transitions between satellites, and stitched together different time periods by correcting for estimated biases. They then scaled the satellite ice-drift series to make it consistent with observed buoy drift.

To reconstruct a time series of ice thickness, the authors turned to a model-based estimate of ice-thickness trends constrained by observations of ice concentration. They then adjusted for potential biases in the modelled thicknesses using both sparse *in situ* data[10] and ice-thickness estimates from satellite data[11]. The time series for ice drift and thickness allowed Haumann *et al.* to make more-robust estimates of freshwater transport than were previously possible. This, in turn, allowed them to estimate the impact of transport trends on the salinity of the Southern Ocean using a simple model of water-mass exchange between the surface and the deeper waters.

The researchers show that the net transport of sea-ice-driven fresh water is substantial: larger than the inputs from glacial melt and comparable to the net input of precipitation and evaporation[9]. The estimated temporal trends are also sizeable: there is a 20% increase in transport over the 26-year study period. Notably, however, there is considerable regional variability in freshwater transport trends, including a large increase in the Pacific sector of the Southern Ocean (which encompasses the Ross Sea, where positive trends in northward ice drift and extent are largest[12]). Transport has decreased slightly elsewhere. Overall, Haumann *et al.* estimate that sea-ice-driven transport has contributed enough fresh water to the open-ocean surface and intermediate waters to explain the observed freshening.

A compelling result is that the calculated trends in sea-ice-driven freshwater transport are consistent with other observed patterns of change. First, the increases in freshwater transport occur in the Pacific sector, where increased freshening in surface waters has been strongest[2]. Second, the increase in salt input due to sea-ice production in the coastal Pacific sector might explain why the observed freshening of Antarctic Bottom Water is less than that predicted from increased glacial melt[5].

It is striking that major changes to ocean properties can occur as a result of relatively small average changes in sea-ice cover. Sea-ice extent has increased only slightly overall during the period covered by the time series, albeit with strongly contrasting regional patterns of change[13]. These regional changes were partly wind-driven[12], but, as Haumann *et al.* show, there may be little to no trend in the mean drift speed of sea ice. This demonstrates that it is the coupled trends in regional ice thickness and ice drift that are key to driving freshwater redistribution.

An important caveat to the findings is that the uncertainty in the derived trends is considerable, and potentially underestimated. The corrections for bias in ice drift are large, and are difficult to quantify for the earlier years, for which there are almost no independent data available to provide validation. Nevertheless, the authors' estimates of freshwater transport remain similar when they are based on ice drift estimated from surface winds, which are a reasonable proxy for drift. The need for better ice-thickness estimates is also clear; ice thickness is the largest source of uncertainty in the results, and ice-thickness trends are the least well constrained by observations. However, a recent complementary study[9] that used a broader array of observations collected between 2005 and 2010 to constrain a coupled ice–ocean model broadly supports the regional patterns of sea-ice-driven freshwater transport estimated in the current study, allaying concerns about the uncertainties.

Haumann and colleagues' findings emphasize that Antarctic sea ice is not merely a passive indicator of climate change and variability, but also a driver of changes in the climate system. Through its potential influence on ocean stratification and CO_2 uptake, sea ice might have a bigger role than previously thought.

The implications of these results for the Southern Ocean in a warming world are uncertain, because climate models do not properly capture the observed changes in Antarctic sea ice[14]. However, anticipated future declines in ice extent and volume would suggest that sea-ice freshwater transport should decrease. If so, then future losses of sea ice can be expected to play a prominent part in changes in the Southern Ocean's overturning circulation. ■

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50 Years Ago

Savage found that pondweeds in the presence of light stimulate spawning in *Xenopus laevis* … This finding prompts me to report my own experience with this amphibian under more natural conditions … At the Provincial Fisheries Institute, Lydenberg, fishponds … are filled with water and fertilized with fowl manure in spring for the breeding of fish. Within 2 or 3 days after fertilization such ponds usually contain large numbers of *Xenopus*, which immediately start spawning, so that by the time plankton has developed the pond is teeming with larvae … that they are attracted by fertilized water and spawn before an algal bloom develops suggests that the primary stimulus for spawning … could be the fertilizer.
From *Nature* 3 September 1966

100 Years Ago

Mr. Beebe has had a wide experience of jungle-life in many lands, and hence his latest experiences in Brazil have the greater value … Abundance of species and a relative fewness of individuals, he remarks, are pronounced characteristics of any tropical fauna … He quickly discovered that more was to be obtained by watching particular trees … [D]uring the space of a week of intermittent watching he obtained no fewer than seventy-six new species … Just before leaving a brilliant idea struck Mr. Beebe … he suddenly bethought him to fill a bag with four square feet of jungle earth, and this was examined … while on board ship on the voyage home … Among the captures thus made were representatives of two genera of ants new to science. There can be no doubt that important discoveries … would accrue if this example of Mr Beebe's were generally followed in the future.
From *Nature* 31 August 1916