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An assessment of the land surface emissivity in the 8 - 12 micrometer window determined from ASTER and MODIS data

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The land surface emissivity is often overlooked when considering surface properties that effect the energy balance. However, knowledge of the emissivity in the window region is important for determining the longwave radiation balance and its subsequent effect on surface temperature. The net longwave radiation (NLR) is strongly affected by the difference between the temperature of the emitting surface and the sky brightness temperature, this difference will be the greatest in the window region. Outside the window region any changes in the emitted radiation by emissivity variability are mostly compensated for by changes in the reflected sky brightness. The emissivity variability is typically greatest in arid regions where the exposed soil and rock surfaces display the widest range of emissivity. For example, the dune regions of North Africa have emissivities of 0.7 or less in the 8 to 9 micrometer wavelength band due to the quartz sands of the region, which can produce changes in NLR of more than 10 w/m*m compared to assuming a constant emissivity. The errors in retrievals of atmospheric temperature and moisture profiles from hyperspectral infrared radiances, such as those from the Atmospheric Infrared Sounder (AIRS) on the NASA Aqua satellite result from using constant or inaccurate surface emissivities, particularly over arid and semi-arid regions here the variation in emissivity is large, both spatially and spectrally.

The multispectral thermal infrared data obtained from the Advanced Spaceborne Thermal Emission and Reflection (ASTER) radiometer and MODerate resolution Imaging Spectrometer (MODIS) sensors 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. The TES algorithm has been validated with field measurements using a multi-spectral radiometer having similar bands to ASTER. The ASTER data have now been used to produce a seasonal gridded database of the emissivity for North America and the results compared to laboratory measured emissivities of in-situ rock/sand samples collected at ten validation sites in the Western USA during 2008. The directional hemispherical reflectance of the in-situ samples are measured in the laboratory using a Nicolet Fourier Transform Interferometer (FTIR), converted to emissivity using Kirchoff's law, and convolving to the appropriate sensor spectral response functions. This ASTER database, termed the North American ASTER Land Surface Emissivity Database (NAALSED), was validated using the laboratory results from these ten sites to within 0.015 (1.5%) in emissivity.

MODIS has 3 channels in this waveband with 1km spatial resolution and almost daily global coverage. The MODIS data are composited to 5 km resolution and day night pairs of observations are used to derive the emissivities. These results have been validated using the ASTER emissivities over selected test areas.