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RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals

Large channels perforate underside of Antarctica's Fimbul Ice Shelf

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Kirsty Langley working with radar on the Fimbul Ice Shelf.

In November 2010 *Langley et al.* used ground-penetrating radar to capture high-resolution measurements of the internal structure of the Fimbul Ice Shelf, a roughly 200 by 100 kilometer sheet of ice that floats off the coast of eastern Antarctica. They found that the ice shelf appears to be decaying from below. At the glacier-ocean boundary, the ice is perforated by a network of channels, grooves cut into the ice that are as wide as the glacier is thick.

The authors found ice bottom channels carved both parallel and at angles to the glacier flow direction. The channels typically range from 300 to 500 meters wide and 50 meters tall for the more common narrow channels; the largest detected channel is up to 1.5 kilometers wide and 75 meters tall.

Ice shelves are important for the role they play in stabilizing on-shore glaciers, and their degradation is often considered a cause for alarm. Whether the Fimbul Ice Shelf channels are unusual, however, is not clear.

Such basal channels have been seen previously in other ice shelves, with similar cuts first detected in the 1970s. Those glacier bottom grooves, however, have typically been found in regions where the surface ocean water is warm enough to promote glacier melting. The Fimbul Ice Shelf, however, floats atop the cold waters off Queen Maud Land in eastern Antarctica, where the water rarely gets above the local freezing point.

The observations suggest that ice shelf bottom channels could be more prevalent than previously thought. That these basal channels are not predicted in ice shelf–ocean models suggests that there are glacier-ocean interactions not currently being considered in those simulations. (*Geophysical Research Letters,* doi:10.1002/2013GL058947, 2014) —CS

Stream and groundwater interactions affect streambed water fluxes

Just beneath the sediment surface of a streambed is the hyporheic zone, where stream water and groundwater mix. The hyporheic zone is a hot spot for chemical and biological processes. How water moves into and out of the hyporheic zone is an important factor controlling the biogeochemistry and biology of the stream ecosystem.

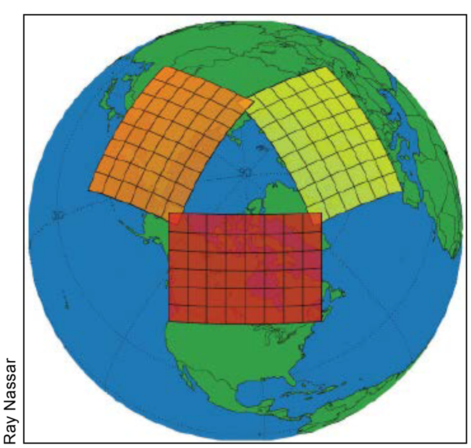
The flow of stream water into the hyporheic zone and back into the stream, known as hyporheic exchange, is affected by a number of factors, most strongly by the stream water velocity. Another important factor guiding the amount of hyporheic exchange is whether the stream is gaining or losing water through the interactions with the groundwater. Though the effect of groundwater levels on hyporheic exchange has been modeled, it has never before been tested and verified in the laboratory. Using a unique flume apparatus that lets researchers control the rates of water flow in the stream and the exchange of water with the groundwater—by pumping water into and out of the bottom of the streambed—*Fox et al.* tested the effect of gaining and losing flow conditions on hyporheic exchange.

Tracers injected into the stream allowed the authors to track the rate of hyporheic exchange across a range of stream velocities and subsurface fluxes. As predicted by theoretical work, the authors found that increasing the gaining or losing flux reduced the rate of hyporheic exchange in a similar manner. They also found that while the hyporheic exchange under small losing and gaining fluxes was controlled by the stream water velocity, at high fluxes the exchange flux became the controlling factor of water and solute exchange between the stream and the groundwater. (*Water Resources Research,* doi:10.1002/2013WR014668, 2014) —CS

Highly elliptical orbit satellites better at observing high-latitude CO_2

Boreal forests have a significant influence on the global carbon cycle. Arctic permafrost holds about twice the amount of carbon as the Earth's atmosphere. Since the boreal and Arctic region (50°N–90°N) has experienced the largest temperature increases in recent decades, understanding its influence on the global carbon cycle will become increasingly important as the climate continues to warm.

Satellite missions have been planned and launched in recent years to investigate greenhouse gases and the dynamics of the carbon cycle. However, the Canadian government is currently considering launching a pair of satellites that would be in a highly elliptical orbit (HEO), as opposed to the satellites already in low-Earth orbit (LEO) or those planned for geosynchronous orbits (GEO). While the latter two types of satellites aim to vastly improve the understanding of the global carbon cycle,



Ray Nassar

Each colored region could be scanned by the proposed highly elliptical orbit dual-satellite mission to map column carbon dioxide over land during daylight hours.

Nassar et al. note that GEO and LEO satellites are lacking in the kind of temporal and spatial coverage needed to study the carbon cycle influence from the high northern latitudes of boreal forests and the Arctic permafrost.

The authors set out to investigate the capabilities of a HEO satellite mission compared to a LEO mission with an inversion model and sets of simulated atmospheric carbon dioxide data. The authors found that the HEO satellite mission would be able to provide much better spatial and temporal coverage of the northern regions than a satellite in low-Earth orbit, particularly during the summer months. With these more comprehensive measurements, scientists will be better able to observe and quantify the carbon cycle dynamics of northern forests and permafrost. (*Journal of Geophysical Research: Atmospheres,* doi:10.1002/2013JD020337, 2014) —JW

Assessing model representations of stratospheric equatorial waves

Some westward-propagating Rossby-gravity waves and eastward Kelvin waves can travel up through the atmosphere following their formation in the tropical troposphere. Once they reach the stratosphere, these waves dissipate, releasing their energy. Known as stratospheric equatorial waves, these Rossby-gravity and Kelvin waves are an important aspect driving the quasi-biennial oscillation (QBO), a roughly monthly reversal, in the direction of the equatorial stratospheric winds. Similar to other atmospheric systems, such as the El Niño–Southern Oscillation or the North Atlantic Oscillation, the phase of the QBO affects global weather patterns, particularly in North America and western Europe.

A growing appreciation of the importance of stratospheric dynamics on global weather means that researchers are increasingly including representations of the atmospheric region in general circulation models. In a new study, *Lott et al.* analyze how well nine global Earth system models are able to represent stratospheric Kelvin and Rossby-gravity waves.

Although all of the models realistically represented some properties of the stratospheric equatorial waves (compared to observations), the authors found prominent differences between models that were designed to simulate QBO and those that were not.

The QBO-simulating models, the authors found, produced Kelvin and Rossby-gravity waves that were higher amplitude and Rossby-gravity waves that propagated eastward more quickly than in the non-QBO models. In general, the QBO models did a better job than the non-QBO models in representing Rossby-gravity waves, although the non-QBO models are more skilled at simulating Kelvin waves.

The reason for the QBO models' superiority, the authors suggest, is that models designed to represent the QBO have higher vertical resolutions. (*Journal of Geophysical Research: Atmospheres,* doi:10.1002/2013JD020797, 2014) —CS

Synthetic greenhouse gases to decline if Montreal Protocol amended

The Montreal Protocol, an international treaty designed to reduce the release into the atmosphere of ozone-depleting gases such as hydrochlorofluorocarbons and chlorofluorocarbons, has been successful since its implementation in the late 1980s. However, related greenhouse gases, such as hydrofluorocarbons (HFCs), have increased in concentration in the atmosphere since then. HFCs, along with other synthetic greenhouse gases (SGHGs), account for a radiative forcing almost 20% as large as that due to the increase in carbon dioxide (CO_2) since the preindustrial era.

The Montreal Protocol does not address HFCs, but amendments have been proposed to phase down their use. *Rigby et al.* used global SGHG data, gathered both in situ and from archived air samples, to explore historical trends in SGHG and the effect of an HFC reduction policy on global radiative forcing.

They found that the proposed amendment to the Montreal Protocol, combined with existing commitments, would decrease the amount of SGHGs in the atmosphere by approximately 26% by 2050 and could avoid the equivalent of between 0.5 and 3 years of global CO_2 emissions over this period. (*Geophysical Research Letters,* doi:10.1002/2013GL059099, 2014) —JW

—Colin Schultz, Writer, and JoAnna Wendel, Staff Writer