CGMS-XXVIII
USA-WP-20
Agenda Item: II.2

# INTER-CALIBRATION OF SATELLITE SENSORS IN THE VISIBLE AND NEAR-INFRARED


**SUMMARY AND PURPOSE OF DOCUMENT**

An overview of research underway in the area of inter-calibration of satellite sensors in the visible and near-infrared at NOAA/NESDIS

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# INTER-CALIBRATION OF SATELLITE SENSORS IN THE VISIBLE AND NEAR-INFRARED

Inter-calibration of satellite sensors in the visible and near-infrared (.0.5 to 1.8μm) will be central to the establishment of blended records of satellite-derived Earth system products (e.g., Normalized Difference Vegetation Index; short-wave radiation climatology; aerosol climatology over oceans; land surface characteristics), and to ensure the accuracy, continuity, and viability of the same. Such records are an essential requirement to attain the objectives of national and international programs/activities directed towards investigations of climate and global change [e.g., the World Climate Research Programme, the International Geosphere Biosphere Program; the global climate, terrestrial, and ocean observing systems (G3OS)]. Thus, there is a keen need to blend geophysical data generated either with the same instrument on successive members of a spacecraft series [e.g., the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA polar orbiters], or with different instruments on different spacecraft (e.g., visible and near-infrared sensors of the AVHRR on the NOAA polar orbiters; the Along-Track Scanning Radiometer-2 (ATSR-2) on the European Remote Sensing satellite; the Moderate-Resolution Imaging Spectroradiometer (MODIS) on NASA's TERRA].

Against this background, a study of the issues related to inter-calibration of satellite sensors, with emphasis on the feasibility of using the AVHRR as a calibration reference or standard, is presently underway at the NOAA/NESDIS Office of Research and Applications. The main components of the study are: (a) determination of criteria that would govern, in the main, the inter-calibration of satellite sensors, taking into account the impact of differences in the spectral and spatial resolution characteristics of the same; (b) evaluation of the feasibility of using the AVHRR as a calibration standard; and (c) development of simple, user-friendly formulae for the calculation post-launch calibration coefficients as a function of elapsed time in orbit. As part of this study, we have looked at the visible and near-infrared sensors on NOAA's Polar-orbiting Operational Environmental Satellite spacecraft (POES), and the Geostationary Operational Environmental Satellite spacecraft (GOES); NASA's Earth Observing System TERRA spacecraft; METEOSAT; the Along-Track Scanning Radiometer-2 on the European Remote Sensing satellite; and the sensors scheduled for flight on ENVISAT.

Our basic approach has been to characterize the in-orbit performance of any given sensor (candidate sensor), using a well-characterized sensor (reference sensor) as a calibration standard. The simple inter-calibration technique consists of two parts: (a) establishing the in-orbit degradation of the sensors, or the stability of the on-board calibrator, using radiometrically stable terrestrial targets (e.g., desert sites; snow fields of Greenland and Antarctica), and (b) rendering the relative degradations thus determined absolute, using model-derived inter-relationships between the top-of-the-atmosphere albedos measured by the two sensors; the model simulations are performed for a very representative set of atmospheric and surface conditions, and of solar illumination and viewing geometries. It is estimated that radiometric calibration accuracy of the order of 5% can be attained using the above procedure.

We have successfully used this technique to characterize the in-orbit performance of the visible channels of the GOES Imager, and the High Resolution Infrared Radiation Sounder (HIRS) on the NOAA polar orbiters, using the visible channel of the AVHRR as a calibration standard. User-friendly formulae for the calibration coefficients for the HIRS and GOES Imager visible channels as a function of elapsed time in orbit, expressed in days after launch, have been developed. A variant of this technique has been used to monitor the in-orbit stability of the onboard calibrator of the Along-Track Scanning Radiometer-2. Procedures have been developed to calibrate in near-real time the visible and near-infrared channels of MODIS, using the ATSR, and to some extent the AVHRR, as calibration standards.

Based on our investigations to date, we have established general criteria that should be met in order for the inter-calibration of satellite sensors in the visible and near-infrared to be meaningful; they are:

(1) There should be considerable overlap in the spectral regions covered by the two sensors (candidate and reference sensor);
(2) Atmospheric (e.g., scattering and absorption by the gaseous and particulate constituents) and surface ( e.g., wavelength dependence of surface reflection) effects over the spectral regions covered by the two sensors should be similar; and,
(3) The effective wavelengths of the two sensors must be close to each other.

In a closely related activity, we are investigating different methods to ensure the traceability of satellite radiance measurements to *Systéme Internationale Unités* (SI units) which will play a key role in he generation of viable lended data sets. This is a collaborative effort among NOAA/NESDIS, the National Institute of Standards and Technology (U.S.A.), and the National Physical Laboratory (U.K.), under the aegis of the Working Group on Calibration and Validation, Committee on Earth Observation Satellites. As part of the same activity, the feasibility of using the International Space Station as a platform for SI-traceable reference spectroradiometers to calibrate satellite radiometers during overpass is being investigated.

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