Mace Head Atmospheric Research Station — characterization of aerosol radiative parameters

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A fairly concise description and a short history of the Mace Head atmospheric research station, at 53°N, 10°W, on the west coast of Ireland is reported. The relatively high latitude site is representative of background marine air in the Northern Atlantic on the western periphery of Europe. The site is ideally located to measure the prevailing (about 52% of the time) westerly-southwesterly air from the Atlantic, as well as polluted air under anticyclonic conditions from sources east of the site within Ireland, from the UK and from mainland Europe. Three years of aerosol radiative data, over a period from January 2000 to December 2002, are indicative of the medium to longterm measurement programme at the site. These include aerosol scattering coefficient, aerosol absorption coefficient, aerosol optical depth and single scattering albedo, supported by meteorological and air mass trajectory input. Variability in aerosol parameters are shown to be dependent on air mass origin, season and meteorological conditions. Measurements indicate that the dominant contribution to aerosol optical depth is due to scattering, with single scattering albedo in the range 0.941 to 0.997. Measured aerosol optical depth for marine air over the 3 year period varies between 0.03 and 0.38 with a mean value of 0.11 and standard deviation of ±0.06. These values are in fair agreement with other data for the North Atlantic region.

Introduction

There is an identifiable need for medium to longer-term measurements, up to decadal time scales, of aerosol particulates and greenhouse gases in the atmosphere. Indeed the Inter-Governmental Panel for Climate Change (IPCC 2001) recommends long-term observational sites for aerosol measurements in order to assess the effects of natural and anthropogenic aerosol
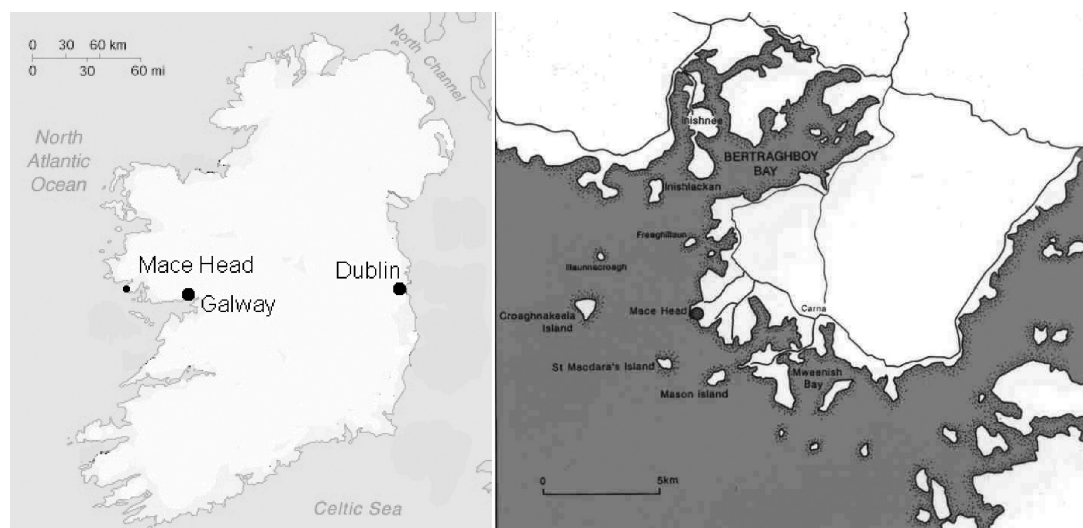
Fig. 1. Detailed and regional location of Mace Head off the coast of Ireland.

on climate change. The World Meteorological Organisation (WMO) Global Atmosphere Watch (GAW) objective is to ensure long-term measurements in order to detect trends and reasons for such trends. The Mace Head background station is, since 1994, one of GAW's global stations, for both aerosol and gaseous species and is mainly representative of marine air. The Mace Head Atmospheric Research Station is located on the west coast of Ireland, near a small village called Carna, County Galway. It is some 88 km from the city of Galway which has a population of about 65 000 inhabitants and where the National University of Ireland, Galway (NUI, Galway) is located with a current student population of around 12 500. Its situation in respect to Ireland and the more immediate locality is shown in Fig. 1.

First atmospheric measurements were carried out in 1958, (O'Connor *et al.* 1960) at a disused coastal look-out post near the current site. In 1973, a derelict cottage on a three-hectare field, stretching about 400 m from the narrow access road to the rocky shore of the Atlantic Ocean was purchased by the University. The cottage was refurbished in 1985 and extended in 1986. Laboratory buildings were built near the shore in 1989–1990, and a 23-m tower was constructed. A photograph of the Shore Laboratory buildings and tower is shown in Fig. 2.

The importance of the Mace Head site as one of the few research facilities in these latitudes (53°N, 10°W) with open exposure to the North Atlantic Ocean was soon recognised by atmospheric scientists and the laboratory buildings have since housed several international atmospheric research campaigns. In 1986, Mace Head was chosen as the primary site on the eastern Atlantic for a major international project (1988–1994): Atmosphere Ocean Chemistry Experiment (AEROCE) to study biogeochemical cycles in the North Atlantic, (Savoie *et al.* 2002). This Project was coordinated by Joe Prospero, University of Miami and Bob Duce, University of Rhode Island, and involved some 20 U.S. Universities and Research Institutes. In 1987, the cottage laboratory became one of only five global sites for the Global Atmospheric Gases Experiment (GAGE), superseded in 1995 by the ongoing Advanced Global Atmospheric Gases Experiment (AGAGE), to study chlorofluorocarbons (CFC's), which was a continuation of work originally carried out by Dr. James Lovelock at Adrigole in the south-west of Ireland. Their substitutes, HFC's and HCFC's, are also being measured at the site by an automated gas chromatograph-mass spectrometer. A good review of the trace gas work at Mace Head is given by Prinn *et al.* (2000).

In 1994 and 1995, the European Background Maritime Contribution to Atmospheric Pollu-

Fig. 2. Photograph of the Mace Head background station.

tion in Europe (BMCAPE) Project assessed the contribution to atmospheric pollution in Europe from microphysical and chemical atmospheric marine measurements taken at six European coastal sites including Mace Head (Jennings *et al.* 1997). A bilateral German–Irish research programme has been operational since 1989 on work relating to the measurement of atmospheric aerosol, trace metals and mercury species (Below *et al.* 1991, McGovern *et al.* 1992, 1994). Mace Head hosted, for example, the first International Intercalibration Workshop of Methods for Mercury Species Measurement in the Atmosphere in September 1995 (Ebinghaus *et al.* 1999).

Research field activities have included the UK Community Research Programme of the Natural Environment Research Council: Atmospheric Chemistry studies in the Oceanic Environment (ACSOE), which centred its ground based measurements at the Mace Head station over the periods June–August 1996 and April–May 1997 (Broadgate 1997). The National Oceanic and Atmospheric Administration (NOAA) have ongoing long term (since 1991) air sampling network measurements at Mace Head (Conway *et al.* 1994). As part of NUI, Galway's continuing aerosol research work, Mace Head has hosted two major intensive measurement campaigns associated with the New Particle Formation and Fate in the Coastal Environment (PARFORCE) Project in June 1998 and in September 1999 (O'Dowd *et al.* 2002).

The following aerosol radiative parameters: aerosol scattering coefficient, aerosol absorption coefficient, single scattering albedo and aerosol optical depth (AOD) are measured at the background marine site. Aerosol scattering measurements by means of nephelometry started at Mace Head in January 1997. Two different measurement instruments, a three-wavelength integrating nephelometer (TSI Model 3563) and a single-wavelength integrating nephelometer (TSI Model 3551), have been employed since then. The earlier measurements from January to July 1997 have been conducted with the three-wavelength instrument and have been resumed since July 2001. Measurements with the single-wavelength instrument have been made on a continuous basis since January 1998. Measurements of light absorption coefficient have been performed by means of aethalometry since February 1989.

Measurements of column-integrated light-extinction have been conducted at the Mace Head site in order to derive aerosol optical depth (AOD) data since March 2000. The AOD is a measure of the attenuation of solar radiation through light scattering and light absorption within the atmospheric column. The measurements are performed with a Precision Filter Radiometer (PFR), developed at the Physikalisch-Meteorologisches Observatorium Davos/World Radiation Centre, (PMOD/WRC), Switzerland, and carried out under the WMO GAW programme. Direct retrieval of aerosol optical
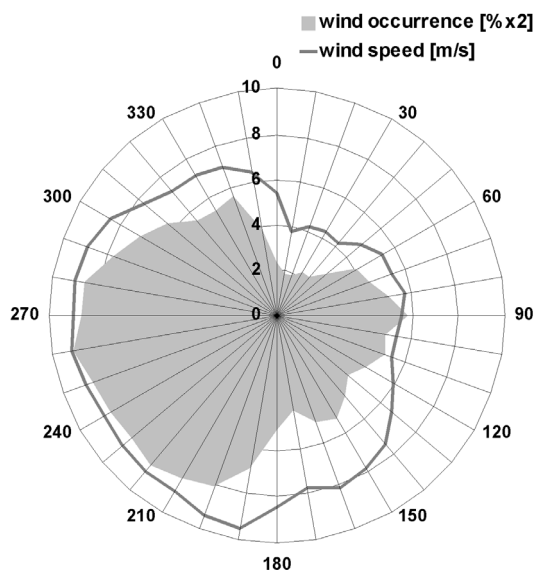
Fig. 3. Wind speed and direction at Mace Head from January 1990 to March 2002.

Fig. 4. ECMWF 96 hours back trajectories arriving at Mace Head for winter months (December, January and February) for the period 1995–2002.

depth by means of radiometry requires cloud-free measurement conditions. Therefore AOD measurements are associated with only certain synoptic weather types imposing a bias on long-term observations. For overcoming the problem of conditional sampling and providing a robust statistical basis, the AOD of the boundary layer (BL) at Mace Head has been calculated from continuously measured ground-based scattering and absorption coefficients, extrapolated over a vertical air column.

The main objective of the work is to provide an analysis of aerosol radiative parameters over a three-year period ranging from January 2000 to December 2002. A secondary objective is to give a brief historical description of Mace Head, presented in the introduction, and a meteorological characterization of the site.

Meteorological characterization of the site

Meteorological parameters

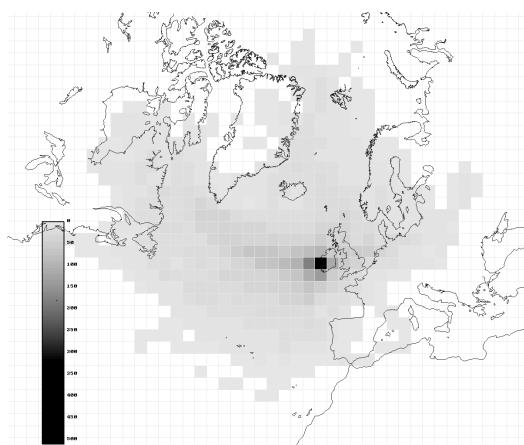Meteorological parameters of wind speed and direction have been measured at the site since 1989 (Fig. 3). The prevailing wind direction is from the designated clean marine sector of 180°–300°, with 52% occurrences of air arriving at the site from that wind sector. The polluted air sector is defined by wind direction alone: 45° < Wind Direction < 135°.

Air mass trajectories arriving at Mace Head, 1995–2002

Back trajectory analyses for air masses arriving at Mace Head at noon of each day for the period 1995–2002 have been calculated using the Met Eireann Global Trajectory Model (GTM). The trajectories are for 96 hours prior to arrival at the Mace Head coordinates. The GTM estimates the three dimensional motion of air parcels based on the ECMWF wind field analyses (McGrath 1989, Draxler 1987). They show the North Atlantic region on an equidistant projection centred on Mace Head (Bugayevsky and Snyder 1995). These observations are consistent with recurrent features of the Irish climate, as identified by Rohan (1986).

During the winter months (December, January, February), there is movement of air from Canada and North America to the west, as well as from Europe including Russia in the east (Fig. 4). In general, the Atlantic low-pressure systems are well established by December and depressions rapidly move eastwards in Decem-

ber and January. The back trajectories confirm that over the period of 96 hours an air mass can readily make the transit from Canada, moving along westerly and northwesterly tracks. However, by late January, cold anticyclones over Europe can extend their influence to Ireland, which can set themselves up as blocking highs, and cause the transport of cold air from Eastern Europe during spells of otherwise fine weather. Spring and autumn show a similar pattern, but with less frequent long range transport. This may reflect the occurrence of unseasonable storms in certain years.

There is a distinct difference between the summer (June, July, August) distribution (Fig. 5) and the winter one (and the other seasons — not shown here). Clearly, the horizontal movement of air masses is less vigorous during the summer months. The region which has recent influence on air masses arriving at Mace Head is much reduced. Quite simply, the air masses move more slowly in summer and the weather systems are less active. There is evidence of less movement of air to Mace Head from western European countries during the summer months. This is due to the onset of the Irish summer rainy season, whereby a quasi permanent summer low over mainland Europe, combined with an expansion of the Azores high in the Atlantic, brings moist air in over Ireland from the Atlantic. Fine weather in the summer months is associated with the occasional growth of the Azores High pressure system to encompass Ireland, bringing clear weather, and transport of air over Ireland and Britain, but not over Europe.

The lack of air mass movement over Greenland is also apparent (Figs. 4 and 5). The Greenland Ice Sheet offers an effective barrier to air masses moving eastward over it. Air to the far north of Canada is generally channelled through the Labrador Strait and approaches Ireland along a nearly westerly trajectory.

Measurement methods

Aerosol scattering coefficient

The TSI Model 3563 nephelometer measures the total aerosol scattering coefficient as well as the
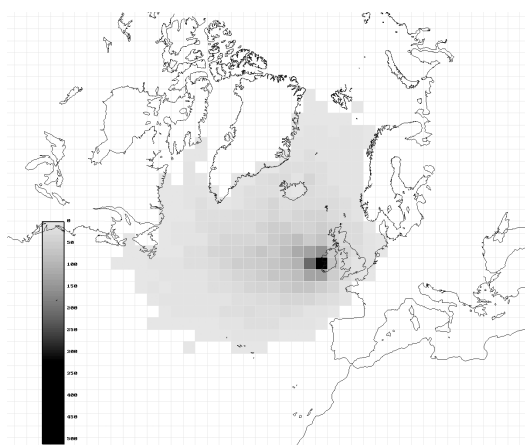

Fig. 5. ECMWF 96 hours back trajectories arriving at Mace Head for summer months (June, July and August) for the period 1995–2002.

hemispheric backscattering coefficient at three wavelengths $\lambda = 450, 550, 700$ nm while the TSI Model 3551 instrument measures the total aerosol scattering coefficient at $\lambda = 550$ nm only. Due to practical design limitations, the nephelometer geometry restricts the sensing of the total aerosol scattering and of the hemispheric backscattering to angles between 7° and 170° and between 90° and 170°, respectively. The instruments are connected via a 15-mm diameter duct to the common air-sampling laminar flow system of the aerosol laboratory building.

On a regular basis, the nephelometers are calibrated with particle-free air as the low span gas, and carbon dioxide as the high span gas. An automatic zero calibration with particle-free air is performed every 60 minutes for setting the instrument to zero. An intercomparison of total scattering coefficient values ($\lambda = 550$ nm) of the three-wavelength and the single-wavelength instrument reveals that both instruments agree to within less than 5%. In order to determine the detection limits of the scattering and backscattering measurements, the instrument noise has been assessed as the standard deviation of the zero baseline measurements. The mean detection limits of the TSI Model 3551 and TSI Model 3563 nephelometers amount to 0.3 Mm^{-1} and 0.7 Mm^{-1} for the scattering coefficient and to 0.5 Mm^{-1} for the backscattering coefficients, respectively, as defined by a signal-to-noise ratio

of two. A detailed discussion of the performance characteristics of this commercial instrument has been given by Anderson *et al.* (1996).

The scattering and backscattering coefficients are recorded as five-minute values. However, the three-wavelength instrument alternates between the total scatter and backscatter measurement modes, thus cutting the effective sampling time by half. The five-minute data are integrated to hourly arithmetic values of scattering and backscattering coefficients. The scattering values are reported for relative humidities < 50% because of the internal heating of the nephelometers.

Due to aerosol losses in the air sampling system, the nephelometer measures only part of the total aerosol particle size spectrum. The 50% cut-off diameter of the nephelometer system has been estimated at about 4 μm at wind speeds of 10 m s^{-1} (Kleefeld *et al.* 2002). Hence the nephelometer measurements represent mainly the light scattering of the submicrometre size fraction of the spectrum rather than that of the total size spectrum.

Aerosol absorption coefficient

The attenuation of light through aerosol laden quartz fibre filters has been measured using Magee Scientific Aethalometer Models AE-8 (February 1989–December 1993) and AE-9 (since January 1994) with manual filter change. These measurements have been made on a continuous basis with occasional unavoidable breaks. Up to 1994, the measurements were made at intervals between 5 and 60 minutes. Thereafter, measurements have been taken at five-minute intervals.

The instrument operates by measuring the attenuation of white light through a quartz fibre filter, whilst air is being drawn through the filter (Hansen *et al.* 1982, 1984). The measured attenuation is the combined effect of the light absorption, scattering and back scattering by the filter medium and by the aerosol trapped in the filter matrix. However, comparison with experimental data (Bodhaine 1995) has shown, that the measured attenuation $\ln(I_2/I_1)$ can be converted to aerosol absorption per meter of air column σ_{ap}

using the equation

$$\sigma_{ap} = -\frac{1}{1.9}\frac{A\ln(I_2/I_1)}{V},\qquad(1)$$

where A is the sample area of the filter, I_1 and I_2 are the intensities of the light detector reference and signal outputs and V is the sampled air volume. The factor 1.9 relates the attenuation measured through the filter to aerosol particle absorption in air (Bodhaine 1995). Aerosol absorption is due to the presence of black carbon aerosol.

Aerosol optical depth (AOD)

A Precision Filter Radiometer (PFR) is mounted on an automated solar tracker and records continuously the columnar light extinction every two minutes. The instrument measures at four wavelengths centered at 862, 500, 412, and 368 nm with a 5-nm FWHM (full width at half maximum) bandwidth. The radiometer is annually calibrated by field comparisons with a travelling standard. In addition, under favourable atmospheric conditions, the Langley extrapolation technique is applied to verify the calibration constants. The comparison of the Mace Head radiometer with the reference instrument shows deviations of < 0.5%, indicating that the PFR exhibits high stability in time. The precision of the PFR is estimated to be 0.01 optical depth. Algorithms for data quality control and data evaluation have been standardized and provided by PMOD/WRC. The cloud screening methodology for identifying cloud-contaminated two-minute measurement points is based on the 'objective algorithm' by Harrison and Michalsky (1994) and on the AERONET triplet method (Smirnov *et al.* 2000).

Results and discussion

The aerosol optical depth of the boundary layer (BL), τ_{BL}, is obtained from integration of the light extinction at ground level:

$$\tau_{BL}(\lambda) = \int_0^h \sigma_{sp}(\lambda) + \sigma_{ap}(\lambda)dz,\qquad(2)$$

where $\sigma_{sp}(\lambda)$ and $\sigma_{ap}(\lambda)$ denote the aerosol scattering and absorption coefficient, respectively, at wavelength λ; z is the height and h gives the upper height of the BL. In a well-mixed boundary layer the scattering and absorption coefficients are assumed to be constant with height. In the following computations of τ_{BL}, the BL height has been set to 1000 m. In order to calculate the BL AOD for a wavelength comparable to the radiometer wavelengths, the nephelometer wavelength of $\lambda = 550$ nm has been chosen. Since the aethalometer gives white light absorption from aerosol collected on a filter, the measured absorption coefficient has been divided by a correction factor of 1.9 (Bodhaine 1995) for determination of σ_{ap} (550 nm) in air. Due to the aforementioned restrictions on the nephelometer measurements and assuming that black carbon aerosol (BC) is found only in the submicrometre size range, τ_{BL} represents mainly the calculated dry submicrometre BL aerosol optical depth at a wavelength of 550 nm.

The BL AOD values are presented as monthly arithmetic means calculated from hourly averages of scattering and absorption coefficients. The data coverages for the years 2000, 2001 and 2002 were 32%, 57% and 67%, respectively. The necessity of scattering and absorption data being available simultaneously reduces the annual data coverage. The three-year (1 January 2000–31 December 2002) data series of calculated BL AOD values are subdivided into a "climatic" data set comprising all data points and into a "marine background" data set. A criterion for classifying marine background air masses is established as described below. The data series are analysed for seasonality and factors controlling the temporal variation of the data are investigated. The contribution of the BL AOD to the total column AOD is quantified.

Criteria for marine background air masses

Three different criteria for characterizing marine background air masses have been tested. Due to the geographical location of Mace Head a wind direction (WD) sector between 180° and 300° opens to the Atlantic Ocean thus allowing the
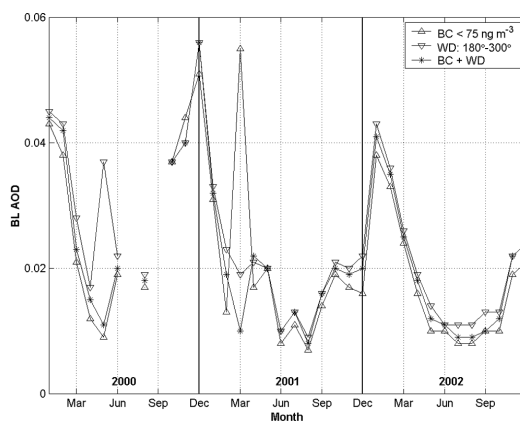

Fig. 6. Calculated monthly averages of boundary layer aerosol optical depth (BL AOD) for the following criteria characterizing marine background air masses: Black carbon mass concentration (BC) < 75 ng m^{-3}; Wind direction (WD): 180°–300°; BC + WD.

advection of marine air from this sector. During the BMCAPE project, measurements at the site revealed that black carbon (BC) mass concentrations show a high sensitivity to air mass. BC mass concentrations < 75 ng m^{-3} are associated with marine air masses (Jennings *et al*. 1997). The BC mass concentration is based on an instrumental attenuation cross-section value of 19 m^2 g^{-1}. Three subsets of calculated marine BL (MBL) AOD data were formed using the above two criteria and their combination (Fig. 6). The intercomparisons show good agreement both in magnitude and time, except for May 2000 and March 2001.

The discrepancy in May 2000 is caused by exceptionally high absorption and scattering coefficients measured in air masses arriving from the marine sector during the first half of the month. During this period the British Isles were dominated by an anticyclonic north-easterly airflow. A trajectory analysis indicates that air masses originating from the North Atlantic passed over the UK and approached Mace Head from a north-westerly direction. The air masses were possibly polluted during their passage over the UK, thus explaining the high absorption and scattering coefficients within the western wind sector of Mace Head.

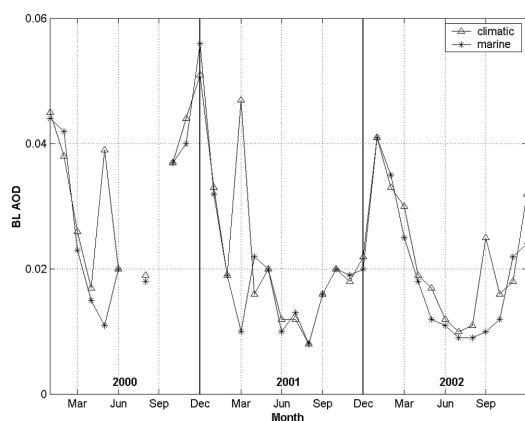The March 2001 discrepancy is associated with an unusual pattern of low BC mass con-

Fig. 7. Time series of calculated monthly averages of boundary layer aerosol optical depth (BL AOD) for all air masses (climatic) and marine background air masses.

Fig. 8. Scatter plot of monthly averages of climatic and marine boundary layer aerosol optical depth (BL AOD) values. A regression line is shown ($r^2 = 0.57$).

centrations < 75 ng m^{-3}, characteristic for marine air masses, occurring in an easterly air flow. At the same time these air masses show a strong scattering signal. The pattern persists for about 5 days. Due to the rather low data coverage of March 2001 of 33%, the monthly BL AOD mean value is dominated by this event. Trajectories of the five-day period (22–26 March) show the advection of air masses from north-eastern Europe. The air mass history in conjunction with the observed high scattering values indicates polluted air masses, for which a strong BC signal would normally have been expected.

Given the observed discrepancies by using the BC criterion alone or the wind direction criterion alone, a combination of both criteria has been used (in the following analysis for characterizing marine background air masses).

Comparison of the climatic and the marine background aerosol optical depth data set

Time series of monthly averages of the BL aerosol optical depth calculated from all data ("climatic") and from marine (using combined WD sector and BC as the marine air criterion) background air mass data only are presented in Fig. 7. Both time series track each other very well except for the months of May 2000, March
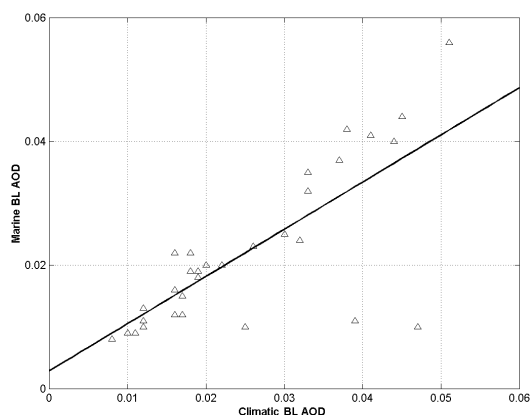
2001 and September 2002. The former two cases have been discussed above. September 2002 was dominated by a long anticyclonic period causing an easterly wind flow. The easterly air flow is associated with enhanced pollution levels resulting in strong light absorption and scattering signals and increased BL AOD values. The westerly marine sector has not been influenced by these air masses and therefore the marine BL AOD is not elevated.

Monthly averages of climatic and marine BL AOD are shown in a scatter plot in Fig. 8. A linear regression between both data sets results in a coefficient of determination of $r^2 = 0.57$. Removing the three outliers (May 2000, March 2001 and September 2002) from the data sets gives a higher coefficient of determination of $r^2 = 0.94$. In addition, the regression line indicates that, with removed outliers, the marine BL AOD is on average about 2% higher than the climatic BL AOD. This good agreement corroborates the finding that the Mace Head site is dominated by marine background air masses most of the time.

Analysis of the BL AOD time series

The time series of monthly averages of the BL AOD data for marine background air masses together with time series of wind speed and single-scattering albedo are presented in Fig. 9.
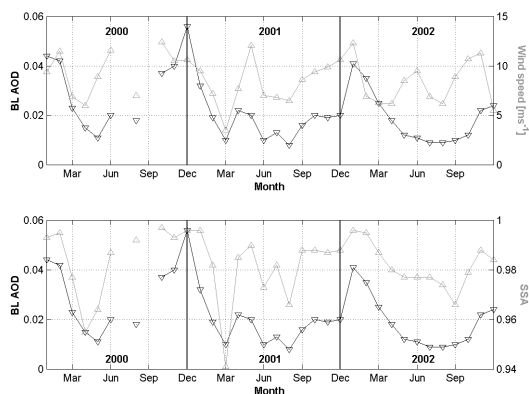
Fig. 9. Time series of monthly averages of boundary layer aerosol optical depth (BL AOD) for marine background air masses together with wind speed and single-scattering albedo (SSA) data.
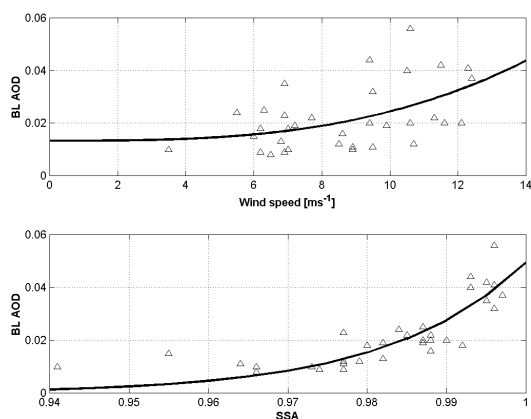

Fig. 10. Scatter plots of monthly averages of boundary layer aerosol optical depth (BL AOD) for marine background air masses with wind speed and single-scattering albedo (SSA). Regression lines are shown.

The wind speed is a proxy for the sea salt production process associated with white capping and the bubble bursting mechanism which gives rise to a strong local aerosol source that will contribute to the BL aerosol optical depth. The single-scattering albedo ω_0 is defined by

$$\omega_0 = \frac{\sigma_{sp}}{\sigma_{sp} + \sigma_{ap}}, \qquad (3)$$

describing the contribution of aerosol light scattering to total aerosol light extinction.

The calculated BL AOD time series for marine air indicates a seasonal cycle with maximum values in winter and about a factor of three lower values in summer (Fig. 9). A comparison with the wind speed time series shows that the general trend in BL AOD seems to be governed by wind speed. The correlation between wind speed and BL AOD for marine air masses is presented in Fig. 10. An exponential regression line is fitted to the data. The calculated BL AOD values exhibit a weak increase with increasing wind speed in excess of about 5 m s^{-1}, as indicated by the regression line. The coefficient of determination is calculated as $r^2 = 0.24$. Therefore only 24% of the variability in the BL AOD data can be accounted for by changes in wind speed. Kleefeld *et al.* (2002) found a similar value for the variability of the aerosol scattering coefficient alone with wind speed at Mace Head. A slightly higher r^2 value of 0.4 has been found by Quinn *et al.* (1998) for the correla-

tion between both submicron and supermicron σ_{sp} with local wind speed over the open ocean south of Australia. The rather low r^2 values indicate that only a fraction in the variability of BL AOD (and aerosol scattering coefficient) can be explained by the local sea salt source. Other aerosol sources including biogenically produced sulphate particles will contribute to the BL AOD.

The time series of the single-scattering albedo in Fig. 9 varies between values of about 0.941 and 0.997, therefore characterizing aerosol light extinction as well as BL AOD as being dominated by aerosol light scattering. The single-scattering albedo tracks the BL AOD quite well as indicated by an exponential correlation with a coefficient of determination of $r^2 = 0.72$ (Fig. 10).

The distribution of calculated BL AOD with wind direction and wind speed for the Mace Head site is presented as a contour plot in Fig. 11. The plot is based on hourly averages of the data and reveals that maximum BL aerosol optical depth values occur during south-westerly winds with wind speeds > 15 m s^{-1}. A secondary maximum can be observed for easterly wind directions and is probably associated with the advection of polluted air masses. Wind speeds are lower for the easterly sector than for the marine western sector. The wind speed and therefore sea salt related maximum BL AOD values are almost a
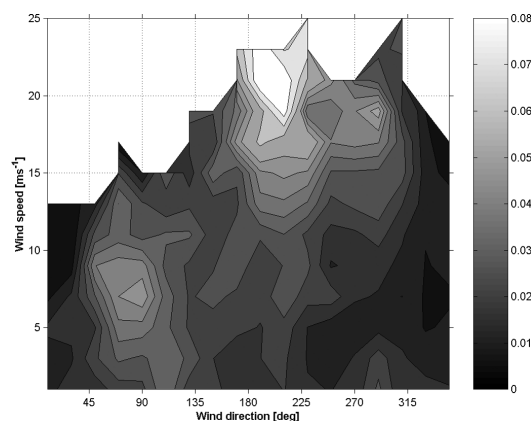
Fig. 11. Contour plot of the distribution of boundary layer aerosol optical depth (BL AOD) with wind direction and wind speed.
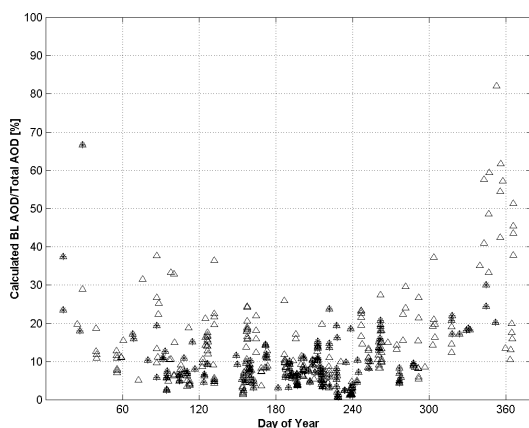

Fig. 12. The percentage contribution of calculated boundary layer aerosol optical depth (BL AOD) to measured total aerosol optical depth (AOD). AOD values for marine background air masses are marked by an asterisk within triangles.

factor of two higher than the pollution-related aerosol optical depths.

Comparison of calculated BL AOD and measured total AOD

The following comparison between calculated BL aerosol optical depth (λ = 550 nm) and measured total aerosol optical depth (λ = 500 nm) values has been performed for hourly averages of aerosol optical depth. The total AOD has been determined
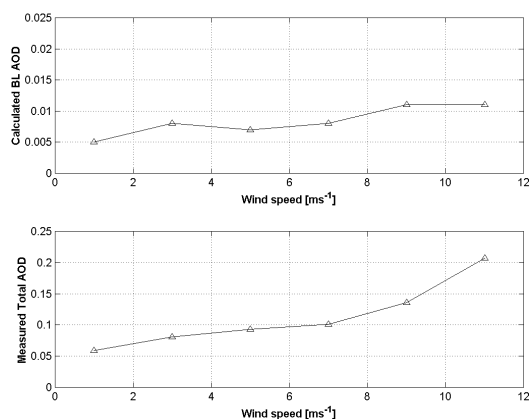

Fig. 13. Wind speed dependence of the calculated boundary layer aerosol optical depth (BL AOD) and the measured total AOD over the period from January 2000 to December 2002.

from continuous measurements performed by the radiometer every two minutes. 15 data points per hour or greater are flagged as valid measurements for the computation of hourly averages of AOD. This criterion as well as the relatively rare occurrence of clear sky measurement conditions considerably limits the number of available hourly averages. Only about 3.2% (*N* = 437) of hourly averages of calculated BL aerosol optical depths coincide with measured total AOD data over the 3 year period. This data subset is presented in Fig. 12; values associated with marine background air masses are indicated by an asterisk within triangles. The contribution of the calculated BL AOD to the measured total AOD during the course of a year, averaged over all three years of data is shown. On average, the BL AOD contributes about 12.5% to the total AOD. However, Fig. 12 indicates that during the winter months the contribution increases up to values of about 80%. This seasonality is only partly reflected in the marine AOD ratios with enhanced values in January alone. Interpretation is necessarily limited because of the small data subset.

The wind speed dependence of both calculated BL AOD and measured total AOD is presented in Fig. 13. The measured AOD shows a more pronounced dependence on wind speed with an increase of about a factor of four over a wind speed range from 0 to 12 m s^{-1} while the calculated BL AOD increases only by a factor of

two. This discrepancy might be explained by the presence of supermicrometre aerosol particles which contribute to the *in-situ* measured total AOD but cannot be detected by the nephelometer due to inlet sampling restrictions and therefore are excluded from the calculated BL AOD.

Conclusions

The strategic importance of the Mace Head atmospheric research station lies in its coastal higher latitude location on the western periphery of Europe and being a receptor of relatively clean marine air for over 50% of the time. The site benefits from the establishment of medium to longer term continuous measurements of aerosol (and gaseous) parameters, some from the later 1980s. A shorter measurement time series, of three years (2000–2002) duration, has been presented in this work to illustrate the range of variability of selected aerosol radiative parameters — a variability which is shown to be dependent on air mass origin and meteorological conditions. Measurements indicate that the dominant contribution to atmospheric extinction is due to scattering, with single-scattering albedo in the range 0.941 to 0.997. The measured total aerosol optical depth (λ = 500 nm) for marine air over the three-year period varies between 0.03 and 0.38 with a mean value of 0.11 and a standard deviation of ±0.06. These values are in fair agreement with other data for the North Atlantic region (Kaufman *et al.* 2001, Villevalde *et al.* 1994).

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