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Evapotranspiration retrieval in Arid and Semi-Arid Areas

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Introduction

Evapotranspiration (ET) is the combined loss of water by evaporation from soils and transpiration from plants. Evaporation accounts for the movement of water to the air from sources such as soils, canopy interception, and water-bodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves. Evapotranspiration is one of the most important components of the hydrological cycle. Combined with rainfall and run off, it controls the availability and distribution of water at the Earth's surface. So ET is of high significance for a number of water-related research and application areas. Quantification of the spatial variability of hydrological and land surface variables is important for water resource management, particularly in agricultural regions. For our application, we require ET over a wide range of spatial and temporal scales. At the regional and continental scales the use of remote sensing or models coupled with remote sensing is a strong requirement. Satellite remote sensing provides a spatial scale of land surfaces and atmospheric data that are logistically and economically very hard to gather with merely field-based observations. And all these model types comply with the laws of the conservation of mass and energy. The article focuses on the development of remote sensing algorithms for area estimation of ET within the typical Arid and semi-Arid region of the Xinjiang province, and uses the NDVI-LST method for regional ET studies using moderate-resolution (1×1 km^2) optical remote sensing data from Aqua/MODIS[1-3].

LST-Albedo Model

ET is the process whereby water - originating from a wide range of sources - is transferred from the soil compartment and /or vegetation layer to the atmosphere. It is the sum of evaporation and plant transpiration. ET represents both a mass and energy flux. The estimate of ET complies with the conservation law of the mass or energy or both of them. This part of the algorithm was built by Willem W. Verstraeten, in 2005. It is mainly based on the energy balance and its development based on the SEBAL model. The surface energy balance algorithm for land is SEBS[4-7].
The surface energy balance can be written as:

$$R_n - G_0 - H - \lambda E = 0 \quad (1)$$

In Eq. (1) R_n is net radiation (net short and net long wave) [W m^{-2}]; G_0 is the soil heat flux [W m^{-2}]; H is the sensible heat flux [W m^{-2}]; λE is the latent heat flux[W m^{-2}], Surface energy fluxes depend strongly on λE (Gillies et al., 1997; Moran et at.1994); λ is the latent heat of vaporization of water, approximately 2,450Jg^{-1}H$_2$O at 20 °C ; E is evaporation [g H$_2$O m^{-2}s^{-1} or mm d^{-1}]. It is the rate of water vapor flux from the surface to atmosphere (Monteith & Unsworth, 1990).