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Detection and tracking of atmospheric blocks: a Lagrangian flow network approach

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In the past decades, boreal summers have been characterized by a number extreme weather events such as heat waves, droughts and heavy rainfall periods with significant social, economic and environmental impacts. One of the most outstanding examples occurred in the summer of 2010 when an anomalously strong heatwave persisted over Eastern Europe for several weeks while extreme rainfalls struck Pakistan, leading to the country's worst floods in record history. Both events were related to the presence of an anomalously persistent atmospheric blocking situation - that is a large-scale, nearly stationary, atmospheric pressure pattern - over Eastern Europe.

The high impact of blocking events has motivated numerous studies. However, there is not yet a comprehensive theory explaining their onset, maintenance and decay and their prediction remains a challenge.

In this work, we employ a Lagrangian dynamics based, complex network description of the atmospheric transport to study the connectivity patterns associated with atmospheric blocking events. The network is constructed by associating nodes to regions of the atmosphere and establishing links based on the flux of material between these nodes during a given time interval, as described in Ser-Giacomi et al. [1]. One can then use the tools and metrics developed in the context of graph theory to explore the atmospheric flow properties. In particular, we demonstrate the ability of measures such as the network degree, entropy and harmonic closeness centrality to trace the spatio-temporal characteristics of atmospheric blocking events.

[1] E. Ser-Giacomi, V. Rossi, C. López, E. Hernández-García, *Chaos* 25(3), 036404 (2015)

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