Cloud Condensation Nuclei in Cumulus Humilis – Selected Case Study During the CHAPS Campaign

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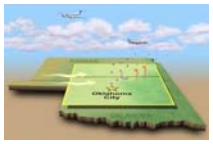
Introduction

The Cumulus Humilis Aerosol Processing Study (CHAPS) provided a unique opportunity to study aerosol and cloud processing. Clouds play an active role in the processing and cycling of atmospheric constituents. Gases and particles can partition to cloud droplets by absorption and condensation as well as activation and impact scavenging. The Department of Energy (DOE) G-1 aircraft was used as one of the main platforms in CHAPS. Flight tracks were designed and implemented to characterize freshly emitted aerosols at cloud top and cloud base as well as within the cloud, i.e., cumulus humilis (or fair-weather cumulus), in the vicinity of Oklahoma City. This presentation will focus on CCN properties in cumulus humilis. Our interest will focus on the differences in particle composition under varying conditions.

Field Deployment

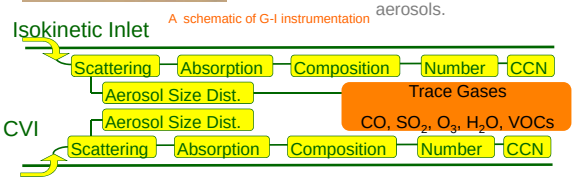


The DOE G-I aircraft

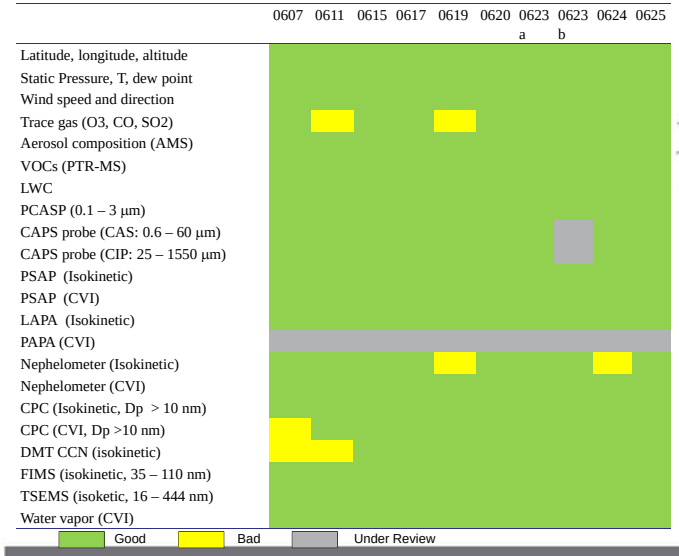
Inlets on G-I

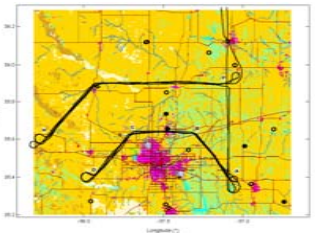
A schematic of G-I instrumentation

Measurements from two instrumented aircraft and a ground site near Oklahoma City allowed scientists to study the effects of aerosols on clouds, and vice versa – the effects of clouds on aerosols.



Summary of all measurements on G-1

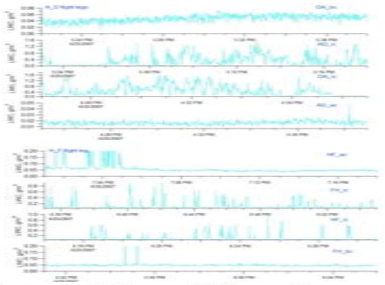


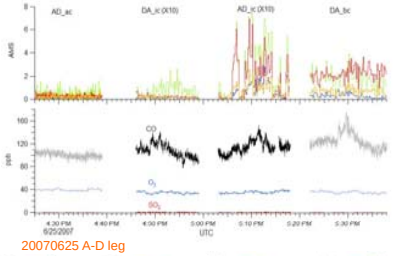


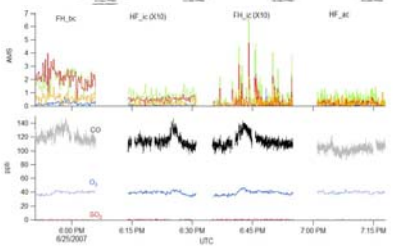
The G-I flight map on June 25, 2007

Leg Name	Start Time (UTC)	End Time (UTC)
AD_ac	16:25	16:39
DA_ic	16:46	16:59
AD_ic	17:03	17:18
DA_bc	17:22	17:38
FH_bc	17:51	18:06
HF_ic	18:14	18:31
FH_ic	18:35	18:55
HF_ac	19:01	19:18

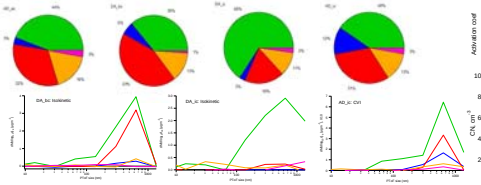
ac: above cloud
bc: below cloud
ic: in cloud

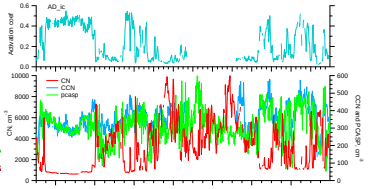




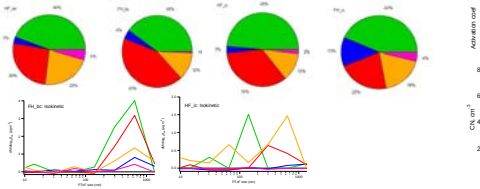


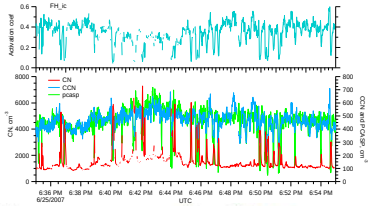
20070625 A-D leg

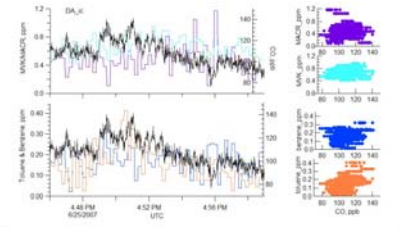


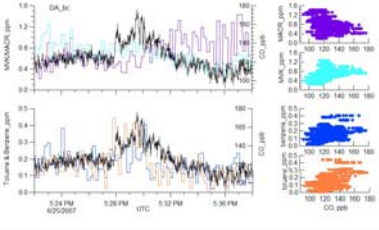


20070625 H-F leg









Conclusions

- Ten G-I flights were analyzed from the perspective of particle chemical composition changes in clouds and out of clouds.
- Comparison between cloud residuals and nonactivated background particles show:
  - NO_3, Chl, NH_4 were enriched in cloud residuals.
  - SO_4 was reduced in cloud residuals 2/3 of the times.
  - Organics were either enriched or reduced
- Chl increased from cloud base to cloud top, total organic decreases from cloud base to cloud top.
- Both primary and secondary aerosols contribute to CCNs.
- VOCs potentially play an important role in the processing of aerosols.

Future Work

Initial analyses indicate that different sources could contribute to CCNs. Several questions and challenges remain.

- Identify the sources of the air masses or plumes observed in flights.
- Determine primary and secondary aerosols and their effect on cloud formation.
- Look closely the ptof data to investigate evolution of particles and activation of CCN.
- Correlate with cloud microphysical observations to understand the effect of aerosol composition and size on cloud particles

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