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Using ATom observations and models to understand what drives NPF and growth to CCN-sizes in the remote free troposphere

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Current estimates suggest that globally, about one third of cloud condensation nuclei (CCN) affecting low-level clouds originate from new particle formation (NPF) that takes place in the free troposphere. However, the exact mechanisms of how new particles form and grow to CCN sizes, and their relative importance are not yet well quantified.
We investigate the formation of new particles and their growth to CCN-sizes in the remote marine atmosphere over the Pacific and Atlantic basins ($\sim$80 °N to $\sim$86 °S). This is done using size distribution measurements (0.003-4.8 μm) from the airborne-based NASA Atmospheric Tomography global survey (ATom; 2016-2018), back trajectory data and two aerosol microphysics box models.
Newly formed particles are ubiquitous at high altitudes throughout broad regions of the tropics and subtropics under low condensation sink conditions and are associated with upwelling in convective clouds. This pattern is observed over four seasons and both ocean basins. NPF was also found in the free troposphere over the Southern Ocean in February 2017, however it was not observed in August 2016, indicating seasonal differences.
In this study we explore processes that govern NPF and growth in the tropical and subtropical free troposphere, and over the Southern Ocean, discuss similarities and differences in NPF in these regions, examine which nucleation scheme (e.g. binary, ternary, or charged) best explain the observations, evaluate whether observed sulfur precursors alone (SO_2 and DMS) can explain the NPF, and discuss the growth of these new particles to CCN sizes.