Maximum Supersaturation in the Marine Boundary Layer Clouds Over the Eastern North Atlantic

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1. Introduction
The maximum supersaturation (SS_max) inside clouds is a key parameter affecting the cloud's microphysical and radiative properties. However, SS_max inside the cloud is very difficult to measure directly.

During the ACE-ENA campaign, measurements are carried out continuously at the ENA observatory, which was set up in late 2013 on Graciosa Island in the Azores, Portugal. Additionally, a total of 39 flights were conducted in the vicinity of the Azores, out of the Lajes airport on Terceira Island.

2. Hoppel Minimum (HM) and Cloud Droplet Concentration
A good agreement between the number concentration of particles larger than HM out-of-cloud and cloud droplet concentration in-cloud was observed, indicating that HM represents the smallest size at which particles are activated into cloud droplets.

3. Derivation of Maximum Supersaturation (SS_max)
- SS_max derived by interpolating size-resolved CCN measurements
- Higher SS_max values and a larger variability in winter
- Mean SS_max values: 0.25% in winter and 0.20% in summer

4. Relationships Between SS_max and CCN population or Synoptic Conditions
(a) Suppression of SS_max by increased condensation sink of water vapor at high N_CCN.
(b) Stronger convection and increased SS_max as cold air advects over warm ocean following the passage of fronts (i.e., low pressure).
(c & d) A weak lower tropospheric stability (LTS) leads to deeper boundary layer and thicker clouds. Thicker clouds tend to have stronger radiative cooling at cloud top and more latent heat release, both of which lead to stronger turbulence and thus higher updraft velocity and increased SS_max.

A multi-linear regression model based on N_CCN,0.50%, pressure, LTS, ILH, and inversion strength (IS) can explain 57.0% of the variation in SS_max.

5. Comparison Between Measured and Simulated SS_max
We used the global Community Earth System Model (CESM) to simulate SS_max values in the Azores. SS_max,CESM values broadly agree with those derived from the measurements (SS_max,SCCN, R=0.70), but they also show some positive biases.

References

Acknowledgments
We acknowledge funding support from Atmospheric System Research (ASR) and Atmospheric Radiation Measurement (ARM) programs.

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