EGU2020-7831, updated on 13 Jun 2021
https://doi.org/10.5194/egusphere-egu2020-7831
EGU General Assembly 2020

Hydrological and Kinematic Precursors of Iceberg Calving at Petermann Glacier in Northern Greenland Observed High-temporal Resolution Sentinel-2 Images

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The Greenland ice sheet is currently contributing to global sea level at an approximate rate of 0.8 mm/yr. Ice mass loss of Greenland is primarily due to both thinning and retreat of outlet glaciers. For enhanced calving events, detail dynamics characteristics of hydrological and kinematic precursors and underlying mechanisms which control the development of ice calving remain poorly understood, especially in the absence of high-resolution remote sensing observations. On July 26 2017, a calving event took place along a pre-existing rift in Petermann glacier, northern Greenland, which removed partly of the glacier tongue and formed a tabular iceberg 5 km long. In this study, we used high-temporal satellite remote sensing data to detect changes in ice-flow speed, melt ponds and ice mélange during May and July. These hydrological and kinematic dynamics derived from Sentinel-1/2 satellite images with sub-weekly acquisition repeat cycles can be utilized as retreat precursors to characterize the detailed calving process. Moreover, the stress field and analytical damage solution were calculated by coupling the remote sensing observations with SSA ice sheet model to explain the dynamics mechanism. Our preliminary results show that the ice speed in dense observation reached to 30 m/d on the eve of the calving, which is roughly 10 times quicker than usual ice velocity. Additionally, there exited obviously abnormal stress distribution in crack region. And the landfast sea ice and ice mélange transformed into open water that the backscatter coefficient decreased to 28 dB. The extent of melt pond reached the peak about 30 square kilometers coverage in duration month of calving event. It is inferred that this calving event of Petermann glacier may be related to weakening of sea ice and ice mélange lost the buttressing for ice glacier terminate, tributary glacier extrusion, related with meltwater infiltrated crevasses. Therefore, dense remote sensing observations and numerical modeling in ice flow system make it possible for early waring and projecting glacier calving in the future.

Key words: Iceberg Calving Precursors, Petermann Glacier, High Resolution Remote Sensing, SSA modeling