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First Global Estimates of Anthropogenic Shortwave Forcing by Methane

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Although the primary well-mixed greenhouse gases (WMGHGs) absorb both shortwave and longwave radiation, to date assessments of the effects from human-induced increases in atmospheric concentrations of WMGHGs have focused almost exclusively on quantifying the longwave radiative forcing of these gases. However, earlier studies have shown that the shortwave effects of WMGHGs are comparable to many less important longwave forcing agents routinely in these assessments, for example the effects of aircraft contrails, stratospheric anthropogenic methane, and stratospheric water vapor from the oxidation of this methane. These earlier studies include the Radiative Transfer Model Intercomparison Project (RTMIP; Collins et al. 2006) conducted using line-by-line radiative transfer codes as well as the radiative parameterizations from most of the global climate models (GCMs) assembled for the Coupled Model Intercomparison Project (CMIP-3).

In this talk, we discuss the first global estimates of the shortwave radiative forcing by methane due to the anthropogenic increase in CH4 between pre-industrial and present-day conditions. This forcing is a balance between reduced heating due to absorption of downwelling sunlight in the stratosphere and increased heating due to absorption of upwelling sunlight reflected from the surface as well clouds and aerosols in the troposphere.

These estimates are produced using the Observing System Simulation Experiment (OSSE) framework we have developed for NASA's upcoming Climate Absolute Radiance and Refractivity Observatory (CLARREO) mission. The OSSE is designed to compute the monthly mean shortwave radiative forcing based upon global gridded atmospheric and surface conditions extracted from either the meteorological reanalyses collected for the Analysis for MIPs (Ana4MIPs) or the CMIP-5 multi-GCM archive analyzed in the Fifth Assessment Report (AR-5) of the Intergovernmental Panel on Climate Change (IPCC). The OSSE combines these atmospheric conditions with an observationally derived prescription for the Earth's spectral surface albedo as inputs to the MODerate resolution atmospheric TRANsmission (MODTRAN) code. MODTRAN is designed to model atmospheric propagation of electromagnetic radiation for the 100-50,000 1/cm (0.2 to 100 micrometers) spectral range. This covers the spectrum from middle ultraviolet to visible light to far infrared. The most recently released version of the code, MODTRAN6, provides a spectral resolution of 0.2 1/cm using its 0.1 1/cm band model algorithm.