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Observation of angular effects on thermal infrared emissivity derived with the MODTES algorithm and MODIS data

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The MOD21 Land Surface Temperature and Emissivity (LST&E) product will be included in forthcoming MODIS Collection 6. Surface temperature and emissivities for thermal infrared (TIR) bands 29 (8.55 μm), 31 (11 μm) and 32 (12 μm) will be retrieved using the ASTER TES method adapted to MODIS at-sensor spectral radiances, previously corrected with the Water Vapor Scaling method (MODTES algorithm). LSE of most natural surfaces changes with soil moisture content, type of surface cover, surface roughness or sensor viewing geometry. The present study addresses the observation of anisotropy effects on LSE of bare soils using MODIS data and a processor simulator of the MOD21 product, since it is not available yet.

Two highly homogeneous and quasi-invariant desert sites were selected to carry out the present study. The first one is the White Sands National Monument, located in Tularosa Valley (South-central New Mexico, USA), which is a dune system desert at 1216 m above sea level, with an area of 704 km^2 and a maximum dune height of 10 m. The grain size is considered fine sand and the major mineralogy component is gypsum. The second site selected was the Great Sands National Park, located in the San Luis Valley (Colorado, USA). Great Sands is also a sand dune system desert, created from quartz and volcanic fragments derived from Santa Fe and Alamosa formations. The major mineral is quartz, with minor traces of potassium and feldspar. The grain size of the sand is medium to coarse according to the X-Ray Diffraction measurements. Great Sands covers an area of 104 km^2 at 2560 m above sea level and the maximum dune height is 230 m.

The obtained LSEs and their dependence on azimuth and zenith viewing angles were analyzed, based on series of MODIS scenes from 2010 to 2013. MODTES nadir and off-nadir LSEs showed a good agreement with laboratory emissivity measurements. Results show that band 29 LSE decreases with the zenithal angle up to 0.041 from its nadir value, while LSEs for bands 31 and 32 do not show significant changes with zenith angle.