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Stratospheric variability and trends in models used for the IPCC AR4

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Abstract. Atmosphere and ocean general circulation model (AOGCM) experiments for the Intergovernmental Panel on Climate Change Fourth Assessment Report (AR4) are analyzed to better understand model variability and assess the importance of various forcing mechanisms on stratospheric trends during the 20th century. While models represent the climatology of the stratosphere reasonably well in comparison with NCEP reanalysis, there are biases and large variability among models. In general, AOGCMs are cooler than NCEP throughout the stratosphere, with the largest differences in the tropics. Around half the AOGCMs have a top level beneath ~2 hPa and show a significant cold bias in their upper levels (~10 hPa) compared to NCEP, suggesting that these models may have compromised simulations near 10 hPa due to a low model top or insufficient stratospheric levels. In the lower stratosphere (50 hPa), the temperature variability associated with large volcanic eruptions is absent in about half of the models, and in the models that do include volcanic aerosols, half of those significantly overestimate the observed warming. There is general agreement on the vertical structure of temperature trends over the last few decades, differences between models are explained by the inclusion of different forcing mechanisms, such as stratospheric ozone depletion and volcanic aerosols. However, even when human and natural forcing agents are included in the simulations, significant differences remain between observations and model trends, particularly in the upper tropical troposphere (200 hPa–100 hPa), where, since 1979, models show a warming trend and the observations a cooling trend.

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