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Prepared by: C.R. Nagaraja Rao
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POST-LAUNCH CALIBRATION OF THE VISIBLE AND NEAR-INFRARED CHANNELS OF THE ADVANCED VERY HIGH RESOLUTION RADIOMETER AND THE GOES IMAGER

An overview of operational and proposed calibration procedures at NOAA/NESDIS for the polar orbiting AVHRR visible and near-infrared channels, and for the visible channel of the GOES Imager is presented.

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The visible and near-infrared channels [channel 1 (□ 0.58 - 0.68μm); channel 2 (□ 0.72 - 1.1μm); and channel 3A (□ 1.58 - 1.64μm)] of the Advanced Very High Resolution Radiometer (AVHRR) flown on NOAA=s polar-orbiting satellites, and the visible channel (□ 0.52 - 0.72μm) of the Imager flown on the geostationary satellites (GOES) have no onboard calibration. There is ample evidence that these channels degrade in orbit, initially because of outgassing and launch-associated contamination, and subsequently because of the continued exposure to the harsh space environment. Thus, vicarious calibration procedures have to be used to characterize the post-launch performance of these sensors in order to ensure the accuracy, continuity, and integrity of geophysical products generated utilizing measurements of the upward radiation at the top of the atmosphere made by the same.

As part of the NOAA/NASA Pathfinder Program (Ohring and Dodge 1992), the potential and limitations of various vicarious calibration techniques for satellite radiometers were studied, and it was decided to employ the technique based on using radiometrically stable desert sites as calibration targets to determine the relative degradation in orbit of the AVHRR visible and near-infrared channels. Radiometric stability implies long-term constancy in time of the top-of-the-atmosphere reflectance over large spatially homogeneous areas. A site located in the southeastern part of the Libyan desert (21 - 23^0 N; 28 - 29^0E) was chosen as the calibration site for the AVHRR. Determination of the relative degradation of the sensors is described in Staylor (1990) and in Rao and Chen (1995). The relative degradations were rendered absolute for the NOAA-7, -9, and -11 AVHRRs by anchoring them to congruent path radiance measurements (Smith et al. 1988; Abel et al. 1993) made by the AVHRR and a calibrated spectro-radiometer on board an ER-2 aircraft flying at an altitude of □20 km over White Sands, New Mexico, U.S.A. The calibration coefficients, and the inter-satellite calibration linkages thus developed for channels 1 and 2 of the NOAA-7, -9, and -11 AVHRRs (Rao and Chen 1995), have been used in the development of the Pathfinder AVHRR atmosphere and land data sets for the period 1981-91(e.g., James et al. 1994; Jacobowitz 1999).

Drawing upon the Pathfinder experience, a simple technique has been developed to update the calibration of the visible and near-infrared channels of the AVHRR in near-real time, using a multi-year time series of the top-of-the-atmosphere reflectance of the Libyan desert site, based on AVHRR and Along-Track Scanning Radiometer measurements, as a calibration reference (Rao and Chen 1999). Monthly updates of the calibration of the AVHRR on NOAA-14 are presently furnished to the user community by NOAA. A first in the history of the AVHRR was achieved when channels 1, 2, and 3A of the AVHRR on the NOAA-15 spacecraft were calibrated within six weeks after launch using this technique.

A procedure similar to the one used for the AVHRR has been employed to determine the in-orbit degradation of the visible channel of the Imager on GOES. The regional coverage of the GOES sensors limits the choice of appropriate calibration sites. A site located in the Sonora desert (32^0N; 114.1^0), Mexico, is used as a radiometrically stable calibration target. The relative degradation thus determined is rendered absolute by utilizing the visible channel of the AVHRR on the NOAA-14 spacecraft as a calibration reference; details of the procedure are found in Rao et al. (1999). Work is also underway to use stars as stable illumination sources to determine the relative degradation in orbit of the GOES Imager visible channel (Bremer et al. 1998).

It is expected that calibration accuracies of the order of ± 5 per cent can be attained in the visible and near-infrared using combinations of vicarious techniques.

Other related activities in the general area of calibration of visible and near-infrared satellite sensors include: (1) Feasibility study of using the AVHRR as a calibration reference for visible and near-infrared sensors on platforms such as Terra, INSAT, and Envisat to gain insight into the intricacies of inter-sensor calibration; (2) Identification and analysis of inter-sensor calibration requirements for the generation of blended or fused data sets; and (3) Development of a comprehensive satellite sensor calibration strategy (Rao 1998).

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