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The Impact of Clouds on the Orbiting Carbon Observatory-2 Satellite Trace Gas Retrievals

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Accurate and continuous measurement of atmospheric CO_2 mixing ratios (XCO_2) is essential for global climate change research. NASA's OCO-2/3 satellites have been deployed to measure XCO_2 with a high level of precision by converting radiance measurements from the oxygen A-band at 765 nm (O_2A), weak CO_2 bands near 1.61 μm (WCO_2), and strong CO_2 bands near 2.06 μm (SCO_2) of a small footprint into the column-average XCO_2. Although the retrieval algorithm filters out cloudy measurements for calculating XCO_2, the presence of clouds in the vicinity of footprints can still interfere with these measurements and cause retrieval biases. This is due to the fact that the forward 1D radiative transfer (RT) model, which is used to develop the retrieval algorithm for OCO, does not account for the horizontal transfer of photons that occurs when clouds are in proximity. Previous research has demonstrated that the 3D cloud effect can be modeled as a function of reflectance, which has the potential to adjust the retrieval algorithm and reduce the impact of clouds on the measurements. This study utilized the 3D satellite radiance simulator "EaR^{3}T" to model the 3D cloud effect for various surface conditions and solar zenith angles. To reduce the computational cost of 3D RT simulation, we developed a parameterization method for the 3D cloud effect parameters. Finally, we demonstrate that the proposed method is feasible for mitigating XCO_2 retrieval artifacts.

Keywords: clouds, satellite, retrieval bias

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