

**UNIVERSITY OF WISCONSIN-MADISON SPECTRE PROJECT SUMMARY**

William L. Smith, Principal Investigator  
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**I. MAIN RESEARCH ACCOMPLISHMENTS**

**A. Project Goals**

The stated goals of the SPECTRE experiment are (1) to close the loopholes present in previous comparison of calculation to measurement through use of uplooking radiance measurements and use of instantaneous temperature and moisture profile measurements and (2) to make radiation field observations close to the 1% accuracy level needed to test radiation and climate models. The UW-Madison contributions to this project make it certain that these goals will be accomplished successfully.

**B. Towards Goal #1**

The University of Wisconsin has contributed to the first goal by developing and fielding an uplooking interferometer spectrometer, operating at  $0.5 \text{ cm}^{-1}$  (unapodized) resolution, able to function continuously in the field. The first year of this project contributed substantially to the refinement of a development system, known parochially as the "Baby HIS", and to the design and fabrication of a second generation uplooking system, the Atmospheric Emitted Radiance Interferometer (AERI). The AERI system development has been funded separately under the Department of Energy Atmospheric Radiation Measurement Instrument Development Program. The second year of this project supported the field measurements made at the SPECTRE site at the Coffeyville, KS airport which was colocated with the NASA FIRE II central site. Both the first generation Baby HIS and the second generation AERI instruments were operated at the SPECTRE site. The AERI instrument operated successfully during all of the SPECTRE intensive operation (IOP) periods as well as the FIRE IOPs. The collocated Baby HIS was operated concurrently with the AERI during several clear sky IOPs to allow later calibration intercomparison.

Another contribution to the first goal has been the development and application of remote sensing algorithms to the infrared spectral data for the purpose of retrieving cloud radiative properties and instantaneous vertical profiles of temperature and water vapor from the surface up through the

planetary boundary layer. This activity, though begun in 1988 before the beginning of the SPECTRE project, has been significantly advanced in the period during and after the Coffeyville field experiment. The first continuous time sequence of boundary layer temperature and moisture retrieval showing the detailed development and decay of the nocturnal temperature inversion was obtained using data from the SPECTRE experiment. The application of the algorithm is being extended to other periods. Cloud base altitude and effective cloud Ice/Water content and particle radius are retrieved and provide the simultaneous measure of the cloud radiative properties (i.e., emissivity, transmissivity, and reflectivity spectra). The unique contribution of these measurements is the simultaneous measurement of cloud radiative properties and boundary layer temperature and moisture profiles (at ten minute intervals) with equal accuracy during night and day. Algorithms are under continual refinement to improve the retrieval accuracy of these important ARM measurement parameters.

### C. Towards Goal #2

The second goal of making radiometric measurements at the 1% level is the central focus of the instrument development program at the University of Wisconsin. The radiometric instrumentation used for the SPECTRE project was the latest in a series of advanced systems designed to accurately measure infrared atmospheric emission at moderately high spectral resolution. In fact, the High-resolution Interferometer Sounder (HIS) was flown over the SPECTRE/FIRE site as part of the NASA FIRE II experiment. This instrument has also been used at UW-Madison, where it is co-located with the Baby HIS and AERI, to assist in the definition of the more recently developed systems. The SPECTRE field measurements were all processed in real-time with a preliminary calibration which has a systematic uncertainty which is already of order 1%, i.e. 1% of a blackbody at ambient temperature. Since the SPECTRE experiment was the first field test of the AERI instrument, several key instrument parameters had not yet been determined precisely. These include the laser wavenumber of the instrument which determines the precise laser sampling interval, the onboard blackbody cavity emissivities, and the longwave (MCT) detector nonlinear response to incident radiation. All of these quantities have been determined with reasonable certainty in laboratory measurements made at the Space Science and Engineering Center during the period following the field experiment. A final calibration of all the SPECTRE data will include these refined parameters to obtain a final accuracy that will be within the 1% goal set by the SPECTRE project. Measurements of this accuracy will be very useful in identifying spectroscopic and modelling errors in forward radiance models, such as those used in climate models.

## II. RESEARCH TRAINING

This project has supported the training of several individuals in the science of remote sensing measurements. These have included both foreign visiting scientists to CIMSS, the Cooperative Institute for Meteorological Satellite

Studies of which the PI is director, and graduate students of PI in the UW-Madison Atmospheric and Oceanic Department.

### III. BIBLIOGRAPHY

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