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Widespread ice sheet retreat in southern Greenland associated with northward expansion and warming of North Atlantic subtropical water masses

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In the past decades a northward expansion of North Atlantic subtropical water masses[1-3] and warming of subtropical mode water[4,5] (350 – 400 m depth) has been observed. Paleoceanographic records from interglacials prior to 400 ka ('early Brunhes ') reveal a marked inter-hemispheric climate asymmetry with the average position of the ocean subtropical front in the eastern North Atlantic having shifted at least 4° latitude to the north[6,7]. Northward displacement of climate and vegetation belts and previously inferred reduction in sea ice cover at northern high latitudes[7] has later been confirmed by modelling studies[8]. North Atlantic ocean circulation was characterized by an enhanced eastern boundary current poleward transport of warm, (sub)tropical water masses both at surface and subsurface depth[9,10]. In recent years (paleo)oceanographic studies of Greenland fjords have demonstrated that 'warm' and saline subsurface water masses of subtropical origin are responsible for sub-glacial melting processes of Greenland tide- water glaciers[11-13]. In periods of the early Brunhes interglacials (MIS 11, 13, 15) during which the eastern North Atlantic was characterized by enhanced northward transport of warm, (sub)tropical water masses[9,10], large parts of the southern Greenland Ice Sheet had melted away and a boreal forest could develop here[14,15] . We conclude that at that time the presence of much warmer, subtropical water masses at subsurface depth in Greenland fjords combined with advection of warm, subtropical air masses with increased precipitation potential from the expanded ocean subtropical gyre region had been responsible for widespread melting of the southern Greenland Ice Sheet. Presently, ongoing northward expansion and warming of North Atlantic subtropical water masses must therefore be considered to be a process leading to further acceleration of widespread melting of the (southern) Greenland Ice Sheet.

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