Application of tritium tracer technique to the partitioning between clear-sky and synoptic precipitation over the Antarctic plateau

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In Antarctic plateau, precipitation falling from clear sky (known as diamond dust) occurs almost daily, but a few major synoptic events can give a significant fraction of the annual accumulation. Thus, it is not clear how much contribution of clear-sky precipitation to the total accumulation on the plateau. Here we introduce alternative method for partitioning between synoptic and clear-sky precipitation: tritiated water (HTO). Tritium (T) is one of the cosmogenic nuclides, which mainly produce in the upper atmosphere over the Antarctica. After the HTO generation, HTO follows the pathway through hydrological cycle, with only small perturbations owing to fractionation effect during phase changes. Consequently, HTO concentrations in diamond dust formed by condensation of local Antarctic water are characterized by higher HTO than the synoptic precipitation accompanied with moisture transported from the surrounding ocean. We analyzed HTO in surface Antarctic snow collected by repeated traverses between Syowa and Dome Fuji and found two prominent spatial features; the gradual increase trend from the coast to plateau region and the rapid increase in HTO toward inland on the plateau. In addition, a good anticorrelation is observed between HTO and δ^{18}O of snow on the plateau. These features indicate that much of the plateau accumulation results from clear-sky precipitation with no synoptic-scale moisture transport. To support this interpretation, here we use the atmospheric circulation model incorporated into HTO. The model can reasonably simulate both a gradual decreasing trend of d18O and increasing trend of HTO toward inland, although the lowest 18O values over the plateau region are much higher than the observations. Moreover, a negative relationship between HTO and δ^{18}O of snowfall is also well simulated by the model. The model results show that the seasonal HTO variation is linked to the precipitation amount. Thus, the highest HTO (lowest δ^{18}O) of snow at Dome Fuji corresponds to the month with weak precipitation flux. In contrast, the months with large precipitation flux due to frequent passage of synoptic systems are characterized by lower HTO values. In this presentation, with an aid of model results, we show that balance between clear-sky and synoptic precipitation is a key driver controls HTO distribution on the Antarctic plateau and introduce the usefulness of the HTO to explore the hydrological cycle changes associated with recent climate change over the plateau region.

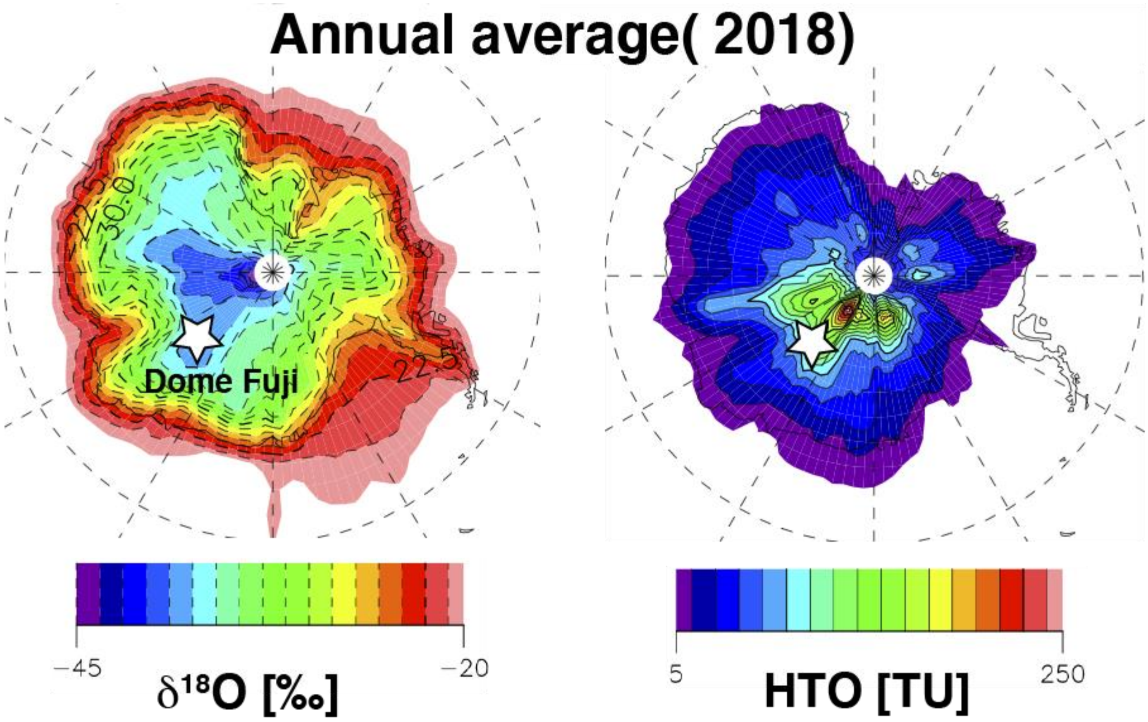

Figure 1. Simulated δ^{18}O (left) and HTO (right) of annual precipitation over Antarctica