

WORLD METEOROLOGICAL ORGANIZATION

**RA V TROPICAL CYCLONE COMMITTEE FOR THE
SOUTH PACIFIC AND SOUTH-EAST INDIAN OCEAN**

ELEVENTH SESSION

(ADELAIDE, AUSTRALIA, 4 to 8 MAY 2006)



FINAL REPORT

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. ORGANIZATION OF THE SESSION (Agenda item 1)

1.1 Opening of the session (agenda item 1.1)

1.1.1 At the kind invitation of the Government of Australia, the eleventh session of the Regional Association V Tropical Cyclone Committee (RA V/TCC) for the South Pacific and South-East Indian Ocean was held from 4 to 8 May 2006 at the Stamford Plaza, Adelaide, Australia.

1.1.2 The session was opened at 09.00 a.m. on Thursday, 4 May 2006, with a warm welcome by Mr Jim Davidson, Regional Director, Queensland Regional Office, Australian Bureau of Meteorology (BoM).

1.1.3 Mr Andrew Watson, Regional Director, South Australian Regional Office, BoM, welcomed the participants on behalf of Dr Geoff Love, Permanent Representative of Australia with WMO and Director of BoM. In his welcome address, he mentioned that, although South Australia is not directly affected by tropical cyclones, remnants of the storms, which had undergone "extra-tropical transition", sometimes produce heavy rain or strong winds. Recent events such as "Larry", "Monica" and "Ingrid" showed the ferocity of tropical cyclones and how they can impact communities in the Region. He stressed that the work of both Meteorological Offices in the northern Australia and the National Meteorological and Hydrological Services (NMHS) in the Pacific region in grappling with forecasting tropical cyclones is admirable. Finally, Mr Watson wished the Committee a successful session.

1.1.4 Speaking on behalf of Mr Michel Jarraud, the Secretary-General of the World Meteorological Organization (WMO), Mr Koji Kuroiwa, Chief, Tropical Cyclone Programme (TCP), Applications Meteorology Department, extended a warm welcome to the participants and expressed the sincere appreciation of WMO to the Government of Australia for hosting the eleventh session of the Committee in Adelaide. He stressed that global efforts, especially within the context of TCP, have resulted in noticeable improvements in the warning systems in many parts of the world. To more effectively address the natural disasters including tropical cyclones, he stressed the importance of further strengthening the collaboration with decision-makers, governmental and non-governmental organizations, the scientific community, the private sector, the media and the public. He assured the session that WMO will continue making every effort to support the work of the RA V/TCC and wished the Committee active discussions and fruitful outcomes.

1.1.5 Mr Arona Ngari (Permanent Representative of Cook Islands with WMO), the acting President of Regional Association V (South-West Pacific), welcomed the participants to the eleventh session of RA V/TCC and expressed his appreciation to WMO and the Government of Australia for hosting the session. The last two years have certainly tested the ability of the Region in addressing tropical cyclones and finding means of minimizing the impact of such hazards to life and property. He expressed his appreciation to Australia for the excellent facilities put in place to cater for this session and looked forward to the deliberations of the participants at this meeting.

1.1.6 Mr Steve Ready (New Zealand), Chairman of RA V/TCC, acknowledged that this meeting would be the last commitment of his sixteen-year chairmanship. He also acknowledged the presence of Mr Ram Krishna (Australia), the previous and first Chairman of the Committee and Mr Rajendra Prasad (Fiji), one of the original members of the Committee since its establishment in 1985. Mr Ready emphasized that one of the major achievements of the Committee was the restructuring of its Technical Plan at its eighth session (Rarotonga, Cook Islands, 5 to 12 September 2000), which made it highly objective as compared to its predecessors. He acknowledged the valuable support of WMO, in particular, Mr Katsuhiro Abe, the previous Chief of TCP. He also thanked the members of the Committee for their cooperation and support during his tenure as Chairman. Mr Ready stressed the importance of further collaboration in the Region. He also pointed out the need of a better understanding of

the impact of tropical cyclones in the Region. He encouraged the participants to take an active part in the discussions.

1.1.7 The session was attended by 22 participants from 13 Members of WMO namely: Australia, Cook Islands, Fiji, Kiribati, Indonesia, New Caledonia, New Zealand, Niue, Papua New Guinea, Samoa, Tonga, USA and Vanuatu and two participants from non-WMO Members (Marshal Islands and Tokelau). It was also attended by the Chairman of RA I/TCC for the South-West Indian Ocean (ex-officio Member of this Committee) and two observers from the Secretariat of the Pacific Regional Environmental Programme (SPREP). The list of participants is given in Appendix I.

1.2 Adoption of the agenda (agenda item 1.2)

The Committee adopted the agenda for the session as given in Appendix II.

1.3 Election of vice-chairman (agenda item 1.3)

Mr Ofa FA'ANUNU (Tonga) was unanimously elected as vice-chairman of the eleventh session of the Committee.

1.4 Working arrangements for the session (agenda item 1.4)

The Committee agreed that the working of the session be conducted in one committee as a whole, in English with whispered interpretation in French. In order to facilitate the working of the session, it established a working group to review the Technical Plan. The Committee also agreed on its working hours with breaks in the morning and afternoon sessions.

2. REPORT OF THE CHAIRMAN OF THE COMMITTEE (Agenda item 2)

2.1 The Chairman presented a comprehensive report on the main activities and progress achieved since its tenth session (Brisbane, Australia, 10 to 15 July 2004).

2.2 The Chairman reported to the Committee that:

- e. As Pacific Island countries become better equipped with more highly qualified personnel, there is a desire to develop their own forecasting capability. Samoa and Vanuatu are already producing its own tropical cyclone warnings. Tonga is in the process of developing its own forecasting capability.
- f. Item 10 of the Technical Plan (2004/2006) is the establishment of a RA V/TCC Contingency Trust Fund. The merits of setting up the Trust Fund have been investigated. One of the major factors for the establishment is the commitment of TCC member Governments to contribute to the Fund.
- g. With respect to tropical cyclone awareness, the Niue Meteorological Service's pre-season experience in 2003 and during the actual passage of tropical cyclone Heta clearly demonstrated that nothing can be taken for granted when it comes to preparedness and gaining the cooperation of government officials. There is a need to keep building linkages between meteorological and other officials.
- h. The 'Wind Averaging' study has yet to be finalized and there were some concerns amongst operational forecasters about the relationships between winds averaged over different time periods.
- i. Many of the issues mentioned in the chairman's report will be discussed under the relevant agenda items of the meeting.

3. COORDINATION WITHIN THE WMO TROPICAL CYCLONE PROGRAMME (Agenda item 3)

3.1 The Committee welcomed Mr Kuroiwa as the new Chief of the WMO TCP and looked forward to working closely with him to achieve the goals and objectives of the RA V/TCC.

3.2 The Committee noted the achievements and progress made in both the general component and the regional component of the TCP since the tenth session of the Committee (Brisbane, Australia, 10 to 15 July 2004).

3.3 The Committee noted the written report provided on the activities of the TCP was dated June 2005. In the future it requested TCP to provide the Committee with an updated report so they may have the most current information to guide their decision making.

3.4 The Committee was informed of the publication of the *Annual Summary of Global Tropical Cyclones Season 2003* (WMO/TD-No.1253) (TCP-50) was published in December 2004 with data provided by the six Tropical Cyclone Regional Specialized Meteorological Centres (TC RSMCs) and four Tropical Cyclone Warning Centres (TCWCs) and also the publication of the *Annual Summary of Global Tropical Cyclones Season 2003-2004* (WMO/TD-No. 1253) (TCP-50) in December 2005.

3.5 The Committee was informed that an Expert Meeting on Effective Early Warnings of Tropical Cyclones was held in Kobe, Japan in January 2005 in conjunction with the World Conference on Disaster Reduction and came up with development targets to be completed by 2015 such as:

- a. All TC RSMCs and TCWCs to strive to increase the accuracy of track and intensity forecasts of tropical cyclones by 10% and;
- b. All TC RSMCs, TCWCs and concerned Members of tropical cyclone regional bodies to issue probabilistic forecasts of tropical cyclones up to five days.

Although these targets are challenging, the Executive Council, at its 57th session, endorsed the recommendations and encouraged the relevant Centers and NMHSs to achieve the goals.

3.6 The Committee noted that, in February 2005, the "Study on the Economic and Social Impacts of Tropical Cyclones and the Warning System – The Philippine Situation" was submitted by Dr Leoncie Amadore (Philippines) to WMO. The study was undertaken in connection with TCP Sub-project No. 25: *Study on the economic and societal impacts of tropical cyclones* which was endorsed by the Fourteenth World Meteorological Congress (Geneva 2003). The Committee requested information on planned follow-up actions to the Philippine's study and urged the WMO Secretariat to carry out a similar pilot study for Small Island Developing States (SIDS) in the Pacific region.

3.7 The Committee was informed that the Fifth Tropical Cyclone RSMCs/TCWCs Technical Coordination Meeting, which took place in Honolulu, Hawaii from 5 to 8 December 2005, recommended a further review and clarification of the Wind Averaging Guidelines. The guidelines were prepared and submitted by the System Engineering Australia Pty. Ltd. (SEA) to WMO. The Committee requested the WMO Secretariat to provide information on the progress of this further review and clarification of the guidelines to the members concerned.

3.8 The Committee also noted that the meeting recommended the development of Standard Terms of Reference (TOR) for Tropical Cyclone RSMCs/TCWCs and appointed Mr Rajendra Prasad (Fiji) as chairperson of the subgroup for drafting of the TOR. Noting that this subgroup requested inputs from all the tropical cyclone regional bodies, the Committee encouraged the RA V/TCC members to provide Mr Prasad with comments for the development of the TOR.

3.9 The Committee noted that arrangements are being made to organize the "Fourth Regional Workshop on Storm Surge and Wave Forecasting - A Hands-on Forecast Training Laboratory" in Manila, Philippines in September 2006, which is a joint effort by TCP and JCOMM and will be hosted by PAGASA. The workshop is a follow-up of the three previous workshops,

organized by TCP, JCOMM, IOC WESTPAC and aims to comply with some of the recommendations of these workshops, as well as to broaden the scope of the training to include other operational oceanographic models.

3.10 The Committee was informed that the Sixth International Workshop on Tropical Cyclones (IWTC-VI) will be held in San José, Costa Rica, from 21 to 30 November 2006. The workshop has served as a forum for operational forecasters and researchers in establishing a coordinated approach on solving tropical cyclone forecasting problems and developing future research projects. TCP informed the Committee that WMO could support at least three representatives from RA V to IWTC-VI. In view of its importance, the Committee requested WMO to work with SPREP, SOPAC, AusAid and other collaborating partners to seek funding toward maximum representation from RA V at this quadrennial event.

3.11 The Committee was informed that the Australian Bureau of Meteorology will hold a satellite training workshop in Melbourne in October 2006.

3.12 The Committee, in recognizing the importance of the TCP sub-projects for enhancement of the regional component, urged the WMO Secretariat to keep RA V/TCC members well informed of the progress of the sub-projects' implementation.

3.14 The Committee expressed its appreciation to the Government of Australia and the Bureau of Meteorology for hosting the Southern Hemisphere Training Course on Tropical Cyclones, the sixth of a biennial series for meteorologist from RA I/TCC and RA V/TCC in May 2005 and its tentative plans to hold a seventh course in 2007.

3.15 The Committee also expressed its appreciation to the Government of the United States of America and to the National Oceanic and Atmospheric Administration for conducting training under the International Pacific Desk Programme of RSMC Honolulu for six forecasters from RA V in 2004, six more in 2005, and plans for six additional trainees in 2006.

3.16 Noting that the objectives of THORPEX are closely related with those of TCP, the Committee urged TCP to enhance coordination with THORPEX.

3.17 The Committee noted during the discussions that many meetings held in the Region produced recommendations and/or action items. However, it was noted that in many cases implementation of these recommendations or action items is not monitored. The Committee requested the WMO Secretariat to review and track various recommendations and action items and to make annual reports on their status.

3.18 In view of the importance of the close linkage with other RA V Working Groups for effective implementation of the TCC activities, the Committee recommended that coordination should be further enhanced between TCC and all working groups and rapporteurs of RA V.

4. REVIEW OF THE 2004/2005 AND 2005/2006 TROPICAL CYCLONE SEASONS (Agenda item 4)

4.1 The RSMC Nadi -TCC presented the reports on the 2004/2005 and the 2005/2006 tropical cyclone seasons in the RSMC Nadi Area of Responsibility (AOR). Tropical cyclone activity in the 2004/2005 season was at its climatological average. A total of nineteen significant tropical disturbances were monitored and assigned numbers of the series (01F, 02F, etc) in the 2004/2005 tropical cyclone season by RSMC Nadi. Nine of these eventually developed into tropical cyclones, of which four were gales (category 1) and five were hurricanes (one category 3, one category 4 and three category 5s). Apart from Judy, all the 2004/2005 tropical cyclone season storms originated around the Dateline between 05°S and 20°S latitudes. This coincided with the pool of warmest SST anomalies. It was also observed that about 50% of the tropical cyclones displayed some northward movement, particularly, in their formative stages. The rest generally moved towards the south or southeast, with the exception of Kerry, which tracked westwards for most of its life as a cyclone.

4.2 Tropical Cyclone activity in the 2005/2006 season, in the RSMC Nadi AOR was also at its climatological average. A total of fifteen significant tropical disturbances were monitored and assigned numbers of the series (01F, 02F, etc) in the 2005/2006 tropical cyclone season by RSMC Nadi. Five of these developed further into tropical cyclones, of which three were hurricanes (all category 3s), one storm (category 2) and one gale (category 1). Apart from Jim, all the 2005/2006 Season cyclones falling inside Nadi AOR originated around the Dateline between 10°S and 16°S latitudes. Incidentally, this was the location of the main 2004/2005 Season genesis area. Jim originated off the Queensland coast, and was named by Brisbane (Queensland) TCWC before it moved into Nadi AOR. It was also observed that three of the five cyclones acquired some westerly track, particularly in their formative stages, before turning pole ward. All of these three developed about the tropical Dateline region.

4.3 The detailed reports of RSMC Nadi are given in Appendix III. Tables of tropical cyclone activity in the South-East Indian Ocean and South Pacific areas during 2004/2005 and 2005/2006 seasons are also provided by the Chairman of the Committee and given in Appendix IV.

4.4 The RSMC Nadi raised a number of operational, policy and strategic issues concerning quality of observations, the need for routine upgrading, maintenance and sustaining of observing networks and systems, communications and continual training and development of meteorologists and technicians, which have been largely covered in the updated Technical Plan (see Appendix V)

4.5 The representative of Australia made a presentation on the cyclones affecting their region during the 2004/2005 and 2005/2006 tropical cyclone seasons. He reported on continuing update of the Australian radar network, the rebuilding of the observing station at Willis Island in the Coral Sea and the increasing development of the Australian TC Module. He also reported on the introduction of a Tropical Cyclone Forecast graphical product and the ongoing development of storm surge modeling capability. The Australian report highlighted the continuing reduction in their 24-hour tropical cyclone track forecast errors but no increased skill for intensity forecasting which remains the major challenge for NWP in the tropical areas. He also reported on a project to review the Australian tropical cyclone database which may also include some reanalysis of previous events.

4.6 The representative of Cook Islands informed the Committee that Cook Islands was affected by five tropical cyclones (Meena, Nancy, Olaf, Percy and Rae) in the 2004/2005 season. The first three struck the main island of Rarotonga while the fourth cyclone wreaked havoc on the islands of Pukapuka and Nassau. State of emergency was declared for these two islands. Rae only brought some heavy rain to Rarotonga.

4.7 The representative of New Caledonia informed the Committee that 2004/2005 tropical cyclone season started later than normal with tropical cyclone Kerry. Although it did not cause any damage, its track was difficult to forecast and caused communication difficulties with the government authorities, media and the public. Two tropical cyclones (Olaf and Percy) crossed Wallis and Futuna area without damage. During the 2005/2006 season, two tropical cyclones (Jim and Wati) crossed the alert area of New Caledonia. Although Jim quickly passed across New Caledonia area, forecasts were quite accurate with a good performance of the numerical model. High quality of medium range forecast allowed anticipation of the risk at an early stage and communicate the risk to the authorities one week before and propose a scenario for the alert five days before. This scenario was confirmed to be very close to the reality. Wati crossed New Caledonia area without a problem. Tropical cyclone Tam formed just near Futuna.

4.8 The representative of New Zealand informed the Committee that seven out of the ten tropical cyclones that formed in the Coral Sea and South Pacific crossed 25° South into the Wellington AOR although only Meena and Olaf arrived with hurricane intensity. All the crossings took place east of 180°. Lola, Nancy and Sheila just made it into the Wellington AOR with no more than 35 knots still in part of the circulation. Judy, a weak tropical cyclone was reclassified as an extratropical depression near 28.5S while Olaf nearly made it to 30°S

before being downgraded and Meena, to 28°S. Both Olaf and Meena continued over the open ocean deep into mid-latitudes before their remnants became incorporated into new developments. Five tropical cyclones crossed 25° South into the Wellington AOR out of the eight that formed over the Coral Sea and the South Pacific area during the 2005/2006 tropical cyclone season. Wati was the only tropical cyclone to arrive with hurricane intensity (about 65 knots). Urmil, Jim, Vaianu and Wait were all reclassified as a depression formerly tropical cyclone Wati before reaching 30S while Tam continued on until 33S 166W. Wellington issued Cyclone Advises for Norfolk Island on 24-25 March as Wati headed along a track that was considered close enough to produce gale force winds and heavy swells.

4.9 The representative of Niue informed the Committee that there were three cyclones that passed close by to Niue in 2004/2005 and 2005/2006 tropical cyclone seasons. He emphasized that the local communities, media, Niue Disaster Council and Government were kept well informed of any information regarding tropical cyclone warnings during the 2004/2005 and 2005/2006 tropical cyclone seasons.

4.10 The representative of Samoa informed the Committee that during the 2004/2005 season, five tropical cyclones (Lola, Meena, Nancy, Olaf and Percy) emerged and passed within 500 nautical miles from the Samoan Island Group. The first Special Weather Bulletin for Samoa during the 2004/2005 season was issued on 2 February (Gale Watch). In 2005/2006, no tropical cyclone affected Samoa but strong winds with gusts between 35 and 50 knots were observed. These were caused by tropical cyclones (Tam, Urmil and Vaianu), all of which developed southwest of the islands.

4.11 The representative of Tonga informed the Committee of the tropical cyclone seasons 2004/2005 and 2005/2006. Tonga reported that tropical cyclones Lola, Meena, Tam, Urmil and Vaianu affected the islands during the seasons. Tropical cyclone Vaianu caused a lot of flooding which forced the Meteorological Office to be relocated to the National Emergency Operation Centre (NEOC). Problems were still experienced with in-country communications among NDMO, media and the meteorological service.

4.12 The representative of Vanuatu informed the Committee that the 2004/2005 Tropical cyclone season has been active with respect to the number of cyclones forming in the South Pacific Region. There were more cyclones forming east of Fiji and further east of the dateline. Vanuatu's area has been somewhat quiet, similar to the 2003/2004 tropical cyclone season. This was due to the normal to somewhat weak El Nino period which sees a shift in the warm water to the east of the date line. There were a serious of lows forming within the vicinity of Vanuatu, but did not develop into a tropical cyclone. A notable example being at the end of the tropical cyclone season in April, when a series of lows embedded in a trough system developed near Vanuatu, with prolonged periods of unstable weather. The 2005/2006 tropical season has been active for the Pacific region as the region has experienced a somewhat weak La Nina period, with active and long periods of deep convection near the equator with an active South Pacific Convergence Zone. In Vanuatu, the season was relatively quiet with tropical cyclone Jim making its way through the passage between Vanuatu and New Caledonia and one tropical depression (TC Wati) in the vicinity of northern Vanuatu waters.

4.13 The representative of USA RSMC Honolulu briefed the Committee on the Central Pacific 2004 and 2005 tropical cyclone seasons. Below averaged number of systems occurred in both years. The average number of tropical cyclone for the central Pacific is five. In 2004, three tropical cyclones occurred in the central Pacific – one formed in the central Pacific (tropical depression One-C) and two moved in from the eastern Pacific (Tropical Depression Darby and Tropical Storm Estelle). The only impact from these systems was remnants of Darby brought record rainfall and flash flooding to Hawaii. During the 2004 season, RSMC Honolulu for the first time used gridded (graphical) forecasts verses strictly text products. A "SmartTool" was used to decode RSMC Honolulu's bulletins and incorporate the information into the forecast grids. The 2005 season was similar to the 2004 season with 3 tropical cyclones – one formed in the central Pacific (tropical depression One-C) and 2 moved in from the eastern Pacific (Hurricane Jova which maintained Category 3 status for 60 continuous hours and Hurricane Kenneth whose remnants brought thunderstorms and heavy

rain to windward side Big Island). In 2005, RSMC implemented graphical and text wind probability products and the track forecast errors from 36-120 hours were smallest on record – the error of 65nm at 48 hours was well below Government Performance and Results Act goal of 128nm.

4.14 The Chairman of RA I/TCC reported that the 2004/2005 tropical cyclone season was an average one with eleven named systems and the 2005/2006 was well below average with only five named ones. He indicated that the seasonal forecast is highly dependent on the Pacific Ocean status, i.e. ENSO, and did not attain its forecast in 2005/2006. Information from the world centers, including WMO, on El Nino, La Nina and “Neutral State”, which was confusing. He noted that the cyclones in the SWIO basin are becoming more and more intense and gaining in strength over shorter duration. Changes, in the trajectory, have also been observed. Instead of the classical parabolic trajectory, these systems tended to move south since the very beginning. Hybrid systems are becoming more frequent. Formation, south of the 20th parallel, is being observed regularly. These systems are short-lived and may influence statistics in the SWIO. It was pointed out that major problems are flash floods due to accompanying torrential rains. He stressed that there can be more interaction between cyclone forecasters of the two regions to share knowledge and experience. Research is to be encouraged.

4.15 Several members noted in their reports the problems faced with the transmission of warnings to authorities and the public in a reliable and prompt manner. Those ranged from the communication of warnings from RSMC Nadi to TCC members to the delivery of the warnings to the users including mariners. In particular, lack of close coordination with media such as radio station was emphasized by some members, which sometimes resulted in delayed dissemination of the warnings. The meeting noted that redundancy in communication channels is desirable and that reliance on e-mail only for receipt of warnings is inadvisable.

4.16 The reports and PowerPoint presentations on the 2004/2005 and 2005/2006 tropical cyclone seasons provided by TCC member countries were distributed in CD-ROM during the session.

5. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN FOR THE SOUTH PACIFIC AND SOUTH-EAST INDIAN OCEAN (Agenda item 5)

5.1 The Committee examined in detail and discussed in-depth the proposed changes to the text and attachments of the Tropical Cyclone Operational Plan for the South Pacific and South-East Ocean (TCOP). It took into account experiences gained during the past tropical cyclone seasons; implementation of items in the Committee’s Technical Plan; and other relevant changes during the intersession.

5.2 The Committee recalled from its 10th Session (Brisbane, Australia July 2004), naming a sub-group to review and update the TCOP during the intersession. Due to other work commitments, this sub-group was unable to complete its work. However, the Committee requested the sub-group to continue its work during the inter-session, and report back to the Committee as soon as possible. The sub-group is composed of Jim Weyman, Jim Davidson, Rajendra Prasad, (Chair of the Committee), and Ausetalia Titimaea.

5.3 During the TCOP discussions, the Committee requested the sub-group to especially consider and address:

- a. The inclusion of the type, format, and content of graphical products being produced in the Region and the URLs for the location of examples;
- b. Definitions of categories of tropical cyclones of hurricane intensity including both the Australia and United States categories and their associated wind speeds;
- c. The method of retiring names; whether the Committee should keep the current method or adopt some new method;

- d. The inclusion of EMWIN headers into the plan in Attachment 3C. There was some discussion whether there should be added a third column to Attachment 3C or a separate table be prepared;
- e. Backup issues such as those regarding Wellington TCWC, Vanuatu, Samoa, American Samoa, and others and to explore the use of the TC Module to assist in any backup situation and list these in Chapter 6, Contingency plans;
- f. Chapter 7 – Pro-Forma for Cyclone Damage Assessment Report. This has been discussed for four years and needs to be resolved by the twelfth session.
- g. Documentation on the transmission of warning information on WWVH.

5.4 The Committee discussed several of the terms provided in Chapter 1 and agreed upon changes to “Maximum wind speed in a tropical cyclone,” and the corresponding French equivalent; “Centre of the tropical cyclone”; “Storm tide”; to further study the definition of “Tropical disturbance” and “Tropical Disturbance Advisory/Bulletin/Summary”; and to define “Wave Setup.”

5.5 In Chapter 2, Responsibilities of members, the Committee agreed to move the warning areas responsibilities and the role of the RSMCs/TCWCs to Chapter 1, some minor additions, and to annotate that Indonesia will take over TC responsibilities for their area at the start of the 2007/2008 season.

5.6 In Chapter 3, the Committee agreed that the format and content for the products listed for each RSMC/TCWC should, as much as possible, be the same.

5.7 The Committee discussed many possible ways for members to help each other to disseminate their warnings and other tropical cyclone products. These included possible additional broadcast on Radio Samoa, Radio Vanuatu, Radio Tonga, and others. However, it was agreed that these changes could not be made at this sessions because of the required approvals and coordination needed with their respective national authorities prior to implementation. Therefore, this will be a discussion item at the 12th Session of the TCC. Once these are determined and approved, the URL for the various radio stations involved should be listed in Attachment 4A.

5.8 The TCC Chairperson requested each member to review Attachment 5B and to provide updates as needed.

5.9 The Committee requested the WMO Secretariat to publish a new edition of the Tropical Cyclone Plan in English and French Versions as a WMO Technical Document (WMO/TD-No. 292) in the TCP series (TCP Report No. TCP-24), before the start of the 2006/2007 tropical cyclone season.

6. FORMULATION OF THE TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME (2006–2010) (Agenda item 6)

6.1 Under this agenda item, the Committee established a working group under the chairmanship of Mr Jim Davidson (Australia) to carry out, during the session, formulation of a new Technical Plan for future development of services for the period 2006 to 2010.

6.2 The Committee carried out a wide-ranging review of the Plan and updated it with activities under six main goals to do with “*training and capacity building*”, “*communications and computing*”, “*observations and engineering*”, “*forecasting, warning and disaster mitigation*”, “*research and transfer to operations*” and important activities and initiatives of relevance to RA V TCC”. This format was slightly different from the previous Plan but the changes should make it easier to assimilate. Each element was given a priority rating of “*essential*”, “*very desirable*” or “*desirable*” rather than a numbered sequence of priority.

6.3 Under “*training and capacity building*”, “*satellite interpretation*”, “*attachment to a main centre*” and “*technical maintenance*” were rated the highest. Under “*communications and computer*”, it was access to “*LRIT satellite information*” and “*emergency equipment*”. Under “*observations and engineering*”, “*upgrading and expanding the observational network*” was given the highest priority. As regards “*forecasting*”, “*access to forecasting applications software*” (e.g., TC Module), “*additional NWP model information*” and “*combined storm surge and wave models*” were recognized as the most important. “*Tropical cyclone intensity and track forecasting*” ranked the highest amongst the “*research*” topics. Several elements under disaster mitigation were listed as very desirable, including post TC impact assessments, public awareness and liaison with NDMOs. The Updated Technical Plan and its Implementation Programme (2006-2010) is given in Appendix V.

7. ASSISTANCE REQUIRED FOR THE IMPLEMENTATION OF THE PROGRAMME FOR THE DEVELOPMENT OF SERVICES (Agenda Item 7)

7.1 The Committee noted that several members of the Committee continued to benefit from the WMO Voluntary Cooperation Programme (VCP). In 2004/2006, eleven VCP project requests were submitted by nine members of the Committee: six of them concerned the upgrading satellite receiving equipment for Low Rate Information Transmission (LRIT), one of them concerned the installation of VSAT ground equipment and ISCS workstation for World Area Forecast System (WAFS) data and products, two for the improvement of upper-air observing network, and two for climatological data rescue and climate database system.

7.2 The Committee was informed that six received support for a total of seven VCP projects for equipment during 2004/2006. However, it noted with concern that 36 projects are still awaiting support as of 20 April 2006.

7.3 The Committee was informed that the VCP activities for 2006 would place emphasis on the natural disaster prevention and mitigation activities in accordance with the 2006 VCP theme, “Preventing and Mitigating Natural Disasters through Voluntary Cooperation”. It was also informed that the VCP theme for 2007 would be “Realizing Social and Economic Benefits through Technical Cooperation with NMHSs”.

7.4 The Committee noted that in 2005/2006, assistance being provided under the WMO Emergency Assistance Scheme and the VCP to the NMHSs in Cook Islands, Niue, Samoa and Tonga for the restoration of basic facilities affected by Tropical Cyclone “Heta”.

7.5 The Committee also noted with appreciation that under the Technical Cooperation among Developing Countries (TCDC), China organized in 2004 and 2005, study tours for Directors and/or Deputy Directors of NMHSs. It noted that Samoa participated in the 2004 study tour.

7.6 The Committee further noted that since the establishment of the WMO Programme for the Least Developed Countries (LDC) and the Trust Fund for the LDCs a number of activities have been carried out, development of the WMO LDC Strategic Action Plan, WMO missions to Kiribati and Vanuatu, and a special session on WMO Programme for the LDC and the Strategy for Small Island Developing States (SIDS) was held in Samoa on 7 December 2005.

7.7 The Committee noted with appreciation that under funding from the US Climate Change Research Initiative and with the support of Australia several Global Climate Observing System (GCOS) Upper Air Network (GUAN) stations of members (Cook Islands, Solomon Islands, Papua New Guinea and Vanuatu) are being/will be upgraded within the framework of the VCP.

7.8 The Committee noted that the Regional and Subregional Offices, in collaboration with WMO Members and regional organizations such as SPREP and SOPAC continued to play a role in supporting technical cooperation activities in the Region. It also noted the new Regional Activities and Technical Cooperation for Development (RCD) Department has been

established to ensure the smooth and efficient implementation of activities within the framework of the Regional and Technical Cooperation Programmes.

7.9 The Committee expressed its appreciation to the RCD Department and the Government of Finland for the initiative to develop a project proposal to enhance the capacity and capability of NMHSs in the Pacific region to address adaptation to climate change and variability and natural disaster prevention and mitigation. It noted that a consultancy mission is being carried out from March to May 2006 and the outcomes in term of a draft proposal would be presented during the Fourteenth Session of Regional Association V (South-West Pacific) in Adelaide, Australia, 9-16 May 2006.

8. OTHER BUSINESS (Agenda item 8)

8.1 The meeting expressed its deep appreciation to the retiring Chairman of the TCC, Mr Steve Ready for his valuable contribution to the development of Committee's activities during his service for the past sixteen years.

Terms of Reference (TOR) of the Tropical Cyclone Committee

8.2 The Committee acknowledged that its Terms of Reference (TOR) needed overhauling as they no longer gave an accurate reflection of what the Committee does. It felt that there were important elements that needed to be specifically included, in particular, the review of the Technical Plan and the Tropical Cyclone Operational Plan. The composition of the Committee has changed over the past decade with the addition of Pacific island territories north of the Equator, as well as East Timor and Nauru and this was not represented in the current TOR. Also, in line with the practice over the last several years, it was recommended that the Chairperson should produce a report to the Members and the President of RA V at least once a year as well as prior to the TCC and RA V meetings. Therefore, the Committee agreed to recommend the following changes to the TORs:

Considering the need for the countries in the RA V TCC area affected by tropical cyclones to continue to work together to accelerate action, particularly within the context of the Sustainable Development of SIDS, to reduce the loss of human life and damage caused each year by tropical cyclones and associated phenomena,

Decides:

- (1) To re-establish a working group to be known as the RA V Tropical Cyclone Committee for the South Pacific and South-East Indian Ocean with the following terms of reference:
 - (a) To promote and coordinate the planning and implementation of measures for the improvement of cyclone warning systems and related meteorological services and the facilitation of efforts to minimize loss of life, human suffering and damage caused by tropical cyclones and related natural hazardous phenomena in RA V;
 - (b) To review regularly the status of tropical cyclone warning systems in the RA V TCC area and recommend measures for the development or improvement of these systems;
 - (c) To review regularly the Tropical Cyclone Operational Plan for the South Pacific and South-East Indian Ocean and recommend any amendments to the text of the Plan to the President of RA V for approval;
 - (d) To coordinate its work with other activities carried out within the WMO Tropical Cyclone Programme, in particular with the RA I Tropical Cyclone Committee for the South-West Indian Ocean and ESCAP/WMO Typhoon Committee;
 - (e) To coordinate its activities with other RA V Working Groups and rapporteurs, and regional organizations;
 - (f) To develop, update, and facilitate the implementation of the Technical Plan of the

RA V Tropical Cyclone Committee;

- (g) To seek through WMO appropriate financial and technical support for the programme activities;

Requests the Chairperson of the Committee to submit a report to the fifteenth session of RA V and at least yearly progress reports, especially in relation to the implementation of the Technical Plan, to the Members of the TCC and to the President of RA V.

Implementation of a TCC Award

8.3 It was decided that the Committee should include a provision for a special award for the Committee members who made outstanding contribution to the work of the Committee. However the Committee noted that many details needed to be determined (such as criteria, selection process, etc.), therefore it agree to work on these details during the intersession.

Role of the Chairperson of the Committee

8.4 Although the WMO Technical Regulations outline the role of the chairperson, the Committee decided something needed to be documented to ensure effective communication and the continuity of the work of the committee between sessions. The Committee considered some informal guidelines for the selection and work of the chairperson – support of the Permanent Representative with WMO, a willingness to demonstrate active leadership by monitoring the progress of the Technical Plan and maintaining effective communication between sessions. It was decided that the vice-chairman would play a larger role than just the one at a TCC meeting by accepting the role of interim chair, should the incumbent have to retire or resign.

Candidates for Chairperson

8.5 The Committee noted that Mr Mike Bergin (Australia) was the only candidate nominated for the next chairperson. The meeting recommended to RA V that Mr Mike Bergin be appointed as the Chairperson of the RA V Tropical Cyclone Committee for the South Pacific and South-east Indian Ocean. It also recommended that Mr 'Ofa Fa'anunu be appointed Vice-chairperson of the Committee until the 12th Session of the TCC.

9. DATE AND PLACE OF THE TWELFTH SESSION (Agenda item 9)

9.1 The Committee expressed the need to continue its work in the light of Resolution 5 (XIII-RA V). It also expressed the desire that its twelfth session be held before the 2008-2009 tropical cyclone season, preferably in July 2008.

9.2 The delegate of Niue informed the Committee that his country is willing to host the twelfth session of the RA V/TCC in 2008. The Committee welcomed the offer and requested the Secretary-General of WMO to take an appropriate action, in consultation with the president of RA V and the chairman of the Committee, to make necessary arrangements for the next session.

10. CLOSURE OF THE SESSION (Agenda item 9)

The report of the eleventh session of the Committee was adopted at its final meeting on 8 May 2006.

LIST OF APPENDICES

- APPENDIX I - List of Participants
- APPENDIX II - Agenda
- APPENDIX III - RSMC Nadi 2004/2005 and 2005/2006 Cyclone Season Summary
- APPENDIX IV - Tables of tropical cyclone activity in the South-East Indian Ocean and South Pacific areas during 2004/2005 and 2005/2006 seasons
- APPENDIX V - Updated Technical Plan and its Implementation Programme (2006-2010)

APPENDIX I

LIST OF PARTICIPANTS

1. Officers of the session

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Vice-chairperson	Mr 'Ofa Fa'anunu	(Tonga)

2. Representatives of WMO Members

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APPENDIX II

AGENDA

1. ORGANIZATION OF THE SESSION
 - 1.1 Opening of the session
 - 1.2 Adoption of the agenda
 - 1.3 Election of the vice-chairman
 - 1.4 Working arrangements of the session
 2. REPORT OF THE CHAIRMAN OF THE COMMITTEE
 3. COORDINATION WITHIN THE WMO TROPICAL CYCLONE PROGRAMME
 4. REVIEW OF THE 2004-2005 AND 2005-2006 CYCLONE SEASONS
 1. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN FOR THE SOUTH PACIFIC AND SOUTH-EAST INDIAN OCEAN
 2. REVIEW OF THE TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME
 3. ASSISTANCE REQUIRED FOR THE IMPLEMENTATION OF THE PROGRAMME FOR THE DEVELOPMENT OF SERVICES
 4. OTHER BUSINESS
 5. DATE AND PLACE OF THE ELEVENTH SESSION
 10. CLOSURE OF THE SESSION
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RSMC Nadi 2004/2005 and 2005/2006 Cyclone Season Summary

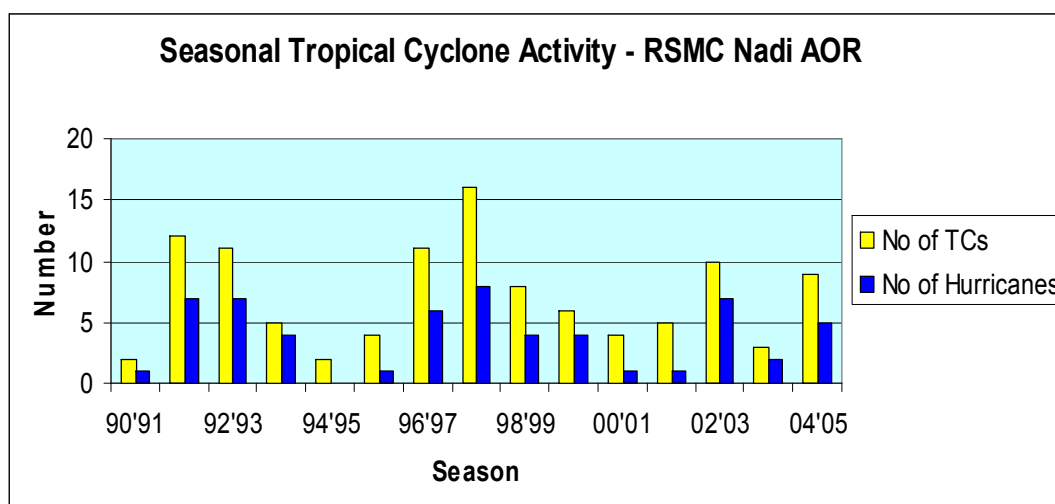
TROPICAL CYCLONE SUMMARY 2004-2005 Season

Introduction

A summary is presented of tropical cyclone activity during the 2004/2005 Tropical Cyclone Season for the Regional Specialised Meteorological Centre Nadi - Tropical Cyclone Centre (RSMC Nadi-TCC) Area of Responsibility (AOR) covering from Equator to 25°South Latitude and 160°East to 120°West Longitude.

Tropical Cyclone activity in the 2004/2005 Tropical Cyclone Season, in the RSMC Nadi AOR was at its climatological average. In total, nine tropical cyclones occurred in the region. Five of these cyclones attained hurricane intensity whilst the remaining four reached gale force.

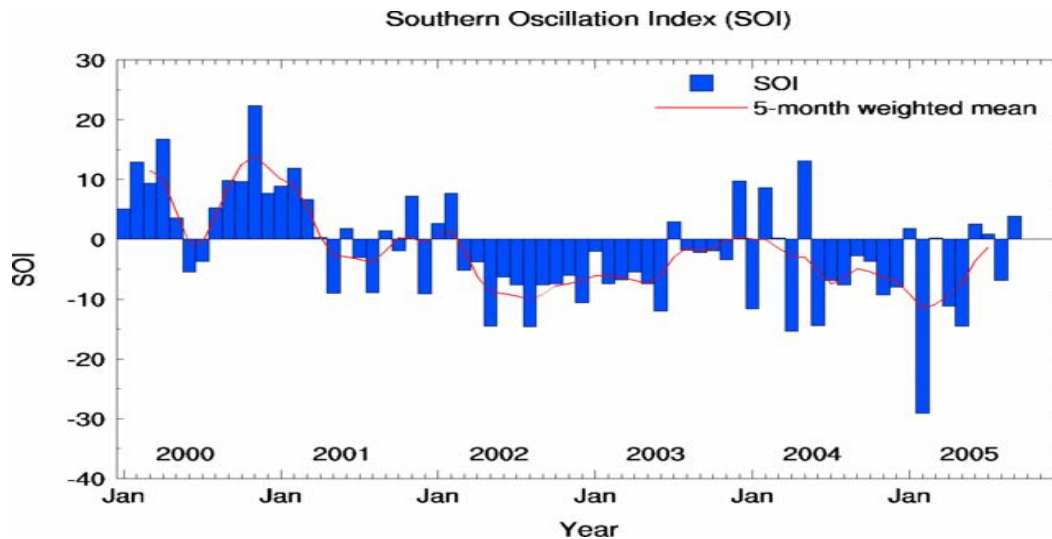
Figure 1: Tropical Cyclone Activity in RSMC Nadi AOR by Season



Climatic Indices

The 2004/5 Season was characterised by a rather “warm” neutral ENSO. The monthly SOI values (refer **Figure 2**) remained mostly negative, with a sharp fall to -29 in February 2005. The associated 5-month running mean SOI, centred on December, was -1.0. Sea Surface Temperature (SST) was warmer than average in the region throughout the Season with the warmest anomalies observed about the near-equatorial Dateline. During January and February, though, very active convection persisted through much of the region. In response to this persistent cloudiness and rainfall, SSTs cooled slightly, but still remained warmer than average. During this period as well, low level westerly wind anomalies were evident west of this convectively active area. However, in the first few months of the Season, near-average trade winds behaviour was observed over much of the tropical Pacific. On most occasions, consistent with the behavior of the active phases of the Madden Julian Oscillation [MJO], the convectively active area progressed eastward across the region, enhancing the formation of tropical cyclones.

Figure 2: Southern Oscillation Index values vs 5-Month Running Means for the period 2000 to late 2005



Occurrence

A total of nineteen significant tropical disturbances were monitored and assigned numbers of the series (01F, 02F,.....etc) in the 2004/5 Tropical Cyclone Season by RSMC Nadi. Nine of these eventually developed into tropical cyclone, of which were four gales (category 1) and five hurricanes (one category 3, one category 4 and three category 5).

Apart from *Judy*, all the 2004/5 Season cyclones originated about the Dateline between 05°S and 20°S latitudes. This identified the genesis trough as coincidental with the pool of warmest SST anomalies.

It was also observed that about 50% of the cyclones displayed some northward movement, particularly, in their formative stages. The rest generally moved towards the south or southeast, with the exception of *Kerry*, which tracked westwards for most of its life as a cyclone, and to a small degree, *Judy* and *Nancy*, for taking a west of south track for certain periods.

Table 1: Tropical Cyclones in the RSMC Nadi area of responsibility, for the 2004/5 Season. All dates and times are in UTC1

Name	Low first identified			Initial tropical cyclone phase			
	Date	Lat.	Long.	Date	Time	Lat.	Long.
Judy	21 Dec	16.0°S	144.4°W	24 Dec	1800	19.5°S	145.3°W
Kerry	03 Jan	09.0°S	176.6°E	05 Jan	1800	13.3°S	171.6°E
Lola	27 Jan	18.0°S	168.4°E	31 Jan	1800	22.6°S	176.2°W
Meena	01 Feb	14.0°S	165.0°W	03 Feb	0600	14.4°S	168.2°W
Nancy	10 Feb	11.7°S	169.6°W	12 Feb	1800	12.8°S	165.8°W
Olaf	10 Feb	13.0°S	179.0°W	13 Feb	0600	09.0°S	177.6°W
Percy	23 Feb	08.5°S	172.8°E	24 Feb	1800	08.2°S	179.3°W
Rae	28 Mar	11.8°S	179.0°E	05 Mar	1800	20.5°S	164.7°W
Sheila	20 Apr	17.0°S	179.5E	22 Apr	0000	17.4°S	170.6°W

Name	Maximum Intensity (knots)						End of Tropical Cyclone Phase			
	Date	Time	Lat.	Long.	Int.	Cat.	Date	Time	Lat.	Long.
Judy	25 Dec	1800	22.5°S	146.7°W	45	1	27 Dec	0000	28.5°S	146.5°W
Kerry	10 Jan	0000	18.1°S	159.1°E	75	3	14 Jan	0000	24.6°S	158.2°E
Lola	01 Feb	0000	23.5°S	175.6°W	40	1	02 Feb	0000	25.1°S	175.5°W
Meena	06 Feb	1200	19.6°S	160.6°W	115	5	08 Feb	0000	28.0°S	150.0°W
Nancy	14 Feb	1200	14.4°S	162.1°W	95	4	17 Feb	0600	25.0°S	164.0°W
Olaf	17 Feb	0000	15.6°S	168.1°W	115	5	20 Feb	0000	32.2°S	161.2°W
Percy	02 Mar	1200	17.6°S	165.1°W	125	5	05 Mar	0000	25.8°S	152.8°W
Rae	06 Mar	0000	21.9°S	163.8°W	40	1	06 Mar	1200	22.9°S	161.3°W
Sheila	22 Apr	1200	19.4°S	166.6°W	40	1	22 Apr	1800	20.9°S	164.8°W

Verification Statistics

Position forecast verification statistics for each cyclone (**Table 2**) was derived by comparing the initial and forecast positions (given in warnings issued by RSMC Nadi-TCC) with post analysis 'best track' positions. It is worth noting that the Australian Tropical Cyclone Workstation (ATCW) verification programme used by RSMC Nadi-TCC is sensitive to the number of forecast positions verified. Subsequently, certain cyclones could not be verified beyond 12-hour and/or 24-hours, with one even at 0-hour.

Overall, initial position errors for individual tropical cyclones were similar to previous Seasons. However, the aggregate for 2004/5 registered the lowest for any of the previous Seasons, even when *Meena*, in its formative stage, ran a gentle clockwise loop, while embedded in an active monsoon trough, before turning and shuttling towards the southeast.

At 12, 24, 36 and 48 hours, errors for all the individual cyclones displayed forecast skills. This was despite *Olaf* executing a tight loop soon after trekking northward and *Nancy*, steadily continuing and eventually running southwest, after an initial southeast and then southward turn.

1 UTC - Universal Coordinated Time (same as Greenwich Mean Time)

Figure 3: RSMC Nadi Forecast Errors since TC Season 1994/95

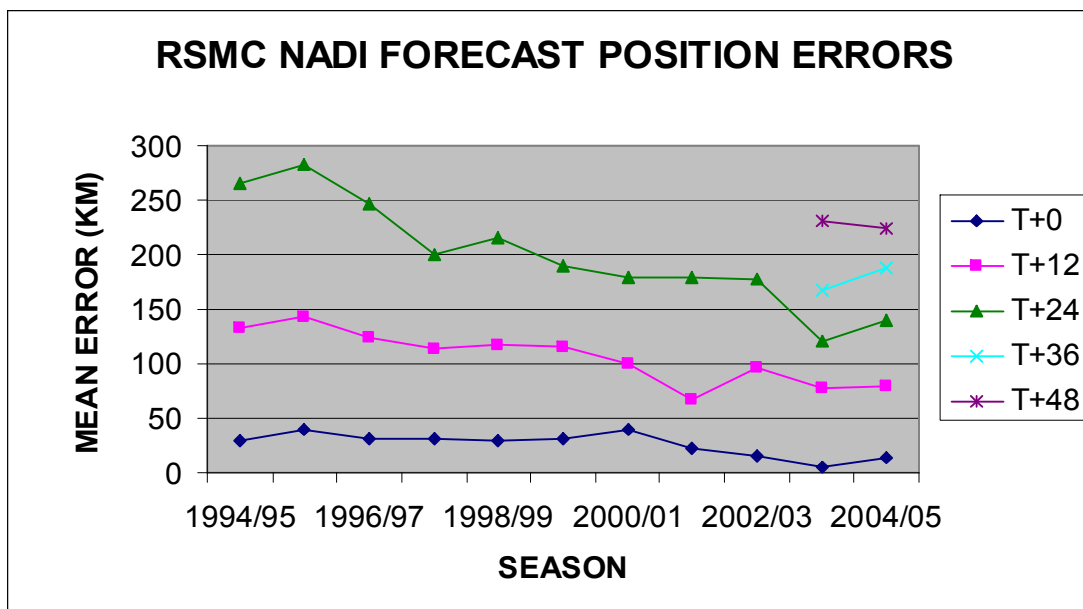


Table 2: Position forecast verification statistics for official warnings issued by RSMC Nadi. Forecast positions are verified against the official best track. Persistence errors (in brackets) are included for comparison.

Lead-time	0 hours		12 hours		24 hours		36 hours		48 hours	
Name	Mean error (km)	No.	Mean error (km)	No.	Mean error (km)	No.	Mean error (km)	No.	Mean error (km)	No.
Judy	14	12	63(61)	6	119(162)	4	-	-	-	-
Kerry	19	16	79(89)	9	125(221)	7	114(460)	4	-	-
Lola	21	7	-	-	-	-	-	-	-	-
Meena	19	24	74(112)	17	117(322)	15	134(593)	12	152(960)	8
Nancy	15	23	99(130)	16	191(360)	14	309(569)	11	353(853)	7
Olaf	10	24	88(134)	20	173(235)	17	237(346)	12	326(590)	8
Percy	13	31	67(84)	27	102(199)	23	137(402)	19	149(659)	15
Rae	9	7	-	-	-	-	-	-	-	-
Sheila	-	-	-	-	-	-	-	-	-	-
Aggregate	14	147	80(107)	100	139(258)	80	188(466)	58	224(744)	38

In Table 3, the radius of the circles (centred on the centroid of the errors) containing 50% of the operational initial positions, is smaller than 0.5 degree of latitude (55.5 km) for all cases. Therefore the location of systems could be summed up as falling within the category of "Position Good" for all the cyclones.

The forecast error centroids and size of the radius of the 50% circle (centred on the centroid of the errors) indicate bias and consistency of bias in the forecast positions. For instance, Nancy, consistently ran east of the expected track, forcing a westerly bias of the centroids. The southwest bias with Meena, Olaf and Percy was attributed to difficulty in forecasting the southward turn when the cyclones were heading east or southeast.

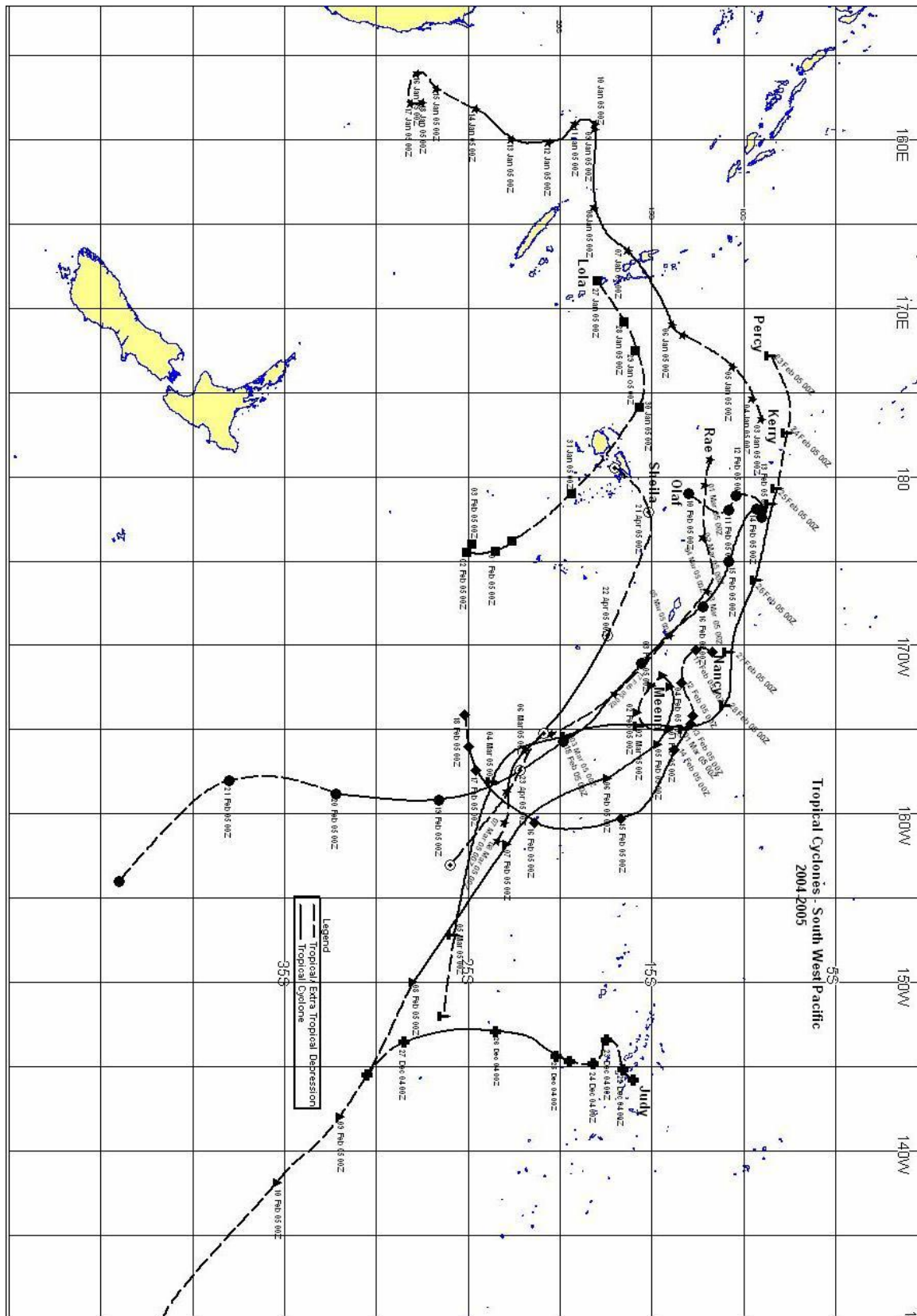
Table 3: Centroid of errors for initial (0-hour lead time), 12-hour and 24-hour forecast positions given in warnings issued by RSMC Nadi with the radius of the circle enclosing 50% of the positions. All distances are in kilometres.

Lead-time	0 hours		12 hours		24 hours	
Name	Centroid E-wd, N-wd	Radius of 50% circle	Centroid E-wd, N-wd	Radius of 50% circle	Centroid E-wd, N-wd	Radius of 50% circle
Judy	4,4	15	12,39	39	67,92	38
Kerry	8,6	24	10,9	67	-2,36	93
Lola	-10,-5	18	-	-	-	-
Meena	1,-8	21	-18,-36	57	-43,-64	89
Nancy	-1,-1	17	-41,8	79	-101,29	115
Olaf	1,-1	11	-36,-17	79	-70,-31	145
Percy	3,-1	17	-31,-15	56	-74,26	83
Rae	-0,2	8	-	-	-	-
Sheila	-	-	-	-	-	-
Aggregate	2,-1	19	-27,-9	72	-59,-17	124

Table3 Contd.....

Lead-time	36 hours		48 hours	
Name	Centroid E-wd, N-wd	Radius of 50% circle	Centroid E-wd, N-wd	Radius of 50% circle
Judy	-	-	-	-
Kerry	-24,98	87	-	-
Lola	-	-	-	-
Meena	-73,-80	88	-89,102	135
Nancy	-180,70	183	-259,139	224
Olaf	-92,-39	158	-97,-47	216
Percy	-89,-57	101	-91,-100	152
Rae	-	-	-	-
Sheila	-	-	-	-
Aggregate	-91,-19	164	-115,-36	217

Figure 4: Tracks of Judy, Kerry, Lola, Meena, Nancy Olaf, Percy, Rae and Sheila



Tropical Cyclones in the RSMC Nadi Area of Responsibility (AOR), 2004/2005 Season

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

Judy (04F) : 24 – 27 December 2004

Judy was the first tropical cyclone observed inside the RSMC Nadi AOR in the 2004/5 Season. It was a 'hybrid' system developing along an active and slow-moving monsoon trough over French Polynesia. After re-assessment of data, 04F was first identified as a tropical disturbance on 21st December 2004 by RSMC Nadi. Up till the 23rd, it was encountering strong shear as well as diurnal effects. However, a low-level centre was developing all this while, but at the southern-most end of the trough. On the 24th, the tropical depression was displaying baroclinic characteristics with the surface centre well exposed. Environmental pressure at the surface was quite low and falling still. Strongest winds at the surface were confined away from the centre but under the associated active convection of the trough. Overnight of the 24th, deep convection erupted over the centre whilst getting significantly organized. At 24/1800 UTC, TD04F was named *Judy*, at gale intensity. The cyclone was then located south of Tahiti and moving south-southwest. Under strengthening shear, *Judy* struggled to maintain its structure. As it moved further towards the south, however, it was caught under the strengthening steering field, enhanced by a short-wave trough to the west. This subsequently neutralized the resultant effect of shear over it. Additionally, *Judy* was moving under the equator-ward entrance of the sub-tropical jet. Consequently, the cyclone intensified further, though only slightly. It reached peak intensity of 45 knots close to the centre, around 25/1800 UTC whilst turning southward and accelerating further into New Zealand's AOR. Wellington TCWC assumed primary responsibility for future warnings on *Judy* from 26/1200 UTC. *Judy* remained as a tropical cyclone inside New Zealand's AOR for another 12 hours before becoming extra-tropical. No reports of damage on this cyclone have been received as yet.

Kerry (05F) : 05 – 14 January 2005

Kerry was first identified and analysed on surface charts as a westward-moving disturbance just west of Tuvalu at 03/0000 UTC January 2005. Environmental shear was weak and SST was around 30°C. At 250-hPa, the subtropical ridge located just north of the disturbance was drifting south maintaining low shear and diffluence over the system. Later on the 3rd, the potential for becoming a cyclone in 24 to 48 hours was raised to moderate to good as banding features became evident. The depression was named *TC Kerry* at 05/1800 UTC as overall organization improved markedly. The cyclone was then located some 315 nm northeast of Port Vila, Vanuatu, and moving southwest at about 11 knots with maximum winds of 40 knots close to the centre.

Kerry maintained gale intensity for the next 48 hours while heading southwest and then west-southwest as middle-level dry air was drawn into the system, suppressing deep convection around the CDO. The cyclone picked up forward speed as it approached Vanuatu, crossing the central parts of the country between 06/1800 UTC and 07/0000 UTC. Interaction with the rugged, volcanic islands further arrested development. During its passage through Vanuatu, the centre crossed over Pentecost, passed to the north of Ambrym and exited via Malekula. Once clear of Vanuatu, at 07/1200 UTC, *Kerry* attained storm intensity whilst continuing west-southwestward at a steady 20-knot speed, driven along the northern side of a deep subtropical ridge to the southeast. 12 hours later, at 08/0000 UTC, *Kerry* reached hurricane status with winds of 65 knots close to the centre, as it moved west and closer to the upper-level ridge axis.

Overall organisation continued to improve with a cloud-filled eye evident at times. At the same time, the cyclone slowed in response to a low-level ridge building to its southwest. Primary responsibility for future warnings on *Kerry* was handed over to Brisbane TCWC after 08/0600 UTC when it exited Nadi AOR. However, the cyclone moved back, albeit marginally, into Nadi AOR between 11/1800 UTC and 13/0000 UTC after doing a southward turn while

progressively weakening. Even though this happened, RSMC Nadi and Brisbane agreed that Brisbane TCWC would continue as the primary warning centre, as it was anticipated that the cyclone would eventually move back into Brisbane AOR. Peak intensity was attained at 10/0000 UTC with 75 knots close to the centre whilst moving slowly south-southwest. *Kerry* remained a cyclone till after 14/00000 UTC, when it was downgraded into a tropical depression.

The remaining exposed low level circulation centre (llcc) of former *TC-Kerry* continued southward to approximately 80 miles off the southern Queensland coast and by 20th January, a week after losing tropical cyclone status, it was still evident in high resolution visible satellite imagery.

No reports of damage associated with *Kerry* have been received. However, there were no reported casualties.

Lola (06F) : 31 January – 02 February 2005

Lola was first identified as a tropical disturbance embedded in the South Pacific Convergence Zone (SPCZ) over Vanuatu on 27th January 2005 and drifting east-northeast about 05 knots. For the next 48 hours, the system was subjected to shear and diurnal influence. Throughout this period, 06F was lying under a divergent region, downstream of an approaching upper trough. SST was around 30°C. On the 29th, convection apparently increased, though briefly, about the low level centre but without any definite organization. TD 06F was then upgraded to a tropical depression. Through the 30th, the depression moved southeast across Fiji about 10 to 15 knots, with deep convection still displaced from the llcc. Overnight of the 31st, the llcc that was exposed in the day moved under the deep convection which had also erupted about the depression centre. Shear was still apparent but spiral bands were evidently wrapping with increasing curvature. 06F was then named *TC Lola* at 31/1800 UTC with winds of 35 knots close to the centre while moving southeast. *Lola* was located about 100 miles to the southwest of Nukualofa, Tonga by this time.

Lola continued southeast with slight intensification but dry air intrusion from the southwest quadrant and strong westerly winds aloft hindered any further development. Later on the 1st, the llcc was apparently re-exposed and movement towards the south slowed significantly. By 02/0000 UTC it was downgraded to a depression whilst located about 250 nm south-southwest of Nukualofa. The remnant depression slowed down in response to the ridge of high pressure to the south and persisted as a westward-moving and fully-exposed depression for several days. Apart from some losses to crops, particularly fruits, damage in Tonga was otherwise minimal.

Meena (07F) : 03 – 08 February 2005

Meena was the fourth cyclone of the Season and the first in a wave of intense tropical cyclones that were to develop in a very active convective trough which persisted through much of the central South Pacific, about the Dateline, for the entire month of February and into early March.

A tropical disturbance was first identified west of the Northern Cooks on the 1st of February, moving initially south slowly, as it began a gentle clockwise loop. At this stage, 07F was evidently sheared, being located just south of a 250 hPa ridge axis but in a divergent region. SST was around 30°C. Shear was anticipated to remain minimal. On the 2nd, the overall organization of the depression improved significantly with convection increasing and cooling about the centre. The llcc, however, was visibly exposed and displaced slightly away from the deep convection and outflow enhanced by the cross-equatorial flow. On the 3rd, the llcc gradually slipped underneath the steadily developing CDO. TD07F was then named *TC Meena* at 03/0600 UTC, while moving slowly north-eastwards and located some 100 miles east of Pago Pago, American Samoa.

12 hours later, at 03/1800 UTC, *Meena* was on a slow eastward path with storm force

intensity, despite interaction with a short-wave upper trough to the southwest, which apparently retarded intensification. By 04/1200 UTC, organization had improved markedly, further, with a banding eye developing, though only discernible in visible satellite imagery. The cyclone then turned to the southeast at 10 knots and gradually accelerated under a strong northwesterly steering field. *Meena* continued to intensify with convective bands wrapping tightly around the CDO, deep convective tops cooling steadily, and a well-defined eye clearly evident. By 06/1200 UTC, peak intensity of 915 hPa and 10-minute average winds of 115 knots was reached and maintained for the following 12 hours. The very destructive core of the cyclone was then centered about 100 miles to the northwest of Rarotonga.

Thereafter, equator-ward outflow decreased with steady erosion in the deep convection in *Meena's* western semicircle. The rapid weakening was enhanced by increasing vertical wind shear and cooling SSTs. The cyclone moved into Wellington's AOR at 07/1200 UTC and soon afterwards merged with a baroclinic zone and was declared extra-tropical at 08/0000 UTC when located approximately 550 miles south of Tahiti. The remnant Low continued to accelerate to the east-southeast at 30 knots towards higher latitudes and the final reference to the former *Meena* system was at 08/1200 UTC with the centre a little over 850 miles southeast of battered Rarotonga.

The entire group of islands in the Southern Cooks fortunately escaped the destructive core of *Meena* as the cyclone weaved its way southwards without making a direct hit. In Palmerston, though, damage was limited to some coconut trees and small huts being blown down. Similarly, damage on Aitutaki was with felled trees and houses losing roofing and other damage caused by debris.

Meena's memorable fury was unleashed in the form of sea swells impacting on the fringing reef and coastline. Waves reportedly averaging 14 metres in height pounded the northern coast of Rarotonga especially in the commercial district of Avarua, causing severe damage to buildings along the waterfront and widespread rocks strewn some distance inland. Moderate damage was reported to homes and businesses immediately on or near the shore. Large amounts of debris were deposited along the coast and coastal roads. Power and phone services remained functional throughout most of the island with only isolated outages reported. Widespread damage was reported to cooking sheds, trees and gardens, especially in exposed coastal areas along the eastern coast. However, damage was considerably less inland away from the coast. On Mangaia, the island's airport was strewn with rocks, the harbour reported as being un-operational and in need of urgent repairs, and the water distribution network was severely disrupted. Inland roads were made inaccessible due to fallen trees. It is believed that no critical injuries or fatalities were caused by the cyclone, which was attributed to good preparedness and public awareness initiatives.

Nancy (09F) : 12 – 17 February 2005

TD09F was first identified embedded in a monsoon trough and located to the northeast of Samoa at 10/1800 UTC. The system was located just west of an upper-level outflow in a low shear environment with SSTs around 30°C. Early development was hindered by an approaching trough from the southwest, which briefly increased shear. However, by 12/0600 UTC organisation and outflow had improved with a small CDO developing under the lcc. At 12/1800 UTC the depression was upgraded to cyclone status and named *Nancy* at approximately 300 miles east-northeast of Pago Pago and moving northeast at about 05 knots. *Nancy* was then located in a region of strong diffluence with good outflow to the north and south.

With the CDO increasing, deep convective tops cooling and primary bands wrapping tightly around the lcc, the cyclone attained storm intensity around 13/1200 UTC. 12 hours later, it reached hurricane force, while located about 400 miles east of Pago Pago, and moving southeast at 04 knots, closer towards, but to the south of Suvarrow Atoll. After some rapid intensification, satellite imagery revealed a symmetrical cloud pattern with an irregular but warm eye. Further intensification followed as *Nancy* remained in a region of strong diffluence

assisted by twin outflow channels to the north and southeast

Peak intensity of 935 hPa and 10-min average winds of 95 knots was achieved at 14/1200 UTC when located approximately 100 nm south-southeast of Suvarrow Atoll and moving east-southeast at 12 knots. A gradual turn to the south-southeast and south ensued in the following 36 hours as Nancy crossed over the uninhabited atoll of Manuae, situated almost midway between Aitutaki and Atiu. Rapid weakening became evident as a result of increasing vertical wind shear associated with a sharpening upper-level trough to the southwest. Hurricane intensity was lost at 16/0600 UTC as the lcc became exposed 30 miles away from deep convection. By this time, *Nancy* had turned to a southwesterly path at 10-12 knots as a result of interaction with strengthening Tropical Cyclone *Olaf* situated to its northwest. Continued interaction with *Olaf* resulted in *Nancy's* deep convection being completely displaced toward the southwest away from the lcc. By 17/0600 UTC, *Nancy* had transformed into an extra-tropical Low on the Fiji/New Zealand border or approximately 300 miles southwest of Rarotonga with convection completely confined to the southern quadrant. The remnant Low moved into Wellington's AOR at this time and was soon afterward absorbed into the outer circulation of intense *Olaf* to the north.

Nancy had weakened considerably before brushing past Rarotonga, on its way towards the southwest. Damage incurred on the islands was severe to crops, trees/foliage, homes, buildings, infrastructure and public utilities. Damaging surge/swells pounded the north and northeastern coastlines of the islands of the Southern Cooks, severely affecting the coastal environment, businesses along the waterfront including hotels, and piling debris on roads as well as inland. As a precaution against surge/swells tourists were moved to evacuation centres and villagers told to move to higher and safer grounds. There were no reports of injury or casualties.

Olaf (08F) : 13 – 20 February 2005

Olaf developed into a tropical cyclone at 13/0600 UTC, only 12 hours after the naming of its 'twin' cyclone, *Nancy*, to its near east. Since 10/0000 UTC, a broad area of low pressure had become established from between Tuvalu across to the north of Samoa. Two disturbances were spawned off this area with the one to the west developing into TD08F roughly 500 miles northeast of Fiji and slow moving. For the following 48 hours, moderate shear and diurnal variations restricted intensification, despite the depression being located south of a 250-hPa outflow centre and under strong divergence. However, by 13/0600 UTC, convection increased in organisation and cooled about the central area with bands spiraling into the lcc. SSM/I data around this time evidently showed a definite banding eye. 08F was then named at 13/0600 UTC, after re-analysis, with winds of 35 knots near the centre. The cyclone was then located about 450 miles to the northwest of Apia, Samoa, and at the commencement of a tight clockwise loop.

At 14/0600 UTC, *Olaf*, underwent some rapid intensification, under decreasing environmental shear and strong diffluence aloft. *Olaf* was upgraded to a hurricane, then, whilst turning and gradually accelerating east-southeast, out of the clockwise loop it started 24 hours prior. The cyclone steadily intensified after this, developing a well-defined and warm eye and central deep convection cooling further. In the Special Advisories issued to Samoa, the intensifying cyclone was anticipated to remain to the northeast of Samoa, steered by a deep northwesterly field. Peak intensity was achieved between 16/1200 UTC and 16/1800 UTC with a central pressure of 915hPa and a 10-minute average wind speed of 115 knots near the centre. During this period, Hurricane *Olaf* was moving steadily southeast passing very close, but just to the east of the Manu'a Islands (Tau and Ofu), in American Samoa

Weakening began around 17/1200 UTC as shear began to increase, aided by an approaching upper-level trough from the west. Dry air entrainment was also evident, gradually eroding convection in the cyclone's southwest quadrant. *Olaf* was then steadily trekking southeast, and located about 200 miles west-northwest of Palmerston, Southern Cooks. The destructive part of the cyclone was steered clear of the Southern Cooks as it accelerated southeast.

Primary responsibility for warnings was handed over to Wellington TCWC as *Olaf* moved into Wellington's AOR at 19/0000 UTC, approximately 330 nm south-southwest of Rarotonga. TC *Olaf* became extra-tropical by 20/0000 UTC as it accelerated further south at up to 25 knots, re-intensifying as a powerful 968-hPa extra-tropical system two days later. At 0000 UTC on the 23rd it was a weakening 40-knot gale, centre crossing the 50th parallel roughly 1700 miles southwest of lonely Pitcairn Island.

In Independent Samoa, winds sustained damage on power lines on Savai'i. Extensive tidal damage was also reported in coastal areas. Faleolo International Airport in Apia was also closed during and after the cyclone. On Tutuila, American Samoa, the National Disaster Council reported that no injuries or major damage was sustained. However, on Manua'a islands, damage was severe on homes, crops, infrastructure, public utilities and coastal environment. Lack of electricity and healthy drinking water created health concerns, making the US President George W. Bush to declare a major disaster in the Manua'a island group after being advised by the territory's Governor. Twenty-three people were rescued from the sea, with two people reported as missing from a fishing boat that sank. At the time of this report, it is not clear whether they had been accounted for.

Despite passing well to the west of the Southern Cooks, there were reports of damage to homes and businesses with disruptions to power and communications on Rarotonga. On the island of Palmerston, heavy swells were reported to have inundated up to 100 meters inland as *Olaf* passed by. There were no reports of death or injury on land from *Olaf*.

Percy (10F) : 24 February – 05 March 2005

Percy was the seventh tropical cyclone of the Southwest Pacific for the 2004/2005 season and the final intense cyclone in a wave of storms to affect the region in February.

10F was first identified as a tropical disturbance embedded in an active monsoon trough at 23/0000 UTC, approximately 380 miles to the west of Funafuti and moving eastwards about 05 to 10 knots. The system was then located just south of a 250-hPa ridge axis, in a diffluent region. Shear and diurnal variations were evidently influencing development. SST was around 31°C. Later on the 24th, shear had decreased markedly. Outflow was favourable and developing in all quadrants. Overnight, the depression underwent explosive development with the deep convection increasing spatially and in organization whilst cooling. Spiral bands were also wrapping tightly around the lcc. By 24/1800 UTC, TD10F was named Tropical Cyclone Percy, while located roughly 100 miles to the east of Funafuti and moving east-southeast at 14 knots under a deep west-northwest steering flow.

12 hours later, with organization increasing markedly and suggestions of an eye forming, though only briefly, *Percy* was upgraded to a storm. 24 hours after being named, the cyclone had attained hurricane intensity, as a ragged but warming eye persisted. *Percy* was then located about 360 miles northwest of Apia or roughly 210 miles west of Nukunono, Tokelau, and beginning to turn slightly more towards the southeast. Between 26/0600 UTC and 26/1800 UTC, the cyclone was at its closest proximity to the Tokelau group, but remaining within 60 to 70 miles to the west and south of the Atoll as it accelerated slightly east-southeast. In the 24 hours ending at 28/0000 UTC, the system adjusted to an eastward track, and decelerated, near Pukapuka, and later on, Nassau, in the Northern Cook Islands, with 85 to 90 knots close to the centre. Hereafter, the cyclone's structure became somewhat asymmetric under the influence of increasing northeasterly vertical wind shear forcing a slight weakening trend between 27/0000 UTC and 28/0600 UTC, but maintaining intensity at hurricane force. The closest *Percy* neared Pukapuka was about 10 to 20 miles to the south at 27/2100 UTC and near or over Nassau at around 28/0300 UTC. After 28/0600 UTC, the cyclone recommenced intensification as deep convection re-organised over the CDO with the cloud pattern regaining a symmetrical pattern and an eye soon re-appearing in EIR imagery. This re-intensification was enhanced by a jet entrance region to the south as the cyclone turned sharply south at 10 knots around the western periphery of a mid-level ridge to the east. Because of this, *Percy* remained at least 110 miles to the west of Suvarrow, and similarly

Palmerston, Southern Cook Islands, as the cyclone continued poleward. After March 02/1200 UTC, the cyclone began to turn towards the southeast and gathered speed under a strengthening northwest steering regime, enhanced by a mid-level ridge to the east. It maintained this track before turning again towards the east-southeast at 04/000 UTC and sped towards Nadi's southern border with the approach of an upper trough. Primary responsibility for future warnings was handed over to Wellington TCWC after 04/1200 UTC, while moving into Wellington's AOR. *Percy* apparently attained two peaks in intensity, the first around 27/0600 UTC with central pressure of 925hPa and winds of 100 knots close to centre. The second was achieved at 02/0600 UTC with a central pressure of 900 hPa and maximum winds estimated at 125 knots.

Percy severely battered Tokelau, damaging hospital facilities, schools, office and community buildings, homes, roads and power lines and leaving widespread debris. Surge/swells coinciding with king tides swamped the atolls in up to a metre of sea water and damaged coastlines and seawalls. Live coral formations were covered by sand and debris. The agricultural sector suffered severely with destruction of staple crops, including fruit-bearing and root crops.

Communications on Swain's Island, north of Samoa, was severed for a week. Severe damage was also sustained on buildings, including one in which residents took shelter. Surge/swell also took its toll with very heavy damage on coastal ecosystem.

All homes in Pukapuka and Nassau in the Northern Cook Islands were either destroyed or suffered heavy damage forcing residents to stay in churches and schools. In Pukapula, schools were severely damaged and water tanks as well as catchment areas polluted by seawater. In Palmerston, Southern Cooks, communications to and from the island was severed during the cyclone.

Rae (12F) : 05 – 06 March 2005

Rae was a short-lived storm that just managed to reach cyclone status, in the wake of its intense predecessor, *Percy*. An easterly-moving tropical disturbance TD12F was first identified at February 28/1800 UTC to the northeast of Rotuma along the SPCZ. The disturbance was then located under a 250-hPa outflow with relatively weak environmental shear. Deep convection remained detached from the centre, apparently active in the northern and eastern quadrants. SST was around 30°C. The system's close proximity to *Percy*, lying to the east, somewhat suppressed development for the following three to four days, despite existence under diffluent flow. All this while the system was steadily moving east before acquiring a southeast track on the 3rd, but keeping to the northeast of Samoa as it continued generally towards the Southern Cooks. It was not until 04/1815 UTC that convective organization rapidly improved with the development of a primary convective band. With some shear and diurnal influences suppressing development, the depression was steadily steered by deep monsoon westerlies towards the south-southeast at 10 knots, into an area of reduced shear, good outflow to the north and the jet entrance region to the south. 24 hours later, 12F was named *Rae*, as convection erupted about the llcc and gales developing in most quadrants near the centre. The cyclone was then located approximately 200 miles west-southwest of Rarotonga and moving southeast at 13 knots. At 06/0000 TC, primary bands were wrapping around the llcc. Peak intensity was also achieved during this time with a central pressure of 990 hPa and wind of 40 knots near the centre. 6 hours later, with the increasing vertical wind shear and drier air entrainment, weakening commenced. By 06/1200 UTC, *Rae* was downgraded to a tropical depression as deep convection was significantly detached to the south of the llcc. 12F was then located approximately 180 miles south of Mangaia, and decelerating east-south against a low-level ridge to the south, which helped sustain gales between the depression and the high pressure ridge to the south, for a couple of days, yet.

There were no reports of damage or casualties as a direct consequence of *Rae*. The cyclone remained over open waters throughout its lifetime.

Sheila (15F) : 22 April 2005

Sheila was the ninth and last tropical cyclone to form in the region during the 2004/2005 season. TD15F was first identified embedded in a persistent monsoonal trough extending from north of the Solomon Islands to Fiji on the 20th of April. At 20/0600 UTC, it was located south of Labasa, Fiji, and moving northeast. Shear was moderate with diurnal influences quite apparent. SST was about 28-29°C. On the 21st, the depression began to turn and eventually accelerated towards the southeast at 20 knots, just north of the Niuas, Tonga. Overnight of the 21st convection about the IICC, erupted. In so doing, resultant shear over the system was reduced sufficiently to allow some development. 15F was named *Sheila* at 22/0000 UTC with winds of 35 knots near the centre, whilst located to the northwest of Niue and steadily shuttling southeast. With the persistence of shear which was steadily increasing, the cyclone soon began to weaken. It was downgraded to a tropical depression at 22/1800 UTC as shear virtually tore away the cyclone structure and while located to the southeast of Southern Cooks. The cyclone peaked with central pressure of 990 hPa and winds of 40 knots close to the centre at 22/1200 UTC. (CP of 990 hPa, maximum 10-min avg winds of 40 knots) near 19.3S/166.4W. There were no reports of damage associated with *Sheila*.

80

References:

1. **Australian Bureau of Meteorology web site**, <http://www.bom.gov.au/>, for Monthly SOI values and 5-month running mean, from 2000 to 2005.
2. **2005 Global Tropical Cyclone Summaries**, Gary Padgett

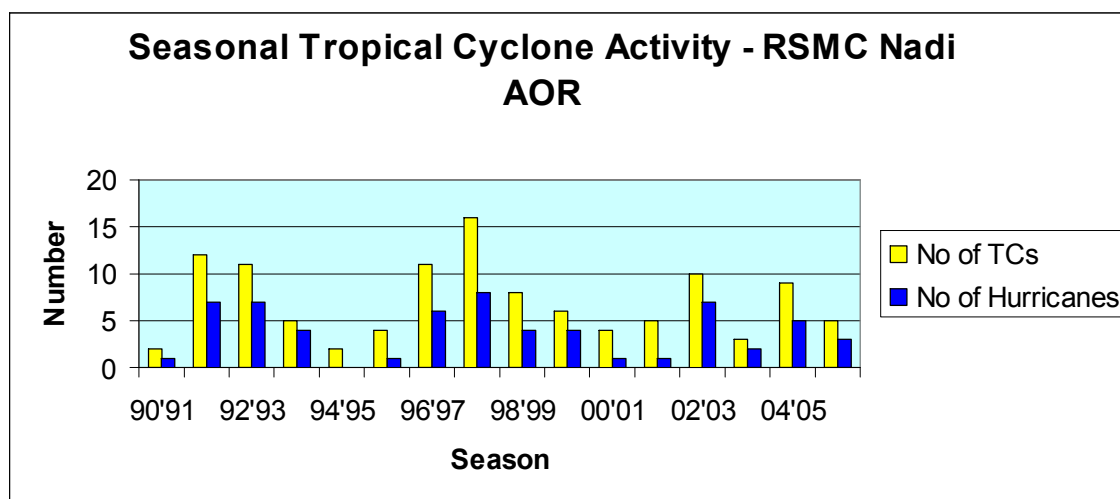
TROPICAL CYCLONE SUMMARY 2005-2006 Season

Introduction

A summary is presented of tropical cyclone activity during the 2005/2006 Tropical Cyclone Season for the Regional Specialised Meteorological Centre Nadi - Tropical Cyclone Centre (RSMC Nadi-TCC) Area of Responsibility (AOR) covering from Equator to 25°South Latitude and 160°East to 120°West Longitude.

Tropical Cyclone activity in the 2005/2006 Tropical Cyclone Season, in the RSMC Nadi AOR was at its climatological average. In total, nine tropical cyclones occurred in the region. Five of these cyclones attained hurricane intensity whilst the remaining four reached gale force.

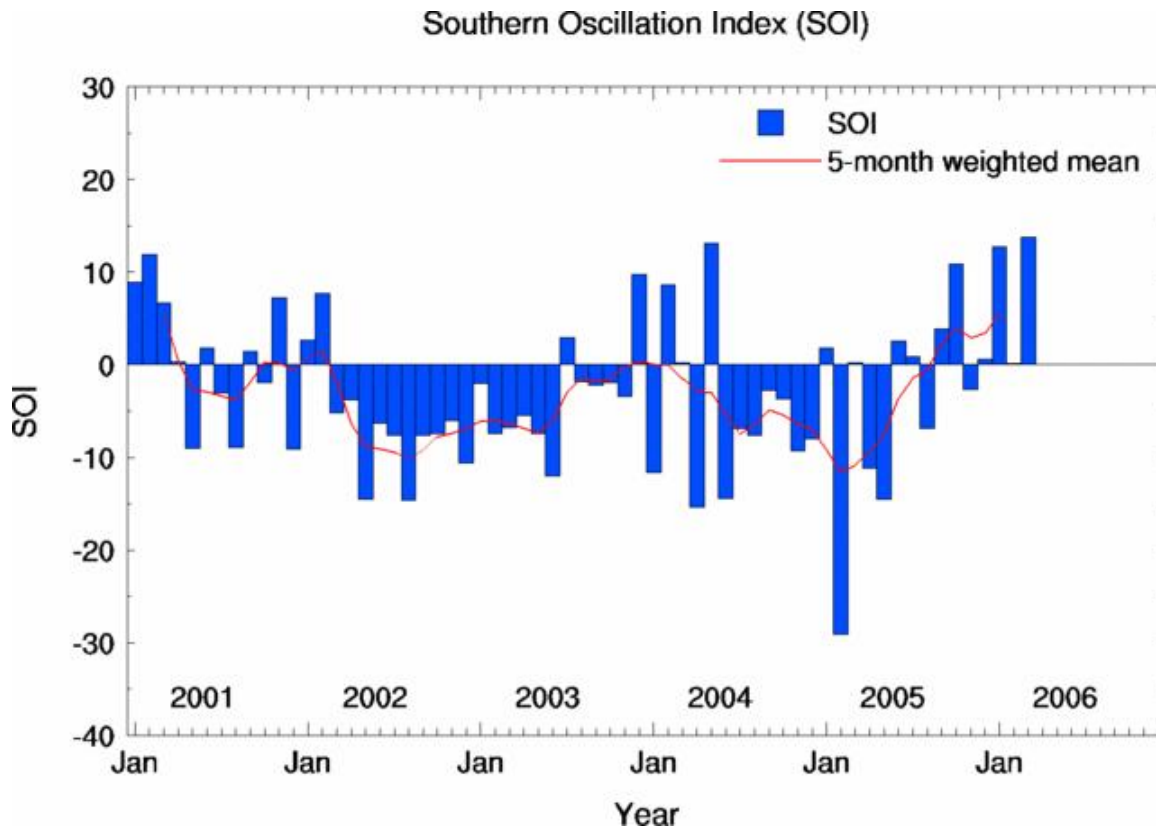
Figure 1: Tropical Cyclone Activity in RSMC Nadi AOR by Season



Climatic Indices

At the beginning of the 2005/6 Season, ENSO displayed a steady transition from a “warm” neutral to a cool episode (weak La Niña). The monthly SOI values (refer **Figure 2**) remained positive, except in November 2005, when the only negative value (for the Season) was registered. The associated 5-month running mean SOI, though, began the turn towards positive values since August 2005. Sea Surface Temperature (SST) was at its climatological average but cooled towards the end of Season. Trade winds also displayed a typical pattern, but gained strength into the Season, aided by “enhanced Walker circulation”. The active MJO phase generally coincided with increased convective activity in the region, particularly from late December 2005 to early April 2006. Towards the end of the Season, active signals fizzled out as soon as they move off the Australian latitudes.

Figure 2: Southern Oscillation Index values vs 5-Month Running Means



Occurrence

A total of fifteen significant tropical disturbances were monitored and assigned numbers of the series (01F, 02F,.....etc) in the 2005/6 Tropical Cyclone Season by RSMC Nadi. Five of these developed further into tropical cyclones, of which three were hurricanes (all category 3), one storm (category 2) and one, gale (category 1).

Apart *Jim*, all the 2005/6 Season cyclones falling inside Nadi AOR originated about the Dateline between 10°S and 16°S latitudes. Incidentally, this was the location of the main 2004/5 Season genesis trough. *Jim* originated off the Queensland coast, and was named by Brisbane TCWC before it moved into Nadi's area of responsibility.

It was also observed that three of the five cyclones acquired some westerly track, particularly in their formative stages, before turning pole ward. All of these three developed about the tropical Dateline region.

Table 1. Tropical Cyclones in the RSMC Nadi area of responsibility, for the 2005/6 Season. All dates and times are in UTC2.

Name	Low first identified			Initial tropical cyclone phase			
	Date	Lat.	Long.	Date	Time	Lat.	Long.
Tam	06 Jan	15.0°S	178.0°W	12 Jan	0000	14.5°S	178.5°W
Urmil	13 Jan	12.8°S	175.8°W	13 Jan	1800	14.6°S	174.4°W
Jim*	26 Jan	17.7°S	146.7°E	27 Jan	0600	18.1°S	148.4°E
Vaianu	09 Feb	15.0°S	179.5°W	11 Feb	1200	17.4°S	174.9°W
Wati	15 Mar	14.0°S	175.5°W	19 Mar	0600	15.7°S	164.5°E

Name	Maximum Intensity (knots)						End of Tropical Cyclone Phase			
	Date	Time	Lat.	Long.	Int.	Cat.	Date	Time	Lat.	Long.
Tam	13 Jan	0600	18.3°S	171.2°W	45	1			28.5°S	146.5°W
Urmil	14 Jan	1200	19.8°S	172.8°W	60	2			24.6°S	158.2°E
Jim*	30 Jan	1800	18.6°S	165.3°E	80	3			25.1°S	175.5°W
Vaianu	14 Feb	0000	22.9°S	176.1°W	70	3			28.0°S	150.0°W
Wati	22 Mar	1200	18.0°S	153.9°E	85	3			20.9°S	164.8°W

* - named by Brisbane TCWC.

Verification Statistics

Position forecast verification statistics for each cyclone (**Table 2**) was derived by comparing the initial and forecast positions (given in warnings issued by RSMC Nadi-TCC) with post analysis 'best track' positions. It is worth noting that the Australian Tropical Cyclone Workstation (ATCW) verification programme used by RSMC Nadi-TCC is sensitive to the number of forecast positions verified. Subsequently, certain cyclones could not be verified beyond 12-hour and/or 24-hours, with one even at 0-hour.

Overall, initial position errors for individual tropical cyclones were similar to previous Seasons. This was despite difficulties in locating *Vaianu* and *Wati* in their formative stages, whilst embedded in active monsoon troughs, and overshadowed by dense cirrus.

Apart from *Tam* at 12-hours, errors for all the individual cyclones at 12-, 24-, 36- and 48-hour forecast times displayed forecast skills. The significant error at 12 hours for *Tam* was attributed to difficulties in forecasting the southward turn when the cyclone persisted on an east-southeast track.

Figure 3: RSMC Nadi Forecast Errors

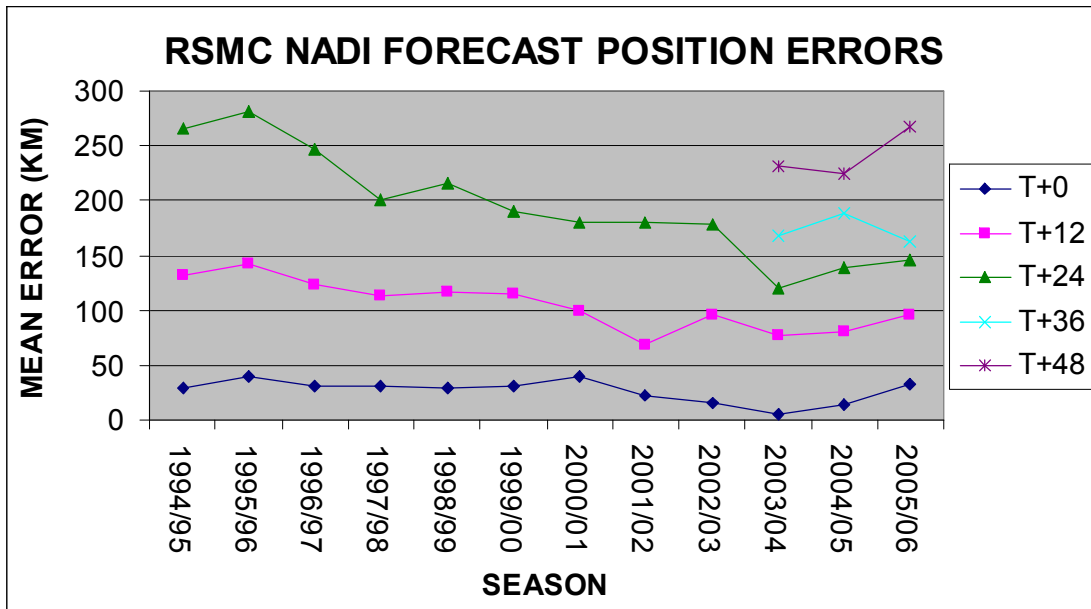


Table 2: Position forecast verification statistics for official warnings issued by RSMC Nadi. Forecast positions are verified against the official best track. Persistence errors (in brackets) are included for comparison.

Lead-time	0 hours		12 hours		24 hours		36 hours		48 hours	
	Mean error (km)	No.	Mean error (km)	No.	Mean error (km)	No.	Mean error (km)	No.	Mean error (km)	No.
Tam	29	16	193(181)	5	119(162)	4	-	-	-	-
Urmil	29	8	79(89)	9	125(221)	7	114(460)	4	-	-
Jim*	9	8	87(177)	4	-	-	-	-	-	-
Vaianu	33	19	65(81)	12	118(257)	10	163(307)	7	268(280)	3
Wati	47	18	-	-	-	-	-	-	-	-
Aggregate	32	69	96(117)	25	146(296)	13	163(307)	7	268(280)	3

In Table 3, the radius of the circles (centred on the centroid of the errors) containing 50% of the operational initial positions, is smaller than 0.5 degree of latitude (55.5 km) for all cases. Therefore the location of systems could be summed up as falling within the category of "Position Good" for all the cyclones.

The forecast error centroids and size of the radius of the 50% circle (centred on the centroid of the errors) indicate bias and consistency of bias in the forecast positions. For instance, *Jim* and *Vaianu* consistently ran east of their expected tracks, forcing westerly biases of the centroids. The significant southwest bias displayed by *Tam* was attributed to difficulty in forecasting the southward turn when the cyclone was steadily trekking between east and southeast.

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

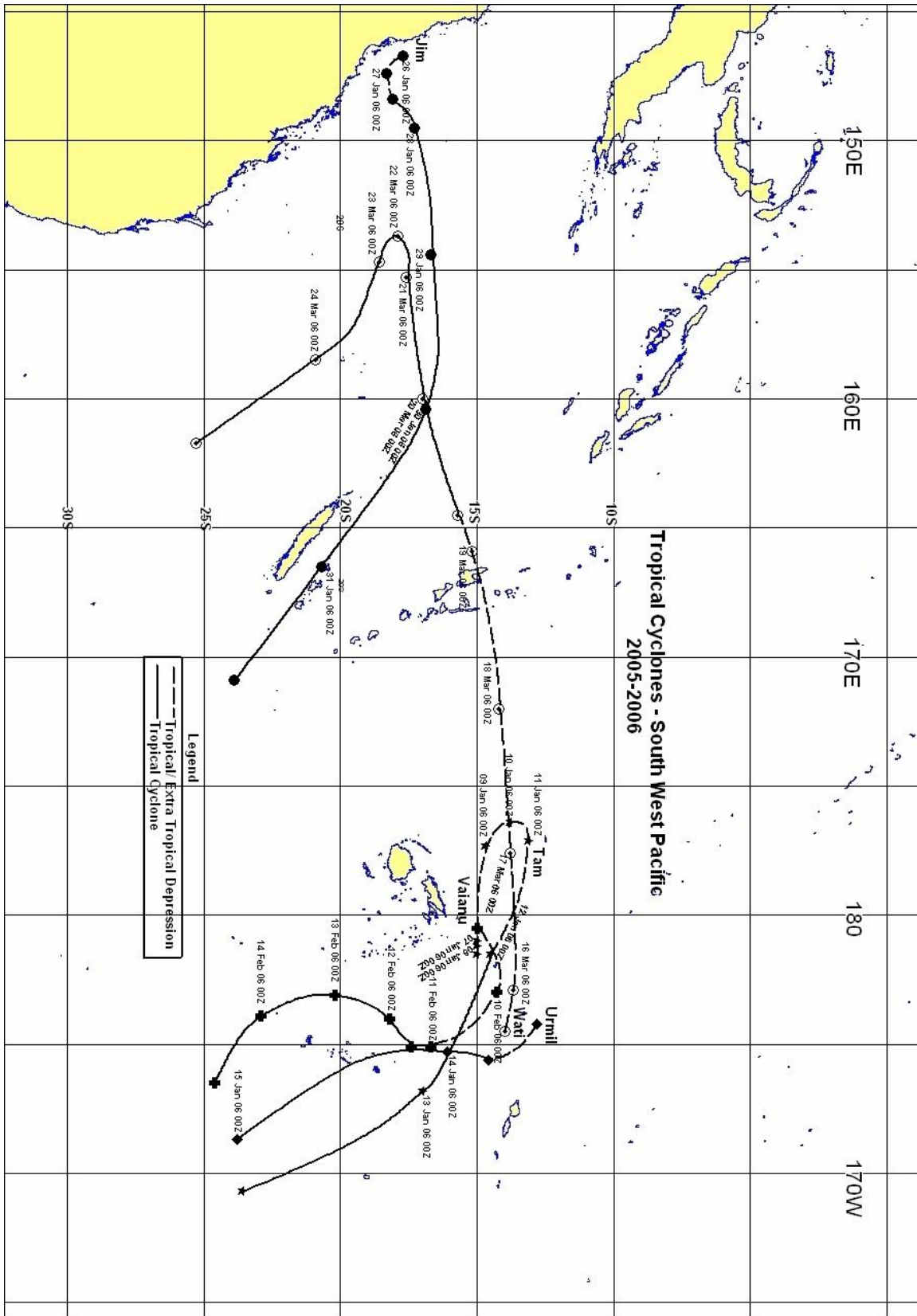
Lead-time	0 hours		12 hours		24 hours	
Name	Centroid E-wd, N-wd	Radius of 50% circle	Centroid E-wd, N-wd	Radius of 50% circle	Centroid E-wd, N-wd	Radius of 50% circle
Tam	-9,-10	17	-50,-76	136	-	-
Urmil	23,8	35	-	-	-	-
Jim*	-3,1	8	-56,6	78	-	-
Vaianu	-2,26	40	-37,11	48	-90,45	75
Wati	7,11	47	-	-	-	-
Aggregate	1,13	42	-34,0	89	-110,51	112

Table 3 Contd.....

Lead-time	36 hours		48 hours	
Name	Centroid E-wd, N-wd	Radius of 50% circle	Centroid E-wd, N-wd	Radius of 50% circle
Tam	-	-	-	-
Urmil	-	-	-	-
Jim*	-	-	-	-
Vaianu	-88,75	80	-95,120	72
Wati	-	-	-	-
Aggregate	-132,88	92	-95,120	72

* - named by Brisbane TCWC.

Figure 4: Tracks of Tam, Urmil, Jim, Vaianu and Wati



Tropical Cyclones in the RSMC Nadi Area of Responsibility (AOR), 2005/2006 Season

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

Tam (04F): 12-14 Jan 2006

Tam was first tropical cyclone in the RSMC Nadi AOR in the 2005/6 Tropical Cyclone Season. It was first identified by RSMC Nadi late on the 6th of January 2006 to the northeast of Fiji whilst moving westwards slowly. It was named Tropical Cyclone Tam at 0600 UTC on the 12th, with 35 knots near the centre. The cyclone was then located within 50 miles to the southeast of Futuna and accelerating towards the southeast at 15 knots, towards Tonga. The cyclone tracked very close to Niuafo'ou, Northern Tonga at 12/1200 UTC, but keeping well away from any inhabited island of the Kingdom as it steadily trekked further southeast. Maximum intensity was reached around 13/0600 UTC with 45 knots near the centre. *Tam* maintained this intensity as it moved into Wellington's AOR, at 14/0000 UTC. Only Tonga and Niue were issued with Special Weather Bulletins (Warnings for the general public) on TC *Tam*. Associated damage reports have yet to be received at RSMC Nadi.

Urmil (06F): 14-15 Jan 2006

Urmil was a rapid developer. It was first identified around 13/0600 UTC, as a weak disturbance, whilst moving southeast about 10 knots. At this same time *Tam* was located about 100 miles to the northwest of Niue and moving rapidly south-southeast. By 14/0000 UTC, 06F was named *Urmil* by RSMC Nadi, with winds of 35 knots close to the centre and located within 15 miles to the south of Niuatoputapu, Northern Tonga. *Urmil* then followed a path similar to that taken by *Tam*, keeping away from any inhabited islands as it steadily moved south-southeast between Tonga and Niue. Peak intensity was reached around 14/1200 UTC with storm force winds of 60 knots close to the centre. The cyclone was then located about 150 miles to the northeast of Nukualofa and rapidly heading south-southeast. No reports of damage have been received on TC *Urmil*.

Jim* (08F): 27 Jan – 01 Feb 2006

Jim developed off the Queensland coast on the 26th of January moving steadily eastwards and intensifying. Brisbane TCWC named the system on 27/0600 UTC. RSMC Nadi took over prime responsibility for warnings on the cyclone at January 30/0600 UTC when the centre was located about 170 miles to the northwest of New Caledonia. By this time, *Jim* was also acquiring a southeast track that eventually kept the centre away from the main island of New Caledonia, but unfortunately right over the chain of smaller islands lying to its east. Peak intensity attained by the cyclone was 80 knots. As *Jim* continued further southeast, it began to weaken rapidly. Primary responsibility for warnings was handed over to Wellington TCWC after February 01/0000 UTC, as the cyclone raced away into higher latitude. It is believed that damage to certain islands of this French territory was severe. However, no reports of damage have been received as yet.

Vaianu (12F): 11-16 Feb 2006

TD 12F was first identified late on the 9th of February as a weak disturbance lying slow moving to the south of Wallis. It was named *Vaianu* at 11/1200 UTC with 35 knots close to the centre whilst located about 120 miles to the northwest of Vava'u and heading southwest, generally towards the Southern Lau Group, Fiji. However, the cyclone stayed just sufficiently away to the east, denying gales from affecting any Southern Lau island. Nonetheless, the entire Lau Group was kept on strong wind warning, over land and sea. Additionally, Fiji was issued with a damaging swell warning as *Vaianu* continued to intensify whilst trekking towards Southern Lau. Tonga was fortunately spared the very destructive core of the cyclone as the centre steered clear of any of the Kingdom's inhabited islands, while on its way south between Fiji and the former. Peak intensity was achieved at 14/000 UTC with 70 knots near the centre.

The cyclone was then located about 120 miles to the south-southwest of Nukualofa and turning towards the southeast, accelerating at the same time. Primary responsibility for warnings was handed over to Wellington after the 14/1800 UTC warning, as it was then racing into their AOR. No damage reports have been received from either Fiji or Tonga on *Vaianu*, when this report was written.

Wati (16F): 19-25 Mar 2006

Wati was first identified as a weak disturbance on the 15th of March between Fiji and Samoa, embedded along an active monsoon trough (easterly wave), and moving steadily westwards. It was named by RSMC Nadi at 19/1200 UTC, with 35 knots near the centre, but on re-analysis, 16F attained tropical cyclone status at 19/0600 UTC. The cyclone was then located about 310 miles west-northwest of Port Villa, Vanuatu and accelerating west-southwest. Primary responsibility for warnings was handed over to Brisbane TCWC after 20/0100 UTC, as the cyclone was on the Nadi/Brisbane border and steadily moving into the Brisbane's AOR. After becoming slow moving approximately 310 miles off the coast of Queensland for 30 hours, *Wati* made an about turn, towards the southeast, at 22/1800 UTC, and headed back towards Nadi's AOR. The cyclone was at the Nadi/Brisbane border at 24/0600 UTC and 12 hours later, at 24/1800 UTC, it had moved into Wellington's AOR. Peak intensity of 85 knots was attained at 22/1200 UTC. During its entire life as a cyclone, *Wati* remained over the waters, away from any populated land area. Damage reports on this cyclone have yet to be received.

80

Reference:

2. **Australian Bureau of Meteorology web site**, <http://www.bom.gov.au/>, for Monthly SOI values and 5-month running mean, from 2001 to 2006.

APPENDIX IV

TABLES OF TROPICAL CYCLONE ACTIVITY IN THE SOUTH-EAST INDIAN OCEAN
AND SOUTH PACIFIC AREAS DURING 2004/2005 AND 2005/2006 SEASONS

TROPICAL CYCLONES in the SOUTH-EAST INDIAN OCEAN and SOUTH PACIFIC AREAS during 2004/2005 cyclone Season

TCWC*	Sept/Oct	Nov	Dec	Jan	Feb	Mar	Apr	June	Tot by Inten
PERTH DARWIN BRISBANE NADI				- -	Meena (115kt) Nancy (110kt) Olaf (125kt) Percy (100kt)	{Ingrid#(120kt)} Ingrid# (115kt)	Adeline##(100kt)		6
PERTH DARWIN BRISBANE NADI			-	(Kerry) Kerry (75kt)	Harvey (85kt) -	Percy (125kt) Willy (75kt)			3
PERTH DARWIN BRISBANE NADI	Phoebe* (50kt)								1
PERTH DARWIN BRISBANE NADI PNG				Raymond**(45kt) Sally (45kt) Tim (45kt)	Vivienne (45kt)	-			
			Judy (40kt)	Lola (40kt)	Lola (40kt)	Rae (40kt)	Sheila** (35kt)		8
	1	0	1	5	7	4	2	0	20\18

***1st week of September; west of Sumatra. ** Short-lived.**

Meena, Nancy and Olaf passed close to Rarotonga within 12 days in February while hurricane intensity.

Percy (Hurricane) and Rae (Gale) passed just to SW of Rarotonga March 3rd and 6th UTC respectively.

Ingrid traversed the Cape York Peninsula twice, also skirted the coast/passed over islands over the Top End before making landfall over the Australian continent.

Cyclones making landfall or having a significant impact on an Island(s) - Meena, Nancy on Southern Cook Islands

These cyclones have been underlined.

##Adeline crossed the 90°E boundary into the Mauritius area and was renamed Juliet.

TROPICAL CYCLONES in the SOUTH-EAST INDIAN OCEAN and SOUTH PACIFIC AREAS during 2005/2006 cyclone Season

Intensity	TCWC*	Sept/Oct	Nov	Dec	Jan	Feb	Mar	Apr	June	Tot by Inten
Major Hur (> 90 knots)	PERTH DARWIN BRISBANE NADI		Bertie/Alvin* (100kt)		- -		Floyd (105kt) Glenda (115kt) Larry (100kt)	Monica (135kt)		5
Hurricane	PERTH DARWIN BRISBANE NADI			-	Clare (75kt) Jim (80kt)	Vaianu (70kt)	Wati (85kt)			4
Storm	PERTH DARWIN BRISBANE NADI				Daryl (60kt) Urmil (60kt)	Kate (50kt)		Hubert (55kt)		4
Gale	PERTH DARWIN BRISBANE NADI PNG				Tam (45kt)	Emma (40kt) Jim (45kt)**	-			2
Monthly Tot		0	1	0	5	4	4	2	0	16\15

*** Renamed Alvin by Mauritius after crossing 90E**

**** Counted in both January and February.**

Larry produced the impact of the 2005/2006 season and was probably the worst TC to affect Australia since Tracy in 1974.

Larry made landfall near Innisfail.

Monica tracked across the Cape York Peninsula, the Gulf of Carpentaria before making landfall over the Top End to the east of Darwin. Monica was the most intense TC of the season.

There were 19 tropical cyclones in the Southern Hemisphere - 7 below average.

There were more TCs in the southeast Indian Ocean than the southwest Indian Ocean as you might expect

APPENDIX V

RA V TROPICAL CYCLONE COMMITTEE'S TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME

(2006-2010)

Goal	Elements	Rating	Strategies	Key Stakeholders	Potential Funding Source/s	Critical Success Indicator	Focal Point	Remarks
To provide a range of training and capacity building opportunities	Satellite product interpretation training	Essential	To conduct a workshop in 2008/2009; to discover appropriate on-line options	Members requiring these skills	WMO	Workshop completed; suitable on-line training sites documented	WMO	
	TC forecaster Mentor training	Very desirable	To conduct mentoring missions	Members still to benefit	To secure funding	At least 2 visits	WMO/ Chairman RA V/TCC	
	RSMC/TCWC Attachment training	Essential	To send Member forecasters to either RSMC Nadi, Australia TCWCs or RSMC Honolulu (Pacific Desk)	All members	WMO, USA	Minimum of 10 attachments	WMO/ SPREP	

APPENDIX V, p. 2

Goal	Elements	Rating	Strategies	Key Stakeholders	Potential Funding Source/s	Critical Success Indicator	Focal Point	Remarks
	Media Skills training	Very desirable	To conduct a workshop	All Members	WMO	Workshop completed	WMO	Skills in TV, radio and newspaper interviews
	IT training <ul style="list-style-type: none"> ○ Web page development 	Very desirable	To piggy back on mentoring missions to assist countries with development of web sites	Members on request	To secure funding	At least 2 visits	WMO/ Chairman RA V/TCC	
	Technical maintenance training <ul style="list-style-type: none"> ● Workshops ○ In-country visits 	Essential Essential	To organise a workshop; to send technician(s) with a wide range of skills into needy countries	Members on request	To secure funding	At least one workshop before 2010; and a minimum of 2 technician visits	WMO/ Meteo-France (French Polynesia)	

APPENDIX V, p. 3

Goal	Elements	Rating	Strategies	Key Stakeholders	Potential Funding Source/s	Critical Success Indicator	Focal Point	Remarks
To upgrade communications and computing capabilities	Satellite Technologies <ul style="list-style-type: none"> ○ Transition to LRIT ○ Upgrade to HiRes capability 	Essential Very desirable	To purchase & install appropriate hardware and software	Members in need of WEFAX replacement; Fiji (Hires)	SPREP/WMO; funding to be secured for Hires	All those in need upgraded to LRIT; Hires upgrade for Fiji	WMO	

Goal	Elements	Rating	Strategies	Key Stakeholders	Potential Funding Source/s	Critical Success Indicator	Focal Point	Remarks
	<p>Communications including WIS</p> <ul style="list-style-type: none"> ○ Emergency Equipment ○ RANET ○ ISCS/WAFS 	<p>Essential</p> <p>Very desirable</p> <p>Very desirable</p>	<p>To equip with suitable backup communications</p> <p>To expand existing network</p> <p>To assess financial viability</p>	<p>Members without</p> <p>Members in need</p> <p>Members able to afford ongoing costs</p>	<p>Where able to be secured, possibly NOAA&U SAID, AusAid & NZAid</p>	<p>All Members with alternative communications</p> <p>2 new installations</p> <p>At least 1 installation</p>	<p>RANET Communications Committee, WMO</p>	<p>Satellite phones, s/w receivers etc</p>
	<p>Upgrade IT capability</p> <ul style="list-style-type: none"> ○ Operational PCs, workstations and servers 	<p>Very desirable</p>	<p>To replace with or install up-to-date computer facilities</p>	<p>Members whose operations urgently require it</p>	<p>To be secured</p>	<p>At least one member with facilities upgrade</p>	<p>WMO</p>	

Goal	Elements	Rating	Strategies	Key Stakeholders	Potential Funding Source/s	Critical Success Indicator	Focal Point	Remarks
To upgrade forecasting and warning capabilities and to strengthen ties to disaster mitigation	Forecasting and warning							
	<ul style="list-style-type: none"> Tropical Cyclone Module 	Essential	To install the software	Members with forecasting capability	AusAID, WMO/Govt Finland	1 or more installations	RA V/TCC Chair	To make a formal request to Director Bureau of Met
	<ul style="list-style-type: none"> Graphical TC warning products 	Very desirable	To develop graphics					Requires appropriate software to begin with
	<ul style="list-style-type: none"> Access to global NWP models and consensus TC track forecasts 	Essential	To assist access to such model info; to seek access to model currently not available	Members with a forecasting capability	WMO	1 model currently unavailable; at least one NMS accessing all available data	RA V/TCC Chair	
	<ul style="list-style-type: none"> Combined storm surge and wave models 	Essential	To develop such a model	Vulnerable Members	WMO/Govt Finland	Combined model used by at least one country	WMO	Model able to be adapted for several countries

APPENDIX V, p. 7

Goal	Elements	Rating	Strategies	Key Stakeholders	Potential Funding Source/s	Critical Success Indicator	Focal Point	Remarks
	<ul style="list-style-type: none"> • TC Warning verification ▪ WMO TC forecaster web site 	<p>Very desirable</p> <p>Very desirable</p>	<p>To install suitable verification software</p> <p>To increase range of info available on web site</p>	<p>Members involved in TC forecasting</p> <p>All members</p>	<p>WMO/ Govt Finland</p> <p>WMO</p>	<p>One new centre doing verification</p> <p>RA V/TCC members catered for</p>	<p>WMO</p> <p>WMO</p>	
	<p>Disaster mitigation</p> <ul style="list-style-type: none"> ▪ Post TC impact assessments ▪ Public awareness and education 	<p>Very desirable</p> <p>Very desirable</p>	<p>To rework Attachment 8B in TCOP; to participate in a project re post-TC impact assessments</p> <p>To produce a suitable handout</p>	<p>Members</p> <p>Members</p>	<p>WMO/CB S Sev Wx demo project for TCs</p> <p>WMO</p>	<p>Attachment 8B revised by 12th session; involved in a project before 2010</p> <p>Completion of task</p>	<p>RA V/TCC Chair</p> <p>RA V/TCC Chair</p>	<p>Possible author Dr Linda Anderson-Berry</p>

Goal	Elements	Rating	Strategies	Key Stakeholders	Potential Funding Source/s	Critical Success Indicator	Focal Point	Remarks
	<ul style="list-style-type: none"> Programs in cooperation with NDMOs 	Very desirable	To run a regional workshop; to conduct in-country training between met and disaster officials	Members/ Disaster officials	WMO/Go vt Finland	One initiative done	RA V/TCC Chair	
To promote research into TCs and to facilitate its timely transfer to operations	Operational research <ul style="list-style-type: none"> TC Track and Intensity forecasting 	Essential	To assess and evaluate existing and new techniques; to provide input on projects aimed at reducing forecast track and intensity errors	All members		Transfer into forecast & warning centres of improved track and intensity forecasting techniques	RSMC/ TCWCs	

Goal	Elements	Rating	Strategies	Key Stakeholders	Potential Funding Source/s	Critical Success Indicator	Focal Point	Remarks
To support important Initiatives and Activities of relevance to RA V/TCC	RA V/TCC Contingency Trust Fund	Very desirable	To establish Trust Fund by 2010	All Members	All Members	Fund operating & Members contributing	RA V/TCC Chair WMO	New Chair starts off with draft TOR prepared by outgoing Chair
	Comprehensive review of the TCOP	Very desirable	Subcommittee* to review and rewrite the existing TCOP	All Members		Completed draft to be part of documentation for 12 th session in 2008	Rapporteur for subcommittee	Members of Subcommittee = RA V Chair, ...
	IWTC-VI in Costa Rica, November 2006	Very desirable	To maximise the number of suitably qualified operational forecasters attending	All Members	WMO	At least 3 forecasters	WMO	Funding to be review immediately after 11 th session to ascertain max. numbers

Goal	Elements	Rating	Strategies	Key Stakeholders	Potential Funding Source/s	Critical Success Indicator	Focal Point	Remarks
	Bilateral cooperation between Indonesia and Australia	Very desirable	Indonesia to take responsibility for International Marine Warnings in its AOR	Australia and Indonesia	Australia	Indonesia ready to take over at start of 2007/2008 cyclone session		Attachment and mentoring missions to facilitate readiness.
	Cooperation with other working groups in RA V	Very desirable	To exchange information with other Working Groups	Working Groups on Hydrology, Climate Matters, Planning & Implementation of WWW, Agrometeorology		RA V/TCC copies newsletters with other working groups at least once per year	RA V/TCC Chair	WMO to provide e-mail contacts for chair of various working groups

The following Elements were rated as “desirable” and, therefore, should be duly considered in strategic planning exercises:

- **Management Training**
- **Weather Radars**

- **Lightning Detectors**
- **Research into structure of 'midget' TCs**
- **Support of student TC research**

Note that the Acronyms listing at the tail of the Technical Plan will need to be reviewed and updated.