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# Observations of icebergs in Antarctic cruises of the R/V "Akademik Mstislav Keldysh"

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We observed two different icebergs near the Antarctic Peninsula. One was one of the largest ever observed (160 km long). It calved from the Filchner Glacier. Fresher water field surrounded the iceberg and drifted together with the iceberg. The other glacier (800 m long) was aground in the Bransfield Strait. A strong current was flowing around this iceberg transporting away the freshwater that melted from the iceberg.

**Keywords:** Iceberg A68, Bransfield Strait, Bransfield Current, CTD-casts, melt water

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## Introduction

Statistical data reveals that there are approximately 200,000 icebergs existing simultaneously in the Southern Ocean [*Williams et al.*, 1999]. Their linear dimensions range from 50 m up to kilometers, and sometimes tens of kilometers. All Antarctic icebergs are formed from the glaciers of Antarctica. They usually calve from the ice shelf in the summer of the Southern Hemisphere during the warm season [*Silva et al.*, 2006]. A large number of icebergs are formed in the Weddell Sea. This is the main source of Antarctic icebergs. Research on motion of icebergs provides important information on their melting. The icebergs drift with the ocean currents and appear in the waters of warmer temperatures than near Antarctica. They are subjected to erosion by higher water temperature and waves. The draft of Antarctic icebergs is in the range 200–300 m. The icebergs are transported by currents in the upper 200-m layer of the ocean rather than by wind [*Collares et al.*, 2018]. In this paper we analyze two icebergs: one of the Weddell Sea origin and the other presumably calved from a glacier in the Bransfield Strait.

## Materials and Methods

**Satellite data.** The position, shape, and size of the icebergs are usually determined from satellite images obtained by the Synthetic-Aperture Radar (SAR). This method for analyzing satellite images is an efficient tool for studying the position of icebergs. The operation of the radar does not depend on cloudiness and illumination, and its undeniable advantages include high spatial resolution and a wide shooting range. In this study, we used the images of the Sentinel-1 series satellites (A and B) to track the motion of the A68A iceberg; a total of 32 HH-polarized images in the Extra Wide swath mode were obtained and analyzed.

**Ship measurements.** Field studies in the region of the iceberg were performed in cruises 79 and 87 of the R/V "*Akademik Mstislav Keldysh*" (AMK79) [*Morozov et al.*, 2020] continuing previous studies of ice and research in the Bransfield Strait [*Bogorodskii et al.*, 2020; *Khimchenko et al.*, 2020; *Marchenko and Morozov*, 2016; *Marchenko et al.*, 2021; *Polukhin et al.*, 2020]. At these stations we measured the vertical distribution of thermohaline parameters, as well as the velocities and directions of currents from the surface to a depth of about 5–7 m above the bottom. In total, four casts were performed near the iceberg with the SBE-911 probe and LADCP RDI Workhorse Monitor and Sentinel 300 kHz current profilers. During the transitions between the stations, measurements of the parameters of currents in the surface layer of the sea were carried out using the built-in SADCP ship profiler (TRDI OS with a frequency of 76.8 kHz). Data collection was carried out using the VmDas software with 2-min time averaging. The influence of tides

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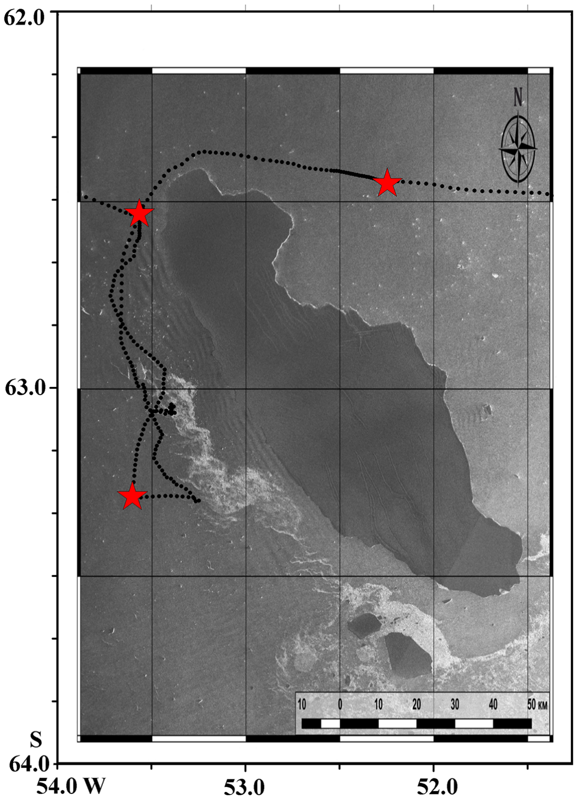


**Figure 1:** Satellite image of iceberg A68A and CTD casts (stars) near the iceberg. The dots indicate route of the ship.

(diurnal and semidiurnal components) was calculated using the global tide model TPXO9.1 [*Egbert and Erofeeva*, 2002].

## Results

In 2020 (February 15–16, 2020), we approached one of the largest icebergs ever observed. It was given a sequential number A68 by iceberg researchers. After small pieces detached from the iceberg its main portion continued to drift as A68A. The iceberg calved from the Larsen Glacier in July 2017 and slowly drifted northward. The length of the A68A iceberg was 160 km, and its area was about 5800 km$^2$ [*Han et al.*, 2019]. By the beginning of December 2019, A68A was already located south of the Joinville Island in the area of our research (Figure 1) [*Morozov et al.*, 2021].

We made three CTD casts near the iceberg. It is important to emphasize that the iceberg was drifting with surrounding currents. All melted water was accumulated near the iceberg and generally drifted in the same direction.

Graphs of the vertical distribution of salinity at these stations and a background vertical profile of salinity from the WOD18 database are shown in Figure 2. The background cast was made in the absence of icebergs in the region. One can clearly see that salinity decrease is observed near the large iceberg even a distance of approximately 1000–2000 m. The decrease in the upper 20 m is as high as a few salinity units.

On February 14, 2022, we found an iceberg in the Bransfield Strait. The iceberg was aground at a depth of approximately 100 m. Its characteristic size was 800 m. The iceberg seemed to be a local one and "young". Usually the icebergs from the Weddell Sea flow around the Joinville Island and concentrate in the southeastern part of the Bransfield Strait. They cannot cross the Bransfield Current because this current immediately transports them to the Scotia Sea. The underwater thickness of the table icebergs from the Weddell Sea is approximately 200–250 m. Many of them are aground at a shallow depth along the Antarctic Peninsula. It is likely that the iceberg we found did not calve from the glacier long ago because it has not been eroded with waves. Its walls were sharp as if breaking occurred shortly before. Its underwater depth was only 100 m and the part that was above the surface was lower than that of the icebergs from the Weddell Sea. Hence it could calve from a glacier immediately in the Southern part of the Bransfield Strait and then strong current transported it to a shallow depth where it set aground.

A strong current along the South Shetland Islands was flowing around it. The velocity of the flow exceeded 50 cm/s. We made seven CTD casts using an AML probe near the iceberg. The closest distance to the iceberg was 300 m. Strong vorticity of the flow near the iceberg prevented the ship to come closer.

Satellite images of the iceberg are shown in Figure 3. The region has been observed since from

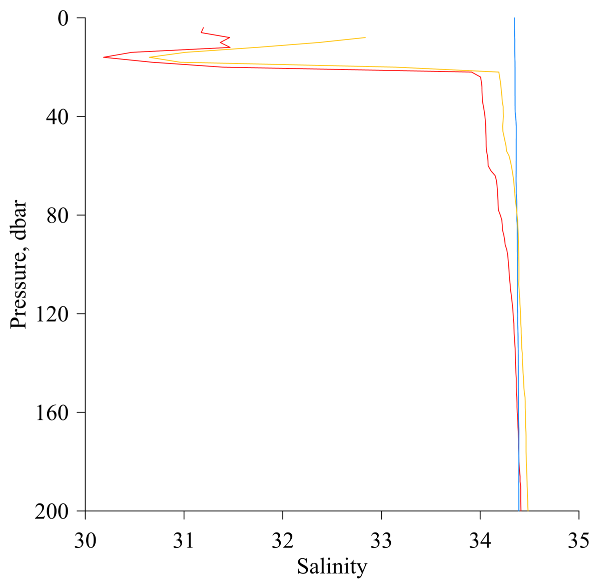


**Figure 2:** Vertical profiles of salinity near the iceberg on February 15, 2020 at stations 6651 (red line; 62°32.3′S, 53°33.8′W); 6652 (yellow line; 63°17.4′S, 53°36.1′W), and background station on February 11, 1991 (blue line; 63°01′S, 54°04′W).

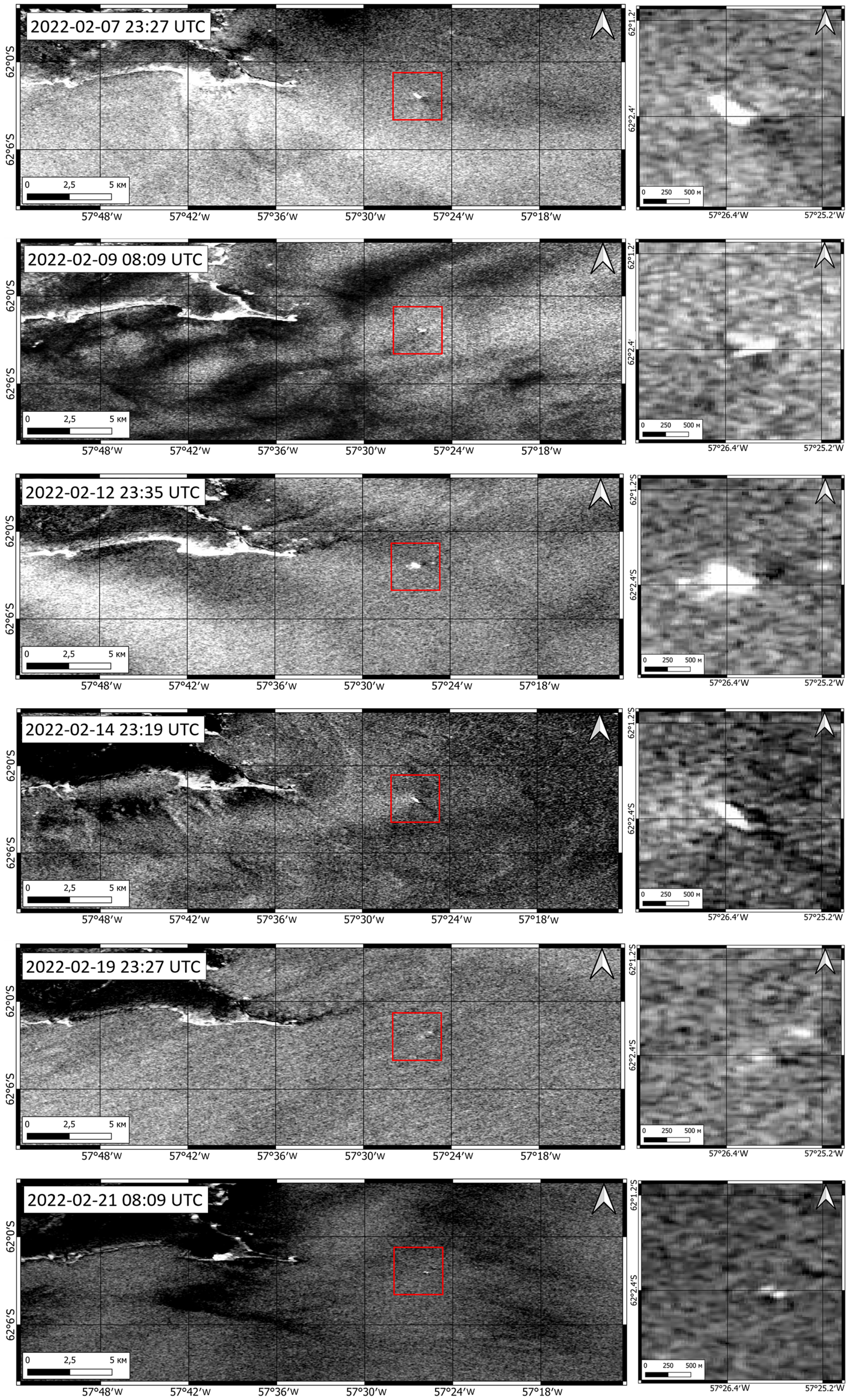


**Figure 3:** Satellite images of the region and iceberg on different days. The resolution of the images is maximum possible. A larger image of the iceberg is shown on the right of each image.

**Figure 4:** A photo of work near the iceberg. Participants of the expedition shoot photos from the ship. A CTD cast is made from the winch.

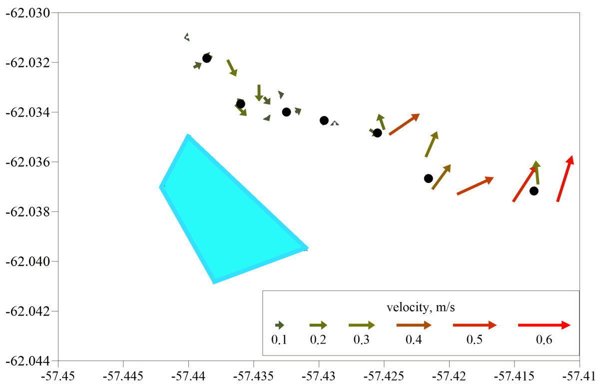


**Figure 5:** Location of the iceberg as taken from the ship radar (blue figure). Locations of CTD casts (black dots), and vectors of velocity in the 25–20 m layer are shown with arrows.

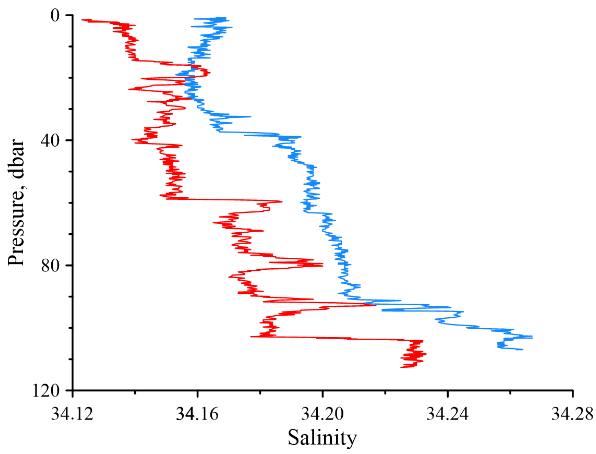


**Figure 6:** Salinity near the iceberg. Blue curve shows background profile and the red curve shows a profile near the iceberg.

February 2 when there was no iceberg. It has been observed from February 7, and on the day of our measurements it started to rotate forced by the current. It is likely that soon the current displaces it and transports away from the region. Beginning from February 19, 2022 one can see significant breaking of the radar image of the iceberg most likely related to its breaking into parts and separation of fragments. From February 21, iceberg images disappear from the satellite radars.

A photo of work near the island is shown in Figure 4. A scheme of the CTD casts around the iceberg is shown in Figure 5 combined with the acoustic Doppler current profiler (ADCP) velocity measured by the shipborne velocity profiler.

The most eastern cast can be considered a background one. Generally salinity decreases near the island (Figure 6). However, this decrease is only within a tenth fracture of a salinity unit because strong current transports the melted fresh water away from the iceberg that maintains its position due to grounding.

## Conclusions

We analyzed salinity field near two icebergs in the region of the Antarctic Peninsula. One of them was an enormously large (160 km) iceberg A68A. Freshwater in the upper layer around the iceberg appeared due to melting of the iceberg and smaller ice floes that surrounded it. Salinity around the iceberg was a few salinity units smaller than that in the background ocean. The freshwater field drifted together with the iceberg transported by the northward currents in the western part of the Weddell Sea.

A smaller iceberg in the Bransfield Strait (800 m) set aground at a depth of 100 m. Strong current around this iceberg transported melted freshwater away from the iceberg so that the salinity around the iceberg decreased only by small fractures of a salinity unit.

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