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Predictability of northern winter stratospheric conditions using JMA one-month ensemble predictions for 2001/02-2009/10

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This study investigates intraseasonal and interannual variations in predictability of Northern winter stratospheric conditions for 9 winters of 2001/02 to 2009/10. One-month ensemble predictions by JMA (Japan Meteorological Agency) are compared to JMA objective analysis data. The period includes 6 major stratospheric sudden warmings (MSSWs) in the winter season (December to February) characterized by reversals of the zonal mean zonal wind in the extratropical stratosphere. The predictability is evaluated with a measure of predictable limit (PL). The PL is defined as a time scale on which the RMSE (root mean square error) of forecast polar temperature or extratropical mean zonal wind with respect to the analysis data first exceeds one standard deviation of the climate (interannual) variability. A series of comparisons of the PL are made to elucidate the nature of the predictability of the Northern winter stratosphere. The comparison is first made between the stratosphere (10 hPa) and troposphere (500hPa). It ensures that the PL in the stratosphere is larger (about two weeks) on average than that in the troposphere (about one week). It further shows that the PL in the stratosphere undergoes larger variability ranging from a few days to a month or longer. The long PL occurs especially after the MSSWs (post-SSW conditions), whereas the PL is shorter in the other pre-SSW conditions. In the pre-SSW period, the predictability is lower when the stratosphere is dynamically active with stronger-than-normal planetary wave forcing from the troposphere. The MSSWs are extreme cases of the active conditions. The RMSE increases rapidly around the MSSWs, when the forecasts fail to predict warming and deceleration of the polar night jet. A further examination on the predictability of the occurrence of the MSSWs suggests strong case-dependences. The occurrence of the two MSSWs (January, 2004 and February, 2008) is well predicted by a large part of the ensembles when initialized about one week before. The MSSW in January, 2009 is the most difficult case to predict: none of the ensemble members predicts the zonal wind reversal with a lead time of about one week or longer. It is also noteworthy that several chances of MSSWs in the early winter (December) of some years are suggested by the forecast data, but were not realized at all. On the other hand, no MSSW is predicted (nor realized) in December of other years such as 2004 and 2008.