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Estimation of hourly land surface heat fluxes over the Tibetan Plateau by the combined use of geostationary and polar-orbiting satellites

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Supplement

According to the characteristics of the SVISSR sensor onboard the FY-2C, the SWA modified by Hu et al. (2018) is utilized, and the T_s can be derived as:

$$T_s = a_0 + a_1 w + [a_2 + (a_3 + a_4 w cos\theta)(1 - \varepsilon_s) - (a_5 + a_6 w)\Delta\varepsilon]\frac{T_i + T_j}{2} + [a_7 + a_8 w + (a_9 + a_{10} w)(1 - \varepsilon_s) - (a_{11} + a_{12} w)\Delta\varepsilon]\frac{T_i - T_j}{2}, \quad \text{(S1)}$$

with $\varepsilon_s = \left(\varepsilon_i + \varepsilon_j\right)/2$ and $\Delta\varepsilon = \varepsilon_i - \varepsilon_j$, where T_i and T_j are the brightness temperature (BT) surveyed in channel i and j centered at 11.0 μm and 12.0 μm, respectively; ε_i and ε_j are the land surface emissivities (LSEs) of channel i and channel j, respectively; ε is the average emissivity; $\Delta\varepsilon$ the emissivity difference of channel i and j; w is the atmosphere WVC; θ is the viewing zenith angle (VZA); and a_0–a_{12} are the model coefficients.

The LSEs of channels 1 and 2 of the FY-2C can be replaced by the LSEs of bands 31 and 32 of MOD11C1 V41 product.

$$\varepsilon_{FIR1} = -0.0611 + 1.0614\varepsilon_{31}, \quad \text{(S2)}$$

$$\varepsilon_{FIR2} = -0.0210 + 1.0199\varepsilon_{32}, \quad \text{(S3)}$$

where ε_{FIR1} and ε_{FIR2} are the LSEs of channels FIR1 and FIR2 of the SVISSR, while ε_{32} and ε_{31} the LSEs of the MODIS bands 32 and 31, respectively.

Brutsaert (1975) proposed a parameterization ε_a estimation method based on ground measurements, which is written as follows.

$$\varepsilon_a = \lambda(e_a/T_a)^k \quad \text{(S4)}$$

where σ is the Stefan-Boltzmann constant and ε_a is the air emissivity. The suggested values of λ and k from Brutsaert are 1.24 and $1/7$, respectively.

The detailed solutions for other variables in Table S1 can be found in Su et al. (2002).

Table S1: Glossary of variables used in determination of land surface heat fluxes.

Symbols	Variable Name	Units
R_n	Net radiation flux	$W \cdot m^{-2}$
H_s	Sensible heat flux	$W \cdot m^{-2}$
LE	Latent heat flux	$W \cdot m^{-2}$
G_0	Soil heat flux	$W \cdot m^{-2}$
R_{swd}	Downwelling solar radiation at the land surface	$W \cdot m^{-2}$
α	Broadband albedo	----
ε_a	Surface air emissivity	----
ε_s	Land surface emissivity	----
σ	Stefan-Boltzmann constant	$W \cdot m^{-2} \cdot K^{-4}$
T_a	Surface air temperature	K
T_s	Land surface temperature	K
α_1	Reflectance of blue band	----
α_2	Reflectance of red band	----
α_3	Reflectance of near infrared band	----
α_4	Reflectance of short wave infrared band	----
Γ_s	Ratio of soil heat flux and net radiation flux for bare soil	----
Γ_c	Ratio of soil heat flux and net radiation flux for full vegetation cover	----
f_c	Vegetation coverage	----
$NDVI$	Normalized difference vegetation index	----
L	Obukhov length	m
c_p	Specific heat at constant pressure	$J \cdot kg \cdot K^{-1}$
θ_v	Surface potential virtual air temperature	K
u_*	Friction velocity	$m \cdot s^{-1}$
k	Von Karman constant	----
g	Acceleration due to gravity	$m \cdot s^{-2}$
u	Mean wind speed at reference height	$m \cdot s^{-1}$
z	Reference height	m
d_0	Zero plane displacement height	m
z_{0m}	Roughness height for momentum transfer	m
z_{0h}	Roughness height for heat transfer	m
Ψ_m	Stability correction function for momentum heat transfer	----
Ψ_h	Stability correction function for sensible heat transfer	----
θ_0	Potential temperature at the surface	K
θ_a	Potential temperature at reference height	K