The variations of the QBO have been suggested to affect the circulation in the Northern Hemisphere winter. The results of 3 ensemble experiments from REFB1 scenario of CCM Validation-2 (CCMVal2-REFB1) for CCSR/NIES CCM were analyzed for 1960–2006. The influence of the QBO on the Northern Hemisphere winter was estimated by a composite analysis with statistical significance. The analyses suggest that the difference in latitude of the critical line in the low latitudes around 10 hPa as well as 50 hPa between the easterly and westerly phases is related to wave propagation over the whole depth of the stratosphere, which is simultaneous with the circulation anomaly. The circulation anomaly is further related to the temperature and zonal wind anomalies at the Northern Hemisphere mid- and high- latitudes. These results suggest a mechanism through which 10 hPa QBO could influence the polar vortex, while the mechanism of 50 hPa QBO influence is unclear. To avoid the effects of volcanic eruptions and SST variation, the experiments without these effects were performed (CNTL). The results of CNTL experiment also indicates very similar results of the CCMVal2-REFB1 experiment, suggesting that the aforementioned mechanism is mainly caused by the QBO. A mechanism modulated by the 11-year solar cycle is also discussed.