WORLD METEOROLOGICAL ORGANIZATION

# RA I TROPICAL CYCLONE COMMITTEE FOR THE SOUTH-WEST INDIAN OCEAN

## SEVENTEENTH SESSION

**Gaborone, Botswana**

**3 to 7 October 2005**

**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 Botswana, the seventeenth session of the WMO Regional Association I (Africa) Tropical Cyclone Committee (RA I/TCC) for the South-West Indian Ocean was held at the Fairground Holdings Convention Centre, Gaborone, Botswana from 3 to 7 October 2005. The session was attended by representatives from Botswana, Comoros, France (La Réunion), Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Seychelles, Swaziland, Tanzania and Zimbabwe. Australia participated as ex-officio member of the Committee. Also in attendance were observers from the WMO Regional Association V Tropical Cyclone Committee (RA V/TCC) for the South Pacific and South-East Indian Ocean, International Civil Aviation Organization (ICAO) and Drought Monitoring Centre-Harare (DMC-H) and representatives of the WMO Secretariat. The list of participants is given in **Appendix I** to this report.

1.1.2 On behalf of Mr Michel Jarraud, Secretary-General of WMO, Mrs Nanette Lomarda, the WMO Secretariat representative, welcomed the participants and expressed the appreciation of WMO to the Government of Botswana for the kind invitation to host this biennial session of the Committee. She said that global efforts, especially within the context of the Tropical Cyclone Programme (TCP), have resulted in a noticeable improvement in the warning systems in many parts of the world. It is evident that where adequate warning and preparedness systems are instituted, a lot of lives can be saved and up to 40 per cent of the property damage can be averted. In general, the accuracy of track forecasts and the timeliness of warnings have been steadily improving. There is clearly an urgent need to speed up the progress in improving the accuracy and reliability of cyclone forecasts, particularly in cases of unusual movement, sudden changes in intensity, especially for longer-range position forecasts, which will give increased lead time to allow for enhanced responses by the public. The tropical cyclone forecasting and warning services of some Member countries in the region, even with recent modest improvements, are admittedly still inadequate to ensure the safety of all their citizens. This is an area of particular concern to WMO and should be given greater attention by the Committee. In this regard, Mrs Lomarda hopes that the session will offer a valuable opportunity for the exchange of views on the successes and problems experienced by the Members since its last session, and that it will develop appropriate strategies for coordinated actions to upgrade tropical cyclone forecasts and warning services. In recognition of the increased concern for security of people against tsunamis, cyclones, and other natural hazards, the Committee adopted for this session the theme: “Early Warning Systems and Disaster Management of all Meteorological and Hydrological Hazards” to emphasize the need to better coordinate the national, regional and international efforts for establishing an integrated early warning system. She hopes that a clear road map would be presented by the Committee for the region after the five-day session.

1.1.3 Mr S.N. Sok Appadu, Chairperson of the RA I/TCC, on behalf of the delegates from Member states of the Committee and on his own behalf, conveyed his deep appreciation to the Government of Botswana for having kindly accepted to host the RA I/TCC XVII and to its people for their warm welcome and hospitality. He highlighted the important role being played by NMHSs in addressing issues related to increasing extreme weather-related events and their impacts on socio-economic activities. Decision and policy makers are seeking accurate and timely inputs from NMHSs, which could be included into the national development plans and forecasts for national growth rate. NMHSs must avail of these new opportunities to convince governments of the important roles they are playing to achieve sustainable and environmentally safe development. With the advent of the tsunami episode in December 2004 over the Indian Ocean, early warning systems and disaster management

are being given high priority both at national, regional and international level. NMHSs in the South-West Indian Ocean are being urged to take advantage of these facilities to modernize their services and to become leaders on national activities related to disaster management and preparedness. Finally, the chairman thanked the Permanent Representative of Botswana with WMO for the excellent arrangement provided for the session. The representative of WMO was kindly requested to express the gratitude of RA I/TCC Members to the Secretary-General of WMO in facilitating their participation to this important meeting. We are looking forward to work very closely with WMO and its Tropical Cyclone Programme for the welfare of the population within the region.

1.1.4 In her opening address, Ms Tutu Tsiang, Deputy Permanent Secretary, Ministry of Environment, Wildlife and Tourism commended WMO for playing a leading role, through its Tropical Cyclone Programme and the network of National Meteorological Services in ensuring effective monitoring and preparedness against tropical cyclones in a bid to minimize loss of life and damage to property. She also expressed her thanks to the Regional Specialized Meteorological Centre, La Reunion, Météo-France for providing real-time advisory information and guidance on tropical cyclones likely to hit the region which is very vital for early warning and disaster preparedness at all levels, locally, nationally and regionally. She urged the centre to look into the possibility of extending their responsibility a little further to include such phenomena as localized severe storms. She recalled that in 2000, Southern Africa experienced floods of record magnitude. Eline (2000) and Japhet (2003) caused devastating torrential rains over the region. In Botswana, rainfall amounts exceeding 200 mm were recorded over a period of 24 hours. The worst hit in the region was Mozambique where more than 700 people died, 544,000 displaced and damage to property amounting to billions of dollars. The advancement in technology has increased expectations of stakeholders on National Meteorological Services and National Meteorological and Hydrological Services. WMO and its Members are therefore faced with a challenge to provide better forecasts for the occurrence of extreme weather events. Up-to-date reliable information on the tracks, intensities and landfall of tropical cyclones is vital for pre-disaster strategies and development of multi-sectoral national disaster management.

1.1.5 Ms Tsiang remarked that it is quite clear that National Meteorological Services in this region do face serious challenges to monitor and reduce the impact of weather related natural disasters. Collective efforts and global cooperation in the field of meteorology is crucial especially for capacity building. This global cooperation should build multi-disciplinary approaches by integrating technologies and expertise in order to deal with disaster management preparedness and mitigation. Experts should continue to share their research findings and conclusions so that the physics can be better represented in numerical weather models. This can contribute significantly to disaster preparedness and response strategies for a range of extreme weather-related events. She called upon countries in the region to collaborate closely in the area of Numerical Weather Prediction (NWP). This is a very important tool that can be used to predict the weather with better accuracy. The short to medium range forecasts that can be derived using this tool are essential in disaster management and preparedness. She urged Member countries to embark on numerical modelling. She said she is confident that WMO through its Public Weather Services (PWS) programme will continue to assist Members who are ready to implement Numerical Weather Prediction projects. She called upon this meeting to come up with constructive conclusions and recommendations that would address the issue of improving warnings on tropical cyclones in the region.

1.1.6 In closing, the Deputy Permanent Secretary who was a former Director of the Department of Tourism and now working for a Ministry responsible for among other things, tourism, concluded with a list of the best sights in Botswana: The renowned Okavango Delta, a wetland of international importance now listed under RAMSAR; the wildlife and wilderness in the Chobe National Park where wild animals roam in their natural habitat; the sand dunes of the Kgalagadi; the wide variety of cultural sites and monuments throughout the country,

and an excellent road network that makes travel within the country easy and which also connects Botswana to some of its neighbouring countries.

1.1.7 The Deputy Permanent Secretary declared the seventeenth session of the RA I Tropical Cyclone Committee for the South-West Indian Ocean officially open.

**1.2 Adoption of the agenda (agenda item 1.2)**

The Committee adopted the provisional agenda with minor modifications. The agenda for the session is given in **Appendix II** to this report.

**1.3 Election of the vice-chairperson (agenda item 1.3)**

The Committee unanimously elected Ms Gladys Ramo thwa (Botswana) as vice-chairperson of the session.

**1.4 Working arrangements for the session (agenda item 1.4)**

The Committee agreed on its working hours and work programme. It decided to establish two working groups, composed of a representative from each Member country, to update its Operational Plan and make a detailed review of its Technical Plan. Mr Franz Uirab (Namibia) and Ms Gladys Ramothwa (Botswana) respectively were designated chairpersons of the said working groups.

**2. REPORT OF THE CHAIRPERSON OF THE COMMITTEE (Agenda item 2)**

2.1 The Committee noted with appreciation the report of the Chairperson of the Committee, which reviewed briefly the activities that took place during the last intersessional period.

2.2 The Chairperson expressed his appreciation to the Governments of France and Australia for co-sponsoring with WMO the 3 nd RA I Training Course on Tropical Cyclones and Public Weather Services (PWS) (Saint-Denis, La Réunion, 27 October to 6 November 2003) and the Sixth Southern Hemisphere Training Course on Tropical Cyclones (Melbourne, Australia, 9 to 20 May 2005) respectively. It is hoped that these training activities will continue on a regular basis and that the Permanent Representative of France with WMO will agree to host the Fourth RA I Training Course on Tropical Cyclones and Public Weather Services at the RSMC in Saint-Denis, La Réunion.

2.3 The Chairman also thanked the RSMC La Réunion for hosting two forecaster attachments in 2004. Those who benefited are Mr Ahmad Hafidhou of Comoros (16 to 27 February 2004) and Mr Hubert Andriamparison of Madagascar (1 to 12 March 2004). The Chairman strongly feels that forecaster attachments at the RSMC La Réunion is important to the region's tropical cyclone programme and to remain a continuous and on-going activity.

2.4 He urged the Members of the Committee to continue to take full advantage of the facilities of the Cyclone Research Cell at the RSMC La Réunion which had since its establishment addressed some important research aspects of tropical cyclones, in particular to improve current forecasting techniques.

2.5 He informed the Members that plans are underway to organize for Region I (Africa) a Regional Workshop on Tropical Cyclone Research in September 2006 tentatively to be held in St. Denis, La Réunion. The workshop aims to be an ideal forum where the South Indian Ocean tropical cyclone research community can gather to exchange information on their ongoing research activities. It is further envisioned that this workshop would foster collaboration between the researchers or lead to the development of research activities of interest to everyone in the region. Collaborative efforts between regional Associations must be encouraged,

2.6 The Chairperson informed the meeting that he represented the Committee at the Tenth Session of the WMO Regional Association V Tropical Cyclone Committee for the South Pacific and South East Indian Ocean. It was held in Brisbane, Australia, from 6 to 15 July, 2004. His attendance was sponsored by WMO. He was also present at the Expert Meeting on the Implementation of Tropical Cyclone Programme, TCP, Sub-Projects on Combined effects of storm surges/wind waves and river floods in low lying areas and Establishment of a tropical cyclone forecaster website.

2.7 The Chairman informed the Session that a Multi-Hazard Early Warning System is being established in the Indian Ocean, following the Tsunami disasters of December 2004. The IOC/UNESCO and WMO are closely collaborating in its designs and operations. Most of the countries forming part of the SWIO-TCC, are also participating in the project.

2.8 The Chairman also expressed his sincere thanks to the Secretary-General of WMO, the Director of the Regional Office for Africa, and the Director of the Applications Programme Department for the assistance extended to him in his capacity as Chairman of the RA I/TCC. He would also like to express a special word of thanks to Mr Katsuhiro Abe, former Chief of the Tropical Cyclone Programme Division who retired late August this year, for his guidance and encouragement.

2.9 Finally, the Chairman thanked all the Members of the Committee for their support.

2.10 The representative of DMC-Harare stated that since **SADC DMC, ACMAD and ICPAC** have a mandate to provide advisories principally to NMHSs on extremes in climate variations (floods, droughts including tropical cyclones) it is vitally important that these centres be actively involved in future activities of the TCP.

2.11 The delegate from Seychelles, confirmed that recent assessment of tropical cyclone track forecasts showed that the 72-hr forecast error in the prediction of the tropical cyclone center in the South-West Indian Ocean is about 250 km. > 3.6.

2.12 In response to the question from the delegate from Botswana on how tropical cyclone information can be effectively passed on to the public and how issues associated with culture, mores, traditions etc. can be overcome, the Chairperson mentioned the various public awareness programmes on tropical cyclones currently being implemented by WMO.

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

3.1 The Committee expressed appreciation for the detailed information provided by the WMO Secretariat on the implementation of the WMO Tropical Cyclone Programme (TCP). It noted with satisfaction the achievements and progress made in both the general component and the regional component of the TCP since the sixteenth session of the Committee (Maputo, Mozambique, 8 to 12 September 2003).

3.2 The Committee noted the targets of the TCP Expert Meeting on Effective Early Warnings of Tropical Cyclones (Kobe, Japan, January 2005) which were endorsed by The Executive Council at its fifty-seventh session (Geneva, June 2005).

(a) All TC RSMCs and TCWCs to strive to increase the accuracy of track and intensity forecasts of tropical cyclones by 10% by 2015. The Council noted the difficult challenge of attaining the intensity goal based on current research;

(b) All TC RSMCs, TCWCs and concerned Members of tropical cyclone regional bodies to issue probabilistic forecasts of tropical cyclones up to five days by 2015;

(c) Members of tropical cyclone regional bodies to educate stakeholders *annually* on proper interpretation of tropical cyclone forecasts, advisories, warnings and other meteorological and hydrological information; and

(d) Members of tropical cyclone regional bodies to ensure dependable and effective dissemination of tropical cyclone nowcasts, forecasts, advisories, watches and warnings in real-time to decision-makers including emergency managers, media, general public and other stakeholders.

3.3 The Committee was informed that:

(a) The *Annual Summary of Global Tropical Cyclone Season 2004* (WMO/TD-No. 1253) (TCP-50) will be published in late October this year and the CDs will be distributed in November 2005;

(b) The updated edition of the Fact Sheet on Tropical Cyclone names (as of 1 July 2005;English version): is now available on line at the TCP Web site;

(c) The TCP home page within the WMO Web site is continuously being updated;

(d) The Study on the Economic and Social Impacts of Tropical Cyclones and the Warning system – The Philippine Situation was submitted by Dr Leoncio A. Amadore to TCP in February 2005. This study was undertaken in connection with TCP Sub-project No. 25: *Study on the economic and societal impacts of tropical cyclones* that was endorsed by the Fourteenth World Meteorological Congress (Cg-XIV) (Geneva, 2003). The report will serve as a prototype for subsequent studies that will be conducted in the four remaining tropical cyclone regional bodies. The working group established to conduct these studies, composed of five tropical cyclone experts representing all the five tropical cyclone regional bodies was scheduled to meet later in 2005.

(e) The technical report on the Wind Averaging Guidelines submitted by the Systems Engineering Australia Pty. Ltd. (SEA) to WMO in June 2004 is currently undergoing a further review of the study by a panel of experts composed of Dr Chris W. Letchford (USA), Dr Craig Miller (Canada), Dr Mark Powell (USA) and Dr Peter Black (USA). A report from the panel of reviewers is expected a month before the meeting of the TC RSMC/TCWC Directors in December 2005;

(f) The Sixth Southern Hemisphere Training Course on Tropical Cyclones was held at the Bureau of Meteorology Training Centre (Melbourne, Australia) from 9 to 20 May 2005 and was attended by three forecasters from RA I (Malawi, Mozambique and Seychelles);

(g) Arrangements are being made for the attachment of two forecasters from Members of the Committee to the RSMC La Réunion during the 2005/2006 cyclone season;

(h) The forecaster's Web site which is currently on test-mode will be fully operational in July 2006. It will be password-protected as access to the Web site will be restricted for use by operational tropical cyclone forecasters.

3.4 As language can sometimes pose a problem for the attachment of forecasters to the RSMC La Réunion, the Committee requested WMO to look into the attachment of forecasters from English speaking Members to other TC RSMCs.

3.5 The delegate from Botswana requested for further information on:

(a) WMO's public awareness programmes/activities;

(b) whether the target for TC RSMCs/TCWCs target to increase the accuracy of track and intensity forecasts of tropical cyclones by 10% by 2015 is achievable; and

(c) accuracy of track and intensity forecasts of tropical cyclones before the said target was set.

3.6 The delegate from Australia stated that getting the science right is only ½ the equation. Hurricane *Katrina* has clearly demonstrated that good science is not enough to avert a disaster. There is a need to ensure that forecasters are trained in speaking to the media and that they develop credibility in vulnerable communities so that their message will be clearly heard, understood, and acted upon. In Australia, this is achieved through media skills training, on-going media exposure in at-risk communities and a policy of having the tropical cyclone forecaster do all radio interviews/broadcasts to affected communities.

3.7 The delegate from Malawi informed the Committee that their meteorological department had embarked on a continuous process of training television weather presenters on communication skills with the National Broadcasting Station and the Audio Visual Centre of the University of Malawi. It had also introduced weather presentations in the local language. This has enhanced the awareness on the use of meteorological terms and the functions of the meteorological department in the mitigation of disasters. Their department will conduct a stakeholders meeting on the new tropical cyclone warning procedures and also on the soon to be available Meteosat Second Generation products. The outlined measures are meant to contribute towards the social and economic development of the country through better understanding of the activities of the meteorological department.

3.8 The delegate from South Africa informed the Committee that the South African Weather Service issues verbal forecasts based on tropical cyclone advisories issued by RSMC La Réunion.

## 4. REVIEW OF THE 2003/2004 AND 2004/2005 CYCLONE SEASONS (Agenda item4)

### Summary of the past two cyclone seasons

4.1 Reports of the 2003/2004 and 2004/2005 cyclone seasons were presented to the Committee by the Mr Philippe Caroff (RSMC La Réunion - Tropical Cyclone Centre, France).

### 2003/2004 cyclone season summary

4.2 Like the previous season (2002-2003), the 2003-2004 cyclone season lasted a long time in the south-west Indian Ocean, but was less active, which was therefore closer to the normal level. This season will otherwise be characterized by atypical tracks, some particularly tortuous, the most extreme being the bizarre track of ELITA, that crossed Madagascar three times in succession. This event will sadly not be a one off, with its successive passages in the “big island” taking dozens of victims and creating significant damage. However this high human and economic toll was not on a similar scale to that seen a few weeks later during the terrible GAFILO cyclone, one of the most violent and destructive that the basin has seen over the last few decades, the phenomenon which will have made its mark on this season and practically eclipsed the rest.

### 2004/2005 cyclone season summary

4.3 Purely in terms of numbers, it can be said that the activity of the 2004-2005 cyclone season was almost normal. However, calling this season normal seems somewhat at odds with its reality. It would indeed not be taking into account the qualitative aspect of its content and events, which gives quite a different impression. If we were to choose a more representative term for the pattern of this season, we would tend towards the word “strange.” The strangeness of this season comes essentially from the nature and way of the genesis of

the phenomena observed over the course of the season. One of the strangest was in particular the fact that no tropical cyclone developed over the south-west Indian Ocean during the whole of the first trimester of 2005 (Mozambique Channel aside). In terms of impact on inhabited land, to the region's people the 2004-2005 season was much more mild than the previous one. While the south of Madagascar was hit by the consecutive passages of ERNEST and FELAPI, the human and economic toll was not however on the same scale as that suffered by the "big island" during the previous season.

4.4 The complete reports on the 2003/2004 and the 2004/2005 cyclone seasons submitted by the RSMC La Réunion and Member countries discussed at the session are given in **Appendix III**.

4.5 Mr Caroff after his presentation responded to the following questions:

(a) from the delegate from Seychelles:

Q: Were any official reports of storm surge on the northeast coast of Madagascar during the occurrence of Tropical Cyclone *Gafilo*?

A: Unless I am wrong, I don't think there is any tide gauge measurement on the NE coast of Madagascar. But following the tsunami event of December 2004, it is planned to implement such equipment for tsunami and storm surge monitoring/watch.

(b) from the Chairman:

Q: What is the average number of cyclone days in a normal cyclone season in the South-West Indian Ocean?

A: The accumulated number of cyclone days (i.e. with presence of a cyclone associated to hurricane force winds) is set at 20 on average (since 1967 - the beginning of satellite era),

Q: Explain how the development of eye ''cycle'' affects the intensity of tropical cyclones especially on the estimation of gusts?

A: During an eyewall replacement cycle, a secondary maximum of winds develop and then take gradually the dominant position while the associated ring of convection shrinks and induces the vanishing of the inner initial eyewall and subsiding of related maximum wind. During this kind of eye-cycle, the intensity of the cyclone goes through a weakening phase that however may be only transient, since at the end of the process the intensity may rise again and may reach an even greater value compared to the initial intensity.

(c) from the representative of ICAO:

Q: What could be the explanation for storms which form near the equator and cross to the other hemisphere?

A: It is commonly stated in tropical meteorology literature that tropical disturbances do not form too close to the equator due to insufficient planetary vorticity (Coriolis force equals zero at the equator). However, we have had recent examples of cyclogenesis taking place very close to the equator, which demonstrates that this is not physically impossible. Besides of the example of the genesis of to-become Tropical Cyclone *Agni*, we can recall the famous case of Typhoon *Vamei* which formed less than $2^{o}$ poleward of the equator and thereafter hit the area close to Singapore a few years ago. With lack of planetary vorticity it is just required that the synoptic environment is in a state to generate the vorticity of the initial disturbance through dynamical processes. In the specific case of *Agni* there was another additional curiosity with the

temporary in road of the initial low into the southern hemisphere keeping its counterclockwise circulation thus shifting temporarily to an anticyclonic circulation.

Q: Does RSMC La Reunion has information pertaining to financial penalties for the aviation industry resulting from the presence of tropical cyclones in the South-West Indian Ocean basin?

A: The centre has not engaged itself into studying the effects of tropical cyclones in financial terms to operations of aircrafts in the basin. ICAO and international airline operators (IATA) might be better placed to study the issue.

4.7 Following the analysis presented by Mr Caroff about the convective outer band being suspected to be at the origin of the capsizing of a ferry boat Samson during Tropical Cyclone *Gafilo* event the delegate from Australia supported the statement of Mr Caroff regarding the need to ensure that there is not an over-emphasis on the centre position of the cyclone. Tropical Cyclone *Fay* had a large, sustained area of convection, approximately 450 km away from the centre and separated from the rest of the system. He also agreed with the need for ground truth verification of satellite date and the difficulties that rapid changes in intensity (e.g. eye-wall replacement) pose for a warning system.

4.8 The delegate from Mauritius stated that because of the risk of cyclones decreasing in intensity and reintensifying again, Dvorak recommended that the current intensity be kept at the initial value for 12 hours, and not to decrease it as soon as the T-number decreases.

4.8 The delegate from Madagascar requested that Mr Caroff's presentation be made available to trainees at the training courses for tropical cyclone forecasters conducted at the RSMC La Réunion.

4.9 The Committee expressed its gratitude to Météo-France for the exemplary work of the Regional Specialized Meteorological Centre (RSMC) La Reunion, in particular in its provision of tropical cyclone advisories to the Members and tropical cyclone information in its Web site. The Committee noted that the tracks displayed at the site continue to be of great help to their operations.

4.10 The Committee took note of the reports of the Members affected by tropical cyclones as given in **Appendix IV**.

## 5. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN FOR THE SOUTH-WEST INDIAN OCEAN (Agenda item 5)

5.1 The Committee recalled that the Operational Plan defines the sharing of responsibilities among Members for the various segments of the system and shows the high level of regional cooperation and coordination achieved. In particular, it provides the agreed arrangements including, amongst others, those for standardization of operational procedures, provision and efficient exchange of various data related to tropical cyclone advisories, and other products of the RMSC La Réunion, which having the required facilities, has the responsibility of analysis, tracking and forecasting of tropical cyclones.

5.2 The Committee conducted a detailed review of all the chapters of the Tropical Cyclone Operational Plan for the South-West Indian Ocean (TCP-12).

5.3 The Committee requested the inclusion of the tropical cyclone passage report form and damage assessment form (see **Appendix V**) in the 2005 edition of TCP-12.

5.4 The Committee after a thorough deliberation approved the list of tropical cyclone names given in **Appendix VI** for the cyclone seasons 2006/2007 and 2007/2008.

5.5 Amendments to the text of the Operational Plan will be submitted to the President of RA I for approval on behalf of the Regional Association.

5.6 The Committee requested the Secretary-General of WMO to publish as soon as possible the 2005 edition of the Tropical Cyclone Operational Plan in English and French as a WMO Technical Document (WMO/TD-No. 577) in the TCP series (TCP Report No. TCP-12). It urged Members of the Committee to forward changes, if they still had not done so, to the WMO Secretariat before 15 October 2005 for inclusion in the 2005 edition.

5.7 The Committee was informed of the proposal from RSMC New Delhi for a change in the said centre's forecast area of responsibility. The Committee found no reason to oppose this proposal which will be submitted for approval at the fourteenth session of RA I (tentatively late 2006).

5.8 The delegate from Mauritius made a presentation on the results of experiments related to the proposed use of the mean of the Western North Pacific (WNP) and the North Atlantic (NA) minimum sea level pressure (MSLP) values for the South-West Indian Ocean (SWIO) cyclones. It may be recalled that the sixteenth session of the Committee (Maputo, 2003) took this proposal into consideration and decided to undertake experiments during the intersessional cyclone seasons whereupon a decision will be taken in this session. Following his investigation during the intercessional period (2004-2005) Mr Veerasamy presented two options:

(a) to use the mean of the WNP and the NA MSLP; or

(b) to use the mean of the WNP and the NA MSLP but to adjust to WNP MSLP if the mean radius of the 1004 hPa isobar was equal to or greater than 4.8 deg lat. And to use the NA MSLP if the mean radius of the 1004 hPa isobar was equal to or less than 3.2 deg lat.

5.9 The delegate from Australia provided the following comments on Mr Veerasamy's presentation:

(a) Consider using the Dvorak C.I.-wind-pressure relations in their ?P form, for while this does not account for variation in size, it does remove another important source of variance-environmental pressure.

(b) Suggested to Mr Veerasamy to look into the study on wind-pressure relations published by Dr Bruce Harper (Systems Engineering, Australia) which is a detailed and exhaustive review of the development of wind pressure relations and the limitations of the various forms in use today.

(c) Agreed with Mr Veerasamy that small cyclones pose extra challenges to early warning systems due to the sudden onset of severe conditions leading to misunderstanding and a lack of response amongst the public. However, there is still the question whether the adoption of a new pressure-wind relation will alleviate the problem.

5.10 The delegate from France provided the following comments on Mr Veerasamy's presentation:

First of all, it is well known that the size of a tropical cyclone is one of the major parameters involved in determining the value of its central minimum sea level pressure (MSLP) and that using a simple and unique intensity-pressure wind relationship is by itself an oversimplification. Thence the idea of trying to integrate the size parameter into the TCs' central pressure estimating process seems a priori interesting. However, the papers presented by S. Veerasamy call for several remarks about the way of modifying the relationship and objections about the practical application :

(a) The concept of establishing a relationship between (MSLP and CI) or even (MSLP, CI, size) should be understood on a statistical sense considering the large scatter in possible central pressure for the same intensity (CI or Max wind). Otherwise it is illusive to hope that a unique or even a multiple intensity-pressure relationship could solve the problem and fit to the reality of TC diversity. Moreover trying to encompass the complexity of the problem would require to also take into account other relevant parameters like the synoptic environment (characterised for instance by the environmental pressure). S. Veerasamy does not address such parameter than can also influence the MSLP. In the case of high environmental pressure, referring to the absolute value of 1004 hPa to define the size of the TC would not be adequate, since not correlated to the really significant size of the circulation (for the same cyclone, the 1004 hPa radius would be much larger in case of low environmental pressure than in case of high environmental pressure). The first step should hence be to discriminate objectively between the more relevant parameters.

(b) To improve the accuracy of such a statistical relation requires a large number of observations. Unfortunately, in the SW Indian Ocean we lack of ground-truth validation. Unlike the NW Pacific or Atlantic basins where the large set of air recon data provided reliable validation, the sample of central core observations made by synoptic stations in the SWIO is too small to allow statistically signifying validation of MSLP relationship versus TC intensity and/or versus size (the probability of seeing a synoptic station having the MSLP passing just right over it is close to zero and is in any case much smaller than the probability of being crossed by the radius of maximum wind). Even for the few examples provided by S. Veerasamy, how can one be sure that we did really measure the MSLP?

(c) The relationship proposed by S. Veerasamy is a "step" one. It has the inconvenience of introducing discontinuities while reality is a continuous spectrum. All TCs having a size on the borderline of the proposed thresholds criteria (3.2 or 4.8 degrees) would undergo large discontinuities in their affected MSLP (imagine a CI 5.0 TC with a mean radius expanding from 4.7 degrees to 4.9 without any change of intensity, associated MSLP would shift abruptly from 962 hPa to 954 hPa).

(d) The practical application of the method proposed by S. Veerasamy would be much complicated for operational forecasters in particular due to the difficulty to precisely assess the radius of the 1004 hPa isobar. Given the lack of observations (despite the drifting buoys network deployed) there would frequently be too much uncertainty to allow a precise measure of the radius (in most cases no one can hope being able to discriminate between a 4.7 or a 4.9 degrees radius). This gap would be exacerbated by the aforementioned discontinuity problem.

(e) Introducing a complex multiple intensity-pressure relationship may add more misunderstanding in the general public perception (not easy to admit for everyone that two TCs with same MSLP can have different intensities) and could even become very confusing in some occasions. Due to lack of correlation between intensity changes and size changes the application of S. Veerasamy proposal could lead to strange situations: imagine an intensifying but shrinking TC (or the reverse a weakening but expanding TC) we could see the max wind rising while the MSLP would stay unchanged or even rise as well, which would be very difficult to understand for the general public.

For all these main reasons, we do believe that though being on the general principle an interesting attempt to try integrate the size criteria and an interesting search topic, the proposal made by Mr Veerasamy would be practically difficult to apply and may moreover add confusion to the general public understanding of the TC-related messages. Without an enough firm experimental basis, the inconvenience will be very much greater than the advantage. A unique intensity-pressure relationship has the advantage of being simple to

apply and easy to understand by the general public. This is probably the reason why every basin works with a single intensity-pressure relationship (unless I'm wrong no sized-linked intensity-pressure relationships are presently used in any TC basin - maybe other RSMC or TCWC members can confirm?).

5.11 The Committee decided that such research endeavours should be encouraged and requested the assistance of WMO and RSMC La Réunion in publishing the results of Mr Veerasamy's study in a scientific journal. Meanwhile, Seychelles highlighted that they will consider implementing the proposed technique on the basis that Seychelles is likely to be affected by small tropical cyclones.

5.12 The Committee established a Working Group on Information Exchange for the effective exchange of information with other tropical cyclone regional bodies on the latest tools and techniques for improving tropical cyclone analysis and warnings. The composition of the Working Group will be finalized in late October 2005.

## 6. REVIEW OF THE TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAM (Agenda item 6)

Under this agenda item, the Committee established a working group Chaired by Ms Gladys Ramothwa (Botswana) which carried out the detailed review of the Plan, taking into account the development and progress made by Members and the RSMC La Réunion - Tropical Cyclone Centre, since the sixteenth session of the Committee.

### 6.1 Meteorological Component (agenda item 6.1)

6.1.1 The Committee noted that the review of the meteorological component of the Plan focused on the status of implementation of the WWW, the needs for additional data, facilities and arrangements for the purpose of tropical cyclone detection, monitoring and forecasting, and on the modernization of the tropical cyclone warning system through regional coordination and cooperation.

**Observing Systems**

6.1.2 The Committee was informed that countries of the region maintained its contribution to the implementation of the Regional Basic Synoptic Network (RBSN) in RA I by operating 166 surface stations and 33 upper-air stations. Countries of the region also continued to contribute to the Regional Basic Climatological Network (RBCN) established to enhance the availability of climate data on the regional scale by operating 167 CLIMAT and 11 CLIMAT TEMP reporting stations.

6.1.3 The Committee was further informed that the average availability of SYNOP and TEMP reports from the countries concerned is 62 per cent and 35 per cent respectively. The availability of reports from the RBSN stations is not satisfactory, in particular for TEMP reports. Fourteen of the 30 upper-air RBSN stations were silent during the July 2005 SMM.

6.1.4 The Committee was informed that through the GCOS programme, a number of stations both surface and upper air, will be rehabilitated in SADC countries. Namibia and Tanzania have already received Hydrogen Generators and upper air stations. Botswana, being a WMO Regional Instruments Centre has been contracted to provide support and back-up services to the GCOS network of stations in SDAC countries.

**Global Telecommunication System (GTS)**

6.1.5 The Committee was informed that several regional circuits were operating at medium/high speed via leased circuits with RTH Nairobi or via Public Data Network services with RTH Pretoria. There was significant progress in the introduction of the data communication TCP/IP protocol, in compliance with CBS recommendations. All the RTHs in

the Region are automated and an increasing number of NMCs have been automated, taking benefit from available, affordable and maintainable technologies based on PCs and the TCP/IP stack of data communication protocols. The rapid development in the field of Information and Communication Technologies is providing better opportunities for modernizing National Meteorological Centres.

6.1.6 The Committee noted that complementary to the GTS dedicated circuits, efficient telecommunication arrangements using the Internet have been implemented in the South-West Indian Ocean to address current telecommunication gaps in that sub-region.

6.1.7 The Committee was informed that the Data Collection System (DCS), the DCP Data Retransmission and the Meteorological Data Distribution System (MDD), which are operated by EUMETSAT, are integrated into the RMTN as a complementary means for the national collection of observational data, and for the distribution of observational data and processed information from RTH/RSMCs. The Data Collection System (DCS) is operated via METEOSAT-8 (Meteosat Second Generation). The data-distribution service, including MDD and DCP Data Retransmission is provided by the EUMETCast service. EUMETCast uses the satellite-based Digital Video Broadcast (DVB-S) technology via the EUTELSAT Atlantic Bird 3 satellite (5°W) in C-band radio frequency spectrum over Africa, for the distribution of MSG satellite data, including image data and derived products (LRIT or HRIT data channels), MDD and DCP data. Through the PUMA project, funded by the European Commission and which covers the implementation of METEOSAT-8/ EUMETCast, receiving stations have been implemented at NMCs in Africa.

6.1.8. The Committee noted that the "Réseau de Transmission d'Information Météorologique" RETIM-Africa data-distribution service via satellite was put in operation in March 2003; France is funding the 128 kbit/s uplink and data-distribution service, including the required connection of RTH Toulouse. The telecommunication technology for RETIM Africa uses the satellite-based Digital Video Broadcast (DVB-S) technology, which was designed for digital TV broadcast, with low cost receiving stations. The RETIM-Africa is operating via the EUTELSAT Atlantic Bird 3 satellite (5°W), and uses the C band radio frequency spectrum that is required for tropical/equatorial areas. Receiving stations need a 1.80 to 3.70 meter dish antenna, that are typical for satellite-based TV reception. The area of coverage of RETIM-Africa includes the whole of Africa including Madagascar and the South-West Indian Ocean. The data are fed to the satellite operator from RTH Toulouse. The initial data rate of the data channel is 128 kbit/s, but the technology allows an increase of the data rate up to 6 Mbit/s. The information received through RETIM Africa, which is in standard WMO formats, can be handled, visualised and processed on PC-based terminals or workstations, or sent, through a Local Area Network (LAN) or via a Message Switching System (MSS), to multiple users. In the South-West Indian Ocean, the following receiving stations have been installed and are in operation, most of them including a Synergie PC-based workstation: (Vacoas, Mauritius; St Clotilde, La Réunion; Mahé, Seychelles; Antananarivo, Madagascar; and Moroni, Comoros).

6.1.9. The Committee was pleased to note that In the framework of the development of the Indian Ocean Tsunami Warning System (IO-TWS), in coordination with UN/ISDR and UNESCO/IOC, WMO has promoted the prominent role of the GTS for supporting the collection, exchange and distribution of TWS related information. The attached annex (diagram) shows the operational arrangements that have been developed for the distribution via the GTS, including RETIM-Africa and EUMETCast/MDD, of interim Tsunami Watch Information bulletins for the Indian Ocean Region that are provided by The Pacific Tsunami Warning Center (PTWC, NOAA/NWS, Hawaii, USA) and the Japan Meteorological Agency (JMA, Tokyo, Japan). WMO has developed an action plan for enabling NMHSs of all IO rim countries, especially developing and less-developed countries, to participate in and contribute to the IO-TWS, within the framework of a global operational multi-hazard system. The WMO action plan includes upgrades to the national and regional GTS components, where required, to meet the exchange requirements for multi-hazard EWS and especially the IO-TWS, benefiting from international assistance. GTS expert team missions have been

carried out to relevant countries for on-site assessment for upgrading national GTS components.

**Data Processing and Forecasting System (DPFS)**

6.1.10. The Committee was informed there has been significant improvement in the monitoring and forecasting of tropical cyclones over recent years resulting from development of the WWW, advances in support technology and scientific understanding and numerical modelling (including NWP) of tropical cyclones and their environment. The rapid increase in computing power is enabling numerical models to attain spatial resolutions where small-scale systems, such as tropical cyclones, are resolved. These models are displaying real skill with regard to motion prediction and have the potential to handle cyclone genesis. However, only a limited number of models have attained resolutions where cyclone structure (including intensity) can be addressed. Nonetheless, current research models and programmes indicate that numerical model forecasts of tropical cyclones may continue to improve steadily. The Committee also noted that EPS model products were increasingly becoming useful for tropical cyclone forecasting. It was, however, noted that most countries of the SWIO were not yet familiar with the use of these products for tropical cyclone forecasting. The Committee therefore requested that WMO conduct a training workshop for the SWIO TCC Member countries with emphasis on the use of EPS model products for TC forecasting.

**Meteorological Satellites**

6.1.11 The Committee noted with appreciation the latest detailed information provided by the Secretariat on the status reports of the operational meteorological satellite systems that are presently providing data or have the potential to provide the data to Members in the South-West Indian Ocean.

6.1.12 The Committee was informed that Meteosat-5 continues the Indian Ocean Data Coverage Service at 63°E.

6.1.13 The Committee was pleased to note that the preparations for Meteosat Second Generation (MSG-2) scheduled to be launched towards the end of 2005, are well underway. Once MSG-2 is fully operational, it will be possible to move Meteosat-7 over the Indian Ocean, this would allow EUMETSAT to provide coverage of the Indian Ocean beyond 2005, until at least 2008. The Committee thanked EUMETSAT for this planned arrangement since ensuring the permanent geostationary coverage of the Indian Ocean is critical to TC monitoring.

6.1.14 The Committee was informed that an analysis for LRIT conversion indicated that in WMO Regions I (Africa) the operation of WEFAX service would terminate in 2005 and an LRIT service had been started in 2004 based upon Meteosat-8 (formerly MSG-1) data but relayed via the EUMETSAT EUMETCast broadcast.

6,1.15 Some Members of the Committee expressed concern at the performance of the systems installed through the PUMA Project. It was noted with deep concern that the Project was to have officially ended in September 2005. Unfortunately, some stations have not yet been installed while those installed were already showing signs of malfunction. The Committee requested WMO to follow-up this matter to ensure the sustainability of the systems.

**Marine Observations**

6.1.16 The Committee noted that buoy reports continue to increase, in particular those with pressure observations. This increase is due largely to the work of the Data Buoy Cooperation Panel (DBCP), and most especially its regional action groups, the International South Atlantic Buoy Programme (ISABP, many of whose buoys eventually drift into the

Southern Indian Ocean), and the International Buoy Programme for the Indian Ocean (IBPIO). The IBPIO maintains a homepage at: http://www.shom.fr/meteo/ibpio/.

6.1.17 The Committee noted with appreciation that as a result of cooperative work within the programme, many of the previous simple oceanographic drifters in the region also now make meteorological measurements.

**Aeronautical Meteorology**

6.1.18 The Committee noted that currently about 190,000 Aeronautical Meteorological Data and Relay (AMDAR) observations per day are being exchanged globally on the GTS representing over a four-fold increase in volume compared to 1998 when the Panel was established. Currently, 14 countries have operational AMDAR programmes, 3 countries are about to start operational programmes and 16 countries have expressed interest in developing such programmes.

6.1.19 The Committee was informed that in Africa, a targeted AMDAR observations programme is being developed by ASECNA that regroups 15 African member countries. It noted that Madagascar is one of these 15 countries and that South Africa has been for some time now running an operational AMDAR Programme particularly relevant to the Committee activities in the South West Indian Ocean Region and to WMO Members in the Southern Africa Region. It is expected that by the end of this year, the South African Airways fleet of 41 Airbus aircraft would be fitted with AMDAR software and that the E-AMDAR Southern Africa programme will be fully operational. Expectations are that there will be a fair coverage of between 40 and 50 automated profiles (soundings) per day from about 13 airports during the period 0400UTC to 2000UTC. The aim now is to establish a full-fledged AMDAR programme in Southern Africa in collaboration with national, regional and international airlines. All NMHSs in the sub-region have been encouraged to join in establishing a regional AMDAR Panel. To achieve this, the NMHSs were urged to establish cooperation with their respective national airlines.

6.1.20 The representative of Mauritius informed the Committee that the AMDAR programme is fully operational in Mauritius with two aircrafts of Air Mauritius already equipped with the AMDAR instrument package and three more planned.

6.1.21. The Committee was informed that the lack of operational humidity/water vapour sensor from the AMDAR package has been a matter that the Panel and WMO Members have been addressing for a number of years to ensure that the AMDAR Programme will indeed be a complement to the WMO upper air observation programme. In this regard, it was pleased to note that a big step has been taken with the start of an operational trial of the US humidity/water vapour sensor (WVSS-II) with 10 sensors reporting as part of an initial trial and 25 sensors by the end of 2005. The first WVSS-II data from US aircraft were received in March 2005. Despite few technical problems, the data quality is very good and much better than any previous sensors.

6.1.22. The Committee was informed that the EC fifty-fifth session held in 2003 agreed that activities should be initiated under the World Weather Watch (WWW) and the Aeronautical Meteorology Programmes for training to facilitate the availability and use of AMDAR data in areas where they were currently not available particularly in developing countries. This is particularly important for African NMSs.

6.1.23. The Committee noted that the Fourteenth Congress (Cg-XIV) in May 2003 stressed that AMDAR had proved to be a very cost-effective data source that responded to the needs of WMO Programmes and brought benefits to end-users. Congress recognized the low cost of AMDAR observations compared to radiosonde soundings, the potential of such systems to improve data coverage in data-sparse areas particularly over ocean areas, and the improvements to NWP attributed to the assimilation of such observations.

6.1.24 The representative of ICAO informed the Committee that there are plans to propose some changes to the format of tropical cyclone advisories as part of Amendment 74 to Annex 3/Technical Regulations [C.3.1] with applicability date of November 2007. ICAO intends to present the draft proposals to the Fifth Technical Coordination Meeting of all TC RSMC/TCWC Directors (Honolulu, December 2005). The proposals will then be finalized based on the feed-back received from the said meeting.

6.1.25 The representative of ICAO thanked RSMC La Réunion/Tropical Cyclone Advisory Centre (TCAC) for the continued support to the aviation industry by issuing tropical cyclone advisories in accordance with the requirements of Annex 3/Technical Regulations [C.3.1].

**6.2 Hydrological Component (agenda item 6.2)**

6.2.1 The Committee was pleased to note that the thirteenth Session of Regional Association I (Africa) (Mbabane, Swaziland, 20-28 November 2002) re-established the Working Group on Hydrology with a core of six members and five sub-regional Steering Committees. It also endorsed the WGH proposal for a hydrological data rescue pilot project.

6.2.2 The Committee was informed of the following activities of WMO's Hydrology and Water Resources Programme (HWRP):

(a) Commission for Hydrology (CHy)

The twelfth session of the Commission for Hydrology (CHy -XII) was held in Geneva (Switzerland) in October 2004. During this session, Mr Bruce J. Stewart (Australia) was elected president and Mr Julius Wellens-Mensah (Ghana) was elected vice-president of the Commission for Hydrology for the current intersessional period. CHy–XII established an Advisory Working Group (AWG) comprising 9 members and five Open Panels of CHy Experts (OPACHE) on five thematic areas to carry out its activities up to the next session. The five theme areas are:

- Basic systems (hydrometry and hydraulics)
- Water resources assessment and water use
- Hydrological forecasting and prediction
- Disaster mitigation – floods and droughts (hydrological aspects)
- Analysis of hydroclimatological data for variability and trends

Apart from identifying the five thematic areas with responsibility assigned to the AWG members, the Commission also decided to identify two additional AWG members, one to focus on activities associated with WHYCOS and international data exchange, and the other on capacity-building and technology transfer activities. The Commission identified a set of activities and outputs for each member of the AWG.

(b) World Hydrological Cycle Observing System (WHYCOS)

WHYCOS has been developed by WMO, with support from the World Bank, the EC and other donor agencies in response to the recommendations of Agenda 21, Chapter 18. The objective is to improve co-operation at the river basin level, as well as at regional and global levels, and to contribute to the establishment of consistent and reliable water data information systems. The objective is to provide the basis for water resources assessment, integrated, intersectoral and intercountry water resources development and management. WHYCOS would contribute to knowledge of hydrological processes and their interaction with climate and the environment.

(c) Hydrological Operational Multipurpose System (HOMS)

An area where there had been encouraging results was that related to HOMS training activities. In total, 84 professionals from Africa (Ghana, Kenya and Nigeria) had thus been trained in one-week courses on flood and low-flows frequency analysis and flood plain delineation procedures using Canadian HOMS components. During these courses they were also introduced to the utilization of the HRM.

(d) Education and training

The three regular training courses approved by Congress are in Venezuela (every two years), Kenya (every year) and United States (every two years). However, due to financial constraints, WMO support to the course in Kenya would be provided once every two years. The course in Caracas is being developed for the first time as a distance-learning course. "Volume II: Hydrology" of the WMO publication No. 258 "Guidelines for the Education and Training of personnel in Meteorology and Operational Hydrology", which also covers the field of integrated water resources management has been prepared. The English version of this volume has been sent to all Members during the first half of 2004.

(e) Voluntary Cooperation Programme (VCP)

Support to developing countries in their efforts to improve the capacity and work of their NHSs was an important responsibility of the WMO Secretariat. In this regard, pilot projects on hydrological data rescue involving several countries of RA I have been implemented using VCP funds. This contributed to: strengthening the human and institutional capacity of the National Hydrological Services in many African countries; strengthening the capacity of trainers in Africa; and the modernization of data archiving systems in the region. Tanzania was one of ten African countries that participated in the project. Each participating country was provided with a PC, printer and scanner, and a software package for data processing and management.

(f) Water resources assessment

WMO has continued in its efforts to promote the use of the methodology contained in the WMO/UNESCO Publication *"Water Resources Assessment – Handbook for Review of National Capabilities"* through regional workshops. It has been distributed to the AWG members as well as to the participants of the regional WRA workshops that had expressed the desire of organizing similar workshops at the national level and to carry out review of national capabilities. A CD-ROM version of the Handbook has been produced. It contains the Handbook in PDF format, Handbook Figures and Tables overheads, Workshop overheads, Workshop papers and Exercises. Once it has been tested at the national level, and the feedback from NHSs taken into account, it should become a HOMS component. WMO has organized five workshops in different regions of the world to introduce the methodology contained in the Handbook, two of which were held in Africa. The third workshop will be held in November for French speaking countries of West Africa, in collaboration with AGRHYMET.

(g) Guide to Hydrological Practices

Following the recommendation of CHy-XI, the sixth edition of the Guide to Hydrological Practices is under preparation. Several chapters have been finalized in preparation for comments from the review committee, some chapters have been peer reviewed and forwarded to authors for finalization, while others were still being peer reviewed. The AWG agreed that the process of review would continue to be overseen by the Review Committee, the next meeting of which is tentatively planned for November 2005, time by which it is expected that all the chapters would have been peer-reviewed. After the meeting of the Review Committee, the Secretariat will proceed with a final technical and scientific review and editing, to ensure consistency and harmonization among the different chapters.

Subsequently WMO Secretariat will also proceed with final proofreading and editing, with the goal of having the final draft ready by March 2006.

(h) Flood initiatives

The International Flood Initiative (IFI) started as the Joint WMO/UNESCO Flood Initiative (JUWFI) and subsequently, with the joining of other UN and non-governmental organizations, has evolved into an International Flood Initiative (IFI). The IFI was launched during the WCDR in Kobe, Japan in January 2005. The WMO EC-LVII has approved the participation of WMO in the International Flood Initiative.

(i) Cooperation with International Organizations

WMO continues its co-operation with other international organizations in the field of hydrology and water resources. WMO maintains close co-operation with a number of agencies within the United Nations system, international river basin commissions, other governmental organizations (IGOs) and non-governmental organizations (NGOs). WMO's closest links are with UNESCO. WMO has cooperated with UNESCO in the publication of the "Water Resources Assessment - Handbook for Evaluation of National Capabilities". Cooperation is also in the publication of the WMO/UNESCO "International Glossary of Hydrology". The two organizations have also worked together with the government of the Netherlands on the establishment of an International Groundwater Resources Assessment Centre (IGRAC), and are cooperating in the International Flood Initiative. WMO is collaborating with other UN agencies working in water-related issues under UN-Water and is participating in preparation of the second WCDR. WMO has participated actively in the Pan-African Implementation and Partnership Conference on water (Addis Ababa, Ethiopia, December 2003) and the third World Water Forum (Kyoto, Japan, March 2003) and will be participating in WWF4 in Mexico in 2006.

(j) World Water day

The 22nd day of March of each year has been designated by the forty-seventh session of the UN General Assembly (November 1992) as World Water Day. Members are urged to devote this day to appropriate national activities, such as promotion of public awareness, and the UN has been asked to make arrangements to ensure the success of the celebrations. For each year's celebration a particular theme is agreed and publicity material is prepared as a collaborative effort of the UN agencies and given wide distribution. For this year, the theme was " Water for Life" and for 2006 it will be "Water and Culture".

6.2.3 In recognition of the need for the active participation of hydrologists in its sessions, the Committee urged its Members to revitalize their efforts to enable hydrologists to be included in their delegation to the biennial sessions and likewise requested WMO's assistance.

## 6.3 Reduction of the Impacts of Natural Disasters and Preparedness Component (agenda item 6.3)

6.3.1 The Committee was pleased to noted that WMO had established a network of National DPM focal points and that until September 2005, 121 nominations had been received from the Permanent Representatives (PRs) of WMO.

6.3.2 The Committee took note of the following activities of WMO under this component:

(a) The DPM Programme has initiated three major fact-finding projects, including:

(i) **"Regional level DPM Assessments"** – With the goal to identify in a systematic manner key weather-, climate- and water-related hazards and to document capabilities (i.e., strengths and weaknesses), gaps and needs in WMO's core

areas of activities related to observing, monitoring, forecasting and early warnings in all six WMO regions;

(ii) **"Country level DPM Assessments"** – With the goal to develop country profiles with respect to DPM related capabilities (i.e., strengths and weaknesses), gaps and needs on WMO's core areas of activities and how effectively the products and services developed by NMHSs are integrated in the disaster risk management and emergency response process for relevant hazards in their respective country; and

(iii) **"Mapping of DPM activities of WMO Major Programmes"** – With the goal to develop a comprehensive matrix of DPM related activities of all relevant WMO major programmes to determine scope, synergies, gaps, redundancies and related budgets.

(b) The DPM Programme is initiating projects on:

(i) "Cataloguing of Weather-, Climate- and Water-related Hazards and their Impacts" to develop a standard methodology for collection of information about hazardous events causing damages.

(ii) "Methodologies for Hydro-meteorological Hazard Mapping and Risk Assessment," to identify a portfolio of hazard mapping and risk assessment methodologies for weather-, climate - and water-related hazards.

(c) WMO is taking a leading role in participating in the Third International Early Warning Conference (EWC III) sponsored by the Government of Germany, to be held in March 2006. Furthermore, WMO, is participating in the Global Early Warning Survey the Global Survey of the Early Warning Systems requested by the UN Secretary General, Kofi Annan, in his report to the General Assembly "In Larger Freedom: towards development, security and human rights for all," A/59/2005, 21 March 2005.

(d) WMO is working together with UNESCO-IOC, ISDR and other key partners at the international, regional, and national levels to contribute its relevant capabilities to the development of end-to-end tsunami early warning systems in the Indian Ocean and other regions at risk. WMO is also committed to developing the capabilities of the National Meteorological and Hydrological Services (NMHSs) of the Indian Ocean Rim countries to establish an effective tsunami early warning system within a multi-hazard framework, particularly related to national multi-hazards alert and response mechanisms.

(e) The WMO Global Telecommunication System (GTS) will be upgraded, where needed to address requirements for tsunami-related information exchange in the Ocean Indian Rim**.** WMO held a multi-disciplinary workshop from 14 to 18 March, 2005 in Jakarta, Indonesia, during which it developed a detailed plan for upgrading the GTS and identified twelve countries in need of equipment upgrades, including the following Members of the Committee:

Comoros, Madagascar, Seychelles, and Tanzania

(f) WMO will take a leadership role to ensure that the tsunami early warning system in the Indian ocean is linked with the existing tropical cyclone early warning system and storm height forecasting, activities related to tropical cyclone and storm surge related flood forecasting to ensure that these early warning systems are linked when appropriate to maximize the benefits of these capabilities for saving of life and property in the coastal regions. To this end, WMO is planning a first meeting in fall 2005 to bring experts from the tropical cyclone and storm surge forecasting

community, hydrological experts in coastal and river flooding together with tsunami and coastal zone management experts.

**6.4 Research Component (agenda item 6.4)**

6.4.1 The Committee noted with satisfaction that the Sixth WMO International Workshop on Tropical Cyclones (IWTC-VI) will be organized in Costa Rica in late 2006, and that it will be involved in the International Committee (IC) for IWTC-VI, co-chaired by Dr C. Y. Lam and Prof Johnny Chan (Hong Kong, China) through the participation of Mr Caroff from RSMC La Réunion. In this regard, the Committee expressed its satisfaction with the close collaboration between Tropical Cyclone Programme and the CAS Tropical Meteorology Research Programme in organizing IWTC series workshops, and encouraged Members of the sub-region to ensure adequate participation in the Workshop in order to further collaboration and exchanges between research and operational experts.

6.4.2 The Committee recognized that great challenges existed for improving the prediction of tropical cyclone land fall and associated high impact weather, and welcomed the organization of an International Workshop on Tropical Cyclone landfall processes, which was held from 21 to 25 March 2005 in Macao, China, and contributed to improving further safety and to reducing the economic losses of tropical cyclone affected countries. The Report of the Workshop (WMO/TD No 1281) summarized the recent advances, gaps and future requirements in understanding and predicting tropical cyclone landfall. The Committee encouraged the CAS Working Group on Tropical Meteorology Research to continue the development of future projects related to tropical cyclone land fall.

6.4.3 The WMO Sub-Regional Officer informed the Committee that the focus of researches in the region could be on how tropical cyclones are connected to climate issues in particular on the inter-relationship with seasonal climate forecasts.

6.4.4 The Committee was pleased to note that France will host a Regional Workshop on Tropical Cyclone Research in St. Denis, La Réunion in October 2006. It urged all Members to actively participate in the said workshop.

**6.5 Training Component (agenda item 6.5**)

6.5.1 The Committee reviewed the involvement of its Members in various education and training activities supported under WMO Voluntary Co-operation Programme (VCP), regular budget (RB), UNDP and TCDC arrangements.

6.5.2 The Committee expressed appreciation for the number of training events and workshops, which were organized since its last session for the benefit of its Members. The Committee noted that its Members had benefited from WMO's education and training activities, relating to the award of fellowships, relevant training courses, workshops, seminars, the preparation of training publications, and the provision of advice and assistance to Members.

6.5.3 The Committee noted that WMO fellowships for long-term and short-term training continued to be granted to the Member countries of the Committee under the various WMO programmes and urged its Members to utilize more effectively the fellowships programme.

6.5.4 The Committee expressed its gratitude to all those Members who made available their training facilities and/or experts to other Members under bilateral or any type of arrangements. These cooperative efforts by the Committee Members have been found by the recipient countries to be very useful, it strongly recommended that such endeavours should continue in the future and be strengthened. The Committee urged its Members to make maximum use of such training facilities.

6.5.5 The Committee noted the recent review of the ETRP Website and the current initiative towards developing an interface to facilitate online access to worldwide training resources, as well as exchange of meteorological case studies and related documentation between advanced and less advanced training institutions.

**Activities of Members**

6.5.6 The Committee reviewed the activities of the Members carried out in during the intersessional period including important achievements, key issues and future directions by each Member under the five components, details of which are presented in **Appendix VII.**

**Updated Technical Plan**

6.5.7 The revised Technical Plan was divided into two phases. One is for short-term implementation for the development of services during the intersessional period (2005-2007). It focused on activities which could be actively pursued cost-effectively in the near term and be a more effective basis for preparation of annual plans. The other is for long-term implementation (mainly made up of continuous activities or those which will require significantly large funding resources, implementation of which will cover the period until the 19th session of the Committee (2005-2009). The Committee ultimately concurred with the updated Technical Plan submitted by the group which is reproduced in **Appendix VIII**.

## 7. ASSISTANCE REQUIRED FOR THE IMPLEMENTATION OF THE TECHNICAL PLAN AND STRENGTHENING OF THE OPERATIONAL PLAN (Agenda item 7)

7.1 The Committee was informed that since the last meeting of the Tropical Cyclone Committee (Maputo, Mozambique, 8-12 September 2003), several countries in the Region continued to receive technical assistance from various funding sources including Trust Funds, UNDP, the Word Bank (WB), the Global Environmental Facility (GEF), the WMO's Voluntary Cooperation Programme (VCP) and Regular Budget. The main objective of these projects was to strengthen the capabilities of National Meteorological and Hydrological Services (NMHSs) and Regional Centres to provide reliable and accurate weather/climate information and products in support of improved agricultural production, environmental protection, natural disaster preparedness and management, water and energy resources management, etc.

7. 2. The Committee noted that at the regional level, the IGAD Climate Prediction and Applications Centre (ICPAC) based in Nairobi, Kenya and the SADC Drought Monitoring Centre (DMCH) in Harare, Zimbabwe continued providing weather and climate information, products and early warning advisories to the eastern and southern African countries. They also organized annually Regional Climate Outlook Fora to develop consensus seasonal climate outlooks for the coming rainy seasons. The operations of ICPAC and the SADC DMC were supported by funds provided by WMO and other cooperating partners especially the United States Agency for International Development (USAID).

7.3. The Committee was pleased to note that further to the above, the SADC-HYCOS and IGAD-HYCOS projects continued to be implemented satisfactorily with funding support from the European Commission (EC). The two projects are aimed at developing relevant tools and providing data and products in support of sustainable water resources management in the two regions.

7.4. The Committee noted that WMO in collaboration with the Intergovernmental Oceanographic Commission (IOC) of UNESCO has developed the "West Indian Ocean Marine Application Project (WIOMAP)" project proposal whose overall objective is to contribute to the conservation and sustainable use of marine resources in the South-West Indian Ocean region through improved application of marine data and products. Efforts are ongoing to secure funding for the project.

7.5 The Committee was informed that as in previous years, WMO continued to collaborate with the various economic sub-groupings such as the East African Community (EAC), the Indian Ocean Commission (IOC), the Intergovernmental Authority on Development (IGAD) and the Southern Africa Development Community (SADC) with the aim of formulating and implementing meteorology development programmes and projects. In this regard, efforts have continued to develop Memorandums of Understanding (MOUs) in order to enhance collaboration between WMO and the respective economic sub-groupings.

7.6 The Committee noted with pleasure that following the establishment of the WMO Programme for the Least Developed Countries (LDCs) by the fourteenth WMO Congress (Cg-XIV) in May 2003, assessment missions were organized to several countries in the region with a view to developing project proposals for enhancing the operational activities of their NMHSs. Furthermore, a workshop was organized in 2004 on strategic planning and resource mobilization. Currently, efforts are ongoing to implement a strategic action plan for the LDCs Programme developed at a meeting held in Geneva in April 2005.

7.7 The Committee was informed that under the PUMA Project financed by the European Commission, most countries in the region have received satellite ground receiving equipment for acquiring data and products from the METEOSAT Second Generation Satellites. The project was planned to be finalized on 30 September 2005, in accordance with the planned deadline. The Project has been successful considering the inherent challenges and obstacles that have been faced during the four years of the implementation of such a highly complex initiative. It is noted that in some countries some residual work still remains to be completed. This matter is under consideration by the Project Steering Committee comprising the EC, WMO, the economic sub-groupings and representatives of NMSs. The post-PUMA development activities have already commenced with the approval by EC of the concept for the "African Monitoring of the Environment for Sustainable Development (AMESD)" project which, not only will foster the use of Earth Observation data and environmental policies, but will also represent a major effort aimed at institution and capacity building and networking at regional and continental level.

7.8 The Committee noted that following the devastating Tsunami in December 2004 that affected many countries in the Indian Ocean area including the eastern African coast, efforts are ongoing by WMO in collaboration with other UN agencies to develop a Tsunami Early Warning System. The WMO GTS system is geared to play a major role in the dissemination of the ensuing early warnings.

7.9. In order to enhance marine and oceanographic observations in the Southwest Indian Ocean area, Members were encouraged to continue their efforts to upgrade their observation systems for the provision of tropical cyclone forecasts. In this regard, it is to be noted that the Kenya Meteorological Department, with the support of NOAA is in the process of deploying 15 drifting buoys along the Kenya coast in the Indian Ocean.

7.10. The Committee was pleased to be informed that under funding from the US Climate Change Research Initiative for the enhancement of global climate atmosphere observing systems, several countries in the region have received assistance within the framework of the VCP to upgrade their upper-air systems within the GUAN network. In this regard, upper-air equipment has been installed in Namibia and Tanzania; while arrangements are under way to install similar equipment in Zimbabwe. Consumables such as radiosondes and balloons have been supplied to some of these countries. Similarly, hydrogen generators have been installed in Kenya, Mauritius, Namibia, United Republic of Tanzania and Zimbabwe under the project.

7.11 The Committee noted that the Botswana Meteorological Service in 2005 was awarded a contract to implement a Technical Support Project to ensure the efficient operation of the GUAN network in southern Africa. In this regard, technical missions have been carried out to several SADC countries for this purpose.

7.12 The Committee further noted that within the framework of the VCP, several Members in the Region received support in terms of equipment, spare parts and consumables, expert services, and training. The VCP statement on the projects related to the members of RA I Tropical Cyclone Committee for the South-West Indian Ocean in the past five years is given in **Appendix IX**.

## 8. SCIENTIFIC LECTURES AND DISCUSSIONS (Agenda item 8)

8.1 During the session, the Committee devoted part of its time to the presentation of the following scientific lectures and technical discussions: THEME: "Early Warning Systems and Disaster Management of all Meteorological and Hydrological Hazards"

(a) Mr Andrew BURTON (Australia):
'' Australian Region Review 2003/2004 and 2004/2005 cyclone seasons''

(b) Mr Denis CHANG-SENG (Seychelles)
''Tropical Cyclone Variability and its predictability in the South-West Indian Ocean''

(c) Mr Henry TEMBA (Zimbabwe)
''Review of the 2003/2004 and 2004/2005 cyclone season in Zimbabwe''; and
''Recent Activities in the Zimbabwe Meteorological Services"'

(d) Mr Andrew BURTON (Australia)
''Early Warning Systems and Disaster Management Enabling Technologies and Risk Communication''

(e) Mr Philippe CAROFF (France)
"Activities of RSMC La Réunion"

(f) Mr S.N. Sok Appadu (Mauritius)
"Disaster Management and Tsunami Warning in the Republic of Mauritius"

8.2 The Committee recorded its appreciation to the lecturers for their interesting and informative presentations.

8.3 The Committee requested WMO for a CD compilation of the above presentations and its distribution with the final report of the session to all the Members. It further requested that the presentations be posted on the TCP web site as soon as possible.

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

9.1 The Committee expressed the need to continue its work in the light of Resolution 6 (XIII-RA I). It also expressed the desire that its eighteenth session be held before the 2007/2008 cyclone season, the precise dates to be determined later.

9.2 The delegates of Malawi and South Africa informed the Committee that their countries would be privileged to host the eighteenth session of the RA I/TCC in 2007.

## 10. CLOSURE OF THE SESSION (Agenda item 10)

The report of the seventeenth session of the Committee was adopted at its final meeting at 1600 hours on 7 October 2005.

## LIST OF APPENDICES

APPENDIX I

## LIST OF PARTICIPANTS

### AUSTRALIA

Andrew BURTON
Manager Severe Weather Services (Western Australia)
Australian Bureau of Meteorology

### BOTSWANA

Ms G.K. Ramothwa
Director of Meteorological Services

Mr P. PHAGE
Chief Meteorologist
Meteorological Services

Ms M. MATLHAGA
Principal Meteorologist I
Meteorological Services

Ms. L. MOAGI
Telecomms Engineer
Meteorological Services

Mr S.M. KING'UYU
Botswana Meteorological Services

Ms. P.M. LESOLLE
Principal Meteorologist
Meteorological Services

Ms E. MOTLAMME
Superintendent
Meteorological Services

Ms G.K. NTHOBATSANG
Principal Meteorologist II
Meteorological Services

Ms K. MMOPI
Chief Technical Officer
Meteorological Services

Mr Othata MMOLOTSI
Senior Meteorologist
Meteorological Services

Mr G.J. STEGLING
Chief Technical Officer Meteorological Services

Ms E. KEPALETSWE
Chief Technical Officer Meteorological Services

Mr B. JAY
Principal Hydrological Engineer
Dept. of Water Affairs

Mr R.M. KWEREPE
Chief Forestry Rangeland Ecology Officer
Ministry of Agriculture

Mr S. RAMONTSHO
Senior Engineer
Water Utilities Corporation

Ms B. MOLALE
Environmental Officer
Water Utilities Corporation

**COMOROS**

Mr Poundja Mahamoud Ali BAY
Director of Meteorological Office

**FRANCE**

Mr Gerard THERRY
France Meteo-France/La REUNION
Director (Meteorological Service at la Reunion)

Mr P. CAROFF
RSMC La REUNION (Meteo-France)
RSMC's Operational Head

**LESOTHO**

Mr L. PESHOANE
Meteorologist
Meteorological Services

**MADAGASCAR**

Mr Razafimahazo Alain SOLO
Director des Exploitations Meteorologiques

**MALAWI**

Mr W. S. CHIMWAZA
Principal Meteorologist Prediction
Dept. of Meteorological Services – Malawi

**MAURITIUS**

Mr Soobaray Nayroo SOK APPADU
Director, National Meteorological Services

Mr VEERASAMY Shymnath
Divisional Meteorologist
Meteorological Services

**MOZAMBIQUE**

Mr H. SUEIA
Weather Forecasting Department

**NAMIBIA**

Mr F. UIRAB
Head, Namibia Met. Service

**SEYCHELLES**

Mr D. CHANG-SENG
Acting Director

**SOUTH AFRICA**

Mr M.C. NKOSI
Meteorologist

**SWAZILAND**

Mr Simon M. NKAMBULE
National Meteorological Service

**UNITED REPUBLIC OF TANZANIA**

Mr P.F. TIBAIJUKA
Director of Forecasting

**ZIMBABWE**

Mr B. GARANGANGA
Acting Coordinator

Mr H. TEMBA
Meteorologist

**ICAO**

Mr B.M. SEKWATI
Regional Officer/Aeronautical Meteorology

**WMO**

Mr S.J.M. NJOROGE
Programme Officer

Ms N. LOMARDA
Scientific Officer

***WMO Interpreters***:
Ms C. MARIOTTE
Mr E. PETROS

***WMO Translator***:
Ms CONFREVILLE

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-chairperson
   1.4 Working arrangements for the session

2. REPORT OF THE CHAIRPERSON OF THE COMMITTEE

3. REPORT OF THE WMO REPRESENTATIVE ON THE IMPLEMENTATION OF THE WMO TROPICAL CYCLONE PROGRAMME

4. REVIEW OF THE 2003/2004 AND 2004/2005 CYCLONE SEASONS

   4.1 Report of RSMC La Réunion
   4.2 Reports of Members on significant/notable cyclones of the seasons

5. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN FOR THE SOUTH-WEST INDIAN OCEAN

   5.1 Forecast Area of Responsibility of RSMC La Réunion and RSMC New Delhi
   5.2 Operational procedures for the assignment of tropical cyclone names
   5.3 Report on the Dvorak analysis for the South-West Indian Ocean cyclones
   5.4 Report on updates for the 2005 edition of TCP-12
   5.5 Exchange of information with other Regional Associations on latest tools and techniques for improving tropical cyclone analysis and warnings

6. REVIEW OF THE TECHNICAL PLAN AND ITS IMPLEMENTATION

7. ASSISTANCE REQUIRED FOR THE IMPLEMENTATION OF THE TECHNICAL PLAN AND STRENGTHENING OF THE OPERATIONAL PLAN

8. SCIENTIFIC LECTURES

   Theme: “Early Warning Systems and Disaster Management of all Meteorological and Hydrological Hazards”

9. OTHER MATTERS

10. DATE AND PLACE OF THE EIGHTEENTH SESSION

11. CLOSURE OF THE SESSION

_____

APPENDIX III

**REPORTS ON THE 2003/2004 AND THE 2004/2005 CYCLONE SEASONS SUBMITTED BY THE RSMC LA RÉUNION**

## THE 2003-2004 CYCLONE SEASON IN THE SOUTH-WEST INDIAN OCEAN

Like the previous season (2002-2003), the 2003-2004 cyclone season lasted a long time in the south-est Indian Ocean, but was less active, which was therefore closer to the normal level.

This season will otherwise be characterized by atypical tracks, some particularly tortuous, the most extreme being the bizarre track of ELITA, that crossed Madagascar three times in succession. This event will sadly not be a one off, with its successive passages in the "big island" taking dozens of victims and creating significant damage.

However this high human and economic toll was not on a similar scale to that seen a few weeks during the terrible GAFILO cyclone, one of the most violent and destructive that the basin has seen over the last few decades, THE phenomenon which will have made its mark on this season and practically eclipsed the rest.

Advisories were issued regarding 16 depression systems, that it to say the same number as the previous year, a parameter which has moreover been remarkable stable for several years. This cyclogenesis was not however as effective in comparison to the previous season, during which the rate of development into mature phenomena had been truly exceptional. Ten tropical storms (TS) were listed this season in this way, a number which is practically normal for the basin (the climatological normal being nine storms). Half of them later reached tropical cyclone stage, a proportion which also conforms to the norm.

The review of the number of days of cyclonic activity, a more reliable parameter to describe disturbance activity, allows us to refine this diagnostic. With a total of 19 days on which a tropical cyclone was present in the area (number of cyclone days), we can regard cyclone activity itself to have been almost completely normal (the average being about 20 days). The disturbance activity at a more moderate stage has, in contrast, been slightly higher than normal, since there were 57 days with the presence of a depression system of an intensity equal to or greater than a moderate tropical storm (mean of 53, median of 48). As in the 2002-2003 season, one depression system alone managed to remain (more than three days) at hurricane force the whole time (cyclone FRANK).

This was not the only analogy between the two seasons. There were more obvious similarities in patterns at the beginning and end of the respective seasons. The beginning of the season in particular was astonishingly similar to that of the previous year, almost completely identical. In both cases, four depression systems developed before the end of the year, which in itself is not very common (the naming of the fourth depression system of the season occurring before 31 December on average once every six years) and furthermore come at almost exactly the same dates; the first depression system – a tropical storm – forming in September (not as prematurely however as in 2002), followed by the first cyclone in November, before a second formed in December, preceding the formation of a new tropical storm right at the end of the year.

The last system of the season that was named developed in May and is a recurrence of an event that had occurred not only in 2003, but also in 2002. Even if that time the last late system of the season didn't reach cyclone stage, as had been the case in the months of May 2002 and 2003, this new succession of three consecutive years with a mature phenomenon in May inevitably brings back numerous questions that were already raised the previous year, in particular on a potential or even real tendency towards a prolongation of cyclone seasons, with underlying speculations of a possible link with global warming without many more answers for the time being.

It is still the case that the consequences in terms of the length of the season were almost the same: 2003-2004 again followed in the steps of its predecessor, one of the longest of modern times, extending over more than seven and a half months, from the end of September until mid May.

If the cyclogenesis is well spread out in time, it is however hardly spread out in space, concentrated in the area around Diego-Garcia (Chagos Archipelago), a geographic area which has even more than usual lived up to its reputation of being a favoured zone for cyclogenesis in the basin. Only three systems, of the ten counted, originated outside of this area, one of which was formed in the Mozambique Channel and two came from the south-west area of the Indian Ocean.

The tracks recorded this season have not often been a good for forecasters: the regularity has hardly been appropriate and cuspidal points, sudden changes of track, sometimes in very unusual directions, have even been the fate of some specimens that are particularly difficult to manage, such as cyclones BENI and FRANK. But in terms of an "exotic" track, it will be difficult to do better than ELITA and its turning track around Madagascar (even if it is not unprecedented – confer FELICIE in 1971).

Cyclogenesis is focalized in the central-east area of the basin, while damage is concentrated in Madagascar. In contrary to last year, when the impacts from different events had been very spread out spatially, with almost all inhabited land being directly or indirectly affected, this year the majority of territories recovered well from it. Southern Africa and Mozambique in particular were completely spared, while the Mascarenes did not have to suffer from the DARIUS' passage, whose rain was even beneficial for the island of Mauritius, putting an end to a long period of drought.

Despite this, this cyclone season will remain a season marked in black, one of the worst that Madagascar has seen over the past twenty years. Accustomed to suffering assaults from devastating cyclones, this time the "big island" was the target of two exceptional events: one, ELITA, was dreadful because of its incredible track, crossing the island three times in an infernal swirl; the other, GAFILO, simply had incredible power and its victims had to be counted not in tens, but in hundreds, not to mention the hundreds of thousands of disaster victims. ELINE or GERALDA were two memorable cyclones in many respects, which have been added to a list of sinister phenomena that was already long, to recall but two from the last decade.

## THE 2004-2005 CYCLONE SEASON IN THE SOUTH-WEST INDIAN OCEAN

Purely in terms of numbers, it can be said that the activity of the 2004-2005 cyclone season was almost normal. However, calling this season normal seems somewhat at odds with its reality. It would indeed not be taking into account the qualitative aspect of its content and events, which gives quite a different impression. If we were to choose a more representative term for the pattern of this season, we would tend towards the word "strange."

The strangeness of this season comes essentially from the nature and way of the genesis of the phenomena observed over the course of the season. One of the strangest was in particular the fact that no tropical cyclone developed over the south-west Indian Ocean during the whole of the first trimester of 2005 (Mozambique Channel aside).

In terms of impact on inhabited land, to the region's people the 2004-2005 season was much more mild than the previous one. While the south of Madagascar was hit by the consecutive passages of ERNEST and FELAPI, the human and economic toll was not however on the same scale as that suffered by the "big island" during the previous season.

Eighteen depression systems resulted in advisories being issued by RSMC La Réunion, that is to say a number that is slightly higher than that reported in previous years. But

cyclogenesis has often been slow and the rate of development into mature phenomena was only moderate towards the end.

Ten systems nevertheless reached the stage of being tropical storms, that is to say a number that is identical to that of the previous season and conforms with the norm of the basin, which is nine storms. Of these ten storms, four developed into tropical cyclones, a proportion which is also very close to normal (on climatological average a little less than half of storms reach tropical cyclone stage in the basin). Moreover, these four cyclones were very intense on average, three of them being classed as intense or even very intense tropical cyclones.

Moreover, these four cyclones lasted long enough to produce a total of 20 cyclone days (total of days with the presence of a tropical cyclone in the area), that it to say a number that is completely equal to the climatological average. Two events remained at cyclone stage for more than five days (BENTO and JULIET), which hadn't happened since the 2001-2002 season.

But if we look at the disturbance activity in even more detail, it appears that it was in fact lower than normal on the whole, since in the south-west area Indian Ocean we can only count a total of 44 days with the presence of a depression system with an intensity equal to or greater than a moderate tropical storm, while the average is 53 days (median of 48). This relative weakness can be explained by the fact that the six storms that hadn't turned into tropical cyclones had quite a small impact in terms of the number of days of significantly intense disturbance activity, only representing a total of 19 days of the 44 mentioned above.

One of the peculiarities of this season was the slightly unusual distribution of cyclone activity over the course of the season. After a rather active and premature start to the season, the rest of the season was a lot more slow. Tropical cyclone JULIET, a cyclone of great intensity and a textbook example of parabolic track, was nevertheless a beautiful ending to the season, this time at a normal date for the end of season after three consecutive late years lasting until May.

As far as the beginning of the season is concerned, the first tropical storm of the season – AROLA- was for the fourth consecutive year named before 15 November, the date corresponding with the date of the median for the beginning of the cyclone season (the first significant depression system forms before this date once every two years). But the real onset of the season should be dated much earlier, as of 30 August, in the middle of the southern winter, with the formation of the first depression system in the extreme east of the basin of the south-west Indian Ocean. After this disturbance had left the area for which RSMC La Réunion is responsible, the south-west area of the Indian Ocean for which the Australians are responsible, it was named PHOEBE on 2 September by the Perth centre, making it at that time the first and far too premature tropical storm of the new season of the southern hemisphere.

Following an active start to the season, two cyclones then formed before the end of the year, the first of them developing from the month of November onwards and it wasn't just an ordinary cyclone! After an explosive deepening, BENTO was exceptionally intense for the beginning of the season, topping cyclone AGNIELLE's record for intensity in the basin in November and becoming at the same time the most intense cyclone ever recorded in the south-west Indian Ocean north of 10°S (all months together).

After starting at such a high level, the main part of the season then turned out in contrast to be abnormally unproductive of mature systems. No tropical cyclones developed in the basin during the first trimester of 2005, with the sole exception being ERNEST. It was the only tropical cyclone recorded during the period, forming in the Mozambique Channel, which brings us back to say that the Indian Ocean part itself remained unaffected by all of the cyclone phenomena characterized from January to March. Although such an event is not unprecedented, it is not a less obvious anomaly as it is only the fourth event of this nature to occur in the last 40 years of observation (after the first trimesters of 1974, 1983 et 1985).

This lack of tropical cyclones did not mean a lack of depression systems. On the contrary, instead of the events classically observed in the basin, a string of events that ranged from weak to moderate occurred, stemming from particularly slow cyclogenesis and some of which occurred in very unusual ways for the basin.

We have also seen several tropical storms forming from depression circulations that are very broad at their place of origin, associated with a monsoon talweg with the most similar characteristics that are often seen in the north-west Pacific. The relatively limited Intertropical Convergence Zone along the meridian that is generally recorded in the basin has indeed left room over weeks for an extremely long and vast large area of low pressures, occupying almost all the tropical area, up to latitudes that are much higher than usual. At the same time trade winds blew southwards and were much weakened. The result of this lasting situation was a very negative anomaly of pressure in the area to the south of Madagascar during the months of February and March (to a total of 4-5 hPa on average per month).

The consequence of this marked encroachment of low equatorial pressures in the southern latitudes was that depression systems formed during this period almost reached their maximum intensity well to the south of 20°S, or even 25°S, while it is normal for the basin's maximum intensity of these phenomena to be north of 20°S. The tropical storm GERARD was the archetype of this type of "baroque" evolution: a rather unusual cyclogenesis starting from a monsoon depression and the maximum intensity was reached around 30°S. The absence of a tropical cyclone during this whole period can be explained to a large extent by the gap marked by disturbance activity towards northern latitudes, depression systems becoming too intense to the south to have time to reach the stage of being a tropical cyclone before being met by a current moving from the west and by the increase resulting from the vertical wind shear.

The cyclogenesis is clearly focused predominantly on the east of the basin. At the same time tracks with recurvature (parabolic or pseudo-parabolic) have to a large extent been dominant, the only tracks that can be qualified as zonal are those of AROLA and DAREN.

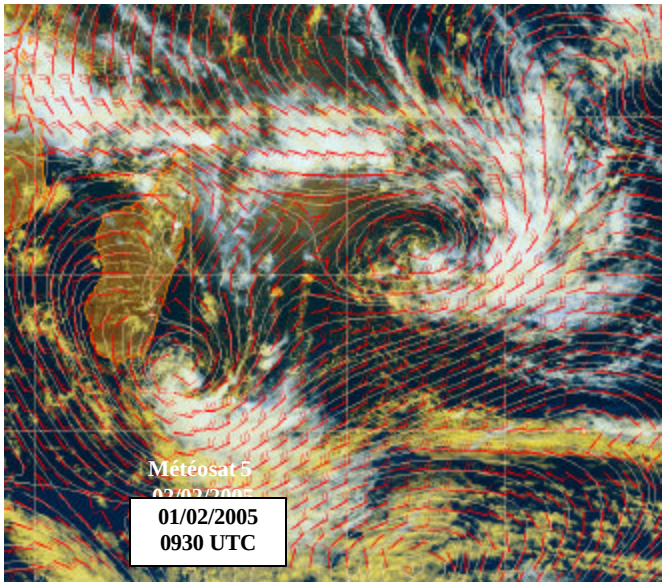
This is a case of configuring the most favourable in terms of reducing the risks for inhabited land, concentrated in the west of the basin. In fact, few phenomena have indeed threatened or influenced the various islands of the area, the African continent remaining, as in the previous season, completely out of the way of all disturbances. The Mascarenes didn't suffer severe damage; the island of Rodrigues was saved from JULIET. However, some depression phenomena caused periods of heavy rain, the most consequential affecting the island of Mauritius, causing floods in the passage of HENNIE.

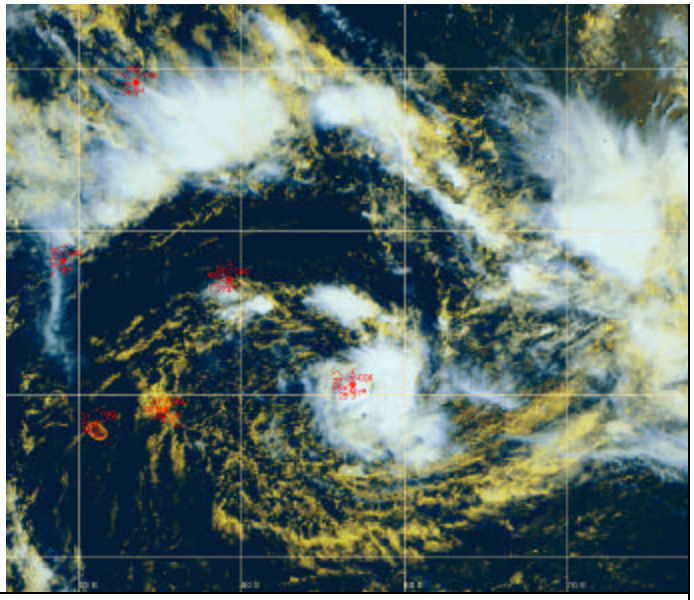
ERNEST passed directly over the island of Mayotte, but at that point it was at the beginning of its intensification phase, which had a moderate influence. This was not the case for the south of Madagascar which suffered more from the impact of the event, the centre of which touched the coast. Strong winds and floods caused by the associated strong rainfall led to an unknown number of victims (several dozen), numerous fishermen who hadn't been informed of the arrival of the cyclone had in particular been taken by surprise. The consequences of the passage of ERNEST, the floods in particular, were later made worse by the arrival of the tropical storm FELAPI only a few days later in the same geographic area.

**SUBJECT: ANALYSIS BY THE RÉUNION TROPICAL CYCLONE CENTRE (RSMC FOR THE SW INDIAN OCEAN) OF SYSTEMS GERARD ET HENNIE**

## A/ EVOLUTION OF THE HEAVY TROPICAL STORM GERARD (1-5 March 2005)

### A.1 ATYPCIAL GENESIS



The tropical depression system which would in the end become the strong tropical storm GERARD had a very slow and unusual genesis for the basin. The origin of this phenomenon was a “monsoon depression,” that is to say a vast low pressure area (towards which the trans-equatorial monsoon flow converges, from which the name comes) characterized by a very large depression circulation (around 1000 km of horizontal expansion in this case), but relatively “weak,” with in particular weak winds in the proximity of the low depression (little mentioned), the strongest winds (reaching near gale force) being localized most of all in the periphery of the depression circulation (left-hand image).

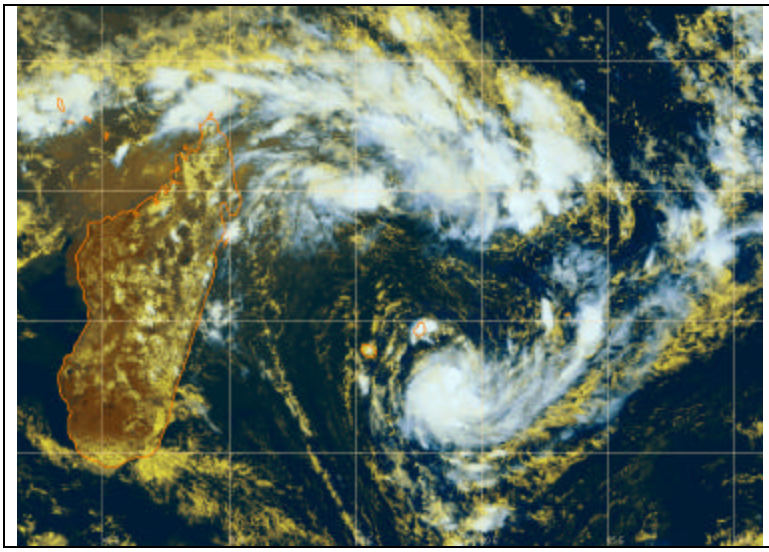
A monsoon depression is not in itself particularly dangerous, but the risk is of seeing this type of depression change structure and develop into a classic depression system (the type of a tropical storm), which has quite different characteristics, that it to say a depression circulation of a reduced size but associated with strong winds near to the centre. The change in structure that this transformation requires is not at all systematic (and is obviously not instantaneous), but it has already been possible to observe it by its past in the basin of the south-west Indian Ocean (even if this type of monsoon depression is rare there, it is a case of a very common form of genesis in the north-west Pacific).

**Situation in the south-west of the Indian Ocean on 02/02/2005 (right-hand image):**

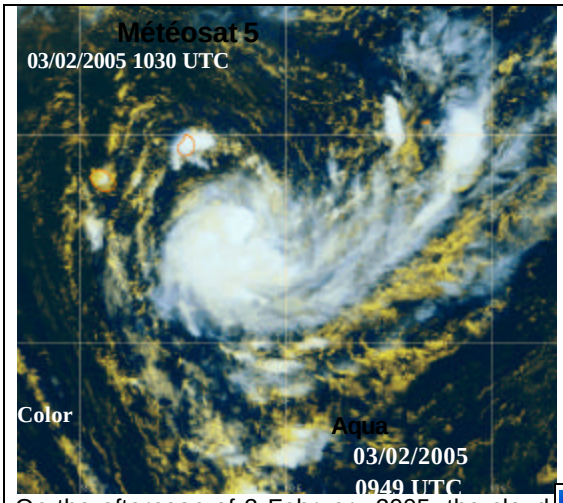
The low-pressure centre associated with the monsoon depression has just passed over the island of Rodrigues, observations of which showed a m inimum pressure value of 1002 hPa, the winds remaining weak in a large central zone.

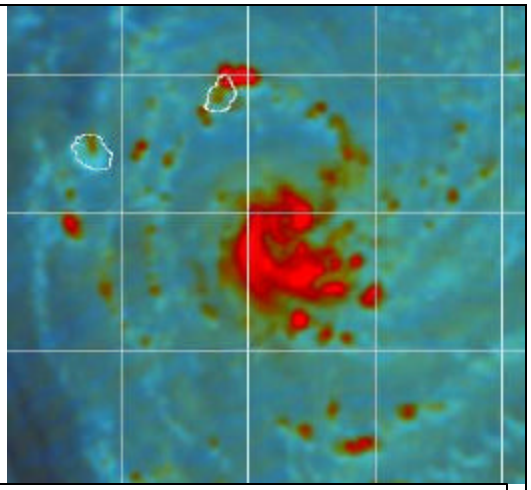
If the structure of the monsoon depression has not fundamentally developed by the following day, the appearance of a persistent convective activity near to the low-pressure centre, from then onwards it leaves the door open for a deepening of the depression and for a development towards a classic depression system, with wind strengthening at the centre.

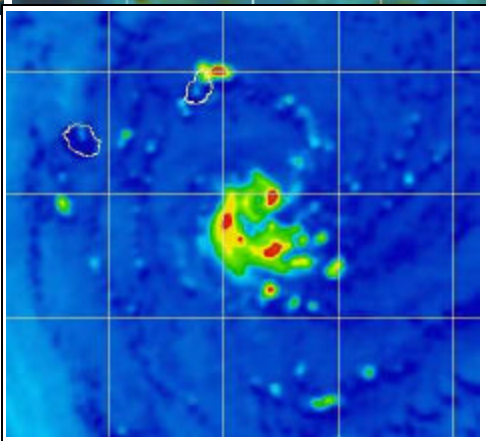
## A.2 A RAPID INTENSIFICATION IN THE MASCARENES' AREA



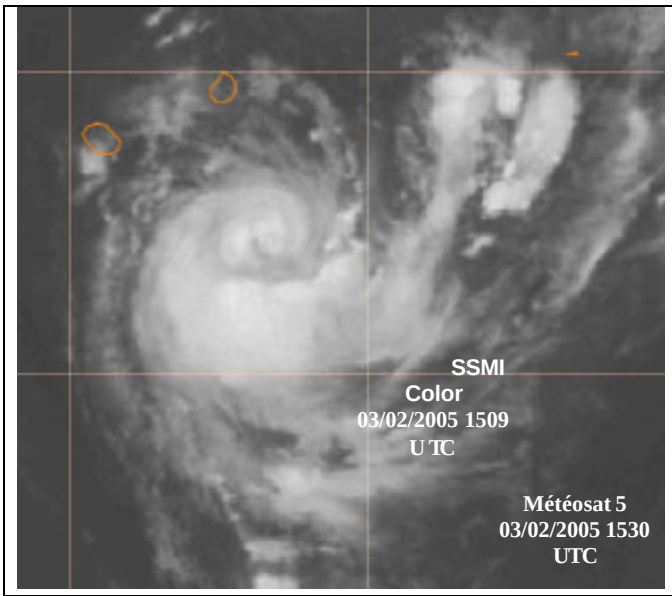
**Situation in the south-west Indian Ocean on 03/02/2005** at 1030 UTC.
Cloud and convective masses started to form around the centre location (whirlwind organization "visually" evident from then onwards on the imagery). At this stage the change of a "monsoon depression" structure type into a classic depression system can be seen as reached. The phenomenon, which can easily be seen on the image with its "umbilical cord" that originally attached it to the convective activity associated with the monsoon flow has just been cut off. It is from then onwards going to be capable of developing independently and deepening freely.

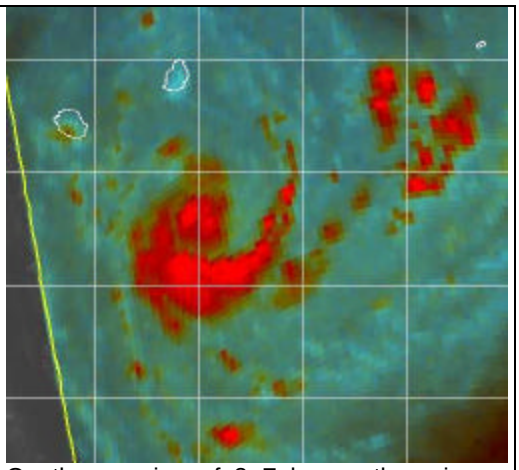


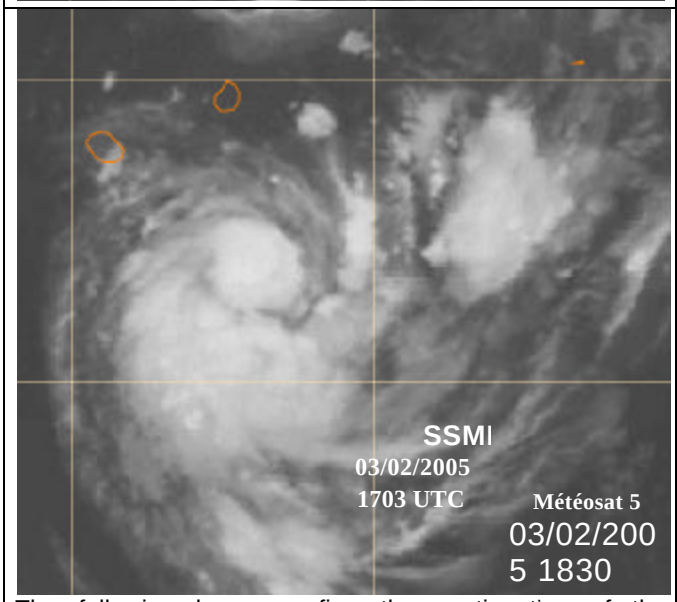


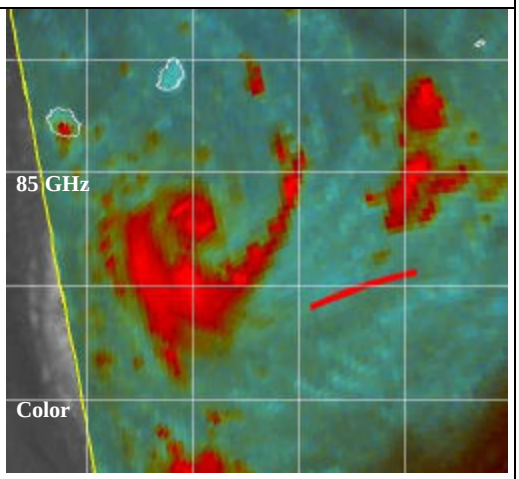

On the afternoon of 3 February 2005, the cloud system is analyzed by the RSMC in tropical depression (2.5 on the Dvorak scale of intensity).
The microwave imagery from the satellite Aqua (opposite) shows even more clearly than classic imagery that the intensification phase of the phenomenon is from then on very much under way: in addition to the small scale of the system and its curved strip structure that was already very clear, note the presence of a small area that is almost clear of rainfall identifying the centre of the depression circulation.
A microwave hallmark that is so distinct would even make one think that the stage of a tropical storm has already been reached.

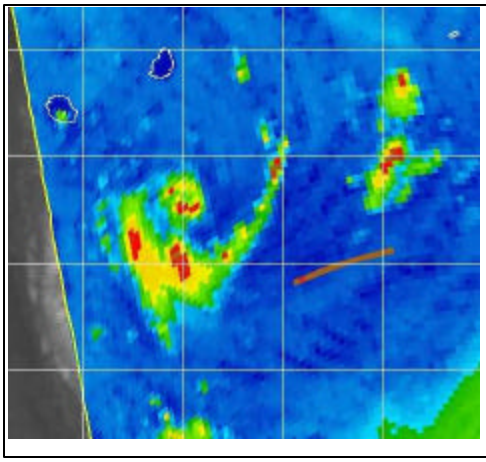


On the evening of 3 February there is no longer any doubt: the cloud configuration shown is characteristic of a moderate tropical storm (T3.0 on the Dvorak scale).



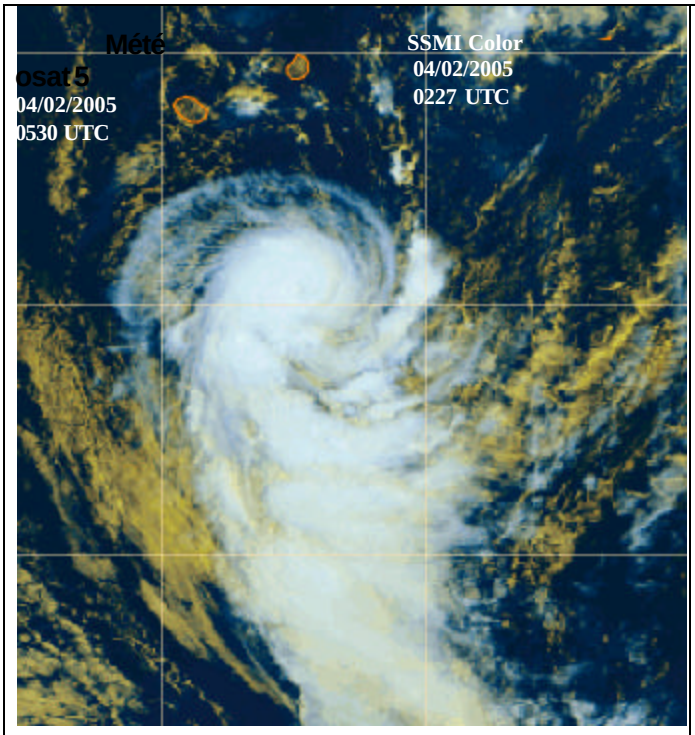



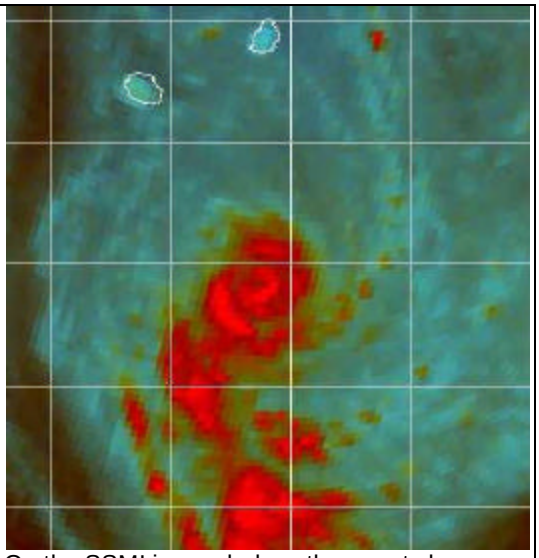



The following hours confirm the continuation of the intensification process. On both classic imagery as well as microwave imagery, the build-up is evident.

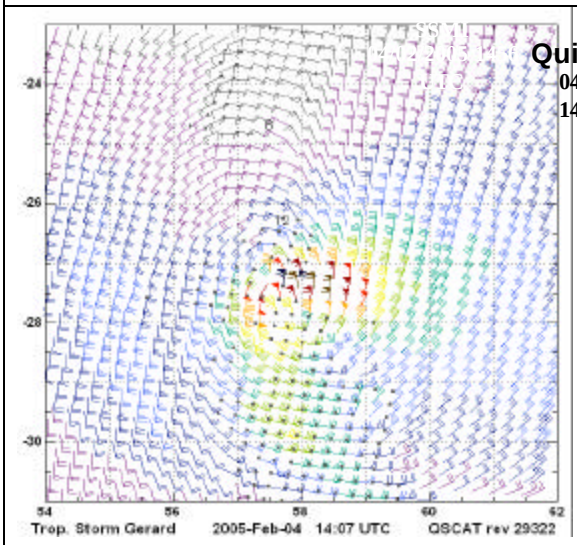
While the centre of the event passes by nearest to La Réunion (275km south-west), the microwave imagery again displays its power of investigation: despite the very poor resolution of the SSMI data, we can make out without any ambiguity the formation of an embryo of an eye within the small central dense cloud mass located at the end of the curved strip.

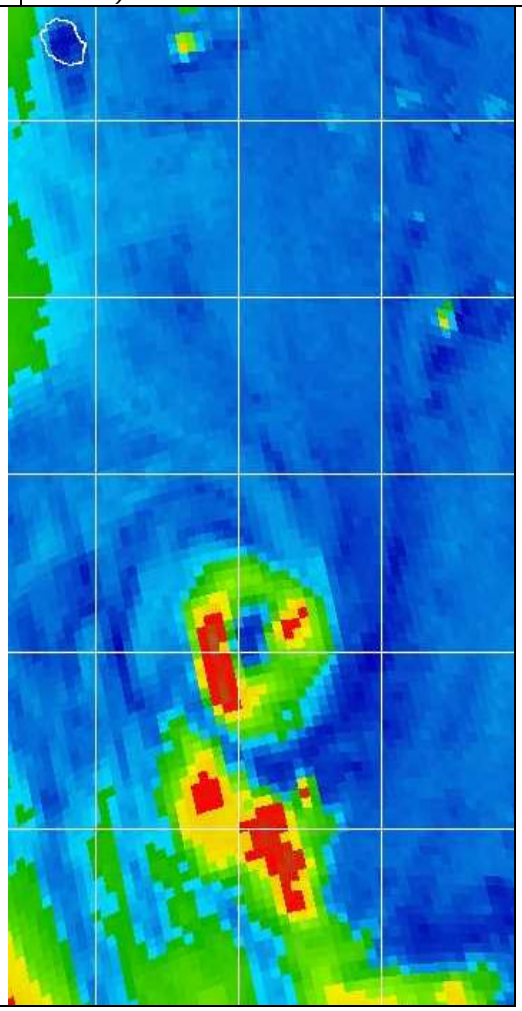
The intensity then analyzed by RSMC La Réunion was T3.0+ on the Dvorak scale at 18 UTC.



On the SSMI image below, the event shows as a clearly identifiable eye and is then analyzed by the RSMC at the later stage of a strong tropical storm (T4.0).
*(NB: GERARD was named by the Mauritius Meteorological Service on 4 February at 03 UTC).*



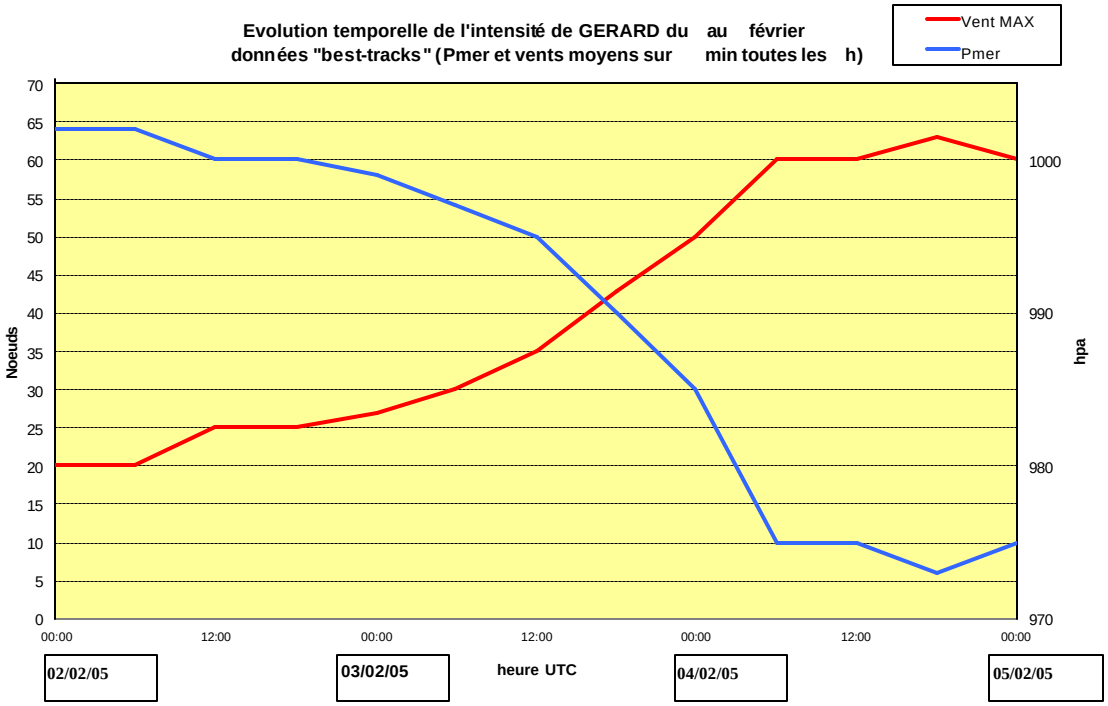



GERARD finally reaches its maximum intensity at the end of the day of 4 February. The microwave imagery shows the degree of intensity of the phenomenon, with a good eye structure (the eye which however widened).

GERARD is then on the brink of the minimum stage of a tropical cyclone (T4.5-), doubt even being allowed regarding the fact of knowing whether this threshold has been crossed. The winds coming from the data of the QuikScat scatterometer radar confirm moreover the virulence of the winds present at the centre of the event, as well as the reduced expansion of the area of strong winds associated with this small-sized system.

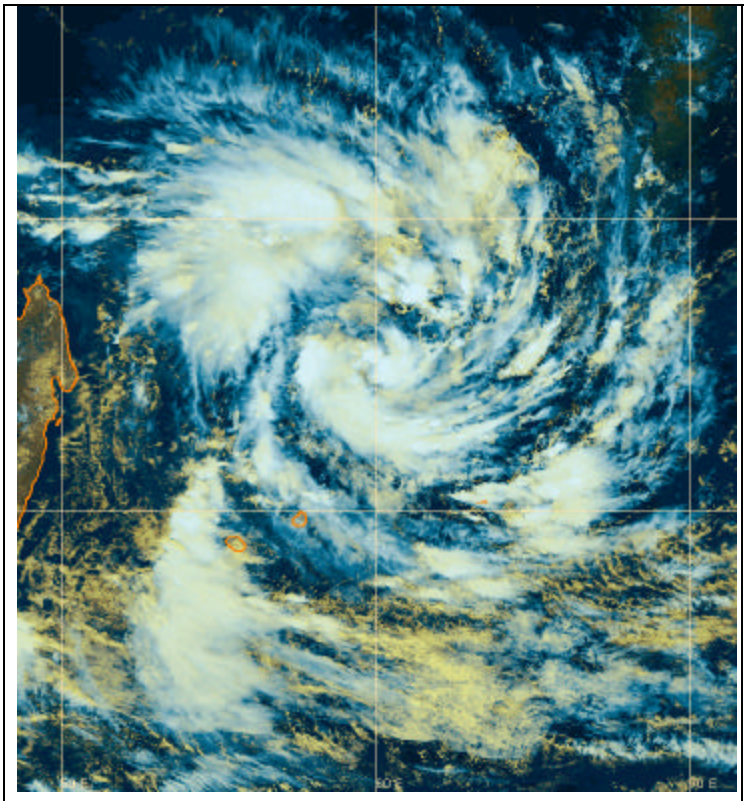
## A.3 SUMMARY OF THE DEVELOPMENT OF THE INTENSITY OF GERARD ANALYZED BY THE RSMC FROM 2-5 FEBRUARY 2005

**Temporal evolution of the intensity of GERARD from 2-5 February 2005**
**"Best-tracks" data (Pmer and medium winds in 10 min every 6hrs)**



## B/ SYSTEM HENNIE

### B.1 INTENSITY ANALYSED BY THE RSMC ON THE MORNING OF 22/03/2005



**Situation in the south-west Indian Ocean on 22/03/2005** at 0553 UTC (image NOAA 17).

*HENNIE has just been named by the Mauritius Meteorological Service at 05 UTC).*

At this time the stage of moderate tropical storm has not however yet been obviously reached: the intensity analyzed by RSMC La Réunion, according to the cloud configuration shown, indicates a Dvorak number of DT=2.0+, with a current intensity of Ci =2.5–.

The associated low depression, then located at some 200km north of the St-Brandon islets, was estimated at 998 hPa.

The stage of a moderate tropical storm is only analyzed by the RSMC about twelve hours later (see "Best-Track" data table).

### EXTRACT FROM THE "BEST-TRACKS" ANALYZED DATA FILE

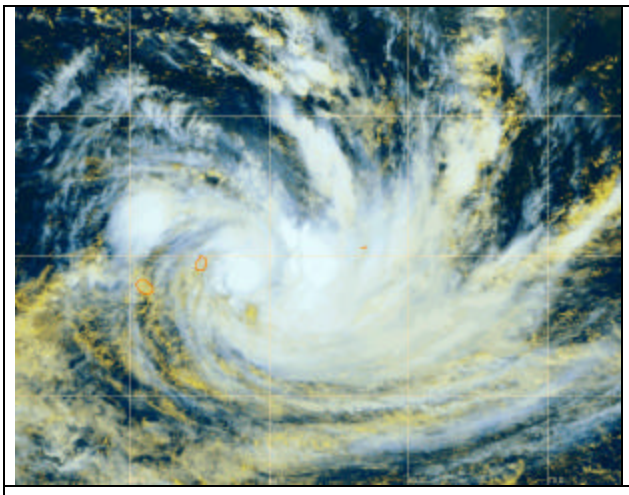
Below is a table summarizing the optimized analyzed data on HENNIE ("Best-Track" data of RSMC La Réunion) in the period examined:

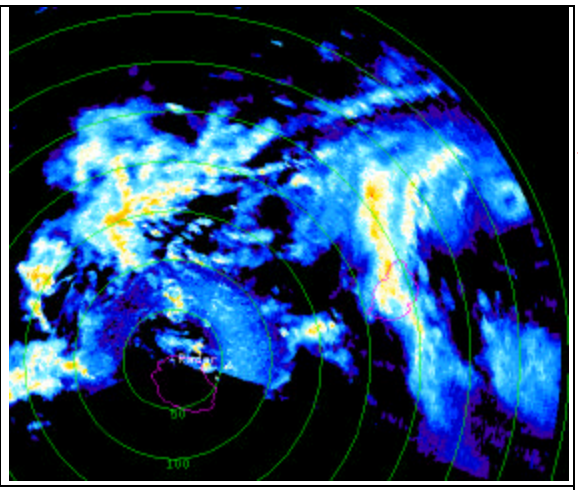
Name given by the sub-regional centre

TS Stage according to the RSMC

| Date | Time (UTC) | LAT | LON | DT (Dvorak) | CI (Dvorak) | Max Wind (10 min) | Pressure (MSLP) |
|---|---|---|---|---|---|---|---|
| 21/03/2005 | 00 | 12.2 | 64.1 | 1.5 | 1.5 | 25 | 1003 |
| 21/03/2005 | 06 | 12.9 | 63.4 | 2.0 | 2.0 | 25 | 1002 |
| 21/03/2005 | 12 | 13.7 | 62.4 | 2.0 | 2.0 | 25 | 1002 |
| 21/03/2005 | 18 | 14.2 | 61.3 | 2.0 | 2.0 | 25 | 1000 |
| 22/03/2005 | 00 | 14.5 | 60.5 | 2.0 | 2.0 | 27 | 999 |
| 22/03/2005 | 06 | 14.8 | 59.8 | 2.5 | 2.5 | 30 | 998 |
| 22/03/2005 | 12 | 15.3 | 59.0 | 2.5 | 2.5 | 30 | 997 |
| 22/03/2005 | 18 | 15.7 | 58.8 | 2.5 | 2.5 | 33 | 996 |
| 23/03/2005 | 00 | 16.1 | 58.8 | 2.5 | 2.5 | 35 | 994 |

## B.2 TRACK ANALYZED BY THE RSMC ON 24/03/2005





An eye of a little less than 25km in diameter is perfectly visible on the edge of the acquisition scope of La Réunion's radar (cf. image above right) and allows us to localize the centre of HENNIE without any ambiguity.
These data are available in real time, in the RETIM-Africa distribution received by all the services in the area.

| Time | RSMC (real time) | RSMC ("Best-Track") |
|---|---|---|
| 00 | 19.4 S / 58.6 E | 19.5 S / 58.7 E |
| 06 | 20.4 S / 59.0 E | 20.5 S / 58.9 E |
| 12 | 21.3 S / 58.8 E | 21.3 S / 58.6 E |
| 18 | 21.8 S / 58.9 E | 21.8 S / 58.8 E |

Table of the positions of the centre of HENNIE as analyzed by RSMC La Réunion from the radar data (positions given in real time and "Best Track" finalized positions)

**SUBJECT: CRITICAL EXAMINATION OF THE WORKING OF THE SYSTEMS COORDINATED IN ACTUAL OPERATING CONDITIONS**

## A/ GERARD EPISODE

### A.1 CHRONOLOGY OF THE CONTACT BETWEEN RSMC LA RÉUNION AND THE MAURITIUS SUB-REGIONAL CENTRE AT THE TIME OF THE "GERARD" EPISODE

- Morning of 3 February 2005: at 06 UTC, the RSMC issues advisory No. 22 on system 12, naming it a tropical depression 997 hPa (therefore an intensification in relation to the previous advisory of 00 UTC, where it was analyzed as a tropical disturbance 1000 hPa).

- Afternoon of 3 February: before the 12 UTC network, the RSMC contacts the Mauritius sub-regional centre by telephone. In view of the recent satellite imagery, RSMC La Réunion indicates that it considers that it is likely that the stage of moderate tropical storm has been reached, analyzing the intensity of the system slightly above 2.5 on the Dvorak scale (DT=2.5+), with a tendency to continue to intensify.

The Mauritius sub-regional centre replies that it does not agree with this analysis and that it consequently does not want to name the system at 12 UTC (NB at the previous synoptic network of 06 UTC, the Mauritius sub-regional centre analyzes the system at the stage of tropical depression and in its satellite analysis advisory ATIO20 it announced it to be 2.5 of Dvorak intensity, also mentioning "DEVELOPING" in the additional indications field).

- Afternoon of 3 February: With a view to making a compromise, the RSMC agrees with good grace to temporize and, in wait for indubitable elements allowing it to validate the cross-over to the stage of being a moderate tropical storm, agrees to defer and therefore to keep the system at the stage of being a tropical depression (996 hPa) in its advisory No. 23 of 12 UTC, therefore keeping to the announcement of near gale (Beaufort Force 7) in its marine advisory, with the aim of maintaining consistency within the whole system of meteorological information.

- End of the afternoon of 3 February (about 13 UTC): In view of the last images and more particularly the microwave data received in the meantime (images available on the Internet, but at a time delay) the Chief Forecaster of cyclones of RSMC La Réunion (Ph. Caroff) mentions the Mauritius Meteorological Service for, on one hand, repeating, with a degree of confidence then onwards important, that the stage of a moderate tropical storm has according to them been reached and on the other hand for ensuring that there would not be a problem in naming the system at the next network of 18 UTC if the evolution continued.

The forecaster of the Mauritius sub-regional centre who has just taken over from the forecaster that day replies that: "The Mauritius Meteorological Service doesn't give the night a name..."
In view of this reply, Ph. Caroff asks to talk to a director. The person he speaks to replies that the Director is not available at that moment.

- End of the day of 3 February (about 14 UTC): Telephone call of Mr. Sok Appadu, Director of the Mauritius Meteorological Services. A long fifteen-minute discussion ensues with Ph. Caroff, in which each of them holds their ground.
Mr. Sok Appadu says that he analyzes the Dvorak intensity of system 12 at 2.0 or 2.5 - at the very most.

Mr. Caroff points to the discrepancy in refusing to name a phenomenon that the Mauritius Meteorological Services moreover calls a "tropical storm." For the whole day in its meteorological advisories "Grand Public" that are available on the Internet, the Mauritius

Meteorological Services talked of the "tropical storm" (that wasn't just the case in the advisory of 16hrs local (12 UTC), but already in the one dated 4hrs local (00 UTC), that morning of 3 February).

Mr. Sok Appadu answers that it wasn't a case of a discrepancy and that a "tropical storm" and a "moderate tropical storm" should not be confused. In the face of the surprise and incomprehension expressed by the person he is talking to, he even adds that this ''new name" "tropical storm" (simple, if it can be said) was introduced at the time of the last Cyclone Committee held in Maputo in 2003, this stage of intensity lying between tropical depression and moderate tropical storm.

Ph. Caroff replies that as far as he could remember that point had been mentioned at some point in Maputo and that that new stage of intensity didn't figure in the Operational Plan in force. He concludes the discussion by saying that he does not agree with the new refusal to name the system and deplores the fact that the intensity of the system analyzed and given by the RSMC would then not be coherent with the "not naming the system" principle adhered to by the sub-regional centre.

- Night of 3-4 February: In view of the evolution shown by the system 12 (obvious and rapid intensification) and in accordance with their analyses of the intensity of the phenomenon, the RSMC gives notice in its advisory No. 24 of 18 UTC of wind of 35/45 knots for the "moderate tropical storm 12 (990 hPa)" then at 00 UTC notice of a storm of 50 knots (Beaufort Force 10) for the "strong tropical storm 12 (985 hPa)."

NB: It is unthinkable for RSMC La Réunion to potentially endanger marine users by giving advice of a near gale of 30 knots (Beaufort Force 7), obviously underestimated, on the pretext of deliberately holding back the true facts, the intensity of the system at the stage of tropical depression, simply with a view to being consistent with the Mauritius sub-regional centre not giving the system a name, when storm force winds are thought to be at the centre of the disturbance.

- Start of the day of 4 February: The RSMC receives a fax from the Mauritius sub-regional centre only announcing the name of GERARD at 03 UTC.

- Morning of 4 February: The RSMC issues, in its advisory No. 26 of 06 UTC, advice of a storm of 50/60 knots (Beaufort Force 10-11) for the "strong tropical storm 12 (GERARD) 975 hPa." It is therefore at this time and stage that the name GERARD appears for the first time in official advisories for marine or other users.

## A.2 "BEST-TRACK" REMINDER OF THE ANALYZED DATA

Below is a table summarizing the optimized analyzed data of GERARD ("Best-Track" data of RSMC La Réunion) in the period concerned:

**TS Stage according to the RSMC** →

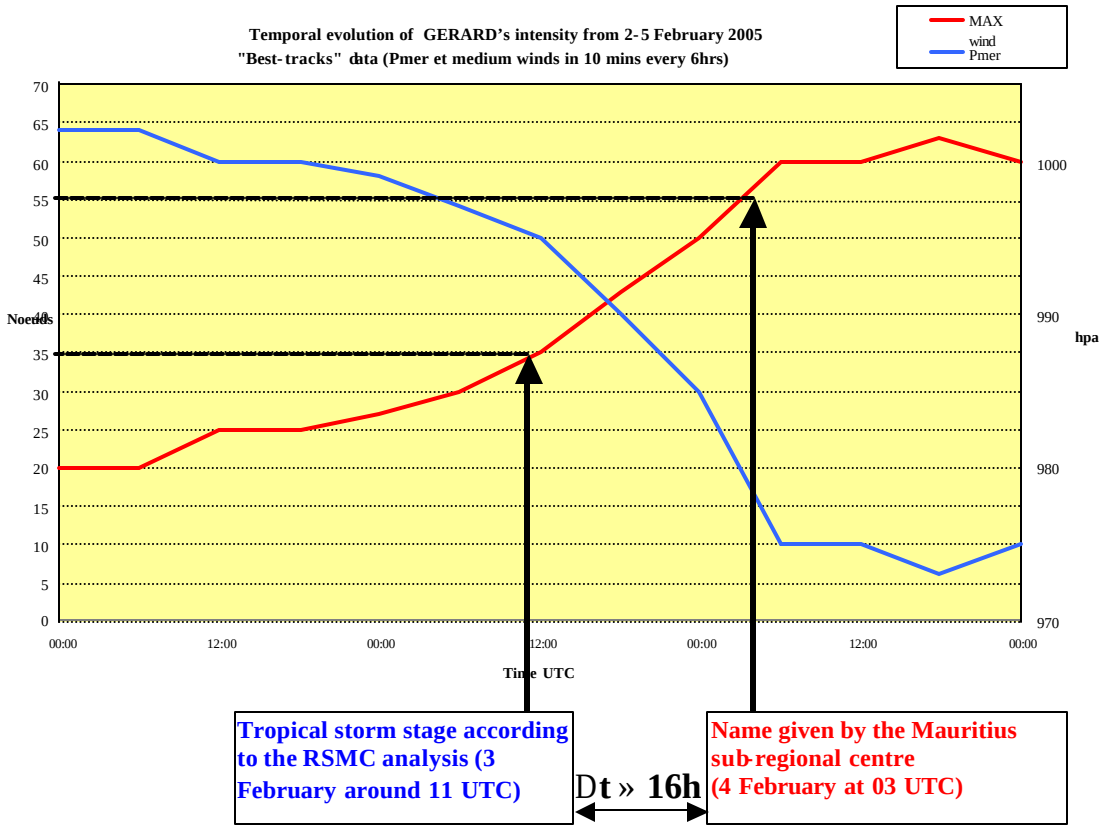
**Name given by the sub-regional centre** ⇢

| Date | Time (UTC) | LAT | LON | DT (Dvorak) | CI (Dvorak) | Max Wind (10 min) | Pressure (MSLP) |
|---|---|---|---|---|---|---|---|
| 03/02/2005 | 00 | 21.3 | 60.4 | 2.0 | 2.0 | 27 | 999 |
| 03/02/2005 | 06 | 21.8 | 59.5 | 2.5 | 2.5 | 30 | 997 |
| 03/02/2005 | 12 | 22.2 | 58.4 | 2.5 | 2.5 | 35 | 995 |
| 03/02/2005 | 18 | 22.9 | 58.0 | 3.0 | 3.0 | 43 | 990 |
| 04/02/2005 | 00 | 23.8 | 57.6 | 3.5 | 3.5 | 50 | 985 |
| 04/02/2005 | 06 | 24.9 | 57.6 | 4.0 | 4.0 | 60 | 975 |
| 04/02/2005 | 12 | 26.7 | 57.9 | 4.0 | 4.0 | 60 | 975 |
| 04/02/2005 | 18 | 28.8 | 58.4 | 4.0 | 4.5 | 63 | 973 |

There was therefore a delay of almost 18hrs between the moment when the RSMC considered the stage of tropical storm (threshold of 34 knots in medium winds) to have been reached and the moment when the Mauritius sub-regional centre gave it a name.

At the moment when the naming took place, the RSMC estimated medium winds of 55 knots (storm force) to be present near the centre (it recalls that hurricane force – 12 Beaufort – begins at 64 knots, corresponding with tropical cyclone stage).

These elements are synthesized in the following evolution graph.




## A.3 CONSEQUENCES OF THIS CONFLICT OF OPIIONS AT THE TIME OF THE "GERARD" EPISODE

Before the name GERARD is finally given, on the morning of 4 February, it is therefore an unnamed strong tropical storm that was developing in the basin, in the southern sector to the south-east near to the islands of Mauritius and La Réunion. Moreover, for a tropical depression system of such intensity not to be named is unprecedented in the recent history of the basin.

Other than the fact that it could have put maritime users in danger if the RSMC had not acted independently from not naming the system, this lack of a name generated great confusion at media and general public level, in La Réunion in particular. They did not legitimately understand what was happening and why people were talking about a "tropical storm" without a name for the first time in Mauritius while RSMC La Réunion was at the same time talking of a tropical depression, before it passed on to being a moderate then strong tropical storm, without a name to begin with, then ending up being called GERARD.

Such disaccord is very regrettable for several reasons as it:

- Ruins all credibility among users, logically inclined to question to what extent they can trust the meteorological services to be able to deliver information when it seems that it is completely inconsistent.

- Unsettles as a result the whole prevention and cyclone alert system, its effectiveness being very much dependent upon the trust that local authorities and the general population have in the words of the meteorological services that are in charge of alerting them.

- Destroys the years of communication and teaching spent trying to teach the basic notions of the terminology associated with the different stages of development in tropical depression systems in *Grand Public*. How can we hope to make people understand the difference between a tropical depression and a tropical storm when the meteorologists, instead of making matters clear, seem to be trying their best to confuse them and adding to the confusion?

## B/ HENNIE EPISODE

The operational management of the depression system No. 16 (the future tropical storm HENNIE) also created significant problems in terms of the functioning of coordinated systems.

In addition to the anticipated name (with regard to the technical criteria for naming), contradictory information on the track was also given by the RSMC on the one hand and the Mauritius sub-regional centre on the other, when the storm is crossing in the sector near to the island of Mauritius which was able to bring about the doubt and confusion in the minds of the media and public, with obvious negative consequences for the general credibility of the cyclone information system implemented in the basin.

### B.1 CHRONOLOGY OF THE CONTACTS BETWEEN RSMC LA RÉUNION AND THE MAURITIUS SUB-REGIONAL CENTRE

- Morning of 21 March 2005: Mr. Beebeejaun of the Mauritius sub-regional centre contacts RSMC La Réunion by telephone and asks to talk to Ph. Caroff (operational head of the RSMC). Having discussed the day's situation, he clearly states his service's intentions: "in view of the fact that the system is moving closer to Saint-Brandon and its predicted track, which is quite threatening, we would like to give the system a name tomorrow, even if it is only at the stage of tropical depression..."

He adds that he will be in regular contact to take stock of the situation.

- End of the night of 21-22 March: RSMC sends out on the network of 00 UTC advisory No. 4 on system 16, classing it a tropical depression (997 hPa) for the first time.
Telephone call of the service forecaster of the Mauritius sub-regional centre to the service forecaster of RSMC La Réunion at 0045 UTC (see below).

- Morning of 22 March: The RSMC receives a fax from the Mauritius sub-regional centre announcing the naming of HENNIE at 05 UTC.

- Morning of 22 March: Following receipt of this fax and surprised that there hadn't been a discussion and prior consultation before the system had been named, Ph. Caroff telephones Mr. Beebeejaun to get some explanations and find out why he hadn't called him first, as he had seemed to be intending to do the previous day.
He replies to him that he hasn't done it because: "the service forecasters of the previous night had already agreed to name the system".

After information has been obtained from the RSMC service forecaster of the previous night, it appears that there has been at the very least a misunderstanding, as the person denies any such agreement about naming the system. After he has been called by his Mauritian counterpart after the network of 00 UTC, he simply says that he took stock of it in his analysis of the situation and added that he would have to see the development of the start of the day as far as the following network was concerned.

- Morning of 22 March : at 06 UTC, in accordance with its own analysis of the situation, RSMC La Réunion publishes advisory No. 5 on "tropical depression 16 (HENNIE) 998 hPa ".

- Beginning of the afternoon of 22 March : Telephone call of Mr. Beebeejaun stating his Director's dissatisfaction at the fact that the RSMC hadn't called HENNIE a moderate tropical storm on the network of 06 UTC.

- Afternoon of 22 March : on the network of 12 UTC, the RSMC issues its advisory No. 6 on the "tropical storm 16 (HENNIE) 995 hPa," but in this case it is a matter of a more "politically" biased intensity (history of not aggravating further relations with the Mauritius sub-regional centre), based on the intensity really analyzed by the RSMC (which will be maintained, in a final optimized analysis "Best Track" at the stage of tropical depression at that time, the stage of moderate tropical storm only being seen as reached after 18 UTC network – see table below).

## B.2 PREMATURE NAMING

Below is a table summarizing the optimized analyzed data on HENNIE ("Best Track" data of RSMC La Réunion) in the period under consideration:

**Name given by the sub-regional centre**

**TS Stage according to the RSMC**

| Date | Time (UTC) | LAT | LON | DT (Dvorak) | CI (Dvorak) | Max Wind (10 min) | Pressure (MSLP) |
|---|---|---|---|---|---|---|---|
| 21/03/2005 | 00 | 12.2 | 64.1 | 1.5 | 1.5 | 25 | 1003 |
| 21/03/2005 | 06 | 12.9 | 63.4 | 2.0 | 2.0 | 25 | 1002 |
| 21/03/2005 | 12 | 13.7 | 62.4 | 2.0 | 2.0 | 25 | 1002 |
| 21/03/2005 | 18 | 14.2 | 61.3 | 2.0 | 2.0 | 25 | 1000 |
| 22/03/2005 | 00 | 14.5 | 60.5 | 2.0 | 2.0 | 27 | 999 |
| 22/03/2005 | 06 | 14.8 | 59.8 | 2.5 | 2.5 | 30 | 998 |
| 22/03/2005 | 12 | 15.3 | 59.0 | 2.5 | 2.5 | 30 | 997 |
| 22/03/2005 | 18 | 15.7 | 58.8 | 2.5 | 2.5 | 33 | 996 |
| 23/03/2005 | 00 | 16.1 | 58.8 | 2.5 | 2.5 | 35 | 994 |

## B.3 INFORMATION GIVEN ON THE TRACK: SOURCE OF CONFUSION

The RSMC are responsible for issuing top level information on tropical depression systems developing in their area of responsibility. This information that is based on the positions and intensities analyzed and forecast for disturbances is given to the international media and community. Produced in the form of advisory bulletins to national meteorological services, they are a way of helping them to find out about the threat represented by a depression system, in the knowledge that the sole responsibility of these meteorological services is to issue appropriate advisories or to manage the associated alerts on their national territory.

In this context, which is not known to be called into question, it appears that it is desirable for there to be maximum consistency between information issued, by the RSMC on one hand and by national meteorological services on the other, which can seriously affect the readability and credibility of cyclone information.
This is what the HENNIE episode illustrated very clearly.

The table below shows a comparison of the positions of the centre of HENNIE as analyzed by RSMC La Réunion from the radar data (finalized "Best Track" positions) and the positions issued by the Mauritius sub-regional centre on 24 March 2005. The corresponding tracks are represented opposite ("Best Track" in green, track seen by Mauritius NMS in black).

| Time | RSMC ("Best-Track") | Mauritius NMS | Distance (km) |
|---|---|---|---|
| 00 | 19.5 S / 58.7 E | 19.0 S / 58.2 E | 76 |
| 06 | 20.5 S / 58.9 E | 20.0 S / 58.1 E | 100 |
| 12 | 21.3 S / 58.6 E | 21.2 S / 58.1 E | 53 |
| 18 | 21.8 S / 58.8 E | 21.8 S / 58.1 E | 72 |

D= 100 km on 24/03/05 at 06 UTC.

The excessively contradictory nature of the information issued by the RSMC and by the Mauritius Meteorological Services on the position and the track of the storm (with a difference in positioning reaching up to 100km), led to confusion and doubts about the credibility of this information in the minds of the media and people.

This is what clearly shows through in the following extract from the article in the newspaper Le Mauricien dated 25 March, where the journalist openly questions the validity of the information given by the Mauritius Meteorological Services: "at about 10 hrs yesterday gusts and showers markedly decreased, starting a period of relative calm that would last several hours. It was calm due to several reasons according to the meteorological services: an interval between two cloud strips and a reduction in the diameter of the most active area of Hennie. It was an explanation that didn't convince everyone, with some finding out that Hennie's track as given by other meteorological services during this period is different to that given by the Mauritian services."

Since people have wide and immediate access to information issued by the audiovisual media, the harmful consequences of all flagrant inconsistency are exaggerated.

_____

APPENDIX IV

## REPORTS OF THE MEMBERS AFFECTED BY TROPICAL CYCLONES

### REVIEW OF THE 2003–2004 AND 2004–2005 CYCLONE SEASONS IN MADAGASCAR

*(Submitted by Madagascar)*

Review of the 2003–2004 and 2004–2005 cyclone seasons in MADAGASCAR
*Submitted by*

**Alain Solo RAZAFIMAHAZO**
Director of Meteorological Operations

### 2003–2004 CYCLONE SEASON

The 2003–2004 cyclone season in Madagascar was one of intense activity, with three cyclonic disturbances affecting the island.

- Tropical Cyclone *Cela* made landfall in the Vohémar district of Madagascar and then headed out to sea in the Mozambique Channel, travelling along the entire western coast of the island, where it caused abundant rainfall.
- Owing to the nature of its track, Tropical Cyclone *Elita* ravaged several regions of the island, and in particular the town of Mahajanga, given that it travelled across Madagascar three times.
- Tropical Cyclone *Gafilo* travelled across the country twice and hammered the town of Antalaha when it made landfall.

Therefore, this season had catastrophic effects in Madagascar.

TROPICAL *CYCLONE*

# C E L A

From 05.12.03 to 21.12.03

## I – TRACK AND DEVELOPMENT

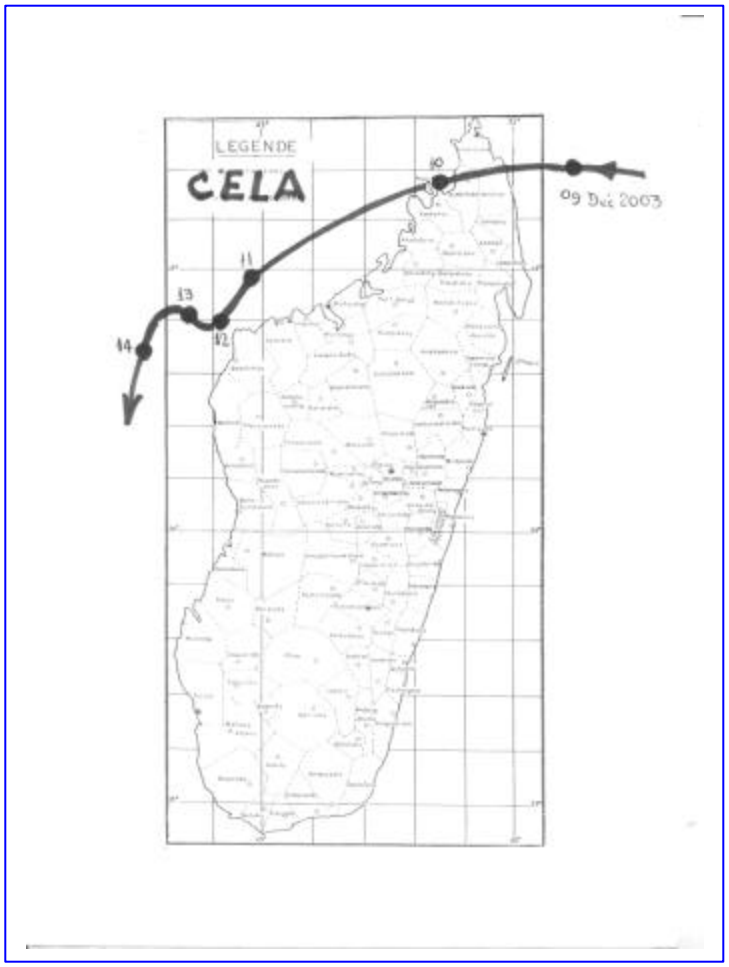
This cyclonic disturbance formed in the Indian Ocean on 05/12/03 at 0600 UT 1 350 km north-east of Antsiranana. The system lost some of its intensity on 06 and 07/12/03, but re-intensified markedly on 08/12/03. At 0600 UT, the system became a moderate tropical storm and was named *Cela*. It was centred 550 km east of Vohémar. *Cela* travelled west and made landfall in the Vohémar district before heading out to sea in the Mozambique Channel when it reached the Ambanja district.

## II – CHARACTERISTICS

The following were recorded during its passage:

- 116.5 mm of rainfall in 24 hours in Vohémar on 09/12/03
- 140.6 mm of rainfall in 24 hours in Nosy-be on 09/12/03
- 316.8 mm of rainfall in 24 hours in Morombe on 16/12/03
- 184 km/h gusts of wind in Vohémar on 09/12/03

## III – TRACK



TROPICAL *CYCLONE*

# E L I T A

From 26.01.04 to 11.02.04

## I – TRACK

Tropical Cyclone *Elita*, which was the fifth cyclonic disturbance of the 2003–2004 season, formed in the Mozambique Channel on 27/01/04 off Maintirano. After travelling north-west and then turning in a south-westerly direction, it intensified and became a tropical cyclone just one hundred or so kilometres west of Mahajanga. *Elita* then violently struck the town of Mahajanga during the afternoon of 28/01/04 with gusts of wind of over 180 km/h. The centre of Tropical Cyclone *Elita* made landfall at Bombetoka Bay at around 5 p.m. local time.

It crossed the island from west to east and headed out to sea in the Indian Ocean to the south of the town of Vatomandry, and had become less intense.

Pushed by the Mascareignes' anticyclone, *Elita* moved west and crossed the island once again travelling from east to west heading out over the Mozambique Channel north of Morondava. The system was in a tropical storm phase when it crossed the island for the second time, with moderate winds.

After having remained almost stationary for several hours off Maintirano, *Elita* made a loop in a south-westerly direction, re-intensified and once again made landfall to the south of the town of Belo-Tsiribihina with gusts of wind of up to 180 km/h. Its third passage ended in the fivondronana of Vohipeno, where it headed out to sea in the early morning of 04/02/04.

> *It should be noted that since 1960,* Elita *is the third cyclonic disturbance to travel across Madagascar three times, with the other two being Cyclone* Felicie *in January 1971 and Storm* Justine *in March 1982.*

## II – CHARACTERISTICS

The following were recorded during its passage:

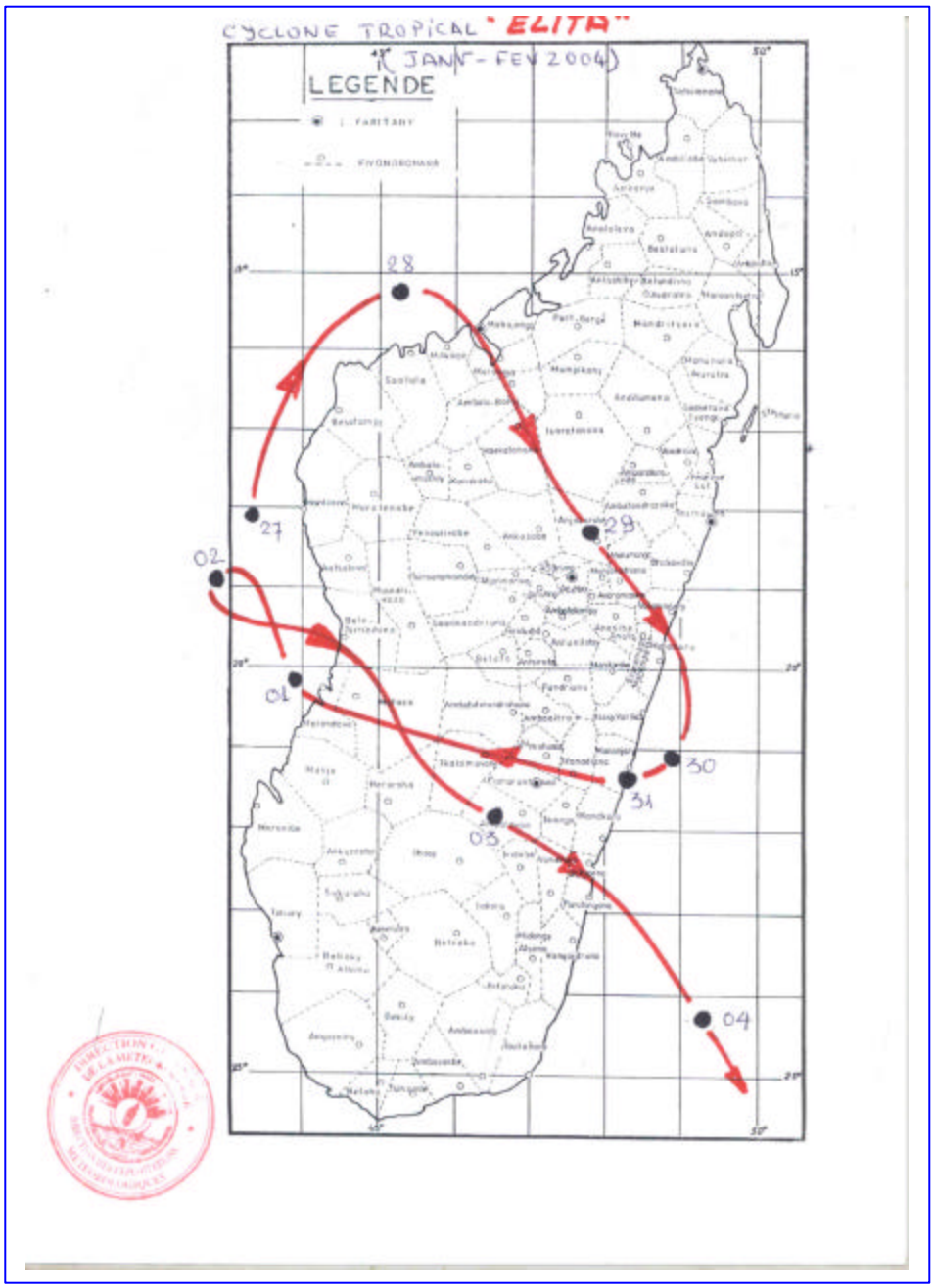
- 153.8 mm of rainfall in 24 hours in Mahajanga on 27/01/04
- 222 mm of rainfall in 24 hours in Antsohihy on 27/01/04
- Gusts of wind were observed as follows:
  - >180 km/h in Mahajanga
  - 100 km/h in Morondava
  - 90 km/h in Fianarantsoa
  - >80 km/h in Antsirabe

## III – DAMAGE STATISTICS *(Source CNS: Conseil National de Secours – Assessment of 26/02/04)*

- 33 people killed
- 4 missing
- 129 injured
- 55 983 homeless
- 10 438 buildings damaged

- 90% of the town of Maintirano was damaged
- 80% of the town of Soavinandriana was damaged

**IIV – <u>TRACK</u>**



**VERY INTENSE TROPICAL CYCLONE**

# G A F I L O

From 03.03.04 to 12.03.04

## I – TRACK

Very intense Tropical Cyclone *Gafilo* was one of the strongest and most notorious to have affected Madagascar during the last twenty years, joining the likes of *Kamisy* (April 1984), *Honorinina* (March 1986), *Geralda* (February 1994), *Nadia* (March 1994) and *Hudah* (March 2000).

This tropical phenomenon formed on 3 March 2004 in the Indian Ocean 1 400 km off Sambava, and headed west-south-west whilst growing more intense and becoming a very intense tropical cyclone with a minimum central pressure of 900 Hpa at sea.

Following its movement in a westerly direction, *Gafilo* violently hit the town of Antalaha with gusts of wind of 250 km/h. The well-defined eye of the cyclone made landfall to the south of the town on 7 March 2004 at around 4.30 a.m. local time.

Given the diameter of the system (around 400 km) and the length of its spiral bands that created frequent and strong gusts of wind, several regions in four provinces (Antsiranana, Toamasina, Mahajanga and Antananarivo) sustained considerable damage caused by strong gusts of wind, torrential rainfall and storm surges.

## II – CHARACTERISTICS

The following gusts of wind were observed during its passage:

- 250 km/h in Antalaha on 07/03/04
- 180 km/h in Sambava on 07/03/04
- 170 km/h in Vohémar on 07/03/04
- 160 km/h in Mahajanga on 08/03/04
- 135 km/h in Maintirano on 09/03/04

Furthermore, the following were recorded in 24 hours

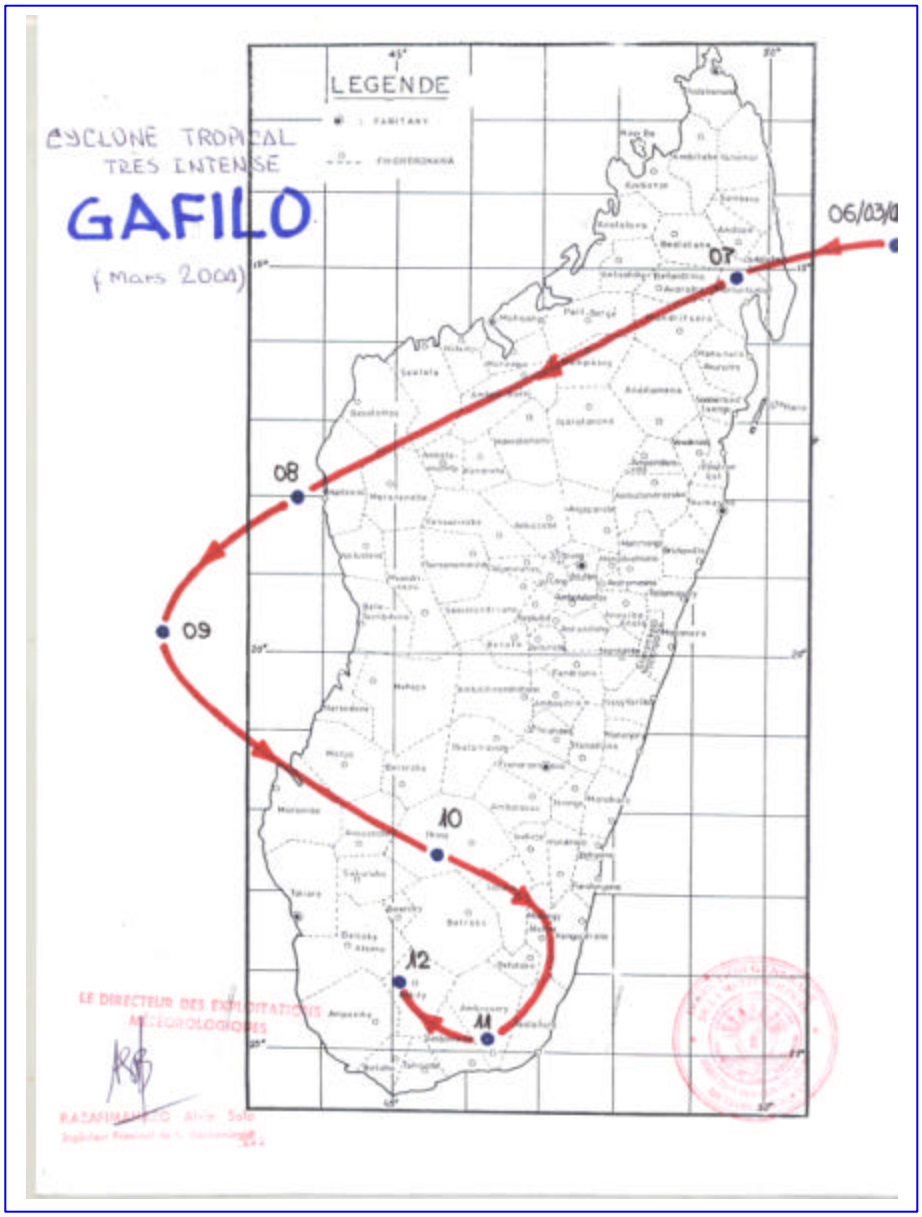
- 98.8 mm of rainfall in Sambava on 06/03/04
- 64.5 mm of rainfall in Vohémar on 06/03/04
- 123.7 mm of rainfall in Antsiranana on 06/03/04
- 255.4 mm of rainfall in Nosy-be on 07/03/04
- 125.5 mm of rainfall in Antsohihy on 07/03/04
- 138.6 mm of rainfall in Besalampy on 08/03/04
- 108.0 mm of rainfall in Morombe on 10/03/04
- 238.4 mm of rainfall in Morondava on 11/03/04

## III – DAMAGE STATISTICS *(Source CNS: Conseil National de Secours – Assessment of 25/03/04)*

- 217 people killed
- 170 missing
- 886 injured
- 245 859 homeless

- 97 369 buildings damaged
- 594 infrastructures/installations damaged
- 32 106 Ha of agricultural land/crops destroyed
- 1 860 cattle/livestock

## IV – **TRACK**



**V – Some photographs – the Antalaha station**

## 2004–2005 CYCLONE SEASON

Of the 10 cyclonic disturbances to develop in the south-west Indian Ocean basin, two affected the weather in Madagascar, namely intense Tropical Cyclone *Ernest* and moderate Tropical Storm *Felapi*. These two cyclonic disturbances made landfall in south-western regions of Madagascar. Furthermore, two heavy rainfall events affected several regions of the island.

INTENSE
*TROPICAL CYCLONE*

**E R N E S T**
From 17.01.05 to 25.01.05

**I – TRACK**

On 17/01/05 the fifth cyclonic disturbance of the 2004–2005 cyclone season formed in the Indian Ocean at 9°5S/57°6E, namely 150 km north-east of Agalega and was named *Ernest.*

The system moved in a general westerly direction. On 19/01/05, the centre was observed at 325 km north-west of Antsiranana. On 20/01/05, *Ernest* moved west-south-west and was located 50 km north-east of the Comoros, namely 400 km north-west of Mahajanga.

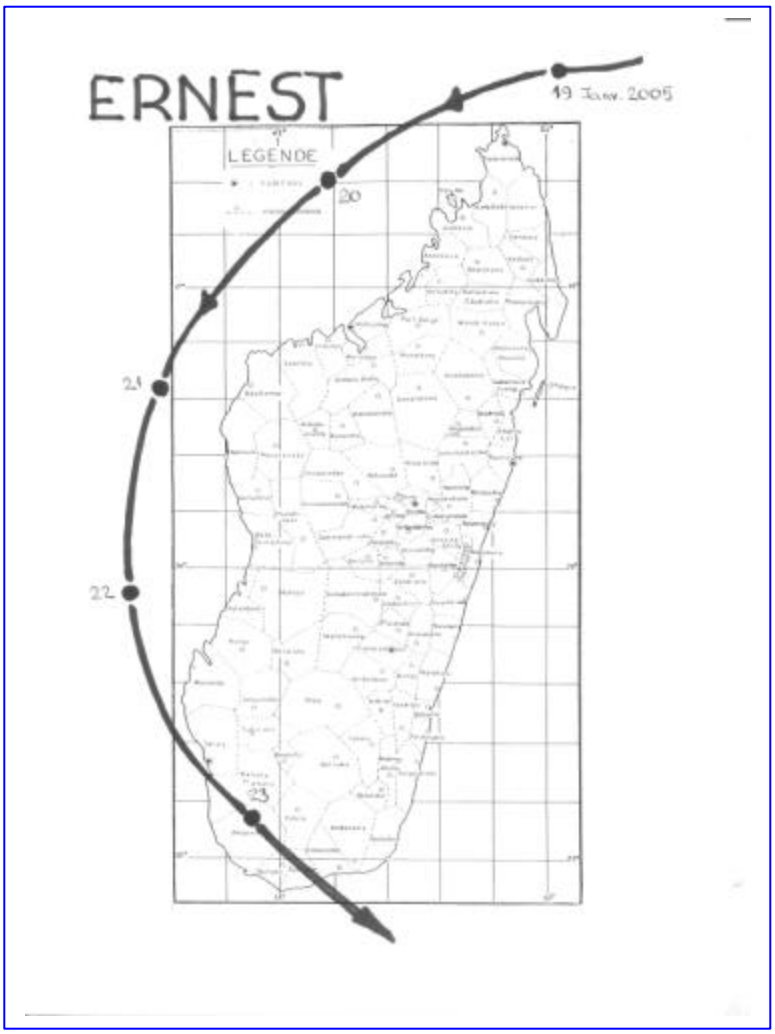
On 21/01/05, the system started to move south, skirting round the south of Madagascar, and on 23/01/05 it brushed the south-west coast of the island over the town of Itampolo in the Toliara district. *Ernest* then quickly moved away towards the south-east and dissipated on 25/01/05 1700 km south-east of Taolagnaro.

## II – CHARACTERISTICS

The following were observed during its passage:

- 237.2 mm of rainfall in 24 hours in Toliara on 22/01/05
- 56 mm of rainfall in 24 hours in Besalampy on 21/01/05
- The following gusts of wind were observed:
  - 180 km/h in Toliara
  - 48 km/h in Morondava
  - 90 km/h in Fianarantsoa
  - 40 km/h in Ranohira

## III – TRACK



MODERATE
*TROPICAL STORM*

# F E L A P I

From 27.01.05 to 29.01.05

## I – TRACK

From a zone of disturbed weather, the sixth cyclonic disturbance of the 2004–2005 season formed in the Mozambique Channel on 27/01/05 at 1800 UT 225 km north-west of Toliara (22°5S/42°0E). It was named *Felapi*.

The system moved east and made landfall in Madagascar on 28/01/05 at 0300 UT in the Toliara district (Manombo). It then moved south-east passing over the Betioky Atsimo and Ampanihy districts. On 29/01/05, it dissipated in the Tsihombe district.

## II – CHARACTERISTICS

The following gusts of winds were observed during its passage:

- 60 km/h in Toliara on 28/01/05
- 52 km/h in Morondava on 28/01/05
- 61 km/h in Ranohira on 27/01/05

Furthermore, the following were recorded in 24 hours:

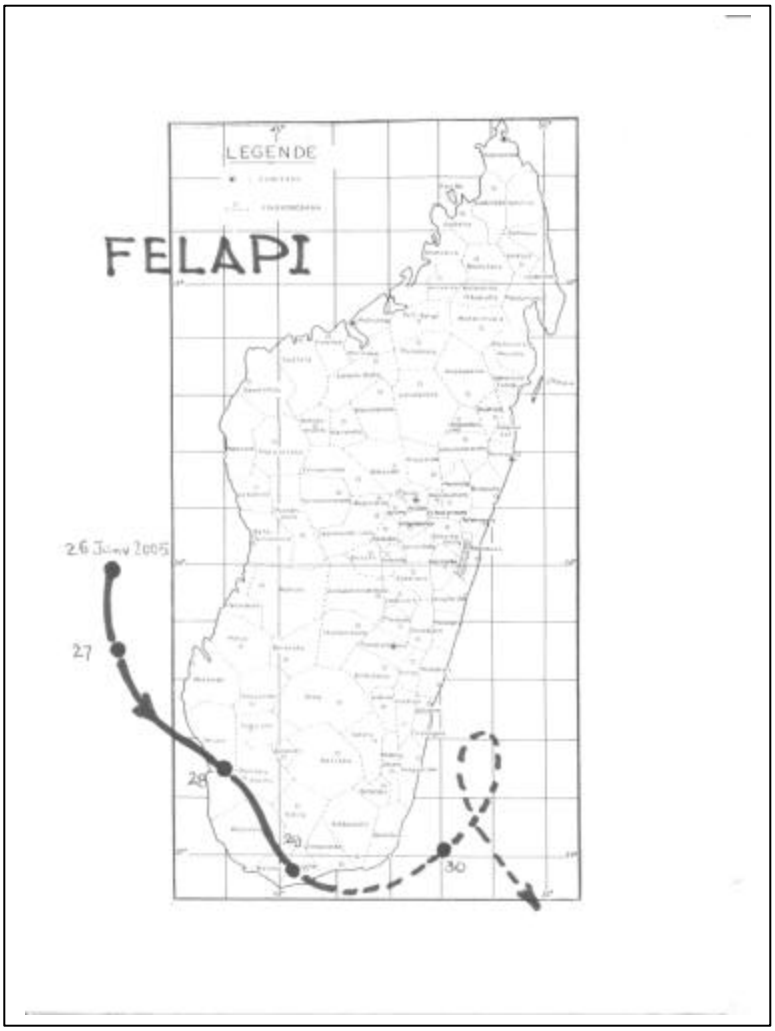
- 106.9 mm of rainfall in Toliara on 27/01/05
- 157.2 mm of rainfall in Morondava on 28/01/05
- 41.6 mm of rainfall in Ranohira on 27/01/05

## III – Damage caused by Cyclones *Ernest* and *Felapi*

*(Source CNS: Conseil National de Secours – Assessment of 25/02/05)*

- 39 people killed
- 214 missing
- 104 injured
- 32 191 homeless
- 5 792 buildings damaged
- 173 infrastructures/installations damaged
- 4 483 Ha of agricultural land/crops destroyed
- 72 cattle/livestock

**IV – <u>TRACK</u>**




**First heavy rainfall event**
***from 28/02/05 to 04/03/05***

In the Mozambique Channel, a very active branch of ITCZ descended on Madagascar from 28/02/05 to 04/03/05 in the area between 14°0S/19°0S and the African coast and the western coast of Madagascar, creating monsoon conditions that led to torrential rain in most parts of the provinces of Antsiranana, Antananarivo, Toamasina and Mahajanga.

## SUMMARY OF RAINFALL AMOUNTS

| STATIONS | 02/02/05 | 01/03/05 | 02/03/05 | 03/03/05 | 04/03/05 | Total | Ten-day normal | Percentage |
|---|---|---|---|---|---|---|---|---|
| SAMBAVA | 96.5 | 1 | 0 | 9.3 | 0 | 106.8 | 98.4 | **108%** |
| IVATO | 30.7 | 36.2 | 10.4 | 3 | 85.7 | 166.0 | 86.4 | **192%** |
| AMPASAMPITO | 6.0 | 44.6 | 7.8 | 0.1 | 26.3 | 84.8 | 77.7 | **109%** |
| ANTSIRABE | 35.7 | 21.1 | 2.9 | 33.0 | 25.2 | 117.9 | 61.3 | **192%** |
| SAINTE-MARIE | 0.7 | 1.6 | 76.4 | 46.2 | 9.3 | 148.6 | 184.2 | **81%** |
| TOAMASINA | 0 | 19.5 | 52.8 | 13.4 | 55.3 | 141.0 | 129.3 | **109%** |
| AMBOHITSILAOZANA | 0.1 | 16.1 | 90.5 | 26.7 | 93.4 | 226.8 | 64.1 | **354%** |
| MAHANORO | 2.3 | 58.8 | 61.0 | 9.3 | 0.2 | 131.6 | 121.0 | **109%** |
| ANTSOHIHY | 3.7 | 0 | 58.0 | 78.1 | 16.8 | 156.6 | 74.1 | **211%** |
| MAHAJANGA | 2.9 | 44.7 | 109.6 | 0.9 | 0 | 158.1 | 85.9 | **184%** |
| MAEVATANANA | 13.0 | 0.9 | 113.5 | 30.0 | 79.0 | 236.4 | 98.3 | **240%** |
| BESALAMPY | 23.7 | 80.3 | 30.1 | 2.6 | 0 | 136.7 | 64.0 | **213%** |
| MAINTIRANO | 43.5 | 3.6 | 0 | 16.4 | 3.2 | 66.7 | 44.2 | **151%** |

**Second heavy rainfall event**
***from 23/03/05 to 25/03/05***

A dense convective cloud cluster formed between the Mascareignes and Madagascar which moved south-west and settled over south-east Madagascar on 23/03/05 at 1200 UT causing abundant rainfall and flooding in low-lying areas. The system then moved south-east and headed out to sea on 25/03/05.

## SUMMARY OF RAINFALL AMOUNTS

| STATIONS | 23/03/05 | 24/03/05 | 25/03/05 | Total | Ten-day normal | Percentage |
|---|---|---|---|---|---|---|
| FARAFANGANA | 30.2 | 132.7 | 3.1 | 166.0 | 121.7 | **136%** |
| TAOLANARO | 181.2 | 93.4 | 49.6 | 324.2 | 54.1 | **599%** |

**FLOOD DAMAGE**
*(Source CNS: Conseil National de Secours – Assessment of 19/04/05)*

- 13 people killed
- 16 injured
- 9 120 homeless
- 22 603 people affected
- 12 buildings damaged
- 21 419 Ha of ricefields flooded

## REPORT ON THE 2003/2004 AND 2004/2005 TROPICAL CYCLONE SEASON

*(Submitted by Malawi)*

### *1. INTRODUCTION*

Malawi is located in the tropics and is approximately 500km inland away from the East African Coast. Malawi is not spared from the effects of tropical cyclones that enter or form in the Mozambique Channel. Tropical cyclones in the Mozambique Channel at times hit the East African Coast and proceed westwards. In this case direct effects are then experienced such as torrential rains and strong winds. Also depending on their position in the Mozambique Channel, tropical cyclones can cause dry spells particularly over Southern Malawi.

The 2003/2004 and 2004/2005 tropical cyclone seasons were both active in terms of frequency but none of the tropical cyclones made land fall along the East African Coast; hence they only affected Malawi indirectly.

### 2. 2003/2004 TROPICAL CYCLONE SEASON

The 2003/2004 tropical cyclone season could be classified as active since about 14 tropical cyclone disturbances developed in the South-West Indian Ocean. Out of these, three entered the Mozambique Channel and affected Malawi indirectly. These are Cela, Elita and Gafilo.

### *2.1 Cela (05 to 21 December 2003)*

Tropical cyclone Cela was named on 8 December before it reached northern Madagascar. On 14 December, Cela moved slowly South-southwestwards into the Mozambique Channel and remained in the channel until 19th December; by 20th December Cela became an extra-tropical storm.

The southern parts of Malawi were indirectly affected because Cela caused dry southwesterly winds; hence a dry spell was experienced.

### *2.2 Elita (26 January to 4 February 2004)*

Tropical Cyclone Elita was named on 27 January. It looped in the Mozambique Channel up to 2nd February. During this time the cyclone drew the Inter - Tropical Convergence Zone along the Zambezi Valley and enhanced Congo air mass into Malawi. This caused widespread rains during the last decade of January which were locally heavy. The heavy rains destroyed more that 80 houses, school blocks and a clinic in some villages in

Karonga District. Table 1 is showing the decadal rainfall amounts that were collected and decadal normal rainfall for the last decade of January from selected stations.

| Station Name | Decadal Total Rainfall (nm) | Decadal Normal Rainfall (mm) | Rain days |
|---|---|---|---|
| Blantyre Town Hall | 157.0 | 111.3 | 6 |
| Chancellor College | 134.8 | 100.8 | 10 |
| Chichiri Met. | 148.2 | 93.0 | 10 |
| Chikwawa Boma | 155.1 | 62.1 | 7 |
| Chileka Airport | 169.4 | 79.3 | 9 |
| Nchalo | 115.6 | 54.2 | 7 |
| Sucoma | | | |
| Satemwa Tea Est. No.1 | 104.6 | 95.0 | 8 |
| Zomba RTC | 156.0 | 107.3 | 7 |
| Chitedze Met. | 95.0 | 81.9 | 7 |
| Bolero Met | 66.7 | 47.3 | 4 |
| Mzimba Met | 129.2 | 63.3 | 9 |
| Mzuzu Met. | 90.3 | 69.9 | 7 |

Table 1 decadal rainfall for the last decade of January from selected stations

### 2.3 Gafilo (2 to 11 March 2004)

Gafilo was named on 2 March while located at 12.9 degrees south and 70.8 degrees east and intensified as it moved westwards. It became an intense tropical cyclone on 5 March and entered into the Mozambique Channel on 8 March. Tropical cyclone Gafilo enhanced an influx of Congo air mass into Central and Northern parts of Malawi while the Inter-Tropical Convergence Zone affected Southern Malawi. Consequently, heavy rainfall amounts were registered in some parts of the country during the first decade of March as is shown in table 2 below.

Heavy rains resulted into flash floods in Phalombe District and more than 78 houses were damaged.

| Station Name | Decadal Total Rainfall (nm) | Decadal Normal Rainfall (mm) | Rain days |
|---|---|---|---|
| Blantyre TownHall | 125.0 | 78.0 | 4 |
| Chancellor College | 169.0 | 110.7 | 6 |
| Chichiri Met. | 131.3 | 76.8 | 5 |
| Lujeri Tea Estate | 119.7 | 14.8 | 9 |
| Mulanje Boma | 146.1 | 136.6 | 8 |
| Mwanza Boma | 126.7 | 73.8 | 9 |
| Zomba RTC | 169.2 | 78.1 | 6 |
| Bolero Met | 99.2 | 56.2 | 7 |
| Chikangawa forest | 141.2 | 84.7 | 6 |
| Chitipa Met | 145.9 | 68.2 | 8 |
| Mzimba Met | 145.3 | 73.9 | 7 |
| NkhataBay Met. | 100.2 | 92.5 | 7 |

Table 2 Decadal rainfall for the first decade of March from selected stations

## 3 2004/2005 TROPICAL CYCLONE SEASON

Four cyclonic events entered into the Mozambique Channel of which two died as tropical depressions. The two that affected Malawi are Ernest and Felapi.

### 3.1 Ernest (17 to 25 January 2005)

Ernest was named on 20 January and moved west-southwestwards into the Mozambique Channel and became an intense tropical cyclone on 22 January. It moved to southwest Madagascar on 24 January and on 23 January tropical cyclone Ernest weakened following its encounter with the land.

Tropical cyclone Ernest compounded dryness mainly over southern Malawi. Many districts were totally dry during this decade as shown by table 3 below

| Station Name | Decadal Total Rainfall (nm) | Decadal Normal Rainfall (mm) | Rain days |
|---|---|---|---|
| Blantyre TownHall | 0 | 111.3 | 00 |
| FortLister Phalombe | 0 | 116 | 00 |
| I.T.G. Limbe | 0 | 116.5 | 00 |
| Masambanjati Agric | 0 | 93.9 | 00 |
| Mpemba Vet | 0 | 104 | 00 |
| Neno Agric | 0 | 105.5 | 00 |
| Zoa Tea Est. | 0 | 101.5 | 00 |
| Dzalanyama Forest | 0 | 91.5 | 00 |
| Kasiya Admarc | 0 | 89.7 | 00 |
| Lisasadzi | 0 | 80.9 | 00 |
| Mchinji Boma | 0 | 88.4 | 00 |
| Mponela Admarc | 0 | 82.7 | 00 |
| Thiwi Agric | 0 | 88.3 | 00 |
| Bwengu Agric. | 0 | 87.6 | 00 |
| Chelinda ( Nyika) | 0 | 77.4 | 00 |
| Chintheche Agric | 0 | 82.6 | 00 |
| Kavuzi Rosefalls | 0 | 82.1 | 00 |

Table 3 Decadal rainfall for the first decade of March from selected stations

**Felapi (26 January to 2 February 2005)**

Tropical storm Felapi developed in the Mozambique Channel on 26 January and was named on 27 January. It moved southeastwards into Southwestern Madagscar. The storm like Ernest also compounded dryness mainly over southern Malawi.

## REVIEW OF THE 2003/2004 AND 2004/2005 CYCLONE SEASONS

*(Submitted by Seychelles)*

*Part 1: Description of TC (intensity, tracks etc) affecting the Seychelles*
*Part 2: Description of impacts*

1.0 Tropical Cyclones 2003/2004 Season

### 1.1 Darius *29th December 2003- 4th January 2004*

**"Darius"** originated as a tropical perturbation on the 29th December to the southeast of Seychelles near 10°S, 63.9°E. It developed into a Tropical Depression (central pressure 999hpa) on the 30th near 12.9°S, 61.0°E. at that time moving in a southwesterly direction with a speed of 9kts (17km/hr).Further development took place over the next 48 hours as the system continued on its southwesterly track, although at a much reduced speed. On New Year's Day 2004, **"Darius"** was classified as a Severe Tropical Storm (984hpa). With position of 16.5°S, 59.0°E and moving in a South-southwesterly direction, it became an immediate threat to the island of Mauritius. At this point the storm remained stationary for a short while before turning into a more southerly direction. **"Darius"** passed to the immediate east of Mauritius on the 2nd January bringing torrential rains to the island. On the 3rd January it was downgraded to a Moderate Tropical Storm (990hpa) near 22.1°S, 57.9°E). After that it accelerated towards the South-southeast and became extra-tropical on the 4th.

### 1.2 Elita *26th January – 12th February*

**"Elita"** formed just off the western coast of Madagascar (over the Mozambique Channel) on the 26th near 18.2°S, 43.1°E. It was classified as a Tropical Depression (997hpa) on the evening of the 26th. On the 27th it deepened into a Moderate Tropical Strom and took a northerly then north-northeasterly track. "Elita" further deepened into a Severe Tropical storm (987hpa) on the afternoon of the 28th before making landfall just to the south of Mahajunga over the northwestern coast of Madagascar. **"Elita"** crossed Madagascar from northwest to southeast and emerged over the ocean as a very weak system (tropical perturbation) on the 30th near 21.1°S, 49.1°E. It remained quasi-stationary for a short while on the 30th before deepening into a Moderate Tropical Storm on the 31st and re-entered Madagascar, this time in a west-northwesterly direction. **"Elita"** re-emerged over the waters of the Mozambique Channel on the 1st February as a Moderate Tropical Strom and became stationary on the 2nd near 19.2°S, 42.2°E. It deepened further into a Severe Tropical Storm on the 2nd and started to displace east-southeast thus making landfall over Madagascar for the third time. It emerged off the southeast coast of Madagascar on the 4th where it lingered for sometime as an extra-tropical depression until its decay on the 12th. There were reports of considerable damage over Madagascar after the passage of **"Elita".**

### 1.3 Frank *27th January –7th February*

Cyclogenesis within the ITCZ on the 27th January near 11.8° S, 64.5°E produced Tropical Depression **"Frank"**. Initial movement was generally south-southwest between 6-10kts (11-18km/hr). It deepened rapidly into a Tropical Cyclone (970hpa) by the 29th and was located at 1000hrs local time near 15.7°S, 63.6°E. On the 29th **"Frank"** changed to a southwesterly track and seemed to be heading straight for Mauritius. However on the next day, 30th, it re-

curved to the northwest, apparently blocked by an approaching anticyclone to the south of the Mascarene. On the 30th at 1000 hrs local time **"Frank"** deepened into a Severe Tropical Cyclone (945hpa) near position 16.0°S, 62.1°E.Thereafter it became quasi-stationary on the 31st before taking a southeasterly track thus creating a loop. On the evening of the 31st it was downgraded to a Tropical Cyclone. Between the 1st and 3rd February **"Frank"** maintained an east-southeasterly track away from the Mascarene Islands, then took a more southerly turn up to the 5th and eventually southeastward before becoming extra-tropical on the 7th. Tropical Cyclone 'Frank" remained over open ocean throughout and thus had no direct effect on any land mass.

### 1.4 Gafilo *2rd March – 15th March*

Satellite picture of the 1st March revealed a zone of disturbed weather to the southeast of Seychelles between 10° and 15° South Latitude and 65° and 75° East Longitude associated with a low pressure area which had the potential to develop into a tropical storm. On the 2nd the 'Low' had deepened further and was classified as a Tropical Perturbation (1002 Hpa) by the Réunion Meteorological Authority. It was centred at 1000 hrs local time near 12.9° S, 70.8° E.By Wednesday 3rd March at 0400hrs the storm had attained Tropical Depression stage and was baptised **"Gafilo"**. It was now at 14.3° S, 66.0° E, and moving West-southwest at a speed of 15 kts. **"Gafilo"** deepened further into a Moderate Tropical Storm later on the 3rd and changed to a westerly track.On Thursday 4th March at 1000hrs **"Gafilo"** was classified as a Severe Tropical Storm (980 Hpa) and was located near 12.2° S, 59.8° E. Its displacement was still westwards but now moving at a much reduced speed (8kts) and heading straight for the Malagasy coast. **"Gafilo"**deepened further into a Tropical Cyclone on the 5th still heading generally westwards. **"Gafilo"** continued to develop further overnight of Friday 5th into an Intense Tropical Cyclone and by 1000hrs local time on Saturday 6th it was classified as a Very Intense Tropical Cyclone (900Hpa). At the time it was located near 14.6°S, 53.4°E, moving west-southwest at 12km/hr. At this point it was inevitable that it would hit the northeast coast of Madagascar. **"Gafilo"** made landfall over the northeast coast of Madagascar near the town of Antalaha early on Sunday the 7th when it was at its maximum intensity. The result was catastrophic for Madagascar. **"Gafilo"**, very much weakened, emerged over the Mozambique Channel on the 8th and was classified as a Moderate Tropical Storm on the 9th. It was located near 19.2°S 42.0°E and moving in a southeasterly direction preparing to re-enter Madagascar on the southwestern corner. Between 10th and 12th **"Gafilo"** was located over southern Madagascar bringing more bad weather to the already ravaged island. It emerged off the southeast coast on the 12th as a very much weakened system.

## 2.0 Tropical Cyclones 2004/2005 Season

December saw the Inter Tropical Convergence Zone (ITCZ) maintain a more northerly positioning (close to the Equator) than usual. As a result cyclonic activity over the South West Indian Ocean (SWIO) was also low. In fact only one tropical storm developed during the month and it was also only the third for the 2004/2005 season. Tropical storm "Chambo" formed over the eastern basin on the 23rd December, reached maximum intensity (Tropical Cyclone) on Christmas Day then became extra-tropical to the southeast of the Mascarenes Islands on the 30th December

## 3.0 IMPACTS ON SEYCHELLES

### 3.1 Effect of "Darius" on Seychelles

The development of Tropical storm "Darius" brought a welcomed relief from the heavy rains which had affected the main islands for most of December. Its displacement to the south cleared the weather over Mahé and the Inner islands bringing a 5-day dry spell between the 30th December and 3rd January. Islands further to the south continued to experience cloudy and wet conditions associated with feeder cloud bands associated with the storm.

## 3.2 Effect of "Elita" and "Frank" on Seychelles

The presence of "Elita" over the northern Mozambique Channel affected the southwestern corner of the Archipelago particularly the islands of Aldabra, assumption, Cosmoledo and Astove where strong winds and rough seas and associated rains were experienced. Less affected where the Providence and Farquhar groups which experienced mostly strong winds. In general the presence of "Elita" and "Frank" over the South Indian Ocean brought dry conditions over the main islands around Mahé extending as far south as the Amirantes. This was particularly the case during the early part of February. On the other hand the storms to the south resulted in an acceleration of the northwesterly winds, a condition not favoured by the local fishermen.

## 3.3 Effect of "Gafilo" on Seychelles

On Thursday 4th March at 1000hrs **"Gafilo"** was classified as a Severe Tropical Storm (980 Hpa) and was located near 12.2° S, 59.8° E. Its displacement was still westwards but now moving at a much reduced speed (8kts) and heading straight for the Malagasy coast. It was also at this point that it had the most impact on Mahé and Inner Islands as well as the Amirantes Group of islands. This was associated with an active 'Feeder Cloud Band'. Rainfall observed over the Mahe and the inner islands varied significantly as indicated in the figure below. Maximum rainfall recorded was 159 mm on the 4th March at Malavoie on the eastern coast of Mahe. Rainfall was 48 mm and 73 mm on 3th and 4th March respectively at the Seychelles International Airport. Moderate flooding was reported over the low lying areas of the eastern coast of Mahe. Dry conditions followed immediately thereafter. Figure 1(a) and (b) show the satellite modelled rainfall ranging from 50 to over 100 mm in TC "Gafilo" spiral rain band on the 4th March over Mahe, Seychelles followed by a period of dry spell as the cyclone tracks southwest to cause more damage in northern Madagascar(Chang-Seng, 2005).

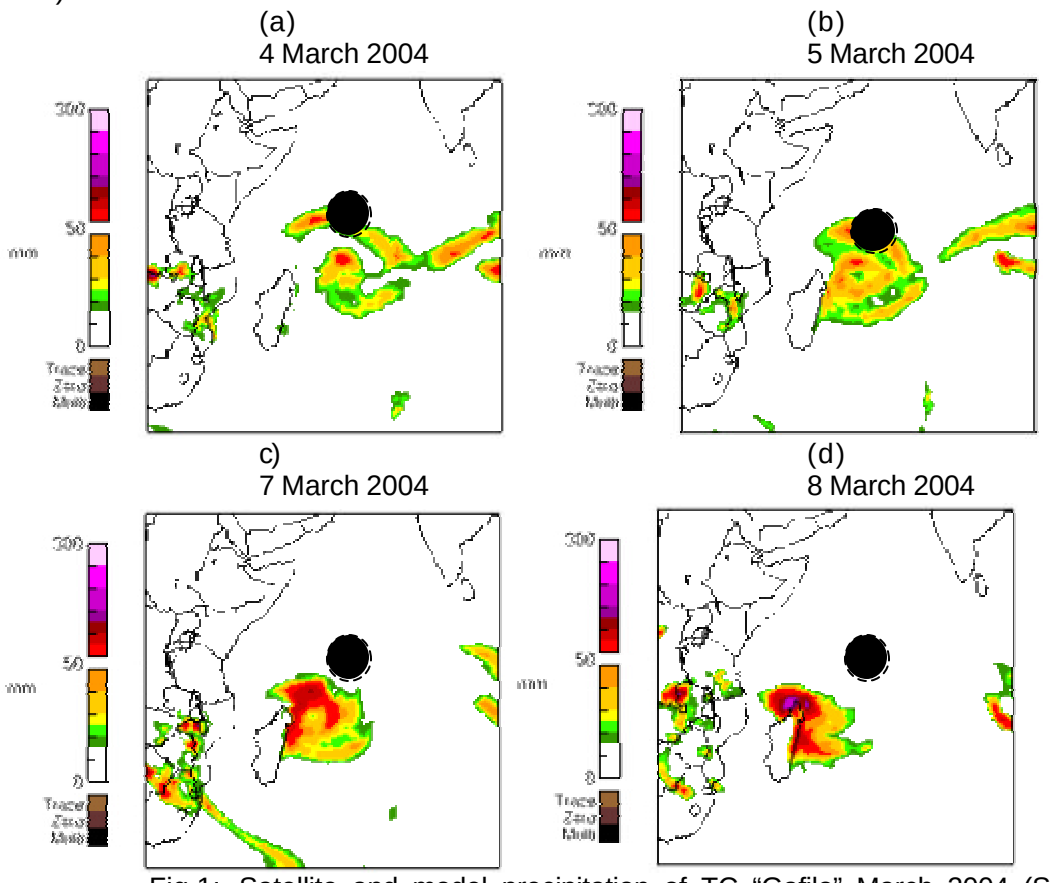



Fig 1: Satellite and model precipitation of TC "Gafilo" March 2004 (Source, Chang-Seng, 2005)

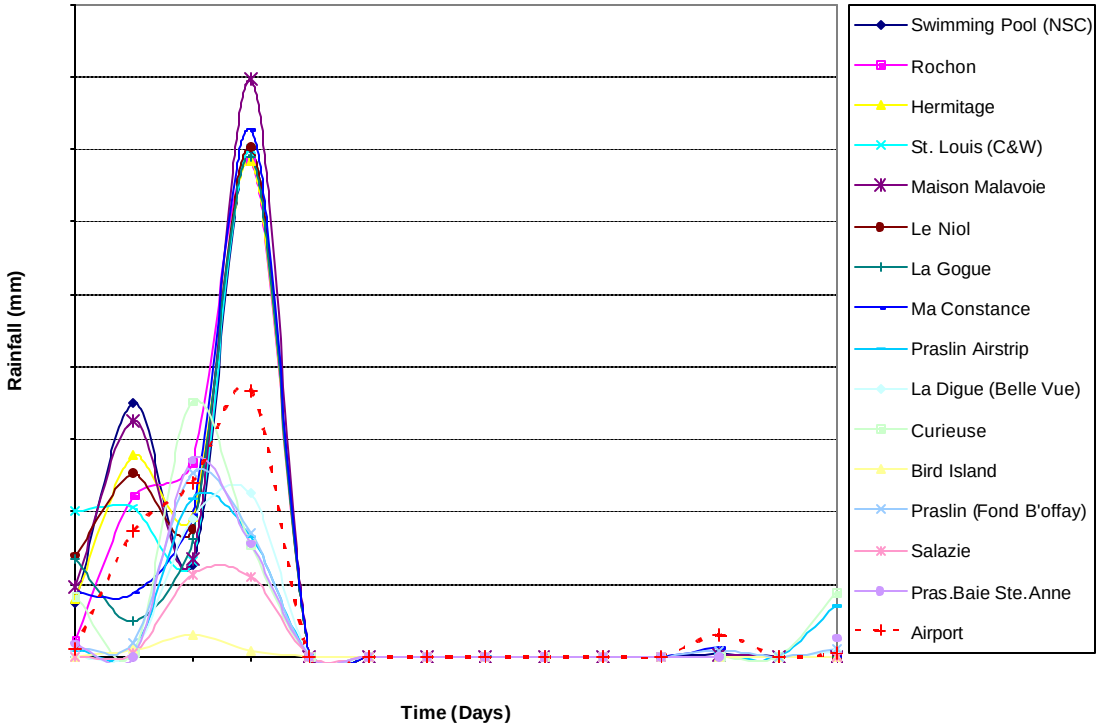



Fig 2: Evolution of daily observed rainfall associated with of TC "Gafilo" in March 2004

## 3.4 Abnormal "Tropical Wave" outside the Cyclone Season of 2004-2005

Severe weather persisted throughout the weekend of the 11th and 12th June 2005 associated with a transient tropical easterly wave. Its movement was slow and at times erratic as it moved westward towards eastern Africa. The warmer than normal sea surface temperature associated with the prevailing neutral to weak El Nino conditions supported the energy of the transient tropical wave. Continuous moderate to intense rainfall prevailed over the inner islands. As the weather system stabilized on Sunday there was a rapid and intense surge in the southeast monsoon flow. The mean wind speed recorded at the Seychelles International airport was averaged at 15 to 30 km per hour with a maximum gust of 80 km per hour between 12 to 1 pm. The record maximum wind speed for June was observed at the Seychelles International Airport in 1991 with a speed of 96 km/h. However, it is estimated that at higher elevations the wind speed was higher that that recorded at the Airport. The channeling effect between the mountains such at St. Louis could have caused the winds to accelerate to at least 100 km per hour. Most areas recorded **30 to 100 per cent more rainfall during the weekend only** when compared to the long term monthly average. One month of rainfall fell in just a few days only. This event highlights the effects of climate variability in Seychelles. A maximum of 337 mm of rain was recorded at Bird Island, 268 at Belombre, 239 at Le Niol, 203 at Rochon and 185 mm at Cascade. The area average rainfall for the entire month of June is 120 mm. The excess water in the soil and the strong surges was a perfect combination for uprooting of trees. The damages to residents were elevated because the surges sustained for several hours.

**E) PROPOSED TROPICAL CYCLONE NAMES FOR CYCLONE SEASON 2006-2007 AND 2007-2008**

| *2006-2007* | *2007-2008* |
|---|---|
| Adolf | Alda |
| Beria | Berin |
| Camillia | Clifton |
| Dayan | Davus |
| Elmy | Elnus |
| Favio | Frentina |
| Gienn | Geradino |
| Hally | Heldi |
| Idely | Ina |
| Jutha | Juanita |
| Ketspne | Kaicha |
| Lennis | Liam |
| Morry | Maxwell |
| Nell | Nimby |
| Odile | Octavie |
| Patty | Pelna |
| Quinny | Queency |
| Rennick | Rollina |
| Soloto | Shyra |
| Tyron | Thyra |
| Una | Urna |
| Vanielle | Vania |
| Willem | Wallace |
| Xina | Xanadir |
| Yohan | Yvette |
| Zymphe | Zahra |

***Reference:***

*Chang-Seng, S. D., 2004: Marine weather variability, tropical cyclone prediction and impacts in the southwest Indian ocean. Msc Thesis. Department of Geography and Environmental studies, University of Zululand.*

*Robert Lajoie, Climate manager for compiling tropical cyclone data/information*

## REVIEW OF THE 2003/2004 AND 2004/2005 CYCLONE SEASONS
## REVIEW OF TROPICAL CYCLONE SEASON 2003/2004 AND 2004/2005

*(Submitted by the United Republic of Tanzania)*

The two tropical cyclone seasons were fairly active with eleven named storms during the 2003/2004 season and 10 named systems during the 2004/2005 season.

Most of the disturbances that approached Tanzania coastal line made indirect enhancement of rainfall in the country by dragging air masses from far west through the country.

### REVIEW OF TROPICAL CYCLONE SEASON 2003/2004

During 2003/2004 season named disturbances were:
ABAIMBA, BENI, CELA,DARIUS, ELITA, FRANK, GAFILO, HELMA, ITSENG, JUBA, KATIBA, LENNY, MOINGAZA, NALEDI.

No severe weather events were directly associated with the tropical cyclone activity.

However during the active period of tropical cyclone 'Frank" (between 22nd January to 07th February there was increased rainfall intensity over the coastal parts of the country.

Rainfall was recorded at several stations as follows:

| **STATION NANE** | **2ND FEB Rainfall in mm** | **3RD FEB Rainfall in mm** | **5TH FEB Rainfall in mm** |
|---|---|---|---|
| Zanzibar | 60 | 17 | 63 |
| Dar es alaam | 66 | 6 | 14 |
| Mtwara | 23 | 0 | 0 |
| Morogoro | 44 | 0 | 16 |

On 7th February Mahenge station recorded 121mm of rainfall. This was one of the three highest 24 hours rainfall amounts ever recorded at the station. It should also be noted that February is a dry month for the coastal areas which recorded the above indicated significant rainfall amounts.

During the active period of tropical cyclone "Gafillo" between 02-15 March 2004 there was increased rainfall activity over the western and southern parts of the country with four stations ( Singida, Dodoma, Tabora and Iringa) in those areas recording rainfall amounts in excess of 100mm between 8 and 12th March 2004. The increase was influenced by tropical cyclone activity.

## REVIEW OF TROPICAL CYCLONE SEASON 2004/2005

During 2004/2005 season ten named disturbances were:
Arola, Bento, Chambo, Daren, Felapi Gerard, Hennie, Isang, and Juliet.

No severe weather events were directly associated with tropical cyclone activity except for the enhancement of convective activity due to passage of converging feeder bands which were crossing the country towards the Indian Ocean.

During the active period of tropical cyclone Chambo (22nd December 2004 to 03 January 2005) there was enhanced of the cyclone particularly in the southern parts of the country where several stations recorded high rainfall amounts. From 20th December to 24th December 2004 significant total amounts were recorded at several stations as follows: Tabora 183 mm, Mbeya 108 mm, Mahenge 188 mm, Songea 96 mm and Mtwara 114 mm.

During the active period of tropical cyclones Fellapi 26 January 2005 to 03 February 2005, there was increased rainfall in the southern parts of the country. The highest amounts were at Mahenge stations which recorded a total of 348 mm in five days starting from 02 February to 06 February 2005.

Advisories were issued whenever the increased rainfall intensity was considered a threat with likely occurrence of floods.

APPENDIX V

## TROPICAL CYCLONE PASSAGE REPORT FORM AND DAMAGE ASSESSMENT FORM

## GLOBAL TROPICAL CYCLONE TRACK AND INTENSITY DATA SET – REPORT FORMAT

| Position | Content |
|---|---|
| 1- 9 | Cyclone identification code composed by 2 digit numbers in order within the cyclone season, area code and year code. 01SWI2000 shows the 1st system observed in South-West Indian Ocean basin during the 2000/2001 season.<br>Area codes are as follows:<br>ARB = Arabian Sea<br>ATL = Atlantic Ocean<br>AUB = Australian Region (Brisbane)<br>AUD = Australian Region (Darwin)<br>AUP = Australian Region (Perth)<br>BOB = Bay of Bengal<br>CNP = Central North Pacific Ocean<br>ENP = Eastern North Pacific Ocean<br>ZEA = New Zealand Region<br>SWI = South-West Indian Ocean<br>SWP = South-West Pacific Ocean<br>WNP = Western North Pacific Ocean and South China Sea |
| 10-19 | Storm Name |
| 20-23 | Year |
| 24-25 | Month (01-12) |
| 26-27 | Day (01-31) |
| 28-29 | Hour- universal time (at least every 6 hourly position -00Z,06Z,12Z and 18Z) |
| | Latitude indicator:<br>1=North latitude;<br>2=South latitude |
| 31-33 | Latitude (degrees and tenths) |
| 34-35 | Check sum (sum of all digits in the latitude) |
| 36 | Longitude indicator:<br>1=West longitude;<br>2=East longitude |
| 37-40 | Longitude (degrees and tenths) |
| 41-42 | Check sum (sum of all digits in the longitude) |
| 43 | position confidence*<br>1 = good (<30nm; <55km)<br>2 = fair (30-60nm; 55-110 km)<br>3 = poor (>60nm; >110km)<br>9 = unknown |
| Note* | Confidence in the center position: Degree of confidence in the center position of a tropical cyclone expressed as the radius of the smallest circle within which the center may be located by the analysis. **"position good"** implies a radius of less than 30 nm, 55 km; "position fair", a radius of 30 to 60 nm, 55 to 110km; and "position poor", radius of greater than 60 nm, 110km. |
| 44-45 | Dvorak T-number (99 for no report) |
| 46-47 | Dvorak CI-number (99 for no report) |
| 48-50 | Maximum average wind speed (whole values) (999 for no report). |
| 51 | Units 1=kt, 2=m/s, 3=km per hour. |
| 52-53 | Time interval for averaging wind speed (minutes for measured or derived wind speed, 99 if unknown or estimated). |
| 54-56 | Maximum Wind Gust (999 for no report) |

57 Gust Period (seconds, 9 for unknown)

58 Quality code for wind reports:
- 1=Aircraft or Dropsonde observation
- 2=Over water observation (e.g. buoy)
- 3=Over land observation
- 4=Dvorak estimate
- 5=Other

59-62 Central pressure (nearest hectopascal) (9999 if unknown or unavailable)

63 Quality code for pressure report (same code as for winds)

64 Units of length: 1=nm, 2=km

65-67 Radius of maximum winds (999 for no report)

68 Quality code for RMW:
- 1=Aircraft observation
- 2=Radar with well-defined eye
- 3=Satellite with well-defined eye
- 4=Radar or satellite, poorly-defined eye
- 5=Other estimate

69-71 Threshold value for wind speed (gale force preferred, 999 for no report)

72-75 Radius in Sector 1: 315°-45°

76-79 Radius in Sector 2: 45°-135°

80-83 Radius in Sector 3: 135°-225°

84-87 Radius in Sector 4: 225°-315°

88 Quality code for wind threshold
- 1=Aircraft observations
- 2=Surface observations
- 3=Estimate from outer closed isobar
- 4=Other estimate

89-91 Second threshold value for wind speed (999 for no report)

92-95 Radius in Sector 1: 315°-45°

96-99 Radius in Sector 2: 45°-135°

100-103 Radius in Sector 3: 135°-225°

104-107 Radius in Sector 4: 225°-315°

108 Quality code for wind threshold (code as for row 88)

109-110 Cyclone type:
- 01= tropics; disturbance ( no closed isobars)
- 02= <34 knot winds, <17m/s winds and at least one closed isobar
- 03= 34-63 knots, 17-32m/s
- 04= >63 knots, >32m/s
- 05= extratropical
- 06= dissipating
- 07= subtropical cyclone (nonfrontal, low pressure system that comprises initially baroclinic circulation developing over subtropical water)
- 08= overland
- 09= unknown

111-112 Source code (2 - digit code to represent the country or organization that provided the data to NCDC USA. WMO Secretariat is authorized to assign number to additional participating centers, organizations)
- 01 RSMC Miami-Hurricane Center
- 02 RSMC Tokyo-Typhoon Center
- 03 RSMC-tropical cyclones New Delhi
- 04 RSMC La Reunion-Tropical Cyclone Centre
- 05 Australian Bureau of Meteorology
- 06 Meteorological Service of New Zealand Ltd.

07 RSMC Nadi-Tropical Cyclone Centre
08** Joint Typhoon Warning Center, Honolulu
09** Madagascar Meteorological Service
10** Mauritius Meteorological Service
11** Meteorological Service, New Caledonia
12 Central Pacific Hurricane Center, Honolulu

Note** no longer used

**Headings** 1-19 Cyclone identification code and name; 20-29 Date time group;
30-43 Best track positions;
44-110 Intensity, Size and Type;
111-112 Source code.

## TROPICAL CYCLONE PASSAGE REPORT FORM

TC Number (RSMC No.)_____

| Station/ buoy/ship Number | Minimum Sea Level Pressure | | Maximum Sutained Wind | | Peak Gust | | Rainfall | |
|---|---|---|---|---|---|---|---|---|
| | hPa | Time Observed (UTC) | (10 min. ave.) mps | Time Observed (UTC) | mps | Time Observed (UTC) | Amount mm | Date Observed |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**REPORT ON DAMAGE CAUSED BY CYCLONES, FLOODS AND DROUGHT**

Country: _____

Period covered by this report

From (Date) _____ (Month)_____ (Year) _____
To (Date) _____ (Month)_____ (Year) _____

Prepared and Submitted by: (Service/Organization) _____

Date Prepared: (Date) _____ (Month)_____ (Year) _____

NOTES:

- This report should cover the total damage caused by tropical cyclones and heavy rainfall, and associated storm surges, floods, landslides, etc.
- This format is designed to aid compilation of data and information which are already collected in each country. (i.e. it does not propose any change in the existing systems of disaster damage survey in the various countries).
- If final official figures for the reporting period are not available, it is recommended that tentative data be reported with appropriate notations.
- Although this format covers broad aspects of disasters and detailed data, if the country is not prepared to provide data on some of the items, those may be left blank.
- Data processing involved in the estimation of damage costs require much time, therefore, if the data are still being processed at the time of reporting, it should be noted when such data will become available.
- Reporting period is a month before the scheduled session of the RA I/TCC.

For consistency, please use the following notations :

… data not available or not separately reported
NIL amount is negligible
NA item is not applicable

Please use the GLIDE number whenever possible (http://www.glidenumber.net/)

| **I. General** | **Unit** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| 1. Type of disasters | | | | | | |
| 2. Date/period of occurrence | | | | | | |
| 3. Area/s seriously affected | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***II. Human Damage*** | | | | | | |
| 4. Dead and Missing | | | | | | |
| 5. Injured | | | | | | |
| 6. Homeless | | | | | | |
| 7. Affected | | | | | | |
| 8. Total | | | | | | |
| **III. Material Damage**<br>**Physical Terms** | | | | | | |
| ***A. Houses and buildings*** | | | | | | |
| 9. Destroyed | | | | | | |
| 10. Damaged | | | | | | |
| 11. Affected | | | | | | |
| 12. Total | | | | | | |
| ***B. Agriculture*** | | | | | | |
| 13. Farmland | | | | | | |
| ***C. Agricultural Products*** | | | | | | |
| 14. Crops | | | | | | |
| 15. Livestock | | | | | | |
| 16. Fruit plants | | | | | | |
| 17. Others | | | | | | |
| ***D. Public Works*** | | | | | | |
| 18. Road | | | | | | |
| 19. Bridge | | | | | | |
| 20. River Embankment | | | | | | |
| 21. Irrigation Facilities | | | | | | |
| 22. Reservoir and Dam | | | | | | |
| 23. Harbour and Port | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 24. Others (please specify) | | | | | | |
| ***E. Public Utilities*** | | | | | | |
| 25. Railway | | | | | | |
| 26. Electric Supply | | | | | | |
| 27. Water Supply | | | | | | |
| 28. Telecommunication | | | | | | |
| 29. Others (please specify) | | | | | | |
| ***F. Others***<br><br>30. Ships lost or damaged | | | | | | |
| 31. Landslide, slope collapse | | | | | | |
| **IV. Material Damage**<br>**Monetary Terms (USD)** | | | | | | |
| 32. Private Property | | | | | | |
| 33. Agricultural Production | | | | | | |
| 34. Industrial Loss | | | | | | |
| 35. Public Works Facilities | | | | | | |
| 36. Public Utilities | | | | | | |
| 37. Total (# 32 to 36) | | | | | | |

APPENDIX VI

**LIST OF TROPICAL CYCLONE NAMES FOR THE CYLONE SEASONS 2006/2007 AND 2007/2008**

| CYCLONE SEASON 2006/2007 | | CYCLONE SEASON 2007/2008 | |
|---|---|---|---|
| ANITA | (Madagascar) | ARIEL | (Mauritius) |
| BONDO | (Malawi) | BONGWE | (Malawi) |
| CLOVIS | (Mauritius) | CELINA | (Mozambique) |
| DORA | (Mozambique) | DAMA | (Namibia) |
| ENOK | (Namibia) | ELNUS | (Seychelles) |
| FAVIO | (Seychelles) | FAME | (South Africa) |
| GAMEDE | (South Africa) | GULA | (Swaziland) |
| HUMBA | (Tanzania) | HONDO | (Zimbabwe) |
| INDLALA | (Swaziland) | IVAN | (Tanzania) |
| JAYA | (Zimbabwe) | JOKWE | (Botswana) |
| KATSE | (Botswana) | KAMBA | (Comoros) |
| LISEBO | (Lesotho) | LOLA | (Madagascar) |
| MAGOMA | (Comoros) | MARABE | (Lesotho) |
| NEWA | (Tanzania) | NUNGU | (Malawi) |
| OLIPA | (Malawi) | OFELIA | (Mauritius) |
| PANDA | (Namibia) | PULANE | (Lesotho) |
| QUINCE | (Mauritius) | QOLI | (South Africa) |
| RABECA | (Mozambique) | ROSSANA | (Mozambique) |
| SHYRA | (Seychelles) | SAMA | (Namibia) |
| TSHOLO | (South Africa) | TUMA | (Swaziland) |
| UNOKUBI | (Swaziland) | UZALE | (Comoros) |
| VUYANE | (Lesotho) | VONGAI | (Zimbabwe) |
| WARURA | (Zimbabwe) | WARONA | (Botswana) |
| XYLO | (Madagascar) | XINA | (Seychelles) |
| YONE | (Botswana) | YAMBA | (Tanzania) |
| ZOULEHA | (Comoros) | ZEFA | (Madagascar) |

APPENDIX VII

**ACTIVITIES OF MEMBERS CARRIED OUT DURING THE INTERSESSIONAL PERIOD INCLUDING IMPORTANT ACHIEVEMENTS, KEY ISSUES AND FUTURE DIRECTIONS BY EACH MEMBER UNDER THE FIVE COMPONENTS**

***(Submitted by Botswana)***

**Observing system**

The two new upper-air stations which were planned to be opened at Kasane (68029) and Ghanzi (68024) as reported during the sixteenth session have not been opened due to financial constraints. The old four stations (68032, 68040, 68240, 68328) have not been functional for a year due to problems of acquisition of consumables mainly hydrogen gas. This will be solved soon as the spare parts for the generators have been acquired.

The Doppler radar installed in Gaborone in 2003 has not been working because of technical problems with some of its components. Therefore the planned network of radars between Botswana and South African has not yet been accomplished. However, major problems have been resolved and the radar is expected to be functional by beginning of the 2005/2006 tropical cyclone season.

**Meteorological satellites**

The MSG equipment has been installed in Gaborone (Met HQ), though not yet used operationally by forecasters as the Forecasting office is based at the airport. However, the Botswana Meteorological Services is sourcing some funds to procure more computers and software for installation at the airport and other offices/sections.

***(Submitted by Comoros)***

**Meteorological component**

UNDER THE REGIONAL METEOROLOGICAL COOPERATION PROGRAMME OF THE INDIAN OCEAN COMMISSION (IOC), THIS PROJECT HAS ENABLED THE METEOROLOGICAL SERVICES OF MEMBER COUNTRIES, INCLUDING COMOROS, TO OBTAIN THE FOLLOWING EQUIPMENT, WHICH HAS IMPROVED WORLD WEATHER WATCH SYSTEMS:

- A system for receiving meteorological data via satellite (RETIM-AFRICA);
- A system for transmitting meteorological data which is compliant with GTS distribution and automatic multi-protocol transmission (fax, e-mail, etc.) (TRANSMET);
- A data-display and monitoring system equipped with a high-priority alarm activated when a tsunami warning is received (SYNERGIE);
- A dedicated connection with neighbouring Meteorological Services, including RSMC la Réunion, through the establishment of a permanent Internet connection of 64 Kbits/s;
- Installation of the MSG (METEOSAT Second Generation) station.

**System performance**

The tropical cyclone warning system proved very effective during the 2003/2004 and 2004/2005 cyclone seasons.

The National Forecast Centre received warnings from the RSMC and the sub-regional centres in Madagascar and Maurice in a timely manner. Similarly, tropical depression and cyclone warnings for the region were received regularly from the meteorological office in Bracknell.

Forecasts were made using the global circulation model, which provides quite satisfactory results regarding the direction and intensity of disturbances.

Forecasts have improved since the installation at the National Forecast Centre of meteorological data transmission and display systems (RETIM-AFRICA, TRANSMET, SYNERGIE, as well as a dedicated connection with the Meteorological Services in the IOC region, including the RSMC).

It should be noted that weather-related damage in our country was caused by the ITCZ, which is sometimes very active in Comoros, as highlighted in the annex to the review of the latest cyclone seasons.

Furthermore, weather conditions worsened and became exceptional in the town of Moroni and its surrounding area with heavy and persistent rain, accompanied at times by strong gusts of wind.

During the cyclone season, the National Meteorological Service uses national and private radio stations to broadcast advisories to the general public twice a day (0400 UTC and 1400 UTC). Faced with an approaching disturbance, the Minister of Defence sets up an emergency task force that regularly receives information on the location, intensity and track of the disturbance in accordance with circular N°03-245/MDIPTTI/cab.

**Disaster prevention and preparedness**

A national disaster preparedness and response plan was adopted in November 2004. Furthermore, the National Meteorological Service is equipped to detect conditions conducive to the formation of adverse weather phenomena before they occur and broadcasts the information in accordance with circular N° 03-245/MDITTI/cab, which defines the different stages of information needed for mobilizing security services should emergency response operations be required.

The Service uses national, and sometimes private and local, radio stations to broadcast forecasts on likely developments at 0400 UTC and 1400 UTC.

When a disturbance is imminent, the Meteorological Service broadcasts three to four advisories within 24 hours.

***(Submitted by Madagascar)***

The following progress has been made by Madagascar to implement the Technical Plan:

**Meteorological component:**

Within the framework of the regional programme on meteorological cooperation of the Indian Ocean Commission, Madagascar has benefited from the improvement of three WWW systems by:

- Placing new products and meteorological information on the RETIM-Africa system;
- Putting into service the automatic transmission system of data and products TRANSMET;
- Updating the NOAA receiving station: high-resolution picture transmission (HRPT);

- Operating the data-processing system SYNERGIE;
- Installing the Meteosat Second Generation (MSG) station.

**Disaster prevention:**

- The National Assembly and the Senate adopted in July and August 2003, Law No. 2003-010 regarding national policy for disaster preparedness and mitigation;
- A stakeholders' brainstorming scheme on natural disasters (cyclones, flooding, etc.) was created and, as a result, the Stakeholders' Committee on Disasters (CRIC) was established;
- Within the framework of the UNDP MAG 00/005 project, a document was drafted by national experts and intended for disaster preparedness and mitigation trainers.

**Research:**

A thesis was presented in May 2005 by a student of the Ecole Supérieure Polytechnique (Polytechnic Institute) of Antananarivo, in collaboration with Météo Malagasy, entitled "La structure dynamique et thermique des cyclones tropicaux à l'aide du modèle à méso-échelle MM5V3—Cas du cyclone GERALDA" (The thermodynamic structure of tropical cyclones by using the MM5V3 mesoscale model: the case of cyclone Geralda).

***(Submitted by Malawi)***

**1. Surface Observations**

**Manned surface System**

Rehabilitation of radar stations:

The assessment on the rehabilitation of the radars at Chileka and Lilongwe was done by WMO Engineers from South Africa Weather Services from 6 to 10 June 2005 and their recommendations are as follows:

Chileka Radar: needs replacement - funds are not available

Lilongwe Radar: can be rehabilitated depending on the availability of spares - funds for spares are not available

**Maintaining of Synoptic observations**

Mzuzu (67489) still not on 24-hour observations – shortage of staff

Chileka(67693) 24-hour observations suspended from 21st February 2005 - shortage of staff: The government will soon carry out a recruitment exercise to address the situation.

Proposal for installation of automatic weather stations at Chileka, Lilongwe and Mzuzu during 2005 – 2008. Funds from Malawi Government

**Upper-air observations**

There are no upper air observations at Chileka, Lilongwe and Mzuzu due to none functioning of the hydrogen plants. Assessments were made by WMO Engineers from South African Weather Service on the hydrogen plants. They recommended for the replacement of the hydrogen plants with small hydrogen plants. Funds are not available but Malawi will submit a VCP application to WMO shortly.

**Space-Based Sub-System**

MSG receiving equipment was installed at the Meteorological Headquarters, Chileka from 7th July to 13th July 2005 to access data and products from Meteosat 8 and other satellites. The equipment is still being tested.

## 2. Support to Meteorological Telecommunications

Proposal for the establishment of Wide Area Network for the Main Synoptic Stations during 2005 to 2006. Funds from Malawi Government.

## 3. Issue of Tropical Cyclone Warnings

The National Tropical Cyclone Warning System was reviewed to incorporate changes made by the Review Team. The reviewed plan will be presented to the National Disaster Management Committee shortly.

***(Submitted by Namibia)***

## 1. Introduction

Namibia's climate is predominantly semi-arid to arid, with large areas to the east and west being occupied by Kalahari desert and Namib desert respectively. The northern and northeastern margins of the country are affected by sub-humid tropical climate regimes.

The main rainy season occurs during southern hemisphere summer in the months of October to April. However, winter rainfall is not an uncommon feature in the extreme southern parts of the country where it accounts for over 50% of annual rainfall in some places. Average Annual rainfall is very highly variable in both time and space. In terms of time, the largest year-to-year differences are in the lower rainfall areas in the western and southern parts of the country where the coefficient of variation generally exceeds 1.00 (or over 100% variability). In the north and northeast, where annual rainfall is relatively much higher, the coefficient of variation is just about 0.20 (or 20% variability). In terms of space, mean annual rainfall varies from under 20mm along the coast, to around 700mm in the extreme northeastern parts of the country.

On average, summer day-time temperatures are warm to hot, and generally range from about 20°C to just under 40°C, while average winter night temperatures range from about 5°C to about 10°C. The coastal areas exhibit the smallest temperature ranges, a moderation partly due to the cool southwesterly winds over the Benguela current in the Atlantic ocean. Over much of the central areas which include Windhoek, the capital city, conditions are fairly pleasant due to the moderating effect of the high altitude.

## 2. Overall Observations and Related National Activities

In recent years, the frequency and severity of droughts is generally higher and this puts a strain on water resources and agricultural activities. The most recent very severe drought was that of 1997/1998 season. On the other end of rainfall performance extreme, floods arising from abnormally high rainfall intensities have also been observed in recent years, the most severe incidences having been in the 2003/2004 when widespread floods occurred in several parts of the country. Before the 2003/2004 flooding incidences, those of 1999/2000 attributed to the circulation patterns induced by the cyclone Eline were the most significant at the close of the millennium.

Recognizing the socio-economic impacts associated with adverse variations in weather and climate in general and with climate change in particular, the Meteorological Service has

embarked on a programme of increasing systematic observations throughout the country in order to make weather and climate data and information more readily available to all needy sectors of society. The programme is consistent with the recommendations of the Namibia Climate Change Committee which underscored the need for more systematic observations in its Initial National Communication the United nations Framework Convention on Climate Change.

The summary profiles for the 2003/2004 and 2004/2005 seasons are given in the Annexes to this brief.

***(Submitted by Seychelles)***

## 1. Meteorological observing system

A consignment of Basic Meteorological Instruments including rain gauges, thermometers, Stevenson screens, hygrograph and thermograph was received from WMO/UK Met Office VCP.

A batch of basic instruments was received from CNES, VASCO, French research experiment during February to March trial experiment. This research has the objective to investigate the ocean-atmosphere interactions at intra-seasonal time scales in the region and its tele-connection with global climate such as ENSO etc. Full scale project is expected in Jan-Feb. of 2006 and 2007. This will benefit Seychelles both in terms of observation and research.

A new data processing system was acquired to improve climate data management and research.

The upgrade of Upper Air Observing System at Rawinsonde Station worth 23,429.00 UK pounds was completed between 21st June to 2nd July 2005. The cost of the upgrade excludes installation and training which lasted for a period of two weeks. The new system uses the latest VAISALA RS92 sondes.

Tide Gauge Infrastructure to house the tide gauge equipped with sea surface temperature sensor almost complete. Actual installation by University of Hawaii staff has been delayed to October on the grounds that the upgrade might need to consider the possibility of extending the monitoring to include Tsunami.Discussions were carried out with IOC representatives to improve the monitoring of SST, tide and sea level from our station in real time and in a graphical user interface format.

**Enhancement of the observational network**

Although there has been much attempt to maintain and improve the observation network, the NMS is struggling to maintain most of the automatic weather stations due to financial constraints and lack of technical support for this model from DEGREANE. A new generation of robust and reliable automatic weather station is recommended for the Seychelles. Such endeavour can only be possible by exploring for new assistance from regional projects such GCOS, IO-GOOS. Enhancement of the observation network in the region should be based on scientific evidence that the location parameters to be monitored are key elements in understanding and predicting the development, intensification and movement of tropical cyclones in the region.

Functioning of the Warning Systems Relative to TD, TC, Storm Surges and Flood for 2003-2004 and 2004-2005.

The NMS issued normal bad weather, heavy rainfall and flood warnings during both TC season for the respective TCs affecting the Seychelles.

An easterly propagating wave approached the area outside the cyclone season. A warning of bad weather was issued on the 11th June at 0845LT. Advisory was issued to the public through the national media systems. The disaster committee was simultaneously informed. The disaster response team was in action for most of the two days due to flooding, uprooted trees and ro of blown away or collapsed from the strong winds gusting between. The following day a strong wind warning was issued at 1005LT to SBC and disaster committee.

## 2. Telecommunication Systems

24–hr access with Internet having high speed upgraded to 256kb/s connection with a TCP/IP type of protocol and a Local Area Network (LAN).

Equipped with a new system of telecommunication within the COI member countries - Meteo project during the 2004 – The Synergie system integrated with Retim 2000 for operational purposes**.**

## 3. Meteorological Satellite

Meteosat Second Generation (MSG) is now operational.

Training of Meteorologist and computer administrators to be completed in Toulouse late September, 2005

Staff are being selected to have specialised training in Satellite Meteorology in Nov.-Dec. in Cairo, Egypt 2005

## 4. Training and Research

The NMS has now one staff with MSc in Meteorology and Oceanography to carry out research activities. One staff is soon to complete his MSc in Agro -meteorology in Nairobi, Kenya. It is expected that next year at least one more graduate will join the research section.

## 5. Early Warning System, Disaster and Risk Management

The NMS has carried out a trial prediction of intense tropical cyclone for the season 2004-2005 based on the latest MSc research. Such predictions have helped Seychelles to prepare and mitigate the impacts of the TCs. So far the results are very encouraging.

As part of the early warning System Seychelles has recently benefited from one SYNERGIE MEDIA SYSTEM to upgrade existing TV Presentation System by UK Met Office.

In the past years the NMS was not directly presented on the National Disaster Committee. Following the recent disasters the NMS has now emerged as a key institution and member of the committee. It is now responsible for the Education, Awareness and Sensitization Campaign and Early Warning System working group for natural disasters. NMS is also member of the working group on hazard mapping. The other working groups are the communication and legal group.

A colour graded warning system is under the development based on the multi-hazard approach. In the case of TC, new technical and logistical operational procedures have been implemented to cater for various TC positions and threat from all Seychelles islands. In addition an early warning team is being formed to back up duty forecasters during bad weather and abnormal phenomena such as tsunami.

***(Submitted by the United Republic of Tanzania)***

**2.1 Network of synoptic land stations**

Tanzania has opened Kilwa Masoko Synoptic Station No. 63940 located at Lat 08deg.55"S long 39deg 31"E. The station is currently operating for 12 hours from 0300 UTC to 1500 UTC.

**2.1.2 Other Networks**

New upper air equipment has been installed at Dar es Salaam International Airport thus reviving operation and upper air observations since October 2004. The station had been silent for more than 10 years.

**2.5.1 APT/WEFAX/HRPT**

The Meteosat Second Generation (MSG) equipment was installed in Dar es Salaam in December 2004 thus improving monitoring of weather events and other applications.

**5.1 Telecommunications Systems**

Tanzania is finalizing arrangements for communication through VSAT between Dar es Salaam and Nairobi RTH at 64 Kbps.

***(Submitted by Zimbabwe)***

**INTRODUCTION**

Tropical cyclones the world over cause some natural disasters such as floods in low-lying areas, loss of lives to human beings and animals, damage to road networks, structural damages to buildings, homes. Clinics schools and other infrastructures. They also add risks of contracting water borne diseases like cholera and diarrhea.

**Management of Flooding Emergencies in Zimbabwe**

Until the devastating floods due to cyclone Eline in the year 2000 and cyclone Japhet in the year 2003, the country's major natural hazard had been droughts that have occurred in cyclic fashion over the years. The Civil Protection Organization in the country was generally unfamiliar with dealing with a sudden onset of a natural catastrophe like a cyclone. As such, the government then formed the Civil Protection Unit whose major function according to its mission statement is ''to prepare for, prevent where possible and mitigate the effects of disasters once they occur'' which disasters maybe natural or man made. Administrators and Civil Planning Committees at national, provincial and district levels assist the Unit in this function (see diagram fig 1).

The Zimbabwe Meteorological Services Department actively participates in all stages of the activities of the Civil Protection Unit. The department is responsible for the issuance of timely warnings of any impending adverse weather conditions in the country, updates these conditions and provides weather conditions suitable for the implementation of rescue operations. This is the area where maybe the WMO Secretariat should assist in the following areas:

a) **Radar:** Assist the department in the procurement of at least one Doppler radar for tracking storm movements when a cyclone gets in to the Mozambique Channel. The radar system network we have do not have adequate

resolutions for such purposes. The aid may be procured under the VCP Programme.

b) **Training:** To organize for training of forecasters in the field of identification of cyclone formations, tracking and also training on NWP using workshops.

The procedure which are taken when a disaster occurs are:

1) The Civil Protection Unit consults the Minister of Local Government, Public Works and National Housing who in turn recommends to the president to declare and gazette a state of disaster depending on the damage caused. The unit is then responsible for mobilizing resources, both financial and material from within and outside Zimbabwe to assist in managing the disaster and in rehabilitation activities once the disaster has passed.

2) The dissemination of data is issued by telephone, radio, TV broadcasts.

3) The Air force of Zimbabwe will be responsible for the uplifting of all people who will have been marooned or possibly drowned.

4) The army will be on standby to build makeshift bridges where these will have been washed away by floods.

5) The Red Cross and WFP will play their respective rolls as and when required.

**LESSONS LEARNT:**

1) The national press must be more informative before, during and after times of any national disaster.

2) Radio broadcasts must be encouraged to transmit warnings as scheduled broadcasts. This type of communication is very good because it covers most remote areas since most people are able to buy a radio.

3) On TV communication, I strongly recommend that:

   a) There should be direct reporting of a cyclone event in news bulletins

   b) A strip message of latest warning details across the bottom of the screen

   c) Graphical representation of the latest warning (Satellite images)

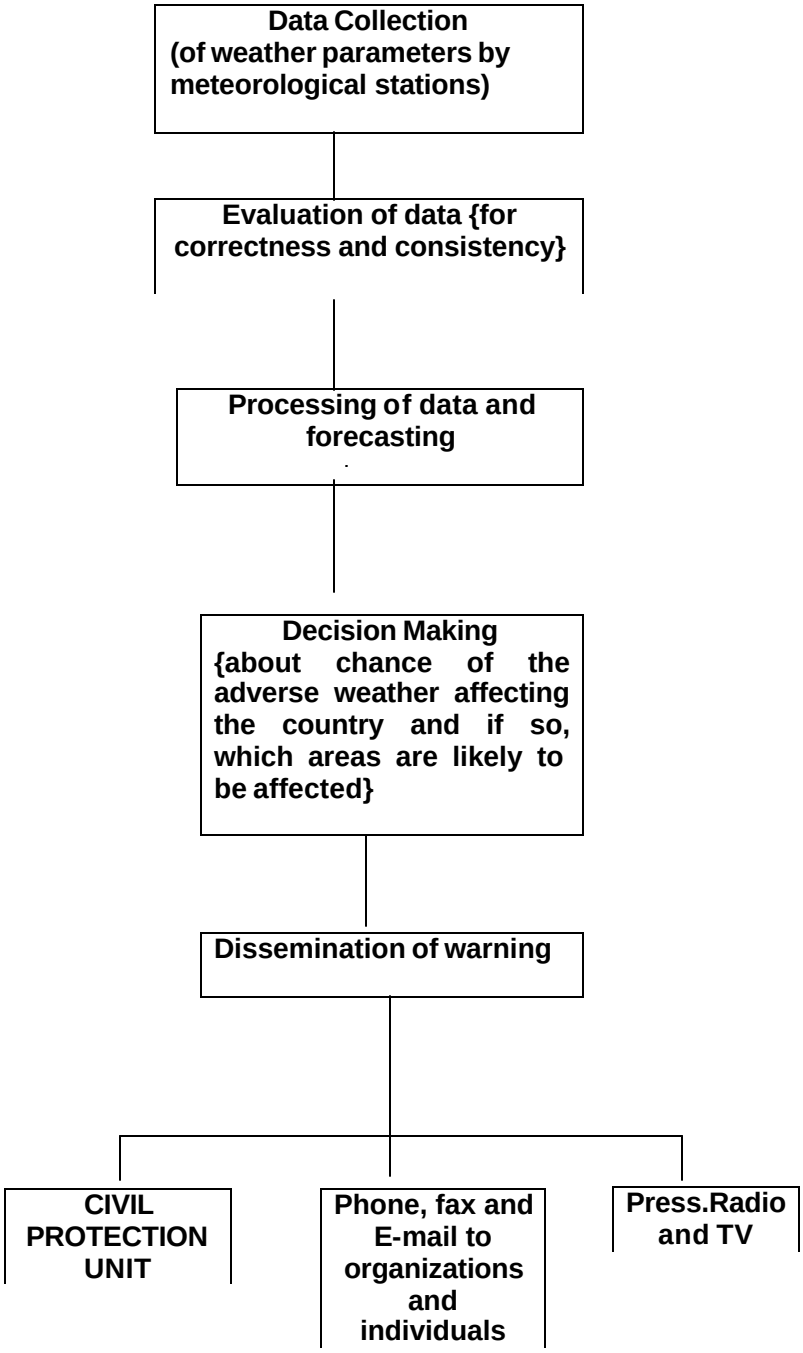
   d) Media interviews with the forecaster on duty

   e) Training in Media Presentation.

4) The government should bar people from resettling in places prone to flooding.

During the 2003/2004 and 2004/2005 season, no tropical cyclones were encountered over the country and hence we have no meaningful contributions to make with regards to flooding etc caused by cyclones during the said seasons.

Figure 1: The warning system for the Zimbabwe Department of Meteorological Services



APPENDIX VIII

# UPDATED TECHNICAL PLAN OF THE RA I TROPICAL CYCLONE COMMITTEE FOR THE SOUTH-WEST INDIAN OCEAN

## I. METEOROLOGICAL COMPONENT

| 1.1 SUPPORT TO THE REGIONAL METEOROLOGICAL OBSERVING SYSTEM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TASKS | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
| | 2006 | 2007 | 2008 | 2009 | | | | |
| **1.1.1 Surface-based sub-system** | | | | | | | | |
| ***1.1.1.1 Surface Observations*** | | | | | | | | |
| a) Manned Surface System | | | | | | | | |
| i) Establishment/Rehabilitation of new/old manned surface stations: | | | | | | | | |
| - Fomboni (67003) | | | | | Comoros | Comoros | | |
| - Mtsangadzon | | | | | Comoros | Comoros | | |
| - Mbabane | | | | | Swaziland | Swaziland | | |
| - Maseru (68454) | | | | | Lesotho | No | Funds needed | |
| - Qachas'nek (68456) | | | | | Lesotho | No | Funds needed | |
| - Mokhohong (68458) | | | | | Lesotho | No | Funds needed | |
| - Mokhotlong (68542) | | | | | Lesotho | No | Funds needed | |
| - Qacha'snek (68546) | | | | | Lesotho | No | Funds needed | |
| - Oxbox | | | | | Lesotho | No | Funds needed | |
| - Cheche | | | | | Lesotho | No | Funds needed | |
| - St. Brandon (61986) | | | | | Mauritius | Mauritius | | |
| - Mapulanguene | | | | | Mozambique | Spain | | |
| - Chigubo | | | | | Mozambique | Spain | | |
| - Panda | | | | | Mozambique | Spain | | |
| - Caia | | | | | Mozambique | No | | |
| - Catandica | | | | | Mozambique | No | | |
| - Espungabera | | | | | Mozambique | Spain | | |
| - Zumbo | | | | | Mozambique | No | | |
| - Furancungo | | | | | Mozambique | Spain | | |
| - Mutarara | | | | | Mozambique | No | | |
| - Milange | | | | | Mozambique | Spain | | |
| - Gúruè | | | | | Mozambique | Spain | | |
| - Mocuba | | | | | Mozambique | Spain | | |

# I. METEOROLOGICAL COMPONENT

**1.1 SUPPORT TO THE REGIONAL METEOROLOGICAL OBSERVING SYSTEM**

| TASKS | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | | | | |
| - Nacala | | | | | Mozambique | Spain | | |
| - Mueda | | | | | Mozambique | Spain | | |
| - Mecula | | | | | Mozambique | Spain | | |
| - Cóbuè | | | | | Mozambique | Spain | | |
| - Likoma Island on Lake Malawi | | | | | Malawi | No | Malawi Government | To monitor lake conditions |
| ii) Maintaining of the synoptic observations at 00 and 18 UTC | | | | | Members | | | Continuous activity |
| | | | | | | | | |
| b) Fixed Automatic Surface Stations: | | | | | | | | |
| - Kartala (Grande Comoro) | | | | | Comoros | No | Funds needed | |
| - Anjouan | | | | | Comoros | No | Funds needed | |
| - Moheli | | | | | Comoros | No | Funds needed | |
| - Maseru | | | | | Lesotho | No | Funds needed | |
| - Qachas'nek | | | | | Lesotho | No | Funds needed | |
| - Nsanje (67797) | | | | | Malawi | No | External (VCP/ Bilateral) | Proposal to convert all these stations to operate on a 24 hour basis |
| - Chileka (67693) | | | | | Malawi | No | | |
| - Lilongwe (67586) | | | | | Malawi | No | | |
| - Mzuzu (67489) | | | | | Malawi | No | | |
| - Karonga (67423) | | | | | Malawi | No | | |
| - Likoma Island on La ke Malawi | | | | | Malawi | No | | |
| - Matsapha Airport | | | | | Swaziland | Swaziland | | |
| - Sikhuphe Airport | | | | | Swaziland | Swaziland | | |
| | | | | | | | | |
| c) Setting up of Automatic Weather Stations Network at 20 sites nationwide | | | | | Zimbabwe | No | Funds needed | |
| | | | | | | | | |
| d) National Lightning observation system covering 60% of the country | | | | | Zimbabwe | No | Funds needed | |

# I. METEOROLOGICAL COMPONENT

## 1.1 SUPPORT TO THE REGIONAL METEOROLOGICAL OBSERVING SYSTEM

| TASKS | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | | | | |
| e) Cyclone Warning Radar Stations | | | | | | | | |
| i) Establishment of new stations: | | | | | Mauritius would like to take the lead and negotiate, on behalf of Member states of the SWIO TCC, with the European Development Fund for the establishment of a Radar Network in the countries of the SWIO, based on a plan proposed by the former Director of RSMC La Reunion, Mr Dominique Landais. | | | |
| - Mzuzu (67489) | | | | | Malawi | No | External | Include in the RAI/TCC radar proj. |
| - Hahaya (67002) | | | | | Comoros | No | External | |
| ii) Replacement of cyclone warning radar | | | | | Mauritius | No | External | |
| iii) Rehabilitation of radar stations: | | | | | | | | |
| - Antalha (67025) | | | | | Madagascar | No | External | |
| - Antananarivo (67085) | | | | | Madagascar | No | External | |
| - Morondava (67117) | | | | | Madagascar | No | External | |
| - Chileka (67693) | | | | | Malawi | No | External | |
| - Lilongwe (67586) | | | | | Malawi | No | External | |
| iv) Installation of Doppler Radar C Band at main airports | | | | | Zimbabwe | No | External | |
| v) Installation of Doppler Radar C Band and upgrading of existing radars at Victoria Falls and Chiredzi | | | | | Zimbabwe | No | External | |
| f) Buoys: | | | | | | | | |
| - deployment of five drifting buoys per year | | | | | France | France | | |
| - deployment of three drifting buoys | | | | | South Africa | South Africa | | |
| - deployment of three drifting buoys | | | | | Mozambique & Tanzania | No | External | |
| g) Fixed buoy | | | | | Members | No | External | |

# I. METEOROLOGICAL COMPONENT

| 1.1 SUPPORT TO THE REGIONAL METEOROLOGICAL OBSERVING SYSTEM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TASKS | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
| | 2006 | 2007 | 2008 | 2009 | | | | |
| ***1.1.1.2 Upper-air Observations*** | | | | | | | | |
| a) Establishment of new pilot balloon stations | | | | | | | | |
| - Anjouan (67004) | | | | | Comoros | No | External | |
| Rehabilitate: | | | | | | | | |
| - 6 pilot balloon stations in Mozambique | | | | | Mozambique | No | External | |
| b) Establishment of upper-air (radiowind) stations: | | | | | | | | |
| - Mzuzu (67489) | | | | | Malawi | No | External | |
| Rehabiliate: | | | | | | | | |
| - Tete | | | | | Mozambique | No | External (VCP/Bilateral) | Currently no upper-air station that is functional |
| - Lilongwe | | | | | Malawi | No | | |
| c) establishment of upper-air (radiosonde) stations: | | | | | | | | |
| - Mutare (67885) | | | | | Zimbabwe | No | External | |
| - Beira (67297) & Maputo (67341) | | | | | Mozambique | No | External | |
| - Matsapha (68396) | | | | | Swaziland | No | External | |
| - Hahaya (67002) | | | | | Comoros | No | External | |
| Rehabiliate: | | | | | | | | |
| - Antsiranana (67009) | | | | | Madagascar | No | External | |
| - Farafangana (67157) | | | | | Madagascar | No | External | |
| - Toliary (67161) | | | | | Madagascar | No | External | |
| d) Provision of radiosonde for station 61995 (Vacoas) | | | | | Mauritius | No | External (VCP) | |
| e) Setting up of wind profilers at Harare and Bulawayo | | | | | Zimbabwe | No | External (VCP) | |
| f) Replacement of upper-air station at Chileka (67693) | | | | | Malawi | No | External (VCP/Bilateral) | |

# I. METEOROLOGICAL COMPONENT

| 1.1 SUPPORT TO THE REGIONAL METEOROLOGICAL OBSERVING SYSTEM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TASKS | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
| | 2006 | 2007 | 2008 | 2009 | | | | |
| g) Upgrading of existing upper-air stations both for radiosonde and upperwind (radiowind) at Vacoas (61996) and of upperwinds at Rogrigues (61988) and at Agalega (61974) | | | | | Mauritius | No | External (VCP) | |
| h) Upgrading of CLICOM Station | | | | | Mauritius | No | External (VCP) | |
| i) Provision of a media system for upgrading the dissemination of meteorological & hydrometeorological information and data | | | | | Mauritius | No | External | |
| | | | | | | | | |
| **1.1.2 Surface-based sub-system** | | | | | | | | |
| ***1.1.2.1 Meteorological Satellite System*** | | | | | | | | |
| a) Undertake necessary steps to receive Chinese polar-orbiting satellite | | | | | Members | Individual Members | External | |
| b) Installation of MSG equipment | | | | | Members concerned with relevant aid | EU | | |
| c) Installation of Data Collection Platforms (DCPs): | | | | | | | | |
| - One DCP in Mozambique | | | | | Mozambique | No | External | |
| - Three DCPs in Tanzania | | | | | Tanzania | No | External | |
| - Installation of Data Collection Platforms (DCPs) – three DCPs to be installed on Alphonse, Coetivy and Denis Islands | | | | | Seychelles | No | WMO/VCP | |
| d) Installation/ rehabilitation of DCS/DRS and MDD reception system | | | | | Botswana Swaziland | VCP | | WMO Technical assistance forthcoming |
| e) Rehabilitation of MDD reception system | | | | | Lesotho | VCP | | WMO Technical assistance forthcoming |

## I. METEOROLOGICAL COMPONENT

| TASKS | | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | | | | |
| | f) Installation of VSAT at Chileka (67693) | | | | | Malawi | No | External (VCP/Bilateral) | Wish to upgrade telecommunication system |
| | | | | | | | | | |
| **1.2** | **SUPPORT TO METEOROLOGICAL TELECOMMUNICATIONS** | | | | | | | | |
| 1.2.1 | Improvement of national data collection network by upgrading telecommunication equipment where necessary. | | | | | Members | No | Members | Continuous activity |
| | Increase national data collection network by increasing the number of stations installed with telecommunication equipment. | | | | | Lesotho | Lesotho | External | |
| | Installation of RETIM satellite telecommunication systems and satellite reception systems at Victoria Falls, Kariba, Bulawayo and Chiredzi. | | | | | Zimbabwe | No | External | |
| 1.2.2 | Establishment/upgrading of appropriate telecommunication links between the Regional and Sub-regional Advisory Centres and the corresponding national cyclone warning centres with adjacent areas of responsibility for the purpose of consultation and exchange of relevant information. To this effect, the following links require early implementation: Madagascar-Mozambique | | | | | Madagascar/ Mozambique | No | EDF, Members concerned, UNDP, VCP and other sources | |
| 1.2.3 | Acquisition of the necessary equipment, as a matter of urgency, to receive NAIROBI AFMET broadcasts at 100 bauds | | | | | Malawi | No | VCP | |

## I. METEOROLOGICAL COMPONENT

| | TASKS | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | | | | |
| **1.3** | **MAINTENANCE** | | | | | | | | |
| 1.3.1 | Maintenance workshop | | | | | Members | EDF (Comoros, Madagascar, Mauritius, Seychelles) | | |
| 1.3.2 | Establishment of a regional centre | | | | | Members | No | External | |
| **1.4** | **ISSUE OF CYCLONE WARNING FOR NATIONAL PURPOSES** | | | | | | | | |
| 1.4.1 | Consideration and, if possible, adoption of the classification of cyclone warnings similar to those already in use in other Member countries and use it within their territories, using all the available mass media, such as television, radio and press. Such classification should indicate simply and quickly the warning status | | | | | Members concerned | Members | | Continuous activity |
| | | | | | | | | | |
| **1.5** | **REGIONAL COMPUTER NETWORK** | | | | | | | | |
| 1.5.1 | Implementation of the regional computer network project on a phased basis | | | | | France, Madagascar, Mauritius and Seychelles | EDF | Members concerned, VCP and other sources | With support from France |
| | | | | | | | | | |
| **1.6** | **CLIMATOLOGY** | | | | | | | | |
| 1.6.1 | Submission of reports on climatological activities to the chairman (Mr S.N. Sok Appadu) before each session of the Committee | | | | | Members | Members | | Regularly |
| | | | | | | | | | |
| **1.7** | **FORECAST** | | | | | | | | |
| 1.7.1 | Implementation of workstations for forecasting | | | | | Members | No | External | |

**HYDROLOGICAL COMPONENT**

| TASKS | | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | | | | |
| **2.1** | **HYDROLOGICAL NETWORKS, SERVICES AND FACILITIES** | | | | | | | | |
| 2.1.1 | Preparation of an inventory of flood-prone areas, including, where available, references to historical floods and related damage, and to rank flood-prone areas according to preliminary estimates of risk and vulnerability | | | | | Members | Members | | |
| 2.1.2 | Prepare plans, targets and measures for the improvement of hydrological networks and related services for monitoring and forecasting of hydrological disaster caused by tropical cyclones | | | | | Members | Members | | |
| 2.1.3 | Establishment, strengthening and expansion of regional and national real-time on near real-time hydrological networks, including SADC-HYCOS network: | | | | | Members | No | External | This is a new entry, it might be tested if it is applicable to other Members |
| | - revitalize SADC-HYCOS DCPs and execute 2nd phase; | | | | | Swaziland | No | Swaziland, SADC, WMO | |
| | - revive and expand telemetric network. | | | | | Swaziland | No | Swaziland, SADC, WMO | |
| | | | | | | | | | |
| **2.2** | **FLOOD RISK ANALYSIS AND MAPPING** | | | | | | | | |
| 2.2.1 | Preparation of an inventory of flood-prone areas and maps of these areas | | | | | Members concerned | Members | | |
| 2.2.2 | Ranking of flood-prone areas after preliminary estimates of risk and vulnerability | | | | | Members concerned | Members | | |
| 2.2.3 | Studies of frequencies, duration and intensity of rainfall (cyclones) | | | | | Members concerned in collaboration with DMC Harare and RSMC Réunion | Members | | |

## II. HYDROLOGICAL COMPONENT

| TASKS | | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | | | | |
| **2.3** | **FLOOD FORECASTING SYSTEM** | | | | | | | | |
| 2.3.1 | Evaluation of existing flood forecasting systems: | | | | | Members, in coordination with the RA I WG on Hydrology | Members | | Continuous activity |
| | - adoption of appropriate model that also responds to meteorological forecasts; | | | | | Swaziland | No | Swaziland | |
| | - Set up a decision support model of a hydrological nature for informing flood warning systems. | | | | | Swaziland | No | Swaziland/ WMO (VCP) | |
| 2.3.2 | Designate a river basin, to be considered for pilot projects, where flood risk assessment and mapping will be demonstrated as well as the establishment of a flood forecasting system: | | | | | Members | No | Members, VCP/ WMO or bilateral | |
| | - conduct this for the Mbuluzi Basin | | | | | Swaziland | No | Swaziland, VCP/ WMO, cooperating partners | |
| 2.3.3 | Establishment, improvement and/or expansion of hydrological forecasting (including flash flood) and warning systems in flood-prone areas | | | | | Members | No | Members | Ongoing |
| 2.3.4 | Comparison of flood forecasting system | | | | | Members | No | Members/ WMO | To be done concurrently with point 2.3.1 |
| 2.3.5 | Creation of a hydrological data bank for river basins, with cyclone related flood problems | | | | | Members in collaboration with DMC Harare | No | Members | |

**II. HYDROLOGICAL COMPONENT**

| TASKS | | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | | | | |
| 2.3.6 | Evaluation of the capacity of Member states to meet flood management requirements | | | | | Swaziland | No | Consultancy | These have been added for Swaziland; in future, it may be tested for other Member states as well |
| 2.3.7 | Establishment of appropriate programme to strengthen lacking capacity | | | | | Swaziland | No | Swaziland, WMO, Cooperating partners | |
| 2.3.8 | Review of reservoir operation rules to ensure optimal contribution of dams to flood disaster mitigation | | | | | Swaziland, in collaboration with Mozambique and RSA | No | Swaziland, consultancy, stakeholders | |

## II. HYDROLOGICAL COMPONENT

| TASKS | | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | | | | |
| **3.1** | **DISASTER PREVENTION AND PREPAREDNESS** | | | | | | | | |
| 3.1.1 | Monitor activities of National Disaster Preparedness and Prevention committees in respect of cyclones and associated floods to formalize disaster preparedness and relief plans and cyclone and flood warning systems | | | | | Members | No | Members | Continuous activity |
| 3.1.2 | Compilation of reports evaluating damage caused by cyclones and heavy rainfalls. A summary of this report to be submitted, using the form provided to Members as guidance, to all other Member countries of the committee particularly RSMC La Réunion and to the Secretary-General of WMO for transmission as appropriate to other international agencies such as DHA and IFRC | | | | | Members | No | Members | Continuous activity |
| 3.1.3 | Planning of study tour in management and/or organization of DPP and relief activities during the cyclone season in cyclone-prone areas | | | | | Members concerned | No | Members and other sources | With assistance from WMO, OCHA and IFRC |
| 3.1.4 | Participation, using all available means (pamphlets, publications, films, video-cassettes) in informing the population concerned | | | | | Members and committee | No | Members | With assistance from WMO; continuous activity |
| 3.1.5 | To prepare an inventory of all focal points for Disaster Management Units in the Member Countries of the RA I/TCC | | | | | WMO | No | Members | Continuous activity |
| 3.1.6 | Strengthen cooperation and collaboration between NMSs and DMUs at National and Regional Levels | | | | | Members | No | Members | Continuous activity |

**III. DISASTER PREVENTION AND PREPAREDNESS**

| TASKS | | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | | | | |
| 3.1.7 | Provision of vital tools in order to strengthen the capacity of Early Warning Systems at NMSs such the setting up of Weather Radars Network among others | | | | | Member and development partners | No | Members and other sources | With assistance from WMO/ ISDR and others |
| 3.1.8 | Increase Public awareness in the use of products, services and warnings issued to mitigate the impacts of natural disasters | | | | | Members | No | Members | With assistance from WMO; continuous activity |
| 3.1.9 | Ensuring availability of adequately trained personnel (Human Resource) in order to implement the objectives of Disaster Reduction and Preparedness Programme | | | | | Members and development partners | No | Members and other services | With assistance from WMO; continuous activity |
| | | | | | | | | | |
| **3.2** | **PROTECTION OF THE ENVIRONMENT** | | | | | | | | |
| 3.2.1 | Maximum use of GEF should be made to protect the environment | | | | | Members | No | Members, GEF | With assistance from WMO and UNEP |
| | | | | | | | | | |
| **3.3** | **ISDR** | | | | | | | | |
| 3.3.1 | Keep abreast with and participate in the activities and programmes of UN-ISDR through the National Focal Points and DMUs and also support the dissemination of the objectives of ISDR | | | | | Members | No | Development partners especially ISDR/UNEP | With assistance from WMO; continuous activity |

## IV. RESEARCH

| TASKS | | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | | | | |
| **4.** | **RESEARCH** | | | | | | | | |
| 4.1 | Undertake climatological work on the effect of sea-surface temperature on tropical cyclone activity and intensity | | | | | Members concerned | Members | | Continuous activity |
| 4.2 | Make intensive studies and investigations on those aspects of cyclone characteristics and their effects which might be peculiar to the South-West Indian ocean, taking into consideration global warming and increased cyclone activity (see 1.6.1 above; regular climatological reports)* | | | | | Members | No | Members | Continuous activity |
| 4.3 | Cooperate, as far as possible, in the implementation of the tropical cyclone related projects being undertaken by the CAS Group of Rapporteurs on Tropical Meteorology and the RA I Working Groups on Research in Tropical Meteorology and Hydrology* | | | | | Members | No | Members | Continuous activity |
| 4.4 | Encourage research with emphasis on the use of methods such as NWP and limited area models. To this effect, research fellows should have access to the scientific facilities at RSMC La Réunion | | | | | Members | No | Members and other sources | Continuous activity |
| 4.5 | Maintain a data bank at RSMC La Réunion in cooperation with DMC-Harare | | | | | RSMC La Réunion, DMC-Harare | France, DMC-Harare | | Continuous activity |

* With the help of RSMC – La Réunion

V. TRAINING

| TASKS | | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | | 2006 | 2007 | 2008 | 2009 | | | | |
| **5.** | **TRAINING** | | | | | | | | |
| 5.1 | Assess current availability and capabilities of personnel and technical staff in the fields of meteorology, hydrology and disaster prevention and promote their training | | | | | Members | Members | | Continuous activity |
| 5.2 | As regards meteorology, emphasis to be placed on: | | | | | | | | |
| | a) training of technicians, particularly with respect to the operational and maintenance of electronic equipment and computers; | | | | | Members, WMO | No | WMO (regular budget, VCP, fellowships, UNDP, Members & other sources) | |
| | b) use of radar and satellite pictures in the location of tropical cyclones, in the determination of their intensity (Dvorak technique) and other characteristics and in their tracking; | | | | | Members, WMO | No | EDF | Continuous activity |
| | c) forecast evolution of tropical cyclones, including the use of traditional methods and familiarization with NWP models. | | | | | Members, WMO | No | | |
| 5.3 | In the field of hydrology, primary attention to be given to: | | | | | | | | |
| | a) hydrology of flood and flood-risk evaluation[T]; | | | | | Members | No | WMO (regular budget, VCP, fellowhips, UNDP, Members & other sources) | Continuous activity |
| | b) hydrological forecasting and warning[T]. | | | | | Members | No | | |

[T] Workshop/Seminar

V. TRAINING

| TASKS | TIME SCALE | | | | BY WHOM | RESOURCES OBTAINED | POSSIBLE RESOURCES | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | | | | |
| 5.4 Training the field of disaster preparedness of appropriate personnel in the operational of warning systems and the operation of disaster preparedness | | | | | Members | No | UNDP and other sources | Continuous activity |
| 5.5 Promote and take appropriate steps to organize training courses, workshops and seminars relevant to all the fields described in the previous paragraphs | | | | | Members | No | WMO (regular budget, VCP, fellowhips, UNDP, Members and RSMC La Réunion | Continuous activity |

**STRATEGIC 2-YEAR TECHNICAL PLAN**

**(2005 – 2007)**

| Priority Rating | Items | Stakeholders | Funding Sources | Remarks/Deadlines |
|---|---|---|---|---|
| 1 | To accelerate the implementation of surface and upper-air observing networks in the Region. | Members | | |
| 13 | To ensure the sustained development or at least the continuation of drifting buoys deployment in the Indian ocean through the joint IOC-WMO IBPIO program and make available the buoy data to Members. | Members | | Recruit more VOL trading in the region; Provision of buoy deployment facilities |
| 2 | To accelerate the establishment of weather radar networks in the Region. | | | |
| 3 | To improve and upgrade of telecommunication equipment in particular the GTS. | | | |
| 4 | To upgrade telecommunication links between the Regional and Sub-regional Advisory Centres and the RTHs and corresponding national cyclone warning centres. | | | |
| 5 | To ensure the completion of the MSG project with special attention to the sustainability of the provided systems | All Members | | |
| 10 | To ensure continued operation of MSG reception in all the African countries. | | | |

| Priority Rating | Items | Stakeholders | Funding Sources | Remarks/Deadlines |
|---|---|---|---|---|
| 11 | Upgrade MSG software and made available to Members free of charge to develop and monitor severe weather events, | | | |
| 12 | To start the implementation of SADC-HYCOS Phase II. | All Members | | |
| 15 | To be involved in the Tsunami Early Warning System Initiative and its integration into Multi-Hazard | All Members | | |
| 9 | To actively participate in the planned Regional Workshop on Tropical Cyclone Research. | All Members | | |
| 7 | To conduct training on the use of NWP and EPS products for TC forecasting in the SWIO. | | | |
| 15 | To carry out monitoring exercise on the effectiveness of training activities in the Region. | | | Report to be submitted to RA I/TCC-XVIII. |
| 14 | To ensure that training is provided that would enable Members to develop user-specific products such as NDVI, SST, forest fires, etc. | | | |
| 6 | To establish Working Group on Information Exchange. | | | |
| 8 | To encourage Meteorological Services to take full advantage of improvements in climate monitoring and prediction services and to have them incorporated in Disaster Preparedness and Management Plans. | | | |

| Priority Rating | Items | Stakeholders | Funding Sources | Remarks/Deadlines |
|---|---|---|---|---|
| 16 | To facilitate exchange of information in tropical cyclone monitoring and prediction with operational regional climate centres. such as DMC, ICPAC. | | | |

APPENDIX IX

**VCP STATEMENT ON THE PROJECTS RELATED TO THE MEMBERS OF RA I TROPICAL CYCLONE COMMITTEE FOR THE SOUTH-WEST INDIAN OCEAN IN THE PAST FIVE YEARS**