Aerosols and Boundary-Layer Structure in the ACE-ENA Summer 2017 and Winter 2018 Campaigns

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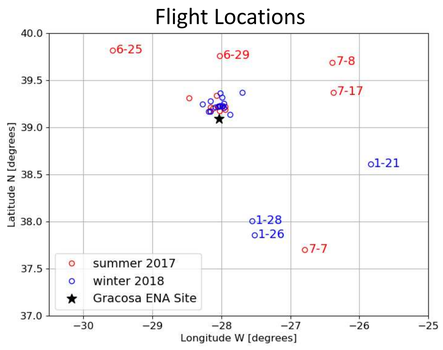
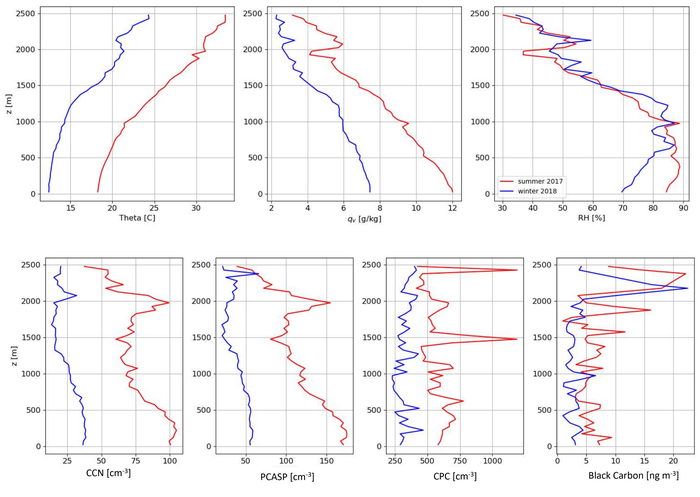
Introduction

During the ACE-ENA summer campaign (June-July 2017) and winter campaign (January-February 2018), the ARM AAF G-1 performed daytime flights in the vicinity of the ARM ENA site at Graciosa. These flights sampled the marine boundary layer and the lower troposphere. Here we present preliminary data from 17 summer flights and 19 winter flights. Most missions spent 3-3.5 hour sampling, typically centered on noon local time, in an L-shaped flight pattern. In-situ measurements include temperature , water vapor, liquid water, aerosol (CCN, condensation particle count (CPC), PCASP, Black Carbon), CO and Ozone, with 1Hz frequency. Here we utilize the means over the main parts of the research flights, discarding CPC and PCASP measurements when liquid water contents exceed 0.025 g/m^3. Our analysis focuses on the changes over the study periods, and the contrasts between the two periods.

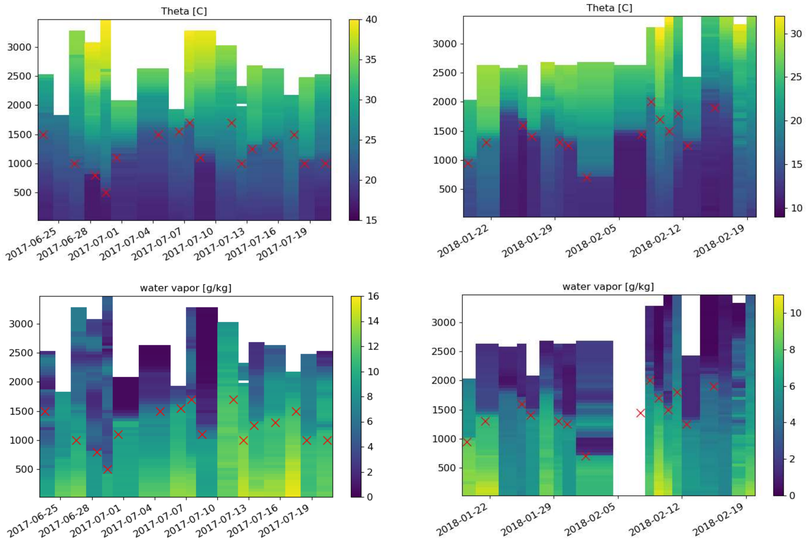


Mean Soundings



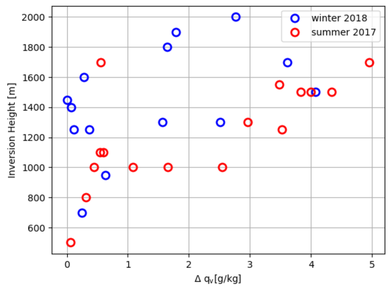
Mean boundary layer depth is comparable between the two flight seasons with similar relative humidity (RH) above the inversion. Aerosol contents are much higher in the summer 2107 than in winter 2018.

Summer 2017 Winter 2018

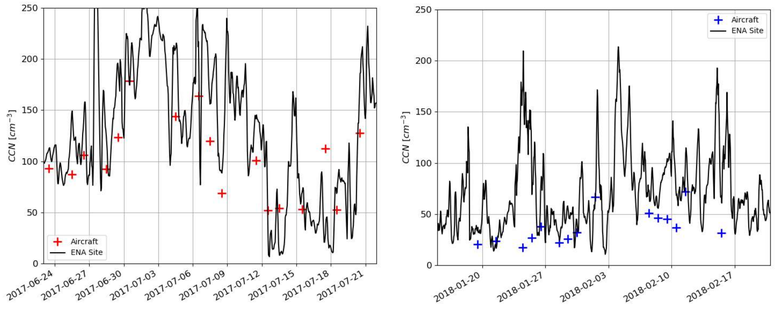


Boundary Layer Decoupling

Here we use the difference in flight-mean q_v near the surface (0-250m) and a 250m-layer below the inversion to diagnose boundary layer decoupling. Both periods include decoupled and well-mixed layers, though winter 2018 flights included more deep well-coupled layers.

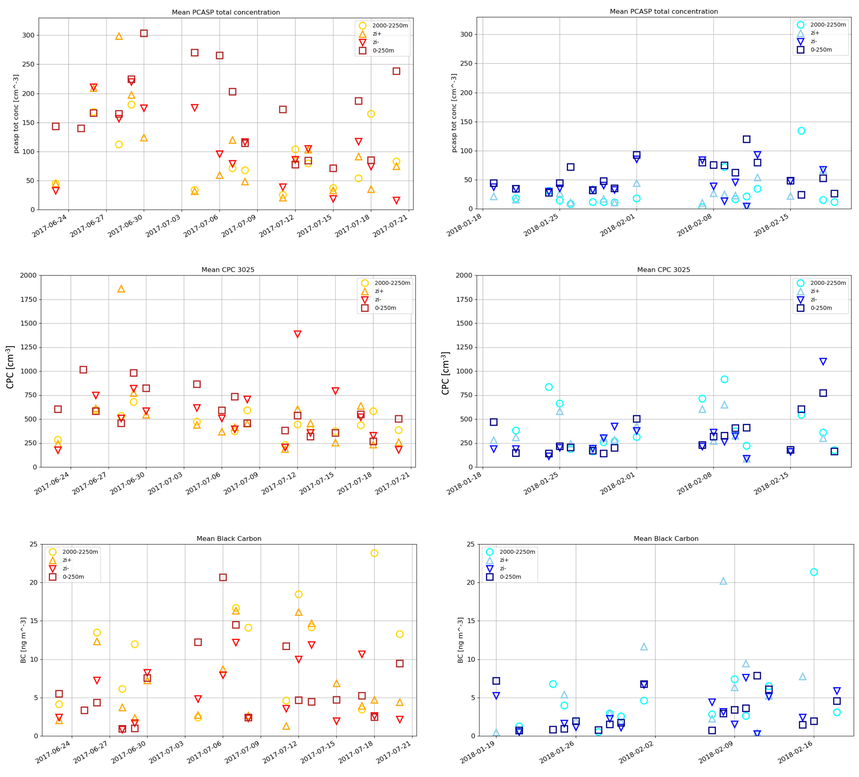


CCN Comparison with ENA Site



The daily flight CCN concentrations (SS=0.14%, 0-250m height) compare reasonably well with Graciosa surface observations (SS~=0.1%, 4-hour running mean), though some relatively high-CCN periods in winter 2018 are not matched in the flight data.

Summer 2017 Winter 2018



Here we compute daily average values of aerosol concentrations in four height categories: surface, just below the inversion, just above the inversion, and free troposphere (2000-2250m). PCASP aerosol concentrations are consistently higher in the boundary layer than above. During the first part of the summer 2017 period, concentrations are much higher than the later July flights, similar to CCN concentrations. The winter period has generally low aerosol concentrations and somewhat less variability. Black carbon has a different vertical structure than PCASP and CCN, with frequently higher concentrations above the inversion than at the surface.

Key points

- Mean boundary layer depths sampled are comparable between summer 2017 and winter 2018, though much day-to-day variability was present in both periods.
- Both coupled and decoupled boundary layers were regularly sampled in both flight periods.
- Summer 2017 flights measured significantly higher aerosol concentrations than the winter 2018 flights.
- CCN and PCASP aerosol concentrations and CPC counts are frequently higher near the surface than aloft.
- Black Carbon concentrations are frequently higher above the boundary layer than at the surface.

Acknowledgements

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