Geophysical Research Abstracts
Vol. 15, EGU2013-4981-1, 2013
EGU General Assembly 2013

Atmospheric and oceanic climate forcing of the exceptional Greenland Ice Sheet surface melt in summer 2012

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The NASA announcement of record surface melting of the Greenland ice sheet in July 2012 led us to examine the atmospheric and oceanic climatic anomalies that are likely to have contributed to these exceptional conditions and also to ask the question of how unusual these anomalies were compared to available records. Our analysis allows us to assess the relative contributions of these two key influences to both the extreme melt event and ongoing climate change. In 2012, as in recent warm summers since 2007, a blocking high pressure feature, associated with negative NAO conditions, was present in the mid-troposphere over Greenland for much of the summer. This circulation pattern advected relatively warm southerly winds over the western flank of the ice sheet, forming a "heat dome" over Greenland that led to the widespread surface melting. Both sea-surface temperature and sea-ice cover anomalies seem to have played a minimal role in this record melt, relative to atmospheric circulation. Two representative coastal climatological station averages and several individual stations in S, W and NW Greenland set new surface air temperature records for May, June, July and the whole (JJA) summer. The unusually warm summer 2012 conditions extended to the top of the ice sheet at Summit, where our reanalysed (1994-2012) DMI Summit weather station summer (JJA) temperature series set new record high mean and extreme temperatures in 2012; 3-hourly instantaneous 2-m temperatures reached an exceptional value of 2.2degC at Summit on 11 July 2012. These conditions translated into the record observed ice-sheet wide melt during summer 2012. However, 2012 seems not to be climatically representative of future "average" summers projected this century.