GAW Programme at Mace Head

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Summary of Mace Head & activities

- WMO GAW Site since 1994, and is also an EMEP site
- Representative of the North Atlantic ocean region (54 degrees Latitude)
- Long term continuous measurements & intensive campaigns
- Gases: Greenhouse gases [GG], CFC’s, Halocarbons, O₃, CO, Hg
- Aerosols: Number, size, PM2.5 mass, chemical composition
- Radiative parameters: Scattering, absorption, optical depth [PMOD/WRC]
- Synoptic Weather Station – through the Irish Meteorological Service
- Data Archival: [GG]: WDCGG; CFC’s etc: WDCGG / CDIAC
- Aerosols archived: EMEP (at NILU) and at the WMO WDCA, Ispra
- Webcasting and visualisation of real time data
- http://macehead.nuigalway.ie
Location of Mace Head

Wind speed and direction at Mace Head from January 1990 to March 2002

Analysis shows that for 51% of the time, marine air reaches the site

[Marine Sector : 180 – 300 degrees]
Air Mass Classification

Marine Air Mass – classified by wind direction from 180 – 300 degrees

Clean Marine Air Mass – classified by wind direction from 180 – 300 degrees + aerosol (BC) absorption < 1.425 Mm⁻¹ (BC mass < 75ng m⁻³)

Polluted Air Mass – classified by wind direction from 45 – 135 degrees
A view of the Shore Laboratories from the Cottage Laboratory

Marine Aerosol Production

Measurement Campaign (PARFORCE)

View of the extended Cottage Laboratory facility 300 m from shore
<table>
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<th>Project</th>
<th>Description</th>
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<td>Air Ocean Chemistry Experiment</td>
<td>[1988-1994]</td>
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<td>BMCAPE</td>
<td>Background Maritime Contribution to Atmospheric Pollution in Europe</td>
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In addition, there have been short-term studies and intercomparisons:

- ASE Air-Sea Exchange experiment [1992]
- Field intercomparison measurements of Atmospheric Mercury [1995]
- MOE Mercury Species over Europe [1998 and 1999]
Daily means of atmospheric CO₂ from continuous measurements at Mace Head for the period from July 1992 through December 2002. Blue circles correspond to daily means calculated from marine air masses, green crosses to European air masses, and gray crosses to non-background data. [CNRS – CEA, Univ. of Bristol]
Advanced Global Atmospheric Gases Experiment [AGAGE] high frequency GC measurements of anthropogenic gas CCl₃F [CFC 11]
The Figure shows new aerosol particle formation at Mace Head with a rapid increase of total particle concentration up to 180,000 cm$^{-3}$ during a low tide nucleation event.

EU Project PARFORCE based at Mace Head (Special JGR issue, October 2002) has shown that new particle formation events are linked to marine biota exposed to sunlight during low tide.

It has been found (O’ Dowd et al, Nature, 417, 632-636, 2002; O’ Dowd et al, Nature, DOI 10.1038/nature03373, 2005) that new particles formed are predominately composed of iodine oxides.
Monthly variation in chlorophyll surface concentration

SeaWiFS Data: http://seawifs.gsfc.nasa.gov
Winter Months

Spring Months

Chlorophyll Surface Water Organic Matter Concentration (mg/m3) in the North Atlantic over a 5 year period
**Marine aerosol chemical composition.** North-Atlantic marine aerosol average size-segregated chemical composition and absolute mass concentrations sampled by a Berner-Impactor, for periods of (a) low biological activity (LBA) and (b) high biological activity (HBA). O’Dowd et al (Nature, 2004)
Seasonality of Cloud Condensation Nuclei (CCN), 1994 - 2003
Monthly geometric means of the marine sector aerosol attenuation coefficients with slope lines determined by autoregression analysis. Shows a significant increasing trend of 7.7% ; 1989 –1997.
Grey diamonds denote monthly geometric means calculated from less than 120 hourly values.
Open grey diamonds denote means calculated from less than 60 hourly values.
The markers on the abscissa denote the middle of each year (30th June)
Some achievements and outputs

• Continuous operation since 1987
• Host to and participant in several intensive campaigns
• Hosting a number of networks including AGAGE, NOAA/CMDL, CNRS-CEA
• GAW site in 1994 – enabling external audits of O$_3$, CO, CH$_4$ [EMPA], aerosol parameters [WCC – Leipzig]
• Have built up a capacity for measurement, and archival of a large suite of aerosol parameters and optical parameters
• Participated in WMO/GAW Workshops - CN & Nephelometer QA/QC
• An active research programme, enabled by presence of local University
Challenges Ahead

• Maintaining the continuance of the long term measurement programmes – with ever increasing challenges for funding
• Replacement of equipment as it becomes older, with acquisition of new equipment
• Recruitment of atmospheric scientists to continue with the work of the GAW programme
• To convince funding bodies of the scientific merit of continuous / monitoring activities
Plans / Needs for the Future

• Chemical composition of size fractionated aerosol

• Knowledge on the organic aerosol fraction needed

• In-situ ambient measurements are required

• Additional meteorological support (boundary layer height and profile) to help with data interpretation

• Vertical information of atmospheric data

• More reliable method(s) for black carbon mass determination – present methods are in question
AGAGE GC-MS measurements of halocarbon HFC – 134a

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