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Climate dependent contrast in surface mass balance in East Antarctica over the past 216 kyr

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Documenting past changes in the East Antarctic surface mass balance is important to improve ice core chronologies and to constrain the ice sheet contribution to global mean sea level change. Here we reconstruct the past changes in the ratio of surface mass balance (SMB ratio) between the EPICA Dome C (EDC) and Dome Fuji (DF) East Antarctica ice core sites, based on a precise volcanic synchronisation of the two ice cores and on corrections for the vertical thinning of layers. During the past 216,000 years, this SMB ratio, denoted SMB_EDC/SMB_DF, varied between 0.7 and 1.1, being small during cold periods and large during warm periods. While past climatic changes have been depicted as homogeneous along the East Antarctic Plateau, our results reveal larger amplitudes of changes in SMB at EDC compared to DF, consistent with previous results showing larger amplitudes of changes in water stable isotopes and estimated surface temperature at EDC compared to DF. Within the last glacial inception (Marine Isotope Stages, MIS-5c and MIS-5d), the SMB ratio deviates by up to 20% from what is expected based on differences in water stable isotope records. Moreover, the SMB ratio is constant throughout the late parts of the current and last interglacial periods, despite contrasting isotopic trends. These SMB ratio changes not reflected in the isotope profiles are one of the possible causes of the observed differences between the ice core chronologies at DF and EDC. Such changes in SMB ratio may have been caused by (i) climatic processes related to changes in air mass trajectories and local climate, (ii) glaciological processes associated with relative elevation changes, or (iii) a combination of climatic and glaciological processes, such as the interaction between changes in accumulation and in the position of the domes. Our inferred SMB ratio history has important implications for ice sheet modeling (for which SMB is a boundary condition) or atmospheric modeling (our inferred SMB ratio could serve as a test).