routine operational lunar view for improved calibration. Preliminary study has demonstrated a ~3% capability in stability trending, which is very useful for GOES-R moon calibration & early preparation.

The first GOES-R Cal/Val Workshop was held in conjunction with the AWG (Algorithm Working Group) Meeting, May 15-18, 2007 at the National Conference Center in Leesburg, VA. The workshop was highly successful with more than 35 active participants including Cal/Val experts from the government, cooperative institutes, academia, and the industry.

GOES-R Cal/Val Plan: A draft of the GOES-R Cal/Val Plan (Volume 1) has been developed and is now available on the GOES-R AWG portal. The document focuses on the plans for on-orbit verification and long term monitoring of level 1b radiances, although it also discusses general areas in prelaunch calibration. The plan is part of the strategy to ensure that the mission requirements for radiances from GOES-R as well as user needs are met. It also supports the strategy for data quality assurance for meeting the objectives of Global Earth Observation System of Systems (GEOSS).

GOES imager and IASI Intercalibration: Preliminary comparison between GOES imager and IASI radiances has been performed at nearly coincidental, and co-located ocean sites. Since IASI has high spectral-resolution and better spectral and radiometric accurate, it can be used as a reference for calibrating broadband GOES imagers. The methodology has been developed to perform spectral convolution, pixel collocation, and statistical analysis. Sample analysis has been done and more data are being processed. This work provides fundamental support to the GSICS as well as GOES-R cal/val. The Star based Calibration for GOES is promising results for achieving long term instrument stability trending.

SNOs between EO1/Hyperion and MetOP/AVHRR: This is a joint experiment involving NOAA, USGS, and NASA. The objective is to resolve the spectral response induced biases between AVHRR and MODIS by using Hyperion data at the SNOs. One acquisition has been realized on May 19, 2007 and currently data analysis is in progress.

Instrument Stability Monitoring using selected products: The objectives are to independently monitor instrument stability; improve understanding of calibration impacts on products; while using the simplest retrieval algorithms over selected sites. Example products of interest include: night time SST in the 3.7um region over specific ocean sites (AIRS approach); aerosol over selected ocean sites, and aerosol sensitivity to calibration modeling.

Support to NCEP Reanalysis Project: This is a new NOAA/NCEP project on reanalysis, which requires re-calibrated satellite data with improved accuracy. Recalibration at NOAA/NESDIS has made significant progress. Currently the MSU re-calibration is most mature, while progress is being made in AVHRR and HIRS recalibration. NCEP will use the recalibrated radiances in their reanalysis. It also contributes to the GCOS climate actions.

Achieving Satellite Instrument Calibration for Climate Change (ASIC3 workshop):

This workshop was held at the National Conference Center, Lansdowne, VA, May 16-18,

2006. The major objective of the Workshop was to formulate a national roadmap for developing calibration systems that will enable us to monitor long-term global climate change. The Workshop was sponsored by the National Oceanic and Atmospheric Administration (NOAA), NASA, the National Institute of Standards and Technology (NIST), the Integrated Program Office for the National Polar-orbiting Operational Environmental Satellite System (NPOESS), and the Space Dynamics Laboratory of Utah State University. The workshop featured invited presentations and break-out groups. The break-out groups included: Infrared, UV, VIS/NIR, Microwave, Broadband, intercalibration, and national roadmap.

In conclusion: The MetOP on orbit verification of the NOAA instruments completed. All instruments are working well. The GOES-R cal/val contributes to the GEO DA-06-02, and will also benefit the GOES-R program.

Recommendation addressing traceability: Traceability requires the establishment of an unbroken chain of comparisons to stated references each with a stated uncertainty. NOAA strongly recommends, that: "Traceability" is added in the CEOS/WGCV terms of reference.

6.8 Russia *(Panfilov, Sapritsky, Krutikov)*

The report focused on the theme *"Metrological Assurance of GEOSS Radiometric Data Compatibility. An Example of Assuring High Quality Basic Climate Data Records (ADC Tasks DA-06-02 and CL-06-02)"*. Presented was the developed in a US-Russia collaboration paper *"Spaceborne Optoelectronic Sensors and Their Calibration"* (NISTIR 7203).

Stated was that, when ensuring traceable and stable instrument radiometric scales, the goal is to meet the most stringent requirements for radiometric instruments that are used for precision monitoring of global climate change. Suggested was to use calibration devices based upon the phenomenon of phase transition of eutectic alloys or pure metals in both the ground calibration and the in-flight monitoring systems.

For in-flight monitoring the following criteria were suggested: for spectral region 0.3–3.0 μm - Stability 0.1 %/d (moon as a test source); and for spectral region 3-25 μm - stability of 0.01 K/d. The development and use of onboard sources based upon phase transition of substances is suggested. Studies are required to select suitable substances (2006), determine their properties under the ground environment (2006), determine their properties under the space environment, and to design onboard sources. The development of a space-borne radiometric calibration facility is also considered.

A review of the current Russian activities, addressing metrological assurance of future GEOSS radiometric data compatibility, was presented. Ground activities included the development of a Russian set of standards for ground calibration of instruments operating within the spectral regions: 1) from 0.3 μm to 25 μm 2) from 0.3 μm to 3 μm, 3) from 3 μm to 25 μm. For in-flight monitoring, the preparation for a space experiment to study the effects of micro-gravity upon the melting/freezing phase transitions of eutectic alloys, was discussed.

Addressing GEO Climate Task CL-06-02, was stated that ensuring the long-term (for decades) high stability of GEOSS's instruments is of critical importance for registration of low-intensity changes of climate. The idea to monitor the stability of onboard instruments with the help of standard sources on the basis of phase-transition materials was considered very promising for solving Climate Task CL-06-02. It was stated that according to the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC. 2004. GCOS – 92 (*WMO/TD #1219) and the *Systematic Observation Requirements for Satellite-based Products for Climate, 2006; GCOS – 107* (WMO/TD № 1338), a necessary condition for obtaining *fundamental climate data records* is the use of high-quality observation instruments whose stability and accuracy are sufficient for climate monitoring purposes. The use of the phenomenon of phase transition of pure metals and eutectic alloys was suggested to provide the means to achieve a satisfactory solution of the instrument calibration task for climate monitoring purposes.

6.9 Thailand *(Raweewan Nutpramoon and Morakot Kaewmanee)*

The Thailand report was prepared by Raweewan Nutpramoon, Morakot Kaewmanee, Sitthisak Moukomla, and presented by ***Raweewan Nutpramoon and Morakot Kaewmanee***. The presentation focused on THEOS activities, and calibration and validation plan.

1. THEOS Mission and Specification: The THailand Earth Observation System (THEOS) is the first earth observation satellite of Thailand. System development started in July 2004, with a launch scheduled for October 2007 (by Dnerp). THEOS's specifications are as follows: 750 kg mass; Sun Synchronous orbit; 822 km altitude; 26 days repeat cycle; 10.00 a.m. mean local time; payload includes panchromatic telescope and multi-spectral camera (4 bands, NIR RGB, 0.45-0.90um); on-board memory of 51Gb; X-band data link and TT&C S-band link, attitude orbit control and 3-axis stabilized, star tracker orbit determination; Gyro, GPS, Magnetic Torque; Sun Sensor; and 5 Years design life time.

2. In-Orbit Test (IOT): The prime contractor EADS Astrium has the responsibility to perform IOT and image calibration and validation. GISTDA will control the satellite after the first year and will perform image quality monitoring during THEOS life time.

3. THEOS Radiometric Calibration Plan
Objectives: 1) Perform the in-flight measurement of radiometric parameters of the THEOS optical payload (to recover the actual radiometric content in the image from digital raw data); and 2) Verify the radiometric parameters meet the specifications.

To assess the level of dark signal the use of no signal producing area, such as Pacific or Atlantic ocean is considered. Pixel response non-uniformity (PRNU) will be studied using uniform areas at different uniform radiance levels (e.g. Amazon forest, Desert (Algeria, Arabia), Greenland ice field, etc.).

For absolute radiometric calibration a test site will be selected in Thailand (required is a feasibility study). The plans for assessment of THEOSs Modulation Transfer Function (MTF) include the use of test sites, such as edge (Salon de Provence), punctual target (Pong Hu) and radial (NASA, Stennis Center)

4. THEOS Geometric Calibration Plan:
Ground Sampling Distance & Swath width: To verify the ground sampling distance, swath width, and check the conformity with specifications is required a Level 1A image (all channels) over landscapes with ground control points, in TIF format.

Pointing Accuracy: To evaluate the pointing error in regard to the expected (i.e. commanded) are required Level 2A images (PAN channel only required), in TIF format, including map information.

Geolocation Accuracy: To evaluate the geolocation error (around 20 m for absolute localization and better than 5 m for the relative one) are required Level 2A images (PAN channel only required) over landscapes with ground control points, (typically 1 to 5 per image), in TIF format, including map information.

Band Registration: To evaluate the band registration performance obtained with the geometric corrections the goals are to reduce registration errors down to 0.2 pixel for PAN and MS channels, except the near-infrared band for which the errors may reach 0.4 pixel. Required is the use of Level 2A images (all channels) over heterogeneous areas (urban landscape typically).

GISTDA plans the following Cal/Val activities to guarantee the basic requirements of the satellite and to obtain enhanced satellite imagery and data higher quality: 1) Validate and verify the satellite and the satellite imagery data; 2) Calibrate the satellite; and 3) Identify & present the status of the satellite imagery data for Users community. Some of the considered Geometric test sites include: Chiangmai, Chainat and Nakhonratchasima.

6.10 USGS *(Gyanesh Chander and Greg Stensaas)*

Gyanesh Chander (SAIC/EROS/USGS) and ***Greg Stensaas*** (EROS/USGS) gave the USGS report.

Mission Status of Landsat 5: Landsat 5 has been on orbit for 24 years, although designed for only 3 year mission life. The satellite has a Solar Array Drive Malfunction. Both primary and redundant drives have failed. On 8/14/2006 the solar array was placed in a fixed position. The imaging limitations due to power issues are currently investigated. TWTA Anomaly: In March 2006: Over Current Protection Circuit (OCP) trip prevented the majority of acquisition attempts. The Flight Operations Anomaly Team received the "international space operations award for outstanding achievement" for dedicated efforts in recovering Landsat 5 from two potentially mission-ending hardware anomalies and restoring the mission to full operations.

Mission Status of Landsat 7: Landsat 7 has been on orbit for 8 years, although designed for only 5 year mission life. Scan Line Corrector (SLC) malfunction occurred on May 31, 2003. The gaps represent a data loss of ~ 25% for any given scene. 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 normal operations have been switched over to ETM+ Bumper mode on Apr 1, 2007.

Landsat end of mission statements: Based on the best atmospheric-drag models and fuel-budget estimates available at the time, NASA and the USGS informed the Administration in June 2005 that decommissioning procedures would commence for Landsats 5 and 7 around October 2010. This projection was most likely a factor in the Administration's December 2005 decision to move forward with a free-flyer LDCM mission as soon as possible. The USGS and NASA, as Landsat Program Management, are not going to announce new decommissioning dates since a subsystem failure could terminate the Landsat 5 or Landsat 7 mission at any time. We will, however, tell interested parties that, while the original October 2010 estimate remains in place, the USGS intends to operate the satellites beyond 2010 as atmospheric drag conditions, resulting fuel budgets, and subsystem performance allow."

Landsat Web-enabled Data Pilot: As of June 4 2007, the USGS will be releasing selected Landsat 7 image data of the United States through the Web: http://glovis.usgs.gov/ or http://earthexplorer.usgs.gov/. These data are of high quality with limited cloud cover. This Web-enabled distribution of new and recently acquired data is a pilot project for the LDCM. The project will allow the Landsat data user community to help refine the distribution system planned for the upcoming LDCM. Each scene will be registered to the terrain, or 'ortho-rectified,' prior to being placed on the Web. Copies of these data will also be available on CD or DVD at the cost of reproduction. The pilot project will be carefully examined. Customer response will be evaluated and their insight will influence the future distribution system.

Landsat Archive Overview: (Marketable Scenes as of April 30, 2007)
ETM+, Landsat 7: includes 715,503 scenes, 664 TB RCC and L0Ra data. The archive grows by 260 GB daily. TM, Landsat 4 & Landsat 5: includes 696,078 scenes, 336 TB of RCC and L0Ra data. The archive grows by 40GB daily. MSS, Landsat 1 through 5: Includes 649,417 scenes, 14 TB of data.

Mid-Decadal Global Land Survey
Provides a follow-up to decadal orthorectified global data sets (1975, 1990, and 2000 epochs) centered on 2004-2006. Phase 1 will identify all candidate scenes and ingest into the USGS archive (USGS lead). Phase 2: Process selected data into an orthorectified dataset compatible with previous surveys (NASA lead). Phase 3: Analyze data set to quantify trends in land cover and vegetation dynamics (NASA LCLUC).

Landsat data continuity mission (LDCM): The measure of success of the overall LDCM mission is the complete integration of LDCM data with past, present, and future Landsat and remotely sensed data for the purpose of observing and monitoring global environmental systems. On Oct 24, 2006, NASA released a revised synopsis to potential offerors of the Agency's planned procurement strategy for the LDCM procurement approach (http://prod.nais.nasa.gov/cgi-bin/eps/synopsis.cgi?acqid=122610). NASAs acquisition approach for LDCM includes separate procurements for the instrument, spacecraft, and mission operations elements. NASA/GSFC will serve as the system integrator for the mission and launch services will be provided by the NASA Launch Services (NLS) contract managed by the Kennedy Space Center (KSC). The targeted LDCM launch readiness date is July, 2011, followed by 90 day on-orbit checkout and acceptance.

NASA will: Acquire the space segment, mission operations systems, and launch services. Perform overall mission systems engineering and integration; Manage space segment early on-orbit ops from launch to acceptance; after on-orbit acceptance, transition ops responsibility to the USGS; and Co-chair the Landsat Science Team.

USGS will: Acquire and operate the ground system including data networks, image collection scheduling, archive, processing, and distribution systems; Perform ground system integration and support mission integration; Operate and maintain the LDCM mission following on-orbit acceptance; and Co-chair and fund the Landsat Science Team.

The Landsat Science Team will offer informed advice and recommendations to the USGS and NASA on topics that will affect the overall success of the LDCM mission. The science team expertise covers: 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; and data issues – including acquisition strategies, data access requirements and

specifications, product characteristics, data management capabilities, data archiving. The first science team meeting was held January 9-11, 2007. The second meeting is planned for June 12-14, 2007.

Landsat Data Gap
It was reported that the Earth observation community is facing a probable and pending gap in Landsat data continuity before LDCM data arrive in 2011, due to: Landsat 5 limited lifetime/coverage and degraded Landsat 7 operations. It was stated that there is a need to develop strategy to reduce the impact of a Landsat data gap. Landsat data are used extensively by a broad and diverse community. The data gap will interrupt a 34-yr time series of land observations during a critical time period. Reported was that Landsat Data Gap Study Team (LDGST), chaired by NASA and the USGS is analyzing the potential solutions. The objective is to recommend options, using existing and near-term capabilities, to populate the USGS National Satellite Land Remote Sensing Data Archives with science quality data. There is no substitute for Landsat as a single source of systematic, global land observations, but use of data from alternate sources may reduce the impact of a Landsat data gap. Multiple systems are being characterized to understand which data sets may be compatible with the Landsat data record and can potentially supplement the Landsat data archive, but no decisions have been made yet. The Landsat Data Gap Study Team will: Finalize the recommendations and strategy for implementation; Present the findings to U.S. civil agency management and the White House Office of Space and Technology Policy; and Implement the recommendations. The on-going Cross-cal work at USGS includes the cross-calibration of: L7 ETM+ and L5 TM sensor, L7 ETM+/L5 TM and EO-1 ALI sensor, L7 ETM+/L5 TM and CBERS-2 CCD sensor, L7 ETM+/L5 TM and IRS-P6 AWiFS and LISS-III sensor, L7 ETM+/L5 TM and ALOS AVNIR-2 sensor, L7 ETM+/L5 TM and Terra MODIS sensor, and L5 TM and L4 TM sensor.

Online Catalogue of World-wide Test Sites for the Post-Launch Characterization & Calibration of Optical Sensors. A whitepaper is drafted that provides a comprehensive list of prime candidate terrestrial targets for consideration as benchmark sites for the post-launch radiometric calibration of space-based instruments. USGS is working on creating an online catalogue that provides easy public web site access to this vital information for the global community. The next step is to work with international agencies and organizations to refine the list further and to provide additional key information needed to characterize each site. A parallel comparison to the CEOS cal/val sites was made.
USGS recommends/advocates the coordination of world-wide Cal/Val sites, including ground control points; and the coordination and planning of vicarious calibration field campaigns.

Session 2: WGCV Contribution to GEOSS/GEO Tasks

1. GEO Update and Opening Remarks *(Dr. Michael Rast, GEO Secretariat)*

Michael Rast, GEO Secretariat, gave an update on the current GEO tasks and priorities and addressed the relevance of CEOS/WGCV to some of them.

Status of GEO and GEOSS: The Group on Earth Observations (GEO) is formally established as intergovernmental organization, the GEO 10-year Implementation Plan has been endorsed, and the GEO Secretariat is established in Geneva. The *Group on Earth Observations* currently comprised 65 member countries, the European Commission and 43 participating organizations. The objective of GEO is: to establish a global, coordinated, comprehensive and sustained system of Earth observing systems, GEOSS. In a global environment (GEOSS), there is a strong need for a system (portal, clearing house) which provides access to all Earth observation data in standard interoperable formats, which require a sustained and comprehensive data quality assurance concept.

The main GEOSS principles include: Process - driven by user needs, supporting a broad range of implementation options; Scope-addresses all observations required for participants to make products, forecasts and related decisions; Capabilities-include observing, processing, and dissemination capabilities, provided by national, regional or international agencies subscribing to GEOSS while retaining their ownership and operational responsibility; Data and its exchange and dissemination-observations and products are to be observed, recorded and stored in clearly defined formats; Operation-secures the future continuity of observations; Catalogue-members and participating organizations and the components they support will be documented in a catalogue that is publicly accessible, network distributed, and interoperable with major Earth observation catalogues. The building of GEOSS should to the largest extent build on already existing components and infrastructures. GEOSS did not only cover remote, but also in-situ observations and their networks on a global scale.

The GEOSS architecture will above all provide systems interoperability and enable an easier and more open data access. Seven shortcomings were listed as the target areas for GEOSS: 1. Lack of access to data and associated benefits in the developing world; 2. Eroding technical infrastructure; 3. Large spatial and temporal gaps in specific data sets; 4. Inadequate data integration and interoperability; 5. Uncertainty over continuity of observations; 6. Inadequate user involvement; and 7. Lack of relevant processing systems to transform data into useful information. The GEOSS architecture would facilitate the interoperability arrangements needed to: Improve and Coordinate Observation Systems; Provide Easier & More Open Data Access; Foster Use through Science and Applications; and to answer Society's need for informed decision making. GEO will support the development of new observation methodologies and will foster the implementation of applications and services (e.g., forecasts).

Dr. Rast presented the following GEO tasks as examples of relevance to WGCV:

The focus of WGCV is on the Task DA-06-02: Develop a GEO data quality assurance strategy, beginning with space-based observations and evaluating expansion to in-situ observations, taking account of existing work in this arena. CL-06-02: Establish actions securing the provision of key data for climate studies and forecasting from satellite systems. EC-06-02: Establish an ad hoc Ecosystems Classification Task Force, covering terrestrial, freshwater, and ocean ecosystems, with a mandate to create a globally agreed, robust, and viable classification scheme for ecosystems.

Stated was that the success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata, and products. The WGCV played an important role, since it would be leading the effort to harmonise the calibration and validation (data quality assurance) procedures and practices globally and across all communities of practice in Earth Observations.

2. GEO Cal/Val Workshop Preparation *(Moderators: Lecomte, Rast and Greening)*

GEO – CEOS Workshop on Quality Assurance of Calibration and Validation Processes

The report was prepared by Marie-Claire Greening & Pascal Lecomte and presented by Marie-Claire Greening.

A GEO-CEOS Workshop on Quality Assurance of Calibration and Validation Processes was planned for 2 – 4 October 2007, in Geneva, Switzerland. The goals of the workshop were to identify the key elements needed to develop and implement a "data quality strategy" as required by GEO task DA-06-02. Key discussion elements would include:

- Best practises in Cal / Val processes,
- Harmonisation and standardisation of quality control and Cal/ Val processes,
- The role of CEOS in the certification of those processes, and
- An implementation strategy.

Seed documentation for each session on the agenda would be made available to all participants well in advance of the workshop. These would take the form of relevant reports and / or other documentation that detailed work undertaken in the topic area. Each session on the agenda would be chaired by an expert in that field and supported by a session facilitator. The role of the chair would be to present a summary of the key issues relevant to that session's topic, as derived from submitted papers and seed documentation, which would be made available to all participants before the workshop commenced. The chair would then lead the discussion as the floor is opened to all. The role of the facilitator would not be to take part in the discussion, but to ensure that the discussion did not deviate too far from the key issues and to ensure that all important points arising were recorded accurately.

Some of the questions to be considered during the include:

- What constitutes a Cal/Val site ?
- How can satellite and *in situ* data be accessed ?
- What methodologies should be used for Calibration and Validation ?
- How can Quality Control Processes be harmonised across missions ?
- Is there a need for CEOS certification for QC and Cal/Val processes ?
- Do users / operators demand CEOS certification for QC and Cal/Val processes ?
- How should Validation Data be efficiently handled ?
- How can *a posteriori* information on data quality be communicated to users?

3. WGCV contributions to GEO Tasks and Activities *(Moderators: Ungar, Datla, Fox)*

The following table summarizes the GEO tasks with GEO participation:

GEO Area	Task #	Task Title
Agriculture	AG-06-04	Forest Mapping and Change Monitoring
Biodiversity	BI-07-02	Invasive Species Monitoring System
Climate	CL-06-01	Sustained Reprocessing and Reanalysis Efforts
Climate	CL-06-02	Key Climate Data from Satellite Systems
Climate	CL-06-03	Key Terrestrial Observations for Climate
Climate	CL-06-05	GEOSS IPY Contribution
Data Management	DA-06-02	GEOSS Quality Assurance Strategy
Data Management	DA-06-04	Data, Metadata and Products Harmonisation
Data Management	DA-06-09	GEOSS Best Practices Registry
Data Management	DA-07-01	DEM Interoperability
Data Management	DA-07-02	Global Land Cover
Disasters	DI-06-04	Implementation of a Tsunami Early Warning System, Global Level
Disasters	DI-06-07	Multi-Hazard Zonation and Maps
Disasters	DI-06-09	Use of Satellites for Risk Management
Ecosystems	EC-06-01	Integrated Global Carbon Observation (IGCO)
Ecosystems	EC-06-02	Ecosystem Classification
Ecosystems	EC-06-07	Regional Networks for Ecosystems
Ecosystems	EC-07-01	Global Ecosystem Observation and Monitoring Network
Weather	WE-06-01	Surface-based Global Observing System for Weather

The GEO tasks were presented and their relevance to the work of the WGCV membership was addressed. New action item was generated for the WGCV Secretariat. WGCV27-1: The WGCV secretariat and the SG chairs to summarize the SG activities relevant to the above GEO tasks.

4. GCOS IP Climate Action Items and GSICS *(Moderators: Ungar, Goldberg, Cao)*

4.1 **Global Space-based Inter-Calibration System, GSICS** *(Goldberg):* GSICS will inter-calibrate operational LEO and GEO satellites, and tie these to common reference standards. It is sponsored by WMO and CGMS and chaired by Mitch Goldberg, the Executive panel kicked off in Geneva, Switzerland Oct. 11-13, 2006. Inter-comparability will result in more accurate observations for weather, water, and climate applications. Current members include: Eumetsat, Russian Federation, Japan, China, and the US. NOAA/NESDIS becomes the GSICS Coordination Center. The GSICS Calibration Support Segments (CSS) will be carried out by participating satellite agencies, national standards laboratories, major NWP centers, and national research laboratories. CSS activities include: Earth-based reference sites**,** such as stable desert areas, long-term specially equipped ground sites, and special field campaigns, will be used to monitor satellite instrument performance; Extra-terrestrial calibration sources**,** such as the sun, the moon, and the stars, will provide stable calibration targets for on-orbit monitoring of instrument calibration; Model simulations will allow comparisons of radiances computed from NWP analyses of atmospheric conditions with those observed by satellite instruments; Benchmark measurements of the highest accuracy by special satellite and ground-based instruments will help nail down satellite instrument calibrations. WMO, CGMS, satellite agencies, national standards institutes, national data centers, major NWP centers, and national research laboratories will carry out the GSICS.

4.2 AVHRR reprocessing in support of T-4: CCRS collaboration *(Trishchenko)*

5. Cal/Val Support to CEOS Constellations *(Moderators: Cao, Bojkov, Ungar)*

5.1. A new action item was generated for the WGCV secretariat - **WGCV27-2: Contact the CEOS/LCI constellation and the other CEOS constellations, inquiring for their Cal/Val needs.**

5.2 CEOS Atmospheric Composition (AC) Constellation (Hilsenrath, Langen and Bojkov)

The report on the CEOS AC Constellation, prepared by Ernest Hilsenrath (NASA Headquarters) and Joerg Langen (ESA ESTEC), was presented by Bojan Bojkov (NASA).

1) Background: CEOS has agreed to provide the space component for GEOSS and deliver data to meet the GEO SBAs: http://www.earthobservations.org/about/about_GEO.html. The Atmospheric Composition (AC) Constellation is one of four pilot projects to bring about technical/scientific cooperation and collaboration among space agencies that meet GEO objectives and also support national priorities. The AC Constellation study will identify mission(s) or data delivery that serves the science and application community that can be advocated by the CEOS agencies (NASA, ESA, CSA, NIVR, NOAA, Eumetsat, JAXA, etc). The AC Constellation study will prioritize user requirements and define missions or a "virtual" system consisting of space and ground segments including archives that meet user requirements. The AC Constellation considers only the space component of atmospheric composition science and applications, but recognizes the need for complimentary ground based measurements and modelling to fully address science priorities

2) Goal: The AC Constellation goal is to collect and deliver data to develop and improve predictive capabilities for coupled changes in the ozone layer, air quality, and climate forcing associated with changes in the environment.

3) Current status: Requirements for Atmospheric Composition measurements have been developed by national and international agencies and panels – e.g. NAS Decadal Survey, NASA Science Plan, USCCSP, CAPACITY, IGACO, GMES. These are mature and are supported by CEOS agencies in ongoing mission definition studies.

Atmospheric Composition supports five of the nine GEO SBAs: Health, Energy, Climate, Hazards, and Ecosystems. Specific users include: forecasting - National weather and environmental protection services; monitoring and assessment - Montreal and Kyoto Protocols, IPCC, WMO/UNEP, CCSP, PROMOTE (GMES), and collaborators and participants. The developing of the NASA Science Plan recognizes that partnerships are essential "...because of the complexity and breadth of these issues and that the atmosphere links all nations". NAS DS also recommends: "…leverage international efforts, teaming...missions…data access".

The participants with major assets for AC missions include: USA: NASA (Lead), ESA (Co-lead) and as participants USA: NOAA, .Netherlands: NIVR, Canada: CSA and MSC, France: CNES and Eumetsat, EU/GMES, Japan: JAXA, China: NSMC, CSSAR and CAST.

The currently existing AC space capabilities include: Aura, Envisat, ACE, ODIN, CALIPSO, Cloudsat, Terra/MOPITT/CERES, Aqua/AIRS/CERES, POESS/SBUV-2, POLDER, Metop/GOME-2/IASI. Some of the upcoming approved AC space capabilities include: OCO, GLORY, NPP/NPOESS (aerosol and ozone, no chemistry), EarthCARE, ADM-Aeolus, GOSAT, FY-3/SBUS-TOU, SWIFT, ESA EE Pre-Phase A: TRAQ (AQ), PREMIER (UT/LS), and A-SCOPE (CO_2). Currently under consideration is the use of high resolution multispectral nadir and limb imagers in coordinated orbits: GMES and NAS DS, NASA Mission Concepts for LEO, GEO orbits.

4) Plans for AC constellation implementation: 1) Establish a framework for long term coordination among the CEOS agencies where the "Constellation" concept will identify specific opportunities for meeting science and application requirements. 2) Assemble international Study Team consisting of CEOS Agencies with Atmospheric Composition interests and assets and authorized to commit resources. 3) A complimentary advisory group from science and application community will be established to insure the appropriate requirements are being considered. The advisory group will participate in establishing the constellation priorities. It will evaluate existing and upcoming missions, both operational and research and compare with requirements; develop a consensus for priorities based on and established user requirements and emerging societal needs from both operational and research communities; establish how existing and approved missions could work synergistically to meet the international user community requirements and in particular the GEO Societal Benefit Areas; define enhancement in the area of cal/val, quality control, and data accessibility and interoperability, major rolls for WGISS and WGCV (ACSG and GEO/CEOS Cal/Val WS); develop rationale, strategy and standards for new mission(s) to meet requirements not being met and for possible new requirements. The strategy should include architecture, schedule, and possibly costs.

5) The first ACC Workshop, March 2007: The participants agreed on the AC Constellation concept and its objectives, on the space agencies and users to participate, on the specific goals and projects – near, mid and long term. Near term objectives (available today or very soon, and where collaboration concentrates on the refinement, use, access to and distribution of existing data products) target the development of combined and synergistic data set. Medium-term goals (feasible within a few years, where collaboration extends to product specification and interoperability) focus on the generation of improved data products and the definition of new mission architecture leading to a Constellation. Long-term plans (achievable within about ten years after original constellation concept is agreed on) target the agreement on the implementation of a Constellation and its architecture. The AC Constellation proposed to provide CEOS with a project, a demonstration in time for GEO Summit, November 2007. Currently the ACC work plan is in preparation.

6) ACC Definitions Studies: NASA has established the Systems Engineering Office to support all four Constellations. It will evaluate requirements, identify missing components, and evaluate end-to-end requirements for Constellation architecture.

ACC assessment is on the way to prepare a report on the ACC system priorities and requirements, to include "standards" (RT/algorithm, end-to-end cal/val, data interoperability). A preliminary assessment and gap analysis report is assessing existing and near-term planned ACC missions against system requirements.

7) Near and Mid Term ACC Projects: CEOS is very anxious to demonstrate the Constellation capabilities in time for GEO summit – Nov 2007. ACC is proposing near and medium term projects emphasizing synergistic

and enhanced data products from multiple missions which include also a component for outreach and capacity building (all major GEO goals).

Project 1: High-quality tropospheric ozone products using two methods will be compared with each other. Total column ozone from TOMS, GOME, SCIAMACHY, OMI, GOME-2 minus stratospheric column ozone from SAGE, SCIAMACHY, MIPAS, MLS. Assimilation/ joint retrieval of radiances measured by nadir UV sensors and nadir IR sensors (AIRS, TES, IASI).

Project 2: Air-Quality assessment from multiple instruments for improved forecast and assessments. Envisat/Metop in morning orbits, Aura/Aqua/Parasol in afternoon orbits. They provide twice daily coverage for reflected sensors, four times for IR sensors. Provide diurnal variation of tropospheric species. CALIPSO/CloudSat provides 3-dimensional view of clouds and aerosols to help in the interpretation of AQ data (BL height, transport). Demo will be developed using NO_2 from SCIAMACHY/GOME-2 and OMI.

Project3: Assemble and array of AC products being developed CEOS agencies for near real time distribution. Products relevant to GEO SBAs and meet the following criteria; Availability, Quality and Functionality. A user workshop will be assembled to define data enhancements and distribution.

Project 4: Develop a global data product for fires and aerosols. This project will make use of the IDEA (Infusion of Satellite Data for Environmental Applications) project which is now operational http://idea.ssec.wisc.edu/). Extending the capability of developing fire, aerosol, and subsequent forecast guidance products for global operational purposes can use the IDEA prototypes and apply to multiple platforms.

Project 5: Long-term aerosol data set. Project will employ several international satellites where aerosol properties are measured in different ways with some overlap. Data will be of value for climate modeling, pollution inventories, and monitoring. Ground based observations will play a key role in validation and providing additional aerosol parameters.

8) Anticipated Constellation Benefits: The synergies provided by the Constellation should substantially improve accuracy and coverage of satellite data and result in improved Atmospheric Composition science and application capabilities. The Constellation would serve as an international scientific forum for debating priorities and formulating future Atmospheric Composition missions. It provides an opportunity for participating space agencies to cooperate in planning, developing, and operating future missions. The Constellation will allow for an efficient response to new requirements as the Earth system responds to climate change.

Session 3: WGCV Reporting to CEOS

WGCV Reporting to CEOS includes the Update/Generation of New WGCV Action Items and Recommendations to CEOS *(All, Campbell, Cao)*

1. Current WGCV Action Items

During the WGCV-27 2 new action items were generated, in addition to 3 action items remaining open from WGCV-26, there are a total of 5 open action items, as listed in the following table.

CURRENT ACTION ITEMS

WGCV25-3	**NIST** to generate for the CEOS best practices a description of the Total Solar Irradiance Workshop.	WGCV26 open, in progress
WGCV26-1	**WGCV Secretariat** to generate a "WGCV suggested cal/val practices" web page and populate it with the materials generated by WGCV. The materials will be transferred to the Cal/Val Portal.	Ongoing

WGCV27-1	**WGCV Subgroup Chairs** (SG) to review with the SG members the *list of GEO tasks in which WGCV is participating* (attached), and to generate a summary of the activities in which the members are participating, relevant to the listed GEO tasks.	WGCV28
WGCV26-5	**WGCV Subgroup Chairs,** to review with the SG members the ***seed questions*** describing QC and cal/val processes, focus of the GEO/CEOS Cal/Val Portal Workshop, and prepare to address them. In addition, similar request to be made to the wider WGCV membership.	CalVal_WS07 completed
WGCV27-2	**WGCV Secretariat**, to contact the CEOS constellation leads and request that the constellation teams evaluate their cal/val requirements.	WGCV28 in progress

2. Recommendations to CEOS

WGCV Recommendation (all WGCV SGs):

CEOS reinforce WGCV-26 recommendation 2 ("*CEOS recommends that member space agencies coordinate efforts with existing cal/val archives and that member agencies supply the necessary resources to implement the requirement to establish uniform data protocols for collecting, archiving, and accessing validation data across Earth science disciplines*"), that for Cal/Val purposes member agencies make the Cal./Val. data and metadata readily available.

3. Date and Place of Next Meeting

The forthcoming WGCV-28 meeting will be hosted by China: NSOAS, SKLRSS and NMRSL/CSSAR/CAS. WGCV28 will be held April 26-29, 2008 in Sanya, China.

Annex A: CEOS/WGCV 27 Agenda

Tuesday, June 12, 2007

9:00 Registration at NPL reception

9:15 Introductions, Logistics, Adoption of Agenda for WGCV27 (Cao, Campbell)

Session 1: Welcome, Overview and Reports

9:30 **1.1 WGCV27 Welcome Address**

9:30 **Welcome and Overview of NPL** *(Dr Martyn Sene, Director, Quality of Life Division, NPL)*

9:50 **Opening remarks from BNSC and United Kingdom Report - Satellite programs, agencies and plans** *(Dr. Arwyn Davies, Director, Earth Observation, BNSC)*

10:30 **1.3 WGCV-27 Meeting Goals, Introduction of the new Subgroup Chairs, WGCV Status and Chair Report** *(Cao)*

11:00 **1.4 Minutes and Status of Action Items from WGCV-26** *(Campbell)*

11:30 **1.5 Subgroup Reports** *(Chairs: Cao, Datla, and Lecomte)*

11:30 1.5.1 Atmospheric Chemistry *(Bojkov)*

12:00 - 13:00 Lunch

13:00 **1.5 Subgroup Reports** *Continued*

13:00 1.5.2 Land Product Validation *(Baret)*
13:30 1.5.3 Infrared and Visible Optical Sensors *(Fox)*
14:00 1.5.4 Microwave Sensors *(Buck)*
14:30 1.5.5 Terrain Mapping *(Muller/Jovanovic)*
15:30 1.5.6 SAR *(Srivastava)*

15:30 - 16:00 Break

16:00 **1.6 Country and Agency Reports** *(Chairs: Cao, Datla and Lecomte)*

16:00 1.6.1 Canada *(White/Srivastava)*
16:25 1.6.2 China *(Dong)*
16:50 1.6.3 ESA *(Lecomte)*
17:15 1.6.4 IPO (*Mango*)
17:40 1.6.5 JAXA *(Murakami)*

18:05 Adjourn

Wednesday, June 13, 2007

8:50 Arrival at NPL

9:00 **1.6 Country and Agency Reports** *Continued*
- 9:00 1.6.6 NASA *(Ungar)*
- 9:25 1.6.7 NIST *(Datla)*
- 9:50 1.6.8 NOAA *(Goldberg)*
- 10:15 1.6.9 Thailand/*GISTDA (Morakot/Raweewan)*

10:40 Break

11:00 **1.6 Country and Agency Reports** *Continued*
- 11:00 1.6.9 TUBITAK-UZAY, Turkey (*Gurol*)
- 11:25 1.6.10 USGS *(Chander/Stenssas/Dwyer)*

12:00 - 17:00 Visit to Satellite Technology Limited (SSTL) and Mullard Space Science Laboratory (MSSL)

19:00 - 23:30 *Hosted Evening Dinner*

Thursday, June 14, 2007

8:50 Arrival at NPL

9:00 **1.6 Country and Agency Reports** *Continued*
1.6.11 Russia (*Panfilov, Sapritsky, Krutikov*)

Session 2: WGCV Contribution to GEOSS/GEO Tasks

9:30 **2.1 GEO Update and Opening Remarks: Dr. Michael Rast, GEO Secretariat**

2.2 GEO Cal/Val Workshop Preparation *(Moderators: Lecomte, Rast and Greening)*
- 2.2.1 Workshop Agenda and Topics
- 2.2.2 Workshop Logistics and Issues

10:30 Break

11:00 2.3 WGCV contributions to GEO Tasks and Activities *(Moderators: Ungar, Datla, Fox)*

2.3.1 GEO task DA-06-02 (WGCV 1-Lead): Develop a GEO data quality assurance strategy, beginning with space-based observations and evaluating expansion to *in-situ* observations, taking account of existing work in this arena. Current status, updates and quarterly reports, (*Ungar)*

2.3.2 CEOS certification of Cal/Val sites: WGCV consensus on site selection and certification criteria; each subgroup recommends 1-3 ideal sites for prototyping. Potential candidate sites include Arizaro (VIS/NIR), Amazon (MS and Radar), etc. *(Fox)*

12:00 Lunch

13:00 2.4 GCOS IP Climate Action Items and GSICS *(Moderators: Ungar, Goldberg,Cao)*

2.4.1 GEO CL-06-02 (WGCV 2-Lead): Establish actions securing the provision of key data for climate studies and forecasting from satellite systems
2.4.2 GSICS (Goldberg)
2.4.3 AVHRR reprocessing in support of T-4: CCRS collaboration *(Trishchenko)*
2.4.4 Absolute measurements

14:00 2.5 Cal/Val Support to CEOS Constellations *(Moderators: Cao, Bojkov, Ungar)*

2.5.1 Contributions to GEO/GEOSS
2.5.2 AC and LSI constellation support
2.5.3 Coordination with WGCV

15:00 Break

15:30 2.6 WGCV participation in Other GEO Tasks *(Moderators: Cao, Ungar)*

2.6.1 DA-07-01 *(Muller)*
2.6.2 Other tasks and issues

16:30 WGCV Reporting to CEOS: Generation of New WGCV Action Items and Recommendations to CEOS *(All, Campbell, Cao)*

17:30 Adjourn

Friday, June 15, 2007

8:50 Arrival at NPL

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

9:00 Finalize WGCV Action Items

10:00 Finalize WGCV Recommendations to Plenary

10:30 Break

11:00 Wrap up and write up *(Cao, Campbell, All Welcome)*

12:00 Closing of Plenary *(Cao)*

12:00 Lunch

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