Future Flight Opportunities and Calibration protocols for CERES : Continuation of Observations in support of the Long-Term Earth Radiation Budget Climate Data Record

The goal of the Clouds and the Earth's Radiant Energy System (CERES) project is to provide a long-term record of radiation budget at the top-of-atmosphere (TOA), within the atmosphere, and at the surface with consistent cloud and aerosol properties at climate accuracy. CERES consists of an integrated instrument-algorithm validation science team that provides development of higher-level products (Levels 1-3) and investigations. It involves a high level of data fusion, merging inputs from 25 unique input data sources to produce 18 CERES data products. Over 90% of the CERES data product volume involves two or more instruments.

Continuation of the Earth Radiation Budget (ERB) Climate Data Record (CDR) has been identified as critical in the 2007 NRC Decadal Survey, the Global Climate Observing System WCRP report, and in an assessment titled 'Impacts of NPOESS Nunn-McCurdy Certification on Joint NASA-NOAA Climate Goals'. Five CERES instruments have flown on three different spacecraft: TRMM, EOS-Terra and EOS-Aqua. In response, NASA, NOAA and NPOESS have agreed to fly the existing CERES Flight Model (FM-5) on the NPP spacecraft in 2011 and to procure an additional CERES Sensor with modest upgrades for flight on the JPSS C1 spacecraft in 2014, followed by a CERES follow-on sensor for flight in 2018.

CERES is a scanning broadband radiometer that measures filtered radiance in the SW (0.3-5 µm), total (TOT) (0.3-200 µm) and WN (8-12 µm) regions. Pre-launch calibration is performed on each Flight Model to meet accuracy requirements of 1% for SW and 0.5% for outgoing LW observations. Ground to flight or in-flight changes are monitored using protocols employing onboard and vicarious calibration sources. Studies of flight data show that SW response can change dramatically due to optical contamination. with greatest impact in blue-to UV radiance, where tungsten lamps are largely devoid of output.

While science goals remain unchanged for ERB Climate Data Record, it is now understood that achieving these goals is more difficult for two reasons. The first is an increased understanding of the dynamics of the Earth/atmosphere system which demonstrates that separation of natural variability from anthropogenic change on decadal time scales requires observations with higher accuracy and stability than originally envisioned. Secondly, future implementation scenarios involve less redundancy in flight hardware (1 vs. 2 orbits) resulting in higher risk of loss of continuity and reduced number of independent observations to characterize performance. Although CERES observations realize a factor of 2 to 4 improvement in accuracy and stability over previous ERBE observations, future observations require an additional factor of 2 improvement. Modest investments in onboard calibration hardware and pre-flight calibration will ensure meeting these goals while reducing costs in re-processing scientific datasets.

The current effort summarizes proposed improvements to the CERES pre-flight sensor characterization program , as well as the in-flight radiometric calibration and validation subsystems and analysis protocol and operational tasking to ensure that science requirements continue to be met in the new operational environment. In addition, an estimate of the impacts to the system level accuracy and traceability is presented.