FRESENIUS ENVIRONMENTAL BULLETIN

Vol. 8, No. 01/02
pp. 001 - 106
January/February 1999
ISSN 1018-4619

Contents

VARIABILITY OF PRECIPITATION PATTERN IN GREECE DURING THE YEAR

Metaxas D. A.(1), Philandras C. M.(1), Nastos P. Th.(2) and Repapis C. C.(1)

[1] Research Center for Atmospheric Physics and Climatology, Academy of Athens
[2] Laboratory of Climatology, Department of Geology, University of Athens

SUMMARY
The patterns of monthly precipitation distributions in Greece, during the months of the year, are studied. Using factor analysis T-mode on mean monthly precipitation for a long period, we try to establish characteristic patterns of precipitation distribution. Only two of the *eigenvectors* (*factors)* were found statistically significant, namely factor I, explaining 67% of total variance and referring to the months of the period from October to March (cold period) and factor II, explaining 23% of total variance and referring to the months from April to September (warm period). During the cold period precipitation is maximum on Western Greek mainland and along the Western Asia Minor coast and islands while minima are shown in Cyclades islands, Attika, Thessaly, Macedonia and Thrace. On the other hand, during the warm period precipitation shows maxima in Central and North continental areas and the interior of Peloponese while minima appeared again in Cyclades, Dodecanese and Crete. Finally, the various areas of the country are distributed in 4 categories, depending on the combination of plus or minus of the normalized factor scores, for each period.

KEY WORDS : Principal Components Analysis, precipitation, Greece.

1. INTRODUCTION

The precipitation distribution pattern in Greece depends on corresponding dynamic and thermodynamic factors that cause precipitation. It is well known[8] that depression activity, the main precipitation factor in the Mediterranean region, is intense during winter and minimum during summer. Apart from the synoptic effect, there are other precipitation factors[1] with strong intraannual variability, such *as warming of air masses passing over the sea.* Such a mechanism causes instability and enrichment of the air mass with water vapor, in combination with vertical velocities induced by the *orography*. Opposite phenomena occur when cooling of the air by the sea prevails. In the first case the development of *dynamic instability* is included, due to a low layer humidification. This type of instability is released when the air mass is raised as a body on a mountainrange, as in the case of Pindus, the main mountainrange of Greek mainland. The whole subject is complex. The various precipitation factors may be interrelated and a large variability prevails during the year. In the present work we intend to study the distribution of rainfall and its variability one year's period. The proper statistical method for this study is the Factor Analysis, T- mode[2,3]. The method has already been used for such a purpose by other investigators[4-6]. In fact, the present study might be considered as a continuation of the last one[6]. We believe that our work has now a more successful data arrangement and coverage, in an area of large climatic variety.

Our basic material consists of monthly precipitation amounts, averaged in a rather large period of years (1951-1990), in 57 stations in Greece[7]. *The data matrix* consists of 57 lines, the stations and 12 columns, the 12 months. 12 intercorrelated space-series are then available. A symmetric *correlation matrix* 12x12 is thus formed, which is used for the estimation of the corresponding 12 *factors* (*eigenvectors)*. A basic work is then the estimation of the eigenvectors that are *statistically significant*. Finally, the *Varimax* method was used to make a shift of the axes.

2. RESULTS AND DISCUSSION

For the determination of the statistical significant factors, we basically used the *rule of 1,* i.e. significant factors are considered those that correspond to eigenvalues > 1. This rule indicated only two factors, Factor I and Factor II. Factor I explains 67% of the total variance and refers to the months of the *cold period* i.e. the main rainy period of the Mediterranean climates, October to March. Factor II (23% of the total variance) refers to the months of the *warm period*, April to September. We note here that April and September were marginally classified in factor II. Testing the results with a new analysis using three significant factors, Factor III explained 5% more of the total variance and referred to the months September and October. Factor I (67% of the variance) refers in this case to the period November to March though November was marginally classified to this factor, and Factor II (23% of the variance) refers to the period April to August but again April was marginally classified to this factor. Therefore we preferred to accept the original analysis with two factors (90% of the variance). We then have only two typical precipitation distributions, the one of the *cold period*, October to March and the one of the *warm period,* April to September. Each type corresponds to characteristics of the precipitation processes, that prevail during each period.

VARIABLES	FACTOR I	FACTOR II
JANUARY	.9463*	-.0339
FEBRUARY	.9648*	.1735
MARCH	.9097*	.2608
APRIL	.6674	.6932
MAY	.3263	.9090*
JUNE	.0985	.9564*
JULY	-.0132	.9612*
AUGUST	.2331	.9492*
SEPTEMBER	.5649	.6723
OCTOBER	.7806*	.4448
NOVEMBER	.8661*	.3634
DECEMBER	.9560*	.0797
Variance (%)	67.0	23.0

Table 1: Loadings of Factors I and II for each month(* stat. sign. 95%).

In Table 1, the factor loadings of the two factors are shown. They are in fact partial correlation coefficients and therefore they are not statistically significant when are bellow a certain value, about 0.2 in our case, and in any case they can be negative too. Typical months of Factor I are December, January and February, with loadings about 0.95 for Factor I and 0.1, not significant by far, for Factor II. For Factor II, more typical months are June, July and August, with loadings over 0.95. The factor scores (for every station) are normalized and shown in Fig. 1 for Factor I and Fig. 2 for Factor II. Positive scores correspond to rainfall above the spatial average for the corresponding period, while negative scores to rainfall below the *spatial average*.

4. CONCLUSIONS

The above analysis corresponds in fact to a relative analysis of the physical processes that cause precipitation in Greece during the year. There are two groups of such processes. The first refers to the Western half of the mainland and the Western coast and islands of Asia Minor (Fig.1) during the cold period of the year.

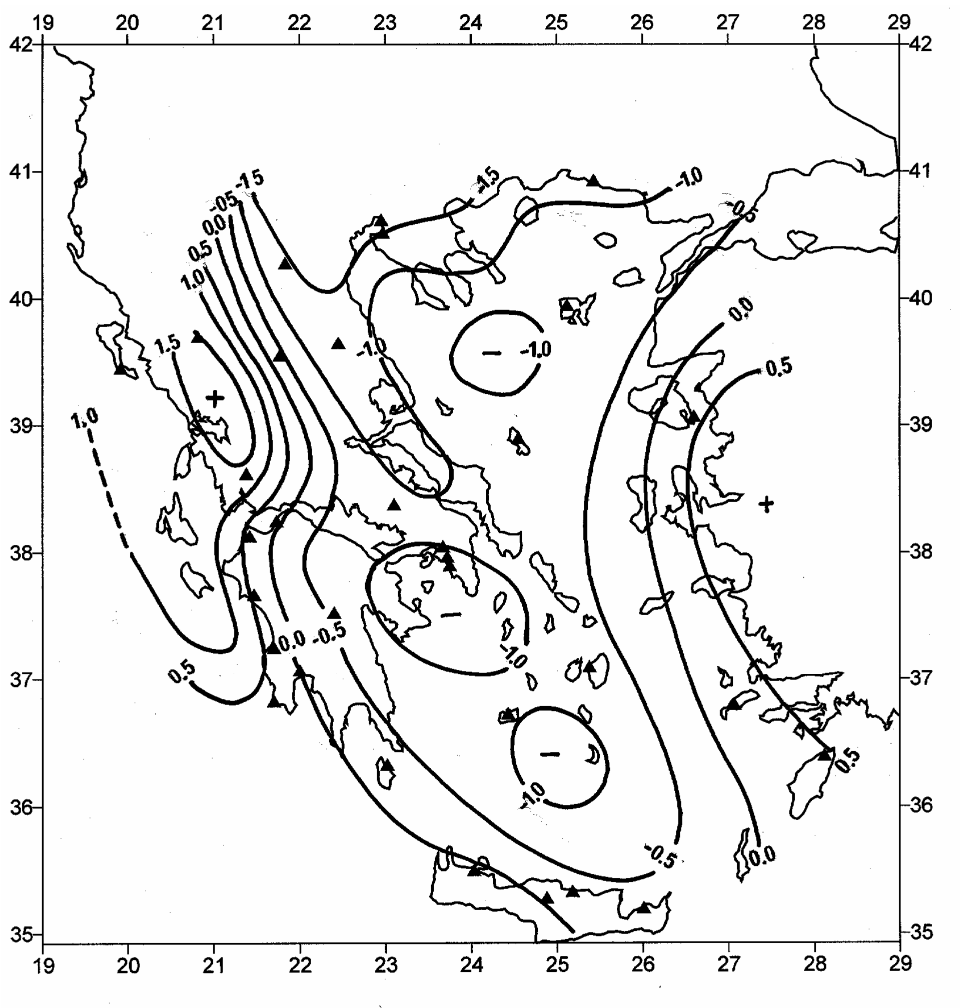

Figure 1. Isoplethes for normalized scores of Factor I, (October - March).

The rainfall in this case is caused by organized barometric lows, in combination with the sea and mountain effect. For the warm period of the year (Fig. 2), the inland areas of the mainland are mostly concerned. Precipitation is caused mainly by upper air barometric lows, in combination with instability and powerful breeze cells, mainly sea-breeze cells which play an important role as water vapor supplier.

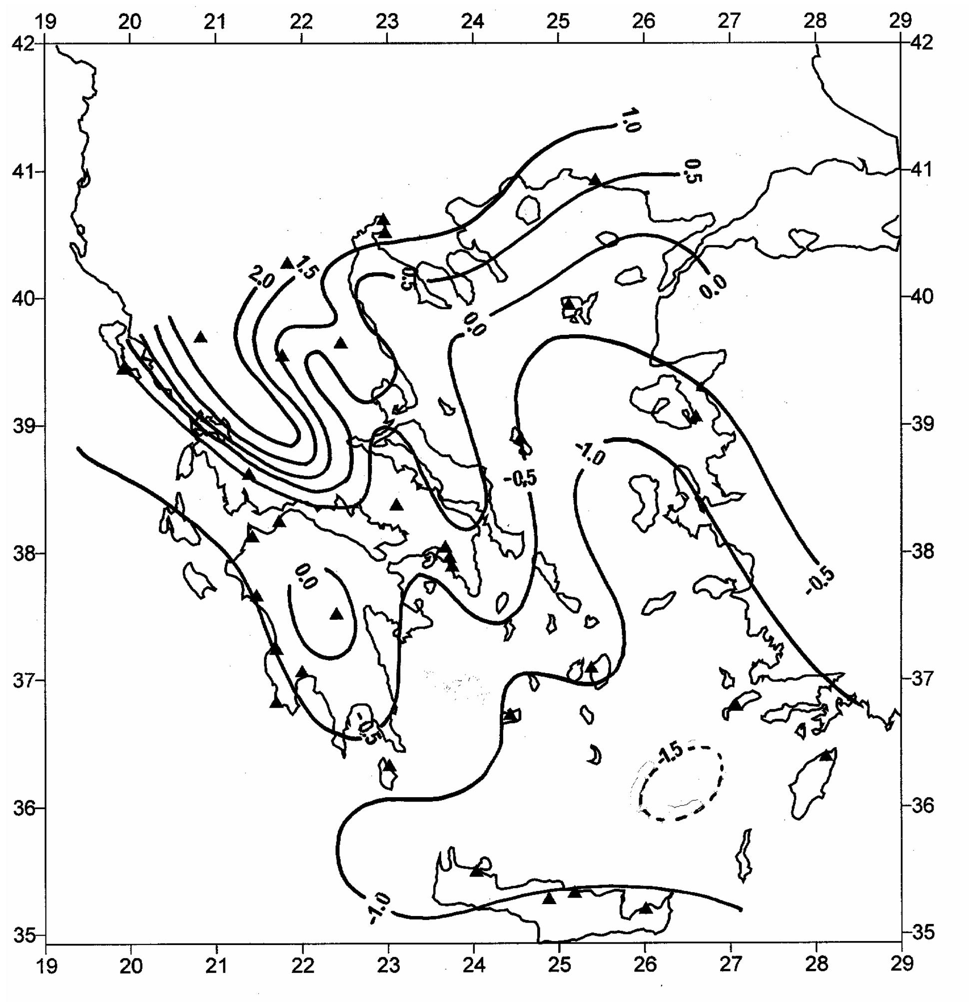

Figure 2. Isoplethes for normalized scores for Factor II, (April-September).

We finally note that the contribution of the above processes in Greece is not the same for the various areas. In Southern Aegean, for example, the factor scores are negative in both periods (Fig. 1 and 2), while in the interior and mountainous areas of Western Greece they are positive in both periods. Therefore Greece can be divided into four categories, according to plus (+) or minus (-) of factor scores, for both factors. For example, the interior of Western mainland is the

+ + type, i.e. above spatial average precipitation in both periods, cold and warm, while the Cyclades island area is the - - one, i.e. below spatial average precipitation in both, cold and warm periods.

Acknowledgments
Thanks are expressed to Hellenic National Meteorological Service for providing unpublished meteorological data.

REFERENCES

1. Metaxas D.A., Arch. Met. Geoph. Biokl., **1978**, Ser A, 27, 69-80.
2. Ritchman M., J. Climatol., **1986,** 6, 293-335.
3. Rummel R.J., Applied Factor Analysis, Northwestern University Press, Evanston, **1970**, 617 pp.
4. Mahairas P., Climatologie de la mer egee et de ses marges continentales. *Des Theses, Universite De Lille III,* **1983**,
5. Balafoutis H., J. Meteorol., **1991**, 16 (157), 90-96.
6. Fotiadi, A.K. D.A. Metaxas, A. Bartzokas, Proceedings of 3rd Hellenic Meteorological-Climatological and Atmospheric Physics Congress, in Athens, **1996**, 52-61.
7. Hellenic National Meteorological Service: Monthly Climatic Bulletin 1951-1988, and further unpublished data from HNMS.
8. Meteor. Office, Weather in the Mediterranean, vol. 1, **1962.**