

## **5. SOUTHERN HEMISPHERE**

### **5.1. TOPOGRAPHY**

#### **5.1.1. INTRODUCTION**

The Southern Hemisphere oceans extend virtually uninterrupted from the west coast of South America to the east coast of Africa. In the Southern Pacific, other than Australia and New Zealand, islands make up most of the land mass within the area. Until reaching the eastern coast of Madagascar and Africa, a scattering of coral islands make up the land mass of the southern Indian Ocean.

NAVPACMETOCEN WEST/JTWC is responsible for a large area of the southern hemisphere extending from the Equator south to 60° South and from 180° West to 17° East. WEAX forecasts are issued for all requesting units transiting or operating in the Southern Hemisphere. Tropical warnings are issued by JTWC for cyclones developing from the International Date Line to the eastern coast of Africa.

#### **5.1.2. SOUTH PACIFIC**

##### **5.1.2.1. AUSTRALIA**

Australia is the smallest continent. Australia extends from 10° South to 44° South and from 113° East to 154° East. It is approximately 2,500 mi (4025 km) from east to west and 2,000 mi (3220 km) from north to south.

Australia is divided into four general regions:

1. A low, narrow, sandy eastern coastal plain;
2. The eastern highlands (Cape York to Tasmania), ranging from 1,000-7,000 ft (305-2135 m) in elevation;
3. The central plains (almost 75% of the continent), consisting largely of north-south series of drainage basins; and
4. The “western plateau”, covered with great deserts and “bigger plains” (regularly spaced sand ridges and rocky wastes from the eroding dissection of old plateaus).

With less than 75% of the land area being over 2,000 ft (610 m) in elevation, the dominant features of the Australian landscape are great plains and plateaus. The eastern highlands (Great Dividing Range) are cut by fairly deep forested valleys, with a few small coastal plains or wider valleys such as those near Brisbane and Sydney. However, the coasts of Australia are fairly smooth and few deep bays or rugged capes exist except for Cape York Peninsula in the northeast and the Great Australian Bight in the south, where mostly rugged coastlines prevail. (Figure 5.1.1)

##### **5.1.2.2. NEW ZEALAND**

New Zealand consists of the North Island, the South Island, Stewart Island and several outlying small island groups, between 33° South and 53° South and 162° East and 173° West. The islands are volcanic in origin. Recent volcanic activity has been limited to the North Island. Less than 25% of the land mass is below 650 ft (198 m). Landscapes are spectacular with snow capped mountains, geysers, deep fjords and rolling hill country. The North Island is far less mountainous than South Island, with peaks less than 6,000 ft (1830 m), except for four active volcanoes (7000-9000 ft/2135-2745 m). The

coastline is sharp with many bays, capes and fjords. Both peninsulas have an irregular coastline with wide shallow bays; however, in the north, at Ninety Mile Beach, the sweeping west coast is smoothed by vast accumulations of sand. The South Island is mountainous with the Southern Alps running the entire length of the island. It has seventeen peaks exceeding 10,000 ft (3050 m). (Figure 5.1.2)

### **5.1.3. TROPICAL SOUTH PACIFIC**

The islands of Melanesia and Polynesia, west of 180° , are very much the same as those of Micronesia. They are mostly low-lying coral atolls interspersed with relatively high islands which are the peaks of submerged mountains and/or extinct volcanoes with the attendant coral reefs flanking the peaks.

#### **5.1.3.1. SOLOMON ISLANDS**

These islands are essentially volcanic with numerous coral atolls. They extend from 5° South to 13° South and 155° East to 170° East. The eight largest Solomon Islands are very mountainous, the highest peak being on Guadalcanal at over 8,000 ft (2440 m). These island mountains have a definite influence on the local weather and contribute to windward-leeward rainfall distribution. The islands are subject to the southeast trades and rainfall averages about 120 in (305 cm) on the windward slopes and 75 in (191 cm) on the leeward side. The average temperature ranges from 72°-95° F (22°-35° C).

#### **5.1.3.2. GILBERT AND ELLICE ISLANDS**

These islands are United Kingdom dependencies. They extend from 4° North to 11° South and from 172° East to 180° . There are thirty-seven coral atolls, with Ocean Island being the only volcanic island. Rainfall varies from 40-120 in (102-305 cm) per year. Most of the islands are subject to the southeast trade winds.

#### **5.1.3.3. PAPUA-NEW GUINEA**

These islands include the islands of New Guinea, the Bismarck Archipelago of which New Britain, New Ireland and Manus are the largest islands; Bougainville and Buka Islands in the Western Solomon Islands and the Trobriand, Woodlark, D'Entrecasteaux and Louisiade Island groups to the east of the New Guinea mainland. They extend from the Equator to 8° South and from 130° East to 155° East. Papua-New Guinea is the largest and most rugged island. The central highlands range from 8,000-15,000 ft (2440-4575 m) and occupy the center of the island with numerous spines extending in all directions. All the people and industry inhabit the narrow coastal plain. The ranges are broken by deep rushing rivers and mountains that make land transportation and communication difficult. The remainder of the islands are volcanic in origin and very precipitous. All-weather roads are almost non-existent. The area's weather is subject to the migration of the monsoon trough and has a southwestern-southeastern flow regime, with heavy rain through most of the year. Variations are acute between islands and even on the same island due to the orographic effects of the rugged terrain.

#### **5.1.3.4. NEW HEBRIDES, LOYALTY, SAMOAN AND FIJI ISLANDS**

These islands are all volcanic, though not as rugged as the Solomon Islands or Papua-New Guinea. They extend from 13° South to 23° South and 165° East to 177° West. The islands east of 180°, excluding portions of Samoa and Fiji, extending to 155° West, are a combination of coral atolls and volcanic islands and make up the Cook and Tonga Islands. The Tonga Islands extend from 15° South to

23.5° South and from 173° West to 177° West. The Cook islands lie North to South from 8° South to 23° South and from 156° West to 167° West. There are approximately 540 islands within the area between 180° and 155° West with sizes ranging from a few square yards/meters to 7055 sq mi (18272 sq km), and from a few feet/meters above sea level to 6090 ft (1857 m) on Savai Western Samoa.

#### **5.1.3.5. BRUNEI DARUSSALAM**

Brunei Darussalam is situated on the northwest coast of the island of Borneo. It is surrounded on three sides by the east Malaysian state of Sarawak and to the north by the South China Sea. It is divided into two parts by Sarawak. To the west is the main part consisting of three districts: Brunei-Muara, Tutong and Belait and in the eastern portion, Temburong. The terrain in the west is predominantly hilly lowlands rising to about 900 ft (275 m). The eastern area is a wide coastal plain that reaches up to the more mountainous regions. Vegetation in the interior consists mainly of primary and secondary tropical rain forests. Mangrove swamps and sandy beaches lie along the coastal plains.

#### **5.1.4. SOUTH INDIAN OCEAN**

##### **5.1.4.1. THE CHAGOS ARCHIPELAGO**

The Chagos Archipelago is administered as the British Indian Ocean Territory (BIOT) which roughly covers from 43° East to 73° East between 10° South and the equator. In this area are Gan and Diego Garcia islands, both of which are major British and U.S. military installations. The Chagos Archipelago is coralline in origin with very limited vertical extent; thus, they have very little effect on even local synoptic features. (Figure 5.1.3)

##### **5.1.4.2. KENYA**

Kenya is split by the equator with Somalia, Ethiopia and Sudan to the north; Uganda and Lake Victoria to the West; Tanzania to the south and the Indian Ocean to the East. The northern three-fifths of the country is arid. South of the Tana River, along the coast, tropical temperatures dominate. The region west of the plateau contains great volcanic mountain chains, of which the principal peak is Mount Kenya 17,058 ft (5203 m). The southern and southeastern portions of the country are heavily forested, and in the west, the immense depression of the Great Rift Valley is marked by a steep cliffline. The Great Rift Valley extends south from Lake Turkana. The land gradually descends from the western rift formation to the shores of Lake Victoria. (Figure 5.1.3)

##### **5.1.4.3. TANZANIA**

Tanzania is bordered on the north by Kenya, on the east by Rwanda and Burundi and on the south by Zaire, Zambia and Mozambique. The famed island of Zanzibar lies just off shore the northeastern coast. The Great Rift Valley runs through the central portion of the country. The Serengeti Plain extends from the southern shore of Lake Victoria in the northeastern corner to the border with Zaire/Zambia in the south. Savannah and tropical rainforest dominate the eastern third of the country. (Figure 5.1.3)

#### **5.1.4.4. MASCARENE ISLANDS**

Mauritius is located about 500 mi (805 km) east of Madagascar. The island was formed by a series of volcanic craters from north-northeast to south-southwest along the center of the island with gently sloping land to the coast. It is surrounded by a reef. The highest peak is 2,711 ft (827 m) with a general area of highlands and peaks about 2,500 ft (763 m) in the southwestern and western portions of the island. Mauritius is an independent nation. Port Louis, a seaport and major city, is on the west coast and averages 40 in (102 cm) of rain annually.

La Reunion is also volcanic in origin and very mountainous. A coastal plain from 0.5-3 mi (.8-4.8 km) wide surrounds the volcanic massif of the interior with the west central area containing several peaks over 9,000 ft (2745 m). Around the massif are wide basins which, in turn, are surrounded by plateaus which descend abruptly to the coastal plain. The climate is dominated by the southeast trade winds from April to October when the northern and western sides are dry and torrential orographic rains fall on the south and east. A trace of snow was once recorded on La Reunion. The rest of the year very light winds prevail, with the coastal lowlands being extremely humid. Elsewhere, temperature, rainfall, and humidity vary tremendously according to altitude. La Reunion is a department of France, similar to a state. The main port is Pointe des Galets in the west. (Figure 5.1.3)

#### **5.1.4.5. SEYCHELLE ARCHIPELAGO**

The Seychelles are located in the Indian Ocean about 1,000 mi (1,610 km) east of Kenya. The nation comprises an archipelago of 92 tropical islands with two distinct types of islands, some granite and some coral. The Mahe group consists of 40 granite islands, all within a 35 mi (56 km) radius of the main island of Mahe. These islands are rocky and most have a narrow coastal strip and a central range of hills rising as high as 3,000 ft (915 m). Mahe is the largest island and is the site of Victoria, the capital. The coral islands are flat with elevated coral reefs at different stages of formation. (Fig 5.1.3)

#### **5.1.4.6. MOZAMBIQUE**

Lowlands make up almost one-half of Mozambique's land mass and mainly consists of coastal areas. The central uplands are formed by plateaus, while mountains lie along the western frontier. Africa's fourth largest river, the Zambezi, divides the country in half north to south. (Figure 5.1.3)

#### **5.1.4.7. MALAGASY REPUBLIC**

The Malagasy Republic includes Madagascar and numerous islands off the east coast of Africa. Madagascar, one of the largest islands in the world, lies almost entirely in the tropics, from 12° to 26° South. The islands of the Malagasy Republic are volcanic and granitic in origin with the volcanic plateau comprising the backbone of the island, with peaks from 2,500-4,500 ft (763-1373 m) high. A narrow 30 mi (48 km) wide coastal zone lies to the east and low plateaus with vast plains extend to the west and south, 60-125 mi (97-201 km) wide. The coast is precipitous with numerous rocky inlets in the south (Fort Dauphin) and river estuaries and deltas in the northeast and northwest (Diego Suarez). (Figure 5.1.3)

#### **5.1.4.8. SOUTH AFRICA**

The Republic of South Africa is bordered on the north by Namibia, Botswana, Zimbabwe, Mozambique and Swaziland; on the east and south by the Indian Ocean; and on the west by the Atlantic Ocean. The topography of South Africa consists primarily of a great plateau, which occupies about two-

thirds of the country. The plateau reaches its greatest heights along the southeastern edge, which is marked by the Drakensberg Mountains. The Drakensberg Mountains are part of a range that makes up a portion of the Great Escarpment, which separates the plateau from coastal areas.

Within the plateau three regions may be distinguished: the Highveld, the Bushveld and the Middle Veld. The Highveld, which covers most of the plateau, ranges in elevation from 4000-6000 ft (1220-1830 m) and is characterized by level or gently undulating terrain. The northern limit of the Highveld is marked by a rock ridge, called the Witwatersrand. North of the Witwatersrand is the Bushveld or Transvaal Basin. The Bushveld, much of which is broken into basins by rock ridges, slopes downward from east to west toward the Limpopo River. The Bushveld averages less than 4000 ft (1220 m) in height. The western section of the plateau, known as the Middle Veld, also slopes downward in a westerly direction. The elevation of the Middle Veld varies from 2000-4000 ft (610-1220 m). Between the edge of the plateau and the eastern and southern coastline, the land descends seaward in a series of abrupt grades, or steps.

The interior step is a belt of hilly country, called the Eastern Uplands. The exterior step is a low-lying plain, called the Eastern Lowveld. On the south, the steps, proceeding from the interior to the coast, are a plateau called the Great Karroo, or Central Karroo; a lower plateau called the Little Karroo, or Southern Karroo; and a low-lying plain. The Swartberg, a mountain range, lies between the Great Karroo and the Little Karroo. Between the latter area and the coastal plain is another mountain range, the Langeberg. On the southern coast, just south of Cape Town, is an isolated peak, Table Mountain about 3563 ft (1087 m). On the southwestern coast the edge of the plateau is marked by a range of folded mountains, irregular in character and direction, which descends abruptly into a coastal plain. South Africa also includes a part of the Kalahari Desert in the northwest and a section of the Namib Desert in the west.



Figure 5.1.1 AUSTRALIA



Figure 5.1.2 NEW ZEALAND

### Western Indian Ocean



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Figure 5.1.3 WESTERN INDIAN OCEAN

## **5.2. OCEANOGRAPHY**

### **5.2.1. BOTTOM TOPOGRAPHY**

#### **5.2.1.1. SOUTHWEST PACIFIC OCEAN**

The Southwest Pacific Ocean is generally recognized as extending from the Equator through the Cook Islands and south to the region of the Subtropical Convergence near 45° South. The whole of the easternmost part of the Southwest Pacific Ocean consists of the Southwestern Pacific Basin with depths to 18000 ft (5490 m). From the basin arise numerous individual islands and seamounts together with dominantly linear island chains. The western margin is formed from north to south by the Tonga and Kermadec Ridges and by the Subantarctic Slope east of New Zealand. The central portion of the Southwest Pacific Ocean is occupied by the New Zealand Plateau and by three major ridges - Lord Howe Rise, Norfolk Ridge and Tonga-Kermadec Ridge. In the western part of the ocean are several major basins -- the Tasman, Coral Sea, South Fiji and North Fiji, with depths ranging from 12000-16000 ft (3660-4880 m).

The dominant sediment is calcareous ooze. Below 15000 ft (4575 m) calcite dissolves and the bottom sediment in deeper water is a residual or red clay. Volcanic ash sediments dominate the bottom around highly active areas. Terrigenous debris dominates the New Zealand Plateau out to approximately 3000 ft (915 m).

#### **5.2.1.2. CORAL SEA**

The Coral Sea is bounded by the coast of Queensland on the western side to include the Torres Straits, extending northward to New Guinea, then eastward to the New Hebrides and New Caledonia to 30° South, back to the coast of Australia.

The three largest barrier reefs in the world are located within the Coral Sea:

1. The Great Barrier Reef of Queensland on the northeast Australian continental shelf,
2. The Tagula Barrier Reef of southeastern Papua and the Louisiade Archipelago and
3. The New Caledonia Barrier Reef surrounding the island.

There are three major basins: the Coral Sea Basin including the Carpenter Deep at 16060 ft (4898 m), the New Hebrides Basin and the Santa Cruz Basin. There are three of the world's great trenches near the eastern margin of the Coral Sea: the San Cristobal Trench, forming an arc around the Solomon Ridge, the Torres Trench joined to the San Cristobal Trench, extending north-south on the west side of the Santa Cruz Plateau and the New Hebrides Trench around the south end of the islands.

The Coral Sea basin is covered mainly by pelagic red clay. The large plateau areas are largely covered by coral sands and carbonate muds. There are extensive volcanic sediments around the new Hebrides.

#### **5.2.1.3. TASMAN SEA**

The Tasman Sea lies between Australia and New Zealand and correlates roughly with a deep basin known as the Tasman Basin. This basin extends as far south as the Macquarie Island-Tasmanian Ridge. The floor of the basins marked by a number of seamounts. In the north, the Tasman Sea extends into the Coral Sea taking in the Lord Howe Rise, the New Caledonia Trough and Norfolk Ridge. The eastern borders are marked by the New Zealand Plateau.

#### **5.2.1.4. ARAFURA SEA**

The boundaries of the Arafura Sea are the Outer Banda Arc, West Irian (former Dutch New Guinea), Torres Strait, the Gulf of Carpentaria and 130° East. The Arafura Sea covers a large shallow

bank, the Arafura Shelf, which is a part of the Northern Australian Shelf. The Arafura Sea is separated from other basins by the Aru Trench in the north and west and the Timor Trough in the east.

Depths in the Arafura Sea range from 150-240 ft (46-73 m) with deeper areas near the trenches. The Aru islands form the most extensive land areas on the shelf.

#### **5.2.1.5. FLORES SEA**

The Flores Sea is bounded by the southern entrance of Makassar Strait, South Sulawesi Peninsula in the north to a line from southeast Sulawesi to the eastern tip of Flores Island to the Lesser Sunda Islands, then to the Paternoster Islands.

The Flores Sea covers four regions with different bottom configurations. The westernmost region is a submerged plateau with depths less than 3000 ft (915 m). Atolls are common on its submarine elevations. There are two deep channels: one near the Sunda Shelf boundary in the southwest and the other off the coast of South Sulawesi. These channels connect the deeper parts of the Flores Trough with Makassar Strait. The second subdivision is comprised of the deep, central Flores Trough with an irregular bottom relief and gently sloping sides. The third region consists of two parallel ridges with an intervening depression. The easternmost portion of the Flores Sea covers the area south of the Bone Gulf where it merges into the Banda Sea.

The broad, almost featureless, bank in the western part is covered by volcanic and terrigenous muds. The area around the Flores Trough and the Makassar Strait is covered by volcanic mud and coralline mud.

#### **5.2.1.6. GULF OF CARPENTARIA**

The Gulf of Carpentaria is defined as the large rectangular embayment bounded by Cape York on the east and Arnhem Land on the west. The whole area of the Gulf is rather shallow, not exceeding 228 ft (70 m), and generally between 150-210 ft (46-64 m). There are two major fault zones: one along the eastern shore and one along the western shore. The center portion of the Gulf is mainly a basin, with a depression adjacent to the eastern fault. Three distinct sedimentary layers are found in the Gulf: green marine mud, dark gray clay or fine silt and a white clay.

#### **5.2.1.7. SOUTHERN INDIAN OCEAN**

The bottom topography of the Southern Indian Ocean is covered in detail in Chapter 4.

### **5.2.2. MAJOR OCEAN CURRENTS**

#### **5.2.2.1. WEST WIND DRIFT (ANTARCTIC CIRCUMPOLAR CURRENT)**

The West Wind Drift is a circumpolar current completely encircling the Antarctic continent at approximately 50° South. The main flow of water is from the west to east under the influence of the prevailing westerlies. The West Wind Drift is the boundary between the sub-tropical waters to the north and the Antarctic waters to the south. (Figure 5.2.1)

#### **5.2.2.2. EAST AUSTRALIAN CURRENT**

The East Australian Current flows south along the coast of Australia and forms the western part of the anticyclonic circulation in the South Pacific. The current is formed at 20° South between the Great Barrier Reef and the Chesterfield Reef. From January to March, it is supplied with equatorial water driven west-southwest by the monsoon winds. From April to December, subtropical water masses entering the Coral Sea, from the east, supply the water.

The East Australian Current is strongest off Cape Byron, where its average speed is 1.2 kt from December to April (summer). During the rest of the year, the current averages 0.8-1.0 kt. In June and July (winter), when southerly winds are frequently very strong, a countercurrent flowing north develops farther offshore.

South of 32° South, the East Australian Current becomes broader, weaker and disintegrates into an eddy system. These eddies drift along the coast as far as Tasmania. Most of the water turns northeast, flowing across the Tasman Sea and moves north of New Zealand. (Figure (5.2.1))

### 5.2.2.3. WEST AUSTRALIAN CURRENT

The West Australian Current flows northerly along the western coast of Australia at an average speed of 0.4-0.7 kt during the summer.. The current becomes southerly and weak during the winter.

### 5.2.2.4. SOUTH EQUATORIAL CURRENT

The South Equatorial Current is the northern leg of the gyre which is a continuation from the West Australian Current at the Tropic of Capricorn due to the effects of the Southeast Trades. The eastern part of the current reaches its greatest velocity (above 1 kt) during the southern winter when the westward flow north of Australia from the Pacific Ocean reinforces it. (Fig 5.2.1)

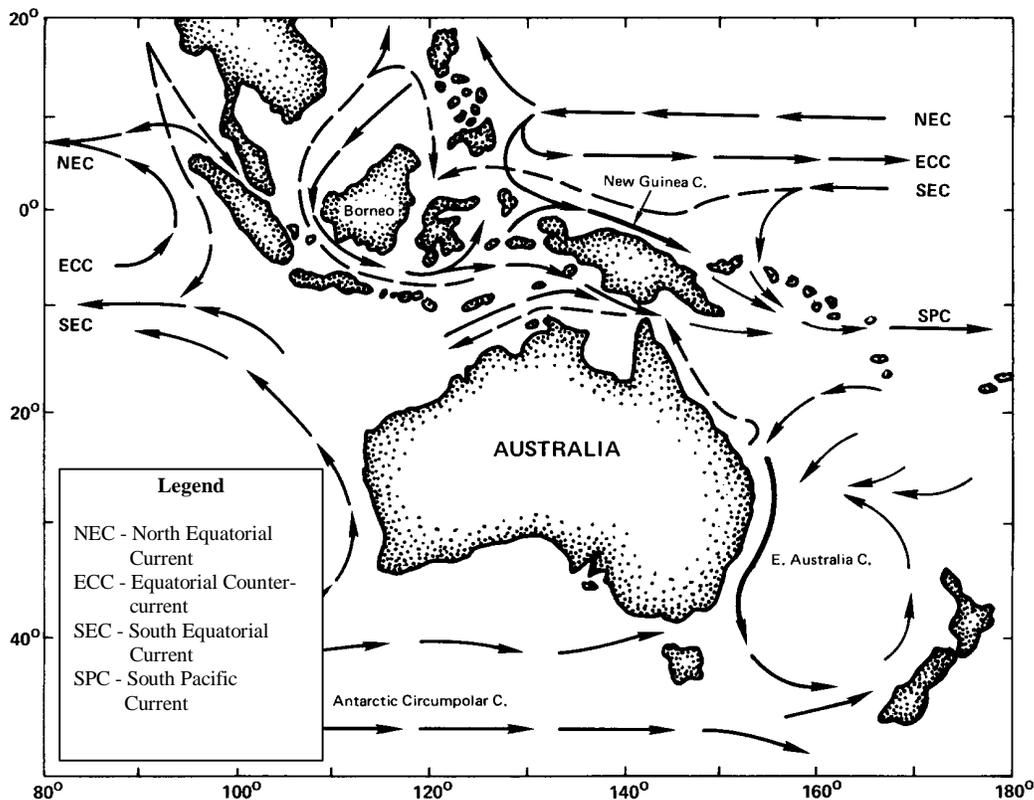


Figure 5.2.1 East Indies and Australian Currents

### 5.2.2.5. AGULHAS AND MOZAMBIQUE CURRENTS

The Mozambique Current is an extension of the South Equatorial Current that flows between the African continent and the Island of Madagascar. The Mozambique Current joins with another extension of the South Equatorial Current that flows down the eastern side of Madagascar. Either or both of these

currents flow into the Agulhas, which then flows southward toward the Cape of Good Hope before doubling back to join with the West Wind Drift. The interaction between the Agulhas and the West Wind Drift can produce rogue waves. As it is nearly impossible to forecast rogue waves, great care must be taken when transiting this area.

The Agulhas Current flows in a southwesterly direction parallel to the coast of Africa. It is quite strong and very narrow. The axis of maximum current speed tends to coincide with the 100 fathom depth contour. The following are rules for forecasting waves associated with the Agulhas:

1. If strong southerly waves/swell are expected, a ship should track as close to shore as safe navigation will permit (particularly if on a southerly track). If this is not feasible, stay well offshore (outside the 100 fathom contour).
2. If the predominant wave/swell is from the northeast, the most comfortable track will be found near the 100 fathom contour.
3. If expected waves are slight to moderate from any direction, the effect of the Agulhas Current on the ship's speed made good is probably the most important factor in tracking a ship around the Horn. (Figure 4.2.1)

### **5.2.3. SECONDARY CURRENTS**

#### **5.2.3.1. CORAL SEA**

The South Equatorial Current enters the Coral Sea between the Solomon Islands and the New Hebrides from January to March under monsoonal flow. During the remainder of the year, the Trade Wind Drift flows into the area. Both of these currents feed the East Australian Current.

#### **5.2.3.2. FLORES SEA**

Surface currents during the southern winter are toward the southwest at 1-1.5 kt. During the southern summer the direction is reversed at rates of 0.5-1 kt in the western half of the Sea and 1-1.5 kt in the eastern half.

#### **5.2.3.3. ARAFURA SEA**

Surface currents north of 8° South have irregular directions and are generally unsteady. South of this latitude the currents are predominately westward, running at 1-2 knots during the winter. During the southern summer the currents have no general directions.

## **5.3. METEOROLOGY**

### **5.3.1. SOUTH PACIFIC**

#### **5.3.1.1. AUSTRALIA**

The climate of Australia is generally warm and dry. There is, however, a diversity of climate due to the span of latitude. Because of Australia's position and size, climatic differences are generally a function of latitude but can be influenced by tropical air masses or extratropical storms in the westerlies. Temperatures range from mild in the south to hot in the interior and north. The north exhibits comparatively little seasonal change (20° F/11°C) along the coast. In the interior, seasonal temperature ranges exceed 30° F/17° C and a monsoonal (i.e., wet summer, dry winter) regime affects the northern third of the continent. Rainfall varies greatly across the continent. About 80% of the continent is either desert or subhumid, with droughts and floods possible over large areas. The three major factors influencing Australian rainfall are:

1. Latitudinal position;
2. The monsoonal effect, with high pressure dominating the north in the dry winter and the equatorial trough and associated tropical showers during the summer; and
3. The long hilly coast of the Great Dividing Range, which is exposed to the southeast trade winds that bring consistent annual rainfall to the eastern highlands.

The climate of the western two-thirds of the continent is typically monsoonal north of 20° South and is Mediterranean south of 30° South. The eastern coast of Australia is dominated by the southeast trades. Most of the inclement weather comes in the summer (December through April) as a result of westerly monsoonal flow and the resulting tropical belt of low pressure. The intermediate desert zone lies too far north of the extratropical rain bearing storm track to receive rainfall regularly either in summer or winter. The northward movement of the Intertropical Convergence Zone (ITCZ) and the establishment of the semi-permanent high brings good weather in the winter seasons (May through November). The weather along the south to southeastern coast of Australia is largely controlled by an eastward progression of anticyclones, which make up a semi-permanent belt of high pressure. Between these migratory highs are troughs and low pressure areas. The axis of the climatological anticyclone lies across southern Australia in winter, drifts southward over the Great Australian Bight during spring and lies south of 35° South in summer. Gales are most likely in winter when storms from the "Roaring 40's" or "Whistling 50's" are able to penetrate northward. Troughs can penetrate as far north as 25° South.

#### **5.3.1.2. NEW ZEALAND**

New Zealand has a moist temperate ocean climate without marked seasonal variations in temperature or rainfall. Prevailing winds are westerly. Strong winds occur in Cook Strait. Cyclonic activity is one of the important contributing factors to the general moderate precipitation. Cyclones cross New Zealand either from the west or the northwest. During summer, cyclones generally move to the south and primarily influence the North Island. The South Island experiences migratory low pressure systems during all seasons of the year. New Zealand is subject to the regular passage of extratropical storms. The generally mountainous nature of the country causes extraordinary contrasts in volume and character of precipitation between the eastern and western sides of the Southern Alps. The mountainous terrain causes turbulent mixing which prevents formation of extensive low and mid cloud sheets. This results in high percentages of insolation. Thus, the mountains act as a mild heat source at higher altitudes.

### **5.3.2. SOUTHERN PACIFIC AND INDIAN OCEANS**

Because of the predominance of water in these areas, atmospheric circulation is far less complex than in the Northern Hemisphere. In the Southern Hemisphere winter, an extensive, warm, high pressure

ridge dominates much of the oceanic region along 30° South. This produces southeasterly trades in the northern portion and westerlies in the south. In southern summer, a warm low forms to the northeast of Australia, with weak troughing over the continent, resulting in a southward shift of the westerlies in the South Pacific Ocean.

Migratory lows which are present over the southern oceans originate in one of three well-defined source regions:

1. The majority of the lows form in the South Atlantic off the coast of Argentina and move rapidly eastward, passing south of the Cape of Good Hope.

2. A secondary region of cyclogenesis lies off the east coast of Africa, south of the Malagasy Republic, Madagascar and is a dominant feature of the southern winter season.

3. A small number of lows originate as waves on the Antarctic front which develop closed circulations and move northward ahead of outbreaks of very cold polar air masses from Antarctica.

### **5.3.3. AFRICA**

The climate of the area is chiefly dominated by the Southeast Trades which blow throughout the year but with variations in steadiness and extent. North of 10° South, the cross equatorial monsoon wind flow prevails from November to March with the Southeast Trades extending north from April to September when it is continuous with the Southwest Monsoon of the Northern Hemisphere.

The region below 30° South comes under the influence of migrating mid-latitude systems. The western region of South Africa, with its plateau region, will weaken systems as they move across the southern tip. An area of cyclogenesis exists just off the eastern coast between South Africa and Madagascar.

## 5.4. FORECASTING RULES

When forecasting for the Southern Hemisphere, several basic environmental factors must be understood. The southern summer occurs during northern winter. Lows in the Southern Hemisphere turn in a CLOCKWISE direction and southern highs in a COUNTER-CLOCKWISE direction. An easy way to remember this is: the wind feathers on an easterly wind should face away from Antarctica when plotted on the wind stem; a westerly wind stem would have the wind feathers pointing toward Antarctica on the stem.

NOGAPS 3.4 will tend to be quick to deepen and slow to fill lows. Speed of movement must be carefully monitored. Systems in the Southern Hemisphere, especially at 40° South and below, have been known to track at 40 kt or better. Because there are no land masses to interfere with speed of movement, close attention should be paid to 500 mb and even 700 mb winds when tracking systems.

The major areas of cyclogenesis, outside frontal wave formation, is the western side of the Cape of Good Hope after fronts depart the African continent and around the western Bight region of Australia. Both areas offer contrasts in air and sea temperatures, induced cyclonic turning and air mass contrasts.

GWAM 4.0 appears to have trouble with long period swell much in the same way as in the Northern Hemisphere. Sea and swell associated with a dynamic system is handled extremely well. Land - sea interface is of little concern except around the Tasman Sea area of Australia and the Cape of Good Hope. Care must be taken when forecasting conditions in the Tasman Sea, the Bass Straits (due to funneling), near the Cape of Good Hope and New Zealand.