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The Lagrangian description of oceanic and atmospheric flows

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Geometry has been a very useful approach for studying dynamical systems. At the basis are Poincare ideas of seeking structures on the phase space that divide it into regions corresponding to trajectories with different dynamical fates. These ideas have demonstrated to be very powerful for the description of transport in purely advective flows and important applications have been found in geophysics. However realistic flows as those obtained by altimeter satellites or from numerical simulations are highly non-periodic and to deal with these flows is a challenge because traditional methods can be used only in autonomous and time periodic dynamical systems. We describe new Lagrangian tools that are applied to general time dependent flows. First we propose a generalisation of the concept of fixed point to aperiodic dynamical systems: the distinguished trajectory [1]. The definition is based on a function called M for which we show is a powerful Lagrangian descriptor [2]. We discuss applications of these new tools on oceanic datasets taken from altimeter satellites on the Kuroshio region, and on reanalysis data on the Antarctic polar vortex [3,4].

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