SSMIS Calibration Anomalies: Observed F-16 and F-17 Anomalies, Detailed Analysis of the Root Causes, and the Path Forward

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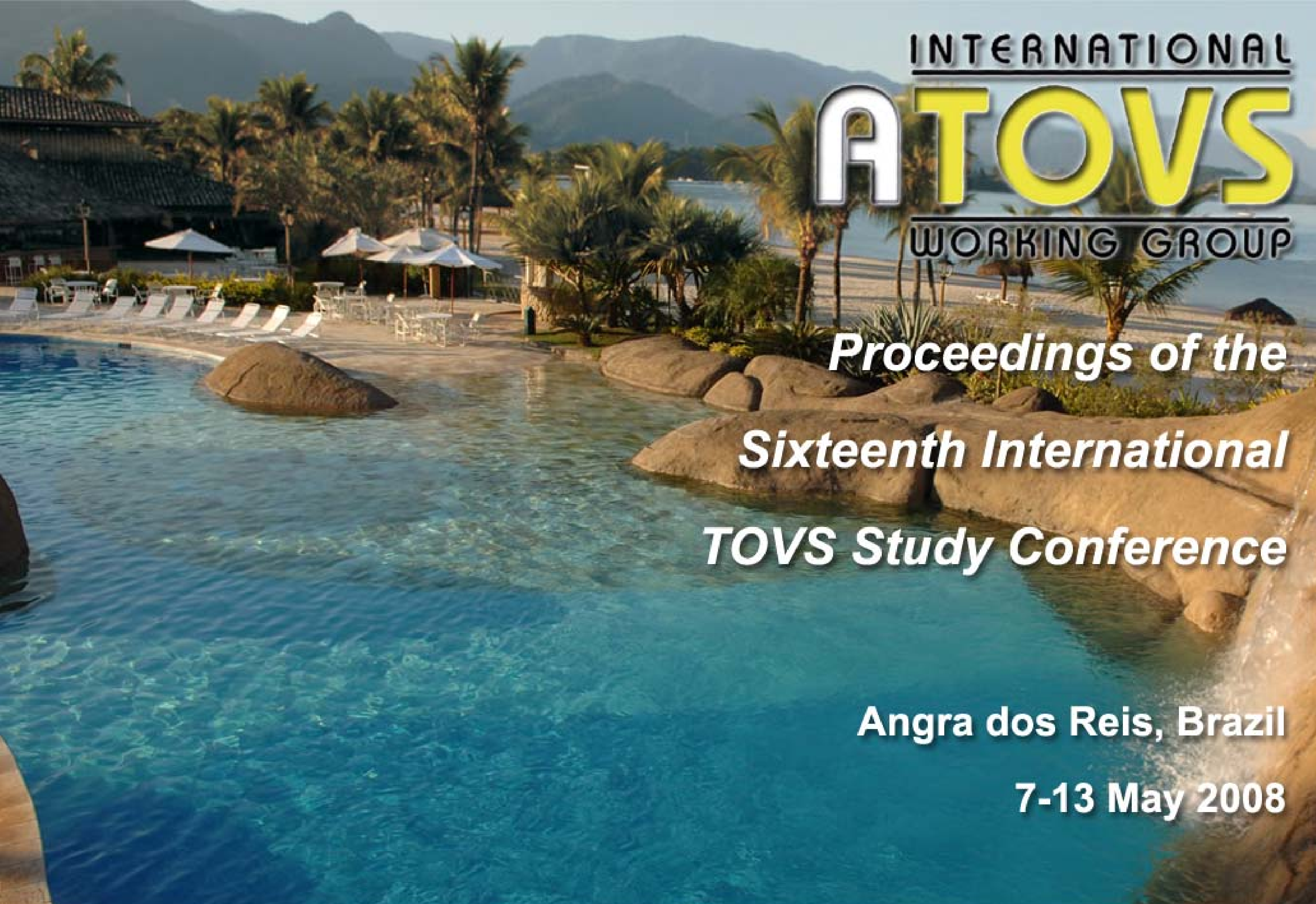
Detailed descriptions and comparisons of the observed F-16 and F-17 SSMIS radiometric calibration anomalies uncovered during the Calibration and Validation (Cal/Val) efforts are presented. As previously described for F-16, two principal anomalies were detected: an intermittent solar intrusion to the warm load calibration target; and reflector emission due to solar heating of the reflector face itself. The solar intrusion anomaly is readily evident in the time series of the individual channel radiometer gains, and can result in as much a 1.5 K peak depression in the observed scene temperatures. A Fourier based filtering mitigation strategy has been implemented to perform the gain filtering in the SSMIS ground processing software for the sensor data records (SDRs). Performance of the F-17 hardware modifications designed to inhibit the direct solar intrusions is presented. The reflector emission bias is a function of both the frequency dependent reflector emissivity and the difference between the reflector face and Earth scene temperatures. Warm biases of 1-2.5 K in the 50-60 GHz channels and up to 5 K in the high frequency channels (150-183 GHz) are observed. These anomalies correspond to reflector emissivities of ~0.015 at 50 GHz to as high as 0.07 at 183 GHz. For F-16 the reflector thermal cycle and resulting emission anomaly is driven by earth and/or spacecraft shadow, and is a maximum when the reflector face is directly illuminated by the sun. F-17 is in the terminator orbit configuration and shading due to the solar panel array dominates the thermal cycle of the SSMIS main reflector. Investigations were performed to directly measure the effective surface electrical conductivity of the main reflectors to determine the root-cause of the apparent high emissivities. Techniques were developed to perform laboratory measurements of the remaining SSMIS flight-unit reflectors have indicated the feasibility of low surface electrical conductivities of the F-16 and F-17 reflectors (i.e. less than 1.0 MS/m) compared with pure aluminum (36 MS/m). Low conductivities were also evident on the reflectors intended for use on other precision space–based microwave radiometer systems. Procedures to determine the electrical conductivity of the reflectors are now part of the pre-flight analysis for future SSMIS instruments. Methods have also been developed to strip existing coatings and re-coat the reflectors to meet the necessary electrical conductivity criteria (~18 MS/m) for a negligibly emissive reflector. The main reflector of the third SSMIS instrument

(F-18) scheduled for launch in mid 2008 has been replaced with a spare reflector having significantly higher conductivity (17-18.5 MS/m) is expected to reduce the on-orbit reflector emission to a negligible level.



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