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On the magnitude of the stratospheric radiative feedback in global warming

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Global warming is amplified by radiative feedbacks. Compared to the feedback in the troposphere, the feedback in the stratosphere is less understood. The stratospheric water vapor (SWV), one of the primary feedbacks in the stratosphere, is argued to be an important contributor to global warming. This, however, is at odds with the finding that the overall stratospheric feedback does not amount to a significant value in global climate models (GCMs). The key to reconciling these seemingly contradictory arguments is to understand the stratospheric temperature (ST) change since the impact of SWV on the top-of-atmosphere (TOA) radiation budget results more from its cooling of the stratosphere than its direct radiative impact on the TOA radiation. Here, we develop a method to decompose the ST change and to quantify the effects of different climate responses associated with SWV on the TOA radiation budget. We find that although the SWV feedback by itself would lead to strong stratospheric cooling, this cooling is strongly offset by the radiative coupling between the stratosphere and troposphere. Such compensation results in an insignificant overall stratospheric feedback. SWV-locking experiments verify that the SWV feedback does not significantly modify the overall climate sensitivity in the GCM global warming simulations.