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Effect of Uncertainty in Water Vapor Continuum Absorption on CO_2 Forcing, Longwave Feedback, and Climate Sensitivity

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We assess the effect of uncertainty in water vapor continuum absorption on CO_2 forcing F, longwave feedback λ, and climate sensitivity S at surface temperatures T_s between 270K and 330K. We calculate this uncertainty using a line-by-line radiative-transfer model and a single-column atmospheric model, assuming a moist-adiabatic temperature lapse-rate and 80% relative humidity in the troposphere, an isothermal stratosphere, and clear skies. Emulating continuum uncertainty in observations, we hold total continuum absorption fixed at room temperature, but change its components: We assume a 10% decrease in self continuum absorption, which comprises interactions between water molecules, and a spectrally varying increase in foreign continuum absorption, which comprises interactions between water and non-water molecules. We find that continuum uncertainty mainly affects S through its effect on λ. Continuum uncertainty primarily impacts the surface feedback at T_s<290K and the atmospheric feedback at T_s>290 K. Under present-day conditions, those two effects have opposite signs and thus largely cancel each other, therefore the effect of continuum uncertainty on S is negligible (0.02K). At T_s>300K, however, the effect on S is much stronger (>0.2K). This is because at those T_s, the effects on λ of decreasing the self continuum and increasing the foreign continuum have the same sign. These results highlight the importance of a correct partitioning between self and foreign continuum to accurately determine the temperature dependence of Earth's climate sensitivity.