Anomalous decadal variability in O and C isotopic ratios of tree-ring cellulose in south-western Japan during the little ice age

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Although the isotopic ratio of tree-ring cellulose is one of the most promising proxies on past land climate, it has not been fully investigated in Japan, probably due to complicated procedures to extract cellulose from tree-ring samples and difficulties in oxygen isotopic measurements of organic matter. After a pyrolysis type of elemental analyzer was developed and combined with isotopic ratio mass spectrometer in 2000, which enabled us to measure d18O of organic matter very easily, we have improved classical procedures of cellulose extraction to shorten total time required for processing of huge numbers of tree-ring samples and applied the modified methods to the tree rings collected all over Japan. Here, we present a first result of long-term (˜300 years) yearly-resolutions of tree-ring cellulose d18O and d13C records, containing 7 sites from sub-boreal (Hokkaido) to sub-tropical (Kagoshima) regions. While there are various scales of temporal variability in the isotopic time series, the major periodicity was found to be much larger in 18th century than in 20th century. Because both of the tree-ring d18O and d13C decrease together with increases in relative humidity and soil moisture contents respectively, both isotopic ratios usually show similar patterns in accordance with past changes in hydroclimate. However, in 17 and 18th centuries the d18O and d13C often shifted to opposite directions in decadal scales. Such anomalous patterns between d18O and d13C were found simultaneously in large areas of southwestern Japan. Therefore, it cannot be explained by local changes in hydroclimate and may suggest the periodic large-scale intrusion of an air mass with low d18O (H_2O) and high d13C (CO_2) in summer, probably originating from tropical regions, to a high latitude air mass dominant in little ice age there. These finding indicate the difference in Japanese climate variability between little ice age and 20th century and the importance of spatiotemporal measurements of tree-ring isotopic ratios more in details to reconstruct past atmospheric dynamics.