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# An investigation on the climatic conditions of the wider area of Athens International Airport "Eleftherios Venizelos", Greece

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**Abstract**

The climatic conditions of the wider area of the Athens International Airport "Eleftherios Venizelos", Spata, Greece are described in the current work. Thus, data derived from meteorological stations of the Hellenic National Meteorological Service, located in the area of Spata, were used. The time series of the climatic parameters for the period between the years 1974 and 2019 were analyzed and their mean monthly and annual values as well as their mean seasonal ones were calculated. These values were used for the estimation of climatic conditions of Spata. It was found that this area is characterized by the Mediterranean climate of Etesians with relatively cool summer and mild winter, high annual sunshine duration, low annual precipitation and long drought in summer. The knowledge of the climatic conditions above plays an important role in aviation because it is a useful tool in the planning of activities related to the operation of the Athens International Airport "Eleftherios Venizelos".

**Keywords:** Air Temperature, Athens, International Airport, Climatic Conditions, Mediterranean Climate, Relative Humidity

## Introduction

The Attica peninsula, located between 37º39´N and 38º20´N as well as between 23º07´E and 24º05´E [1], is characterized by intense relief with mountainous ranges that surround the lowland areas of Mesogaia, Athens basin, Thriasio Pedio and Megara [2]. The area of Spata is part of the Mesogaia plain and is about 24 km away from the densely populated capital of Greece, Athens. In the past, there was intense agricultural activity (olive growing, viticulture, vegetable farming, etc.) in the plain of Spata.

The geomorphology of the area of Spata and its proximity to Athens were the preconditions for the change of its use after the year 2000, when the Athens International Airport "Eleftherios Venizelos" (AIA) was established there with a noticeable contribution both locally and nationally [3, 4], taking into account that it is a main gateway to Greece. It is characteristically reported that the number of passengers travelling through this airport overdoubled in the year 2019 compared to the beginning of its operation (2002) while the number of flights increased by 42% [5].

The existence of meteorological and climatic data in an area is a valuable asset for its promotion and utilization. In the plain of Spata there was a meteorological station in operation since 1974. The data of this station helped both prevention and treatment of fungal and entomological diseases in the cultivated plants, determining the exact time of plant protection interventions for their best effectiveness, as well as decisions, in general, that the grower had to make to face the daily problems.

The continuous operation of meteorological station in the plain of Spata until today provides, due to its long-term operation, the knowledge of the climatic parameters that describe and characterize this area. These climate data are a valuable material in aviation, because this information combined with the current daily values of meteorological parameters could contribute greatly to the planning activities related to the operation of AIA located in Spata.

## Materials and methods

From the existing meteorological stations in the area of Spata, the data of two stations of the Hellenic National Meteorological Service were selected to be used. The first station (37º58´N, 23º55´E) is located at an altitude of 67.0 m with a duration of operation from 1974 to 1999. The second station (37º55´16´´N, 23º55´52´´E) is located at an altitude of 72.0 m and operates from the year 2000 until today. The relatively short distance (5.2 km) and the altitude difference of only 5.0 m between them fulfill the conditions for making use of their data. The selection of these stations was based on both proper operation and large time series of meteorological data provided by them.

From the data of time series of air temperature and relative humidity, precipitation, atmospheric pressure, wind speed as well as sunshine duration, the mean monthly and annual values (Table 1) as well as the mean seasonal ones of the above parameters (Table 2) were calculated. The air temperature is of particular interest, since the physiological functions of both plant organisms [6] and animal ones [7] are decisively influenced by the thermal environment in which they live. For this reason, air temperature is the most important climatic element and the most basic parameter in all climatic classifications [8]. So, the knowledge of both means monthly and extreme values of air temperature and their changes during the months and seasons of the year leads to the necessity of an extensive analysis of this parameter.

It is pointed out that the reference to air temperature and relative humidity includes the thermohygrometric conditions that form in the shade at a height of 1.80 m above the ground, the height of precipitation that falls on the ground, the wind speed at a height of 6.0 m from it and the conditions of atmospheric pressure at a height of 96.0 m above sea level.

## Results and discussion

The processing and analysis of the data of the meteorological stations of Spata showed that the value of mean annual air temperature was 17.6 ºC, while the mean annual maximum and minimum air temperatures were 21.7 ºC and 12.1 ºC, respectively. The highest values of the mean monthly maximum temperature were observed in July and August, reaching 31.5 ºC and 31.3 ºC, respectively, while the lowest mean monthly minimum temperature (4.6 ºC) was found in January (Table 1). The annual course of mean monthly temperature values showed a simple fluctuation, which means that the coldest month was January with a mean temperature of 8.7 ºC and the warmest month was July with a mean temperature of 27.6 ºC.

During the winter months of the reference period (1974-2019), January showed the highest percentage frequency of occurrence of the lowest mean minimum temperatures (48.8%), followed by February and December with frequencies 34.2% and 17.0%, respectively. Also, as regards the summer months, July showed the highest percentage frequency of occurence of the highest mean maximum temperatures (68.3%), followed by August at a lower percentage, almost by half (31.7%).

Regarding the progressive change of air temperature from month to month in the area of Spata (Table 1), it was found that the smallest positive changes of the mean monthly temperature, maximum and minimum temperatures (+0.7, +0. 6 and +0.3 ºC, respectively) were observed during the transition from January to February which is considered cold to a considerable extent. During these months, decreased air temperature values are observed in the most areas of Greece, a fact which could be attributed to the intense atmospheric circulation observed during the mentioned time period. More specifically, the lows that are created in the Mediterranean area in combination with the anticyclone of Eurasia and its extensions, affect the areas of the Greek mainland, resulting in a drop in air temperature [8].

The smallest negative changes in both mean monthly temperature (-0.5 ºC) and maximum one (-0.2 ºC) were observed in the transition from July to August, a period in which weather uniformity is detected [9]. In other words, stable air masses prevail, which are moved towards the Greek region as a result of the expansion of the Atlantic anticyclone in combination with the impact of the summer low of India and Pakistan [10].

The largest positive changes from month to month were detected during the period of temperature rise and specifically in the transition periods from April to May (mean air temperature +5.0 ºC, mean maximum +5.2 ºC, mean minimum +4.3 ºC) and from May to June (mean air temperature +5.1 ºC, mean maximum +5.0 ºC, mean minimum +4.5 ºC), fact which certified the beginning of the warm season with the weakening of the activity of the lows. In contrast, the largest negative changes in air temperature (mean temperature -4.7 ºC, mean maximum -5.1 ºC, mean minimum -3.9 ºC) were detected during the period of its fall from September to October, which marks the beginning of the cold season. This fact could be attributed to the reduction of the duration of the day and the reduction of the meridian height of the sun [9, 11] as well as to the appearance of cold invasions in the Greek area [12].

The mean seasonal air temperature (Table 2) during the winter and summer periods was 9.5 ºC and 26.7 ºC, respectively. Values between 9.5 ºC and 26.7 ºC were observed during the transitional seasons (spring and autumn). In particular, the mean air temperature in spring was 15.7 ºC, while in autumn it was higher by 2.9 ºC. That is, autumn is thermally superior to spring, which is generally observed in the areas of Greece. This behavior is highlighted by comparing the mean monthly temperature of the first months of spring and autumn, that is, March and September, which is 11.7 and 23.2 ºC, respectively (Table 1). That is, March and September have characteristics of winter season and summer one, respectively, to a remarkable degree.

The annual course of the mean monthly values of relative humidity in Spata (Table 1) showed a simple fluctuation with a minimum (47%) during the warmest month of the year, July, and two maximums (74%) in November and December. The low relative humidity values observed during the summer period could be attributed, apart from the high temperatures, to the increased frequency of the Etesians, which lead to the reduction of the relative humidity. In contrast, the relative humidity peaks were not observed during the coldest month of the year, January, but during November-December, in which intense activity of lows was observed and the precipitation height (Table 1) was higher in comparison to other periods.

**Table 1:** Mean monthly and annual values for basic climatic parameters in the area of Spata, Attica

| Months/Climatic parameters | Ta | Tx | Tn | RH | P | WS | AP | SUNS |
|---|---|---|---|---|---|---|---|---|
| January | 8.7 | 12.7 | 4.6 | 71 | 54.5 | 7.2 | 1018.4 | 138.8 |
| February | 9.4 | 13.3 | 4.9 | 71 | 48.7 | 7.9 | 1017.4 | 107.2 |
| March | 11.7 | 15.7 | 6.7 | 69 | 42.8 | 7.9 | 1015.7 | 151.3 |
| April | 15.2 | 19.4 | 9.1 | 65 | 23.4 | 6.9 | 1014.2 | 203.8 |
| May | 20.2 | 24.6 | 13.4 | 59 | 21.8 | 6.9 | 1013.3 | 256.7 |
| June | 25.3 | 29.6 | 17.9 | 49 | 6.7 | 7.4 | 1012.6 | 313.9 |
| July | 27.6 | 31.5 | 20.8 | 47 | 8.3 | 8.8 | 1010.9 | 339.2 |
| August | 27.1 | 31.3 | 21.1 | 50 | 2.5 | 8.9 | 1011.4 | 318.8 |
| September | 23.2 | 27.9 | 17.3 | 58 | 11.7 | 7.0 | 1014.5 | 270.8 |
| October | 18.5 | 22.8 | 13.4 | 67 | 33.9 | 7.0 | 1017.6 | 189.4 |
| November | 14.1 | 18.0 | 9.7 | 74 | 68.7 | 6.5 | 1018.4 | 119.5 |
| December | 10.4 | 14.1 | 6.3 | 74 | 82.0 | 7.1 | 1018.7 | 103.6 |
| Mean annual values | 17.6 | 21.7 | 12.1 | 63 | 405.0 | 7.5 | 1015.3 | 2513.0 |
| Reference period | 1974-2019 | 1974 -2019 | 1974-2019 | 1974-2000 | 1982-2019 | 1982-2019 | 1991-2019 | 1974-1997 |

$T_a$: Air temperature (ºC), $T_x$: Maximum air temperature (ºC), $T_n$: Minimum air temperature (ºC), RH: Relative humidity (%), P: Precipitation (mm), WS: Wind speed (Knots), AP: Atmospheric pressure (mbar), SUNS: Sunshine duration (h)

**Table 2:** Mean seasonal values for basic climatic parameters in the area of Spata, Attica

| Seasons/Climatic parameters | $T_a$ | $T_x$ | $T_n$ | RH | P | AP | SUNS |
|---|---|---|---|---|---|---|---|
| Winter | 9.5 | 13.3 | 5.3 | 71.9 | 185.2 | 1018.2 | 349.6 |
| Spring | 15.7 | 19.9 | 9.7 | 64.1 | 88.0 | 1014.4 | 611.8 |
| Summer | 26.7 | 30.8 | 20.0 | 48.8 | 17.5 | 1011.7 | 971.9 |
| Autumn | 18.6 | 22.9 | 13.5 | 66.2 | 114.3 | 1016.8 | 579.7 |

$T_a$: Air temperature (ºC), $T_x$: Maximum air temperature (ºC), $T_n$: Minimum air temperature (ºC), RH: Relative humidity (%), P: Precipitation (mm), AP: Atmospheric pressure (mbar), SUNS: Sunshine duration (h)

The analysis of the changes of the mean monthly values of the relative humidity from month to month (Table 1) showed that the largest differences were observed during the transitional seasons of the year which are the periods in which relative humidity falls and rises to a relatively considerable degree, that is, May to June (-10%) and September to October (+ 9%), respectively. On the contrary, zero changes in relative humidity were detected either at the beginning (from November to December), or at the end (from January to February) of the winter season.

The term precipitation expresses the total liquid or frozen water, which reaches the ground in the form of rain, snow, hail, etc. and translate to measurable amount of water [13, 14]. As shown in Table 1, the mean monthly precipitation height in the area of Spata showed a simple fluctuation with a maximum in December (82.0 mm) and a minimum in August (2.5 mm). From the seasonal distribution of precipitation height (Table 2), it is ascertained that its maximum values (185.2 mm) were recorded during the winter period, while, in autumn, smaller but noticeable amounts of precipitation (114.3 mm) were observed. In the opposite direction, low quantities (almost 22% of the total annual value) reached the ground during the spring period while in summer the lowest values (17.5 mm) of this parameter were observed.

Changes in air temperature lead to atmospheric pressure variations, defining the basic processes that regulate the movement of air masses and the general circulation of the atmosphere [15, 16]. Also, the changes in atmospheric pressure contribute greatly to the creation and evolution of various weather systems and atmospheric disturbances [15, 17]. In the area of Spata, the atmospheric pressure showed a simple fluctuation with a minimum (1010.9 mbs) in July and a maximum (1018.7 mbs) in December (Table 1).

Seasonal values of atmospheric pressure showed a similar behavior. More specifically, the lowest value (1011.7 mbs) appeared in summer and the highest one (1018.2 mbs) in winter (Table 2). These low values of atmospheric pressure are mainly due to the effect of the low of India, which impacts the areas above the Aegean Sea and extends westward, while the contribution of the Atlantic anticyclone seems to be smaller [9]. On the contrary, the higher values of atmospheric pressure in winter could be attributed, mainly, to the influence of the Siberian anticyclone, which spreads to the west during the cold period of the year [8].

From the analysis of the mean monthly values of wind speed, regardless of direction, it can be concluded that wind speed showed a double fluctuation with primary peaks in July (8.8 Knots) and August (8.9 Knots) and secondary peaks (7.9 Knots) during February and March (Table 1). There were also two minimums during the transition periods, the first in November (6.5 Knots) and the second in April and May (6.9 Knots).

From the annual course of the mean monthly values of the duration of sunshine in Spata, Attica (Table 1), a simple fluctuation was found with a maximum in July (339.2 h) and a minimum in December (103.6 h). The total duration of sunshine in this area is 2513 h of which about 40% was distributed during the summer season. The transitional seasons followed, which in total cover about half of the annual duration of sunshine and a small percentage remained for the winter period due to the short duration of the day.

The climate of the wider area of Spata, according to the Köppen classification which is based on annual rainfall (distribution throughout the year) and monthly and annual values of air temperature, was characterized as Mediterranean (Csa). However, in an attempt to describe the conditions of the Mediterranean climate as comprehensively as possible, many classifications have been proposed by various researchers. The most realistic one in our case seems to be that of de Martonne, on the basis of which the subdivision of Mediterranean climate of the Etesians describes successfully the climatic conditions of Spata.

According to this subdivision [8] the main feature of this climatic type is the existence, mainly during the summer, of the Etesians. In particular, in the area of Spata, the Etesians

have a northeastern, mainly, address and can start in May and end in October with higher frequency from mid-July to mid-September. The intensity of these winds in the studied area is high and the winds are characterized as strong and can reach the level of the storm. The dominance of Etesians during the summer season is considered favorable for the residents of the wider area and the passing travelers of the airport, because a strong feeling of coolness is caused, due to the increased evaporation speed. Thus, the Mediterranean climate of the Etesians, which prevails in Spata, is characterized by relatively cool summer and mild winter with a large annual number of sunshine hours, low annual rainfall and long period of drought during the summer.

The knowledge of the described climatic parameters is valuable material in aviation, leading to information which, in combination with the current daily values of meteorological parameters, are the basis for planning activities related to the operation of the Athens International Airport "Eleftherios Venizelos".

## Conclusions

From the detailed analysis of the data, it was ascertained that, in general, the wider area of the Athens International Airport "Eleftherios Venizelos" is included in the Mediterranean climate of the Etesians with relatively cool summer and mild winter, large annual number of sunshine hours, low annual rainfall and long period of drought during the summer. More specifically, the following conclusions emerged:

- The mean annual air temperature was 17.6 ºC. Its annual course showed a simple fluctuation with a minimum in January (8.7 ºC) and a maximum in July (27.6 ºC). From the transition seasons, autumn was warmer than spring.
- The largest changes in air temperature occured at both the beginning of the warm season (from May to June) and the beginning of the cold season (from September to October). In contrast, the smallest changes of air temperature were detected during winter and summer, that is, during the transition from January to February and from July to August.
- The highest relative humidity values were recorded during the last two months of the year, in which noticeable amounts of precipitation were observed. On the contrary, low values of this parameter were observed during the summer, a season with the highest frequency of Etesians.
- The wind speed showed double fluctuation with maximums during the warmer months of the year and during February and March, while the minimums occurred in spring and autumn.

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