Characterization of low-loss reflectors for spaceborne microwave radiometers

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Abstract**—** Every reflector of a microwave radiometer will introduce a certain loss which affects the sensitivity and radiometric accuracy of the instrument. These losses depend on material properties of the reflector, the frequency, as well as on the incidence angle and polarization. An accurate measurement of the losses is required in order to select the optimum reflector coating and to correct the losses in the calibration process.

We characterized different reflector samples of the Ice Cloud Imager (ICI, 183-670 GHz) and the Microwave Sounder (MWS, 23-230 GHz) instruments of the Meteorological Operational Satellite - Second Generation (MetOP-SG). The samples were provided by Airbus Defence and Space Madrid and Friedrichshafen. One purpose of these tests was to determine the influence of the coating materials and processes, of the surface roughness, and of aging due to long term storage which was simulated by accelerated lifetime tests in high humidity and high temperature. The second purpose was to provide a lookup table of the resulting reflector losses depending on the frequency bands, incidence angles and variable polarizations during the ICI and MWS operation. These values, and their associated uncertainty, are needed for the radiometric error model of the two instruments.

It is not trivial to determine the reflector losses with the required measurement accuracy of about 0.1%. For the lowest frequency of the MWS instrument at 23 GHz we used a custom built circular waveguide cavity. For all higher frequency bands up to 640 GHz we used a free space cavity in which the sample was inserted either at normal incidence or at an incidence angle of 45º with either TE or TM polarization. The resulting resonance lines of the cavity were measured with a submm vector network analyzer. The quality factor Q of these resonances is a measured of the total cavity losses. It was determined by a simultaneous least squares fit of the amplitude and phase of the complex valued measurements. In the data analysis all additional loss factors need to be considered, including atmospheric losses, coupling losses and truncation losses. In the end we compare the measurement results with the different frequencies and incidence cases with an analytical model based on ideal reflectors with finite a conductivity.

The talk will give an introduction to the theory of reflector losses and the used resonators. After an overview of the test results it will discuss the resulting calibration bias of the MetOP-SG instruments.