The Air Mass Back-trajectories: A Key Factor in the Interpretation of Isotopic Depositional Processes on the East Antarctic Plateau

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The isotopic composition (δD and δ18O) of snow precipitation, archived in the Antarctic ice sheet every year, is an important proxy of climatic conditions. This signal is observed to be dependent on several parameters including temperature, altitude and distance from the coast. The well-established correlation between water stable isotopes and local temperature - commonly used in paleoclimate reconstructions - is strongly observed in the earlier dataset of Antarctic surface snow isotopic composition (Masson-Delmotte et al. 2008), and the spatial variability of this relationship across the distinct regions of the continent was investigated to improve the use of this proxy.

Here, we aim to explore the temperature vs water stable isotopes on the East Antarctic Plateau characterized by very low snow accumulation. The surface (a few cm average) and bulk (top 1 m average) snow samples were collected as a part of the East Antarctic International Ice Sheet Traverse (EAIIST) in the summer 2019-2020. Our sampling covers the area from Dumont D’Urville to Dome C and the unexplored area from Dome C towards the South Pole. The linear relationship between surface temperature and isotopic composition is completely lost in the latter part of the traverse. This area is subject to strong post-depositional processes such as wind redistribution and sublimation effect (Windcrust and Megadune sites). For this reason, ahead of evaluating the post-depositional effects able to modify surface snow composition, we decided to investigate a priori the snow depositional conditions and processes, which define the original isotope signal over 600 km on the Antarctic Plateau. While geographical parameters are constant, such as the altitude and the distance from the coast (increasing distance from the Indian Ocean but decreasing distance from the Pacific and Atlantic Ocean), we investigate the origin of the air masses for the different sampling sites, observing significant variations moving towards the Megadunes area. The 10-day back trajectories of the air masses were calculated for each sampling site at a 12-hour resolution,
spanning from January 2016 to January 2020, using the FLEXPART - FLEXible PARTicle dispersion model. For each sampling site, we estimated the corresponding annual mean footprint. To assign greater weight to air masses responsible for precipitation on the Antarctic Plateau, those footprints are calculated through a weighted average of back-trajectories using the ERA5 precipitation rate.

The different origins can contribute to distinct isotopic signals, despite similar climatic and geographic factors on the East Antarctic Plateau. This divergence poses a challenge in the determination of the post-depositional processes affecting the isotopic composition of snow and in the reliable use of this proxy in reconstructing past temperatures in the context of Antarctic ice core science.