COOPERATIVE INSTITUTE
FOR
CLIMATE and SATELLITES (CICS)

Scientific Report

For the period:
July 1, 2009 – March 31, 2010

NOAA Grant NA09NES4400013

Dr. Phillip Arkin
Director

April 1, 2010
A Recalibration of the AVHRR Data Record to Provide An Accurate and Well Parameterized FCDR

J. Mittaz, A. Harris; (NOAA Collaborator: Eileen Maturi) – JMJJMAVHRR10

Background: Scientific Problem, Approach, Proposed Work

As is becoming more and more apparent, the current calibration of the Advanced Very High Resolution Radiometer (AVHRR) sensor has introduced biases and errors which must be removed if we are to produce an accurate fundamental climate data record (FCDR) from the more than 25 years of AVHRR data. Recently it has been shown by us that the observed biases and errors can be removed by using a completely new physically based calibration methodology which has also highlighted the complex sources of bias and error in both the pre-launch and in-orbit data. By including effects such as stray light and instrument temperature drifts, our new calibration can remove much of the source of error currently seen in AVHRR radiances and provide a nearly zero bias calibration. The new calibration also has the capability of predicting instrument gain during times when the on-board calibration data are affected by solar and/or Earthshine contamination and during times when there are thermal gradient problems over the internal calibration target (ICT). Solar contamination has been a significant problem for many NOAA platforms as their equator crossing times drift and our work on the in-orbit behavior of the AVHRR instrument also shows that the daytime segments of morning satellites at least may be affected by strong thermal gradients. The presence of such effects in the current data record will have lead to inconsistencies in the time series, for example, but our ability to predict the calibration over bad times should lead to a more consistent FCDR than is currently available.

We will approach the recalibration is a number of ways. Firstly, we will use our new calibration equation thereby removing scene and instrument temperature dependent biases introduced by the current operational calibration. Secondly, because the pre-launch test data suffered from significant scattered light problems as well as poor test procedures many of the derived calibration coefficients were corrupted and are unusable for the in-orbit data. Therefore, we will rederive the effected calibration parameters using accurate top-of-atmosphere (TOA) radiance sources such as the (Advanced) Along Track Scanning Radiometer ((A)ATSR) series or hyper-spectral sounders such as the Infrared Atmospheric Sounding Interferometer (IASI). In essence, we match AVHRR radiances with our TOA radiance sources and refit our AVHRR calibration so that the AVHRR matches our TOA calibrators. Preliminary work done before this project started shows the power of this technique (see Fig. 1). For the modern AVHRRs we can also use IASI and AIRS to refine any spectral response function (SRF) shifts that may be needed. For the historic dataset our baseline calibration source will be the (A)ATSR series as these sensors are known to be well calibrated to better than 50mK and can go back to 1991. For the (A)ATSR comparisons we will use RTM based techniques to look at
the problem of SRF shifts. Pre-1991 we will investigate a range of approaches including using the AVHRR overlap periods and/or using RTM simulations as a baseline. Validation of these techniques will be done using current era data where we can independently derive the calibration. Once the optimum method of deriving the new AVHRR calibration pre-1991 is found, we will be able to derive the complete AVHRR data record acceptable for use for climate data studies.

Figure 1. The left hand panel shows a comparison of the biases present in the Walton et al. calibration (operational) relative to IASI radiances. Right hand panel shows the new (Mittaz et al.) calibration relative to the same data set. The data shown here is independent of any fitting to IASI data.