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A Lagrangian study of large-scale horizontal transport in the southern stratospheric polar vortex

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The mechanisms responsible for large-scale horizontal transport of air masses within the well-isolated lower southern stratospheric polar vortex during the austral spring are investigated. A new Lagrangian descriptor M is applied to describe the horizontal geometry of the Antarctic lower stratospheric flow. Specifically, at a given time t, M accounts for the length of the particle trajectories advected by the wind field over a range of times [t-τ, t+τ], and has already been shown to be a powerful Lagrangian descriptor in oceanographic contexts [1].
In the present work, we show with unprecedented clarity the Lagrangian features of the stratospheric polar vortex, namely the isolated interior of the vortex, the transport barrier at the vortex edge and the "collar" region in the vortex outskirts where large-scale stirring takes place. Of particular interest are the geometrical Lagrangian features in the vortex interior. We show several examples of transport by lobes both in the periphery of the stratospheric vortex edge and in the vortex interior just by visualizing M. The Lagrangian structures are compared against observations of quasi-Lagrangian drifters in the lower stratosphere gathered during the Vorcore campaign in the southern spring of 2005. Different dynamical sources for the existence of interior hyperbolic trajectories, which govern mass exchange between the vortex core and the jet, are proposed.

[1] Carolina Mendoza, Ana M. Mancho. The hidden geometry of ocean flows. Physical Review Letters 105 (2010), 3, 038501-1-038501-4