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A polarized adding-doubling radiative transfer model for simulating multi-layer scattering atmospheres

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Polarized radiative transfer models (RTMs) are of significant importance for satellite remote sensing, providing polarization information about the atmospheres, clouds, and aerosols, which is indispensable for meteorological, climate, and environmental studies. Currently, polarized RTMs are still challenged in terms of their computational efficiency, particularly for multi-layer cloudy conditions. In this study, an accurate and efficient model for solving polarization in multi-layer scattering atmospheres is introduced developed based on the Adding-doubling (AD) method. Instead of performing multiple doubling simulations for a cloudy layer, machine learning techniques were employed to generate reflectivity and transmittance of each layer. This model exhibited a high level of precision in the visible and near infrared spectrum. This model can be applied to various non-homogeneous atmospheres, especially multi-layer cloudy (ice above water) atmospheres. The efficiency of the adding process can be further improved to meet the requirements of satellite retrieval and other applications.