

Review of egosphere-2026-723

March 5, 2026

General comments

This study evaluates errors in satellite retrievals of global horizontal irradiance (GHI) due to three-dimensional (3D) cloud-radiation interactions at different spatial resolutions (from fine (50 m) to coarse resolutions (12.4 km)). This is achieved by utilizing two shallow-cumulus Large Eddy Simulations (LES) cloud fields, alongside retrieval algorithms and both 3D and 1D radiative transfer framework to perform a comprehensive study via a 1D/3D GHI retrieval vs 1D/3D GHI reference pathway approach, and mapping of differences to plane parallel approximation (PPA), independent pixel approximation (IPA) and residual biases. They show that at fine spatial resolutions current retrieval algorithms assuming the IPA prove to be insufficient to accurately resolve heterogeneous cloud conditions and emphasize the need to develop 3D RT parameterizations and corrections for GHI retrievals.

The work is well motivated, interesting, and the manuscript is mostly well written. There are a few areas where I think more examples and explanations are needed. For example, the study was mostly based on nadir viewing ($\theta = 0^\circ$) to avoid parallax error, even though geostationary satellites viewing zenith observations over mid-latitudes are typically off-nadir. The study also includes slant-view case ($\theta = 70^\circ$) and discusses parallax-induced smoothing, but the operational message (“The current generation of geostationary satellites already resolves these finer spatial scales in which IPA-related errors dominates”) partly depends on typical viewing conditions. It would be interesting to add one intermediate viewing zenith angle (e.g., $35 - 45^\circ$) to bridge between overhead (0°) and extreme (70°) view zenith. Also, since this study is based on two cloud fields of the same cloud type (shallow-cumulus clouds), care should be taken to draw conclusions objectively from the results. These are all minor concerns and are stated in my specific comments below. I congratulate the authors for this great work and, after addressing these remarks, I recommend prompt publication in ACP.

Specific comments

L97: Do both cloud scenarios have the same cloud top height (CTH) of 6.4 km? If not, state the CTH of each cloud scene and briefly explain how the CTH and cloud base height (CBH) of the two cloud fields were obtained.

L113: Reference this study: <https://doi.org/10.1029/2022JD036822> and include it in the discussion. Ambient aerosols have been shown to have a significant impact on the 3D radiative effect of cumulus scenes such as those considered in this work.

L118-119: Provide a justification for rounding the scene cloud droplet effective radii to their nearest integer values. The authors referred to Sect 3.1 where we see the range of droplet radii for MONKI simulations as 3 to 22 μm in 1 μm steps, but no satisfactory justification was made.

Fig. 1: I really like this figure. It captures the descriptions of the methods in the text. Two comments:

1. The rectangle in the topmost row showing the reflectance output from MONKI (3D), it will be helpful to include “(3D)” to the VIS/NIR reflectances. This would aid swift visualization that the reflectances here are from 3D RT and readers can grab the big picture by just looking at the figure.
2. Try to indicate that the CPP-SICCS in the first two rows are based on plane-parallel atmosphere and the different columns are independent. Like include “(1D RT theory)” or “1D”.

L164 - 167: cloud mask is generated based on the liquid water path from the LES data based on LES LWP > 0, while retrieved optical depth can return small non-zero τ even in clear pixels, and a separate $\tau > 0$ condition is also mentioned for cloudy masking. Because much of the mechanism relies on pixels being (mis)classified as cloudy/clear (especially enhancement/shading), inconsistencies here could affect residual attribution. What is the mismatch frequency between (LWP>0) and (retrieved $\tau > 0$) at each resolution (or at least at 50 m and one coarser scale)? Show that the main conclusions are not driven by classification artifacts. Consider reporting a sensitivity where the retrieval uses the retrieved τ threshold consistently for SICCS cloudy/clear (even if only for one scenario).

L194: As mentioned in the general comments above, can you include an experiment for intermediate viewing zenith angle (e.g., 35 - 45°) to bridge between overhead (0°) and extreme (70°) view zenith, showing how these compares to the current results. This can be discussed in Section 5.3 L514 to L546.

L525 - 529: “The magnitude of parallax depends on the height of the cloud and the viewing angle.” One suggestion is to include a figure of the cloud top height and cloud base height for clouds, this would allow the readers to see the CTH distribution and might envisage how shadowing of one cloud can affect its neighbor, depending on the solar-view geometry.

Technical corrections

L7: Abstract indicates resolution range considered as 0.05 to 12.4 km (as well as L80 and L553), while in L207 the largest resolution was stated as 12.2 km. Please standardize (12.2 vs 12.4).

L103: The Solar zenith angle for Scene 1 is given as 50.53° but Table 1 and elsewhere often uses 51° . This is okay but clarify rounding.

L152: Replace “which would additional uncertainties” with “which would cause additional uncertainties”.