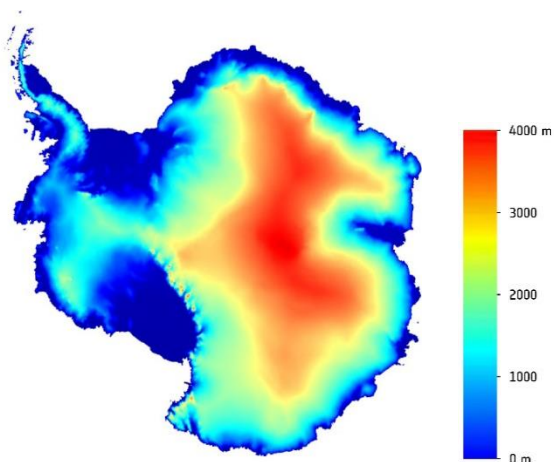


1 Seasonal sea ice dynamics in the Antarctic Region (sea ice extent, cyan: Sept. 2020, light blue: March 2020).



2 Antarctic ice sheet thickness derived from data acquired by CryoSat.

### Antarctic Ice Sheet and Ice Shelves

During the last decades, Antarctica, the largest desert on Earth, has gained increasing awareness in the scientific and political communities. This is due to its importance for Earth's climate and for the consequences of climate change for humanity.

The Antarctic ice sheet covers about 14 million square kilometres, holding around 26.5 million cubic kilometres of ice, equivalent to 60-70% of the world's fresh water. If fully melted, this ice sheet could raise global sea levels by nearly 58 meters. The ice sheet is divided into two main sections: the more stable East Antarctic Ice Sheet and the smaller, more vulnerable West Antarctic Ice Sheet, which alone could raise sea levels by 3.3 meters if it collapses.



Where the glaciers of Antarctica meet the Antarctic Ocean, the ice shelves are located. Ice shelves are typically 100 to several hundred metres thick, stable ice bodies floating on the water. The warming of the oceans reduces the stability of the ice shelves and leads to the calving of large icebergs. The ice shelves, like the Ross and Filchner-Ronne Ice Shelves, help stabilize glaciers and prevent them from flowing directly into the ocean. However, warming ocean currents are melting these shelves from beneath, threatening their stability. For example, the dramatic collapse of the Larsen B Ice Shelf in 2002, which lost 3,250 square kilometres of ice in just a few weeks, highlights the potential for rapid ice loss.

Antarctica experiences seasonal sea ice variation. During the Antarctic winter, the sea ice expands dramatically, covering up to 18 million square kilometres (about twice the size of the United States). In the summer, the ice recedes to 3-4 million square kilometres. This seasonal cycle influences the heat exchange between the ocean and atmosphere.

Satellite observations show current trends: Antarctica has been losing about 150-200 billion tons of ice per year on average over the past few decades, with accelerated ice loss in the West Antarctic region. Altimetry satellites like ESA's CryoSat-2 provide data on ice thinning rates.

### Exercises

- Look at the visualisation of the Antarctic sea ice extent in September and in March try to estimate the seasonal change of the sea ice extent.
- Why is there more ice in September? In which months do we have summer/winter in the southern hemisphere?
- Let's estimate the amount of ice stored in the Antarctic sea ice. Sea ice is typically 1-2 metres thick. Using the maximum extent of 18 million square kilometres leads to a total volume of about 25,000 cubic kilometres (check taking the used units into account!).
- Compare this value with the volume of the Antarctic ice sheet given in the text (26.5 million cubic kilometres). How much more ice is stored in the ice sheet? Is this factor of about 1000 plausible? Think about the differences in the thickness of the ice bodies.

### Links and Sources

- [https://www.esa.int/Applications/Observing\\_the\\_Earth/Space\\_for\\_our\\_climate/An\\_improved\\_view\\_of\\_global\\_sea\\_ice](https://www.esa.int/Applications/Observing_the_Earth/Space_for_our_climate/An_improved_view_of_global_sea_ice) - ESA report on technical improvements of sea ice data from satellites.
- [https://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-1/Antarctic\\_ice\\_shelf\\_demise](https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-1/Antarctic_ice_shelf_demise) - development of the Antarctic ice shelves.
- [https://www.esa.int/ESA\\_Multimedia/Images/2019/05/Antarctic\\_ice\\_loss\\_1992\\_2019](https://www.esa.int/ESA_Multimedia/Images/2019/05/Antarctic_ice_loss_1992_2019) - ESA Applications animation of the Antarctic ice loss as derived from CryoSat data (animated map and diagram)
- <https://www.resilience.org/stories/2018-06-15/sea-level-rise-due-to-antarctic-ice-melt-has-tripled-over-past-five-years/> - Report on the ice loss from Antarctica with a diagram assigning the loss to the main parts of Antarctica.
- [https://www.esa.int/Applications/Observing\\_the\\_Earth/FutureEO/CryoSat/Our\\_world\\_is\\_losing\\_ice\\_at\\_record\\_rate](https://www.esa.int/Applications/Observing_the_Earth/FutureEO/CryoSat/Our_world_is_losing_ice_at_record_rate) - Putting the different global ice loss contributions into context.

