In this study, we have investigated the dominate submonthly variability of zonally symmetric atmospheric circulation in the Northern Hemisphere (NH) winter, with a focus on its phase transition and interactive stratosphere-troposphere processes. The submonthly variability is measured and identified by using a modified zonal index (MZI), which mimics the Northern Annular Mode index but concentrates on zonal mean circulation. An idealized lifecycle is then composed. Our analysis results suggest a two-way coupling process between stratosphere and troposphere that plays a decisive role in the phase transition of the submonthly variability event in the NH high latitudes. Specifically, anomalous zonal wind occurring in the Atlantic and Pacific sectors of the Arctic propagates upward from the troposphere to the low stratosphere, perturbing the polar vortex. The deformed polar vortex redistributes air mass, resulting in anomalously high geopotential height, which subsequently propagates downward to the troposphere and changes the sign of the surface zonal wind. Triggers and mechanisms associated with these two-way coupling processes were also examined. Documentation and understanding of this submonthly variability may have important implication for improving weather and short-term climate predictions for time scales of a week or two.

KEYWORDS: Zonal-mean Circulation, Stratosphere-Troposphere Interaction, Polar vortex, Northern Hemisphere Annular Mode