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Estimation of moisture fluxes in East Antarctica and their impact on the isotopic composition of the snow surface

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The ability to infer past temperatures from ice core records has in the past relied on the assumption that after precipitation, the stable water isotopic composition of the snow surface layer is not modified before being buried deeper into the snowpack and transformed into ice. However, in extremely dry environments, such as the East Antarctic plateau, the precipitation is so sparse that the surface is exposed to the atmosphere for significant time before burial. During that exposure, several processes have been recently identified as impacting the snow isotopic composition after snowfall: (1) exchanges with the atmosphere (i.e. sublimation/condensation cycles), (2) wind effects (i.e. redistribution and pumping) and (3) exchanges with the firn below (i.e. metamorphism and diffusion).

Here we present the data over several seasons and years of the atmospheric water vapor and snow surface isotopic composition at Dome C, East Antarctica. To understand the link between these two elements, we investigate the moisture fluxes at the surface of the ice sheet, at the snow-air interface. No eddy-covariance measurements are available for the recent years, we therefore make use of the available primary meteorological parameters measured continuously on site to estimate the surface moisture fluxes using the bulk method. We estimate that the cumulative effect of the moisture fluxes is positive: about 12% of the mean annual accumulation is sublimated away. Alongside, we see an enrichment in $d^{18}O$ in the snow surface during the summer months, when most of the moisture fluxes are taking place. The snow d-excess is also affected and evolving in anti-phase with $d^{18}O$. This indicates occurrence of fractionation during sublimation in line with previous field and laboratory studies. The moisture fluxes could be a key driver of changes in the snow isotopic composition between precipitation events influencing the climate signal stored in the isotopic record of ice cores.