# Evaluation of a land surface model with stable water isotopes

# Kei Yoshimura[1]

[1] IIS, Univ of Tokyo

http://hydro.iis.u-tokyo.ac.jp/~kei

Stable isotopes of water (HDO and H218O) are good tracers of hydrologic cycle, because their concentrations in water portion indicate integrated records of physical phase-changes. In particular, large heterogeneity of precipitation isotopes in time and space is regarded as proxies of complex atmospheric behavior. In the past, many observational studies on precipitation isotopes have been curried out, and lately the simple two-dimensional isotope circulation model by Yoshimura et al. (2003) showed that the heterogeneity of observed precipitation isotopes is dominantly controlled by large-scale atmospheric moisture transport processes. Their model reproduced daily H218O variability over the sub-tropics, particularly Thailand, and monthly averages at global scales with GNIP (Global Network of Isotopes in Precipitation, WMO/IAEA). However, there remain discrepancies between the observation and the simulations. Effect of land surface processes, which was neglected in the model, is one of the causes. This paper, to take a deeper insight on short-term variability of precipitation isotopes, incorporates behavior of the isotopes into land surface model and analyzes isotopic land-atmosphere interaction and effect of land on the atmosphere by coupling it with the atmospheric isotope circulation model.

In this study, physical behavior of stable water isotopes is incorporated to one of land surface models (LSMs), MATSIRO (Minimal Advanced Treatments of Surface Interaction and Runoff; Takata et al., 2003), which is designed and optimized to be coupled with global atmospheric model. In this Iso-MATSIRO, three distinct treatments of evapotranspiration that possibly make differences in isotopic fractionation are taken into account, such as evaporation from soil, transpiration from vegetation, and evaporation from intercepted water by canopy. In case phase-changes (e.g., liquid to gas) take place, kinetic isotopic fractionation, in addition to equilibrium fractionation, are explicitly conducted.

The results show there are very large fluctuations of isotopic compositions in evaporative fluxes and very near surface water, such as canopy water and the first layer (5cm) of soil. By taking those into account, the daily variations of observed precipitation delta-18O was slightly better reproduced in Chiangmai, Thailand, than the atmospheric isotope circulation simulation without land surface processes in Yoshimura et al. (2003). Moreover, global comparison with GNIP observations shows better agreement in this study, too.

This study did not tune any physical parameters related with water and energy equations, and did not examine variables except isotopes, such as water and energy variables. These processes are significantly important and more direct way for improvement of the LSM, but what the current study tries is another way of diagnose of the LSM. Even though reasonable energy and water budgets are somehow computed in LSMs, these results may be systematically wrong answer, thus isotopes can additionally tell that it is 'truly' reasonable or not.

Nevertheless, this study indicated land surface processes should be reasonably taken into account for more precise estimation of precipitation isotope distribution. In these regards, reproduction of d-excess parameter (deltaD-8*delta18O) in precipitation would be the next step.

Yoshimura, K., T. Oki, N. Ohte, and S. Kanae, JGR, 108(D20), 4647, 2003.
Takata, K. S. Emori, and T. Watanabe, GPC, 38, 209-222, 2003.