

RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals

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What controls methanol emissions from grassland?

Emission of volatile organic compounds, including methanol (CH_3OH), from plants can affect atmospheric chemistry and climate. Seasonal variations such as changes in leaf growth result in changes in atmospheric methanol concentrations. Hörtnagl *et al.* sought to test whether the controls on methanol fluxes reported from controlled laboratory experiments at the leaf level applied to in situ conditions at ecosystem scales. They measured methanol fluxes above a managed grassland in the Stubai Valley in Austria and studied controls on methanol exchange by analyzing half hourly and daily average data.

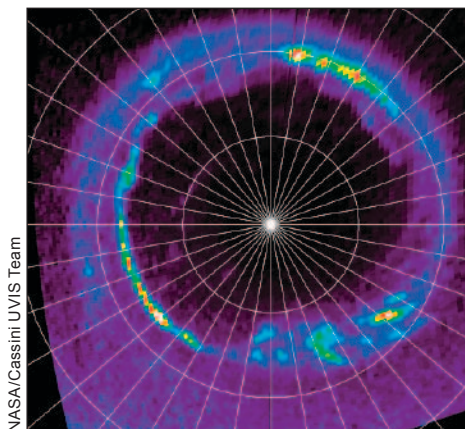
The researchers observed considerable interannual variability in methanol exchange. They found that the highest methanol emissions occurred shortly after the grass was cut, as methanol stored inside plant cells escaped. Methanol emissions also rose shortly after the application of organic fertilizer to the field. During the undisturbed growing season, methanol emissions varied with diurnal air temperature changes, peaking during the middle of the day and dropping off during the nighttime. Furthermore, in contrast to expectations based on lab studies at the leaf level, changes in the amount of green plant area exerted only a minor control on methanol emissions. (*Journal of Geophysical Research-Biogeosciences*, doi:10.1029/2011JG001641, 2011) —EB



Researchers investigated methanol emissions from grassland at this study site near Neustift in Stubai Valley, Austria.

Small-scale structures observed in Saturn's aurora

Observations from the Ultraviolet Imaging Spectrograph Subsystem on NASA's Cassini spacecraft provide new detail about Saturn's aurora. The measurements, reported by Grodent *et al.*, were made in August 2008 when the spacecraft was only 5 Saturn radii



A polar view of Saturn's southern ultraviolet aurora observed on 27 August 2008 with the Cassini/Ultraviolet Imaging Spectrograph Subsystem from a distance of 6 Saturn radii (~360,000 kilometers).

from the surface. They found two types of ultraviolet auroral substructures in the main ring of the emission—bunches of spots and narrow arcs—ranging in size from 500 kilometers to several thousand kilometers. The researchers suggest that the small-scale structures are associated with magnetic-field-aligned electrical currents in Saturn's upper atmosphere that result from fluctuations in plasma flow triggered by Kelvin-Helmholtz waves in the magnetosphere.

This is the first study to measure the small-scale structures in Saturn's ultraviolet aurora in detail and that provides insight into the dynamics of Saturn's magnetosphere. (*Journal of Geophysical Research-Space Physics*, doi:10.1029/2011JA016818, 2011) —EB

Climate model's historical accuracy no guarantee of future success

To validate and rank the abilities of complex general circulation models (GCMs), emphasis has been placed on ensuring that they accurately reproduce the global climate of the past century. But because multiple paths can be taken to produce a given result, a model may get the right result but for the wrong reasons. Following this line of thinking, Crook and Forster analyzed the construction of 11 atmosphere-ocean coupled GCMs. Rather than looking at the models' reproductions of twentieth-century global average temperatures, which tend to perform well on all counts, the authors broke the models' results into their

re-creation of average, Arctic, and tropical climates. Further, they analyzed the models' treatment of climate forcings (such as solar activity), feedback systems (like Arctic ice melt or the effects of clouds), and representations of heat storage and transport mechanisms.

The authors found that of the 11 models analyzed, 8 had global average, Arctic, and tropical temperatures that fell within an acceptable range of historical temperature observations for the past century. However, most were unable to capture a warming period that occurred in the 1920s and 1930s. Three models fell outside of the authors' limits for acceptable historical accuracy. The authors also suggest that two additional models had warming profiles that unrealistically emphasized either Arctic or tropical temperature change. Because the models each use different weightings to describe the influence of various feedback systems and climate forcings, the authors believe that higher accuracy in reproducing historical observations is not an assurance that they will be more accurate in predicting future climate. They also suggest that the problem lies not necessarily with the models but rather with the understandings of some forcing and feedback mechanisms being only loosely constrained. They recommend that effort should be placed on determining physically accurate representations of aerosol forcing to refine future models. (*Journal of Geophysical Research-Atmospheres*, doi:10.1029/2011JD015924, 2011) —CS

Building an empirical model of global carbon flux

Predicting the behavior of a complex system, like the one that explains the exchange of carbon between the Earth's surface and the atmosphere, by trying to produce theoretical formulations of every environmental process is a daunting challenge. Likewise, the alternative approach—forsaking numerical abstraction in favor of predictions based explicitly on observations—has been hindered by a lack of both observational data and the computational power needed to make sense of it. Expanding detector networks, advancements in processing power, and the development of new computational techniques, however, are opening the door to the development of empirical models of complex systems.

Drawing on meteorological data provided by satellites as well as on observations

from FLUXNET, *Jung et al.* produced the first empirical model of global surface-atmosphere carbon flux. FLUXNET, a global network of eddy covariance towers, generates high-spatial- and high-temporal-resolution measurements of wind speed, trace gas fluxes, and other atmospheric parameters. By combining these point measurements with the broad areal coverage of satellite observations, the authors produced a $0.5^\circ \times 0.5^\circ$ spatial resolution set of monthly data that spanned from 1982 to 2008. Using a machine learning analysis, a computational technique that sifts through vast data sets to identify underlying patterns, the authors developed a model that accurately estimated a number of ecosystem-atmosphere fluxes, including the amount of carbon used to fuel plant growth, the carbon produced by the ecosystem, and the latent and sensible energy transfer rates. The authors' model omits a number of known processes and gives up control over how each environmental dynamic is represented in order to generate a model based entirely on observational data. They suggest that their empirical approach is not meant to replace theoretically derived simulations but, rather, to work with them to improve the understanding of environmental dynamics. (*Journal of Geophysical Research-Biogeosciences*, doi:10.1029/2010JG001566, 2011) —CS

Finding rates of incorporation of windblown dust into soils

As winds blow dust around, a significant amount settles back into terrestrial soils,



Ken Ferrier

A new study suggests a novel geochemical method for inferring millennial-scale rates of dust incorporation in eroding terrain, such as the mountains of the Idaho Batholith pictured here.

providing minerals to the soils and affecting soil chemistry and erosion rates. However, the rate at which dust is incorporated into regolith, the loose soil and rock on surfaces, is difficult to measure, especially on eroding terrain. *Ferrier et al.* have developed a simple method of estimating the long-term (millennial-scale) rate of dust incorporation into actively eroding regolith by measuring regolith production rates and the concentrations of two immobile elements

(e.g., zirconium and titanium) in dust, soil, and bedrock.

The researchers applied their method at 17 field sites in the South Fork of the Salmon River in central Idaho and inferred dust incorporation rates of 3–13 tons per square kilometer per year, which is comparable to results from other studies. They suggest that their technique can be used to estimate long-term rates of dust incorporation into soils, which can then be compared to modern measurements of dust deposition to study the effects of recent changes such as climate change and human activity. (*Journal of Geophysical Research-Earth Surface*, doi:10.1029/2011JF001991, 2011) —EB

All channel networks share some properties

Channel networks transport water through a catchment and play a key role in hydrology. Understanding the network properties can be useful, so *Moussa et al.* developed a model to calculate the morphometric properties of catchments. They found some parameters that are the same in all natural channel networks (though not in all virtual networks), regardless of the size or shape of the catchment. In particular, the total area of the headwater catchment is always the same fraction (about 29%) of the total basin area. (*Water Resources Research*, doi:10.1029/2010WR010132, 2011) —EB

—ERNIE BALCERAK and COLIN SCHULTZ, Staff Writers