Conditional statistics of coherent structures in turbulent Rayleigh-Bénard convection

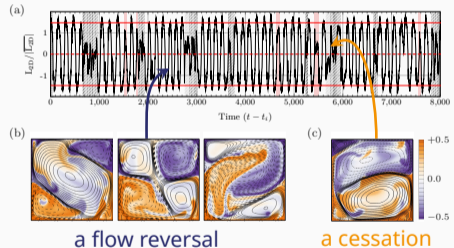A. Castillo, A. Sergent, B. Podvin & M. Rossi - LIMSI-CNRS / ∂'Alembert

Long term dynamics of the large-scale flow in turbulent Rayleigh-Bénard convection

$$\text{Ra} \equiv \frac{g\beta\Delta T H^3}{\kappa\nu} \sim 10^5 - 10^8, \qquad \text{Pr} \equiv \frac{\nu}{\kappa} = 3 - 4.3, \qquad \frac{W}{H} = 1 \qquad (1)$$

Over extended periods of time, we identify 2 intermittent flow regimes

The first regime is composed of a series of consecutive flow reversals

The second regime is composed of extended cessation of the large-scale circulation

a flow reversal   a cessation

We combine a conditional statistics approach with proper orthogonal decomposition (POD) to study the large-scale dynamics in both regimes
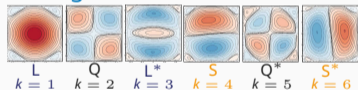
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Conditional statistics of coherent structures in turbulent Rayleigh-Bénard convection

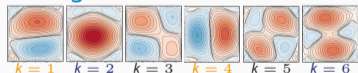A. Castillo, A. Sergent, B. Podvin & M. Rossi - LIMSI-CNRS / ∂'Alembert

POD modes are sorted in groups based on their symmetr___ ___ ___d y

- Fully symm___

$k = 1$ $k = 2$ $k = 3$ $k = 4$ $k = 5$ $k = 6$

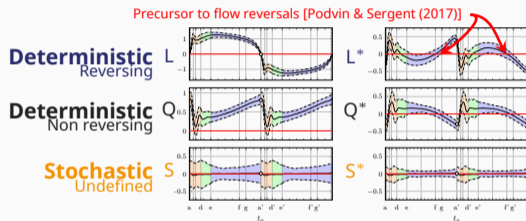**Similar flow structures in both regimes, the difference is their dynamics**

During generic reversals, modes in the same group display a similar behavior

Precursor to flow reversals [Podvin & Sergent (2017)]

Deterministic L
Reversing

Deterministic Q
Non reversing

Stochastic S
Undefined

L*

Q*

S*

A statistical characterization of each regime using leading modes L and S

The system keeps track of previous events during consecutive reversals

That "memory" is lost during the extended cessations