Putting the brakes on the hurricane heat engine

Kerry Emanuel's elegant description of hurricanes as heat engines (PHYSICS TODAY, August 2006, page 74) leads to the question of whether it might be possible to weaken a hurricane by interfering with that engine. It is well known that covering the water with a surfactant can reduce water evaporation by an order of magnitude. If that could be done in advance of a hurricane, the amount of latent heat of condensation available to drive the storm would be reduced.

Dispensers of surfactant could be placed on the ocean floor in the path of a hurricane. They could be distributed by aircraft along the storm's path a few days before its predicted arrival, or earlier and more broadly on the continental shelf, and opened by acoustic signal when a storm is imminent. The quantity of surfactant required is modest: Covering a 100 km $\times$ 1000 km storm track with a monolayer requires only about 100 tons.

The important questions are how long the surfactant layer would last (it could be continuously replenished by suitable dispensers), how effective it would be in reducing evaporation in real near-hurricane ocean conditions, and how much effect it would have on the hurricane. These questions can only be answered empirically, but the cost of such an experiment would be much less than the damage—tens of billions of dollars—that a severe hurricane would do to a populated seacoast.

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Emanuel replies: Jonathan Katz advances the intriguing idea that hurricanes could be mitigated by attacking the air–sea interface, through which enthalpy must flow to power the storms. The notion that the fluxes could be reduced by applying a surfactant was first proposed, to the best of my knowledge, by Robert Simpson and Joanne Simpson.[1] But the idea remained on the table for decades and has yet to be adequately tested. A few years ago, Moshe Alamaro and I did experiment with surfactants using a wind–wave flume, a laboratory apparatus in which air is moved at high speed over a water surface. We confirmed that at low wind speeds, surfactants dramatically reduced surface enthalpy flux. But at high speeds, the surfactant layer disintegrated and showed no measurable effect on the fluxes. We were only able to experiment with a limited number of candidate substances, but, given the stakes, this idea is surely worth deeper exploration.

Reference

1. R. Simpson, J. Simpson, *Trans. NY Acad. Sci.* **28**, 1045 (1966).

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Postscripts on geodynamo's beginnings

I agree with Henry Kolm that we need to "stand on the shoulders of giants" (PHYSICS TODAY, October 2006, page 14), but he needs to put his giants in the right place, and get his facts right.

Much of my 1949–52 PhD work at the University of Manchester in the UK was a laboratory-model simulation and extension of an early idea of Edward Bullard's that a single eddy in Earth's core could perturb the dipole field sufficiently to give a local focus of the nondipole field. Toward the end of that work, my fellow student Arvid Herzenberg became interested and produced a formal algebraic solution; in 1957 the two aspects were reported together.[1] Herzenberg then extended his work on a single eddy to two eddies, and showed that such a two-eddy situation could give a self-exciting dynamo.[2]

But Herzenberg's paper was highly mathematical; it also considered only a steady-state situation, while the geomagnetic dynamo was reversing intermittently. By then I was teaching at Newcastle, so I selected a promising graduating student, Ian Wilkinson, and we set about building a laboratory-scale, self-exciting dynamo based on Herzenberg's geometry. In 1963 we reported steady-state self-excitation.[3] Our dynamo was made of Perminvar, a magnetically soft steel alloy, and used 3.5-cm-diameter half-cylinders (not the "two meters" Kolm states). The cylinders rotated with their axes at right angles in a larger stationary block, with a thin layer of mercury (not just "equatorial") between the rotors and the block. By going to a larger system made of annealed mild steel, with 5-cm-diameter rotors and variable geometry, we eventually produced a reversing dynamo. Kolm says that the field "reversed its direction every 20 minutes," giving a