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Evaluation of linear interference effects in CMIP5 models

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We here update recent work by Smith and Kushner (2012) concerning the role of linear interference in stratosphere-troposphere interactions. Wave-driven variability of the Northern Annular Mode (NAM) and the Southern Annular Mode (SAM) is often dominated by linear interference between the climatological stationary wave field and the anomalous wave field; when the climatological stationary wave field is amplified or attenuated, the stratospheric jet correspondingly weakens or strengthens. The importance of linear interference can be quantified by decomposing interannually varying wave activity fluxes into terms that are linear and nonlinear (quadratic) in the wave anomalies. Smith and Kushner find that in observations interannual variability in extratropical vertical wave activity fluxes is dominated by linear interference during the season of strongest stratosphere-troposphere coupling. The timing and persistence of linear interference effects reflects the timing and persistence of the phase of the planetary wave 1 anomaly. Linear interference effects dominate displacement stratospheric sudden warmings and aspects of the timing of final warmings.

We here seek to evaluate in the CMIP5 high-top and low-top models the observed characteristics of linear interference reported by Smith and Kushner (2012). Focusing initially on the Northern Hemisphere, we find that the CMIP5 models exhibit a broad range of stratospheric variability but are on average biased towards weak variability. The linear term is somewhat weak and the nonlinear term is very weak in the models, implying that linear interference effects are unrealistically dominant in the CMIP5 models. We attribute the previously reported delay in the seasonal peak of extratropical stratospheric variability to a corresponding delay in the linear interference term. The weak bias in the linear term can be attributed to a weak bias in the climatological stationary wave field; possible causes for the very weak bias in the nonlinear term will also be discussed.