A contribution to the wind conditions over the Caribbean Sea and Gulf of Mexico

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ABSTRACT

The wind conditions over the Central American Seas are discussed on the basis of 9-year mean charts for selected pressure levels and meridional cross-sections along 80° W. The field of large-scale vertical motion is computed for all months of one year. Over the Caribbean Sea, a vigorous downward motion is found during the second part of the winter half-year, which is fed by convergence in the upper-tropospheric southwesterly current. During the greater part of the year, however, upward motion prevails, with a weak tendency to subsidence in midsummer. Over the Gulf of Mexico, subsidence is indicated during great part of the year, changing to ascending motion in midsummer. Implications of the vertical circulation for certain climatic characteristics in the region of the Central American Seas are discussed.

1. Introduction

Characteristic of the Central American Seas is their situation on the western flanks of a subtropical high pressure cell. Position, strength, and three-dimensional structure of the western tip of the North Atlantic Anticyclone display a marked seasonal march, thus governing the atmospheric circulation over the Caribbean Sea and the Gulf of Mexico.

General circulation and atmospheric energetics in the area of the Central American Seas were the object of an extensive study (Hastenrath, 1966), based essentially on all available radiosonde ascents of 1960. Aerological data for longer periods of time are unfortunately scarce. It appeared desirable to supplement and corroborate the detailed analysis of the 1960 material on a climatic time scale. With this objective, the available upper air observations covering several years (USWB, 1957–66, *a*, *b*; Crutcher, 1961) were evaluated. The pertinent result are presented in this paper.

2. Seasonal characteristics of the pressure pattern

Pressure distribution and flow situation display a winter pattern from about November through April, contrasting with a summer type circulation from about May through October. There is of course a certain transition period from the winter to the summer type circulation and the conditions within each half-year are far from uniform. Always two months with a similar circulation pattern were combined in the charts (Figs. 1 and 2), thus giving three sets of charts for both the winter and the summer half-years. With the exception of a few stations with a shorter period of observation, the charts are based on the 9-year period 1957–65. 850, 500, and 200 mb were chosen as representative pressure levels. O'Connor (1961*b*) presented mean monthly maps (period 1947–58) of 700 mb and sea-level pressure for the Northern Hemisphere. O'Connor's monthly charts in general appear to tie in nicely with the analysis of pressure levels used in the present study. It will be recalled that the previous normal weather maps for the Northern Hemisphere (U.S. Weather Bureau, 1952) do not cover the lower latitudes.

Characteristic of the winter conditions is high surface pressure over the southern United States, decreasing steadily towards the northern coast of South America. The thermal structure of the continental high and the strong meridional temperature gradient throughout all layers imply a southward tilt of the high pressure axis (see Fig. 1). Thus the boundary between the belt of temperate latitude Westerlies and

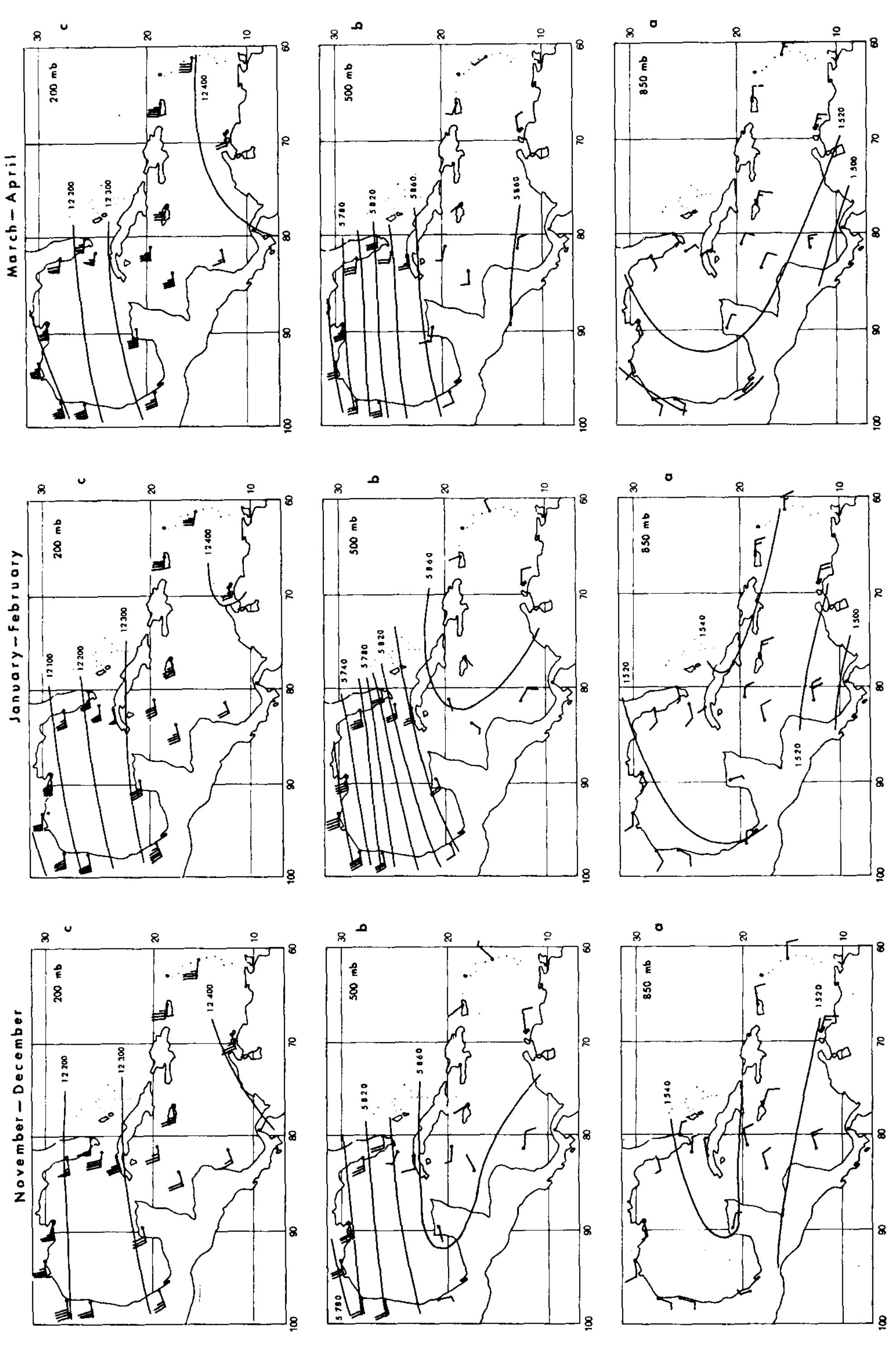

Fig. 1. Winter half-year; geopotential height (*m*) and resultant winds in constant pressure levels. Triangle means 25, long barb 5, and short barb 2.5 m/sec (period 1957–65). (*a*) 850 mb, (*b*) 500 mb, (*c*) 200 mb.

the tropical Easterlies, though increasing in elevation, reaches far down into the deep tropics. The westerly jet stream around 200 mb is displaced far southward over the Gulf States. Westerlies in the upper tropopshere reach as far south as northern South America during most of the winter. Only in very low latitudes they may be topped again by Easterlies, in the substratosphere. The trade winds in the lower troposphere have their core in a relatively narrow band over the southern Caribbean Sea.

The pressure and flow pattern for the 1957–65 period is in good agreement with the previous analysis of the year 1960. The winter circulation pattern is best developed in January and February (cf. Fig. 1). A characteristic of the development from late fall towards the end of the winter season is a southward shift of the high pressure axis. Associated with the continued cooling of the North American Continent, the meridional pressure gradient in the upper troposphere is reinforced, which implies an intensification of the Westerlies.

The development of the winter circulation becomes apparent from a comparison of the November/December charts and the January/February charts (Fig. 1). A rather abrupt change from the summer to the winter type circulation usually occurs around the end of October (e.g. Namias, 1952; Bryson & Lahey, 1958; Hastenrath, 1966). The March/April charts (Fig. 1) display the decay of the winter type circulation. The development towards the circulation pattern of the rainy season in the Caribbean area more properly takes place around the second half of April and the first half of May. This change is more gradual, while the end of the summer circulation is rather abrupt.

Anomalies of weather and circulation for each month of 1960 in the American sector have been described mainly on the basis of 700 mb charts (e.g. Gelhard, 1961; Green, 1960*a*; Stark, 1960*a*; Dunn, 1960; O'Connor, 1960, 1961*a*). The representativeness of the normal period referred to in these studies has been questioned by O'Connor (1961*b*). Characteristic departures during the months of the winter half-year of 1960 can be summarized from these reports as follows. Low zonal index prevailed from January through March 1960, with the belt of Westerlies in general displaced southward. A return to high index was found for April. High index dominated also during November and the greater part of December 1960. The description of anomalies in these reports is not quite conclusive for the area of the Central American Seas.

The summer circulation over the Caribbean Sea and the Gulf of Mexico contrasts sharply with winter, and some of its characteristics can be stated clearly, although the conditions are far from uniform throughout the summer half year (cf. Fig. 2). Generally speaking, the axis of the subtropical high pressure cell is shifted far northward and shows a pronounced extension westward. The boundary between temperate latitude Westerlies and tropical Easterlies is fairly steep, and meridional pressure gradients are weak. Easterlies extend from the surface into the upper troposphere. The core of the Easterlies over the Caribbean Sea reaches the greatest wind speeds and the highest vertical development in summer.

A certain similarity in the circulation pattern is apparent between May and June on one hand, and September and October, on the other (cf. Fig. 2). Conditions in July and August, however, contrast with the other months of the summer half-year (cf. Fig. 2). In this connection it should also be noted that the frequency of tropical storms in the western Caribbean has a double maximum, in June and again in late September and October.

Through May and June (cf. Fig. 2), the upper-tropospheric Westerlies over the Central American Seas continue to weaken and give way to a higher extension of the Easterlies over the Caribbean Sea. The high axis shifts northward. The circulation pattern changes rather abruptly around the end of June, in agreement with the findings of Bryson & Lahey (1958).

In July and August, the extension of the North Atlantic High with its axis between 20° and 30° N clearly dominates the area of the Central American Seas up to the 500 mb level (see Fig. 2). Towards higher levels, its axis is shifted southward, at least in its western extension. In the upper troposphere, two separate high areas tend to develop, separated by a trough. This is clearly seen in the 200 mb chart, and is in good qualitative agreement with the previous study of the year 1960. The split into two separate high cells in the upper troposphere may begin in late June, is most pronounced in July and August, and is still reflected in the 9-year mean 200 mb chart for September. This

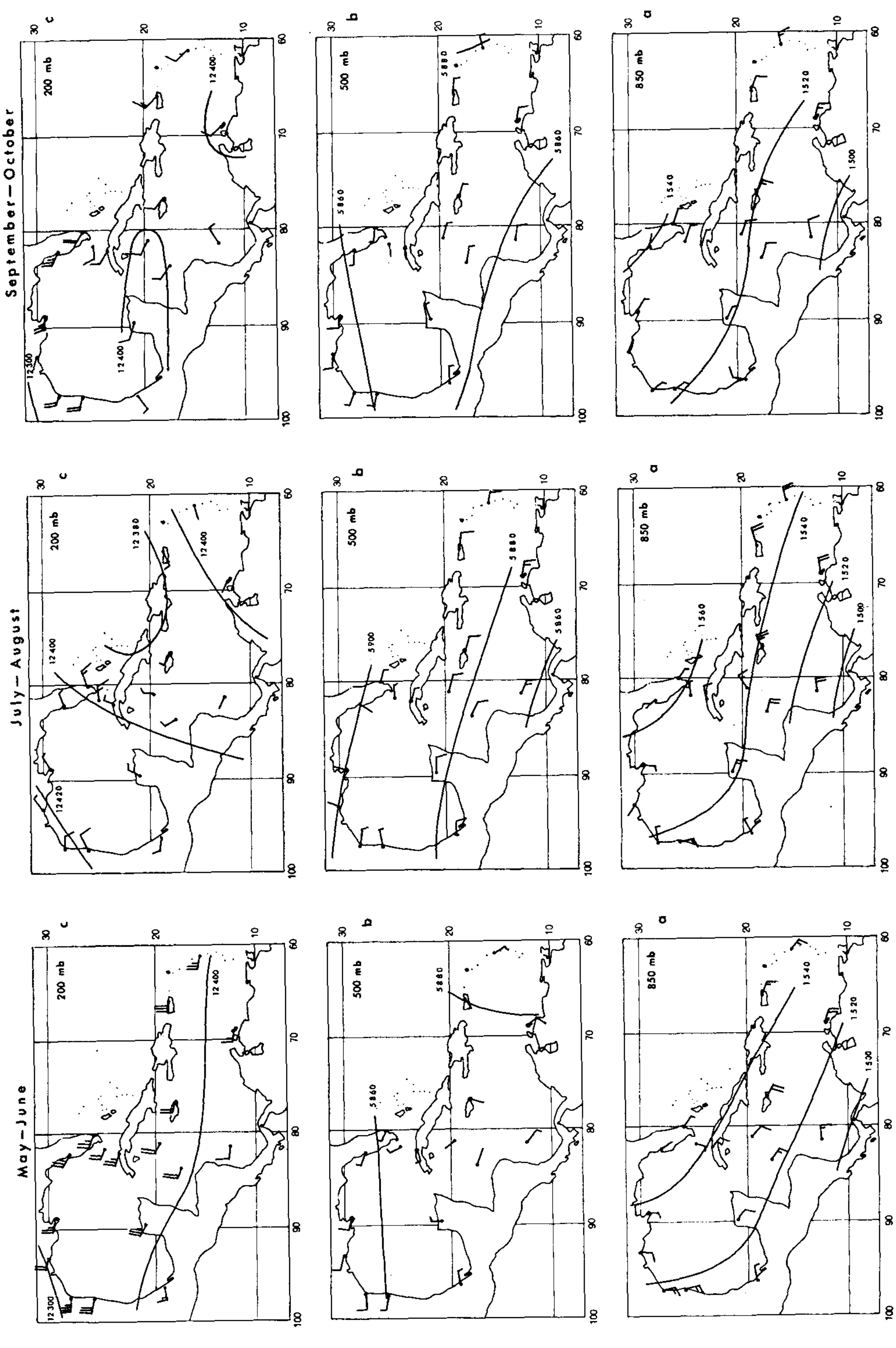

Fig. 2. Summer half-year; geopotential height (*m*) and resultant winds at constant pressure levels. Triangle means 25, long barb 5, and short barb 2.5 m/sec (period 1957–65). (*a*) 850 mb, (*b*) 500 mb, (*c*) 200 mb.

upper-tropospheric pressure distribution in the area of the Central American Seas appears to have some rather important climatic implications, which will be discussed in more detail elsewhere.

The circulation pattern in September/October (see Fig. 2) reflects a return to conditions similar to those found in the early part of the summer half-year. Interestingly, this is associated with a similar change in the weather character. Bryson & Lahey (1958) found a jump-like change in the hemispheric circulation pattern at the end of October, in good agreement with the results of Namias (1952) for North America. This coincides closely with the sudden turnover to the winter circulation from October to November, which marks the rather abrupt end of the rainy season in large parts of Central America and the Caribbean.

Anomalies of weather and circulation during the summer half-year of 1960 have been discussed in monthly reports, mainly based on 700 mb charts (Andrews, 1960, 1961; Woffinden, 1960; Green, 1960*b*; Stark, 1960*b*; Tisdale, 1960). During June 1960, the mid-tropospheric Westerlies were displaced south of their normal position. Temperate latitude Westerlies were stronger than usual for July through September returning close to their normal values during October in the American sector. For details reference is made to the above-mentioned monthly reports. Comparison of the 850, 500, and 200 mb charts for the 1957–65 and the 1960 periods showed for both the summer and winter half-years in general a good agreement in all essential features.

3. Vertical structure of the wind field

Seasonal characteristics of the atmospheric circulation were discussed in the preceding section on the basis of charts of geopotential height and resultant winds in selected pressure levels. For a better understanding of the vertical structure of the wind field, this will now be supplemented by meridional cross-sections along approximately 80° W. In contrast to the charts of constant pressure levels presented in the preceding section, these transects were analyzed from the more detailed material available for the year 1960 only. It is believed that the pertinent features are of a general importance.

Figure 3 represents the zonal wind component for January 1960 in a meridional cross-section extending from northern Florida down to the Panama Canal Zone. The boundary between temperate latitude Westerlies and tropical Easterlies is strongly tilted southward with increasing height. In the upper troposphere, Westerlies extend down to the north coast of South America, in accordance with the discussion given in the preceding section. The lower-tropospheric Easterlies, the trade winds, reach northward to the Florida Straits throughout the winter, though in a very shallow layer. The core of the Easterlies, that is the maximum wind speed and highest vertical development, is observed over the Caribbean Sea. In the area of Panama, winds with a westerly component are maintained throughout the year, in a shallow layer.

A great directional steadiness of wind $(100 \cdot \overline{\vec{V}}/\overline{V})$ is found in the vicinity of the westerly jet, and again in the core of the trade wind current, while the region of the greatest variability coincides in general with the large-scale boundary between temperate latitude Westerlies and tropical Easterlies (see Fig. 4). The pattern of directional steadiness closely follows the seasonal displacement of the wind regime.

The essential features of the vertical wind structure during the summer season are reflected in Figs. 5 and 6, representing transects for July 1960. In summer, the boundary between temperate latitude Westerlies and tropical Easterlies is steep and displaced far northward. Fig. 5 underlines the discussion of the charts in Fig. 2, presented in the preceding section. Easterlies extend from the surface into the upper troposphere. Westerly wind components are maintained in a shallow layer in the area of Panama throughout the winter and summer seasons. A great directional steadiness of wind is found in the core of the Easterlies over the Caribbean Sea (see Fig. 6).

Since we are concerned here mainly with the essential differences between the winter and summer half-years, cross-sections for intermediate months are omitted.

4. Vertical distribution of large-scale divergence and convergence

With the objective of a larger scale comparison, the horizontal wind divergence was computed for the areas of the Caribbean Sea and the

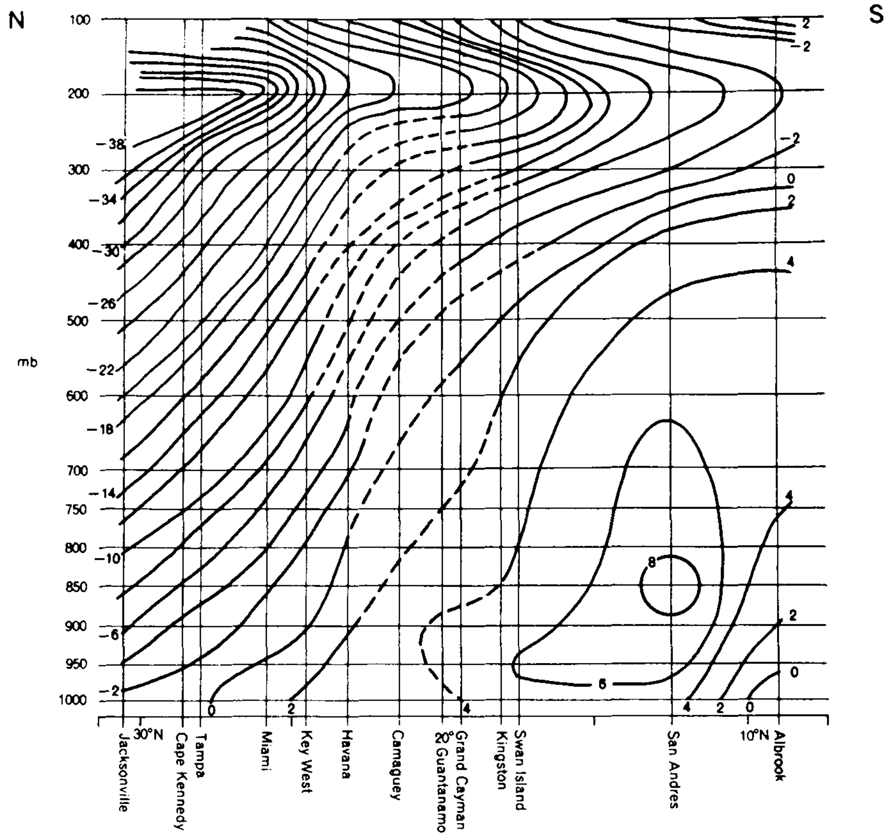

Fig. 3. Zonal wind component in a meridional cross-section along 80° W, January 1960 (m/sec, Westerlies negative).

Gulf of Mexico separately. In spherical polar coordinates, the two-dimensional divergence is given by

$$D \equiv \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{v}{r} \cdot \tan \varphi. \qquad (1)$$

Here u and v denote the East and North components of wind, r the earth radius, and φ the geographic latitude. The last term of (1) takes into account the convergence of the meridians poleward.

For the year 1960, data for the following constant pressure levels were available: (sfc), 1000, 950, 900, 850, 800, 750, 700, 600, 500, 400, and 300 mb. Networks of ten stations each were used for the two sea areas considered. The ten stations available for the Caribbean Sea were: Grand Cayman, Kingston, San Juan, St. Martins, Raizet, Swan Island, San Andres, Albrook, Plessman AP, Trinidad. The ten stations used to represent the Gulf of Mexico were correspondingly: Corpus Christi, Lake Charles, Burrwood, Valparaiso, Tampa, Brownsville, Merida, Havana, Key West, Miami.

For the longer observation period, 1957–65, only the constant pressure levels 850, 500, and 200 mb were at our disposal (USWB, 1957–66, *a*, *b*). For the Caribbean Sea, the following seven stations were used: Grand Cayman, Kingston, San Juan, Raizet, Plessman AP, San Andres, Swan Island. For the Gulf of Mexico, only the following six stations were available: Lake Charles, Burrwood, Tampa, Miami, Merida, Brownsville (see Fig. 7).

In the divergence computations it was assumed that both the zonal and the meridional wind components vary linearly between adjacent stations around the perimeter of an enclosed area. This is the assumption commonly

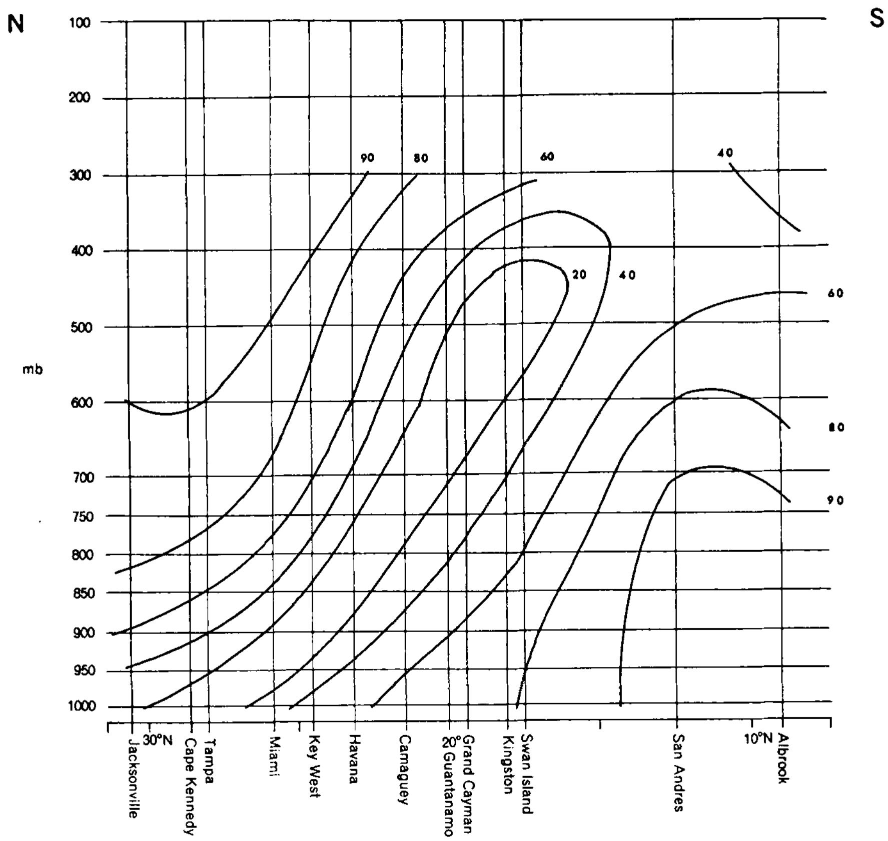

Fig. 4. Directional steadiness of wind ($100 \cdot \vec{\vec{V}}/\bar{V}$) in a meridional cross-section along 80° W, January 1960.

implied in the line integral procedure. It is understood that the scarcer networks for the 1957–65 period will render the computations less reliable, although they are probably sufficiently accurate for a semi-quantitative comparison with the 1960 results.

The vertical distribution of divergence and convergence as computed for the periods 1960 and 1957–65, respectively, is illustrated in Fig. 8. For convenience, always two consecutive month with a similar pattern were combined, as in the treatment of the flow patterns in section 2.

Over the Caribbean Sea in winter, strong divergence is found in the lower layers, changing to convergence between the 700 and 500 mb levels and again to divergence around the 400 mb level. This pattern of a vertical distribution is corroborated by Colóns (1960) study for two months of the winter 1956/57. A pronounced convergence in the upper-tropospheric Westerlies has to compensate for the mass loss in the lower layers (e.g. Hastenrath, 1966). Figure 8 illustrates that this pattern gradually develops from November/December to January/February. In March the lower-tropospheric divergence and upper-tropospheric convergence become even stronger. Concerning the important qualitative features of the vertical distribution, a good agreement is found between the computations for 1960 and the more deficient material for the period 1957–65.

Remarkably different conditions are found over the Caribbean Sea during the summer half-year. Divergence is maintained only near the 1000 mb level. Convergence dominates most of the lower and mid troposphere. This is compensated by a tendency to divergence in the upper-tropospheric Easterlies. This pattern is most clearly seen in the graphs for May/June and September/October. Conditions are some-

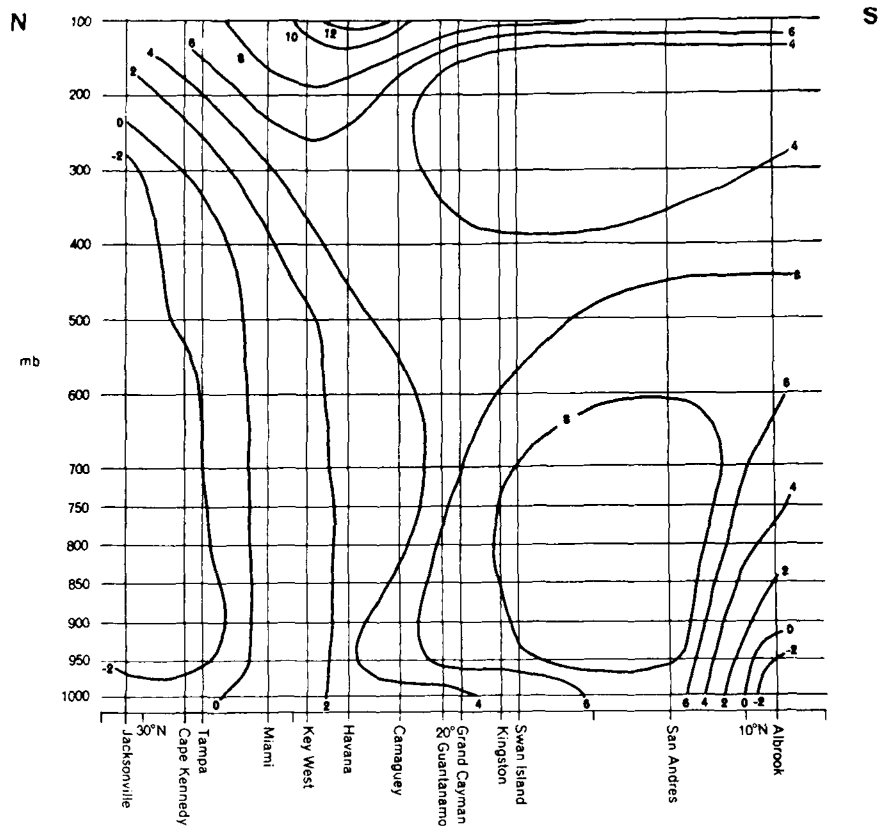

Fig. 5. Zonal wind component in a meridional cross-section along 80° W, July 1960 (m/sec, Westerlies negative).

what different in July/August, inasmuch as there is a marked lower-tropospheric divergence, together with stronger convergence in the upper layers. In the discussion of pressure distribution and flow patterns in section 2 it has already been pointed out that July and August contrast with the other months of the summer half-year. During the summer half-year, too, the 1960 and the 1957–65 computations agree qualitatively in the essential features of the vertical distribution. Deviations of the large-scale flow pattern in 1960 from long-term mean conditions have been briefly mentioned in the preceding section 2.

The vertical distribution of divergence and convergence over the Gulf of Mexico shows clear regional contrasts with the Caribbean Sea. During the winter half-year, divergence in the lower layers is considerably weaker than over the Caribbean Sea, while a stronger tendency to convergence appears in the mid troposphere. The qualitative agreement between the 1960 and the 1957–65 computations appears satisfactory.

Over the Gulf of Mexico, too, conditions in July and August differe from the other months of the summer half-year. In May/June and in September/October, a tendency to divergence is indicated for most of the lower and mid troposphere, associated with convergence in the upper troposphere. In July/August convergence dominates in most of the lower and mid troposphere, with a maximum between the 900 and 700 mb levels. Divergence is maintained in the 1000 and around the 500 mb level. A tendency to divergence is indicated for the upper troposphere. Again, the computations for 1957–65 corroborate the essential qualitative features of the 1960 findings.

In order to supplement the material pre-

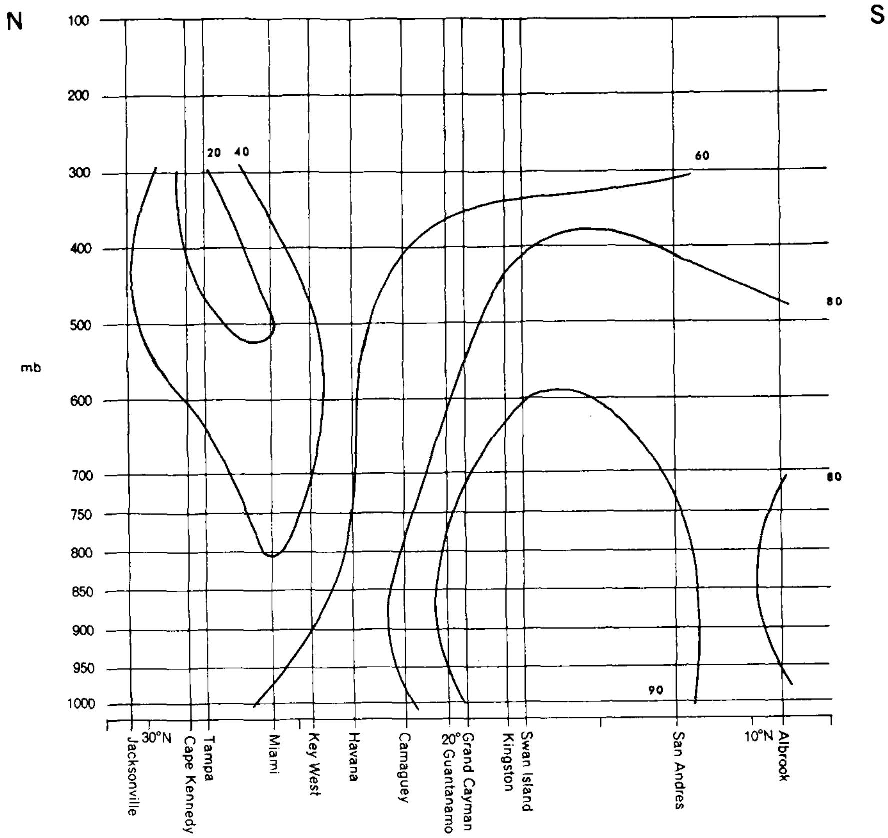

Fig. 6. Directional steadiness of wind ($100 \cdot \overline{\vec{V}}/\overline{V}$) in a meridional cross-section along 80° W, July 1960.

sented above, an attempt was made to compute the large-scale divergence in the area of the Central American Seas from the wind data contained in Crutcher's (1961) meridional cross-sections. These transects give wind data for meridians 10° apart, combining always three months into a seasonal mean. Wind data in 1000 mb for the winter and summer seasons were read from Tucker's (1957) charts.

Divergence was computed for the squares 70–80° W, 10–20° N, covering part of the Caribbean Sea, and 80–90° W, 20–30° N, covering part of the Gulf of Mexico, respectively. December, January, and February represent the winter, and June, July, and August the summer season. Results are represented in Fig. 9. The profiles of Fig. 9 refer to somewhat different areas than those of Fig. 8, they are computed from much coarser networks, and finally the combination of the original data into three-month period is quite arbitrary for the region

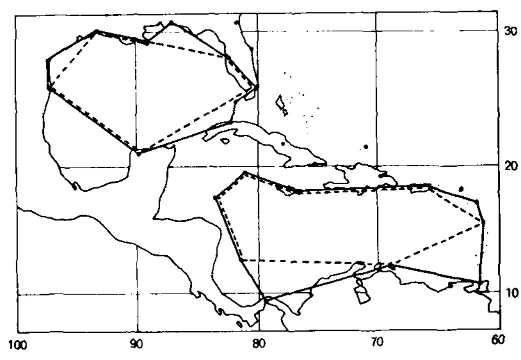

Fig. 7. Station networks used in divergence computations. Solid lines refer to 1960, broken lines to the 1957–65 period.

of the Central American Seas. This should be taken into account in comparing the absolute values of Fig. 9 with those of Fig. 8. The relative pattern in the vertical distribution of divergence

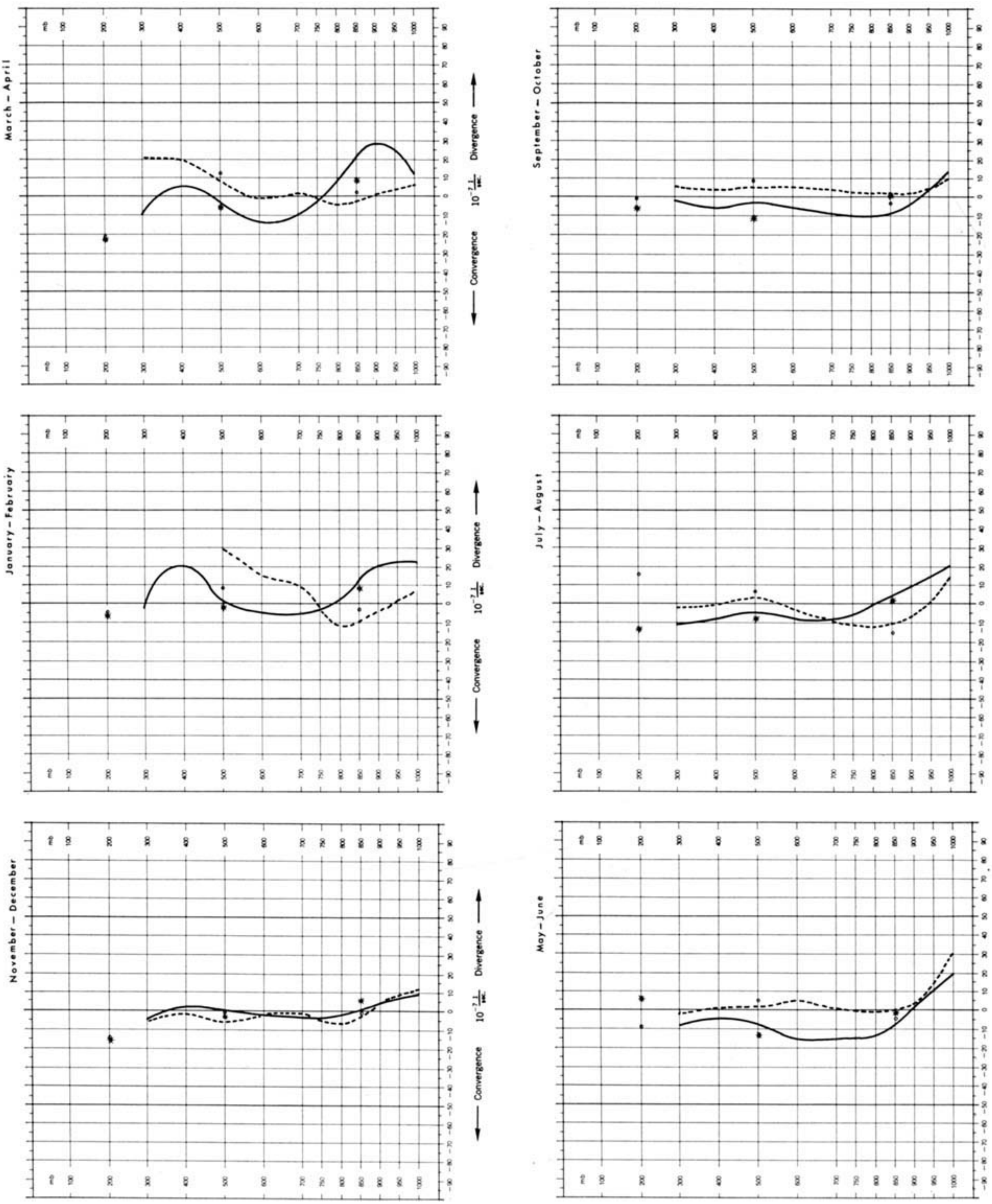

Fig. 8. Vertical distribution of divergence and convergence. 1960 data are given by a solid line for the area of the Caribbean Sea and by a broken line for the Gulf of Mexico; 1957–65 values are represented by asterisks and open circles, respectively.

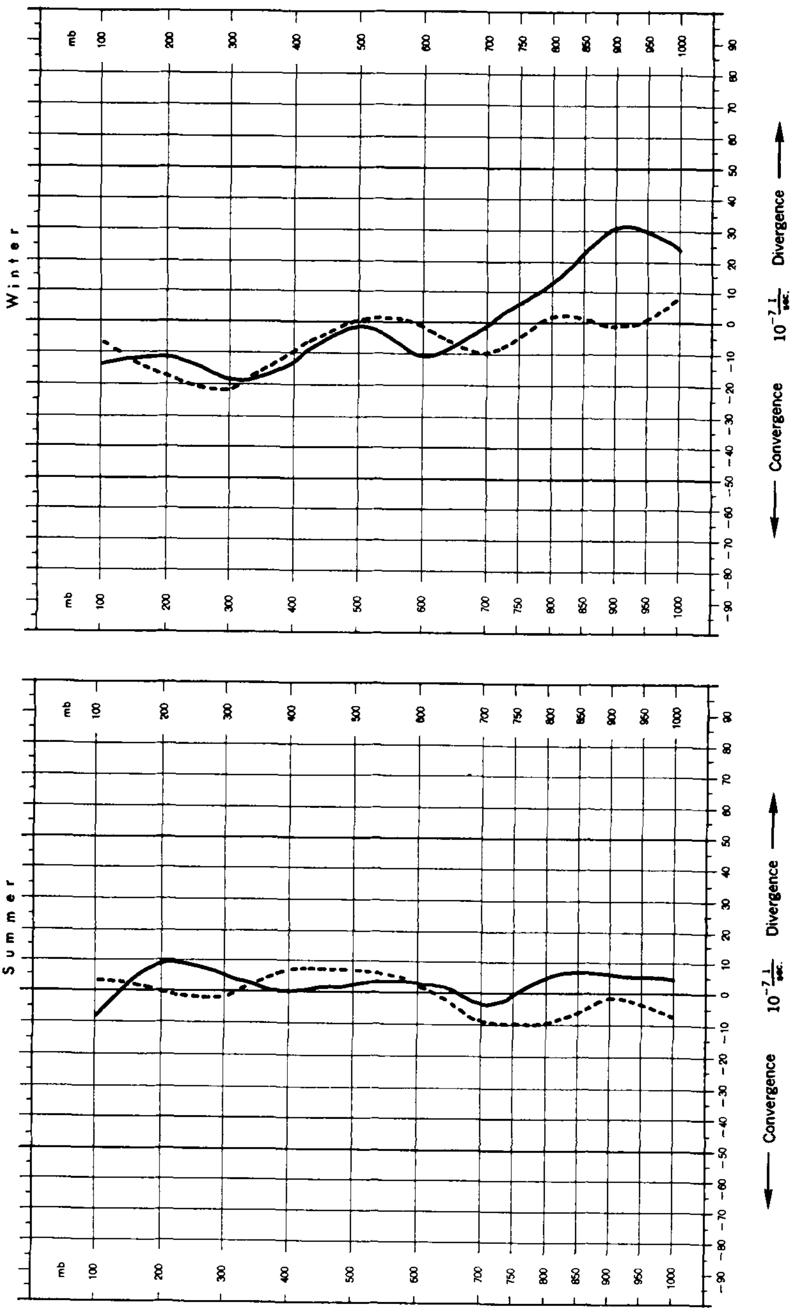

Fig. 9. Vertical distribution of divergence and convergence for the squares 70–80° W, 10–20° N (Caribbean Sea), solid line; and 80–90° W, 20–30° N (Gulf of Mexico), broken line; computed from Crutcher's (1961) wind data. December–January–February represent the winter, and June–July–August the summer season.

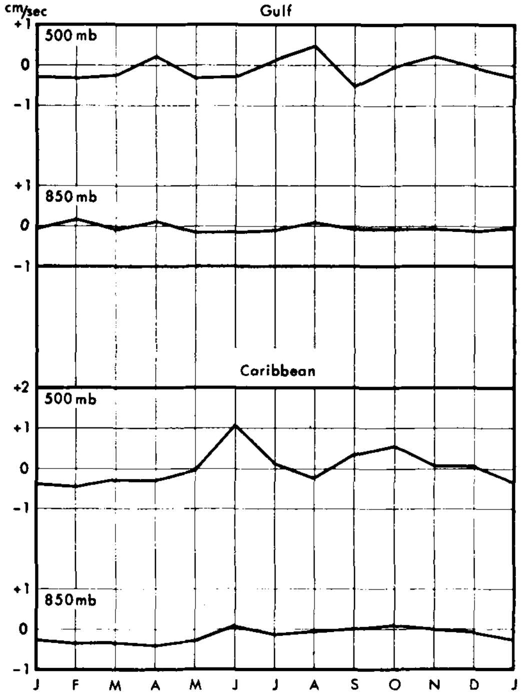

Fig. 10. Seasonal march of vertical motion in the 850 and 500 mb levels for the areas of the Caribbean Sea and the Gulf of Mexico; 1960 data.

and convergence, however, is found to agree qualitatively with the bimonthly profiles of Fig. 8.

5. The field of large-scale vertical motion

From the vertical distribution of divergence and convergence vertical velocities in constant pressure levels can be computed, using the kinematic method. This was done on a month-to-month basis for 1960. The spacing of isobaric levels was too wide for a computation for the 1957–65 period. An analogous seasonal march of vertical motion is, however, suggested from the vertical distribution of divergence and convergence. It should be mentioned that calculations for 1960 by the independent thermodynamic method (Hastenrath, 1966) agree essentially with the results of the kinematic method.

Fig. 10 illustrates the seasonal march of vertical motion in the 850 and 500 mb levels for the areas of the Caribbean Sea and the Gulf of Mexico, respectively. The prominent features can be summarized as follows.

Over the Caribbean Sea, a strong subsidence develops particularly in the second part of the winter half-year, associated with the pronounced lower-tropospheric divergence, and convergence in the upper-tropospheric soutwesterly current originating over the equatorial regions of the Eastern Pacific (e.g. Hastenrath, 1966). Upward motion prevails, on the other hand, during the summer half-year, together with the convergence in the lower layers as described in the preceding section. July and August contrast with the other months of the summer half-year, inasmuch as they display a tendency to downward motion. The particular conditions in July and August are also reflected in pressure distribution and flow pattern, as well as in the vertical distribution of divergence and convergence, as was pointed out in the preceding sections.

Over the Gulf of Mexico, a tendency to downward motion prevails during the greater part of the year. Ascending motion develops, however, in July and August, associated with the convergence in the lower layers. This is the same time of year at which a tendency to subsidence develops over the Caribbean Sea.

A detailed analysis of the standard pressure levels shows, that the vertical distribution of divergence and the seasonal march of vertical motion over the Caribbean Sea and the Gulf of Mexico are related to the seasonally varying position of these two sea areas relative to the western tip of the North Atlantic Anticyclone.

6. General climatic implications

The study of the wind conditions in the free atmosphere and particularly the field of large-scale vertical motion may contribute to an understanding of climatic characteristics in the greater region of the Central American Seas. The alternation of winter and summer type circulation patterns is associated with pronounced turnovers of the weather character. Also, changes of the flow pattern within the winter or summer half-years, as discussed in section 2, are reflected in the observed weather and seasonal climate of the area.

The turnover from the summer to the winter type circulation around the end of October marks the end of the rainy season in most of the Central American and Caribbean area. During the first part of the winter half-year, cold air outbreaks (Northers) originating in the cold interior of the North American continent penetrate deep into the tropics. Northers occur less frequently at the time of the strongest development of the winter-type circulation and towards the end of the winter half-year.

Particularly during the later part of the winter half-year, the broad upper-tropospheric southwesterly current originating in the equatorial regions of the Eastern Pacific displays a

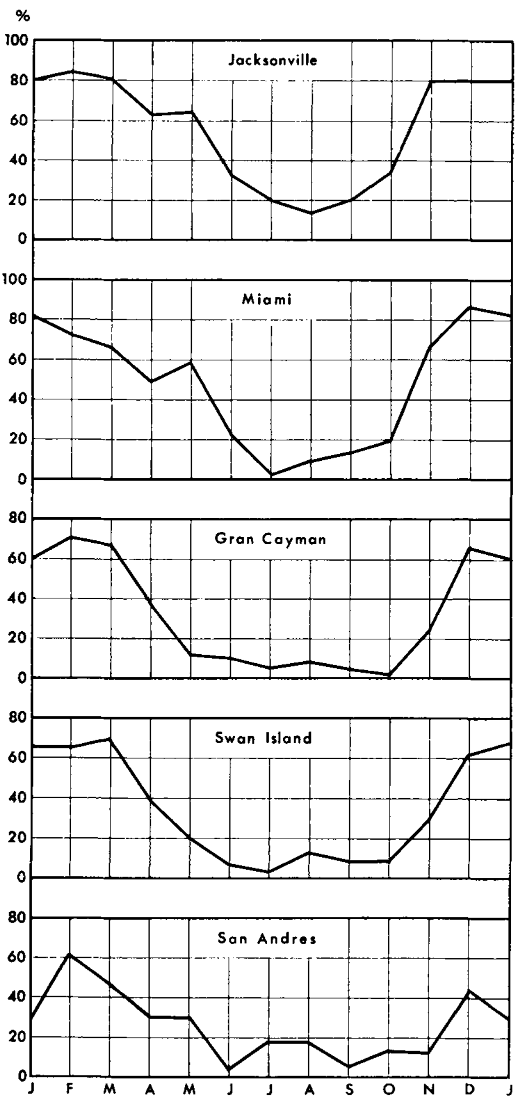

Fig. 11. Frequency of the trade inversion in percent of total radio ascents, for stations along a meridional transect from northern Florida to Panama; 1960 data.

marked convergence in the area of the Central American Seas, thus feeding the vigorous downward motion over both the Caribbean Sea and the Gulf of Mexico. The large-scale subsidence in turn controls in a decisive way both the development of the trade inversion and the seasonal march of rainfall.

Frequency and persistence of the trade inversion closely follow the variations in the field of vertical motion. Fig. 11 illustrates the seasonal march of the frequency of the trade inversion in 1960 for stations along a meridional transect from northern Florida down to Panama. Gutnick (1958) has stressed the role of convective activity for the seasonally varying frequency of the trade inversion over the Caribbean Sea. There should be no doubt that the interplay of large-scale subsidence and convection from the surface is instrumental in the development of the trade inversion. However, a dominant control of seasonal march and regional differences in the climatic time scale appears to be given by the field of large-scale vertical motion. Turbidity and visibility conditions towards the end of the dry season in Central America were found to be clearly related to the development of the large-scale inversion (Hastenrath, 1963).

The seasonal march of the rainfall activity in the area of the Caribbean Sea follows remarkably closely that of the large-scale vertical motion (compare Fig. 12). The most pronounced dryness coincides with the strongest subsidence in the later part of the winter half-year. In the land areas around the Central American Seas, orographic and stress-differential induced divergence effects may account for a contrastingly different pattern (Hastenrath, 1967).

In contrast to the abrupt turnover to the winter type circulation at the end of October, the development towards the summer circulation pattern around the end of April and the beginning of May is rather gradual. This is accompanied by a more gradual transition towards the weather characteristics of the rainy season.

Around the beginning of the summer half-year, the intensity of the Easterly Waves over the Caribbean Sea tend to increase. A causal relationship with the field of vertical motion and large-scale inversions is suggested and would deserve further study.

In clear contrast to the second part of the

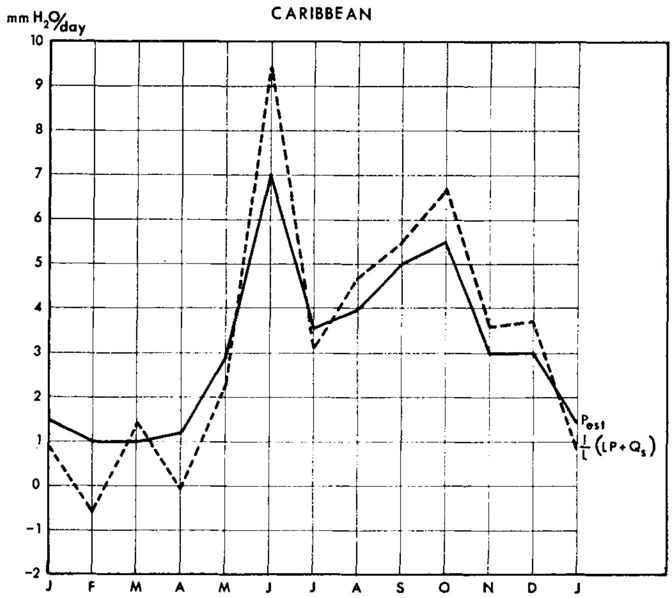

Fig. 12. Large-scale precipitation P_{est} in the area of the Caribbean Sea in 1960, as estimated from island and coastal stations; and sum of sensible heat transfer from the sea surface and large-scale precipitation $(Q_s+LP)/L$ in equivalents of mm H_2O per day, as computed from the atmospheric energy budget.

winter half-year, the rainy season in the area of the Caribbean Sea is a time of pronounced ascending motion (compare also Figs. 10 and 12). The single rainfall peak around mid-summer in the Gulf of Mexico area also coincides with an intensified upward motion. The double peak in the seasonal march of rainfall in the area of the Central American Seas is not related to a double passage of the equatorial trough, which appears to be the case in certain other parts of the tropics (e.g. Hastenrath, 1967).

The circulation patterns of May/June and September/October are somewhat similar, and so are the observed weather conditions. During July/August, on the other hand, both flow pattern and weather characteristics are typically different. The double peak in the hurricane frequency has already been mentioned in section 2. The temporales on the Pacific side of Central America also occur typically in June and again in September and October.

A temporal is an atmospheric disturbance originating over the Pacific Ocean and affecting above all the Pacific regions of Central America. Characteristic is a thick and extended cover of nimbostratus, with an extremely persistent rainfall, though of moderate intensity. The orographic effect exerted by coastal ranges and isolated volcanoes is reflected in the rainfall pattern of a temporal period. There are indications that temporales form as disturbances in the ITC, In fact, the mean latitudinal position of the ITC over the eastern North Pacific, as given by Alpert's (1945, 1946) study displays a similar seasonal march as that of the temporal frequency.

The secondary minimum of rainfall around the middle of the rainy season in the Caribbean area also coincides with a tendency to downward motion. There are, however, other circumstances which appear to be of some importance in this respect. Sudden and extended dry spells (canículas in Central America) typically occur during July and August. According to synoptic-climatological experience in Central America, these are associated with a northerly flow in the upper troposphere. Similar conditions are indicated for the area of the Caribbean Sea (cf. Lahey, 1958). The peculiar upper-tropospheric pressure distribution illustrated in Fig. 2 appears to represent the climatic frame within which the individual canícula situations develop. A study of this phenomenon is presently still under way. For the Pacific side of Central

America, the greater frequency of temporales in June, and again in September and October, obviously contributes to the double peak in the seasonal march of rainfall.

The relation of the flow pattern and the field of vertical motion with the seasonal characteristics of the atmospheric energy budget in the area of the Central American Seas is discussed elsewhere (Hastenrath, 1966). The Central American Seas represent a region in the poleward curving downstream portion of the trade wind system. This appears to imply certain features in the atmospheric circulation and climatic characteristics. Studies in analogous situations on the western flanks of a subtropical anticyclone appear desirable; serious limitations are for the time being imposed by the lack of adequate observations.

Acknowledgements

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Zusammenfassung

Die Windverhältnisse über dem Amerikanischen Mittelmeer werden diskutiert auf Grund von neunjährigen Mittelwerts-Karten ausgewählter Druckniveaus, sowie Meridionalschnitten entlang 80°W. Die grossräumige Vertikalbewegung wird für alle Monate eines Jahres berechnet. Über dem Karibischen Meer zeigt sich während der zweiten Hälfte des Winterhalbjahres eine kräftige Abwärtsbewegung, die von einer Konvergenz in der hochtroposphärischen Südweströmung aufrechterhalten wird. Während des grössten Teils des Jahres dagegen herscht Aufwärtsbewegung, mit einer schwachen Tendenz zu Subsidenz im Hochsommer. Die Bedeutung der Vertikalzirkulation wird mit Hinblick auf gewisse klimatische Besonderheiten im Gebiet des Amerikanischen Mittelmeers diskutiert.

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О ВЕТРЕ НАД КАРИБСКИМ МОРЕМ И МЕКСИКАНСКИМ ЗАЛИВОМ

Обсуждается ветер над морями Центральной Америки на основе средних девятилетних карт для избранных уровней давления и меридионального разреза вдоль 80° з. д. Поле крупномасштабного вертикального движения вычисляется для всех месяцев одного года. Над Карибским морем найдено сильное нисходящее движение в течение второй половины зимнего полугодия, которое поддерживается конвергенцией юго-западного течения в верхней тропосфере. Однако, во время большей части года превалирует восходящее движение, со слабой тенденцией к опусканию в середине лета. Над Мексиканским заливом опускание отмечается во время большей части года; в середине лета оно переходит в восходящее движение. Обсуждаются климатические характеристики, которые следуют из вертикальной циркуляции, в районе морей Центральной Америки.