Aircraft Cloud measurements during ACE-ENA
Fan Mei, Jennifer Comstock, Alyssa Matthews, Jason Tomlinson
Pacific Northwest National Laboratory, Richland, WA

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 overlapped 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.

Discussions

- 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, 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.

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Ranges</th>
<th>Resolution</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCDP</td>
<td>2-50 µm</td>
<td>1-2 µm</td>
<td>2 µm</td>
</tr>
<tr>
<td>2D-S</td>
<td>10-3000 µm</td>
<td>15-150 µm</td>
<td>10 µm</td>
</tr>
<tr>
<td>HVPS</td>
<td>150 µm-2 cm</td>
<td>150 µm</td>
<td>150 µm</td>
</tr>
<tr>
<td>WCM</td>
<td>0-6 gm⁻³</td>
<td>0.01 gm⁻³</td>
<td>0.01 gm⁻³</td>
</tr>
</tbody>
</table>

ACKNOWLEDGEMENTS:

\[\text{\textcopyright 2017, ARM Science Partnership, Big Sky, MT.} \]

\[\text{All rights reserved.} \]

\[\text{This work is supported by the U.S. Department of Energy,} \]
\[\text{Office of Science, and the AR"{A}M"{G} Program.} \]

\[\text{The ARM aerosol research system and the} \]
\[\text{supporting data are available from the} \]
\[\text{website of the ARM program.} \]

\[\text{For more information, visit the} \]
\[\text{ACE-ENA project website.} \]

\[\text{Further details are provided in the} \]
\[\text{technical report.} \]

\[\text{The authors appreciate the} \]
\[\text{support of the} \]
\[\text{gulfstream} \]