

Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Dynamical similarities of the direct and inverse turbulent cascades¹ ALBERTO VELA-MARTIN, JAVIER JIMENEZ, Univ Politecnica de Madrid — A fully reversible homogeneous isotropic turbulent system is constructed using inviscid LES to model energy fluxes in the inertial range. It recovers energy and other turbulent quantities when reversed after being allowed to decay. During the first phase, a direct cascade transfers energy from large to small scales while, during the second, an inverse cascade does the opposite. Short-time Lyapunov (STL) analysis is used to study and compare the dynamics of both cascades. This allows us to identify a smallest length scale for the chaotic flow behavior, below which the system behaves as a unit dynamically enslaved to larger motions by the contracting effect of the model. Above it, the inertial forces become relevant and the system is fully chaotic. When the inertial scales are isolated, the leading STL exponent is similar for both cascades, suggesting that the dynamics of the inertial range is conservative and time-symmetric, and that the direct and inverse energy cascades share similar energy transfer mechanisms. The cascade would thus be a bi-directional reversible process with similar up and down mechanisms, although, because the L_2 norm used in the STL analysis respects the geometry of phase space, the entropy-driven cascade directionally is not precluded.

¹Funded by the ERC Multiflow program

Alberto Vela-Martin
Univ Politecnica de Madrid

Date submitted: 27 Jul 2015

Electronic form version 1.4