Arctic circulation from a Lagrangian perspective

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In the context of rapid increase of temperature in the polar regions, inducing a dramatic ice melting, Lagrangian transport in the Arctic Ocean becomes an area of key interest. There exists evidence of changes in the circulation of water masses at different depths such as a notable decrease in intensity of the so-called Beaufort Gyre and the discharge of a great amount of fresh water into the North-West Atlantic Ocean. These facts may have a direct impact on the global circulation of water and heat.

The aim of this talk is to show the phase portrait of the sea currents throughout the Arctic Ocean, which allows us to study aspects of their dynamics. This is done by means of the numerical method known as Lagrangian descriptors [4], which computes and graphically displays flow structures over a given domain of the ocean, highlighting coherent jet circulation patterns in red color.

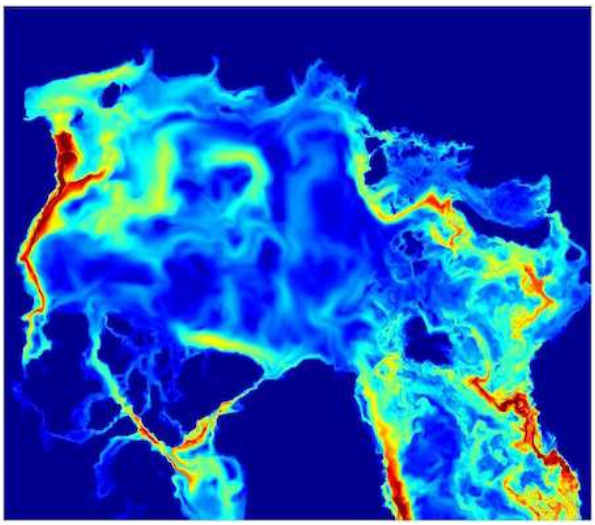

FIGURE 1. Lagrangian descriptor values over a grid of points located in the Arctic region and at a depth of 30 meters. This image corresponds to the 11th March 2013.

This method was originally based on the computation of the Euclidean arc length of trajectories of a dynamical system. In this work the considered dynamical system is a velocity field given by data sets collected through observations. Other quantities integrated along trajectories, such as the p-norm of the velocity field, also highlight remarkable features of the phase space such as distinguished trajectories and their stable and unstable manifolds [3].

The images provide us both a validation of already known and well reported flow structures [2], and also the discovery of singular features in the ocean which correspond to extreme weather events [1]. These observations quantify how much global climate warming has made impact to the general circulation of the Arctic Ocean.

Keywords: Lagrangian transport, phase space, Lagrangian descriptors.

Acknowledgments

The research of FB-I, VG-G and AMM is supported by the MINECO under grant MTM2014-56392-R. We acknowledge support from MINECO: ICMAT Severo Ochoa project SEV-2011-0087.

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