Addendum to the response to the review of B. Alexander

Comment by Dr Alexander : *“Section 5: What about a discussion of the impact of “light” HNO_3 derived from the photolysis of snow nitrate depositing downwind of its emission? Wouldn’t this impact (lower?) the apparent fractionation factor?“*

In our first response to Dr Alexander’s comment, we deferred this discussion to the companion paper. However, because the calculation of apparent isotopic fractionations is at the core of the present paper, we would like to provide a more complete response to that comment.

Apparent fractionation constants are purely derived from observations regardless the mechanisms and processes controlling the isotopic composition of nitrate deposited on snow. In other words, no hypothesis is made on the isotopic composition of nitrate deposited on the snowpack to derive the apparent fractionation constant. Therefore, a constant shift in the isotopic signature of the primary nitrate deposited at a given site is not expected to impact the apparent fractionation constants observed in snow. That said, “light” HNO_3 feeding sites located down-wind of the plateau may well represent a source which varies in the season (with a peak expected in phase with the peak of the photolytic activity). This scenario therefore deviates from the “constant shift” considered above and an impact on the calculated apparent fractionation constants may be expected.

Moreover, we note that the transport of ‘light” HNO_3 may impact the year-round averaged $\delta^{15}N$ of the “primary” nitrate received at a given site. As a consequence, we expect that the asymptotic $\delta^{15}N$ value (representing the $\delta^{15}N$ in the archived nitrate down to a depth of 30-60cm) will change and that this change is very close to that occurring in the $\delta^{15}N$ in the “primary” nitrate. For instance, a year-round average shift of 20‰ in the primary nitrate may well result in a 20‰ shift in the asymptotic $\delta^{15}N$.

Many processes contribute to the isotopic composition of nitrate depositing on snow, including short- medium- and long-range advection of airborne nitrate, some of which may be influenced by the recycling processes described and illustrated by our publication. However, we maintain that it is beyond the scope of this publication to investigate in detail the impact of processes occurring upwind the field sites. A quantitative discussion of the isotopic impact of processes occurring upwind the field sites requires detailed modeling (at some point in the future with a regional CTM) with site specific local emission/deposition strength (vertical exchange) and advection (horizontal exchange), beyond the scope of this paper.