RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals

Stratospheric ozone affects mesospheric temperature trends

Since 1961, temperatures in the summer mesosphere have undergone a series of reversals. From 1961 to 1979 the atmospheric layer that stretches from roughly 50- to 100-kilometer altitude cooled by 0.5 K per decade. In the subsequent 2 decades the rate of cooling escalated to –3 to –5 K per decade, while the next 10 years saw a mild recovery. Though these temperature flips are seen in the observational record, they have never been reliably re-created in computer models of the middle atmosphere. Unlike the troposphere or stratosphere, for which there are extensive records, observations of mesospheric temperature are limited to point-source detections, making accurate modeling particularly important.

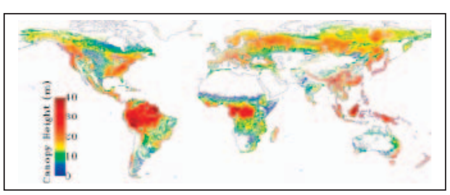
Using an updated version of the Leibniz Institute Middle Atmosphere Model (LIMA), *Berger and Lübken* successfully simulated the recent temperature anomalies while also isolating the likely driver of the swings. Relying on stratospheric temperature and wind patterns, measures of incoming solar radiation, and records of stratospheric carbon dioxide and ozone, LIMA mirrored the decadal-scale mesosphere temperature anomalies seen in the observational record. Further, by fixing the simulated concentrations of ozone, or of ozone and carbon dioxide, the authors found that changes in stratospheric ozone explained a majority of the mesospheric temperature variability. Given the authors' findings, determining the sensitivity of mesospheric temperature to varying ozone and carbon dioxide concentrations will be important in coming decades as stratospheric ozone rebounds and carbon dioxide continues to climb. (*Geophysical Research Letters,* doi:10.1029/2011GL049528, 2011) —CS

New global map of forest canopy height

Just how tall are forests around the world? A new global map shows forest canopy height at 1-kilometer spatial resolution.

Simard et al. used satellite data from the Geoscience Laser Altimeter System aboard the Ice, Cloud, and land Elevation Satellite (ICESat) to create a global map of the height of the forest canopy. They validated their map by comparing it with field measurements of canopy height from sites around the globe. The authors compared their map against another recently published map of canopy height and found that it was better correlated with the field data. They also found canopy height differences across forest disturbance gradients.

Lidar (light detection and ranging) enables mapping forest vertical structure, a parameter that cannot be easily retrieved from optical systems and provides information on biomass, primary productivity, and biodiversity. (*Journal of Geophysical Research-Biogeosciences,* doi:10.1029/2011JG001708, 2011) —EB



A new global map of forest canopy height.

Using Loch Ness to track the tilt of the world

That the rise and fall of the tide is driven primarily by the gravitational pull of the Moon and the Sun is common knowledge, but not all tides are controlled by such a standard mechanism. Researchers working on Loch Ness in Scotland found that rather than the loch's tide being driven directly by this so-called astronomical tide, it is also controlled by a process known as ocean tidal loading. Loch Ness lies just 13 kilometers inshore from the North Sea. The astronomical tide redistributes the ocean to such an extent that the changing mass of water along the coast deforms the seafloor. As the ocean tide ebbs and flows, the surface of the Earth rises and falls.

By using a series of pressure sensors distributed throughout Loch Ness that measured the height of the water—and by ruling out other potential sources—*Pugh et al.* found that this local shift in the shape of the Earth—like a bowl of water on an unstable table—controlled the loch's tide. They found that the tide had a magnitude of 1.5 millimeters, a measurement made to an accuracy of just 0.1 millimeter over the loch's 35-kilometer length. The authors suggest that this sensitivity in measuring the effects of tidal loading surpasses even that possible using GPS receivers. The authors hope that similar experiments conducted at suitable lakes worldwide could be used to better understand oceanic tidal loading. (*Journal of Geophysical Research-Oceans,* doi:10.1029/2011JC007411, 2011) —CS

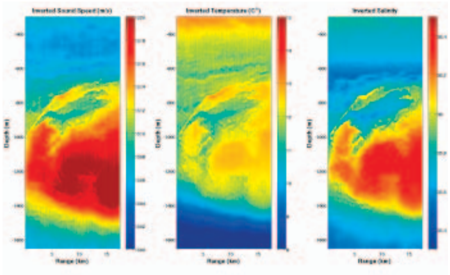
Gravity's effect on landslides: A strike against Martian water

A pile of sand, gravel, or other granular material takes on a familiar conical shape, with the slope of the pile's walls coming to rest at the static angle of repose. If the material exceeds this angle, it will trigger an avalanche, tumbling down until it comes to rest at the dynamic angle of repose. Static angles of repose for coarse, angular materials tend to be around 40° from the horizontal, while smooth grains are stable at up to 20°. As largely a matter of geometry, grain properties, and internal friction, scientists have assumed these two angles of repose are fixed for a given substance. Observations of the angles of gully walls on Mars, found to be too shallow for the materials involved, have been used to argue that surface water must have played a part, either lubricating landslides or depositing the material directly. However, research by *Kleinhans et al.*, using the parabolic flight of an airplane to test the effect of gravity on angles of repose, demonstrates that water need not have been present.

As the plane followed its roller coaster–style path, slowly rotating cylinders containing different materials experienced one tenth of Earth's gravity (0.1 *g*), Martian gravity (0.38 *g*), and the Earth's normal pull (1 *g*). The authors found that at 0.1 *g*, the static angle of repose for all materials increased by 5°, while the dynamic angle of repose decreased by 10°. They suggest that weaker gravity would reduce internal friction for avalanching material and could explain the shallow gully walls on the Martian surface. Further, as angles of repose are commonly used as measures of material properties, this challenge to their presumed gravity independence will require a reassessment of many other surface processes at lower slopes. (*Journal of Geophysical Research-Planets,* doi:10.1029/2011JE003865, 2011) —CS

Reconstructing ocean properties from seismic data

Ocean temperature, density, and salinity change with depth on fine scales. Some scientists are beginning to use acoustic images to reconstruct these water column properties. In this technique, acoustic waves are generated in the ocean by an active seismic source such as an air gun array, and the reflected waves are recorded at surface.



Inverted physical properties from inverted synthetic seismic data set.

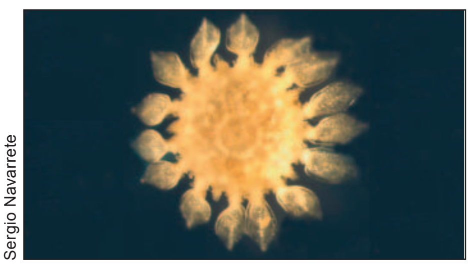
The recorded field is then carefully processed to obtain an acoustic image of the layer's reflectivity. The speed of sound and the amount of energy reflected and transmitted vary depending on the water's temperature and salinity, so these reflected acoustic waves indirectly contain information on the water properties. However, analyzing acoustic data to extract water column properties can be tricky. *Kormann et al*. show that a mathematical method known as full waveform inversion can be used to reconstruct high-resolution temperature and salinity profiles from simulated one-dimensional seismic ocean data. The work is a step toward making the method of using seismic data to retrieve water column properties more widely applicable. (*Journal of Geophysical Research-Oceans,* doi:10.1029/2011JC007216, 2011) —EB

Changing Chilean coastal currents could drive aquatic evolution

For invertebrate and fish species that spend most of their lives in rich coastal waters rather than migrating freely throughout the open ocean, the formation of island populations and the associated risk of genetic diversity loss are threats to long-term population health. Many species cope through a spawning mechanism whereby larvae are released en masse into near-shore ocean currents, like pollen adrift in the wind. The larvae are viable in open waters from days to months, but only those that find their way back to shore can settle and develop. To increase their chances, different species' larvae often use particular swimming behaviors, for example, varying their depth in the water column throughout the day.

Off the coast of central Chile, the effects of climate change on oceangoing larvae are investigated by *Aiken et al.* Observations and climate simulations suggest that the southerly winds that blow along the Chilean coast will become stronger and more frequent by the end of the century, given a fragmented and economically motivated global response to climate change. Using an ocean circulation model, the authors found that this change will increase coastal upwelling and the strength of surface eddies. Applying a particle dispersion model to the forecast of future currents lets the authors identify the likely success rate of larvae making their way back to the coast. They found that the viability of passively drifting larvae was severely degraded, as the strong flows often carried them along or away from the shore. The vertical swimmers, on the other hand, could sink below the 20-meter-thick Ekman transport layer, marginally increasing their chances of finding a viable habitat. The authors suggest that changing coastal currents could become a powerful evolutionary selection pressure, favoring species with vertically mobile larvae over those without. (*Journal of Geophysical Research-Biogeosciences,* doi:10.1029/2011JG001731, 2011) —CS

Sergio Navarrete



*Black sea urchins (*Tetrapygus niger*) spend the early stages of their life adrift in currents far from the Chilean coast. Researchers think the viability of urchin (and other species') larvae will be affected by changing coastal currents.*

Nick Morgan/NOAA Corp

A balloon-borne ozonesonde launch from South Pole Station.

When will Antarctic ozone begin to recover?

Emissions of ozone-depleting substances have declined over recent decades, but it takes time for the ozone layer to recover. Regular measurements of ozone levels above the South Pole now stretch back 25 years. *Hassler et al.* analyzed these recorded ozone data to assess changes in ozone loss rates. Consistent with previous studies, they found that ozone loss rates have been stable over the past 15 years, neither increasing nor decreasing. However, they predict that, assuming future atmospheric dynamics are similar to today's, ozone loss rates will begin to decline noticeably between 2017 and 2021. (*Journal of Geophysical Research-Atmospheres,* doi:10.1029/2011JD016353, 2011) —EB

—Ernie Balcerak, Staff Writer, and Colin Schultz, Writer