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Expanding the concept of atmospheric greenhouse effect using thermodynamic principles: Implications for predicting future climate change

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The natural and enhanced greenhouse effects are currently well understood as radiative phenomena. In the context of this paradigm, increasing concentrations of infrared absorbing gases inevitably causes a rise in the global surface air temperature. However, there is a great deal of uncertainty in regard to the magnitude of planetary warming that would result from rising levels of CO2 and other radiatively active gases. In this study, we show that this uncertainty is governed by an important thermodynamic feature of the atmosphere that is missing in the current theory and in present climate models. This feature involves a mechanism that has surprisingly eluded scientific scrutiny until now. We use empirical observations to quantify this mechanism and demonstrate its close interaction with the long-wave radiative transfer in the troposphere; hence, elucidating its key role in determining the net effect of increasing greenhouse-gas concentrations on climate. Implications of the new thermodynamic mechanism for deeper understanding of the natural greenhouse effect, the Earth's climate history, and future climate trends are discussed.