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Nitrate isotope variability on the East Antarctic plateau: Results from the EAIIST (East Antarctic International Ice Sheet Traverse) project

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Nitrate is one of the most abundant ions in Antarctic ice, but interpreting its concentration and isotopic variability in ice cores is difficult due to substantial photolytic mass loss after its atmospheric deposition onto the snow surface. To improve our understanding of Antarctic nitrate dynamics, particularly in extreme environments, nitrate sampling was a priority for the French-Italian-Australian EAIIST project's Antarctic land vehicle traverse in austral summer 2019/2020. Over three months, the EAIIST team traveled from the Adélie coast to the remote interior Megadunes site (650 km south of Dome C) by way of Concordia station before returning back to the initial coastal starting point. This 3600 km transect covered a wide range of Antarctic environments from wet and windy coastal regions to the dry and relatively calm interior plateau, with the Megadunes site offering a particularly unusual landscape of wind glazed areas, rolling dunes with spatially variable accumulation rates, and visible surface cracking. During EAIIST, ˜ 0.5–1kg of snow was collected twice a day from both the snow surface and at 1-m depth to be later melted and processed for nitrate isotopic analysis. Additionally, 1-m deep snow pits were incrementally sampled in 2–10 cm intervals at seven sites to precisely observe how the nitrate profile changed with depth. These 262 total samples show a clear spatial relationship between nitrate and snow accumulation rate, with more post-depositional changes (i.e., lower nitrate concentration, higher nitrogen isotopes, lower oxygen isotopes) observed in the nitrate at drier sites. Samples from the Megadunes region, however, suggest that this relationship becomes more complex at sites with very low accumulation rates due to wind-pumped mobilization of near-surface nitrate into deeper firn. This holds important context for interpreting nitrate in deep ice cores, as glacial period conditions at coring sites may have been similar to the modern environments that we observed at the Megadunes.

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Track Classification: Progress in proxy development and interpretation