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Geometric and crystallographic microstructural anisotropy in polar snow: A case study of the EastGRIP snowpack, Greenland.

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Snow processes in shallow polar snowpacks are often considered only as a perturbation of the initial state for the actual formation of microstructural signals deeper in the firn. To advance the understanding of the different types of microstructural anisotropy, we have taken a shallow snow core (0-3 meters) from EastGRIP (Greenland) and analyzed full profiles of the three-dimensional (geometrical) microstructure of the ice matrix obtained from X-ray tomography and of the (crystallographic) microstructure from the texture obtained from polarized light microscopy on thin sections. We clarify the notion of different fabric tensors for the characterization of the geometrical and the crystallographic anisotropy. We show that the geometrical fabric of snow unambiguously reveals the seasonal cycles in contrast to otherwise rather featureless near-surface signals of density or specific surface area. By comparing the different fabric parameters, we provide some indications that the crystallographic and geometrical anisotropy develop correlations already at shallow depth. We discuss our findings in view of temperature gradient metamorphism as i) the unambiguous origin of the geometrical signal and ii) the potential origin of the crystallographic signal, and their mutual feedback on the mechanical properties of polar snow. These results will be compared to previous similar measurements performed on snow deposited under the cold conditions of the Point Barnola site (East Antarctica) where high resolution texture measurement along a firn core are also available. We wonder how the microstructural anisotropy and the associated layering evolves from snow to firn, and if it has, or not, an impact on the climatic signal layering.