

physics update

These items, with supplementary material, first appeared at <http://www.physicstoday.org>.

Florida's mangroves expand northward. Just north of St. Augustine, around a latitude of 30° N, lies the stretch of Florida's east coast where the littoral vegetation switches from the mangrove forests of the south to the salt marshes of the north. Stubby, salt-tolerant mangrove trees thrive in warm

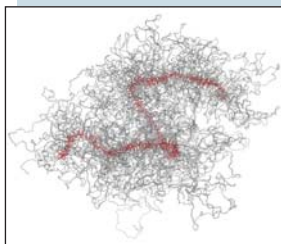


climates. As Earth's mean temperature rises, Florida's mangroves should expand northward, says Kyle Cavanaugh of the Smithsonian Environmental Research Center in Edgewater, Maryland, and Brown University in Providence, Rhode Island.

He and his collaborators analyzed 28 years of *Landsat* images of Florida's east coast and found that mangroves are indeed pushing northward—but in a surprising way. South of 27° N, the area covered by mangroves remained the same during the study's 1984–2011 span. North of that latitude, however, mangrove coverage grew—at a rate that increased with latitude. In the study's northernmost zone, 29°–29.75° N, the coverage doubled. Locally, mean annual and mean winter temperatures have risen throughout Florida since 1984, but neither trend correlated with the expansion's latitude dependence. Of all the environmental factors that Cavanaugh and his colleagues investigated, the only one to yield a strong correlation was a threshold: the annual change in the number of days with minimum temperatures below –4 °C. Such days are becoming rarer throughout Florida, but their frequency is falling fastest in the northern part of the state. Thanks to their deep roots, mangroves protect fragile coasts. Though benign, the dramatic expansion of Florida's mangroves underlines the importance of identifying thresholds in other ecosystems that could trigger a rapid, possibly disastrous, response to climate change, the study's authors say. (K. C. Cavanaugh et al., *Proc. Natl. Acad. Sci. USA*, in press.) —CD

Picturing the organization of mitotic chromosomes.

Chromosomes, with their tightly coiled but elongated X-shaped profile, are among the most recognizable features of a dividing cell. But how DNA is organized inside the chromosomes is largely unresolved.

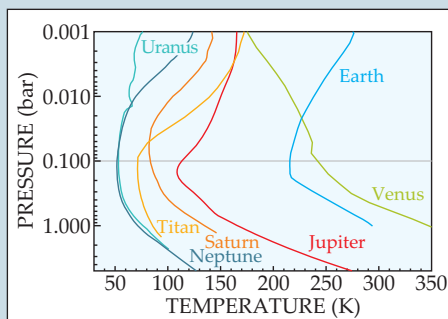


Although a chromosome may look hopelessly tangled, there exist distinct patterns in how it contorts and arranges itself. Methods known collectively as chromosome conformation capture, first developed by Job Dekker of the University of Massachusetts

Medical School and colleagues a decade ago, offer a way to examine the folded conformations by chemically linking parts of the chromosome that are spatially close. Sequencing the linked DNA segments allowed the researchers to figure out which parts of the chromosome are likely to have intersected. The result was a map of contact points at which segments of base pairs fold inside a nucleus (see *PHYSICS TODAY*, December 2009, page 19). Dekker, Leonid Mirny (MIT), and their

colleagues have now combined chromosome conformation capture with polymer simulations of DNA to model how a chromosome disassembles and then reassembles itself during mitosis. They found that as the cell nucleus is dissolved, chromosomes become reorganized in two phases. First, the long chromosome fiber of protein and DNA compacts itself into an array of consecutive loops of some 80 000 to 120 000 base pairs that emanate from and return to a central scaffold—the flexible, dark-colored rod pictured here. That phase is then followed by axial compression of the scaffold to form a short, dense cylinder. (For a movie that illustrates the process, see the online version of this update.) Yet to be understood is what interactions guide the reorganization. (N. Naumova et al., *Science* **342**, 948, 2013.) —RMW

Many planets, similar tropopauses. In the troposphere, the lowest layer of Earth's atmosphere (extending to 10–15 km above the surface), temperature decreases with altitude. But in the enveloping layer, the stratosphere, that trend changes direction. At the boundary between the two,



called the tropopause, the temperature is at a minimum and, in the global average, atmospheric pressure is about 0.1 bar. (See the articles by Raymond T. Pierrehumbert

in *PHYSICS TODAY*, January 2011, page 33 and by Bjorn Stevens and Sandrine Bony in *PHYSICS TODAY*, June 2013, page 29.) Curiously, such temperature minima have also been found in the atmospheres of Jupiter, Saturn, Uranus, Neptune, and the Saturnian moon Titan, all at roughly the same pressure despite significant differences in solar irradiation, atmospheric composition, and gravity. Tyler Robinson (now at NASA's Ames Research Center) and David Catling (University of Washington) show how a simple physical model helps explain that commonality. At low altitudes and higher pressures, atmospheres are opaque to long-wavelength thermal IR radiation and are heated from below; the result is convective mixing. At lower pressures, radiative heat transfer at shorter wavelengths dominates. The researchers note that although the various atmospheres differ in their details, they are all generally thick, which leads to a generic pressure-squared dependence for molecular IR absorption. Because of that scaling, stratospheric temperature inversions ascend from a relatively narrow range of parameter space around the observed pressure of 0.1 bar. That general rule, the pair notes, could provide useful insights into exoplanets and exomoons. (T. D. Robinson, D. C. Catling, *Nat. Geosci.* **7**, 12, 2014.) —RJF

Noninteracting quantum gas cools when diluted. Dilute a typical gas by allowing it to expand, and its temperature will change. In classical physics, that so-called Joule–Thomson effect disappears in the ideal-gas limit of vanishing interactions. But as shown theoretically in 1937 by Daulat Kothari and B. N. Srivasava, at very low temperatures, for which the rules of quantum mechanics apply, a Bose gas will