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Optimal evaporation models for simulation of large lake levels: application to lake Titicaca, South America.

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The aim of the work is to validate evaporation models that can be used for paleo-reconstructions of large lake levels. For this purpose, input data are limited to the most available ones in the past, i.e. air temperature and solar radiation. Furthermore, such an evaporation model could be used as potential evapotranspiration approximation in the framework of a lake basin modelling. The case study is the lake Titicaca for which a severe water level fall occurred during Holocene (∼6 kyr BP).

Lake Titicaca is located in a high altitude tropical place (3810 m a.s.l.) in the northern part of Andean Altiplano (16˚S-69˚W). Its surface area is about 8500 km^2 and its mean depth is 135 m (284 m max.). The cold and semi-arid climate is controlled by the shift of ITCZ. Basin runoff and direct precipitation over the lake provide respectively about 45% and 55% of the water inflow during the rainy season (dec.-jan.-feb.). Evaporation is the major part of water losses (1600 mm, i.e. 95%) while the discharge of the only outlet, Desaguadero river, is about 30 m^3/s. A preliminary analysis showed that lake water balance strongly depends on the variability of evaporation flux.

At the interannual scale, evaporation estimation presents a great variability: mean annual values range from 1500 to 1800 mm/year. However, it has been found that the mean yearly rainfall is closely related to the evaporation amount by a decreasing relationship taking into account the implicit effect of nebulosity and humidity.

At the seasonal scale, we used two monthly datasets coming from i) Class A pan observations (Pouyaud, 1993), ii) energetic budget of the lake (Carmouze et al., 1983). Comparison between pan observed data and lake estimated data shows i) only one max.-min./year for pan data and two max.-min./year for lake data, ii) pan evaporation exceeds lake evaporation by 100 mm/year. These differences are mainly due to a depth scale factor and have been simulated by a simple one-dimensional thermal model T(z) of a water column. It shows that pan evaporation is strongly correlated to direct solar radiation while the presence of a second peak in lake evaporation is related to the water heat restitution towards atmosphere at the end of austral winter.

Eight evaporation models were tested in order to get the optimal ratio efficiency/complexity in the context of future lake level paleo-reconstructions(Xu and Singh, 2000). The best results are obtained by the radiative Abtew model (r=0.70) and by the radiative/air temperature Makkink model (r=0.67).

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