Organic Composition of Aerosol at Cape Grim

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Bureau of Meteorology

The Centre for Australian Weather and Climate Research
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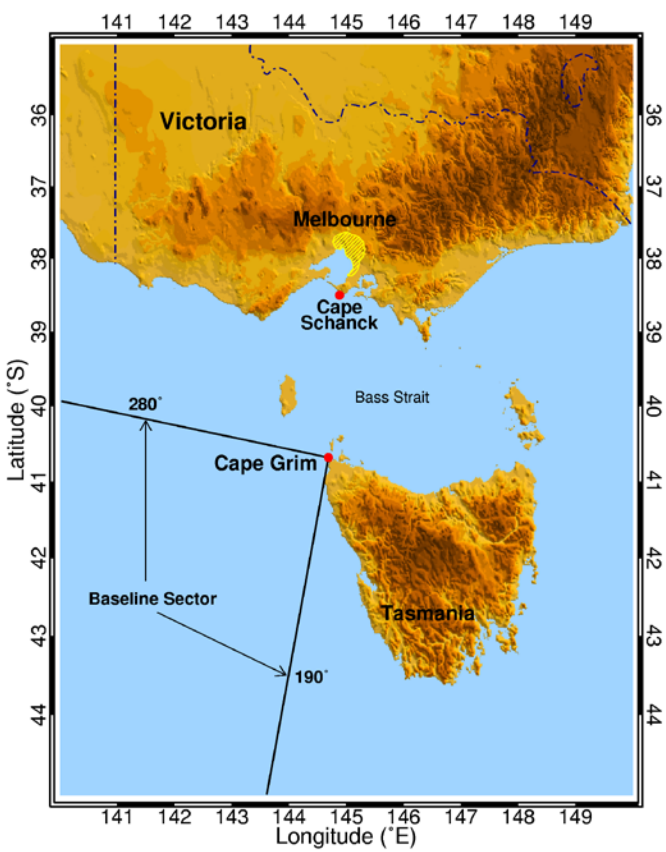
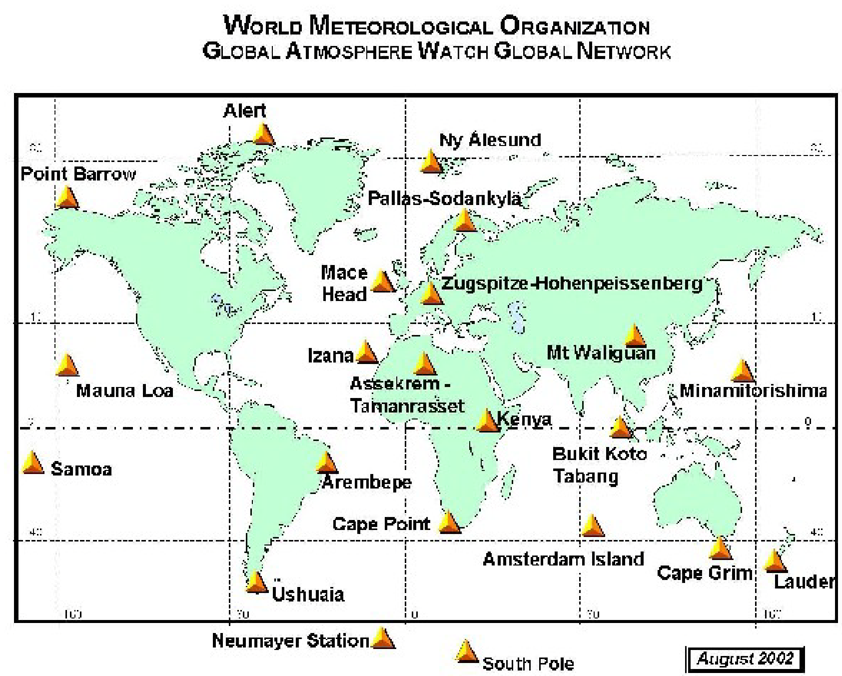
CSIRO

Cape Grim

- Operated by Bureau of Meteorology and CSIRO since 1976
- Global Atmospheric Watch Baseline Station





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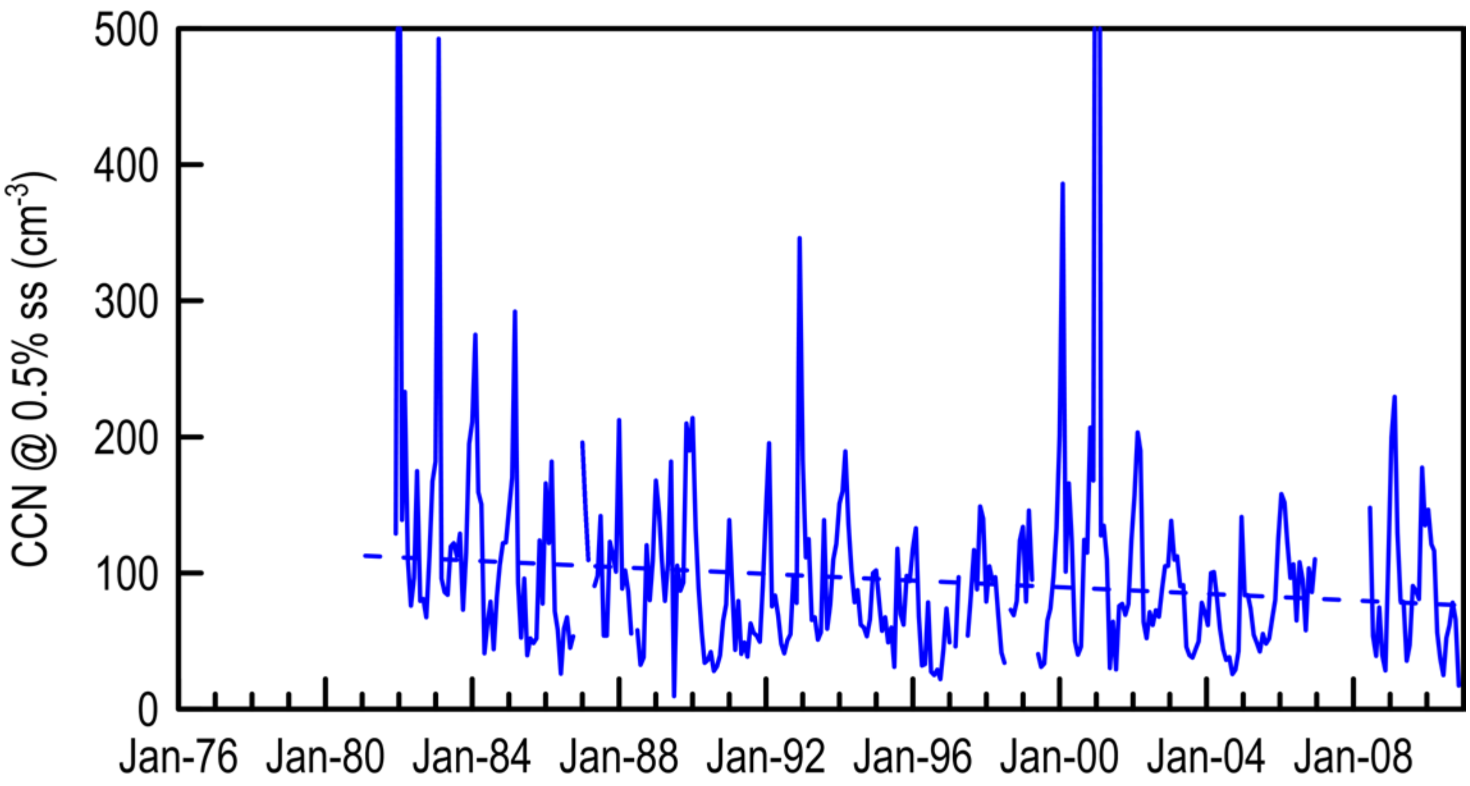
Organic aerosol in the marine boundary layer

- MBL aerosol - dominated by sea-salt in coarse particles
- Submicron particles
  - Includes nssSO4, sea-salt
  - Large fraction of submicron particles in MBL uncharacterised (Quinn et al. 2000)
  - Organic compounds as significant as nssSO4 e.g. Mace Head (Cavalli et al. 2004, O'Dowd et al. 2004)
- Organic aerosol in MBL
  - Presence has been known since 1960's (Lodge et al., 1960, Blanchard 1964, Hoffman and Duce 1964)
  - OC in remote MBL globally of the order of ng m^{-3} (Liousse et al. 1996) – based on modelling
  - At Cape Grim during ACE-1, 10% of aerosol mass (Baseline) was organic (Middleton et al. 1999).
  - Amsterdam Island organosulfates identified (Claeys et al., 2010)

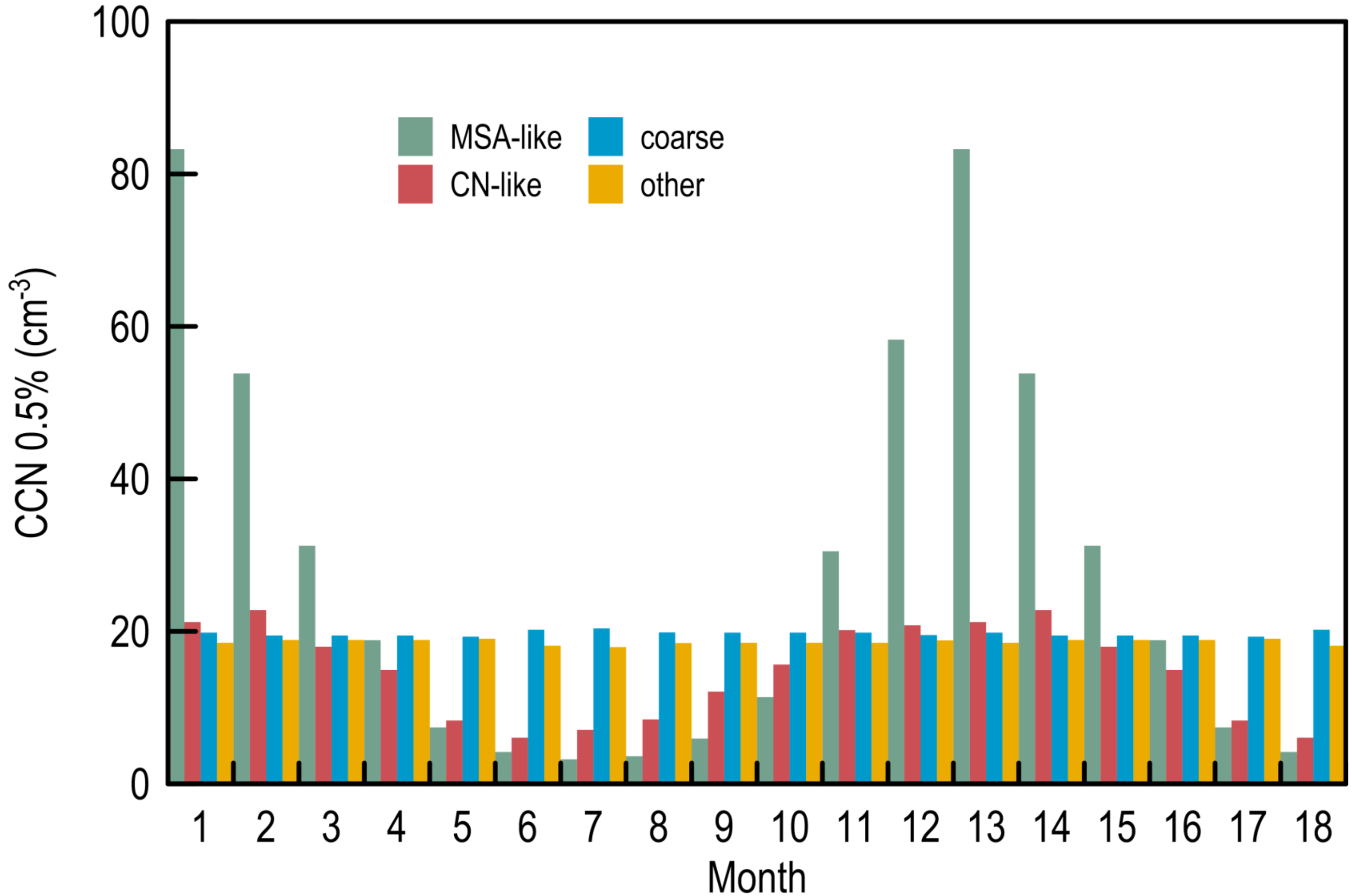
CCN at Cape Grim

downward trend of around 1.35 cm^{-3} per year (equivalent to around -1.3% per year).



From John Gras

Sources of CCN



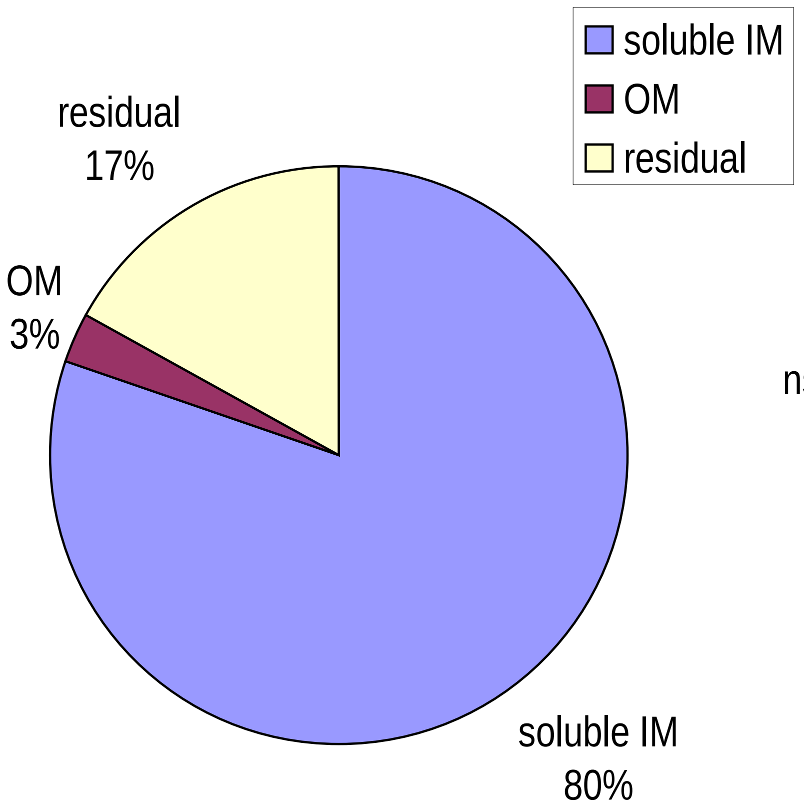
From John Gras

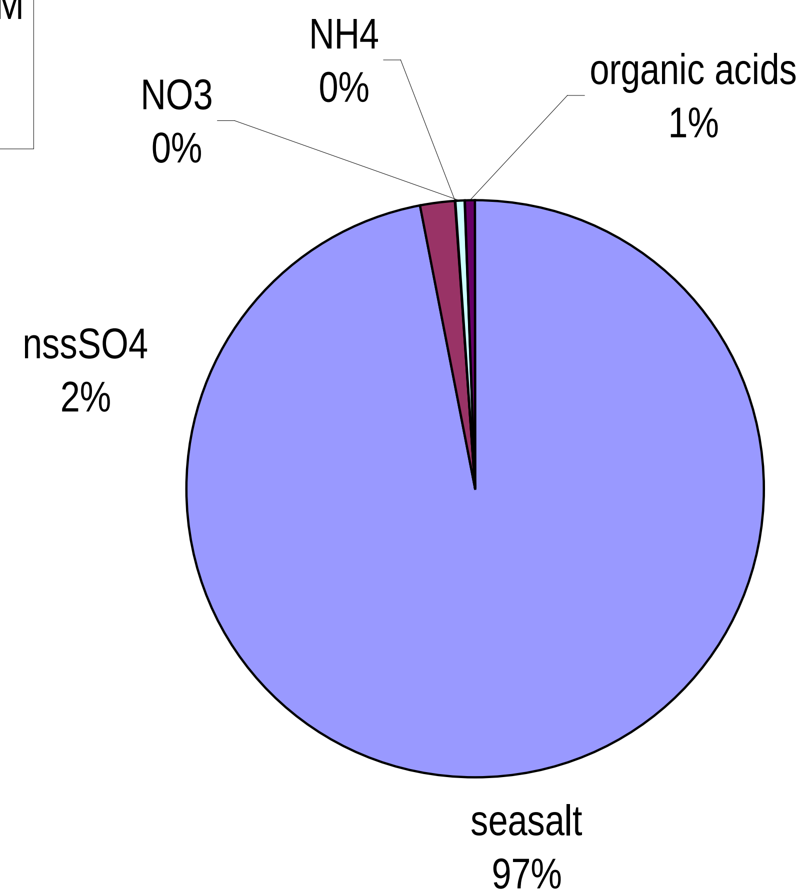
Methodology

- Samples collected using a PM10 high volume sampler between October 2002 and August 2003
  - quartz filters for one week
  - baseline only
  - 45 samples plus 10 blanks

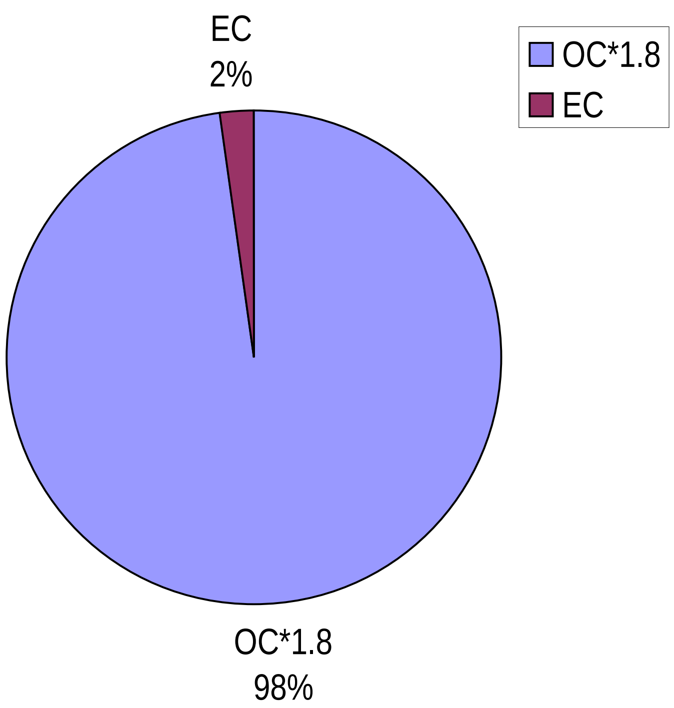
- Mass, soluble ion composition (CMAR)
  - Ion Chromatography
- OC, EC, WSOC (Gent University, Belgium)
  - thermal-optical transmission
- Non-polar semi volatile OC (Desert Research Institute, Reno)
  - thermal desorption-gas chromatography/mass spectrometry (TD-GC/MS)
  - 21 samples (7 summer, 14 winter)
  - Uncertainty of 5%

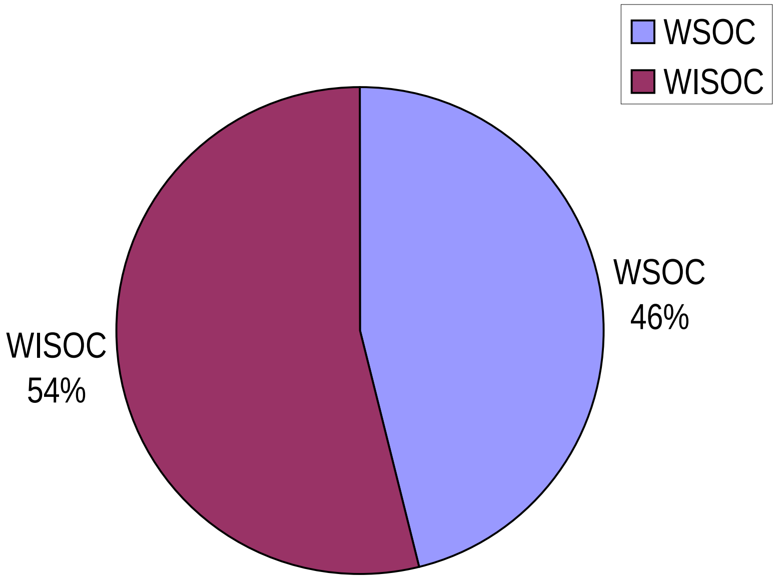
Mass Balance





Total Organic Carbon





Non-polar semi-volatile organic compounds

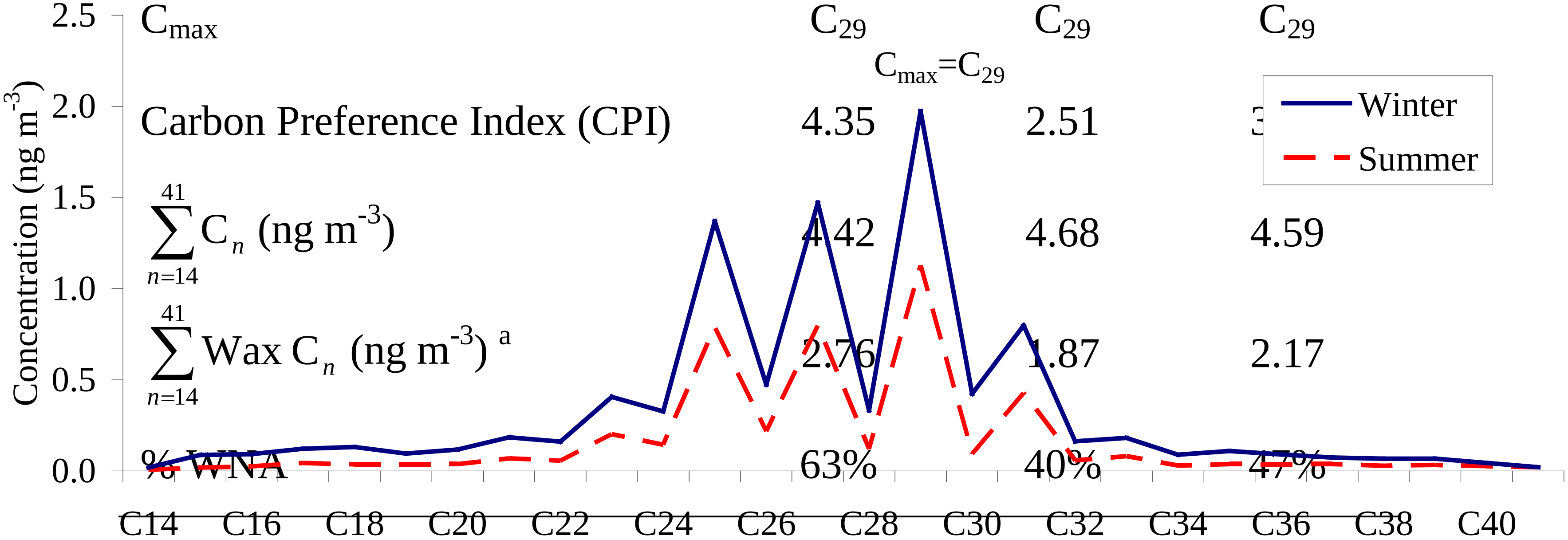
- PAH, ***n*-alkanes,** hopanes and **cycloalkanes**

n-Alkanes

- *n*-alkanes (C14 - C41) dominant group of species
- Mean concentration 4.59 ± 2.99 ng m^{-3}
- 7 summer samples between November 2002 and December 2002
- 14 winter samples between April 2003 and August 2003
- No seasonal variation
- Use *n*-alkane indices to distinguish between biogenic and anthropogenic sources

Summary of N-alkane indices

	Summer (n-7)	Winter (n=14)	Mean (n=21)
C_{max}	C_{29}	C_{29}	C_{29}
Carbon Preference Index (CPI)	4.35	2.51	3[illegible]
$\sum_{n=14}^{41} C_n$ (ng m^{-3})	4.42	4.68	4.59
$\sum_{n=14}^{41}$ Wax C_n (ng m^{-3}) [a]	2.76	1.87	2.17
% WNA	63%	40%	47%

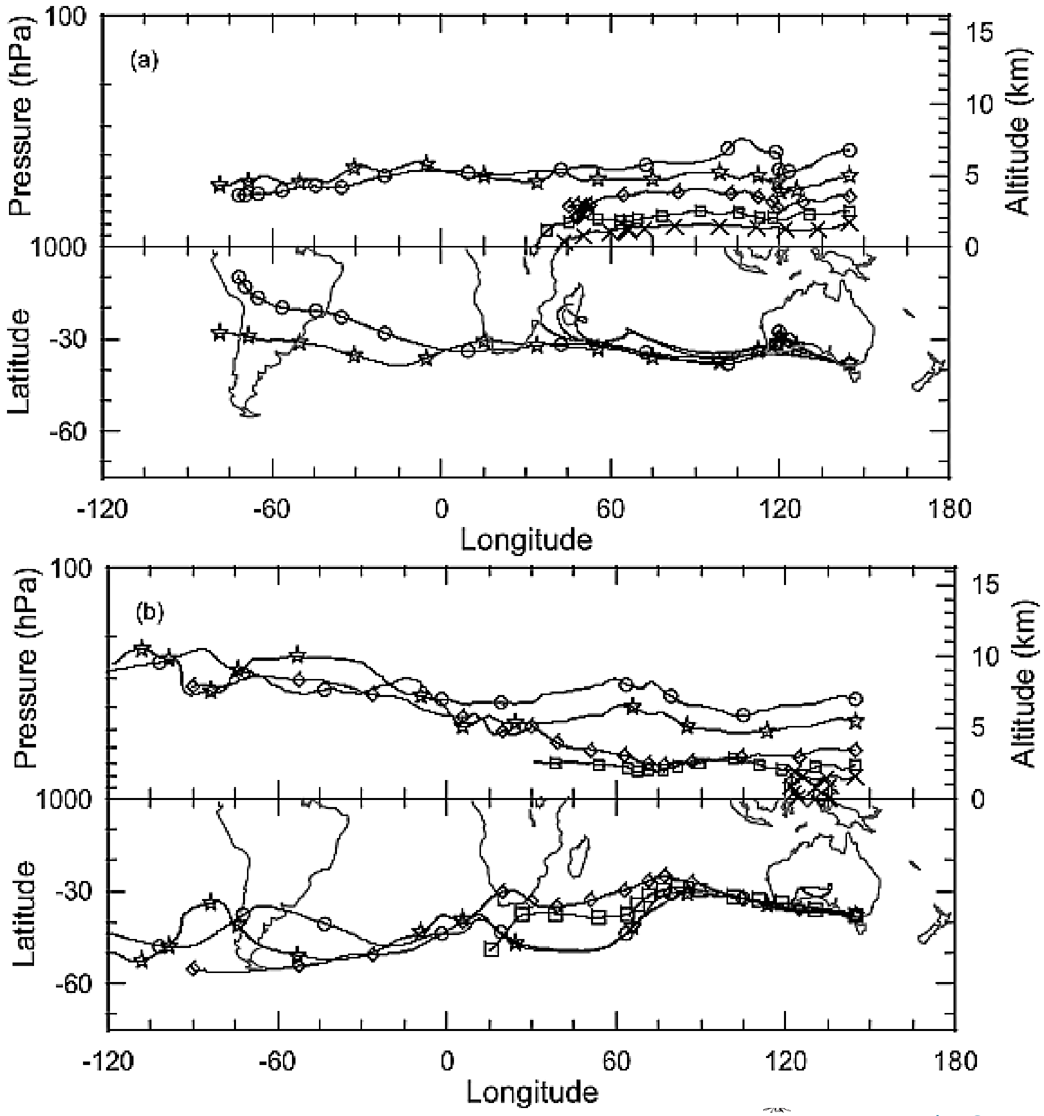


Cycloalkanes

- Significant amounts of cycloalkanes (C15-C28) were detected in all samples,
- Rarely reported in literature
- Mean total concentration = 0.84 ± 0.80 ng m^{-3}
- ~0.3% of the OC
- Wood burning is a source for cycloalkanes (Hays et al, 2004)
- Summer (Nov & Dec) = 1.16 ± 1.12 ng m^{-3}
- Winter (April to Aug) = 0.66 ± 0.54 ng m^{-3}

- Long range transport of biomass burning smoke from Southern Africa
  - Peak burning activity is September to October
- Unregulated ship emissions in the Southern Ocean

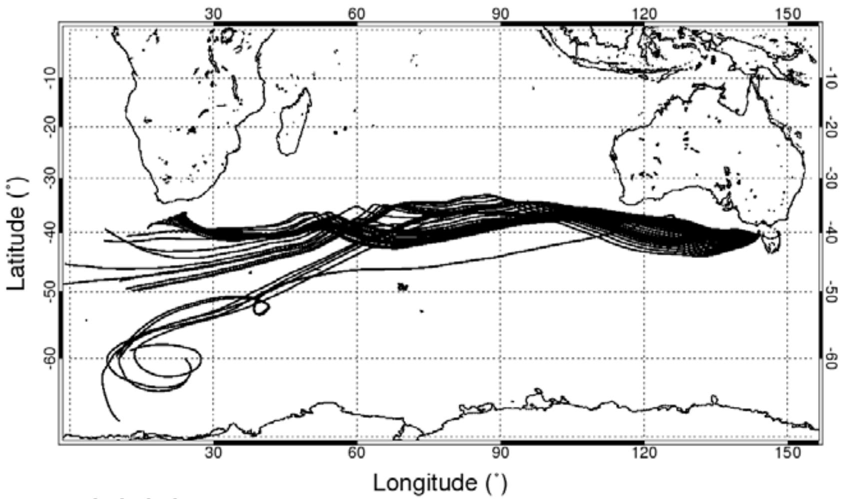
From Pak et al. 2003



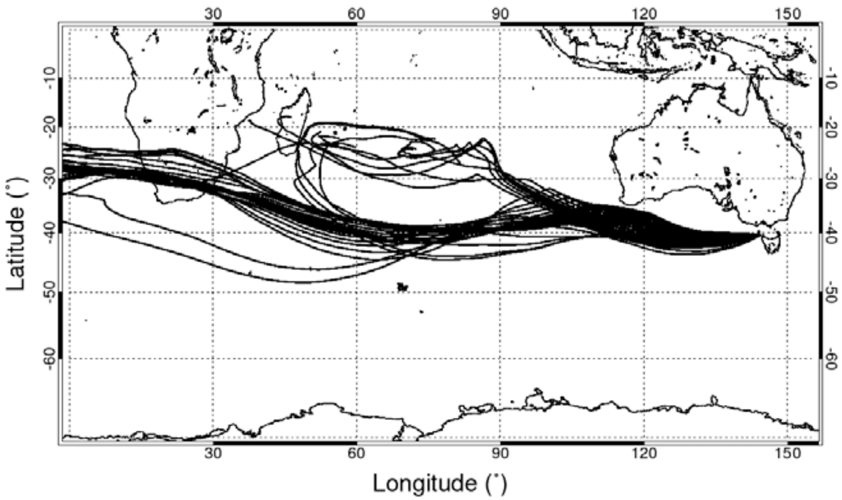
- Back trajectories for air masses arriving at about 2, 3, 4, 5, and 7 km above Melbourne on (a) 13 September 2000 and (b) 28 September 2000.
- Pak et al. 2003

QZ09 12 November 2002

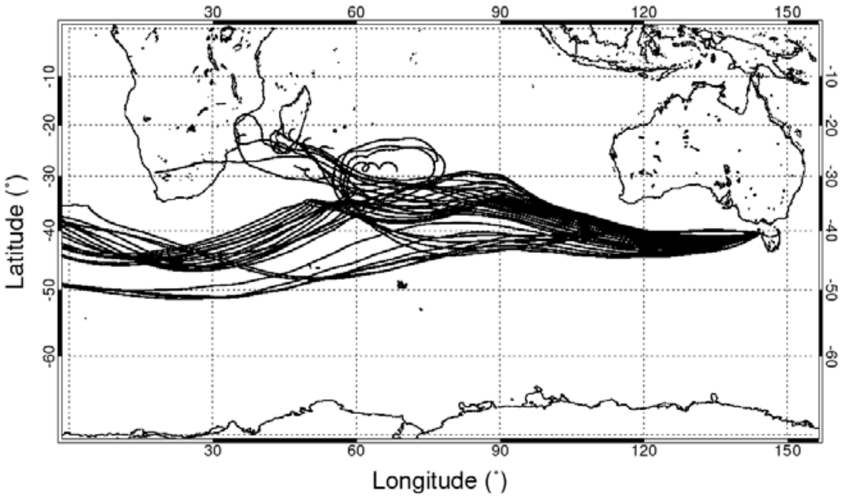
100 m

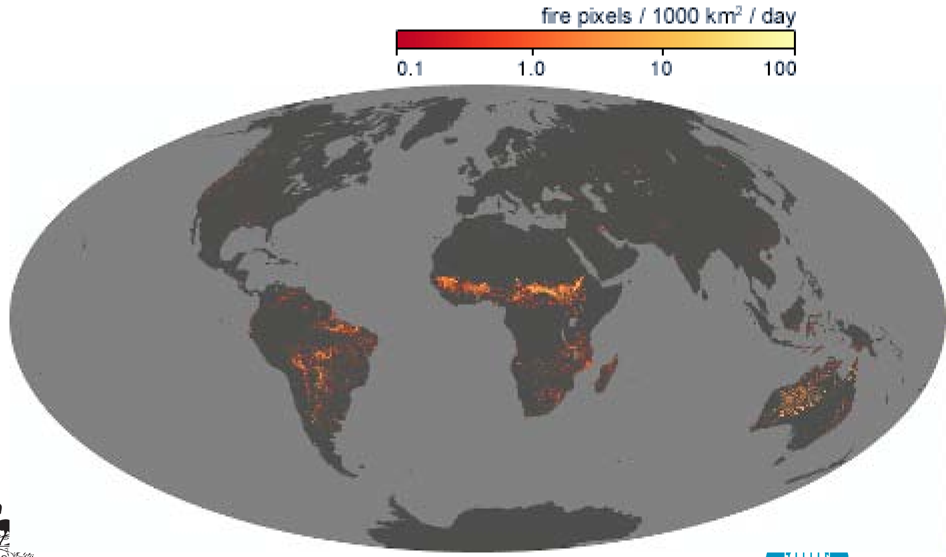


5000 m



3000 m





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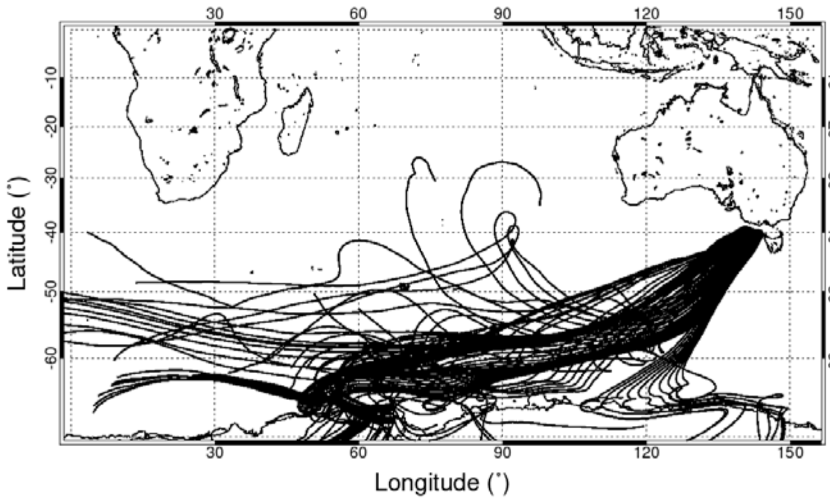
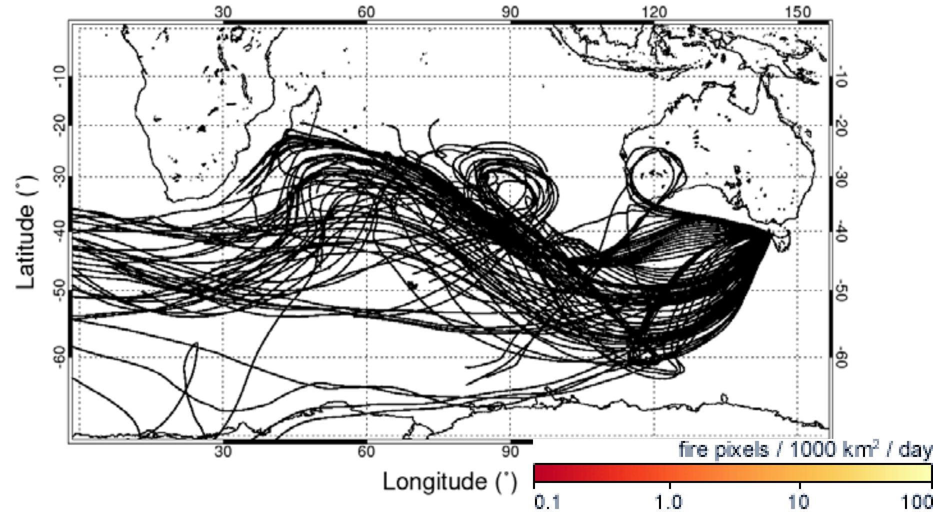
Q-14 10 December 2002

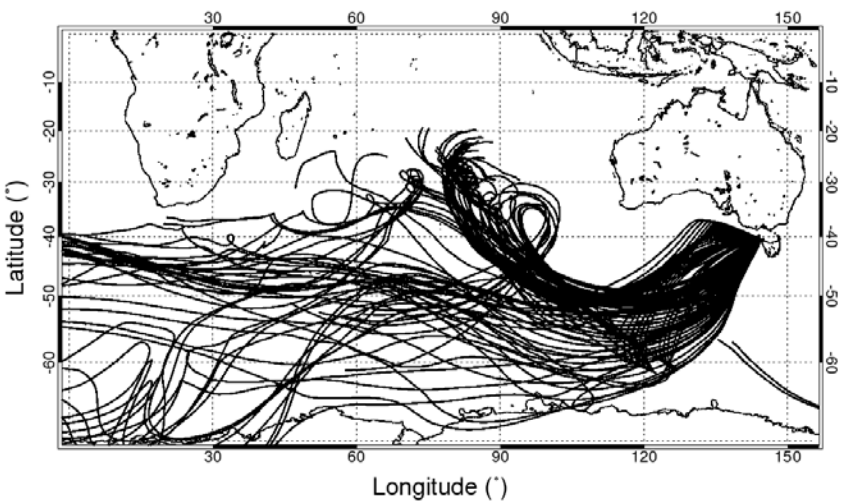
100 m

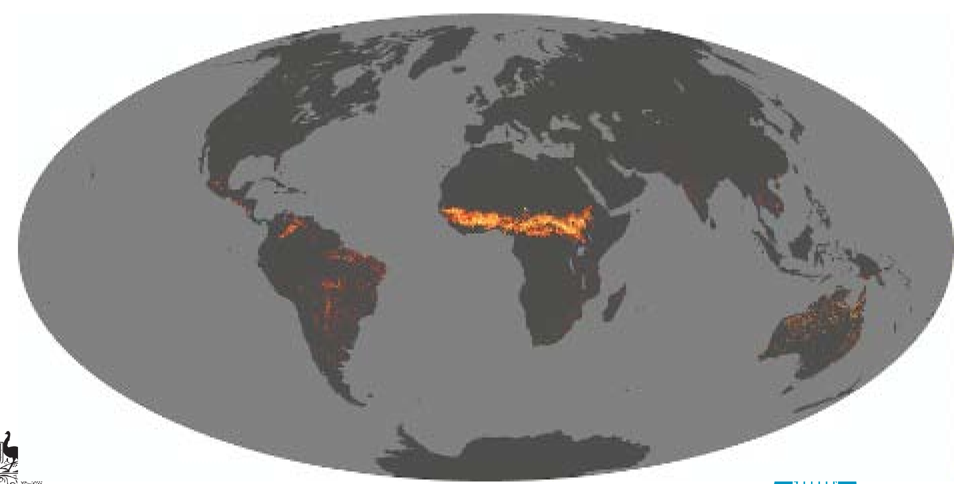


5000 m



3000 m



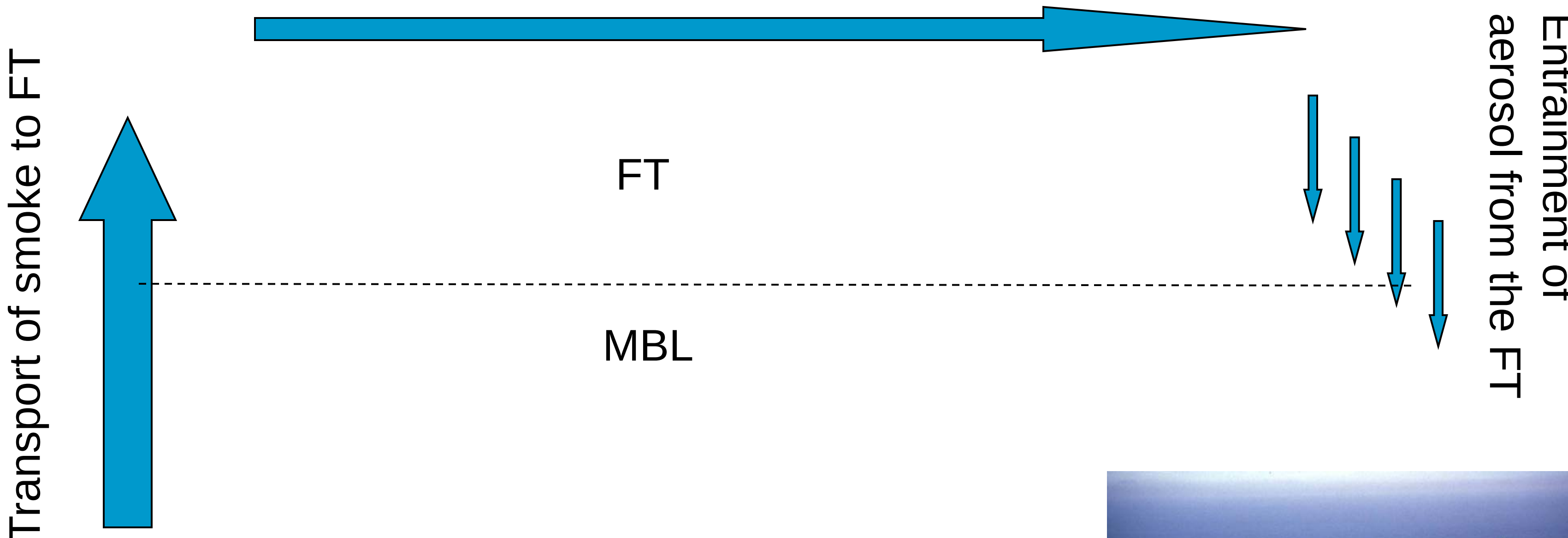


Long range transport is only part of the issue

Long range transport in FT

Transformation of aerosol

Organic aerosol in FT



Source of smoke

Cycloalkane indicator of smoke

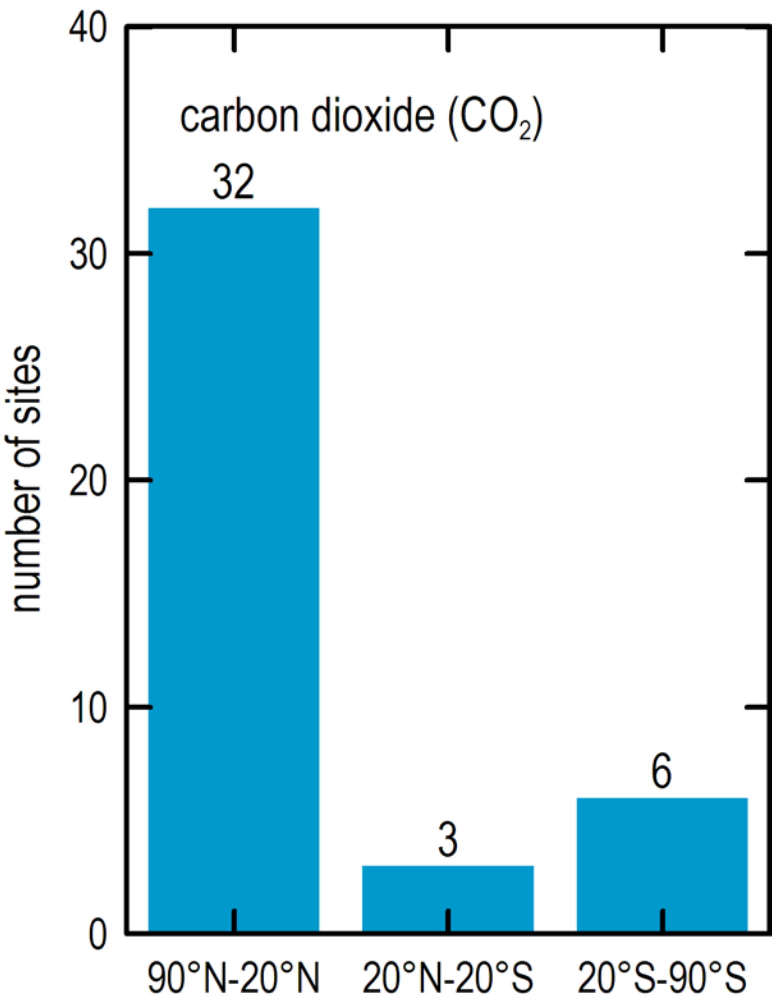
Source of CCN in the remote marine boundary layer

- Difficulties in applying information derived from bulk PM samples to the problem
- Sensitivity of analytical procedures
- Need to bring together global and process scale models
- New program of investigation
  - High flow cascade sampling under baseline conditions
  - Exploring new methods for organic speciation via collaboration with other groups (Jason Surratt UNC)
  - Collaboration with other groups to bring instrumentation needed to Cape Grim (Zoran Ristovski QUT-PhD project).

Gunn Point (NT) - existing radar station (BoM)
(25m ASL, Lat/Long: 12.25 S, 131.05 E)

Global *in situ* CO_2 observations

- 50 real-time observing sites reporting *in situ* CO_2 data for carbon cycle modelling studies
  - only three surface observation site in the tropics reporting to WMO GAW World Data Centre for Greenhouse Gases (WDCGHG: Samoa, Peru, Malaysia)
  - only one of sufficient quality to be used in NOAA's ongoing web-based CO_2 inverse study (Samoa) to derive global sources and sinks
  - enhanced understanding of the global C-cycle requires more real-time, high quality tropical data
  - same conclusions for CH_4 and N_2O observations



Gunn Point Observations

- *In-situ* CO_2 & CH_4 (CRDS)
- *In-situ* $^{13}CO_2/^{12}CO_2$ (CRDS)
- Flask CO_2, CH_4,$^{13}CO_2/^{12}CO_2$, N_2O, CO, H_2
- Radon "mini" (AlphaGUARD)
- **Aerosols (dry season campaign completed June 2010)**
- Meteorology : WS/WD (windsonics)

- O_3, CO, NOx, **MAAP, Nephelometer** (~Mar 2011)
- Radon (~June 2011)
- Short-lived halocarbons ($CHBr_3$, CH_2Br_2, $CHCl_3$, C_2Cl_4, CH_2CCl_3, CCl_4..): "µ-Dirac" GC-ECD (N. Harris, U. Cambridge, UK) (~July 2011)**
- AWS (?2011/12 CAPEX)
- N_2O/CO: QCL (Aerodyne) (?2011/12 CAPEX)
- CFCs, HCFCs, HFCs, PFCs, SF_6, CH_3Br- GC-MS-Medusa
- PM2.5/PM10
- **Arrives Asp. next week

Contributors

Desert Research Institute: Judith Chow & Stephen Ho

Gent University: Xuguang Chi & Willy Maenhaut

CMAR: Rob Gillett, Kate Boast, Jason Ward, Paul Selleck, John Gras & Bim Graham

Cape Grim BAPS: Jill Cainey, Laurie Porter, Stuart Baley & Chris Rickard

Thank you

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