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New particle formation: where, how and why it's important? Observations from the Atmospheric Tomography Mission (ATom)

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Current estimates suggest that new particle formation (NPF) may account for over half of the cloud condensation nuclei (CCN) present in the atmosphere. However, the exact mechanisms of NPF, the growth of these particles to CCN sizes, and their relative importance are not yet well quantified. The NASA Atmospheric Tomography (ATom) airborne campaign maps the remote atmosphere over the Pacific and Atlantic basins (∼80 °N and ∼65 °S) in continuous ascents and descents (0.2 and ∼13 km), providing latitudinal and vertical information on greenhouse gases, reactive and tracer species and aerosol properties and their seasonal variability. Size distribution measurements during the NASA ATom reveal high number concentrations (»1000 cm-3) of nucleation mode particles at high altitudes throughout broad regions of the tropics and subtropics under low condensation sink conditions and are associated with upwelling in convective clouds.
In this study, we investigate the link between convection and NPF by exploring the processes that govern NPF and growth in the tropical and subtropical free troposphere of the Pacific and Atlantic Oceans. We couple measurements of size distributions between 0.003 and 4.8 μm measured on ATom (August 2016 and February 2017) with calculated air mass back trajectories and the TwO-Moment Aerosol Sectional (TOMAS) box model. The back trajectories identify air masses potentially influenced by recent convection. We discuss similarities and differences in NPF over the Pacific and Atlantic Oceans and their relationship to convection. Furthermore, we examine which nucleation schemes (e.g. binary, ternary, or charged) are most consistent with the observations, and discuss the importance of NPF for the Earth's radiative budget.