Giant atmospheric rivers add mass to Antarctica's ice sheet

January 20 2015

East Antarctica, near the Princess Elisabeth base. This photograph, taken in February 2011 shortly after a storm had passed, shows the dramatic cloud structures that can accompany snowstorms in Antarctica. Credit: Irina Gorodetskaya

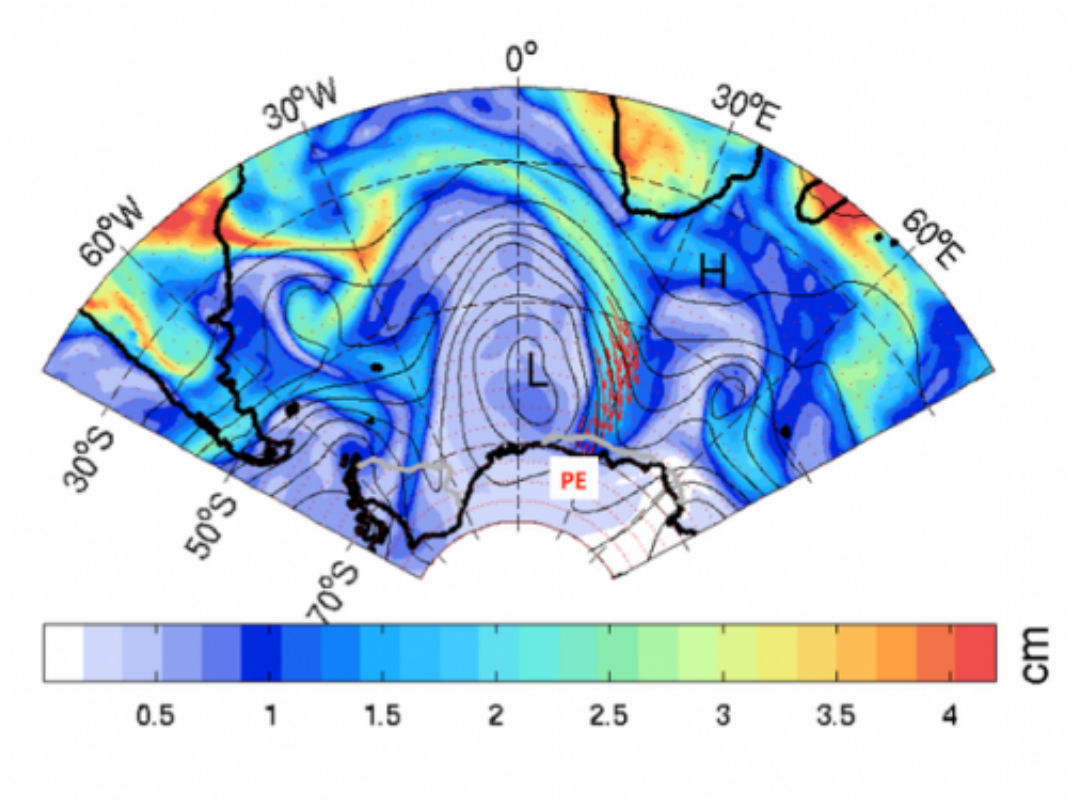
Extreme weather phenomena called atmospheric rivers were behind intense snowstorms recorded in 2009 and 2011 in East Antarctica. The resulting snow accumulation partly offset recent ice loss from the Antarctic ice sheet, report researchers from KU Leuven.

Atmospheric rivers are long, narrow water vapour plumes stretching thousands of kilometres across the sky over vast ocean areas. They are capable of rapidly transporting large amounts of moisture around the globe and can cause devastating precipitation when they hit coastal areas.

Although atmospheric rivers are notorious for their flood-inducing impact in Europe and the Americas, their importance for Earth's polar climate - and for global sea levels - is only now coming to light.

In this study, an international team of researchers led by Irina Gorodetskaya of KU Leuven's Regional Climate Studies research group used a combination of advanced modelling techniques and data collected at Belgium's Princess Elisabeth polar research station in East Antarctica's Dronning Maud Land to produce the first ever in-depth look at how atmospheric rivers affect precipitation in Antarctica.

The researchers studied two particular instances of heavy snowfall in the East Antarctic region in detail, one in May 2009 and another in February 2011, and found that both were caused by atmospheric rivers slamming into the East Antarctic coast.



A meteorological image of an atmospheric river slamming into the East Antarctic coast on 15 February 2011. L indicates the atmospheric river's low-pressure trough and H indicates the blocking high-pressure ridge further downstream, directing moisture transport (red arrows) into the Dronning Maud Land and the Princess Elisabeth base (white square). The colours show total moisture amounts (in centimetres equivalent of water). Credit: Irina Gorodetskaya

The Princess Elisabeth polar research station recorded snow accumulation equivalent to up to 5 centimetres of water for each of these weather events, good for 22 per cent of the total annual snow accumulation in those years.

The findings point to atmospheric rivers' impressive snow-producing power. "When we looked at all the extreme weather events that took

place during 2009 and 2011, we found that the nine atmospheric rivers that hit East Antarctica in those years accounted for 80 per cent of the exceptional snow accumulation at Princess Elisabeth station," says Irina Gorodetskaya.

And this can have important consequences for Antarctica's diminishing ice sheet. "There is a need to understand how the flow of ice within Antarctica's ice sheet responds to warming and gain insight in atmospheric processes, cloud formation and snowfall," adds Nicole Van Lipzig, co-author of the study and professor of geography at KU Leuven.

A separate study found that the Antarctic ice sheet has lost substantial mass in the last two decades - at an average rate of about 68 gigatons per year during the period 1992-2011.

"The unusually high snow accumulation in Dronning Maud Land in 2009 that we attributed to atmospheric rivers added around 200 gigatons of mass to Antarctica, which alone offset 15 per cent of the recent 20-year ice sheet mass loss," says Irina Gorodetskaya.

"This study represents a significant advance in our understanding of how the global water cycle is affected by atmospheric rivers. It is the first to look at the effect of atmospheric rivers on Antarctica and to explore their role in cryospheric processes of importance to the global sea level in a changing climate," says Martin Ralph, contributor to the study and Director of the Center for Western Weather and Water Extremes at the University of California, San Diego.

"Moving forward, we aim to explore the impact of atmospheric rivers on precipitation in all Antarctic coastal areas using data records covering the longest possible time period. We want to determine exactly how this phenomenon fits into climate models," says Irina Gorodetskaya.

"Our results should not be misinterpreted as evidence that the impacts of global warming will be small or reversed due to compensating effects. On the contrary, they confirm the potential of the Earth's warming climate to manifest itself in anomalous regional responses. Thus, our understanding of climate change and its worldwide impact will strongly depend on climate models' ability to capture extreme weather events, such as atmospheric rivers and the resulting anomalies in precipitation and temperature," she concludes.

More information: The study, "The role of atmospheric rivers in anomalous snow accumulation in East Antarctica", was published recently in the American Geophysical Union's *Geophysical Research Letters*: onlinelibrary.wiley.com/doi/10 … 014GL060881/abstract

Provided by KU Leuven