China National Report to SCAGI

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1. Mapping surface fractures on pan-Antarctic ice shelves using deep learning

This work was done by Sun Yat-sen University.

Surface fractures have a great impact on ice shelf stability in Antarctica and can be regarded as precursors of ice shelf disintegration. The disintegration of ice shelves generally occurs in highly fractured areas, and detachment boundaries are formed along rifts. However, the spatial distribution and temporal evolution of surface fractures on Antarctic ice shelves are less known. Researchers from the Polar Research Center in Sun Yat-sen University implemented a deep learning model, ResUNet, to map the spatial distribution of Antarctic ice shelf surface fractures in 2004, 2009, and 2014, using MODIS-based Mosaic of Antarctica (MOA). The model identified 44744.594 km² of surface fractures in 2004, 43737.156 km² in 2009, and 42978.672 km² in 2014, showing a decreasing trend. The reduction is predominantly attributed to the variation in surface fractures within 20 km of the ice front, especially in the Amundsen and Wilkes sectors. They also investigated the spatial distribution of surface fractures on ice shelves. The fracture concentration (FC) index indicates that shear margins, suture zones and ice fronts are prone to yielding surface fractures. From an individual ice shelf perspective, the West Ross, Ronne, and Brunt Stancomb Ice Shelves have a great number of surface fractures. This study provides comprehensive and detailed information about surface fractures on Antarctic ice shelves, and our findings have implications for evaluating ice shelf vulnerability.
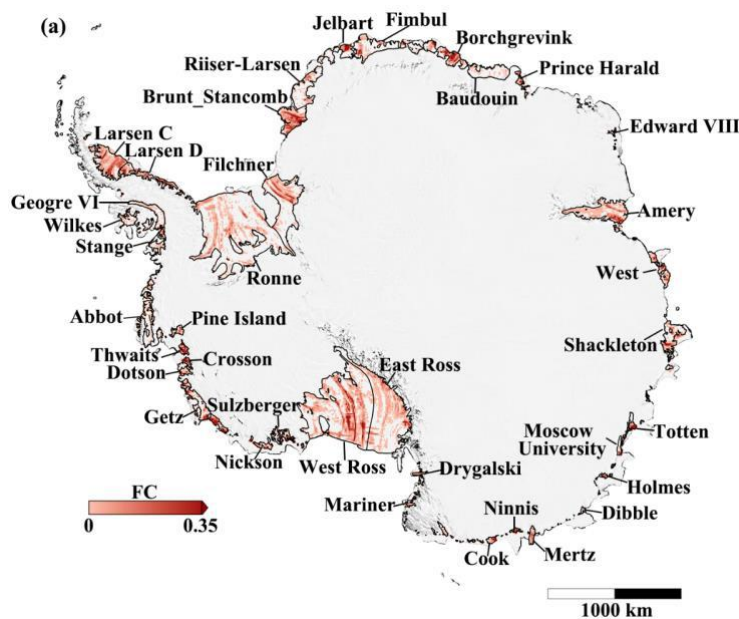
2. A 15-year circum-Antarctic iceberg calving dataset derived from continuous satellite observations

This work was done by Beijing Normal University.

Iceberg calving is the main process that facilitates the dynamic mass loss of ice sheets into the ocean, which accounts for approximately half of the mass loss of the Antarctic ice sheet. Fine-scale calving variability observations can help reveal the calving mechanisms and identify the principal processes that influence how the changing climate affects global sea level through the ice shelf buttressing effect on the Antarctic ice sheet. Iceberg calving from entire ice shelves for short time intervals or from specific ice shelves for long time intervals has been monitored before, but there is still a lack of consistent, long-term, and high-precision records on independent calving events for all of the Antarctic ice shelves. In this study, a 15-year annual iceberg calving product measuring every independent calving event larger than 1 km2

over all of the Antarctic ice shelves that occurred from August 2005 to August 2020 was developed based on 16 years of continuous satellite observations. First, the expansion of the ice shelf frontal coastline was simulated according to ice velocity; following this, the calved areas, which are considered to be the differences between the simulated coastline, were manually delineated, and the actual coastline was derived from the corresponding satellite imagery, based on multisource optical and synthetic aperture radar (SAR) images. The product provides detailed information on each calving event, including the associated year of occurrence, area, size, average thickness, mass, recurrence interval, and measurement uncertainties. A total of 1975 annual calving events larger than 1 km2 were detected on the Antarctic ice shelves from August 2005 to August 2020. The average annual calved area was measured as 3549.1 km^2 with an uncertainty value of 14.3 km2 , and the average calving rate was measured as 770.3 Gt yr^{-1}. with an uncertainty value of 29.5 Gt yr^{-1}. The number of calving

events, calved area, and calved mass fluctuated moderately during the first decade, followed by a dramatic increase from 2015/2016 to 2019/2020. During the dataset period, large ice shelves, such as the Ronne–Filchner and Ross ice shelves, advanced with low calving frequency, whereas small?and medium-sized ice shelves retreated and calved more frequently. Iceberg calving of ice shelves is most prevalent in West Antarctica, followed by the Antarctic Peninsula and Wilkes Land in East Antarctica. The annual iceberg calving event dataset of Antarctic ice shelves provides consistent and precise calving observations with the longest time coverage. The dataset provides multidimensional variables for each independent calving event that can be used to study detailed spatial–temporal variations in Antarctic iceberg calving. The dataset can also be used to study ice sheet mass balance, calving mechanisms, and responses of iceberg calving to climate change.
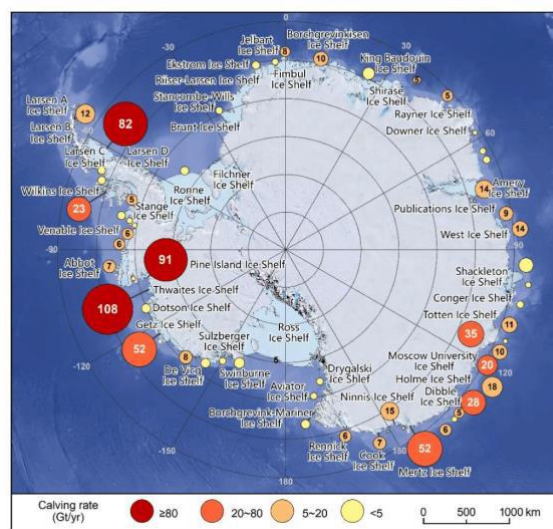

Fig.2. Spatial distribution of average calving rate (Gt yr−1) of Antarctic ice shelves from August 2005 to August 2020.

Qi, M., Liu, Y, Liu, J., Cheng, X., Lin, Y., Feng, Q., Shen, Q., and Yu, Z.: A 15-year circum-Antarctic iceberg calving dataset derived from continuous satellite observations, Earth Syst. Sci. Data, 13, 4583−4601, https://doi.org/10.5194/essd-13-4583-2021, 2021

3. A fine flow unit map of Antarctic ice sheet

This work was done by Beijing Normal University.

We generate a complete, accurate, high-resolution, digital mosaic flow unit map for the whole Antarctica by a novel automatically tracking method based on surface ice flow velocity dataset. Multi-level and up to 10200-neighborhood (101 by 101) search windows are used to track directions along flow lines with high precision, and adapt to the spatial inconsistency of the original flow directions. A set of restrictions based on physical principle of ice flow are also taken in account. The flow lines obtained are highly consistent with the ice flow features revealed by the remote sensing images. This detailed flow unit map give a clear divide of the ice sheet-ice shelf systems of the whole Antarctica. This view of ice sheet motion redefines

our understanding of spatial distribution pattern and characteristics of Antarctic ice streams, and has far-reaching implications and application for the reconstruction and prediction of ice sheet evolution, ice mass supply and migration.
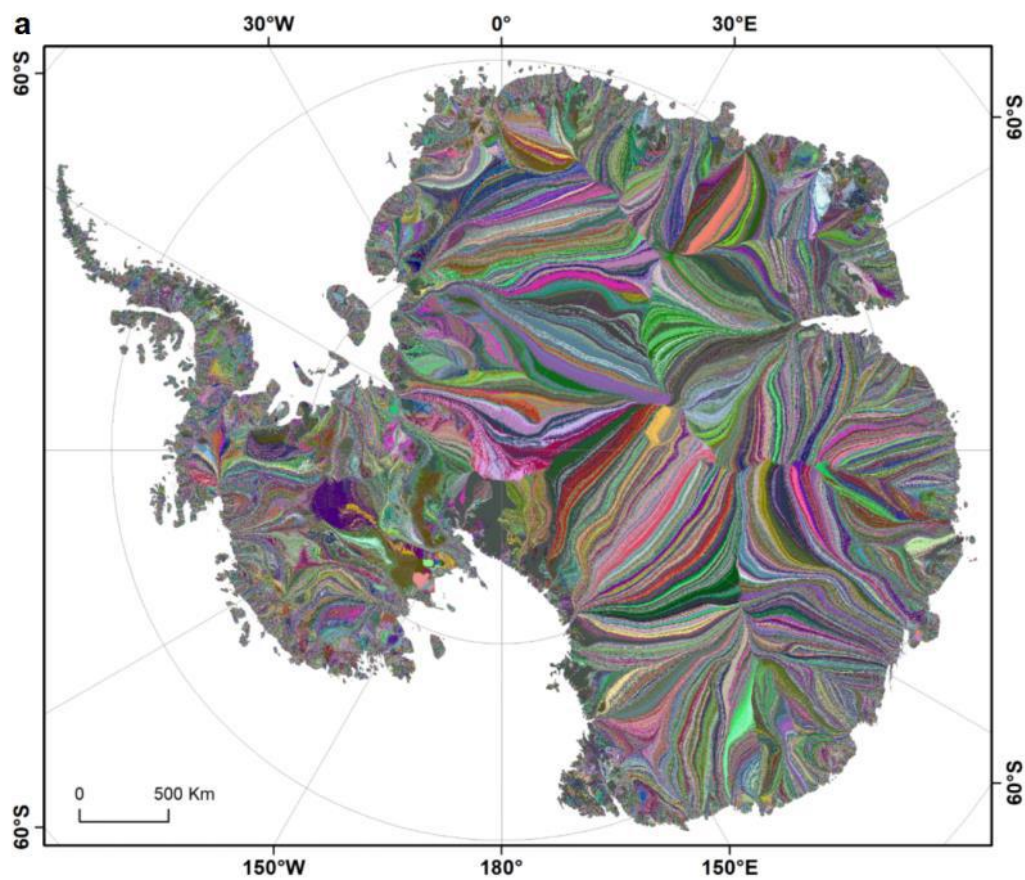

Fig.3.   A fine flow unit map of Antarctic ice sheet

Yan Liu, Liyun Zhao, John C. Moore1, Xiao Cheng. Fine flow unit map of Antarctic ice sheet，in preparing

4. PolarGo – Evaluation of Antarctic Human Activities

This work was done by Wuhan University.

A 3D web GIS platform (PolarGo) is online now (http://x.hbaa.cn). All the polar vessels and aircrafts are presented in this platform, with near real-time positions and historical tracks. We can evaluate the human activities in the Antarctica via these vessels and aircrafts.
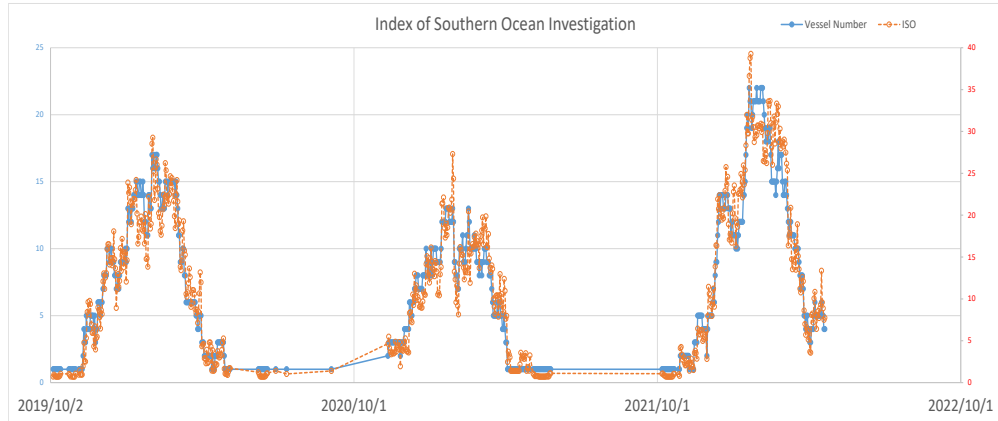
Fig.4.   The index of southern ocean investigation vessels 2019-2022

5. Sub-ice Antarctic place naming

This work was done by Polar Research Institute of China.

Chinese Arctic and Antarctic Administration is coordinating Chinese institutions on Antarctic place naming. 5 sub-ice place names were published, and some potential new place names will be proposed through in-situ Antarctic investigations of CHINARE, especially in the previously "blank mapping" area.
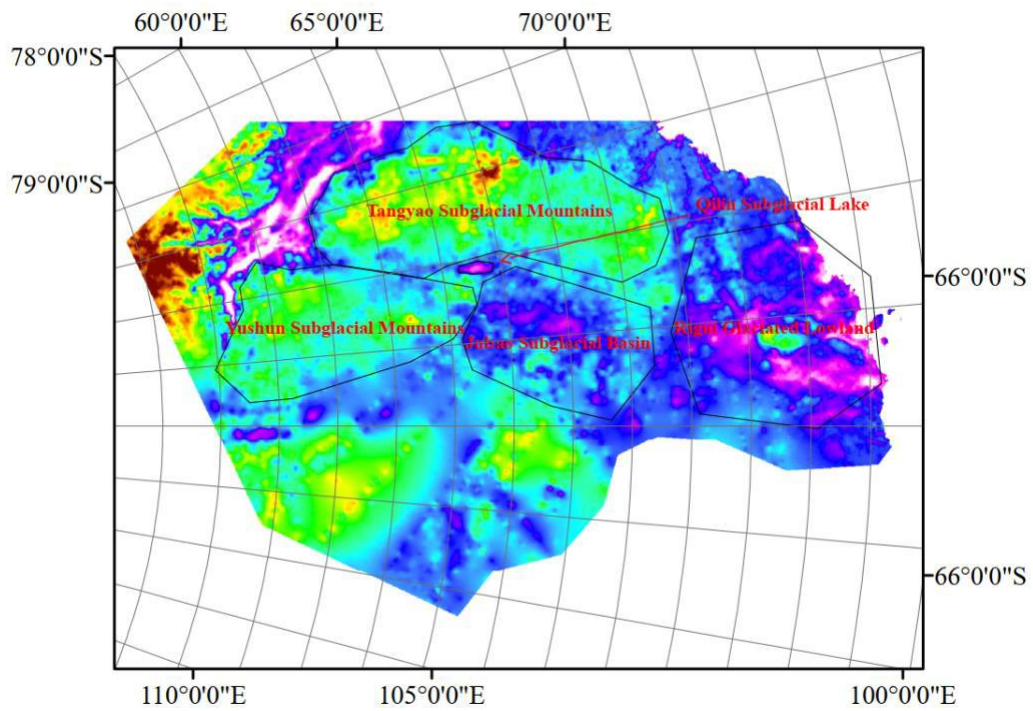

Fig.5.   Five sub-ice Antarctic place names published by China