Aircraft Cloud measurements during ACE-ENA

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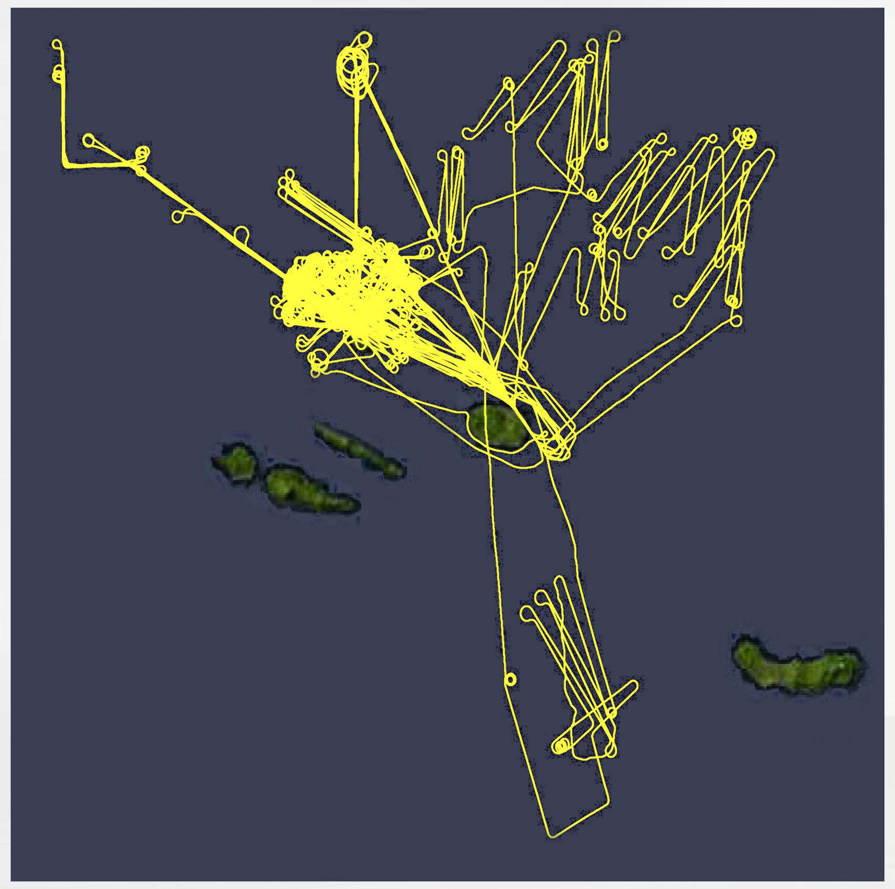
Introduction

The Aerosol and Cloud Experiments in the Eastern North Atlantic (ACE-ENA) was designed to characterize the boundary-layer structure comprehensively, and associated vertical distributions and horizontal variabilities of low clouds and aerosol over the Azores. The ARM Aerial Facility (AAF) Gulfstream -1 (G-1) aircraft was deployed to ACE-ENA during two intensive observing periods (IOPs) in early summer of 2017 and winter of 2018. One of objectives of ACE-ENA was to use the combination of aircraft cloud observations of the thermodynamic and drizzle characteristics, with scanning radar observations of the mesoscale organizations of cloud and drizzle, to quantify the thermodynamic and spatial characteristics of MBL cold pools and how those characteristics relate to drizzle occurrence/properties and cloud/drizzle mesoscale organization. The G-1 payload and the flight plans provided detailed characterization of the mesoscale variations of cloud and drizzle microphysics, and the co-variance of these fields.

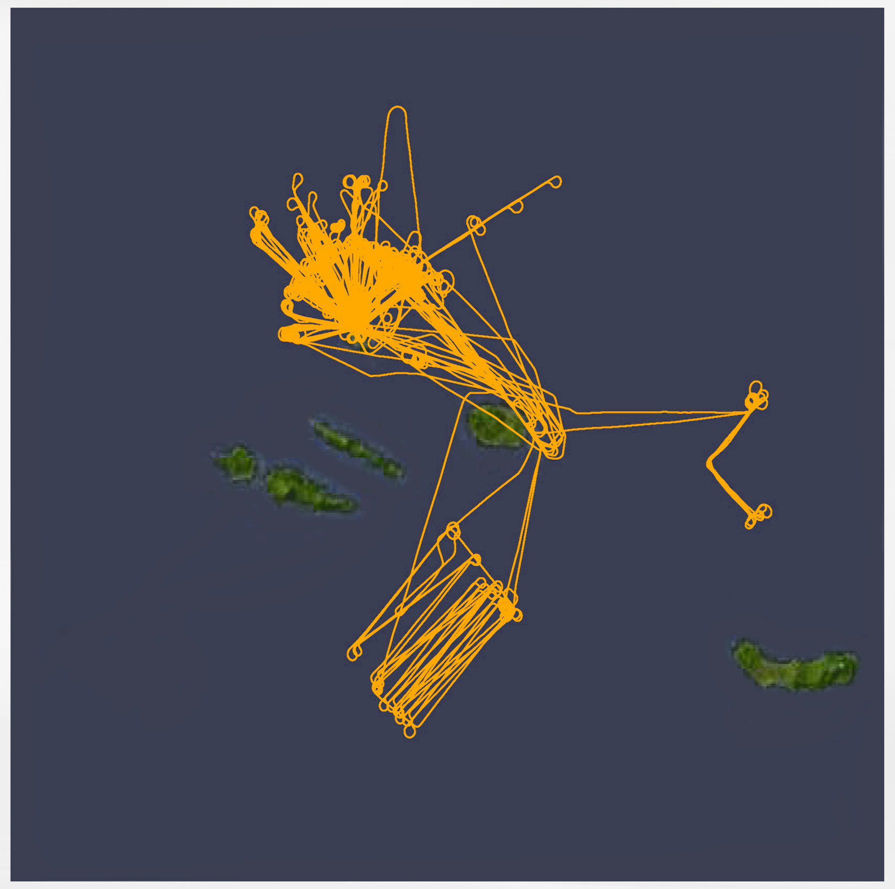
In this study, the size distribution of cloud droplets, drizzle, and raindrops were characterized using a combination of a Fast Cloud Droplet Probe (FCDP), Two-Dimensional Stereo probe (2D-S), and High-Volume Precipitation Spectrometer (HVPS), which covers the droplet size range from 2 µm to 2 cm. Three cloud probes were compared in their over-lapped size ranges, and the best-estimated size distribution is estimated for further studies of cloud microphysical structures. Based on the cloud classification, we studied the cloud droplet size distributions at the cloud base, inside the cloud, and at the cloud top. The characteristics of the droplet size distributions between the two IOPS are also discussed.

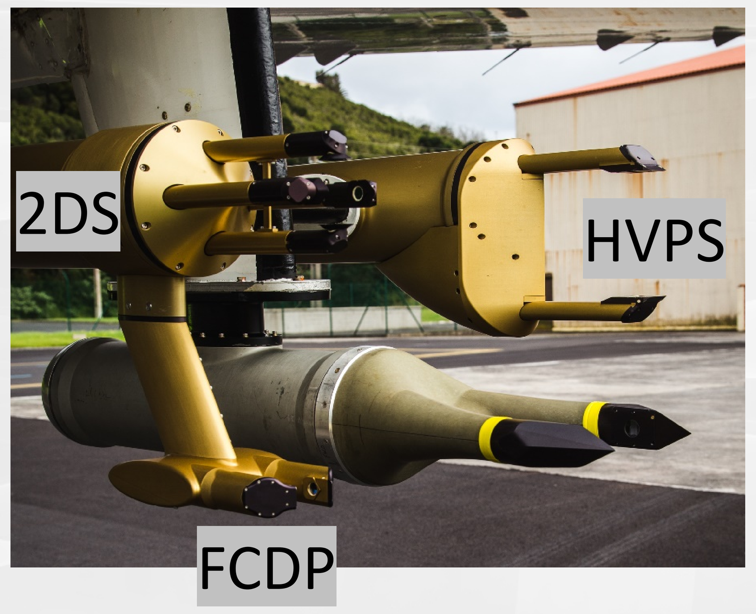
39 Research Flights | 153.2 Total hours

IOP1: 20 Flights | 77 Hours

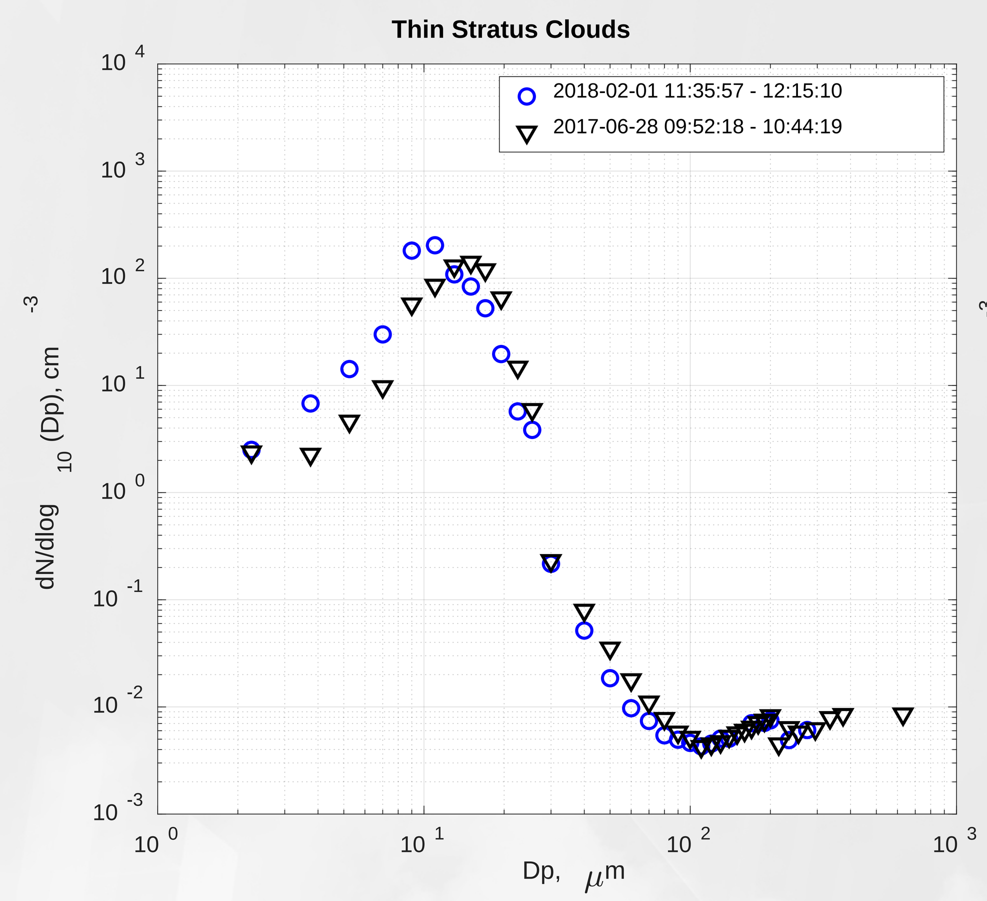


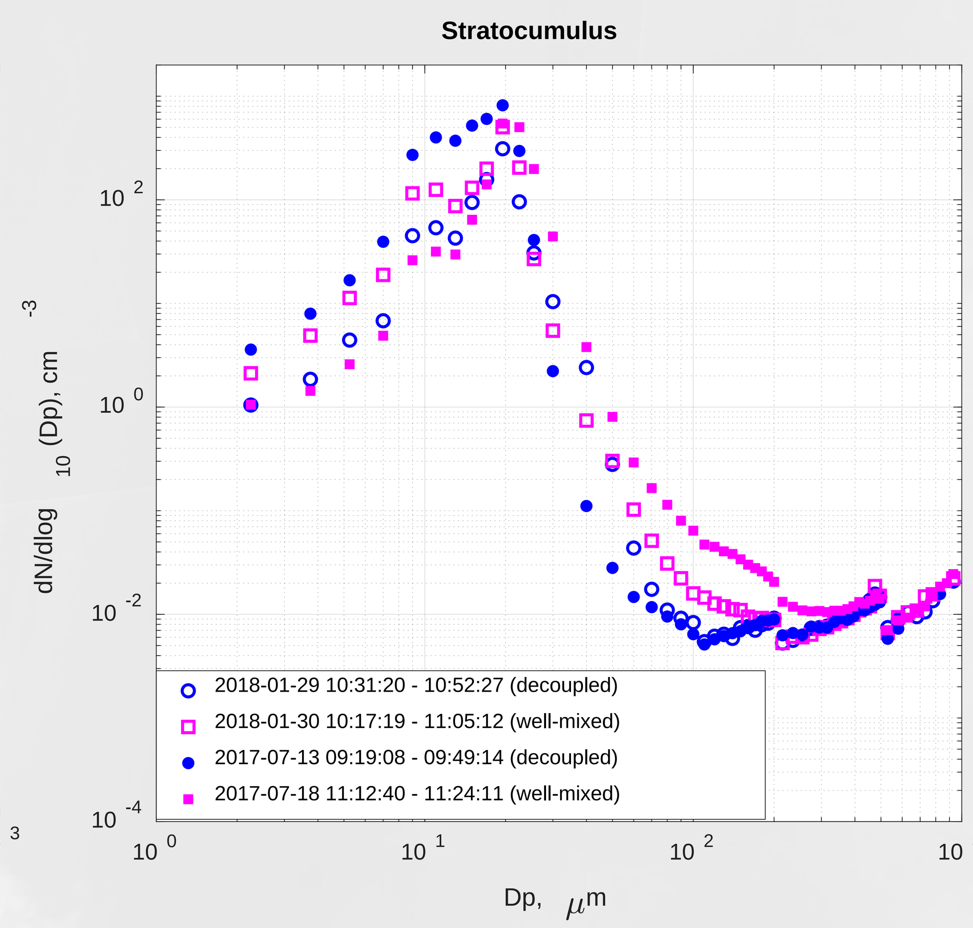
IOP2: 19 Flights | 76.2 Hours

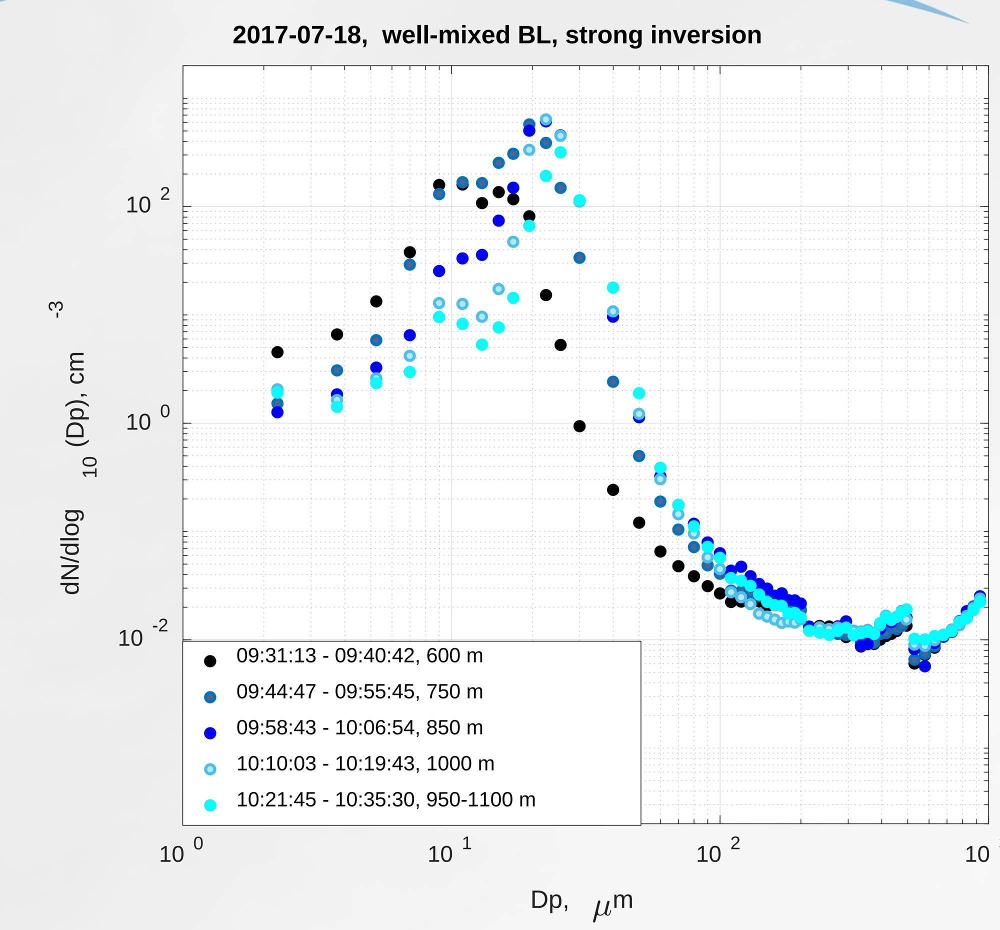




Instruments	Ranges	Resolution	Accuracy
Fast Cloud Droplet Probe (FCDP)	2-50 µm	1 -2 µm	2 µm
Two dimensional stereo (2DS) probe	10-3000 µm	25 – 150 µm	10 µm
High Volume Precipitation Spectrometer (HVPS)	150 µm-2 cm	150 µm	150 µm
Water Content Monitor (WCM 2000)	0-6 gm^{-3}	0.01 gm^{-3}	0.01 gm^{-3}

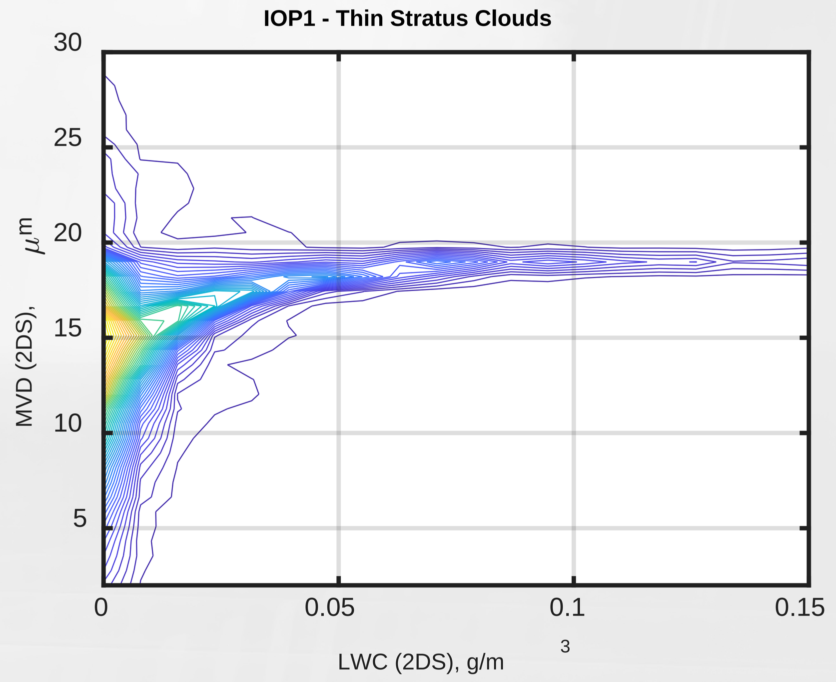


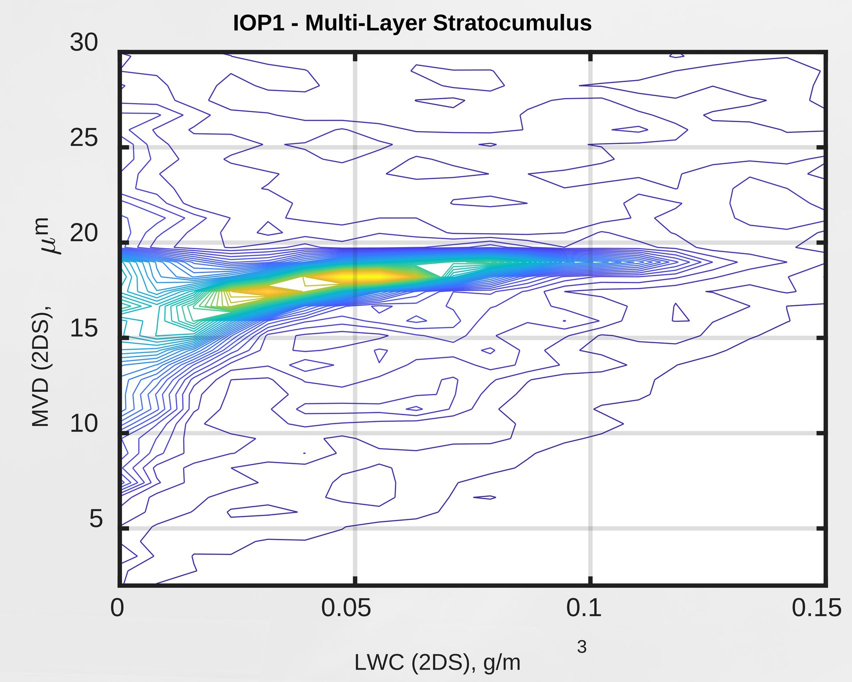


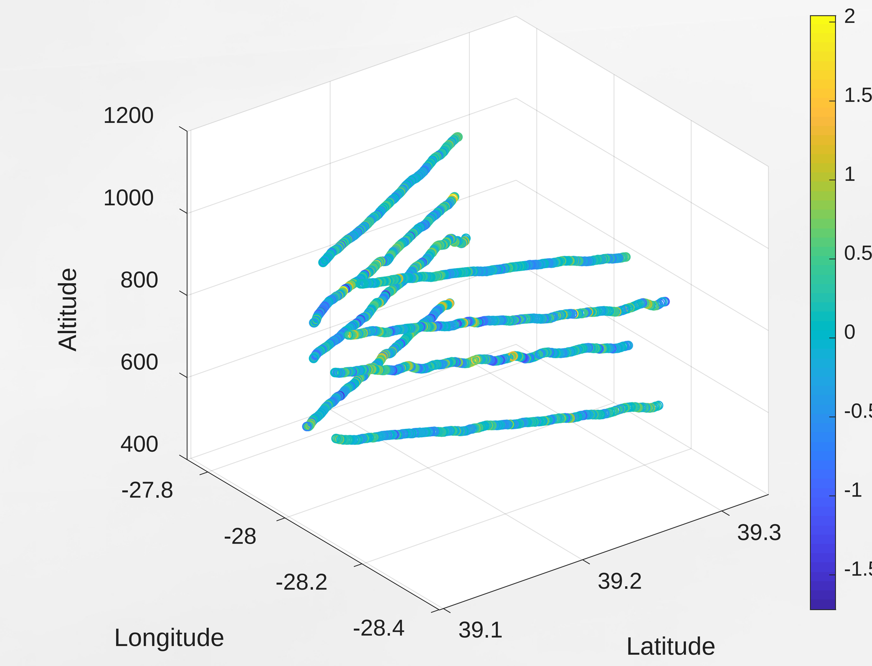


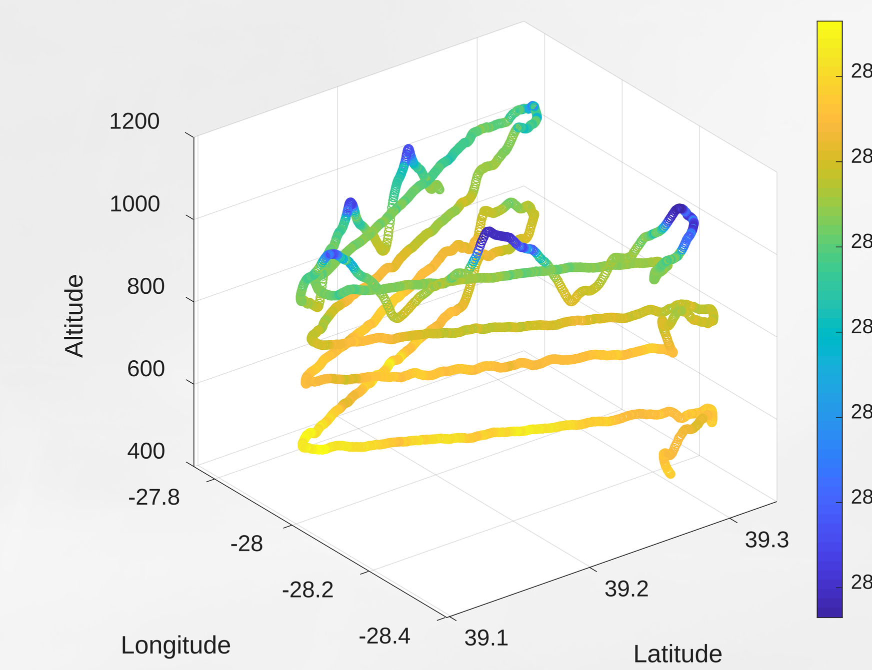
Discussions

- Comparing the clouds between IOP 1 (Summer, 2017) and IOP 2 (Winter, 2018):
  - For thin stratus clouds, the summer clouds have a larger mean droplet diameter than the winter clouds
  - Under the decoupled boundary layer (BL) and well-mixed BL conditions, the stratocumulus clouds size distributions are similar in winter, but have a significant difference in summer.
- The thin stratus clouds and stratocumulus clouds had similar characteristics in winter 2018. However, in summer 2017 they had different median volume diameter and liquid water content values.









- The cloud sampling on 7/18/2017 showed the cloud droplet growing with the increase of the flight altitude from 600 m to 1100 m.
  - The cloud droplet size distribution peaked around 10 µm at the cloud base and grew to 25-30 µm at the cloud top.
  - No significant wind vertical velocity changes at different altitude legs.
  - Dew point temperature decreases with the increase of the flight altitude.

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