EVALUATION OF WAVE STATISTICS BY USING TWO WIND DATA SETS FOR MEDITERRANEAN SEA REGION IN TURKEY

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ABSTRACT

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In Turkey, due to lack of on-site wave measurement data, design of coastal structures primary relies on wind measurements. Meteorology and ECMWF are the most commonly used data sources for the data sets, which provide valuable information about wind and wave characteristics. In the scope of this research, these two data sets are chosen to be analysed and compared according to their extreme and long term wave characteristics, in order to see different data sets impact on design process. In this study, seven meteorology stations and their nearby coordinates along Mediterranean coast in Turkey are chosen as inspected regions. After both data sets are acquired from respective sources, these data are processed and formatted to make them ready to be used specifically for wind.exe and W61 programs, which are used for data analysis part of this research. For each selected location, scatter graphs wind roses, extreme and long term analysis are made for both graphical visualization and numerical calculations. Moreover, importance of selected ECWMF coordinates and change of design wave height related to the coordinate is also investigated. The results of research is presented and also outcomes are compared with previous studies to provide a comprehensive point of view in the research topic. In addition to analysis part of study, a further online research of historical storm occasions around

Mediterranean coast of Turkey is conducted, found events and their characteristics are presented and compared with available data sets.

Keywords: Mediterranean Sea, Meteorology, ECMWF, Wind Data, Wave Statistics

ÖZ

TÜRKİYE’NİN AKDENİZ BÖLGESİ İÇİN İKİ RÜZGAR VERİ SETİ KULLANILARAK DALGA DEĞERLERİNİN HESAPLANMASI

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Türkiye’de yerinde yapılan dalga ölçümleri yeterli olmadığından kıyı yapılarının tasarımında rüzgar ölçümleri öncelikli olmaktadır. Rüzgar ve dalga karakterleri hakkında bilgi veren meteoroloji ve ECMWF kaynakları, veri setleri içinde en çok kullanılanlardır. Bu araştırma kapsamında, bu iki veri seti, farklı veri setlerinin tasarım aşamalarına etkisini görebilmek için en yüksek ve uzun dönem dalga karakterlerine göre analiz edilip, karşılaştırılmıştır. Bu çalışmada, Türkiye’nin Akdeniz kıyıları boyunca yedi meteoroloji istasyonu ve yakınlarındaki koordinatlar inceleme bölgeleri olarak seçilmiş, seçilen bu veri setleri, kendi kaynaklarından alındıktan sonra işlenerek ve düzenlenerek araştırmanın analiz kısmında kullanılacak olan wind.exe ve W61 programlarında kullanılmaya hazır hale getirilmiştir. Seçilen her bir bölge için, dağılım grafikleri, rüzgar gülleri, en yüksek ve uzun dönem dalga analizleri hem grafiksel görüntüleme hem de sayısal hesaplamalar için yapılmıştır. Ayrıca, ECMWF koordinatlarının seçiminin önemi ve bu seçimin tasarım dalga boyuna etkisi incelenmiştir. Araştırmadan elde edilen sonuçlar sunulmuş ve geçmiş çalışmalar ile karşılaştırılmıştır. Çalışmanın analiz kısmına ek olarak, Türkiye’nin Akdeniz kıyılarında gözlemlenmiş geçmiş fırtınalara ait araştırma yürütülmüş, bulunan bilgiler ile mevcut veri setleri karşılaştırmalı olarak incelenmiştir.

Anahtar Kelimeler: Akdeniz, Meteoroloji, ECMWF, Rüzgar Verileri, Dalga İstatistiği

To My Family,

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CHAPTER 1

INTRODUCTION

Design wave height prediction is one of the most important and difficult fields of research for coastal engineering. This prediction mostly depends on available wind data sets due to the lack of on-site measurement for many of the shorelines in Turkey. Unreliable wind data sets could cause false design wave height calculation and it leads to an inaccurate design for the project. In other words, using unreliable wind data sets makes it difficult to plan a coastal project in terms of both financial and technical aspects. So, it is important to test and compare wind velocity measurement methods according to their results because of difficulties in gathering wind data sets. For this purpose, two commonly used wind data sets in Turkey which are used in this study are Turkish State Meteorological Service and European Centre for Medium-Range Weather Forecasts (ECMWF) data sets.

ECMWF and meteorological data sets may differ from each other with respect to their measurement methods and points. These differences could cause a divergence in calculated design wave height values. For this reason, a comparison is needed for finding the best data set for different regions. Moreover, it is important to remember that inspecting wave characteristics from available wind data sets could be very helpful for this purpose.

At this point, the effects of the selection of the closest ECMWF points to the meteorological station were also examined in this study for a better understanding of the impact of ECMWF data sets' locations.

For the study area, the coasts of Turkey have been investigated. Due to its touristic and economic importance, Mediterranean Sea region is found to be suitable. After deciding the inspected region, 7 locations are chosen for providing diversity in terms of both geological and wave characteristics. After the selection of location, analysis and comparison are made for all the locations by using both data sets. Moreover, 3 geologically different locations are selected from 7 previous locations for investigating ECMWF's chosen point's effects in long term and for extreme analysis.

In brief, it can be said that this study aims to:

- Investigate differences between the results of two wind data sets and their level of inconsistency.
- Determine the impact of the selected data set on the design wave height value.
- Determine the impact of selected ECMWF points on wave characteristics and design wave height.
- Determine the reliability of different wind data sets by comparing them with historical storm events.

Additionally, the comparison of these study results with on-site buoy measurements is necessary for validation. It can be noted that any significant inconsistency or consistency with on-site buoy measurement will test the reliability of the data sets and reduce uncertainty in these wind data sets. In this study, only two major wind data sets have been analysed and compared due to the lack of on-site buoy measurements.

For these purposes;

- Chapter 2 contains a literature review about past investigation on Mediterranean Sea region of Turkey and the review of the characteristics of used wind data sets.
- Chapter 3 contains the explanation of used programs and the methodology. Besides, in this chapter, the points selected for analysis and comparison are represented.
- Chapter 4 contains the results of the analysis both in graphical and numerical form. The results of extreme and long-term analysis are discussed. Possible reasons for differences and their impacts are examined. In addition, past storm events and wind data sets are compared with each other.
- Chapter 5 contains conclusion and recommendation in the light of the information collected in this study.

CHAPTER 2

LITERATURE REVIEW

In this chapter, general information on used wind measurement data sets and some past studies about the wind and wave characteristics of Turkey's Mediterranean coast are presented.

2.1. WIND MEASUREMENTS

The European Centre for Medium-Range Weather Forecasts (ECMWF) and Turkish State Meteorological Service's wind data sets are used for this study. Even though, they are the most commonly used data sets in Turkey, they obtain their data sets in different ways.

2.1.1. ECMWF

The European Centre for Medium-Range Weather Forecasts (ECMWF) is based in Reading, UK. ECMWF is an international and independent organization. It was established in 1975 and it is currently supported by 34 states. The organization carries out both research and operations about numerical weather predictions and measurements. Moreover, it restores data sets in a supercomputer facility which is the largest of its kind in Europe.

ECMWF makes many different types of archiving activities. In this study, a decision is made to use an operational archive which includes an atmospheric model. In terms of satellite measurement and the speciality of time duration, the atmospheric model has been chosen for the most suitable results for this study. Moreover, it is necessary to mention that the atmospheric model contains thirteen different data sets. Surface analysis data sets are prepared for wind data measurement. So, for this study, the surface analysis data set of atmospheric model which has a 6-hour forecast for each day has been used. (http://www.ecmwf.int/)

2.1.2. Meteorology Stations

Turkish State Meteorological Service's meteorology stations are the most commonly used wind data sets in Turkey. Measurement methods such as radar and satellite images, ground and ship observations have been used by Turkish State Meteorological Service while producing wind data sets and forecasting weather. On the other hand, the data gathered from automatic meteorological observations stations (AMOS) constitutes the majority of Turkish State Meteorological Services wind database. Meteorological Service has 861 AMOSs all across the coasts of Turkey. These stations measure wind velocities and directions 10 m above on land. Then, the AMOSs formed by gathering the data sets from this process are used for weather forecast analysis. (www.mgm.gov.tr)

2.2. PREVIOUS STUDIES ON MEDİTERRANEAN SEA OF TURKEY

A literature review is conducted for Mediterranean Sea region of Turkey with respect to the wind and wave characteristics. There are some studies about the characteristics of the region, but it is important to note that none of the studies analyses Mediterranean Sea region by using either of the data sets. Available studies are summarized and presented below.

"Özhan, E. and Abdalla, S.: Turkish Coast Wind and Deep Water Wave Atlas, 1999" is one of the important studies about the wind and wave characteristics of Turkish coasts. Wave data is presented by using continuous data collection. This study examines yearly and seasonal wind and wave roses. Moreover, extreme and long term analyses are conducted for each location. Long term analysis is conducted made by using the data of 8 years for every 3 hours while extreme analysis is conducted made by using maximum wind velocity and wave height data for 17 years (1979-1995). This field of study is not only Mediterranean Sea region, but Black Sea, Marmara and Aegean Sea regions are also inspected.

"Ergin, A. and Özhan, E.: 15 Deniz Yöresi İçin Dalga Tahminleri ve Tasarım Dalgası Özelliklerinin Belirlenmesi, 1986" is a study inspecting the wave parameters of 15 regions wave by using wave hind cast methods. Meteorology stations' wind data and synoptic maps are used in this study. Extreme analysis is conducted for both wind data and synoptic maps by using Gumbel distribution model. Moreover, significant wave height vs. return period graphs are plotted by using wind data and synoptic maps for 15 regions.

“Alpli, R.: Ege Denizi-Akdeniz Dalga Atlası ve Küresel İklim Değişiminin Dalga İklimine Etkisi, 2011” is a study inspecting the wave characteristics of Aegean and Mediterranean Sea by comparing them with Özhan, E. and Abdalla, S. (1999) study. In this study, the data of 14 years ECMWF wind data sets (1994-2008) is used. Both extreme and long term analyses are conducted and compared with Wave Atlas. Moreover, wind and wave roses are presented in this study.

“Özyurt, G. and Özbahçeci, B.: Tasarım Dalgasının Bulunmasında Dağılım Modelinin Etkisi” is a study inspecting the best distribution type of extreme analysis for Mediterranean, Aegean and Black Sea. The data of 17 years is used in this study for Mediterranean Sea. Results of this study are also compared with Ergin, A. and Özhan, E. (1999) study. Gumbel, Log- normal, Fisher Tippet II (k=2.5, 3.33, 5.0 and 10.0) and Weibull (k=0.75, 1.0, 1.4, and 2.0) are compared and the variability of the best distribution types is analysed.

“Esen, M.: A Comparative Study on Wind and Wave Sources for Turkish Coast” is a study inspecting the reliability of the wind measurements of the meteorology stations in Turkish coasts. Founded results of the extreme and long term analysis are compared with the data set of ECMWF. Besides, wind roses of the inspected regions are compared for validated the quality of wind measurements.

Hence, studies on the wave characteristics analysed and investigated for Turkish coasts of Mediterranean Sea are very limited. Some studies which are not very highly loosely related to this study are also represented here.

“Music, S. and Nickovic, S.: 44 Year Wave Hindcast for the Eastern Mediterranean, 2008” is a study inspecting different areas in Mediterranean Sea by using the wind data set of 44 years for an EU Project called HIPOCAS (Hind cast of Dynamic Process of the Ocean and Coastal Areas of Europe). For this study, wind data is generated from REMO (regional atmospheric model) and analysed with WAM (third generation wave model). The whole Mediterranean region is inspected for this steady. On the other hand, Eastern Mediterranean inspected grid resolution is higher than others Mediterranean resolutions. Resulting wave heights of the study are compared with in-situ and satellite measurements.

“Ayat, B.: Wave Power Atlas of Eastern Mediterranean and Aegean Seas, 2012” is a study for obtaining the potential of wave energy in Eastern Mediterranean and Aegean Sea. For this study, the ECMWF wind data of 15 years is used. Wave characteristics are determined and wave roses are presented for Alanya, Dalaman and Bozcaada.

“Akbaşoğlu, S.: Short Term Statistics of Wind Waves around the Turkish Coast, 2004” is a study where wave characteristics are analysed and compared with model distribution for three regions Alanya, Dalaman and Hopa. Moreover, in Akbaşoğlu, S. (2004) study, the joint probability distribution of individual wave heights and the periods of analysed regions are included and compared with theoretical distributions.

CHAPTER 3

DATA SETS, PROGRAMS and METHODOLOGY

3.1. DATA SETS:

Seven different regions and their meteorology stations have been selected for this study. The selection of the meteorology stations is made according to the location of stations and the stability of their data sets. The study of Esen, M. (ICCE 2014) was used while deciding the used meteorology stations. The data sets of some stations have some time gap due to this reason for a detail inspection of the wave characteristics of these data sets which are not suitable for analysis. Following this selection, seven different coordinates for each of the selected meteorology stations have been selected for specifying the used ECMWF coordinates. The data sets of meteorology stations are gathered from Turkish Meteorological Service while ECMWF data sets are gathered from its website (http://apps.ecmwf.int/datasets/).

Figure 3.1. General View of Selected Meteorology Stations

3.1.1. Meteorology Data Sets

Wind velocities and their directions are measured hourly at 10 m above land by Turkish Meteorological Service within their stations.

Selected meteorology stations and their numbers can be seen at Table 3.1.

Table 3.1. General Information on Meteorology Stations

Station Name	Station Number	Measurement Start Date	Measurement End Date
Mersin - Anamur	17320	1.11.1966	31.3.2009
Antalya - Finike	17375	1.1.2000	30.4.2011
Antalya - Gazipaşa	17974	1.1.2000	31.12.2010
Hatay - İskenderun	17370	1.1.2000	31.12.2010
Mersin - Yenişehir	17340	1.1.2000	31.12.2010
Adana - Karataş	17981	1.12.1973	31.3.2009
Adana - Yumurtalık	17979	1.12.1982	31.3.2009

Moreover, it can be easily seen in Table 3.1 that different stations have different start and end measurement dates. The inconsistency of measurement dates makes it harder to compare meteorology data sets with other data sets. For handling this problem, in this study, every comparison is made with time period on how both data sets are sorted together.

The data sets of meteorology stations data sets are formed in seven columns; station number, year, month, day, hour, wind velocity and wind direction. The data set of this text document is shown as an example sample in Figure 3.2.

```
17320;1966;11;1;0;4.9;N
17320;1966;11;1;1;5.1;N
17320;1966;11;1;2;5.0;N
17320;1966;11;1;3;5.1;N
17320;1966;11;1;4;4.5;N
17320;1966;11;1;5;4.1;N
17320;1966;11;1;6;3.7;N
17320;1966;11;1;7;3.2;N
17320;1966;11;1;8;2.9;N
17320;1966;11;1;9;3.2;ESE
17320;1966;11;1;10;7.4;E
17320;1966;11;1;11;7.1;E
17320;1966;11;1;12;7.8;E
```

Figure 3.2. General Appearance of Meteorology Data Set

In this study, used programs are compatible with meteorology data set. Except, for a certain organizing process of data set, it is easier to use these programs with meteorological data set other than data sets.

3.1.2. ECMWF Data Sets

ECMWF data sets are created by pressure values which are gathered from satellites. In these data sets, wind velocities can be found every six hours. In this perspective, ECMWF data points can be found in the form of coordinates.

According to the selected meteorology stations, seven coordinates which are closest to a station, are selected. For ensuring to avoid the land effect for the selected ECMWF data sets, coordinates have been selected on the sea area. At this point, it is important to remember that ECMWF data points represent an area of 0.1 degree square which means that ECMWF data set of 36.00N and 32.90E represents the area between 36.05N - 32.95E and 35.95N - 32.85E

ECMWF data sets can provide horizontal (u) and vertical (v) wind velocity values. Each value also has a plus and minus sign which indicates the direction. For these data sets, plus means north and east direction.

Selected coordinates and general information on ECMWF Data points can be found in the following Table 3.2;

Table 3.2. General Information on ECMWF Data Points

Closest Station Name	Coordinate	Measurement Start Date	Measurement End Date
MERSİN-Anamur	36.00N-32.90E	1.1.1983	10.31.2013
ADANA-Karataş	36.50N-35.40E	1.1.1983	10.31.2013
ADANA-Yumurtalık	36.70N-35.80E	1.1.1983	10.31.2013
ANTALYA-Finike	36.30N-30.20E	1.1.1983	10.31.2013
ANTALYA-Gazipaşa	36.20N-32.30E	1.1.1983	10.31.2013
HATAY-İskenderun	36.60N-36.10E	1.1.1983	10.31.2013
MERSİN-Yenişehir	36.70N-34.60E	1.1.1983	10.31.2013

Exact locations for both meteorology and ECMWF data sets are presented in the following figures which are listed from Figure 3.3 to Figure 3.9.

ECMWF data sets obtained from 36.00N-32.90E have been used to compare Mersin – Anamur meteorology station which is approximately 9.5 km away.

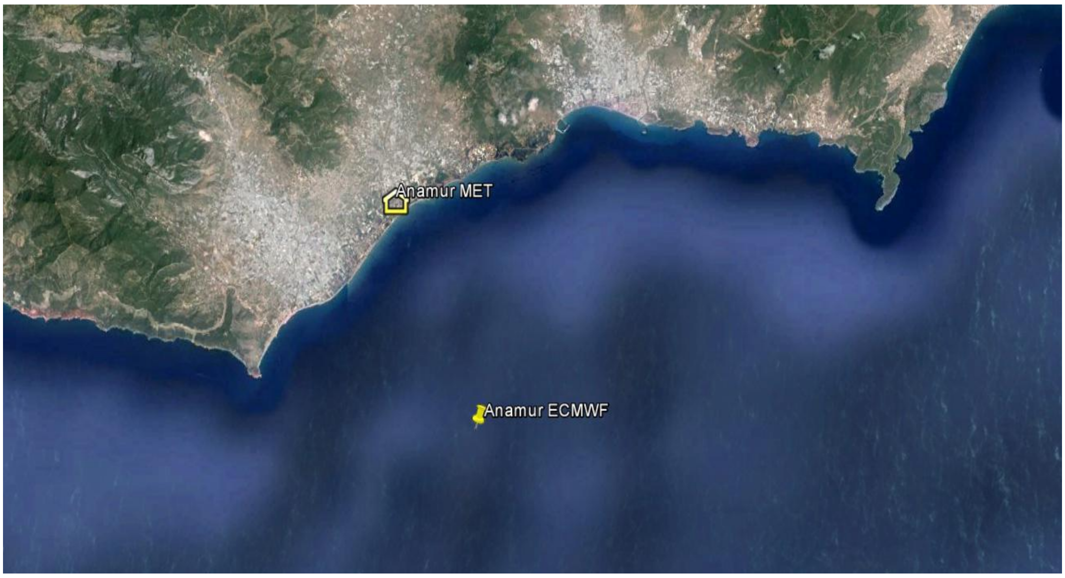


Figure 3.3. Mersin-Anamur Measurements Points

ECMWF data sets obtained from 36.50N-35.40E have been used to compare Adana – Karataş meteorology station which is approximately 8 km away.

Figure 3.4. Adana-Karataş Measurements Points

ECMWF data sets obtained from 36.70N-35.80E have been used to compare Adana-Yumurtalık meteorology station which is approximately 8 km away.

Figure 3.5. Adana-Yumurtalık Measurements Points

ECMWF data sets obtained from 36.30N-30.20E have been used to compare Antalya-Finike meteorology station which is approximately 5 km away.

Figure 3.6. Antalya-Finike Measurements Points

ECMWF data sets obtained from 36.30N-32.30E have been used to compare Antalya-Gazipaşa meteorology station which is approximately 10 km away.

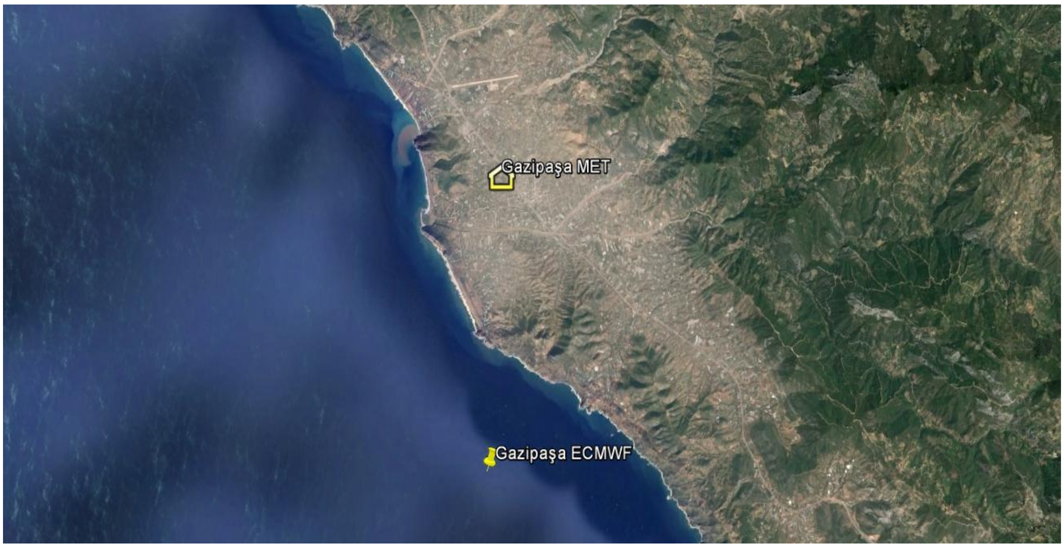


Figure 3.7. Antalya-Gazipaşa Measurements Points

ECMWF data sets obtained from 36.60N-36.10E have been used to compare Hatay-İskenderun meteorology station which is approximately 5 km away.

Figure 3.8. Hatay-İskenderun Measurements Points

ECMWF data sets are obtain from 36.70N-34.60E was used to compare Mersin-Yenişehir meteorology station which is approximately 10 km away.

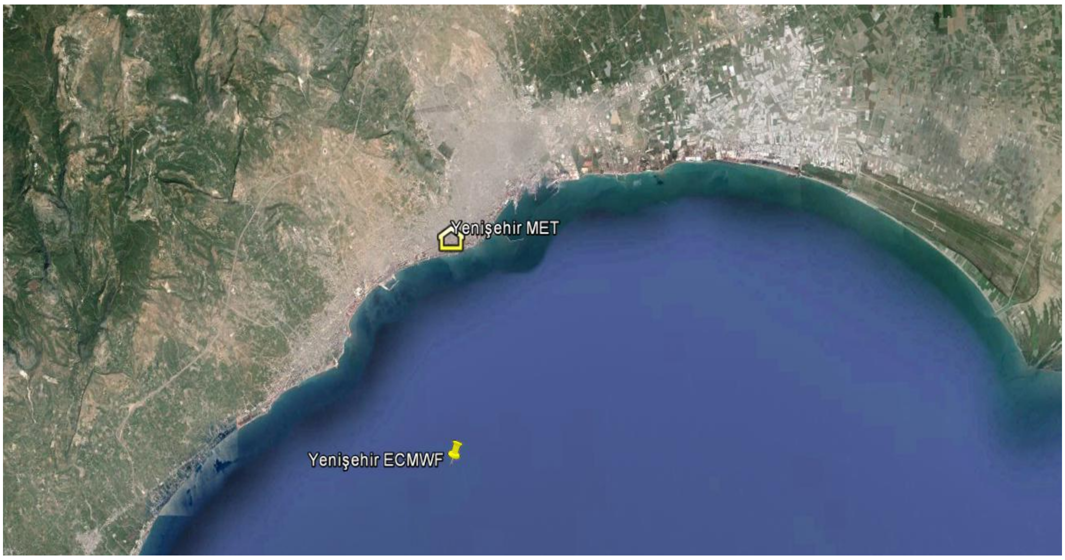


Figure 3.9. Mersin-Yenişehir Measurements Points

Used programs are not totally compatible with ECMWF data sets. For this region, some arrangements and calculations are performed on ECMWF data sets before the analysis of the data sets. These calculations are explained in sections 3.3.1 and 3.3.2.

3.2. PROGRAMS

For organization and analysis process, two different programs have been used in this study. These programs are wind.exe and W61 which allow the creation and analysis of wave data sets obtained from wind data sets.

3.2.1. Wind.exe

This program is used prior to W61. Basically, it organizes wind data to find out the individual storms.

As an input, wind.exe needs a wind data set with a .dat file extension. This input file should be in the format of a meteorology data set. In addition, this program make it possible to change three different parameters about wind data sets minimum storm velocity, wave height group interval and period group interval. It should also be noted that wind.exe needs fetch distances depending on their directions for organizing and determining the durations of storms.

As an output, wind.exe creates a txt file for each year. This output file contains the duration of storms and wind velocities for each storm together with their start and end dates. A part of output file can be seen in Figure 3.10.

```
  15    9    1 1988    7   12    1 1988   64
13 31 13 39 13 48 13 56 13 64 13 70 13 76 13 81 13 86 13 91 13 95 13 99
13102 13105 13106 13106 13104 13100 13 96 13 92 13 89 13 86 13 84 13 83
14 82 14 82 14 82 14 82 14 83 14 83 13 84 13 84 13 82 13 80 13 76 13 71
13 66 14 61 14 56 14 52 14 51 14 51 15 52 15 55 15 57 15 58 15 58 15 57
15 55 15 53 15 51 14 49 14 49 14 48 14 48 14 47 14 47 14 46 14 45 14 43
13 41 13 39 13 37 13 33
  18   12    1 1988   16   13    1 1988   22
20 31 21 37 21 44 21 51 21 56 21 61 22 63 22 62 22 59 22 55 22 51 22 47
22 44 22 44 22 45 22 46 22 47 22 48 21 47 21 44 21 38 21 32
  19   14    1 1988   22   14    1 1988    3
13 32 13 36 13 41
   7   15    1 1988   13   15    1 1988    6
13 46 13 48 13 51 13 54 13 55 13 56
  14   20    1 1988   15   20    1 1988    1
21 30
   9   22    1 1988    3   23    1 1988   18
20 30 20 36 21 42 21 47 21 49 21 50 21 49 21 48 21 46 21 44 21 44 21 43
20 43 20 43 20 42 20 40 19 35 19 30
   8   23    1 1988   23   24    1 1988   39
18 36 18 46 18 57 18 66 18 73 18 77 18 78 18 77 18 75 18 73 17 70 17 67
17 63 17 59 18 54 18 50 18 46 18 41 18 37 18 34 18 33 18 34 18 37 18 44
18 53 18 62 18 72 18 80 19 84 19 85 19 82 19 77 19 70 20 62 20 54 20 47
21 40 21 34 22 30
   6   25    1 1988   18   25    1 1988   12
22 33 22 40 22 48 22 56 22 64 22 69 22 72 22 72 22 69 22 65 22 60 22 55
```

Figure 3.10. Example Output of Wind.exe Program

With regard to this output file, the first row shows the start and end time of determined storm while the last column of the first row shows the duration of that specific storm. This first row is like a heading for a storm, below this row, the hourly direction and velocities of storm can be seen. The first pair of 2 digit number indicates the direction while the second pair of number indicates velocity.

In this study, the minimum value for storm velocity is chosen as 30 dm/s. For a better understanding of wave characteristic for all directions, this value is chosen relatively low.

For fetch distance part of wind.exe, it is necessary to say that for both data sets, the same fetch distances are taken into account. These fetch distances are taken from the closest shoreline for each meteorology station. This fetch approximation could cause negligible fetch error due to the fact that the ECMWF coordinates which are closest to a meteorology station have been chosen. Used fetch distances for selected stations are shown in Chapter 4.2.

As an example, a screen shot of wind.exe user interface can be seen below Figure 3.11.

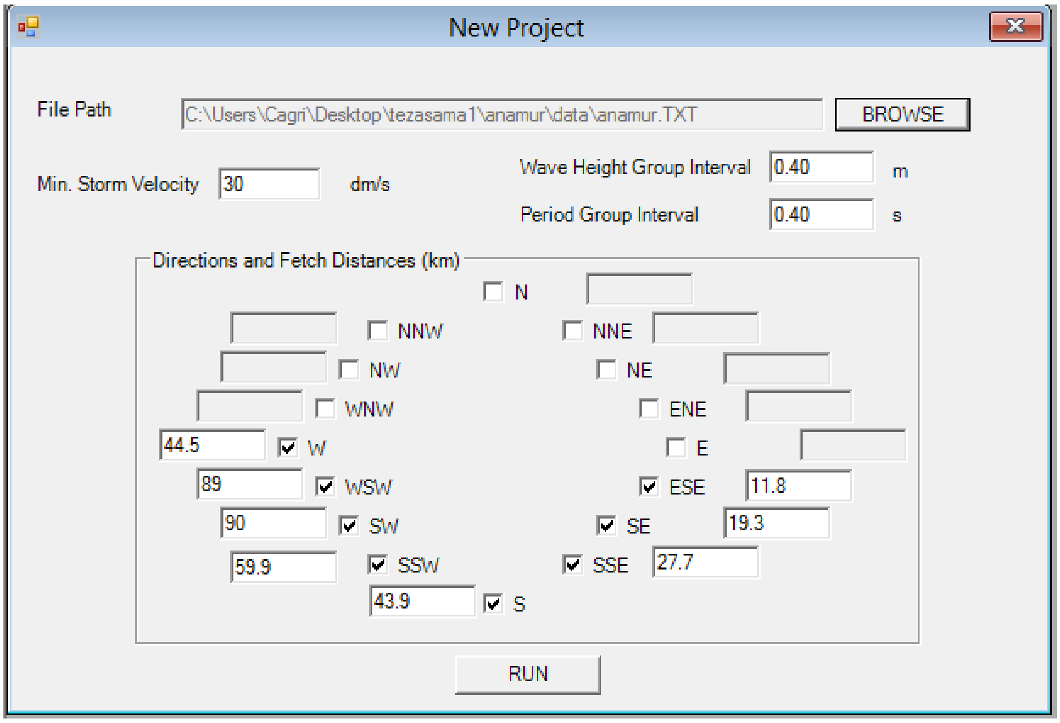


Figure 3.11. Wind.exe User Interface

3.2.2. W61

This program is an open source FORTRAN code. It basically uses wind to wave transformation created by METU, Coastal Engineering Department. W61 needs only one input file which is the output file of wind.exe. For this reason, W61 can transform wind to wave for each separate year. After running the program, it creates five different output files. These files contain individual Hs and Ts values for each wave and storm, average velocity, date, duration of each storm and finally a table of cumulative wave numbers for each year which is grouped by directions.

As mentioned earlier, chosen ECMWF coordinates are on the above sea area while meteorology stations measure wind velocities on land. For this reason, the boundary conditions of meteorology and ECMWF data sets are different. In order to reflect this land effect into calculations for meteorology data sets, an empirical equation has been used in the code. By using that empirical formula (Hsu, 1980), land measurements can be converted to sea measurements.

$$U_{sea} = 3 * (U_{land})^{2/3}$$

By using W61 output files, comparison and analysis have been made in this study for both extreme and long term analyses.

3.3. RE-ARRANGEMENT of DATA SETS

As mentioned earlier, the start and end dates of meteorology data sets are different from each other. On the other hand, all of ECMWF data sets start in 1983 and end in 2013 for all coordinates. For conducting an appropriate comparison, the start and end dates of both data sets are balanced with each other. The data sets of meteorology stations are trimmed before 1983 and the start and end dates of ECMWF data sets are trimmed according to their relevant meteorology stations.

3.3.1. Corrections for Data Sets

In this part, the corrections applied on data sets for rendering them compatible with the programs that are used are explained.

3.3.1.1. Meteorology Data Set

Meteorology data format and the used programs are already compatible with each other. For this reason, a correction process has not been applied on meteorology data sets.

3.3.1.2. ECMWF Data Set

The correction of ECMWF data sets includes some major changes in data set format. Acquired ECMWF data sets have wind measurement every six hours. On the other hand, used programs demand hourly data. For this reason, spline method is used for converting six hour data to hourly data. This process has been carried out by using a MatLAB code which is developed by Coastal Engineering Department, METU.

Secondly, the modification of represented direction type is made for ECMWF data set. In ECMWF data set, wind directions are indicated with plus and minus wind velocity components. For converting this component to degrees, arctan method has been used on MatLAB. After this calculation, these degrees are transformed into letters which indicate wind directions.

Lastly, for finding the resulting wind velocity, simple Euclid's formula has been used, because wind.exe requires the resulting wind velocity with its direction.

$$U = \sqrt{u^2 + v^2}$$

```
17232;1983;1;1;0;4.8952;N
17232;1983;1;1;1;5.058;N
17232;1983;1;1;2;5.1622;N
17232;1983;1;1;3;5.2106;N
17232;1983;1;1;4;5.2121;N
17232;1983;1;1;5;5.179;N
17232;1983;1;1;6;5.1262;N
17232;1983;1;1;7;5.0694;N
17232;1983;1;1;8;5.0247;N
17232;1983;1;1;9;5.0066;NNW
17232;1983;1;1;10;5.0274;NNW
17232;1983;1;1;11;5.096;NNW
17232;1983;1;1;12;5.2176;NNW
17232;1983;1;1;13;5.3892;NNW
17232;1983;1;1;14;5.5876;NNW
17232;1983;1;1;15;5.7851;NNW
17232;1983;1;1;16;5.9554;NNW
17232;1983;1;1;17;6.0734;NNW
17232;1983;1;1;18;6.1149;NNW
17232;1983;1;1;19;6.0642;NNW
```

Figure 3.12. Final ECMWF Data after Re-Arrangement

3.3.2 Methodology

After determining data sets and programs, a standard methodology has been implemented. Below, the process of implementation is explained step by step.

1 - Data sets have been organized for a more simple and understandable graphical comparison. Moreover, some calculations are made on ECMWF data sets for rendering them compatible with the programs which are used.

2 - Graphical comparison is made by using wind data sets (Time series graphs, wind roses and radar graphs).

3 - Wind.exe output files are prepared in order to use them as input files for w61.

4 - Output files of w61 are used for making extreme and long term analysis of the selected point.

5 – By using an excel file, the tables and graphs of extreme and long term analysis have been prepared for every station and coordinate.

6 – The tables and graphs of extreme and long term analysis have been discussed for every inspected point.

7 – Final results and recorded historical storms are compared.

CHAPTER 4

COMPARISON AND ANALYSIS

In this chapter, discussion about the results of graphical and numerical analysis has been made. As described in the third chapter, seven stations and the coordinates which are close to them are analysed. For a better understanding of their wind and wave characteristics, time series scatter graphs and wind roses are presented. Numerical calculations about extreme and long term analysis and their results are shown in comparison with the results of past studies. Moreover, uncertainties in relation to wind data due to the selection of ECMWF coordinate are also investigated. At the end of the chapter, an additional comparison has also been made between historical storm events and the results of both data sets in this study.

4.1. GRAPHICAL COMPARISON AND DISCUSSION

4.1.1. Comparison and Discussion about Time Series

For the visualization of wind data, time series graphs are drawn. The aim of this part of the study is to see the general difference between two data sets in a clear way. On the other hand, both data sets have many measurements for this reason, three different months (April, August and December) are selected from three different years (1988, 1996 and 2004) for Anamur, Karataş and Yumurtalık regions. Moreover, it should be noted that due to the lack of measurements for the data sets for Finike, Gazipaşa, İskenderun and Mersin stations, all 12 months of 2004 has been selected for the purpose of this part.

For example, only December 2004 has been presented in this part, the remaining graphs can be found in the Appendix A. All graphs consist of one hour meteorology data, one hour ECMWF data and six hour ECMWF data. For this study, 9.5, 5 and 3 m/s have been chosen as threshold values. 9.5 m/s represents stormy weather while between 5 m/s to 3 m/s represents calmly weather.

In relation to the time series, it is important to note in these graphs that directions are not considered. The inspection of these graphs could not demonstrate the importance of wind directions. Wind velocities vs. time are presented in the time series.

Mersin – Anamur:

The wind data comparison of both data sets can be seen in the following scatter graph for December 2004 in Figure 4.1. Based on the time series graph, ECMWF and meteorology data sets provide similar results if there is calm or relatively low wind velocity. Besides, when the wind velocity measurement is increased, ECMWF gives more critical results. Both data sets show stormy weather at the same time, but ECMWF measurement shows storms as more powerful when compared meteorology data sets. It is easy to say that during calm weather, both data sets follow the same pattern it is expected that the extreme analysis of ECMWF data will give higher results in terms of wave height.

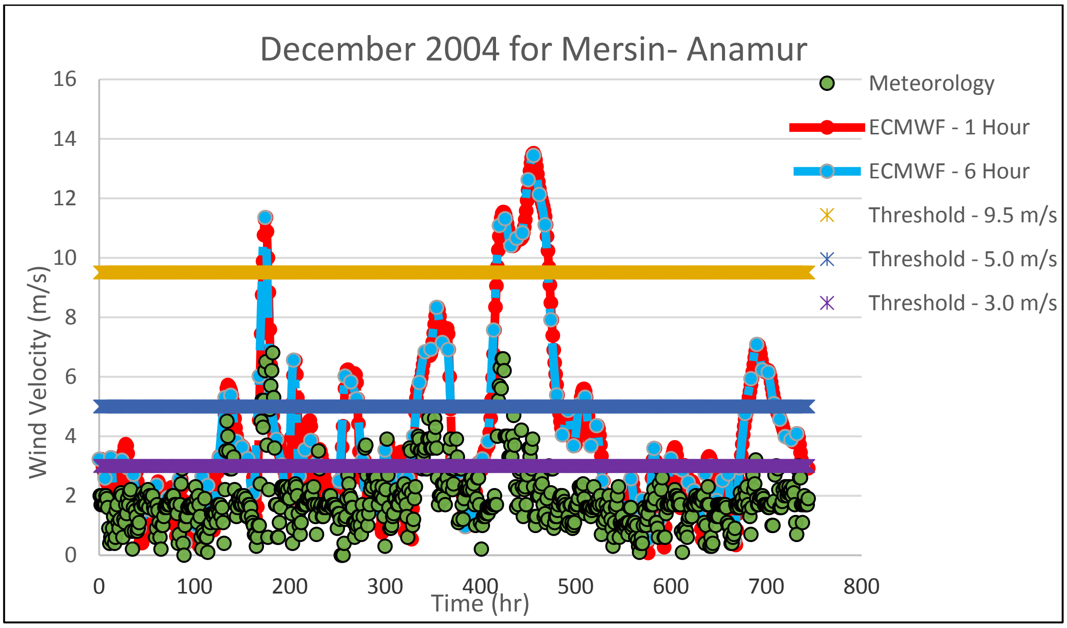


Figure 4.1. Time Series for Mersin-Anamur

Adana-Karataş:

The wind data comparison of both data sets can be seen in the following scatter graph for December 2004 in Figure 4.2. From the scatter graph, it is clear that ECMWF data set gives higher wind velocity than meteorology data set. Similarly, both data sets are subject the same storms for December 2004. Besides, both data sets show almost same duration for storms. In some cases, especially the last storm event in December 2004, it is obvious that ECMWF gives longer duration for the storm. For this region, the most remarkable part of the scatter graph for December 2004 is that both data sets measure similar wind velocities at the beginning and end of the stormy weather. Furthermore, it can be noted for this month that ECMWF data passed the threshold value for twice.

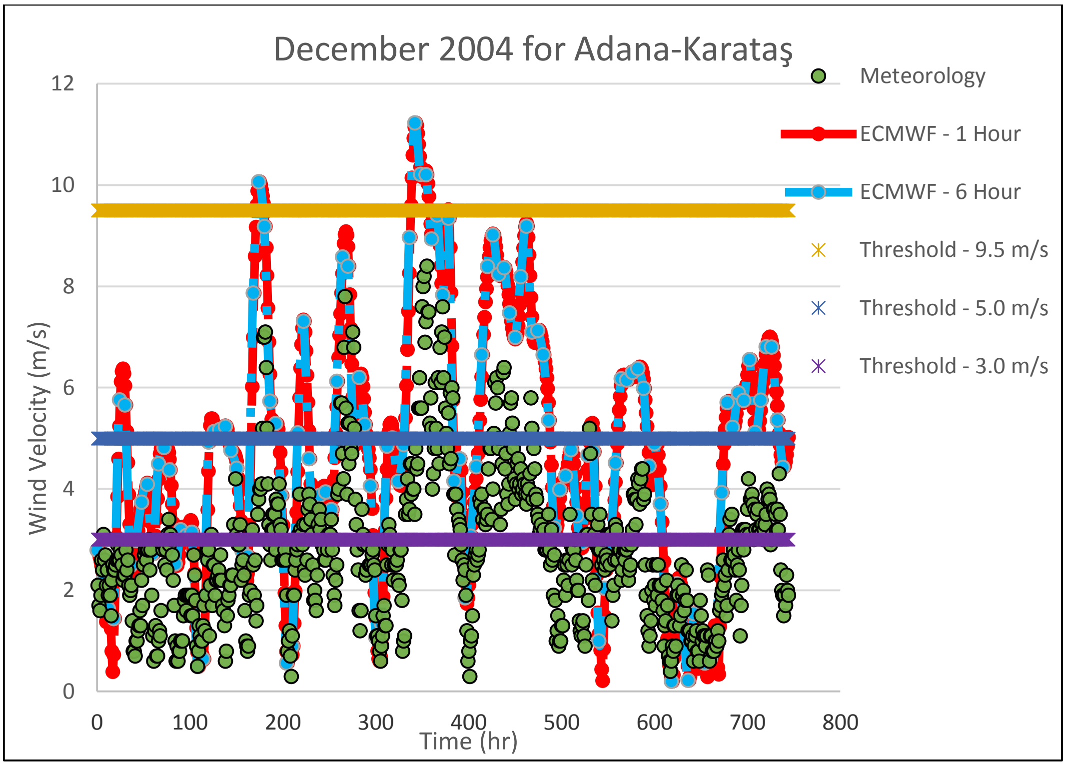


Figure 4.2. Time Series for Adana-Karataş

Adana-Yumurtalık:

The wind data comparison of both data sets can be seen in the following scatter graph for December 2004 in Figure 4.3. First of all, as a result of relatively low wind velocity, the values of both data sets are in good agreement for this region. Differently from

Anamur and Karataş region, meteorology data sets sometimes give higher wind velocities than ECMWF data set. Moreover, a one hour meteorology data set passes the threshold value while ECMWF data set never passes this value for this time period. When other drawn time series graphs are inspected, it is seen that Adana-Yumurtalık characteristics in December 2004 is an overall trend for this region. Nevertheless, both data sets show the same duration of storm and wind velocity, respectively because of a relatively calm weather measurement in December 2004.

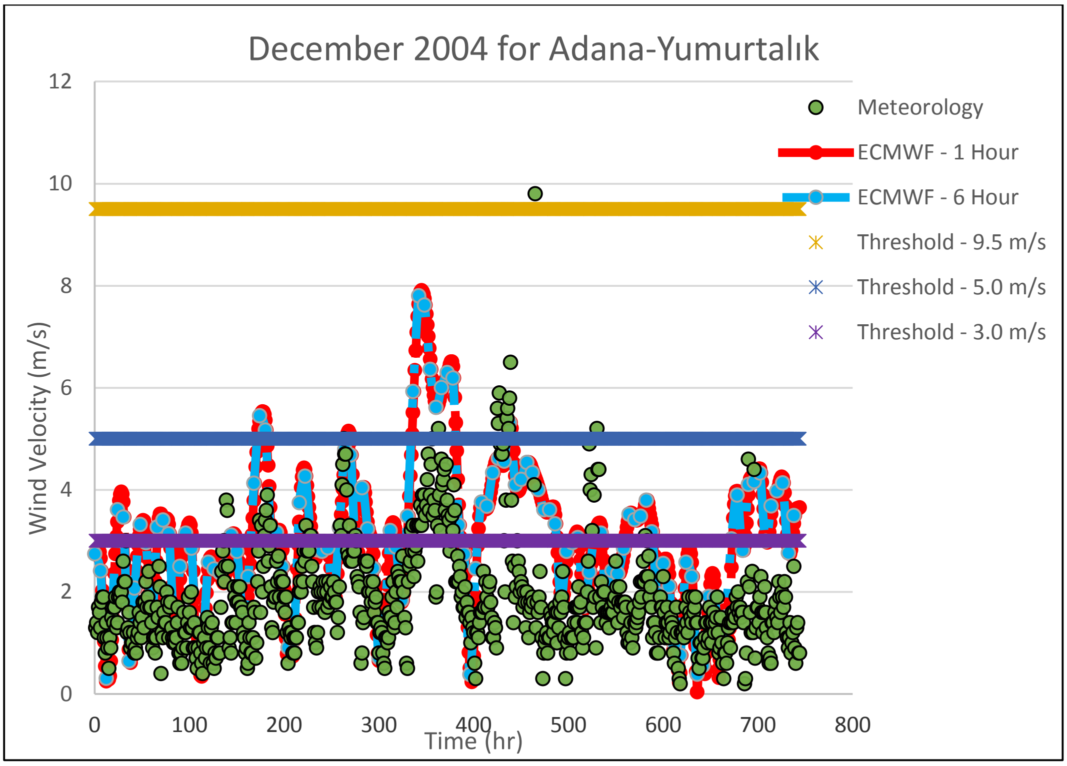


Figure 4.3. Time Series for Adana-Yumurtalık

Antalya-Finike:

The wind data comparison of both data sets can be seen in the following scatter graph for December 2004 in Figure 4.4. For this region, the time series graph clearly show that especially when the storm happens, ECMWF data set gives much higher wind velocities than that of the meteorology. The threshold value was exceeded once by ECMWF for this month. Nevertheless, the durations of storms follow similar paths for both data sets. Moreover, it is important to note that the values of meteorology data sets rarely give higher wind velocity than ECMWF values for this month. However, the results of ECMWF's extreme wave height should be expected higher than the results of meteorology data sets.

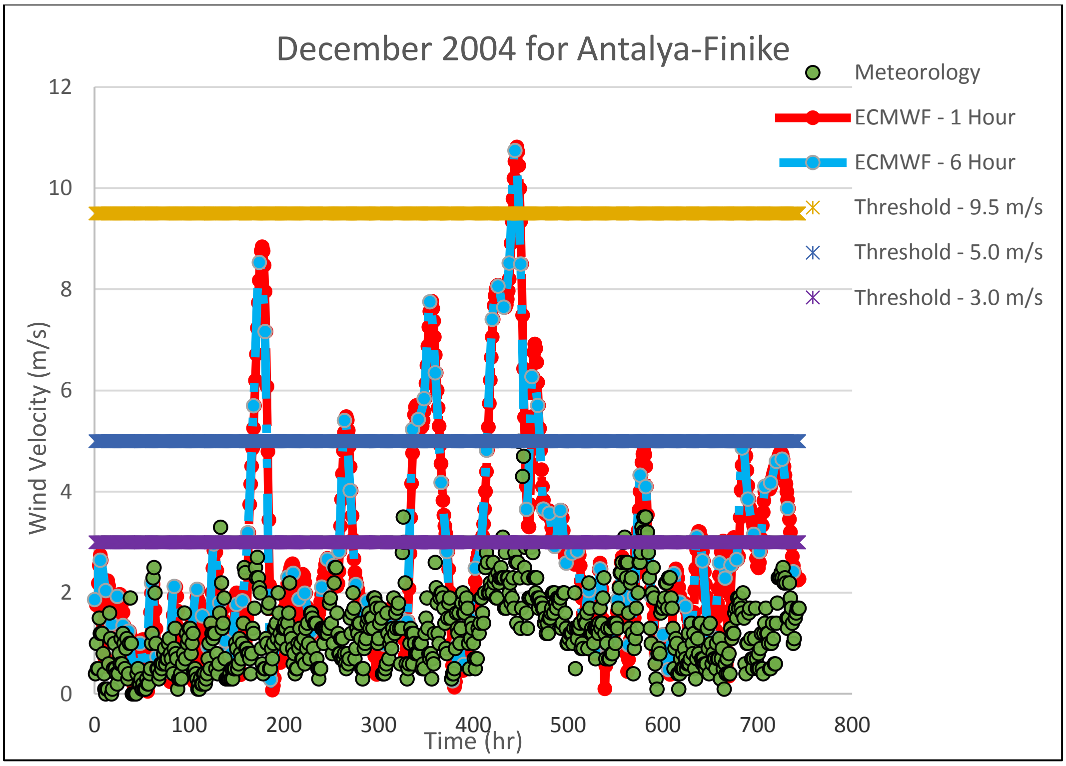


Figure 4.4. Time Series for Antalya-Finike

Antalya-Gazipaşa:

The wind data comparison of both data sets can be seen in the following scatter graph for December 2004 in Figure 4.5. Like Finike station, in this region, in terms of the values of low wind velocities, sometimes meteorology data sets give higher wind velocity results than ECMWF's. On the other hand, in relation to higher wind velocities, there is a huge difference between ECMWF and meteorology. Where ECMWF data is above the threshold once, meteorology data sets give almost half velocity for that time and it is around 5 m/s. In the light of this information, it can be easily said that ECMWF data governs all peak values and it is expected that higher extreme wave height values are created.

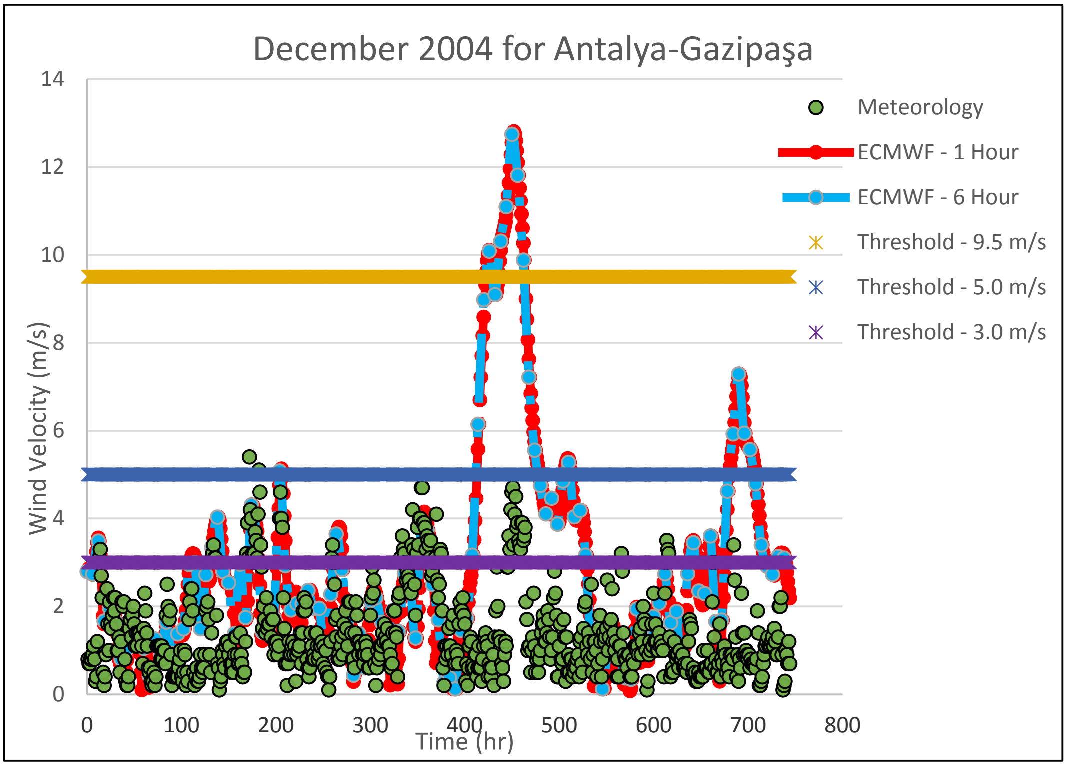


Figure 4.5. Time Series for Antalya-Gazipaşa

Hatay-İskenderun:

The wind data comparison of both data sets can be seen in the following scatter graph for December 2004 in Figure 4.6. For Hatay-İskenderun region, generally, meteorology data sets give higher wind velocities. Besides, it is interesting to see that some durations of storms have a couple of hourly differences from set to set. From the graph, it can be seen that meteorology data set dominates the peak values and it has 5 values which are above the threshold of 9.5 m/s while in ECMWF data set, none of the values can reach that limit. Moreover, the ECMWF data set dominates the values between 5 m/s and 3 m/s. In other words, according to time series scatter graphs, this region generally follows a very different path. When inspecting all the other parts of remaining data of 2004, it is seen that other months also acts like this month.

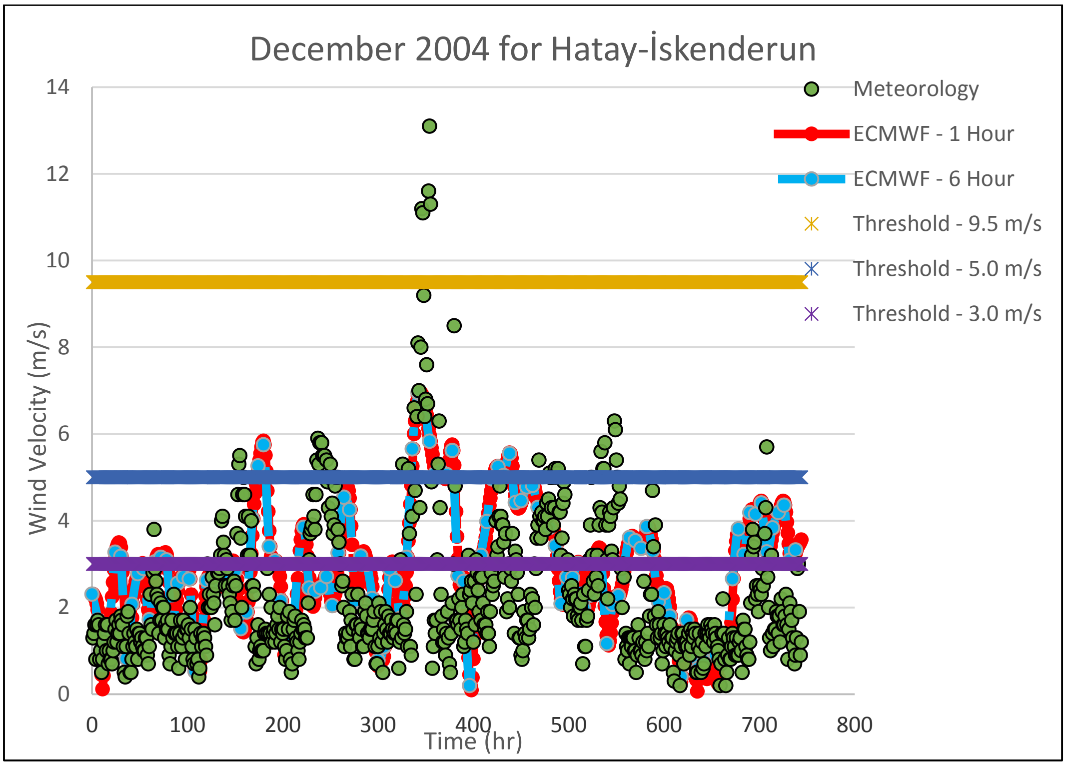


Figure 4.6. Time Series for Hatay-İskenderun

Mersin-Yenişehir:

The wind data comparison of both data sets can be seen in the following scatter graph for December 2004 in Figure 4.7. The first thing that is striking for this region's scatter graph is that there is no value that can pass the threshold limit in either meteorology or ECMWF data set. For further discussion, from the graph, sometimes the difference between two data sets increases a lot and ECMWF data set contains higher values. Moreover, for this region, it is interesting to see that in some places while the values of the ECMWF data sets show a rising characteristic, meteorology values follow a stable path. Due to this reason, from the extreme analysis of the ECMWF data set, higher wave heights are expected for this region.

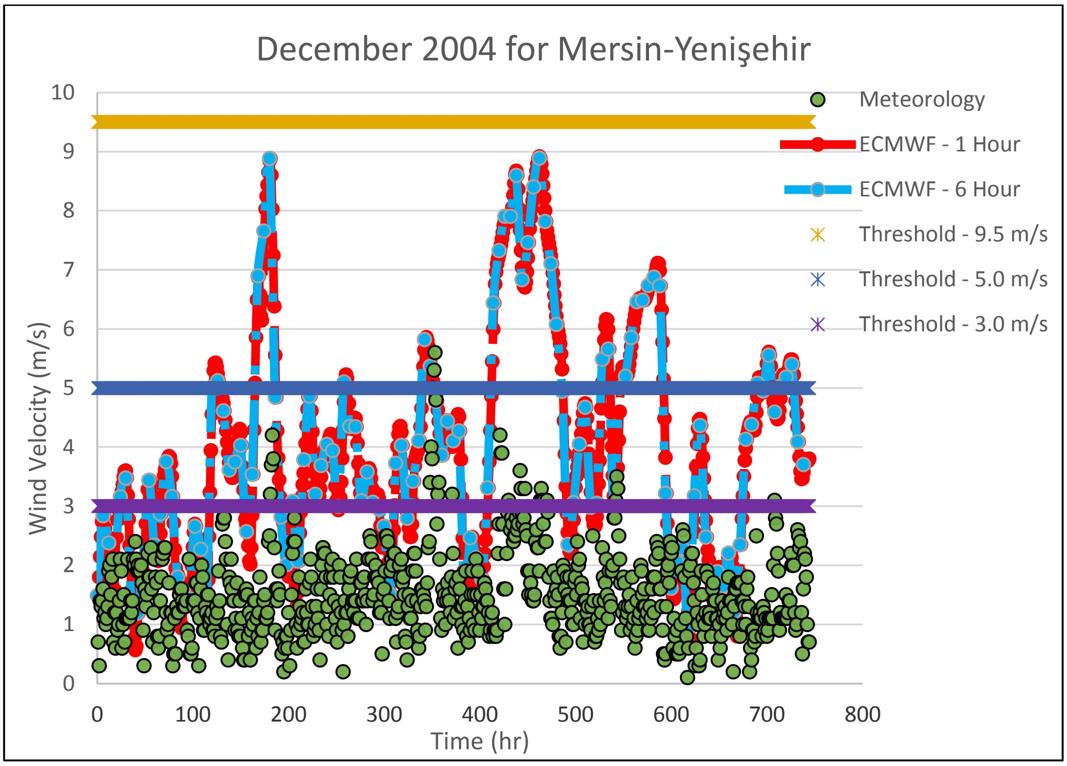


Figure 4.7. Time Series for Mersin-Yenişehir

4.1.2. The Comparison and Discussion of Wind Roses

Wind roses have been drawn for both meteorology and ECMWF data sets. For each point, there are 5 plotted graphs; annual, fall, winter, spring, summer.

Annual wind roses has been drawn to show the data for all years. On the other hand, the ninth, tenth, eleventh months have been chosen for fall graphs. The winter graph shows the twelfth, first and second months. The spring graph shows the third, fourth and fifth months. Finally, the summer graph shows the sixth, seventh and eighth months.

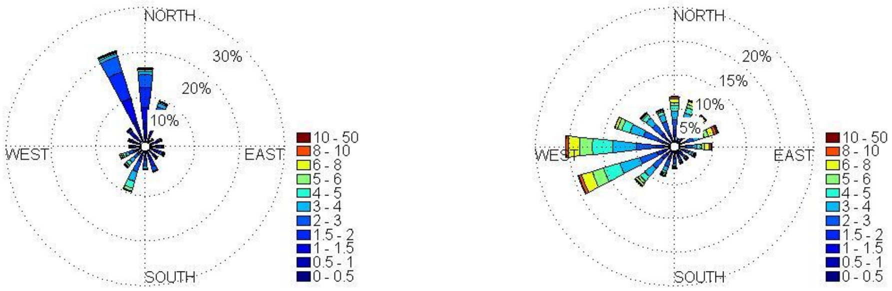
For further discussion, Wave atlas (Özhan, E. and Abdalla, S., 1999) and study of Alpli R. (2011) are used in comparison with this study. It is important to note that ECMWF data for Mediterranean Sea (1994-2008) has been used in the study of Alpli R. (2011) and only the annual wind rose graphs has been analysed.

Mersin-Anamur:

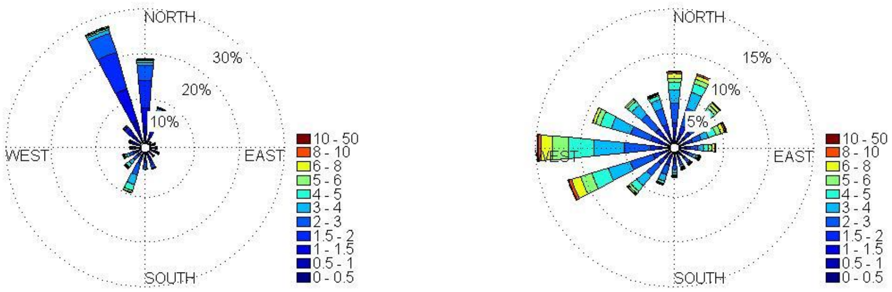
Wind rose graphs for Mersin-Anamur region according to the data between 1983 and 2009 are presented in Figure 4.8.

Meteorology ECMWF

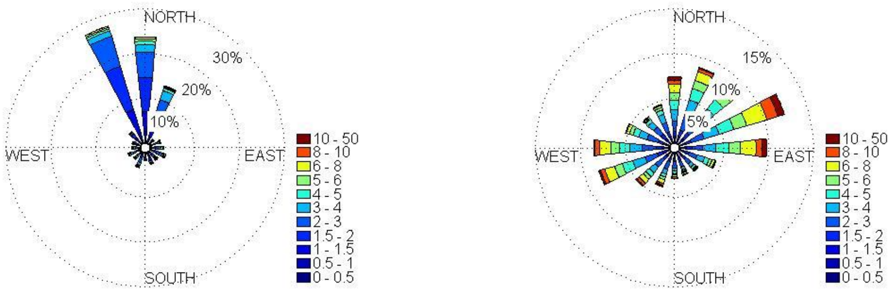
Annual



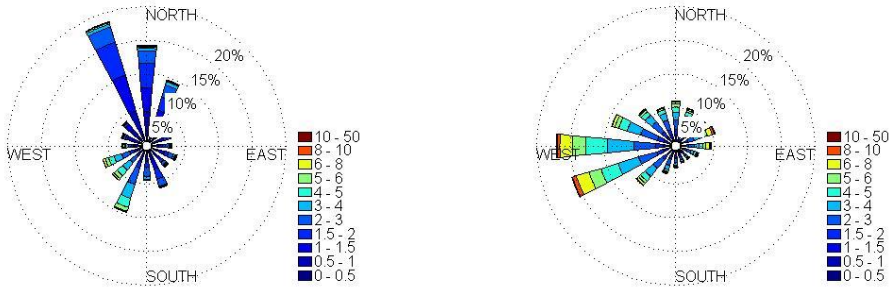
Fall



Winter



Spring



Summer

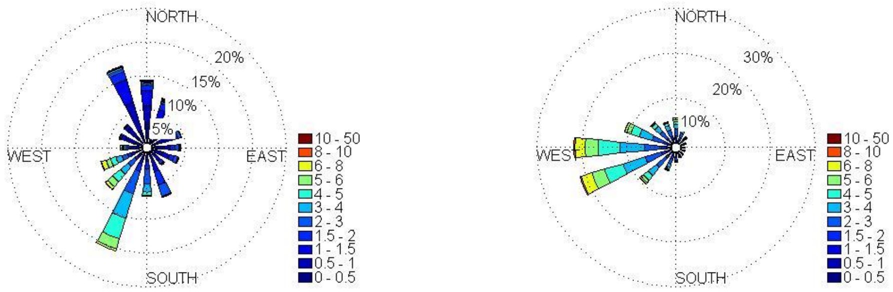


Figure 4.8. Wind roses for Mersin-Anamur

First of all, it should be noted that the wind directions which can create waves are ENE, E, ESE, SE, SSE, S, SSW, SW, WSW and W.

Annual graphs can show that according to the meteorology data, the dominant wind direction is SSW. On the other hand, ECMWF data graphs indicate WSW as a dominant direction. Besides, ECMWF data shows higher wind velocity for all wind rose graphs.

From seasonal wind rose graphs, the meteorology gives similar results according to the dominant direction which is SSW. However, it can be seen that strong wind percentages is highest in winter and lowest in summer while, the spring and fall results are closer to winter. In accordance with ECMWF data, seasonal directions are almost similar, but the fall season has higher wind percentage.

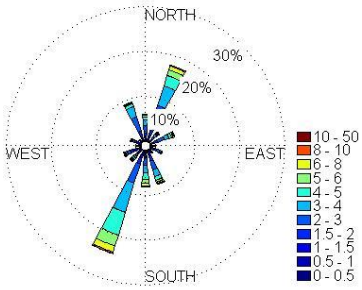
When the study of Alpli R. (2011) and Wave Atlas (Özhan, E. and Abdalla, S., 1999) are checked, similar results are found to be for ECMWF annual graph. Wave Atlas (Özhan, E. and Abdalla, S., 1999) seasonal graph and ECMWF graphs in this study give similar results with respect to wind direction and percentage. However, in winter, Wave Atlas (Özhan, E. and Abdalla, S., 1999) shows higher wind velocity percentage in SSW direction.

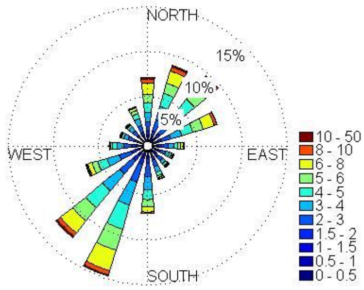
Adana-Karataş:

Wind rose graphs for Adana-Karataş region according to the data between 1983 and 2009 are presented in Figure 4.9.

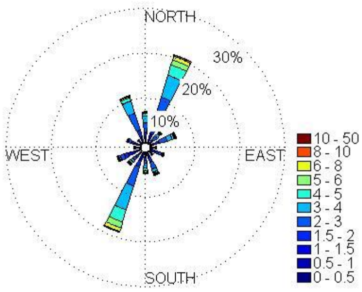
Meteorology ECMWF

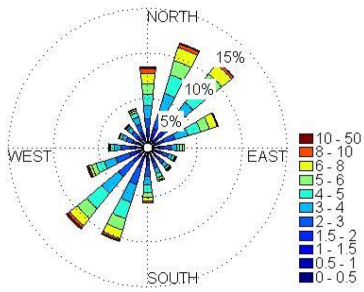
Annual



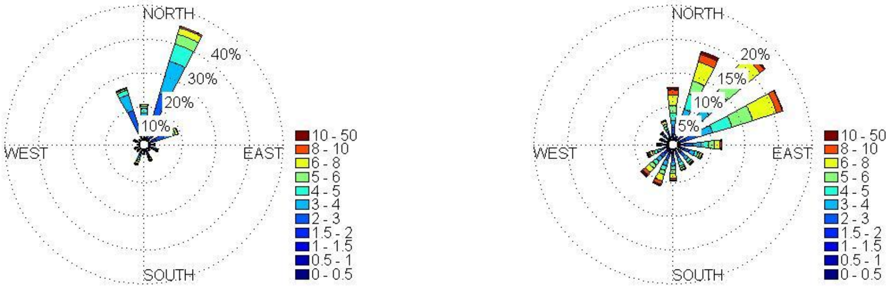


Fall

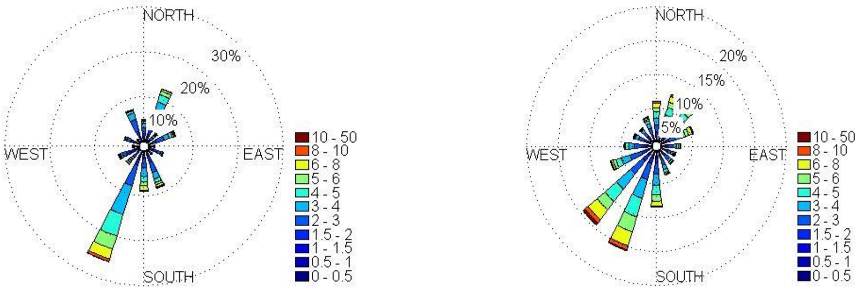




Winter



Spring



Summer

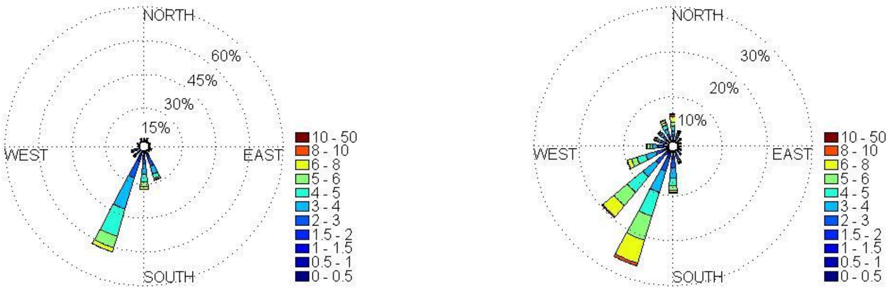


Figure 4.9. Wind roses for Adana-Karataş

First of all, it should be noted that the wind directions which can create waves are ENE, E, ESE, SE, SSE, S, SSW, SW and WSW.

The annual graphs of both ECMWF and meteorology data sets give similar results. Both of them have the same dominant direction which is SSW. However, ECMWF data set shows stronger wind velocities.

From seasonal wind rose graphs, ECMWF and meteorology graphs act almost parallel to each other according to the point of view of wind direction. ECMWF data set shows SW as the second dominant direction for Adana-Karataş region. In fall season, SW direction creates stronger winds than SSW direction for ECMWF data set. It should be mentioned for winter season that the meteorology data graphs show similar direction compared to the ECMWF data set graph. Even though it has a low percentage, it can easily be seen that in winter season, the meteorology and ECMWF show SSW direction as a dominant direction

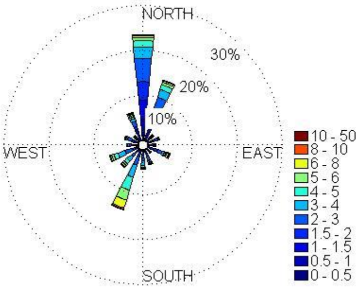
For this region the Wave Atlas (Özhan, E. and Abdalla, S., 1999) yearly wind rose graph shows particular characteristics. In addition, Alpli. , R. (2011) finds SW as a dominant direction. It means that the results of this study and Alpli R. (2011) study show similarities. The ECMWF data set gives SW as the second highest percentage value which is getting close after the SSW direction. In relation to the particular characteristics of both regional and all-year graphs of Wave Atlas (Özhan, E. and Abdalla, S., 1999), they show really low wind velocity. This study and Alpli R. (2011) study show that there are some significant wind activities in the region in SW or SSW direction.

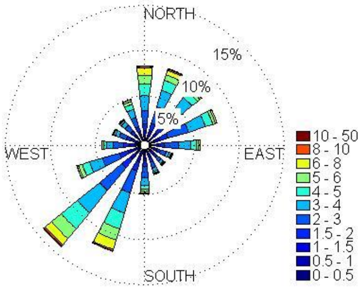
Adana- Yumurtalık:

Wind rose graphs for Adana-Yumurtalık region according to the data between 1983 and 2009 are presented in Figure 4.10.

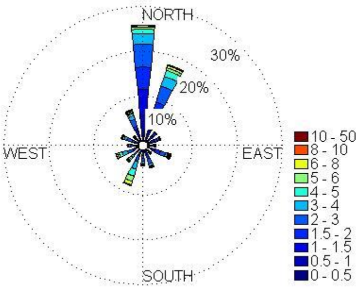
Meteorology ECMWF

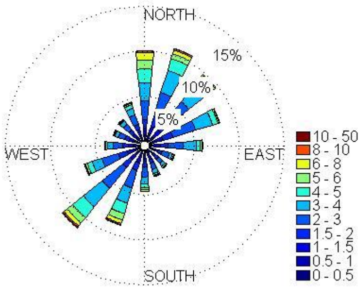
Annual



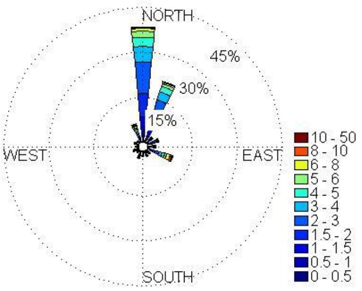


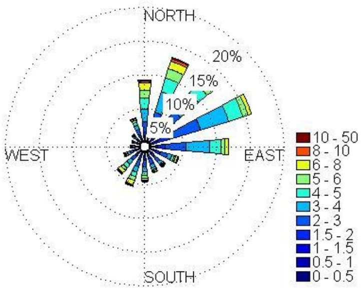
Fall



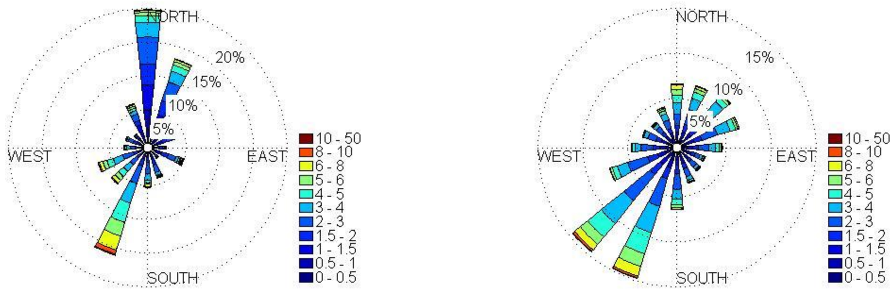


Winter





Spring



Summer

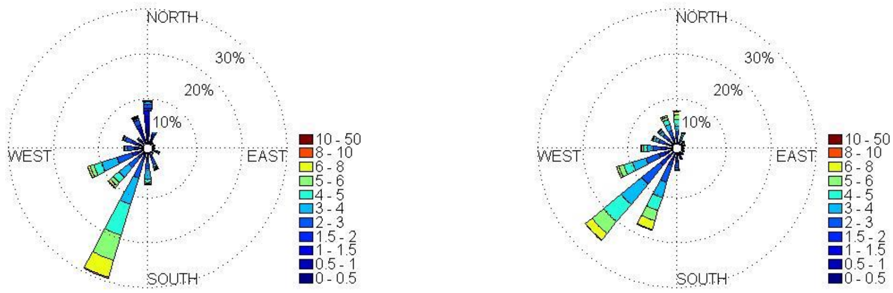


Figure 4.10. Wind roses for Adana-Yumurtalık

First of all, it should be noted that the wind directions which can create waves are NE, ENE, E, ESE, SE, SSE, S, SSW and SW.

In terms of annual graphs, the meteorology creates SSW direction as a dominant direction. ECMWF has a close direction as a dominant direction which is SW. Besides, for this point, it should be observed that while the meteorology data has low wind percentages in SW, it is interesting to see that the ECMWF data set shows it as a dominant direction. In addition, it can be concluded that the meteorology measurements are not totally incompatible, because the ECMWF annual graph shows SSW as the second strongest wind direction.

Seasonal wind rose graphs show almost the same characteristic path as their annual seasonal graphs with respect to direction. However, it can be seen that in winter season, there is a considerable difference in wind directions. In winter and spring season, the ECMWF gives SSW as a dominant direction while the meteorology gives ESE.

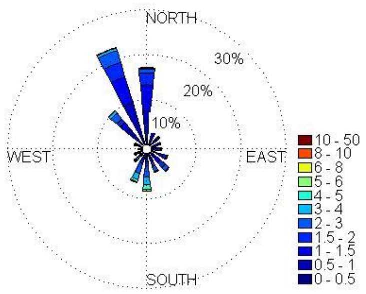
For this region, both annual and seasonal graphs of the Wave atlas (Özhan, E. and Abdalla, S., 1999) show different results like Karataş region. It gives not only lower wind velocity, but also weaker wind activity. On the other hand, the study of Alpli R. (2011) indicates a similar result with the ECMWF data set based on the examination of wind direction. Nonetheless, the percentage of wind directions is quite different in the study of Alpli R. (2011). The differences could be due to analysing different durations of the same data set; in this study 27 years data sets have been used while in Alpli R. (2011) 14 years data were used.

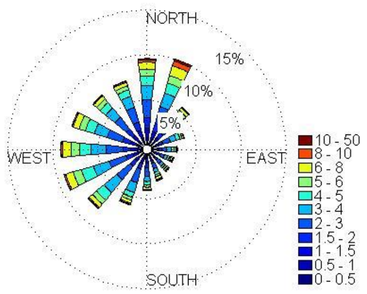
Antalya-Finike:

Wind rose graphs for Antalya-Finike region according to the data between 2000 and 2011 are presented in Figure 4.11.

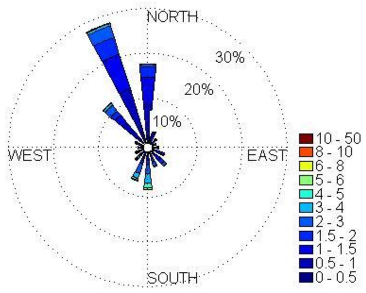
Meteorology ECMWF

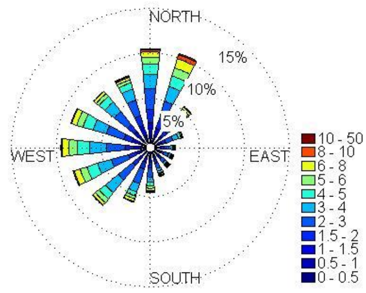
Annual



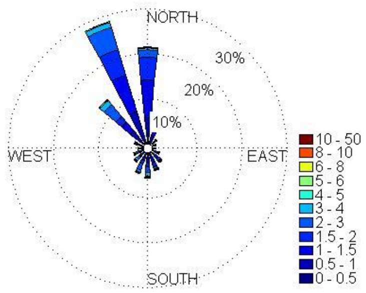


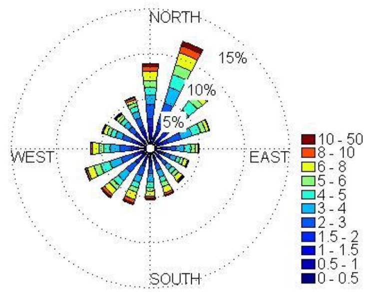
Fall



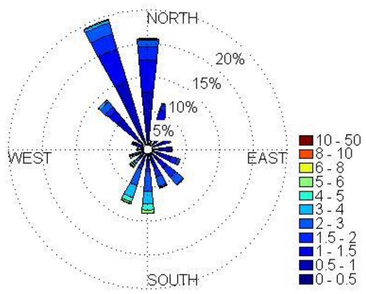


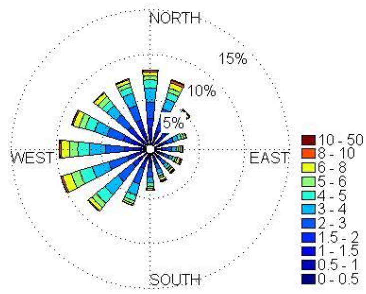
Winter





Spring





Summer

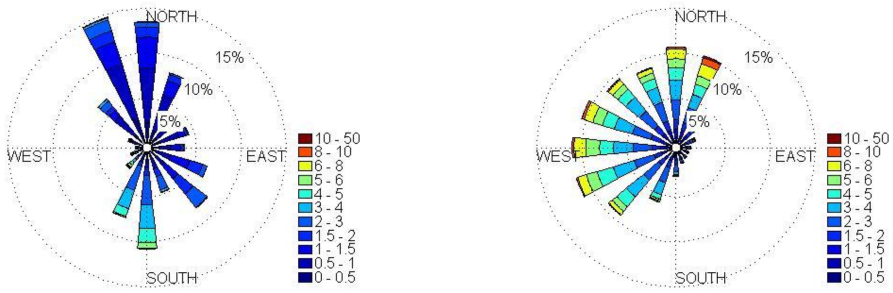


Figure 4.11. Wind roses for Antalya-Finike

First of all, it should be noted that the wind directions which can create waves are E, ESE, SE, SSE, S, SSW, SW and WSW.

From annual seasonal graphs, S direction is dominant for the meteorology while the ECMWF shows WSW as a dominant wind direction. It is important to remark that the ECMWF data set is measured to have higher wind velocity and percentage while the meteorology shows very low values for WSW, SW and SSW directions.

Seasonal graphs for the meteorology data set show parallel results. However, spring and summer season show much higher wind percentage for SSW and the dominant direction which is S. For the ECMWF result in seasonal graphs, summer and spring seasons give higher wind percentage as in the meteorology data set and a similar wind dynamism is observed in annual graphs.

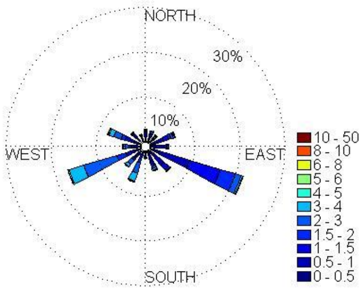
For comparison of the result, similarities between the study of Alpli R. (2011) study and the ECMWF data set are important for this region. Both studies give very similar results about wind velocity, direction and percentage. On the other hand, the Wave atlas (Özhan, E. and Abdalla, S., 1999) and meteorology show that S direction is dominant for this region, for both the values of wind velocity and percentage, this direction could be important for wave height in this region. However, it is interesting to see that, for S direction, according to the Wave Atlas (Özhan, E. and Abdalla, S., 1999), winter is more critical for this region with higher wind velocity and percentage, while the meteorology data set indicates that stronger and outnumbered storms could happen in summer when compared to other seasons.

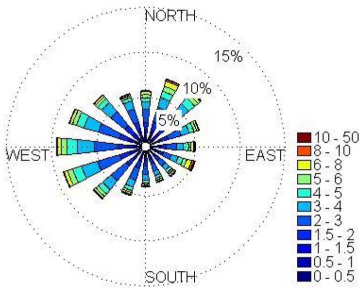
Antalya-Gazipaşa:

Wind rose graphs for Antalya-Gazipaşa region according to the data between 2000 and 2010 are presented in Figure 4.12.

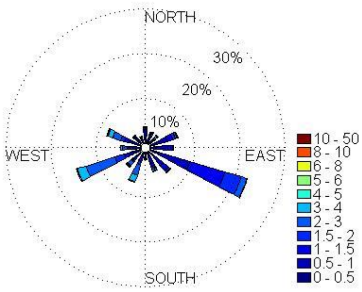
Meteorology ECMWF

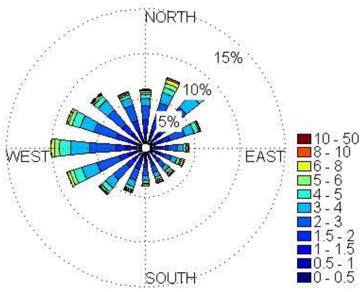
Annual



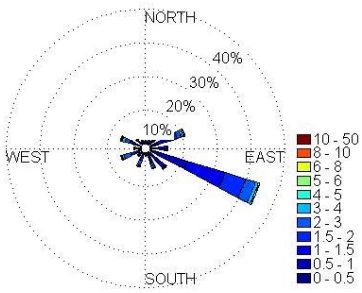


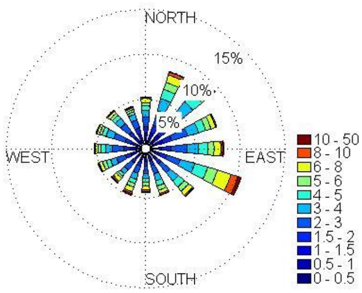
Fall



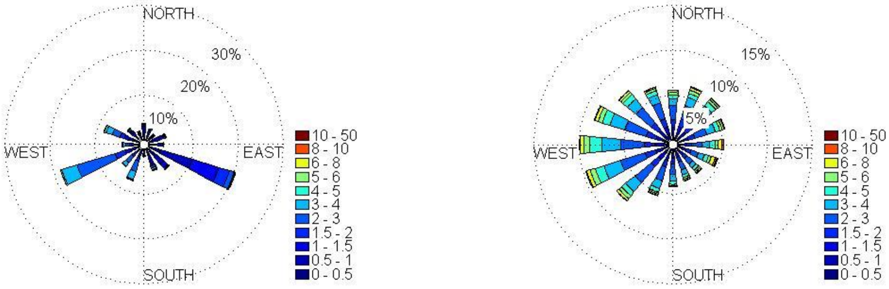


Winter





Spring



Summer

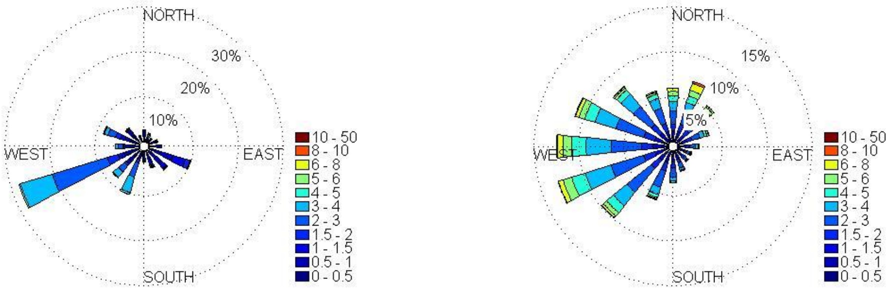


Figure 4.12. Wind roses for Antalya-Gazipaşa

First of all, it should be noted that the wind directions which can create waves are ESE, SE, SSE, S, SSW, SW, WSW, W, WNW and NW.

Annual graphs for Antalya-Gazipaşa region show that the meteorology data set gives ESE direction as a dominant one. On the other hand, the ECMWF data set shows that W direction is the dominant one. ECMWF data set also gives similar wind velocity for W, WSW and WNW directions.

In the meteorology data set's seasonal graph, the biggest difference is that in the fall season ESE has stronger winds while in the summer season, WSW direction becomes dominant. Besides, in the meteorology data set, the wind percentage of the winter season decreases in WSW direction. The ECMWF wind percentage values of Antalya –Gazipaşa region change dramatically in the winter season. It can be easily seen that ESE direction becomes dominant in the winter season. On the other hand, other 3 seasonal graphs look similar and it is observed that the summer season has higher wind percentage.

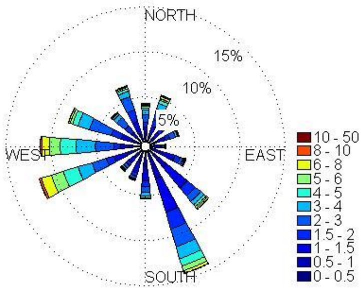
For this region, the Wave Atlas (Özhan, E. and Abdalla, S., 1999) and ECMWF annual graph shows the same direction as a dominant direction. Furthermore, while the Wave Atlas (Özhan, E. and Abdalla, S., 1999) indicates a similar result with the ECMWF in winter, the difference between two data sets in the summer season is important. When other data sets are checked, neither the meteorology nor the study of Alpli R. (2011) shows that W is dominant for Gazipaşa. On the other hand, it needs to be specified that both the meteorology and the study of Alpli R. (2011) show WSW direction as the second critical direction.

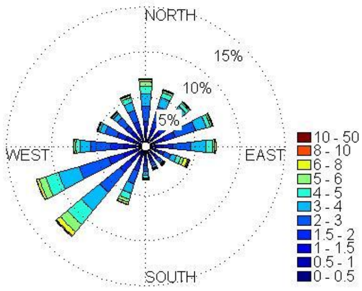
Hatay-İskenderun:

Wind rose graphs for Hatay-İskenderun region according to the data between 2000 and 2010 are presented in Figure 4.13.

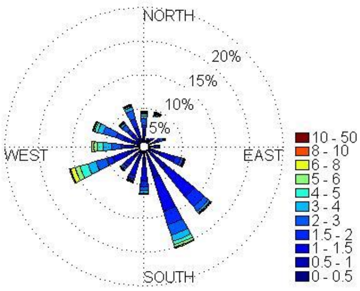
Meteorology ECMWF

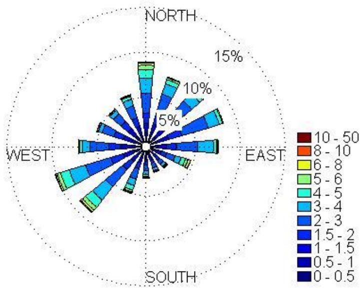
Annual



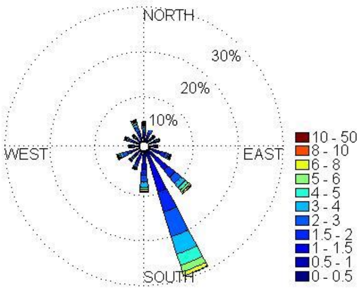


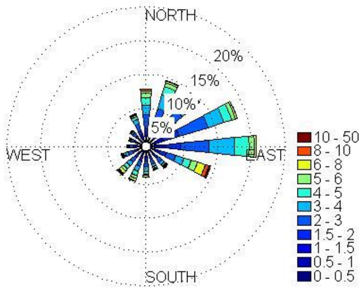
Fall



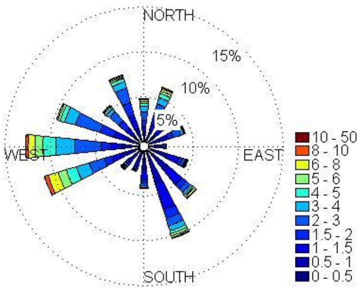


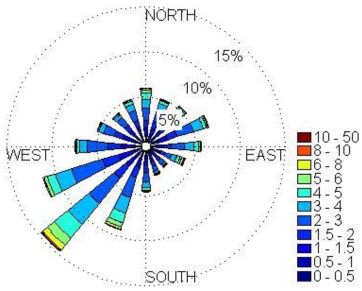
Winter





Spring





Summer

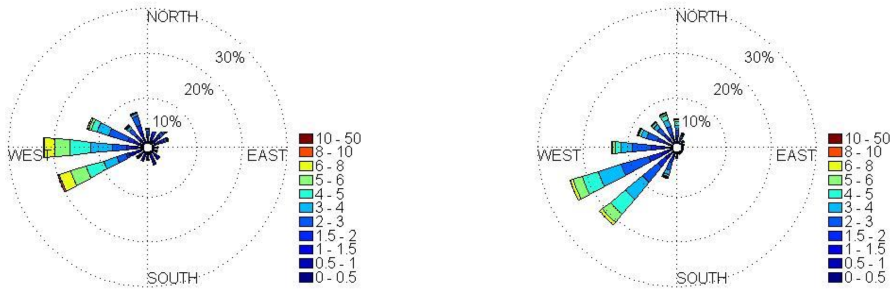


Figure 4.13 Wind roses for Hatay-İskenderun

First of all, it should be noted that the wind directions which can create waves are SSW, SW, WSW, W, WNW, NW and NNW.

The comparison of annual seasonal graphs between the ECMWF and meteorology data sets overall trend is similar with respect to the dominant wind direction. The meteorology shows WSW direction while the ECMWF shows SW direction. Moreover, WSW direction which is the dominant direction for the meteorology data is the second strongest wind direction for the ECMWF.

Spring and summer seasonal graphs for Hatay –İskenderun region keep their general characteristics for both the ECMWF and meteorological annual graphs. However, for both data sets, winter graphs show that there is a dramatically decreasing wind percentage in winter. Also, it is different to see that for the summer season apart from other seasons, both data sets interestingly show similarities.

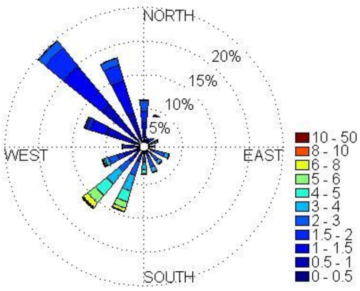
The annual data graph of the ECMWF and the results of the study of Alpli R. (2011) study are again similar for this region. On the contrary, the Wave Atlas (Özhan, E. and Abdalla, S., 1999) similarly implies much lower and weaker wind activities for this region in terms of both seasonal and annual aspects. Especially in the summer season, while the meteorology and ECMWF show considerably strong winds, the summer result of the Wave Atlas (Özhan, E. and Abdalla, S., 1999) is quite unusual.

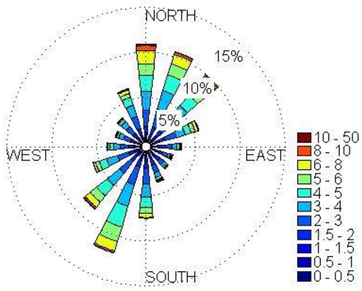
Mersin-Yenişehir:

Wind rose graphs for Mersin-Yenişehir region according to the data between 2000 and 2010 are presented in Figure 4.14.

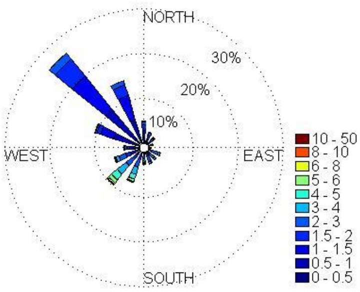
Meteorology ECMWF

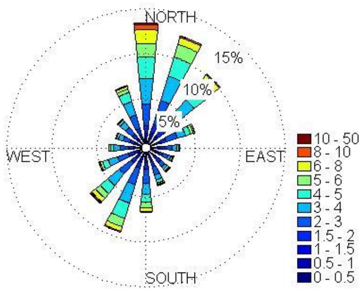
Annual



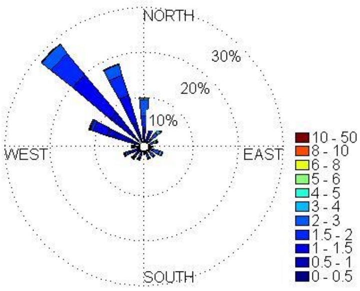


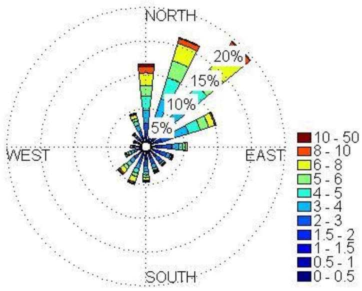
Fall



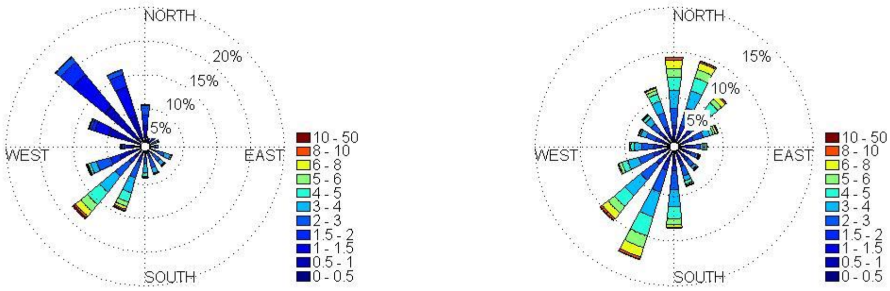


Winter





Spring



Summer

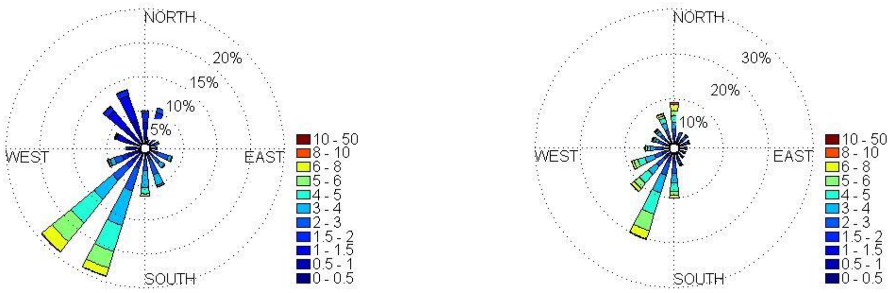


Figure 4.14. Wind roses for Mersin-Yenişehir

First of all it should be noted that the wind directions which can create waves are E, ESE, SE, SSE, S, SSW, SW and WSW.

The annual seasonal graphs of Mersin- Yenişehir region indicate that the dominant direction of the ECMW is SSW and that the dominant direction of the meteorology data set is SW. The main difference between the annual graphs of two data sets is while SW direction is the second strongest wind velocity direction in the ECMWF data set, SSW is the second strongest wind velocity direction in the meteorology graph. So, according to the annual graph, it can be easily said that the meteorology and ECMWF data gives approximately close results in terms of directions.

From the seasonal graphs of both the ECMWF and meteorology data, a remarkable change occurs in the winter and summer season. In winter, wind percentages decrease again for both data sets and in summer, SSW direction becomes dominant for the meteorology data set. Moreover, it is important to mention that in the spring season, the ECMWF data gives much higher wind percentage values than other seasons.

When the study of Alpli R. (2011) is checked, both the ECMWF and meteorology graphs show similar characteristics. Though, like İskenderun region, the results of the Wave Atlas (Özhan, E. and Abdalla, S., 1999) again imply lower and weaker wind activities for this region.

4.2. NUMERICAL COMPARISON

In this study, numerical comparison is also made for a better understanding of the wave characteristics of each region each region wave. Graphical comparisons show that the data set of each region has its own characteristics. For this reason, both extreme and long term wave analyses are performed by using the ECMWF and meteorology data sets for all regions. With this comparison, wave height differences which have a crucial part for the design process can also be seen clearly.

First of all, for numerical comparison, the calculation of fetch distances has been made for each region. Due to geographical differences, every region has its own unique fetch distances and direction characteristics for some directions, small fetch distances have not been included the calculations. Furthermore, for minimizing the error of fetch distances, effective fetch lengths have been calculated and used in this part of the study. Effective fetch distances and their directions for all regions are shown in the following Table 4.1.

Table 4.1. Fetch Distances

CHOOSEN POINTS	Fetch Distances (km)													
	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Anamur-MERSİN	-	108.8	187.5	145.1	90.5	75.2	88.5	383.1	783.5	553.6	140.5	-	-	-
Karataş-ADANA	-	25.9	45.7	45.3	63.9	176.8	436.9	506.7	447.6	235.6	-	-	-	-
Yumurtalık-ADANA	10.1	23.6	31.3	33.3	33.47	72.5	341.4	484.2	241.7	-	-	-	-	-
Finike-ANTALYA	-	-	87.8	265.4	517	650.2	637.4	681.5	654.1	343.2	-	-	-	-
Gazipaşa-ANTALYA	-	-	-	94.6	147.1	187.7	409.9	687.9	867.8	744.2	403	135.1	58.1	-
İskenderun-HATAY	-	-	-	-	-	-	-	151.7	420	362.9	229.6	31.6	29.9	24.2
Yenişehir-MERSİN	-	-	39.7	106.2	192.2	270.4	231.7	162.4	136.1	54.9	-	-	-	-

It is also important to mention that this study is aimed at a general understanding of the behaviour of the data sets and their impacts on a design process. With this perspective, a storm by storm comparison has not been made in this study. Besides, it should be noted that with these large data sets, a storm by storm analysis is impractical and very inconsistent. However, both data sets have hundreds of storms with different durations and powers.

The wind measurement data sets re-arranged and organized with the help of wind.exe and W61 programs are used for obtaining individual wave heights and periods. At this point, it should be mentioned that for the use of wind.exe program, effective fetch distances are used and after the use of w61 program, maximum wave heights with directions and corresponding wave periods are found for each year and each region. A sample output of W61 program is presented below in Figure 4.15.

```
YEAR: 1988
    Hmax (m.)    Tmax (sec.)    Direction
         0.00           0.00          NNE
         0.00           0.00           NE
         3.01           6.28          ENE
         1.64           4.95            E
         1.15           4.14          ESE
         1.01           3.78           SE
         0.84           3.47          SSE
         1.82           4.96            S
         3.24           7.08          SSW
         3.87           7.98           SW
         3.89           7.81          WSW
         2.38           5.78            W
         0.00           0.00          WNW
         0.00           0.00           NW
         0.00           0.00          NNW
         0.00           0.00            N
         3.89           7.81 ALL Directions
```

Figure 4.15. A Sample Output of W61

From the above sample output, it can be seen that for some directions, wave heights and period calculations have not been made due to the negligible values of fetch distances. As mentioned earlier, every region has directions with a negligible distance.

4.2.1. Non- Directional Analysis

Firstly, a non-directional analysis has been made for this study. The aim of the non-directional analysis is to see the differences of maximum wave heights with different return periods without considering the direction. So, for this purpose, the highest wave height values have been selected for each region and each year without considering its direction.

11 different distribution methods have been used for the extreme analysis of the region. These methods are Gumbel (new distribution method which uses α=0.44, β=0.12), Gumbel (old distribution method which uses α=0.00, β=1.00), Fisher –Tipper II with k=2.5, 3.33, 5.0 and 10.0, Weibull with k=0.75, 1.0, 1.4, 2.0 and finally, Lognormal distribution (Goda, 2000). By using these distribution types, 7 different return periods have been calculated for 5, 10, 20, 50 and 100 years.

In this study, in the part of the extreme wave analysis, 4 different best fitting criteria have been used for selecting the best distribution method. Below, all the best fitting criteria are explained.

Coefficient of correlation, r criterion:

The criterion of coefficient of correlation is representing the correlation between ordered Hs and its corresponding probability in the extreme analysis. When Hs value and its corresponding probability are close to each other, it means that *r* value is closer to 1 and that *r* criterion could be a better fit for the inspected data set.

Residue of correlation coefficient, Δr (REC criterion):

Residue of correlation coefficient is described as one minus coefficient of correlation ($\Delta r = 1 - r$). For this criterion, Goda and Kobune (1990) proposed a boundary criterion which can be found with an empirical equation.

$\Delta r\%95 = \exp\left(a + b \ln N + c\,(\ln N)^2\right)$

In the above empirical equation, N represents the number of data and a, b, c are the empirical parameters which are established by Goda (2000).

A distribution which has a higher residue of correlation coefficient (Δr) than the boundary criterion (Δr%95) is rejected.

Minimum ratio of residual correlation coefficient Δr/ Δrmean (MIR criterion):

The criterion of the ratio of residual correlation coefficient was proposed by Goda and Kobune (1990). In this criterion, the smallest ratio between the residue of correlation coefficient and the mean residue of correlation coefficient is selected as the best fit for the data set. For calculating Δrmean, the following formula can be used and a, b, c values can also be provided in Goda (2000).

$\Delta r\%95 = \exp(a + b\ln N + c(\ln N)^2)$

Deviation of outlier (DOL criterion):

Large data sets can contain some measurement points that have a large difference than other measurement points. With the deviation of outlier criterion which is proposed by Goda and Kabune (1990), outliers in the extreme wave analysis can be detected. DOL criterion is used ξ as a dimensionless deviation for the biggest data in the extreme analysis.

ξ is expressed in the following formula:

$$\xi = \frac{(H_1 - \bar{H})}{s}$$

H_1 represents the biggest data while $\bar{H}$ is the mean and s is the standard deviation. For boundary conditions, $\xi_{\%5}$ and $\xi_{\%95}$ should be calculated and if ξ_{data} satisfies the boundary conditions, ($\xi_{\%5} < \xi_{data} < \xi_{\%95}$) model is accepted according to the DOL criterion. $\xi_{\%5}$ and $\xi_{\%95}$ can be calculated by using the following formula:

$\xi\%5$ *or* $\xi\%95 = a + b\ln N + c(\ln N)^2$

In the above formula, N means the number of data and a, b, c are the parameters which can be provided in Goda (2000).

For all regions, the aforementioned criterion has been checked to find the best distribution method for both data sets. In some cases, the same criterion determines more than one best distribution. This situation shows that all of these distribution types are satisfying the required limits. In cases where different criteria determine different best distribution models, *r* criterion is selected as a decisive criterion. The study of Özyurt, G. and Özbahçeci, B.Ö. (2008) shows that it is not possible to determine a specific best distribution method for the entire Mediterranean Sea region. With this perspective, a decision is made to select the best distribution methods region by region. Moreover, it should be noted that the study of Özyurt, G. and Özbahçeci, B.Ö. (2008)

shows that the selection of the best distribution model creates a difference of approximately 10% in design wave height values for 50 and 100 years.

For example, results of the non-directional analysis for Mersin –Anamur are presented below. The non- directional analysis for the remaining regions are presented in Appendix B.

Mersin-Anamur:

According to the Meteorology data:

Table 4.2. Extreme Analysis Results of Mersin-Anamur According to the Meteorology Data

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	2.78029	3.21464	3.63128	4.17057	4.57469	5.50856	5.91004	Best Distr.	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	2.71441	3.10921	3.48791	3.97810	4.34542	5.19426	5.55919	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	2.40768	2.76400	3.22249	4.05017	4.90727	8.09653	10.24113	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	2.49550	2.89432	3.37128	4.16346	4.92061	7.41601	8.92092	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	2.58070	2.99920	3.46417	4.17453	4.80068	6.63036	7.61759	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	2.65515	3.07095	3.50022	4.10379	4.59440	5.86817	6.48220	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	2.51004	2.98641	3.51375	4.27529	4.89328	6.44644	7.16030	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	2.63179	3.09720	3.56261	4.17785	4.64326	5.72391	6.18932	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	2.72444	3.14162	3.52383	3.99222	4.32573	5.04965	5.34435	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	2.77074	3.12829	3.43495	3.79001	4.03157	4.53017	4.72468	~	~	Best Distr.	Best Distr.
LogNormal	2.72247	3.09173	3.43414	3.86509	4.18203	4.90540	5.21557	~	~	Best Distr.	Best Distr.

The meteorology data set shows an extreme wave height of 4.57m for a return period of 100 years when Gumbel1 (old) is selected as the best distribution.

According to the ECMWF data:

Table 4.3. Extreme Analysis Results of Mersin-Anamur According to the ECMWF Data

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.69827	5.27364	5.82556	6.53995	7.07529	8.31237	8.84421	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	4.60808	5.12874	5.62816	6.27462	6.75904	7.87848	8.35974	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.19506	4.64874	5.23251	6.28636	7.37766	11.43839	14.16899	~	~	~	~
FT 2 (k2=3.33)	4.30988	4.82203	5.43454	6.45184	7.42416	10.62870	12.56128	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	4.42349	4.96579	5.56833	6.48884	7.30023	9.67120	10.95050	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.52503	5.06871	5.62998	6.41916	7.06064	8.72612	9.52897	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.32616	4.93397	5.60681	6.57847	7.36697	9.34868	10.25950	~	~	~	~
Weibull (k2=1.0)	4.49061	5.09476	5.69890	6.49754	7.10168	8.50446	9.10861	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.62113	5.17117	5.67509	6.29263	6.73236	7.68680	8.07535	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.69037	5.16709	5.57597	6.04938	6.37145	7.03624	7.29559	Best Distr.	~	Best Distr.	Best Distr.
LogNormal	4.65491	5.12937	5.55744	6.08210	6.45912	7.29536	7.64482	~	~	Best Distr.	Best Distr.

The ECMWF data set shows an extreme wave height 6.37m for a return period of 100 years when Weibull (k4=2.0) is selected as the best distribution.

4.2.2. Directional Analysis:

In addition to the non-directional analysis, for the purpose of finding critical directions and comparing two data sets, a direction-wise analysis is also done for some regions. In the directional analysis comparison, the main problem is that the similar amount of data for the same direction cannot be provided from both data sets. Nevertheless, not only both data sets have enough measurement, but also they suggest the same dominant directions in the extreme analysis, it can be assumed that the directional analysis could give a clue about the dissimilarities between the extreme wave heights of their dominant wave direction. In this sense, due to the amount of measurements, a direction-wise analysis can only be done for Mersin-Anamur, Adana-Karataş and Adana-Yumurtalık regions. An analysis period of 27 years with similar dominant directions in the extreme analysis might have provided optimum conditions for the directional analysis.

For further explanation, for example Mersin –Anamur region, both data sets have the period of measurement from 1983 to 2009 (measurement data of 27 years). When the results of both data sets examined for Mersin-Anamur region, the ECMWF has WSW direction as the dominant one for 8 years, SW direction for 6 years while the meteorology has SSW for 6 years and WSW for 5 years. With respect to these results, WSW direction has been chosen for comparing both data sets according to the directional analysis.

Results of the direction-wise analysis for Mersin-Anamur region are presented below. Directional analyses for the remaining regions are presented in Appendix C.

Mersin-Anamur:

As explained above, for this region one direction (WSW) is selected.

According to the Meteorology data:

WSW:

Table 4.4. Directional Analysis Results (WSW) of Mersin-Anamur According to the Meteorology Data

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.82791	4.68990	5.51673	6.58698	7.38898	9.24228	10.03904	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	3.50527	4.16959	4.80682	5.63165	6.24974	7.67806	8.29211	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	2.99906	3.68730	4.57290	6.17162	7.82715	13.98740	18.12982	~	~	~	Best Distr.
FT 2 (k2=3.33)	3.14441	3.86905	4.73570	6.17510	7.55085	12.08502	14.81946	~	~	~	Best Distr.
FT 2 (k3=5.0)	3.28201	4.01232	4.82375	6.06338	7.15608	10.34904	12.07184	~	~	~	Best Distr.
FT 2 (k4=10.0)	3.40378	4.11218	4.84350	5.87177	6.70761	8.87767	9.92376	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.15130	3.98754	4.91325	6.25008	7.33492	10.06141	11.31454	~	~	~	Best Distr.
Weibull (k2=1.0)	3.32897	4.11371	4.89845	5.93582	6.72056	8.54267	9.32741	~	~	~	Best Distr.
Weibull (k3=1.4)	3.47051	4.16664	4.80441	5.58599	6.14251	7.35047	7.84222	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	3.55512	4.15826	4.67558	5.27453	5.68201	6.52310	6.85123	~	~	Best Distr.	Best Distr.
LogNormal	3.62674	4.45559	5.28110	6.39451	7.26435	9.40415	10.38508	Best Distr.	~	Best Distr.	Best Distr.

The meteorology data set shows an extreme wave height of 7.26 m for a return period of 100 years for WSW direction when Lognormal is selected as the best distribution.

According to the ECMWF data:

WSW:

Table 4.5. Directional Analysis Results (WSW) of Mersin-Anamur According to the ECMWF Data

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	5.41834	6.15043	6.85266	7.76163	8.44278	10.01680	10.69350	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	5.20126	5.80219	6.37861	7.12474	7.68385	8.97588	9.53134	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.74742	5.35195	6.12984	7.53410	8.98826	14.39922	18.03778	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	4.87794	5.52210	6.29250	7.57204	8.79499	12.82557	15.25632	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	5.00196	5.65668	6.38412	7.49545	8.47504	11.33751	12.88200	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	5.11125	5.74987	6.40916	7.33614	8.08965	10.04596	10.98901	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.88457	5.62709	6.44906	7.63606	8.59932	11.02024	12.13293	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	5.05344	5.75930	6.46517	7.39828	8.10414	9.74312	10.44898	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	5.18669	5.81585	6.39228	7.09867	7.60166	8.69343	9.13787	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	5.26261	5.80674	6.27345	6.81381	7.18143	7.94024	8.23626	~	~	Best Distr.	Best Distr.
LogNormal	5.28042	5.85302	6.37241	7.01231	7.47423	8.50451	8.93723	Best Distr.	~	Best Distr.	Best Distr.

The ECMWF data set shows an extreme wave height of 7.47 m for a return period of 100 years for WSW direction when Lognormal is selected as the best distribution.

4.2.3. Summary and Discussion about the Results of the Extreme Wave Analysis:

As mentioned above, the extreme analysis is performed in all regions and the coefficient of correlation criterion selected as a decisive criterion to determine the best distribution method. The results of all regions results are shown in Appendix B and C.

The directional analysis is also done for comparing two data sets. It is important to note that due to the lack of measurement data, some regions have been found to be unsuitable for the direction-wise analysis. So, the directional analysis is done for Mersin-Anamur, Adana-Karataş and Adana- Yumurtalık regions.

For further study, the obtained results are also compared with the past studies. These studies are Ergin, A. and Özhan, E. (1986), Özhan, E. and Abdalla, S. (1999).

The study of Ergin, A. And Özhan, E. (1986) is conducted for 15 regions along Turkish coasts. In this study, the extreme analysis has been done for 15 different regions by using wind data and synoptic maps. Anamur region in the study of Ergin, A. And Özhan, E. (1986) has been used for comparison. For further discussion, it is expected to see the similar results between the meteorology and wind data set in the study of Ergin, A. And Özhan, E. (1986) since the same data source is used for analysis in both studies. Also, a similar result is expected between the results of ECMWF and synaptic maps in the study of Ergin, A. And Özhan, E. (1986) due to the similarities in the gathering method of data set for both data sets.

The study of Özhan, E. and Abdalla, S. (1999) which is known as the Wave Atlas for Turkish coasts has also been used for comparing the results of all the regions in this study. In the Wave Atlas, Gumbel distribution method has been used for all coordinates. With this perspective, within the scope of the comparison between the Wave Atlas and this study, the effects of the distribution type will also be analysed. Furthermore, it is important to mention that, the coordinates which are closest to the regions inspected in this study have been chosen from the Wave Atlas for a reliable comparison.

Mersin –Anamur:

Table 4.6. Results of the Numerical Analysis Comparison for Mersin-Anamur

MERSİN-Anamur	Meteorology		Best Distribution	ECMWF		Best Distribution	H_{50} Differences (%)	H_{100} Differences (%)
	H_{50}	H_{100}		H_{50}	H_{100}			
All Direction	4.17	4.58	Gumbel(old)	6.05	6.37	Weibull (k4=2.0)	45.08	39.08
WSW	6.39	7.26	LogNormal	7.01	7.47	LogNormal	9.70	2.89

For the Mersin-Anamur region, the comparison of all direction results between the ECMWF and meteorology gives different values. The difference is about 45 percent. Besides, the best distribution methods are different from each other. When the results of both data sets are inspected, it is seen that their second strongest wave direction is different, too. On the other hand, the results of the dominant direction, WSW, for both data sets, give similar wave height values. Especially, the differences of Hs100 value is about 3 percent which indicates that there is good agreement between the data sets considering dominant direction.

When the study of Ergin, A. and Özhan, E. (1986) is checked for the purpose of comparison, seeing a difference between the results of the wind data and the results of the meteorology data sets has been interesting. The study of Ergin, A. and Özhan, E. (1986) has been used for the wind data sets of 15 years, between 1969 and 1984. On the other hand, in this study, the wind data sets of 27 years, between 1983 and 2009 have been used for analysis. At first glance, the differences between the period of inspected years and the wind to wave transformation programs that are used seem to be the cause of the dissimilarities between the results of the study of Ergin, A. and Özhan, E. (1986) and of the meteorology data set. Nevertheless, Synoptic map and ECMWF data sets give similar results despite the different period of inspected years for this region. This could show that using pressure data for the extreme wave height analysis gives steady results for Mersin-Anamur region.

Table 4.7. Results of the Wind Data and Synoptic Maps Comparison for Mersin-Anamur

Mersin-Anamur	Gumbel(old)		Best Distribution	
	Hs50 (m)	Hs100 (m)	Hs50 (m)	Hs100 (m)
Wind Data	6.28	6.76	-	-
Synoptic Map	6.98	7.55	-	-
Meteorology	4.17	4.58	4.17	4.58
ECMWF	6.53	7.08	6.05	6.37

For comparing the results, Wave Atlas (Özhan, E. and Abdalla, S., 1999) has been used and the results of 36.00 N and 32.80 E have been selected as the coordinate which is the closest one for this region. In this comparison, both the best distribution case and Gumbel distribution case have been used for the meteorology and ECMWF data sets.

Table 4.8. Results of the Wave Atlas Comparison for Mersin-Anamur

Mersin-Anamur	Wave Atlas	Meteorology		ECMWF	
	Gumbel(old)	Gumbel(old)	Gumbel(old)	Weibull(k4=2.0)	Gumbel(old)
Hs50 (m)	10.75	4.17	4.17	6.05	6.53
Hs100 (m)	11.75	4.58	4.58	6.37	7.08

For this region, the results of the Wave Atlas (Özhan, E. and Abdalla, S., 1999) results are significantly different in terms of both the meteorology and ECMWF values. Neither Gumbel distribution nor the best distribution of both data sets gives similar results. Nevertheless, the values of the ECMWF are closer to the results of the Wave Atlas (Özhan, E. and Abdalla, S., 1999).

Adana-Karataş:

Table 4.9. Results of the Numerical Analysis Comparison for Adana-Karataş

Adana-Karataş	Meteorology		Best Distribution	ECMWF		Best Distribution	H_{50} Differences (%)	H_{100} Differences (%)
	H_{50}	H_{100}		H_{50}	H_{100}			
All Direction	6.90	7.49	Weibull (k3=1.4)	7.28	7.91	Gumbel(old)	5.43	5.67
SSW	7.11	8.22	FT 2 (k3=5.0)	5.39	5.65	Weibull (k4=2.0)	-24.16	-31.29

For this region, it can be easily seen that the results of the dominant direction is different from each other than expected. It is interesting to see that in the directional analysis, SSW direction results in the meteorology data give higher values than those of the ECMWF while in all directions, it gives lower results. In case of higher differences in dominant directions, the primary reason can be that SSW is the dominant direction for the meteorology data while the ECMWF data set has SW as a primary dominant direction. Besides, it is important to see that all direction results for H_{50} are the closest ones with 5.43% when compared to all other results.

For comparing the results, Wave Atlas (Özhan, E. and Abdalla, S., 1999) has been used and the results of 36.50 N and 35.50 E have been selected as the coordinate which is the closest one for this region. In this comparison, both the best distribution case and Gumbel distribution case have been used for the meteorology and ECMWF data sets.

Table 4.10. Results of the Wave Atlas Comparison for Adana-Karataş

Adana-Karataş	Wave Atlas	Meteorology		ECMWF	
	Gumbel(old)	Weibull(k3=1.4)	Gumbel(old)	Gumbel(old)	Gumbel(old)
Hs50 (m)	8.00	6.90	7.19	7.28	7.28
Hs100 (m)	8.75	7.49	7.89	7.91	7.91

For this region, the Wave Atlas (Özhan, E. and Abdalla, S., 1999) and ECMWF give similar values. Moreover, both of them give their results with the same distribution method. On the other hand, the meteorology wave heights, especially in the best distribution case, give much smaller results when compared to the other two sources.

Adana -Yumurtalık:

Table 4.11. Results of the Numerical Analysis Comparison for Adana-Yumurtalık

Adana-Yumurtalık	Meteorology		Best Distribution	ECMWF		Best Distribution	H_{50} Differences (%)	H_{100} Differences (%)
	H_{50}	H_{100}		H_{50}	H_{100}			
All Direction	6.07	6.69	LogNormal	5.88	6.43	Weibull (k3=1.4)	-3.19	-3.86
SSW	5.91	6.40	LogNormal	6.07	6.86	FT 2 (k4=10.0)	2.71	7.21

For Yumurtalık region, the meteorology gives similar wave height in both all directions and the case of SSW. In this region, SSW is the dominant direction for both meteorology and ECMWF data sets. In terms of both the results of all directions and the dominant direction, differences are not too high. For this region, another interesting issue is that both data sets and the direction analysis give the same distribution method as the best one.

For comparing the results, Wave Atlas (Özhan, E. and Abdalla, S., 1999) has been used and the results of 36.75 N and 35.80 E have been selected as the coordinate which is the closest one for this region. In this comparison, both the best distribution case and Gumbel distribution case have been used for the meteorology and ECMWF data sets.

Table 4.12. Results of the Wave Atlas Comparison for Adana-Yumurtalık

Adana-Yumurtalık	Wave Atlas	Meteorology		ECMWF	
	Gumbel(old)	LogNormal	Gumbel(old)	Weibull(k3=1.4)	Gumbel(old)
Hs50 (m)	7.50	6.07	6.45	5.88	6.15
Hs100 (m)	8.25	6.69	7.14	6.43	6.81

The results of the Wave Atlas (Özhan, E. and Abdalla, S., 1999) give closer wave height when compared to the values of the meteorology than the values of the ECMWF. Besides, it is important to show that the meteorology data set gives much closer results with Gumbel method than its best distribution. For this region, the ECMWF values are the smallest, but contrary to the meteorology data sets, the ECMWF data sets with an analysis of Gumbel distribution give higher wave height than its best distribution method.

Antalya-Finike:

Table 4.13. Results of the Numerical Analysis Comparison for Antalya-Finike

Antalya-Finike	Meteorology		Best Distribution	ECMWF		Best Distribution	H_{50} Differences (%)	H_{100} Differences (%)
	H_{50}	H_{100}		H_{50}	H_{100}			
All Direction	2.92	3.10	Weibull (k4=2.0)	5.10	5.41	LogNormal	74.66	74.52

For this region, the ECMWF data set gives larger extreme wave height results than expected. Almost 75% of the differences should be investigated. When the results are checked, the ECMWF data set reaches maximum wave height at 4.34 m in 2003 while in the same year the meteorology data set gives 2.21 m as the maximum wave height which is almost half of the ECMWF result.

For comparing the results, the study of Wave Atlas (Özhan, E. and Abdalla, S., 1999) has been used and the results of 36.25 N and 30.40 E have been selected as the coordinate which is the closest one for this region. In this comparison, both the best distribution case and Gumbel distribution case have been used for the meteorology and ECMWF data sets.

Table 4.14. Results of the Wave Atlas Comparison for Antalya-Finike

Antalya-Finike	Wave Atlas	Meteorology		ECMWF	
	Gumbel(old)	Weibull(k4=2.0)	Gumbel(old)	LogNormal	Gumbel(old)
Hs50 (m)	7.50	2.92	3.31	5.10	5.52
Hs100 (m)	8.20	3.10	3.64	5.41	5.96

From the comparison of the Wave Atlas (Özhan, E. and Abdalla, S., 1999), although both the Meteorology and ECMWF data sets give higher wave height values for Gumbel distribution, it is clear that the Wave Atlas gives still much higher results. But in relation to the results of the Wave Atlas, it can be concluded that the ECMWF values are in a better agreement with Wave Atlas.

Antalya-Gazipaşa:

Table 4.15. Results of the Numerical Analysis Comparison for Antalya-Gazipaşa

Antalya-Gazipasa	Meteorology		Best Distribution	ECMWF		Best Distribution	H_{50} Differences (%)	H_{100} Differences (%)
	H_{50}	H_{100}		H_{50}	H_{100}			
All Direction	1.96	2.01	Weibull (k4=2.0)	4.03	4.19	LogNormal	105.61	108.46

Like Antalya-Finike region, very different wave height values are obtained from both data sets for this region. Almost 109% of the differences and different types of distribution methods are not expected.

When the results are reviewed, the ECMWF data set reaches the maximum wave height at 3.55 m in 2003 while in the same year, the meteorology data set gives 1.84 m as the maximum wave height which is almost half of the ECMWF result. Moreover, a wave height of 1.84 m in 2003 is also the maximum wave height value for the period of meteorology extreme analysis between 2000 and 2010

For comparing the results, Wave Atlas (Özhan, E. and Abdalla, S., 1999) has been used and the results of 36.25 N and 32.20 E have been selected as the coordinate which is the closest one for this region. In this comparison, both the best distribution case and Gumbel distribution case have been used for the meteorology and ECMWF data sets.

Table 4.16. Results of the Wave Atlas Comparison for Antalya-Gazipaşa

Antalya-Gazipaşa	Wave Atlas	Meteorology		ECMWF	
	Gumbel(old)	Weibull(k4=2.0)	Gumbel(old)	LogNormal	Gumbel(old)
Hs50 (m)	10.25	1.96	2.08	4.03	4.34
Hs100 (m)	11.20	2.01	2.18	4.19	4.62

Like Antalya-Finike region, the Wave Atlas gives higher wave height values when compared to the results of both data sets. From this comparison, it can be seen that even though the wave height results in Gumbel distributions are higher than other selected best distribution types, the Wave Atlas gives much higher results in Gumbel distribution. Again, like Antalya-Finike region, for this region, the results of the ECMWF data set gives closer results than the meteorology data set according to the study of Özhan, E and Abdalla, S (1999).

Hatay-İskenderun:

Table 4.17. Results of the Numerical Analysis Comparison for Hatay-İskenderun

Hatay-İskenderun	Meteorology		Best Distribution	ECMWF		Best Distribution	H_{50} Differences (%)	H_{100} Differences (%)
	H_{50}	H_{100}		H_{50}	H_{100}			
All Direction	3.86	4.07	Gumbel (old)	5.79	6.20	Weibull (k4=2.0)	49.88	52.37

In Hatay- İskenderun region, the ECMWF gives higher results than the meteorology. The differences are about 50%. Moreover, for this region, the meteorology data set has Gumbel (old) while the ECMWF has Weibull (k4=2.0).

For the further investigation of the differences between the results of the data sets, it should be noted that the comparison period of both data sets is only 10 years and that within these years, the meteorology data set gives WSW direction as the dominant one while ECMWF indicates SSW as the dominant one. The differences in dominant direction or maximum wave height value within the analysis period can cause this difference.

For comparing the results, the study of Wave Atlas (Özhan, E. and Abdalla, S., 1999) has been used and the results of 36.75 N and 36.10 E have been selected as the coordinate which is the closest one for this region. In this comparison, both the best distribution case and Gumbel distribution case have been used for meteorology and ECMWF data sets.

Table 4.18. Results of the Wave Atlas Comparison for Hatay-İskenderun

Hatay-İskenderun	Wave Atlas	Meteorology		ECMWF	
	Gumbel(old)	Gumbel(old)	Gumbel(old)	Weibull(k4=2.0)	Gumbel(old)
Hs50 (m)	5.25	3.86	3.86	5.79	6.69
Hs100 (m)	5.75	4.07	4.07	6.20	7.43

Unlike Antalya-Finike and Antalya-Gazipaşa regions, in this region, the ECMWF results are in better agreement with those of the Wave Atlas (Özhan, E. and Abdalla, S., 1999). Nevertheless, the meteorology data set gives a lower wave height compared to the Wave Atlas and ECMWF. Besides, it is important to note that like other regions, for this region, the ECMWF results for Gumbel distribution give higher wave height values.

Mersin-Yenişehir:

Table 4.19. Results of the Numerical Analysis Comparison for Mersin-Yenişehir

Mersin-Yenişehir	Meteorology		Best Distribution	ECMWF		Best Distribution	H_{50} Differences (%)	H_{100} Differences (%)
	H_{50}	H_{100}		H_{50}	H_{100}			
All Direction	5.18	5.49	LogNormal	4.54	4.88	Gumbel (old)	-12.36	-11.11

For this region, the differences of data set results are within an acceptable range. Almost 13% of the differences of wave height for 50 years seems to be a decent ratio when compared to the differences of results in other regions. However, from graphical comparison, it is expected that the ECMWF data set gives higher wave heights due to higher wind velocity peaks. The extreme analysis shows that the meteorology data set gives higher wave height results than the ECMWF unlike Antalya regions. Nevertheless, again, both data sets choose a different distribution method.

For comparing the results, Wave Atlas (Özhan, E. and Abdalla, S., 1999) has been used and the results of 36.75 N and 34.60 E have been selected as the coordinate which is the closest one for this region. In this comparison, both the best distribution case and Gumbel distribution case have been used for the meteorology and ECMWF data sets.

Table 4.20. Results of the Wave Atlas Comparison for Mersin-Yenişehir

Mersin-Yenişehir	Wave Atlas	Meteorology		ECMWF	
	Gumbel(old)	LogNormal	Gumbel(old)	Gumbel (old)	Gumbel(old)
Hs50 (m)	6.50	5.18	5.65	4.54	4.54
Hs100 (m)	7.25	5.49	6.11	4.88	4.88

The Wave Atlas (Özhan, E. and Abdalla, S., 1999) again gives higher wave heights for this region. The results of the meteorology data set along with Gumbel distribution are the closest ones to those of the Wave Atlas. The ECMWF and meteorology data sets give closer results for this region, but it should be mentioned that the meteorology data set is in better agreement with the result of the Wave Atlas.

4.3. DISCUSSION ON GRAPHICAL AND NUMERICAL ANALYSIS

When the results are inspected in this study, generally, the ECMWF data sets give higher wind velocities and wave heights than the meteorology stations. Sometimes, the differences between two data sets are higher than expected. For discussing the results obtained from the graphical and numerical analysis, possible reasons which could cause the differences between two data sets are investigated in this section.

4.3.1. Calculation Error and Code Validation

Calculation mistakes may the biggest reasons which could cause errors. On the other hand, all calculations are double checked in this study. So, the possibility of calculation errors is fairly low in this study.

4.3.2. Effect of Spline

As mentioned above, the ECMWF data set has wind velocity measurement for every 6 hour. On the other hand, all codes and programs that are used require an hourly measurement. For converting, 6 hour data into hourly data, spline method has been applied on the ECMWF data sets. The effects of this method could be seen clearly in the time series graphs. The ECMWF hourly data set which is created by spline method follows stacked line type while the values of the meteorology data set acts in an irregular way along the path. Spline method is causes these path differences and these differences create higher durations for storm and higher wave heights. For understanding these differences clearly, some of the outputs of the meteorology and ECMWF can be seen in Figure 4.16 and Figure 4.17.

```
  10   20    4 1988   19   20    4 1988    9
21 43 21 51 21 57 21 67 21 63 21 59 22 56 22 32 22 33
  10   21    4 1988   18   21    4 1988    8
21 38 21 45 22 45 22 53 22 57 22 56 22 50 22 54
  11   22    4 1988   17   22    4 1988    6
20 31 20 52 21 63 21 58 21 47 22 33
  10   24    4 1988   17   24    4 1988    7
21 37 21 37 19 34 20 43 21 47 21 49 21 42
  11   25    4 1988   18   25    4 1988    7
```

Figure 4.16. Durations of Storms for the Meteorology Data set

```
  10   20    4 1988   23   21    4 1988   37
21 30 21 33 21 37 21 41 21 44 21 48 21 51 21 54 21 57 21 59 21 60 21 61
21 61 21 61 22 61 22 60 22 58 22 57 22 55 22 54 21 53 21 53 21 53 21 54
21 55 21 57 21 58 21 60 20 60 20 60 20 59 21 57 21 54 21 50 21 45 22 42
22 39
   8   22    4 1988   19   22    4 1988   11
19 32 19 36 19 38 19 38 20 38 20 38 21 38 21 40 22 43 22 46 22 47
  10   25    4 1988   16   25    4 1988    6
22 30 22 35 21 41 21 46 22 48 22 50
  15   26    4 1988   18   26    4 1988    3
22 30 22 32 22 32
```

Figure 4.17. Durations of Storms for the ECMWF Data set

From the example, it is seen that the meteorology shows partial storms with a short duration while the ECMWF indicates one storm with a longer duration. These impacts are caused by the spline method. Actually, both data sets show the same storm which begins on 20.04.1988, but the ECMWF shows this duration of storm to be 4 times higher than the meteorology.

4.3.3. Effect of Raw Data Number

In this part, only the number of measurement data is compared. For inspecting the effects of the data number, all data above the storm threshold value which is selected as 3 m/s in wind.exe program and fetch directions are included and the raw data number is compared in Table 4.21.

Table 4.21. The Number of Data above Threshold for All Region

REGIONS	Number of Measurements for Meteorology	Number of Measurements for ECMWF
MERSİN-Anamur	30475	78551
ADANA-Karataş	70077	88016
ADANA-Yumurtalık	41871	61759
ANTALYA-Finike	7317	12074
ANTALYA-Gazipaşa	9873	19915
HATAY-İskenderun	16913	19339
MERSİN-Yenişehir	17710	17232

Due to the differences of measurement time period between stations, the number of measurements shows significant differences. Moreover, there is also a difference between the data sets in the same region. Investigation of raw data measurements number could not give a certain impact to results because when inspecting regions which has close raw data measurement various results have been obtained. For example both Yenişehir and İskenderun regions have close raw data measurement. On the other hand, Yenişehir gives similar results while İskenderun has a huge differences between two data sets results. This lack or extra data could cause different wave height values between the data sets but this cannot be considered as an only reason for differences.

Yearly inspection could be decreasing the effect of raw data number. For this reason, yearly maximum wave height for each region is inspected below.

Mersin-Anamur:

An analysis of 27 years for both data sets gives the following below Hs values for Anamur region in Table 4.22. The extreme analysis shows that the ECMWF data set gives a higher result of 45% than the meteorology for a return period of 50 years. Maximum wave height differences at the same year is huge in this region. For example, the ECMWF data set maximum wave height value is 5.91 m in 2004 but the meteorology data set gives 1.54 m in 2004. This yearly differences are the main reasons of variety of the extreme analysis results.

Table 4.22. The Output of W61 for Mersin-Anamur

Mersin - Anamur			
Meteorology		ECMWF	
Year	Hs Max	Year	Hs Max
1986	3.75	2004	5.91
1984	3.63	1986	5.24
1987	3.4	2009	5.21
1983	2.91	2006	5.07
1985	2.62	1985	4.83
2003	2.61	2002	4.75
1991	2.61	2007	4.63
1990	2.57	2003	4.61
2002	2.55	1983	4.43
1994	2.41	2000	4.37
2001	2.39	2008	4.18
1988	2.31	1987	4.11
2007	2.15	1984	4.05
1997	2.14	2005	3.99
2006	1.97	1988	3.89
1989	1.91	2001	3.69
2005	1.9	1989	3.41
1998	1.88	1990	3.32
2000	1.78	1999	3.24
1992	1.75	1996	3.12
1993	1.71	1993	3.09
2009	1.63	1991	3.08
1996	1.61	1997	3.03
2004	1.54	1998	2.95
1995	1.53	1995	2.94
2008	1.38	1994	2.9
1999	1.32	1992	2.8

Adana-Karataş:

An analysis of 27 years for both data sets gives the following Hs values for Karataş region in Table 4.23. Results are close to each other. The extreme analysis shows that ECMWF data set gives a result which is almost 6% higher than that of the meteorology for a return period of 100 years. Like Anamur region, maximum wave height differences at the same year is huge in this region. For example, ECMWF data sets maximum wave height year and meteorology data sets minimum wave height year is the same which is 2004.

Table 4.23. The Output of W61 for Adana-Karataş

Adana - Karataş			
Meteorology		ECMWF	
Year	Hs Max	Year	Hs Max
1987	6.61	2009	6.54
1983	6.51	2004	6.44
1986	6.24	2006	5.86
1984	5.24	2003	5.43
1985	4.81	2008	4.99
1991	4.36	1992	4.85
1994	4.23	1990	4.83
2003	3.92	1999	4.82
2004	3.8	2000	4.59
1990	3.77	2005	4.51
1995	3.73	2001	4.41
1992	3.71	1994	4.32
1988	3.68	1997	4.14
1989	3.63	1993	3.97
1999	3.57	2007	3.93
2007	3.51	2002	3.6
1993	3.25	1986	3.6
2008	3.24	1987	3.57
1996	3.17	1995	3.55
2001	3.01	1989	3.52
2005	2.98	1996	3.43
1997	2.91	1988	3.41
1998	2.86	1991	3.35
2002	2.81	1984	3.2
2006	2.71	1998	2.9
2000	2.52	1985	2.78
2009	2.37	1983	2.74

Adana-Yumurtalık:

An analysis of 27 years for both data sets gives the following Hs values for Yumurtalık region in Table 4.24. Results are close to each other as in Karataş region. On the other hand, this time, the extreme analysis shows that the ECMWF data set gives a result which is almost 4% lower than that of the meteorlogy for a return period of 100 years.

Table 4.24. The Output of W61 for Adana-Yumurtalık

Adana - Yumurtalık			
Meteorology		ECMWF	
Year	Hs Max	Year	Hs Max
1985	5.81	2009	5.91
1987	5.73	2006	4.88
1986	5.24	2007	4.78
1984	3.93	2003	4.14
1988	3.87	2008	3.97
1991	3.86	1983	3.95
1989	3.68	2004	3.91
1983	3.58	2005	3.32
1994	3.54	1992	3.1
1990	3.27	2001	3.08
1993	3.25	1988	2.94
1992	3.23	1989	2.82
2003	2.96	1986	2.82
1996	2.91	1987	2.69
2007	2.83	1990	2.61
2005	2.8	1993	2.61
1995	2.79	1997	2.51
2006	2.69	1991	2.48
2008	2.42	1984	2.41
1999	2.39	1999	2.3
2004	2.2	1985	2.3
2001	2.13	1994	2.27
2000	1.95	1995	2.06
2009	1.93	1996	1.89
1997	1.84	1998	1.69
2002	1.76	2002	1.65
1998	1.58	2000	1.64

Antalya-Finike:

An analysis of 12 years for both data sets gives the following Hs values for Finike region in Table 4.25. Results are different from each other than expected. The extreme analysis shows that the ECMWF data set gives results which are 75% higher results than those of the meteorology for a return period of 50 years. The number of measurement differences ratio could be the cause of this difference.

Table 4.25. The Output of W61 for Antalya-Finike

Antalya - Finike			
Meteorology		ECMWF	
Year	Hs Max	Year	Hs Max
2004	2.44	2003	4.34
2001	2.25	2001	4.26
2003	2.21	2000	4.14
2010	2.04	2004	3.82
2006	2.03	2002	3.57
2009	1.85	2006	3.28
2008	1.55	2010	3.1
2002	1.53	2007	3.06
2005	1.45	2008	3.05
2011	1.4	2005	2.91
2007	1.17	2011	2.64
2000	0.72	2009	2.2

Antalya-Gazipaşa:

An analysis of 11 years for both data sets gives the following Hs values for Gazipaşa region in Table 4.26. Results are different from each other than expected. The extreme analysis shows that the ECMWF data set gives results which are 106% higher than those of the meteorology for a return period of 50 years. Not only the number of measurement differences, but also the limited period of analysis could be the cause of this difference.

Table 4.26. The Output of W61 for Antalya-Gazipaşa

Antalya - Gazipaşa			
Meteorology		ECMWF	
Year	Hs Max	Year	Hs Max
2003	1.84	2003	3.55
2005	1.76	2004	3.52
2008	1.76	2010	3.47
2009	1.65	2009	3.18
2001	1.61	2002	3.16
2007	1.6	2007	3.06
2006	1.55	2000	2.88
2002	1.53	2001	2.79
2000	1.42	2005	2.62
2004	1.42	2008	2.56
2010	1.41	2006	2.32

Hatay-İskenderun:

An analysis of 11 years analysis for both data sets gives the following Hs values for İskenderun region in Table 4.27. Results are different from each other than expected. The extreme analysis shows that the ECMWF data set gives results which are 61% higher than those of the meteorology for a return period of 50 years. Not only the number of measurement differences, but also the limited period of analysis could be the cause of this difference.

Table 4.27. The Output of W61 for Hatay-İskenderun

Hatay-İskenderun			
Meteorology		ECMWF	
Year	Hs Max	Year	Hs Max
2008	3.38	2009	4.68
2010	3.3	2006	4.39
2009	3.08	2007	4.12
2005	3.01	2004	3.37
2006	2.84	2010	3.35
2007	2.8	2008	3.22
2004	2.7	2003	3.17
2002	2.7	2005	3.03
2001	2.63	2001	2.38
2003	2.63	2002	1.59
2000	2.38	2000	0.9

Mersin-Yenişehir:

An analysis of 11 years for both data sets gives the following Hs values for Yenişehir region in Table 4.28. The extreme analysis shows that ECMWF data set gives results which are 13% lower than those of the meteorology for a return period of 50 years. Yenişehir station is unique when Hs values are considered because the meteorology station gives higher wave height values when compared to the ECMWF data set.

Table 4.28. The Output of W61 for Mersin-Yenişehir

Mersin - Yenişehir			
Meteorology		ECMWF	
Year	Hs Max	Year	Hs Max
2009	4.47	2006	3.82
2000	4.3	2004	3.37
2007	4.27	2007	3.34
2001	3.67	2005	3.24
2008	3.37	2001	2.7
2004	3.34	2003	2.67
2005	3.19	2002	2.6
2002	3.13	2008	2.56
2003	3	2009	2.49
2010	2.75	2010	2.32
2006	2.32	2000	2.18

According to above analysis of yearly maximum wave height for each region. Especially, in the time period 2000-2010, the difference between the meteorology data sets and the ECMWF data sets is widely different. For the same years, while ECMWF data sets provide highest wave heights as a result of extreme analysis, meteorology data set provides the lowest wave heights.

4.4. LONG-TERM ANALYSIS

In this study, a long term analysis has been done for analysing and understanding the conditional distributions of wave heights for fetch directions. Directional and wave height differences for a long term wave height distribution could be helpful for understanding the behaviour of the data sets.

For the long term analysis, the following expression of this distribution has been used:

$$H_{1/3} = A * logQ\left(> H'_{\frac{1}{3}}\right) + B$$

Mersin-Anamur:

For Anamur region, WSW direction of both data sets gives critical results with respect to other directions. Moreover, the second and third critical directions do not change for this region on high wave height values, either. On the other hand, as expected from the extreme analysis, exceedance probability of the ECMWF data sets gives higher values for wave heights 10 hour/year probability. The exact wave height which can occur in 10 hours/year can be seen in the following table.

Table 4.29. The Results of Long-term Analysis for Mersin-Anamur

Mersin - Anamur	Major Direction	Wave Height (10 hours/year)	Differences (%)
Meteorology	WSW	2.52	43.25
ECMWF	WSW	3.61	

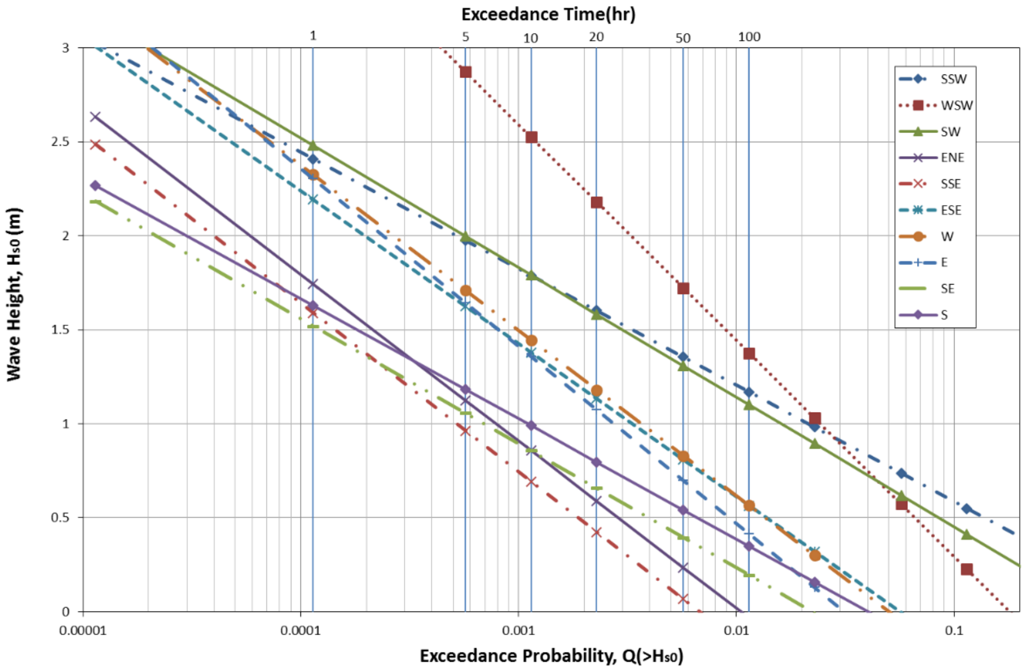


Figure 4.18. H_{s0} vs. $Q(>H_{s0})$ for Dominant Directions According to the Meteorology Data Set for Mersin-Anamur

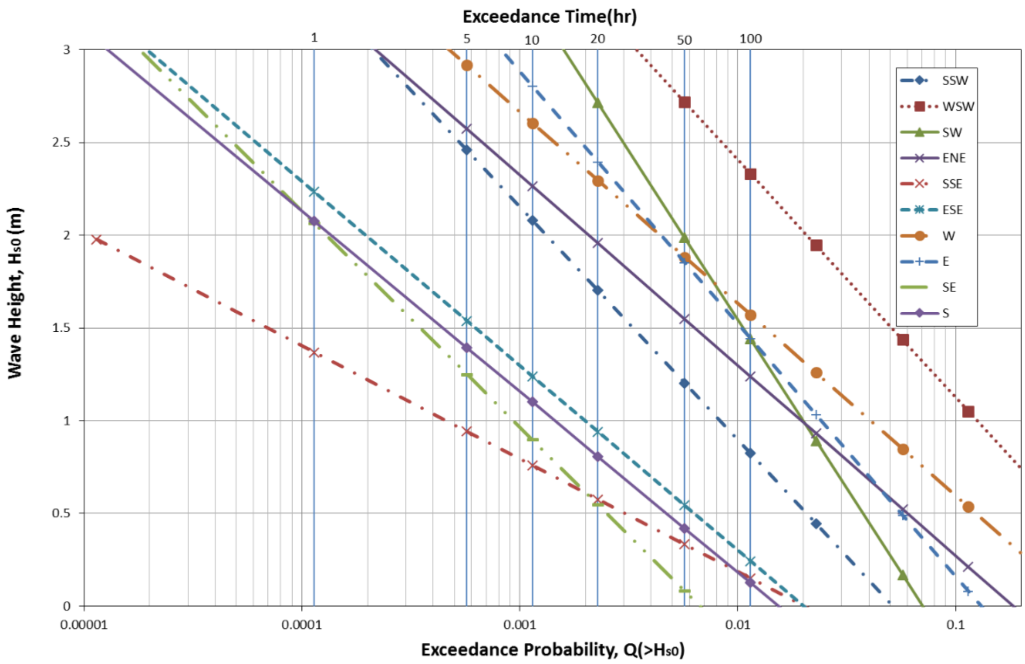


Figure 4.19. H_{s0} vs. Q(>H_{s0}) for Dominant Directions According to the ECMWF Data Set for Mersin-Anamur

Adana-Karataş:

For Karataş region, the long term analysis of both data sets gives different critical directions but the similarities of direction which have low probability. Actually, this similarity is expected from the extreme analysis and wind rose results. For inspecting critical direction, the meteorology data set gives SSW direction as critical while the ECMWF shows SW as the dominant one. At this point, it is necessary to say that at a higher probability of exceedance, the ECMWF also shows SSW direction as critical. Besides, the exact wave height which can occur in 10 hour/year can be seen following table.

Table 4.30. The Results of Long-term Analysis for Adana-Karataş

Adana - Karataş	Major Direction	Wave Height (10 hours/year)	Differences (%)
Meteorology	SSW	3.97	-0.76
ECMWF	SW	3.94	

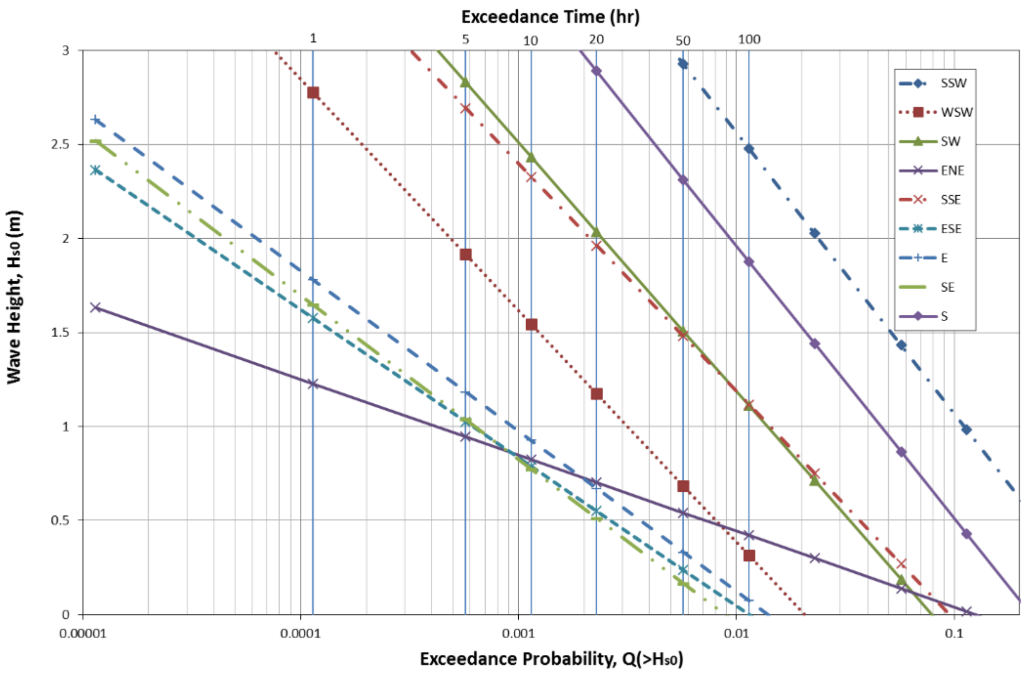


Figure 4.20. H_{s0} vs. $Q(>H_{s0})$ for Dominant Directions According to the Meteorology Data Set for Adana-Karataş

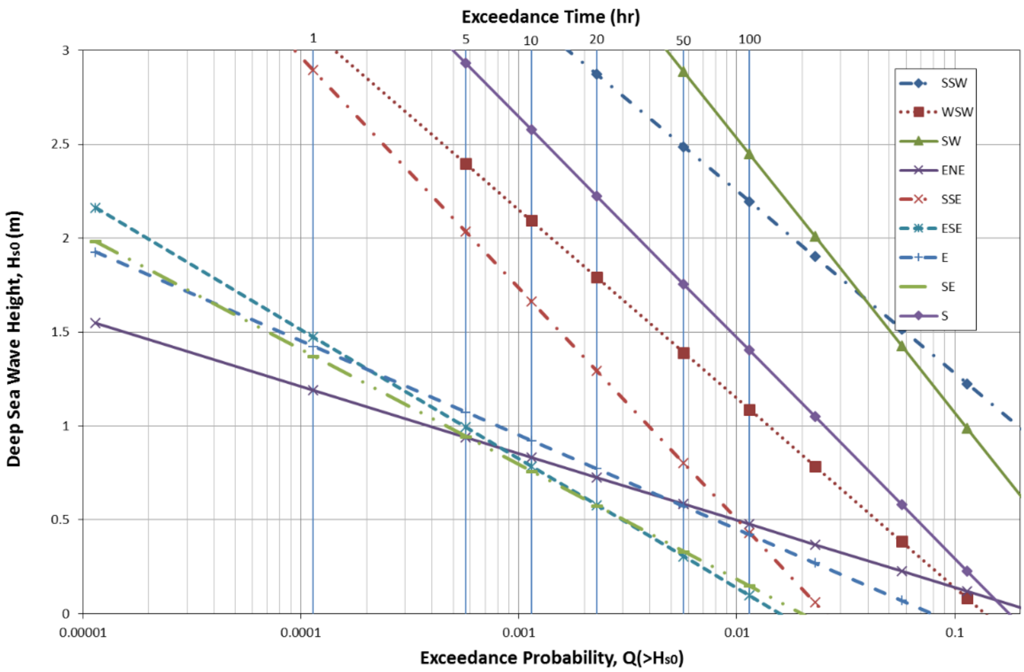


Figure 4.21. H_{s0} vs. $Q(>H_{s0})$ for Dominant Directions According to the ECMWF Data Set for Adana-Karataş

Adana-Yumurtalık:

For Yumurtalık region, both data sets show SSW direction as critical. However, they have disagreements about the second critical direction at a lower probability of exceedance. The meteorology indicates S direction as the second one at a lower probability of exceedance while the ECMWF clearly shows that SE is the second one. Differences of critical direction is in the acceptable range for this region which is about 13% higher in favour to meteorology data set. Besides, the exact wave height which can occur in 10 hours/year can be seen in the following table.

Table 4.31. The Results of Long-term Analysis for Adana-Yumurtalık

Adana - Yumurtalık	Major Direction	Wave Height (10 hours/year)	Differences (%)
Meteorology	SSW	3.69	-13.28
ECMWF	SSW	3.20	

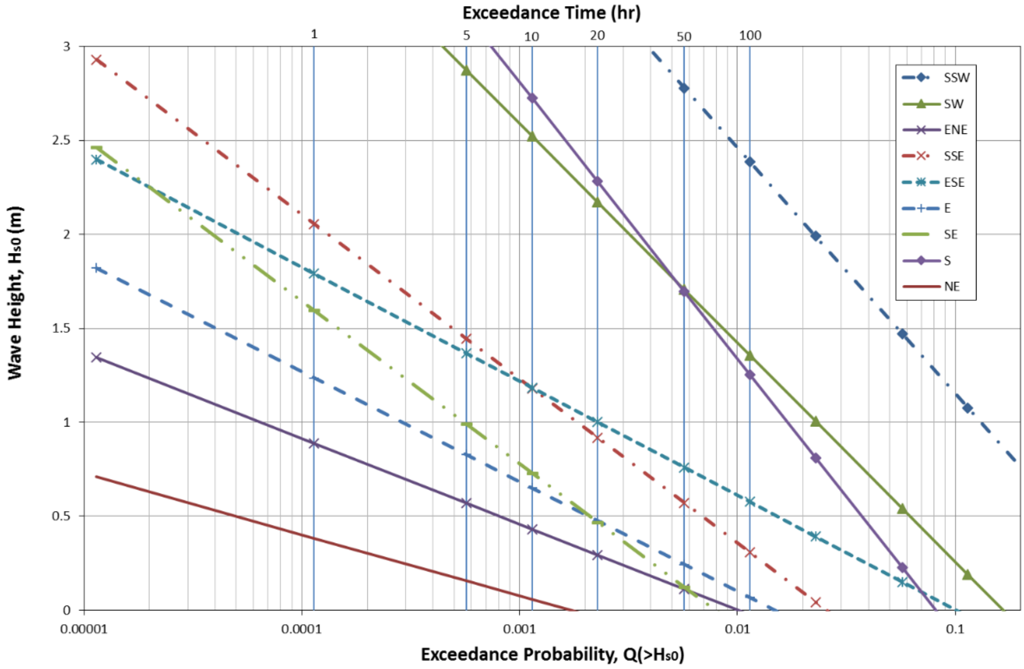


Figure 4.22. H_{s0} vs. $Q(>H_{s0})$ for Dominant Directions According to the Meteorology Data Set for Adana-Yumurtalık

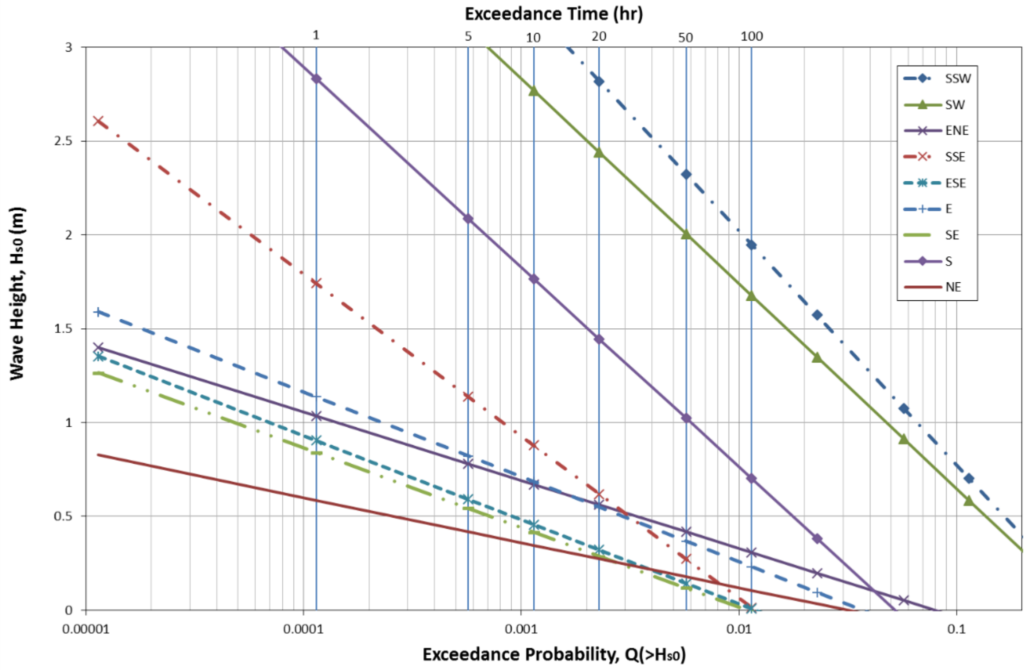


Figure 4.23. H_{s0} vs. Q(>H_{s0}) for Dominant Directions According to the ECMWF Data Set for Adana-Yumurtalık

Antalya-Finike:

For Finike region, two data sets have a conflict about the critical direction. The meteorology data set shows WSW direction as critical while the ECMWF shows SW direction as critical. Moreover, two data sets act highly unlikely in an area with a lower probability of exceedance, too. If SE direction is inspected for both graphs, the difference can be clearly seen. Direction disagreement continues at wave height values, the disagreement between two data at their major directions is about 87%. Besides, the exact wave height which can occur in 10 hours/year can be seen in the following table.

Table 4.32. The Results of Long-term Analysis for Antalya-Finike

Antalya - Finike	Major Direction	Wave Height (10 hours/year)	Differences (%)
Meteorology	WSW	1.69	86.98
ECMWF	SW	3.16	

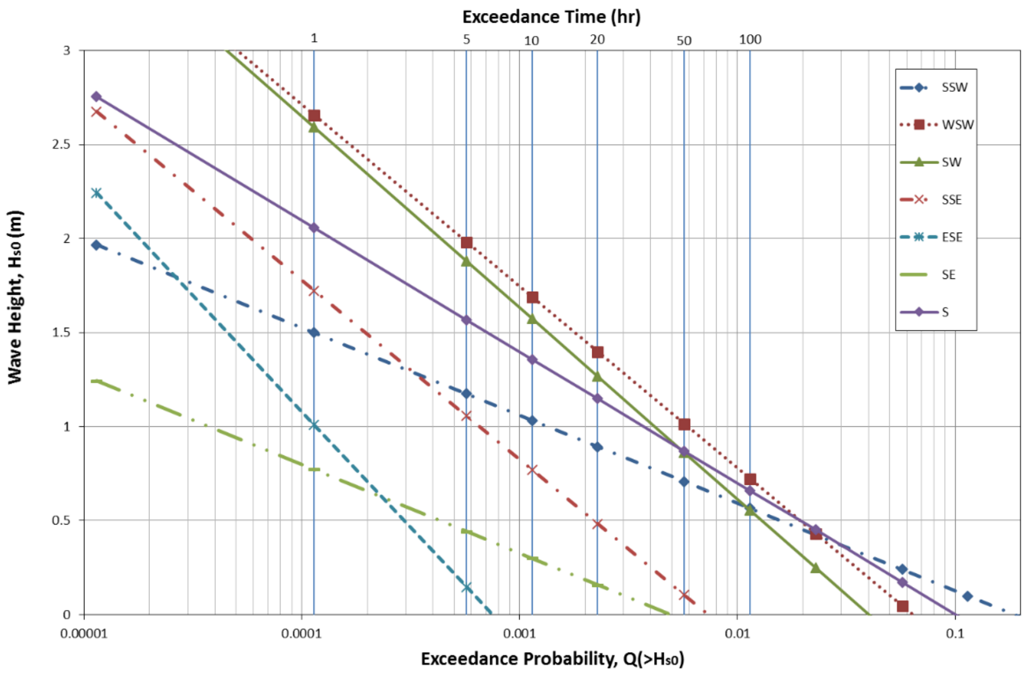


Figure 4.24. H_{s0} vs. Q(>H_{s0}) for Dominant Directions According to the Meteorology Data Set for Antalya-Finike

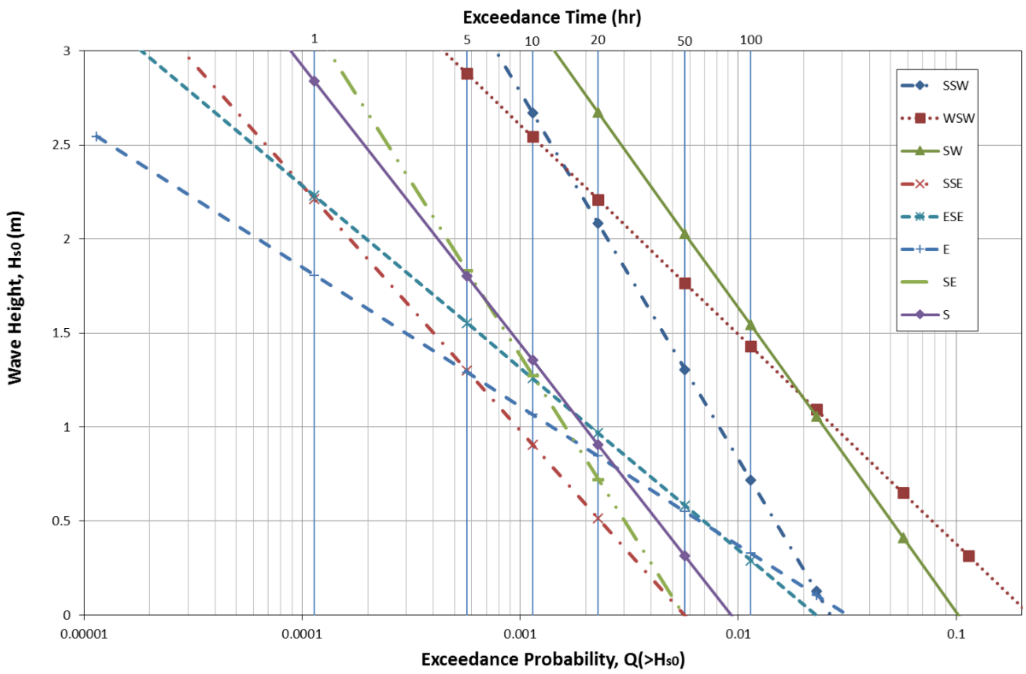


Figure 4.25. H_{s0} vs. Q(>H_{s0}) for Dominant Directions According to the ECMWF Data Set for Antalya-Finike

Antalya-Gazipaşa:

For Gazipaşa region, results of the long term analysis are highly different. The ECMWF data set gives 98% higher wave height for 10 hours/year. For example, WNW and SSE directions are critical according to the meteorology data set, but the ECMWF shows this direction in the area of the lowest wave height. On the other hand, as mentioned before, results of the extreme analysis for this area are also highly different like 105% for a return period of 50 years. So, it can be easily said that both directions and the wind velocity values of the meteorology and ECMWF data sets have complete disagreement for this region. Besides, the exact wave height which can occur in 10 hours/year can be seen in the following table.

Table 4.33. The Results of Long-term Analysis for Antalya-Gazipaşa

Antalya - Gazipaşa	Major Direction	Wave Height (10 hours/year)	Differences (%)
Meteorology	WNW	1.21	98.35
ECMWF	ESE	2.40	

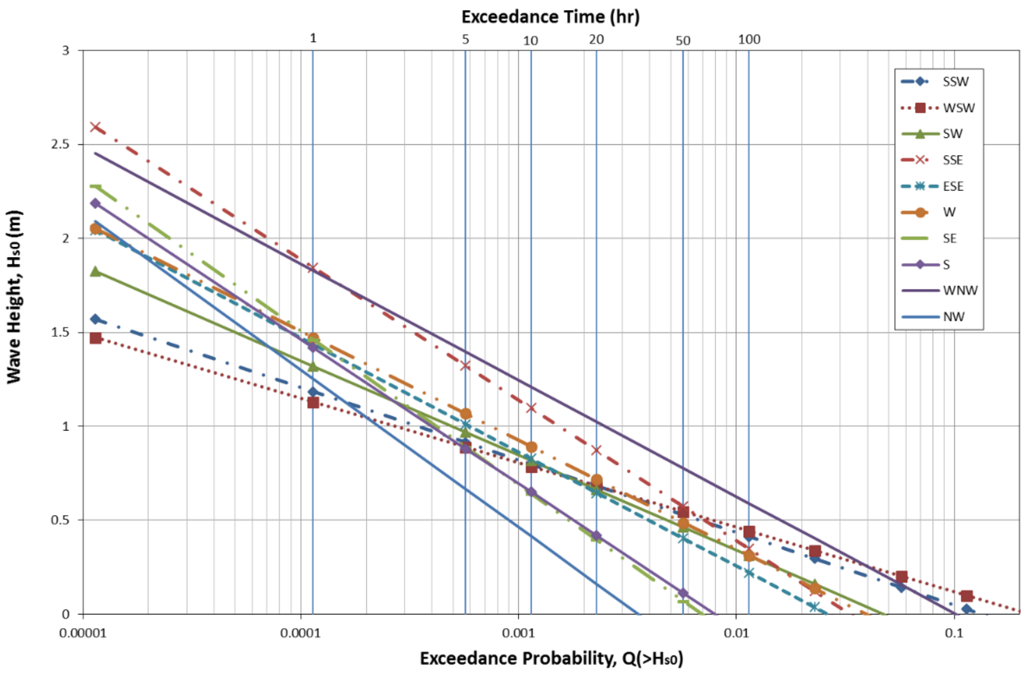


Figure 4.26. H_{s0} vs. $Q(>H_{s0})$ for Dominant Directions According to the Meteorology Data Set for Antalya-Gazipaşa

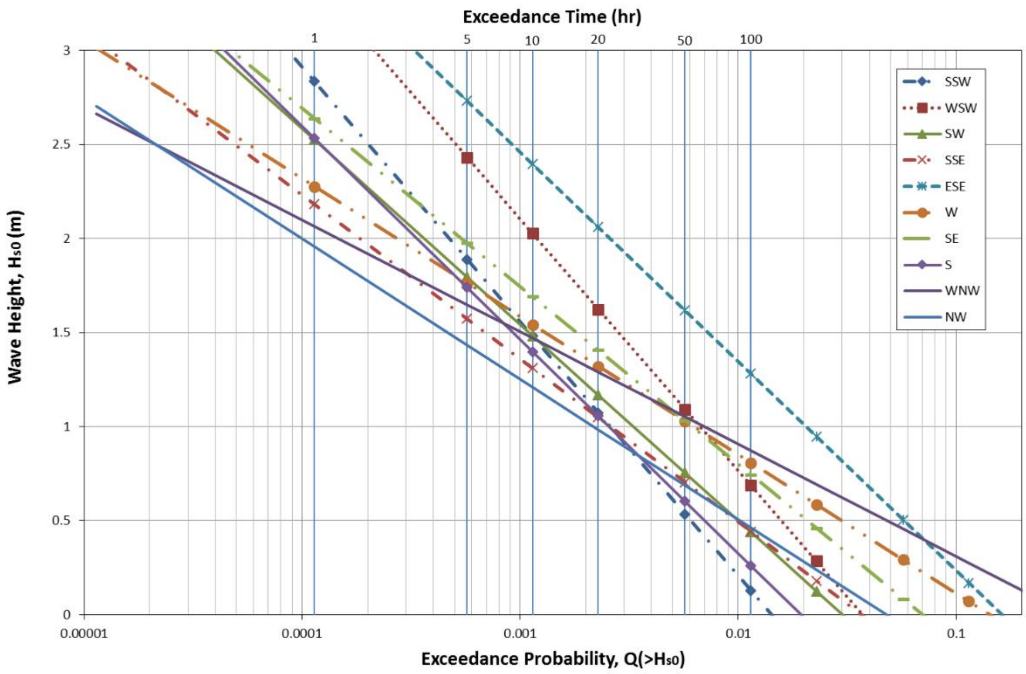


Figure 4.27. H_{s0} vs. $Q(>H_{s0})$ for Dominant Directions According to the ECMWF Data Set for Antalya-Gazipaşa

Hatay-İskenderun:

For İskenderun region, SW direction differences in the long term analysis are interesting. The ECMWF gives SW direction as the first critical one and WSW direction as the second critical one while the meteorology claims the opposite. Moreover, the following path of W direction is also different for both data sets. For this direction, the meteorology indicates that wave height can be created at a high probability of exceedance. On the other hand, the ECMWF data set claims the opposite. 14 % differences have been founded between two data sets at their major direction in wave height at 10 hours/year probability. Besides, the exact wave height which can occur in 10 hours/year can be seen in the following table.

Table 4.34. The Results of Long-term Analysis for Hatay-İskenderun

Hatay - İskenderun	Major Direction	Deep Sea Wave Height (10	Differences (%)
Meteorology	WSW	2.71	14.39
ECMWF	SW	3.10	

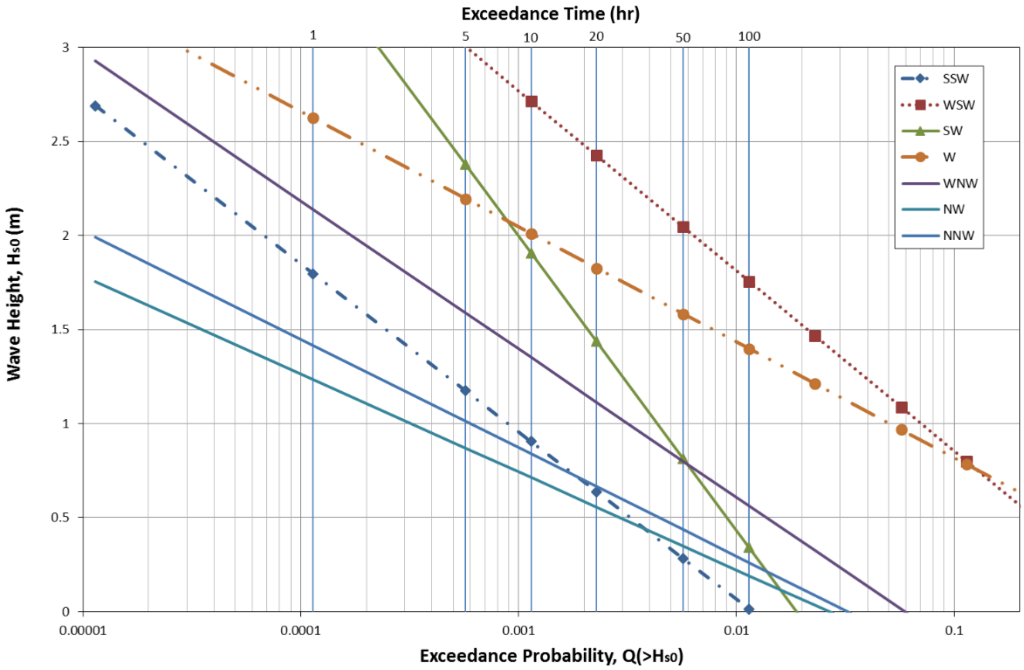


Figure 4.28. H_{s0} vs. Q(>H_{s0}) for Dominant Directions According to the Meteorology Data Set for Hatay-İskenderun

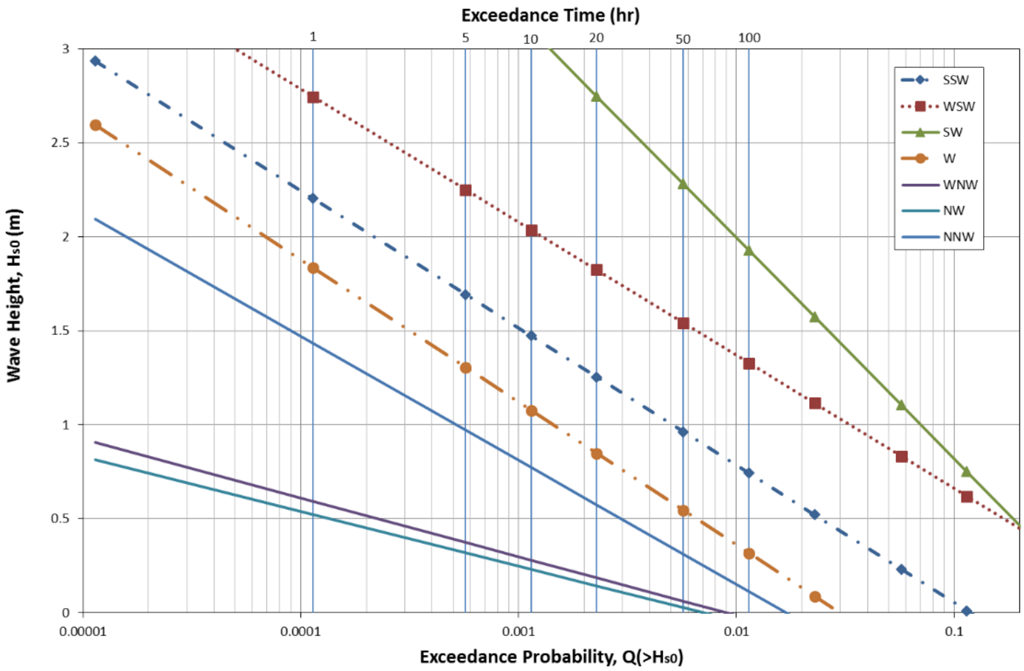


Figure 4.29. H_{s0} vs. Q(>H_{s0}) for Dominant Directions According to the ECMWF Data Set for Hatay-İskenderun

Mersin-Yenişehir:

For Yenişehir region, both data sets find SW direction as critical. Moreover, SE direction path in the ECMWF graph is clearly different from the meteorology data set. In the meteorology data set, top 3 directions, SW, SSW and S, draw almost parallel lines. On the other hand, in the ECMWF data set, SE direction's slope is too steep and this makes it the second critical direction in an area with a lower probability of exceedance. Wave height differences 10 hours/year probability at their major direction is about 12% for this region. Besides, the exact wave height which can occur 10 hours/year can be seen in the following table.

Table 4.35. The Results of Long-term Analysis for Mersin-Yenişehir

Mersin - Yenişehir	Major Direction	Wave Height (10 hours/year)	Differences (%)
Meteorology	SW	2.50	-11.60
ECMWF	SW	2.21	

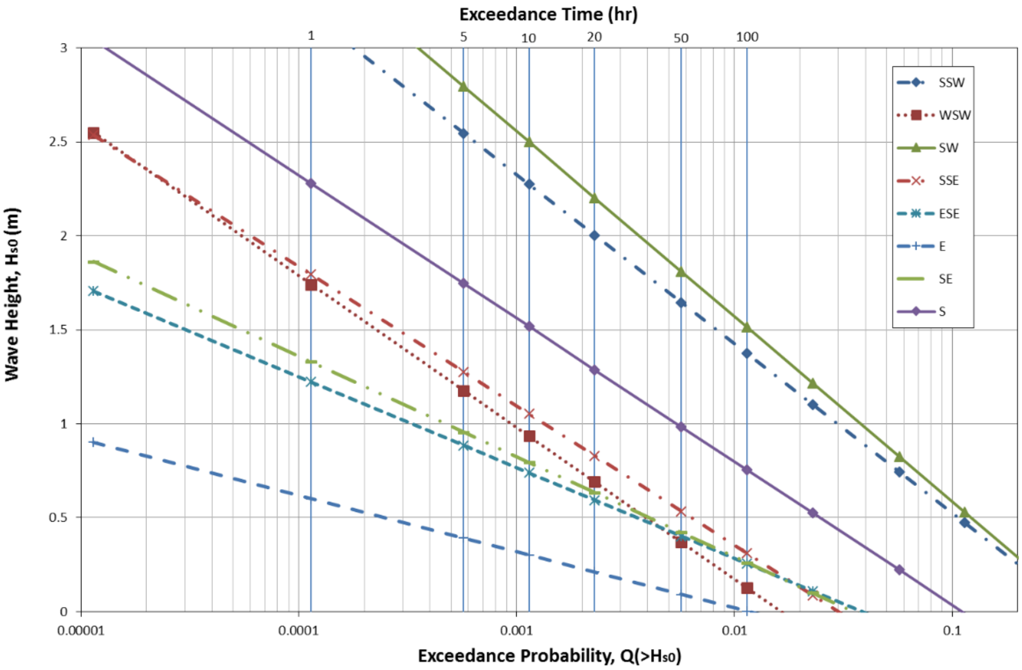


Figure 4.30. H_{s0} vs. $Q(>H_{s0})$ for Dominant Directions According to the Meteorology Data Set for Mersin-Yenişehir

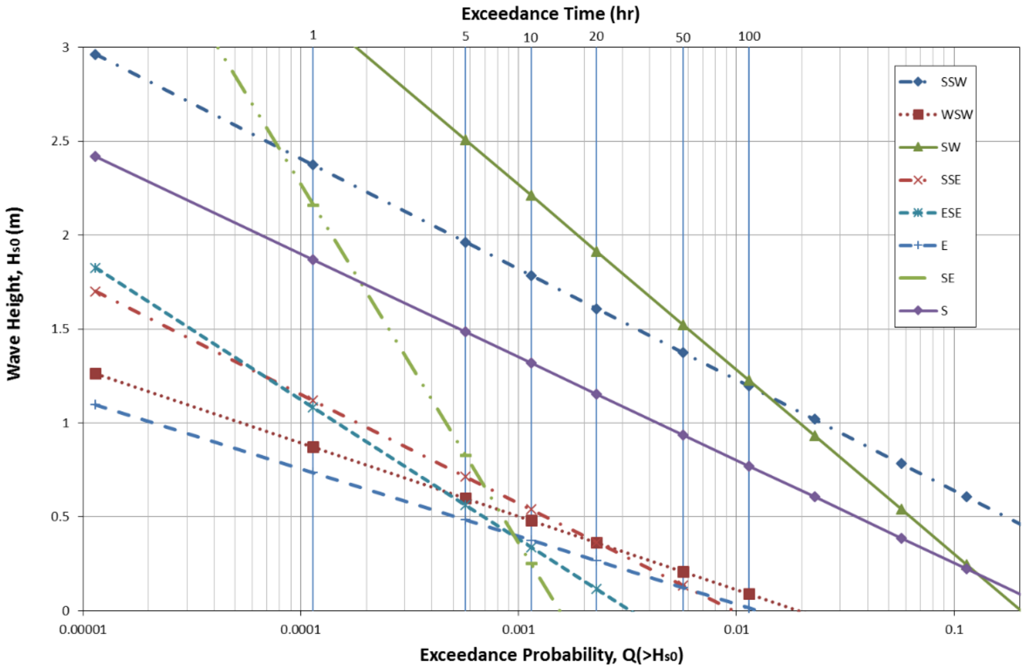


Figure 4.31. H_{s0} vs. $Q(>H_{s0})$ for Dominant Directions According to the ECMWF Data Set for Mersin-Yenişehir

Generally, stations major direction and 10 hours/year wave heights follow the same path. Which means if major direction is the same or close to each other, 10 hours/year wave heights differences are in a good agreement.

4.5. UNCERTAINITIES IN RELATION TO WIND DATA DUE TO THE SELECTION OF ECMWF COORDINATE

In this part, the effects of the selected coordinates of ECMWF will be investigated. For a reliable results, while ECMWF coordinates are chosen, it is important to pay attention to the fact that the coordinates' data set needs to have wind measurement above sea. Moreover, investigating the effect of the selected ECMWF coordinates for different regions could give an idea of the land geological impact of the selected ECMWF data sets. As mentioned earlier, for obtaining the wave data, it is necessary to convert the wind data sets. Besides, visualising the wind data sets could be very helpful for having an idea about the wave characteristics of selected region.

For examining the effect of land geology, three different region are selected: Gazipaşa, Karataş and Mersin. Gazipaşa region can be described as a mountainous region. As the characteristic of Turkish Mediterranean Sea region, the area behind the sea is covered with mountains and it is parallel to the shore. Karataş region can be described as a low land. The mountains of Karataş region are far away from the shore and their impacts on the ECMWF wind data set could be minimized. On the other hand, the characteristics of Mersin region are mixed like Gazipaşa and Karataş regions. The area behind Mersin region is not covered with full of mountains. Besides, this region cannot be described as a low land, either.

Moreover, it is important to mention that for the purpose of comparing the ECMWF sets within themselves and the meteorological stations, Gazipaşa and Mersin ECMWF data sets have been inspected between 1983-2013 and 2000-2010 while Karataş ECMWF data sets have been inspected between 1983-2013 and 1983-2009.

For investigating the effect of the difference of the ECMWF data sets and their impact, first of all, it is more likely to determine which ECMWF coordinate will be chosen. For this purpose, the coordinates which are close to the meteorological stations have been identified. Following this process, some points have been chosen according to their probability of being chosen in a project for this area. After choosing probable coordinates, wind and wave characteristics are compared both between each of the ECMWF data sets and meteorology data sets. For this comparison, first of all, a MatLAB code has been used to determine the ECMWF coordinate data which will be organized according to their wind velocities and directions. The frequency table shows the percentage of wind velocities according to their direction. Below, Gp-34 table can be seen as an example.

Table 4.36. The Frequency Table of Station Gp-34

36.00N-32.10E (GP-34)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-0.5 (m/s)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.017
0.5-1 (m/s)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.003	0.050
1-1.5 (m/s)	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.006	0.006	0.006	0.006	0.005	0.077
1.5-2 (m/s)	0.006	0.006	0.006	0.005	0.005	0.004	0.004	0.004	0.005	0.006	0.008	0.009	0.009	0.008	0.008	0.006	0.098
2-2.5 (m/s)	0.006	0.006	0.006	0.006	0.005	0.005	0.004	0.004	0.005	0.006	0.009	0.011	0.012	0.010	0.009	0.007	0.111
2.5-3 (m/s)	0.006	0.006	0.006	0.005	0.005	0.004	0.004	0.004	0.005	0.006	0.009	0.012	0.014	0.012	0.009	0.007	0.113
3-3.5 (m/s)	0.005	0.005	0.005	0.005	0.004	0.004	0.003	0.003	0.004	0.005	0.009	0.013	0.014	0.013	0.009	0.006	0.107
3.5-4 (m/s)	0.004	0.004	0.005	0.004	0.004	0.003	0.003	0.003	0.003	0.004	0.007	0.011	0.014	0.013	0.008	0.004	0.093
4-4.5 (m/s)	0.003	0.004	0.004	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.005	0.009	0.012	0.012	0.006	0.003	0.077
4.5-5 (m/s)	0.003	0.003	0.003	0.002	0.002	0.003	0.002	0.002	0.001	0.002	0.003	0.007	0.009	0.009	0.005	0.002	0.058
5-5.5 (m/s)	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.002	0.005	0.007	0.006	0.003	0.002	0.044
5.5-6 (m/s)	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.004	0.005	0.004	0.002	0.001	0.034
6-6.5 (m/s)	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.003	0.004	0.003	0.001	0.001	0.026
6.5-7 (m/s)	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.020
7-7.5 (m/s)	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.016
7.5-8 (m/s)	0.001	0.001	0.000	0.000	0.001	0.002	0.001	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.012
8-8.5 (m/s)	0.000	0.001	0.000	0.000	0.001	0.002	0.001	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.000	0.010
8.5-9 (m/s)	0.000	0.001	0.000	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.008
9-9.5 (m/s)	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006
9.5-10 (m/s)	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
>10 (m/s)	0.000	0.000	0.000	0.000	0.001	0.009	0.001	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.018
Σ	0.050	0.055	0.051	0.045	0.048	0.061	0.040	0.036	0.039	0.048	0.070	0.102	0.119	0.106	0.076	0.053	1.000

After organizing and preparing the tables, three types of chart have been created. First two charts have been prepared according to directions and wind velocities. Final type of chart has been specifically adapted to fetch directions to see clearly the differences between the percentages of wind velocity.

Final comparison for this part of the study is to compare the extreme and long term analyses. Determined ECMWF coordinates are compared with each other by using both the extreme and long term analyses. The coordinates of the extreme and long term analysis have been made by using W61 and wind.exe programs.

Antalya - Gazipaşa Region:

For Antalya - Gazipaşa nearby ECMWF coordinates are shown below.

Figure 4.32. The Coordinates Which Are Close to the Antalya-Gazipaşa Meteorological Station

Possible coordinates have been shown in Figure 4.32. The numbers of the coordinates which are likely to be chosen have been shown above figure and also below table.

Table 4.37. The Coordinates Which Are Likely to Be Chosen for Antalya-Gazipaşa

Antalya-Gazipaşa	
Gp-34	36.00N-32.10E
Gp-26	36.10N-32.20E
Gp-27	36.10N-32.30E
Gp-20	36.20N-32.20E
Gp-19	36.20N-32.10E
Gp-14	36.30N-32.30E
Gp-13	36.30N-32.10E
Gp-12	36.30N-32.00E

These selected coordinates, the meteorology data set for this region and the previously used Gazipaşa ECMWF coordinates (36.20N-32.30E) have been used for all wind comparisons.

Wind Analysis for Antalya-Gazipaşa:

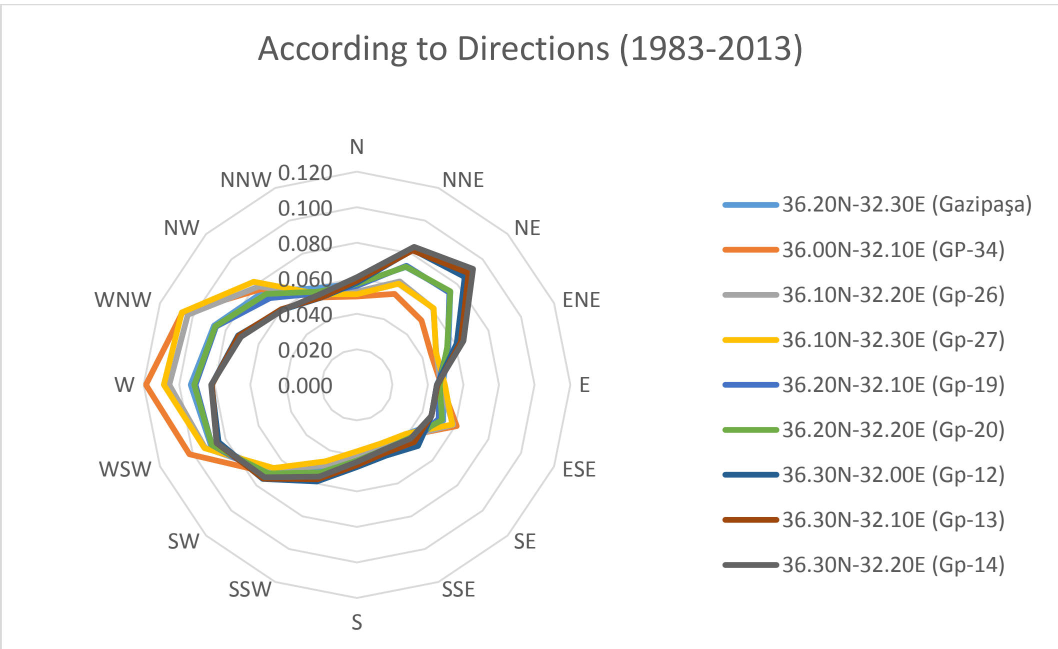


Figure 4.33. The Frequency Chart According to Directions for Only ECMWF Data Sets

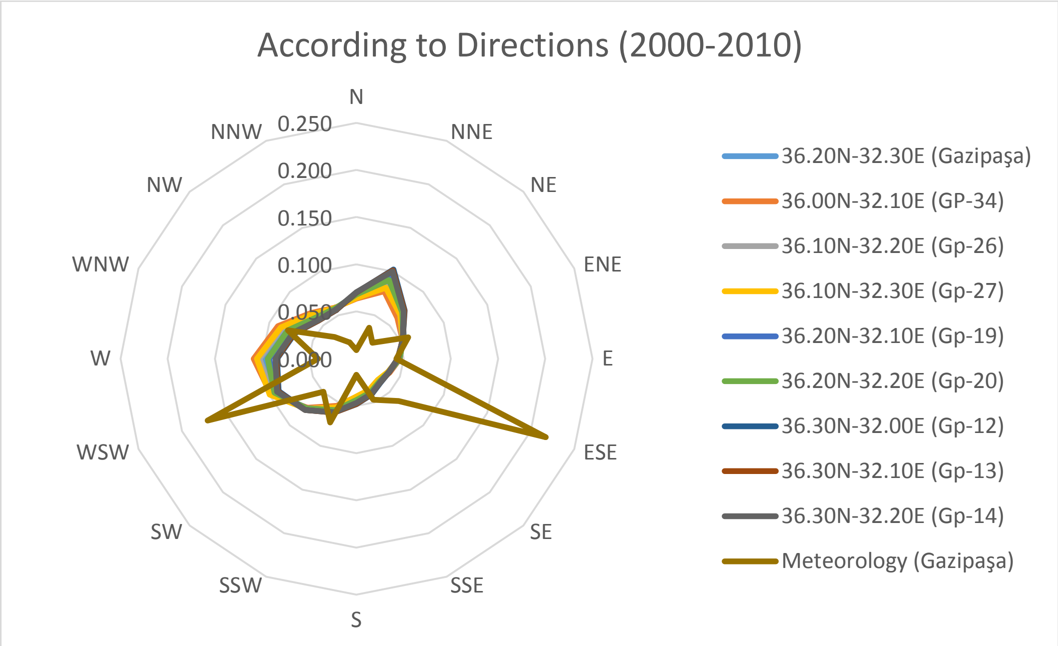


Figure 4.34. The Frequency Chart According to Directions for Both Meteorology and ECMWF Data Sets

From the above chart of 1983-2013, it can be seen that the station Gp-34 gives higher wind percentage values in WSW and W directions which are also fetch directions for this region. Besides, the Gp-34 station has lower wind percentage in NNE and NE directions. It means that the impact of winds from earth on the Gp-34 station is minimum.

Moreover, from the chart of 2000-2010 with the meteorology data set, it could be seen that a smaller year range converges the ECMWF data sets. On the other hand, the differences between the ECMWF data sets and the differences between the wind percentages of the meteorology station are highly unexpected. Moreover, it is important to say that the measurement method and the location of the meteorology station which is on the land could affect the results.

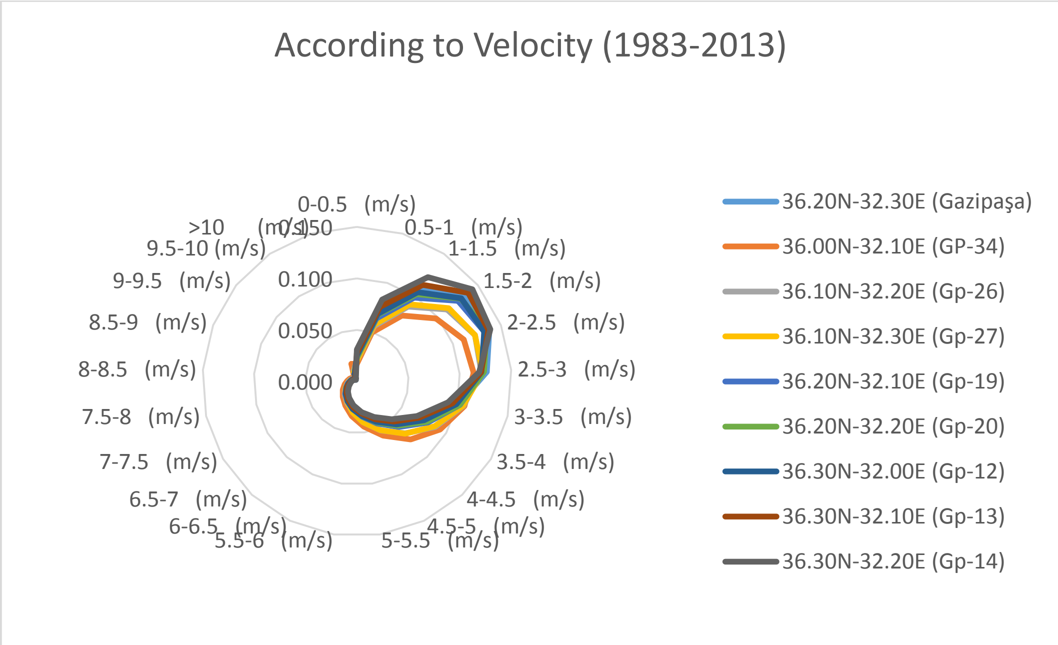


Figure 4.35. The Frequency Chart According to Velocity for Only ECMWF Data Sets

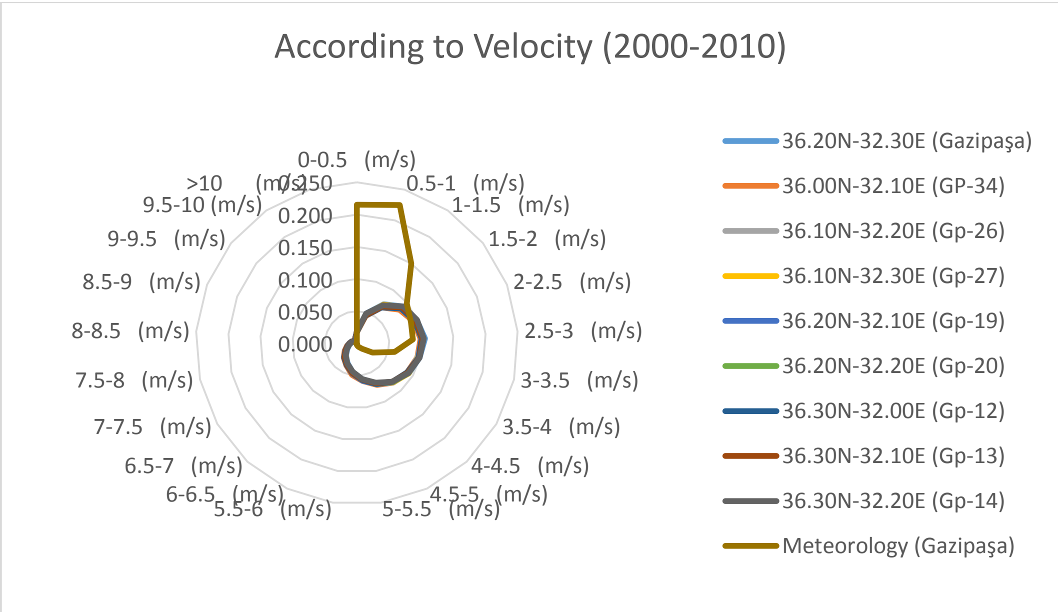


Figure 4.36. The Frequency Chart According to Velocity for Both Meteorology and ECMWF Data Sets

The Gp-14 station becomes prominent at lower wind velocities while the Gp-34 station exhibits its differences in the charts of velocity. Moreover, it is important to mention huge differences at lower velocity values between the meteorology and ECMWF data sets. In the chart of velocity, it is seen clearly once again that a lower year range analysis for the ECMWF data sets makes the difference smaller. Besides, percentage vs velocity charts have been created for revealing the difference in a clear manner. For this region, ESE direction has been chosen an example, because in this direction, at a lower level of velocity the difference the percentages of the meteorology and ECMWF data sets is too high. ESE direction charts can be seen below. The remaining graphs for rest of the directions are presented in Appendix D.

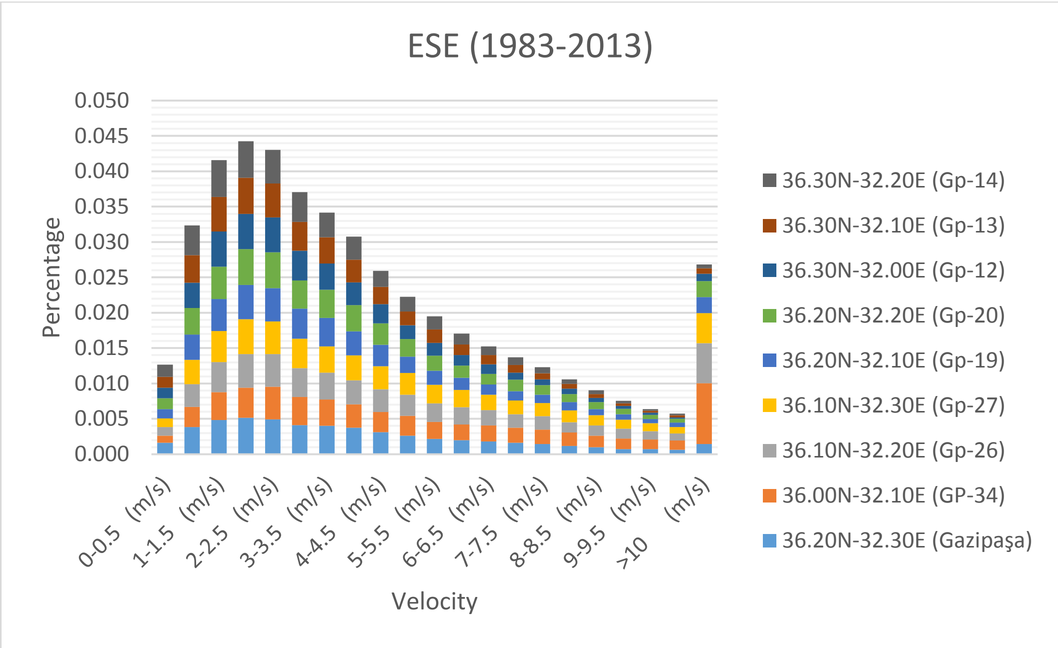


Figure 4.37. The Frequency Chart of ESE Direction for Only ECMWF Data Sets

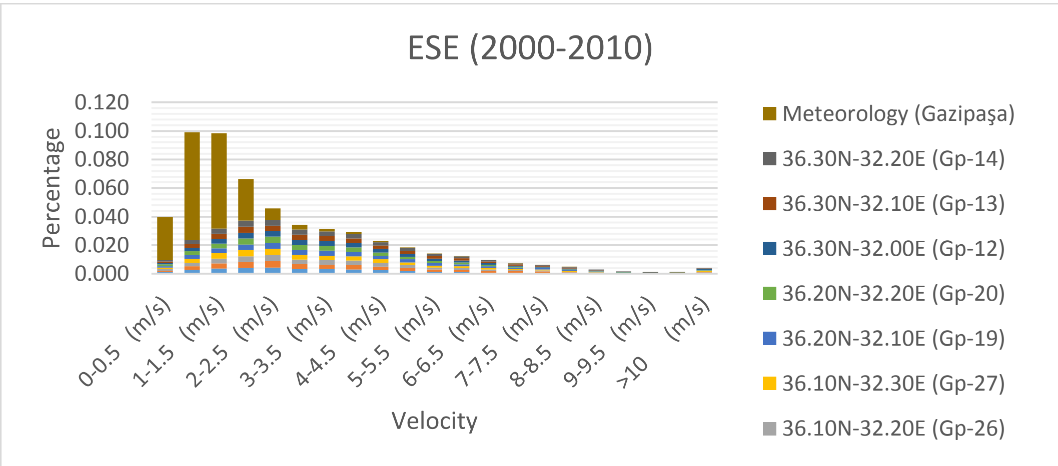


Figure 4.38. The Frequency Chart of ESE Direction for Both Meteorology and ECMWF Data Sets

According to ESE direction charts, it can be said that for lower wind velocity values all stations except the meteorology have similar characteristics. On the other hand, in particular, the stations Gp-34 and Gp-26 are explicit for higher wind velocities for ESE direction according to previously used ECMWF coordinates. For this direction, the meteorology data sets mostly measure lower wind velocity values.

For the direction of SE, all ECMWF stations act similarly. It is easy to see that this direction has the same importance for all the ECMWF stations according to the wind velocity values. Moreover, for this direction, the meteorology station measures lower wind velocities according to the ECMWF stations.

For SSE direction, wind velocity at 1.5-2 m/s is dominant according to the ECMWF data sets. On the other hand, it is seen as a significant wind velocity percentage in the range of 3.5-4 m/s in the meteorology data set.

The meteorology does not give critical values for S direction with respect to the ECMWF. When percentage values are inspected for higher wind velocities, the wind percentage values of the meteorology station are quite low.

SSW, WSW, SW, WNW and NW directions differ from others by the intensity difference of wind velocities. Between a winds velocity of 2 and 3 m/s seems to be common for this direction. Moreover, for SSW and WSW directions, the meteorology data sets act dominant for lower and middle wind velocity percentages.

For W direction, two different ranges of years have their own characteristics. Between 2000 and 2010, a wind velocity of 4.5-5 m/s has a similar percentage with 4-4.5 m/s contrary to the examination of 1983-2013 data sets. For W direction, it can be said that in recent years, wind velocity values are increasing for this direction.

Wave Analysis for Antalya-Gazipaşa:

Three ECMWF coordinates have been chosen according to the wind analysis and comparison from this region. Chosen station numbers for these coordinates are GP-34, GP-26 and GP-14. Gp-34 represents open sea characteristics while Gp-14 was chosen close to shore. Final coordinates, Gp-26 is closed to previously selected ECMWF coordinates and ranked as between Gp-34 and Gp-14. Following the long term and extreme analysis made for the meteorology, the previously selected ECMWF coordinates, GP-34, GP-26 and GP-14.

Extreme Analysis for Antalya-Gazipaşa:

Comparison of the extreme analysis for this region can be seen in the following table. From this table, it is seen that the ECMWF data set chooses lognormal distribution type as the best one for the period from 1983 to 2013. Besides, it is critical to see that the station GP-34 gives higher wave height for both the periods of 2000-2010 and 1983-2013 as expected due to the open sea effects. Gp-14 gives smaller wave heights in 1983-2013 time periods according to selected ECMWF coordinates. This could be the cause of shore effect in the Gp-14 measurements. As a result, wave height difference between the meteorology and ECMWF data sets is highly elevated if the GP-34 station is chosen for comparison. Besides, result tables for each coordinate could be found in Appendix E.

Table 4.38. Results of the Numerical Analysis Comparison for Antalya-Gazipaşa

Antalya-Gazipaşa	2000-2010		Best Distribution	H_{50} Differences (%)	H_{100} Differences (%)	1983-2013		Best Distribution	H_{50} Differences (%)	H_{100} Differences (%)
	H_{50}	H_{100}				H_{50}	H_{100}			
Meteorology	1.96	2.01	Weibull (k4=2.0)	-	-	-	-	-	-	-
ECMWF(36.20N-32.30E)	4.03	4.19	LogNormal	105.77	108.20	4.75	5.02	LogNormal	-	-
GP-34	6.40	6.95	FT 2 (k4=10.0)	227.25	245.52	5.80	6.11	LogNormal	22.04	21.54
GP-26	5.40	5.66	LogNormal	175.78	181.30	5.39	5.69	LogNormal	13.45	13.26
GP-14	3.56	3.68	LogNormal	81.67	83.05	4.69	4.97	LogNormal	-1.39	-1.02

Long Term Analysis for Antalya-Gazipaşa:

Long term analysis for this region gives significantly different results according to both major directions and wave height values. On the other hand, it should be noted that if the period of analysis is increased, the ECMWF stations give similar results. Only the major direction of the station GP-34 has not changed when the period of analysis is increased. In other ECMWF stations their major directions have changed wave height for 10 hours/year. When it is compared to the meteorology and ECMWF station, it is seen that no ECMWF station has shared the same major direction with the meteorology data sets. Besides, the meteorology data set is the one which gives the lowest wave height for 10 hours/year within the time period of 2000-2010. Besides, result graphs for each coordinate could be found in Appendix F.

Table 4.39. The Results of Long-term Analysis for Antalya-Gazipaşa

Antalya - Gazipaşa	2000-2010		Differences (%)	1983-2013		Differences (%)
	Major Direction	Wave Height (10 hours/year)		Major Direction	Wave Height (10 hours/year)	
Meteorology	WNW	1.21	-	-	-	-
ECMWF (36.20N-32.30E)	ESE	2.40	98.35	SSW	2.87	-
GP-34	WSW	3.67	203.31	WSW	3.35	16.72
GP-26	ESE	3.27	170.25	SSW	3.01	4.88
GP-14	SE	1.99	64.46	SSW	2.78	-3.14

Mersin - Yenişehir Region:

For Mersin – Yenişehir, nearby ECMWF coordinates have been shown below.

Figure 4.39. The Coordinates Which Are Close to the Mersin-Yenişehir Meteorological Station

Possible coordinates have been shown in Figure 4.39. The numbers of the coordinates which are likely to be chosen have been shown above figure and also below table.

Table 4.40. The Coordinates Which Are Likely to Be Chosen for Mersin-Yenişehir

Mersin-Yenişehir	
Mr-21	36.50N-34.60E
Mr-22	36.50N-34.70E
Mr-9	36.60N-34.50E
Mr-10	36.60N-34.60E
Mr-11	36.60N-34.70E
Mr-12	36.60N-34.80E
Mr-4	36.70N-34.70E

These selected coordinates, the meteorology data set for this region and the previously selected Yenişehir ECMWF coordinates (36.70N-34.60E) have been used for all wind comparisons.

Wind Analysis for Mersin-Yenişehir:

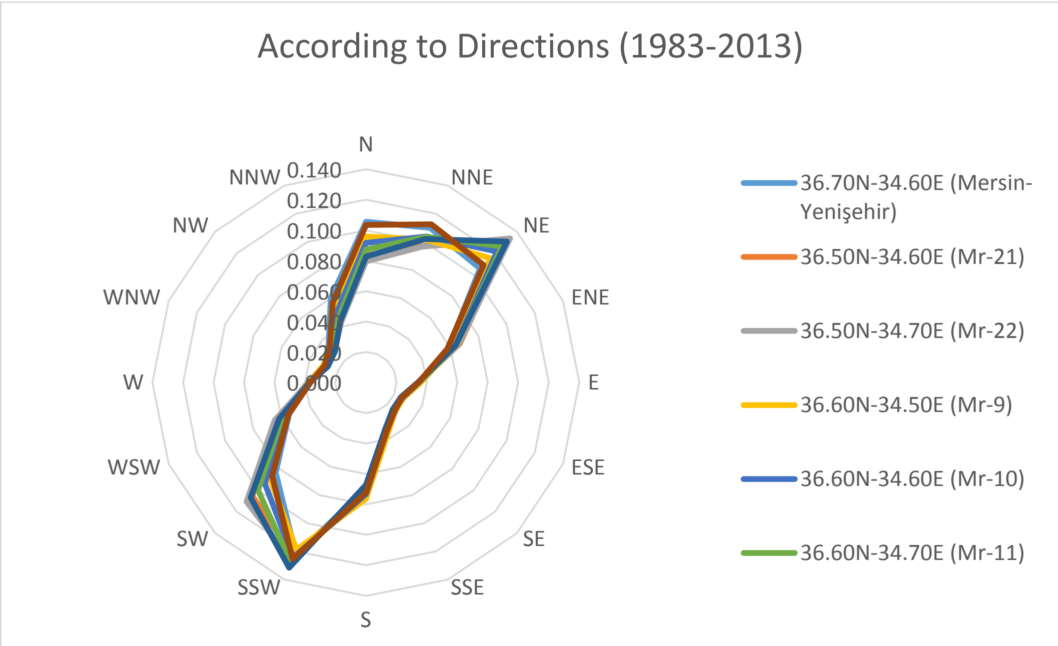


Figure 4.40. The Frequency Chart According to Directions for Only ECMWF Data Sets

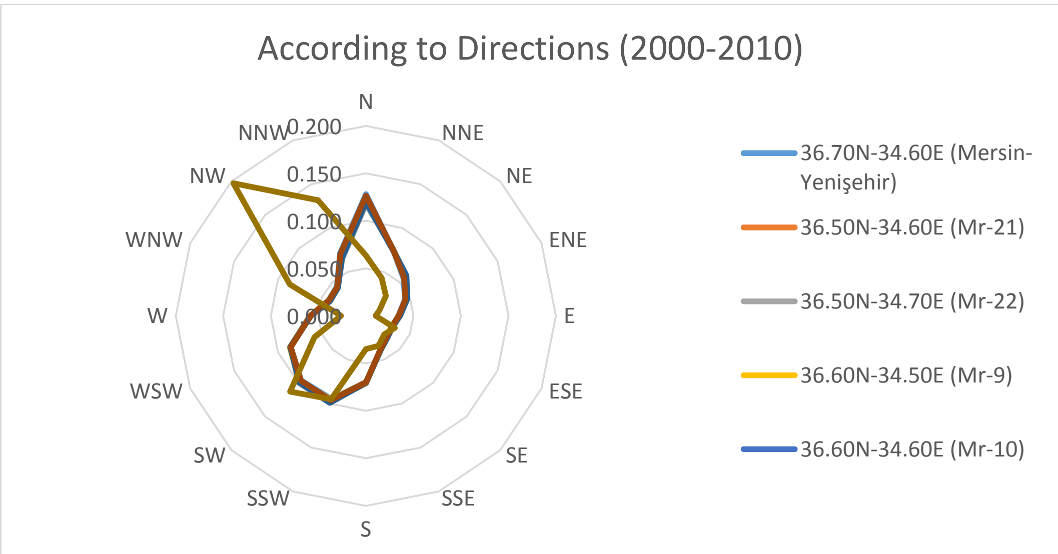


Figure 4.41. The Frequency Chart According to Directions for Both Meteorology and ECMWF Data Sets

From the above chart of 1983-2013, when the fetch directions are inspected, it is seen that the highest wind percentages are given by the Mr-22 in SW direction and the Mr-9 in S direction. Moreover, the previously selected ECMWF station (36.70N-34.60E) gives the highest wind percentages in SSW direction while the station Mr-9 gives the smallest one. This percentage difference for the Mr-9 along close directions could be the result of the open sea effects. Besides, it is remarkable that SE direction has the lowest wind percentages for all selected Yenişehir ECMWF coordinates.

Moreover, the chart of 2000-2010 shows that the meteorology data set gives higher wind percentages for SW direction and nearly the same percentages for SSW direction with respect to the selected ECMWF coordinates. Even though NW direction is not a fetch direction, differences between the meteorology and ECMWF data sets are remarkable.

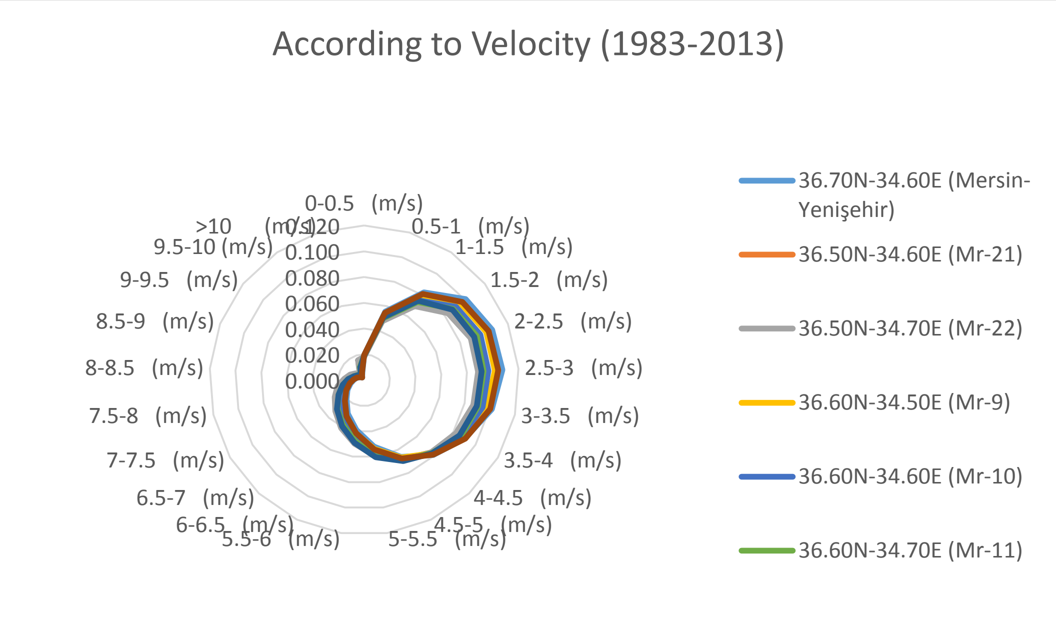


Figure 4.42. The Frequency Chart According to Velocity for Only ECMWF Data Sets

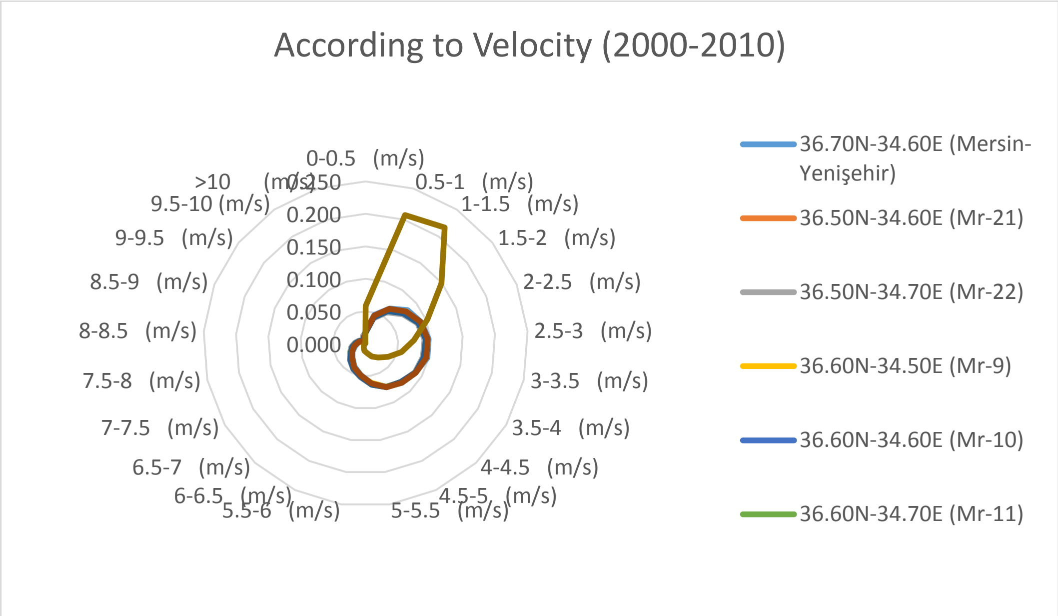


Figure 4.43. The Frequency Chart According to Velocity for Both Meteorology and ECMWF Data Sets

From velocity graphs, the highest percentage of the velocity 7-7.5 m/s have been found from the Mr-22 station. The previously selected ECMWF data set has dominated the low-mid range of velocity of 2-2.5 m/s and 2.5-3 m/s. Moreover, the difference between the ECMWF data sets and the meteorology in a low velocity range supports the results of the previously performed extreme wave analysis for this region. Besides, percentage vs velocity charts have been prepared for revealing the difference clearly. For this region, SSE direction has been chosen as an example, because in this direction at a velocity level of 1-3 m/s, the difference between the percentages of the meteorology and ECMWF data sets is high. SSE direction charts can be seen below. The remaining graphs for rest of the directions are given in Appendix D.

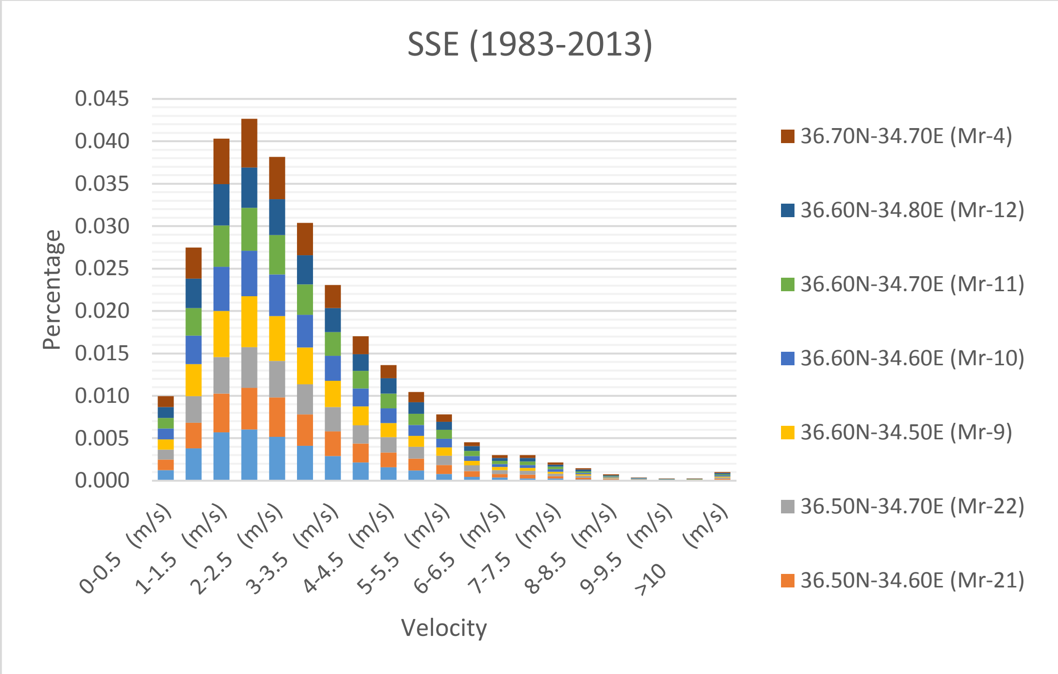


Figure 4.44. The Frequency Chart of SSE Direction for Only ECMWF Data Sets

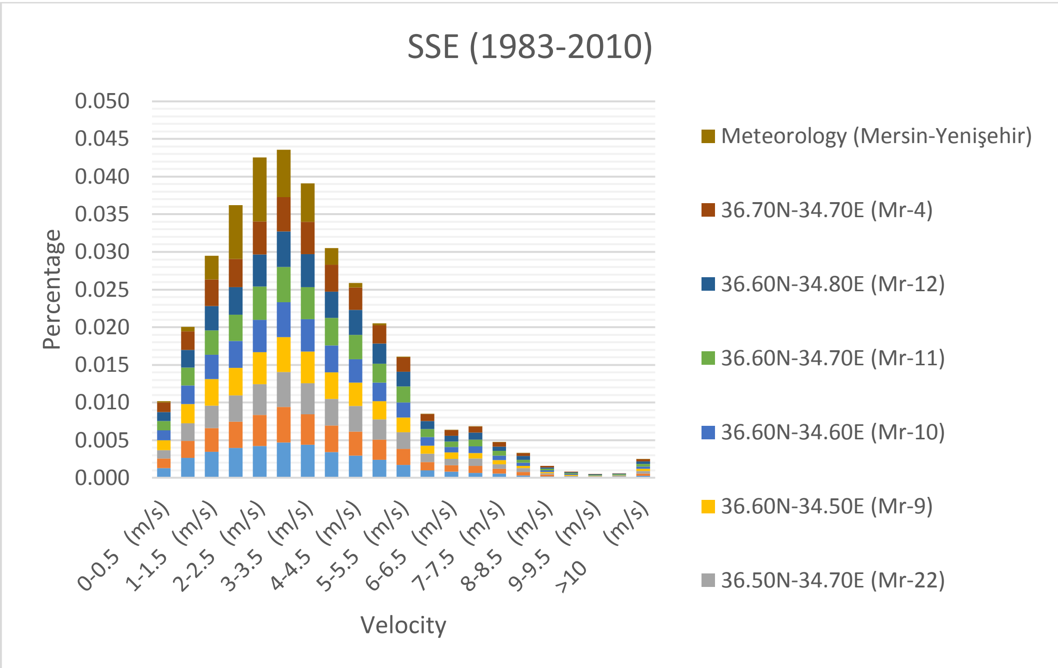


Figure 4.45. The Frequency Chart of SSE Direction for Both Meteorology and ECMWF Data Sets

In SSE direction, the meteorology data set has higher wind percentages between 1.5 m/s and 2.5 m/s. Wind percentages do not change significantly between the ECMWF data sets for this region. Besides, it is interesting to see that the wind intensity percentage shifts to right in the graph of 1983-2010 graph.

For E direction, the change in time period does not affect the intensity percentage in velocity axis and the percentage of the meteorology data set for this direction is low according to the results of the ECMWF data sets.

The graphs of ESE and SE directions almost follow similar paths. The main difference between two charts is that in ESE direction, none of the data sets analysed gives wind velocity that is higher than 10 m/s. Except for this difference, the wind intensity percentages of ESE and SE charts are very similar.

For S and SSW directions, both the ECMWF and meteorology data sets give similar percentages of wind velocity. On the other hand, it is revealed that Yenişehir region is exposed to stronger wind from SSW when two charts are compared.

Both SW and WSW directions follow a steep decreasing path when the wind velocity is increased. The main difference about two directions is that SW chart starts decreasing a little later than that of WSW. So, it can be easily said that SW direction is more critical than WSW direction for this region.

Wave Analysis for Mersin-Yenişehir:

Two ECMWF coordinates have been chosen according to the wind analysis and comparison from this region. Station numbers for these coordinates are Mr-22 and Mr-9. Mr-22 has the highest wind percentages and it is the most open one to have an open sea effects in the likely to be chosen ECMWF coordinates. Mr-9 is close to previously used ECMWF coordinates. So, it is chosen for inspecting close coordinates differences. Following the long term and extreme analysis made for the meteorology, the previously selected ECMWF coordinate, Mr-22 and Mr-9.

Extreme Analysis for Mersin-Yenişehir:

Comparison of the extreme analysis for this region can be seen in the following table. The wave height values and the best types of distribution of the ECMWF data sets give unexpected results. None of them has any agreement about the best distribution. For an analysis period of 10 years, the best distribution differences can be explained by the impact of the short analysis period. On the other hand, for an analysis period of 31 years, the best distribution differences are highly interesting. However, it is founded that the values of wave heights are not very different in the same inspected time period. Difference time period and different best distribution type for the same coordinate give different results as expected. This differences is about 1m for each ECMWF coordinate. Besides, if the meteorology data set is added into the comparison, it will be seen that none of the results of the ECMWF coordinates gives higher wave height than the meteorology within the period of 2000-2010. Besides, result tables for each coordinate could be found in Appendix E.

Table 4.41. Results of the Numerical Analysis Comparison for Mersin-Yenişehir

Mersin-Yenişehir	2000-2010		Best	H_{50} Differences	H_{100} Differences	1983-2013		Best	H_{50} Differences	H_{100} Differences
	H_{50}	H_{100}	Distribution	(%)	(%)	H_{50}	H_{100}	Distribution	(%)	(%)
Meteorology	5.18	5.49	LogNormal	-	-	-	-	-	-	-
ECMWF(36.70N-34.60E)	4.54	4.88	Gumbel (old)	-12.44	-11.07	4.44	4.68	LogNormal	-	-
MR-22	4.97	5.18	Weibull (k4=2.0)	-3.98	-5.60	5.41	6.02	FT 2 (k3=5.0)	21.94	28.75
MR-9	4.37	4.58	LogNormal	-15.54	-16.65	5.02	5.48	FT 2 (k4=10.0)	13.09	17.26

Long Term Analysis for Mersin-Yenişehir:

Unlike the extreme analysis, the long term analysis for this region gives very similar results. All data sets give SW as the major direction for both periods of analysis. Moreover, wave height values for 10 hours/year are also similar. The highest 10 hours/ year wave height is 3m at Mr-22 in the analysis period of 2000-2010 while the lowest one is 2.16 m at the previously selected ECMWF station (36.70N-34.60E) in the analysis period of 1983-2013. Besides, result graphs for each coordinate could be found in Appendix F.

Table 4.42. The Results of Long-term Analysis for Mersin-Yenişehir

Mersin - Yenişehir	2000-2010		Differences (%)	1983-2013		Differences (%)
	Major Direction	Wave Height (10 hours/year)		Major Direction	Wave Height (10 hours/year)	
Meteorology	SW	2.50	-	-	-	-
ECMWF (36.70N-34.60E)	SW	2.21	-11.60	SW	2.16	-
MR-22	SW	3.00	20.00	SW	2.77	28.24
MR-9	SW	2.49	-0.40	SW	2.30	6.48

Adana - Karataş Region:

For Adana – Karataş, nearby ECMWF coordinates have been shown below.

Figure 4.46. The Coordinates Which Are Close to the Adana-Karataş Meteorological Station

Possible coordinates was shown in Figure 4.46. Likely to be chosen coordinates number was shown above figure and also below table.

Table 4.43. The Coordinates Which Are Likely to Be Chosen for Adana-Karataş

Adana-Karataş	
Kr-45	36.30N-35.30E
Kr-46	36.30N-35.40E
Kr-34	36.40N-35.30E
Kr-35	36.40N-35.40E
Kr-36	36.40N-35.50E
Kr-23	36.50N-35.50E

These selected coordinates, meteorology data set for this region and previous used Karataş ECMWF coordinates (36.50N-35.40E) were used for all the wind comparison.

Wind analyses for Adana-Karataş:

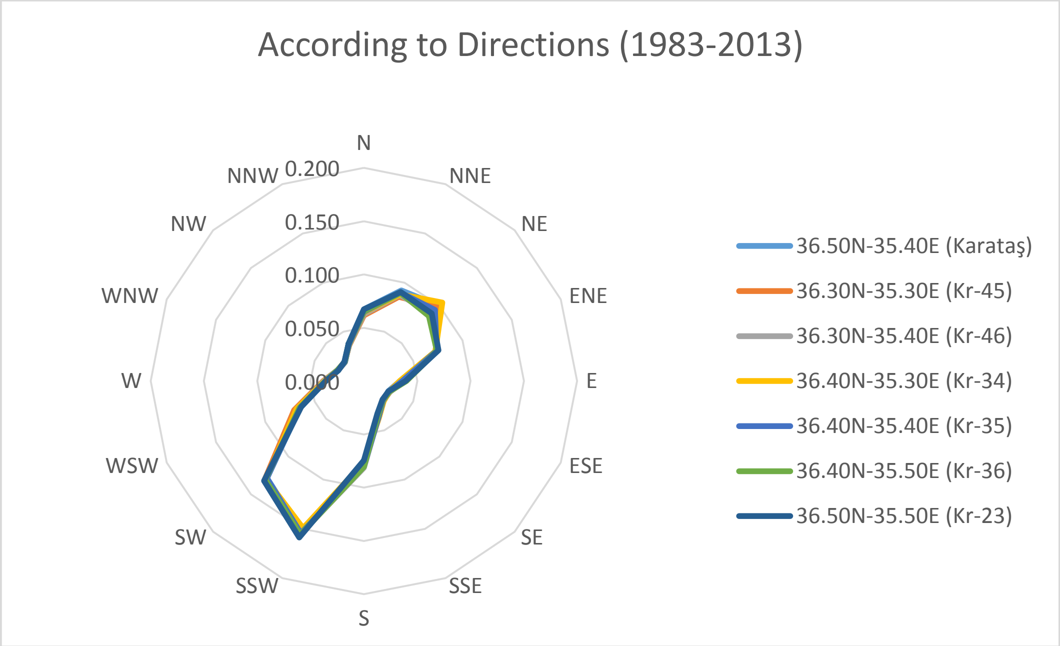


Figure 4.47. The Frequency Chart According to Directions for Only ECMWF Data Sets

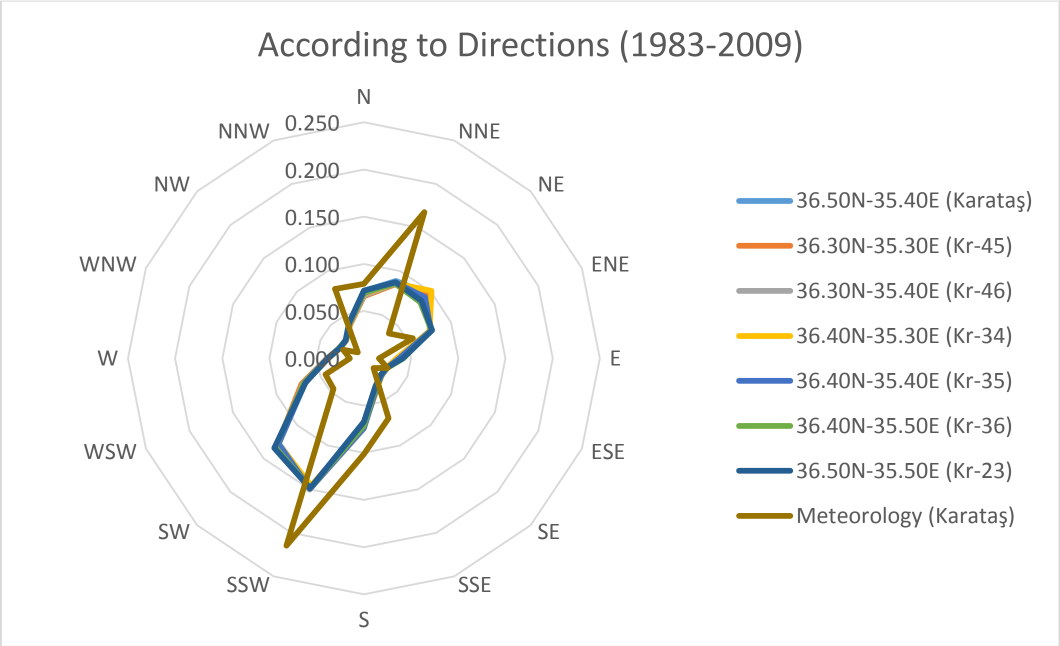


Figure 4.48. The Frequency Chart According to Directions for Both Meteorology and ECMWF Data Sets

From the above chart of 1983-2013, ECMWF coordinates give almost similar results. When the fetch directions are inspected, the Station Kr-36 for SSE direction and the Station Kr-23 for SSW direction seems to be critical coordinates. Moreover, it should be noted that the differences for NE direction could be neglected for this comparison because NE is not a fetch direction for Karataş region.

Besides, the chart of 1983-2009 with the meteorology data set shows that SSW direction has the highest wind percentages as in the ECMWF data set. Moreover, the second major directions which give very close results for the ECMWF stations and meteorology stations are SE and SSE. Although the meteorology data set measures higher wind percentages for its two major directions, this similarity between the ECMWF and meteorology data sets is important for understanding the wind characteristics of the region.

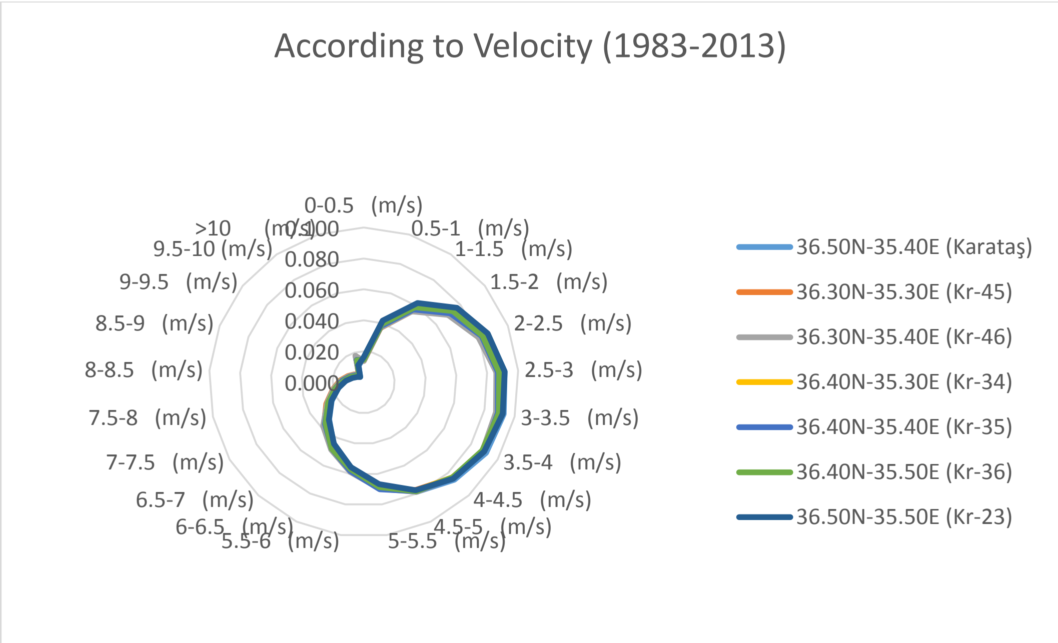


Figure 4.49. The Frequency Chart According to Velocity for Only ECMWF Data Sets

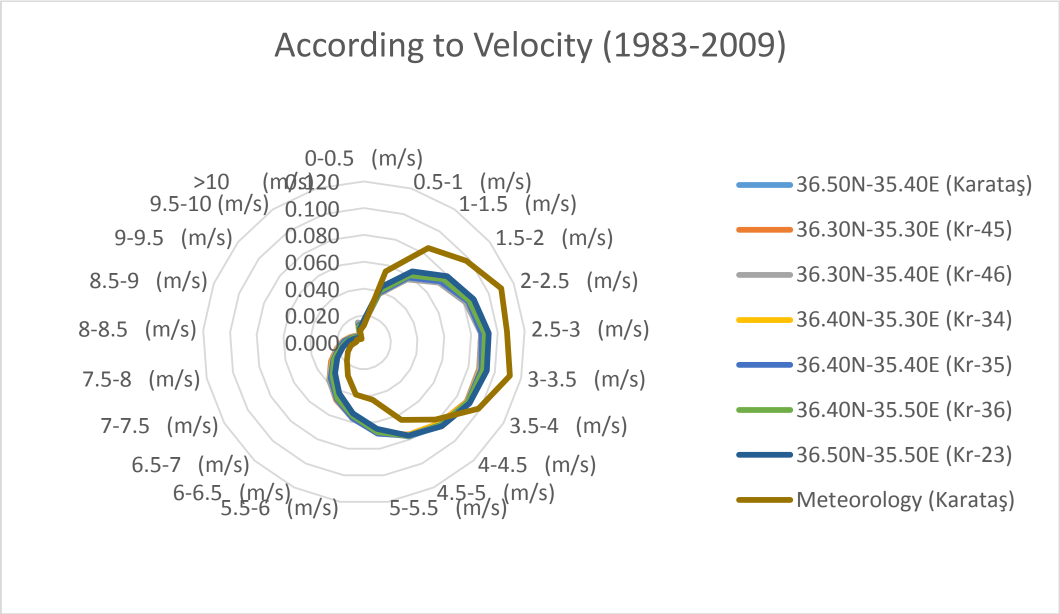


Figure 4.50. The Frequency Chart According to Velocity for Both Meteorology and ECMWF Data Sets

According to the graph of velocity, the stations Kr-46 and Kr-36 have relatively higher wind percentages in the range of 5.5 m/s to 7.5 m/s than other ECMWF coordinates. Besides, Kr-23 gives higher percentages between the velocity range of 1.5 m/s and 3.5 m/s. As expected from the extreme analysis, the meteorology data set has smaller wind percentages in strong wind velocity range than the ECMWF coordinates. Moreover, percentage vs velocity charts have been created for revealing the difference clearly. For this region, SSE direction has been chosen as an example. In SSE direction, the meteorology and ECMWF follow a similar path, but the meteorology gives much higher wind percentages. SSE direction charts can be seen below. The remaining graphs for rest of the directions are given in Appendix D.

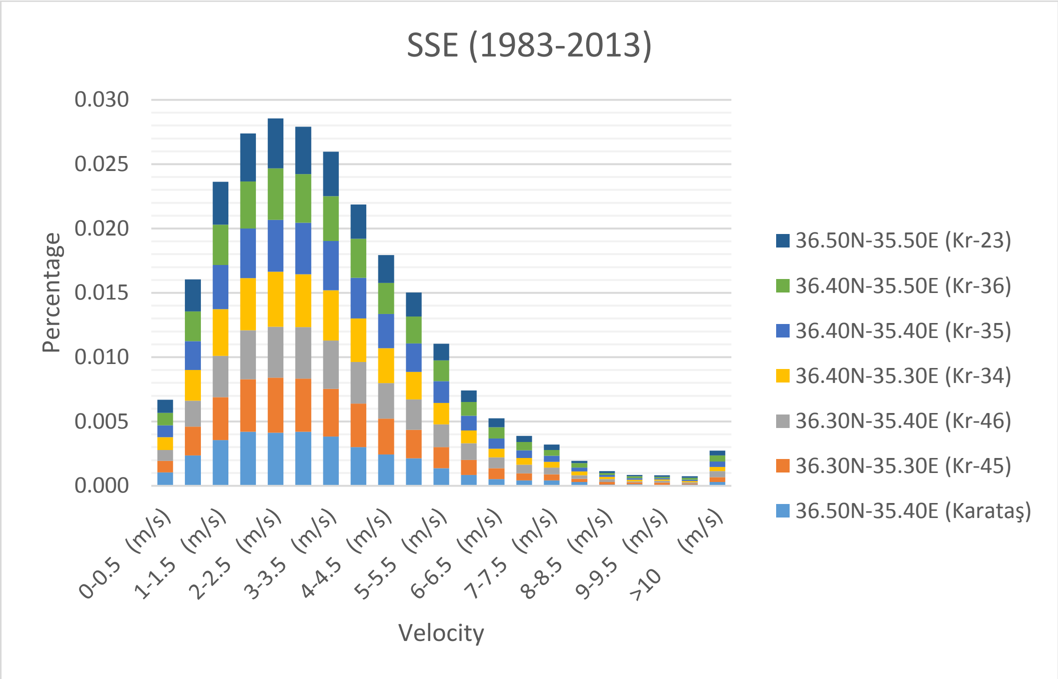


Figure 4.51. The Frequency Chart of SSE Direction for Only ECMWF Data Sets

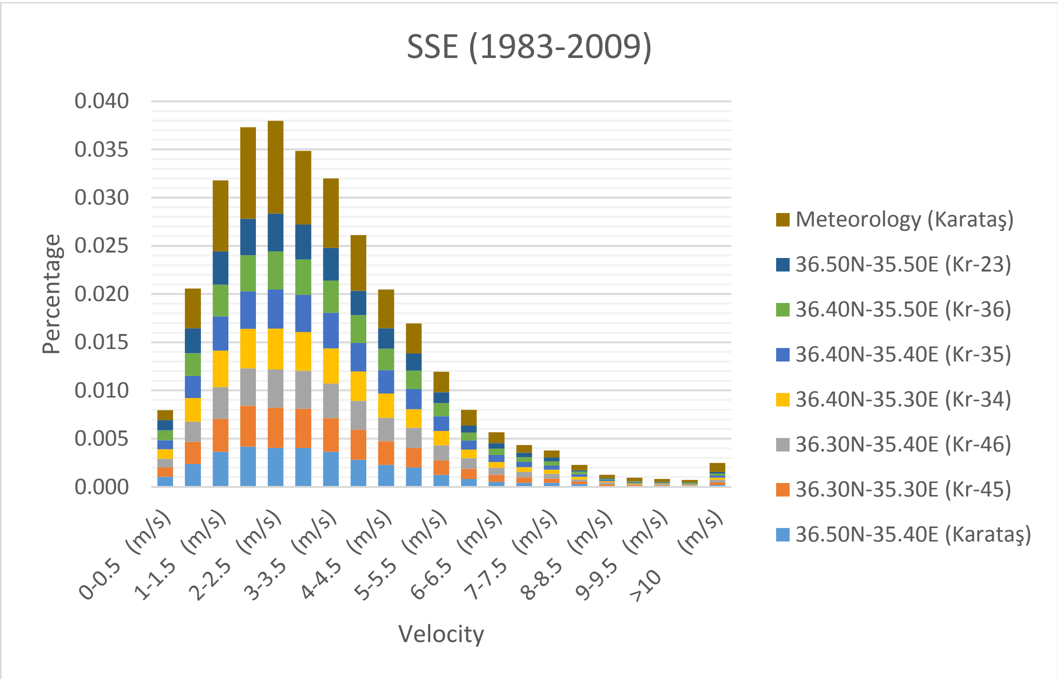


Figure 4.52. The Frequency Chart of SSE Direction for Both Meteorology and ECMWF Data Sets

According to SSE direction charts, the meteorology data set has the highest wind percentage in the velocity range of 0.5-5 m/s. Besides, charts show a sudden increase at a wind velocity that is higher than 10 m/s. A general characteristic percentage distribution for the ECMWF data set can be seen from SSE direction charts.

SE and SSE directions have almost similar wind characteristics in terms of SSE direction. Except for these two directions, the wind percentage values of the meteorology data set are lower than SSE direction. Besides, E direction can be very similar to SE and SSE directions, but it should be remembered that E direction has a less steep decreasing path while the value of wind velocity is increased.

Both SSW and SW directions have the same characteristics according to the comparison of the ECMWF coordinates. Both directions reach higher wind percentage values in the velocity range of 4-5 m/s. On the other hand, SW direction has in itself more wind velocity values that are higher than 10 m/s. Besides, it can be said that the meteorology data set shows less wind impact than SW direction for this region.

WSW and S directions follow a similar path as a result of the comparison of the ECMWF data set in this region. On the other hand, S direction characteristics of the meteorology data set are more likely to be present than the SSW and SW characteristics of the meteorology data set.

Wave Analysis for Adana-Karataş:

Two ECMWF coordinates have been chosen according to the wind analysis and comparison from this region. Station numbers for these coordinates are Kr-46 and Kr-36. Like Mersin-Yenişehir region Kr-46 is the most suitable coordinates to inspect of the open sea effects in the likely to be chosen ECMWF coordinates and Kr-9 is close to previously used ECMWF coordinates. So, it is chosen for inspecting close coordinates differences. Following the long term and extreme analysis made for the meteorology, the previously selected ECMWF coordinate, Kr-46 and Kr-36.

Extreme Analysis for Adana-Karataş:

Comparison of the extreme analysis for this region can be seen in the following table. From this table, it is seen that except for the station Kr-36, the ECMWF stations do not change in terms of best types of distribution within the period of analysis. Besides, the differences of wave height values for all data sets are within the acceptable range for both inspected time period. For this region, it can be easily said that both meteorology and ECMWF coordinates results are in the acceptable range. Besides, result tables for each coordinate could be found in Appendix E.

Table 4.44. Results of the Numerical Analysis Comparison for Adana-Karataş

Adana-Karataş	1983-2009		Best	H_{50} Differences	H_{100} Differences	1983-2013		Best	H_{50} Differences	H_{100} Differences
	H_{50}	H_{100}	Distribution	(%)	(%)	H_{50}	H_{100}	Distribution	(%)	(%)
Meteorology	6.90	7.49	Weibull (k3=1.4)	-	-	-	-	-	-	-
ECMWF(36.50N-35.40E)	7.28	7.91	Gumbel (old)	5.43	5.72	7.24	7.86	Gumbel (old)	-	-
KR-46	6.76	7.18	LogNormal	-2.09	-4.08	6.99	7.42	LogNormal	-3.55	-5.61
KR-36	7.24	7.87	Gumbel (old)	4.84	5.09	6.89	7.27	Weibull (k4=2.0)	-4.90	-7.46

Long Term Analysis for Adana-Karataş:

As in the wave height results of the extreme analysis, the long term analysis for this region gives very similar results. All ECMWF sets give SW as the major direction for both periods of analysis. On the other hand, the meteorology data sets give a similar, but different major direction: SSW. Moreover, wave height values for 10 hours/year are also similar. The highest 10 hours/ year wave height is 4.18m at the Kr-46 in the analysis period of 1983-2009 while the lowest one is 3.86 m at the Kr-36 in the analysis period of 1983-2009. Close periods of analysis constitute the basis for similar results for 10 hours/year wave height. Besides, result graphs for each coordinate could be found in Appendix F.

Table 4.45. The Results of Long-term Analysis for Adana-Karataş

Adana - Karataş	1983-2009		Differences (%)	1983-2013		Differences (%)
	Major Direction	Wave Height (10 hours/year)		Major Direction	Wave Height (10 hours/year)	
Meteorology	SSW	3.97		-	-	-
ECMWF (36.50N-35.40E)	SW	3.94	-0.76	SW	3.97	-
KR-46	SW	4.18	5.29	SW	4.34	9.32
KR-36	SW	3.86	-2.77	SW	3.96	-0.25

4.6. HISTORICAL STORM EVENTS

Analysis and comparison results indicate that the measurement of neither the meteorology nor the ECMWF data set give fully reliable results in different regions. For this reason, one more comparison has also been made. Past storm events and measurement data sets have been compared.

For this comparison, an online news research has been made through local and national news websites. Lots of past storm news have been found, but many of them do not give specific information about storm location, characteristics, wind velocities or wave heights. The ones which have useful information for comparing available data sets are shown in Table 4.46 with the comparison of both the meteorology and ECMWF data sets. Comparison has been made by using the measured wind velocities on given dates and the calculated maximum wave heights for the storms that occur in the relevant years.

Table 4.46. The Comparison of the Historical Storm Events

Storm Events				Meteorology		ECMWF	
Location	Date	U (km/h)	H (m)	U (km/h)	H (m)	U (km/h)	H (m)
Adana	19.10.2014	60-75	-	-	-	-	-
Batı Akdeniz	03.06.2014	60-75	-	-	-	-	-
Doğu Akdeniz	31.03.2014	75	4	-	-	-	-
Batı Akdeniz	07.12.2013	60-75	-	-	-	-	3.12
Batı Akdeniz	27.11.2013	75-90	-	-	-	-	3.12
Batı Akdeniz	25.11.2013	60-75	-	-	-	-	3.12
Antalya	04.10.2013	60-75	-	-	-	74	3.12
Antalya	08.02.2013	72	-	-	-	49	3.12
Batı Akdeniz	24.05.2012	60-75	-	-	-	44	3.22
Doğu Akdeniz	28.02.2012	75-88	-	-	-	76	3.57
Batı Akdeniz	07.02.2012	50-70	3	-	-	48	3.22
Mersin	23.01.2012	-	6	-	-	67	3.22
Alanya	18.02.2011	60-75	4-5	-	-	28	2.94
Antalya	18.04.2010	45-70	3-5	29	2.04	31	3.47
Batı Akdeniz	11.02.2010	60-75	3,5-4,5	18	2.04	62	3.47
Adana,Mersin	05.05.2009	70	6	-	1.63	115	5.21
Hatay	05.05.2009	90	6-7	92	3.08	126	4.68
Orta Akdeniz	07.12.2005	90	-	42	1.9	50	3.99

Insufficient data measurement and the lack of the knowledge of historical storm events are reducing the reliability of this comparison. Besides, some of the wave height and wind velocity figures have been directly taken from witnesses’, so their subjectivity is contradictive. For comparison, sometimes, the reported events give a general region instead of giving a specific location. In those cases, the analysed specific region has been selected as it has the highest annual wave height results. On the other hand, if the available data is inspected, the ECMWF data set provides much closer results to the witnessed events.

CHAPTER 5

CONCLUSION AND SUGGESTION

Analysing and comparing the most commonly used data sets i) the meteorology and ii) ECMWF constitute the main objective of this study. Besides, the effect of the selected ECMWF coordinates is also investigated. Mediterranean Sea coast of Turkey is selected as the study area because of having limited wind and wave analysis in the region. The results of this study provides, a better understanding of wave characteristics in the Mediterranean Sea coast of Turkey and help the determination of design wave heights for future studies or in engineering applications.

Seven regions in Mediterranean Sea of Turkish coast are selected for investigation in this study. After the required meteorology and ECMWF data sets are acquired, two programs which are supplied by METU, Department of Civil Engineering, Ocean Engineering Research Centre, are used for organizing and analysing the acquired data sets. Both data sets are subjected to re-arrangements for a proper comparison. After this re-arrangement is done, a graphical comparison has been made for understanding general characteristics. Moreover, wind roses for each region have been drawn for both data sets. For the long term and extreme analysis, the outputs of wind.exe program have been used as an input file for W61 FORTRAN code. The outputs of W61 program basically contain annual Hs, Ts values and the tables of frequency (in hours) waves. Directional, non-directional extreme analysis and long-term analysis have been made by using W61 output files in an excel sheet which has been used through the methodology presented in Goda, 2000. As mentioned earlier, for the investigation of the impacts of the selected ECMWF coordinates, three regions have been selected in the seven previously selected seven regions and some frequency charts have also been prepared to compare the differences of the ECMWF data sets.

The time series graph prepared for graphical comparison is very helpful for seeing the differences of measurement clearly. On the other hand, the behaviour of each region's data set is different from each other. For example, the meteorology data set present higher wind velocity in Hatay-İskenderun region while the ECMWF data set behaves more critically in Antalya-Gazipaşa region in December 2004. Moreover, the graphs of wind roses which have been drawn for both data sets support the finding in the time series graphs.

After obtaining the first impression from the graphical comparison for a better, detailed analysis and comparison, the extreme and long term analysis has also been made. The extreme analysis gives both highly different and similar results for different regions from the comparison of both data sets and similar studies. For example, in Antalya-Gazipaşa region, the ECMWF data sets give higher H_{s50} and H_{s100} values than the meteorology data set while the study of Özhan, E and Abdalla, S (1999) (Wave Atlas) which gives even higher design wave height values. On the other hand, in Mersin-Yenişehir region, the meteorology data set gives critical H_{s50} and H_{s100} when compared to the ECMWF data sets. Moreover, a direction wise analysis has also been made if the analysis of both data sets gives a suitable direction for a reliable comparison. For direction-wise analysis, it can be said that the results differ from region to region. For a directional comparison, the long term analysis has also been made. In general, the ECMWF and meteorology data sets have an agreement with the major direction in the long term analysis, but the wave height values for 10 hours/year show divergence. For example, in Antalya-Finike region, 10 hours/year difference between two data sets is about 87% whereas in Adana-Karataş region, the differences of results are very slight.

Especially for the last 10 years, the data sets of ECMWF and Meteorology provides widely different values. While ECMWF dataset provides highest wave heights for the extreme analysis, Meteorology dataset provides the lowest wave height values for the same years. This is a constant and significant trend for all of the seven stations used in the research. The reason for this trend has to be analysed further as the reason could be due to (i) rapid urbanization around the meteorological stations or (ii) better wind data processing done by ECMWF.

The effects of the selected ECMWF coordinates on the comparison also investigated. From this comparison, the ECMWF coordinates which are likely to be chosen for the three selected regions are analysed together with their wind and wave characteristics. Frequency tables, direction and velocity difference charts have also been prepared for visualisation. From these charts, the general characteristics of each selected coordinate and their differences based on the meteorology and the previously selected ECMWF data set have been evaluated. The coordinates which have a relatively higher distance to the shore give higher wave heights while the coordinates which are close to the shore give lower wave heights when compared to the previously selected ECMWF data sets on the part of the extreme analysis. However, in the long term analysis, the ECMWF coordinates generally give the same direction as a major and a similar wave height for a probability of 10 hours/year have been obtained. Selected three region which have different geomorphological specialities shows that selection of the ECMWF coordinates for a low land region like Adana-Karataş, has lower effects to wave characteristics.

As for the recommendations, this study shows that a larger scale study is needed for a better understanding of wind and wave characteristics in the Mediterranean coast of Turkey. An extensive study by using more regions and more data could be very helpful for finding more feasible and reliable design wave heights. Besides, as mention before, meteorology stations are placed in the land and inspection of their placement with respect to growing cities around them could be very helpful for evaluating their measurement health and correction.

Adding the comparison of on-site buoy measurements with the available data set measurements will considerably help to determine a more reliable wind data set. Within this perspective, a buoy measurement study in the Mediterranean Sea cost of Turkey may make a significant difference. On the other hand, using wind data seems to be the only way for finding design wave heights for Turkey due to the economic burden of buoys. As a result, using both data sets and previous studies on the project area could be very helpful for feasible designs as it is understood that neither the meteorology nor the ECMWF data set could present reliable results for all regions.

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APPENDIX – A

TIME SERIES

Mersin-Anamur:

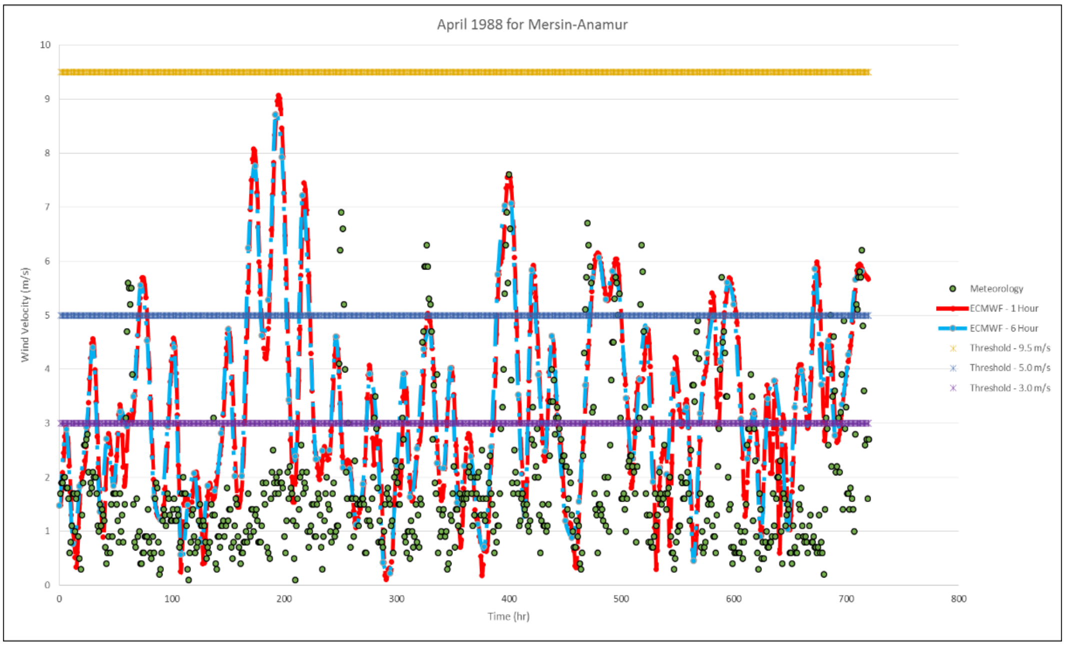

Figure A.1. Time Series for Mersin-Anamur (April 1988)

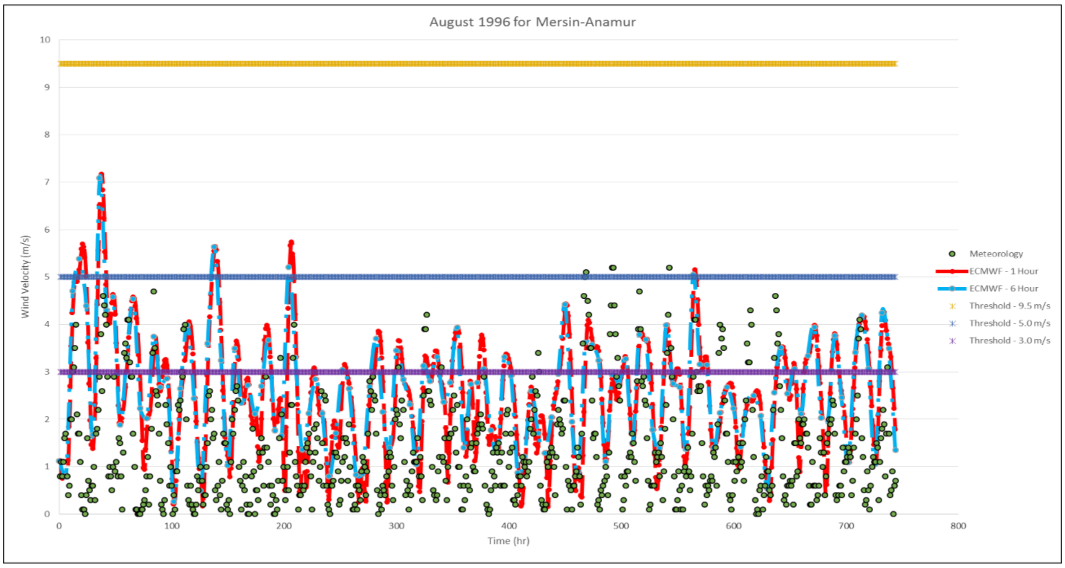

Figure A.2. Time Series for Mersin-Anamur (August 1996)

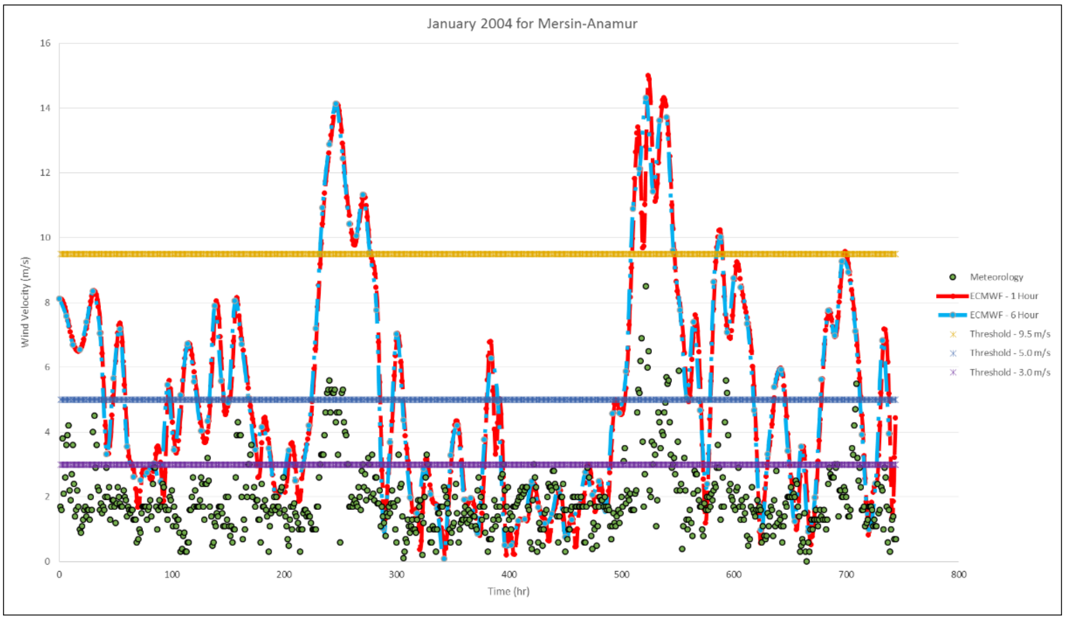

Figure A.3. Time Series for Mersin-Anamur (January 2004)

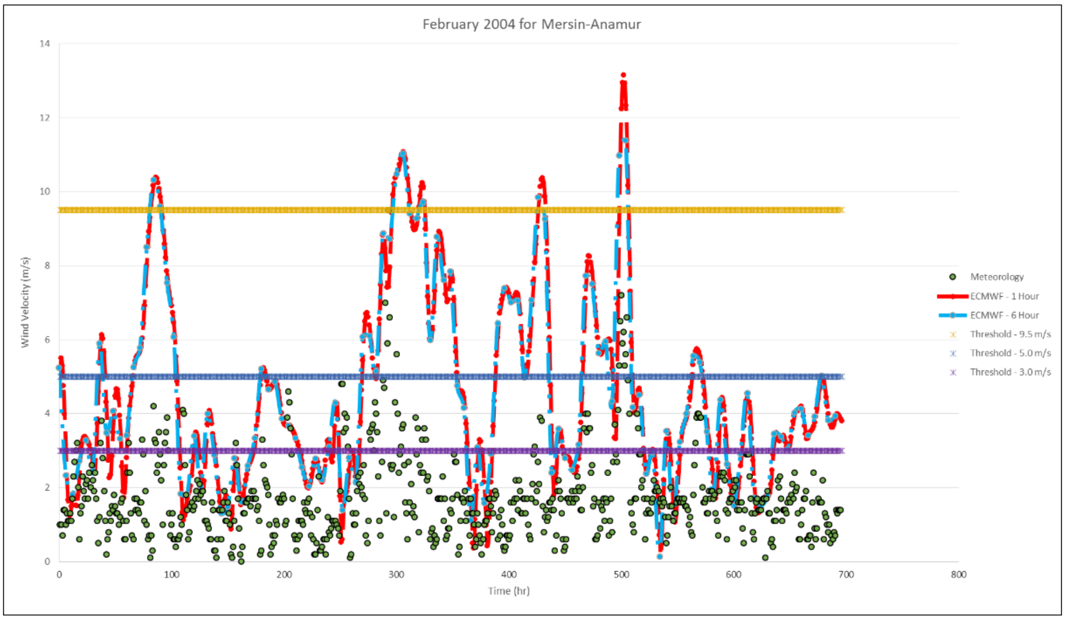

Figure A.4. Time Series for Mersin-Anamur (February 2004)

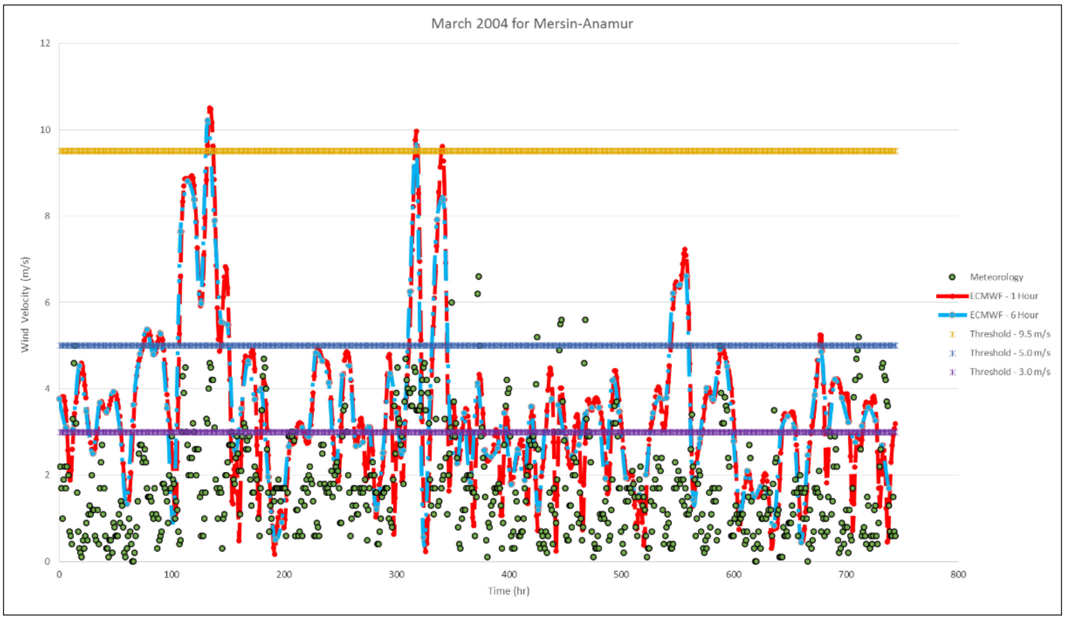

Figure A.5. Time Series for Mersin-Anamur (March 2004)

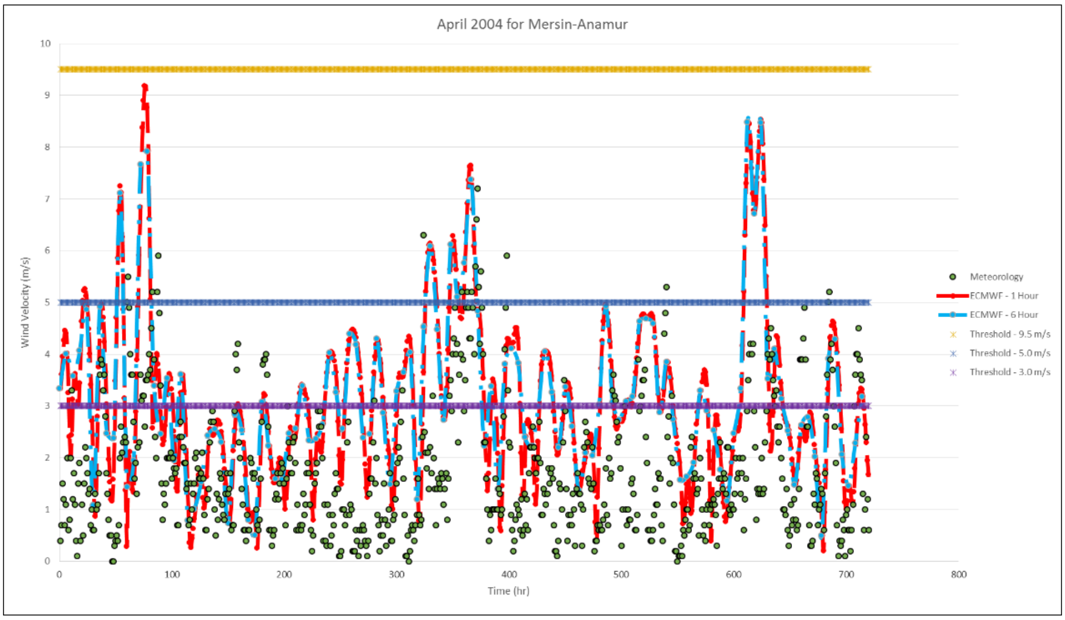

Figure A.6. Time Series for Mersin-Anamur (April 2004)

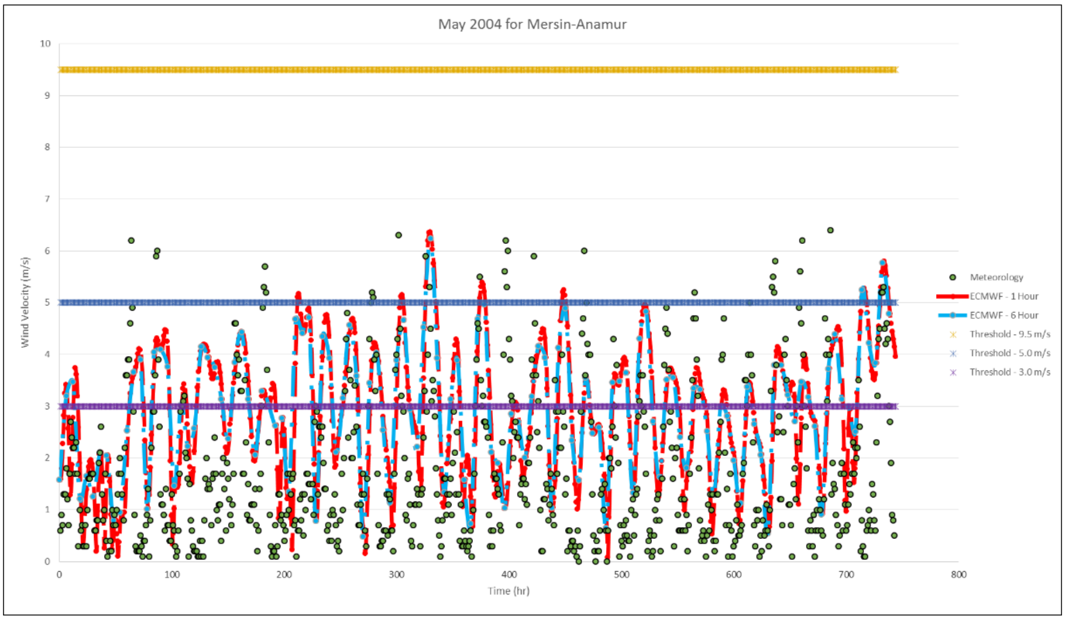

Figure A.7. Time Series for Mersin-Anamur (May 2004)

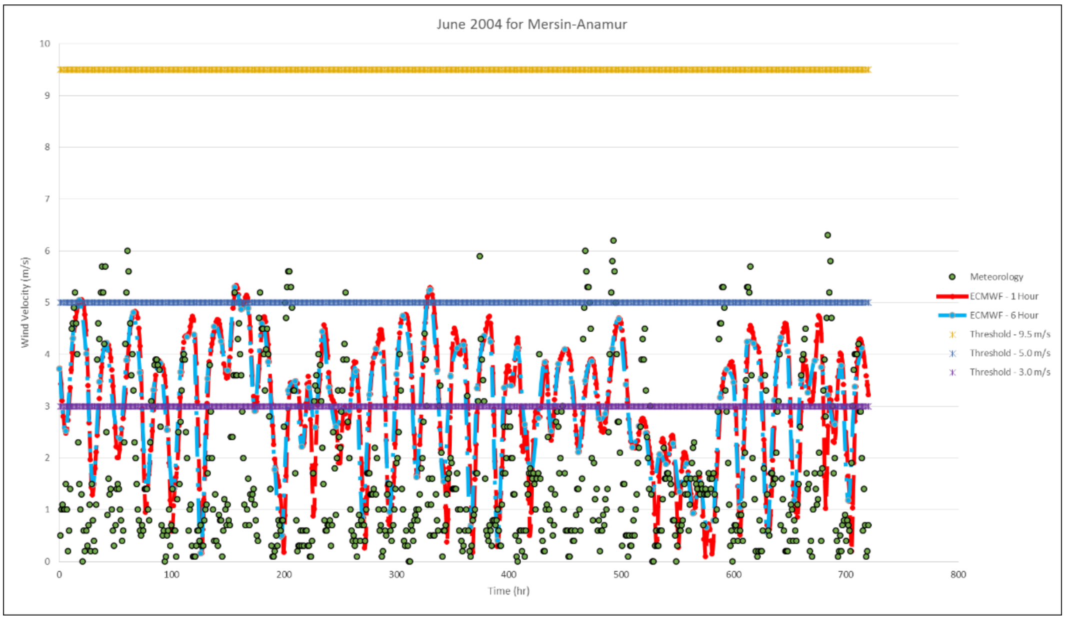

Figure A.8. Time Series for Mersin-Anamur (June 2004)

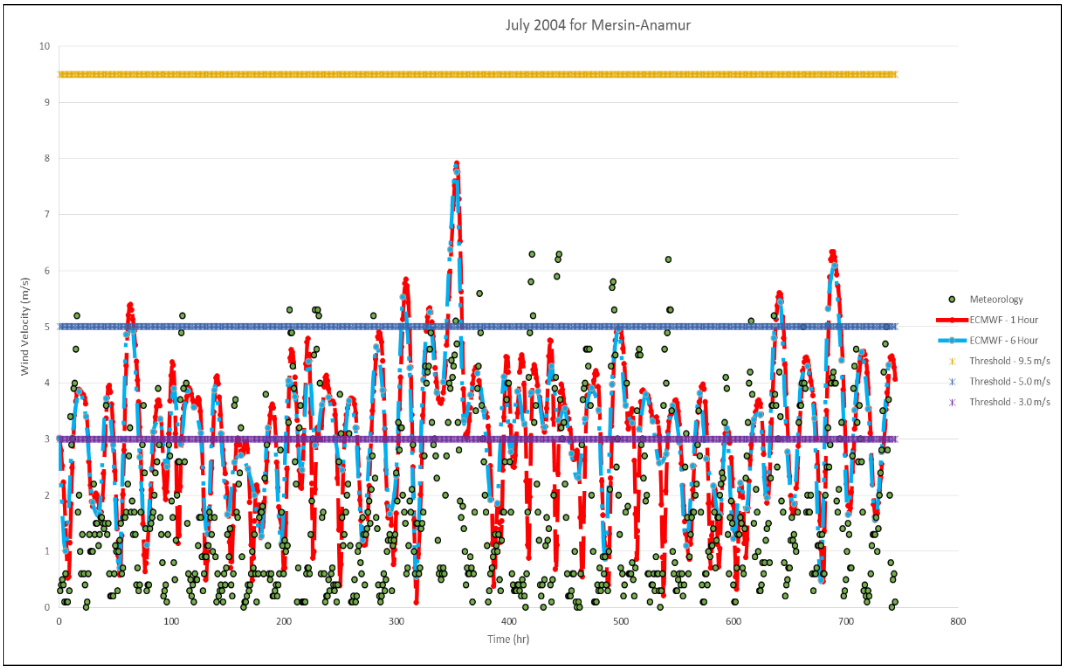

Figure A.9. Time Series for Mersin-Anamur (July 2004)

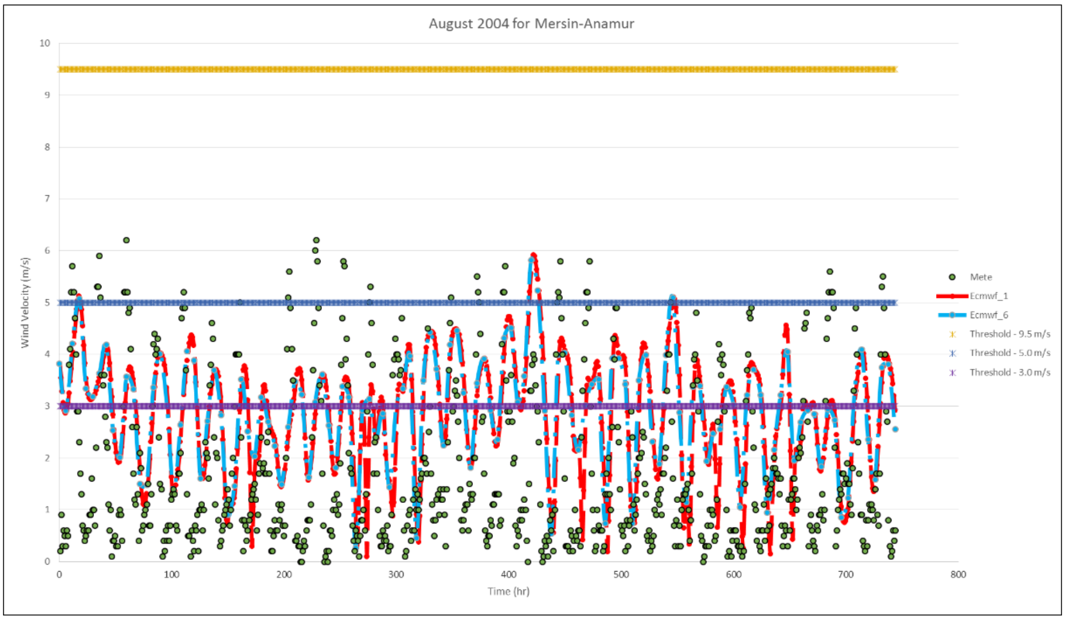

Figure A.10. Time Series for Mersin-Anamur (August 2004)

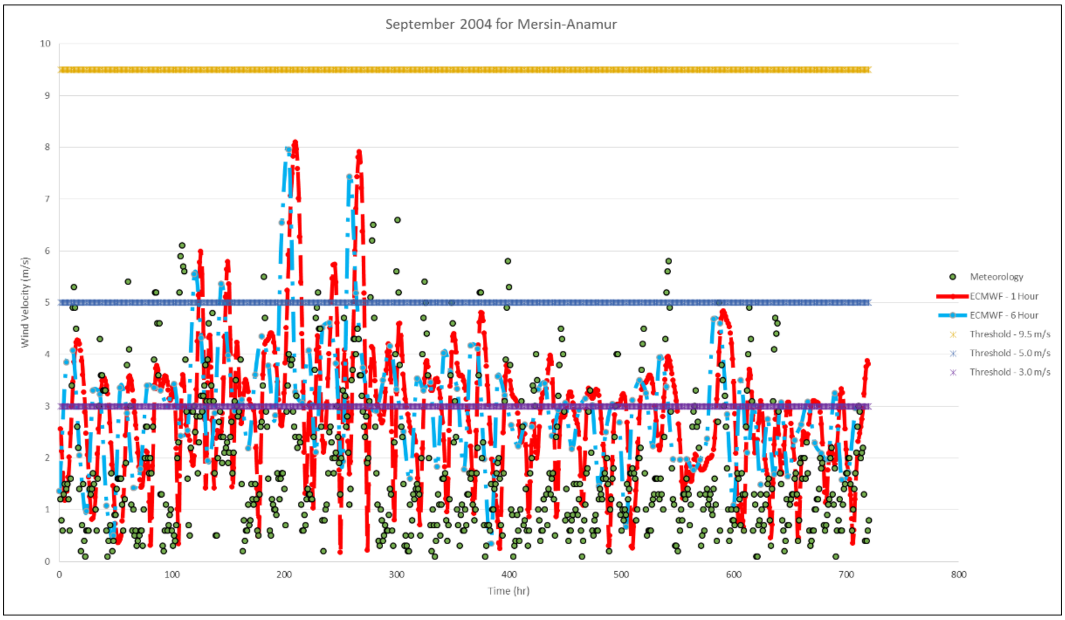

Figure A.11. Time Series for Mersin-Anamur (September 2004)

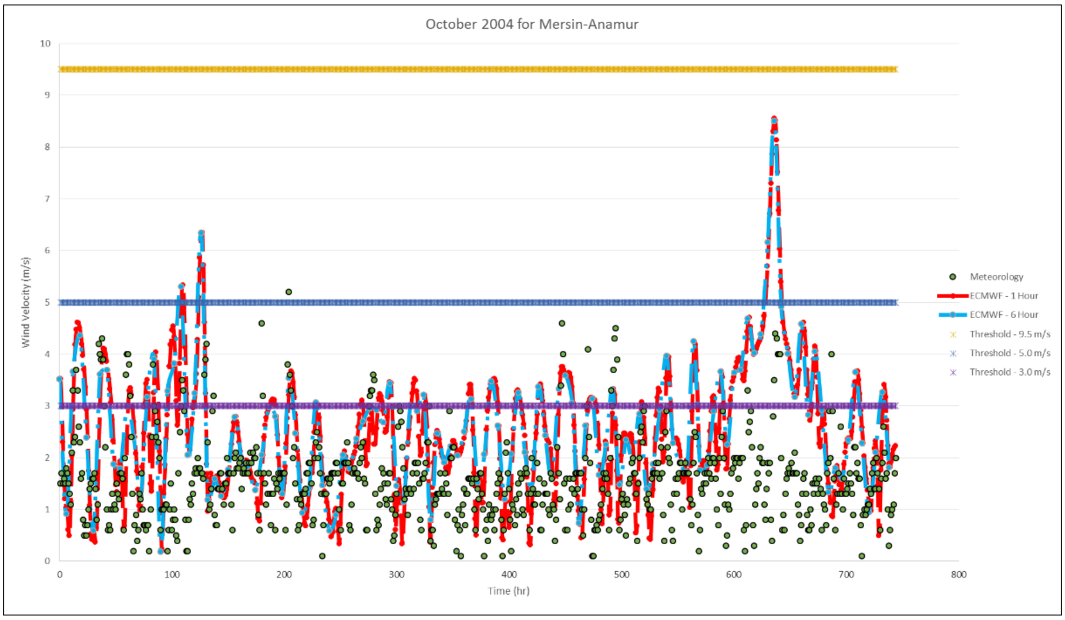

Figure A.12. Time Series for Mersin-Anamur (October 2004)

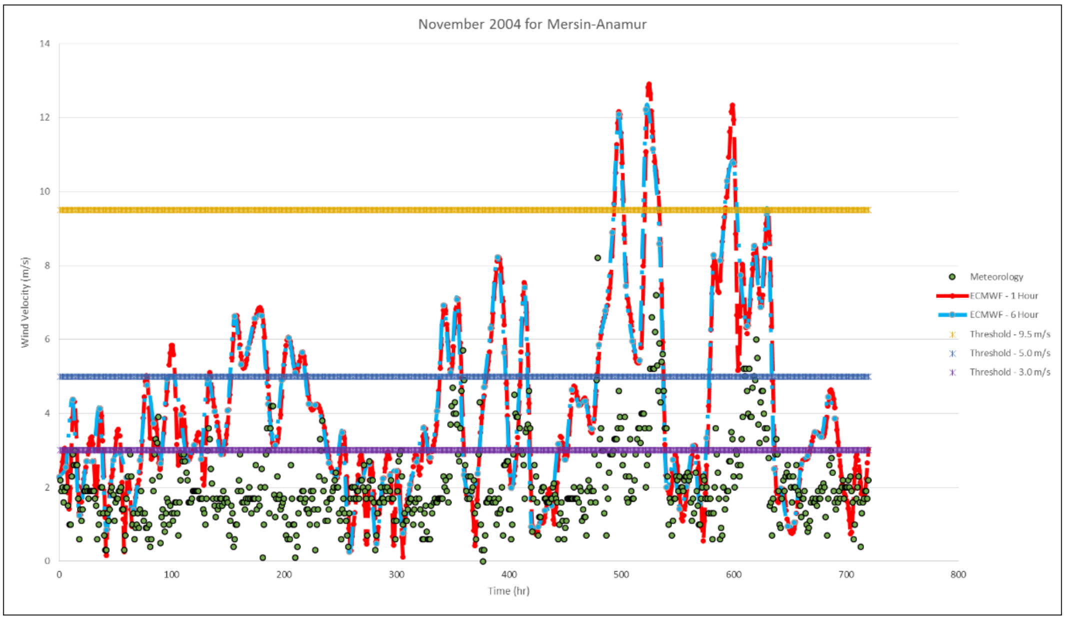

Figure A.13. Time Series for Mersin-Anamur (November 2004)

Adana-Karataş:

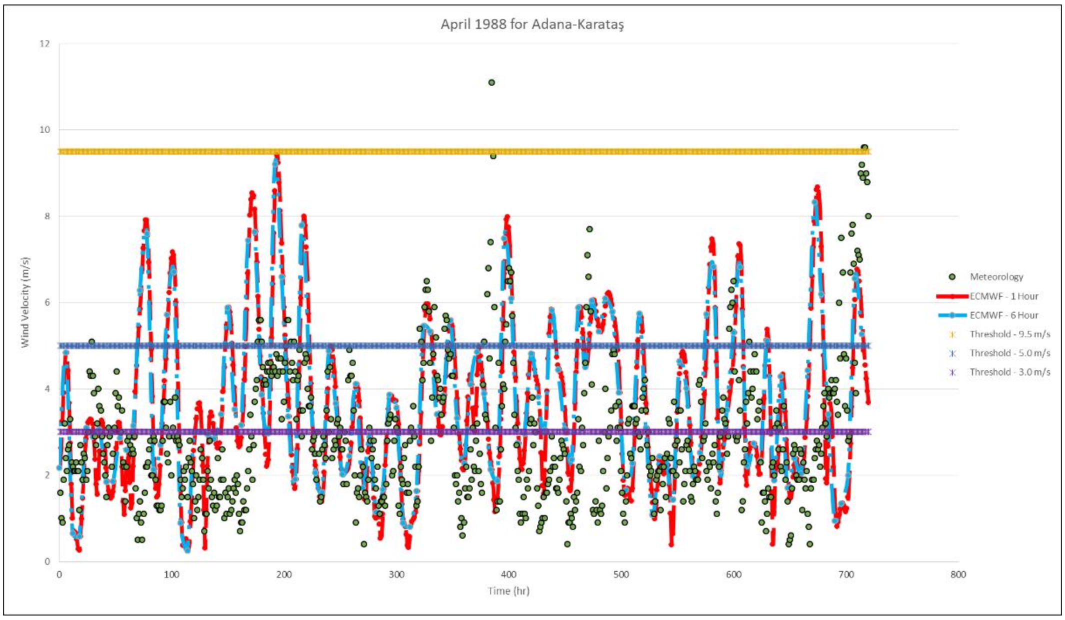

Figure A.14. Time Series for Adana-Karataş (April 1988)

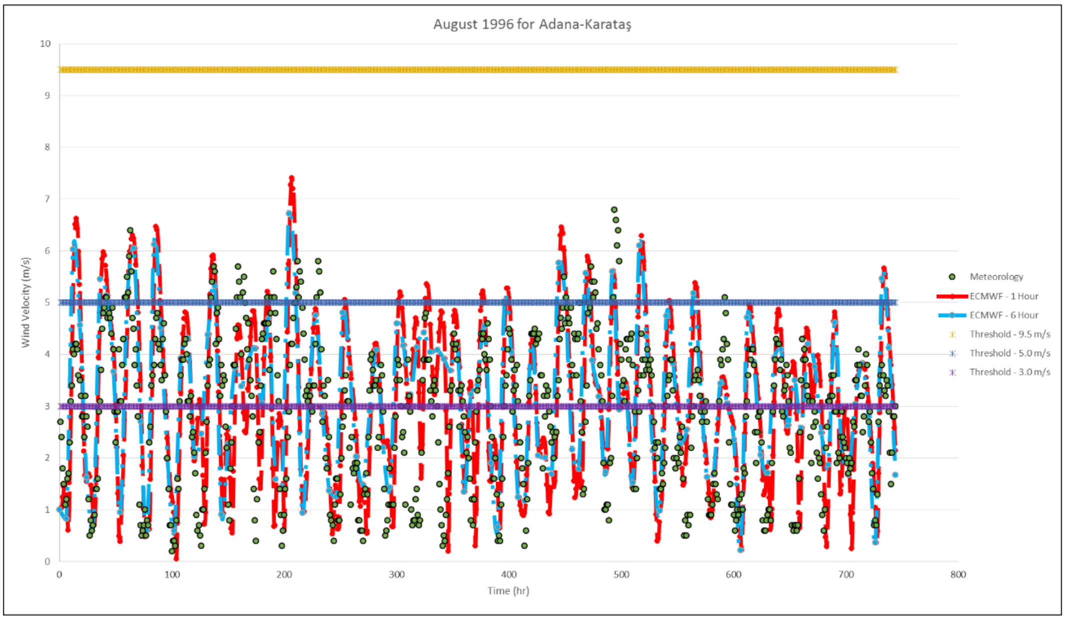

Figure A.15. Time Series for Adana-Karataş (August 1996)

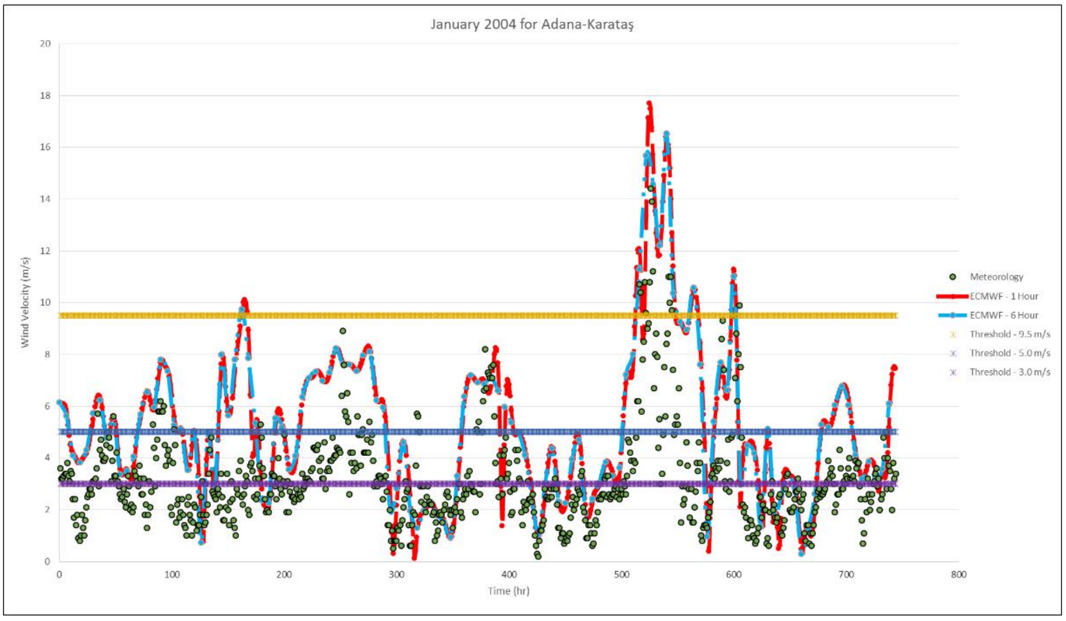

Figure A.16. Time Series for Adana-Karataş (January 2004)

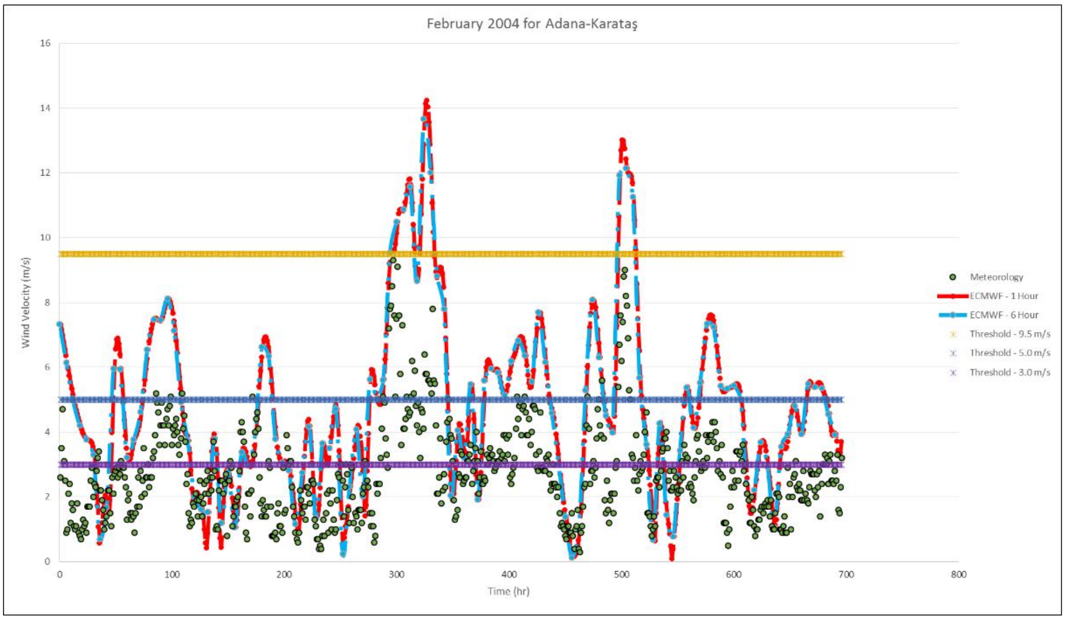

Figure A.17. Time Series for Adana-Karataş (February 2004)

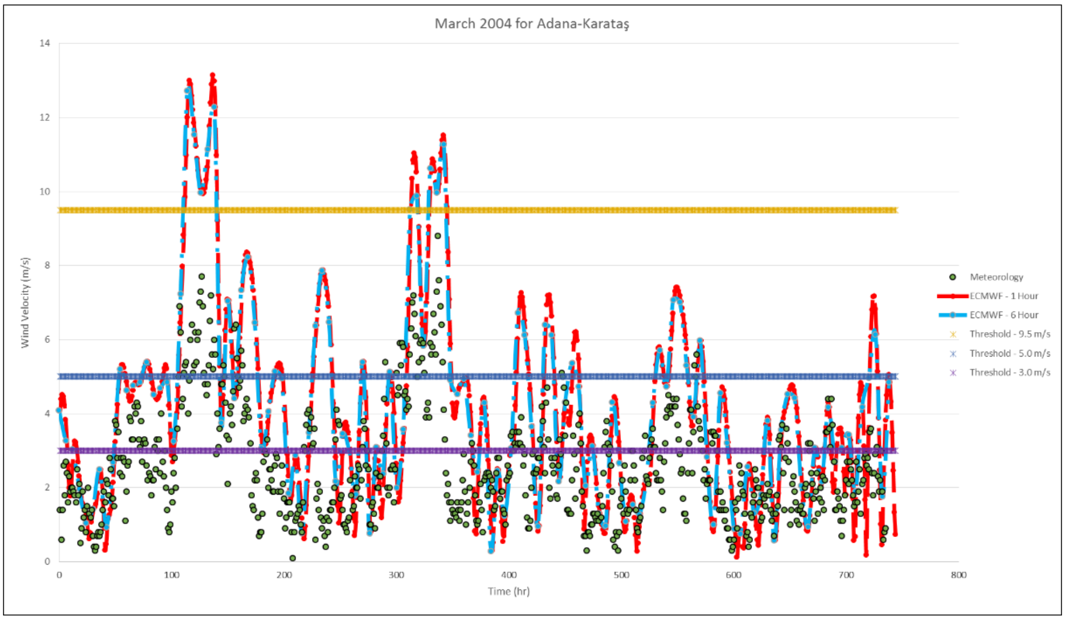

Figure A.18. Time Series for Adana-Karataş (March 2004)

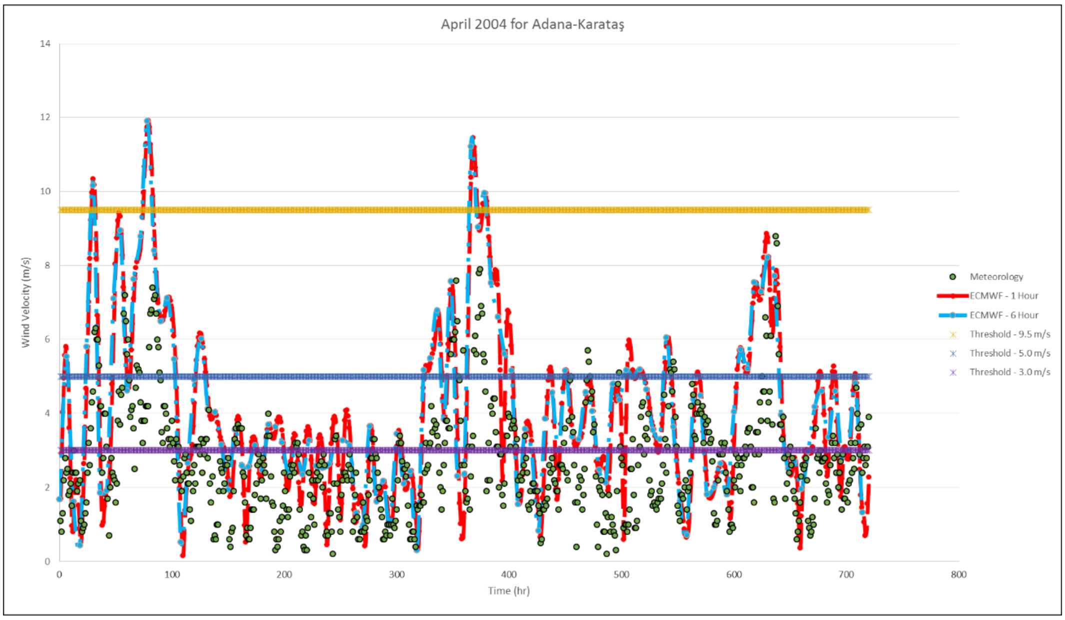

Figure A.19. Time Series for Adana-Karataş (April 2004)

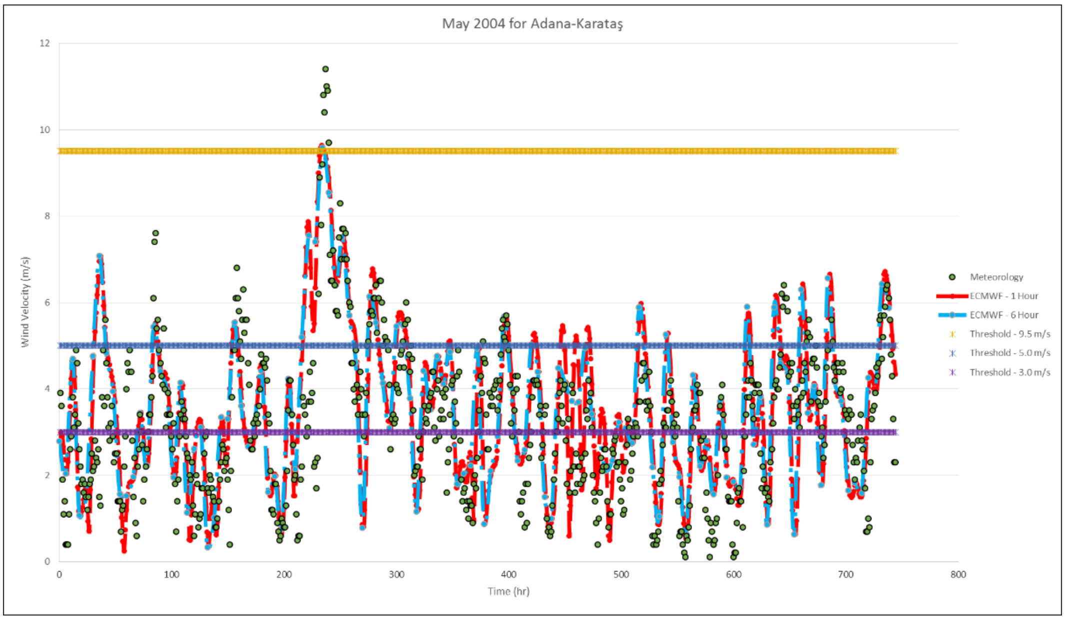

Figure A.20. Time Series for Adana-Karataş (May 2004)

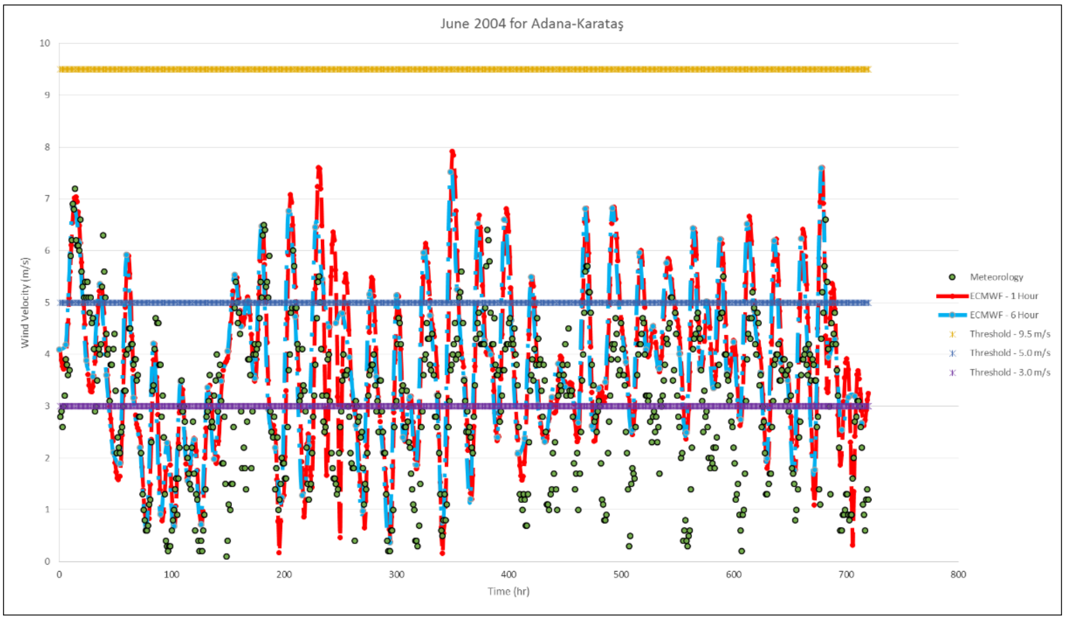

Figure A.21. Time Series for Adana-Karataş (June 2004)

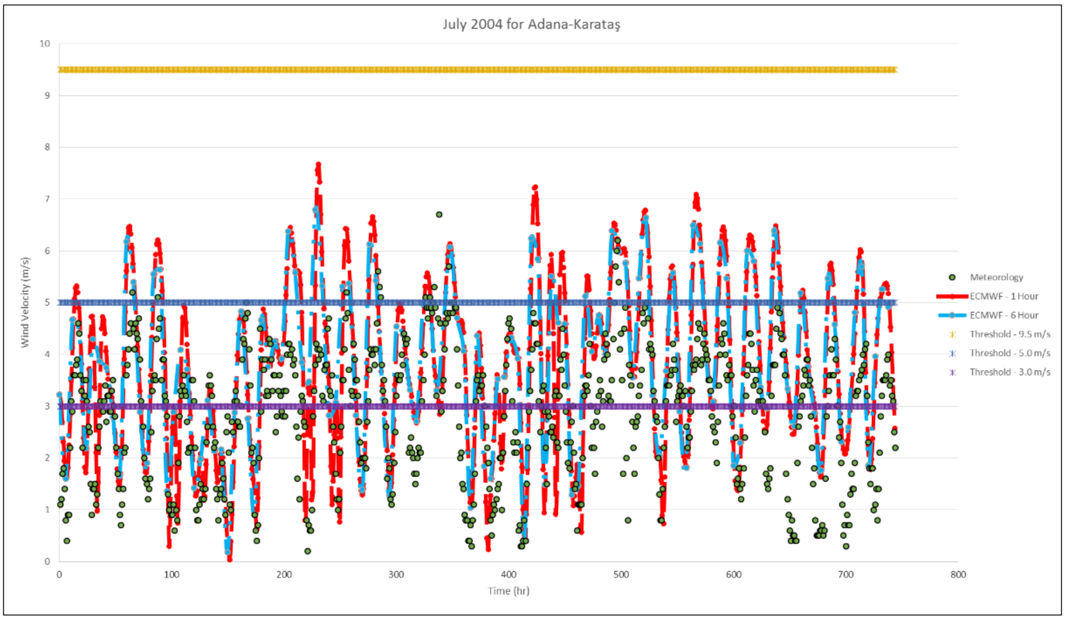

Figure A.22. Time Series for Adana-Karataş (July 2004)

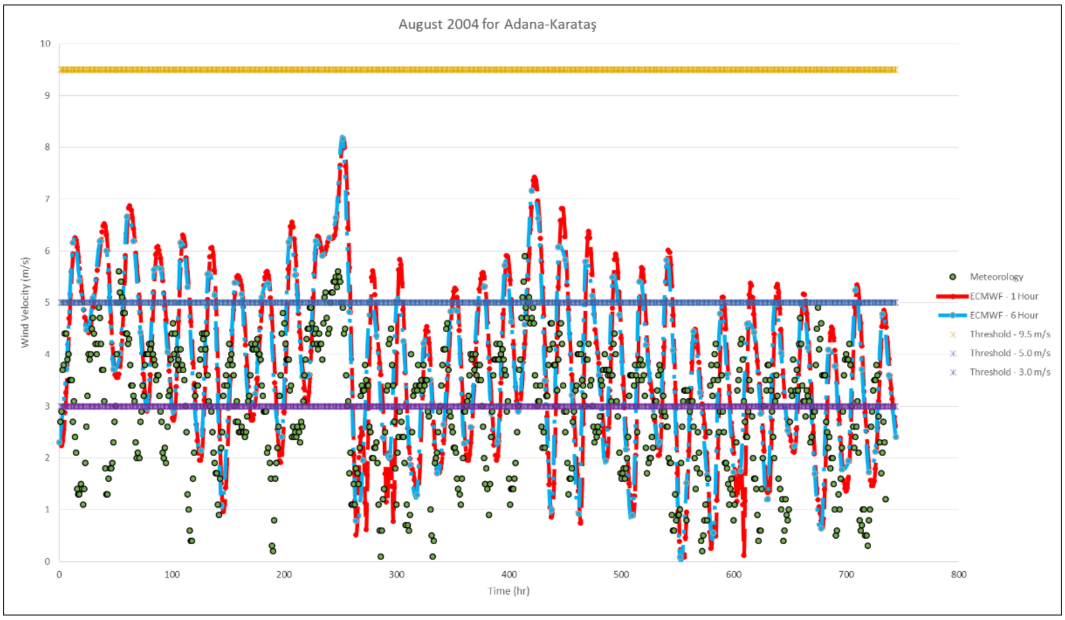

Figure A.23. Time Series for Adana-Karataş (August 2004)

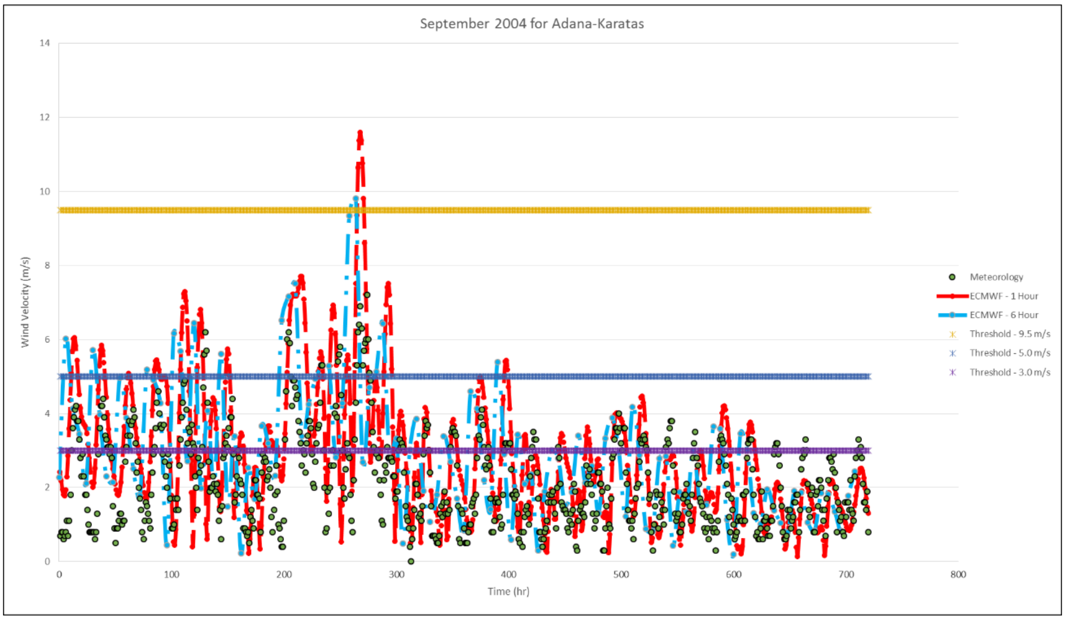

Figure A.24. Time Series for Adana-Karataş (September 2004)

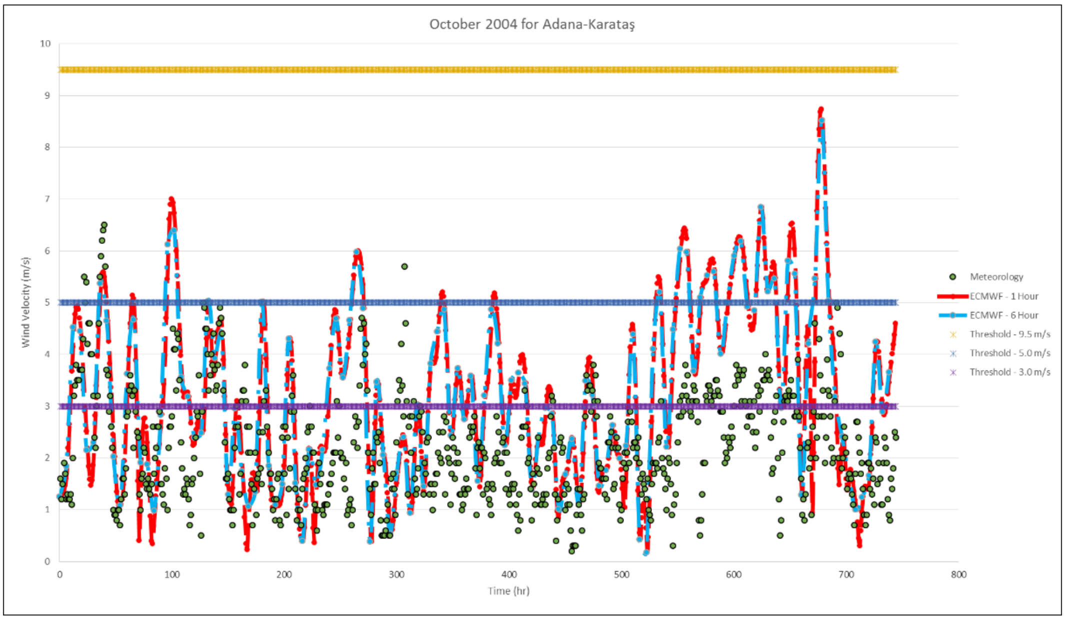

Figure A.25. Time Series for Adana-Karataş (October 2004)

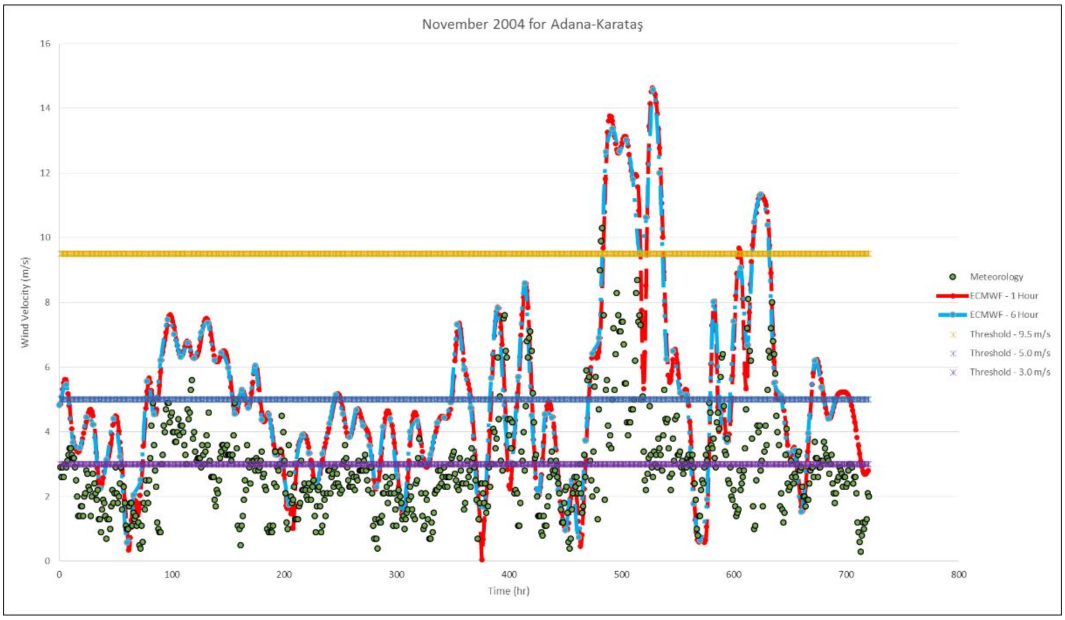

Figure A.26. Time Series for Adana-Karataş (November 2004)

Adana-Yumurtalık:

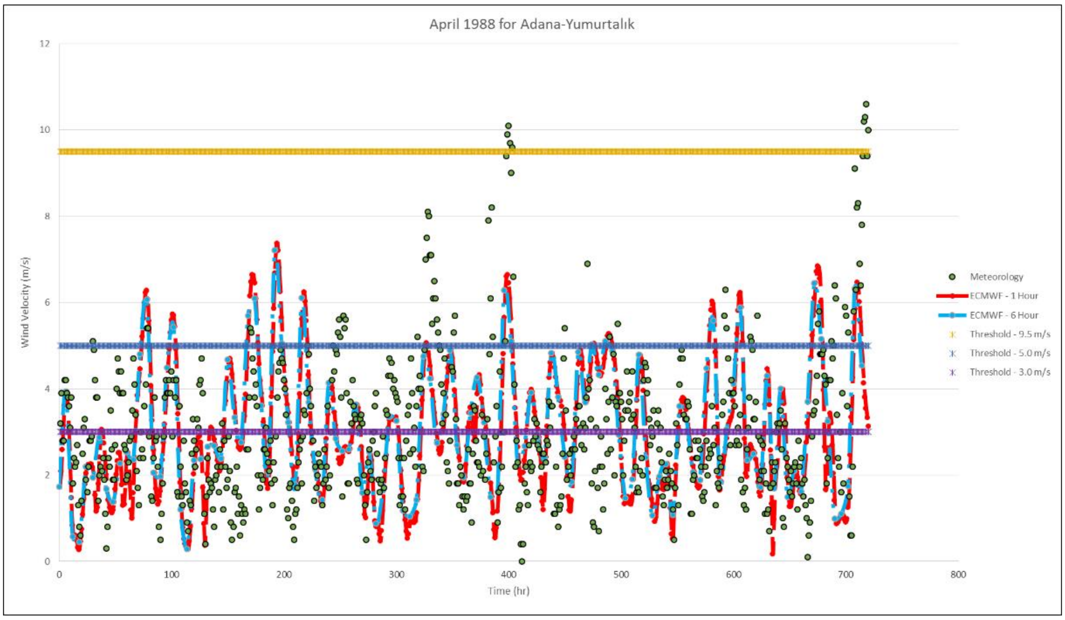

Figure A.27. Time Series for Adana-Yumurtalık (April 1988)

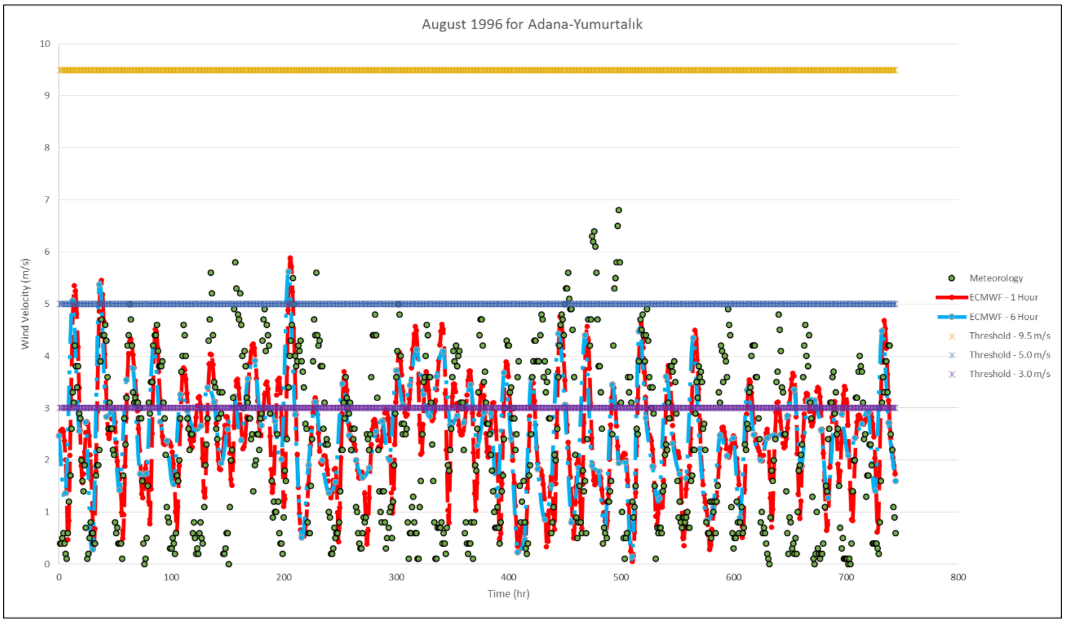

Figure A.28. Time Series for Adana-Yumurtalık (August 1996)

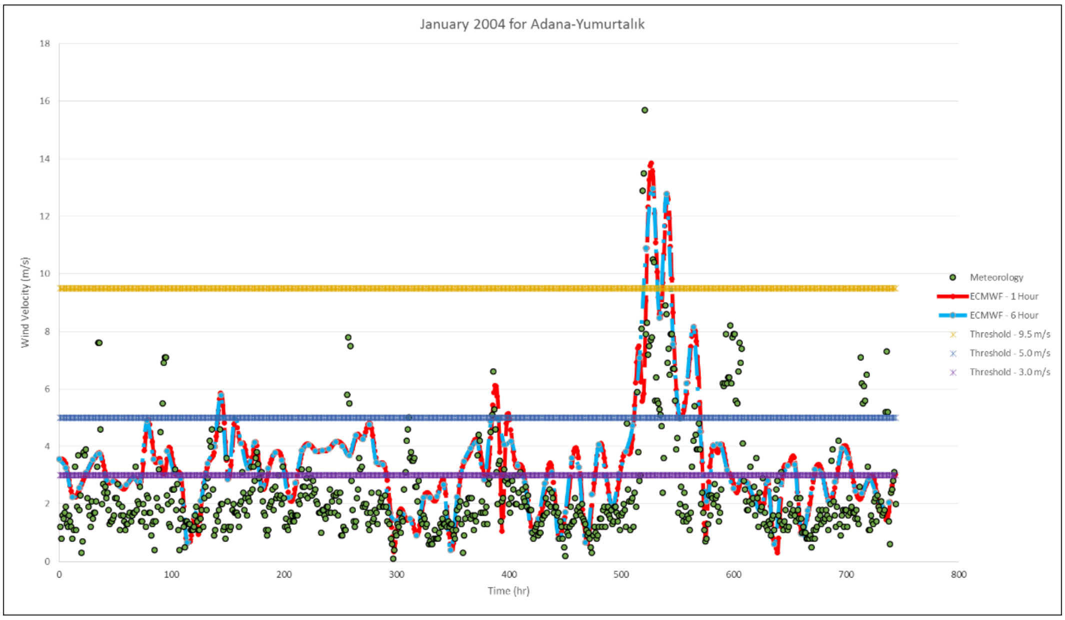

Figure A.29. Time Series for Adana-Yumurtalık (January 2004)

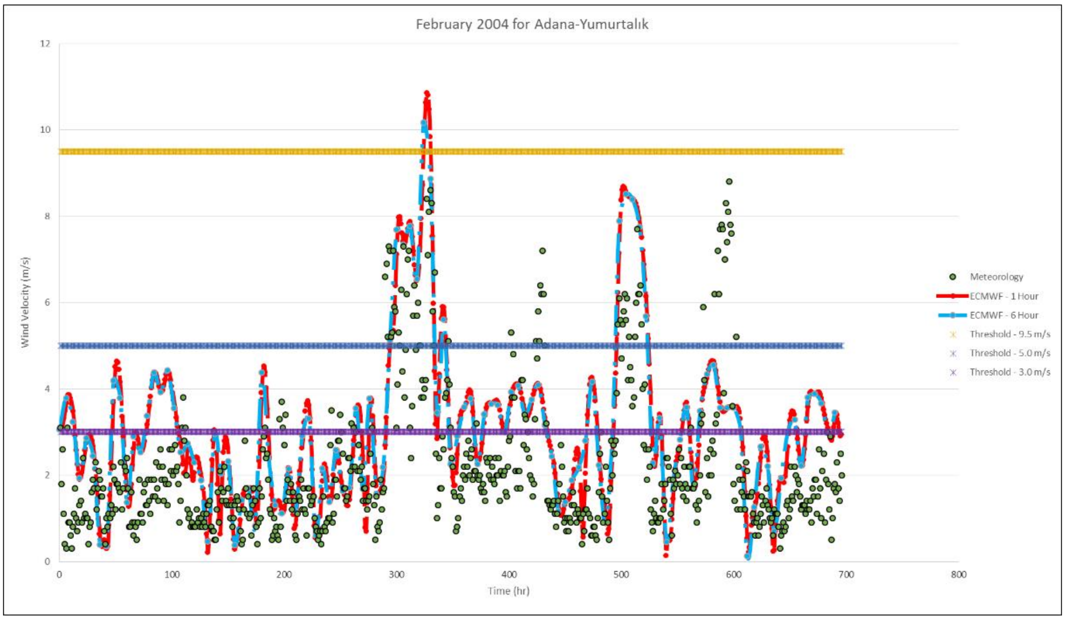

Figure A.30. Time Series for Adana-Yumurtalık (February 2004)

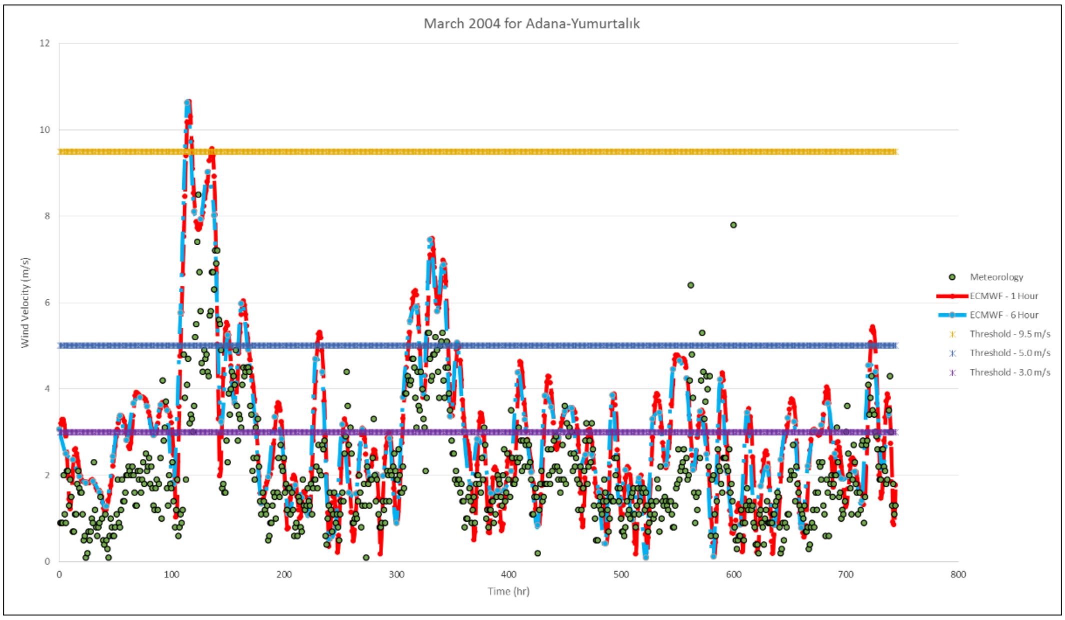

Figure A.31. Time Series for Adana-Yumurtalık (March 2004)

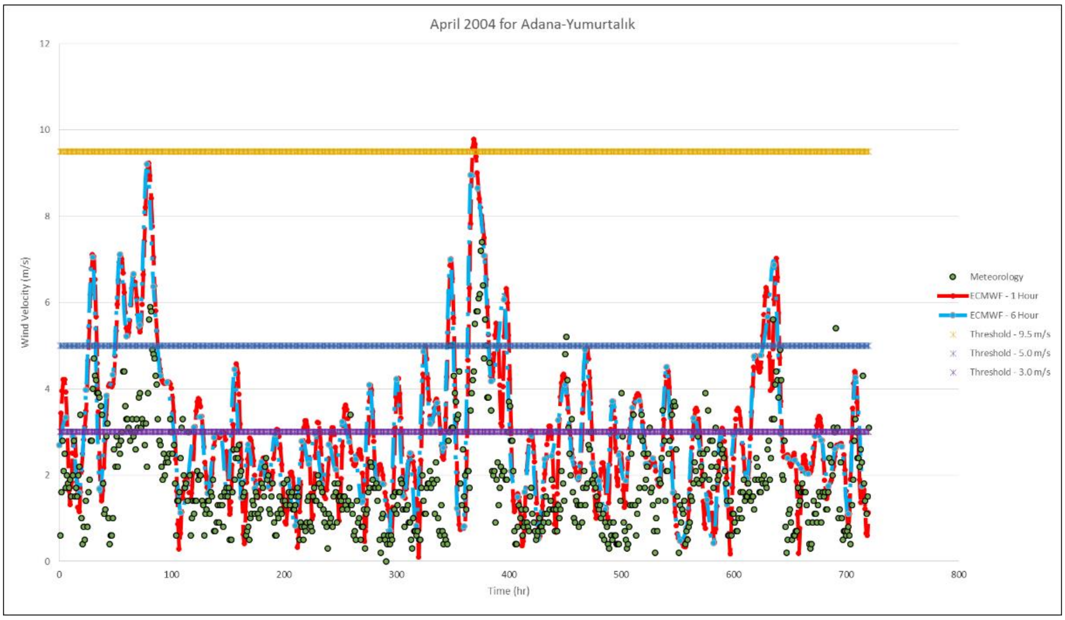

Figure A.32. Time Series for Adana-Yumurtalık (April 2004)

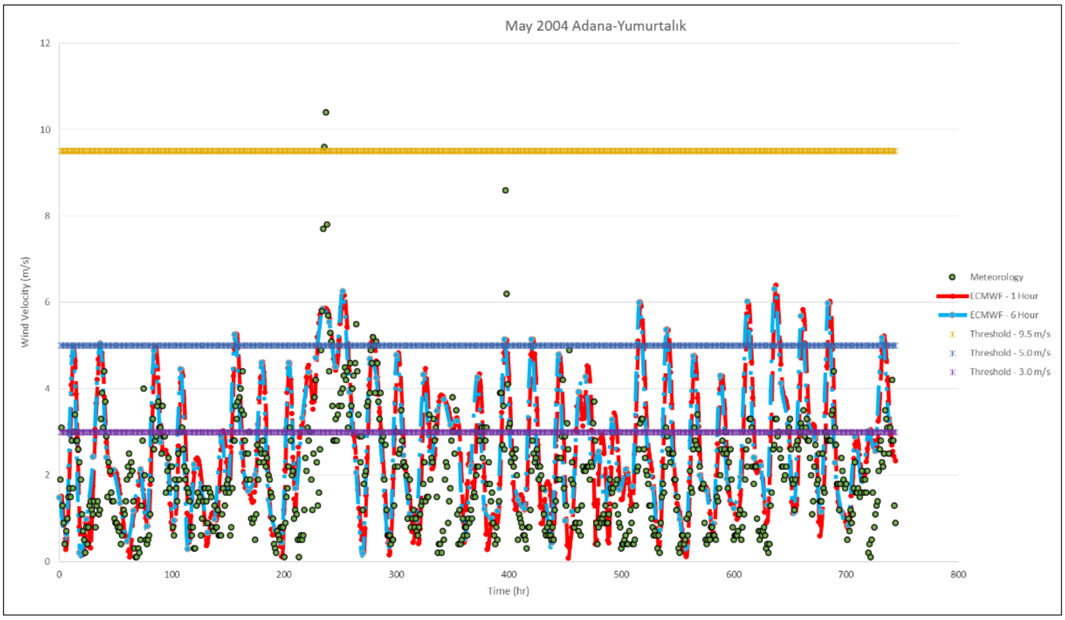

Figure A.33. Time Series for Adana-Yumurtalık (May 2004)

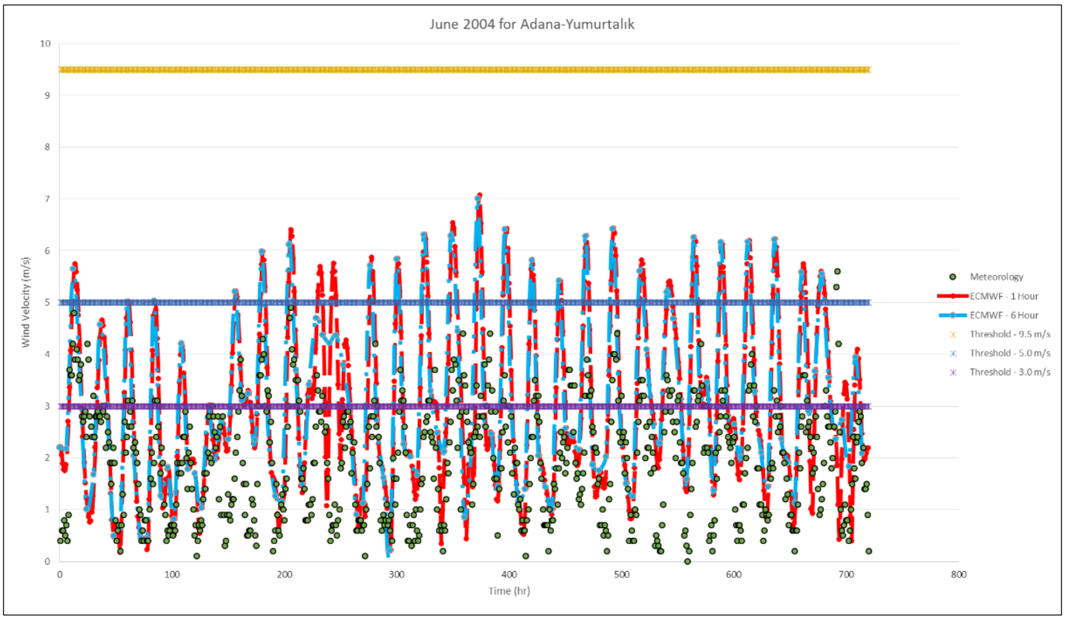

Figure A.34. Time Series for Adana-Yumurtalık (June 2004)

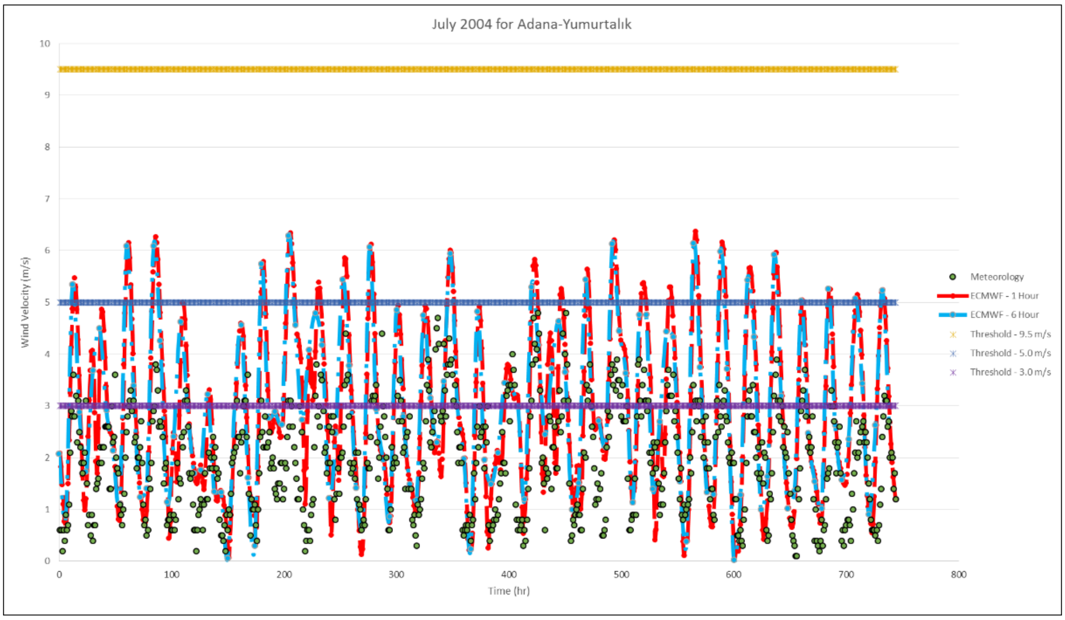

Figure A.35. Time Series for Adana-Yumurtalık (July 2004)

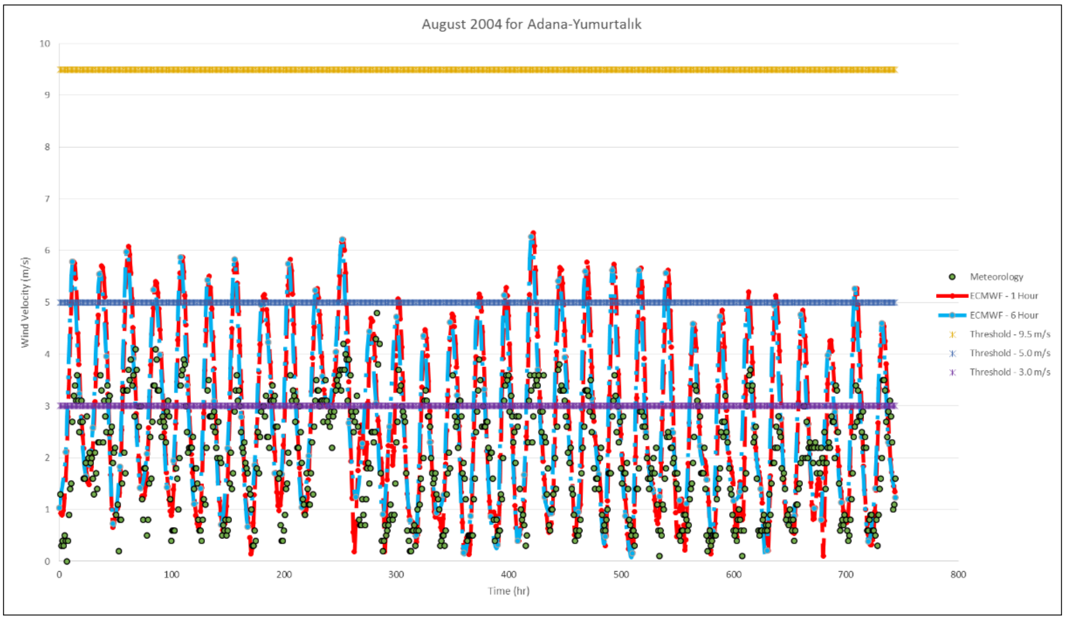

Figure A.36. Time Series for Adana-Yumurtalık (August 2004)

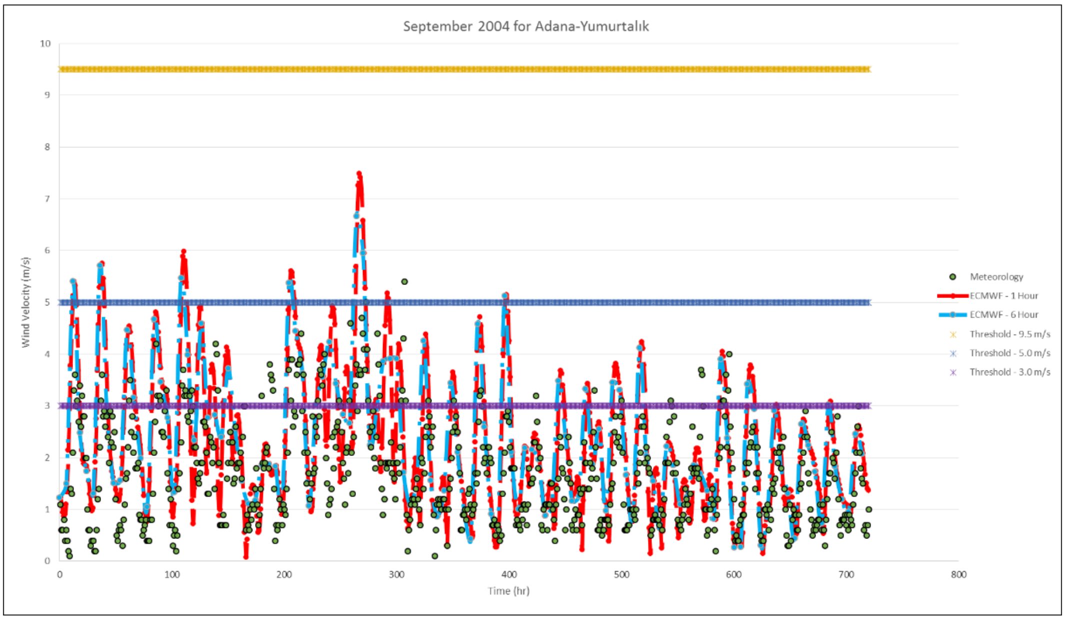

Figure A.37. Time Series for Adana-Yumurtalık (September 2004)

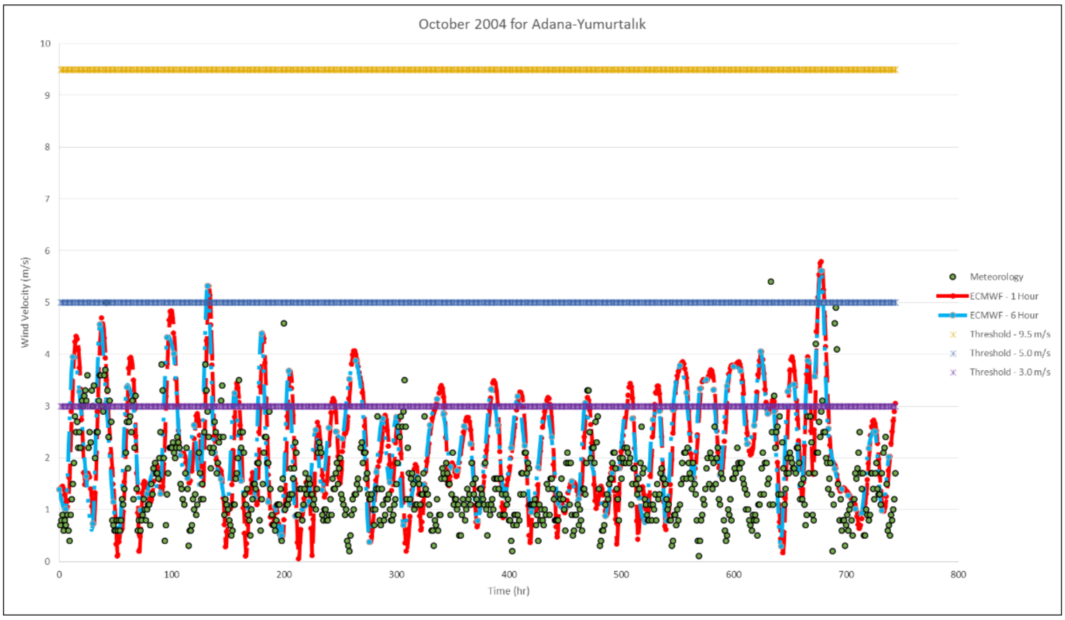

Figure A.38. Time Series for Adana-Yumurtalık (October 2004)

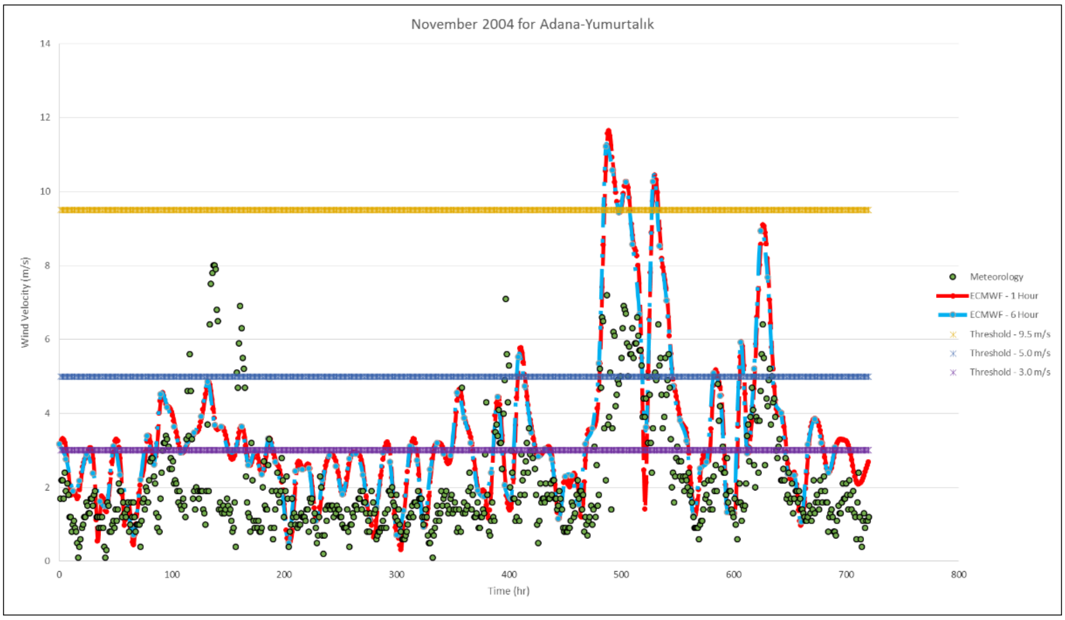

Figure A.39. Time Series for Adana-Yumurtalık (November 2004)

Antalya-Finike:

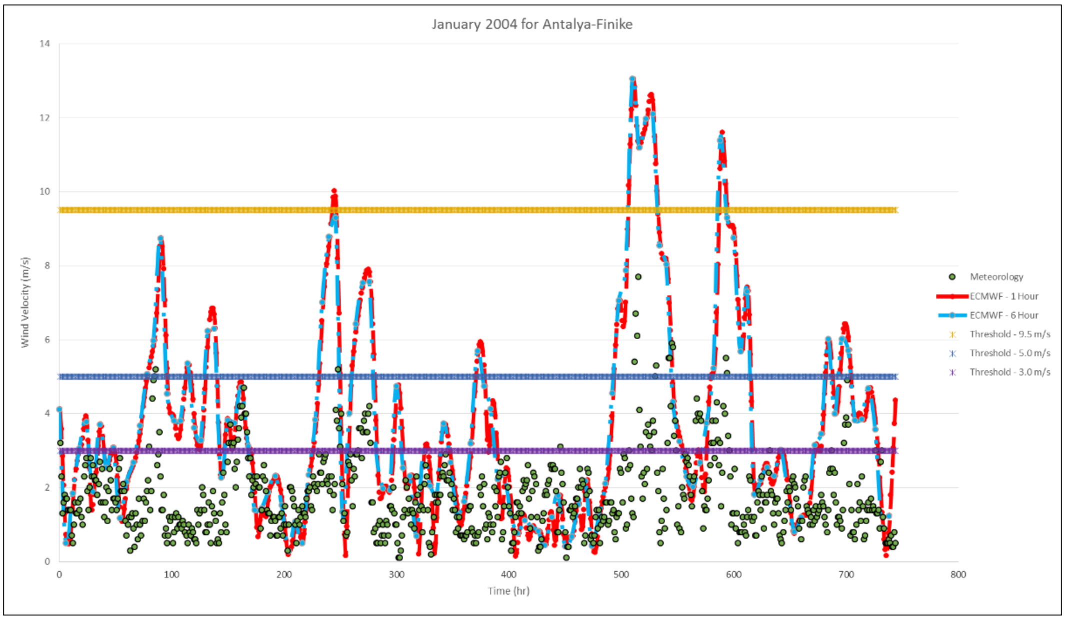

Figure A.40. Time Series for Antalya-Finike (January 2004)

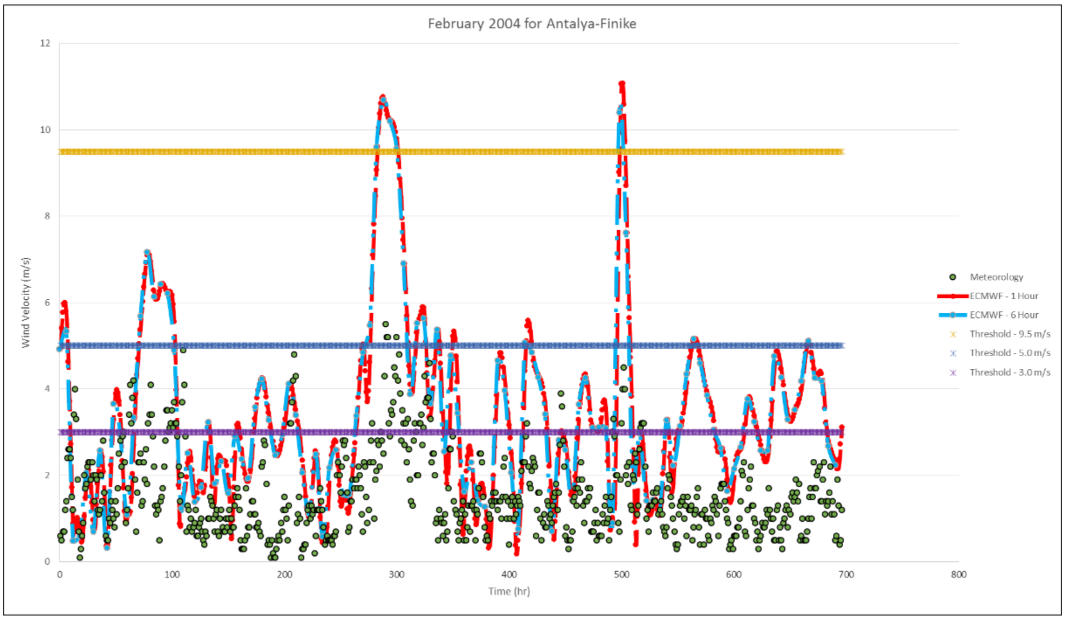

Figure A.41. Time Series for Antalya-Finike (February 2004)

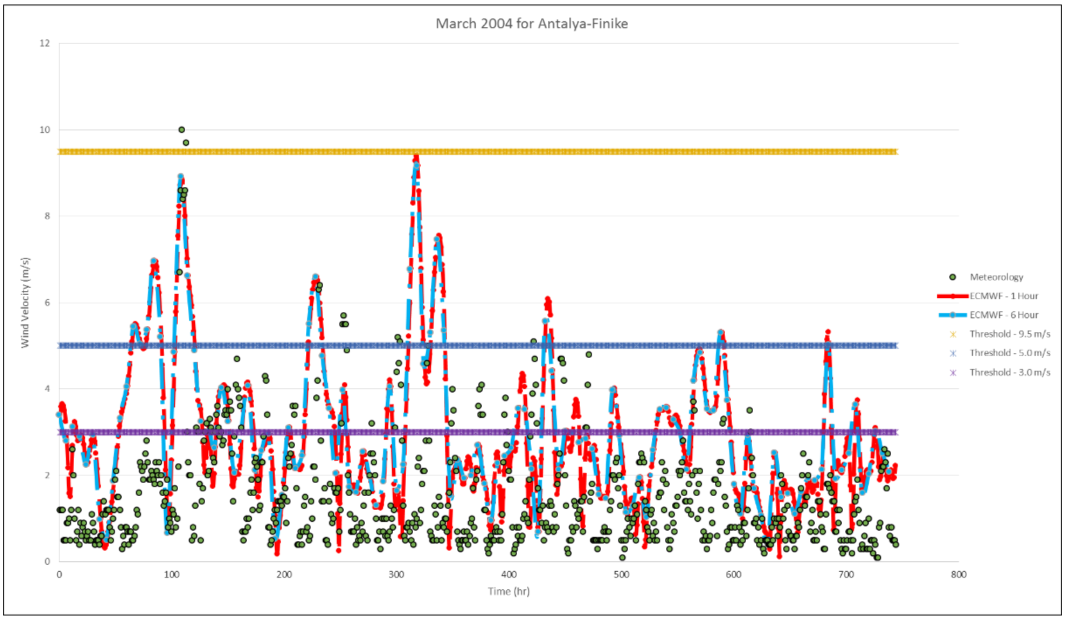

Figure A.42. Time Series for Antalya-Finike (March 2004)

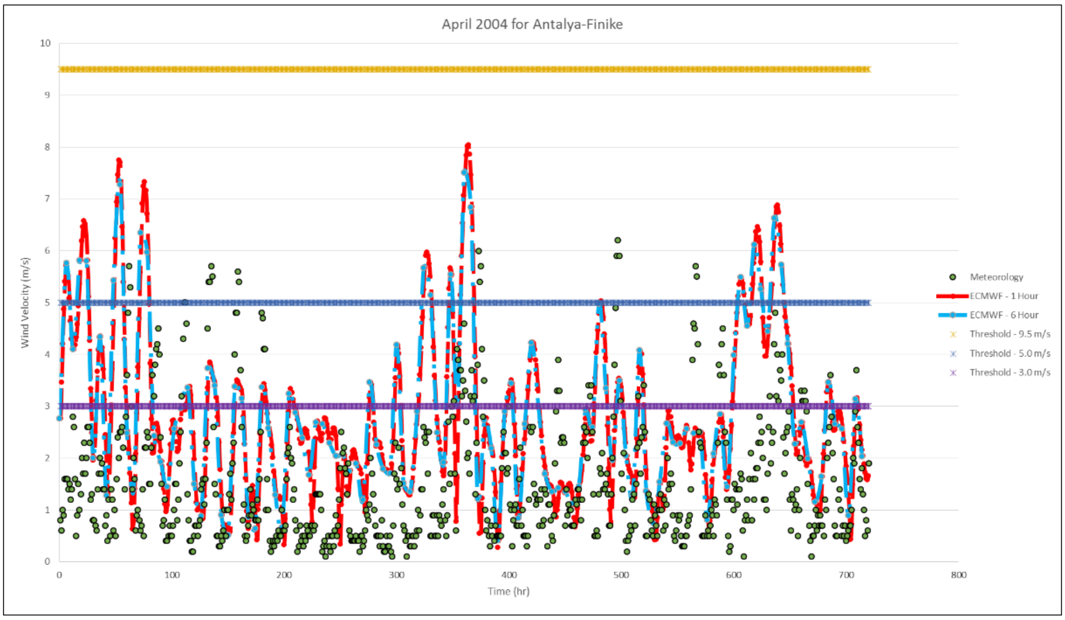

Figure A.43. Time Series for Antalya-Finike (April 2004)

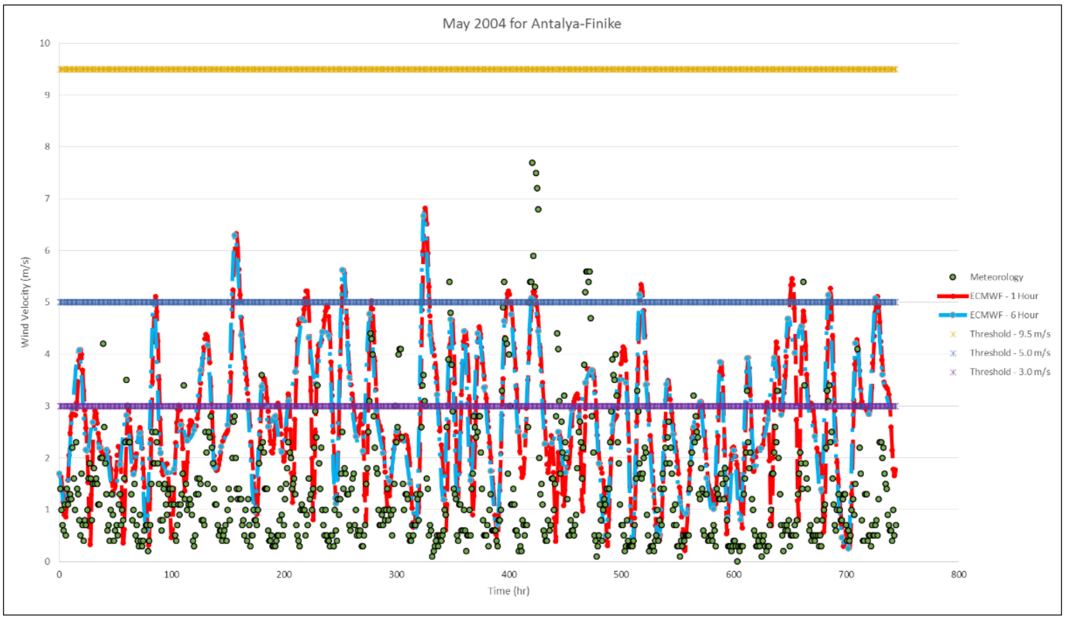

Figure A.44. Time Series for Antalya-Finike (May 2004)

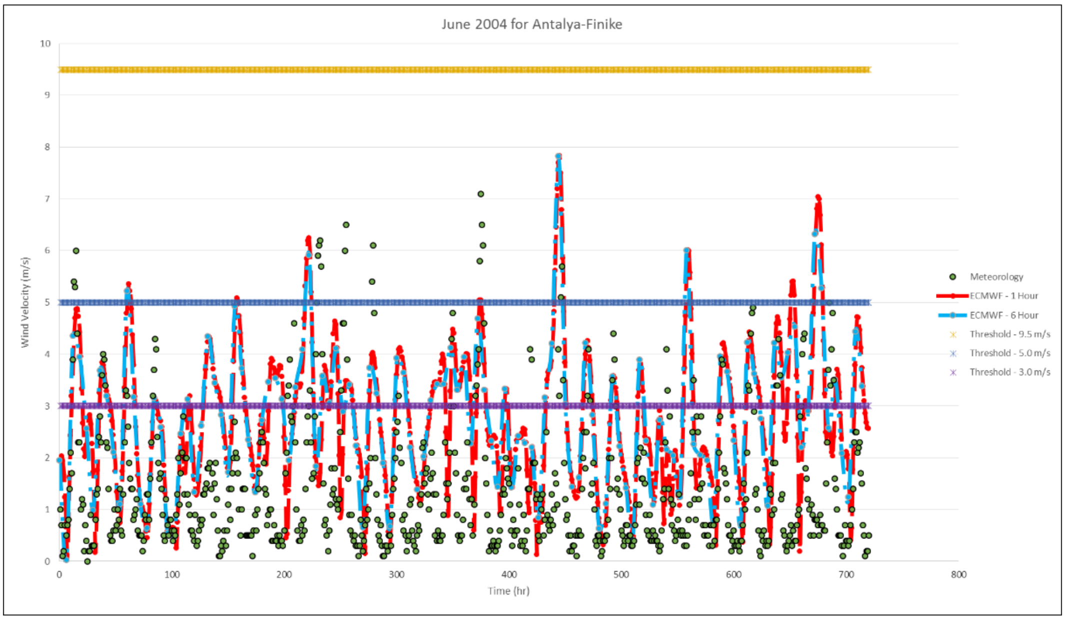

Figure A.45. Time Series for Antalya-Finike (June 2004)

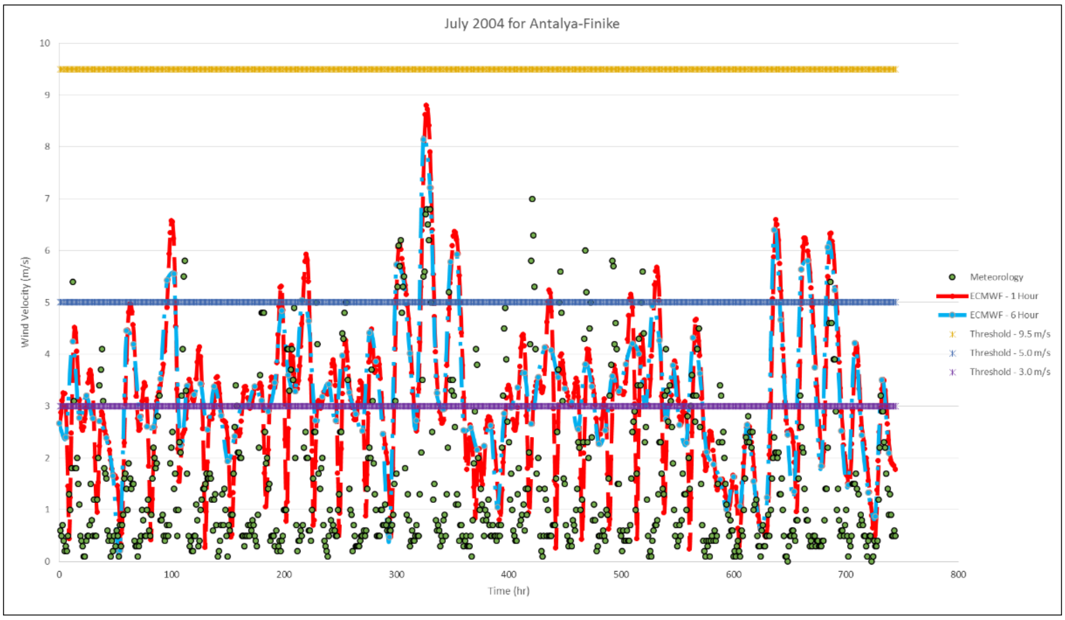

Figure A.46. Time Series for Antalya-Finike (July 2004)

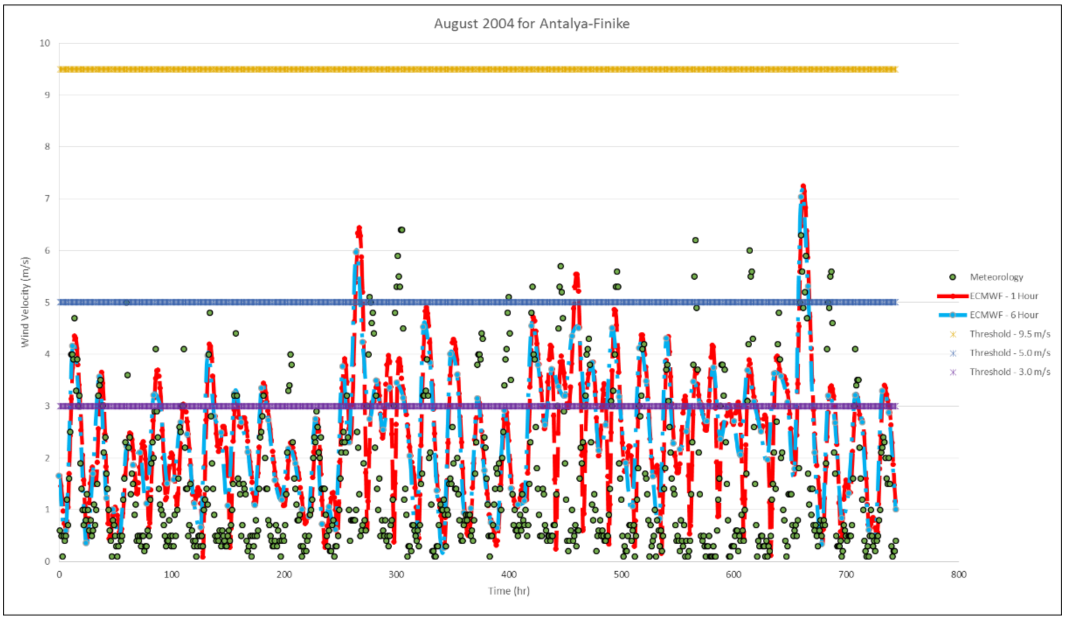

Figure A.47. Time Series for Antalya-Finike (August 2004)

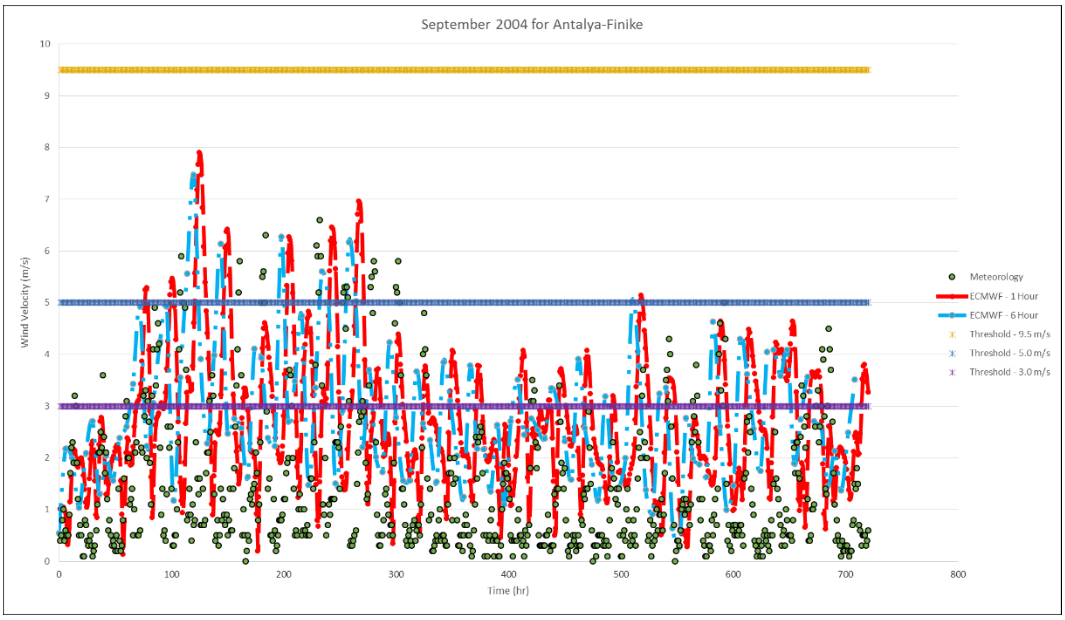

Figure A.48. Time Series for Antalya-Finike (September 2004)

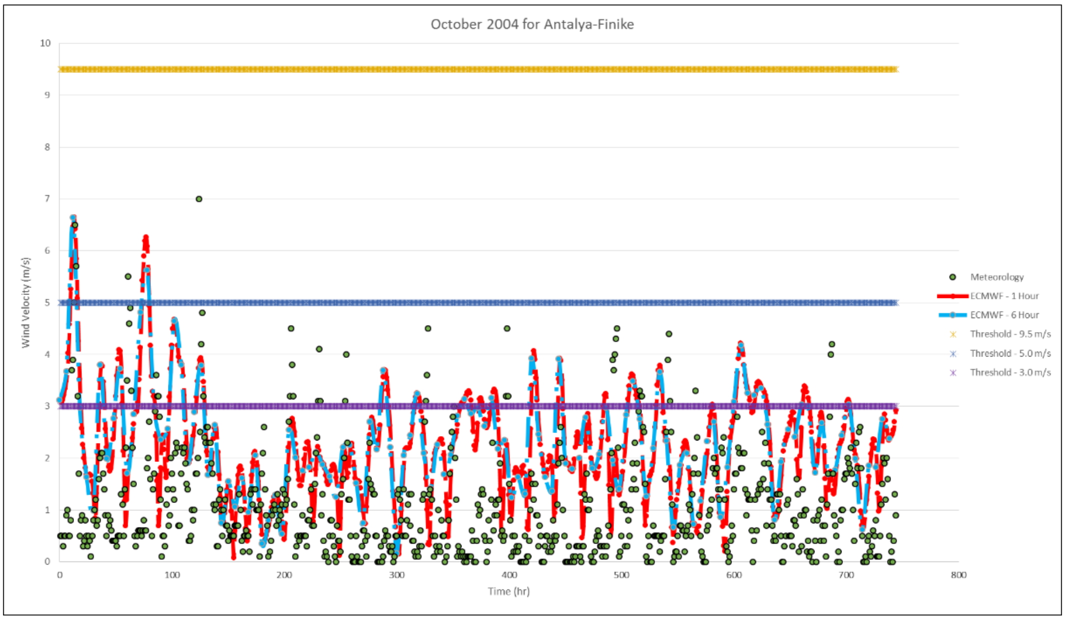

Figure A.49. Time Series for Antalya-Finike (October 2004)

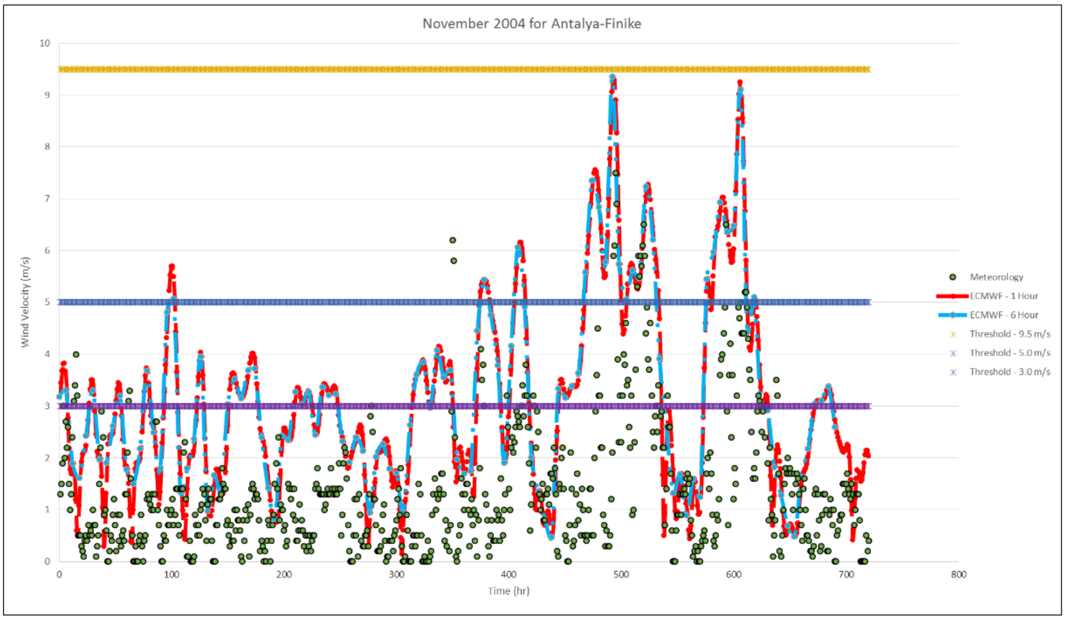

Figure A.50. Time Series for Antalya-Finike (November 2004)

Antalya-Gazipaşa:

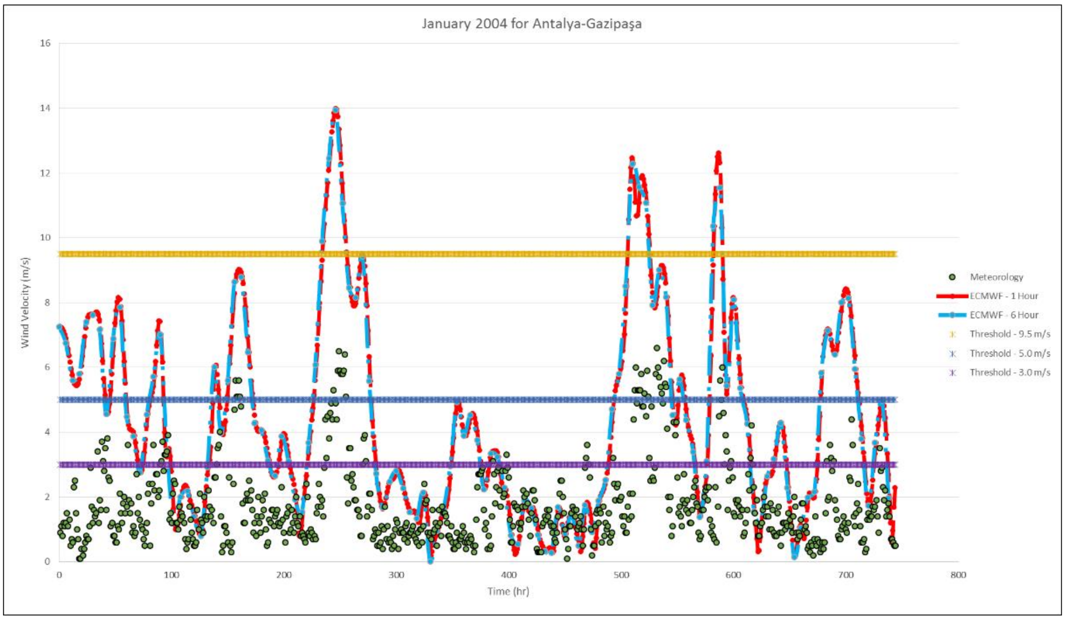

Figure A.51. Time Series for Antalya-Gazipaşa (January 2004)

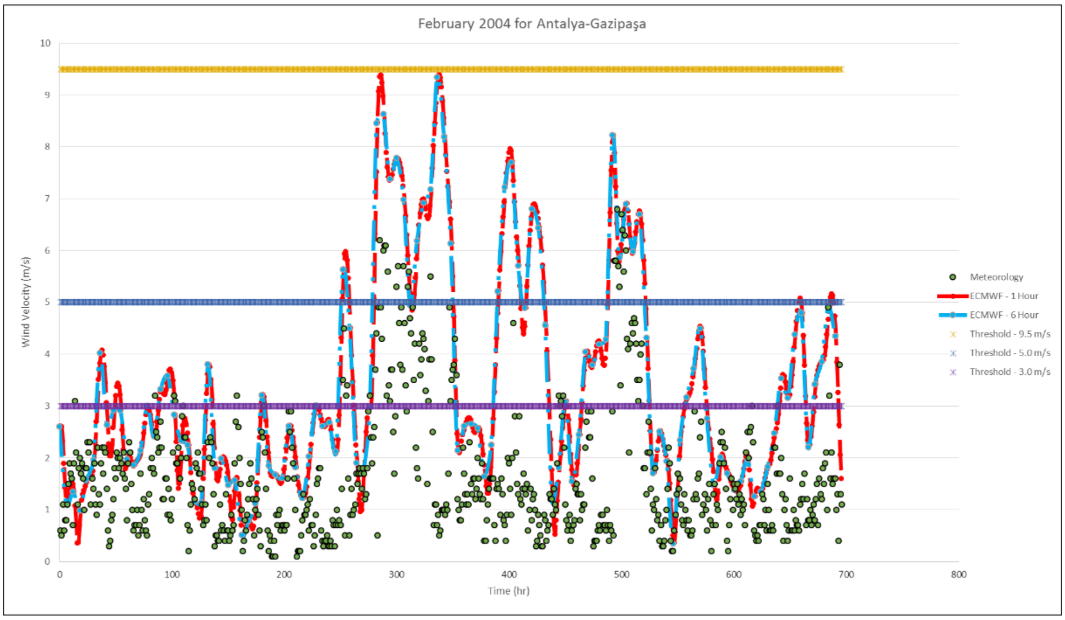

Figure A.52. Time Series for Antalya-Gazipaşa (February 2004)

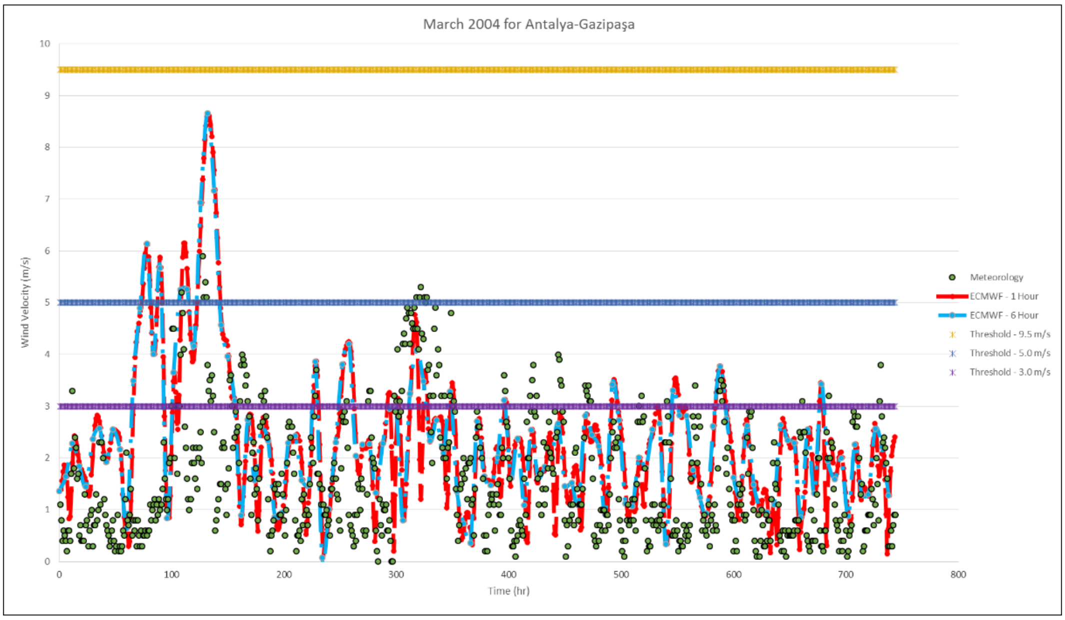

Figure A.53. Time Series for Antalya-Gazipaşa (March 2004)

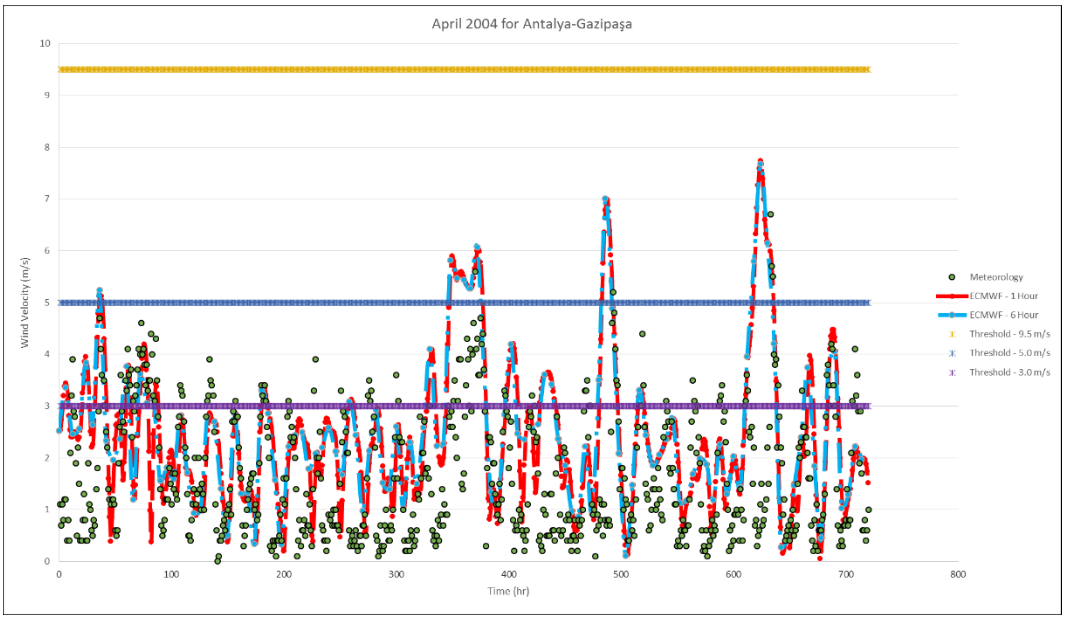

Figure A.54. Time Series for Antalya-Gazipaşa (April 2004)

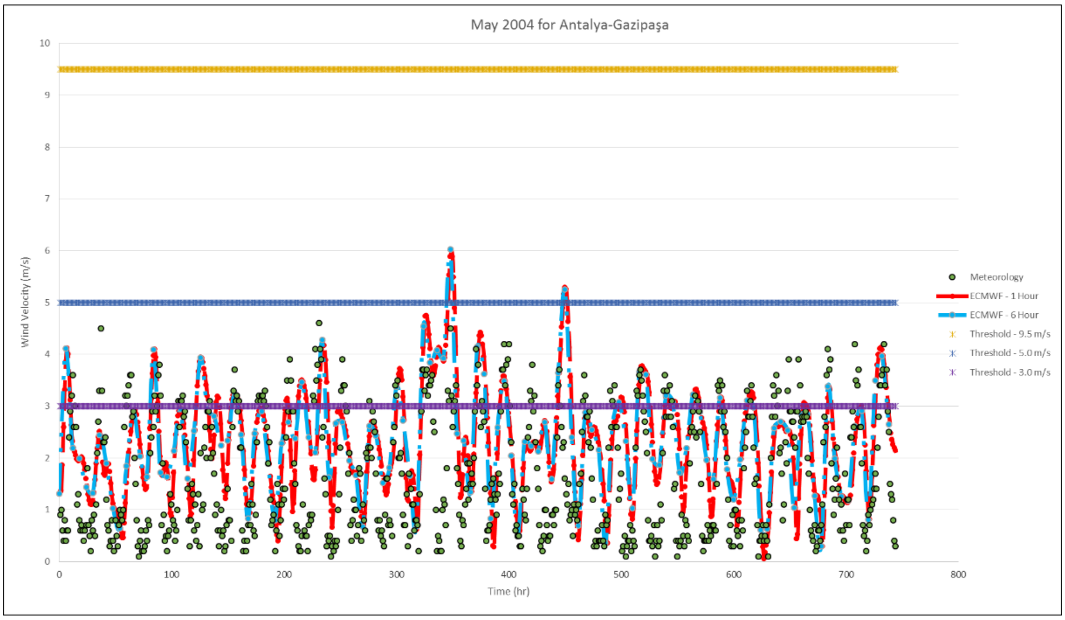

Figure A.55. Time Series for Antalya-Gazipaşa (May 2004)

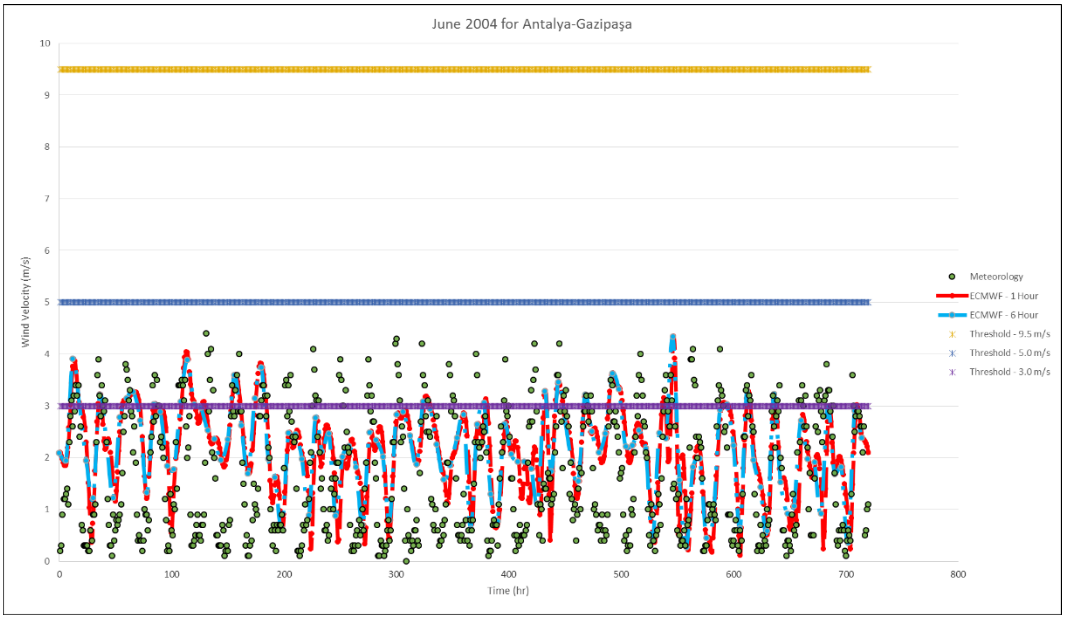

Figure A.56. Time Series for Antalya-Gazipaşa (June 2004)

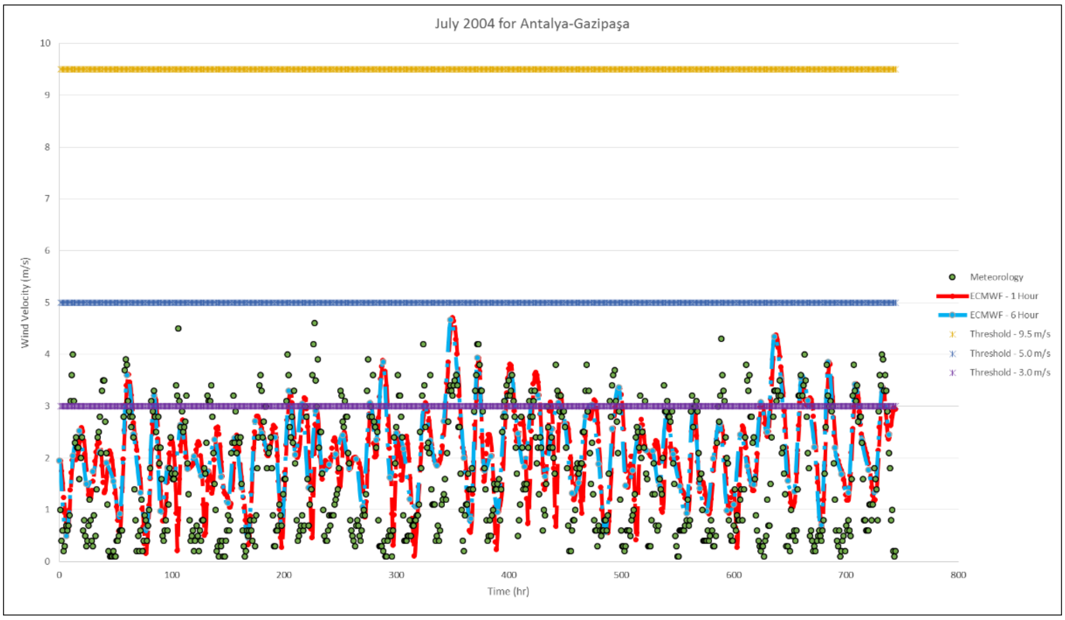

Figure A.57. Time Series for Antalya-Gazipaşa (July 2004)

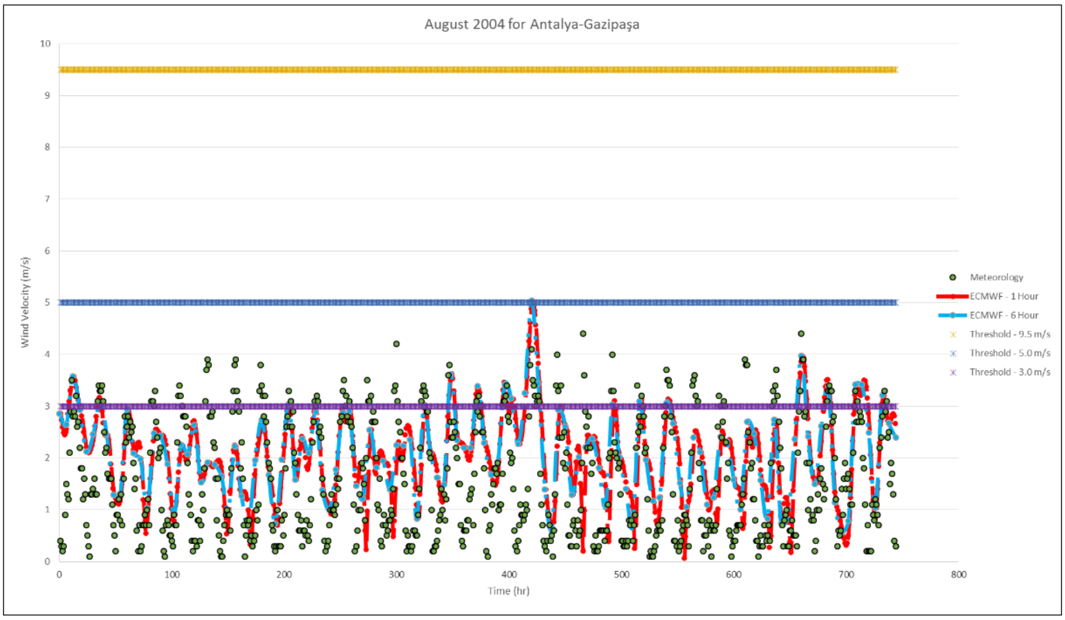

Figure A.58. Time Series for Antalya-Gazipaşa (August 2004)

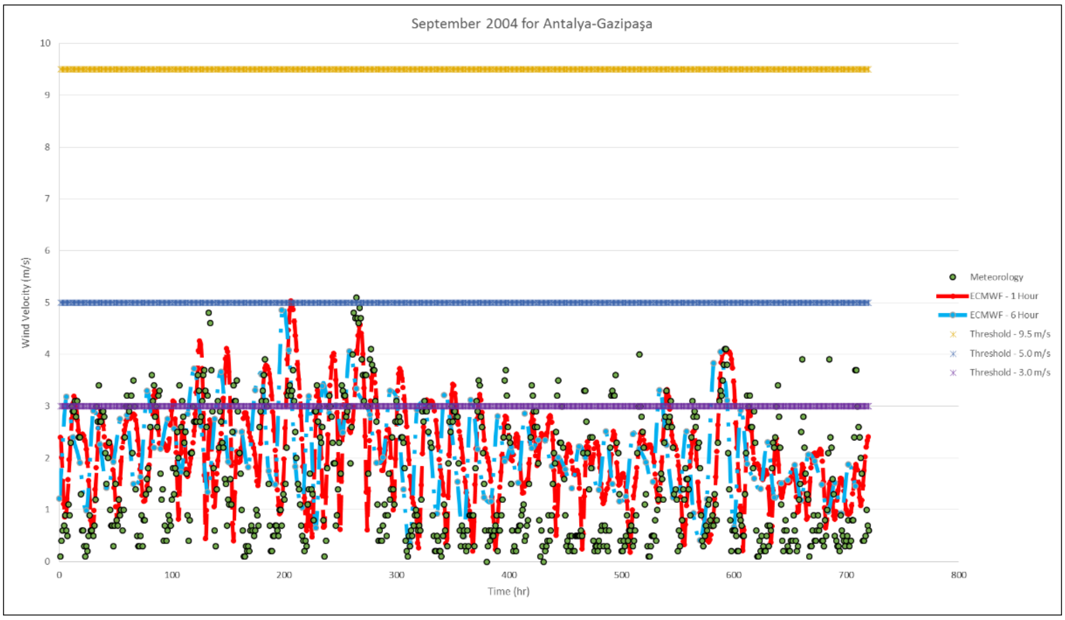

Figure A.59. Time Series for Antalya-Gazipaşa (September 2004)

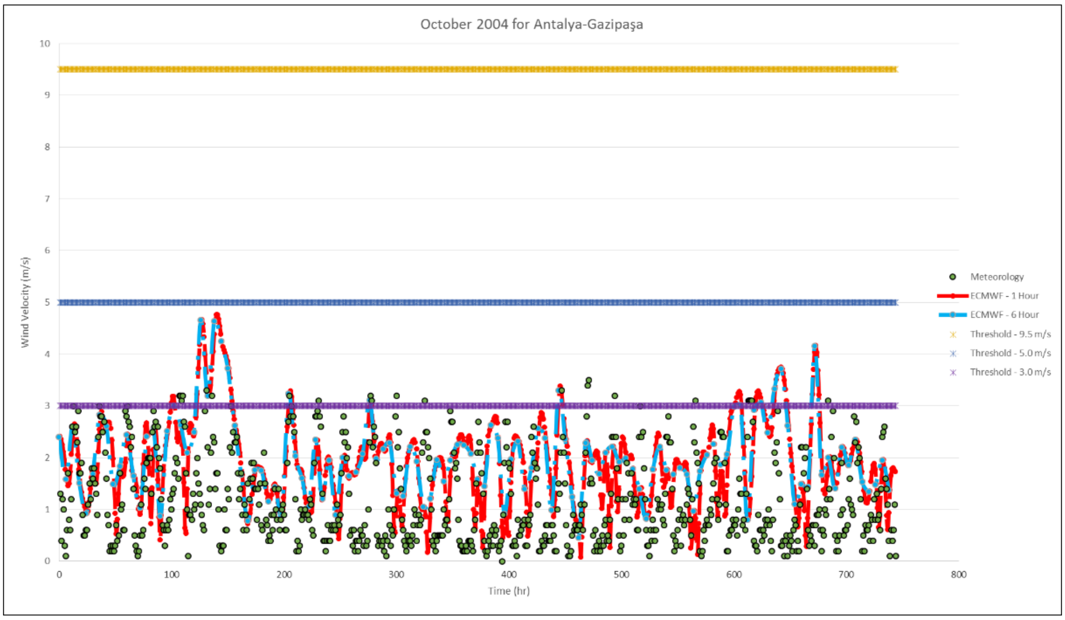

Figure A.60. Time Series for Antalya-Gazipaşa (October 2004)

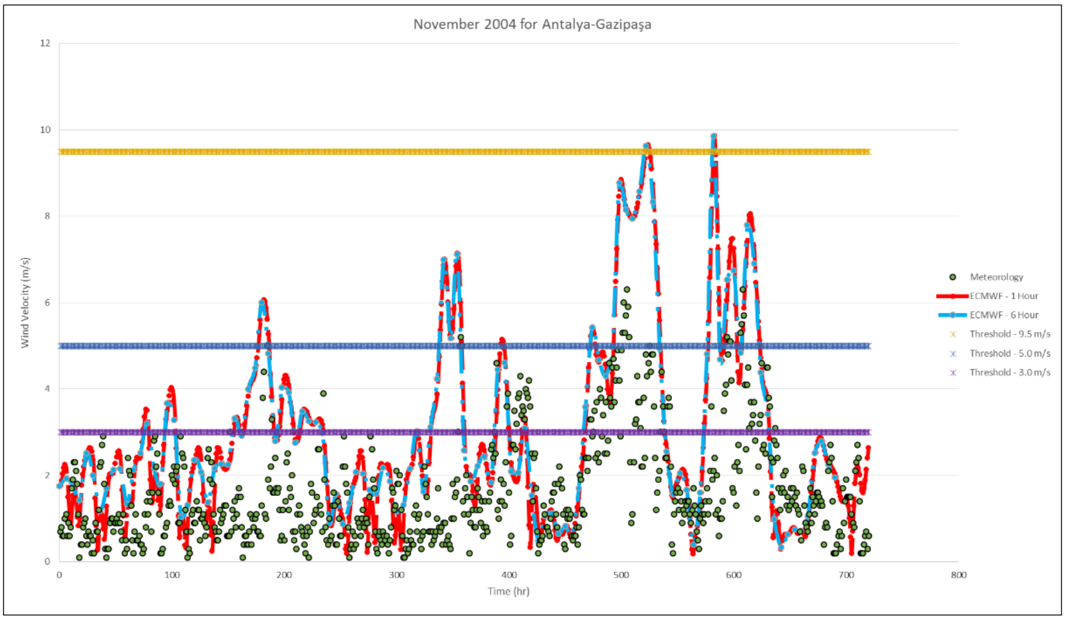

Figure A.61. Time Series for Antalya-Gazipaşa (November 2004)

Hatay-İskenderun:

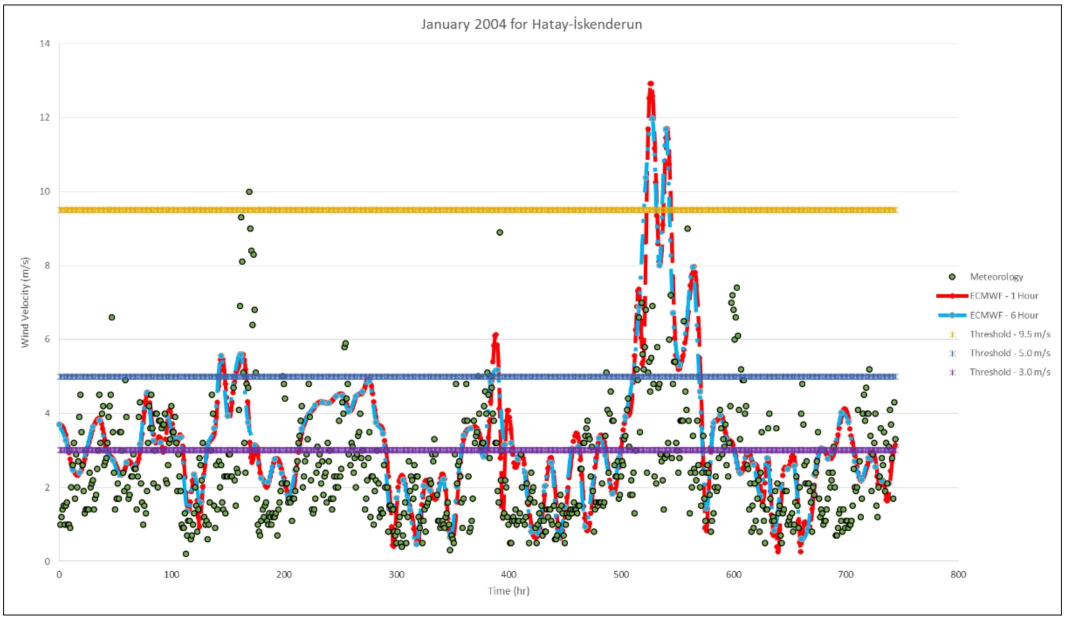

Figure A.62. Time Series for Hatay-İskenderun (January 2004)

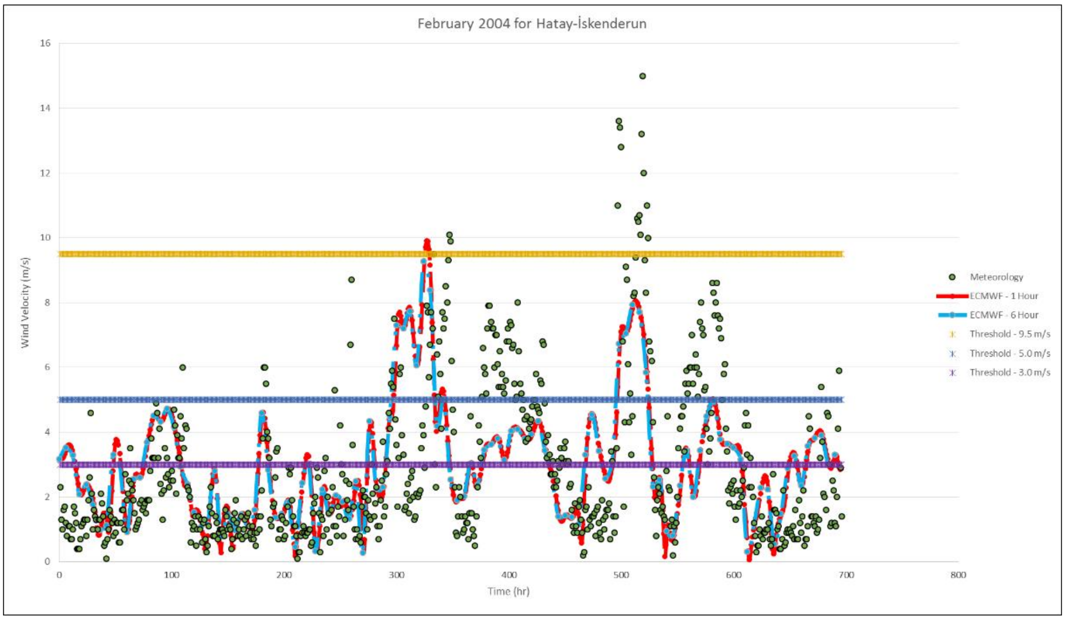

Figure A.63. Time Series for Hatay-İskenderun (February 2004)

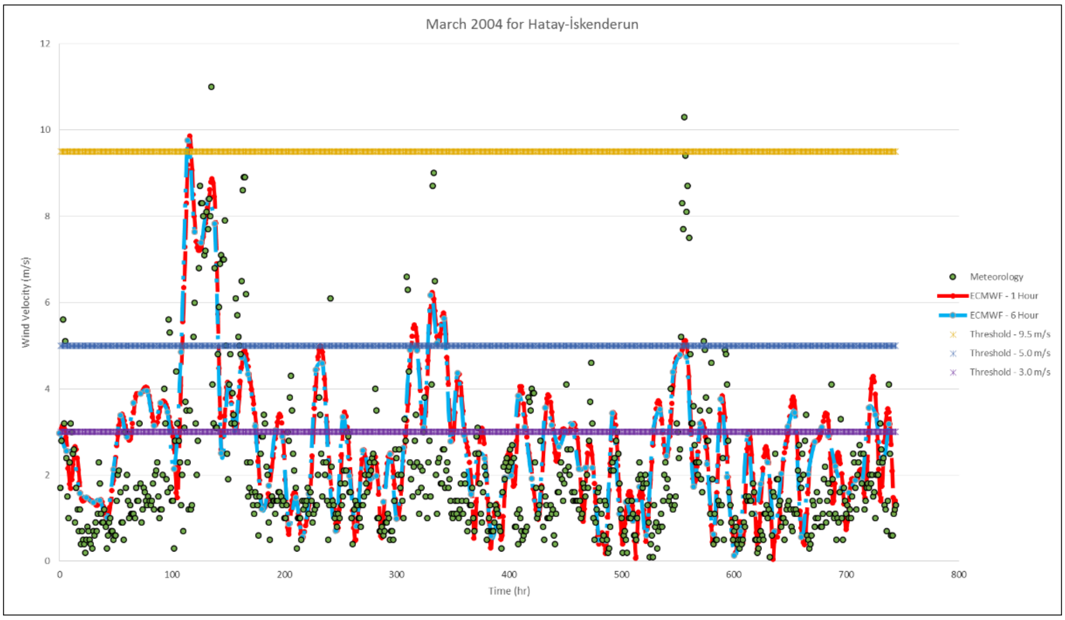

Figure A.64. Time Series for Hatay-İskenderun (March 2004)

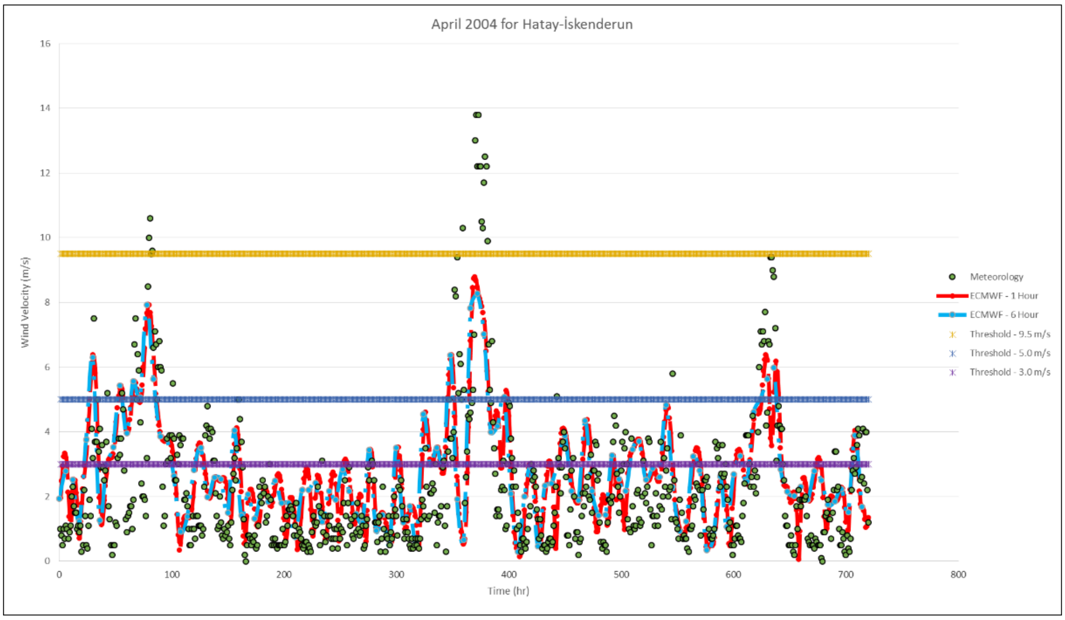

Figure A.65. Time Series for Hatay-İskenderun (April 2004)

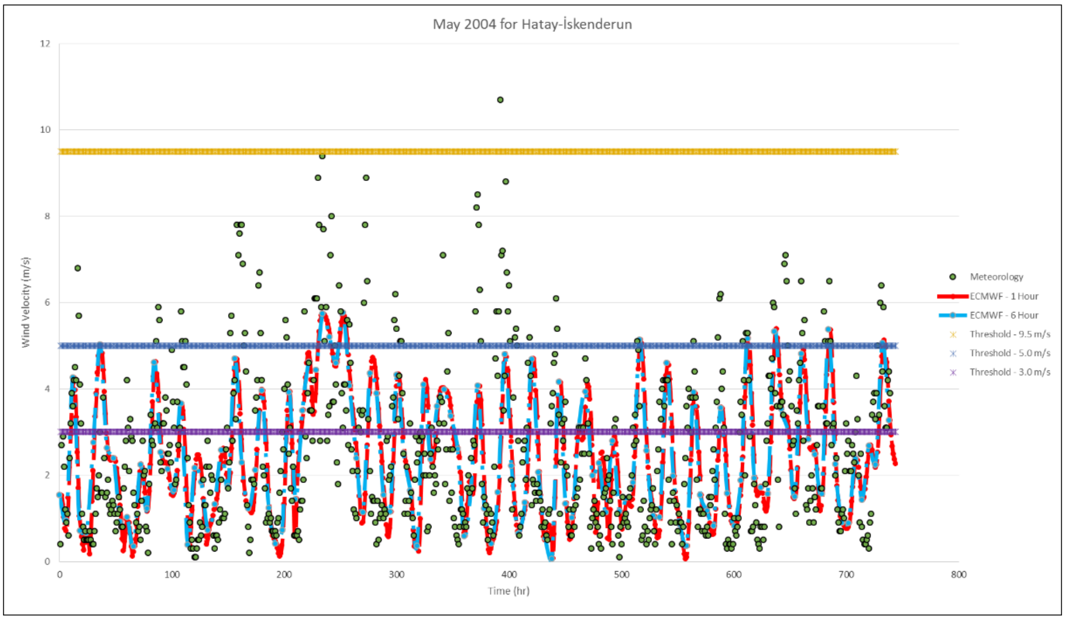

Figure A.66. Time Series for Hatay-İskenderun (May 2004)

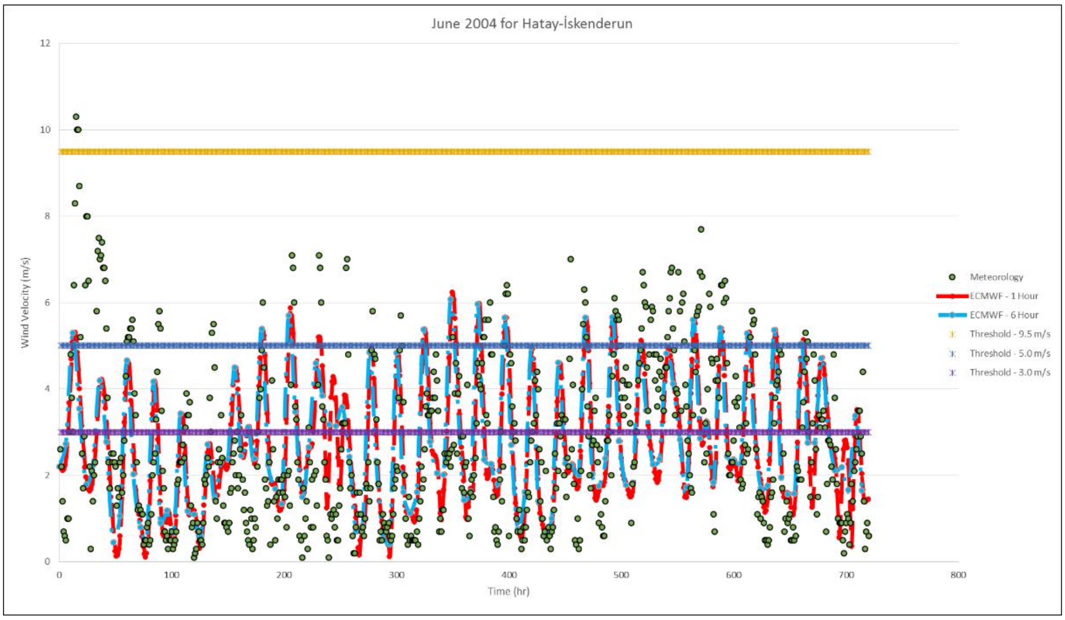

Figure A.67. Time Series for Hatay-İskenderun (June 2004)

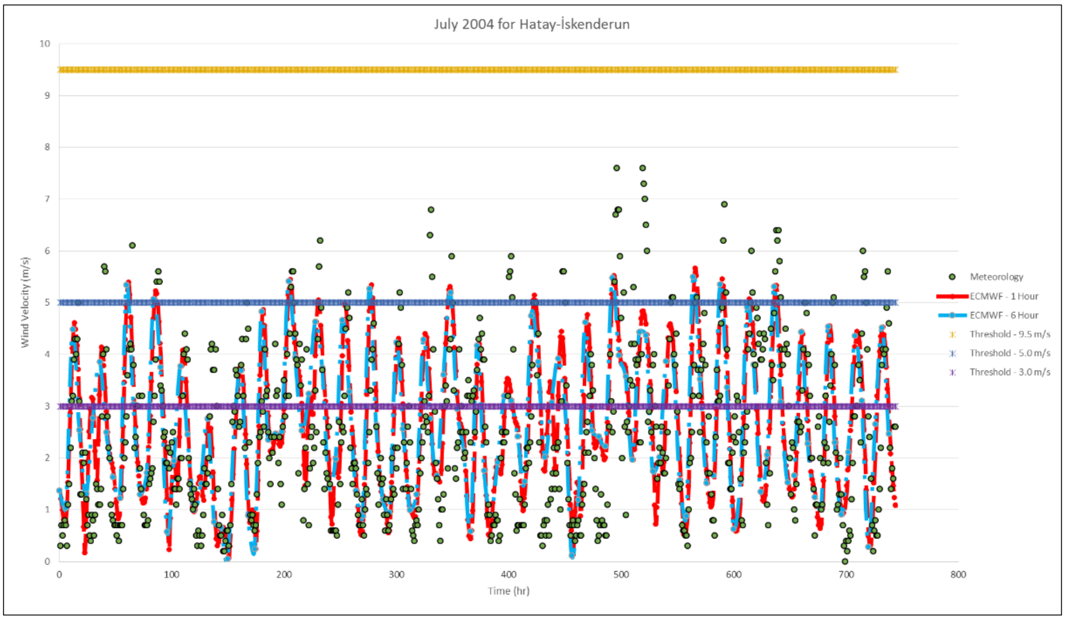

Figure A.68. Time Series for Hatay-İskenderun (July 2004)

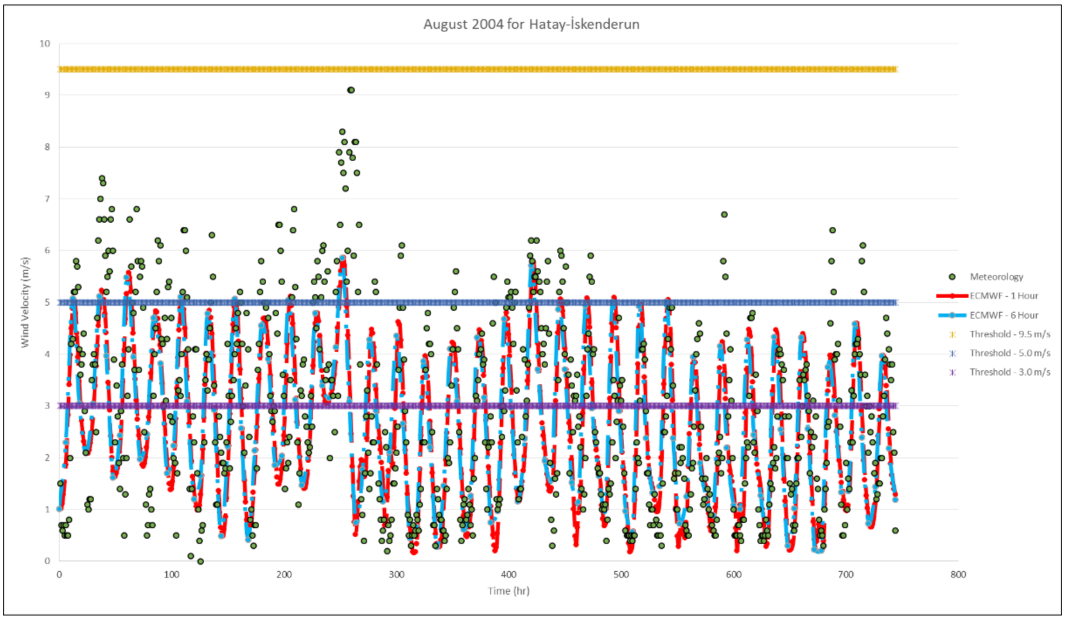

Figure A.69. Time Series for Hatay-İskenderun (August 2004)

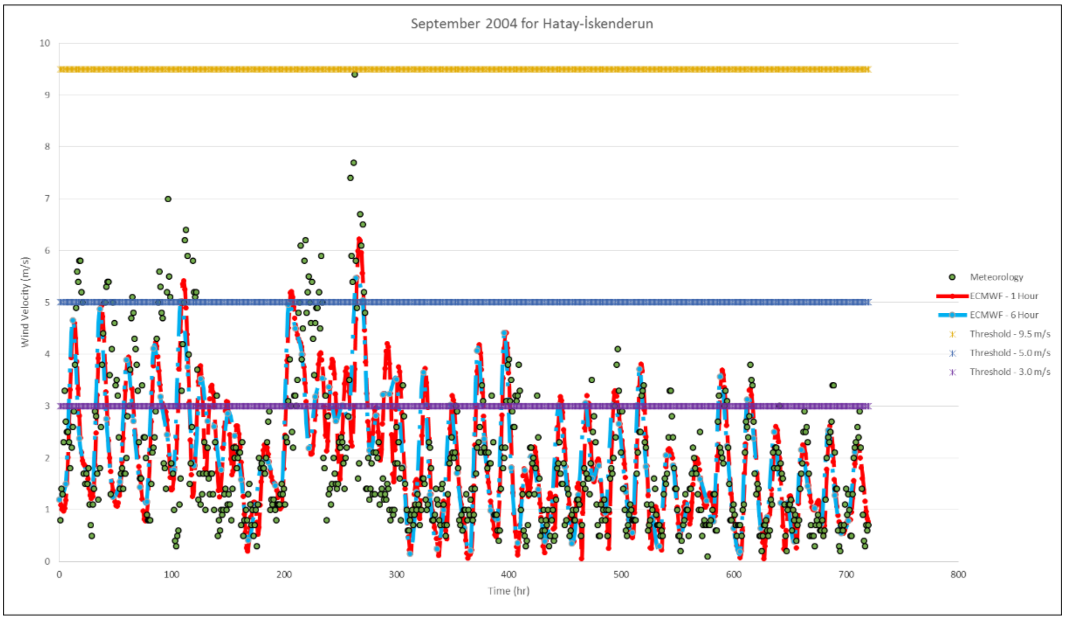

Figure A.70. Time Series for Hatay-İskenderun (September 2004)

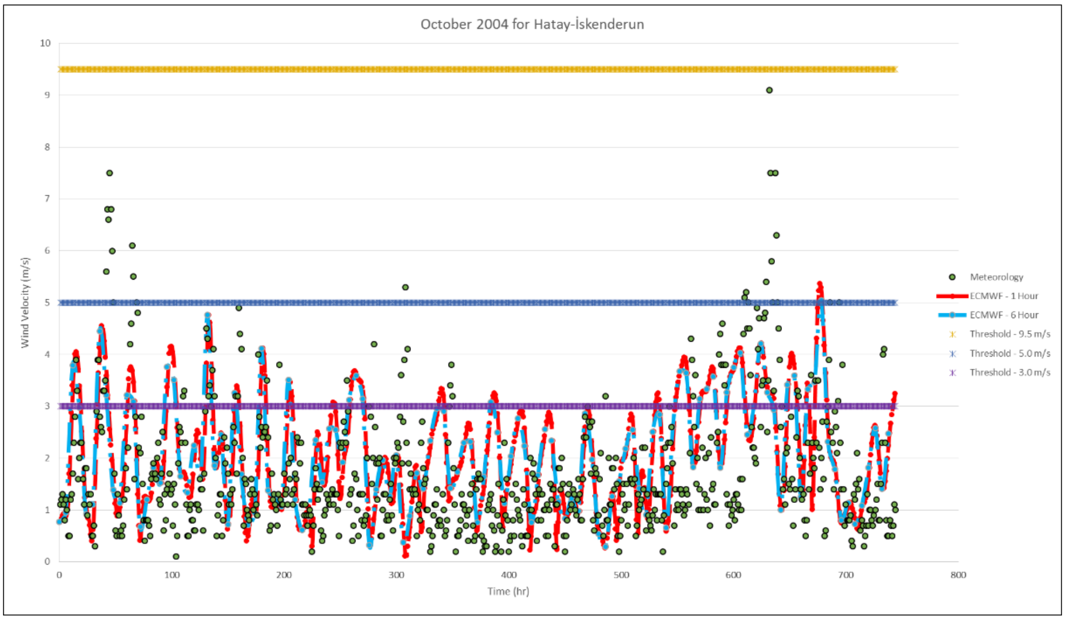

Figure A.71. Time Series for Hatay-İskenderun (October 2004)

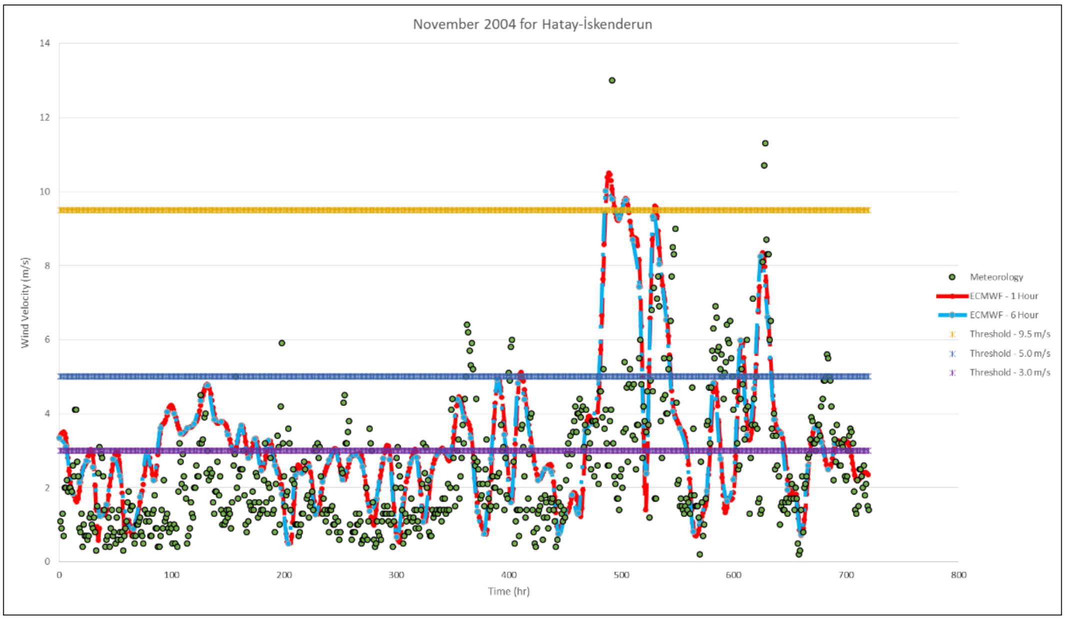

Figure A.72. Time Series for Hatay-İskenderun (November 2004)

Mersin-Yenişehir:

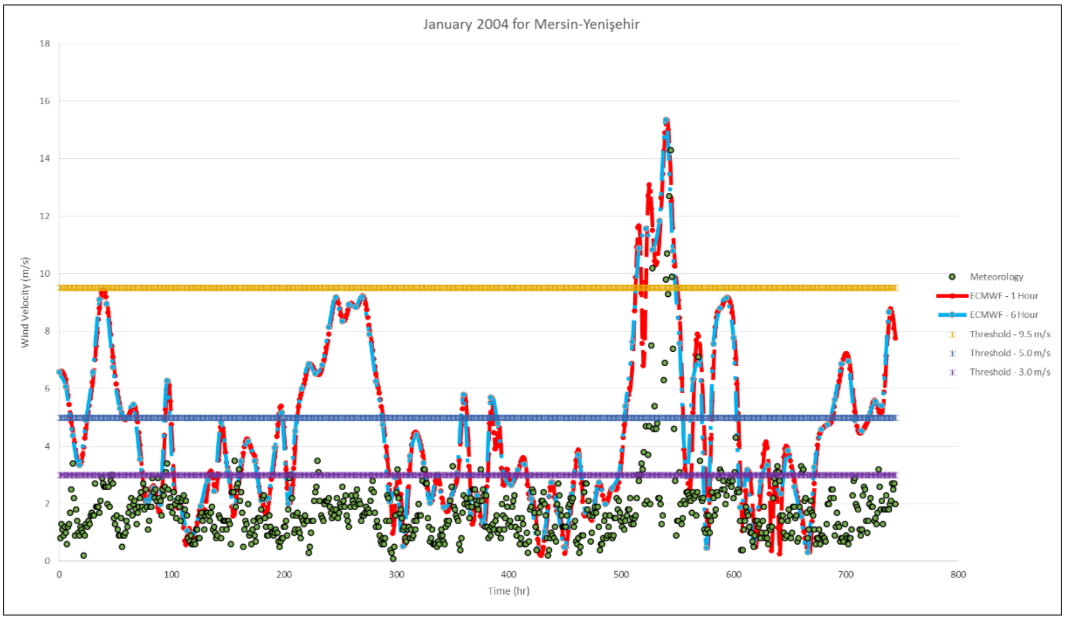

Figure A.73. Time Series for Mersin-Yenişehir (January 2004)

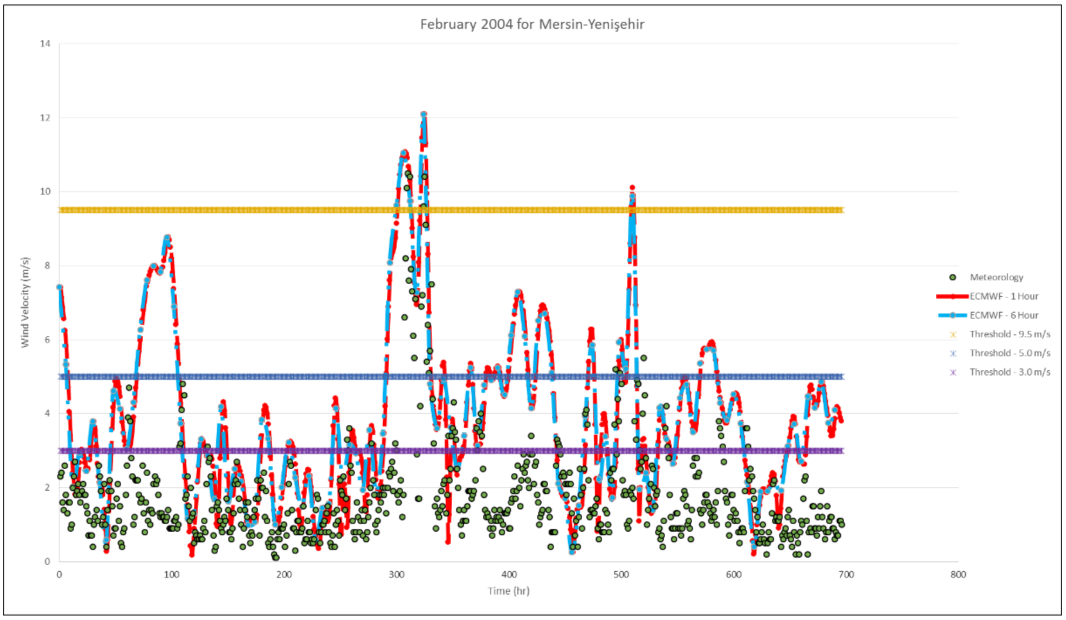

Figure A.75. Time Series for Mersin-Yenişehir (February 2004)

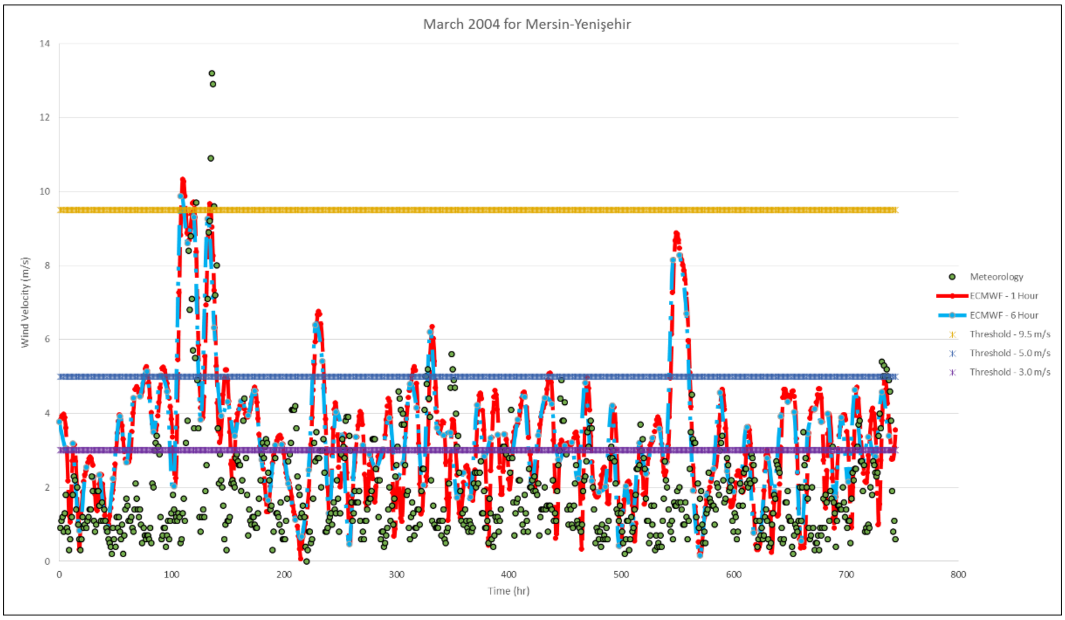

Figure A.76. Time Series for Mersin-Yenişehir (March 2004)

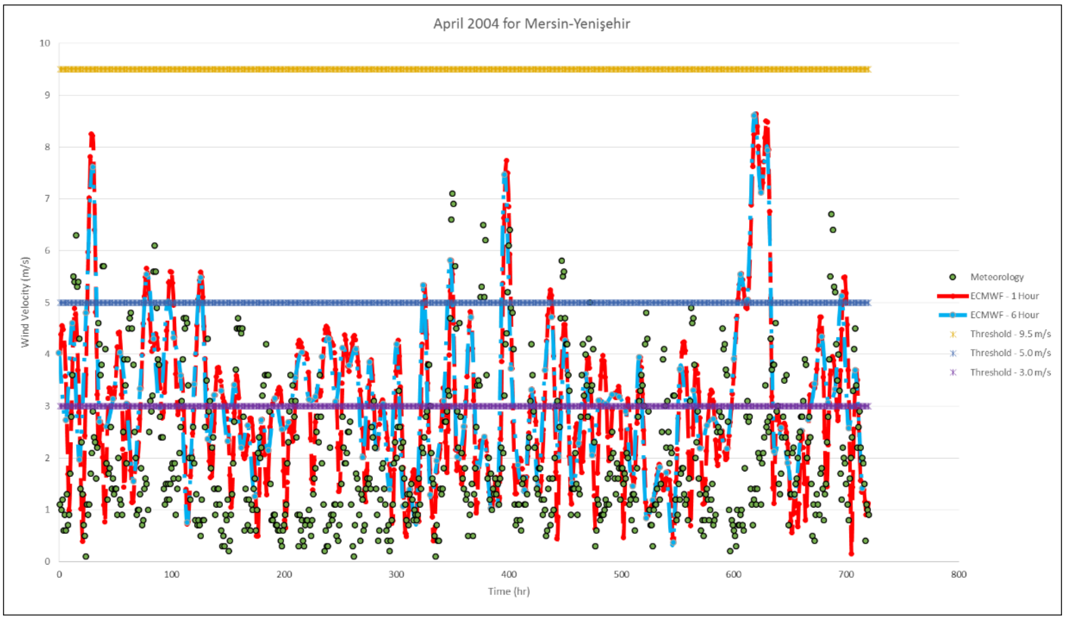

Figure A.77. Time Series for Mersin-Yenişehir (April 2004)

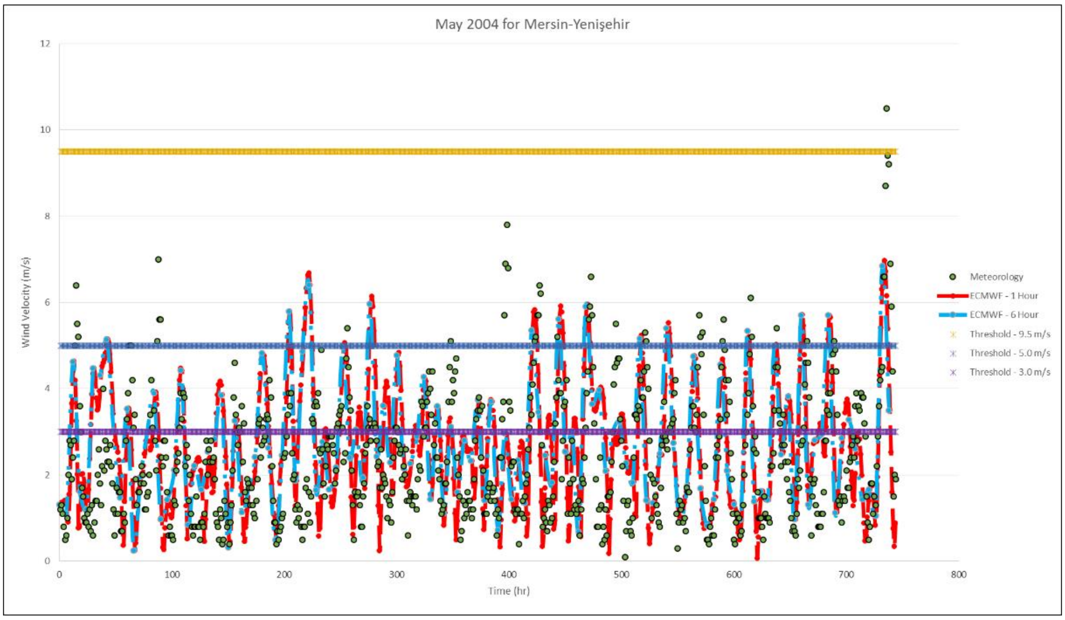

Figure A.78. Time Series for Mersin-Yenişehir (May 2004)

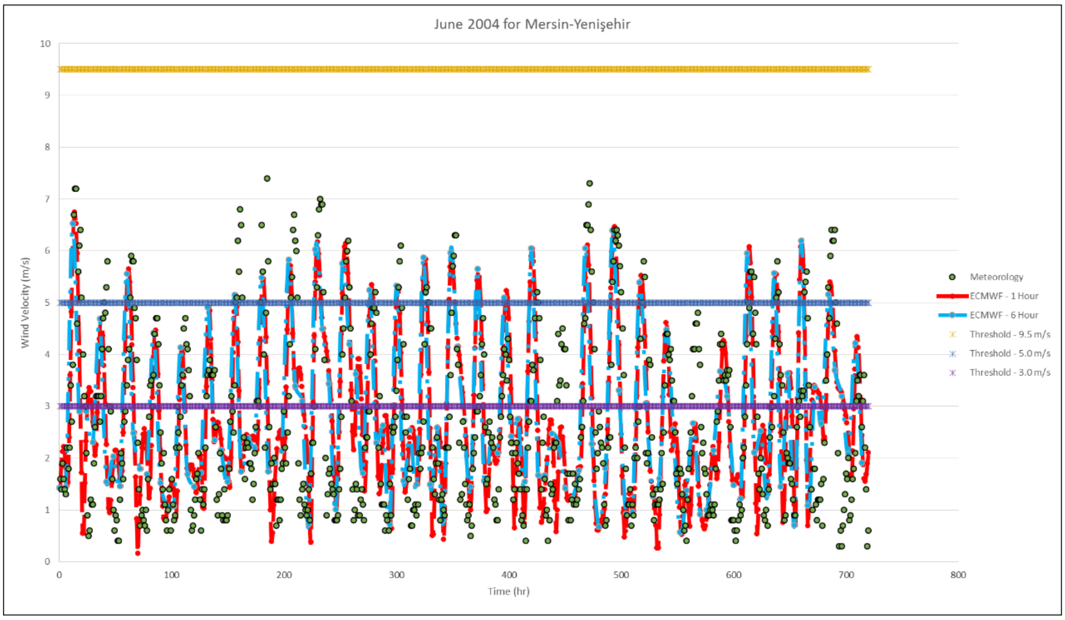

Figure A.79. Time Series for Mersin-Yenişehir (June 2004)

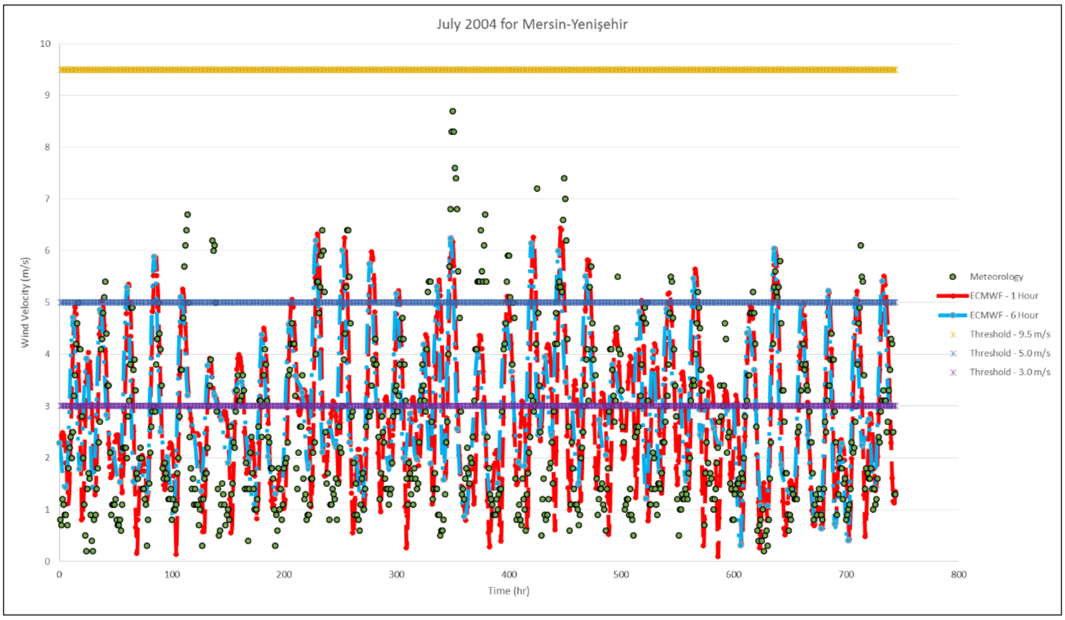

Figure A.80. Time Series for Mersin-Yenişehir (July 2004)

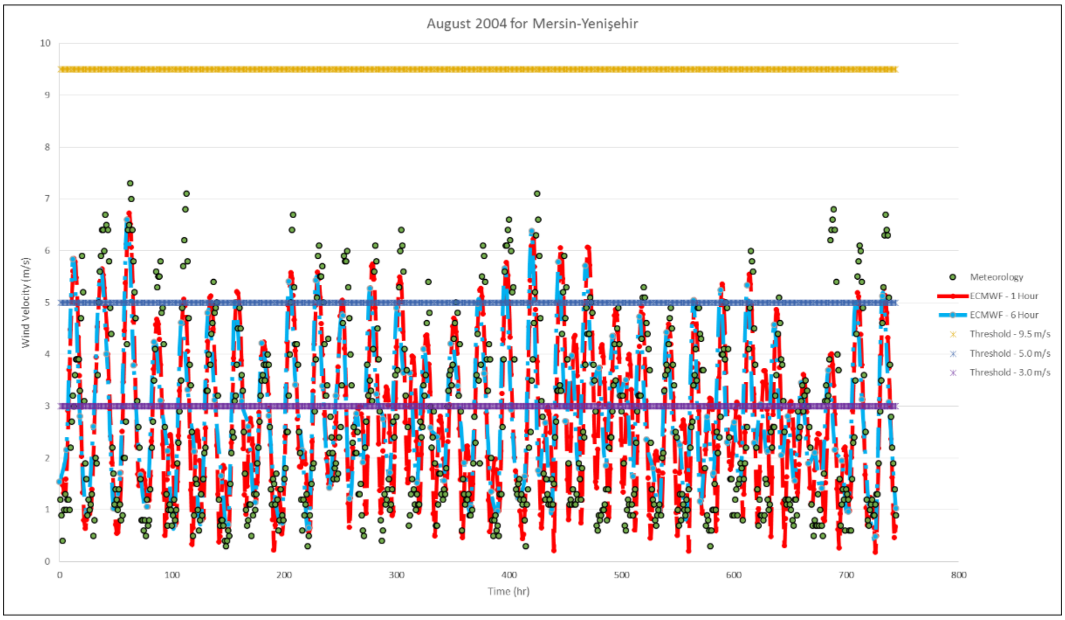

Figure A.81. Time Series for Mersin-Yenişehir (August 2004)

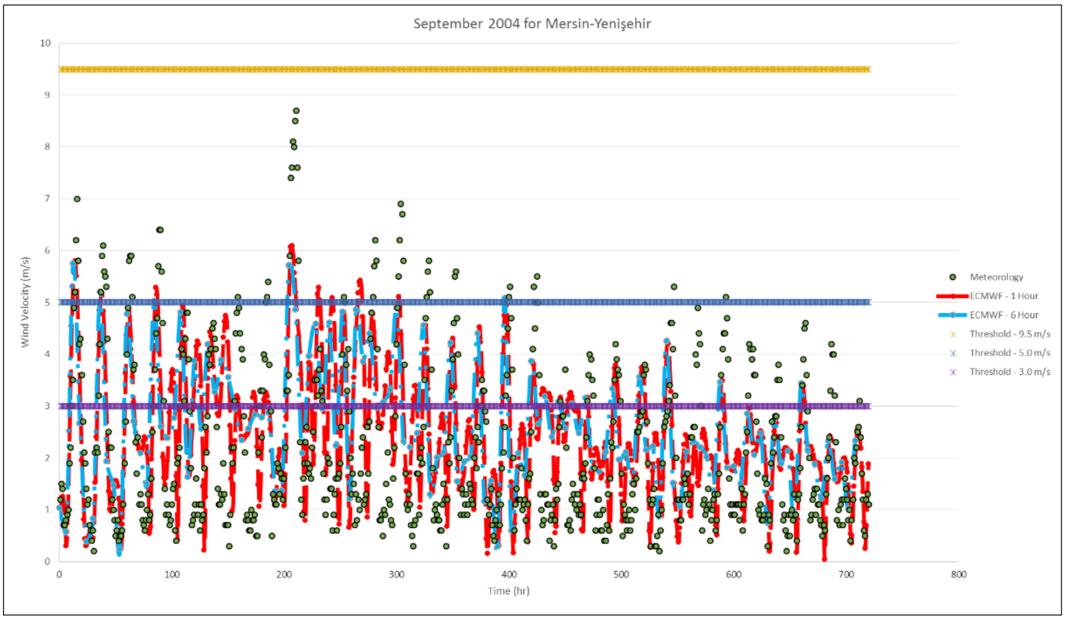

Figure A.82. Time Series for Mersin-Yenişehir (September 2004)

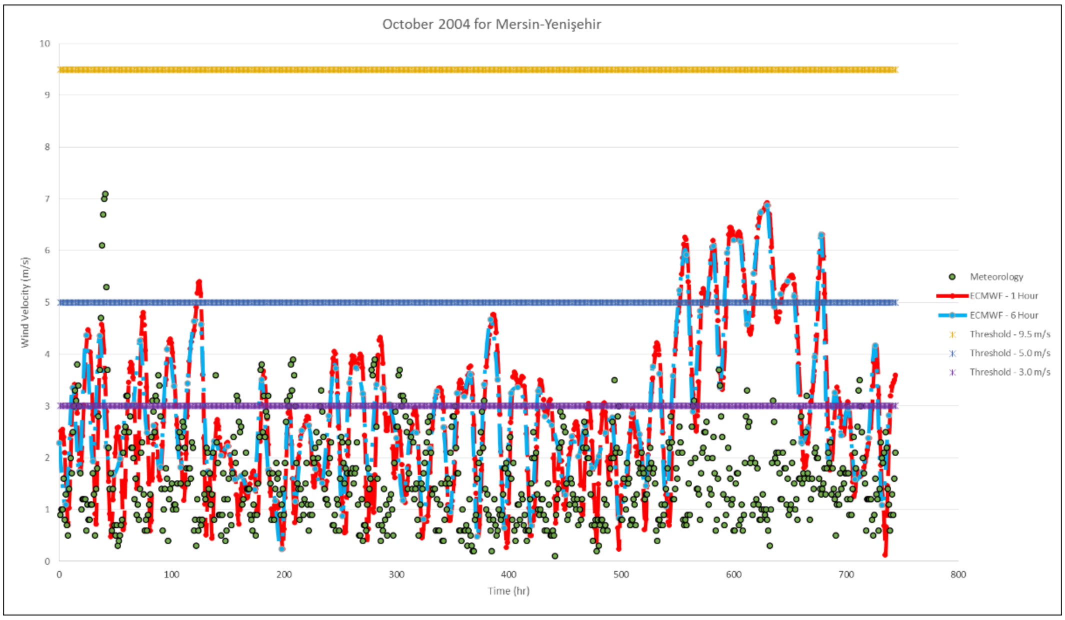

Figure A.83. Time Series for Mersin-Yenişehir (October 2004)

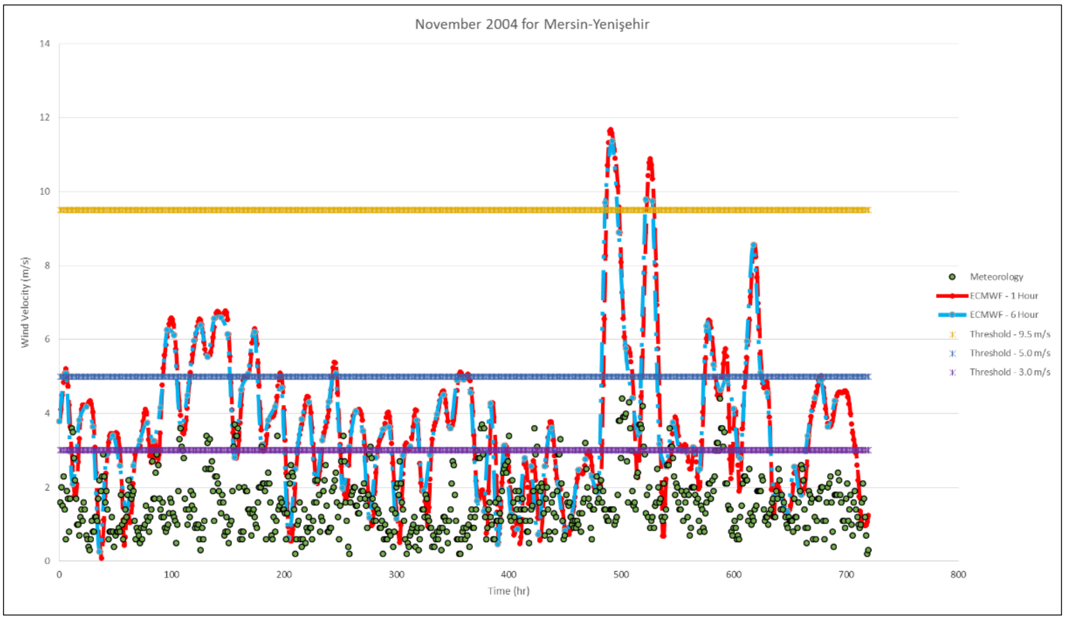

Figure A.84. Time Series for Mersin-Yenişehir (November 2004)

APPENDIX – B

NON-DIRECTIONAL ANALYSIS:

Mersin-Anamur:

Table B.1. The Result Table of the Extreme Analysis for the Mersin-Anamur Meteorology Data Set (1983-2009)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	2.78029	3.21464	3.63128	4.17057	4.57469	5.50856	5.91004	Best Distr.	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	2.71441	3.10921	3.48791	3.97810	4.34542	5.19426	5.55919	-	-	Best Distr.	Best Distr.
FT 2 (k2=3.33)	2.49550	2.89432	3.37128	4.16346	4.92061	7.41601	8.92092	-	-	Best Distr.	Best Distr.
FT 2 (k3=5.0)	2.58070	2.99920	3.46417	4.17453	4.80068	6.63036	7.61759	-	-	Best Distr.	Best Distr.
FT 2 (k4=10.0)	2.65515	3.07095	3.50022	4.10379	4.59440	5.86817	6.48220	-	-	Best Distr.	Best Distr.
Weibull (k1=0.75)	2.51004	2.98641	3.51375	4.27529	4.89328	6.44644	7.16030	-	-	Best Distr.	Best Distr.
Weibull (k2=1.0)	2.63179	3.09720	3.56261	4.17785	4.64326	5.72391	6.18932	-	-	Best Distr.	Best Distr.
Weibull (k3=1.4)	2.72444	3.14162	3.52383	3.99222	4.32573	5.04965	5.34435	-	-	Best Distr.	Best Distr.
Weibull (k4=2.0)	2.77074	3.12829	3.43495	3.79001	4.03157	4.53017	4.72468	-	-	Best Distr.	Best Distr.
LogNormal	2.72247	3.09173	3.43414	3.86509	4.18203	4.90540	5.21557	-	-	Best Distr.	Best Distr.

Table B.2. The Result Table of the Extreme Analysis for the Mersin-Anamur ECMWF Data Set (1983-2009)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.69827	5.27364	5.82556	6.53995	7.07529	8.31237	8.84421	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	4.60808	5.12874	5.62816	6.27462	6.75904	7.87848	8.35974	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.19506	4.64874	5.23251	6.28636	7.37766	11.43839	14.16899	~	~	~	~
FT 2 (k2=3.33)	4.30988	4.82203	5.43454	6.45184	7.42416	10.62870	12.56128	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	4.42349	4.96579	5.56833	6.48884	7.30023	9.67120	10.95050	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.52503	5.06871	5.62998	6.41916	7.06064	8.72612	9.52897	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.32616	4.93397	5.60681	6.57847	7.36697	9.34868	10.25950	~	~	~	~
Weibull (k2=1.0)	4.49061	5.09476	5.69890	6.49754	7.10168	8.50446	9.10861	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.62113	5.17117	5.67509	6.29263	6.73236	7.68680	8.07535	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.69037	5.16709	5.57597	6.04938	6.37145	7.03624	7.29559	Best Distr.	~	Best Distr.	Best Distr.
LogNormal	4.65491	5.12937	5.55744	6.08210	6.45912	7.29536	7.64482	~	~	Best Distr.	Best Distr.

Adana-Karataş:

Table B.3. The Result Table of the Extreme Analysis for the Adana-Karataş Meteorology Data Set (1983-2009)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.78788	5.53889	6.25929	7.19176	7.89052	9.50524	10.19943	~	~	Best Distr.	Best Distr.
Gumbel2 (new)	4.67682	5.36175	6.01875	6.86916	7.50643	8.97905	9.61216	~	Best Distr.	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.15582	4.79520	5.61793	7.10315	8.64115	14.36405	18.21237	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	4.30962	5.01974	5.86903	7.27959	8.62777	13.07109	15.75074	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	4.45596	5.19489	6.01589	7.27017	8.37576	11.60642	13.34957	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.58072	5.30852	6.05988	7.11632	7.97506	10.20458	11.27932	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.34024	5.19628	6.14391	7.51239	8.62291	11.41395	12.69676	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	4.54766	5.37114	6.19462	7.28320	8.10668	10.01874	10.84222	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.69741	5.42380	6.08930	6.90486	7.48558	8.74607	9.25920	Best Distr.	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.76527	5.37952	5.90638	6.51637	6.93135	7.78794	8.12211	~	~	Best Distr.	~
LogNormal	4.63182	5.22668	5.77510	6.46148	6.96381	8.10338	8.58937	~	~	Best Distr.	Best Distr.

Table B.4. The Result Table of the Extreme Analysis for the Adana-Karataş ECMWF Data Set (1983-2009)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	5.07949	5.76563	6.42379	7.27572	7.91411	9.38935	10.02358	Best Distr.	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	4.97480	5.59798	6.19575	6.96949	7.54931	8.88918	9.46520	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.48814	5.04582	5.76342	7.05885	8.40031	13.39192	16.74849	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	4.62664	5.25236	6.00069	7.24357	8.43150	12.34664	14.70776	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	4.76157	5.41962	6.15076	7.26774	8.25232	11.12935	12.68169	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.88000	5.53513	6.21148	7.16245	7.93545	9.94238	10.90983	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.64930	5.39644	6.22352	7.41792	8.38718	10.82317	11.94279	~	~	~	Best Distr.
Weibull (k2=1.0)	4.84206	5.57406	6.30607	7.27373	8.00573	9.70540	10.43740	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.98988	5.64777	6.25050	6.98915	7.51510	8.65671	9.12145	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	5.06489	5.63001	6.11473	6.67593	7.05773	7.84581	8.15325	~	~	Best Distr.	Best Distr.
LogNormal	5.00538	5.56964	6.08327	6.71824	7.17796	8.20710	8.64077	~	~	Best Distr.	Best Distr.

Adana-Yumurtalık:

Table B.5. The Result Table of the Extreme Analysis for the Adana-Yumurtalık Meteorology Data Set (1983-2009)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.07346	4.81558	5.52744	6.44887	7.13936	8.73496	9.42093	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	3.96232	4.63802	5.28616	6.12511	6.75379	8.20657	8.83114	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.44131	4.05870	4.85311	6.28722	7.77230	13.29827	17.01417	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.59184	4.28046	5.10404	6.47189	7.77925	12.08804	14.68656	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.73693	4.45718	5.25743	6.48000	7.55765	10.70664	12.40572	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.86284	4.57635	5.31297	6.34867	7.19056	9.37632	10.42997	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.61682	4.43916	5.34948	6.66409	7.73089	10.41205	11.64436	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	3.82330	4.62255	5.42181	6.47836	7.27761	9.13342	9.93267	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	3.97889	4.69241	5.34611	6.14721	6.71763	7.95577	8.45980	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.05569	4.66564	5.18881	5.79452	6.20661	7.05720	7.38903	~	~	Best Distr.	Best Distr.
LogNormal	3.95736	4.62313	5.25658	6.07393	6.68828	8.12867	8.76138	Best Distr.	~	Best Distr.	Best Distr.

Table B.6. The Result Table of the Extreme Analysis for the Adana-Yumurtalık ECMWF Data Set (1983-2009)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.89917	4.60490	5.28185	6.15810	6.81472	8.33208	8.98441	~	~	Best Distr.	Best Distr.
Gumbel2 (new)	3.79530	4.43932	5.05708	5.85671	6.45591	7.84059	8.43588	~	Best Distr.	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.30564	3.90726	4.68141	6.07891	7.52608	12.91102	16.53208	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.44896	4.11513	4.91185	6.23509	7.49983	11.66811	14.18190	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.58579	4.27846	5.04806	6.22380	7.26017	10.28855	11.92255	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.70341	4.38628	5.09126	6.08248	6.88821	8.98009	9.98849	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.47267	4.26745	5.14727	6.41782	7.44887	10.04018	11.23119	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	3.66791	4.43548	5.20305	6.21773	6.98530	8.76754	9.53511	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	3.81237	4.49349	5.11750	5.88223	6.42675	7.60866	8.08981	Best Distr.	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	3.88121	4.46057	4.95748	5.53282	5.92423	6.73215	7.04733	~	~	Best Distr.	Best Distr.
LogNormal	3.77296	4.38794	4.97069	5.71964	6.28064	7.59033	8.16343	~	~	Best Distr.	Best Distr.

Antalya-Finike:

Table B.7. The Result Table of the Extreme Analysis for the Antalya- Finike Meteorology Data Set (2000-2011)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	2.18635	2.53757	2.87446	3.31053	3.63731	4.39244	4.71708	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	2.09941	2.39792	2.68425	3.05488	3.33261	3.97442	4.25034	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	1.86126	2.12929	2.47418	3.09678	3.74151	6.14056	7.75378	~	~	~	~
FT 2 (k2=3.33)	1.92572	2.22187	2.57606	3.16433	3.72658	5.57963	6.69716	~	~	~	~
FT 2 (k3=5.0)	1.98989	2.30019	2.64496	3.17168	3.63595	4.99262	5.72464	~	~	~	~
FT 2 (k4=10.0)	2.04882	2.35927	2.67978	3.13042	3.49673	4.44776	4.90621	~	~	~	Best Distr.
Weibull (k1=0.75)	1.92693	2.26504	2.63933	3.17985	3.61847	4.72087	5.22754	~	~	~	~
Weibull (k2=1.0)	2.01681	2.35201	2.68720	3.13031	3.46550	4.24381	4.57900	~	~	~	~
Weibull (k3=1.4)	2.09307	2.40205	2.68512	3.03203	3.27904	3.81521	4.03347	~	~	~	Best Distr.
Weibull (k4=2.0)	2.14036	2.41390	2.64851	2.92015	3.10495	3.48640	3.63521	Best Distr.	~	Best Distr.	Best Distr.
LogNormal	2.18594	2.54068	2.87664	3.30819	3.63128	4.38513	4.71483	~	~	Best Distr.	Best Distr.

Table B.8. The Result Table of the Extreme Analysis for the Antalya- Finike ECMWF Data Set (2000-2011)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.99663	4.47294	4.92983	5.52123	5.96439	6.98849	7.42876	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	3.87882	4.28373	4.67213	5.17487	5.55160	6.42217	6.79644	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.55989	3.93126	4.40913	5.27179	6.16510	9.48913	11.72435	~	~	~	~
FT 2 (k2=3.33)	3.64812	4.05690	4.54579	5.35777	6.13385	8.69162	10.23415	~	~	~	~
FT 2 (k3=5.0)	3.73483	4.16101	4.63452	5.35792	5.99557	7.85884	8.86419	~	~	~	Best Distr.
FT 2 (k4=10.0)	3.81312	4.23700	4.67461	5.28990	5.79004	7.08854	7.71449	~	~	~	Best Distr.
Weibull (k1=0.75)	3.65408	4.12780	4.65221	5.40950	6.02405	7.56857	8.27845	~	~	~	~
Weibull (k2=1.0)	3.77564	4.24034	4.70503	5.31932	5.78401	6.86299	7.32768	~	~	~	Best Distr.
Weibull (k3=1.4)	3.87465	4.29744	4.68479	5.15948	5.49747	6.23113	6.52979	~	~	~	Best Distr.
Weibull (k4=2.0)	3.93227	4.30194	4.61901	4.98612	5.23586	5.75138	5.95249	~	~	Best Distr.	Best Distr.
LogNormal	3.94738	4.33414	4.68193	5.10487	5.41138	6.08451	6.36493	Best Distr.	~	Best Distr.	Best Distr.

Antalya-Gazipaşa:

Table B.9. The Result Table of the Extreme Analysis for the Antalya-Gazipaşa Meteorology Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	H_s										
Gumbel1 (old)	1.73830	1.84547	1.94826	2.08131	2.18102	2.41142	2.51048	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	1.71088	1.80147	1.88836	2.00084	2.08513	2.27990	2.36363	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	1.64145	1.72865	1.84085	2.04341	2.25317	3.03367	3.55851	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	1.66122	1.75577	1.86885	2.05666	2.23617	2.82778	3.18457	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	1.68024	1.77757	1.88570	2.05090	2.19652	2.62202	2.85161	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	1.69708	1.79282	1.89167	2.03066	2.14363	2.43695	2.57834	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	1.66279	1.77269	1.89435	2.07003	2.21260	2.57092	2.73561	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	1.68947	1.79561	1.90175	2.04206	2.14820	2.39465	2.50079	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	1.71048	1.80575	1.89304	2.00000	2.07617	2.24149	2.30879	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	1.72203	1.80442	1.87508	1.95689	2.01255	2.12743	2.17225	Best Distr.	~	Best Distr.	Best Distr.
LogNormal	1.72228	1.79620	1.85962	1.93369	1.98471	2.09213	2.13494	~	~	Best Distr.	Best Distr.

Table B.10. The Result Table of the Extreme Analysis for the Antalya-Gazipaşa ECMWF Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	H_s										
Gumbel1 (old)	3.40295	3.69774	3.98051	4.34652	4.62079	5.25460	5.52708	~	~	~	Best Distr.
Gumbel2 (new)	3.32563	3.57334	3.81095	4.11851	4.34899	4.88158	5.11055	~	~	~	Best Distr.
FT 2 (k1=2.5)	3.12817	3.35222	3.64052	4.16097	4.69992	6.70534	8.05387	~	~	~	~
FT 2 (k2=3.33)	3.18196	3.42921	3.72491	4.21603	4.68543	6.23248	7.16547	~	~	~	~
FT 2 (k3=5.0)	3.23533	3.49397	3.78133	4.22035	4.60733	5.73812	6.34825	~	~	~	Best Distr.
FT 2 (k4=10.0)	3.28409	3.54233	3.80894	4.18381	4.48851	5.27962	5.66098	~	~	~	Best Distr.
Weibull (k1=0.75)	3.18411	3.46829	3.78287	4.23716	4.60581	5.53234	5.95819	~	~	~	~
Weibull (k2=1.0)	3.25893	3.53997	3.82101	4.19253	4.47357	5.12612	5.40716	~	~	~	~
Weibull (k3=1.4)	3.32151	3.57952	3.81591	4.10560	4.31187	4.75959	4.94186	~	~	~	Best Distr.
Weibull (k4=2.0)	3.35931	3.58665	3.78165	4.00742	4.16102	4.47806	4.60175	~	~	~	Best Distr.
LogNormal	3.37354	3.59732	3.79327	4.02661	4.19009	4.54162	4.68443	Best Distr.	Best Distr.	Best Distr.	Best Distr.

Hatay-İskenderun:

Table B.11. The Result Table of the Extreme Analysis for the Hatay-İskenderun Meteorology Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	H_s										
Gumbel1 (old)	3.15425	3.37567	3.58807	3.86299	4.06901	4.54508	4.74975	Best Distr.	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	3.09869	3.28674	3.46712	3.70060	3.87556	4.27987	4.45369	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	2.95618	3.14027	3.37714	3.80475	4.24756	5.89525	7.00322	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	2.99731	3.19604	3.43371	3.82846	4.20575	5.44922	6.19912	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.03651	3.24017	3.46644	3.81212	4.11683	5.00721	5.48763	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.07084	3.27036	3.47634	3.76595	4.00136	4.61255	4.90718	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.00120	3.23313	3.48989	3.86066	4.16155	4.91776	5.26533	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	3.05559	3.27743	3.49927	3.79253	4.01437	4.52947	4.75132	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	3.09746	3.29490	3.47579	3.69747	3.85531	4.19792	4.33739	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	3.11999	3.28980	3.43545	3.60408	3.71880	3.95561	4.04799	~	~	Best Distr.	Best Distr.
LogNormal	3.11924	3.27319	3.40603	3.56201	3.66995	3.89855	3.99015	~	~	Best Distr.	Best Distr.

Table B.12. The Result Table of the Extreme Analysis for the Hatay-İskenderun ECMWF Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.16308	4.95376	5.71221	6.69393	7.42960	9.12961	9.86047	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	3.95998	4.62779	5.26836	6.09752	6.71886	8.15468	8.77196	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.42915	4.03598	4.81682	6.22642	7.68611	13.11765	16.77004	~	~	~	~
FT 2 (k2=3.33)	3.57305	4.24012	5.03792	6.36297	7.62942	11.80337	14.32058	~	~	~	~
FT 2 (k3=5.0)	3.71584	4.41229	5.18610	6.36827	7.41030	10.45524	12.09817	~	~	~	~
FT 2 (k4=10.0)	3.84699	4.54225	5.26002	6.26923	7.08958	9.21942	10.24612	~	~	~	~
Weibull (k1=0.75)	3.57288	4.32986	5.16783	6.37794	7.35996	9.82801	10.96237	~	~	~	~
Weibull (k2=1.0)	3.77073	4.51770	5.26468	6.25212	6.99910	8.73352	9.48049	~	~	~	~
Weibull (k3=1.4)	3.93993	4.62810	5.25858	6.03122	6.58138	7.77553	8.26166	~	~	~	~
Weibull (k4=2.0)	4.04724	4.65784	5.18156	5.78793	6.20045	7.05195	7.38413	Best Distr.	~	Best Distr.	Best Distr.
LogNormal	4.22276	5.18647	6.14607	7.44004	8.45073	10.93640	12.07565	~	~	Best Distr.	~

Mersin-Yenişehir:

Table B.13. The Result Table of the Extreme Analysis for the Mersin-Yenişehir Meteorology Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.08972	4.57918	5.04868	5.65640	6.11180	7.16416	7.61659	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	3.96450	4.37828	4.77519	5.28894	5.67393	6.56358	6.94606	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.64346	4.03439	4.53743	5.44553	6.38590	9.88502	12.23798	~	~	~	Best Distr.
FT 2 (k2=3.33)	3.73368	4.15986	4.66956	5.51609	6.32520	8.99183	10.60001	~	~	~	Best Distr.
FT 2 (k3=5.0)	3.82127	4.26205	4.75178	5.49996	6.15945	8.08654	9.12633	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.89952	4.33505	4.78469	5.41689	5.93077	7.26497	7.90813	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.74012	4.23442	4.78161	5.57180	6.21305	7.82467	8.56539	~	~	~	~
Weibull (k2=1.0)	3.86206	4.34163	4.82120	5.45517	5.93474	7.04827	7.52785	~	~	~	Best Distr.
Weibull (k3=1.4)	3.95961	4.39226	4.78863	5.27438	5.62026	6.37101	6.67663	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.01528	4.39148	4.71415	5.08774	5.34190	5.86653	6.07119	~	~	Best Distr.	Best Distr.
LogNormal	4.02408	4.41138	4.75917	5.18350	5.48721	6.15756	6.43645	Best Distr.	~	Best Distr.	Best Distr.

Table B.14. The Result Table of the Extreme Analysis for the Mersin-Yenişehir ECMWF Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.34167	3.71461	4.07234	4.53538	4.88237	5.68420	6.02892	Best Distr.	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	3.24888	3.56621	3.87061	4.26462	4.55987	5.24215	5.53548	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.01241	3.33069	3.74023	4.47955	5.24515	8.09393	10.00958	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.08180	3.42293	3.83091	4.50852	5.15616	7.29063	8.57789	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.14718	3.49457	3.88053	4.47018	4.98994	6.50872	7.32820	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.20373	3.54215	3.89153	4.38277	4.78208	5.81880	6.31856	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.08891	3.48776	3.92928	4.56689	5.08430	6.38471	6.98240	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	3.17998	3.55867	3.93737	4.43797	4.81667	5.69597	6.07466	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	3.24853	3.58314	3.88970	4.26539	4.53290	5.11354	5.34991	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	3.28380	3.56969	3.81490	4.09881	4.29195	4.69063	4.84617	~	~	Best Distr.	Best Distr.
LogNormal	3.26743	3.53954	3.78125	4.07309	4.28006	4.73178	4.91780	~	~	Best Distr.	Best Distr.

APPENDIX – C

DIRECTIONAL ANALYSIS:

Adana-Karataş:

Table C.1. Directional Result of the Extreme Analysis (SSW) According to the Adana-Karataş Meteorology Data

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.58800	5.32828	6.03837	6.95752	7.64629	9.23793	9.92219	~	~	Best Distr.	~
Gumbel2 (new)	4.45763	5.12203	5.75935	6.58428	7.20245	8.63096	9.24509	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.98343	4.67277	5.55977	7.16102	8.81917	14.98918	19.13815	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	4.13128	4.86922	5.75178	7.21758	8.61857	13.23593	16.02054	~	Best Distr.	Best Distr.	Best Distr.
FT 2 (k3=5.0)	4.26580	5.01180	5.84066	7.10693	8.22311	11.48468	13.24450	Best Distr.	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.37609	5.09458	5.83634	6.87927	7.72702	9.92803	10.98903	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.15600	5.03387	6.00567	7.40905	8.54790	11.41012	12.72565	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	4.34406	5.16163	5.97920	7.05996	7.87753	9.77587	10.59344	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.47165	5.17599	5.82128	6.61208	7.17516	8.39737	8.89493	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.52392	5.11099	5.61452	6.19751	6.59413	7.41281	7.73219	~	~	Best Distr.	~
LogNormal	4.36281	4.90578	5.40477	6.02733	6.48173	7.50911	7.94594	~	~	~	~

Table C.2. Directional Result (SSW) of the Extreme Analysis According to the Adana-Karataş ECMWF Data

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.41033	4.90128	5.37222	5.98179	6.43858	7.49416	7.94796	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	4.28043	4.69319	5.08911	5.60159	5.98562	6.87307	7.25459	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.96601	4.36952	4.88874	5.82605	6.79667	10.40836	12.83702	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	4.05580	4.49053	5.01046	5.87398	6.69933	9.41947	11.05993	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	4.14180	4.58722	5.08211	5.83817	6.50461	8.45201	9.50275	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.21783	4.65475	5.10582	5.74003	6.25555	7.59399	8.23919	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.06141	4.56412	5.12061	5.92425	6.57641	8.21545	8.96878	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	4.18008	4.66208	5.14407	5.78124	6.26324	7.38241	7.86441	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.27387	4.70534	5.10065	5.58509	5.93003	6.67876	6.98356	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.32694	4.70059	5.02108	5.39214	5.64458	6.16566	6.36894	Best Distr.	~	Best Distr.	Best Distr.
LogNormal	4.33522	4.71064	5.04505	5.44992	5.73772	6.36768	6.62779	~	~	Best Distr.	Best Distr.

Adana-Yumurtalık:

Table C.3. Directional Result of the Extreme Analysis (SSW) According to the Adana-Yumurtalık Meteorology Data

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.28854	4.98388	5.65086	6.51420	7.16116	8.65617	9.29889	~	~	Best Distr.	Best Distr.
Gumbel2 (new)	4.15167	4.76604	5.35536	6.11817	6.68979	8.01072	8.57860	~	Best Distr.	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.69703	4.30692	5.09170	6.50841	7.97546	13.43438	17.10519	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.83222	4.49095	5.27877	6.58725	7.83786	11.95960	14.44532	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.95893	4.63207	5.37997	6.52257	7.52972	10.47271	12.06065	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.06707	4.72316	5.40049	6.35284	7.12697	9.13681	10.10566	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.84895	4.62387	5.48170	6.72049	7.72577	10.25232	11.41356	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	4.02691	4.76243	5.49796	6.47028	7.20581	8.91366	9.64919	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.15782	4.80505	5.39802	6.12469	6.64212	7.76523	8.22243	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.22181	4.77173	5.24341	5.78951	6.16104	6.92791	7.22709	~	~	Best Distr.	Best Distr.
LogNormal	4.15117	4.71899	5.24601	5.90989	6.39853	7.51481	7.99389	Best Distr.	~	Best Distr.	Best Distr.

Table C.4. Directional Result (SSW) of the Extreme Analysis According to the Adana-Yumurtalık ECMWF Data

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.96596	4.66172	5.32910	6.19297	6.84031	8.33623	8.97934	~	~	Best Distr.	Best Distr.
Gumbel2 (new)	3.84046	4.46255	5.05927	5.83167	6.41047	7.74799	8.32301	~	Best Distr.	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.38441	4.00692	4.80793	6.25393	7.75132	13.32313	17.06986	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.52075	4.19121	4.99307	6.32485	7.59774	11.79291	14.32291	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.64797	4.33155	5.09106	6.25139	7.27417	10.26285	11.87543	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.75613	4.42126	5.10793	6.07340	6.85819	8.89573	9.87794	Best Distr.	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.53539	4.32016	5.18889	6.44344	7.46151	10.02019	11.19620	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	3.71515	4.45919	5.20323	6.18679	6.93083	8.65843	9.40247	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	3.84740	4.50175	5.10125	5.83592	6.35904	7.49452	7.95676	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	3.91196	4.46777	4.94449	5.49644	5.87194	6.64702	6.94940	~	~	Best Distr.	Best Distr.
LogNormal	3.83486	4.43056	4.99166	5.70860	6.24291	7.48245	8.02182	~	~	~	Best Distr.

APPENDIX – D

FREQUENCY CHARTS:

Antalya-Gazipaşa:

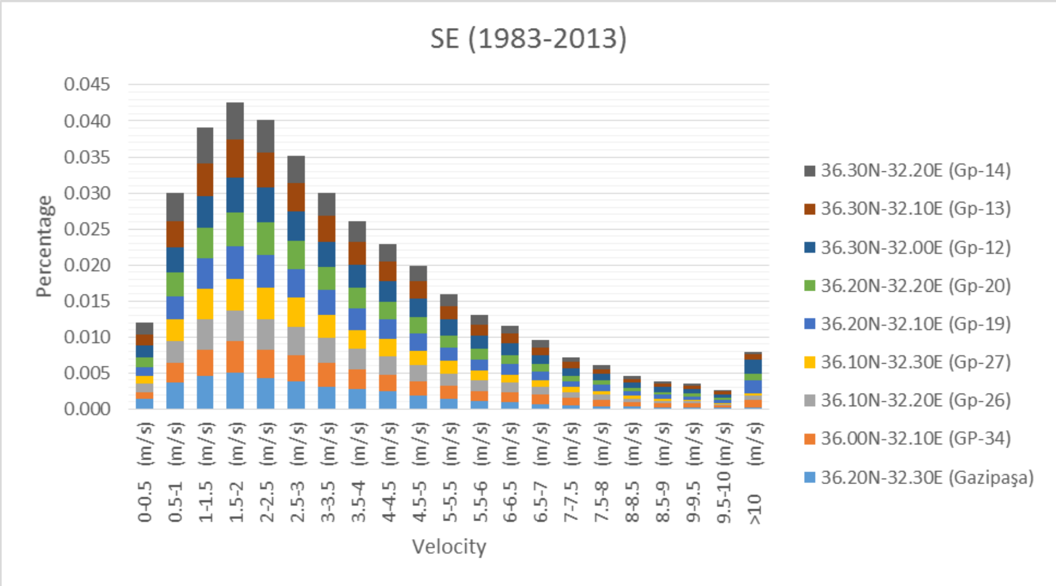

Figure D.1. The Frequency Chart of SE Direction for the Antalya-Gazipaşa ECMWF Data Sets

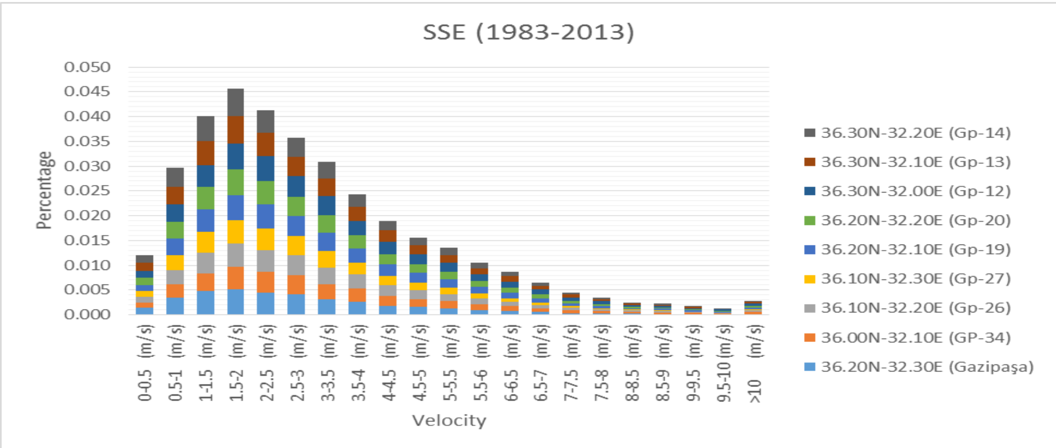

Figure D.2. The Frequency Chart of SSE Direction for the Antalya-Gazipaşa ECMWF Data Sets

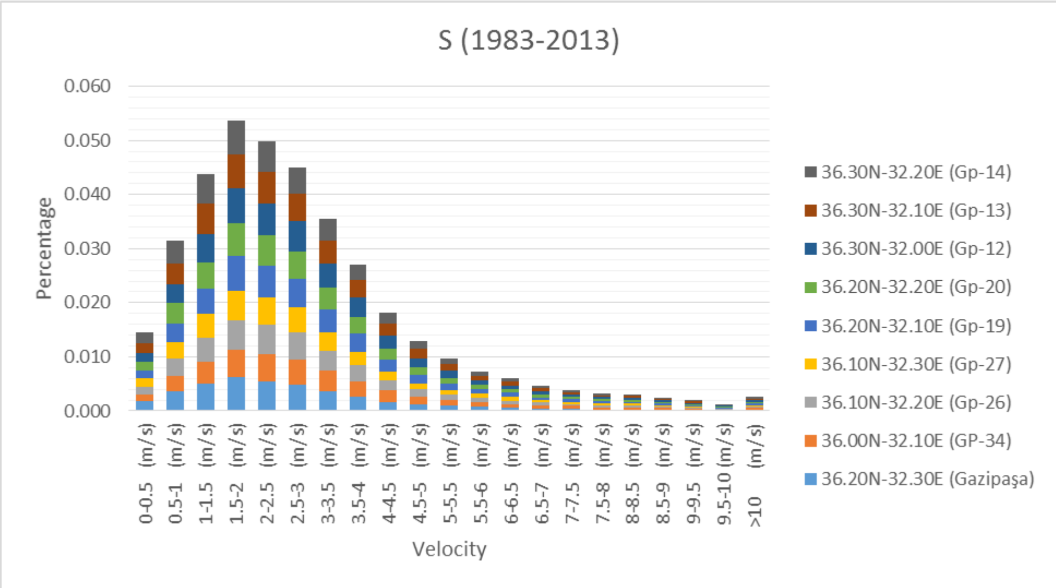

Figure D.3. The Frequency Chart of S Direction for the Antalya-Gazipaşa ECMWF Data Sets

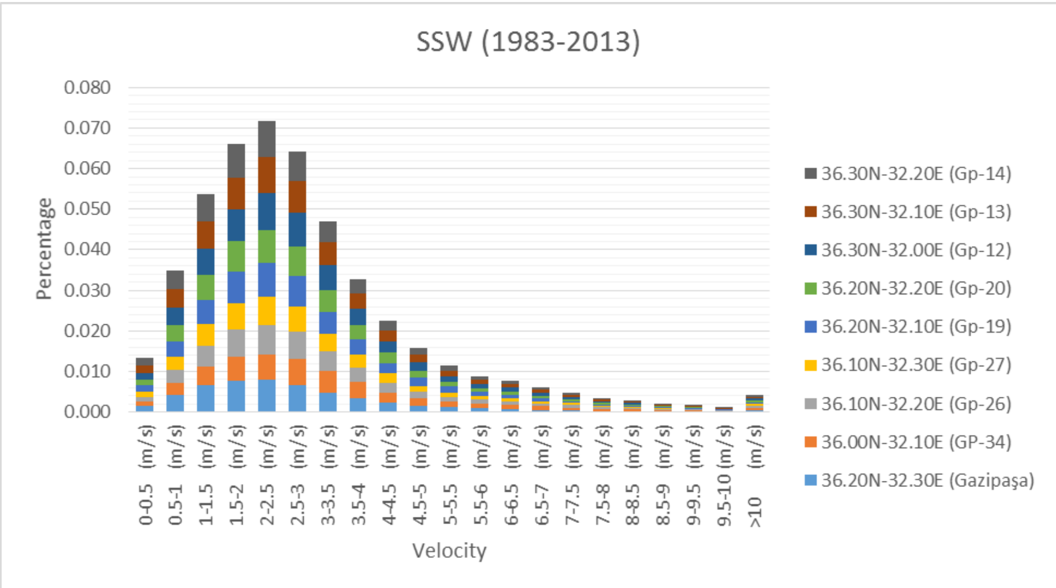

Figure D.4. The Frequency Chart of SSW Direction for the Antalya-Gazipaşa ECMWF Data Sets

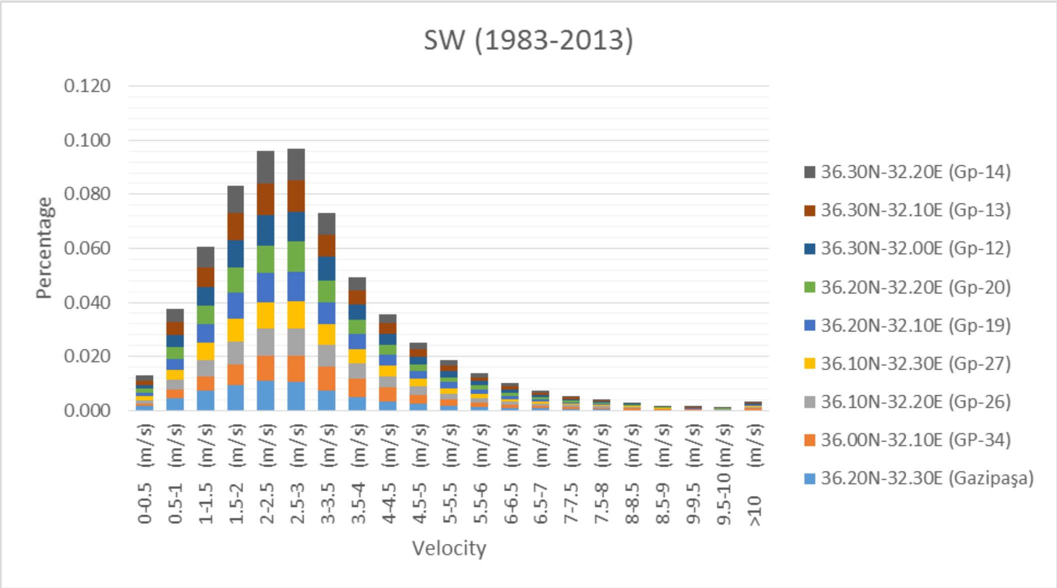

Figure D.5. The Frequency Chart of SW Direction for the Antalya-Gazipaşa ECMWF Data Sets

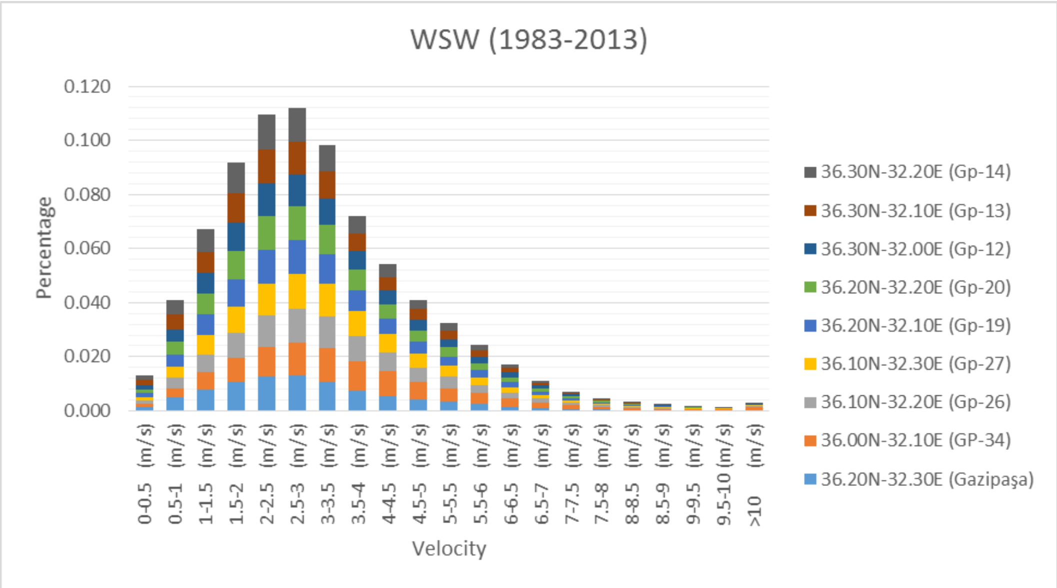

Figure D.6. The Frequency Chart of WSW Direction for the Antalya-Gazipaşa ECMWF Data Sets

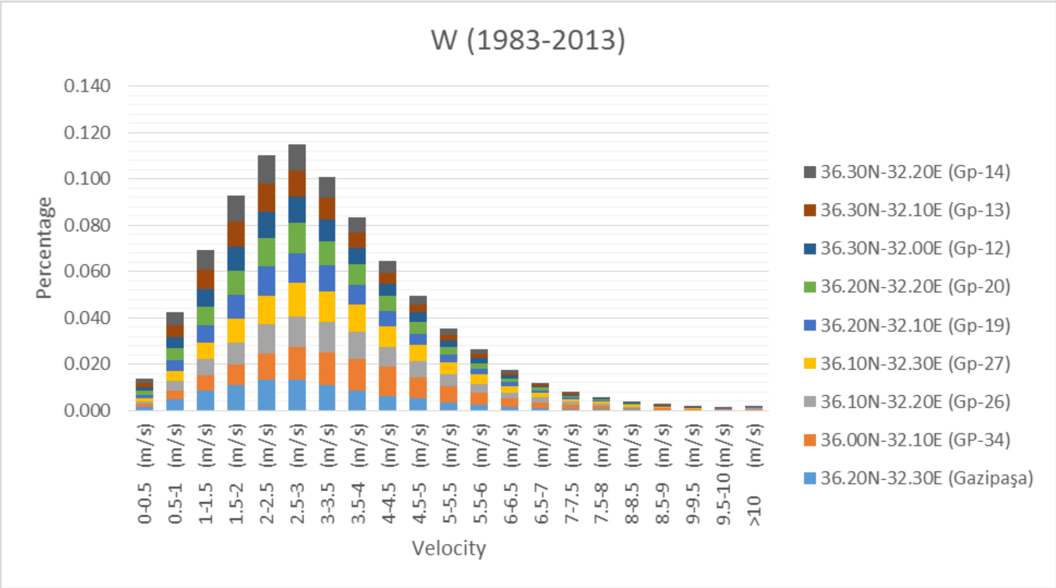

Figure D.7. The Frequency Chart of W Direction for the Antalya-Gazipaşa ECMWF Data Sets

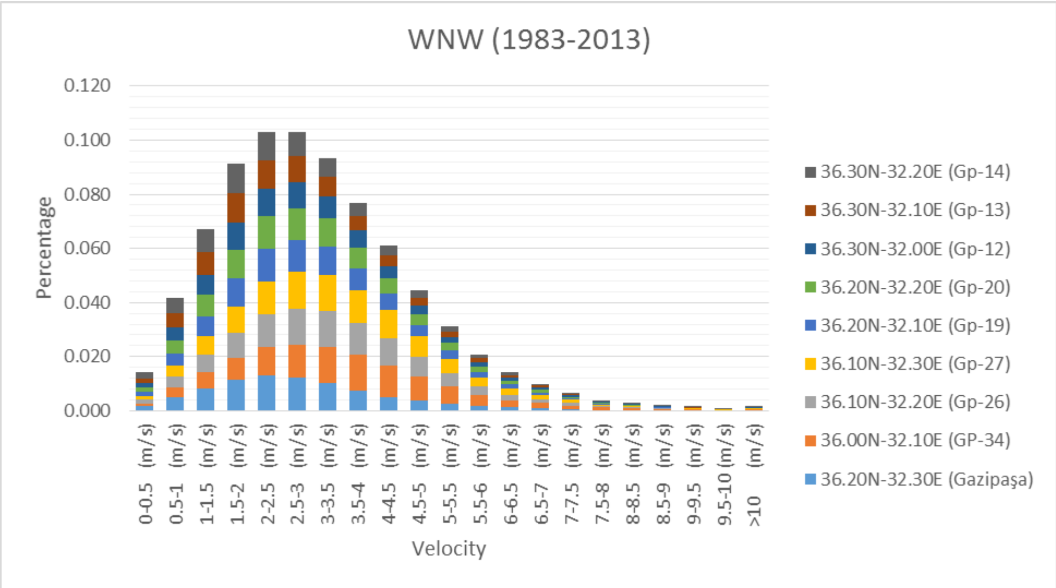

Figure D.8. The Frequency Chart of WNW Direction for the Antalya-Gazipaşa ECMWF Data Sets

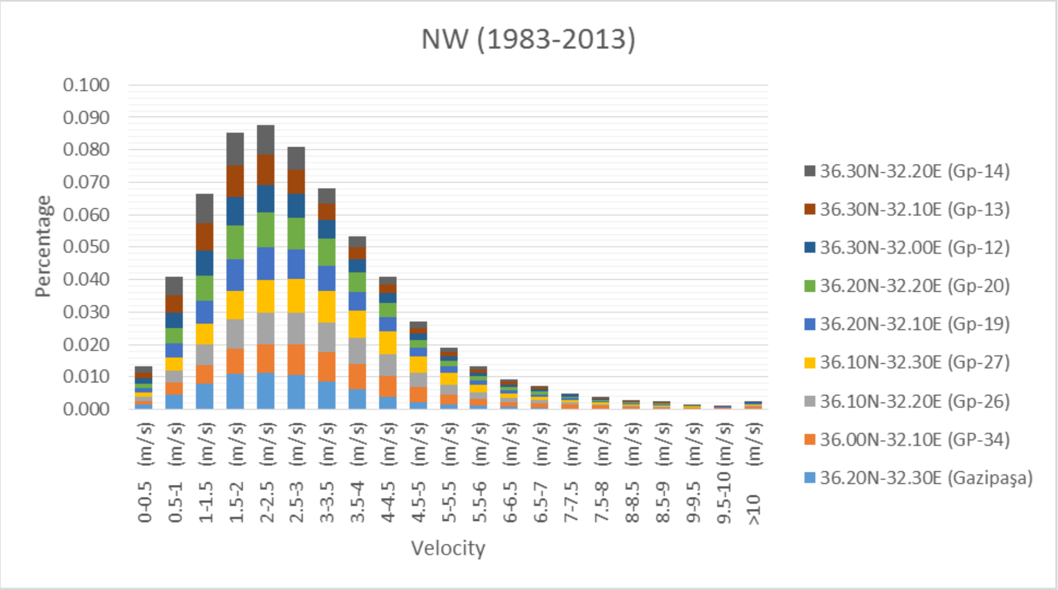

Figure D.9. The Frequency Chart of NW Direction for the Antalya-Gazipaşa ECMWF Data Sets

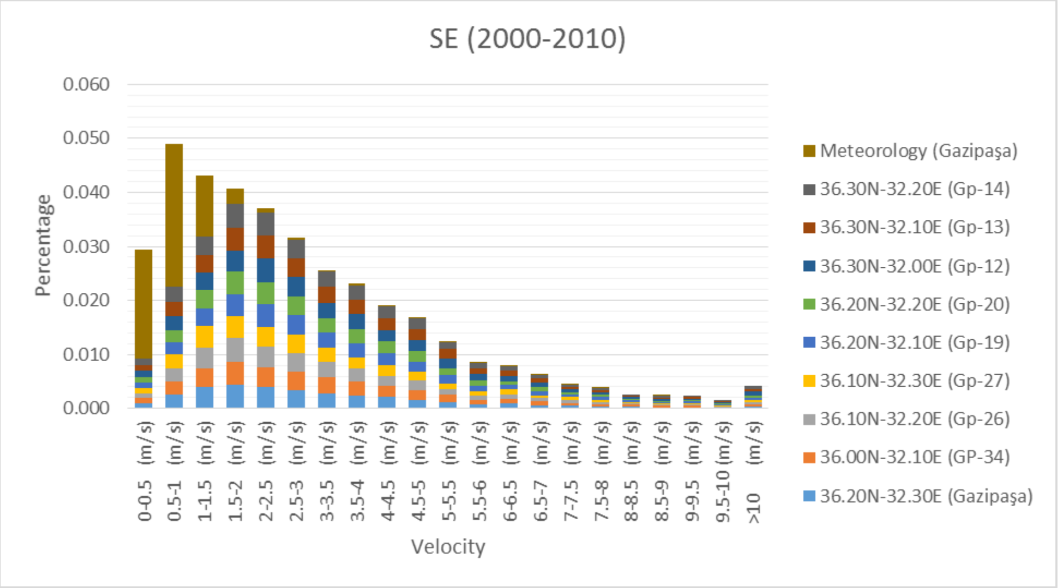

Figure D.10. The Frequency Chart of SE Direction for the Antalya-Gazipaşa Meteorology and ECMWF Data Sets

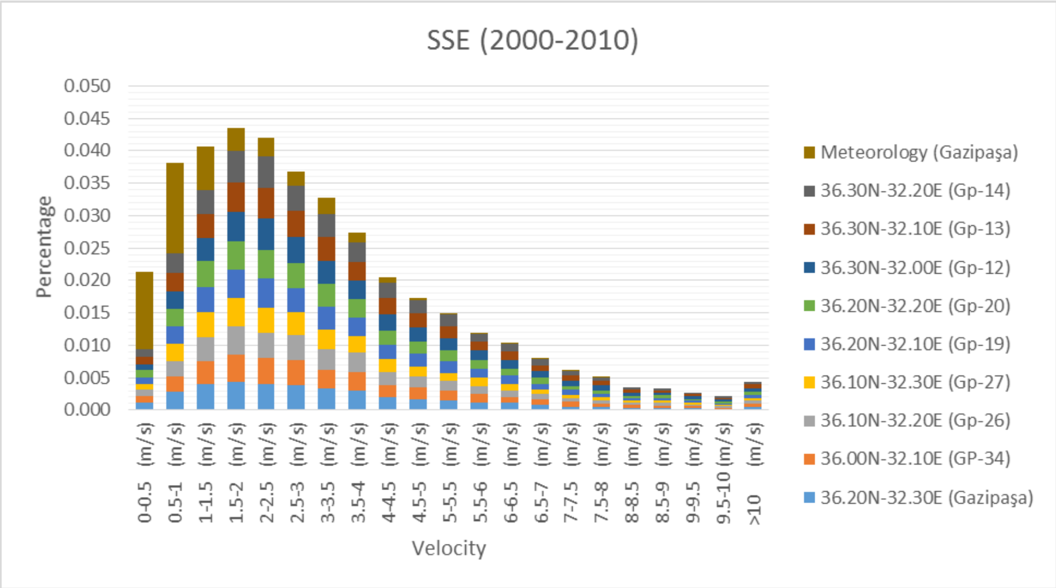

Figure D.11. The Frequency Chart of SSE Direction for the Antalya-Gazipaşa Meteorology and ECMWF Data Sets

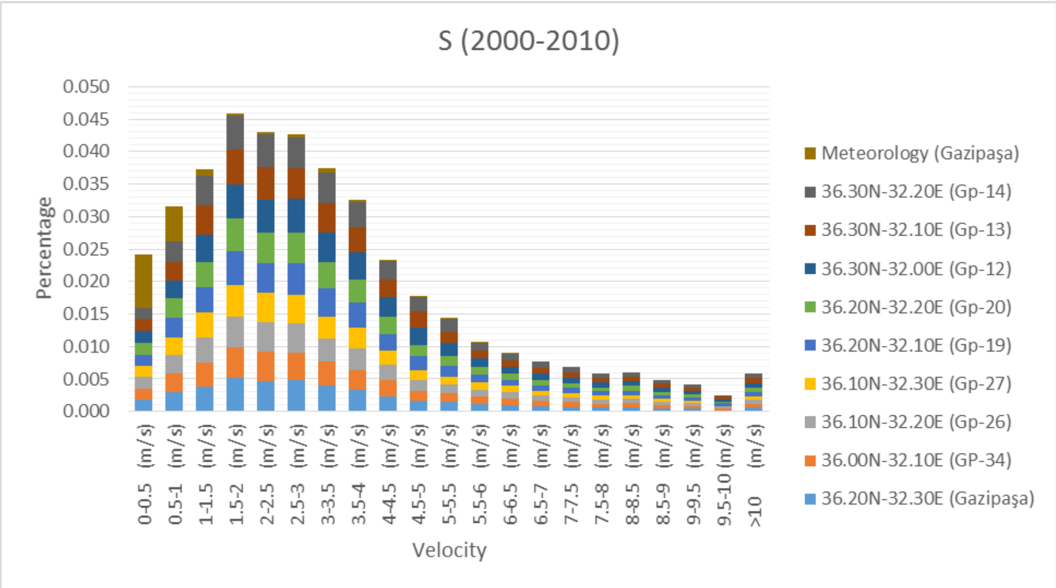

Figure D.12. The Frequency Chart of S Direction for the Antalya-Gazipaşa Meteorology and ECMWF Data Sets

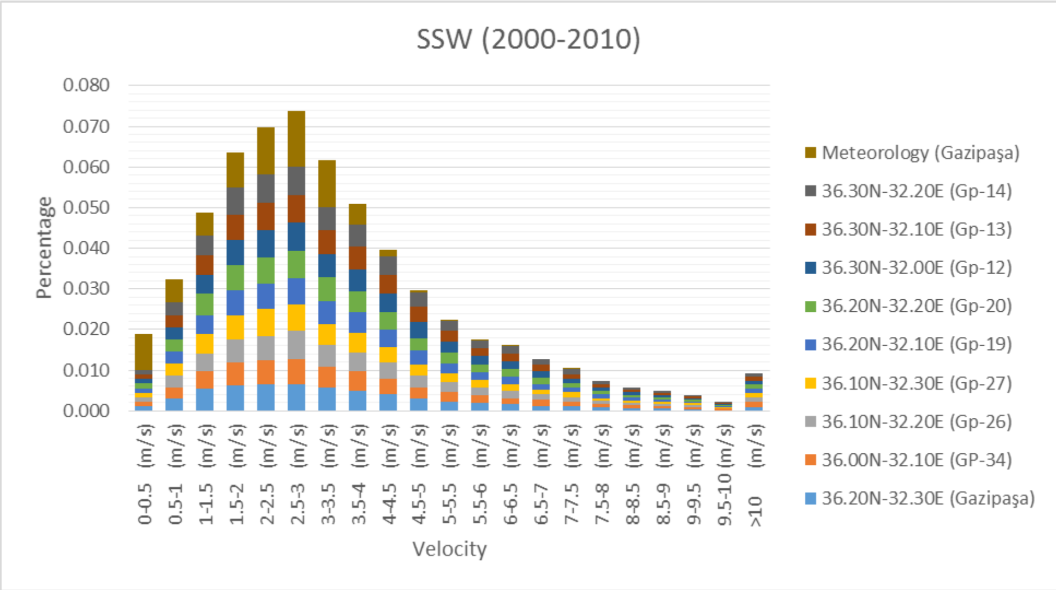

Figure D.13. The Frequency Chart of SSW Direction for the Antalya-Gazipaşa Meteorology and ECMWF Data Sets

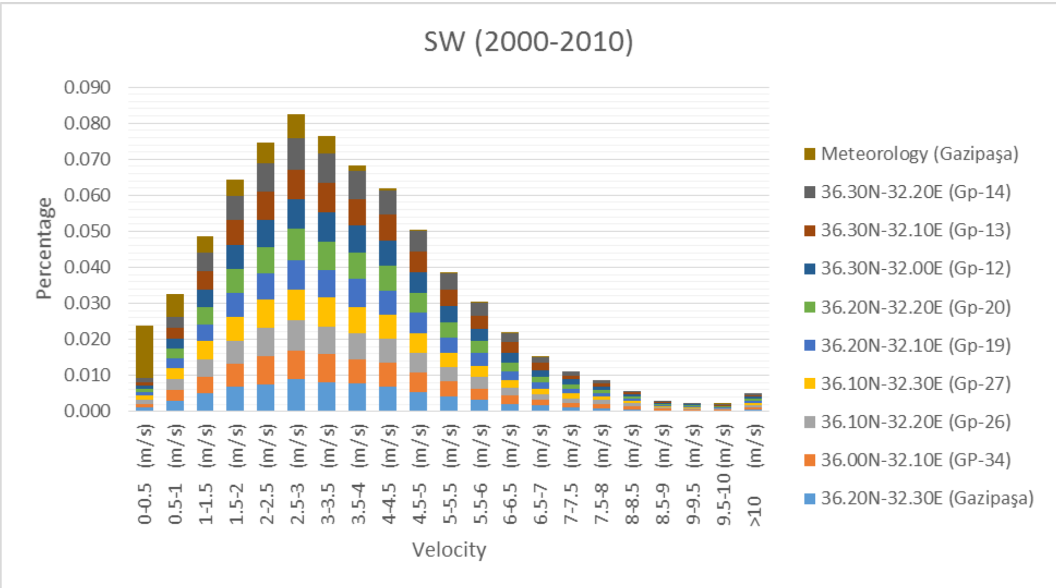

Figure D.14. The Frequency Chart of SW Direction for the Antalya-Gazipaşa Meteorology and ECMWF Data Sets

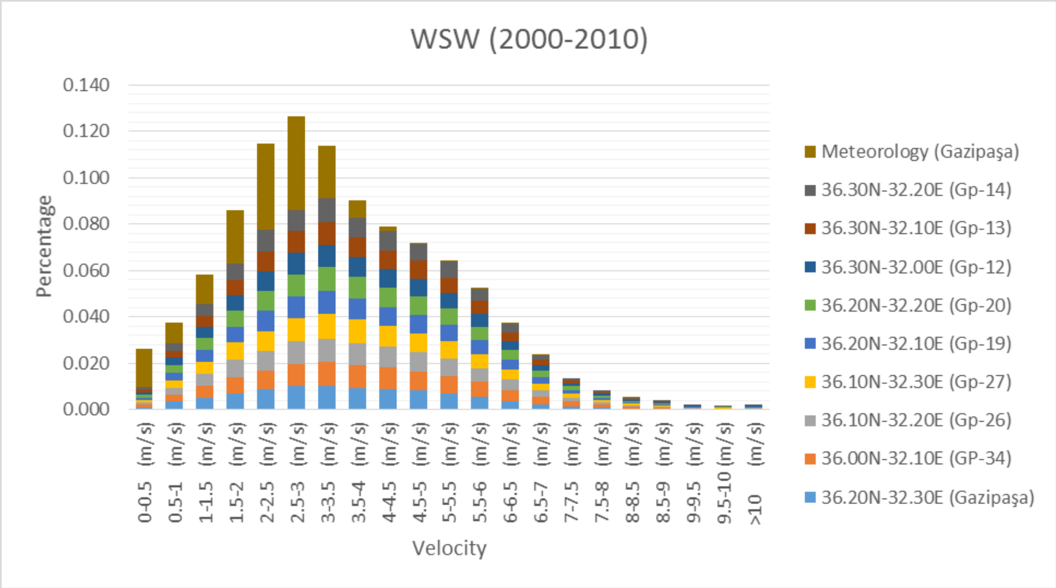

Figure D.15. The Frequency Chart of WSW Direction for the Antalya-Gazipaşa Meteorology and ECMWF Data Sets

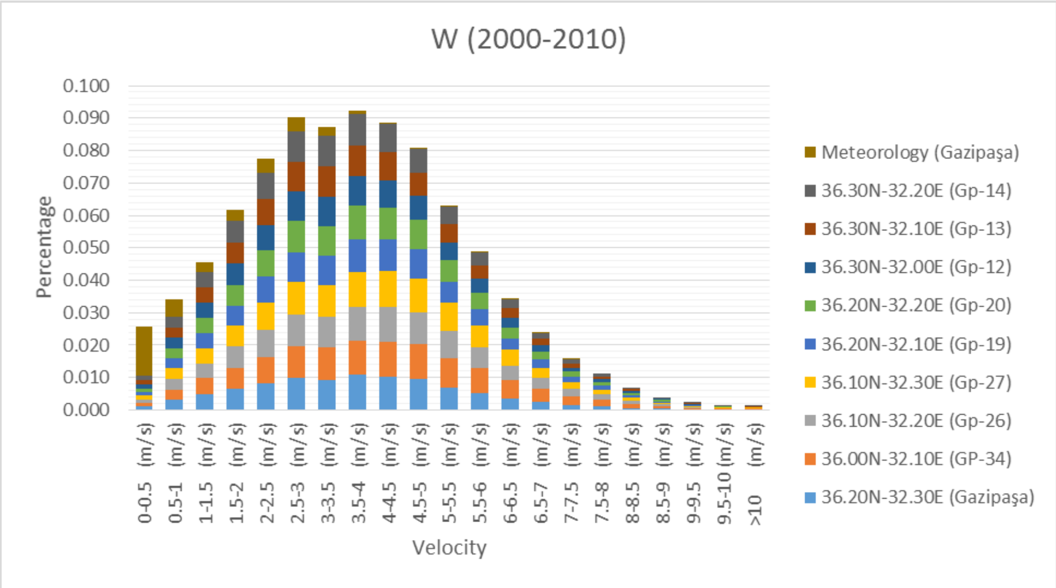

Figure D.16. The Frequency Chart of W Direction for the Antalya-Gazipaşa Meteorology and ECMWF Data Sets

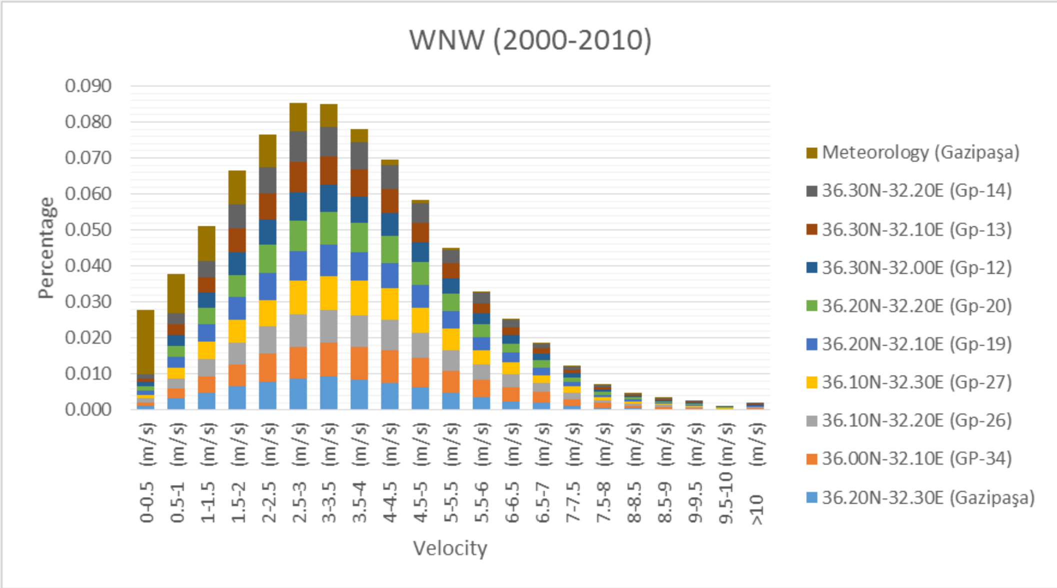

Figure D.17. The Frequency Chart of WNW Direction for the Antalya-Gazipaşa Meteorology and ECMWF Data Sets

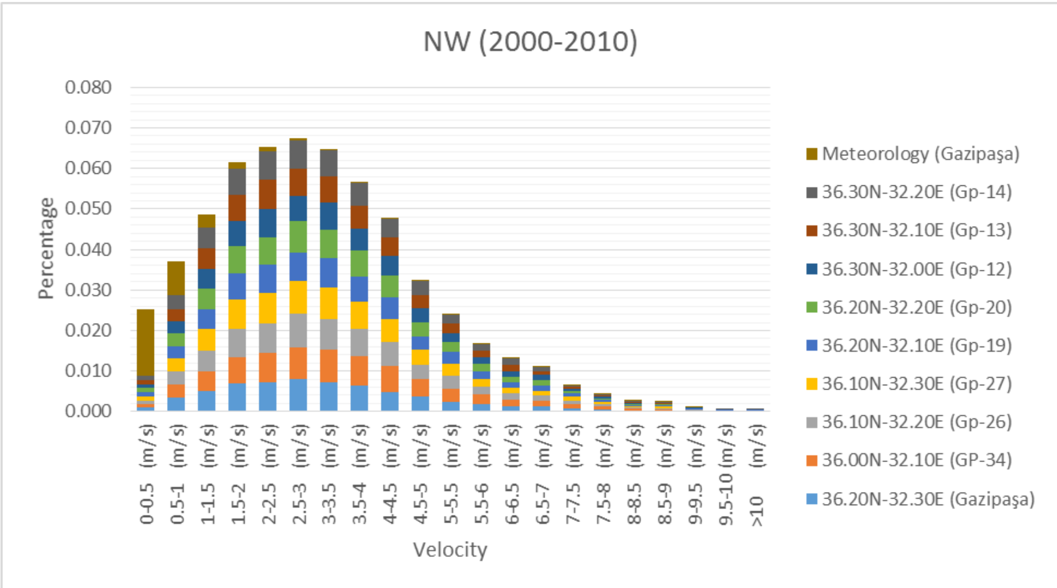

Figure D.18. The Frequency Chart of NW Direction for the Antalya-Gazipaşa Meteorology and ECMWF Data Sets

Mersin-Yenişehir:

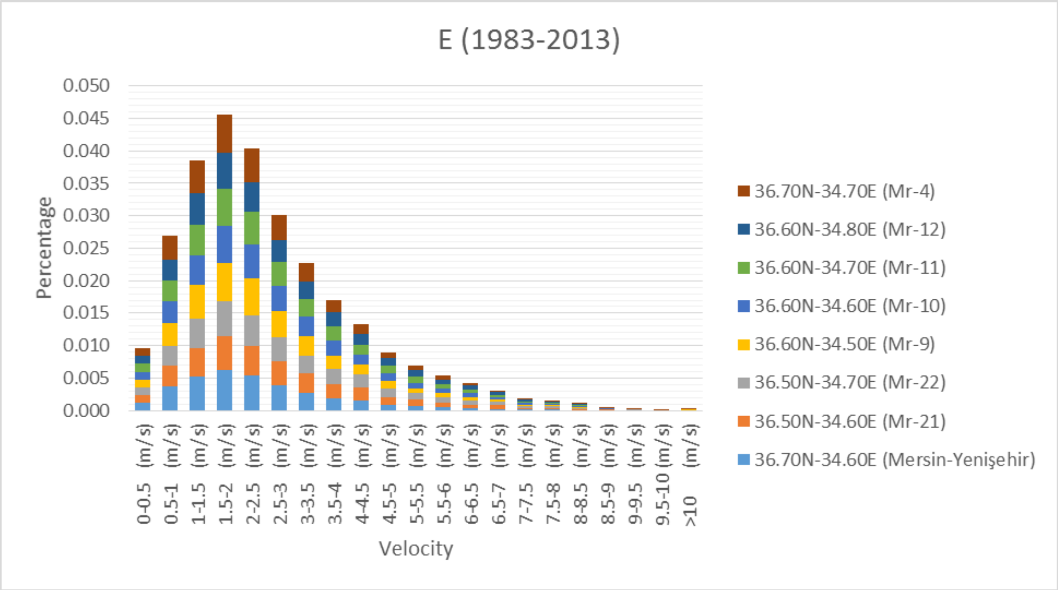

Figure D.19. The Frequency Chart of E Direction for the Mersin-Yenişehir ECMWF Data Sets

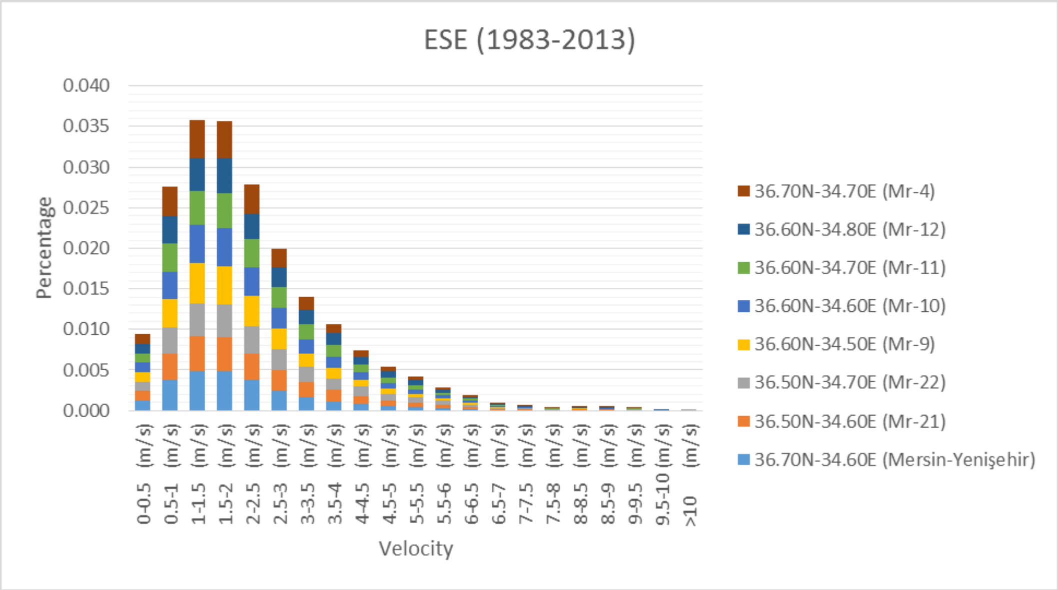

Figure D.20. The Frequency Chart of ESE Direction for the Mersin-Yenişehir ECMWF Data Sets

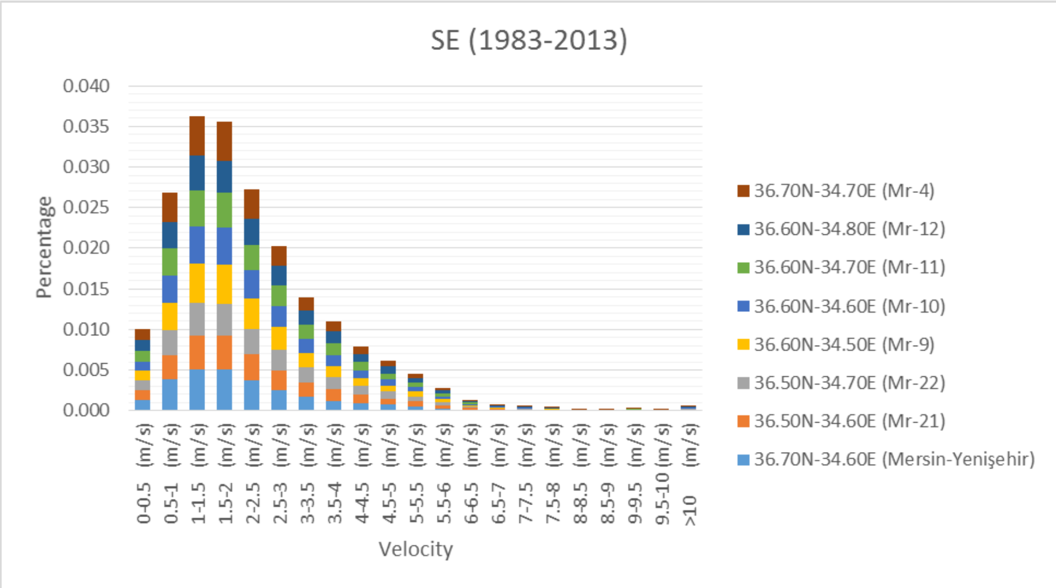

Figure D.21. The Frequency Chart of SE Direction for the Mersin-Yenişehir ECMWF Data Sets

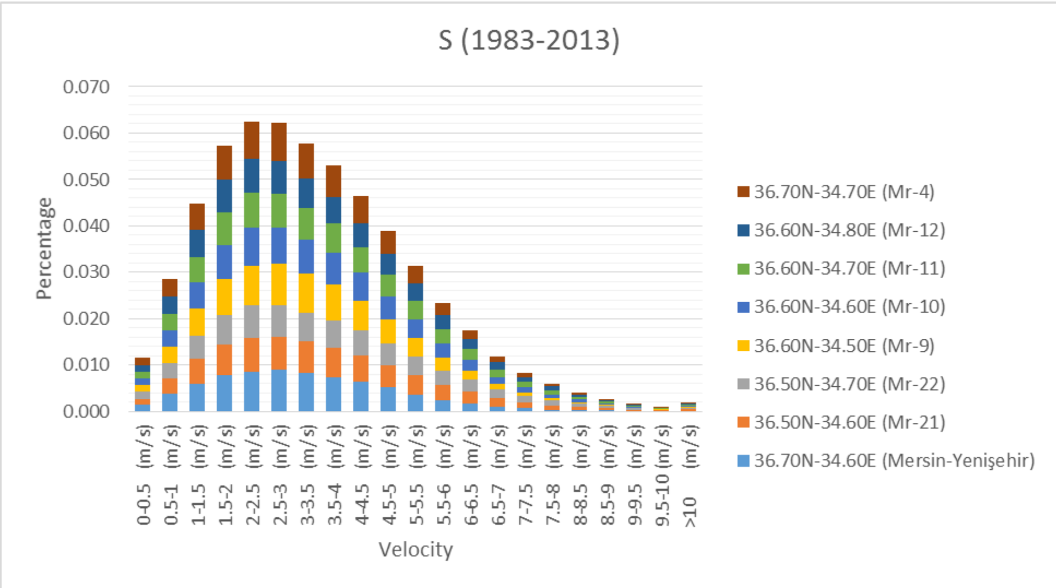

Figure D.22. The Frequency Chart of S Direction for the Mersin-Yenişehir ECMWF Data Sets

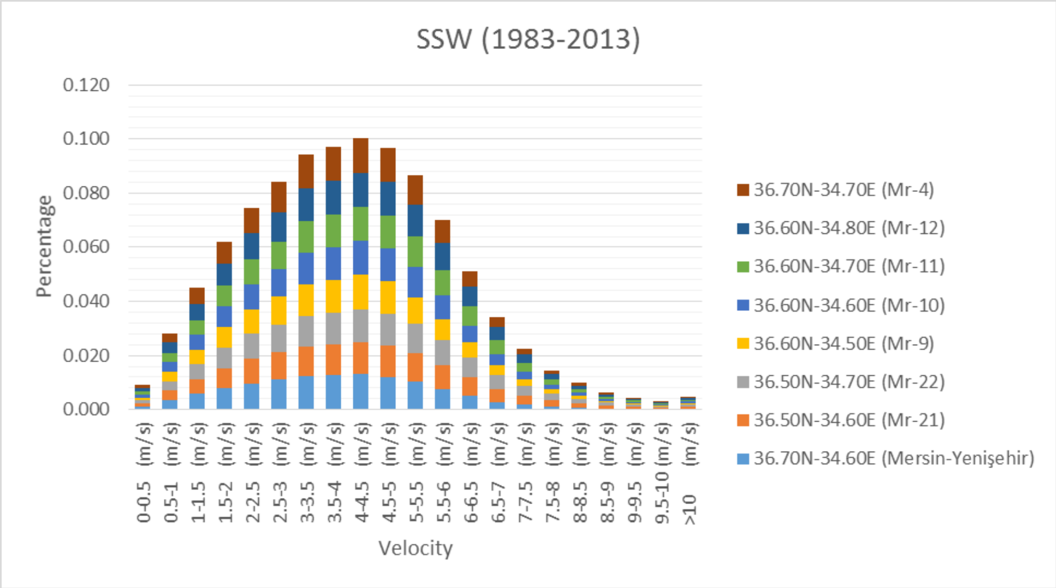

Figure D.23. The Frequency Chart of SSW Direction for the Mersin-Yenişehir ECMWF Data Sets

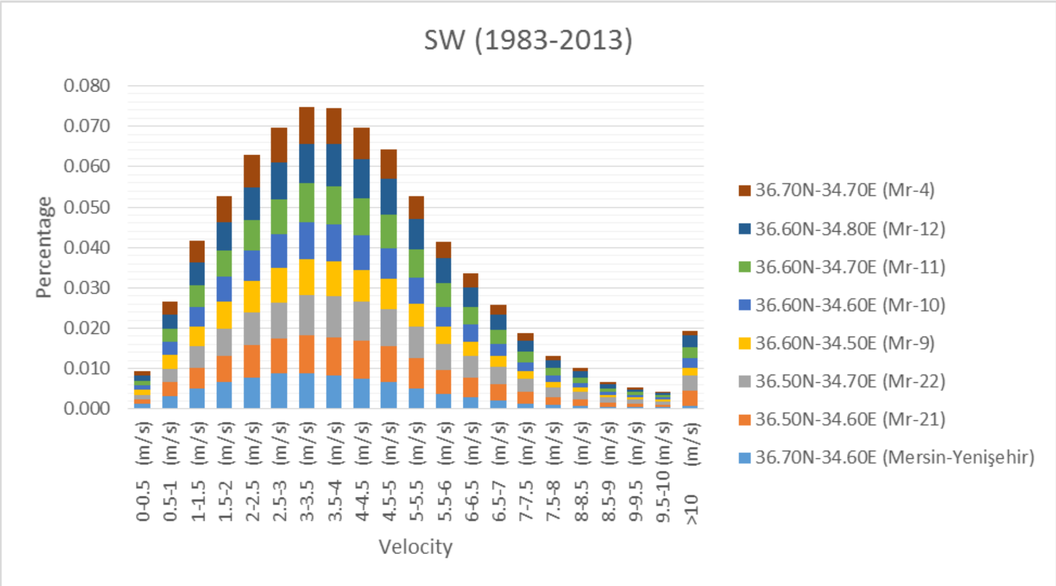

Figure D.24. The Frequency Chart of SW Direction for the Mersin-Yenişehir ECMWF Data Sets

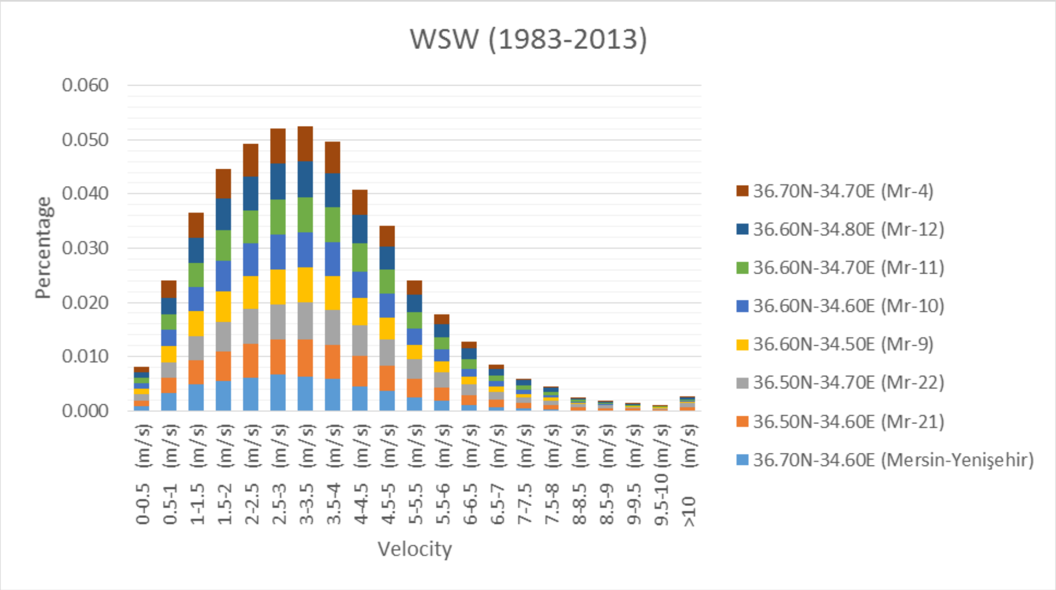

Figure D.25. The Frequency Chart of WSW Direction for the Mersin-Yenişehir ECMWF Data Sets

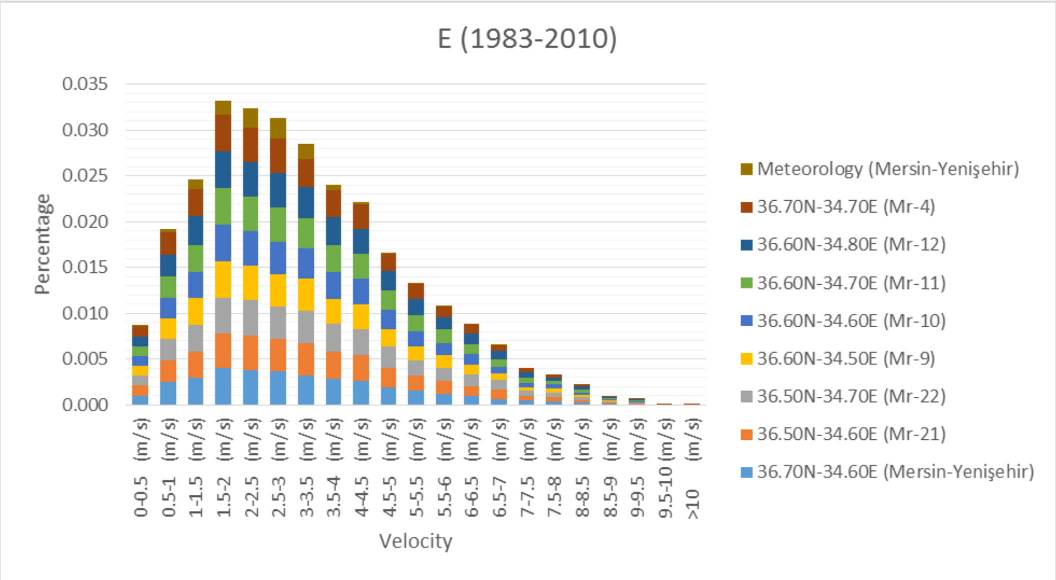

Figure D.26. The Frequency Chart of E Direction for the Mersin-Yenişehir Meteorology and ECMWF Data Sets

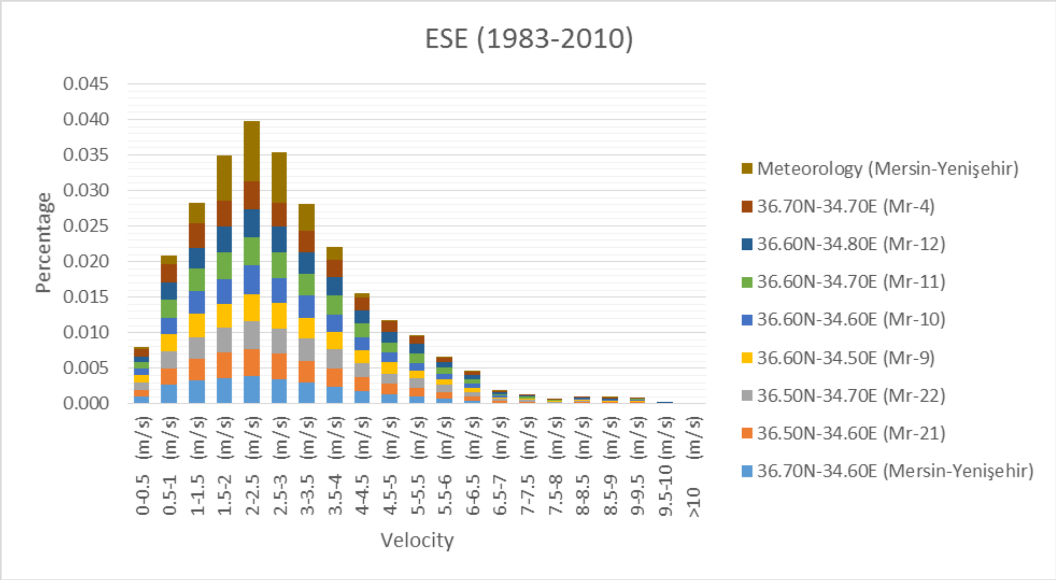

Figure D.27. The Frequency Chart of ESE Direction for the Mersin-Yenişehir Meteorology and ECMWF Data Sets

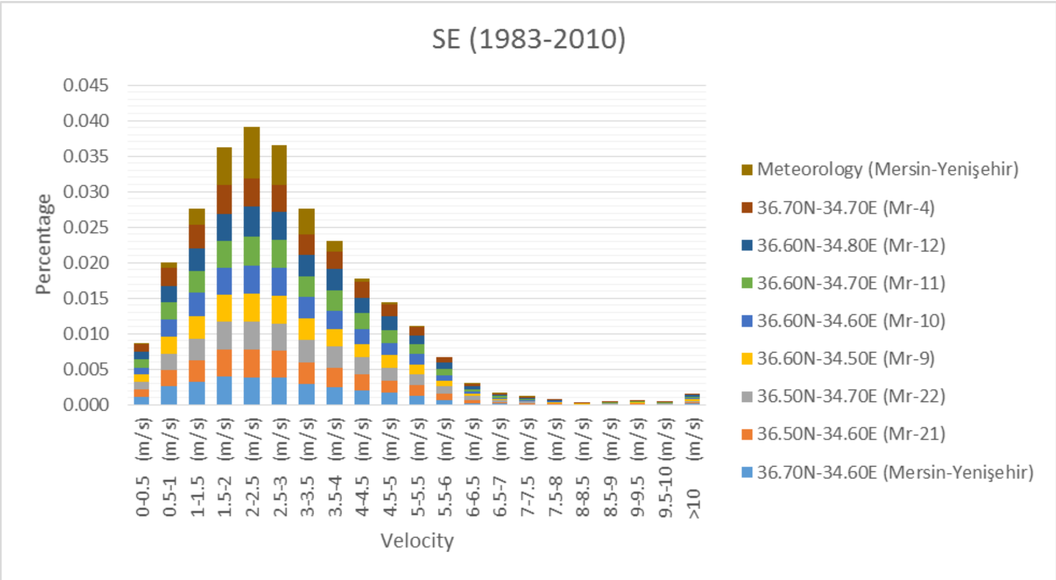

Figure D.28. The Frequency Chart of SE Direction for the Mersin-Yenişehir Meteorology and ECMWF Data Sets

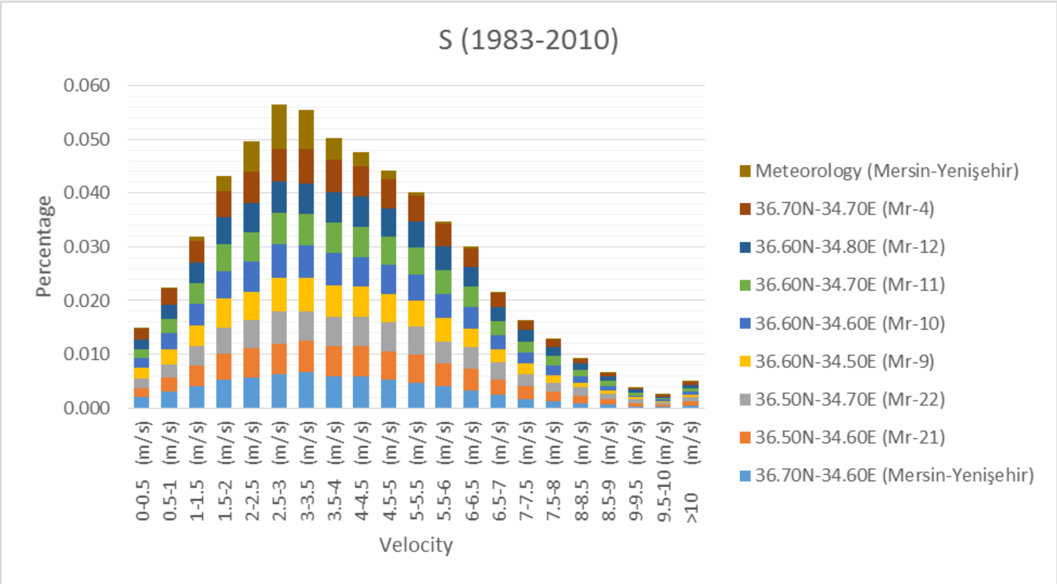

Figure D.29. The Frequency Chart of S Direction for the Mersin-Yenişehir Meteorology and ECMWF Data Sets

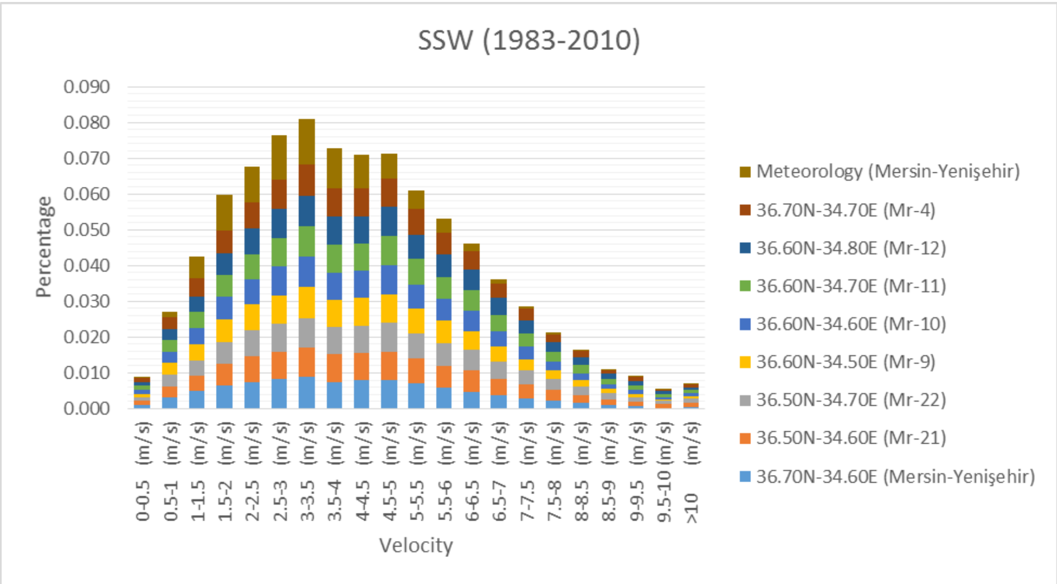

Figure D.30. The Frequency Chart of SSW Direction for the Mersin-Yenişehir Meteorology and ECMWF Data Sets

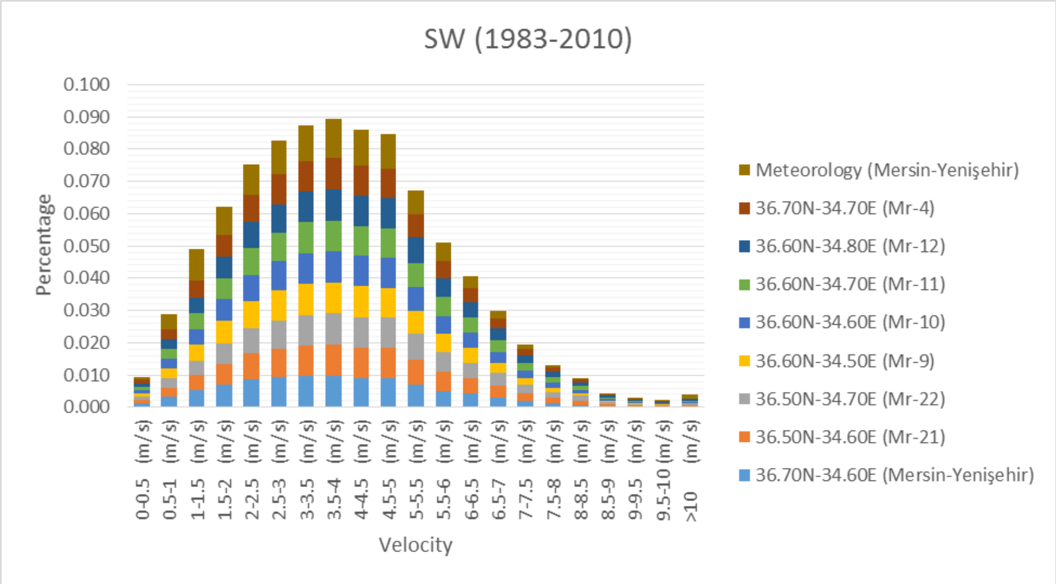

Figure D.31. The Frequency Chart of SW Direction for the Mersin-Yenişehir Meteorology and ECMWF Data Sets

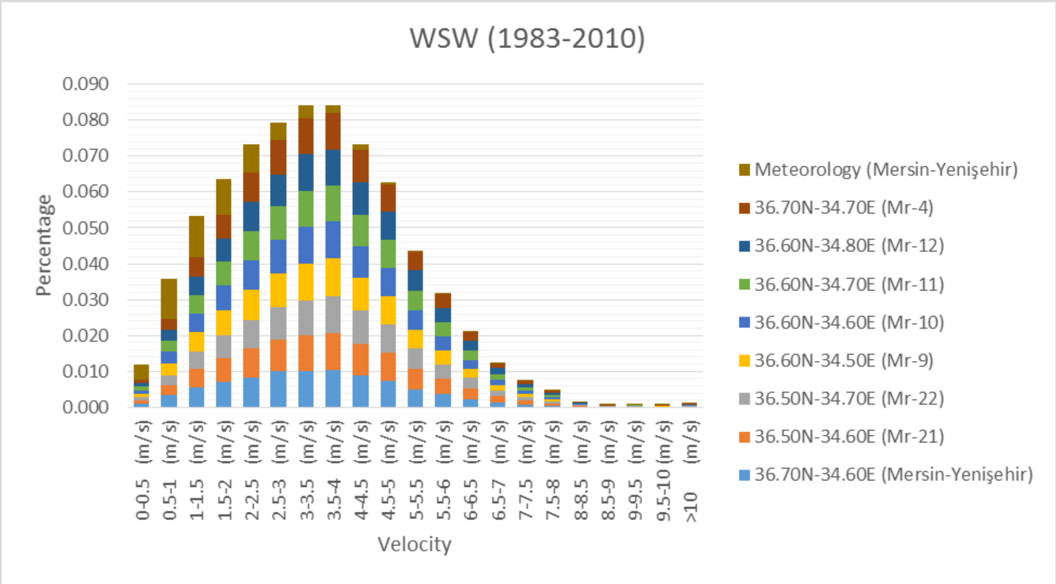

Figure D.32. The Frequency Chart of WSW Direction for the Mersin-Yenişehir Meteorology and ECMWF Data Sets

Adana-Karataş:

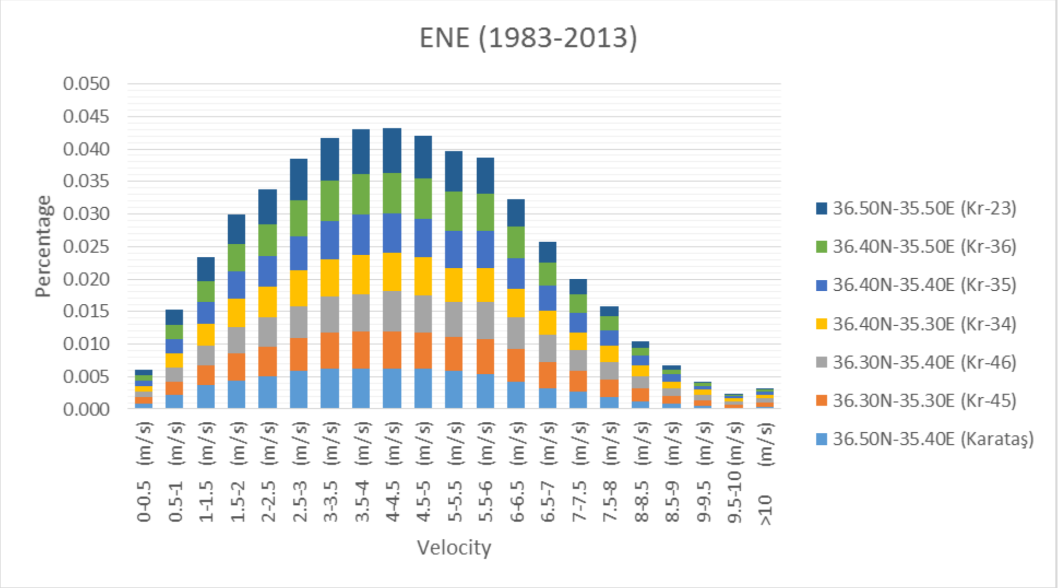

Figure D.33. The Frequency Chart of ENE Direction for the Adana-Karataş ECMWF Data Sets

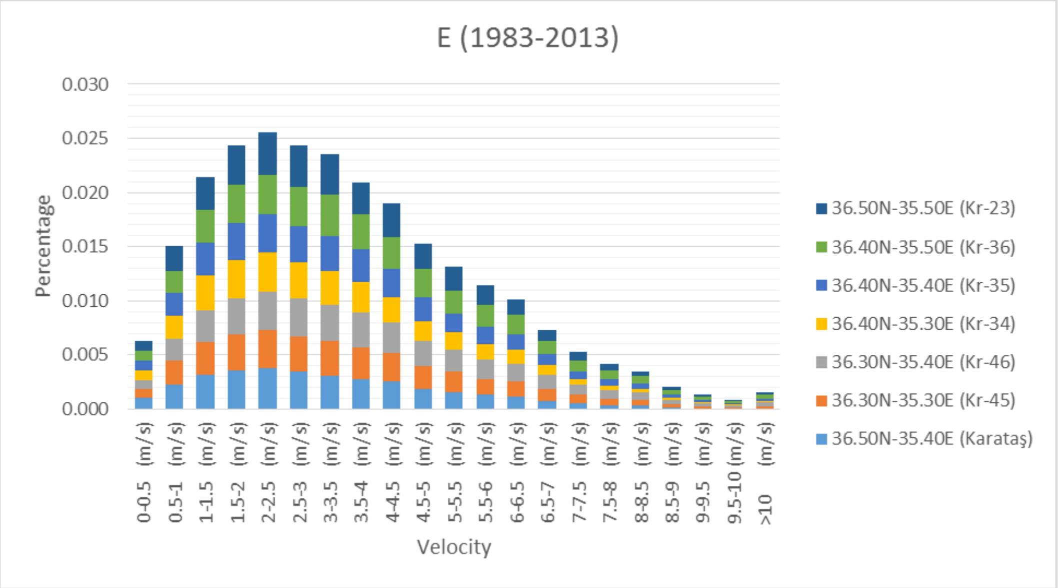

Figure D.34. The Frequency Chart of E Direction for the Adana-Karataş ECMWF Data Sets

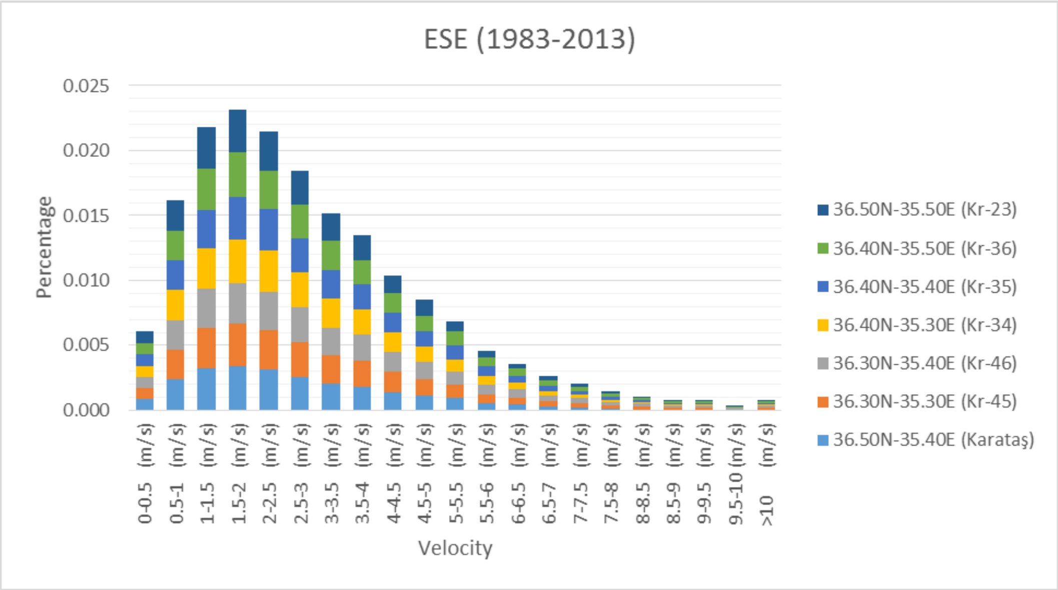

Figure D.35. The Frequency Chart of ESE Direction for the Adana-Karataş ECMWF Data Sets

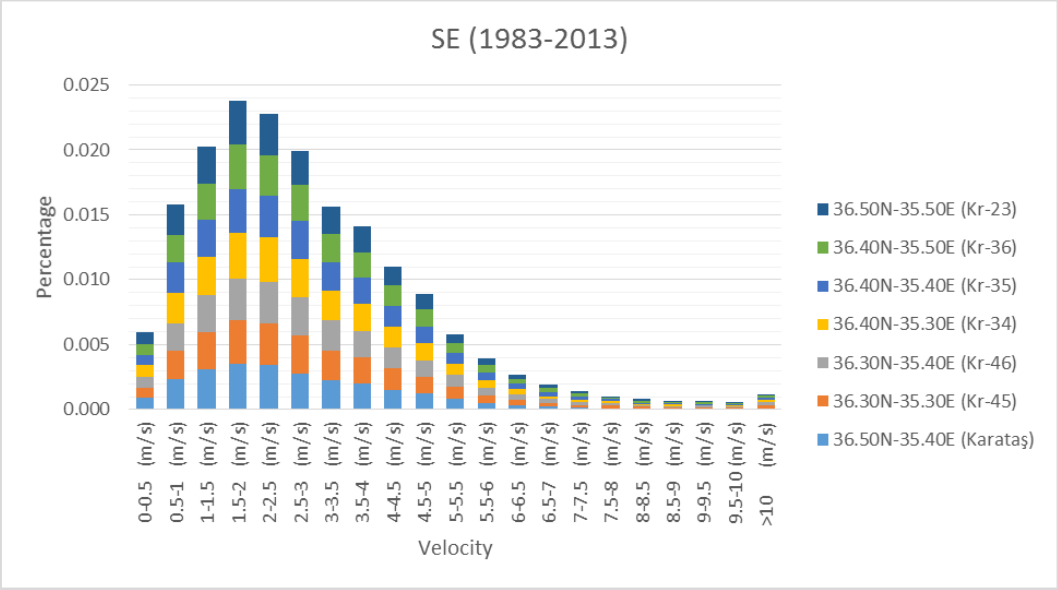

Figure D.36. The Frequency Chart of SE Direction for the Adana-Karataş ECMWF Data Sets

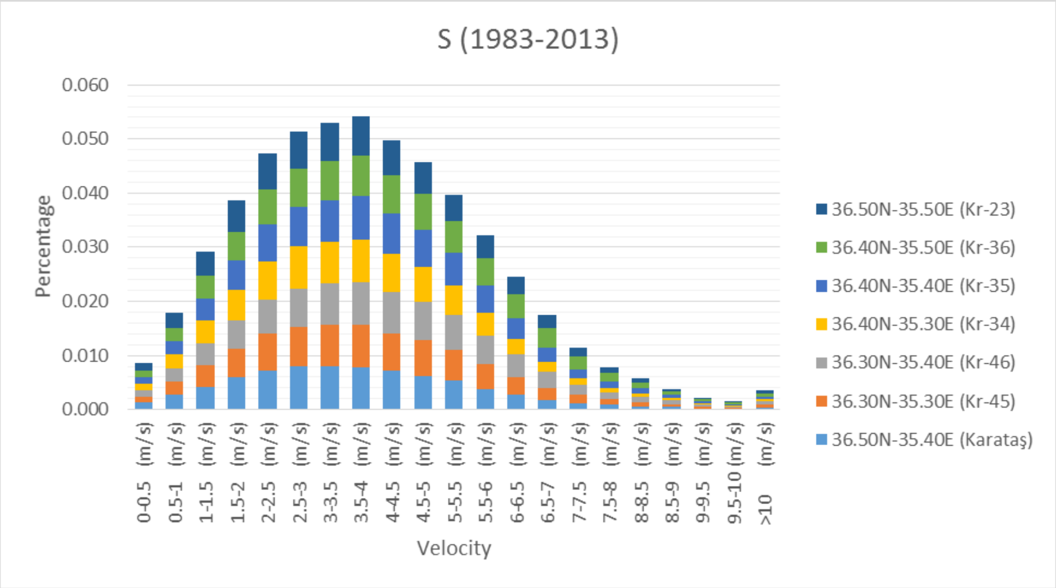

Figure D.37. The Frequency Chart of S Direction for the Adana-Karataş ECMWF Data Sets

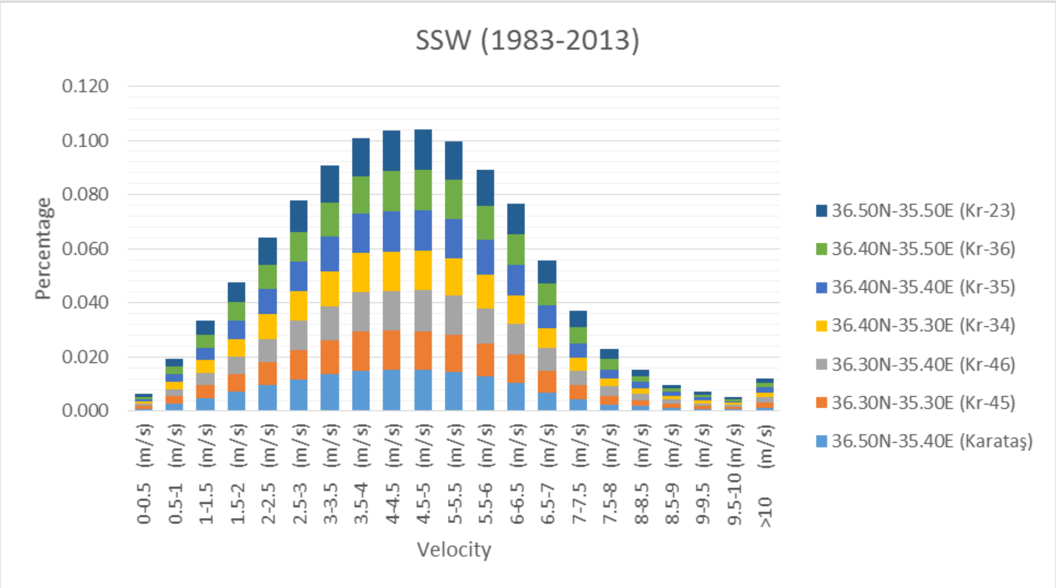

Figure D.38. The Frequency Chart of SSW Direction for the Adana-Karataş ECMWF Data Sets

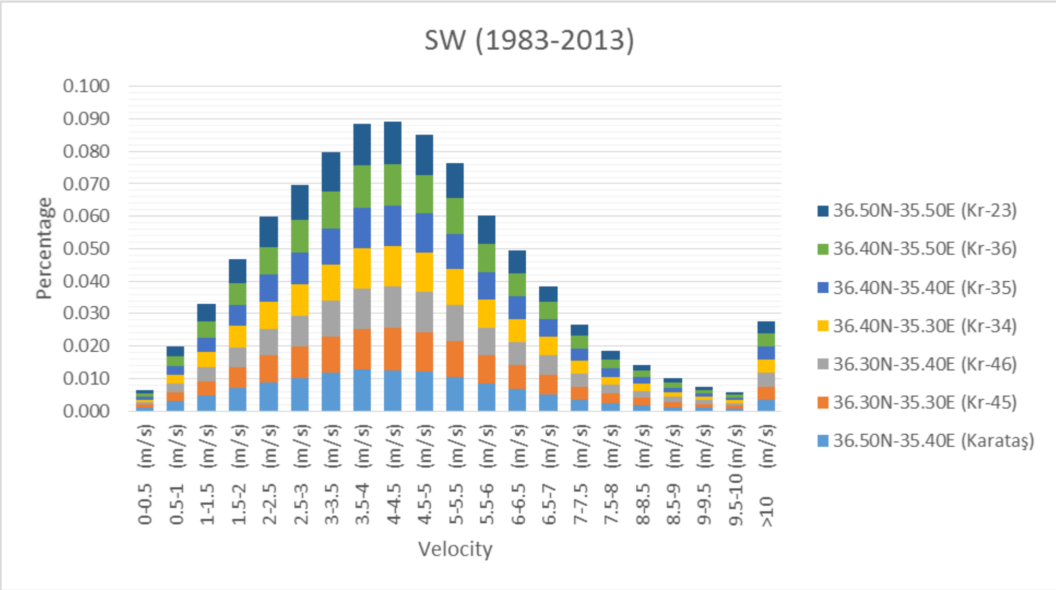

Figure D.39. The Frequency Chart of SW Direction for the Adana-Karataş ECMWF Data Sets

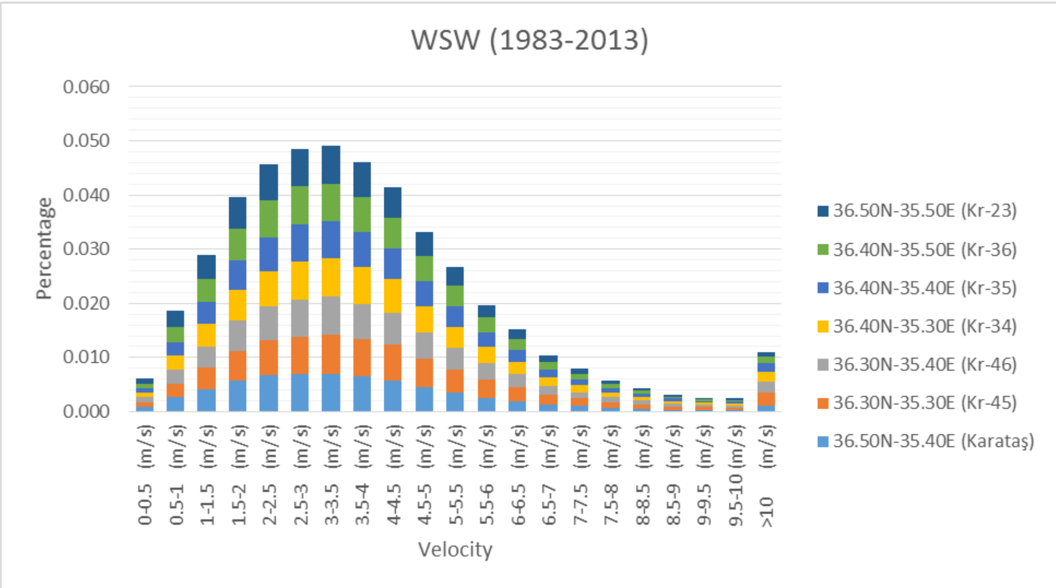

Figure D.40. The Frequency Chart of WSW Direction for the Adana-Karataş ECMWF Data Sets

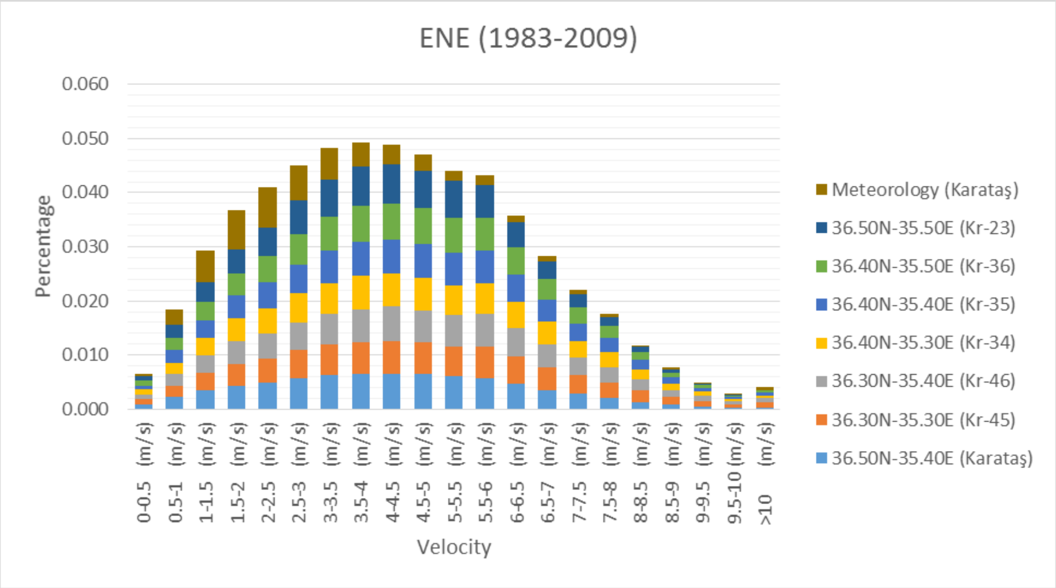

Figure D.41. The Frequency Chart of ENE Direction for the Adana-Karataş Meteorology and ECMWF Data Sets

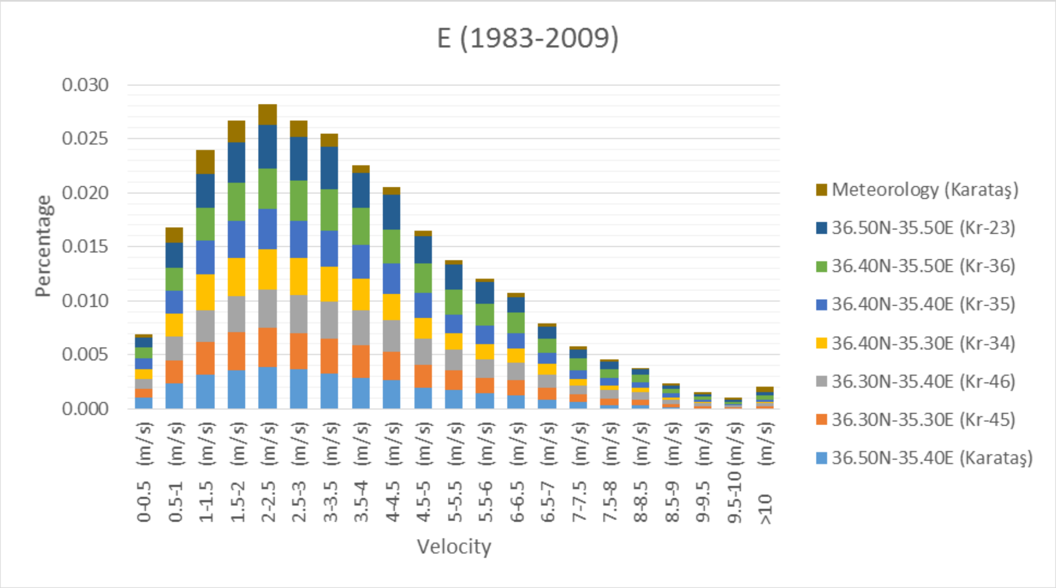

Figure D.42. The Frequency Chart of E Direction for the Adana-Karataş Meteorology and ECMWF Data Sets

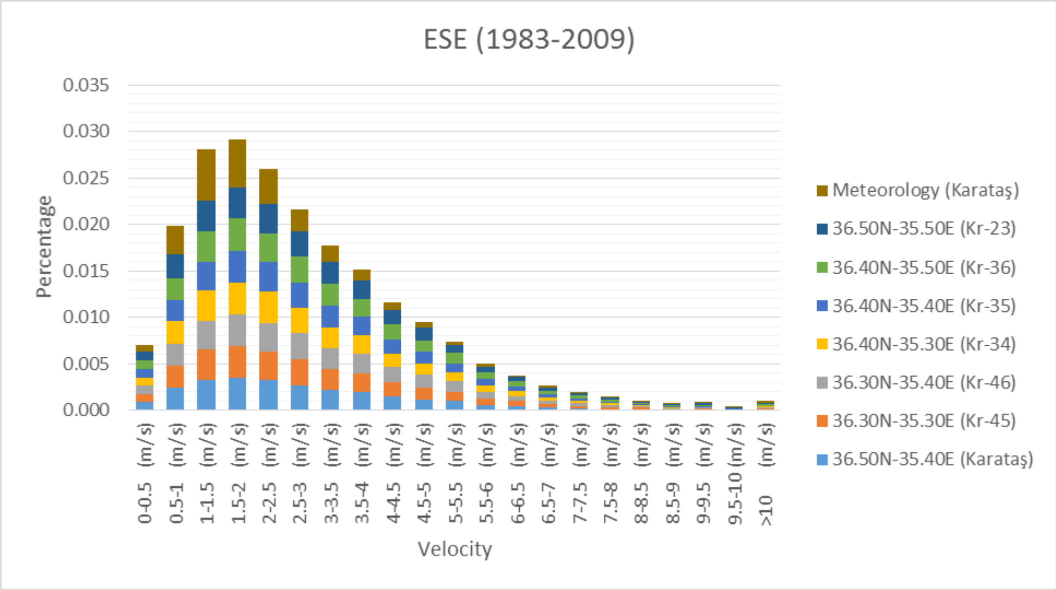

Figure D.43. The Frequency Chart of ESE Direction for the Adana-Karataş Meteorology and ECMWF Data Sets

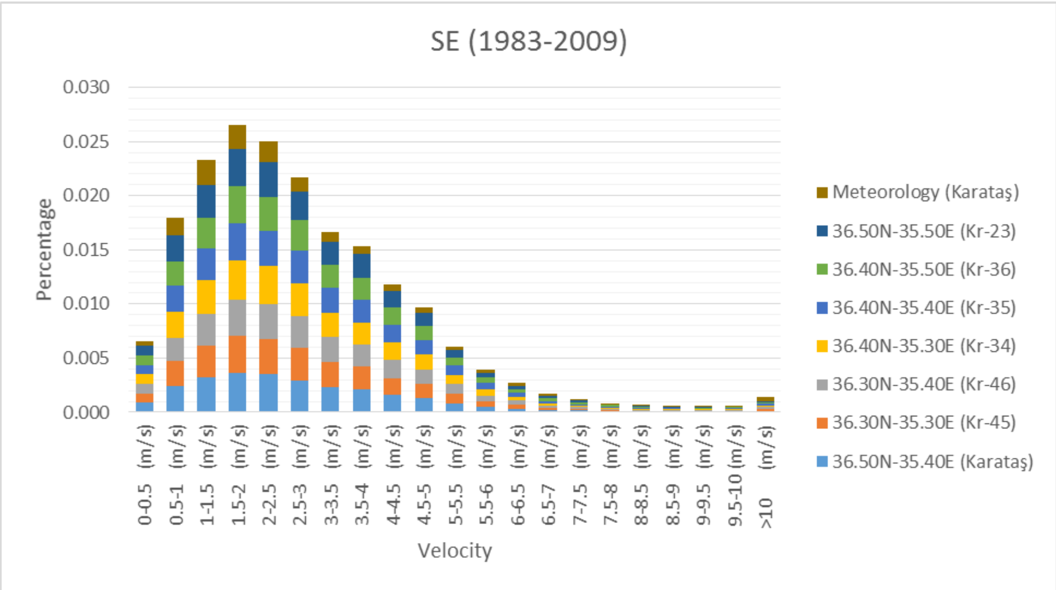

Figure D.44. The Frequency Chart of SE Direction for the Adana-Karataş Meteorology and ECMWF Data Sets

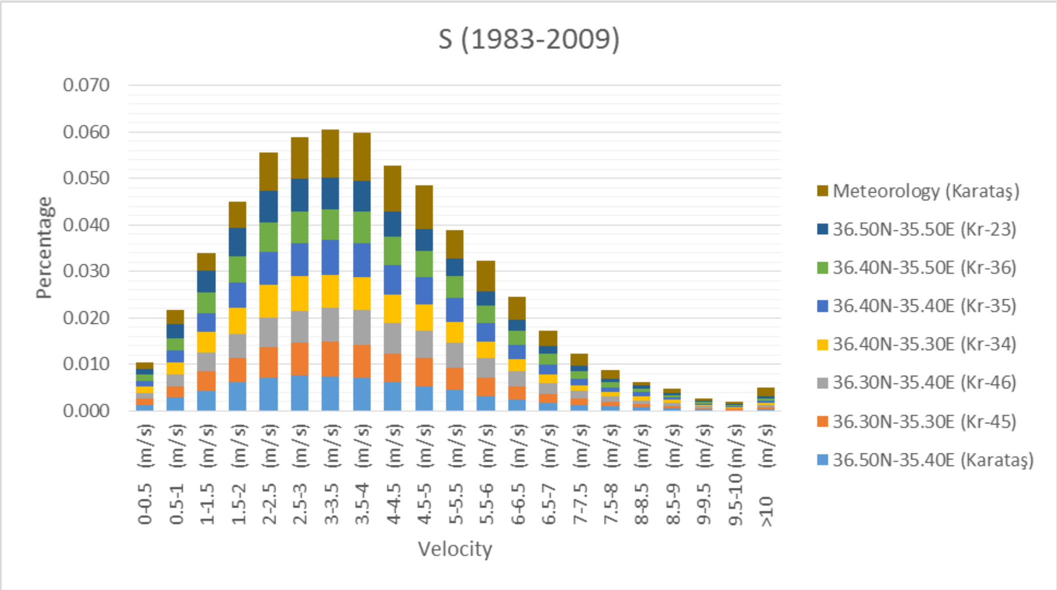

Figure D.45. The Frequency Chart of S Direction for the Adana-Karataş Meteorology and ECMWF Data Sets

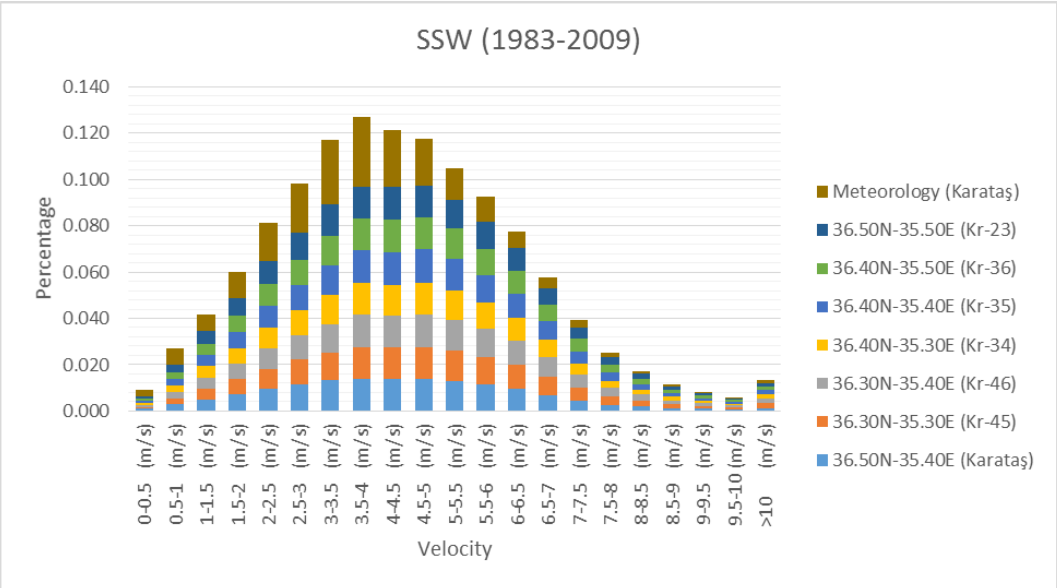

Figure D.46. The Frequency Chart of SSW Direction for the Adana-Karataş Meteorology and ECMWF Data Sets

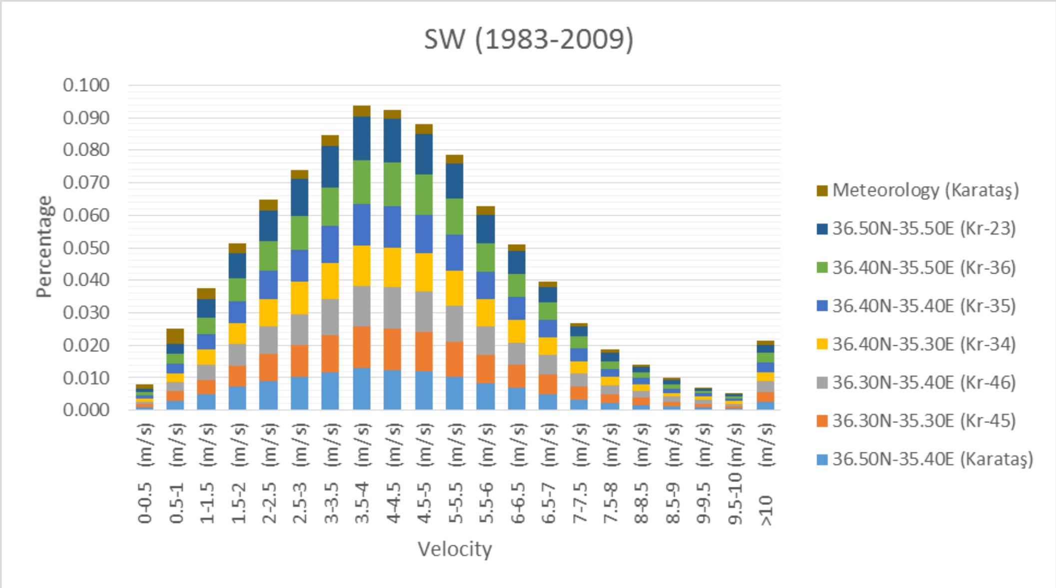

Figure D.47. The Frequency Chart of SW Direction for the Adana-Karataş Meteorology and ECMWF Data Sets

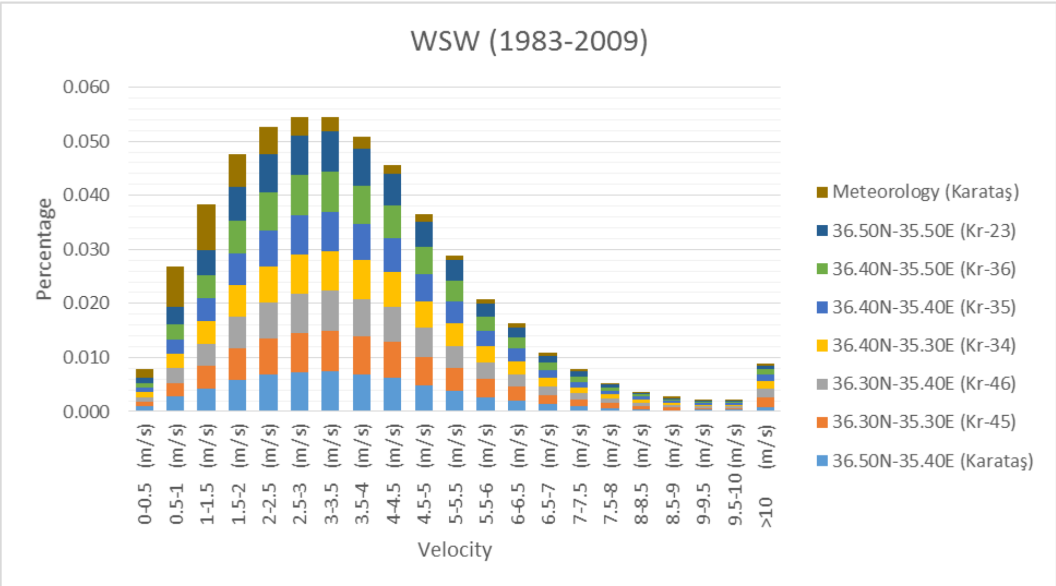

Figure D.48. The Frequency Chart of WSW Direction for the Adana-Karataş Meteorology and ECMWF Data Sets

APPENDIX – E

NON-DIRECTIONAL RESULTS OF THE EXTREME ANALYSIS OF UNCERTAININITIES IN RELATION TO WIND DATA DUE TO THE SELECTION OF ECMWF COORDINATE:

Antalya-Gazipaşa:

ECMWF (36.20N-32.30E):

Table E.1. The Result Table of the Extreme Analysis for the Antalya- Gazipaşa ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.70420	4.10850	4.49631	4.99829	5.37445	6.24370	6.61741	~	~	Best Distr.	Best Distr.
Gumbel2 (new)	3.64529	4.01369	4.36708	4.82449	5.16726	5.95935	6.29988	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.34580	3.65151	4.04490	4.75504	5.49042	8.22678	10.06683	~	~	~	~
FT 2 (k2=3.33)	3.42657	3.77683	4.19574	4.89149	5.55647	7.74811	9.06983	~	~	~	~
FT 2 (k3=5.0)	3.50816	3.88378	4.30113	4.93872	5.50073	7.14299	8.02909	~	~	~	~
FT 2 (k4=10.0)	3.58268	3.96347	4.35659	4.90932	5.35862	6.52512	7.08744	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.43603	3.84896	4.30608	4.96620	5.50188	6.84821	7.46700	~	~	~	~
Weibull (k2=1.0)	3.55337	3.97006	4.38675	4.93759	5.35429	6.32182	6.73851	~	~	~	~
Weibull (k3=1.4)	3.65081	4.03625	4.38938	4.82213	5.13027	5.79910	6.07138	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	3.70699	4.04599	4.33676	4.67341	4.90243	5.37518	5.55961	~	~	Best Distr.	Best Distr.
LogNormal	3.71106	4.05963	4.37203	4.75249	5.02434	5.62319	5.87188	Best Distr.	Best Distr.	Best Distr.	Best Distr.

GP-34 (36.00N-32.10E):

Table E.2. The Result Table of the Extreme Analysis for the GP-34 ECMWF Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.95939	5.46428	5.94859	6.57547	7.04524	8.13078	8.59748	~	~	Best Distr.	Best Distr.
Gumbel2 (new)	4.83788	5.27072	5.68592	6.22334	6.62607	7.55671	7.95680	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.52566	4.97937	5.56318	6.61710	7.70847	11.76946	14.50025	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	4.62028	5.10037	5.67455	6.62819	7.53967	10.54368	12.35532	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	4.70736	5.19059	5.72750	6.54775	7.27077	9.38351	10.52347	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.78084	5.24674	5.72773	6.40402	6.95374	8.38098	9.06898	Best Distr.	Best Distr.	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.63078	5.19293	5.81522	6.71387	7.44313	9.27595	10.11835	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	4.75125	5.27609	5.80093	6.49474	7.01959	8.23824	8.76308	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.83820	5.29527	5.71402	6.22720	6.59261	7.38575	7.70863	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.88000	5.26637	5.59776	5.98145	6.24248	6.78128	6.99148	~	~	Best Distr.	Best Distr.
LogNormal	4.84796	5.20041	5.51071	5.88215	6.14359	6.70891	6.93976	~	~	Best Distr.	Best Distr.

Table E.3. The Result Table of the Extreme Analysis for the GP-34 ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.59396	5.05690	5.50097	6.07576	6.50649	7.50184	7.92975	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	4.53011	4.95483	5.36225	5.88960	6.28477	7.19797	7.59056	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.19228	4.55895	5.03076	5.88249	6.76449	10.04642	12.25333	~	~	Best Distr.	~
FT 2 (k2=3.33)	4.28512	4.69936	5.19479	6.01762	6.80406	9.39601	10.95916	~	~	Best Distr.	~
FT 2 (k3=5.0)	4.37738	4.81668	5.30478	6.05047	6.70776	8.62843	9.66475	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.46064	4.90227	5.35818	5.99922	6.52029	7.87314	8.52528	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.29344	4.77707	5.31244	6.08557	6.71297	8.28979	9.01453	~	~	Best Distr.	~
Weibull (k2=1.0)	4.42413	4.90454	5.38494	6.02001	6.50041	7.61588	8.09629	~	~	Best Distr.	~
Weibull (k3=1.4)	4.53170	4.97211	5.37560	5.87007	6.22216	6.98639	7.29750	~	~	Best Distr.	~
Weibull (k4=2.0)	4.59465	4.98120	5.31274	5.69661	5.95776	6.49681	6.70710	~	~	Best Distr.	Best Distr.
LogNormal	4.61221	5.01216	5.36847	5.79988	6.10657	6.77796	7.05519	Best Distr.	~	Best Distr.	Best Distr.

GP-26 (36.10N-32.20E):

Table E.4. The Result Table of the Extreme Analysis for the GP-26 ECMWF Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.40925	4.85675	5.28601	5.84164	6.25800	7.22015	7.63380	~	Best Distr.	~	Best Distr.
Gumbel2 (new)	4.29103	4.66642	5.02649	5.49258	5.84184	6.64894	6.99593	~	~	~	Best Distr.
FT 2 (k1=2.5)	3.99150	4.33046	4.76662	5.55399	6.36934	9.40327	11.44341	~	~	~	~
FT 2 (k2=3.33)	4.07305	4.44733	4.89497	5.63843	6.34902	8.69097	10.10333	~	~	~	~
FT 2 (k3=5.0)	4.15401	4.54576	4.98101	5.64596	6.23209	7.94481	8.86894	~	~	~	~
FT 2 (k4=10.0)	4.22802	4.61932	5.02328	5.59127	6.05296	7.25164	7.82947	~	~	~	Best Distr.
Weibull (k1=0.75)	4.07632	4.50656	4.98282	5.67059	6.22872	7.63145	8.27617	~	~	~	~
Weibull (k2=1.0)	4.19038	4.61674	5.04310	5.60672	6.03308	7.02305	7.44941	~	~	~	~
Weibull (k3=1.4)	4.28589	4.67780	5.03686	5.47687	5.79019	6.47025	6.74710	~	~	~	Best Distr.
Weibull (k4=2.0)	4.34330	4.68863	4.98482	5.32775	5.56105	6.04262	6.23049	~	~	~	Best Distr.
LogNormal	4.36170	4.71213	5.02264	5.39667	5.66137	6.23760	6.47434	Best Distr.	~	Best Distr.	Best Distr.

Table E.5. The Result Table of the Extreme Analysis for the GP-26 ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.20380	4.62915	5.03716	5.56529	5.96104	6.87557	7.26874	~	Best Distr.	~	~
Gumbel2 (new)	4.13967	4.52554	4.89567	5.37477	5.73379	6.56343	6.92010	~	~	~	~
FT 2 (k1=2.5)	3.81576	4.11649	4.50345	5.20201	5.92539	8.61711	10.42713	~	~	~	~
FT 2 (k2=3.33)	3.89962	4.25055	4.67026	5.36735	6.03361	8.22947	9.55373	~	~	~	~
FT 2 (k3=5.0)	3.98671	4.36929	4.79436	5.44376	6.01618	7.68884	8.59134	~	~	~	~
FT 2 (k4=10.0)	4.06859	4.46217	4.86848	5.43978	5.90416	7.10982	7.69101	~	~	~	~
Weibull (k1=0.75)	3.90684	4.31686	4.77074	5.42620	5.95811	7.29493	7.90935	~	~	~	~
Weibull (k2=1.0)	4.03179	4.45510	4.87841	5.43799	5.86130	6.84419	7.26750	~	~	~	~
Weibull (k3=1.4)	4.14130	4.54156	4.90827	5.35767	5.67767	6.37223	6.65498	~	~	~	~
Weibull (k4=2.0)	4.20969	4.56827	4.87583	5.23192	5.47418	5.97423	6.16930	~	~	~	~
LogNormal	4.24258	4.62820	4.97293	5.39173	5.69036	6.34643	6.61824	Best Distr.	~	Best Distr.	Best Distr.

GP-14 (36.30N-32.30E):

Table E.6. The Result Table of the Extreme Analysis for the GP-14 ECMWF Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.04822	3.28080	3.50390	3.79268	4.00908	4.50915	4.72414	~	Best Distr.	~	Best Distr.
Gumbel2 (new)	2.98772	3.18356	3.37142	3.61458	3.79680	4.21787	4.39890	~	~	~	Best Distr.
FT 2 (k1=2.5)	2.83040	3.00524	3.23022	3.63636	4.05694	5.62190	6.67425	~	~	~	~
FT 2 (k2=3.33)	2.87261	3.06588	3.29703	3.68094	4.04788	5.25722	5.98654	~	~	~	~
FT 2 (k3=5.0)	2.91482	3.11758	3.34286	3.68702	3.99039	4.87685	5.35516	~	~	~	~
FT 2 (k4=10.0)	2.95387	3.15709	3.36690	3.66189	3.90168	4.52423	4.82433	~	~	~	~
Weibull (k1=0.75)	2.87254	3.09184	3.33460	3.68517	3.96966	4.68465	5.01328	~	~	~	~
Weibull (k2=1.0)	2.93133	3.14938	3.36744	3.65569	3.87374	4.38005	4.59811	~	~	~	~
Weibull (k3=1.4)	2.98202	3.18399	3.36902	3.59578	3.75724	4.10771	4.25038	~	~	~	~
Weibull (k4=2.0)	3.01433	3.19407	3.34823	3.52672	3.64815	3.89879	3.99658	~	~	~	Best Distr.
LogNormal	3.03451	3.21400	3.37020	3.55511	3.68398	3.95934	4.07055	Best Distr.	~	Best Distr.	Best Distr.

Table E.7. The Result Table of the Extreme Analysis for the GP-14 ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.61811	4.05160	4.46742	5.00565	5.40898	6.34101	6.74170	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	3.55659	3.95292	4.33309	4.82518	5.19394	6.04607	6.41241	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.24179	3.58476	4.02608	4.82276	5.64776	8.71758	10.78185	~	~	~	~
FT 2 (k2=3.33)	3.32946	3.71814	4.18298	4.95503	5.69294	8.12492	9.59159	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.41617	3.82854	4.28671	4.98667	5.60366	7.40657	8.37935	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.49350	3.90724	4.33437	4.93493	5.42311	6.69054	7.30152	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.34255	3.80504	4.31701	5.05635	5.65632	7.16422	7.85728	~	~	~	~
Weibull (k2=1.0)	3.46681	3.92541	4.38400	4.99023	5.44883	6.51365	6.97225	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	3.56517	3.98200	4.36389	4.83189	5.16513	5.88844	6.18290	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	3.61780	3.97913	4.28906	4.64788	4.89200	5.39589	5.59247	~	~	Best Distr.	Best Distr.
LogNormal	3.59814	3.96030	4.28670	4.68635	4.97327	5.60899	5.87438	Best Distr.	~	Best Distr.	Best Distr.

Mersin-Yenişehir:

ECMWF (36.70N-34.60E):

Table E.8. The Result Table of the Extreme Analysis for the Mersin-Yenişehir ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.55855	3.95365	4.33265	4.82323	5.19084	6.04035	6.40556	~	~	Best Distr.	~
Gumbel2 (new)	3.50971	3.87674	4.22880	4.68452	5.02601	5.81515	6.15441	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.23929	3.59719	4.05772	4.88907	5.74998	8.95340	11.10752	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.31999	3.70990	4.17622	4.95072	5.69097	8.13068	9.60201	~	Best Distr.	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.39553	3.79588	4.24070	4.92026	5.51927	7.26963	8.21406	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.45969	3.85092	4.25482	4.82271	5.28432	6.48280	7.06053	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.32707	3.78105	4.28361	5.00936	5.59831	7.07848	7.75880	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	3.43437	3.86791	4.30146	4.87457	5.30811	6.31477	6.74831	~	~	Best Distr.	~
Weibull (k3=1.4)	3.51482	3.89850	4.25002	4.68080	4.98753	5.65332	5.92435	~	~	~	~
Weibull (k4=2.0)	3.55532	3.88274	4.16358	4.48874	4.70995	5.16656	5.34469	~	~	~	~
LogNormal	3.51882	3.82799	4.10368	4.43780	4.67552	5.19643	5.41173	Best Distr.	~	~	Best Distr.

MR-22 (36.50N-34.70E):

Table E.9. The Result Table of the Extreme Analysis for the MR-22 ECMWF Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.15362	4.55529	4.94059	5.43932	5.81305	6.67667	7.04795	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	4.05094	4.39059	4.71638	5.13809	5.45410	6.18435	6.49829	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.79031	4.11666	4.53659	5.29466	6.07968	9.00072	10.96496	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.86426	4.21807	4.64122	5.34401	6.01572	8.22954	9.56464	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.93556	4.29986	4.70463	5.32300	5.86807	7.46082	8.32021	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.99883	4.35748	4.72774	5.24834	5.67151	6.77019	7.29981	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.86938	4.27937	4.73323	5.38865	5.92053	7.25727	7.87166	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	3.96940	4.36592	4.76244	5.28662	5.68314	6.60383	7.00035	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.04875	4.40539	4.73213	5.13254	5.41766	6.03651	6.28844	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.09298	4.40200	4.66706	4.97394	5.18272	5.61366	5.78178	Best Distr.	~	Best Distr.	Best Distr.
LogNormal	4.09346	4.39065	4.65227	4.96541	5.18580	5.66232	5.85689	~	~	Best Distr.	Best Distr.

Table E.10. The Result Table of the Extreme Analysis for the MR-22 ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	4.02741	4.42817	4.81259	5.31018	5.68305	6.54470	6.91514	~	~	Best Distr.	Best Distr.
Gumbel2 (new)	3.97675	4.34813	4.70437	5.16549	5.51103	6.30952	6.65281	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.70221	4.06259	4.52631	5.36344	6.23032	9.45598	11.62505	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.78516	4.18023	4.65273	5.43748	6.18754	8.65956	10.15037	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.86258	4.26926	4.72111	5.41141	6.01989	7.79792	8.75728	Best Distr.	Best Distr.	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.92748	4.32463	4.73464	5.31112	5.77972	6.99633	7.58280	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.79848	4.26863	4.78907	5.54064	6.15055	7.68340	8.38792	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	3.90782	4.35477	4.80172	5.39256	5.83951	6.87730	7.32425	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	3.98572	4.37710	4.73567	5.17508	5.48797	6.16711	6.44358	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	4.02084	4.35081	4.63383	4.96152	5.18445	5.64460	5.82412	~	~	~	~
LogNormal	3.97236	4.26607	4.52492	4.83510	5.05361	5.52662	5.71997	~	~	~	~

MR-9 (36.60N-34.50E):

Table E.11. The Result Table of the Extreme Analysis for the MR-9 ECMWF Data Set (2000-2010)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.62280	3.97476	4.31237	4.74937	5.07685	5.83358	6.15891	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	3.53366	3.83192	4.11801	4.48833	4.76583	5.40710	5.68278	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.30385	3.58865	3.95511	4.61667	5.30174	7.85088	9.56503	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.36837	3.67711	4.04635	4.65962	5.24577	7.17759	8.34263	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.43089	3.74913	4.10272	4.64292	5.11907	6.51046	7.26120	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.48687	3.80085	4.12499	4.58075	4.95121	5.91304	6.37669	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.37056	3.72461	4.11654	4.68253	5.14183	6.29617	6.82673	~	~	Best Distr.	~
Weibull (k2=1.0)	3.45776	3.80110	4.14445	4.59833	4.94168	5.73890	6.08225	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	3.52875	3.83945	4.12410	4.47293	4.72132	5.26046	5.47994	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	3.57041	3.84168	4.07434	4.34372	4.52698	4.90527	5.05284	~	~	Best Distr.	Best Distr.
LogNormal	3.58263	3.85207	4.08979	4.37493	4.57599	5.01171	5.19000	Best Distr.	~	Best Distr.	Best Distr.

Table E.12. The Result Table of the Extreme Analysis for the MR-9 ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	3.74975	4.14906	4.53210	5.02789	5.39942	6.25797	6.62708	~	~	Best Distr.	Best Distr.
Gumbel2 (new)	3.69959	4.06988	4.42508	4.88484	5.22937	6.02553	6.36780	~	Best Distr.	Best Distr.	Best Distr.
FT 2 (k1=2.5)	3.42324	3.77760	4.23357	5.05671	5.90910	9.08084	11.21366	~	~	Best Distr.	Best Distr.
FT 2 (k2=3.33)	3.50483	3.89335	4.35800	5.12972	5.86732	8.29828	9.76433	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	3.58187	3.98284	4.42835	5.10897	5.70891	7.46200	8.40790	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	3.64780	4.04124	4.44741	5.01850	5.48272	6.68795	7.26894	Best Distr.	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	3.51317	3.96765	4.47075	5.19728	5.78686	7.26863	7.94967	~	~	Best Distr.	Best Distr.
Weibull (k2=1.0)	3.62205	4.05771	4.49338	5.06929	5.50495	6.51653	6.95220	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	3.70410	4.09065	4.44480	4.87880	5.18784	5.85861	6.13167	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	3.74601	4.07661	4.36017	4.68848	4.91183	5.37287	5.55273	~	~	~	~
LogNormal	3.72021	4.03596	4.31683	4.65639	4.89748	5.42439	5.64165	~	~	~	Best Distr.

Adana-Karataş:

ECMWF (36.50N-35.40E):

Table E.13. The Result Table of the Extreme Analysis for the Adana-Karataş ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	5.11859	5.78226	6.41886	7.24288	7.86036	9.28728	9.90073	Best Distr.	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	5.02426	5.63092	6.21283	6.96607	7.53051	8.83485	9.39560	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.54317	5.06963	5.74706	6.96998	8.23636	12.94856	16.11725	~	~	~	~
FT 2 (k2=3.33)	4.67795	5.27486	5.98874	7.17441	8.30765	12.04257	14.29500	~	~	~	Best Distr.
FT 2 (k3=5.0)	4.81084	5.44382	6.14710	7.22153	8.16859	10.93601	12.42921	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.92875	5.56309	6.21796	7.13873	7.88718	9.83038	10.76710	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.70002	5.41353	6.20338	7.34400	8.26962	10.59595	11.66517	~	~	~	~
Weibull (k2=1.0)	4.89013	5.59582	6.30152	7.23439	7.94009	9.57866	10.28435	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	5.03892	5.67824	6.26396	6.98175	7.49285	8.60222	9.05384	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	5.11688	5.66927	6.14307	6.69163	7.06483	7.83516	8.13568	~	~	Best Distr.	Best Distr.
LogNormal	5.07349	5.63105	6.13740	6.76195	7.21325	8.22109	8.64486	~	~	Best Distr.	Best Distr.

KR-46 (36.30N-35.40E):

Table E.14. The Result Table of the Extreme Analysis for the KR-46 ECMWF Data Set (1983-2009)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	5.17593	5.78398	6.36724	7.12221	7.68796	8.99530	9.55735	~	Best Distr.	~	Best Distr.
Gumbel2 (new)	5.07722	5.62473	6.14991	6.82971	7.33912	8.51629	9.02237	~	~	~	Best Distr.
FT 2 (k1=2.5)	4.62828	5.07752	5.65558	6.69910	7.77971	11.80068	14.50455	~	~	~	~
FT 2 (k2=3.33)	4.74840	5.26484	5.88249	6.90832	7.88879	11.12021	13.06900	~	~	~	~
FT 2 (k3=5.0)	4.87046	5.42602	6.04329	6.98632	7.81756	10.24652	11.55711	~	~	~	~
FT 2 (k4=10.0)	4.98257	5.54729	6.13030	6.95002	7.61634	9.34628	10.18021	~	~	~	Best Distr.
Weibull (k1=0.75)	4.76320	5.37345	6.04900	7.02456	7.81623	9.80591	10.72040	~	~	~	~
Weibull (k2=1.0)	4.93930	5.55831	6.17732	6.99561	7.61462	9.05191	9.67092	~	~	~	~
Weibull (k3=1.4)	5.08611	5.66052	6.18677	6.83168	7.29088	8.28762	8.69338	~	~	~	Best Distr.
Weibull (k4=2.0)	5.17075	5.67660	6.11048	6.61283	6.95458	7.66001	7.93521	~	~	~	Best Distr.
LogNormal	5.17238	5.70036	6.17677	6.76076	7.18044	8.11145	8.50054	Best Distr.	~	Best Distr.	Best Distr.

Table E.15. The Result Table of the Extreme Analysis for the KR-46 ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	5.31301	5.91500	6.49245	7.23989	7.80000	9.09431	9.65076	~	Best Distr.	~	~
Gumbel2 (new)	5.22045	5.76511	6.28757	6.96384	7.47061	8.64168	9.14514	~	~	~	~
FT 2 (k1=2.5)	4.76204	5.18423	5.72748	6.70819	7.72374	11.50262	14.04370	~	~	~	~
FT 2 (k2=3.33)	4.88086	5.37515	5.96629	6.94812	7.88653	10.97931	12.84449	~	~	~	~
FT 2 (k3=5.0)	5.00442	5.54431	6.14416	7.06057	7.86835	10.22877	11.50237	~	~	~	~
FT 2 (k4=10.0)	5.12037	5.67615	6.24993	7.05668	7.71245	9.41502	10.23575	~	~	~	~
Weibull (k1=0.75)	4.89408	5.47658	6.12141	7.05260	7.80827	9.70747	10.58037	~	~	~	~
Weibull (k2=1.0)	5.07313	5.67627	6.27941	7.07672	7.67986	9.08030	9.68344	~	~	~	~
Weibull (k3=1.4)	5.22822	5.79775	6.31953	6.95897	7.41428	8.40256	8.80488	~	~	~	~
Weibull (k4=2.0)	5.32207	5.83003	6.26571	6.77014	7.11332	7.82168	8.09802	~	~	~	~
LogNormal	5.34462	5.89015	6.38240	6.98580	7.41944	8.38138	8.78340	Best Distr.	~	~	Best Distr.

KR-36 (36.40N-35.50E):

Table E.16. The Result Table of the Extreme Analysis for the KR-36 ECMWF Data Set (1983-2009)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	5.08109	5.75525	6.40192	7.23897	7.86622	9.31571	9.93886	Best Distr.	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	4.97704	5.58839	6.17481	6.93387	7.50268	8.81711	9.38220	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.49609	5.03645	5.73176	6.98696	8.28676	13.12335	16.37567	~	~	~	Best Distr.
FT 2 (k2=3.33)	4.63169	5.23998	5.96749	7.17579	8.33066	12.13685	14.43227	~	~	Best Distr.	Best Distr.
FT 2 (k3=5.0)	4.76464	5.40645	6.11955	7.20897	8.16925	10.97529	12.48933	~	~	Best Distr.	Best Distr.
FT 2 (k4=10.0)	4.88217	5.52309	6.18475	7.11507	7.87129	9.83464	10.78108	~	~	Best Distr.	Best Distr.
Weibull (k1=0.75)	4.65325	5.37884	6.18207	7.34201	8.28331	10.64904	11.73637	~	~	~	~
Weibull (k2=1.0)	4.84378	5.55844	6.27311	7.21784	7.93251	9.59191	10.30657	~	~	Best Distr.	Best Distr.
Weibull (k3=1.4)	4.99172	5.63703	6.22823	6.95275	7.46864	8.58841	9.04426	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	5.06818	5.62437	6.10143	6.65376	7.02952	7.80515	8.10773	~	~	Best Distr.	Best Distr.
LogNormal	5.01689	5.57523	6.08287	6.70971	7.16310	8.17681	8.60351	~	~	Best Distr.	Best Distr.

Table E.17. The Result Table of the Extreme Analysis for the KR-36 ECMWF Data Set (1983-2013)

Return Period	5 Year	10 Year	20 Year	50 Year	100 Year	500 Year	1000 Year	R Criteria	MIR Criteria	DOL Criteria	REC Criteria
Distribution Type	Hs										
Gumbel1 (old)	5.25588	5.93855	6.59338	7.44099	8.07616	9.54393	10.17495	~	Best Distr.	Best Distr.	Best Distr.
Gumbel2 (new)	5.15515	5.77621	6.37195	7.14307	7.72092	9.05623	9.63030	~	~	Best Distr.	Best Distr.
FT 2 (k1=2.5)	4.65062	5.16670	5.83076	7.02955	8.27094	12.89016	15.99632	~	~	~	~
FT 2 (k2=3.33)	4.78770	5.38003	6.08843	7.26500	8.38955	12.09580	14.33094	~	~	~	~
FT 2 (k3=5.0)	4.92578	5.56112	6.26703	7.34547	8.29607	11.07382	12.57260	~	~	~	Best Distr.
FT 2 (k4=10.0)	5.05107	5.69443	6.35862	7.29249	8.05159	10.02243	10.97249	~	~	~	Best Distr.
Weibull (k1=0.75)	4.80834	5.51431	6.29580	7.42436	8.34019	10.64192	11.69983	~	~	~	~
Weibull (k2=1.0)	5.00768	5.71863	6.42959	7.36942	8.08038	9.73116	10.44212	~	~	~	~
Weibull (k3=1.4)	5.16972	5.82385	6.42315	7.15757	7.68052	8.81561	9.27770	~	~	Best Distr.	Best Distr.
Weibull (k4=2.0)	5.25912	5.83059	6.32075	6.88825	7.27433	8.07126	8.38216	Best Distr.	~	Best Distr.	Best Distr.
LogNormal	5.23496	5.83139	6.37483	7.04728	7.53455	8.62647	9.08702	~	~	Best Distr.	Best Distr.

APPENDIX – F

THE GRAPHS OF THE LONG TERM ANALYSIS OF UNCERTAINITIES IN RELATION TO WIND DATA DUE TO THE SELECTION OF ECMWF COORDINATE:

Antalya-Gazipaşa:

ECMWF (36.20N-32.30E):

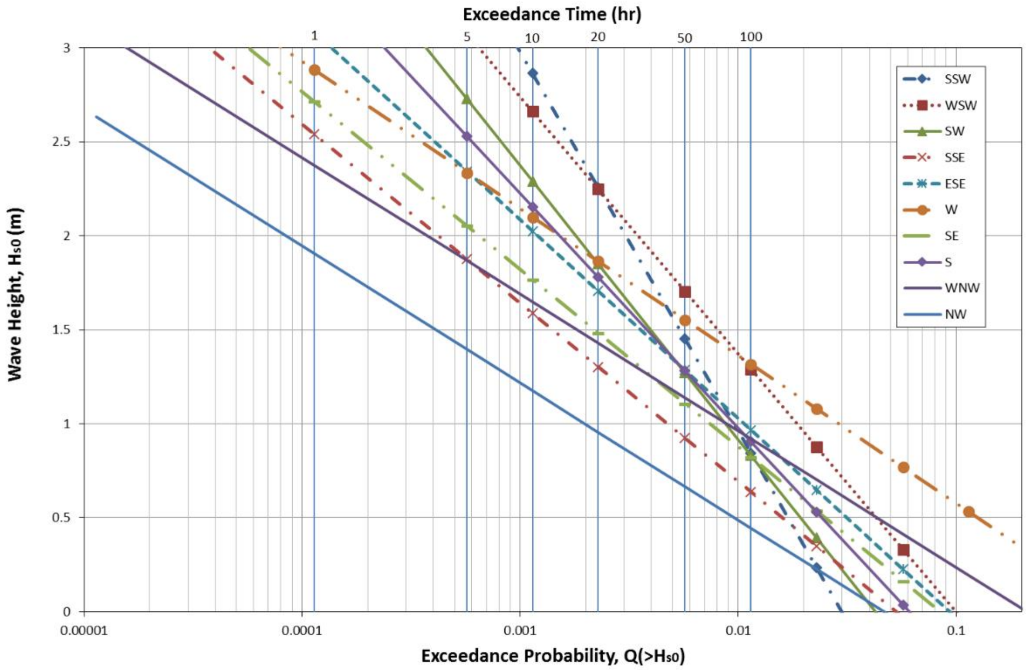

Figure F.1. The Long Term Analysis Graph for the Antalya-Gazipaşa ECMWF Data Set (1983-2013)

GP-34 (36.00N-32.10E):

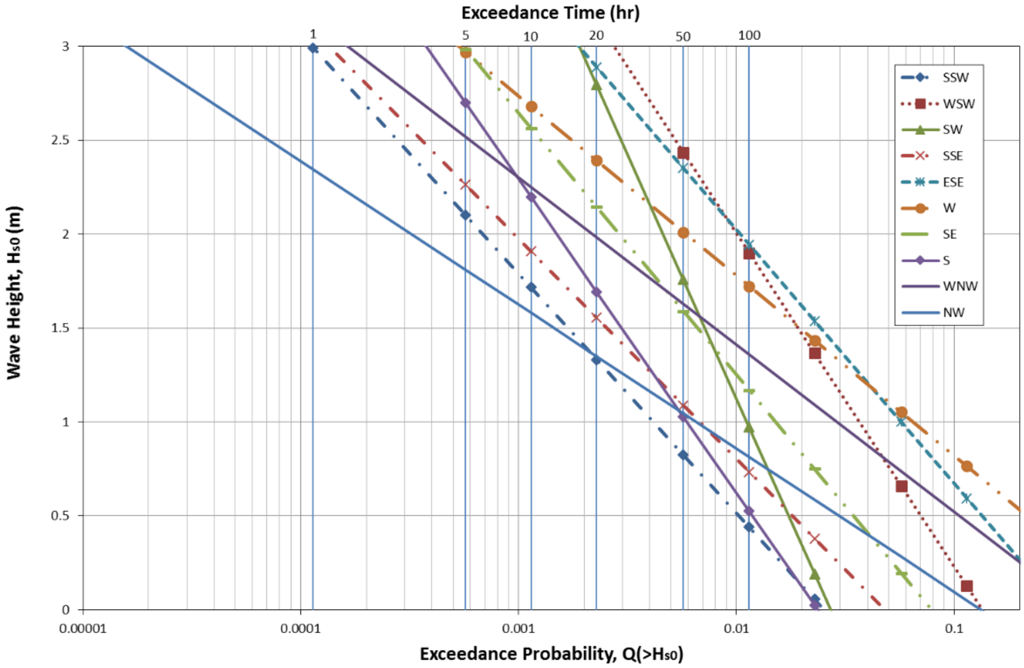

Figure F.2. The Long Term Analysis Graph for the GP-34 ECMWF Data Set (2000-2010)

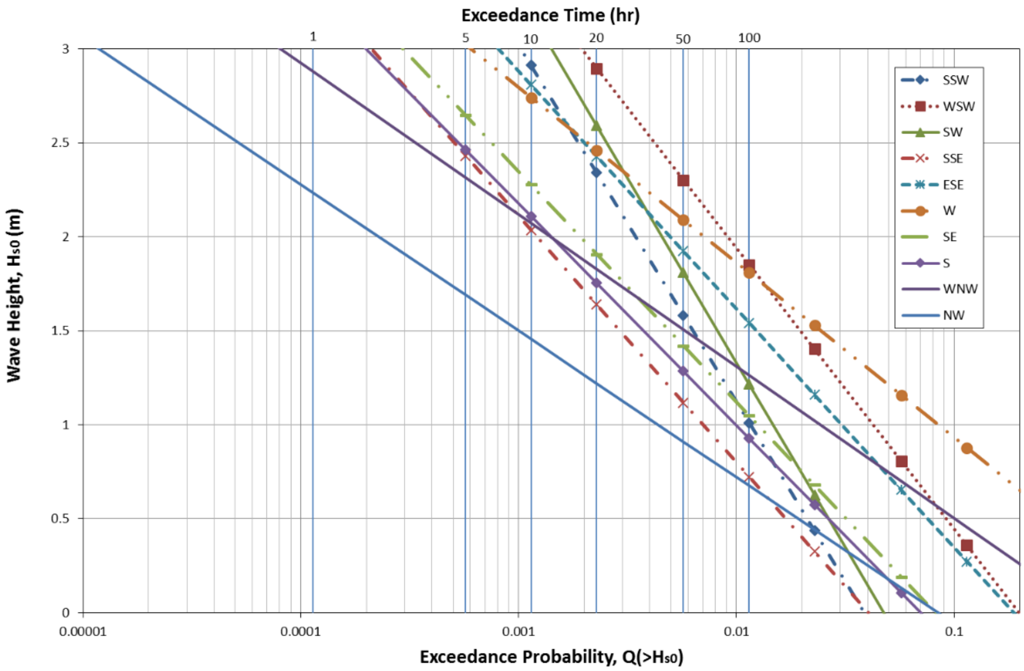

Figure F.3. The Long Term Analysis Graph for the GP-34 ECMWF Data Set (1983-2013)

GP-26 (36.10N-32.20E):

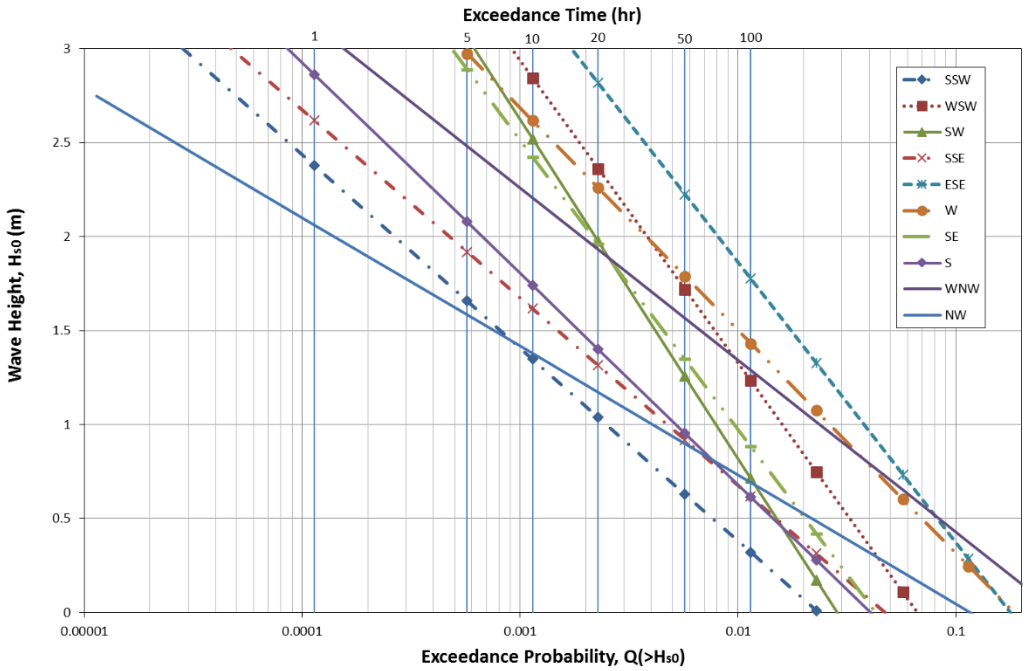

Figure F.4. The Long Term Analysis Graph for the GP-26 ECMWF Data Set (2000-2010)

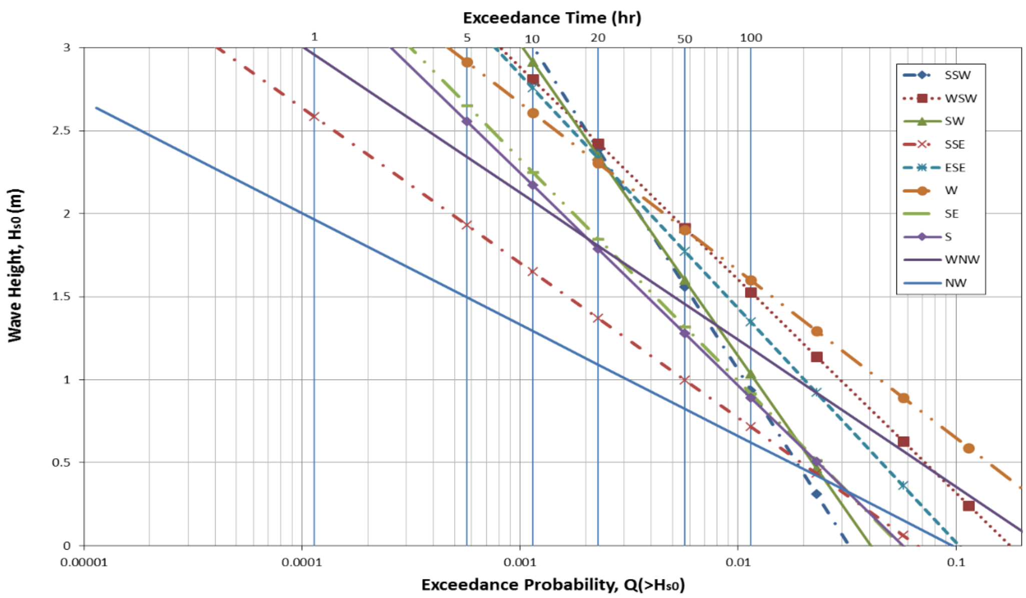

Figure F.5. The Long Term Analysis Graph for the GP-26 ECMWF Data Set (1983-2013)

GP-14 (36.30N-32.30E):

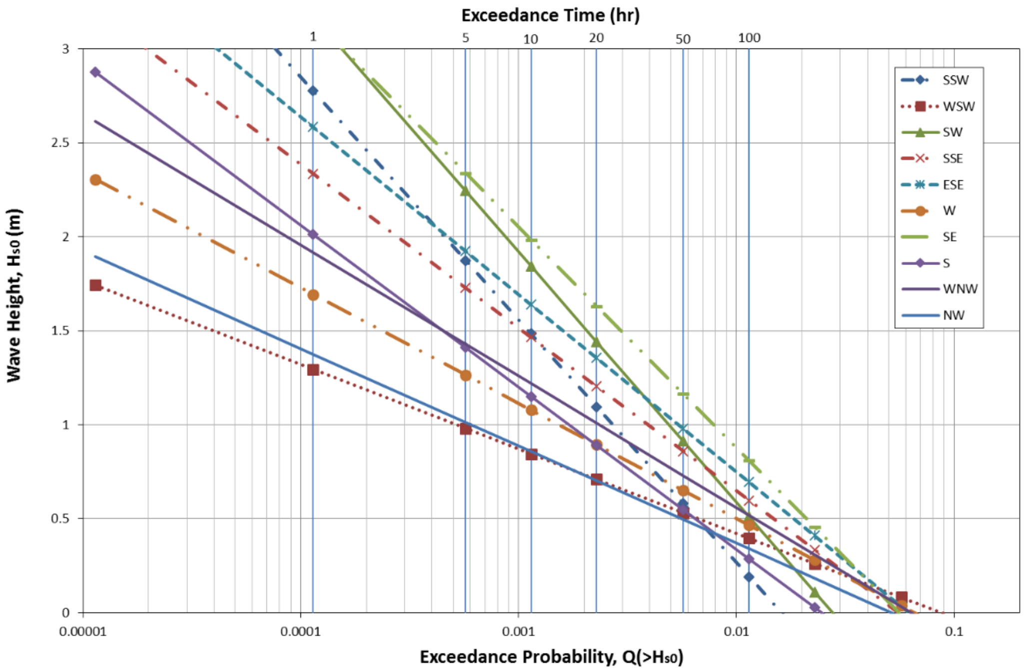

Figure F.6. The Long Term Analysis Graph for the GP-14 ECMWF Data Set (2000-2010)

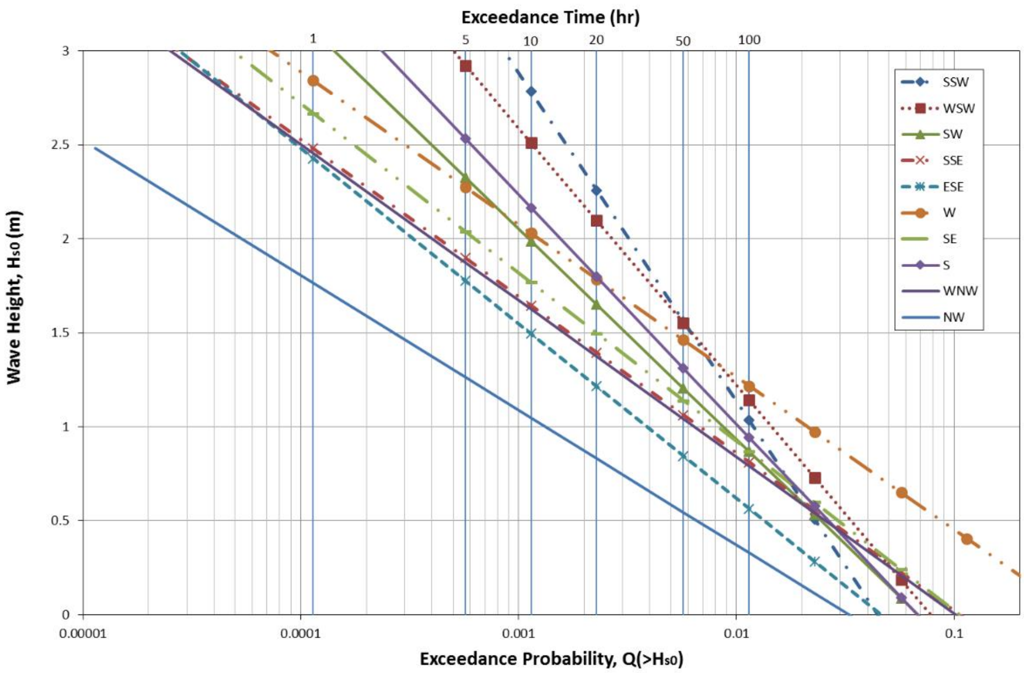

Figure F.7. The Long Term Analysis Graph for the GP-14 ECMWF Data Set (1983-2013)

Mersin-Yenişehir:

ECMWF (36.70N-34.60E):

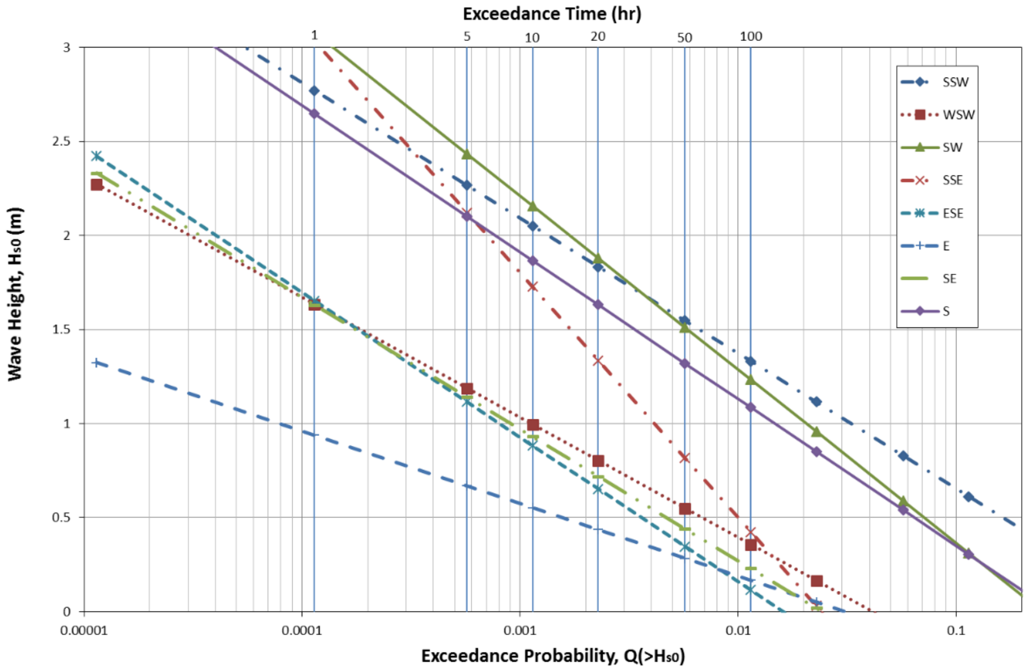

Figure F.8. The Long Term Analysis Graph for the Mersin-Yenişehir ECMWF Data Set (1983-2013)

MR-22 (36.50N-34.70E):

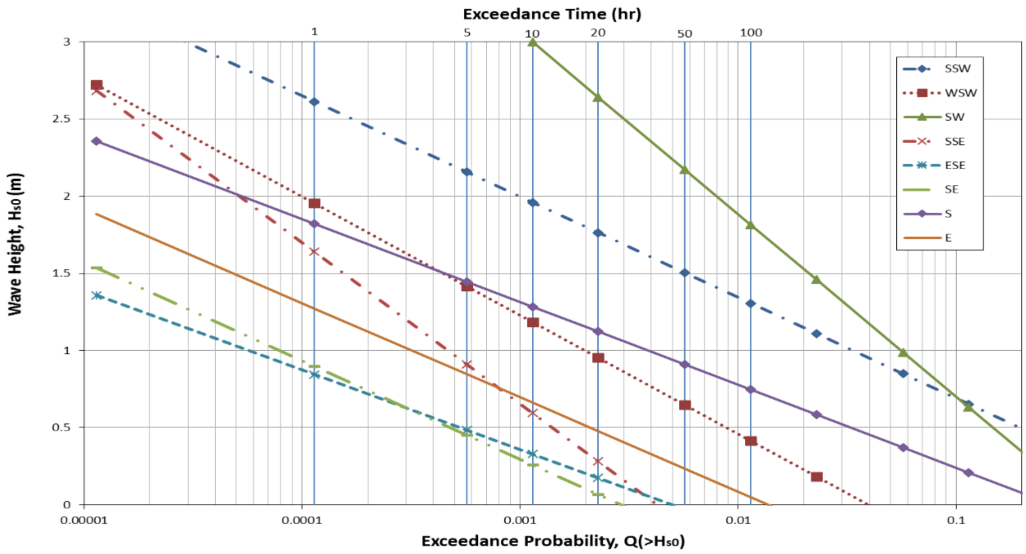

Figure F.9. The Long Term Analysis Graph for the MR-22 ECMWF Data Set (2000-2010)

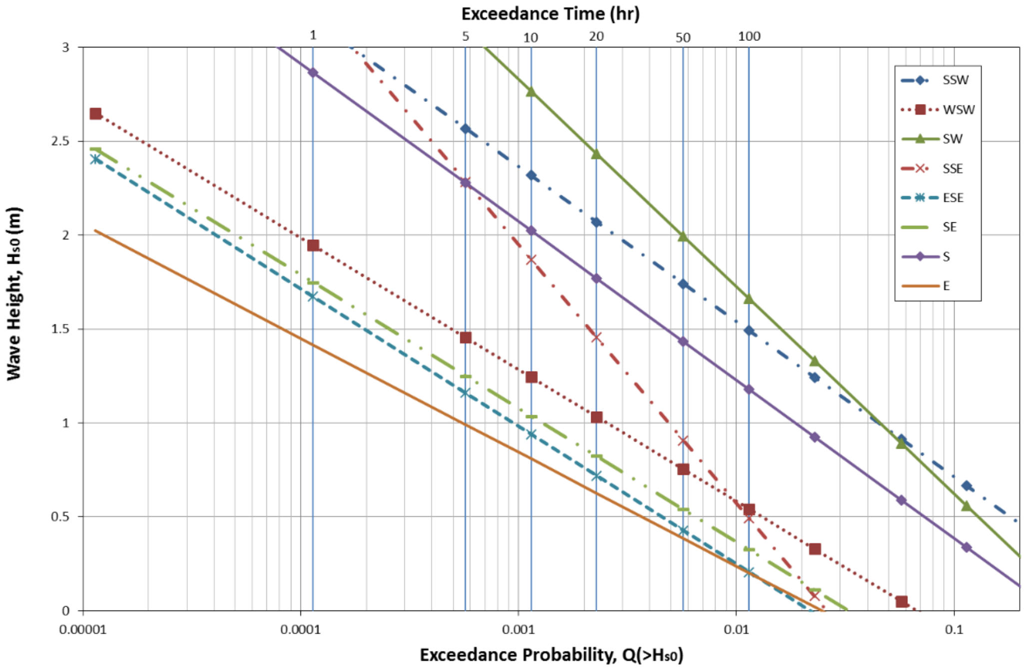

Figure F.10. The Long Term Analysis Graph for the MR-22 ECMWF Data Set (1983-2013)

MR-9 (36.60N-34.50E):

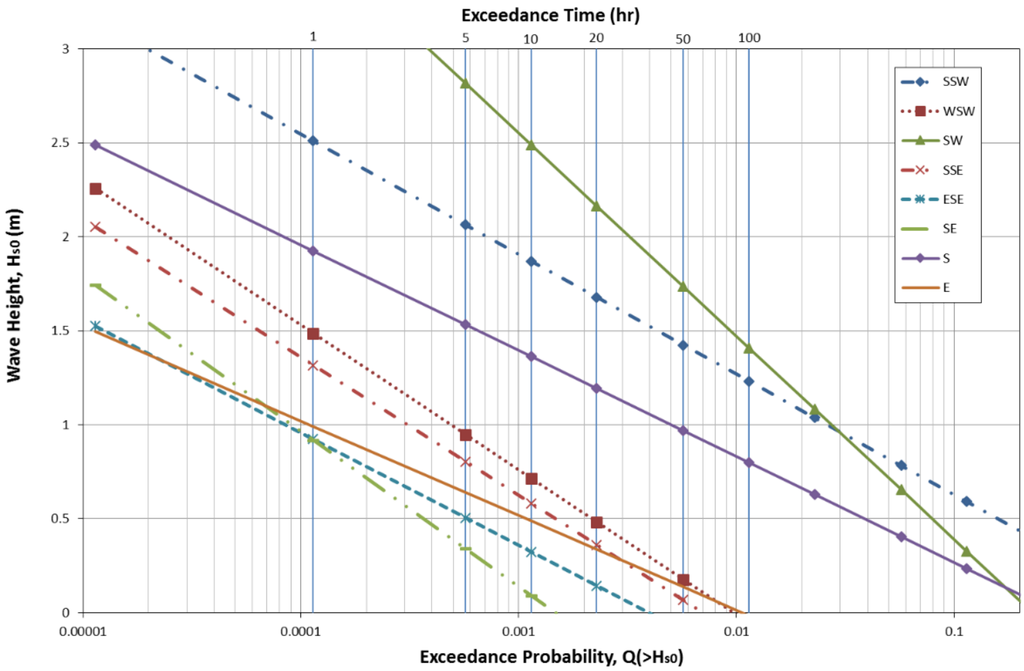

Figure F.11. The Long Term Analysis Graph for the MR-9 ECMWF Data Set (2000-2010)

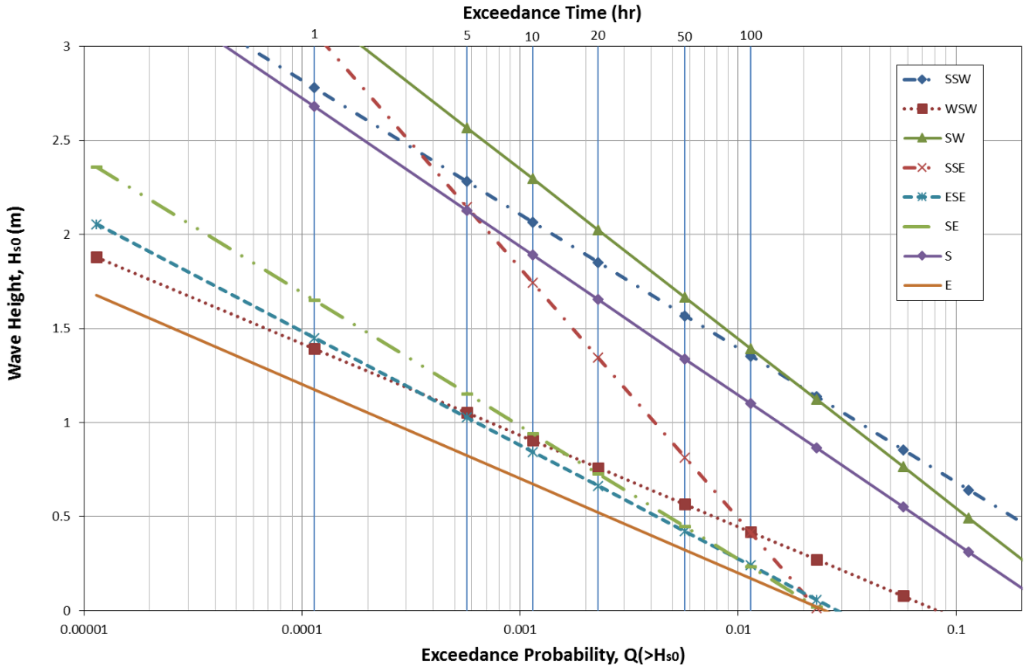

Figure F.12. The Long Term Analysis Graph Analysis for the MR-9 ECMWF Data Set (1983-2013)

Adana-Karataş:

ECMWF (36.50N-35.40E):

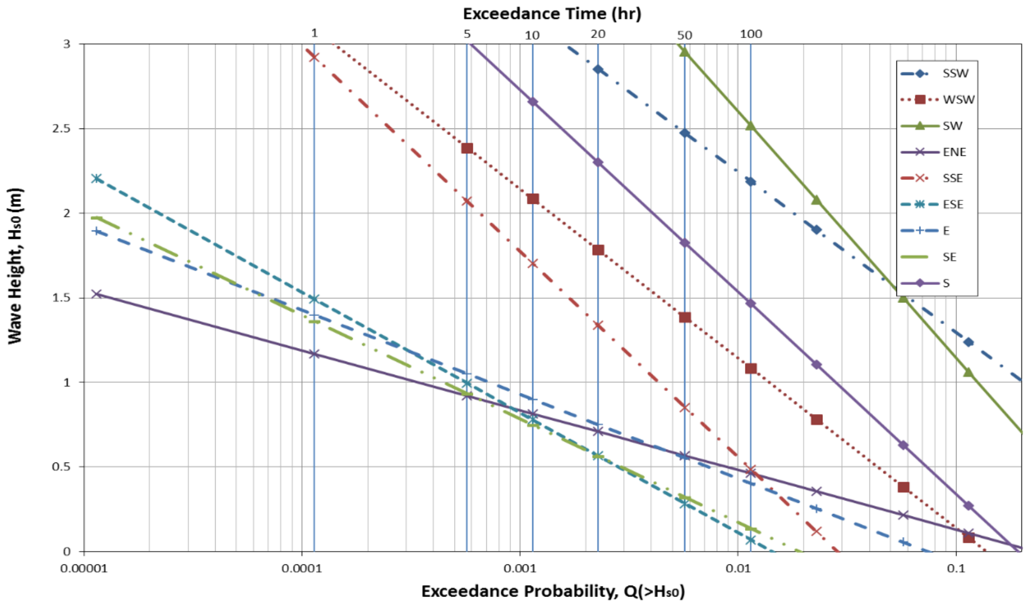

Figure F.13. The Long Term Analysis Graph Analysis for the Adana-Karataş ECMWF Data Set (1983-2013)

KR-46 (36.30N-35.40E):

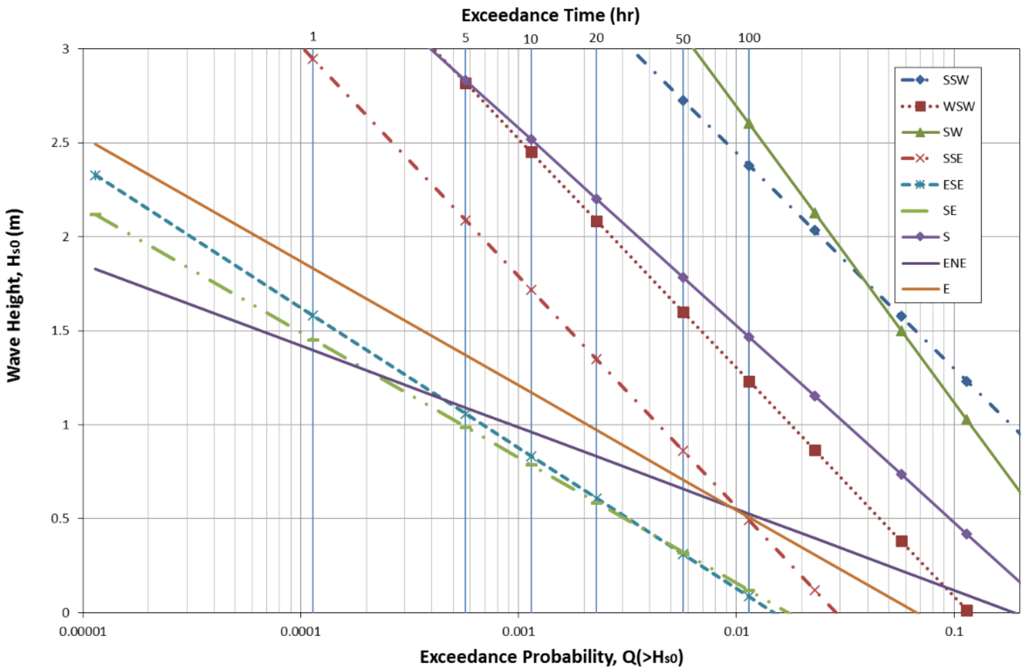

Figure F.14. The Long Term Analysis Graph for the KR-46 ECMWF Data Set (1983-2009)

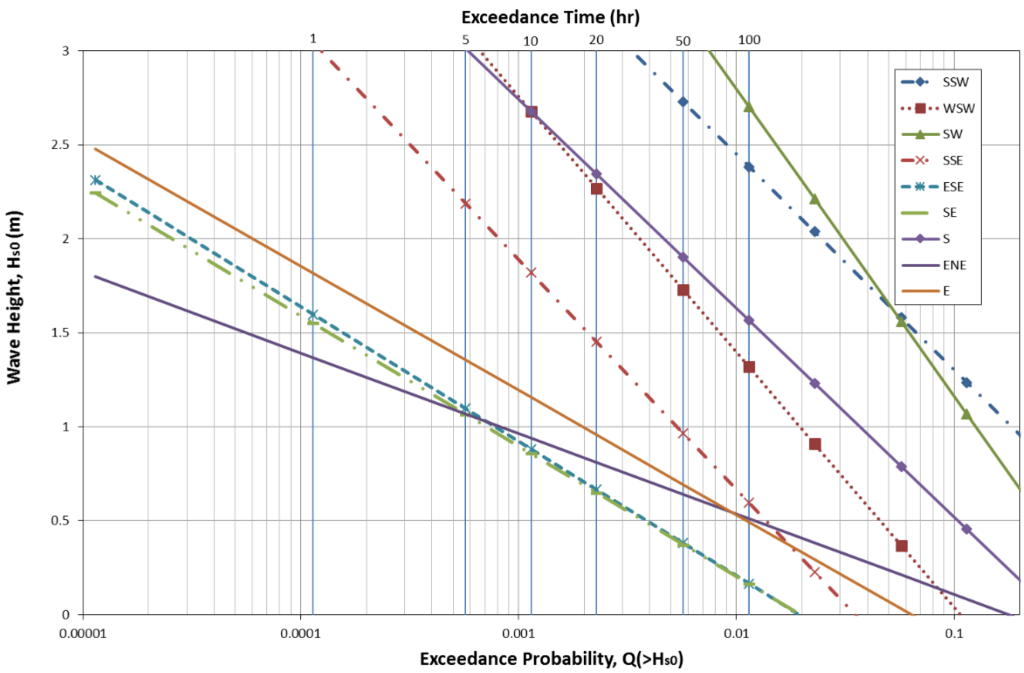

Figure F.15. The Long Term Analysis Graph for the KR-46 ECMWF Data Set (1983-2013)

KR-36 (36.40N-35.50E):

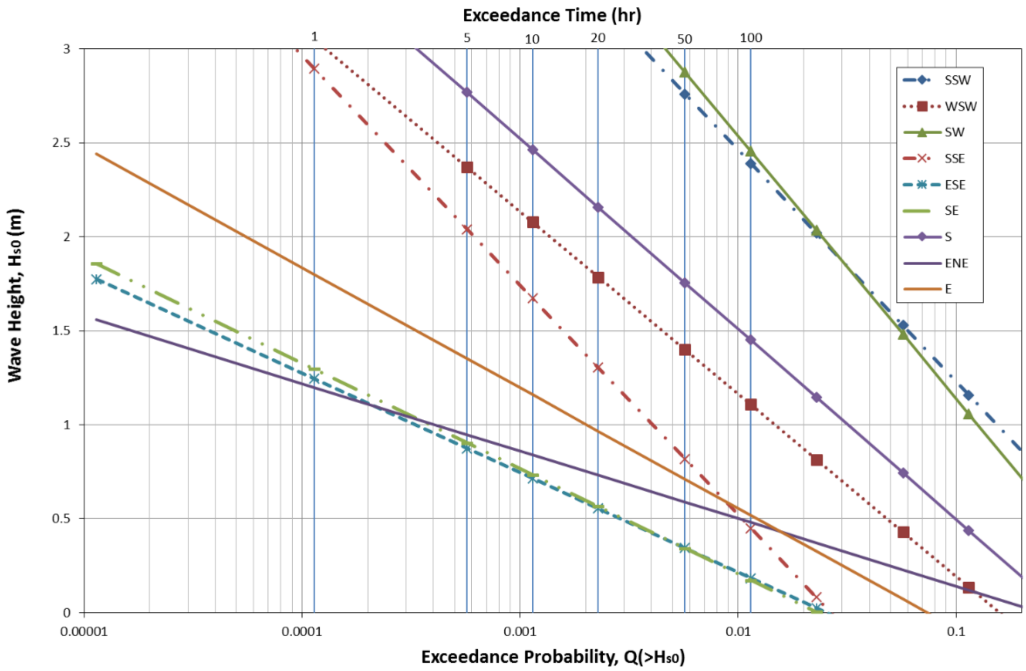

Figure F.16. The Long Term Analysis Graph for the KR-36 ECMWF Data Set (1983-2009)

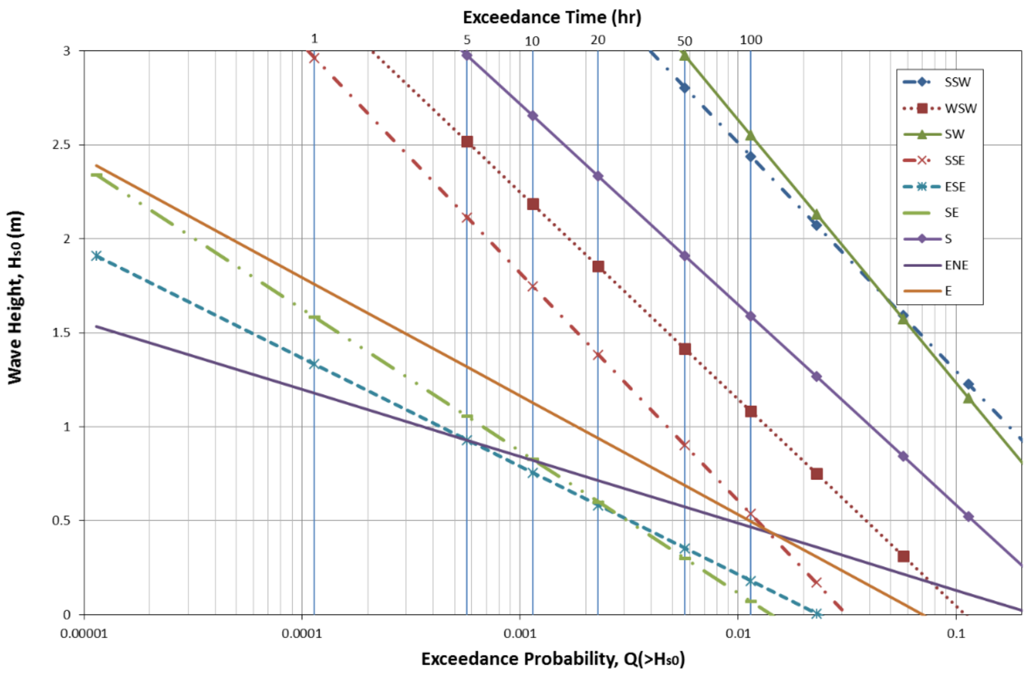

Figure F.17. The Long Term Analysis Graph for the KR-36 ECMWF Data Set (1983-2013)