Geophysical Research Abstracts
Vol. 14, EGU2012-5458-2, 2012
EGU General Assembly 2012

Breakdown of turbulence in a plane Couette flow. Can extreme fluctuations be used to understand critical transitions?

D. Faranda (1), V. Lucarini (1,2), and P. Manneville (3)

(1) University of Hamburg, Klimacampus, Hamburg, Germany, (2) Department of Mathematics and Statistics, University of Reading, United Kingdom, (3) Laboratoire d'Hydrodynamique de l'X (le LadHyX), Paris, France

Critical transitions are observed in many natural phenomena and it is a scientific challenge to find out whether there are suitable observables to get early warnings of them. Among all the relevant physical problems that exhibit critical transitions, the breakdown of the turbulence in a plane Couette Flow is of great interest as varying the Reynolds number (Re) we observe three different dynamic regimes: if for higher Reynolds number the flow is completely turbulent, when 325< Re<410 plane Couette forms alternately turbulent and laminar oblique bands out of featureless turbulence. Eventually, when Re<325 turbulence is suppressed and a laminar behaviour prevails. We focus on the transition between the intermediate bands regime and the laminar behaviour trying to analyse the fluctuations of the so called perturbation energy. In particular we find that studying extreme fluctuations of the perturbation energy transient through the classical Extreme Value Theory (EVT) helps in understanding the mechanism of the suppression of turbulence: when the Reynolds number is decreased below Re=300, minima fluctuations amplitude increases considerably whereas maxima fluctuations remain about the same. This is compatible with the idea that the system is eventually going to suppress turbulence increasing the probability to observe very low values of turbulent perturbation energy. Although EVT was originally derived in the setting of stochastic variables, the application to fluid dynamics has been made possible by recent progresses on EVT in more general dynamical systems. We believe that testing EVT in an intermediate complexity fluid model could help in understanding what are the real possibilities in applying it to geophysical systems that represent complex real phenomena. Moreover, in the last years a lot of research effort has been directed towards understanding the role of early indicators of critical transitions both as diagnostic or prognostic tool: linking the behaviour of a system near the tipping points to modifications on its extreme fluctuations may improve our understanding of the dynamics when critical transitions occur.