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"Without big data analytics, companies are blind and deaf, wandering out onto the web like deer on a highway." - Geoffrey Moore

DATA ANALYSIS FROM DIFFERENT METAR WEATHER STATIONS IN EUROPE

METEOROLOGIA

Introduction

The initial aim of this project was to analyse the weather patterns in Europe to see how they could impact on the aviation aiming for a better flight planning, however due to the lack of data and the need to implement a meteorological model made it very difficult and off the scope of this subject.

Therefore, a simpler approach has been taken where 5 meteorological weather stations are being analyse for 30 days using their every 30 minutes published data.

The stations chosen are Barcelona, Madrid, Bilbao, Seville, and Frankfurt airports. The first four stations have been chosen as they are key assets in the Spanish aeronautical sector and have a different climate which will help to contrast between a Mediterranean, extreme Mediterranean, Central and Atlantic climate. Finally, a Central Europe Airport has been taken as it will be out of a pressure system affecting the entire Iberian Peninsula.

Data analysis:

As stated, from each station it has been obtained a total of 1440 METARs corresponding to a report every 30 minutes during a 30 days period (all databases for more than 30 days are pay ware) from May 19th 2021 at 09:00 UTC to June 18th 2021 at 09:00 UTC.

Once all data was gathered it was time to filter the METARs, to do so all elements from TEMPO and BECMG have been removed, as well as runway data, RE data (which stands for recent events data). Finally, COR and NIL which stands for corrections and nil reports have been discarded.

Additionally, some reports had to be corrected as they had some format mistakes which made them impossible to process a clear example would be the AUTO reports which had a different structure missing NOSIG, BECMG or TEMPO and therefore had to be arranged in order to be processed.

The program consists of four files:

The first one contains an object called METAR where all the values of a report are stored as arguments. The second one called LeerDatos, is in charge of reading every line, splitting it into the different elements creating an object of class METAR and finally it returns and array of METAR. The third one is called ProcessarDatos and it is an object which inherits from the class METAR and adapts the data in order to be plotted, it also has methods returning the arguments needed to perform every plot. Finally, there are two mains: the first one plots all the data from one airport, whereas MainPlots plots the data from the four Spanish airfields in order to compare them.

The bar plots regarding the different phenomena and the clouds coverage represents the percentage of repetition of that item over the METAR's file from each airport.

Regarding to the wind plots variable wind directions have been discarded as well as the gusting velocity and winds with VRB have been considered nil.

The QNH plot will be shown in the comparison for the first four airports.

Barcelona LEBL airport, Mediterranean climate

It is characterized by having warm and dry summers with a mean temperature over 22ºC and a smooth winter humid and rainy.

Bellow it can be seen all the data processed at LEBL:

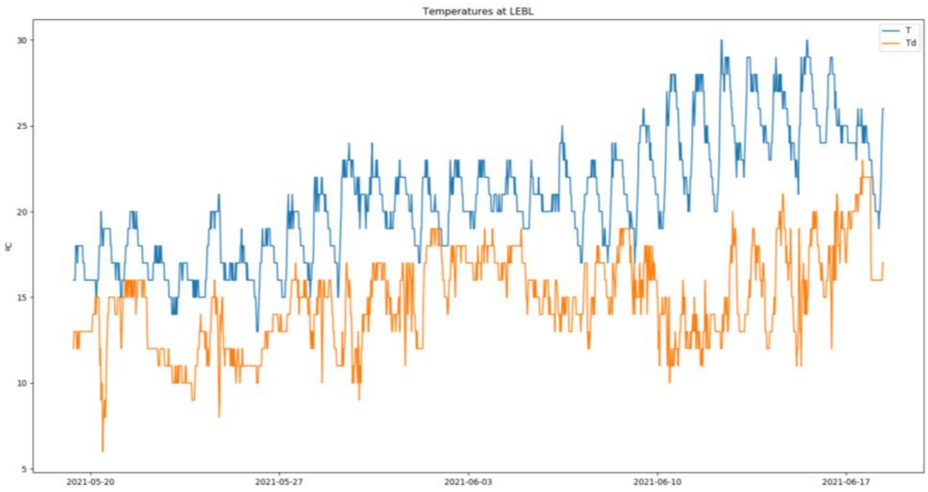

Figure 1: LEBL temperatures

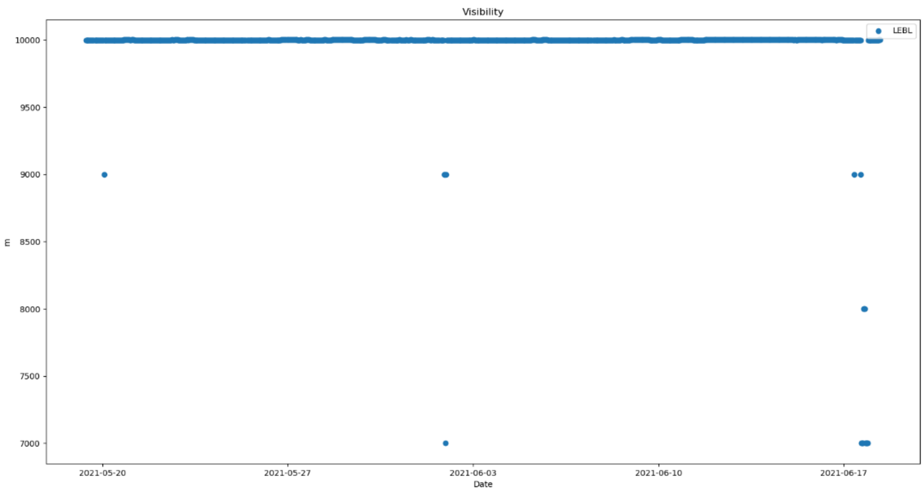

Figure 2: LEBL htz visibility

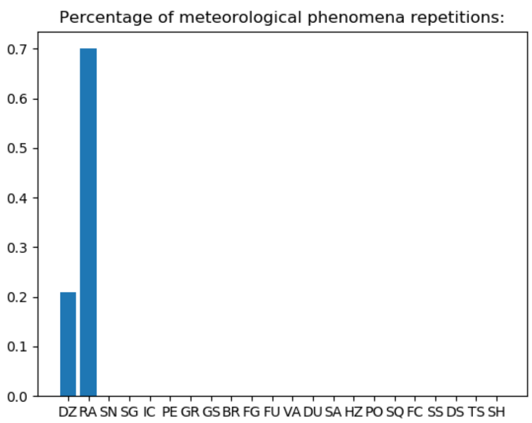

Figure 4: LEBL met. phenomena

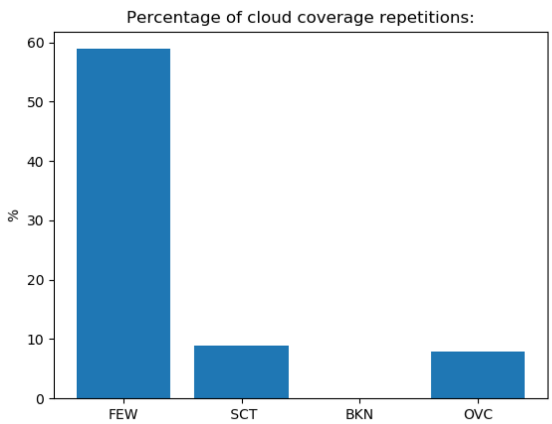

Figure 3: LEBL cloud coverage

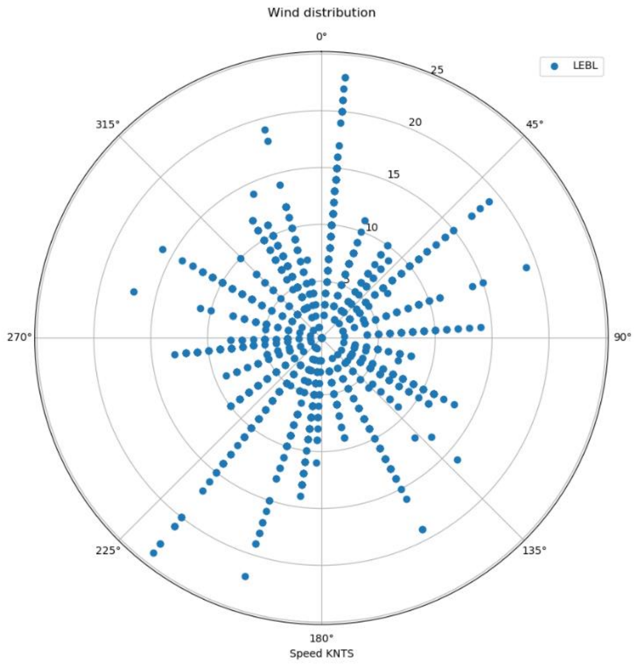

Figure 5: LEBL wind rose

Seville LEZL Airport, Dry Mediterranean climate

It is a transition between the desertic and Mediterranean climate. It has warm winters where most of precipitations take place and very hot summers with temperatures rising well above 25ºC in the coast particularly in the centre and in Seville temperatures can rise to 45ºC.

Bellow it can be seen all the data processed at LEZL:

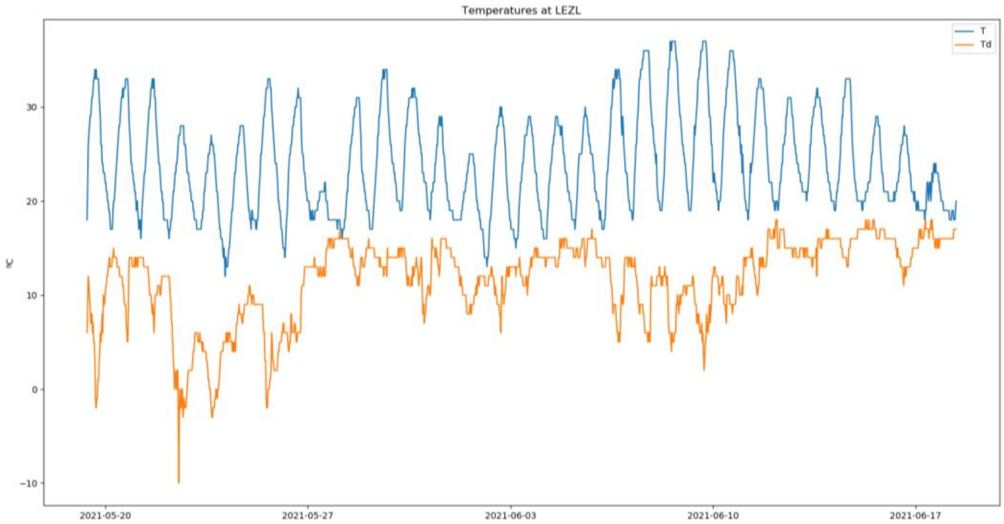

Figure 6: LEZL temperatures

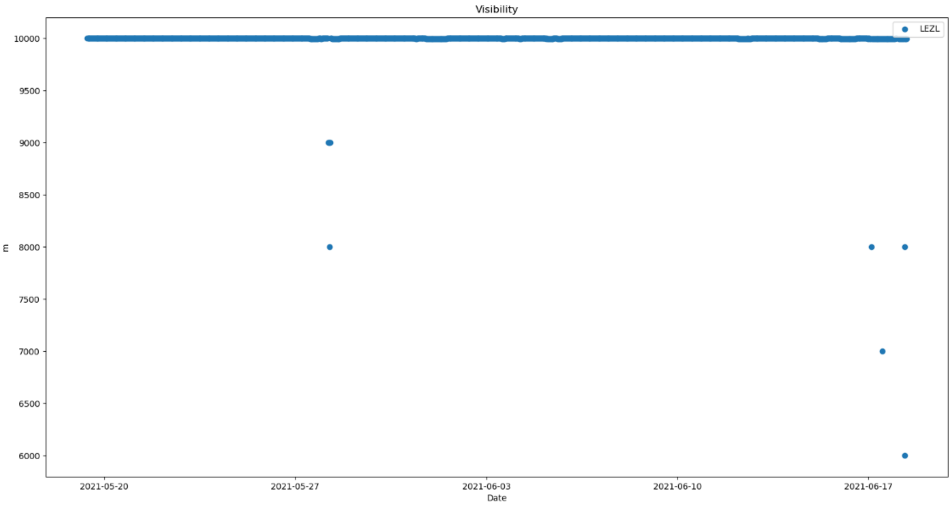

Figure 7: LEZL htz visibility

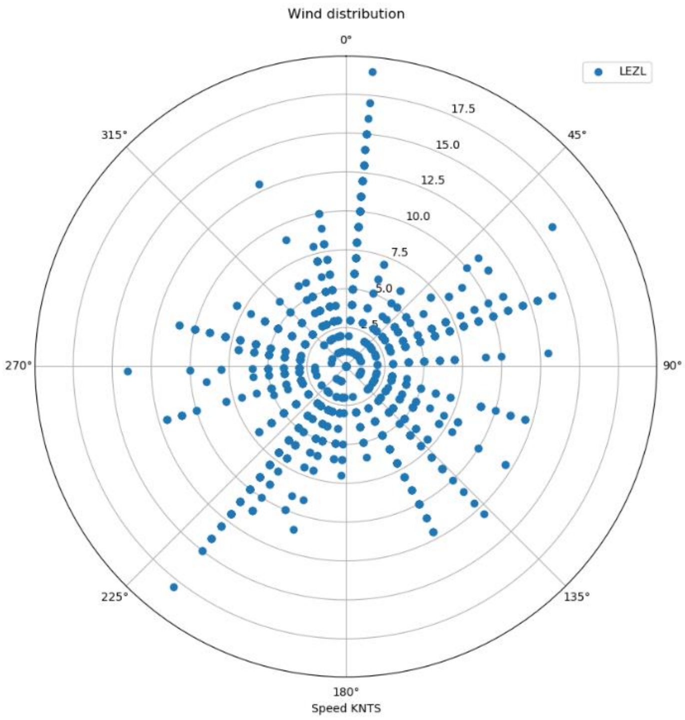

Figure 9: LEZL wind rose

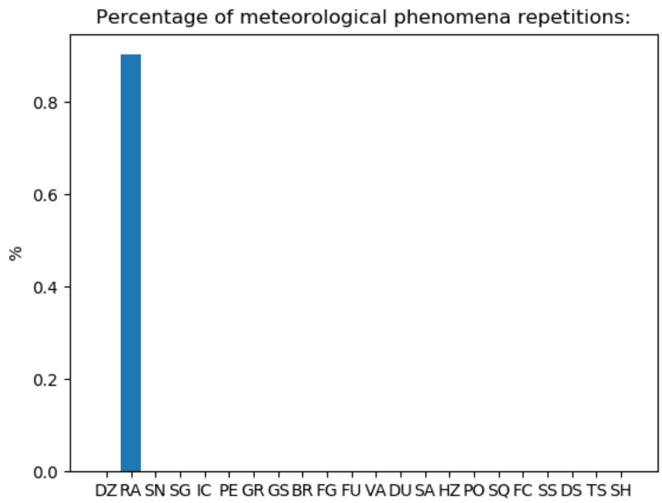

Figure 8: LEZL met. phenomena

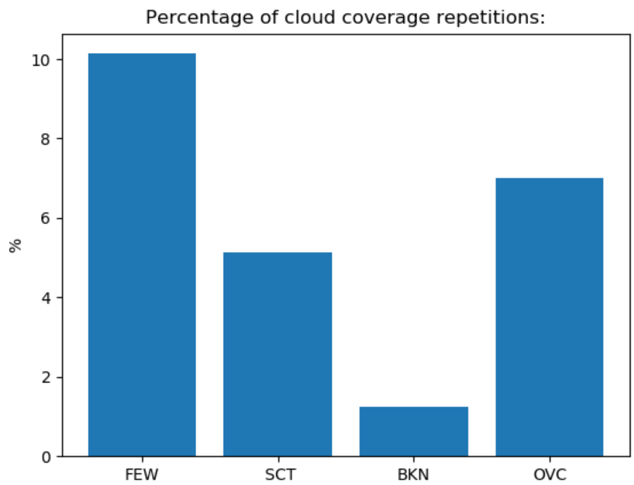

Figure 10: LEZL cloud coverage

Madrid LEMD airport, Continental Mediterranean climate

Madrid climate is special as it is clearly a continental one but at the same time it has some influences from the Mediterranean climate. Also, it is important to recall the altitude of the Spanish plateau to the sea level which also has an impact to the meteorology and aviation.

Therefore, it differs from central Europe, it is characterised by stepper thermic amplitudes which lead to cold winters with snow and frost to the warmest temperatures in Europe in summer.

Bellow it can be seen all the data processed at LEMD:

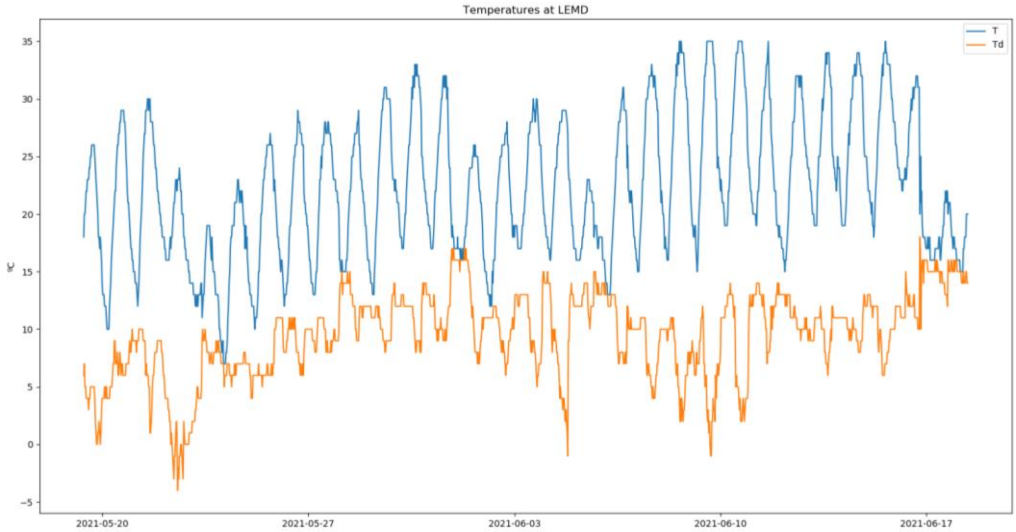

Figure 11: LEMD temperatures

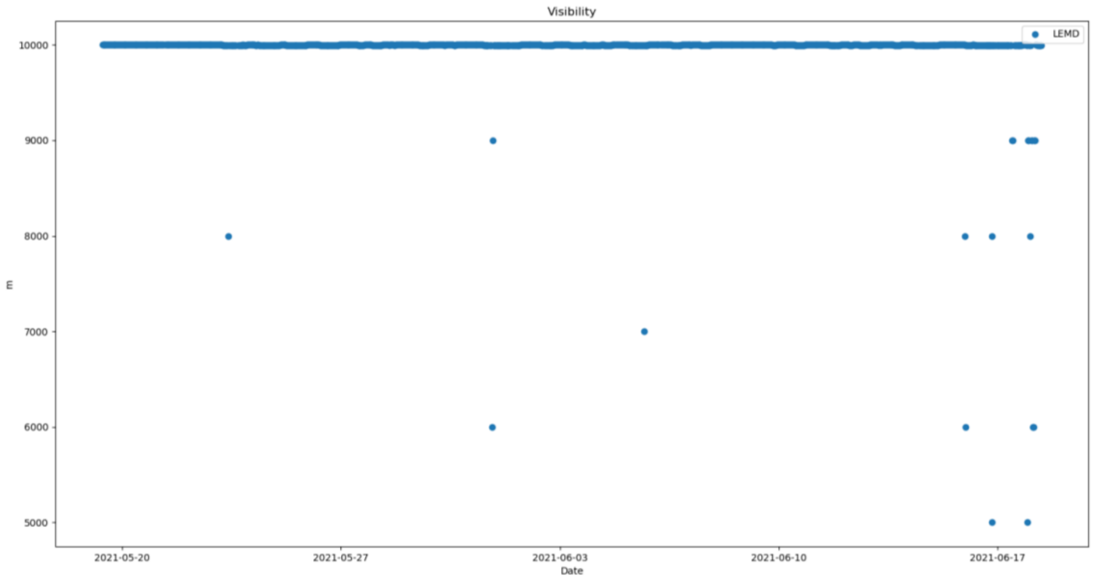

Figure 12: LEMD htz visibility

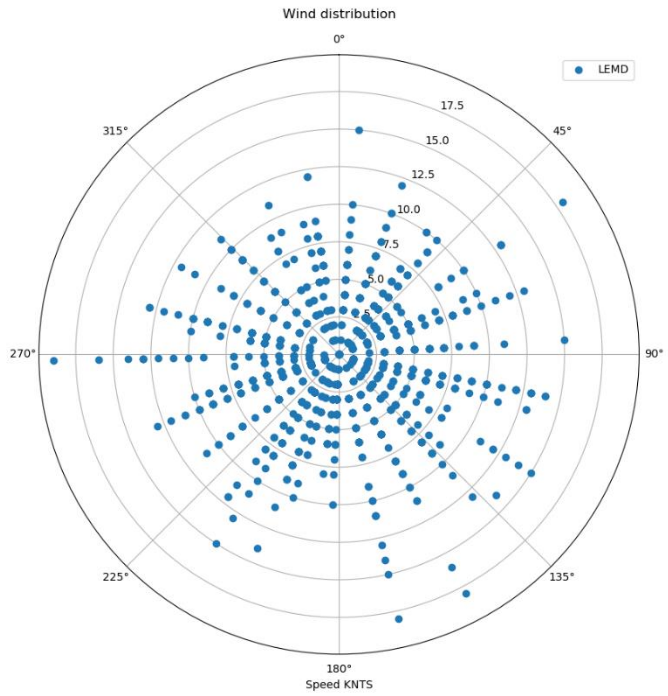

Figure 14: LEMD wind rose

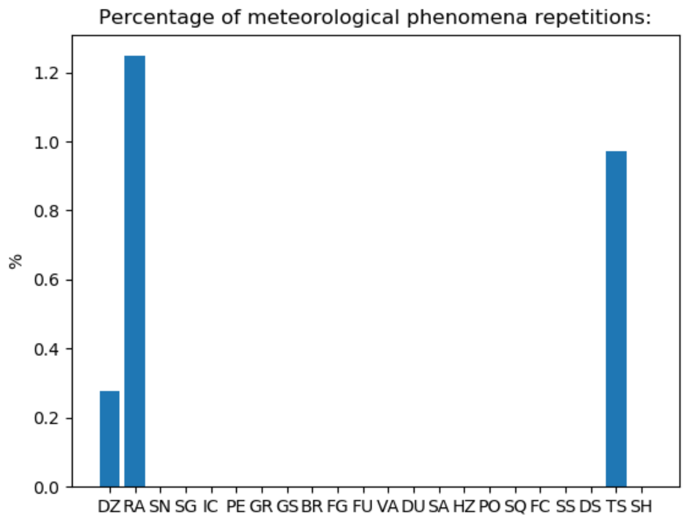

Figure 13: LEMD met. phenomena

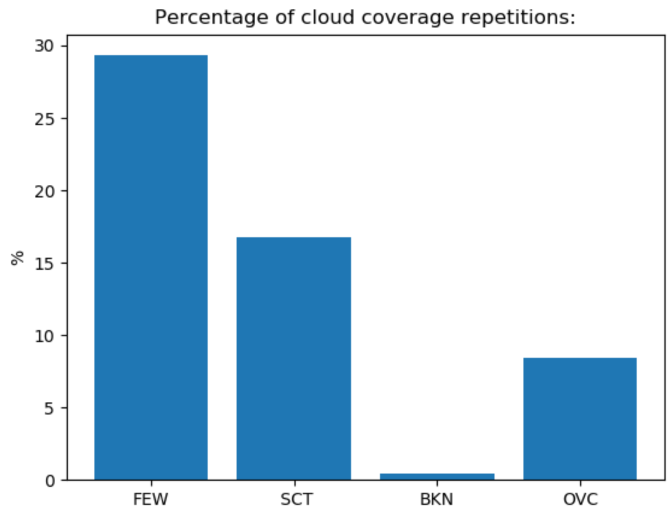

Figure 15: LEMD cloud coverage

Bilbao LEBB airport Atlantic/Oceanic climate

It is influenced by the water mass from the Atlantic Ocean, also from polar fronts and subtropical high-pressure systems from the convergence of Ferrell's and Hadley's cells it rains during all the year with more intensity in the winter the mean temperature is between 7ºC and 14ºC, in winters it can snow sometimes.

Bellow it can be seen all the data processed at LEBB:

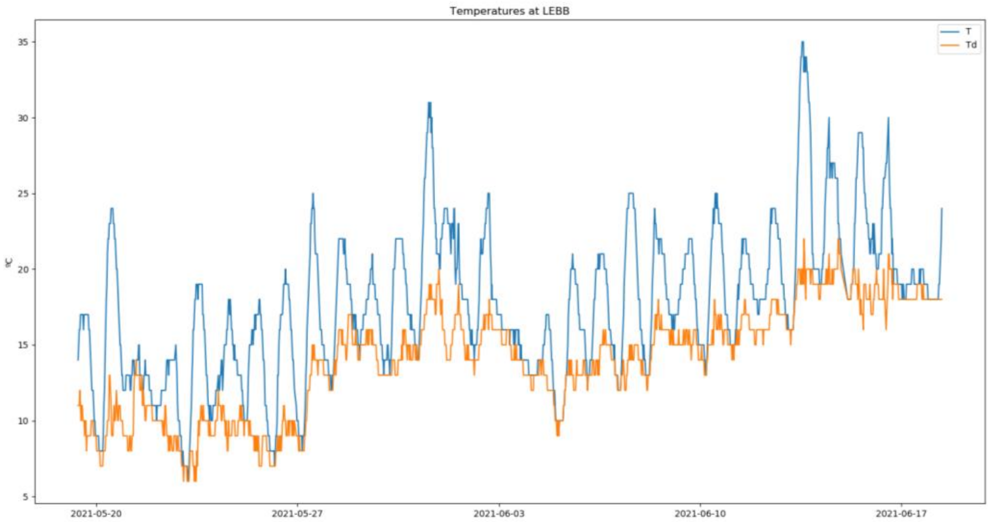

Figure 16: LEBB temperatures

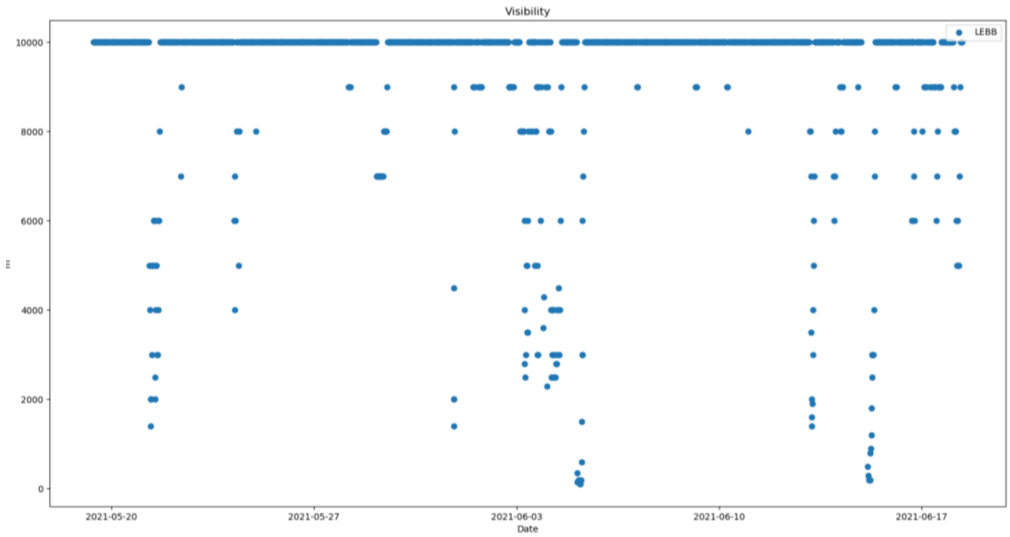

Figure 17: LEBB htz visibility

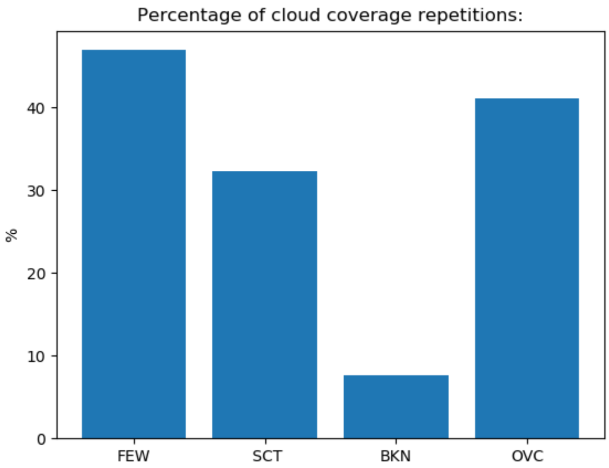

Figure 18: LEBB cloud coverage

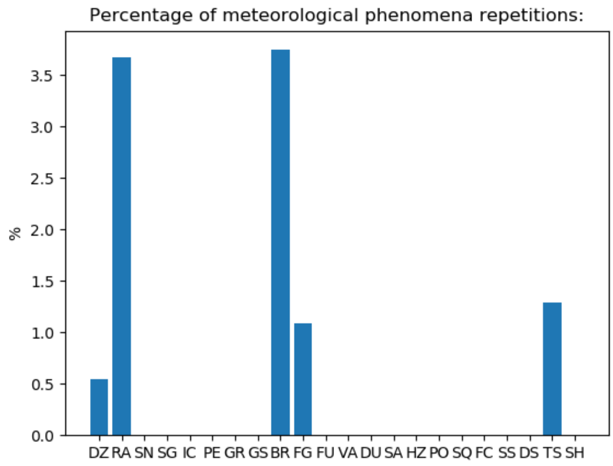

Figure 19: LEBB met. phenomena

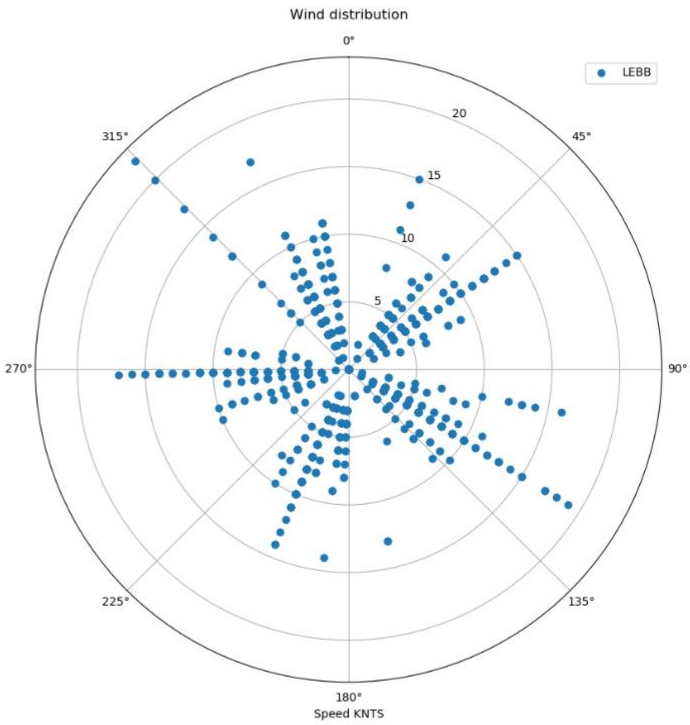

Figure 20: LEBB wind rose

Frankfurt EDDF airport Continental /Marine West Coast Climate

It is a clear example of a central Europe climate with some effects from the Atlantic coast, it has smooth summers and cold winters with snow and frost, and rains during the entire year.

Bellow it can be seen all the data processed at EDDF:

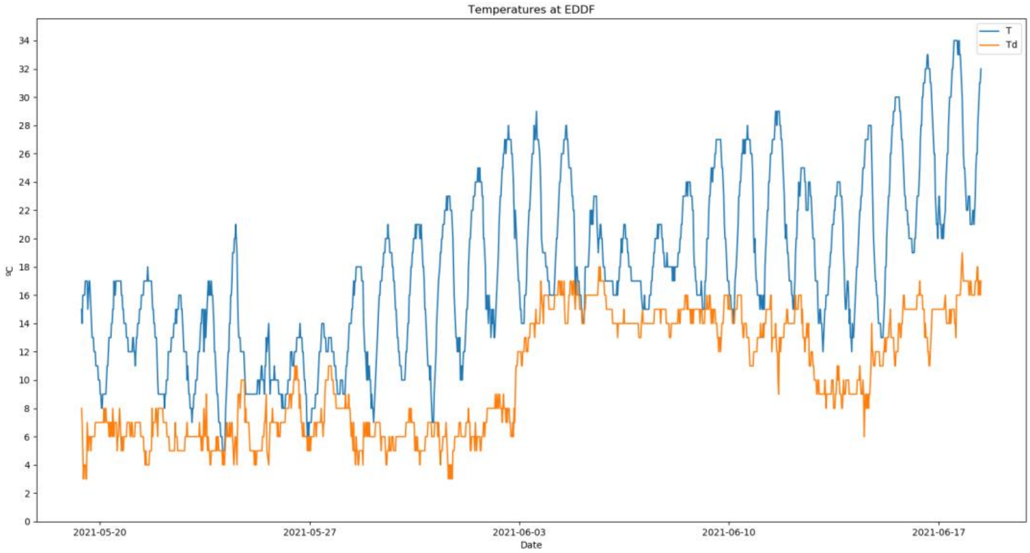

Figure 21: EDDF temperatures

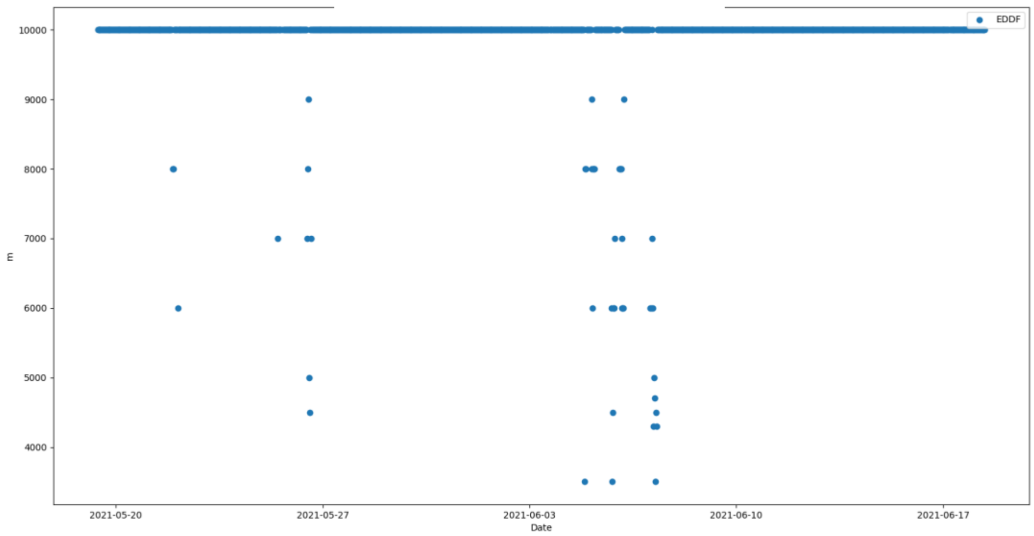

Figure 22: EDDF htz visibility

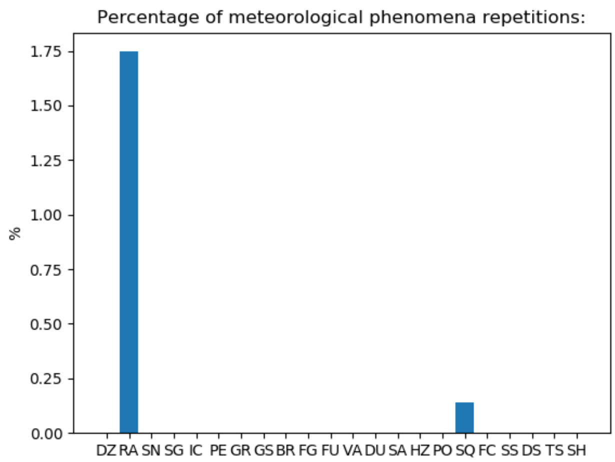

Figure 24: EDDF met. phenomena

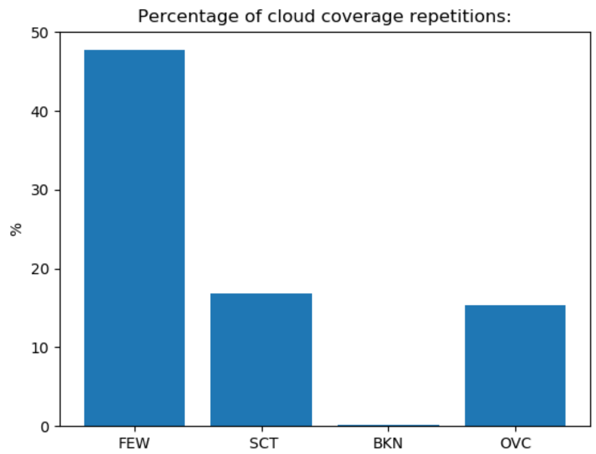

Figure 23: EDDF cloud coverage

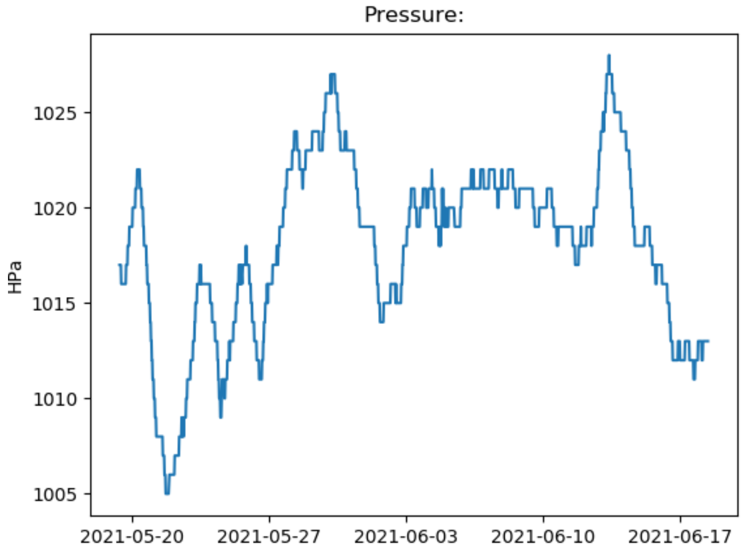

Figure 26: EDDF QNH

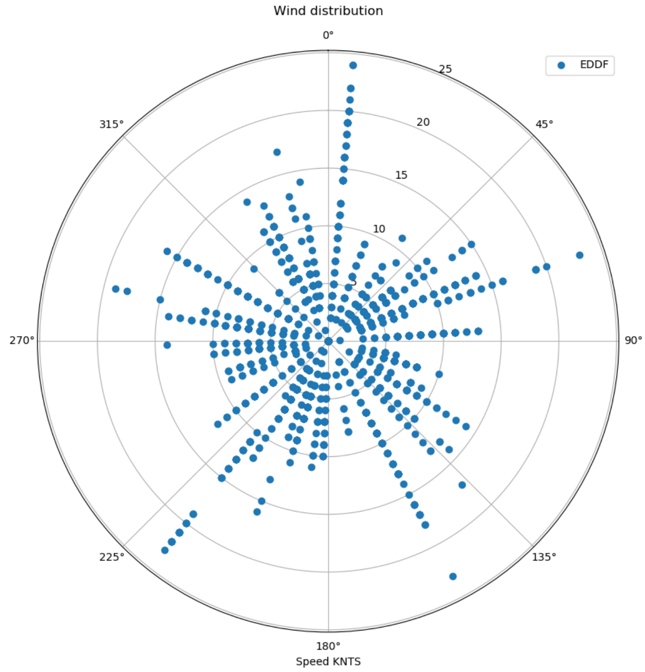

Figure 25: EDDF wind rose

Climate comparison

⇒ Temperature

As seen in Figure 27, Sevilla airport (dry Mediterranean climate) has the highest average temperatures due to north African weather influence, while Madrid (Continental Mediterranean) has similar temperature values, only a little lower. It is important to notice that the data taken is from May and June, almost summer dates, and Madrid is influenced by step thermic amplitudes which makes the temperature to increase during the summer while if the data were taken during winter, the same phenomena would generate cold temperatures. Finally, as seen in the plot Barcelona and Bilbao have the lowest temperatures since both airports are located near the sea which produces a drop in temperatures. Also, Bilbao temperatures are slightly lower since they are affected by northern polar fronts and subtropical high-pressure systems.

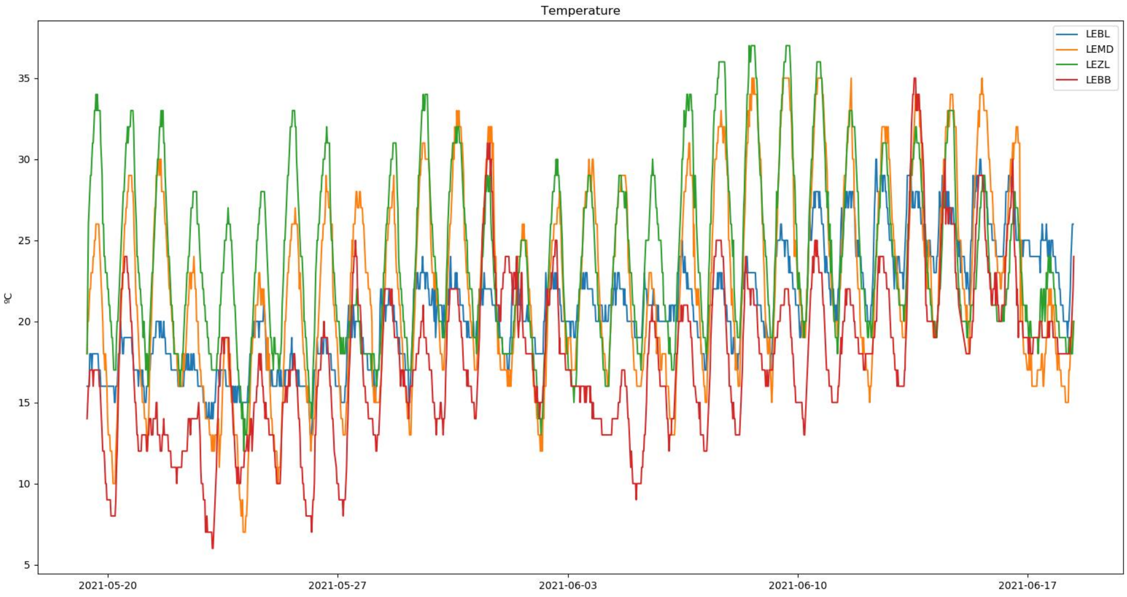

Figure 27: temperatures comparison

⇒ Pressure

As seen in Figure 28, Bilbao has the highest pressures since it is affected by subtropical high-pressure systems, Also the lower values can be related to polar maritime fronts entering the Iberian Peninsula by the north Atlantic coast and the Vizcaya gulf.

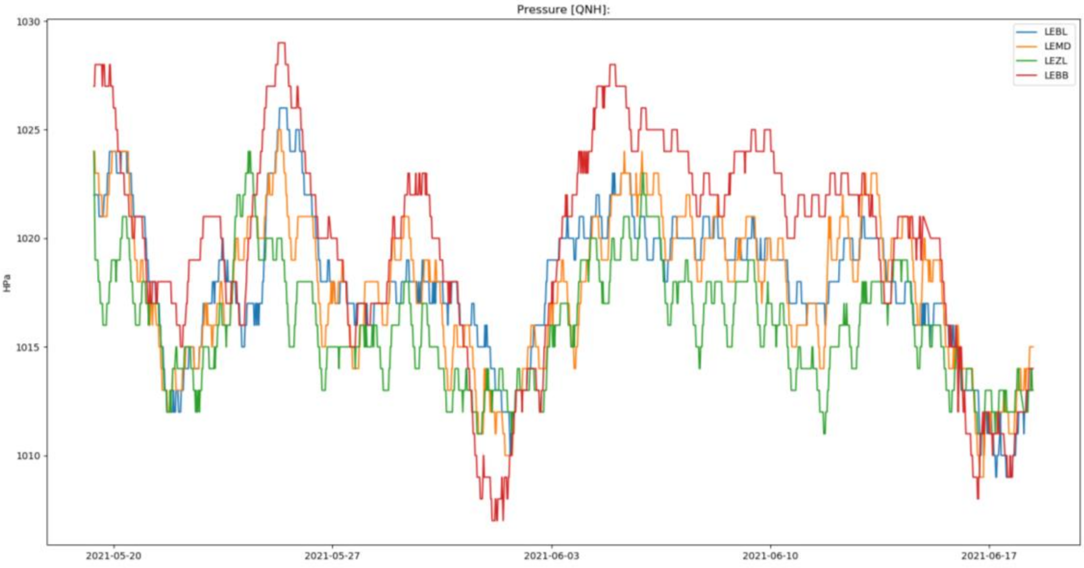

Figure 28: QNH comparison

⇒ Cloud coverage

As seen in Figure 29, Bilbao has the highest cloud coverage due to its meteorological conditions, which produces frequent rains. Barcelona usually has some clouds 1-2 oktas, due to its proximity to the sea, which evaporates gases that act as cloud condensation nuclei. Finally, Sevilla and Madrid have low cloud coverage since both airports are surrounded by unstable air mass conditions.

Both Barcelona and Bilbao could be related the cloud coverage to their proximity to big water masses interacting with the ground

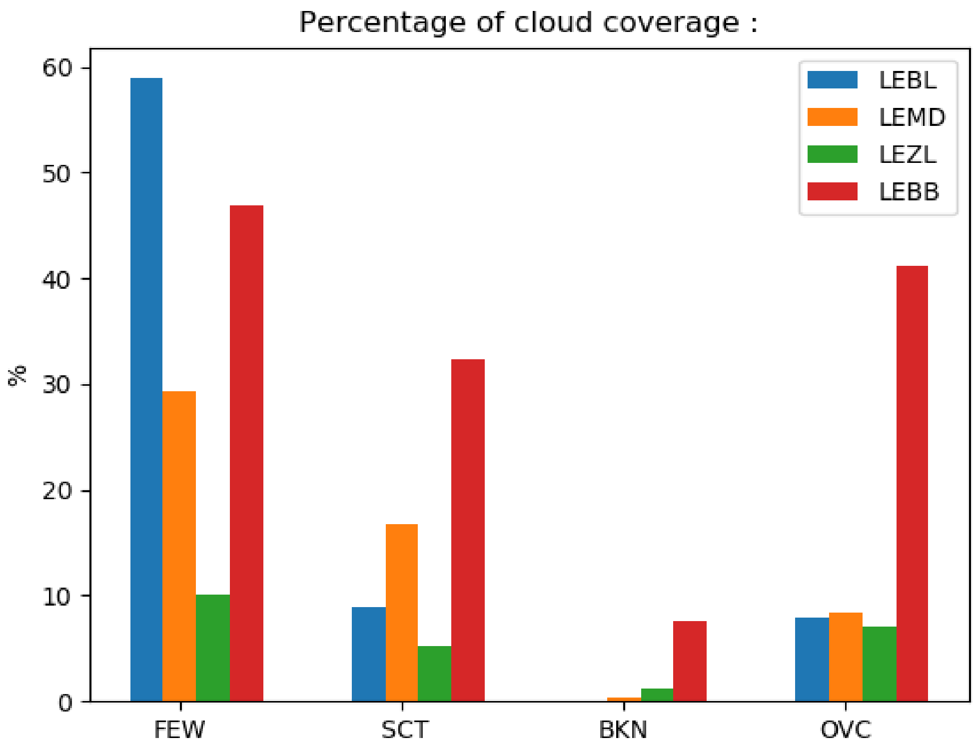

Figure 29: cloud coverage comparison

⇒ Meteorological phenomena

As seen in Figure 30, Barcelona, Seville and Madrid most common phenomena is rain which barely represents 1% of the reports. On the other hand, Bilbao has frequent rains and mist, also it has some fog and thunderstorm. Bilbao has a reasonably stable weather (during some days because of fog occurrence) affected mainly.

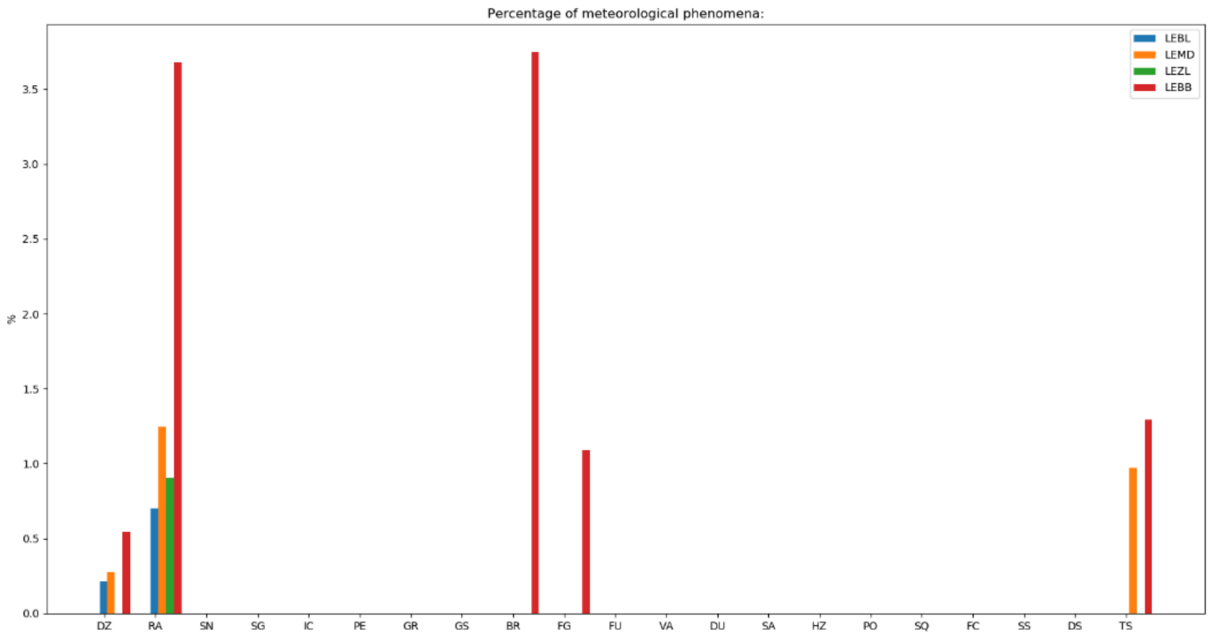

Figure30: met. phenomena comparison

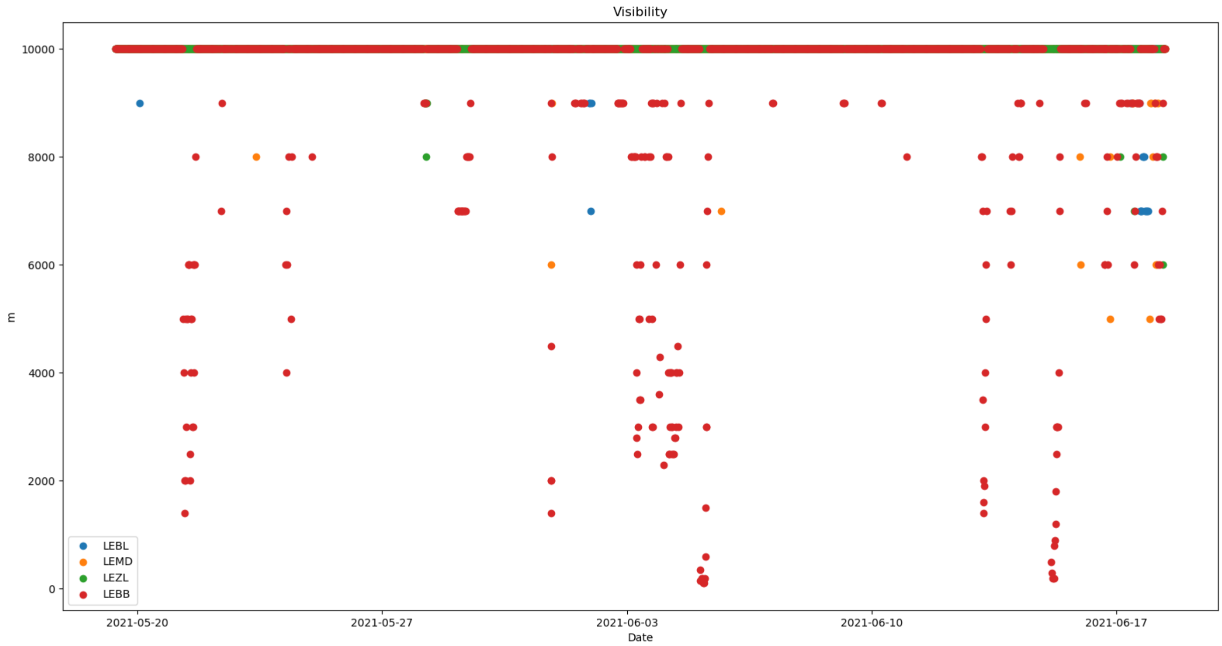

Figure 31: visibility in Spanish airfields

⇒ Horizontal visibility

With clear difference Bilbao is the airport with poorest visibility, this can be explained as a conjunction of fog development when stable weather and bad weather (rain, storms, …) which clearly decreases the visibility, by contrast Barcelona is the airport with the best visibility average.

Conclusions

- Mediterranean climate (LEBL) → characterised by warm summers and normal winds, and often between 1 and 2 oktas of cloud coverage. The most frequent meteorological phenomena is rain, though it is not usual.
- Dry Mediterranean climate (LEZL) → characterised by hot and dry summers and warm winters and soft winds. Clouds are not usual, and they appear with different coverage ranges, between 1-2 oktas, 3-4 oktas or more than 8 oktas. The most frequent meteorological phenomena is rain, slightly more usual than in LEBL.
- Continental Mediterranean climate (LEMD) → characterised by hot summers and cold winters and soft winds, and often between 1 and 4 oktas of cloud coverage. The most frequent meteorological phenomena are rain and thunderstorm.
- Oceanic climate (LEBB) → characterised by cool summers and cold winters and normal winds. Clouds are usual, covering up to 8 oktas, although coverage range between 5 and 6 oktas is less usual. Rains and mist are very usual, while fog and thunderstorms are less usual.
- Continental climate (EDDF) → characterised by warm summers and cold winters and high winds. Clouds are usual, with a range coverage of 1 to 2 oktas. Furthermore, coverage ranges up to 8 oktas can also be found, but with less frequency. Rains are very usual, and squall can barely happen.

Further improvements

Further improvements on this project should be to increase the robustness of the code and its automation, additionally it would be interesting to add data from pluviometers from different airports in order to quantify the amount of water that each precipitation provides.

Bibliography

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Global Navigation for Pilots 2nd Edition PhD Dale de Remer, Donald w. Mclean, ASA, ISBN 978-1-56027-312-7