More than a bumpy ride: Turbulence offers boost to birds

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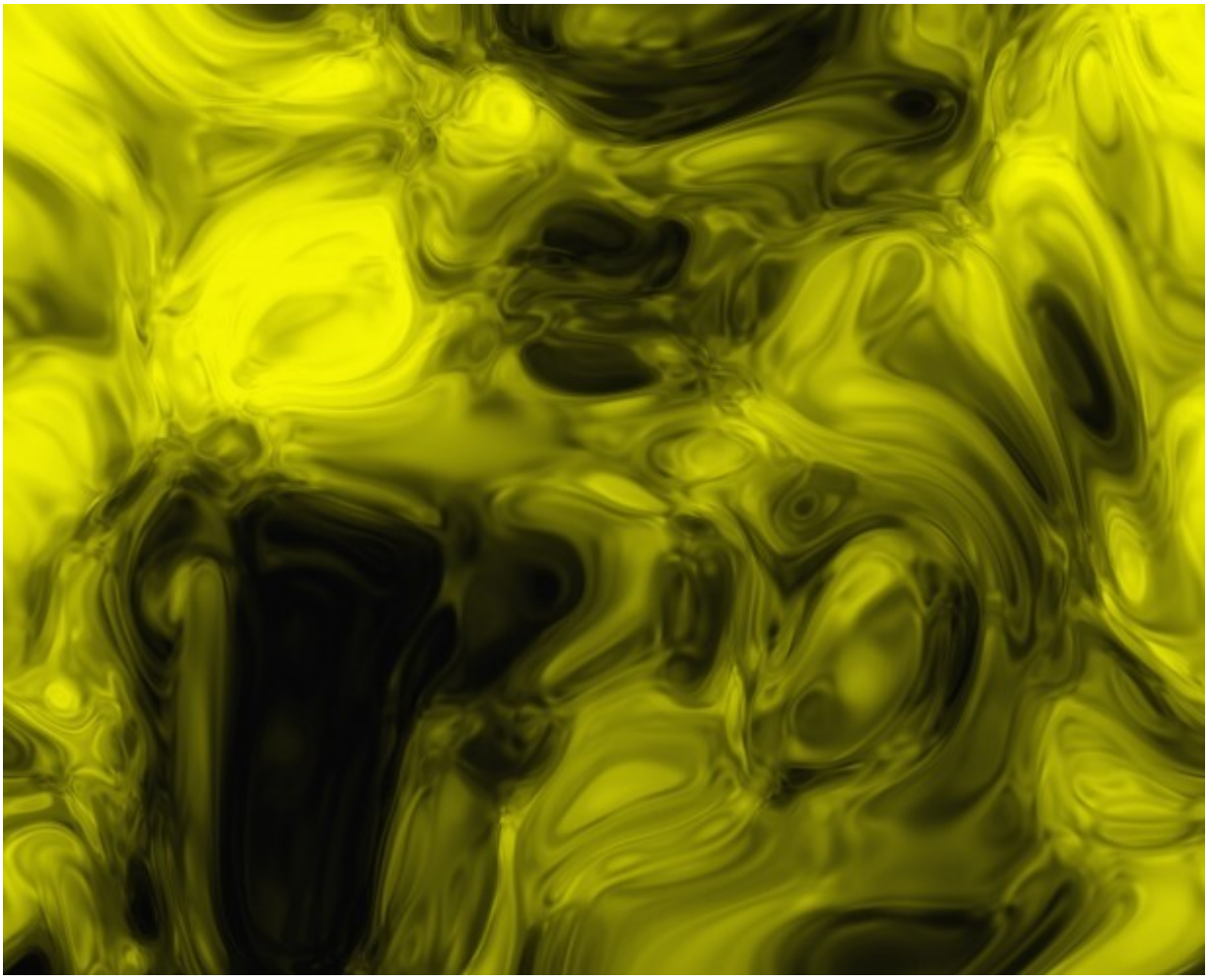

Credit: Piotr Siedlecki/public domain

Most sensible air travelers dread turbulence. A little atmospheric hiccup can shake airplanes, rattle nerves and spill beverages. A Cornell University-led study found that birds don't mind at all.

By combining wind speed data with the measured accelerations of a golden eagle outfitted with GPS tracking instruments, the researchers suggest that, rather than hindering flight, turbulence is a source of energy that birds may use to their advantage.

This counterintuitive discovery could revise what we know about avian flight, and help the aerospace industry develop faster, more efficient ways to fly in turbulent environments.

The paper, "Turbulence Explains the Accelerations of an Eagle in Natural Flight," published in *PNAS*. The lead author was doctoral student Kasey Laurent.

While the flight of birds may appear easy and graceful to earthbound spectators, winged animals are actually navigating air flow that is structured, textured and constantly in flux, according to Gregory Bewley, assistant professor in the Sibley School of Mechanical and Aerospace Engineering, who led the team.

In order to take his experiments out of the lab and into the sky, Bewley's team partnered with two groups—Conservation Science Global and Cellular Tracking Technologies. Scientists from these companies captured a female golden eagle in Alabama, rigged it with a solar GPS telemetry unit with an accelerometer weighing less than 3 ounces, then released the bird.

Over the course of 17 days, as the eagle migrated north along the Appalachian Mountains toward Canada, the GPS "backpack" transmitted more than 200 hours of data—including location coordinates, altitude,

ground speed and tri-axial acceleration—via cellular networks.

Bewley's lab then obtained wind speed data from the National Centers for Environmental Prediction's weather history databases and mapped it onto the eagle's flight measurements, identifying the bird's various flying and nonflying behaviors.

They found a "highly irregular, fluctuating pattern" in the eagle's accelerations, which resembles the typical trajectories of particles in turbulent airflows. At timescales ranging from 0.5 to 10 seconds—which translates to approximately 1 to 25 wingbeats—the eagle's accelerations and atmospheric turbulence were completely in synch.

And just how intense are these accelerations? As a point of comparison, people riding in a car or aboard a commercial flight experience less than 0.1 g, or one factor of earth's gravitational acceleration. Meanwhile, the accelerations of birds exceed 1 g—which would throw those human passengers out of their seats.

Of course, aeronautical engineers strive to reduce turbulence as much as possible, and no airline passenger or pilot wants a bumpy ride. But Bewley believes there are opportunities to harness the energy of turbulence, particularly for person-less transport and small reconnaissance aircraft.

"If you could find a path in which every vortex is pushing you the right way, then obviously you get there a little faster with a little less energy," Bewley said. "We're still working hard to understand turbulence by itself. I think it's fascinating that there might be some practical empirical knowledge embodied in wildlife that we don't appreciate yet."

More information: Kasey M. Laurent et al, Turbulence explains the accelerations of an eagle in natural flight, *Proceedings of the National*

Academy of Sciences (2021). DOI: 10.1073/pnas.2102588118