Observation and Modeling of Atmospheric Oxygen Millimeter-wave Transmittance

by

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Abstract

The Microwave Temperature Sounder (MTS) was used on multiple ascents and descents of NASA ER-2 aircraft to measure downwelling thermal atmospheric emission viewed from 0-20-km altitudes in millimeter-wave bands dominated by molecular oxygen, and to infer atmospheric opacity in these bands. The MTS includes two super-heterodyne receivers: one with eight IF channels covering 350-2000 MHz from the 118.75-GHz oxygen line and the other with 20-300 MHz IF and a tunable LO stepped through eight frequencies from 52.7-55.6 GHz. Simulations of MTS zenith-view antenna temperatures based upon local radiosondes and the MPM92 absorption model of Liebe, *et al.* [50] were consistent with observations in the 52.5-55.8 GHz band. Adjustment of the temperature dependence exponent of the 118.75-GHz linewidth from the MPM92 value of 0.8 to 0.97±0.03 was found to produce significantly better agreement in observations with MTS channel centered on this line. This increase in low-temperature linewidth changes total atmospheric opacity in these channels by less than 2.5 percent.

Other investigators have noted systematic discrepancies as large as several Kelvin between measured and simulated upwelling brightness temperatures, both in satellite observations of the earth in the 50-60 GHz band and in nadirial-viewed MTS observations from 20-km altitude in the band 116.7-120.8 GHz. Resolution of these biases through adjustment of the oxygen absorption model requires increases in the MPM92 expression of up to 20 percent. The utility of current and proposed satellite-based millimeter-wave temperature sounders for the monitoring of global climate, the initialization of numerical weather models, and the remote monitoring of severe weather systems is compromised by this model uncertainty.

The zenith-viewing configuration through ascents and descents of the current MTS measurements are several times more sensitive to perturbation of atmospheric opacity than are space-based observations. The implication of the current results is that errors in the oxygen absorption model are not the source of observed discrepancies. Reexamination of the satellite instruments' response characteristics is indicated.

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