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Limitations of passive satellite remote sensing to constrain global cloud condensation nuclei

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Aerosol–cloud interactions are considered a key uncertainty in our understanding of climate change. Knowledge of the global abundance of aerosols suitable to act as cloud condensation nuclei is fundamental to determine the strength of the anthropogenic climate perturbation. Direct measurements are limited and sample only a very small fraction of the globe so that remote sensing from satellites and ground based instruments is widely used as a proxy for cloud condensation nuclei. However, the underlying assumptions cannot be robustly tested with the small number of measurements available so that no reliable global estimate of cloud condensation nuclei exists.

This study overcomes this limitation using a fully self-consistent global model (ECHAM-HAM) of aerosol radiative properties and cloud condensation nuclei. An analysis of the correlation of simulated aerosol radiative properties and cloud condensation nuclei reveals that common assumptions about their relationships are violated for a significant fraction of the globe, important for studies of aerosol–cloud interactions. The findings suggest that multi-spectral vertically resolved remote sensing techniques, such as satellite-based high spectral resolution lidars, have a large potential for global monitoring of cloud condensation nuclei.