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Comparison of 2013 and 2012 Greenland Ice Sheet Surface Melt and Associated Mechanisms

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We examine the characteristics of the Greenland Ice Sheet surface melt in summer 2013 and compare the results with 2012. The atmospheric dynamic and thermodynamic differences between these two cases and their impacts on the Greenland Ice Sheet surface melt are also examined. Results show that the maximum surface melt extent is only 44% in 2013, which is far less than 97% in 2012. The averaged extent and duration of the surface melt in 2013 are close to the climatology. The summer atmospheric circulation anomalies in 2013 are nearly opposite to those observed in 2012. Greenland and the surrounding areas show anomalously low pressure, particularly a negative height at 500-hPa, which leads to a more zonal pattern than that in 2012. The corresponding anomalous cyclonic circulation in the north and south areas of Greenland is favorable for advecting cold Arctic air to Greenland. Moreover, the surface downward radiation pattern in 2013 is oriented in a southwest–northeast direction over Greenland, which differs from the north–south distribution in 2012. The net downward radiation is small due to the cancellation of downward shortwave and longwave components in 2013. However, downward shortwave dominates from the distribution perspective, leading to an insignificant impact on surface temperatures over Greenland. The combination of dynamic effects of atmospheric circulation and thermodynamic effects of the radiation budget contribute to the surface melt of the Greenland Ice Sheet. We further find that a positive feedback between the variability in the extent of summer Arctic sea ice and melt area of the summer Greenland ice sheet, which affects the Greenland ice sheet mass balance.