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New Methods for Representing Transmission in Radiative Parameterizations

W. Collins A. Conley
National Center for Atmospheric Research, Colorado, USA

The accuracy of radiative parameterizations from AOGCMs in the IPCC 4th Assessment has been evaluated recently by the Radiative Transfer Model Intercomparison Project (RTMIP; Collins et al, 2005). The results of RTMIP reveal a number of significant deficiencies in the calculations of radiative forcing by long-lived greenhouse gases using these AOGCM codes. Motivated by these findings, we have initiated a systematic study of mathematical methods to improve the accuracy of AOGCM radiative parameterizations. The transmission through a medium is one of the most basic quantities in the solution of the radiative transfer equation. At present, the approximations used in correlated-k codes for the transmission through broadband absorbers such as CO2 or H2O are very ad hoc. We briefly review the methods commonly used by the global modeling community. Based upon the mathematical properties of the transmission function, we have developed a new, constructive method for approximating the transmission in an accurate yet efficient manner. The approximation has the same convenient functional form as an exponential sum fit (ESFT). Unlike the ESFT, however, our method insures that the error in the approximation is always less than a user-selectable tolerance for any absorber path-length. In addition, unlike ESFT, our method insures that the approximation satisfies this error bound with a minimum number of terms. We conclude by comparing the performance of our method against the ESFT and other traditional transmission approximations for several major absorption bands of water vapor and carbon dioxide.