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Effect of energetic electron precipitation on polar vortex modulated by QBO phase and influenced by sudden stratospheric warmings

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Polar vortex is a jet of strong westerly winds in the stratosphere that develops each winter around the winter pole. It experiences considerable inter-annual variability, which is also reflected on tropospheric weather. Recent research has established a link between polar vortex variations and energetic electron precipitation (EEP) from the near-Earth space into the polar atmosphere, which is mediated by EEP-induced chemical changes causing ozone loss in the mesosphere and stratosphere. Ozone loss modifies stratospheric heating/cooling rates and causes significant variations in the polar vortex and wintertime ground circulation patterns. Long-term climate records show that the EEP-driven variations are strongly modulated by the Quasi-Biennial Oscillation (QBO) of the tropical stratospheric zonal wind. EEP-related variations in the polar vortex in late winter are predominantly observed only in the easterly phase of the QBO. Here we show that the late winter modulation of the polar vortex is due to both QBO and EEP affecting the occurrence and timing of Sudden Stratospheric Warmings (SSW), which momentarily break the polar vortex. Thus SSWs are identified here as an additional factor in mediating the EEP influence on polar vortex dynamics in late winter.