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Examination of ASTER TIR Data for the Retrieval of Regional European Surface Temperature Spatial Distribution

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Accurate estimates of land surface temperature and emissivity are critical to many earth energy balance studies, as well to specific applications in agrometeorology, environmental and earth system science and climate modeling. Multispectral remote sensing in the thermal infrared provides the possibility to retrieve spatially distributed information on land surface temperature and emissivity, though it is typically posed as an underdetermined problem (i.e. more unknowns than there are wavelength observations). Several algorithms have been developed to get around this limitation, one such being the Temperature Emissivity Separation (TES) algorithm, based on an empirical relationship between the range of observed spectral emissivities and their actual minimum value. TES is currently used in deriving operationally distributed maps of land surface temperatures and emissivity from the Advanced Spaceborne Thermal Emission and Reflection Scanning Radiometer (ASTER), launched on EOS Terra in December 1999.

The present work aims to provide an independent examination of the performance of the ASTER TES algorithm at European sites representing homogeneous areas of different land and environmental condition. The standard ASTER-TES product was assessed, and our own implementation where MODTRAN 4 and local radiosonde data was used to perform the atmospheric correction prior to the TES algorithm application. Broadband emissivity was calculated from the narrow-band emissivities derived from the ASTER TIR channels, and the longwave heat fluxes (both downwelling and upwelling) was calculated. Results were evaluated against relevant *in situ* observations

made at three selected CARBOEUROPE fluxtower sites.

Our analysis demonstrated that specific atmospheric correction of the ASTER-measured spectral radiances using local atmospheric sounding data improves the performance of the TES algorithm in retrieving land surface temperature by about 0.5 K when compared to an atmospheric correction using only modeled atmospheric profiles (as is used operationally in the ASTER product). Though there is some uncertainly when comparing individual point-based measurements from fluxtowers to the 90 m x 90 m estimates provided by ASTER, comparisons showed a mean root mean square (rms) error of less than 3 K between the two land surface temperature measures. Derived broadband emissivity for the different land uses classes tested agreed well with reference broadband emissivity values obtained from ASTER spectral library, with a mean rms difference of 0.015. Point comparisons of longwave upwelling and downwelling radiation components evidenced the ability of the ASTER TES approach to provide usable estimates of these parameters.

KEYWORDS: land surface temperature, temperature-emissivity separation, TES, broadband emissivity, ASTER, validation