Indirect and Semi-Direct Aerosol Campaign

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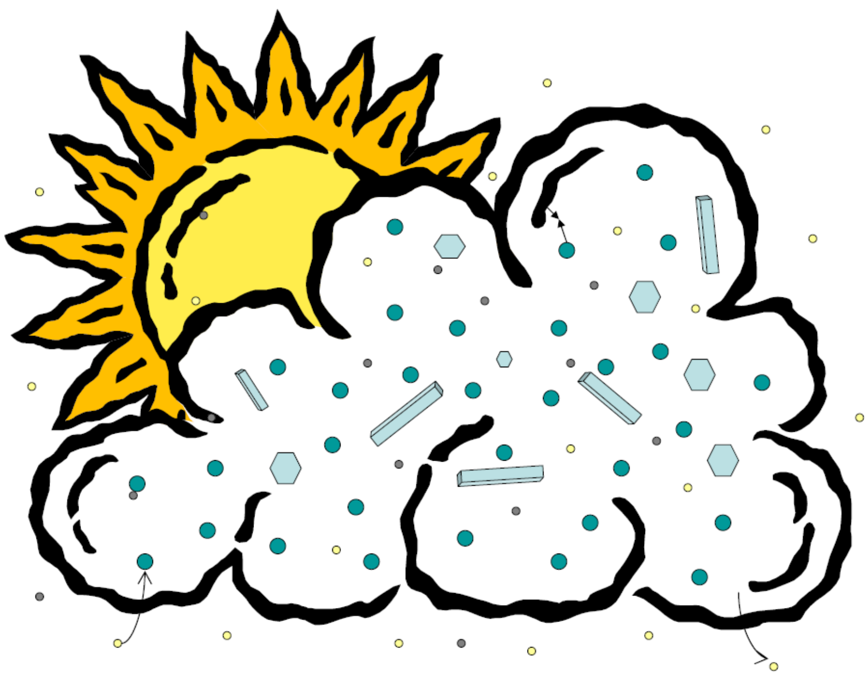


Barrow, Alaska

April 2008

Key Issues

- How do properties of Arctic aerosol during April differ from those measured by M-PACE during October?

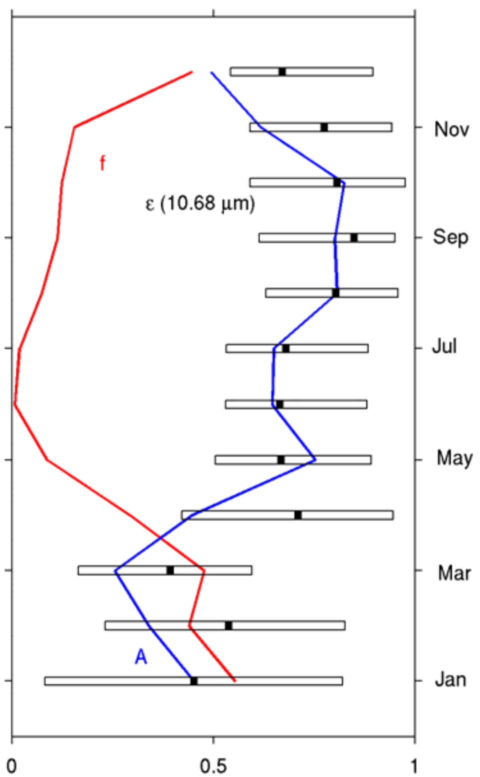
- To what extent do different properties of aerosol change cloud microphysical and macrophysical properties & surface energy balance?
  - Distinguish between aerosol effects in clean conditions observed during M-PACE & more polluted conditions expected in April

- How well can cloud models & cloud parameterizations used in climate models simulate sensitivity of Arctic clouds & surface energy budget to differences in aerosol between April and October?

- How well do surface measurements at NSA provide retrievals of aerosol, cloud, precipitation & radiative heating in Arctic

Motivation

- Submicron arctic aerosol concentrations & compositions vary widely with season



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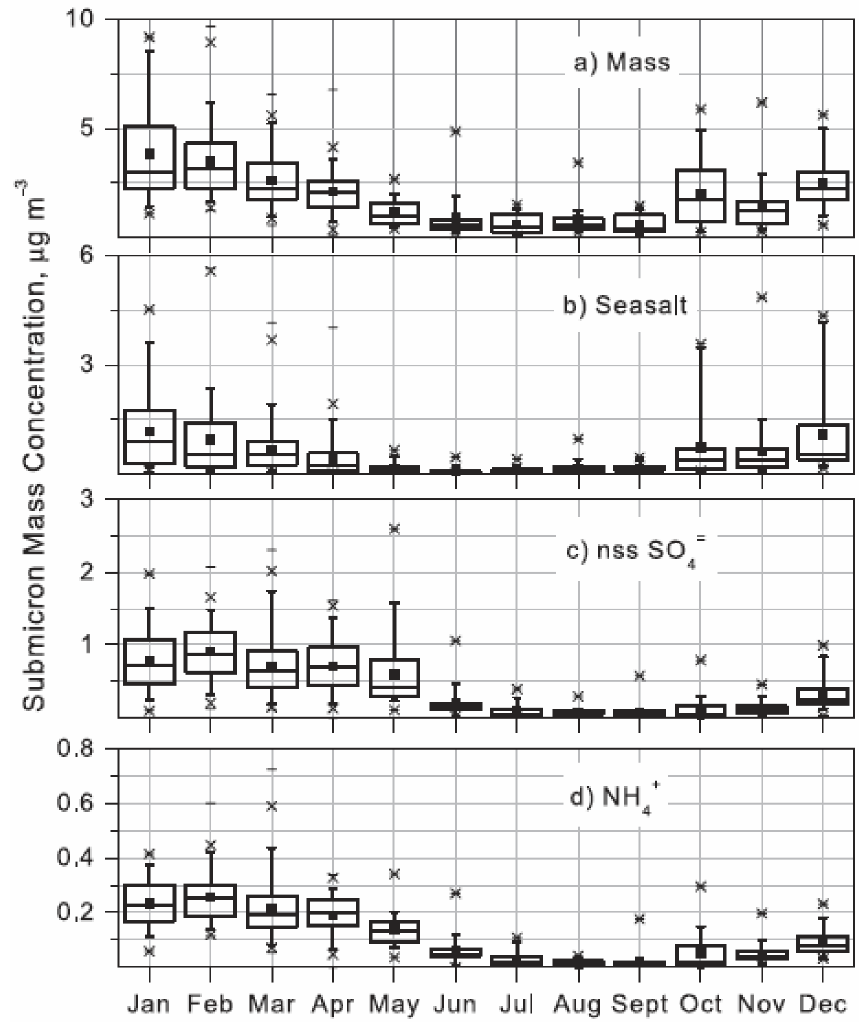

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Why at NSA?

- Stratiform clouds more prevalent at NSA & they play important role in cloud feedbacks
- Large *arctic* climate sensitivity due to snow/ice albedo feedback and cloud feedbacks more important and more poorly understood in Arctic
- Most studies of cloud-aerosol interactions have focused on warm clouds
- Cloud-aerosol interactions more complex for ice or mixed-phase clouds
  - Glaciated & mixed-phase clouds more common at NSA than other sites
  - Aerosols have strong seasonal cycle at NSA so can look at indirect effects
- Colder & drier environment permits tests of radiative transfer codes

Aircraft Measurements: G-1/Citation/Falcon

- Temperature
- Humidity
- Total particle number
- Aerosol size distribution & hygroscopicity
- Cloud condensation & ice nuclei concentration
- Optical scattering and absorption
- Updraft velocity
- Cloud liquid water and ice water content
- Cloud droplet & crystal size distribution
- Cloud particle shape
- Cloud extinction

Surface Measurements

- Profiles of temperature, humidity and winds (radiosonde)
- Water vapor & liquid water path (microwave radiometer)
- Profiles of T, q, LWC, u, v, T_v (microwave & wind profiler)
- LWC & IWC profiles (radar)
- Aerosol backscatter & depolarization (lidar)
- AERI retrievals (T, q_v, WP, τ, r_e for water & ice)
- Aerosol t (radiometers and sun photometer)
- Downward & upward longwave & solar radiance
- Cloud base altitude (ceilometer)
- Precipitation (hot plate rain gauge) & Snow gauge
- Aerosol scattering & absorption as f(RH)
- Total particle number, accumulation mode number & CCN number
- Daily chemical analysis

Applications

- CCN closure
- Droplet number closure
- Cloud water closure
- Cloud extinction closure
- CCN retrieval
- Cloud property retrievals
- Cloud modeling
- Semi-direct effect
- Relation between IN and ice crystal concentration

Cloud Modeling: M-PACE vs ISDAC

- ISDAC and M-PACE boundary conditions are likely to be very different because of the much more extensive ocean water during M-PACE
- Separate influence of different boundary conditions from difference aerosol by performing four simulations:
  - M-PACE aerosol and boundary conditions
  - M-PACE aerosol and ISDAC boundary conditions
  - ISDAC aerosol and M-PACE boundary conditions
  - ISDAC aerosol and boundary conditions.