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Important role of the mid-tropospheric atmospheric circulation in the recent surface melt increase over the Greenland ice sheet

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Since 2007, there has been a succession of surface melt records over the Greenland Ice Sheet (GrIS) in continuity of the trend towards increasing melt observed since the end of the 1990s. But, these last two decades are characterized by an increase of negative phases of the North-Atlantic Oscillation (NAO) favouring warmer and drier summers than normal over GrIS.

In this context, we use a circulation type classification based on the daily 500 hPa geopotential height to evaluate the role of the atmospheric dynamics in this surface melt acceleration for the last two decades. Due to the lack of direct observations, the interannual melt variability is gauged here by the summer (June-July-August) mean temperature from reanalyses at 700 hPa over Greenland; analogous atmospheric circulations in the past show that $\sim$70% of the 1993-2012 warming at 700 hPa over Greenland has been driven by changes in the atmospheric flow frequencies. Indeed, the occurrence of anticyclones centred over the GrIS at the surface and at 500 hPa has doubled since the end of 1990s, which induces more frequent southerly warm air advection along the Western Greenland coast and over the neighbouring Canadian Arctic Archipelago (CAA). These changes in the NAO modes explain also why no significant warming has been observed these last summers over Svalbard, where northerly atmospheric flows are twice as frequent as before.

Therefore, the recent warmer summers over GrIS and CAA cannot be considered as a long term climate warming but are rather a consequence of the NAO variability impacting the atmospheric heat transport.

While no global model from the CMIP5 database projects consequent changes in NAO through this century, we cannot exclude that these changes in NAO are due to global warming. Indeed, we have performed several sensitivity experiments performed with the regional climate model MAR over an integration domain large enough for allowing MAR to simulate its own general circulation independently of the forcing (ERA-INTERIM). These MAR simulations seem to suggest that the NAO anomalies over summers 2007-2012 are due to changes in the Sea Ice Cover (SIC) and Sea Surface Temperatures (SST) in the Arctic.