

Variability and Trend of Sensible Heat Exchange over the Tibetan Plateau Using an Updated Surface Flux Parameterization

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The Tibetan Plateau (TP) exerts significant thermal effects on Asian monsoon systems and climate. The surface-atmosphere sensible heat exchange needs to be accurately calculated in order to quantify the atmospheric heat source/sink. The surface flux parameterization has been widely used to calculate the sensible heat flux (H). However, its application faces two difficulties that lead to great uncertainties in the spatio-temporal variability and long-term trend of H. One is to find a proper heat transfer coefficient (CDH); the other is to guarantee the spatial representativeness of H. Using routine measurements (wind velocity, air and surface temperatures) at 69 sites by the China Meteorological Administration, our study intends to re-examine the trend of H over the TP with special attention to both relevant difficulties. An extensively validated parameterization for the thermal roughness length is adopted in order to physically model the diurnal variation of CDH that has been assumed constant in previous efforts. The spatial representativeness of H is indirectly confirmed by analyzing its spatio-temporal characteristics. The daily mean H peaks in the pre-monsoon period, about 60 W m^{-2} from March to May. Higher sensible heat exchange (absolute value for nocturnal periods) is found in the western and northern TP (semi-arid areas or desert). The study reveals a decreasing trend of H during the past two decades ($-1.0 \text{ W m}^{-2} \text{ decade}^{-1}$), mainly linked with the weakening wind velocity. All sites are then categorized into four groups by elevation to detect potential dependency. Only the sites above 3000 m produce statistically meaningful trends of H. A trend as weak as $-0.65 \text{ W m}^{-2} \text{ decade}^{-1}$ is observed for 18 sites above 4000 m (mean elevation of the TP). It implies that the overall decreasing trend over the TP should be much weaker than that found by a recent study using $\text{CDH}=0.004$.

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