One person in the PHYSICS TODAY story said that geoengineering may result in changes in various weather patterns, but nobody knows what the changes are going to be and how they will affect the climate system. If the warming in the Arctic is a big event to mitigate, then it will require a significant "geoengineering" effort. To me, that means significant changes will occur elsewhere. Who can say whether those changes will be less serious than those taking place now? How can geoengineers talk about modifying clouds and albedo when clouds are represented in the climate models as mostly linear parameterizations?

Kramer's report did not mention hurricanes, but geoengineers also propose to dissipate them. Hurricanes are unique in the climate system because they represent major self-organization. As physicists well know, self-organization occurs in dissipative systems in which energy is not conserved but instead is exchanged with the environment. Hurricanes involve huge amounts of energy. Scientists have little idea how the atmosphere and the ocean will be affected if that energy is not allowed to be exchanged.

I would not have a problem with geoengineering if the physics and dynamics of the climate system were well known. Climate scientists have a good idea of the large-scale flow of ocean currents, but detailed measurements are not available. They know the basic physics of cloud formation and its thermodynamics but do not fully understand detailed cloud microphysics or the complex connections between climate and ecosystems. And with complex nonlinear systems, details are important. So we need to make an effort to improve our understanding of our climate system and its components before we try to operate on it. We can engineer a car or a plane because we know the underlying physics of motion, combustion, and flight, and we understand the role of every component. Can geoengineers say the same about climate?

Reference

1. K. Steinhaeuser, A. A. Tsonis, *Clim. Dyn.* (2013), doi:10.1007/s00382-013-1761-5.

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Letters and commentary are encouraged and should be sent by email to ptletters@aip.org (using your surname as the Subject line), or by standard mail to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842. Please include your name, work affiliation, mailing address, email address, and daytime phone number on your letter and attachments. You can also contact us online at http://contact.physicstoday.org. We reserve the right to edit submissions.

Water weight figures in jetpack dynamics

Authors Matthew Vonk and Peter Bohacek, in their Quick Study on jetpacks (PHYSICS TODAY, January 2013, page 54), include in their weight calculations the water in the suspended feed hose. Since the mass of the water is supported by the pressure of the watercraft's output jet, it ought not to be included. One can easily visualize this by imagining the hose and water standing upright on their own: The hose will fall from its own weight, while the water column will continue to rise upward, thanks to the system pressure behind it.

The skin friction between the upwardly flowing water and the interior surface of the hose further diminishes the effective weight of the suspended hose, although that factor will contribute little to the net force acting downward.

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■ **Vonk and Bohacek reply:** We'd like to clarify two points that weren't explicit in our Quick Study. First, between the watercraft and the jetpack, the extra hose simply floats near the river's surface. Because the floating portion of the hose cannot support any additional weight without sinking, the full weight of the water above the river's surface must be supported from above. Second, the initial velocity of the water from the personal watercraft is horizontal. Thus the water must be accelerated upward by the upward-curving hose, which exerts an additional downward force on the jetpack. In the end, the downward force exerted by the hose water on the jetpack is greater than, not less than, the simplified calculation in the Quick Study.

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