FY 1991

ARM
Atmospheric Radiation Measurement Program

HIGH-SPECTRAL-RESOLUTION RADIANCE MEASUREMENTS FOR THE ARM PROGRAM

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Objective. To design and deliver three instruments to CART sites to provide the highly accurate observations needed for detailed comparisons with line-by-line calculations (such as FASCODE3) and for determining the radiative characteristics of clouds, aerosols, and trace gases.

Product. Fourier-transform infrared-spectroscopic expertise and instrumentation to support the improvement of high-resolution line-by-line radiative-transport codes and to improve the physical understanding of longwave radiation transport in the atmosphere.

Approach. Three instrument types will be developed to provide the highly accurate observations needed for detailed comparisons with line by-line calculations and for determining the radiative characteristics of clouds, aerosols, and trace gases. Two will make highly accurate measurements of the atmosphere-emitted radiation (AERI and AERI-X), and the third (SORTI) will measure the atmospheric transmission to high accuracy with observations of the sun at different air masses.

The AERI (atmospheric emitted radiance interferometer) instrument will operate over the spectral range of 4 to 20 microns (2500 to 500 wavenumbers) at a resolution of 1 wavenumber. It will be sufficiently inexpensive to be deployed throughout the ARM networks and, as such, will provide the link of point measurements to the larger scale. A system of AERI instruments would also provide important 3-D measurements of meteorological parameters in the lower atmosphere.

The AERI-X instrument will provide improved spectral resolution (0.1 wavenumber) over the wavelength range of 4 to 20 microns. It will provide the higher spectral resolution needed at a more limited number of locations to acquire the best available emission observations for comparison with line-by-line calculations.

The Solar Radiance Transmission Interferometer (SORTI) measurements with a resolution of 0.002 wavenumber will yield the atmospheric transmission at essentially full resolution. It will reveal deficiencies in the way model calculations handle absorption line shapes and line interactions. Prototypes of all instruments will be

delivered for testing at the first CART site in 1992.

Results to Date. Design concepts have been verified for the AERI, AERI-X, and SORTI. The AERI and AERI-X will require accurate calibration procedures integral to the system designs. These concepts have been extensively tested with a complete development system. Tests included the successful participation in the WISP/ARM field experiment at Platteville, Colorado, in March 1991. Key instrument subsystems extensively analyzed with the development system include the black-body heater controller, the temperature monitoring system, the scene switching-mirror controller, and the interferometer-data ingest and formatting functions. In addition, software has been written to provide real-time calibrated products within minutes of the atmospheric observations. The black-body cavities used in the development system have been carefully modelled with a thermal analysis program validated with laboratory test data. This model has been extrapolated to the larger black-body cavities required for the AERI and AERI-X systems while maintaining a high degree of temperature uniformity. In addition, the highest-resolution interferometer hardware has been extensively tested in comparison with BOMEM and BRUKER products. Both instrument options demonstrated the sensitivity needed for the SORTI and AERI-X instruments.
