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Effect of Sudden Stratospheric Warmings on Subseasonal Prediction Skill in the NASA S2S Forecast System

M. Joan Alexander (1), Lawrence Coy (2), Laura Holt (1), Zhao Li (3), Andrea Molod (3), and Steven Pawson (3)

(1) NWRA, (2) USRA/NASA, (3) NASA/GMAO

Sudden stratospheric warmings (SSW) represent a major mode of subseasonal variability in the winter atmosphere, representing a potential for “Forecasts of Opportunity” in S2S systems. So-called “major SSWs” appear as dramatic polar cap warmings of 20o or more accompanied by weakening of the circumpolar zonal wind and reversal from the normal westerly to easterly. SSW anomalies can develop rapidly over days, descend in time over 1-2 weeks, and persist at the tropopause for 1-2 months. These stratospheric wind changes affect the vertical and latitudinal propagation of planetary waves throughout the atmosphere. Thus extreme stratospheric wind events, whether extremely weak or strong, are statistically associated with anomalous southward or northward shifts in the storm tracks with associated surface temperature and precipitation pattern shifts. Previous work has suggested enhanced prediction skill at the 16-60 day forecast range when forecasts are initialized during SSW events. However, prediction skill of the SSWs themselves remains poor beyond 10 days.

NASA’s Global Modeling and Assimilation Office (GMAO) at Goddard Space Flight Center has recently released a new subseasonal to seasonal forecast system, GEOS-S2S version 2.1. Compared to GMAO’s previous system, the new version runs at higher atmospheric resolution (approximately 1/2o globally), contains a substantially improved model of the cryosphere, includes additional interactive aerosol model components, and the ocean data assimilation system has been replaced with a Local Ensemble Transform Kalman Filter. A set of retrospective 45-day forecasts was initialized based on the MERRA2 reanalysis at 5-day intervals throughout years 1999 to 2015, with 4 ensemble members per initialization date. Our analysis of these retrospective forecasts reveals surface anomaly patterns in the period following SSW events, and compares key measures of forecast skill, contrasting forecasts initialized during an SSW to those initialized during normal conditions. We compare these results to those previously published using other forecast systems, and we examine the potential role of stratospheric wind biases and orographic gravity wave drag on the forecast skill.