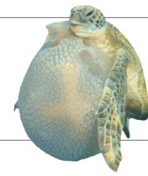
THIS WEEK

EDITORIALS

AWARDS Nature Research announces two awards for women in science **p.150**

WORLD VIEW Make drugs that improve quality of life for people with cancer **p.151**



GRIP AND FLIP Turtles use their flippers to hold and eat prey **p.153**

Watch the ocean

Long-term monitoring is essential for working out how changes in the Atlantic Ocean current system will affect the planet.

The Atlantic meridional overturning circulation (AMOC) has spurred scientific interest and human imagination for decades. A complex and fundamental system of ocean currents, including the wind-driven Gulf Stream, the AMOC influences the exchange of heat between the tropics and high latitudes. Driven mainly by cold, dense water in the salty Greenland and Labrador seas sinking to the bottom of the North Atlantic Ocean, the circulation regulates temperature and so serves as a global thermostat.

But for how much longer? Potential sharp changes in the circulation have been identified as a possible tipping point in Earth's physical systems. Since the 1950s, geologists and oceanographers have been gathering convincing evidence that alterations in ocean circulation are a key determinant of climate change.

Ice-core records from Greenland suggest that abrupt shifts in circulation strength triggered dramatic temperature fluctuations during the last glacial period. Climate fluctuations on such a scale have, fortunately, not occurred in the present Holocene interglacial era. Still, signs of a markedly weakening AMOC, reported in 2005 (H. L. Bryden *et al. Nature* **438**, 655–657; 2005), provoked concern that the circulation might be on the brink of tipping into a weak phase once again, possibly as a result of human-induced climate warming.

Subsequent ocean observations, from arrays of sensors strung across the North Atlantic, offered a more reassuring picture: the current was hugely variable, and so a single snapshot could be unrepresentative.

Researchers have now gone back and taken another look. In a paper in *Nature* this week, scientists present palaeo-oceanographic evidence that deep convection of surface waters in the North Atlantic — the engine that keeps the AMOC in constant motion — began to decline as early as around 1850, probably owing to increased freshwater influx from Arctic ice that had melted at the end of a relatively cold period called the Little Ice Age (D. J. R. Thornalley *et al. Nature* **556**, 227–230; 2018). This could have caused a weakening in the ocean circulation.

In a second paper, researchers used global climate models and data sets of sea surface temperature to date the onset of the weakening to more recent times, around the mid-twentieth century (L. Caesar *et al. Nature* **556**, 191–196; 2018). According to their models, the slowdown was about 15%; was most pronounced during winter and spring; and has led to a cooling of sea surface temperatures in parts of the northern Atlantic, together with a slight northward shift of the mean Gulf Stream path. This, the authors say, is probably a consequence of anthropogenic climate change.

Importantly, the findings agree that the AMOC is in a relatively weak state. The wide margin of disagreement between the two independent studies on when the circulation started to weaken is probably due to the different methods used — and it highlights how immensely difficult it is to capture the AMOC's past variability. This will probably frustrate those who prefer their science to send a clear signal. But then, science is rarely so obliging. Can the effects of climate change and natural variability on the AMOC be disentangled? And if the ocean circulation is sensitive to climate change, as is highly likely, will the currents respond abruptly and perhaps violently at some point, or will the transition be smooth? These are among the most pressing questions in climate science.

The slow progress on answering them should offer a stark reminder that the oceans are the most under-sampled component of the Earth system. The AMOC is just one part of a world-spanning circulation system, the physics — and influence on chemical cycling — of which is only poorly understood.

Numerical models are an indispensable tool for studying ocean circulation and climate. But despite ever-increasing computer power, models fall short when it comes to reconstructing something as nuanced and variable as ocean circulation. Long-term, serial measurements of circulation strength are what is needed.

It is crucial, therefore, that existing ocean monitoring systems — including the Overturning in the Subpolar North Atlantic Program and the South Atlantic Meridional Overturning Circulation programme — are maintained over decades to come. Data from these arrays of monitoring instruments are just beginning to shed light on the complex water flows in key ocean regions. Yet securing funding for lengthy studies is an ongoing fight.

There is more to be done. A United Nations sustainable development goal already includes a call for greater research capacity for promoting ocean health. Regional and national ocean-observation efforts should be coordinated, ideally under the Global Ocean Observing System. Meticulous observation is a prerequisite for understanding the oceans on which, ultimately, humankind depends. ■ **SEE NEWS & VIEWS P.180**

Cosmic sirens

Gravitational waves could help us understand differing measurements of the Universe.

Cosmology has come a long way since Edwin Hubble determined the rate of cosmic expansion around 90 years ago. Since the 1990s, multiple independent techniques have converged on values much lower than Hubble's. They differ by less than 10%, but the differences seem to be statistically significant (3.7 standard deviations). Innovative techniques, including the detection of gravitational waves from stellar collisions such as one that astronomers witnessed last August, should settle the question in the next few years. The answer could contain some new and unexpected physics.

In our expanding Universe, a galaxy's rate of recession from our own can be measured easily from its redshift — how much its light waves stretch as they travel, owing to the expansion of the intervening space. The difficult part is measuring the galaxy's distance. With his early