Butterfly effects

We have read Tim Palmer's article "The real butterfly effect and maggoty apples" (Physics Today, May 2024, page 30) with much interest. He writes that the popular conception of the butterfly effect, in which "the flap of a butterfly's wings in Brazil can set off a tornado in Texas a week later," is "folklore" that "isn't quite correct."

We recently published a relevant paper on this topic.[1] We conclude that a butterfly in Brazil cannot cause a tornado in Texas because of its tiny spatial scale and the dominant role of molecular dissipation at that scale.

The notion of a butterfly's flap causing a tornado is distinct from that of a sensitive dependence on initial conditions affecting the solutions to the equations of motion. Our paper offers a scientific discourse that the former effect is not at all plausible for the real atmosphere. In our chaos studies,[2] we have focused on finite predictability in Edward Lorenz's models of 1963 and 1969[3] and on three kinds of butterfly effects within those models.

We offer more comments at the online version of Palmer's article.

References

1. R. A. Pielke Sr, B.-W. Shen, X. Zeng, *Weatherwise* **77**(3), 14 (2024).
2. B-W. Shen et al., *Encyclopedia* **2**, 1250 (2022).
3. E. N. Lorenz, *J. Atmos. Sci.* **20**, 130 (1963); *Tellus* **21**, 289 (1969).

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► **Palmer replies:** While plausible, of course, the model of Roger Pielke, Bo-Wen Shen, and Xubin Zeng is nevertheless heuristic: As mentioned in my article, no rigorous proof or disproof of the real butterfly effect exists. Indeed, in contrast with the paper by Pielke and his coauthors,[1] recent published work[2] on spontaneous stochasticity in high Reynolds number flows (see reference 7 in my article) suggests that not only may macroscopic circulations be sensitive to flaps of butterflies' wings in finite time, but they may also be sensitive to the motions of individual molecules.

References

1. R. A. Pielke Sr, B.-W. Shen, X. Zeng, *Weatherwise* **77**(3), 14 (2024).
2. D. Bandak, A. A. Mailybaev, G. L. Eyink, N. Goldenfeld, *Phys. Rev. Lett.* **132**, 104002 (2024).

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Where physics students find community

It was with the joy of recalling fond memories that I read the recent article by Hannah Means about the International Association of Physics Students (Physics Today, June 2024, page 28). I became acquainted with IAPS in

the mid 1990s when I was director of the Society of Physics Students. For several years SPS sponsored two students' attendance at the flagship IAPS event, the International Conference of Physics Students (ICPS). It was my privilege to attend four of the conferences and encourage closer interactions between our societies. I made many friends among the young IAPS leaders.

I was immediately impressed with the organization's annual conference, its journal (*jIPAS*), and its sense of community. IAPS is effectively and steadfastly maintained by student initiative. It collaborates with other organizations, such as the European Physical Society. But the students themselves, with their governing board and an army of volunteers, organize and secure funding for each ICPS, carry out site selection, and build the meeting schedule. Their governing board meetings take place at the close of each ICPS; I was welcomed as an observer and witnessed how the IAPS board conducts its affairs with professionalism on par with any American Institute of Physics (publisher of Physics Today) member society.

The ICPS week features field trips to sites of cultural significance and physics history. For instance, the Denmark ICPS included guided tours of the Niels Bohr Institute and a bus trip to Roskilde to see the Danish royal tombs in the cathedral, followed by a visit to the Viking Ship Museum. At the Hungarian ICPS, the organizers arranged a block of seats at the outdoor performance of the musical *Elisabeth* sung in Hungarian (although IAPS conducts its business in English).

The social highlight of each ICPS occurs at the Wednesday evening International Party. There, students from each country provide food and some kind of performance to give everyone a sample of their cultures. For example, when Hungary hosted, the US delegation presented a version of the Abbott and Costello skit "Who's on First?," followed by a passage from a Native American tale of the Sky People. The evening ended with everyone caught up in traditional, robust Hungarian dances. The next morning it was back to serious physics sessions that lasted all day. IAPS knows how to combine physics with a good time!

In those days IAPS was trying to extend its network beyond Europe. I was glad to see in the June 2024 article that it is achieving success in that direction. Freeman Dyson observed that one of the beautiful faces of science is its role as an "international club."[1] That becomes manifestly clear, with contagious enthusiasm, when one encounters IAPS and its ICPS. I wish them well, and I thank Physics Today for giving these young physicists a prominent article.

Reference

1. F. J. Dyson, *Am. J. Phys.* **59**, 491 (1991).

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