

Microphysical and physico-chemical properties of atmospheric aerosols.

A wide range of aerosol particle sizing and mass measurement equipment is used to study the microphysical and physico-chemical properties of the atmospheric aerosol at the Mace Head atmospheric research station. The work, begun in 1987, has also involved collaboration with the US National Science Foundation funded Air Ocean Chemistry Experiment (AEROCE) involving several US University and Governmental institutions.

AEROCE had its main eastern Atlantic primary site located at Mace Head over the period 1988 - 1994 to study biogeochemical cycles in the North Atlantic, which also formed part of the North Atlantic Regional Experiment (NARE). Aerosol particle generation techniques are employed in the Aerosol Physics Laboratory located in the School of Physics, National University of Ireland, Galway to produce both monodisperse and polydisperse particles (and droplets) in order to calibrate the field instrumentation. The field research work includes studies of aerosol volatility and microphysical characterisation of the atmospheric aerosol in many environments- see references below for further details. The focus is presently on the aerosol nucleation and accumulation modes.

Recent new research activities have related to identifying the composition of newly formed nano-particles in the size range 3-6 nm. These techniques comprised novel Pulse-Height-Analyser Condensation Particle Counters in conjunction with differential mobility analysis or nucleation mode particles along with high resolution Transmission Electron Microscopy and EDX analysis .

Aerosol radiative research

Earlier work has focused on analysis of the effect of the real and imaginary index of refraction and aerosol particle size distribution upon extinction, scattering and absorption in the atmosphere. Relatively recent work involved the propagation of electromagnetic radiation through aerosol and cloud media in the laboratory, using visible and middle IR (using a CO₂ laser) wavelengths.

The field research programme is focused on the measurement of black carbon absorption (and mass concentration), ongoing since 1989. The seasonal and air mass influence on black carbon levels are being investigated. Measurements of aerosol scattering coefficient have recently (since summer 1997) been investigated at Mace Head. Recent relevant publications arising from the work are given.

A new generation sunphotometer called a Precision Filter Radiometer (PFR) was installed at the site in March, 2000. The PFR is designed, tested and calibrated by the World Optical Depth Research and Calibration Centre (WORCC) at Physikalisches Meteorologisches Observatorium, Davos, Switzerland, funded by the Swiss Federal Government as a contribution to the World Meteorological Organisation, Global Atmosphere Watch (GAW) programme. Mace Head is one of three initial GAW global sites to be equipped with PFR instrumentation. Aerosol optical depth measurement is determined using the PFR, which is mounted on a Brusag solar tracker.

New (secondary) particle formation in the coastal environment

Rapid particle nucleation events are being studied under a wide variety of environmental conditions and locations, including Mace Head (coastal), Hyytiälä (forest) and open ocean on aircraft.

The EU funded European Union Environment and Climate Programme research proposal: New Particle Formation and Fate in the Coastal Environment: PARFORCE whose field activities are centred at Mace Head gives impetus to determining processes which control and promote new-particle nucleation in the marine boundary layer. Intense measurement campaigns took place in 1998 and 1999. Detail on PARFORCE can be found on the PARFORCE web site along with reprints of a Special Issue published in JGR-Atmospheres.

New particle formation in the forest environment

A sister project, BIOFOR, (Biogenic Aerosol Formation over the Boreal Forest) was conducted over the forest canopy in Southern Finland.

Natural production of new particles over Europe

As a combined development of both BIOFOR and PARFORCE, a 3-year EU project QUEST (Quantification of Aerosol Nucleation in the European Boundary Layer) is on-going, quantifying the source of natural nucleation mode aerosol particles into the atmospheric boundary layer.

Primary particle formation over the ocean

Enterprise Ireland funded a 2-year programme to determine the flux of primary marine (sea-salt and organic) aerosol particles over the ocean. The project, entitled "Measurement and Parameterisation of Primary Marine Aerosol Source Functions" started in January 2002 and utilises the eddy-correlation technique from a 22 m tower at Mace Head.

The driving reasons behind this research can be summarised as follows: The greatest uncertainty in climate change prediction is associated with the role of aerosols in the Earth's radiation budget. Aerosols reflect incoming solar radiation directly and determine cloud reflectance, thereby influencing the radiative budget. There are, however, no reliable source-function parameterisations for primary marine aerosols and consequently, this aerosol source is not adequately included in climate models. Measurements of primary marine aerosol fluxes, using an eddy-covariance technique, are proposed in this work. These measurements will result in the development of a series of parameterisations for the generation of primary marine aerosol fluxes under different meteorological conditions. The end users will be climate modellers determining the effect of natural and anthropogenic aerosols in global climate forcing.