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Estimating lake-water evaporation from data of large-aperture scintillometer in the Badain Jaran Desert, China, with two comparable methods

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Accurate quantification of evaporation (E_0) from open water is vital in arid regions for water resource management and planning, especially in the desert. The scintillometers are increasingly recognized by researchers for their ability to determine sensible (H) and latent heat fluxes (*LE*) accurately over distances of hundreds of meters to several kilometers, though scintillometers are mainly used to monitor the land surface processes. Here it is installed on both sides of the shore over a lake to derive the sensible and latent heat fluxes. In this paper, compared to the panevaporation, the scintillometer was successfully applied to Sumu Barun Jaran in Badain Jaran Desert by the classical method and the proposed linearized β method. Due to the difficulty to measure water surface temperature and the easiness to monitor the water temperature at different depths, it is worth thinking that if is feasible to utilize the shallow water temperature instead of the water surface temperature and how much errors it will cause. Water temperature at 10 cm and 20 cm depths were used to replace the lakewater surface temperature in the two methods to analyze the changes of sensible and latent heat flux in hot and cold seasons at halfhour and daily time scales. Based on the classical method, at halfhour time scale, the values of H were almost barely affected, and the average value of *LE* using water temperature at 20 cm depth is 0.8% ∼9.5% smaller than that at 10 cm depth in cold seasons. In hot seasons, compared to the results at 10 cm depth, the average value of H increased by 20% ∼ 30%, and *LE* decreased by about 20% at 20 cm depth. At daily time scale, the values of H were also almost unchanged, and the average values of *LE* and E_0 were 0.2%∼8.5% smaller using water temperature at 20 cm depth than that at 10 cm depth in cold seasons. In hot seasons, compared to the results at 10 cm depth, the average value of H increased by 6.2%∼18.3%, and *LE* and E_0decreased by 9.6%∼18.3% at 20 cm depth. In the proposed linearized β method of scintillometer, only the slope of the saturation pressure curve (Δ) is related to the water surface temperature, which was estimated using available equations of saturated vapor pressure versus temperature of the air. Compared to the values of Δ estimated by the air temperature, while the water surface temperature are replaced by water temperature at 10 cm and 20 cm depths, in different seasons, the errors of 2%∼25% in Δ were caused. Thus Δ was calculated by the original equation in the proposed linearized β method of scintillometer. Interestingly, at halfhour and daily time scales, the water temperature at 10 cm and 20 cm depths had little effect on H, *LE* and E_0in different seasons. The reason is that the drying power of the air (E_A) accounted for about 85% of the evaporation (i.e. the changes of Δ have only about 3% impact on evaporation), which indicated that the driving force from unsaturated to saturated vapor pressure at 2 m height has the main role on evaporation. So the proposed linearized β method of scintillometer is recommended to quantify the H, *LE* and E_0 over open water, especially when the water surface temperature cannot be accurately measured.

Keywords: Large-aperture scintillometer, Sumu Rarun Jaran, Badain Jaran Desert, classical method, proposed linearized β method