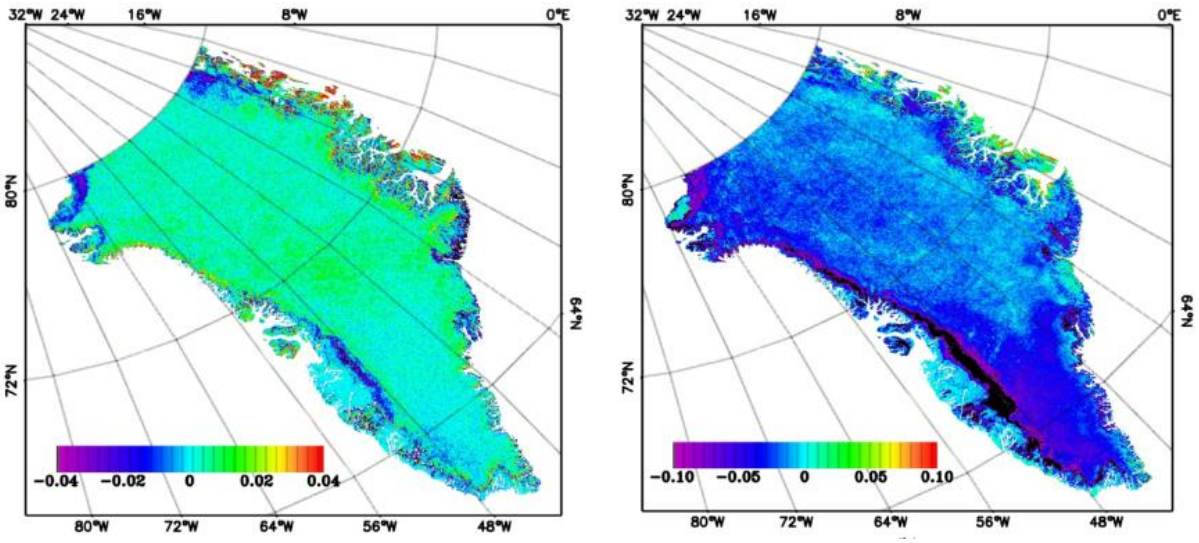
IEAGHG Information Paper 2017-IP46; The Greenland Ice Sheet is Melting Faster than Before

Currently, the Greenland ice sheet is adding up to 1mm a year to the rise in the global average level of the oceans. It is the largest mass of ice in the northern hemisphere covering an area about seven times the size of the United Kingdom and reaching up to 3km (2 miles) in thickness. If it all melted, the average sea level would rise around the world by about seven metres (approximately 23ft). The impact of such a rise in sea level on countries like the Netherlands, or on cities like Venice and New Orleans would be catastrophic. There is a great map that you can go to and chart the impact of sea level rise on the land map in various parts of the world. Go to: http://geology.com/sea-level-rise/

There is now concern amongst scientists that the melting of the Greenland ice sheet could accelerate and raise sea levels more than expected. The reason for this appears to be twofold darkening of the snow and decreasing cloud cover:

Darkening of the ice and Albedo change. It is known that small amounts of debris such as soot (or 'black carbon'[1]) from wild fires or anthropogenic sources can have a major effect on ice albedo in the ablation zone, where meltwater is produced. Such 'contaminants' effectively darken the surface, and thus lower the albedo. Since dark surfaces absorb more of the sun's heat than highly reflective clean ice or snow, the darkening results in increased melt.

In addition, the warmer conditions in Greenland caused by Global warming are encouraging algae to grow. The algae then darken the surface of the ice sheet. White snow reflects up to 90% of solar radiation while dark patches of algae will only reflect about 35% or even as little as 1% in the blackest spots. Algae were first observed on the Greenland ice sheet more than a century ago but until recently, their potential impact was ignored. However, in the last, few years researchers have started to explore how the microscopically small plants could affect future melting.



The maps above show (a) Decadal July albedo change rate over Greenland from GLASS products in 1981–2000; (b) decadal July albedo change rate over Greenland from GLASS products in 2000–2012. Darkening has been particularly clear since 2000, especially along the western coast. Figure courtesy of He et al. (2013, Env. Res. Lett.) reproduced under the Creative Commons Attribution 3.0 License. Source: https://blackandbloom.org/our-science/

[1] For further details on the impacts of black carbon see: http://www.ieaghg.org/docs/General_Docs/Publications/Information_Papers/2014-IP17.pdf

A five-year UK research project known as Black and Bloom is under way to investigate the different species of algae and how they might spread, and then to use this knowledge to improve computer projections of future sea level rise. The possibility of biologically inspired melting was not included in the estimates for sea level rise published by the UN's climate panel, the IPCC, in its latest report in 2013. Initial projections by the Black and Bloom team suggest that the worst-case scenario was a rise of 98cm by the end of the century.

Further details on the Black and Bloom project can be found at:
https://blackandbloom.org/our-mission/

Decreasing cloud cover. In a separate research project, researchers have analysed satellite data and they conclude "the abrupt reduction in surface mass balance since about 1995 can be attributed largely to a coincident trend of decreasing summer cloud cover enhancing the melt-albedo feedback".

Satellite observations, the suggest, "Show that, from 1995 to 2009, summer cloud cover decreased by 0.9 ± 0.3 % per year. Model output indicates that the Greenland ice sheet summer melt increases by 27 ± 13 gigatone (Gt) per cent reduction in summer cloud cover, principally because of the impact of increased shortwave radiation over the low albedo ablation zone".

Further, "The observed reduction in cloud cover is strongly correlated with a state shift in the North Atlantic Oscillation promoting anticyclonic conditions in summer and suggested that the enhanced surface mass loss from the Greenland Ice Sheet is driven by synoptic-scale changed in Arctic-wide atmospheric circulation".

Their research has been published in Science Advances, which can be found at: http://advances.sciencemag.org/content/3/6/e1700584

Summary
The indisputable truth seems to be that the Greenland Ice sheet is melting and melting at a faster rate, which will have global consequences. The reason for the cause of the increased melting is being studied by research groups, which we hope will shed more light on the problem and the potential consequences. Once understood the impact of the increased melting will need to be included into the climate modelling work done in AR6.

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