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The significance of shortwave methane forcing for climate change

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The radiative effects of methane are computed for the current climate. The longwave radiative forcing due to anthropogenic methane is the second largest forcing from the long-lived greenhouse gases (LLGHGs). We calculate the shortwave and longwave radiative forcing by methane at the top of atmosphere, tropopause, and surface. The shortwave forcing by methane has, to date, been omitted from models used in the assessments of global warming by the Intergovernmental Panel on Climate Change (IPCC). However, our results show that the shortwave and longwave surface forcings due to the increase in methane from pre-industrial to present-day concentrations are comparable in magnitude. The surface shortwave forcing from anthropogenic methane exceeds that of anthropogenic carbon dioxide. The spectral variations in the shortwave effects of water vapor, methane, and other LLGHGs are compared using line-by-line models. Global forcings are determined using the Rapid Radiative Transfer Method for GCMs (RRTMG) combined with the Community Climate System Model (CCSM). These calculations demonstrate that the shortwave forcing by methane is an important perturbation to the energy budget of the Earth's surface. The effects of methane on solar insolation should be included in future projections of climate change and simulations of paleoclimatic conditions.