別紙 4

報告番号	※　　第　　号

主　論　文　の　要　旨

論文題目　Hydroclimate variability over the last two and a half centuries inferred from oxygen isotope records of tree rings in southwestern Japan (樹木年輪の酸素同位体記録が示す過去 2 世紀半の西南日本における水循環変動)

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論　文　内　容　の　要　旨

To predict occurrences of flood and drought disasters in future using climate models, it is necessary to improve our understanding on the past changes in hydroclimate and mechanisms driving the variability. Japan is located at the northeastern rim of East Asia Summer monsoon, whose small variations result in large changes in hydroclimate. it is pivotal important to understand the past hydroclimate variability in Japan. Although some records can provide the information about the climate of Japan during the last two hundreds years and a half, the variations of hydroclimate in annual resolution has not been implemented. Tree rings are obvious candidates for paleoclimate reconstruction due to its high-resolution, accurate chronology and widespread. In Japan, reconstruction of the past hydroclimate using long-term isotope dendrochronology has been very limited. On the other hand, historical documentary records including official and private diaries in Japan have provided rich information on the past climate to extend the instrumentally observed records, therefore we can validate the tree-ring based reconstruction of past climate during the period independently.

In the study of paleoclimate studies using tree rings, many species have been involved. It makes sense to know whether or not there is any difference in responses to climate parameter of different tree species. The potential uses of our study can lay the foundations for further isotope dendroarcheological and dendroclimatological work in this region. In this study, I analyzed stable oxygen isotope ratio of pine (*Pinus densiflora*) and oak (*Quercus serrate* and *Quercus variabilis*) trees growing in central Japan from 1970 to 2011 as the representative of gymnosperm and angiosperm to examine the similarities and differences in responses to climate parameters between different tree species.

We demonstrated that the inter-annual variations between species are similar, suggesting that $\delta^{18}O$ values of the tree-ring cellulose in each species, each tree, and each radius is influenced by common external factors, despite significant differences in absolute $\delta^{18}O$ values among different species. High negative correlations are present between summer precipitation and $\delta^{18}O$ values of tree-ring cellulose in pine and oak trees, indicating that the tree-ring $\delta^{18}O$ values in these species of trees can serve as proxies for the amount of summer precipitation in central Japan, which, in turn, is mainly influenced by the stationary rain front (Baiu front) in early summer and typhoon events in late summer. Multiple regression analysis revealed that tree-ring $\delta^{18}O$ is largely governed by summer precipitation in the region, for both pine and oak. Relative humidity does not seem to greatly affect tree-ring $\delta^{18}O$ values of oak, in contrast with pine, which may be interpreted as a

difference in leaf morphology or biosynthesis processes of cellulose in the cambium. Tree-ring $\delta^{18}O$ values of both pine and oak can act as reliable proxies of June-August precipitation, while pine trees tend to exhibit more potential for reconstruction of relative humidity. Namely, the coniferous tree species is likely to be more appropriate for hydroclimte reconstruction.

Then, using a conifer species *Abies homolepis*, I present the first long tree-ring oxygen isotope chronology in order to investigate the regional hydroclimate variability over the last two and a half centuries in southwestern Japan.

In this study, a 234-year tree-ring cellulose $\delta^{18}O$ chronology using six Fir (*Abies homolepis*) trees growing on Kamegamori Mountain of Shikoku Island, southwestern Japan had been developed. The chronology is significant negative correlated to local precipitation, relative humidity and suggests that both precipitation and atmospheric vapor-pressure deficit drive tree-ring oxygen isotope values from the oxygen isotope values of source water and the leaf water enrichment.

The spatial correlation analysis indicated that moisture supplied into the study area originates from Pacific Ocean. The tree-ring $\delta^{18}O$ chronology is consistent with the local climate disasters recorded by many historical documents in this region. The low tree-ring cellulose $\delta^{18}O$ values correspond with years of prolonged duration of Baiu front, an early summer stationary front in East Asia, indicating that the isotope ratios in tree-ring are mainly controlled by the location of Baiu front and moisture supply into the front. In addition, historical variation in the tree-ring $\delta^{18}O$, representative of Baiu front location and activity in southwestern Japan, is tightly correlated with El Niño-Southern Oscillation (ENSO). The correlation coefficient is not stationary but reversing at about 30-40 years periodicity over last more than 200 years. Climatological analyses for recent two periods with positive (1976-91) and negative (1960-75) correlations indicated that teleconnections between tropical and extratropical western Pacific regions through atmosphere and ocean might control the summer precipitation in southwest Japan. This study revealed that ENSO influences East Asia Summer Monsoon, including Baiu front, and the teleconnection is not stationary but reversed periodically at multi-decadal time scales possibly according to some longer time scale of changes in atmosphere-ocean circulation, such as PDO regime shift. Establishments and comparisons of many tree-ring $d^{18}O$ chronologies all over Asian monsoon region would elucidate the climate dynamics more in detail for the period before instrumental meteorological observations.