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Estimate of sensible heat flux by using bi-angular brightness temperature measurements

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The land surface-atmosphere mass and heat exchange for complete vegetation canopies may be represented by a so-called and widely used single-source model. For sparse canopies, however, a frequent case in nature, interaction between sparse canopies and the atmosphere is complex due to the canopy geometry. The latter determines the distribution of absorbed solar radiation in the canopy as well as has influence on the airflow in the canopy space and the boundary layer resistance of leaves and soil, thereafter changing the source/sink strength and inducing spatial variability of sources and sinks of heat and water vapor in the canopy space. A large spacing between plants or lower leaf density, for instance, makes the exposed soil to play an important role in the land-atmosphere interaction. The interaction between thermodynamic and dynamic processes will lead to thermal heterogeneity, which will in turn give rise to the anisotropy in the exitance of canopy. Such information has been used to retrieve soil and foliage component temperatures. A mixture of foliage and soil is characterized by large temperature differences within the canopy space. Under these conditions heat transfer between foliage and air and between soil and air should be described separately. A dual-source model is therefore developed accommodating the individual interactions between soil-atmosphere and between foliage-atmosphere using bi-angular brightness temperature measurements. To make traditional single-source model still useful, a new parameterization of resistance for heat transfer in a single-source model is proposed by using directional brightness temperature measurements. The dual-source model and the new parameterization in the single-source model are first evaluated at field scale using directional brightness temperature measurements made by a goniometer system over a row canopy and over a grassland surface. The agreement between the estimated and measured sensible heat flux are quite good. At the regional scale sensible heat flux density was modeled using bi-angular ATSR-2 observations of exitance and compared with measurements by Large Aperture Scintillometers at a spatial scale comparable with the ATSR-2 spatial resolution. Limitations of the proposed models are discussed.