High-resolution ocean dynamics from microcanonical formulations in non linear complex signal analysis

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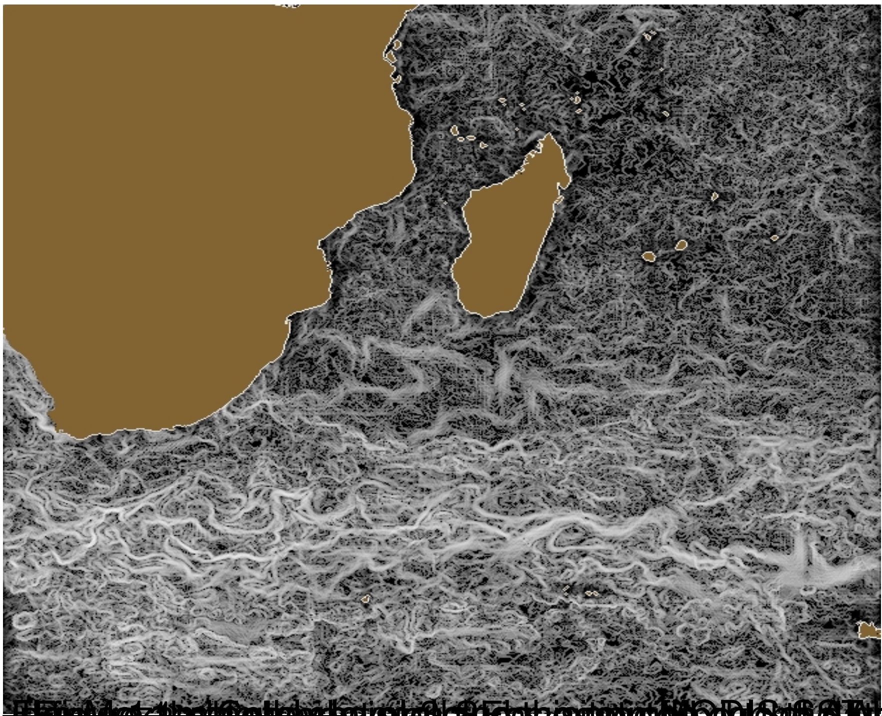
Abstract

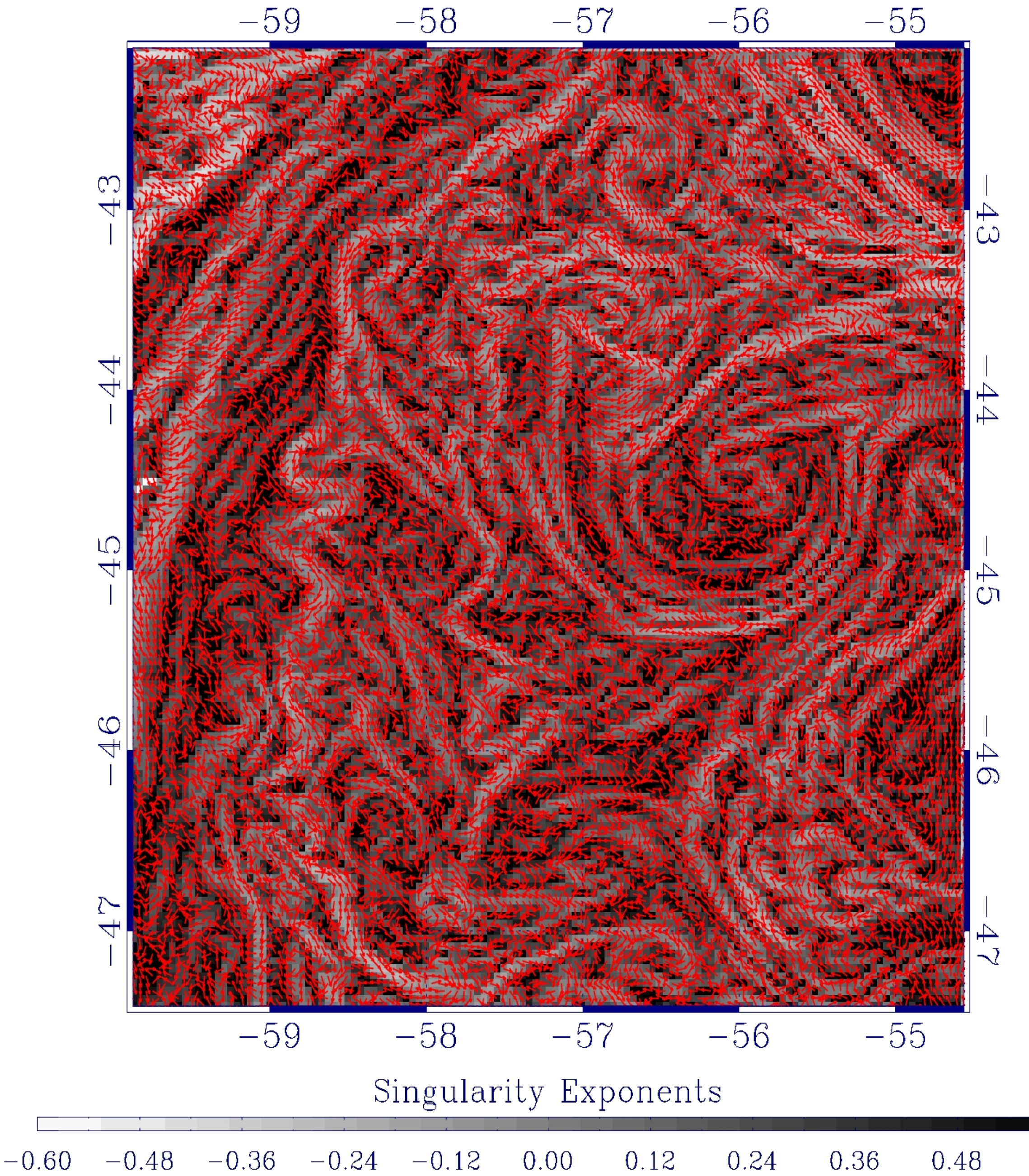
This article develops on a microcanonical formulation [1,2] for the analysis of the dynamics in acquisitions of remotely sensed oceanographic images using non-linear methods. In new approaches to complexity [3,4], fundamental quantities such as singularity exponents (SEs) are computed without any stationary hypothesis, i.e. in situations far from statistical equilibrium, as it is the case in Oceanography. SEs characterize rigorously complex oceanographic coherent structures and their relations. These quantities can be computed from the acquired data using advanced signal processing tools [5]. Computational precision is pivotal and we first give some details on techniques available in non-linear signal processing for computing SEs. SEs relate to the geometric structures linked with the cascading properties of indefinitely divisible variables in turbulent flows. In a second step, we show how cascading properties can be represented by optimal wavelets (OWs) [6]; this opens new and fascinating directions of research for the determination of ocean motion field at high spatial resolution. OWs in a microcanonical sense pave the way for the determination of the energy injection mechanisms between the scales. We describe a new method for the complete evaluation of oceanic motion field which consists in propagating along the scales the norm and the orientation of ocean dynamics deduced at low

spatial resolution (geostrophic from altimetry [7] and a part of ageostrophic from wind stress products). Using this approach, there is no need to use several temporal occurences as in Optical Flow, Maximum Cross Correlation or FSLE techniques. Instead, the proper determination of the turbulent cascading and energy injection mechanisms in oceanographic signals allows the determination of oceanic motion field at the SST or Ocean colour spatial resolution (pixel size: 4 kms) which often surpasses the results obtained with SQG models. We use the Regional Ocean Modelling System (ROMS) [8] to validate the results on simulated data and compare the motion fields obtained with other techniques.

Figures



[illegible]



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