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How is the atmospheric residence time of evapotranspired water altered with a dried-up lake or a forest restoration scenario and what is the impact on precipiation?

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Land surface characteristics and processes may have complex interactions with the physical and dynamical processes of the atmosphere. However, adequate methods for systemically understanding individual processes of the nonlinearly coupled land-atmosphere continuum are still rare. Therefore, in this study, the age-weighted evaporation tagging approach of Wei et al. (2016) and the three-dimensional online atmospheric water budget analysis of Arnault et al. (2016) were implemented into the Weather Research and Forecast (WRF) model. In addition to the total and tagged atmospheric water states of matter, the latter approach was further extended for age-weighted tagged atmospheric water states of matter, thereby providing a prognostic equation of the residence time of state variables in the atmospheric water cycle. This extension allows to systematically quantify the fate of evaporated and transpired water in terms of magnitude, location, composition, and residence time. The extended WRF model was tested for a land use and land cover change study for the Poyang Lake basin, the largest freshwater lake in China. Two hypothetical scenarios, i.e., a dried-up lake and a forest restoration scenario, were simulated and then compared to a real-case control simulation using the original land-use data. The results of the basin-scale precipitation recycling in the context of evapotranspiration partitioning and the modified atmospheric water cycle due to both scenarios will be presented and discussed. We conclude that our newly developed modelling framework and the proposed analysis strategy have the potential to be applied for better understanding and quantifying the nonlinearly intertwined processes between the land and the atmosphere.

References:

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