ECOLOGY

Rivers of Gene Flow

Antibiotic resistance is becoming an urgent problem. We point one finger at lax medication sales, and another at livestock husbandry, but there is also an ancient background signal of antibiotic resistance, in part stemming from the natural functions of these molecules in the soil. Even if we control the clinical use of antibiotics, there is still a growing problem of resistance. Where is it coming from? Pruden et al. have made the enormous undertaking of identifying environmental sources of antibiotic resistance genes in one river system from pristine sources in the Rocky Mountains, flowing through not just an altitudinal gradient but also a gradient of human activity. The background signal was measured by the occurrence of the tet(W) (tetracycline resistance) gene, whereas the sul1 (sulphonamide resistance) gene was taken as a marker of anthropogenic contamination. The results unambiguously showed accumulation of the sul1 gene down the river basin, primarily contributed by upstream animal feeding operations, with a modest input from wastewater treatment. — CA


CLIMATE SCIENCE

Less Snow in the Arctic

At high northern latitudes, the amount and timing of snow melt in spring have important consequences; for example, for water availability, climate, and ecosystem processes. However, snow cover in these regions varies widely in time and space, complicating monitoring efforts. Derksen and Brown used a weekly snow chart time series produced by the U.S. National Oceanic and Atmospheric Administration since 1967, mostly from satellite data, to analyze trends in snow cover in the Arctic during spring. For May and June, the record shows statistically significant reductions in snow cover for both North America and Eurasia. Snow cover loss accelerated since around 2000, with record lows set in the past 5 years. Overall, snow cover over Northern Hemisphere land areas in June between 1979 and 2011 has been lost at a rate of 17.8% per decade. These losses exceed those projected by state-of-the-art models and are also larger than sea ice losses (10.6% per decade since 1979). The results contribute to the emerging evidence for an accelerated response at high latitudes to global warming. — JFU


PHYSICS

Spin-Cavity Computing

Today’s (very rudimentary) quantum computers come in different guises, each with their own set of pros and cons. A growing trend has been to put two different technologies together in hybrid architectures in order to have the best of both worlds. One of the aims of such initiatives is to realize long-distance coupling between spin qubits (quantum bits based on electron spins) in quantum dots (zero-dimensional semiconductor nanostructures that allow controlled coupling of one or more electrons) via interactions with a superconducting microwave cavity. Petersson et al. made progress toward that goal by coupling a double quantum dot in an InSb nanowire to the electric field of a cavity, taking advantage of the strong spin-orbit interaction of InSb. The coupling was demonstrated by using a pulse sequence to electrically control the spin state, which was then read out in the phase response of the cavity. The estimated spin-cavity coupling is still shy of the strong limit required for two distant spin qubits to communicate; however, it is expected that improving the quality of the cavity and the coherence of the qubit, and/or using a material with stronger spin-orbit interactions, will bring physicists closer to that goal. — JS


CLIMATE SCIENCE

The Shape We’re In

Climate is warming—there is no doubt about it—but how fast is it happening? Different regions are warming at different rates, but the one where temperatures are increasing most rapidly is the Arctic, making it an important region to understand. Based on data from three different satellite sensors, together with temperature measurements from a number of weather stations and field observations of snow and ice conditions, Nghiem et al. report that surface melting extended across more than 98% of the Greenland Ice Sheet in July 2012. This is a rare event (similar episodes are known to have occurred only twice in the past 800 years) and, in isolation, it cannot be understood as part of a trend. However, because there is so much frozen water in the Greenland Ice Sheet and sealevel rise from its melting is a potentially serious problem, it will be important to determine how often, how extensively, and why such extreme melt events occur. Being able to observe these events so soon after they occur could provide additional opportunities to determine their impacts more explicitly and thus to reveal more clearly the shape we’re in. — HJS


ECONOMICS

Teaching Texting

Mobile phones are abundant in developing countries; why not use them to teach reading and math in place of the far more cumbersome and fragile channels of books and computers? Aker et al. describe the results of a randomized
Editors’ Choice

experiment in Niger, one of the poorest countries in the world, with one of the lowest rates of adult literacy and numeracy. In half of the 113 villages studied, adult students participating in the same education program received nonsmart mobile phones, with one phone per group of five students and instruction in sending and receiving short messages. Tests before and after the program showed that the students improved from a pre-class beginner level (no literacy or numeracy) to grade one in writing and grade two in math, with those in the mobile phone classes scoring 10% higher. Although proficiency declined somewhat during the 7-month agricultural season, the differential between the phone and phoneless students persisted. Furthermore, the combination of teaching and mobile phone access also resulted in more calling and messaging (both of which rely on numbers, symbols, and letters). Because initiating calls is expensive in Niger, whereas receiving calls is free, providing students with knowledge and means may help to solidify classroom gains. — GJC

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GEOLOGY

Tsunamis of the Past

According to some seismic hazard maps, a large earthquake was not expected to occur offshore of the Tohoku region in Japan. The occurrence of the 2011 $M_n$ 9.0 Tohoku-oki earthquake—one of the largest earthquakes in recorded history—and the resulting devastation after both the earthquake and the subsequent tsunami demonstrated that the model used to assess risk in that region may need serious revision. However, there were some signs that the region had the potential for a very large earthquake. Previous, although uncertain, historical accounts and sedimentological records of a large tsunami point to the occurrence of another large earthquake in 869 CE, often called the Jogan earthquake. Sawai et al. synthesized sedimentary data, including diatom assemblages and radiocarbon dates, of nearly 400 new and previously identified paleotsunami deposits from the Jogan and other historical earthquakes along the coast of Japan. By combining observations of coseismic subsidence in the sediment with tsunami simulation models, the authors estimate that the size of the Jogan earthquake was at least $M_n$ 8.4, and the resultant tsunami reached at least 1.5 km inland. With a recurrence interval of 500 to 800 years, large earthquakes in this region of Japan do not occur frequently but are more likely to occur than predicted by previous hazard models. — NW


GENETICS

Genome Packaging with a Bow

The genomes of prokaryotes, like those of eukaryotes, must be carefully condensed to fit into and function within the cells they control. The resultant “nucleoid” structure can be partitioned into four macrodomains (MDs): Ori (containing the replication origin), Right, Left, and Ter (containing the replication termination site). This organization is critical for chromosome segregation during cell division.

Dupaigne et al. analyzed the structure and function of the Macrodomain Ter protein (MatP) from Escherichia coli and Yersinia pestis, which is specifically responsible for Ter MD organization. MatP was composed of three domains. The central domain was required for MatP dimerization. The N-terminal four-helix-bundle domain bound specifically to a DNA consensus sequence, matS, scattered throughout the Ter MD but was not found in any of the other MDs. The C-terminal coiled-coil domain drove association of the DNA-bound MatP dimers into tetramers. The tetramer formed a long rod-shaped complex, with the two DNA binding sites at opposite ends, up to 135 Å apart. The coiled-coil domain could also kink to impart a variety of bend angles to the rod complex and was critical for condensation of the Ter MD DNA, probably through MatP’s ability to organize DNA between distant matS sites into loops. — GR

Spin-Cavity Computing
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