Researchers go small to better understand atmospheric motion

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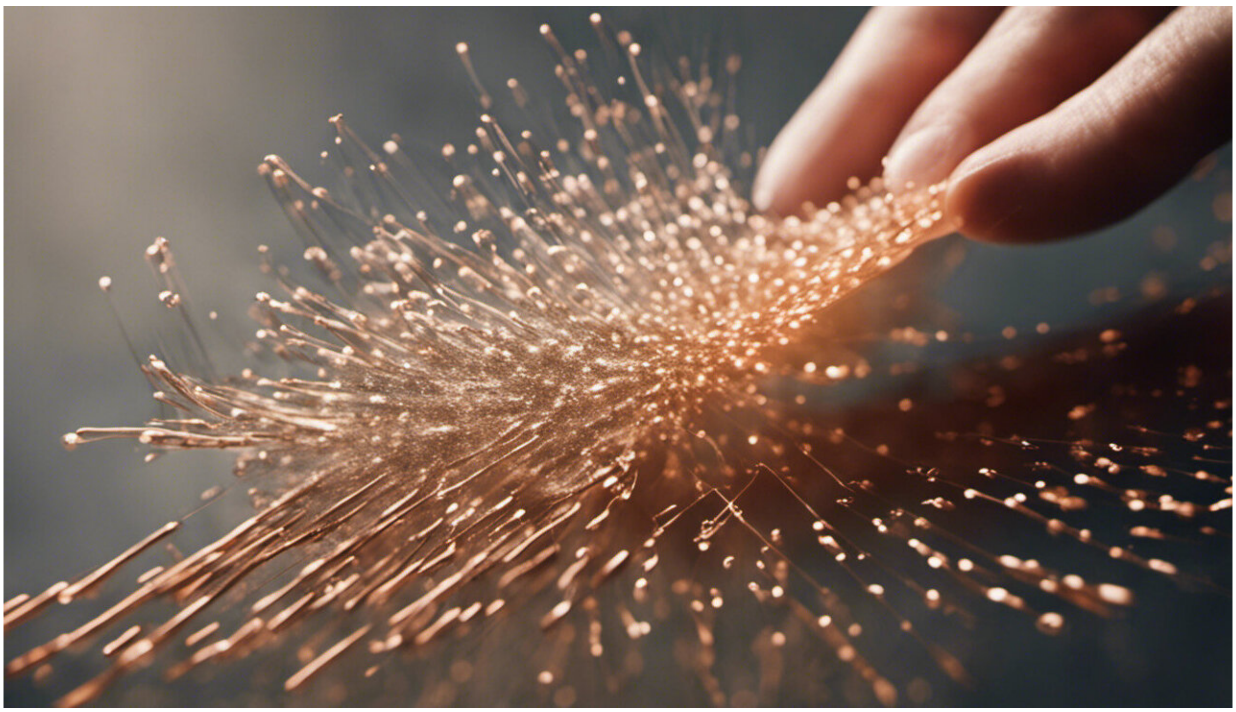

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Researchers at New York University and the Massachusetts Institute of Technology have shed new light on the nature of small-scale atmospheric motion—findings that could lead to lengthening the accuracy of weather predictions.

Their work, which appears in the journal *Proceedings of the National Academy of Sciences*, shows that on the small scale, atmospheric flows exhibit wave motion rather than vortical motion, as was previously thought. In the past, the motion of these small-scale vortices had previously been thought to be too irregular to be able to predict, but this may not be the case for small-scale waves.

The researchers used databases containing wind and temperature readings gathered by commercial airliners flying at approximately 30,000 ft. They then used these data to run computer simulations of atmospheric motion consisting of waves, which oscillate, and vortices, which move in a whirling fashion. They discovered that predictable wave motion occurs at scales smaller than previously realized. These findings suggest that at large scales, vortices are the dominant form of motion but at smaller scales wave motion is dominant.

This discovery modifies older ideas about atmospheric motion that stem from turbulence theory, which held that atmospheric motion becomes less regular as scale decreases.

"The standard argument from turbulence theory was that if it had all been vortices, all the way down to the smallest possible scale, then those are very unpredictable," explains Oliver Bühler, a professor at NYU's Courant Institute of Mathematical Sciences and one of the study's co-authors. "By contrast, the waves are much more predictable."

That regularity could have important applications in weather prediction.

"If waves are the dominant form of motion, we might actually be able to use a bit more computer development to get to the point where we could actually predict further into the future," Bühler explains. "Today, no weather forecast is reliable for more than six days, but with waves dominating the small scales we might be able to push this further than previously thought possible."

The methodology, the scientists add, could also be used for studying ocean waves. Bühler explains that using the computer advances that are available today, researchers can combine computer simulations and world-observation.

Currently, they rely on computers to analyze large data sets, but they don't have the capacity to do all the calculations necessary to replicate real-world phenomena. As a result, researchers must make estimates for certain calculations, thereby adding a degree of uncertainty to the results.

By contrast, Bühler says that by using the methods applied in their paper, researchers can improve their understanding about what is actually occurring because existing knowledge about the motion of weather vortices can complement predictions made by the computer. This helps scientists to know if the predictions are likely to be accurate.

"If you really know what kinds of motions you're trying to see, it makes a significant difference," Bühler says. "If we know that better, then the whole process of trying to guess what should be there could be much improved," leading to more accurate simulations.

Bühler says that this is especially important in the study of natural phenomena, an area where "the data is still extremely sparse, and extremely costly."

He explains that in atmospheric and ocean studies, applying methods like the ones used in this study could be very helpful in satellite data gathering because they can help to pinpoint where satellites can be most effectively deployed.

"In developing satellite missions, it is vital to know what to look for because the planning and instrumentation for their deployment is incredibly long range," Bühler says. "It takes many years and it's extremely costly. So they want to know what processes and motion they're actually going to find."

More information: Transition from geostrophic turbulence to inertia–gravity waves in the atmospheric energy spectrum, Jörn Callies, 17033–17038, DOI: 10.1073/pnas.1410772111

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