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Editorial: Cryosphere and climate change in the Arctic, the Antarctic, and the Tibetan plateau

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Editorial on the Research Topic
Cryosphere and climate change in the Arctic, the Antarctic, and the Tibetan plateau

Introduction

The Tibetan Plateau (TP) is known as the "third pole," which together with the Arctic, the Antarctic is known as the "three poles of the Earth" (Xie et al., 2022). The "three poles" play an important role in the formation of the global climate, and they are also sensitive regions to climate change (Shepherd et al., 2018). Under global warming, rapid changes in "three poles" will affect regional and even global hydrological, ecological and climate systems (Pattyn et al., 2018; Mouginot et al., 2019; Li et al., 2021). The rapid changes of the Earth's three poles affect not only the local climate and hydrology, but also the large-scale atmospheric and oceanic circulation through various feedback mechanisms (IPCC, 2019). "Three poles" are not independent and there are potential correlations among "three pole." Numerous studies have revealed correlations between the Arctic and the TP (Zhang et al., 2019; Li et al., 2020). The negative Arctic Sea ice area anomaly could influence the circulation in the TP by Rossby wave train (Li et al., 2020). Through thermohaline circulation the Antarctic and the Arctic are also connected (Chylek et al., 2010; Blunier and Brook, 2011).

Along with the Arctic and Antarctic, the TP which is recognized to have a profound influence on regional and global climate systems, as well as the eco-environment and ecological economy (Hu et al., 2018; Yang et al., 2019). Recently, the study of TP glaciers and their response to climate change has shown a strong development (Bolch et al., 2011; Bolch et al., 2012; Kääb et al., 2015; Brun et al., 2017; Yao et al., 2019). Glaciers change has suggested that enhanced glacier melting has induced increased glacier runoff, and the consequent glacier melting brought a series of response of regional eco-environment problems (Yao et al., 2019).

A large number of studies have focused on the characteristics and impacts of past, present, and future changes in the "three poles" (Kattsov et al., 2005), but many research results are still controversial (Shepherd et al., 2018). For example, there is still a lack of observational data in the "three poles," and there are still great uncertainties in model

simulation and influence mechanism (Screen et al., 2018). The physical mechanisms of Arctic warming can be summarized as local feedbacks (such as albedo, cloud and water vapor feedback, etc.) and large-scale circulation forcing, but the relative contribution of each feedback mechanism remains unclear (Wu et al., 2019).

This brief review of editorial focus on these studies of Frontiers in Earth Sciences Research Topic examines various aspects of Cryosphere and Climate Change in the Arctic, the Antarctic and the Tibetan Plateau.

Glaciers change over the Tibetan plateau

In this Research Topic, He and Zhou provide a comprehensive analysis of ten glacier inventories. The assessment results indicate that the overall quality of the small-scale glacier inventories is higher than the large-scale inventories. By merging the products of the eight glacier inventories, a new glacier inventory product of the best comprehensive quality was derived for the entire TP. We think that this database will meet the needs of a variety of potential researchers, including those who prefer to get information for a particular parameter from a single glacier inventory.

Glacier mass balance is a key factor in understanding the relationship between glaciers and climate (Kääb et al., 2015; Hock et al., 2017). Xu et al. present glacier mass budgets in the Turgen Daban Range, over the western Qilian Mountain, from 1966/75 to 2020 by means of the digital elevation models generated by the topographic maps and ASTER images. The results show that glacier mass decreased by −18.79 ± 12.48 m w.e. during the past 50 years. Similarly, Chang et al. also found glaciers in the Altai Mountains had experienced an accelerated shrinkage from 2000 to 2020 compared to the 20th century. Based on multiple source data, Chen et al. reported mass balance change of the Baishui River Glacier No. 1 (BRG1) in Yulong Snow Mountain with contour line maps.

The latest IPCC (2019) report stated that under the influence of global warming, changes in the cryosphere will lead to an increase in glacier surges, snow/ice avalanches, glacial debris flow, glacial lake outburst flood (GLOF), occurring frequently and caused serious catastrophes on TP, thereby increasing local infrastructure, cultural, tourism damage (Ding et al., 2018). Sha et al. stated that the distance between Tuosu Lake and the Qinghai-Tibet Railway has been shortened year by year, with the shortest distance of 0.85 km in 2021. With the intensification of climate change impacts, glacial hazards in TP and the hazards chains triggered by glacier change are more frequent. Therefore, in recent decades, the significant melting and retreating of temperate glaciers along the TP region have drawn great attention to the glacier hazards (Ding et al.,2021; Richardson and Reynolds, 2000). In addition, the climate change of the TP also attracts attentions of researchers. Yang et al. connect the spring heat source over the TP with the winter warm Arctic–Cold Siberia pattern. The results of EOF1 showed there was a significant positive correlation between these two.

Climate change in the Antarctic

In this Research Topic, Zeng et al. evaluated the estimation performance of the global solar radiation (DGSR) at the Great Wall Station from empirical models and machine learning models. Thy presented the first reconstruction of the Antarctica Great Wall Station DGSR spanning 1986–2020 with a significant increasing trend of 0.14 MJ/m^2/decade. Besides, more people care the relationship between the Antarctic change and low latitude sea surface temperature. Yang et al. suggested that the winter precipitation in the Lambert Glacier basin (LGB) in Antarctic is closely related to the autumn sea surface temperature variability in Southern Indian Ocean (SIO) without the influence of El Niño–Southern Oscillation. It is shown that the positive autumn SIO dipole of SST anomalies is usually followed by reduced precipitation in the following winter over the LGB region and vice versa. The positive (negative) autumn SIOD can persist into the winter and excite cyclonic (anticyclonic) circulation and deepen (weaken) SIO low in high latitude, corresponding to an enhanced northward (southward) wind anomaly in LGB and central SIO. This mechanism prevents (promotes) the transportation of warm and moist marine air to the LGB region and hence decreases (increases) the precipitation during the following winter.

Changes in typical drainage basins of the Greenland ice sheet

Lu et al. investigated the spatial and temporal characteristics of ice motions of three branches in the Northeast Greenland Ice Stream (NEGIS) between 1985 and 2018. The temporal variability of ice velocity of typical glaciers shows a clear regional speedup, with a mean increase of 14.60% and 9.40% in 2001–2018 compared to 1985–2000, and a widespread slowing of Storstrømmen glacier with a mean of 16.30%, which were related to a 184% surface runoff increase. This work highlights crucial roles of subglacial topography and surface runoff on ice motion, which helps to promote understanding of dynamic changes of NEGIS response to changing atmospheric circumstances.

In the future, comprehensive monitoring of “three poles” region needs to be strengthened to improve the simulation capability of models on the physical processes of the climate change and glaciers shrinkage, and multi-model, multi-data and multi-method integrated research should be carried out.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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