

Airborne Full Polarization Radiometry Using the MSFC Advanced Microwave Precipitation Radiometer (AMPR)

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The applications of vertically and horizontally polarized brightness temperatures in both atmospheric and surface remote sensing have been long recognized by many investigators, particularly those studying SMMR and SSM/I data. Here, the large contrast between the first two Stokes' parameters (T_V and T_H) can be used for detection of sea ice, measurement of ocean surface wind speed, and measurement of cloud and water vapor opacity. High-resolution aircraft data from instruments such as the NASA/MSFC AMPR is crucial for verifying radiative transfer models and developing retrieval algorithms. Currently, the AMPR is outfitted with single-polarization channels at 10, 18, 37 and 85 GHz. To increase its utility, it is proposed that additional orthogonal linearly-polarized channels be added to the AMPR. Since the AMPR's feedhorns are already configured for dual orthogonal linearly polarized modes, this would require only a duplication of the currently existing receivers. To circumvent the resulting polarization basis skew caused by the cross-track scanning mechanism, the technique of Electronic Polarization Basis Rotation [1-3], developed by the authors with support from NASA/MSFC and NASA/GSFC, is proposed to be implemented. Implementation of EPBR requires precise measurement of the third Stokes parameter $T_U = \langle E_V E_H^* \rangle$, and will eliminate polarization skew by allowing the feedhorn basis skew angle to be corrected in software. In addition to upgrading AMPR to dual polarization capability (without skew), the modifications will provide an opportunity to demonstrate EBPR on an airborne platform. This is a highly desirable intermediate step prior to satellite implementation.

However, only recently have potential remote sensing applications of the third Stokes parameter T_U been investigated [3-6]. Laboratory measurements by the authors using a full polarization radiometer and a rotatable wave tank have shown values of T_U of amplitude up to ± 5 K that are directly related to the orientation of small gravity waves [6]. This effect, which has been corroborated using radiative transfer calculations based on the Kirchoff method, is observed at both extreme incident angles ($\sim 65^\circ$) and near nadir. In order to further investigate the use of T_U for remote sensing of surface state variables such as ocean surface wave direction, airborne experiments are needed. As modified for EBPR, the AMPR would have the capability to accurately measure T_U throughout its entire scan range, thus providing important scientific field data on these radiation-polarizing phenomena.

As previously proposed to NASA by the authors, EPBR modifications to AMPR are suggested to proceed via two phases: (1) First, the 37-GHz channel would be modified. A polarized calibration load would be constructed for ground-based referencing, but would not be used during flight. The 37-GHz channel would provide initial information on the potential of airborne T_U measurements. (2) Pending successful modification of the 37-GHz channel the 10, 18 and 85-GHz channels would be modified. The total time required for the modifications and subsequent aircraft experiments would be approximately three years. (Further details concerning this proposal are

available from the authors.) Modifications would be performed by the author and students within the Laboratory for Remote Sensing at the Georgia Tech School of Electrical Engineering. These individuals are uniquely qualified for airborne investigations involving polarimetric radiometry.

References

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