Extraction of coherent vortex tubes in a 3D turbulent mixing layer using orthogonal wavelets

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Abstract We present a new technique to extract coherent vortex tubes out of turbulent flows. The method is based on an orthogonal vector-valued wavelet decomposition of the vorticity field using the fast wavelet transform. A nonlinear thresholding of the wavelet coefficients is applied, where the threshold depends on the Reynolds number and on the total enstrophy of the flow, only. The coherent vortex tubes are reconstructed from the strong wavelet coefficients while the remaining weak coefficients correspond to an incoherent background flow. As example we present an application of this method to a turbulent mixing layer computed by high resolution direct numerical simulation. We find that only few wavelet coefficients are necessary to represent the coherent vortex tubes of the flow. The incoherent background flow reconstructed from the remaining weak coefficients is structureless and exhibits an energy equipartition.

Of wavelets I'm an adherent;
Though some people think me quite errant,
Like the structures extracted
By techniques compacted,
My lecture's entirely coherent.

1. Introduction

Many turbulent flows exhibit organised structures (*e.g.*, Jimenez & Wray 1993) evolving in an unorganised random background. A separation of the flow into these two components is a prerequisite for a sound physical modelling of turbulence. Since these coherent vortices are well localised and excited on a wide range of scales, we have proposed to use the wavelet representation of the vorticity field to analyse (Farge 1992), to extract (Farge, Schneider & Kevlahan 1999) and to compute them