SOME NEEDED STANDARDS AND BEST PRACTICES FOR CALIBRATION AND VALIDATION OF REMOTE SENSING DATA

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ABSTRACT

Quality Assurance for Earth Observation data (QA4EO) requires a basic set of reference standards and best practices for evaluating and communicating the errors and biases within remote sensing data products. These products come from a wide variety of data sources employing differing calibration and validation methods. Reference standards play an important role in the development of Quality Indicators (QIs) that serve as measures of reliability for end-users of GEOSS-supplied remote sensing data. This paper presents the results of an initial effort to identify reference standards authored by a number of international organizations (e.g. ISO, NIST, and IEEE/ICEO) that best relate to the calibration and validation of remote sensing data.

Laboratory instruments, constructed at several national laboratories, with known measurement characteristics traceable to SI reference standards, provide critical measurements for new electro-optic satellite sensors that will be subject to a range of pre- and post-launch calibration procedures. EO and microwave instruments developed at NIST and NPL (e.g. NIST's TXR and NPL's TSARS radiometers) are cited as important examples.

Another type of standard, which can be used to underpin a QI, is a written set of specifications and/or standards aimed at assuring product or process reliability. ISO Technical Committee 211's work in developing documentation and metadata standards for the geographic information community is highlighted as well as certain standards put forth by the Open Geospatial Consortium (OGC) in the area of geospatial interoperability. Such written standards can also be used to specify documentation details and procedures necessary to establish the "traceability" of all instrument-based and software-based steps used in a wide range of calibration and validation processes employed by various remote sensing project teams. CEOS's Working Group on Cal/Val (WGCV) is cited as the body with specific responsibilities within GEO for defining Cal/Val best practices and reference standards. The WGCV has made "traceability" a crucial criterion for its Cal/Val Quality Assurance strategy.

The QA4EO guidelines document (published by CEOS/WGCV in September 2008) states that "data quality can be considered the key to GEOSS interoperability". The capabilities of several web-based tools that promote overall interoperability within the GEOSS core architecture are outlined in this paper. The GEOSS Components and Services Registry, the GEOSS Standards and Interoperability Registry and the GEOSS Best Practices Wiki (the latter two developed by the IEEE and its ICEO committees) are given as prime examples of on-line tools that can readily be utilized to link and service various GEO Cal/Val organizations (such as project-specific Cal/Val groups within NASA and ESA) that may operate under a broad set of standards. In addition, the ESA Cal/Val data portal, along with other similar world-wide remote sensing data portals, plays an important role in the storage, dissemination, and evaluation of interoperable EO data by making available to web-based clients a wide range of EO data along with the associated Cal/Val metadata. A recommended set of portal best practices, which can serve as a guide for improved portal usability and functionality, is also presented.

While the calibration and validation of specific remote sensing instruments and derivative data products is a vital step in assuring the veracity and quality of the output data, GEO is particularly concerned with the error of (or confidence in) specific data products delivered to a typical end-user. A typical end-user will most likely fall within one of GEO's nine societal benefit areas (e.g. water, climate, agriculture, disaster, etc). Certain end-user products [e.g. a leaf area index (LAI) map, derived from MODIS optical sensor data, made available to a farmer in Africa] may not require the super-low levels of calibration error often cited as design goals for various high precision remote sensing systems. The validity and reliability of the algorithms used to derive such products must also be considered. Construction of a meaningful data Quality Indicator policy requires that "fitness of purpose" be a guiding criterion.

We present, at the conclusion of this paper, a proposal to establish a set of relationships between Cal/Val data-quality requirements for remote sensing instruments (e.g. EO radiance accuracy) and representative user-centered error tolerance. A detailed study is recommended to determine how best to couple the requirements for instrument calibration to the accuracy requirements for a typical end-user who is associated with one or more of GEO's nine societal benefit areas. Once a set of end-user requirements is developed (e.g. I need to know leaf area index, LAI, to within 5%; or I need to know if 80% or more of my crop is currently viable), the goal will be to mark, via a set of QIs, those calibrated data sets that can be confidently considered suitable for a specific end-user's problem. Once the effort to establish such a relationship between instrument error and end-product error is established, GEOSS will have an important set of criteria for defining meaningful data Quality Indexes for the user. Establishing such a "fitness for purpose" Quality Index is one of the primary goals set for the CEOS/WGCV calibration/validation community and an ultimate goal of this paper.