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Effects of boundary layer particle formation on cloud droplet number and changes in cloud albedo from 1850 to 2000

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Abstract. We use a global aerosol microphysics model to estimate the effect of particle formation through activation nucleation in the boundary layer (BL) on cloud droplet number concentration (CDNC) on global and regional scales. The calculations are carried out for years 1850 and 2000 using historical emissions inventories for primary particles and aerosol precursor gases. Predicted CDNC in 2000 are in good agreement with in-situ observations when activation nucleation is included. We find that BL particle formation increases global annual mean CDNC by approximately the same relative amount in both years (16.0% in 1850 and 13.5% in 2000). As a result, global mean changes in cloud albedo are similar with and without BL particle formation. However, there are substantial regional effects of up to 50% enhancement or suppression of the 1850–2000 albedo change. Over most modern-day polluted northern hemisphere regions, including BL particle formation scheme suppresses the 1850–2000 increase in CDNC and cloud albedo because BL particle formation is already large in 1850. Over the Arctic the albedo change is suppressed by 23% in the annual mean and by 43% in summer when BL particle formation is taken into account. The albedo change of the persistent stratocumulus cloud deck west of Chile is enhanced by 49%.

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