SOUTH PACIFIC WEATHER

South Pacific Weather — What's Where?

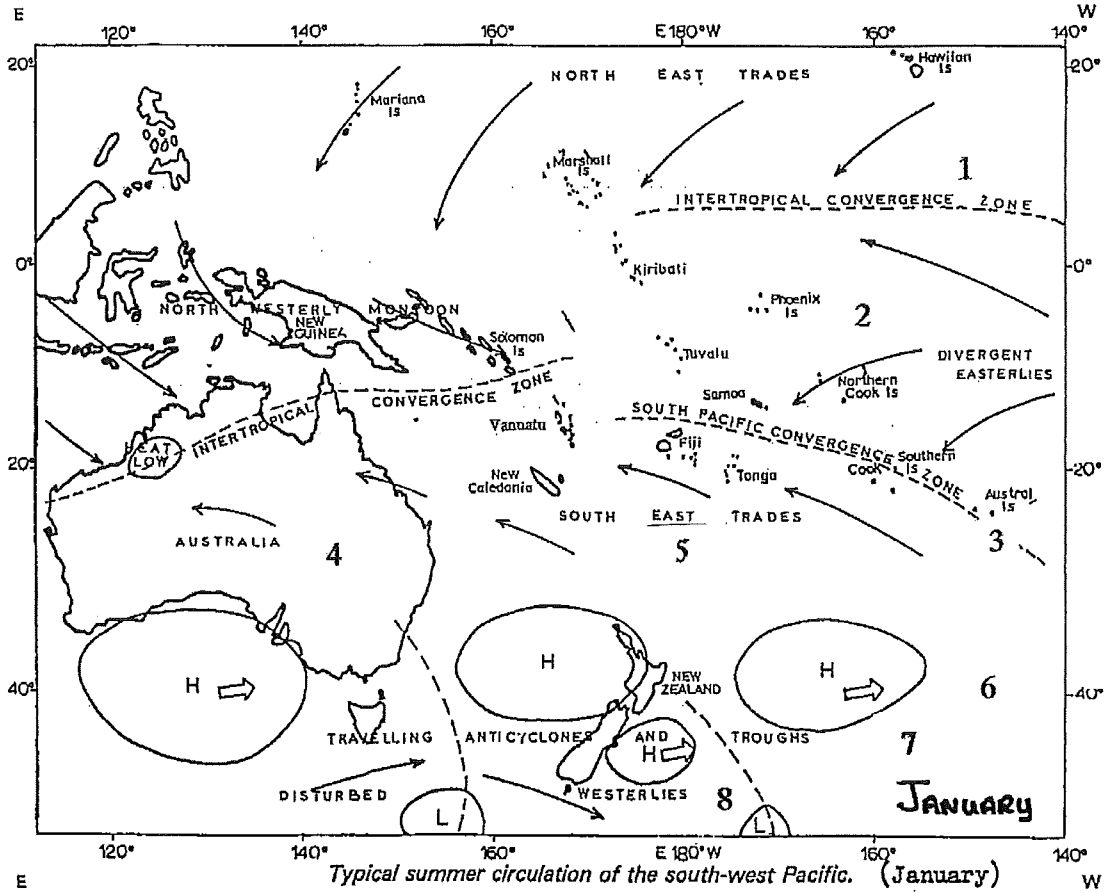
The prime movers of our air are fire and ice. The fire of the sun updates the warmth of the tropics every day. But each pole has six continuous dark months each year to grow icy cold. It is this varying temperature difference between equator and poles that drives our weather. On the daily weather map of the Pacific, between the warm equator and the icy Polar Regions, there are eight identifiable features that are normally present. These are shown in the diagrams on the next page, which also show how they move around with the time of year. *In the following descriptions, mention is made in italics about how some of features change during an El Niño event. (See the end of this section for more details.)*

1. The **INTERTROPICAL CONVERGENCE ZONE (ITCZ)** snakes across the Pacific always between 5° and 10° north of the equator. From July to October its western flank is over the Marshall and Mariana Islands, brewing tropical cyclones at the rate of one a week.

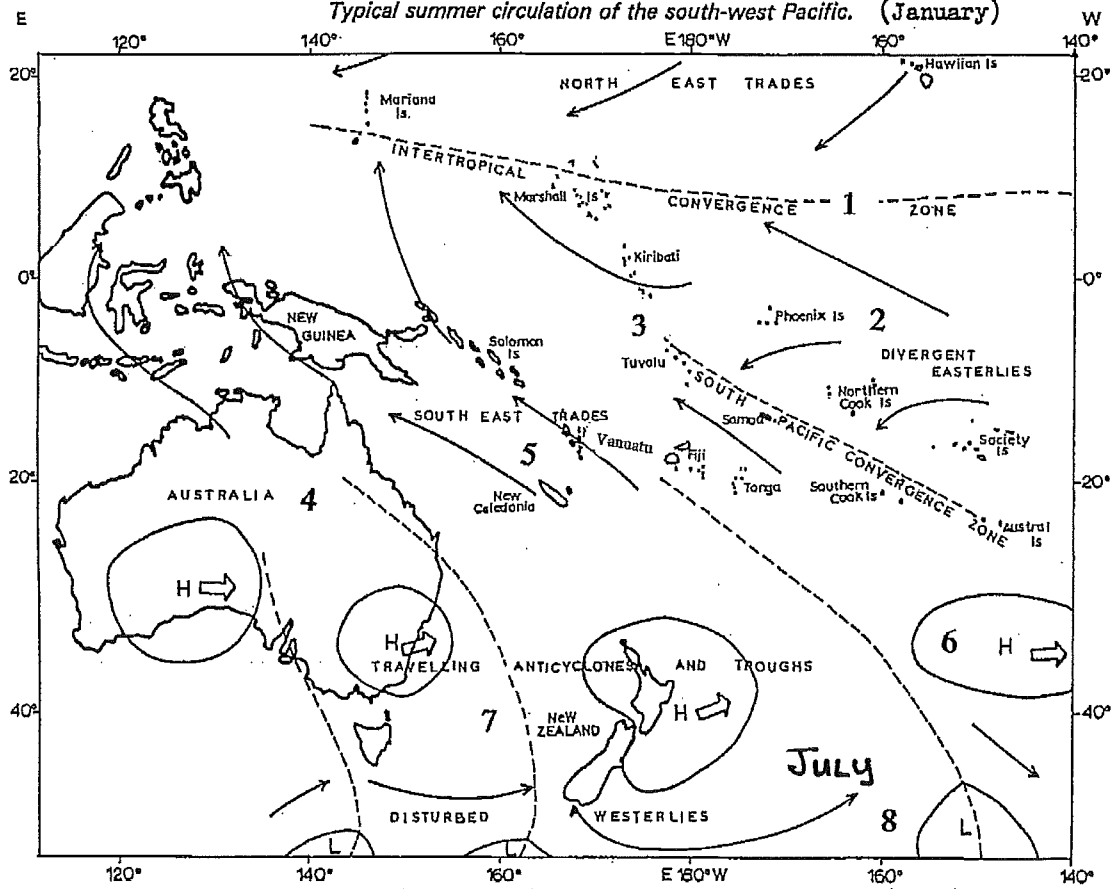
2. A flow of **EQUATORIAL EASTERLIES** is found over and about the equator. This flow, about 5 to 15 knots, comes from the northern side of a large semi-permanent area of high pressure found just west of the South American Andes. It spreads out (diverges) over the island groups just south of the equator where there is a remarkable zone of low rainfall. Often this flow runs out of puff especially around or just east of the Solomons; this is called a DOLDRUM area, and is characterised by light winds with scattered squalls.

3. The **SOUTH PACIFIC CONVERGENCE ZONE (SPCZ)** (also called the Trade Wind Front in French Polynesia) is where the equatorial easterly winds converge with (bump into) the southeast trade winds. It is a zone where clouds form, some containing occasional heavy and squally downpours (winds shifting in the immediate area and gusts reaching 30 to 40 knots in the squalls). Each cloud mass generally moves off to the southeast and dissipates as another cloud mass reforms near the source area. North of the zone, winds are often light and from the northeast, but within about 120 miles south of the zone, winds are usually from the southeast at 20 to 30 knots.

During May to October (dry season), this zone stretches from Tuvalu across Samoa and between the Northern and Southern Cooks. It is not very active and is often broken into segments, separated by as much as 600 miles of fine weather. Its squalls are not violent and could be a welcome relief from a hot muggy day. But from November to April (wet season), it is active, stretching on average from about Vanuatu to the Southern Cooks. This is the season when it brews tropical cyclones, usually about six to nine a year. These tropical cyclones are most vigorous when the sea surface temperatures are at their highest during February and March.
During an El Niño event, tropical cyclones are more likely than normal east of the date line about the Cooks and French Polynesia.



Typical summer circulation of the south-west Pacific. (January)



Typical winter circulation of the south-west Pacific. (July)

In the area between Niue and the Southern Cooks, every so often a tropical depression (low) will form on the SPCZ. These depressions have strong to gale-force easterlies on their southern side, and take two to four days to move off to the southeast. They are heralded by a change in the swell waves and a shift to northeasterly winds accompanied by a very rapid fall in the barometer.

4. AUSTRALIA is continental. During its hot (wet) season (November to March), there is a HEAT LOW over the northwest. A branch of the ITCZ (more properly called a monsoon trough) stretches from north Australia towards the Solomons, sometimes to Tuvalu. The air to the south of this zone is usually dry and rather cloudless, whereas the air to the north blasts out of Asia (called the North-westerly Monsoon) and is wet and cloudy. *During an El Niño event, this monsoon is less wet than normal (droughts occur).*

From about May to September, the southeast trade winds are drawn into the heat over Asia. However, these winds decrease as they move across the Solomons and New Guinea, resulting in lots of shower activity and scattered squalls interspersed with areas of light variable wind.

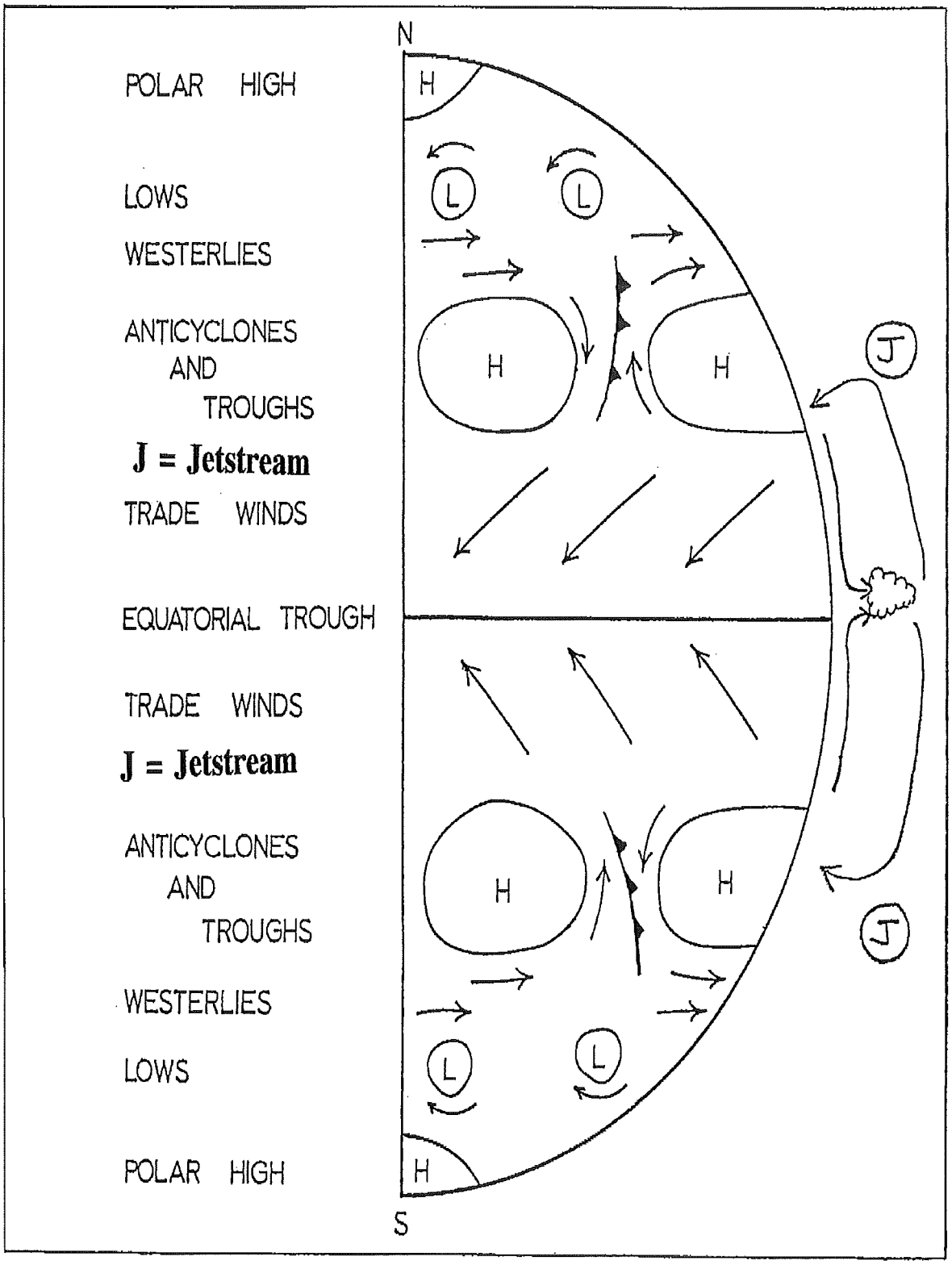
5. The **TRADES** is the name for the winds found in the tropics between the band of low pressure around the equator and the band of high pressure that lies roughly along 30° latitude, so called because they are reliable enough for sailors to use them as trading routes. In the Southern Hemisphere they blow from the southeast (but are more easterly about their northern limit).

General circulation theory for the earth explains the trade winds this way: sunlight reaching the surface is strongest around the equator, heating the air and forming the equatorial low-pressure band. This heated air rises and then spreads poleward where it eventually sinks, forming bands of surface high-pressure about 30° latitude. Propelled by this high pressure, surface air from the Temperate Zone flows into the equatorial low to help replace the rising air. The rotating earth deflects the direct path of the moving air towards the west, forming the trade winds, and preventing the pressure imbalance from being fully relieved.

Trade winds between 5° and 15° South are usually only 10 to 20 knots, and are freshest between May and October. Between 15° and 25° South, they can blow at 15 to 25 knots, building a 2 m swell and dragging the sea with a 1 to 2 knot set on a drift to the west. They also are reinforced when an anticyclone (say over 1030 hPa) tracks by to the south; this can take a week or so and is called BOGI WALU in Fiji (or MARA'UMU in French Polynesia). *In an El Niño event, they slacken and allow the hot water of the western Pacific to penetrate eastwards.*

In the trade wind belt, the eastern sides of larger islands are cloudy and often wet; the western sides of larger islands are sunny, and showers are suppressed over the nearby oceans. An interesting feature is wind banding — although the isobars may be drawn uniformly to an average wind speed, say 20 knots, within the trade wind belt, there may be long narrow bands stretching west to east, some

The General Circulation of the Atmosphere



containing 30 knots, and separated by other bands containing 10 knots.

6. The **HORSE LATITUDES**, also known as the **VARIABLES**, are so called because, in the past, sailing ships would become becalmed in the mid north Atlantic and crews would dump the horses. This is where high-pressure areas (anticyclones) travel generally from west to east. In the Pacific these highs usually end up merging with the semi-permanent high, which is found west of the South American Andes. The anticyclone track is, in summer (say, November to April), usually across the Southern Australian Bight and New Zealand latitudes. The track migrates northwards in winter, following the sun. Because of the seasonal variation of land-sea temperature differences, the winter track is further north over Australia than New Zealand. An anticyclone's strength and size change daily, growing to a maximum in about three days then decaying. Often, as one collapses, a new one forms somewhat to the southwest. It is common for an anticyclone to slow down west of New Zealand whilst a new nose of high pressure forms east of the Southern Alps. This new centre then moves off to the east while the old one dies.

*To get from New Zealand to the tropics, you have to cross the horse latitudes. They are not always serene: the Kermadecs and Minerva Reef are known as "**ship graveyards**". To find out why, read about Low Index Weather in the next section.*

During an El Niño event the travelling anticyclones are weaker and do not extend as far south as normal. More information about anticyclones can be found in the section How To Read A Weather Map.

7. TRANSIENT TROUGHS and **FRONTS** occur in the mid-latitudes where the main clash of air masses takes place. This is where any air flowing out of the tropics meets with air coming from Polar Regions. But these airflows are of different density so they do not mix — they clash, twisting around each other to make low pressure systems, and bumping into each other to make fronts. In the mid-latitudes, therefore, there is a varying procession of high and low-pressure systems.

Between every two major anticyclones is a trough. Note that the speed of this trough is determined by the behaviour of the features to its left and right. In the Southern Hemisphere, as each trough passes by, there is a transition from northerly winds (determined by the departing anticyclone) to southerly winds (determined by the coming anticyclone). Transition is gradual in the horse latitudes, but can be abrupt further south, with warm winds from the north being replaced by colder winds from the south bringing rain and sometimes-thundery downpours. Transient troughs are normally linked to depressions that move east or southeast along latitudes 40–60° south. These create changing swell patterns, which radiate northwards, giving cross-swells in the trade wind belt.

*Between Niue and French Polynesia, especially during the months April to November, there is what some call a "**frontal graveyard**" — the northern stretches of each front slow down and die here as they merge with the SPCZ.*

More information about fronts can be found in the section How To Read A Weather Map.

8. DISTURBED WESTERLIES, also known as the **ROARING FORTIES**, blow in the latitudes south of the travelling anticyclones. This region is marked by rapid changes from windy rain belts (troughs) to fair weather (ridges).
The average strength of the disturbed westerlies is related to the temperature difference between the tropics and Polar Regions. This is greatest when Antarctica is at its coldest, namely soon after the Spring Equinox (when the sun starts shining there after six dark months). So the winds of the disturbed westerlies have a strong season during the southern spring (September to November), at which time they also extend furthermost north (extending to 30° south latitude). Some New Zealanders call the winds at this time of the year "Equinoctial Gales".

RHYTHMS IN THE WEATHER

Weather is a mix of pattern and randomness. There are several rhythmic variations in the weather and climate patterns that can be useful. They repeat themselves, but they never repeat exactly. The sequence of the weather is easier to predict than is the timing. The difficulty in dealing with weather expectations beyond a week is that chaotic variations in the interim are likely to knock the weather onto a new path. It can then be misleading to try and pick developments in wind and rain with a daily precision.

• Low Index Weather
The usual pattern over New Zealand (higher pressure to the north, depressions to the south) is called "High Index" weather. This pattern is strongest during the southern spring (Sep–Nov). Occasionally, this pattern is disrupted by "Low Index" weather — if an anticyclone crossing the south Tasman Sea is preceded by an outbreak of cold southerly winds, this anticyclone may slow down and remain in the south. A consequence of this is sometimes the development of a deep depression (low) over the north Tasman Sea. Some such depressions can go through a period of explosive deepening, and move very quickly towards the North Island, changing moderate winds into gales almost without warning. These depressions are suitably called (meteorological) "BOMBS" (see the "case study" chapter).

• A weekly (6–9 day) cycle often appears within the area affected by transient troughs. This affects the Tasman Sea and New Zealand area usually during the winter and spring months (June to November). With this pattern, major cold fronts are about a week apart, so if there is unsettled weather mid-week then there is settled weather over the weekend (or vice versa). In the time it takes for a normal voyage across the Tasman Sea, this pattern means the voyager encounters a ridge-trough-ridge or a trough-ridge-trough sequence.

In the tropics, this weekly pattern affects the trade winds thus:
• The ridge gives strength to the southeasterly trade winds
• Winds then back to be from the northeast with cloudy conditions
• Winds then veer, returning to be from the southeast, with clearing conditions

• The Madden-Julian (six-weekly or 30 to 60 day) Oscillation is the name given to pulses (or waves) of increasing then decreasing rainfall that move out from the Indian Ocean across Indonesia into the central Pacific at least as far as the date line,

producing two weeks of unsettled weather, then four weeks settled. These are most noticeable during the wet season. During some years, these waves are regular and pronounced; whilst in other years they are erratic and weak. During the wet season, cyclones tend to form with the increased rainfall phase, which can sometimes be anticipated. It is not uncommon for as many as three cyclones to be triggered by the same oscillation.

• El Niño and La Niña events

In Peru at about Christmas time in some years, the coast becomes warm and salty. This brings rain, which blossoms the normally parched interior. Locals have labelled this pattern El Niño (which, in capitals, translates to Christ Child, after the time of year). It is a mixed blessing, for the rain causes landslides, and the warm salty water drives anchovies (local small fish) deep down or offshore and out of reach, making it a tough time for birds, tuna and other fish gatherers. El Niño is now taken to refer to one phase of an ocean/weather seesaw that spans the entire Pacific Ocean and beyond. The name coined for the other phase is La Niña (girl child).

This seesawing pattern takes several years to go back and forth. It works as follows: in normal years (La Niña phase), the Humboldt current and upwellings in the sea off the west coast of South America keep the sea there relatively cool and the sky cloud-free. Sun-heated surface water of the central Pacific is steered by trade winds towards Australia (equatorial current). This builds a bulge of hot sea between New Guinea and the Philippines, which feeds thundery showers. Air thrown up and out of these showers is drawn off to Peru where it sinks, bringing warm dry conditions (the Walker circulation). Sometimes (El Niño phase), the trade winds relax and ponds of hot salty equatorial water develop east of the date line and slop east towards Peru, creating their own pockets of rising air. These pillars of rising air split the Walker circulation into fragments with parts rotating in reverse.

The state of this climatological seesaw may be measured by variations in air pressure. Sir Charles Walker (on seeking insight into failures of the Indian monsoon which affected the price of tea) noticed that, often when air pressure at Darwin (Australia) is above normal, Tahiti is below. He coined the term Southern Oscillation Index (SOI) for the value of Tahiti minus Darwin (normalised) air pressure. One unit on the SOI scale is equivalent to one standard deviation from this mean. When the SOI is sufficiently negative (high pressure in the west and low in the east), the pattern is called an El Niño event or episode (sometimes referred to as a "warming event" or an ENSO event — El Niño phase of the Southern Oscillation). A sufficiently positive SOI gives a La Niña event. If SOI is near zero (less than 1 standard deviation from mean), the pattern is best described as indeterminate.

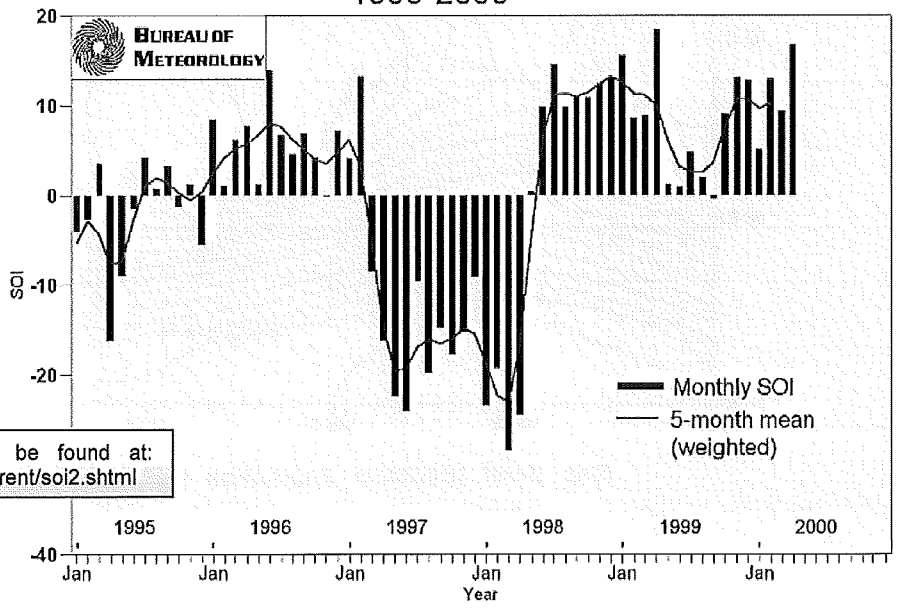
On average in the past, El Niño episodes have lasted a few years and been interspersed by several non-El Niño years. One theory is that global warming (and warmer seas) may lead to longer-lasting El Niño episodes in the future.

	La Nina	El Nino
Trade winds	Stronger	Weaker
ITCZ and SPCZ	goes polewards	goes equatorwards
Tropical Cyclones	most to west of dateline.	some to east of dateline
Australia	Longer wet season	Longer dry season
New Zealand	Northeast winds for Northland	Critical Southwest winds
Peru	Dry. Cool seas. Plenty of fish	Wet. Warm seas. Lack of fish

SOI values were mostly negative in the early 1990s. This lingering El Niño gave four dry years to Australia. In 1996, we had a weak La Niña. During 1997, the SOI plummeted quickly and the resulting El Niño has been called **El Niño Grande**, rivalling the large El Niño of 1982. Sea surface temperatures off Peru rose to 5° above normal. Floods occurred along America's west coasts, with droughts in Indonesia, Australia, and Papua New Guinea, also several tropical cyclones around the Cooks and French Polynesia during the 1997/8 season — standard El Niño weather.

During late 1998 and much of 1999, the SOI has been positive and a La Niña has brought drought conditions to Kiribati and floods to Fiji. The next El Niño is expected around 2001 or 2002.

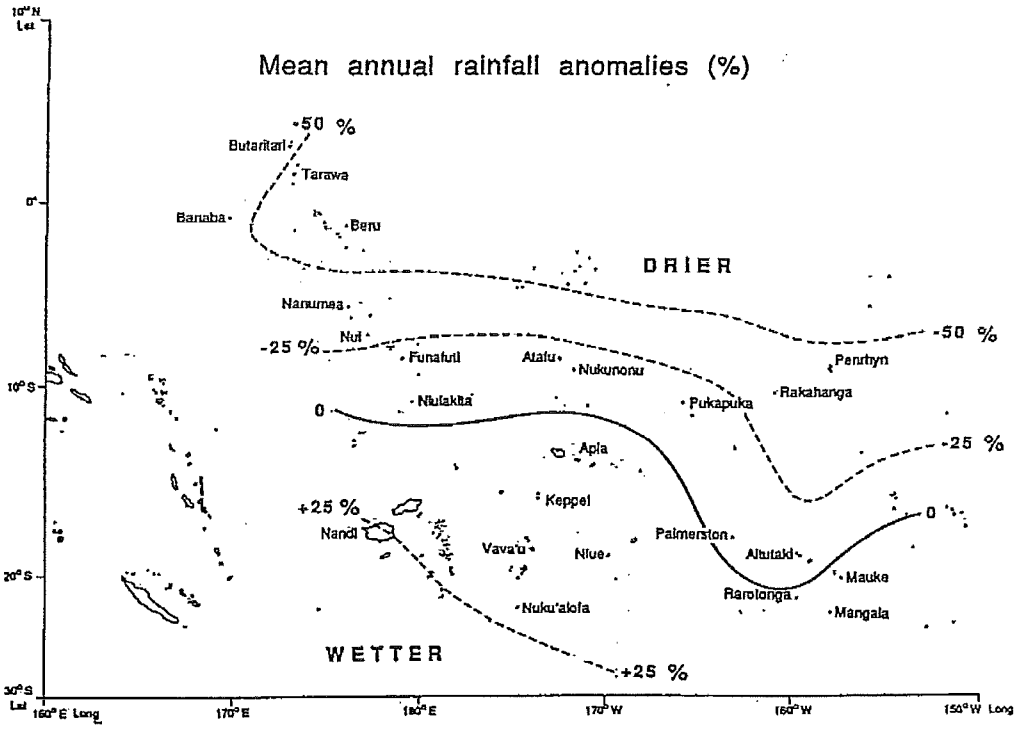
Southern Oscillation Index (SOI)
1995-2000

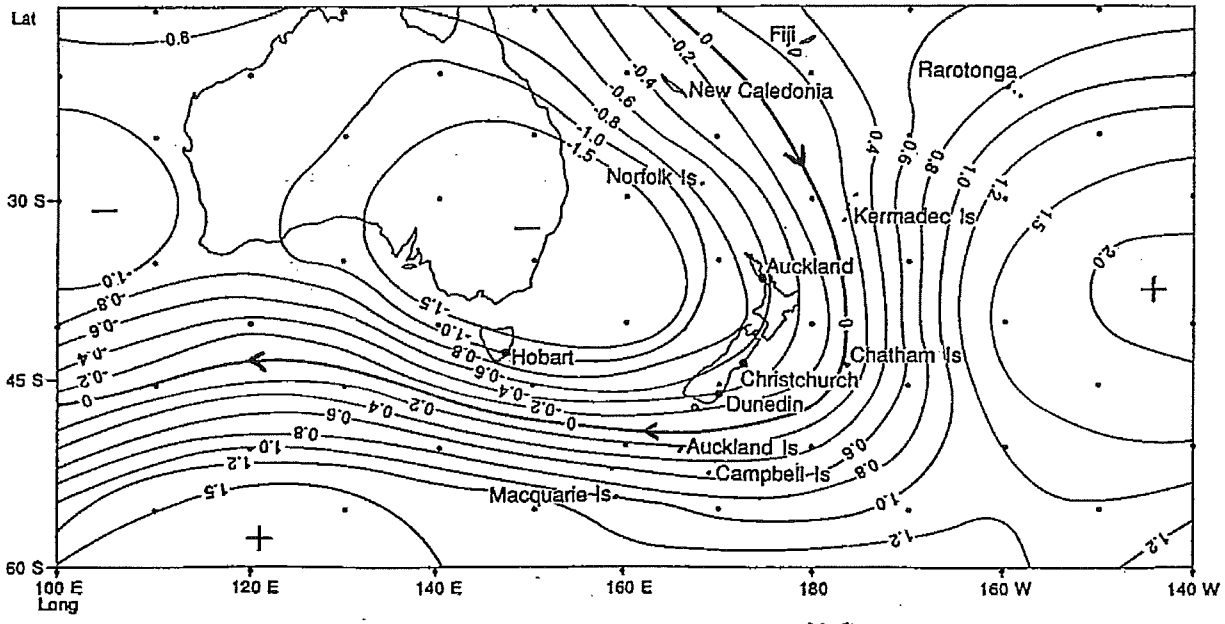


An update of this graph can be found at:
http://www.bom.gov.au/climate/current/soi2.shtml

These figures come from the article "Climatological Seesaws in the Southwest Pacific" by John Hay (University of Auckland), Jim Salinger (NZ National Institute of Water and Atmospheric Science), Blair Fitzharris (University of Otago) and Reid Basher (NZ National Institute of Water and Atmospheric Science) in the NZ Met Society Journal, "Weather and Climate", February 1993. Their permission is thankfully acknowledged.

La Nina (Southern Oscillation Index POSITIVE)
Pacific rainbelt shifts to the south. Good trade winds.

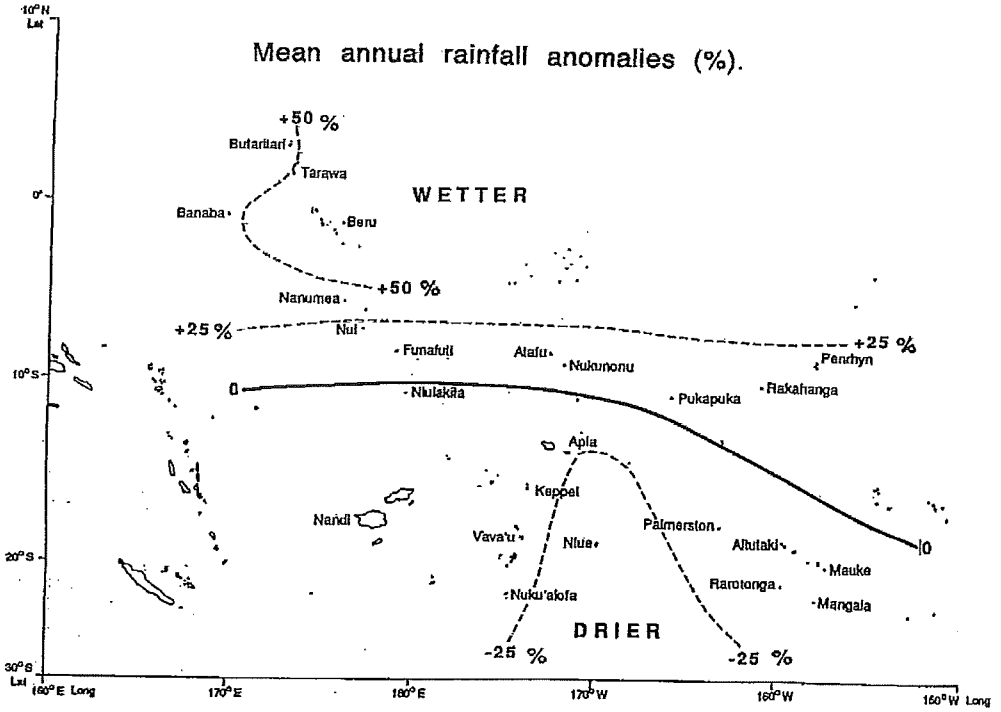


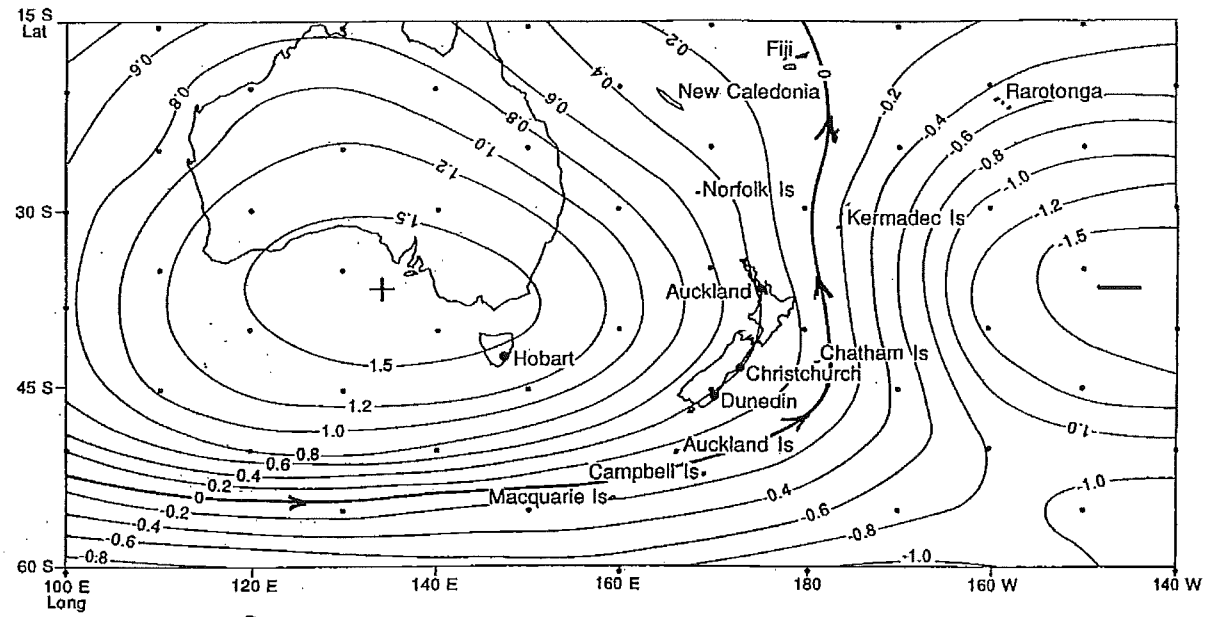


Sea level pressure anomalies (hPa) for May to October

These figures show that in a La Niña episode, the SPCZ spends more time over Fiji and Tonga and less time north of Samoa. In an El Niño event, the opposite occurs. In terms of pressure, the centres of action are well marked west and east of New Zealand. New Zealand is, therefore, in the key pivotal position, and (during May to October at least) the wind flow over New Zealand is sensitive to the SOI, with anomalously extra southerly flow when SOI is negative, and northerly flow when SOI is positive.

El Niño (Southern Oscillation index NEGATIVE)
Pacific rainbelt shifts to the north. Weaker trade winds.





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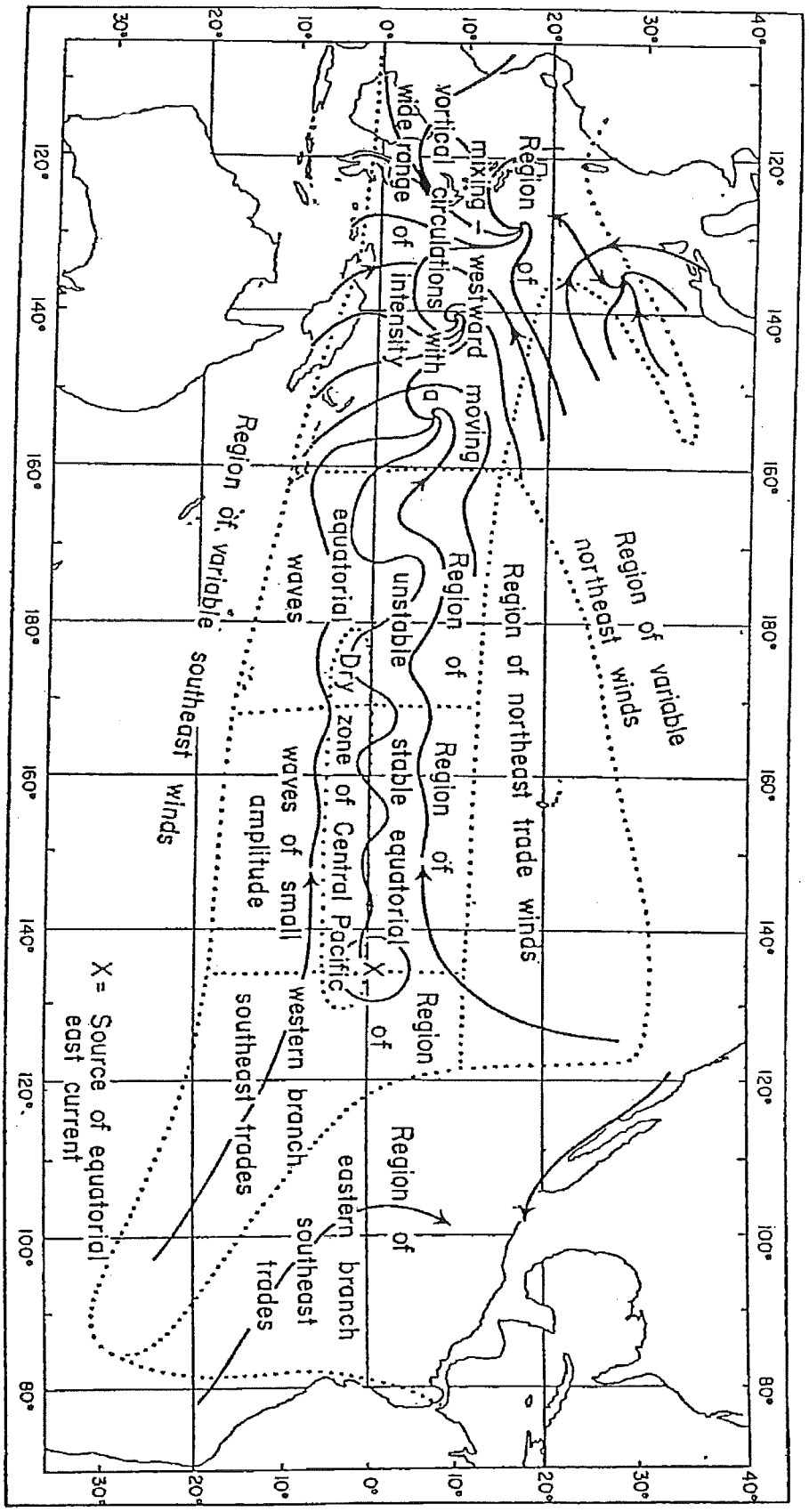
Region of variable northeast winds
Region of northeast trade winds
Region of stable equatorial
Region of southeast trades
Region of eastern branch southeast trades
Region of western branch southeast trades
Region of variable southeast winds
Region of unstable equatorial waves
Dry zone of Central Pacific
waves of small amplitude
vertical mixing
wide range of intensity
westward moving circulations with a
X = Source of equatorial east current
X
40°
30°
20°
10°
0°
120°
140°
160°
180°
100°
80°