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What is driving the isotopic composition of surface snow in East Antarctica? - Insights from a multi-year time series of surface snow at Dome C

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The isotopic composition (d^{18}O, dD) of surface snow on an ice sheet is primarily seen as a recorder of the air temperature and is used to reconstruct past climatic conditions from ice cores. The second order parameters d-excess and ^{17}O-excess can preserve climatic signals from the moisture origin and are indicative for kinetic fractionation processes in the water cycle between the source and the deposition site. Fractionation is especially important for the surface snow which can exposed to the atmosphere for a long time during periods without snowfall. The resulting effect of this process on the isotopic composition and the second order parameters in the interior of Antarctica is, however, unclear. In order to better understand the contribution of secondary processes on the isotopic signature and to disentangle the climate characteristics at the moisture source region and at the ice core site, we study both the isotopic composition and the second order parameters of surface and subsurface snow at Dome C on the East Antarctic Plateau. For this, we make use of an extensive data set of isotopic data (d^{18}O, dD, dexcess and ^{17}O-excess) from surface (0 - 1.5 cm) and subsurface snow (1.5 - 4.5 cm) covering continuously the period from 2016 to 2020. This data set is complemented with previously published isotopic data of surface snow and precipitation data back to 2011. For additional comparisons and analyses, we use data from a nearby weather station, the ERA5 reanalysis data set, a satellite-derived grain index estimate and simulations from the detailed snowpack model CROCUS.

We observe a good (weak) correlation between the ambient temperature and the surface (subsurface) layer. Most years are characterised by a strong increase in the isotopic composition

towards the summer and a gentle decrease towards winter while d-excess shows a contrary behaviour. We suggest that the strength of the summer increase is related to the amount of precipitation and the magnitude of metamorphism at the surface. The degree of metamorphism can (to some degree) be approximated from observational data (e.g. the grain index) or from model output (e.g. latent heat flux from CROCUS). In addition to presenting possible mechanisms leading to strong or weak increases in the isotopic composition in summer, we developed a simple model using temperature and snowfall data from ERA5 to analyse the contribution of temperature and other parameters to the observed isotopic signals.