Reply to Editor Initial Decision

Dear Prof. Christine Stumpp,

Thank you for your valuable comments.
We discussed again and revised our manuscript following your suggestions. Your suggestions improved the quality of our manuscript. We hope the revised version is acceptable for HESS.

Corresponding Author: Masanori Katsuyama, on behalf of authors.

Your comment:
Two reviewers thoroughly evaluated your manuscript. Main points were raised that concern (i) the presentation of spatial resolution in the Figures (topography and isotopes), (ii) explanation of differences in d-Excess, (iii) comparison isotope contents of one time surface water samples with spatial and temporal patchy isotopes in precipitation, and (iv) missing information about data collection.

You answered in detailed to all the reviewers' comments. I agree to almost all answers and additionally have some important points I want to emphasize:

1) Concerning the explanation of differences in d-Excess, I highly recommend including the evaporation into the discussion of the manuscript, because it seems to be important when comparing the reported ranges of d-Excess in precipitation and surface water. Not only seasonal recharge can result in lower d-Excess, but also evaporation. Even if the data plot close to the GMWL, it is no evidence for lack of evaporation as (i) LWMLs would be required and (ii) mixing of surface water from different regions would even require more detailed knowledge about the regional distribution of isotopes in precipitation, both in time and space. Besides, the authors refer to Figure 2 in their answers concluding that evaporation is not of major relevance. However, the line already inherits evaporation effects and -as correctly mentioned in chapter 3.2- is different compared to the Japanese Meteoric Water Line. Summarizing, evaporation needs to be included in the discussion more critically.

Our Reply:
We considered the effect of evaporation on d-excess values, and inserted the following

discussion within the section 4.2.

Evaporation during the infiltration processes is also affect the d-excess value. The d-excess value will be smaller when the effects of evaporation is larger. Evaporation from a forest consists of canopy interception loss and evapotranspiration from the forest floor. In our result (Figure 5), the d-excess value is larger at the Sea of Japan side. Kondo et al. (1992) showed that the canopy interception was larger at the Sea of Japan side compared to the Pacific Ocean side because the canopy interception was positively correlated with the number of precipitation days in both coniferous and broad-leaf forest (Kondo et al., 1992; Komatsu et al., 2008), and the number was larger at the Sea of Japan side (Kondo et al., 1992). Thus, the canopy interception can make the d-excess values smaller at the Sea of Japan side. On the other hand, the evaporation from forest floor estimated in Japan is generally small and negligible. For example, Tsujimura and Tanaka (1998) estimated the value as 2% of annual precipitation at the central Japan. Kubota and Tsuboyama (2004) showed the values were below 10% of annual throughfall in both mature- and young forest in Kanto region. These effects of evaporation may be reflected in the smaller slopes and interceptions in the regression for stream water (Eq. 1) than in the regression for precipitation (Eq. 4). However, even the effects of the evaporation, especially of the canopy interception, is considered, the difference of d-excess values at the Sea of Japan side and at the Pacific Ocean side is clear. This fact also support that the difference is highly controlled by the recharge process in each region.

Reference:

Komatsu, H., Shinohara, Y., Kume, T. and Otsuki, K.: Relationship between annual rainfall and interception ratio for forests across Japan, Forest Ecology and Management, 256, 1189-1197, 2008.

Kondo, J., Nakazono, M. and Watanabe, T.: Hydrological climate in Japan (2) : Forest rainfall interception, Journal of Japan Society of Hydrology & Water Resources, 5, 29-36, 1992 (in Japanese with English summary).

Kubota, T. and Tsuboyama, Y.: Estimation of evaporation rate from forest floor using oxygen-18 and deuterium compositions of throughfall and stream water during a non-storm runoff periods, J. For. Res., 9, 51-59, 2004.

Tsujimura, M. and Tanaka, T.: Evaluation of evaporation rate from forested soil surface using stable isotopic composition of soil water in a headwater basin, Hydrol. Process., 12, 2093-2103, 1998.

Your comment:

2) Further, I agree with one of the reviewers pointing out the complex relationship between precipitation and surface water. I already asked for more details here when the manuscript was submitted the very first time ("One main issue concerns the length of the sampling period and whether it biases the isotope results. Certainly, such a high number of samples cannot be taken in just some weeks. However, if there still is a seasonal signal of isotopes in stream water, you cannot compare samples that were taken 3 months apart. Then the isotope content in stream water strongly depends on the travel time of the river water and you do not have a temporal integrated isotope signal of precipitation reflected in a one-time sampling time in stream water as indicated on page 8 ln 4-5. I suggest two things: first, convince the reader that the samples are not biased depending on the date they were taken and second, at least discuss the possibility of different water transit times and recharge areas in your catchments."). In your answer it is indicated that samples were taken during base flow conditions and that the base flow is mainly groundwater. You also mentioned that it is shallow groundwater. Here, the seasonal signal of isotopes in precipitation can still be present if transit times are short. Please take this point into consideration when revising the manuscript.

Our Reply:

To reply your first suggestion (convince the reader that the samples are not biased depending on the date they were taken), we revised the section 3.3 and Figure 6 to consider the seasonal signal of isotopes in streamwater as well as precipitation, using available long-term data from three stations in Tottori, Shiga, and Nara prefectures. The section 2.2 also appropriately revised.

Moreover, to discuss the possibility of different water transit times and recharge areas in our catchments, we also revised the section 3.3. As you know, the seasonality is used to estimate water transit times. However, the control factors of transit times are actively argued in the scientific community. The transit time of our samples must be different each other, however, it doesn't necessary controlled by simple parameters such as recharge area. In other words, the clear spatial distribution found in Figure 4 and Figure 5 is robust even the relationship between precipitation and streamwater in each catchment may be complex.

The following paragraphs inserted within the section 3.3.

Our observation conducted from July to October. The isotope signature in streamwater should have seasonal variation and the samples may be biased depending on the date they were taken to some extent. However, as shown in Figure 6b, the seasonality in streamwater clearly dampen compared to that in precipitation (Figure 6a) in all stations. The coefficient of variation (CV) calculated with the one-year data (Figure 6c) for precipitation and streamwater in each site were compared. The CV for precipitation and streamwater were 0.50 and 0.09 in Tottori, 0.43 and 0.07 in Shiga, and 0.62 and 0.14 in Nara, respectively. The CV calculated with the data from July to October for precipitation and streamwater were 0.16 and 0.07 in Tottori, 0.27 and 0.03 in Shiga, and 0.48 and 0.07 in Nara, respectively. Certainly, we cannot consider the seasonality in streamwater for all of our sampling, however, these values imply that the samples are less biased depending on the date they were taken compared to the seasonality in precipitation.

The damping of the seasonality in streamwater is result of the hydrological processes within the catchment. The seasonality of d-excess values is sometimes used to estimate the water residence (and transit) times (Kabeya et al., 2007; Lee et al., 2007; Kim and Jung, 2014), and the smaller seasonality in streamwater generally means the longer residence time. The control factors of residence times are actively argued in the scientific community; for example, the geomorphic factors (McGuire et al., 2005; Tetzlaff et al., 2009a) and the bedrock permeability (Katsuyama et al., 2010) can be control factors. However, it doesn't necessary controlled by simple parameters such as recharge area. In other words, the clear spatial distribution found in Figure 4 and Figure 5 is robust, though the residence time of our samples must be different each other because the complex relationship between precipitation and streamwater in each catchment.

Reference:

Kabeya, N., Katsuyama, M., Kawasaki, M., Ohte, N., and Sugimoto, A.: Estimation of mean residence times of subsurface waters using seasonal variation in deuterium excess in a small headwater catchment in Japan, Hydrol. Process., 21, 308–322, doi: 10.1002/hyp.6231, 2007.

Katsuyama, M., Tani, M. and Nishimoto, S.: Connection between streamwater mean

residence time and bedrock groundwater recharge/discharge dynamics in weathered granite catchments, Hydrol. Process., 24, 2287-2299, doi: 10.1002/hyp.7741, 2010.
Kim, S. and Jung, S.: Estimation of mean water transit time on a steep hillslope in South Korea using soil moisture measurements and deuterium excess, Hydrol. Process., 28, 1844-1857, doi: 10.1002/hyp.9722, 2014.
Lee, K., Kim, J., Lee, D., Kim, Y. and Lee, D.: Analysis of water movement through an unsaturated soil zone in Jeju Island, Korea using stable oxygen and hydrogen isotopes, J. Hydrol., 345, 199-211, doi:10.1016/j.jhydrol.2007.08.006, 2007.
McGuire, K. J., McDonnell. J. J., Weiler, M., Kendall, C., McGlynn, B. L., Welker, J. M. and Seibert, J.: The role of topography on catchment-scale water residence time, Water Resour. Res., 41, W05002, doi: 10.1029/2004WR003657, 2005.
Tetzlaff, D., Seibert, J., McGuire, K. J., Laudon, H., Burns, D. A., Dunn, S. M., and Soulsby, C.: How does landscape structure influence catchment transit time across different geomorphic provinces?, Hydrol. Process., 23, 945–953, doi: 10.1002/hyp.7240, 2009.