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# CALIPSO-derived cloud variables to estimate Longwave Top-Of-Atmosphere fluxes and constrain the long term cloud feedback in climate models with short term variability

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New cloud variables from CALIPSO lidar observations are defined for the GCM-Oriented CALIPSO Cloud Product (GOCCP) version 3.0. This new product splits the clouds in two categories : opaque clouds, when the atmosphere is only sounded down to an altitude termed "z_opaque" where the lidar beam is fully attenuated, and thin or broken clouds, when the lidar sounds the full vertical extent of the profile. It is first shown that, at global scale, opaque clouds drive both the Longwave (LW) and the Shortwave (SW) Cloud Radiative Effect (CRE). A strong link between the equivalent radiative temperature of opaque clouds, depending on the altitude of opacity z_opaque, and the Top-Of-Atmosphere (TOA) LW fluxes is demonstrated using theoretical calculations and a radiative transfer model. This relationship allows a simple and accurate estimate of the LW CRE with only 5 CALIPSO-derived variables. This LW CRE simple expression enables to decompose its temporal evolution into quantifiable contributions of each of the 5 cloud variables needed to estimate the LW CRE. In the last decade, we show that the altitude and the cover of opaque clouds are both the major contributors of the LW CRE changes observed in the Central Pacific which is strongly influenced by the El Nino Southern Oscillation. At global scale, the opaque cloud cover is currently the main contributor (70%) to the LW CRE monthly changes. This new framework and variables, transposed to the CFMIP Observation Simulator Package (COSP) lidar simulator, open exciting opportunities to constrain the LW cloud feedback. Indeed, if clouds long term behavior can be physically linked to clouds short term variability, we can compare the latter to the 10-year observation record of CALIPSO and infer how strong the in-print of current cloud biases may be in the LW cloud feedback response given by climate models.