REVIEW OF THE 2006-2007 AND 2007-2008 CYCLONE SEASONS

OVERVIEW OF THE FUNCTIONING AND PERFORMANCE OF THE AUSTRALIAN REGION TROPICAL CYCLONE WARNING SYSTEM FOR THE 2006-07 AND 2007-08 SEASONS

(Submitted by Australia)

1. Review of 2006-07 and 2007- 08 Seasons

1.1 The past two tropical cyclone seasons have continued the series of years with below average tropical cyclone numbers in the Australian region (105E–160E) since 2000, with the exception of the two near-average seasons, 2004-05 and 2005-06. In 2006-07 there were 5 tropical cyclones, which is less than half the average number, of which 3 were severe (reached Category 3 or more on the Australian scale). In the 2007-08 season, there were 10 tropical cyclones of which 4 were severe, but no severe tropical cyclone coastal crossings on the Australian mainland.

1.2 There were significantly less than average tropical cyclones in the Eastern Region - two in 2006-07 and only one in 2007-08, with one coastal crossing by category-2 tropical cyclone Nelson on the eastern Gulf of Carpentaria coast in February 2007. An intense monsoon depression in the Coral Sea was named Odette by Brisbane TCWC in March 2007 but was declassified after post-season reanalysis. However, there were a number of hybrid tropical lows during the 2007-08 season which either formed over the Coral Sea (December and January), or moved from land to sea and vice versa (January and February). Impacts included the evacuation of 3000 people from Fraser Island due to large waves and storm tides in December 2007, severe wind damage over land near Charters Towers, the sinking of 60 vessels at Airley Beach, unprecedented flooding at Mackay and Emerald, and severe flooding at Rockhampton, Townsville and Cairns.

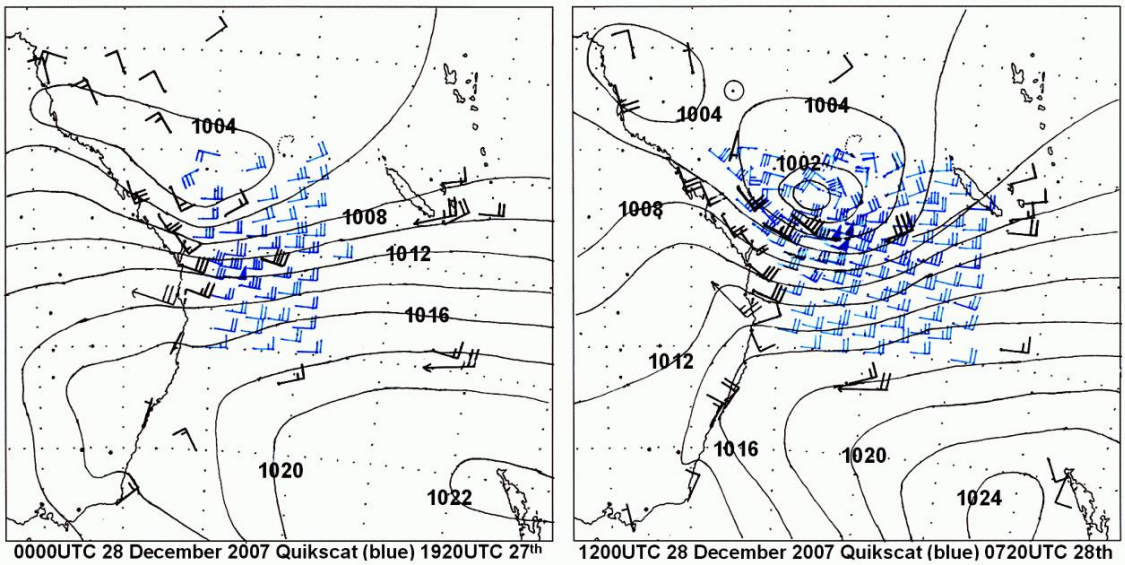


Figure 1. Development of a hybrid tropical low off the Queensland coast in Dec. 2007.

1.3 It is surmised that anomalous high-amplitude upper-atmosphere troughs affecting the Coral Sea contributed to the formation of baroclinic tropical lows rather than tropical cyclones in this region.

1.4 There were also below average coastal impacts in the Western region (105E-125E) during both seasons, with only two coastal crossings – George in March 2007, the most destructive tropical cyclone to affect Port Hedland for 33 years, and Melanie, in December 2008, an insignificant category 1 cyclone at landfall.

1.5 Severe tropical cyclone George was both very intense (category 5 at landfall) and also larger than average for the Australian region. The 194 km/h wind speed measured at Bedout Island is the highest 10-minute mean wind speed ever officially recorded in Australia. Three people were killed and many injured in demountable buildings at mining camps 100 km inland from the coast, due to an unusual persistence of very destructive winds for at least 8 hours after landfall.

1.6 Wind gusts to 145 km/h were recorded on the coast at Port Hedland Airport before equipment failure, where the lowest barometric pressure measured was 962.7 hPa. Estimated wind gusts to 205 km/h in the town of Port Hedland caused only minor damage to cyclone-resistant houses. Only ten roofs were lost and the Bureau of Meteorology's radar dome was damaged. Fortunately, the modelled 4.8 metre storm surge associated with George at landfall occurred at low tide, so the storm tide did not exceed the highest astronomical tide level.

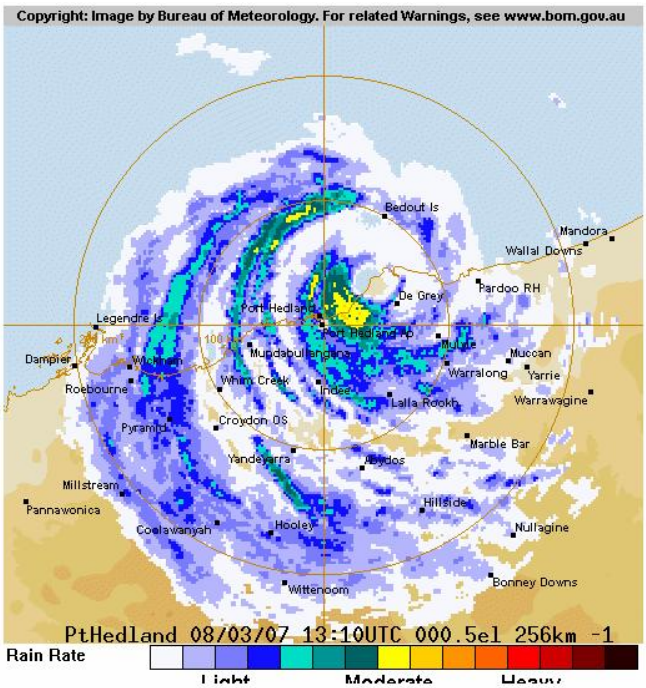


Figure 2. Severe Tropical Cyclone George as seen by the Port Hedland radar at landfall, 1310 UTC 8 March 2007.

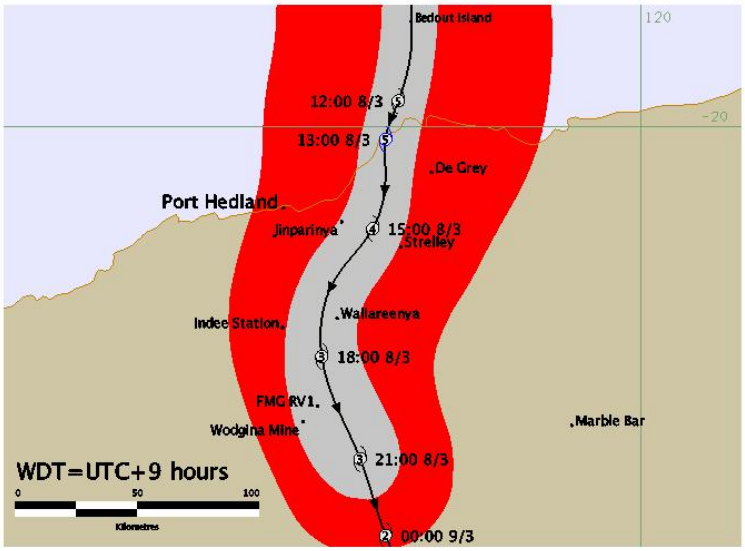


Figure 3. Simplified depiction of the swathe of the eye and very destructive winds in TC George.

1.7 Small tropical cyclone Jacob formed far to the northwest of George and an apparent Fujiwhara interaction between the two systems caused an abrupt 90-degree direction change in George's motion towards the coast, about 36 hours before landfall. Fortunately Perth TCWC forecasters were able to respond quickly to the change in situation and issued tropical cyclone warnings for a severe impact at coastal communities around 24 hours prior to the onset of gales.

1.8 Operational NWP guidance failed to capture this turn, and a standard consensus average of deterministic and statistical models produced very poor 48-hour track forecast errors in the Official Forecast Track at this time. However, it was noted after the event that some experimental UKMO ensemble members from earlier runs did forecast this scenario, although the majority of later EPS runs did not. This case is worthy of further study to investigate the cause of the failure of operational NWP guidance.

1.9 In the Northern Region, category 2 tropical cyclone Helen caused the first significant damage in the Northern Territory's capital city of Darwin in 22 years, mainly due to fallen trees and powerlines. Additionally, the precursor tropical lows to tropical cyclones George and Ophelia produced heavy rainfall and flooding in Northern Territory river catchments during March in 2007 and 2008. Significant rainfall and flooding also occurred in the semi-desert Pilbara and Fortesque regions of northwestern Western Australia in March 2008 due to the combined effect of tropical cyclones George, Jacob, Kara and Pancho.

1.10 Significant offshore impacts included the closure of Western Australian ports and northwest shelf oil and gas facilities due to slow-moving severe tropical cyclone Nicholas in January 2008. The cost of lost production was estimated to be between AUD $200m and $300m. Waves associated with tropical cyclone Nelson in February 2007 were measured up to 5.6 metres at Weipa on Cape York Peninsula and caused the helicopter evacuation of the crew of a zinc ore carrier in the southern Gulf of

Carpentaria. There were also peripheral wave and swell impacts on the offshore islands of Cocos Island in the Indian Ocean (TC Rosie, April 2008) and Norfolk Island in the Tasman Sea (TC Funa, January 2008 – east of 160E).

1.11 Unusual low-latitude tropical cyclones Guba (November 2007) and Pierre (May 2007) in the Eastern Region affected PNG. Guba was the first severe tropical cyclone on record in November in this region, and caused around 200 landslide deaths in PNG. Another unusual out of season tropical cyclone (Lee) formed briefly in the Indian Ocean in July 2007.

2. Overview of the Performance of the Australian Region TC Warning System

2.1 The Tropical Cyclone Warning System operated by the Bureau of Meteorology functioned well during the past two seasons. The continuing long-term decrease in forecast position error is due mainly to steady improvements in the performance of NWP guidance and the forecast process. Average 24-hour forecast position errors were slightly greater in 2006-07 (163 km) than in previous years (below 150 km), due in part to an unforecast change in direction of TC George and poor NWP guidance for this event. However the systematic use of consensus techniques incorporating the major global and Australian Regional models generally produces the best performing forecast overall and has contributed to a reduction in track forecast errors over the past 5 years.

2.2 The Australian Tropical Cyclone Module has been further developed, integrating the TCWC work process into its operation. The module and its shared database now enables forecasters to track, ingest NWP forecasts tracks and prepare text and graphical products at each of the 3 tropical cyclone warning centres in Australia. During the past four years, the TC Module-generated track map product has progressed from experimental status to a key operational product. Separate maps displaying past and forecast tracks have been combined into one product, the ‘TC Forecast Track Map’, which now includes a forecast track uncertainty area, showing the likely range of a tropical cyclone’s future movement out to +48 hours.

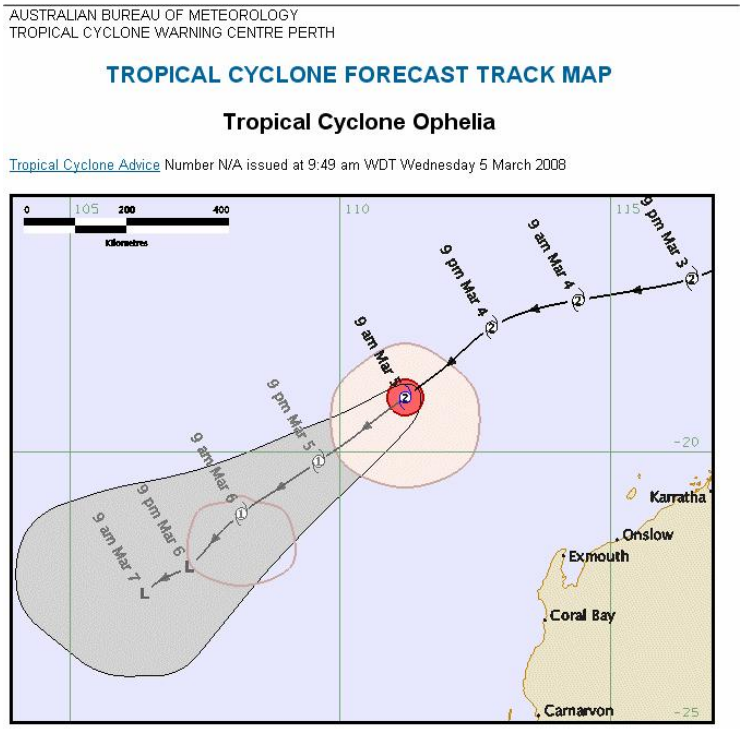


Figure 4. A Tropical Cyclone Forecast Track Map issued for TC Ophelia by Perth TCWC.

2.3 A significant regional development was the establishment of the Jakarta TCWC in Indonesia early in 2008. Bureau of Meteorology TCWCs in Darwin and Perth had previously provided an interim tropical cyclone warning service for the Jakarta area of responsibility from the Equator to 10S, between 90E and 125E. Although this interim arrangement has been concluded, Bureau assistance to Jakarta TCWC forecasters will continue in the form of special advisory messages and operational exchange of TC analysis and forecast data. Operational liaison and support was provided to Jakarta TCWC in February and March 2008 during TC Rosie and the TCWC's first named tropical cyclone, Durga.

2.4 A national Bureau of Meteorology tropical cyclone web site has been developed as a one-stop-shop portal for tropical cyclone information for the Australian region. A map showing the location of active tropical depressions and cyclones provides links to all associated outlooks, warnings and advisories. Additional links provide information about past tropical cyclones in the Australian region, FAQs, cyclone climatology, warning services and preparation and safety procedures. The web page can be found here: http://www.bom.gov.au/weather/cyclone/index.shtml.

2.5 A national TC Warning Services Strategic Plan has been drafted by the Bureau of Meteorology to ensure consistent policy guidelines for the provision of TC warning services in Australia, incorporating specific objectives and plans.

3. Tropical Cyclone Monitoring

3.1 Advances in the remote sensing of tropical cyclones over the oceans and new data displays have been gradually incorporated into operations at Australian TCWCs and provide an adjunct to the long-lived Dvorak technique of intensity estimation. The development of the high-resolution ASCAT sensor provides improved scatterometer wind data within tropical cyclones, while the Cloudsat radar provides cross sections through tropical cyclone clouds. Improvements to the display of microwave sensor data in 'morphed' animations, total global precipitable water displays and the 'pass mosaic' render this data easily accessible in real-time operations.

3.2 Offshore observations remain crucial for ground-truthing satellite intensity estimates, and despite the widespread Australian network of automatic weather stations (AWS), crucial data is frequently unavailable during the passage of tropical cyclones due to equipment or communication failures. However, the increasing investment in offshore production facilities is providing new opportunities to expand the offshore AWS network, especially in the northwest shelf area.

3.3 Weather radars continue to be the primary means of tracking tropical cyclones close to the coast, and enabling warnings to be updated hourly. The Bureau of Meteorology's five-year program to modernise its radar network is nearing completion, with replacement or upgrades to coastal radars at Darwin, Brisbane, Broome and Carnarvon implemented during the past two years. New radar products including Doppler wind fields and calibrated rainfall accumulation rates are progressively being made available to public users.

4. Tropical Cyclone Forecasting & Warning

4.1 The Bureau of Meteorology's TC Module has enabled the production of a range of improved services from Australian TCWCs. The official forecast track available to the public has been extended from +24 to +48 hours in graphical products such as the TC Forecast Track Map and text products such as the TC Technical Summary. Forecasts to +72 hours are available to specialised users such as emergency service authorities together with graphical products in GIS-compatible formats. Coded analysis bulletins (in CREX and BUFR format) are now being produced for tropical depressions as well as tropical cyclones for initialisation of numerical weather prediction models. Brief event summaries are uploaded to the Bureau of Meteorology web site as soon as possible after significant tropical cyclone impacts.

4.2 A dedicated team of software developers working with TCWC forecasters has driven the evolution of the TC Module to improve the efficiency of TCWC operations. Significant workflow gains have been achieved through a forecast policy wizard, automatic ingestion of track data, seeding of product templates and automated graphical product generation. Specific TC Module operating skills require a core group of TCWC experts, who must be trained before each season. In recent years, experts have been outposted to active TCWCs for short periods, however the development of a shared national database will allow the workload to be shared between two or more TCWCs via remote data input to TC Module.

4.3 A series of upgrades to Bureau of Meteorology NWP models, including the Tropical Extended Limited Area Prediction System (TXLAPS) and the high-resolution

TCLAPS have continued during the past 2 years. Although recent forecast performance has remained static, it is anticipated that the ingestion of higher resolution satellite data, an improved TC bogus system and nesting in the UKMO Unified Model will lead to significantly improved TCLAPS forecasts during the next two years.

4.4 Experimental tropical cyclone Ensemble Prediction System products have become available from various global centres during the past two years and are being integrated into the forecast process. The relationship between the spread of ensemble member TC tracks and the ensemble mean provides additional insight into operational TC track and intensity scenarios.

5. Storm Surge Modelling & Forecasting

5.1 With below average numbers of coastal crossings, storm tide modelling for TCWC operations was limited to two or three significant events. Operational storm tide forecasts using a parametric model for TC Helen's landfall south of Darwin were verified as accurate in a post-event survey. Despite this limited operational usage, significant development work in storm tide modelling has been completed during the past two years.

5.2 The software interface of the storm tide modelling system in use in Darwin TCWC has been upgraded and improved by a consultant. In Queensland, several projects have been completed including modelling of maximum storm tide inundations at key coastal locations, updates to the Queensland storm tide response system handbook and some hydrodynamic modelling. Perth TCWC is continuing to improve its operational storm surge methodology and is planning a change to the parametric modelling technique used in Darwin TCWC.

6. Operational Liaison with Hydrology/Flood Warning Centre

6.1 Drought-breaking rains in parts of Queensland associated primarily with three hybrid tropical lows required extended activations of the Brisbane TCWC and Flood Warning Centre during the 2007-08 season, over a total of 79 days. Monitoring of tropical cyclone development potential by TCWC forecasters and flood potential by hydrologists was necessary as several tropical lows caused severe weather and major flooding in many parts of Queensland.

6.2 Flooding in the Pilbara region of Western Australia after TCs George and Jacob required the activation of the Perth Flood Warning Centre in March 2008. The Darwin Flood Warning Centre was not activated in either season due to a lack of basin-wide flooding, however, significant sub-catchment flooding occurred in the lower Daly River, Fergusson and Adelaide Rivers.

7. Operational Interaction with the Media & Disaster Management

7.1 The frequent risk of severe weather and flood impacts in early 2008 affecting populated areas of Queensland resulted in a high level of demand for liaison with the media and disaster management agencies. At the height of the season, briefings for Emergency Management Queensland were provided by the Brisbane TCWC and Flood

Warning Centre twice each day, including detailed regional four-day outlooks. The dedicated media centre at the new accommodation for Brisbane TCWC was well utilised.

7.2 Effective working relationships between the Bureau of Meteorology, media and emergency service authorities were also tested in Western Australia and the Northern Territory during the few significant events such as the landfall of TCs George and Helen. Major events affecting key coastal communities attract widespread community and media interest and extend the Bureau's capacity to meet the demand for live and recorded interviews. Each TCWC provides additional staff to service this need, mainly during major events.

8. Communications

8.1 The Bureau of Meteorology's web site continues to experience a steady growth in demand, with access to radar imagery accounting for over one half of the Bureau's Internet traffic. Demand peaks during summer severe weather events, especially tropical cyclones. The new Tropical Cyclone Forecast Track Map has rapidly become the favoured method of accessing tropical cyclone forecast information when compared with conventional text products.

8.2 There is an increasing demand for SMS and email alerts for initial warnings but a corresponding decrease in demand for fax products. However, fax remains the most reliable means of dissemination for TC Advices to the media and emergency service authorities and also remote communities, as it provides a hard copy and a record of successful delivery of warnings. Recorded telephone warning services using automated text-to-speech technology are also well utilised.

9. Public Awareness & Education Programs

9.1 In all three Regions, a combined disaster mitigation and public awareness campaign was conducted prior to each season in vulnerable communities across northern Australia in collaboration with state and local government agencies. The campaign launch was coordinated with the release of a seasonal outlook for each region and also with a pre-season 'cyclone summit' at Cairns in north Queensland in 2007.

9.2 Public awareness resources were updated and developed for the Bureau's national TC web page, including the 'Surviving Cyclones' brochure, the web-based 'Storm-Watchers' children's game, descriptions of warning services, TC FAQs, safety and preparedness information.

10. Post-event Surveys

10.1 An investigation into damage caused by TC George in Western Australia was completed by Perth TCWC with help from structural engineers, and a report released. A damage and storm tide survey was also completed by Darwin TCWC after TC Helen, providing useful verification of maximum wind estimates and the storm surge forecast. Investigations continued into the impacts of Monica in the Northern Territory and Larry

in Queensland, focussing on damage to structures and vegetation. As a result of several recent category-5 cyclone impacts, reviews of building codes in northern Australia have commenced, resulting in an upgrading of cyclone shelter wind resistance regulations in Queensland.

10.2 Community surveys conducted by James Cook University in Darwin after a threat from TC Monica in 2006 reported high levels of preparation in response to Bureau of Meteorology warnings and the predominant use of the Bureau web site to access warnings. Preparation activities were focussed on residential dwellings rather than at workplaces.

11. Tropical Cyclone database

11.1 A major project is currently underway at the Bureau of Meteorology to correct the national database of historical tropical cyclone data in the Australian region and in the broader southern hemisphere region. The first phase of this project, involving correction of gross errors in the Australian region data and removal of hybrid tropical lows has been completed. Many hybrid tropical lows have a greater impact than the weaker tropical cyclones in the database, highlighting the need for a companion database for hybrid or sub-tropical lows.

11.2 The proposed second phase of this project incorporates a full reanalysis of source data held in at the Bureau of Meteorology and the National Australian Archives. This would result in a much improved database but would require a substantial investment of resources, yet to be confirmed. A web interface is under development to allow easy access to the database with a filtering capability according to a number of criteria.

12. Training Initiatives

12.1 A comprehensive set of tropical cyclone forecasting competencies have been recently finalised to underpin the Bureau of Meteorology's annual training program. Core competency training modules for TC genesis, Dvorak analysis, storm surge and wave forecasting have also been completed and are made available to staff online. Additional training resources on the principles of consensus track forecasting and interpretation of microwave imagery have also been developed.

12.2 An online TCWC simulation for a Western Region tropical cyclone was used as part of the pre-season training program in Perth TCWC in 2007. The simulation focuses on TC Module operations and TC forecasting skills. It is planned to expand the library of simulated events with Northern and Eastern Region cases during the next two years.

12.3 The Bureau of Meteorology hosted the 7th Southern Hemisphere Training Course on Tropical Cyclones in September 2007 in Melbourne.

13. International Activities

13.1 The Bureau of Meteorology's ongoing international cooperation activities include the regional development of meteorological services in the Southwest Pacific and South Asia.

13.2 Two meteorologists were attached to Nadi RSMC-TCC for one year each spanning both 2006-07 and 2007-08 seasons one funded by the Bureau and another under an AusAID Pacific Governance Support Program (PGSP) project to provide capacity building in support of tropical cyclone warning services. Additionally, a recent version of TC Module was installed and staff trained in its use at Nadi and also at the Vanuatu and Samoa Meteorological Services.

13.3 A major project to assist the Indonesian Meteorological and Geophysical Service to establish the Jakarta TCWC was completed at the end of 2007. Hardware and software systems were installed, including the Bureau's TC Module, and training programs for meteorologists and technicians were completed in Jakarta, Darwin and Melbourne. Ongoing operational support for Jakarta TCWC operations will continue for the next couple of cyclone seasons.

13.4 Two meteorologists from the Malaysian Meteorological Service participated in two weeks of TCWC training in Darwin in December 2007 at the same time as four Indonesian meteorologists. Five weeks of TC forecasting training was also conducted in Vietnam and the Philippines during 2007.

13.5 A regional subproject under the WMO-CBS Severe Weather Forecasting Demonstration Project in RA V is currently in the planning stages. Darwin RSMC will be involved in this project.

Acknowledgements: Joe Courtney (WA), Alan Sharp (WOSPB), and Jeff Callaghan (Qld).

Reiew of Past Cyclone Seasons

(Submitted by Cook Islands)

Although the Cook Islands has an average of two tropical cyclones a year, the two seasons of 2006/2007 and 2007/2008 did not bring any cyclones to the Islands. There were, however, some concerns in the number of tropical depressions that could have become but very short of tropical cyclones status. Two such tropical depressions in 2007/2008 season caused two boats to be thrown onto the reef within the vicinity of the main habour in Rarotonga. A close look at the criteria for the transition from tropical depressions to cyclones by RSMC Nadi and some definitions in the Tropical Cyclone Operational Plan would increase the awareness of the communities to the warning systems in the region.

2006/7 and 2007/8 Tropical Cyclone Seasonal Reports

(Submitted by Fiji)

2006/7 Season

Tropical Depression (09F): 4 – 5 Feb 2007

A weak tropical disturbance was first identified to the northeast of Rotuma on 31st January 2007 by RSMC Nadi. The disturbance eventually intensified into a tropical depression on February 2nd and initially drifted south-southwest. Through the 3rd, it began turning south-southeast, keeping to the west of Rotuma, as it headed towards Fiji. However, early on the 4th, the depression further turned towards the southeast, and headed directly towards the northwest coast of Vanua Levu. It made landfall along the Macuata coast, some 40km west-southwest of Labasa, between 2pm and 3pm on the 4th. The depression made its exit off the southern coast of Vanua Levu, a mere 20km west-southwest of Savusavu, between 4pm and 5pm on the 4th. As it made its exit from Vanua Levu, the depression accelerated southeast through the Lau group on the night of the 4th. On the morning of the 5th, it brushed past the southern parts of the Tongatapu group in Tonga, as it continued into the high seas, rapidly weakening.

The depression attained a maximum (10-minute) average wind speed of 32 knots and momentary gusts of 50 knots at its peak intensity. Associated torrential rain caused one of the worst, but certainly very destructive flooding incidents, in Vanua Levu, according to residents. Landslides and flooding destroyed forests, parts of villages and homes, as well as surrounding environment.

Tropical Depression 910F): 8-10 Apr 2006

TD10F was small/midget system that developed to the northwest of Fiji on April 7th and eventually made it into Fiji through the Yasawa group. At midday the centre was located about 36 nautical miles north-northeast of Nadi, heading towards the Rakiraki coast. The depression made landfall around 1.30pm on the 8th close to Rakiraki. Once over Viti Levu, the associated cold and deep convection was sustained by a strong influx of moist flow over the Bligh Waters and latent heat from the resultant strong precipitation activity. However, before exiting the Viti Levu landmass, strong friction induced by the rugged terrain together with strengthening shear basically tore the convection to two clusters. One was displaced to the southeast of Viti Levu generally towards the Capital, Suva. This cluster was soon refuelled by a strong, moist and humid onshore flow which eventually triggered an almost separate burst of very squally and torrential rain activity about the southeastern parts of Viti Levu. The main cluster was shuttled into Lomaiviti and later on over Southern Lau, significantly destabilised, during the latter part of the 8th and morning of Good Friday, April 9th 2004.

By 6pm on the 8th, the tropical depression was accelerating southeast about 20 knots and further into very strong northwesterly shear and cooler seas. This amazingly did little to dislodge the cold and deep convection off the system, though much reduced spatially and winds abating significantly. TD10F eventually moved into New Zealand's area of responsibility around 6am on the 10th.

Damage/destruction was confined to a thin strip along the path of the tropical depression. Nonetheless, at least 11 people are confirmed dead, and 9 still missing. Most fatalities were through drowning. Destruction of infrastructure and public utilities, particularly roads and bridges was severe, due mainly to flooding and landslides. Root crops, suffered severely. Other root- and fruit crops were destroyed or severely damaged. Most family homes were severely damaged or destroyed (blown or washed away). The business community also suffered severely mostly through flooding. The Kings Road between Rakiraki in Ra and Korovou in Tailevu, was closed for all traffic for several days as parts of the road were washed away. Communications into or out of this affected area was severed particularly during the height of the storm. Damage costs were confirmed at F$5.6 million (this figure includes damage costs to flooding in Tailevu, Rewa, Navua and Serua on April 15th).

Cliff (14F): 04-06 Apr 2007

Tropical Disturbance 14F was first analysed by RSMC Nadi on April 1st 2007 as a weak system 130 miles to the southwest of Rotuma and drifting towards the southeast. After 04/0000 UTC, as the deepening depression rounded the northeastern tip of Vanua Levu, and about 60 miles to the east-southeast of Labasa and approximately 15 miles to the east-northeast of Taveuni, TD14F was named Cliff. By this time, though, at least gales were present around the llcc some distance away from the centre, but rapidly increasing towards the centre. Once named, Cliff took a south-southeast track through the Lau group picking up speed as it coursed through, but keeping just west of Tonga. The peak intensity was attained at 05/1800 UTC with a central pressure of 980 hPa and maximum 10-minute average winds of 55 knots. The cyclone was then located about 150 miles south-southwest of Nuk'alofa, Tonga and poised to accelerate into Wellington's AOR under a strengthening northwesterly steering field.

Cliff caused extensive damage to crops, landslides from heavy intensity rainfall and flooding, minor damages to infrastructure, buildings and homes and disrupted communications and public utilities to certain areas in the eastern parts of Vanua Levu, Taveuni and nearby smaller islands. In the Lau group, damage to homes was minor but crops were severely affected. The total cost of damages caused by *Cliff* was approximately FJ$6 million. There were no reports of any serious damages from the kingdom of Tonga.

2007/8 Season

Tropical Cyclone Daman (04F): 05 - 09 Dec 2007

Daman was the first cyclone to occur inside the RSMC Nadi AOR in the 2007/8 Season. The cyclone was notable for its compact size as well taking an abrupt turn from a southward track to one of due east course late on the 6th. This sudden turn also spared the largest island in Fiji, Viti Levu, from the full brunt of the cyclone. Unfortunately, this change in track brought the centre right over or very close to Cikobia, an island lying a few miles to the north Vanua Levu.

TD04F was named *Daman,* whist located 50 miles east-northeast of Rotuma and beginning to turn west-southwest at 10 knots with gale intensity. Soon after 06/0600 UTC, whilst located about 180 miles north-northwest of Nadi and tracking southwards, *Daman* made an abrupt turn, heading due east. As it did, the cyclone essentially put Cikobia island, the northern-most island of the Fiji group and lying due north of Udu Point, Vanua Levu, directly in its path. At this time as well, an approaching short-wave upper trough upstream of the cyclone enhanced the associated outflow over the system. Convection also cooled further, and by 06/1200 UTC, spotting a cloud-filled eye, the cyclone's intensity was raised to hurricane force. The cyclone steadily intensified to reach peak strength by 07/1200 UC, with a central pressure estimated at 925 hPa and a maximum 10-minute sustained wind of 100 knots near the centre. Accelerating a little, the cyclone began to turn towards the southeast, staying just east of the Northern Lau group, Fiji. During the 8th, *Daman* took another turn towards the south, under a mid-level ridge to the southeast. Slowing a little, weakening set in quite quickly with strengthening vertical shear and cooler SSTs. By 08/1200 UTC it had weakened to a storm and 12 hours later, gale. The cyclone was downgraded into a tropical depression by 09/0600 UTC, whilst tracking south-southwest, through the southern island of the Lau group. The remnant of 04F was eventually lost into a quasi-stationary front to the south after the 10th, under hostile conditions.

Daman did its most damages on Cikobia island, with a population of 119. Damage to houses, school buildings, crops, fruit-bearing trees and foliage was extensive. Water pipes were damaged by felled trees. No life was lost to *Daman*. There were no reports of wave damage to coastlines anywhere in Fiji. The cost of damages was FJ$0.5 million.

Tropical Cyclone Funa (10F): 16 - 19 Jan 2008

TD10F, which later became Tropical Cyclone *Funa* was a rapid developer. It originated just west of northern Vanuatu, moving eastwards initially before turning southeast between Fiji and Vanuatu. *Funa* reached peak intensity with a central pressure 930 hPa and 10-minute average winds of 95 knots close to the centre at 19/0600 UTC. Through the 18th and 19th, as the cyclone steadily accelerated southwards, active bands of cloud and squally, heavy rain breaking off from the system brought strong and gusty north to northwest winds over the western half of Fiji, particularly. During this period, this part of Fiji experienced very rough to high seas with heavy swells. However, *Conway Reef,* was under hurricane warning for a brief period as the centre passed very close to it on its way southward.

Tropical Cyclone Gene (12F): 28 Jan – 03 Feb 2008

Severe Tropical Cyclone Gene was an unusually long-lived tropical cyclone, though not rare for the Southwest Pacific basin. Tropical Depression TD 12F was first identified by RSMC Nadi as a weak disturbance on the 26th of January, with a weak centre located some 180 miles east-northeast of Rotuma, moving south-southeast. Throughout the 27th, TD 12F made steady but significant intensification under minimal shear and developing upper outflow whilst also turning south-southwest towards Fiji. Between 27/1800 UTC and 28/0000 UTC, the depression turned southwest hugging the east and then southern coastline of Vanua Levu, under a mid-level ridge to the southeast.

During this period as well, Quikscat confirmed 10-minute average winds of at least 30 to 35 knots within 30 to 60 miles away from centre in the southeast quadrant moving with the depression. Though the large scale conditions were still conducive to further development, the effects of the topography of Vanua Levu effectively hindered the spin-up of the system, thus delaying the development of gales near the centre. However, by 28/0600 UTC, as the centre moved across the Bligh Waters, convection markedly erupted about it, with tops cooling significantly. In retrospect, TD 12F should have been named at this later time, but for humanitarian reasons, it was named *Gene* 6 hours earlier. During the night hours of the 28th, the cyclone tracked over Viti Levu making an entry on the northeast side and exit almost directly overhead of Nadi late in the evening, whilst also turning west-southwest over the Mamanuca Group. As it moved over water, it was upgraded to a category 2 cyclone at 29/0000 UTC, but due to moderate vertical shear, intensity was lowered briefly to category 1 at 29/1200 UTC. By 29/1800 UTC, environmental conditions improved and Gene began to re-intensify, reaching hurricane status at 30/1200 UTC, while located about 240 miles east-southeast of Port Vila, Vanuatu.

The cyclone continued to slowly intensify as it trekked west-southwest. It reached a peak intensity of 10-minute average winds of 85 knots and a central pressure estimated at 945 hPa at February 01/0000 UTC.

Six lives were lost in Fiji during *Gene's* passage, 2 to drowning, 1 while fishing, 1 to fire burns, 1 to cancer complications and the sixth during sleep. Significant damage was inflicted on homes, infrastructure, public utilities, education, health, agriculture and forestry. The total cost of the damages caused by *Gene* was FJ$51 million, according to the National Disaster Management Council (DISMAC) Task Force Report.

Operational Issues

1. Lack of quality terrestrial and upper-air observations in the region.
2. Verification of Dvorak in the Southwest Pacific region, beginning with upgrade of the synoptic observations network to ensure quality outputs always.
3. Real-time feedback to RSMC Nadi during TC events from National Meteorological Service's in the region - partnership in early warning.
4. Training on satellite-derived data for operational forecasters.

Recommendations

1. Regional synoptic observations network must be urgently upgraded to meet required standards and increasing demands.
2. Regional NMSs encouraged to provide feedback to Nadi on operational matters/impacts during TC events.
3. Availability of new data sources has overtaken the analytical knowledge/skills of forecasters in the region. Formal training for forecasters on scatterometry and other satellite-derived data and products is a priority need and must be undertaken as soon as practicable.
4. Capacity building in SIDs through short-term attachments of personnel or formal exchange of skills/tools between SIDs and our developed counterparts.

REVIEW OF THE 2006/2007 AND 2007/2008 TROPICAL CYCLONE SEASONS

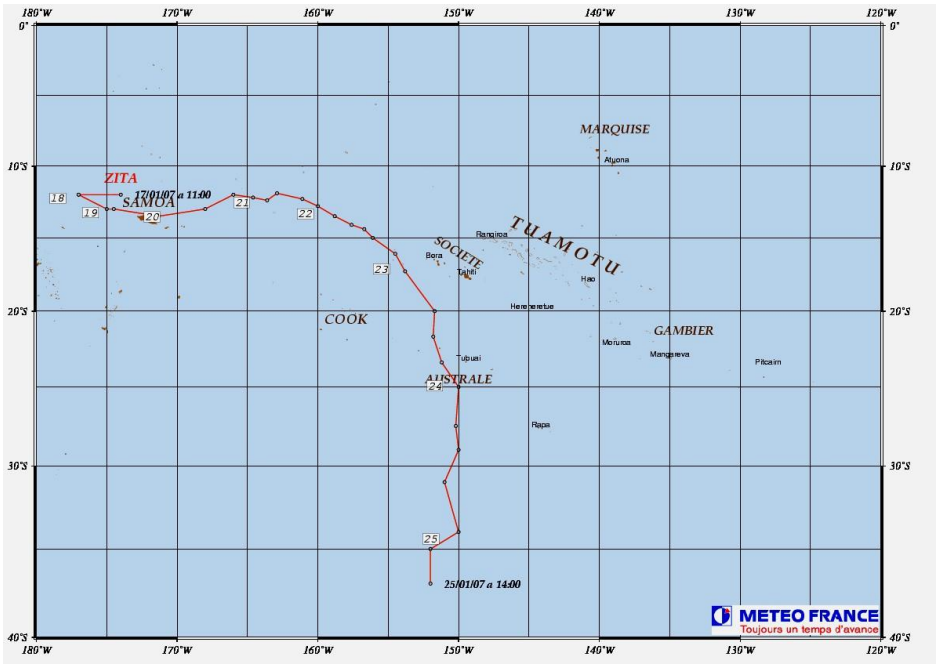
(Submitted by French Polynesia)

2006-2007 CYCLONE SEASON

Tropical cyclones

Two tropical cyclones (storms) interested french Polynesia : ZITA and ARTHUR.

Tropical cyclone (storm) ZITA, from January 22th to 25th 2007



Phenomenon

Since January 18th, tropical depression 07F moves easterly in West part of ITCZ (North of South pacific monsoon trough). Convection get organized and strengthen very quickly towards 1700UTC (7.00 local) on January 22th, at 900 km North-West Bora Bora Island (West Société). It is named ZITA (tropical cyclone, gale) by Nadi RSMC at 2257UTC (12.57 local) on January 22th. Storm stage is reached towards 2330UTC (13.30 local). ZITA moves 13 kt towards East South East, then South-East from 06UTC on January 23th (20.00 local on January 22th). Minimum pressure is estimate to 975 Hpa and winds near centre to 60 kts, (111 km/h). The centre moves close the islands of Bellinghausen, Scilly and Mopelia (atolls, extreme West Société) toward 0900UTC on January 23th (23.00 local on January 22th). Then the intensity is weakening. Rururu Island (Australes) with strongest winds estimated to 47 kt (87 km/h).

Measures and effects

There are thirty inhabitants in Mopelia atoll and ten in Scilly. In Mopelia, some light habitations and 20% of coconuts palms were damaged; the sea was not very rough.

In Australes, there is a weather station in Tubuai, and some daily rain data available on others islands. For rain, 62,1 mm and 60,5 mm were collected on two places in Rurutu. In Tubuai station, maximum mean wind (10 mn) was 35 kt (65 km/h) and maximun instant wind 47 kt (87 km/h). In Rurutu there were moderate floods, several plantations and some houses damaged, and electrecity interruptions.

Warnings and alerts

ZITA strengthened very quicly in the morning of January 22th. Tahiti-Faa'a meteorological center use RSMC Nadi and JTWC bulletins and makes also its own analysis and forecast. Forecaters must know tropical analysis and forecast methods; in situations such ZITA, rapidity is important.

In case of cyclonic phenomenon threating or interesting French Polynesia, Tahiti-Faa'a meteorological centre issues AVIS DE PHENOMENE CYCLONIQUE bulletins to authorities and public. First warnings and alerts are issued by authorities responsible for security.
AVIS DE PHENOMENE CYCLONIQUE can concern :

- Cyclonic phenomenon **threat on more than 48 hours range**; it corresponds to **First warning** annouced and applied by authorities responsible for security.

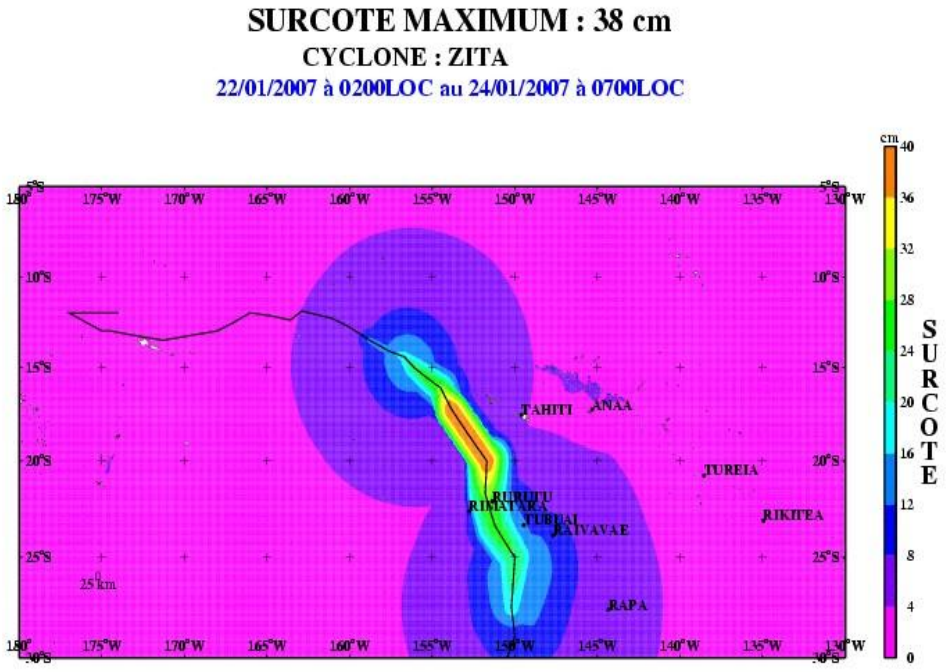
- Cyclonic phenomenon **threat between 48 hours et more than 18 hours ranges** ; it corresponds to **Orange alert** annouced and applied by authorities responsible for security.

- Cyclonic phenomenon **threat in 18 hours range or less, or phenomenon in course** ; it corresponds to **Red alert** annouced and applied by authorities responsible for security.

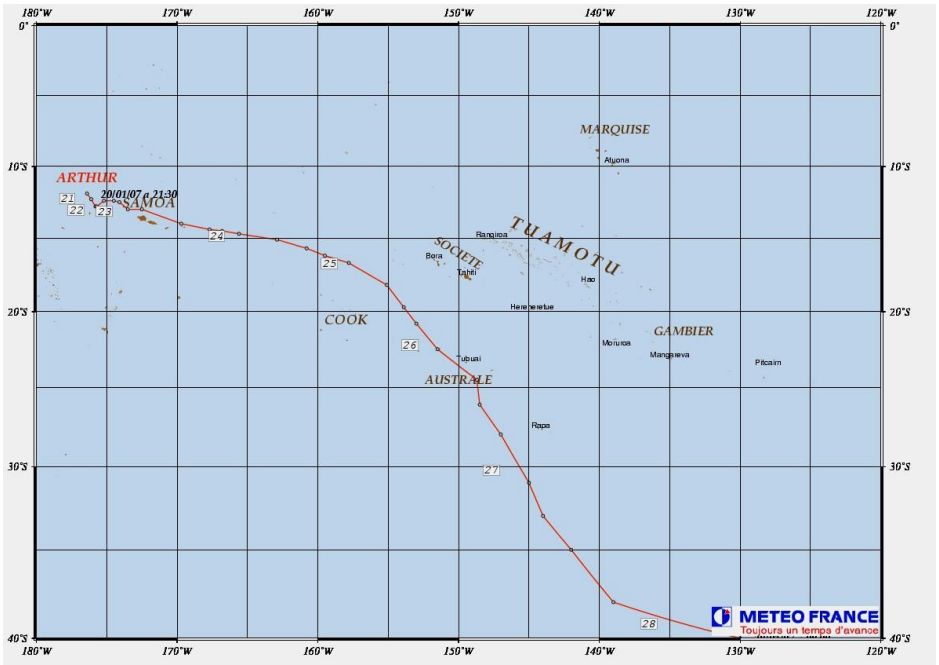
For ZITA, Bellinghausen, Scilly and Mopelia were directly in red alert. Australes were in orange then red alert. Ten AVIS DE PHENOMENE CYCLONIQUE bulletins were diffused.

Storm surge for ZITA

The chart below is an example of Meteo-France surge model output for ZITA. This model is actived in Tahiti-Faa'a meteorological centre if a tropical cyclone affects French Polynesia.



Tropical cyclone (storm) ARTHUR, from January 24th to 27th 2007



Phenomenon

The centre of ARTHUR tropical cyclone (storm, 60 kt , 111 km/h, near centre) passes 160 km West Mopelia island (farthest West Société islands) at the end of night from

January 24th to 25th. Then ARTHUR moves towards Australes islands weakening into tropical depression. But during the night from January 25th to 26th it regains quickly to tropical cyclone (storm) strength. The centre passes just West Tubuai island at the end of this night, with 50 kt (93 km/h) estimate winds.

Measures and effects

No significant rains on Australes islands. In Tubuai station maximum mean wind (10 mn) was 45 kt (83 km/h) and maximun instant wind 62 kt (115 km/h).

In Tubuai, several houses were damaged and roads obstructed by fallen trees. The sea was rough in Tubuai and Rurutu sectors.

Warnings and alerts

For Australes islands :

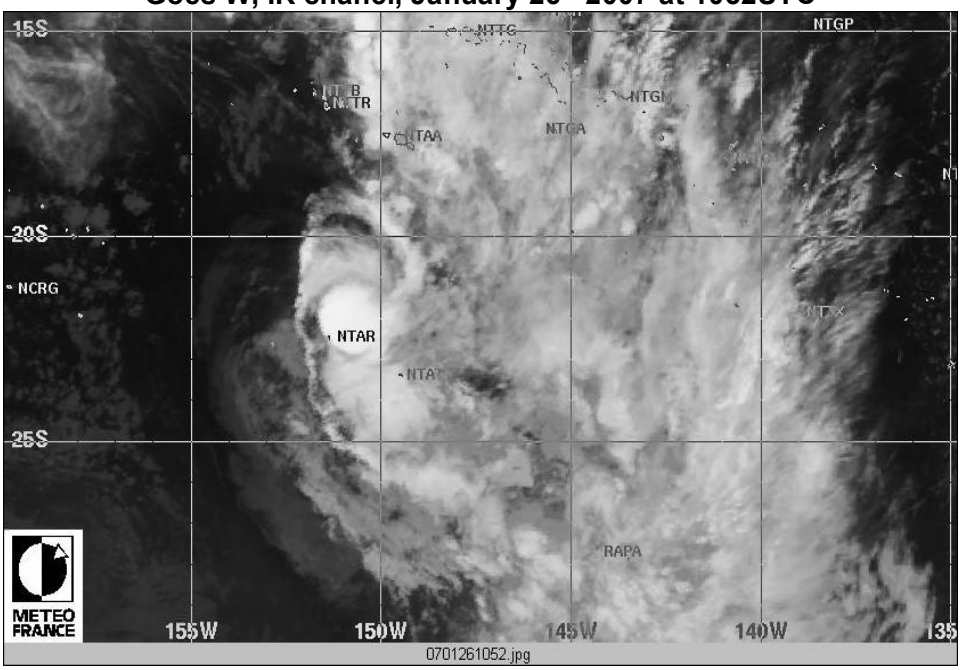
- **Orange alert** : From 24 January 2030UTC (10.30 local)
- **Red alert** : Rurutu and Tubuai islands, from 25 January 19UTC (9.00 local).

Ten AVIS DE PHENOMENE CYCLONIQUE bulletins were diffused.

ARTHUR reintensification when arriving on Australes islands

Three successive convective systems developped in 8 hours, from 0900UTC to 1700UTC on January 26th (23.00 local on January 25th to 7.00 local on January 26th).

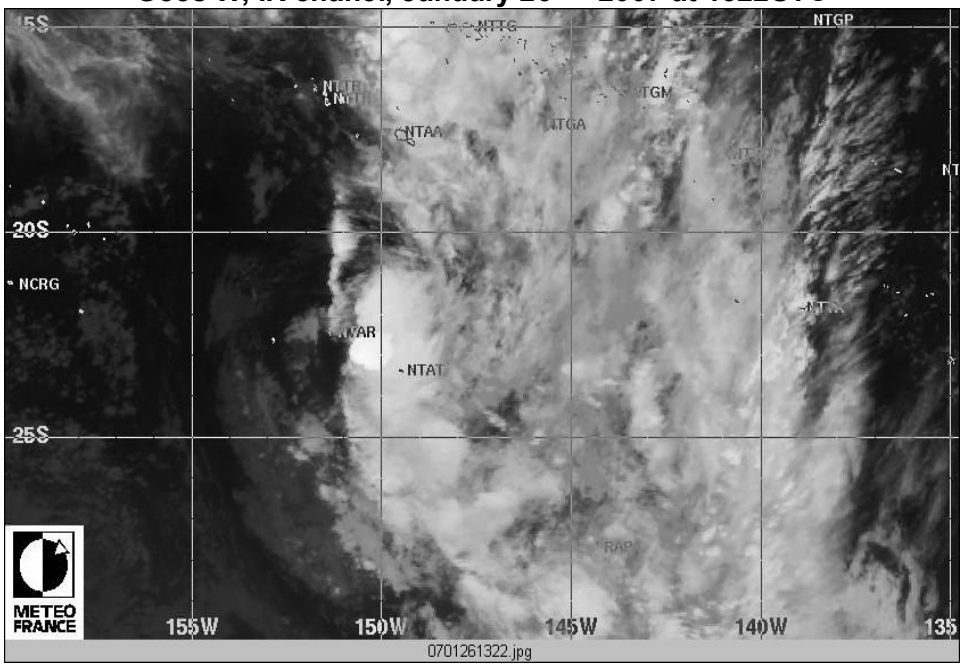
Goes W, IR chanel, January 26th 2007 at 1052UTC



NTAR : Rurutu ; NTAT : Tubuai ; NTAA : Tahiti : NCRG : Rarotonga (Cook islands).

The first convective system starts at 0900UTC and reaches maturity at 1052UTC (image above), to close Norh-East of Rurutu. The second convective system starts a short time before 1322UTC (image below), between Rurutu and Tubuai. A third convective system will follow (image not shown) South Tubuai towards 1600UTC.

Goes W, IR chanel, January 26th 2007 at 1322UTC



Other phenomena (but tropical cyclones)

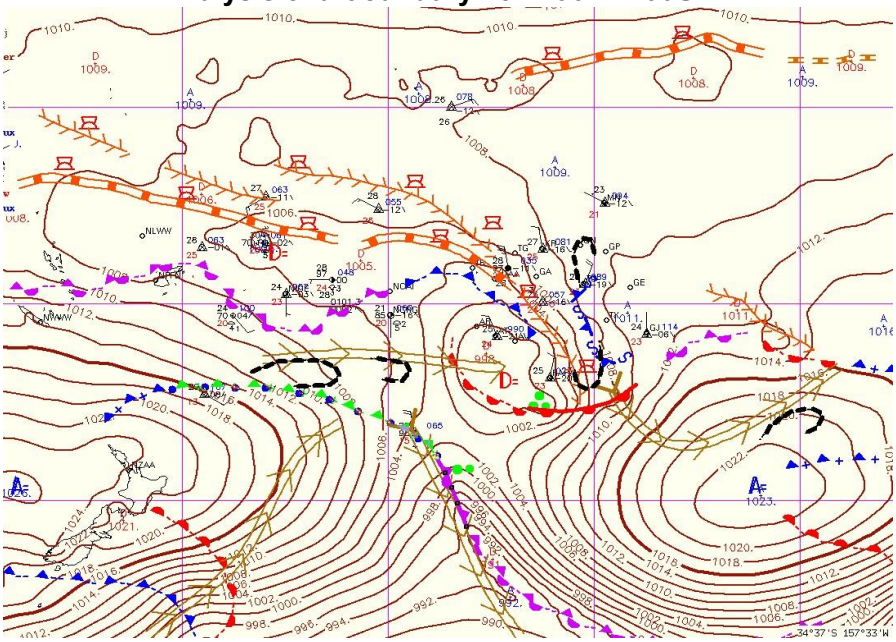
ZITA and ATHUR were not exceptional and very dangerous phenomena. Two other phenomena which were not tropical cyclones were more dangerous and recognized as “exceptional”.

Heavy rains on Tahiti and Moorea during the night from January 17th to 18th 2007

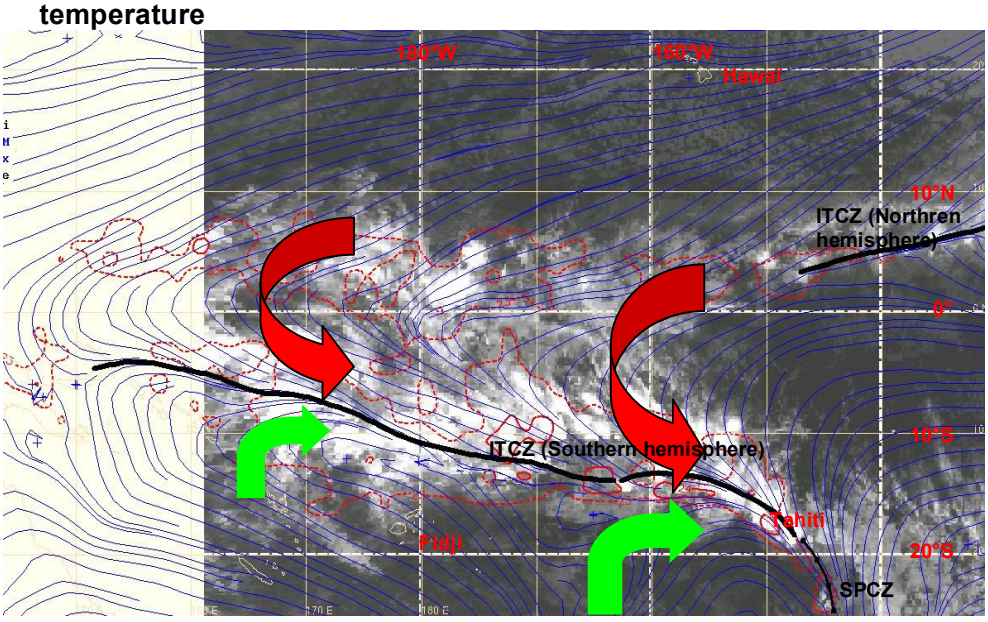
Phenomenon

Heavy rains in Tahiti and Moorea during the night from January 17th to 18th 2007, with strong gusts, are due to a wide convective system related to a burst from the West by the ITCZ. Such westerly ITCZ bursts, when Western South Pacific monsoon trough extends to French Polynesia are rare enough and can occur during El Niño events. Westerly ITCZ bursts are one of the meteorological systems recognized at the present time as potentially exceptionnally dangerous in French Polynesia.

Analysis chart January 18th 2007 1200UTC



January 18th 2007 1200UTC : Goes W image, IR chanel ; ECMWF model analysis : blue lines, surface flow ; red dashed lines : 850 hPa wet bulb temperature



Measures and effects

Flash floods and landslides are important on West and North parts of Tahiti. There were only material damages. In some places rainfall go beyond 200 mm in 24 hours and might have been above 150 mm in 6 hours; there are no real time rain observations in places which were the most concerned.

Warnings and alerts

Present procedure for meteorological hazards is :

- ATTENTION messages (added in public regular bulletins) for dangerous phenomena first warnings or to anounce dangerous enough or occasionally dangerous phenomema.

- AVIS DE PHENOMENE EXCEPTIONNEL bulletins for dangerous phenomena.

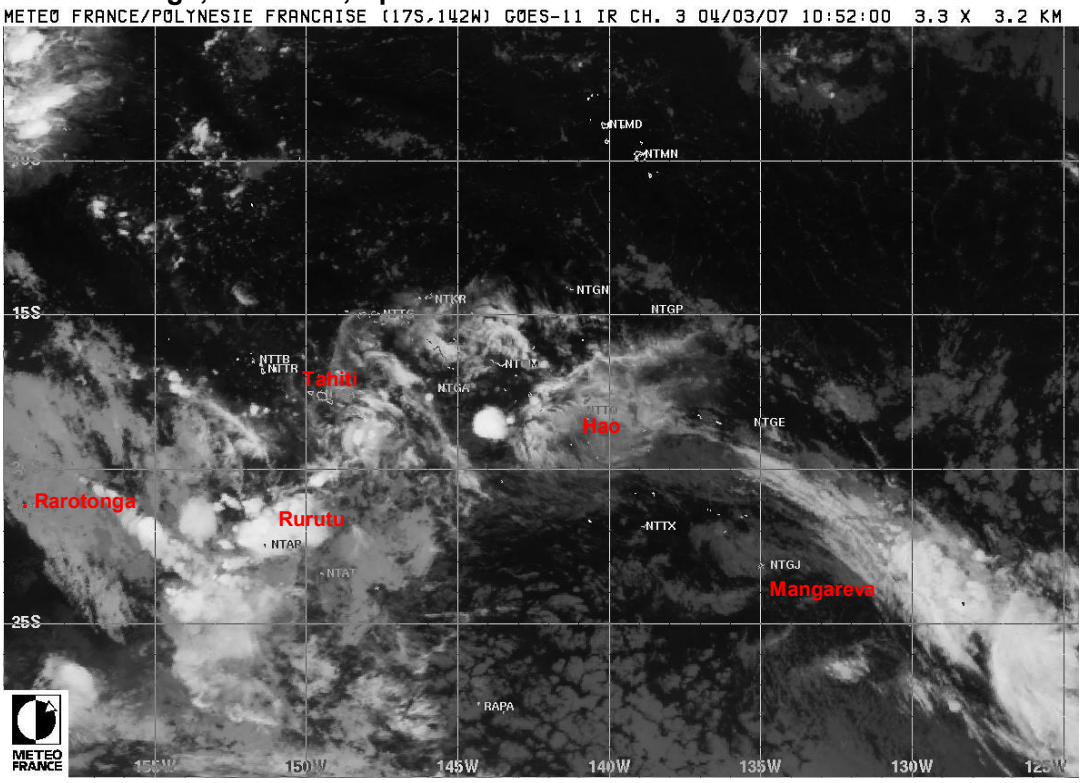
ATTENTION messages announced heavy rains. An AVIS DE PHENOMENE EXCEPTIONNEL bulletin was issued at 1530UTC (5.30 local) on January 18th .

This meteorological situation have been studied in the scope of of "experience return studies".

Very important 24 hours total precipitations in Rurutu island (Australes) on April 3rd 2007

Phenomenon

Goes W image, IR chanel, April 3rd 2007 1052UTC



NTAR: Rurutu ; NTAA: Tahiti ; NTTO: Hao (Tuamotu archipelago) NTGJ: Mangareva (Gambier archipelago).

Clouds pattern squares with a shear line (from NE Mangareva to Hao and SE Tahiti) activation in its West part (towards Rurutu), related to the arrival of an altitude trough. There are several variants in an active shear line; in this case, a weak subtropical depression has deepened 90 NM South of Rarotonga at 18UTC on April 2nd and moves very slowly to South (blocking by the anticyclone in South-East); there is no direct action of this depression on the shear line. Altitude dynamics (tropopause dynamic anomaly to South-West of Rurutu, moving slowly to East) and hot and wet air in low level (related to the shear line) give, during 24 hours, short-lived and not extended but frequent convective cells in Rurutu sector.

The satellite image takes place at the beginning of the event. Rains in one hour might have been strong but it is the total in 24 hours which is significant.

Active shear lines are one of the meteorological systems recognized at the present time as potentially exceptionally dangerous in French Polynesia.

Measures and effects

From April 3rd 18UTC (8.00 local) to 4th 18UTC (8.00 local), 326 mm and 240 mm are measured in two rain gauge places in Rurutu. There are not real time data in Rurutu. The nearest weather station is Tubuai, 120 NM to ESE, where 9,6 mm 24 hours precipitations were measured on April 3rd .

In Rurutu, damages due to floods are important enough on habitations and cultivations. This meteorological situation have been studied in the scope of “experience return studies”.

2007-2008 CYCLONE SEASON

There was no important phenomenon in 2007-2008 cyclone season. During La Niña events, the South Pacicific monsoon trough is laying to the West of this ocean and tropical cyclones most of time spare French Polynesia.

CONCLUSION

In French Polynesia tropical cyclone danger is only important during El Niño events. Most frequent meteorological hazards are not related to tropical cyclones.
After each important meteorological event, there is an “experience return study”. The aims are :

- To study meteorological situation and look for forecasting potential elements;
- To analyse event’s effects and warning procedure, for eventual improvement measures to take.

A process is in course in French Polynesia met service to study, recognize and classify main meteorological systems which can induce dangerous phenomena in the region.

Numerical weather prediction progresses now permit to precise conceptual models. Some results have been briefly presented in this document, but must be confirmed.

We have a project for an international training course organized in Tahiti in year 2009. We propose to focus the training on dangerous met phenomena forecasting, according to the approach “regional met systems study” got under way by French Polynesia met service. For this project we wish regional national met services contribution through typical meteorological situations presentations and their discussion. A previous work would be necessary to prepare these typical meteorological situations presentations.

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REVIEW OF THE 2006/2007 AND 2007/2008 TROPICAL CYCLONE SEASONS

(Submitted by Federated States of Micronesia Draft 13 July 2008)

2007 was relatively quite, no tropical cyclone in the central Pacific, and this includes Guam, the Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Palau and the Marshall Islands. Nevertheless, unrelated tropical cyclones' events such as high tides, salt intrusion and inundation continued to have tremendous impacts on most of the low islands in Micronesia. The damage to the food crop is a long-term effect in which the islands must find ways to fill in or make up for the food shortage. There is a need to improve preparedness and mitigation measures to address impacts from disasters in Micronesia. The National Weather Service (NWS) has played a significant role in upgrading of the facility and infrastructure. For example, a new Weather Service Office (WSO) Majuro (Marshall Islands) has been completed this year; the construction of a WSO Office Koror (Palau) is underway; and a proposed new building for WSO Pohnpei (Federated States of Micronesia) which has been approved with finding allocation. WSO Chuuk (Federated States of Micronesia) will go into renovation and expansion in 2011. The development clearly shows the long-term commitment of the US Government to ensure that the WSOs in Micronesia are operating within the required standards.

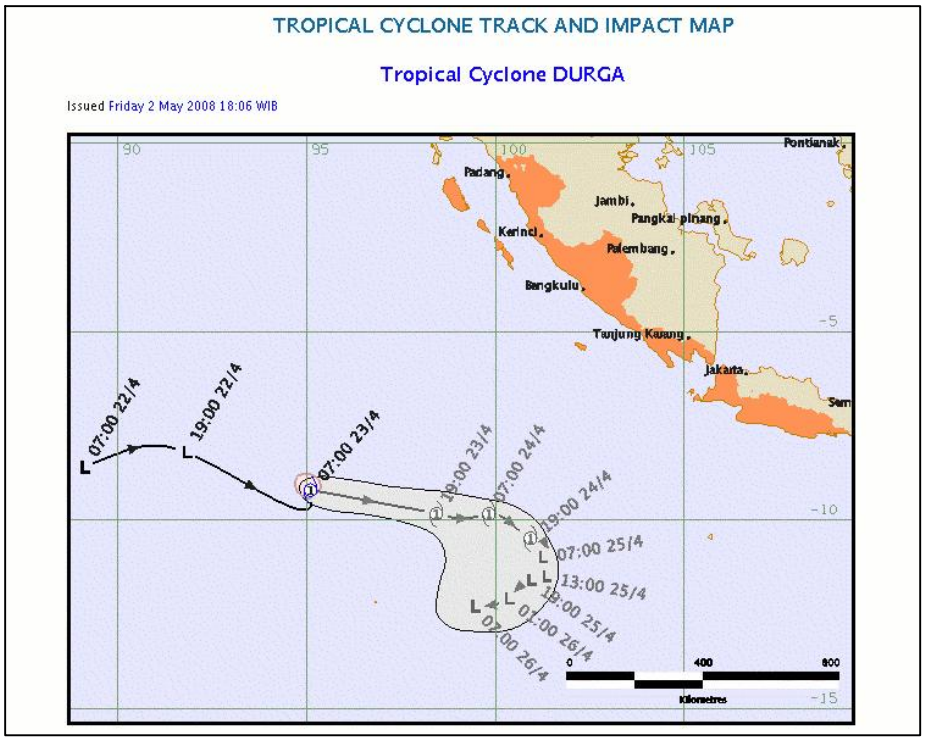
REVIEW OF THE 2006/2007 AND 2007/2008 TROPICAL CYCLONE SEASONS

(Submitted By Indonesia)

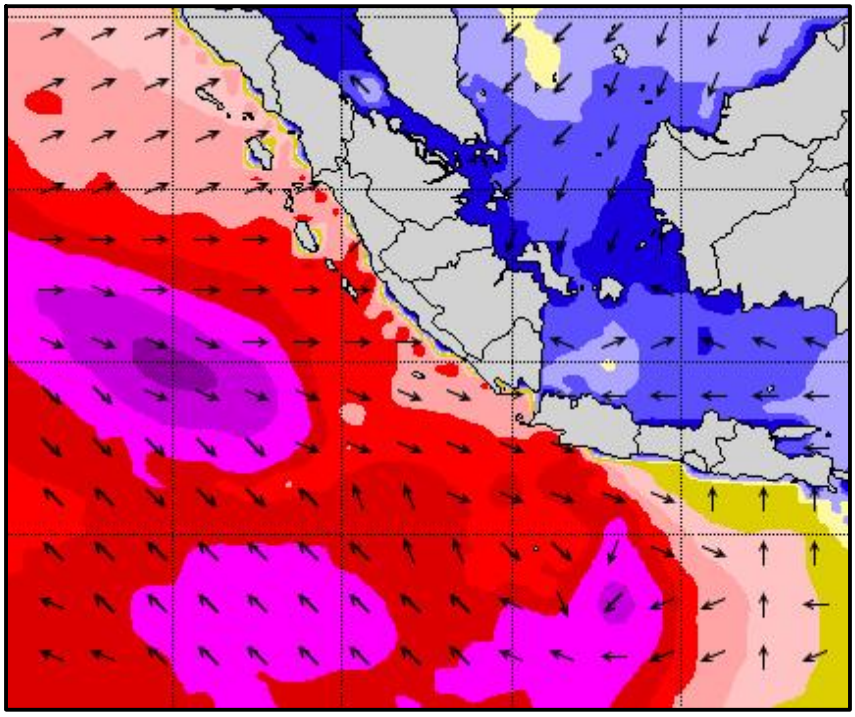
During 2007/2008 season there is one tropical cyclone develop in Jakarta TCWC area of responsibility, named Tropical Cyclone Durga (April 22 – 25, 2008).

TC Durga firstly indicated at April 22, 2008 00.00Z in the position of 8.1° S and 90.4° E. Durga get it's mature stage at April 23 2008, 00.00Z in the position of 9.2° S and 95.1° E with the 35 knot maximum wind and weakened at April 25 2008, 06.00Z in the position of 11.9° S and 99.6° E (Perth TCWC AOR).

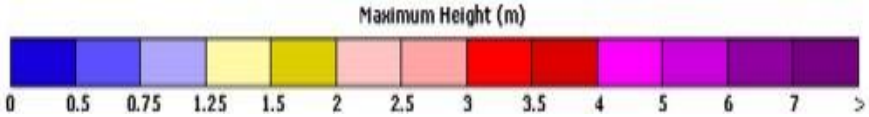
TC Durga give an impact of high waves (3 – 5 meter) in Indian Ocean (west of Sumatera up to south of Java). The wind speed of 28 knot was recorded in Bengkulu at April 24, 2008 and 34 knot at April 25, 2008 in Palembang.

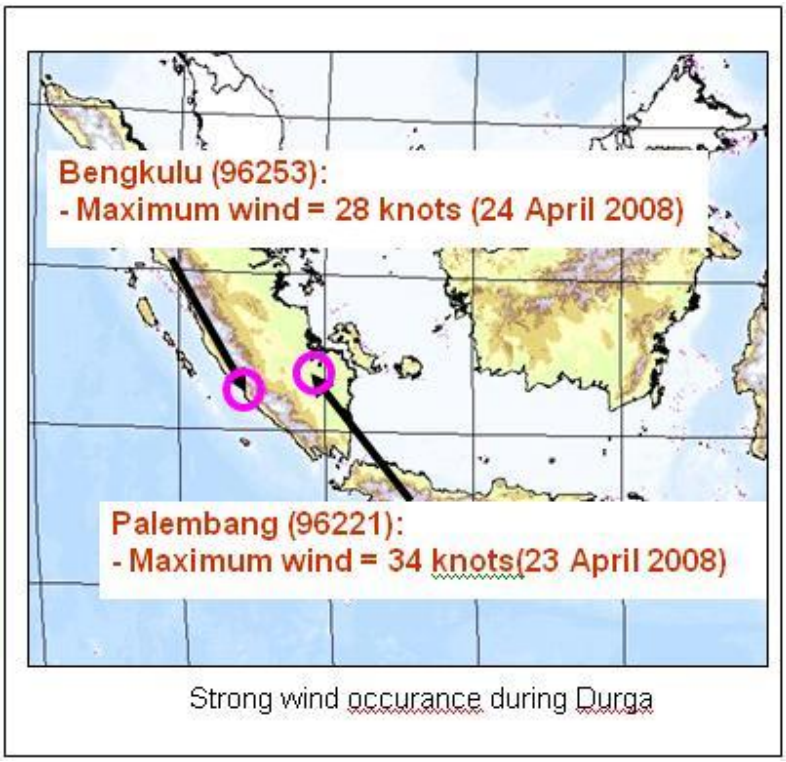


TC Track and Impact Map (23 April 2008,00.00 UTC)



High waves (3 – 5 meters) at 23 April 2008





Strong wind occurance during Durga

THE OPERATION OF JAKARTA TROPICAL CYCLONE WARNING CENTRE (JAKARTA TCWC)

I. Brief History of Jakarta TCWC

1. Overview

   Indonesia has been a member of the RA-V Tropical Cyclone Committee since it was established by RA V-IX in 1986, Indonesia operated Jakarta TCWC covering the sea area of 90° – 125°E and 10°S – Equator.

2. Decisions of RA V-XII, 1998

   RA V-XII recommended Australia to assume warning responsibilities covering Indonesia as an interim measure, until BMG operational staff had been completed the training to provide the service.

3. Postponement of Indonesia's Tropical Cyclone Warning Responsibility
   - RA V-XIII recommended that BMG postpone taking responsibility for operation of TCWC for 2005/06 TC season, and again for 2006/07.
   - In TCP-24, 2006 Edition : Indonesia takes over responsibility from Australia starting 2007/2008 cyclone season.
   - The Indonesian Government accepted the proposal and provided BMG with funds since then.

II. Background

- WMO Mandatory

  WMO Tropical Cyclone Opertional Plan For The South Pacific And South East Indian Ocean (TCP-24, 2006 Edition) stated Indonesia would take over responsibility at the start of the 2007/2008 cyclone season.

- Internal Interest of BMG

  Eventhough Indonesian region is not directly affected by tropical cyclone, the occurance of tropical cyclone near the region, gives impact to the Indonesian weather variability (e.g. extreme weather, flood, landslide), therefore, BMG needs to establish TCWC to monitor the tendency of tropical cyclone occurance

III. Task and Responsibilities

1. Forecasts and warnings for the general population :

   Responsibilities for preparing and issuing warnings on tropical cyclones and related hazardous weather phenomena for the general population on the coastal waters and land areas of Indonesia

2. Forecast and warning for open sea

   Responsibilitlies for the preparation of marine tropical cyclone forecasts and warnings in the area of responsibility 90° – 125°E and 10°S – Equator.

IV. Area of Responsibility

Jakarta TCWC area of responsibility is 90^{o} -125^{o} E and 0^{o} – 10^{o} S. Jakarta TCWC was located in BMG head office, Jakarta.

V. Activity and Planning

A. Current Activity

1. Daily Monitoring of tropical cyclone in the AOR and area around Indonesia (Northwest Pacific & South Indian Ocean)

2. Identify the extreme weather occurred in Indonesia during the tropical cyclone period
3. Interpreting TC Special Advisory for Indonesia received from Darwin & Perth TCWC

B. Short Term Plan
- Completing the Standard Operational Procedure of TCWC
- Development of Database system for Jakarta TCWC
- Development of Denpasar TCWC

C. Middle – Long Term Plan
- Recruitment and training for the human resources with competency on tropical cyclone analysis and forecasting
- Development of the system adjust with the needs of BMG

VI. Jakarta TCWC Products

No.	Product Name	Format	Frequency of issuance	Languange	Remarks
1.	Extreme weather warning	Text	6 hourly	English & Indonesia	
2.	TV Crawler messages	Text		Indonesia	
3.	High seas warning	Text	6 hourly	English & Indonesia	International exchange
4.	Coastal Zone Warning	Text	6 hourly	English & Indonesia	
5.	TC Technical Bulletin	Text	6 hourly	English & Indonesia	
6.	TC Public Information Bulletin	Text	6 hourly	Indonesia	
7.	TC Outlook	Text	Daily	English & Indonesia	
8.	TC Aviation Advisory	Text	6 hourly	English	
9.	CREX	Text	6 hourly	English	
10.	TC Track & Impact map	Graphical	6 hourly	English & Indonesia	
11.	Extreme Weather map	Graphical		English & Indonesia	

VII. Infrastructures of Jakarta TCWC

A. Hardawares
1. 2 units of Application servers
2. 2 units of Internal web server
3. 2 units of Forecaster workstations
4. 1 unit Media display workstation
5. 1 unit Radar display workstation

6. 1 unit MTSAT digital satellite receiver
7. 2 units MTSAT PC processing
8. 2 units of LCD TV for product display
9. Miscelleanous equipments (Laser printer, fax machine, confrence phone)

B. Softwares
1. Software for Weather and Satellite Image Analysis :
   a. *Satellite Animation and Interactive Diagnosis (SATAID)*
   b. *On Screen Analysis*
   c. *Tabular Browser*
2. Software for Tropical Cyclone Tracking and Production *(TC Module)*
3. Software for Radar Data Display :
   a. Radar Data Server (Rowlf)
   b. 2D Radar Module
4. Web Browser :
5. Cyclogenesis Checksheet
6. Storm Surge
7. HRIT MTSAT satellite receiver

VIII. First Activation of Jakarta TCWC

1. Jakarta TCWC has made its first real activation during he event of Tropical Cyclone Durga
2. Tropical Cyclone “Durga” was firstly developed at April 22, 2008 00.00 UTC with the position 9.2 S – 95.1 E, which is inside area of responsibility of Jakarta TCWC and dissipated at April 25, 2008 in area of responsibility of Perth TCWC
3. TC “Durga” is the first tropical cyclone which named by Jakarta TCWC
4. It is also the first time for Jakarta TCWC issuing the High Seas Warning

IX. Staffs of Jakarta TCWC

Jakarta TCWC was operated by 12 staffs, divided into 2 (two) groups :

- Forecaster group (10 staffs), responsible for tropical cyclone analysis and forecasting, product preparation and dissemination
- IT group (2 staffs) responsible for technical support and infrastructures maintenance

X. Inauguration of Jakarta TCWC

Jakarta TCWC was officially inaugurated by BMG Director General at March 24, 2008 and attended by Chairman of RA-V Tropical Cyclone Committee

Current Status
of the Kiribati Meteorological Service in Relation to Weather and Climate Services

(Submitted By Kiribati)

First I would like to acknowledge Developed Countries in Region V Australia (BoM), New Zealand Met Service, US Met Service, Philippine, Japan, Meto-France etc some of the developing countries like Fiji Met Service etc including CROP Agencies like SPREP and SOPAC for their continuing support.

The Kiribati Meteorological Service (KMS) comprises of one Global Upper Air Network (GUAN) and eight Basic Reporting Synoptic Network (BRSN) including Tarawa. GUAN station is located on Betio only and BRSN stations are located on following Islands; Butaritari, Tarawa, Beru, Arorae, Banaba, Kanton, Kiritimati and Tabuaeran. Out of the eight BRSN stations only Kanton, Kiritimati and Tarawa are the only stations, functioning. The rest are closed due to lack of instruments/equipments. Equipment can become obsolete quite quickly. With time meteorological equipment becomes more complex and sophisticated. New special skills and knowledge are required to sustain and upgrade in meeting new technology. This is one of the greatest deficiencies in our service (KMS) Equipment can become obsolete quite quickly.

Meteorology and sustainable socio-economic development

1. Due to the heavy reliance of the economic and social activities of our islands on the natural environment, these activities are very weather and climate sensitive, particularly to extreme weather and climate events.

2. KMSs can contribute very significantly to the success of all national activities. Timely and accurate severe weather warnings and climate services (including seasonal predictions) can contribute substantially to social well-being and economic development. Agriculture (commercial and subsistence), fisheries, aviation, maritime transport, water resource planning and management, tourism, banking and financial services, disaster management, telecommunications, construction and engineering, energy (renewable and non-renewable) generation and supply, tourism, environmental protection, food production, health and medical services, insurance, legal services, offshore operations, port and harbor management, leisure activities, retails, sports, urban planning, and land use planning can all benefit from the work of KMS.

3. While the work of KMSs has large short term and long term socio-economic impacts, pre-eminently, the benefits of the services provided by them in designated islands are of social nature, which relate directly to safety of life and property. These include:

a) The avoidance of loss of life that would otherwise occur if the general public did not have an efficient official centre to issue advance warnings on the onset of severe weather and climate events such as droughts; Since March 2007 we have received rainfall below average resulted in worst droughts ever experienced.

b) The enormous contributions to the safety and security of the travelling public, especially those travelling by air and sea, because of the international, regional and

national arrangements put in place for rapid exchange of data, information and warnings for the marine and aviation communities;

c) The ubiquitous contribution to the day to day safety, comfort, enjoyment, and general convenience of citizens through access to weather and climate information which assist them in their planning, making decisions on what to wear, where to go, what to do and when to do it; and

d) Other indirect forms of social benefit, including the ease of mind of having access to the latest information on developments affecting distant communities; the cultural values associated with maintaining reliable records of major weather related disasters; the contribution to the integrity of the justice system from the legal uses of official weather records and the pleasure and satisfaction from increased understanding of the phenomena of the natural world.

4. Of particular importance to Kiribati Government is the preservation and storage of historical weather and climate records. These historical records are of immense value in planning economic development in the various sectors, monitoring trends in climate change, understanding and predicting climatic variability, and assisting in formulating appropriate response measures to the potential impacts of climate change.

Roles of Kiribati Meteorological Service

5. The basic and essential functions of KMS can be summarised as follows:

a) To plan, implement, operate and maintain BRSN and GUAN upper air observing networks;

b) To provide and maintain systems for the collection and quality control of observational data and their processing in support of meteorological research, the provision of real time weather and climate services, and assembly of a national climate record;

c) To advance meteorological science and the development and improvement of its own operations and services through supporting research and development;

d) To provide a range of weather information, forecast and warning services to the community at large, usually through the mass media;

e) To provide a range of sector-specific operational meteorological services through the mass media and through other channels, to major user groups such as agriculture, shipping, and aviation;

f) To keep and maintain the Kiribati national climate archive and the provision of climate data and climate monitoring and prediction services;

g) To provide advice on meteorological and climatological matters to other government agencies and to our national community;

h) To fulfill our obligations under regional and international conventions such as the Convention of the WMO, the United Nations Framework Convention on Climate Change, the Vienna Convention, ICAO Convention and the Convention to Combat Desertification.

Public good nature of Kiribati Meteorological Services

6. KMS have systematically measured and recorded, historically, weather and climate variables as a national resource with high back-up from NZ Met Service and Australia BoM, for planning collective economic and social activity and to exploit them for the benefit of the public.

Conclusion

In fulfilling the obligations as required, I strongly urged to the committee if they look upon the KMS needs. I know that there is one component in each of the ongoing adaptation programmes, National Adaptation Programme and Action and the Kiribati Adaptation Programme which is now in their second phase. Knowing the hierarchy of our service will there be any possibility in speeding up the process?

Knowing that process is slow, I have shared the problem with other members within the WMO Region V directors meeting last year and very happy to inform this committee that Australian Government through their Bureau of Meteorology have shown great interest in addressing KMS needs.

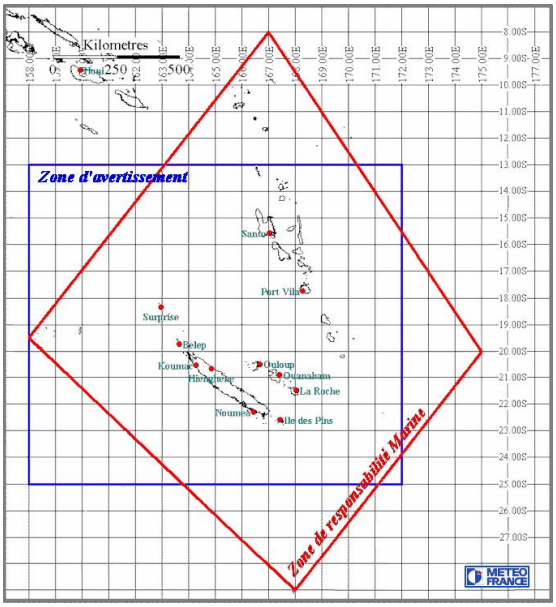
Australian Bureau of Meteorology have had provided assistance in addressing KMS needs after sharing the problem during the past Director's meetings.

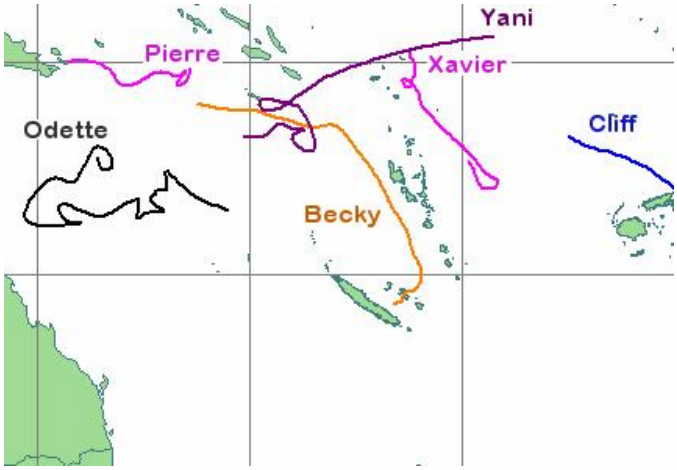
KMS have limited capacity to install modern equipment or software and to maintain these, in particular data processing, communications and observational equipment in replacing the old Met basic equipment is not yet in place. We prefer the old Met Basic/Manual type instruments.

I strongly urge and support Samoa on the facts if New Zealand and Australia and other recognise institute could review their criteria in terms of those applicable in participating in Meteorologist or Climatologist course they run.

REVIEW OF THE 2006/2007 AND 2007/2008 TROPICAL CYCLONE SEASONS

(Submitted by New Caledonia)





I. Cyclonic season 2006/2007

General

Name	Intensity	Date
Xavier	Cyclone	20 / 26 October
Yani	Cyclone	18 / 26 November
Zita	Tropical cyclone (storm)	20 / 25 January
Arthur	Tropical cyclone (storm)	20 / 28 January
Nelson	Tropical cyclone (storm)	01 / 08 February
Odette	Tropical cyclone (gale)	27 February / 07 March
Becky	Tropical cyclone (storm)	25 / 29 March

Cliff	Tropical cyclone (storm)	01 / 06 April
Pierre	Tropical cyclone (gale)	18 / 26 May

The 2006/2007 cyclonic season began in southwest pacific during El Nino phase and ended in neutral phase. So we had a very early beginning of the season. The first tropical cyclone began on October 22nd in the north of Vanuatu. It is a record of earliness in the New Caledonia area; the previous record was on 31st October 1982.

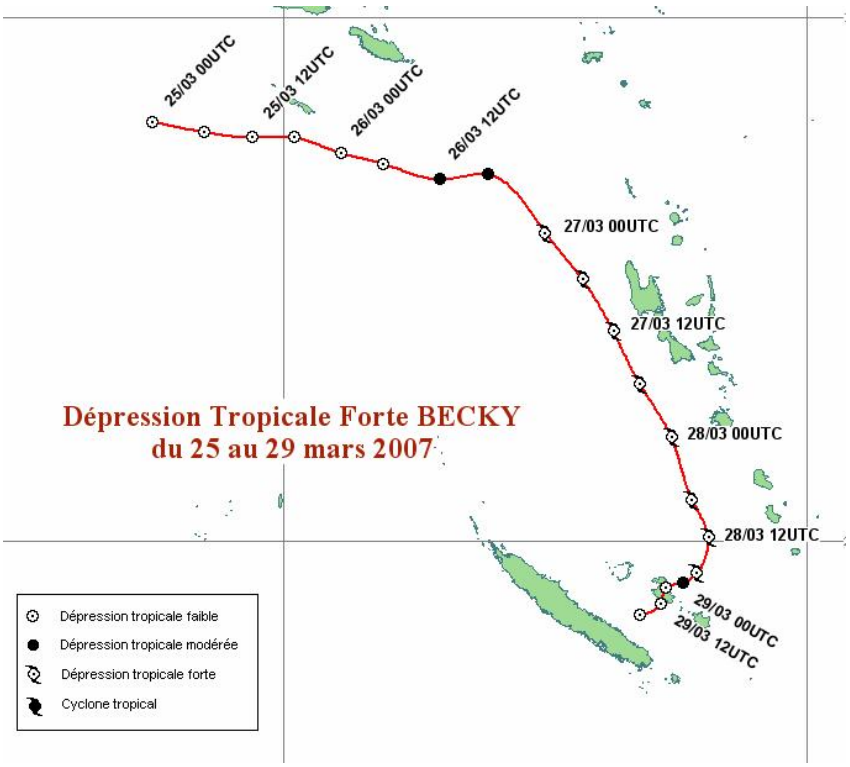
In the New Caledonia area, March 29th was the end of the season.

Three tropical cyclones crossed the New Caledonia area and only Becky had threatened the country.

- **Tropical cyclone Xavier**

« Xavier » was a very precocious phenomenon for the southwest pacific region. This cyclone was intense but happily did not hit any country and had stayed over the open seas.

- **Tropical cyclone Becky**



Becky is the last tropical phenomenon of this cyclonic season which had needed to initiate a cyclonic alert on New Caledonia's territory.

The first level of alert was in force between 27 March 16:00 and 29 March 18:00.

Second level of alert was in force between 28 March 18:00 and 29 March 18:00 on Loyalty Islands, Isle of Pines and south part of « Grande Terre ».

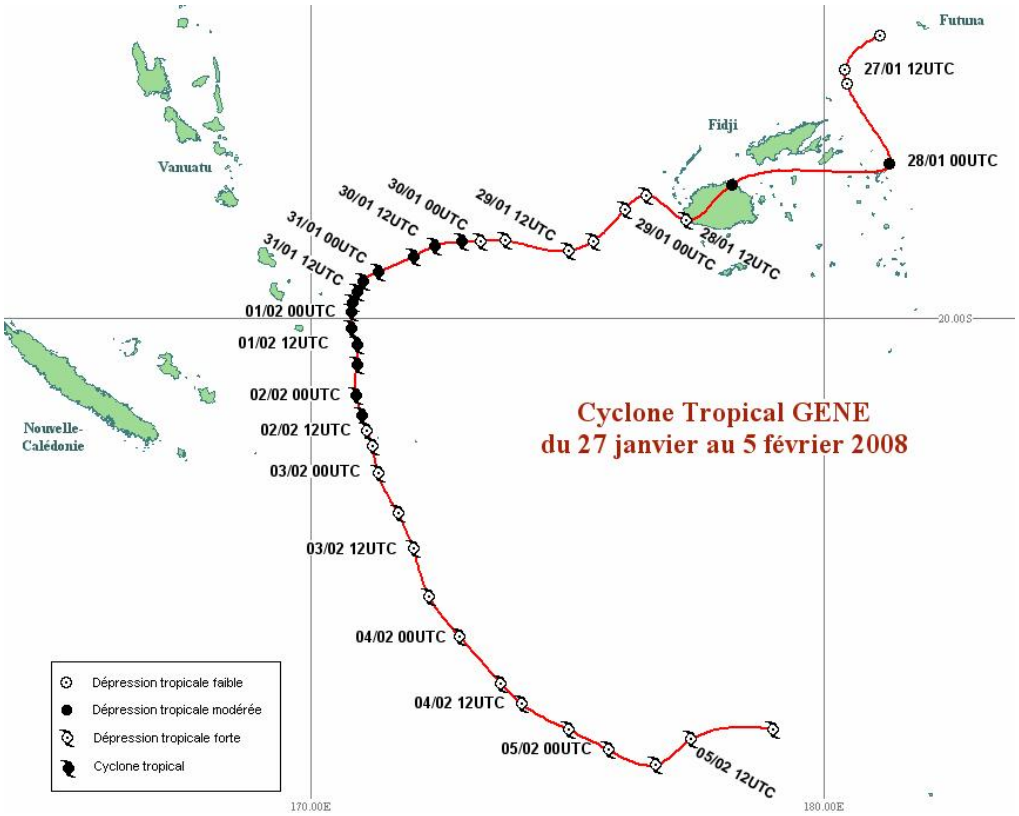
There were no severe weather conditions on Loyalty Islands despite of a track just on Lifou because Becky was weakening very fast approaching New Caledonia. Mean wind was never more than 20 knots with gust at 45 knots on Lifou.

Maximum rain fall were on Maré with 105 mm in 24 hours.

II. Cyclonic season 2007/2008

The cyclonic season in the New Caledonia area was very calm. Only one cyclone, Gene, had entered in alert zone and had threatened lands.

- **Tropical cyclone Gene**



Cyclone Gene entered in alert zone on 30 January. Forecasted track threaten New Caledonia

So the first level of alert was in force on 30 January 18:00. The second level of alert was in force on Lifou and Mare from 31 January 19:00 to 2 February 12:00. All alerts were stopped on 3 February 12:00.

Gene‘s track had turned southward far enough from New Caledonia to have limited impact on lands.

But cyclonic season « La Nina » was exceptional for rainfall

- **2007/2008, the season of all the records**

For the 2007/2008 rainy season, the monthly mean departure from normal, calculated out of 28 reference stations, was +57% in December, +9% in January, +79% in February, +120% in March and +195% in April.

From the measurement period of 1951-2008, April 2008 is ranked second wettest April (the wettest April was recorded in 1975 with +220%). On the other hand, March 2008 is the new wettest March, the old record was observed in 1967 with +117%.

This 2007/2008 rainy season wettest period is between February and April with a three- month mean departure from normal of +121%. This makes it the wettest February to April since 1951, the beginning of measurement. The other wettest years were 1975 with +93%, 1967 with +84% and 1992 with +48%. This gives a good idea of the value of this new record.

Finally, the December to April assessment for the 2007/2008 rainy season come up with a five-month mean departure from normal of +86% which is a new record slightly above the oldest value of +85% observed in 1988/1989 season.

This deluge over New Caledonia can greatly be explained by the La Niña event that was observed this summer which was materialized by the ITCZ more south of it’s usual position in February and March and by a very unusual position of the SPCZ very far South and West from it’s normal location in April. It is also important to note that New Caledonia was not directly affected by any tropical cyclone and this makes this 2007/2008 season even more atypical.

It was explained that the 2007/2008 season was very wet. To make it even more evident, here are some values of December to April rainfall amounts with a comparison to the annual average total which show that many stations recorded more rain in 5 months that they usually do in one year:

- 1282 mm at Koumac, this is 31% more than the annual mean total.
- 2910 mm at Canala, this is 73% more than the annual mean total.
- 3384 mm at Ponérihouen, this is 26% more than the annual mean total.
- 3541 mm at Yaté-Usine, this is 10% more than the annual mean total.
- 1668 mm at Ouanaham (Lifou), this is 2% less than the annual mean total.
- 893 mm at Nouméa, this is 16% less than the annual mean total.

Koumac and Nouméa are on the West Coast. Canala, Ponerihouen and Yaté-Usine are on the East Coast and Ouanaham is on Lifou Island

February to April was the wettest period of the 2007/2008 rainy season. Here are some three months totals with the departure from average:

- 926 mm at Koumac, this is +151% departure from February to April average.
- 1064 mm at Bourail, this is +151% departure from February to April average.
- 2303 mm at Canala, this is +237% departure from February to April average.
- 2381 mm at Ponérihouen, this is +133% departure from February to April average.
- 2772 mm at Yaté-Usine, this is +135% departure from February to April average.
- 1456 mm at Ouanaham, this is +139% departure from February to April average.
- 691 mm at Nouméa, this is +84% departure from February to April average.

Impacts of the 2007/2008 rainy season

Agriculture was deeply impacted by the continuous rainfall. Moisture and diseases destroyed a lot of crops (tomatoes, lettuce, etc…) and planting schemes had to be significantly delayed because the soil was too wet.

Roads have been severely damaged by the rainfall and the construction industry has to face huge delay.

Mining industry had also to face some difficulties, particularly on one location where a big landslide, triggered by high rainfall, ended in the lagoon. The angry neighborhood and ecologists led the mining company to start huge works to limit the environmental impact.

Two people were drowned in flooding rivers.

One of the most serious outcomes of high rainfall anomalies during the late part of the 2007–2008 rainy season was an outbreak of dengue fever, with more than 600 people affected by the disease from January to April.

During these five months, 55 bulletins for heavy rain were issued by Météo-France forecast bureau for 23 days of severe conditions.

REVIEW OF THE 2006-2007 AND 2007-2008 CYCLONE SEASONS

(Submitted by New Zealand)

TROPICAL CYCLONES IN THE WELLINGTON AREA OF RESPONSIBILITY DURING THE 2006/2007 CYCLONE SEASON

INTRODUCTION

Only three tropical cyclones crossed 25ºS into the Wellington area of responsibility out of the 9 that formed over the Coral Sea and the South Pacific area during the 2006/2007 cyclone season. All three, CLIFF, ZITA and ARTHUR stayed away from land areas in the Wellington area of responsibility. Arthur was the strongest of the three TC's as they crossed 25S, followed by ZITA. Both CLIFF and ZITA were downgraded to depressions before reaching 30S, while Arthur continued as a tropical cyclone until it reached 31S 145W.

A map showing the 6 hourly verification positions of the three tropical cyclones is on page 5 of this document.

1. TC ZITA (07F) 24 January UTC; Maximum wind 40 knots

Zita crossed 25S at 1100 UTC 24 January 2007 in longitude 150W. It was moving south-southeast 20 knots with central pressure 990 hPa and maximum wind speed of 45 knots. Zita weakened over the next 6 hours with central pressure rising to 998hpa by 1700 UTC 24 January. It was finally downgraded to a depression at 0000 UTC 25 January, and was absorbed by a westerly trough at 0600 UTC 25 January.

TC ZITA (07F) - FIJI
Depression numbered: Jan 17/2100 UTC, 12.0S 174.0W, 1002hPa
TC named: Jan 22/2100 UTC, 14.4S 156.7W, 995hPa, max wind 35kt
Peak intensity: Jan 23/1200-1800 UTC, 975hPa, max wind 60kt
Crossed 25S: Jan 24/1100 UTC (this warning issued by NZ)
Last TC warning: Jan 24/1700 UTC, 27.5S 150.2W, 995hPa, max wind 35kt
Downgraded: Jan 25/0000 UTC, 29S 150W, 998hPa, max wind 35kt

The transfer of warning responsibilities arrangements worked as described in 2.2.1.3 of the TCOP.

2. TC ARTHUR (08F) 26 January UTC; Maximum wind 55 knots

Arthur formed soon after Zita and followed a similar track. It crossed 25S between 1800 UTC 26 and 0000 UTC 27 January in longitude 149W. Arthur reached its peak intensity at 0000 UTC 25 January, and then started to weaken. However, it started to re-intensify between 1800 UTC26 and 0000 UTC 27 January while crossing 25S with central pressure lowering to 980hPa and maximum wind rising to 55 knots. Arthur continued to move southwards under the influence of an upper trough and very gradually weakened. It was finally downgraded to a depression around 1200 UTC 27 January. Arthur

continued to track southwards as a depression until it became hard to track from around 0000 UTC 29 January.

TC ARTHUR (08F) - FIJI
Depression numbered: Jan 21/0730 UTC, 12.2S 164.6W, 1002hPa
TC named: Jan 24/1200 UTC, 14.7S 165.6W, 995hPa, max wind 35-40kt
Peak intensity: Jan 25/0000-0600 UTC, 975hPa, max wind 60kt
Crossed 25S: between 26/1800 - 27/0000 UTC (Fiji and NZ warnings respectively)
Last TC Warning: Jan 27/0500 UTC, 28S 147W, 985hPa, max wind 50kt
Downgraded: Jan 27/1200 UTC, 31S 145W, 990hPa, max wind 45kt

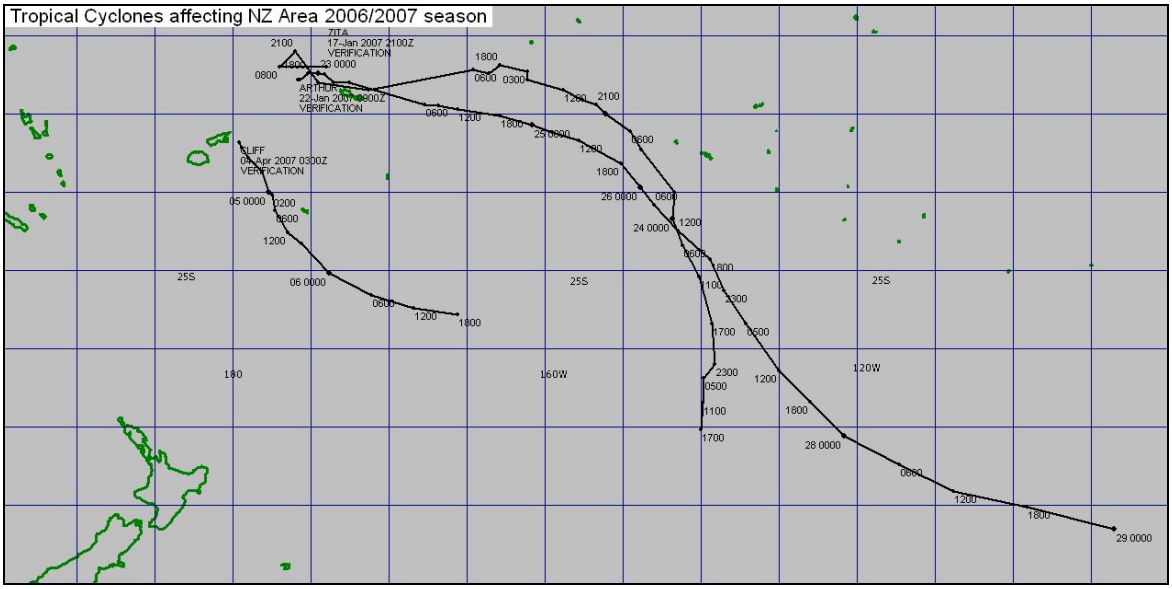
The transfer of warning responsibilities arrangements worked as described in 2.2.1.3 of the TCOP.

3. TC CLIFF (14F) 6 April UTC; Maximum wind 50knots

Cliff crossed 25S around 0000 UTC 6 April in longitude 173W. It reached its peak intensity at 0200 UTC 5 April and maintained it through to 0600 UTC 6 April and then started to weaken rapidly due to strong upper northwest winds. It was downgraded at 1200 UTC 6 April. The remains of Cliff was detectable on IR imagery until 1800 UTC 6 April.

TC CLIFF (14F) - FIJI
Depression numbered: Apr 3/0600 UTC, 14.7S 176.5E, 1004hPa
TC named: Apr 4/0300 UTC, 16.8S 179.6E, 995hPa, max wind 40kt
Peak intensity: Apr 5/0200 - 5/1800 UTC, 980hPa, max wind 50kt
Crossed 25S: Apr 6/0000 UTC (this warning issued by NZ)
Last TC warning: Apr 6/0600 UTC, 26.2S 171.5W, 987hPa, max wind 45kt
Downgraded: Apr 6/1200 UTC, 26.3S 168.1W, 995hPa, max wind 35kt

The transfer of warning responsibilities arrangements worked as described in 2.2.1.3 of the TCOP.


Tropical Cyclones affecting NZ Area 2006/2007 season
ZITA
17 Jan 2007 2100Z
VERIFICATION
ARTHUR
22 Jan 2007 0600Z
VERIFICATION
CLIFF
04 Apr 2007 0300Z
VERIFICATION
25S
180
160W
120W
29 0000

TROPICAL CYCLONES IN THE WELLINGTON AREA OF RESPONSIBILITY DURING THE 2007/2008 CYCLONE SEASON

INTRODUCTION

Only two tropical cyclones crossed 25ºS into the Wellington area of responsibility out of the four that formed over the Coral Sea and the South Pacific area during the 2007/2008 cyclone season. TC Funa moved southwards, west of the North Island of New Zealand, and dissipated as an Ex-Tropical cyclone near 38.3S 169.2E. TC Gene remained over open waters east of New Zealand after crossing 25S and went through a classic extra-tropical transition over colder waters forming a large circulation. It continued to move southwards over the next 2 to 3 days before the maximum winds near centre eased below 35 knots.

A map showing the 6 hourly verification positions of the two tropical cyclones is on page 8 of this document.

1. TC FUNA (10F) 19 January UTC; Maximum wind 85 knots

Funa crossed 25S between 1200 and 1800 UTC on 19 January 2008 in longitude 175E. At 1800 UTC 19 January, Funa had a central pressure of 945hPa and maximum wind 85 knots close to centre and was moving south-southwest at 20 knots. Funa continued to move southwards and gradually weakened. It was downgraded to extra-tropical cyclone at 1800 UTC 20 January with maximum winds of 65 knots. The depression started moving southeast after 0600 UTC 21 January and dissipated after 12 hours west of central New Zealand near 38.3S 169.2E

TC Funa(10F) - Fiji
Depression numbered: Jan 15/2100 UTC, 15.4S 163.0E, 998hPa
TC named: Jan 16/0600 UTC, 14.4S 164.8E, 990hPa, max wind 35-40kt
Peak intensity: Jan 19/0000 - 19/1200 UTC, 930hPa, max wind 95kt
Crossed 25S: between Jan 19/1200 - 19/1800 UTC (Fiji and NZ warnings respectively)
Last TC Warning: Jan 20/1200 UTC, 30.0S 170.0E, 970hPa, max wind 65kt
Downgraded: Jan 20/1800 UTC, 30.0S 169.0E, 975hPa, max wind 60kt

The transfer of warning responsibilities arrangements worked as described in 2.2.1.3 of the TCOP.

2. TC GENE (12F) 3 February UTC; Maximum wind 65 knots

TC Gene crossed 25S between 1200 and 1800 UTC 3 February 2008 in longitude 173E. Based on the 031200Z Nadi warning, it was expected to weaken significantly over the next 6 to 12 hour period. However, Gene's intensity was reassessed and Kelburn's first warning was a hurricane warning. Gene maintained hurricane intensity for the following 6 hours, and then eased to storm. It continued moving east to southeast with storm force winds until 1800 UTC 5 February. During this time, Gene went through extra-tropical transition with the gale area and the eye expanding and a frontal band forming in the southern quadrant. The last TC warning was issued at 1800 UTC 5 February. Further warnings on extra-tropical cyclone Gene continued with intensity increasing to hurricane force again between 0000 and 0600 UTC 6 February. A central dense overcast seemed to re-appear around 1800 UTC 5 February, as low level cold air wrapped around the centre secluding the mid level warmer air. This mid level convective cloud continued to move with extra-tropical depression until 1200 UTC 6 February and was then engulfed into the frontal cloud band as the direction of movement changed to southwest. The depression continued to move southwest and storm force winds finally eased below 35 knots around 1800 UTC 8 February.

TC GENE (12F)
Depression numbered: Jan 26/1800 UTC, 12.4S 179.4W, 1004hPa
TC named: Jan 28/0000 UTC, 17.0S 178.7E, 990hPa, max wind 35-40kt
Peak intensity: Jan 31/1800 - Feb 1/0600 UTC, 945hPa, max wind 85kt
Crossed 25S: between Feb 3/1200 - 3/1800 UTC (Fiji and NZ warnings respectively)
Last TC Warning: Feb 6/0000 UTC, 28.9S 177.8W, 972hPa, max wind 65kt
Downgraded: Feb 6/0600 UTC, 30S 175W, 972hPa, max wind 65kt

The transfer of warning responsibilities arrangements worked as described in 2.2.1.3 of the TCOP.

During 27 January 2008, bulletins issued by JTWC, the US Weather Service Forecasting Centre (Honolulu), and UK Met Office indicated an increasing organization in tropical depression 12F, the precursor to Gene. RSMC Nadi consistently diagnosed 12F as being less intense and having less potential for development into a tropical cyclone.

Between 2000 UTC 27 January and 1800 UTC 3 February there were a number of errors in the meteorology, in position and in numbering in bulletins issued by RSMC Nadi on TC Gene. Errors in the numbering of warnings and other bulletins, while clearly not desirable, are generally less serious than errors in the content of the warnings and bulletins themselves. Errors in the meteorology were primarily mis-matches between cyclone intensity, as described by the classification scale number and/or central pressure, and expected wind strength.

MetService Pre-season Preparations

1. Pre-Season Tropical Cyclone Workshop
Every year in October National Weather Services division holds a practical 2-day workshop for the Marine Forecasters and any one else rostered on other forecasting desks who wishes to attend. The purpose of the workshop is to re-familiarise forecasters with the TCOP as well as key aspects of tropical meteorology such as the climatology of the TC season, tropical latitudes MSL pressure and wind analysis, tropical depression identification and development, tropical cyclone forecasting, extra-tropical transition.
The workshop includes working through at least 3 practical exercises conducted in compressed real-time. Each exercise focuses on a particular aspect of tropical cyclone meteorology; development (or non-development), naming phase, track forecasting, extra-tropical transition, etc.

2. RSMC Nadi Backup Roster
In preparation for each tropical cyclone season, a Backup Roster of at least 3 non-rostered meteorologists with tropical cyclone experience is established. These meteorologists are called upon when there is a requirement to activate the Fiji/New Zealand Contingency Arrangements as detailed in Attachment 6A of the TCOP. At the end of the season the Backup Roster is stood down.

3. Pacific Island in-country preventative maintenance visits
Prior to the beginning of each tropical cyclone season, MetService engineers undertook in-country preventative maintenance visits to 12 Pacific Island Countries and Territories, namely Cook Islands, Kiribati, Fiji, Niue, Papua New Guinea, Pitcairn Island, Samoa, Solomon Islands, Tonga, Tuvalu, Tokelau and Vanuatu to calibrate, check, repair and upgrade observational and telecommunication networks.

Additional Activities

1. Practical Forecasting Assistance for Niue Meteorological Service

In the week following the RA-V/TCC-XII meeting, Ross Marsden of the New Zealand delegation will be providing practical assistance and guidance to help the Niue Meteorological Service. The objective is to assist NMS to find and use current meteorological information, supplementing the services and guidance provided by the Fiji Meteorological Service, and provide the people of Niue with timely and useful meteorological information, forecasts and warnings.

REVIEW OF THE 2006/2007 AND 2007/2008 TROPICAL CYCLONE SEASONS

(Submitted by Niue)

During the 2006/2007 cyclone season, only two tropical cyclones, namely Cliff and Arthur passed between 500 to 800 kilometers from Niue, Cliff to the north and Arthur to the south of the island, but these tropical cyclones did not cause any damages to Niue. There were a couple of tropical depressions forming but it did not develop into tropical cyclones.

In 2007/2008, one tropical cyclone, Elisa, passed between 600 to 700 kilometers from the west of Niue. The only impact from this system was remnants from Elisa bringing heavy rainfall on Niue.

The Niue Disaster Council, Government, Media and Public were kept well informed of any information regarding tropical cyclone warnings during the 2006/2007 and 2007/2008 Tropical Cyclone Seasons.

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2006/2007 and 2007/2008 Seasonal Tropical Cyclone Summary Report

(Submitted by Papua New Guinea)

Review of 2006/07 and 2007/08 Seasonal Tropical Cyclone

Papua New Guinea on the average has about one (1) tropical cyclone per season and about average tropical cyclones occurred in the past two tropical cyclone seasons. In 2006/07 there was one tropical cyclone, PIERE and in 2007/2008 again there was one tropical cyclone GUBA, these two cyclones were not severe tropical cyclones.

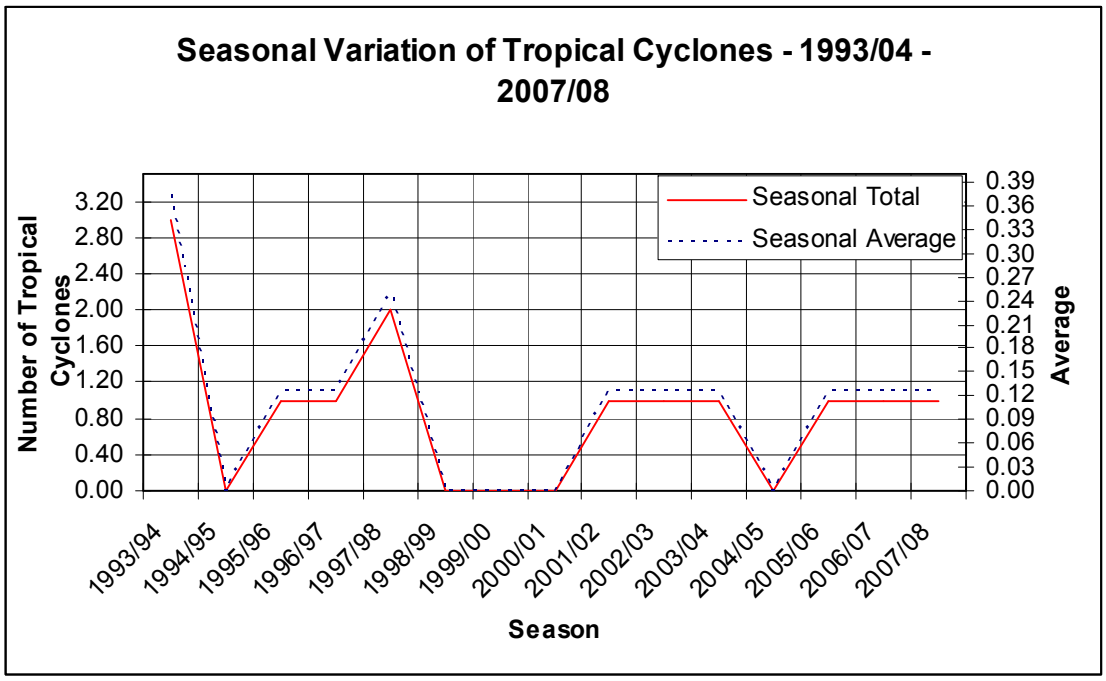


Figure 1: Seasonal variation of Tropical Cyclones in Papua New Guinea since 1993/94 to 2007/08 season.

2006/2007 Season: A category one Tropical Cyclone PIERE formed late in the 2006/07 season from a tropical depression on the 17th May 2007 at 01:45 UTC and it was named by the Queensland Tropical Cyclone Warning Centre of the Bureau of Meteorology. At 03:30 UTC, Port Moresby Tropical Cyclone Warning Centre issued the Flash Tropical Cyclone Warning and the media release was issued by the Acting Director. A Gale warning was also issued for the Milne Bay Islands in the south eastern parts of Papua New Guinea. It tracked northwest and begun to weaken on the 18th March 2007. A final warning was issued on the 19th May 2008 at 19:00UTC and tracked as a low (ex-TC PIERE) northwest and turned southwest through Milne Bay and Central Provinces and dissipated on the 23rd May 2008 at 06:00 UTC in the western Coral Sea.

Casualties: PIERE did not cause any major casualties, except for few houses were destroyed in Milne Bay Province.

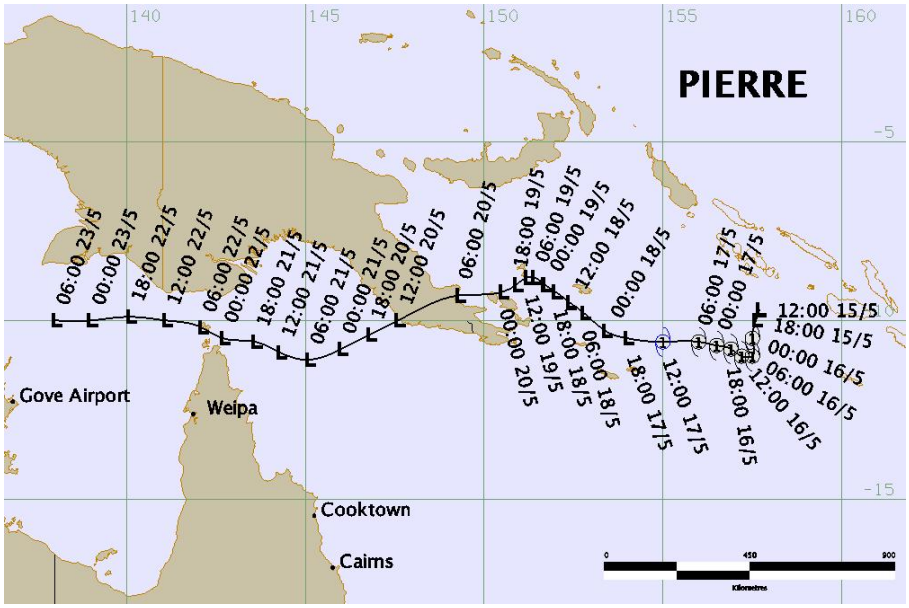


Figure 2: Track of category one Tropical Cyclone Piere. Adopted from the Bureau of Meteorology operational track.

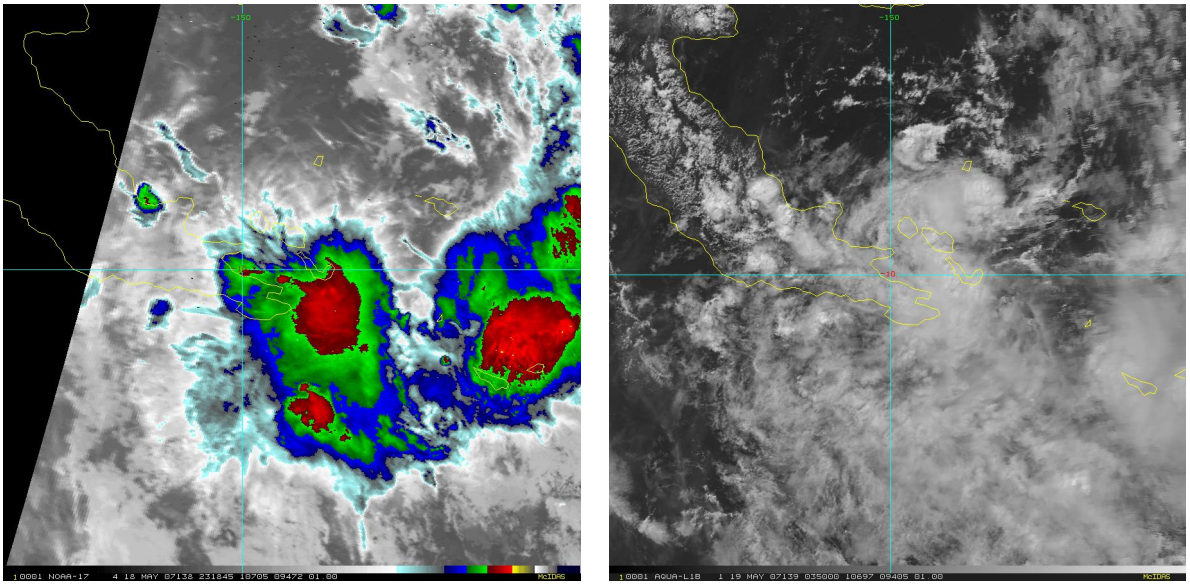


Figure 3: Enhanced Infrared image (left) and visible (right) satellite images taken by NOAA17 18th May 2007 and AQUA L1B on the 19th May 2008 respectively. Adopted from the JTWC, Hawaii, Honolulu, US.

2007/2008 Season: Tropical Cyclone GUBA formed from a tropical depression which tracked from the Solomon Seas and tracked southwest through Milne Bay and slipped into the Coral Seas on the 13th November 2008 at 00:00 UTC. By 19:00UTC Port Moresby Tropical Cyclone Warning Centre issued a Gale Warning for the Milne Bay, Central and Gulf Provinces, however the system still remained as a tropical low with central pressure of 998hpa. On the 14th November 2008 at 02:00 UTC, Port Moresby Tropical Cyclone Warning Centre issued the Flash Tropical Cyclone Warning and named it GUBA, a category one system. GUBA remained quasi-stationary and remained so. It was upgraded to category 2 on the 16th November 2007 and on the 17th November 2007, it intensified to category 3. It tracked southwest and did a U turn, tracked back northwest and begun to weaken on the 18th November 2007. A final warning was issued on the 18th November 2008 at 01:00UTC and tracked as a low (ex-TC GUBA) north and dissipated on the 19th November 2008 at 21:00 UTC in the Coral Sea.

Casualties: Papua New Guinea Meteorological Service were unable to send officers to Oro for the post-mortem, however, information from PNG National Disaster Centre and the UN Team assessment reports were made available.

Topical Cyclone GUBA was a classical example of the split system due to the mountain (Owen Stanley Range) barrier. TC GUBA was in the Coral Sea and not over Oro, however, due to the maintain range barrier, a large cloud build was observed to the north eastern sector and was over Oro Province for 4 days and caused the flooding there. Much of the flooding occurred when the TC was still a Tropical Depression.

In Brief the Number of casualties as follows:
1. Deaths: 103
2. Missing persons: 104
3. Injured persons: 32
4. Destroyed Schools: 12
5. Destroyed Houses: 1, 823
6. Destroyed Churches: 4
7. All Bridges and Food Gardens were destroyed in the affected area.
8. Health problems; Skin Disease, Flu, Severe Malaria, Diarrhea and Typhoid are on the rise.

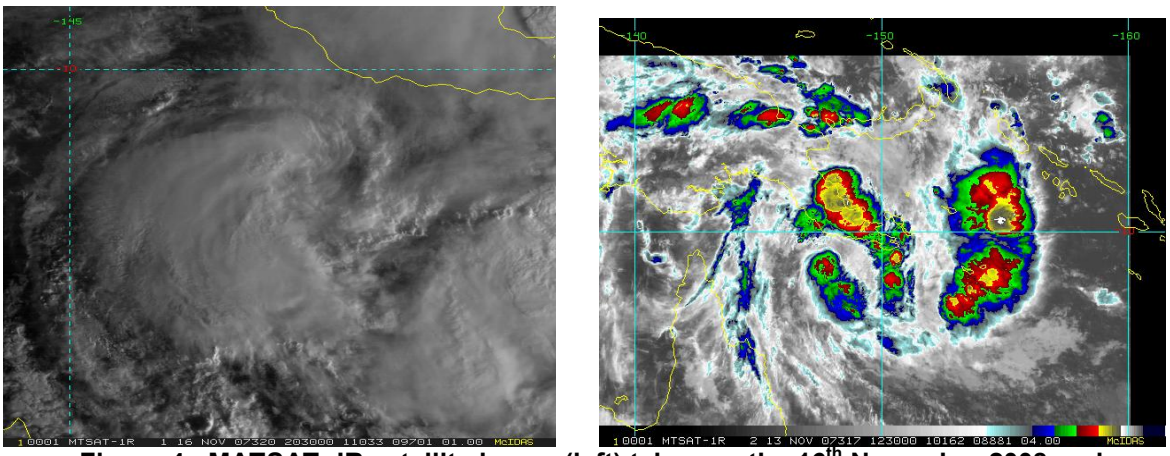


Figure 4: MATSAT- IR satellite image (left) taken on the 16th November 2008 and Enhanced MATSAT - IR (right) satellite image taken on the 13th November 2008. Adopted from the JTWC, Hawaii, Honolulu, US.

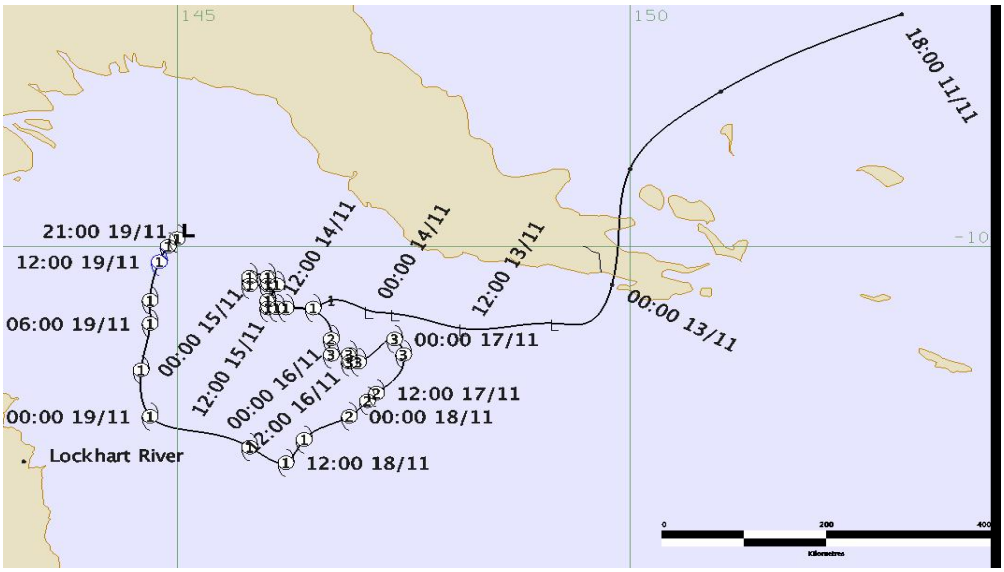


Figure 5: Track of category one Tropical Cyclone GUBA. Adopted from the Bureau of Meteorology operational track.

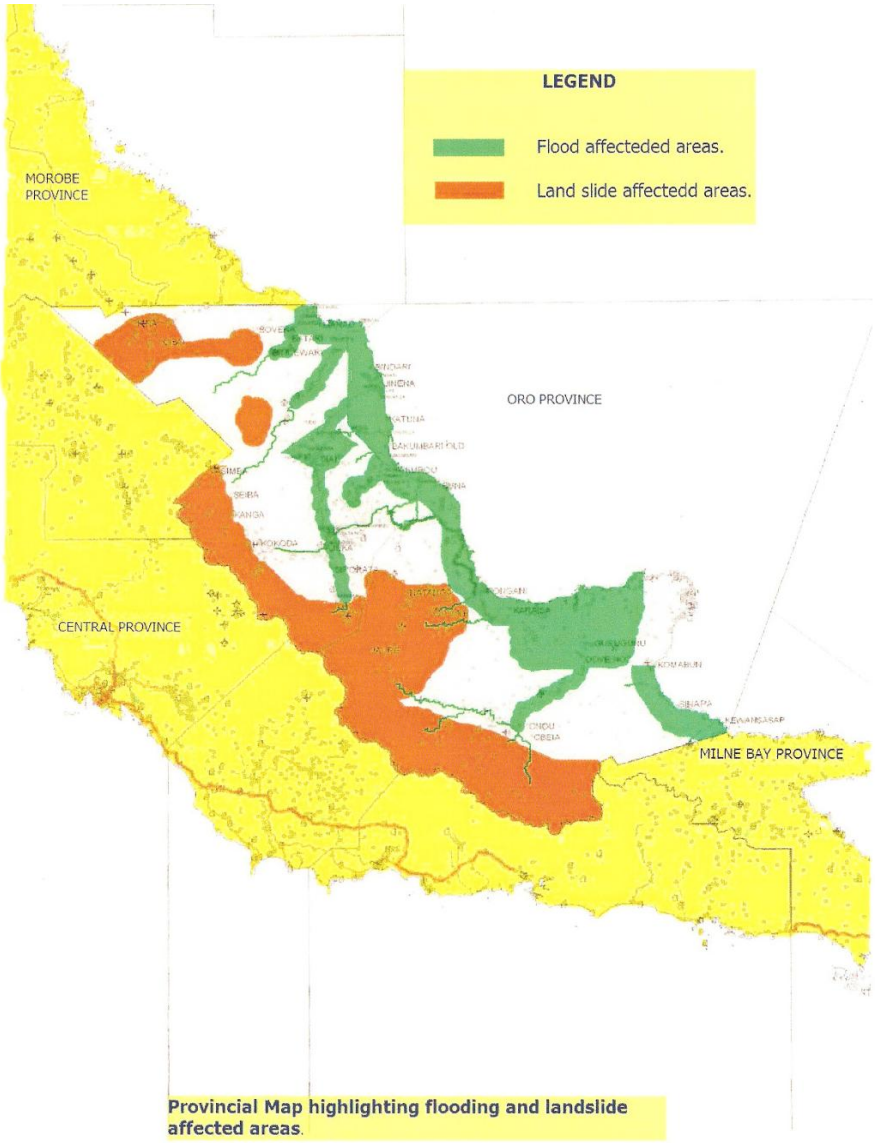


Figure 6: Oro Province Tropical Cyclone GUBA related flooding and landslide affected area map. Adopted from the National Disaster Assessment Team Report dated 24th February – 10th March 2008.

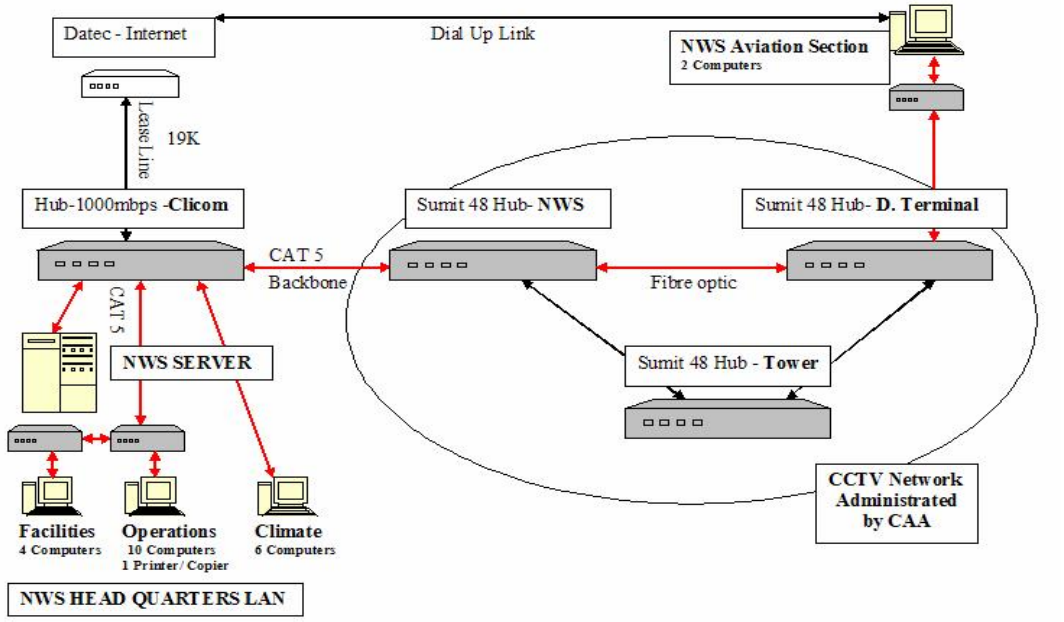
Tropical Cyclone Monitoring & Forecasting: The Port Moresby Tropical Cyclone Warning Centre (TCWC) larks skilled Forecasters and Monitoring and Forecasting Tools. The forecasters use a DEVORAK technique manually, and it takes time to do the calculations to determine the position and the strength of the Tropical Cyclone. It is important that Port Moresby TCWC be upgraded immediately.

With continued assistance and support from the Queensland Regional TCWC, Port Moresby TCWC was able to monitor the two Tropical Cyclones that occurred in the last two seasons.

Applications Software: SATAID is a very good soft and JMA should be encouraged to improve it so Pacific Island countries can use it operationally. Tropical Cyclone Module Software has been made available for monitoring of Tropical Cyclone, although Papua New Guinea Meteorologist have been trained on it, there is no copy or the system installed in the

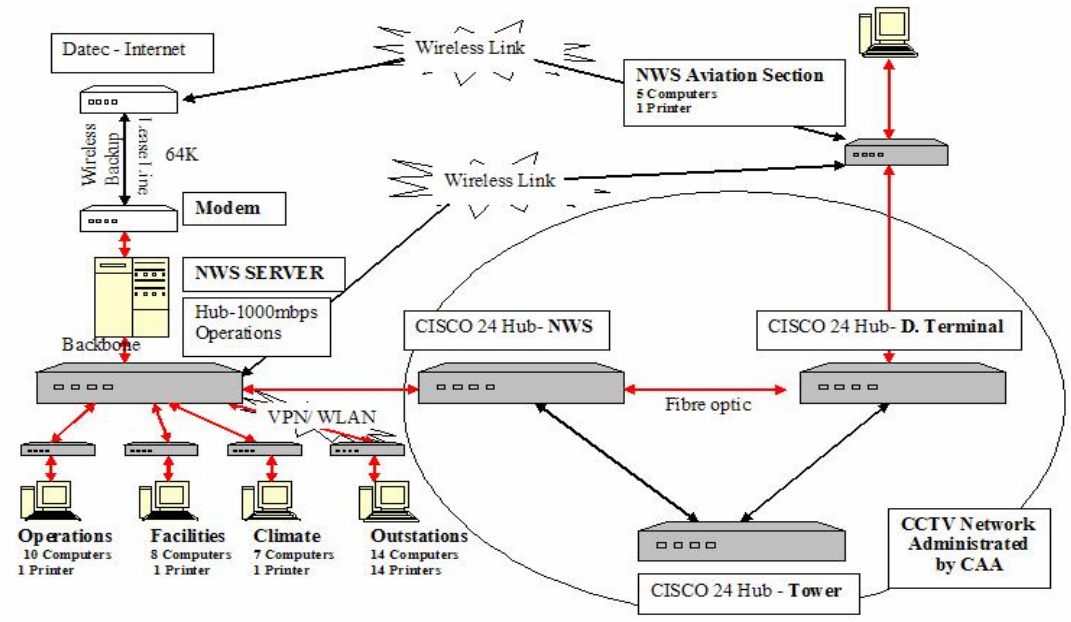
Port Moresby Tropical Cyclone Warning Centre, we still uses convenient way of tracking and forecasting Tropical Cyclones. There are no tools for storm surge modeling and forecasting as well. QFAX, satellite receiving system has been decommission and switched off on the 23rd March 2008 and Port Moresby TCWC has been relying on the internet heavily, however, this mode of communications and access of information is not very reliable due to continuous internet outages.

Communications: PNG National Weather Service has a continuous communications problem. At the moment, GTS is not operational. Internet which is not very reliable and fax and telephones are major modes of communications. A major upgrade is need in its current communications setup. Plans have been put in place to have this problem address and currently working very closely with the IT Advisor through the Australian Transport Sector Support Program to Papua New Guinea.



Note: Currently, there are 20 NWS Computers are hooked up to the Internet and 19 Email Addresses. Fibre Optics Link U/S due to Sumit 48 Switches U/S.

Figure 7: Current Internet Setup of the PNG National Weather Service LAN



Note: Future Expansions - HQ 31 NWS Computers and 30 Email Addresses, 3 Printers.
Outstations - 14 Computers, 14 Printers
Cablings - Cat 6

Figure 8: Planned Future expansions of the PNG National Weather Service LAN

Public Awareness & Outreach: Under the Department of transport, the Secretary has recognized, importance of Climate Change, and Climate Change is really the monitoring of the severe or extreme weather events. A major outreach and awareness program is planned for October this year. Number of officers will be sent out to various Tropical Cyclone, Frost and Drought prone areas to do awareness on climate change and extreme events.

Training: Three (3) Officers were trained in the APSATS training in Melbourne Australia, three in the Pacific Desk, however, one has left for Fiji. PNG National Weather Service has just completed a restructure and a handful of Forecasters have reached retirement age, and this will create a very big gap in the forecasting area. PNG National Weather Service will be going into recruitment drive to recruit 3-5 new cadet meteorologists from the University of Papua New Guinea, however, training of these cadets will be a problem and therefore may seek immediate assistance for funding from WMO, AUSAID and NZAID.

METEOROLOGY DIVISION- WEATHER SERVICES

(Submitted by Samoa)

TROPICAL CYCLONE SEASON REPORT – 2006/07

A tight pressure gradient from the sub-tropical high pressure system southeast of Samoa and Tropical Cyclone Xavier which was located between Fiji and Vanuatu on the 23rd brought strong winds of 30 knots and gusting up to 40 knots on the 23rd to 28th of October 6 mainly on the northern and western side of Upolu Manono and Apolima islands. From the same system continuous and heavy rain fall from a trough lingering around the islands have flooded most of the rivers and some of the low lands areas were affected with minor floods. November and December were quiet months with January being the busy month of the season

The most significant event of the season is the issuance of seven Special Weather Bulletin (SWB) as a result of Tropical Depression 08F which was formed approximately 115 nautical miles northwest of Samoa and tracking south-southeast on the 23rd of January The tropical depression develops as it got closers to Samoa and re-intensified into Tropical Cyclone Arthur forming southeast of Manua island of the American Samoa group. Samoa Meteorology National Forecasting unit (SMNFU) were issued with four (4) Special Advisory Bulletins from the RSMC Nadi for this system. The final SWB was issued by SMNFU when the system's centre was about 50 nautical miles direct north of Apia. Flooding of urban Apia was prevalent but not as dramatic compared to the February 2006 flood event. The lowest recorded pressure was 999.5 hpa.

The second tropical depression, 09F was developed approximately 600 nautical miles from Samoa on 3rd February 2007. The movement of the system was uncertain during the first 24 hours of development but local prevailing conditions warrant the issuance of a Wind Advisory for Samoa. The Wind Advisory was cancelled as the system starts moving south-southwest and further away from Samoa region.

TROPICAL CYCLONE SEASON REPORT 07/08

The first month of the tropical season was quiet and records showed that only the 7th of October have wind speed sustain between 22 to 28 knots for more than six hours with highest gust of 33 knots was recorded at Apia. This was due to a tight pressure gradient from a low pressure system forming just southeast of American Samoa.

On 29th of November was the second day of the 2007-2008 TC season that have winds average at 28 knots for more than four hours with highest gust of 37 knots and a lowest pressure of 1002.7 was recorded at Apia. Similar weather conditions were observed on the 28th of December with average sustained winds of 28 knots with gusts of up to 40 knots which were recorded in Apia.

The second half of the 2007/2008 season was also quiet apart from flooding in low lying areas of Apia and its suburbs. January and February recorded gusts of 38 knots with average maximum winds speed of 28 knots possible from active convergence over the islands and compound by the active western sector of the region. The lowest surface pressure of 996.7 hpa was recorded at Apia.

OTHER PROJECTS TO ENHANCE SERVICES

A JICA project to upgrade aviation services will commence in August 2008, establishment of AMOS at Faleolo; a second with the purpose of observing climatic-weather mesoscale trends is currently in the pipeline.

Under the NAPA an integrated Climate Early Warning System (CLEWS) will enhance weather services- forecasting capability, to be funded by GEF. The primary focus is improving the adaptive capacity of agriculture and health sectors but the core baseline information is observation data, so it will certainly improve the network.

REVIEW OF THE 2006/2007 AND 2007/2008 TROPICAL CYCLONE SEASONS

(Submitted by Solomon Islands)

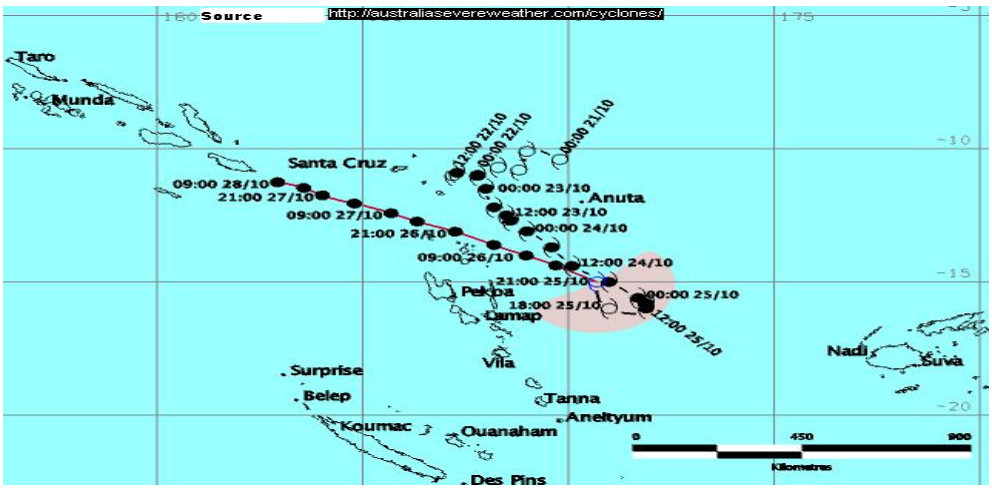
1.00: 2006/2007Cyclone Season
The 2006/2007 cyclone season ended with a total of 4 tropical (Xavier, Yani, Becky and Pierre) cyclones that posses some significant threats to parts of the Solomon Islands. Apart from those 4 tropical cyclones, a number of tropical depressions were also analyzed in the Southern parts of the country, specifically Rennell and Bellona and Temotu Province but fortunately they either dissipate or moved south or south east before they developed into tropical cyclones.

1.11 Tropical Cyclone Xavier.
On the 22/10/06 tropical cyclone Xavier was first located at latitude 11.0S and longitude 167.8E with a central pressure of 995hPa and the forecasted position at 221200UTC is 11.3S 168E and the system is expected to intensify. Winds are 35 knots but Increasing to 45 knots near the centre.

At 232130 UTC TC Xavier was upgraded to Severe Tropical Cyclone and was located at: Latitude: 12.9S, Longitude: 168.9E. The central pressure has deepened to 945hPa and is 40 nautical miles south southeast of Tikopia but moving further away from Solomon Islands. Mean maximum winds to 80 knots near the centre, with gusts to 115 knots.
On the 24/10/06 severe tropical cyclone Xavier was located at latitude 13.7S and longitude 169.0E. Central pressure is 935hPa. Mean maximum winds to 95 knots near the centre, with gusts to 135 knots but the system has moved South East.

1. 12: Warnings
A total of 16 special advisories were issued by Brisbane, appropriate warnings have been send to affected areas. Significant warnings include hurricane warning; large swells and storm surge are warnings for Tikopia and storm wind warning and very large swells through the Santa Cruz Islands and Anuta Island. Flood and strong wind warnings were also issued for Guadalcanal, Makira, Rennell and Bellona and Temotu Province.
Rainfall at the station closest to the most affected areas was highest for that month, 65.4mm on the 22/10/06.

1.13: TC XAVIER TRACKS



Source: http://www.australiasevereweather.com/cyclones/

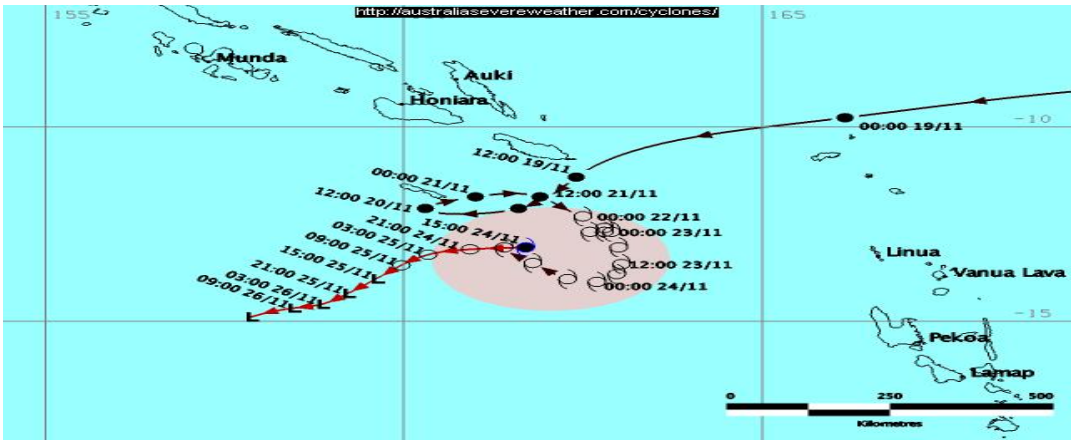
1.20: Tropical Cyclone Yani.
On the 22/11/06 at 220225 UTC Tropical Cyclone Yani was located near Latitude: 12.2S Longitude: 162.5^{E} with a central pressure of 995hPa but is expected to intensify. The

system movement at this stage is South East at 04 knots. Mean maximum winds to 35 knots near the centre but increasing to 45 knots.

At 231000 UTC, TC Yani was located at Latitude: 13.5S Longitude: 163.0E, moving: South at 5 knots with a Central Pressure of 965 hPa but expected to deepen. Mean maximum winds to 70 knots close to the centre, increasing to 80 knots with maximum gusts to 100 knots. TC Yani was at stage outside of Solomon Islands

1.21: Warnings
Gale warning was issued for Rennell and Bellona Islands from 22/11/06 to 23/11/06. Flood and strong wind warnings were issued for Makira and Rennell and Bellona Province.

1.22: TC Yani Tracks

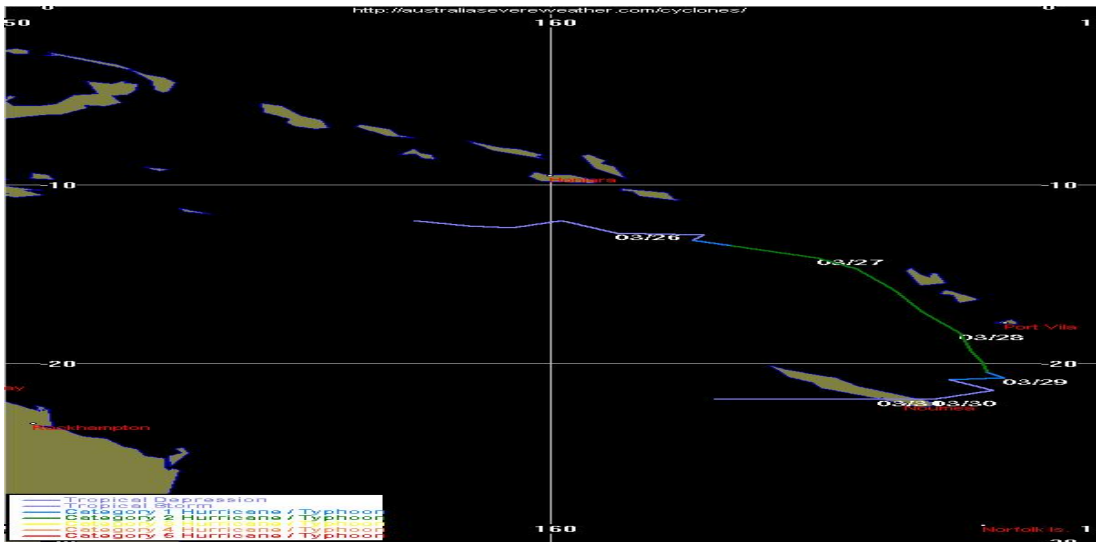


Source: http://www.australiaseverewеather.com/cyclones/

1.30: Tropical Cyclone Becky
Tropical Cyclone Becky formed within the Solomon Islands territory. For most of the time it was within this area, the system was still categorised tropical depression.

1.31: Warnings
Appropriate warnings were issued for the Southern parts of the country based on advisories and information gathered from Brisbane TCWC and Nadi RMSC and this includes strong wind and flood warnings

1.32: TC Becky Tracks



Source: http://www.australiaseverewеather.com/cyclones/

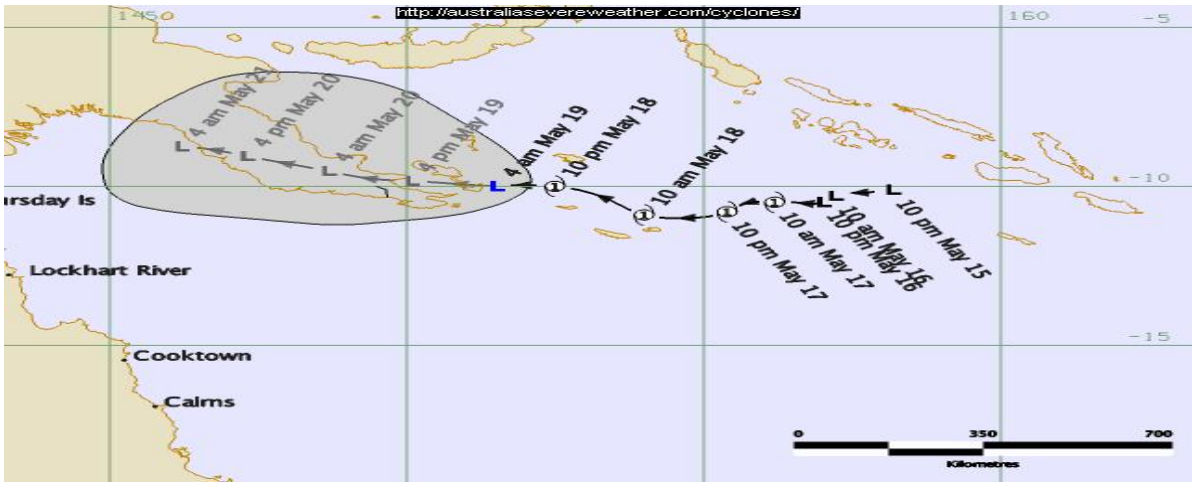
1.40: Tropical Cyclone Pierre

On the 16th May 2007 at 1800UTC, a low pressure system (998hPa) was located at 10.4 S 157.0 E and is intensifying. At 0000 UTC a Tropical Cyclone Pierre, central pressure 995 hPa was centered within 20 nautical miles of 10.7 S 156.6 E and moving west at 3 knots. Forecasted maximum winds of 40 knots increasing to 55 knots but the system has moved into Papua New Guinea's Territory before it intensifies.

1.41: Warnings

Based on special advisories, a number of warnings have been issued for the Southern parts of the country. Warnings included flood warnings and strong wind warnings for the southern waters.

1.42: TC Pierre Tracks



Source: http://www.australiasevereweather.com/cyclones/

2:00: 2007/2008 Tropical Cyclone Season

No major tropical cyclones have either formed or pass through Solomon Islands during this season. However, couple of tropical depressions were formed in the country, approximately within the region, longtitude: 11S -13S and latitude 160E-165E. These systems dissipates before they form into tropical cyclones because of unfavorable conditions as a result of the La Nina conditions.

2.10: Warnings

Warnings issued were mainly due to deteriorating conditions associated with these depressions. A couple of flood warnings were issued for low lying areas due to extreme rainfall expected from the cloud band.

Other issues experienced during this season apart from tropical cyclones was the extreme high tide which has caused a lot of problems in coastal communities.

3.00: Impacts of Tropical Cyclones for 2006/2007 and 2007/2008 Season

Impacts of these systems are mainly restricted to flooding in low lying areas and minor damages to buildings with locally build materials. Reports received from the National Disaster Management Office of damages to food crops especially in parts of Guadalcanal, Makira, and Rennell and Bellona.

Not only that but in 2007/2008 season, most of the atolls/low lying islands have experienced food shortage as result of the extreme high tides.

4.00: Other Developments

Major developments planned to be implemented or are ongoing within the Solomon Islands Meteorological Services to enhance it's capability so as to successfully meet it's obligation are:

1. Establishing a new National forecasting Office and upgrading of forecasting facilities.
2. Establishing a manned observation station at Rennell as the region is critical in TC formation.
3. Installation of standby generator to address the issue of regular power cuts especially during cyclone seasons.
4. Forecaster training at Victoria University of Wellington for which funding to be sought from NZ Scholarship.
5. Annual awareness program aired through the National Broadcaster (SIBC) and other media outlets in partnership with the National Disaster Management Office(NDMO) and the Marine Division- Search and Rescue Section. This awareness program usually happens during the cyclone season and is mainly funded by the NDMO.

REVIEW OF THE 2006/2007 AND 2007/2008 TROPICAL CYCLONE SEASONS

(Submitted by Tonga)

There were two Tropical Cyclones that affected Tonga during 2006-2007 and one during 2007-2008.

TROPICAL CYCLONE *"CLIFF"* (5 – 6 April 2007)

Introduction

Tropical Cyclone "CLIFF" had its origin in an intense and active area of the South Pacific Convergence Zone which stretched from northern Fiji to Wallis and Futuna and Vava'u to Niue.

At about 040400UTC Tropical Depression (14F) was named Tropical cyclone "CLIFF" when it was lies about 16.8S latitude and 179.6E longitude or 700km to the northwest of Tongatapu. The cyclone estimated intensity was 40-50 knots gusting to 85 knots. The cyclone tracked southeast and then south-southeast just in time for its area of gales force winds to miss the land area of Ha'apai and Tongatapu.

The maximum sustained 10 minutes winds and maximum winds gust recorded in Tonga were 18 knots and 28 knots respectively at 051100UTC at Fua'amotu Station. Again at Fua'amotu the maximum amount of rainfalls were 35.9mm as recorded at 052100UTC.

Warnings

A total of 4 Special Weather Bulletins were issued for Tonga on Tropical Cyclone "CLIFF".

Tropical cyclone warning system

The Meteorological service experienced power failure (mains) at 042200UTC. The standby power could not be restored therefore operations were shifted to the National Emergency Operations Centre (backup) in Nuku'alofa for the remainder of the cyclone operations although Fua'amotu continued to operate on a mobile generator. Communications remained satisfactory although some difficulties were experienced during the power outages at Fua'amotu.

TROPICAL CYCLONE "DAMAN" (8 December 2007)

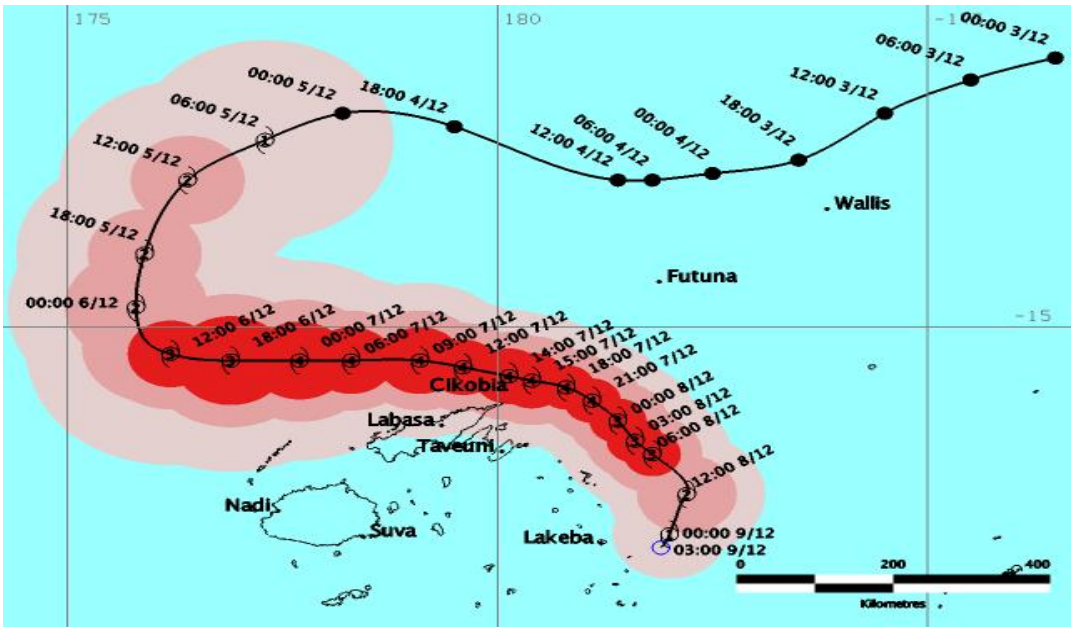
Summary

Tropical Cyclone "DAMAN" originated in an active area of the South Pacific Convergence Zone that was stretched from Tuvalu to the North of Samoa. It first originated as Tropical Depression 04F before it reached Tropical Cyclone strength on December 5 at about 7:00pm. That time the Cyclone was about 900km to the West- Northwest of Niuafo'ou.

The cyclone tracked ESE on December 8 towards the kingdom about midday at 10 knots and the 10-minute average winds near the centre were 90 knots with gust up to 125knots. That time the cyclone center was about 550 km WNW of Vavau. After a few hours, new observations became available indicating the cyclone was weakening at a very quick rate and tracking SSW. Hence it no longer posed any level of threat for Tonga.

A total of two SPECIAL WEATHER BULLETINS were issued for Tonga. The cyclone did not exert any damaging winds to Tonga except for the strong winds.

Track of Tropical Cyclone DAMAN (FMS)



Conclusion

Tropical Cyclone Cliff did not inflict any damage to the Group. In fact it was the last Cyclone of the season.

TROPICAL CYCLONE "ELISA" (10 January 2008)

Summary

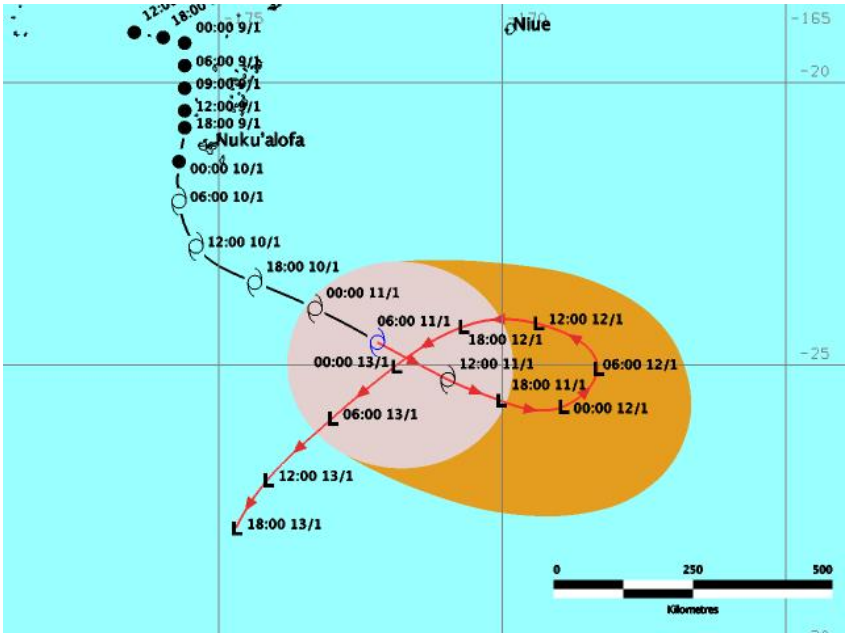
Tropical Cyclone "ELISA" originated in an active area of the South Pacific Convergence Zone which stretched from Solomon Islands to the two Niuas.

At 7:00pm January 10 Tropical Depression 07F was named Tropical Cyclone Elisa when it was located 75km West-Southwest of Fua'amotu moving southeast at 5 knots.

Heavy rain associated with the Tropical Depression and strong winds caused damages mostly to fruit bearing trees in Tongatapu and Eua. Further to that, associated rough and high seas moved small vessels and fishing boats ashore in Nuku'alofa.

The Strongest wind gust of 44knots was measured at Fua'amotu at 8:00am Thursday 10 Jan 2008 and the average winds ranged from 20 to 30knots.

Track of Tropical Cyclone ELISA (FMS)


Niue
Nuku'alofa
00:00 9/1
06:00 9/1
09:00 9/1
12:00 9/1
18:00 9/1
00:00 10/1
06:00 10/1
12:00 10/1
18:00 10/1
00:00 11/1
06:00 11/1
12:00 11/1
18:00 11/1
00:00 12/1
06:00 12/1
12:00 12/1
18:00 12/1
00:00 13/1
06:00 13/1
12:00 13/1
18:00 13/1
-165
-20
-25
0
250
500
Kilometres

REVIEW OF THE 2006 AND 2007 TROPICAL CYCLONE SEASONS

(Submitted by United States of America)

2006 Central North Pacific Tropical Cyclone Season

Overview

The 2006 central north Pacific tropical cyclone season had near normal activity despite the development of a relatively weak El Nino in September 2006. A total of five tropical cyclones occurred during the season, including two hurricanes. One of the hurricanes, Ioke, reached category 5 intensity and set several central Pacific tropical cyclone records. The other three systems only reached tropical depression intensity. Two signals of El Nino were that 4 of the 5 systems developed within the central Pacific basin where ocean waters were warmer than normal and the three depressions occurred from mid-September to mid-October. Based on long-term averages, the typical season has 4.4 total tropical cyclones, 1.6 being hurricanes, 1.3 tropical storms and 1.5 tropical depressions.

Ioke struck Johnston Island with peak winds estimated to be in the 95 to 115 knots range. This resulted in significant damage to vegetation and coastal erosion. The native bird population was also affected, however no injuries occurred despite a survey crew being on the otherwise uninhabited island at the time. Remnants of both Hurricane Daniel and TD-04C helped fuel locally heavy rains across the Big Island of Hawaii.

Table 1. Summary Table (Data only for the Central North Pacific)

Name	Dates	Max Wind	Est. Minimum Pressure
Hurricane Daniel	Jul 24-26	80 kt/ 90 mph	980 mb/28.94 in
Hurricane Ioke	Aug 19-26	140 kt/160 mph	915 mb/27.02 in
TD two-c	Sep 18-20	30 kt/ 35 mph	1007 mb/29.74 in
TD three-c	Sep 26	30 kt/ 35 mph	1008 mb/29.77 in
TD four-c	Oct 13-14	30 kt/ 35 mph	1007 mb/29.74 in

Specific Tropical Cyclones

1. HURRICANE DANIEL 24-26 July 2008

Tropical Depression (TD) 5-E formed south of Baja California near 12.4N 109.9W at 0000 UTC 17 July then quickly intensified and became Tropical Storm Daniel 12 hours later near 12.4N 112.2W. Development continued unabated until Daniel became a hurricane at 1800 UTC 18 July near 11.9N 117.6W. Thanks to favorable SSTs and low shear environment, Hurricane Daniel continued to strengthen as it moved west, reaching its peak of 130 knots on 22 July. Hurricane Daniel exhibited a relatively rare structure, with very little convection outside of a nearly perfectly symmetrical eye wall. This type of hurricane, known as an annular hurricane, has been shown to maintain its intensity longer than the average hurricane, and Daniel was no exception.

However as it moved westward, Daniel began to slowly weaken and the Central Pacific Hurricane Center (CPHC)/RSMC Honolulu estimated the mean sustained winds to be 80 knots when it crossed 140W and moved into CPHC area of responsibility shortly before 1200 UTC 24 July. Hurricane Daniel became a tropical storm within 18 hours of crossing

140W and a tropical depression within 36 hours. By the time it reached 16.2N 144.4W, CPHC classified it as a remnant low.

CPHC issued the last bulletin on Daniel at 2100 UTC 26 July and classified it as a dissipating remnant low with maximum sustained winds of 30 knots located about 800 miles east southeast of Hilo, Hawaii.

Impacts: The remnant circulation of Daniel passed just south of the island of the Big Island of Hawaii on 28 July. Radar and rain gages recorded two to five inches of rainfall across windward areas of the Big Island and Maui on 28 and 29 July. The remnants also brought gusty easterly winds to the main Hawaiian Islands. For a brief period during the afternoon on 28 July, a wind gage at South Point on the Big Island recorded sustained winds of approximately 30 knots with gusts to 40 knots.

2. HURRICANE IOKE 20-27 August 2006

CPHC started tracking a tropical disturbance at 1200 UTC 16 August located near 10.7N 144.7W or 925 nm southeast of Hilo, Hawaii. The disturbance moved due west over the next four days becoming Tropical Depression 01-C at 0000 UTC 20 August near 10.4N 158.7W or 675 nm south of Honolulu, Hawaii.

Tropical Depression 01-C rapidly intensified becoming Tropical Storm Ioke near 10.6N 159.0W six hours later at 0600 UTC 20 August. Ioke was the first named tropical cyclone to develop within the Central Pacific since 2002. The system continued to strengthen and at 0000 UTC 21 August, only 24 hours after becoming a depression, Ioke became a hurricane. CPHC estimated maximum sustained winds at 65 knots with a center near 11.5N 163.8W or 685 nm southwest of Honolulu.

Twenty-four hours after becoming a hurricane, Ioke, on a northwest course towards Johnston Island, had estimated maximum sustained winds of 115 knots at 0000 UTC 22 August. After the previous rapid increase in intensity, Ioke began to weaken and at 1800 UTC 22 August had winds estimated near 90 knots about 40 miles south-southeast of Johnston Island. Ioke passed approximately 30 miles south of Johnston Island as a Category 2 hurricane during the 6 hours from 1800 UTC 22 August to 0000 UTC 23 August. After 36 hours as a Category 2 hurricane, Ioke once again started to intensify. CPHC hurricane specialists estimated the maximum sustained winds to be near 100 knots at 0600 UTC 24 August. Twenty-four hours later at 0600 UTC 25 August, CPHC placed the maximum sustained winds at 140 knots, a category 5 hurricane, centered near 19.1N 174.2W moving to the west-northwest at 6 knots. Ioke crossed the International Dateline near 17.7N between 0300 and 0600 UTC 27 August with winds estimated at 140 knots. With the crossing of the International Dateline, Hurricane Ioke became Super Typhoon Ioke and took aim at Wake Island.

Impacts. Hurricane Ioke passed just southwest of Johnston Island on 22 August. The island is a wildlife refuge and normally uninhabited. However, a survey ship and 12 crew members were on the island when Ioke hit. After securing their ship, the crew took shelter in a sturdy concrete building and rode out the storm. There were no injuries, and the ship received only minor damage.

No meteorological instruments were on the island. However based on the crew's eyewitness accounts, tropical storm force winds lasted nearly 27 hours, from about 1200 UTC August 22 until 1500 UTC August 23. Hurricane force winds began shortly before 2200 UTC and lasted 6 to 8 hours. The crew visually estimated the peak winds at 95 to 115 knots. The hurricane washed away a portion of a sea wall and adjacent road. Also, Ioke blew off the tops of an estimated 15 percent of the island's palm trees, and blew down some ironwood

trees. The crew estimated the majority of the bird life on the island made it through the hurricane unscathed.

Ioke was:

- The first named tropical cyclone to form in the central Pacific since 2002 when there was Alika, Ele and Huko;
- The fifth Category 5 hurricane on record in the central Pacific;
- The first Category 5 hurricane with origins in the central Pacific since record keeping began in the early 1960s. In 1994, Emilia, Gilma and John strengthened to Category 5 hurricanes in the central Pacific, but these hurricanes originated in the east Pacific. Patsy, also a Category 5 hurricane, was a rarity because it came into the central Pacific from the west across the Dateline in September 1959;
- The hurricane which set a new record for the lowest estimated surface pressure for any hurricane within the central Pacific;
- A Category 4 or higher hurricane for 198 consecutive hours which was the longest continuous time period at that intensity observed for any tropical cyclone anywhere on earth.

3. TROPICAL DEPRESSION 02-C 18-20 September 2

Tropical Depression 02-C developed from a tropical disturbance embedded within the ITCZ south of Hawaii. First identified as a tropical disturbance on 14 September near 10.6N 145.3W, the system persisted as an organized cluster of thunderstorms. Through 17 September, QuikSCAT satellite winds and other data did not indicate a closed circulation. TD 02-C became a tropical depression on the morning of 18 September when a 1623 UTC QuikSCAT pass displayed a closed circulation at the surface. This same QuikSCAT data indicated maximum sustained winds of 45 knots near the center of TD 02-C, but these data were rain flagged (contaminated due to heavy rain). Thus based largely in part on agency fixes of 1.0 to 1.5 Dvorak numbers, CPHC set the initial intensity at 25 knots. Over the next 36 hours, TD 02-C failed to reach tropical storm strength with winds remaining at 25 to at 30 knots from 0600 UTC 19 September to 0600 UTC 20 September. By early on 21 September, persistent convective activity had ceased and TD 02-C lost its low level circulation.

Impacts. TD 02-C remained over water and away from any significant or otherwise populated Pacific islands.

4. TROPICAL DEPRESSION 03-C 26-27 September 2006

Tropical Depression 03-C developed over the open tropical ocean near the International Dateline far to the west southwest of the Hawaiian Islands. This system which formed within a cluster of thunderstorms within the ITCZ was the second weak tropical cyclone (first was TD 02-C) to develop in the southwestern portion of the central Pacific Ocean after the occurrence of powerful Hurricane Ioke in August 2006. On 25 September, CPHC began tracking the cluster of disorganized, but persistent deep convection, which spawned TD-03C. Based upon the appearance of significant cold cloud tops in infrared satellite imagery, a low level circulation center evident in early morning visible satellite imagery, and a somewhat ambiguous QuikSCAT pass, CPHC declared the system TD 03-C at 2100 UTC 26 September. At that time, the center of TD 03-C was near 11.2N 177.8W or about 1530 miles west-southwest of Honolulu, Hawaii and 710 miles west-southwest of Johnston Island. CPHC estimated the maximum sustained wind speed at the time to be 30 knots, and the tropical depression was moving toward the west-northwest at slightly less than 8 knots. However, TD-03C struggled to maintain its identity during the next several hours. QuikSCAT data from 0827 UTC 27 September indicated TD-03C no longer had an identifiable closed low level circulation center. As a result, CPHC issued the final advisory

for dissipating TD-03C at 0900 UTC 27 September as it was crossing the International Dateline.

Impacts. TD 03-C remained over water and away from any significant or otherwise populated Pacific islands.

5. TROPICAL DEPRESSION 04-C 13-14 October 2006

Tropical depression 04-C formed from a persistent cluster of Thunderstorms nearly 750 miles southwest of Oahu on October 13. TD04-C moved north and then northeast as it was embedded in a southwesterly steering flow ahead of a mid latitude trough closer to the dateline. As the trough approached, upper level winds increased and caused the convection to shear away from the low level center. By early on October 14, TD04-C was nothing more than a low level cloud swirl.

Impacts: The remnants ultimately moved northeast in advance of the upper level trough and helped fuel heavy rainfall and flooding from thunderstorms across the big island of Hawaii on October 17.

2007 Central North Pacific Tropical Cyclone Season

The 2007 central north Pacific tropical cyclone season had below normal activity with the occurrence of a La Nina. A total of only two tropical cyclones occurred during the season, including only one hurricane. Based on long-term averages, the typical season has 4.4 total tropical cyclones, 1.6 being hurricanes, 1.3 tropical storms and 1.5 tropical depressions.

1. TROPICAL DEPRESSION COSME 19 – 24 July 2007

The Central Pacific Hurricane Center (CPHC)/RSMC Honolulu assumed forecast responsibility of Tropical Depression Cosme at 0000 UTC 19 July, with the first official position at 15.2N 140.7W. Cosme was moving to the west at 12kt, with maximum winds estimated at 30kt.

While in the Tropical Prediction Center (TPC) area of responsibility east of 140W, Cosme was a hurricane at 1800 UTC 16 July, only to weaken to a tropical storm at 0600 UTC 17 July. Cosme remained a tropical storm until just prior to crossing 140W, when it weakened to a tropical depression at 1800 UTC 18 July. Maximum winds at that time were estimated at 35kt.

Tropical Depression Cosme proceeded to move to the west across the Central North Pacific, passing 65nm south of NOAA Buoy 51004 at 2000 UTC 20 July. The buoy reported maximum winds of 27kt and seas to 13ft. Cosme passed 160nm south of South Point on the Island of Hawaii at about 0400 UTC 21 July, where there was no appreciable increase in the winds. Cosme then passed about 60 nm south of NOAA Buoy 51002 at 1300 UTC 21 July. The buoy recorded maximum winds of 28kt for a short period of time and seas to 18ft.

The last CPHC advisory was written at 0000 UTC 23 July, when the system was near 16.1N 168.3W, or about 40nm south southeast of Johnston Island. Four hours later, at 0400 UTC 23 July, a weakening Cosme passed about 6nm south of Johnston Island. The persistent remnant low with estimated maximum winds of 25kt was tracked by WFO Honolulu to 15.8N 179.4W at 1800 UTC 24 July, whereupon it weakened into an open trough.

Impacts: Showers and thunderstorms north of Cosme reached the east and southeast slopes of the Big Island during the afternoon of 20 July, and persisted through the morning

of 21 July. Highest rainfall totals were 6.94 in at Hakalau, 6.68in at Glenwood, 4.77in at Waiakea Uka, and 4.37in at Mountain View. Hawaii County Civil Defense did not report any significant flooding as a result of Cosme's passage.

2. HURRICANE FLOSSIE 11-16 August 2007

Hurricane Flossie crossed longitude 140°W into the Central North Pacific during the morning of 11 August 2007. The National Hurricane Center in Miami, FL had been issuing advisories on this tropical cyclone starting on 8 August. Flossie was a very impressive hurricane with a distinct eye embedded within a solid eye wall and a very impressive upper level outflow pattern as it entered the CPHC Area of Responsibility (AOR). The hurricane maintained maximum 1-minute sustained wind speeds of 130 to 140 mph for the next two days. Flossie was a relatively small tropical cyclone with sustained winds speeds of 39 mph of greater extending out about 100 miles from the center in the northern semicircle time period during this same time period. A hurricane watch was issued for the Big Island of Hawaii early on the morning of 13 August due to the close proximity of the projected track to that island, as well as the intensity forecast maintaining Flossie as a hurricane when it arrived in the vicinity of that island within 36 hours. A tropical storm warning was hoisted for the Big Island later that same morning. Fortunately, the long anticipated increase in vertical wind shear took its toll on Flossie during 14 August. As a result, Flossie weakened to a tropical storm later that night. As it was passing south of the islands of Oahu and Kauai late on 15 August, Flossie weakened to a tropical depression due to the very strong vertical wind shear. CPHC issued the final advisory on dissipating tropical depression Flossie during the early morning hours on 16 August.

Impacts. Even though the center of Flossie passed about 100 miles due south of South Point on the Big Island of Hawaii, it generated very large waves along the southeast facing shoreline of that island. The height of the largest wave faces was estimated to be near 20 feet. In fact, coincident with the passage of Flossie, a 44 acre lava bench slipped into the ocean during the night on 13 August. According to the United States Geological survey (USGS), it is possible this loss of shoreline was due to the large pounding surf generated by the hurricane, a 5.4 magnitude earthquake that occurred around the same time, or a combination of both events. Flossie weakened and remained far enough south of the Big Island during its closest approach on 14 August to prevent any excessive rainfall amounts over land. However, sustained winds of at least 39 mph were recorded on South Point as Flossie passed by. No significant damage or injuries were reported on the Big Island.

The 403rd wing of the US Air Force Reserve 53rd Weather squadron ("Hurricane Hunters") flew reconnaissance missions into Flossie while it was a threat to the Aloha State. These critical missions provided important data in real-time to the forecasters at CPHC.

TC Season 2006-2007 and 2007-2008,

(Submitted by Vanuatu)

TC Season 2006-2007

The 2006/2007 tropical cyclone season has been relatively quiet in Vanuatu in comparison with previous seasons. With ENSO conditions pointing towards El Nino development, Xavier was the first cyclone to embrace the season, a month before its official opening. Tropical Cyclone Becky was the last system of the season to affect Vanuatu.

Tropical Cyclone Xavier

A tropical depression developed on the 21st of October 2006 north northeast of Torba province, and rapidly develops overnight due to good support aloft and warm sea surface temperature. On the 22nd of October 2006 at midday, the system was named TC Xavier. At that time TC Xavier was 250 kilometers east northeast of Torba province, heading south southeast. As the system continues to move in a southeasterly direction and with the anticipation of it turning west southwest, warnings were issued for the northern and central parts of Vanuatu. On the 26th of October 2006, the final information was issued by the Vanuatu Meteorological Service on TC Xavier. A total of 24 3-hourly warnings were issued for TC Xavier. The lowest pressure reading was 1006hPa, observed at Sola Observation. The maximum sustained wind was 30 knots, recorded at Sola Observation Station.

Damages

There were reports of gale winds being experienced on some islands of Torres Group in Torba province, with garden crops being damaged. Over other parts of the central and southern islands, only strong winds were experienced.

Tropical Cyclone Becky

On the 25th of March 2007 a tropical low formed 200 nm southwest of Honiara, Solomon Islands. On the 26th, it was named TC Becky. The Vanuatu Meteorological Service issued the first advisory on the system at 8:30am, the 27th of March 2007 when it was 350 kilometers west of the Torba group. At that time, the central pressure of the system was 990hPa with winds at 40 knots. The fist gale warning was issued at 12pm the same day for Torba, Sanma and Penama province. The gale warning was extended to Malampa and Shefa the next day. All warnings were downgraded at 9pm on the 28th of March 2007. A total of 12 3-hourly warnings were issued by the Vanuatu Meteorological Service. The lowest pressure reading was 999hPa, recorded at Bauerfield, with the highest maximum sustained wind measured at 17 knots. There were no reports of damages or casualties caused by Becky.

Cyclone Season 2007-2008

The ENSO conditions for the 2007-2008 Cyclone season was showing signs of La Nina conditions, with the South Pacific Convergence Zone drifting southwest, positioning itself over Vanuatu and New Caledonia for the latter part of the cyclone season.

TC Funa

A low pressure system developed northwest of Santo on the 15th of January 2008. The convection associated with the low become more apparent with evidence of a low level circulation. At 5am on the 16th of January, the low intensified into a depression, located 350KM west of Santo. This prompted the Vanuatu Meteorological Service to issue the first

advisory on the system at 12am on the same day. The system continued its east southeast movement, positioned 300KM west of Santo. At 5pm, the system was named Funa, and the Vanuatu Meteorological Service issued the first gale warning for the Northern provinces. The warning was upgraded to storm on the 17th as TC Funa intensified.

The warnings were downgraded on the 18th of January as TC Funa continued a southeast track, and moved away from Vanuatu. A total of 12 3-hourly warnings were issued by the Vanuatu Meteorological Service. On its course, TC Funa made landfall on the northern part of the island of Santo, north Ambae and Maewo

Damages

Mostly garden crops and houses made of local materials were damaged, mostly over Northern provinces. Telecommunication was also disrupted. Over Torba Province, a dining hall as well a local government building was damaged. One person was injured as a result of a fallen tree. Additionally, three bungalows close to coastal areas have at least one of their buildings being blown away by the gale and storm winds of Funa.

TC Gene

A tropical depression was evident east northeast of Fiji. Organization improved, with good support aloft, and on the 28th of January, 2008, the depression became tropical cyclone Gene. Gene's initial path was southwest, and then west, that brought it through the two main island of Fiji. As it moves past Fiji, with the anticipation of it moving west southwest, the Vanuatu Tropical Cyclone Warning issue the first advisory on Gene on the 30th of January. Tropical cyclone Gene was 300KM east of Futuna Island. The first warning was issued on the 31st of January at 3am in the morning specifically for the central and southern islands.

On the 31st of January, at 6pm, TC Gene started to slowly move in a west southwest track, as well as intensify. Warnings for central islands were cancelled, while warnings for the southern islands were upgraded to storm and Hurricane, as Gene continues to intensify to 955hPa, 80 knots (Cat 3). The hurricane and storm wind warning was maintained until the 01st of February 2008, at 6pm. On the 2nd of February 2008, warnings for Tafea were downgraded to gale as TC Gene reduced its intensity. The final warning was issued at 3pm, on the 2nd of February 2008 when Gene was located 300KM southeast of Aneityum Island. The closest Gene came to Futuna was 30 KM to the southeast of the island. Winds of 50 to 60 knots were recorded on Aneityum. The lowest pressure recorded on Aneityum was 998hPa on the 31st of January 2008 at 11pm, while the observation station on Whitegrass, Tanna reported 994hPa on the 1st of January at 5am local time.

Damages

On the island of Futuna, Tafea province, garden crops and houses (both native and non native) were severely damaged. More than 70% of garden crops were damaged by the winds of TC Funa, prompting the Vanuatu Government to declare the area a disaster zone.