Application of the evaporative fraction in estimating daily evapotranspiration based on hourly measurement in water-saving irrigated rice field

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Evaporative fraction (EF), which is known to exhibit variation in response to changes in crop species, soil and meteorologic conditions, plays an important role in interpreting the components of energy budget and estimating evapotranspiration (ET), while such information is scarce for humid rice fields. The present study examines the pattern of hourly, daytime and daily EF after monitoring energy components by eddy covariance for water-saving irrigated (WSI) rice paddies of 2015 and 2016, and estimates the daily ET by an improved EF up-scaling method in the subtropical monsoon climate region of East China. Main results indicate that EF exhibits obviously greater than the reports that from upland crops. Diurnally, hourly EF is deemed as an approximately concave-up shape in different growth stages of rice season. The seasonal average value varies gently, with a minimum around 10:00–11:00 AM. Seasonally, the mean daytime EF for the whole growth stage is 0.86, 7% lower than the daily value. Daily EF exhibits mostly higher than 0.8 except later yellow ripening period, approaching 1.0 in the milk stage. In addition, differences are noted in the results with respect to the daily ET estimation by EF up-scaling method. The estimated daily ET ($ET_{EF,d}$) from hourly EF during 10:00–11:00 h is highly correlated to the measured ET (ET_{true}) by the weighed micro-lysimeters though the $ET_{EF,d}$ value is underestimated. Such a considerable gap serves in forming a relationship between $ET_{EF,d}$ and $ET_{true,d}$, that is, by simply multiplying the representativeness ET value based on the EF up-scaling method by a correction procedure calibrated for this region. In conclusion, an improved EF up-scaling method is proposed for estimating effective daily ET.

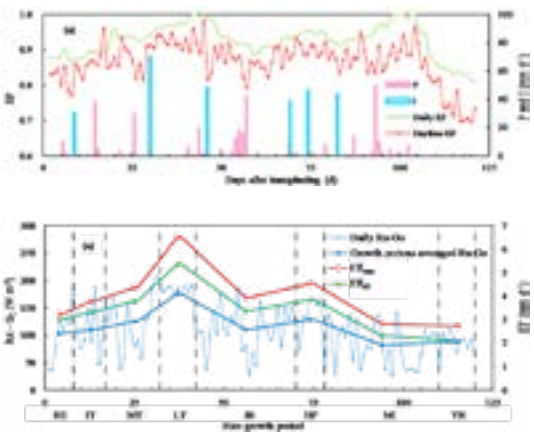

Fig. 1 Behavior of the daily and daytime evaporative fraction (EF) and corresponding precipitation (P) and irrigation (I) during the rice season of (a) 2015 and (b) 2016

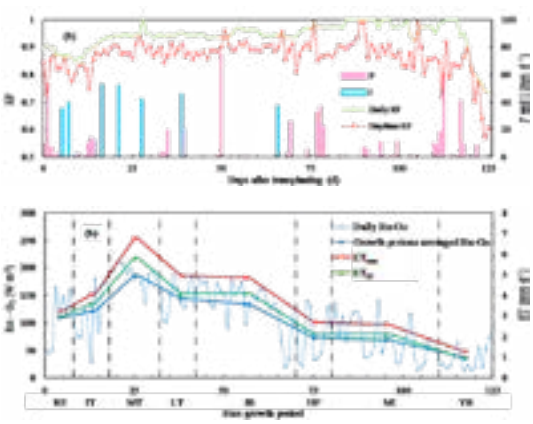

Fig. 2 Behavior of the measured (ETture) and simulated ET (ETEF) (based on 10:00–11:00 period) and corresponding available energy (Rn–G0) during the rice season of (a) 2015 and (b) 2016 (RE, IT, MT, LT, JB, HF, MI and YR represents the re-greening, early tillering, middle tillering, later tillering, jointing and booting, heading to flowering, milk and yellow ripening stage, respectively)

Recent Publications

1. Xiaoyin Liu, Junzeng Xu, Shihong Yang, et al. Vapor Condensation in Rice Fields and Its Contribution to Crop Evapotranspiration in the Subtropical Monsoon Climate of China. Journal of hydrometeorology. 2018, 19(6),1043-1057.
2. Xiaoyin Liu, Shihong Yang, junzeng Xu, et al. Effects of soil heat storage and phase shift correction on energy balance closure of paddy fields. Atmósfera 2017, 30(1), 39-52.
3. Xiaoyin Liu, Junzeng Xu, Shihong Yang, et al. Surface Energy Partitioning and Evaporative Fraction in a Water-Saving Irrigated Rice Field. Atmosphere 2019, 10, 51.
4. Xiaoyin Liu, Junzeng Xu, Shihong Yang. Rice evapotranspiration at the field and canopy scales under water-saving irrigation. Meteorology and Atmospheric Physics. 2018, 130(2):227-240.
5. Junzeng Xu, Xiaoyin Liu, Shihong Yang, et al. Modeling rice evapotranspiration under water-saving irrigation by calibrating canopy resistance model parameters in the Penman-Monteith equation. Agricultural Water Management. 2017, 182, 55-66.

Biography

Xiaoyin Liu, PhD, lecturer; graduated from Hohai University, majoring in Agricultural Soil and Water Engineering, and Ph.D. in Engineering, December 2017; then working in College of agricultural engineering, Hohai University. She has been engaged in the research on the efficient utilization of agricultural water resources and its ecological environment effects for a long time. There are some innovative research results on water, heat and carbon fluxes in paddy fields under water-saving irrigation practice in terms of scale conversion, scale effect and coupling simulation. To date, She has published more than 20 articles, 8 of which published in the SCI, 3 published in the EI and some core articles. She is responsible for 3 major infrastructural research grants from the National Natural Science Foundation of China, the Fundamental Research Funds for the Central Universities, the Natural Science Foundation of Jiangsu Province. As a major researcher, I have also participated in 4 National Natural Science Foundation of China. Previously, she was awarded the first prize for excellent papers of China Water Resources Efficient Utilization and Water Saving Technology Forum in 2017.

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