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Poleward transport of African dust and its impact on Greenland Ice melt

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This study aims at advancing our understanding of the role of Saharan mineral dust in the Arctic climate system. It focuses on dust emission over the Sahara and the mechanisms by which Saharan dust can reach the Arctic by investigating a case study of intense Saharan dust emission that occurred in April 2011.

The poleward transport of dust was associated with an intense Saharan cyclone that occurred over North Africa in early April 2011. Satellites observations at high spatial-temporal resolution are used to characterize the dust activity over North Africa associated with the Saharan cyclone as well as the transport of dust toward the Arctic and its deposition over Greenland. Beside the observations, a simulation at high resolution was performed using the MesoNH model in order to estimate the dust load transported northward and to evaluate the dust deposition north to 60[U+25E6]N.

In this study, we identify a new and important mechanism for the transport of dust over long distances toward the northern pole: the poleward migration of Saharan cyclones, in which dust from the Sahara is transported toward the Arctic following a newly identified path; across the Northern Atlantic Ocean around the Icelandic Low. This path is to be added to the two preferable paths mentioned in previous studies i.e. through transport across Northern Europe and across the Atlantic Ocean around the Bermuda High. The poleward migration of the Saharan cyclone following this path was favorite by a negative-Arctic-Oscillation like situation associated with a slowed polar vortex and polar jet stream, which caused the intrusion of a lobe of low pressure further south with which the Saharan cyclone has merged and moved northward. The Saharan cyclone was accompanied by warm air that reached Greenland and caused a rise in surface temperature of about 10C over 3 days which led to ice melt over the southeastern parts of Greenland. This melt was detected in satellite observation of brightness temperature.

A total dust load of about 38.35 Tg was carried by this cyclone to areas located north of 40 N and dust deposition was estimated to be 1.3 Tg to the north of 40N. The frequency of such events as well as the changes in ice albedo due to dust deposition on ice need to be evaluated in future studies in order to estimate the total impact of such event on Arctic ice both through melting and albedo changes.

Key words: Arctic, North Africa, dust storm, dust deposition, surface albedo, ice melt.