Retooling the ocean conveyor belt

June 18 2010

For decades, oceanographers have embraced the idea that Earth's ocean currents operate like a giant conveyor belt, overturning to continuously transport deep, cold polar waters toward the equator and warm equatorial surface waters back toward the poles along narrow boundary currents. The model held that the conveyor belt was driven by changes in the temperature and salinity of the surface waters at high latitudes.

In a paper in the June 18 issue of *Science*, a Duke University oceanographer reviews the growing body of evidence that suggests it's time to rethink the conveyor belt model.

"The old model is no longer valid for the ocean's overturning, not because it's a gross simplification, but because it ignores crucial elements such as eddies and the wind field. The concept of a conveyor belt for the overturning was developed decades ago, before oceanographers had measured the eddy field of the ocean and before they understood how energy from the wind impacts the overturning," says Susan Lozier, professor of physical oceanography and chair of the Division of Earth and Ocean Sciences at Duke University's Nicholas School of the Environment.

"It is important to understand that there is clear and convincing evidence that the ocean waters overturn and that this overturning impact's the Earth's climate," she says. "Recent studies, however, have cast doubt on our ability to describe this overturning as a conveyor belt. From these studies we now understand that the overturning waters are not restricted to narrow boundary currents, that the overturning may vary from one

ocean basin to the next and that the winds may create variability in the amount of water that overturns and in the pathways for the upper and lower limbs of the overturning."

The *Science* article also reviews what remains unknown about the ocean's overturning. As surface waters warm and/or freshen due to climate change, how might the overturning change? Though modeling studies have addressed this question, there has been no observational study.

A new international research program in the planning stages, led by Lozier, aims to address the question of climate effects. The initiative will bring together researchers from the United States, Germany, Canada, France and the United Kingdom to study overturning in the northern North Atlantic over a five-to-10-year period.

In her *Science* article, Lozier reviews the emerging view of the overturning circulation within a historical framework that chronicles significant scientific developments in the field, from the first reported measurement of ocean overturning in 1751 through the present.

"Basically, our ability to refine our understanding of the ocean's overturning stems in large part from our ever increasing ability to measure the ocean at finer and finer scales and at depths previously unmeasured," she says. "Because the ocean waters are corrosive, at high pressure and generally inaccessible, the ocean has historically been a sparsely observed system. Recent technological advances are rapidly expanding the ocean's observational database and with it, our understanding of ocean circulation."

Provided by Duke University

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