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Forecasted deep stratospheric intrusions over Central Europe: case studies and climatologies

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Abstract. Based on daily predictions of stratospheric air intrusions, obtained from trajectory calculations by ETH Zürich with wind fields from ECMWF forecasts, a high number of measurements with the ozone lidar at IMK-IFU (Garmisch-Partenkirchen, Germany) were carried out in 2001. The lidar measurements show a large variety of rather different cases reflecting the full complexity of intrusion episodes that is not visible in classical case studies. In part, tropopause folds could be fully captured. The frequency of intrusion cases forecasted and verified by vertical sounding or in the in-situ data recorded at the nearby Zugspitze summit (2962 m a.s.l.) exceed that in previous work by more than a factor of two. Three cases mapped with the lidar were selected to validate the results for the corresponding time periods extracted from a one-year run with the new hemispheric version of the chemistry-transport model EURAD. Due to the high spatial resolution chosen for these simulations the agreement with the lidar measurements is satisfactory. The Zugspitze ozone data from 1978 to 2004 were recently filtered by applying different criteria for stratospheric air, based on the ^{7}Be and humidity measurements. Here, by using the daily model forecasts during the time period 2001–2005, we examine three criteria and determine how well they represent the stratospheric air intrusions reaching the mountain site. Seasonal cycles for the period 2001–2005 were derived for the forecasts as well as the intrusion frequency per month for the forecasted intrusions and each of the criteria, distinguishing eight different characteristic transport pathways. In most cases a winter maximum and a summer minimum was obtained, but in the case of cyclonic arrival of intrusions starting over Greenland a late-spring maximum is seen. Two of the filtering criteria examined, based on combining a relative-humidity (RH) threshold of 60% with either a ^{7}Be threshold of 5.5 mBq m^{-3} or the requirement for RH≤30% within ±6 h, rather reliably predict periods of deep intrusions reaching the Zugspitze station. An "or" combination of both these criteria yields slightly more cases and covers 77.9% of the intrusions identified. The lack of observations in the complementary 22.1%

are mostly explained by overpasses. In this way the long-term trend of stratospheric ozone observed at this site as well as the corresponding ozone budget may be derived on the basis of measurements only. This effort will be the subject of a subsequent publication.

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