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Validation of the TES algorithm for emissivity determination using field measurements

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Knowledge of the surface emissivity is important for determining the radiation balance at the land surface. This is especially true for arid regions with sparse vegetation, where the emissivity of the exposed soils and rocks is highly variable. The multispectral thermal infrared data obtained from the Advanced Spaceborne Thermal Emission and Reflection (ASTER) radiometer on NASA's Terra satellite have been shown to be of good quality and provide a unique new tool for studying the emissivity of the land surface. ASTER has 5 channels in the 8 to 12 micrometer waveband with 90 m spatial resolution, when the data are combined with the Temperature Emissivity Separation (TES) algorithm the surface emissivity over this wavelength region can be determined along with surface temperature. To overcome the problem of having too many unknowns, i.e. 5 emissivities and the surface temperature, TES makes use of an empirical relation between the minimum emissivity and the range of values for the 5 ASTER channels. The TES algorithm was validated using measurements with a multispectral thermal infrared field radiometer (CIMEL 312) which has essentially the same 5 bands as ASTER. The measurements were made on several soils in the Jornada Experimental Range (JER) and the White Sands National Monument in southern New Mexico, USA. The JER is a long-term ecological reserve (LTER) site located at the northern end of the Chihuahuan desert. The site is typical of desert grassland where the main vegetation components are grass and shrubs. At the White Sands National Monument dunes of gypsum sand cover about 700 km2 (275 square miles). Since gypsum has a unique emissivity spectra with a pronounced minimum at the 8.6 micrometer wavelength it is a good target for satellite observations of emissivity. The observed emissivity spectra for these sites in New Mexico show good agreement (<0.02) with values calculated from the laboratory spectra for the soil samples when the difference of physical condition of the sample is taken into account. The laboratory spectra for the soil samples were measured at NASA's Jet Propulsion Laboratory (JPL) in Pasadena California. These results indicate that the TES algorithm works very well and that its use with ASTER data from space is warranted.