Correlation analysis of intra-annual variation of tree-ring oxygen isotope ratios with synoptic scale meteorological conditions on Amami Island, Japan

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Recent extreme weather events have raised interest in climate change. Therefore, various proxy data are used to reconstruct past climates. Among them, tree rings, are widely studied because of the ease of collecting and preserving samples. We estimate past climate by using the negative correlation between oxygen isotope ratios in tree rings and relative humidity. Precipitation events such as baiu and typhoons occur within a short time scale of about one month or less. High-resolution tree-ring oxygen isotope ratio data is necessary to estimate such precipitation events. Amami Island, the target area of this study, has a longer warm season than the main island of Japan. Therefore, it is expected that climates in longer season are recorded in tree rings in Amami Island due to longer growth season. We measure detailed tree-ring intra-annual variations in cellulose oxygen isotope ratios and identify their seasonal growth pattern by comparing them with meteorological observation data.

We used two Ryukyu pine (*Pinus luchuensis*) trees of about 200 years old, that recently died from pine wilt desease in Amami Island(28.4˚N, 129.5˚E). In this study, a total of 15 rings with very wide ring-width were selected from the overlapping period with meteorological observation data. After extracting cellulose from the thin cross-section plates cut from the wood sample, each tree ring was divided into 24 segments in the direction of growth. Oxygen isotope ratio measurements were performed using an equipment at Nagoya University.The intra-annual variation of oxygen isotope ratios of tree-ring cellulose obtained was superimposed on a graph of relative humidity observed at Naze weather station to estimate the growth pattern of tree rings. The time axis of relative humidity was adjusted so that the two graphs were in best visual agreement. The results show that start and end of the growth of the Ryukyu pine trees measured in this study correspond to late March and late November, respectively. However, in the latter half of the growth season, many samples showed a larger discrepancy between the two graphs, suggesting that the end time of tree ring growth is highly variable from year to year.

Compared to the first rainy season due to stationary front (Baiu), the correspondence with relative humidity was found to be worse in the second rainy season due to typhoons. We will discuss these results by comparing them with weather maps for 36 years since 1957, the year when the weather maps and 12-devide tree-ring oxygen isotope ratio data are both available. In order to show the discrepancy from the negative relationship between relative humidity and tree-ring oxygen isotope ratio, we standardized both data and added them together to obtain a new index. A high (low) value of this index indicates a high (low) oxygen isotope ratio and high (low) relative humidity. The number of days that typhoons were present in a particular area near Amami Island (20-30˚N,120-140˚E) in August and September was counted for each year and correlated with the index. The value of the correlation coefficient was 0.45, indicating a significant positive correlation. This implies that the number of typhoons and their migration paths are indirectly related to the oxygen isotope ratio of precipitation in Amami Island.

Keywords: tree rings, oxgen isotope ratio