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TROPICAL CYCLONE REPORT 87/5

TROPICAL CYCLONE SALLY
26 DEC 1986 - 5 JAN 1987

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Note: Tropical Cyclone Reports are intended to be quickly available, preliminary, descriptive reports for public use. Their early issue means that details may be subject to subsequent correction.

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Introduction

Sally was the second intense tropical cyclone of the 1986-1987 season. It spawned from a trough of low pressure to the southwest of PukaPuka in the Northern Cooks and moved rapidly towards the southeast and then curved to the south before slowing down and executing a loop over an area to the north of Southern Cooks. After affecting the islands of Palmerston and Aitutaki in the Southern Cooks with a prolonged period of gale to storm force winds, it accelerated and passed almost directly over Rarotonga. The cyclone then gradually curved towards the east and weakened, passing to the south of the Austral Islands and bringing a very brief period of gales to the island of Rapa.

Sally's intensification was very rapid. It developed from a depression with gale force winds into a tropical cyclone with hurricane force winds of about 75 knots within 36 hours, and it retained hurricane intensity for about six days. Its well defined eye remained visible most of the time during this period.

The cyclone affected the island of Suwarrow in the Northern Cooks during its early developing stage. Within the next three days it did considerable damage to a number of islands in the Southern Cooks, especially to the main island of Rarotonga which suffered directly from destructive hurricane force winds. Palmerston and Aitutaki experienced some damage from the prolonged period of gales and a brief period of storm force winds. The rest of the islands in the Southern Cooks escaped from the damaging winds but suffered some damage from heavy swell in the low-lying coastal areas.

Very rapid development and its relatively long period of hurricane intensity (almost a week) were two of the more interesting features of Sally.

International Marine Warnings and Special Weather Bulletins for Southern Cooks were issued from the Tropical Cyclone Warning Centre (TCWC) at Nadi, until it passed south of 250S latitude and into Wellington's area of responsibility.

History

The development of a shallow depression from which tropical cyclone Sally later evolved was first noticed to the southwest of PukaPuka in the Northern Cooks around 260000 GMT* (see attached figure for details of track). By 261200 GMT, the depression moved towards the southeast and seems to have been centred about 90 miles to the south of PukaPuka. During the next 12 hours the winds at PukaPuka backed from northwesterly to southwesterly indicating that the depression had moved further to the southeast. The lack of significant pressure falls and any clear organization of the clouds in the high-resolution GMS-3 satellite pictures suggested that the development of a tropical cyclone in the next 12 to 24 hours was unlikely at that stage. Honolulu mentioned the development of the depression deepening into a tropical cyclone at 271530 GMT. Nadi TCWC issued the first gale warning on the depression at 271800 GMT and shortly afterwards named it Sally.

Post analysis of Suwarrow hourly weather observations from 261730 GMT showed that the estimated winds at this small atoll in the Northern Cooks had increased from northwesterlies at 15 knots at 270330 GMT to 40 knots by 271120 GMT and 60-80 knots by 271530 GMT. Even though these wind reports from Suwarrow are likely to have been over-estimated by an order of 20-30 knots or even more, it is still highly likely that the depression had developed gale force winds by 270000 GMT. Good organization of the clouds around the low by 280000 GMT, as evident in the high resolution satellite pictures, and the subsequent development of an eye by 282100 GMT substantiate the view of a rapid deepening of the depression from its early stages of a shallow depression at 260000 GMT into a tropical cyclone by 280000 GMT. In retrospect it seems that one of the likely causes of this rapid deepening may have been the favourable upper-level flow combined with the strengthening of the low-level westerlies to the north of the depression as tropical cyclone Raja moved to within 600 miles west of the depression while going through a loop. The broad belt of easterlies to the south, between the depression and ~ relatively intense anticyclone also hastened the rapid deepening of the depression, by contributing to the low-level cyclonic vorticity.

* Times are given in GMT in this format which includes the day of the month (in this case 26th).

Based on the favourable prospects for further intensification of Sally, Nadi issued a storm warning (for the high seas) at 280000 GMT and a hurricane warning at 280600 GMT. A small eye became visible in the GMS-3 high resolution picture at 282100 GMT and became more marked in the subsequent satellite pictures. The eye remained visible for most of the time during the next six days.

By 290000 GMT the maximum winds near the centre of Sally were estimated to be about 75 knots. During the next 24 hours the cyclone slowed down further to 03-05 knots and it became apparent at this stage that it was changing its course towards the southeast. In fact between 300000 GMT and 011200 GMT, it executed a loop that was fairly well monitored since the eye remained visible most of the time during this period. After completing the loop, Sally accelerated towards the southsoutheast at 07 to 10 knots.

The easterly winds at Pa1merston had increased to gale force by 290000 GMT and to storm force during the next 12 hours. However, from 301200 GMT the winds decreased to gale force and 24 hours later to below gale force.

The winds at Aitutaki increased to gale force around 310000 GMT but later dropped to near-gale force by 311200 GMT and remained as such until about 011200 GMT at which time Sally was coming out of the loop. After 011200 GMT, the winds at Aitutaki once again increased to gale force and near 020000 GMT to storm force as Sally came within 60 miles of the west of the island. As the cyclone accelerated towards the southeast, the winds at Aitutaki decreased rapidly.

By 021200 GMT, Sally was still maintaining hurricane force winds, with estimated maximum winds of 75 knots close to the centre and a visible eye, and was starting to curve to the south towards the main island of Rarotonga. From 020000 GMT the easterly winds at Rarotonga increased very rapidly from below gale force to storm force with gusts over 70 knots as the cyclone came within 60 miles northnorthwest of the island. Over the next 3 hours, winds increased to a peak of hurricane force with a maximum gust of 83 knots reported at 021400 GMT and 021500 GMT respectively~' During the period from 021800 GMT to 022030 GMT, Sally's eye passed very close to Rarotonga. The winds very rapidly dropped to below 15 knots and changed direction from easterly to northwesterly. The rain also eased considerably during this period, with the skies clearing partly to the west temporarily. The mean sea level (MSL) pressure dropped to a minimum of about 967mb around 021900 GMT. With the eye having passed over Rarotonga by 022100 GMT, the winds quickly increased to storm force and to hurricane force for a very brief period around 022300 GMT. Heavy rain once again affected the island. AT 030000 GMT, Sally was located about 40 miles to

the south of Rarotonga and had started to curve towards the southeast and continued to accelerate. Winds at Rarotonga decreased to below storm force by 030200 GMT and below gale force during the next 6 hours.

The sharp drop in wind speed, change in wind direction, and the fact that the rain eased and skies cleared partly temporarily indicate that Sally passed almost over Rarotonga. However, the anemograph there recorded a maximum 10 minute average wind speed of only 60 knots. It is possible that the anemograph at Rarotonga Airfield registered 5 to 10 knots below the true wind speed since Sally had every indication of being an intense system with hurricane force winds of over 63 knots when it passed over the island. However, this needs to be verified.

At 030600, GMT Sally was located about 80 miles to the southwest of the island of Mangaia. Estimated wind reports from Mangaia show that the northeasterly winds had reached gale force around 021800 GMT reaching hurricane force by 030200 GMT. Though there is no doubt that gales or even near storm force, winds affected Mangaia between the period from 021800 GMT to 031200 GMT, the reports of hurricane force winds during this period are considered to be over-estimates. By 031800 GMT Sally was located about 150 miles to the south of Mangaia, by which time the winds had gone round to the west and decreased to below gale force. Sally now moved towards the eastsoutheast at 15 knots as it came under the influence of strong upper-level westerly flow. Increased shearing caused Sally to weaken rapidly and it is estimated that shortly after 040000 GMT, it lost hurricane force winds and in the next 24 hours had acquired extra-tropical characteristics. The area of gales increased in the southern semi-circle due to interaction between Sally and a relatively intense anticyclone to the south.

At 050600 GMT Sally was located about 200 miles to the southwest of the island of Rapa in the Austral Islands. Rapa experienced a very brief period of gale force winds as Sally once again curved to the southeast and accelerated to over 20 knots.

Warnings and Advisories

Honolulu first issued an advisory on the shallow depression from which Sally later evolved at 270230 GMT. In the following two advisories at 270830 GMT and 271530 GMT Honolulu suggested the possibility of the depression deepening into a tropical cyclone. Nadi issued a gale warning on the depression at 271800 GMT and subsequently named it as Sally at 280000 GMT. Nadi upgraded the gale warning to a storm warning at 280000 GMT and to hurricane warning at 280600 GMT. Honolulu upgraded Sally to storm intensity at 281200 GMT and to hurricane intensity at 282100 GMT.

Nadi continued issuing hurricane warnings every six hours from 280600 GMT up to 031800 GMT after which the primary responsibility of issuing warnings on Sally was formally transferred to Wellington. Honolulu continued issuing advisories on Sally every three to six hours. Wellington issued its first hurricane warning on Sally at 040000 GMT by which time Sally was crossing the 25 degree latitude into New Zealand's area of responsibility. Wellington downgraded Sally to storm intensity by 041200 GMT. Tahiti commenced issuing a warning on Sally at 031600 GMT and continued thereafter as Sally moved closer to the Austral Islands.

Based on the estimated gale force and higher wind reports from Suwarrow as early as 271200 GMT (but not received at Nadi until much later) it seems that gales set in about 12 hours before the warnings was brought into force. The very rapid intensification of the depression and the non-availability of Suwarrow reports in time were at least partly responsible for the delay.

Honolulu's positioning of Sally was consistently 1 to 2 degrees to the West of Nadi's in the early stages of Sally, but the discrepancy improved to 0.5 to 1 degree as the eye developed. Some difficulty was encountered by both Nadi and Honolulu in locating the centre of Sally due to the lack of fine grids (the GMS-3 satellite picture is received with 10 degrees gridding). This problem was further compounded by the fact that Sally was located on the edge of both the GMS-3 and GOES-E satellite pictures, giving rise to parallex errors. The emergence of an eye in the cloud pictures at 282100 GMT and its continued appearance during most of the following six days helped in decreasing the uncertainities in locating the centre of Sally.

Nadi issued Special Weather Bulletins (SWB) for the islands in the Southern Cooks. A tropical cyclone alert was first issued for Palmerston and Aitutaki at 280300 GMT when Sally was located about 180 miles north of Palmerston. A storm warning was issued for Palmerston about twelve houns before Palmerston started to experience near-storm force winds. For Aitutaki a storm warning was issued two and half days before it experienced gales and, about four days before it was affected by storm force . winds. A hurricane warning was issued for Rarotonga twelve hours before hurricane force winds affected the islands.'

The Special Weather Bulletin for the Southern Cooks were issued every six hours when a gale warning was in force and every three hours once storm and hurricane warnings were in force. A total of fifty one Special Weather Bulletin were issued for the Southern Cook islands.

Domestic warnings for the Austral Islands in the French Polynesian archipelago were issued by Tahiti.

Winds and Effects

Sally caused considerable damage to the Southern Cooks, the cost of which was estimated to be over 30 million New Zealand dollars. Rarotonga, Aitutaki and Palmerston suffered extensive damage to houses, coconut trees and other vegetations. The rest of the islands in Southern Cooks also experienced some damage to wharves and coastal areas from high seas and heavy swells. The maximum winds and lowest pressures reported by some stations during the height of Sally are shown below.

STATION	MAXIMUM WINDS (KNOTS) AND TIME	MAXIMUM GUSTS (KNOTS) AND TIME	MINIMUM SEA LEVEL Pressure (Mb)
Palmerston*	70 between 291500 GMT and 291800 GMT	100 at 291500 GMT	993
Aitutaki	47 between 020500 GMT and 020700 GMT	70 at 020600 GMT and 020800 GMT	983
Rarotonga #	60 at 022300 GMT	83 at 021400 GMT and 021500 GMT	967
Mangaia*	75 between 030300 GMT and 030430 GMT	95 between 030300 GMT and 040500 GMT	986

* Palmerston and Mangaia wind reports are considered to be over-estimates by 20-30 knots.

It is possible that Rarotonga's anemograph registered 5-10 knots below the true wind speed.

The following is a detailed report of damages caused by Sally to the Cook Islands as received from Rarotonga.

Northern Cooks

Suwarrow

The people living on Suwarrow were caught unprepared for the gale force winds as no alerts or warnings were issued. Damage to the coconut trees was extensive as strong to gale force winds continued for about 1 to 2 days. Damage to houses was also reported.

Southern Cooks

(i)Palmerston

Prolonged gale force winds over a period of 3 days caused extensive damage to coconut trees and weak structures on coastal areas. Little damage to permanent housing was reported. Heavy swells caused some damage to coastal areas. It seems that cyclone Ima in February 1986 was more destructive. People took shelter in the interior of the island during the period of greatest risk.

(i i) Aitutaki

Aitutaki also suffered from a prolonged period of gales and for a brief period from storm force winds. Damage to housing was reported. High seas and heavy swells damaged the wharf and the cargo shed.

(iii) Rarotonga

Rarotonga suffered more than any other island in the Southern Cooks. Storm force and, for a brief period, hurricane force winds affected Rarotonga causing extensive damage to housing and vegetation. Storm surges reportedly caused severe damage in the low-lying coastal areas. A wave-rider buoy installed by the New Zealand Ministry of Foreign Affairs reported waves of more than 10 metres breaking on -the reefs.

(iv) Mangaia

Mangaia escaped any significant damage. However storm surge caused some damage to the wharf area on the, western coasts.

(v) Other island in the Southern Cooks

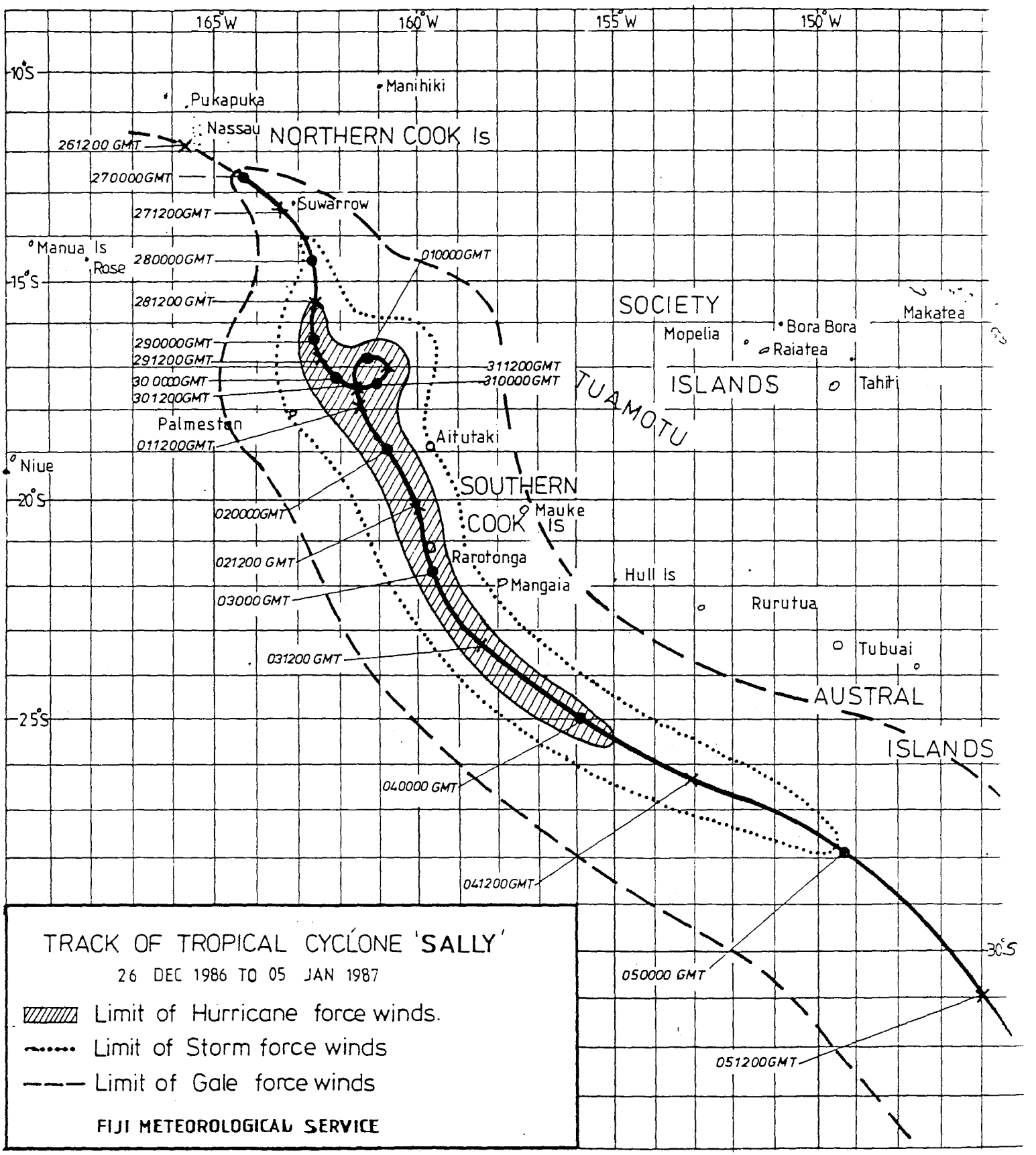
The rest of the small islands in the Southern Cooks suffered from strong to gale force winds and heavy swells. However, no reports of damage were received at Tropical Cyclone Warning Centre Nadi.

Conclusion

Sally was the second severe cyclone of the 1986-87 seasons and the first to have formed to the east of 170 degrees west. It was notable for its very rapid intensification and its long duration.

Sally caused considerable damage to the islands in Southern Cooks, particularly to Palmerston and Aitutaki, which suffered from a prolonged period of gales, and to Rarotonga, which experienced hurricane force winds. High seas and heavy swells caused a lot of damage to the low-lying coastal areas in these islands and the other small islands in the Southern Cooks. Suwarrow in the Northern Cooks also suffered some damage from Sally at its developing stage.

Apart from some delay at the beginning, warnings and advisories were issued in time and with few problems. Some difficulty was encountered in locating the centre of Sally owing to its position on the edges of both the GMS-3 and GOES-E satellite pictures. However, the presence of an eye during the most intense stages helped in locating the centre with more accuracy.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TRACK OF TROPICAL CYCLONE 'SALLY'
26 DEC 1986 TO 05 JAN 1987
Limit of Hurricane force winds.
Limit of Storm force winds
Limit of Gale force winds
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