Isotopic variation of precipitation over eastern Mongolia

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Introduction

For understanding mechanisms of precipitation variability, it worth quantifying contribution ratio of local and non-local water vapors to precipitation. Stable isotopes of water are powerful tool for tracing atmospheric water transport.

The present study describes characteristics of precipitation isotopes in eastern Mongolia as a basic knowledge to assess the above subject. In the concrete the objectives of this study are threefold:

(1) to clarify time-space structure of isotopic variation of precipitation in and around the Kherlen River basin
(2) to understand the isotopic variation in terms of atmospheric water cycle and land surface-atmosphere interaction
(3) to detect isotopic signal indicating source of precipitation.

Methods

- Monthly sample (2002.10-2003.9)
- Daily sample (2003.4-2003.9)


Rain collector


Snow collector

MGM: Mongenmorit
KBU: Kherlen-Bayan Ulaan
UDH: Underhaan
ULB: Ulanbaatar
CBS: Choibalsan
MDG: Mandalgobi
SHB: Sukhbaatar

Fig. 1 Map of monitoring sites

Results

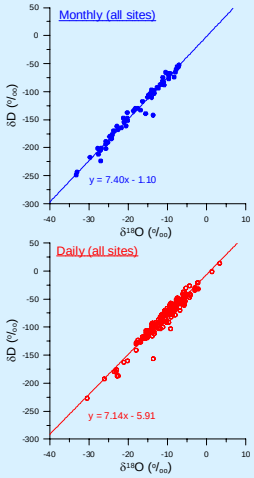

Fig. 2 δ-diagram

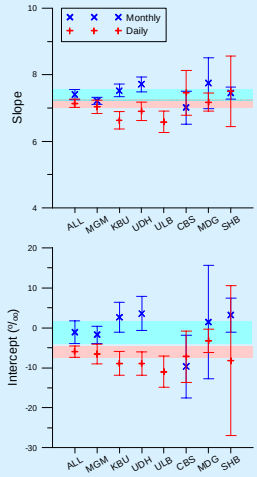

Fig. 3 Regression coefficients of local meteoric water lines

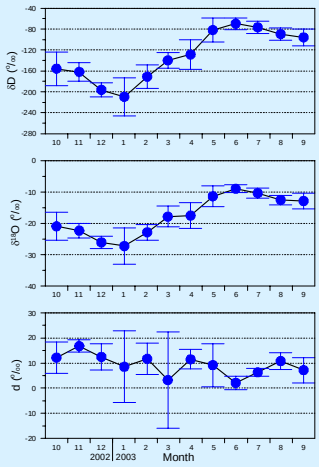

Fig. 4 Annual variation pattern of precipitation isotopes (spatial average ±s.d.)

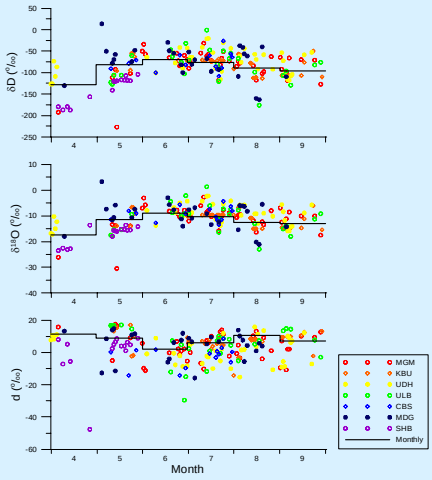

Fig. 5 Inter-storm variability of precipitation isotopes

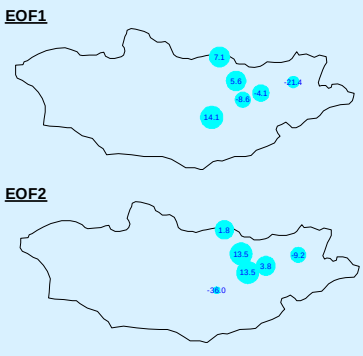

Fig. 6 Score distribution of EOF1&2 for spatial pattern of d

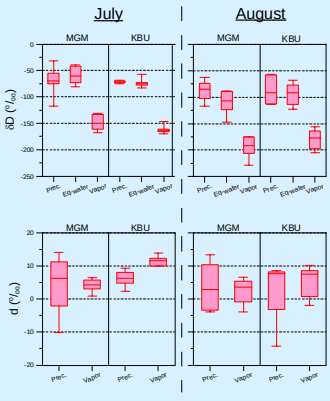

Fig. 7 Box-Whisker plots for isotopes in precipitation, atmospheric water vapor, and water in equilibrium with the vapor

- Figs. 2-4
  Isotopes in precipitation are considerably homogeneous over all the monitoring sites (i.e., eastern Mongolia).
- Fig. 4
  1-yr periodicity is dominant in annual variation in δ-values indicating strong temperature effect.
- Fig. 5
  Inter-storm variability is high but along with annual trend.
- Fig. 6
  Spatial distribution pattern is not structural but stochastic.
- Fig. 7
  Isotopic compositions of precipitation is higher than those of atmospheric water vapor but corresponds well with estimated compositions of water in isotopically equilibrium with the vapor.

Discussion and conclusions

Temporal variation of precipitation isotopes, which has a periodicity of 1-year, is considerably homogeneous in and around the Kherlen River basin. Local characteristics are not significant. These facts indicate that large scale circulation of atmospheric water vapor is dominant.

Precipitation is in isotopically equilibrium with water vapor within the atmospheric boundary layer (ABL). According to Yamanaka et al. (2004), contribution ratio of local water vapor produced by evapotranspiration to the ABL water vapor is estimated to be 20% or less. From this estimate and results of this study, it is suggested that recycling ratio of water within the basin is no more than 20%. Although any isotopic signals indicating strong recycling of water cannot be identified at the present state, causes of inter-storm variability should be further investigated.