Climate: New spin on ocean's role

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New studies of the Southern Ocean are revealing previously unknown features of giant spinning eddies that have a profound influence on marine life and on the world's climate.

These massive swirling structures – the largest are known as gyres - can be thousands of kilometres across and can extend down as deep as 500 metres or more, a research team led by a UNSW mathematician, Dr Gary Froyland, has shown in the latest study published in *Physical Review Letters*.

"The water in the gyres does not mix well with the rest of the ocean, so for long periods these gyres can trap pollutants, nutrients, drifting plants and animals, and become physical barriers that divert even major ocean currents," Dr Froyland says.

"In effect, they provide a kind of skeleton for global ocean flows. We're only just beginning to get a grip on understanding their size, scale and functions, but we are sure that they have a major effect on marine biology and on the way that heat and carbon are distributed around the planet by the oceans."

One of the best known large-scale gyres in the world's oceans is that associated with the Gulf Stream in the North Atlantic, notes fellow researcher Professor Matthew England, co-director of the UNSW Climate Change Research Centre.

"This current pumps massive amounts of heat towards Europe, warming the atmosphere and giving the region a relatively mild climate: to see how important that is, you only have to compare Portugal's climate to that of Nova Scotia, in Canada, which as roughly the same latitude," says Professor England.

"After releasing heat to the atmosphere the waters re-circulate toward the equator, where they regain heat and rejoin the flow into the Gulf Stream. In this way the ocean's gyres play a fundamental role in pumping heat poleward, and cooler waters back to the tropics. This moderates the planet's extremes in climate in a profound way, reducing the equator-to-pole temperature gradients that would otherwise persist on an ocean-free planet."

The East Australia Current has a similar, although more modest, impact on local climate on the Australia's east coast. Eddies also regulate biologically important properties such as nutrient upwelling to the surface. They are also fundamental in mixing heat across the Antarctic Circumpolar Current.

The Australian team is working with German colleagues at the University of Paderborn and the Technical University of Dresden. The team discovered last year that these gyres can escape detection by traditional observational methods, which concentrate on scrutinising average water flow or sea surface height.

Instead of monitoring flow in the ocean point by point, the team applied a mathematical technique known as Lagrangian analysis, which allowed them to take into account all possible current movements simultaneously and pick out the least intensive mixing regions. Using computer simulations, they found that this technique clearly identified where gyres and eddies trap drifting surface material in the seas near Antarctica.

The work is presently being extended to assess how the threedimensional flow in the gyres extends deep down into the ocean. This will reveal their potential to influence climate and marine life, Dr Froyland says.

Source: University of New South Wales