

400 years interval of amplification in quasi bi-decadal climate variability: a case of summer precipitation in Japan

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Introduction

Quasi bi-decadal climate variability, often found in palaeoclimatological time series, should be not only attributed to internal climate variation such as ocean-atmosphere interaction, but also owing to astronomical climate forcing like 22 year cycle of solar activity. In long human history, the multi-decadal climate variations are sometimes enhanced to cause long abnormal meteorological conditions and result in numerous famines, wars and political regime shifts. Why does the amplitude of natural climate variation change? If we can understand mechanism of the amplitude modulation in climate variability and predict its future, it must be very helpful for improvement of our adaptability to climate change. In this presentation, I will discuss climatic mode of 400 year intervals of amplification in quasi bi-decadal climate variability found in last two millennial records of summer precipitation which were reconstructed annually by tree-ring cellulose isotope ratios.

Reconstruction of summer precipitation by tree-ring oxygen isotope ratio

Until recently, paleoclimatologists in Japan could not reconstruct precipitation before Edo era when weather descriptions in numerous diaries enable us to discuss climate change precisely. However, it is now possible to elucidate historical changes in summer precipitation with annual time resolution using tree-ring cellulose oxygen isotope ratios all over Asia monsoon area including Japan. Last two millennial summer precipitation variations have been reconstructed in central Japan using many wood samples of Japanese cypress from living trees, old architectures, archaeological remains and buried logs.

Amplification of quasi bi-decadal variability occurring at 400 years intervals.

By wavelet analysis of the two millennia length of summer precipitation record in central Japan, I have found that there are distinct periods of amplitude modulation for the multi-decadal variability, especially at quasi bi-decadal periodicity, in 2nd, 6th, 10th, 14th and 18th centuries when long lasting flood and drought occurred. In fact, 2nd, 6th and 14th centuries correspond to the end of Yayoi, Kofun eras and the medieval upheaval period (Namboku-cho, twin dynasty, era) in Japan, respectively. 10th and 18th centuries are also known as periods of the collapse of centralized political system and the occurrence of giant famines all over Japan, respectively. The amplitude modulation in quasi bi-decadal periodicity occurring at 400 years intervals always started with sudden decrease in tree ring $\delta^{18}O$, accompanied with sudden increase and decrease in its $\delta^{13}C$ and $\delta^{14}C$ content, respectively. At present, I can propose the sudden enhancement of summer monsoon activity bringing tropical air mass to explain all signals of sudden changes in tree-ring isotope records. Especially, sudden increases in temperature during 14th century, which is corresponding to the precipitation increase in Japan, are found at low and middle latitudinal areas in both hemispheres, illustrating that they are actually owing to the summer monsoon enhancement originating from tropical areas. If the amplification in quasi bi-decadal variability at 400 year intervals is related to the periodical change in solar activity such as 800 year cycle, it must be very important to elucidate astronomical and climatic mechanisms combining cause (solar cycle) and effect (amplitude modulation) precisely.

Keywords: tree ring, oxygen isotope, bi-decadal change, precipitation