AGU Journal Highlights -- Aug. 31

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The following highlights summarize research papers that have been recently published in *Paleoceanograpy* (PA), *Geophysical Research Letters* (GRL), and *Journal of Geophysical Research-Biogeosciences* (JGR-G).

1. Was ocean acidification responsible for history's greatest extinction?

Two hundred and fifty million years ago, the world suffered the greatest recorded extinction of all time. More than 90 percent of marine animals and a majority of terrestrial species disappeared, yet the cause of the Permian-Triassic boundary (PTB) die-off remains unknown. Various theories abound, with most focusing on rampant Siberian volcanism and its potential consequences: global warming, carbon dioxide poisoning, ocean acidification, or the severe drawdown of oceanic dissolved oxygen levels, also known as anoxia.

To narrow down the range of possible causes, Montenegro et al. ran climate simulations for the PTB using the University of Victoria Earth System Climate Model, a carbon cycle-climate coupled general circulation model. The model's highlights include dynamic representations of terrestrial vegetation, ocean carbon fluxes, and net primary production. The researchers ran nine simulations, using three different concentrations of atmospheric carbon dioxide, three modes of ocean floor topography, and two competing theories for the geography of the time.

The authors find that varying the ocean floor topography by adding deep ocean ridges increases the strength of the Meridional Overturning Circulation (MOC) - a convective cycle that mixes ocean waters. Also, the presence of the MOC was not abated by elevated atmospheric carbon dioxide as was found in previous research, suggesting that the ocean would have been well mixed and well oxygenated, restricting the chances of widespread deep ocean anoxia.

Further, the researchers find that if atmospheric carbon dioxide concentrations were 3000 parts per million by volume or higher, fitting within estimates for the Permian-Triassic boundary, the ocean pH would have been 7.34 or lower. At those levels, the authors say the ocean's acidity would have had significant negative impacts on mollusks, corals, and other species that rely on oceanic calcium carbonate, suggesting ocean acidification may have been the main culprit in the Permian-Triassic boundary extinction.

Source: *Paleoceanography,* doi:10.1029/2010PA002058, 2011
http://dx.doi.org/10.1029/2010PA002058 [1]

Title: Climate simulations of the Permian-Triassic boundary: Ocean acidification and the extinction event

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2. Reforesting northern farmland can have a cooling effect

Land cover changes such as clearing forests to create farmland influence climate not only by changing the amount of carbon dioxide absorbed by the vegetation but also by changing the albedo, the fraction of sunlight reflected back to space. These two effects often oppose each other. For instance, farmland may absorb less carbon dioxide than forests, contributing to warming; but at the same time, farmland tends to reflect more light than forests, contributing to cooling. This cooling is strongest in northern latitudes because highly reflective snow is hidden under dark trees when covering agricultural fields.

Therefore, for northern lands, previous studies suggested that forestation would not be effective as a climate change mitigation strategy. However, these studies assumed idealized large-scale forestation that did not take historical patterns of land use conversion into consideration.

Using simulations that account for past choices made by farmers regarding where to settle and farm, Pongratz et al. find that reverting to historical land cover could contribute to climate change mitigation even in the northern latitudes. The researchers find that farmers generally chose to deforest land that was more productive than average. Reforesting this land can absorb a lot of carbon dioxide and have a strong cooling influence. This land was furthermore less snowy than average. Reforestation therefore would not absorb very much additional sunlight. The researchers conclude that the net effect of the historical preference for productive, snow-free land is to increase the climate cooling potential for reforestation on this land.

Source: *Geophysical Research Letters,* doi:10.1029/2011GL047848, 2011
http://dx.doi.org/10.1029/2011GL047848 [2]

Title: Past land use decisions have increased mitigation potential of reforestation

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3. Dikes provide insight into early history of Mars

New observations from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) show the presence of multiple magmatic intrusions in the Valles Marineris canyon on Mars. Flahaut et al. determine the composition of these dikes using CRISM data. They find that the composition and distribution of the dikes in ancient crust in the lower walls of Valles Marineris suggest that they were formed early in the history of Mars and may have played a significant role in the formation of the Valles Marineris.

Source: *Geophysical Research Letters,* doi:10.1029/2011GL048109, 2011
http://dx.doi.org/10.1029/2011GL048109 [3]

Title: Dikes of distinct composition intruded into Noachian-aged crust exposed in the walls of Valles Marineris

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4. Exploring the effects of climate change on carbon stored in northern soil

Over recent millennia, northern ecosystems have been an important sink for the global carbon cycle, with vast quantities of carbon slowly accumulating and becoming trapped within thick layers of permafrost or peat. Some scientists have raised the prospect that global warming will free this carbon from its icy prison, with devastating effects on the global climate. However, researchers have identified a number of dynamic feedback systems that drive boreal and tundra ecosystems, suggesting that the fate of the 1,400 to 1,850 petagrams (1.54 trillion to 2.04 trillion short tons) of stored carbon-enough to raise atmospheric carbon dioxide concentrations by 660-870 parts per million if ever fully released-is much less certain.

To tease out the potential consequences of a warming world, Grosse et al.

assimilated the growing body of knowledge on northern soil carbon storage, seeking to identify key pressures and feedback systems. The authors define two broad classes of external forces that may accelerate and intensify in a warming Arctic: "pulse" impacts, described as one-off extreme events, and "press" impacts, slow but persistent change in an environmental parameter. They find that permafrost thawing and changes in the regional hydrologic regime are the most important press forces, with previous research suggesting that up to 20 percent of permafrost will turn to being only seasonally frozen by 2100. For pulse forces, the authors identify wildfires and rapid thawing of icy permafrost as the most important. In the past 60 years the strength, frequency, and area affected by wildfires have all increased - a trend that is expected to continue into the future. Although the authors describe the tangled web of interacting forces that affect northern soils, further research is required to determine regionally specific rates of impact and the fate for carbon stores.

Source: *Journal of Geophysical Research,* doi:10.1029/2010JG001507, 2011
http://dx.doi.org/10.1029/2010JG001507 [4]

Title: Vulnerability of high-latitude soil organic carbon in North America to disturbance

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5. Magnetic field data suggest thin atmosphere on Saturn's moon Dione

A new study indicates that one of Saturn's moons, Dione, probably has a tenuous atmosphere. NASA's Cassini spacecraft has conducted only two close flybys of Dione. Magnetic field observations from one of those flybys, described by Simon et al., show evidence of an atmospheric interaction with magnetospheric plasma. The authors use a model to demonstrate that a low-density atmosphere would explain the magnetic field data.

Source: *Geophysical Research Letters,* doi:10.1029/2011GL048454, 2011
http://dx.doi.org/10.1029/2011GL048454 [5]

Title: Magnetic signatures of a tenuous atmosphere at Dione

Authors: Sven Simon, Joachim Saur, Fritz M. Neubauer, and Alexandre Wennmacher: Institute of Geophysics and Meteorology, University of Cologne, Cologne, Germany;

Michele K. Dougherty: Space and Atmospheric Physics Group, Blackett Laboratory, Imperial College London, London, UK.

6. Ultraviolet and infrared observations of Saturn's aurora

New observations of Saturn's southern auroral oval made simultaneously in ultraviolet (UV) and infrared (IR) wavelengths show how complex and dynamic the auroral oval is. Melin et al. present high-spatial-resolution observations from the Cassini spacecraft's UV and IR instruments. The auroral oval varies over short time scales and has many small-scale structures. The researchers observe three different arcs within the auroral oval, which they suggest are probably caused by precipitation of particles with different energies. In addition, the researchers find that the main auroral oval is morphologically similar in UV and IR, but in the auroral emissions equatorward and poleward of the main oval, there were noticeable differences in UV and IR, highlighting the need for observations at a range of wavelengths.

Source: *Geophysical Research Letters,* doi:10.1029/2011GL048457, 2011
http://dx.doi.org/10.1029/2011GL048457 [6]

Title: Simultaneous Cassini VIMS and UVIS observations of Saturn's southern aurora: Comparing emissions from hydrogen, hydrogen gas and protonated molecular hydrogen at a high spatial resolution

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