SEBS for ILWIS: A Multi-stage Tool for Surface Energy Balance Estimates in an open source operational RS/GIS Environment

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The Surface Energy Balance algorithm SEBS (Su, 2002) is an extension of the SEBI concept with a dynamic model for thermal roughness (Su et al., 2001), the Bulk Atmospheric Similarity (BAS) theory (Brutsaert, 1999) for PBL scaling and the Monin-Obukhov Atmospheric Surface Layer (ASL) similarity for surface layer scaling. As such SEBS can be used for both local and regional scaling under all atmospheric stability regimes thus providing a link for radiometric measurements and atmospheric models at various scales.

SEBS4ILWIS consists of a set of tools for the determination of the land surface physical properties and state variables, such as albedo, emissivity, temperature, vegetation coverage etc. from spectral reflectance and radiance; an extended model for the determination of the roughness length for heat transfer (Su et al., 2001); and a new formulation for the determination of the evaporative fraction from the energy balance at limiting cases. SEBS is integrated in ILWIS, a powerful open source GIS and RS environment able to pre-process RS and in-situ data, regarded as source input data for SEBS.

At the present stage of the developments, SEBS4ILWIS is able to retrieve energy balance fluxes and derived products from MODIS, AATSR and ASTER raw data images. SEBS requires as inputs three sets of information. The first set are land surface properties derived from RS and some additional ground data (albedo, emissivity, temperature, fractional vegetation cover, LAI, and the height of the vegetation or roughness height, where NDVI could be used as a surrogate). The roughness height is obtained either from vegetation height using NDVI values or based upon land-use look-up table approach assigning each class with a roughness value.. The second set is related to meteorological data or maps of air pressure, air temperature, humidity, and wind speed at a reference height (in the PBL or ASL). This data can also consist of estimates by a large scale meteorological model. The third data set deals with incoming SW and LW radiation either from direct measurements, model output or parameterization. The GIS/RS environment offered by ILWIS is able to provide all this data and models to the input in the format required by SEBS.

SEBS was validated under a wide range of environmental and climatological conditions; it was tested versus AET rates in a semiarid inland basin in NW China (Li, 2001; Su et al., 2003a), and for drought disaster monitoring (Su et al., 2003b). It was evaluated well as compared with other remote sensing techniques over irrigated fields (Norman et al., 1995; Zhan et al., 1996; Kustas and Norman, 1999; Su et al,. 2001, Su, 2003, Su et al., 2007). More recently, validations of SEBS have been reported by (Su et al 2005, 2007) using data from the SMACEX experiment and CEOP references sites. Other applications of SEBS have been reported by (Oku et al., 2007) for climate research on the Tibetan plateau and by (Qin et al. 2008) for water resources management in Nothern China.

SEBS4ILWIS incorporates an adapted ILWIS module for the atmospheric correction of the visible and NIR bands (SMAC, Rahman H., Dedieu G. 1994). Meteorological

information is externally input as either constant values for the whole image or as maps generated by interpolations of such information or estimates from a atmospheric model.

This process result in maps of net radiation, latent, sensible and soil heat fluxes, evaporative fraction, instantaneous and daily AET, and complementary files as standard outputs. This paper describes the details of the different models used and some case studies.

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