# PRECIPITATION PATTERNS OF THE EARTH

by

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**Összefoglalás:** *(A Föld csapadékrendszerei).* A tanulmány bemutatja a Föld csapadékeloszlásának néhány jellemző sajátosságát. Megismerjük 10°-os övezetenként a különböző évi csapadékmennyiségek által borított területek abszolút és relatív (százalékos) kiterjedését *(I. és II. táblázatok)*, s az évi átlagos csapadékösszegek egész Földre vonatkozó eloszlásfüggvényét *(III. táblázat)*.

A csapadék átlagos évi menete alapján meghatározta a szerző a csapadék éven belüli koncentrálódásának mértékét, amelyet úgy fejez ki, hogy a legcsapadékosabb hónap átlagos csapadékösszegét az átlagos évi összeg százalékában adja. Az erős és gyenge koncentrálódás területeit a *2. ábra* szemlélteti.

Meghatározza a szerző, hogy a csapadék maximuma és minimuma melyik évszakra esik, s ennek alapján 12 *formális típust* különít el. Földgömbi eloszlásukat a *4. ábra* szemlélteti. Következőkben a csapadékmaximum évszakját a Nap járásának megfelelő *termikus évszakok* szerint csoportosítva, s megkülönböztetve a sivatagi területeket is, 8 *genetikus típusba* sorolja Földünk csapadékrendszereit. Ezek eloszlását az *5. ábra* szemlélteti. A genetikus típusok kiterjedésének százalékos arányát övezetenként — az egész Földre, külön a kontinensekre és óceánokra — az *V—VI—VII. táblázatok* tartalmazzák. Végül egy Afrikán és Európán áthaladó meridionális metszet mentén feltünteti a csapadék havi területi átlagait, ezt a *6. ábra* szemlélteti.

**Zusammenfassung:** *(Die Niederschlagssysteme der Erde).* In der Arbeit werden einige kennzeichnende Besonderheiten erörtert, welche in der Niederschlagsverteilung unseres Planeten auftreten. Für Zonen von 10° Breitenunterschied wird die absolute und relative (prozentuelle) Erstreckung der Gebiete mit einem gegebenen Jahresniederschlag *(Tabellen I und II)* angegeben und die Verteilungsfunktion des durchschnittlichen Jahresniederschlages *(Tabelle III)* angeführt.

Auf Grund des durchschnittlichen Jahresganges wurde das Mass der interannuären Konzentration des Niederschlages bestimmt, ein Begriff, der in der Weise beschrieben wurde, dass die durchschnittliche Niederschlagsmenge des niederschlagsreichsten Monats in Prozenten der durchschnittlichen Jahressumme ausgedrückt wird. Die Gebiete der starken und der schwachen Konzentrierung sind an *Abb. 2* dargestellt.

Es wird festgestellt, in welche Jahreszeit das Maximum und das Minimum des Niederschlages fällt, und auf dieser Weise werden 12 *formale Typen* unterschieden. Ihre planetare Verteilung wird an *Fig. 4* dargestellt. Ferner werden die Jahreszeiten mit einem Niederschlagsmaximum nach den dem Gange der Sonne entsprechenden *thermischen Jahreszeiten* eingeteilt, und bei Unterscheidung der Wüstengebiete erhält man 8 *genetische Typen* für die Niederschlagssysteme der Erde. Die Verteilung derselben wird an *Abb. 5* dargestellt. Die prozentuale Verhältnisse der Erstreckung der verschiedenen genetischen Typen (für die ganze Erde, sowie getrennt für die Kontinente und für die Ozeane) sind in den *Tabellen V—VI—VII* enthalten. Endlich werden entlang eines Meridionalschnittes, durch welchen Afrika und Europa durchquert werden, die monatlichen arealen Durchschnittswerte des Niederschlages angegeben und dies wird an *Abb. 6* dargestellt.

**Summary:** This paper deals with some peculiar properties of the precipitation distribution on our planet. For zones of 10 degrees of latitude difference, the absolute and relative (percentage) extensions of the areas receiving given amounts of annual precipitation *(Table I and II)* as well as the distribution of average precipitation amounts over the whole Earth *(Table III)* are discussed.

On the basis of the average annual variation of temperature, the degree of precipitation concentration in the course of the year has been determined, this quantity being defined as the average precipitation amount of the wettest months of the year expressed in percentages of the average annual amount. The areas of strong and, respectively, of weak concentration are illustrated on *Fig. 2.*

The seasons in which the maxima and minima of precipitation are occurring, have been determined, and, on this basis, 12 *formal types* are defined. Their global distribution is shown on *Fig. 4.* Further, grouping the seasons in which the precipitation maximum is occurring, on terms of the thermal seasons expressing the annual path of the Sun, the precipitation patterns of the Earth are classified into 8 *genetical types.* Their distribution is shown on *Fig. 5.* The percentual extensions of the various genetical types for the whole globe, and further for the continents only and for the oceans only are listed in *Tables V—VI—VII.* Finally, along a meridional section passing over Africa and Europe, the areal monthly average precipitations are shown on *Fig. 6.*

The distribution in time and space of the some $526.10^3 km^3$ of precipitation occurring during an average year over the globe [1] is determining the most prominent features of the various climates.

In case of uniform spatial distribution, this would yield an annual precipitation amount of

$$1030 \text{ litres } m^{-2}$$

However, as a result of the well-known features of planetary circulation and of the thermal pattern of the Earth, this precipitation is distributed by far not in a uniform way, but according to a determined *zonal system,* and this system is clearly manifesting itself even in spite of the disturbing effects exerted by orography and by the factors of local circulation.

*Table I*

*Areal distribution of annual precipitation for zonal belts of 10 degrees of latitude ($10^6 km^2$)*

| | | <50 mm | 50—100 mm | 100—250 mm | 250—500 mm | 500—1000 mm | 1000—2000 mm | 2000—4000 mm | >4000 mm | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| N | 90—80° | — | 2,4 | 0.9 | 0.6 | — | — | — | — | 3.9 |
| | 80—70° | — | 3.2 | 5.1 | 2.1 | 0.8 | 0.3 | — | — | 11.5 |
| | 70—60° | — | — | 4.9 | 9.2 | 3.0 | 1.6 | 0.1 | — | 18.8 |
| | 60—50° | — | — | 0.4 | 9.9 | 8.7 | 5.6 | 0.9 | — | 25.5 |
| | 50—40° | — | 1.9 | 3.3 | 4.2 | 9.3 | 12.5 | 0.2 | — | 31.4 |
| | 40—30° | 0.4 | 2.9 | 3.5 | 5.9 | 12.2 | 11.0 | 0.5 | — | 36.4 |
| | 30—20° | 6.2 | 3.0 | 5.6 | 6.4 | 7.2 | 10.5 | 1.3 | 0.1 | 40.3 |
| | 20—10° | 1.5 | 2.5 | 2.7 | 5.2 | 9.4 | 16.6 | 4.6 | 0.4 | 42.9 |
| | 10— 0° | — | 0.1 | 0.4 | 1.9 | 4.0 | 17.7 | 19.1 | 1.1 | 44.3 |
| S | 0—10° | — | 1.6 | 5.1 | 5.0 | 6.8 | 12.0 | 13.2 | 0.6 | 44.3 |
| | 10—20° | 1.9 | 3.3 | 4.8 | 6.0 | 8.1 | 13.1 | 5.7 | — | 42.9 |
| | 30—40° | — | 0.2 | 1.4 | 3.6 | 18.0 | 13.1 | 0.1 | — | 36.4 |
| | 40—50° | — | — | 0.6 | 0.6 | 2.4 | 26.4 | 1.4 | — | 31.5 |
| | 50—60° | — | — | 0.2 | 0.3 | 5.6 | 18.7 | 0.6 | 0.1 | 25.4 |
| | 60—70° | — | 0.3 | 2.4 | 8.6 | 7.0 | 0.5 | — | — | 18.8 |
| | 70—80° | 2.8 | 1.3 | 3.0 | 3.5 | 0.9 | — | — | — | 11.5 |
| | 80—90° | 1.4 | 0.8 | 1.7 | — | — | — | — | — | 3.9 |
| | Area | 15.0 | 25.8 | 54.8 | 81.3 | 110.9 | 172.0 | 47.9 | 2.3 | 510.0 |
| | % | 2.9 | 5.1 | 10.8 | 15.9 | 21.7 | 33.8 | 9.4 | 0.4 | 100.0 |

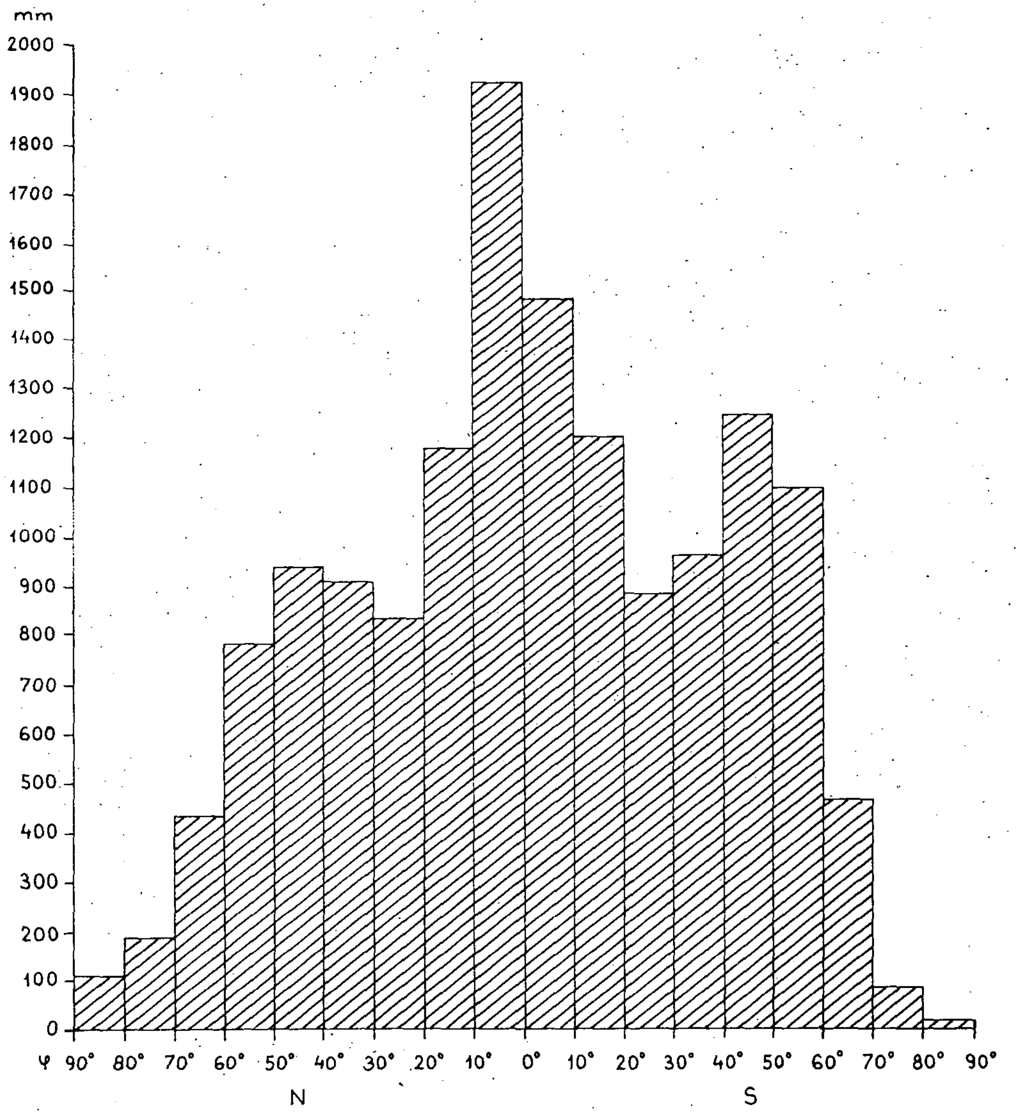


*Fig. 1. Zonal averages of annual precipitation amounts*

*1. ábra. A csapadék évi összegeinek övezetes átlagai*

The well-known features of the zonal distribution of precipitations consist in the following: 1. Highest amount of precipitation is occurring in the tropical belt within the latitudes 10°N and 10°S. This maximum of precipitation is conneccted to the presence of the Inter-Tropical Convergence Zone (I.T.C.Z.) and to the high moisture content of these torrid areas. 2. A well-defined secondary maximum is exhibited, on both hemispheres, within the temperate zone situated between the latitudes 40° to 60°. This is caused by the presence of the Polar Frontal Zone and by the connected cyclonic activity. 3. Lowest amounts of precipitation are encountered in Polar areas, as a consequence of low temperatures, 4. Secondary minimums of the zonal precipitation distribution are found on both hemispheres between latitudes 20° and 30°, that is, in the subsidence area of subtropical anticyclonic cells. These basic features are most pregnantly expressed by zonal average values of the annual precipitation amount (Fig. 1).

A further and more detailed information on the zonal and global distribution of precipitation is yielded by the absolute and relative extensions of areas having an annual precipitation amount which is falling between some given limiting values *(Tables I and II)*. These tables had been prepared on the basis of the most recent charts of the distribution of average precipitation amounts [2] by using a planimeter. From

*Table II*

*Percentual areal distribution of annual precipitation for ten-degree latitudinal belts of the Earth (%)*

| | | <50 | 50—100 | 100—250 | 250—500 | 500—1000 | 1000—2000 | 2000—4000 | >4000 mm | $10^6$ km² |
|---|---|---|---|---|---|---|---|---|---|---|
| N | 90—80° | — | 62.2 | 22.8 | 15.0 | — | — | — | — | 3.9 |
| | 80—70° | — | 28.6 | 45.3 | 18.6 | 7.2 | 0.3 | — | — | 11.5 |
| | 70—60° | — | — | 25.8 | 48.9 | 16.1 | 8.6 | 0.6 | — | 18.8 |
| | 60—50° | — | — | 1.7 | 38.9 | 33.9 | 21.9 | 3.6 | — | 25.5 |
| | 50—40° | — | 6.1 | 10.6 | 13.3 | 29.3 | 40.0 | 0.3 | — | 31.4 |
| | 40—30° | 1.1 | 8.1 | 9.5 | 16.2 | 33.4 | 30.3 | 1.4 | — | 36.4 |
| | 30—20° | 15.3 | 7.5 | 13.9 | 15.8 | 17.8 | 26.1 | 3.3 | 0.3 | 40.3 |
| | 20—10° | 3.6 | 5.8 | 6.4 | 12.2 | 21.9 | 38.6 | 10.6 | 0.9 | 42.9 |
| | 10— 0° | — | 0.3 | 0.8 | 4.2 | 8.9 | 40.0 | 43.3 | 2.5 | 44.3 |
| S | 0—10° | — | 3.4 | 11.8 | 11.5 | 15.5 | 27.3 | 30.4 | 1.4 | 44.3 |
| | 10—20° | 4.4 | 7.8 | 11.1 | 13.9 | 18.9 | 30.6 | 13.3 | — | 42.9 |
| | 20—30° | 1.9 | 5.8 | 21.7 | 20.6 | 18.6 | 30.8 | 0.6 | — | 40.3 |
| | 30—40° | — | 0.6 | 3.9 | 10.0 | 49.4 | 35.8 | 0.3 | — | 36.4 |
| | 40—50° | — | — | 1.9 | 1.9 | 7.8 | 83.9 | 4.4 | — | 31.4 |
| | 50—60° | — | — | 0.6 | 1.1 | 21.9 | 73.9 | 2.2 | 0.3 | 25.5 |
| | 60—70° | — | 1.7 | 13.0 | 45.4 | 37.1 | 2.8 | — | — | 18.8 |
| | 70—80° | 24.2 | 11.7 | 25.8 | 30.8 | 7.5 | — | — | — | 11.5 |
| | 80—90° | 35.0 | 20.0 | 45.0 | — | — | — | — | — | 3.9 |

these data, it was possible to derive the *distribution function* of annual average precipitation amounts for the whole globe, and it may be determined, on what a percentage of the area of the Earth the precipitation amounts are lower than any given value (*Table III*).

After the establishment of this basic information, we are now reviewing the features of the inter-annual precipitation distribution. For this sake, we analysed the multi-year monthly average precipitations of about 3000 stations distributed over the globe. In analysing the inter-annual distribution they are 1. a measure for the inter-annual concentration of precipitations. 2. the time of the occurrence of the wettest and driest seasons.

## 1. A Measure of the Inter-Annual Concentration of Precipitations

A measure of inter-annual concentration or the steepness of the annual variation is most simply obtained by expressing the average precipitation amount of the wettest month as a percentage of the annual average precipitation:

$$C = \frac{100\, P_{max}}{\Sigma P}$$

The areas with a strong inter-annual concentration were delimited by the value $C > 25\%$, while $C < 12.5\%$ has been considered as characteristical for a uniform inter-annual distribution. The global distribution of the areas defined by these two limiting values of C is shown on *Fig. 2*.

The steepness of the annual variation of precipitation and together with it, its inter-annual concentration is reflecting a *characteristically geographical pattern.* A strong inter-annual concentration of precipitation is characteristic, on both hemispheres, for the zone lying between 10° and 20° of latitude which is essentially coinciding with the area of the *tropical monsoons,* and is connected to the seasonal migration of the two big air-flow-divides, i.e. of the Inter-Tropical Convergence Zone (I.T.C.Z.) and of the subtropical high-pressure belt (India Indochina, southern Arabia, shores of East Africa, the central regions of Northern and Southern Africa, Northern Australia, the northeastern parts of Brazil, the shores of Central America). Further, a strong inter-annual concentration of precipitation is characteristic for the area of Central and Eastern Asia as well as for the central and northern parts of North America in connection to the extratropical summer monsoons which are prevailing on these areas.

The uniform inter-annual distribution of precipitation (with $C < 12.5\%$) is a characteristical feature for the temperature zone and mainly for the oceanic areas of this zone, and also for some smaller areas of the equatorial zone, as well as for the parts of this zone lying in South America, in Central Africa and in Indonesia. The

*Table III*

*Percentage of the surface area of the Earth on which the average annual precipitation amount is lower than a given value*

| | | | | | | |
|---|---|---|---|---|---|---|
| % of surface of the globe | 5 | 10 | 25 | 50 | 75 | 90 |
| Annual precipitation (mm) | <70 | <130 | <380 | <820 | <1550 | <2000 |

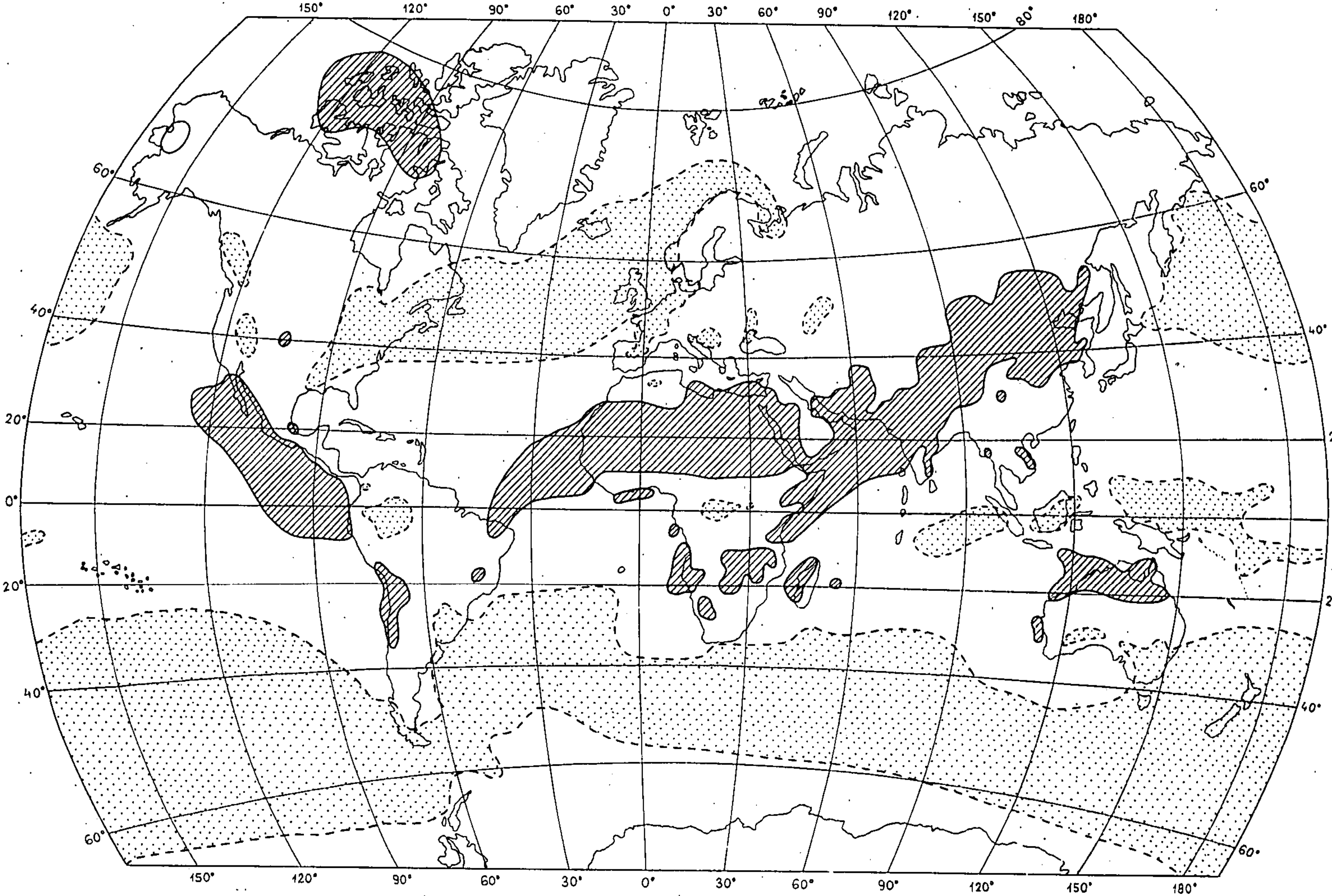


*Fig. 2. Areas of strong (C>25%) and week (C<12,5%) inter-annual concentration of precipitation*

*2. ábra. A csapadék éven belüli erős (C>25%) és gyenge (C<12,5%) koncentrálódásának területei* uniform inter-annual distribution of precipitation is indicating that the areas in question are subjected during *the whole year* to identical circulator conditions and they are coinciding with the belt of prevailing westerlies of the temperate zone.

For demonstrating the *zonal pattern* exhibited by the measure of inter-annual concentration of precipitation amounts, we determined, by using a detailed chart of the geographical distribution of the index C, average values of this index for various latitudes *(Fig. 3)*. On the basis of this figure it can be stated that the inter-annual concentration is exhibiting on our planet two characteristical zonal maxima as well as minima. The most pronounced is the annual average variation of precipitation in the

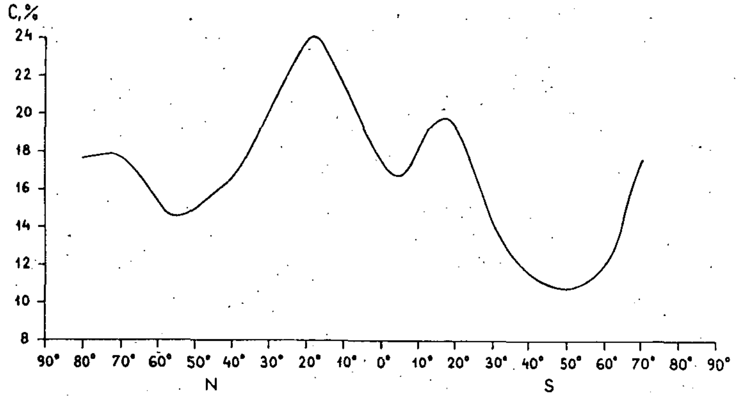


*Fig. 3. Zonal averages of the index C*
*3. ábra. A C index övezetes átlagai*

areas lying between latitudes 15° and 20° on both hemipsheres, the maximum being stronger on the northern hemisphere. The basic explanation of this phenomenon has been already mentioned above (the presence of the tropical monsoons), and the main maximum exhibited on the Northern Hemisphere is of course a consequence of the larger continental areas, leading to a stronger temperature rise in summer and to a higher degree of convectional activity as well as a stronger evaporation which are all contributing to the precipitation maximum. Minimum values of the index C are found on both hemispheres in the belts between 40° and 60° of latitude, the minimum on the Southern Hemisphere being a more pronounced one as a consequence of the mostly oceanic character of this hemisphere. In the equatorial belt, a somewhat weaker secondary minimum is exhibited, as a result of the factors mentioned above.

## 2. **Types of Inter-Annual Distributions of Precipitations**

For the typification of the annual variations of temperature, the simplest objective procedure seems to be the following one: we are determining, on the basis of seasonal average values, the times of the wettest and driest periods and their possible combinations. The consideration of monthly averages, which should reflect even the finer details, has been omitted because, on the one hand, their statistical uncertainty is larger than that of the seasonal averages, and because, on the other hand, the combinations of all the possible times of the occurrence of the wettest and driest months would yield an extremely high number of types, and finally, because, in areas possessing longer precipitation-free periods, the determination of the driest month is quite impossible.

In terms of the quarterly occurrences of precipitation maxima and precipitation minima, the following combinations may arise:

| Type | Maximum of precipitation months | Maximum of precipitation months |
|---|---|---|
| 1 | XII—I—II | III—IV—V |
| 2 | XII—I—II | VI—VII—VIII |
| 3 | XII—I—II | IX—X—XI |
| 4 | III—IV—V | XII—I—II |
| 5 | III—IV—V | VI—VII—VIII |
| 6 | III—IV—V | IX—X—XI |
| 7 | VI—VII—VIII | XII—I—II |
| 8 | VI—VII—VIII | III—IV—V |
| 9 | VI—VII—VIII | IX—X—XI |
| 10 | IX—X—XI | XII—I—II |
| 11 | IX—X—XI | III—IV—V |
| 12 | IX—X—XI | VI—VII—VII |

In addition of these types, we are adopting a type of double *precipitation maximum*. The criterions for such a type are as follows: 1. a time interval of at least three months between the main and the secondary maxima; 2. the precipitation amount of the month of the secondary maximum should be larger than 10.5 per cents of the annual amount, 3. the precipitation amount of the month of the secondary minimum should be lower than 8.3 per cents of the annual amount. As a further type was erected that of the *desert* having low precipitation in all months during the whole year, with a criterion following to which the average annual precipitation amount should be lower than 50 mm. Finally, some areas have been classified into the type of *unpronounced precipitation variations*. They are generally areas of *transition* among various characteristical types, a circumstance which is reflected in the variations in the times of maxima and minima and, as a result, on a trimestrial basis, no clear-cut maxima and minima can be found.

The global pattern of these *formal types* of the inter-annual distribution of precipitation is shown on *Fig. 4,* while the extensions of the areas belonging to the various types are listed, according to zonal belts, in *Table IV.* The tabulated material is extending, as a consequence of the limited availability of global data, only to the area between the latitudes 80°N and 70°S, which is however representing some 96 per cents of the total surface of our planet. Largest extensions are possessing the types 7, 2 and 6. Type 7 is meaning, on the Northern Hemisphere, a maximum of precipitation in summer and a minimum in winter, to which corresponds, on the Southern Hemisphere, type 2. Type 6 is occurring mainly on the temperate regions of the Southern Hemisphere, meaning in this part of the globe a precipitation maximum in the autumn and a precipitation minimum in spring.

The chart of the global distribution of the formal types of precipitation variation is possessing mainly an informative character. For obtaining a more detailed analysis, the time of occurrence of the precipitation maxima should be considered in terms

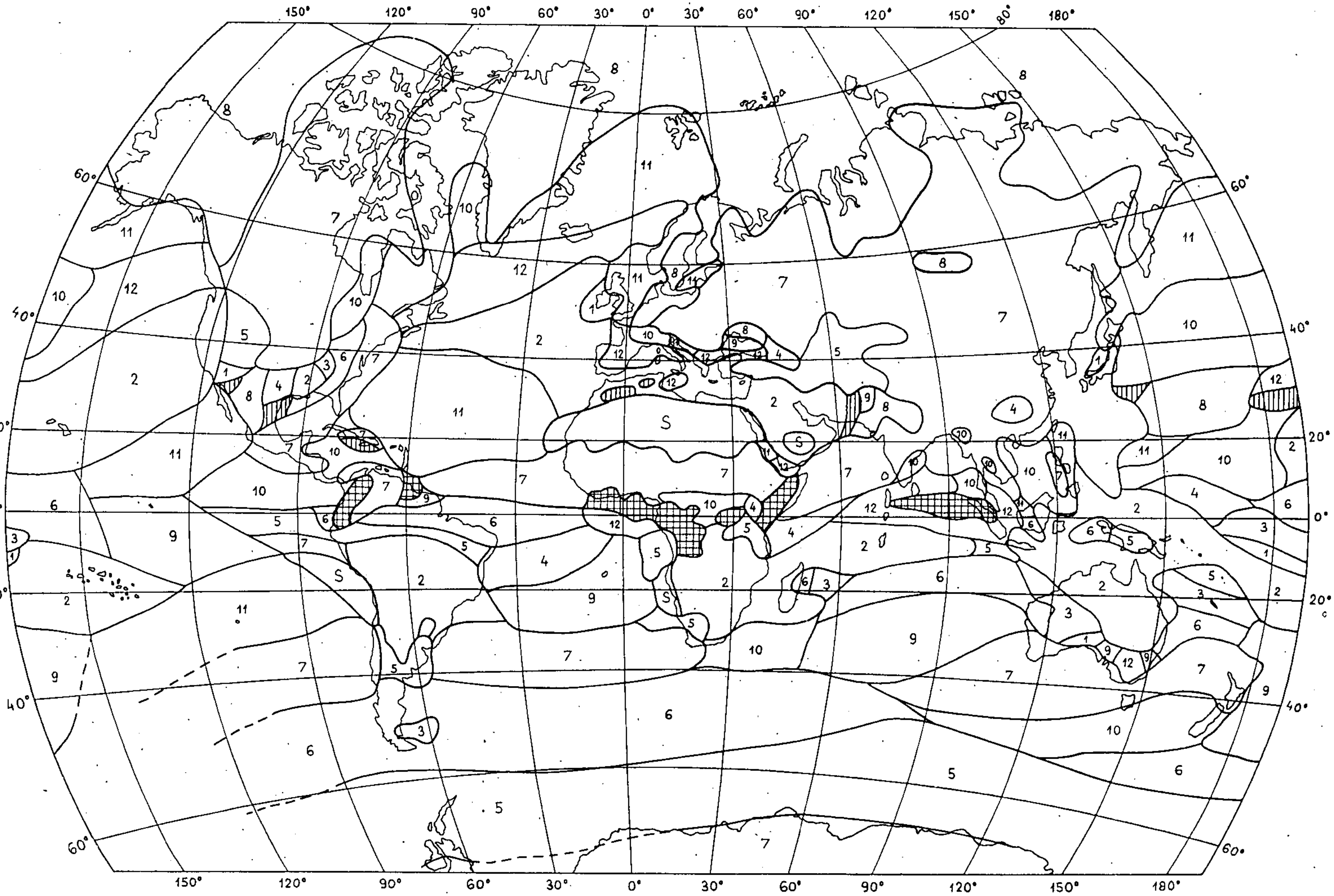


*Fig. 4. Formal types of inter-annual distribution of precipitation*
*4. ábra. Az éven belüli csapadékeloszlás formális típusai*

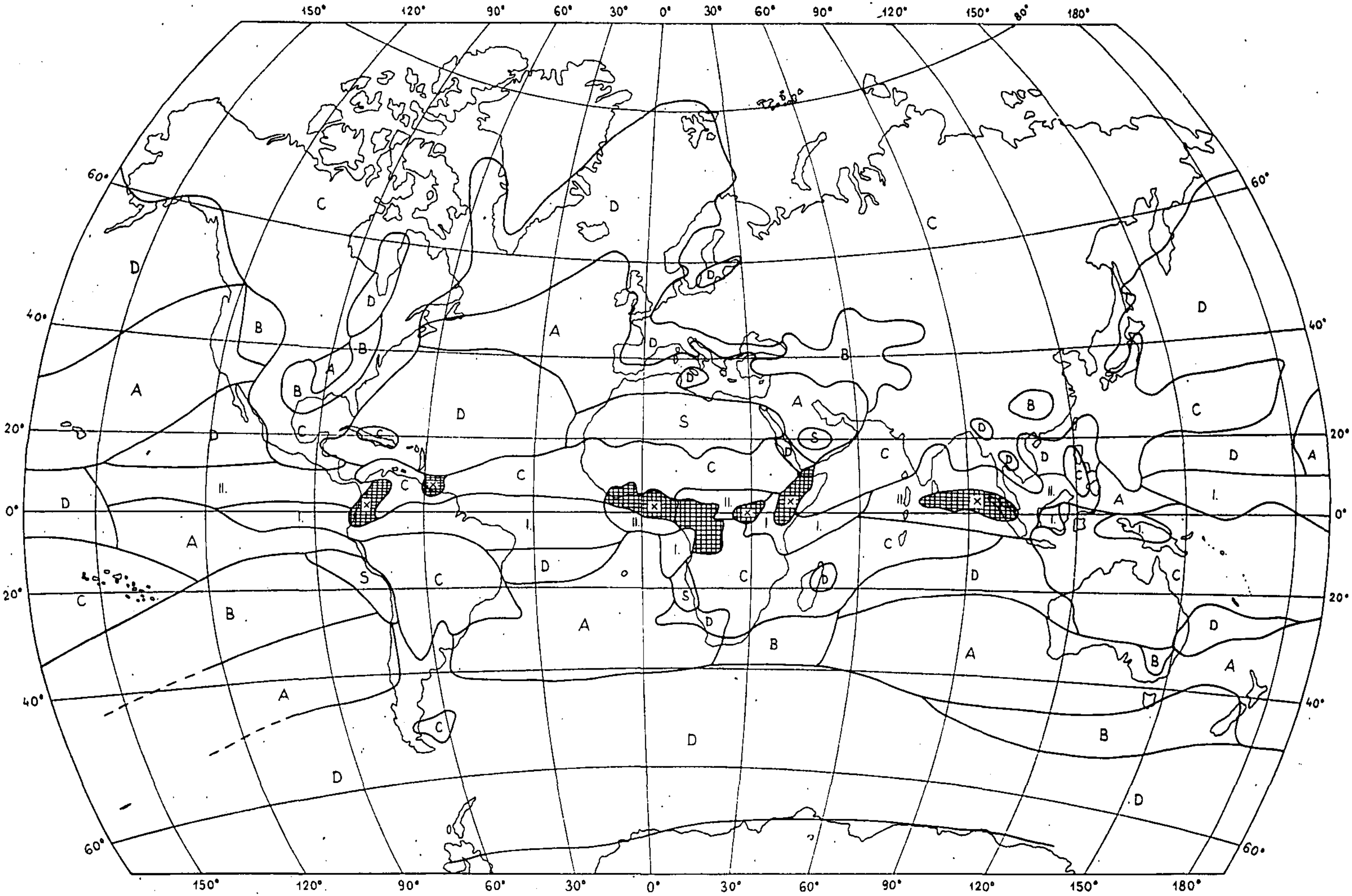


*Fig. 5. Genetical types of inter-annual distribution of precipitation*
*5. ábra. Az éven belüli csapadékeloszlás genetikus típusai*

*Table IV*

*Extension of the formal types of precipitation* ($10^6$ km²)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Double | Unpro-noun-ced | Desert | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N 80—70° | — | — | — | — | — | — | 2.2 | 7.5 | — | 0.2 | 1.6 | — | — | — | — | 11.5 |
| 70—60° | — | 0.1 | — | — | — | — | 6.8 | 7.8 | — | 0.6 | 2.0 | 1.5 | — | — | — | 18.8 |
| 60—50° | 0.5 | 1.3 | — | — | — | — | 11.6 | 3.1 | — | 0.5 | 5.6 | 2.9 | — | — | — | 25.5 |
| 50—40° | 0.1 | 6.5 | — | 0.3 | 2.6 | 0.3 | 10.5 | 0.6 | 0.3 | 5.1 | 1.4 | 3.7 | — | — | — | 31.4 |
| 40—30° | 0.4 | 10.1 | 0.1 | 0.8 | 2.8 | 0.6 | 8.0 | 2.3 | 0.2 | 3.4 | 4.4 | 2.3 | — | 0.6 | 0.4 | 36.4 |
| 30—20° | — | 8.5 | — | 1.1 | — | 0.4 | 7.9 | 5.5 | 0.2 | 0.9 | 8.3 | — | — | 1.3 | 6.2 | 40.3 |
| 20—10° | — | 4.2 | — | — | — | 0.1 | 16.8 | — | — | 9.5 | 10.4 | 0.1 | — | 0.3 | 1.5 | 42.9 |
| 10—0° | — | 3.2 | 0.6 | 2.2 | 0.3 | 5.2 | 11.4 | — | 1.7 | 8.8 | 2.7 | 1.9 | 6.3 | — | — | 44.3 |
| S 0—10° | 0.6 | 13.7 | 1.9 | 2.6 | 5.5 | 8.3 | 1.0 | — | 5.8 | 0.4 | — | 1.9 | 2.6 | — | — | 44.3 |
| 10—20° | 0.3 | 19.7 | 2.5 | 3.3 | 1.9 | 5.4 | 0.3 | — | 5.4 | — | 2.1 | — | — | 0.1 | 1.9 | 42.9 |
| 20—30° | 0.1 | 14.9 | 2.3 | — | 0.8 | 3.0 | 1.1 | — | 10.1 | 0.4 | 6.2 | — | — | 0.6 | 0.8 | 40.3 |
| 30—40° | 0.1 | 1.3 | 0.1 | — | 1.0 | 0.3 | 20.2 | — | 7.3 | 2.9 | 2.9 | 0.2 | — | 0.1 | — | 36.4 |
| 40—50° | — | — | 0.1 | — | 0.5 | 13.8 | 9.6 | — | 3.7 | 3.7 | — | — | — | — | — | 31.4 |
| 50—60° | — | — | 0.4 | — | 8.9 | 15.6 | — | — | — | 0.6 | — | — | — | — | — | 25.5 |
| 60—70° | — | — | — | — | 14.3 | 0.1 | 4.4 | — | — | — | — | — | — | — | — | 18.8 |
| Area | 2.1 | 83.5 | 8.0 | 10.3 | 38.6 | 53.1 | 111.8 | 26.8 | 34.7 | 37.0 | 47.6 | 14.5 | 8.9 | 3.0 | 10.8 | 490.7 |
| % | 0.4 | 17.0 | 1.6 | 2.1 | 7.9 | 10.8 | 22.8 | 5.5 | 7.1 | 7.5 | 9.7 | 3.0 | 1.8 | 0.6 | 2.2 | 100.0 |

of the thermal seasons which are corresponsing to the annual path of the Sun. On this basis, we are erecting the following types, which could be referred, in contradistinction to the above considered formal types, as *genetic types:*

| Type | Time of occurrence of precipitation maximum |
|---|---|
| A | Maximum in winter |
| B | Maximum in spring |
| C | Maximum in summer |
| D | Maximum in autumn |
| I | Maximum in the vicinity of the spring equinox or during one of the two following months |
| II | Maximum in the vicinity of the autumn equinox or during one of the two following months |
| X | Duble maximum in the vicinity of the equinoxes |
| S | Desert (annual amount of precipitation lower than 50 mm). |

In view of the fact, that, within the equatorial zone, any seasons in the thermal sense of the word, cannot be distinguished, we included, in the area between 10°N and 10°S, the formal types 4—5—6 into the genetic type I and the formal types 10—

*Table V*

*Zonal distribution of genetic precipitaion types expressed in percentage of the areas of the zones Whole of the Eaerth*

| | A | B | C | D | I | II | X | S |
|---|---|---|---|---|---|---|---|---|
| N 80—70° | . | . | 86 | 14 | . | . | . | . |
| 70—60° | 0 | . | 83 | 17 | . | . | . | . |
| 60—50° | 7 | . | 58 | 35 | . | . | . | |
| 50—40° | 23 | 12 | 34 | 31 | . | . | . | . |
| 40—30° | 30 | 13 | 28 | 28 | . | . | . | 1 |
| 30—20° | 21 | 2 | 34 | 27 | . | . | . | 16 |
| 20—10° | 11 | . | 39 | 37 | 2 | 7 | 0 | 4 |
| 10— 0° | 5 | . | 24 | . | 24 | 33 | 14 | . |
| S 0—10° | 13 | . | 33 | . | 40 | 8 | 5 | . |
| 10—20° | 12 | 6 | 55 | 21 | 1 | . | . | 5 |
| 20—30° | 32 | 17 | 37 | 12 | . | . | . | 2 |
| 30—40° | 68 | 24 | 4 | 4 | . | . | . | . |
| 40—50° | 44 | 15 | . | 41 | . | . | . | . |
| 50—60° | . | 3 | 2 | 95 | . | . | . | . |
| 60—70° | 23 | . | . | 77 | . | . | . | . |

*Table VI*

*Zonal distribution of genetic precipitation types expressed in percentages of the areas of the zones Continents*

| | A | B | C | D | I | II | X | S |
|---|---|---|---|---|---|---|---|---|
| N 80—70° | . | . | 93 | 7 | . | . | . | . |
| 70—60° | . | . | 94 | 6 | . | . | . | . |
| 60—50° | . | . | 93 | 7 | . | . | . | . |
| 50—40° | 4 | 24 | 61 | 11 | . | . | . | . |
| 40—30° | 27 | 30 | 40 | 1 | . | . | . | 2 |
| 30—20° | 15 | 4 | 40 | 5 | . | . | . | 36 |
| 20—10° | 2 | . | 64 | 15 | . | 5 | 1 | 13 |
| 10— 0° | . | . | 41 | . | 4 | 20 | 35 | . |
| S 0—10° | . | . | 32 | . | 48 | 2 | 18 | . |
| 10—20° | . | . | 94 | . | 2 | . | . | 4 |
| 20—30° | 4 | . | 83 | 13 | . | . | . | . |
| 30—40° | 37 | 10 | 27 | 26 | . | . | . | . |
| 40—50° | . | . | . | 100 | . | . | . | . |
| 50—60° | . | . | . | 100 | . | . | . | . |
| 60—70° | 90 | . | . | 10 | . | . | . | . |

*Table VII*

*Zonal distribution of genetic precipitation types expressed in percentage of the areas of the zones Oceans*

| | A | B | C | D | I | II | X | S |
|---|---|---|---|---|---|---|---|---|
| N 80—70° | . | . | 84 | 16 | . | . | . | . |
| 70—60° | 2 | . | 31 | 67 | . | . | . | . |
| 60—50° | 16 | . | 14 | 70 | . | . | . | . |
| 50—40° | 41 | . | 7 | 53 | . | . | . | . |
| 40—30° | 34 | . | 19 | 47 | . | . | . | 0 |
| 30—20° | 24 | 1 | 29 | 42 | . | . | . | 4 |
| 20—10° | 15 | . | 29 | 45 | 3 | 7 | . | 1 |
| 10— 0° | 6 | . | 18 | . | 30 | 37 | 9 | . |
| S 0—10° | 17 | . | 34 | 1 | 37 | 9 | 2 | . |
| 10—20° | 15 | 8 | 44 | 27 | 1 | . | . | 5 |
| 20—30° | 39 | 21 | 26 | 12 | . | . | . | 2 |
| 30—40° | 71 | 25 | 2 | 2 | . | . | . | . |
| 40—50° | 44 | 15 | . | 41 | . | . | . | . |
| 50—60° | . | 3 | 2 | 95 | . | . | . | . |
| 60—70° | 15 | . | . | 85 | . | . | . | . |

11—12 into the genetic type II. Accordingly, these types are indicating precipitation maxima occurring nearly at the time of the largest elevation angles of the Sun. We retained further the types of tropical double maximum (X) and of deserts (S), however, we omitted the type of unpronounced precipitation variation, which was limited to a

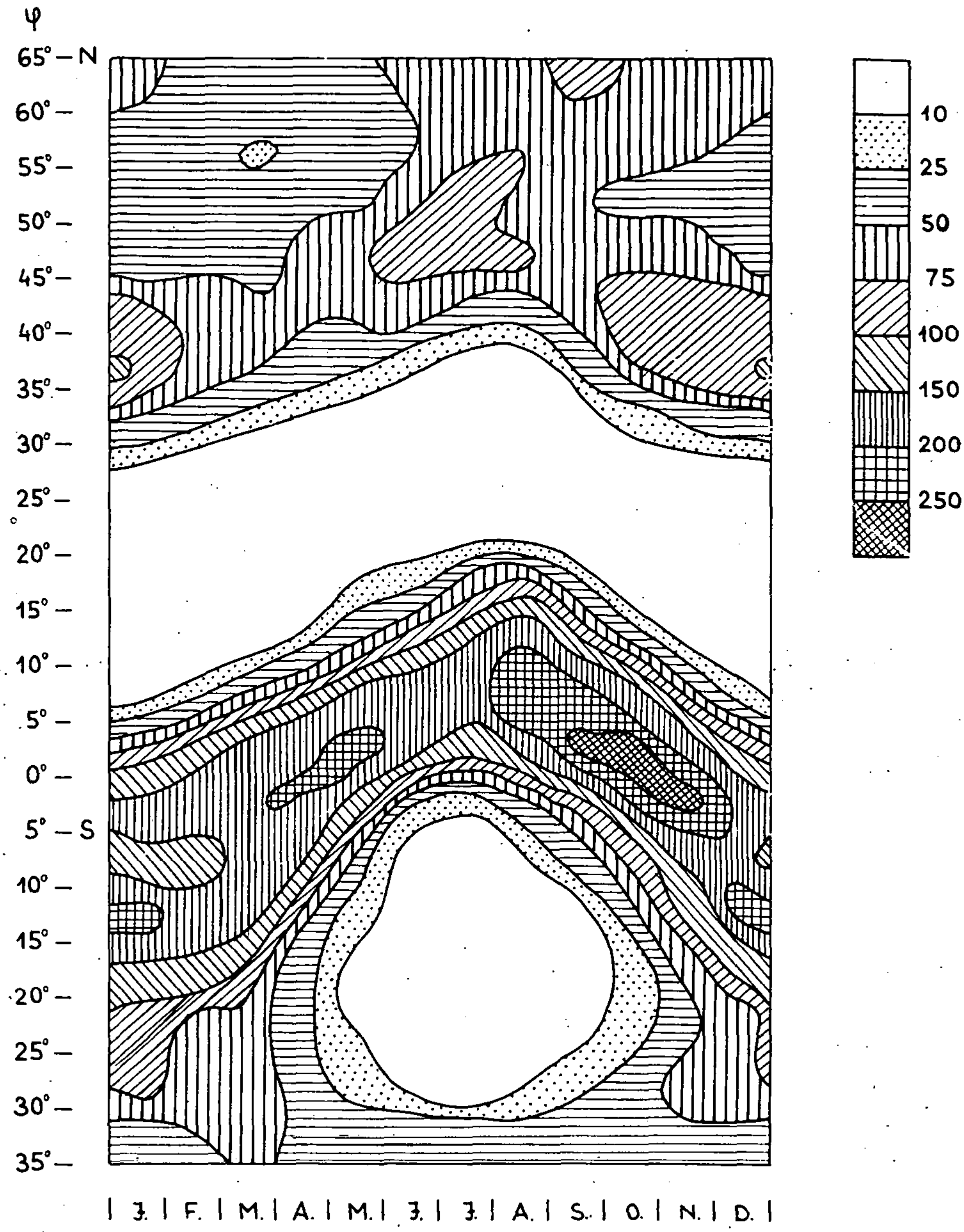


*Fig. 6. Isopleths of monthly average precipitation for the area 10° E—30° E and 65 °N—35° S*
*6. ábra. A csapadék havi átlagainak izoplétái a 10° E—30° E hosszúságok és a 65° N—35° S szélességek között*

relatively small area and it was incorporated into the types which are characteristic for rather large areas.

The global distribution of the genetic types is illustrated on *Fig. 5*. For the demonstration of their zonal character, we determined the percentages of zonal belts covered by the various genetic types. Further, for exhibiting the influence exerted on this distribution by the continents and oceans, we executed separate processings for the continents and separate ones for the oceans *(Tables V, VI and VII)*.

The main features of the global distribution of the genetic types are as follows:

1. For the largest part of our planet, the summer and autumn precipitation maxima are characteristic (types C and D).

2. Type C is mainly a feature of continental areas, while type D is that of oceanic areas.

3. The summer maximum is most pronounced on the temperate and higher latitudes of the Northern Hemisphere which is possessing rather a continental character, as well as on the southern boundary of the equatorial belt. The later feature is connected to the migration in polar direction of the I.T.C.Z. during the high solar elevations in summer, i.e., the tropical monsoons.

4. The autumn maximum is most pronounced in the oceanic areas of the temperate zone between latitudes 40° to 70° on both hemispheres. Its geographical pattern is connected to the autumn maximum of cyclonic activity in the temperate zones.

5. The distribution of the winter precipitation maximum is exhibiting as well a characteristic zonal pattern. Its highest frequency occurs on both hemispheres between the latitudes 30° and 40° and is caused by the meridional migration of the position of the subtropical anticyclones following the annual path of the Sun. Again, this type is mainly occurring on the shores which are transition belts between continental and oceanic areas.

6. On the continental areas of the Northern Hemisphere, at identical latitudes, type A is substituted by type B (mainly formal type 5, which means on this hemisphere a spring maximum and a summer minimum). Its origin is again connected to the annual migration of the subtropical high-pressure belt, however, these areas are in the winter under the influence of the continental thermal anticyclones, and, as a consequence, the rainy period begins only after the dissolution of the anticyclone, in March or in April.

The characteristic zonal pattern of the various types of inter-annual precipitation connected to the virtual annual path of the Sun can be most clearly visualized by the process of determining, for a given area, the monthly average precipitations for each zone, and plotting the values obtained as functions of the geographical latitude. On *Fig. 6* isopleths of precipitation are shown, obtained for an area limited by the meridians 10°E and 30°E and the latitudes 65°N and 35°S and divided into quadrangles of side lengths of 5 degrees, by computing the areal average precipitation amounts. This section is crossing Europe and Africa and the results are well illustrating the characteristic zonal pattern of the inter-annual precipitation distribution.

**References**

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[2] *Geiger, R.:* Die Atmosphäre der Erde, 5.