

Description of the Mace Head Infrastructure

1. Short introduction describing the Institution in charge of the field station.

The Physics Department at the National University of Ireland, Galway, operates the Atmospheric Research Station at Mace Head, near Carna, Co. Galway, Ireland. The Department of Experimental Physics exists within the Faculty of Science of the University, which was formerly named University College Galway. This Faculty has the largest student enrolment of any Science Faculty in the country. Degrees in either Experimental Physics, Applied Physics and Electronics Degree, or Physics and Astronomy are offered. There has been a rapid recent growth in the number of research personnel in the department, which now has more than 30 postgraduate students and a similar number of postdoctoral and research staff.

For more information on the Department, please visit the web site:

<http://www.physics.nuigalway.ie>

2. Research interests of the Department

The Department of Experimental Physics recently completed a Strategic Plan as a framework for managing change and development over the period up to 2007. A key element in this strategy is the rationalisation of the research activity into three viable research clusters which includes the recent addition of Applied Optics:

- (a) Atmospheric, Environmental & Aerosol Physics
- (b) Applied Optics, Photonics & Biological/Biomedical Sensing
- (c) Astronomy & Astronomical Instrumentation

The Atmospheric, Environmental and Aerosol Physics cluster, consists of four permanent staff (Byrne, Jennings, Roddy, O'Dowd), one Adjunct Professor (Reist), and currently some ten research staff and 10 postgraduate students. These twenty or more people work in three research groups within the cluster, namely the Built Environment Group (Miriam Byrne), the Atmospheric Research Group (Gerard Jennings, Colin O'Dowd) based in the Department of Physics, and the Meteorology Group (Aodhagán Roddy), located in the Martin Ryan Marine Science Institute. The cluster members have developed a leadership role in Ireland and abroad in areas of climate change and air quality. The Mace Head Atmospheric Research Station, near Carna, Co. Galway is operated under the auspices of the Mace Head Management Committee, drawn from cluster personnel (<http://macehead.nuigalway.ie>). Members of the cluster are also involved in research activities under the auspices of the Environmental Change Institute (<http://nuigalway.ie/eci/>).

3. Precise description of the facilities at Mace Head

a1) Geographical information and some photographs

The name Mace comes from the Irish word Más meaning buttock. In place names, it indicates a broad and elevated area. To the east and south-east of the site, it is indeed broad and elevated (elevation ~30m above MSL). The area around Mace Head is

generally wet and boggy with a lot of exposed rock. The main rock type is granite (Biotite granodiorite, age ~400 millions years). The soil type is mainly peat. Soil depth is generally shallow, varying from a few centimeters to several meters (usually shallower on hill slopes and deeper on flatter ground where it overlies hollows). There are very few trees, other than some conifer plantations consisting mainly of sitka spruce and lodgepole pine. None of these plantations are close to the site. Vegetation consists mainly of grasses, sedges, ferns, rushes, gorse and heathers. The area is hilly (average height ~35m). There are a lot of small lakes, most of them in bogs and rainwater-fed. Agricultural activity in the area is limited to grazing of sheep and cattle. Some agricultural burning of gorse occurs during the spring. Boat traffic is minimal and does not seriously impact on any of the sampling programs here. All the local fish farms are located outside the clean sector and their activities also appear to have little or no impact on our operations.

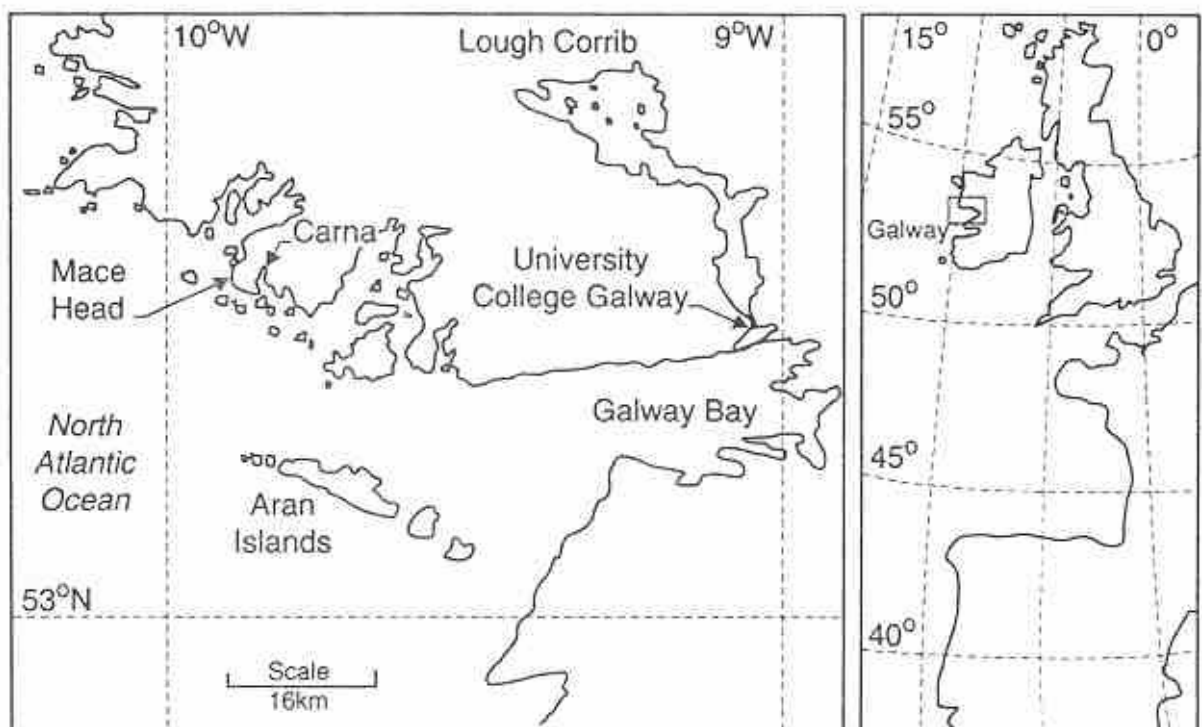


Figure 1 Location of the Mace Head Atmospheric Research Station



Figure 2 View of the extended Cottage Laboratory facility 300 m from shore



Figure 3 A view of the Shore Laboratories from the Cottage Laboratory

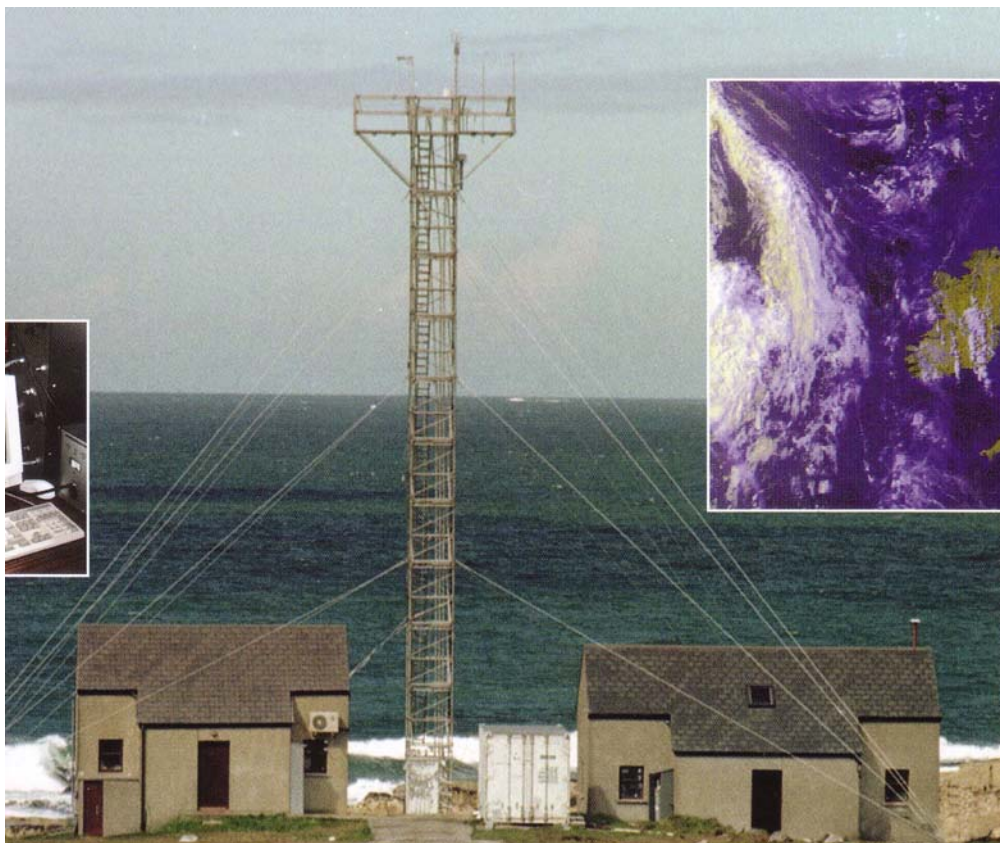


Figure 4 The 2 Shore Laboratories at the Mace Head Atmospheric Research Station



Figure 5 The original 22 m AEROCE tower and the 2 shore laboratories

a2) Meteorological information

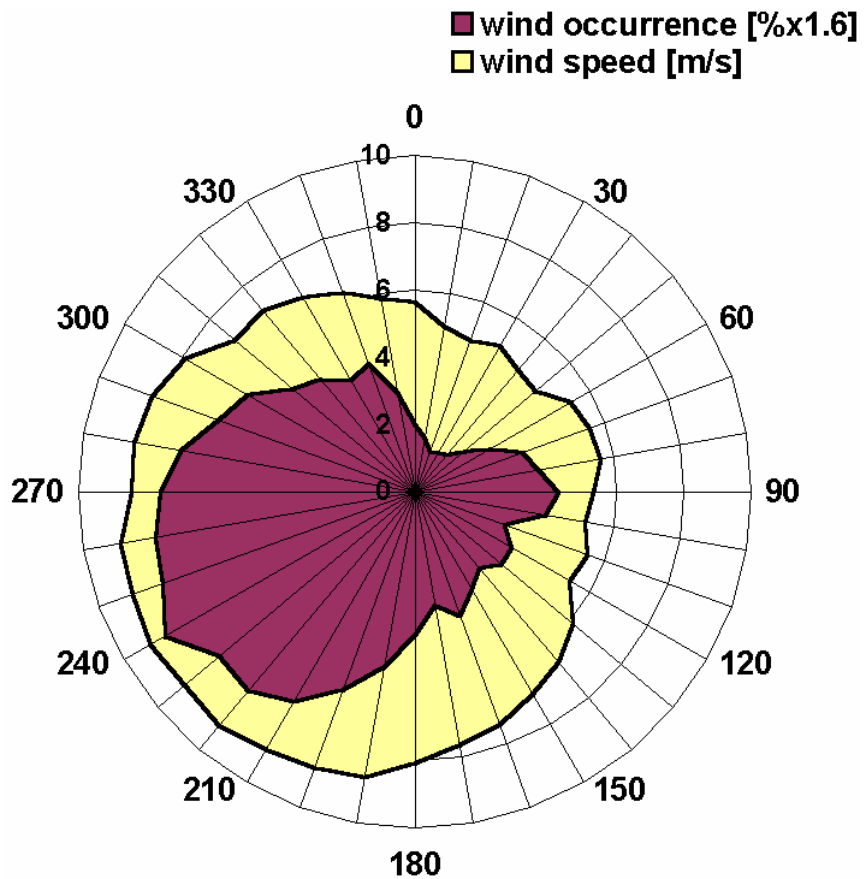


Figure 6 Wind speed and direction at Mace Head from January 1990 to March 2002

The meteorological records show that on average, over 50% of the air masses arrive at the station *via* the clean sector. These clean air masses are ideal for carrying out background aerosol and trace gas measurements. Significant pollution events also occur at the site when European continental air masses, generally originating from an easterly direction, reach Mace Head. The Mace Head atmospheric research station, is uniquely positioned for resolving these different air masses and for comparative studies of their constituents and characteristics.

The climate is mild and moist, being dominated by maritime air masses. From collected data we see (Figure 6) the distribution of mean hourly wind direction in 10 degrees intervals from January 1990 to March 2002 which shows that, for this period, the wind was within the clean sector for about 51% of the time. Annual rainfall is approximately 1200 mm. October to December are the wettest months, with April and May being the driest. Relative humidity is generally high, at about 80-85%. Average air temperature is about 10 degrees Celsius (~15 degrees Celsius in summer, ~5 degrees Celsius in winter). Sea temperature ranges from about 10 degrees Celsius in winter to about 15 degrees Celsius in summer. Sunshine is scarce, averaging 1290 hours per annum. May is the driest and sunniest month (179 hours), and December is the dullest (38 hours).

The Atmospheric Research Station at Mace Head, Carna, County Galway is unique in Europe, offering westerly exposure to the North Atlantic ocean (clean sector, 180 degrees through west to 300 degrees) and the opportunity to study atmospheric composition under Northern Hemispheric background conditions as well as European continental emissions when the winds favour transport from that region. The site location, at 53 degrees 20 minutes N, 9 degrees 54 minutes W, is in the path of the mid-latitude cyclones which frequently traverse the North Atlantic. It is 88 km west of Galway city (population approximately 70,000) which is the nearest major conurbation. The main Atlantic shipping routes are over 150 km away, while the transatlantic air corridors are over 80 km away. There are three small islands offshore which are within the clean sector, but these are uninhabited and do not appear to influence any of the measurements made at the site.

b) Available instrumentation and measurement activities

Table 1 A description of current aerosol, gaseous, radiation and meteorological measurements at Mace Head.

Parameter	Instrument/Method	Institute	Period	Frequency
Meteorological data				
Wind speed/direction, Atmospheric pressure		AEROCE/NUI, Galway CNRS, Gif-sur- Yvette, France	October 1989 –	1 min

Temperature, Relative humidity		AEROCE/NUI, Galway	July 1991 – August 1994	1 min
		University of Miami, US, www.rsmas.miami.edu NUI, Galway	August 2001 -	1 min
Micrometeorology		NUI, Galway	January 2002	30 min
UV A (315 – 400 nm)	UV A, photopic: custom made detectors	National Radiological Protection Board (NRPB), Chilton, UK www.nrpb.org	November 1993 -	5 min
Solar visible radiation (photopic, 400 – 770 nm)	Robertson –Berger type detector			
Erythemally weighted UV radiation (280 – 400 nm)				
Gaseous Measurements				
CFC13, CF2Cl2, CF2ClCFCl2, CHCl3, CH3CCl3, CCl4, and N2O	EC/FI/MR-GC, Electron capture detectors	Advanced Global Atmospheric Gases Experiment (AGAGE)	1987 - present	40 min
CH4	EC/FI/MR-GC, Flame Ionisation detector	AGAGE	1987 - present	40 min
CO and H2	EC/FI/MR-GC, Mercuric oxide reduction detector	AGAGE	1987 - present	40 min
CO2	Siemens IR carbon dioxide analyser	LSCE/CEA	1992-present	40 min
PAN	EC-GC, Electron capture detector	AGAGE	episodically	40 min
Ozone	UV Spectrometer	AGAGE	1987 - present	40 min
HFC's and other Halocarbons	GC-MS, gas chromatography mass spectrometer	AGAGE	1995 -present	40 min

Aerosol Chemistry				
Aerosol sampling	11-stage MOUDI rotating impactor MD 110	NUI, Galway	August 2001 –	Weekly (clean sector)
	Two 8-stage BERNER impactors		February 2002 –	Weekly (clean sector)
	High Volume PM-10 5-		August 2001 -	Weekly

	stage impactor			(clean sector)
PM-2.5 mass concentration	R&P Tapered Element Oscillating Microbalance (TEOM), Model 1400a	NUI, Galway	October 1998 -	0.5 h

On-line Aerosol Systems				
Aerosol volatility	Heated inlet tube apparatus used in conjunction with aerosol particle size distribution	NUI, Galway	Episodically	
Condensation Nuclei (CN)	TSI Model 3025 CPC (d > 3 nm), 3010m (d>5 nm), 3010 (d>10 nm)	NUI, Galway	1997 - present	1 s
			Episodically	20 s
	Pulse-Height-Analyser (PHA) CPC			
Aerosol particle size distribution	Scanning Mobility Particle Sizer (SMPS), (d = 10 – 400 nm)	NUI, Galway	October 2000 –	5 min
	Nano Scanning Mobility Particle Sizer (nSMPS), (d = 3 – 20 nm)		June 2003 -	5 min
	Particle Measuring Systems (PMS) ASASP-X, (d = 0.1 – 3.0 µm)		January 2002 -	1 s
	TSI Model 3320 Aerodynamic Particle Sizer (APS), (d = 0.5 – 20 µm)		January 2002 -	2 min
	Dekati Electrical Low Pressure Impactor (ELPI), (d = 0.03 – 10 µm)			
Aerosol Flux Package	Sonic + 3010 CPC	NUI, Galway	January 2002	30 min
Cloud Condensation Nuclei (CCN)	DH Associates, Model M1 CCN counter (Twomey static thermal diffusion chamber at 0.5 % supersaturation)	NUI, Galway	March 1994 -	7 min
Aerosol Optical Properties				

Total light scattering and Backscattering coefficient at $\lambda = 450, 550, \text{ and } 700 \text{ nm}$	TSI Nephelometer Model 3563	NUI, Galway	January – July 1997 July 2001 -	5 min 5 min
Aerosol Optical Depth at $\lambda = 368, 412, 500, \text{ and } 862 \text{ nm}$	Precision Filter Radiometer (PFR), mounted on a solar tracker	World Radiation Centre, Davos, Switzerland www.pmodwrc.ch NUI, Galway	March 2000 -	2 min
UV A (315 – 400 nm) Solar visible radiation (photopic, 400 – 770 nm) Erythemally weighted UV radiation (280 – 400 nm)	UV A, photopic: custom made detectors Robertson –Berger type detector	National Radiological Protection Board (NRPB), Chilton, UK www.nrpb.org	November 1993 -	5 min

Data/Network Facilities				
100mb Ethernet		NUI, Galway	December 2003	variable
Satellite broadband access		NUI, Galway	December 2003	variable
Web casting of meteorological and aerosol data		NUI, Galway	December 2003	variable

c) Policy in relation to data availability and accessibility to data

Meteorological data is freely available for research purposes. Contact person - see **j)** below for details – should be contacted for access to the data.

Micrometeorological, gas, aerosol and aerosol optical property research data is normally within the preserve of the Research Investigators operating this equipment at the station.

If data is required by an external investigator to directly support a research task, collaboration, and if appropriate, authorship on scientific publications, should be offered to the research team responsible for measurements, quality assurance and interpretation of the research data in question in order to ensure that proper credit is given to the researchers and that maximum added value can be extracted from the suite of measurements.

There is an increasing amount of Mace Head hourly data being placed on the CREATE (EU Project) Database housed at NILU (<http://www.nilu.no/projects/ccc/create>) . This data is also converted to a suitable format for archiving at the World Data Centre for Aerosols (<http://ies.irs.cec.eu.int/wdca>) at Ispra - (information on data submission and retrieval is found in the WDCA web site; contact: Julian Wilson)

d) Web site address of the field station: <http://macehead.nuigalway.ie>)

e) Access to the Facility:

Contact details for the
Mace Head Atmospheric
Research Station

Atmospheric Research Group

Lodging:

Write to:

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f) Field campaigns at the site international Networks..

There is normally one large scale intensive field campaign on average each year at Mace Head. Recent and earlier internationally based campaigns include: QUEST, BIOFLUX, NAMBLEX, PARFORCE, ACSOE, TOR, BMCAPE and AEROCE.

g) International Networks..

Mace Head is a Global Atmosphere Watch (GAW) station of the World Meteorological Organisation since 1994. It is host to a number of internationally based Research Networks including AGAGE (Advanced Global Atmospheric Gases Experiment); GAW Precision Filter Radiometer network for measurement of aerosol optical depth; NRPB network for continuous measurement of UV and solar radiation; measurement of total gaseous mercury in cooperation with the Irish Environmental Protection Agency (EPA) and GKSS, Geesthacht, Germany; national ozone network in cooperation with the EPA; flask sampling network in collaboration with NOAA; CO₂ collaborative programme with CNRS, Gif sur Yvette, Paris and the University of Bristol.

h) Specific issues on which collaboration is sought

Collaboration is particularly sought on issues relating to aerosol formation processes, aerosol microphysics and physicochemical properties; the radiative properties of aerosols; and on effects of aerosols on both the direct effect and indirect effect of aerosols on climate.

i) Fees for use of facility

Unfortunately, Mace Head received no ongoing infrastructural support and relies totally on subsidy from general research grants to support specifically targeted research projects. Therefore, to maintain facilities at Mace Head and to cover running costs such as electricity and network access, a modest fee is charged to visiting scientists. This fee amounts to 50-100 euro per day depending on instrument power requirements etc. Changes to infrastructure to accommodate specific sampling and associated technician costs will have to be costed in any Access-to-Infrastructure proposal along with the aforementioned access/running costs.

j) Contact persons:

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