Aerosol and Cloud Experiments in Eastern North Atlantic (ACE-ENA)

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ARM/ASR Joint User Facility PI meeting
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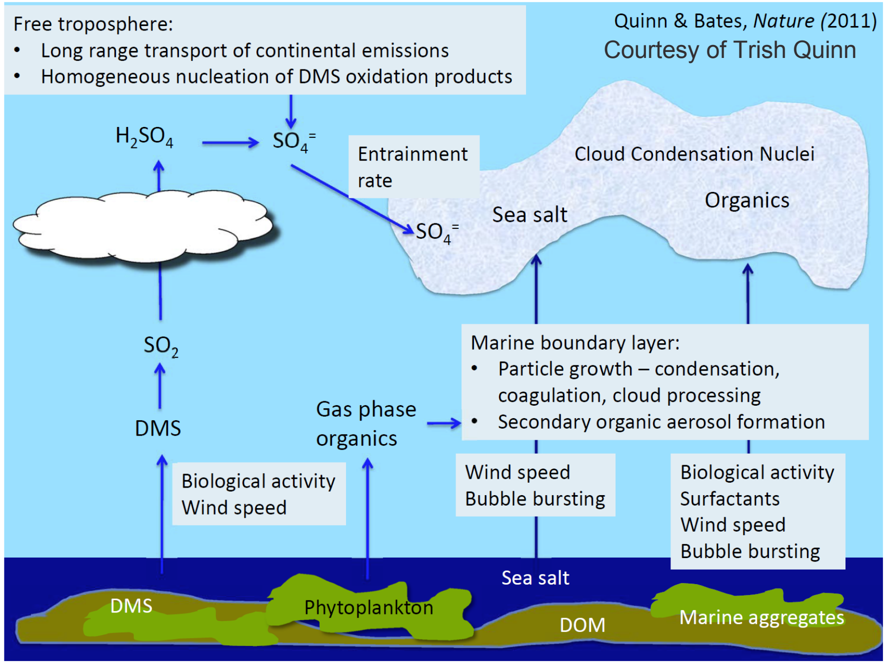
When and where

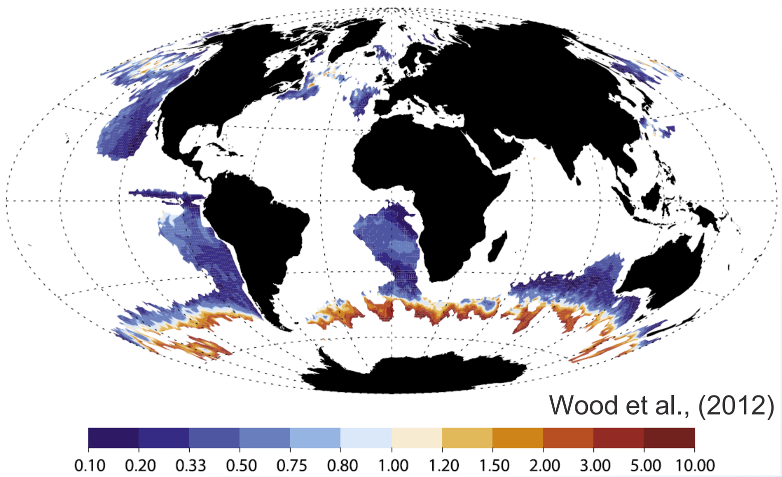
1st IOP (summer): 80 flight hours, June 15-July 25, 2017

2nd IOP (winter): 80 flight hours, January 11 – February 20, 2018

Budget of MBL Aerosol and CCN



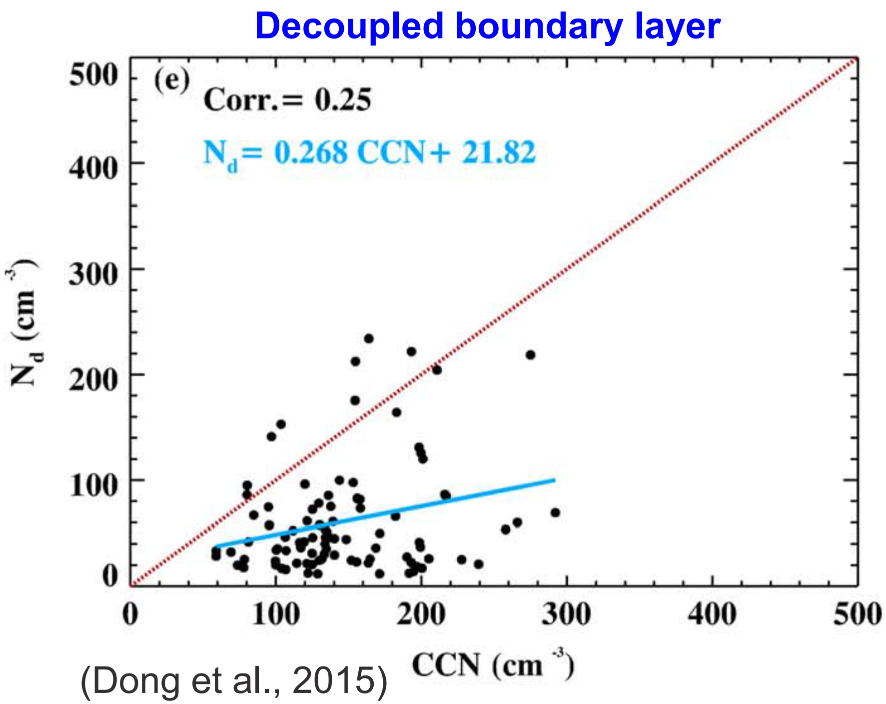
In the subtropics and tropics, the majority of the CCN likely originate from the FT



Ratio of CCN flux from surface to that due to FT entrainment

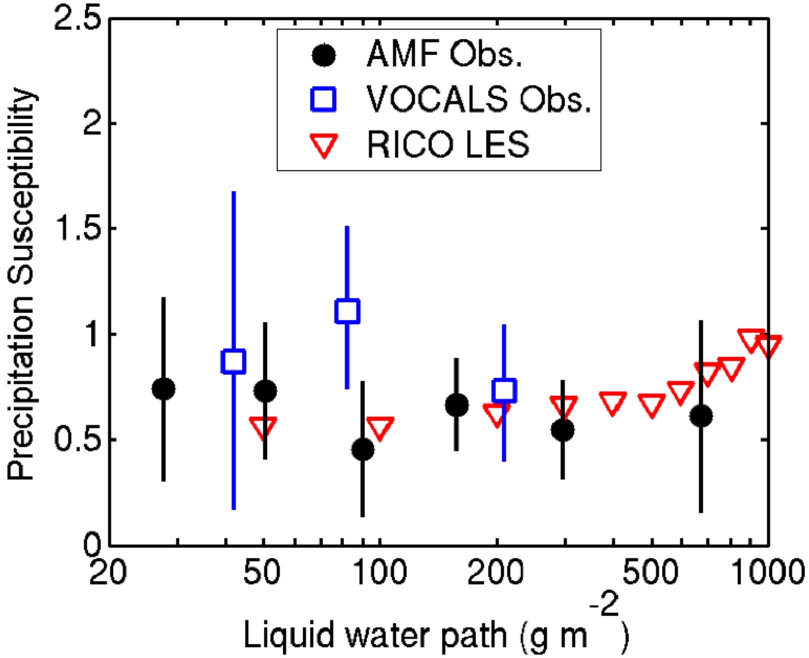
- What are the contributions from different sources, including sea spray aerosol, long-range transport, and new particle formation? What are the seasonal variations of the characteristics and contributions of various sources?
- How does removal of CCN by droplet coalescence control the CCN population in the MBL for representative cloud regimes?

Effects of Aerosol on Clouds and Precipitation



(Dong et al., 2015)

Mann et al. (2014)

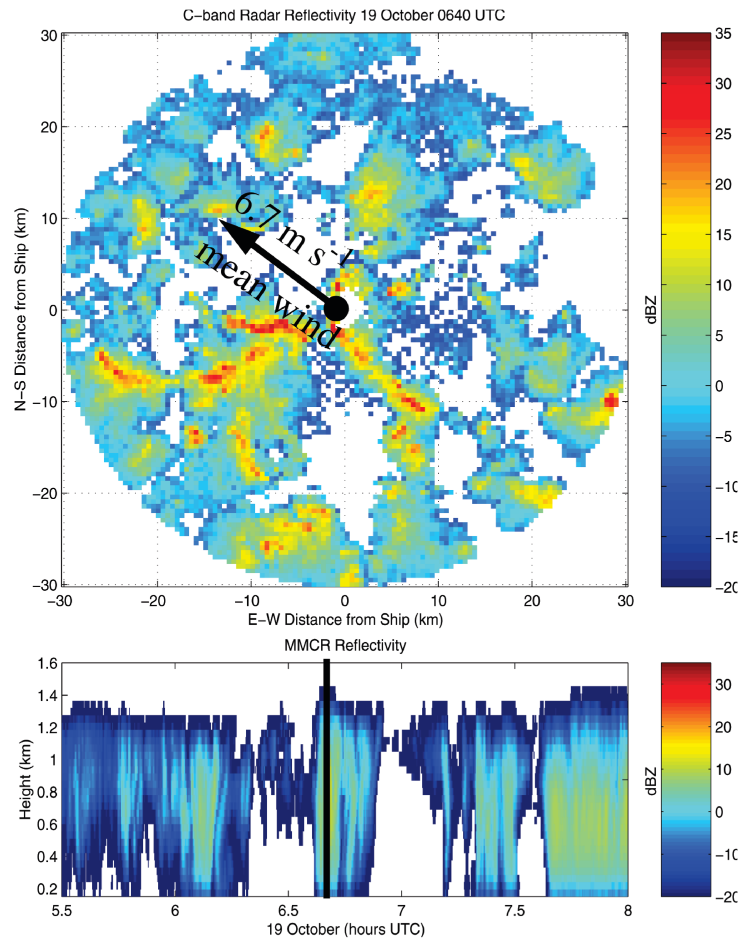


- How can ground based Lidar and CCN measurements be used to better infer CCN concentration at cloud base?
- How does the CCN budget affect cloud microphysics? Do high CCN concentrations lead to increased cloud droplet concentrations and suppressed precipitation? Is precipitation susceptibility to CCN weaker in the deep open cells observed in the Azores?

Cloud Microphysical and Macrophysical Structures, and Entrainment Mixing

- What are the mesoscale variabilities of cloud microphysics and vertical velocity and how do they influence drizzle mesoscale organization and rates? What are the thermodynamic and spatial characteristics of cold pool and how do they relate to the properties and mesoscale organizations of cloud and drizzle?
- What are the relationships between the entrainment rate, thermodynamic stability, wind shear above cloud top, and coupling structure below cloud base? What is the prevalent entrainment mixing mechanism, and what are the controlling factors? What are the microphysical effects of entrainment mixing?

An example showing MBL clouds over the SE Pacific during EPIC (Bretherton et al., 2004)

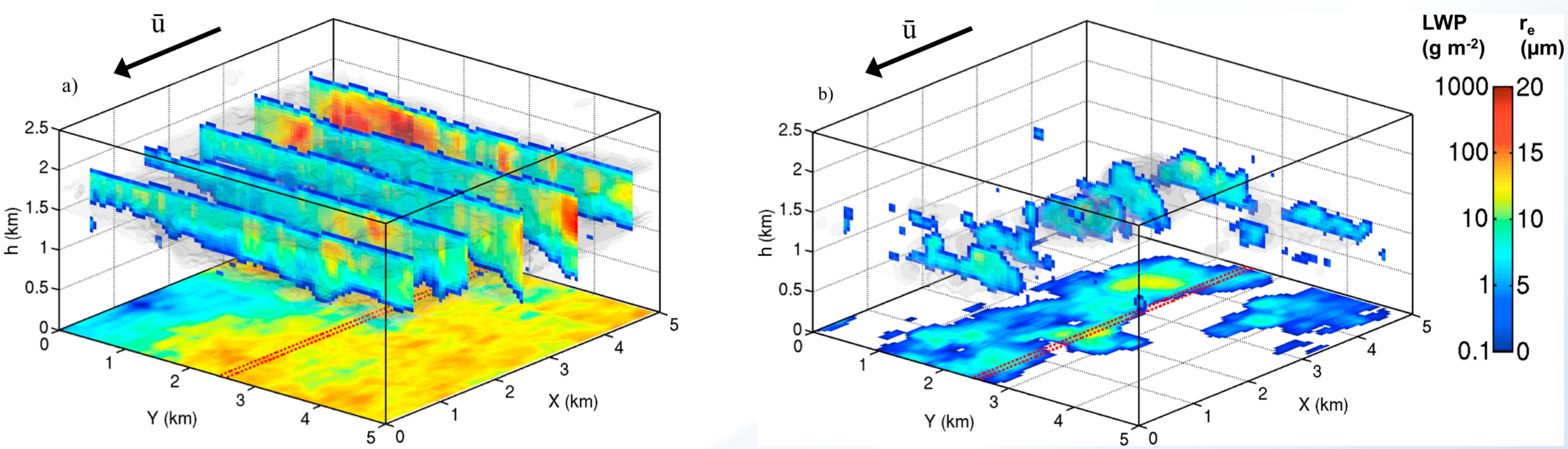


Advancing Retrievals of Turbulence, Cloud, and Drizzle

- Validating and quantifying the uncertainties in turbulence, cloud and drizzle microphysical properties retrieved from vertically pointing observations
- Validating and improving 3-D cloud and drizzle retrievals from scanning radars

Stratocumulus case

Cumulus case



Fielding et al. (2014)

Model Evaluation and Processes Studies

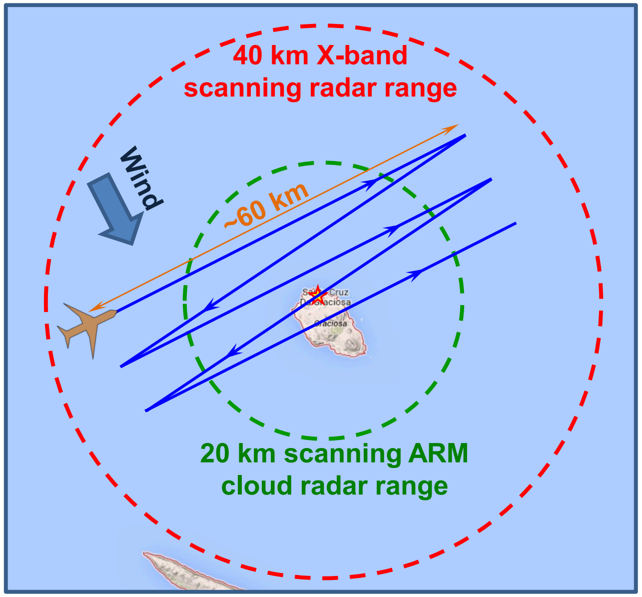
- Comparison of the airborne data with predictions of global models using “nudged” or “specified” meteorology and local simulations with LES and WRF-Chem models.

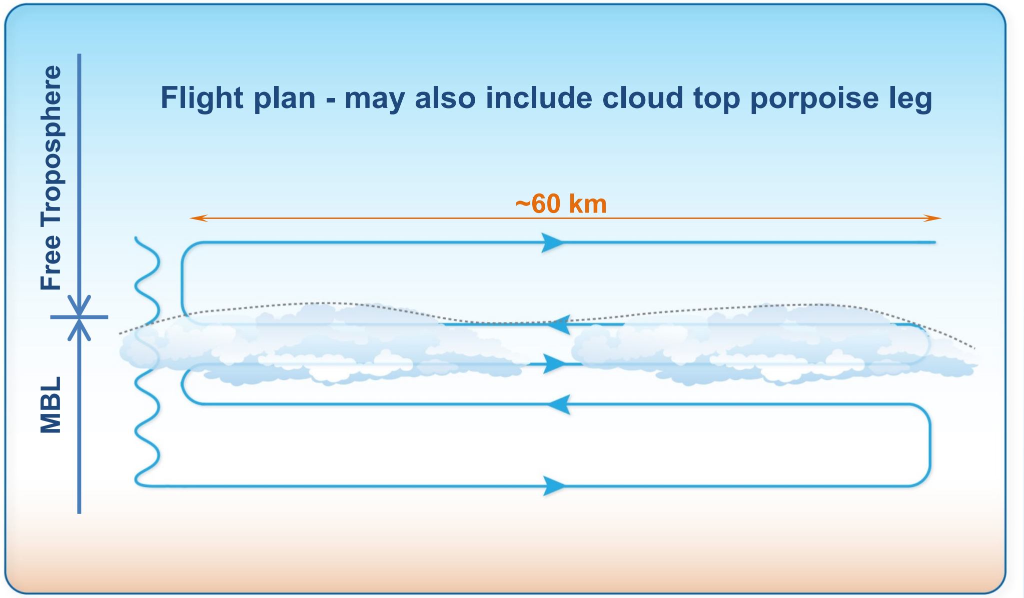
- Examining the CCN budget terms and processes driving the vertical structure and mesoscale variation of aerosol, cloud, and drizzle fields using validated/constrained GCM and LES model simulations.

AAF Gulfstream-1 payload

- Baseline G1 instruments for Atmospheric State and Aircraft State
- Radiometric measurements, up- and down-welling radiation
- Fast CDP, 2D-S, HVPS-3, CAPS, WCM-2000, and Gerber probe (cloud and drizzle microphysics)
- HOLODEC (cloud droplet size spectrum)
- Trace gas monitors (CO, O3)
- PTR-MS (trace gas VOC aerosol precursors)
- CVI and isokinetic inlets to switch between sampling interstitial aerosol and cloud-droplet residuals
- FIMS, UHSAS, and PCASP (Aerosol size distribution from 10 nm to 3 microns in diameter)
- CPC (> 10 nm) and UCPC (> 3 nm) (total aerosol number concentration)
- Dual-CCNC (cloud condensation nuclei concentrations)
- PSAP and Nephelometer (aerosol absorption and scattering)
- HR-ToF-AMS (mass concentrations of submicron non-refractory aerosol species, bulk and size resolved)
- Particle Into Liquid Sampler (PILS, soluble aerosol composition)
- SP2 (single particle measurement of black carbon)
- TRAC sampling systems (Collection of atmospheric particles for post-campaign off-line analysis)

Draft flight patterns





- Lagrangian drift for characterizing the vertical structure and mesoscale variation of thermodynamics, aerosol, cloud, and precipitation
- Repeated spirals near the ENA site and straight and level runs at multiple altitudes, approximately 20-30 km in length along the direction of the MBL wind between two fixed points, overpassing the ENA site.
- Additional aerosol profiling in FT - vertical profile up to 5000 m to identify potential elevated aerosol layers in the FT, which will then be sampled using horizontal legs.

Additional measurements at the ENA site during IOPs

- Two additional soundings per day (total four per day) on days when the G-1 is sampling
- Ultrafine CPC (> 3 nm) (total aerosol number concentration)
- Scanning mobility particle sizer (aerosol size distribution from 10 nm – 500 nm) with both ambient and thermal denuder inlets
- Size-resolved CCN measurements
- TRAC and MOUDI sampling systems (Collection of atmospheric particles for post-campaign off-line analysis)

Synergistic Activities

- Measurements at the ENA site!
- North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) (NASA EVS-2 project 2015-2019)
- Deployment of Leibniz Institute for Tropospheric Research Helicopter-borne measurement payload (ACTOS) in the summer of 2017
- Measurements of (free tropospheric) aerosols at PICO mountain observatory in the summer of 2017(by Leibniz Institute for Tropospheric Research)

Thank you!

Informal ACE-ENA session on Wednesday evening (7:30-9:00pm)

Comments and questions?

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