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Persistence and photochemical decay of springtime total ozone anomalies in the Canadian Middle Atmosphere Model

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Abstract. The persistence and decay of springtime total ozone anomalies over the entire extratropics (midlatitudes plus polar regions) is analysed using results from the Canadian Middle Atmosphere Model (CMAM), a comprehensive chemistry-climate model. As in the observations, interannual anomalies established through winter and spring persist with very high correlation coefficients (above 0.8) through summer until early autumn, while decaying in amplitude as a result of photochemical relaxation in the quiescent summertime stratosphere. The persistence and decay of the ozone anomalies in CMAM agrees extremely well with observations, even in the southern hemisphere when the model is run without heterogeneous chemistry (in which case there is no ozone hole and the seasonal cycle of ozone is quite different from observations). However in a version of CMAM with strong vertical diffusion, the northern hemisphere anomalies decay far too rapidly compared to observations. This shows that ozone anomaly persistence and decay does not depend on how the springtime anomalies are created or on their magnitude, but reflects the transport and photochemical decay in the model. The seasonality of the long-term trends over the entire extratropics is found to be explained by the persistence of the interannual anomalies, as in the observations, demonstrating that summertime ozone trends reflect winter/spring trends rather than any change in summertime ozone chemistry. However this mechanism fails in the northern hemisphere midlatitudes because of the relatively large impact, compared to observations, of the CMAM polar anomalies. As in the southern hemisphere, the influence of polar ozone loss in CMAM increases the midlatitude summertime loss, leading to a relatively weak seasonal dependence of ozone loss in the Northern Hemisphere compared to the observations.

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