International study finds lightning storms are causing sea ice to melt faster at the North Pole

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An international study with the participation of researchers from Tel Aviv University has found that alongside the general warming of the

globe, lightning storms have been directly hastening the ongoing process of sea ice retreat covering the Arctic Ocean.

According to the researchers, "Until recently, lightning as a phenomenon was extremely rare in the Arctic region of the North Pole, due to the intense cold. However, due to the warming of the Earth, lightning storms have become more common there in the summers, and these storms further increase the melting process of the ice sheets—in a feedback loop."

Prof. Colin Price and MSc student Tair Plotnik from the Department of Geophysics at TAU's Porter School of the Environment and Earth Sciences participated in the study, alongside Dr. Anirban Guha and Dr. Joydeb Saha from Tripura University in India. The article is published in the journal *Atmospheric Research*.

Arctic's cold reality: Understanding rapid ice loss

Prof. Price explains, "The Arctic region is defined as the region located north of the 66.5° latitude. In the heart of this region, around the North Pole, there is no land, and due to the extreme cold conditions, the sea is covered with a thick layer of sea ice, which currently extends over about 8 million square kilometers. The white ice reflects the sun's rays and thus contributes to the cooling of the Earth.

"But in recent decades, with the warming of the Earth, the ice cover has retreated at a rate of about 70,000 square kilometers per year, or 6.5% per decade (In this context, it is important to note that the temperature at the North Pole has been rising at an accelerating pace—about 4° until today, in contrast to about 1° on Earth as a whole).

"The retreat of the ice increases the warming even further, because the dark areas of the ocean under the ice, which are getting bigger and

bigger, absorb the sun's rays that would normally be reflected in space. This is how a feedback loop is created: the retreat of the ice increases the warming, which in turn increases the melting of the ice, and the cycle repeats."

Lightning's role in polar ice melt

According to the researchers, the phenomenon of melting ice sheets at both poles is firstly attributed to the result of human activity due to the increase in the amount of greenhouse gases in the atmosphere, creating a kind of "blanket" that preserves the heat and does not allow it to disperse into space.

However, studies have not found a direct match between the greenhouse gas changes, which increase at a more or less constant rate every year, and the rate of sea ice melting, which varies immensely from year to year. This study sought to examine the possible effect of another factor—lightning storms—on the melting of the sea ice in the Arctic region.

The researchers explain that lightning, as a phenomenon, was extremely rare in the Arctic region until recently, due to the intense cold that prevails there. But in recent decades, apparently, due to global warming, lightning storms have been observed there in the summertime, when the sun does not set at all, heating the surface (lightning storms form when the surface of the ground heats up, and pockets of air rise in the atmosphere, where they cool, condense, and become clouds that sometimes develop into thunderstorms).

To test their hypothesis that lightning storms contribute to the melting of the ice around the North Pole, the researchers compared two sets of data: images from NASA satellites that have been documenting the retreat of the ice in the Arctic Sea for more than 40 years, and lightning

data collected by the global network WWLLN (wwlln.net)—which includes around 70 lightning detection stations, deployed in research institutions all over the world—one of which stands on the roof of the Faculty of Exact Sciences building at TAU.

Prof. Price explains, "Lightning is the result of a massive electric field that is discharged at once and transmits radio waves that can be received even thousands of kilometers away from the lightning. The global network's sensors detect and map thunderstorms anywhere on the planet, in real-time and non-stop.

"Cross-referencing the information from the various stations allows for an accurate determination of the location and time of each lightning strike detected, and thus, a global map of lightning over time is obtained. For this study, we collected data on lightning in the Arctic region during the summer months of June, July and August every year since 2010."

Lightning storms: Catalysts for polar ice melt

A statistical analysis of the ice sheet retreat crossed with the number of lightning storms revealed a correlation: As the number of storms increased in a certain year, so did the melting of the sea ice increase that year. The researchers explain this by comparing thunderstorms to a giant vacuum cleaner, sucking water vapor up from the surface layer to the upper atmosphere (5-10 km altitude), where it accumulates and acts like an additional blanket, trapping the surface heat from leaving, and increasing the surface temperature—just like man-made greenhouse gases.

Another possibility observed in a previous study is that these same lightning storms lead to an increase in the formation of high cirrus clouds in the upper layers of the atmosphere—which also form a similar "blanket."

Prof. Price concludes, "In our research, we found a clear statistical relationship between the number of lightning storms in the Arctic region in a certain year and the rate of sea ice melting that year. This means that the storms are another factor that increases the melting of the polar ice, producing a feedback loop: The initial melting of the ice increases the dark surface areas of the sea, which absorb more of the sun's rays, warming up the waters, causing more melting, accelerating the rate of warming, which in turn increases the number of lightning storms, and the cycle repeats itself.

"As a result of this, and of the warming of the Earth in general, we expect that the frequency of lightning storms in the Arctic region will increase in the coming years, and with it, the rate of sea ice retreat in the Arctic Sea will accelerate."

More information: J. Saha et al, Are thunderstorms linked to the rapid Sea ice loss in the Arctic?, *Atmospheric Research* (2023). DOI: 10.1016/j.atmosres.2023.106988

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