Tropical Cyclone Season Summary 1998-99

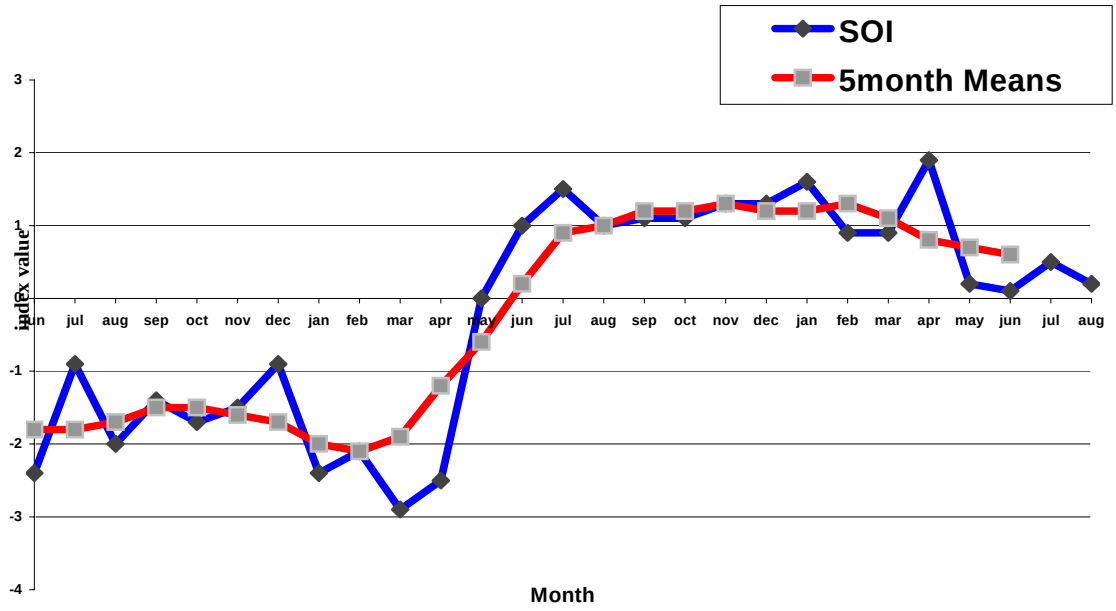
Introduction

A summary is presented of tropical cyclone activity during the 1998-99 cyclone season for the Regional Specialised Meteorological Centre Nadi - Tropical Cyclone Centre (RSMC Nadi-TCC) area of responsibility (Equator to 25°South, between 160°East and 120°West).

1998/1999 was an average season, as far as the number of tropical cyclones is concerned. This followed the arguably most active season, in terms of number, intensity and length, for the past 20 years, at least. Only six cyclones developed in Nadi's area this season. Another two, Olinda and Pete, from Brisbane's area of responsibility, visited only briefly. In total, seven cyclones affected Nadi's area of responsibility this season (discounting Gita, which, though formed in Nadi's area, attained cyclone status inside Wellington's). Of these seven, four cyclones attained hurricane force intensity.

The 1998-99 season was characterised by a cold ENSO episode; almost a complete opposite of the previous season's extremely warm situation. This contributed significantly towards this season's "slump" in activities. Monthly values of the Southern Oscillation Index (SOI) (refer to **Figure 1** below) were +13 in November, +13 in December, +16 in January, +9 in February, +9 in March and +19 in April. The shift from a warm extreme last season to a cold 'extreme' this season, also helped redeem the genesis area back to the Coral Sea region, from just east of the Northern Cooks, where it was anchored in the previous season. As testimony to this, five cyclones, out of the eight, had their origins in the Coral Sea region, this season.

Figure 1 **Southern Oscillation Index values vs 5-Month Running Means for the period 1997 to 1999.**



Another notable feature of this season was that about 50% of the cyclones that affected Nadi's area were small and compact systems, displaying "midget" characteristics. This did

pose some challenges, especially in intensity forecasts, to RSMC Nadi, which was attributed mainly to lack of proper research into, and understanding of their structure and behaviour, in the Southwest Pacific basin. Midgets, until very recently (last two to three seasons), were always a rarity in this region.

Table 1. Tropical Cyclones in the RSMC Nadi area of responsibility, for the 1998-99 Season. All dates and times are in UTC.

	Low first identified			Initial tropical cyclone phase			
Name	Date	Lat.	Long.	Date	Time	Lat.	Long.
Cora	21 Dec	14.0°S	173.5°W	23 Dec	1800	15.2°S	178.2°W
Dani	14 Jan	15.7°S	164.7°E	15 Jan	0000	15.9°S	164.9°E
Olinda*	19 Jan	15.0°S	155.0°E	20 Jan	0900	17.2°S	158.3°E
Pete*	20 Jan	17.5°S	150.0°E	21 Jan	0000	15.0°S	149.0°E
Ella	10 Feb	11.2°S	160.7°E	11 Feb	0600	13.4°S	164.4°E
Frank	16 Feb	21.5°S	150.1°E	18 Feb	1800	19.6°S	160.9°E
Gita**	27 Feb	24.5°S	156.1°W	27 Feb	1200	26.0°S	156.0°W
Hali	11 Mar	18.0°S	154.5°W	12 Mar	1800	20.2°S	159.1°W

	Maximum Intensity (knots)					End of Tropical Cyclone Phase			
Name	Date	Time	Lat.	Long.	Int.	Date	Time	Lat.	Long.
Cora	26 Dec	0000	20.6°S	175.4°W	75	28 Dec	0500	27.5°S	156.0°W
Dani	17 Jan	0000	15.1°S	163.4°E	95	22 Jan	0500	27.0°S	173.5°E
Olinda*	22 Jan	1800	23.9°S	165.0°E	50	23 Jan	1800	25.5°S	172.5°E
Pete*	24 Jan	0000	23.8°S	161.0°E	50	26 Jan	0000	24.7°S	167.6°E
Ella	11 Feb	1800	15.4°S	164.8°E	45	13 Feb	1200	25.5°S	170.0°E
Frank	20 Feb	0600	21.5°S	165.9°E	80	21 Feb	1800	27.0°S	163.0°E
Gita**	28 Feb	0600	27.0°S	155.5°W	45	28 Feb	1800	28.5°S	156.5°W
Hali	16 Mar	0600	22.4°S	164.1°W	65	18 Mar	1200	24.5°S	161.1°W

* Named by Brisbane TCWC, Australia.
** Named by Wellington, New Zealand

Verification Statistics

Position forecast verification statistics for each cyclone (**Table 2**) were derived by comparing the initial and forecast positions (given in warnings issued by RSMC Nadi-TCC) with post analysis 'best track' positions.

Overall, initial position errors were similar to previous seasons, with an exception to Cora, though to a lesser degree. This was basically due to difficulty in tracking the low-level circulation centre, while being subjected to strong vertical shear.

At 12 hours, the aggregate reveals persistence slightly better than forecasts. This was attributed largely to difficulties in forecasting re-curvature, especially with Hali and to a lesser degree, Dani, Olinda and Pete.

At 24-hours, forecasts show a significant improvement over persistence and are also slightly better than the previous two seasons. This was despite the better performance of persistence over forecasts at the 24-hour lead-time with Hali, which was due to the cyclone's unique midget characteristics, together with the reasons given above.

Table 2. **Position forecast verification statistics for official warnings issued by RSMC Nadi, except those marked with an asterisk, which include warnings issued by Brisbane. Forecast positions are verified against the official best track. Persistence errors (in brackets) are included for comparison.**

Lead-time	0 hours		12 hours		24 hours	
Name	Mean error (km)	Number	Mean error (km)	Number	Mean error (km)	Number
Cora	53	23	94 (105)	11	221(283)	9
Dani	24	30	116 (108)	26	200 (267)	24
Olinda*	11	7	168 (158)	7	373 (433)	7
Pete*	43	10	151 (148)	9	325 (373)	10
Ella	27	16	144 (151)	9	245 (375)	7
Frank	25	12	75 (115)	8	144 (330)	6
Hali	18	23	99 (80)	21	157 (137)	19
Aggregate	30	121	117 (115)	91	216 (274)	82

Note : ***TC Gita is not verified because it attained cyclone status in Wellington's area of responsibility.***

In **Table 3** below, the radius of the circles (centred on the centroid of the errors) containing 50% of the operational initial positions, is smaller than 0.5 degree of latitude (55.5 km) for all cases. Therefore the warning positions could have been given as "Position Good", all of the time.

The forecast error centroids and size of the radius of the 50% circle (centred on the centroid of the errors) indicate bias and consistency of bias in the forecast positions. For example Cora, Olinda and Ella, consistently ran east of the expected track, so the centroids are biased to the west.

For the 24-hour forecasts, Cora's large westerly bias was due to the difficulty in forecasting its movement to the southeast when it was steadily moving south-southwest and also in locating the low-level circulation centre, when the cyclone was subjected to vertical shear. With Olinda, the large westerly bias at both the 12 and 24-hour forecasts were due to the expected turn towards the southeast instead of east. Pete's southerly bias was due to its steady movement towards the east against an expected turn to the south. The large northwest bias associated with Ella was attributed to difficulties in locating the system when the upper level canopy was tracking rapidly southeastwards.

Table 3. **Centroid of errors for initial (0-hour lead time), 12-hour and 24-hour forecast positions given in warnings issued by RSMC Nadi, except those with an asterisk as in Table 2, with the radius of the circle enclosing 50% of the positions. All distances are in kilometres.**

Lead-time	0 hours		12 hours		24 hours	
Name	Centroid E-wd, N-wd	Radius of 50% circle	Centroid E-wd, N-wd	Radius of 50% circle	Centroid E-wd, N-wd	Radius of 50% circle
Cora	5, 33	48	-52, 9	72	-164, 31	147
Dani	-11, 7	26	5, -19	106	16, -80	188
Olinda*	-3, -2	9	-125, 1	103	-261, 8	175
Pete*	-9, -15	41	28, -47	121	-2, -149	229
Ella	-5, 8	27	-52, 54	116	-182, 143	112
Frank	-4, -6	26	-30, -1	57	-77, 8	93
Hali	3, -6	18	-17, -36	86	-31, -65	158
Aggregate	-3, 6	34	-23, 12	107	-64, -40	199

Note : TC Gita is not verified as it attained cyclone status in Wellington's area of responsibility.

Figure 2 : Tracks of Cora, Dani, Olinda, Pete, Ella, Frank, Gita and Hali.

Tropical Cyclones in the RSMC Nadi area of responsibility, 1998-1999.

In the discussion that follows, distances are in nautical miles and wind speeds are 10-minute averages.

Cora (03F): 21 - 28 December 1998

RSMC Nadi began monitoring a disturbance over the Northern Cooks on the 18th of December (all dates and times in UTC[1]), which was embedded in the South Pacific Convergence Zone. The disturbance was drifting slowly west-southwest but convection was far from organised and was being influenced by diurnal effects. Nadi issued the first gale warning on the depression at 0600 UTC on the 21st in certain sectors, based on surface observations, as the system gradually intensified, while steadily tracking west-southwest.

Late on the 23rd, it stalled, made a tight loop, and then began to move slowly to the south-southeast. At 0600 UTC on the 24th, it was named Tropical Cyclone Cora, when it was located about 300 miles east-northeast of Nadi, but heading for Tongatapu in the Kingdom of Tonga, on which is located the capital, Nukualofa.

Cora developed rapidly after being named, reaching hurricane intensity by 0900 UTC on the 25th, when it was located about 150 miles northwest of Tongatapu. The cyclone reached its peak intensity of 75 knots at 0000 UTC on the 26th when just northwest of Nukualofa. The eye seemed to have made its closest approach to the island of Tongatapu around 0300 UTC on the 26th when it passed a short distance to the northeast. Fortunately, the capital was located to the right front side of the hurricane.

After passing Tonga Cora began to accelerate, first towards the east-southeast, but finally southeastward and out of Nadi's Area of Responsibility (AOR). Wellington assumed warning responsibility after 0600 UTC, but within 24 hrs, Cora was deemed extra-tropical.

The lowest pressure recorded at Nukualofa was 959.5 hPa at 0400 UTC on the 26th and a peak gust of 70 knots was recorded 54 minutes later. Most of the damage was to agriculture, with root crops being the hardest hit. A few houses had damaged roofs and power was disrupted due to lines being downed. Tonga Broadcasting Commission's satellite receiver was damaged, forcing transmission closure from 0000 UTC on the 26th till 0330 on the 27th. The overall damage estimate was placed at $19.6 million in Tongan dollars (equivalent to $12 million U.S. dollars).

Dani (07F) : 14 - 22 January 1999

A weak disturbance was first identified embedded in a monsoon trough just south of the Solomon Islands on 13th of January 1999, drifting southeast. After 0600 UTC on the 14th, convection improved significantly. However, the low-level circulation centre (llcc) was slightly sheared off this main activity area while diurnal effects were still influencing development.

[1] UTC - Universal Co-ordinated Time (same as Greenwich Mean Time)

The system continued to move generally southwards off to the west of Espiritu Santo Island in Vanuatu. By 0600 UTC on the 15th, convective organization had improved significantly with the llcc totally engulfed under this deep convection, which was cooling and expanding spatially. Nadi then named the system Tropical Cyclone Dani, locating it about 200 miles west of Port Vila.

About the time that Dani reached tropical cyclone intensity, a 500-mb ridge to the south strengthened, thereby preventing any further poleward movement. It then drifted slowly westward on the 16th as it rapidly intensified. Storm intensity (47 knots) was reached by 1800 UTC on the 15th, and hurricane intensity six hours later, as it drifted westward to about 250 miles west of Port Vila. Dani then began a slow northward track as it came under the influence of a mid-level anticyclone to its northwest. The cyclone reached its peak intensity of 95 knots at 0000 UTC on the 17th when it was located about 325 miles west-northwest of Port Vila. Dani was by now moving northward at a slightly faster pace and began to curve more to the northeast as the anticyclone to its northwest extended a ridge to the northeast. The storm also weakened slightly (80 knots) most likely, due to interaction with the SPCZ.

As the ridge to the north strengthened Dani turned more to the east, reaching the northern-most point of its track at 0000 UTC on the 18th, when it was located 150 miles northwest of the northern tip of Espiritu Santo Island. The cyclone then began turning slowly to the south as the main steering influence shifted from the ridge to its north to the mid-level ridge to its east and southeast. Dani then assumed a southeasterly course before turning due south and struck the island of Espiritu Santo around 0300 UTC on the 19th, near Hog Harbour, with winds of hurricane intensity. Interaction with the rugged terrain weakened the storm further, but it re-intensified back to 80 knots as it accelerated away from it on its way south, brushing past the west of the country. Dani passed about 50 miles west of Port Vila at 0000 UTC on the 20th.

As Dani continued further south it passed close by the Loyalty Islands which lie east of New Caledonia, passing very near Mare Island around 0000 UTC on the 21st. From this point, the cyclone began to accelerate to the southeast and weaken as it came under increasing vertical shear. The warning responsibility was passed to Wellington after 1800 UTC. The cyclone became extra-tropical by 0500 UTC on the 22nd.

There were two deaths reported due to Dani: one on Ambae Island and one on Malekula. Bauefield Airport in Port Vila (on Efate Island) recorded 545 mm of rainfall in 24 hours, including 312.4 mm between 0000 UTC and 0600 UTC on the 20th -the average January rainfall for Bauefield is 457 mm. On Espiritu Santo, Malekula and some nearby islands, roads were badly damaged, and one bridge was washed 200 to 300 metres from its location. Many houses of lighter construction, plus some traditional homes, were destroyed. River flooding was the major problem on Efate with 12 homes destroyed in Vila by the La Colle River. Agricultural crops affected included sweet potatoes, yams, tapioca, kava, and coconut.

Olinda (09F) : 19 - 24 January 1999

Tropical Cyclone Olinda formed in the eastern portion of the Australian Region and was named by the Brisbane TCWC at 1800 UTC on 21st January. Shortly after this, it entered Nadi's AOR a strong gale (45 knots), steadily moving east-southeast towards an area of westerly shear and slightly cooler SST's. However, environmental factors outweighed this and the system intensified further to reach storm force at 1800 UTC on the 22nd, 24 hours

after being named. Wellington took over warning responsibility for this system after 0000 UTC on the 23rd, while on an easterly track. Peak intensity of 55 knots was reached at 1800 UTC on the 23rd, well into Wellington's AOR, when it was also deemed extra-tropical.

While in Nadi's AOR, Olinda did not directly threaten any populated areas. The cyclone remained on a relatively steady east-southeasterly trajectory, carrying it about 150 miles southwest of New Caledonia. Olinda passed about 150 miles south of Noumea at 0000 UTC on the 23rd, just as it was about to cross into Wellington's AOR.

Pete (10F) : 20 - 26 January 1999

Tropical Cyclone Pete also formed in the Australian Region and was named by the Brisbane TCWC at 1200 UTC on 22nd, when located about 400 miles east of Cairns, Queensland. Pete entered Nadi's AOR around 1800 UTC on the 23rd at a point only about 90 miles to the south of where Tropical Cyclone Olinda had crossed 160E, forty-eight hours earlier. Pete entered Nadi's area at its peak intensity of 50 knots and, like Olinda, moved at a fairly quick pace towards the southeast under a strong northwesterly steering current. The cyclone was being subjected to strengthening westerly shear at this stage and was also racing into waters already cooled by the passage of Olinda and Dani. At 0600 UTC on the 24th, it started to turn east-southeast and six hours later was located near our common boundary with Wellington. Warning responsibility was handed over to Wellington in anticipation of Pete's continued east-southeastward motion, but by 0000 UTC on the 25th, it was clearly evident on visible satellite imagery that the center was back north of the boundary.

Consequently, Nadi resumed issuing warnings as Pete headed east. However, unfavorable environmental conditions forced Pete to weaken and by late on the 25th the low-level centre was exposed, with deep convection sheared well off. Pete passed about 100 miles south of Noumea around 1200 UTC on the 25th and continued drifting slowly eastwards as it weakened steadily. It was downgraded to a depression at 0600 UTC on the 26th with gales continuing in the southern and eastern quadrants for another day or so. Pete did not approach any populated land areas during its lifetime in Nadi's AOR.

Ella (14F) : 9 - 14 February 1999

A depression was first identified by RSMC Nadi embedded in a monsoon trough just south of Rennel Island, the southern-most island in the Solomons, at 1200 UTC on the 9th., The depression drifted slowly eastward for a day or so, then turned to the southeast and began to intensify. Convective organisation improved greatly after 0600 UTC on the 10th. At the same time, vertical shear was steadily decreasing over the system. Nadi named the system Tropical Cyclone Ella at 0400 UTC on the 11th. After reaching cyclone intensity Ella turned southwards and accelerated.

Tropical Cyclone Ella passed about 100 miles west of the northern tip of Espiritu Santo around 1500 UTC on the 11th. The cyclone reached its peak intensity of 45 knots around 1800 UTC on the 11th. Soon after, an area of strong subsidence to the south of Ella and a southerly flow entrained drier air into the system hindering further development. Also, the steering current forced the cyclone quickly southward, into an area of increasing vertical shear. Consequently, the low-level circulation centre (llcc) was exposed for most parts of

the daytime hours on the 12th. Ella's intensity dropped also as a result, but was increased again at 1200 UTC as the llcc moved back under the deep convection.

Ella passed about 175 miles west of Port Vila, Vanuatu, at 0000 UTC on the 12th and accelerated to the south-southeast through the Loyalty and continued on within 60 miles east-northeast of New Caledonia around 1800 UTC, weakening gradually. Wellington took over warning responsibility after 0600 UTC on the 13th as the system slipped south of the common boundary. It was declared extra-tropical by Wellington at 0000 UTC on the 14th when it was located about 200 miles northeast of Norfolk Island.

The rapid translational motion through the Loyalty Group augmented the winds on the left-hand front side of the storm. Lifou recorded a maximum 10-minute average wind of 46 knots at 1314 UTC on the 12th with a peak gust of 65 knots. Some significant damage was sustained by buildings and vegetation on the northern side of Lifou, but, no casualties or fatalities were reported.

Frank (16F) : 16 - 23 February 1999

Tropical Cyclone Frank originated in the Australian Region, being a re-development of Tropical Cyclone Rona, which had wreaked havoc along the Queensland coast on 11th and 12th February. After Rona weakened over the Queensland coast, its remnant low to mid-level circulation tracked southward, re-emerging over water and then drifted eastwards. At 1800 UTC on the 18th, the system had just crossed into Nadi's AOR and was named Frank, while located about 350 miles west-northwest of Noumea.

Frank continued on a generally easterly course towards the northern tip of New Caledonia and intensified. The cyclone reached hurricane force just about the time it struck the extreme northern tip of the island around 1800 UTC on the 19th. As a ridge to the east began to build and with a trough approaching from the west, Frank was turned towards the southeast along the eastern coast of New Caledonia. Frank reached its estimated peak intensity of 80 knots around 0600 UTC on the 20th. The cyclone later turned south and crossed right over the middle of the island, close to Noumea, on the west coast. Friction together with increased northwesterly shear and cooler SSTs forced Frank to weaken rapidly. Warning responsibility was passed to Wellington after 0000 UTC on the 21st and became extra-tropical 18 hours later.

Frank possessed a very small radius of damaging winds. Some townships in the northern and western parts of New Caledonia suffered power outages, disruption to water supply and telecommunications, and there were some landslides on coastal roads. Flooding caused some crop damage in the northeast portion of the island, but there were no casualties or serious damage to infrastructure.

Gita (18F) : 27 February - 2 March 1999

At 0000 UTC on the 25th of February, a shallow depression was located just north of the Southern Cooks, embedded in the SPCZ and drifting slowly southwards. Convection was quite disorganised, though low-level cloud lines were already seen curving into the estimated low-level center. The depression at this time was located in a strongly sheared environment, but after 1800 UTC, the upper-level situation changed to favour development, with diffluence increasing and a weak ridge developing over the system. By 1200 UTC on the 26th, curved convective bands were beginning to form with the overall

organization greatly improved as the system moved out of the Southern Cooks towards the southeast.

At 0000 UTC on the 27th, Nadi issued the first gale warning on certain sectors only, when the depression was located about 175 miles southeast of Mangaia or about 275 miles southeast of Rarotonga. Another gale warning was issued 6 hours later as the system was nearing the border of the Wellington AOR. By 1200 UTC the system was clearly a tropical cyclone but had moved out of Nadi's AOR. It was then, named Tropical Cyclone Gita by Wellington.

Gita continued south-southeastwards into the "no man's land", reaching an estimated peak intensity of 45 knots by 0600 UTC on the 28th. It was downgraded to an extra-tropical gale 12 hours later at 1800 UTC. However, the system continued to display significant central convection until after 0600 UTC on the 1st of March. Atypical of most tropical cyclones in this part of the South Pacific, Gita was not picked up by a westerly trough and accelerated into higher latitudes. In a relatively weak, sheared environment with gradually cooling SSTs, the cyclone spun down slowly, continuing to generate some convection near the centre until March 2nd.

Hali (19F) : 11 - 19 March 1999

A tropical disturbance was first identified around 0000 UTC on 11 March, embedded in an active SPCZ between the Southern Cooks and French Polynesia and moving slowly southwestwards. By 0600 UTC on the 11th it had become a tropical depression about 300 miles east of Aitutaki. Still under the influence of diurnal effects and some significant vertical shear, the depression continued to develop slowly while drifting through the Southern Cooks. Although the depression stayed under a 250-mb ridge with much improvement in convective organization, the low-level circulation centre (llcc) was still partly exposed. By 1800 UTC on the 12th though, the llcc had slipped under the deep convection. The depression was then upgraded to Tropical Cyclone Hali while located about 90 miles north-northeast of Rarotonga.

Hali continued on a general westerly course for the next three days as it gradually intensified. Around 1200 UTC on the 15th, it was located about 325 miles east-southeast of Niue Island or 275 miles west of Rarotonga. The cyclone turned rather abruptly to the south at this time ahead of an approaching upper trough. At 0000 UTC on the 16th; Hali developed an eye, and the intensity was upgraded to hurricane for a 12-hour period. It reached its peak intensity of 65 knots around 0600 UTC on the 16th and after 1200 UTC, the cyclone began to weaken under increasing shear and cooler SST's. Interference from a developing depression to the east aided in Hali's rapid demise, and was therefore downgraded to a depression at 1200 UTC on the 18th when it was located about 200 miles south-southwest of Rarotonga. At 0000 UTC on the 19th, without any convection near the centre, Hali was caught up in the low-level steering field and drifted into Wellington's AOR. This very small, midget tropical cyclone did not cause any damage to any populated land area.