Ocean circulation rethink solves climate conundrum

September 28 2015

Credit: Tiago Fioreze / Wikipedia

Researchers from the University of Exeter believe they have solved one of the biggest puzzles in climate science. The new study, published in *Nature Geoscience*, explains the synchrony observed during glacial periods when low temperatures in the Southern Ocean correspond with low levels of atmospheric carbon dioxide (CO_2).

The interdisciplinary study, carried out in collaboration with the University of Tasmania, demonstrates how a reconfiguration of ocean circulation can result in more carbon being stored in the deep ocean that previously thought.

The researchers used a computer model representing the physics of the ocean along with a biogeochemical model of ocean chemistry to show how the so far neglected aspect of changed water buoyancy can make a major contribution to atmospheric CO_2.

During an ice age, the glacial conditions on Antarctica mean that the water near to the continent is colder and so less buoyant. The upwelling of warmer water - during which CO_2 is lost to the atmosphere - occurs further away from Antarctica enabling carbon dioxide to be drawn down into the ocean, and also producing a larger volume of deep cold water in the Southern Ocean in which carbon can be stored.

Professor Andrew Watson from Geography at the University of Exeter said: "Our study offers a new explanation for a problem that has occupied oceanographers and climate scientists for more than 30 years - what caused atmospheric CO_2 to increase and decrease in near-perfect synchrony with the series of glacial cycles that have occurred over the last million years?

"This is a major advance in our understanding of the natural carbon cycle that comes from applying new ideas about how the 'overturning circulation' of the Southern Ocean works."

Professor Geoffrey Vallis from Mathematics at the University of Exeter said: "We combined a model of the ocean circulation with a model of the carbon cycle and obtained a rather striking result, hopefully throwing some new light on an old problem."

The new mechanism provides an explanation for the positive feedback that occurs during an ice age. As the temperature drops, more CO_2 is absorbed into the ocean resulting in less atmospheric CO_2 and so a reduction in the greenhouse effect, meaning that it gets colder still. And so the cycle continues.

Scientists had previously presumed that the reduced levels of CO_2 in the atmosphere during an ice age meant that more CO_2 was being stored in the oceans but this new mechanism explains how this can actually occur and why it is that temperatures in a specific region of the world - Antarctica - are so closely linked to the atmospheric CO_2 concentration.

More information: Southern Ocean buoyancy forcing of ocean ventilation and glacial atmospheric CO2, *Nature Geoscience*, DOI: 10.1038/ngeo2538

Provided by University of Exeter