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Lagrangian analysis of the northern polar vortex split in April 2020 during development of the Arctic ozone hole

Jezabel Curbelo[1], Gang Chen[2], and Carlos R. Mechoso[2]
[1]Universitat Politècnica de Catalunya, Departament de Matemàtiques, Barcelona, Spain (jezabel.curbelo@upc.edu)
[2]University of California, Los Angeles, Department of Atmospheric and Oceanic Sciences, Los Ángeles, USA

The evolution of the Northern Hemisphere stratosphere during late winter and early spring of 2020 was punctuated by outstanding events both in dynamics and tracer evolution. It provides an ideal case for study of the Lagrangian properties of the evolving flow and its connections with the troposphere. The events ranged from an episode of polar warming at upper levels in March, a polar vortex split into two cyclonic vortices at middle and lower levels in April, and a remarkably deep and persistent mass of ozone poor air within the westerly circulation throughout the period. The latter feature was particularly remarkable during 2020, which showed the lowest values of stratospheric ozone on record.

We focus on the vortex split in April 2020 and we examine this split at middle as well as lower stratospheric levels, and the interactions that occurred between the resulting two vortices which determined the distribution of ozone among them. We also examine the connections among stratospheric and tropospheric events during the period.

Our approach for analysis will be based on the application of Lagrangian tools to the flow field, based on following air parcels trajectories, examining barriers to the flow, and the activity and propagation of planetary waves. Our findings confirm the key role for the split played by a flow configuration with a polar hyperbolic trajectory and associated manifolds. A trajectory analysis illustrates the transport of ozone between the vortices during the split. We argue that these stratospheric events were linked to strong synoptic scale disturbances in the troposphere forming a wave train from the north Pacific to North America and Eurasia.

Reference: J. Curbelo, G. Chen, C. R. Mechoso. Multi-level analysis of the northern polar vortex split in April 2020 during development of the Arctic ozone hole. Earth and Space Science Open

Archive. doi: 10.1002/essoar.10505516.1

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