Cloud condensation nuclei in pristine tropical rainforest air of Amazonia: size-resolved measurements and modeling of atmospheric aerosol composition and CCN activity

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Atmospheric aerosol particles serving as cloud condensation nuclei (CCN) are key elements of the hydrological cycle and climate. We have measured and characterized CCN at water vapor supersaturations in the range of $S = 0.10-0.82\%$ in pristine tropical rainforest air during the AMAZE-08 campaign in central Amazonia.

The effective hygroscopicity parameters describing the influence of chemical composition on the CCN activity of aerosol particles varied in the range of $\kappa = 0.05-0.45$. The overall median value of $\kappa \approx 0.15$ was only half of the value typically observed for continental aerosols in other regions of the world.

The effective hygroscopicity parameters were much lower, the integral CCN efficiencies observed in pristine rainforest air were similar to those in highly polluted mega-city air. Moreover, model calculations of $N_{CCN}$ with a global average value of $\kappa = 0.3$ led to systematic overpredictions, but the relative deviations exceeded $\sim50\%$ only at low water vapor supersaturation (0.1%) and low particle number concentrations ($\leq 100 \text{ cm}^{-3}$).

These findings confirm earlier studies suggesting that aerosol particle number and size are the major predictors for the variability of the CCN concentration in continental boundary layer air, followed by particle composition and hygroscopicity as relatively minor modulators.

Depending on the required and applicable level of detail, the information and parameterizations presented in this paper should enable efficient description of the CCN properties of pristine tropical rainforest aerosols in detailed process models as well as in large-scale atmospheric and climate models.

