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Investigation of polar ozone anomalies with a Chemistry Transport Model: The role of stratospheric dynamics and heterogeneous chemistry

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We introduce a 29-year dataset of stratospheric ozone which has been created from sequential assimilation of Solar Backscatter UV (SBUV) satellite ozone profile observations into a chemistry transport model (CTM). Our assimilated dataset shows excellent agreement with ozone profile data from independent observations (satellite instruments and sondes), including during polar night when no SBUV observations are available. The dataset can thus be viewed as a consistent long-term dataset closing the gaps in satellite observations in order to investigate high-latitude ozone variability. We use the assimilated dataset to analyze the development and persistence of ozone anomalies in the Arctic stratosphere, and their relation to stratospheric dynamics. Ozone anomalies typically develop in the 1000K potential temperature ($\sim$ 35 km) region and slowly descend from there, showing an unexpectedly high persistence of up to seven months. Anomalies in the stratospheric circulation, expressed by the Northern Hemisphere Annular Mode (NAM) index, are shown to have a large influence on ozone anomalies. Extreme phases of the NAM index (strong and weak vortex events) lead to the creation of distinctively shaped ozone anomalies, which first appear in the uppermost stratosphere and then rapidly cover the upper and middle stratosphere, from where they then slowly descend into the lowermost stratosphere within five months. Using the CTM, we further quantify the role of heterogeneous chemistry for polar ozone anomalies, and its impact on mid-latitude ozone trends.