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On-Orbit Absolute Radiance Standard for the Next Generation of IR Remote Sensing Instruments

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The next generation of infrared remote sensing satellite instrumentation, including climate benchmark missions will require better absolute measurement accuracy than now available, and will most certainly rely on the emerging capability to fly SI traceable standards that provide irrefutable absolute measurement accuracy. As an example, instrumentation designed to measure spectrally resolved infrared radiances with an absolute brightness temperature error of better than 0.1 K will require high-emissivity (>0.999) calibration blackbodies with emissivity uncertainty of better than 0.06%, and absolute temperature uncertainties of better than 0.045K (k=3). Key elements of an On-Orbit Absolute Radiance Standard (OARS) meeting these stringent requirements have been demonstrated in the laboratory at the University of Wisconsin and are undergoing further refinement under the NASA Instrument Incubator Program (IIP). This work will culminate with an integrated subsystem that can provide on-orbit end-to-end radiometric accuracy validation for infrared remote sensing instruments. We present the new technologies that underlie the OARS and updated results of laboratory testing that demonstrate the required accuracy. The underlying technologies include on-orbit absolute calibration of the imbedded blackbody cavity temperature sensors using the transient melt signatures of small quantities (<1g) of reference materials (gallium, water, and mercury) that are also imbedded in the cavity; and on-orbit cavity spectral emissivity measurement using a heated halo. Absolute temperature calibration of the temperature sensors at the reference material melt points has been demonstrated to better than 10 mK (k=3), both before and after exposure to simulated full life cycle testing. The blackbody emissivity is measured using a broadband source (heated halo) placed out in front of the cavity that is viewed by the spectroradiometer that normally views the cavity for calibration verification, but in this case it is measuring the reflected signal of the heated halo. With the knowledge of the heated halo and effective background temperatures, and the solid angle view factor of the cavity view to the halo, the cavity emissivity can be calculated. Laboratory measurements of an OARS type blackbody, with a spectral emissivity greater than 0.999, have been made with uncertainties less than 0.0004 (k=3).