# CHAPTER 9 : Confidence limits for mean monthly wind speeds

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## 9.1 Introduction

The WAsP model has been used in POWER to predict the parameters of the wind field at various heights (see Chapter 4 and [Watson et al. (2000)]) from the geostrophic winds (see Chapter 3 and [Palutikof and Holt [2000)]). Here, we summarize the methodology for gauging the reliability of the estimated wind speeds by calculating confidence limits. It is not practical to present results for each height and grid point. Therefore, we concentrate on regions identified as important in the analysis of the long-term wind field (see Section 7.2, Table 7.2) and provide results for a single height, selected to be a typical hub height for offshore wind turbines.

## 9.2 Data

The WAsP output described in Chapter 4 gives the monthly mean parameters shown in Table 9.1 for each grid square at heights from 10 to 150m at 20 m intervals. The columns are: wind direction in 30 degree bins, the scale (A) and shape (k ) parameters of the Weibull distribution, the frequency of the wind in each directional bin, and the proportion of the wind energy associated with a direction.

| Direction | A (scale) | k (shape) | Wind% | Energy% |
|---|---|---|---|---|
| 0 | 10.0 | 2.13 | 3.0 | 1.5 |
| 30 | 10.6 | 2.56 | 2.9 | 1.5 |
| 60 | 10.5 | 2.17 | 3.5 | 1.9 |
| 90 | 12.1 | 2.35 | 5.5 | 4.4 |
| 120 | 11.8 | 2.36 | 7.1 | 5.2 |
| 150 | 12.0 | 2.40 | 8.3 | 6.3 |
| 180 | 12.4 | 2.29 | 9.4 | 8.2 |
| 210 | 13.9 | 2.64 | 11.4 | 12.8 |
| 240 | 15.3 | 2.82 | 18.6 | 27.0 |
| 270 | 13.2 | 2.51 | 15.0 | 14.8 |
| 300 | 13.4 | 2.15 | 9.9 | 11.6 |
| 330 | 11.3 | 1.74 | 5.4 | 4.8 |

**Table 9.1** Example monthly mean wind parameters from WAsP

Principal Component Analysis of the long term wind field (Section 7.2) identifies six areas of spatially coherent wind variability relevant to offshore wind energy development. For this demonstration analysis, we selected a grid square to represent these areas (Table 9.2) and extracted the relevant data from the WAsP output. To provide a concise example, we only analysed data for 90 m, this being the closest the WAsP output comes to the expected hub height of large offshore turbines. The methodology can be readily applied to data for any height at any location.

The columns in Table 9.2 represent: the factor identified by the PCA in the analysis of the long term wind field, the region identifier used in here (to avoid confusion because PCA factor 3 is not relevant), the latitude and longitude of the grid square chosen to represent the region, and the area identified as having a spatially coherent wind field. It is important to note that the results presented for each sample grid square are not intended to give reliable estimates of confidence limits for the whole of the region defined in Table 9.2. The confidence limits apply just to the grid square, and need to be reworked for every required grid square.

| Factor | Region | Latitude | Longitude | Area identified |
|---|---|---|---|---|
| 1 | 1 | 55 N | 10 E | Baltic, Scandinavia, UK, Ireland, North Sea, and northern France |
| 2 | 2 | 40 N | 5 E | Mediterranean, Spain, Portugal, and western France |
| 4 | 3 | 40 N | 10 W | northern Portugal and Spain, northern and western France, Ireland, Wales, and England |
| 5 | 4 | 60 N | 5 W | Iceland, Scotland, northern Norway, Sweden, and Finland |
| 6 | 5 | 35 N | 10 W | northwest Africa and southern Spain and Portugal |
| 7 | 6 | 35 N | 25.5 E | Egypt, southern Turkey, south-eastern Greece, Israel and Lebanon |

**Table 9.2** Areas represented in the determination of confidence limits (taken from the Principal Components Analysis performed in Section 7.2)

## 9.3 Methodology

The methodology is applied to data similar to that in Table 9.1 for each month in each of the six regions identified in Table 9.2. This gives 72 sets of results.

Using the Weibull parameters for each directional bin, twelve sets of simulated wind speeds are created, one for each directional bin, with 100 simulated wind speeds per bin. It is important that the number of simulated wind speeds is of the same order as the observed wind speeds. Here, the calculation of the Weibull parameters is based on 10 years of 6-hourly data, that is, 1200 values in total, and hence of the order of 100 per directional bin. If, for example, 1000 simulated wind speeds were used this could give a possibly spurious precision to the estimated confidence limits.

The simulated wind speed data for each directional bin are then resampled with replacement (see for example, [Efron (1983)]) 1000 times and confidence limits estimated using the bias-adjusted percentile method as described by [Davison and Hinkley (1997)]. This method of determining confidence limits is described as bootstrapping. The simulated data are then used to calculate the monthly mean wind speed for that grid square for each bin. To arrive at an overall mean, the bin means are weighted according to the frequency of wind speeds associated with each direction, and then summed. The 95% confidence limits for the overall mean are derived by applying the frequency weighting procedure to the confidence limits for each directional bin. The methodology is summarised below. A detailed review is beyond the scope of this report.

The creation of simulated data fitting a known distribution is fairly straightforward and the facility is available in many commercial statistics packages. The whole of this analysis was performed in MatLab, a widely-used graphical/mathematical analysis utility. The advantage of using an analytical tool of this type, over a conventional statistics package, is that the development of the analysis is completely flexible since MatLab is essentially a specialised high-level programming language. The formula to create a random number x from a Weibull distribution with parameters A and k is:

```
x = A*(-log(1-p))^(1/k)
```

p in the equation is a probability generated by a uniform random number routine giving values between 0 to 1. The expression is evaluated once for each required item in the simulated data series, with a new random value for p being chosen each time.

Bootstrap estimation of confidence limits eliminates many of the theoretical restrictions limiting the application of “classical” statistical methods to the problem. A further advantage of bootstrapping is that it is relatively easy to understand and the methodology seems intuitively sensible. Essentially, bootstrapping uses the available data to create a large number of extra data sets using resampling with replacement. The original data is resampled, using a random number generator, with the proviso that the new data set must have the same number of items as the original and can contain only the numbers present in the original series. The “with replacement” condition allows any of the original numbers to be repeated in the new data set on a random basis. The assumption is that, in the absence of further information, if the original sample data set is resampled a sufficient number of times, the resulting suite

of data series will give a fairly reliable representation of the population statistics of the variable. The number of resamples required will vary with the analysis but, generally, 1000 should be adequate.

In this analysis, we first generate confidence limits for the monthly mean wind speed of each directional bin, at the 95% confidence level. That is, we wish to say that we are confident that 95% of the time the monthly mean wind speed for a directional bin will be between the specified upper and lower limits. Following the resampling with replacement, we can calculate 1000 mean wind speeds for each directional bin. The 95% confidence level could then be determined by sorting the means and simply taking the $25^{th}$ value as the lower limit and the $975^{th}$ value as the upper limit. A problem with this approach is that it assumes the 1000 wind speeds are symmetrically distributed. This is often not the case and various adjustments can be applied to compensate for asymmetry. The method used here, bias-adjusted percentiles, was tested and found to give consistent estimates of confidence limits using a range of iterations from 500 to 20000.

The monthly mean wind speed as a weighted average over all directional bins is obtained from:

```
weight(i) = meanwind(i)*windfrequency(i)/100
```

where i ranges from 1 to 12 (for each directional bin). To obtain the monthly mean wind speed averaged over all directional bins, we sum the 12 weights. To obtain the 95% confidence limits for the overall average wind speeds, the weighting procedure is applied to the 95% confidence limits for each directional bin.

## 9.4 Results

The estimated monthly mean wind speed over all wind directions and the 95% confidence limits, for each month and the grid squares identified in Table 9.2, are shown in Table 9.3. The 95% confidence limits for the mean wind speed for each directional bin can be found in the next Section.

| Month | Region | Lower (m/s) | Mean (est.) (m/s) | Upper (m/s) |
|---|---|---|---|---|
| January | 1 | 10.6 | 11.6 | 12.6 |
| | 2 | 7.6 | 8.4 | 9.2 |
| | 3 | 7.8 | 8.6 | 9.6 |
| | 4 | 12.3 | 13.7 | 15.1 |
| | 5 | 7.3 | 8.1 | 8.8 |
| | 6 | 6.9 | 7.7 | 8.4 |
| February | 1 | 10.2 | 11.2 | 12.2 |
| | 2 | 7.5 | 8.3 | 9.3 |
| | 3 | 8.0 | 9.0 | 10.0 |
| | 4 | 11.8 | 13.0 | 14.3 |
| | 5 | 6.5 | 7.3 | 8.1 |
| | 6 | 7.5 | 8.4 | 9.2 |
| March | 1 | 9.4 | 10.3 | 11.1 |
| | 2 | 7.4 | 8.3 | 9.1 |
| | 3 | 7.5 | 8.4 | 9.3 |
| | 4 | 12.2 | 13.3 | 14.5 |
| | 5 | 7.1 | 7.9 | 8.6 |
| | 6 | 6.5 | 7.3 | 8.1 |
| April | 1 | 7.7 | 8.6 | 9.5 |
| | 2 | 7.5 | 8.3 | 9.1 |
| | 3 | 7.9 | 8.8 | 9.7 |
| | 4 | 10.0 | 11.0 | 12.0 |
| | 5 | 7.0 | 7.7 | 8.5 |
| | 6 | 5.7 | 6.3 | 7.0 |

**Table 9.3** 95% Confidence limits for monthly mean wind speed averaged over all directional bins

| Month | Region | Lower (m/s) | Mean (est.) (m/s) | Upper (m/s) |
|---|---|---|---|---|
| May | 1 | 7.1 | 7.8 | 8.5 |
| | 2 | 5.2 | 5.9 | 6.6 |
| | 3 | 7.1 | 7.8 | 8.6 |
| | 4 | 8.6 | 9.4 | 10.3 |
| | 5 | 6.4 | 7.0 | 7.6 |
| | 6 | 5.5 | 6.1 | 6.6 |
| June | 1 | 6.7 | 7.4 | 8.2 |
| | 2 | 4.5 | 5.1 | 5.7 |
| | 3 | 7.8 | 8.5 | 9.2 |
| | 4 | 7.8 | 8.7 | 9.5 |
| | 5 | 6.4 | 7.0 | 7.5 |
| | 6 | 6.2 | 6.6 | 7.1 |
| July | 1 | 7.0 | 7.6 | 8.4 |
| | 2 | 4.1 | 4.6 | 5.1 |
| | 3 | 8.1 | 8.8 | 9.5 |
| | 4 | 7.9 | 8.6 | 9.4 |
| | 5 | 7.4 | 8.0 | 8.6 |
| | 6 | 8.1 | 8.5 | 9.0 |
| August | 1 | 7.0 | 7.7 | 8.5 |
| | 2 | 4.0 | 4.4 | 4.9 |
| | 3 | 7.0 | 7.6 | 8.3 |
| | 4 | 8.2 | 9.1 | 10.0 |
| | 5 | 6.3 | 6.8 | 7.3 |
| | 6 | 7.4 | 7.8 | 8.2 |
| September | 1 | 8.0 | 8.8 | 9.7 |
| | 2 | 4.7 | 5.3 | 5.9 |
| | 3 | 6.6 | 7.3 | 8.1 |
| | 4 | 10.0 | 11.0 | 12.1 |
| | 5 | 5.9 | 6.4 | 6.9 |
| | 6 | 6.1 | 6.6 | 7.0 |
| October | 1 | 8.5 | 9.4 | 10.3 |
| | 2 | 6.0 | 6.6 | 7.3 |
| | 3 | 7.2 | 8.1 | 8.9 |
| | 4 | 10.7 | 11.8 | 13.0 |
| | 5 | 5.6 | 6.3 | 6.9 |
| | 6 | 5.2 | 5.7 | 6.3 |
| November | 1 | 9.7 | 10.5 | 11.4 |
| | 2 | 6.9 | 7.6 | 8.4 |
| | 3 | 7.8 | 8.6 | 9.5 |
| | 4 | 11.0 | 12.0 | 13.2 |
| | 5 | 6.8 | 7.5 | 8.3 |
| | 6 | 6.2 | 6.9 | 7.6 |
| December | 1 | 9.8 | 10.8 | 11.8 |
| | 2 | 7.4 | 8.3 | 9.1 |
| | 3 | 8.3 | 9.2 | 10.2 |
| | 4 | 11.1 | 12.3 | 13.6 |
| | 5 | 7.2 | 8.0 | 8.8 |
| | 6 | 6.9 | 7.6 | 8.4 |

**Table 9.3** (continued) 95% Confidence limits for monthly mean wind speed averaged over all directional bins

## 9.5 Comments

Bootstrapping gives apparently reasonable estimates of the limits of the 95% confidence level in monthly mean wind speed data defined by Weibull parameters. Confidence limits can also be estimated

using Monte Carlo simulation, a method similar to bootstrapping but requiring many more iterations. We tested Monte Carlo simulation on the 12 directional bins for Region 1 in January. The confidence limits were similar to those from bootstrapping but the analysis took 100 times longer, making the use of this method prohibitively slow.

The bias adjusted percentile method of estimating confidence limits used here transforms the data by fitting to a normal distribution. The method will give erroneous results in the presence of outliers. This is not an issue here since our data are simulated from the Weibull distribution.

The following tables contain the 95% confidence limits of the mean monthly wind speed for each directional bin.

## Confidence limits for Region 1 Coasts of Northern Europe

| Direction | lower Jan | mean Jan | upper Jan | Lower Feb | mean Feb | upper Feb | Lower Mar | mean Mar | upper Mar |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 7.84 | 8.56 | 9.33 | 7.74 | 8.64 | 9.56 | 6.52 | 7.25 | 7.98 |
| **30** | 7.97 | 8.62 | 9.30 | 7.52 | 8.36 | 9.34 | 5.93 | 6.58 | 7.32 |
| **60** | 8.09 | 8.90 | 9.70 | 7.18 | 8.01 | 8.92 | 7.06 | 7.79 | 8.62 |
| **90** | 8.74 | 9.70 | 10.62 | 9.68 | 10.57 | 11.42 | 8.35 | 9.20 | 10.01 |
| **120** | 9.18 | 10.04 | 10.88 | 11.15 | 11.99 | 12.98 | 9.57 | 10.33 | 11.01 |
| **150** | 10.09 | 11.01 | 12.00 | 10.94 | 11.91 | 12.91 | 9.76 | 10.63 | 11.54 |
| **180** | 9.87 | 10.90 | 11.98 | 9.93 | 10.91 | 11.85 | 7.97 | 8.82 | 9.75 |
| **210** | 11.61 | 12.69 | 13.76 | 10.93 | 11.88 | 12.80 | 8.91 | 9.98 | 10.98 |
| **240** | 12.63 | 13.64 | 14.69 | 13.14 | 14.21 | 15.24 | 9.47 | 10.32 | 11.13 |
| **270** | 11.31 | 12.14 | 13.07 | 9.42 | 10.49 | 11.50 | 10.28 | 11.12 | 12.00 |
| **300** | 11.14 | 12.23 | 13.16 | 9.97 | 11.00 | 12.20 | 12.20 | 13.33 | 14.42 |
| **330** | 9.62 | 10.68 | 11.97 | 7.62 | 8.73 | 9.78 | 9.91 | 11.04 | 12.23 |

**Table 9.4** Region 1: 95% confidence limits for mean monthly wind speed by direction, January to March

| Direction | lower Apr | mean Apr | upper Apr | Lower May | mean May | upper May | lower Jun | mean Jun | upper Jun |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 6.75 | 7.55 | 8.44 | 5.66 | 6.30 | 7.00 | 4.79 | 5.33 | 6.00 |
| **30** | 6.84 | 7.77 | 8.73 | 5.76 | 6.39 | 6.99 | 4.82 | 5.40 | 5.99 |
| **60** | 7.19 | 8.08 | 8.95 | 6.87 | 7.56 | 8.26 | 5.84 | 6.63 | 7.33 |
| **90** | 9.07 | 9.82 | 10.66 | 8.21 | 8.84 | 9.50 | 6.02 | 6.65 | 7.42 |
| **120** | 8.63 | 9.54 | 10.47 | 7.87 | 8.53 | 9.17 | 6.72 | 7.41 | 8.14 |
| **150** | 7.59 | 8.52 | 9.58 | 7.71 | 8.37 | 9.03 | 7.18 | 7.88 | 8.62 |
| **180** | 6.86 | 7.60 | 8.49 | 5.59 | 6.27 | 6.91 | 6.19 | 7.05 | 7.98 |
| **210** | 7.11 | 7.83 | 8.70 | 6.93 | 7.52 | 8.20 | 6.69 | 7.25 | 7.88 |
| **240** | 7.24 | 8.16 | 9.08 | 7.11 | 7.91 | 8.79 | 7.70 | 8.45 | 9.22 |
| **270** | 7.04 | 7.74 | 8.61 | 6.14 | 6.82 | 7.51 | 6.65 | 7.29 | 8.05 |
| **300** | 9.11 | 10.19 | 11.24 | 7.68 | 8.59 | 9.52 | 7.86 | 8.71 | 9.56 |
| **330** | 8.37 | 9.51 | 10.74 | 7.52 | 8.33 | 9.22 | 6.83 | 7.61 | 8.50 |

**Table 9.5** Region 1: 95% confidence limits for mean monthly wind speed by direction, April to June

| Direction | lower Jul | mean Jul | upper Jul | Lower Aug | mean Aug | upper Aug | lower Sep | mean Sep | upper Sep |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 5.26 | 5.88 | 6.58 | 5.21 | 5.81 | 6.55 | 7.00 | 7.55 | 8.13 |
| **30** | 4.45 | 5.06 | 5.67 | 4.83 | 5.72 | 6.67 | 6.65 | 7.21 | 7.75 |
| **60** | 4.55 | 5.03 | 5.56 | 4.97 | 5.82 | 6.60 | 8.73 | 9.39 | 10.17 |
| **90** | 5.82 | 6.54 | 7.21 | 5.41 | 6.09 | 6.81 | 7.98 | 8.73 | 9.41 |
| **120** | 6.67 | 7.36 | 8.06 | 6.80 | 7.61 | 8.34 | 8.08 | 8.90 | 9.86 |
| **150** | 6.28 | 6.89 | 7.56 | 7.21 | 8.00 | 8.84 | 7.65 | 8.37 | 9.11 |
| **180** | 5.16 | 5.68 | 6.22 | 6.21 | 6.91 | 7.82 | 5.72 | 6.46 | 7.27 |
| **210** | 5.67 | 6.25 | 6.86 | 7.02 | 7.79 | 8.59 | 8.26 | 9.20 | 10.02 |
| **240** | 7.01 | 7.69 | 8.40 | 7.68 | 8.35 | 9.19 | 9.00 | 9.73 | 10.57 |
| **270** | 7.78 | 8.45 | 9.25 | 7.05 | 7.66 | 8.30 | 8.05 | 9.11 | 10.14 |
| **300** | 9.34 | 10.17 | 11.01 | 8.55 | 9.37 | 10.26 | 8.37 | 9.39 | 10.39 |
| **330** | 7.50 | 8.33 | 9.16 | 6.97 | 7.83 | 8.68 | 7.40 | 8.19 | 9.06 |

**Table 9.6** Region 1: 95% confidence limits for mean monthly wind speed by direction, July to September

| Direction | lower Oct | mean Oct | upper Oct | Lower Nov | mean Nov | upper Nov | lower Dec | mean Dec | upper Dec |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 6.71 | 7.45 | 8.32 | 8.49 | 9.62 | 10.90 | 7.78 | 8.70 | 9.56 |
| **30** | 6.78 | 7.65 | 8.61 | 7.14 | 7.96 | 8.78 | 7.92 | 8.82 | 9.78 |
| **60** | 7.08 | 8.07 | 9.13 | 8.35 | 9.19 | 10.18 | 7.80 | 8.67 | 9.67 |
| **90** | 8.92 | 9.92 | 10.89 | 9.03 | 9.76 | 10.59 | 9.35 | 10.33 | 11.41 |
| **120** | 10.39 | 11.27 | 12.14 | 9.47 | 10.28 | 11.05 | 8.45 | 9.54 | 10.48 |
| **150** | 8.67 | 9.62 | 10.60 | 9.07 | 10.02 | 11.00 | 8.77 | 9.81 | 10.87 |
| **180** | 8.12 | 9.00 | 9.93 | 9.54 | 10.28 | 11.15 | 8.53 | 9.50 | 10.46 |
| **210** | 8.71 | 9.54 | 10.45 | 10.89 | 11.78 | 12.71 | 9.57 | 10.54 | 11.56 |
| **240** | 9.16 | 9.91 | 10.88 | 10.87 | 11.77 | 12.62 | 11.52 | 12.44 | 13.47 |
| **270** | 7.66 | 8.44 | 9.13 | 9.62 | 10.45 | 11.22 | 10.34 | 11.13 | 11.88 |
| **300** | 8.59 | 9.57 | 10.66 | 10.08 | 10.98 | 12.07 | 11.58 | 12.70 | 13.78 |
| **330** | 7.72 | 8.66 | 9.69 | 8.21 | 9.17 | 10.21 | 9.85 | 10.86 | 11.96 |

**Table 9.7** Region 1: 95% confidence limits for mean monthly wind speed by direction, October to December

## Confidence limits for Region 2 Coasts of Western Mediterranean

| Direction | lower Jan | mean Jan | upper Jan | Lower Feb | mean Feb | upper Feb | lower Mar | mean Mar | upper Mar |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 6.60 | 7.33 | 8.06 | 6.86 | 7.94 | 8.98 | 7.51 | 8.56 | 9.58 |
| **30** | 6.03 | 6.79 | 7.58 | 6.56 | 7.33 | 8.18 | 7.46 | 8.43 | 9.47 |
| **60** | 5.78 | 6.57 | 7.47 | 5.68 | 6.36 | 7.05 | 8.45 | 9.26 | 10.02 |
| **90** | 7.21 | 7.95 | 8.76 | 6.87 | 7.71 | 8.53 | 7.52 | 8.48 | 9.43 |
| **120** | 6.17 | 6.82 | 7.49 | 7.07 | 7.86 | 8.69 | 6.40 | 7.17 | 7.91 |
| **150** | 6.38 | 7.10 | 7.85 | 4.75 | 5.23 | 5.78 | 5.33 | 5.92 | 6.47 |
| **180** | 6.96 | 7.66 | 8.38 | 5.09 | 5.77 | 6.56 | 4.94 | 5.60 | 6.35 |
| **210** | 8.34 | 9.20 | 9.88 | 7.32 | 8.12 | 9.09 | 5.57 | 6.26 | 6.97 |
| **240** | 7.59 | 8.35 | 9.19 | 7.12 | 7.88 | 8.74 | 6.40 | 7.14 | 7.89 |
| **270** | 8.80 | 9.89 | 10.83 | 7.84 | 8.60 | 9.58 | 7.54 | 8.32 | 9.18 |
| **300** | 8.67 | 9.51 | 10.40 | 8.94 | 9.88 | 11.13 | 8.32 | 9.15 | 10.09 |
| **330** | 7.87 | 8.77 | 9.70 | 9.01 | 9.99 | 11.02 | 8.69 | 9.57 | 10.53 |

**Table 9.8** Region 2: 95% confidence limits for mean monthly wind speed by direction, January to March

| Direction | lower Apr | mean Apr | upper Apr | Lower May | mean May | upper May | lower Jun | mean Jun | upper Jun |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 6.63 | 7.65 | 8.59 | 4.74 | 5.24 | 5.77 | 3.58 | 4.00 | 4.48 |
| **30** | 5.03 | 5.92 | 7.01 | 3.91 | 4.44 | 4.98 | 2.41 | 2.77 | 3.25 |
| **60** | 5.35 | 6.20 | 6.99 | 4.72 | 5.22 | 5.68 | 3.70 | 4.22 | 4.90 |
| **90** | 7.14 | 8.04 | 9.06 | 5.35 | 5.93 | 6.64 | 4.64 | 5.39 | 6.18 |
| **120** | 6.39 | 7.10 | 7.85 | 4.59 | 5.17 | 5.77 | 4.13 | 4.65 | 5.35 |
| **150** | 4.95 | 5.52 | 6.14 | 3.36 | 3.79 | 4.24 | 3.30 | 3.65 | 4.05 |
| **180** | 4.71 | 5.27 | 5.91 | 3.18 | 3.64 | 4.08 | 3.33 | 3.75 | 4.22 |
| **210** | 5.57 | 6.29 | 6.99 | 4.76 | 5.41 | 6.15 | 4.06 | 4.58 | 5.04 |
| **240** | 7.11 | 7.79 | 8.56 | 4.56 | 5.22 | 5.90 | 4.91 | 5.37 | 5.85 |
| **270** | 8.80 | 9.61 | 10.39 | 5.85 | 6.67 | 7.60 | 4.60 | 5.17 | 5.75 |
| **300** | 9.27 | 10.17 | 10.99 | 7.35 | 8.15 | 8.91 | 5.59 | 6.24 | 6.96 |
| **330** | 9.49 | 10.42 | 11.40 | 6.09 | 6.88 | 7.61 | 5.05 | 5.59 | 6.23 |

**Table 9.9** Region 2: 95% confidence limits for mean monthly wind speed by direction, April to June

| Direction | lower Jul | mean Jul | upper Jul | Lower Aug | mean Aug | upper Aug | lower Sep | mean Sep | upper Sep |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 3.24 | 3.74 | 4.30 | 2.90 | 3.32 | 3.78 | 3.98 | 4.35 | 4.77 |
| **30** | 2.72 | 3.02 | 3.42 | 3.16 | 3.48 | 3.77 | 4.06 | 4.54 | 4.98 |
| **60** | 3.49 | 3.94 | 4.37 | 3.65 | 3.95 | 4.25 | 4.66 | 5.24 | 6.01 |
| **90** | 4.45 | 4.98 | 5.57 | 3.84 | 4.26 | 4.76 | 5.52 | 6.11 | 6.71 |
| **120** | 3.70 | 4.15 | 4.65 | 3.51 | 3.90 | 4.28 | 4.77 | 5.26 | 5.75 |
| **150** | 3.66 | 4.00 | 4.39 | 3.52 | 3.85 | 4.19 | 4.58 | 5.00 | 5.43 |
| **180** | 3.49 | 3.87 | 4.30 | 3.22 | 3.59 | 3.96 | 4.49 | 5.04 | 5.62 |
| **210** | 3.27 | 3.73 | 4.32 | 3.22 | 3.67 | 4.14 | 3.98 | 4.64 | 5.40 |
| **240** | 4.06 | 4.54 | 4.99 | 3.84 | 4.31 | 4.75 | 4.88 | 5.47 | 6.12 |
| **270** | 4.45 | 4.92 | 5.35 | 4.33 | 4.81 | 5.27 | 4.54 | 5.08 | 5.71 |
| **300** | 5.15 | 5.63 | 6.12 | 5.08 | 5.57 | 6.17 | 4.80 | 5.43 | 6.19 |
| **330** | 4.45 | 4.93 | 5.43 | 4.65 | 5.16 | 5.71 | 5.07 | 5.58 | 6.14 |

**Table 9.10** Region 2: 95% confidence limits for mean monthly wind speed by direction, July to September

| Direction | lower Oct | mean Oct | upper Oct | Lower Nov | mean Nov | upper Nov | lower Dec | mean Dec | upper Dec |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 5.56 | 6.55 | 7.64 | 6.83 | 7.77 | 8.75 | 8.90 | 9.91 | 10.78 |
| **30** | 3.58 | 4.45 | 5.53 | 4.39 | 4.99 | 5.71 | 6.20 | 7.10 | 8.21 |
| **60** | 5.00 | 5.63 | 6.26 | 6.18 | 6.69 | 7.29 | 5.77 | 6.54 | 7.30 |
| **90** | 6.24 | 6.75 | 7.33 | 6.13 | 6.74 | 7.43 | 7.11 | 7.78 | 8.49 |
| **120** | 6.05 | 6.58 | 7.23 | 6.04 | 6.76 | 7.54 | 7.07 | 7.71 | 8.34 |
| **150** | 5.28 | 5.88 | 6.44 | 6.18 | 6.78 | 7.43 | 5.67 | 6.28 | 6.94 |
| **180** | 5.02 | 5.58 | 6.12 | 6.05 | 6.78 | 7.66 | 5.67 | 6.37 | 7.09 |
| **210** | 5.39 | 5.98 | 6.57 | 6.21 | 6.99 | 7.83 | 7.50 | 8.30 | 9.14 |
| **240** | 6.35 | 6.96 | 7.51 | 6.87 | 7.57 | 8.22 | 7.65 | 8.46 | 9.31 |
| **270** | 6.28 | 6.93 | 7.58 | 7.03 | 7.86 | 8.59 | 7.12 | 7.89 | 8.69 |
| **300** | 6.59 | 7.25 | 7.99 | 7.92 | 8.66 | 9.42 | 7.96 | 8.97 | 10.02 |
| **330** | 7.45 | 8.24 | 9.13 | 8.44 | 9.26 | 10.22 | 8.94 | 9.84 | 10.81 |

**Table 7.11** Region 2: 95% confidence limits for mean monthly wind speed by direction, October to December

## Confidence limits for Region 3 Coasts of Southern UK to Northern Iberia

| Direction | lower Jan | mean Jan | upper Jan | lower Feb | mean Feb | upper Feb | lower Mar | mean Mar | upper Mar |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 6.93 | 7.85 | 8.77 | 8.68 | 9.76 | 10.85 | 8.35 | 9.13 | 10.02 |
| **30** | 7.73 | 8.48 | 9.32 | 8.34 | 9.31 | 10.32 | 8.68 | 9.47 | 10.29 |
| **60** | 6.11 | 6.88 | 7.72 | 5.32 | 6.29 | 7.37 | 7.06 | 8.00 | 8.90 |
| **90** | 5.01 | 5.71 | 6.43 | 4.20 | 4.96 | 5.79 | 6.64 | 7.65 | 8.82 |
| **120** | 5.87 | 6.54 | 7.34 | 4.76 | 5.53 | 6.43 | 5.98 | 6.84 | 7.93 |
| **150** | 6.41 | 7.26 | 8.19 | 5.36 | 6.19 | 7.05 | 6.94 | 7.82 | 8.69 |
| **180** | 9.11 | 10.11 | 11.24 | 8.55 | 9.51 | 10.58 | 6.38 | 7.24 | 8.10 |
| **210** | 9.61 | 10.57 | 11.66 | 9.56 | 10.56 | 11.65 | 8.22 | 9.21 | 10.53 |
| **240** | 9.85 | 10.75 | 11.86 | 10.01 | 11.13 | 12.38 | 8.09 | 9.02 | 9.97 |
| **270** | 8.63 | 9.82 | 11.13 | 9.07 | 10.19 | 11.29 | 6.70 | 7.48 | 8.33 |
| **300** | 7.90 | 8.68 | 9.50 | 7.89 | 8.91 | 9.95 | 6.56 | 7.34 | 8.14 |
| **330** | 5.75 | 6.67 | 7.61 | 8.04 | 8.92 | 9.84 | 6.80 | 7.60 | 8.52 |

**Table 9.12** Region 3: 95% confidence limits for mean monthly wind speed by direction, January to March

| Direction | lower Apr | mean Apr | upper Apr | lower May | mean May | upper May | lower Jun | mean Jun | upper Jun |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 8.88 | 9.79 | 10.64 | 7.98 | 8.70 | 9.53 | 8.97 | 9.75 | 10.57 |
| **30** | 9.27 | 10.05 | 10.85 | 9.64 | 10.41 | 11.23 | 9.97 | 10.66 | 11.43 |
| **60** | 6.88 | 7.51 | 8.21 | 5.24 | 5.93 | 6.71 | 8.98 | 9.55 | 10.20 |
| **90** | 5.94 | 6.68 | 7.39 | 3.55 | 4.06 | 4.59 | 4.82 | 5.42 | 6.06 |
| **120** | 5.21 | 5.89 | 6.74 | 4.72 | 5.31 | 5.94 | 3.92 | 4.44 | 4.97 |
| **150** | 6.53 | 7.72 | 9.01 | 6.82 | 7.64 | 8.38 | 4.52 | 5.27 | 6.03 |
| **180** | 9.00 | 10.00 | 11.08 | 8.06 | 8.92 | 9.74 | 5.91 | 6.71 | 7.60 |
| **210** | 8.06 | 9.09 | 10.16 | 6.75 | 7.57 | 8.51 | 7.05 | 7.99 | 8.91 |
| **240** | 7.41 | 8.61 | 9.70 | 6.36 | 7.24 | 8.14 | 6.38 | 7.18 | 7.94 |
| **270** | 7.11 | 7.99 | 9.01 | 5.90 | 6.62 | 7.46 | 5.45 | 6.07 | 6.56 |
| **300** | 6.92 | 7.67 | 8.57 | 5.61 | 6.27 | 6.98 | 5.62 | 6.03 | 6.48 |
| **330** | 8.06 | 8.82 | 9.74 | 6.38 | 7.04 | 7.75 | 6.75 | 7.41 | 8.02 |

**Table 9.13** Region 3: 95% confidence limits for mean monthly wind speed by direction, April to June

| Direction | lower Jul | mean Jul | upper Jul | Lower Aug | mean Aug | upper Aug | lower Sep | mean Sep | upper Sep |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 9.07 | 9.85 | 10.58 | 8.50 | 9.17 | 9.89 | 7.53 | 8.24 | 8.92 |
| **30** | 9.80 | 10.48 | 11.20 | 8.38 | 9.08 | 9.78 | 7.75 | 8.53 | 9.33 |
| **60** | 7.17 | 7.87 | 8.52 | 6.86 | 7.44 | 8.05 | 6.48 | 7.13 | 7.81 |
| **90** | 4.66 | 5.07 | 5.57 | 3.35 | 3.84 | 4.38 | 3.77 | 4.26 | 4.77 |
| **120** | 3.64 | 3.97 | 4.25 | 2.23 | 2.51 | 2.77 | 3.37 | 3.80 | 4.33 |
| **150** | 3.43 | 3.75 | 4.08 | 3.44 | 3.87 | 4.28 | 4.46 | 5.22 | 5.97 |
| **180** | 2.50 | 2.74 | 3.00 | 3.96 | 4.39 | 4.88 | 5.46 | 6.36 | 7.15 |
| **210** | 4.26 | 4.50 | 4.75 | 4.36 | 5.05 | 5.73 | 6.24 | 7.25 | 8.33 |
| **240** | 5.12 | 5.55 | 6.01 | 4.25 | 4.89 | 5.55 | 6.58 | 7.52 | 8.65 |
| **270** | 5.08 | 5.65 | 6.26 | 4.37 | 4.84 | 5.35 | 5.20 | 5.97 | 6.73 |
| **300** | 5.19 | 5.65 | 6.09 | 4.68 | 5.15 | 5.62 | 5.15 | 5.73 | 6.38 |
| **330** | 7.46 | 8.08 | 8.74 | 6.92 | 7.62 | 8.30 | 6.70 | 7.42 | 8.11 |

**Table 9.14** Region 3: 95% confidence limits for mean monthly wind speed by direction, July to September

| Direction | lower Oct | mean Oct | upper Oct | lower Nov | mean Nov | upper Nov | lower Dec | mean Dec | upper Dec |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 7.30 | 8.12 | 8.96 | 7.29 | 8.06 | 8.80 | 7.39 | 8.15 | 8.89 |
| **30** | 6.70 | 7.34 | 8.11 | 7.28 | 8.09 | 8.88 | 7.50 | 8.45 | 9.43 |
| **60** | 6.68 | 7.31 | 7.93 | 6.44 | 7.17 | 7.89 | 5.82 | 6.58 | 7.46 |
| **90** | 5.11 | 5.84 | 6.68 | 4.92 | 5.49 | 6.28 | 6.21 | 7.06 | 8.00 |
| **120** | 5.25 | 6.01 | 6.69 | 7.33 | 8.19 | 9.16 | 7.34 | 8.18 | 9.04 |
| **150** | 7.47 | 8.22 | 9.02 | 6.91 | 7.80 | 8.82 | 8.32 | 9.17 | 10.22 |
| **180** | 8.74 | 9.67 | 10.56 | 8.72 | 9.68 | 10.87 | 8.86 | 9.95 | 11.05 |
| **210** | 8.67 | 9.72 | 10.99 | 9.27 | 10.21 | 11.21 | 10.45 | 11.60 | 12.75 |
| **240** | 8.71 | 9.91 | 11.20 | 9.72 | 10.51 | 11.44 | 11.63 | 12.75 | 13.91 |
| **270** | 6.90 | 7.65 | 8.34 | 8.32 | 9.11 | 9.83 | 7.79 | 8.75 | 9.71 |
| **300** | 6.02 | 6.79 | 7.66 | 6.83 | 7.41 | 8.06 | 6.73 | 7.44 | 8.16 |
| **330** | 6.44 | 7.11 | 7.82 | 7.90 | 8.61 | 9.29 | 6.27 | 6.98 | 7.75 |

**Table 9.15** Region 3: 95% confidence limits for mean monthly wind speed by direction, October to December

## Confidence limits for Region 4 Coasts of Iceland to Scotland

| Direction | lower Jan | mean Jan | upper Jan | lower Feb | mean Feb | upper Feb | lower Mar | mean Mar | upper Mar |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 9.19 | 10.37 | 11.76 | 7.46 | 8.41 | 9.44 | 10.07 | 11.17 | 12.65 |
| **30** | 8.08 | 9.30 | 10.63 | 7.13 | 8.24 | 9.32 | 8.94 | 10.25 | 11.67 |
| **60** | 9.66 | 10.84 | 12.04 | 6.62 | 7.63 | 8.71 | 7.64 | 8.75 | 9.85 |
| **90** | 10.19 | 11.33 | 12.66 | 9.11 | 10.28 | 11.44 | 8.87 | 9.76 | 10.69 |
| **120** | 11.42 | 12.62 | 13.74 | 13.36 | 14.81 | 16.32 | 9.69 | 10.67 | 11.57 |
| **150** | 11.96 | 13.06 | 14.20 | 12.71 | 13.88 | 15.23 | 11.94 | 13.03 | 14.20 |
| **180** | 14.20 | 15.64 | 17.20 | 13.66 | 14.83 | 16.05 | 13.08 | 14.32 | 15.69 |
| **210** | 15.49 | 17.02 | 18.48 | 13.51 | 14.80 | 16.01 | 12.51 | 13.48 | 14.51 |
| **240** | 13.22 | 14.57 | 15.98 | 14.33 | 15.69 | 16.89 | 14.57 | 15.67 | 16.89 |
| **270** | 13.08 | 14.42 | 15.71 | 11.93 | 13.04 | 14.30 | 13.87 | 15.02 | 16.46 |
| **300** | 9.39 | 10.94 | 12.58 | 10.27 | 11.58 | 12.98 | 10.74 | 11.85 | 12.80 |
| **330** | 8.72 | 10.04 | 11.35 | 9.50 | 10.60 | 11.89 | 10.97 | 11.94 | 13.26 |

**Table 9.16** Region 4: 95% confidence limits for mean monthly wind speed by direction, January to March

| Direction | lower Apr | mean Apr | upper Apr | lower May | mean May | upper May | lower Jun | mean Jun | upper Jun |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 10.34 | 11.41 | 12.50 | 7.89 | 8.69 | 9.41 | 7.98 | 8.67 | 9.48 |
| **30** | 9.20 | 10.18 | 11.11 | 7.45 | 8.20 | 9.09 | 6.57 | 7.55 | 8.81 |
| **60** | 9.23 | 10.04 | 10.89 | 7.08 | 7.90 | 8.81 | 6.45 | 7.37 | 8.31 |
| **90** | 8.97 | 10.01 | 11.13 | 8.69 | 9.59 | 10.55 | 7.18 | 7.98 | 8.88 |
| **120** | 9.43 | 10.68 | 12.09 | 9.82 | 10.69 | 11.61 | 6.93 | 7.58 | 8.25 |
| **150** | 10.95 | 11.81 | 12.81 | 9.69 | 10.48 | 11.18 | 8.07 | 8.92 | 9.76 |
| **180** | 10.58 | 11.49 | 12.52 | 9.94 | 10.82 | 11.75 | 8.18 | 8.89 | 9.77 |
| **210** | 10.98 | 11.83 | 12.70 | 9.77 | 10.71 | 11.74 | 9.10 | 9.86 | 10.56 |
| **240** | 10.49 | 11.34 | 12.32 | 8.32 | 9.27 | 10.35 | 8.92 | 9.85 | 10.76 |
| **270** | 10.14 | 11.23 | 12.34 | 8.14 | 9.05 | 10.03 | 8.14 | 9.00 | 10.03 |
| **300** | 9.13 | 10.18 | 11.17 | 7.69 | 8.58 | 9.47 | 7.14 | 8.03 | 9.16 |
| **330** | 8.71 | 9.60 | 10.61 | 8.22 | 8.98 | 9.77 | 7.41 | 8.25 | 8.99 |

**Table 9.17** Region 4: 95% confidence limits for mean monthly wind speed by direction, April to June

| Direction | lower Jul | mean Jul | upper Jul | lower Aug | mean Aug | upper Aug | lower Sep | mean Sep | upper Sep |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 7.12 | 8.15 | 9.17 | 9.02 | 10.07 | 11.39 | 9.23 | 10.24 | 11.28 |
| **30** | 8.19 | 9.15 | 10.09 | 8.69 | 9.75 | 10.92 | 8.58 | 9.49 | 10.42 |
| **60** | 8.88 | 9.72 | 10.59 | 6.13 | 6.82 | 7.64 | 6.92 | 7.66 | 8.48 |
| **90** | 8.52 | 9.14 | 9.75 | 8.28 | 9.11 | 9.91 | 7.84 | 8.83 | 9.71 |
| **120** | 7.83 | 8.56 | 9.29 | 8.55 | 9.46 | 10.44 | 7.63 | 8.56 | 9.50 |
| **150** | 6.69 | 7.45 | 8.23 | 7.76 | 8.55 | 9.45 | 9.88 | 11.05 | 12.24 |
| **180** | 7.70 | 8.54 | 9.27 | 8.58 | 9.53 | 10.50 | 11.80 | 12.85 | 13.95 |
| **210** | 9.02 | 9.63 | 10.32 | 8.60 | 9.46 | 10.39 | 11.89 | 12.88 | 14.06 |
| **240** | 7.96 | 8.66 | 9.37 | 9.25 | 10.18 | 11.15 | 10.29 | 11.20 | 12.21 |
| **270** | 7.79 | 8.60 | 9.48 | 7.59 | 8.34 | 9.20 | 11.36 | 12.36 | 13.55 |
| **300** | 7.31 | 8.15 | 8.98 | 6.74 | 7.49 | 8.28 | 8.62 | 9.66 | 10.85 |
| **330** | 6.98 | 7.80 | 8.63 | 7.34 | 8.35 | 9.41 | 8.33 | 9.35 | 10.50 |

**Table 9.18** Region 4: 95% confidence limits for mean monthly wind speed by direction, July to September

| Direction | lower Oct | mean Oct | upper Oct | Lower Nov | mean Nov | upper Nov | lower Dec | mean Dec | upper Dec |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 10.60 | 11.79 | 13.07 | 10.11 | 11.34 | 12.62 | 9.25 | 10.39 | 11.82 |
| **30** | 12.16 | 13.30 | 14.72 | 9.57 | 10.81 | 12.27 | 7.51 | 8.93 | 10.25 |
| **60** | 9.71 | 11.03 | 12.40 | 9.00 | 10.19 | 11.43 | 9.24 | 10.50 | 12.01 |
| **90** | 10.16 | 11.21 | 12.25 | 9.76 | 10.77 | 11.82 | 8.89 | 10.14 | 11.56 |
| **120** | 10.90 | 11.86 | 12.87 | 10.80 | 11.78 | 12.79 | 9.75 | 11.10 | 12.42 |
| **150** | 10.81 | 11.84 | 12.89 | 12.59 | 13.92 | 15.02 | 11.60 | 13.07 | 14.45 |
| **180** | 10.34 | 11.61 | 12.70 | 13.05 | 14.12 | 15.40 | 11.84 | 13.02 | 14.18 |
| **210** | 11.21 | 12.52 | 13.73 | 10.95 | 12.11 | 13.27 | 12.16 | 13.24 | 14.35 |
| **240** | 11.20 | 12.24 | 13.35 | 11.70 | 12.68 | 13.75 | 12.00 | 13.12 | 14.29 |
| **270** | 10.24 | 11.24 | 12.36 | 10.25 | 11.02 | 11.95 | 11.46 | 12.70 | 13.94 |
| **300** | 9.85 | 11.19 | 12.56 | 10.18 | 11.12 | 12.08 | 10.88 | 11.93 | 13.19 |
| **330** | 10.02 | 11.35 | 12.66 | 9.65 | 10.79 | 11.88 | 11.25 | 12.38 | 13.56 |

**Table 9.19** Region 4: 95% confidence limits for mean monthly wind speed by direction, October to December

## Confidence limits for Region 5 Coasts of Northwest Africa & Southern Iberia

| Direction | lower Jan | mean Jan | upper Jan | lower Feb | mean Feb | upper Feb | lower Mar | mean Mar | upper Mar |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 5.22 | 5.83 | 6.36 | 5.82 | 6.55 | 7.34 | 6.71 | 7.26 | 7.87 |
| **30** | 6.67 | 7.29 | 7.86 | 6.41 | 7.06 | 7.71 | 7.88 | 8.52 | 9.17 |
| **60** | 7.36 | 8.00 | 8.71 | 6.37 | 7.08 | 7.87 | 7.38 | 8.09 | 8.80 |
| **90** | 6.00 | 6.64 | 7.35 | 6.41 | 7.22 | 8.22 | 7.48 | 8.41 | 9.43 |
| **120** | 5.19 | 5.91 | 6.67 | 5.04 | 5.60 | 6.22 | 5.35 | 6.08 | 6.93 |
| **150** | 6.69 | 7.43 | 8.17 | 3.78 | 4.24 | 4.75 | 5.69 | 6.41 | 7.23 |
| **180** | 7.84 | 8.56 | 9.51 | 5.03 | 5.70 | 6.44 | 6.38 | 7.18 | 8.04 |
| **210** | 8.74 | 9.58 | 10.47 | 7.55 | 8.39 | 9.40 | 5.96 | 6.98 | 8.08 |
| **240** | 10.31 | 11.25 | 12.21 | 7.56 | 8.47 | 9.31 | 7.18 | 8.20 | 9.22 |
| **270** | 9.75 | 10.92 | 12.33 | 7.85 | 8.99 | 10.06 | 7.07 | 7.84 | 8.75 |
| **300** | 7.62 | 8.56 | 9.46 | 7.60 | 8.47 | 9.46 | 7.25 | 7.88 | 8.64 |
| **330** | 3.86 | 4.55 | 5.33 | 6.63 | 7.61 | 8.57 | 6.92 | 7.63 | 8.31 |

**Table 9.20** Region 5: 95% confidence limits for mean monthly wind speed by direction, January to March

| Direction | lower Apr | mean Apr | upper Apr | lower May | mean May | upper May | lower Jun | mean Jun | upper Jun |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 7.22 | 7.83 | 8.43 | 6.61 | 7.12 | 7.73 | 6.98 | 7.54 | 8.14 |
| **30** | 7.60 | 8.27 | 8.98 | 8.19 | 8.80 | 9.36 | 7.78 | 8.34 | 8.89 |
| **60** | 7.83 | 8.63 | 9.39 | 8.40 | 9.03 | 9.73 | 7.58 | 8.22 | 8.86 |
| **90** | 6.42 | 7.36 | 8.17 | 4.12 | 4.97 | 5.82 | 2.72 | 3.19 | 3.78 |
| **120** | 3.43 | 4.00 | 4.59 | 3.01 | 3.39 | 3.81 | 1.91 | 2.14 | 2.37 |
| **150** | 3.08 | 3.45 | 3.77 | 3.47 | 3.90 | 4.33 | 3.08 | 3.41 | 3.82 |
| **180** | 5.36 | 6.04 | 6.78 | 6.16 | 6.87 | 7.64 | 2.64 | 2.92 | 3.23 |
| **210** | 8.18 | 9.24 | 10.32 | 6.25 | 6.88 | 7.54 | 3.90 | 4.50 | 5.14 |
| **240** | 7.94 | 8.94 | 9.86 | 5.19 | 5.83 | 6.49 | 4.43 | 4.98 | 5.61 |
| **270** | 6.73 | 7.56 | 8.40 | 4.66 | 5.22 | 5.73 | 4.21 | 4.66 | 5.08 |
| **300** | 5.80 | 6.51 | 7.28 | 4.27 | 4.82 | 5.34 | 4.84 | 5.30 | 5.74 |
| **330** | 5.95 | 6.58 | 7.22 | 5.12 | 5.65 | 6.28 | 6.00 | 6.62 | 7.19 |

**Table 9.21** Region 5: 95% confidence limits for mean monthly wind speed by direction, April to June

| Direction | lower Jul | mean Jul | upper Jul | Lower Aug | mean Aug | upper Aug | lower Sep | mean Sep | upper Sep |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 7.75 | 8.36 | 9.00 | 7.25 | 7.81 | 8.39 | 6.18 | 6.66 | 7.13 |
| **30** | 8.48 | 9.06 | 9.65 | 6.91 | 7.45 | 7.93 | 6.97 | 7.53 | 8.08 |
| **60** | 9.07 | 9.61 | 10.14 | 7.02 | 7.48 | 7.99 | 6.80 | 7.41 | 8.00 |
| **90** | 8.82 | 9.26 | 9.66 | 5.27 | 5.83 | 6.39 | 4.13 | 4.71 | 5.38 |
| **120** | 0.08 | 0.09 | 0.10 | 2.63 | 2.93 | 3.24 | 3.59 | 4.06 | 4.53 |
| **150** | 0.09 | 0.09 | 0.10 | 3.30 | 3.60 | 3.93 | 4.53 | 5.10 | 5.61 |
| **180** | 1.37 | 1.55 | 1.76 | 2.91 | 3.19 | 3.49 | 4.72 | 5.28 | 5.84 |
| **210** | 2.21 | 2.37 | 2.52 | 3.43 | 3.73 | 4.05 | 4.93 | 5.54 | 6.09 |
| **240** | 4.82 | 5.37 | 6.07 | 3.18 | 3.54 | 3.86 | 4.65 | 5.19 | 5.81 |
| **270** | 4.20 | 4.66 | 5.10 | 3.83 | 4.18 | 4.49 | 3.94 | 4.42 | 4.97 |
| **300** | 4.87 | 5.31 | 5.66 | 4.22 | 4.53 | 4.82 | 4.37 | 4.92 | 5.42 |
| **330** | 6.00 | 6.59 | 7.19 | 5.36 | 5.83 | 6.28 | 4.92 | 5.37 | 5.86 |

**Table 9.22** Region 5: 95% confidence limits for mean monthly wind speed by direction, July to September

| Direction | lower Oct | mean Oct | upper Oct | lower Nov | mean Nov | upper Nov | lower Dec | mean Dec | upper Dec |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 5.30 | 5.77 | 6.22 | 5.26 | 5.84 | 6.43 | 5.20 | 5.75 | 6.32 |
| **30** | 5.89 | 6.45 | 7.03 | 6.59 | 7.16 | 7.71 | 6.59 | 7.34 | 7.99 |
| **60** | 5.85 | 6.48 | 7.04 | 6.87 | 7.37 | 7.88 | 6.21 | 6.86 | 7.57 |
| **90** | 4.71 | 5.20 | 5.77 | 6.38 | 7.03 | 7.58 | 5.33 | 5.87 | 6.45 |
| **120** | 3.90 | 4.57 | 5.29 | 4.89 | 5.52 | 6.25 | 5.37 | 6.33 | 7.26 |
| **150** | 4.73 | 5.49 | 6.30 | 6.41 | 7.17 | 8.02 | 6.96 | 7.75 | 8.53 |
| **180** | 6.06 | 6.82 | 7.69 | 7.10 | 7.89 | 8.76 | 9.46 | 10.42 | 11.51 |
| **210** | 8.01 | 9.01 | 9.99 | 8.32 | 9.18 | 10.21 | 10.00 | 11.06 | 12.19 |
| **240** | 6.99 | 7.79 | 8.64 | 9.25 | 10.36 | 11.48 | 9.23 | 10.26 | 11.38 |
| **270** | 5.14 | 5.96 | 6.70 | 7.96 | 8.95 | 10.17 | 7.22 | 8.14 | 9.30 |
| **300** | 4.06 | 4.46 | 4.93 | 6.19 | 7.01 | 7.96 | 6.60 | 7.54 | 8.55 |
| **330** | 4.46 | 4.91 | 5.40 | 4.43 | 4.94 | 5.51 | 5.67 | 6.39 | 7.13 |

**Table 9.23** Region 5: 95% confidence limits for mean monthly wind speed by direction, October to December

## Confidence limits for Region 6 Coasts of Eastern Mediterranean

| Direction | lower Jan | mean Jan | upper Jan | lower Feb | mean Feb | upper Feb | lower Mar | mean Mar | upper Mar |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 7.98 | 8.68 | 9.40 | 8.04 | 8.87 | 9.72 | 6.15 | 6.97 | 7.89 |
| **30** | 6.96 | 7.60 | 8.30 | 7.32 | 8.12 | 8.97 | 5.08 | 5.69 | 6.33 |
| **60** | 5.15 | 5.77 | 6.39 | 4.58 | 5.28 | 5.99 | 4.38 | 4.85 | 5.34 |
| **90** | 5.36 | 5.81 | 6.37 | 5.15 | 5.58 | 6.13 | 5.07 | 5.72 | 6.29 |
| **120** | 6.61 | 7.39 | 8.14 | 6.15 | 6.99 | 7.95 | 6.29 | 7.09 | 8.02 |
| **150** | 6.21 | 6.90 | 7.68 | 8.61 | 9.66 | 10.67 | 6.91 | 7.77 | 8.47 |
| **180** | 6.50 | 7.39 | 8.23 | 9.11 | 9.94 | 10.90 | 7.66 | 8.47 | 9.28 |
| **210** | 8.45 | 9.40 | 10.40 | 8.36 | 9.41 | 10.45 | 7.33 | 8.15 | 9.10 |
| **240** | 8.79 | 9.75 | 10.71 | 8.01 | 8.86 | 9.78 | 7.60 | 8.69 | 9.69 |
| **270** | 5.66 | 6.33 | 7.10 | 5.39 | 5.88 | 6.43 | 6.24 | 6.92 | 7.61 |
| **300** | 5.37 | 6.06 | 6.75 | 6.51 | 7.22 | 7.95 | 6.19 | 6.77 | 7.49 |
| **330** | 6.66 | 7.21 | 7.83 | 8.19 | 9.05 | 10.00 | 6.79 | 7.54 | 8.38 |

**Table 9.24** Region 6 95% confidence limits for mean monthly wind speed by direction, January to March

| Direction | lower Apr | mean Apr | upper Apr | lower May | mean May | upper May | lower Jun | mean Jun | upper Jun |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 5.19 | 5.81 | 6.52 | 5.38 | 5.93 | 6.58 | 7.35 | 7.86 | 8.32 |
| **30** | 4.76 | 5.29 | 5.86 | 3.23 | 3.75 | 4.32 | 4.17 | 4.84 | 5.54 |
| **60** | 3.56 | 4.04 | 4.60 | 3.15 | 3.76 | 4.51 | 3.20 | 3.57 | 3.99 |
| **90** | 4.89 | 5.39 | 5.95 | 3.92 | 4.54 | 5.38 | 3.21 | 3.50 | 3.81 |
| **120** | 6.47 | 7.25 | 8.04 | 4.99 | 5.62 | 6.22 | 4.26 | 4.70 | 5.21 |
| **150** | 7.86 | 8.70 | 9.66 | 6.24 | 6.92 | 7.62 | 5.07 | 5.56 | 6.11 |
| **180** | 6.47 | 7.20 | 7.85 | 6.06 | 6.85 | 7.69 | 4.01 | 4.48 | 5.01 |
| **210** | 5.46 | 6.18 | 7.02 | 4.40 | 5.02 | 5.69 | 3.23 | 3.64 | 4.10 |
| **240** | 5.76 | 6.56 | 7.35 | 4.46 | 4.99 | 5.58 | 4.17 | 4.68 | 5.27 |
| **270** | 5.41 | 5.91 | 6.47 | 4.93 | 5.45 | 6.06 | 5.52 | 5.95 | 6.42 |
| **300** | 5.65 | 6.19 | 6.84 | 6.21 | 6.68 | 7.13 | 6.31 | 6.71 | 7.17 |
| **330** | 5.58 | 6.12 | 6.68 | 6.16 | 6.65 | 7.12 | 7.19 | 7.62 | 8.08 |

**Table 9.25** Region 6 95% confidence limits for mean monthly wind speed by direction, April to June

| Direction | lower Jul | mean Jul | upper Jul | lower Aug | mean Aug | upper Aug | lower Sep | mean Sep | upper Sep |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 8.92 | 9.40 | 9.86 | 8.54 | 8.93 | 9.31 | 7.42 | 7.92 | 8.52 |
| **30** | 8.39 | 8.84 | 9.27 | 8.43 | 8.87 | 9.29 | 6.34 | 7.02 | 7.73 |
| **60** | 3.77 | 3.99 | 4.21 | 0.07 | 0.08 | 0.08 | 3.54 | 4.10 | 4.66 |
| **90** | 0.75 | 0.77 | 0.79 | 0.09 | 0.10 | 0.11 | 3.85 | 4.38 | 4.89 |
| **120** | 0.67 | 0.69 | 0.70 | 0.09 | 0.10 | 0.11 | 3.73 | 4.05 | 4.38 |
| **150** | 2.21 | 2.37 | 2.54 | 0.07 | 0.08 | 0.09 | 3.69 | 4.01 | 4.33 |
| **180** | 2.15 | 2.33 | 2.49 | 4.92 | 5.08 | 5.24 | 4.11 | 4.60 | 5.13 |
| **210** | 6.93 | 7.08 | 7.23 | 4.57 | 4.75 | 4.94 | 4.11 | 4.73 | 5.42 |
| **240** | 6.11 | 6.53 | 7.00 | 6.18 | 6.59 | 6.96 | 4.44 | 4.99 | 5.61 |
| **270** | 5.82 | 6.17 | 6.50 | 5.82 | 6.12 | 6.45 | 5.01 | 5.44 | 5.83 |
| **300** | 7.47 | 7.91 | 8.30 | 6.83 | 7.20 | 7.65 | 5.53 | 5.91 | 6.23 |
| **330** | 8.78 | 9.26 | 9.71 | 7.96 | 8.37 | 8.77 | 7.03 | 7.50 | 7.98 |

**Table 9.26** Region 6 95% confidence limits for mean monthly wind speed by direction, July to September

| Direction | lower Oct | mean Oct | upper Oct | lower Nov | mean Nov | upper Nov | lower Dec | mean Dec | upper Dec |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 5.52 | 6.18 | 6.80 | 7.18 | 7.96 | 8.73 | 7.76 | 8.53 | 9.35 |
| **30** | 4.68 | 5.28 | 5.81 | 5.85 | 6.65 | 7.54 | 5.72 | 6.35 | 6.96 |
| **60** | 3.37 | 3.81 | 4.18 | 4.09 | 4.54 | 5.14 | 4.28 | 4.70 | 5.14 |
| **90** | 3.63 | 3.96 | 4.31 | 3.28 | 3.73 | 4.25 | 4.02 | 4.46 | 4.83 |
| **120** | 3.74 | 4.21 | 4.66 | 4.53 | 5.18 | 5.89 | 4.35 | 4.74 | 5.22 |
| **150** | 4.95 | 5.56 | 6.24 | 6.02 | 6.61 | 7.14 | 6.55 | 7.27 | 8.04 |
| **180** | 4.94 | 5.49 | 6.17 | 6.52 | 7.18 | 7.81 | 8.48 | 9.50 | 10.52 |
| **210** | 4.80 | 5.44 | 6.11 | 7.75 | 8.59 | 9.47 | 8.40 | 9.16 | 9.96 |
| **240** | 4.41 | 4.93 | 5.47 | 7.10 | 7.72 | 8.48 | 7.47 | 8.37 | 9.30 |
| **270** | 4.32 | 4.69 | 5.09 | 4.68 | 5.13 | 5.65 | 5.14 | 5.77 | 6.38 |
| **300** | 4.84 | 5.30 | 5.80 | 5.05 | 5.55 | 6.08 | 6.23 | 6.90 | 7.59 |
| **330** | 6.12 | 6.79 | 7.41 | 6.50 | 7.22 | 7.95 | 6.68 | 7.53 | 8.50 |

**Table 9.27** Region 6 95% confidence limits for mean monthly wind speed by direction, October to December

## 9.6 References


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