Vortex-vortex interactions for the maintenance of atmospheric blocking: The selective absorption mechanism

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Atmospheric blocking is a quasi-stationary anticyclone with a radius of ~5000 km persisting for about 1 week or more, characterized by a pronounced meandering of the middle-latitude westerly jet stream. To clarify why blocking anomalously persists beyond the typical time scale of synoptic eddies has been an important issue for the blocking dynamics. In this stream, we proposed a new maintenance mechanism for atmospheric blocking, the selective absorption mechanism (SAM). According to this mechanism, which is based on vortex-vortex interactions (i.e., the interactions between a blocking anticyclone and synoptic eddies with the same polarity), a blocking anticyclone actively and selectively absorbs synoptic anticyclones (strictly, air parcels with low potential vorticity) from the storm-track regions in mid-latitudes. The blocking anticyclone, which is thus supplied with low potential vorticity of the synoptic anticyclones, can subsist for a prolonged period, withstanding dissipation. The SAM is one of the eddy-feedback mechanisms that describes the interaction between blocking and synoptic eddies with different time scales each other. At first, through the comparison with the famous maintenance mechanisms proposed in the previous studies, uniqueness and distinction of the SAM from other previously proposed maintenance mechanisms are discussed. And then, the SAM was verified in case studies and idealized numerical experiments.
In the case studies, trajectory analyses were conducted by using a reanalysis dataset provided by the Japan Meteorological Agency and the Central Research Institute of the Electric Power Industry. Ten actual cases of blocking were examined. Trajectories were calculated by tracing parcels originating from synoptic anticyclones and cyclones located upstream of the blocking. Parcels starting from anticyclones were attracted to and absorbed by the blocking anticyclone, whereas parcels from cyclones were repelled by the blocking anticyclone. The numerical experiments performed here were based on the nonlinear equivalent-barotropic potential vorticity equation, with varying conditions with respect to the shape and amplitude of blocking, the characteristics of storm tracks (displacement and strength), and the characteristics of background zonal flow. The experiments indicate that the SAM effectively maintains blocking, independently of the above conditions. The above results verify that the SAM is an effective general maintenance mechanism for blocking.

Keywords: Atmospheric blocking, Storm tracks, Potential vorticity, Tropopause, Dynamical meteorology

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