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Paleoclimate for the Last Glacial-interglacial cycle based on a modern analog technique in the central Japanese

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Among the various proxies of paleoclimate used recently in the world, the modern analog method for pollen composition is an excellent way to estimate meteorological parameters such as annual temperatures and precipitation on land area. We tried to convert the pollen data for the last several tens of thousands years in the central Japan using Polygon 1.5 software proposed by Nakagawa et al. (2002). The major data source is the pollen composition of the NJ88 core from Lake Nojiri and TKN-2004 core from Takano Formation.

The Takano Formation in Nagano City consists of Late Pleistocene lacustrine sediments. A continuous sediment core of 53.88 m length named TKN-2004 was taken at the center of Takano basin in June 2004, of which altitude is 730 m. The age of TKN-2004 core is from 160 to 37 ka, and the time resolution of pollen analysis is about 400 years for 37~99 ka and about 1000 years for 99~160 ka.

Lake Nojiri locates at the northernmost part of Nagano Prefecture. Its altitude is as high as 654m. A scientific drilling core named NJ88 was taken at 28 m depth off the Biwa-jima in Lake Nojiri. The upper 34 m part of the drilled core is composed homogenous silty clay with many thin layers of marker tephra, and covers the last 72 ka. The time resolution of pollen analysis is about 80 year. The pollen composition data were analyzed by Dr. Kawai, S. and Dr. Kanouchi, A. (Kumon et al., 2012: Kanauchi et al.,2009).

Total organic carbon (TOC) and total nitrogen (TN) contents were measured for both sediment cores in 30~50 years interval (Kumon and Tawara, 2009). The TOC data can show relative warmness in detail. We estimated paleoclimate for the last 160 ka as follows stage by stage on the basis of the Polygon analysis (Nakagawa et al., 2002).

In the marine isotope stage (MIS) 6, annual temperature is about 3.7 degree, suggesting very cold climate. The coldness is also shown by the lowest content of TOC.

In MIS 5e, annual temperature becomes a little warm, about 5.7 degree on average. In spite of Last Interglacial Stage, annual temperature in MIS 5e is much lower than that in MIS 1. In MIS 5d, annual temperature is as cold as 3.7 degree on average. That of MIS 5c is 5.2 degree on average, showing a little warmer climate. The annual temperature in MIS 5b is a little low, about 4.5 degree on average. And that of MIS 5a is 6.5 degree on average, warmer than that in MIS 5c. TOC amounts vary quasi-periodically in concordance with the estimated temperatures.

In MIS 4, the annual temperature is about 3.2 degree, as cold as in MIS 6. TOC is also constantly low.

Annual temperature of MIS 3 varies from 2.7 to 12 degree, showing general coolness with many abrupt warm intervals. TOC is also slightly high with a short periodic fluctuation. Both reconstructions from Lake Nojiri and Takano Formation are very similar each other in MIS 3.

In MIS 2, the annual temperature is 3.4 degree, corresponding to the Last Glacial Maximum (LGM) the coldest climate. During 15 to 11 ka, annual temperature show a sudden increasing from 3.0 to 13 degree in MIS 1. The annual temperature drops to 9.0 degree in the latest MIS 1. TOC amounts changes correspond well with the reconstructed temperatures during MIS 2 to MIS 1.

The results reconstructed by modern analog method are generally conformable with the common knowledge. However, there are a few discrepancies. The cause seems to be due to some scarcity of modern analog data for fossil pollen composition. For example, temperature may be estimated too high in late MIS 5 and the early MIS 1 by the excess of Cryptomeria or Quercus.

Keywords: pollen compositions of a modern analog method, Polygon, TKN-2004 core, NJ 88 core, TOC content, TN content