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ATLAS OF H-ALPHA SYNOPTIC CHARTS FOR SOLAR CYCLE 19 (1955-1964)

Carrington Solar Rotations 1355 to 1486

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1. Introduction

The morphology and dynamics of the large scale magnetic fields on the solar surface can be understood and interpreted with the aid of synoptic charts. These charts are constructed from the H-alpha filtergrams or spectroheliograms which depict chromospheric features that are closely associated with photospheric magnetic field structures. The association is so well established, that the chromospheric features can be used as a good proxy for the magnetic structures (McIntosh, 1972; Makarov, et al. 1982). The most important among the chromospheric features are the H-alpha filaments seen in the spectroheliograms that represent the neutral line of the radial component of the magnetic fields on the sun. Once, these neutral lines are identified and mapped unambiguously by accumulating information from spectroheliograms, the boundaries where polarities reverse become clear and so, the distribution of the large scale magnetic fields also become obvious. H-alpha charts do not provide any information on the strength of the magnetic field, but can however be used with confidence to represent the boundaries of large scale magnetic field regions of one predominant polarity with greater precision than can be derived from magnetograms that map only the longitudinal component.

McIntosh (1972, 1979) developed the guidelines for inferring magnetic polarities on the sun from H-alpha observations and constructed synoptic charts for the 20th cycle (November 1964 through July 1974). These have formed ready material for investigations on the evolution and dynamical processess of large scale magnetic field regions. Finally, the close agreement of these synoptic charts with Mt. Wilson magnetograms brought out their reliability. For investigations on large scale unipolar regions, it is seen that, these charts are more useful from practical point of view, as the magnetograms (even those with large apertures) show too many details and may prove bewildering.

2. Construction of Synoptic Charts

Makarov and Fatianov (1980) computed the trajectory of the poleward drift of the magnetic neutral lines and hence the epoch of the sign reversal of the polar fields for the cycles 20 and 21, using the synoptic charts. Motivated by the success of this method, Makarov and Sivaraman (1983) extended this study for the years prior to and subsequent to McIntosh's charts. For this purpose, we constructed synoptic charts on the lines of McIntosh (1979), for the solar cycles 19 through 14, using the Kodaikanal H-alpha and Ca⁺K spectroheliograms which date back to 1904. The Kodaikanal spectroheliograms form an uninterrupted collection obtained with the same instrument set up, possessing high internal consistency. Besides the original spectroheliograms on plates, the solar data bank at Kodaikanal contain daily sketches of the H-alpha filaments made from the spectroheliograms on Stonyhurst charts of 20 cm diameter marked with heliographic latitudes and longitudes in degrees for the appropriate P_0 and B_0 values. In addition to the filaments, the prominences on the limb are also sketched for every day on the same charts. The positions of the filaments on the Stonyhurst charts were now compared with the Meudon charts of filament distribution (Cartes Synoptiques de la Chromosphere Solaire) and wherever necessary, the positions of the filaments on the Kodaikanal charts were manually transferred onto the Meudon charts. The position of these filaments were once again cross checked with the prominences on the Kodaikanal charts. The Meudon charts show only the distribution of filaments,

but not the prominences. Prominences with optical depth less than unity along the line of sight, while on the disc do not show up as filaments but only as filament channels and that too not on all occasions. Such prominences appearing day after day were also noted down from the spectroheliograms and from these, the filament channels were mapped on the Meudon charts. The same features were mapped repeatedly from several spectroheliograms pertaining to the same rotation to ensure the positional accuracy of these structures. When all these features namely, the filaments, filament channels, floculli corridors and prominence are mapped on the Meudon charts, the continuous boundaries of the large scale unipolar regions become quite obvious. Our charts cover data on the neutral line from pole to pole in contrast to McIntosh's charts which reach only upto 70° in latitude in the two hemispheres.

3. Inference of Polarity

We have adopted again McIntosh's (1979) rules for polarity inference, according to which the polarity signs (+ and -) are assigned knowing the polarity of the leader and the follower spots in the Northern and Southern Hemispheres for any particular cycle. For examples, in solar cycle 19, the leader had a plus polarity (North, directed outwards) in the Northern Hemisphere and a minus polarity (South, directed inwards) in the Southern Hemisphere. Once the polarities are assigned to the leader and follower spots in the two hemispheres, the polarities are now alternated at every crossing of a neutral line. The construction of the neutral lines and the polarities thus marked were checked against the polarities of other bipolar spots in the hemispheres, so that there is no conflict in the deductions which can arise due to a possible error or omission in the number of neutral lines inferred. One additional counter check we have employed, is to make sure that the polarity reversal at the poles is also obeyed. And finally, the close agreement between the polarity assignment done by the above rules and the Mt. Wilson magnetograms established the ultimate reliability of this method (Makarov et al. 1983).

4. Format of the Synoptic Chart

This volume contains H-alpha synoptic charts for the period 1955-1964 constructed the way described above. This enables one to determine, the true epoch of the polarity reversals of the magnetic fields at the poles. We have not mapped the detailed pattern of the magnetic neutral lines in active regions which undergo rapid changes. Also, we have not shown the contours of active regions as these may confuse the neutral line pattern especially at the peak of solar activity. Distinct neutral lines averaged over the solar rotation are shown by solid lines which are the confirmed position of filaments. The inferred neutral lines which are estimated from filament channels and flocculi corridors are represented by dashed lines. Islands of one polarity, which are very conspicuous by their large numbers, particularly in the rising part of the solar activity are enclosed by contours with the inferred polarity (+ or - as the case may be) marked within the contour.

Each chart is map of the solar globe for one rotation. Solar longitudes are marked at the bottom every 10 degrees and are based on the mean rotation, assumed to be 27.2753 days. Solar latitudes are marked on the right vertical every 10° for both the hemispheres from the equator to the poles. The year and the Carrington rotation number are indicated at the top at the centre. The dates and month are also marked at the top of each chart. These dates represent the epochs of the central meridian passage of the solar longitudes that are in line beneath each date interval. The spatial resolution of the charts is about 3 heliographic degrees or $1/20 R_{\odot}$ or of the order of the size of the supergranulation. The accuracy of the coordinates for filaments is within ± 2 heliographic degrees and $\pm 5^{\circ}$ in the case of filament channels.

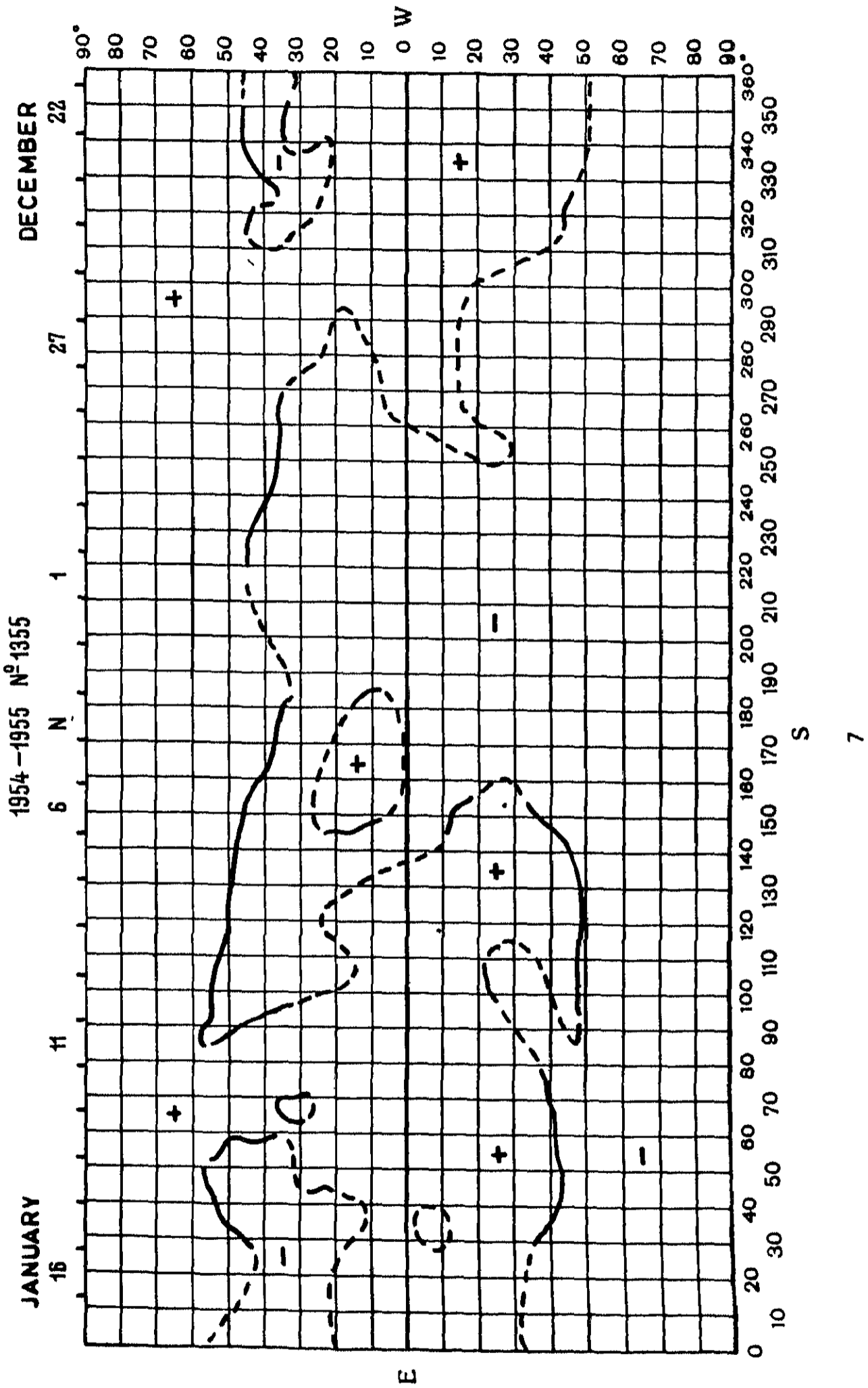
5. Acknowledgements

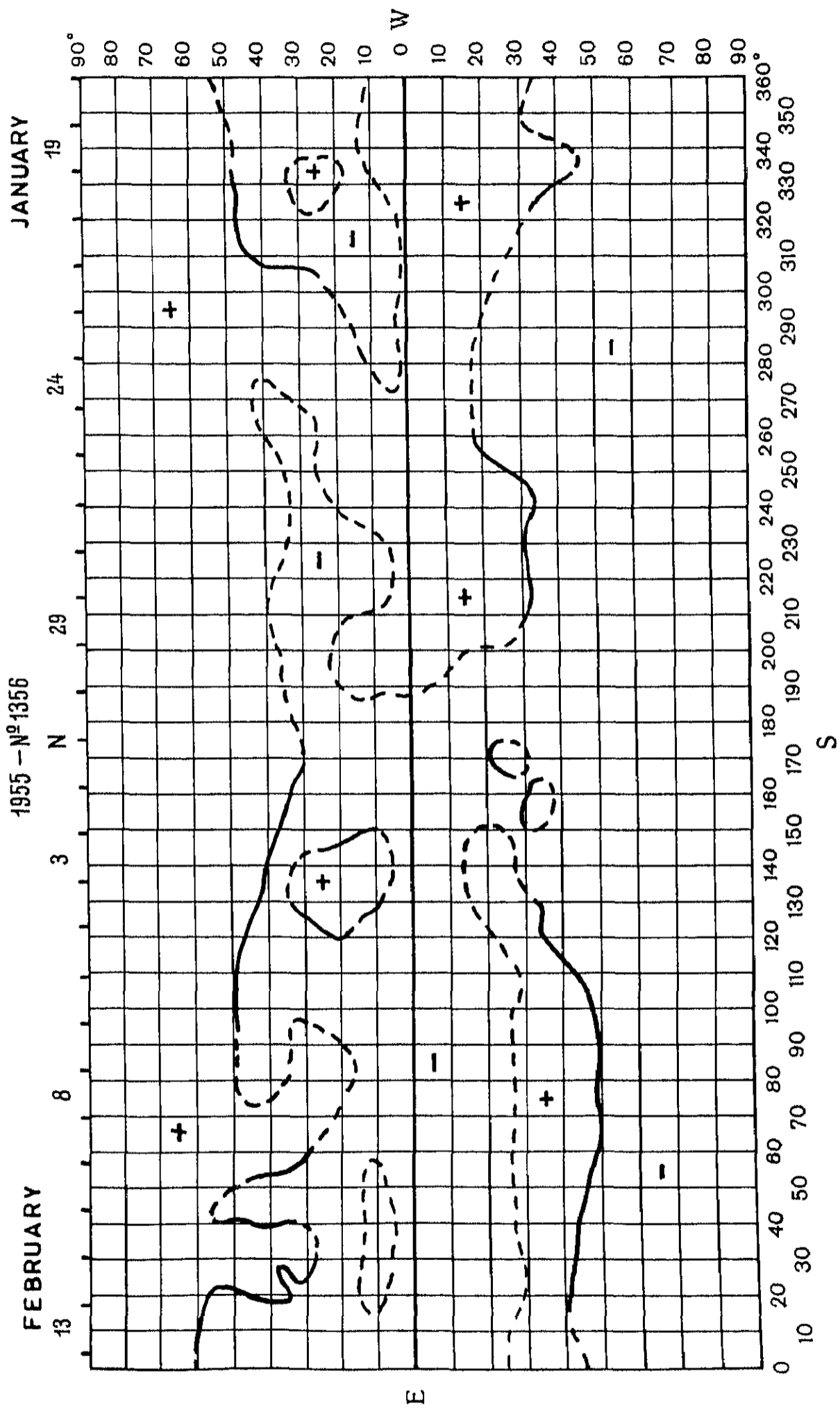
The authors are thankful to the late Dr. M.K.Vainu Bappu for his kind encouragement when the investigation was started and during its

progress. The first version of these charts used for the polar field reversal study was prepared while Dr. M.K.Vainu Bappu was the Director of the Indian Institute of Astrophysics and one of us (V.I.M) is grateful to the Director for the kind hospitality bestowed during his stay at the Indian Institute of Astrophysics in Bangalore and in Kodaikanal. We are grateful to Prof. J.C.Bhattacharyya, Director, Indian Institute of Astrophysics whose constant encouragement made the preparation of these charts in their final form and their printing as a volume of the Kodaikanal Observatory Bulletin, possible. The work was done within the frames of scientific cooperation between the USSR Academy of Sciences and the Indian National Science Academy under the theme "Physics of Plasma, Astrophysical aspects".

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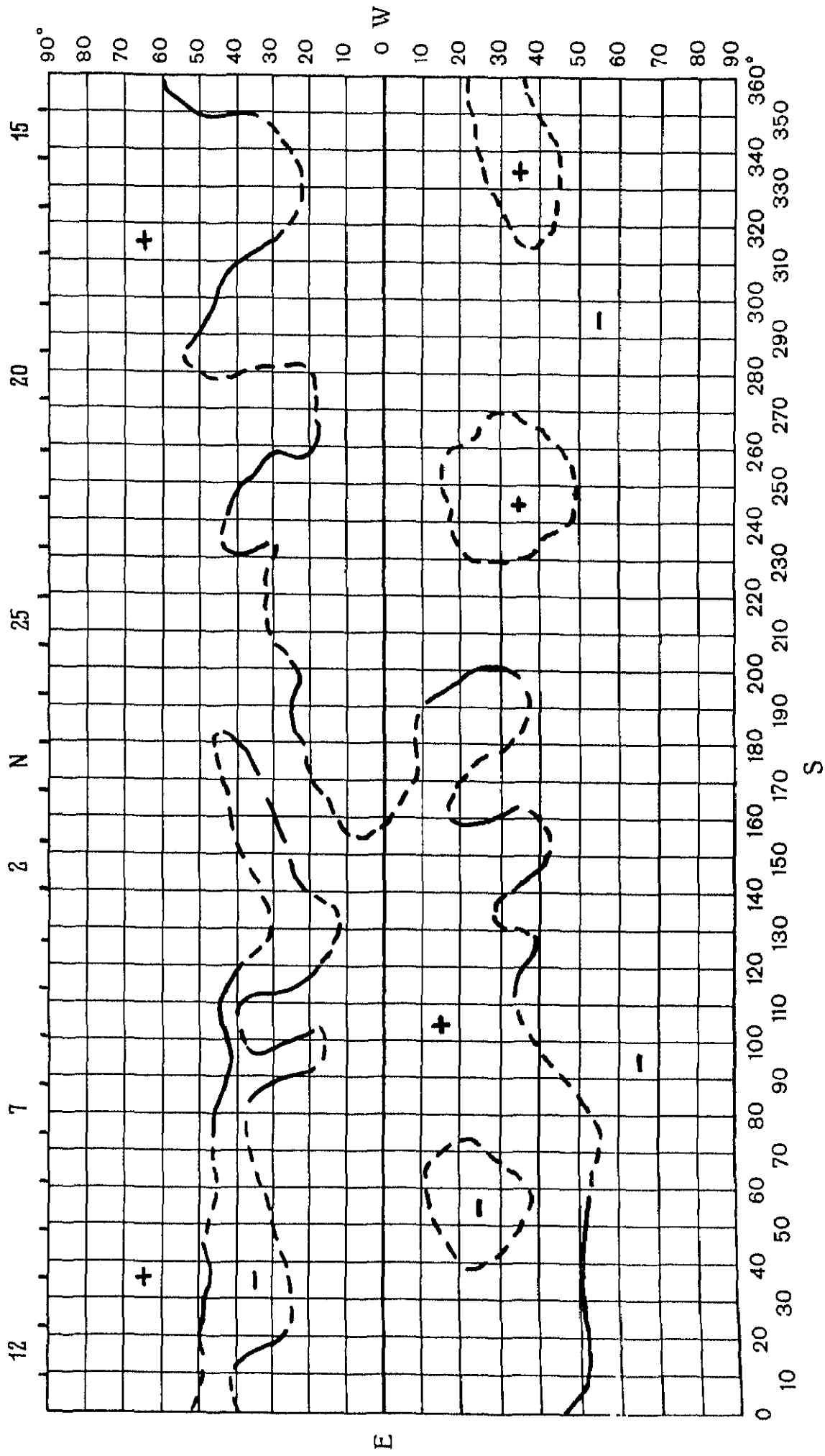




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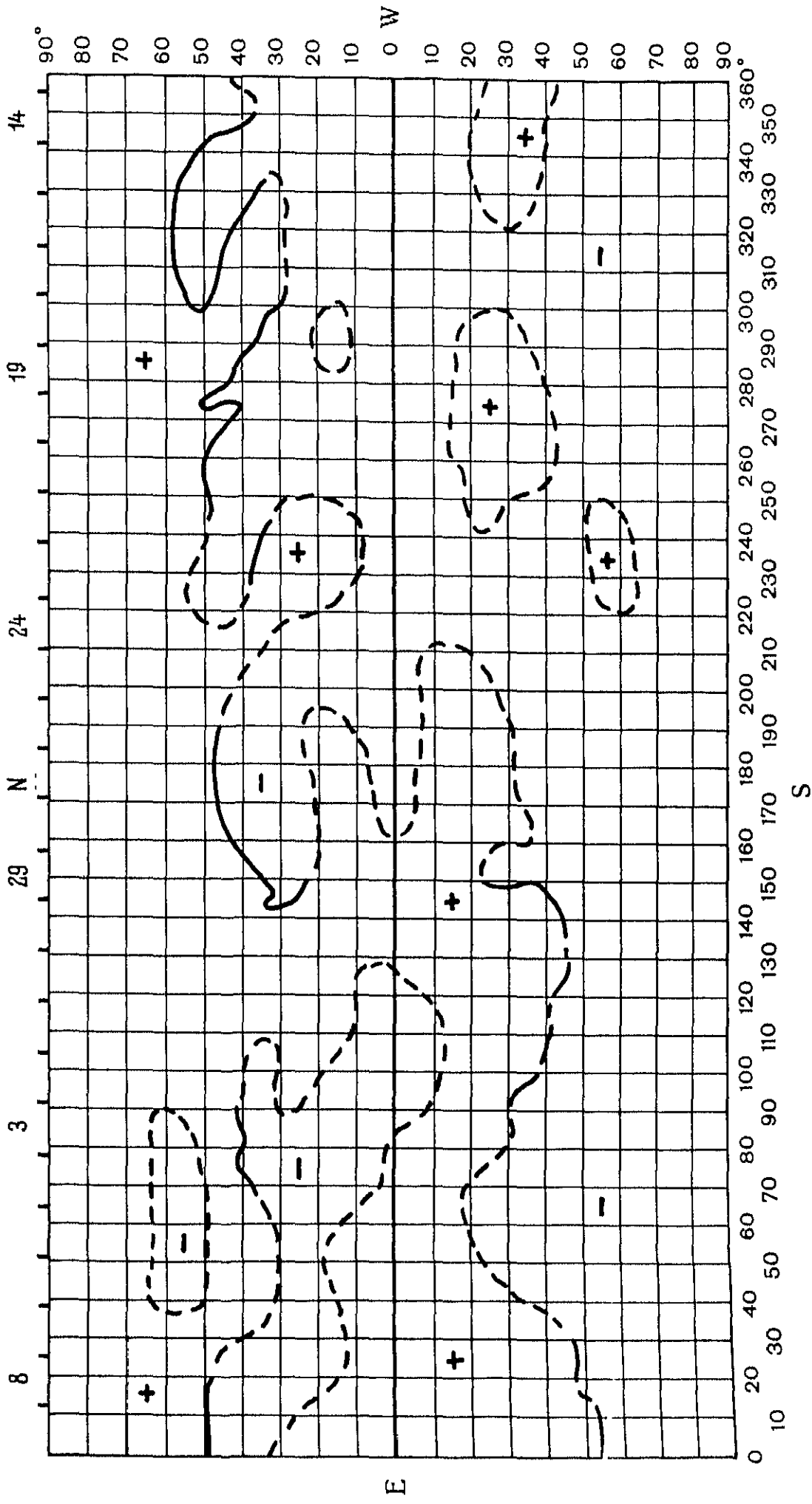
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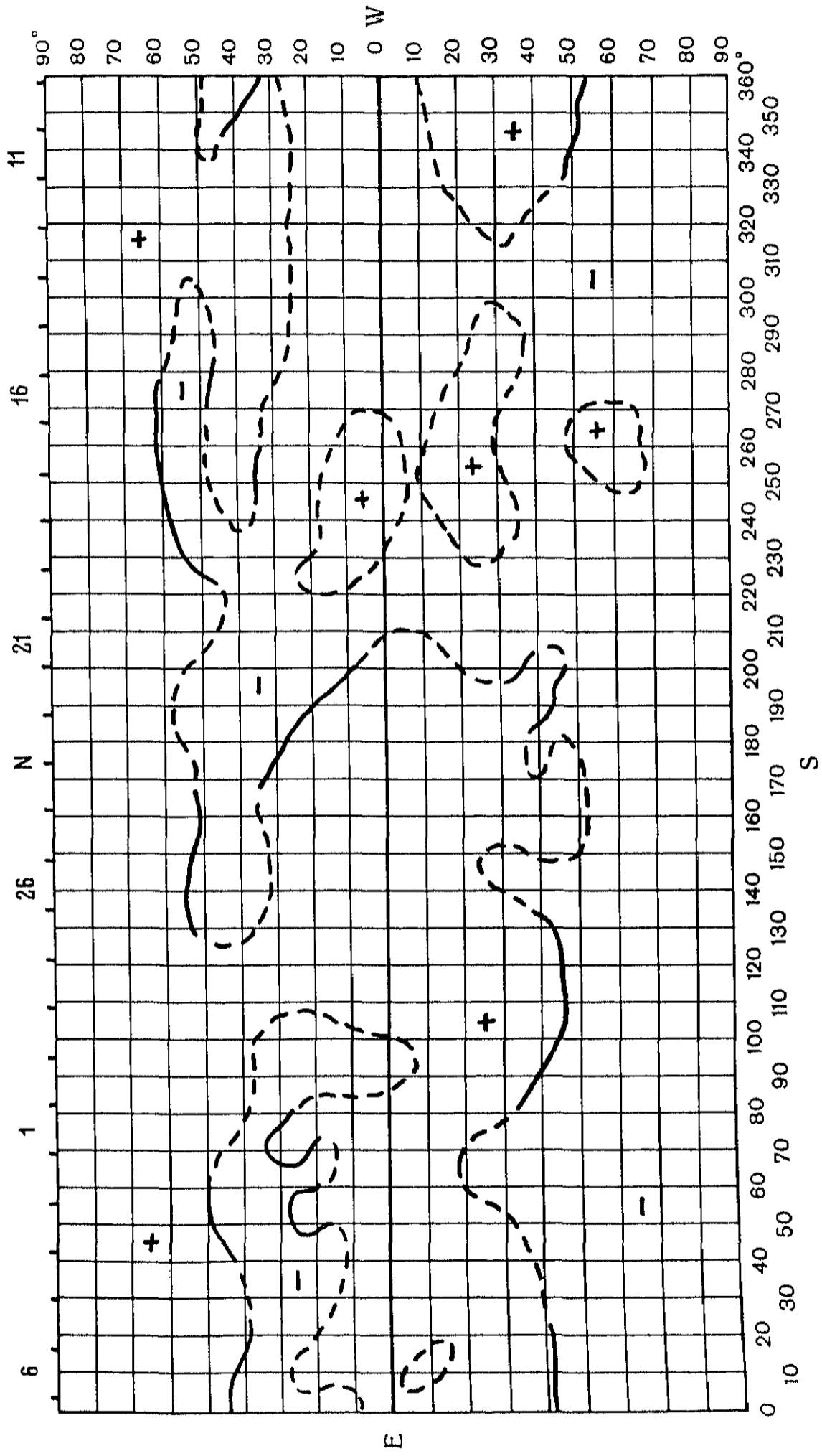


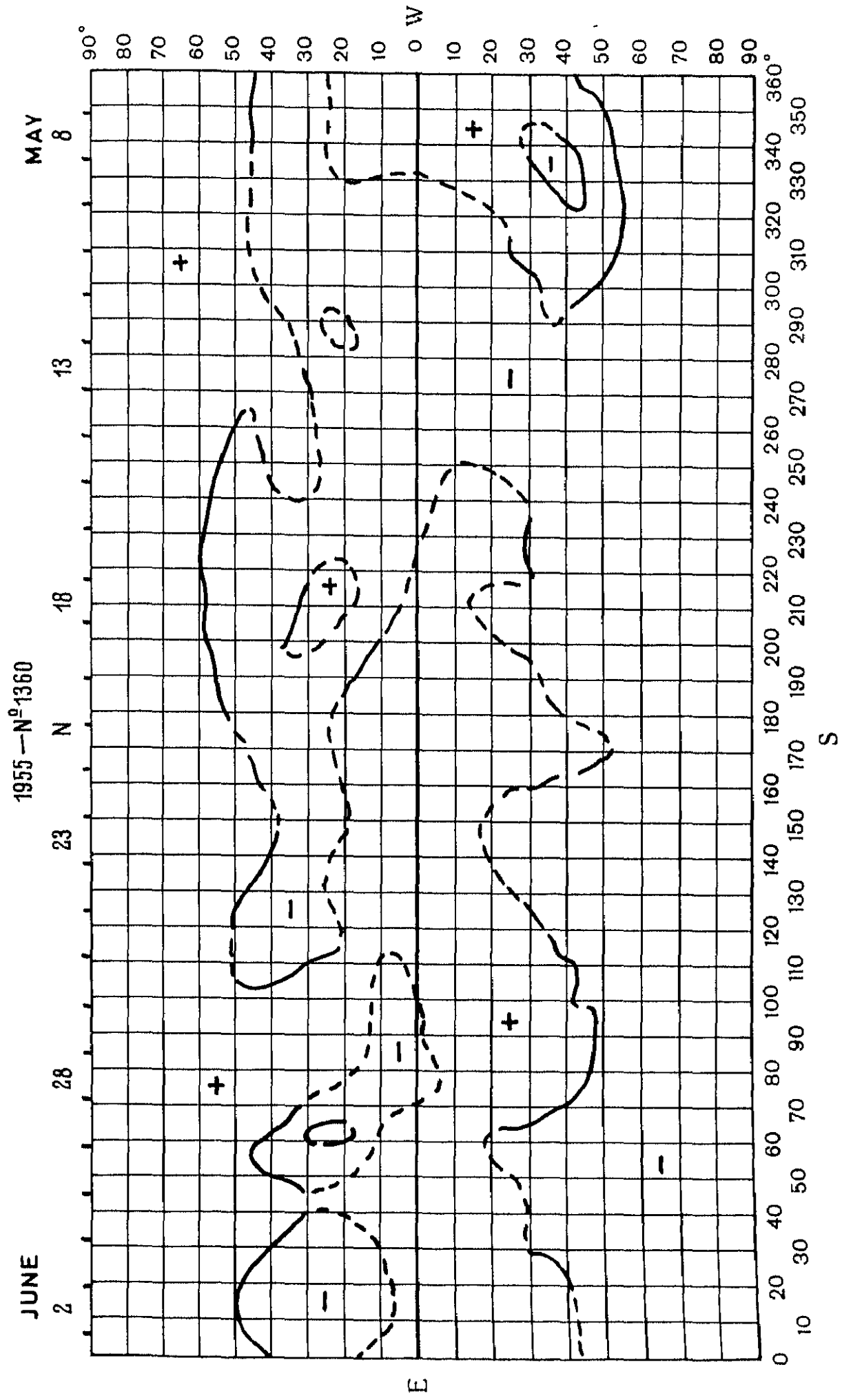
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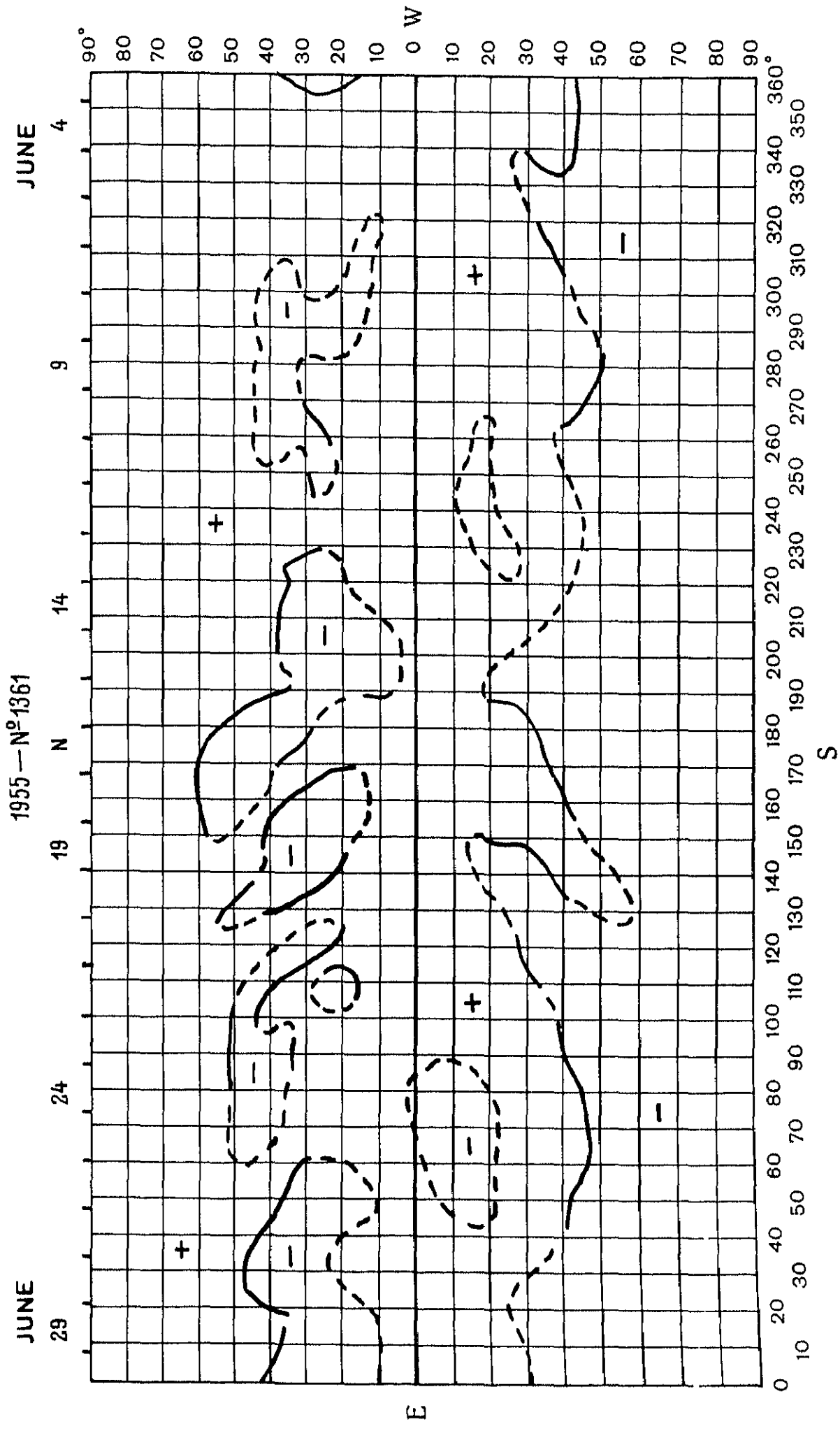
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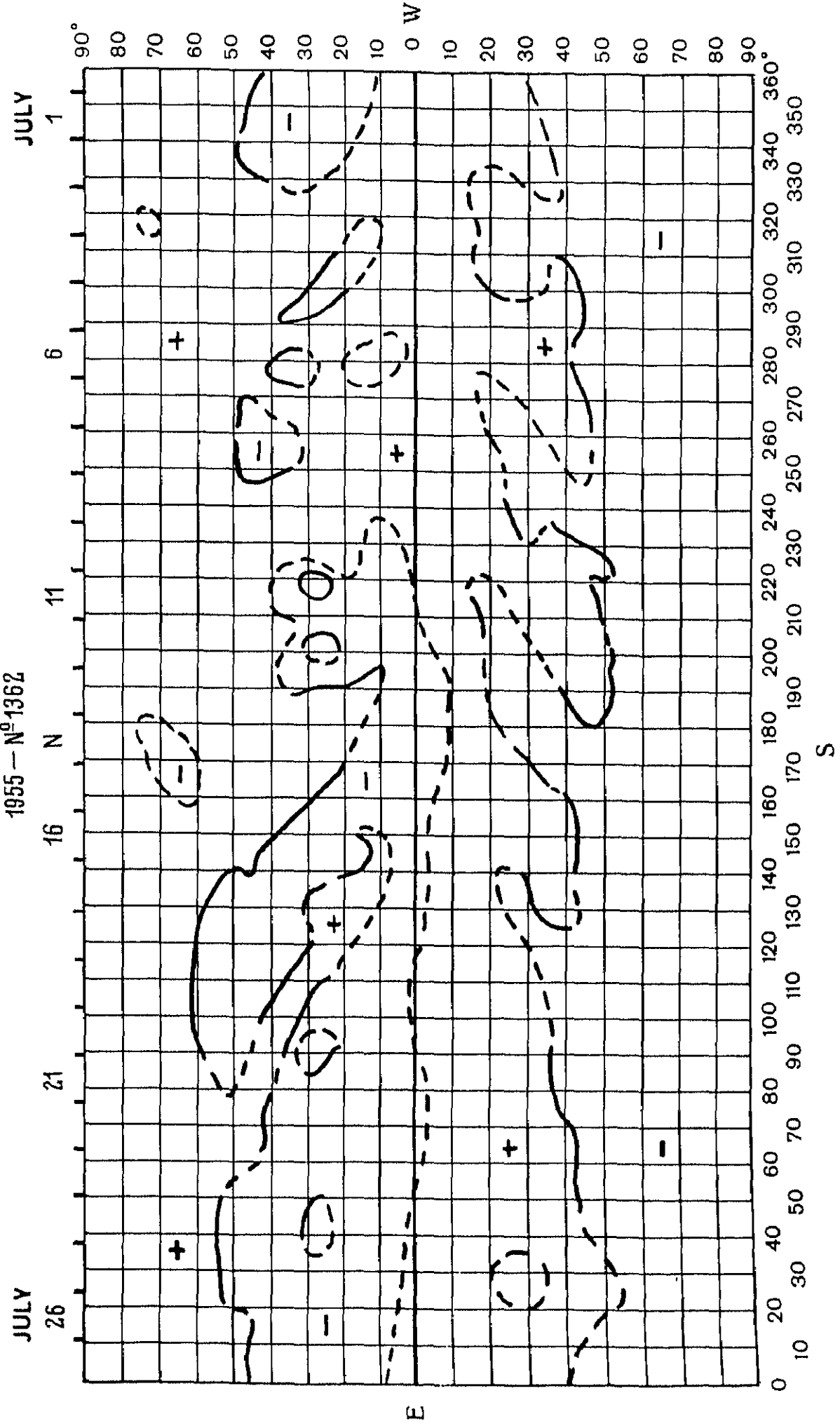


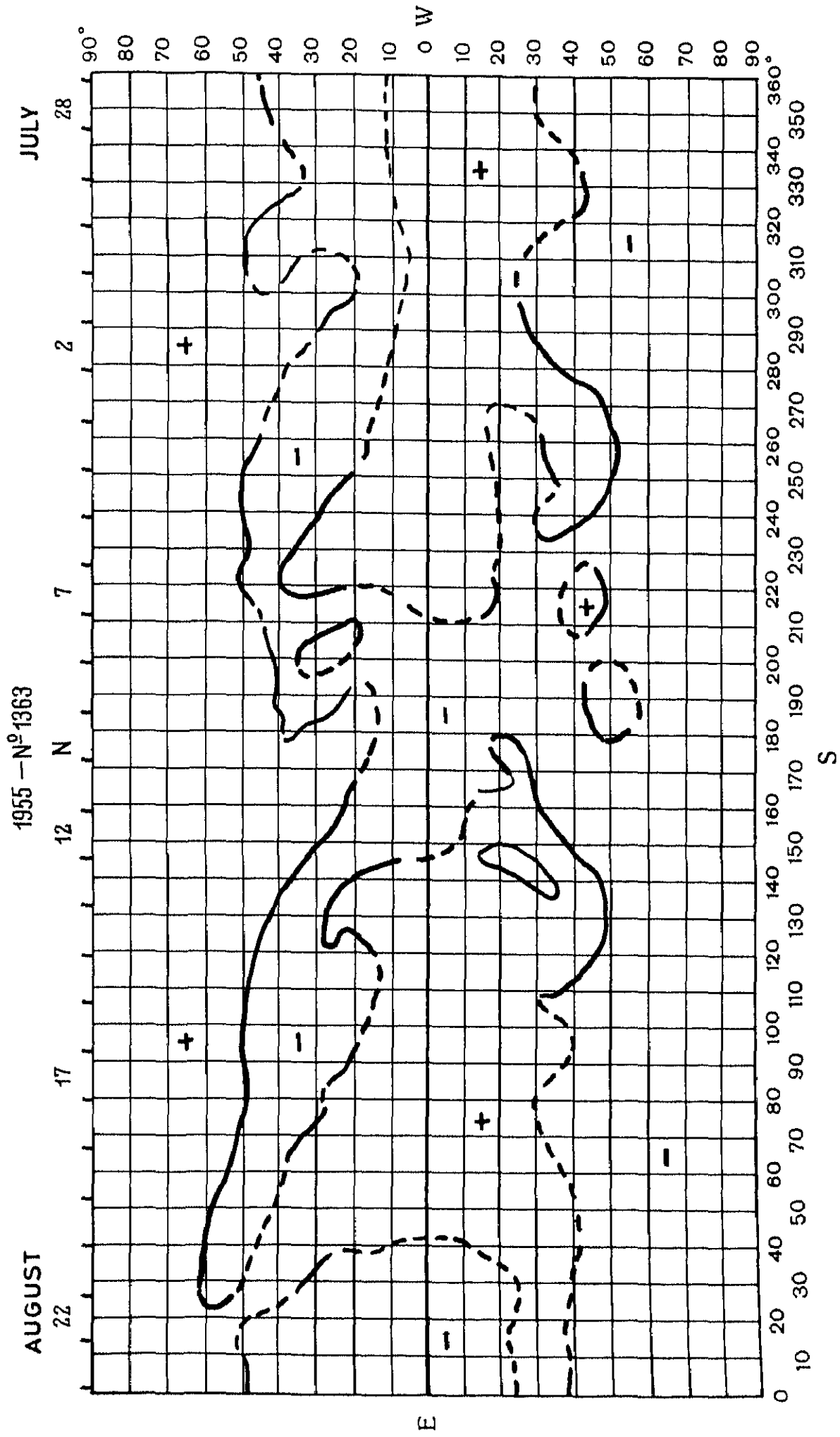


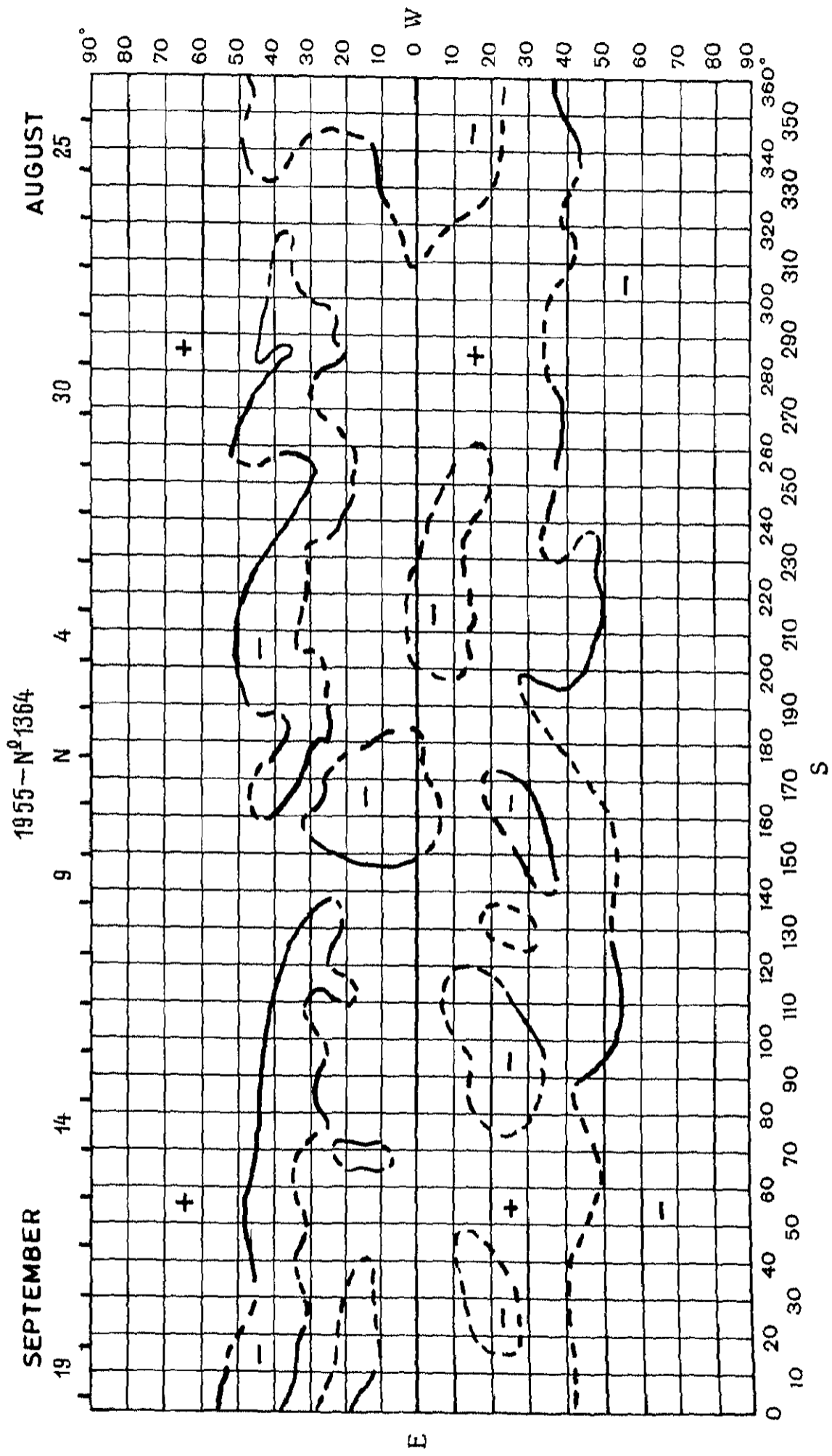


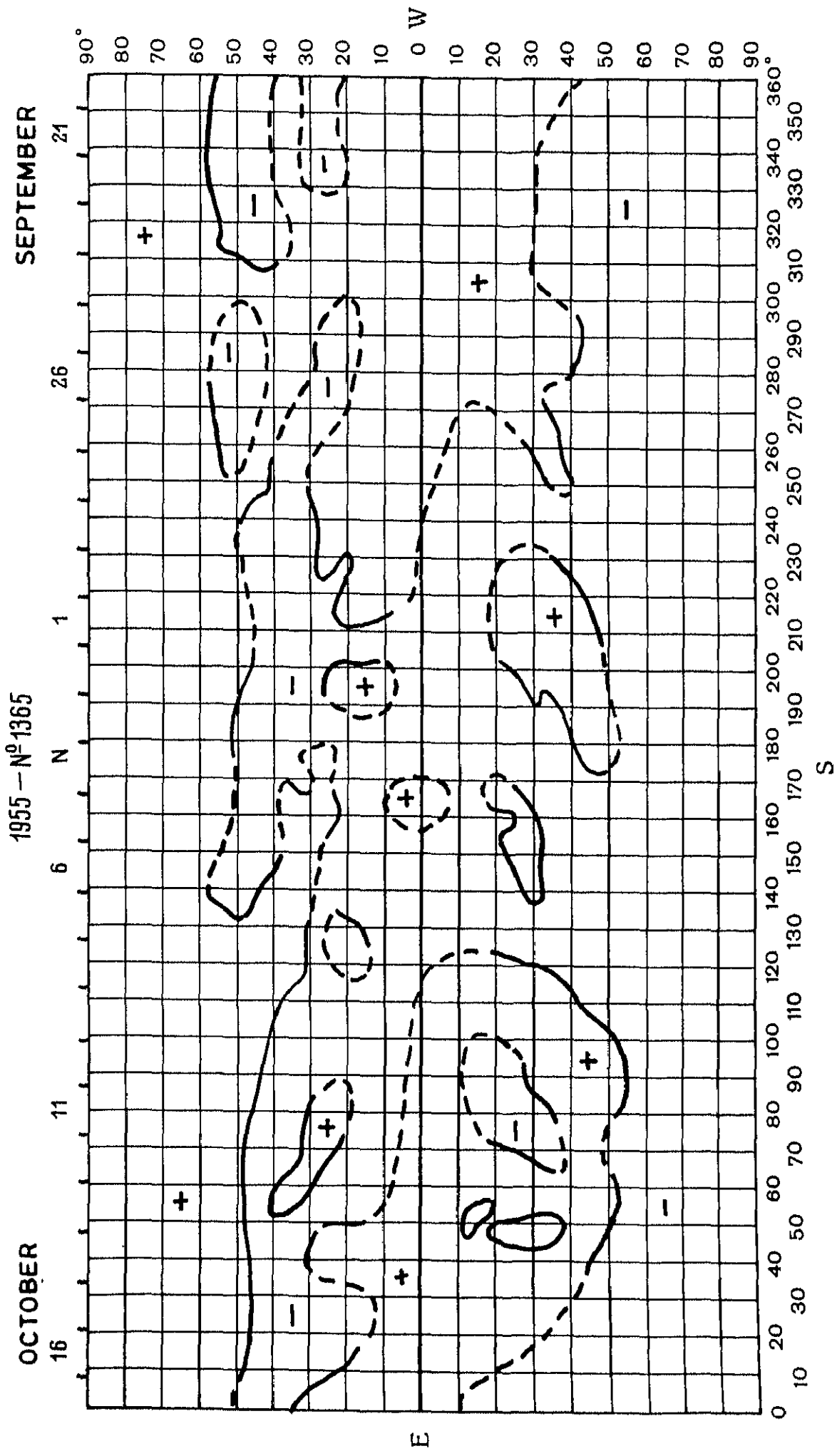


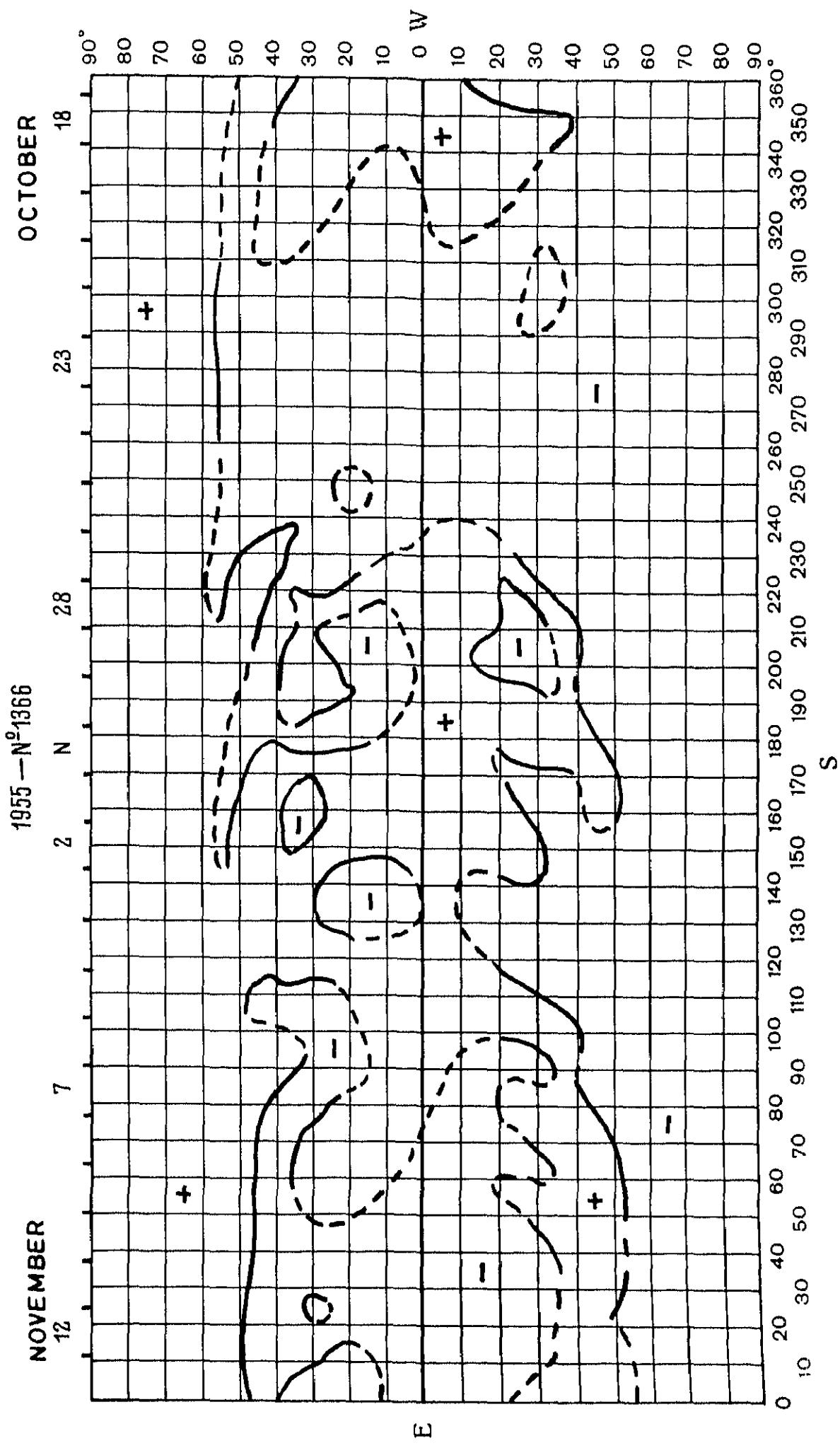
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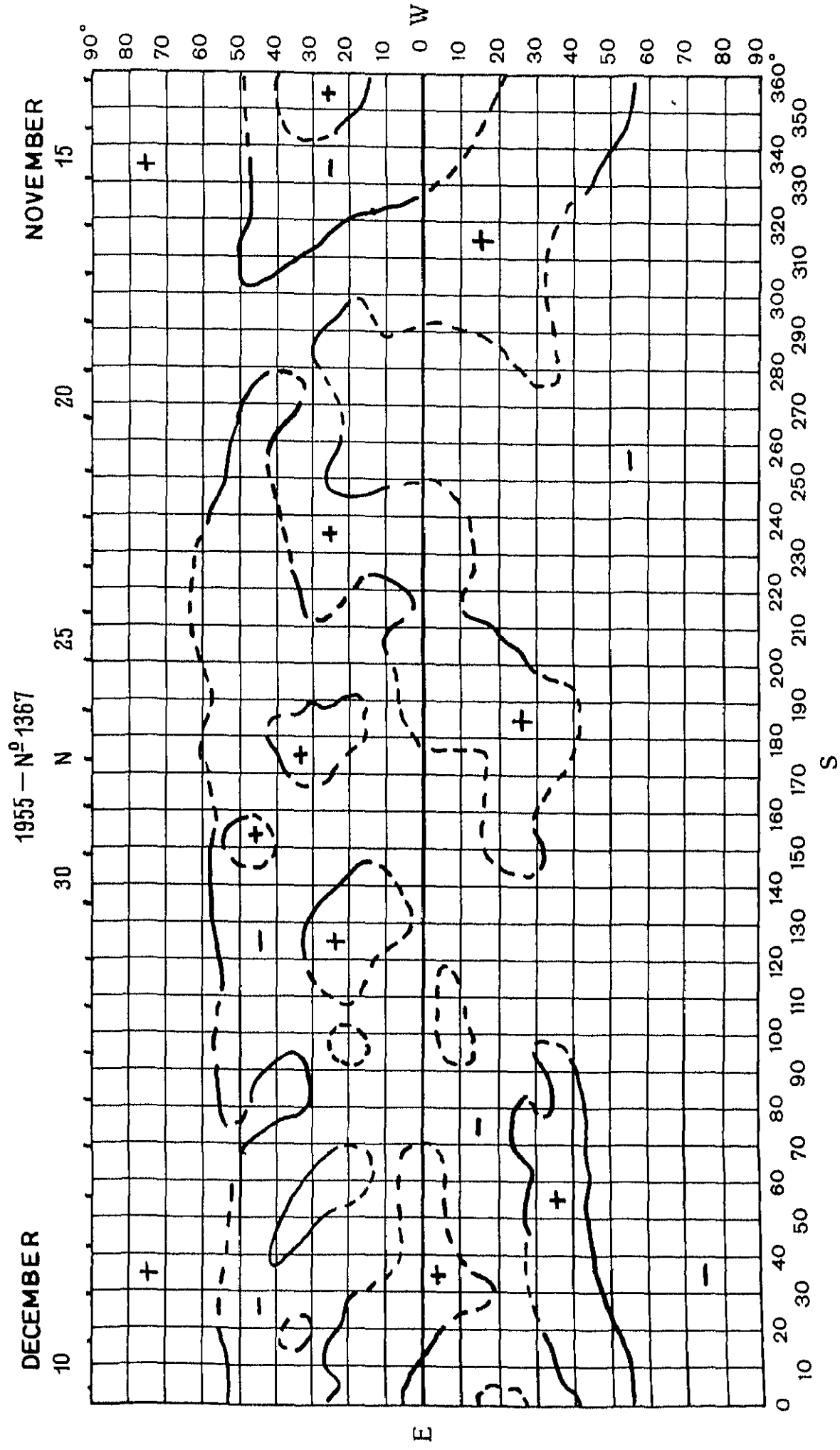


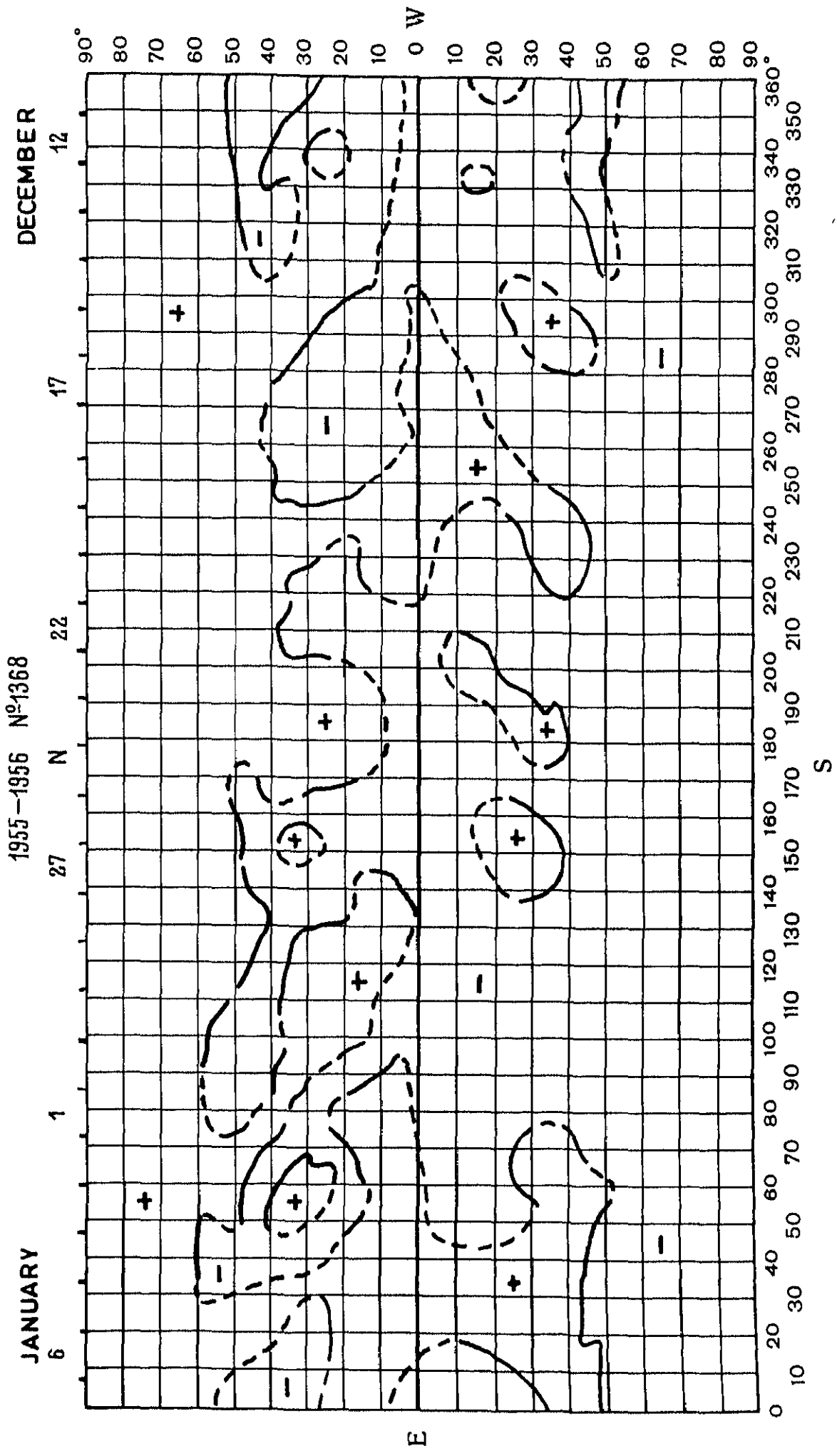


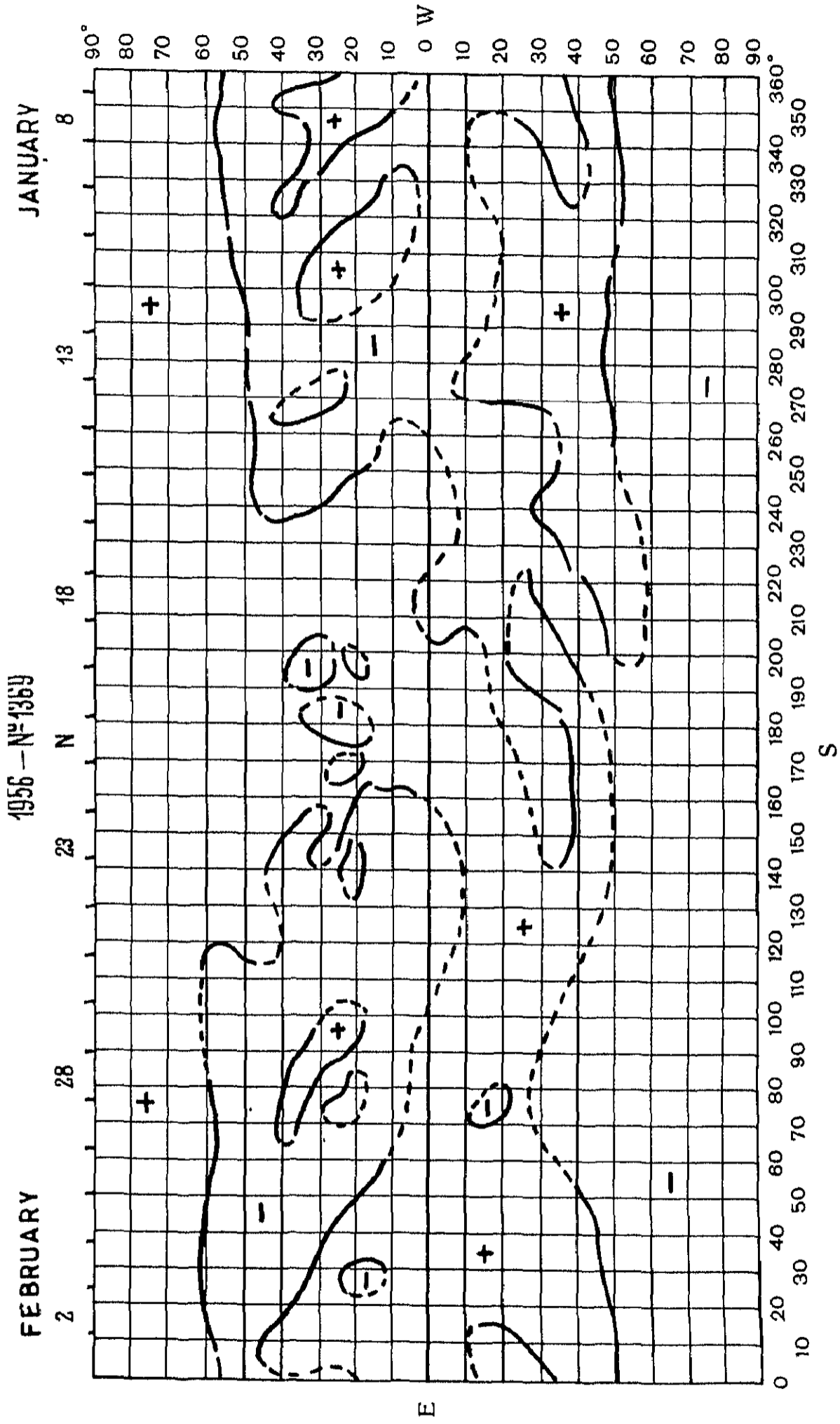


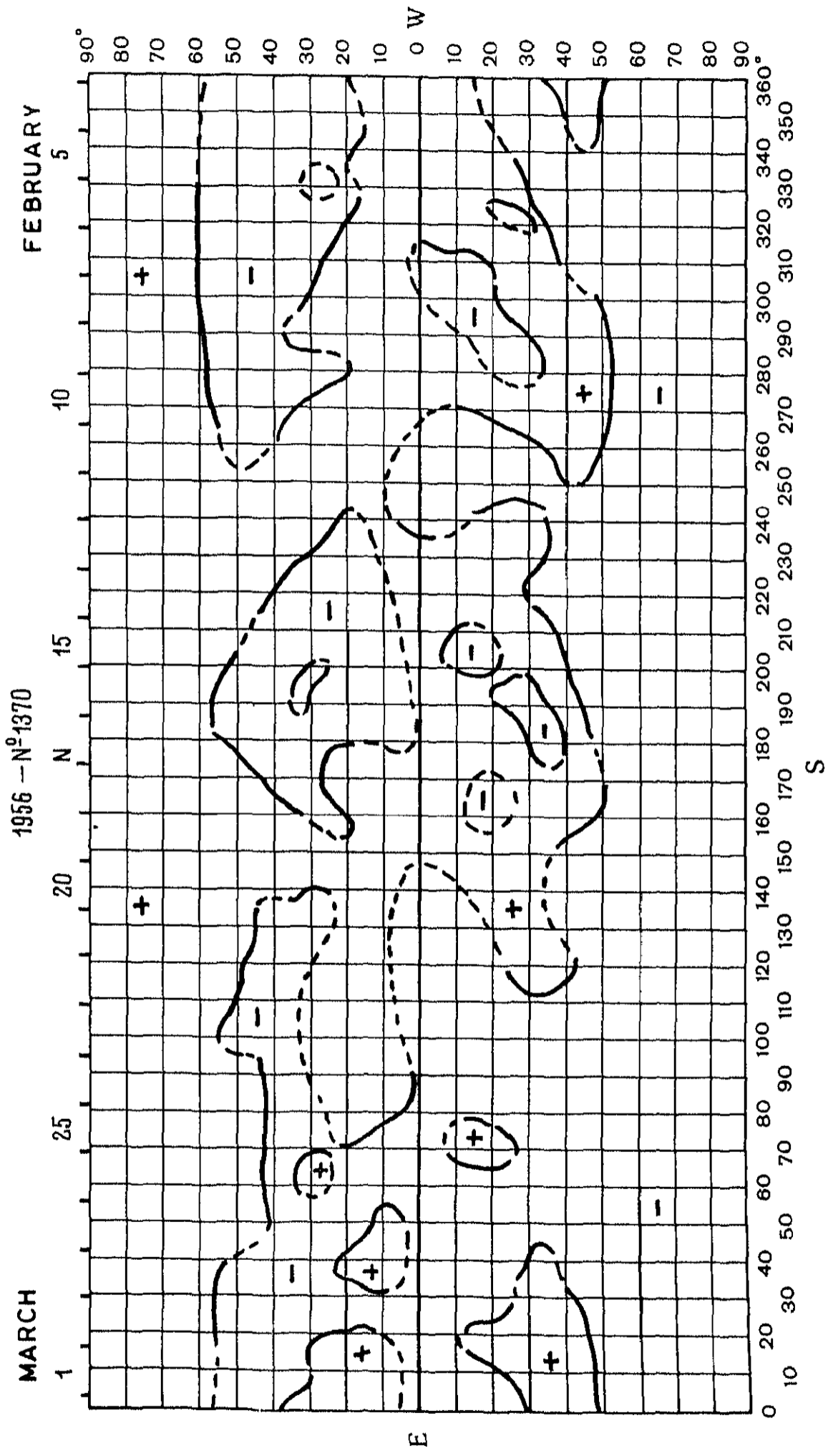




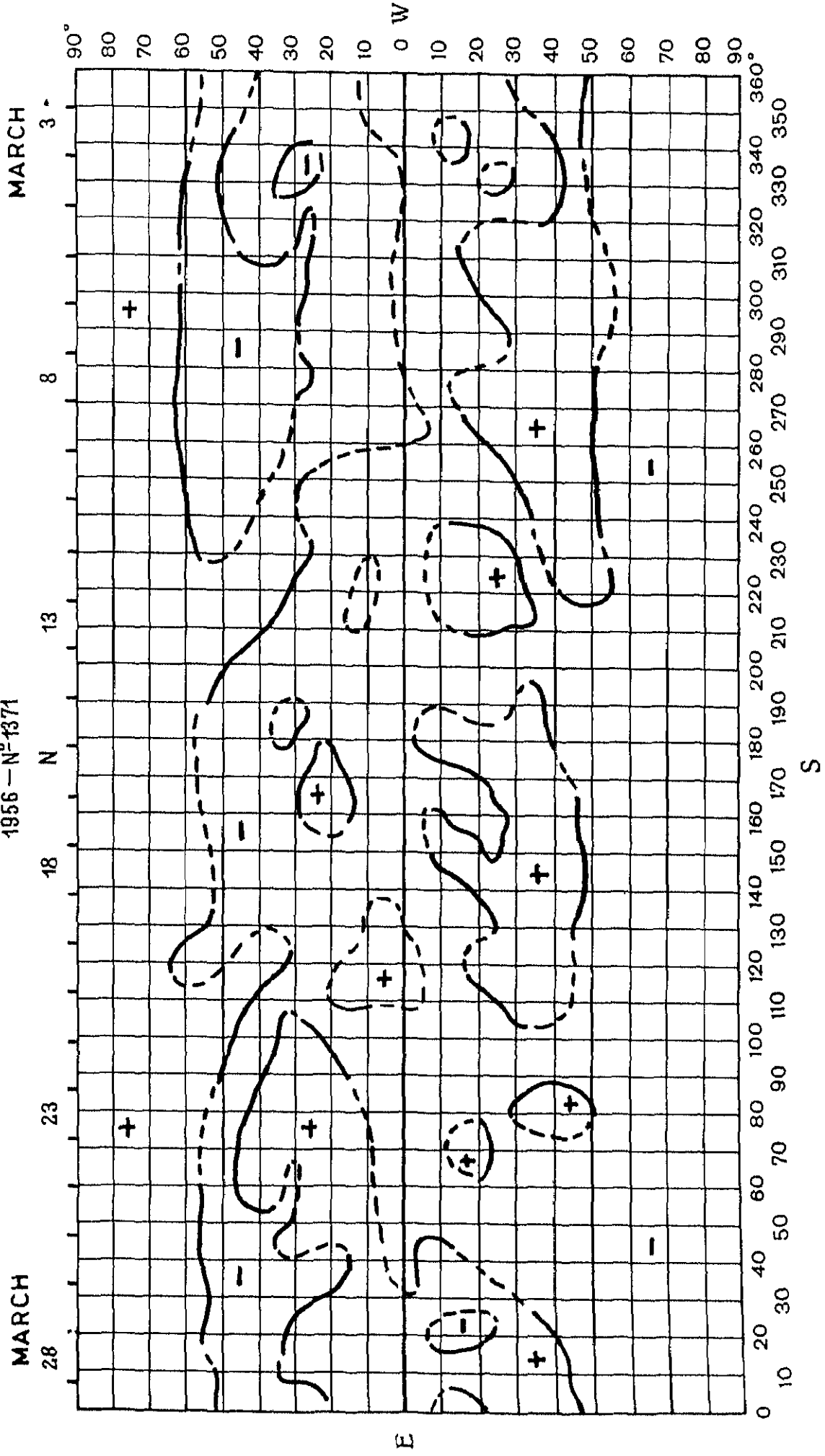


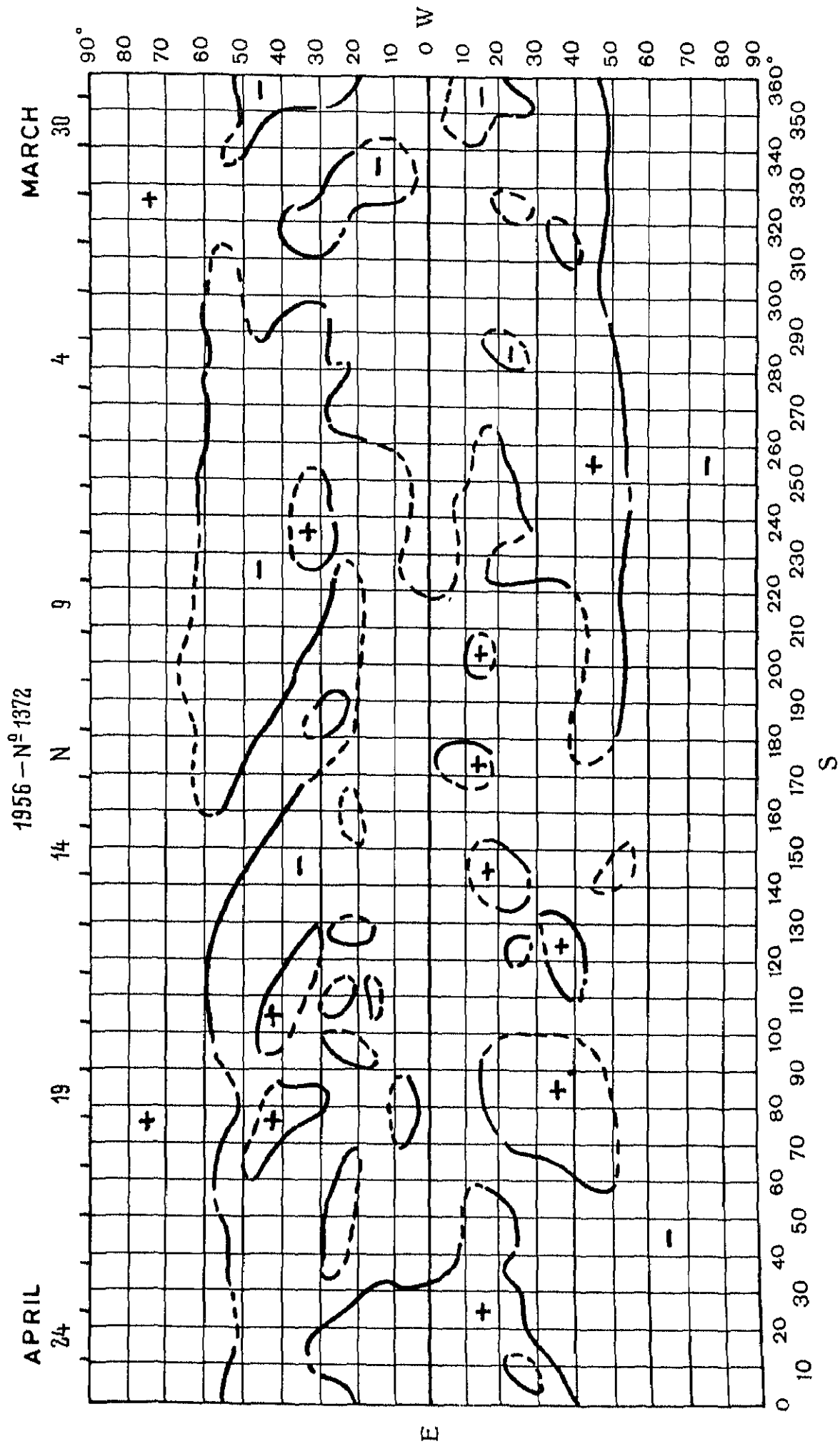


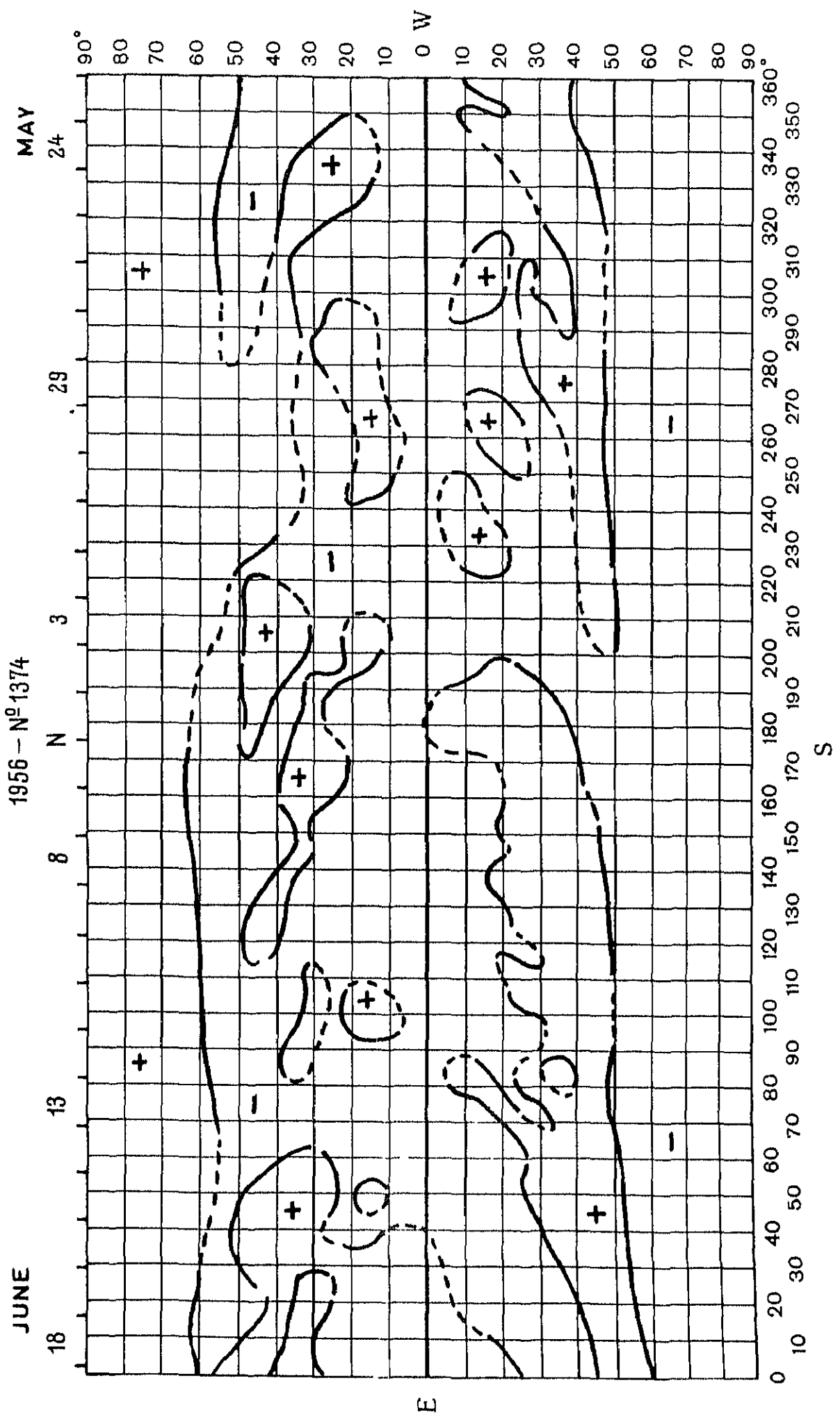


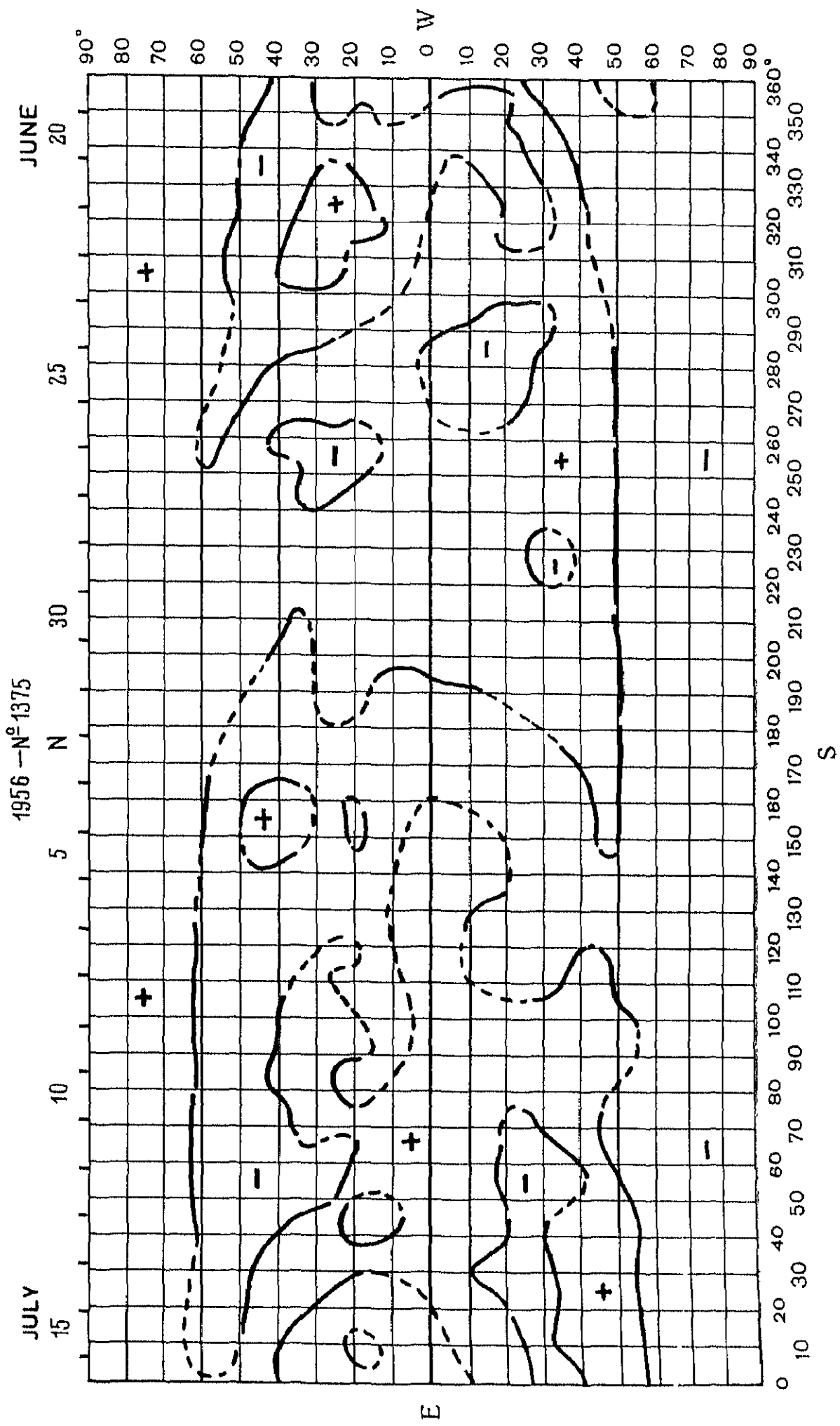


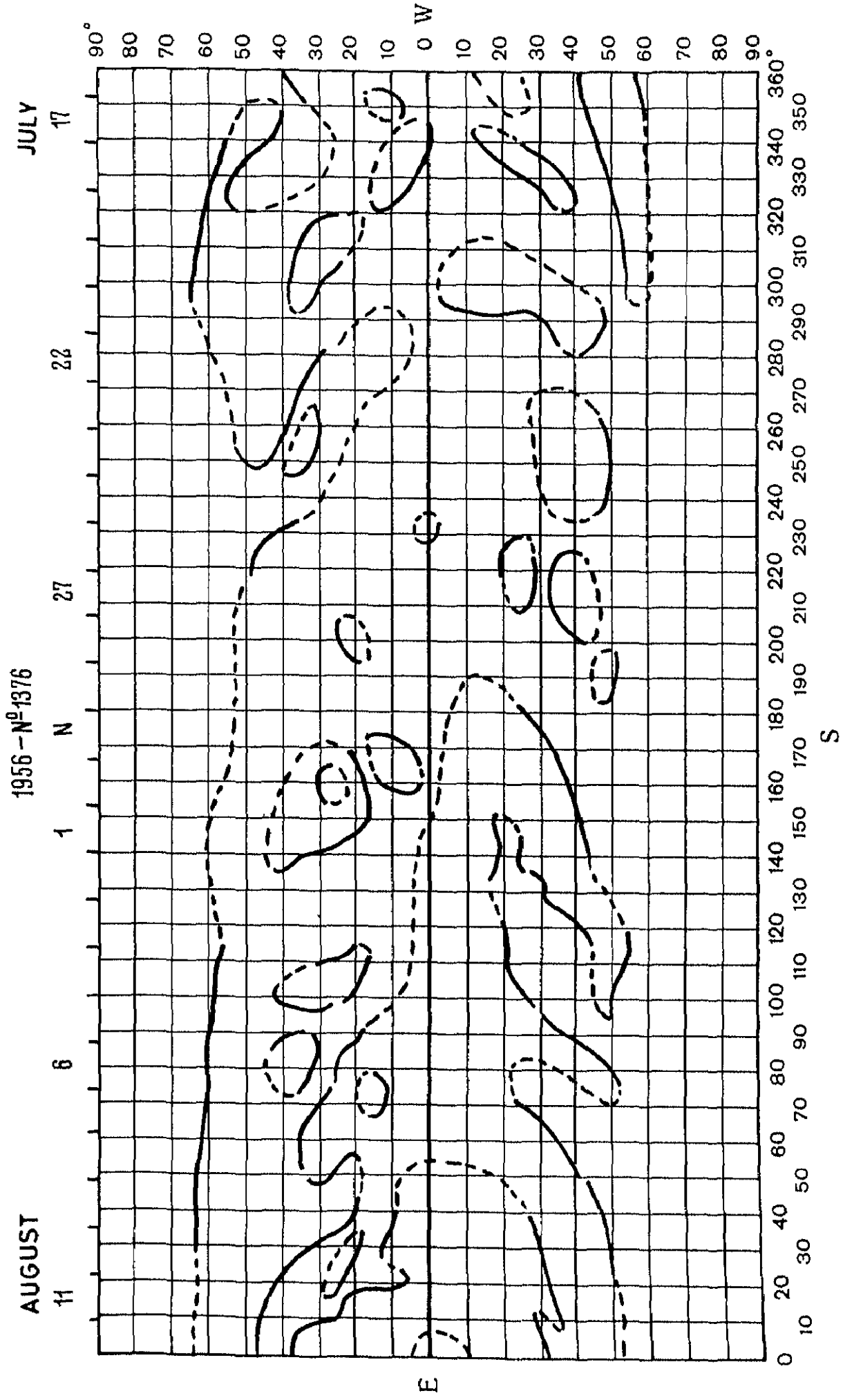
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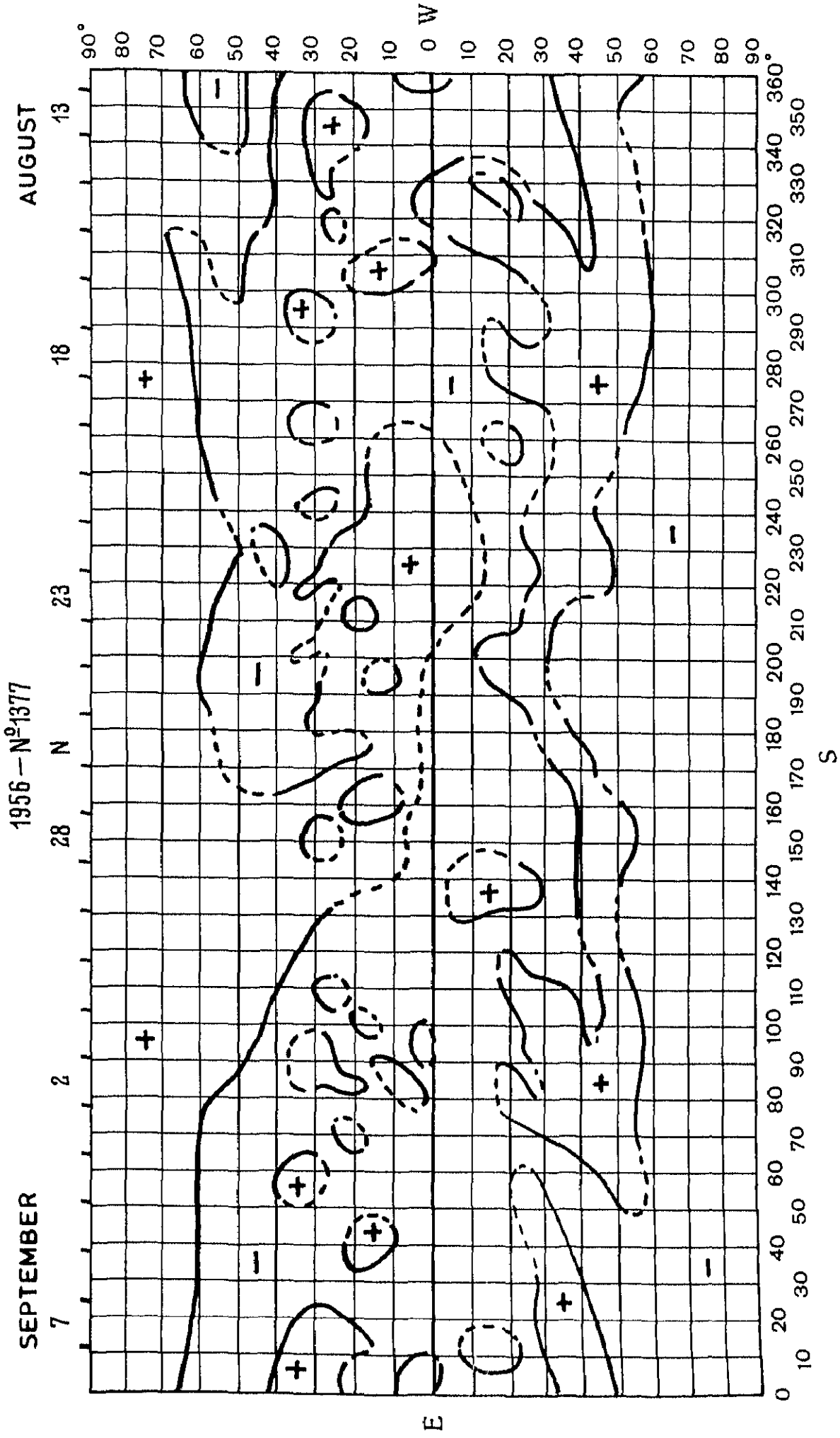


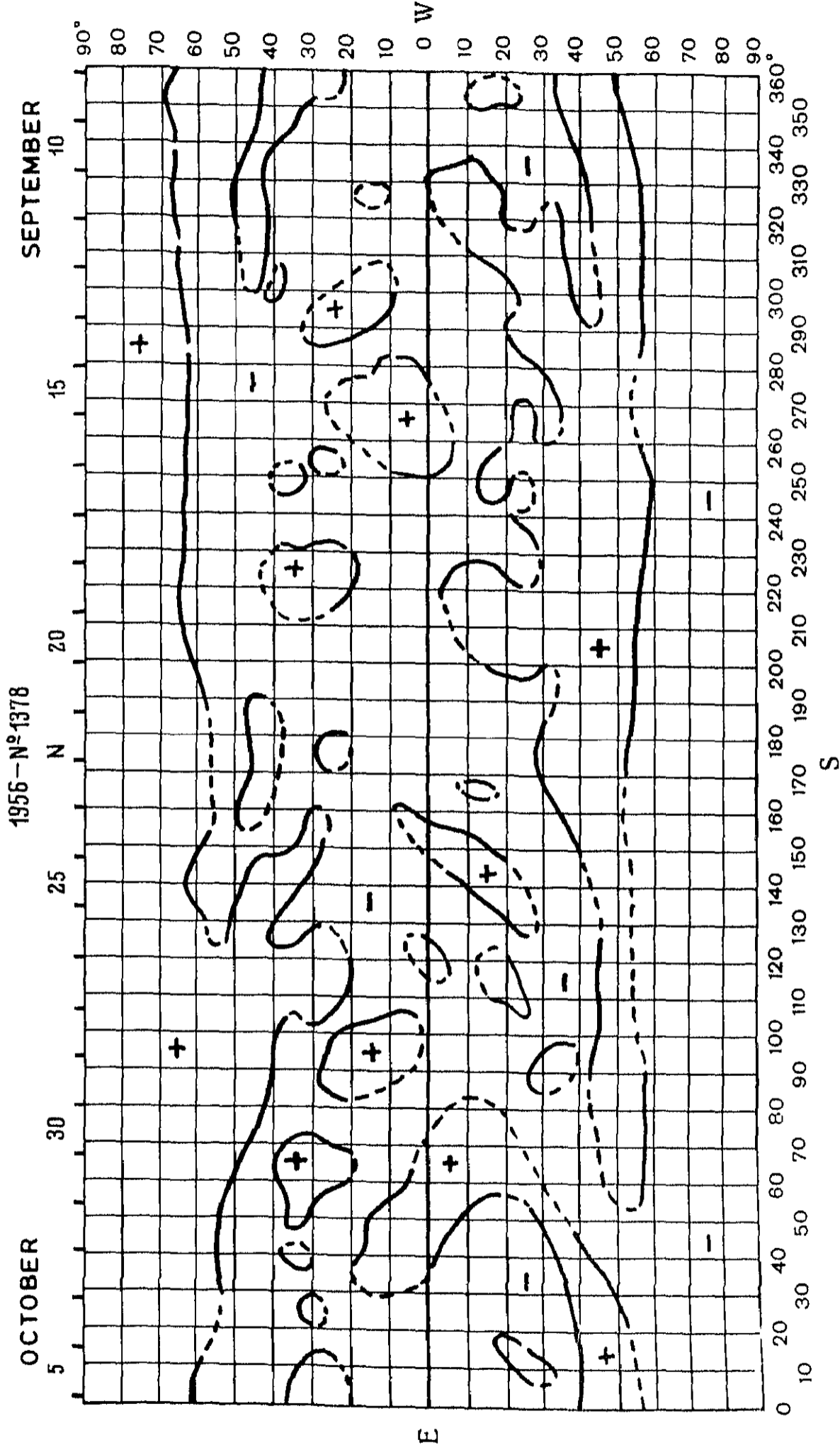


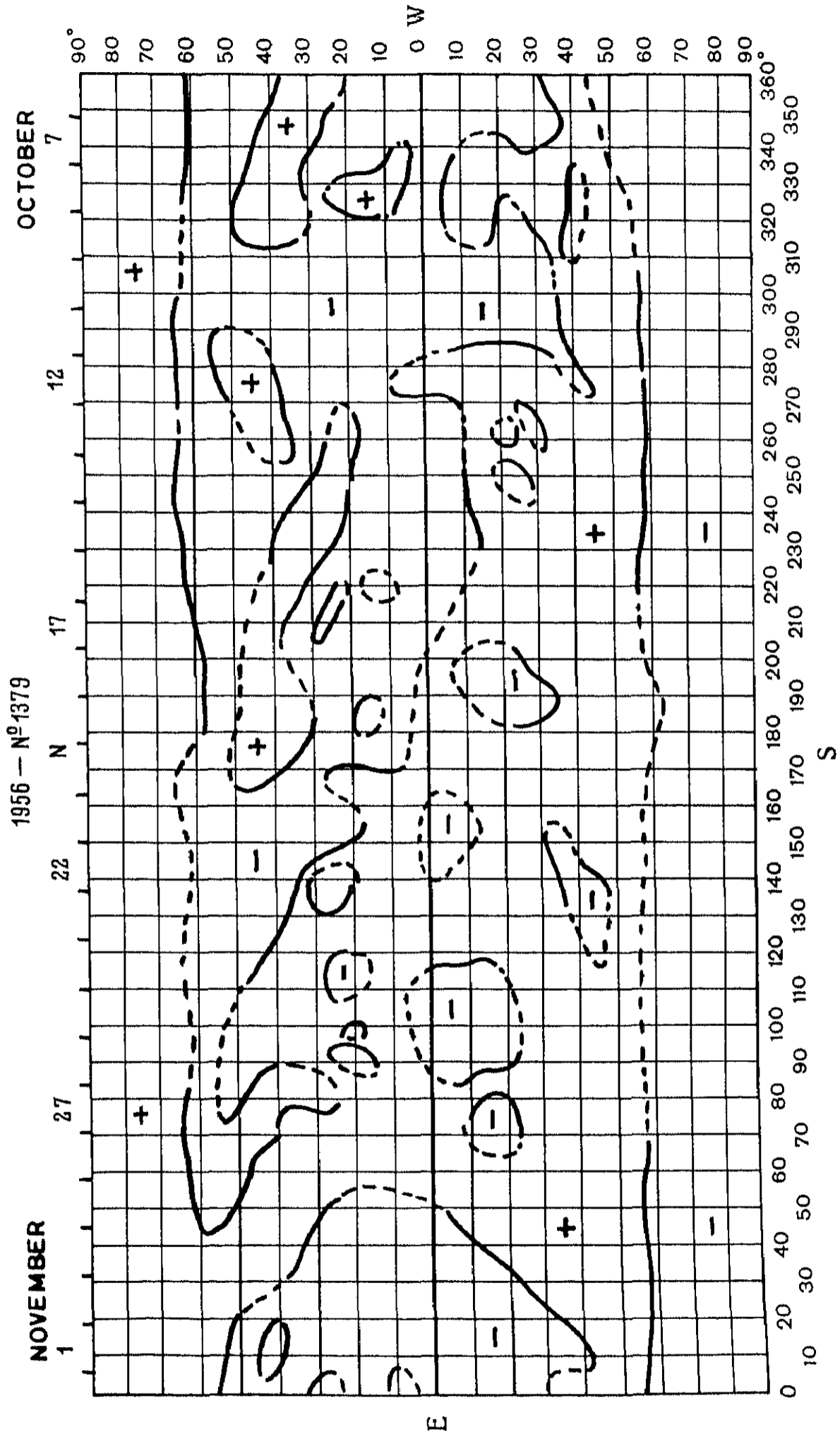


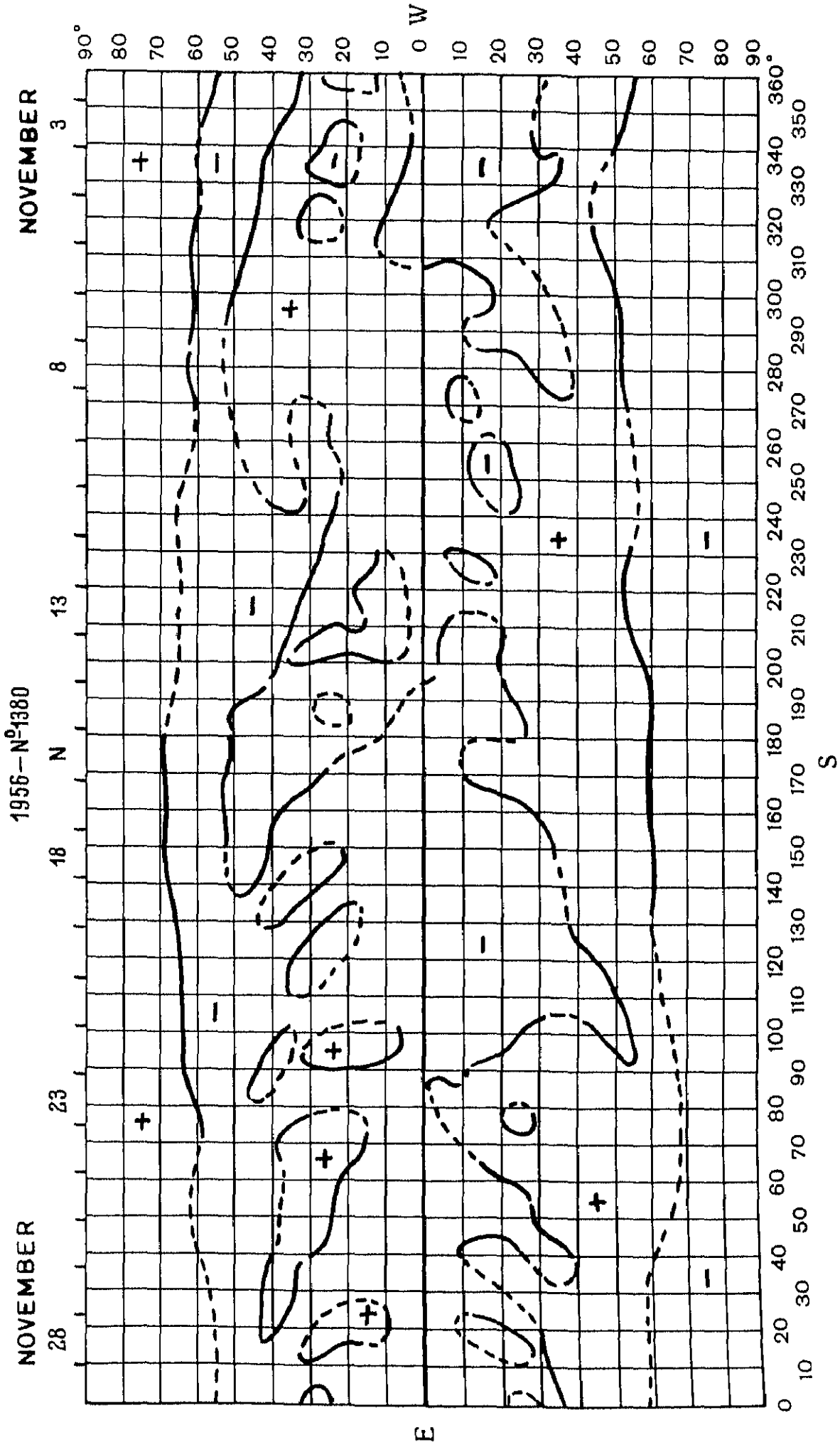


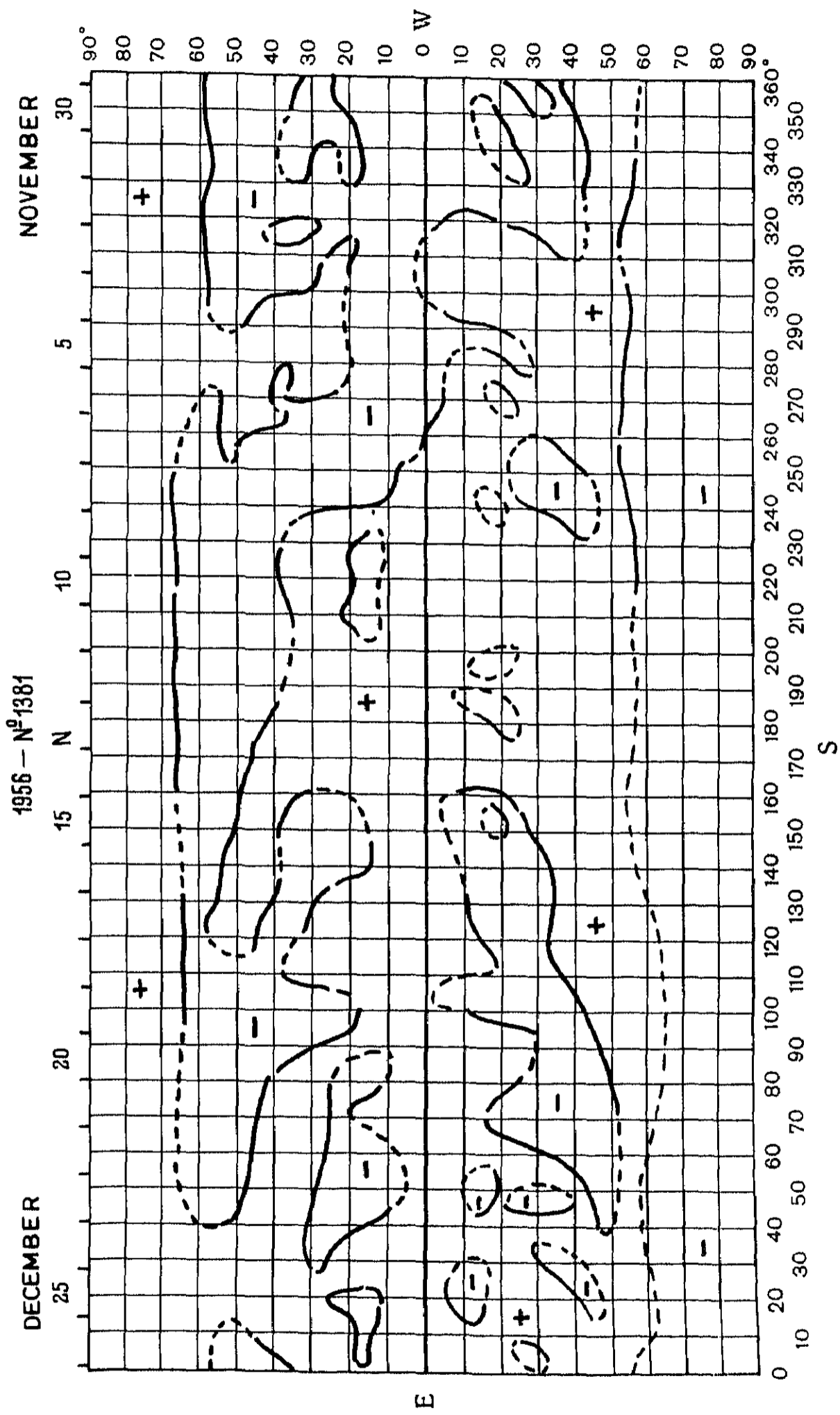


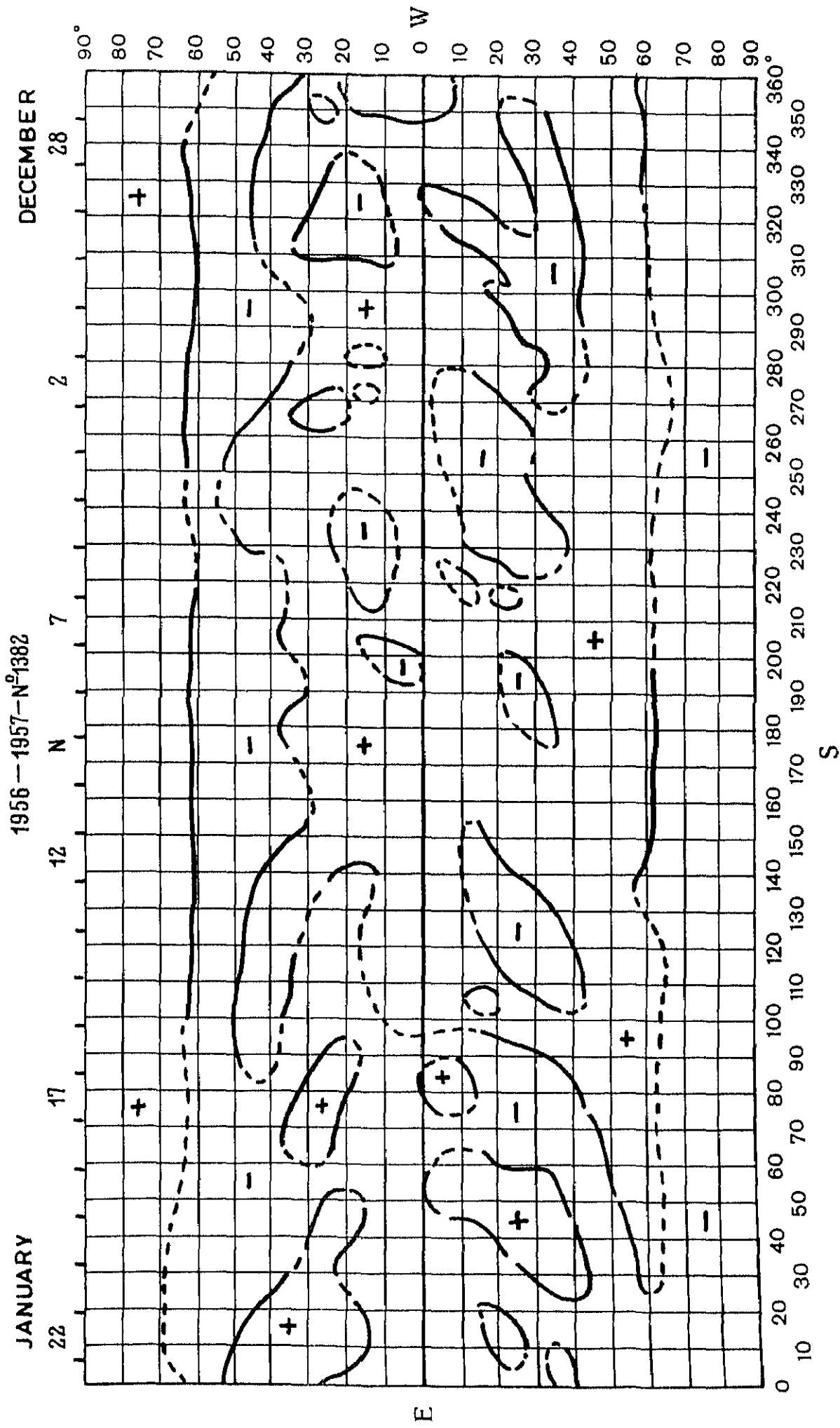


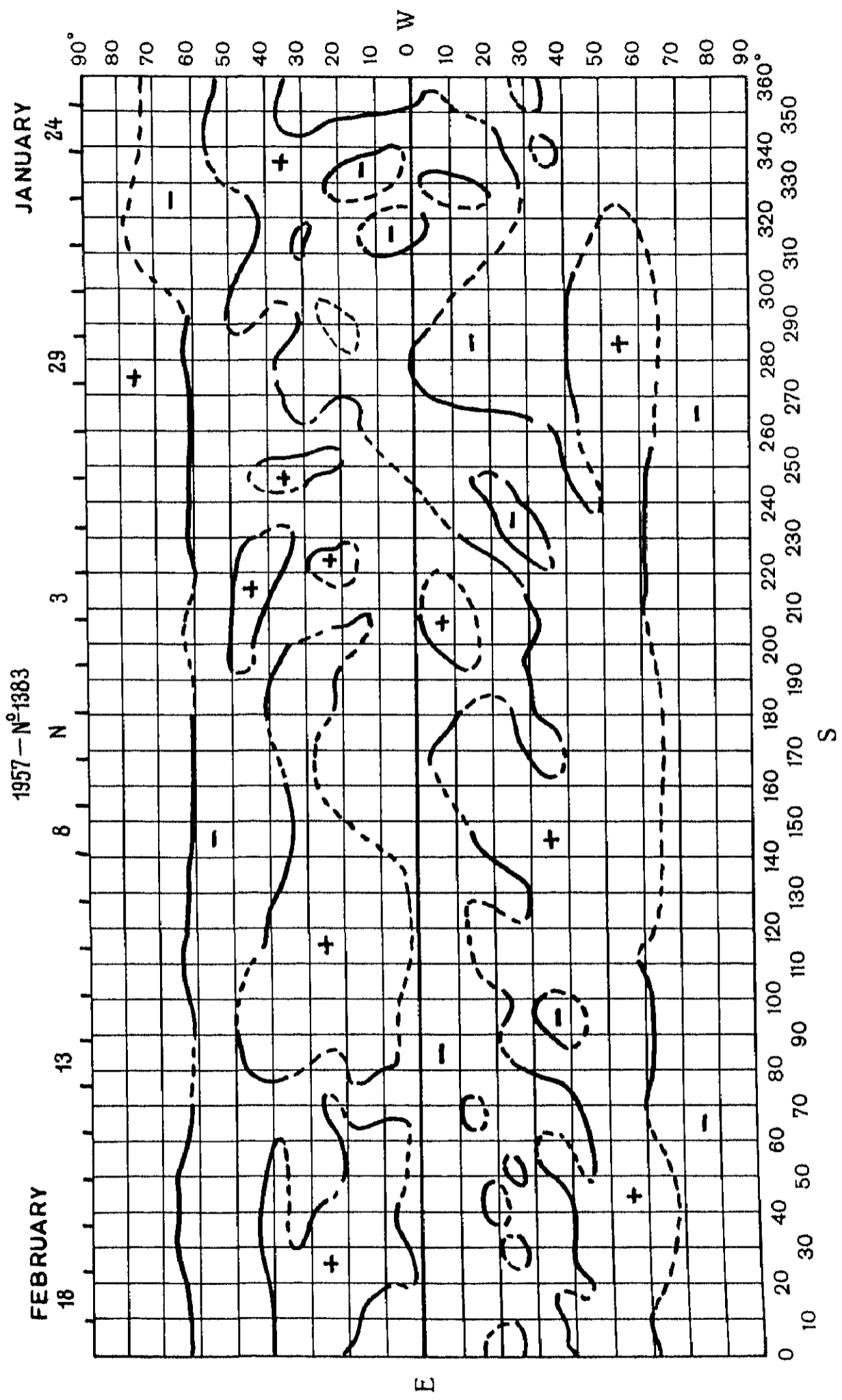


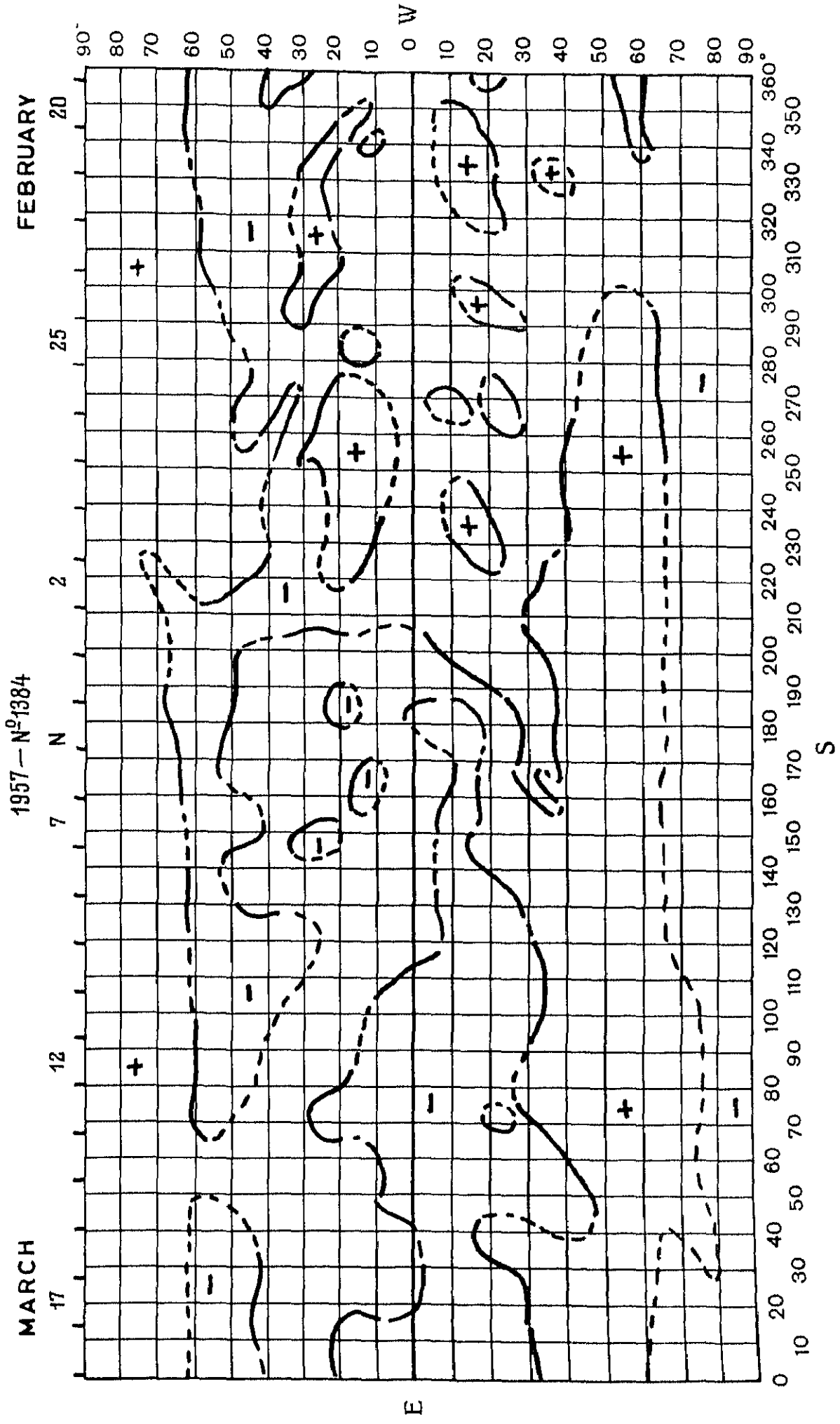


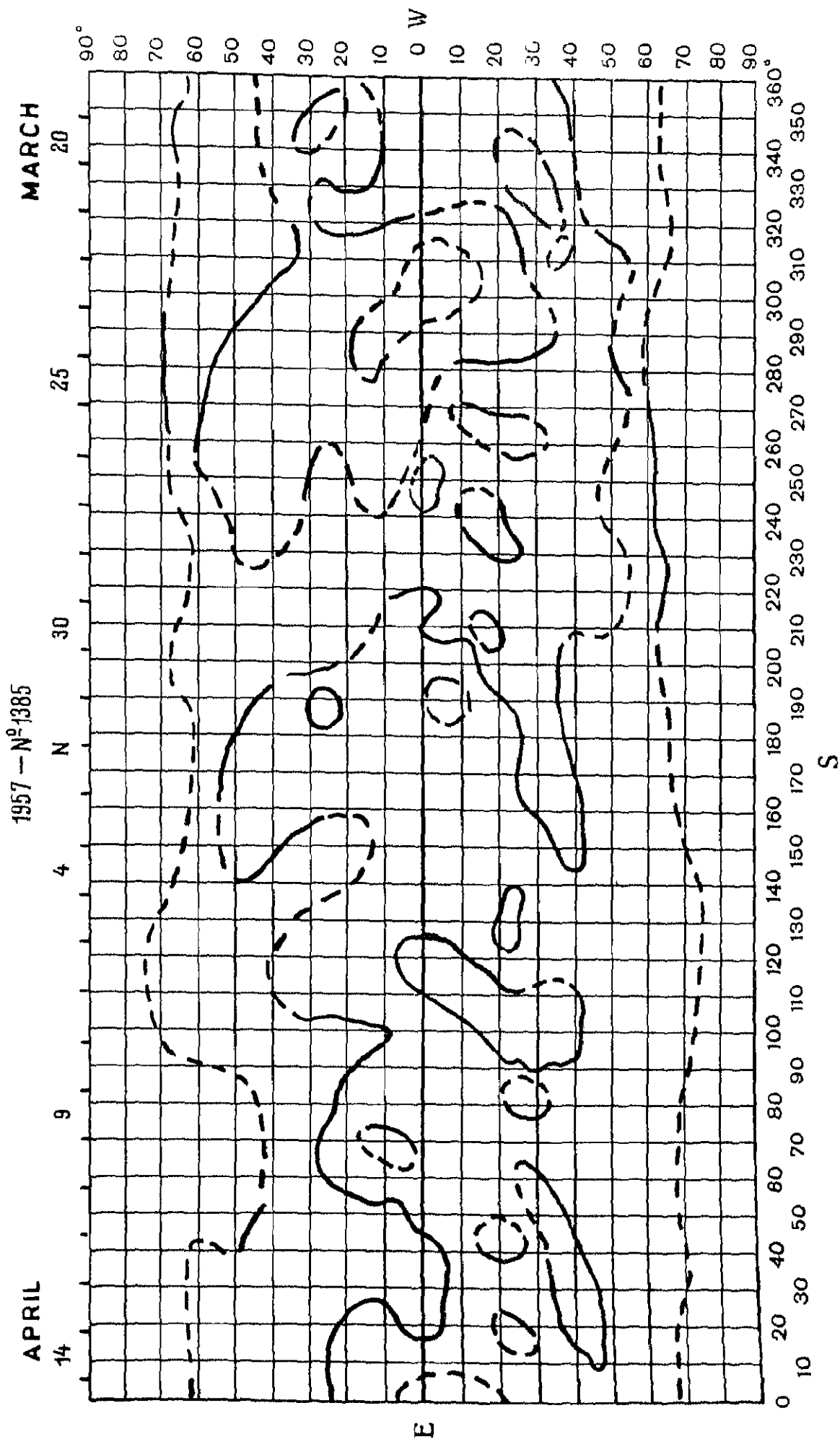


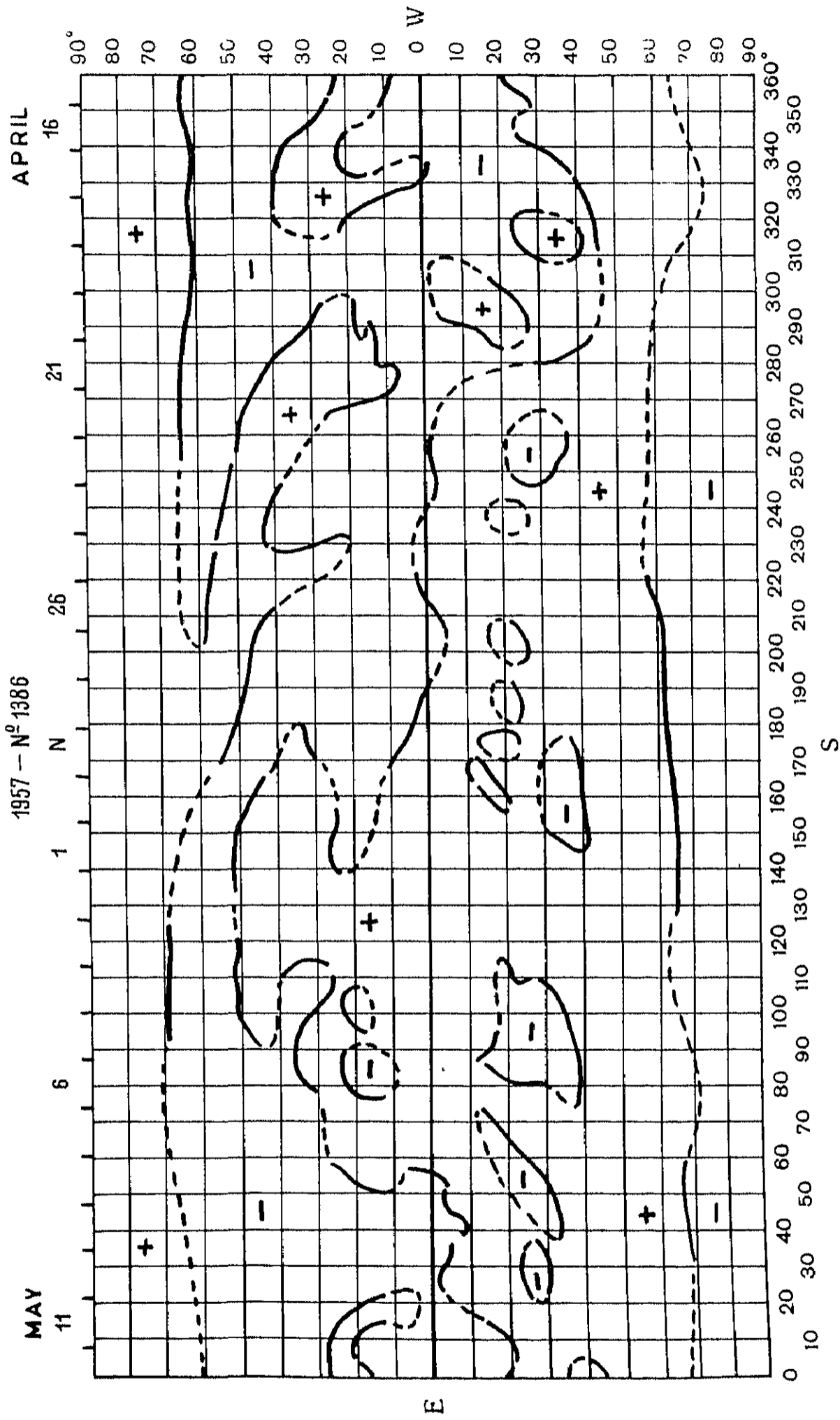


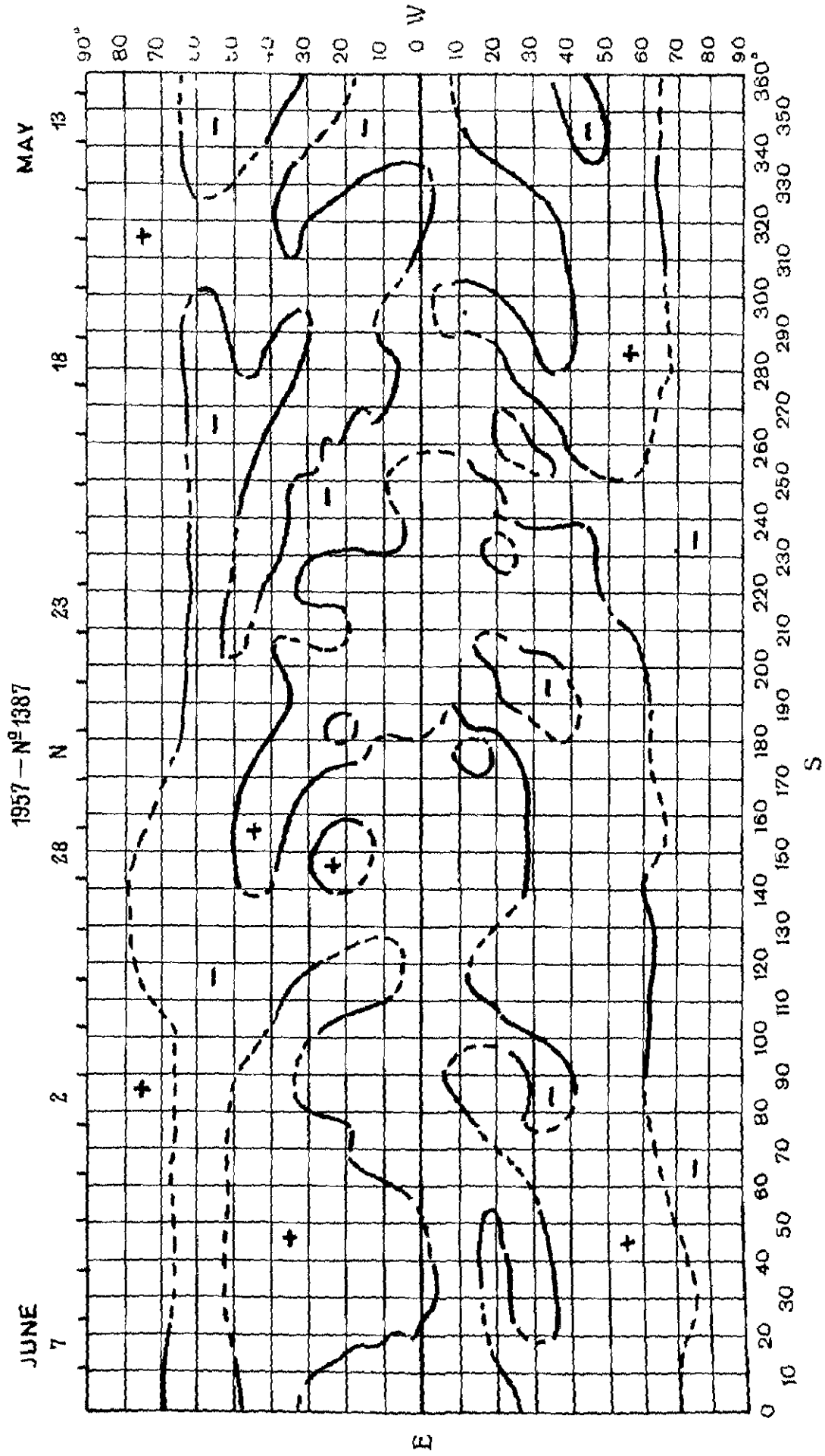


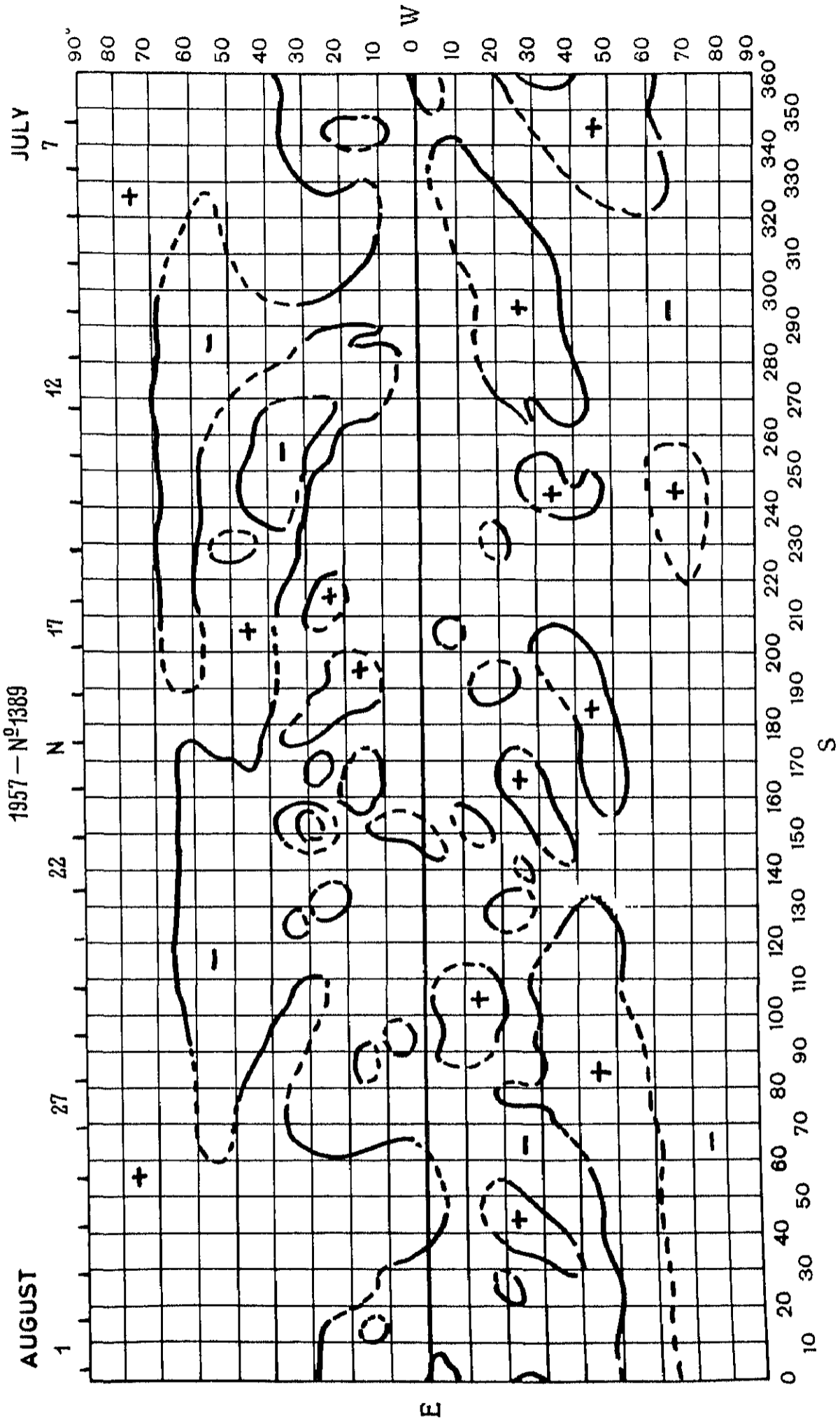


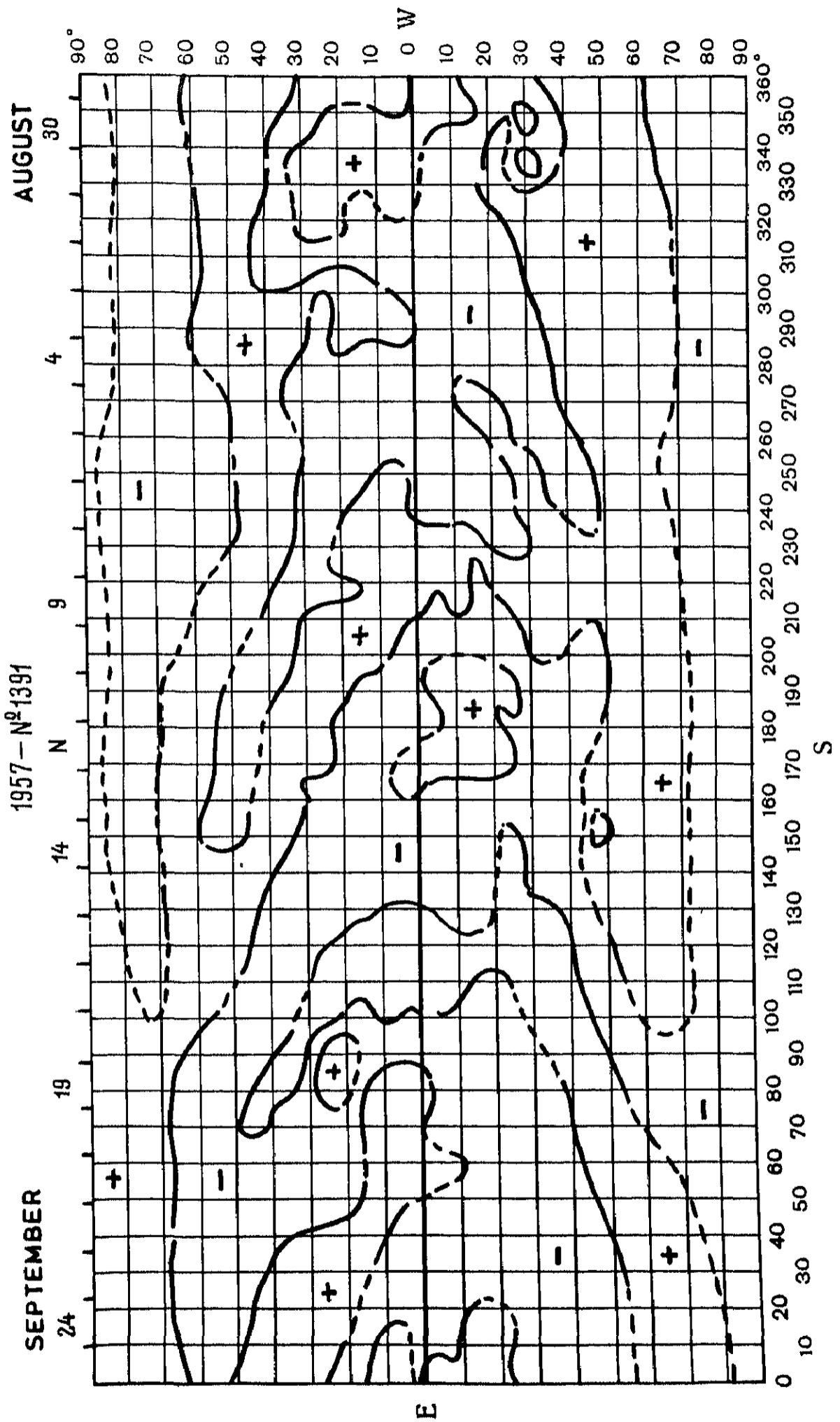


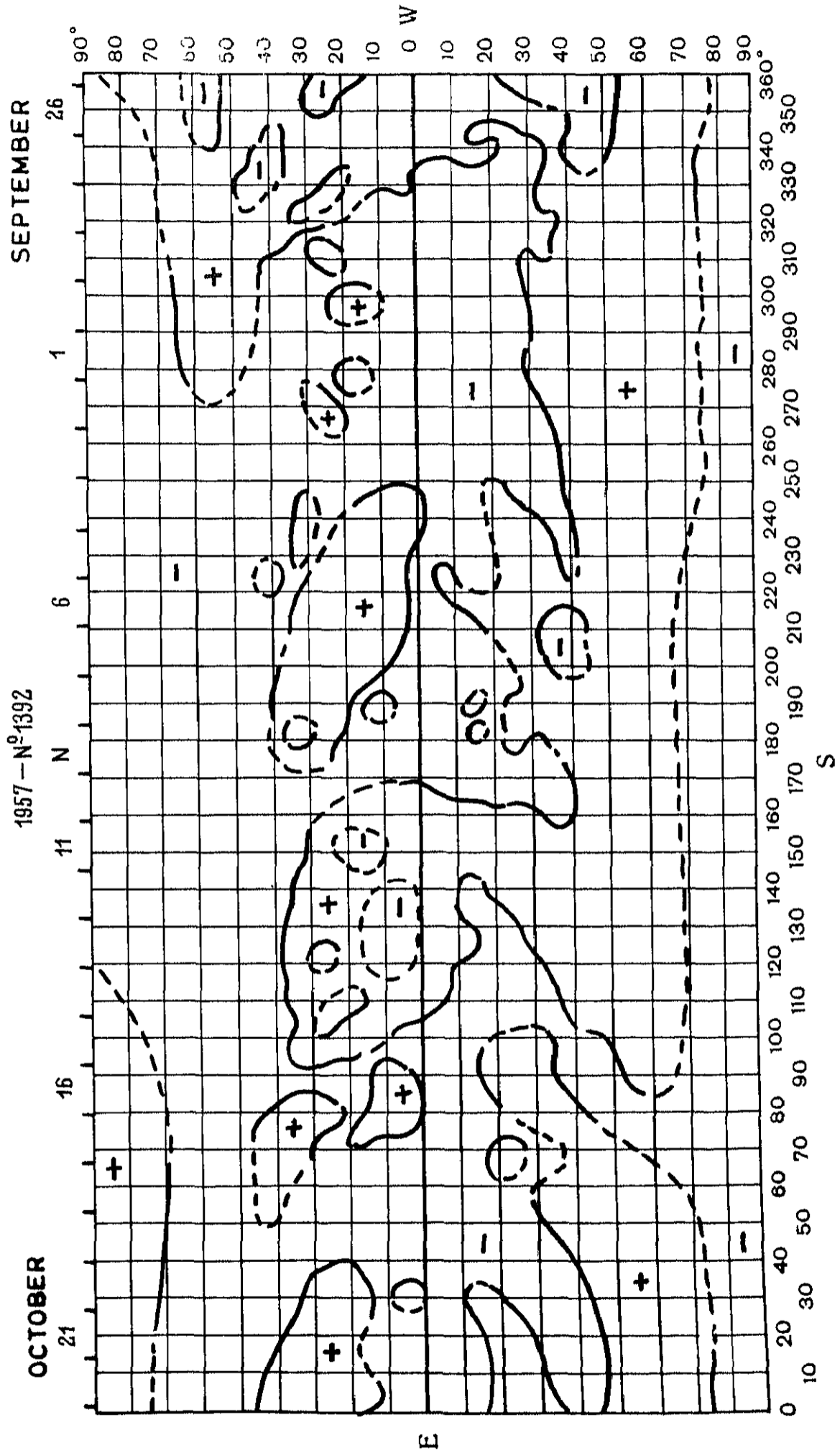


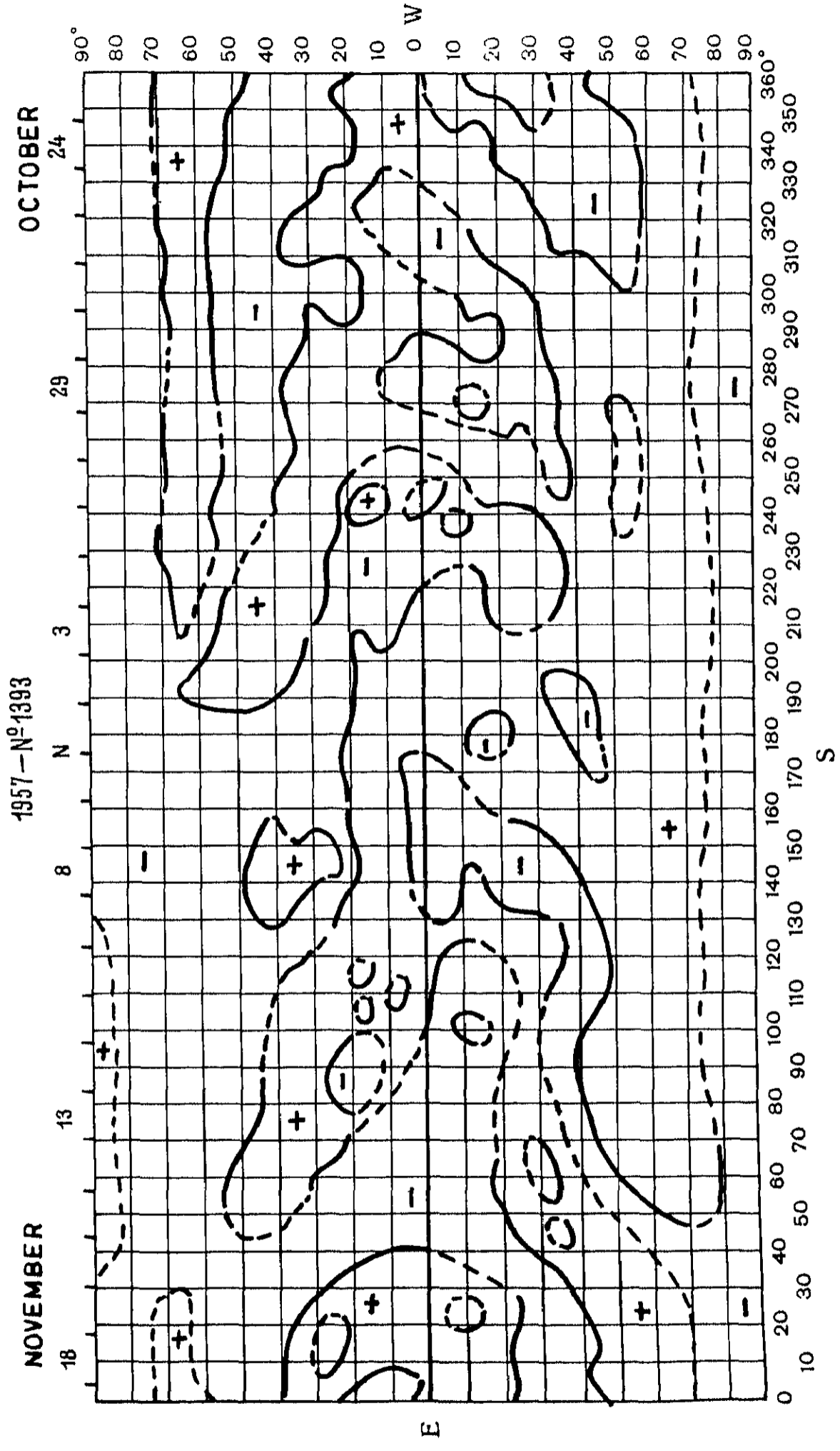


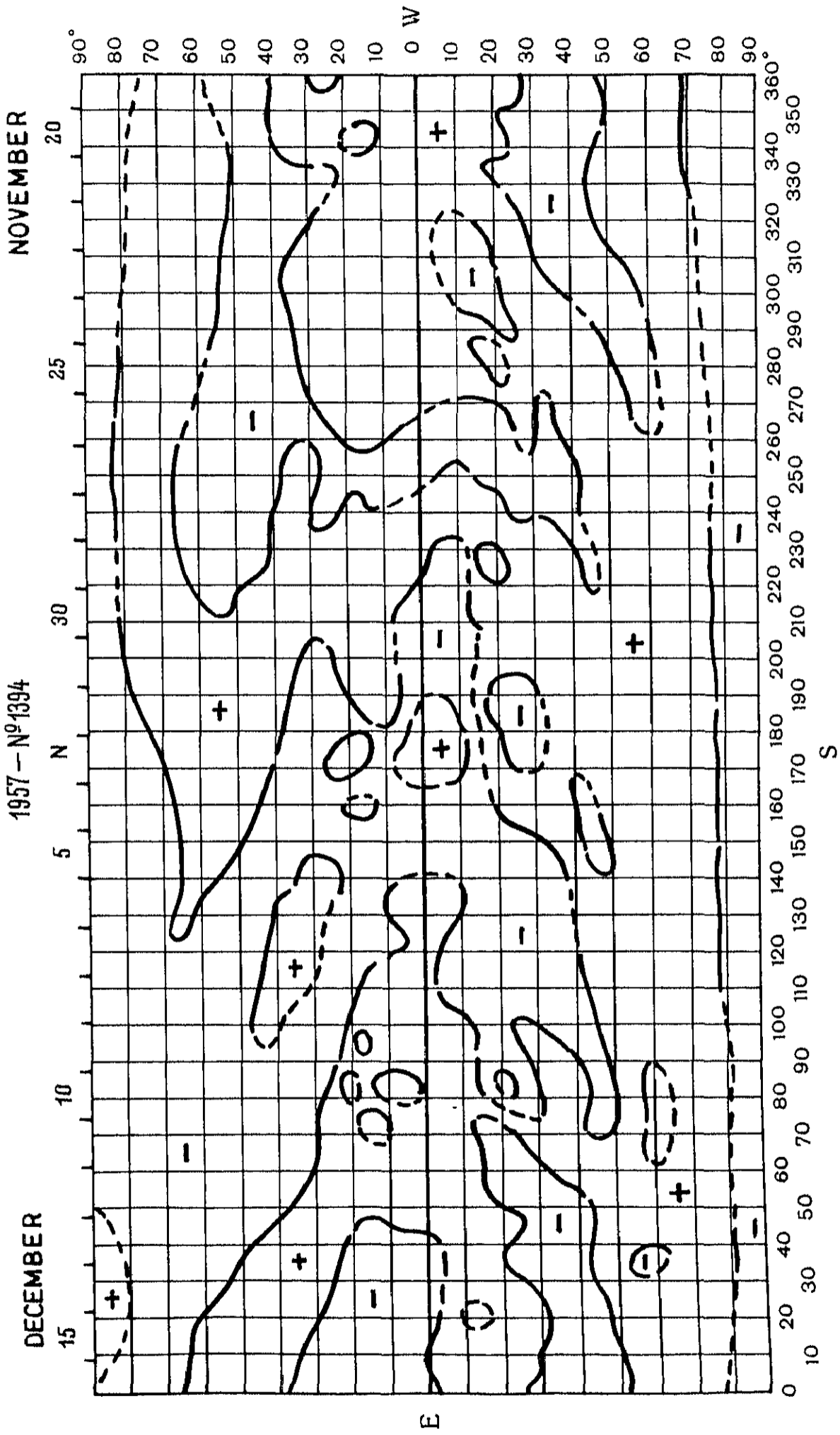


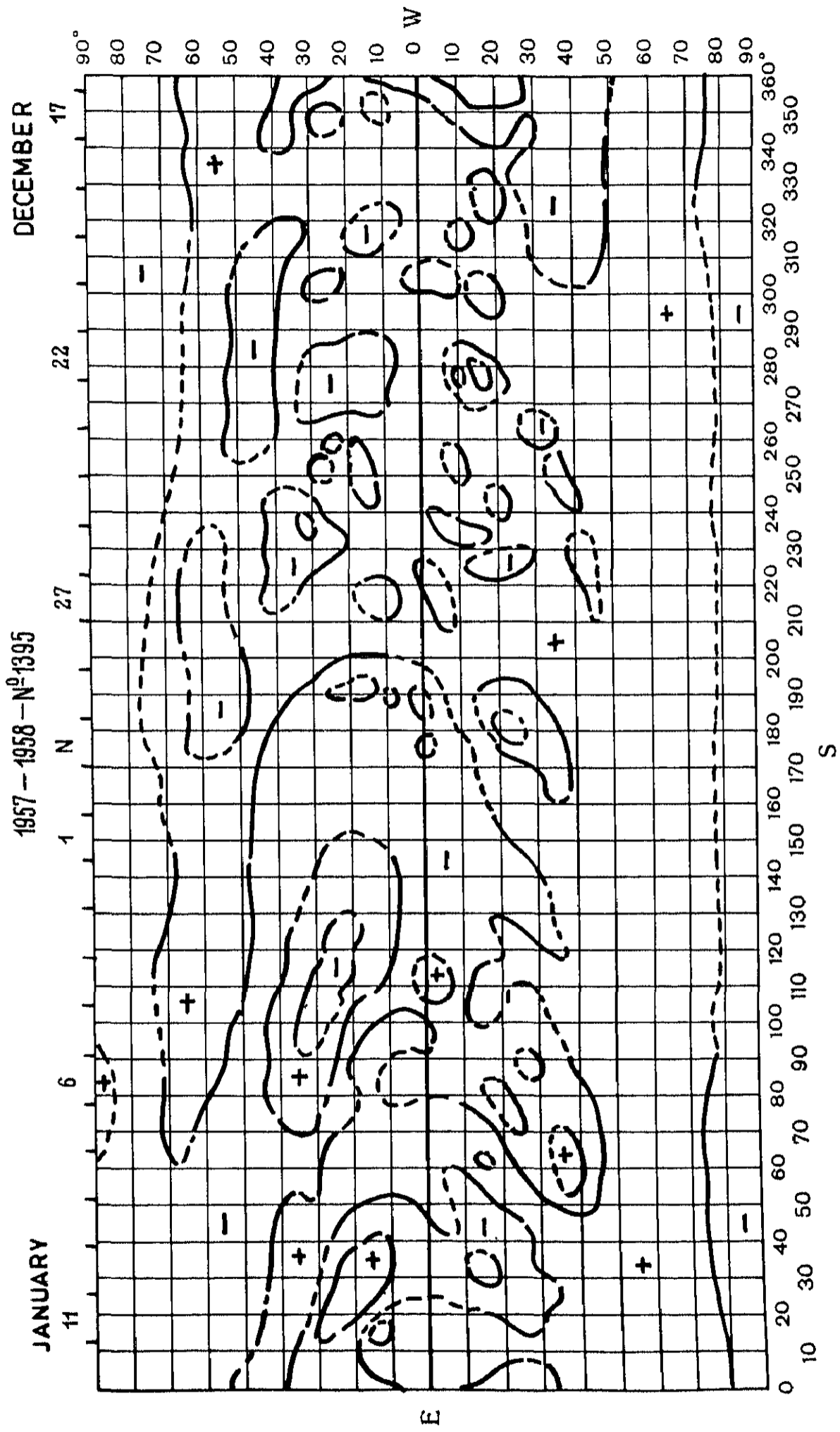


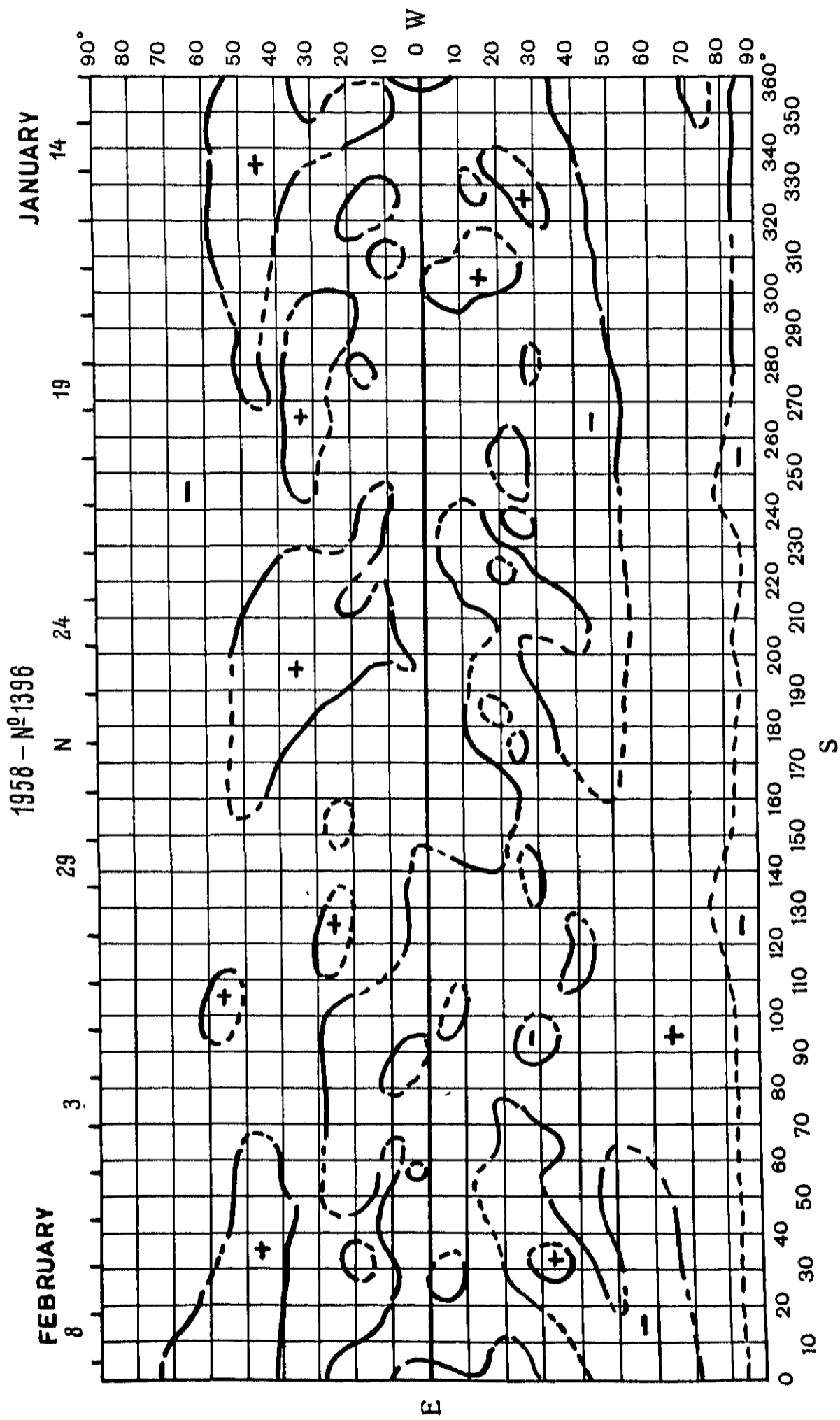


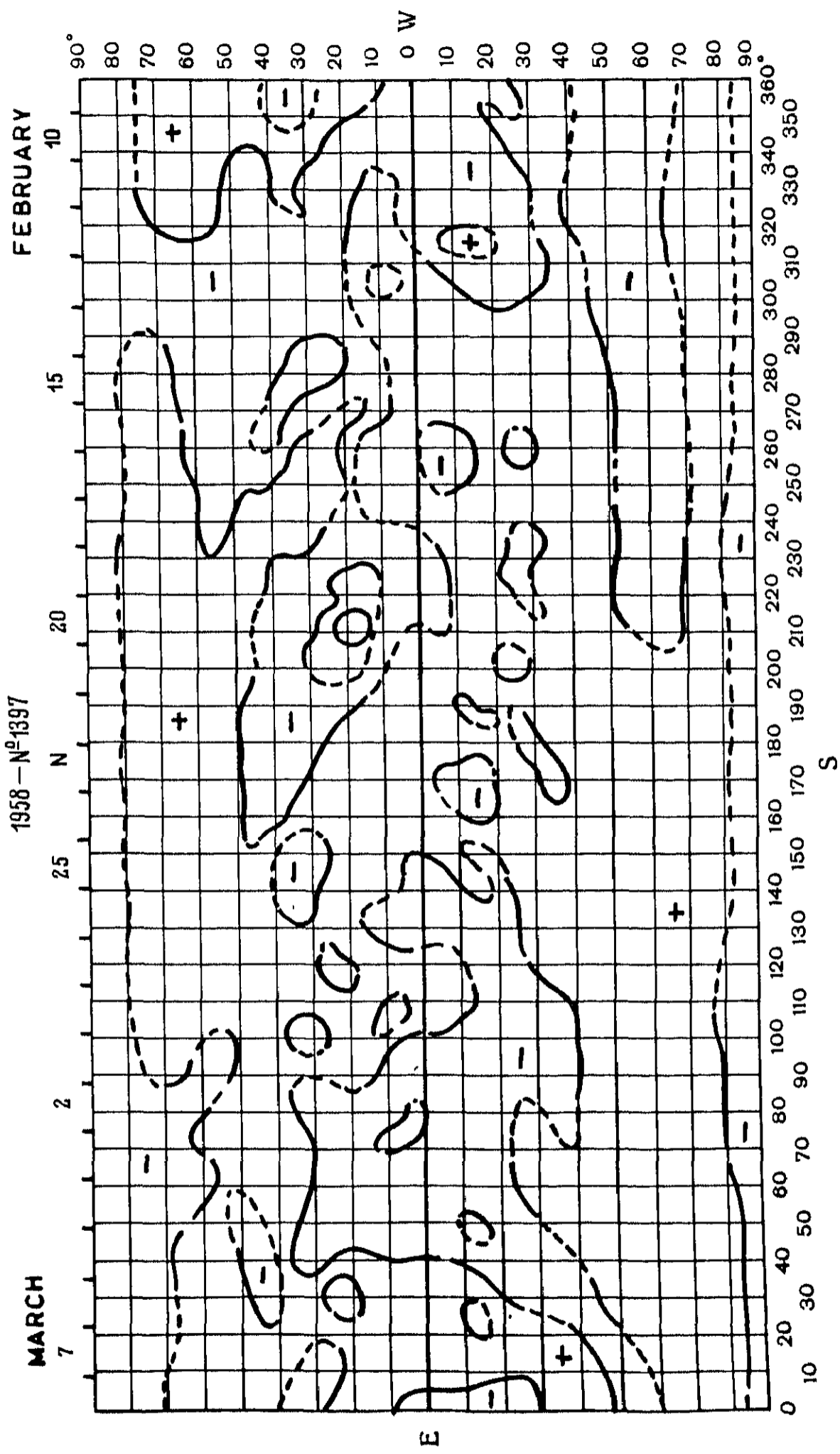


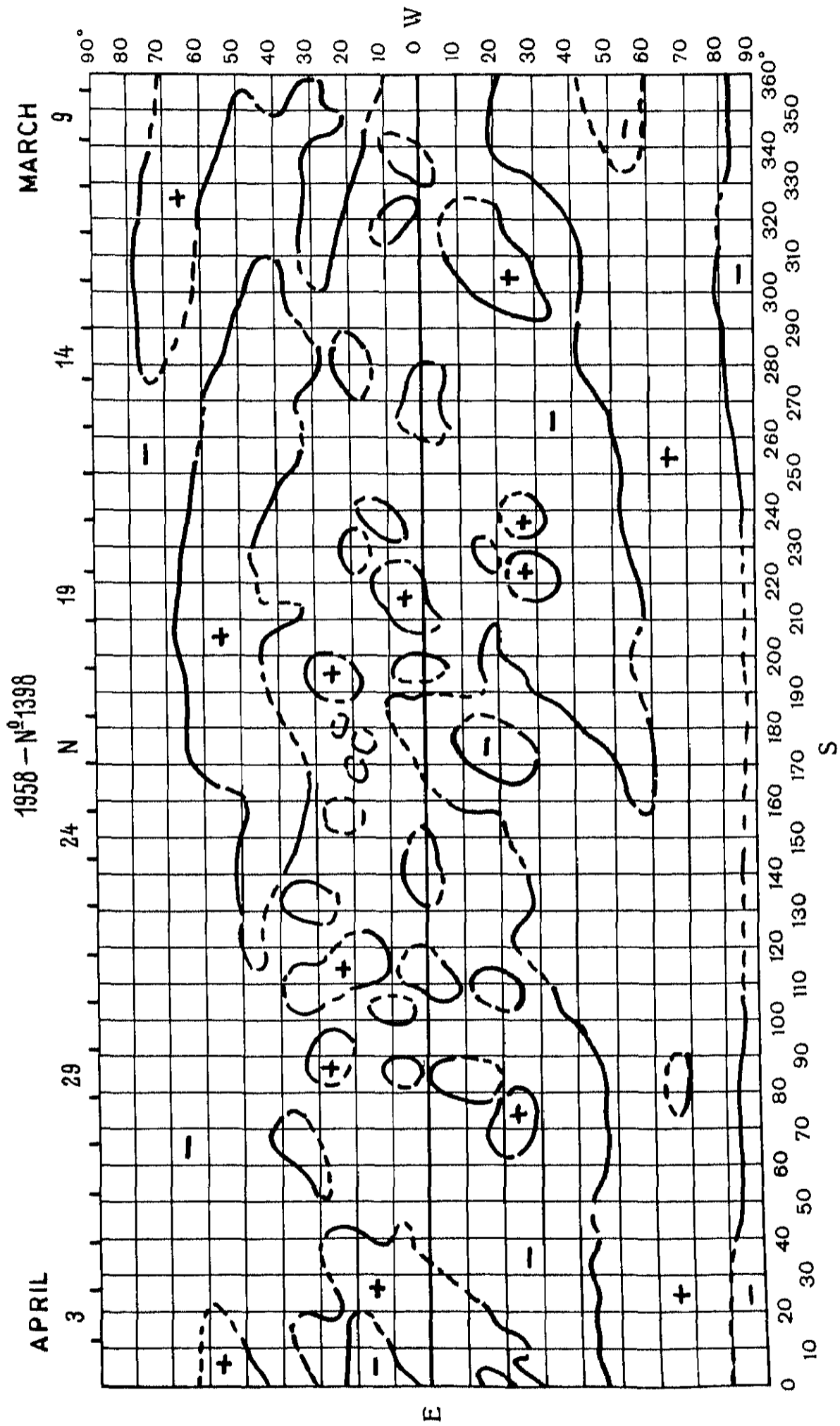


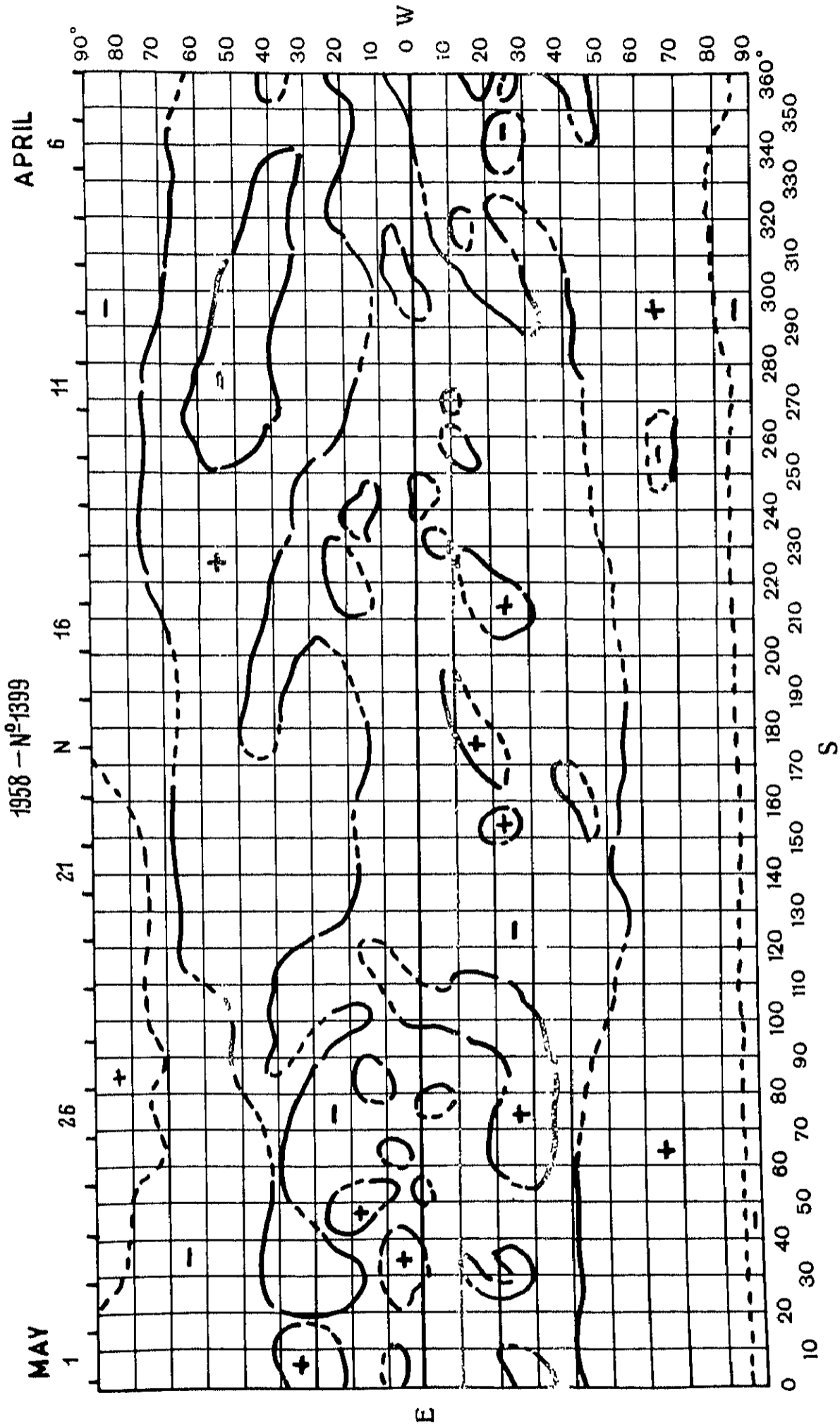


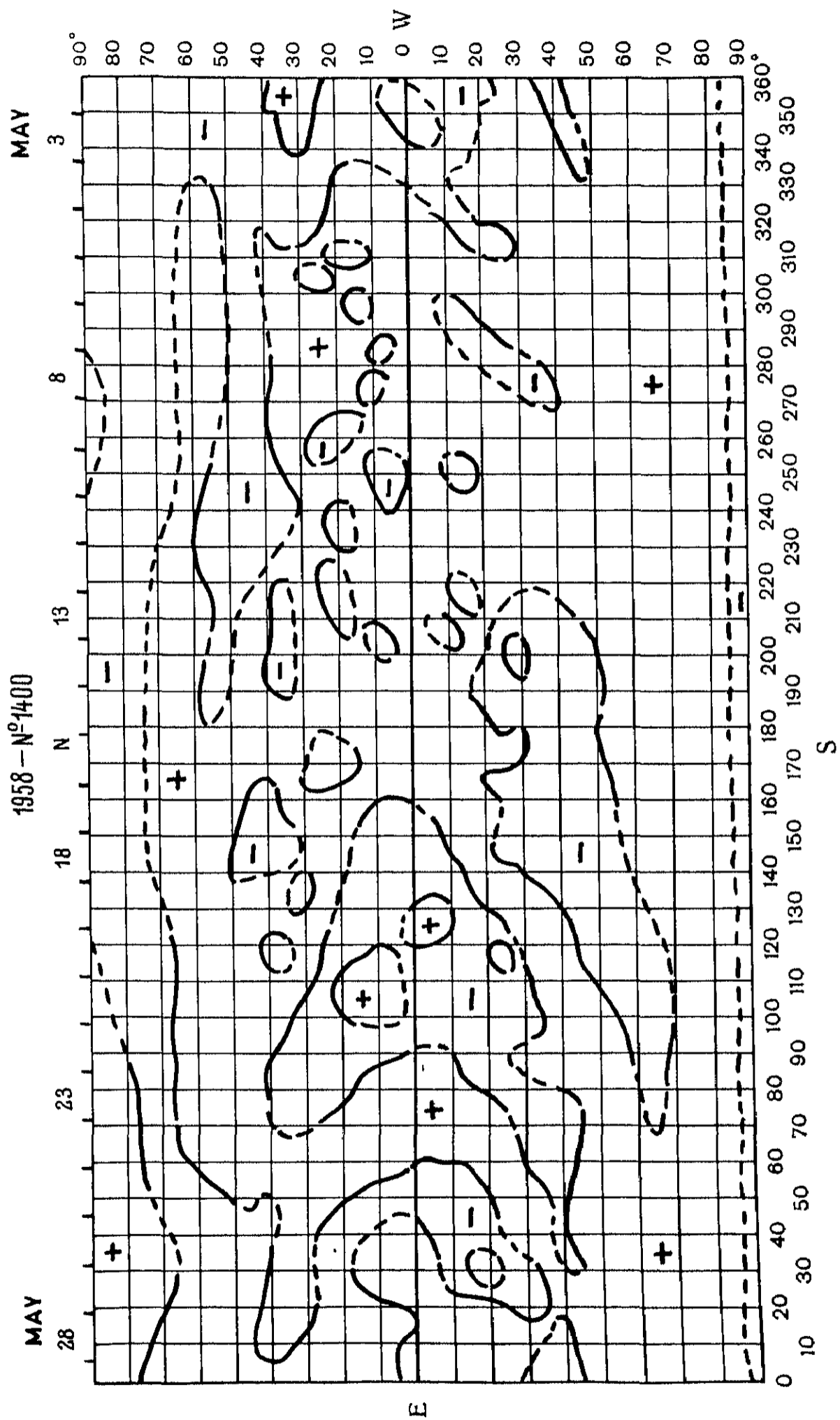


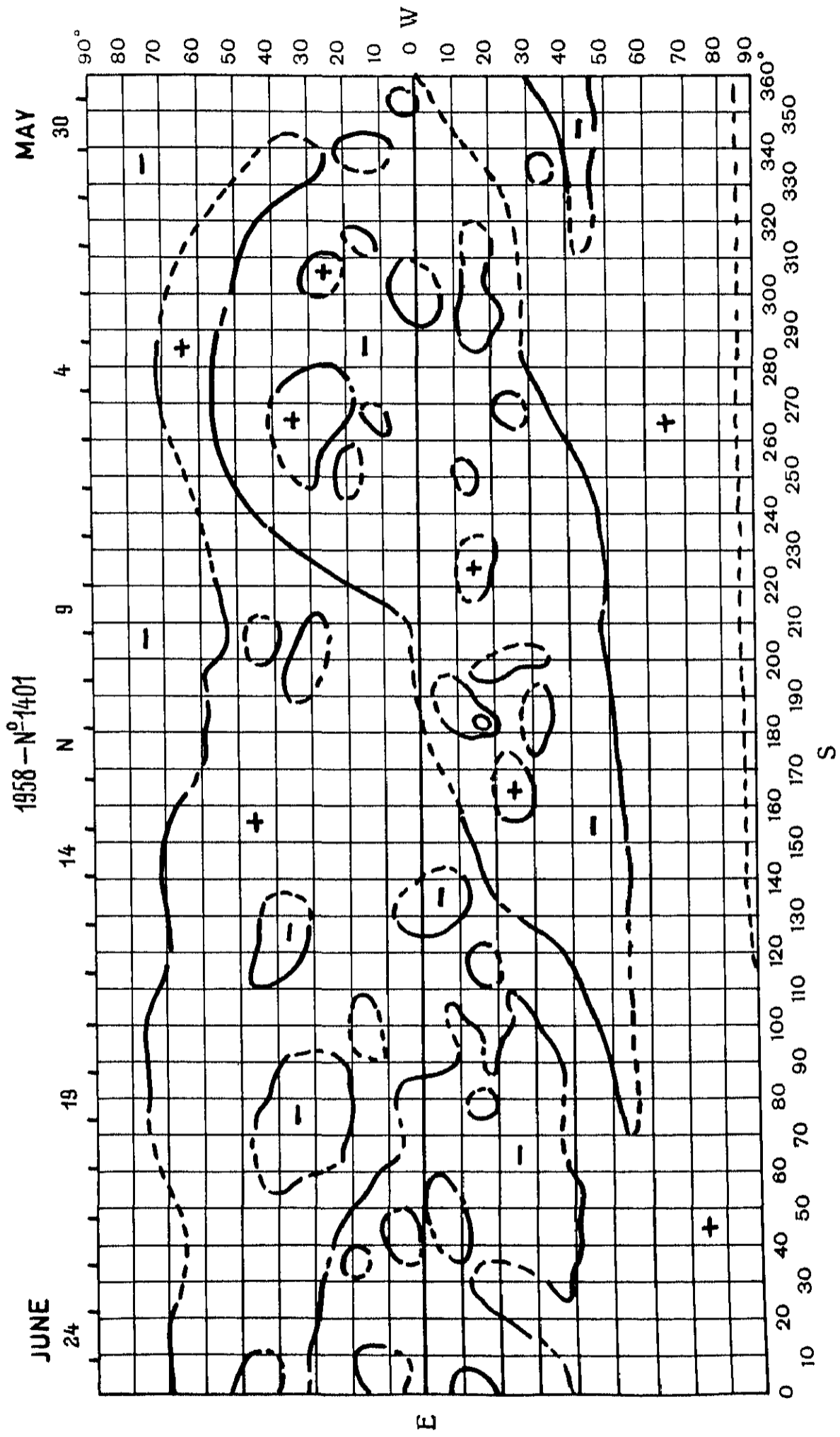


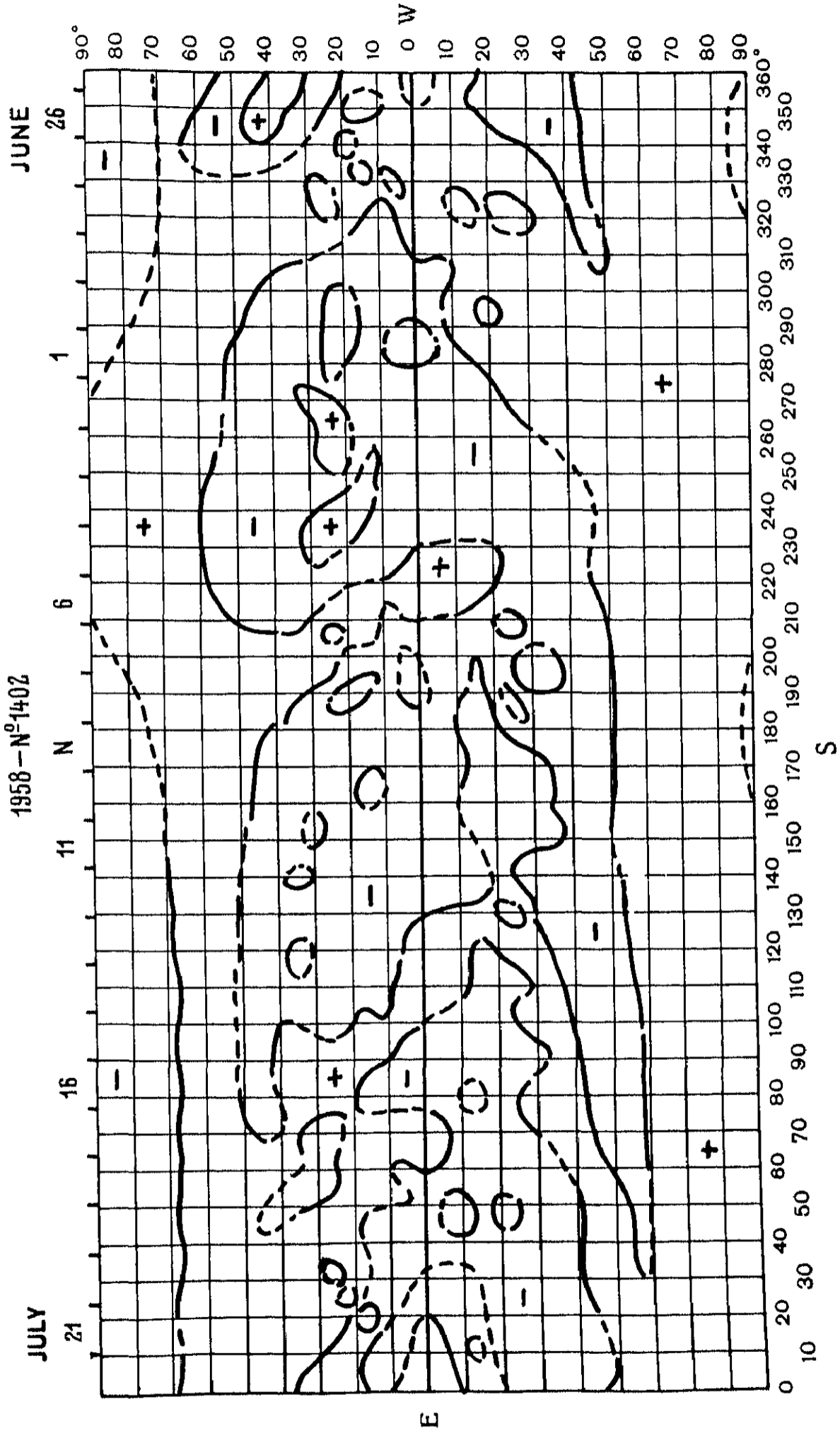


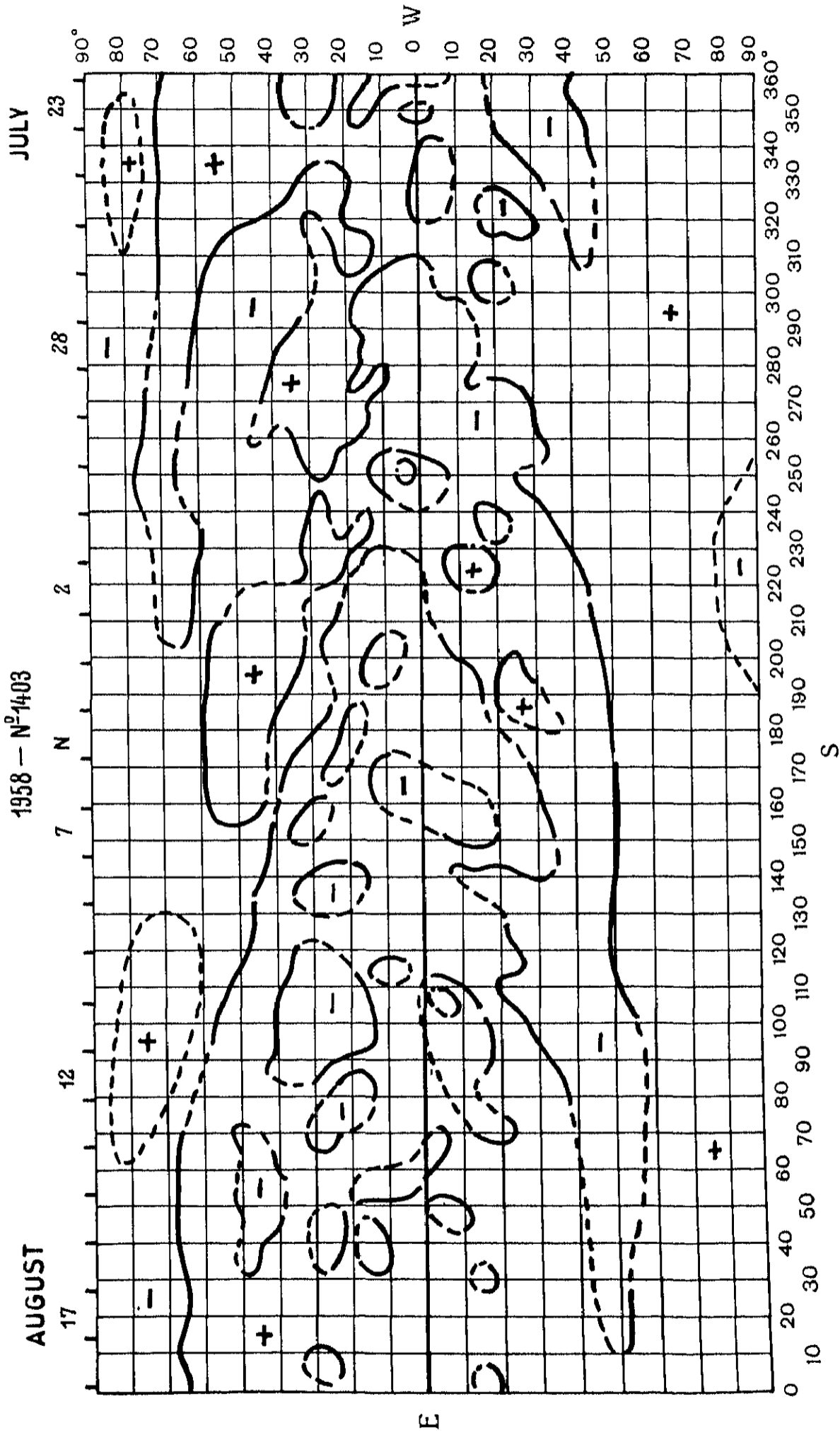


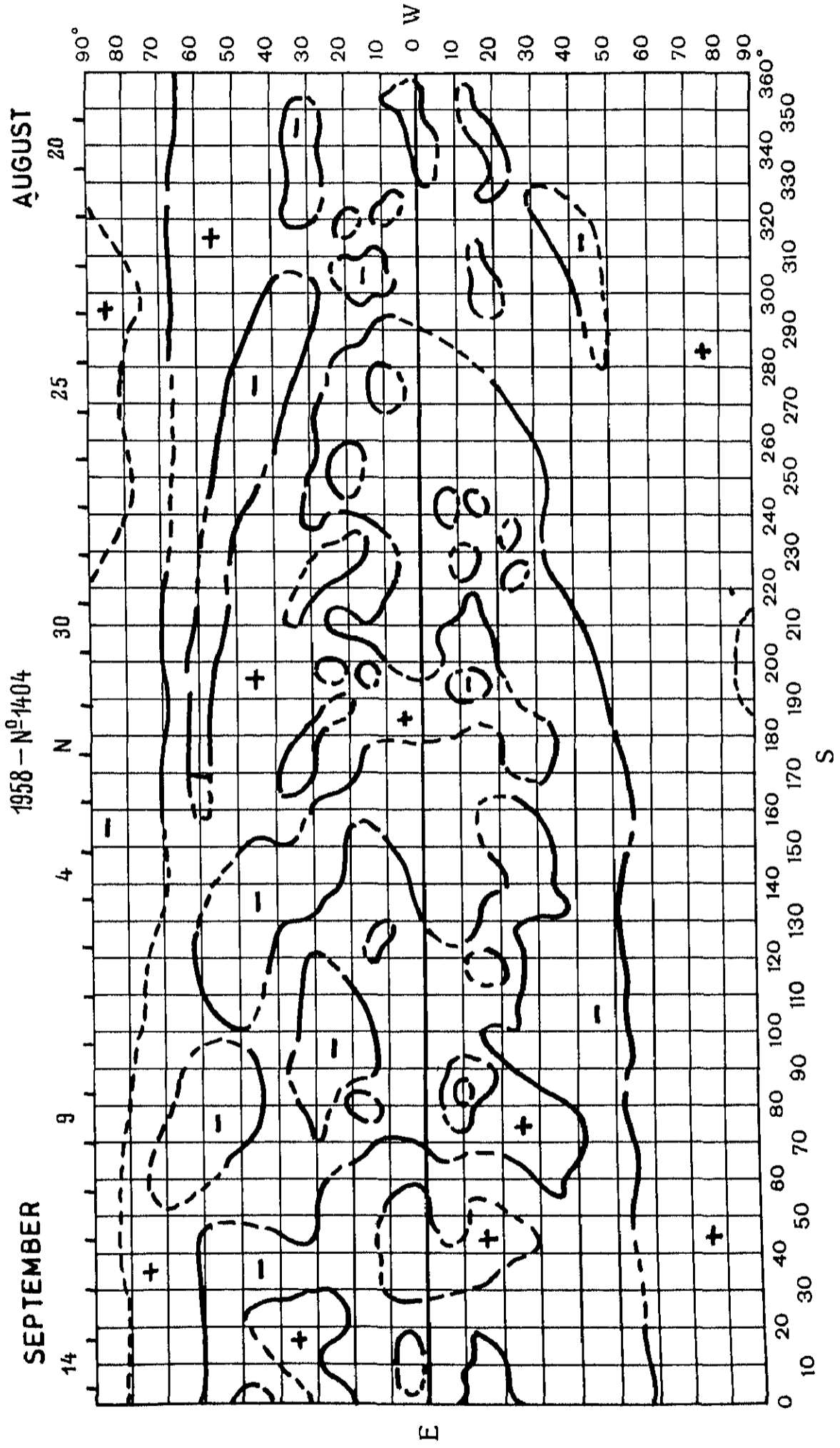


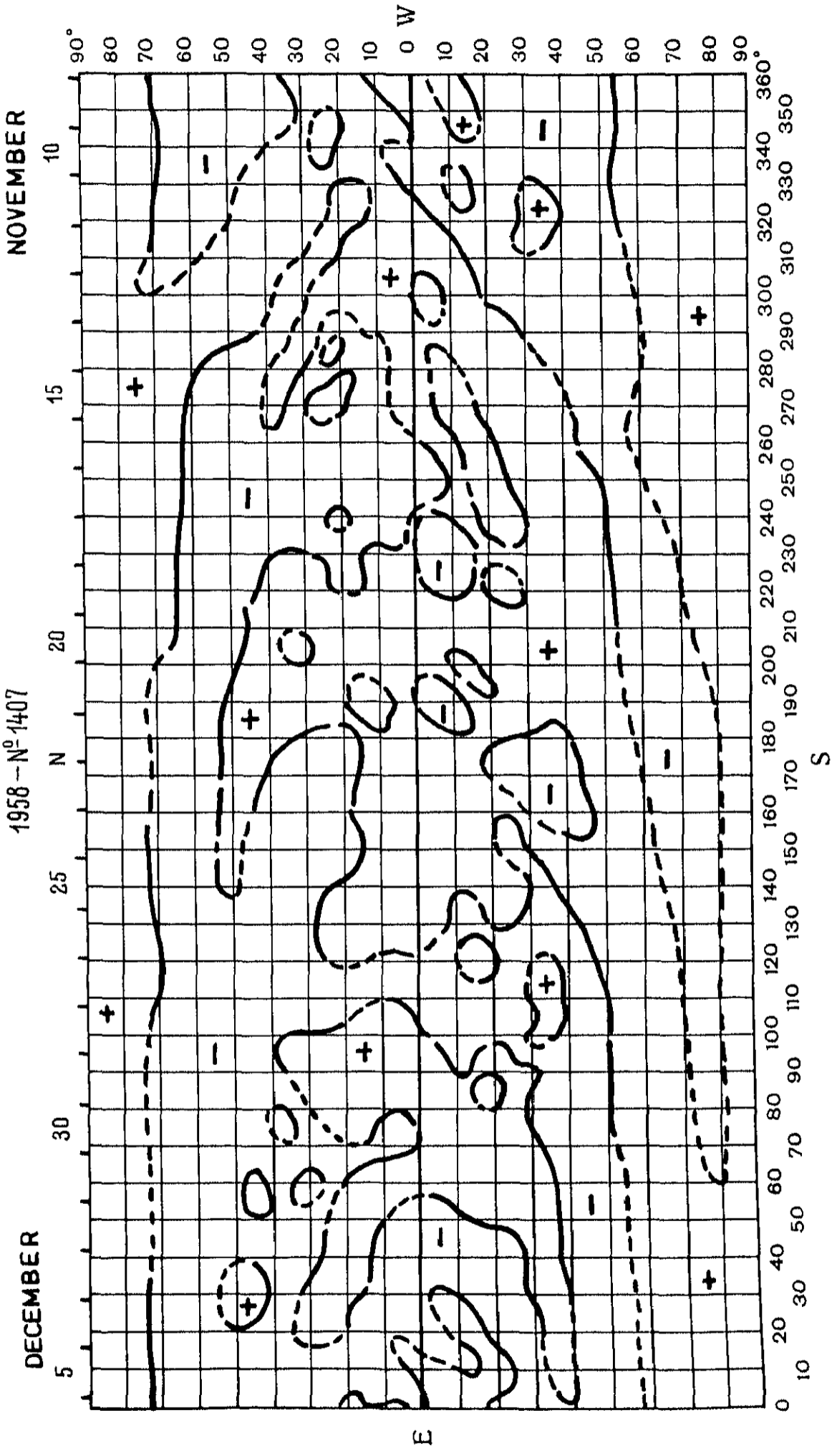


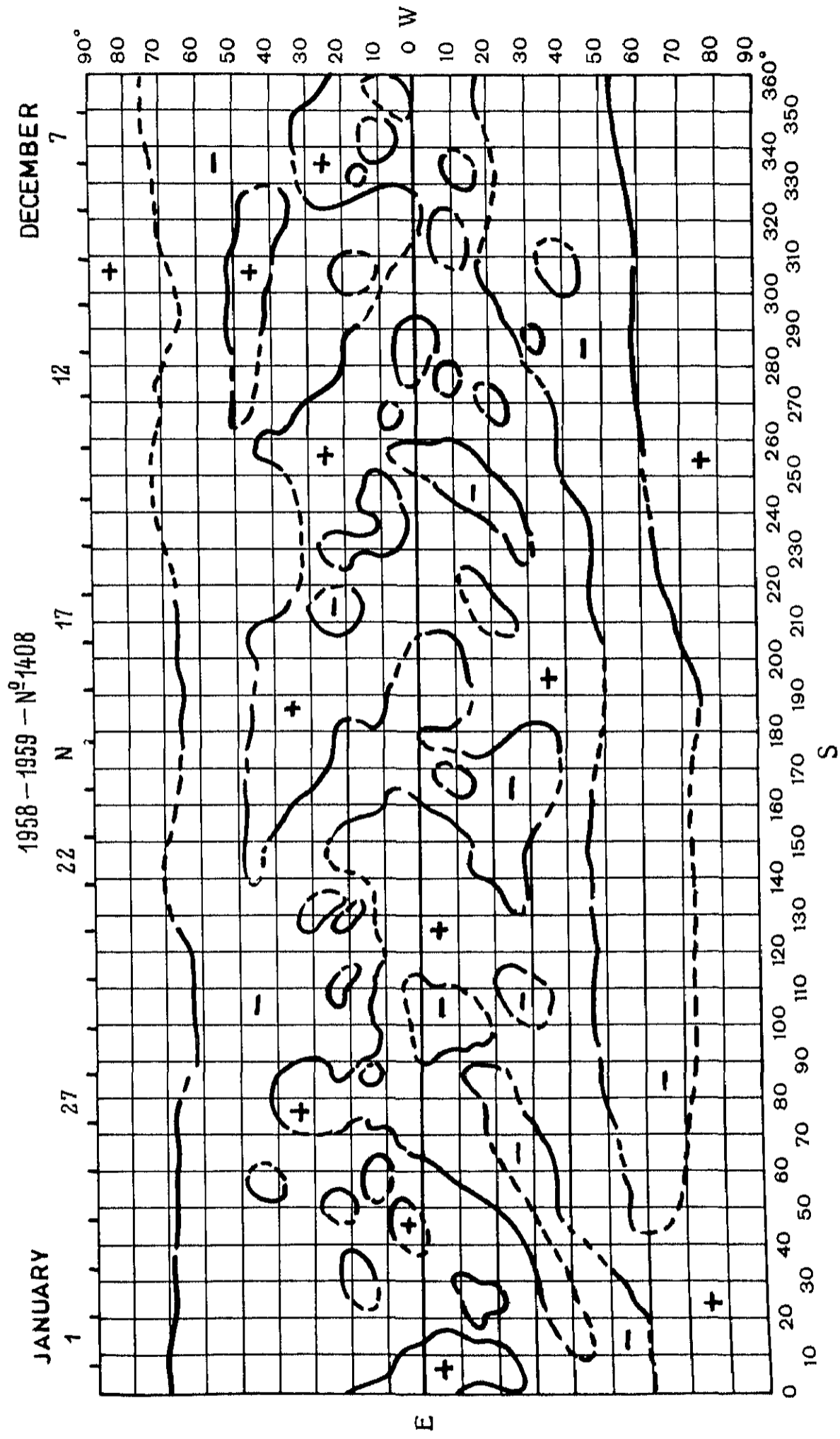


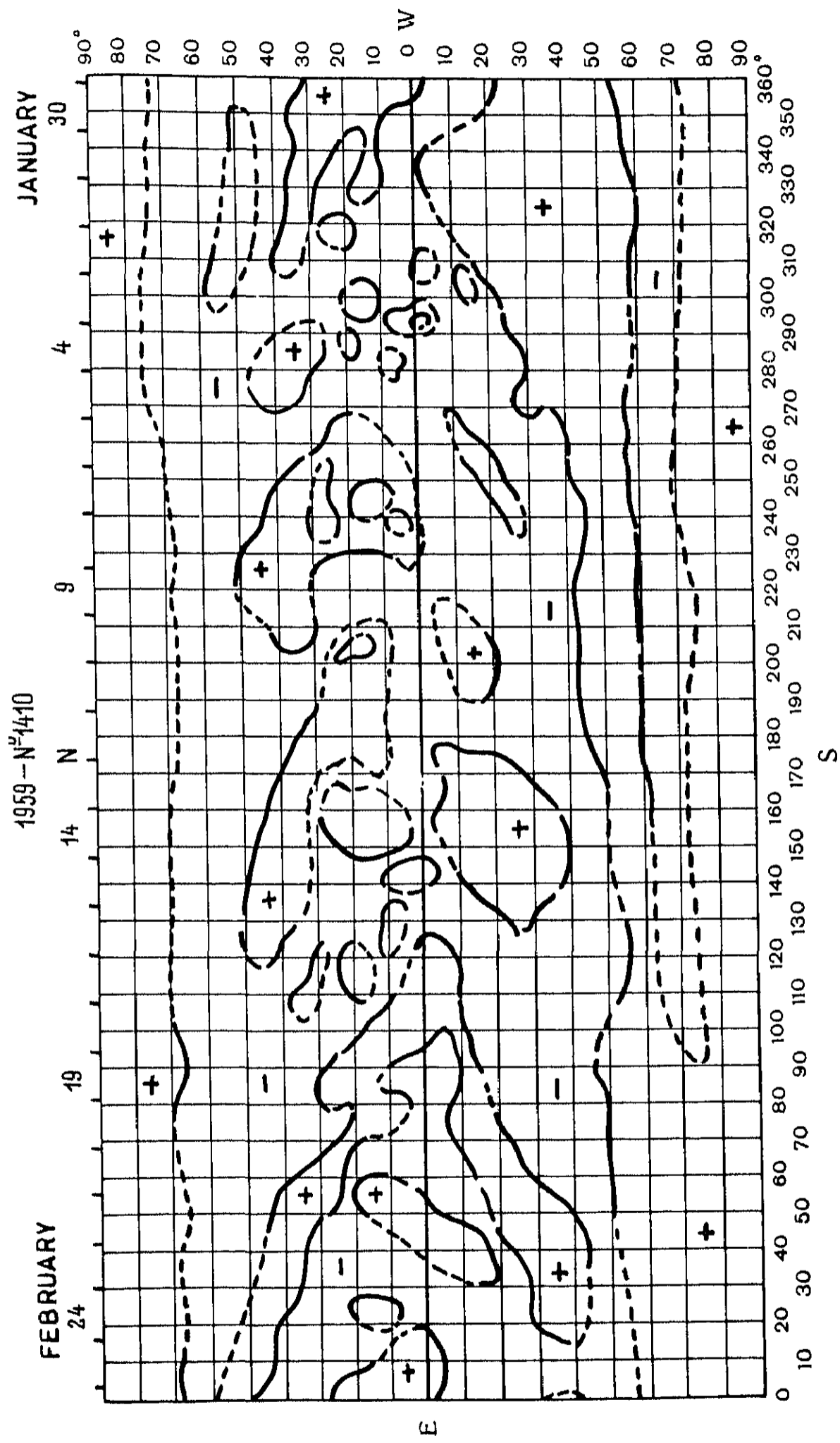


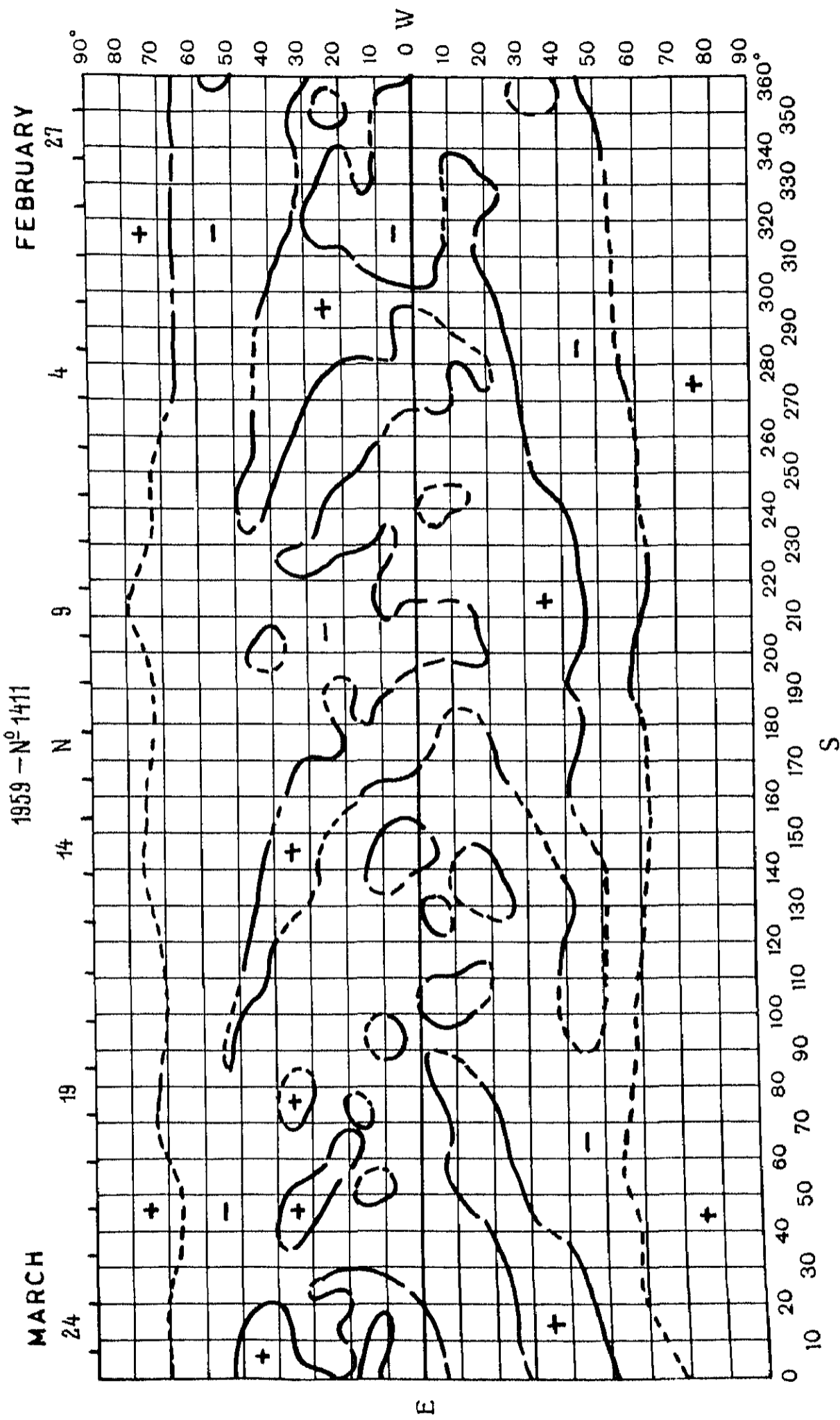


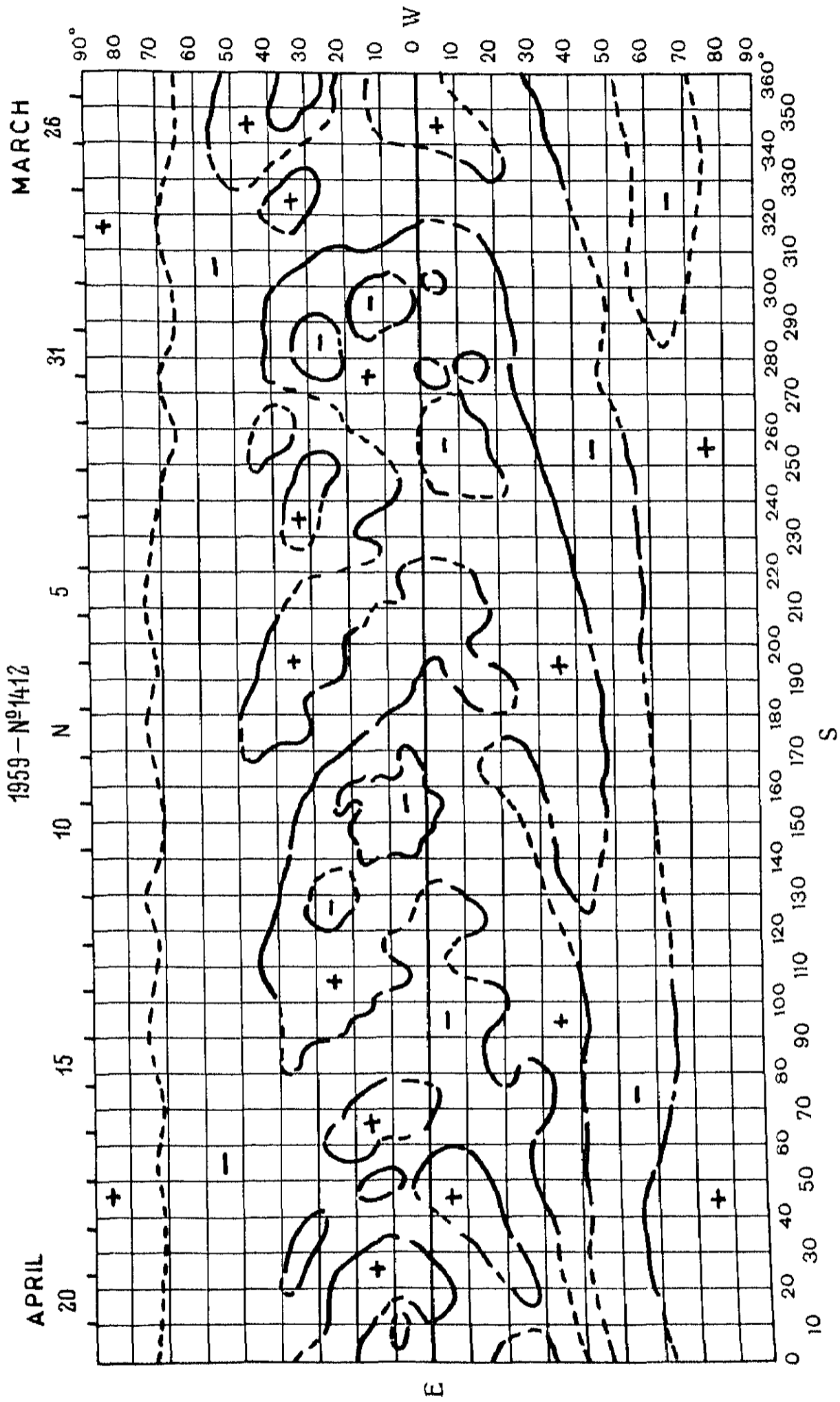


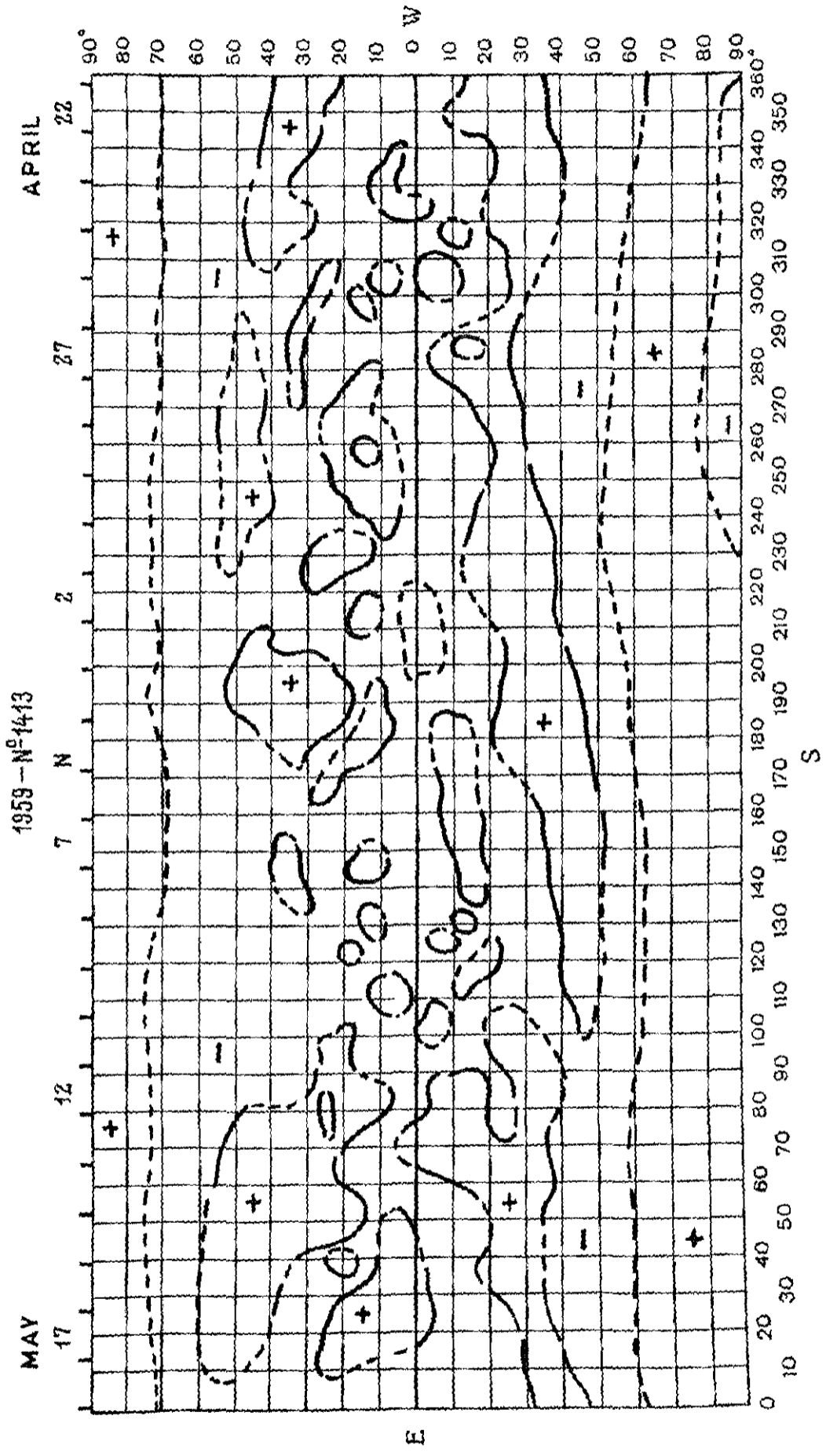


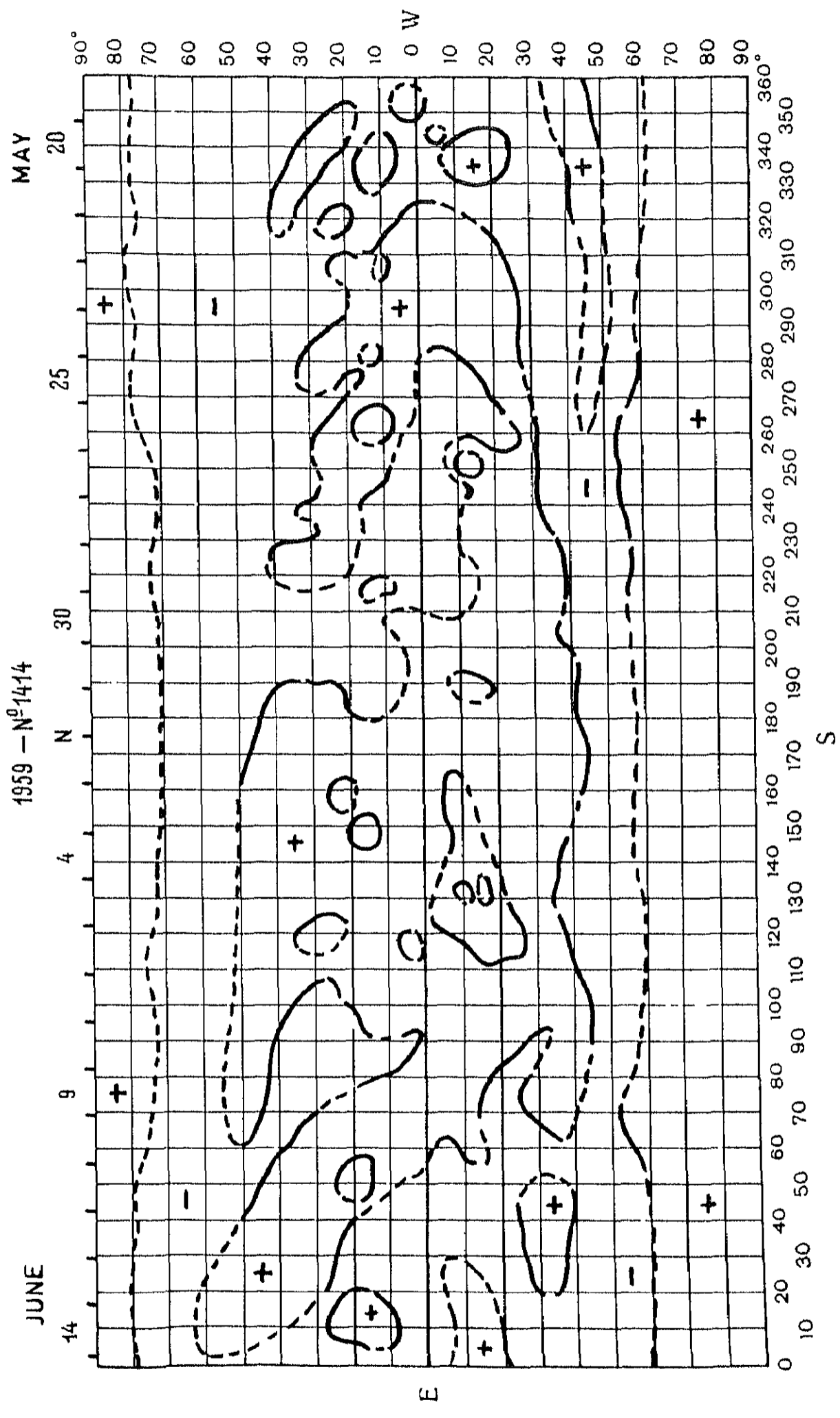




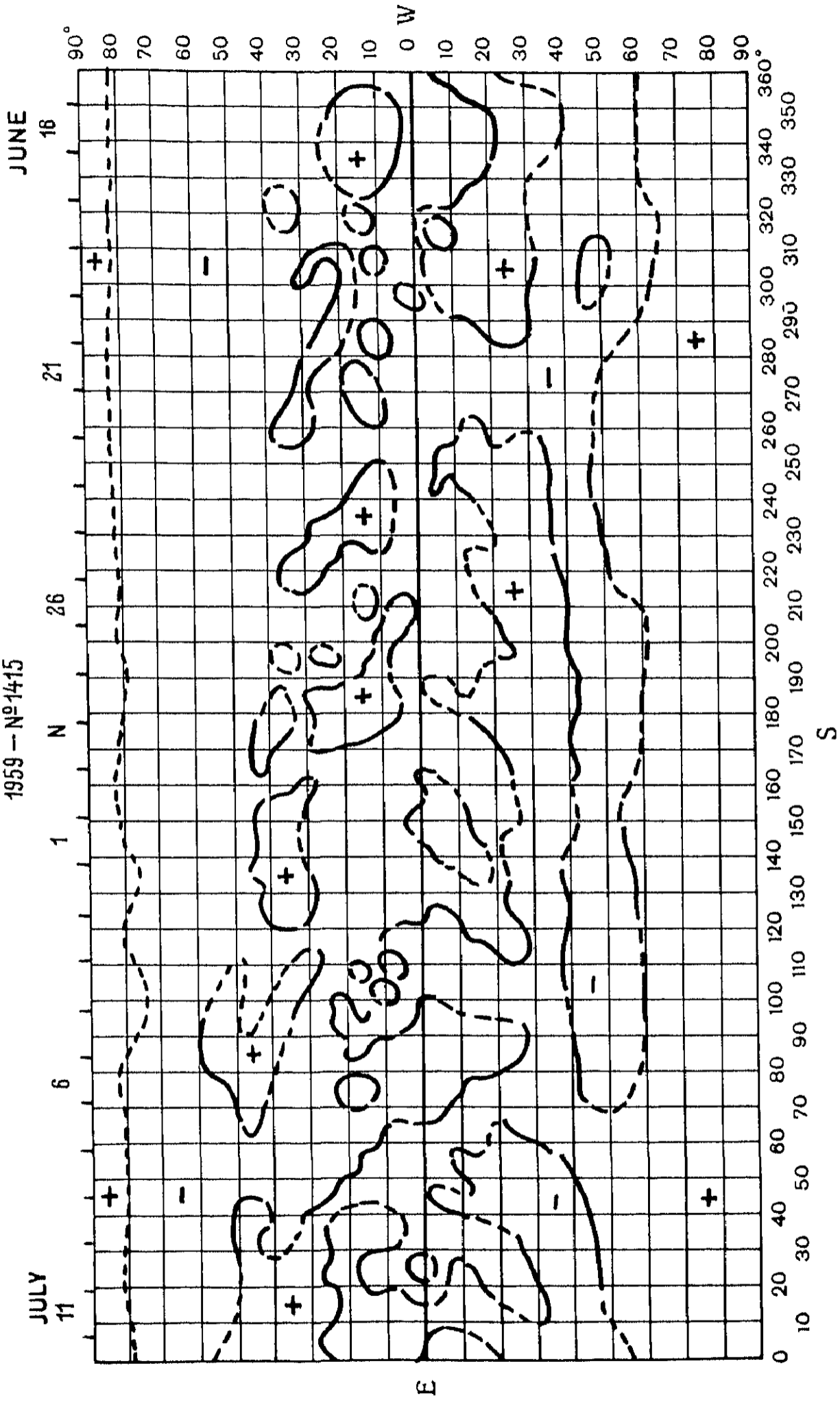


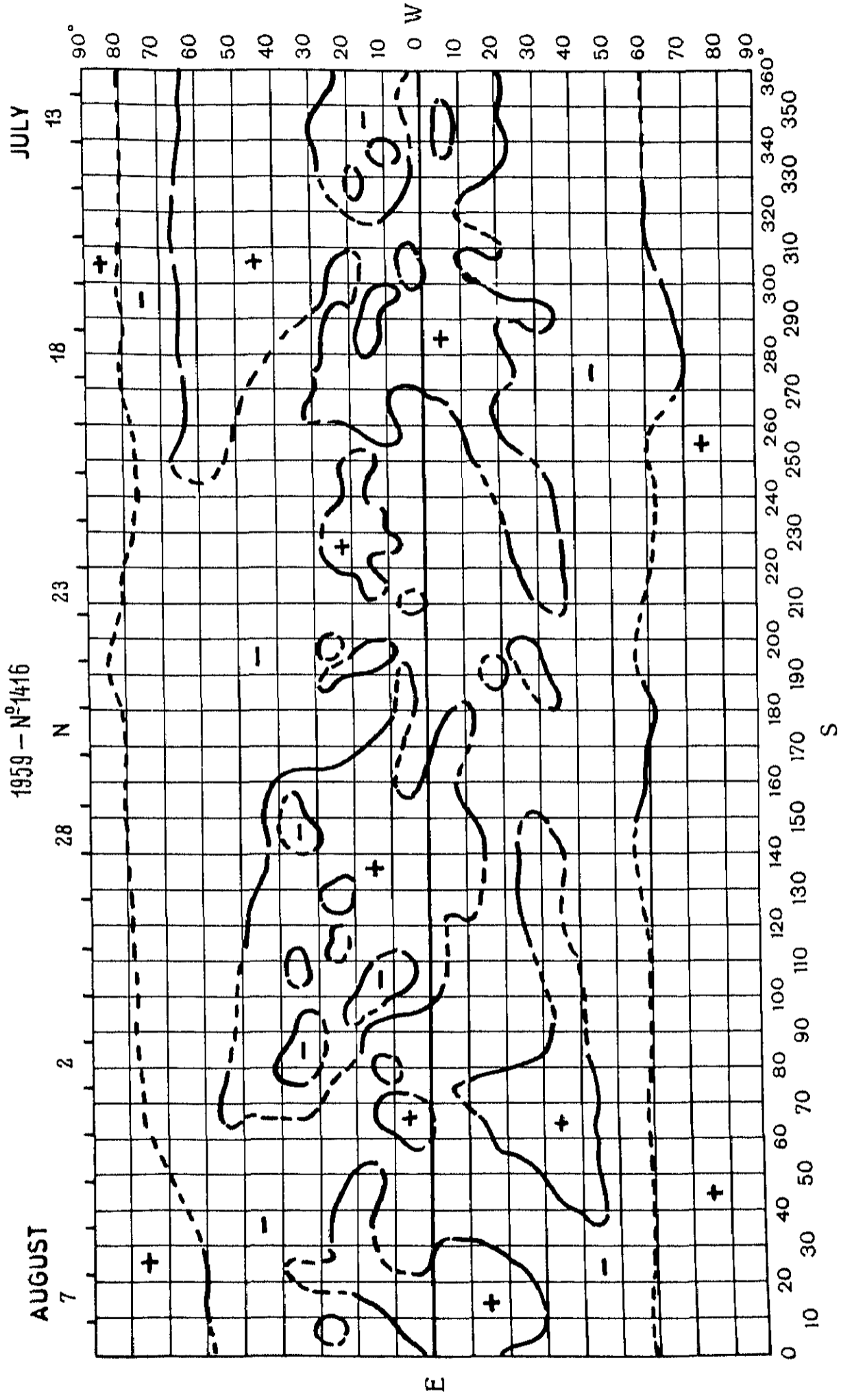


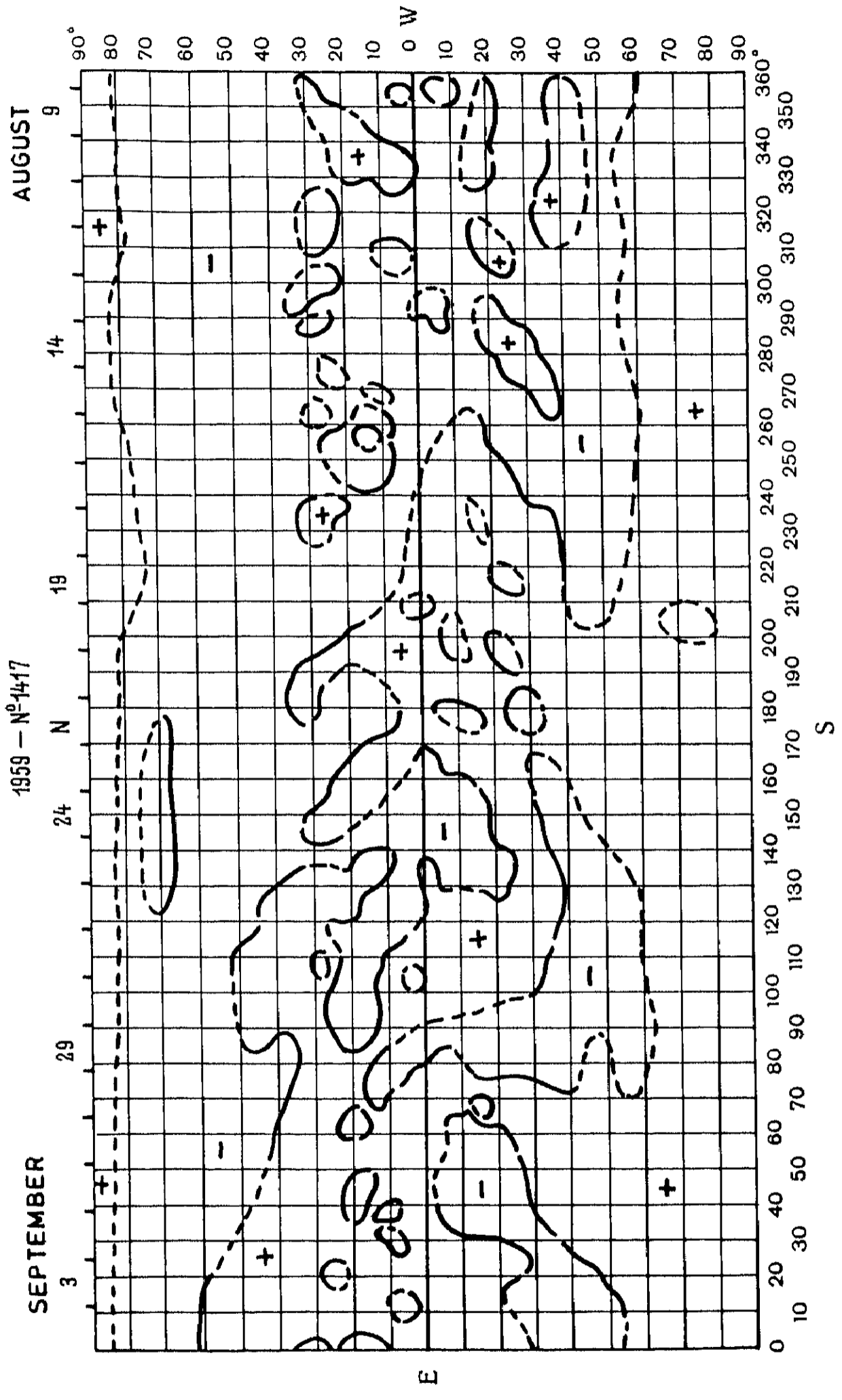


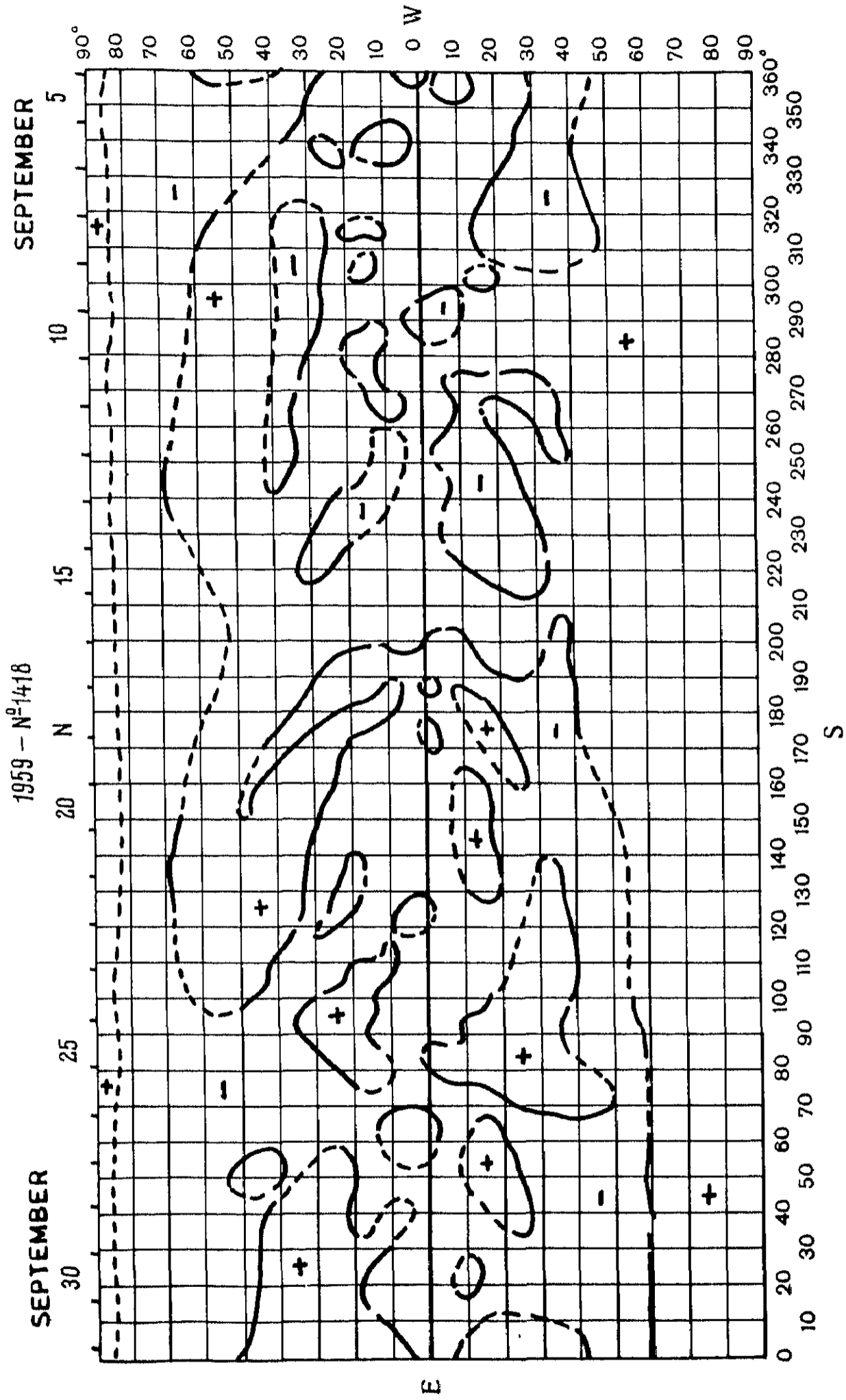


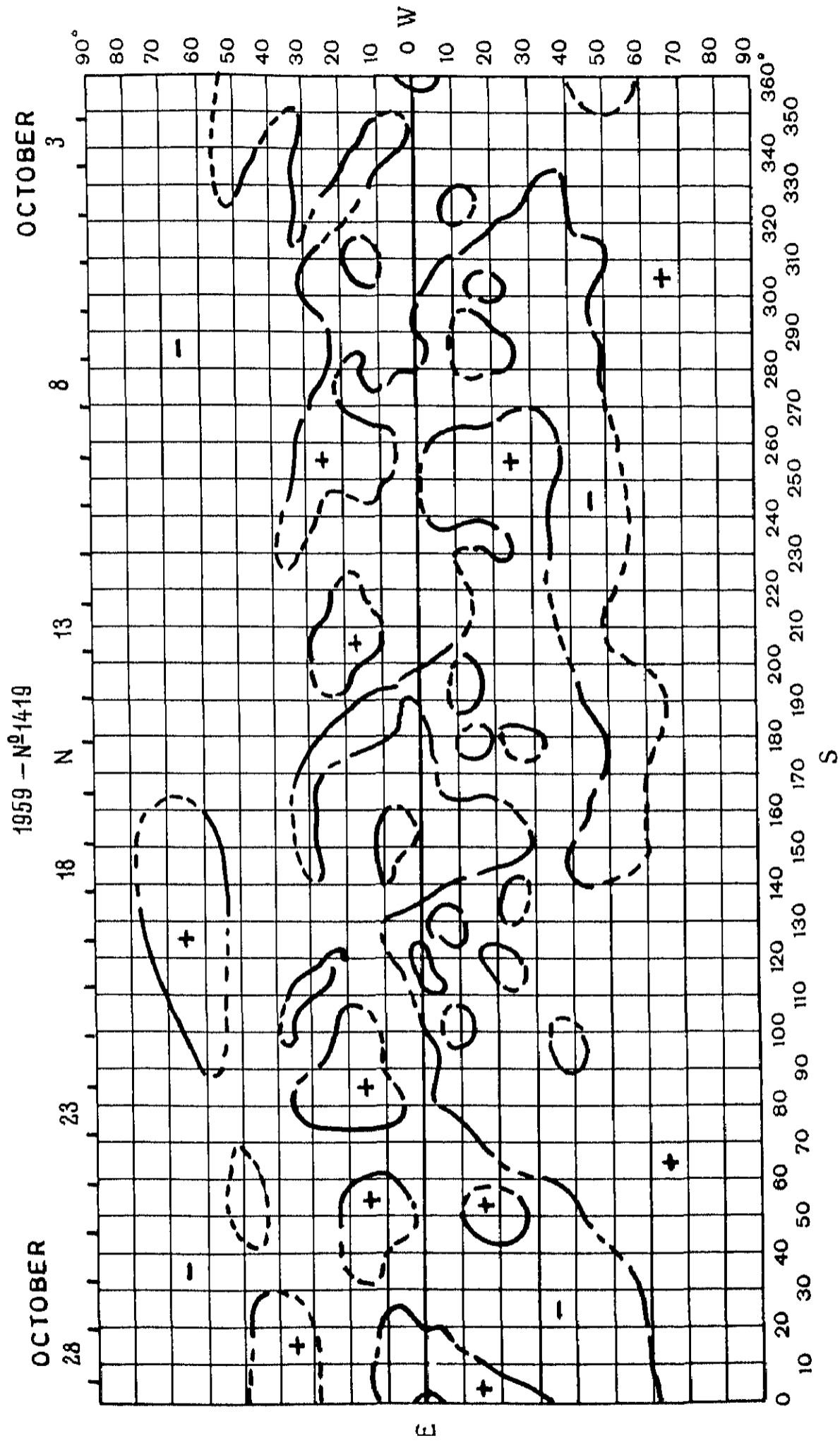
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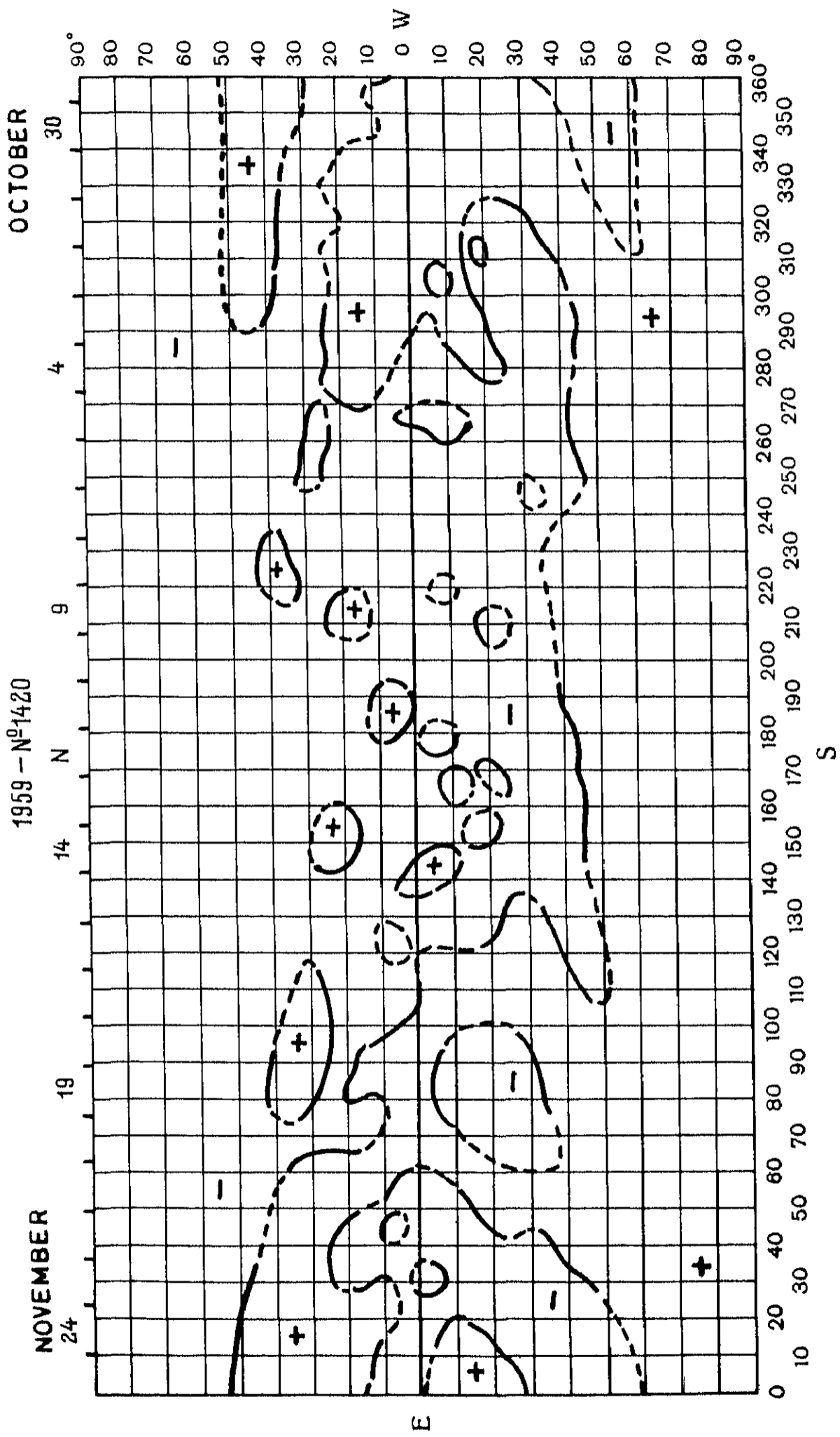


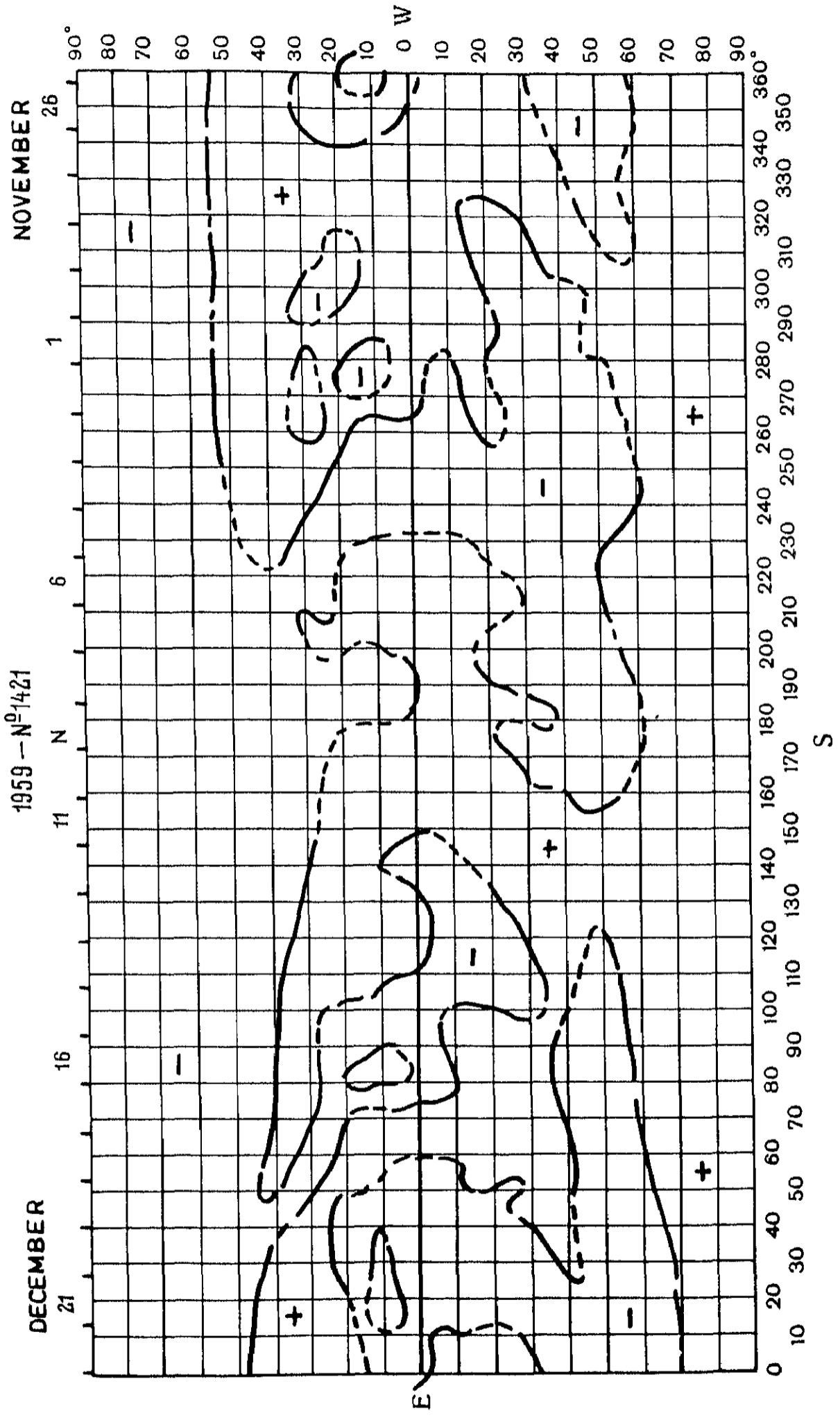


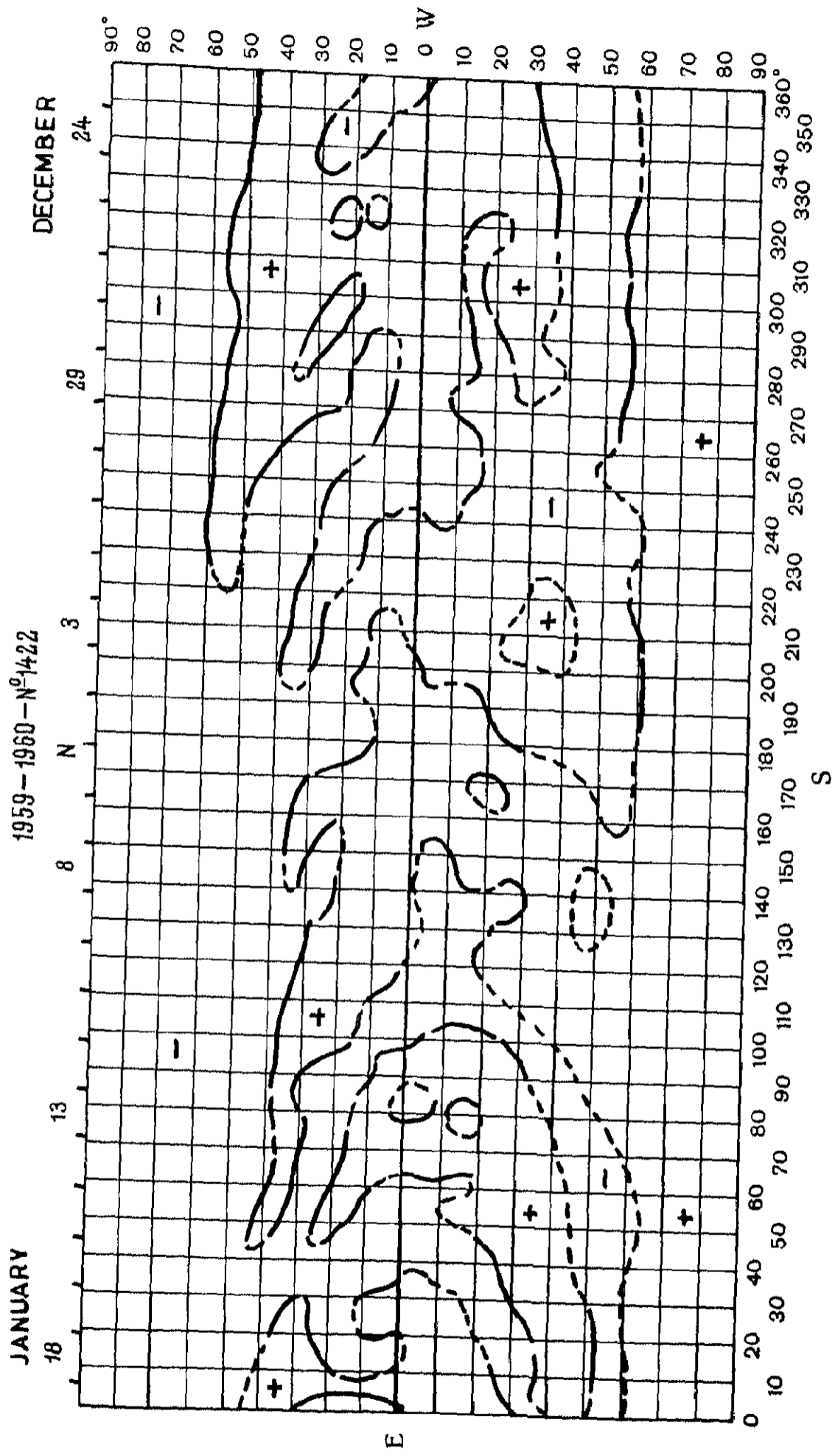


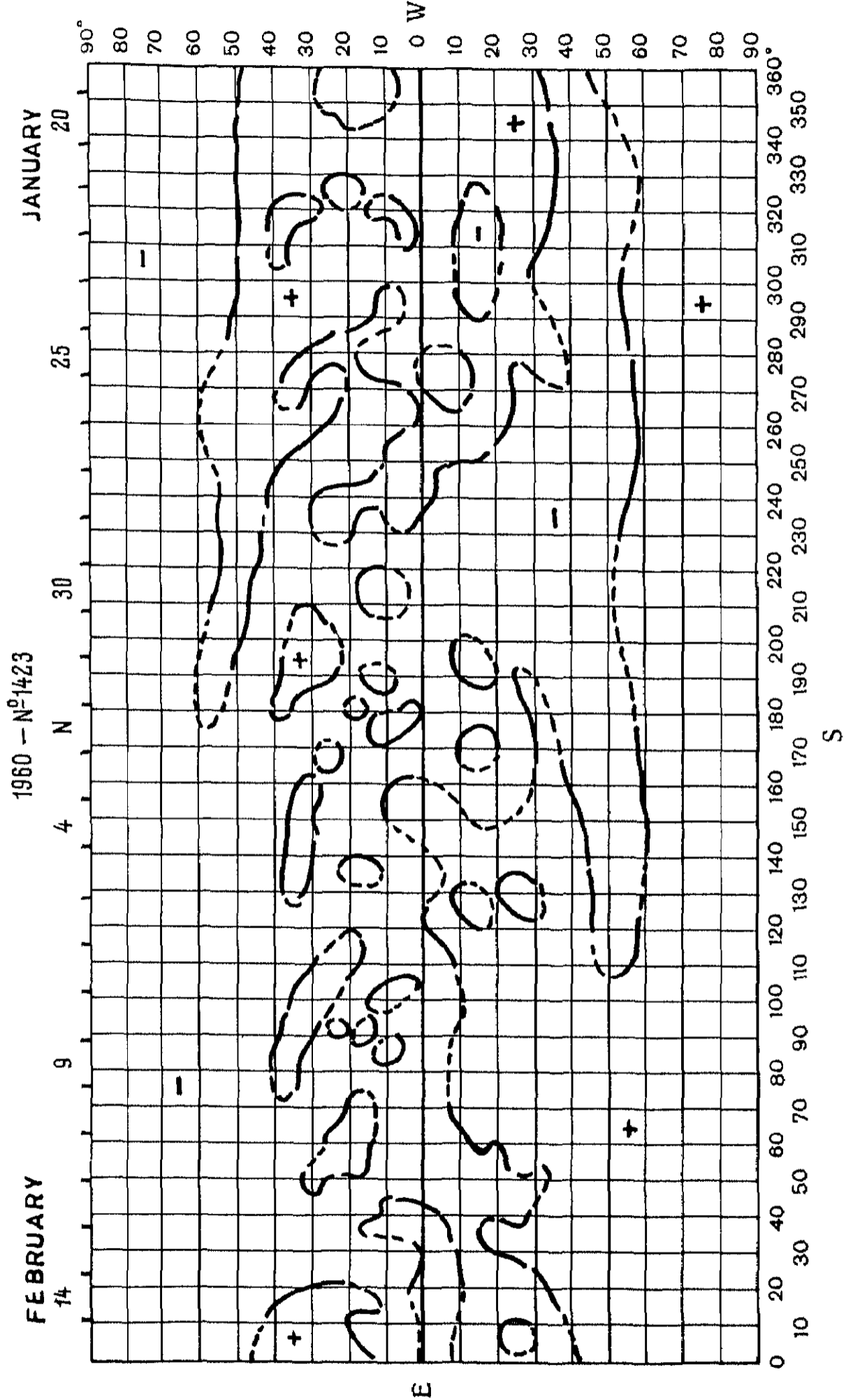


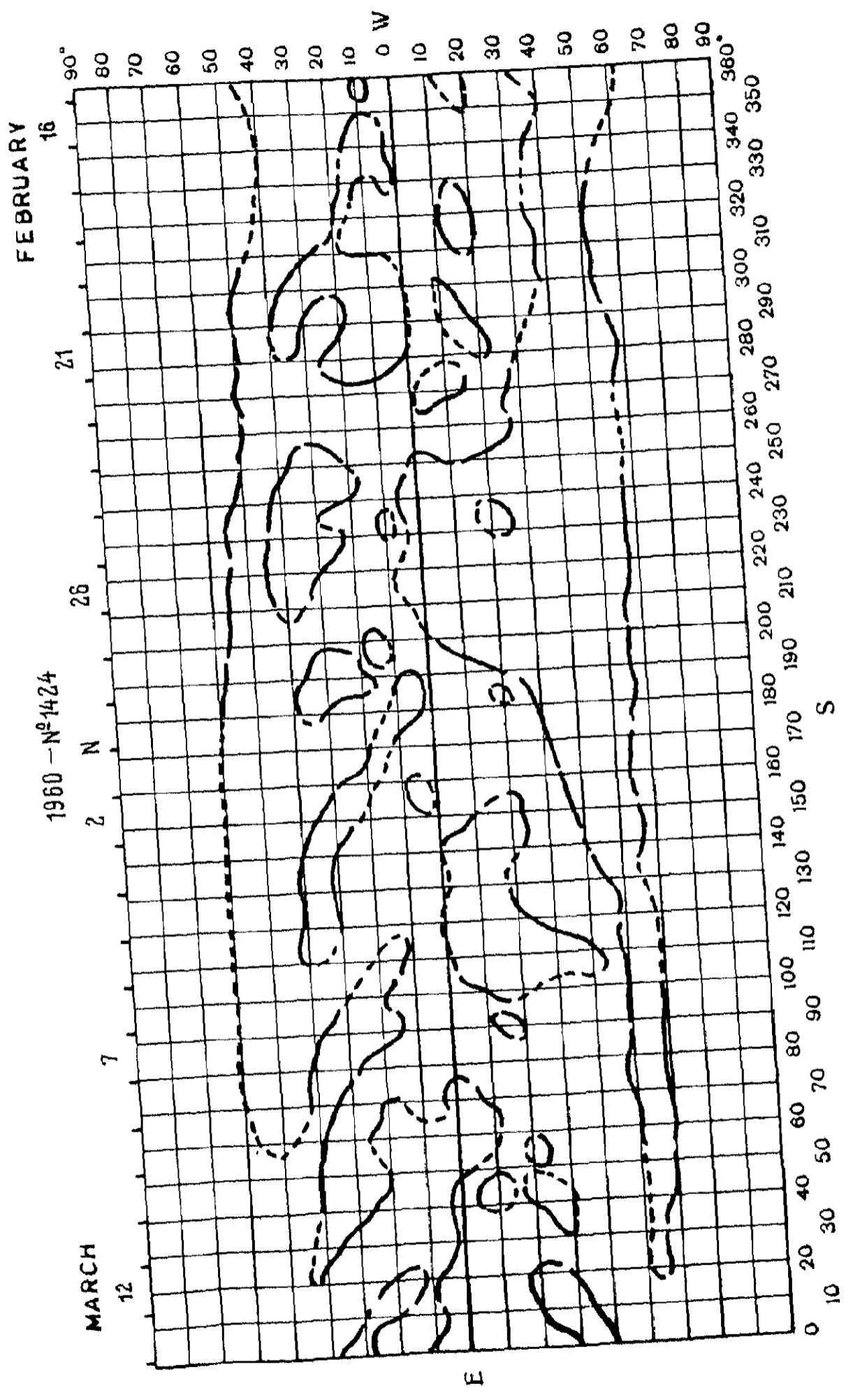


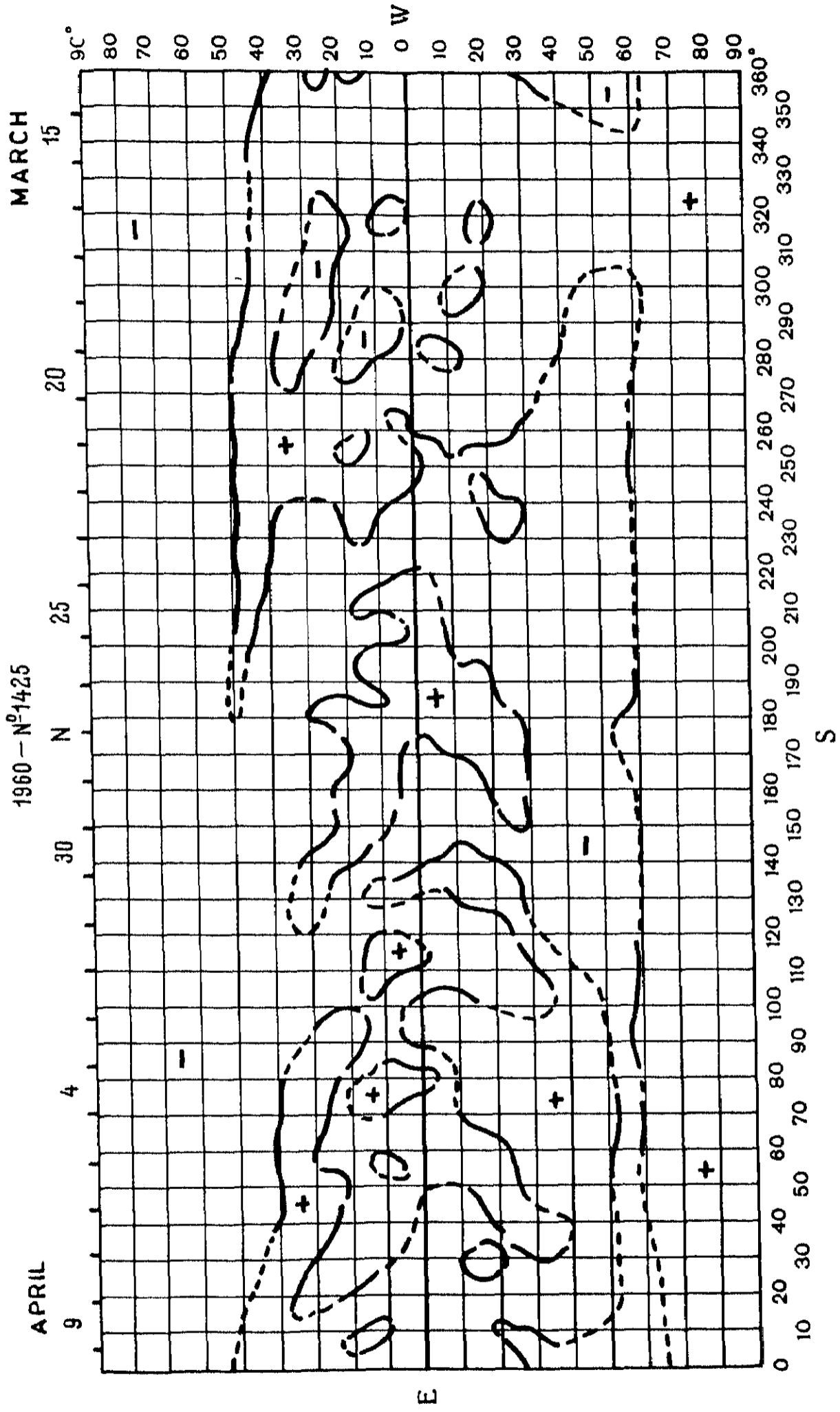


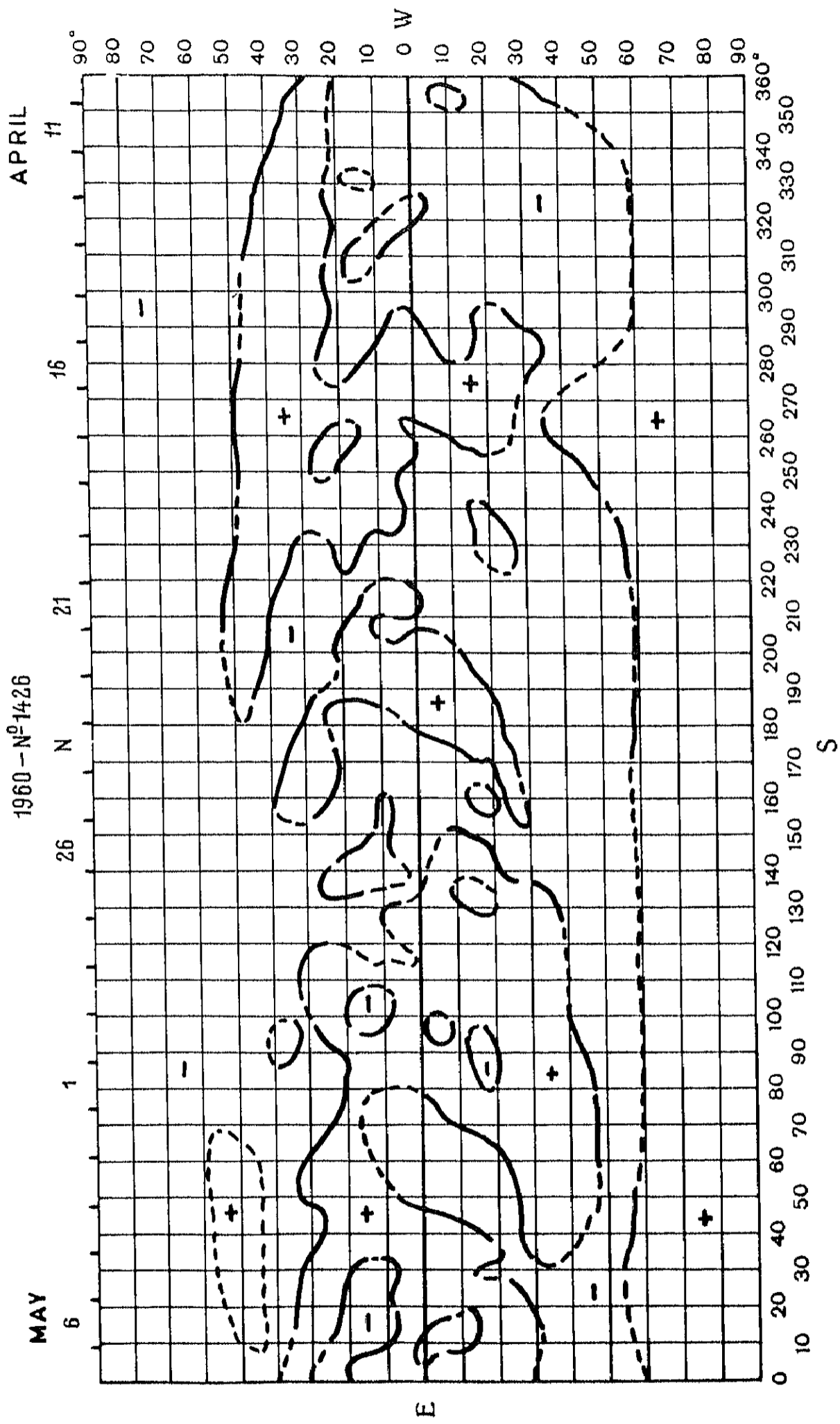


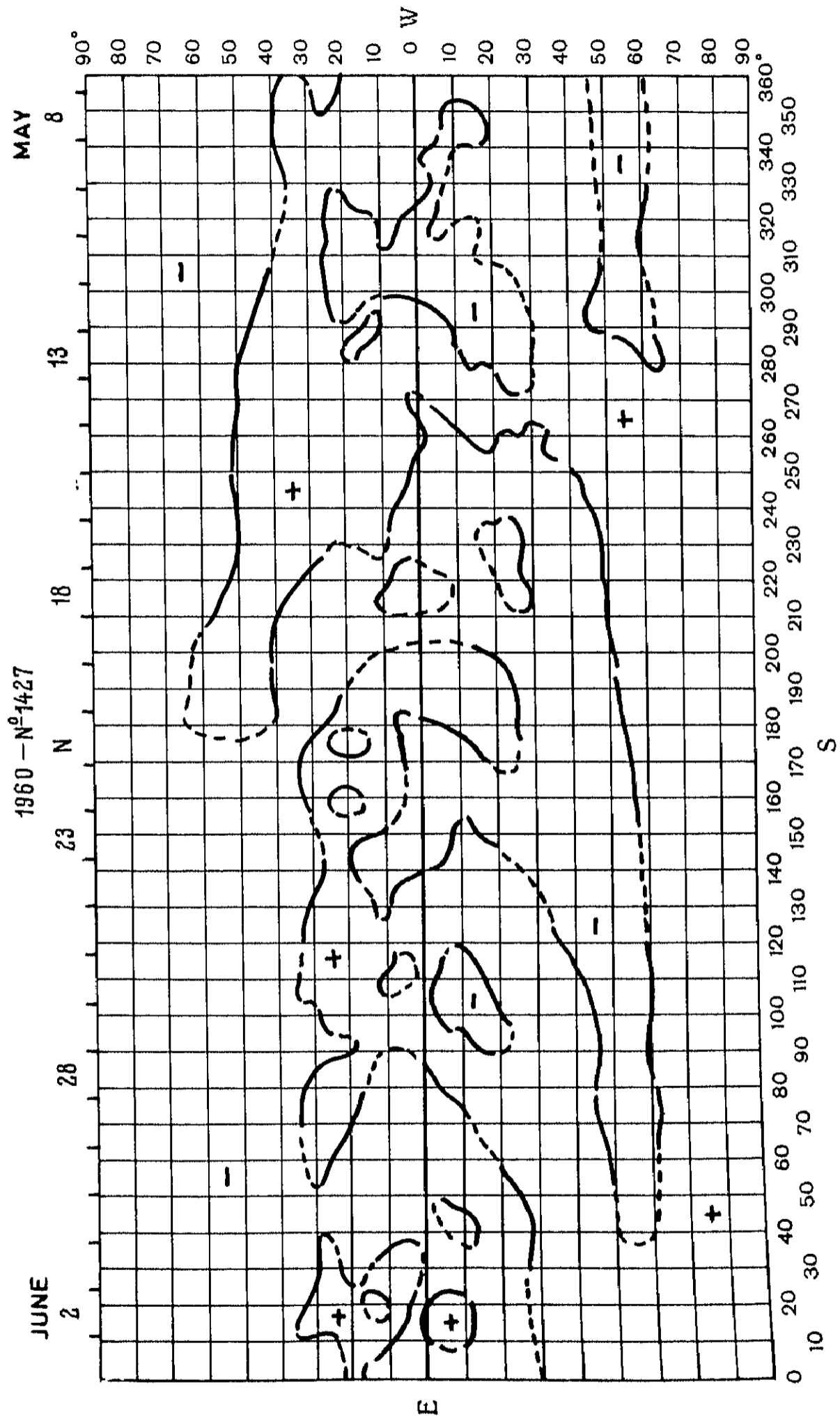




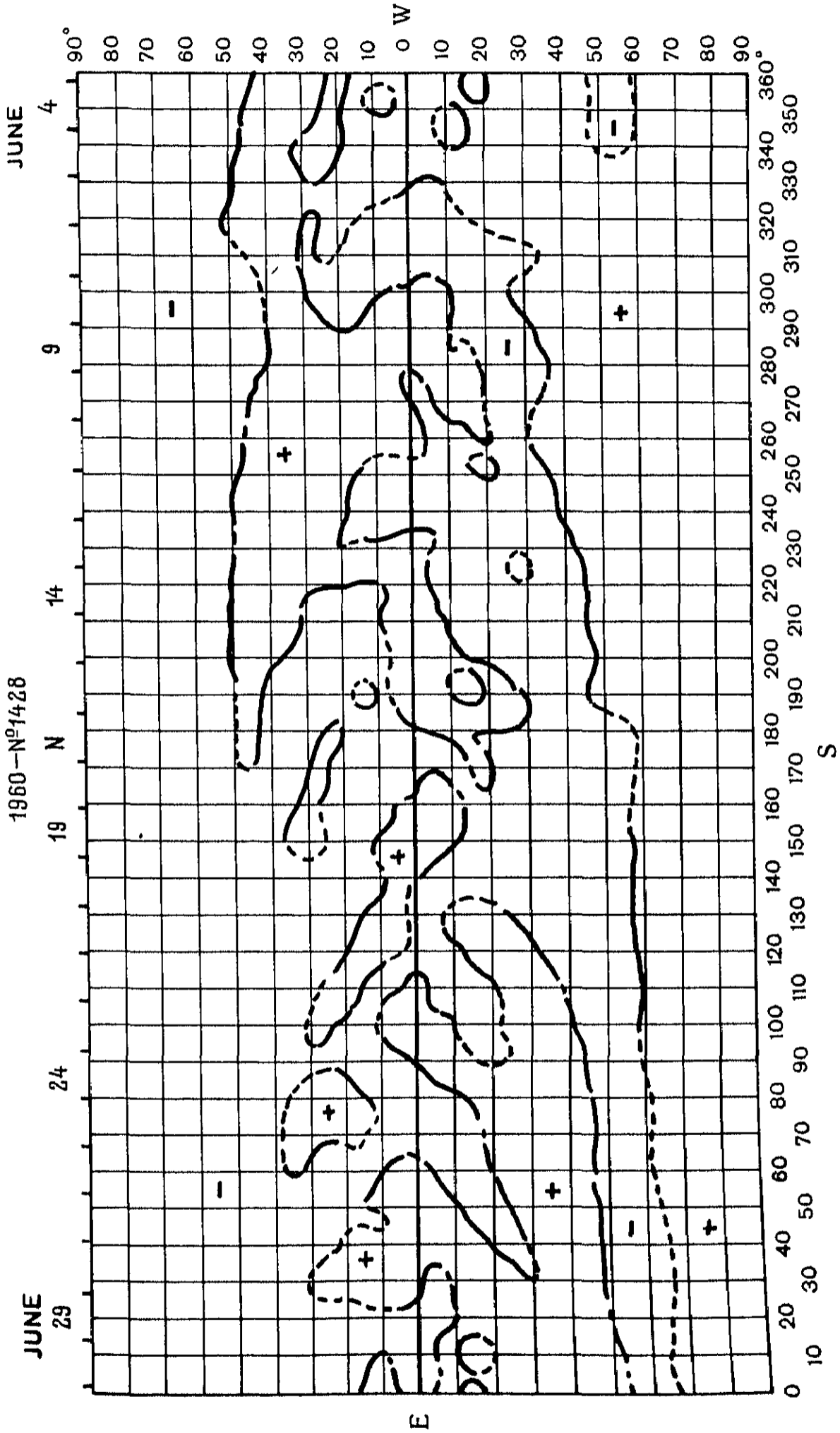


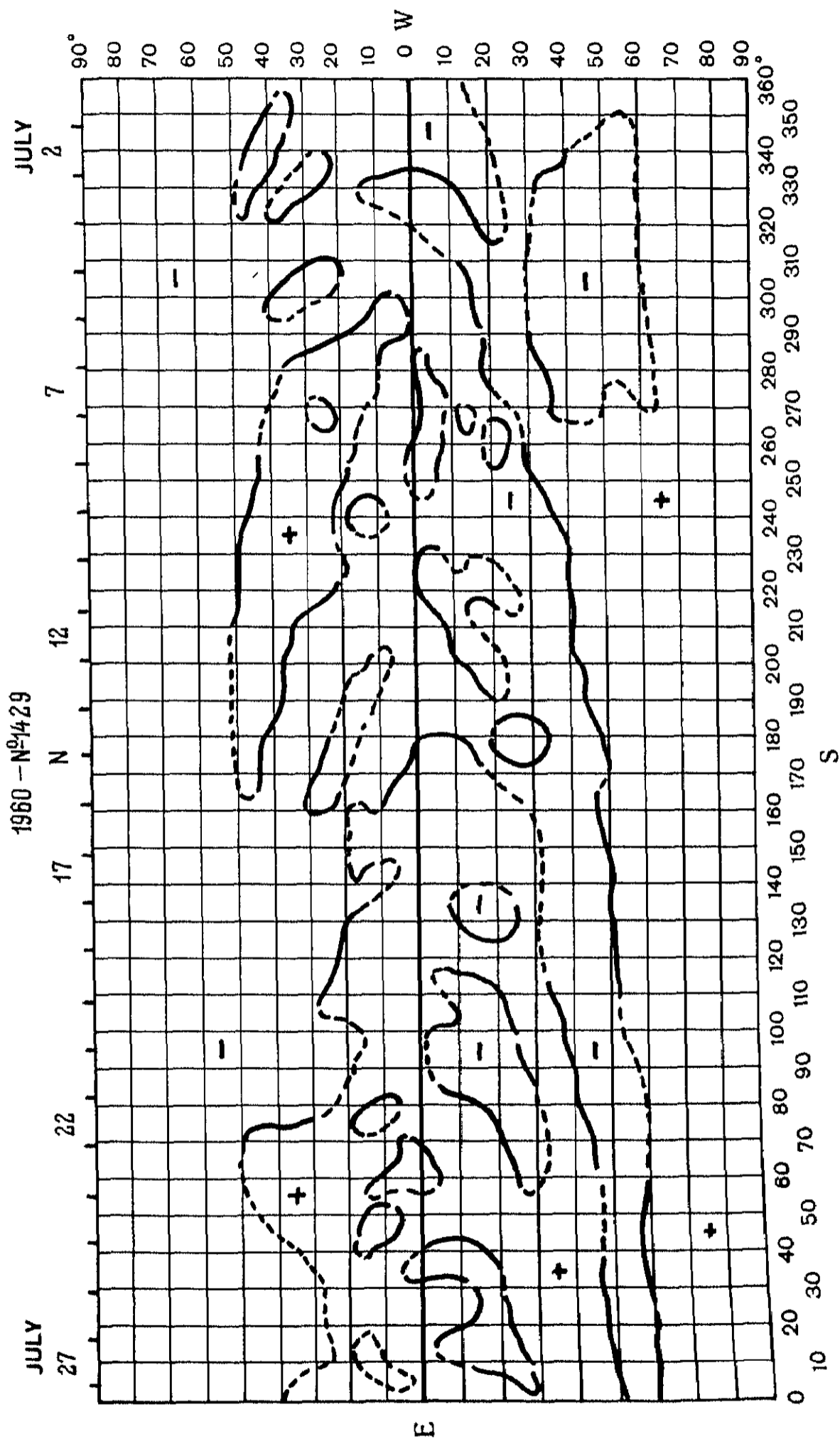


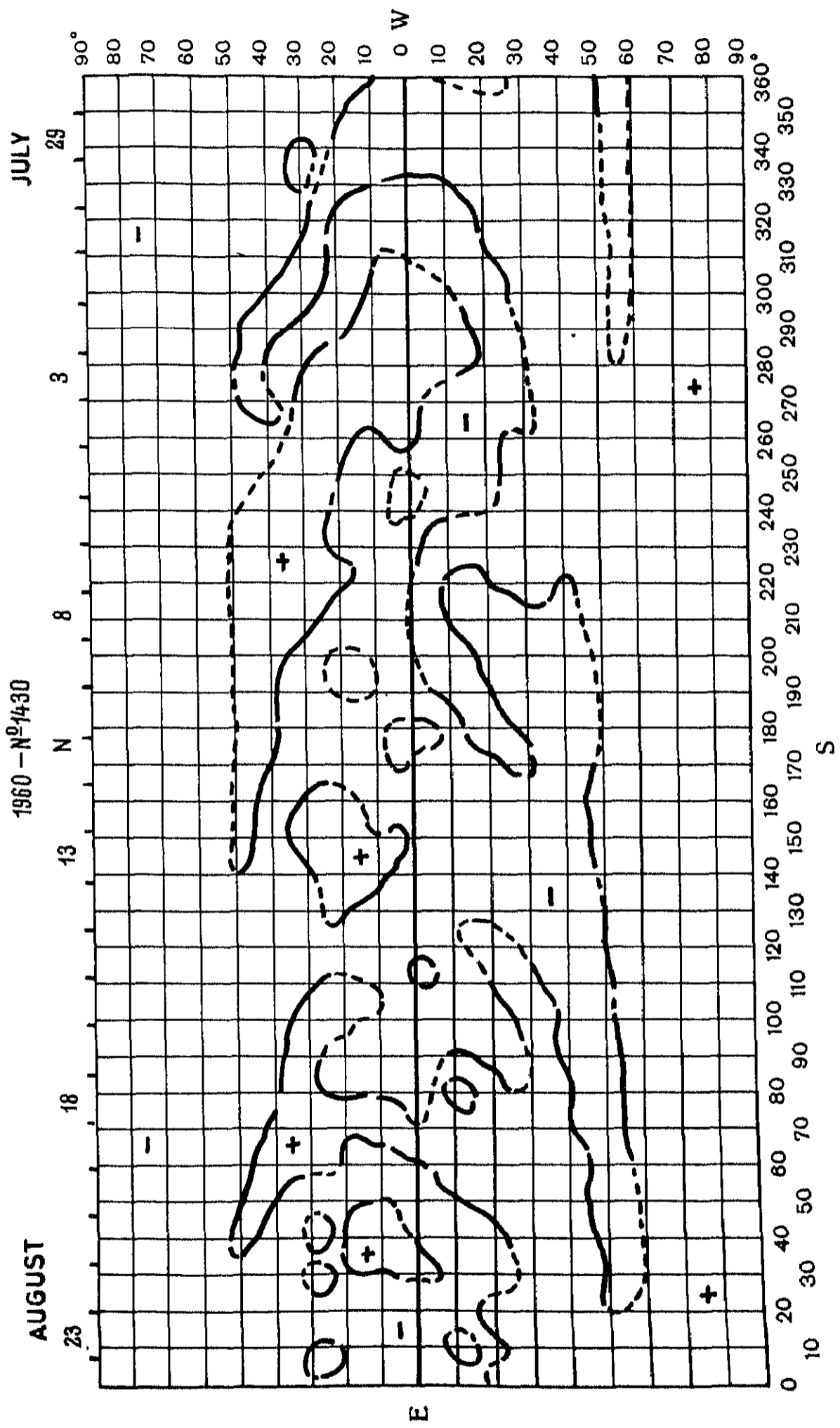


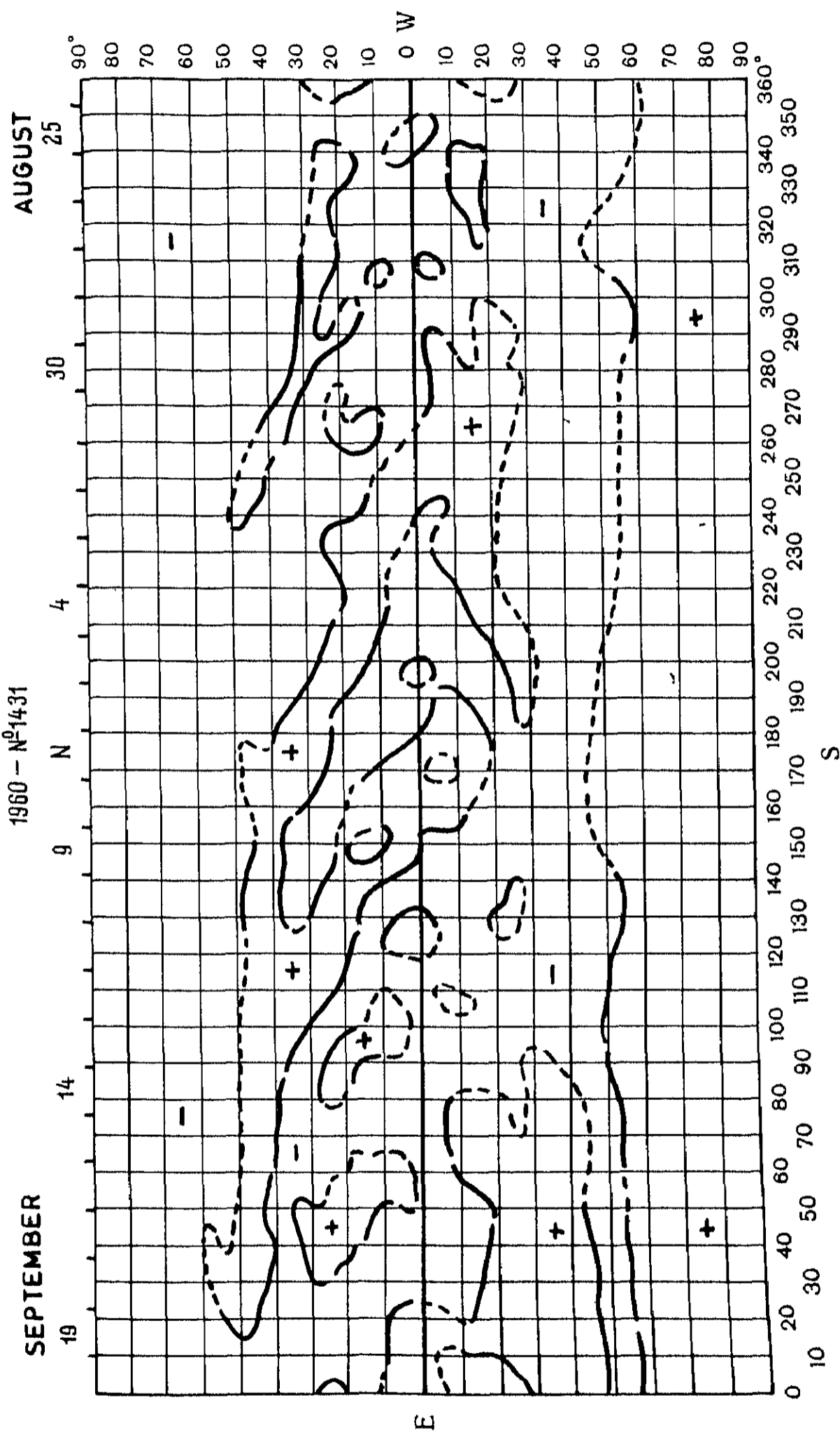


1960-N^o1428





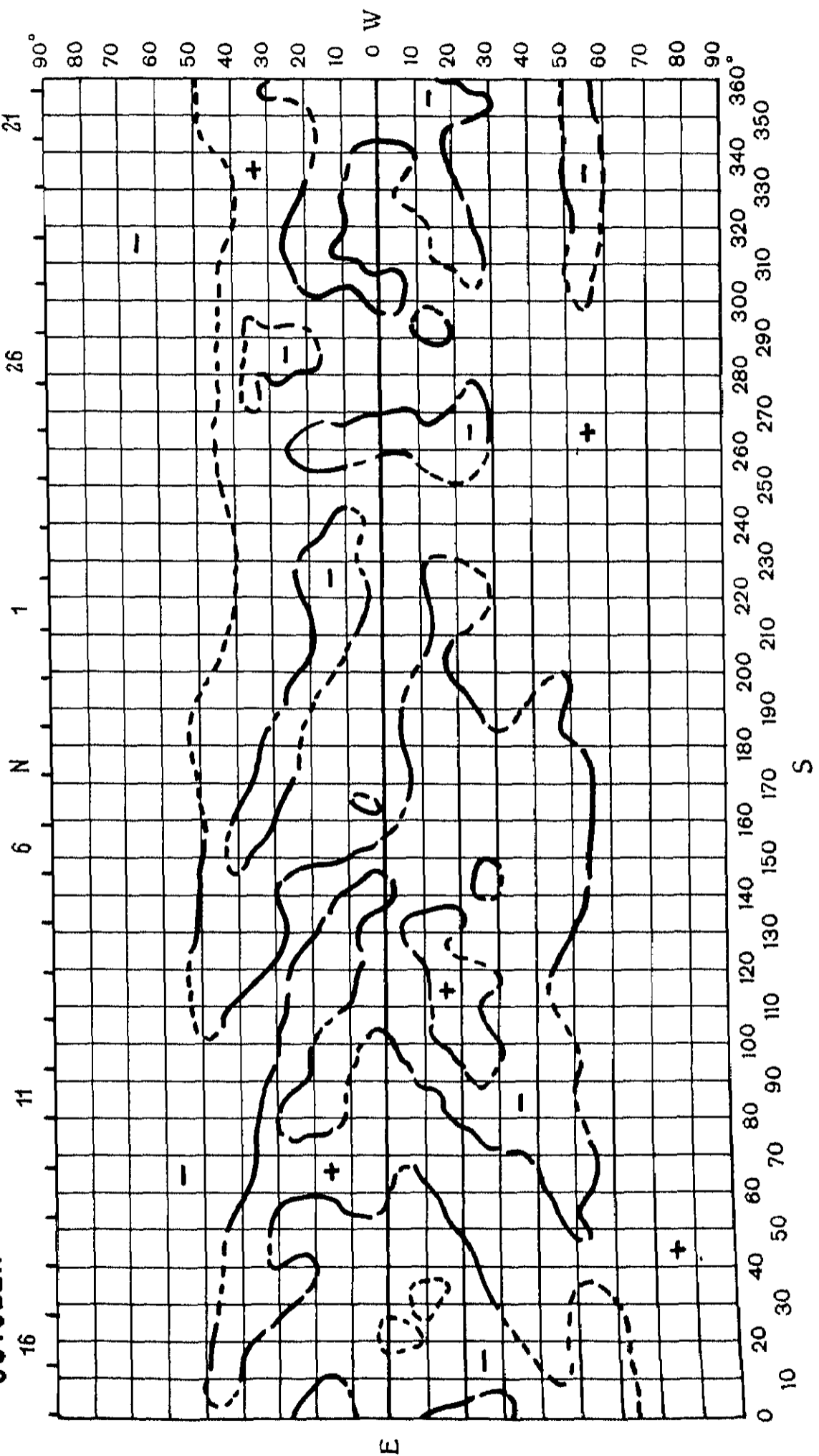




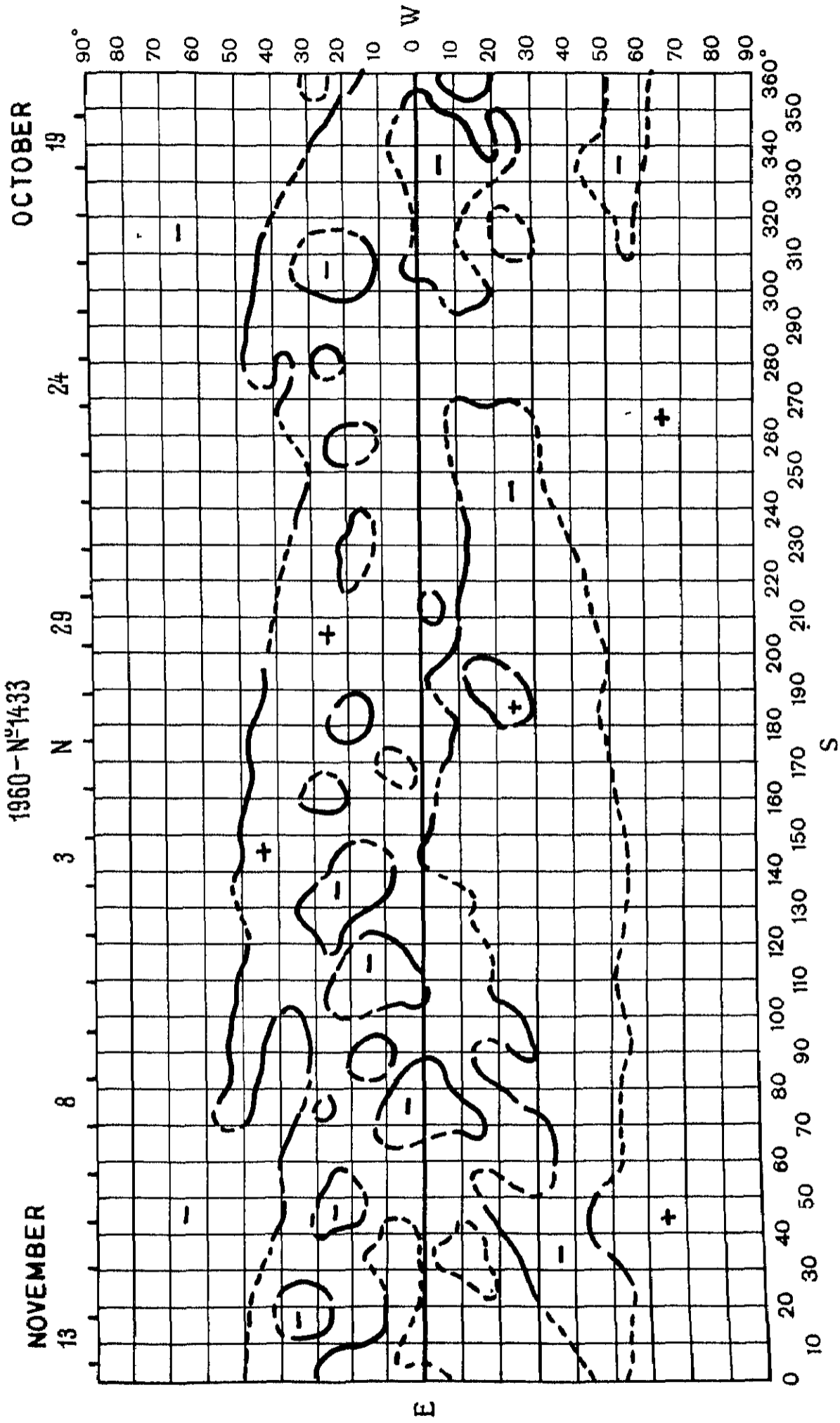
1960 -- N° 1432

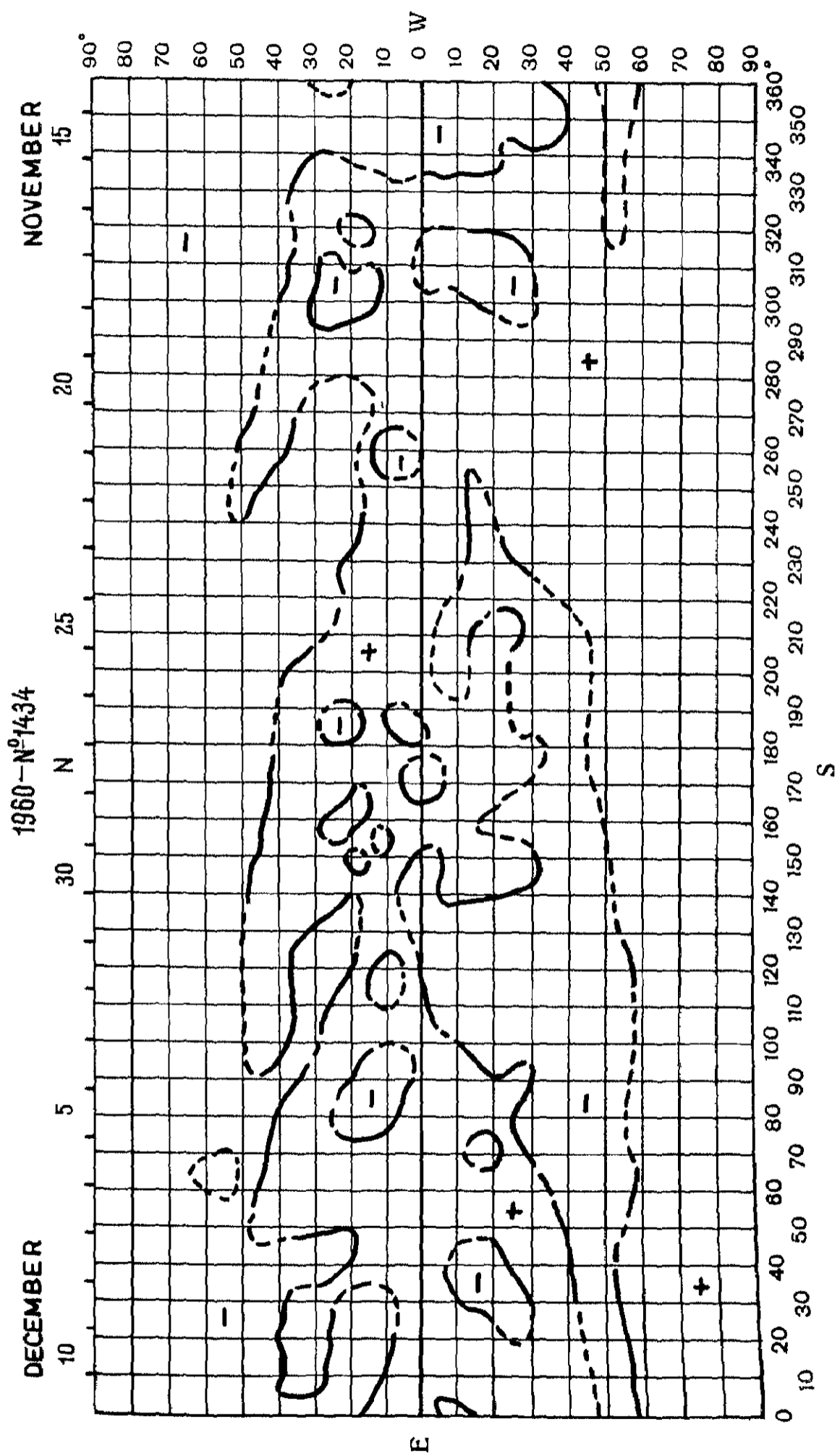
SEPTEMBER

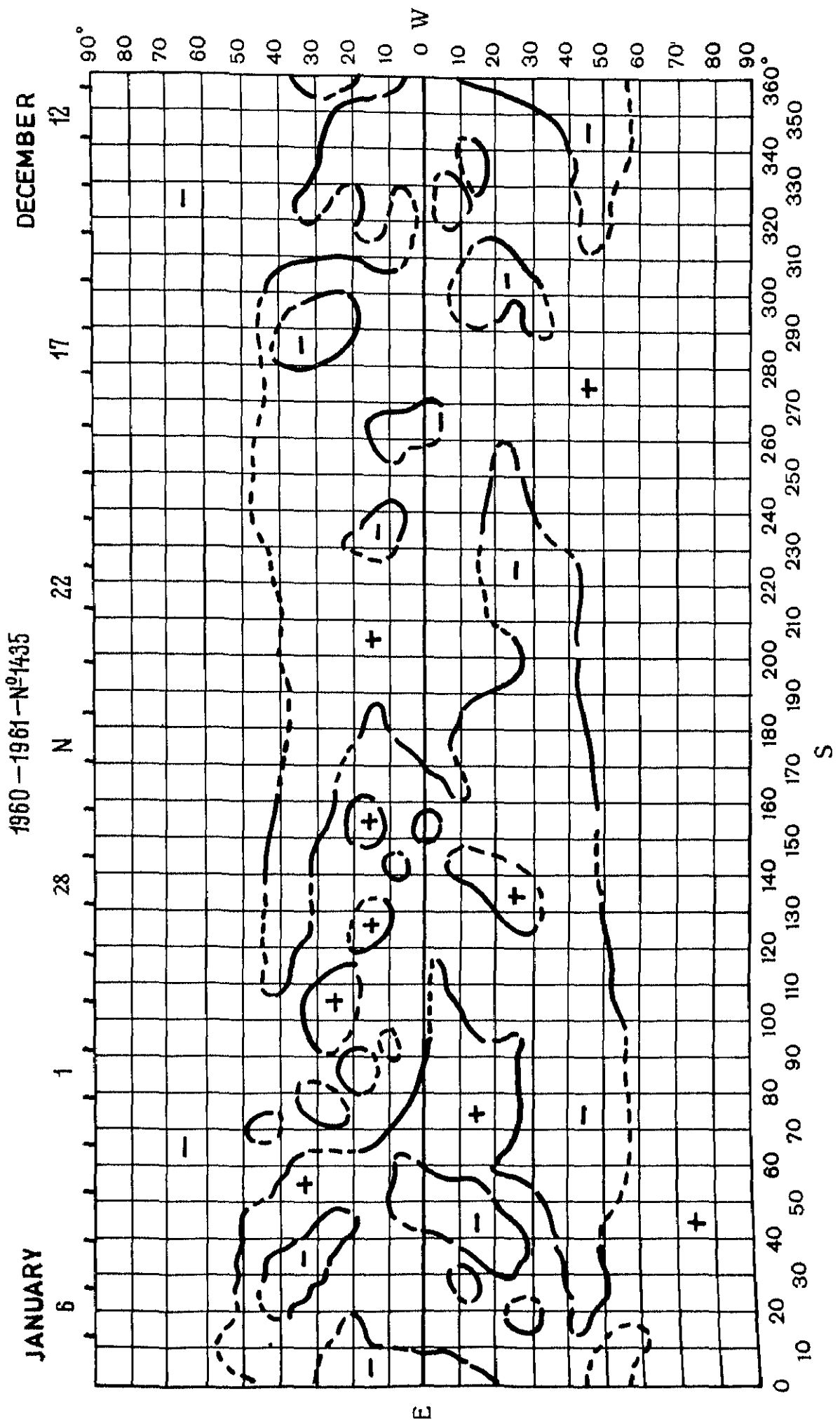
OCTOBER

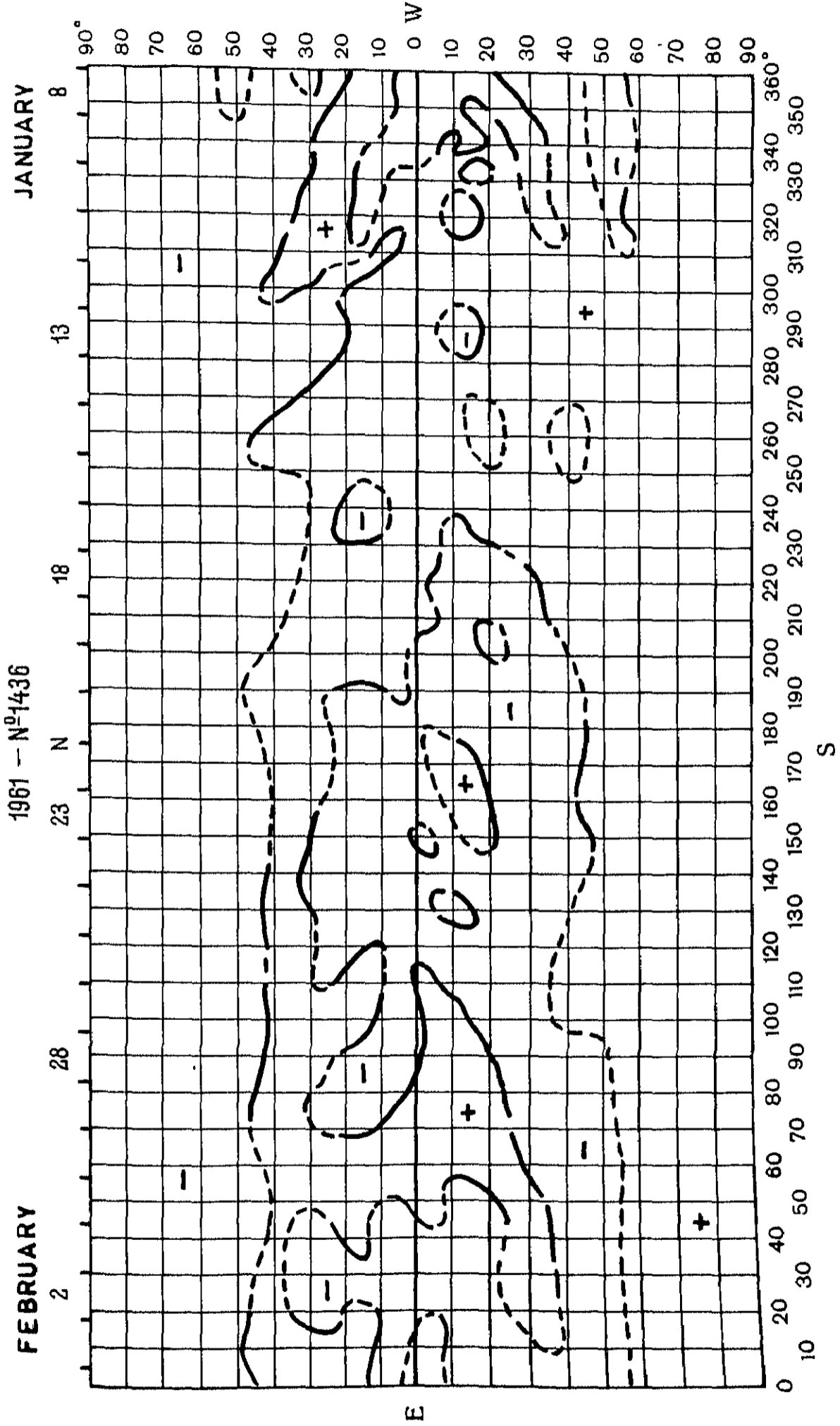


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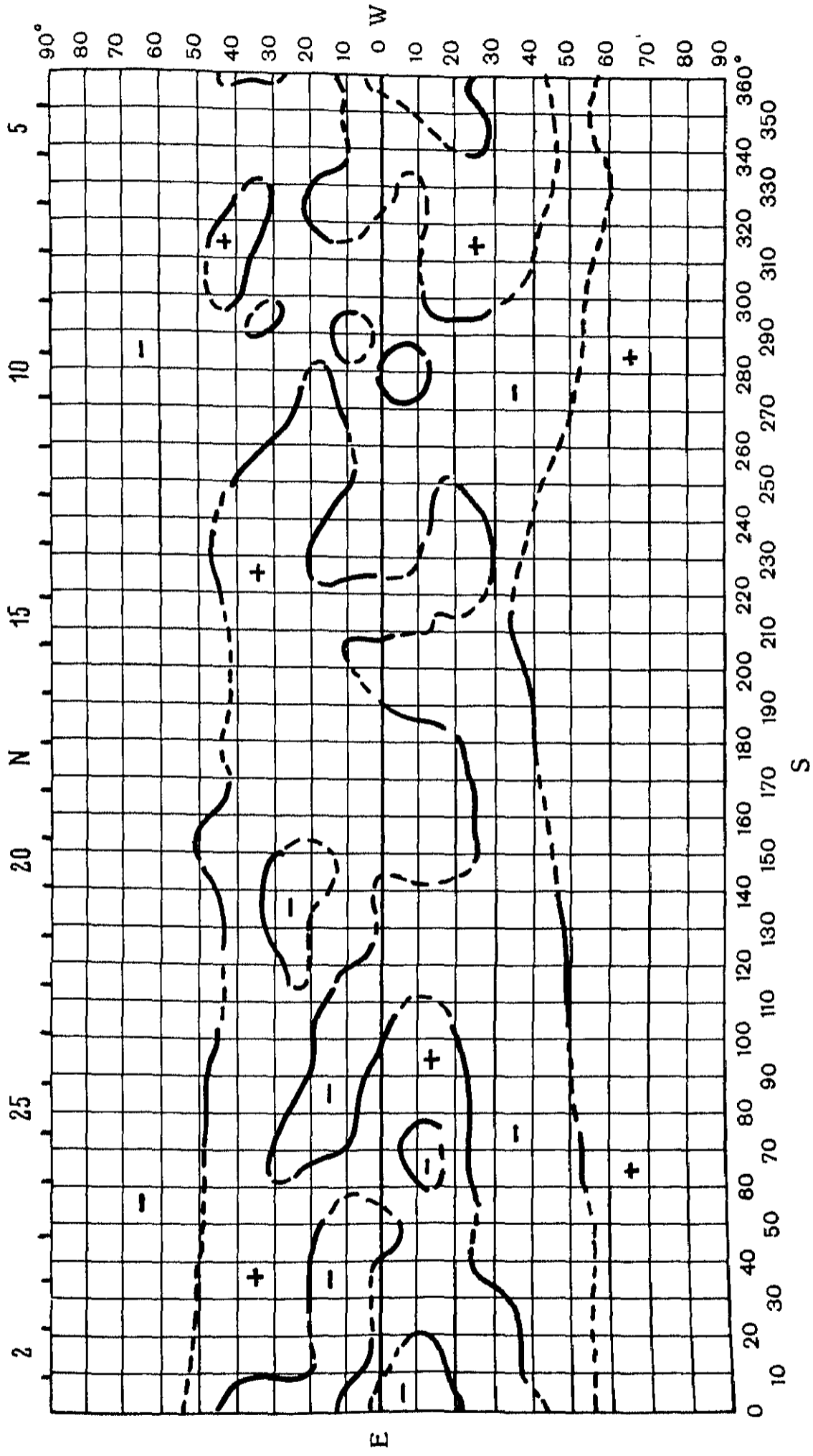


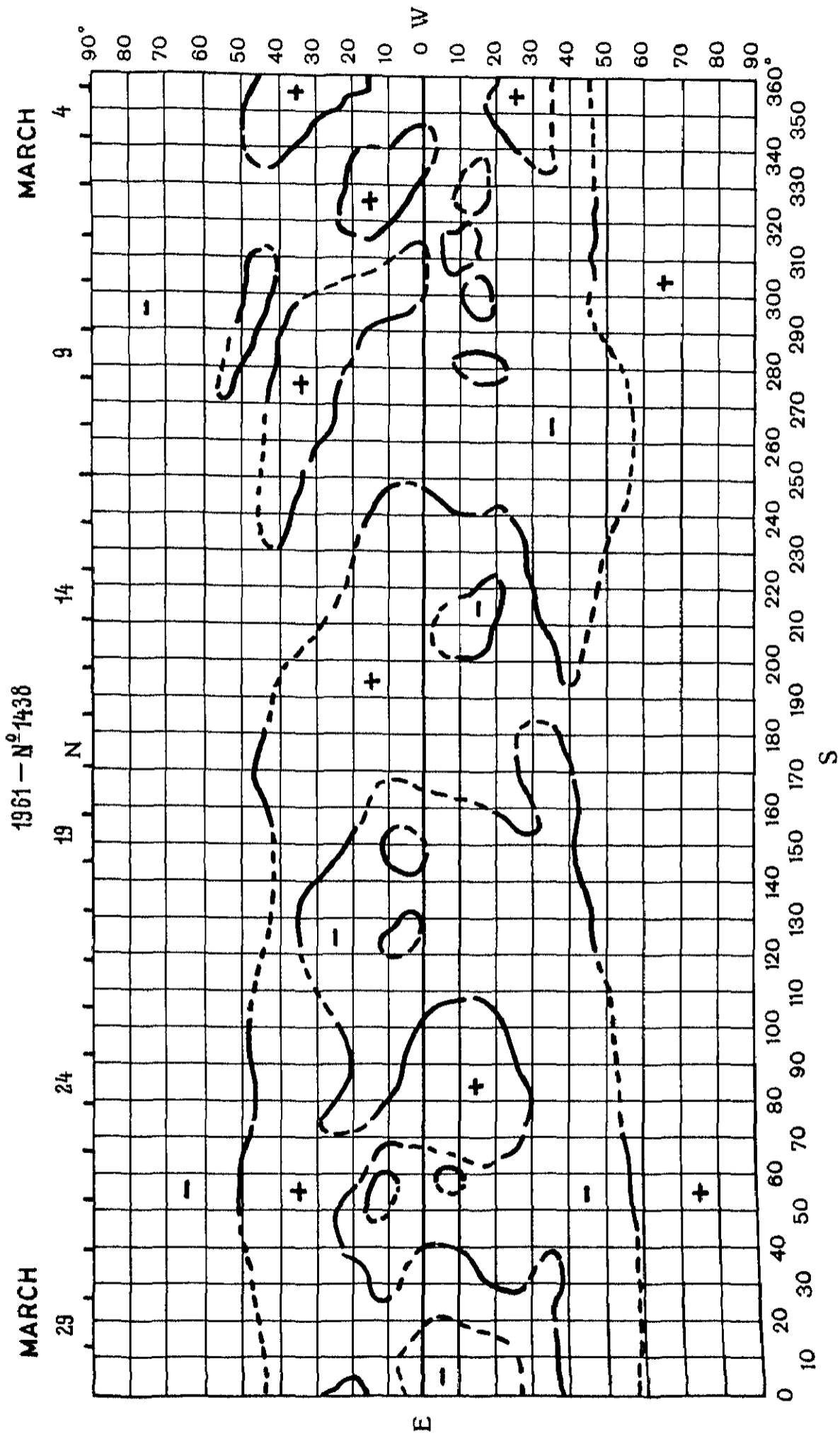


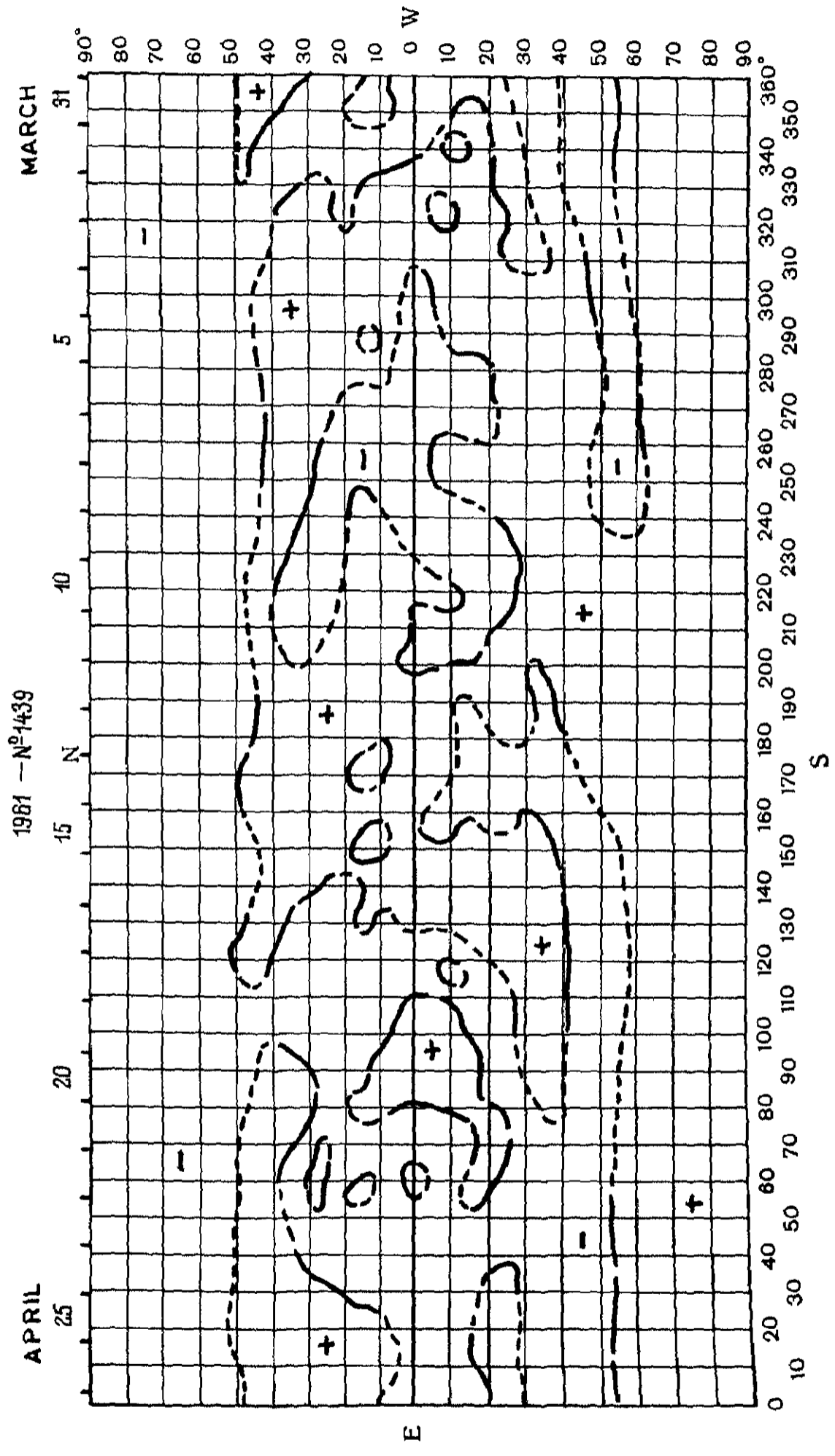
1961 - N° 1437

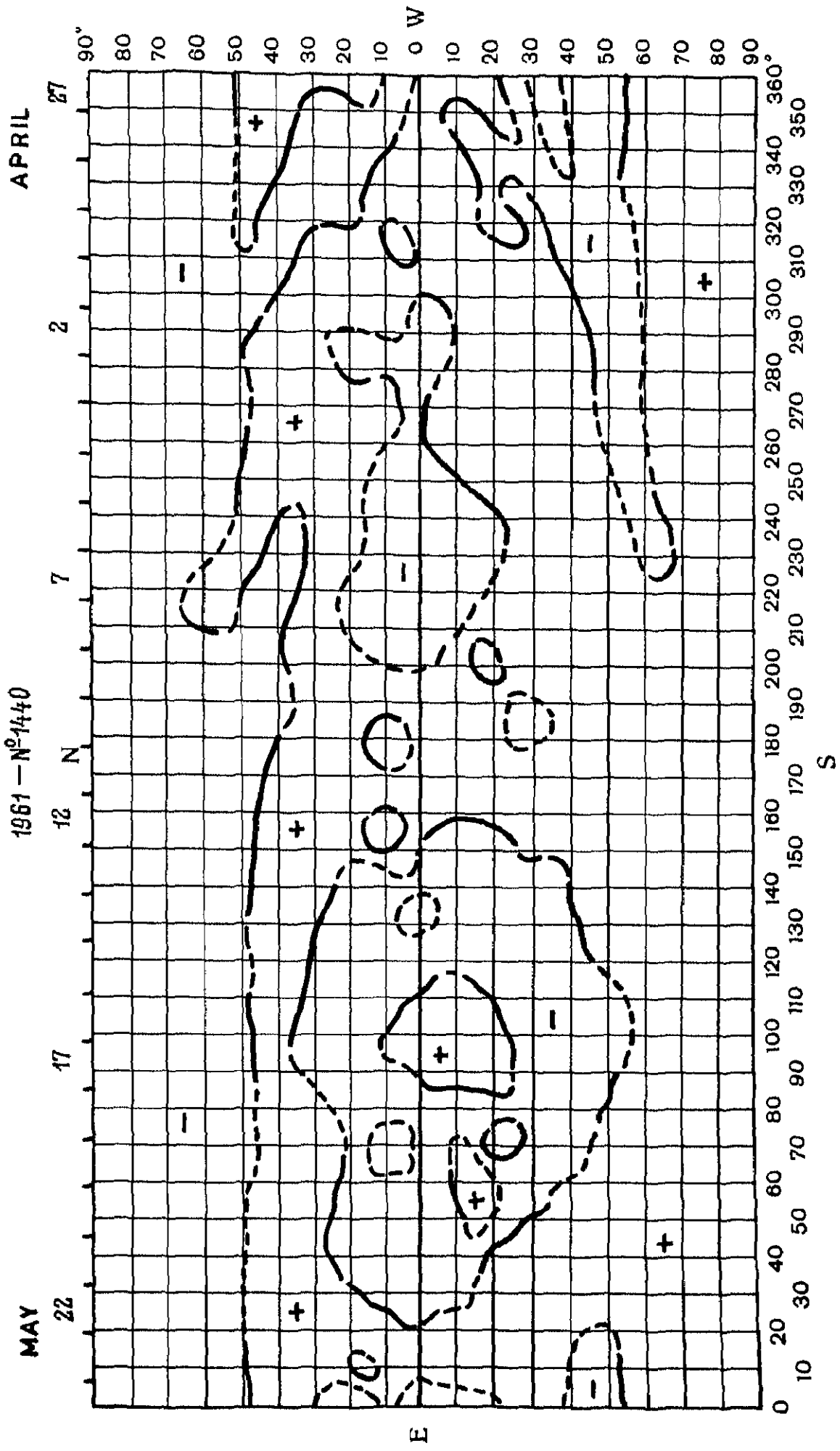
MARCH

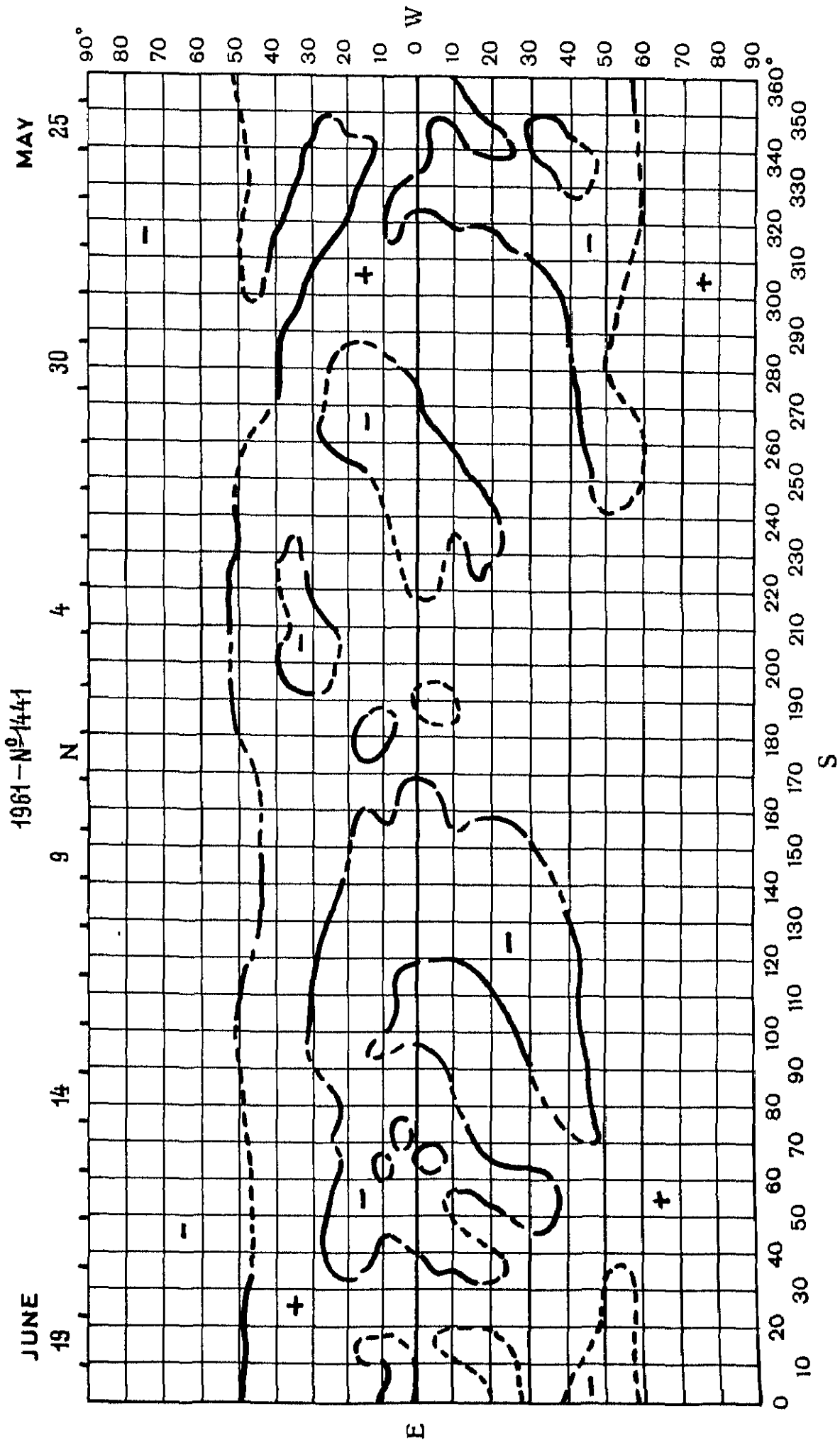
FEBRUARY

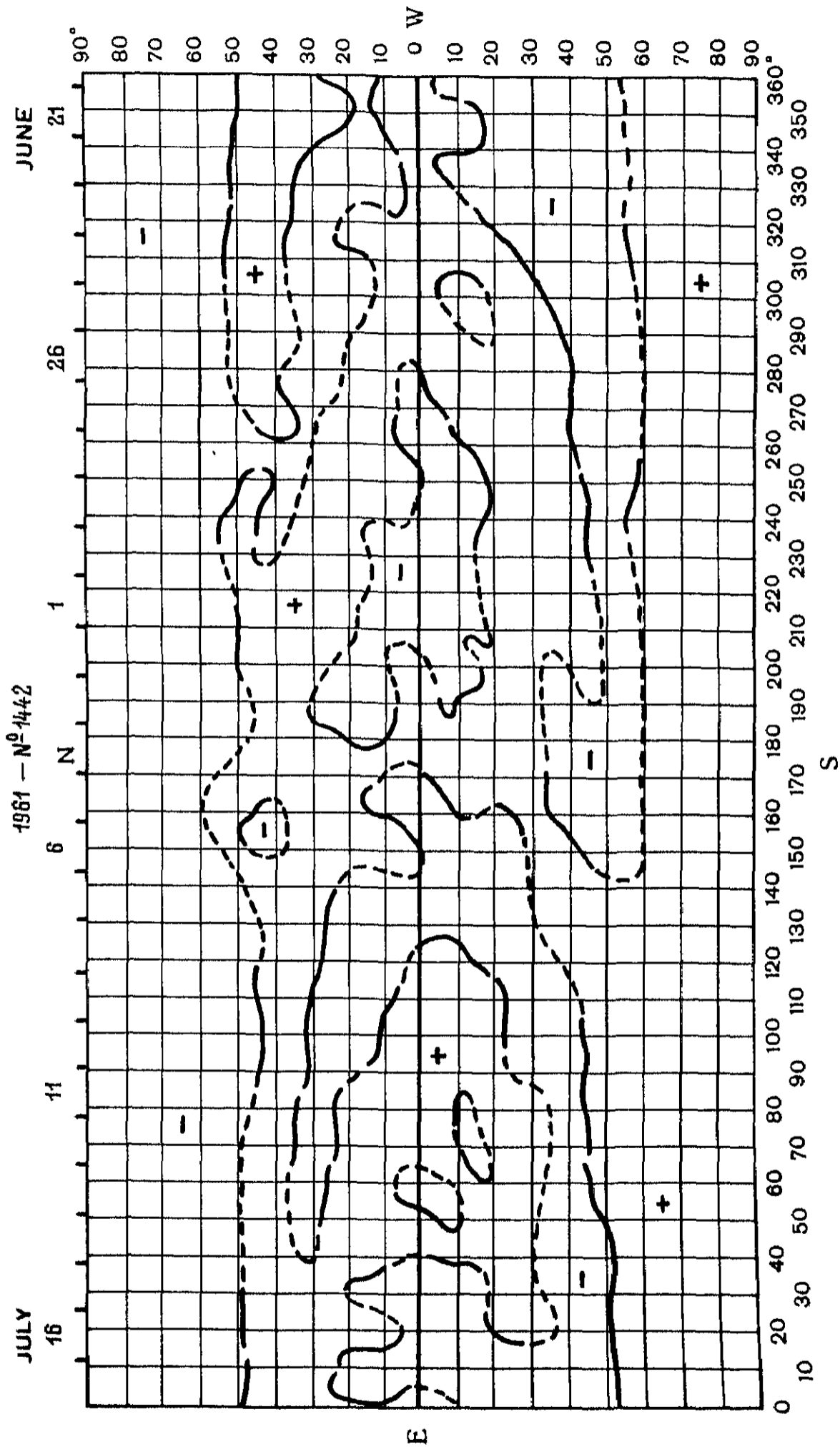


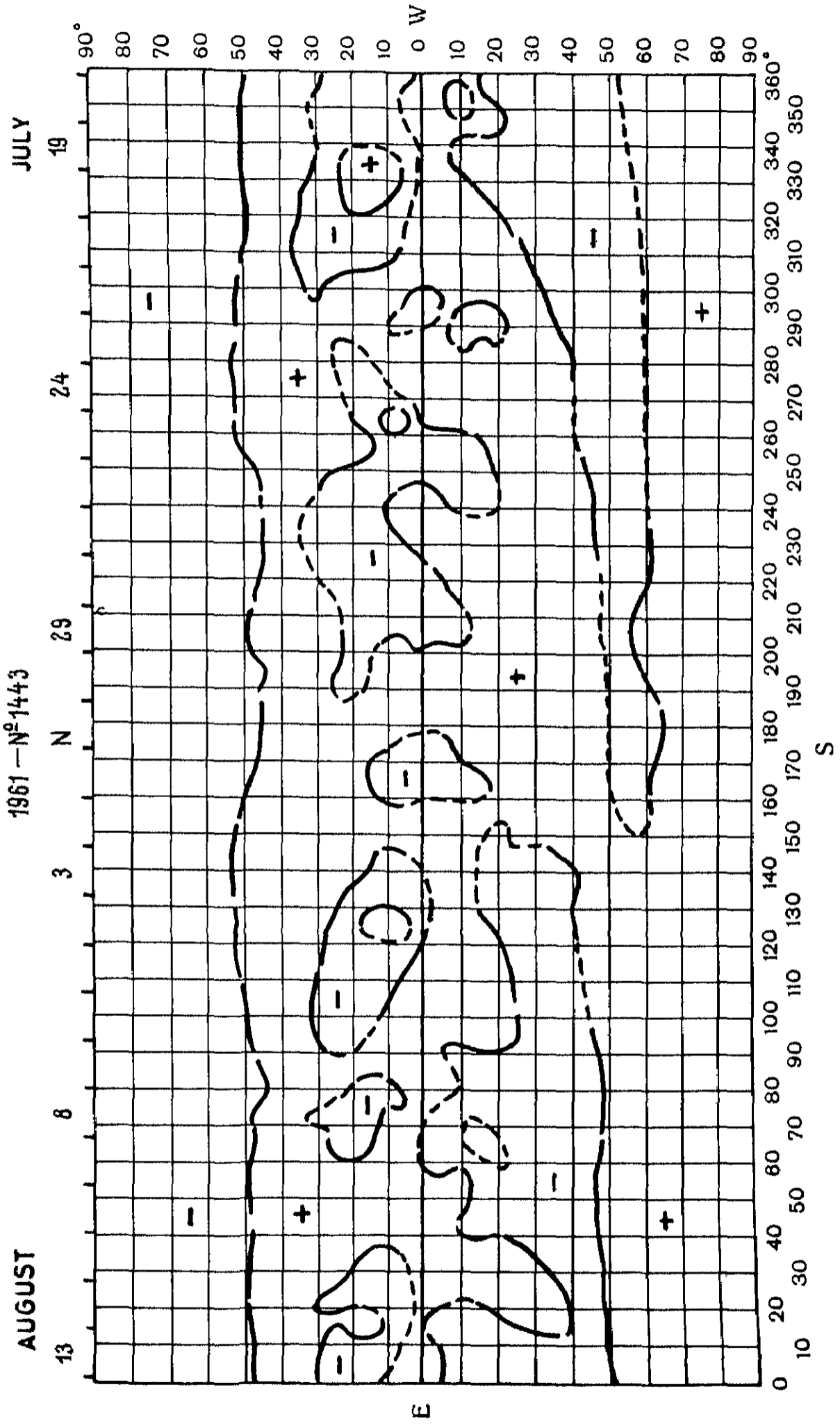


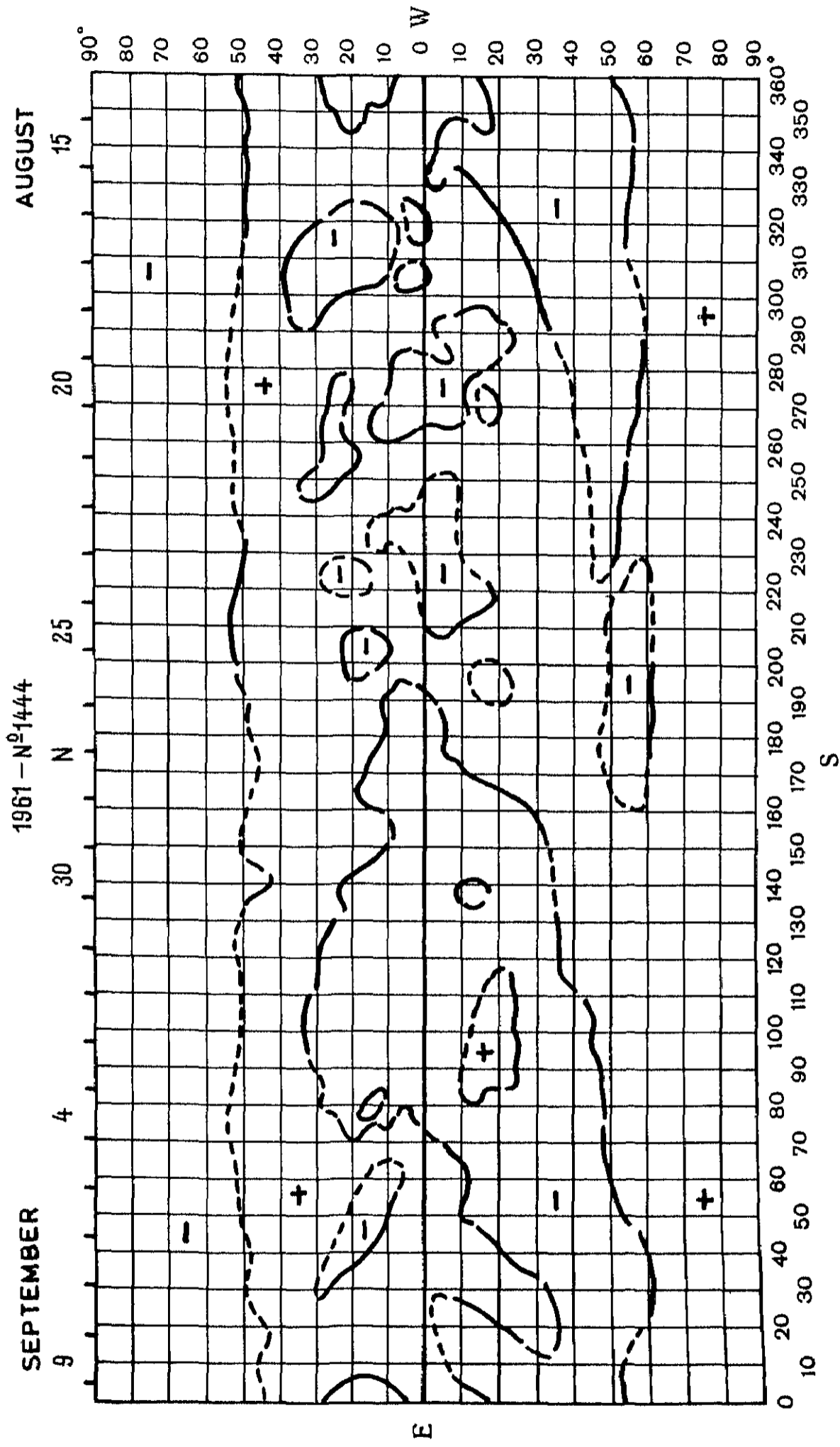


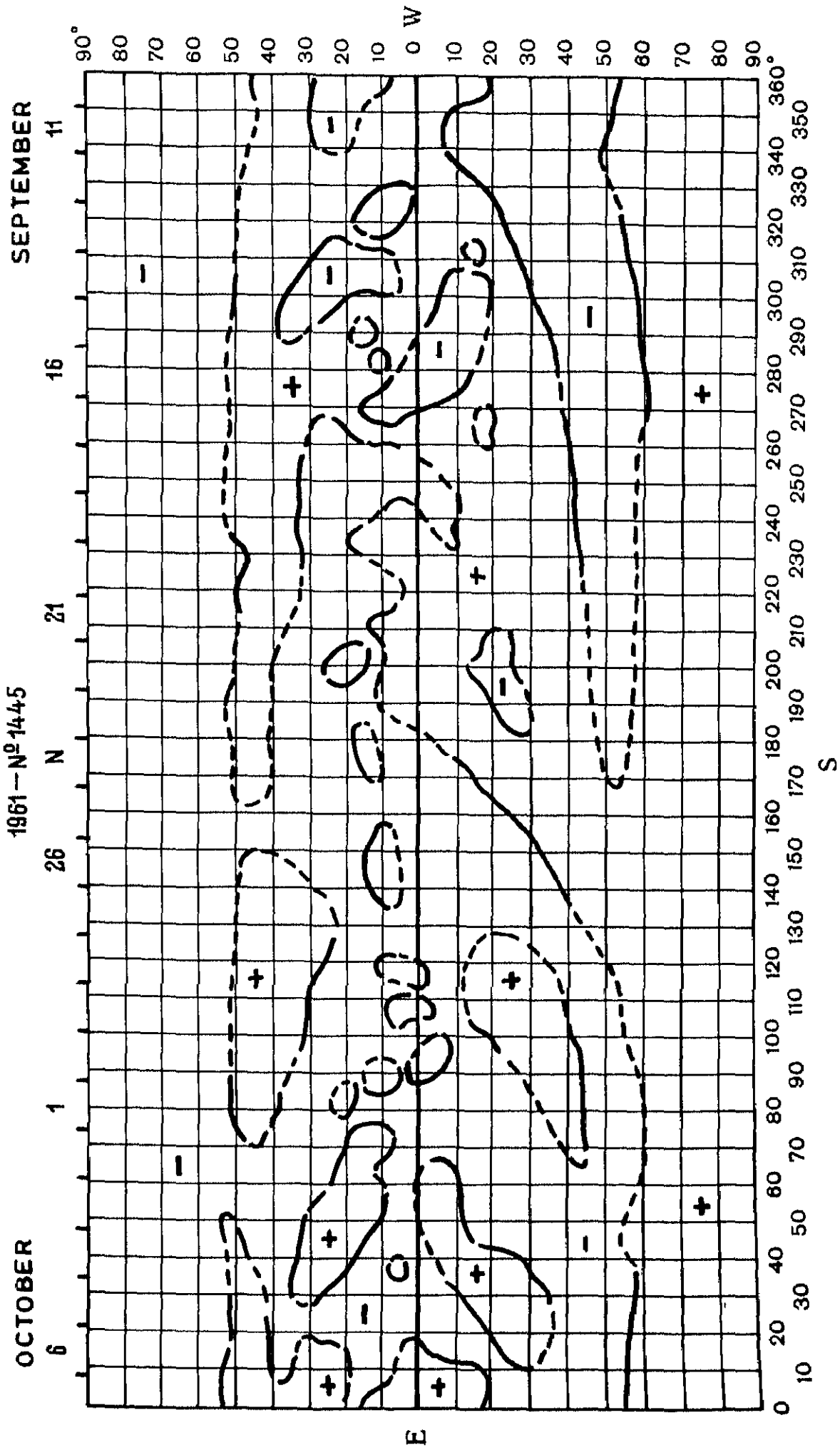


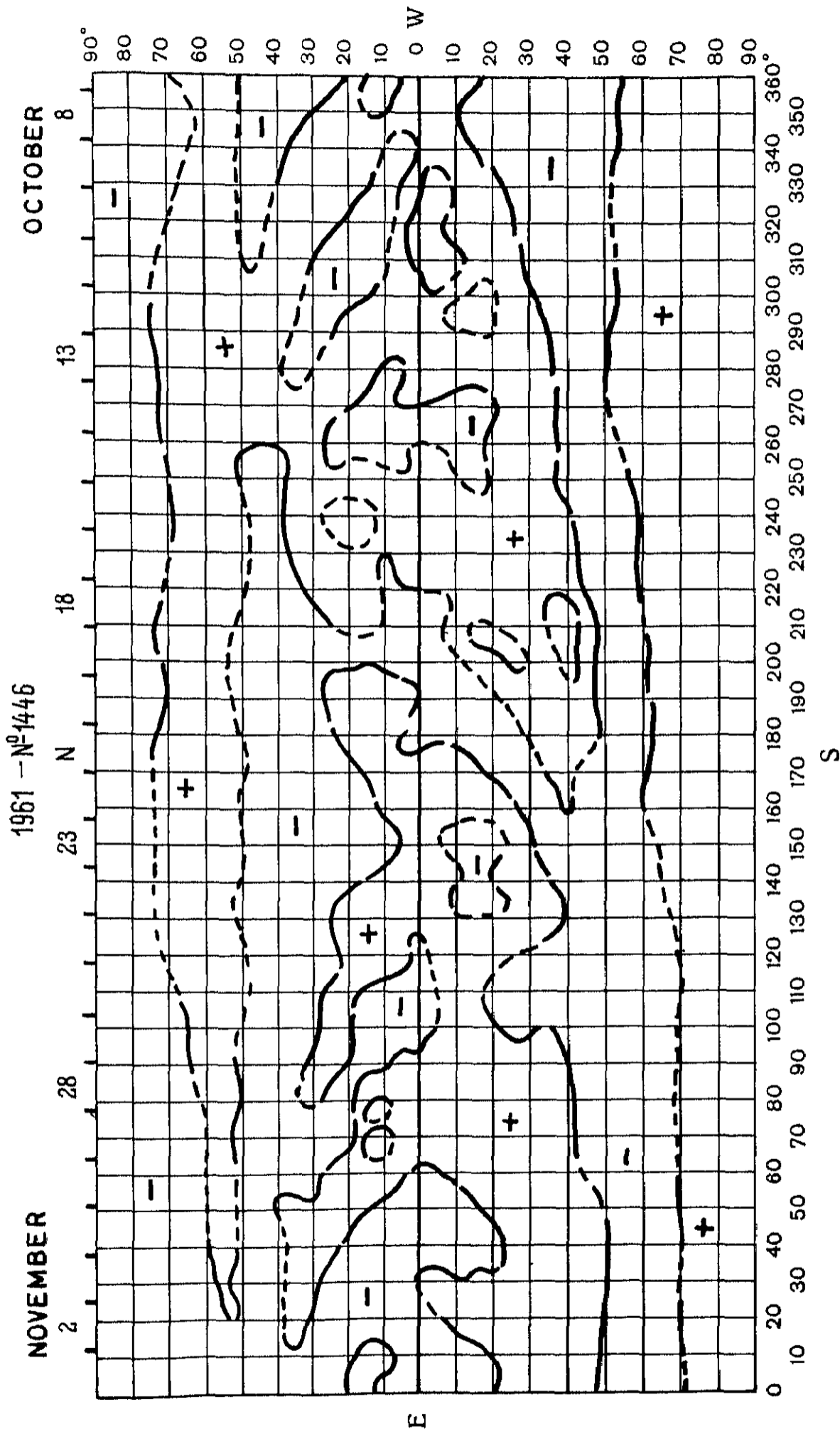


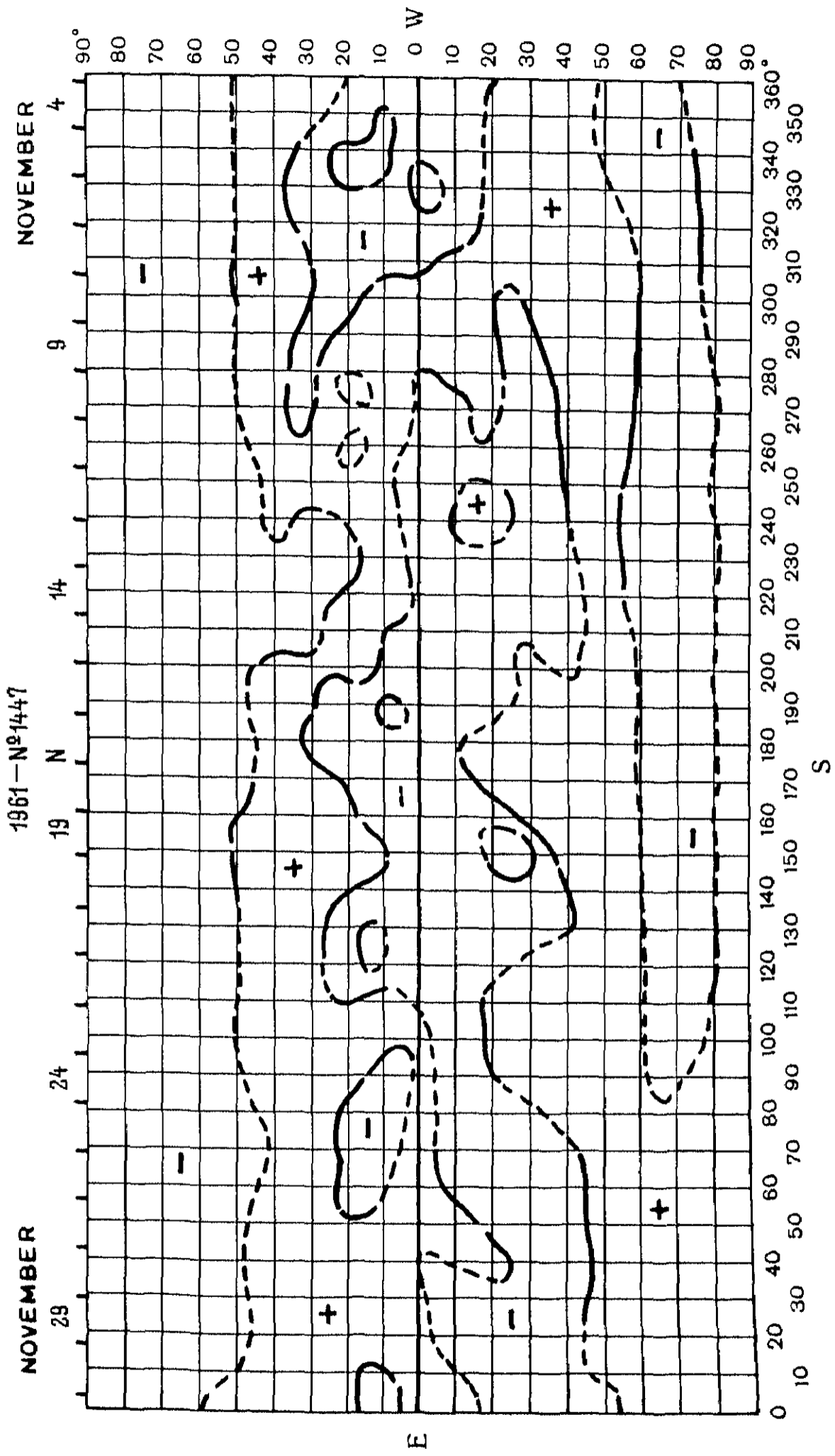


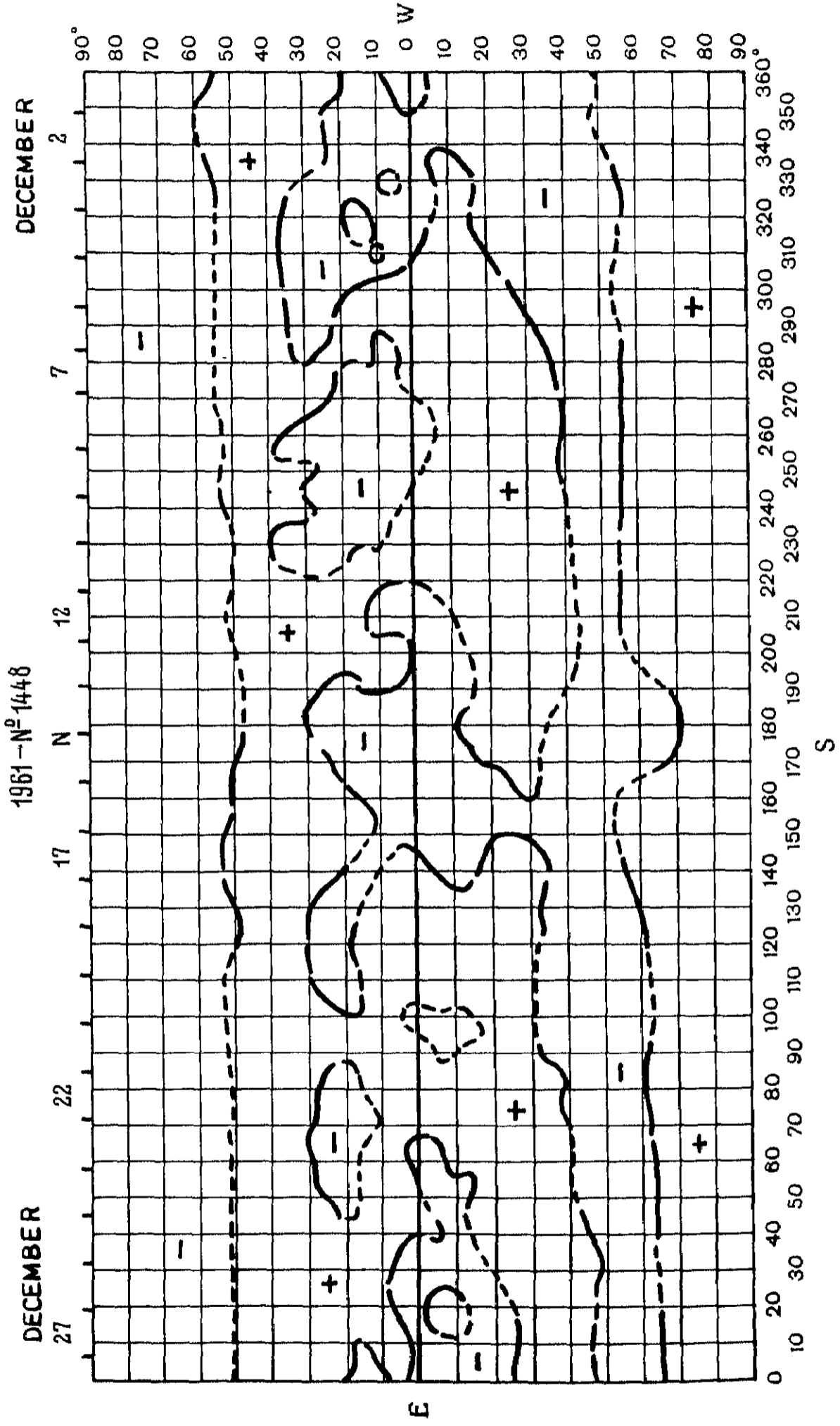


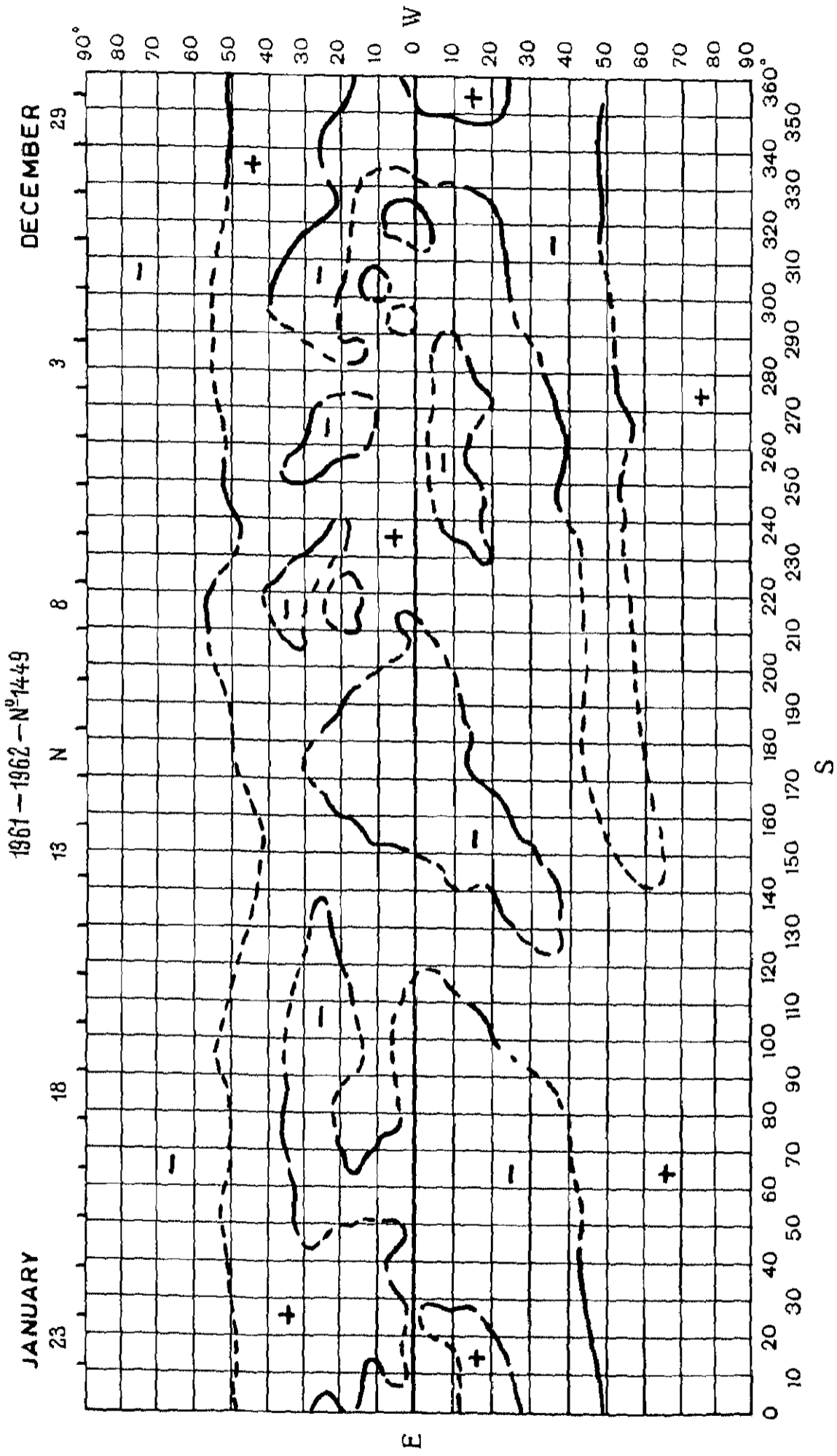


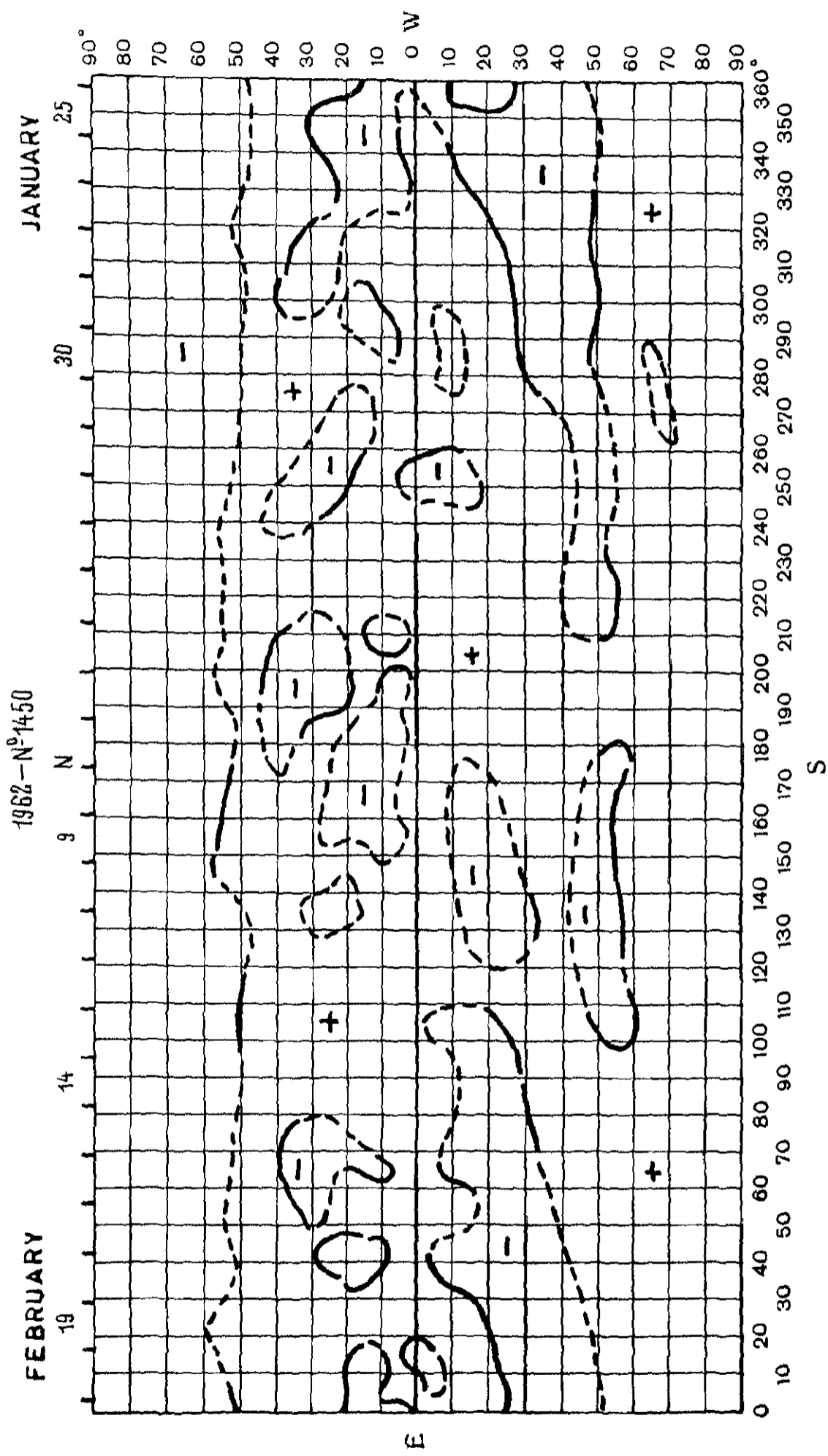


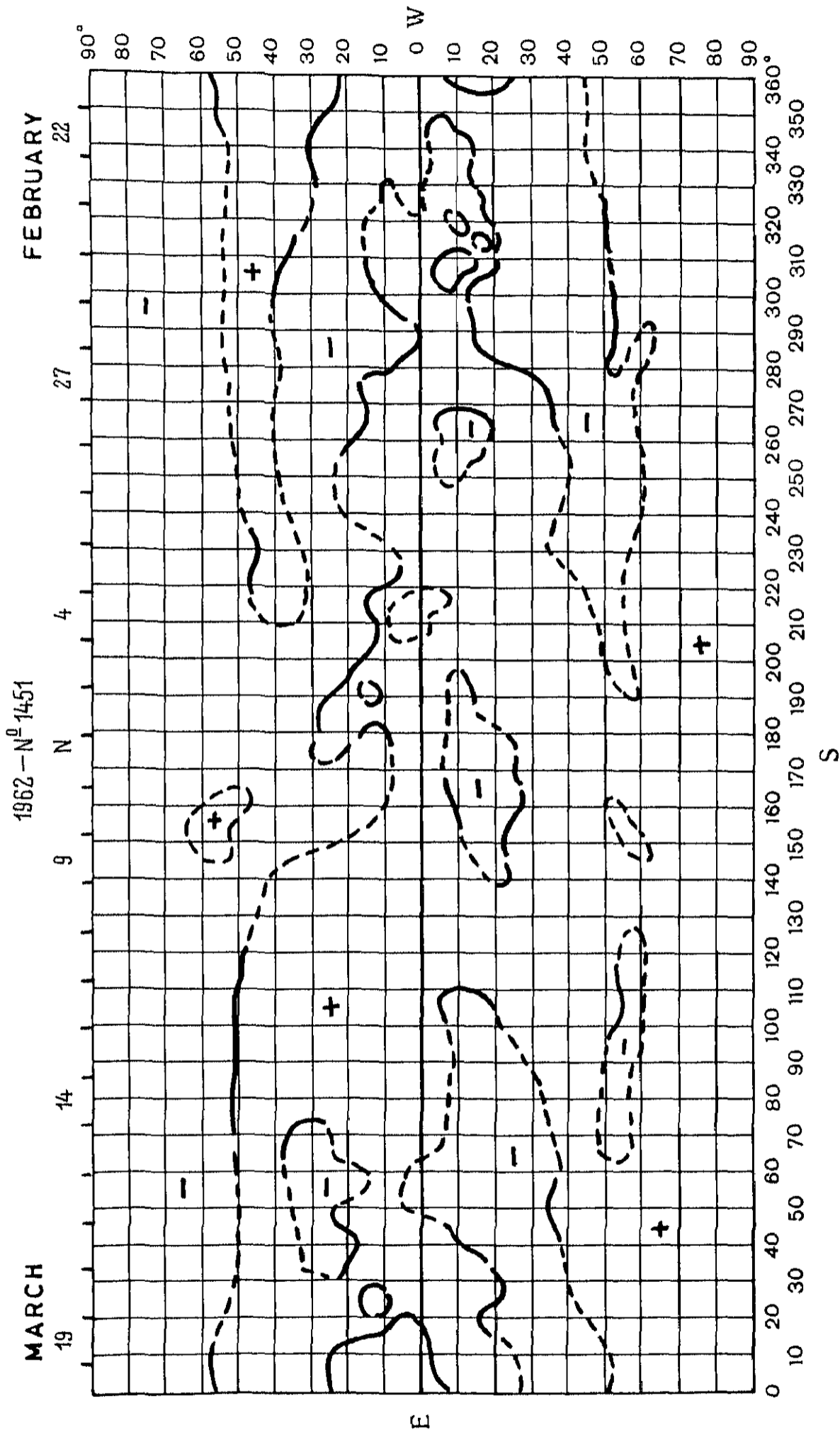


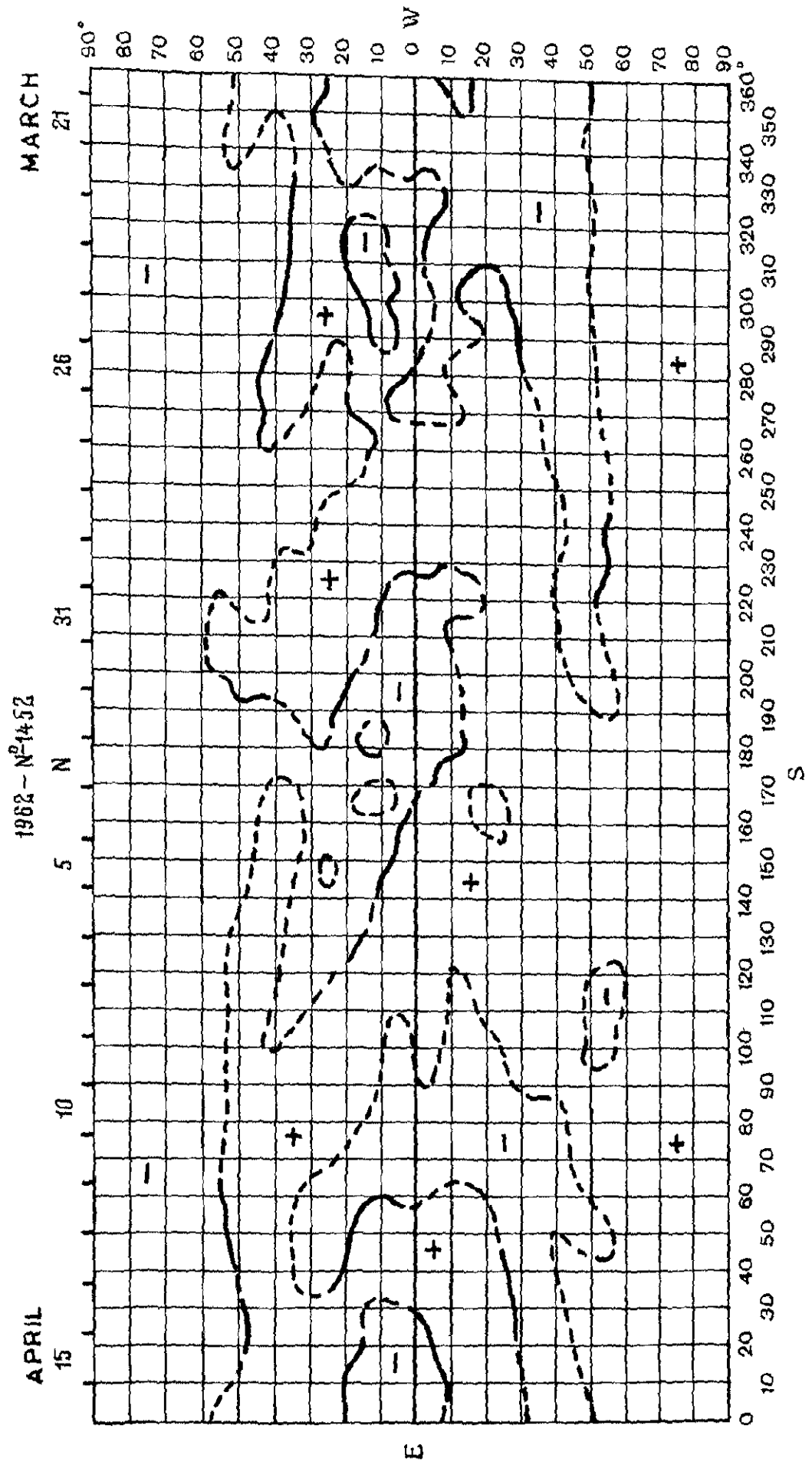




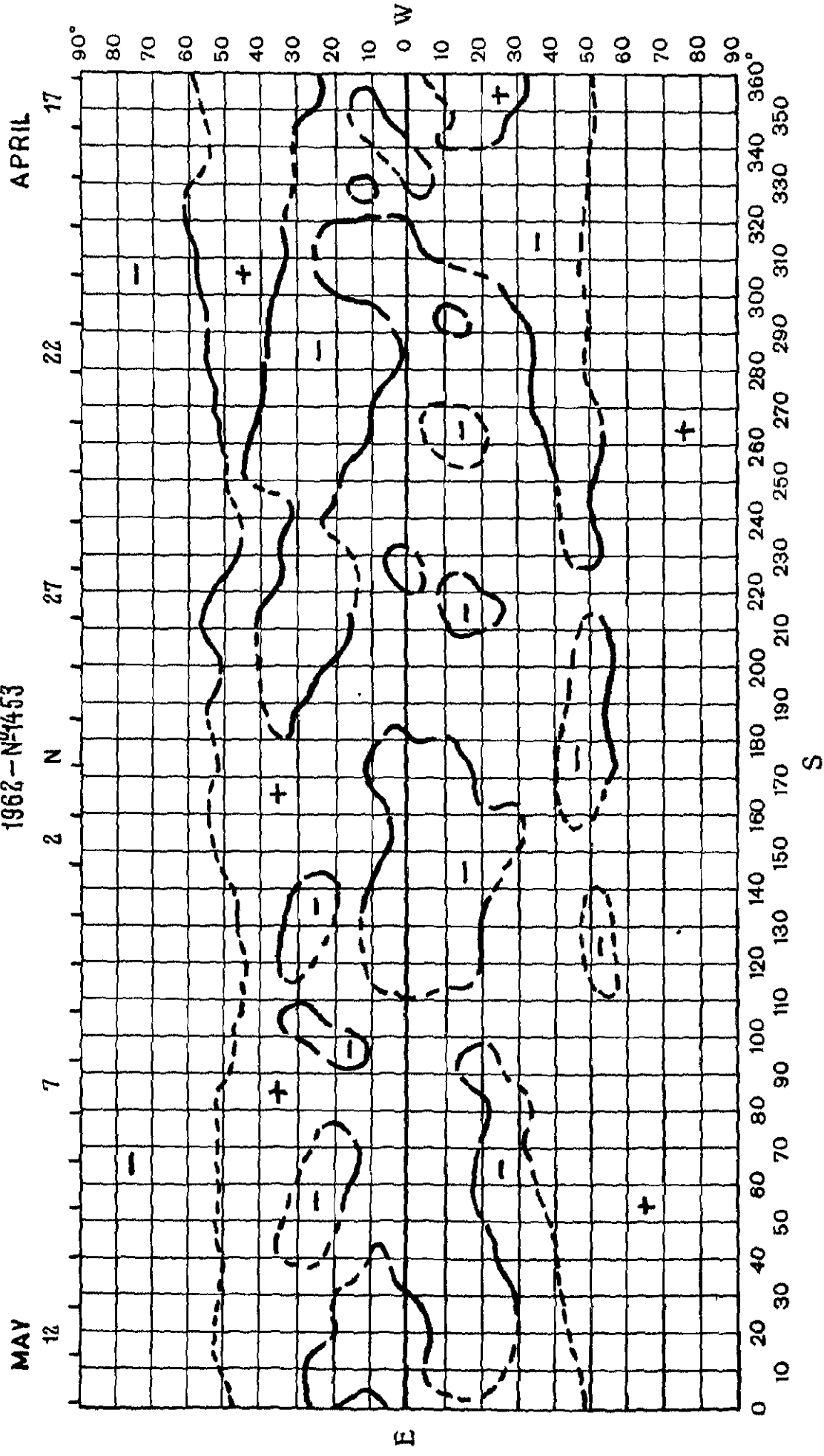








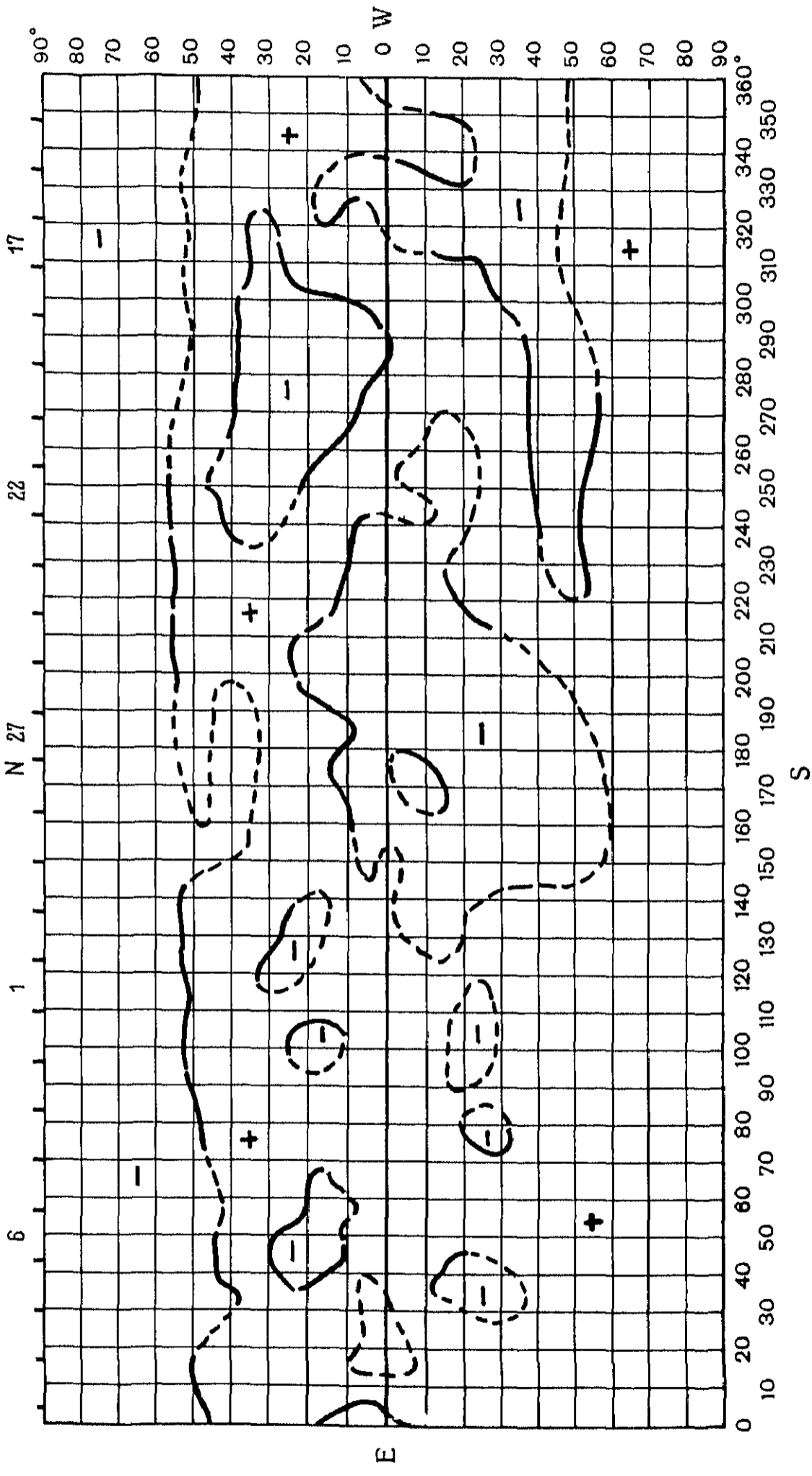
1962 - N°1453

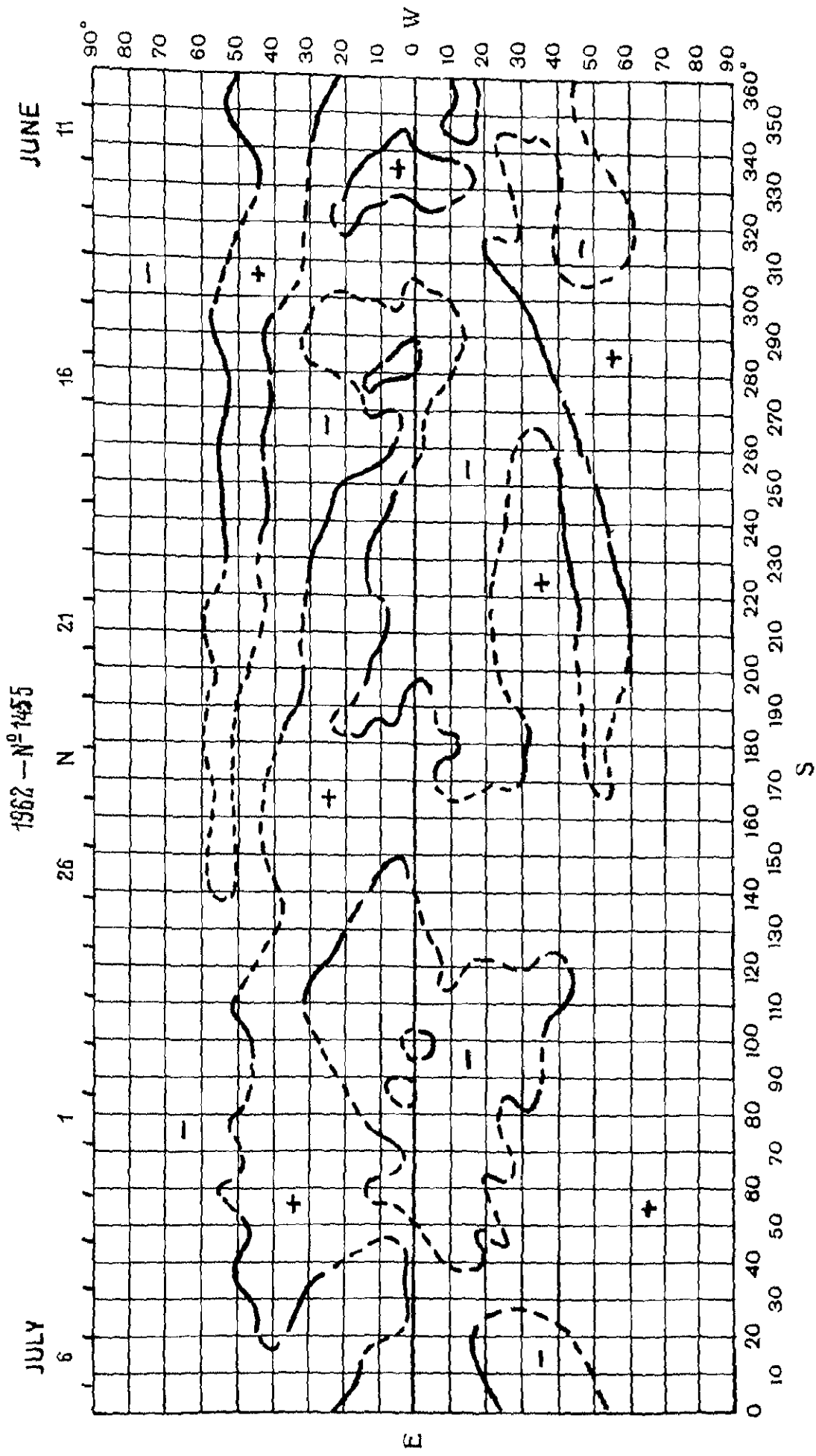


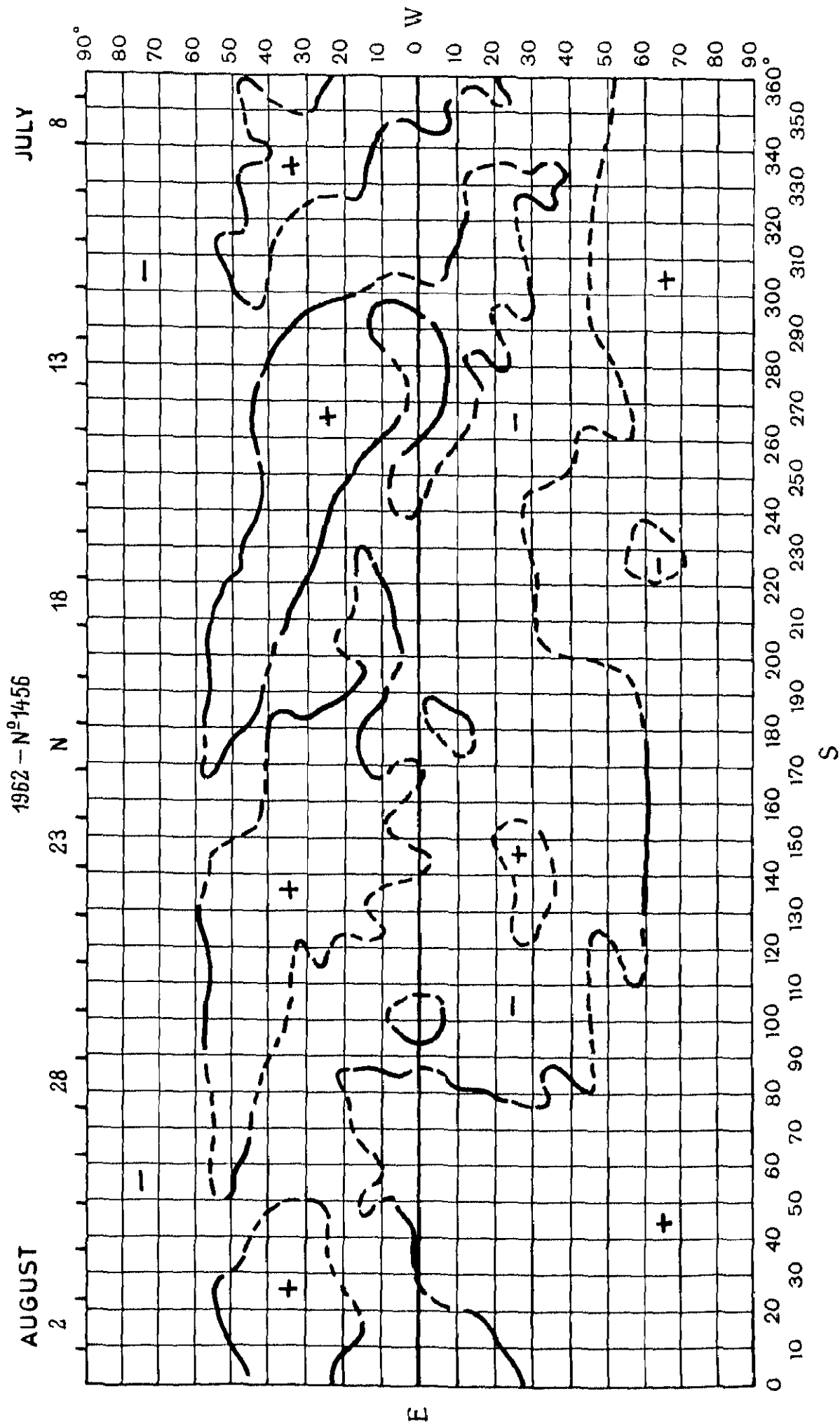
1962 - N^o 1454

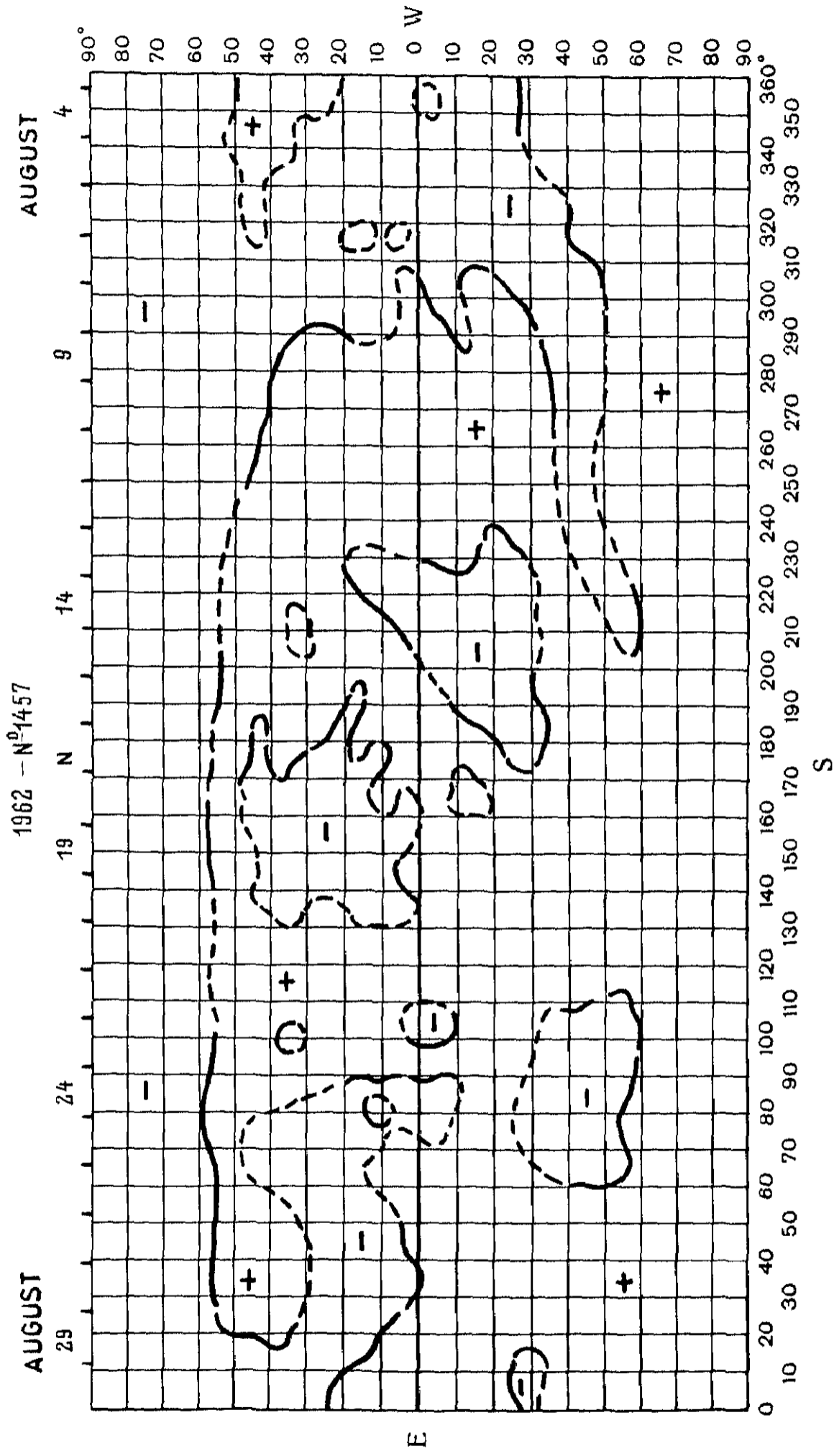
JUNE

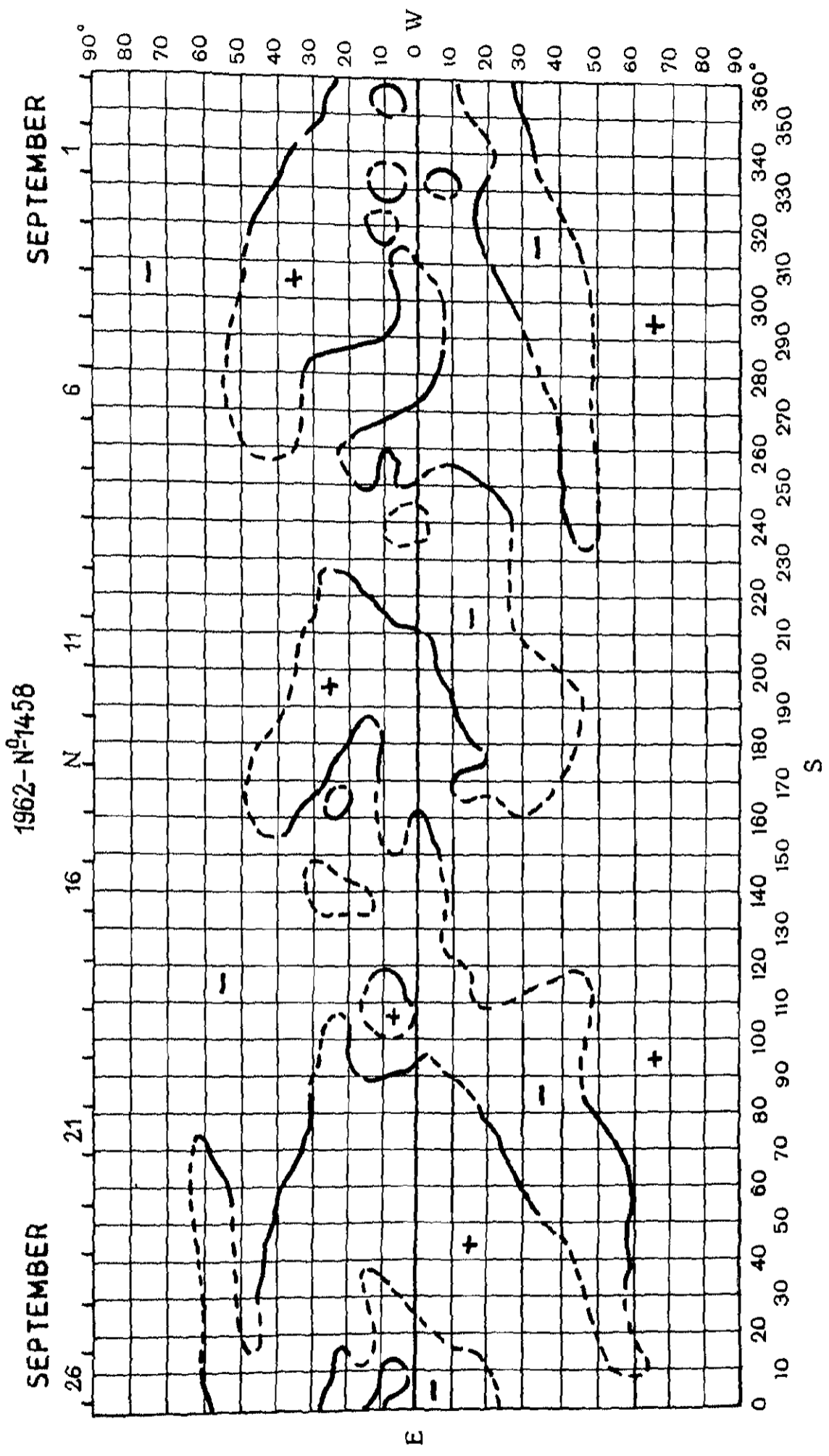
MAY

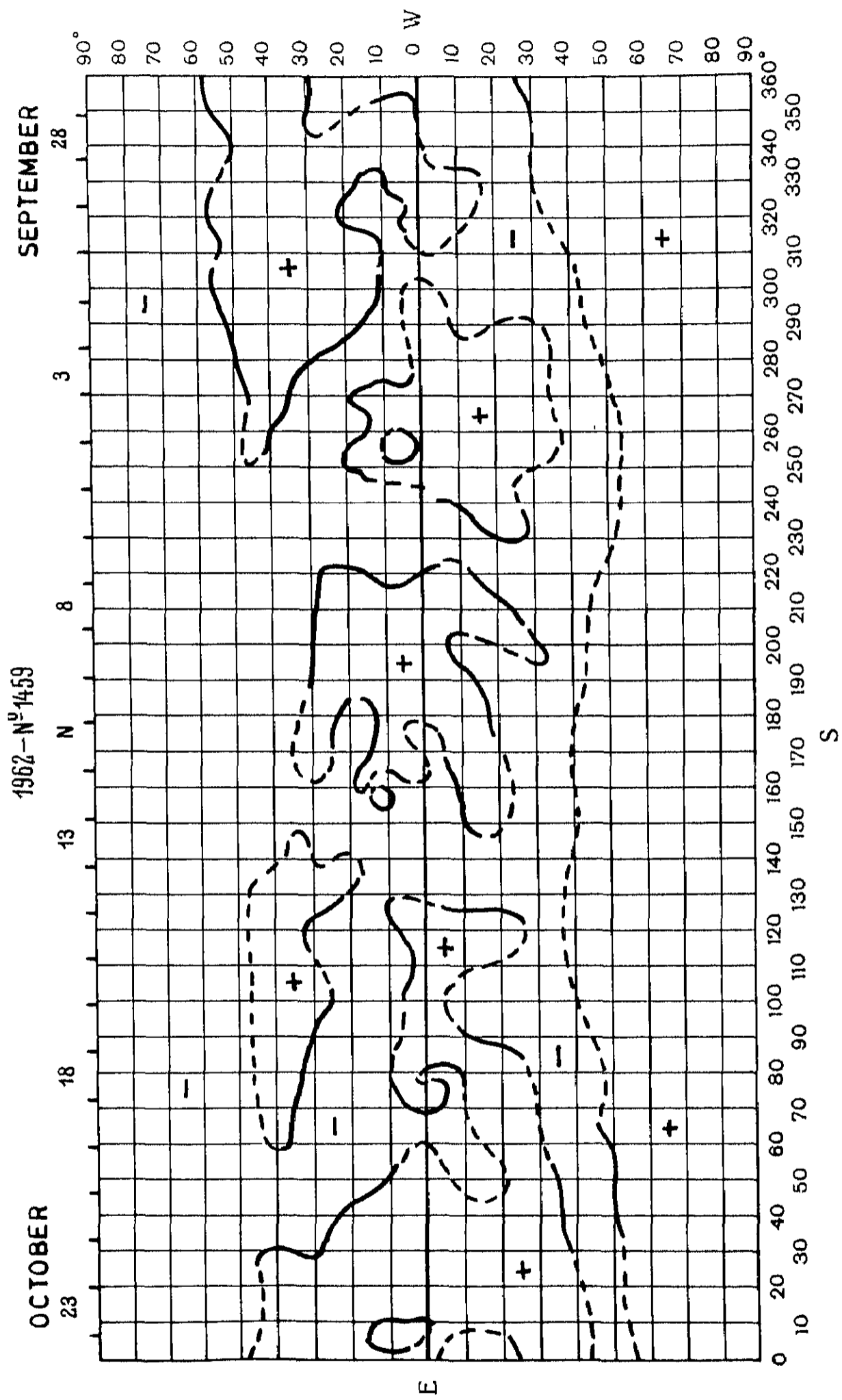


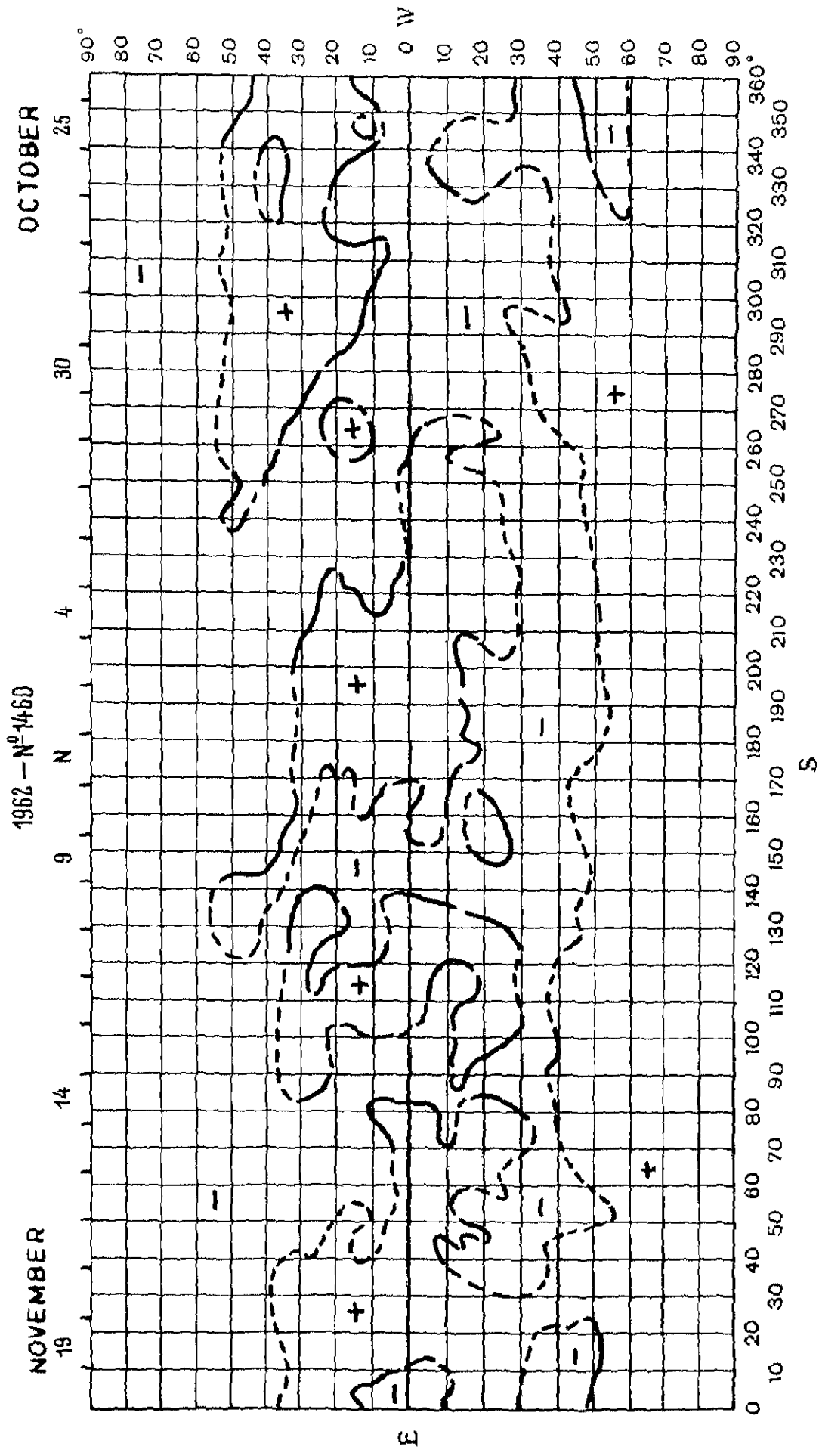


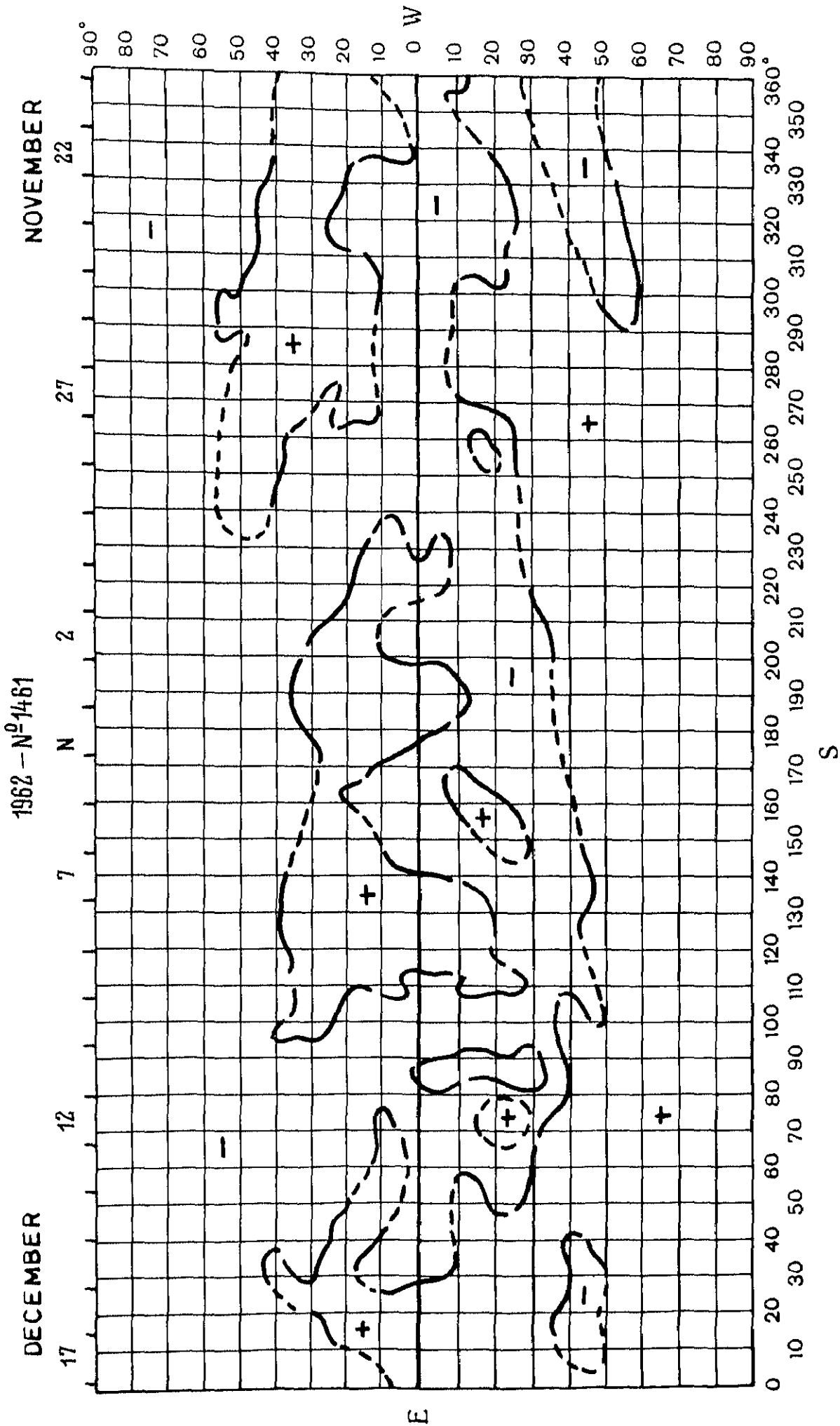


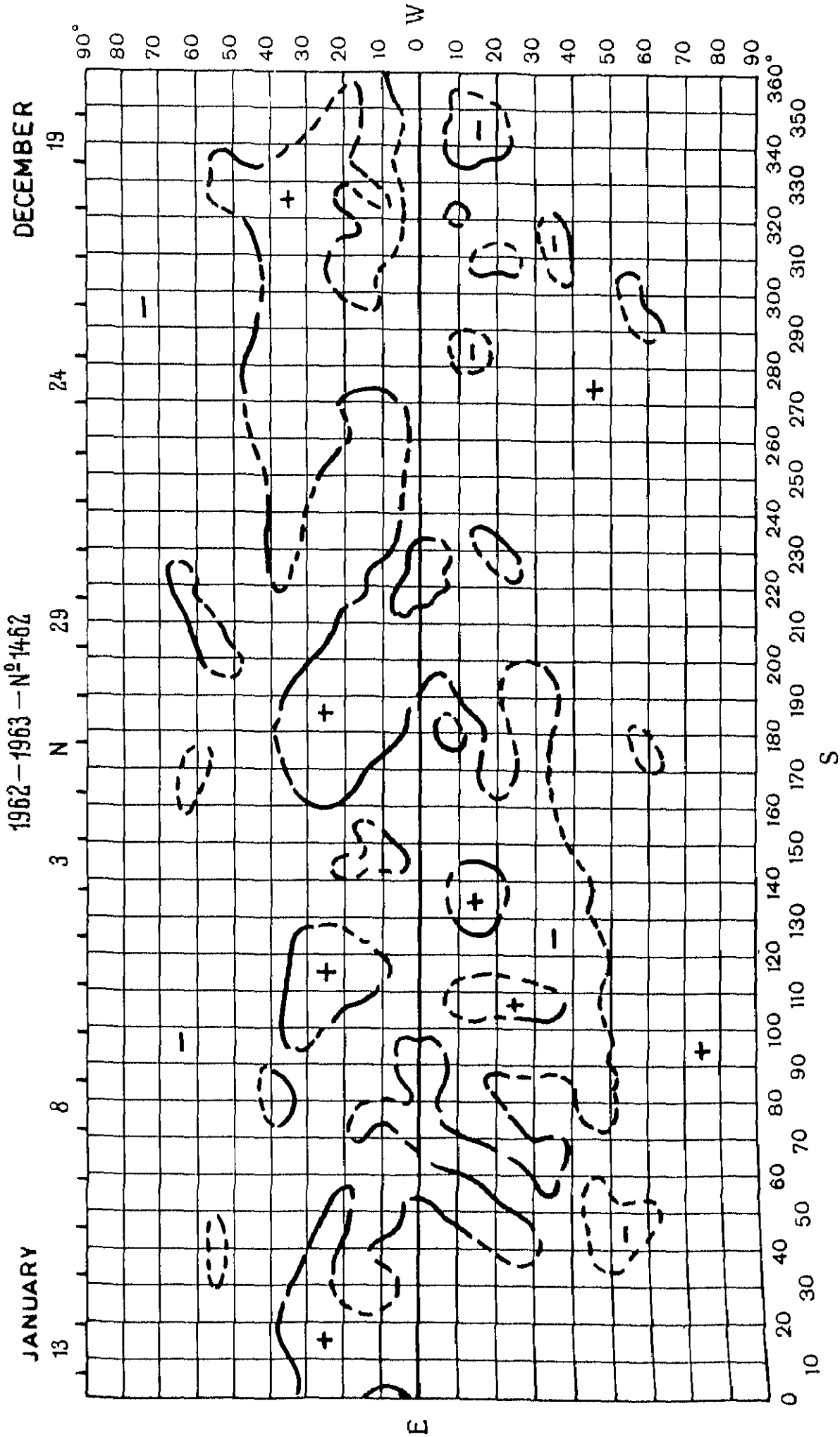


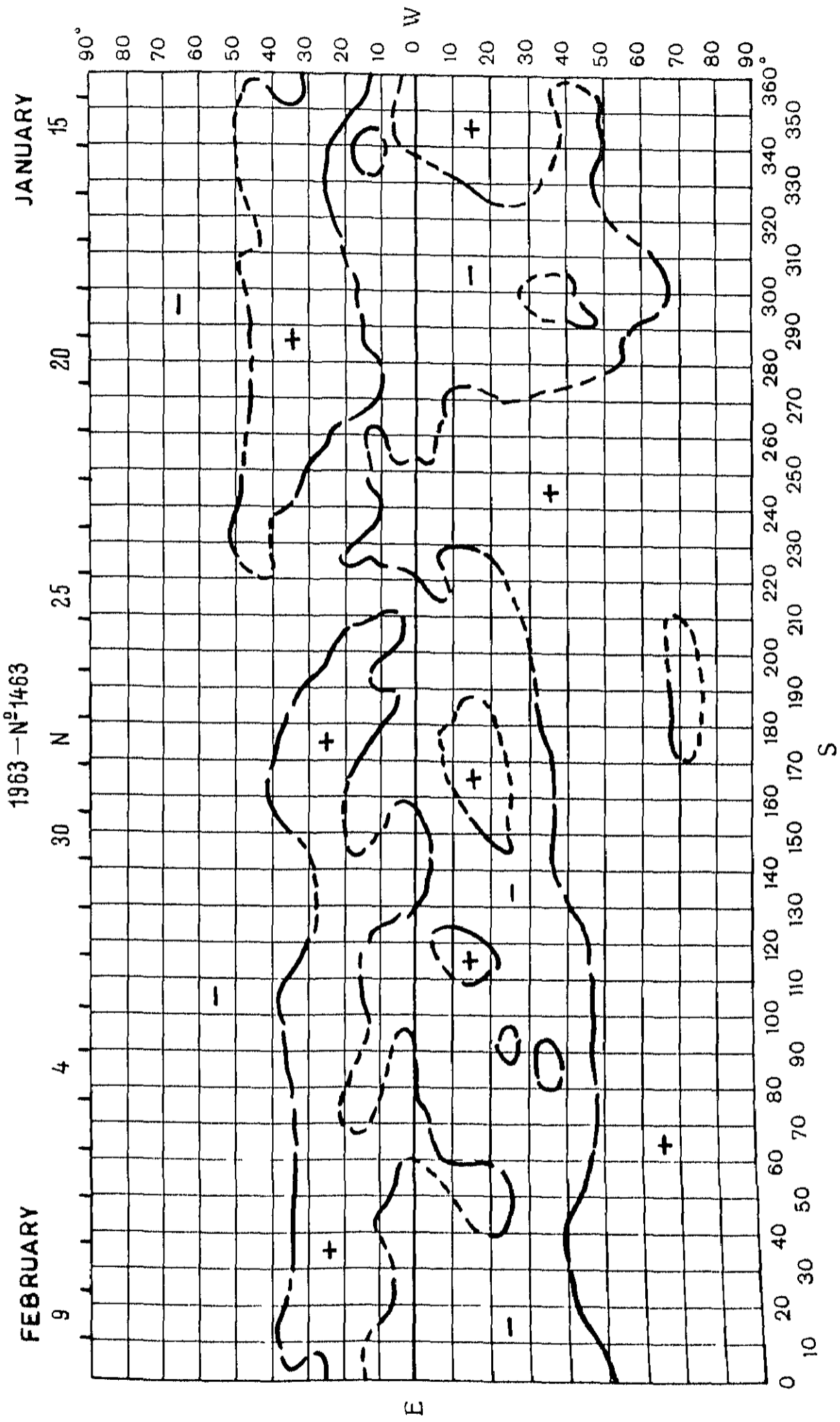


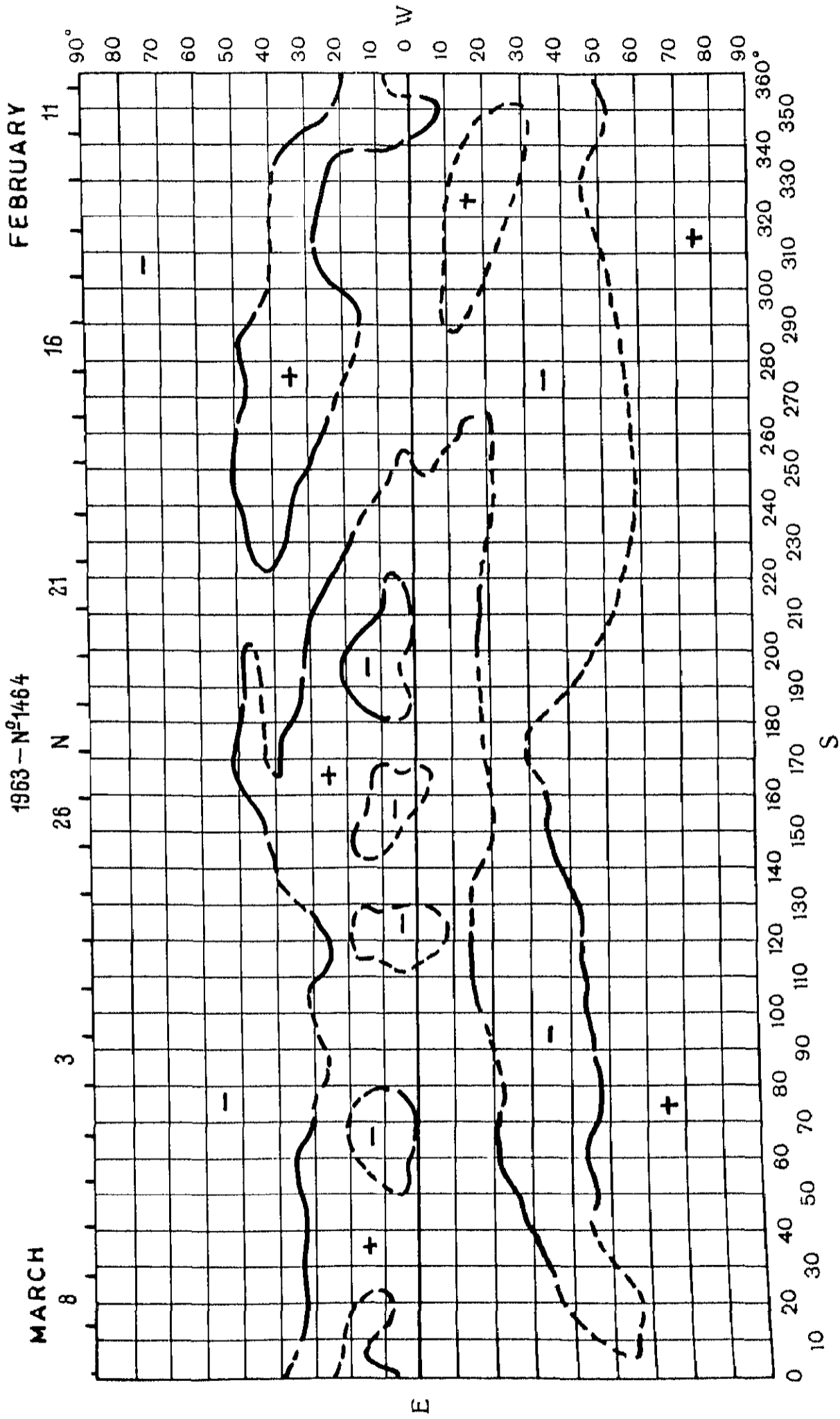


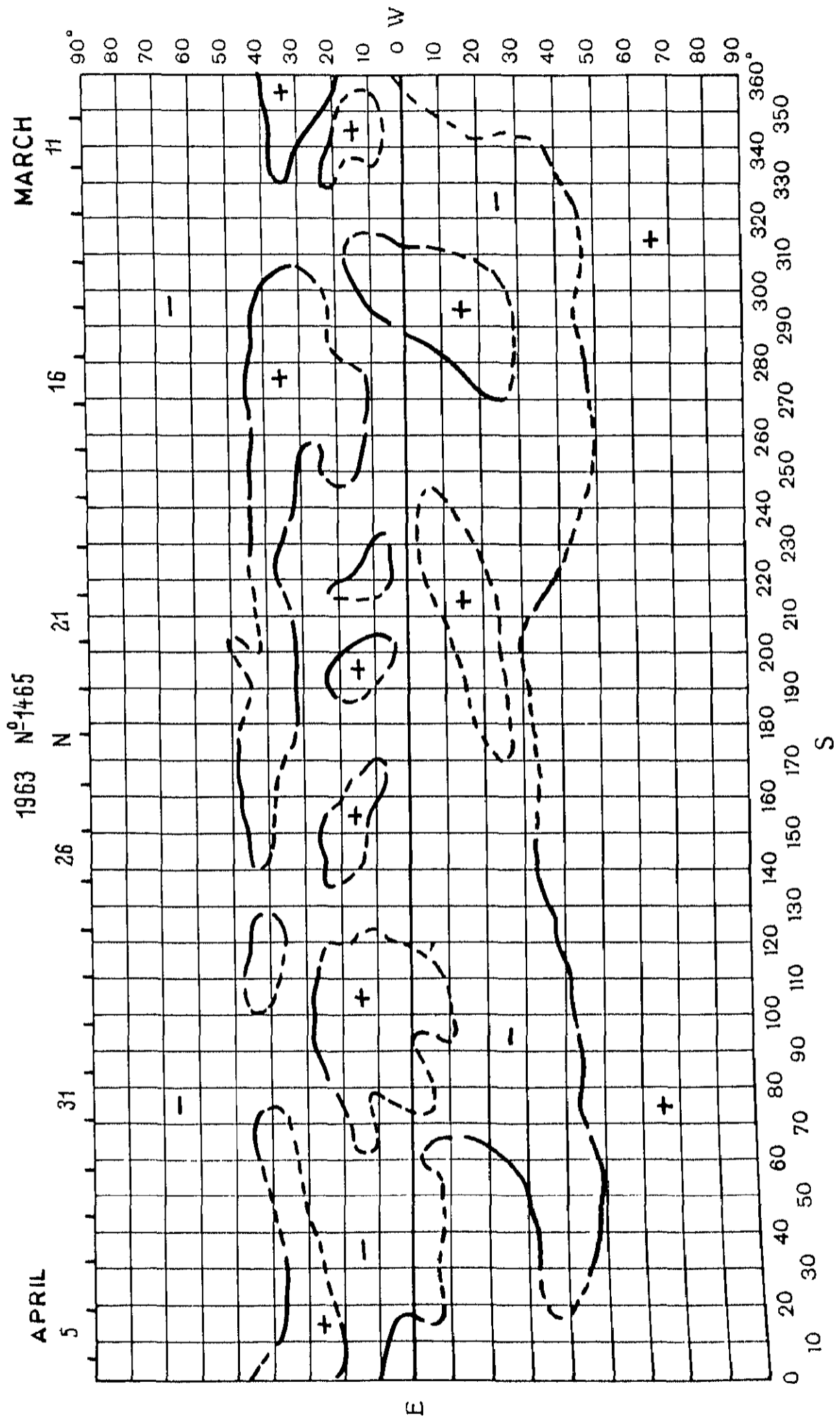


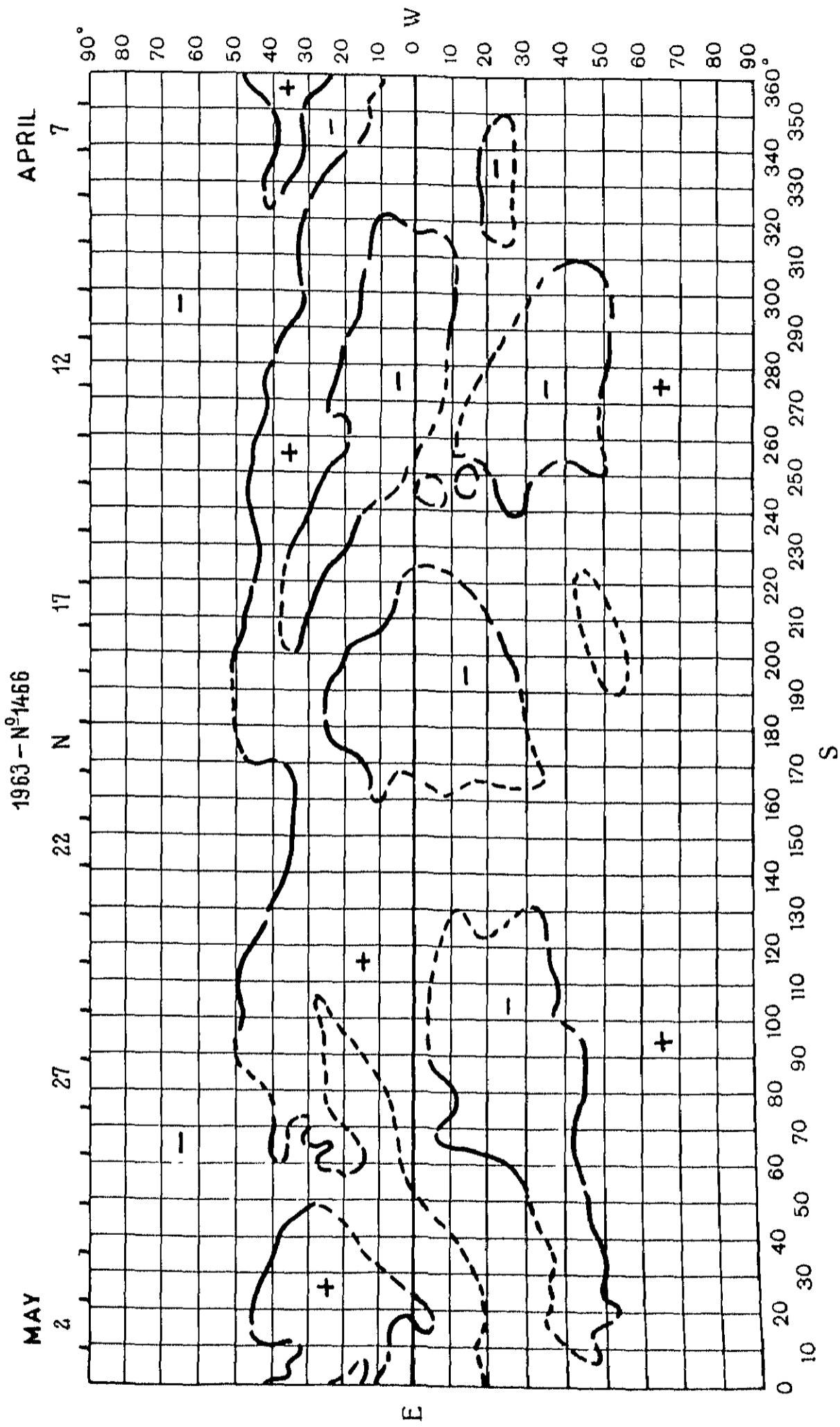


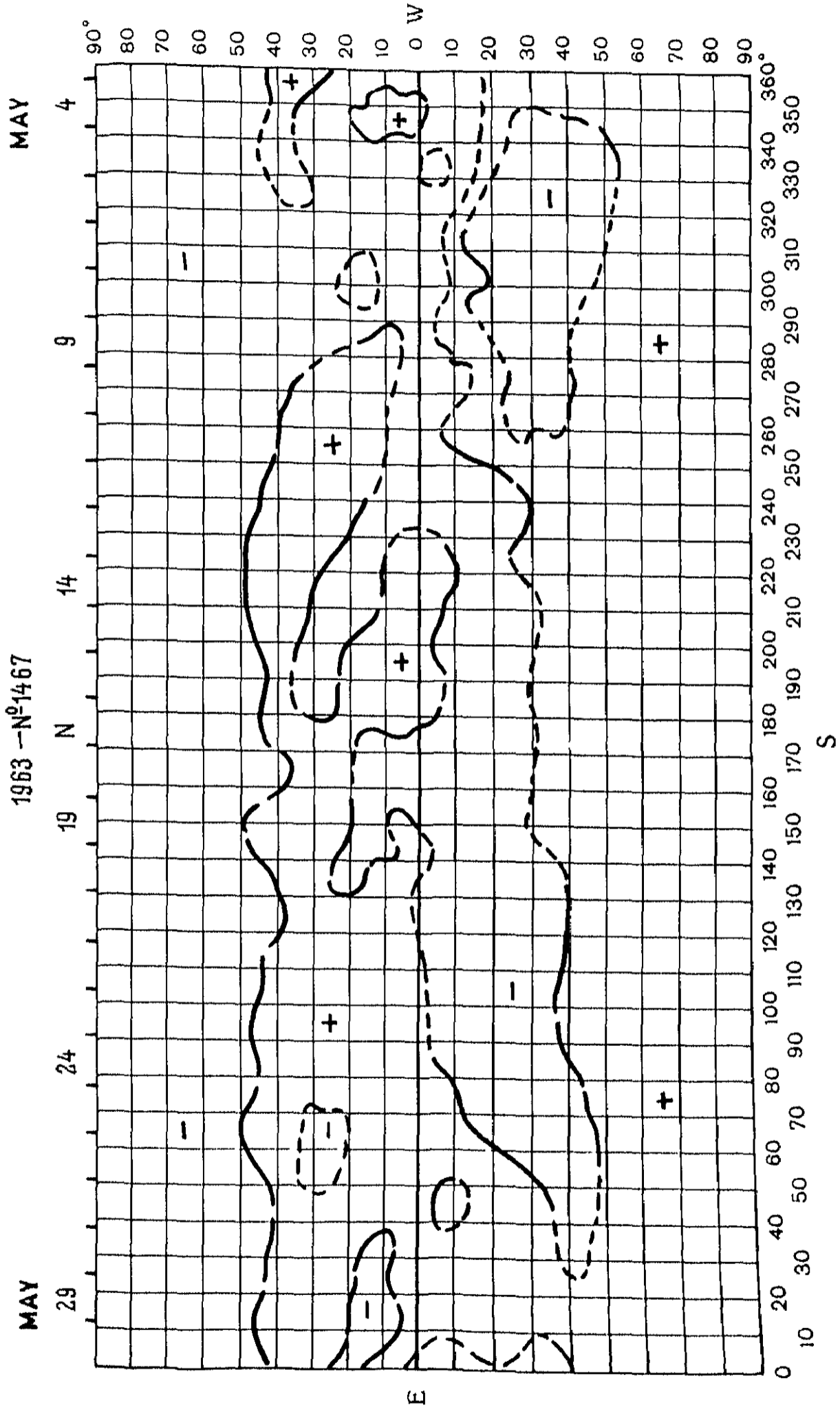


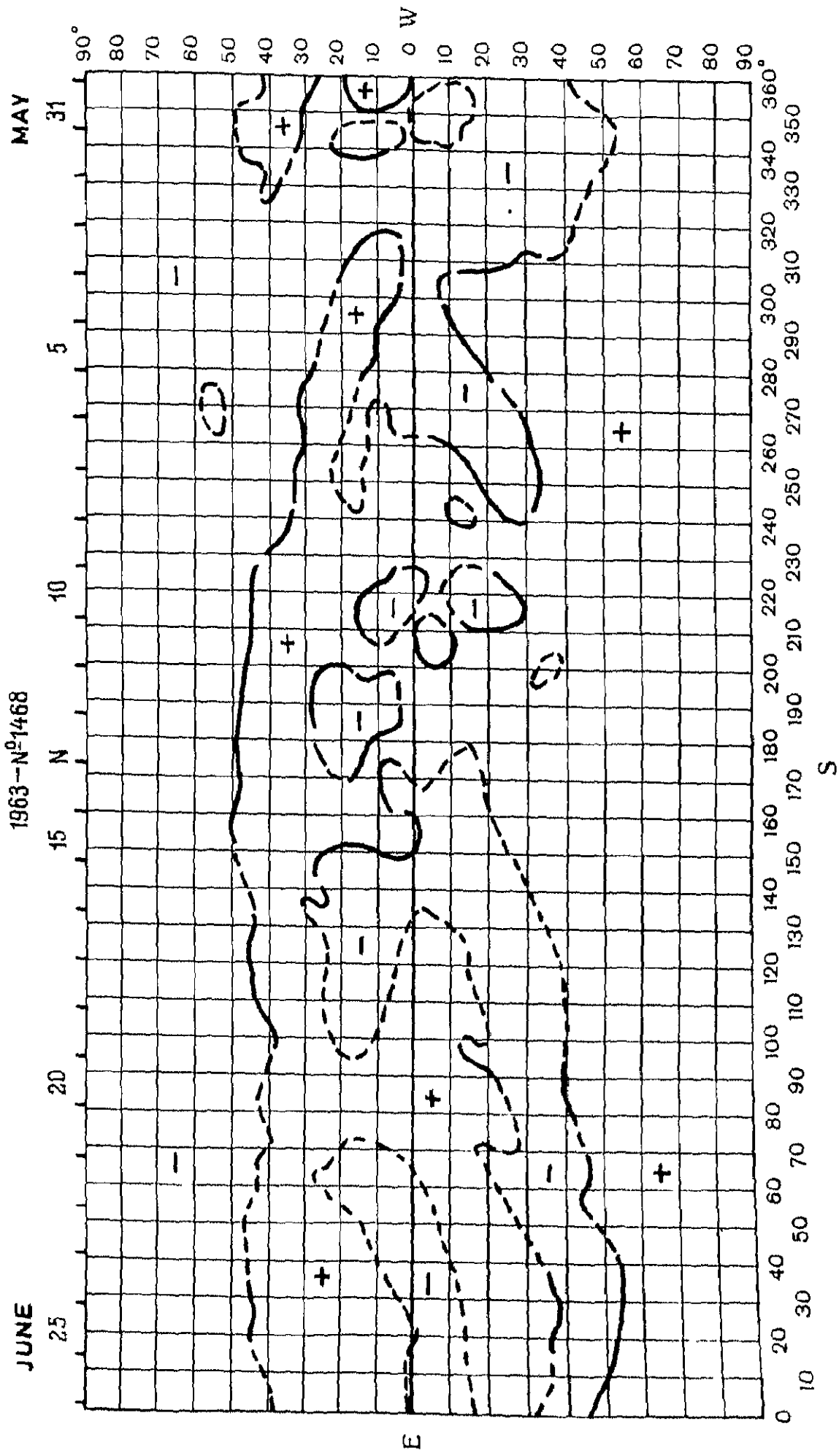


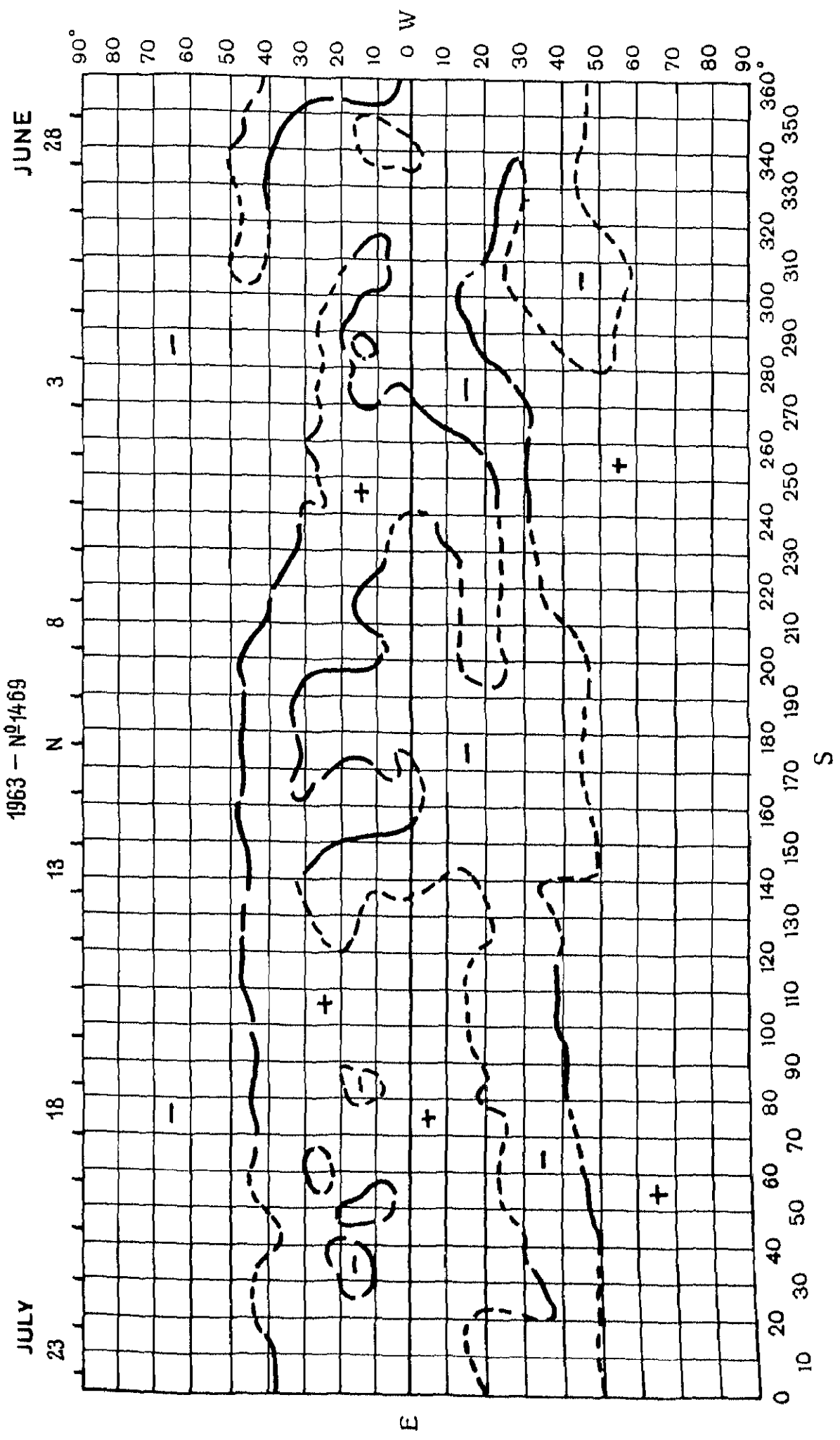


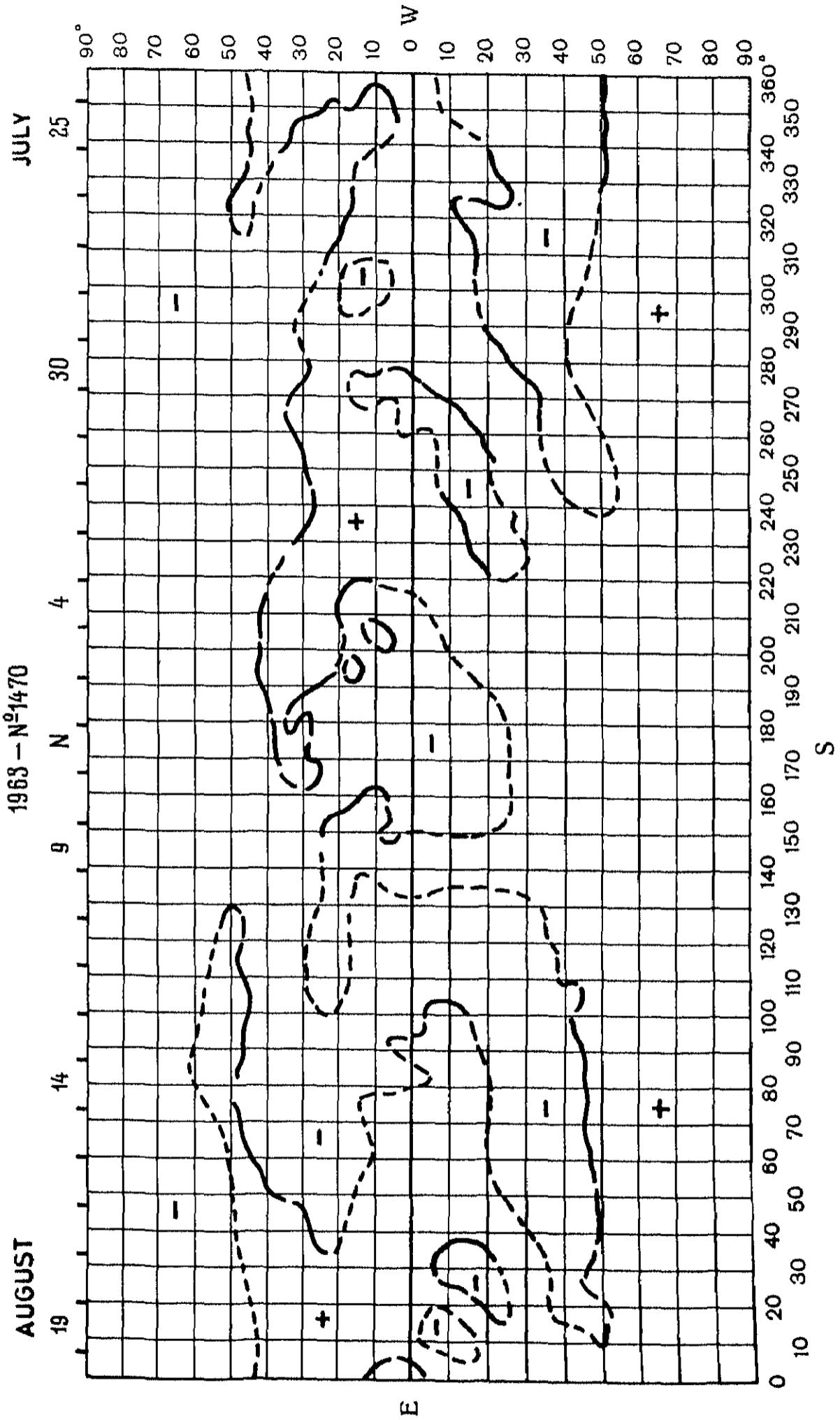


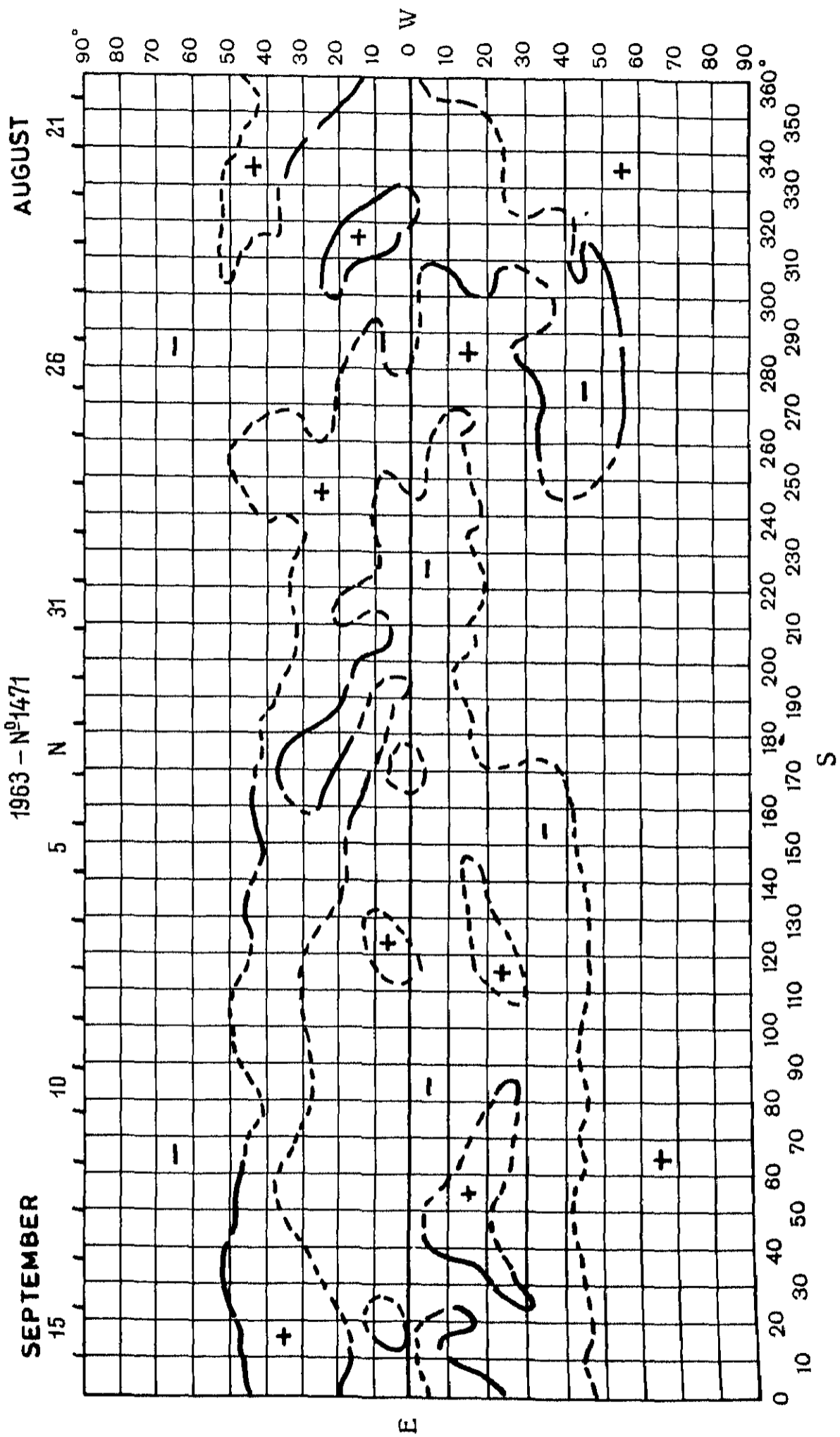


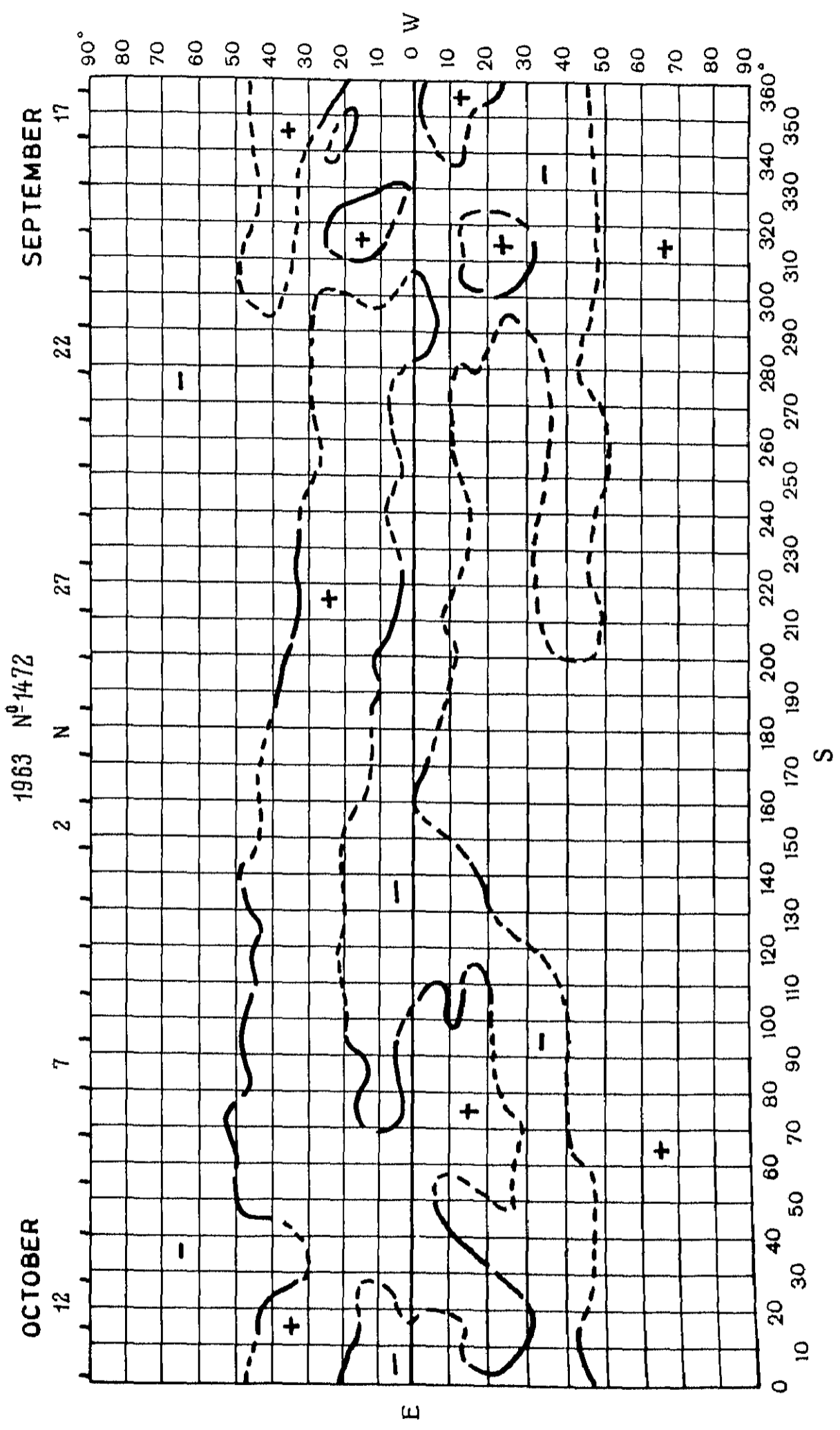


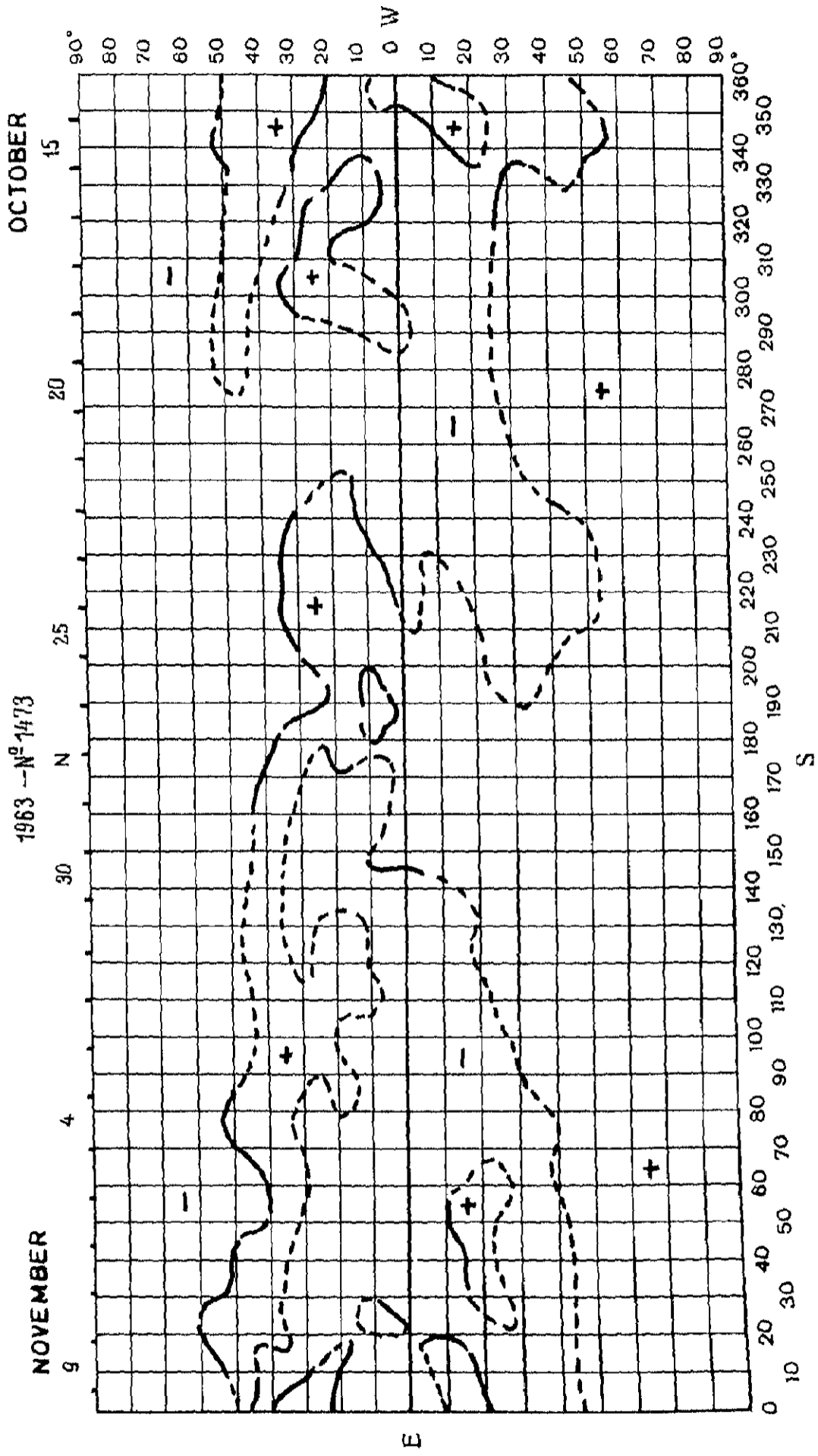


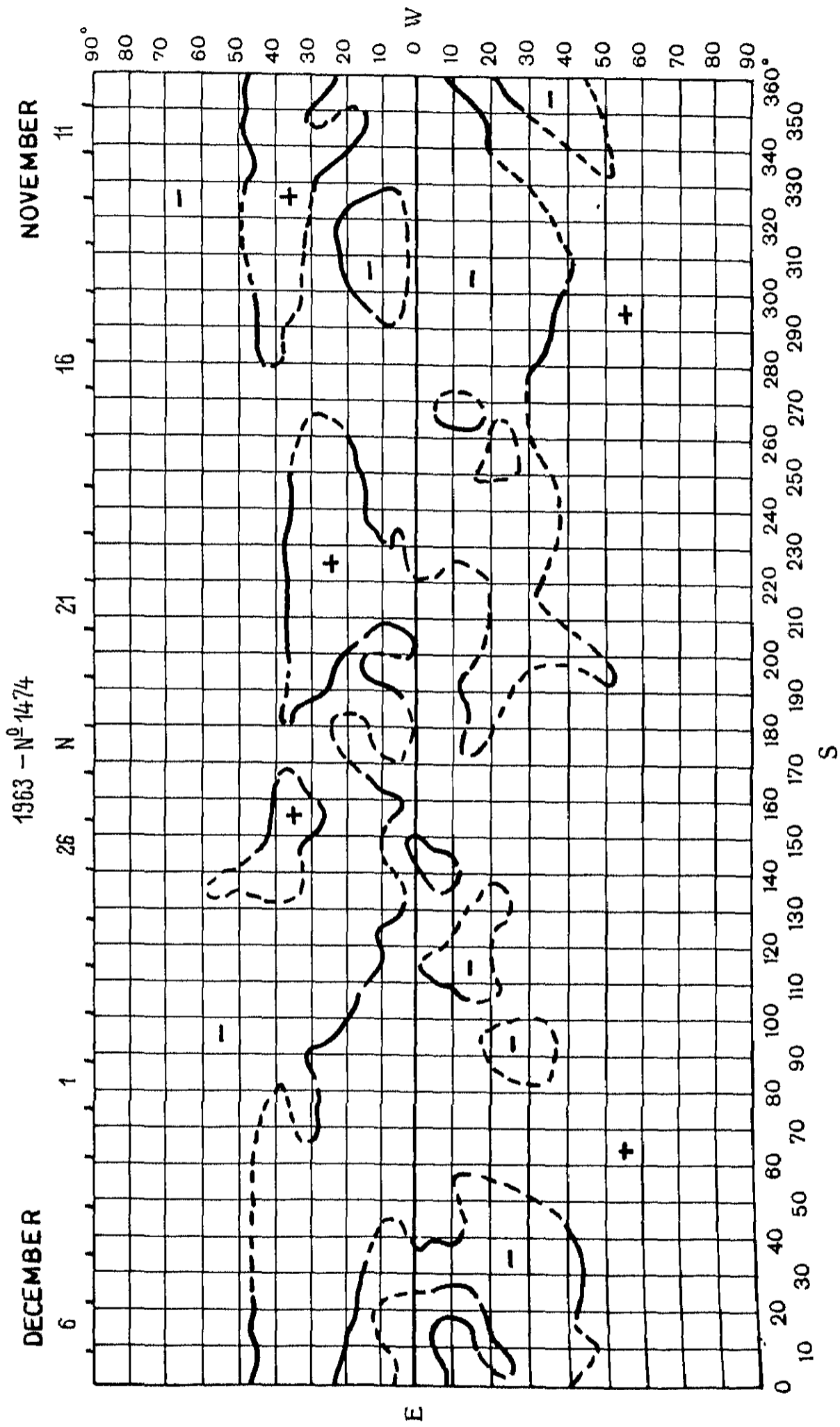


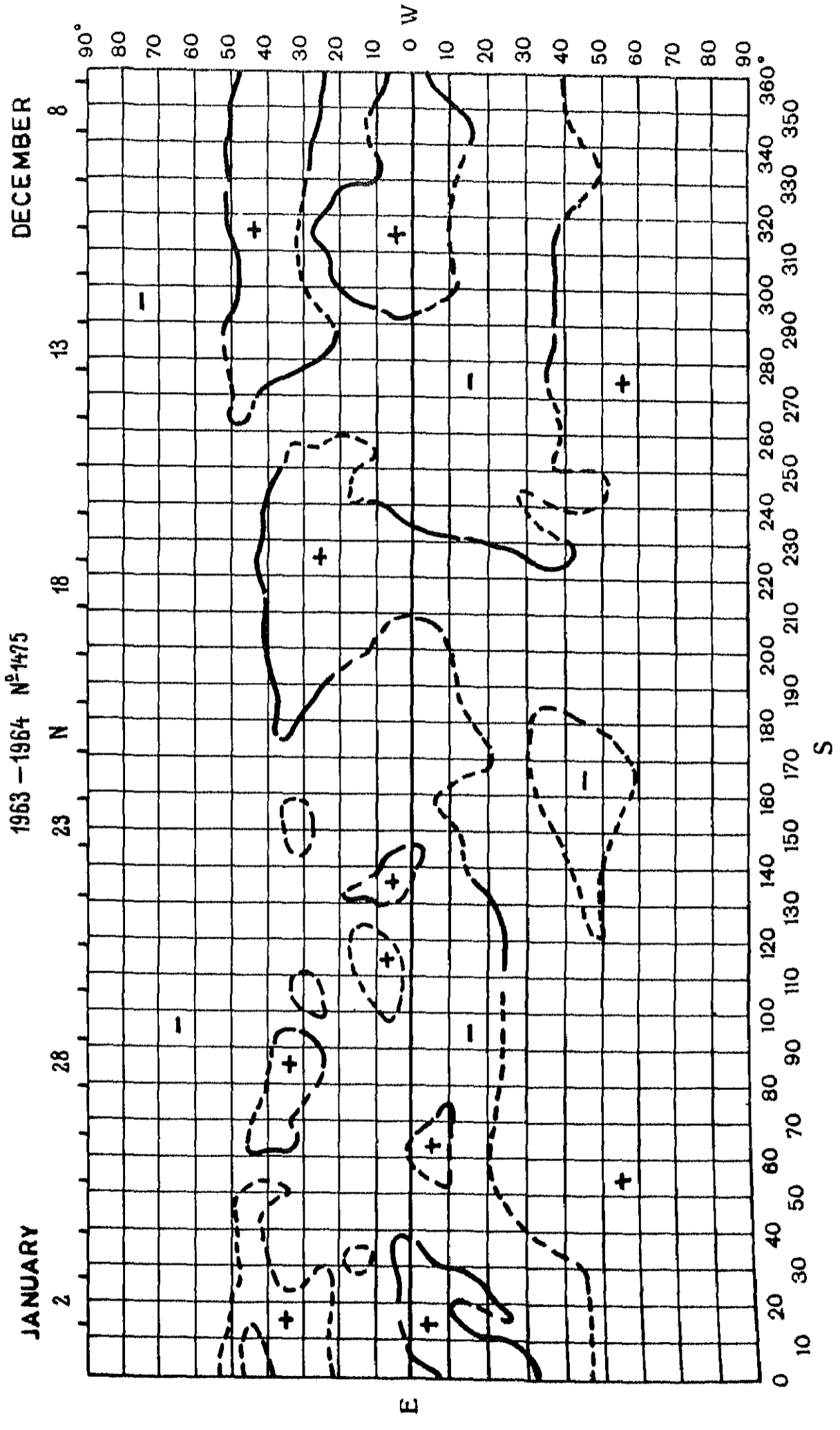


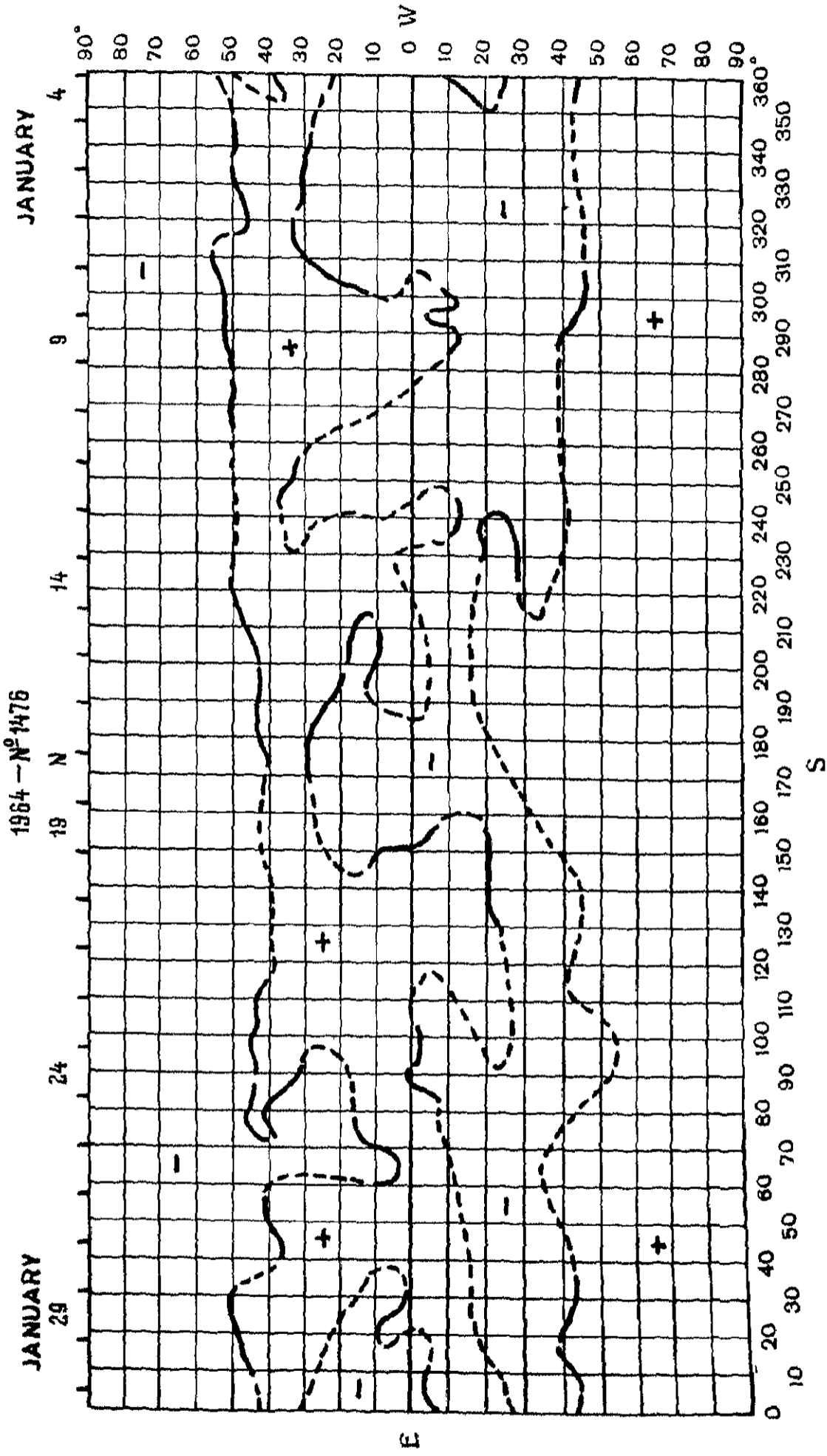


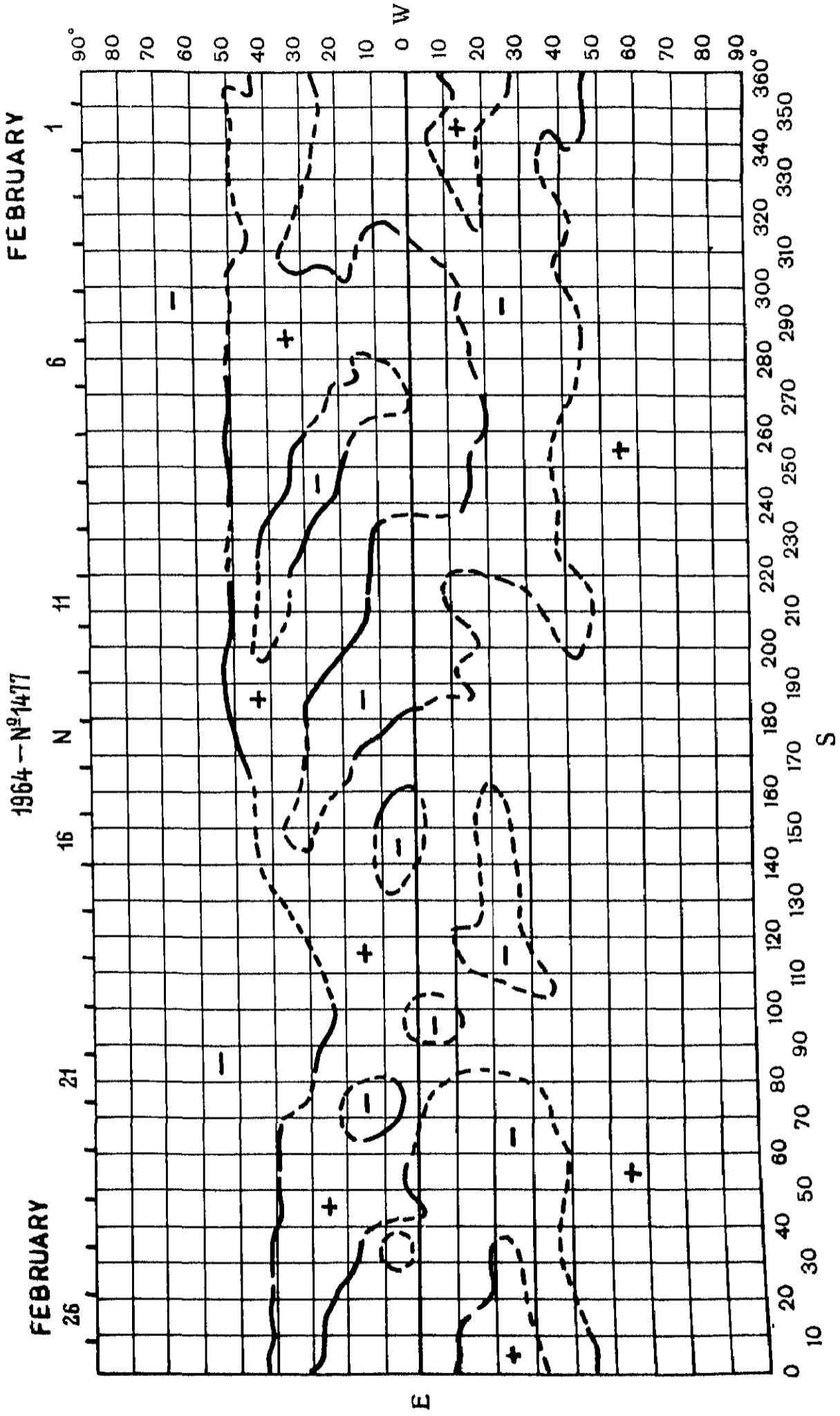


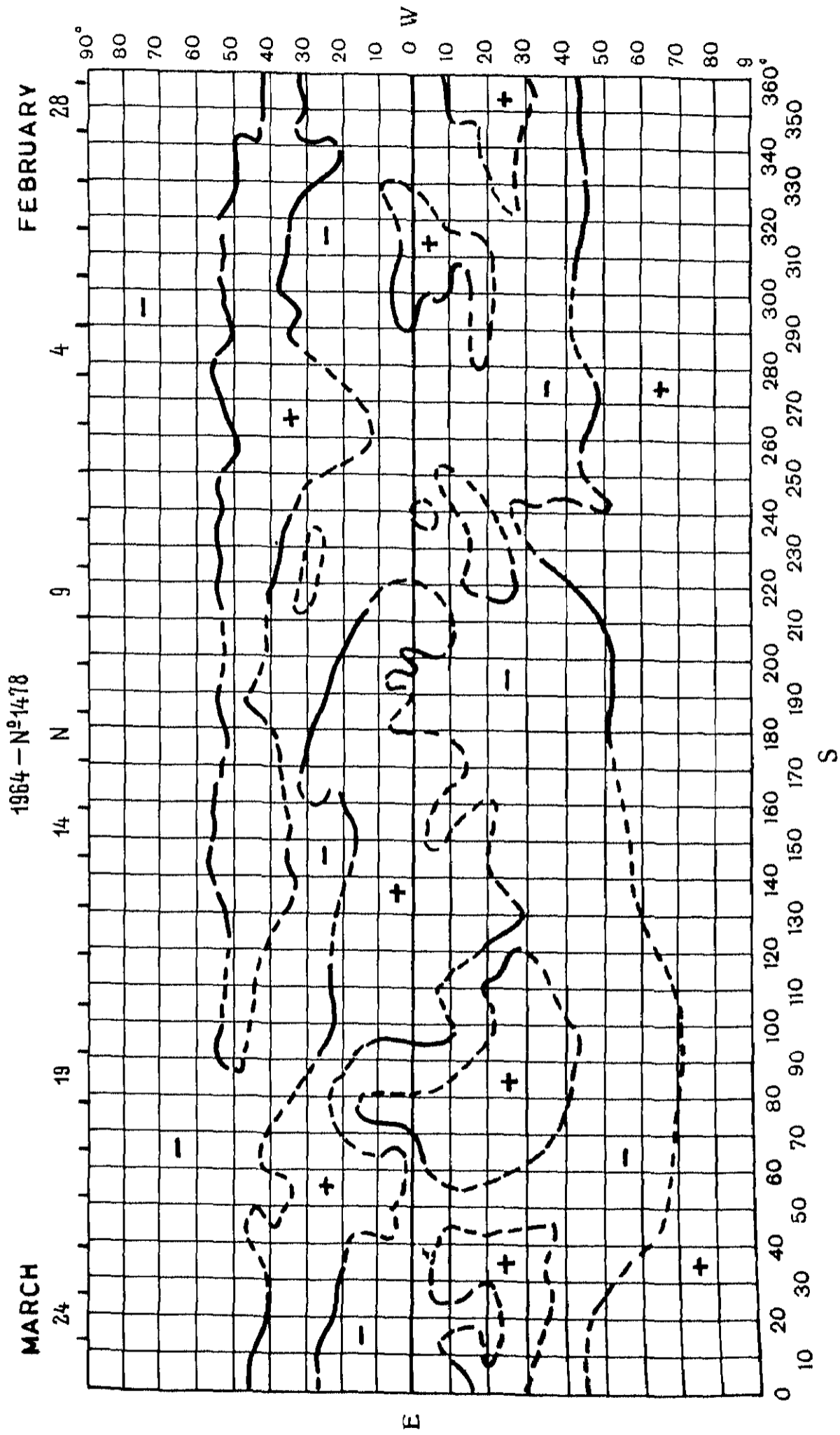


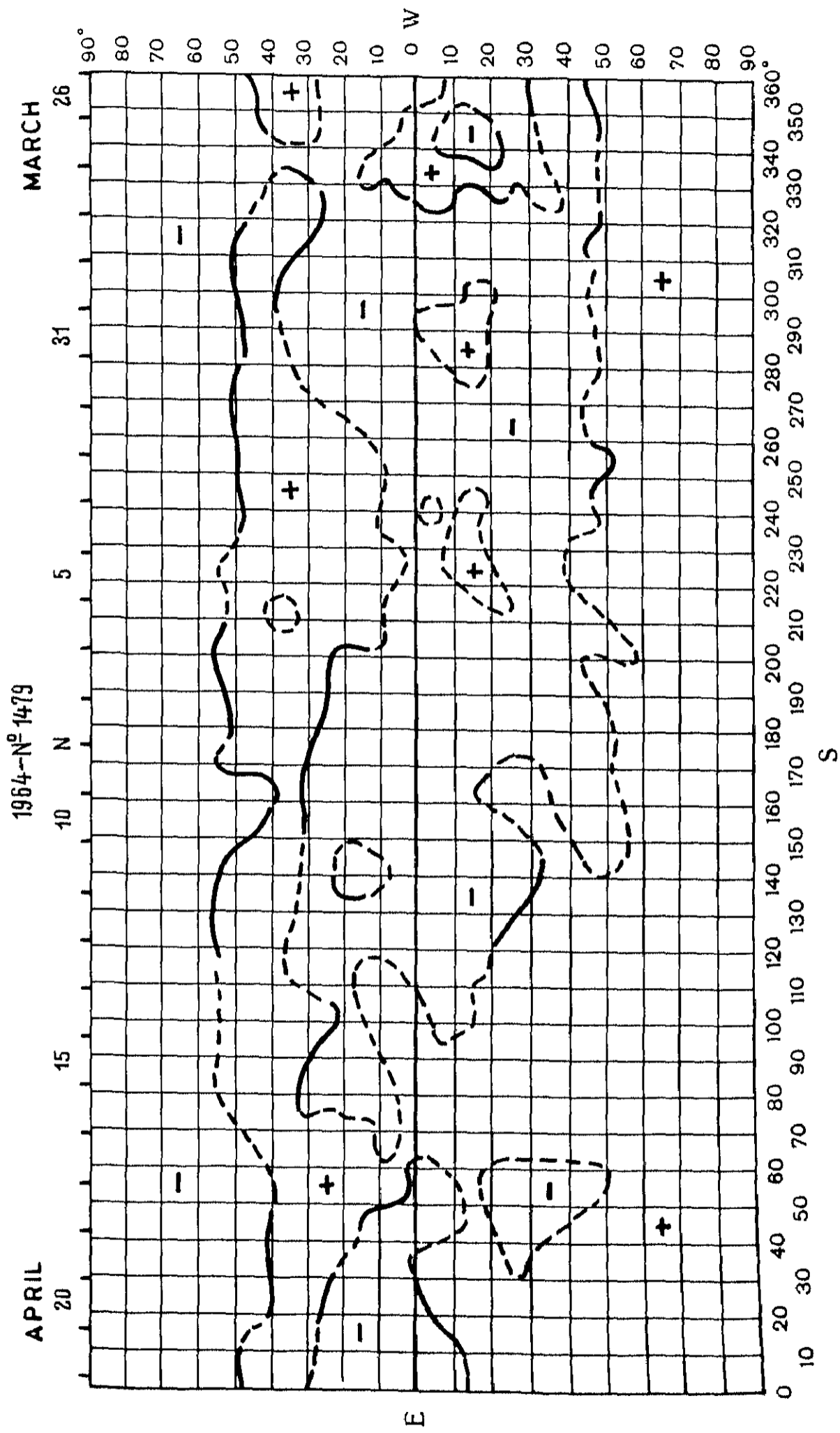


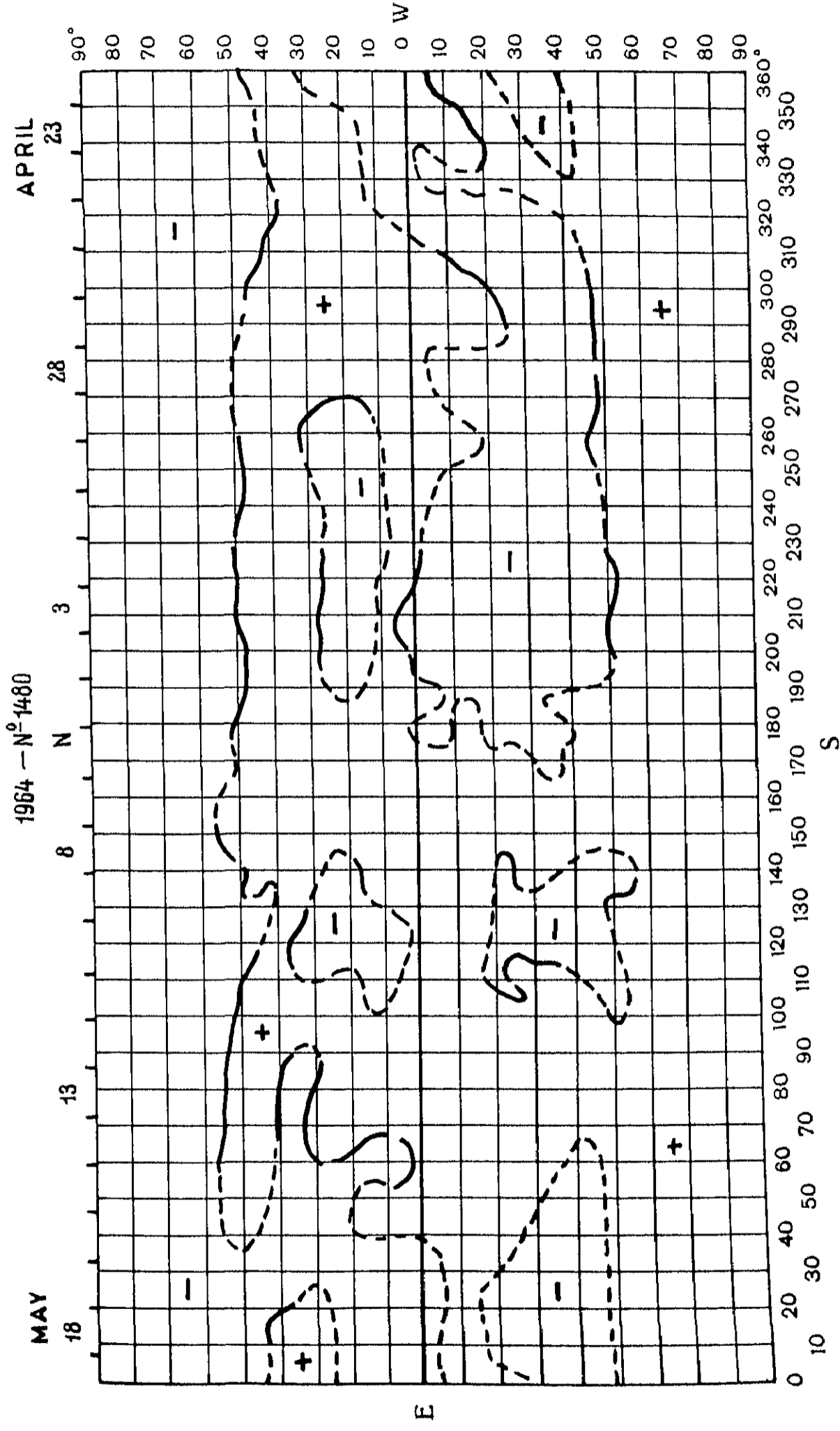


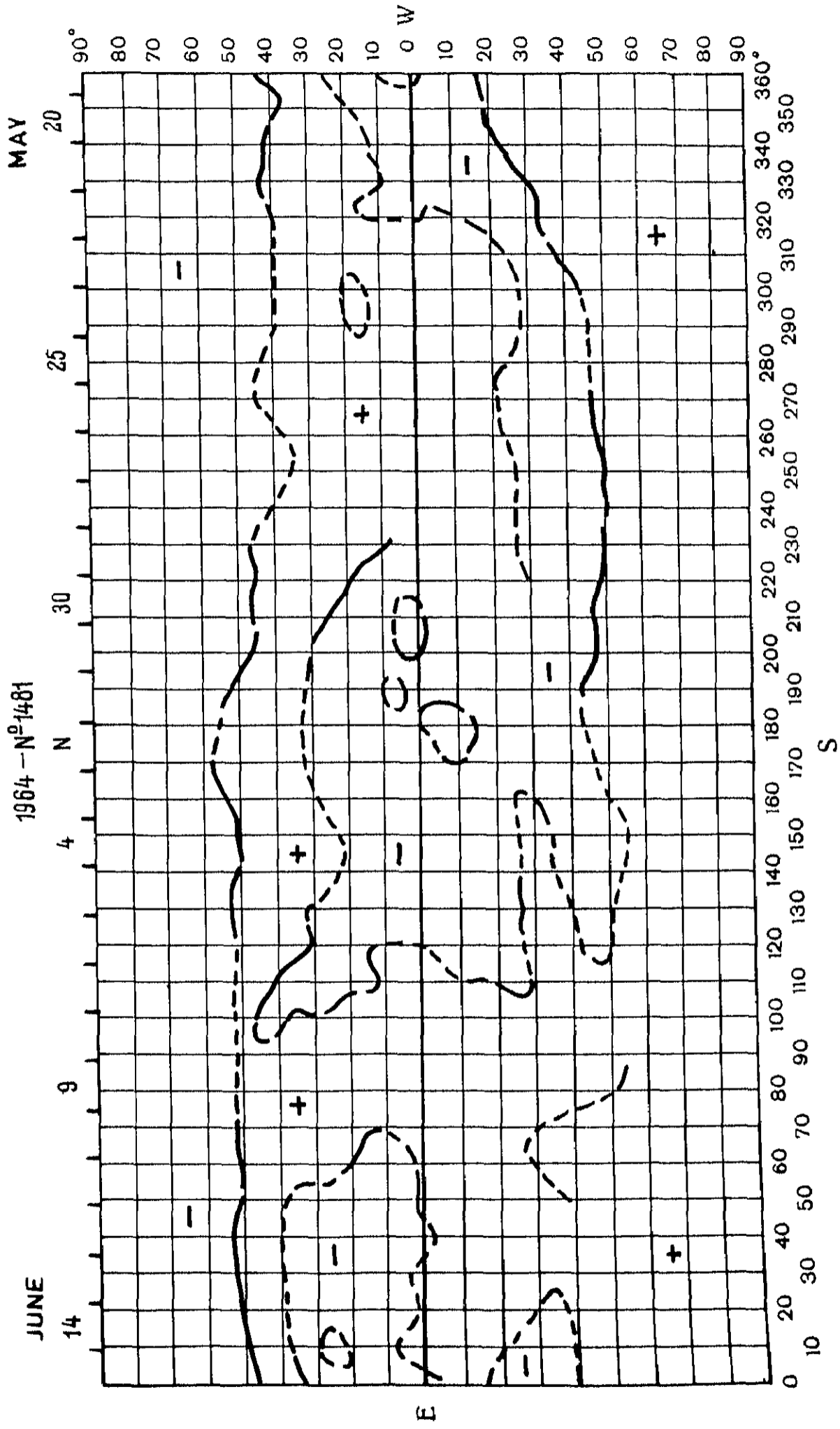


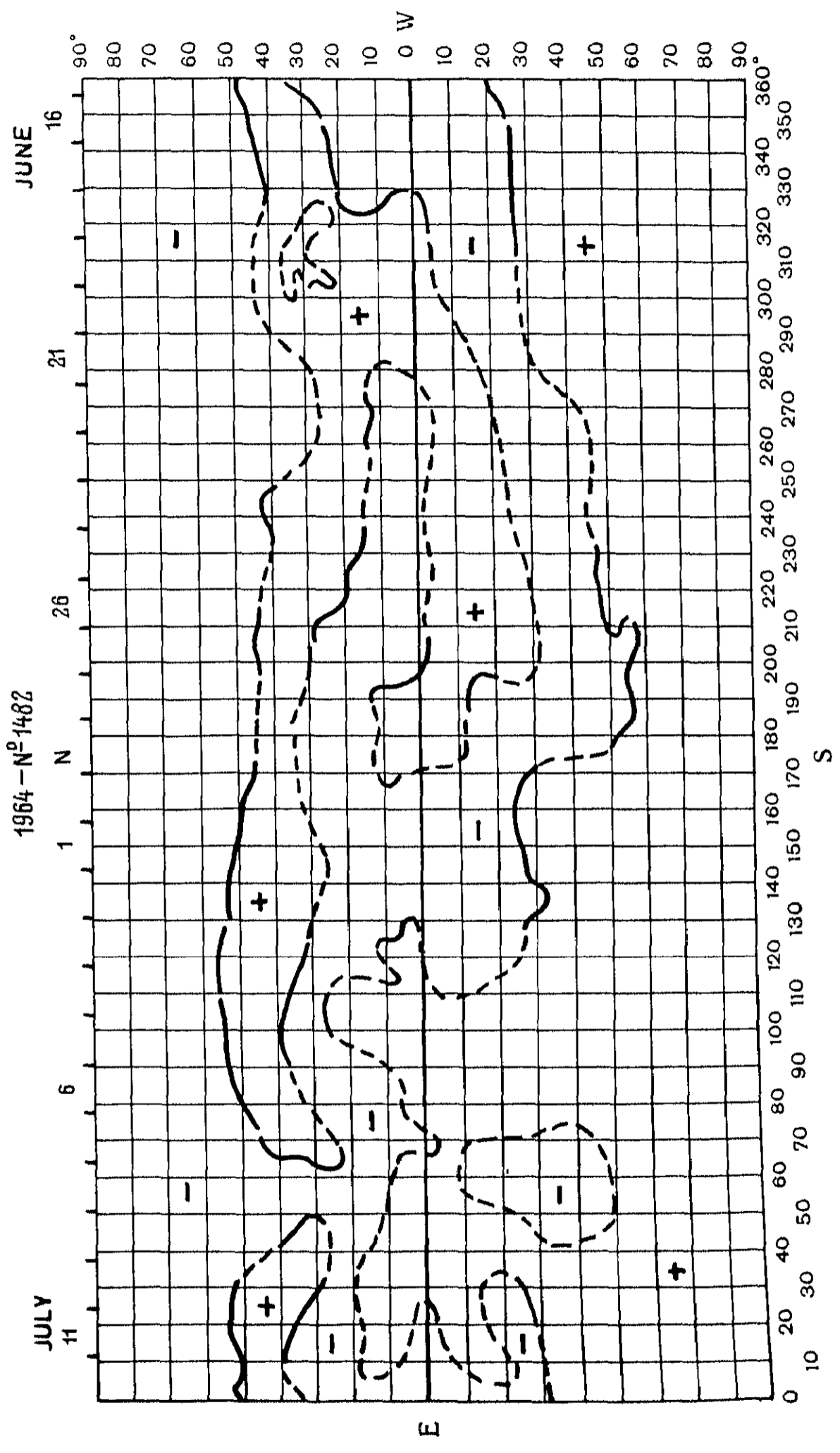


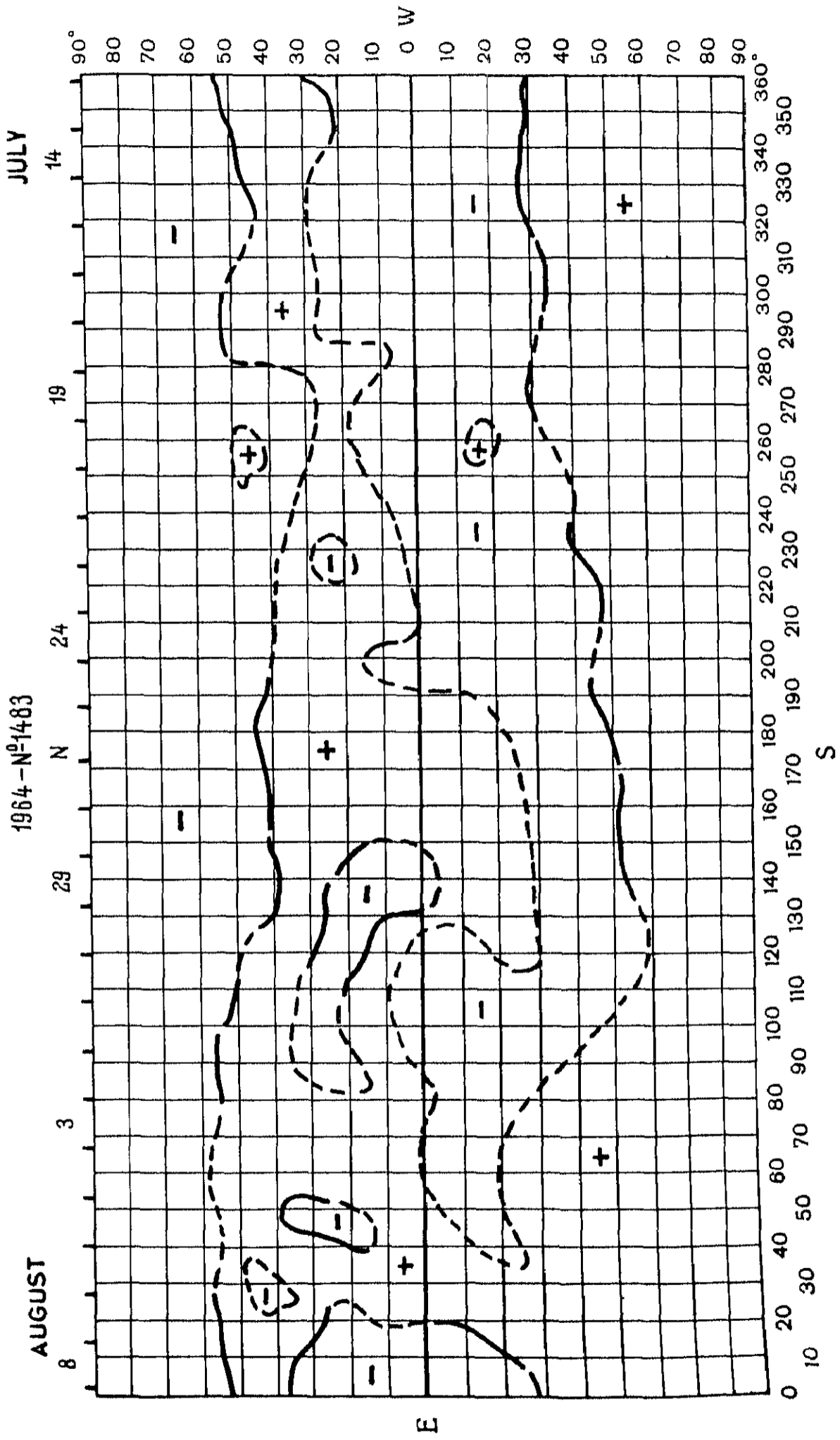


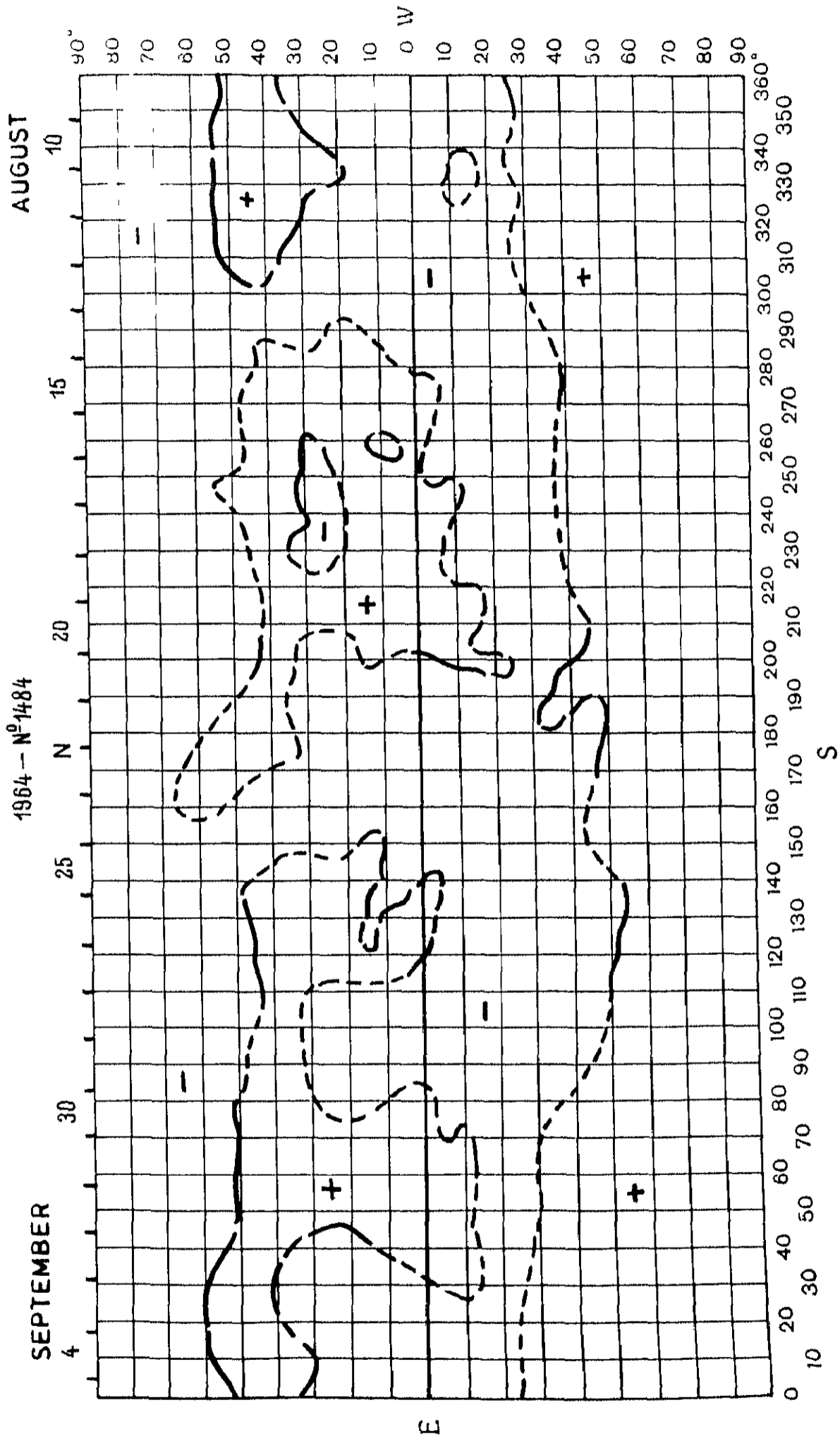


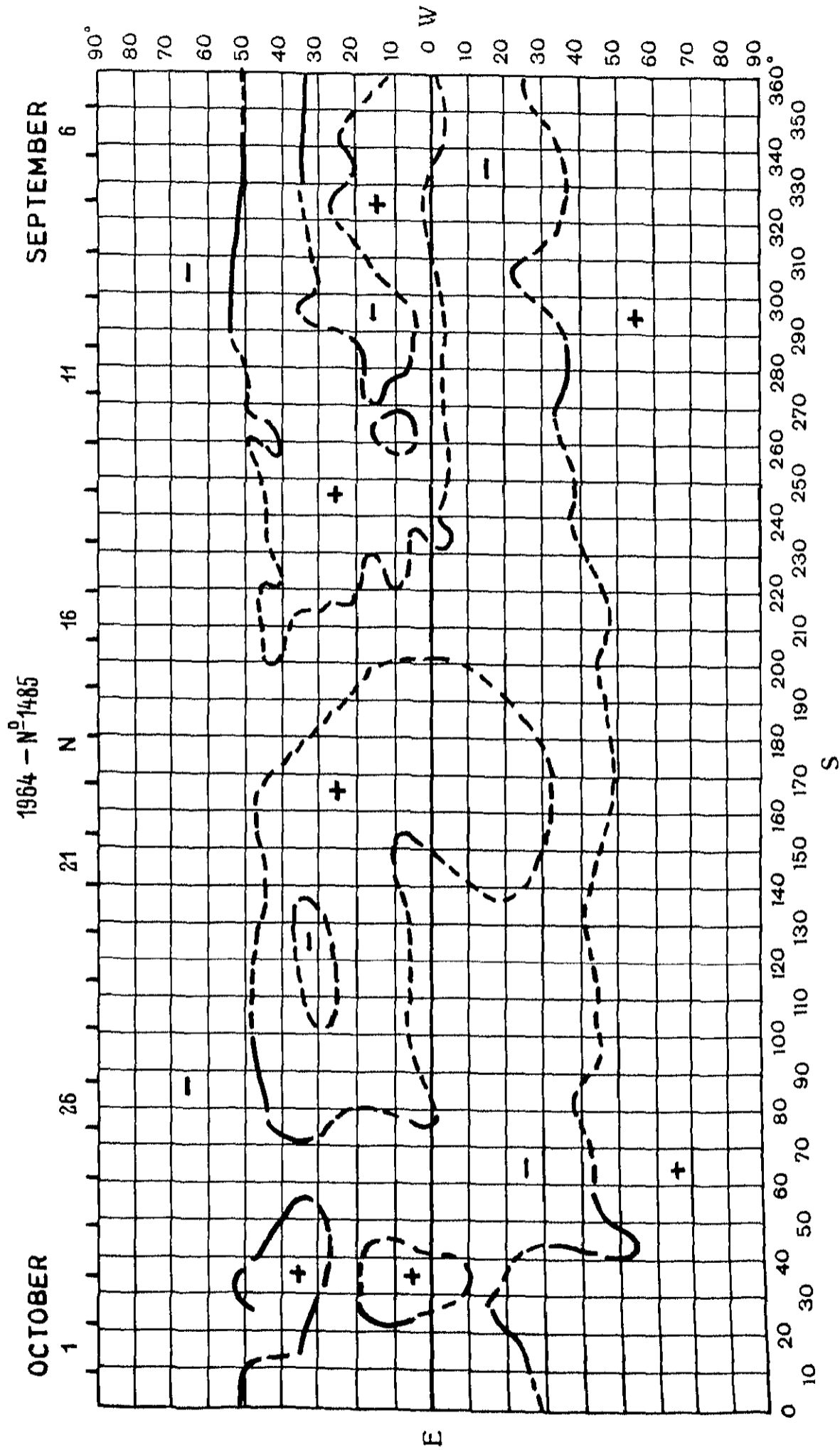












1964 - N° 1486

