neglects not only latitudinal variations. The strength of this circulation system is derived by integrating a complex three-dimensional system of currents along latitude lines, and therefore also neglects variations in circulation with longitude. When modelling the Antarctic Circumpolar Current, such a two-dimensional view is highly misleading: there it suggests that surface water sinks to the deep ocean[8], when in fact, it drops only a few hundred metres at most as Antarctic intermediate water is formed. Key processes, such as the convective mixing of surface and deep water, are also missed when only net downward or northward transport is considered[9]. The extent to which zonally integrated measures of the Atlantic MOC similarly misinform climate studies in the North Atlantic is unclear.

Lozier *et al.*[3] provide clear evidence for latitude-dependent changes in the Atlantic MOC. Combined with the limitations associated with zonal integration, their findings suggest the need for alternative measures of this circulation system that address the specific problem being studied. For the climate of western Europe, heat transport at a specific latitude may be the most informative property. For the carbon cycle, it would be more important to determine the rate at which deep water is replenished by surface waters. The overarching challenge for climatologists is to discern how a changing climate will affect each of these measures separately. ❐

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CLIMATE SCIENCE

Polar low-down

Small-scale, but intense storms strike the Arctic and Southern oceans every winter. These polar low-pressure systems create hazardous shipping conditions and threaten offshore activities such as oil and gas exploration. Like tropical cyclones, the storms usually dissipate once they hit the land, but on occasion they create heavy snowfall and gale-force winds that disrupt coastal communities.

Seafarers and Scandinavian coastal communities have felt the effect of these lows for centuries, and stories of sailors' battles with violent and unexpected storms have entered folklore. Indeed, the loss of many small ships that sailed at high northern latitudes has been attributed to these lows.

Polar lows were officially recognized as a distinct meteorological phenomenon only following the advent of polar-orbiting satellites in the 1960s. Yet they have remained elusive. Polar lows are notoriously difficult to forecast. And, owing to their small size and transitory nature, they are often missed in coarse-resolution global climate models.

Yet climate warming may bring relief from these storms. Matthias Zahn and Hans von Storch simulated the frequency and distribution of polar lows in the North Atlantic Ocean under three global warming scenarios, using a high-resolution regional climate model (*Nature* **467,** 309–312; 2010). Encouragingly, in their simulations the frequency of polar lows dropped substantially over

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the twenty-first century, as a result of anthropogenic-induced warming.

Just like many species of birds, trees and butterflies, and in accordance with a northward-shifting ice edge, polar lows were found to migrate northwards in a warmer climate. As a result, the present-day clustering of storms south of Iceland disappeared, and the concentration of storms in the Barents Sea shifted north into the Greenland Sea.

A diminishing temperature gradient at the polar sea surface could explain the projected reduction in storm frequency in a warmer world: a large contrast between the relatively warm upper ocean and the icy overlying air is known to favour the formation of polar lows. Over the next century, the North Atlantic Ocean is expected to warm only moderately, whereas the lower atmosphere in the Arctic is expected to warm more intensely than the global average. As the temperature gap between the surface ocean and the lowermost atmosphere closes, conditions will become less conducive for the development of polar lows.

Climate change is typically associated with the intensification of extreme weather events. Polar lows seem to be one instance in which we may look forward to relief from adverse conditions.

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