

# Report on the endorsement of standards and protocols within the fields of calibration and validation of Earth Observation data

May 6<sup>th</sup> 2008

## Authors

Dr. Stephen Mackin

Dr. Robert Iacovazzi

Dr. B. Kartikeyan

Professor Junwu Tang

# Role

Overall the role is to determine outline guidelines covering

the management and technical control required for the endorsement of methodologies for use in the calibration of satellite and ground sensors (*used for satellite data validation*)

the management and technical control required for the establishment of standards for vicarious, on-board and laboratory pre-launch calibration and post-launch validation.

The procedures and potential problems of implementation will be examined.

# Aims

- [1] : Any developed protocol or characterised reference standard must follow best practice guidelines in their development. This does not restrict content, but guarantees that certain steps have been completed (e.g., Determination of uncertainty).
- [2] : The overall objective is to try and determine uncertainty in both procedural (protocol) use and use of standards so that we can have traceability from our final measurement back to (in theory) an SI unit

# Terminology

For this report we will define

- Reference Calibration Target
- Reference Calibration Standard
- Protocols (procedures, methods)
- Standard Data Sets

# Reference Calibration Target

- A reference target may be supported and used, but it does not become an endorsed standard until it is well-characterised
- Targets include the Moon, stars, desert sites, snow fields (DOME-C), forests (Amazon), even diffusers and lamps that have not been characterised.
- [3] : Until endorsed all Reference Calibration Standards should be named Reference Calibration Targets. They do not become standards until endorsed.

# Reference Calibration Standard

- A standard is a well-characterised calibration target. Characterisation includes determination of uncertainty in their use.
- A standard must also have a description of the limitations on its use (for example view angle limitations due to insufficient characterisation of BRDF)
- Even standards which are not invariant such as Railroad Valley can be endorsed, if they are re-characterised at a suitable time close to their use.
- [4] : Fitness for purpose is a key content requirement for standards characterisation. The limitation of any standard (e.g. BRDF) must be stated when requesting endorsement.

# Protocols (methods, procedures)

- A protocol is a methodology used to carry out a specific operation. The operation may be a measurement, a resampling, a merging of data from disparate sources. In many cases it will be a measurement protocol
- Protocols also cover how the data is handled after an initial measurement, including resampling and averaging. Any process which takes place that can potentially affect observation (and hence the uncertainty) needs to be identified and the uncertainty level defined

# Standard Data Sets

- Have been generated for cross-comparison of models (methods) in the past.
- There may be a need to endorse specific data sets as standards, that can be used to evaluate the output from protocols (including models)
- This area requires further investigation

# Approach for this study – Split One

- Current
  - Protocols and standards that already exist and are in use and have been in use for some time. To endorse these current protocols and standards requires a great deal of retrospective work
- Future
  - Protocols and standards which are being developed that we can hope to “shape” to meet “Best Practice” guidelines

# Approach for this study – Split Two

- Common / Specific
  - Common standards that are used by the whole community (vicarious targets) such as invariant targets (Moon, Desert sites) and other targets which require some re-characterisation for use (Railroad Valley for example). These standards are used to facilitate interoperability and comparison.
  - Specific standards used on specific missions such as lamps, diffusers and field spectrometer reference panels. They are used to update the calibration coefficients of a specific instrument and hence traceability and can not be used by the whole community.

# Current Common Protocols and Standards

- Many established common protocols and standards
- Could be endorsed simply as long as they satisfy the basic generic guidelines being drawn up by the CEOS WGCV (easier for standards than current protocols)
- Characterisation of these common standards is already underway within the remit of two projects, a USGS test site database and an ESA sponsored study
- However we still need a clear endorsement mechanism

# Suggested Procedure

- Every protocol and standard in use will originally be given a status of “**No information**” and for the cases of standards, they will be referred to a calibration targets.
- Agencies or institutes can then submit a protocol with its uncertainty budget or a standard with its characterisation information (including uncertainty) to an endorsing authority. Once submitted it will be given a “**Pending**” status. An initial review on reception will determine if it receives the “Pending” status. If the basic criteria for acceptance are not present it will be returned to the submitter. At this stage potential calibration standards are still targets.
- The endorsing authority will then be responsible using working groups to validate the data provided and make a recommendation to class the protocol or standard in one of two states
  - “**Endorsed**” in which the protocol or standard meets all the criteria for general use and can be placed on an “Accepted Protocols List (APL)” or “Accepted Standards List (ASL)”. The target becomes a standard at this stage.
  - “**Awaiting Information**” in which the protocol has met most criteria but there are elements that need clarifying before endorsement. Or a standard needs additional characterisation. The potential calibration standard is still a calibration target at this stage.
- Those protocols and standards that are endorsed by the working groups will then be presented at regular meetings of the endorsing body for final ratification and acceptance.

# Current Specific Protocols and Standards

- Much more difficult to retrospectively endorse this area.
- Developed by agencies and expert labs under contract. Now in use on satellite systems and ground segments
- There is good characterisation of standards pre-launch (but with decreasing accuracy post-launch)
- Protocols used are not so well defined in terms of uncertainty
- No incentive to retrospectively endorse
- Possible problems of proprietary protocols
- Self-endorsement the only practical measure (time and costs, proprietary, specific to an instrument so less interest from the general community)

# Suggested Procedure

- Every protocol and standard in use will originally be given a status of “**No information**”.
- The endorsing authority (in the case of self-endorsement the agency responsible for operating the protocol or standard) will then validate the data provided and make a recommendation to class the protocol or standard in one of two states
  - “**Endorsed**” in which the protocol or standard meets all the criteria for general use
  - “**Awaiting Information**” in which the protocol has met most criteria but there are elements that need clarifying before endorsement. Or a standard needs additional characterisation.
- The status information (Endorsed, No Information, etc.) on the protocol or standard should be made available publicly to outside users in the form of a simple quality statement.
- The information supporting the status should also be made available where possible (non-proprietary). This may come from an external review of procedures or an external confirmation of the accuracy of a characterisation process (such as the NIST evaluation of the MERIS diffusers, with similar findings as TNO).

# Future Common Protocols and Standards

- Greater adherence to guidelines outlining how to determine uncertainty and provide the information required for endorsement
- Expected to be a slow addition, but can be guided by agencies that may contract the development of new algorithms or wish to endorse them
- Relatively simple process
- Follows same endorsement procedure as for Current Common Protocols and Standards

# Future Specific Protocols and Standards

- Use of a “Quality Stamp” as an incentive
- Agencies to state generic guidelines to external contractors as basis for new developments (embedded in ITT’s).
- The information on the endorsement process must be provided to contracted labs or companies, this leads to key elements required

# First Key Steps

The necessary steps prior to endorsement include provision of,

- Guidelines on the acceptance of protocols and standards (whether commonly used or specific)
- A well-defined acceptance route for protocols and standards which needs to be split into two parts,
  - For those protocols and standards that are commonly used by multiple agencies (common forms of radiometric processing and vicarious calibration sites for example)
  - For specific protocols and standards such as instrument specific protocols and on-board standards such as lamps and diffusers used for traceability.
- Suitable web/database resource to display and deliver the common (not specific) content to potential users
- Initial work carried out by the endorsing agency to begin the process and show the utility of the methods, by selecting and endorsing some of the more commonly used protocols and standards as a start point in the database development

# Key Guidelines

- [10] : Protocols and standards that do not match the criteria listed in guideline [7] above can still be used, but users must make the status (Pending, Endorsed, etc..) clear in all documentation. The aim is not to stifle use, but to slowly generate the necessary quantitative information on uncertainty for each protocol and standard.
- [11] : A mechanism for the rapid assessment of data generated by the USGS and ESA site characterisation studies to endorse these sites as calibration reference standards is required urgently. This in part is related to guideline [8] above under the last bullet point.
- [12] : Further work is required to determine the mechanism for endorsing Standard Data Sets. Discussions with workers with experience of cross-comparison of models or sensors using Standard Data sets is required to determine the ideal endorsement procedure.
- [13] : No attempt should be made to try and incorporate all current SPECIFIC protocols and standards into this scheme due to the limitations on resources and the lack of incentive to commercial companies to revisit and re-evaluate all current protocols and standards used. Therefore it is expected the adoption will be slow and patchy for SPECIFIC protocols.
- [14] : A self-endorsement process should be presented for SPECIFIC protocols and standards.

# Key Guidelines

- [15] : Agencies carrying out self-endorsement need to provide adequate information to support the endorsement and present the information on request.
- [16] : A clear endorsement approach and guidelines needs to be presented to agencies carrying out the self-endorsement process for SPECIFIC protocols and standards.
- [17] : A possible incentive to carry out self-endorsement of SPECIFIC protocols and standards, is to provide a recognised quality “Stamp” to those agencies following the generic guidelines in the self-endorsement process. This may enhance sales (for a commercial company) or contracts (expert lab)
- [18] : For new protocols and standards developed in the future, conformance to the CEOS WGCV guidelines is a critical process, whether for commonly used protocols and standards for vicarious calibration or for SPECIFIC protocols and standards used in mission on-board calibration.
- [19] : A template or templates that captures the essential information requirements for a new protocol development or standard characterisation is required to provide a more uniform input of information for the endorsement process.
- [20] : Agencies which contract calibration activity should place a large emphasis within ITT’s for conformance to the CEOS WGCV guidelines to guarantee endorsement for both commonly used (vicarious) and specific calibration protocols and standards.

# Key Guidelines

- [22] : The more SPECIFIC protocols and standards, developed for traceability for specific missions, should be contracted in a more rigorous way by agencies and companies, so as to meet the CEOS WGCV guidelines.
- [23] : Guidelines and templates need to be prepared well in advance of use and made available to the wider community to prevent adhoc developments of protocols and standards that do not match the criteria for endorsement.
- [24] : The value of a quality stamp can be increased if a more rigorous process is implemented by agencies contracting calibration work. This is a necessary incentive to persuade the whole community on the usefulness of the procedure and implementation.
- [25] : As this is a self-endorsement process, a suitable disclaimer by the international endorsing body is required, as the responsibility for self-endorsement lies with the agency carrying out the process.