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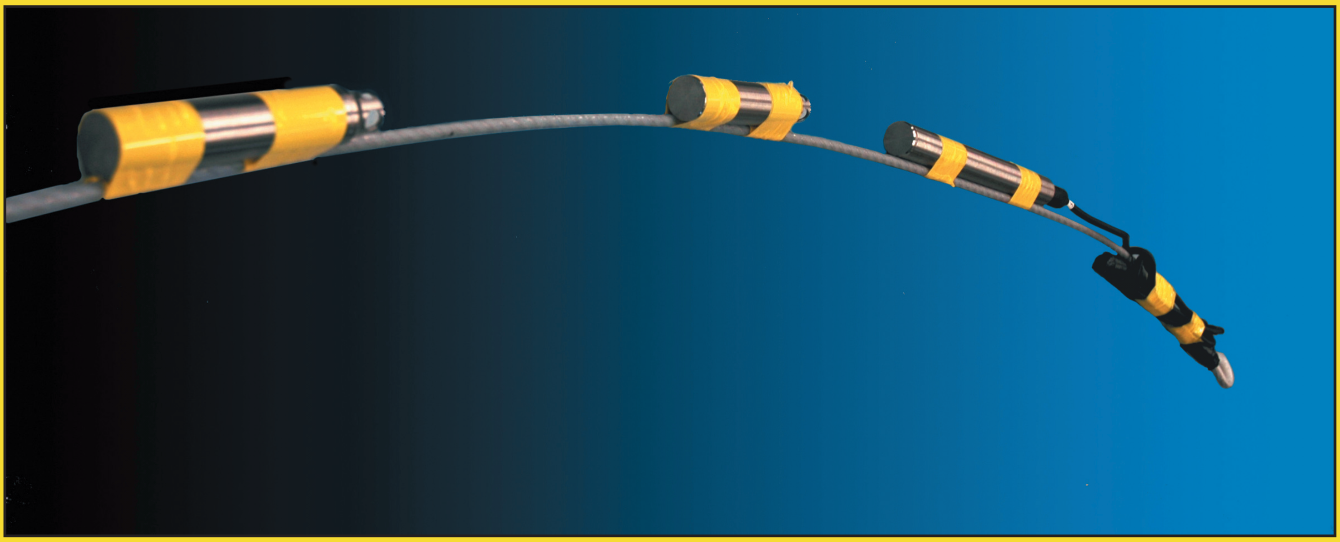

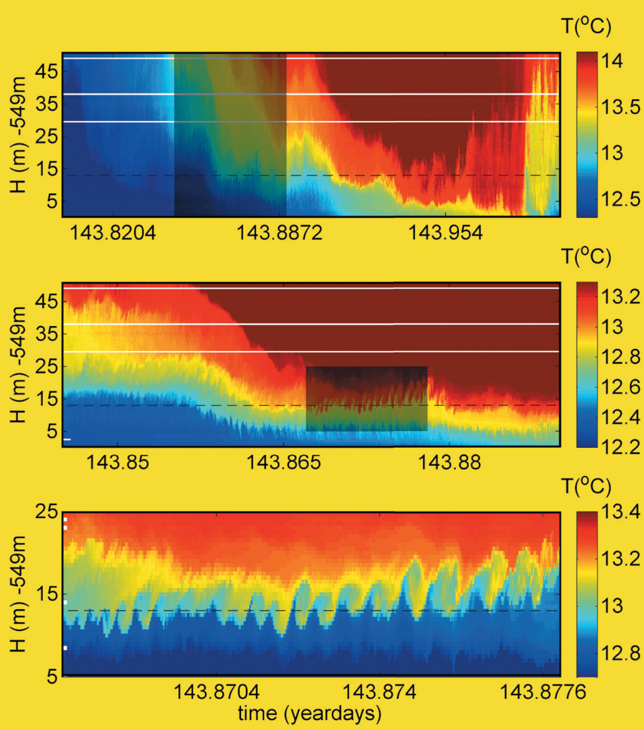


Deep-ocean billows observed • Solar wind pressure drives away Mars's atmosphere • Lack of ice "arches" in 2007 led to loss of ice from Arctic Ocean • Estimating climate feedbacks

# Highlights of this issue

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## Deep-ocean billows observed

Ocean wave mixing in the deep ocean is important to ocean circulation, but detailed observations are rare of turbulent mixing at the ocean floor. To take a more detailed look at deep-ocean wave patterns, **van Haren and Gostiaux [L03605]** designed moored temperature sensors to observe overturning above the sloping side of the Great Meteor seamount, an underwater tablemount in the Canary basin. They observed a turbulent mixing pattern with puffy, billowing structures called a Kelvin-Helmholtz billow train. Kelvin-Helmholtz instabilities have been previously observed in the laboratory, in the atmosphere, and near the surface of the ocean; this is the first reported detailed observation of these structures in the deep ocean. The researchers observed patterns with as many as 10 billows forming a train. The observations show how internal ocean waves break above the slopes of the ocean bottom, creating turbulent mixing in the deep ocean. The authors note that this kind of turbulent mixing is important in stirring up sediments and returning nutrients to the water column and could be significant for ocean circulation.

## Solar wind pressure drives away Mars's atmosphere

Mars is constantly losing parts of its atmosphere to space. The processes driving that loss of atmosphere are not completely understood. A new study shows that pressure from solar wind pulses is a significant contributor to Mars's atmospheric escape. **Edberg et al. [L03107]** analyzed solar wind data and satellite observations that tracked the flux of heavy ions leaving Mars's atmosphere. They found that Mars's atmosphere does not drift away at a steady pace; instead, atmospheric escape occurs in bursts. The authors relate those bursts of atmospheric loss to solar events known as corotating interaction regions (CIRs). CIRs form when regions of fast solar wind encounter slower solar wind, creating a high-pressure pulse. When these CIR pulses pass by Mars, they can drive away particles from Mars's atmosphere. The researchers found that during times when these CIRs occurred, the outflow of atmospheric particles from Mars was about 2.5 times the outflow when these events were not occurring. Furthermore, about one third of the material lost from Mars into space is lost during CIRs. The study should help scientists better understand the evolution of Mars's atmosphere.

## Lack of ice "arches" in 2007 led to loss of ice from Arctic Ocean

In most years during the winter, "arches" of ice form across the Nares Strait, a narrow channel between Greenland and Ellesmere Island. These arches block the flow of sea ice, keeping ice contained in the Arctic Ocean. But in 2007, no such arches formed. **Kwok et al. [L03502]** used satellite images to determine how much ice had flowed out of the Arctic Ocean through the Nares Strait in each year from 1997 to 2009. They found that the volume of ice lost in 2007 was more than twice the average ice loss during those 13 years. Furthermore, although the Nares Strait is quite narrow, ice flowing through it in 2007 accounted for a significant percentage of the total Arctic ice lost—the 2007 ice flow through the Nares Strait was about 10% of the average annual ice flow through the much wider Fram Strait. The ice flow in 2007 depleted the thick ice that had built up in the Arctic over multiple years. This multiyear ice could take years to replace, affecting summer ice cover for years. The study shows that ice arches are an important factor in controlling Arctic ice outflow through the Nares Strait. The authors note that as the climate warms, arches could stop forming, leading to increased loss of Arctic sea ice.

## Simple formula helps explain ocean carbonate dynamics

The buildup of carbon dioxide in the atmosphere is making seawater more acidic, which over time will have profound effects on marine biota and cycling of elements. Over the next few thousand years, this acidification will be counteracted by dissolving calcium carbonate shells of dead organisms in sediments of the deep sea, a process known as carbonate compensation. Two factors, the carbonate saturation depth and the carbonate compensation depth, are used in studying carbonate dynamics. The carbonate saturation depth is the depth below which the oceans become undersaturated with respect to calcium carbonate. Above this depth, water is saturated with carbonate ions, and calcifying organisms can form and retain calcium carbonate shells. Below this depth, calcium carbonate shells arriving at the sediment surface will dissolve. However, calcium carbonates may be produced or accumulate more rapidly than they dissolve, so some calcium carbonates can remain in sediments below the saturation depth. The carbonate compensation depth is the depth at which calcium carbonates are dissolving at the same rate that they are accumulating; that is, below this depth, calcium carbonates are no longer found

**Cover.** *High-resolution temperature variations during a downslope tidal phase above a slope of deep-sea Great Meteor Seamount using 100 Netherlands Institute for Sea Research (NIOZ) thermistors at 0.5-m intervals. This tidal phase is "permanently" turbulent some distance from the bottom, with finger-like motions that occasionally develop 10-m-high Kelvin-Helmholtz overturning billows. The shaded regions in the top two plots highlight the time range for the bottom plot; white lines indicate missing sensors. In the bottom plot all data points are included from the 1-Hz sampled thermistors. The photo shows a mooring cable with two high-resolution (<1 mK accuracy; 1 Hz sampling rate) NIOZ temperature sensors below a time synchronizer. Photo NIOZ.* See van Haren and Gostiaux [L03605].