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Predictions of the boreal winter stratosphere with the C3S multi-model seasonal forecast system

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As a result of the recent progress in the performance of seasonal prediction systems, forecasts of the mid-latitude weather at seasonal time scales are becoming increasingly important for societal decision making, as in risk estimate and management of meteorological extreme events. The predictability of the Northern-Hemisphere winter troposphere, especially in the Euro-Atlantic region, stems from the representation of a number of sources of predictability, notably El Nino Southern Oscillation, the stratospheric polar vortex, Arctic sea-ice extent, Eurasian snow cover. Among these, the stratospheric polar vortex is known to play a paramount role in seasonal forecasts of the winter tropospheric flow.

Here, we investigate the performance in the stratosphere of five seasonal prediction systems taking part in the Copernicus Climate Change Service (C3S), with a focus on the seasonal forecast skill and variability, and on the assessment of stratospheric processes. We show that dynamical forecasts of the stratosphere initialised at the beginning of November are considerably more skilful than empirical forecasts based on observed October or November anomalies. Advances in the representation of stratospheric seasonal variability and extremes, i.e. sudden stratospheric warming frequency, are identified with respect to previous generations of climate models running roughly a decade ago. Such results display, however, a large model dependence. Finally, we stress the importance of the relation between the stratospheric wave activity and the stratospheric polar vortex (i.e. the wave—mean-flow interaction), applied both to the variability and to the predictability of the stratospheric mean flow. Indeed, forecasts of the winter stratospheric polar vortex are closely connected to the prediction of November-to-February stratospheric wave activity, in particular in the Eurasian sector.