Séminaire du CETHIL

Jeudi 21 juin 2018 à 13h30

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Renversements à grande échelle en convection turbulente de Rayleigh-Bénard

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Résumé :

Rayleigh-Bénard convection is a classical prototype for many applications of industrial or environmental interest. Despite the turbulent regime, a large-scale circulation (LSC), commonly referred to as the wind, can settle for very long periods of time, before suddenly reorganizing itself into a different form. Topics such as the coexistence of different large-scale structures, the heat transfer scaling or the origin of the reversal have been addressed mostly by experimental studies or 2D computations but more rarely by 3D computations. In 3D flows, LSC reorientations are achieved by rotation of the LSC plane or LSC extinction, referred to as cessation. In 2D the growth of corner-flow rolls leads to an orientation switching of the main diagonal roll. However, cessations are still present but as a specific regime between two time periods of intermittent reversals.

Based on long-term direct numerical simulations, we investigate the properties of 2D and 3D flow reversals. Proper Orthogonal Decomposition (POD) and energetic budget approaches are used to describe the reversal dynamics. First, we show that only a few POD modes are required to describe the main features of the reversals and the dynamics of the successive regimes observed from the onset of convection up to the turbulent flow regime. Focusing on the physical mechanisms responsible of 2D reversals, a filtering method is proposed to discriminate successive reversals from cessations. By use of conditional statistics, the presence of a three-phase generic reversal cycle is demonstrated, which includes a rebound event and a sudden energy exchange process from potential to kinetic energy. The successive reversal and cessation regimes are then analyzed in terms of symmetry properties of the POD modes and the stochastic behavior of their coefficients.

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