Group on Earth Observations / Committee on Earth Observation Satellites

Minutes of the

GEO / CEOS Workshop
on
Quality Assurance of Calibration and Validation Processes: Establishing an Operational Framework

6 – 8 May 2008

Hosted by:
National Institute for Standards and Technology (NIST), National Oceanic and Atmospheric Administration (NOAA) & National Aeronautics and Space Administration (NASA)
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1 Welcome & Introduction

1.1 Raju Datla (NIST)

Raju Datla (NIST) welcomed the workshop participants to NIST. He provided a few introductory remarks and outlined the logistics for the workshop.

1.2 Katherine Gebbie (Director, Physics Division, NIST)

The Director of the Physics Division of NIST, Katherine Gebbie, presented a short welcome. She used the example of climate research undertaken at NIST as epitomising the need for traceability to international units due to the long timescales involved and the variety of measurements undertaken. She identified that the 2009 budget now included specific funding for climate observation.

Gebbie reported that in 2002 a meeting, sponsored by NIST, the National Aeronautics and Space Administration (NASA), the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and the National Oceanic and Atmospheric Administration (NOAA), was held on satellite measurements for climate change. That meeting set some stringent requirements for measurement accuracy. These requirements, however, were not being met. Gebbie suggested that instruments must be tied to national and international standards and that there was a very strong need for calibration and characterisation of instrumentation both pre-launch and also in-orbit. She stressed the importance of ensuring that measurements are compared, validated, documented and that reports are peer-reviewed. Gebbie also reported that the World Meteorological Organisation (WMO) and the International Committee for Weights and Measures (CIPM) had agreed to work together to ensure that data related to measurements of state and composition of atmosphere and water resources, coming from the programmes organised under the auspices of the WMO, are properly based on units traceable to the SI through the procedures of the CIPM MRA and the technical regulations of the WMO.

1.3 Changyong Cao (NOAA / WGCV Chair)

Cao provided the background to the workshop and explained that the workshop provided a good example of interactions between the Global Earth Observation System of Systems (GEOSS), the Group on Earth Observations (GEO) and the Committee on Earth Observation Satellites (CEOS). He went on to further expand on these relationships: GEOSS is a structure that connects systems and monitors changes in the global environment; GEO was launched in 2002 and is coordinating all the efforts; CEOS was established in 1984 and is the major international forum for the coordination of Earth Observation (EO) satellites. CEOS has become the space-based component of GEOSS

and is the space-arm of GEO. Constellation teams had also been formed to assist the process and, at a recent CEOS Strategic Implementation Team (SIT) meeting, two new constellations had been proposed to address ocean colour and ocean winds / waves. Cao went on to outline the structure of the CEOS Working Group on Calibration and Validation (WGCV) and its subgroups, and identified that all the major topic areas were represented at the workshop.

Cao identified the importance of data quality assurance for GEOSS to be successful. He advised that a GEOSS data quality assurance strategy made sense as a guide for the space agencies who usually have fairly minimal data quality assurance programmes. GEO task DA-06-02 is fundamental and cross-cutting and this workshop, together with the one held in Geneva in October 2007, represented key contributions to this effort. Cao emphasised that the CEOS WGCV joint effort with GEO on data quality assurance was recognised as one of the early achievements at the Cape Town Ministerial Summit in 2007, among the "First 100 Steps to GEOSS" (http://earthobservations.org).

1.4 Michael Rast (GEO Secretariat)

Rast reported that approximately 500 people, including 15 ministers from GEO member countries, attended the GEO Ministerial Summit in Cape Town in November 2007. At that summit, the first 100 steps to GEOSS were defined. Rast suggested that GEO was about connectivity and bringing people together. "The full picture", a publication available from the GEO website (www.geo.org), covers the nine Societal Benefit Areas (SBAs) as well as the GEO transverse areas.

At the 2007 GEO summit, some agencies / oranisations announced the opening of their archives and others announced joint activities, but at that time there was no joint platform for the sharing of data. GEO is a non-legally binding, voluntary process, so there was a need to find ways to sustain needs and operations. Major organisations were being lobbied to fund projects and there had been further development of a GEO web portal to try and make this the single entry point for all Earth Observation (EO) data and for the EO community, underpinned by a set of data sharing principles.

The GEO data sharing principles were devised so that data brought in as a contribution to GEOSS could be shared. The GEOSS virtual constellations highlight the cross-cutting dimension of GEO and they were collectively working together to address the SBAs. If best practices and procedures were not standardised then there could be no GEOSS. Rast recommended using the guidelines framework as the "bible" and the Calibration / Validation (Cal/Val) portal as the vehicle for bringing the community together.

Rast commented that GEO should be the framework to make life easier, the platform to make things happen, to harmonise data management practices, to make different Cal/Val procedures more compatible and to ensure that data is fit for purpose. Exaction should

not be sought when approximation is satisfactory; documentation and traceability is the key.

1.5 Guest Presentation – Tom Armstrong (Head of Climate Change, USGS); presented by Gregory Stensaas (USGS)

Tom Armstrong (USGS) was unable to be present at the workshop. His presentation was undertaken by Greg Stensaas (USGS). Stensaas provided information on abrupt climate change and showed examples and associated impacts. Stensaas reported that climate change and natural hazards are having a big impact on society, and, if there was no accurate calibration and validation information, the scale of change could not be accurately estimated. Countries have been signing up to the CEOS constellation efforts with agency backing and these collaborations will be invaluable for future progress toward understanding climate change.

2 Background, requirements, progress review and workshop objectives

2.1 The Need for a QA Strategy – Pascal Lecomte (ESA)

Lecomte introduced the need for a Quality Assurance (QA) strategy based on a small set (12-15) of high-level guidelines. These guidelines would be further expanded upon at a lower (technically-specific) level, but the requirement to start the process was the definition of an essential number of key high-level guidelines that could scope the initial framework. He stressed that this was the principle objective of the workshop.

2.2 Methodologies & Guidelines for Cal/Val – Nigel Fox (NPL)

Fox reviewed the conclusions of the Geneva workshop and the progress made since then. He stressed the importance of common terminology and the need for the whole system to be traceable and validated from conception to completion.

Cao brought up the definition of calibration and that the CEOS WGCV's current definition still evoked some debate. He suggested that it may be necessary to refine the definition. Ungar responded that the definition had been around for a long time and that there was probably no need to change it. He would be more inclined to define an additional definition rather than to change it. Fox added that there was an International Organisation for Standardisation (ISO) definition that that could be investigated if there was a real desire and need to change (***Action WS08-1***).

Fox emphasised how the subgroups had embraced the outcomes of the Geneva workshop and made significant progress in a number of aspects. This reinforced the belief that the community as a whole were ready and keen to move forward and establish an harmonised QA infrastructure.

2.3 Cal/Val Sites – Gregory Stensaas (USGS)

Stensaas reported on progress on the definition and characterisation of a set of target Cal/Val sites. He outlined the scope of the sites and highlighted that the use of sites was currently the only practical means of deriving knowledge on any biases between sensors. Examples were presented from most subgroups showing the momentum within the process.

Minnett asked about the list of desirable target sites for microwave and questioned the proposed use of a target site at sea. Alber responded that he had just been reviewing some best practices for microwave and had input from people who use broad areas of the ocean. He surmised that they were looking for broad areas of the ocean that have some

homogeneity (at a scale of over100 km) and the plan was to use these areas to undertake intercomparisons and remove the biases between microwave sensors. Stensaas recommended that those concerned with this issue get in touch with the microwave subgroup, which was not represented at the workshop.

2.4 Satellite & in situ Data Access – Bojan Bojkov (NASA)

Bojkov reported on satellite & *in situ* data access issues. He outlined the requirements for the Cal/Val portal as an information gateway, but not necessarily directly storing data, and he also presented issues involved in meeting these requirements. Underpinning this, a specific data policy needed to be drafted to facilitate the effective sharing of data. This data policy should take into consideration the GEO data sharing principles. Bojkov suggested that, as DA-06-04 is the data homogenisation effort for GEO, this task team should also be involved in this process.

Brockmann suggested that there was a need to think about having a centralised archive for products. CEOS should be enlisted to ensure that there is a long-term archive of different processes and calibrations in order to allow one to step back in time should the need arise. Bojkov reported that the WMO had set up an EO data centre to do exactly this. Discussions should be undertaken at the higher CEOS level and Stensaas agreed that some clause would be needed to ensure that data could be placed somewhere if a specific facility fails. Alongside this data there should also be documentation of the processes. Bojkov assessed that it was about more than just preserving datasets and input of the algorithms and that the code should also be archived. Rast added that the issue of archiving should be discussed together with the CEOS Working Group on Information Systems and Services (WGISS).

2.5 Harmonisation of Quality Information – Pascal Lecomte (ESA)

Lecomte introduced the issue of harmonisation. More and more routinely, EO products and services require the fusion of data acquired by several sensors / platforms. It has, therefore, become imperative to establish an harmonised framework for Quality Control (QC), QA and Cal/Val activities across missions and applications. This would assist interoperability and increase confidence and reliability of the end-product quality. Lecomte also introduced the concept of Quality Indicators (QI) as information on quality and uncertainty estimation that each process should have associated with it.

2.6 Report from WGCV Taskforce to Address Governance for Cal/Val Processes / Guidelines – Stephen Mackin (DMCII)

Mackin presented a report on the endorsement of standards and protocols within the fields of Cal/Val of EO data. A taskforce to address governance for Cal/Val processes / guidelines had been set up at WGCV-28 to address this issue and had produced a 20 page report. The use of reference targets had been recommended and Mackin explained that anything potentially could be a target as long as it had been characterised and that it was fit for purpose.

Alber identified that the calibrating instrument itself needed to be calibrated to an assured standard. Mackin agreed that there was a need to encompass everything in order not to introduce biases. Fox added that it would be important not to consider these issues in isolation. For every activity or procedure the requirement would be to follow the guidelines within the framework and provide a complete traceability chain; it would be an all-encompassing process, but the level of rigour would depend on the actual requirement. Ungar identified the need to be very clear and distinct about terms and definitions and Brockmann suggested that one should also mention the purpose of the standard or calibration as part of the descriptor for the calibration target or reference standard.

The taskforce had determined that, in terms of specific implementation, some form of self-endorsement (review) of complying with the (eventually) CEOS endorsed guidelines would be the only practical measure. The requirement would thus be to determine a set of general guidelines that would have to be met in order to achieve a quality stamp, i.e. "the framework". In order to obtain the quality stamp it would be necessary to prove that the endorsed processes had been followed. The quality stamp could be an important way of ensuring that the data providers / users met the approved guidelines. However, in order for this to work, some organisation would have to take the lead (e.g. CEOS WGCV) in beginning the endorsement process and in establishing a means to facilitate the review of evidence needed for proof..

Ungar identified that there would generally be a problem with the notion of endorsing a protocol that was about evaluation. The issue would not be to try to determine if a particular satellite's data was good or bad, rather to determine the steps involved in the process. This would be very time consuming. Mackin agreed that it would be very difficult given the huge number of satellites and that it would also be hard to obtain the resources for an endorsement body if this process needed to happen for all activities. For self-endorsement, one would need to provide sufficient information to prove unequivocally that the guidelines had been followed and thus necessitating no formal endorsement except by the user of the service / information. Some commercial organisations may find it harder to be open with information than the agencies, but as more organisations disclose, then others would be convinced to follow.

Llewellyn-Jones requested information about the process that this document would go through until it was accepted and, in particular, if it would it be run past people who are closely involved at the sharp end. Mackin explained that the current report was an outline that was indicative of where the process should be going. People were not being forced down a particular route rather they were being encouraged to follow a set of suggested guidelines. Fox clarified that the taskforce report represented a very specific activity on governance. There were some potential inconsistencies between this report and the framework guidelines document. Essentially, once the top-level guidelines had been determined and the process implemented, it would then be up to the agency or the user of the more detailed procedures (written following these top-level guidelines) to evaluate whether it was fit for purpose and that the procedure was compliant. There may eventually be some technically-specific or detailed guidelines and procedures that should be formally endorsed, but that was not the current status and thinking. Such issues would be further discussed within the subgroups and developed within the community.

Brockmann suggested that the guidelines be applied to some existing protocols / activities so that they could be tested to assess their usefulness. Mackin identified the need for a lead from the WGCV and to have a set of example tests. Fox explained that the subgroups were already starting to do this. Reviews of the key guidelines would be undertaken as an ongoing activity to assess how they fit within the process and how they could be adapted if required.

Alber asked that if bodies are self-endorsing, and claim to be receiving a quality stamp, how they could then give themselves that stamp. Fox explained that the need for a CEOS-endorsed standard / protocol was at the level of the need for that process. The aim was not to produce an unmanageable system, and in general there would be no need for many procedures to be formally endorsed by CEOS. It would be up to the user or funding body to assess that the process was “fit for purpose”, followed the guidelines and that this could all be demonstrated. The guidelines framework would facilitate that process. The framework scopes the operability and provides an harmonised structure of the system and this does need to be endorsed by CEOS. Stensaas further expanded that the aim was to establish key guidelines and that self-endorsement of the downstream process had still to be defined, implemented and discussed. A possibility was that some of the more widely-used procedures could be approved and endorsed by coming through the subgroups, thereby allowing future users to use these processes as good examples of sound procedures. Within the guidelines framework document, there was guidance on establishing suitability and acceptability. The taskforce’s report was a contribution to this guideline. Fox explained that some of what had been requested by the taskforce was already been incorporated within the framework guidelines. The taskforce had also identified the value of having common content of descriptors as part of each procedure, and Fox noted that this was already included in the guidelines document as an annex. Morisette asked about the sections in the framework document related to the subgroups

and what needed to be referred to with respect to the taskforce report. Fox explained that Mackin had presented the report of a task group on how one might endorse reference standards and reference procedures. The filling in of the subgroup chapters was for the future and would be shown within the completed document as annexes. These would be, in effect, the detailed implementation of the key guidelines for priority areas within the subgroup domains. However, these annexes would probably not be completed by September when the document would be put forward for approval by CEOS.

Muller asked about traceability to metrological processes / standards that may not be derived directly from radiometric processes. It would be possible to trace radiometry to a standard, but that would not, for example, include information about the accuracy of the terrain derived from it. Fox explained that the task of defining metrological reference standards would lie with particular communities who would be able to assess the appropriateness of a particular reference standard and that these did not have to be radiometric but could, for example, be a specific location with pre-measured terrain, or a specific vegetated site. All that would be required was that the specialist expert community agreed on the criteria, characteristics and specific locations that could be used by all. Cao talked about the issue of reference standards and that the main focus was to identify what reference standards were already available and review them in context. Cao explained that the space agencies needed to focus on traceability of fundamental measurements. Morisette added that GEO is all about the SBAs and agricultural productivity did not care about radiometric drop monitoring. There were higher level products derived with CEOS agency funding and it would be necessary to show how these related to the SBAs. Fox stressed the need to define a QI and for traceability, but the reference standards did not themselves need to be traceable to, e.g., NIST or NPL. There was a need, however, to have internationally agreed reference standards with a statement of uncertainty attached and these could be defined by the community. Mackin explained that every protocol used to derive higher level products would have associated uncertainties. Morisette added that this should also include the model and model output. Fox explained that the scope of the framework included the whole processing chain and included everything all the way up to the delivery of a knowledge information product to the end user. Once the framework had been established, it would be applicable to every part of the system. Thome added that traceability was the key, including traceability of the higher level products of the SBAs.

2.7 Workshop Objectives & Implementation – Pascal Lecomte (ESA)

Lecomte explained that the objectives of the workshop were to review the framework document, both addressing its structure and content, and agree on any modifications and/or corrections that needed to be addressed before it could be implemented. It was explained that each guideline in the draft document had to be discussed and agreed upon. The draft document was not to be considered exhaustive or final and additional guidelines

/ content could be added as and when the need arose as this should be a living document. The overall workshop aim was to set up the initial required framework for an harmonised QA strategy and this initial framework should have sufficient breadth and clarity to scope the expected immediate need, whilst recognising that it would evolve with use.

3 Harmonisation

Chairs: Nigel Fox (NPL) & Gyanesh Chander (USGS)

Fox introduced the session on Harmonisation and outlined the key session objectives. He introduced the two guest speakers. Jeffrey Morisette (NASA) presented "Examples from the Land Product Validation Subgroup" and David Llewellyn-Jones (University of Leicester) presented "SST Validation, a Possible Case Study for Harmonisation".

Morisette provided the background to the WGCV's Land Product Validation (LPV) subgroup and its formation. He suggested that harmonisation was more organic than standardisation. Morisette gave an example of harmonisation from the Food and Agriculture Organisation (FAO) of the United Nations (UN), who had adopted a land cover classification system and now all land cover classifications adopt this schema. He highlighted the need to make sure that the peer-reviewed literature process is tapped into, as well as, e.g., ISO standards, and these should be included as acceptable practises. Leaf Area Index (LAI) global intercomparison falls under the CEOS umbrella and would not have come about if it were not for CEOS. This was good example of harmonisation and has a global distribution of sites that are funded by a variety of agencies and/or organisations.

Ungar identified that both traceability and repeatability were sometimes needed, citing the example of Aerosol Robotic Network (AERONET). Thome expressed the concern that one should not be pressurised into doing exactly the same things and that independent thinking should not be discouraged as long as there was traceability.

Muller agreed that the definition of the QI would be fine for radiometric products that were directly derived from some model, but he was not convinced that it would work for the more complex products (L3, L4, …) that required atmospheric correction, etc, and which could potentially have to deal with a whole downstream list of QIs. Fox agreed that it would not be easy or straightforward, but the guidelines concerned with uncertainties should facilitate the process. There would have to be some model to allow for the combination of the uncertainties and once such a model existed there would then be a means to evaluate the overall products. The guidance would be there and training would allow the process to be implemented, although Fox agreed that the process would not be easy. Muller identified the complex issue of cloud masking where there was no adequate method of characterising the uncertainty of a cloud mask. Fox in return asked the question, what value does a product that uses a cloud mask actually have to the end user if there was no uncertainty attached to it? Even if the uncertainty was a guess then this would be adequate as long as the guess itself was justified and stated. The guidelines would not force anyone down a particular route, but simply provide a framework to facilitate that the evidence (of traceabilty) and documentation were consistent. Rast

agreed with the notion to keep to a minimum number of guidelines, but he stressed that they should be fully-encompassing. Fox reiterated that this was the starting point to scope the system and that the key guidelines were intended to be fully-encompassing. Any subsequent technically-specific additions would be more like a handful of guidelines rather than many.

Llewellyn-Jones suggested that at the beginning of each guideline in the framework document there should be a 3-4 line summary text. Fox explained that the intent of the framework was to provide a descriptor of what that guideline was seeking to do. The current draft was not the final version, but this was exactly what was intended to link the guidelines into the framework. Cao suggested a need to standardise the way the guidelines were described. Fox suggested that one first needs agreement of the process and after this one could work on tidying up the document. The purpose of the workshop was to look at the content of the guidelines rather than the structure of the document. Stensaas agreed and reiterated that the current intent was to ensure that the information about each guideline was pertinent and to establish where more effort was required. Suggestions for the documentary structure would be gratefully received and should be provided as editorial comments, but the workshop would focus on the technical content.

Fox then led the discussion through each guideline on Data Quality (please see "Quality Control / Assurance and Best practice Guidelines on Calibration & Validation Processes: A Documentary Framework", April 2008, Version 0.9, for more details)

Data Quality - Guideline 1

> *A guide to content of a documentary procedure to meet the Quality Assurance requirements of CEOS.*

Llewellyn-Jones questioned the value of guideline 1 and interpreted this guideline as essentially telling scientists how to write a scientific paper. Fox responded that he had read many papers that did not provide this type of information, and so he believed that there had to be a guideline on this subject. Ungar reminded the workshop that, as a guideline, there would be no actual requirement to adhere to it, but that people should not ignore what was essential. He asked if the guideline could somehow point out what is absolutely required and what was not. Fox stressed that the guideline / annex actually said that not everything was obligatory, it was just fit for purpose. Alber suggested that there should be an executive summary / abstract at the beginning to say what the essence of the information was. Fox explained that the "scope" section at the beginning was intended to describe the task but agreed that this suggestion would be incorporated and a short abstract added.

There was unanimous agreement that the content and context for Data Quality Guideline 1 was acceptable.

Data Quality – Guideline 2

To establish a QI for satellite sensor delivered data products the following guidelines are recommended…(see guidelines document for more details)

Fox explained that the top-down and bottom-up approach to the guidelines started to merge with this guideline. The guideline had been agreed at the Geneva workshop and the detailed guidelines that followed from it had not yet been agreed upon and rested with the subgroups. This was an example topic where there was likely to be additional endorsed guidelines at the sensor-specific level, but these were not needed to initiate the process.

There was unanimous agreement that the content and context for Data Quality Guideline 2 was acceptable.

Data Quality – Guideline 3

Organisation and analysis of a measurement comparison

This was to be based on the adoption of guidelines written and in use by the international metrology community (standards laboratories) and would need minor modification to the wording to reflect the different community.

There was unanimous agreement that the content and context for Data Quality Guideline 3 was acceptable.

Data Quality – Guideline 4

Establishing a reference standard – suitability and acceptance

The question was raised concerning the need or otherwise to define reference standards for pre-launch calibration. Cao confirmed the need for reference standards pre-launch and reported that, already in many cases, those defined for pre-launch were much better defined than those for post-launch. Fox clarified that the concern was for a set of CEOS reference standards that everyone would be obliged / encouraged to use. It was, therefore, questionable if this community would want to be specific and say that, for example, all optical sensors should view an integrating source. Cao added that, in the context of developing standards, this community was not the only one developing standards and sometimes maturity should be the consideration. Best practises evolve and if the 'best' way of doing something had been demonstrated then this could be considered as a standard. Stensaas explained that there already were many fully-documented standards defined for pre-launch measurements of sensors in the laboratory. These types of standards were really documentary standards and different to the CEOS reference standards under discussion. He suggested having a document that referred to those standards already established rather than creating a set of specific standards. Ungar added that it was an essential piece of work to consider pre-launch issues, but it was

imperative not to invent new standards if others already existed and were "fit for purpose". Stone identified that instrument builders were generally good at establishing their reference and documentary standards and doing calibration pre-launch. The key would be to encourage traceability as the key component of any standard. Alber reminded the meeting that CEOS did not have the authority to impose a dictum to the instrument calibration community. Fox reiterated that the guidelines would not oblige use, they were about encouraging use. There could be recommendations on the type of desirable options, but the principle of having a reference standard that was fit for purpose was the fundamental requirement. Some examples could be provided to exemplify the requirement, but there should be no impression given that this was obligatory. Srivastava added that it was impossible to impose that an instrument builder adopted a CEOS reference standard pre-launch, but it would be possible to do this post-launch. Minnett suggested that one should be saying that if traceability to a reference standard could be achieved pre-launch then it should be done. He further went on to question who would be the one to give acceptance for a reference standard. Ungar recommended that this community be the one to set the reference standards as this group embodied the complete knowledge of relevant information. Fox explained that the detail on how one should execute the judgemental process would be discussed in the Implementation session. For a guideline document one would need to state what was required for a reference standard to be suitable and fit for purpose and this was what the framework guidance document aimed to set out.

There was unanimous agreement that the content and context for Data Quality Guideline 4 was acceptable.

Data Quality – Guideline 5

Evaluating and expressing uncertainty of measurement

Fox explained that guideline 5 already existed as an ISO guide but that there may need to be some work on training and examples and its promotion. He suggested that the WGEdu should be engaged in this process.

There was unanimous agreement that the content and context for Data Quality Guideline 5 was acceptable.

Data Quality – Guideline 6

Writing and validating models and algorithms

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Data Quality – Guideline 7

Writing and validating software

Guidelines 6 and 7 were addressed together. Fox explained that there already were documents and guides specifically for this process in the generic sense and he suggested

that they were probably "fit for purpose" and should be referenced within guidelines 6 and 7. This list could always refer to others in the future as more were identified further down the line. Fox added that, if there were others known to the group, then they should be identified soon so that they could be reviewed and incorporated into the guidance framework (***Action WS08-2***). Guidelines 6 & 7 only address the process of how one validates models & algorithms and software & testing, in the context of its adequacy for the intended task. These guidelines are not about the actual writing of software, models, etc., which are well documented elsewhere. Stensaas clarified that there were ISO standards and relevant information already available for the process of writing and general testing. A list of these would be included, alongside which would be details of their appropriateness. Fox added that one should seek to add in some EO-specific examples of the process to complement those of a more generic nature that are in the current published versions. Brockmann fully agreed with this and with the need for standards for evaluating and validating software. He explained that the European Cooperation on Space Standardisation (ECSS) was concerned with the process of writing software and it would be important to be precise about what the examples used within the guidelines were about. Fox clarified that the guidelines would say that ECSS was an example for use when writing rather than when validating software. Alber suggested that there should be a specific example from within the CEOS community that followed each guideline and this would make it clearer for the user and show that it already applied within the EO community. Fox clarified that the final document would have exactly this for each guideline.

There was unanimous agreement that the content and context for Data Quality Guidelines 6 & 7 were acceptable.

Lecomte asked the workshop if there were any guidelines missing for Data Quality. He stressed that there would always be the opportunity at a later date to add further guidelines should there be a need. Alber suggested that there should be something included that connected the calibration process to the nine SBAs. Stensaas clarified that there were clear areas where it would be important to establish actions for implementation and case study generation. The intent at this level was, however, not to do a complete assessment of all the SBAs and trace them down the chain. The framework would provide information to allow users and operators within the SBAs the ability to make their own judgements on suitability. This would subsequently lead to feedback from them on their required needs and this could then be interpreted by the agencies and system builders outside of the QA framework.

4 Data Policy

Chair: Bojan Bojkov (NASA)

Bojkov introduced the Data Policy session and its guest speaker Mark Schoeberl (NASA) who presented "Data Access, Release and Distribution".

Ungar explained that WGISS had been working on protocols on metadata structure and requirements and that Open Geospatial Consortium (OGC) requirements were being set up. He suggested that the Cal/Val portal should be set up to be consistent with other portals and one should work in concert with others in CEOS and GEO. Morisette added that metadata guidelines were required and the movement towards a consensus on structure could also be attempted. There could be some mention of structure within the guidelines, with the aim to leave this as flexible as possible. Lecomte explained that the key guidelines were high level and would not describe the data structure of every single group, but they would provide some information and in particular ensure commonality and availability of key information. Morisette suggested including examples of how one would adopt the guidelines within the document. Iacovazzi asked that, if there were contributory datasets that were not in the stated format, would there be a requirement for adaptors. Bojkov responded that, if there were already well established procedures in communities, there would be no point in establishing something new. This would not be an issue as long as the formats were a standard.

Bojkov then led the discussion through each guideline on Data Policy (please see "Quality Control / Assurance and Best practice Guidelines on Calibration & Validation Processes: A Documentary Framework", April 2008, Version 0.9, for more details)

Data Policy – Guideline 1

Establish common format for Cal/Val data exchange.

This guideline addressed the need for a common or recommended format for types of data, for example ISO 19.115 should be used for metadata formats.

There was unanimous agreement that the content and context for Data Policy Guideline 1 was acceptable.

Data Policy – Guideline 2

Code of practise for Cal/Val data providers and users to ensure free access and unencumbered access whilst providing recognition for the efforts in its generation.

Morisette suggested that, to help agencies generate a data policy, one should provide them with a kind of template. Brockmann suggested that, at the high level of these guidelines, there should be a guideline to suggest there be distribution and reporting. This should then be passed to the subgroups to fill in the detail. Bojkov suggested that it may be good to have a baseline but to still head towards a more generalised approach. Stensaas added that the code of practice guideline should be undertaken at the working group level because the approach may be completely different depending upon the instrument type. Bojkov suggested using NASA's Aura Validation Data Centre (AVDC)'s data policy as a starting point for discussion within the subgroups. Morisette recommended that Bojkov highlight those parameters within the AVDC data policy that were optional, and those that would vary, and the subgroups could then customise them (***Action WS08-3***).

There was unanimous agreement that the content and context for Data Policy Guideline 2 was acceptable.

Data Policy – Guideline 3

A common set of content and means of association of metadata to Cal/Val data sets.

There was consensus that already-established ISO standards should be used where appropriate and be referenced within this guideline.

There was unanimous agreement that the content and context for Data Policy Guideline 3 was acceptable.

Fox summarised that there had been agreement that some of the detail of the guideline on a code of practice was subgroup specific and, in writing guideline 2, this should be clearly stated. Fontaine reminded the workshop of the need to make sure that the GEO data sharing principles were also taken into account. Ungar suggested that, when it came to initial release of Cal/Val data, one should not be restrictive rather be as inclusive as possible. Data could be made available with a caveat that there be sharing and/or feedback, ground truth etc. Fontaine explained that eventually the GEO data sharing principles would have quality indicators attached. Bojkov clarified that the consideration here was data reporting guidelines for Cal/Val and this could encompass many issues. There would be nothing wrong with opting out of some GEO data sharing principles if they did not fit into the core policy. Thome added that sharing had never really been an issue, it was the formats that had been the problem. Minnett suggested that there were

some data policies that were imposed upon PIs by the data providers and this must also be recognised. Bojkov agreed that this was often the case and should be considered. Srivastava reported that in Canada a regulation act had come into force and data could not now be shared unless it had been cleared by foreign affairs. This was also due to come into force in Germany.

5 Implementation

Chairs: Pascal Lecomte (ESA) & Gregory Stensaas (USGS)

Stensaas introduced the session on Implementation and introduced the two guest speakers. Pasky Pascual (EPA) presented "All models are wrong, some are wronger" and Irwin Alber (IEEE) presented "Review of Standards and Best Practices related to Remote Sensing Calibration/Validation".

Pascual identified the limitations of data as limiting the performance of models. Llewellyn-Jones exemplified that models did not seem to be capable of predicting abrupt changes and that it was these sudden changes that would wreak havoc on the planet. Modellers did not seem to consider this and could therefore not predict major changes in climate. Herein lay a serious question as to responsibility. If someone had an instrument that did not follow established guidelines, was it the government who used the data to make policy decisions that should be ultimately held responsible. Pascual answered that the government should be held responsible for ensuring that technical needs were being met. Alber suggested that there had been substantial foot dragging in making decisions and this had serious consequences both politically and in the environment. For example, in the case of the polar bear, a decision had only been taken recently to place it on the endangered list, even though there had been a lot of evidence already that the polar ice caps were melting. He suggested that politicians just slow down the process. Pascual responded that without the use of the legal mechanism the situation would be a lot worse, although it was indeed a slow process. Morisette suggested that the US did not seem to have a very good research plan to take measurements acquired by research satellites and translate those into operational decisions. The issue was how to better connect and tell the story that these measurements are important. Pascual suggested that one needed models to get from data to the end point and GEOSS has been very useful for this. He was somewhat dubious about top-down approaches and was more convinced that bottom-up approaches work, where individual PIs made the associations and worked with the stakeholders to make more appropriate decisions. One should try to create and encourage collaboration at the bite-size project level and communicate upwards. Fraser expressed the opinion that often there was information overload and there were no tools to assess the quality of the information presented. Pascual responded that there were ways to make a formal claim that a particular set of models best describe the data. The hypothesis went that if there was disagreement with a data product, the proof would lie with other data and counter-models. Iacovazzi suggested that, in an environment where funding limits us down to a certain way of working and thinking, this kind of approach would be difficult. Pascual responded that government was bringing up the rear to industry and there were going to be sectors outside the public sector that would come through first. Through Principal Investigator (PI) funding, the terms and conditions should state what the

conforming requirements of having the data were. However, he agreed that to come up with mapable anthologies was difficult.

Stensaas explained that the goal of the Implementation session was to brainstorm and discuss opportunities to maintain the guidelines and to discuss actions to move that forwards. The presentation covered the strategy to progressively implement the key guidelines without imposing the development of detailed implementation processes. Such a strategy would generate a natural system in which detailed implementation processes on procedures and methodologies would become necessary to assure the applicability and correct use of data (similar to ISO). Both a bottom-up and a top-down approach would be necessary to achieve successful results. The overall governance process and funding mechanisms were also presented as a discussion point. Stensaas proposed a timeline towards the ultimate endorsement by CEOS of the key guidelines:

- Peer review by CEOS WGCV and Geneva & Gaithersburg workshop participants
    - Version 1.0 draft issued by 27th June 2008 based on comments at Gaithersburg workshop
- Final review by CEOS WGCV
    - Provide comments to Gaithersburg workshop Chairs and WGCV subgroup chairs by 1 August 2008
    - Review and incorporation by 15 August 2008
    - Version 1.0 final produced by 1st September 2008 based on comments received and then submitted to CEOS WGCV plenary
- CEOS WGCV level agreement WGCV-29 (France)
- CEOS level agreement CEOS (South Africa)
- GEO agreement GEO plenary

Fox confirmed that the intent would not be to have a complete set of annexes from the subgroups by WGCV-29. Muller expressed the concern that there would not be time at all within the schedule to work within the subgroups. He suggested that it would be helpful to have a half-page cover that the subgroups could send to its members that summarised the document (***Action WS08-4***). Morisette suggested that it would also be a good idea to undertake an external review within this timeline. Ungar agreed that external review would be helpful, but this was the final hurdle after a plan had been developed and when there was forward motion. Stensaas agreed that this was a good suggestion. Llewellyn-Jones suggested that review was needed both from the bottom-up and top-down ends. The key contribution of the bottom-up would be to check that what was being proposed was reasonable. The review therefore needed to include people at the sharp end. This could be done at one or more selective workshops where people who had actually collected data and had responsibility for programmes were invited.

Srivastava and Fontaine expressed concerns about the timeline. Stensaas clarified that the goal was to get the document approved by WGCV. There would be remaining issues

still to be resolved between the WGCV, CEOS and GEO plenaries, but the overall structure should be sound at that stage. Lecomte clarified that the first version would go to the CEOS SIT and to GEO, and this would be the version published on the 15th August. Stensaas clarified that the aim was to incorporate potential example information within the document as far as possible for the 27th June version. If examples were not included in this version, then there would at least be placeholders. Fox suggested that it should be possible to give at least a baseline example to start the process, even if the detail within was not complete. Cao reminded the meeting that the top-level requirement was to develop a QA strategy for GEOSS and he suggested leaving out the subgroup chapters completely for the first version. Fox suggested that the subgroup inputs should be included as annexes, not chapters, and should scope where additional content would be. Petiteville informed the workshop that the documents would need be ready the end of August at the latest in order to be ready for submission to GEO. Ungar said that it would be impossible to submit for CEOS endorsement a week before the GEO summit. Therefore, it should be circulated to the DA-06-02 team (a very open forum of mostly hands on people) by the 1st August to obtain their responses by the 1st September.

Fox reminded the meeting that there was no restriction to the membership of the subgroups and that the subgroups were the mechanism for taking the guidelines forwards. Brockmann suggested that, in order to increase awareness, the portal would be a good tool and should be used. Morisette had some ideas of potential reviewers within industry or at sensor team level and he would seek to put them forward. He asked for a summary (2 or 3 slides) of the main points by the following week so that the workshop could be reported on (***Action WS08-5***). Stensaas agreed that a short summary would be produced and also a few slides that detailed the way forward and allowed for outreach. These would be sent out and posted on the Cal/Val portal.

Iacovazzi expressed concern about how what was being laid down as groundwork here would affect the product developers. He suggested considering setting up meetings, or a system of meetings, once a year or so, where product developers could meet and be trained. Stensaas agreed that there was a need to start thinking about doing this and about who the trainers would be. Fox agreed that some guidance and training on how to apply these guidelines would be of enormous value. This could feasibly be done through workshops and/or some virtual material available through the portal (with help from WGEdu).

Cao explained that there were two highly relevant areas to the work on standards – geometric (the ISPRS have done a lot of work here and the WGCV has a role, particularly within the high resolution domain) and radiometric reference standards. These are highly important, especially for climate change. Llewellyn-Jones asked how an ISO standard would actually be effectively implemented. Alber explained that ISO is a voluntary process. Usually an external reviewer would assess that the standards have been met and this is often set out as a requirement within a contract. Fox suggested that

once the set of guidelines on how one established traceability of calibration processes had been agreed, then it would not be difficult to turn this into a new ISO standard if the community wanted. However, the minimum 5 years it would take to establish the documentary standard would probably not be what was wanted in the short term as a workable process is needed now. No adoption of guidelines / documentary standards was being suggested as compulsory, the framework simply gives guidance, opportunities and consolidation of a set of best practices.

Minnett reported that in 2001 there had been a CEOS radiometer intercalibration for sea-going instruments to characterise black-body targets that calibrate radiometers that go to sea. The timing of the comparison activity coincided with the launch of Terra, Aqua and Envisat. The plan was to have another comparison coinciding with the middle age of these satellites, organised by CEOS IVOS and organised following the framework guidelines. Minnett asked that if anyone would like to participate in this activity to contact him or the IVOS chair (Nigel Fox) (***Action WS08-6***).

6 Conclusion & Wrap-up

Moderator: Stephen Ungar (NASA; GEO Task DA-06-07 lead)
Panel: Pascal Lecomte (ESA), Gregory Stensaas (USGS), Nigel Fox (NPL) & Bojan Bojkov (NASA)

Fox clarified that the guidelines framework under discussion at this workshop represented a process that would not require everybody or anybody to go through any formal certification, it is simply a set of guidelines on a process that facilitates harmonisation. Cao added that the guidelines were very general and were not a substitute for specific programmes or missions. Morisette suggested that the guidelines could possibly be too general, but that it was hard to realise this until there were some examples following the process through, specifically for the constellations. Stensaas agreed. Llewellyn-Jones suggested following the example of the Global Ocean Data Assimilation Experiment (GODAE)'s High Resolution Sea-Surface Temperature (SST) Pilot Project (GHRSST) where approximately 11 sensors all provided SST in an agreed format with associated error statistics. Fox agreed that this could be used as an example of the process, but he did not believe that the guidelines were too general. He suggested that they are essentially very specific guidelines on topics that scope the QA infrastructure, but are general enough to be accepted across the community and allow repeatability. In fact, many of the guidelines were adaptations of those used in the broader terrestrial industrial sectors. The detailed sensor- / application- specific guidelines are those that needed to be written.

Fox highlighted an example offered by Ungar of two measurements taken by NASA, both NIST traceable but both producing different answers. The words "to be traceable to NIST" was not necessarily always interpreted in a robust manner. It should mean that there is a full link back to the NIST Primary standard with a documented and evaluated uncertainty based on comparison, or at least evidence, that all the calibration steps have been carried out adequately. This is not always the case and often the claim of traceability simply means that there has been a purchase of an artefact calibrated by NIST (or even that someone in the chain has purchased such an artefact). It does not confirm, unless asked for, that the user is using it correctly, that it has not aged, and that they have assessed the uncertainty correctly. The full traceability chain must be defined and documented. Ungar agreed that alleged traceability was sometimes not sufficient. Fox went on to say that the whole point of traceability was to know the uncertainties, not necessarily that it was the most accurate of measurements. Cao added that traceability was a term open to many interpretations and it would be important to be clear about its definition (***Action WS07-7***).

Bojkov explained that the atmospheric composition community looked more at L2, L3 and sometimes L4 products. There had been over 50 years' of measurement networks *in*

situ and it would be important to take what already existed and make it suitable for the satellite community without breaking established traditions. The approach should be very diplomatic and the distribution of documentation should be very specific and targeted to ensure inclusivity. Bojkov explained that there already was documentation and procedures for a lot of atmospheric composition measurements. Some were long-standing and not necessarily suitable for measurements from space, but there was a need to ensure everybody was informed so that the whole system was not broken and long-term continuity of measurements maintained. Fox reiterated that most of what was being proposed was not revolutionary or new, it was merely about consolidation and a more consistent form of presentation. It was agreed that the higher-level products should be exemplified to be meeting the guidelines at least in spirit as this was the ultimate objective.

Iacovazzi suggested that any endorsement process would need to also keep track of things that were not being done well so that this could be fed back at ministerial level. Fox reiterated that products themselves would not be endorsed by CEOS (although conceptually by implementing agencies) as part of this process. Certain reference standards would be endorsed and a set of guidelines fully endorsed by CEOS. If people followed the guidelines it would allow them to assign a QI to a product so that the user could then make a judgement as to whether the data was fit for purpose. If there was a parameter or measurement for which an uncertainty could not be assigned then a guess would need to be made. An uncertainty could be as much as 100% as long as the basis for this estimation was stated.

Morisette reviewed the list of suggested examples for each of the guidelines as GHRSST, AVDC, the LAI intercomparison, the Miami sensor intercomparison and the EO-1 experiment. It was agreed that, for each guideline, there would be a sentence on how each of them would have applied to the former activities (***Action WS08-7***). There could also be a publication that would outline them in a journal. Lambert expressed concern that it would be the higher level products (L3 and L4) that would be used for GEOSS applications and he asked about the link between DA-06-02 and DA-06-03. Ungar explained that DA-06-02 extended across all the SBAs and that it was hard to see where DA-06-02 stopped and DA-06-03 took over. The WGCV was not officially participating in DA-06-03 and this was a concern.

Muller explained that terrain data was mostly L3 and most of the source pixels were not provided. He exemplified the case of ASTER data where JAXA was not providing any quality indicators. So, in the final L3 product, there would be no associated quality indicators. Fox responded that, once the guidelines had been agreed by GEO, they would become highly visible and it would be very obvious where there were gaps. Once any limitations to a particular data product were pointed out to the customer and he/she was not able to have what they required, there would be pressure to change.

Stensaas summarised that the subgroups would be tasked with contributing their specific requirements to the framework within the annexes as well as to provide some examples. The subgroup chairs and the workshop chairs would work on populating the document. A one-page summary (***Action WS08-4***) and 2-3 slides (***Action WS08-5***) would be produced within a week, and the minutes within two to three weeks. In addition, IVOS agreed to send something to the subgroup chairs to detail exactly what is required from them (***Action WS08-8***).

Lecomte thanked everyone for participating to this workshop and to the Geneva workshop. He reviewed that, in the first workshop, the process was put in place, and in this workshop the first important step had been taken. He thanked NIST and NOAA for their support for the workshop. He thanked the organising committee for all their hard work – Greg Stensaas (USGS), Bojan Bojkov (NASA), Nigel Fox (NPL), Gyanesh Chander (SAIC), Giuseppe Ottavianelli (ESA) & Marie-Claire Greening (Greening Consulting). He also thanked Changyong Cao (WGCV chair), Steve Ungar (task DA-06-02 lead), and Petya Campbell (WGCV secretariat).

7 Actions

7.1 Review of Actions from GEO / CEOS Workshop on Quality Assurance of Calibration and Validation Processes: Guiding Principles, Geneva, 2 – 4 October 2007

Number	Action	Responsibility	Status	Due Date	Description
WS07-1	Categories for the test site catalogue to be transformed into “equipped and maintained” and “non-equipped and non-maintained” rather than use “absolute cal”, “pseudo-invariant cal” and “cross-cal”.	Chander, IVOS Subgroup	Closed		This action is related to the Radiometric test site classification and the process of categorizing sites. It was decided that site could be re-categorized as equipped and maintained and non equipped
WS07-2	Provide the current IVOS Cal/Val site list & baseline characteristics list as an example to the other subgroups	Chander	Closed		The generic template developed and agreed to in the meeting would be updated and used as a baseline for other sub-groups. The IVOS sub-group will finish the evaluation of the radiometric site process and make it available as an example for other to consider during other system test site template development.
WS07-3	Review & establish test site template to define (best practices) requirements for test site identification within the subgroup domain.	WGCV Subgroups	Open	01-Aug-08	Each sub-group will define test site criteria and requirements of systems within the sub-group purview, and provide this information for use. The generic template could be considered as starting point.
WS07-4	Define criteria for test site classification for suitability for a particular application.	WGCV Subgroups	Open	01-Aug-08	In addition to best practices and test site requirements suggested above, the sub-group will provide a method to classify sites for use as discriminator. This is important so that system owners can provide full data over test sites for interoperability.
WS07-5	Formulate a request to the Constellation leads to evaluate their requirements for Cal/Val needs.	Bojkov, Stensaas, Campbell, Cao	Open	01-Aug-08	Suggest that CEOS constellations provide Cal/Val requirements for evaluation and update by the WGCV. Currently working with constellation teams.

Number	Action	Responsibility	Status	Due Date	Description
WS07-6	Investigate Jim Butler's CEOS Information Server (http://spsosun.gsfc.nasa.gov/calval/index.html) and see if it contains any useful for the portal	ESA	Closed		The Cal/Val portal developers will evaluate the usefulness of the information on the CEOS information server and any lessons on why it failed.
WS07-7	Establish & define key Cal/Val terminology as an input into a WGCV dictionary.	WGCV Subgroups	Open	01-Aug-08	Each sub-group will define Cal/Val terminology associated with specific systems and measurements within their sub-groups purview, and provide it to the WGCV.
WS07-8	Draft a recommendation regarding the need to maintain long-term archives of Cal/Val process data to support EO.	Fleig	Open	01-Aug-08	Provide the long term requirement for Cal/Val data and metadata. Long term climate change will be the primary focus point in defining the requirements.
WS07-9	Draft guidelines for writing best practice	IVOS/FOX	Closed		IVOS will provide a guideline template (key content) to other sub-groups for potential use in writing Cal/Val best practices associated with systems and data used in the sub-groups purview.
WS07-10	Formulate a draft list of key common best practices for Cal/Val.	WGCV Subgroups	Closed		Each sub-group will provide a list of best practices used for Cal/Val in measurement, evaluation, assessment, and applications used within the sub-groups. This list will support and prioritise the writing of best practices for each item in the list.
WS07-11	Establish a committee to explore options on how we are able to establish authority for the endorsement of best practices for Cal/Val.	WGCV Chair	Closed		The WGCV chair will establish a committee to assess the basis for adopting and standardizing Cal/Val best practices to meet CEOS and GEO requirements, and present the recommendation from the established committee at the next meeting.

Number	Action	Responsibility	Status	Due Date	Description
WS07-12	Include a discussion at the joint WGCV / WGISS meeting in February 2008 on the idea of adopting a standard set of best practices and the means to establish an authority to endorse them, possibly with a CEOS, ISO or similar stamp.	WGCV Chair	Closed		See previous action description.
WS07-13	Define wish list of requirements for functionality from the Cal/Val portal and feedback to the Cal/Val portal maintainers (ESA).	WGCV Subgroups	Open	01-Aug-08	Each sub-group should define functionality requirements needed within the Cal/Val portal and provide them to the sub-group lead for submission to the Cal/Val portal developer.
WS07-14	Establish some mechanism to feedback portal development information to the subgroups (user community).	ESA	Closed		Develop a newsletter or news page with notification or subscription to subgroups users will be provided. Allowing the users to keep up with new developments and provide appropriate feedback.
WS07-15	Make the Cal/Val portal front end a more CEOS / GEO one and change the website URL.	ESA / NASA	Closed		Establish a CEOS url address for the portal via NASA CEOS domain and present the portal as GEO/CEOS component with appropriate logos and caveats.
WS07-16	Draft a WGCV data policy (code of use) for Cal/Val data that will be consistent with the GEO data sharing & principles guidelines.	Stensaas, Bojkov	Open	27-Jun-08	Write a draft agreement for users and use of Cal/Val data in the portal consistent with the GEO Data Sharing policy.
WS07-17	Present Cal/Val portal prototype to CEOS and GEO plenaries [but restrict open access until data policy (Action 16) has been agreed upon].	WGCV Chair	Closed		Allow presentation of the Cal/Val portal but restrict use until user and data policy agreements are established.
WS07-18	Review terms and definitions list used for the workshop.	Workshop Chairs	Open	01-Aug-08	Update the definition list to be consistent with definition discussed in the workshop and in accordance with official standards definitions
WS07-19	Distribute GEOSS data sharing principles & guidelines document	Rast	Open	27-Jun-08	This document will be used in conjunction with writing the Cal/Val data sharing policy.

Number	Action	Responsibility	Status	Due Date	Description
WS07-20	Evaluate the possibility of including MODIS tools and EOS field data to the Cal/Val portal	Morisette, Brockmann	Open	01-Aug-08	Evaluate the availability of Cal/Val tools and discuss them with Cal/Val portal developer for potential use.
WS07-21	Evaluate the potential of incorporating EO1 tools & data into the Cal/Val portal	Stensaas, Brockmann	Open	01-Aug-08	Evaluate the availability of Cal/Val tools and discuss them with Cal/Val portal developer for potential use.

7.2 Actions from this workshop

Number	Action	Responsibility	Due Date	Description
WS08-1	Assess the applicability of the ISO definition for Calibration as a possible substitute for the current WGCV definition.	Cao / Fox	WGCV-29	There is a requirement for a review of the current WGCV definition for calibration.
WS08-2	Identify any documentation / guides relevant to Data Quality guidelines 6 and 7 that should be listed as a reference within the guideline.	All	27-Jun-08	These guidelines refer to the writing and validating of models and algorithms, and the writing and validating of software.
WS08-3	Customise the AVDC Data Policy and use it as a starting point for discussions at a subgroup level on a QA4EO data policy.	Bojkov & Subgroup Chairs	27-Jun-08	Bojkov to identify those points within the AVDC Data Policy that are optional / variable requirements and those that are fundamental and feed this to the subgroups for them to customise into an appropriate QA4EO data policy.
WS08-4	Draft a summary document outlining QA4EO for use as outreach and for reporting.	QA4EO steering committee	16-May-08	The summary should include an outline of QA4EO, the work agreed at the workshops and the plans for the future approval and endorsement of the framework.
WS08-5	Create a summary presentation outlining QA4EO for use as outreach.	QA4EO steering committee	16-May-08	The presentation should include details of the QA4EO process and plans.

Number	Action	Responsibility	Due Date	Description
WS08-6	Contact Minnett / Fox for participation in the next sea-going radiometer inter-calibration	All	WGCV-29	A radiometer intercalibration for sea-going instruments is being planned and anyone interested in participating is asked to contact Peter Minnett (University of Miami)
WS08-7	Include, for each guideline, a working example and a sentence on how that guideline would fit in with some example projects	QA4EO steering committee	01-Aug-08	Each guideline should be exemplified by working examples to exemplify the process and highlight its applicability within the community.
WS08-8	Provide more information to the subgroup chairs to detail what is required from the subgroups.	Fox / IVOS	27-Jun-08	More information will be provided to detail what is required from the subgroups as their contribution to the process.

Annex A: Agenda

Tuesday 6 May 2008	Wednesday 7 May 2008	Thursday 8 May 2008
8:30 Coffee & Refreshments **09:00 Registration** 09:30 NIST Opening remarks (Raju Datla, NIST) 09:40 NIST Welcome (Katharine Gebbie, Director, NIST) 09:50 CEOS (Changyong Cao, WGCV chair) 10:10 GEO (Michael Rast, GEO Secretariat) 10:30 Guest Presentation (Tom Armstrong, Head of Climate Change, USGS) **11:00 Coffee** 11:30 The need for a QA strategy (Pascal Lecomte, ESA) 12:00 Methodology & guidelines for Cal/Val (Nigel Fox, NPL)	**7:45 Coffee & Refreshments** **Harmonisation (Chairs: Nigel Fox, NPL & Gyanesh Chander, SGT/USGS)** 08:30 Guest speaker (Jeffrey Morisette, NASA) 09:00 Discussion **10:15 Coffee** 10:45 Guest speaker (David Llewellyn-Jones, University of Leicester) 11:15 Discussion	**7:45 Coffee & Refreshments** **Implementation (Chairs: Pascal Lecomte, ESA & Gregory Stensaas, USGS)** 08:30 Guest speaker (Pasky Pascual, EPA) 09:00 Discussion **10:15 Coffee** 10:45 Guest speaker (Irwin Alber, IEEE) 11:15 Discussion
12:30 Lunch	*12:30 Lunch*	*12:30 Lunch*
14:00 Cal/Val sites (Gregory Stensaas, USGS) 14:30 Satellite & *in situ* data access (Bojan Bojkov, NASA) 15:00 Harmonisation of quality information (Pascal Lecomte, ESA) **15:30 Coffee & Refreshments** 16:00 Actions & Guidelines (Marie-Claire Greening, GC/ESA) 16:30 Report from WGCV taskforce to address governance for Cal/Val processes / guidelines (Stephen Mackin, DMCII) 17:00 Discussion & questions 17:30 Workshop objectives & implementation (Pascal Lecomte, ESA)	**Data Policy (Chair: Bojan Bojkov, NASA)** 14:00 Guest speaker (Mark Schoeberl, NASA) 14:30 Discussion **15:45 Coffee & Refreshments** 16:15 Discussion	**13:30 Conclusion & Wrap-up** Open panel session chaired by Stephen Ungar, NASA Panel: • Harmonisation: Nigel Fox (NPL) & Gyanesh Chander (SGT/USGS) • Data Policy: Bojan Bojkov (NASA) • Implementation: Pascal Lecomte (ESA) & Gregory Stensaas (USGS)
17:45 Close *17:45 Special Session – Invited Guest Speaker – Dr. James F. Schooley, NIST Alumni –" Early history of National Bureau of Standards"* *18:00- 20:00 NIST MUSEUM Tours and Reception*	*18:00 Close* *18:00 – 19:30 Optional NIST Laboratory Tours*	*16:30 Close* *16:30 – 18:00 Optional NIST Laboratory Tours*

Annex B: Participation List

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