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Up-side-down MIS 12-11 climatic transition in the Vostok core highlights basal ice behaviour.

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Sampling of undisturbed ice layers by deep ice coring is a prerequisite for reconstruction of long climate record as exemplified by the recently obtained EPICA Dome C record (EPICA community members, 2004). At Vostok, the flow line originates from Ridge B 300 km upstream, and the 3750 m thick glacier floats over a subglacial lake for about 50 km prior the station. About 220 m of lake ice is accreted at its base, and over the 3538m thickness of glacier ice, due to the ice flow near the bedrock and over the lake, the horizontal layering is disrupted limiting the climatic record to 3310 m depth and about 410 kyrs B.P., a period just following the onset of interglacial MIS11. The very basal ice from 3450 m depth is highly deformed and even contains glacial flour. In between, from 3320 and 3350 m, within a 24 m ice interval, two very rapid (within 2m) shifts with a glacial–to-interglacial amplitude are synchronous for deuterium, dust and gas values, making discontinuities in the climate record.

Now, a simple upturning the above mentioned 24m thick layer between the two discontinuities renders the climatic record very similar to the EPICA record for deuterium and dust. This operation also provides a record of the gases shifted by a few meters with respect to deuterium as expected from the following climatic transitions. This expands the Vostok record to 3350 m depth and to 440 ky BP, giving trustfully access to the climatic transition MIS12-11. Understanding the such anomalies in ice flow would bring additional confidence when reconstructing the climate record.

During the 300 km travel from Ridge B area to Vostok, deep ice layers are thinned. At great depth, ice is mainly deformed by simple shear, but due to changing bed slope, ice

can be subjected to compression along layers. Folding and subsequent recumbent folding can occur for ice layers more viscous than the surrounding ones, a phenomenon already suggested from several other deep ice cores studies. Variations of the rheological properties of ice with grain size, impurities, crystal orientation or other parameters are therefore expected at depth in glacier ice flowing to Vostok. In addition, to explain the disappearance of the normal limb of a recumbent fold, as suggested by simply upturning the MIS12-11 layer, subsequent lamination is a plausible mechanism while boudinage can also occur as the glacier ice could be under longitudinal extension as soon as it is approaching the lake. On the other hand, the preservation of the overturned limb of the fold, if not by chance, could be due to the change in rheological properties of MIS12-11 layer into similar to the surrounding ice layers.

Vostok reconstruction for MIS 12-11 transition, based on the coherence with the EPICA climatic record, suggests that folding and boudinage can affect a decameter-thick ice layer and a complete climatic transition. The search for the previous climatic transition (MIS14-13) in deeper ice (from 3350 to 3450m) and its association to a recumbent fold will be interesting in this respect.