Antarctic sea-ice plays an important role in regulating Earth's energy budget

October 29 2021

MetOp is a series of three polar-orbiting satellites launched by the European Space Agency in 2006, 2016, and 2018. All three satellites are still in use, and they orbit Earth 14 times each day. Credit: ESA/CC BY-SA 3.0 IGO

When Earth's snow and ice cover melts, the reflectivity of Earth's surface—known as albedo—decreases. And when the albedo of Earth's surface decreases, a smaller share of sunlight is reflected back into space. As a result, more solar radiation energy remains on Earth, warming its climate system. Similarly, as the snow and ice cover grows, reflectivity increases, which has a cooling effect. This mechanism is called snow and ice albedo feedback. The scale of the snow and ice albedo feedback is determined by, for example, the amount of sunlight and cloudiness.

In their new study published in *Nature Geoscience*, scientists from the Finnish Meteorological Institute and the Norwegian Institute of Bioeconomy Research calculated the heating and cooling effect of changes in reflectivity in both the Arctic and Antarctic regions. The study period was between 1982 and 2018 and calculations were based on satellite observations.

Albedo changes in polar regions alter Earth's energy budget

The results confirmed previous findings that melting of the snow and ice cover in the Arctic region since the 1990s has had a warming effect. In addition, the new study describes two significantly different developments taking place in the Antarctic region: Between 2000 and 2015, the expansion of the Antarctic sea-ice cover produced a cooling effect that largely balanced out the warming effect caused by the melting of the Arctic region. However, in 2016 there was a notable reduction in Antarctic sea-ice cover, which completely reversed the cooling effect that had increased over the previous 15 years.

"Our results highlight the important, but previously little-known, role of the Antarctica's sea-ice cover as a regulator of the radiative energy

budget in polar regions," says Aku Riihelä, Research Professor at the Finnish Meteorological Institute and the corresponding author of the study.

"The dramatic change in the sea-ice cover in 2016 also shows that major changes in the sea-ice cover can take place rapidly. For this reason, more attention should be paid to the monitoring of Antarctica and its sea-ice in the future, as well as the development of related models," Riihelä says.

Loss of Antarctic sea-ice could also add to the anthropogenic global warming

Between 1992 and 2018 the changes in the reflectivity of polar regions, on average, amounted to a global warming effect of +0.08 Watts per square meter. This corresponds to about 10 percent of the warming effect caused by annual anthropogenic carbon dioxide emissions since 1992. And this share may increase if the Antarctic sea-ice cover does not recover from its recent shrinkage.

"The question of whether the huge loss in Antarctic sea ice can be recovered is important, given the profound implications for Earth's radiative energy balance. The Antarctic has long served as a sort of refrigerator in the earth system. Breaking it beyond repair would really chip away at our remaining emission budgets, making it ever more difficult to meet our ambitious mitigation targets," says Ryan Bright, a Research Professor at the Norwegian Institute of Bioeconomy Research and one of the study's co-authors.

However, more recent studies have shown partial recovery in the Antarctic sea-ice.

"While this may be seen as good news, we cannot afford to dismiss the

2016–2018 reversal as anomalous until we really understand the mechanisms that caused it," says Bright.

More information: Aku Riihelä et al, Recent strengthening of snow and ice albedo feedback driven by Antarctic sea-ice loss, *Nature Geoscience* (2021). DOI: 10.1038/s41561-021-00841-x

Provided by Norwegian Institute of Bioeconomy Research