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Vertical Profiles of Trace Gas and Aerosol Properties over the Eastern North Atlantic

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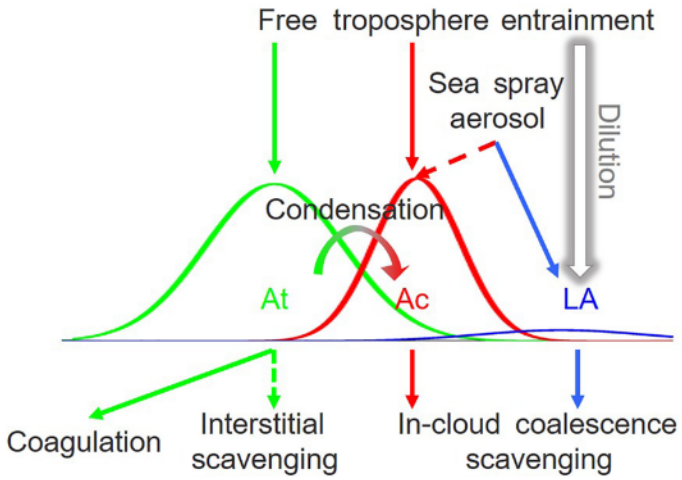
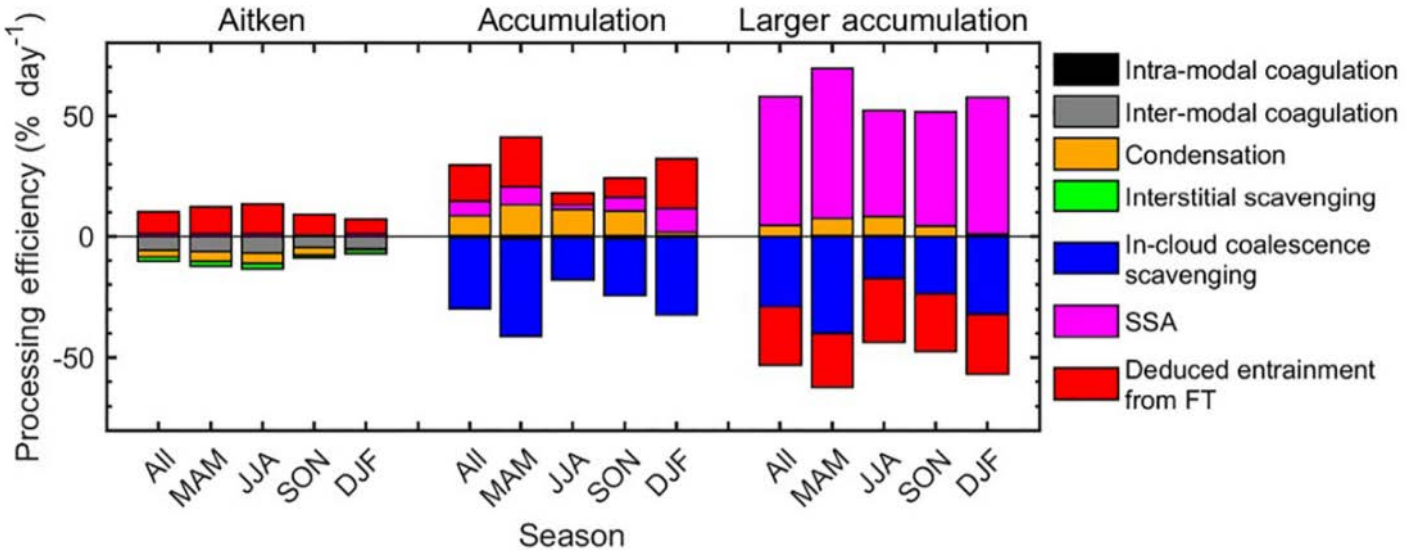
Processes governing the aerosol properties at ENA



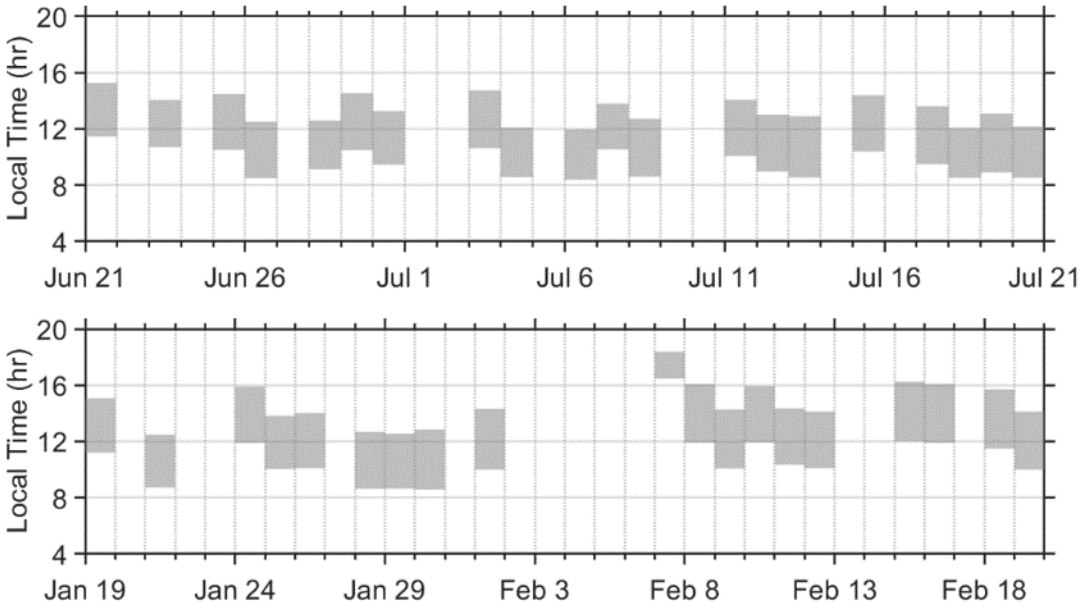
- Long-term ground observation at ENA
- Aerosols are governed by different processes at ENA
- Strong seasonal variabilities in aerosol population and controlling processes
- Lack of aircraft-based observations

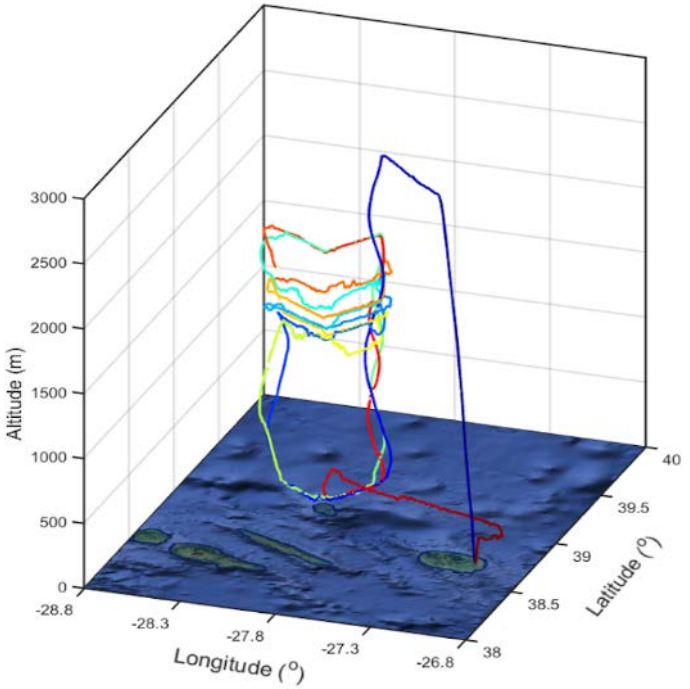


Zheng, G., et al. (2018). Atmospheric Chemistry and Physics 18(23): 17615-17635.

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

- 2 intense operation periods (IOPs)
  - Early summer (June to July, IOP1) of 2017
  - Winter (January to February, IOP2) of 2018



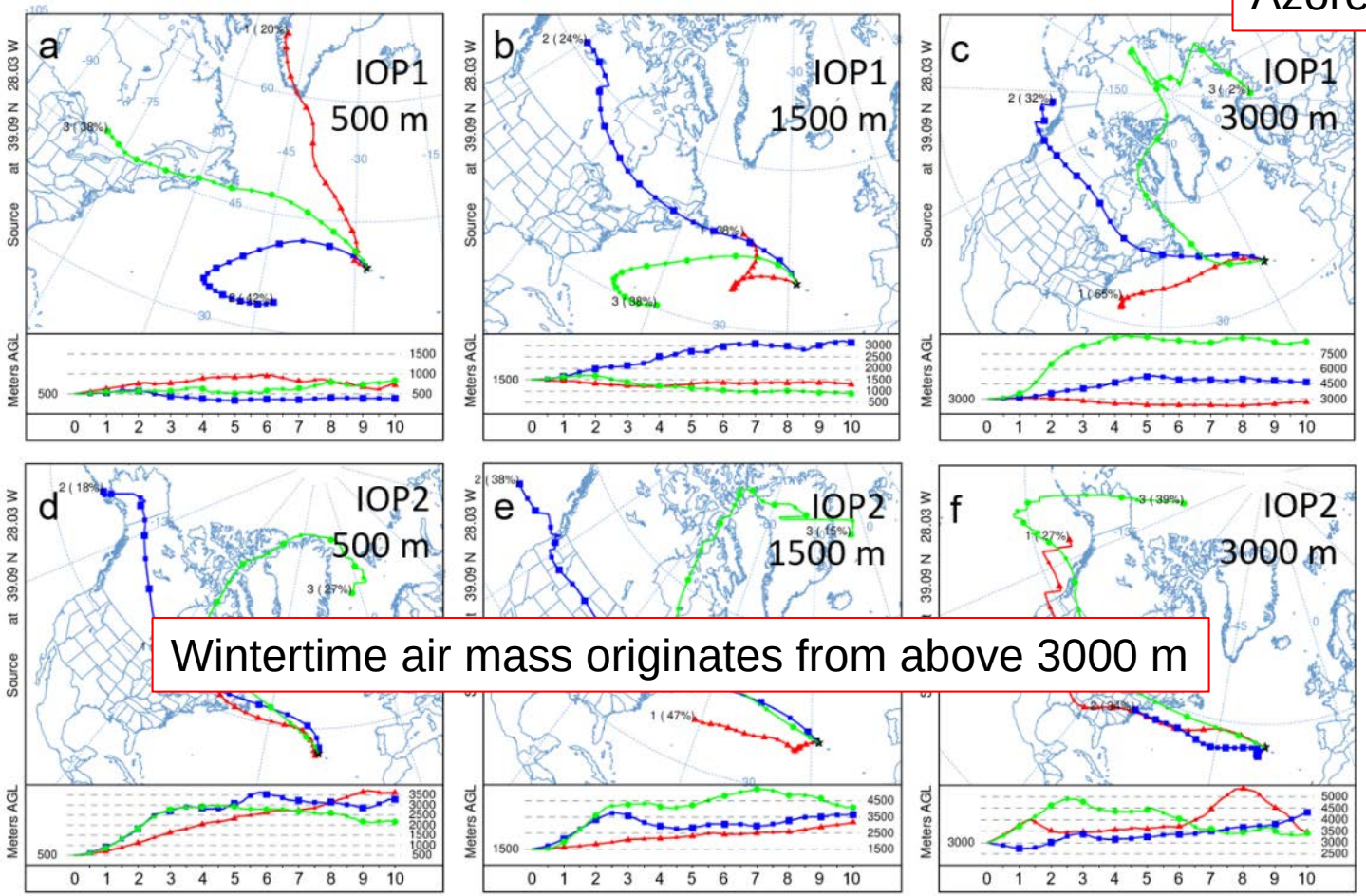


- "L-shaped" flight pattern
- Vertical profiles of trace gas and aerosol properties

Cluster analysis of back trajectories during flight days

- MBL heights: 1220±450 (IOP1) and 1640±480 m (IOP2)
- 3 altitudes: 500 m, 1500 m, 3000 m

North America
Arctic
Azores high

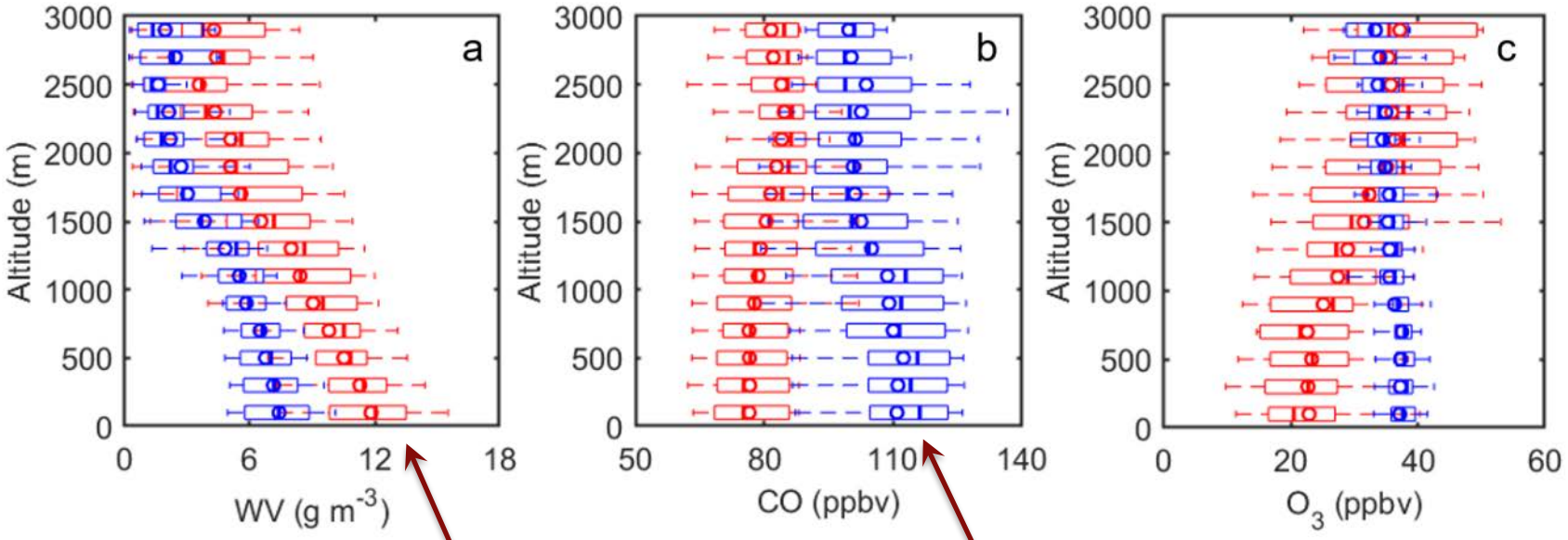


Wintertime air mass originates from above 3000 m

Stein, A. et al., Bulletin of the American Meteorological Society, 96, 2059-2077, 2015.

Gas species

- Water vapor (WV), carbon monoxide (CO), and ozone (O_3)



Difference in ambient temperature and saturation vapor pressure

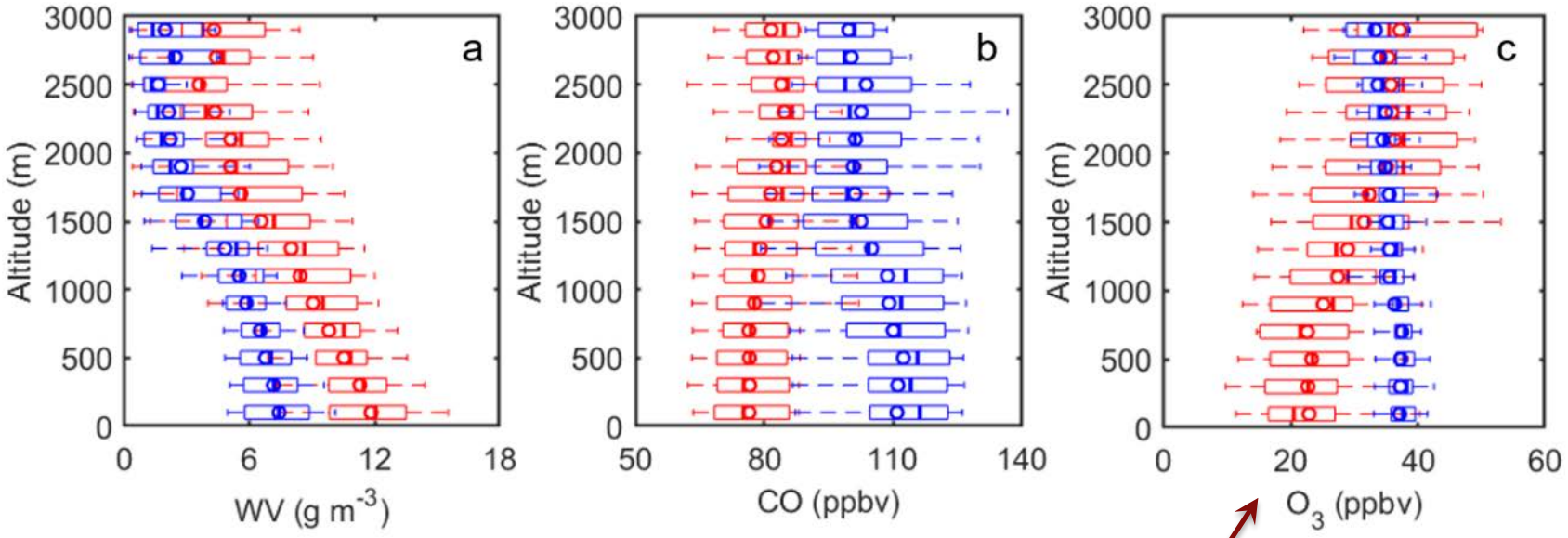
Major sink of CO is OH radical

Vertical trend:

- Continental temperature
- Vertical transport

Gas species

- Water vapor (WV), carbon monoxide (CO), and ozone (O_3)



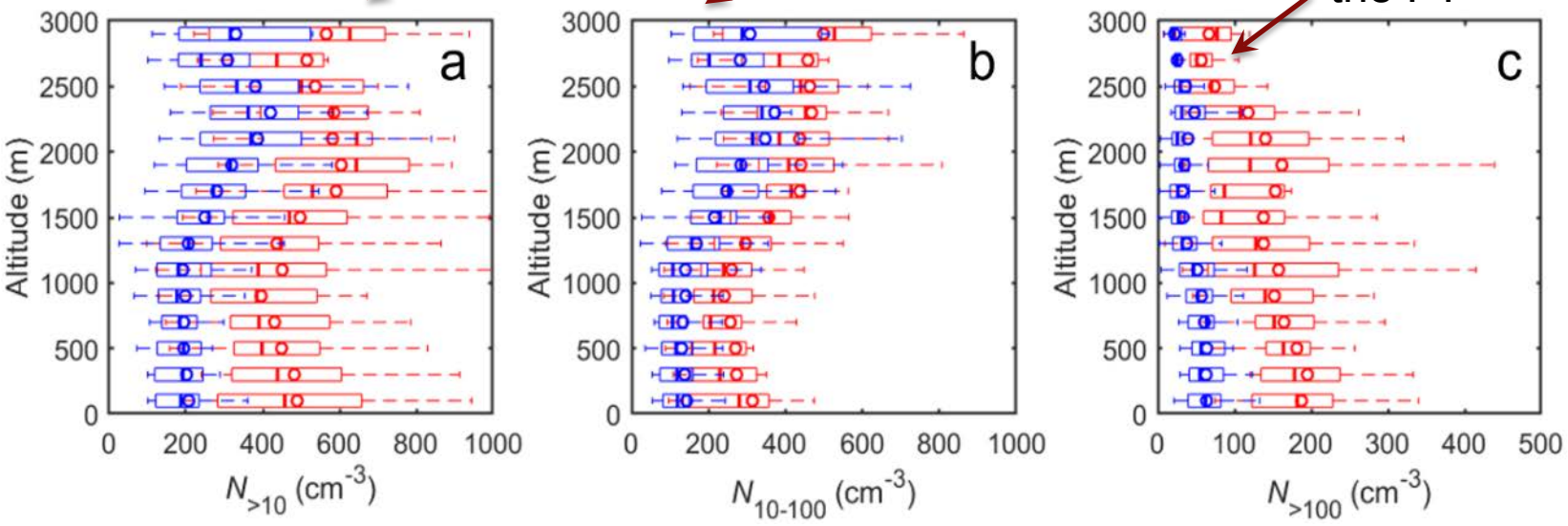
- Major sink of O_3 is the formation of OH during photolysis

Aerosol number concentrations and sizes

Higher total concentration in the FT

Dominated by Aitken-mode aerosols

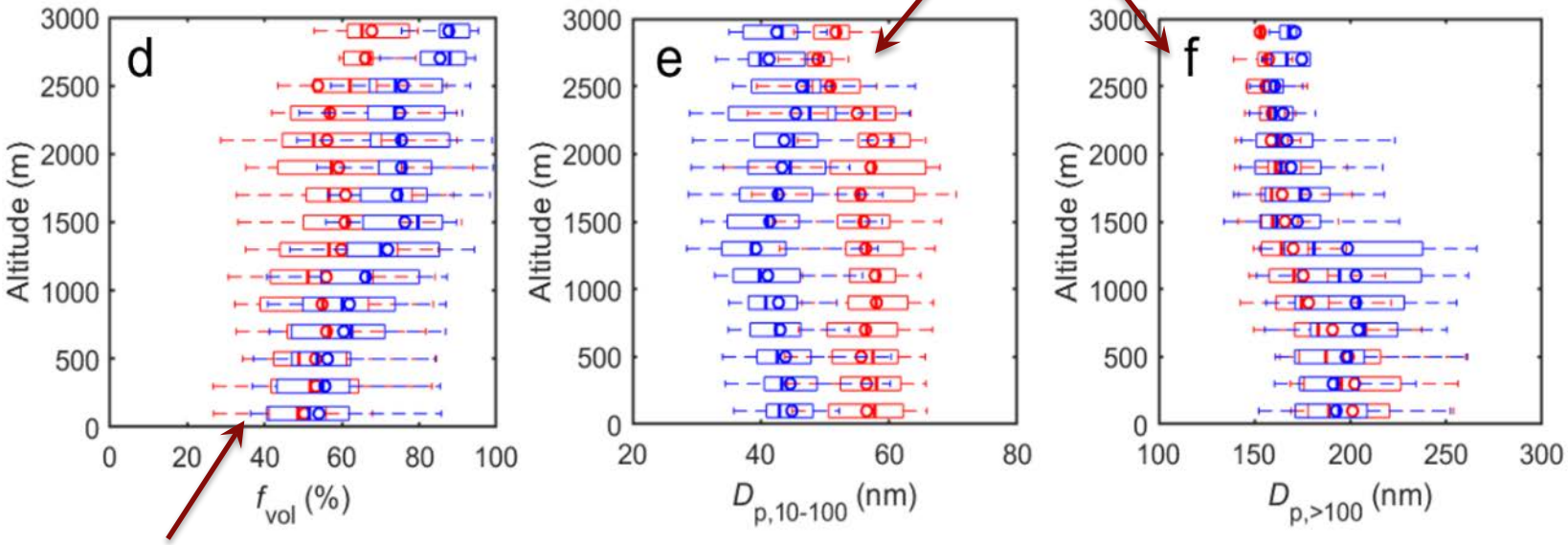
Lower Accumulation-mode aerosol concentration in the FT



FT is unlikely the source of accumulation mode aerosols in the MBL

Aerosol number concentrations and sizes

Smaller Aitken- and Accumulation-mode size in the FT (surface growth and in-cloud processing)



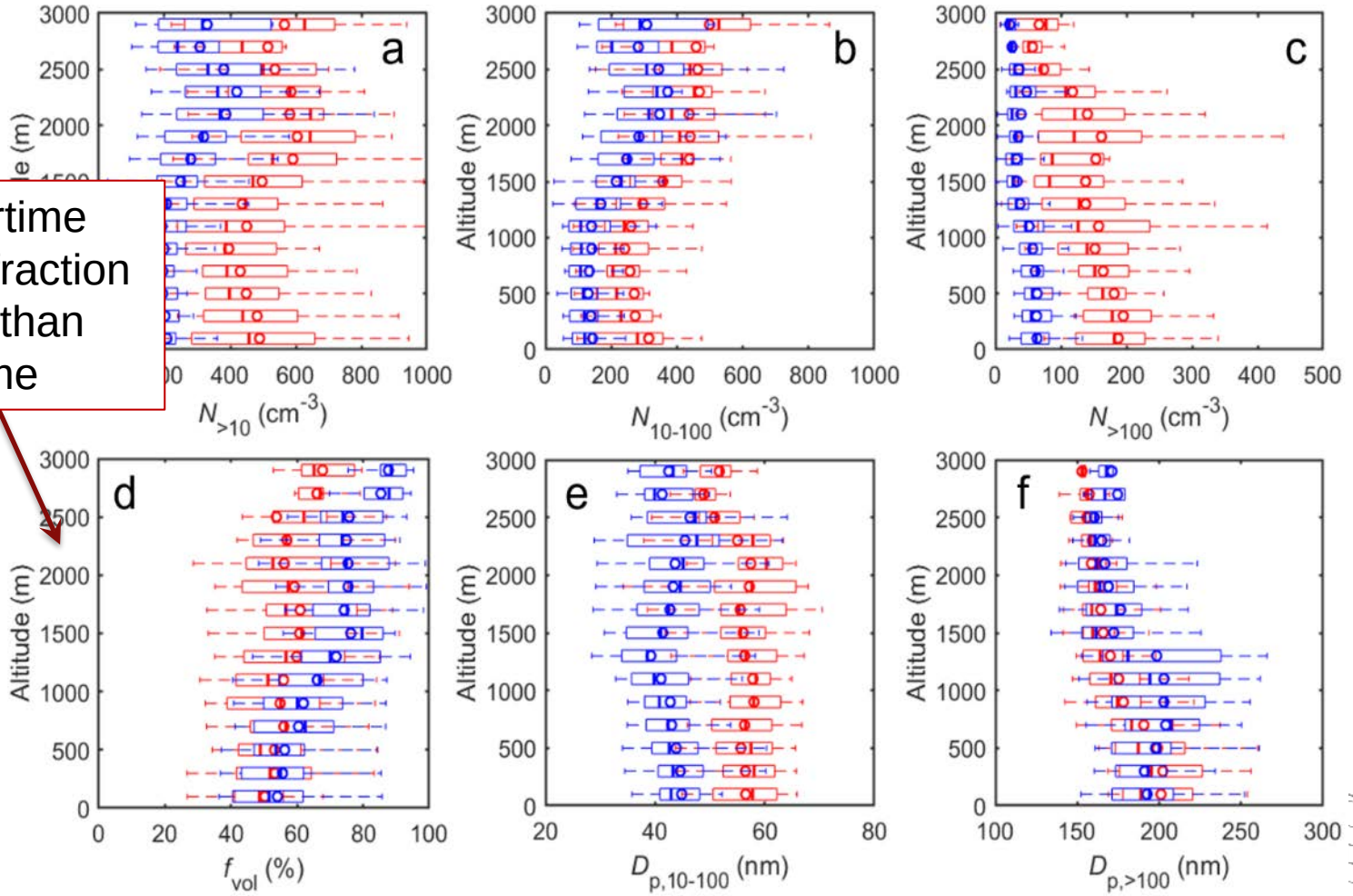
Higher volatile fraction in the FT (influence of new particle formation)

Aerosol number concentrations and sizes

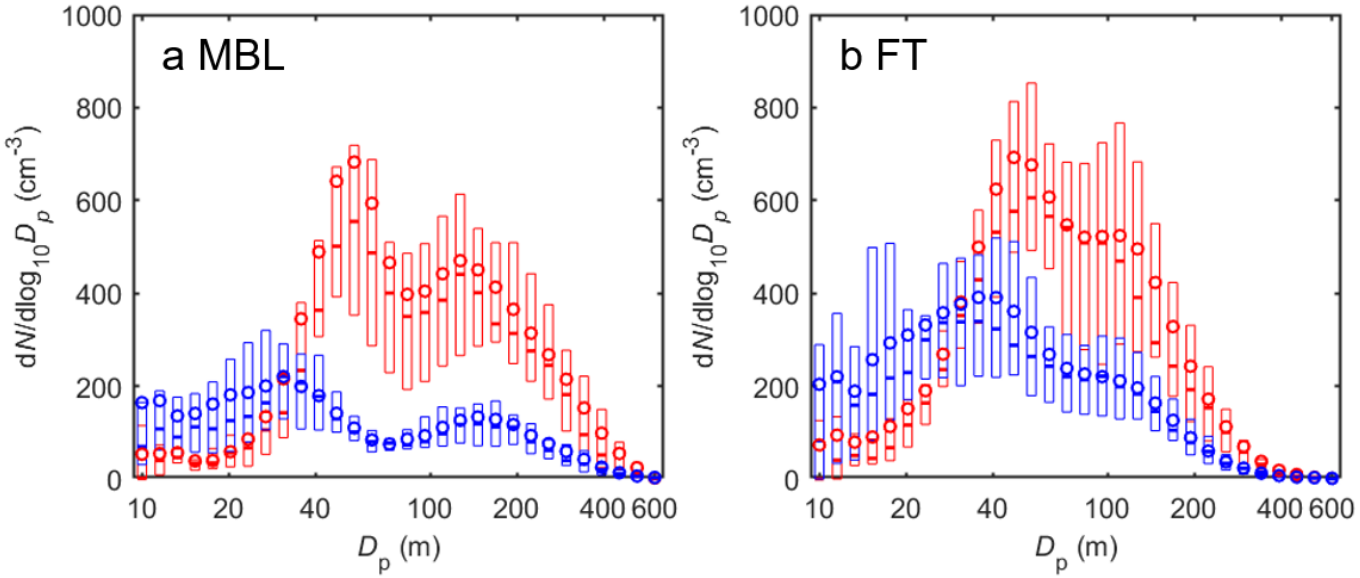
Seasonal variation: higher summertime concentration in all size ranges at all altitudes

- Influence of long-range transport and potentially stronger new particle formation

Summertime volatile fraction is lower than wintertime

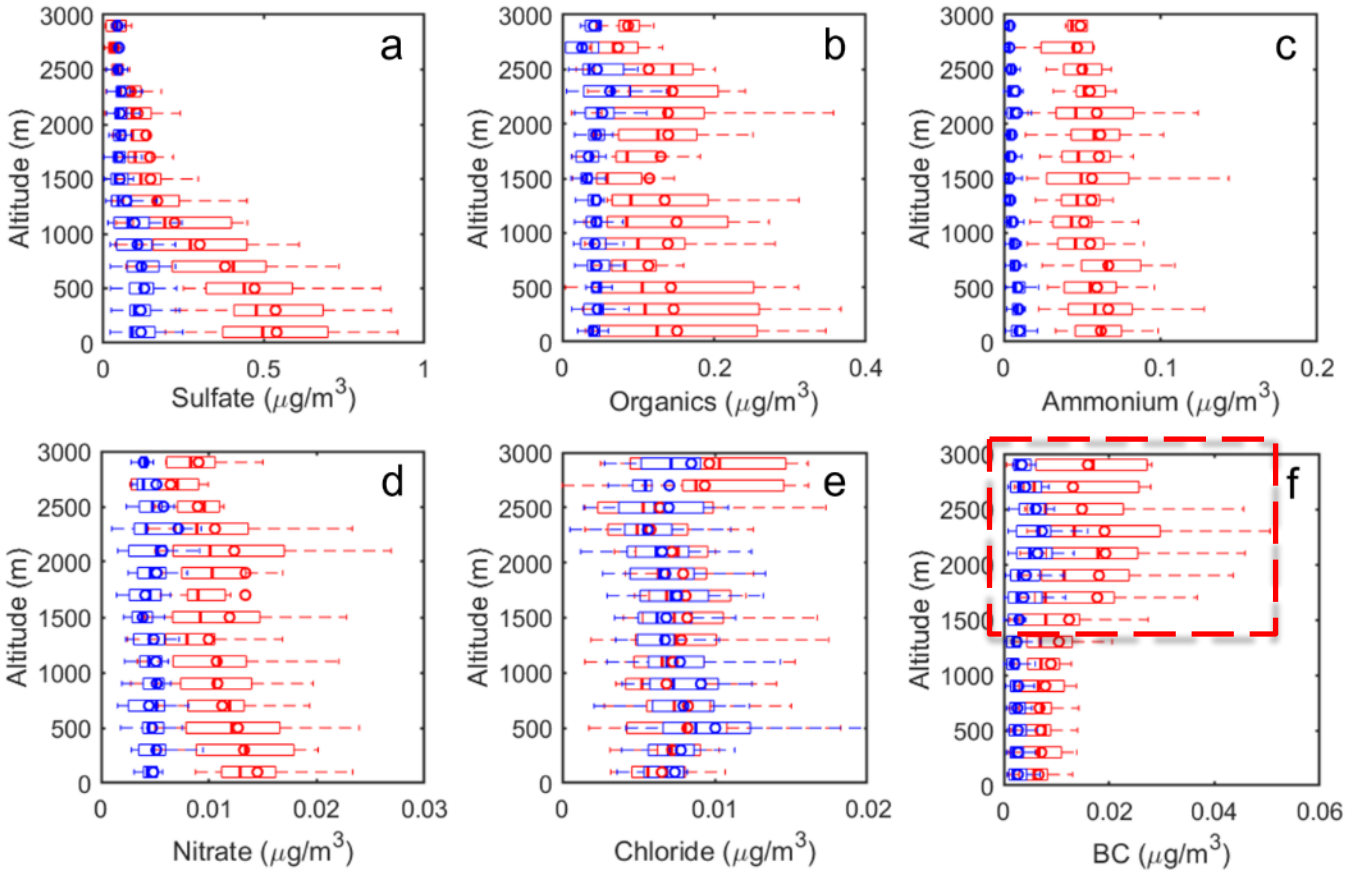


Average aerosol size distributions



- Total aerosol concentration: higher in summer
- Large difference in Aitken-mode size
- New particle formation during winter

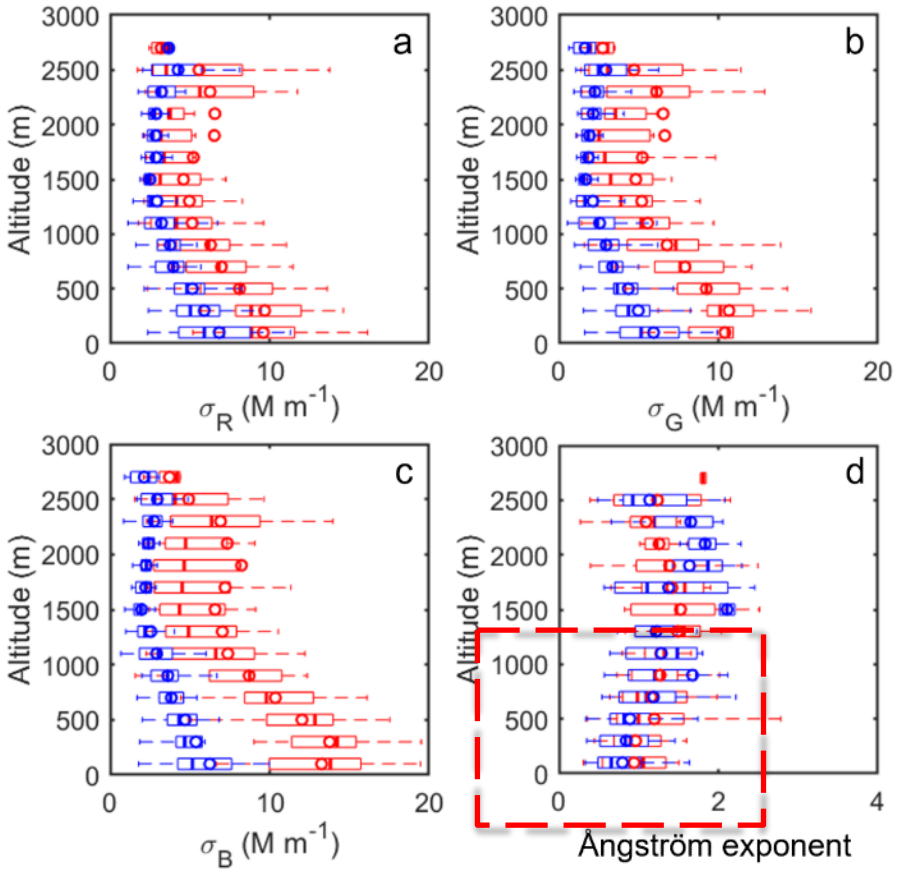
Aerosol chemical compositions



- Sulfate, organics, and ammonium constitute majority of non-refractory aerosol mass
- Higher sulfate concentration in the MBL
- BC concentration is higher in the FT (long-range transport)
  - Anthropogenic pollution or biomass burning aerosols?

Aerosol scattering properties

- Scattering coefficients at wavelengths of 700, 550, and 450 nm
  - Higher values in the MBL
  - Ångström exponent is lower at surface due to sea spray aerosols



Conclusions

- Vertical profiles of trace gas and aerosol properties
  - Higher CO and O_3 concentrations during winter due to reduced sink
  - Stronger influence of long-range transport during summer
  - Higher aerosol concentration during summer at all altitudes
  - Larger particle sizes due to stronger surface growth

Future plans:

- Identify the source of the long-range transport aerosols
  - Aerosol composition and back trajectories
- Impact of synoptic conditions on aerosol and trace gas properties

ARM CLIMATE RESEARCH FACILITY

ASR Atmospheric System Research

Thank you!