

**Trading farms and forests for biofuel.** With political sentiment growing in favor of greenhouse gas (GHG) restrictions, biofuels from plant cellulose are being considered among the alternatives to fossil fuels: Plants are renewable and biodegradable, and



they sequester carbon. Yet a new report validates concerns that a global biofuels program could put intense pressure on land supply and distribution. To predict the impact of a biofuels-based economy on climate change, an international team of researchers from the US, Brazil, and China linked an economic model of land use with a terrestrial biogeochemical model of global GHG levels. The team considered two cases for cellulosic biofuel crop growth: The primary focus of case 1 is on converting unfarmed areas such as forests, as shown in the image; of case 2, on exploiting existing farmland to the extent possible. In both cases, biofuel feedstock becomes a dominant global crop by year 2100, but in the process, total forest area is cut—by 56% in case 1 and by 24% in case 2. The loss of carbon-sequestering trees in case 1 results in a net release of carbon. In case 2, the gains from biofuel production ultimately lead to increased carbon sequestration in the farmed soil from the addition of nitrogen fertilizer, which paradoxically releases  $N_2O$ , another potent GHG. The research suggests that stabilizing GHG levels will require a limited and more efficient use of forests and fertilizers for biofuel crop production. (J. M. Melillo et al., *Science*, in press, doi:10.1126/science.1180251. Image courtesy of Chris Neill, Marine Biological Laboratory, Woods Hole, MA.) —JNAM

**Rough surface gives drops the heave-ho.** A common step in industrial cooling processes is the liquefaction of a vapor on a condenser. However, if a liquid film forms on the condenser, the cooling may be compromised. The problem can be addressed

by coating the condenser with a hydrophobic material conducive to drop formation and then letting the drops slide off due to gravity. Chuan-Hua Chen of Duke University and his student Jonathan Boreyko now report a different approach. By depositing carbon nanotubes on silicon micropillars and coating both with hexadecanethiol ( $C_{16}H_{34}S$ ), they engineered a rough “superhydrophobic” surface. The water drops that condensed on it were about a hundred times smaller than those on a conventional hydrophobic surface that the Duke team considered as a standard; the surface roughening offers the promise for more efficient cooling. Furthermore, as the figure and online video show, when two sufficiently large drops coalesce into a single drop, that drop literally springs off the condenser—no external prompting needed. The post-combination drop has less surface energy than do the two drops from which it forms. Most of the released surface energy is dissipated, but Chen and Boreyko observed that the vertical component of the drop’s velocity can be as much as one-sixth of the theoretical maximum. Nature has her own version of the jumping trick: Coalescence of a wet portion of a spore with a dew drop provides the energy for spore ejection in certain mushrooms. (J. B. Boreyko, C.-H. Chen, *Phys. Rev. Lett.* **103**, 184501, 2009.) —SKB

**Understanding ferromagnetism in graphite.** Ferromagnetism usually arises from transition metals rich in  $3d$  and  $4f$  electrons. The occurrence of ferromagnetism in pure carbon, which contains only  $s$  and  $p$  electrons, is thus surprising—even controversial, given the weakness of the magnetic signal and a Curie temperature well above room temperature. Using magnetic force microscopy and a superconducting quantum interference device to probe the surface and bulk magnetization of graphite, Dutch researchers Jiri Červenka and Kees Flipse (Eindhoven University of Technology) and Mikhail Katsnelson (Radboud University) offer evidence that the ferromagnetism arises from a two-dimensional network of point defects at grain boundaries. The breaking of the lattice’s translational symmetry by the defects leads to localized electron states at the Fermi level. Because of electron–electron interactions, those states become polarized, which, in turn, leads to the formation of local magnetic moments. Grain-boundary defects are more complicated than single vacancies: The figure here shows 2D planes of periodic defects, each an extended zigzag discontinuity that propagates through individual graphene sheets of the bulk crystal. A magnetic moment can be associated with each defect; and the step edge at the surface is a manifestation of the grain boundary buried underneath it. The Curie temperature deduced from experiment is, reassuringly, comparable to the theoretical value based on weak interlayer coupling. (J. Červenka, M. I. Katsnelson, C. F. J. Flipse, *Nat. Phys.* **5**, 840, 2009.) —RMW

