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

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: $1220 \pm 450$ (IOP1) and $1640 \pm 480$ m (IOP2)
- 3 altitudes: 500 m, 1500 m, 3000 m

Gas species

- Water vapor (WV), carbon monoxide (CO), and ozone (O₃)

- Major sink of CO is OH radical
- Vertical trend:
  - Continental temperature
  - Vertical transport

Difference in ambient temperature and saturation vapor pressure
Gas species

- Water vapor (WV), carbon monoxide (CO), and ozone (O₃)

- Major sink of O₃ 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

Thank you!