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Solar absorption in the clear and cloudy skies – quantification and attribution

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We estimate atmospheric solar absorption at 433 locations worldwide through combining ground-based measurements of surface solar radiation (SSR) with collocated satellite-derived surface albedo and top-of-atmosphere net irradiance under both, all-sky and clear-sky conditions. Using two ground-based SSR datasets (BSRN and GEBA) and the CERES EBAF data product, we estimate atmospheric absorption at around $23\pm2\%$ of TOA incident irradiance under all-sky conditions widely representative of the global scale. The cloud radiative forcing on atmospheric absorption is overall positive with around 11.5 Wm^{-2} (4%) using ground-based data and 5 Wm^{-2} (1.5%) in the satellite product. Within the frame of the latter, the clear-sky atmospheric absorption is generally lower over the oceans as compared to the land, while the atmospheric cloud effect is more pronounced. Low clouds thereby significantly enhance atmospheric absorption, while high clouds lead to a near-zero cloud radiative forcing on atmospheric absorption. The latitudinal distribution of atmospheric absorption is more uniform under all-sky than under clear-sky conditions, as the cloud radiative forcing acts stronger in the extra-tropics than in equatorial regions, where the fraction of high clouds and the initial clear-sky absorption are the largest.