Response to Reviewers

Manuscript: *Long-term trends in daytime cirrus cloud radiative effects*

The authors thank the reviewers for their constructive feedback. In the following, we respond point-by-point. All new or revised text is incorporated into the manuscript and, where appropriate, highlighted in red in the tracked version.

Reviewer #2 (RC2)

Comment. Writing and clarity (overly complex prose; units; "TOA cloud forcing" vs "TOA CRE").
Response. We simplified sentences, standardized terminology to "CRE," and harmonized units (W m^{-2} yr^{-1}). (Global edits).

Comment. Missing/ambiguous info: UCDM/GCDM definitions; placeholder "modified seasonal MK test (?)".
Response. Expanded UCDM/GCDM descriptions with references and removed the placeholder; we now cite the seasonal MK formulation used. (Sec. 2.3.1; Sec. 2.4).

Comment. CALIPSO (Lines 120–122): Is it used to calculate DF for Eq. (1)? Discuss spatial/temporal resolution/limitations.
Response. Yes. We clarified the role (regional CF for scaling) and added a brief discussion of representativeness and limitations. (Sec. 2.3/2.3.2).

Comment. Figure captions should be more descriptive (Fig. 1 and Fig. 3 questions).
Response. Rewrote captions to describe content (sampling, COD color bins, CI shading) and improved figure resolution. (Figures 1 and 3).

Comment. Data processing description (filtering criteria; bookend ratios; discarding non-cirrus).
Response. Added the operational workflow: single-layer cirrus selection, temperature thresholds, COD limits; explained "bookend" lidar ratios (20/30 sr) with literature support; specified removal of non-cirrus. (Sec. 2.3.1).

Comment. Equation formatting/notation (Eq. 1 unclear; define variables; add SFC equation).
Response. Re-typeset Eq. (1) with explicit summation and defined all symbols ($\mathrm{COD\_RF}_i$, CRF_i, CF, DF). Added the analogous surface CRE equation and an explanatory sentence right after. (Sec. 2.3.2).

Comment. Uncertainty quantification (lack of CI; error propagation).
Response. We now report 95% CI for Sen slopes via 12-month moving-block bootstrap; OLS slopes with HAC (Newey–West) 95% CI; and we visualize CI ribbons in the figures. (Sec. 2.4; Figs. 4–5).

Comment. Instrument upgrade in 2010: evaluate its effect (pre-/post-2010).
Response. Performed split-period Theil–Sen (2003–2009 vs. 2010–2022) with bootstrap CI and an OLS interaction (time×post-2010); no statistically significant slope break was detected. (Sec. 3.4.2; Table "SZA–adjusted trends and split-period slopes").

Comment. Section 4 lacked CI and visual uncertainty.
Response. We added CI to all trend estimates and show CI shading in the time series plots. (Figs. 4–5; Sec. 3).

Comment. MDT not clearly related to reported trends.
Response. We added an MDT table that lists MDT_{95} and the ratio $R = |\hat{\beta}|/\mathrm{MDT}_{95}$; in the text we explicitly state that observed trends exceed MDT_{95} (detectable). (Sec. 3.5; Table "Trend detectability").

Comment. Surface albedo attribution (needs evidence; e.g., MODIS or CERES).
Response. We added an observational albedo analysis using CERES SYN1deg (V4) at 1°×1° resolution over GSFC. The albedo trend is significantly negative (Sen = 0.00036 yr^{1}), with

seasonal behavior reported (DJF: 0.00064 yr^1; MAM: 0.00024 yr^1; JJA: 0.00040 yr^1; SON: 0.00035 yr^1). We cite regional snow cover literature (see, e.g., Dyer Mote, 2006) and revise the manuscript language to avoid causal inference, now stating that the CRE and albedo trends are "consistent with reduced wintertime surface reflectivity." (Sec. 3.2, Sec. 3.8/3.9; Fig. 5; Tables 3–5). Evidence in manuscript: CERES description and use; trend 0.00036 yr-1 and seasonal details; snow-cover citation

Comment. SZA sensitivity: quantify impact on radiative measurements.

Response. We estimated SZA-adjusted trends via $\mathrm{CRE}_t = \beta_0 + \beta_1 t + \beta_2 \mathrm{SZA}_t + \varepsilon_t$ (HAC(12) CI). Surface trends remain significantly negative; TOA adjusted CIs include zero. We added a concise interpretation sentence in Results. (Sec. 3.4.2; Table and paragraph).

Comment. Comparative context and generalizability (single site; satellite comparison requested).

Response. We agree that single-site results should be contextualized. We added a dedicated paragraph in the Discussion, clarifying that magnitudes are site-specific and that multisite MPLNET and broader satellite syntheses are a natural next step.

Editorial note: We also standardized units (W m^{-2} yr^{-1}, deg yr^{-1}), acronym use, and capitalization ("albedo"), corrected minor typos, and simplified dense sentences throughout.

Summary of Key Additions

- Clear TOA/SFC CRE equations with complete symbol definitions; added SFC analogue. (Sec. 2.3.2)
- Formal uncertainty: Sen 95% CI (block bootstrap), OLS/HAC 95% CI; CI ribbons in figures. (Sec. 2.4; Figs. 4–5)
- SZA sensitivity and instrument check: SZA-adjusted trends (HAC) and split-period Sen; no significant 2010 break; TOA not robust after SZA adjustment. (Sec. 3.4.2)
- MDT_{95} analysis and detectability table with $R = |\hat{\beta}|/\mathrm{MDT}_{95}$. (Sec. 3.5)
- CERES albedo trend and tempered attribution language. (Sec. 3.9; Discussion)

We appreciate the helpful suggestions of the reviewers, which substantially improved the clarity and rigor of the manuscript.