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High Spectral Resolution FTIR Observations for the ARM Program: Continued Technique Development, Data Evaluation and Analysis

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OBJECTIVE: To develop three types of instruments that provide highly accurate observations of emitted atmospheric radiation and of infrared atmospheric transmission and to develop techniques for using the data in spectroscopic and remote-sensing applications.

APPROACH: State-of-the-art Fourier-transform-infrared (FTIR) radiometric instrumentation is being developed to acquire high-spectral-resolution, infrared, atmospheric radiance and absorption data, especially in atmospheric window regions where the water vapor continuum is important. Three instrument types are being developed: □ The standard AERI operates over the spectral range of 3.3 to 19 microns (520 to 3020 wavenumbers) at a resolution of 0.5 wavenumber. An extended-spectral-range version is also under development to extend the longwave limit to 24 microns for Arctic applications, where the low level of water vapor makes longer wavelengths important to the surface radiation budget. □ The AERI-X instrument provides improved spectral resolution (0.1 wavenumber, apodized) over the wavelength range from 6 to 14 microns (700 to 1500 wavenumbers). The higher spectral resolution of AERI-X will yield the best available emission observations for detailed evaluation of line-by-line calculations. It will also allow the potential advantages of still higher spectral resolution for atmospheric remote sensing to be explored. □ The SORTI tracks the sun to obtain absorption spectra at extremely high spectral resolution (0.0035 wavenumber, apodized), essentially at the full resolution of atmospheric absorption for one or more air masses. It will cover the range from 2.5 to 14 microns (700 to 4000 wavenumbers) to reveal deficiencies in the way model calculations characterize line strengths and line shapes. Also, it will provide remote sensing of the gaseous constituents of the upper atmosphere.

RESULTS TO DATE: The AERI prototype was operated at the SGP CART site from March 1993 to July 1995 in various configurations, with data being provided routinely to the ARM Science Team starting in December 1993. A refined data set extending from April 1994 to July 1995 was recently compiled to remove the effect of a small sky-view obstruction discovered during April 1995, when the first operational AERI was brought to the site. The new AERI, incorporating a Stirling cooler for maintenance of cryogenic detector temperatures without liquid nitrogen, showed excellent agreement with the prototype after elimination of the prototype obstruction. AERI data are being used by many science teams for both spectroscopy and remote sensing of atmospheric temperature, water vapor, and cloud properties. Construction of multiple AERIs for SGP, TWP, and Alaska has begun. The SORTI prototype has been operated successfully at the site on clear days since February 1994, and construction of the first operational SORTI is under way. The operational SORTI will incorporate several improvements to simplify operations and will make use of the automatic quality-control techniques developed with the prototype. The SORTI data stream, currently transferred to DU on the Internet and stored on optical disks, has been used to retrieve the total-column amounts of several gases (0, N O, CH, and HN0) and the profiles of 0, HCl, and HF. The radiometric performance of the AERI-X was successfully demonstrated at the SGP in the spring of 1995.

DELIVERABLES: Improvements in the water-vapor continuum as currently reflected in the ARM line-by-line radiative-transfer model (LBLRTM); identification of the important spectrally varying effect of aerosols on window-region radiances; demonstration of the ozone-profiling capabilities of SORTI; annual progress report; reprints of publications.

COLLABORATIONS: D. G. Murcray, University of Denver.

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