Distribution of oxygen-18 and deuterium in streamwaters across Japan

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Introduction Hypothesis "Streamwater is a proxy for precipitation"

$\delta^{18}O$ and δD in Streamwater reflect...
history of precipitation and/or local hydrological processes
Precipitation: Large Spatial Variability (Catchment area>>>Funnel area)
Streamwater: Easy to collect, "integrated memory" of catchment

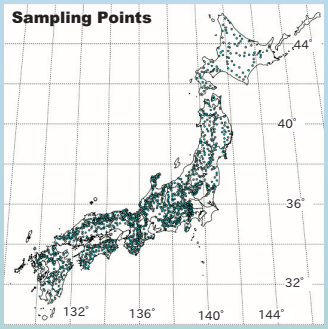
Objectives

(1) describe the spatial variability in $\delta^{18}O$ and δD of the streamwaters in Japan,
(2) evaluate the correlations of the isotopic compositions with selected parameters,
(3) describe the spatial variability in d-excess of the streamwaters in Japan,
(4) compare the data with available precipitation isotope data, and
(5) discuss the validity of the spatial patterns as a proxy for precipitation compositions.

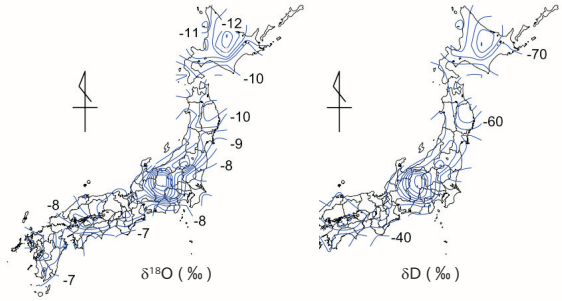
Sampling (Konohira et al., 2006)

Streamwater Samples are collected
- simultaneously in Summer 2003 (Jul.-Oct.)
- under baseflow condition
- at 1278 points of the whole of Japan
- in forested headwaters to avoid anthropogenic effects (<1km² - >100km²)

n=1278



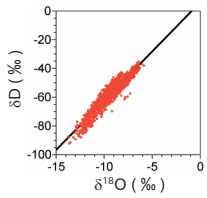
(1) Spatial variability in $\delta^{18}O$ and δD



Lower value is high latitudes and high altitudes

δ diagram

$\delta D = 6.85\delta^{18}O + 6.11$ ($R^2 = 0.89$)



Linear relation is clear

Previous studies

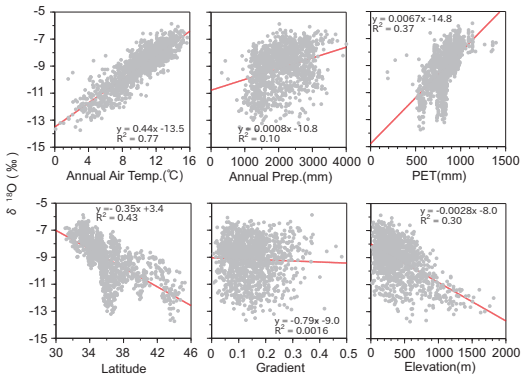
Mizota&Kusakabe (1994)
$\delta D = 7.03\delta^{18}O + 7.91$ ($R^2 = 0.93$, n=298)

Machida&Kondo (2003)
$\delta D = 6.72\delta^{18}O + 3.94$ ($R^2 = 0.91$, n=1067)

Our result will be a general relation between $\delta^{18}O$ and δD of streamwater in Japan

Topography of Japan

(2) Correrations of $\delta^{18}O$ with selected parameters



Higher Correlation with Air Temp., Latitude, Elevation, and PET
Similar to the results in USA (Kendall&Coplen, 2001)

Temperature effect / Altitude effect of Precipitation are clearly mirrored to streamwater (Latitude ≒ Air Temp.)

PET(Potential Evapotranspiration): Priestley&Taylor (1972)

$$Ep = \alpha \frac{\Delta}{\Delta + \gamma} Rn$$

Correrate with Net Radiation, thus, PET is smaller in High Latitude

Characteristics of the Japanese archipelago
Long north and south
Steep mountains

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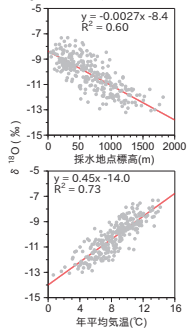
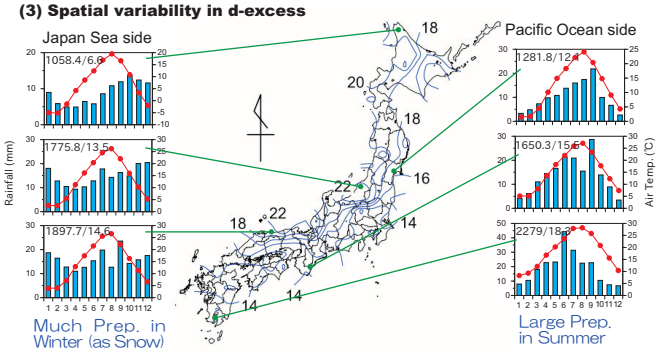
Clearly appeared in the isotope composition

Mountaneous Region, Japan Alps (35-37°N,136-139°E)



Altitude effect(-0.27 ‰ /100m)
(difficult to divide with Temp. effect)

(3) Spatial variability in d-excess



Much Prep. in Winter (as Snow)

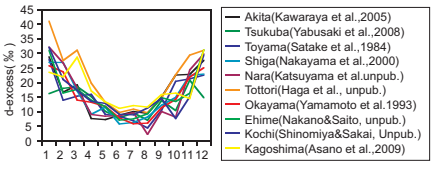
Large Prep. in Summer

$d = \delta D - 8\delta^{18}O$ (Dannsgaard, 1964)

Precipitation in Japan...
= Higher in Winter, Lower in Summer

⇦ Streamwater...
Backbone Mountains devide the value
Lower at Pacific Ocean side
Higher at Japan Sea side

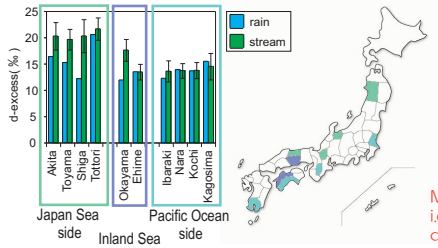
(4) Comparison with available precipitation isotope data



Seasonal Variation of d-excess in Precipitation in Japan

Sampling was done during Summer(Jul.-Oct.), however,
Contribution of Winter precipitation (Snow) may be large at Japan Sea side

(5) Discussion for the validity of the spatial patterns as a proxy for precipitation compositions



Comparison of arethmetic mean of streamwater d-excess with annual weighted mean of precipitation for each prefecture

Pasific Ocean Side: Well agreed.

Japan Sea Side: Less agreed. Stream d-ex. is higher. except Tottori, where Precipitation was collected at the ridge.

Inside Sea region: Corresponded with the location

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Meteorological and Hydrologic System, i.e., snowmelt, infiltration, and recharge processes delay the contribution of Winter Precipitation to Summer Streamwater

Conclusion

Hypothesis "Streamwater is a proxy for precipitation"

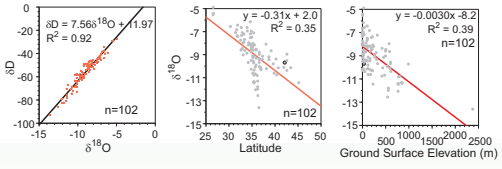
Streamwater isotopic composition appear to be primarily reflecting precipitation, and so may do a better job of integrating the spatial variability in the meteorological cycle.

However in Japan, we have to consider more about the effects of snowmelt, especialy at the Japan Sea side.

Preliminary Results; How about in the Groundwater? - Bottled Water Measuring Project-

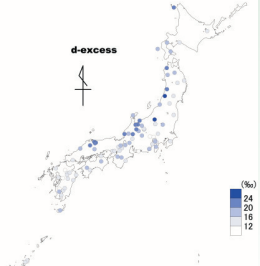
There are a lot of commercial bottled waters with many different bottling sources through Japan ⇦ Very Easy to Collect

Good Groundwater Samples!



- Good Correlation between $\delta^{18}O$ vs. δD
- Temperature (Latitude) / Altitude effect are clear
- d-excess
  Lower at Pacific Ocean side / Higher at Japan Sea side

Groundwater (Bottled water) may be a good proxy of precipitation, as well as of streamwater



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