Eos, Vol. 95, No. 26, 1 July 2014

RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals

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Conditions favorable to new central Alaskan permafrost will not last

Martin Briggs

The dried margin of Twelvemile Lake and associated bands of new willow shrub growth as seen from a floatplane.

Permafrost—ground that has been frozen for longer than 2 years—has been useful for tracking the effects of climate change because thawing permafrost has implications for greenhouse gas emissions and shifting ecosystems. In the last 30 years, shrinkage of Arctic and subarctic lakes has been tied to permafrost thaw. However, on the margins of recently receded lakes, scientists recently have witnessed permafrost growth, complicating how climate change may affect future Arctic lakes. Scientists question whether these new permafrost-friendly conditions will continue into the future.

Briggs et al. investigated permafrost growth at Twelvemile Lake in north central Alaska. They measured the lake's shrinking shoreline, observed the subsequent succession of new vegetation, and noticed permafrost buildup during the summers of 2011 and 2012.

The authors created a model with the assumption that shade from the new vegetation had a net cooling effect on the lake margins, which caused buildup of localized permafrost. They then simulated the coming century for a variety of possible climate conditions. Under a warming climate, which is predicted for the next century, the authors found that permafrost buildup would reach a maximum after 45 years and then would begin to degrade and completely disappear by year 69. (*Geophysical Research Letters,* doi:10.1002/2014GL059251, 2014) —JW

Updated global data set tracks sea ice from 1850 to 2007

For more than a century and a half, scientists, sailors, pilots, and others have collected measurements of everything from sea ice extent to temperature to atmospheric pressure, using a range of procedures, tools, and techniques. To reconstruct a clear global picture and create the long-term data sets that underlie much of modern climate science, researchers need to bring these parts together, correcting for biases and gaps in the data.

In a new study, *Titchner and Rayner* describe a global sea ice concentration data set that represents the period 1850 to 2007 and will be updated in the future. The new data set—known as the Met Office Hadley Centre sea ice and sea-surface temperature data set (HadISST) version 2.1.0.0—is more internally consistent than previous versions. It draws on a range of sources, from early 20th century German records of the Southern Ocean to modern interferometric synthetic aperture radar satellite observations to represent the global monthly sea ice concentration for the 157-year period on a 1° by 1° grid. Because some grid points lacked direct observations, gaps were filled by climatology-based estimations.

Compared against a separate record and against their own earlier version, the authors' data set has, in general, more ice and larger sea ice extents, though recent trends are similar to those found in other data sets. The authors caution that because some of the observational gaps were filled by estimation, the new data set should not be relied upon for assessing trends in sea ice concentration in the Arctic prior to 1953 or in the Antarctic prior to 1973. (*Journal of Geophysical Research: Atmospheres*, doi:10.1002/2013JD020316, 2013) —CS

First depth measurements taken for extraterrestrial lake

Since 2004, NASA's Cassini mission has been orbiting Saturn and taking measurements of the planet itself as well as its largest moon, Titan, which has an atmosphere that can serve as an analog for a young Earth. During Cassini's flyby of Titan in May 2013, it collected data from the moon's second-largest sea, Ligeia Mare.

Mastrogiuseppe et al. used radar altimeter data collected by Cassini to estimate the depth of Ligeia Mare, the first time scientists have determined the depth of an extraterrestrial sea. Based on the data, the authors estimate that the deepest point of the sea, as measured by Cassini radar, is 160 meters below the surface.

They were also able to confirm previously observed topographic characteristics of the sea—that its north shore is sloped more gently than its south shore. In addition, the authors found that the sea was remarkably transparent, which further strengthens the notion that it is primarily composed of liquid methane and ethane. (*Geophysical Research Letters*, doi:10.1002/2013GL058618, 2014) —JW

Preindustrial land use change caused 0.73°C of global warming

Since the dawn of the Holocene nearly 12,000 years ago, humans have been shaping the Earth's surface and atmosphere. By redistributing soil and nutrients, clearing land, chopping down trees, rerouting rivers, setting fires, and, later, burning fossil fuels, humans have gradually become the dominant driver of change in the Earth's climate.

Through widespread land use change—first for agriculture and later through urbanization and industrialization—humans have gradually changed the balance of the global energy budget. Using a global climate model, *He et al.* have figured out how the land-clearing practices of preindustrial civilizations affected the Earth's temperature.

Unlike the always-upward change in temperature caused by anthropogenic greenhouse gas emissions, the effects of land use change are far more nuanced. Clearing a forest causes not only biogeochemical effects by reducing surface carbon storage but also biogeophysical effects by modifying momentum, moisture, heat, and radiation fluxes as well as changing the albedo. In some places, such as the midlatitudes in the Northern Hemisphere, deforestation causes local cooling. In others, like Southeast Asia, India, and Africa, it causes warming.

Building on an existing model of historical land use change, the authors calculated the effects of those changes on the global temperature. They found that by influencing biogeophysical systems, Holocene era land use change caused 0.17°C of global cooling. The 0.90°C of warming caused by the biogeochemical effects, however, more than made up for this decline, resulting in a net 0.73°C of warming caused by preindustrial land use change. By comparison, the authors note, the post industrial era has seen 0.8°C of anthropogenic global warming. (*Geophysical Research Letters*, doi:10.1002/2013GL058085, 2014) —CS

Tracing the effects of an enormous meteorite impact 3 billion years ago

The most well-known and popularized meteorite impact occurred 65 million years ago and left behind the Chicxulub crater, a feature more than 110 miles in diameter. Dust kicked up by the impact, which lingered in the atmosphere for years, may have helped kill all the nonavian dinosaurs along with three quarters of the world's plant and animal species.

Now imagine an impact several times larger than the one that left the Chicxulub crater. In the last decade, evidence of such an impact was found in the Barberton greenstone belt in South Africa.

New research presented by *Sleep and Lowe* describes the physical impact and seismic activity caused by the 37- to 58-kilometer-wide meteorite that smashed into the Earth during the Archean era, 3.26 billion years ago. The Archean is known as a period of "heavy bombardment," when the Earth was continuously peppered with cosmic impacts.

Using scaling relationships and estimates of seismic activity, the authors found that the Archaen impact triggered an earthquake that was more than 100 times larger than typical earthquakes and lasted at least half an hour. The impact produced major fracturing in the shallow part of the lithosphere, generated global tsunamis, and may have initiated subduction at the impact site. (*Geochemistry, Geophysics, Geosystems*, doi:10.1002/2014GC005229, 2014) —JW

Ice melt rates during explosive subglacial eruptions

Volcanic eruptions occurring under glaciers melt cavities in the overlying ice, and this meltwater may drain out in a large, sudden flood known as a jökulhlaup. Observations show that ice melts rapidly in liquid-filled subglacial cavities when these eruptions occur, but until now scientists have not had a quantitative description of the heat transfer processes involved.

Woodcock et al. calculated heat transfer rates within liquid-filled subglacial cavities during explosive eruptions, considering several heat transfer mechanisms. They compared their estimated heat fluxes with those required to match observed rates of ice melting and flow rates from jökulhlaups. They found that their calculated heat fluxes can explain the jökulhlaup flow rates in many, but not all, recent eruptions. (*Journal of Geophysical Research: Solid Earth*, doi:10.1002/2013JB010617, 2014) —EB

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