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CLIMATIC FEATURES OF THE TROPICAL SOUTHWEST

PACIFIC OCEAN

TIC 108

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SOUTHWEST PACIFIC OCEAN

1. General Weather Regime

The area mainly considered in this survey extends from near the equator to approximately 30°S and lies between longitudes 150°E and 150°W. Although this area lies for the most part south of the equator an understanding of its main climatic features is greatly facilitated by a knowledge of the conditions prevailing in the tropical north Pacific. At about latitude 30° both the north and south Pacific Oceans are characterized by belts of high atmospheric pressure. East of about 150°W there is in each ocean a single more or less permanent anticyclonic cell, but elsewhere the belts consist of large moving anticyclones. Between these anticyclonic belts lies the region of the trade winds where the surface winds blow almost constantly from the east with comparatively little variation from day to day. An important exception occurs, however, in the western Pacific where a northwesterly monsoon blows for a few months of the year.

In the northern hemisphere the trade winds have a direction from between east and northeast, and in the southern hemisphere from between east and southeast. There is thus a tendency for convergence between the trade wind streams of the opposite hemispheres. In the region where they approach one another there is a more or less gradual ascent of air which sometimes becomes concentrated into a narrow zone of convergence known as the Equatorial or Intertropical Front. It is generally characterized by extensive cloud masses and disturbed showery weather due to the ascending motion of the air, although its intensity fluctuates considerably from time to time. This front constitutes one of the important climatic features of this region and indeed most of the seasonal features of the weather and climate of this region may be described with reference to the seasonal variations in the Equatorial Front.

2. Seasonal Variations in Wind and Weather

The seasonal shifting of the heat equator (zone of highest surface air temperatures) induces a corresponding shift in the average position of the Equatorial Front and corresponds with a similar shift in the positions of the subtropical anticyclonic belts. East of longitude 160°W the boundary between the

northern and southern hemisphere trades (equatorial front) remains in a fairly constant position near latitude 5° - 8° N. Farther westward the front undergoes a marked seasonal oscillation between about latitude 8° N and 15° S.

From late June to early October in most years the front lies entirely north of the geographical equator giving disturbed weather over the Caroline, Marshall and northern Gilbert Islands. Throughout the tropical south Pacific the easterly to southeasterly trades prevail with generally favourable weather except when interrupted by the unsettled weather associated with the arrival of cold fronts from the temperate regions farther to the south. By late October or early November the Equatorial Front first appears south of the geographical equator and begins to affect the weather over northern New Guinea, New Britain and the southern Gilbert group. The Solomon and Ellice Islands usually come under its influence sometime during December, although this may vary by as much as a month either way in different years. Throughout January, February and March the Equatorial Front is in its southernmost position, giving disturbed weather over northern Queensland, southern New Guinea, New Hebrides and occasionally oscillating as far south as New Caledonia, Fiji and Samoa.

During this period the major southward deflections of the front over the western parts of the tropical Pacific allow the northeasterly trades to cross the equator and penetrate far into the southern hemisphere. Due to the rotation of the earth these winds become deflected into northwesterly or westerly directions and it is then that the convergence of the airstreams on opposite sides of the Equatorial Front tends to be the strongest and the associated weather correspondingly worst. The westerly winds occur mainly from January to March and give the name "westerly" or "monsoon" season to this period.

Throughout April and May the Equatorial Front retreats northward again allowing the southeast trades to extend progressively northward over the New Hebrides, the Ellice and Solomon Groups and New Guinea.

Apart from this slow and rather regular seasonal movement the Equatorial Front undergoes more or less irregular oscillations lasting a few days at a time, when it may move northward or southward 50-100 miles in a day.

Apart from occasional heavy rains due to tropical storms a large proportion of the rainfall in the tropics is due to the disturbed weather associated with the Equatorial Front. Consequently, in the south Pacific, the rainy season corresponds to the southern summer (approximately November or December to March or April) when the front is south of the equator. In addition, the majority of tropical cyclones (hurricanes) have their origin at or near the Equatorial Front, so that nearly all of these storms occur from December to March or April. This period is therefore often referred to as the "hurricane season" in contrast to the winter period or "trade wind season".

3. Extra-tropical Influences on Tropical Weather

The most important extra-tropical influence on the weather of the tropical Pacific is provided by the fact that from time to time, at any season, but most marked in winter, cold fronts from temperate latitudes move northward into the trade wind region. These fronts are normally found in the troughs of low pressure between the moving anticyclones of the sub-tropical high pressure belt and are therefore found most frequently in the western part of the Pacific. When they enter the trade wind belt they are usually fairly slow moving and lie across the area in a general NW - SE or WNW - ESE direction. Their motion is normally northward and eastward but occasionally they may remain stationary for several days or may even move southward again as a warm front. The weather conditions associated with the tropical portions of these fronts are usually less severe than in the temperate portions, but occasionally they are associated with a broad band of squally rainy weather. These fronts generally become retarded in the far eastern part of the area where they enter the region occupied by the semi-permanent south Pacific anticyclone. Most of the fronts arriving in this area from the west eventually amalgamate to form the main south Pacific polar front of which the northern portion remains in tropical latitudes as a semi-permanent quasi-stationary frontal system. This system undergoes a seasonal oscillation through about 5° of latitude but its mean position lies in a line WNW - ESE just to the south of Tahiti and Samoa in summer and somewhat farther to the north in winter.

4. Weather Conditions in the Main Air-streams

Conditions in the trade wind stream are relatively stable from day to day but in the westerly or northwesterly monsoon weather conditions may vary considerably. In most cases a few days of squally unsettled weather alternate with periods of fine clear weather. These contrasting conditions may be referred to as "disturbed" or "undisturbed" monsoon conditions.

- (a) Trade wind current: The most important feature of the trade wind current is the very frequent presence of a marked temperature inversion occurring somewhere between 4000 and 9000 feet. This inversion has a decisive influence on the growth of convective cloud as the top of such clouds can rarely penetrate into the dry air above the inversion and showers are then less likely to form.

Wind: Below the inversion the wind is normally moderate E or SE although occasionally wind velocities may reach 25 - 30 knots for two or three days at a time. Above the inversion the wind generally blows from a westerly direction.

Weather: A few scattered light showers about mountainous islands; some scattered light showers over the sea when the surface winds are strong.

Cloud: Scattered or broken cumulus base 1500-3000 feet top 5000-8000 feet with higher tops over mountainous terrain.

Visibility: Hazy below the inversion, especially if winds are strong; visibility generally 7 - 15 nautical miles.

- (b) Undisturbed monsoon: The monsoon current in the undisturbed state usually shows an inversion below 8000 - 10,000 feet separating the moist near-surface air from the relatively dry air aloft. Thus, this separation of the tropical atmosphere into a lower moist and upper dry layer is characteristic also of monsoon currents as well as of the trade wind stream.

Wind: Light to moderate winds prevail at all levels. Directions are rather variable but westerly predominate at all levels.

Weather: No precipitation over the sea but showers common in the afternoon over islands and high ground.

Cloud: Over the sea cloud is normally scattered small cumulus at dawn and this decreases during the day. Cloud base 1500 - 2000 feet top 3000 - 5000 feet. Over land the scattered small cumulus at dawn increases during the day and showers are likely in the afternoon or evening. Cloud base is 1500 - 4000 feet with top 4000 - 6000 feet at first but rises to 10,000 - 12,000 feet late in the day. Cloud generally decreases during the night.

Visibility: Usually 20 - 50 nautical miles.

- (c) Disturbed monsoon: The inversion is absent in this current of air and the stability of the air stream is, on the whole, small.

Wind: Wind is often light and variable but W - NW winds may occasionally exceed 25 - 30 knots. The wind does not normally vary very much with height.

Weather: Heavy showers and often thunderstorms occur frequently. Over the sea conditions are worst during the late night and early morning but over the land the weather is best in the early morning with a tendency toward thunderstorms in the late afternoon or early evening.

Cloud: Much towering cumulus and cumulonimbus with irregular layers of altocumulus and altostratus and a high canopy of cirrostratus spreading out from the upper parts of the cumuliform clouds. Cloud base is 1000 feet but lowers to 100 - 300 feet in heavy showers. Cloud tops are generally 15,000 - 25,000 feet but occasionally reach 40,000 - 50,000 feet.

Visibility: Up to 10 - 20 nautical miles between showers but less than 200 yards in the heaviest showers.

5. Weather Conditions Associated with Fronts

Great variation is found in the character and intensity of the Equatorial Front. When weak (inactive) its effective width may vary from 10 - 20 miles to a broad doldrum belt exceeding 300 miles. The associated weather is then only scattered showers falling from scattered towering cumulus cloud, base 1000 feet top 8000 - 12,000 feet or from isolated cumulonimbus with tops reaching to 25,000 feet. There is generally some scattered layers or bands of altocumulus or altostratus cloud between 7000 feet and 14,000 feet. When the front is strong (active) the belt of disturbed weather is normally 50 - 200 miles wide and is characterized by a solid wall of cumulonimbus, base 500 - 1000 feet top 25,000 - 30,000 feet, with associated

decks of altostratus, altocumulus and cirrostratus stretching out from the front to distances of up to 300 miles.

The cold fronts or quasi-stationary fronts met with in the tropics are generally extensions into the tropical belt of the ordinary cold fronts of temperate latitudes. Their effective widths are generally from between 10 and 50 miles but may temporarily exceed 100 miles if a depression has formed on the front. The associated weather is characterized by a line of showers or intermittent rain falling from towering cumulus cloud and scattered cumulonimbus, base 1000 feet tops 9000 - 15,000 feet, with irregular layers of altostratus and altocumulus at 8000 - 12,000 feet extending outward for distances of 50 - 100 miles on either side of the front.

6. Tropical Revolving Storms, Tropical Cyclones or Hurricanes

Numerous minor depressions constantly form in this region, mainly during the summer season, but also in some measure during the winter season as well. They are usually associated with an area of unsettled showery weather up to a few hundred miles in diameter and a fresh or strong squally wind circulation (clockwise around the region of lowest pressure), but only a very small proportion of these develop into tropical cyclones. It is usual, however, for several tropical cyclones (hurricanes) to be experienced in this area each year but the number occurring each year is very irregular.

Thus, during the years 1940 - 1951 the number of fully developed hurricanes varied between 0 and 5 the average lying between 3 and 4. These storms show a strong concentration of frequency into the months December - March and although it is possible for hurricanes to occur outside this period they are relatively rare. The so-called "winter" cyclones are probably formed in a different manner to the "summer" type and do not seem to attain the same intensity. For the period 1940 - 1951 the monthly frequency distribution of the 43 fully developed hurricanes which occurred between longitudes 150° E and W is shown in Table 1.

TABLE 1

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
11	14	10	-	-	-	-	1	1	-	-	6	43

Cyclones do not form within about 300 miles of the equator and, even when formed, travel some distance before attaining sufficient intensity to be classed as a hurricane. For the period 1940 - 1951 the frequency of origin of the 40 tropical disturbances which originated in the area between 150°E and W longitude by 5° latitude zones is given in Table 2, column 1, but it should be emphasized that these figures refer to the origin of tropical disturbances which later developed into tropical hurricanes. Table 2, column 2 gives similar statistics for the place of first record of actual tropical hurricanes. It will be seen that the distributions are quite similar except that the zone of maximum in column 1 occurs in the 10 - 15° latitude zone instead of in the 15-20° zone as in column 2. This indicates that on the average a tropical disturbance traverses about 5° of latitude in a meridional direction before it gains sufficient intensity to rank as a fully developed hurricane.

TABLE 2

Latitude Zone	(1)	(2)
0 - 5°S	-	-
5 - 10	11	-
10 - 15	24	9
15 - 20	5	26
20 - 25	-	5
25 - 30	-	-
TOTAL	40	40

Hurricanes in this area vary considerably in intensity and extent but commonly affect the weather over an area of 500 - 800 miles wide. The area of gale winds often has a diameter of 200 miles and near the centre of the hurricane winds may exceed 100 knots. Anywhere near the centre flying conditions may be considered prohibitive for routine operations. The formation of a hurricane is usually preceded by several days of increasing squalliness and gradually

lowering barometric pressures. The newly formed hurricane usually moves southward but may possess also a component of motion either towards the east or west. This eastward or westward motion depends strongly on the month of the year; in December over 80% of storms move initially toward the east, in January 45%, February 15%, March 50%, while the very rare winter storms almost invariably pursue a course towards the east. Those storms which move first toward the west, as is common in February, continue until some latitude, usually between 20° and 30° S, is reached when the storm recurves and begins to move toward the east. The paths in these cases often roughly resemble parabolic curves. Storms that move first towards the east generally maintain this motion but in rare cases this can become reversed with a period of westward motion and a later recurve. The speed of travel of a hurricane moving towards the west is generally around 5 - 15 knots but those moving towards the east have more variable speeds lying between 10 and 30 knots.

Cirrus cloud sometimes extends as much as 500 miles ahead of a hurricane and rain often sets in at 100 - 150 miles from the centre. Ocean swell extending outward from the centre can usually be observed several hundred miles away and a heavy swell with no local disturbance of the wind often provides a valuable warning of the existence of the storm.

7. Miscellaneous Features

Fog is extremely rare in the tropical south Pacific. A phenomenon closely resembling true fog is the morning mist that appears in patches on some of the more mountainous islands, or patches of very low stratus cloud sometimes remaining after a shower, but both of these soon disappear.

Sea breezes become strongly developed on all the main islands, reaching their maximum speed in the afternoon and often then completely masking the general wind flow (e.g. trade or monsoon) for several miles out to sea.

Barometric pressure is usually fairly uniform over a wide area, except in the vicinity of a hurricane where steep pressure gradients may develop. A noteworthy feature of the pressure field is a twice-daily rise and fall of pressure amounting to about 1 - 3 millibars. Highest pressures occur at about 1000 and 2200 hours local time and

lowest pressures at about 0400 and 1600 hours. When a hurricane is developing in the area the normal rise in the barometer often fails to occur.

Turbulence in the south Pacific area is normally slight but in cumulonimbus clouds, especially those associated with marked fronts or with lines and areas of convergence, severe turbulence is likely. Flight in cumulus or towering cumulus cloud, although bumpy, is not likely to be particularly turbulent until the clouds have built up above the freezing level. In this case showers falling from them are liable to be very heavy and turbulence severe. Icing may be severe in cumulonimbus clouds but is normally avoidable as the freezing level is usually at about 13,000 - 18,000 feet, lowering only occasionally to 9000 - 12,000 feet near cold fronts.

Although not of much significance for aviation a striking feature of general climatic interest is the existence of a vast area of low average rainfall extending from the coast of Peru westward toward the Gilbert and Ellice Islands. Thus the Marquesas Islands, Malden Island, Christmas Island, Canton Island and some of the central Gilbert Islands all have average annual rainfall totals of less than 60 inches.