Geophysical Research Abstracts
Vol. 19, EGU2017-9413, 2017
EGU General Assembly 2017

Cloud System Evolution in the Trades (CSET): Airborne sampling of Lagrangian airmass evolution in the Northeast Pacific stratocumulus-cumulus transition

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The CSET field study in July-August 2015 over the Northeast Pacific ocean was motivated by a need for more in-situ sampling of the subtropical stratocumulus to cumulus (Sc-Cu) transition zones. One goal was comprehensive documentation of observational cases suitable for detailed intercomparison with large-eddy simulation models run following Lagrangian air columns and global models run in a hindcast mode. A second goal was to understand the role of aerosol and precipitation processes in this transition.

The U.S. National Science Foundation G-V, equipped with cloud, aerosol, turbulence probes, a multispectral lidar, a cloud radar, and dropsondes, flew seven missions consisting of an outbound leg from northern California to Hawaii and a return leg two days later. Each mission was based on forecast air trajectories within the boundary layer; the goal was to sample a 2000-km long vertical curtain of boundary-layer air on the outbound leg and resample the advected position of that curtain on the return leg, using ramped sawtooths. In this way, most missions successfully captured the Lagrangian Sc-Cu transition. While CSET sampled diverse aerosol conditions, including the interaction of the boundary layer with smoke plumes from massive forest fires, lower tropospheric stability was the primary control on cloud cover.

Mesoscale cloud organization was ubiquitous. Toward Hawaii, clusters of 2 km deep precipitating shallow cumulus and patchy thin stratiform 'veil cloud' with extremely low droplet concentrations were embedded in ultraclean layers at the trade inversion. These were separated by drier regions of suppressed convection. LES and parcel modeling plausibly explain these features.