Analysis of Aerosol Indirect Effects in California Coastal Stratus and Fog

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1.Marine Stratus Radiation, Aerosol, and Drizzle Experiment—Pt. Reyes, CA

MASRAD was conducted during March-September 2005 using the ARM Mobile facility and in conjunction with the MArine Stratus Experiment (MASE). Typical ARM remote sensors were combined with a comprehensive suite of surface aerosol measurements.

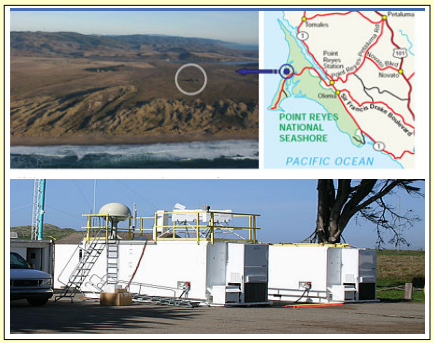


Figure 1. The ARM Mobile Facilty at Pt. Reyes.

2. Coastal Impacts on Cloud Structure

Data from MODIS Aqua and Terra were used to examine changes in cloud structure along the coastline near Pt. Reyes for a summer season. Results suggest that the mean optical depth increases, while the effective radius and cloud fraction decrease. Liquid water path remains relatively constant.

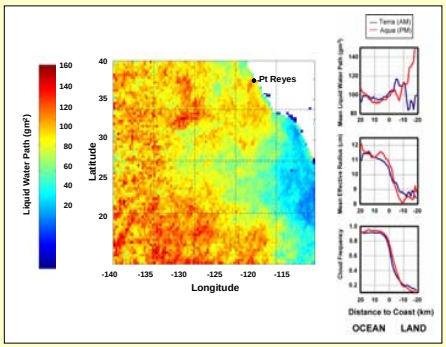


Figure 2. An elongated rectangle of 10-km by 40-km oriented with its smaller dimension parallel to the coast and ± 20 km from the shore is the analysis area. Dates?

3. Air Mass Source Analysis

The HYbrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) was used to identify aerosol source areas and paths taken by aerosols reaching the Pt. Reyes site. A 10-day back trajectory was computed for each radiosonde launch at two starting heights: one 25 meters below the lowest inversion and the second 25 meters above.

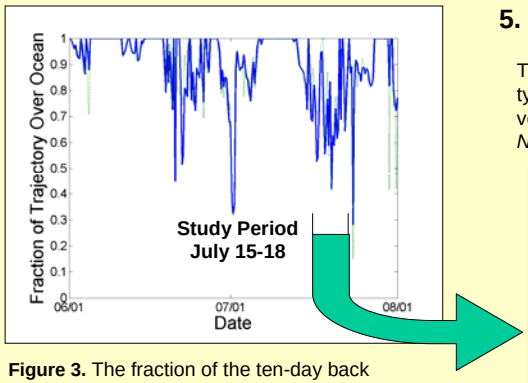


Figure 3. The fraction of the ten-day back trajectory spent over a land mass.

4. Two Components of Cloud Droplet Formation: Updrafts and Cloud Condensation Nuclei

A 95-GHz Doppler radar measures the in-cloud vertical velocity spectrum, while cloud condensation nuclei are measured at multiple supersaturations.

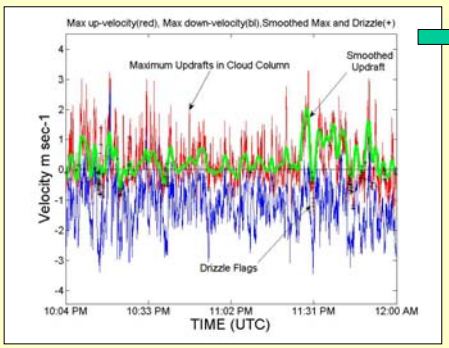
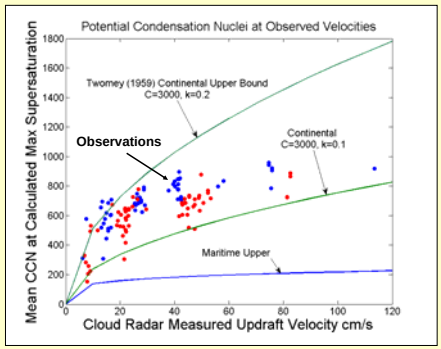


Figure 4. Two-hour example of vertical velocity during the three-day study period. The inset plot is an example of CCN vs. percent supersaturation.

SUMMARY
Data from the AMF deployment during MASRAD can be used to directly test the performance of existing cloud droplet nucleation parameterizations in coastal stratus clouds. The example below is a test of Twomey's 1959 parameterization. More sophisticated parameterizations have been formulated and will be tested in a similar manner.

5. Testing Nucleation Parameterizations

The maximum supersaturation in an updraft, S_{max}, is typically parameterized as a function of the updraft velocity and the number density of nucleated particles, N_d, as a function of S_{max}.



Parameterization

$$S_{max} = f(U, parameters)$$

$$N_d = f(S_{max}, parameters)$$

References

Draxler, R.R. and G.D. Hess, 1997: Description of the Hysplit_4 modeling system, NOAA Tech Memo ERL ARL-224, Dec, 24p.

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Twomey, S., 1959: The nuclei of natural cloud formation: the supersaturation in natural clouds and the variation of cloud droplet concentration. Geofis. Pura et Appl., 43, 243-249.