

A unified-principal-component radiative transfer model

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This study presents a fast radiative transfer (RT) model, referred to as the UPCRTM (Unified Principal Component RT model), to calculate the high-spectral resolution radiation. The principal component analysis is used twice independently to reduce the number of accurate RT simulations and subsequently minimize the number of channels for which RT calculations are performed. Thus, by performing many fewer accurate radiative transfer simulations (a few tens), we can get high-spectral resolution results (a few tens of thousands) efficiently without significant loss of accuracy. Gas absorption, aerosol scattering, and Rayleigh scattering can be fully considered in the model, and a comprehensive database by considering a large amount of atmospheric and aerosol profiles over the entire solar spectrum is developed for the PCA-based data training and validation. The UPCRTM is found to be three orders of magnitudes faster than the corresponding accurate models, and shows relatively small errors, generally within 0.5%. The efficiency and accuracy of the UPCRTM not only enables its application for high-spectral resolution instruments, but also provides a possible method for accurate RT simulations in mesoscale numerical weather models and general circulation models.

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