Topics (T)
Climate Change Impacts and Challenges (Biodiversity, Forests and Land, Ocean/Marine Ecosystems, the Artic and beyond) [1] (2A)

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EARTH OBSERVATION FOR THE MONITORING OF ANTARCTIC SUPRAGLACIAL MELTWATER DYNAMICS AND LINKS TO CLIMATE CHANGE

Abstract

Earth Observation (EO) provides a wealth of data for the monitoring of global environmental change. Since a few years, data of the European Copernicus Sentinel missions enable the investigation of climate change impacts at unprecedented spatio-temporal resolution. In the light of global warming, space programs such as Copernicus identified polar regions as a key monitoring priority, facilitating the surveillance of regions that are particularly vulnerable to a changing climate and have the potential to contribute significantly to global sea-level-rise. One of these regions is the Antarctic Ice Sheet, which holds 58 m of sea-level-equivalent and is by far the largest potential contributor to future sea-level-rise.

During the past decades, Antarctica contributed 7.6 mm to sea-level-rise, mainly due to oceanic and atmospheric forcing. In this context, atmospheric forcing not only led to surface melting and consequent ice thinning, but also drove the formation of supraglacial meltwater lakes on the ice sheet and surrounding ice shelves. Supraglacial lakes can have severe implications for ice shelf stability and ice dynamics and, due to their ability to penetrate through ice, lead to ice shelf collapse, increased ice discharge and accelerated sea-level-rise. Although recent progress in the monitoring of supraglacial lakes contributed to an improved understanding of present-day Antarctic surface hydrology, detailed analyses of supraglacial lake impacts on ice dynamics are still missing, mainly due to the lack of an automated mapping method for supraglacial lake identification in satellite imagery. Given that recent studies point towards atmospheric warming and melt intensification to become the dominant driver of future Antarctic ice mass loss, the establishment of a monitoring service for supraglacial lake identification in EO data is overdue.

Here, we present a novel framework for automated supraglacial lake identification in Sentinel-1 SAR (Synthetic Aperture Radar) and optical Sentinel-2 satellite data exploiting the state-of-the-art of available methods from artificial intelligence and big data processing. We implement the developed processing chain on the High-Performance-Computing infrastructure of the German Aerospace Center (DLR) and for the first time apply it to the full archive of available Sentinel-1/-2 satellite imagery over six major Antarctic regions. We show results on supraglacial lake dynamics and link anomalous melting periods with a particularly high occurrence of supraglacial lakes to a range of climatic drivers. The results significantly contribute to an improved understanding of climate change impacts on Antarctic surface melting and highlight the pressing need for improved monitoring efforts over the global ice sheets.