Geophysical Research Abstracts
Vol. 21, EGU2019-4337-1, 2019
EGU General Assembly 2019

A model experiment of the quasi-biennial oscillation

Benoît Semin (1,2), François Pétrélis (2), and Stephan Fauve (2)

(1) Laboratoire PMMH, CNRS ESPCI, 7 quai saint-Bernard, 75005 Paris, France, (2) Laboratoire de Physique Statistique, Ecole Normale Supérieure, CNRS, 24 rue Lhomond, 75005 Paris, France

The quasi-biennial oscillation (QBO) is the periodic reversal of the wind in the lower equatorial stratosphere. The period of the oscillation is 28 months on average, and is not linked to the year duration. This wind is known to be generated by atmospheric waves, in particular internal gravity waves.

We have set up an experiment which reproduces this phenomenon in the laboratory. This experiment is inspired by the one of Plumb and McEwan [1]. Linearly stratified salty water is located between two plexiglas cylinders. Internal gravity waves are generated in the fluid using 16 membranes located at the top of the fluid. Each membrane oscillates sinusoidally in the vertical direction, in opposition of phase with its two neighbors: the wave is stationary in the azimuthal direction. When the amplitude of the forcing is large enough, a mean flow is generated, and oscillates with a period which is much larger than the wave period. This oscillation of the mean flow is similar to the one observed in the atmosphere.

We report the first quantitative measurements of the saturated velocity of the mean flow. We show that the QBO is generated by a bifurcation that is either supercritical or subcritical depending on the dominant dissipative process. This is confirmed by a theoretical analysis in the vicinity of the instability threshold [2].

[1] R. Plumb and A. McEwan, "The instability of a forced standing wave in a viscous stratified fluid: A laboratory analogue of the quasi-biennial oscillation", J. Atmos. Sci. 35, 1827?1839 (1978).

[2] B. Semin, N. Garroum, F. Pétrélis, S. Fauve, "Nonlinear saturation of the large scale flow in a laboratory model of the quasibiennial oscillation", Phys. Rev. Lett. 121, 134502 (2018)