

Topological geo-physical waves

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Several atmospheric and oceanic waves are known to be trapped around the Earth's equator. Strikingly enough, two of them (the so-called Kelvin and Yanai waves) can only propagate eastward. This remarkable uni-directional behavior looks similar to those of chiral boundary states in Chern insulators. Beyond this analogy, it can be shown that the solutions of the continuous shallow water model, commonly used in geo-physics to describe ocean and atmospheric dynamics over large distances, indeed carry a topological property that is quantified by a first Chern number, in agreement with the existence of two unidirectional modes [1].

[1] P. Delplace, B. Marston and A. Venaille, *Science* **358**, 1075 (2017)

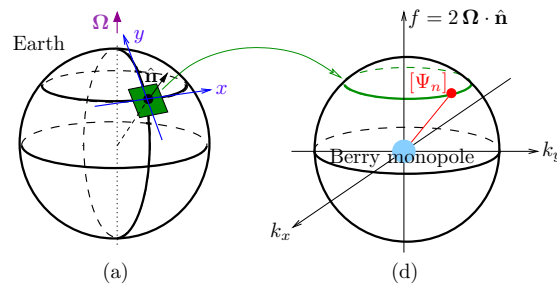


Figure 1: The dynamics of the fluid is described by the shallow water model in the tangent plane of earth. For each latitude, the waves that are solutions of this model can be parametrized on a sphere in (k_x, k_y, f) space, where f encodes the Coriolis force. The family of solutions, when f varies and changes sign, covers this sphere, but cannot be continuous and single-valued. This reflects a topological property of these waves that is quantified by the first Chern number.