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THE EXTREME EUROPEAN COLD SPELL IN 2011/12 WINTER. PART I: ROLES OF ROSSBY WAVE TRAINS AND STORM TRACK FEEDBACK

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In the 2011/12 boreal winter, much of the European continent experienced an extreme cold spell that brought severe blizzards and extreme low temperature. In this study, a brief overview of this cold spell is first presented including its spatial and temporal features on the basis of observational and reanalysis datasets. It reveals that the cold spell starts from mid-January, grows rapidly in late January, and matures from the end of January to mid-February. Accordingly, the cold spell is divided into the initiation, growth, and mature stages and the mechanism of the formation of circulations during these stages is investigated. The roles of low-frequency Rossby wave train and high-frequency transient eddies are specifically investigated. In the initiation stage, a Rossby wave train emanates from the North Atlantic and propagates towards Europe, leading to cyclonic anomalies over Europe and the initiation of the cold spell. Transient eddies contribute to both the maintenance of the wave train and the deepening of the anomalous cyclonic center via its feedback forcing. In the growth and mature stages, an anticyclonic center around the Scandinavia Peninsula is the key feature. The formation of its western portion is mainly contributed by the feedback forcing of transient eddies, while that of its eastern portion is mainly contributed by the convergence of Rossby wave train. This mechanism is especially efficient during the growth stage but less efficient during the mature stage. As will be shown in a companion talk to be given by Hisashi Nakamura, the conversion of available potential energy from basic state into the anticyclonic anomaly plays an important role during the mature stage.