A overview of published VOCALS studies on gas composition and aerosol along 20S

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20-South Rationale

- Statistically representative cloud, thermodynamic and composition dataset in support of modelling.
- UK BAe-146, US DoE-G1, US NSF-C130 and Ron Brown used.
- 35 flights = 230 hours sampling time.
- 70 - 90 W, from 0-7 km, over 24 days.
- Composition statistics as a function of longitude interpreted for airmass history.
- Allen et al, 2010, ACPD, in press
- Links to Bretherton et al., 2010, ACP
Back Trajectory Analysis

10-day Back Trajectories, 20081024, 00UTC

- BL trajectories show lack of variability and more south-north direction than FT
- FT has a gradient in source origin
  Continental PBL sources near the coast
- Descended long-range remote sources west of 75 W.
- Uplift to UT may have frozen in some pollution signatures and removed others
Back trajectories - FT
Coastal Gradients – MBL (Allen et al 2011)

• CO decreases with distance offshore – reduced reach of combustion-affected airmasses
• SO2 shows episodic enhancement near-shore. Note long tail.
• Ozone essentially flat, note bimodal in remote zone
Coastal gradients - FT

- Weak gradient in CO
- Strong gradient in SO2 with episodic nature
- Increasing gradient in ozone – note bimodal distribution in CO and O3.
MBL Aerosol composition and clouds

[Graphs showing aerosol composition and clouds across different longitudes, with data points and error bars for each variable (ORG, NH₄, SO₄) and channel (CCN, CDN, ACN, CN).]
FT Aerosol and clouds

FT ORG

ORC / µg m⁻³

-85  -80  FT NH₄  -75  -70

FT NH₄ / µg m⁻³

-85  -80  FT NH₄  -75  -70

FT SO₄ / µg m⁻³

-85  -80  FT NH₄  -75  -70

FT CDN / cm⁻³

-85  -80  FT NH₄  -75  -70

FT ACN / cm⁻³

-85  -80  FT NH₄  -75  -70

FT CN / cm⁻³

-85  -80  FT NH₄  -75  -70

FT CCN / cm⁻³

-85  -80  FT NH₄  -75  -70

FT CDN / cm⁻³

-85  -80  FT NH₄  -75  -70

FT ACN / cm⁻³

-85  -80  FT NH₄  -75  -70

FT CN / cm⁻³

-85  -80  FT NH₄  -75  -70
Aerosol acidity
• MBL well mixed
• Often enhancements in the FT – discrete layers.
• Evidence of entrainment and mixing in the cloud layer
Aerosol size distributions

Dominant 100-110 nm mode. Occasional evidence of recent growth (cloud depletion)
Size distributions from coastal sites

- Little variability at Paranal (2690 masl)
- High variability at Paposo (690 masl), especially in growth modes (40 nm)
Source attribution at the coast

Chand et al., ACP, 2010
Aerosol chemical characterisation offshore

Hawkins et al., JGR, 2009
Aerosol chemical characterisation offshore

Hawkins et al., JGR, 2009
Summary of VOCALS Chemical characterisation findings published to date

• Significant zonal gradients in mean MBL sub-micron aerosol particle size and composition, CO, O3 and SO2 – associated with similar gradients in CDN

• FT is often more polluted than the MBL in the mean but highly variable – complex interleaving of air masses from diverse source

• Points to entrainment being an important process – Tony Clarke

• Coastal measurements indicate that whilst urban/biofuel sources dominate the contribution to aerosol mass, biomass burning are an important contribution to CCN

• Shipborne measurements indicate the majority of the organic matter in aerosol are anthropogenic in nature, with some primary marine contribution