

Impact of Satellite Observations on Forecasting Sudden Stratospheric Warmings

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Observational impacts of satellite data assimilation on extended-range forecasts of sudden stratospheric warmings (SSWs) are investigated by conducting ensemble reforecast experiments based on the Japanese unique reanalysis products: the Japanese 55-year reanalysis (JRA-55) and its equivalent assimilating conventional observations only (JRA-55C). Since JRA-55C has no observational anchoring above the upper stratosphere, the upper part of the polar-night jet resolved in JRA-55C has quite different structure compared with that of JRA-55, due to the uncured bias stemming from insufficient gravity wave drags in the numerical prediction model of JRA-55 (Noguchi and Kobayashi 2018). Therefore, this investigation also highlights a possible role of mesospheric and upper stratospheric circulations on the onset and development of SSWs.

The ensemble reforecasts starting from JRA-55 and JRA-55C are performed by using an AGCM of Meteorological Research Institute, in a similar manner to Noguchi et al. (2016), for 20 SSWs during 1978/1979-2011/2012 Northern winter (December to February). A comparative examination on the reproducibility for SSW events between the two ensemble forecasts reveals that the impact of satellite observations is quite large for forecasts starting about 5 days before the SSW central dates of each event. The reproducibility of the SSW onset in ensemble forecasts initialized from JRA-55C is about 20% lower than that for forecasts starting from JRA-55, which correctly capture the onset timing of SSW events (over 70%). This result suggests that a current practical agreement of the deterministic limit of SSW predictability (at least 5 days) owes to the quality of the initial condition benefited by the sophisticated use of satellite information.

Moreover, it is found that several forecasts starting 5-10 days before the onset of vortex-splitting SSW events (e.g. 1985, 2009) show a sudden appearance of deep difference between JRA-55 forecast field and JRA-55C one, which lasts over a few months in the lower stratosphere and significantly affects the surface climate. This is due to the facts that the barotropic splitting behavior is well captured in the JRA-55 forecasts while the deformed polar vortex recovers instantaneously in the JRA-55C forecasts. Such a large difference between the two forecasts is consistent with a bifurcating property of the stratosphere-troposphere coupled system just before the onset of the vortex-splitting SSW, as reported by several previous studies.

Key words: sudden stratospheric warming, predictability, satellite observation, reanalysis, gravity wave drag

References

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