COMMITTEE ON EARTH OBSERVATION SATELLITES

Working Group on Calibration & Validation (WGCV)

MINUTES OF THE 29th WGCV MEETING

WGCV-29

Avignon, France

September 30-October 3, 2008

Hosted by:

L'Institut National de la Recherche Agronomique (INRA)

and

Centre National d'Etudes Spatiales (CNES)

France

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

Introduction, Logistics and Adoption of Agenda for WGCV-27 (Changyong Cao and Martha Maiden)

The WGCV Chair Changyong Cao and the LVP Chair and host of the meeting Frederic Baret introduced the participants. The Chairs recognized the *CEOS/SIT* representative *Brian Killough (NASA)* and the participating country and agency representatives. The role of CEOS/SIT in coordination of the CEOS agencies to support GEO in its realization of the space segment of GEOSS was discussed. The logistics of the meeting and the needs of the participants were addressed.

In addition to the traditional reports and WGCV contributions to GEOSS, the meetings included also: panel discussions with moderators and invited keynote speakers, leading experts/scientists on specific issues. **The WGCV-29 Agenda (Annex A) and Goals were approved as presented.**

Session 1: Welcome, Introductions and WGCV Reports

1. Welcome from the official WGCV-28 host Dr. Baret *(INRA)*

Our hosts, ***Frederic Baret*** *(INRA)*, and ***Patrice Henry*** (CNES), welcomed the WGCV. Dr. Baret gave an *"Introduction to INRA, Avignon: activities for environmental monitoring with remote sensing*". Dr. Henry presented an "*Overview of the satellite programs of France"* and discussed the CNES agency goals, instruments and capabilities. For more details, please see their presentations at the WGCV29 web page.

The **WGCV Chair, Changyong Cao** thanked the hosts for their kind remarks, informative presentations and for organizing the meeting. The goals of WGCV29 were presented. They included reviewing progress made for the CEOS 2008 actions, tasks, and deliverables, providing cal/val update by subgroups and member agencies, learning more about the remote sensing programs in France, and holding a special session on land product validation. Collaboration opportunities with WGISS and SEO were explored and the election of a vice chair was be held, along with preparations for chair succession.

2. WGCV-29 Chair's Report *(Changyong Cao)*

Changyong Cao presented the WGCV Chairman Report. The Report included short introduction and background on WGCV as a framework for the current and planned activities, and 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.

WGCV Background: The Working Group on Calibration and Validation (WGCV) was originally established in 1984. This resulted from the recognition by CEOS that calibration and validation activities should play a key role in all satellite Earth Observation missions to ensure the clear and quantitative understanding of the data they generate. Calibration is the process of quantitatively defining the system responses to known, controlled signal inputs. Validation is the process of assessing, by independent means, the quality of the data products derived from the system outputs. In the GEOSS era, CEOS has become the space segment of GEOSS in support of GEO. WGCV is actively engaged in both GEO and CEOS tasks. WGCV is one of the three CEOS working groups (WGCV, WGISS, WGEdu) that report to the CEOS and the SIT (Strategic Implementation Team). The CEOS/SIT plays a central role in coordination of existing and future missions of CEOS agencies, particularly to support GEO in its realization of the space segment of GEOSS.

CEOS WGCV Subgroups Chairs (update):

- Atmospheric composition (ACSG) 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 (not present);
- Synthetic Aperture Radar (SAR) – Dr. Satish S*rivastava*, CSA;
- Terrain Mapping (TM) – Prof. J. Peter Muller, UCL.

The following major activities since WGCV28 were reported:

The CEOS/SIT21 meeting was held in Woods Hole, MA on April 22-24, 2008. It was chaired by Mary Kicza of NOAA/NESDIS and focused on 2008 CEOS actions. The main conclusion of the meeting was the need for more CEOS constellations with three new constellations proposed: Ocean Color Radiometry, Ocean Surface Topography, and Ocean Surface Vector Wind. The GEO/CEOS workshop was held in at Gaithersburg, MD on May 6-8, 2008, where data quality assurance key guidelines were developed and discussed. The CEOS 2008 Action Project workshop was held in Ottawa on

June 4-5, 2008, where measurement consistency for 1-5 km sensors was discussed. The CEOS/SIT21 meeting was held in Tokyo, Japan on September 17-18, 2008. It was chaired by Mary Kicza and focused on 2008 CEOS actions and deliverables. The satellite constellation concept is going forward.

The WGCV 2008 Actions Items included: On the GEO DA-06-02 action item, data quality assurance for GEOSS, GEO-CEOS held a workshop in Gaithersburg, MD on May 6-8, 2008. It was organized by ESA and hosted by NIST/NOAA/NASA. The findings at the workshop were endorsed by the CEOS/SIT Chair and GEO Director.

The data quality assurance guidelines (led by ESA, USGS, and NASA) contain ten key guidelines. This report is currently under final review, to be delivered at WGCV29 in the afternoon. CEOS needs to endorse this document.

The Dome C calibration campaign in Antarctica is completed and had its results summarized in the IGARSS08 paper (July, 08) (delivered to the CEOS repository). There is additional work at NOAA on SeaWiFS over Dome C. The transfer of SeaWiFS stable lunar calibration to AVHRR and other sensors at Dome C (Research to Operations) still needs to be done.

The CL-06-02: Key Climate Data Sets from Satellites (GSICS collaboration) action item has been completed. The main action was to develop measurement consistency for 1-5 km sensors. The recommendations & strategies for recalibrating historical satellite data (Support Climate Actions: T-4, T-3, O-17) were as follows: Hold a workshop in Ottawa in June 2008 at CCRS (NOAA, NASA and USGS). CCRS/CSA will lead the 1KM AVHRR reprocessing, supported by NOAA, USGS, & NASA. There will be early preparation for the calibration session at the AVHRR workshop in November 08.

The CL-06-01: Reanalysis and Reprocessing (GSICS collaboration) action item is completed. A paper was presented SPIE in August 08, (delivered to the CEOS repository) on "Infrared sounder: Historical HIRS spectral calibration using IASI/AIRS". A journal version of this paper ahs been submitted as well.

The DA-07-01: Global DEM interoperability action item is near completion. BNSC/UCL has the lead on this. A workshop was held in Beijing, hosted by IRSA/CAS. A guideline paper has been developed and delivered to the CEOS repository.

The DA-06-02: Data Quality Assurance action item is currently a work in progress. The two tasks here are benchmark mission coordination (Climate Action A-5) (NASA and BNSC/NPL) and creating a radiometric reference standard report (NOAA/NIST/IEEE). Also, preparations for the 2009 ground based cal/val campaign are under way. International radiometer intercomparison is set for May 2009, and invitations have been sent out to CEOS colleagues. Support from CEOS is needed to gain space agency funding.

The EC-06-01: Integrated Global Carbon Observations action item, a greenhouse gas workshop at CalTech, organized by AC subgroup chair B. Bojkov, has been completed.
The EC-06-02: Ecosystem Classification action item, the LPV (land product validation) session at WGCV29 (Sept. 2008) has been completed.

The DA-06-04: Data, Metadata, and Products Harmonization action item is still a work in progress.

Vice Chair Nominees

There were three nominees for the position of Vice Chair.

- Mr. Greg Stensaas/USGS/EROS Center, Physical Scientist/Project Chief, BSME, South Dakota State University, 1982 (CV in appendix).
- Dr. Kurt Thome/NASA, Professor, University of Arizona, Optical Science Center, Joining NASA/GSFC/Code 614.4, Ph.D., U. of Arizona, 1990 (CV in appendix).
- Dr. Xingfa Gu/NRSCC/CAS/IRSA, Director, Institute of Remote Sensing Applications, Chinese Academy of Sciences, Ph.D., Physical Remote Sensing, University of Paris, 1991 (CV in appendix).

WGCV Upcoming Events

- CEOS 22nd plenary, Nov. 10-13, George, SA
- SPIE Asia Pacific GEOSS/CEOS Conference, Noumea, New Caledonia, Nov. 17-21, 2008
- CEOS/SIT meeting, March, 2009, Coco Beach, FL
- International Radiometer Intercomparison, May 2009, Miami, FL.

3. WGCV Secretariat update *(Petya Campbell)*

- Minutes from WGCV-28 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 and Action items in support of GEO tasks:

WGCV26-1	**WGCV Secretariat** to maintain a "WGCV suggested cal/val practices" web page, populated 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* (WGCV Sec. will distribute updates), and to generate a summary of the activities in which the members are participating, relevant to the listed GEO tasks.	Ongoing
WGCV27-2	**WGCV Secretariat**, to contact the CEOS constellation leads and request that the constellation teams evaluate their cal/val requirements.	Ongoing
WGCV28-1	**WGCV Secretariat and Chair**, to review and update the table of WGCV 2008 deliverables for GEO/CEOS-SIT (ftp://uranus.eo.esa.int/pub/ceos/CEOS-GEO Work Table).	March 7 completed
WGCV28-2	**All GEO task action leads**, deliver results by the agreed deadlines, and include an update on the task action in their reports at WGCV29.	WGCV29
WGCV28-3	NOAA to provide the ASIC3 report (or a link to it), to be posted by the WGCV Secretariat on the wgcv web site.	WGCV29
WGCV28-4	VNIIOFI Rusia representtives (Burdakin, Sapritsky and Privalov) to generate a one page summary with recommendations on: long-term radiometric standards, for reliable monitoring of the dynamics in thermal radiation data and validation global climate change trends.	WGCV29
WGCV28-5	WGCV/SGs, to identify *Fundamental radiometric reference standards* and guidelines for long term global EO.	WGCV29
WGCV28-6	WGCV Sec., report of achievement to CEOS/GEO: WGCV/SAR establishing calibration specifications for Polarimetric SAR. Add on WGCV web site relevant publications/reports (or link to them). Addressing DA-06-02.	March 7 completed
WGCV28-7	USGS (Stensaas and Chander) provide summary (1 p.) to WGCV Sec. on the cal/val sites for EO.	WGCV29
WGCV28-8	USGS (Stensaas and Chander) provide to WGCV Sec. 1 page summary on the comparison of Landsat cal/val methods.	WGCV29
WGCV28-9	WGCV (USGS, Stensaas and Chander) to provide a list of potential calibration sites to the LSI Constellation Study Team. LSI compilation of cal/val sites would be part of an effort to define sites (environmentally sensitive, calibration, geohazard, etc.) that the agencies currently flying mid-resolution optical systems would agree to acquire (and make available) data over on a regular basis.	WGCV29 Probably completed
WGCV28-10	NOAA(Weng, Cao), to establish coordination between GSICS and the Cal/Val portal to link relevant activities/prototype projects.	WGCV29
WGCV28-11	Xiong (NASA) and Trishchenko (CCRS) to generate recommendations for AVHRR data re-calibration.	WGCV29
WGCV28-12	**Nigel/IVOS** to generate a formal request for a joint NASA and BNSC Benchmark missions to meet the needs of climate and land surface imaging constellation. NASA to formally request BNSC's collaboration. Meiden and Ungar to help identify NASA/HQ person to contact David Williams, BNSC. (CLARREO, Dave Young NASA Langley and TRUTHS, Nigel Fox NPL)	WGCV29

WGCV28-13	IVOS (Nigel, Patrice, Cao, Xiong) to define by WGCV29 the protocol (procedures and activities) for CEOS instrument intercomparison exercise at Dome C site, to be conducted in the winter of 2008-09. Recommendation to CEOS requesting for agencies participation (Nigel and Petya to generate specific list of agencies and instruments).	WGCV29
WGCV28-14	S. Mackin DMCii, provide WGCV Sec. a summary (1p.) on modular QA/QC, for consideration by the SG, and potentially trail during the WGCV 2008-09 winter cal/val exercise at DOME C site.	WGCV29
WGCV28-15	WGCV members, to nominate future WGCV Vice Chair and TMSG Vice Chair.	WGCV29
WGCV28-16	**WGCV Tec. Sec.,** to help determine the dates of next WGCV29 (set meeting maker).	March 2008 completed
WGCV28-17	WGCV agencies need to ensure resources are available and in some cases specific datasets, if the Global DEM task is to succeed. Specifically, some CEOS member agencies need to ensure that resources are made available for support for validation services (e.g. NASA to support GSFC to offer an ICESAT/GLAS validation service) and that other CEOS agencies (JAXA for ALOS-PRISM, ISRO for Carto-DEM, DLR for SRTM-X and TANDEM-X and CNES for SPOT Image Reference 3D) non-ASTER to be provided for (a) gap-filling ASTER-GDEM; (b) validation (EO-DEM data for up to 200 1 x 1 degree cells).	WGCV29
Follows from above	JAXA to provide validated DEMs for sites on other continents (e.g. Africa, South America, Asia, Australasia, Antarctica) which can be established in different land covers and employed for validation of ASTER and final Global DEM	J-P Muller, to provide a list with coordinates

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

4. Reports from the WGCV Subgroups

4.1 Atmospheric Chemistry Subgroup *(Bojan Bojkov)*

Bojan Bojkov, the Chair of the Atmospheric Chemistry subgroup presented the report from the AC subgroup. The report included summaries of the 2007 subgroup activities, review of AC missions, and provided recommendations to WGCV and CEOS for resolving some of the issues.

ACSG focus and background

The focus of ACSG is atmospheric chemistry (ozone, nitrogen dioxide) and composition (aerosols and greenhouse gases). ACSG consists of 15 members from space agencies and other relevant agencies and organizations with experience in calibration, algorithm development, ground-based instrumentation, modeling and validation. ACSG is a forum that fosters interactions between mission scientists and data users, recommends network validation sites, develops comprehensive validation methodologies involving ground-based and space-borne assets, and specifies comprehensive and consistent multi-mission validation datasets.

Status of Current AC Missions

- ESA Envisat (3/'02): 3 AC instruments (GOMOS, MIPAS, SCIAMACHY) operating well; fuel depleted in 2011 timeframe; orbit maneuver proposed to extend mission life to 2013 (to be confirmed in late 2008)
- NASA Aura (7/'04): nominal operations of 3 AC instruments (OMI, MLS, TES); HIRDLS instrument failure in March; platform fuel through 2015
- A-Train: Aqua, Calipso, CloudSat, Parasol (and Aura) operating nominally
- MetOp-A (10/'06): GOME-2 and IASI operations nominal
- ERS-2 GOME, NOAA-16/17/18 SBUV/2, Odin OSIRIS/SMR, SCISAT-1 ACE

Status of Up-and-coming AC Missions

- JAXA/NIES GOSAT: global CO2 and CH4 measurements, to be launched in 2009
- NASA Glory mission: aerosols/black carbon, to join A-Train in 2009
- NASA OCO: global CO2 measurements; instrument problems; to join ATrain in 2009
- NSMC/CMA FY-3a with SBUS and TOU ozone instruments, to be launched in 2009

- ESA ADM-Aeolus: wind and aerosols, to be launched in 2010
- NPOESS Preparatory Project (NPP) launch scheduled for 2010 (in A-Train)

2008 Sub-Group Activities
ACSG actively participated in the preparations and significantly contributed to the GEO/CEOS QA4EO Workshop and the preparatory meeting held in May 2008. The workshop was attended by a number of the sub-group members. The sub-group also participated in a limited review of QA4EO draft documents.

Significant progress was reported in the synchronization of ESA and NASA atmospheric composition cal/val activities/priorities, including: Mission planning, ground-based ozone calibration, NO2 intercomparison, aerosol/H2O lidar homogenization/intercomparison; In situ and satellite data sharing, formats and data requirements (information content); and NASA AVDC, ESA GECA (including cal/val leading experts).

ACSG coordinated the validation baseline for AC level 2 products. The first (of 5) ozone instrument absolute calibration campaigns in Europe/Africa ended September 26, 2008. The first (of 3) groundbased tropospheric chemistry/air quality intercomparisons are to be held in Italy in 2009. Lidar intercomparisons/characterization using European and NASA mobile reference instruments are set to begin in 2009. This will require close coordination between ESA-ESRIN and NASA-GSFC.

ACSG organized a GHG validation workshop in May 2008 at CalTech. The initial focus was on carbon dioxide (carbon dioxide and methane). The 25 attendees were from NASA, ESA, JAXA/NIES, TCCON, NDACC, aerosol teams, and CO2 profiling mission study scientists (NASA and ESA). This workshop recommended validation data sharing and coordination between mission teams, characterization of ground sites using aircraft essential prior to satellite missions, and that the GHG be part of ACC. The validation of merged/combined data products could include the validation of MODIS/Calipso merged aerosol products, and the validation of combined L3 products (albedo/reflectivity, clouds, water vapor, aerosols, etc.).

Past Recommendations
WGCV-27-1: 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).
WGCV-27-2: 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 recommended 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. Status: Currently ESA is supporting the efforts through INM, DWD, FMI; and NASA with NOAA ESRL. 8 campaigns are planned in the 2008-2012 time period, involving European, US and African sites. The first campaign is scheduled for July 2008 at Arosa, Switzerland. The second campaign is planned for September/October 2008, at Izaña, Canary Islands, Spain.
WGCV-27-3: laboratory cross-section measurement. ESA is supporting the efforts at the University of Bremen. It is to be completed by 2010.
WGCV-27-4: NO2 ground-based instrument intercomparisons. Status: lead by NASA-ESA, the plan is to include European, US, Chinese and Japanese teams. It is supported by UAV and possible ultra-lite aircraft. The effort is delayed to Summer 2009 due to site selection and organizational constraints.
WGCV-27-5: Data sharing/requirement coordination: 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. Status: On-going through the AVDC and GECA projects with an objective to integrate the GHG validation datasets.

Status of Recoemmendations
WGCV-27-3: NO2 groundbased instrument intercomparison. These intercomparisons are essential as AQ constituents are increasingly retrieved from space and new missions are proposed. This is an ESA-NASA lead initiative. The first campaign to take place in Italy (ESRIN) during June-July 2009. A second campaign to take place in 2011 – location TBD.
These campaigns are to include European, US, Chinese and Japanese teams, supported by UAV and possible ultra-lite aircraft or measurement grid. Their goal is to measure NO2, Formaldehyde, glyoxal, water vapour and aerosols.

The concerns about this recommentation are that NASA's participation is now uncertain, while the ESA budget has been allocated and the consortium formed (late 2007). It is essential to stress the importance of this recommendation and answer SIT action 22-5

ACSG recommendations for WGCV-29

The ACSG recommends following through with WGCV-27 rec. 3 (NO2/AQ groundbased instrument intercomparison campaigns). This impacts ESA, NASA, and NOAA. The end users of this will likely be EPA, EEA, etc.

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

The IVOS Chair, ***Nigel Fox***, presented the report from the IVOS subgroup.

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.

Workplan/Operational Mechanisms

Meetings are held at least annually (nominally 9 monthly). The group has 50 *email members but 15-30 attend the meetings.* The group have established password protected document store and workspace (at **http://ceoswgcv-ivos.org**); It encourages attendance through development of key policy items; Considered are bi-annual "conference/workshops" linked to existing meetings.

Key Activities include: information exchange, developing and addressing GEO task DA 06-02 (Data Quality Assurance strategy), initiation of Cal/val portal (for communication), the establishment of cal/val "best practices", identification and classification of "test sites" for sensor performance evaluation, and WGCV Lead on CEOS climate Action A5, C7 (*Benchmark mission to establish SI traceable measurements in orbit).*

Work Plan and Progress 1

The QA4EO project is a major effort. The first draft of the procedural guidelines has been written, including the "Use of Moon for Calibration" by Tom Stone. The comparison protocol on Dome C is in progress. The procedure on establishing a test site is being drafted by Tubitak Uzay (Turkey)/NPL. We are hoping to have procedures on test site characterisation, use of Rayleigh scattering, sun-glint, etc. are the first priorities. We are evaluating the prospect of incorporating RAMI comparison as an example of models/algorithms, and establishing reference standards and key characteristics.

Work Plan and Progress 2

This comprises comparisons between DOME C inter-satellite radiances, terrestrial based radiometers for IR emitted radiance (land and ocean), and terrestrial based VIS/SWIR solar reflected "radiance". A European pilot project it to be followed by a full opening of CEOS, including multi-satellite comparison.

This collaborative research aims to establish a network of test sites, and requires "traceably" characterised sites, common instrument specifications (ideally autonomous), consistent means to match sensor footprint (spatial and spectral), atmospheric correction, and site-to-site coordination for "operational GEOSS service" (Land) (GHRSST a good example for SST).

IVOS Recommendations

Recommendation 1:

Recognizing the existence of biases between sensors, and the need to combine data sets from different sensors for operational and long term studies it is critical that any (normalization to a designated "reference sensor) is fully documented and transparent. Since often the cause for bias differences is unknown it is recommended that a non-normalized data set is also maintained and archived as well as any bias-removed data.

Recommendation 2:

In defining new missions, agencies are encouraged to ensure that the requirement (and ability where practicable) to cross-compare with existing similar sensors (e.g. common channels) is built into the commissioning programme of the sensor. In particular where two nominally similar sensors are being built for simultaneous flight (similar orbits differing phase) it is important to ensure that a requirement is established to ensure commonality of performance between them.

Recommendation 3:
When application specific task groups of experts are established for cal/val e.g. the recently formed group for SST validation, they are encouraged to take advantage of the infrastructure of CEOS WGCV to provide a framework to promote their activities and ensure that maximum benefit can be obtained for the community as a whole through the sharing and use of best practices in terms of QA.

Recommendation 4:
Recognise that regular comparison of instrumentation and methodologies is an essential component of any data quality strategy, providing evidence of maintained traceability. This requirement includes the key instrumentation and associated methods used to validate/calibrate performance of sensors through ground based measurements. In particular, it is noted that it is timely to repeat the highly successful comparison of IR radiometers used for SST measurements (Miami) and also to initiate a similar comparison for Land based spectroradiometers. Such comparisons will require commitment from agencies to support participation and also to sponsor the organisation and necessary infrastructure. The following associated actions were discussed: IVOS has established two working groups with coordination from NPL (Land and Ocean) to establish appropriate protocols, plans and cost for such comparisons. The location for the Ocean comparison is to be defined, whereas the Land comparison is baselined to take place at the new “core site” in Turkey; Potential sponsor agencies are sought to support the above planning and subsequent comparisons; Ocean to occur in spring 2009, and Land, Summer 2010 with pilot activities in 08/09.

Recommendation 5:
Recognising the need to establish international accepted Reference standards where necessary to facilitate interoperability between agencies and missions by ensuring that biases and sensor performance and dependent data products can be assessed in a consistent manner, CEOS WGCV proposes that the following (together with an associated operational best practice) are adopted as international reference standards for their associated characteristics and subsequently used by agencies. The Moon and “CEOS standard Desserts” as reference standards for radiometric gain stability and the “CEOS Landnet test sites” for gain assessment on Land imagers. The following associated actions were discussed: CEOS IVOS to provide coordinates of LandNet sites on cal/val portal; CEOS IVOS to provide operational guidance for use of the reference standards; CEOS IVOS to provide defining characteristics of the associated standards on the cal/val portal; agencies to encourage the viewing of such sites in existing and future missions; agencies to ensure resources are made available to maintain and develop such standards and to encourage the development of others to complement the existing LandNet sites to ensure adequacy in number and geographical distribution.

4.3 Microwave Sensors *(Christopher Buck)*
Christopher Buck, the Chair WGCV-MSSG was not present.

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

What Global DEM's are Available Now?
There are several global Digital Elevation Models (DEM) available currently. The first data set is ETOPO5, available from http://www.ngdc.noaa.gov/mgg/global/relief/ETOPO5/. It is currently being held by NOAA, National Geophysical Data Center (NGDC). This data set is categorized as "Land Surface and Sea Floor", with a resolution of 5 arc-minutes (about 10 km). The data is in geographic latitude/longitude projection and was originally produced in 1988.

The second data set is GTOPO30 and its variants (GLOBE, ACE-DEM), available from http://edc.usgs.gov/products/elevation/gtopo30/gtopo30.html. It is currently being held by the U.S Geological Survey (USGS). This data set is categorized as "Land Surface – Bare Earth - Map sources", with a resolution of 30 arc-seconds (about 1 kilometre). The data is in geographic latitude/longitude projection and was originally produced in 1997.

But how well validated are these global DEM datasets? "Although the spatial resolution of both ETOPO5 and TerrainBase is only 5-arcminutes, these global DEMs give better representation of the Australian topography than the 30-arc-second resolution GTOPO30 or GLOBE_v1." from Hilton, R. D., W. E. Featherstone, P. A. M. Berry, C. P. D. Johnson, and J. F. Kirby, 2003: Comparison of digital elevation models over Australia and external validation using ERS-1 satellite radar altimetry. *Australian Journal of Earth Sciences*, 50, 157-168. Muller (ISPRS 2000 Congress) showed how global ERS Radar Altimetry and a global set of airport runway locations could be employed to estimate accuracy of global DEMs. However, poor accuracy of GTOPO30 DEM. GTOPO30-RA stats of 10.98±77.67m for N=11,408,774

ERS-RA data compared with nearest planimetric neighbour from the Jepsen Airport runway ends' point data-sets (see Bamber & Muller: JGR, 103(D4):32,159-32,168).

GEO Task DA-07-01 : Global DEM Inter-operability

The objectives are to facilitate interoperability among Digital Elevation Model (DEM) data sets. The end goal is to produce a global, coordinated and integrated DEM. This global DEM should be embedded into a consistent, high accuracy, and long term stable geodetic reference frame for Earth observation. This activity shall also include coastal zone bathymetric maps in shallow waters (~30-40 m), DEMs of DTED1-class (3", ≈90m), now updated to DTED2 (1", ≈30m) for the generation of topographic maps and land use/land cover maps at scale 1/50,000 or 1/100,000.

Specific tasks include requesting input from system operators and data users (GEO members or participating organizations) regarding their experience on interoperability, and compiling lists of current DEM data and its specifications. Based on the above results, we are developing the first "GEOSS Interoperability Guidance on DEM data". The first draft was completed in May 08, and the second in August 2008. This document will be submitted for review to the GEO plenary (Beijing, November 2008). There are presently 40 members of Task Team (UK (lead supported by BNSC), US, AU, DE, FR, IT, ES, JP, CN, KR, WMO, OGC.

Why does GEO Need Global Topography/Bathymmetry?

Global DEMs are required for 6 of the 9 societal benefit areas identified by the 10 year Implementation Plan of GEOSS. Natural disasters all require detailed knowledge of topography, either directly for volcanic dome monitoring, flood inunadtion areal predictions, landslides, or for downstream EO processing, e.g. InSAR for earthquake monitoring and possible prediction. Poor bathymmetric and topography knowledge hinders tsunami forecasts. The tsunami of 2006 has been a main spur for GEO implementation.

The currently available data set is STRM and its variants with filled gaps, available from http://www2.jpl.nasa.gov/srtm/. It is currently being held by National Geospatial-Intelligence Agency (NGA). This data set is categorized as " Land Surface - Reflective ", with a resolution of 3 arc-seconds (1 arc-second over the US). The data is in geographic latitude/longitude projection and was originally produced in 2003.

The SRTM C-band DEM produced at DTED-2 (1 arc-second≈30m) but is only publicly available (apart from the conterminous US) at DTED-1 (3 arc-second≈90m). But, there are significant gaps/voids in the coverage even after ("edited" or "finished") V2 of the product was produced and SRTM is only available for the region from 60ºS-56ºN.

What datasets could be employed to fill these voids if they were available? SPOT-5 has complete coverage for 1 arc-second. It has 30 M sq.km. at NATO DTED2 specification inc coastal DEMs for Antarctica. The objective is to have completed 100 M sq.km. by 2013.

Joint US-Japan Project to Create a Global 30m ASTER-DEM

The fusion of several DEMs are a possible alternative. The voids in SRTM DEM could be filled in using ASTER data. Improved SRTM DEM could be used to remove artefacts (e.g. clouds) in ASTER DEM. And finally, the remaining voices could be filled in using the interpolated SRTM DEM layer.

On 4 October 2007, updated on 21 February 2008, Bryan Bailey (Principal Remote Sensing Scientist, USGS, EDC) reported "The National Aeronautics and Space Administration (NASA) and Japan's Ministry of Economy, Trade and Industry (METI), in cooperation with the U.S. Geological Survey (USGS) and METI's Earth Resources Data Analysis Center (ERSDAC), have announced plans to produce a global digital elevation model (DEM) from stereo data acquired during the past 8 years by Japan's Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) that flies on the U.S. Terra spacecraft. The ASTER Global DEM (GDEM) will have 30m postings, and it will cover land surfaces between 83N and 83S with estimated accuracies of 20 m at 95 % confidence for vertical data (elevation) and 30 m at 95 % confidence for horizontal data (geolocation). METI and NASA have accepted an invitation from the Group on Earth Observations (GEO) to contribute the ASTER GDEM to the Global Earth Observing System of Systems (GEOSS), and it will be available at no cost to users from around the world. At the GEO Summit in Cape Town, South Africa, last November, US Secretary Kempthorne and Japanese Minister Tokai announced the two countries' plans to produce the ASTER GDEM and contribute it to GEOSS." It is very likely that some (unknown number of) gaps will still exist due to persistent cloud cover or lack of contrast in the stereo images

The global ASTER DEM employs a method of stacking and averaging of cloud-screened ASTER L1B data. We have assessed the impact of stacking using multiple ASTER DEMs over some of the CEOS-WGCV-TSMG test-sites. As the USGS-supplied ASTER DEMs contained heights above clouds irrespective of cloud cover, we applied a fixed threshold (ASTER Z>1060m) as a threshold to eliminate clouds, rather than the cloud clearing methods being employed by ASTER-DEM project.

Conclusions
The Global Land Surface topography is now a realistic goal at resolutions from 1km down to 30m. At 3 arc-seconds (90m), the fusion of SRTM with ASTER GDEM may provide the necessary accuracy. At 1 arc-second (30m), the ASTER Global DEM (GDEM) will provide a very significant step forward towards meeting the land surface topography goal. However, it is unclear how much of the Earth's land mass will contain gaps or bad data from the GDEM. It is also unknown how we will obtain comparable resolution and accuracy for the world's continental shelves to help protect coastal communities from the impacts of tsunamis.

Outstanding Issues to Resolve
How will the voids in the ASTER GDEM be filled? How many of the CEOS-GEOSS space agency partners are willing and able to contribute height pixels to a free and unrestricted global dataset at 30m? How will the global ASTER GDEM be validated in 4 months prior to release and where will the resources come from ? How can we ensure that the ASTER GDEM receives the same intensive worldwide effort for validation that SRTM received? What role could ISPRS play in coordinating such a global effort? For example through the establishment of a WG to address technical issues How do we ensure that there is a similar level of effort for producing global bathymmetric data over continental shelves?

NOAA-NGDC are engaged in mapping extensive areas around the US coastline. USGS has demonstrated the fusion of such bathymetric and land DEMs. However, most other such bathymmetric data sources are extremely expensive (e.g. UKHO) and subject to © restrictions. How does GEO persuade the oceanographic community that it is in their best interests to donate such proprietary data for the 9 societal benefit areas agreed by the GEOSS ministers, especially that of natural disasters and hazards?

India's CartoSAT may provide the higher resolution DEMs needed for gap-filling or validation. This data set has 1/3 arc-second (10m) resolution with 7.5 x 7.5 arc-minute tiles. It is due for completion by the end of 2008. We should issue a formal invitation from GEO for participation in GDEM void-filling and validation.

There may be an opportunity for the global validation of ASTER GDEM using ICESAT-GLAS. NASA's ICESat-GLAS lidar with a 70m footprint every 170m would be an ideal (OGC) source of global validation points. It would also enable the penetration depth from InSAR and stereo to be quantified.

InSAR may also be usable to fill current DEM voids, if it were available. SRTM-X is available at 1", ≈30m, but only for subset strip areas after height adjustments made for the differences between the SRTM-X and C-band datums. ERS-1/2 tandem is available at ≈30m (most of Europe available from DLR, SARMAP/Telespazio, UCL) but problems with WV effects remain in all cases. Also, would require very extensive processing effort to generate the DEMs.

4.5 Land Product Validation Special Session *(Baret, Garrigues & Nightingale)*
WGCV29 was hosted by WGCV/LPV and included a special session on LPV activities.

4.5.1 LPV Report *(Baret)*
Frédéric Baret, the Chair of LPV presented the subgroup report. Fred Baret is the LPV chair, while Sebastien Garrigues is the vice-chair.

Definition of LPV
LPV 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.

Land Products Targeted
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.). The following products are NOT targeted: Net Ecosystem Exchange/Productivity (NEE/NEP) and Evapotranspiration.

LPV Structural Problem

There is a structural problem in LPV, mainly that biophysical products are not as close to sensors as radiometric calibration is!! The community is large and scattered: more focus on product families corresponding to a better identified (unified?) community (land cover, fire, biophys, energy, soil). A possible solution is the creation of several sub-sub-groups. These are broken up as follows.

Land cover	M. Herold, M. Friedl
Fire	K. Tansey, C. Justice
Biophysical characteristics	R. Fernandes
Energy	G. Shaepman, C. Schaaf
Soil	W. Wagner, Y. Kerr

LAI Validation Effort

The methods developed and published in 2006 have been applied and the validation results published in 2007 and 2008. But… Updates are needed with new product versions - an on line validation exercise. The number of validation sites is still small, Suggested is a continuous increase of number of sites (new sites and inclusion of processed archive sites) to get closer to stage 3 validation. A problem also is that there are very little 'continuous' ground LAI measurements – the use of PAR@METER devices is encouraged. Also, dew to a lack of interpixel homogeneity for some sites may be needed to revise the BELMANIP. The next group of products to validate are fAPAR products.

Development of Virtual Constellation Products

The objective of the work is to develop consistent products from several sensors to allow simple fusion, within the framework of GEO/CEOS virtual constellations, and GEOLAND_2. Approach: Evaluated was the performances of neural networks when trained with several inputs and outputs and application for comparison of CYCLOPES/VEGETATION and MODIS (reflectance and LAI). In the 2001-2003 timeframe were sampled 397 BELMANIP sites. General consistency between original products was established, with better results for reflectances than for LAI. Neural networks showed good capacity to "learn" the algorithms. In conclusion, the innovative approach allowed easy fusion of observations coming from several sensors. The high importance of the training data base (LAI) was emphasized. The approach can be applied to any product (even albedo!). Does not require absolute reflectance calibration or strong spectral consistency between sensors: just temporal and spatial stability! Allows the application over instantaneous observations (including or not atmosphere). It requires good geometrical consistency. It was initially implemented in GEOLAND_2 project (EC) for Long Time Series (as opposed to Near Real Time). The results are published in: Verger, A., F. Baret, and M. Weiss. 2008. Efficiency of neural networks for consistent calibration of LAI products from input reflectance coming from several sensors: Application to CYCLOPES/VEGETATION and MODIS data. *Remote Sensing of Environment*, accepted for publication.

Update BELMANIP: BELMANIP2

We propose an ensemble of sites representative of vegetation type and state for inter-comparison. The sites should be flat and homogeneous at 1 km scale (inter pixel variance limited).The first version of BELMANIP uses a compilation of currently existing sites: AERONET/FLUXNET/DIRECT… COMPLET ! Unfortunately, several sites thought to be homogeneous (same class between neighboring pixels) by ECOCLIMAP (1km) were not.

For BELMANIP2 there will be new site selection principles, including dividing latitude by 10° strips, computing land cover (GLC2000 6 classes), selecting 'pseudo' randomly sites (number of sites proportional to frequency of GLC2000) for each class in 'homogeneous' (1km) places, and checking with Google earth homogeneity to refine the selection if necessary. Currently, the sites have been selected and evaluation of representativity is ongoing. A paper describing BELMANIP2 (short letter) is in preparation.

Characterization of Products PSF

Currently, there is confusion between sampling intervals and actual spatial resolutions. PSF is known at the sensor level, but several processes degrades sensor PSF. PSF is required for validation and fusion between products and other information. Ongoing work includes VEGETATION, MODIS and MERIS fAPAR products.

Ongoing Validation Activities

We are currently engaged in LAI and fAPAR validation at several 3x3 km sites. The products being validated include MODIS Collection 5, CYCLOPES V3.1, GLOBCARBON, and MERIS (G-POD extraction). The methodologybeing used is an inter-comparison over BELMANIP2, and direct validation with distinction between effective and 'true' values for LAI.

Development of Continuous fAPAR and LAI Measurement Systems
In this development, most sites that are currently instrumented/sampled correspond to 'one shot' measurements. The need is for sampling different development stages / states of the vegetation. There is keen interest in seasonality (canopy functioning). Classical systems with sensors connected to a data logger exist but, they are expensive (data logger) and difficult to install/desinstall (wires). Development continues on a wireless affordable system (PAR@METER).

Planned Activities
Plans for future activities include: fAPAR products validation, Continue collecting ground validation, Test and exploit PAR@METER devices for continuous fAPAR/LAI monitoring, Products PSF characterization, On line validation (CALVAL portal), Populate cal/val portal (definitions, best practices).

LPV Recommendations
Monitoring progress of previous recommendations: 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; Encourage agencies to prepare subsets of data/products for global product intercomparison activity as described by CEOS/WGCV/LPV . Needed is more consistency in geometrical formats (grid/projection/datum). Needed are resources for implementation of the 'on line validation tool' in the CAL/VAL portal.

New recommendations: Encourage agencies to develop easy to use, open source, software tools for (re)projecting any product in (at least) the main projection systems used.

4.5.2 LAI Product Intercomparison *(Garrigues)*

Sébastien Garrigues, CNES, Toulouse (NASA/GSFC, MD, USA)

Background: Leaf Area Index Product
Leaf Area Index (LAI) is a key surface characteristic for land surface models (cf. GCOS). LAI is defined as half the total developed area of green leaves per unit ground horizontal surface area (Chen and Black, 1992). There is currently a multiplicity of LAI satellite products, including MODIS (C4, C5), CYCLOPES (SPOT/VEGETATION), GLOBCARBON (VEGETATION, ATSR), CCRS (SPOT/VEGETATION), and MSG/SEVIRI. Understanding the uncertainty of a given LAI product and differences between products is critical for their proper use (cf. QA4EO).

In the LPV initiative (Morisette et al., 2006) has the benefit of using the LPV infrastructure to share data, methods, and results. This is a coordinated international effort with USA (Boston University, Oregon State University, the USDA Forest Service, and the EPA), Canada (CCRS and University of Alberta), and Europe (ESA; INRA, Medias-France; the University of Milan-Bicocca, University of Helsinki; DLR; EOLAB and others) all cooperating.

Methodological Framework: Two Approaches
The first approach is direct validation, which can quantify the absolute uncertainty of a given (LAI) product through comparison with *in situ* measurements. The second approach is product intercomparison (i.e. indirect validation) which can assess the spatial and temporal consistency between products.

Investigated Products

Product	Sampling	Algorithm	Shoot clumping	Canopy clumping	Landscape clumping	Smoothing
CYCLOPES (V3.1) *Baret et al., 2007*	1/112° 10 days	Neural Network, RTM 1D	No	No	Yes	No
ECOCLIMAP *Masson et al., 2003*	1/120° 1 month	Empirical (based on NDVI variation)	Yes	Yes	No	No
GLOBCARBON (V1) *Deng, 2006*	1/11.2° 1 month	Model derived VI-LAI relationship	Yes	Yes	No	Yes
MODIS (C4) *Knyazikhin et al., 1998; Myneni et al., 2002*	1 km 8 days	Main: LUT, RTM 3D; Backup: LAI-NDVI empirical relationship	Yes	Yes	Partly	No

Intercomparison: at 1/11.2° and a monthly time step, Period: 2001-2003

Global LAI Value Distributions
There are important differences between the LAI value distributions in July. LAI distributions for ECOCLIMAP are erratic and unrealistic. The LAI for MODIS have too low frequency of low values. CYCLOPES suffers from early saturation (max LAI~ 4).

Temporal Consistency
Most products show consistent and realistic temporal profiles over croplands and grasslands. All the products capture interannual LAI variations, except ECOCLIMAP. Best agreement is achieved between MODIS and CYCLOPES. CYCLOPES and MODIS show important data gap over Northern Latitude sites (because of cloud, snow contamination…). Over DBF, there is an overestimation of MODIS in winter and failure in summer. There are large temporal inconsistencies and poor temporal continuity over EBF.

Summary of Product Performances

Criteria	CYCLOPES	ECOCLIMAP	GLOBCARBON	MODIS
Global distribution	+	-	+	+
Spatial consistency	+	-	-	+
Spatiotemporal continuity (no gaps)	-	+	+	-
Temporal consistency	+	-	-	+
High LAI	-	+	+	+
Low LAI	+	+	+	-
Comparison to in-situ data	+	-	-	-

Conclusions & Pending Issues
There is a need to improve the measurement accuracy of validation data and quantify their uncertainty. Better characterization of the seasonal and global variability of LAI is also needed. Current work includes refining LAI data at 3km spatial sampling and including the new version of LAI products in MODIS Collection 5. LAI products should be part of the cal/val process as defined by WGCV and QA4EO. They are required for a consistent integration of multiple satellite products in climatic data records. LAI products need to be properly updated and supported by space agencies.

4.5.3 OLIVE: On Line Interactive Validation Exercise *(Baret, Weiss, Garrigues)*

Introduction
With successive versions (collections) of satellite products available, and new products arriving all the time, validation of these products has become a large issue. We need traceability and transparency in validation efforts, and a consensus framework for validation. All information on the products evaluated and any corresponding ground measurements must be captured and easily accessible to the community. The answer to this problem is OLIVE: **O**n Line **I**nteractive **V**alidation **E**xercise, supported by ESA.

OLIVE can provide validation information to the community. In *Test Mode,* it provides a stand-alone comparison of existing products by potential product producers. In *Validation Mode,* it performs actual validation and makes the results visible to the community, and adds the product to the community database. It can also handle the addition of data from ground sites for direct validation by individual contributors.

OLIVE Usage
For OLIVE to work properly, the user needs to extract comparison data over the interested sites (BELMANIP and DIRECT). This data must be in the specified map projection, which is sinusoidal (3x3 km^2 or 10x10 km^2). Then, the database extracts data from existing products over BELMANIP2 and creates a compilation of DIRECT measurements. It also produces documentation of the sites/variables definition/references.

Typical OLIVE outputs may include temporal continuity, temporal consistency, temporal smoothness, histograms/PFT, scatterplots, spatial consistency, and direct validation.

Management
The management of the OLIVE project needs criterion to decide which direct validation site to incorporate in the internal database. A steering committee (CEOS LPV) needs to propose the criterion for the selection (general), decide on including a new proposed site in the internal database, and update of the database in a timely manner (yearly?).

Status

The tools for OLIVE have already been developed, but are currently running only in Matlab 'manual' mode. Outputs are created in both html files for reporting (mainly graphics), and in Excel files (metrics). There needs to be significant adaptations to run this software interactively through the EO web portal. Discussions with ESA are commencing to start this activity.

4.5.4 Actual Spatial Resolution (PSF) of Current Products *(Weiss, Baret)*

Introduction

Why is the actual resolution of a product not equivalent to the sensor resolution? The sensor itself is characterized by its Point Spread Function (PSF). A substantial portion of the signal measured at a given pixel comes from its surrounding area. But, products are issued from many processes which add complementary terms to the proper sensor PSF, including geo-location uncertainties, spatial resampling, atmospheric scattering, synthesis, and inversion algorithms.

Impact on applications

Products must be evaluated either by comparing with other products or with actual measurements. When using the products in models (canopy functioning, global change, climate, forestry), model parameters depend on the land surface type. Medium resolution pixels are often mixed but when accounting for actual PSF, it is much worse! This will impact model simulations!

Method to Evaluate the PSF

MR products are co-registered with High Resolution (HR) images assuming that the PSF is the product (G) of two gaussian PSF functions in the X and Y directions characterized by their Full Width at Half Maximum (FWHM). The HR (60kmx60km) images are projected in each MR image (100km x100km) original projection (Sinusoidal: MODIS, PlateCarrée: CYCLOPES, UTM/WGS84: MERIS). The algorithm to do this evaluation has 4 steps, with each step being basically the same, except that the process gets more accurate:

- Step 1: Rough evaluation of the position of the HR image in the MR image (no PSF, at 3km) -> provide roughly the position in MR image
- Step 2: assuming a gaussian PSF (1800m) to refine HR & MR position
- Step 3: refine the PSF shape ($FWHM_x$ and $FWHM_y$) with fixed HR and MR position
- Step 4: refine all (FWHM, MR and HR positions)

Preliminary Results

PSF was evaluated over 2 sites, on FAPAR products using 2 SPOT images (20m) that were corrected from atmosphere (SunPhotometer). The FAPAR was estimated using neural networks (NNT) trained with the SAIL model at TOC level. This evaluation also used MODIS (LAI/FPAR product collection 5, 16 days). MERIS (TOAVEG algorithm (NNT at TOA level), daily), VEGETATION (CYCLOPES product, V3.1 (NNT at TOC level), decade) data.

Conclusions

Actual PSF is much wider than 1km and users should be aware of that, and should adjust either by degrading the products at 3 to 10km, or by taking into account that the PSF MERIS and CYCLOPES products are more spatially smooth than MODIS FAPAR. The PSF is not easy to evaluate, as sites must be contrasted and there is no topography data.

And what next….

The study will be continued over about 8 sites. These contrasted sites will be selected (over the BELMANIP2 database) with latitudes well distributed (effect on the projection). The effect of the projection on PSF estimation will be also studied through the selection of one product, resampling it in the 2 other projections, estimating the PSF, and comparing the 3 results.

4.5.5 MODIS Burnt Area Validation Protocol *(Nightingale)*

Presented by Dr Joanne Nightingale, NASA/GSFC, MODIS Land Validation Lead on behalf of Dr Luigi Boschetti (University of Maryland) and Dr David Roy (South Dakota State University)

Global C5 MODIS Burned Area Product

The Burned Area Product was funded as part of NASA MODIS Fire Science Team (Justice *et al.*) to complement the MODIS 1km active fire product. It has global applications, including green house gas & aerosol emissions estimation, applied users (e.g., natural resource management), and LCLUC research (e.g., Fire – Climate – People). Product prototyping by regional algorithm development was started during the MODIS Collection 4 era. Collection 5 processing is now completed for the whole MODIS record (year 2000 onwards).

C5 Burned Area Product Algorithm

The algorithm uses rolling BRDF-based expectation change detection. It is semi-physically based, making it less dependent upon imprecise but noise tolerant classification techniques, plus giving it very few thresholds. The algorithm is automated, and does not need training data or human intervention. It has been applied independently per pixel to daily gridded MODIS 500m land surface reflectance time-series to produce global 500m maps for the location and approximate day of burning.

C5 Burned Area Product Validation Protocol

Should we have one burned area validation protocol everywhere? In different fire regimes, the pre-fire conditions and the physical characteristics of fires and their remotely observable characteristics vary considerably. Cloud persistence varies regionally in space & time. Ambiguous changes of a similar direction and magnitude not caused by fire also vary in space & time. This impacts the temporal and spatial derivation of independent reference data, and helps define a common protocol with different regionally dependent specifics.

For burned area product validation protocol, we have compared MODIS burned area product with independent burned area data derived from multi-temporal Landsat ETM+ data. SAFNet field trip was held to develop the mapping protocol and African fire information needs, Zimbabwe-Zambia, July 2000. We have a consensus mapping protocol to ensure regionally consistent independent validation data. That protocol was followed in 2000-2002 at ~11 ETM+ scenes/year.

We need a reference dataset produced using pre-burn and post-burn data. The priorities here are to ensure the accuracy of the reference data. Local partners need to be involved in the interpretation of the high resolution data. For temporal consistency, we must map the changes between two acquisitions. For spatial consistency, we must differentiate between unburned areas and areas that could not be interpreted due to data quality issues, or not visible because of clouds or shadows.

Product Validation Plan with GOFC-GOLD – Fire Regional Networks

To reach Validation Stage 2, we must have an emphasis on sampling a range of continentally representative conditions, including where the burned area product has apparent limitations, i.e., in regions with high forest cover, high LAI, and in croplands. The different areas covered are Europe (in partnership with JRC-EC), Australia (in progress (GOFC)), Southern Africa (Done – SAFNET), the Boreal Forest (in progress), South America (Redlatif INPE & Imazon collaboration), China(in planning), and India (planning).

Conclusions

This method of Burned Area Product creation has been widely tested and published in peer reviewed literature. It can be applied to any high resolution data (10-30 m). A document describing an international protocol for the data generation phase of burned area validation has been developed for LPV consideration. The protocol on accuracy statements and metrics is in progress. The Landsat archive provides opportunity for broad international participation. GOFC-GOLD is facilitating participation through its regional networks. Validation dataset will be made freely and openly available to the scientific community (original and interpreted data).

Recommendations

There is a growing number of global and continental burned area products derived from different coarse resolution systems (250m to 8km). Users need to understand accuracy and utility of these products. We therefore recommend that the burned area validation protocol be endorsed by LPV as an *international standard.*

Suggested Next Steps

We need public comment on the LPV website (GOFC-GOLD fire community, GFMC…). Community outreach is being done through ARSPC Darwin October 2008, IGARSS Cape Town 2009, Earsel SIG September 2009, and the LPV topical workshop. We also need a revision of the LPV endorsement, including a implementation in partnership with GOFC Fire regional network and implementation team.

5. WGCV Country and Agencies Member Reports

5.1 Canadian Space Agency, CSA *(Satish Srivastava)*

Dr. Satish Srivastava, Canadian Space Agency representative and WGCV/SAR SG chair presented a summary of the current activities of the Canadian Space Agency.

RADARSAT-1 Program Status

The satellite is in its thirteenth year of operation and funding is available to continue operations until March 2009. Data is received and processed at 40 ground stations with 27 archive facilities globally. As of September 1, 2008, it has completed 66,960 orbits, planned 311,436 user requests corresponding to a total acquisition of 601,439 minutes of SAR data. The average system performance maintained is better than 95%. As a member of International Charter Space and Major Disasters, RADARSAT-1 has provided **493** RADARSAT-1 images for **141** Charter emergencies to date. The image quality and calibration is maintained better than system specification. Multiple coverage campaigns have been completed under baseline Background Mission, including (using Radarsat-1 and -2): multi-polarization coverage of continents and polar caps; Canadian site-specific data acquisitions for agriculture, environment, forestry, natural hazards, etc. Currently is providing ongoing four-season coverage of the Arctic Basin, in support of IPY.

RADARSAT-1 has provided data for a special project, entitled: Hurricane Watch. The program has started in 1999, operates from June 1st to November 30th. Hurricane Watch monitors North Eastern Atlantic, North Eastern & North Western Pacific regions to acquire RADARSAT-1 data of tropical cyclones. It has generated unique archive of 598 Hurricane Watch images, of which 221 images capturing the eye or edge of cyclones. CSA has announced an opportunity (AO) "*Innovative research and development of applications using RADARSAT-1 Hurricane SAR data",* to give access to 160 images from archives to the scientific community.

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 present fiscal year alone for the period: Apr. 1, 2008 – Aug. 31, 2008, amounts of science data collected were: FTS: 292.3 GB, Imager: 42.5 GB, MAESTRO: 10.9 GB. The collected data is routinely provided to the science team. Intensive data analyses by scientists have produced a number of new results that have been disseminated at international scientific conferences and through the publication of peer-reviewed scientific papers.

RADARSAT-1 and SCISAT Programs

Funding in place to continue operations of both RADARSAT-1 and SCISAT until 31st March 2009. A submission has been made to the CSA Executive Committee to fund the two operations for three more years. CSA's decision is expected in October, 2008.

RADARSAT-2 Program Overview

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 was successfully launched December 14th 2007. RADARSAT-2 characteristics include: 7 years design life, C-band (5.405 GHz) imaging frequency used, expected spatial resolution of 1-100m, polarization modes: single (HH, VV, VH, HV), Dual (HH/HV, VV/VH) and Polarimetric, right and left looking. The satellite was operation as of April 25, 2008.

	RADARSAT-1	**RADARSAT-2**
Mass at Launch	2750 kg	2280 kg
Design Life	5 years	7 years
On-board Recording	Tape recorder	Solid-state recorder
Spacecraft Location	S/C ranging	GPS on-board
Imaging Frequency	C-Band, 5.3 GHz	C-Band, 5.405 GHz
Spatial Resolution	10 to 100 metres	1 to 100 metres
Polarization	HH	HH, HV, VV and VH
Look Direction	Right-looking	Routine left-and right-looking

RADARSAT-2 Image Quality Status
All imaging modes except Spotlight are available for operational use. The geo-location accuracy for all single beam modes is better than 50m. In dual-polarized mode, all modes are radiometrically calibrated for both left- and right-looking imaging, and all impulse response measures (including resolution) are better than specification. The noise floor is several dB lower than for equivalent RADARSAT-1 modes. And ScanSAR images essentially free of visible beam boundaries and "scalloping" In quad-polarized mode, the channel registration checks consistently show registration to better than 1% of a pixel in each dimension after correction. The largest cross-polarization leakage term (after correction) is <-35dB. Relative inter-channel phase error after correction is <4º, and relative inter-channel amplitude error after correction is 0.4dB.

For imaging radar applications, the polarization state of the radar wave is defined with-respect-to the Earth's surface. The co-polarized state transmits/receives **horizontal** or **vertical** (HH or VV). The cross-polarized state transmits **horizontal** and receives **vertical** (HV). It also transmits **vertical** and receives **horizontal** (VH).

5.2 CNES *(Patrice Henry)*
P. Henry, the CNES representative gave an overview of the in-orbit calibration activities of CNES for visible and NIR sensors.

Activity for CNES Project in Orbit
The JASON 2 project has just completed the in flight commissioning phase, with very good performances. In other missions, the IASI calibration is going well and PARASOL, IIR (Calipso), SPOT HR, VGT are all doing routine calibration operations. Reprocessing of VGT1 calibration is being done to insure 10 years of consistent data (VGT1 + VGT2).

Activity for CNES Project in Development Phase
The Pleiades project is in final instrument characterization, and all performances are above specification. The Calibration & Performance Assessment Centre development is in progress, as is the definition of calibration methods (geometric and radiometric) to be applied during in flight commissioning.

For the Venμs project, the definition of the processing algorithms is underway, as is stray light characterization and correction algorithms.

2008 CNES Study Over Desert Sites
This study has been trying to establish a method for directional ground reflectance characterization. It wants to improve atmospheric correction by studying several BRDF models and defining an iterative filtering method (to get rid of data affected by atmospheric problem). This project is focusing on the 5 CEOS selected sites and is performing computation of directional characterization for 5 spectral bands : $r(q_s,q_v,Df)$. The main conclusions are that there are very good results except in the 'blue' range, there is proof of existing models limitation, and the definition of a range of geometrical conditions is acceptable for accurate cross calibration process.

2008 CNES Study over Dôme C Sites
The Dôme C sites characterization has been using 6 years of VGT1 images (Nov. 1998 to Feb. 2004) and 5 years of VGT2 images (Nov. 2002 to Feb. 2007). Its main objectives are to study the effects of atmospheric correction using BRDF modeling of data. The final goal is to use Antarctica sites for multitemporal and cross-sensor calibration.

Dôme C Area: Selected Sites Comparison
RAL (ESA) is doing site comparisons using ATSR, MERIS data with Dôme 4 (100x100 km^2). NASA is using MODIS, SeaWiFS with Dôme C (20x20 km^2). And CNES is using VGT, PARASOL, SPOT with Dôme 1, 2, 3 & C (100x100 km^2).

Recommendations for Calibration Over Dôme C
Atmospheric correction is to be applied to the first level correction with standard parameters, and the ozone measurements are mandatory. The sun zenith angle must be lower than 75°. Several sites should be used to get rid of site behavior. As many acquisitions as possible should be gotten every day during austral summer. For sensors cross calibration use of the Warren BRDF model is recommended. Dome-C can also be used for low temperature TIR channels calibration.

5.3 DMCii / SSTL *(Stephen Mackin)*

The DMCii/SSTL report was presented by ***Stephen Mackin***, Chief Scientist, DMC International Imaging Ltd.

Calibration

The current satellite calibration approach is that all satellites used in constellation have independent absolute calibration over RRV, which requires a lot of co-ordination and a lot of field work with higher costs. Older satellites have gravity-gradient booms so can only point at Earth. So the Moon is out of the question. Currently for absolute calibration is used data acquired at the Railroad Valley Nevada (RRV). For large linear arrays only nine pixels can be calibrated over RRV. DOME-C in Antarctica is used after that to transfer absolute calibration of the nine pixels to the rest of array.
Of consideration are the need of lots of overpasses and flat and stable target. The Pacific at night is used as dark reference. Problems arise in the co-ordination and data collection, which result in variable quality of the final calibration. As result, small variations in response are noticeable among the satellites in the constellation. The newer satellites launched late in the year (two planned for October 2008) will miss the 2008 Absolute Campaign over RRV.

The proposed calibration approach is to concentrate efforts on a single satellite "Gold" standard, with 6-10 good acquisitions per season over RRV (Landsat suggestion was 4-6). As spacecraft in the constellation are in more than one orbital plane, transfer the calibration from one to another could be done using the Antarctica site (DOME-C). Intersection of acquisitions would likely occur over same site within 30 seconds to a minute of each other, others would occur within tens of minutes, but the atmospheric conditions are usually very stable so this should not present a problem. New satellites launched late in the season can have updated calibration for at least three months using cross-calibration over DOME-C. The approach gives uniform calibration across the constellation and excellent absolute when the "Gold" standard is well calibrated.

Vicarious Calibration Uncertainties

Vicarious calibration had uncertainties, stated nominally by University of Arizona at approximately 3%. Additionally, since we sample 9 pixels from our 20,000 detector array and only two rows, there is a variability which includes, surface variability at RRV, system noise, and surface variability at DOME-C. This produces a 2.75% (1**s**) additional uncertainty component.

The overall level of uncertainty will be of the order of 5%. However, processing each individual satellite in this manner can lead to small but detectable differences between satellites when used in vegetation studies. The absolute uncertainty cannot be improved unless we improve the technologies (SNR, spatial resolution). Relative uncertainty can be improved by the cross-calibration process.

Cross-Calibration

In cross-calibration, the same data sets are used: dark, vicarious and white transfer images. Vicarious data are only for one satellite "Gold" standard. Currently Nigeriasat-1, campaign just finished in Nevada. Transfers between end October and February using intersections between satellites over DOME-C. Transfer uses overlapping images with time separation of less than one minute. They use then mean of images (minimises noise contribution) and corrects for solar elevation at scene centres. There is a small uncertainty due to pointing knowledge of sensor (0.3% radiance change 1s) for typical solar elevation.

To evaluate the uncertainty in the cross-calibration process, multiple joint acquisitions will be made with the two most stable satellites. Assuming one is "fixed" from a first cross-calibration, the variation in the cross-calibration will be assessed for the other acquisitions. The contributions in this case will be from pointing knowledge (0.3%), surface variability in the overlapping images, and rapid atmospheric changes (which are unlikely).
It has been noted in previous studies that the DOME-C site is not perfectly uniform in response. This obviously has impacts on the calibration. As part of the procedure, we use a 50 x 50 pixel moving window to determine the mean and standard deviation of the Antarctic surface to assess homogeneity and exclude observations that show too much variability. Note that when imaging in ascending node we can see the increase in radiance as we move from south to north across the area.

Cross-calibration has its advantages. We expect reduced inter-satellite variability, It provides basis for long term archive stability, and allows detailed analysis for new satellites which change rapidly in early months of life.

QA / QC - Calibration

Work has started on a modular QA/QC system at SSTL/DMCii. Initially, thus system will be focused on the calibration area writing procedural modules. There have already been some physical modules created. There have been some difficulties in integrating these modules into a single structure (complex relationships). We have decided to write individual modules with simple interfaces and link them together later.

The first product algorithms based around modular QA/QC routines have been developed. These modules are standalone, so there is no real traceability outside of module. Once connected, they should provide full traceability. Only a small proportion of the hundreds of potential modules are currently under development (26 modules in total).

The immediate benefit is in seeing the areas for which we have NO uncertainty estimates, and the identification of the areas where QC has not been applied rigorously (more areas than imagined). This has given us more confidence in the previous calibration work as uncertainties in some cases have been lower than expected.

Unfortunately, interfacing the QA/QC modules to current processor software has been problematic. This is mainly due to the lack of suitable feedback mechanisms for automated QC of data processing. Many uncertainty estimates relate to processes being carried out by third parties (Arizona – Vicarious; Spacemetric – Geometric). There is no proper connection to best practice, as the current QA4EO is too high in level for implementation in some cases.

ESA Requirements

IT is good to see that TPM mission requirements include data on system performance and collection of calibration data. A lot of requirements are based on one paper. We would prefer to see them based on CEOS best practice guidelines. We would also like to know how this data is to be used, as in its basic form it is not a quality index.

Summary and Conclusions

The change from normal vicarious calibration to cross-calibration based on a "gold" standard should reduce costs, management, and satellite to satellite variability. We hope to have results posted in 2009. QA/QC is progressing, but the progress is slow as there is no clear structure to use. Therefore, we are developing our own implementation structure (best efforts in spare time).

5.4 ESA *(Pascal Lecomte and Beatrice Berthelot)*

The ESA report was presented by ***Pascal Lecomte***. After the report, ***Beatrice Berthelot***, ESA discussed ESA Calibration

Test Sites: Selection and Characterization. The ESA report focused on Sensor Performance, Product and Algorithm development and harmonisation, in the context of Product and Processes harmonisation.

Kopernicus

The Kopernikus programme is one of the world's most intense environmental monitoring project. It plans to launch five satellites to measure different aspects of climate change. The first satellite, called Sentinel 1, is scheduled to be launched in 2011. The ESA-EC GMES architecture is being used for data access services – GSCDA.

The GMES Service Projects

Three GMES Fast Track Services (FTS), and two additional GMES pilot services (Security and Atmospheric) have been identified by the European Commission (EC) for early operational implementation in 2008-2010 and additional GMES services are expected to become operational beyond 2010. The scope of the GMES Core Services is summarised hereafter: The Marine Core Service (MCS) is tasked with delivering a set of services for forecasting, monitoring and reporting on the ocean state. These will include sea ice & iceberg monitoring, vessel tracking and fisheries monitoring, oil pollution monitoring, Sea Surface Temperature monitoring, ocean colour monitoring, and altimetry.

The Land Core Services (LCS) is tasked with providing timely, continuous and independent observations about the use of land resources and the changes of the land environment. These include forest Monitoring, land use / land cover state & changes, land cover mapping for water & spoil management, and urban land-use mapping.

The Emergency Response Core Services (ERCS) is tasked with supporting all stages of the intervention cycle from early warning, to crises management and recovery in response to natural, environmental, technological and man-made emergencies (e.g. droughts, floods, storms, earthquakes, tsunami, volcano eruptions, landslides fires, nuclear plant accidents, etc) at a global level. These include active seismic zone and volcano observatory, regional landslide risk monitoring, rapid flood mapping & damage assessment, regional forest fire area mapping & stats, and urban subsidence risk assessment.

The Security Core Service (SEC) is tasked with supporting security agencies and institutions with monitoring for crises management and recovery in response to technological and man-made emergencies (e.g. nuclear plant accidents, refugee monitoring).

The Atmospheric Core Service will support atmospheric-related analysis and monitoring of pollutants and ozone holes at a global level.

The GMES Space Component Data Access (GSCDA) project has been initiated by ESA for providing EO data to the Fast Track and to the two Pilot Services. Within this project, a Data Access Portfolio (DAP) Management function (GSCDA-P) is in charge of capturing the data and services requirements from the GSPs.

The GMES Space Component
The GMES Space Component (GSC) includes the Sentinel satellites and the access to ESA and European EO missions. The EO missions contributing to the GSC have similar characteristics (e.g. radar, optical HR, atmospheric…) and are referred to as "Sentinel-type" group for convenience.

- S1-type: SAR
- S2-type: optical high and very high resolution
- S3-type: altimetry, optical/IR medium and low resolution
- S4/S5 type: interferometers for atmospheric chemistry

The ESA is responsible for the development of the Sentinel satellites and of coordinating the data provision to the GMES Services. The GSC Data Access (GSCDA) Project is the ESA starting step for GMES set-up. It covers the GSC pre-Sentinels ("pre-operational") phase (i.e. 2008-2010) and is based on existing missions (ESA + European)

The main GSE service drivers are large data volumes involved (e.g. for the three Sentinels, about 2-3 TB/day), stringent timeliness requirements (e.g. NRT1h, NRT3h), heterogeneous environment (several EO missions and sensors are contributing to the same data-sets), and operational constraints (high reliability, availability, maintainability). The GSCDA implementation approach includes the evolution from mission/sensor product concept to data-set concept, and the harmonized access for users achieved through an enhanced coordination layer on top of existing infrastructures ("data access coordinated functions") with no impact on source products and no impact on GCM core infrastructure. Enhanced system operability is achieved through interoperable catalogues/ordering/programming (see HMA interfaces standardization). GSC will do dedicated archiving for long-term data sets availability.

GSCDA-S Architectural Concept
The GMES Contributing Missions (GSC CM) is the core G/S of the GSCDA-S, located at each Contributing Mission. It includes an acquisition/processing system, a long term archive (for L0 data), a short-term data repository (L1 and higher), a dissemination function, a User Service, and also a Quality, Monitoring and Control function. GSC Coordinated User Services (GSC CUS) is the system front-end to the GMES Service Projects. It interacts with the User Services of the various GCMs for ensuring user support and for coordinating mission planning. It includes a Customer Service, a GMES Coordinated Catalogue and a coordinated mission planning capability. GSC Coordinated Archive (GCA) is the store for (almost) all data acquired and distributed by the GSCDA. GSC Post Processing Element (GSC PPE) is a facility providing post-processing capabilities when necessary (e.g. for ortho-rectification) GSC Coordinated Quality Control (GSC CQC) is in charge of organising harmonized publication and definition of data quality for GSC data, relying on CM quality standards. GSC Monitoring & Control (GSC M&C) is in charge of ensuring the overall control and monitoring of the system.

Calibration Test Sites: Selection and Characterization *(Beatrice Berthelot, ESA)*
Context
The study is a contribution to CEOS/WGCV strategy to ensure the quality of data for current and future missions (Calibration, Validation, Operational quality). The study focuses on calibration in relation to the CEOS activities through Cal/Val Working Group (WGCV), including sites identification and characterization. It also studies calibration is relation to the Cal/Val portal, including data, methodologies, recommendations, and the key people who manage calibration activities (sites, programs etc).

Analysis of the External Calibration Requirements
We need to identify the objectives of this study. What do we want to observe from space? What variable (e.g. ECV) can be obtained? We must establish the requirements on the products in terms of Accuracy and stability, then relate it satellite measurements (relationship is not direct and non linear).

Specifying the requirements on the radiometric and spectral performances of a satellite sensor can be done by sensitivity studies including complete calibration. These will include radiometric calibration, geometric calibration, and instrument characterization (image quality). But the stability of the instrument is not guarantied to achieve the product requirement with time (device degradation). Vicarious calibration can help to meet these requirements by giving us a structured approach to classifying the sensors, creating recommendations.

WP110 – Sensor Classification

Class Number	Sensor Type	Main Characteristics
Class 1	• Synthetic Aperture Radar • Radar altimeter • Microwave radiometer	

Class 2	• Optical sensor medium resolution • Geostationary instruments	• Large FOV (BRDF) • Good revisiting time • Large pixels (spatial sampling) • Narrow filters
Class 3	• Optical sensor high resolution	• Small FOV • Poor revisiting time (accuracy) • Small pixels • Large filters (spectral sampling)
Class 4	• Atmospheric instruments	• large FOV • Poor revisiting time (accuracy) • large pixels • Very Narrow filters

WP210 - Identification and Description of Calibration Sites Through Existing Programs
There are may existing calibration sites that can be used in this project. We need to identify the main key-actors (e.g. PI) in calibration activities and collect information about their sites (localization, size, surface type). We also need to identify the operations conducted on the site (frequency, experimental campaigns) and collect information from various sources: common scientific community knowledge, technical publications, web information, expert networks, committees, direct contact with project leaders.

5.5 INPE *(Leila Fonseca)*

The INPE represenative, ***Dr. Leila Fonseca, Brazil*** and her associate Dr. Flávio Jorge Ponzoni presented the report from the Brasilian space agency (INPE).

China-Brazil Earth Resources Satellite Program
- 1988: agreement between Brazil and China to develop CBERS-1 and CBERS-2
- 1999: CBERS-1 launching
- 2002: agreement for CBERS-3 and CBERS-4
- 2003: CBERS-2 launching
- 2004: agreement for CBERS-2b
- 2007: CBERS-2B launching
- 2011- CBERS-3 launching

CBERS-2B, Updates on International Ground Stations
CBERS-2B was successfully launched on September 19, 2007. It has a Wide Field Imager Camera – WFI (258 m), a CCD Camera (20 m), and a High Resolution Camera – HRC (2.7 m). There are three Chinese ground stations to monitor and control the satellites in Changchun, Nanning and Keshi. There are two Brazilian ground stations in Cuiabá and Alcântara under control of the Tracking and Control Center of INPE in São José dos Campos.

There are three Chinese image receiving stations in Beijing, Nanning, and Wulumuqi. There is one Image Receiving Stations in Cuiabá, Brazil. This station has a 11.8 m Viasat antenna (36 dB/K) with demodulators and bit-synchronyzers for Landsat-5, SPOT-4, RADARSAT-1 and CBERS-2B; a 10 m Viasat antenna (34 dB/K), and one Cortex HDR programmable demodulator with two demodulators. A contract has been signed with the manufacturer Viasat, Inc., of the U.S.A., to upgrade both antenna systems with state-of-the-art technology. After this contract INPE will have two tracking antennas and five dual channel programmable demodulators, capable of tracking and receiving most Earth observation satellites, present and future.

A high-speed internet connection is being set up to allow the timely download of the raw data acquired in the Cuiabá ground station to the Remote Sensing Data Center (CDSR) in Cachoeira Paulista, SP. The products generated by the CDSR are archived in long term archival systems from where they can be browsed by the users and freely downloaded through the internet, from anywhere in the world (http://www.dgi.inpe.br/CDSR).

An additional ground station at Boa Vista, RR, is planned. This is a complete new system yet to be built if the necessary funding can be found. It will have a 32 dB/K system, an antenna size between 5 and 7 meters, dual polarization (RHC and LHC), and two programmable demodulators with two demodulators each.

During the GEO Ministerial Meeting in Cape Town, in October, 2007, the Brazilian and the Chinese governments agreed to establish a network of ground stations to cover Africa and to make the free distribution of image products to the African countries. Some ground stations or sites were identified.

Maspalomas (INTA – Spain) (Canary Islands): Brazil will support this ground station. Trial reception of CBERS-2B was successfully performed. Ingest and processing software was installed in the ground station computers. Antenna system is not yet operational. MOU was approved by the parties and it will be signed in the end of October 2008

Hartebeeshoek (SCIR - South Africa): China supports this ground station. Trial reception was performed three times by a Brazilian team. New antenna system was received and CRESDA has installed a processing system there. MOU will be signed in the end of October 2008.

Aswan (NARSS – Egypt): The Brazilian team has been to Aswan in May, 2008. The ground station had problems, so trial reception could not be performed. New trial was reception scheduled for 18th October, 2008.

Jos (NASRDA – Nigeria) & Malindi (ASI – Kenya): INPE has been in touch with them about the CBERS for Africa program. They showed great interest in participating.

Libreville – Gabon: There is yet no ground station in Gabon. However, the French and the Brazilian government, are willing to cooperate in order to establish an image reception capability there.

Future Challenges and tasks on calibration issue

One challenge is atmospheric correction between MODIS data and sunphotometers. We need to improve the radiometric data collection from the reference surface during the satellite overpass, to guarantee periodic and systematic vicarious calibration campaigns. We are developing a creative and efficient way to properly inform the remote sensing community about the criteria and procedures adopted in the calibration coefficients determination. The future tasks are:

- Reference surface and Atmosphere characterization
- Increasing our participation in international calibration campaigns (WGCV/CEOS)
- Cross calibration
- Uncertainties estimation
- Validation studies

5.6 Joint Research Center (JRC) Report (*Widlowski)*

The JRC representative, ***J-L. Widlowski***, presented the report. The reports was generated with contributions by J-L. Widlowski N. Gobron, B. Pinty, G. Zibordi & colleagues, JRC

AERONET – Ocean Color

AERONET-OC is an integrated network supporting ocean color validation with highly consistent time-series of standardized $L_{WN}(\lambda)$ measurements.

Surface Albedo Product Intercomparison

BHR: Bi-Hemispherical Reflectance in the ratio between the upward and the downward radiant fluxes, that is, accounting for the downwelling diffuse intensities from the sky. This depends on both surface and atmospheric radiative properties and the solar zenith angle.

DHR: Directional Hemispherical Reflectance is the ratio between the upward flux and the downward collimated flux coming from one single direction. This depends on surface radiateive properties and the solar zenith angle.

If the downwelling diffuse intensity from the sky is assumed fully isotropic then the BHR is equal to the integral of the DHR over all incoming directions. The BHR becomes a BHRiso called White Sky albedo by MODIS and depends on surface radiative properties only and the solar zenith angle. The DHR boils down to a single integral of BRF on all the outgoing directions, called Black Sky albedo by MODIS where the BRF, a Bidirectional Reflectance Factor expressing the probability for radiation coming from one particular direction to be scattered in a specific outgoing direction.

MISR delivers DHRs and BHRs as flux ratios but under ambient conditions and for the Sun illumination conditions at the time of the observations as well as all information needed to reconstruct the DHRs at any other solar zenith angle and the BHRiso. EUMETSAT delivers DHRs for a fixed Sun angle and all information needed to reconstruct the DHRs at any other solar zenith angle as well as the BHRiso. MODIS delivers DHRs and BHRiso. To reconstruct the BHRs may require substantial investments or some level of assumption.

JRC-FAPAR

JRC-FAPAR products exist at different spatial and temporal resolutions for various sensors:

- **SeaWiFS** (Sep 1997 – Jun 2005) -- http://fapar.jrc.it/
- **MERIS** (2002 – end of mission) -- http://envisat.esa.int/
- **MODIS, MISR, GLI, MOS, VEGETATION** (case by case)

JRC-FAPAR algorithm accounts for spectral band specifics to make JRC-FAPAR product independent of instrument/sensor characteristics, viewing and illumination conditions, atmospheric conditions, and background brightness. JRC-FAPAR products include instantaneous (q_0, j_0) direct only and 'green' material only, with an error of ±0.1 absolute.

For ground-based FAPAR, the total FAPAR is the fraction of incident radiation that a given canopy volume (excluding soil) absorbs in the PAR (0.4-0.7 µm). The impact of H depends on the canopy structure, the canopy height (Δz), the spatial resolution (S), the spectral properties (w, a) , and the illumination conditions (q_0).

For land validation sited, the radiation transfer regime after Davis & Marshak (2004) JQSRT uses "Fast" variability, 1-D RT theory on full domain. Internal variability of extinction coefficient (leaf densities) are statistically homogeneous (Poisson-like). Types of vegetation at the resolution of the investigation are short vegetation and tall but rather dense canopy layers. One type of vegetation covers the whole domain.

For ground-based FAPAR, the following caveats exist. Total FAPAR is the fraction of incident radiation that a given canopy volume (excluding soil) absorbs in the PAR (0.4-0.7 µm)**.** Inappropriate sampling may lead to local absorption estimates that overestimate the true absorption. Total FAPAR is the fraction of incident radiation that a given canopy volume (excluding soil) absorbs in the PAR (0.4-0.7 µm). Use a different RT model, a different set of remote sensing data and generate the same FAPAR product.

RAdiative transfer Model Intercomparison
The purpose of RAMI is to act as common platform for intercomparison efforts of canopy reflectance models, to document uncertainties and errors among models, to establish protocols for the evaluation of RT models, and to foster scientific debate. Generation of **reference data** set from simulations of six 3-D MC models that agree within 1%.

5.7 NASA *(Garrick Gutman)*

Garrick Gutman, presented the NASA agency report.

NRC Recommended Missions - Early/Mid

Mission	**Mission Description**	**Orbit**	**Instruments**
Tier #1			
CLARREO (NASA portion)	Solar and Earth radiation: spectrally resolved forcing and response of the climate system	LEO, Precessing	Absolute, spectrally-resolved interferometer
SMAP	Soil moisture and freeze/thaw for weather and water cycle processes	LEO, SSO	L-band radar L-band radiometer
ICESat-II	Ice sheet height changes for climate change diagnosis	LEO, Non-SSO	Laser altimeter
DESDynI	Surface and ice sheet deformation for understanding natural hazards and climate; vegetation structure for ecosystem health	LEO, SSO	L-band InSAR Laser altimeter
Tier #2			
HyspIRI	Land surface composition for agriculture and mineral characterization; vegetation types for ecosystem health	LEO, SSO	Imaging spectrometer Multiband Thermal
ASCENDS	Day/night, all-latitude, all-season CO_2 column integrals for climate emissions	LEO, SSO	Multifrequency laser
SWOT	Ocean, lake, and river water levels for ocean and inland water dynamics	LEO, SSO	Ka-band wide swath radar C-band radar
GEO-CAPE	Atmospheric gas columns for air quality forecasts; ocean color for coastal ecosystem health and climate emissions	GEO	High and low spatial resolution hyperspectral imagers
ACE	Aerosol and cloud profiles for climate and water cycle; ocean color for open ocean biogeochemistry	LEO, SSO	Backscatter lidar Multiangle polarimeter Doppler radar

Previous and Current Studies
HyspIRI consists of a visible shortwave infrared (VSWIR) imaging spectrometer and a multispectral thermal infrared (TIR) scanner. Initial studies for the mission and both instruments were undertaken in 2007 and reported out to NASA HQ in fall 2007. A follow-up HypspIRI mission study is now underway utilizing the 2007 mission and instrument design studies. The study is being led at NASA HQ by Woody Turner and John Labrecque (Project Scientists) and Steve Neeck (Program Executive). The VSWIR imaging instrument (aka Plant Physiology and Functional Types spectrometer) [PPFT] study was led by Rob Green. The multispectral TIR imaging instrument study was led by Simon Hook. A small science

study group for the HyspIRI mission has been identified by NASA HQ which will help refine the scientific requirements and refine the science goals for the mission. A science workshop will be held in the fall of 2008 to maximize community involvement and understanding of the mission

HyspIRI Execution Structure
The HyspIRI Working Group (HWG) will be managed by the HyspIRI Steering Committee with representatives of the principal HyspIRI scientific disciplines. The HWG will coordinate the activities of the Science Study Group, the Partnership Coordination Group and the Mission Design Group.

HyspIRI Working Group
HyspIRI Steering Committee
- W. Turner, J. LaBrecque (PS Co-leads); S. Neeck (PE Lead)
- M. Maiden (Data); J. Haynes (Applied); B. Smith (ESTO)
- Terrestrial Ecosystems, Biodiversity, Solid Earth, Ocean Biology, Carbon Cycle

HyspIRI Partnership Coordination Group
- Co-Chairs R. Green, S. Hook, S. Ungar
- Ensure potential partnerships are assessed and appropriately documented

HyspIRI Science Study Group
- Co-Chairs R. Green, S. Hook, S. Ungar
- 31 member scientists
- Science oversights, Mission Dev. and Sci. Outreach

HyspIRI Mission Design Group
- Co-Chairs F. Rogez, T. Pagano, B. Knox
- Supported by Team X, ISAL, External Capabilities
- Mission, Instrument, Launch, Operations, Data Systems, Technology

Plant Physiology and Functional Types (PPFT), NASA Decadal Survey Science Questions
- What is the composition, function, and health of land and water ecosystems?
- How are these ecosystems being altered by human activities and natural causes?
- How do these changes affect fundamental ecosystem processes upon which life on Earth depends?

PPFT Science Topic Questions
Ecosystem Function and Diversity:
- What are the spatial distributions of different plant functional groups, diagnostic species, and ecosystems?
- How do their locations and function change seasonally and from year to year?
- What are the trends?

Biogeochemical Cycles:
- How do changes in the physical, chemical, and biotic environment affect the productivity, carbon storage and biogeochemical cycling processes of ecosystems?
- How do changes in biogeochemical processes feed back to other components of the Earth system?

Ecosystem Response to Disturbance:
- How do human-caused and natural disturbances affect the distribution, biodiversity and functioning of ecosystems?

Ecosystems and Human Well-being:
- How do changes in ecosystem composition and function affect human health, resource use, and resource management?

Instrument: Offner Spectrometer, Low Cost and High Fidelity
The instrument design selected is an Offner imaging spectrometer with extensive relevant heritage, including Hyperion, CRISM, COMPASS^{air}, TB^{air}, ARTEMIS, and M3. At the core of the PPFT instrument is a pair of f/2.5, high signal-to-noise ratio, uniform, full-spectral-range Offner spectrometers. Each spectrometer has two full range detector arrays that cover the spectral range from 380 to 2500 nm @ 10 nm intervals with 610 cross-track spatial elements used.

Thermal Infrared Multispectral Scanner (TIMS), NASA Mission Science Questions
- Volcanoes: What are the changes in the behavior of active volcanoes? Can we quantify the amount of material released into the atmosphere by volcanoes and estimate its impact on Earth's climate? How can we help predict and mitigate volcanic hazards?

- Wildfires: What is the impact of global biomass burning in the terrestrial biosphere and atmosphere, and how is this impact changing over time?
- Water Use and Availability: As global freshwater supplies become increasingly limited, how can we better characterize trends in local and regional water use and moisture availability to help conserve this critical resource?
- Urbanization: How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?
- Land surface composition and change: What is the composition and temperature of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?

5.8 NIST *(Carol Johnson)*

Carol Johnson, Optical Technology Division, Physics Laboratory, National Institute of Standards and Technology presented the NIST report. The report included contributions from David Allen, Steven Brown, Joe Rice, Eric Shirley, Allan Smith, Howard Yoon, Raju Datla, Keith Lykke, Gerald Fraser.

Summary Statement
The NIST Optical Technology Division continues to support and/or partner with weather & climate related satellite programs. It maintains and improves radiometric tools, facilities and the capabilities to do so.

Absolute Flux of Standard Stars
The goal is to establish a set of SI traceable stars for calibration. Current stellar light measurements are too inaccurate (2% to 5%), which presents a problem for various applications, such as: Earth sciences, weather & astronomical satellite calibration, atmospheric monitoring, fundamental astronomy, astronomical surveys, navigation and physics and cosmology.

The approach for calibration is to use "SIRCUS on a mountaintop". NIST/SIRCUS detectors have been calibrated for irradiance responsivity. They use a laser (or SC in SLE) -illuminated sphere as an irradiance standard (fixed point blackbody in 1970s work). They also use Si PDs w/ apertures at distances z, or a portable telescope as a transfer radiometer. These tools are used to determine horizontal atmospheric extinction.

For vertical atmospheric extinction atmospheric correction, it is important to avoid known features and select the site carefully. It requires complete characterization (e.g. LIDAR for aerosols) for the lowest uncertainty. It is also important to utilize existing stellar standards to determine atmospheric correction *in situ* during actual observations from the Absolute Color Calibration Experiment for Standard Stars (ACCESS).

NIST Stars Accomplishments
In the NIST Stars program, there have been two site visits. The first was to the 42-inch telescope at Lowell Observatory; first actual calibration will be there or at Mt. Hopkins. The second visit was to PanSTARRS in Haleakala, Maui. Close collaboration was established with Chris Stubbs of Harvard University, and a Harvard-designed near field fiber-optic fed large area source was used to acquire data. Collaboration was established with ACCESS team and NIST will participate in calibration of the rocket-borne spectrographs (4 stars, four flights).

There was a traveling SIRCUS deployment last May – June, 2008 to JPL for calibration of the Narrow Band Imager (high resolution spectrograph at 850nm) and two broadband imagers (H and I bands) that are part of the Cosmic Infrared Background Experiment (CIBER) mission as a test of overall methodology; additional measurements planned for January 2009.

The wavelength calibration of an echelle spectrograph was done using a tunable ring dye laser at Mt. Hopkins' Multiple Mirror Telescope was completed; requirement was 0.0001nm uncertainty, additional measurements scheduled for November 2008. A new NIST facility for calibration of the reference telescope for point source geometry in a 80m tunnel was also implemented.

CLARREO -- Climate Absolute Radiance and Refractivity Observatory
There will be a Community Workshop, Washington, DC. On Oct 21 – 23, 2008. The goal of this workshop is to draft science objectives. NIST is in discussion with LARC on cal/val elements for this project. The Web site is http://clarreo.larc.nasa.gov/.

NIST participation in program elements:
- LASP – NIST detector calibration support for IIP funded research on on-orbital calibration
- University of Wisconsin, Harvard – IR radiometry for climate change
- LARC – far IR radiometry (blackbody sources)

- JPL – NIST calibration support in a subcontractor role – "Internal Spherical Integrating Source" an ACT proposal

BRDF
The Scale Realization for BRDF was raised from 1100 nm to 2500 nm, The Spectral Tri-function Automated Reference Reflectometer (STARR) facility was modified to include an InGaAs detector. NIST did a comparison of sample's 0/45° reflectance values from STARR to an independent irradiance (FEL lamp) / radiance (strip lamp) scale. This impacts SWIR band calibration for sensors, as heretofore users relied on 8°/hemispherical data.

Flat Plate Illuminator
The Flat Panel Illuminator (FPI) requires a vacuum-compatible source to test for sensor repeatability from sensor-level testing to spacecraft-level testing. It is important to identify changes in VIIRS sensitivity from sensor build to S/C integration w/in 10%. This is a joint project with IPO for VIIRS. The requirements are a spectral range 0.4 to 1.8 μm, 25 cm square or greater, moderately uniform radiance, and simple operation.

To date, the filtered diode reference monitors are key to radiometric stability and accuracy. There needs to be very low power dissipation in vacuum chamber. The FPI still in testing at NIST. The capability of applications much broader than envisioned with initial problems.

HIP: Hyperspectral Image Projector
For the HIP, a contract with Resonon is in place, where VNIR/SWIR PDR will be completed and CDR in January 2009. The "Spectral Light Engine" is "half a HIP" – digitally programmable tunable light source; fed with TQH, Xe, or supercontinuum light source.

Supercontinuum light sources utilize non-linear effects in a photonic crystal optical fiber to greatly broaden the spectrum of a 1064 nm pump laser. The broadband light is generated in a single-mode (5 um core diameter) photonic crystal (holey) optical fiber. There are currently no etendue issues as with lamps or blackbodies. This system is ideally suited for coupling to a spectral engine. It is high power and high spectral resolution, 3mW/nm spectral power density from 450 nm to 1700 nm, and it is commercially available.

Other Notes
NIST has prepared a TSI Workshop Report: "Sources of differences in on-orbital Total Solar Irradiance measurements and description of a proposed laboratory intercomparison," *J. Res. NIST*, 113, 187 – 203 (2008). A paper on best practice for the IR is in preparation between NOAA (Mitch Goldberg) and NIST (Raju Datla) for GSICS. It will be expanded to include Vis/NIR. Preliminary laboratory comparison activities for TSI (TIM) on SIRCUS were also completed.

There was a GEO/CEOS Workshop, "Quality Assurance of Calibration and Validation Processes Establishing Operational Framework," May 6 – 8, 2008, (NOAA/NIST). A MOU with NOAA/NESDIS for GOES-R cal/val support is in place, current focus is on Advanced Baseline Imager (ABI). A copy VXR instrument will be built and NIST will lead in the characterization of the GSFC/NIST transfer radiometers. An agreement in place between NASA/GSFC and NIST for cal/val support of the Operational Land Imager (OLI).

5.9 Peoples Republic of China, PRC *(Xiaolong Dong and Heguang LIU)*
The PRC report was presented by ***Xiaolong Dong***, NMRSL/CSSAR/CAS. The report focused on the **Recent Progress of Earth Observation Satellites and CAL/VAL Activities in China**

FY-3
FY-3 is part of China's new generation polar-orbit meteorological satellite. FY-3A was successfully launched on May 27, 2008 from Taiyuan Launch Site in northern China. In-orbit payload test and performance validation are ongoing.

FY-4
FY-4 is also part of China's new generation geostationary orbit meteorological satellite. FY-4 will have an optical version (FY-4O) and a microwave version (FY-4M) of the satellite. Development of the sensors for FY-4M has already started, including both a microwave sensor with real aperture antenna and synthetic aperture technique. A prototype of the synthetic aperture microwave sensor is being developed with support from China's High-Tech R & D Program (863 program). It is due to be completed by 2010. A clock scanning scheme is also being developed to reduce the number of receiving elements for the required visibility function (u-v) coverage.

HY-2 Ocean Dynamic Environment Measurement Satellite
The HY-2 satellite's main payload are microwave sensors, including a dual frequency (Ku, C) radar altimeter and 3-channel nadir-looking microwave radiometer for atmospheric correction, a Ku-band radar scatterometer, and a multi-

frequency microwave imager (6.6GHz-37GHz). An engineering model was started in 2008, and launch is expected around 2010.The Returned Signal simulator is being developed for prelaunch calibration. The after-launch CAL/VAL campaign is being planned and prepared.

HJ-1 Series Environment and Disaster Monitoring Constellation (A/B/C)
The HJ-1 satellite system has two phases of deployment. Phase 1 is HJ-1A/B/C, which is a 3 satellite constellation with 2 optical satellites and one SAR. HJ-1A also contributes to the Asia Pacific Multilateral Small Satellite Program. Phase 2 will be made up of an 8 satellite constellation with 4 optical satellites and 4 SAR satellites.

HY-1A/B were successfully launched by a single launcher from Taiyuan Launch Site on September 06, 2008. The data from these satellites will be distributed by CRESDA. The data application center belongs to the Chinese Ministry of Environment Protection and the National Commission of Disaster Reduction.

CAL/VAL Activities of Satellite Sensors
FY-3 Prelaunch Calibration
Before launch, an airborne campaign was completed to validate the instrument performance. At Dunhuang, comparisons were made with optical emissions. Measurements at Qinghai Lake were used to validate the sensor performance. Measurements at Pu'er (Simao) in Yuan Province were used to validate the possibility for after launch validation.

CE-1 Prelaunch Calibration
The microwave radiometry data was overlaid on Clementine uncontrolled mosaic images from 2007.12.4-12.30. Only night data were used, and no data area were drawn as blank area in the map.

HY-2 Prelaunch Calibration
A full-wave simulator is being built for before launch calibration and performance assessments. After launch CAL/VAL has been planned. The building of in-situ instruments has started and the platform-based system will be integrated by the end of 2008. This will include C\X\Ku band radar scatterometer, and C~Ka band microwave radiometer.

HY-1B Postlaunch CAL/VAL
The HY-1B satellite, launched on April 11, 2007, is the 2nd ocean observation satellite of China, for Ocean Color and Temperature sensing. HY-1B has two optical sensors: COCTS & CZI. COCTS is a 1km ocean color and temperature sensor. CZI is 250m ocean color sensor with fluorescence ability.

FY-3A Postlaunch CAL/VAL
On-board calibration methodology of FY-3A payloads has started. MERSI, VIRR, and IRAS, have the capability of in-orbit real-time two-point calibration. MWHS, MWTS and MWRI have the capability of real-time calibration by looking of on-board blackbody and the cold-sky alternatively. SBUS/TOU, ERM/SIM also have capability of on-board calibration. Preliminary after launch calibration and inter-comparison had been done. Further calibration and performance evaluation are ongoing.

5.10 NOAA *(Changyong Cao)*
An update on the NOAA Satellite Calibration/Validation Program was presented by ***Dr. Changyong Cao***, Center of Satellite Applications and Research; National Environmental Satellites, Data and Information Services; National Oceanic and Atmospheric Administration. Satellite data are used daily in the NOAA Global Numerical Weather Prediction Models. An overview and time table of current and planned until 2020 missions was presented (see NOAA presentation at WGCV29 web page).

POES & GOES Calibration Status
Continuing updates of POES and GOES visible and near infrared calibration coefficients. This is operational calibration support to provide data quality assurance. The NOAA calibration supports both weather and climate applications.

NOAA-N Launch
The launch readiness of NOAA-N was also reported. The satellite will be in a PM orbit, with MetOP in an AM orbit. The instrument package will contain AVHRR/AMSU/HIRS/MHS/SBUV. The satellite launch readiness review was held in September 2008, which will include presentation on the analysis of prelaunch thermal vacuum data, and readiness review for the calibration parameter input datasets. The satellite will be launched in February 2009.

IASI Update
Studies have found that IASI can be used as on-orbit radiometric/spectral reference standard. There is excellent agreement between IASI and AIRS (at the SNOs). This is the same conclusion reached in several studies (Bluemstein, Tobin, Straw, etc.).

IASI has also successfully detected the changes after GOES-12 decontamination. Inter-calibration of GOES-12 imager water vapor channel (Ch 3) was carried out using the IASI hyperspectral radiance measurements by selecting one year of the simultaneous nadir observations with homogeneous scenes. IASI successfully detected the changes after the GOES-12 decontamination on July 2 2007. The BT difference between IASI and GOES-12 for water vapor channel is roughly the same order of magnitude but opposite in sign before and after decontamination.

HIRS Visible Channel Calibration using Deep Convection Cloud (DCC)
Deep Convective Clouds (DDC) are cumulonimbus clouds (<205K at +/-30 Lat). These clouds are very cold and have stable reflectance. The STAR cal/val team is adding the new capability of DCC calibration based on previous studies by NASA Langley and others. A pilot study was done for HIRS visible channel on NOAA-17 using DCC. The results clearly show instrument degradation over a 6 year period, with small uncertainties. Among the advantages, DCC does not require atmospheric radiative transfer calculations as other Earth based target do. Further evaluation is needed for climate quality stability using this method.

GSICS Progress Update
GSICS (Global Space-based Inter-satellite Calibration System): GSICS is a part of the WMO (World Meteorological Organization) space program. Its main goal is to facilitate the generation of fundamental climate data records. GSICS will contribute to the development of RSSC-CM (Regional Specialized Satellite Centers-Climate Monitoring.

GSICS Information Services and Products Roster, a list of current and potential GSICS products and services are provided:
- Satellite Instrument Information
- Satellite Instrument Performance Monitoring
- LEO-LEO Inter-calibration
- GEO-LEO Inter-calibration
- Spectral Calibration
- Spatial Calibration
- Vicarious Calibration of Solar Reflective Bands
- Radiative Transfer Simulations of Satellite Instrument Radiances
- Inter-comparison with SI Traceable Aircraft Radiometers
- GSICS Product Guides
- GSICS Communication Tools

GSICS Procedure for Product Acceptance
The success of GSICS is intimately linked to the quality and usefulness of its products. The GSICS Procedure for Product Acceptance (GPPA) is designed to establish a method by which distribution-ready products from data providers around the world can be first carefully inspected, and then accepted as a GSICS product. The procedure consists of three majors steps:
1. The product provider fills out a GSICS Product Application Form (GPAF);
2. The GPAF is scrutinized by the GSICS Product Oversight Panel (GPOP); and
3. If the application is accepted by the GPOP, it is sent to the GSICS Executive Panel, who is responsible for the final decision to accept the product application.

GSICS Web Site Updates
Currently, the NESDIS/STAR web designer is transforming the current GSICS web site using the NESDIS/STAR web site kit.

GSICS Computing Services
GSICS now had a Google Groups account. This allows GSICS groups e-mails broken down into several subgroups, including GRWG (gsics-research), GRWG Leads (gsics-research-wg), and GDWG (gsics-data). These groups are limited only to invited members, and e-mails go directly to all members of the group. The group e-mails are also organized by thread and archived at Google.

5.11 NPL Report *(Fox)*

The NPL representative Dr. Nigel Fox, also IVOS SG Chair gave an update on the current NPL activities.

Introduction

In 2002, an NPL led a team (largely from CEOS IVOS) have submitted a proposal TRUTHS (Traceable Radiometry Underpinning Terrestrial- and Helio- Studies) to open ESA call. Benchmark mission is proposed to provide SI traceable measurements of incoming solar irradiances (total and spectrally resolved and reflected spectral radiances (0.01 to ~ 0.3% respectively). The goals include transferring its in-flight calibration accuracy to other sensors via calibrating a set of ground targets and the moon.

Under the NRC, US decadal survey 2007 similar mission CLAREO is being considered as one of four missions under consideration by NASA. Traceability to SI in orbit is key to *avoid high risk strategy needing data overlaps and instrument degradation.* Operationally can provide calibrations to other dedicated EO missions.

In a workshop in July 2007 were detailed the requirements and options. Ideally it will include 3 satellites (2 for IR, 1 solar reflective). International collaboration is required to implement it. TRUTHS was baselined to provide solution for solar band.

GERB 3: Calibration (Geo-stationary Earth Radiation Budget)

NPL has given its support to the Imperial College of London for the calibration of GERB 3. This will use black bodies for "total radiance" and TSARS (Transfer Standard Absolute Radiance Source) for solar reflection. There is also support to RAL for calibrating mirror reflectance.

TRUTHS: Cryogenic Solar Absolute Radiometer (CSAR)

The CSAR system measures TSI on ground to replace WRR of WMO. It is a collaboration between PMOD/WRC Davos and MSSL. This instrument is designed for space flight as primary standard of TRUTHS. The mechanical and thermal FE analysis now complete. A video of the TRUTHS concept is available on "YouTube" at http://www.youtube.com/watch?v=TMMyObOjBl4

5.12 NPOESS Integrated Program Office (IPO) Report *(St. Germain)*

Dr Karen St. Germain presented the NPOESS report.

Mission

The NPOESS mission involves environmental monitoring in support of civil and defense applications. It features rapid data delivery, 4 times faster than legacy systems. It quickly react to changing conditions, has up to 10 times the data of the older systems, and has more accurate data for better forecasts. This system is based on international collaboration. This system delivers critical inputs to weather forecast models, science quality data to users including research scientists, and it has a continuity of climate data records.

Tri-agency Effort to Leverage and Combine Environmental Satellite Activities

The NPOESS mission is to provide a national, operational, environmental polar-orbiting remote-sensing capability. This program converges DoD and NOAA satellite programs into a three satellite system with European partnership.
NOAA is the host agency and lead for operations and international partners. The US Air Force has acquisition responsibility, and NASA is responsible for development of and insertion of new technologies.

NPOESS Payload Development Status

CrIS Instrument (ITT)

The CrIS (Cross-track Infrared Sounder) instrument, manufactured by ITT, is in good shape. The modules have all been built and re-integrated, with initial bench testing completed in November 2007. The Electromagnetic Interference (EMI) testing was completed in December 2007, and the vibration testing in February 2008. The EDU was integrated onto the NPP spacecraft for initial functional test. Final CrIS Thermal Vacuum (TVAC) testing has started. This instrument has a pre-shipping review in December 2008.

VIIRS Instrument (Raytheon)

The VIIRS (Visible/Infrared Imager/ Radiometer Suite) instrument, manufactured by Raytheon, has completed ambient testing. The Electronics Module (EM) Thermal Cycle test has also been completed, as have the cryoradiator vibration testing (Jan 2008), the final Ambient Regression testing (Feb 2008), and the Pre-Environmental Test Review (PER) (Apr 2008). The cryoradiator was recently integrated with the rest of sensor. The final environmental testing is currently underway.

OMPS Instrument (Ball)
The OMPS (Ozone Mapping & Profiler Suite) instrument, manufactured by Ball Aerospace, has complete Integrated Sensor Risk Reduction testing. The Nadir, Limb and Main Electronic Box (MEB) testing has also been completed, and the Nadir/Limb/MEB has been integrated into final Integrated Sensor Suite configuration. The Final Acceptance Testing is ongoing. The TVAC test is scheduled for summer 2008 and Pre-Ship Review is in September 2008.

ATMS Instrument (NGES)
The ATMS (Advanced Technology Microwave Sounder) instrument, manufactured by NGES, had its Flight Unit 1 delivered to NPP in 2005 for integration. The Delta Critical Design Review (CDR) for replacement of obsolete components will be held in September 2008.

CERES Instrument (NGST)
CERES (Clouds and Earth's Radiant Energy System) instrument, manufactured by NGST, has been approved for flight by NASA for NPP. The Delta CDR is complete. The instrument is currently undergoing modifications for an October 2008 delivery to NPP. The instrument has been approved for flight by NOAA for NPOESS C1.

NPP Cal/Val Phases
There are four phases for the planned calibration/validation (Cal/Val) of NPP.

1. Pre-Launch; all time prior to launch – Algorithm verification, sensor testing, and validation preparation
2. Early Orbit Check-out (first 30-90 days) – System Calibration & Characterization
3. Intensive Cal/Val (ICV); extending to approximately 18 months post-launch – xDR Validation
4. Long-Term Monitoring (LTM); through life of sensors

For each phase, exit criteria have been established and activities summarized. Products mature through the various phases independently form each other.

NPP Cal/Val Plan Development, IPO Discipline Team Leadership
NPP IPO Cal/Val Discipline Leads have been selected strategically from the community to best represent customer product priorities. Cal/Val Discipline Leads are building teams of Subject Matter Experts (SMEs) to develop and execute cal/val tasks.

- **SDR Lead Dr. Bruce Guenther**
  - VIIRS – Dr. Frank DeLuccia, Aerospace
  - CrIS/ATMS - Dr. Gail Bingham, USU/SDL
  - OMPS – Dr. Scott Janz, NASA/GSFC
- **EDR Lead Mr. Carl Hoffman**
  - VIIRS Atmosphere: Dr. David Starr, NASA/GSFC
  - VIIRS Land: Dr. Jeff Privette, NOAA/NESDIS/NCDC
  - VIIRS Ocean: Dr. Bob Arnone, NRL
  - VIIRS Imagery/Cloud Mask: Mr. Tom Kopp, Aerospace at AFWA
  - CrIS/ATMS Sounding: Dr. Chris Barnet, NOAA/NESDIS/STAR
  - OMPS Ozone: Dr. Larry Flynn, NOAA/NESDIS/STAR

NPP SDR Cal/Val Objectives
The plan is to evaluate instrument response on orbit, by characterizing instrument response from pre-launch bench and TVAC tests, and incorporating lessons learned from heritage radiometric and spectral calibration approaches, including CrIS - AIRS, IASI, TES, ATMS – AMSU, VIIRS – MODIS, and OMPS - OMI, TOMS, SBUV/2, GOME(-2), SCIAMACHY. The build team of SMEs from both customer and science communities plan to leverage heritage knowledge and tools as well as assure understanding of Customer Mission Success.

CrIS SDR Cal/Val Strategy Highlights
The CrIS pre-launch activities are to analyze the TVAC data, evolve TVAC findings into improved operational algorithm, verify the RDRs and sensor vendor engineering parameters (LUTs), update TVAC analysis tools for on-orbit operational data, and exercise operational algorithm with TVAC gas cell dataset and day-in-the-life test sequence.

The post-launch activities include comparisons of SDRs against other sensor measurements (e.g. A-Train; MetOp), radiometric, spectral and geolocation evaluation and trending, comparisons of SDRs with cloud-cleared radiance IPs, GFS models, and long-term stability SDR characterization.

ATMS SDR Cal/Val Strategy Highlights
ATMS pre-launch activities include analysis of TVAC data. The post-launch activities include comparison of on-orbit vs. T/V data, possibly including maneuvers, quantifying scan biases from sidelobes and s/c structure, scan uniformity/bias analysis, X-comparison with other satellite sounders and resampling and comparison w/AMSU.

Underflights and pre-launch cal/val exercises are possible. Other activities will include NWP radiance validation and comparison w/model Tb fields, geolocation checking, RFI contamination checking, ascending/descending Tb comparisons, gross anomaly identification and parameter trending, ATMS-CrIS footprint matching, and ATMS 57.29 GHz Center Frequency Stability & Drift between ATMS & CrIS.

VIIRS SDR Cal/Val Highlights
VIIRS plans to use heritage techniques for geolocation, including GCP training with Landsat (MODIS). They will also use Reflective Band Radiometry, including SD, vicarious calibration, and lunar calibration (MODIS, Seawifs, MISR), and X-Sensor calibration (AVHRR). Emissive Band Radiometry will be used with OBCBB, vicarious calibration (MODIS), X-and Sensor calibration.

They plan to identify problems using EDRs, CM, AOT, and SST for emissive band radiometry, CM, AOT, and OC for reflective band radiometry, and OC for polarization. Imagery will be used for geolocation and mapping accuracy. Comparisons with ground truth data sources will take place at the following locations:

- Lake Tahoe TOA radiance data
- Railroad Playa TOA radiance data
- ROLO or processed lunar data
- Sensor data from EOS A-train during time of overlap
- Landsat GCP database

OMPS SDR Cal/Val Strategy Highlights
OMPS plans to use heritage calibration techniques including dark current observations (dark current, bad pixels), lamp measurements (linearity), solar calibrations (diffuser degradations and CCD characteristics), wavelength monitoring, yaw maneuver (diffuser goniometry), trending of calibration parameters and results, unbinned and terminator Earth SDRs (stray light, geolocation, gain), statistical analyses of calibrations and Earth SDR radiances, and comparisons of OMPS radiances (cross-track calibration consistency & 300 to 310 nm).

The team will also use TC EDR and NP IP to identify problems with SDRs, EOF spectral covariance analysis, Mg II Index (core-to-wing ratio for solar activity), Aerosol Index and R/lambda linearity dependence, reflectivity monitoring – ice radiances, equatorial Pacific minimum, and spectral discrimination.

The team will use information from EDRs to check stray light contamination, analyze ozone retrieval residuals, check for degradation by examining reflectance spectra, and attitude check for consistency across swath.

They plan to cross-compare with data from VIIRS SDR M1 band radiances, ground instrument data (CasaNosa) from pre-launch characterization, radiances from OMI, GOME-2, SBUV/2, and solar irradiances from SORCE, SSBUV, SBUV/2.

EDR Cal/Val Strategy Highlights
The build teams of SME's from both customer and science communities want to leverage heritage knowledge and tools as well as assure understanding of Customer Mission Success. They plan to incorporate lessons learned from Heritage Data Product Validation by concentrating on datasets of proven valuable for global validation (e.g. ECMWF, NCEP/GFS, RAOB's), and working with experiments of opportunity for detailed characterization of products.

The teams will characterize performance of EDRs in various ensembles of cases, and leverage existing capabilities – (e.g. NESDIS operational real-time AIRS and IASI processing and validation systems and aircraft validation campaigns). They will prioritize validation as follows: validation of "First Light" spectral with model analysis or forecasts, followed by validation of key performance parameters using validated SDRs against other sensor products, operational and dedicated RAOBs, etc, inter-comparison of operational products (from IDPS) with research products generated by heritage algorithms, and finally the characterization of all EDR products and long-term demonstration of performance against operational and dedicated in situ observations.

Summary
Substantial progress has been made in the instrument, ground system, and NPP spacecraft development and testing.

The test program will present additional challenges, which are expected in this phase of development. The planning for intensive Cal/Val is underway. NPOESS on track to deliver key weather and climate data.

5.13 Russia *(Budarkin, Panfilov, Sapritsky)*

No report was provided at this time, since no major developments have occurred since WGCV28.

5.14 USGS *(Gyanesh Chander and Greg Stensaas)*

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

USGS Archive Overview

Through May 31, 2008, ETM+ data from Landsat 7 has 830,440 scenes, 771 TB RCC and L0Ra data. The archive grows by 260 GB daily. TM data for Landsat 4 &5 have 745,235 scenes, 373 TB of RCC and L0Ra data. The archive Grows by 40 GB daily. MSS (Landsat 1 through 5) has 652,174 scenes, for 20 TB of data total.

The USGS archive also contains Land Processes DAAC, Long Term Archive, and commercial Remote Sensing archive (ASTER, MODIS, EO-1, ResourceSat, hi-res satellites, aerial film, other satellite instruments, digital aerial datasets, LiDAR).

Landsat 7 Mission Status

Landsat 7 has been on orbit for 9 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 5 Mission Status

Launched on 1 March 1984**,** Landsat 5 has been on orbit for 25 years, although designed for only 3 year mission life. The spacecraft had a battery 2 anomaly in October, 2007 and a star tracer issue in June of 2007. The solar array issues were resolved and since August 2006 operations are normal. The TM sensor is functioning normally in a bumper-mode. Landsat-5 has exceeded 130,000 orbits!

Landsat 7 ETM+ Calibration Update

The band-to-band registration has been typically 0.05 pixels or better in line and scan direction (excluding band 6). The switch to bumper mode disrupted ETM+ sensor alignment calibration and degraded it's geodetic accuracy - pre-switch there were 97% scenes with better than 50 meters RMSE, while post-switch only 65% scenes had better than 50 meters RMSE. The relative detector-to-detector normalization, i.e., striping is less than ± 0.1%. The absolute radiometric accuracy is better than ± 5% (reflective) and 1 K (thermal). The noise has been stable over the mission life. The SLC failure had no significant impact on L7 ETM+ and the reflective band radiometry continues to be excellent.

Landsat 5 TM Calibration Update

Within-band within-scene internal stability: The scan-correlated shift (SCS) is up to 0.7 DN, but it is correctable with scan line-by-scan line background subtraction. The memory effect is currently up to 4 DN, and is corrected in the NLAPS processing. So me of the banding and striping issues remain to be resolved.

Between-date stability: There is an interference cycling caused from icing on B5 and B7. It is correctable with IC processing or LUT that includes interference cycling.

Radiometric calibration processing: Uses Gain Calibration History stored in Look-Up Table; Extracts and applies biases on a scan line by scan line basis, A scene is rescaled to Fixed Radiance Range (LMIN, LMAX). The look-up table was revised on April 2, 2007 to reflect the revised trends from Sahara desert site data obtained from ESA.

Landsat Web-enabled Data Pilot

As of June 4 2007, the USGS will be releasing selected Landsat 7 image data (SLC-off, 2003 to present, < 20% cloud cover image data) of the United States (only) 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. The following recipe was recommended by LST for the Web-enabled LDCM pilot project and for Global Land Survey dataset: pixel size 15m/30m/60m, media type Download (no cost) or CD/DVD ($50), product type: L1T (terrain-corrected), output format GeoTIFF, map projection UTM, orientation North up, re-sampling Cubic convolution.

Landsat L1T Data Released @ No Cost
All Landsat 7 L1T data has been released at no cost to the users. The data is pre-processed US coverage with <20% cloud cover during growing season. The remaining data is available by request. Once requested, the data is processed to L1T and made available on-line to all users. L1T "standard recipe" is the only format available as free download. Other products such as L0Rp are not available via on-demand processing.

The entire collection of Landsat data will be released as L1T in December 2008. The plan is to pre-process some data prior to release All new data will have <20% cloud cover automatically. This is the same operations concept as Landsat 7. Other products such as L0Rp are not available via on-demand processing.

Landsat data are desired where other coverage exists. International participation is strongly desired to help augment gaps in Landsat coverage, provide data coverage for participating agency ground station footprints, and intensify regional collection of multi-sensor data. Landsat is currently the primary data source and represent the U.S. contribution to the international effort. We intend to pursue international participation through the CEOS LSI Constellation Study Team.

OLI Maintains Landsat Legacy
In January 09, 2007 NASA released Request For Proposals (RFP) for an Operational Land Imager (OLI). On Feb. 23, 2007 the proposals were received and the OLI contract was awarded to Ball Aerospace in July 2007. Since the contract award numerous subsystem peer reviews have been conducted. A successful Instrument Systems Requirements Review was completed. An Instrument Integrated Baseline Review was successfully completed, which formally baselines the plan for building the instrument. The flight optics, filters, detectors, and optical bench are in various phases of design and production. NASA successfully fended off a protest of the OLI award to Ball, without impact on the OLI development schedule. There is an on-going Requirements Optimization Exercise, which maximizes the probability of maintaining 39 month OLI development schedule.

Landsat Science Team
USGS is co-chairing and funding the Landsat Science Team. The 1st Science Team meeting was held in January 9-11, 2007; the 2nd June 12-14, 2007, the 3rd January 8-10, 2008, and the 4th on July 17, 2008.. The Science Team is funded to conduct research and provide feedback to the LDCM in the following areas: applied research in natural resource monitoring and algorithm development, participation in ground system requirements reviews, definition of product specifications, development of LTAP-8, instrument engineering, communications, outreach and policy recommendations.

Lessons from PI Presentations
Overall, there is clear value in a consistent time series, including access to the full Landsat archive (US and global), with a need for increased temporal frequency. There is strong evidence of the necessity for SWIR and growing evidence of TIR usefulness. Experimental results show potential value of aerosol blue band for water resources applications. Landsat offers high level of geometric and radiometric consistency, and the consistent calibration of all bands aids science and applications. Improved signal to noise performance and > 8 bit quantization will improve analytical results.

LDCM-Related LST Outcomes
LDCM development progress is encouraging. USGS is making progress on LTAP-8. There has been a positive response to cloud assessment investigation. The next steps should probably include cloud shadow masking and assessing the role of the cirrus band. The LDCM development concerns are launch delays and the impact of TIRS, and the absence of a surface reflectance product requirement.

LDCM Standard L1T
The parameters are based on consistency with heritage Landsat products. These Standard Product Characteristics are: TOA reflectance, precision and terrain correction, 16-bits for each OLI band, 16-bit QC band (cloud, shadow, land, water, snow/ice, invalid data, etc.). The data should be generated for all globally acquired OLI data that can be processed to meet product specifications. Any reprocessing should be driven by algorithm, software, and/or calibration parameter file (CPF) and bias parameter file (BPF) updates.

Landsat Cross-calibration Activities
The planned Cross-calibration Activities include L7 ETM+/L5 TM with: Cartosat-2, CBERS-2B, DMC, GEOEYE, MODIS, RapidEye, ResourceSat, SPOT, Worldview, digital aerial camera. There will be presentations at Joint Agency

Commercial Imagery Evaluation (JACIE) Workshop, 31 March–April 2, 2009. See the Web site http://calval.cr.usgs.gov/ for more information.

Session 2: CEOS/IP - Data quality assurance strategy for GEOSS

1. GEO-CEOS Quality Assurance, Calibration and Validation *(Lecomte/Greening)*

Lecomte and Greening presented an overview and summary of results from the GEO/CEOS Cal/Val Workshop and the developed GEO-CEOS Quality Assurance Strategy for Satellite Calibration and Validation

Data Quality Assurance for GEO Task DA-06-02

Data Quality

All data and derived products must have associated with them a Quality Indicator (QI) based on documented quantitative assessment of its traceability to community agreed reference standards. This requires all steps in the data and product delivery chain (collection, archiving, processing and dissemination) to be documented with evidence of their traceability.

Traceability is a property of a measurement result relating the result to a stated metrological reference through an unbroken chain of calibrations of a measuring system or comparisons, each contributing to the stated measurement uncertainty (ISO guide 99:2007).

The data quality guidelines are generic in scope to cover all data-related "activities". They provide guidance (and indicative templates) on how to establish a QI and the means to obtain and document associated evidence. These include content/writing of a "procedure", validating models and algorithms, selecting "reference standards", evaluating uncertainties, organising and analysing comparisons, and evidence of traceability.

Data Quality Guidelines

QA4EO-CEOS-GEN-DQK-001: A guide to establishing a Quality Indicator on a satellite sensor derived data product.
Used in the translation of "Guiding principle" which underpins the philosophy of QA4EO data quality.

QA4EO-CEOS-GEN-DQK-002: A guide to content of a documentary procedure to meet the Quality Assurance (QA) requirements of CEOS. Procedural template / "checklist" to aid the harmonised collection and presentation of data to achieve the requirements of DQK-001.

QA4EO-CEOS-GEN-DQK-003: A guide to "reference standards" in support of Quality Assurance requirements of QA4EO.

QA4EO-CEOS-GEN-DQK-004: A guide to comparisons – organisation, operation and analysis to establish measurement equivalence to underpin the Quality Assurance requirements of QA4EO.

QA4EO-CEOS-GEN-DQK-005: A guide to establishing validated models, algorithms and software to underpin the Quality Assurance requirements of QA4EO.

QA4EO-CEOS-GEN-DQK-006: A guide to expression of uncertainty of measurements.

QA4EO-CEOS-GEN-DQK-007: A guide to establishing quantitative evidence of traceability to underpin the Quality Assurance requirements of QA4EO.

Data Quality: Implementation

Following the key guidelines within QA4EO should allow all stakeholders to have confidence in any assigned Quality Indicator (QI). Where appropriate, sensor- or application- specific guidelines/procedures may be endorsed by CEOS on behalf of the community to facilitate harmonisation. The structure / content of these additional guidelines should follow that of the Key guidelines. Ideally, these should be based on agreed "mature" best practise. These are not necessarily unique. These guidelines should be "peer reviewed" and endorsement through CEOS WGCV sub-groups

Individual agencies will be responsible for implementation in their "domain of influence" although CEOS WGCV will provide technical support and a forum for ensuring inter-agency consistency. The key requirement is "documented evidence and quantification of traceability to an agreed reference". Evolution of guidelines as a result of feedback and to encompass full GEOSS community.

Guideline DQK-003: Reference Standards

This guideline provides definitions of types of standard and uses of artefacts, natural sites, and data sets. It defines the requirements of standards that need to be considered, and offers a template to guide collection and provision of information. It requires a listing to be established and maintained via portal, and needs an endorsement process (CEOS WGCV).

Guideline DQK-004: Comparisons

This guideline provides pro-forma for organisation, analysis, and reporting based on that used by National Standards labs. These must be "blind", they must have uncertainties, the participants must have an opportunity to review peers before seeing results, they must be published (no withdrawals) but can be repeated, and they are encouragement of open and inclusive participation. CEOS WGCV and sub-groups are to provide a framework for approval of results. Thee guidelines are provided as an example "protocol" and analysis.

Guidelines DQK-005 and 006: Uncertainties and Models, Algorithms and Software
QA4EO guidelines serve as a pointer to other existing guidelines. Both provide a brief outline summary of the content of the existing guidelines. These guidelines need EO targeted case studies and training to aid community understanding particularly in guideline 6 (highlighted in peer review).

Guideline DQK-007: "Establishing Evidence"
This guideline provides a summary of the overall requirement. It proposes that comparisons are "key" but can be used in "sampling" mode and test aggregates not everything. This guideline is a place holder and pointer for the community to define "satisfactory evidence". It provides a framework to encourage how this evidence will be defined, agreed and made visible to the community. This guideline needs work to refine "implied linked content" and is focus for effort during implementation phase, and it needs infrastructure to facilitate practical implementation.

2. GEO Task DA-07-01 *(Jan-Peter Muller)*

GEO Task DA-07-01 : Global DEM Inter-Operability
The objectives of this task are to facilitate interoperability among Digital Elevation Model (DEM) data sets. The end goal is to produce a global, coordinated and integrated DEM. This global DEM should be embedded into a consistent, high accuracy, and long term stable geodetic reference frame for Earth observation. This activity shall also include coastal zone bathymetric maps in shallow waters (~30-40 m), DEMs of DTED1-class (3", ≈90m), now updated to DTED2 (1", ≈30m) for the generation of topographic maps and land use/land cover maps at scale 1/50,000 or 1/100,000.

The specific tasks include requesting input from system operators and data users (GEO members or participating organizations) regarding their experience on interoperability. Compiling a list of current DEM data and its specifications. Based on the above results, develop the first "GEOSS Interoperability Guidance on DEM data". The first draft of this was completed in May 08, and the second draft in August 2008. This document is to be submitted for review to the GEO plenary (Beijing, November 2008).

Status-Overview: GEO DA-07-01: Global DEM Interoperability
A workshop on "Practical steps towards global DEM interoperability" was held on 2 July 2008 at IRSA (CAS), Beijing, China. The venue was close to Olympic stadium & ISPRS Convention Centre. At the workshop, 30 recommendations produced along with 14 action items. These are sorted by WGISS, WGCV and CEOS Plenary or GEO in what follows. Wyn Cudlip will present these at WGISS Plenary and JPM at WGCV Plenary the following week. Final Guidelines have been produced and approved by BNSC. It is not clear if BNSC will table these at GEO IV Plenary in November. If not, who should these guidelines be sent to?

ASTER 30m GDEM production has accelerated and product due to be released in April 2009. The USGS plans to send it out by the end of Sept. 2008 as a "pre-release RFP" for validation of non-conterminous US areas (inc. Alaska) for up to five 1º x 1º tiles. JPM has proposed to BNSC that there should be a major international programme of validation and gap-filling after the product is released. However, it is unclear who in the UK would pay for this given the budget problems. This is awaiting internal BNSC discussions. ASTER's 1 arc-second (≈30m) global DEM has been offered by JAXA and NASA to GEO for free, unrestricted use and global distribution in April 2009. A JAXA contractor plans to fill gaps in ASTER with SRTM. However, it is unclear how the contractor will deal with differences in resolution. BNSC have offered to support this task, but as stated previously, there do not appear to be sufficient finances to support this after the CEOS-WGCV Plenary.

POC has proposed a Global Topography Project Office to be based at UCL to co-ordinate the construction of a 30m void-filled publicly and freely available global DEM and adjoining bathymmetric data. This would include public outreach for this Global DEM and its potential applications. This would involve a coordinated international validation effort involving as many of the world's space agencies as feasible. POC will provide web-pages on project status as well as "well known product issues" as wiki. They will develop a OGC-compliant web distribution system.

The 30m bathymmetry project has started in US for area within 200 nautical miles of the US coastline (timescale currently unknown). 55 nations have submitted detailed charts to the UN Office on "Law of the Sea" of their own territories. GEO should make formal request to this UN Office for access to these data. It is still unclear how the remainder the world's coastline continental shelves will be mapped and how these data will be provided for free to this project. The RFP on limited validation of non-US areas is to be released on 30 September 2008. The ASTER GDEM matching of

1.25M scenes is due to be completed by October 2008. Stacking and averaging (including cloud removal) is due to be completed by December 2008. Gap-filling using SRTM is due to be completed in time for product release on 1 April 2009.

JPM is planning to propose a CEOS-GEO-ISPRS workshop on the ASTER GDEM project to take place as part of IGARSS09 in Cape Town, South Africa. This will include the launch of an international programme to improve the ASTER GDEM quality, complete large-scale validation, demonstrate where data is of different qualities, and launch "user report" wiki. This is all subject to BNSC funding.

GEO DA-07-01: Global DEM Interoperability: Next Steps

The GEO Secretariat is to table recommendations at upcoming GEO IV Plenary in Beijing in November 2008. WGISS and WGCV Chairs are to table recommendations at the CEOS Plenary in November 2008. We need to look for co-funding from public and private sources to meet these ambitious goals as well as seek project partners to perform most of the work. We need to encourage individual governments to set aside resources to perform validation and provide feedback to the project office to improve the product.

We should include an updated version of DA-07-01 to 2009-2011 plan to focus on data production, data dissemination techniques. This will require massive mobilisation of resources for bathymmetric data acquisition, validation of entire datasets and data dissemination. We must proselytise the value of this 30m DEM/bathymmetry dataset by showing example applications on the web and inviting the international community to provide further examples relevant to their own situation.

Outstanding Issues to Resolve

How many of the invited CEOS-GEOSS partners are willing and able to contribute height pixels to a free and unrestricted global dataset at 30m? What role will CEOS-WGISS play in promoting this GEOSS task in the context of the GDTT, Web Processing Services, provision of WMS, WCS, WFS data servers? How do we ensure that there is a similar level of effort for producing global bathymmetric data over continental shelves?

NOAA-NGDC are currently engaged in mapping extensive areas. USGS are also working in this area. However, most other such bathymmetric data sources are extremely expensive (e.g. UKHO) and subject to copyright restrictions. How does CEOS-GEOSS persuade the oceanographic community that it is in their best interests to donate such proprietary data for the 9 societal benefit areas agreed by the GEOSS ministers, especially that of natural disasters and hazards?

Summary of Actionable ACTIONs: CEOS Plenary

CEOS Plenary is recommended by WGCV and WGISS to support GEOSS task DA-07-01 through the following actions. Encourage all CEOS member space agencies who are creating global EO-DEMs to consider making these DEMs or different DEM subsets (e.g. small groups of pixels identified in ASTER GDEM as missing) publicly available through OGC-compliant servers. Encourage all CEOS member space agencies to liaise with their national mapping agency to provide DEM test sites with publicly available "ground truth" data for assessment of global EO-derived DEMs. Encourage each EO-DEM data supplier to provide web-GIS facilities for the reporting of "Known Issues" including the delineation of areas of "bad data" which can later be flagged as such and compared against and substituted by other datasets. Ensure that resources are made available so that all published DEM datasets can be re-processed if "Known Issues" identify bad data and these cannot be replaced from another source. Encourage all member agencies to develop continental-shelf bathymmetry programmes and request CEOS member agencies to encourage their relevant international and national body to make publicly available their bathymmetry heights using the mechanisms proposed for land DEM or something consistent with these principles.

Summary of Actionable ACTIONs: CEOS-WGISS (24-Feb-08) in Sanya, PR China

CEOS-WGISS is invited to contribute technology to facilitate interoperability between different global DEM datasets. To ensure that all Global DEMs are made available in OGC-compliant (WMS and WCS) formats and their URLs are easily discoverable. To agree on a common standard for the representation of WMS (e.g. ICEDS colour LUT and 30º (elevation), 330º (azimuth)). To agree on a common standard for WCS format (e.g. geotiff). To facilitate the filling in of gaps (or artifact identified regions) in ASTER GDEM from another dataset including how QC information is to be incorporated into the data fusion process. This procedure should be best incorporated within a Web Processing Service. To allow easy inter-comparison of different satellite-derived DEM datasets stored as WCS datasets including both publicly released versions and those stored in-house. To allow standard QA procedures to be fully automated so that when new "ground truth" datasets become available, existing EO-derived DEMs can be assessed. To develop "Known Issues" web facilities to allow users of global DEMs to report issues with the data including geospatial reporting (e.g. the following DEM pixels via this shapefile have been shown to be in error).

Recommendations and ACTIONs for GEO Plenary IV (Beijing, 11/08)

A workshop at IRSA on 2 July 08 was established to review status of global spaceborne DEM production, validation and dissemination. They are to decide on the best way forward to plug gaps/fill voids in global DEM products, and the most practicable method for validating DEMs including who, where and when? They need to decide how best to disseminate the 30m product worldwide. They must finalise draft recommendations contained in Guidelines on how to achieve these goals, and the actions on space agencies/national mapping agencies to meet the goals.

Recommendations and ACTIONS: Gap-Filling
Global DEM suppliers (both land and continental shelf bathymetry) should be strongly encouraged by CEOS and GEO to consider participating in a global 30m DEM project. Such a project would not only be for their mutual benefit but also to the benefit of all GEO societal benefit areas, particularly related to natural disaster mitigation. Before any void filling, voids need to be identified and the DEM statistics characterized. CEOS sponsoring agencies should ensure that resources are made available so that all published spaceborne DEM datasets can be re-processed if "Known Product Issues" identify bad data and these cannot be replaced from another source. CEOS-WGISS should encourage the development of software and infrastructure to allow easy inter-comparison of different satellite-derived DEM datasets stored as WCS datasets including both publicly released versions and those stored in-house.

CEOS and GEO member agencies should consider sponsoring the development of continental-shelf bathymmetry programme, especially those using remote sensing to provide 30m bathymmetry information on near-shore and on continental shelves. CEOS member agencies to encourage their relevant national and international bodies to make publicly available their bathymmetry heights using the mechanisms proposed for land DEM or something consistent with these principles. There is a need for a common reference frame to merge land topography and bathymetry. There is need to update coastal + bathymetry at much higher temporal frequency. Both needs are urgently required for predicting the behaviour of tsunami-generated waves. CEOS-WGISS should help facilitate the filling in of gaps (or artifact identified regions) in ASTER GDEM from another dataset. CEOS-WGCV should investigate how QC information is to be incorporated into the data fusion process. This procedure should be best incorporated within a Web Processing Service.

Recommendations and ACTIONS: Validation
All global DEM products provided for use in GEOSS societal benefit areas must be validated. Validation statistics must also be supplied with the products. There is a need to update the "best practice standards" for DEM validation and reporting DEM validation statistics in the light of the requirement to create a global DEM at 30m. Funding support is required from the relevant space agencies to develop such a standards document. DEM suppliers (both over land and continental shelf bathymetry) should be strongly encouraged by CEOS-GEO to consider participating in a validation effort for the global 30m DEM project. This could include supply of validation statistics and/or DEM and/or control data for validation.

There is a need to create and agree on a global colour LUT and hill shading parameterisation (e.g. scale specific) for the representation of global DEM elevation so that each supplier can ensure that they represent their data fairly and to allow users to compare one dataset against another. CEOS member space agencies should liaise with their national and/or regional mapping and/or hydrographic agency to provide DEM test sites with publicly available "ground truth" data for assessment of global EO-derived DEMs. If publicly available mapping and/or hydrographic data is not available, suitable licensing mechanisms should be developed for access to these data by validation scientists. Or if data cannot be distributed, a point-of-contact within the national mapping agency should be nominated who can act as a clearinghouse for DEM validation and provide standardized validation results on (a) specific test sites(s).

CEOS should encourage each EO-DEM data supplier to provide web-GIS and/or wiki facilities for the reporting of "Known Product Issues" including the delineation of areas of "bad data" which can later be flagged as such and compared against and substituted by other datasets (e.g. locating DEM pixels via a shapefile which have been shown to be in error). CEOS member agencies to provide funding support for a user support service, including a "wiki" and "web-GIS" and, above all, a moderator. An example of such a system developed for product quality assurance of MODIS land products can be viewed at http://modis-250m.nascom.nasa.gov/cgi-bin/QA_WWW/newPage.cgi?fileName=terra_issues.

NASA to provide a Web Processing Service for ICESAT-GLAS data for validation of global EO-DEM data. This would first be applied and developed for SRTM and could later on be applied to ASTER GDEM and also be used by SPOT5, ALOS-PRISM, CARTOSAT and TANDEM-X

ESA to consider developing a comparable service for Radar Altimeter and gravity data for the same applications. JAXA and other CEOS members to provide validated DEMs for sites on other continents (e.g. Africa, South America, Asia, Australasia, Antarctica). These test sites should be established over different land covers

CEOS-WGISS to allow easy inter-comparison of different satellite-derived DEM datasets served through WCS including both publicly released versions and those stored in-house CEOS-WGISS member agencies to develop suitable computing facilities to allow standard QA procedures to be fully automated so that when new "ground truth" datasets become available, existing EO-derived DEMs can be easily and very quickly assessed. CEOS member space agencies should be encouraged to fund activities to prepare validation and control data set including data derived from current and previous EO missions e.g. ICESat. This will provide globally consistent reference data.

Recommendations and ACTIONS: Dissemination
Global DEM suppliers should be encouraged to agree on a common format for data and metadata. CEOS member agencies should be encouraged to sponsor a study as to whether either Geotiff or the emerging GMLJP2 standard would be "fit for purpose" especially with regard to the storage of validation statistics and relevant metadata. CEOS member agencies should be encouraged to sponsor a study as to whether it would be better to use a single Global DEM distributor, mirrored DEM distributors or to employ new standards such as Peer-to-peer or WMS caches to ensure integrity and reliability for global DEM supplies in the future, especially when multi-TB datasets will be available. Existing Global DEM distributors should be strongly encouraged to set up WMS/WCS data servers, preferably at the same time as ftp servers are set up, with a view to making WMS the standard method to view the data and WCS the preferred method to deliver SMALL quantities of data (<100Mb?) with ftp being available for larger downloads. Pilot study or studies should be funded to investigate the best mechanisms. CEOS member space agencies who are creating global EO-DEMs should consider making these DEMs or different DEM subsets (e.g. small groups of pixels identified in ASTER GDEM as missing) publicly available through OGC-compliant servers. JAXA and NASA have shown the way forward with the proposed global ASTER GDEM but encouragement needs to be provided by CEOS and GEO to SPOT Image (via CNES), DLR (for SRTM-X and TerraSAR-TANDEM-X) and ISRO (for CartoSAT) to participate in providing data subsets to this GEO task. CEOS-WGISS is to ensure that all Global DEMs WMS/WCS server URLs are easily discoverable.

3. Accuracy Assessment of Pre-Flight Radiometric Calibrations Using the Sun as a Source *(Thome)*

Kurtis J. Thome, Remote Sensing Group, University of Arizona, Tucson, AZ

Introduction
Multiple methods are required to provide accurate and traceable radiometric and spectral calibration, including intercomparison between sensors and climate data records. The sun can be used as a preflight calibration source allowing sensor intercomparison.

Radiometric Calibration
For source-based radiometric calibration, preflight and inflight calibration require sources of known output, including blackbodies in the thermal emissive and lamps and sphere sources in reflective. Cross-calibration requires moving the sources from place to place.

For solar-based calibration, the sun provides a constant source with identical spectral output anywhere on the earth. The sun can be used as a source both preflight and in flight. It can be used with direct views on ground and space, and with diffusers on orbit. It is also feasible to use diffusers on the ground.

Solar Approaches - Direct View
Direct solar view approach points the instrument at the sun and collects transmitted solar irradiance. The irradiance on the sensor [W/m2] depends on the incident irradiance (sun angle and earth-sun distance effects) and the atmospheric transmittance.

Direct view is used primarily to determine the solar "constant" and determine atmospheric composition. It can also be used in satellite-based measurements of the solar irradiance versus time. The data have been forced to match through comparisons. This system used model-based atmospheric transmittance versus wavelength.

Solar Approaches – Diffuser
Use of a solar diffuser allows sunlight to be used as an extended source. The sun can be well-approximated by a point source, but the imaging systems require an extended source. This is analogous to using a spherical integrating source with a lamp. The radiance on the sensor [W/(m2 sr)] depends on atmospheric transmittance, incident solar irradiance, and panel reflectance.

Skylight can be removed by a shadowing system and differencing diffuse and global. Diffuse light can be ignored by characterizing the total energy from the diffuser using calibrated radiometers

Solar Approaches – Transfer to Orbit

Sensors with on-board diffusers can be calibrated relative to the solar beam preflight. This was first done for SeaWiFS. The approach is identical to diffuser approach, where you use a know conversion to radiance. The system output is converted to that expected on orbit after correction for atmosphere.

Solar Approaches – Traceability
Intercomparison between sensors requires traceable approaches and known uncertainties. The direct solar approach has traceability (to NIST) via the solar model that is chosen. The requirements are standards of spectral irradiance and electrical substitution radiometers. The diffuser approach has traceability through reflectance standards. The transfer to orbit scheme has no traceability in traditional sense. Characterization of the reflected radiance in the diffuser case has traceability to standards of spectral irradiance

Uncertainties - Direct Solar
Errors in the direct solar approach are dominated by solar model and transmittance knowledge. Errors from airmass (solar angle) uncertainty are minimal as long as you keep solar zenith angles <60 degrees, and know the time to better than 1 second. This solar model leads to an absolute error but can be cancelled in comparisons between sensors. Transmittance error is both in precision and "absolute". The instrument variations typically an order of magnitude smaller than atmospheric changes. The solar radiometer can be calibrated to better than 0.3%. Two solar radiometers calibrated under similar conditions agree to better than 0.005 in optical depth. The differences are 0.01 to 0.02 in optical depth between two independent radiometers (<2% in transmittance).

Not discussed at this point is that the transmittance is measured as a function of wavelength. The direct solar approach relies on a aerosol model to convert from multispectral to hyperspectral. Optical depth uncertainties lead to errors in aerosol model. Pathological case of optical depth error of -0.02 at 450 nm and +0.01 at 850 nm. The largest errors are in transmittance, -5% at longest wavelengths in SWIR and 5% at 350 nm. Random error gives 2% transmittance error at shortest wavelength and 1% error opposite sign at longest.

Uncertainties – Diffuser Approach
For the diffuser approach, errors are same as for direct solar approach with added uncertainty from reflectance characterization. Errors in measuring reflectance of diffuser panels can approach a 1% uncertainty (all errors are 1). Minimal errors are caused by knowledge of view direction and incident direction. Combine reflectance creates uncertainty. Direct solar irradiance also had uncertainty, including the ever-popular root-sum-square, 2.2% at wavelengths in the blue, and 1.4% in the SWIR. The diffuser approach assumes diffuse-light effects and forward scatter are correct. Uncertainties have been "verified" through multiple calibrations of UofA transfer radiometers.

Uncertainties – Direct Characterization
The direct characterization approach measure the at-sensor radiance using a well-calibrated radiometer. Transfer radiometer uncertainties are <2% in the VNIR, and larger uncertainties exist in the SWIR. Additional error is caused by interpolating from transfer radiometer bands. We need to account for atmospheric variations. The proper selection of spectral bands limits errors. It may not be better to use a hyperspectral sensor.

Uncertainties – Transfer to Orbit
Transfer-to-orbit uncertainties will be similar in value to those of the direct solar. This method is relative to the solar model.

Typical solar radiometer errors as described previously lead to optical depth errors are ±0.02 at 450 nm and ±0.01 at 850 nm, 2% error at shortest wavelength, and 1% error opposite sign at longest wavelength. Correlation is the biggest issue that requires further study.

Conclusions
All of the methods described here are suitable with absolute uncertainty <3%. Errors are largest at the shortest wavelengths. Atmospheric effects have the largest uncertainties in blue. Laboratory calibrations also have the largest uncertainties in the blue (low lamp output). Absolute uncertainties are slightly larger than those in the laboratory. Direct characterization with transfer radiometers gives only slightly larger errors. The diffuser approaches require accurate diffuser characterization. The biggest advantage is the sun shines brightly the same everywhere (at least that's the conclusion from Arizona).

4. GEO Task DA-06-02, Dome C Calibration Experiment *(Jing & Cao, NOAA)*

Dome C Calibration Experiment: - Basic Questions

Assuming the snow reflectance is stable long-term at Dome C, and the atmospheric effect is small, can this site be used for accurate cross calibration for sensors? How well can we do with the Dome C site (how low can the uncertainty be)? What will it take to make Dome C calibration SI traceable?

Datasets used in the Dome C Study

With dedicated lunar calibration, SeaWiFS is one of the most stable instruments (uncertainty < 1% per 8 years) that can potentially meet the climate change detection requirement. MODIS is stable with absolute calibration accuracy ± 2% (mission requirement). AVHRR relies on vicarious calibration. Hyperion is most useful in resolving the spectral differences. Thuillier 2002 solar irradiance can be used to assess the Esun values from different instruments (Esun: in-band solar spectral irradiance; W m^{-2} um^{-1}).

Results

Preliminary findings were presented at WGCV28. More results were presented at the IGARSS in July, 2008. The current report focuses on the latest findings with SeaWiFS observations at Dome C, the Hyperion Dome C analysis, and the solar irradiance analysis.

Resolving the Reflectance Value Differences

There are several possible causes for the differences seen in reflectances. An example of this is that SeaWiFS reflectance is a few percent lower than that of MODIS at SZA=60°. We have tried convolving Hyperion radiance at Dome C with the SRFs of MODIS and SeaWiFS. We have also used the MODTRAN simulation (a radiative transfer model) and the Esun value solar irradiance analysis with Thuillier 2002.

Summary

Preliminary Dome C analysis with SeaWiFS observations has been performed at NOAA. Assuming SeaWiFS is stable, the Dome C site stability is found to be promising. Differences between SeaWiFS and MODIS reflectance values need to be resolved. Further study on the BRDF effect is needed.

5. SIT Status Report *(Killough)*

Brian Killough, CEOS SEO

CEOS SIT-22 Pre-Meetings
Tuesday, September 16 2008

LSI Constellation Study Team reported that WGISS is leading the development of an LSI web portal (Lyn Oleson). The demo of LSI portal is planned for GEO-5 (Bucharest) and CEOS Plenary (George, South Africa). SEO is leading the development of an LSI standards document. The GCOS Climate Actions/UNFCCC Planning report as given, including the CEOS Climate SBA (Mitch Goldberg) & GCOS Secretariat (Stephen Bojinski). The CEOS Coordination of SAR for GEO Task on Forest Carbon Tracking report was presented, as was the CEOS/Commercial Sector Interactions report.

Wednesday, September 17, 2008

A report was presented on the Data Democracy Initiative, by the CSIR 2008 Plenary Chair. South Africa is receiving multiple satellite data streams. GISTDA/Thailand is planning to continue this initiative (Plenary Chair in 2009). Group reports were presented, including the various working groups, the constellations group, and the SBAs. The constellations process paper has been agreed on, the ocean color radiometer constellation has approved, and the ocean surface vector winds constellation has been approved.

Thursday, September 18, 2008

CEOS will put out a report highlighting accomplishments for GEO-5 Plenary. The Bucharest Demo Task Team has been defined (LSI Portal Demo). SEO and CEO will register agency data sets prior to GEO-5 (ref: CEOS actions). CEOS is defining and addressing observational gaps. SIT/CEO is to host 2nd CEOS/GEO Actions Meeting in early 2009. SEO will developing a system requirements database for gap assessments. This includes mission and measurement data (EO Handbook) and GEO content.

The GEO Data Sharing Principles presentation talked about the 2nd Seminar on Space-based Observations for Climate Change. This session followed the CEOS SIT meeting. There were presentations by Dr. Furikawa (JAXA), Jose

Achache (GEO), Stephen Bojinski (GCOS), Mary Kicza (NOAA, CEOS SIT Chair), Mike Freilich (NASA), and Stephen Briggs (ESA).

CEOS Website Status
The SIT Team (NOAA lead) will take over the responsibility of hosting the CEOS website. This was previously managed by JAXA and NASA. This responsibility will rotate with future SIT leadership. Support will be provided by the CEO and SEO. The new proposed website has been developed by the SEO (NASA) and temporarily hosted on the WGISS server. Much of the old CEOS content has been replicated and updated on the new site, along with new content for Constellations. The CEOS SIT team would like feedback from the CEOS users by October 18 to make a decision about using this approach at the CEOS Plenary. If approved, the new CEOS website would replace the old website after the CEOS Plenary Meeting in November. Until that time, the existing CEOS website (www.ceos.org) is still available and the "official" CEOS website.

New Proposed CEOS Website
The website utilizes a Content Management System (CMS) approach called "Joomla". The "Joomla" approach requires less administrative burden and allows content modification by select users. The new site has improved access to CEOS content, direct links to Actions, GEO, and the CEOS calendar and provides needed content for Constellations.
http://wgiss.ceos.org/ceos/joomla/

6. SEO Activity Report *(Killough)*

Brian Killough, CEOS SEO

What is the SEO?
The Committee on Earth Observation Satellites (CEOS) Systems Engineering Office (SEO) was established in April 2007 to provide system engineering leadership and facilitate the development of CEOS global space constellation plans. The SEO technical tasks include requirements definition, gap assessments, architecture development and the development of technical decision support tools. The SEO management tasks include fostering communication among CEOS partners by coordinating and participating in CEOS meetings, developing management tools for more efficient and effective operation (action tracking and enhanced website), and developing visualization products for educating the global Earth Observation community about CEOS.

2008 Task Summary
As part of the Systems Analysis task, a system requirements database tool for requirement definition, gap assessments, and architecture planning was developed. Also, preliminary gap analyses for ACC Constellations, Energy SBA and Climate SBA was performed. Task personnel managed a subcontract with Rutherford Appleton Lab (RAL) to develop a detailed Atmospheric Composition gap analysis for the CEOS ACC Team. The development of a "Standards Document" for Land Surface Imaging in support of the CEOS LSI Constellation Team was also initiated. Conducting a mid-resolution surface imaging gap analysis to support the LSI Constellation. Efforts to consider cloud constraints on measurements were expanded.

To enhance communications, a web-based tool for documenting and tracking CEOS actions was developed. Task personnel led a NASA/NOAA team to revise the CEOS website to include new constellation content and enhanced functionality for users. We also supported the planning of the 3rd ACC Workshop at GISS in October 2008, and engaged with CEOS Working Groups (WGCV, WGISS, and WGEdu) to develop appropriate tasks and perform analyses in support of CEOS objectives.

Systems Requirements Database
The purpose of this database us to capture the space-based measurement requirements driven by science, applications, and decision makers and compare them with the space-based measurement capabilities of CEOS to determine measurement and time gaps and to identify potential collaborative opportunities for CEOS.

The approach used was to develop a database tool in MS-ACCESS and MS-SQL, hosted by the SEO. Future migration to a web-based tool linked to the CEOS website. This system uses pre-defined and user-defined queries and reports supporting the GEO Communities of Practice, CEOS Constellations, CEOS SIT leadership, and CEOS agencies. It supplies EXCEL-formatted downloads for user analyses, and graphical output for viewing reports.

In the future, data content development and authentication is required by GEO and CEOS. Integration with the EO Handbook update process (ESA) will also be added.

ACC Constellation Gap Analysis

Mission count summary shows potential gaps in several areas that are consistent with the detailed analysis results in the detailed RAL analysis. Similar gaps include BrO, ClO, HCl, CH4, CO2, N2O, NO2, and H2O.

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-29 a number of new action items were generated, in addition to the action items remaining open from previous WGCV meetings, as listed in the following table.

WGCV26-1	WGCV Secretariat to maintain a "WGCV suggested cal/val practices" web page as depository for the materials generated by WGCV. The materials will be transferred to the Cal/Val Portal when appropriate.	Ongoing (the central panel on the WGCV web page)
WGCV27-1	WGCV Subgroup Chairs (SG) to review with the SG members the list of GEO tasks in which WGCV is participating (WGCV Sec. to distribute updates as they become available), and to generate a summary of the activities in which the members are participating, relevant to the listed GEO tasks.	Ongoing
WGCV27-2	WGCV Secretariat, to contact the CEOS constellation leads and request that the constellation teams evaluate their cal/val requirements and offer WGCV support.	Ongoing
WGCV29-1a	***Regarding "Dome C, Phase 2 Instrument Inter-comparison":*** IVOS (Nigel Fox) develop **protocols** for instrument inter-comparison and notify participating agencies (ESA, NASA, NOAA, CSA, and SG chairs).	November/December, 2008 completed
WGCV29 – 1b	***Regarding "Dome C, Phase 2 Instrument Inter-comparison":*** Participating CEOS agencies collect satellite data over Dome C in the December/January timeframe. WGCV/IVOS (Nigel Fox) to coordinate.	December 08-January 09 timeframe
WGCV29-2	***Regarding the "Miami Instrument Inter-comparison":*** IVOS (Nigel Fox) provide to CEOS/SIT (Brent Smith): Cover letter of relevance to CEOS, Unsolicited Proposal, Itemized budget and Budget Justification. They are to be forwarded to NASA (Chris Blackerby), NOAA (Mary Kiza, Brent Smith) and USGS to request support.	December 2008 completed
WGCV29-3	Peter Muller (TMSG), to send the Global DEM guidelines to Ivan Petiteville (CEOS/SIT), and to WGCV/Sec. to post on the WGCV web site.	October 3 completed
WGCV29-4	WGCV Chairs present QA4EO at CEOS plenary.	November 2008 completed
WGCV29-5	WGCV chairs explore / establish with CEOS and WGCV member agencies an international capability for funding cal/val campaigns. This is to facilitate the Miami and future cal/val campaigns.	2008/2009
WGCV29-6	CRESDA (Xiaolong Dong) potentially HJ-1 A provide to Cao, Ungar, Campbell and Thome sample high spectral resolution satellite data over, for select cal/val sites, including: Dome C, Antarctica; Dunhuang and Chang Bay Shan, China; Greenbelt, MD, USA; and Libyan desert.	WGCV30
WGCV29-7	Pascal Lecomte, inquire with Christopher Buck – MWSG chair, about Xiaolong Dong becoming a Co-chair for the group.	Completed.
WGCV29-8	CNES (Patrice Henry) provide a report on BRDF for Dome C and Desert sites to WGCV.	WGCV30

WGCV29-9	WGCV members – agencies contribute to the cal/val portal information regarding the test sites characterization. List of sites to be made available on cal/val portal .	WGCV30
WGCV29-10	WGCV, WGISS and LSI – put together a study to achieve a coordinated quality index for land cover products.	WGCV30
TBDs: Below are listed *"future"* action items which are not ready yet. Keep in mind and follow up with Martha Maiden and the WGCV members.		
WGCV29-11	WGISS and WGCV work jointly to establish a mechanism for making data available for test sites - WGCISS and WGCV extracts for future cal/val and LPV sites, considering the metadata and assoc. guidelines.	TBD
WGCV29-12	WGCV and WGISS chairs to determine the mechanism for extracts for sites, considering the metadata and associated guidelines.	TBD

2. Recommendations to CEOS

WGCV29 Recommendation to CEOS Plenary

Recommendation 1
It is recommended that CEOS endorse the guidelines adopted by WGCV for Quality Assurance for Earth Observation (QA4EO).

Background: The guidelines are required for GEO Task DA-06-02 and serve as a basis for data inter-operability for generating long term satellite records.

Recommendation 2
CEOS advises the member agencies operating optical imagers, microwave sounders and radar systems, to acquire contemporaneously data over Dome C site during the January – February 2009 time frame. It is requested that for planning and coordination purposes, the agencies express their intent to participate by sending a letter to the WGCV chair, designating a contact person for the activity by the end of December.

Specific protocol of procedures, site coordinates and a timeframe are to be posted on the Cal/Val portal by the end of December 2008 and sent to the agencies that have stated intent to participate. Intent to participate has been already stated by CNES, CSA (SAR), ESA, NASA and NOAA.

Background: In support of GEO constellations and GEO task DA-06-02 and QA4EO, WGCV has scheduled for the January-February timeframe an instrument inter-comparison, using contemporaneously acquired satellite data over the same location/site. The objective is to determine the characteristics of Dome Concordia, Antarctica (Dome C site) for instrument inter-comparisons. Dome C site is to serve as basis for instrument-intercomparisons, when establishing long term stability records.

Recommendation 3
Background: GEOSS and CEOS recognize the importance of digital elevation models (DEMs) for GEO societal benefit areas and the downstream earth observing data services, and welcome the substantial progress made in recent years towards the provision of a global 30m Digital Elevation Model (DEM), although there are still deficiencies in coverage and in validation data.

Therefore, CEOS recommends that member agencies cooperate in the completion of a gap-free and validated DEM, in the June 2010 - June 2011 time frame, a key for the success of GEO task DA-07-01 *"Guidelines on Global DEM inter-operability"*.

This global DEM should include heights at 30m spacing over land based primarily on existing proven G-DEMs, such as that based on data from the ASTER sensor and for bathymetry down to depths of 30-40m on continental shelves including the production of a much more accurate coastline especially in the Arctic region.

Recommendation 4
CEOS agencies, operating global middle resolution optical sensors (~30m, Landsat – like), such as CBERS (China and Brazil) and IRS P6 (India), to provide selected scenes and associated sensor characterization for the generation of 2010 global land cover dataset, which will be generated by NASA and distributed free of charge to the community.

Recommendation 5 (ACSG, Bojan Bojkov)

Background/Problem: Air quality is an increasing priority with the space agencies (e.g. ESA, NASA, and NOAA) and has clear Societal Benefits. ACSG, e. g. Envisat-Sciamachy, Aura-OMI, MetOp-GOME/2 are already measuring many key tropospheric air quality constituents (NO2, HCHO, CHOCHO, SO2, etc.). There are however serious limitations in the validation capabilities. In-situ measurements (from established networks) are not necessarily suitable for validation and/or are very difficult to interpret. A ground-based remote sensing effort is planed to quantify instruments and algorithms.
Recommendation:

CEOS, to encourage satellite agencies (esp. NASA and NOAA) to participate in the air quality ground instrument inter-comparison. The campaign is planned for the Summer of 2009.

Action:
NASA reps.: Maiden, Gutman to inform the appropriate NASA HQ official (? TBD).

Recommendation Draft (draft for future work and consideration)
(This is a working draft, modified by Carol, needs input from Karen St. Germain, NOAA)
Background: GEOSS[1] and CEOS recognize that all spectroradiometric-based results from both operational and research Earth-observing radiometric satellites in the reflected solar and thermal emitted spectral regions[2] are strongly dependent on accurate and timely (e.g., simultaneous with satellite overpasses) *in situ* data sets for the purpose of vicarious calibration (as in ocean color), validation of data products, evaluation of sensor biases, and investigations of satellite sensor performance. However, the existence of these necessary measurement campaigns and/or *in situ* networks is not guaranteed as the respective satellite programs are generally not authorized to fund calibration or validation activities, which includes the long term maintenance of a continuous data set with established traceability.

CEOS advises the member agencies operating Earth-observing satellite sensors[3] to implement, by adequate and proper allocation of resources, the establishment of cal/val activities at the time of mission concept. CEOS also advises the member agencies of the long term and fundamental nature of such activities, with the consequence that these in situ programs must be maintained continuously into the future.

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[1] Not sure if GEOSS should be here.

[2] I am not well versed enough in all the subgroup disciplines to know if cal/val data is an absolute necessity for SAR, atmospheric correction, active vs passive remote sensing, etc, & I defer to those subgroup chairs. My perspective is primarily IVOS.

[3] Here we could spell out exactly what: imagers, spectroradiometers, atmospheric sounders, microwave sounders, radar systems, etc…..

Annex A: CEOS/WGCV 29 Agenda

Dates: ***September 30-October 3, 2008***[†] *Location:* ***Avignon, France*** *Hosted by* ***INRA and CNES***

<u>Day 1: Tuesday, Sept. 30, 2008</u>

Session 1: Welcome and Introduction

8:30 *Registration*

9:00 **Introduction and Adoption of the WGCV-29 Agenda** *(Cao, 10 min.)*
Welcome and Introduction *(Baret, 10 min.)*
INRA Avignon activities for environment with remote sensing *(Baret, 20 min.)*
France satellite programs *(Henry, 20 min.)*

10:00 *Break* *(30 min.)*

Session 2: WGCV Reporting

10:30 WGCV Chair Report *(Cao, WGCV Chair)*
Minutes from WGCV28 and Status of Current Action Items *(Campbell, WGCV Secretariat)*

11:20 ***Session 2.1 WGCV Subgroup Reports*** *(Chairs: Lecomte, Cao; 30 min each)*
Infrared and Visible Optical Sensors *(Fox)*
Atmospheric composition *(Bojkov)*
SAR *(Srivastava)*

1:00 – 2:00 *Lunch*

Session 3: CEOS 2008 Actions – Progress report and deliverables

Session 3.1 Data quality assurance strategy for GEOSS (Lecomte, Greening)

This session addresses the GEO task DA-06-02: Developing data quality assurance strategy for GEOSS

2:00 GEO/CEOS Cal/Val Workshop Report
Deliverable: Key Guideline Document for Data Quality Assurance for GEO (QA4EO)
Future tasks under GEO DA-06-02

4:30 *Break (10 min.)*

4:40 Accuracy assessment of pre-flight radiometric calibrations using the sun as a source *(Dr. Kurtis J. Thome)*

5:10 SIT Status Report *(Killough)*

5:40 *Adjourn*

Day 2, Wednesday, Oct. 1, 2008

9:00am

Session 2 continued

Session 2.1 WGCV Subgroup Reports and Country and Agency Reports *(Chairs: Lecomte, Cao)*

Canada *(Srivastava)*

Terrain mapping *(Muller)*

GEO Task DA-07-01: Discussion of key issues, recommendations and action items *(Muller)*

Note: LPV will report in the special session

10:10 *Break (15 min.)*

Session 2.2: WGCV Country and Agency Reports *(Chairs: Cao, Lecomte)*

10:25 China *(Dong)*
10:45 CNES *(Henry)*
11:05 ESA *(Lecomte)*
11:25 Calibration Test Sites Selection and Characterisation, ESA *(Berthelot)*
11:40 IRSA/CAS *(Gu)*
12:00 INPE *(Fonseca & Ponzoni, Brazil)*
12:30 NPOESS Integrated Program Office (IPO) *(Dr. Karen St. Germain)*

1:00 - 2:00 *Lunch*

Session 2.2: WGCV Country and Agency Reports *(Continued, Chairs: Cao and Lecomte)*

2:00 JRC *(Widlowski)*
2:20 DMCii *(Mackin)*
2:40 NASA *(Gutman)*
3:10 NIST *(Johnson)*
3:30 NOAA *(Cao)*

3:50 *Break (20 min)*

Session 2.2: WGCV Country and Agency Reports *(Continued, Chairs: Cao and Lecomte)*

4:10 Russia *(Burdakin, Panfilov, Sapritsky)*
4:30 USGS *(Dwyer/Stensaas/Chander)*
4:50 NPL *(Fox)*
5:10 SEO Status Report (Killough/Cecil)

*5:40** *Adjourn*

8:00pm Dinner in a restaurant in Avignon hosted by CNES and INRA

Day 3, Thursday, Oct. 2, 2008

Session 4: Land Product Validation Special Session *(Chairs: Baret, Garrigues)*

9:00 LPV subgroup report with contribution to GEOSS/GEO tasks *(F. Baret 30min)*
9:30 CEOS Land portal and WGCV/WIGISS collaboration *(M. Maiden, 30min)*
10:00 LAI products intercomparison *(S. Garrigues, 20min)*
10:20 SAF land products and validation *(F. Camacho, 20min)*
10:40 Break (15 min.)
10:55 OLIVE project for on line open validation *(F. Baret, 20min)*
11:15 Actual spatial resolution (PSF) of current products *(M. Weiss, 20min)*
11:35 MODIS Burnt Area validation protocol *(J.M. Nightingale, 20min)*
11:55 LCLUC Landsat Products *(G. Gutman, 30min)*
12:25 *GOFC-GOLD* achievements and interactions with WGCV *(M. Herold, 30min)*

12:55 Lunch
2:00pm Site visit of the 'La Crau' calibration site, les Baux de Provence

Day 4, Friday, Oct. 3, 2008

Session 3 continued: CEOS 2008 Actions – Progress report and deliverables

9:00 **Brief updates on other CEOS/WGCV 2008 actions**
CEOS 2008 Category 1 and 2 actions
10:00 Break (30 minutes)

WGCV reporting and Chair/Vice Chair succession

10:30 Summary of achievements to be reported to the CEOS Plenary/GEO *(Campbell, All)*
New WGCV28 Action Items and Recommendations to CEOS *(Campbell, All)*
11:00 WGCV Chair/Vice chair succession *(Cao/Lecomte)*
11:30 Dates for the next WGCV meeting *(Lecomte, All)*

12:00 Closing of WGCV29 *(Cao)*

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