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On the Effective Solar Pathlength

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The effects of atmospheric spherical curvature and refraction and their impact on radiative transfer have been studied. It is shown that the Rodgers' formule widely employed in GCMs for atmospheric curvature and refraction underestimates the effect of effective solar pathlength. A new parameterization is therefore proposed. It is emphasized that the atmospheric curvature effect on radiative transfer is a localized problem with height dependent. A method corresponding to the local effective pathlength factor is proposed. This rigorous scheme enables variations in both of the pathlength and gaseous amount along a solar direct beam to be accurately evaluated in the radiative transfer process. The results of the rigorous scheme can be used as the benchmark to the proposed parameterizations for the effective pathlength factor. It is found that new parameterization proposed in this note is better in results of flux and heating rate compared to other parameterizations. The climate impact by the new formula is shown through GCM simulation.