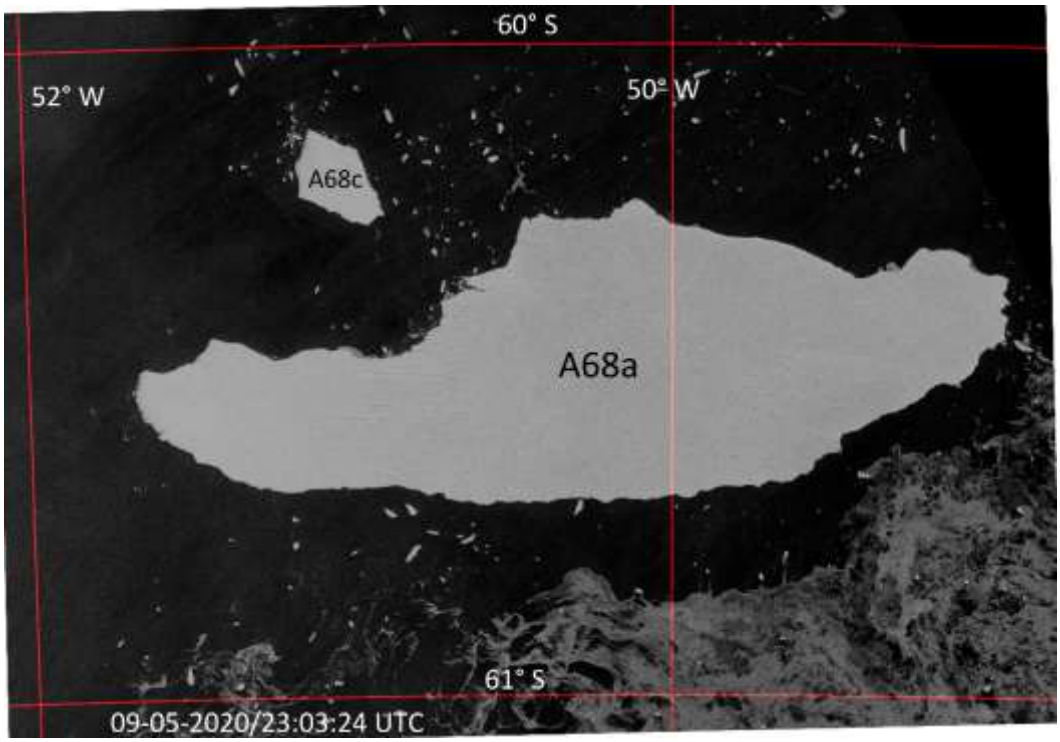
Tabular Iceberg A68a in Open Water

Drift Pattern, Rotation and Disintegration

Updated and Supplemented Version



A documentation on the basis of Sentinel-1 SAR images

compiled by

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as

Info Paper

for the

21st MEETING OF THE INTERNATIONAL ICE CHARTING WORKING GROUP

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Sessions 1, 4 and 5

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Preliminary Remark

This version of Sept. 18, 2020, is replacing the original version of August 2020 because of following reasons:

Since September 8, 2020, this paper is presented in the shared drives for all of the IICWG meeting documents. The documentation was finished with data up to Sept. 04, 2020. In order to have for the Meeting up-to-date information about the movement of A68a, the centre positions for the last two dates (Sept. 11 and 18, 2020) are added to Fig. 3. and a time series of 4 SAR images for the period from Sept. 07 to 19, 2020 is presented. Minor changes in the layout and the wording were performed and 3 mistakes had to be corrected:

- In Fig.3 the position for Sept. 04 was not on longitude 48°41' W but on 49°41' W.
- On page 6, last paragraph, Fig. 5 must read Fig. 6.
- On page 9 the date for the 3rd image from left is 04.06. instead of 04.05.

Furthermore, the coordinates of the centre points of icebergs A68a and A68c provided by NIC and used for Fig. 3 are listed as Table 4, and the dates of the Sentinel-1 SAR images used for the paper as Table 3.

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ANNEX I: Time series of 10 Sentinel-1 SAR images (sections) for the period March 30 to May 15, 2020 (PPP as PDF file)

ANNEX II: Time series of 24 Sentinel-1 SAR images (sections) for the period April 24 to July 17, 2020 (PPP as PDF file)

Abstract

In February 2020, the end of the austral summer, tabular iceberg A68a was released about 60 nautical miles east of King George Island from the Weddell Sea pack ice into open water. In this paper the further drift into the Scotia Sea is surveyed by Sentinel-1 SAR images. Exiting drift patterns and rotations of the berg itself could be documented. Furthermore, the disintegration of the iceberg is delineated.

1. Data and Data Handling

POLARVIEW (http://polarview.org/about/) is providing **SAR images** of the ESA satellite Sentinel-1 for the polar and sub-polar regions in near-real time (NRT). They are freely accessible and can easily been downloaded from the WEB page https://www.polarview.aq/antarctic. This service is of great value for science and operations in ice-covered areas and related applications, and it is very much appreciated by the author. – About 10 to 15 scenes from iceberg A68a per month could be downloaded. The images used for this paper are listed in Table 3

Corresponding to the swath of the SAR the images are normally presented in sections of 400 km x 400 km with an overlaid grid of a normal stereographic azimuthal projection (Fig. 1a). To facilitate the geographical positioning the images were rotated with the paint.net software into a north-south orientation (Fig. 1b) for a distinct meridian for further handling and comparison of cut sections with iceberg A68a.

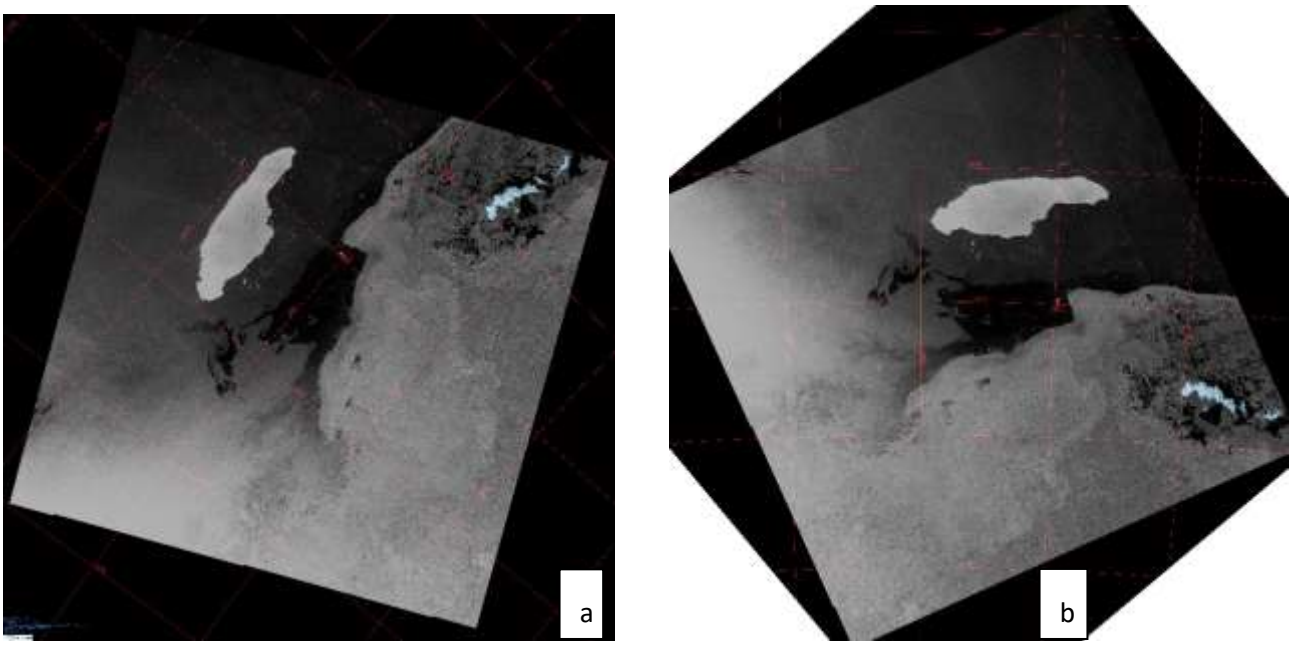

Fig. 1: Sentinel-1 SAR image of 27-08-2020, 22:47:23 UTC in swath orientation (a) and north-south orientation (b)

The sections with A68a were compiled into track patterns, time series and – with the PhotoScape software – into overlays. The given grid was used to align the image sections.

Since 1978[1] the US. National Ice Center (NIC) is tracking **icebergs in Antarctic waters** with at least 10 nm on its longest axis (https://www.natice.noaa.gov/doc/Notice_Iceberg_Tracking_Criteria.pdf). They are named/ numbered in relation to the geographical quadrant, where they have been first sighted. The Weddell Sea belongs to quadrant A (0-90 W). The data base gained by this activity provides extreme good knowledge on the track patterns (cp. Fig. 2). The actual positions of relevant icebergs are provided in tables, which are

[1] It has to be recalled that the first iceberg tracked on the basis of satellite images was in 1977 the so-called Trolltunga iceberg (Swithinbank, C., et al, 1977, Strübing, K., 1978). With the help of archived and finally actual optical images of weather and research satellites (ESSA, Nimbus, NOAA), the nearly rectangular berg of 55 km x 105 km could be tracked from Oct. 1967 until early May 1978 along the whole coast of the Weddell Sea (from 12° W westwards) into the Scotia Sea north of King George Island.

weekly up-dated (https://www.natice.noaa.gov/pub/icebergs/Iceberg_Tabular.pdf). – The author thanks Chris Readinger of NIC for providing relevant data to be used in Fig. 3. All data are listed in Table 4.

If not otherwise noted all figures are compiled by the author

2. Introduction

Since its calving in July 2017 from the Larsen Ice Shelf at the east coast of the Antarctic Peninsula, tabular iceberg A68 (cp. cover) was not only in the focus of the relevant scientific world but of the media, too. Naturally, that was because of its tremendous size of about 152 km in length and 52 km at the broadest part, by which it was one of the largest recorded ever[2]. Whichever search machine is fed with the key word "A68" or "A68a", it provides a lot of information as reports, articles in newspaper and magazines, video clips etc. A most recent one (July 10) originates from ESA and summarizes the *story* of A68 very informatively. It includes also the first drift phase of the iceberg into the open water region as shown by the included map of iceberg track, which is adopted as Fig. 2 (https://phys.org/news/2020-07-giant-a-iceberg-years.html)

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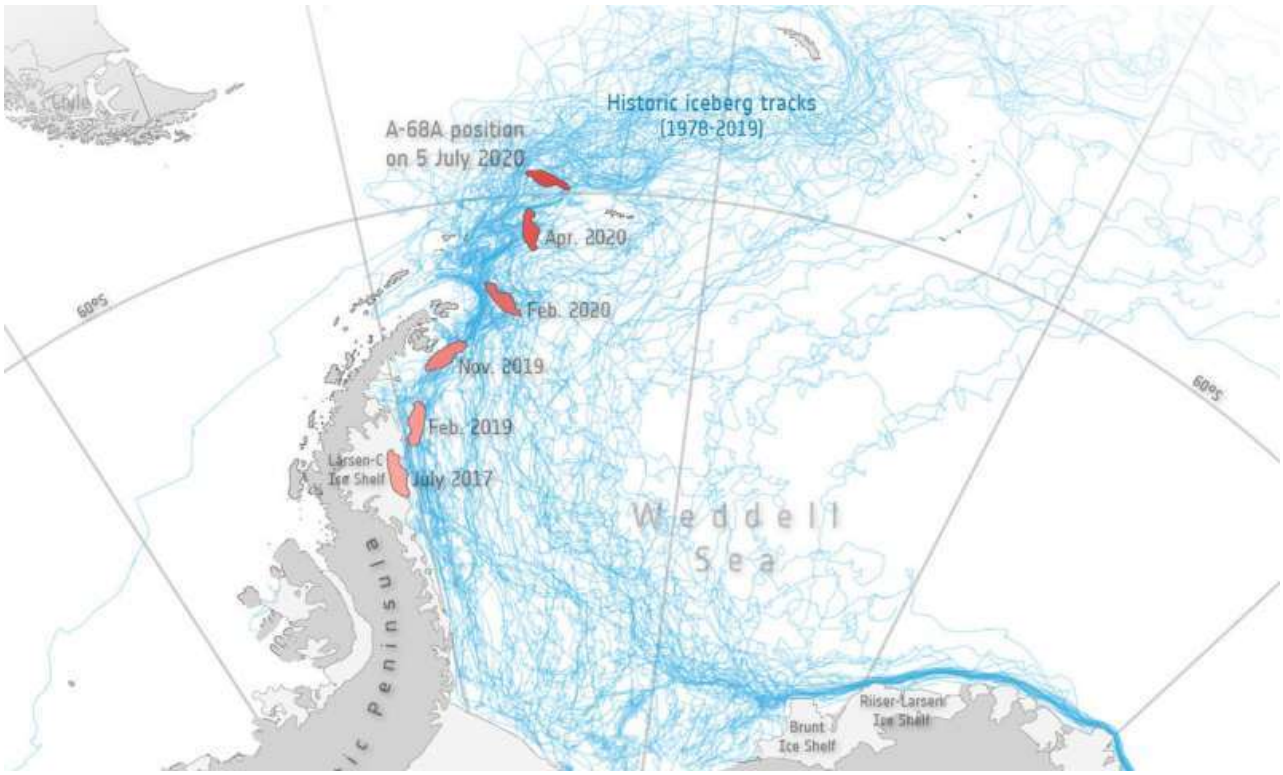


Fig. 2: *A-68A path. Credit: contains modified Copernicus Sentinel data (2017–20), processed by ESA; Antarctic Iceberg Tracking Database* (https://phys.org/news/2020-07-giant-a-iceberg-years.html)

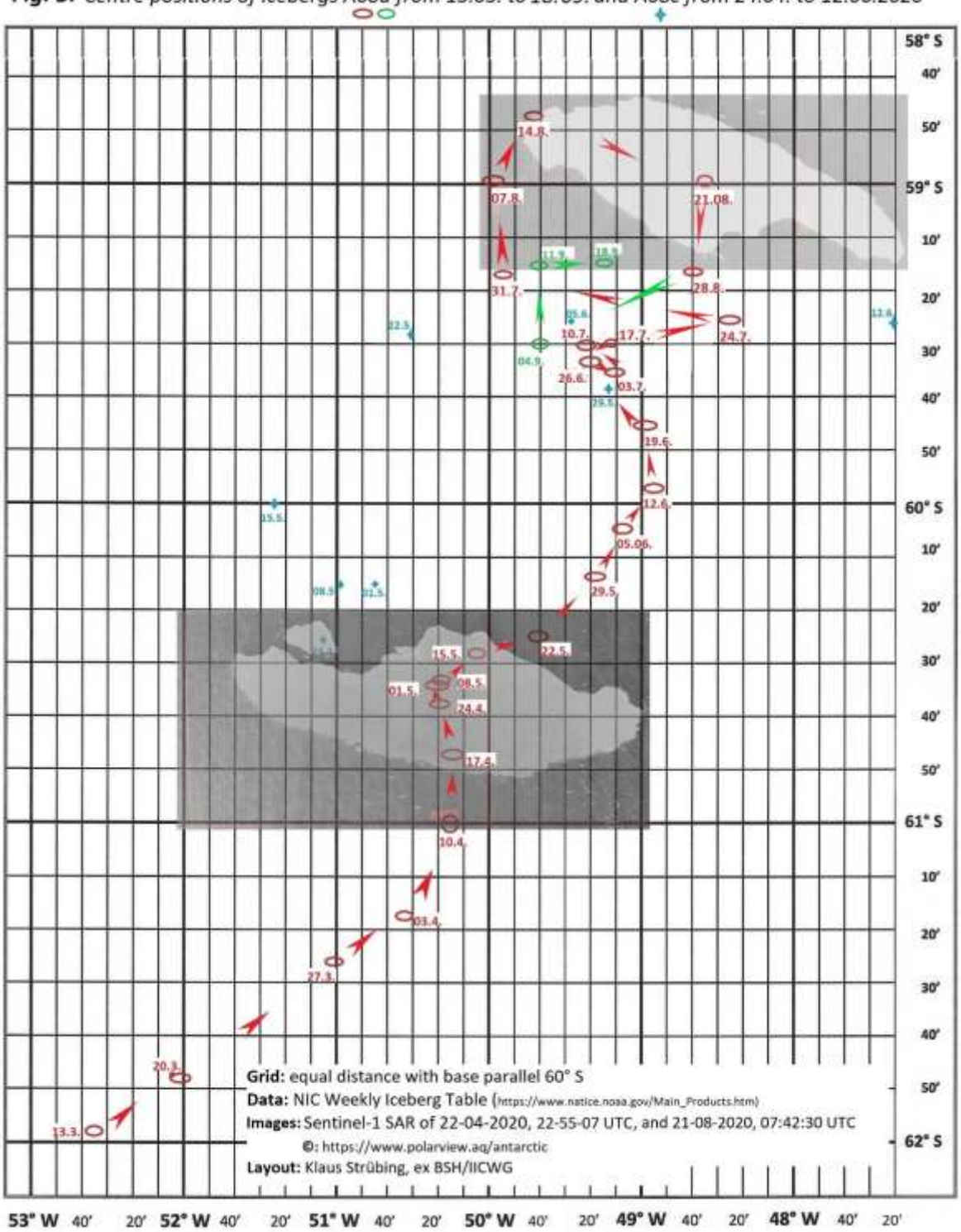
[2] https://www.britannica.com/science/iceberg/Iceberg-structure: "For many years, the largest reliably measured Antarctic iceberg was the one first observed off Clarence Island (one of the South Shetland Islands) by the whale catcher *Odd I* in 1927; it was 180 km (110 miles) long, was approximately square, and possessed a freeboard of 30–40 metres (100–130 feet). In 1956 an iceberg was sighted by USS *Glacier* off Scott Island (a small island about 500 km [300 miles] northeast of Victoria Land in the Ross Sea) with unconfirmed length of 335 km (210 miles) and width of 100 km (60 miles). However, recently there have been many calvings of giant icebergs in the Ross and Weddell seas with dimensions that have been measured accurately by satellite. In 2000 iceberg B-15 broke off the Ross Ice Shelf with an initial length of 295 km (about 185 miles). Although B-15 broke into two fragments after a few days, B-15A—the larger portion, measuring 120 km (75 miles) long by 20 km (12 miles) wide—obstructed the entrance to McMurdo Sound and prevented the pack ice in the sound from clearing out in the summer. In October 2005 B-15A broke up into several large pieces off Cape Adare in Victoria Land because of the impact of distant swell. Iceberg C-19 was an even larger but narrow iceberg that broke off the Ross Ice Shelf in May 2002. It fragmented before it could drift far."

3. Drift Pattern

The drift of greater tabular icebergs is mainly determined by oceanographic surface or even sub-surface currents. Because of its size, the little freeboard of about 20 m and the flat surface the actual wind situation is of minor influence. While the clockwise drift with the Antarctic Coastal Current is related to the configuration of the Antarctic Peninsula, the free drift in the open ocean is obviously the result of currents influenced by the interacting of factors as the main wind fields, differences in the water density, Coriolis forces, bottom and surface topography.

Fig. 3 shows the drift route of A68a from March 13 to September 18, 2020, based on the weekly centre positions provided by NIC (cp. Section 2). The region extended from 62° S northwards to about 59° S and from 53° W to 48° W. The positions for A68a are given as red ovals (in Sept. in green as the tracks overlapped each other), for A68c in blue.

Fig. 3: *Centre positions of icebergs A68a from 13.03. to 18.09. and A68c from 24.04. to 12.06.2020*



Until about April 10 the general drift direction was about NE, which corresponds quite nicely with the overall drift pattern shown in Fig. 2. Weekly drift rates between about 40 to 70 nm could be calculated. From April 10 to 17 the drift rate decreases to about 30 nm and then until April 24 to about 20 nm. The drift direction was shifting to N and NNW. In the period from about April 21 to mid-May A60a became nearly stationary. As shown in Fig. 3, it was rotating somewhat on a position of about 60°30’ S and 50°10’ W.

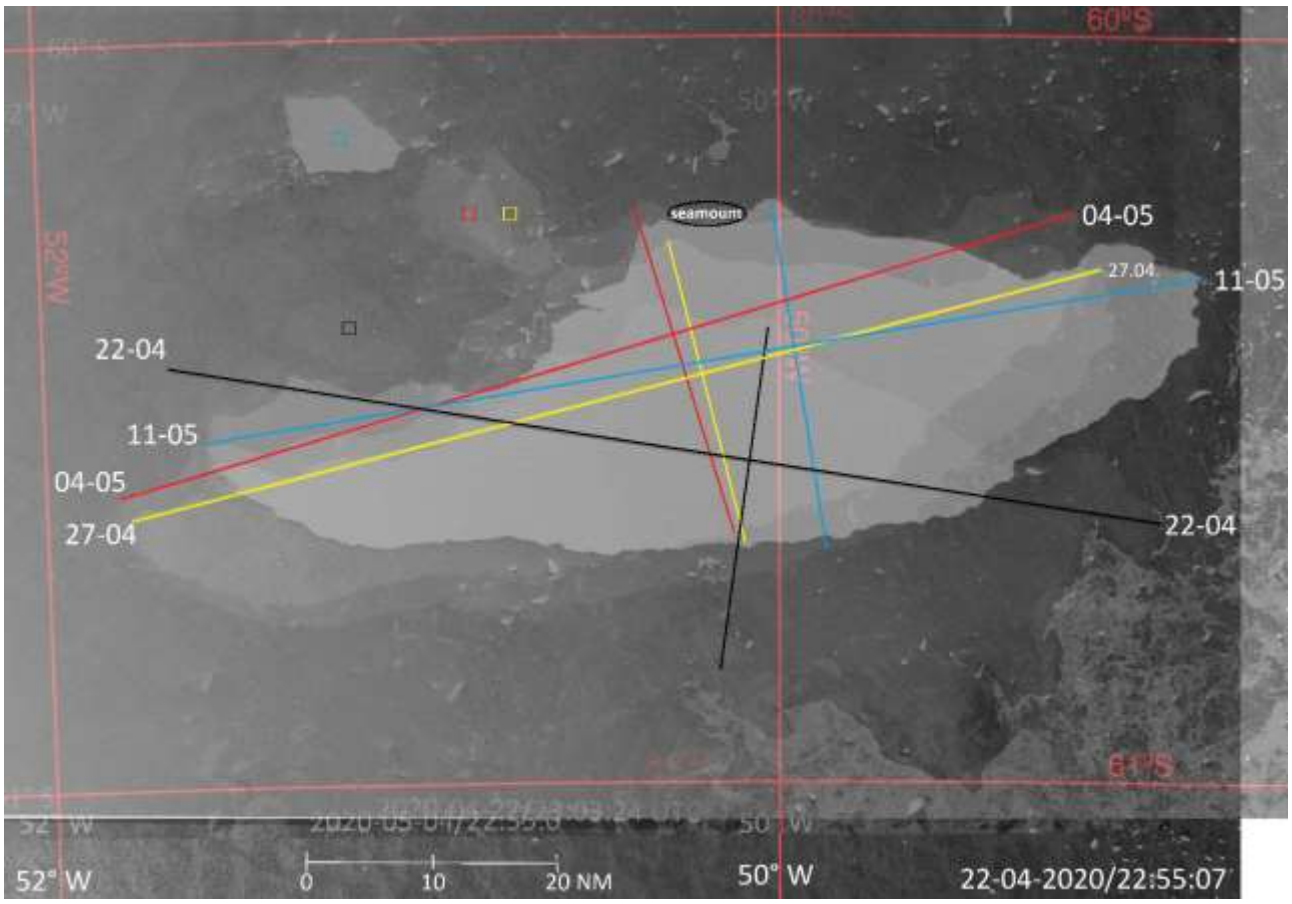


Fig 4: ***Overlay of 4 Sentinel-1 SAR images (sections) from April 22 to May 11, 2020, showing icebergs A68a and A68c, which has just calved from the main body.***

Due to this abnormal - nearly fixed - position questions for the reason arose. Grounding was a first guess. The bathymetry shows indeed a seamount on the South Scotia Ridge, however the depth contours ended by 500 m (cp. Fig 5). With an estimated freeboard of about 20 m, the draft of the iceberg should not exceed about 180 to 200 m. When the given depths are correct, grounding can be excluded, and perhaps a water eddy – e.g. created by the seamount – could be the reason.

By mid-May A68a again gained momentum, however, at lower weekly rates of about 10 to 15 nm. Direction until mid-June was mainly NE. Then the drift turned to N and NNW and ended by the end of the month until mid-July at about position 59°32’ S / 49°15’ W in a rudimental anticlockwise eddy with a diameter for the centre points of only about 5 nm, which means that A68a was nearly stationary over the deep sea (Protector Basin – cp. Fig. 5). Furthermore, it has to be noted that because of the seasonal extension of the Weddell Sea pack ice the berg was situated within the marginal ice zone. Details are given in Fig. 2.

Shortly after mid-July A68a escaped from the small eddy in a bigger eastward step of about 24 nm/week. However, the unusual drift continued in the last week of July, when the berg turned around and drifted about 45 nm westwards. This turn continued clockwise in a wide circle around about position 59°10’ S / 49°15’ W. The diameter of the circle, which was formed by the centre points, measured approximately 45 nm. On August 28 the centre point was located only about 11 nm NW of its position on July 24. The relevant SAR images are shown in Fig. 6. Further on, within the next 7 days until September 4 by a WSW-ward drift (cp. Fig. 7) A68a even crossed the track, which was passed in the last week of July. Then the track turned clockwise N-wards and by Sept. 11 at least until Sept. 18 E-wards with an anticlockwise berg rotation (cp. Figs. 3 and 9).

Fig. 3 shows also the drift of iceberg A68c, which differs considerably from that of A68a. Already after June 16 it was drifting east of the map section (Fig. 2). Thus, it appears that it is very likely that their different drift pattern depended on their size.

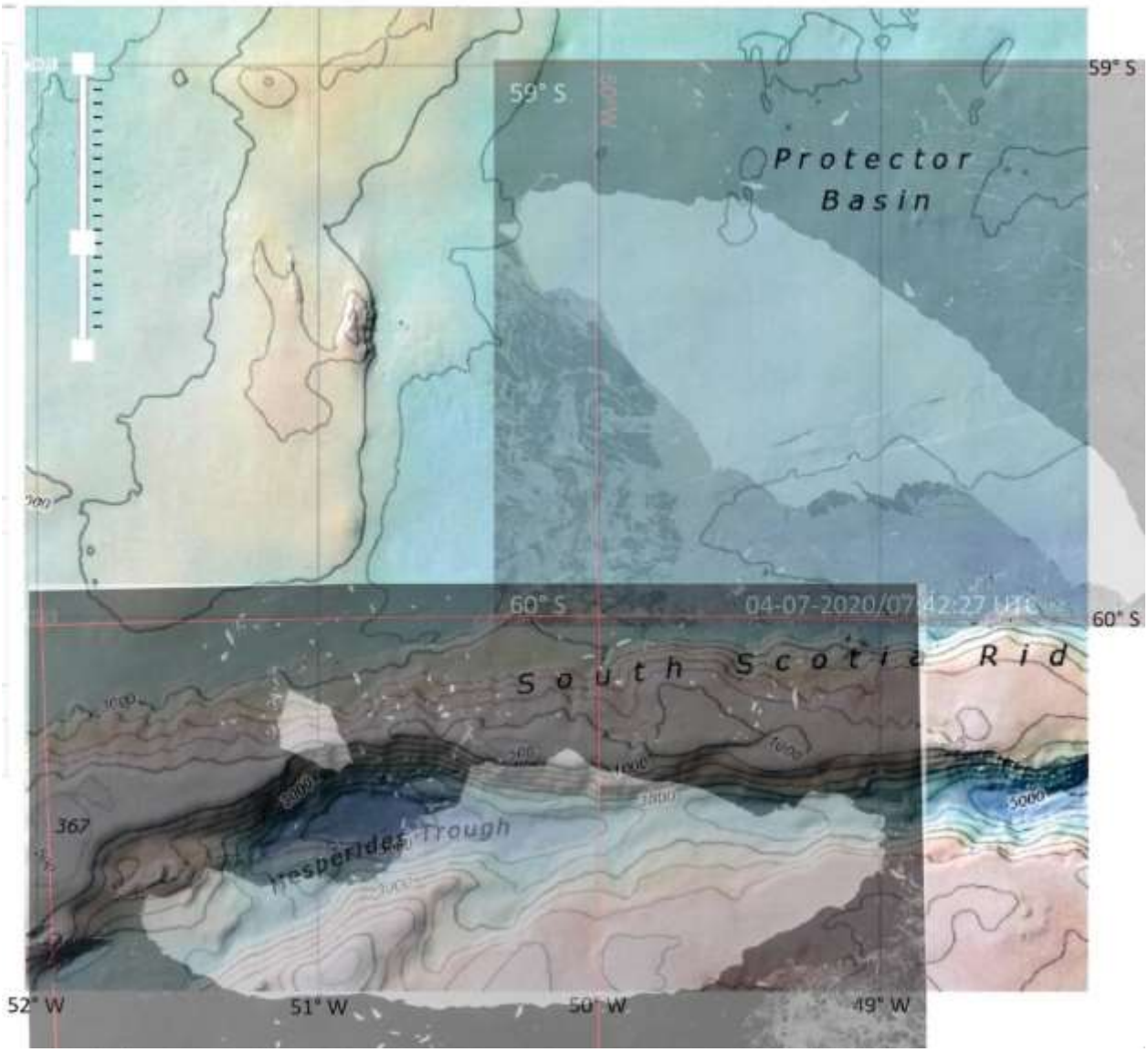


Fig. 5*: Overlay of SAR images of May 9 and July 4 2020, on a section of the NOAA Bathymetric Data Viewer (**https://maps.ngdc.noaa.gov/viewers/bathymetry/**). *Beside different projections the overlay fits quite sufficiently. The upper central edge of A68a merged on May 9 with the 500 m contour line while the berg on July 9 was drifting over the deep Scotia Sea (Protector Basin).

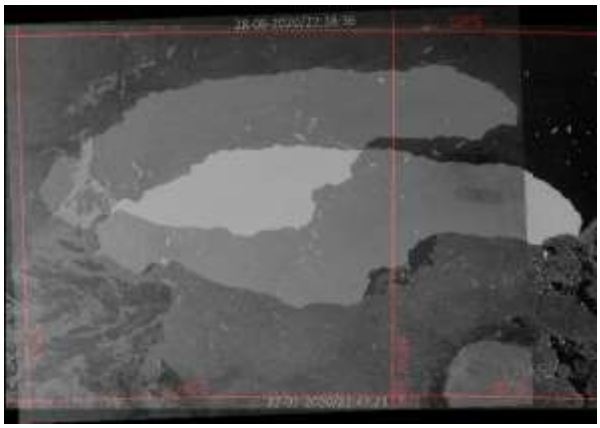


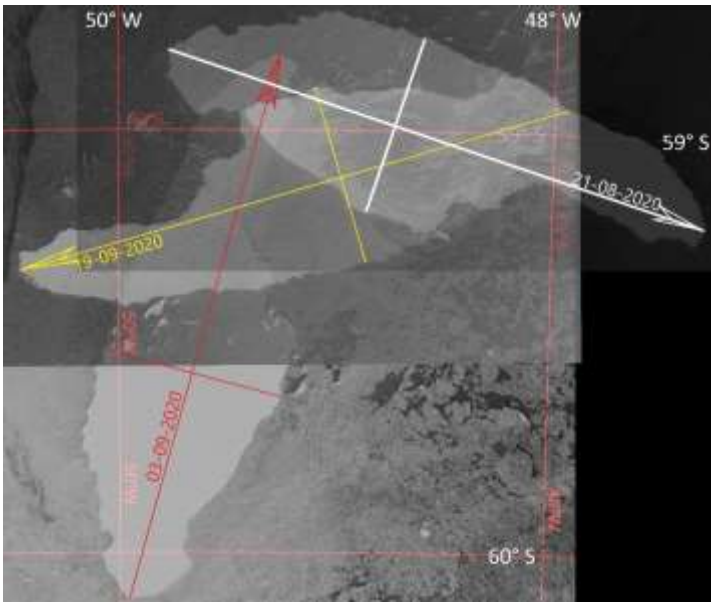
***Fig. 6:* Overlay of SAR images of July 22 (down) and August 28,2020.** *After a clockwise drift of about 5 weeks A68a has reached a nearly identical position (cp. Fig. 2). The next stage of the drift is shown in Figs. 3 and 9.*

4. Rotation

In addition to the iceberg drift itself internal motions are of interest, too, as they indicate small to mesoscale oceanographic dynamics. Good indicators are mainly bigger tabular icebergs with a characteristic shape. A68a with a length of about 150 km is a unique sample.

Beside minor rotations of about less than 30 degrees as shown in Fig. 4, much higher values could be observed rather often. Quite up-to-date A68a performed from Aug. 21 to Sept. 19 an anticlockwise turn of about 255 degrees and until Sept. 03 a southwards movement of its western tip of about 78 nm (Fig. 7)[3].

***Fig. 7:* Overlay of SAR images of August 21 and September 03 and 19 documenting an anticlockwise rotation of about 255 degrees within the marginal ice zone. Details are given in Fig. 9, phase 7.**



The first turn of A68 was not because of internal forces within the water body, but because of a coastal obstacle. Early May 2019 it hit the rocky coast of Robertson Island – already after a 180 degrees anticlockwise rotation - with the originally southern tip. Within 4 months the berg was turned around by the coastal current about 90 degrees anticlockwise, until it came clear from the Island by early September (Fig. 8).

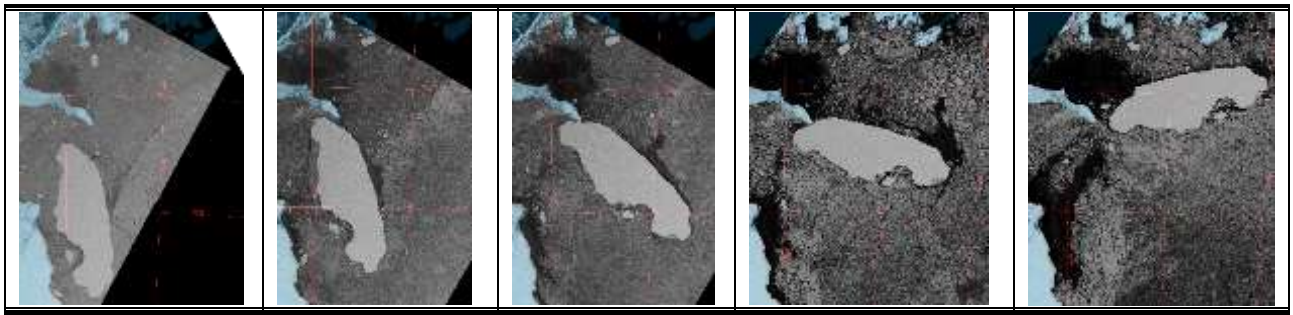
Within the free drift of A68a in the Scotia Sea so far there occurred seven events of rather intensive rotations. From the beginning of March 2020 started a clockwise rotation (phase 1). At that date the long axis was situated in nearly N – S direction. The phase finished after about 10 days at 60 ↔ 240 degrees direction. By mid-March the rotation became anticlockwise and ceased by April 20 in nearly W ↔ E direction (phase 2). Until the end of May A68a showed no essential rotation, but only some minor bidirectional movements (cp Fig. 4). Afterwards the anticlockwise rotation continued for one month to the end of June (phase 3). At that time the axis was oriented in 120 ↔ 300 direction. A short phase from July 15 to 21 of a further anticlockwise resulted in an E ↔ W orientation (phase 4). By the end of July, the anticlockwise rotation started again, however, stopped on August 3 with the axis on 50 ↔ 230 degrees (phase 5). Then immediately it changed into a clockwise mode, which continued until only until mid-August at direction 150 ↔ 300 degrees (phase 6). By mid-August A68a turned slowly into an anticlockwise rotation. At the beginning of September, it increased considerably (phase 7) and reached at the editorial deadline of this paper 19.09.) a direction of 255 ↔ 75 degrees, i.e. a total rotation of – 255 degrees (cp. Fig. 6). The results of the rotations of iceberg A68a since March 2020 in open water or at the marginal ice zone, respectively, are summarized in the following table:

Table 1.: Essential rotation phases of tabular iceberg A68a in the Scotia Sea March to early September 2020

Phase	Period	Orientation of main axis	Rotation	Value
01	01.03. – 10.03.	N↔S to 60 ↔ 240	clockwise	+ 60°
02	15.03 – 20.04.	60 ↔ 240 to W ↔ E	anticlockwise	- 150°
03	01.06 – 30.06.	W ↔ E to 120 ↔ 300	anticlockwise	- 150°
04	15.07. – 21.07.	120 ↔ 300 to E ↔ W	anticlockwise	- 30°
05	30.07. – 03.08.	E ↔ W to 50 ↔ 230	anticlockwise	- 40°
06	04.08. – 15.08.	50 ↔ 230 to 150 ↔ 330	clockwise	+ 100°
07	15.08. – 19.09.	150 ↔ 330 to 255 ↔ 75	anticlockwise	- 255°

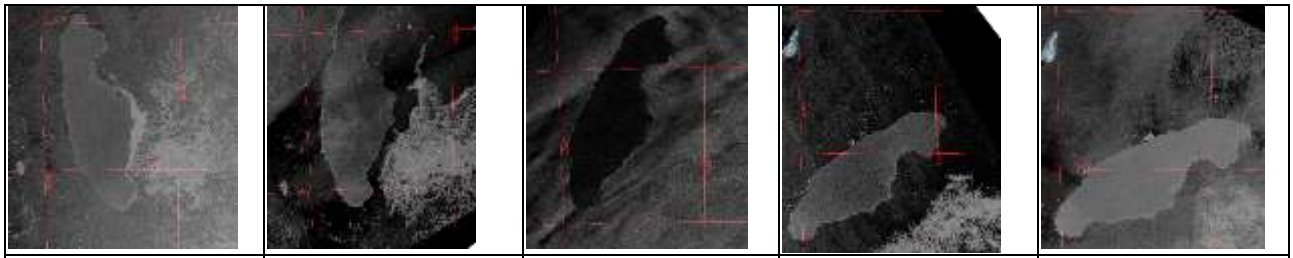
[3] To avoid confusion and to allow relevant numbers, the values for the rotation of A68a are related to the geographical orientation of the originally northern tip after the calving, which was that of the narrow part of the iceberg heading north. Therefore, the first specification of a direction is always the heading of the mentioned tip.

The events are documented with up to 5 scenes each in Fig. 8 and Fig. 9



13-04-2019	20-05-2019	25-06-2019	27-07-2019	13-09-2019

***Fig. 8*: Rotation because of an obstacle - Between April and September 2019 Iceberg A68a stroke against Robertson Island and was turned around** *(centre region between 65° and 66° S and 58° and 60° W)*



28-02-2020	02-03-2020	06-03-2020	08-03-2020	11-03-2020

Phase 1 with clockwise rotation of about 60 degrees *(centre region between 62° and 66° S and 52° and 54° W)*

15-03-2020	25-03-2020	06-04-2020	15-04-2020	22-04-2020

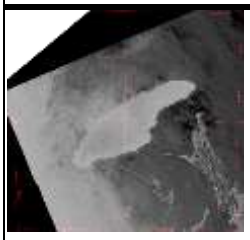
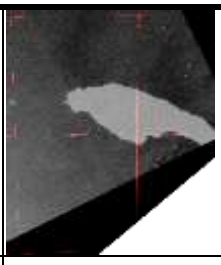
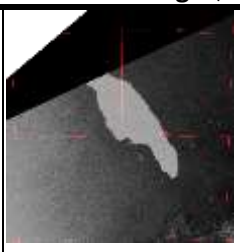
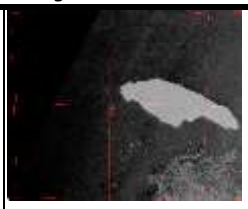
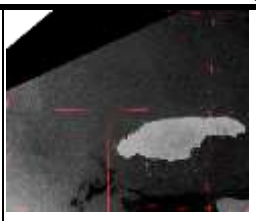
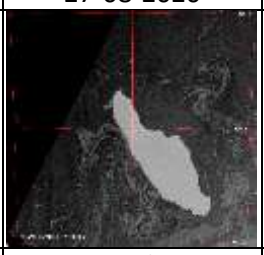
Phase 2 with anticlockwise rotation of about 150 degrees *(centre region between 60° and 62° S and 48° and 52° W)*

23-05-2020	30-05-2020	04-06-2020	15-06-2020	29-06-2020

Phase 3 with anticlockwise rotation of about 150 degrees*(centre region between 59° and 61° S and 48° and 50° W)*

10-07-2020	17-07-2020	21-07-2020		

Phase 4 with short anticlockwise rotation of about 30 degr. *(centre region betw. 59° and 60° S and 48° and 50° W)*

28-07-2020	29-07-2020	03-08-2020		
Phase 5 with short anticlockwise rotation of about 40 degr. *(centre region betw. 59° and 60° S and 48° and 50° W)*				
				
04-08-2020	08-08-2020	15-08-2020	21-08-2020	
Phase 6 with clockwise rotation of 100 degrees *(centre region between 58° and 60° S and 48° and 51° W)*				
				*(centre region between 59° and 60° S and 48° and 50° W)*
21-08-2020	27-08-2020	28-08-2020	03-09-2020	
				*(centre region between 59° and 60° S and 48° and 50° W)*
07-09-2020/07:50:52	14-09-2020/07:42:31	15-09-2020/22:39:18	19-09-2020/07:50:52	
Phase 7 with first slow, then rapid anticlockwise rotation of 155 degrees				

<u>Fig.9:</u> Phases of mostly rather obvious rotations in open water and along the marginal ice zone from March to the beginning of September 2020

Video clips of the behaviour of A68a, presented in the web (click for "A68"), may be perhaps more exciting and show inclusive the surrounding pack ice a useful impression about their dynamic interaction, but the spot lights compiled in Fig. 8 and Fig. 9 allow a better numerical approach. In addition, the time series compiled in Annex I for the period March 30 to May 15 and in Annex II for period April 21 to July 17, 2020, can create perhaps a similar effect. 10 and 24 scenes, respectively, are stringed together showing always the same geographical window. A68a has to be inspired by manual clicks

5. Disintegration

By external factors as weather and sea state (waves and swell) as well as by internal cracks a tabular iceberg as A68 is under permanent stress. More or less big pieces of ice are breaking off continually from its edges or calving as a bigger area like icebergs A68b and A68c becoming remarkable individuals. Thus, not only its shape is changing, but its area is decreasing. However, because of the size of A68 (cp. Table 2) its special shape has outlasted so far more than three years.

5.1 The Shape of Iceberg A68 – Ruptures and Calving

To highlight the loss of space, SAR images of three different dates have been put on top of each other. Fig. 10 shows the loss over about 30 months from August 2017 to February 2020, when A68 on its northward drift with the Antarctic Coastal Current and within the pack ice along the east coast of the Antarctic Peninsula had reached the open water in the north-western Weddell Sea (cp. Fig. 2).

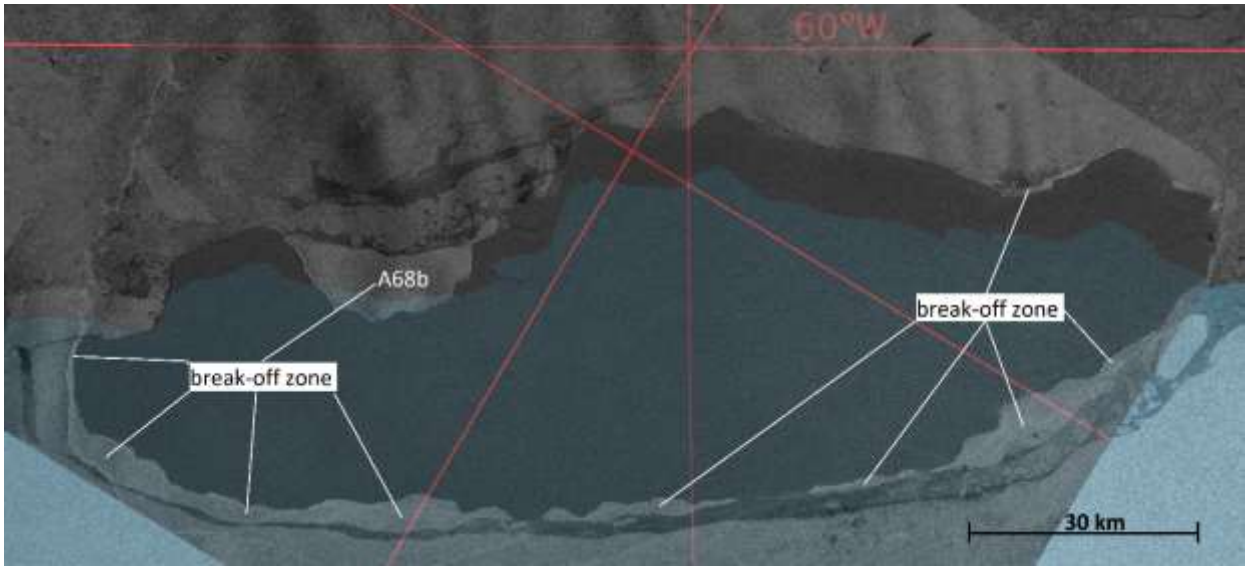


Fig. 10: ***Overlay of 2 Sentinel-1 SAR images (sections): 03-08-2017 versus 11-02-2020.*** *The break-off zones during that time period are shown in grey. Beside of the portion, called after calving iceberg A68b, most break-offs are situated along the edge at the bottom, the calving edge from Larsen Ice Shelf.*

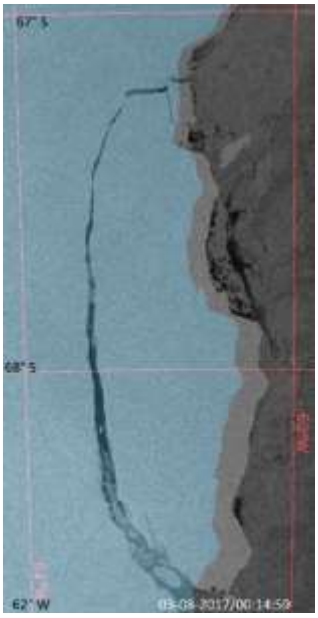


Fig. 10a

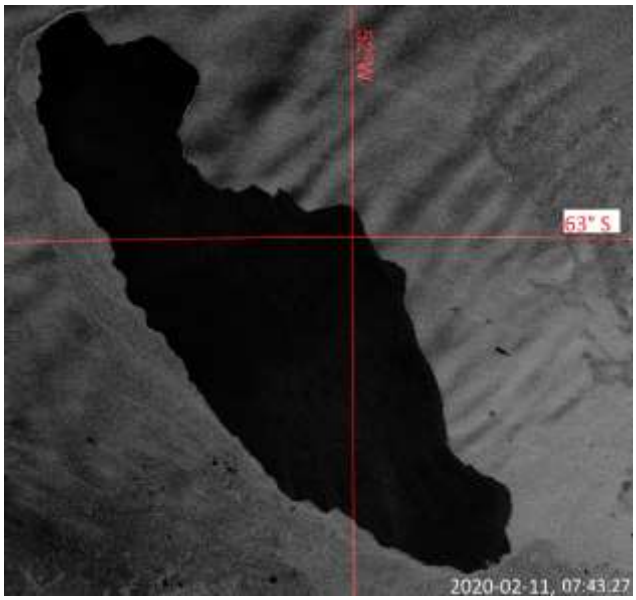


Fig. 10 b

The sections of Sentinel-1 SAR images used for the overlay above are presented in the correct geographical position.

The image of 03-08-2017 (left) shows the situation of A68 about 3 weeks after the calving from Larsen Ice Shelf. The shading on the eastern border is created by the difference between the virtual coast line and its real position. Fig. 10b shows the situation of A68a on February 20, 2020, in the open water of the north-western Weddell Sea under southern summer conditions. Because of the melting conditions on the surface of the tabular iceberg, the backscattering of radar waves is decreasing considerably, and the iceberg appears in the SAR image very dark. The sea ice conditions for that time are given in Fig. 13.

The second overlay (cp. Fig. 11) shows the difference in area from February 11 to August 27, 2020, when A68a was drifting in open water (cp. Fig 2 and Fig 3). In this 6,5 months' time period occurred the calving of iceberg A68c (cp. Fig. 8, phase 2) and at least as much ruptures along the edges as in the 30 months before. This indicates that the disintegration of icebergs in open water due to waves, swell and higher (water) temperatures is much stronger than in pack ice.

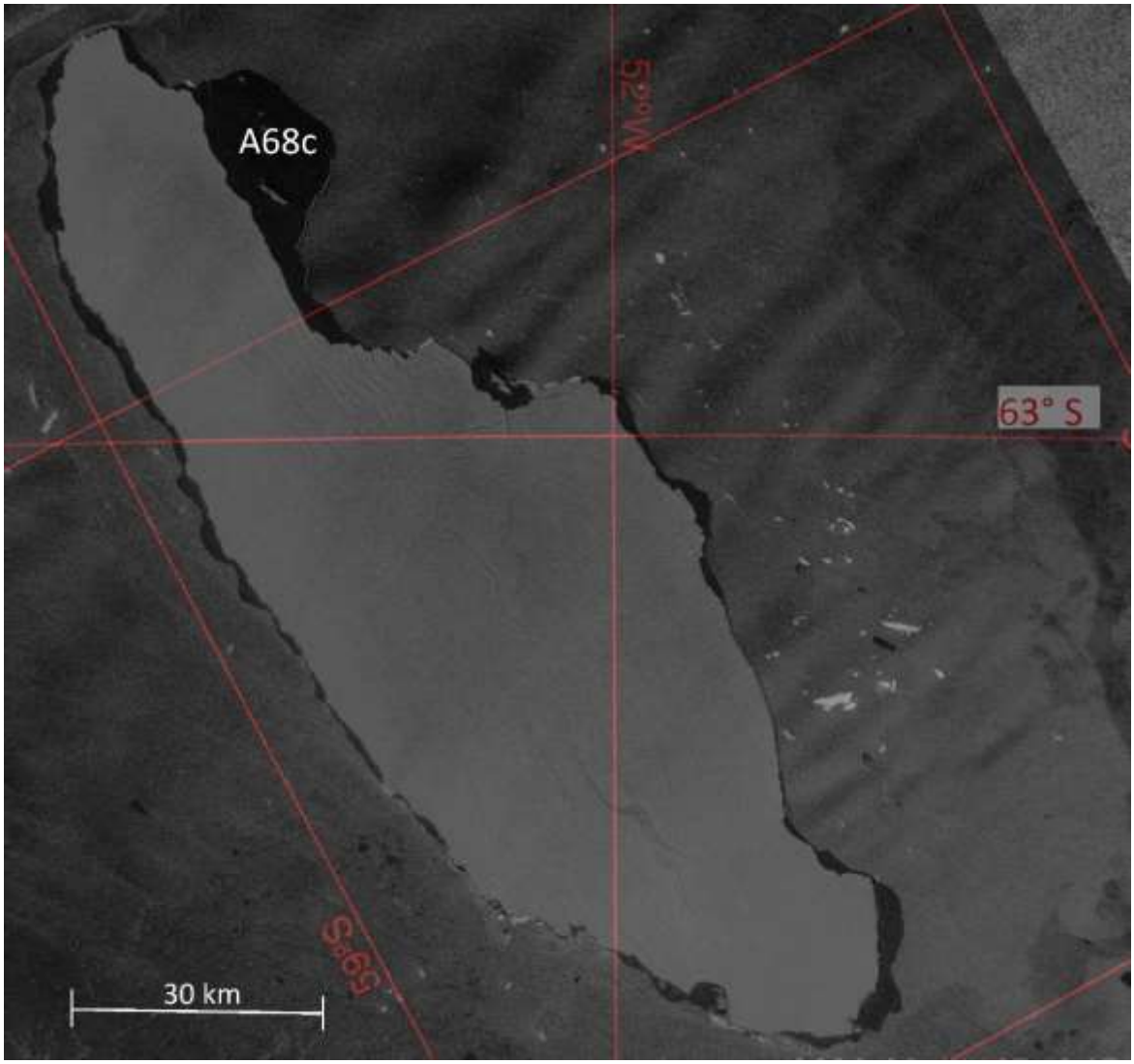


***Fig. 11:* Overlay of Sentinel-1 SAR images (sections): 11-02-2020 versus 27-08-2020.** *The grid for the position of A68a on Feb 11 (dark contours) is aligned in normal N-S- and E-W-direction. The marginal break-off zones during that time period are appearing in dark grey or black. Beside the portion, called after calving on 21/22-04-2020, iceberg A68c (cp. Fig. 10b), the losses of ice are more or less equally distributed. The image of Aug 27 (cp. Fig. 12) on top shows the contours of A68a very clearly, as the surface melting during the southern winter has decreased resulting in increasing backscattering for radar waves (= bright appearance).*

The results of the disintegration can be seen on Figs. 11 and 12. The ice ruptures from the edge of A68a are crowding the water surface close to the main body. That indicates that the break-offs have occurred quite recently and continuously.

With respect to the recent shape of A68a one could assume that especially the portion – currently being east of about 48° W (cp. Fig. 12) - could separate within the near future. However, that are speculations.

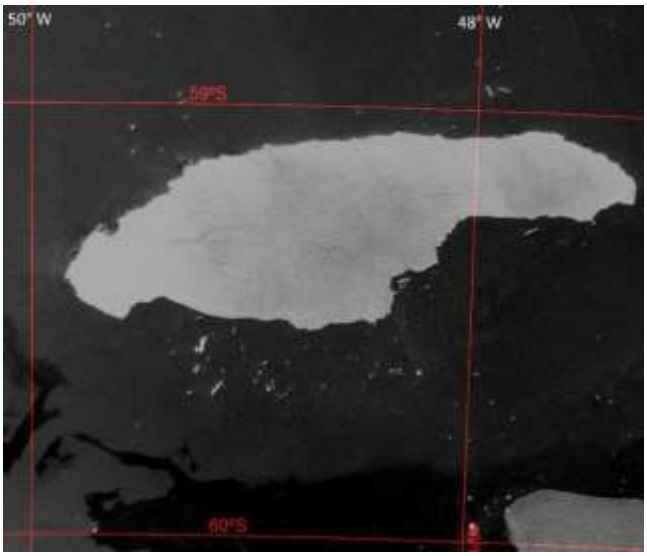


***Fig.12:* Sentinel-1 SAR image of 27-08-2020 in correct geographical position**

Considering safe navigation, it is surely of advantage that A68a is drifting away from the preferred tracks of cruise vessels towards the Antarctic Peninsula. The many fragments of glacier ice around the spectacular huge tabular iceberg is definitely a danger for visitors. At the end of the last cruise vessel season some of them have already targeted A68a (see e.g.: https://www.shipvideos.net/, choose Hanseatic). However, that large icebergs as A68a of course have also the potential to cross further northwards the commercial shipping lanes of cargo vessels. We will see … .

5.2 Size and extent

The data for the size of A68a are calculated on the basis of grid which is part of the SAR images provided by PolarView (see section 1). As reference value the distance between the two parallels in the respective region of A68a is used (60 nm = 111 km) was used. The extent (surface area) of the iceberg was defined with the analogue method (millimetre paper). Drift rates were defined by using the coordinates of the weekly iceberg positions provided by NIC (Cp. Section 1). The results of the relevant calculations are summarized in the following table 2.

date	03-08-2017	11-02-2020	27-08-2020
length (km / nm)	158 / 85,3	150 / 81,0	148 / 79,9
balance		- 8/4,3	- 2/1
max. with (km/nm)	52 / 28,1	51 / 27,5	48 / 25,9
balance		- 1/0,6	- 3/1,6
extent (km²)	5.650	4.965	4.405
balance		- 685	- 560

Table 2: ***Calculated values for the size and extent of iceberg A68a***

The disintegration of icebergs is a natural process. It is reduced within the southern pack ice zone, and intensifies, when the bergs are drifting into regions of higher temperature and open water, mainly beyond the Antarctic Convergence. Therefore, the numbers given in table 2 could be expected. A68a became somewhat smaller and shorter. More striking are the numbers for the extent. The decrease in the last half year was nearly as high as in the 3,5 years before

6. Conclusions

Christopher Readinger's (Antarctica Team Lead, NIC) statement about "*all the crazy rotations A68A has been making as it exits the sea ice the past few months*" [4] can only be stressed. As shown by Fig. 2 east of the of the northern tip of the Antarctic Peninsula the iceberg tracks are concentrated in a rather narrow band. However, farther off they distribute into a wide sea area, showing very individual distinguished tracks. That means that there is of course an overall trend into east northeast directions, but each track has its individual characteristic resulting from the particular environmental conditions during the drift as interacting currents, eddies and wind. Therefore, it seems very likely that from the actual behaviour of an iceberg during the drift e.g. more information on the dynamic oceanographical conditions in the surface and near-surface layers can be extracted than vice versa from the available oceanographic and meteorological data and general knowledge. The rather short-term reaction/rotation of such a huge ice mass indicates very strong mesoscale processes for which an explanation requires further investigations. - Hopefully iceberg A68 can be tracked further on.

Once more it has to be stressed that data from operational (radar) satellites are the only resources to get the necessary information for safe navigation and scientific questions

[4] Personal communication of August 14, 2020

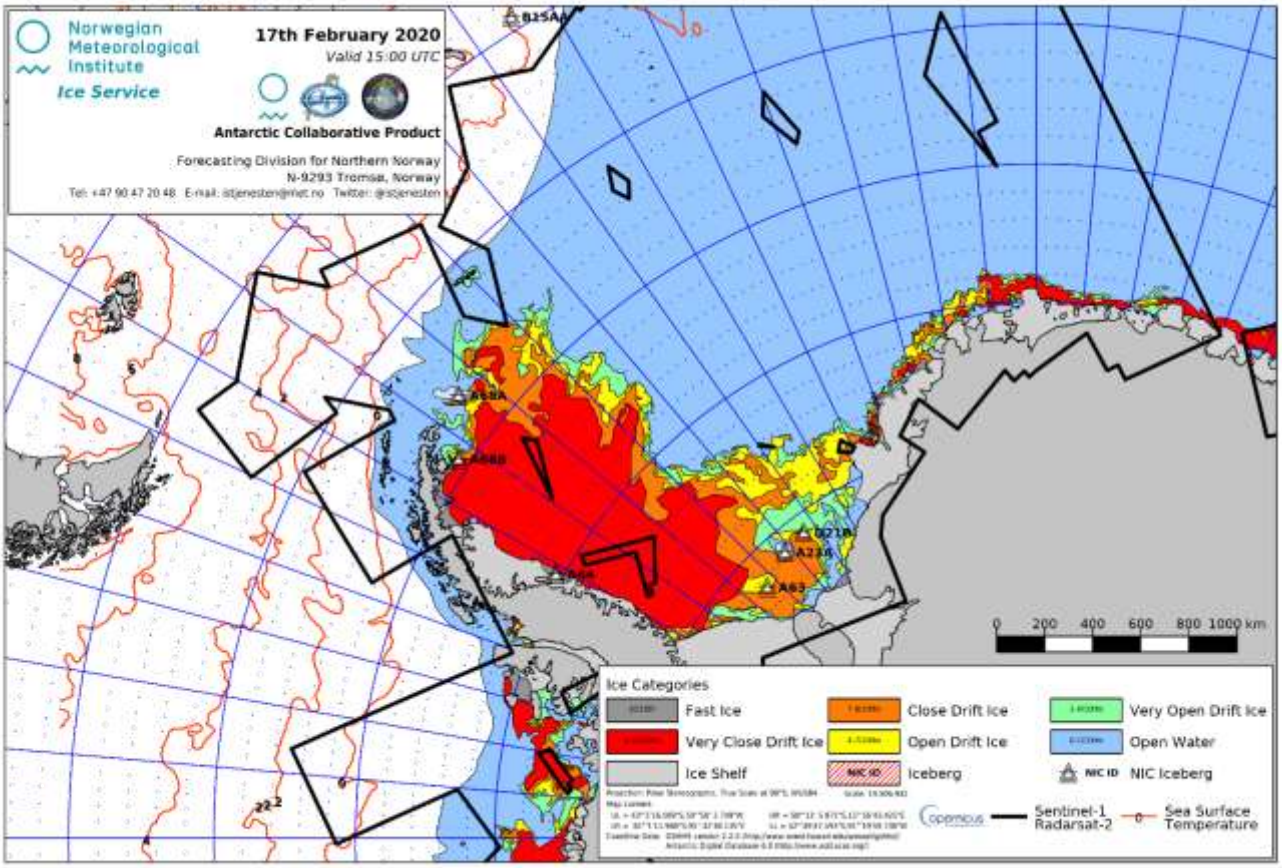


Fig. 13: ***Norwegian ice chart of February 17, 2020. The positions of greater tabular icebergs are marked.***

(Source: https://cryo.met.no/sites/cryo.met.no/files/latest/antarctic_latest.png)

Table 3: ***List of the used Sentinel-1 SAR images provided by PolarView*** (https://www.polarview.aq/antarctic)

Date	UTC	Date	UTC	Date	UTC	Date	UTC
2017-08-03	00:14:59	2020-04-21	23-02-41	2020-06-29	22:38:32	2020-09-03	22:39:18
2019-04-13	08:17:13	2020-04-22	22-55-07	2020-07-04	07:42:27	2020-09-07	07:50:52
2019-05-20	08:09:53	2020-04-27	23-03:24	2020-07-05	22:39:14	2020-09-08	22:47:23
2019-06-25	08:09:55	2020-05-04	22:55:07	2020-07-09	07:50:48	2020-09-09	22:38:36
2019-07-27	07:52:47	2020-05-09	23:03:24	2020-07-10	22:47:20	2020-09-14	07:42:31
2019-09-13	07:52:50	2020-05-11	22:47:17	2020-07-17	22:39:15	2020-09-15	22:39:18
2020-02-11	07:43:27	2020-05-15	23:02:43	2020-07-21	07:50:49	2020-09-19	07:50:52
2020-02-28	07:51:47	2020-05-22	07:50:45	2020-07-22	22:47:21		
2020-03-02	23:18:54	2020-05-23	22:47:17	2020-07-23	22:38:33		
2020-03-06	07:43:26	2020-05-24	22:38:30	2020-07-28	07:42:29		
2020-03-08	23:19:36	2020-05-30	22:39:12	2020-07-29	22:39:16		
2020-03-11	07:51:47	2020-06-03	07:50:46	2020-08-03	22:47:22		
2020-03-15	23:11:28	2020-06-04	22:47:18	2020-08-04	22:38:34		
2020-03-25	07:35:12	2020-06-10	07:42:26	2020-08-08	22:56:13		
2020-03-30	07:43:27	2020-06-11	22:39:13	2020-08-15	22:47:22		
2020-04-06	07:35:12	2020-06-15	07:50:47	2020-08-21	07:42:30		
2020-04-11	07:43:27	2020-06-22	07:42:27	2020-08-27	22:47:23		
2020-04-15	23:03:23	2020-06-27	07:50:47	2020-08-28	22:38:36		

Table 4: ***Centre positions of icebergs A68a and A68c published by NIC – cp. Fig. 3***
(https://www.natice.noaa.gov/pub/icebergs/Iceberg_Tabular.pdf)

A	B	C	D	E	F	G
A68A	82	26	61°58’S	52°35’W	belle	03/13/2020
A68A	82	26	61°48’S	52°03’W	belle	03/20/2020
A68A	82	26	61°26'S	51°03'W	belle	03/27/2020
A68A	82	26	61°17'S	50°34'W	belle	04/03/2020
A68A	82	26	61°00’S	50°16’W	belle	04/10/2020
A68A	82	26	60°47'S	50°16'W	belle	04/17/2020
A68A	82	26	60°37'S	50°19'W	belle	04/24/2020
A68A	82	26	60°33’S	50°22’W	belle	05/01/2020
A68A	82	26	60°32'S	50°21'W	belle	05/08/2020
A68A	82	26	60°28’S	50°05’W	belle	05/15/2020
A68A	82	26	60°24’S	49°43’W	belle	05/22/2020
A68A	82	26	60°13'S	49°17'W	belle	05/29/2020
A68A	82	26	60°04’S	49°07’W	belle	06/05/2020
A68A	82	26	59°57'S	48°55'W	belle	06/12/2020
A68A	82	26	59°45'S	48°59'W	belle	06/19/2020
A68A	82	26	59°33’S	49°19’W	belle	06/26/2020
A68A	82	26	59°35'S	49°11'W	belle	07/03/2020
A68A	82	26	59°31'S	49°23'W	belle	07/10/2020
A68A	82	26	59°30'S	49°13'W	belle	07/17/2020
A68A	82	26	59°25'S	48°26'W	belle	07/24/2020
A68A	82	26	59°17'S	49°55'W	belle	07/31/2020
A68A	82	26	58°59'S	49°58'W	belle	08/07/2020
A68A	82	26	58°47'S	49°44'W	belle	08/14/2020
A68A	82	26	58°59'S	48°36'W	belle	08/21/2020
A68A	82	26	59°17'S	48°39'W	belle	08/28/2020
A68A	82	26	59°30'S	49°41'W	belle	09/04/2020
A68A	82	26	59°15'S	49°41'W	belle	09/11/2020
A68A	82	26	59°13'S	49°15'W	belle	09/18/2020

A – Iceberg number **B** – Length (NM)
C – Width (NM) **D** – Latitude
E – Longitude **F** – Remarks
G – Date of last Update

A	B	C	D	E	F	G
A68C	11	7	60°25’S	51°06’W	belle	04/24/2020
A68C	11	7	60°14’S	50°46’W	belle	05/01/2020
A68C	11	7	60°14'S	50°59'W	belle	05/08/2020
A68C	11	7	60°00’S	51°25’W	belle	05/15/2020
A68C	11	7	59°28’S	50°31’W	belle	05/22/2020
A68C	11	7	59°38'S	49°14'W	belle	05/29/2020
A68C	9	5	59°26’S	49°28’W	belle	06/05/2020
A68C	9	5	59°26'S	47°21'W	belle	06/12/2020
A68C	9	5	58°49'S	47°42'W	belle	06/19/2020
A68C	9	5	58°49'S	46°26'W	belle	06/26/2020
A68C	9	5	57°47'S	45°54'W	belle	07/03/2020
A68C	9	5	56°59'S	43°33'W	belle	07/10/2020
A68C	9	5	57°41'S	41°12'W	belle	07/17/2020
A68C	9	5	57°52'S	38°58'W	belle	07/24/2020
A68C	9	5	57°50'S	38°54'W	belle	07/31/2020
A68C	9	5	56°33'S	38°25'W	belle	08/07/2020
A68C	9	5	57°24'S	35°42'W	belle	08/14/2020
A68C	9	5	57°19'S	34°48'W	belle	08/21/2020
A68C	9	5	57°16'S	34°19'W	belle	08/28/2020
A68C	9	5	57°07'S	33°06'W	belle	09/04/2020
A68C	9	5	56°43'S	32°36'W	belle	09/11/2020
A68C	9	5	56°20'S	32°37'W	belle	09/18/2020

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Swithinbank, C. et al, 1977: Drift tracks of Antarctic Icebergs. Polar Records 18, H116, p. 495 – 501

Links

http://polarview.org/about

https://www.polarview.aq/antarctic

https://www.natice.noaa.gov/doc/Notice_Iceberg_Tracking_Criteria.pdf

https://www.natice.noaa.gov/pub/icebergs/Iceberg_Tabular.pdf

https://phys.org/news/2020-07-giant-a-iceberg-years.html

https://www.britannica.com/science/iceberg/Iceberg-structure

https://maps.ngdc.noaa.gov/viewers/bathymetry/

https://www.shipvideos.net/, choose Hanseatic

https://cryo.met.no/sites/cryo.met.no/files/latest/antarctic_latest.png

ANNEX I

Tabular Iceberg A68a in Open Water

Drift Pattern, Rotation and Disintegration

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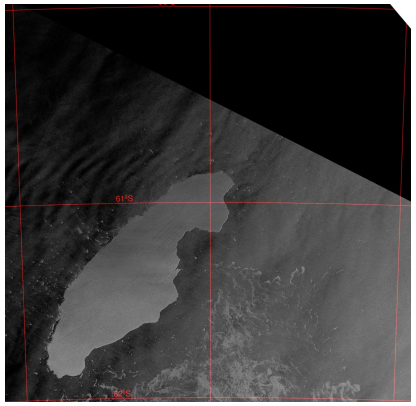

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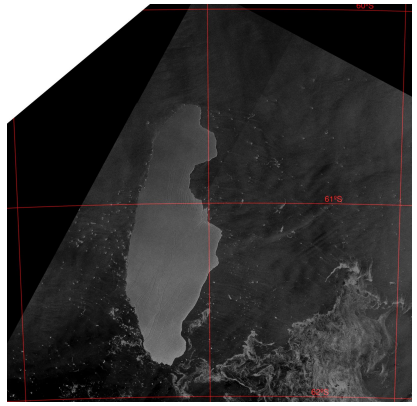

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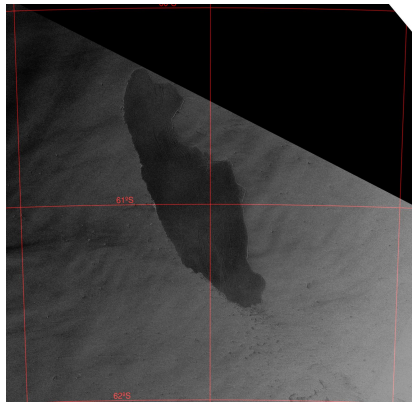

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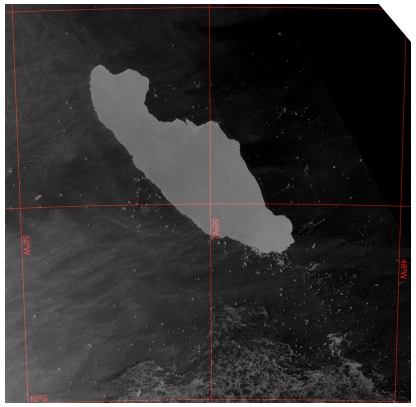

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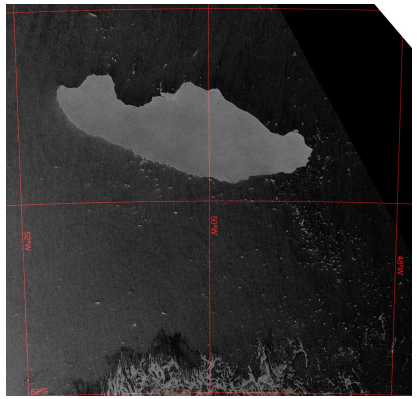

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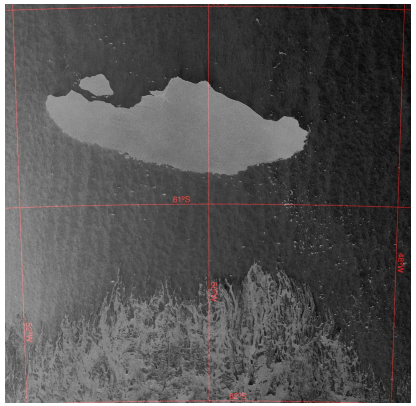

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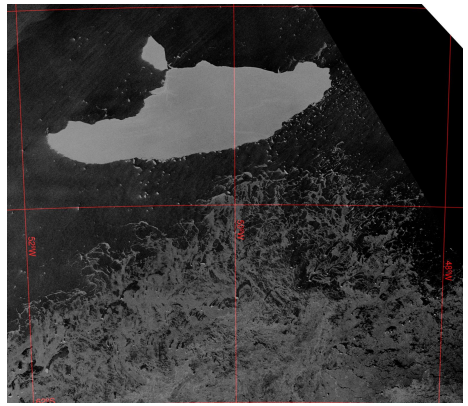

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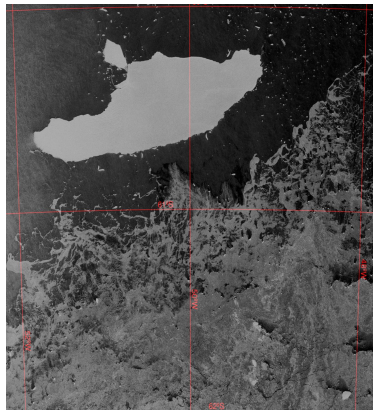

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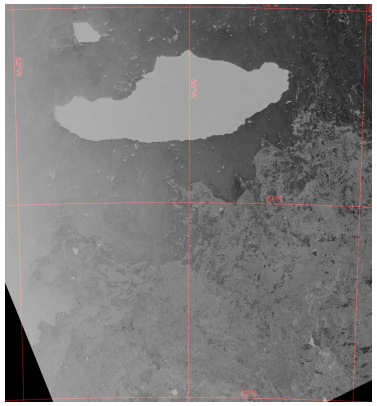

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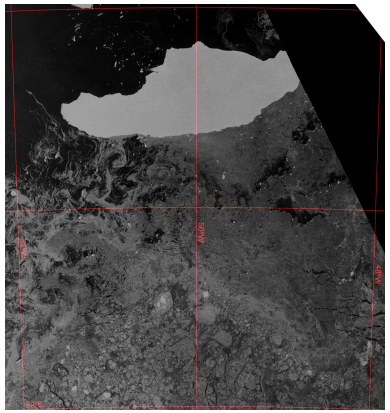

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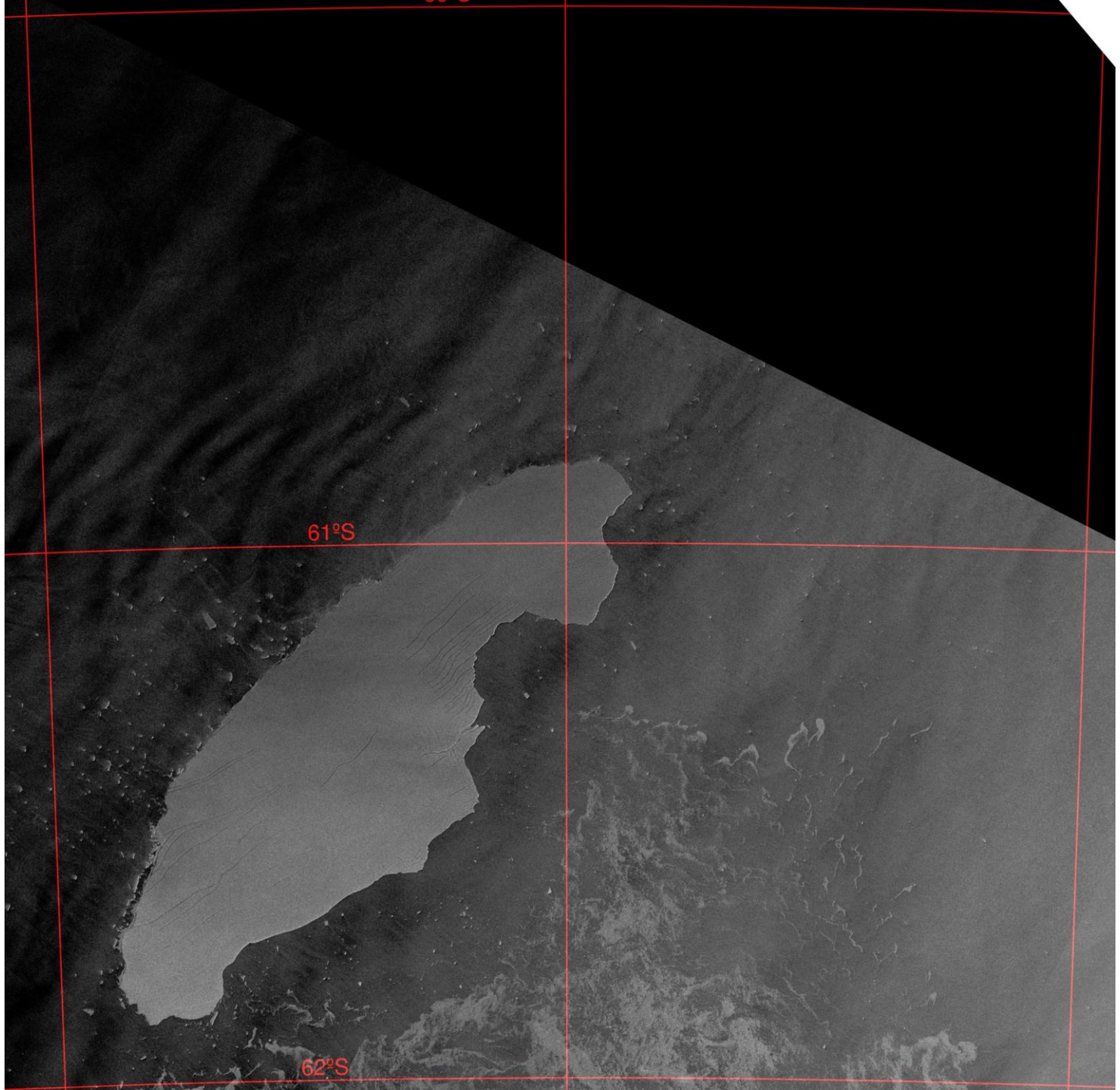

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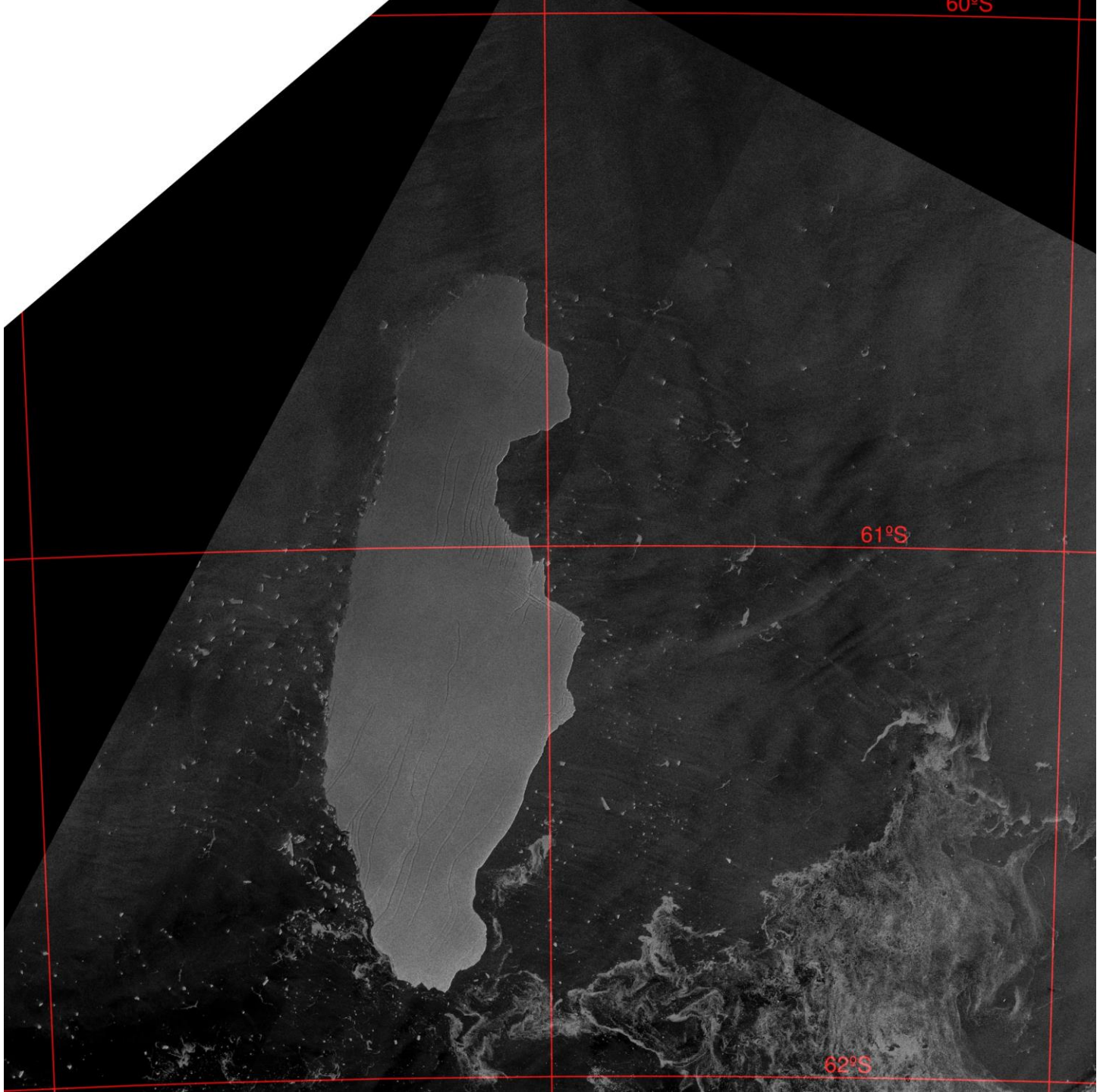

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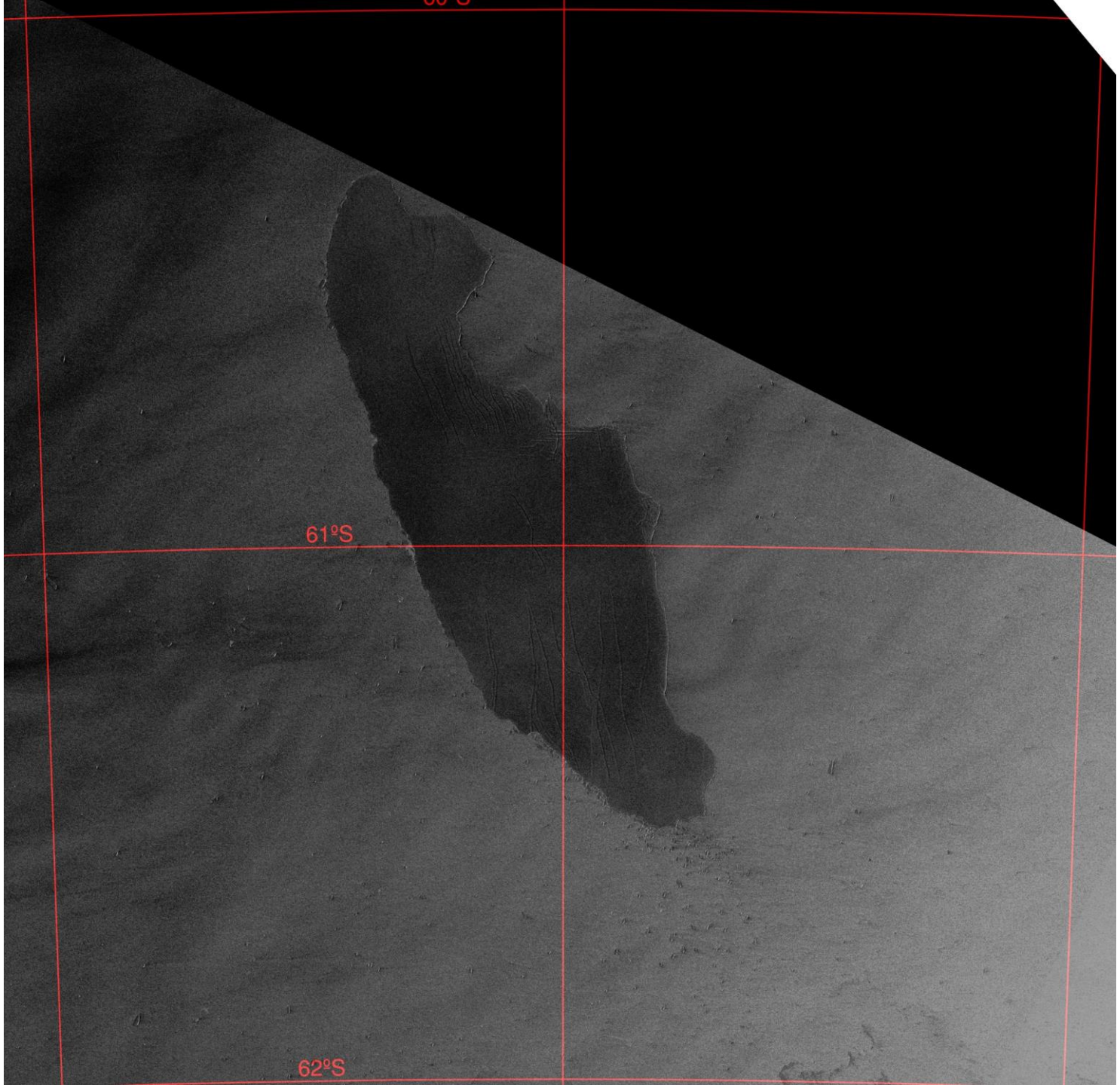

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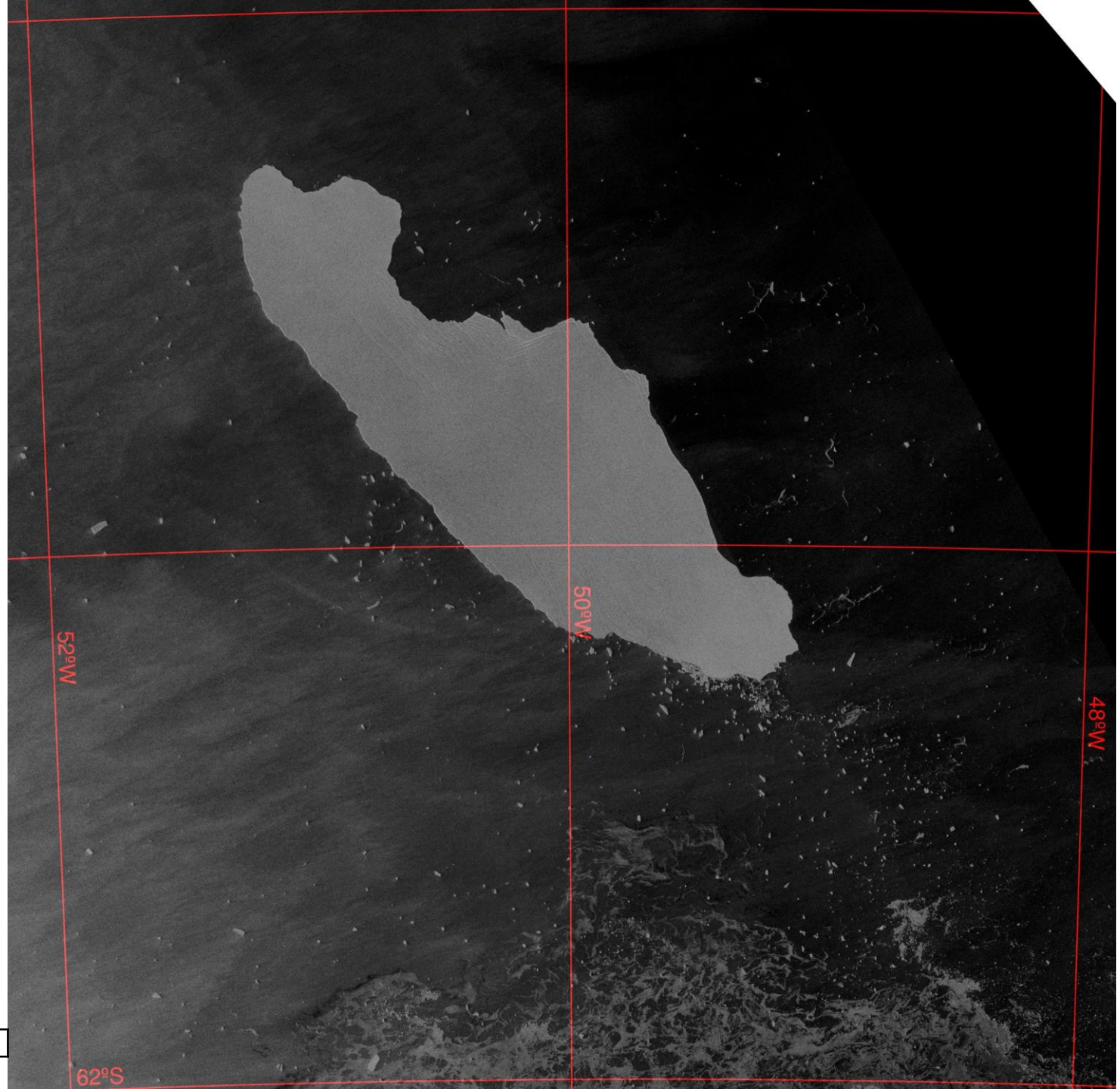

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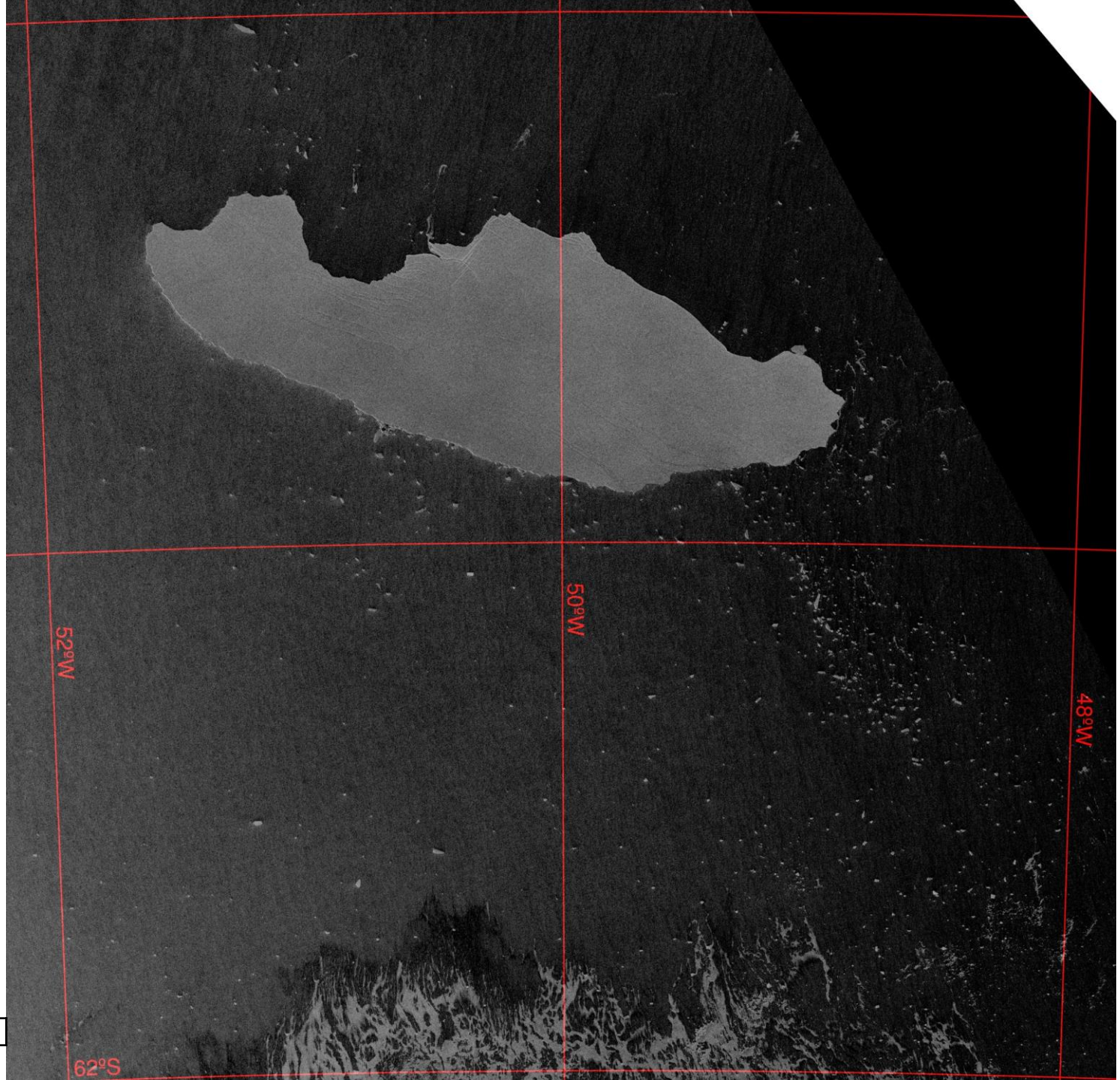

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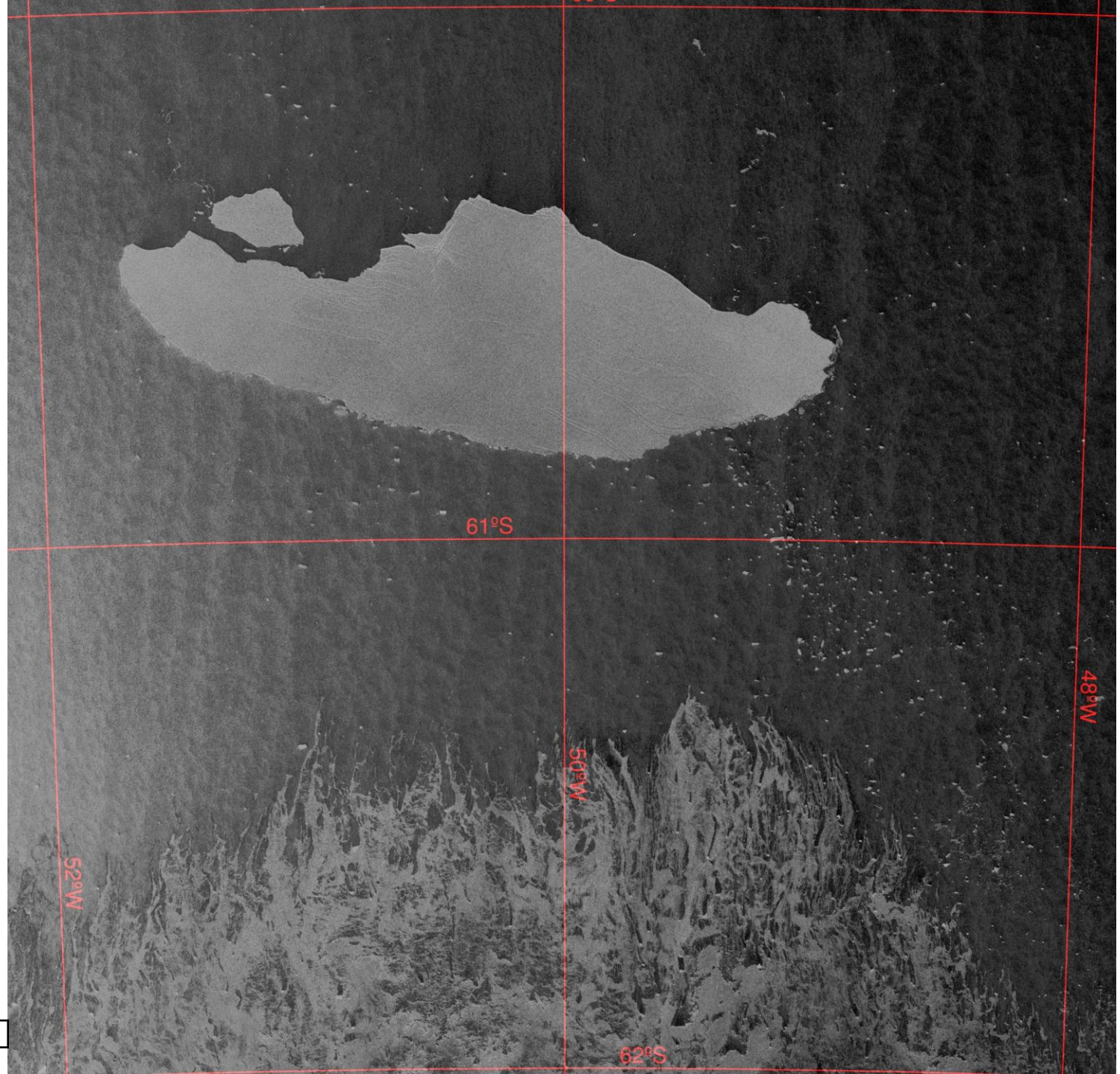

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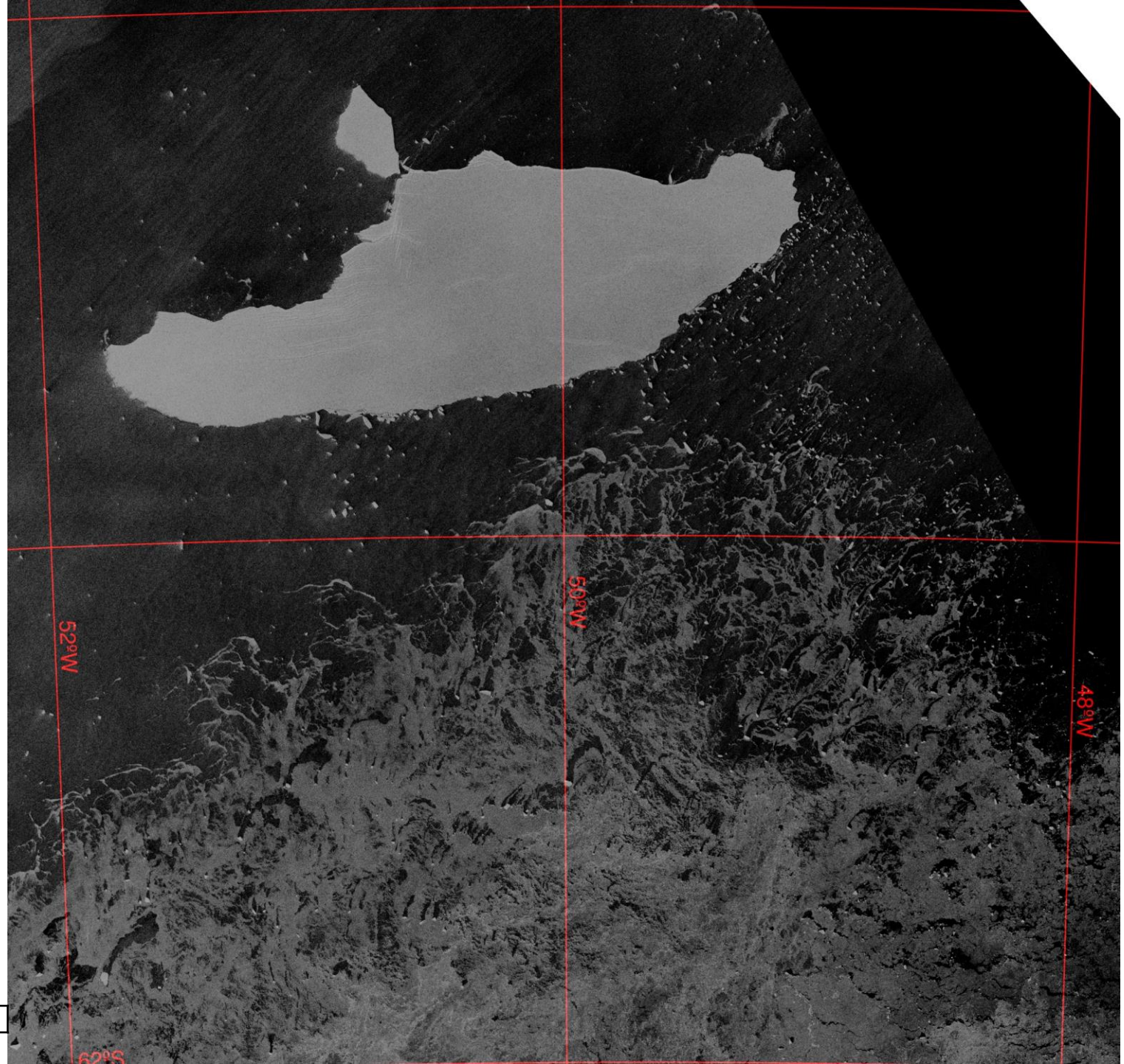

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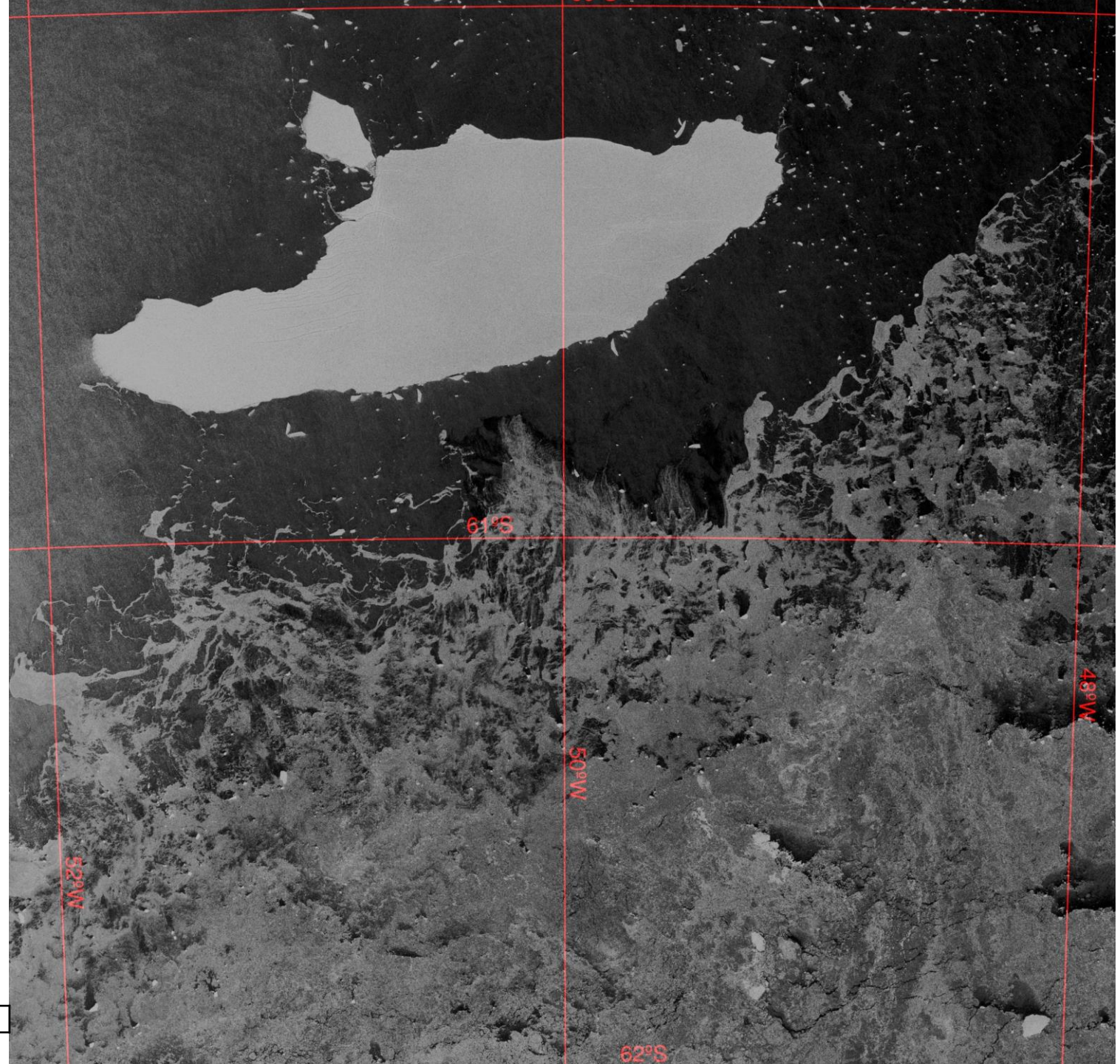

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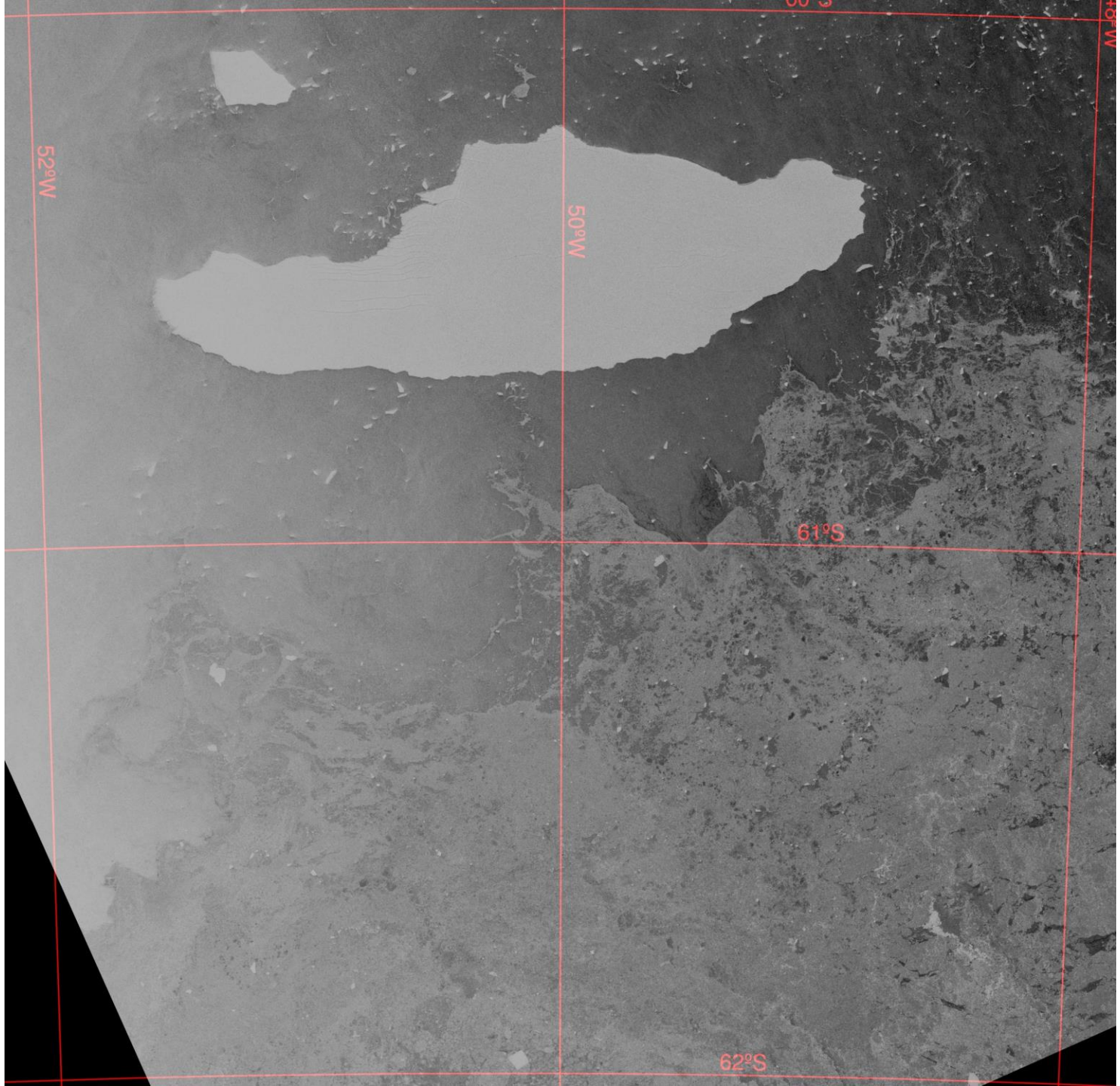

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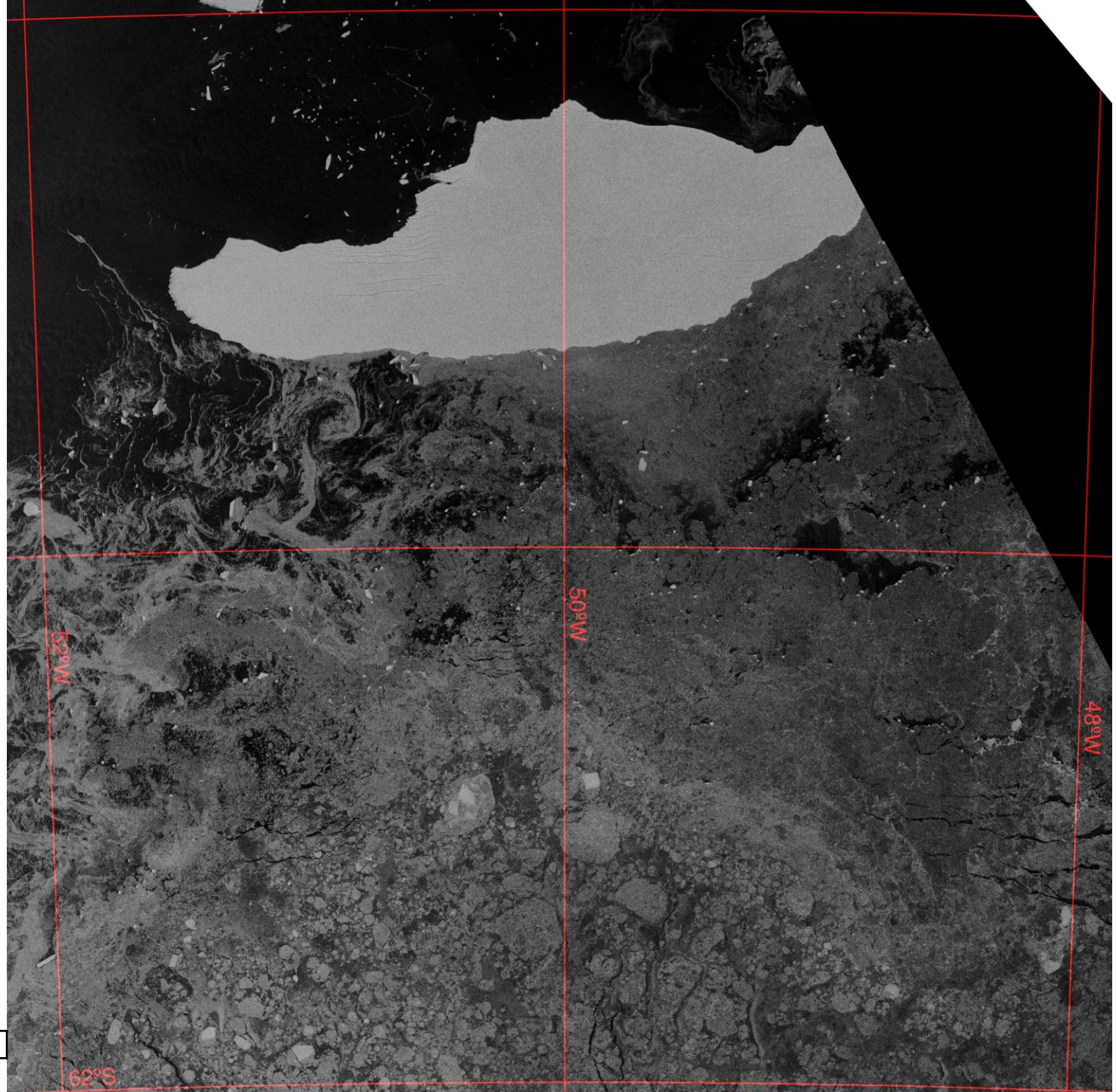

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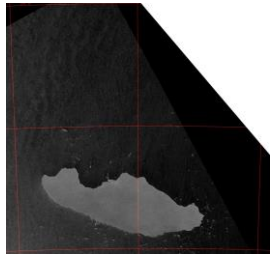
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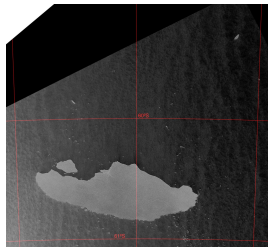
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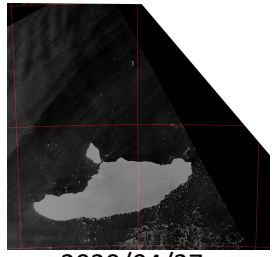
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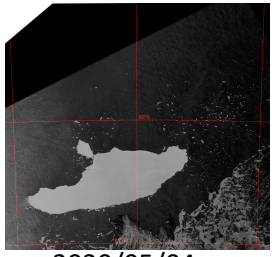
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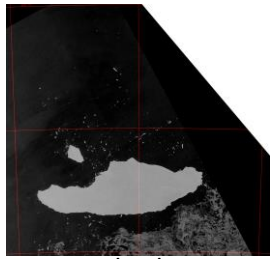
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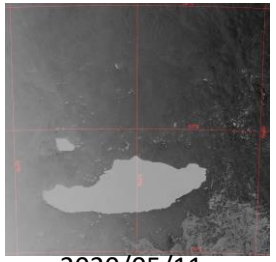
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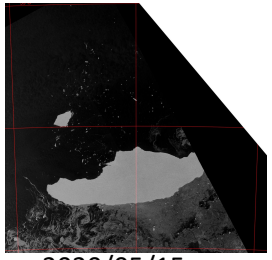
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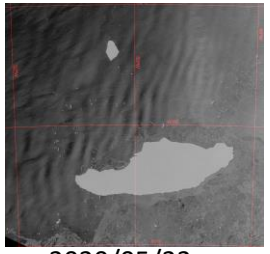
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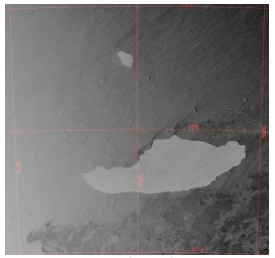
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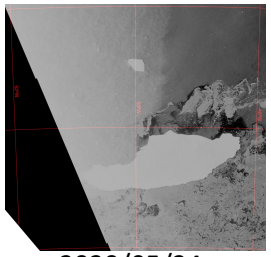
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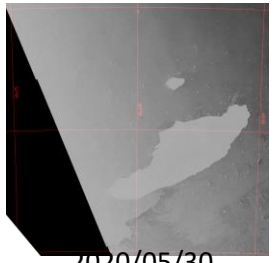
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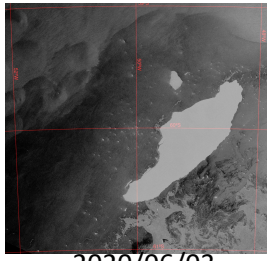
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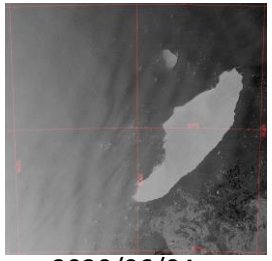
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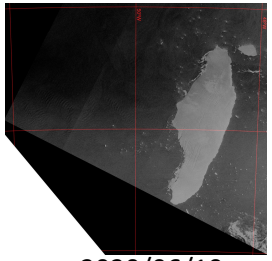
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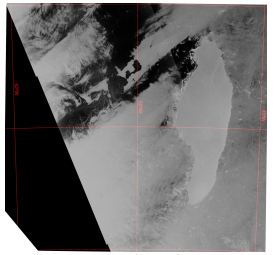
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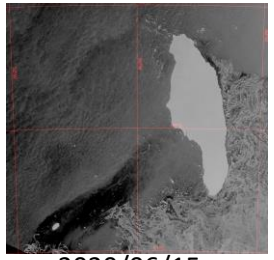
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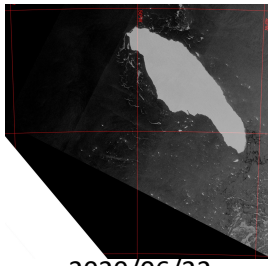
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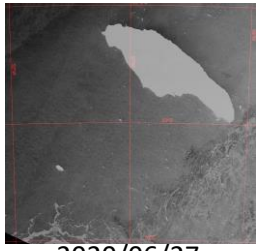
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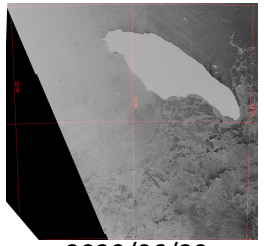
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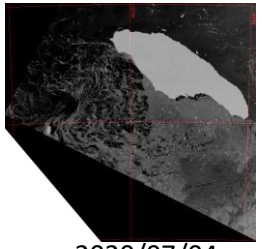
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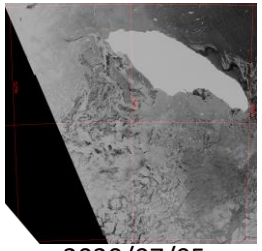
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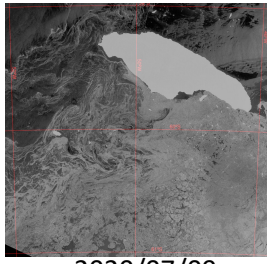
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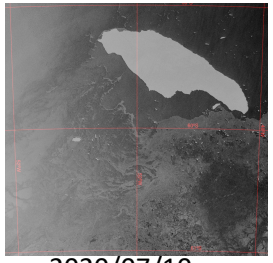
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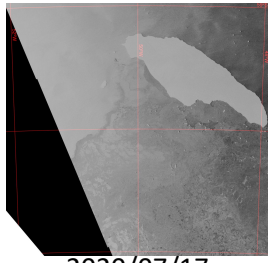
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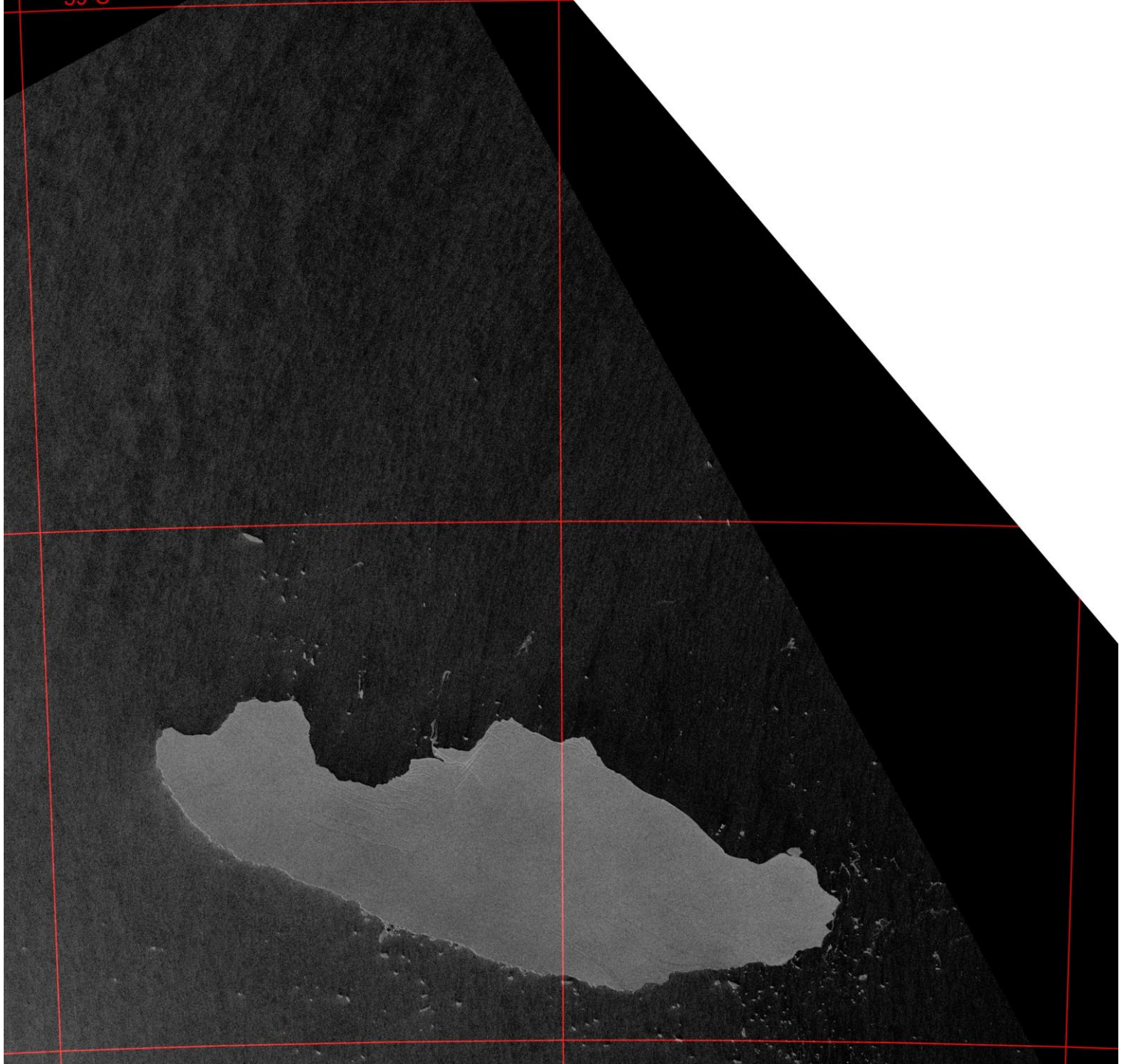
*sections with centre point on 60° S and 50° W



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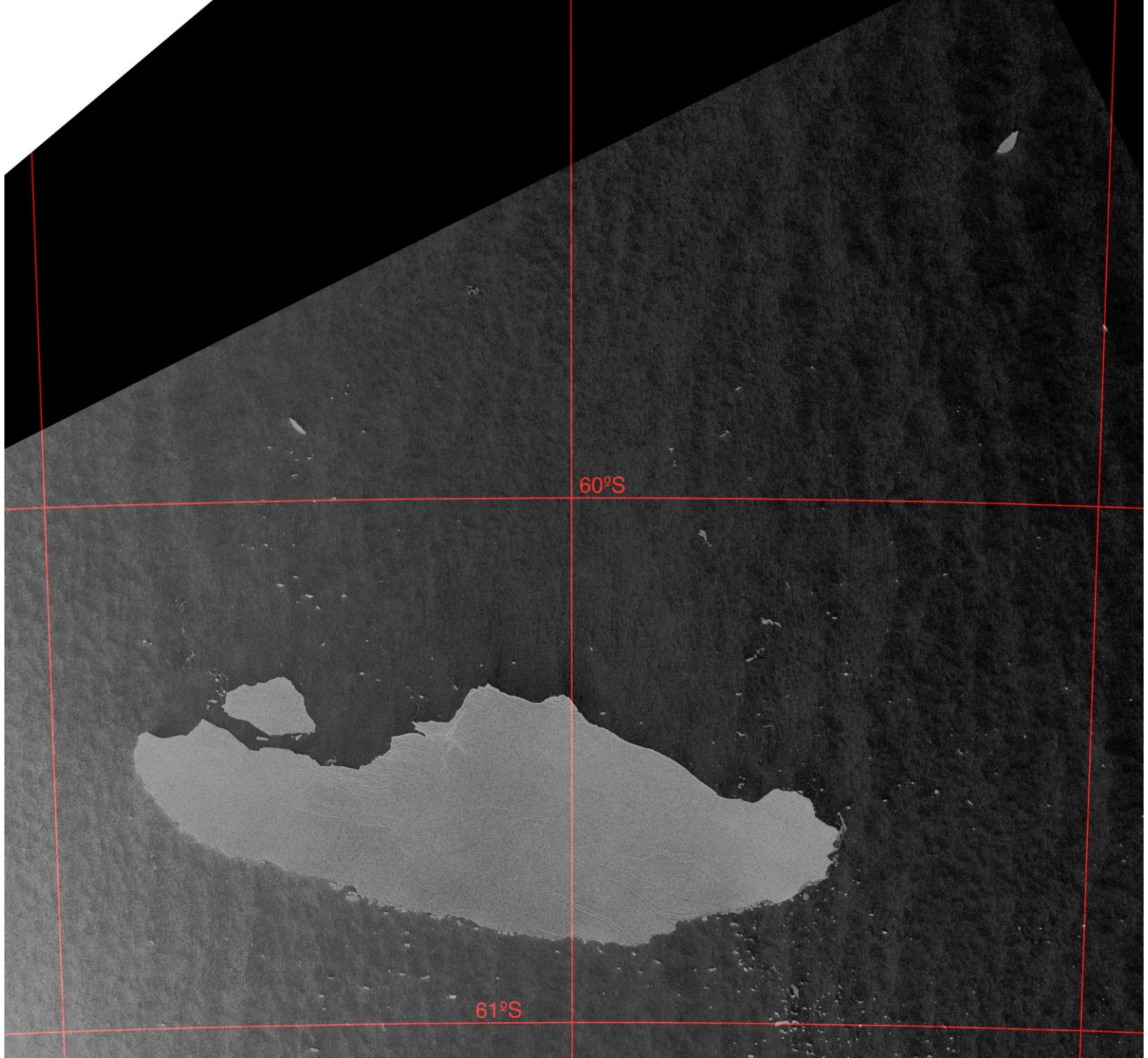

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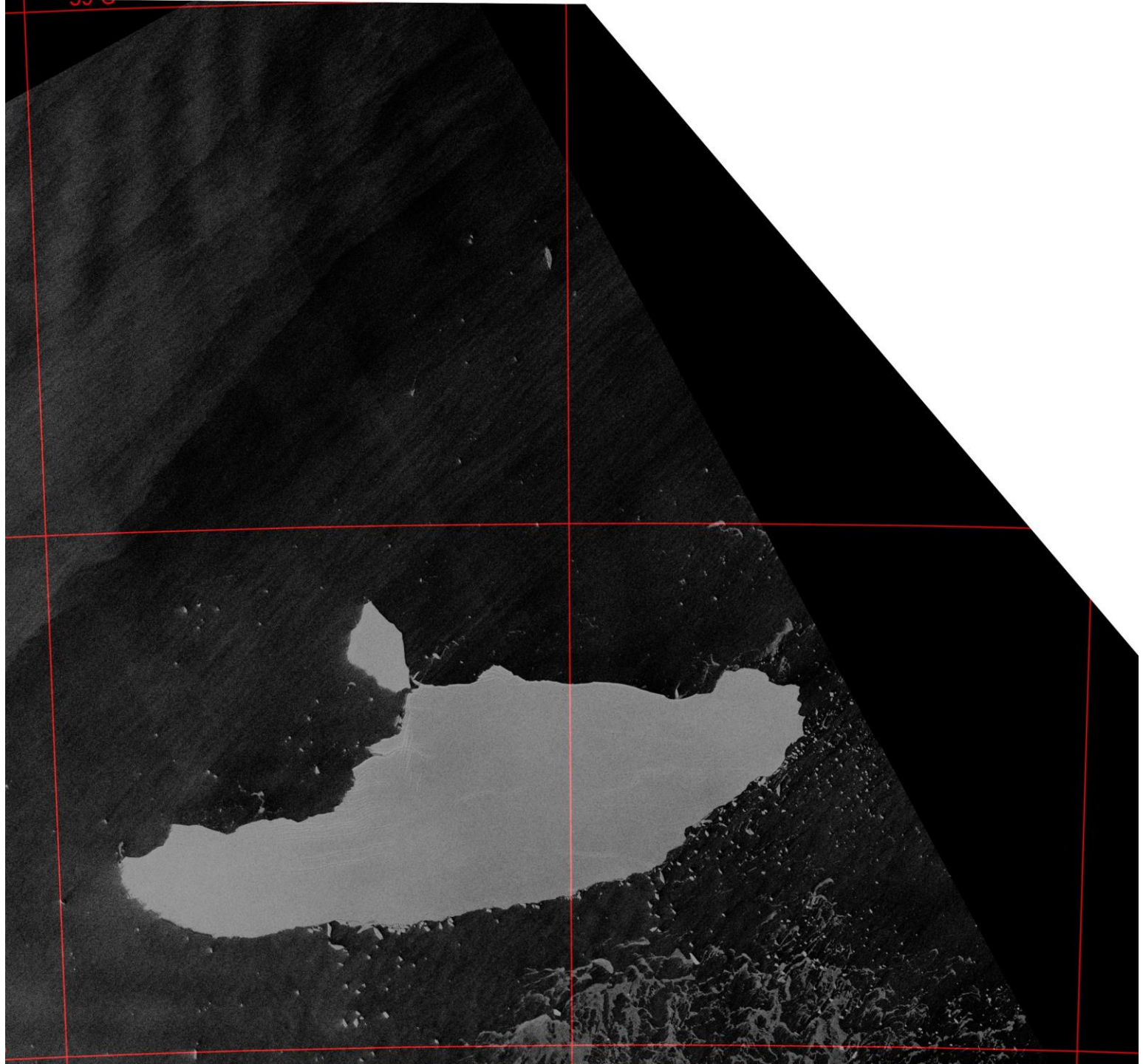

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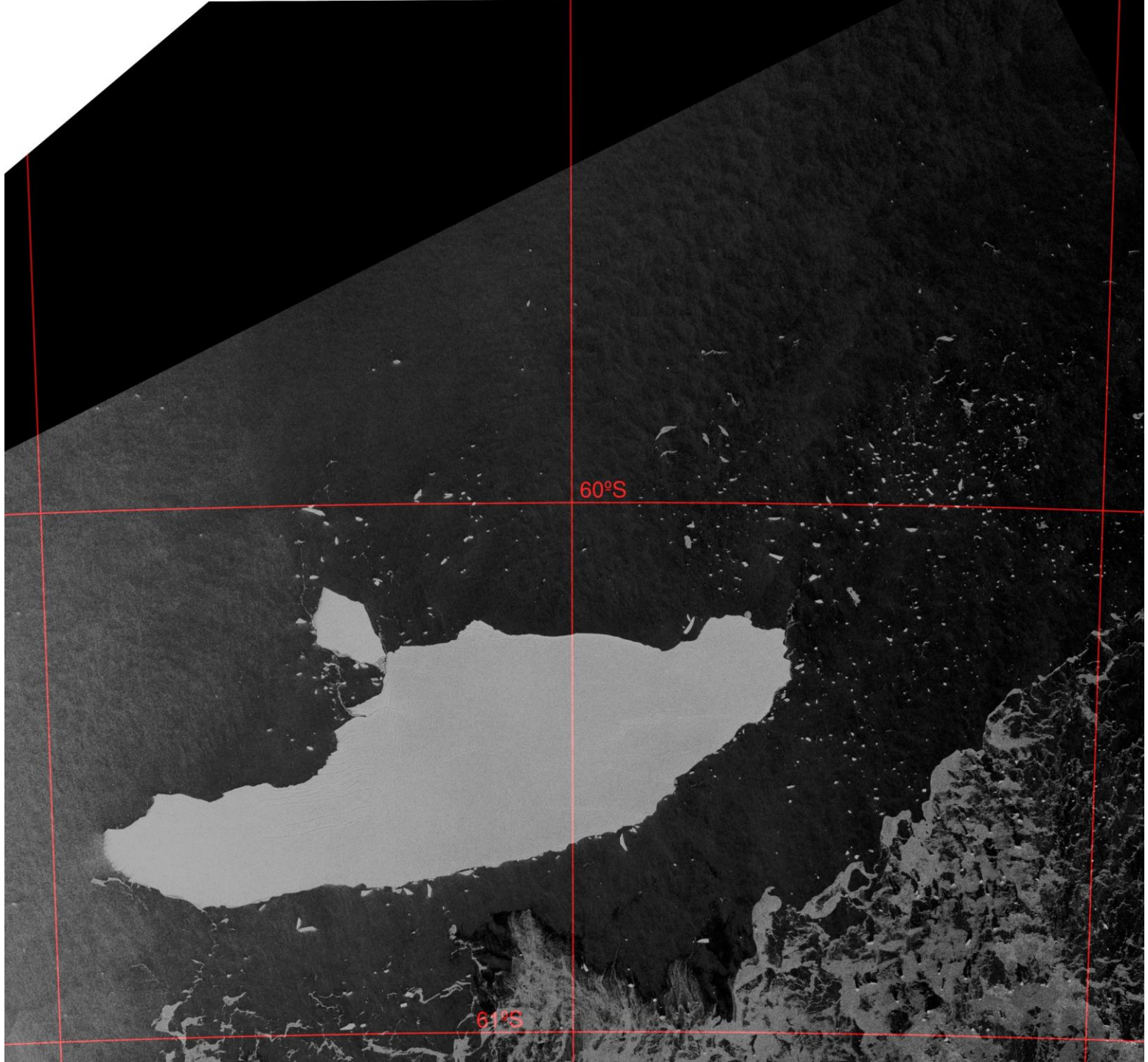

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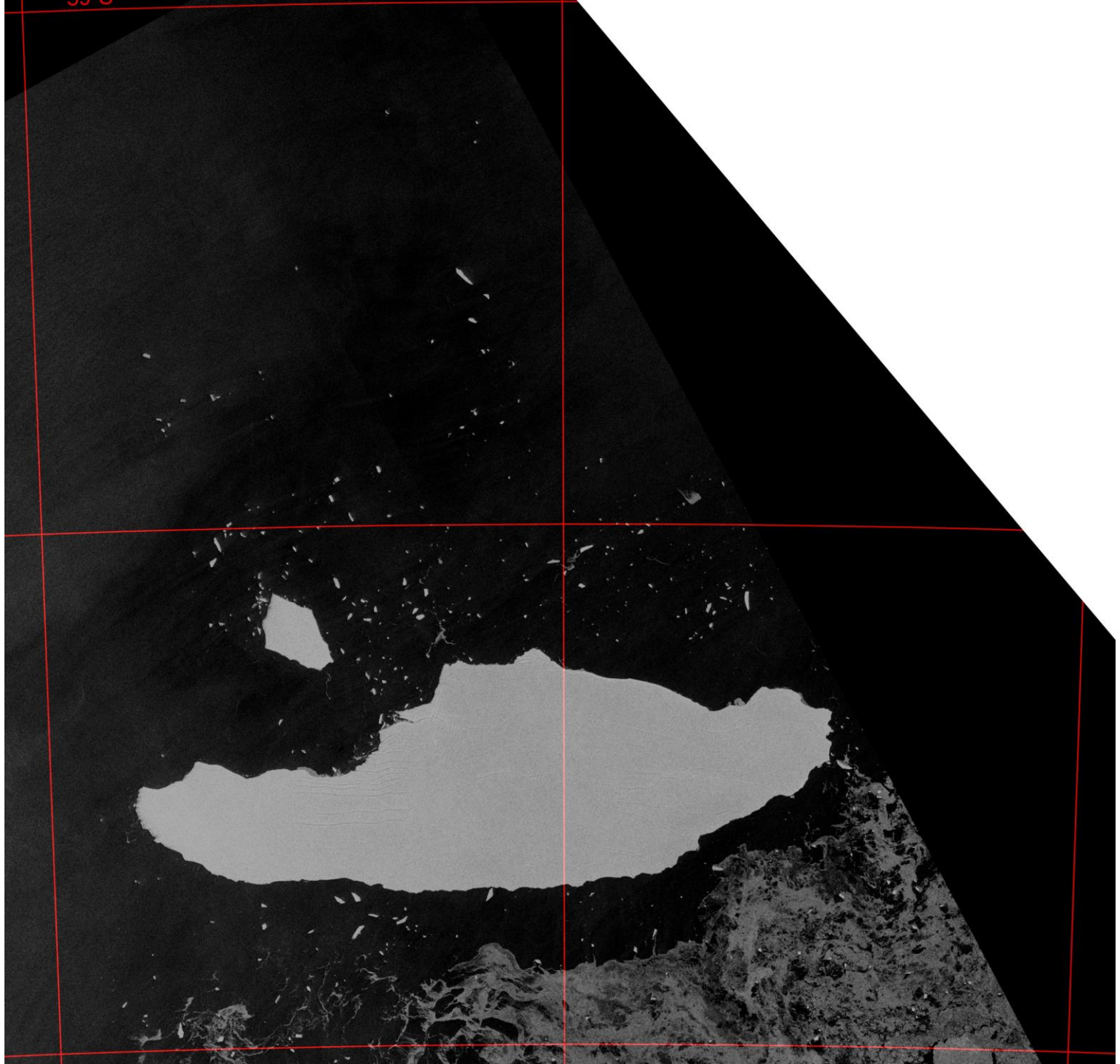

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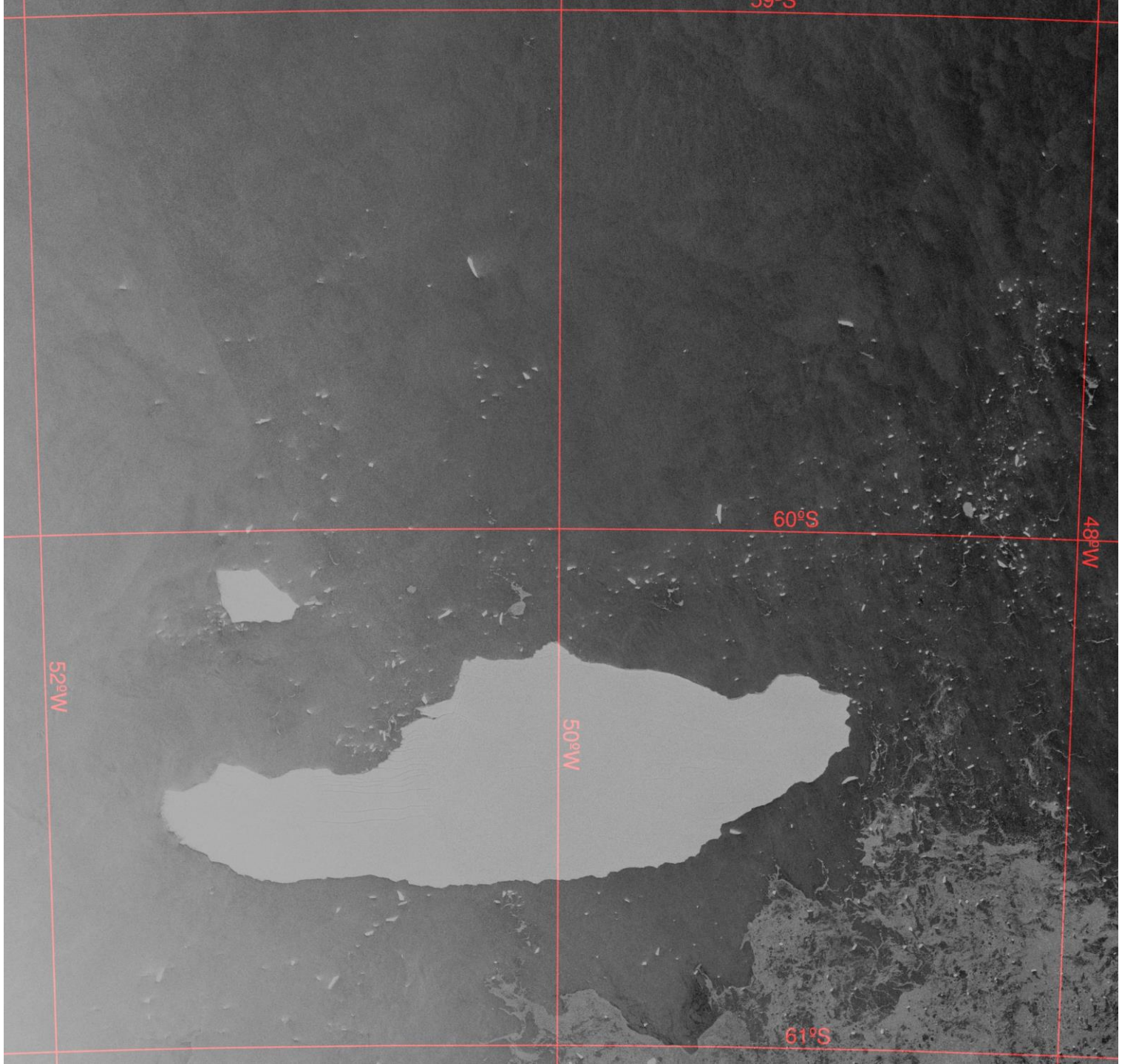

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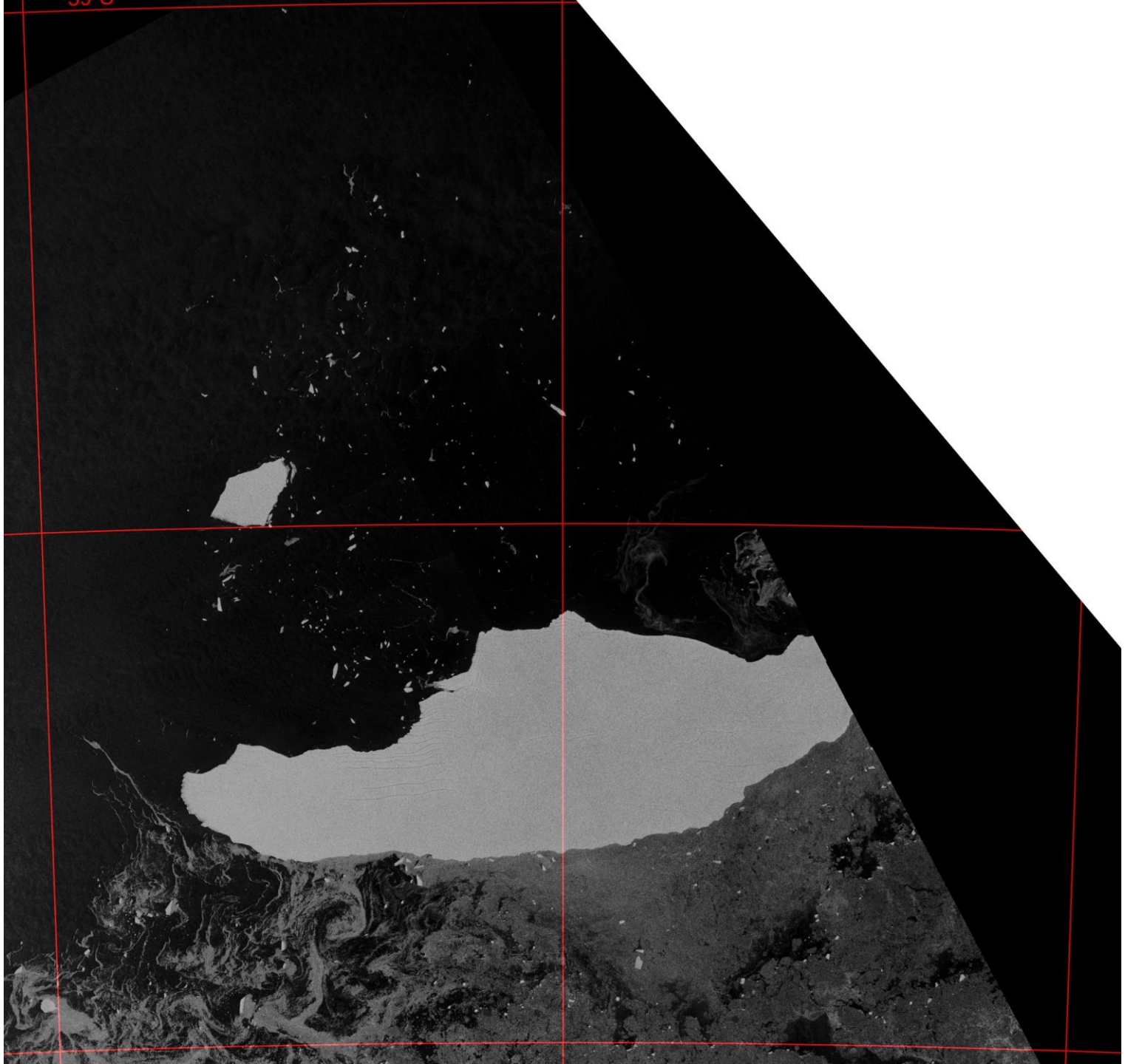
21.04.-15.05. nearly fixed position with some rotation



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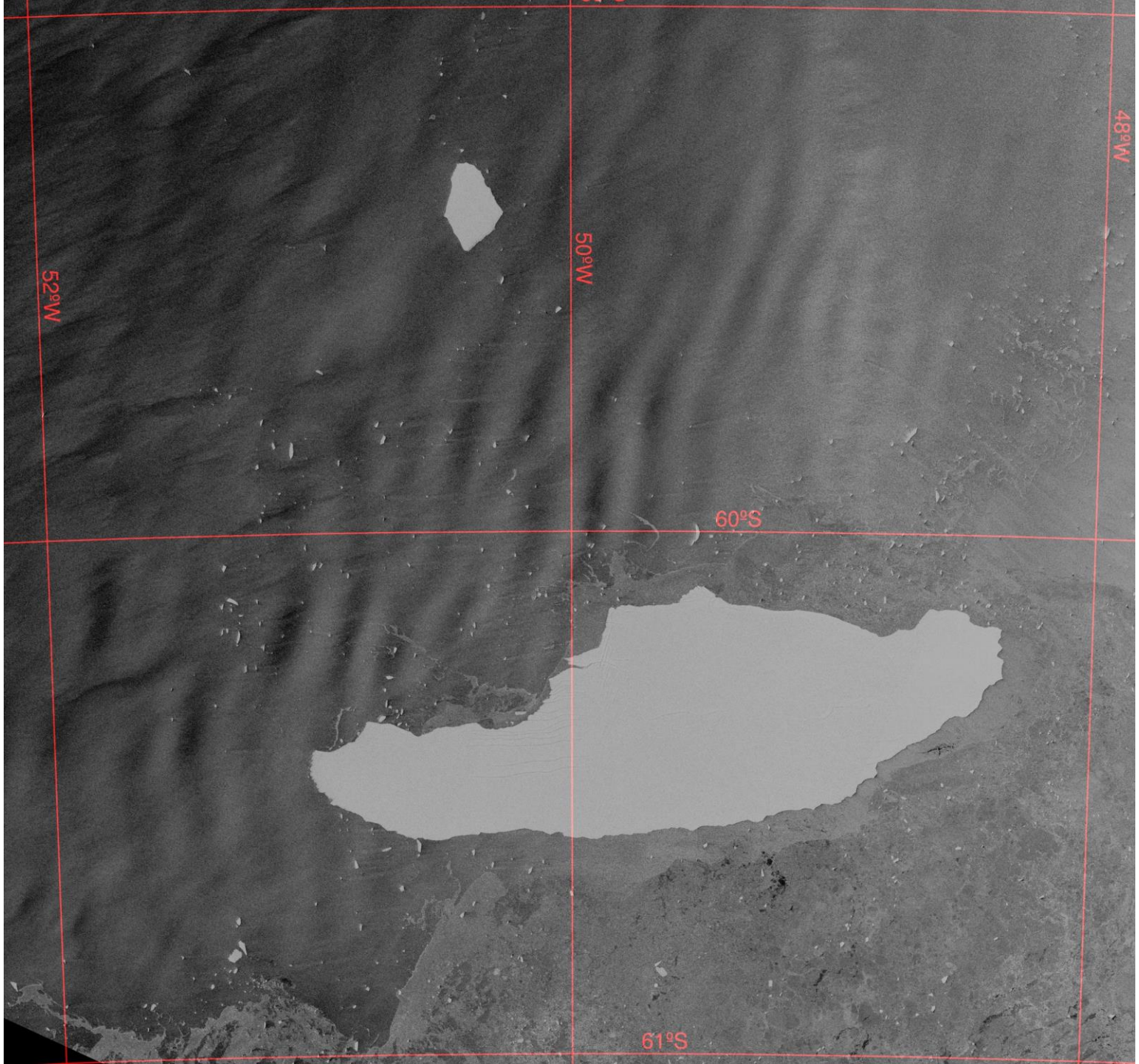

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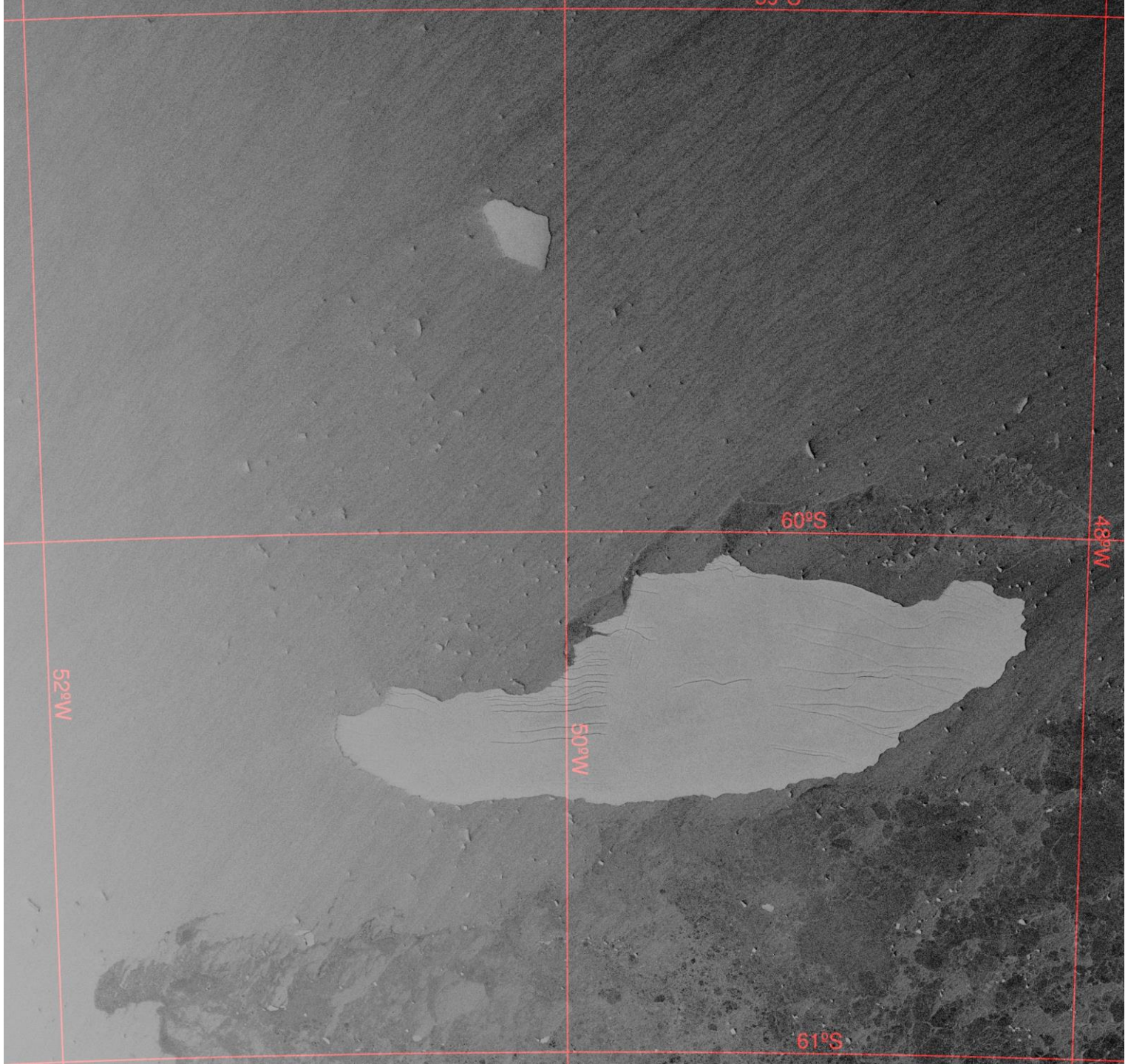

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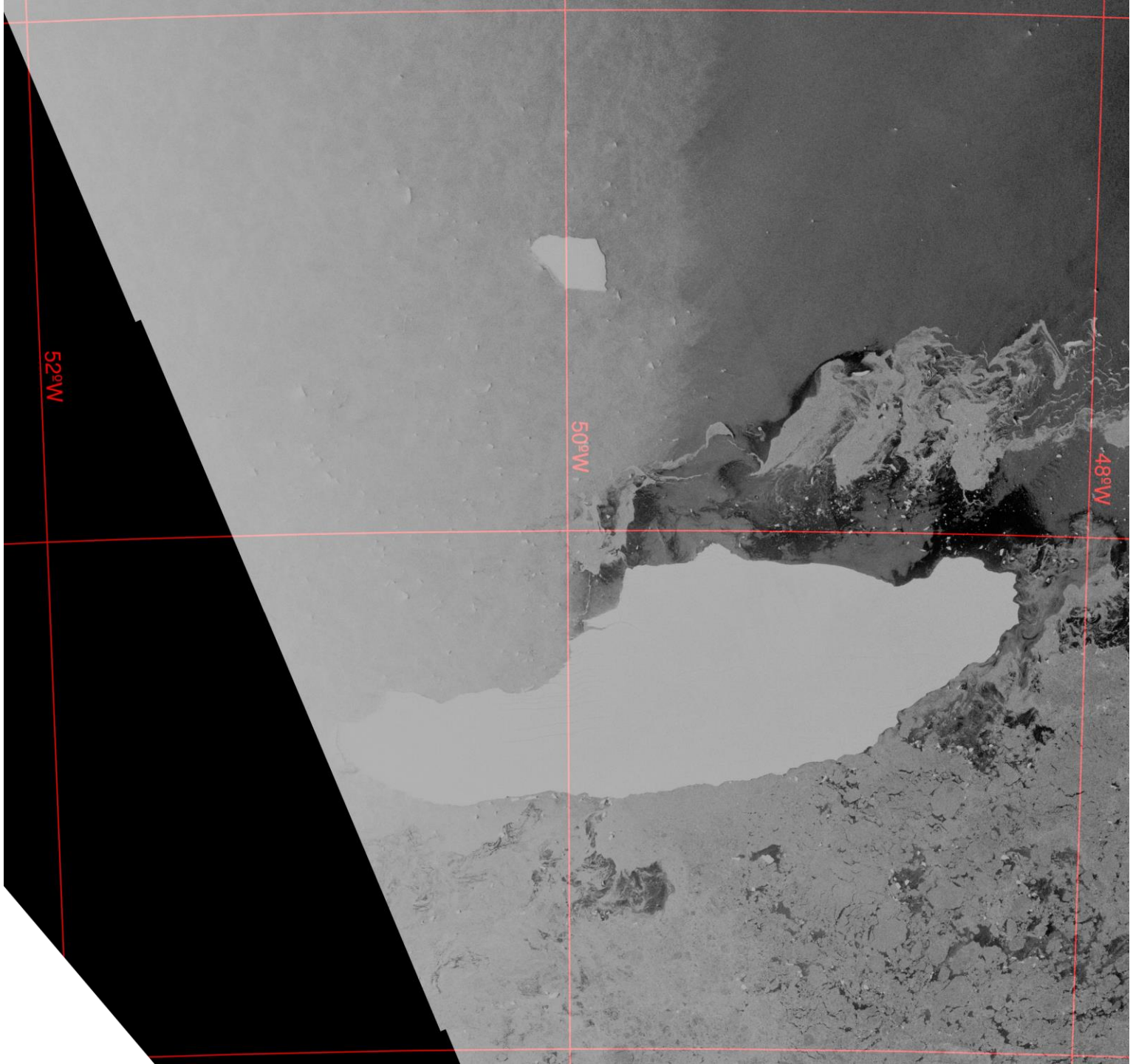

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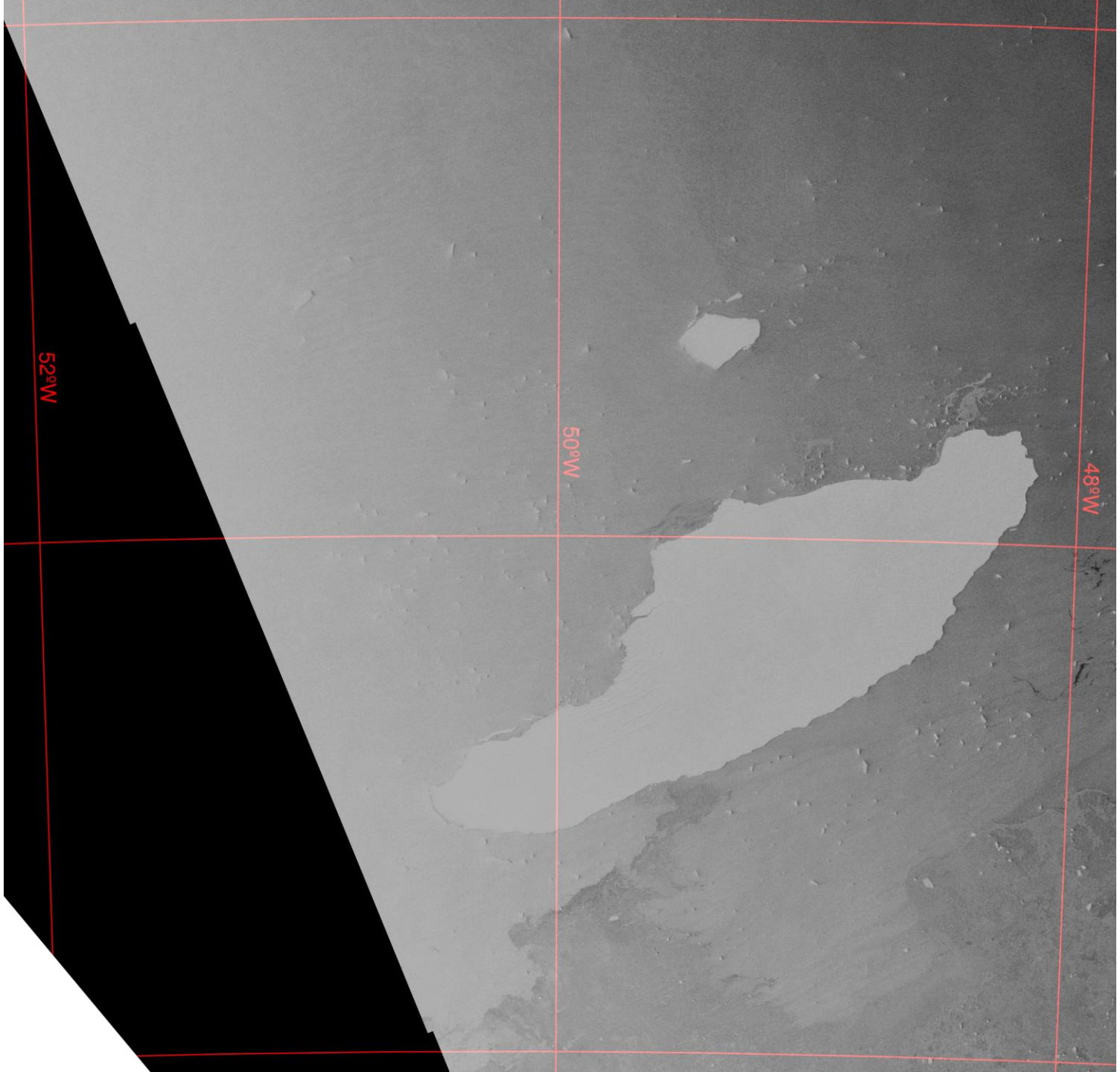

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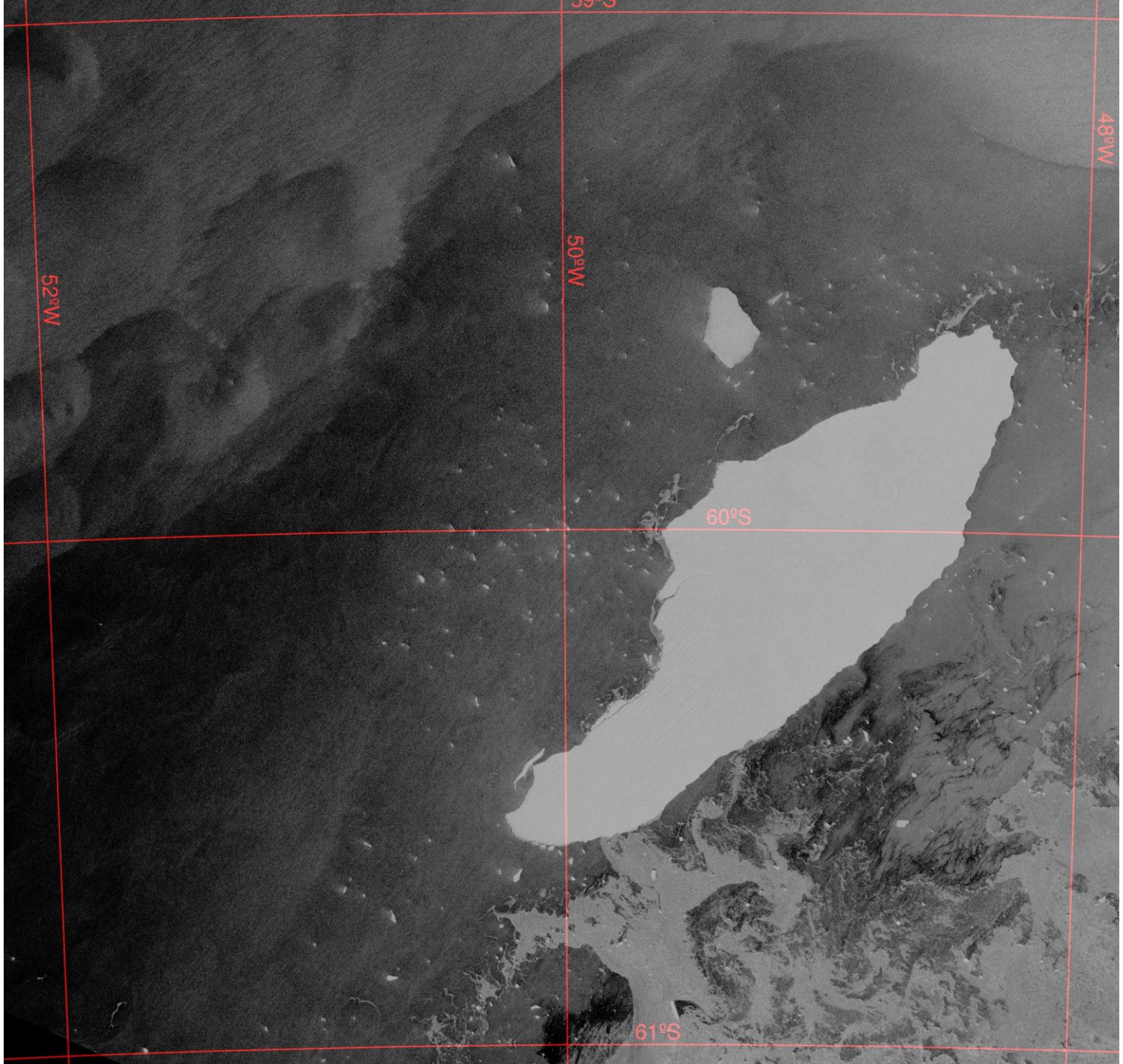

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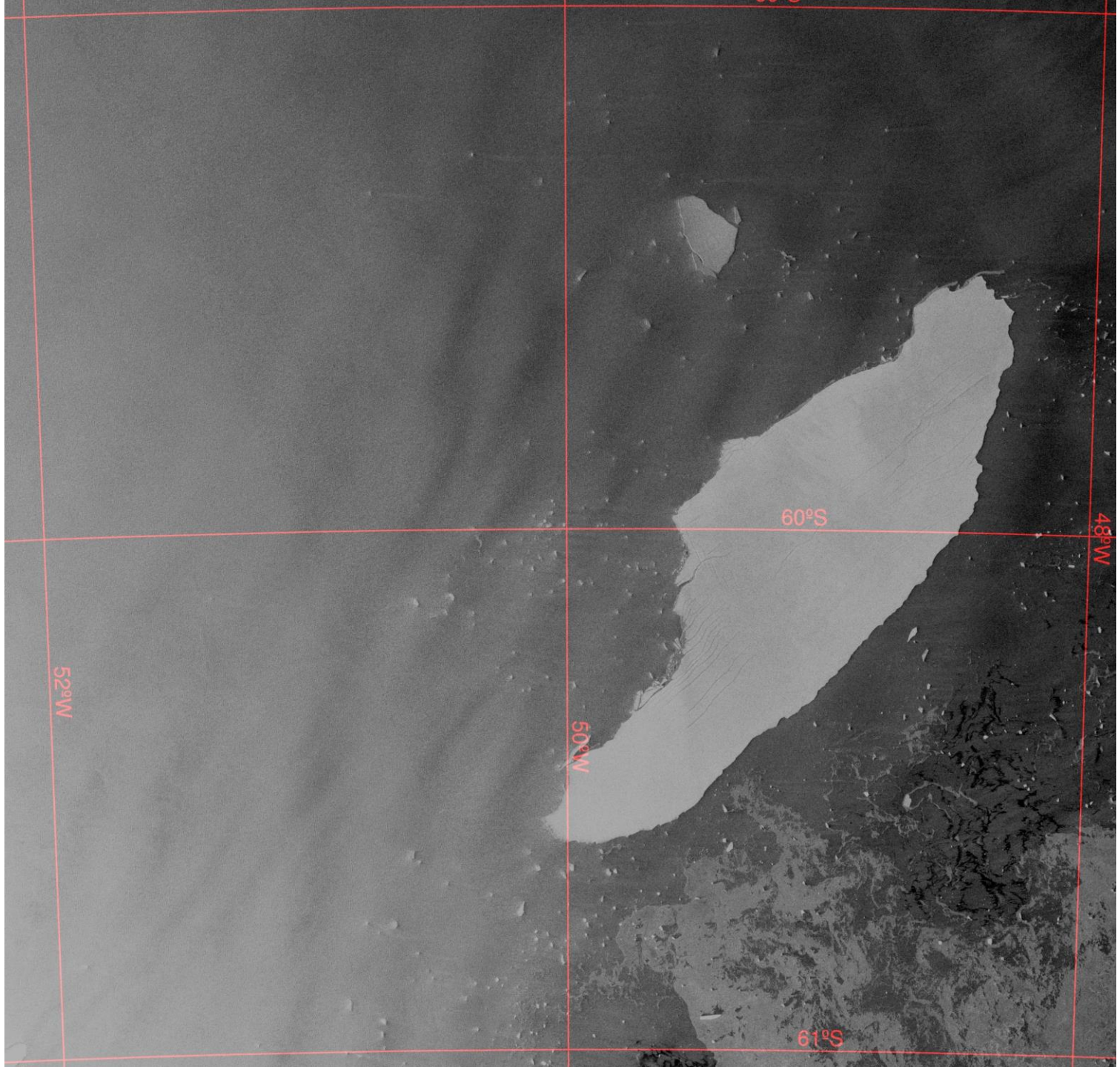

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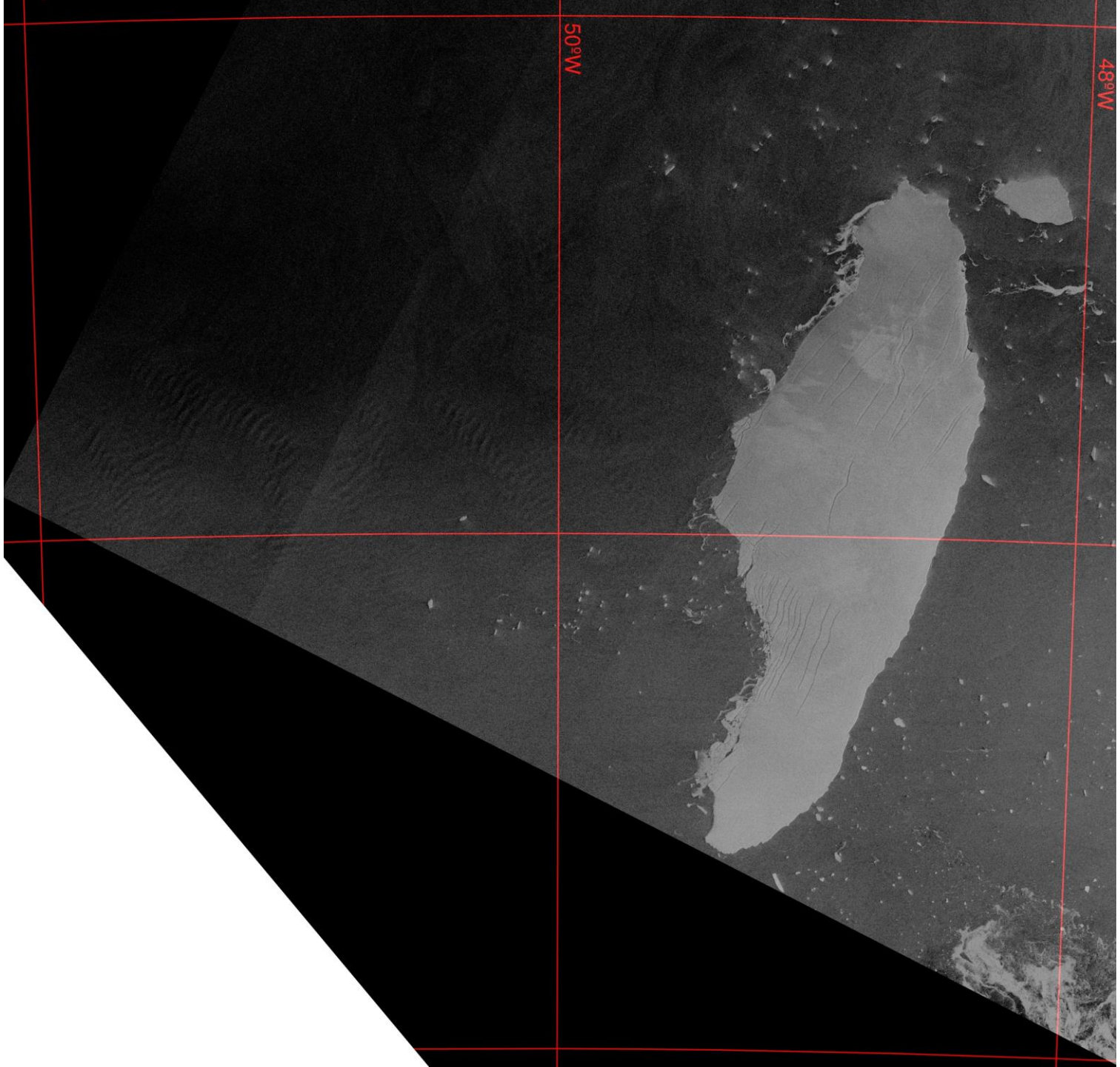

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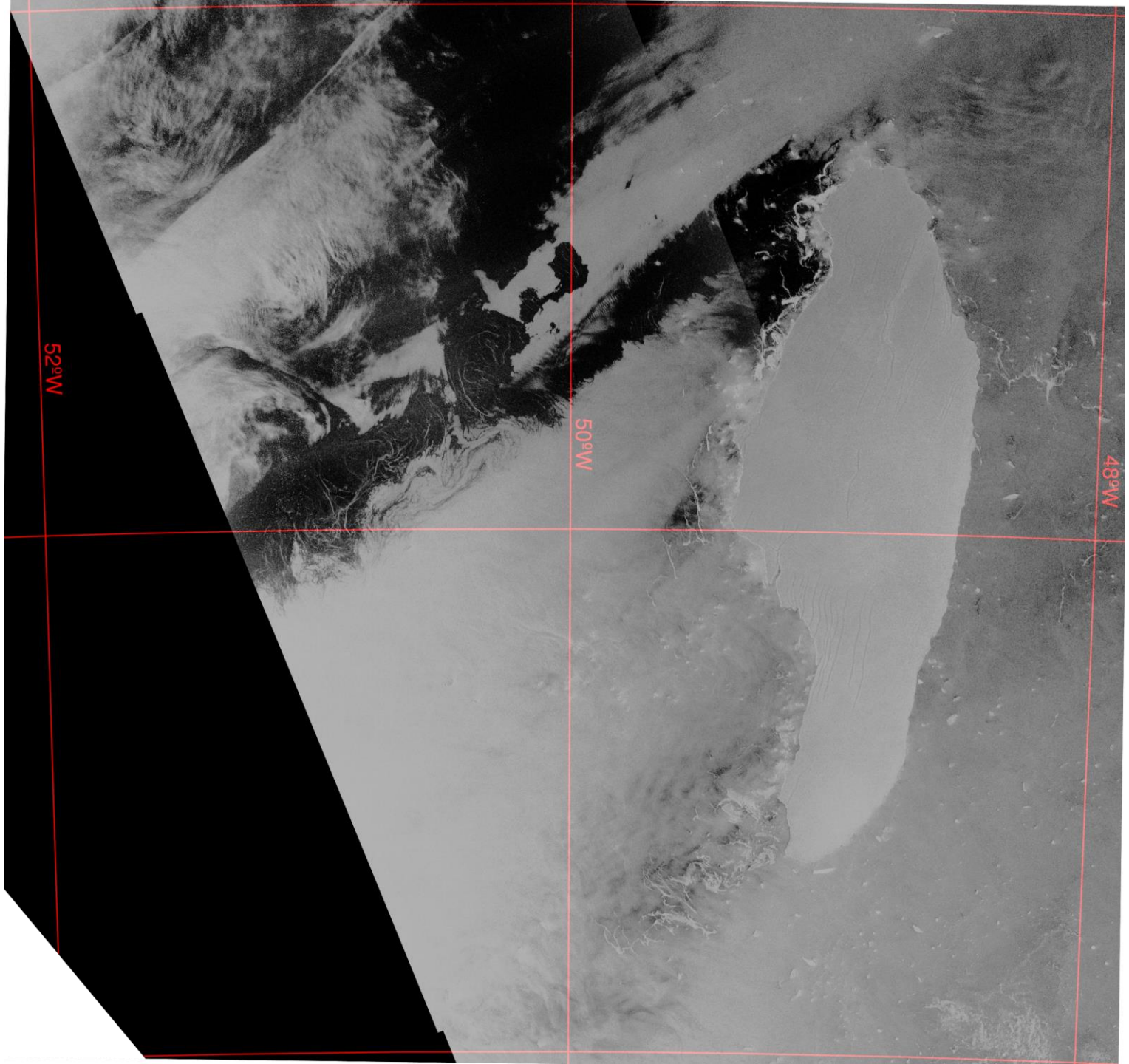

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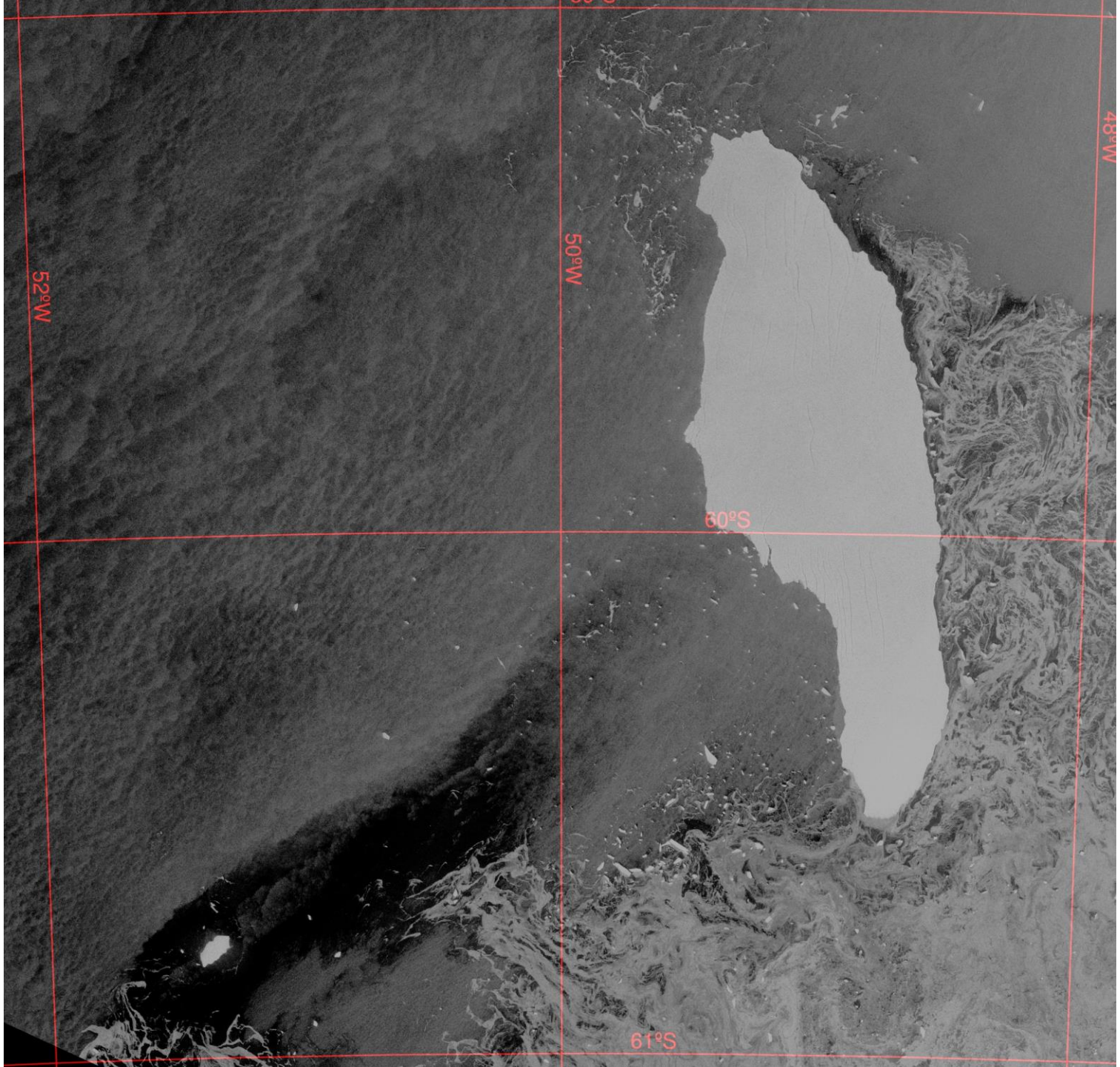

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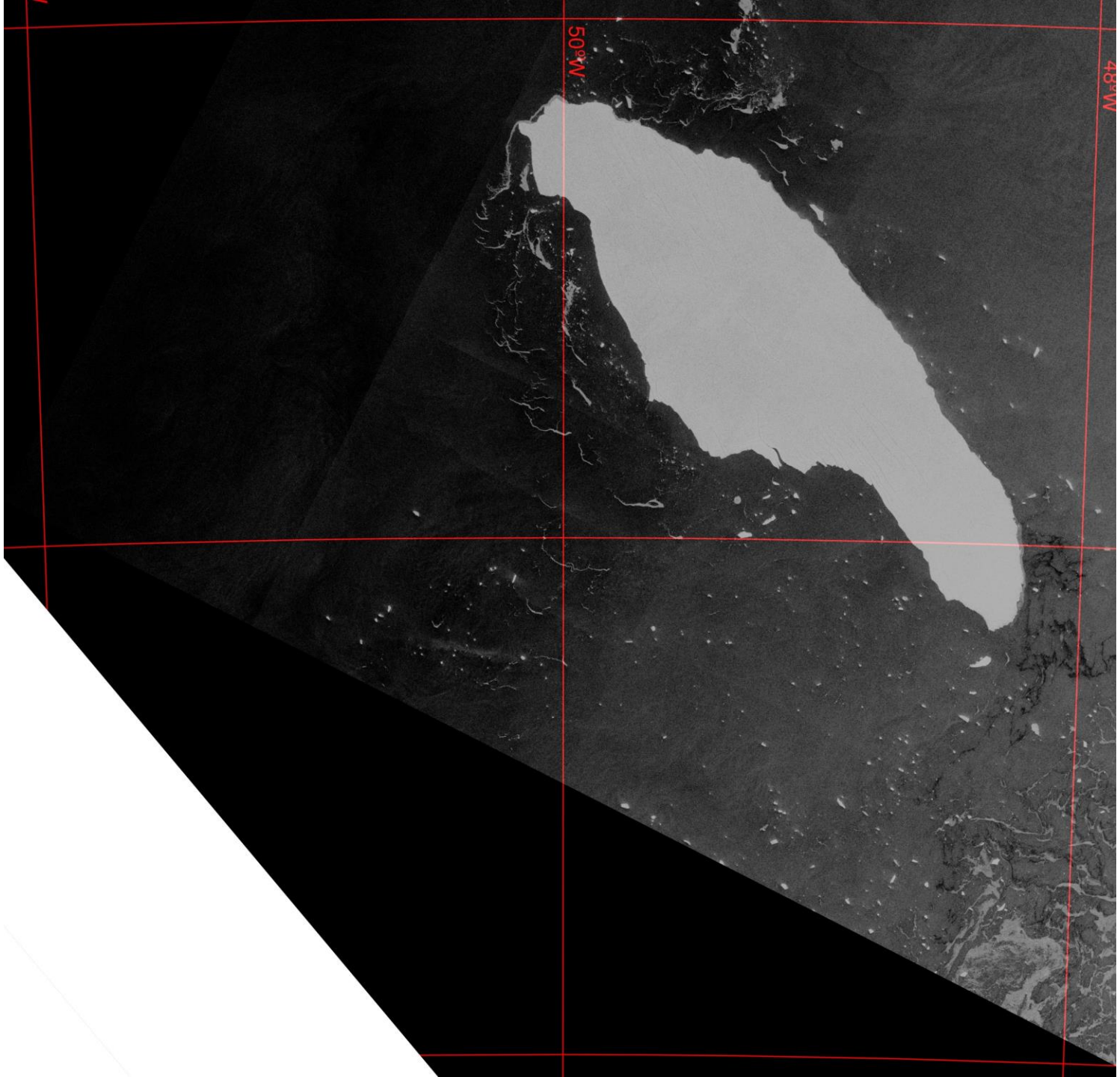

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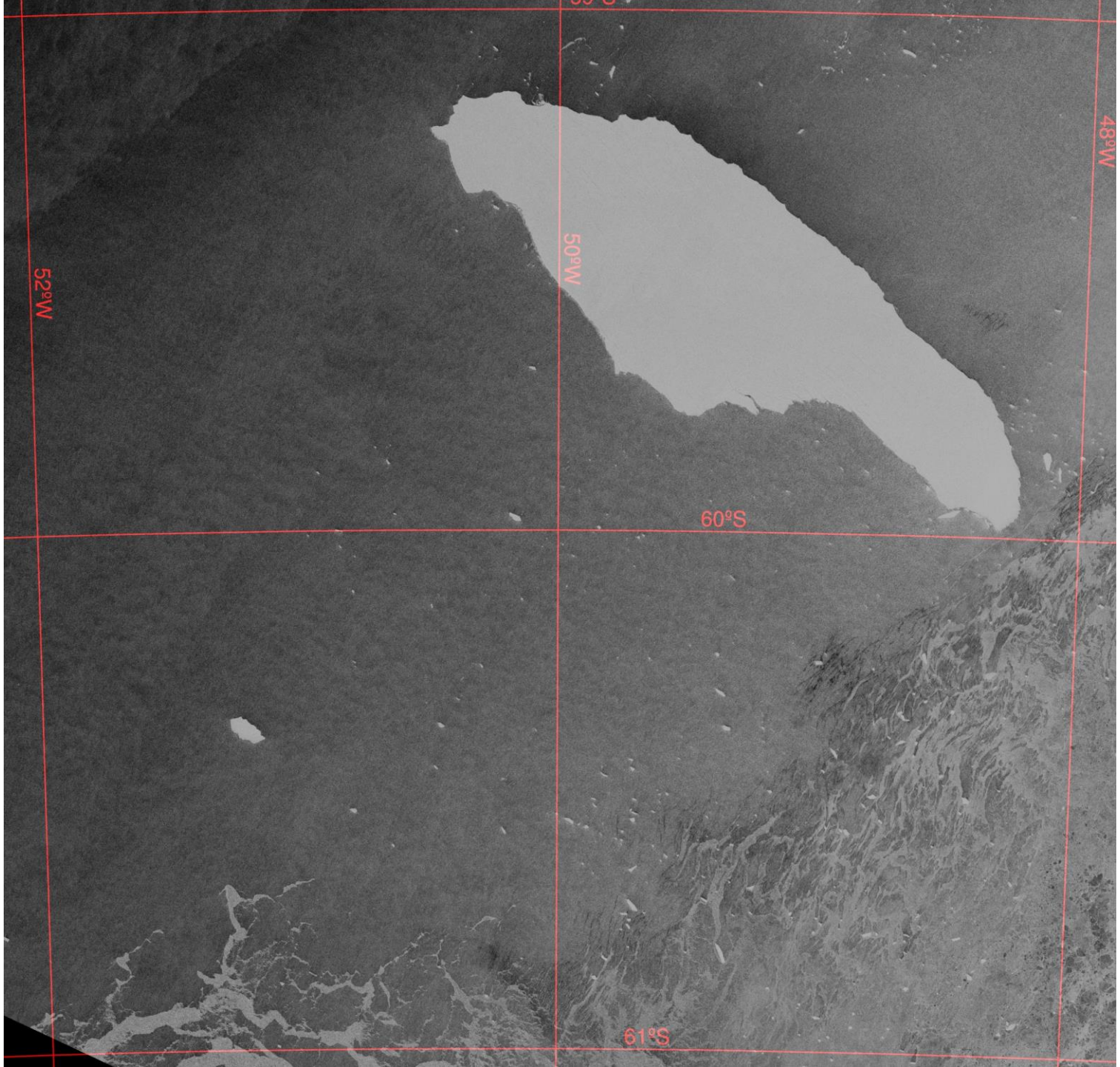

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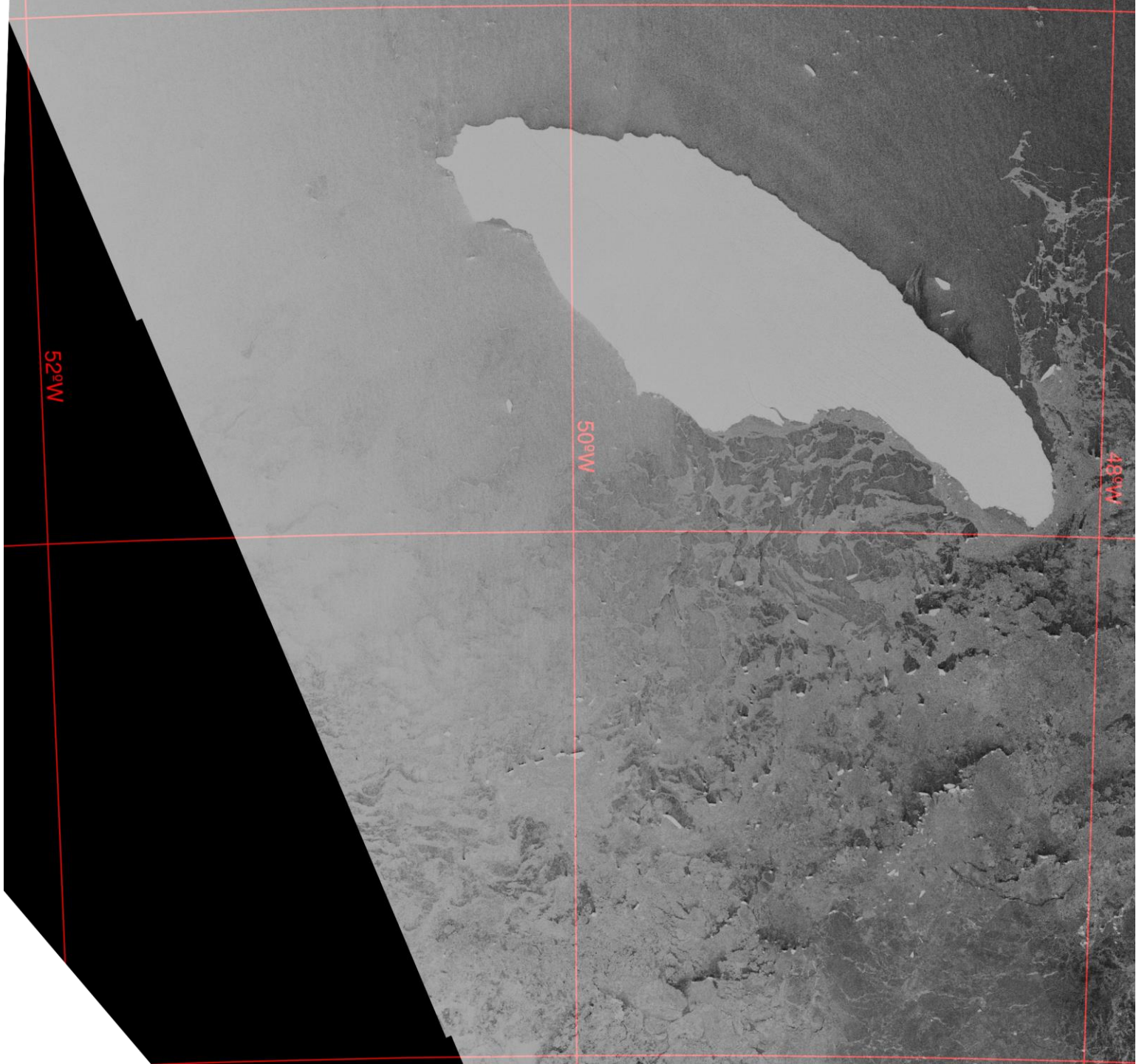

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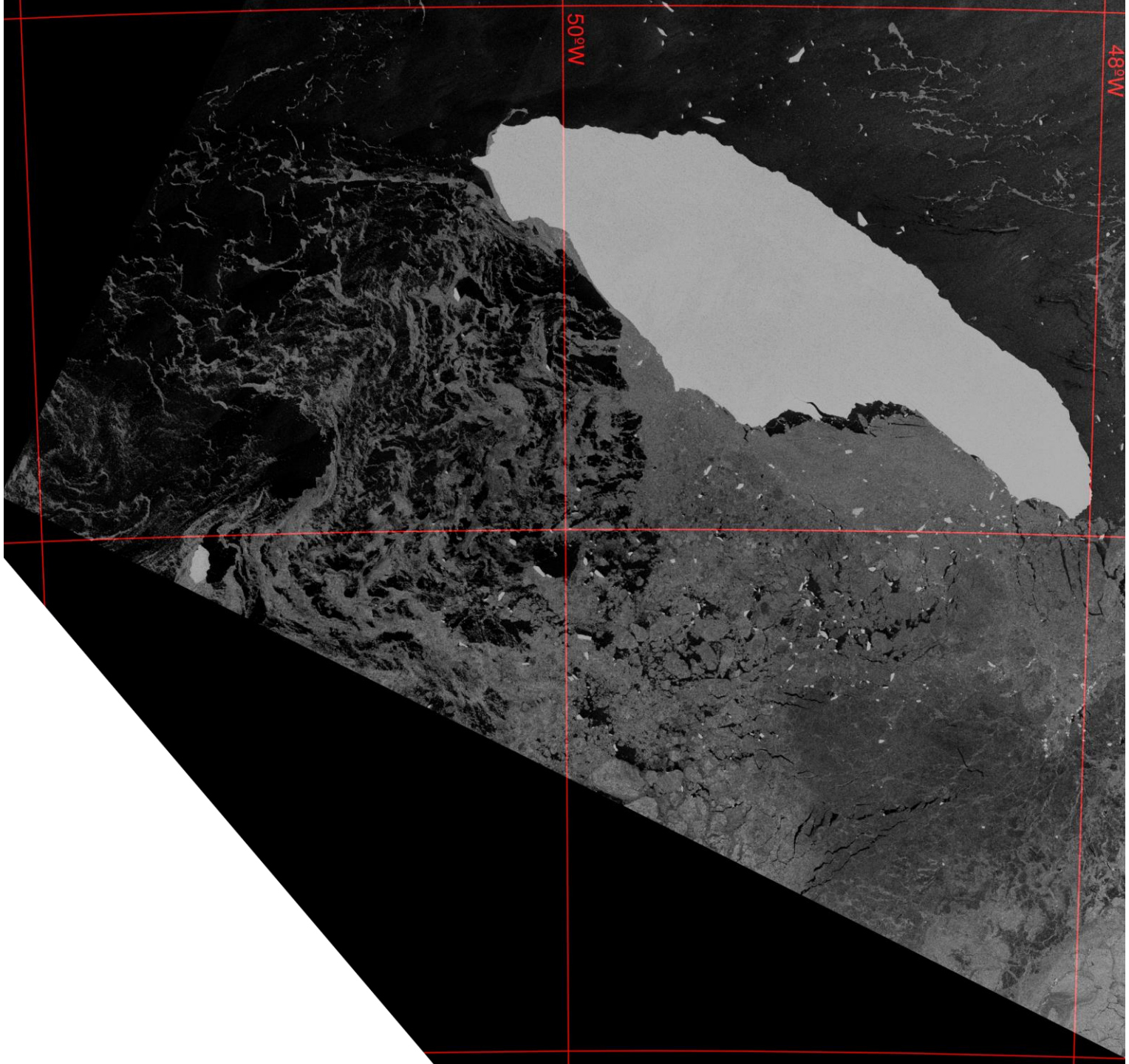

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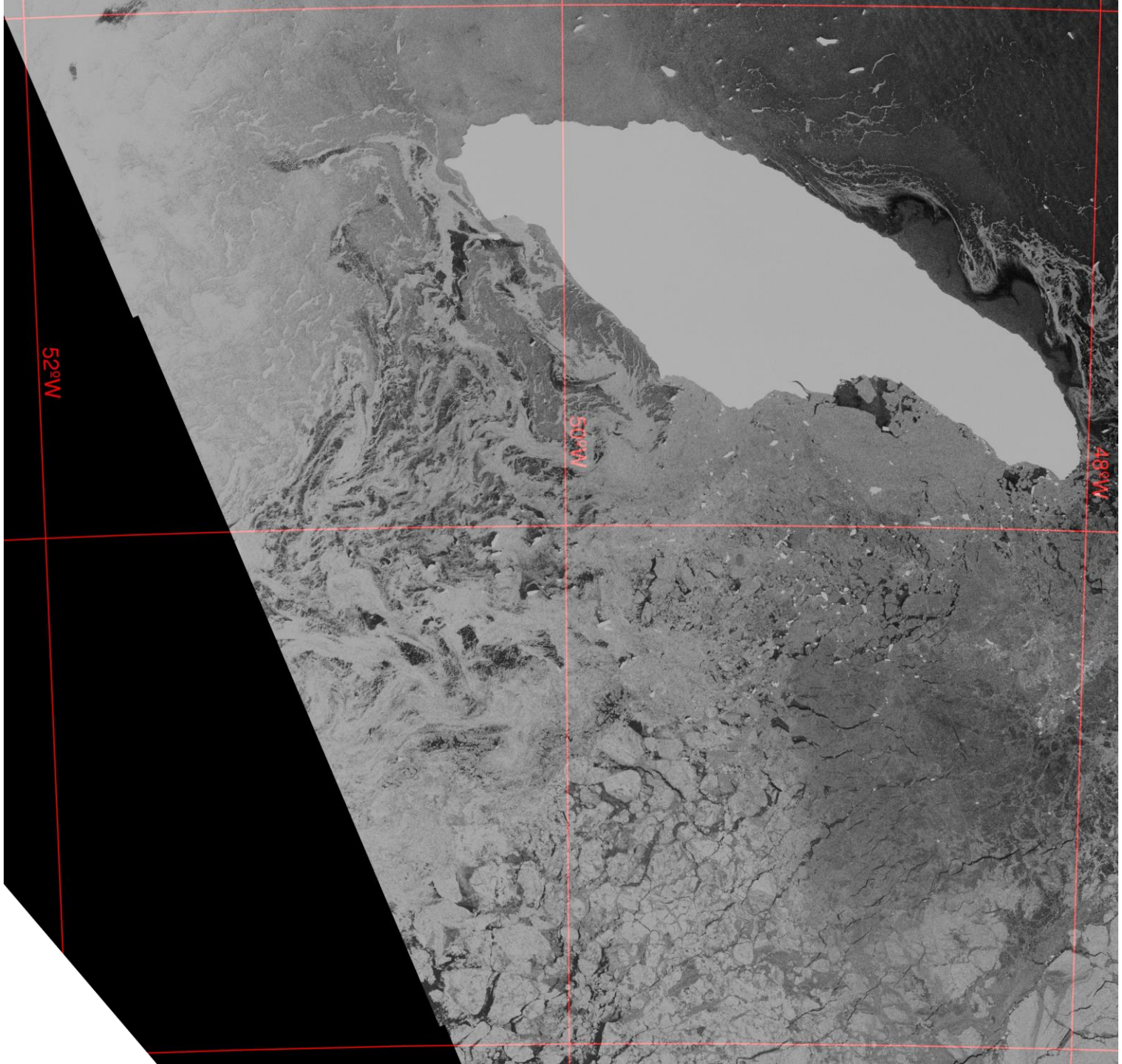

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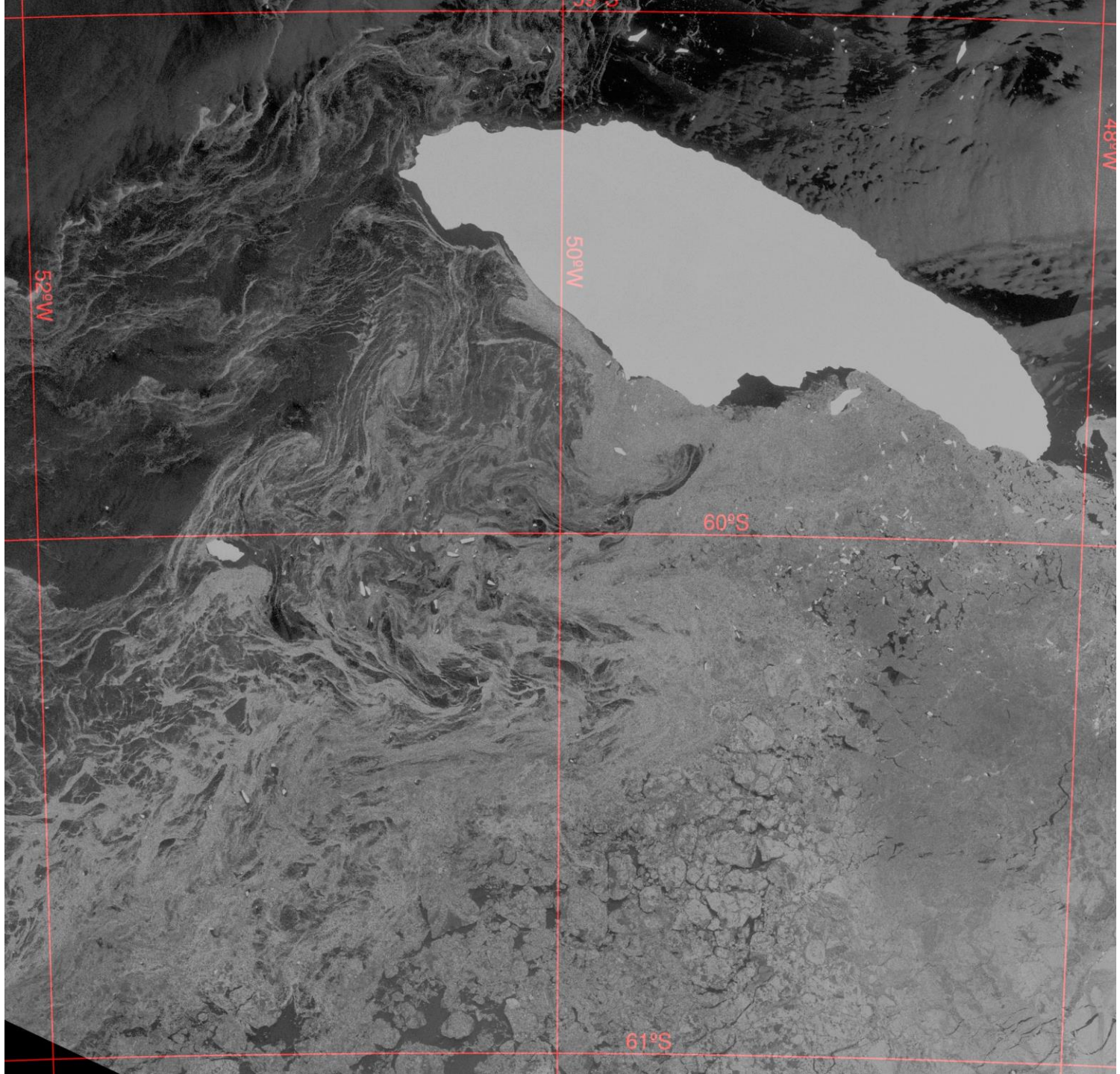

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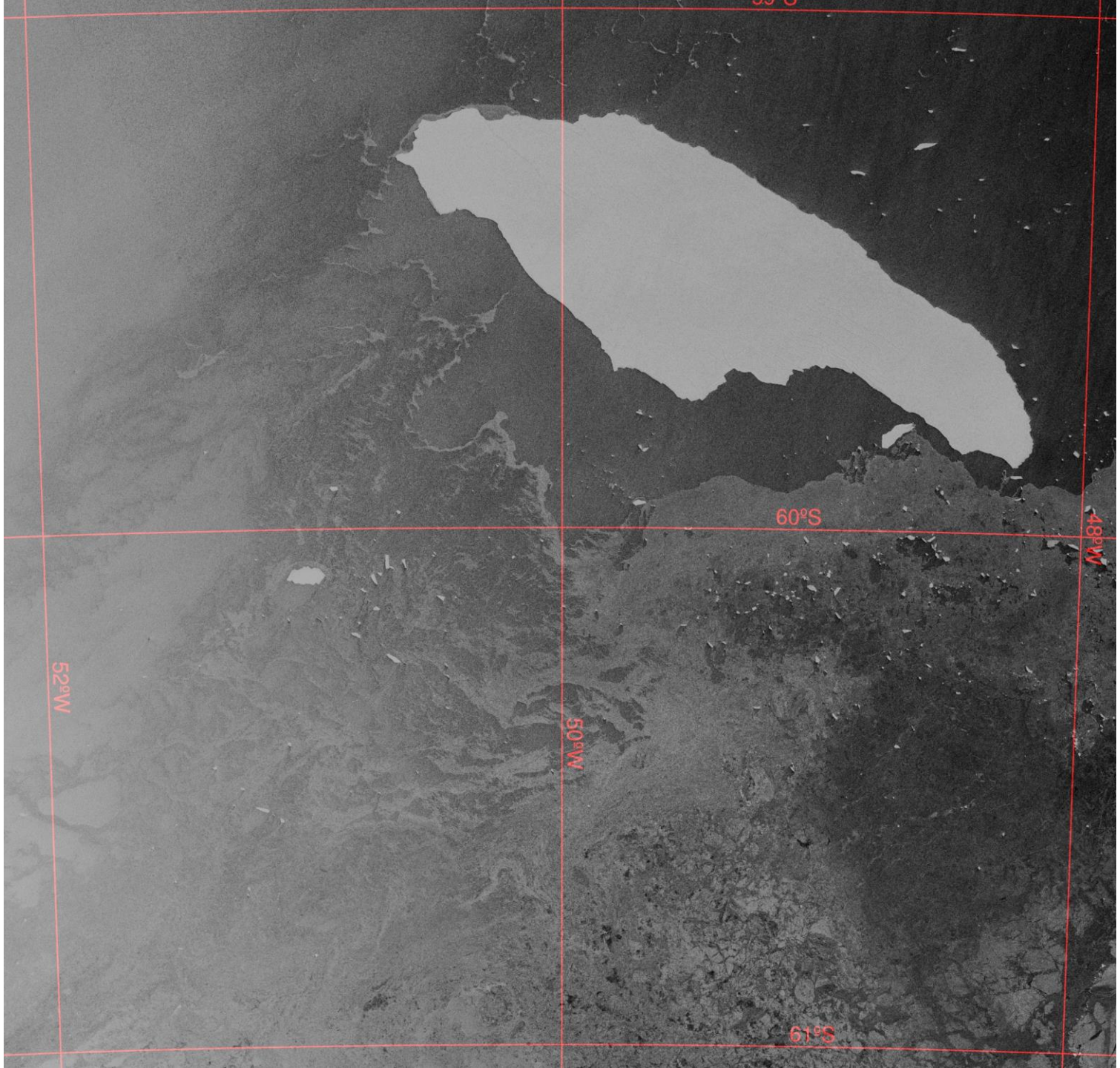

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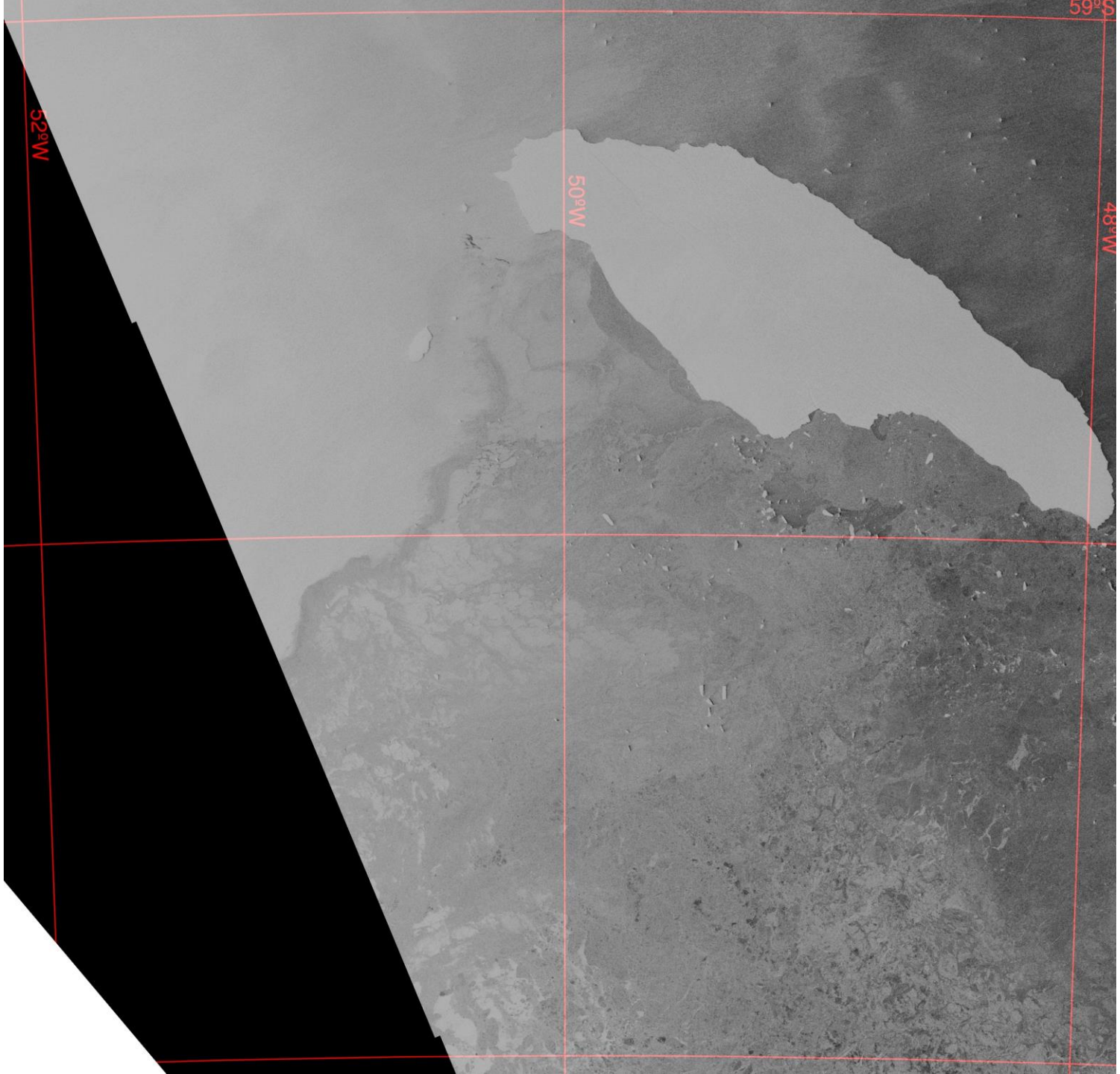

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ANNEX III

Tabular Iceberg A68a in Open Water
Drift Pattern, Rotation and Disintegration

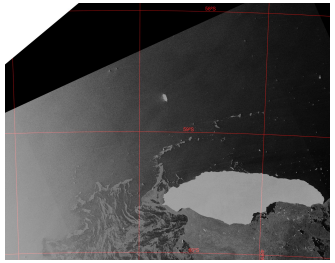
A documentation on the basis of Sentinel-1 SAR images
compiled by
Klaus Strübing, ex BSH/IICWG

as
Info Paper
for the
21st MEETING OF THE INTERNATIONAL ICE CHARTING WORKING GROUP
Videoconference - September 21-25, 2020
Sessions 1, 4 and 5

Großensee, Germany – October 03, 2020

Time series of 18 Sentinel-1 SAR images*

for the period July 22 to October 01, 2020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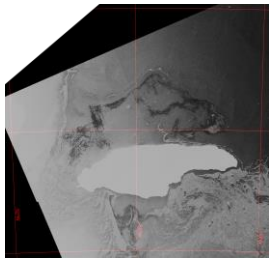
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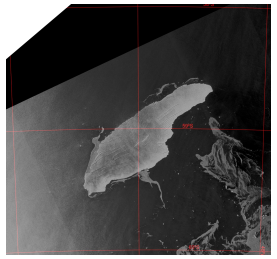
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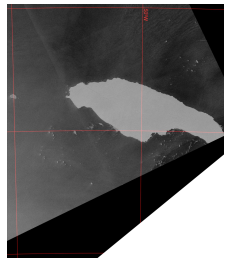
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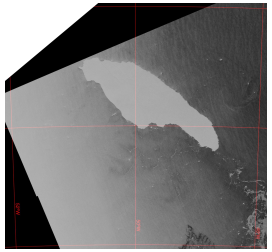
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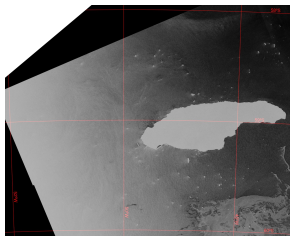
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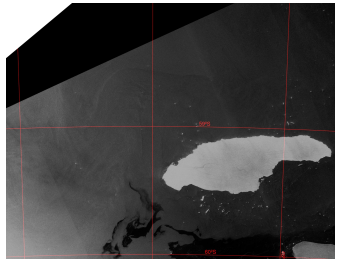
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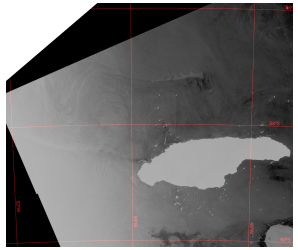
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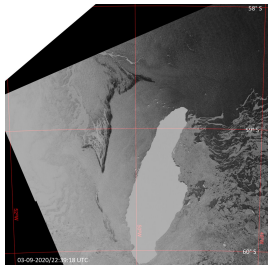
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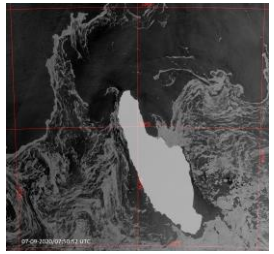
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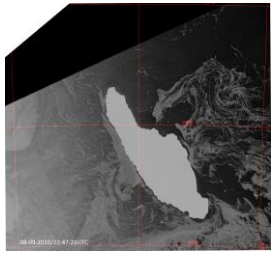
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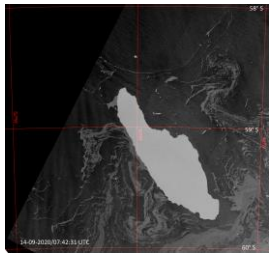
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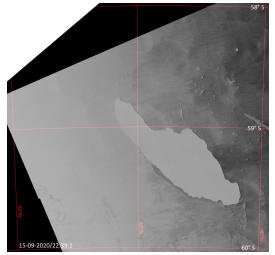
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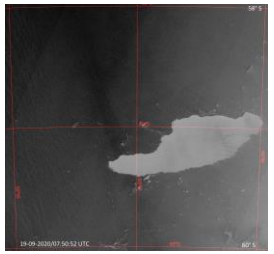
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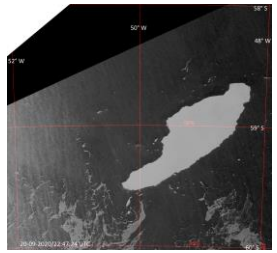
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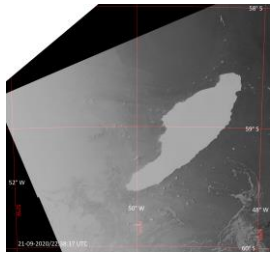
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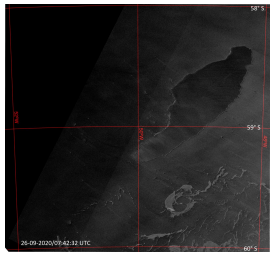
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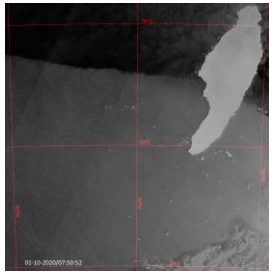
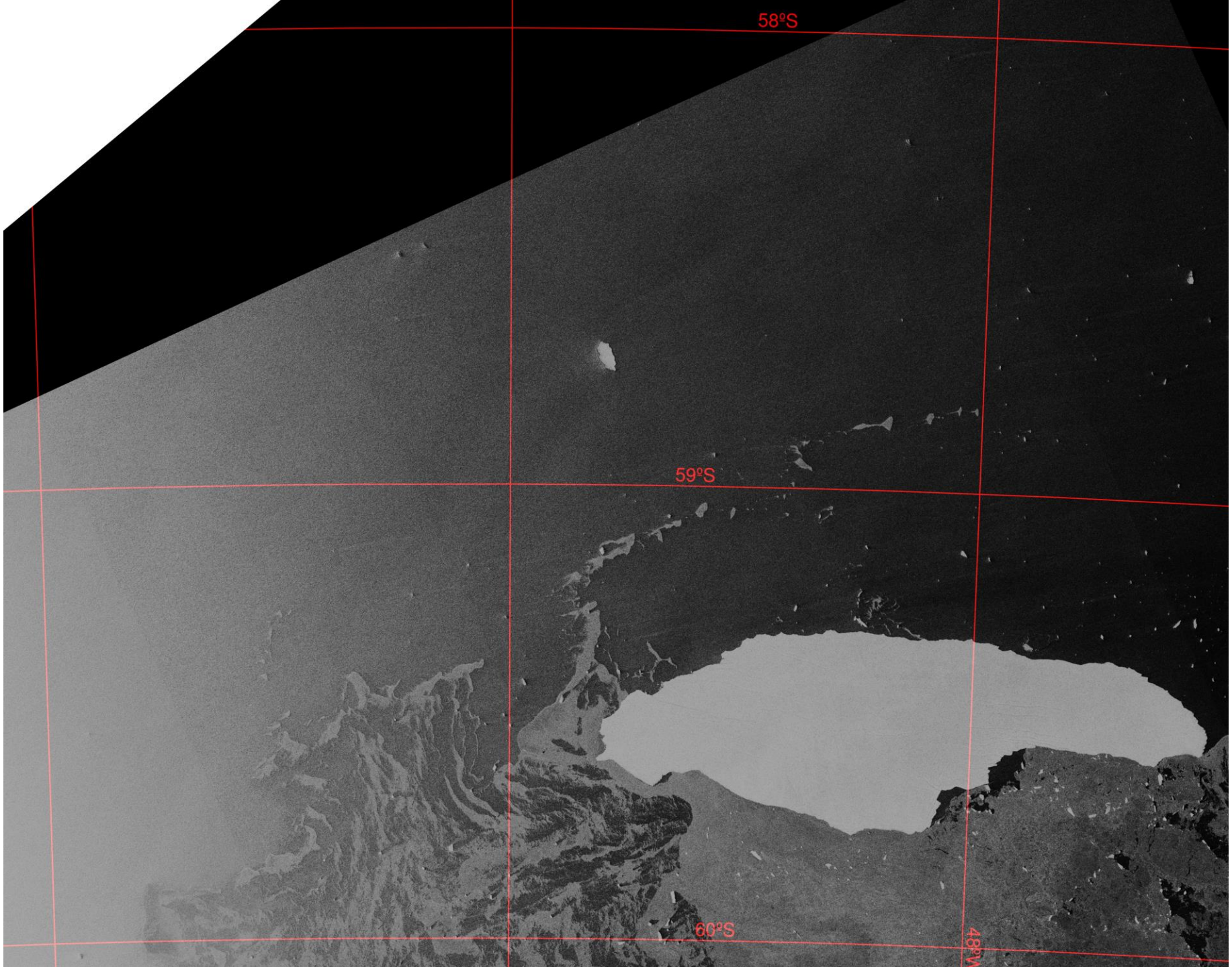

01-10-2020

*sections with centre point on about 59° S and 50° W, degree squares 58 to 60 S , 48 to 52 W



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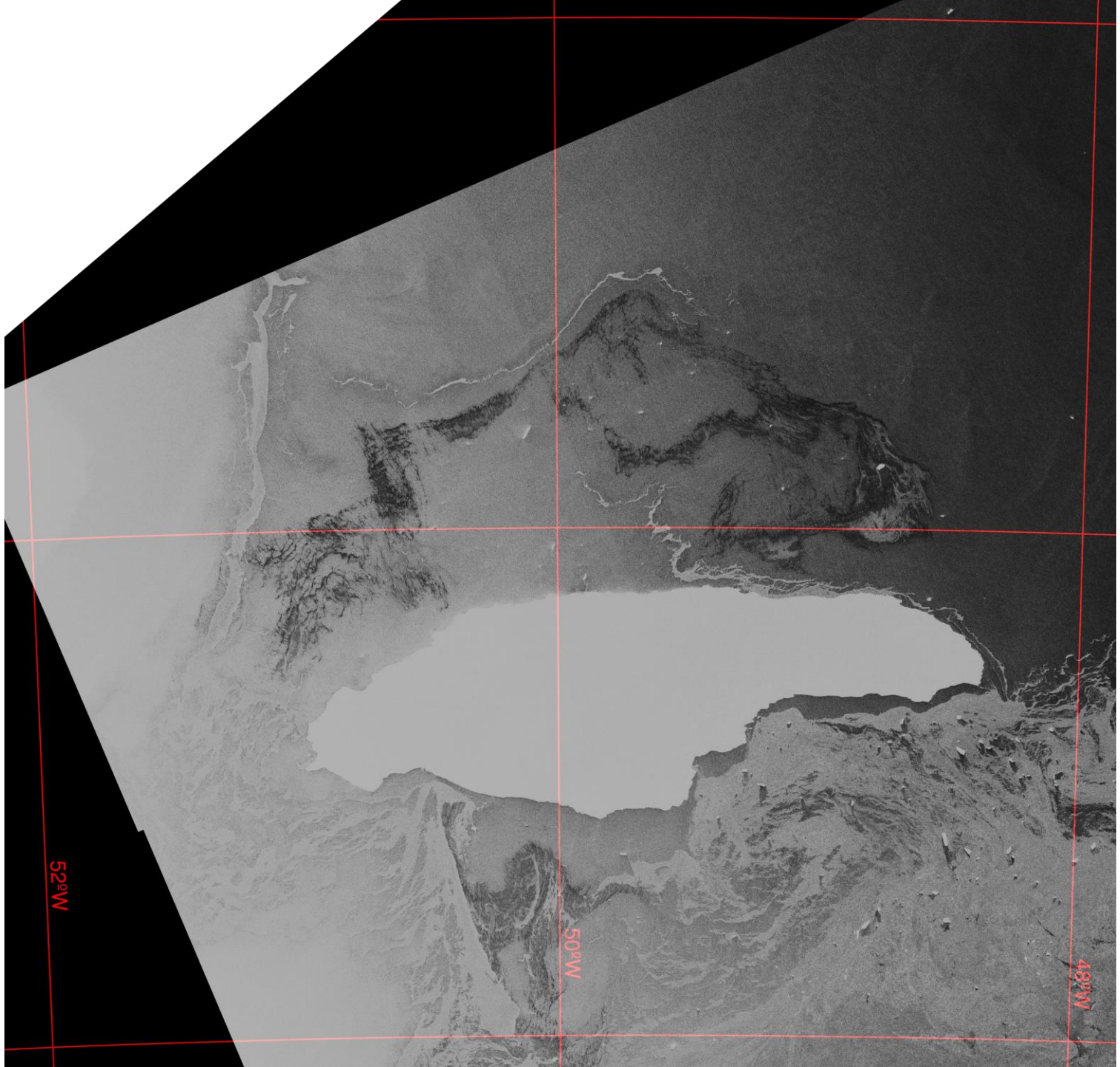

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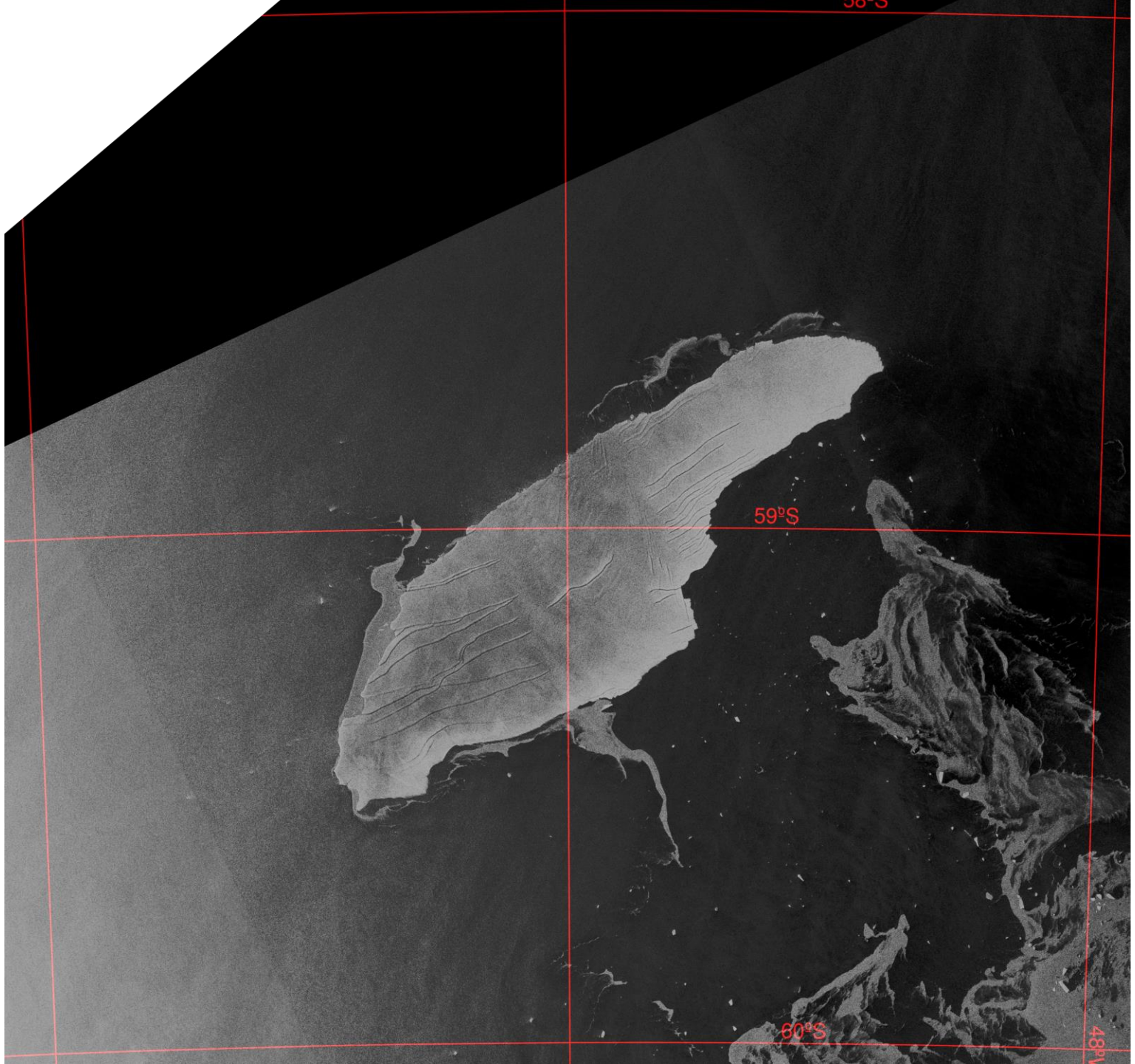

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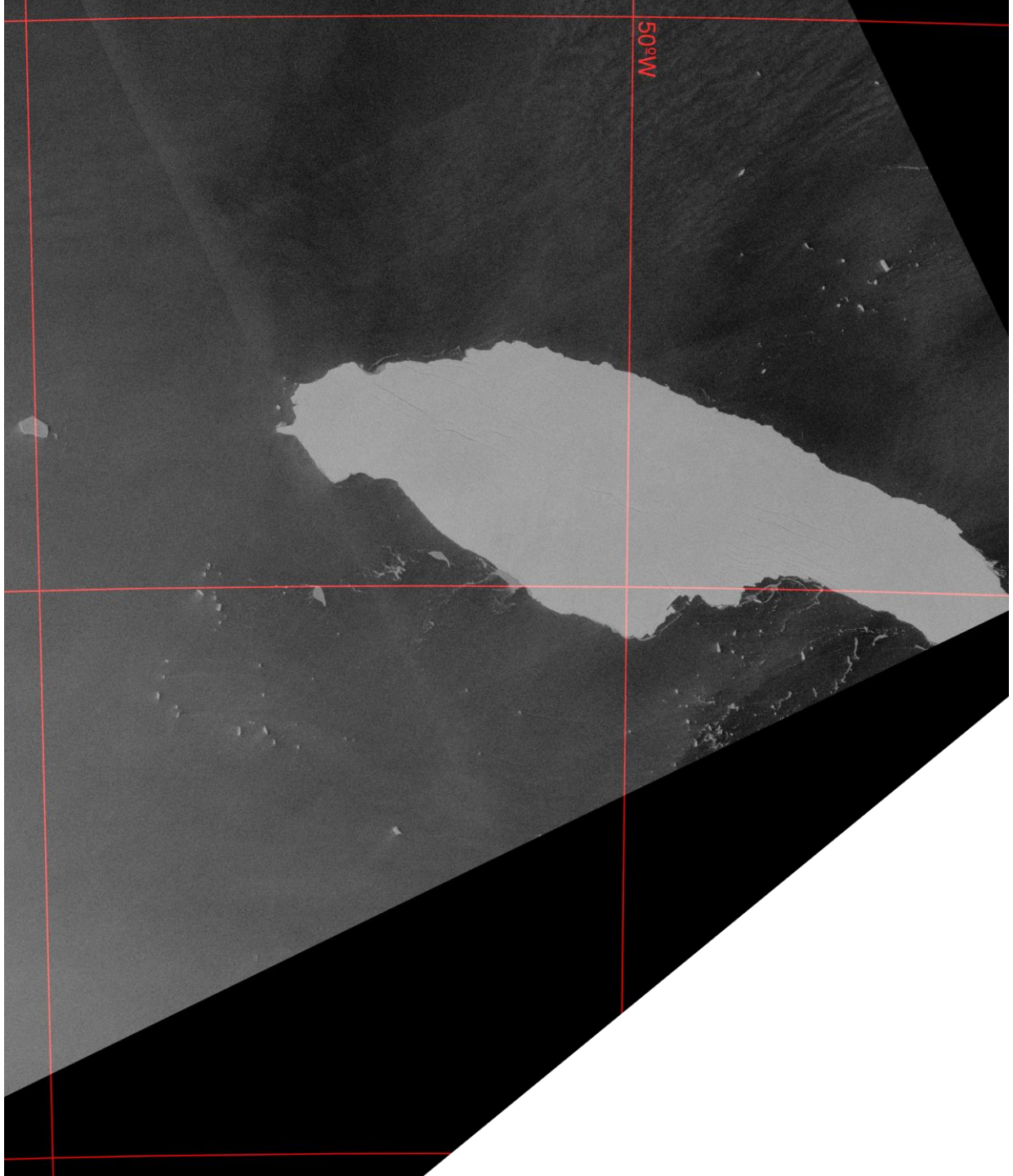

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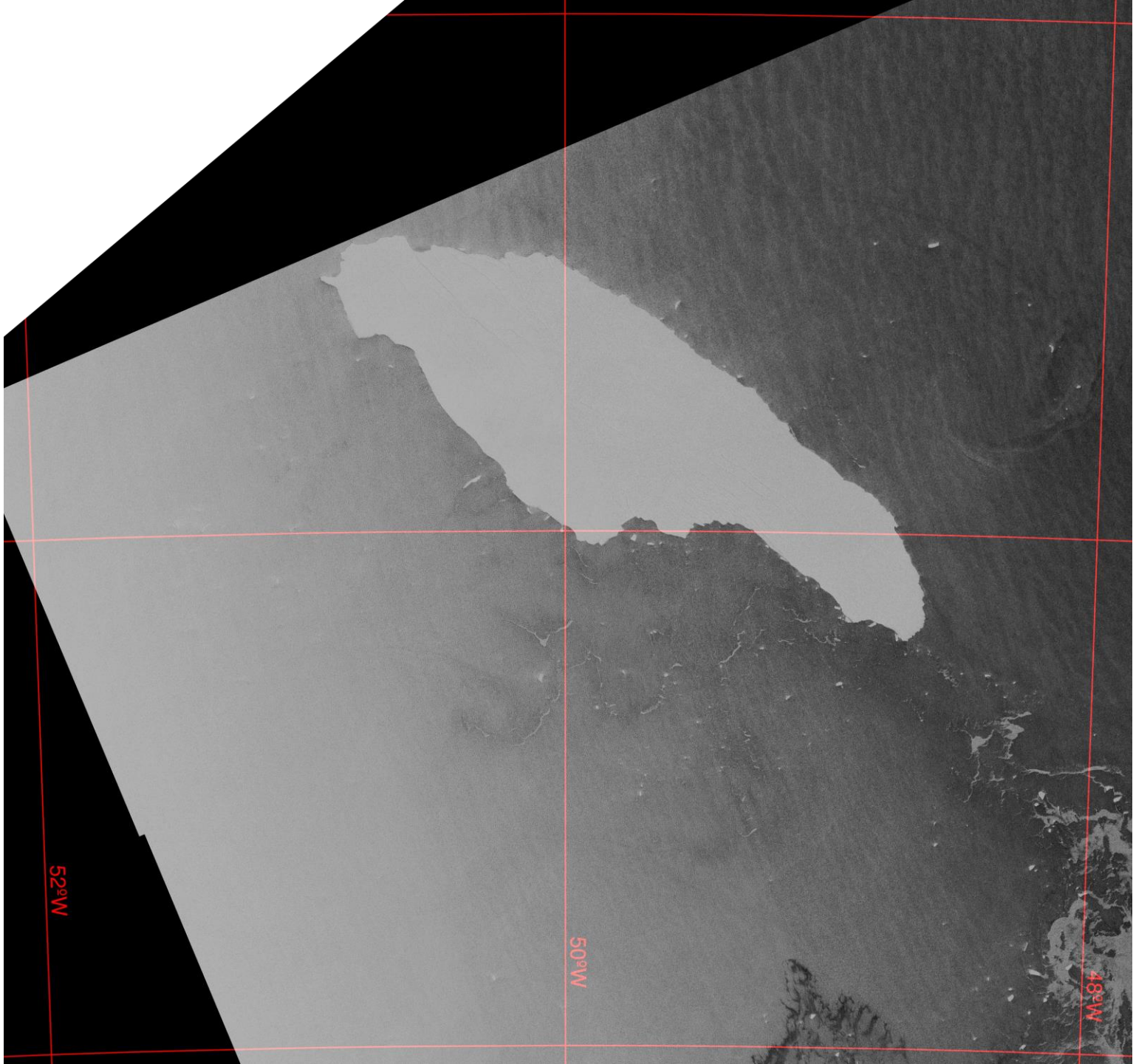

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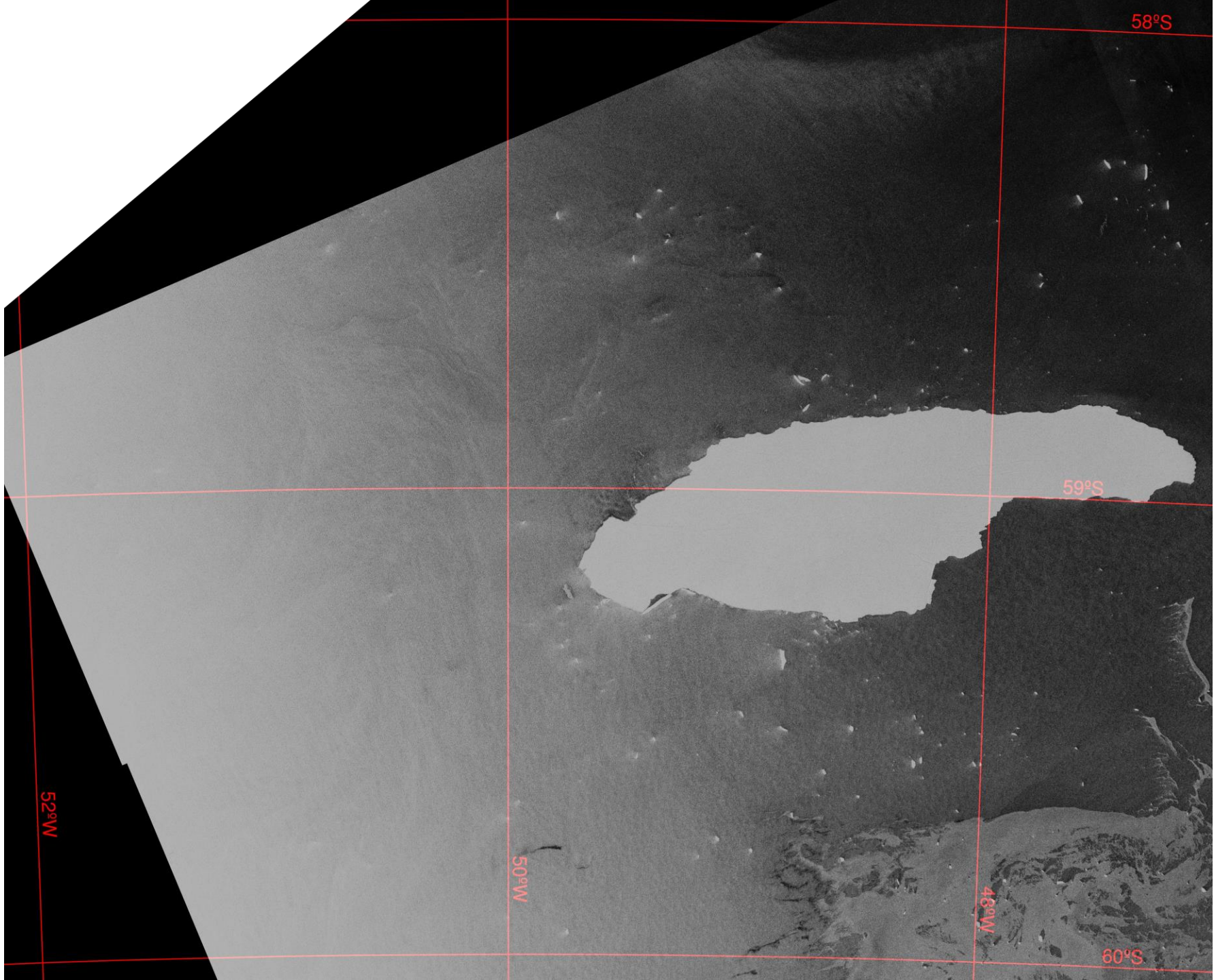

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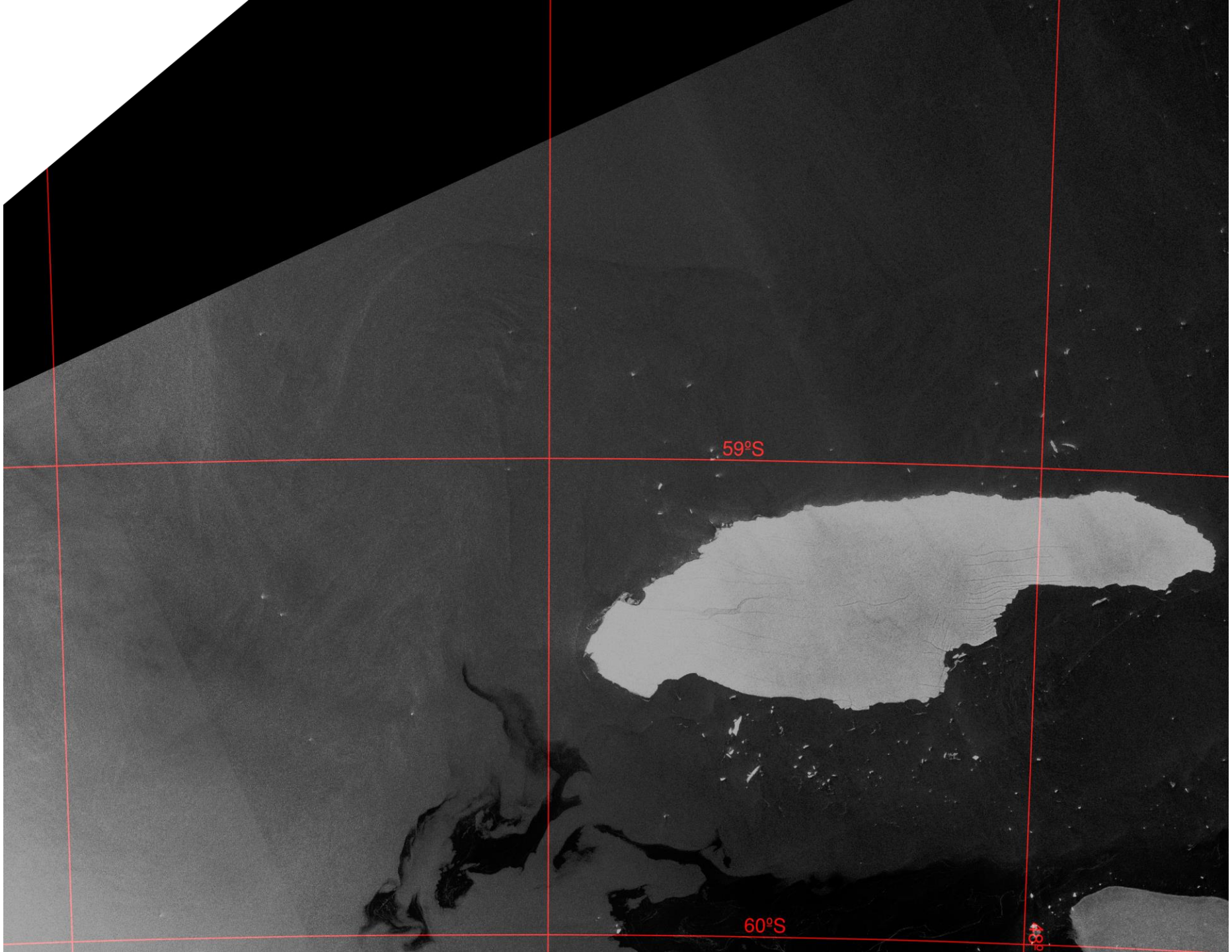

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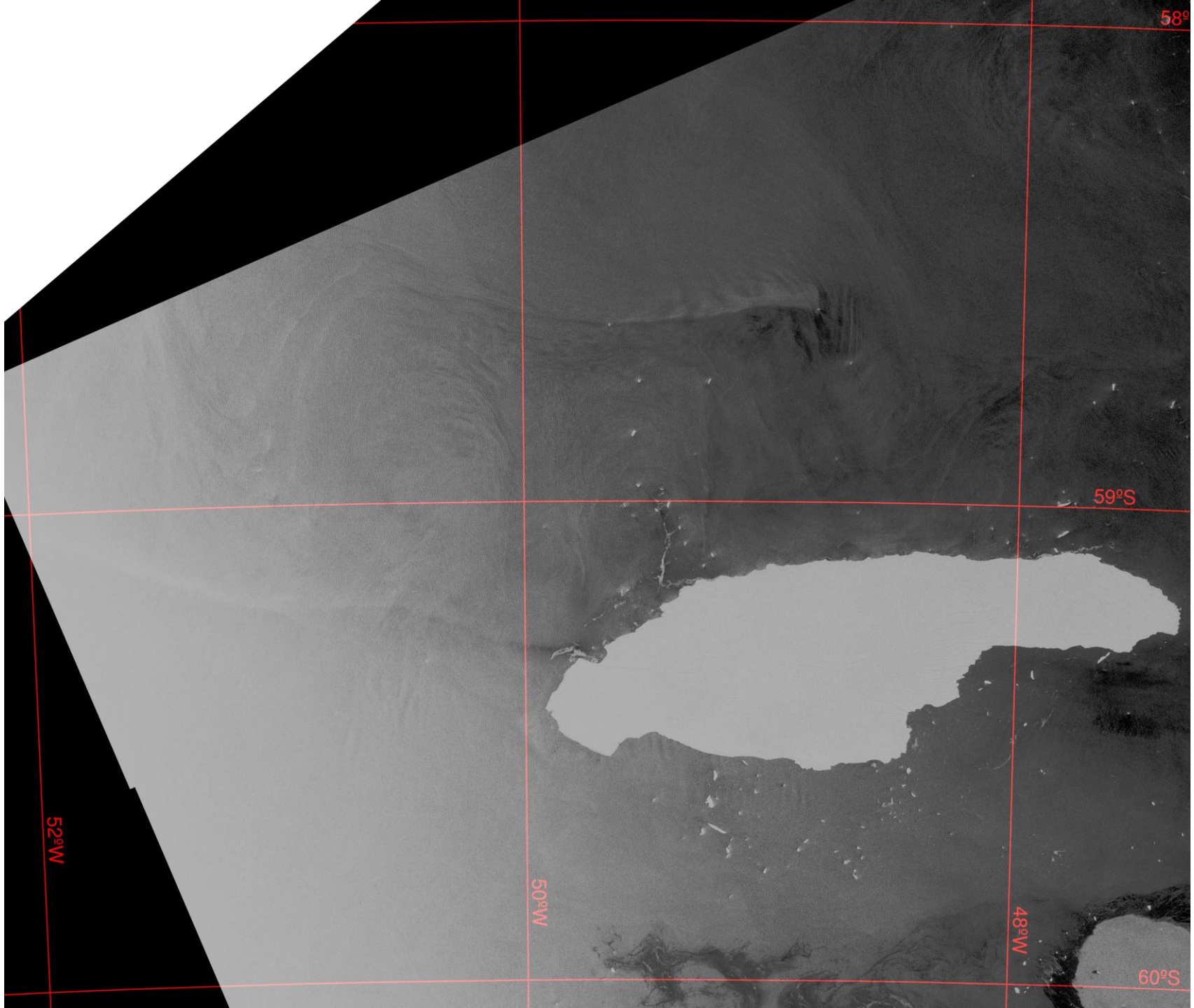

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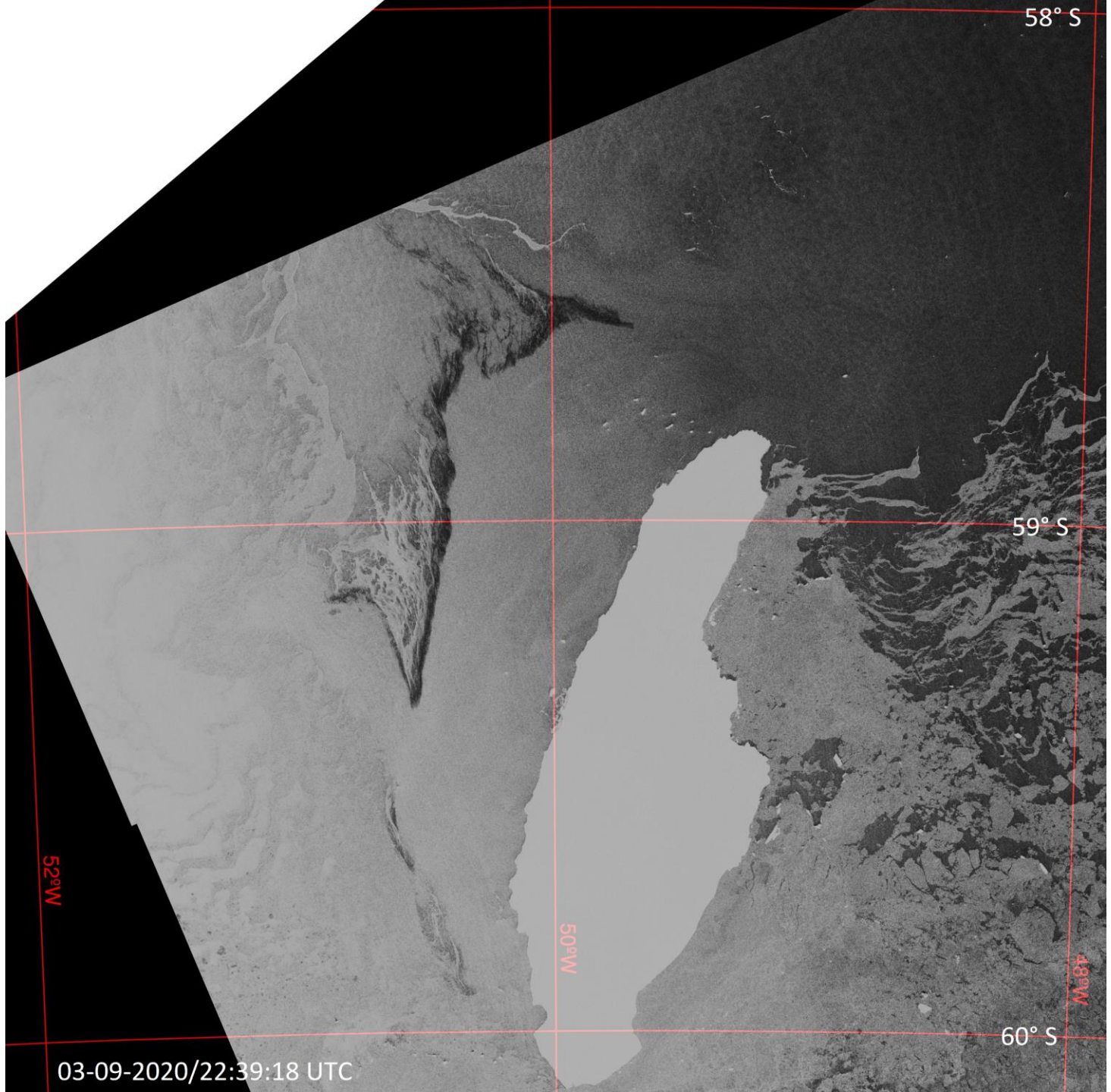

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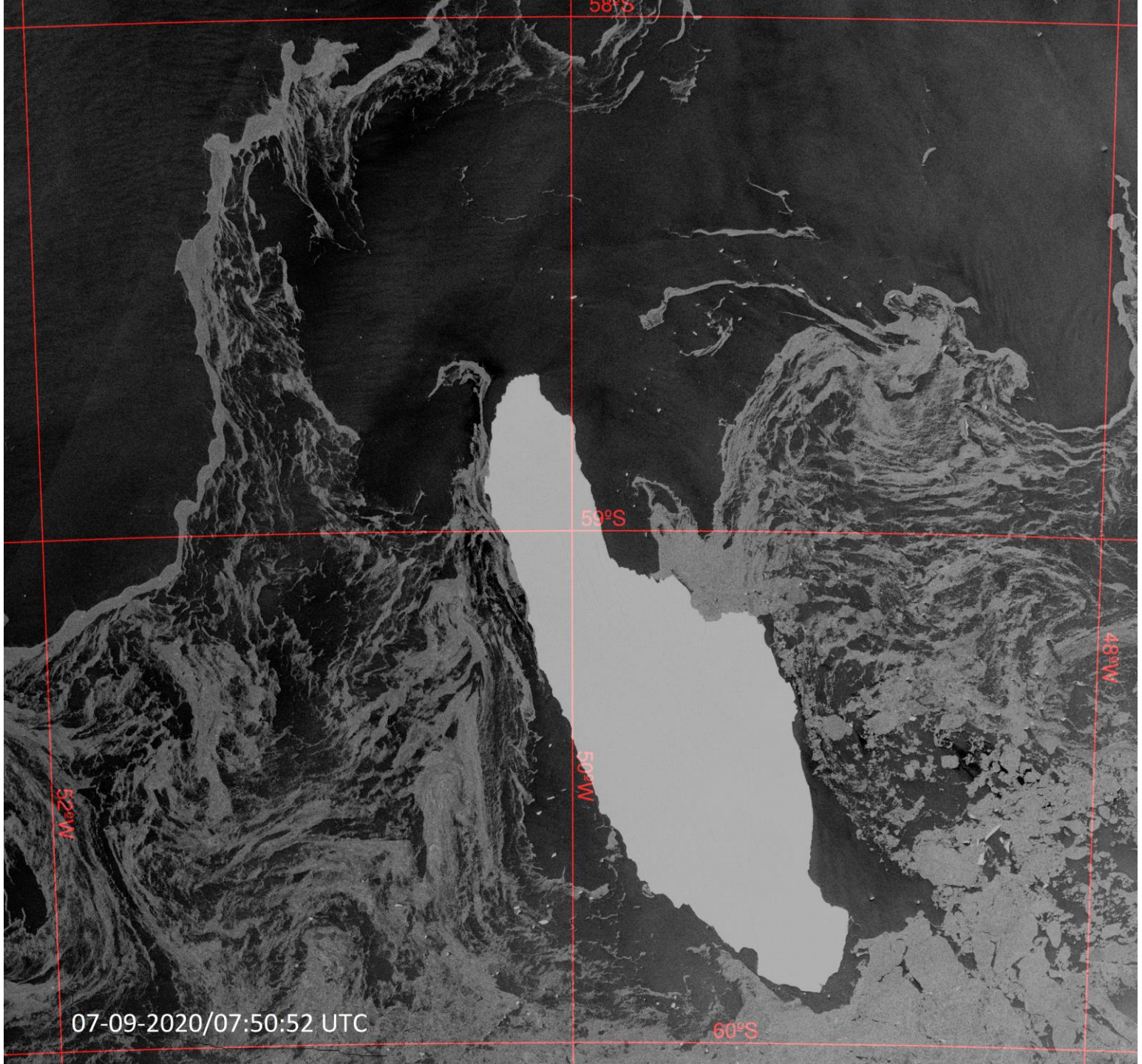

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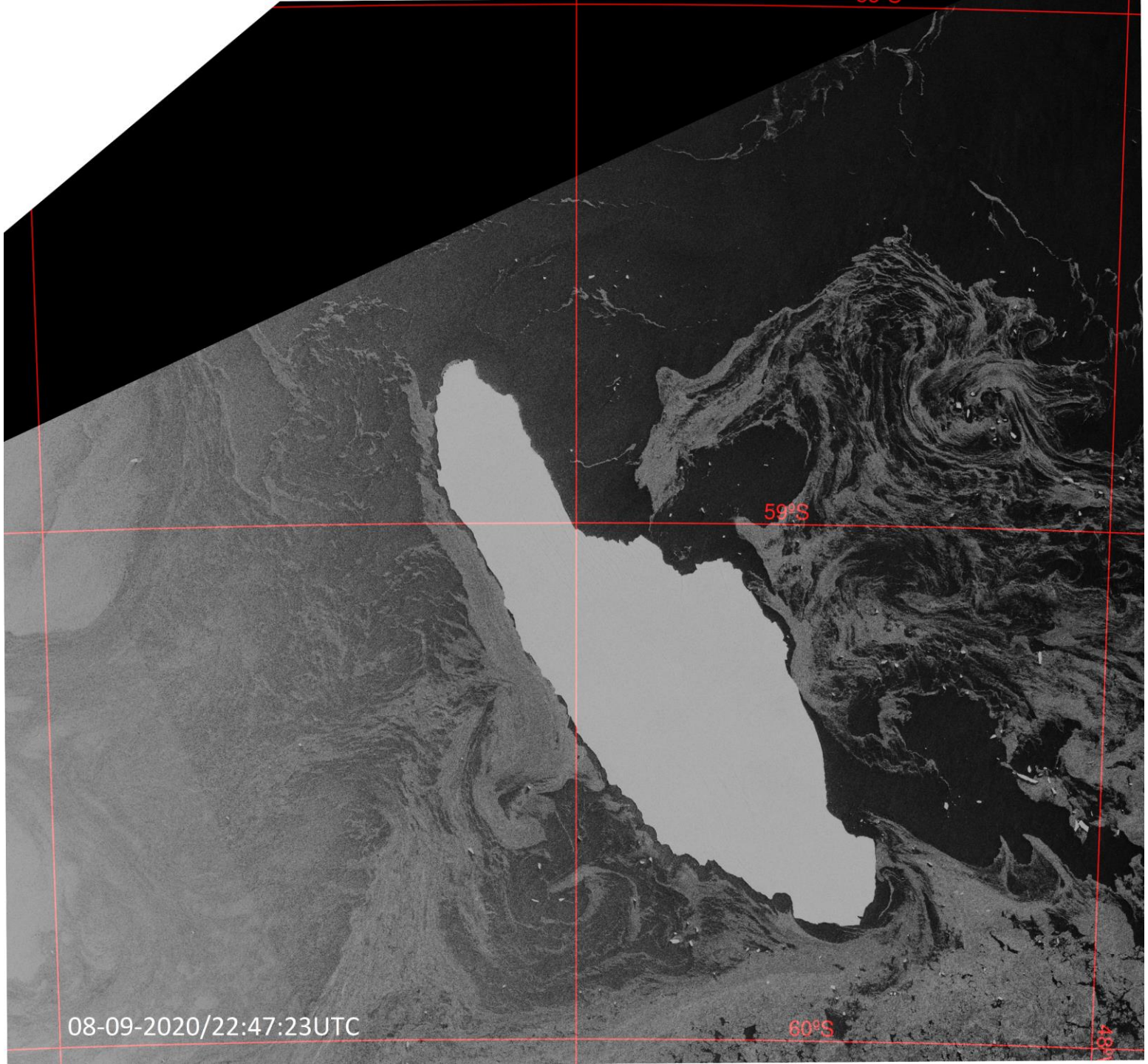

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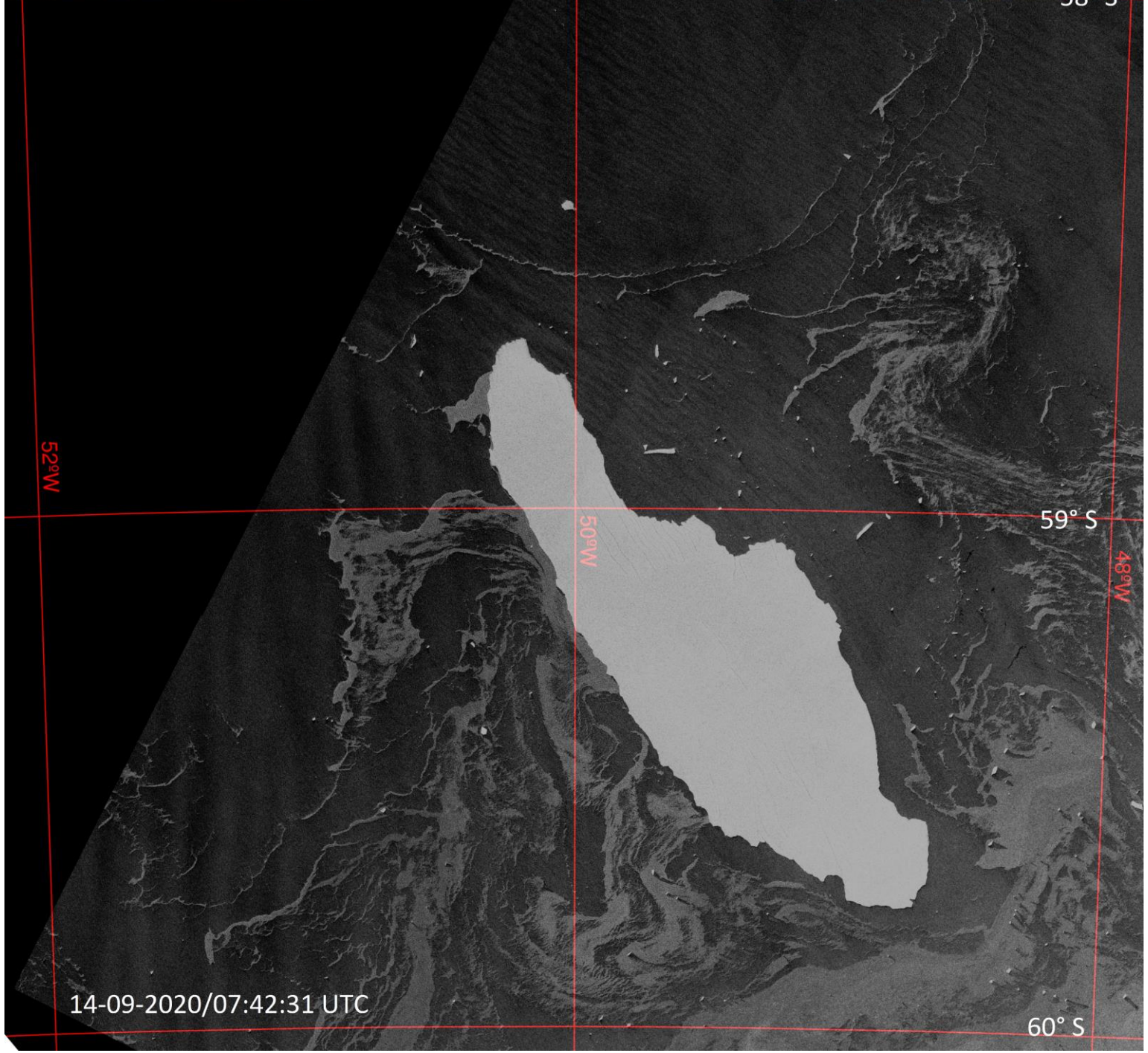

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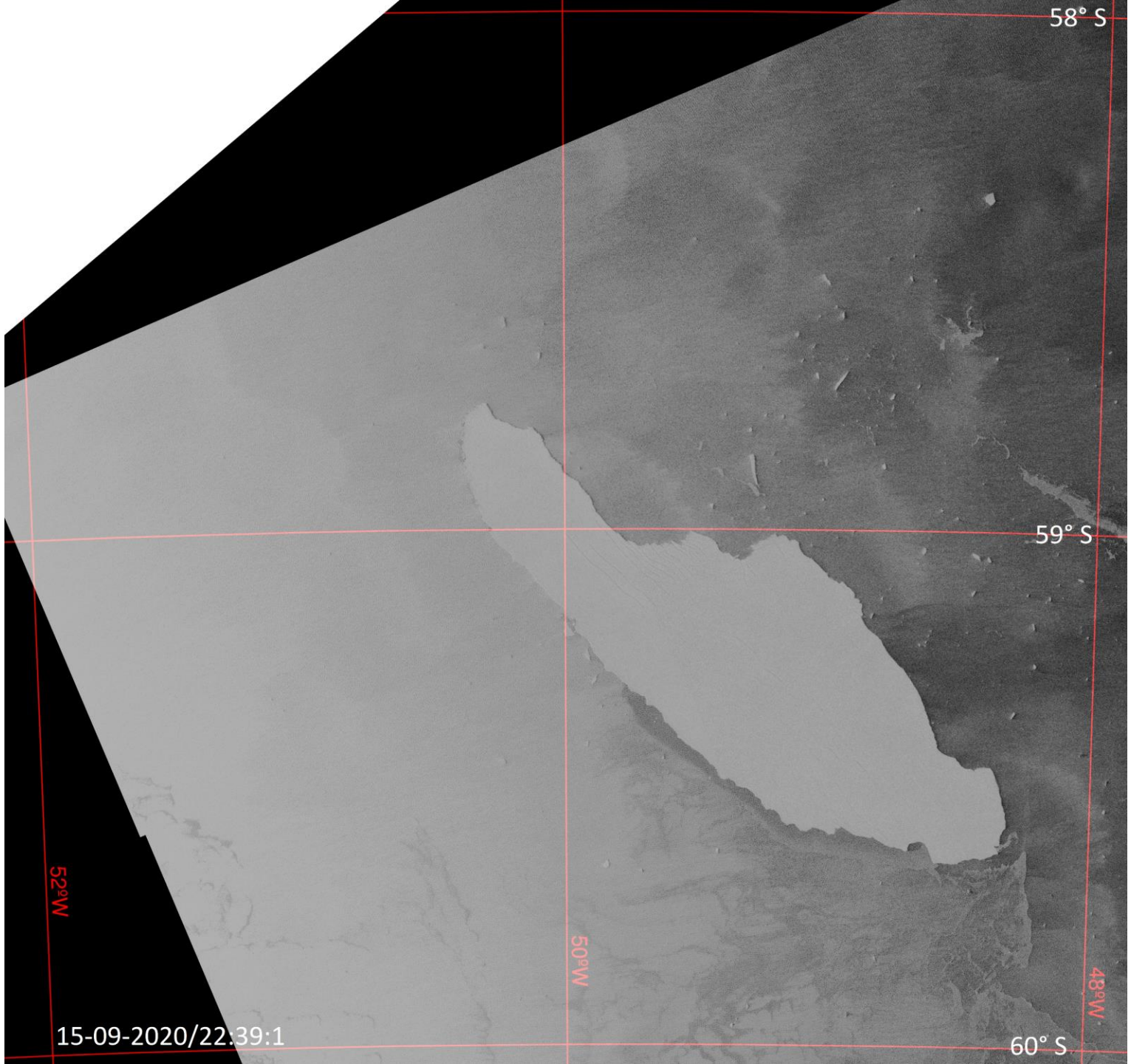

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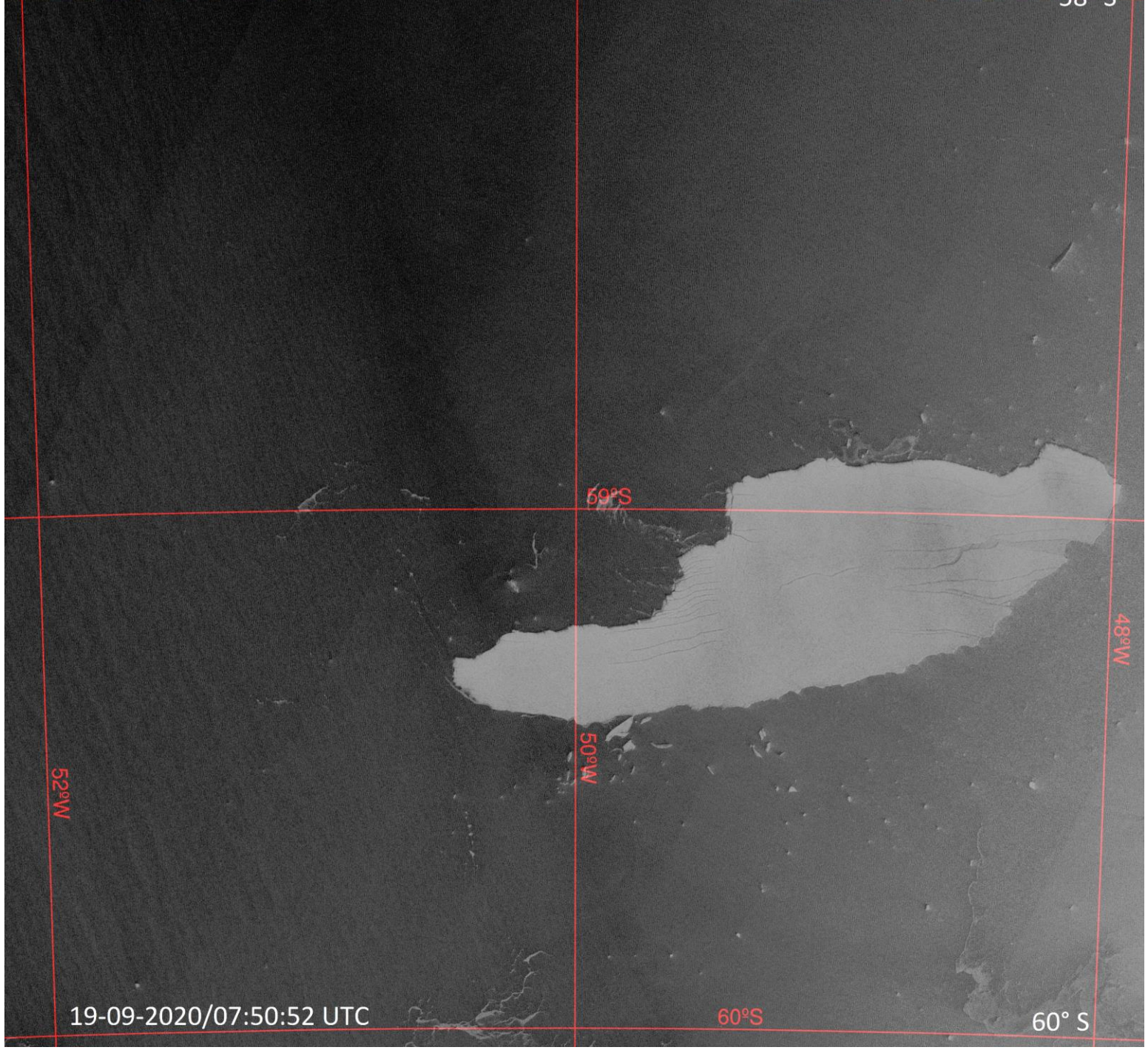

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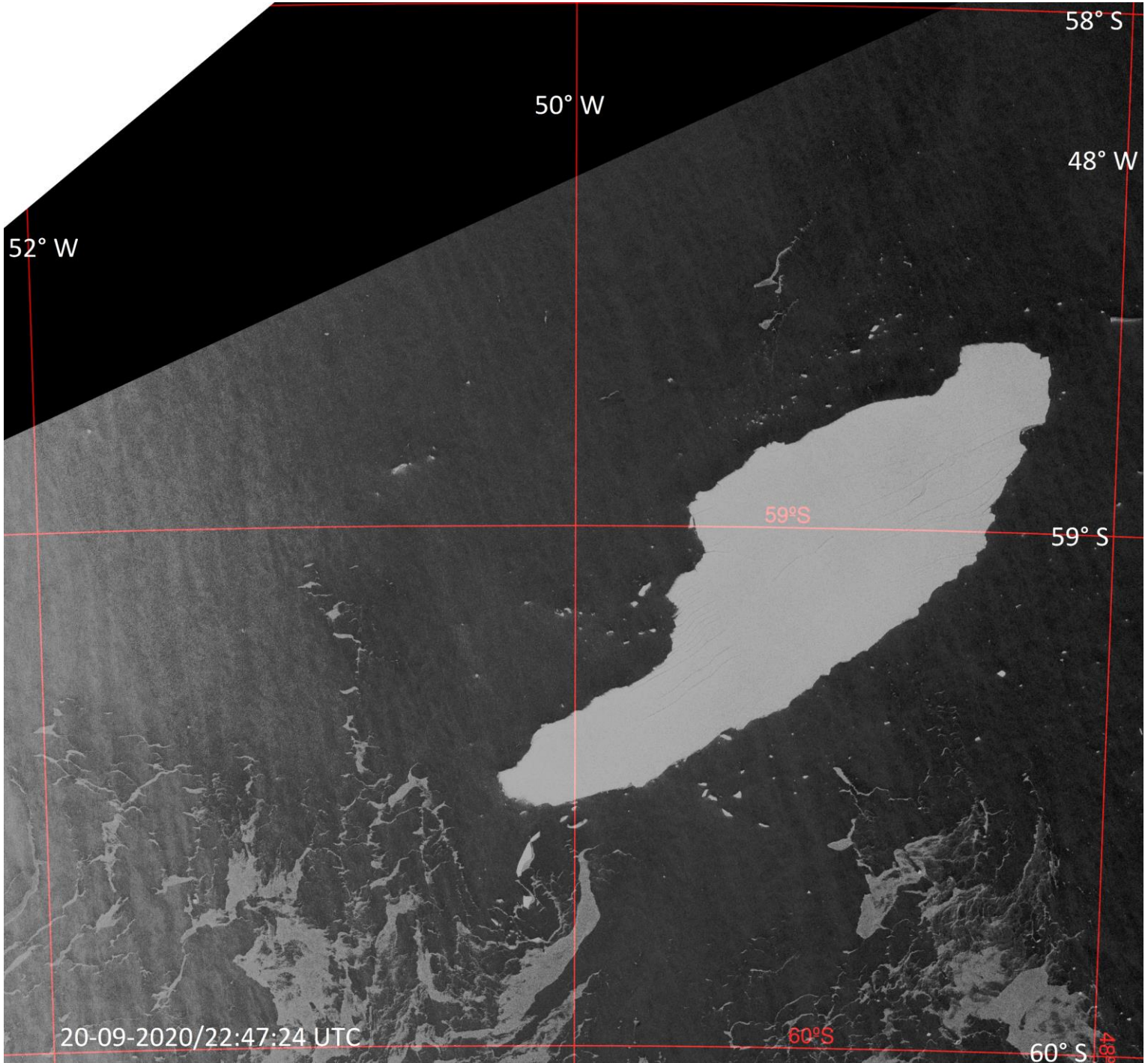

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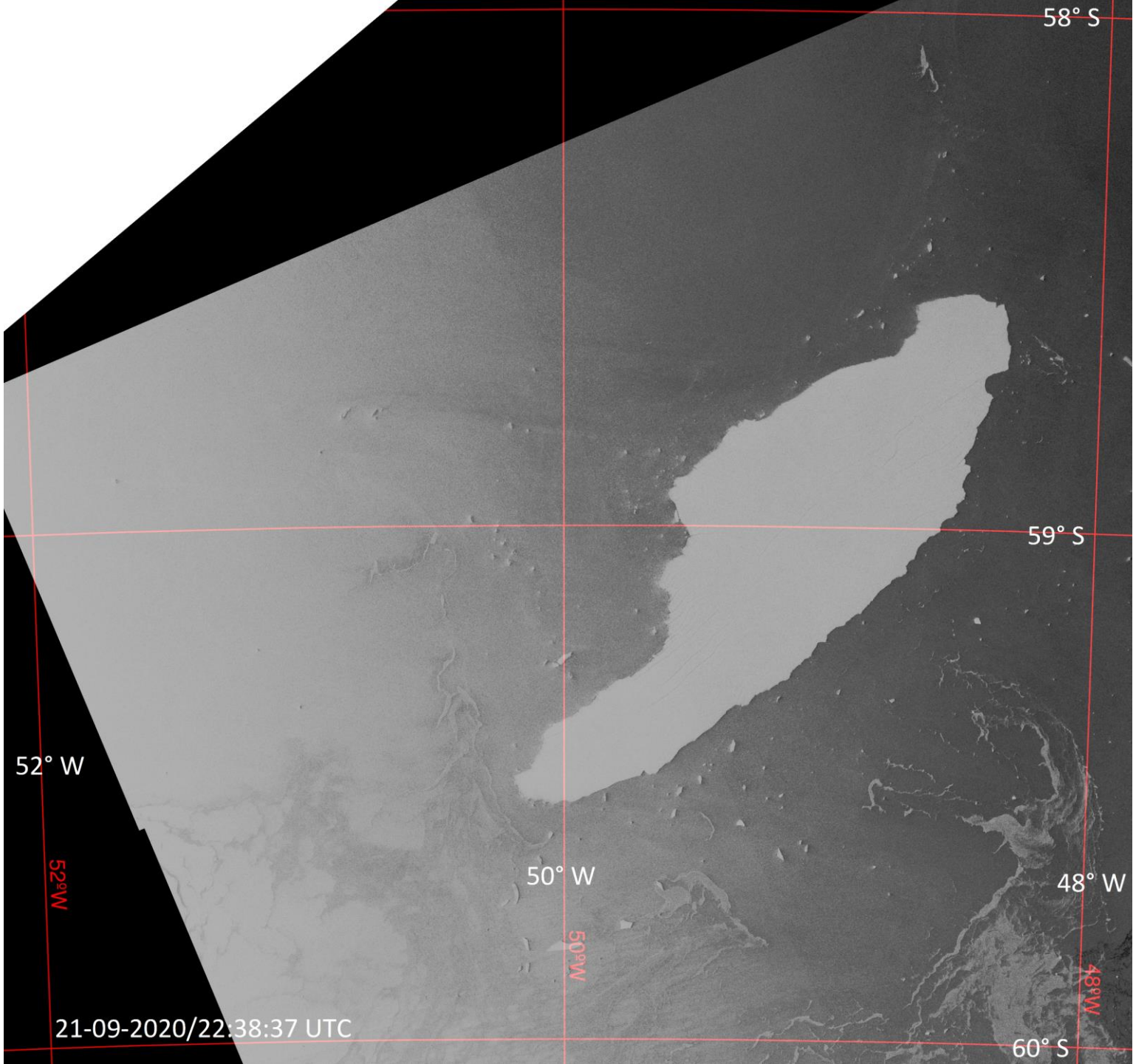

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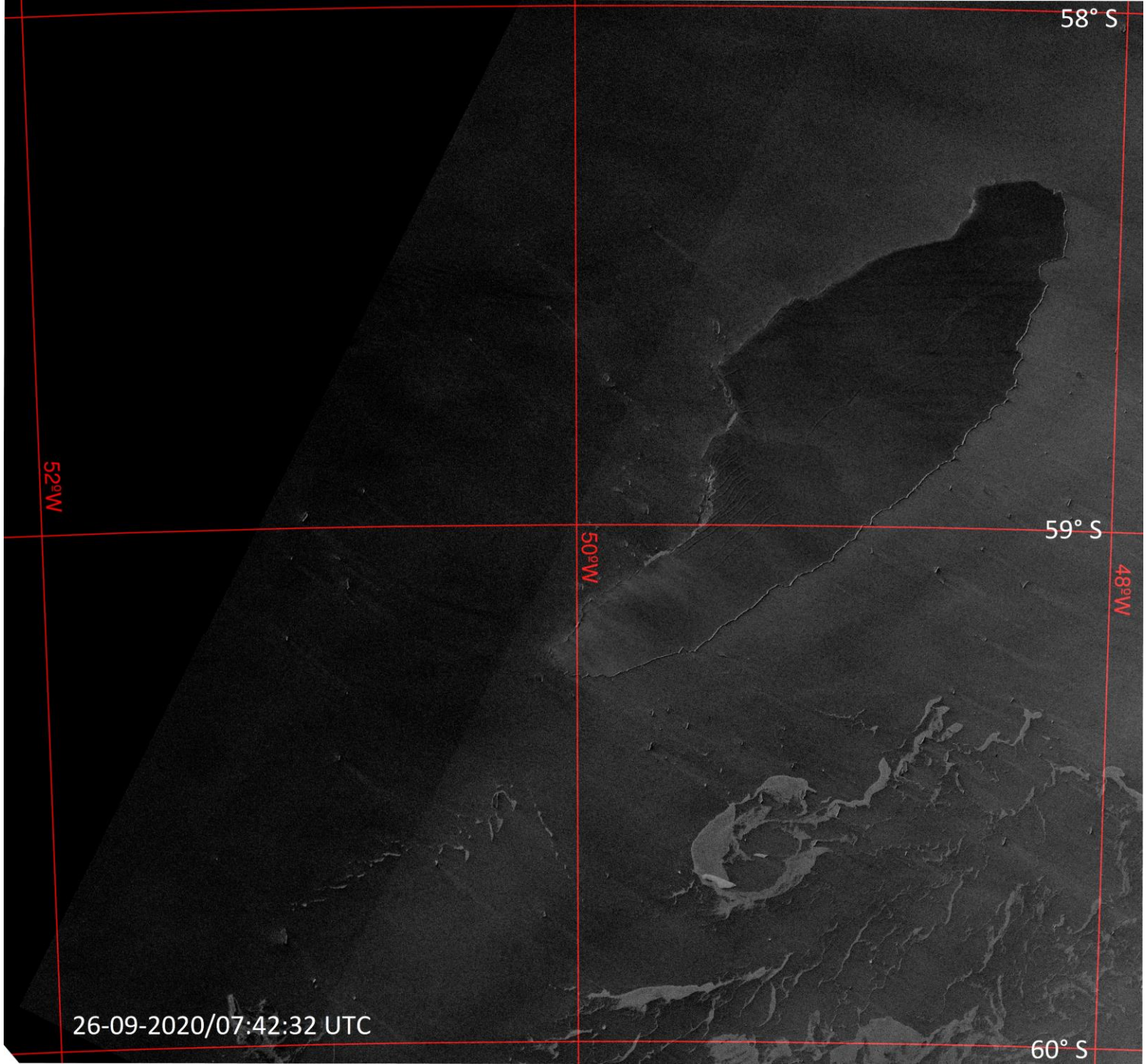

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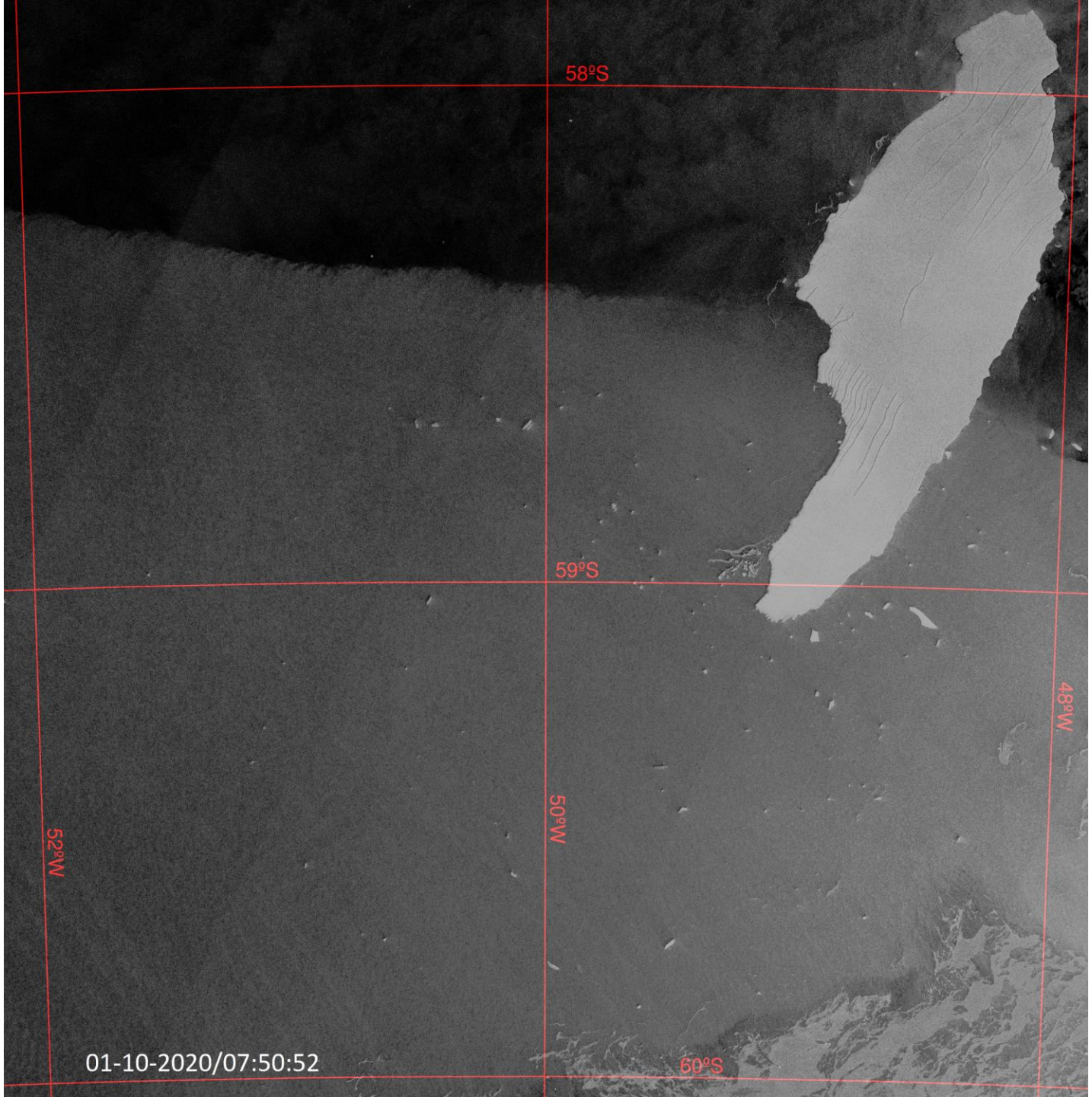


01-10-2020

ANNEX/UPDATE IV

Tabular Iceberg A68a in Open Water
Drift Pattern, Rotation and Disintegration

A documentation on the basis of Sentinel-1 SAR images
compiled by
Klaus Strübing, ex BSH/IICWG

as
Info Paper
for the
21st MEETING OF THE INTERNATIONAL ICE CHARTING WORKING GROUP
Videoconference - September 21-25, 2020
Sessions 1, 4 and 5

Großensee, Germany – November 18, 2020

https://drive.google.com/drive/folders/10Vyld5giunQyg8gbUscVmyjSCG1flSkS

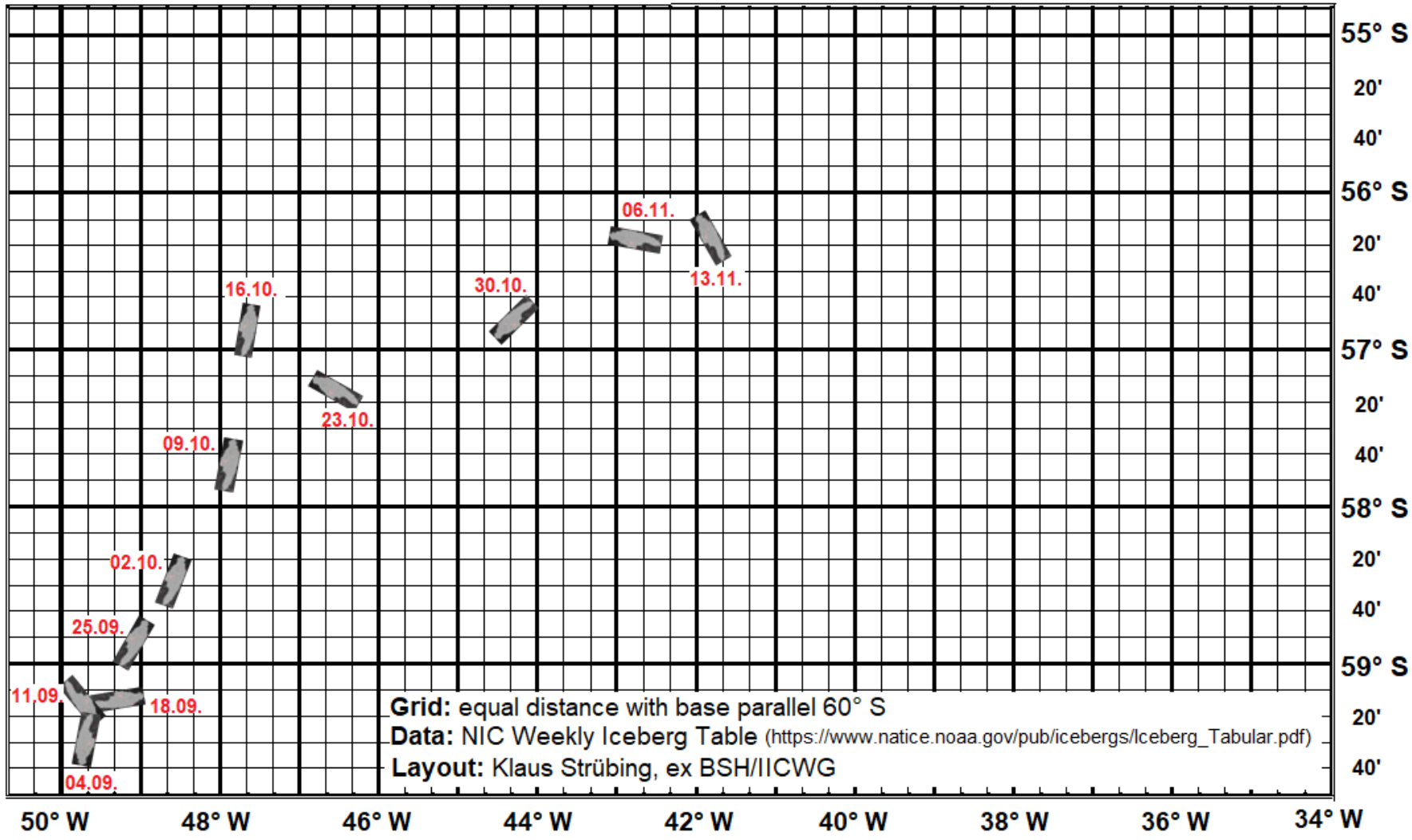
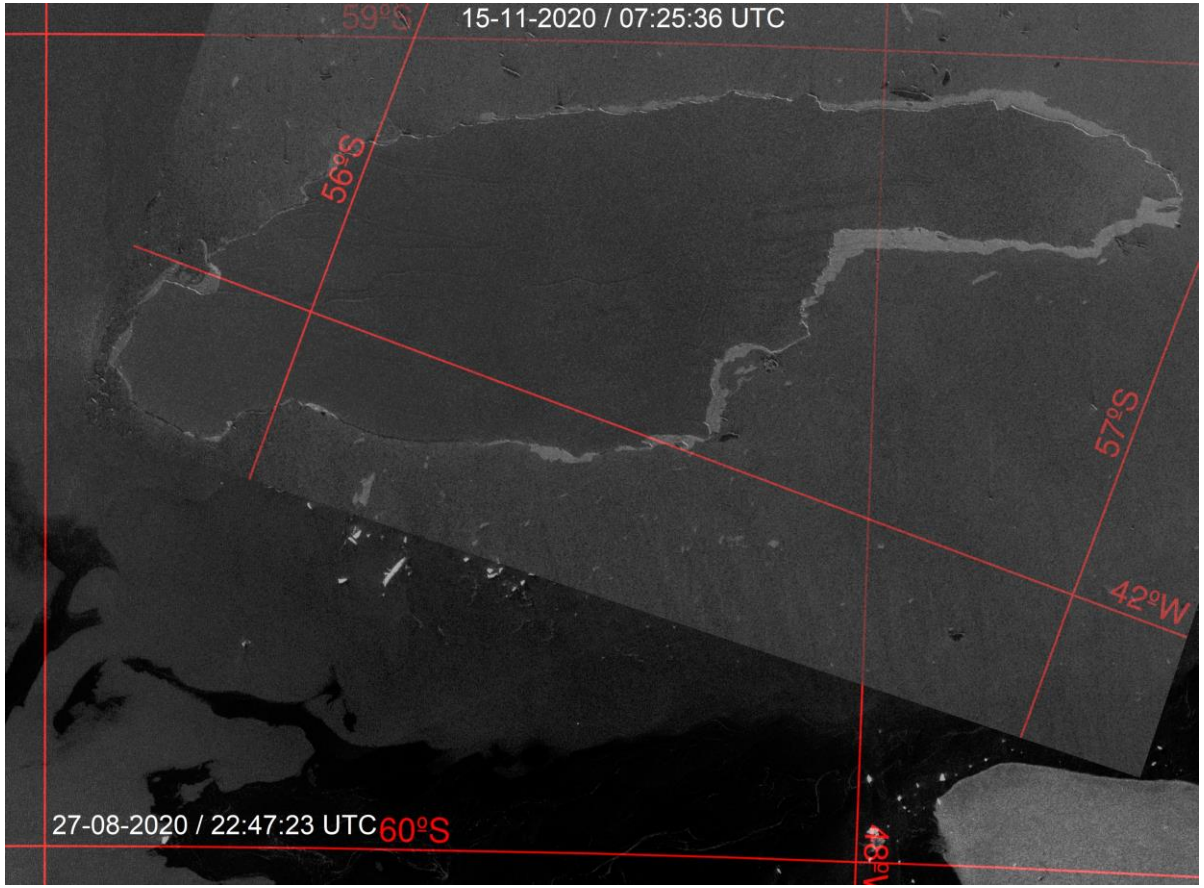


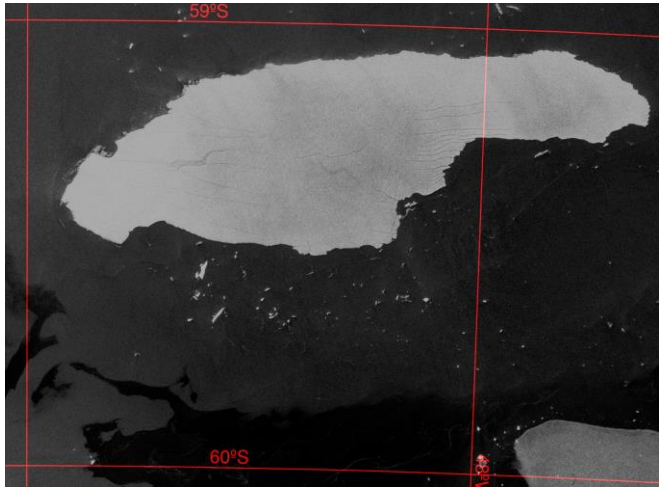
Fig. 3 ff: Weekly Centre Positions of Iceberg A68a from Sept. 4, 2020.*
Its rotation is highlighted by a minimized Sentinal SAR image (scale about 1:4).

*Complemented version of Fig. 3 on page 5 in

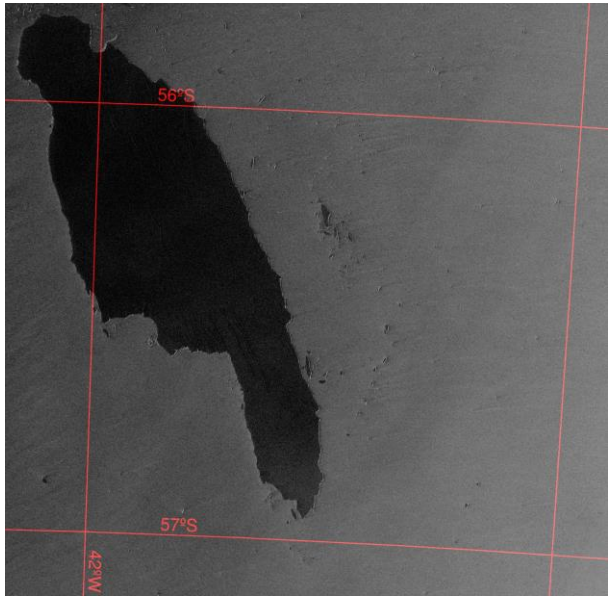
Strübing, K., 2020: Tabular Iceberg A68a in Open Water - Drift Pattern, Rotation and Disintegration.

Updated and Supplemented Version. A documentation on the basis of Sentinel-1 SAR images. - Info Paper for IICWG-21. *(https://drive.google.com/drive/folders/10Vyld5giunQyg8gbUscVmyjSCG1flSkS)*





Sentinel-1 SAR image of 27-8-2020 (section) in geographical position



Sentinel-1 SAR image of 15-11-2020 (section) in geographical position

Overlay of the two Sentinel-1 SAR images shown in the right.

The recent one (dark*) is overlaying the older one with the lighter grey tone. Thus, the ice areas having calved from A68a within the period from Aug. 27 to Nov. 15, 2020 are highlighted. Its extent decreased by about 320 km^2 (cp. slide 4).

*Due to the season (spring) and geographical position, on Nov. 15, 2020, A68a had a wet surface, which considerably decreases the backscattering of radar waves resulting in a dark display of its surface.

date	03-08-2017	11-02-2020	27-08-2020	15-11-2020
length (km/nm)	158 / 85,3	150 / 81,0	148 / 79,9	147 / 79,6
balance		- 8/4,3	- 2/1,1	- 1/0,3
max. with (km/nm)	52 / 28,1	51 / 27,5	48 / 25,9	47 / 25,4
balance		- 1/0,6	- 3/1,6	- 1/0,5
extent (km²)	5.650	4.965	4.405	4.085
balance		- 685	- 560	-320

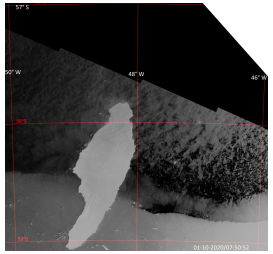
Table 2 ff*:* Calculated values for the size and extent of iceberg A68a

*Complemented version of Table 2 on page 13 in

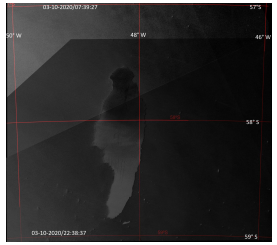
Strübing, K., 2020: Tabular Iceberg A68a in Open Water - Drift Pattern, Rotation and Disintegration. *Updated and Supplemented Version*. A documentation on the basis of Sentinel-1 SAR images. - Info Paper for IICWG-21. *(https://drive.google.com/drive/folders/10Vyld5giunQyg8gbUscVmyjSCG1flSkS)*

Time series of xx Sentinal-1 SAR images for the period Oct. 1 to Nov. 15, 2020

sections with centre point on about 58° S and 48° W, degree squares 57 to 59 S, 46 to 50 W



01-10-2020



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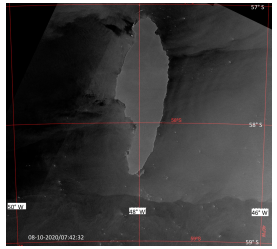
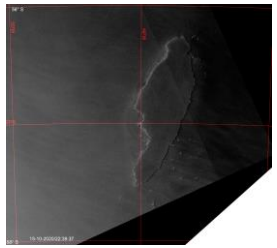


08-10-2020

sections with centre point on about 57° S and 48° W, degree squares 56 to 58 S, 46 to 50 W



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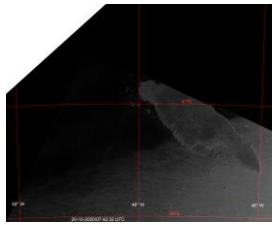
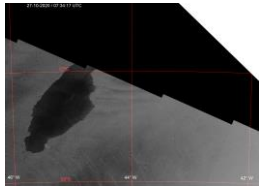


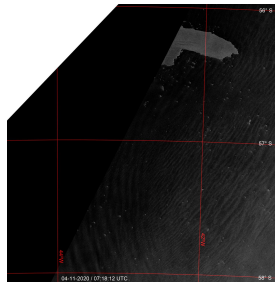
15-10-2020

section with centre point on about 57° S and 44° W, degree squares 56 to 58 S, 42 to 46 W



27-10-2020

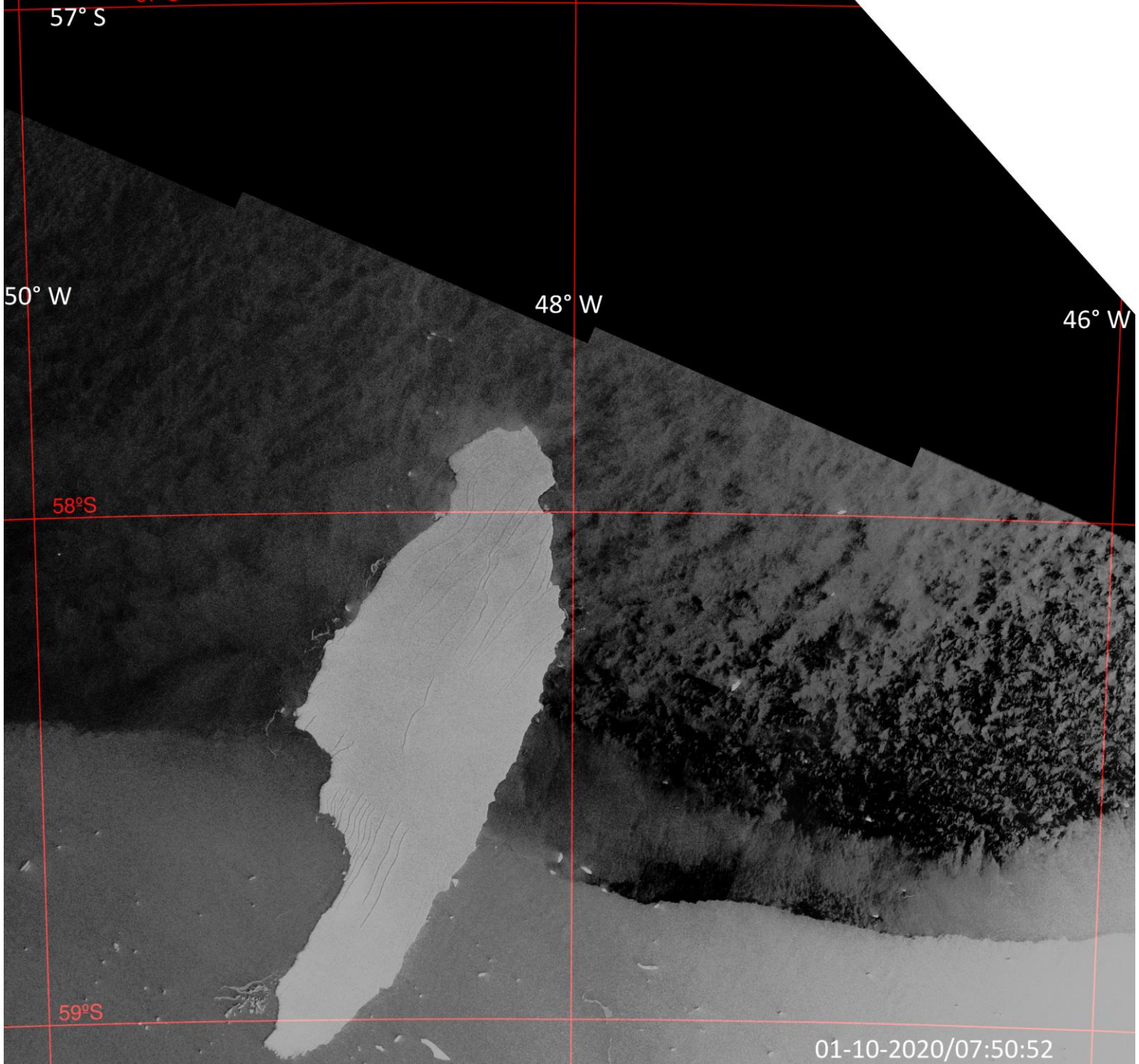
sections with centre point on about 57° S and 42° W, degree squares 56 to 58 S, 40 to 44 W



04-11-2020

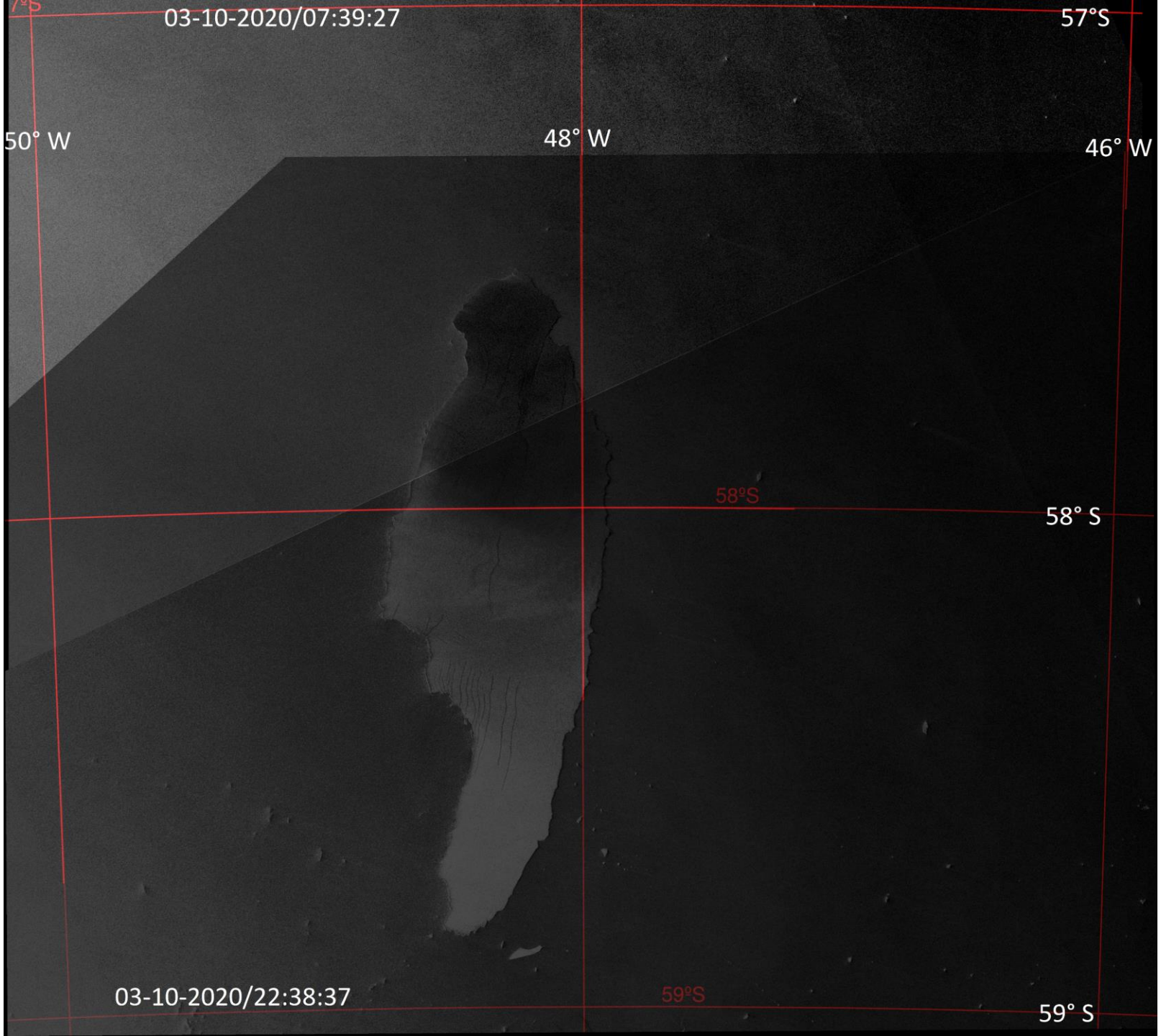
Explanatory note

A68a changed recently its behaviour. After slowly circling around from end of June to end of September 2020 in the area between about 58°50’ and 59°40’ S and 48°30’ and 50°00’ W, it gained momentum and drifted away NNE- to NE-wards from the mentioned area with weekly rates of about 45 nm and more (cp. slide 2). Thus, the series of SAR images of the iceberg for the mentioned period are situated in different 2 degrees latitude/4 degrees longitude boxes, whereby the dynamic of the drift appears not that obvious. However, its rotation is clearly shown.

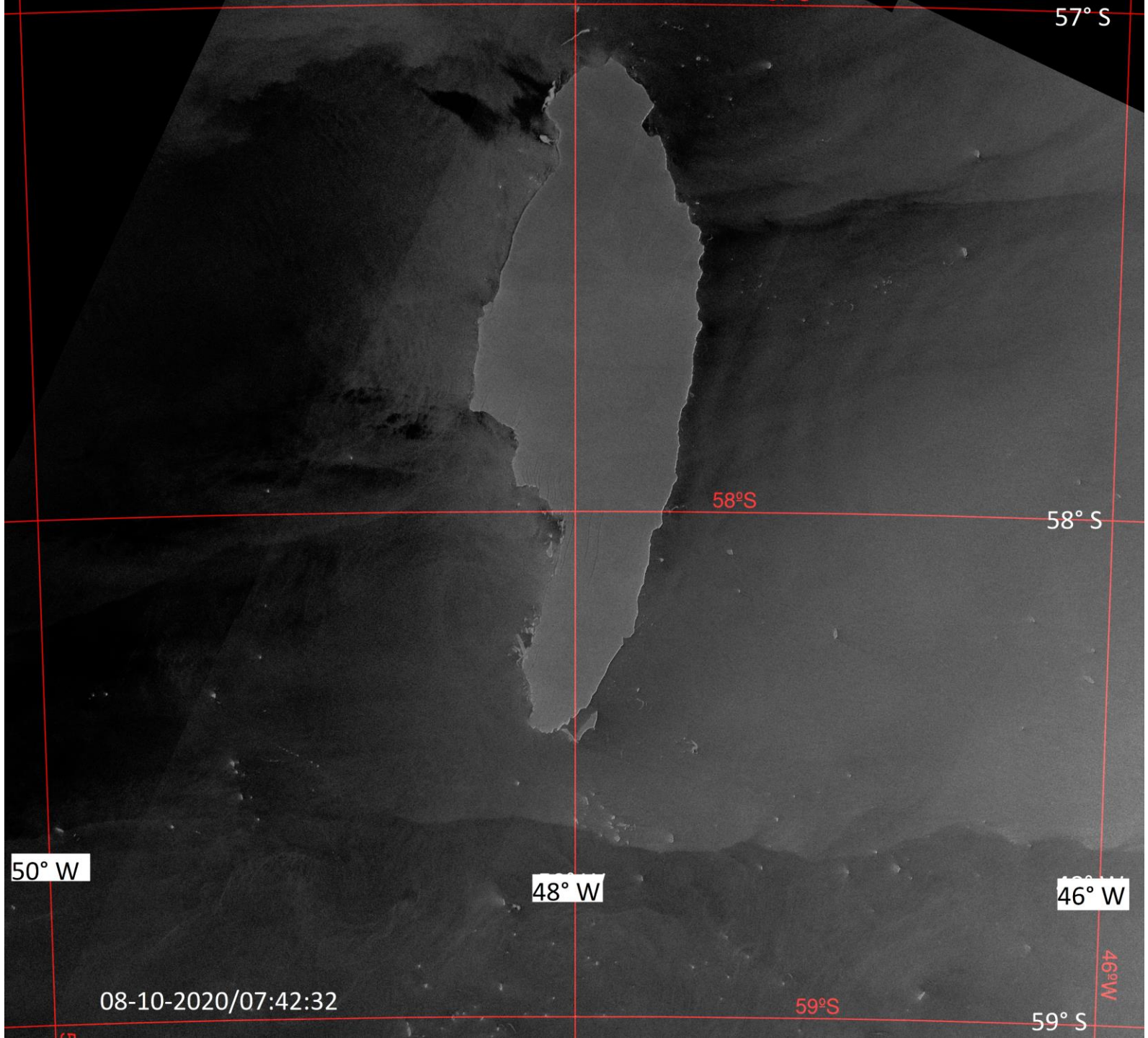


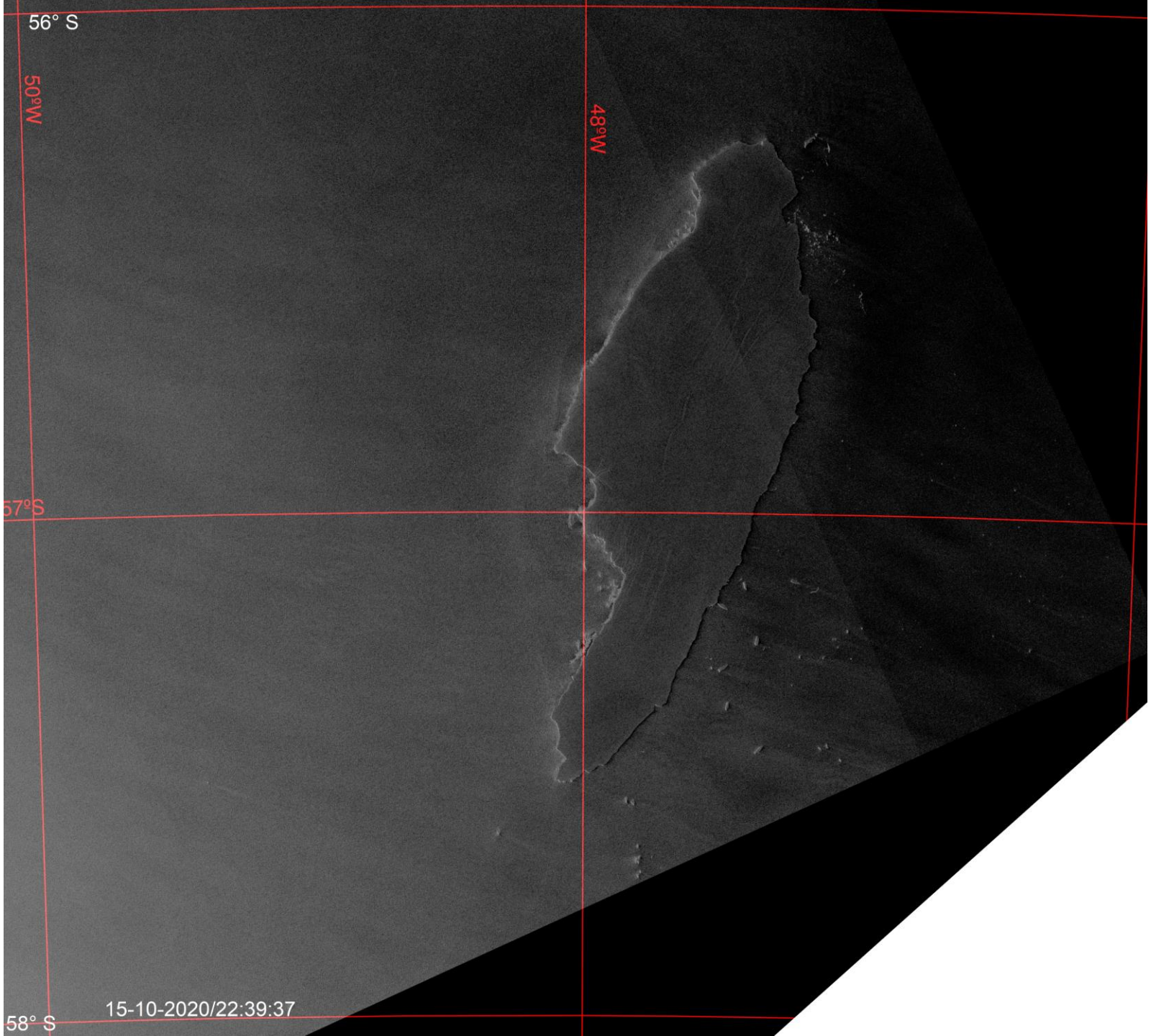
01-10-2020

03-10-2020


03-10-2020/07:39:27
57°S
50° W
48° W
46° W
58ºS
58° S
03-10-2020/22:38:37
59ºS
59° S

08-10-2020





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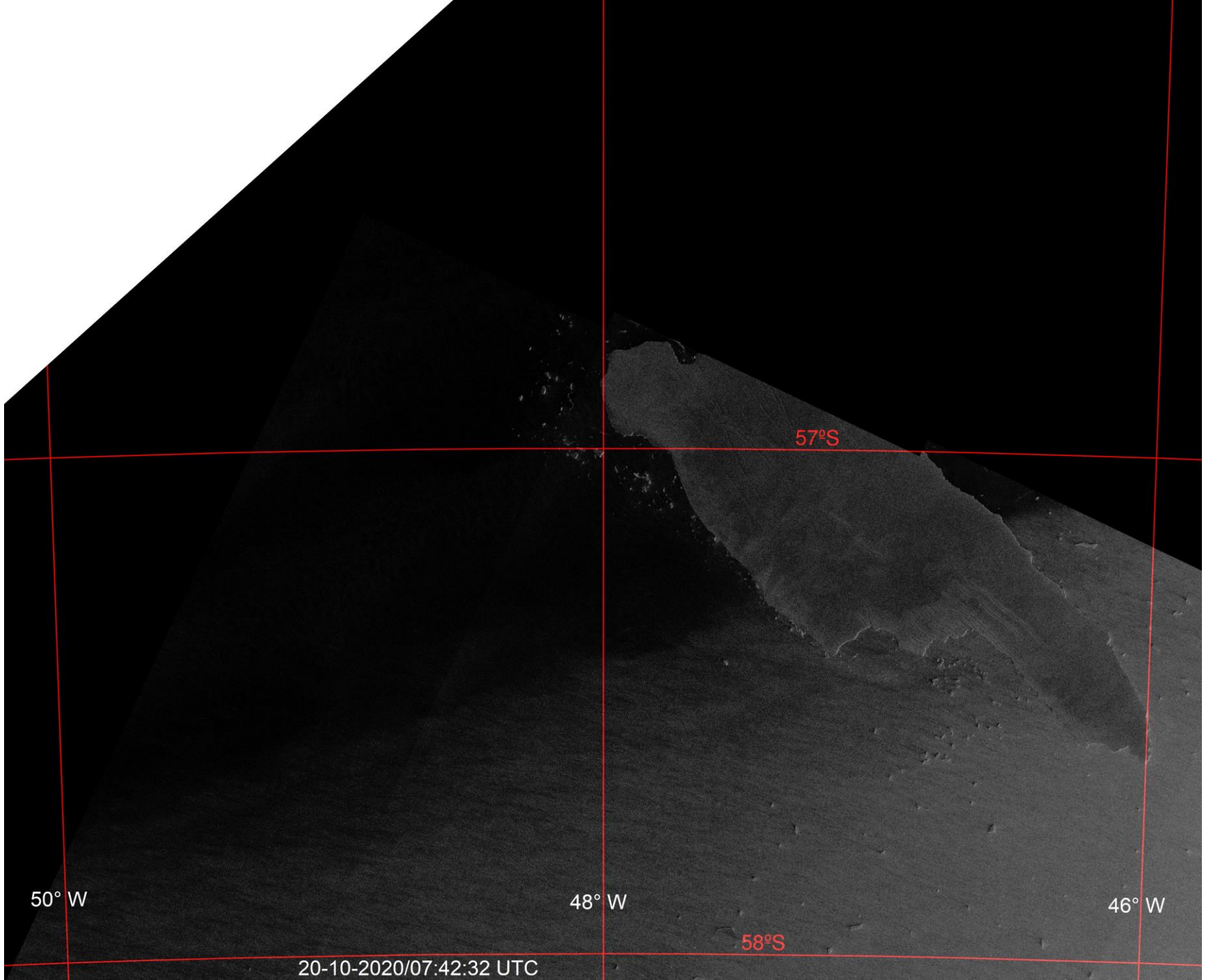

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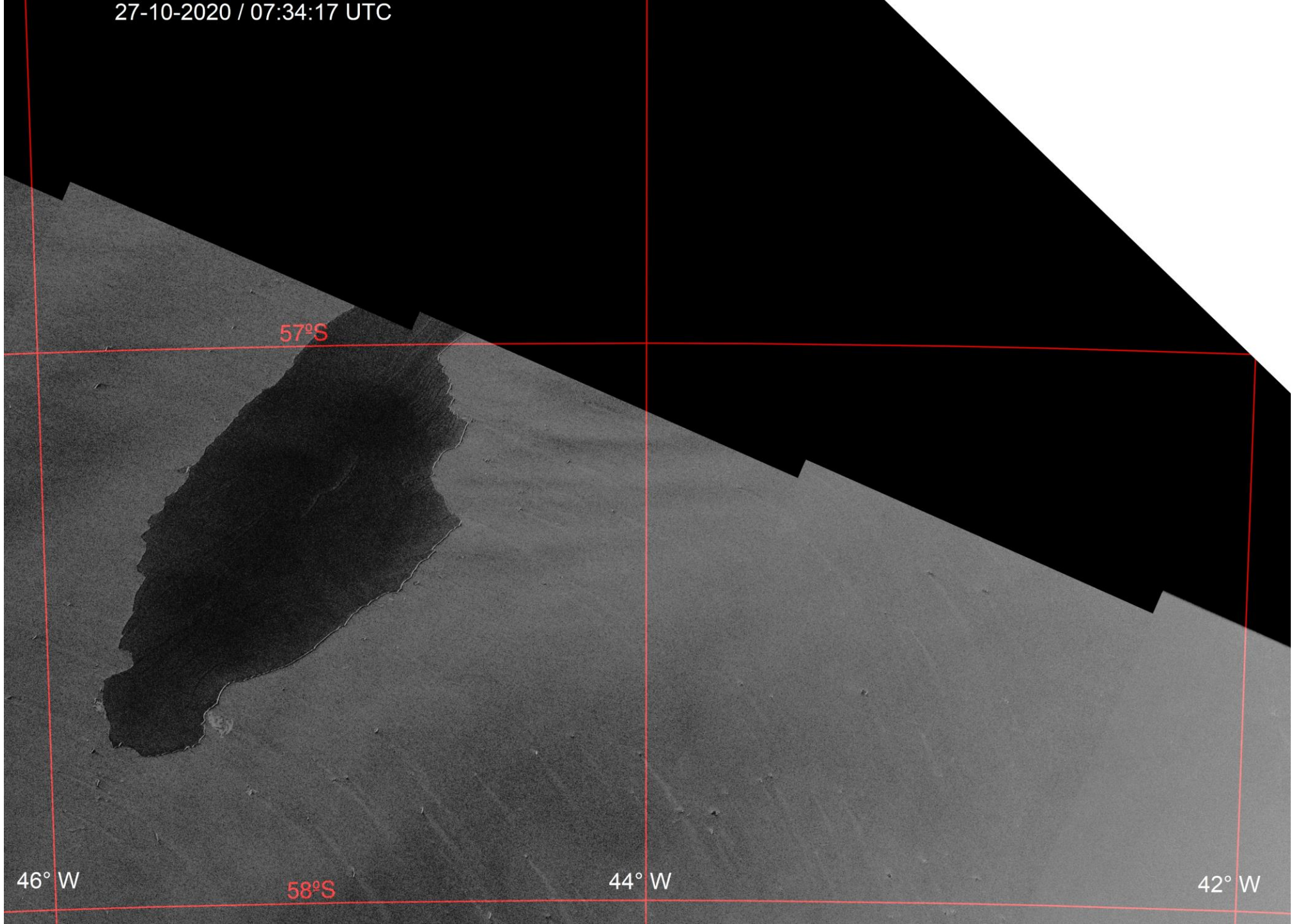
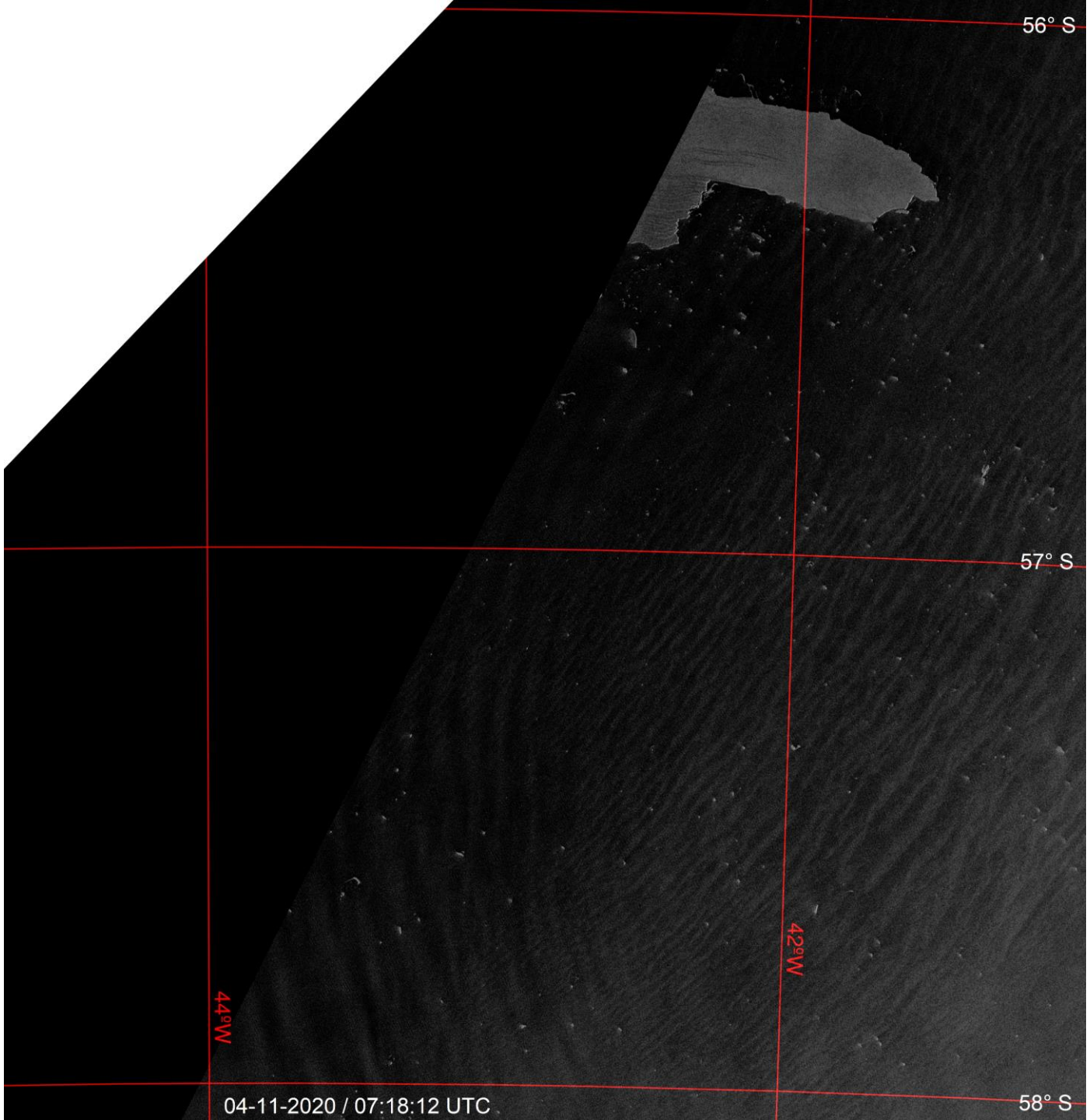
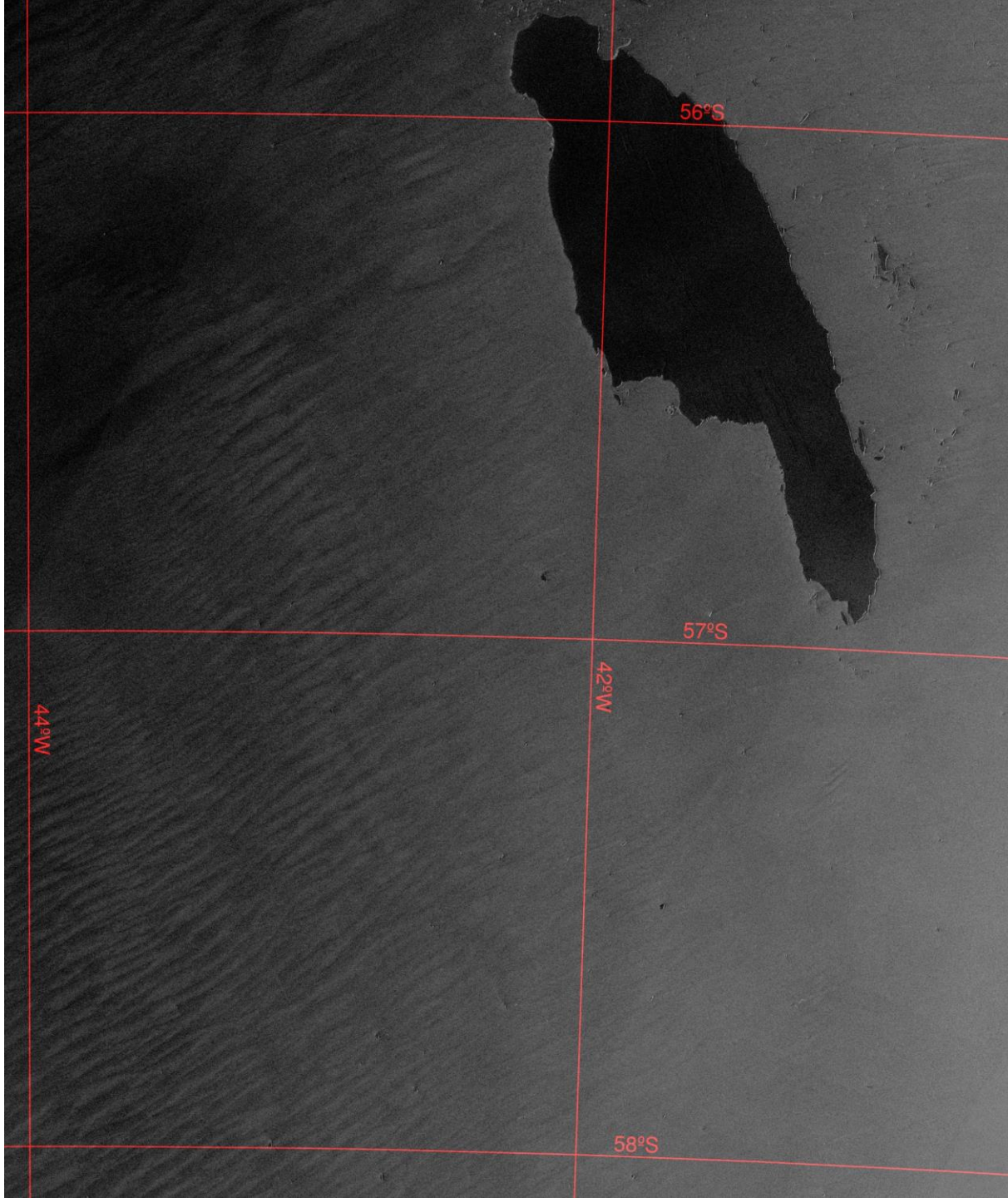


04-11-2020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