Topological waves in geophysical fluids

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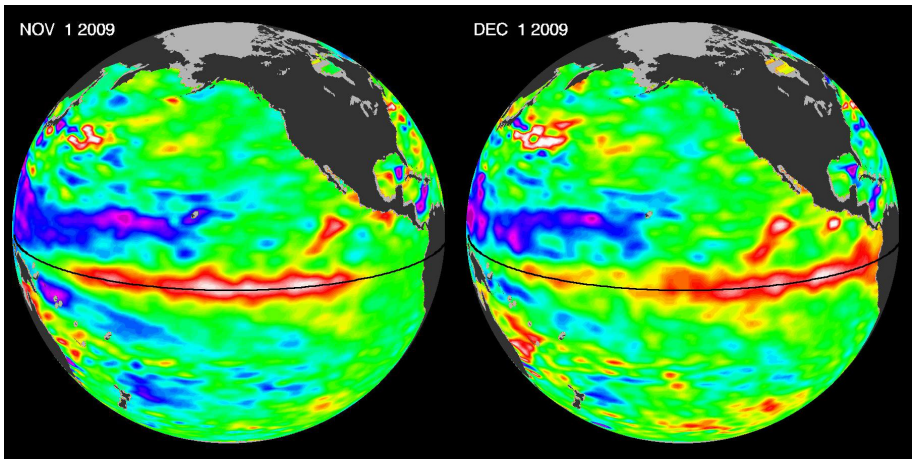

Figure 1: Eastward propagation of a temperature anomaly before an El Nino event in the pacific ocean. (crédit JPL, NASA). This is a Kelvin wave, now understood as a topological wave [1].

Oceanic and atmospheric waves can be extremely robust: their propagation properties do not depend on the details of the flow model and are immune to disorder. This is for instance the case of a class of equatorial waves that travel across the Pacific ocean without backscattering before an El Nino event. Is the origin of this robustness encoded in the structure of geophysical flow models?

In fact, other systems in acoustic, mechanics, or optics have the remarkable property to support the propagation of states on the edge of the system without dissipation, whose existence is guaranteed by topology. This topological protection implies that their propagation is not affected by the presence of defects, weak interactions, or disorder. These topological phases have been discovered in the context of quantum Hall effect thirty years ago, but physicists have realized the universality of this phenomenon only recently. This has rapidly motivated a surge of theoretical and experimental work across many fields of physics.

Until this year, these ideas had yet never been applied to geophysical flows. These flows support a variety of waves associated with symmetry breaking mechanisms. Physicists from ENS de Lyon have shown that equatorial waves have an origin in topology. Other topological waves remain to be found in this context, and their physical manifestations need to be addressed.

The aim of the internship is to establish the relation between symmetries of geophysical flow models, and the existence of topological waves in these flows. This will make possible fruitful analogies with other condensed matter systems and shed new light on geophysical phenomena along boundaries. According to the state of the intern, it will be possible to develop theoretical or numerical aspects of the projects, including collaborations with experimentalists in the lab.

Contacts

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- Possible collaboration with Brown (B. Marston)

Référence

[1] *P. Delplace, J.B. Marston, A. Venaille* 2017, Topological Origin of Equatorial waves, Science.