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Evidence for a "Traffic Jam" Onset of Blocked Flow from Ensemble Sensitivity Analysis

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Recently, Nakamura and Huang proposed a simplified model of blocking onset in which blocks form due to an obstruction of the zonal propagation of wave activity on the mid-latitude waveguide analogous to how traffic jams emerge on a highway. The theory is derived from the budget of finite-amplitude local wave activity which can quantify blocking even during the non-linear and high-amplitude stage accurately.

Using the local wave activity framework, we investigate the development of a winter European block and asssess the possible role of the "traffic jam" mechanism in the flow transition. We determine processes contributing to the blocking onset by evaluating the terms of the wave activity budget with data and carry out an ensemble sensitivity analysis to track precursor Rossby wave activity through time. Complementing previous reanalysis-based composite studies which found a large case-to-case variability, the ensemble approach enables us to apply the wave activity framework to individual blocking events, yielding a flow-dependent analysis.

We find evidence for a “traffic jam” blocking onset on 18 December 2016. Block development is sensitive to upstream precursor Rossby wave activity up to 2.5 days prior to the onset date. However, threshold behavior as implied by the idealized theory is not detected. The relationship of finite-amplitude local wave activity and its zonal flux as mapped by the ensemble exhibits the established characteristics of a traffic jam. We therefore suggest that the traffic jam mechanism may play an significant role in some cases of blocking onset and discuss the implications for the predictability of blocking.