

Recent spatial distributions of Tritium concentration in surface snow over East Antarctica

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The stable water isotopes in snowfall (δD , $\delta^{18}O$) have been provided abundant knowledge regarding past and present water cycle over the Antarctica. The spatiotemporal variations of δD and $\delta^{18}O$ in Antarctic snow result from accumulated isotopic fractionation during evaporation at the source region and during transportation from source to deposition site. Here, we introduce alternative useful tracer of Antarctic hydrological cycle: tritiated water (HTO). Tritium (T) is one of the cosmogenic nuclides such as ^{14}C , ^{10}Be , and ^{36}Cl . T is produced by the interaction of cosmic radiation with oxygen and nitrogen atoms, has a half-life of 12.3 years, then rapidly enters the hydrological cycle as the form of HTO molecules. Although vast amount of T had been injected into upper atmospheres by the atmospheric testing of thermonuclear bombs between 1951 and 1980, by the end of 1990s most of this bomb T had been removed from the atmosphere. As a consequence, HTO concentration in today's precipitation is very close to the natural levels.

The major natural source of HTO is the spallation reaction over the Antarctic atmosphere. As a part of water molecular, HTO follows the pathway through hydrological cycle, with only small perturbations owing to fractionation effect during phase changes. Different from the δD and $\delta^{18}O$, these fractionation effects are small and can be ignored relative to uncertainties of HTO measurements. Consequently, HTO is considered as the useful tracer for partitioning between local Antarctic moisture (high HTO) and moisture transported from the surrounding ocean (low HTO). Here we show the usefulness of the HTO through examining if the local moisture significantly contributes to snow accumulation over Antarctica.

Surface snow sampling at every 10km along the traverse from the coast to Dome Fuji have been conducted in two Australian summer, 2017/2018 (JARE 59). We left S16 base near the coast in early November and arrived at Dome Fuji station early December. We then went back to S16 in mid-January. Snow samples were collected on both ways. Total number of samples are 157. HTO concentration of surface snow was measured by liquid scintillation counter (Quantulus 1220, Perkin-Elmer Inc.) without electrical enrichment. The analytical uncertainties associated with repeated measurements of each sample is less than 3 TU, 1 TU meaning a T/H ratio of 10^{-18} .

Figure 1 exhibits the spatial variation of HTO concentration in snow between coast (S16) and interior station (Dome Fuji). For comparison, HTO concentrations of snow pits (typically 20cm depth) sampled in summer 2012/2013 (JARE 54) are also plotted. There is a clear increase trend of HTO in both surface snow and snow pits from coast to Dome Fuji. This indicates that moisture transport from surrounding oceanic region is not dominant contribution of snowfall over the East Antarctica, but contribution of local moisture to snowfall increase toward inland (see Fig. 2). This is consistent with the fact that clear-sky deposition of diamond dust are frequently observed at the inland station such as Dome Fuji. Quantitative understanding of HTO in snow may help us to estimate how much contribution of diamond dust contributes to annual accumulation. In this presentation we discuss the physical mechanism of observed increase HTO trend using HTO production model.

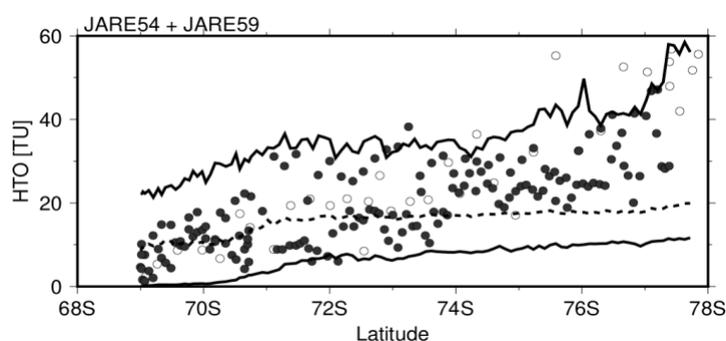


Figure 1. HTO concentration along the JARE traverse to Dome Fuji. Filled (open) circles are sampled in JARE59 (JARE54). Solid lines represent the simulated upper and lower HTO concentration. Dashed line is the monthly average HTO during the traverse.

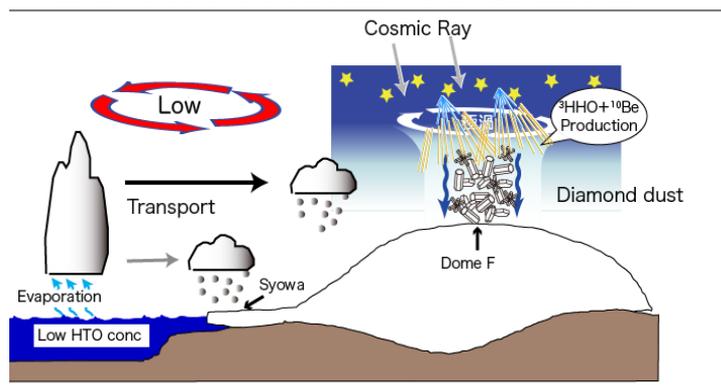


Figure 2. Schematic illustration of the HTO over the Antarctica