W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

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

FIFTEENTH SESSION

Moroni, Comoros

4 to 10 September 2001

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 Comoros, the fifteenth session of the WMO Regional Association I (Africa) Tropical Cyclone Committee for the South-West Indian Ocean was held at the Centre National de l' Artisanat Comorien, Moroni, Comoros, from 4 to 10 September 2001. The session was attended by representatives from Botswana, Comoros, France (La Réunion), Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Republic of South Africa, Seychelles, Swaziland, United Republic of Tanzania and Zimbabwe. Australia and Kenya participated as ex-officio members of the Committee. Observers from the Indian Ocean Commission (IOC), the WMO Regional Association V Tropical Cyclone Committee (RA V/TCC) for the South Pacific and South-East Indian Ocean, Southern Africa Transport and Communications Commission (SATCC), International Federation of Red Cross and Red Crescent Societies (IFRC) and local representatives of Comoros also attended the session. The list of participants is given in Appendix A to this report.

1.1.2 Mr Mahamoud Ali Bay Poundja, Chief of the Meteorological Services and Permanent Representative of Comoros with WMO, welcomed the participants to Comoros. He expressed appreciation to WMO and the Committee for selecting Comoros to host the fifteenth session of the RA I/TCC. He noted that the frequency of occurrence and severity of tropical cyclones in this region was a major challenge as we enter the 21st century. He reiterated his support to the work of the Committee. He conveyed the deep gratitude of the Committee to the Secretary-General of WMO for the assistance provided to the participants before and during the session.

1.1.3 In his welcome remarks, Mr Bakar Abdallah Boina, Governor of the Grand Comoros emphasized the point that weather systems such as tropical cyclones pay no heed to international boundaries. It is, therefore, imperative that national meteorological services cooperate to the fullest extent possible in their respective regions.

1.1.4 The Chairman 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 the Federal Islamic Republic of the Comoros and to its people for their warm welcome and hospitality. Gratitude was also expressed to the Permanent Representative of Comoros with WMO for the excellent facilities provided to the delegates in order to bring the work of the Committee to a successful conclusion.

1.1.5 On behalf of Professor G.O.P Obasi, Secretary-General of WMO, Ms Nanette Lomarda, the WMO Secretariat representative welcomed the participants and expressed the appreciation of WMO to the Government of Comoros for the kind invitation to host the biennial session of the Committee. She thanked Mr R.R Vaghjee for the excellent work accomplished by the Committee before his retirement as Chairman in June 2000 and congratulated Mr S.N. Sok Appadu on his designation as Chairman. She also congratulated the RSMC La Réunion and the Members of the Committee as well as ex-officio members Australia and Kenya on the excellent work accomplished during the intersessional period. In closing, she assured the Committee that WMO will continue to support the RA I/TCC in achieving its objectives to the extent possible.

1.1.6 In his inaugural address, Honourable Harithi Bacar, Minister of Economy and Acting Minister of Transport, on behalf of the President of the Federal Islamic Republic of the Comoros, Col Azali Assouman, the Prime Minister and the people of Comoros, welcomed all participants to the country. He stated that it was of great importance for Comoros to host this session particularly after a rather severe tropical cyclone season in the region. He noted that

there is a need for closer regional cooperation in order to mitigate the disastrous effects of cyclones. In this regard, he was grateful to the assistance extended to Comoros and other developing countries in the region particularly by WMO and Météo-France through the RSMC La Réunion Tropical Cyclone Centre in enhancing their capacity to issue much needed timely warnings.

1.1.7 The Minister hoped that the future plans and activities of the Committee will encourage the collaboration with the South African Development Community (SADC) in order to cope with problems associated with the damaging effects of cyclones. He noted that although the Meteorological Service of Comoros has the capacity to provide adequate weather forecasts to the people, he urged for enhanced collaboration with non-governmental organizations in the country who could be instrumental in forging closer contacts with the end-users. He wished the session success and fruitful deliberations. The Minister declared the fifteenth session of the 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 without change. The agenda for the session is given in Appendix B to this report.

1.3 Election of the vice-chairman (agenda item 1.3)

The Committee unanimously elected Mr Mahamoud Ali Bay Poundja (Comoros) as vice-chairman 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 a working group, composed of a representative from each Member country, to make a detailed review of its Operational and Technical Plan. Mr Ian Tyrrell Hunter (RSA) was designated Chairman, Mr Paul Remois (France) as Co-chairman while Mr E.J. Mutoni (Tanzania) was given the task of Rapporteur for the said working group.

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

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

2.2 The Chairman expressed satisfaction with the training events on tropical cyclone forecasting held during 1999 and 2000 in which some Members of the Committee participated. He also welcomed the attachment of forecasters from Comoros and Seychelles to the RSMC La Réunion during the 2000/2001 cyclone season.

2.3 On behalf of the Committee, the Chairman expressed appreciation on the decision of the Permanent Representative of France with WMO for RSMC La Réunion, in collaboration with WMO, to conduct the Second RA I Training Course on Tropical Cyclones and Public Weather Services in Saint-Denis, La Réunion, from 29 October to 13 November this year.

2.4 The Chairman noted with satisfaction the progress made by the Southern African Countries especially within the GTS and Observing System during the intersessional period.

2.5 The Chairman noted with appreciation the effective role played by the South African Weather Service in the implementation of activities benefiting the Members particularly during the cyclone season.

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 fourteenth session of the Committee (Quatre Bornes, Mauritius, 21 to 27 September 1999).

3.2 The Committee noted with satisfaction the publication by WMO of the booklet "Twenty Years of Progress and Achievement of the WMO Tropical Cyclone Programme (1980-1999)" and the brochure "Specialized Centres Provide up-to-date Tropical Cyclone, Hurricane and Typhoon Advisories".

3.3 The Committee was pleased to note that the need for close collaboration with the TCP had been recognized at JCOMM-1, especially in areas of storm surge and wave prediction associated with tropical cyclones.

3.4 Recognizing the importance of capacity building among the Members, the Committee was pleased to note the continuation of co-sponsorship by WMO for the two-week Southern Hemisphere Training Course organized by the Bureau of Meteorology, Australia and the RA I Training Course on Tropical Cyclones by Météo-France.

3.5 Noting the significant progress achieved through collaborative projects in some TCP regional bodies, the Chairman called upon Members to put forward proposals for similar projects in RA I.

4. REVIEW OF THE 1999/2000 AND 2000/2001 CYCLONE SEASONS (Agenda item 4)

Summary of the past two cyclone seasons

4.1 Reports of the 1999/2000 and 2000/2001 cyclone seasons were presented to the Committee by the representative of the RSMC La Réunion - Tropical Cyclone Centre.

RSMC La Réunion 1999/2000 cyclone season summary

4.2 The 1999/2000 cyclone season in the South-West Indian Ocean marked the return of a much greater activity than usual in the basin. The excess of activity was not due to a particularly large number of depressions but rather to an average life cycle lengthened by the occurrence of two systems (Hudah and Eline) whose life cycles were exceptionally long, especially more so in the case of the latter.

4.3 Compared with the 1999/2000 season, the cyclone activity in 2000/2001 was nearly reduced by half and set noticeably below normal activity, thus reaching the same level of the 1998/1999 fairly inactive season. This reduced activity was due essentially to the small number of systems of moderate intensity (tropical storms), with the number of cyclonic days (with the presence of two mature tropical cyclones) being for its part slightly more than normal.

4.4 The reports on the 1999/2000 and the 2000/2001 cyclone seasons submitted by the RSMC La Réunion and member countries discussed at the session are given in Appendices C and D to M, respectively.

4.5 The delegate from Zimbabwe requested that copies of the CD-ROM "Floods of Mozambique" (a video presentation of UNDP and the Republic of Mozambique) presented during the session be distributed to Members of RA I/TCC. The session then proposed that

France, through RSMC La Réunion investigate the possibility of making copies available to Members.

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 an in-depth review of all the chapters of the Tropical Cyclone Operational Plan for the South-West Indian Ocean.

5.3 The Committee noted the proposal of the RA V/TCC that a tropical cyclone have only one name during its lifetime.

5.4 The Committee noted the request of South Africa that RSMC La Réunion continue their regular bulletin while the system is still overland and life-threatening in terms of extreme precipitation events. In this regard, the representative from RSMC La Réunion informed the Committee that the centre is willing to continue to provide regular information on the tropical disturbance after their landfall. However, the centre can not ensure the provision of all technical bulletins. In connection with this, RSMC La Réunion requested Members to provide the centre with tropical cyclone data such as tropical cyclone passage reports.

5.5 The Committee further noted the following proposals put forward by RSMC La Réunion:

- that the date for change of season be moved from 1 August to 1 July for the SWIO cyclone basin;
- that a tropical disturbance retain its originally assigned name throughout its lifetime in the entire South-West Indian Ocean cyclone basin;
- that the cyclone basin adopt a single list of tropical cyclone names;
- that a rotating (circular) list of tropical cyclone names be used; and
- that the boundary of the SWIO cyclone basin be moved from 90E to 95E.

5.6 After a lengthy and detailed discussion, the Committee decided on the following:

- the date for change of season is moved from 1 August to 1 July for the South-West Indian Ocean cyclone basin;
- retention of the procedure on naming tropical cyclones in the SWIO as specified in the Operational Plan for the SWIO;
- that the boundary of the SWIO cyclone basin not be moved from 90E to 95E.

5.7 The Committee after a thorough deliberation approved the list of tropical cyclone names given in Appendix N for the cyclone seasons 2002/2003 and 2003/2004.

5.8 Amendments to the text of the Operational Plan as given in Appendix O were recommended to the President of RA I for approval on behalf of the Regional Association.

5.9 The Committee requested the Secretary-General of WMO to publish the 2001 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 submit to the WMO Secretariat before 30 September 2001 any subsequent changes to the Plan for inclusion in the 2001 edition.

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

Under this agenda item, the Committee established a working group 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 fourteenth session of the Committee. The Committee ultimately concurred with the updated Plan submitted by the group which is reproduced in Appendix P.

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 as compared with 1998, the overall coverage by surface data (based on monitoring results from 1 to 15 April 2001) has been improved. In particular, the number of stations providing 50% reports or more is 96 (92 in 1998), the number of stations with less than 50% of reports has been decreased from 30 in 1998 to 23 in 2001. The positive trend was also detected in terms of silent stations - from 17 in 1998 to five in 2001. The major input for the above improvement of data coverage has been provided by Botswana, Comoros, France (French islands), Madagascar, Mauritius, Seychelles, South Africa, and Zimbabwe.

6.1.3 The Committee was also informed that no improvement in the availability of TEMP reports in the region was noted in the recent monitoring results.

6.1.4 The Committee urged Members to ensure that they inform both the regional and global monitoring centres of any change/s in their observation networks.

Telecommunication Systems

6.1.5 The Committee noted that the results of the annual global monitoring carried out from 1 to 15 October 2000 show that the availability of SYNOP and TEMP reports from the countries concerned is still not regionally satisfactory. The difficulties which developing countries have in maintaining equipment throughout the year, procurement of costly expendables as well as lack of reliable telecommunication links in the region, are still the reasons for the low results.

6.1.6 The Committee was informed that significant improvement in the implementation of the Regional Meteorological Telecommunication Network (RMTN) has taken place in parts of RA I.

6.1.7 The committee noted with satisfaction that, in addition to the GTS circuits, a network for meteorological exchanges network using the Internet had been implemented in the southwest Indian Ocean. This network had made good the past insufficiencies of the subregion. In the light of the presentation of this network made by Laurent Zerbib of RSMC Réunion, the Committee encouraged all NMHSs to continue their activities in this area. They were reminded that the Director-General of Météo-France had officially given Mr Zerbib the mission of helping to improve telecommunications in the RA I subregion and were

encouraged to communicate with the RSMC in order to obtain the information and advice required to implement this very promising solution. Still on the subject of new technology, the Committee invited all the participants to ask the RSMC Director for access to the RSMC web server at the following address: www.meteorologique.eu.org/CMRS.

6.1.8 The Committee further noted that a regional meteorological data communication strategy, in parallel with GTS rehabilitation and capacity building projects required to urgently address the most significant implementation shortcomings in RA I, have been agreed upon and are currently under development.

6.1.9. Mr Laurent Zerbib, of RSMC Réunion, presented the RANET project implemented in the region by ACMAD, demonstrating, in particular, reception and real-time visualization of the data distributed by this system. Satellite images, cyclone trajectories, cyclone forecast bulletins, etc., were presented in real time on a microcomputer fitted with the "Worldspace" receiving system. Aware of the immense possibilities offerred by this inexpensive piece of equipment (approximately US$ 200) enabling a very wide and almost continuous distribution of cyclone information to different groups of people, even in the most remote regions, the Committee urged the Members to facilitate wider implementation of this new tool. It proposed that a working group be formed to define the list of products that should be distributed via this system and to determine a way in which the different NMHSs of the subregion may supply this server. It invited the NMHSs wishing to deploy many of these units in their countries to approach ACMAD to obtain the best prices negociated within the RANET project.

6.1.10 Bearing in mind the increasing value of the Internet - both for the dissemination of observations and its potential for providing forecasters with tropical cyclone prediction tools, the Committee urged Members to request their NMHSs to increase their Internet capacity.

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 reiterated its concern about the absence of any permanent geostationary satellite coverage over the Indian Ocean and requested WMO to make representations with EUMETSAT to find a solution ensuring geostationary coverage of the Indian Ocean beyond the lifetime of Meteosat-5. The Committee thanked EUMETSAT for agreeing to maintain its coverage over the Indian Ocean beyond the end of 2001. It also requested for information on EUMETSATs contingency plans if any.

Marine Observations

6.1.13 The number of ship reports remain fairly constant from one year to another, concentrated on the main shipping routes, but 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 in particular 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/

As a result of cooperative work within the Programme, many of the previous simple oceanographic drifters in the region also now make meteorological measurements.

6.1.14 To assist in expanding the availability of marine data in the region, the Committee urged Members to:

- participate in whatever way possible in the work of the International Buoy Programme for Indian Ocean (IBPIO) (e.g. through the provision of buoy deployment facilities);

- recruit more Voluntary Observing Ships (VOS) trading in the region;

6.1.15 The Committee noted that the Chairman has to approach the UK Meteorological Office, Bracknell in order to consider upgrading the MDD receiving system so that all VOS observations in the South-West Indian Ocean will be made available.

Aeronautical Meteorology

6.1.16 Automated meteorological reports from aircraft collectively known as Aircraft Meteorological Data Reporting (AMDAR) systems represent a prime source of good quality, high resolution and timely upper air data. AMDAR data are vital for improving the accuracy of meteorological forecasts and warnings particularly over data sparse areas such as the Indian Ocean. In March 1998, WMO established an AMDAR Panel to coordinate and promote global AMDAR development with the goal to enhance the upper air component of the WWW Global Observing System (GOS).

6.1.17 The Work Programme of the Panel included four high priority items to be addressed in the short term. These items included the coordination of national and regional AMDAR programmes, improvement of AMDAR data exchange and quality control, and two pilot projects including one on Southern Africa. The aim of the pilot project on Southern Africa was to enhance the quantity of automated reports over the Southern Africa region, including adjacent areas of the Indian Ocean, as a means to improve meteorological forecast accuracy. The South Africa Weather Service has kindly taken the lead in implementing this high priority AMDAR pilot project. Activities undertaken include a survey of airports and aircraft flying in the region, AMDAR data collection and distribution as well as the promotion and evaluation of their use in improving NWP output. Airlines operating aircraft equipped with the required AMDAR data collecting systems have been identified and arrangements made to download the AMDAR data from participating aircraft on the GTS. The first AMDAR data was received during a SAA flight Johannesburg/Miami/Johannesburg on 22 February 2000. The AAA software package had been loaded on to other 747-400s. Evaluation tests are planned to be conducted shortly to determine the impact of AMDAR data on the performance of NWP models.

6.1.18 In addition to foreign international airlines providing AMDAR data over Africa and the Indian Ocean region, such as British Airways, KLM, SAUDIA and Lufthansa, two African airlines, namely, Air Mauritius and South African Airways flying over the South Indian Ocean continue to provide AMDAR data to the region. In addition to AMDAR data provided by the main participating airlines, Air Namibia and Qantas were also expected to provide AMDAR data to the project but on an irregular basis. The next step would be to implement a self-sufficient Southern Africa AMDAR Programme starting with South Africa and Namibia and hopefully with other countries of the regions joining the programme later.

6.1.19 Given the importance of this data in the subregion, the Committee invited its Members to do everything possible to encourage airline companies not yet participating in the AMDAR programme to transmit AMDAR data and to ensure that these data be forwarded to the GTS.

6.2 Hydrological Component (agenda item 6.2)

RA I Working Group on Hydrology

6.2.1 A summary report on the work of the RA I Working Group on Hydrology, established by XII-RA I was presented by a member of the RA I Working Group on Hydrology. The main task of the group is to develop and to promote the implementation of action proposals for water resources assessment based on the recommendations of the Sub-Saharan African Hydrological Assessment Project and the action plan agreed by the African Conference on Water Resources: Policy and Assessment (Addis Ababa, March 1995). The activities of the working group are particularly relevant to the aims of the Committee, for providing adequate liaison to the hydrological component of the Tropical Cyclone Committee.

Regional HOMS activities

6.2.2 The Committee noted with appreciation that the process of updating the HOMS Reference Manual (HRM), initiated in 1998, culminated in its first phase in July 2000 when the Version 2000 became available online and that in early 2001, a CD-ROM containing Version 2000 of the HRM, together with promotional material on HOMS in the form of a brochure and a slide presentation with relative script, were distributed to the 125 HOMS National Reference Centres (HNRC) currently in operation. Steps have been taken to distribute future versions of the HRM via e-mail, to make the updating process as dynamic as possible.

Flood-risk analysis and flood forecasting systems

6.2.3 The Committee was informed that the SADC-HYCOS project currently operates about 40 data collection platforms (DCPs), which have been installed on the major rivers in the sub-region. The DCPs transmit the flood-related information (water level and rainfall) six times per day. The information is made available by EUMETSAT, Darmstadt, Germany on their Web-site. The data is automatically collected from there by the Regional Centre of the Project, hosted by the Directorate of Hydrology, Department of Water Affairs and Forestry (DWAF), Pretoria, RSA. The water level data are converted into discharges and stored into the regional data base, and from there are accessible on the Web-site of the project. (http://www-sadchyco.pwv.gov.za/sadc/).

6.2.4 The Committee was further informed that during the February-March 2000 and 2001 floodings which affected the south-eastern part of the region (Botswana, Mozambique, South Africa, Swaziland, and Zimbabwe), the Web-site was not fully operational and the NHS(s) of some of the countries did not have fast and easy access to the internet. Therefore, during the flooding, the information on water levels and flows was exchanged mostly through telephone communications between the Director of Hydrology, DWAF, Coordinator of the project and the officers-in-charge in the concerned NHS(s).

6.2.5 The Committee noted that a flood monitoring and warning system might become an identified component for the coming Phase II of SADC-HYCOS, if the participating countries and SADC express such willingness.

Technical cooperation activities

6.2.6 The Committee noted with satisfaction that under the supervision of WMO, WHYCOS continues to progress and has become a major activity under the HWRP. At present, there are 17 HYCOS components at various stages of development and implementation. Five of these projects are being developed in RA I at the request of, and with the participation of, the Member countries. Since the last session of RA I/TCC, the first phase of MED-HYCOS has terminated and a proposal has been prepared for a second phase. France has offered to continue hosting the Project Regional Centre in Montpellier and to support its work for a further period of 4 to 5 years. The SADC-HYCOS contributed substantially to the monitoring

and management of the floods, which affected Southern Africa during early last year. This increased awareness of the value of the project has stimulated action for the development of a second phase of the project so as to consolidate and expand its activities.

6.2.7 The Committee was informed that the implementation of the Pilot Phase of AOC-HYCOS (Western and Central Africa) started in January 2000, thanks to a grant of 2 million French Francs (USD 300,000) from the Ministry of Foreign Affairs of France. The pilot phase is being considered by potential donors as a test run for a comprehensive regional HYCOS project, which could involve up to 23 countries of the sub-region. A technical review of the pilot phase and a donor meeting to discuss the funding of the comprehensive AOC-HYCOS project are planned for 2001.

6.2.8 The Committee was further informed that a project document of IGAD-HYCOS has been prepared, reviewed and endorsed during the seventh annual meeting of the IGAD Directors of Meteorology, Hydrology and Early Warning Systems (Nairobi, Kenya, 27-28 January 2000) and subsequently submitted to the European Commission. The EC suggested that, because of the highly technical nature of the project and the need to establish more surely the project's sustainability and long term capacity to respond to the regional needs, a detailed project document was necessary, including a detailed preparation and design phase followed by an implementation phase. Upon request from the IGAD Secretariat, WMO is assisting in the preparation of such a document.

6.2.9 The Committee was pleased to note that the Hydrology and Water Resources Programme (HWRP) of WMO through VCP (F) initiated a hydrological data rescue project with a pilot study involving seven African countries. The project has been completed and provided a PC with some software and an expert to train local staff in each country. It should assist the countries in their data bank management and ensure the security for the historical hydrological data which are essential for climate prediction and long term planning of projects for sustainable water resources development and food security.

6.2.10 The Committee urged WMO to organize a Regional Workshop on Estimation of Precipitation and Storm Surge Prediction during the intersessional period.

6.2.11 Activities to be carried out by the Members are described in the Committee's Technical Plan and its Implementation Programme.

6.3 Disaster Prevention and Preparedness Component (agenda item 6.3)

6.3.1 The Committee noted with appreciation the report of the WMO representative on activities and efforts of WMO to meet the goals of the ISDR (post-IDNDR) and the leading role it plays through those aspects of its major scientific and technical programmes that concerned mitigation of, and preparedness for, natural disasters of meteorological and hydrological origin.

6.3.2 The Committee noted the prominent role of WMO in the Inter-Agency Task Force (IATF) on Disaster Reduction established in the context of the ISDR.

6.3.3 The Committee was informed that the Second and Third Meetings of the IATF had taken place in Geneva, 10-11 October 2000 and 3-4 May 2001 respectively. WMO, as lead agency of Working Group 1 (Climate and Disasters), presented reviews of work undertaken by the group, including the considerable inter-agency work initiated or supported by the group's predecessor, the Inter-Agency Task Force on El Niño.

6.3.4 The Committee was pleased to note that to ensure that the WMO Secretariat acts quickly and effectively in support of Members in situations of emergency and disaster, the Secretariat established the Emergency and Disaster Response Group (EDRG) as the primary steering component. In response to a request from the EDRG in its meeting held on 20 August 2001, the Committee urged Members to provide the WMO Secretariat through the

TCP Division, information in case of natural disasters to enable WMO's Emergency Assistance Response Team (EART) to take timely action.

6.3.5 With a view to facilitating the quantifying of loss of life and property damage caused by tropical cyclones, the Members were urged to include in their national country reports for the next session the completed form for "disaster damage report" distributed by WMO to all Members of RA I/TCC at the previous session.

6.3.6 The Committee was informed that a training seminar on natural disaster is being planned for the second half of 2002 under the European Union funded "Meteorological Cooperation Project" of the International Oceanographic Commission (IOC). Inasmuch as the IOC lacks both expertise and sufficient financial resources required for the organization of this event, the representative of IOC requested WMO for assistance and to help identify United Nations agencies that might be willing to contribute to this event.

6.3.7 The Committee requested WMO to provide Members information on the legal framework pertaining to Disaster Management.

6.4 Research (agenda item 6.4)

6.4.1 The Committee noted that the report of the proceedings of the Fourth WMO/ICSU International Workshop on Tropical Cyclones (IWTC-IV) (Haikou, China, 21 to 30 April 1999) has been published and received by Members. It urged all Members to ensure that all relevant recommendations in the report are implemented.

6.4.2 The Committee was informed that the second session of the CAS Working Group on Tropical Meteorology Research Programme (WGTMR-II) (Cairns, Australia, 28 May to 1 June 2001) has recommended that the Fifth WMO Workshop on Tropical Cyclones (IWTC-V) be held in Cairns, Australia from 3 to 12 December 2002 with Professor R.L. Elsberry (USA) as the chairman of the International Committee (IC). In accordance with the usual practice, the Chairman of RA I TCC will represent the Committee in the IC. The Committee urged its Members to ensure full participation in the workshop. The Committee appealed to relevant scientific organizations and countries to provide logistical and financial support to Members to enable them to participate in the workshop.

6.4.3 The Committee noted that although the final report of the WGTMR-II was yet to be published, some of the recommendations of the meeting are relevant to the activities of the Committee. These include:

- The distribution at all TCP meetings of copies of the paper entitled "Tropical cyclones and global climate change" which was published in the AMS Bulletin and the continuation of future assessments of the paper with quadrennial updates to coincide with future meetings of the WGTMR;

- The continuation of the CAS demonstration project "Tropical Cyclone Disaster" adopted by CAS-XI as a priority mission. The project should however be renamed "WMO/CAS Priority Mission on Tropical Cyclones".

The Committee was pleased with the recommendations and stressed the substantial contribution of their implementation to the other efforts being made to reduce the adverse effects of tropical cyclones.

6.4.4 The Committee was pleased to note that under CAS Project TC3 (Landfalling Tropical Cyclones) discussed at its last meeting, a formal project proposal was submitted by WGTMR to the Scientific Steering Committee (SSC) of the World Weather Research Programme (WWRP) which approved it. The Committee urged donor countries and relevant scientific organizations to support the project which if fully implemented will no doubt reduce substantially the disastrous impact of tropical cyclones on coastal communities.

6.4.5 The Committee was pleased to note that the field testing exercise of the autonomous aircraft for tropical cyclone reconnaissance (Aerosonde) held in August this year was highly successful and welcomed its operational use, hopefully in the near future.

6.5 Training (agenda item 6.5)

6.5.1 The Committee was informed of the major training activities of WMO since its fourteenth session in 1999. It agreed that training events such as courses, workshops and seminars were of great value and an effective means of technology transfer and human resources development.

6.5.2 The Committee noted that most of WMO Regional Meteorological Training Centres (RMTCs) in the Region and other RMTCs in neighbouring Regions, continued to offer training at various levels and different fields of specialization. The Committee urged its Members to make maximum use of the courses offered by those Centres.

6.5.3 In addition to the RMTCs, some national training institutions in the Region also offered training in meteorology. The Committee urged its Members to make maximum use of such facilities whenever possible.

6.5.4 The Committee was pleased to note the attachment of two forecasters (one each from Comoros and Seychelles) during the 2000/2001 cyclone season at the RSMC La Réunion Tropical Cyclone Centre. The attachment was planned within the context of a regional cooperation project with funding support from the Indian Ocean Commission and European Commission. The Committee further noted with appreciation that Météo-France would continue its arrangements for attachment of forecasters from Member countries of the Committee to the RSMC La Réunion during the cyclone season and that WMO would consider providing financial assistance for two forecasters in a two week period during the 2002/2003 and 2003/2004 cyclone season. The Committee thanked the Permanent Representative of France and WMO for these efforts.

6.5.5 The Committee noted that the Second RA I Training Course on Tropical Cyclones and Workshop on Public Weather Services will be held in St. Denis, La Réunion from 29 October to 13 November 2001. This training course is being organized by Météo-France in close coordination with WMO.

6.5.6 The Committee noted with appreciation that a Virtual Training Library (VTL) has been activated within the Internet ETRP sub-page and urged its Members to make use of the facilities and holdings of the Training Library, in particular its audio-visual aids and Computer-Aided Learning (CAL) modules in their training programmes.

6.5.7 The Committee noted that WMO fellowships continued to be awarded to its Members under the various WMO programmes. The Committee further noted that the new scientific and technological developments in the applications of meteorology and hydrology in such areas as tropical cyclone forecasting had resulted in an increase in the demand for post-graduate and specialized studies in those areas. More fellowships focusing on specific technologies would be required in future to meet the increasing use of new technologies. The Committee, therefore, urged donor Members to arrange for relevant training at all levels to enable personnel from Member countries of the Committee to utilize more effectively the new technologies in those specialized fields.

6.5.8 The Committee noted with appreciation the capacity-building project "West Indian Ocean Marine Application Project (WIOMAP)" of the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) to monitor and predict coastal impacts. The project will contribute to the sustainable development of marine resources, the protection of the marine environment, and better long-term planning and management of the impacts of extreme weather events through enhancement of coastal

meteorological infrastructure and associated communication technology, and marine support activities.

6.5.9 The Chairman urged Members to include in their national reports a detailed list of their training activities at the national level.

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 of WMO activities in technical assistance carried out in the Member countries as well as in the region since its fourteenth session. Under the VCP programme, six VCP supported projects valued at about US $200,000 have been implemented for enhancing telecommunication equipment, in particular in the areas of Internet connectivity, CLICOM systems, satellite-based distribution systems for WAFS data and products (SADIS), TV weather presentation equipment, and training activities.

7.2 The Committee noted with appreciation that the RA I Working Group on Planning and Implementation of WWW in Africa during its fourth session held in Cairo, Egypt from 19 to 23 March 2001 designed a strategic plan for the implementation and improvement of telecommunication systems in Africa including other components of WWW. The strategy will address the use and deployment of appropriate telecommunications and information technologies that would alleviate the serious deficiencies in the operational status of WWW components.

7.3 The Committee was informed that the Indian Ocean Commission (IOC)/European Development Fund (EDF) Project on Meteorology, Phase II is under implementation with IOC as the implementing agency. The Member countries involved in the said project are Comoros, France (La Réunion), Madagascar, Mauritius and Seychelles.

7.4 The Committee was also informed that the Preparation for the use of MSG in Africa (PUMA) Project has been approved for funding by the European Commission. The Kenya Meteorological Department in Nairobi will host the Project Management Unit (PMU). The project will be implemented through the respective economic sub-groupings, in this case, the IOC and SADC.

7.5 The Committee was pleased to note that through the Drought Monitoring Centres in Harare and Nairobi, Members have continued to receive assistance through the on-going projects funded by USAID, World Bank, NOAA/OGP and SADC such as capacity building workshops and the climate Outlook Fora.

7.6 The Committee was further informed that WMO is implementing the SADC/HYCOS project for the improvement of Water Resource Management in the region.

7.7 The Committee, aware of the serious observation gaps in the subregion, urged its Members to do everything possible to improve the observing systems (surface and upper-air), since observation was the fundamental component of the WWW.

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:

- Application of the DVORAK Scale in the Classification of Tropical Storms evolving in the South-West Indian Ocean Cyclone Basin by Mr S. Veerasamy (Mauritius);

- The Comoros Meteorological and Hydrological Service by Mr Ibrahim Kassim (Comoros);

- Interesting Tropical Cyclones during the 1999/2000 and 2000/2001 Cyclone Seasons by Mr Philippe Caroff (La Réunion);

- Some aspects of the 1999/2000 Tropical Cyclone Season in the North West of Australia, by Mr Len Broadbridge (Australia);

- Passage du Cyclone Hudah à Madagascar (April 2000) by Mr A.S. Razafimahazo (Madagascar);

- Hydrological activities and a project on natural disaster management in Madagascar by Madame Christine Razafy;

- The Effect of El Niño and La Niña on the tropical cyclone climatology of the South Indian Ocean by Mr Len Broadbridge (Australia); and

- The GTS in the SWIO and the RANET System by Mr Laurent Zerbib (France).

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

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

9.1 The Committee expressed the need to continue its work in the light of Resolution 6 (XII-RA I). It also expressed the desire that its sixteenth session be held before the 2003/2004 cyclone season, the precise dates to be determined later.

9.2 The delegate of Mozambique informed the Committee that his country would propose to host the sixteenth session in 2003, subject to the approval of his Government. Should Mozambique be unable to host the session, Malawi is willing to host it. The Committee, in welcoming the information and accepting with pleasure this offers, expressed its warm appreciation to the Governments of Mozambique and Malawi. It requested the Secretary-General of WMO to take appropriate action, in consultation with the President of RA I, its Chairman and the host country for the convening of the session in 2003.

10. CLOSURE OF THE SESSION (Agenda item 10)

10.1 The report of the fifteenth session of the Committee was adopted at its final meeting on 10 September 2001.

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APPENDIX A

LIST OF PARTICIPANTS

MEMBERS

BOTSWANA	Gasewasepe Konopo NTHOBATSANG (Mrs) Edwin LETSAPA
COMORES	Yahaya BEN AMADI Mahamoud Ali Bay POUNDJA (Vice-chairman) Ibrahim KASIM Abdou AHMED Abdourahamane MADI Charifa ABOUBACAR Hadidja ALI MOUNDHIR Ahmad HAFIDHOU
FRANCE (LA RÉUNION)	Dominique LANDAIS Paul REMOIS Philippe CAROFF Laurent ZERBIB
LESOTHO	Mabafokeng Felesiah MAHAHABISA (Mrs)
MADAGASCAR	Christine RAZAFY (Mrs) Alain Solo RAZAFIMAHAZO
MALAWI	James Alexander KALUNGWE
MAURITIUS	S.N. SOK APPADU (Chairman) Shyamnath VEERASAMY
MOZAMBIQUE	Mussa MUSTAFA
SEYCHELLES	Denis CHANG-SENG
SOUTH AFRICA	Ian Tyrrell HUNTER
SWAZILAND	Simon NKAMBULE
UNITED REPUBLIC OF TANZANIA	Emmanuel Jonathan MUTONI
ZIMBABWE	Desmond MANATSA

EX-OFFICIO MEMBERS

Australia	Len W. BROADBRIDGE
Kenya	Samuel MWANGI

OBSERVERS

RA V Tropical Cyclone Committee (RA V/TCC)	Len W. BROADBRIDGE
Indian Ocean Commission (IOC)	Mohamed SAID SALIM
International Federation of Red Cross and Red Crescent Societies (IFRC)	Mohamed MAANFOU
Southern Africa Transport & Communications Commission (SATCC)	Tracy ZINANGA (Ms)

LOCAL OBSERVERS

Ministry of Interior	Amir Mohamed KARIHILA
Prince Said I International Airport	Ali Madi Moiha CHAMAOUNI

WMO SECRETARIAT

Nanette Lomarda (Mrs)
Stephen Njoroge

INTERPRETERS

Nelly CONFORTY-FERREUX
Joe MUHINDI
Emmanuel PETROS

APPENDIX B

AGENDA

1. ORGANIZATION OF THE SESSION

    1.1 Opening of the session
    1.2 Adoption of the agenda
    1.3 Election of the vice-chairman
    1.4 Working arrangements for the session

2. REPORT OF THE CHAIRMAN OF THE COMMITTEE

3. COORDINATION WITHIN THE WMO TROPICAL CYCLONE PROGRAMME

4. REVIEW OF THE 1997/1998 AND 1998/1999 CYCLONE SEASONS

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

6. REVIEW OF THE TECHNICAL PLAN AND ITS IMPLEMENTATION PROGRAMME

    6.1 Meteorological component
    6.2 Hydrological component
    6.3 Disaster prevention and preparedness component
    6.4 Research
    6.5 Training

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

8. SCIENTIFIC LECTURES AND DISCUSSIONS

9. DATE AND PLACE OF THE FIFTEENTH SESSION

10. CLOSURE OF THE SESSION

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APPENDIX C

1999/2000 CYCLONE SEASON IN THE SOUTH WEST INDIAN OCEAN
(Summary by the Tropical Cyclone Centre of la Réunion)

(Submitted by RSMC - La Réunion)

Following two relatively calm cyclone seasons, the 1999/2000 season marked the return of a much greater activity than usual in the basin of the South West Indian Ocean. The excess of activity was not due to a particularly great number of depressions but rather to an average life cycle lengthened by the occurrence of two systems (HUDAH and ELINE) whose life cycles were exceptionally long, especially more so for ELINE's when we consider its overall life cycle from the time it started in the South East Indian Ocean to its final stage when it dispersed in NAMIBIA.

The cyclogeneses were not more frequent than usual, but when they did occur, they were generally not counterfeited as the disturbances came across mostly propitious conditions to their developing and maintaining. Not only did the average life cycle of the depressions last longer than normal, but their intensity also was much greater.

Given the most powerful systems concerned populated lands, this season will be sadly remembered for its devastating phenomena especially among the Malagasy and Mozambican populations, as well as the winds and especially the catastrophic floods engendered by ELINE, GLORIA and HUDAH that caused thousands of deaths among the human population and significant damage that seriously affected the already fragile economy and sanitary conditions of these countries.

This 1999/2000 cyclone season ended on the same date as the previous one (on 24th April), but started earlier (on 23rd December). Despite this earlier start compared with the two previous seasons, the 1999/2000 cyclone season can be classified as a relatively tardy season. Given the dates of the start of season recorded since the beginning of the satellite era (dates defined according to the starting point of the first significant system in the season), the start of this season did indeed occur after the last quintile (around mid-December). As a reminder, concerning the starting dates of the cyclone seasons, the median is usually around the 17th November (50% of starting dates of seasons occurring before17th November, and 50% afterward).

During the four months this cyclone season lasted, 14 depressions gave rise to special forecast bulletins, i.e. just like in the 1998/1999 season, and two less than during the 1997/1998 season, seasons which both weren't very active. One of these 14 systems influenced the South West Indian Ocean only slightly (the peripheral circulation of Cyclone NORMAN- which remained in the Australian PERTH Area of Responsibility - by just brushing against Longitude 90°East). So, in real terms, only 13 systems involved the area of responsibility of LA REUNION RSMC. However, out of these 13 systems, 11 were finally kept in the final season assessment (significant systems that reached, for at least 24 hours, an intensity equal to that of a tropical depression stage). That means that the conversion rate of cyclo-genesis velleities into mature depressions was particularly high, the great majority of the systems showing great ease in developing further, unlike the previous seasons which saw a great number of systems either abort or stagnate without really managing to get to the intensification stage.

Out of these 11 systems, 9 were graded as tropical storms and consequently named, while four reached the tropical cyclone stage. These last two figures fit in exactly with the average values observed on the basin. Worth of note is an additional system that couldn't be named in real time even though it deserved to. This atypical hybrid system which affected the south MOZAMBIQUE Channel was finally graded as a subtropical depression even though it could have just as well been graded as a tropical storm.

Despite an usual number of systems, this cyclone season should be considered as an above average active season. Indeed, one just needs to refer to one of the best adapted parameters to define the degree of activity of a cyclone season, i.e. the number of days with the presence on the area of a tropical depression of significant intensity. So, the total number of days on which the disturbances were of intensity at least equal to that of a tropical storm, which was **61** (compared with a 48 median), i.e. more than double the previous season's number of days, shows there were disturbances which lasted at an intensification stage considerably higher than normal, and which greatly influenced the average life cycle of all the disturbances. The same holds for the number of "cyclonic" days.

The disturbances were evenly distributed intensity wise (indeed, one tropical depression, two moderate tropical storms, three severe tropical storms, one tropical cyclone, two intense tropical cyclones, one very intense tropical cyclone and, so, one subtropical depression, could be observed) with nonetheless an obvious move towards more intense systems than usual, as stated previously. The systems were also more evenly spread in time (very few coexisting systems), the activity peak of the season occurring between mid-February and beginning of March. Finally, one should stress that the cyclo-genesis zones were evenly spread in space, unlike the previous season. One should note however, that only one cyclogenesis occurred in the low latitudes (North of 10°S). Only the MOZAMBIQUE Channel had such few geneses, but this assertion is relative considering the way ELINE and HUDAH intensified again on the MOZAMBIQUE Channel could be likened to revivals.

Despite three disturbances (BABIOLA, CONNIE, FELICIA) which presented "parabolic" or "pseudo-parabolic" tracks, zonal courses definitely prevailed during the season. This marked zonal trend, with a majority of tracks canalised between 15° and 18° south, underlay the presence of significant high subtropical pressure in the zone. This was indeed the case for most of the time, except in January - with the two non-zonal courses of BABIOLA and CONNIE - which had the consequence - among others -, to maintain a pressure gradient, often very strong at the tropical latitudes.

These very long zonal courses took many systems West of the basin, where most inhabited lands lie and became exposed to a great risk of undergoing a cyclone. While the MASCARENE Islands were relatively spared by the various meteors of the season – LA REUNION and to a lesser degree MAURITIUS, rather welcomed the heavy rains caused by CONNIE and ELINE, for MADAGASCAR, MOZAMBIQUE and even countries rarely threatened, like ZIMBABWE, the storms and cyclones of the season were their heavy ransom.

With ELINE, MOZAMBIQUE went through its most powerful cyclone in the recent past. Even though the data were very uncertain before the start of the satellite imagery era, or imprecise afterwards, as technical estimates of tropical cyclone intensity are relatively recent (1980s'), we can still confidently assert that no cyclone of such intensity had directly affected MOZAMBIQUE for the last few decades. Rather than winds, it was the torrential rain left by ELINE which caused most damage and victims, the exact number still unknown to this day. ELINE's devastating influence spread far into the African Continent, causing a great number of human deaths, as far as ZIMBABWE.

After a two-year period of calm, MADAGASCAR, which is naturally exposed to cyclones, went yet again through three blasting meteors which took the island back to the somber times of the1993/1994 season when 4 cyclones caused death casualties and desolation on their passage (DAISY, GERALDA, LITANNE and NADIA). This time two intense cyclones (ELINE and HUDAH) struck nearby the towns of Mahanaro and Antalaha, killing tens of people. The severe tropical storm GLORIA, occurring less than two weeks after ELINE on still saturated grounds, brought about deathly floods that caused as many casualties as ELINE, reminding us - as if it needed be after what happened in MOZAMBIQUE and ZIMBABWE with ELINE's passage -, that cyclone rainfall tends to affect more widely spread areas than tropical disturbance-related violent winds do, and are a major cyclone risk.

While less intense than HUDAH, the most powerful cyclone of the season which went through a similar course (zonal course, landing on MADAGASCAR at the intense cyclone stage, re-intensifying to the cyclone stage on the MOZAMBIQUE Channel, and finally landing on the MOZAMBIQUE coast), ELINE will remain THE phenomenon of the season and even of the last decades for a good part of SOUTHERN AFRICA. Its life cycle was exceptionally long - 29 days -, i.e. it lasted throughout all of February, its extraordinary journey taking it over 11 000 km, i.e. nearly a third of the circumference of the earth, its relentless striking of inhabited areas at intensity peak, all this makes this cyclone a memorable one, confirmed by its occurrence in Year 2000.

From the beginnings of to-be LEON at its initial life stage in the Australian zone, up to its dispersing in the Namibian KALAHARI Desert, ELINE had indeed a very unusual life cycle: it went through a spectacular intensification stage nearby MADAGASCAR, then regenerated on the waters of the MOZAMBIQUE Channel to reach a second dramatic intensification stage nearby the MOZAMBIQUE coasts. Its power, longevity and the dramatic human consequences caused by its passage, summarize the symbolism of the mixture of fear and fascination connected to this type of paroxysmal meteorological phenomenon nature is capable of.

The pictures of floods and disaster victims that went round the world and fed the media news for a few days, won't be forgotten and will cruelly remind us that the way to avoid the devastating effects of these tropical disturbances still remains a real challenge at the dawn of this third millennium.

The Tropical Cyclone Centre of LA REUNION does their best to contribute to this challenge. It has tried just like every year, to fulfill at best its various tasks of detection, monitoring and predicting of the development and track of the systems, transmit warnings and technical messages to users and countries of the Indian Ocean zone in conformity with its international responsibility as the Tropical Cyclones RSMC of the South West Indian Ocean.

METEO-FRANCE - RSMC LA REUNION
1999/2000 CYCLONE SEASON

(insert table)

METEO-FRANCE: THE 1999/2000 CYCLONE SEASON ON LA REUNION

Only two systems (out of the nine tropical storms and cyclones of the season) really caused anxiety on La Réunion, but three of them triggered the cyclone warning system. They were :

- **CONNIE** (Intense Tropical Cyclone) which passed 130 km north-west of the island on 29 January 2000, when it was at the stage of a simple tropical cyclone (with wind gusts of 155 km/h observed at Petite-France, 160 km/h on the volcano, and 216 km/h on Maïdo).

- **ELINE** (Intense Tropical Cyclone) which passed 160 km north-west of the island on the night of 15 to 16 February 2000, at the stage of a heavy tropical storm (with gusts of 140 km/h observed on the volcano, and 187 km/h on Maïdo).

- **HUDAH** (Very Intense Tropical Cyclone) which passed 490 km north of the island on 1 April 2000, when it was at the stage of an intense tropical cyclone.

The three episodes caused a total of 13 days of alerts on La Réunion, broken down into 142h of cyclone vigilance, 64h30 of orange alert and 25h30 of red alert.

Two marked episodes relating to the heavy rains occurred in the course of this season, both of them associated with tropical disturbances passing close to the *département* (CONNIE and ELINE) :

- from 28 to 31/01/2000: episode CONNIE (7 heavy rain warnings issued) from 14 to 18/02/2000: episode ELINE (8 warnings)

The remainder of the rainy season was excessively calm. Only four other episodes of heavy rains were the subject of warnings.

APPENDIX D

REPORT ON THE TROPICAL CYCLONE SEASON 1999-2000

(Submitted by Botswana)

APPENDIX D, p. 2

APPENDIX D, p. 3

(hard copy only)

REPORT ON THE TROPICAL CYCLONE SEASON 2000-2001

(Submitted by Botswana)

Among the five tropical cyclones developed over the South-West Indian Ocean, none affected Botswana. Even tropical cyclone Dera, which developed over the Mozambique Channel from 09/03/2001 to 12/03/2001, moved southeastwards without depriving the country much of moisture influx as would have been expected.

APPENDIX E (disponible en Français uniquement)

RESUME DE LA SAISON CYCLONIQUE 1999-2000

(Présenté par les Comores)

RESUME DE LA SAISON CYCLONIQUE 2000-2001

(Présenté par les Comores)

APPENDIX F (disponible en Français uniquement)

REVUE DES SAISONS CYCLONIQUES 1999-2000 ET 2000-2001 A MADAGASCAR

(Presenté par le Madagascar)

(hard copy)

APPENDIX G

REVIEW OF THE 1999/2000 and 2000/2001 CYCLONE SEASONS

(Submitted by Malawi)

(hard copy only)

APPENDIX H

REVIEW OF THE 1999/2000 and 2000/2001 CYCLONE SEASONS

(Submitted by Mauritius)

1999/2000 CYCLONE SEASON

During the 1999-2000 cyclone season of the South-West Indian Ocean, there were nine named tropical depressions: three moderate storms, two severe, one cyclone and three intense cyclones. One of the three intense cyclones, namely Hudah, reached the very intense stage. The number of named storms during the 1999-2000 season compared very well with the mean number of named storms from 1976-1999.

The season started in December 1999 with the formation of severe tropical storm ASTRIDE near 11.0° S 76.0°E, and ended in April with moderate tropical storm INOCENTE. Neither Mauritius nor Agalega, St Brandon and Rodriguez experienced cyclonic winds. On the other hand, Madagascar and Mozambique suffered terribly from ELINE and HUDAH.

Three storms originated east of longitude 90°E. Two of them, ELINE and HUDAH became intense cyclones and caused havoc in Madagascar and Mozambique. HUDAH reached the very intense cyclone category (that is, the superstorm stage) just before making landfall in the north east of Madagascar.

ELINE had the longest track. It originated as a low pressure area near 11.0°S 110°E, in the extreme eastern part of the tropical Indian Ocean on the 3rd of February and dissipated near 24°S 20°E in Southern Africa on the 2nd of March 2000.

APPENDIX I

REVIEW OF THE 1999/2000 and 2000/2001 CYCLONE SEASONS

(Submitted by Mozambique)

Introduction

Due to its geographical location, Mozambique is a country vulnerable to natural disasters, such as tropical cyclones, which can originate from the Mozambique Channel or reach it from the East, depending on the atmospheric conditions.

Generally, the tropical cyclones of greatest intensity are those originating outside the Mozambique Channel, which cause torrential rains in the coastal areas, associated with strong winds, floods and the consequent infra-structure damages.

In the Mozambique Channel, 3 to 5 cyclones are observed annually with the peak frequency around January to February. The most affected regions are the coastal areas of northern and central Mozambique. The provinces of Inhambane, Gaza and Maputo are occasionally affected by tropical cyclones which can travel inland reaching 400 to 500 km.

During the last two tropical cyclone seasons, Mozambique suffered devastating floods which caused the death of almost a thousand people, displaced over a million and infringed considerable set-backs on the social and economic development of the country.

1999/2000 CYCLONE SEASON

From December 1999, Mozambique started receiving heavy rainfall in the southern part of the country which associated with rain in the neighboring South Africa and Swaziland, caused the rivers Incomate and Umbeluzi to rise rapidly. From 27 to 28 January, unprecedented rainfall, of a kind never recorded before (328 mm/day) caused the flooding of the cities of Maputo and Matola. To make things worse a tropical disturbance formed in the Mozambique Channel near to the coast of Inhambane gave origin to heavy rainfall in the provinces of Inhambane, Gaza and Maputo.

From 20 to 22 February, when the situation was still critical due to heavy rainfall, the country was hit by tropical cyclone ELINE that struck hardest the provinces of Inhambane, Sofala and Manica, causing destruction and human suffering that are still hard to estimate (estimate of over 700 people dead and half a billion dollars in damages).

On the 5th of April, tropical cyclone HUDAL started affecting the northern provinces of Nampula and Zambézia. This cyclone made landfall on the 8th of April causing the death of 3 people, injuring 3 and causing considerable damages.

2000/2001 CYCLONE SEASON

The tropical cyclone season 2000/2001 was an exceptional season for Mozambique due to the low cyclone activity.

During this period five tropical cyclones formed in the South West Indian Ocean: ANDO (3-10 January 200); BINDU (8-16 January 2001); CHARLY (20-25 January 2001); DERA (9-12 March 2001) and EVARISTE (5-8 April 2001). Tropical cyclone DERA formed over the northern part of Mozambique channel and caused torrential rains in the provinces of Nampula, Zambezia and Sofala.

The intensity of the Inter-Tropical Convergence Zone associated with tropical disturbances caused heavy rains which resulted in floods and inundations mainly in central provinces of Tete, Zambezia and Sofala. An estimated hundred and thirteen people lost their lives and considerable damages on infrastructure and crops were sustained.

APPENDIX J

REVIEW OF THE 1999/2000 and 2000/2001 CYCLONE SEASONS

(Submitted by the Republic of South Africa)

1999/2000 CYCLONE SEASON

Tropical Cyclone Eline

The South African Weather Bureau (SWAB) was heavily involved with this particular system which made landfall on 22 February 2000 approximately 90 km south of Beira, after having rapidly attained "Intense Tropical Cyclone" status the previous evening. The SAWB relies almost entirely on RSMC La Réunion for its tropical cyclone analysis and prediction products and would like to take this opportunity to thank the forecasters at the Centre once again for their skillful model interpretations and the resulting accurate predictions for this system.

Prior to Eline reaching the Mozambican coast, the involvement was largely related to marine warnings in METAREA VII (initially in the 'Madagascar East' forecast area, which extends to 55E - moving into the Mozambique Channel on 18 February) - for which South Africa is responsible.

When the cyclone moved overland, the port of Beira suffered heavy storm damage with a total of 5 vessels sank in the harbour - *after* the port had been closed. This included the trawler 'Zambesia' which sank in the entrance channel thus stopping all traffic into and out of the port until March 5. The contract for removal of the wrecks went to Smit-Pentow Marine in Durban and the SAWB was called upon to provide hindcast reports for the several marine court enquiries which followed the sinkings.

The SAWB was called upon to provide special forecast products to a number of different organizations, particularly those involved in flood relief over Mozambique and the NE parts of South Africa, but also to companies with marine interests. Levubu in the northern province reported 502 mm during the period 22-25 February but this rain had also been preceded by very heavy rains earlier in February. The worst of the flood damage - several days later at the lower end of the Limpopo basin - was as much a *hydrological* phenomenon as meteorological. Huge amounts of water from the many branches of this river system combined to cause the very high flood levels and large parts of the town of Xai Xai at the Limpopo river mouth were left several metres under water.

Other systems

The other systems which entered METAREA VII in the 1999/2000 season were Astride, Connie, Gloria and Hudah. Of these, only Hudah (apart from Eline) - had any marked effect on navigation in the Mozambique Channel. Fortunately, this system did not make landfall on the flooded Mozambican coast but weakened NE of Beira.

2000/2001 CYCLONE SEASON

Tropical Cyclone 'Dera' 9-12 March

This was the only tropical cyclone to have any significant effect in METAREA VII - and the only one to track through the Mozambique Channel in what was a very quiet season. However, as in the previous season severe flooding had already occurred over Mozambique as a result of relatively benign but persistent tropical depressions - and Dera, like Hudah in April 2000, was initially seen as a major threat to flood relief operations. The SAWB was again contacted by a number of agencies early in March. Fortunately, Dera tracked southwards as she intensified (not so fortunate for Ile Europa where, according to Météo-France, the pressure dropped to 973 hPa with the winds ahead of the system gusting to 84 knots. RSMC La Réunion again provided good guidance for this system.

APPENDIX K

REVIEW OF THE 1999/2000 and 2000/2001 CYCLONE SEASONS

(Submitted by the Seychelles)

1999/2000 CYCLONE SEASON

The 1999/2000 cyclone season was one that was very active with at least nine tropical storms being named. However, the storms developed and moved south of the ten-degree latitude as they crossed the South West Indian Ocean basin.

The Seychelles islands were not directly influenced by these tropical storms and no warning system was needed.

2000/2001 CYCLONE SEASON

The 2000/2001 cyclone season started late with the first tropical storm developing early January 2001. The development of tropical storm 'ANDO' produced some heavy rain between 30th December 2000 and 2nd January 2001. After 'ANDO', two other systems (BINDU and CHARLY) followed in the month of January but did not influence our weather. Two other storms 'DERA' and 'EVARIST' moved more or less southwards after their formation and hence no effect over our area.

APPENDIX L

REVIEW OF THE 1999/2000 and 2000/2001 CYCLONE SEASONS

(Submitted by Swaziland)

1999/2000 CYCLONE SEASON

The 1999/2000 season was one of the worst seasons in record in the country. There were about three tropical cyclones that were threatening to affect the country but out of the three, only one managed to deposit a lot of rainfall. The other two affected us by depriving the country of moisture. A few days before the effects of the tropical cyclone, a heavy downpour was received in the country caused by a tropical depression that gave us rains for not less than 10 days.

Tropical Cyclones

Tropical Depression (5-15 February 2000)

A heavy downpour started late on the 5th of February and ended in most places on the 13th of February 2000. This wet spell caused a tremor on the 8th of February 2000 that caused temporary power cuts and the nation was scared. The tremor was one of the biggest to be recorded in the country. This non-stopping downpour was caused by a cyclonic cloud band (tropical depression earlier reported) which formed in the Mozambique Channel and migrated inland covering Swaziland. The cloud bands moved more inland and attacked parts of South Africa as well. When this storm was showing signs of dissipating, a cold front came and merged with the storm and thus the persistent wet weather over the country.

Tropical Cyclone ELINE

Most of the damage was exacerbated by tropical cyclone ELINE that entered the Mozambique Channel on the 19th of February 2000 and by the 20th the effects were signalled. The previous wet spell caused by the tropical depression earlier in the month caused the soil to be saturated and when the cyclone became in the Mozambique Channel, worse was revealed. As from 21 February, a heavy downpour was expected and this posed a serious threat. By morning of 21 February, cloud bands started to show. The cyclone was at the Mozambique coast near Beira (see picture below).

Enhanced rainfall was received over the northeastern parts of the country.

Adverse Weather

Thunderstorms

Since the beginning of the 1999/2000 rainfall season, there has been reasonable above nomral rainfall over the country. Fierce lightning and thunder were experienced most often and these resulted in fatal accidents. Thunderstorms are mostly short-lived and their movement, direction, area of origin and magnitude may not be picked by either the weather forecast models or by weather satellite. A forecaster can only pick the occurrence of thunderstorms and usually thunderstorms produce high intensity rainfall.

Heavy Rainfall

There were 28 people recorded killed by flooded rivers. An estimated cost of about E 16 million damage was incurred by different sectors in the country's economic and social affairs. Most schools suspended operations due to the river floods since students would not cross the rivers to attend school.

DAMAGE

Heavy Rainfall (Cyclone and Depression)

From heavy rainfall, river flooding is exacerbated and from the heavy downpours recorded over the two seasons (1999/2000 and 2000/2001), 5 people were reported drowned. Crop yields were flooded. No machinery, either harvesting or planting, was deployed into the fields because of mud caused by the rain.

Damage in shelter structures was reported. The wet weather, in addition caused one major landslide in one location in the northern part of the country.

Thunderstorms

There was about E58,000,000 (USD 7,800,000) worth of property was damaged by these storms. The destruction included cutting of communication lines, cutting of power lines, blown residential houses and buildings, destroyed vehicles, killed livestock and destroyed education centres (schools). Crops were destroyed by hailstorms.

A lot of damage is done by this kind of phenomenon in Swaziland. This season, about 7 fatal accidents reported to have been caused by lightning.

2000/2001 CYCLONE SEASON

During the 2000/2001 season, only one tropical cyclone affected us by depriving the country of moisture.

November 2000 Wet Spell Damage

Wet weather conditions prevailed throughout the country almost the whole month of November 2000. A November 2000 monthly rainfall totals and the country's spread of rainfall is shown in Maps to 3. There was an overspill of the wet conditions into December the same year especially in the beginning of December 2000.

Tropical Cyclone ANDO

As from 2nd of January 2001, tropical cyclone influenced our weather system and caused withdrawal of moisture from the subcontinent. This activity caused a dry spell as from the 2nd January 200. Tropical cyclone ANDO existed east of Madagascar for its entire period.

As of the 11th January, tropical depression ANDO was still strong and continue weakening weather systems in the sub-continent, thus resulting in less moist air prevailing. A high pressure cell persisted over the country and sub-continent as a whole in the upper levels suppressing any rain favourable weather systems that may be brought by the weak surface low-pressure cell dominating the sub-continent.

Adverse Weather

Thunderstorm

A stormy start to the New Year

Parts of the country were affected by rather inclement weather during the New Year's period. This was brought about by a cold front accompanied by a feature known as a cut-off low which moved into the country by the 1st of January and intensified rapidly while doing so. This system moved out of the country late on the 2nd. A large part of the country was affected and quite a variety of related severe weather, ranging from hot and humid conditions initially, and heavy hailstorm accompanied by heavy rain and gale force winds during its passage that left a line of destruction over the Shiselweni District. Very cold conditions followed behind this as a result of cold air advection from the snow-affected areas over parts of the Drakensburg Mountains. The chart adjacent shows the surface conditions and the position of the cold front on 1st January at 2pm.

Widespread rain fell over the country, with heavy rain over some areas. Between 50-70 mm of rain fell mainly over the southern parts of the country between 8 o'clock in the morning of the 1st and 8 o'clock in the morning of the 2nd of January 2000.

The satellite picture above, taken at 2:30pm on the 1st of January shows the position of the clouds covering the country. Thick clouds are visibly over the country from the satellite image. Due to the strength of the system, strong winds were experienced over large parts of the country with heavy rains accompanied by hail.

Predictability of Cyclones and Adverse Weather Systems

The Meteorological Services issued forecasts concerning adverse weather conditions to prevail. Disaster mitigation institutions issued warnings in respect to the weather conditions projected and gave safety precautions as well as mitigation measures after the disasters.

The general public called the national radio giving information on the conditions of wather related affections in various areas of the country. This proved to be very useful especially the river floods.

Although thunderstorms likelihood warnings are issued by the NMS, the intensity and place of occurrence of such events are still hard to predict. The strength of force and direction of winds are predictable but the duration of windy conditions is not predicted by the service. An additional problem is that thunder and hailstorms are mostly short-lived and some observational aids available (e.g. remote sensing systems) may only capture a formation and dissipation of clouds. A pick of such weather systems in such situations is not available.

Once a tropical storm is formed. Its route may be forecasted and warnings be issued to the general public. A formation of such events may be difficult to predict although conditions favourable for their formation may be picked.

DAMAGE

Heavy Rainfall

However, no fatal incidences reported during the heavy downpour that occurred in November 2000, but damaged infrastructure was evident and a setback threat to the national economy became high especially in the agricultural sector. Water was logged especially in the crop fields and rivers were flooded.

Due to excessive water, outbreak of waterborne diseases was reported demanding public health centres to acquire more resources. Rivers were flooded and about 28 people were reported drowned in various flooded rivers especially in the flat land region.

Thunderstorms

Most damage is caused by adverse weather in the form of thunderstorms that are accompanied by gusting winds and hail. Swaziland experiences relatively thunderous weather during summer. In some incidences thunderstorms are fatal due to the lightning.

Damage to structures and maize fields with trees uprooted and roofs blown of houses and some house walls collapsing mainly over places in the Shiselweni and Lubombo Districts was experienced on the 1st of January 2001.

A heavy storm ripped off roofs of about six classrooms and nearby homesteads in the south and central parts of the country on the 3rd of February 2001. Then storm was short-lived and not much can be told from the satellite picture.

Since the beginning of the 2000/2001 rainfall season, about 8 schools were damaged by such storms and many more homesteads and national infrastructures. The agricultural sector has witnessed damage to crops and in some cases replanting was necessary while in other cases alternate crops were to be planted. The damage is estimated to be E200,000 (USD 30,000) at one school only. Destruction was also witnessed in the crop fields, energy supply lines and communication lines. Roads were reported flooded. Fatal incidences were reported that about 4 people were struck by lightning.

HEAT STRESS

As from 5th until 0th of January 2001, the country experienced a heat spell that saw one person reported to have died of heat on the 10th of January when the heat spell was at its peak.

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APPENDIX M

(Submitted by the United Republic of Tanzania)

APPENDIX N

ZIMBABWE WEATHER EVENTS OF THE YEAR 2000-2001 AND THEIR CONSEQUENCES

(Submitted by Zimbabwe)

(hard copy)

APPENDIX O

LIST OF NAMES TO DESIGNATE CYCLONES IN THE SOUTH-WEST INDIAN OCEAN BASIN

Cyclone season: 2002-2003		**Cyclone season: 2003-2004**	
ATANG	(Botswana)	ABAIMBA	(Tanzania)
BOURA	(Comoros)	BENI	(Zimbabwe)
CRYSTAL	(Mauritius)	CELA	(Swaziland)
DELFINA	(Mozambique)	DARIUS	(Mauritius)
EBULA	(Swaziland)	ELITA	(Malawi)
FARI	(Zimbabwe)	FRANK	(Seychelles)
GERRY	(Kenya)	GAFILO	(Madagascar)
HAPE	(Lesotho)	HELMA	(Mozambique)
ISHA	(Seychelles)	ITSENG	(Botswana)
JAPHET	(Malawi)	JUBELA	(Swaziland)
KALUNDE	(Tanzania)	KATIBA	(Lesotho)
LUMA	(Swaziland)	LENNY	(Zimbabwe)
MANOU	(Madagascar)	MOINGAZA	(Comoros)
NOE	(Mauritius)	NALEDI	(Botswana)
OPANGA	(Tanzania)	OLIE	(Kenya)
PALE	(Comoros)	PATOU	(Madagascar)
QACHA	(Lesotho)	QUILMANE	(Mozambique)
RITA	(Malawi)	RALPH	(Kenya)
SERAME	(Botswana)	SEFATE	(Lesotho)
TINA	(Zimbabwe)	TOM	(Malawi)
ULYSSE	(Madagascar)	UMURI	(Comoros)
VICENTE	(Mozambique)	VALETTA	(Mauritius)
WINSTON	(Seychelles)	WELLS	(Malawi)
XENA	(Kenya)	XIVIER	(Tanzania)
YVES	(Mauritius)	YVONNE	(Seychelles)
ZAITOUNE	(Comoros)	ZURI	(Kenya)

APPENDIX P

**TROPICAL CYCLONE OPERATIONAL PLAN
FOR THE SOUTH-WEST INDIAN OCEAN**

2000 Edition

WMO TD-No. 577

Supplement No. 1 December 2001

This supplement contains the amendments to the Operational Plan adopted at the fifteenth session of the RA I Tropical Cyclone Committee for the South-West Indian Ocean.

Replace page I-8 by new page I-8

Replace pages II-2, II-3, II-4, II-6 by new pages II-2, II-3, II-4, II-6

Discard pages II-7 to II-10

Replace page III-4 by new page III-4

Replace page IV-2 by new page IV-2

Replace Attachment V-A, pages 1 and 2 by new Attachment V-A, pages 1 and

Replace page VII-1 by new page VII-1

W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N
T E C H N I C A L D O C U M E N T

WMO/TD-No. 577

TROPICAL
CYCLONE PROGRAMME

Report No. TCP-12

TROPICAL CYCLONE OPERATIONAL PLAN FOR THE SOUTH-WEST INDIAN OCEAN

2002 Edition

SECRETARIAT OF THE WORLD METEOROLOGICAL ORGANIZATION
GENEVA - SWITZERLAND

1.5 Identification of tropical cyclones

The list of names to be used for identifying tropical storms and cyclones in the South-West Indian Ocean area, within the area bounded by 5°S, 90°E, 30°S and 30°E, has been established by the Committee at its fifteenth session in September 2001 for the 2002-2003 and the 2003-2004 cyclone seasons. The names chosen are:

Cyclone season: 2002-2003		**Cyclone season: 2003-2004**	
ATANG	(Botswana)	ABAIMBA	(Tanzania)
BOURA	(Comoros)	BENI	(Zimbabwe)
CRYSTAL	(Mauritius)	CELA	(Swaziland)
DELFINA	(Mozambique)	DARIUS	(Mauritius)
EBULA	(Swaziland)	ELITA	(Malawi)
FARI	(Zimbabwe)	FRANK	(Seychelles)
GERRY	(Kenya)	GAFILO	(Madagascar)
HAPE	(Lesotho)	HELMA	(Mozambique)
ISHA	(Seychelles)	ITSENG	(Botswana)
JAPHET	(Malawi)	JUBELA	(Swaziland)
KALUNDE	(Tanzania)	KATIBA	(Lesotho)
LUMA	(Swaziland)	LENNY	(Zimbabwe)
MANOU	(Madagascar)	MOINGAZA	(Comoros)
NOE	(Mauritius)	NALEDI	(Botswana)
OPANGA	(Tanzania)	OLIE	(Kenya)
PALE	(Comoros)	PATOU	(Madagascar)
QACHA	(Lesotho)	QUILMANE	(Mozambique)
RITA	(Malawi)	RALPH	(Kenya)
SERAME	(Botswana)	SEFATE	(Lesotho)
TINA	(Zimbabwe)	TOM	(Malawi)
ULYSSE	(Madagascar)	UMURI	(Comoros)
VICENTE	(Mozambique)	VALETTA	(Mauritius)
WINSTON	(Seychelles)	WELLS	(Malawi)
XENA	(Kenya)	XIVIER	(Tanzania)
YVES	(Mauritius)	YVONNE	(Seychelles)
ZAITOUNE	(Comoros)	ZURI	(Kenya)

* 1st of July to June

Index number	Name of station	Time of observation
61976	Serge-Frolow (Ile Tromelin)	00 (radiosonde)
61986	St. Brandon	12
61988	Rodrigues	12
61995	Vacoas (Mauritius)	12 (radiosonde)

N.B. Requests shall be addressed by the Director of the national Meteorological Service making the request to the Director of the national Meteorological Service concerned. A message cancelling the request shall be sent as soon as additional observations are no longer required.

When a tropical cyclone is forecast to threaten a Member country, its NMC should initiate enhanced observation programmes for its stations, to maximize its observational input to the RSMC La Réunion, by increasing the coverage or increasing the scheduled frequency of observations.

2.1.2 Other networks

Surface observations at one-hourly intervals may be requested by any Member, whenever a cyclone becomes an imminent threat to the Member, from the following additional stations:

Index number	Name of station
67003*	FOMBONI (MOHELI)
67017*	VOHEMAR
67023*	SAMBAVA
67037*	BESALAMPY
67107*	ANTSIRABE
67131*	MOROMBE

The request should be addressed to the national Meteorological Service concerned.

2.2 Mobile ship stations

Whenever there is an intensifying tropical disturbance in the area, all relevant NMSs should endeavour to increase the number of ship observations in the immediate area of the disturbance by:

(a) Requesting relevant Voluntary Observing Ships (VOS) to make 3-hourly observations and to include sea state groups as far as possible. This communication will take place through the existing marine communications systems;

(b) Appealing to non-VOS vessels to send informal weather observations to the nearest NMS via radio stations or other means of communication.

Both (a) and (b) could be achieved by adding the necessary text to all marine forecasts covering the area of the disturbance. Alternatively, NMSs could contact directly, vessels known to be in the area.

Member states receiving ship reports urged to distribute the same to all other countries.

* Unlimited list. All stations are able to make hourly OBS

Members should transmit the observations – with the least delay – to the RSMC La Réunion and the two Sub-regional Tropical Cyclone Advisory Centres in Mauritius and Madagascar.

2.3 Aircraft reports

Aircraft reports which are of particular importance for cyclone analysis or forecasting will be exchanged on a priority basis.

The RSMC La Réunion - Tropical Cyclone Centre will, when possible, provide radar observations, made from C160 Transall aircraft on scheduled flights, giving the position of the cyclone centre as closely as possible, when the centre is sufficiently close to the flight path to be detected.

2.4 Special stations

2.4.1 Regional radar network

Members shall exchanges, in particular, with the RSMC La Réunion - Tropical Cyclone Centre as a first priority, radar information concerning cyclone eye fixes, as well as other radar data. For this purpose, they may:

- use Part A of code form FMM 20 V - RADOB and/or apply the procedures described in Table 2, or

- exchange the data in plan language by any appropriate means available (SSB, telefax, telefone, etc.).

The example of Mauritius and Réunion has shown that this solution appears to be more flexible, less demanding, thus more effective during cyclonic alert periods when operational staff is already kept busy with other tasks.

The list of operational weather radar stations is as follows:

Station name	Lat.°S	Long.°E	Wavelength	Make
La Réunion	21	55 doppler	10 cm	GEMATRONIK
Antalaha*	15	50	10 cm	Mitsubishi
Morondava	20	44	10 cm	Mitsubishi
Antananarivo*	19	47	10 cm	Mitsubishi
Lilongwe*	14	34	10 cm	Toshiba
Chileka*	16	35	5.4 cm	EEC
Trou aux Cerfs	20	57	10 cm	EEC
Beira*	20	35	10 cm	MRL-5
Harare	18	31	5.4 cm	Thompson CSF
Bulawayo Airport			5.4 cm	Thompson CSF
Bufallo Range			5.4 cm	Thompson CSF
Durban	29°58'	30°57'	5 cm	Enterprise C-band
Ermelo	26°31'	29°59'	5 cm	Enterprise C-band
Pietersburg	23°30'S	29°25'	5 cm	Enterprise C-band

* Temporarily out of order.

2.5 Meteorological satellites (ground segment)

2.5.1 APT/WEFAX/HRPT

In relation to the tropical cyclone detection, monitoring and forecasting services, Members will operate and maintain satellite data reception equipment as follows:

.	Botswana	APT/WEFAX and PDUS Station at Gaborone
.	Comoros	APT/WEFAX MDD/PDUS Station at Moroni
.	France (Réunion)	APT/WEFAX, HRPT and MDD/PDUS Station at St. Denis
	Lesotho	MDD/PDUS Stations at Maseru
.	Madagascar	APT/WEFAX/HRPT, MDD/PDUS Station at Antananarivo and Ivato
.	Malawi	MDD
.	Mauritius	APT/WEFAX/HRPT, MDD/PDUS Station at Vacoas
.	Mozambique	MDD/PDUS Station at Maputo
.	Rep. of South Africa	APT/WEFAX , MDD/PDUS Station at Pretoria
.	Seychelles	SDUS Station at Mahé
.	Swaziland	MDD/PDUS Station at Matsapha Airport
.	Tanzania	MDD/PDUS Station at Dar-es-Salaam
.	Zimbabwe	APT/WEFAX/HRPT and MDD/PDUS Station at Belvedere-Harare

In order to enable comparisons with each other of results obtained, Members and, in particular, the RSMC La Réunion - Tropical Cyclone Centre, will exchange on a priority basis analyses of satellite information on tropical cyclones. The text of cyclone advisories for this purpose will take the form:

(a) Time of picture, identification of satellite;

(b) Position of centre in degrees and tenths of degrees;

(c) Intensity: T number of estimated maximum wind speed and central pressure;

(d) Other characteristics deduced from the picture, e.g. development characteristics, estimated extent of winds of specified speeds.

TABLE 1 - LIST OF IMPLEMENTED OBSERVING STATIONS

Stations and observations programmes comprising the basic synoptic network for tropical cyclone forecasting in the South-West Indian Ocean

Refer to WMO Volume A for an up-to-date list of stations and observational programmes.

TABLE 3

CYCLONE BULLETINS ISSUED BY RSMC/TROPICAL CYLONE CENTRE LA REUNION

Bulletins		Headings	Dissemination time
Marine Warnings	English	**WTIO20, 22, 24**	**GTS** 00, 06, 12, 18 UTC
	French	**WTIO21**	Same
RSMC Bulletins	English	**WTIO30**	**GTS** 06, 18 UTC
	French	**WTIO31**	Same
Satellite Bulletins	English	**TPIO20**	**GTS** as soon as possible after the satellite's passage
	French	**TPIO21**	same
ICAO Advisories	English	**-** **FKIO20**	**AFTN** 00, 06, 12, 18 UTC **GTS** 00, 06, 12, 18 UTC
"BUFR" Bulletins	-	**ATIO01**	**GTS** 00, 06, 12, 18 UTC
"Best-Track" Bulletins	-	**AXIO20**	**GTS** within one month after the cyclone's death
Cyclonic information Bulletin	English	**AWIO20**	**GTS** 12 UTC
	French	**AWIO21**	**GTS** 12 UTC

4.3.1 Areas of responsibility

More than one Member can issue warnings for the high seas for any given area.

Members having official responsibility for issuing forecasts and warnings for the high seas are:

Kenya[*]	-	Sea areas from 12°N to 11°S between the African coast and 60°E.
Madagascar	-	Sea areas from 10°S to 30°S between the African coast and 60°E, and from 5°S to 30°S between 60°E and 70°E.
Mauritius	-	Sea areas from 10°S to 30°S between 50°E and 60°E and from the Equator to 30°S between 60°E and 90°E.
Mozambique	-	Sea area in the Mozambique Channel from 12°S to 25°S.

Comoros and La Réunion (France) also issue bulletins with warnings for the Comoro archipelago and the area between 5°S and 30°S, and 40°E and 90°E, respectively.

The implementation of the GMDSS will modify progressively these responsibilities according to the Joint WMO/IOC Technical Commission for Oceanography and Meteorology (JCOMM).

4.3.2 Form and content of bulletins

Tropical cyclones are classified in marine bulletins for the high seas as:

(i) Tropical depression;

(ii) Moderate tropical storm;

(iii) Severe tropical storm;

(iv) Tropical cyclone;

(v) Intense tropical cyclone;

(vi) Very intense tropical cyclone.

Warnings to be issued for the high seas shall be:

(i) Near gale warning;

(ii) Gale warning;

(iii) Storm warning[**];

(iv) Hurricane warning.

[*] In accordance with Resolution 12 (X-RA I), Kenya designates an ex-officio member of the RA I Tropical Cyclone Committee for the South-West Indian Ocean.

[**] Used only for marine purposes.

ATTACHMENT V-A

LIST OF ADDRESSES AND TELEPHONE NUMBERS

COUNTRY	MAIL ADDRESS	TELEX/FAX/E-MAIL	TELEPHONE NUMBER
AUSTRALIA Len Broadbridge Regional Director (Western Australia)	PO Box 1370 West Perth Western Australia 6872	Fax: (61-8) 926 32211 E-mail: broadbridge@bom.gov.au Web: www.bom.gov.au	(61-8) 926 32222 (61-8) 926 32210 (direct)
BOTSWANA Ms G.K. Ramothwa Director of Meteorological Services (G.K. NTHOBATSANG)	P.O. Box 10100 Gaborone	Fax: (267) 356 282 Fax: (267) 311 427	(267) 356 281/4 (267) 314 175/6
COMOROS Poundja Ali Bay Director of Meteorological Office	P.O. Box 78 Moroni	Telex: 241 PUBLIC KO Fax: (269) 730 447, 731 468 E-mail: dgacm@snpt.km	(269) 744 246, 730 447 Home: 732 925
FRANCE D. Landais Director of Meteorological Service P. Rémois Head of Network and Operations	P.O. Box 4 97491 Saint-Clotilde Cédex La Réunion France P.O. Box 4 97491 Saint-Clotilde Cédex La Réunion France	Fax: (262) 921 147/8 E-mail: dominique.landais@meteo.fr Fax: (262) 921 147/8 E-mail: paul.remois@meteo.fr Web: www.meteo.fr	(262) 921 100 Home: 921 155, 971 407 (262) 921 107 Home: 921 162
KENYA Director of Meteorological Service Attention: Samuel Mwangi	P.O. Box 30259 Nairobi	Fax: (254 2) 567 888/9 or (254 2) 577 373 E-mail: mwangi@meteo.go.ke Web: www.meteo.go.ke	(254 2) 567 864
LESOTHO B.T. Sekoli Director of Meteorological Services Attention: J.R. Mphethi	P.O. Box 772 Maseru	Fax: (266) 325057 (266) 350325 E-mail: bulane@lesoff.co.za	(266) 325041 (266) 317250
MADAGASCAR Direction de la Météorologie et de l'Hydrologie Razafy Christine Directeur Razafimahazo Alain Solo Chef du Service Météorologique Razafindrakoto Helison Chef du Service Hydrologique	P.O. Box 1254 Antananarivo 101	 Fax: (261) 20.22.405.81 E-mail: meteo@dts.mg (Home: tsaranazy@simicro.mg) Fax: (261) 20.22.408.23 E-mail: meteo@simicro.mg Fax: (261) 20.22.40.581 E-mail: meteo@dts.mg	 (261) 20.22.405.35 (261) 20.22.407.75 (261) 20.22.402.41
MALAWI Director of Meteorology Attention: J.A. Kalungwe	Meteorological HQ P.O. Box 2 Chileka	Telex: WEATHER MI Fax: (265) 692 329	(265) 692 201 (265) 692 333 Director: (265) 692 312
MAURITIUS S.N. Sok Appadu Director of Meteorological Services	St Paul Road Vacoas	Fax: (230) 686 1033 E-mail: meteo@intnet.mu	Direct: (230) 969 5626 Office: (230) 686 1031/2 (Home: (230) 696 6088) (Home: (230) 686 4743

MOZAMBIQUE Filipe Lucio Director of Meteorology Attention: H. Sueia/ F. Tualufo	P.O. Box 256 Maputo	Telex: 6259 SMMMP MO Fax: (258) 1 491 150	(258) 1 493 193 490 148/490 064 465 138 (Airport)
REP. OF SOUTH AFRICA I.T. Hunter Deputy Director Maritime Service	Private Bag X097 Pretoria 0001	Fax: (27 12) 309 3990 E-mail: ian@weathersa.co.za Web: www.weathersa.co.za	(27 12) 309 3104
SEYCHELLES Wills Agricole Acting Director of Meteorological Service Francis Bijoux	Division of Environment Policy Planning and Services P.O. Box 181 Victoria	Fax: (248) 384 078 E-mail: metadmin@seychelles.net	(248) 384 065/66/68
SWAZILAND E.D. Dlamini Director of Meteorology Attention: S.M.Nkambule	P.O. Box 58 Mbabane	Telex: 2001 WD Fax: (268) 40 41 530, (268) 40 46 438 E-mail: weather@realnet.co.sz	(268) 40 46 274 (268) 40 48 859
UNITED REP. OF TANZANIA Director General Attention: P.F. Tibaijuka	Directorate of Meteorology P.O. Box 3056 Dar-es-Salaam	Telex: 41442 HEWA Fax: (255) 51110231/844299 E-mail: met@meteo-tz.org	(255) 51 844 438
ZIMBABWE Director Meteorological Services Attention: D. Manatsa	P.O. Box BE 150 Belvedere Harare	Telex: 40004 METEO ZW Fax: (263) 4 774 890/7 E-mail: weather@utande.co.zw Web: www.weather.utande.co.zw	(263) 4 774 891 (263) 4 774 894
RA I Coordinator of National Research Focal Points B.S. Nyenzi	Directorate of Meteorology P.O. Box 3056 Dar-es-Salaam United Rep. of Tanzania	Telex: 41442 HEWA Fax: (255) 51 110231 E-mail: bnyenzi@nyenzi.com	(255) 51 110227
WMO Subregional Office for Eastern and Southern Africa Attention: S. Njoroge	P.O. Box 47464 Nairobi Kenya	Fax: (254) 2 577373 E-mail: wmo.nairobi@lion.meteo.go.ke E-mail: stephen.njoroge@lion.meteo.go.ke	(254) 2 577371

C H A P T E R VII

TROPICAL CYCLONE INFORMATION SERVICES

Members will exchange information on a non-real-time basis as required for the establishment of tropical cyclone data files and information services nationally. The information will include available annual charts of cyclone tracks in the appropriate area, with the intensity of the cyclone at each position marked in accordance with WMO regulations and recommended practices. Also to be included are available classifications of cyclones by month, intensity and movement, as well as groupings over periods of years made in accordance with the standard periods stated in WMO regulations and recommended climatological practices.

In compliance with these recommendations, RSMC La Réunion establishes the final official trajectories (and information on intensities) for each disturbance which occured during the season. The relevant data are on the GTS in bulletins called "best-track bulletins" (with heading AXIO20) within 1 month after the end of each cyclonic event. On the other hand, a computer file including all this information, and supplemented as required, is established at the end of the cyclone season. This file complies with the WMO recommended format (Attachement VII-A). It is sent to the NOAA National Climate Data Center (NCDC) in Asheville, (North Carolina, USA) and is also available to any Member of the Committee upon request.

Members maintaining tropical cyclone information files which are at the disposal of all Members of the Committee, as well as other WMO Members and research institutions are:

France (La Réunion)

On disk	-	Complete file of tropical disturbances observed in the South-West Indian Ocean since 1850 (includes almost 1200 disturbances).

Madagascar

On magnetic tape	-	Identification, position, intensity, characteristics of meteorological elements, direction and speed of movement;
On diskettes	-	Trajectory of all depressions and all cyclones in the region since 1911;

Mozambique

On microfilm	-	Surface weather maps for the South-West Indian Ocean area.

ANNEX

METEO FRANCE

Direction Interrégionale de la Réunion

BP 4 97491 Ste-Clotilde CEDEX Tél +262 262 92 11 00
Fax direction +262 262 92 11 47 Fax exploitation +262 262 92 11 48

La Réunion Tropical Cyclone Centre

Tropical Cyclone RSMC / South-West Indian Ocean

1. Functions of the Centre

The Direction of Météo-France in La Réunion has been formally designated as the Regional Specialized Meteorological Centre (RSMC) - Tropical Cyclones for the South-West Indian Ocean during the 45th session of WMO/Executive Council (Geneva, June 1993), with effect on 1 July 1993.

The area of responsability of the RSMC includes the tropical and subtropical areas of the South-West Indian Ocean from 05°S to 30°S west of 90°E, including the Mozambique Channel.

The primary mission of the RSMC/La Réunion is to provide appropriate guidance information (analyses, forecasts, prognostic reasoning,...) to the 13 Members of the RAI Tropical Cyclone Committee (Botswana, Comores, France, Lesotho, Madagascar, Malawi, Maurice, Mozambique, Seychelles, South Africa, Swaziland, Tanzanie, Zimbabwe) for all the tropical disturbances occuring in its area of responsability. However, beyond this fundamental operational function, the RSMC has the role to become the regional core for all the other activities conducted in the field of tropical cyclones such as, for instance, Training and Research/Development. And if the RSMC has, of course, initially given priority to its operational missions, it is now considering the allocation of extra resources to these two areas.

In addition to its responsabilities as an RSMC, Météo-France La Réunion has numerous other national and international responsabilities. Within the GTS, it is a hub in the regional telecommunication network. In the framework of GMDSS, it has the responsability to prepare marine forecasts and warnings for extensive parts of METAREA VII-OI and METAREA VIII-S. Furthermore, with the role of assisting the MWO's of the whole region in the preparation of SIGMET messages for tropical cyclones, ICAO has designated it as its Regional Tropical Cyclone Advisory Centre.

Météo-France La Réunion takes also an active part in the International Buoys Programme in Indian Ocean (IBPIO). It regularly organizesthe deployment in tropical or polar areas, of drifters, from ships calling at La Réunion.

2. Human resources

The overall manpower of Meteo-France La Réunion is a bit less than one hundred people, all divisions included, of which 18 are engineers (class 1 WMO) and about 50 are technicians (class 2 WMO).

2.1 Forecast

The team of forecasters consists of 5 senior forecasters and 15 class II forecasters working under the direction of a chief-forecaster. The service is organized in such a way to allow the 24-hours assignment of one (or two during critical periods) senior forecasters exclusively to the monitoring, tracking and forecasting of the tropical disturbances occuring in the RSMC's area of responsability.

In order to preserve a maximum of the forecasters'time for reasoning, all the tasks that could be automated, have been automated. For instance, in order to cope with the necessary introduction of new bulletins, a software has been developed which on the basis of the information regularly entered by the forecaster in a data-base, generates then disseminates automatically the different tropical cyclone bulletins issued by the RSMC.

2.2 Research and Development

Till July 1998, Research and Development capacities of the RSMC were limited. Till this date actually, the Center gave priority in terms of allocation of human resources, to the strengthening of operational teams.

However, after this necessary first step, the RSMC is now in position to do more in this essential domain. Thus, the creation of a high-level research and development team in the tropical cyclones area, has been decided by the General Direction of Météo-France. This team, supported by the National Centre of Meteorological Research of Météo-France in Toulouse has joined the RSMC on the 1 August 1998. and includes 3 researchers-ingeneers, 2 university teachers, one computer scientist, and 6 to 7 students-tranees on average per year. This team can also receive researchers from the different countries of the Indian Ocean, and will be strengthened in the future.

3. Facilities

3.1 Telecommunications

In the Regional Meteorological Telecommunication Network (RMTN), the Centre of Saint-Denis/La Réunion is a hub connected with several countries by a number of reliable and high speed links. Functions of telecommunication are completely automated, and only one controller is requested.

Thanks to a TCP/IP 256kbits/s link via Toulouse, the Centre is connected to the two Regional Telecommunication Centres of Eastern and Southern Africa (Nairobi and Pretoria).

This connection with Toulouse, securitized with a 64 kbits/s (Numeris) link is a real umbilical cord for the RSMC. Thanks to this, the Centre can access to all the databases of Météo-France and in particular to the outputs of the French (ARPEGE) and ECMWF global models.

The RSMC is also equipped with :

- a data reception station (MDD, METEOSAT Data Dissemination) which allows the reception of the three MDD channels (Bracknell, Roma and Toulouse) and offers a solution for alternative reception of alpha-numerical messages and graphical products in case of failure of the telecommunication system.

- a Data Reception System (DRS) for the direct satellite reception of the numerous DCPs that have been installed in the region during the last years.

A server of meteorological messages and bulletins, operational since 1991, gives to the NMCs of the region the possibility of directly accessing to the data and bulletins collected or produced by the RSMC, and also to information (for instance, received from Toulouse) that is not available through the programmes of the RMTN.

The Centre resorts also to Internet, especially to exchange data at the regional level where this network is a good alternative to traditional links. E-mail allows for exemple the collect of the Seychelles' observations and the dissemination, daily more and more important, of very numerous messages to South Africa, Madagascar, Comoros and Seychelles.

Because of the intense traffic due to the sending of numerical model outputs to Mauritius Island, the FTP protocol has been installed between the 2 islands, and gives complete satisfaction.

Furthermore, the RSMC has now a specialized server with restricted access, where all the meteorological data available on its SYNERGIE servers can be found via the URL :

www.meteorologie.eu.org/CMRS

Finally, for the countries who have not Internet access yet, or in the aim to provide a cheap spare possibility, the CMRS, in collaboration with Worldspace, has accepted to put some of its elaborated products (plottings, models outputs, cyclone warnings) on the server RANET.

3.2 Meteorological satellites receiving systems

Through a HRPT station (installed in November 1990 and regularly upgraded till then) and a PDUS station (installed at the end of 1995 and upgraded in 2000), the RSMC has now real-time access to high resolution digital data from both the European geostationary meteorological satellites METEOSAT (0° and 63° for the moment) and the American TIROS polar-orbiting satellites.

The software used for the processing of HRPT imagery has been developed by the Space Meteorology Centre in Lannion and by the RSMC/La Réunion. Besides the usual functions (calibration, navigation, zoom, enhancement, etc...), it offers different tools that have been developed in order to help the forecasters in the analysis of tropical cyclones (overlaying and fitting of various logarithmic spirals, overlaying of "compass-cards" for easier cross-analysis with the wind observations available in the tropical cyclone area, etc...).

3.3 Radar

At the end of 1993, a 10 cm Doppler radar has been installed on a site in upper Saint-Denis, about 600 meters high and 12 km away from the Meteorological Centre. This radar is operated by remote control. Raw data are processed on the site and the different products (PPI, CAPPI,...) are transmitted to the centre via a 9600 b/s specialized line.

The view of the radar is totally clear from the east to the north and the west-south-west, sectors of origin of more than 95% of tropical cyclones approaching La Réunion. It permits nearly continuous coverage of tropical cyclones within about 350/400 km of the coast and, therefore, effective monitoring of those that threaten the island. This results in more accurate forecasts of the final track and impact in terms of strong winds and heavy rain, and finally in better warnings and better timing in the final phase of the alert process.

This radar opens also up very interesting possibilities for Resarch and Development on the effects that the orography can have on the core structure of landfalling tropical cyclones and, more generally speaking, combining radar observations with data collected in real-time by the network of about 25 automatic stations implemented on the island, on the effects the orography has on heavy rain distribution (La Réunion holds all the rainfall world records between 12 hours and 15 days, all these records being associated with the passage of tropical cyclones over or in vicinity of the island).
The installation of a second radar in the South of the island is studied.

3.4 SYNERGIE

"SYNERGIE" (same meaning as SYNERGY in English) is the name of the system developed by Météo-France. This system is used by all the forecasters of Meteo-France to synthetize the more and more abundant meteorological information and then to elaborate the documents resulting of their cross-analyses. SYNERGIE is an abbreviation of « Système Numérisé d 'Exploitation

Rationnelle et de Gestion Interactive et Evolutive » (Digitized System of Rationnal Exploitation and of Interactive and Upgradeable Handling) of the meteorological data..

Thanks to this tool, the forecaster can build a conceptual model of the real state of the atmosphere by displaying on his workstation all the available meteorological information (conventionnal data, NWP products, satellite and radar imagery…). To be noted is the fact that processing and storage of all the numerical data collected through the local imagery acquisition systems (radar, satellite…) or directly received from Toulouse via TRANSMET are simultaneously done on two servers SUN E450, one hot spare of the other. Quick and securitized access is then possible in real-time from any « client » workstation.

SYNERGIE offers a wide range of possibilities : displaying all the available meterological information with possibility of overlaying, objective analyses, vertical profiles, animation, bulletin composition, etc.). Furthermore, thanks to its competence, RSMC/La Réunion has been chosen to participate to the validation of the new and expected modules for expertise and for monitoring the tropical cyclones before their integration in the new version 3.5 of the software.

Finally, one of the most important possibilities of SYNERGIE is to re-display past interesting meteorological situations like the cyclone CONNIE, studied by the trainees during the international workshop organized at La Réunion

4. Cyclone monitoring

As a result of the lack of aircraft reconnaissance and the fact that conventional data are very limited in the RSMC area of responsability, the monitoring of tropical cyclones is essentially based on satellite imagery, except when these systems are within the scope of La Réunion or Mauritius radars.

Of course, all the information available is combined to determine the position and intensity of tropical cyclones. But the satellite-based DVORAK technique (used since 1982 by the RSMC) is generally the only mean available to estimate intensity and, in most cases, no information other than satellite imagery is available to determine the centre location.

4.1 Satellite coverage

Until the 1995-1996 tropical cyclone season, the tropical cyclone watch at the RSMC relied almost exclusively on the use of TIROS HRPT imagery which provides a very good spatial resolution but suffers greatly from a lack of temporal resolution.In fact, depending on the orbits of the TIROS satellites and on the distance from La Reunion of the monitored tropical cyclones, 4 to 5 NOAA images of the latter (but only 1 or 2 when the cyclones are located on the far eastern portion of the RSMC's area of responsability) are received daily.

The implementation in 1995 of the PDUS now permits a far better coverage of the western portion of the RSMC area of responsability whithin which all the inhabitated lands of the region are located. Even if the resolution is less than with TIROS imagery (10 by 6 kilometres at La Réunion's longitude and, of course, less to the east) and if the viewing angle can cause large errors if uncorrected, the 30 mn intervals imagery, the possibility of animation and the access to the water vapor images notably improve the capacity for the analysis of tropical cyclones situated west of about 65° East and of their environment.

Futhermore, since 1996, the WEFAX GMS imagery that covers the far eastern portion of the RSMC area of responsability is integrated in quasi real-time on SYNERGIE, which offers a better environment for its analysis than the PC's software used before.

Finally, since June 1998 (and still for a few years), the RSMC receives the satellite pictures from METEOSAT 5 (which has moved from 0° to the 63°E, for the international experiment INDOEX) This is a very good improvement for the cyclonic survey in this area, where no operational and permanent global satellite coverage exists, as satellite INSAT data are still not available.

In the future, satellites « METEOSAT Seconde Génération » (MSG), will offer numerous new products and increased spatial and temporal resolutions. The RSMC will then be equipped in such a way to receive the new data and to deal with the big quantity of information.

4.2 RSMC mean position errors

The following table gives the estimated mean position errors (km) for the 8 last tropical cyclone seasons regarding the different class of cyclone intensity (*number of cases in brackets)*. It must been keep in mind, that these mean position errors which are calculated by comparison of the operational fixes with the after-the-fact "best-tracks", are not absolute errors as the "best-tracks" remain, by nature, approximations of the ground truth.

Saison	All intensities		CI ³ 2.0		CI ³ 3.0		CI ³ 5.0	
1990-1991	**52 km**	*(193)*	**52 km**	*(180)*	**46 km**	*(136)*	**39 km**	*(14)*
1991-1992	**62 km**	*(231)*	**59 km**	*(208)*	**63 km**	*(110)*	**35 km**	*(39)*
1992-1993	**39 km**	*(215)*	**38 km**	*(205)*	**33 km**	*(116)*	**16 km**	*(39)*
1993-1994	**58 km**	*(442)*	**58 km**	*(423)*	**53 km**	*(328)*	**31 km**	*(87)*
1994-1995	**38 km**	*(345)*	**38 km**	*(341)*	**32 km**	*(238)*	**25 km**	*(51)*
1995-1996	**41 km**	*(282)*	**41 km**	*(273)*	**39 km**	*(189)*	**27 km**	*(68)*
1996-1997	**39 km**	*(376)*	**39 km**	*(366)*	**37 km**	*(250)*	**25 km**	*(61)*
1997-1998	**37 km**	*(174)*	**38 km**	*(147)*	**39 km**	*(58)*	**22 km**	*(8)*
1998-1999	**32 km**	*(181)*	**32 km**	*(174)*	**25 km**	*(75)*	**15 km**	*(24)*
1999-2000	**34 km**	*(331)*	**35 km**	*(305)*	**26 km**	*(197)*	**17 km**	*(51)*
2000-2001	**34 km**	*(168)*	**34 km**	*(164)*	**25 km**	*(111)*	**18 km**	*(42)*

5. Cyclone forecasting

5.1 Track and intensity forecasting

Track and intensity forecasts rely to a great extent on the numerical models outputs available at the RSMC.

These fields are analysed to evaluate the constraints imposed on the tropical cyclones by their environment. This subjective analysis added to the observation data, derived from satellite and other sources allows to determine how the current behaviour of the cyclone will be influenced.

5.2 Numerical forecast models

Many numerical forecast models are used by the RSMC forecasters :

1. Statistical model :

Based on the tropical cyclones historical file maintained by RSMC/ La Réunion (which contains today the data of about 1170 tropical cyclones of the period 1848-2001), a simple « analogs » model have been developed. However, the interest of this model for operational forecasting is rather limited, although it is helpful to new or young forecasters for acquiring the necessary climatological knowledge.

This kind of models allows to have quickly access to track and intensity cyclone forecasts. For the moment, those models are essential to make forecasts at short range (<12 hours).

2. Baroclinic models :

Among all the global numerical weather prediction models available at RSMC, the most useful are ECMWF model IFS, and French model ARPEGE. The French one is a global model with stretched area over Europe. A new version of ARPEGE, with its focus point on the Indian ocean (called “ARPEGE/Réunion”), has routinely been used by forecasters from December 1998 till mid-2001.

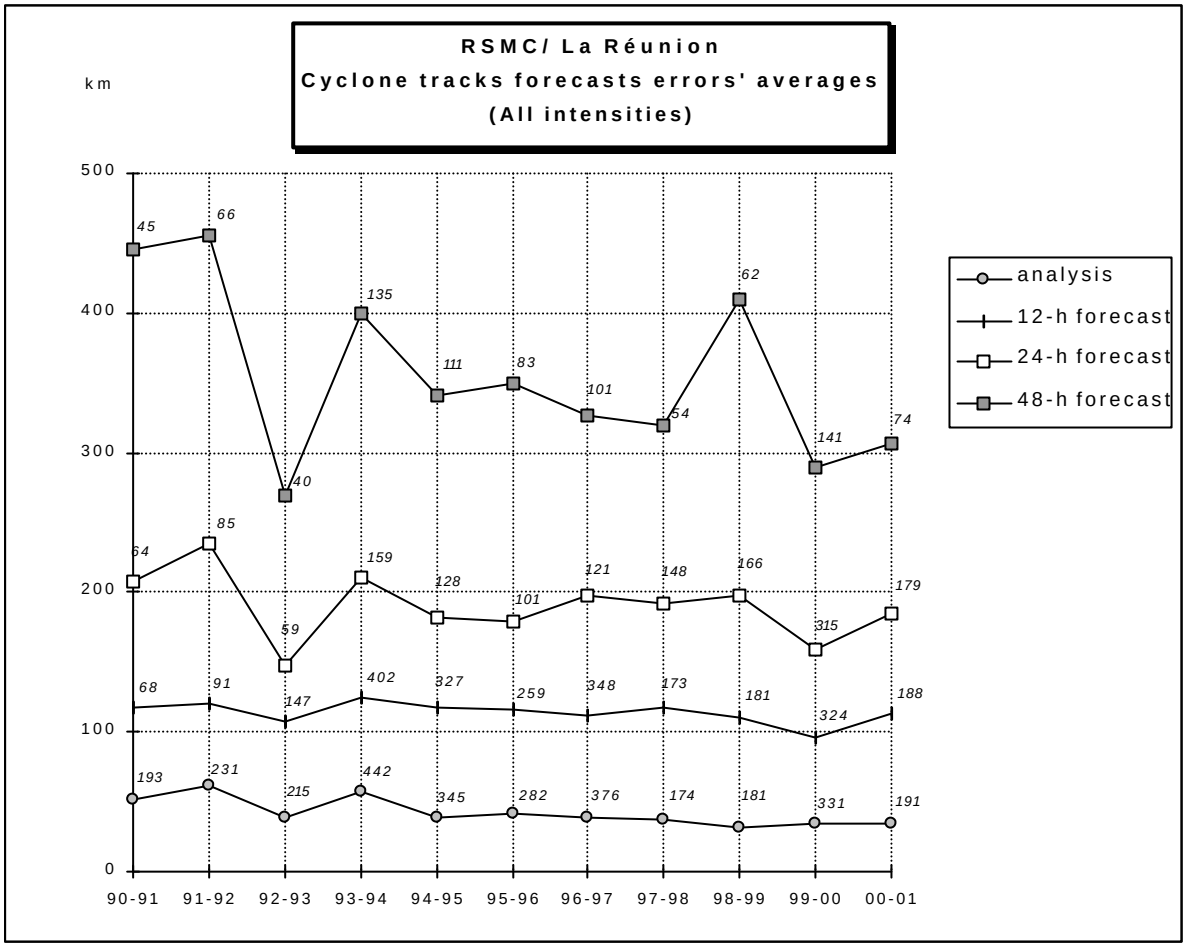
From cyclone season 2001-2002, a new operational model will be used, constituted of the uniform resolution global model ARPEGE, coupled with fine mesh and limited area model ALADIN over the Indian Ocean (called “ARPEGE/Tropique”). Physical parametrizations have been especially calculated for the cyclone forecast, and the bogussing method will be used for the analyse.

5.3 Evaluation of RSMC forecasts

Since 1990, detailed forecast performance statistics are prepared at the end of each tropical season. Graphs below give the results for different intensity families (intensity of the tropical cyclone at the initial position).

Nota : The initial positioning error is not removed from these verification statistics. Moreover, these statistics are not adjusted for forecast difficulty using the CLIM model forecasts.

(in italics : number of forecasts)


RSMC/ La Réunion
Cyclone tracks forecasts errors' averages
(All intensities)
km
500
400
300
200
100
0
90-91
91-92
92-93
93-94
94-95
95-96
96-97
97-98
98-99
99-00
00-01
analysis
12-h forecast
24-h forecast
48-h forecast
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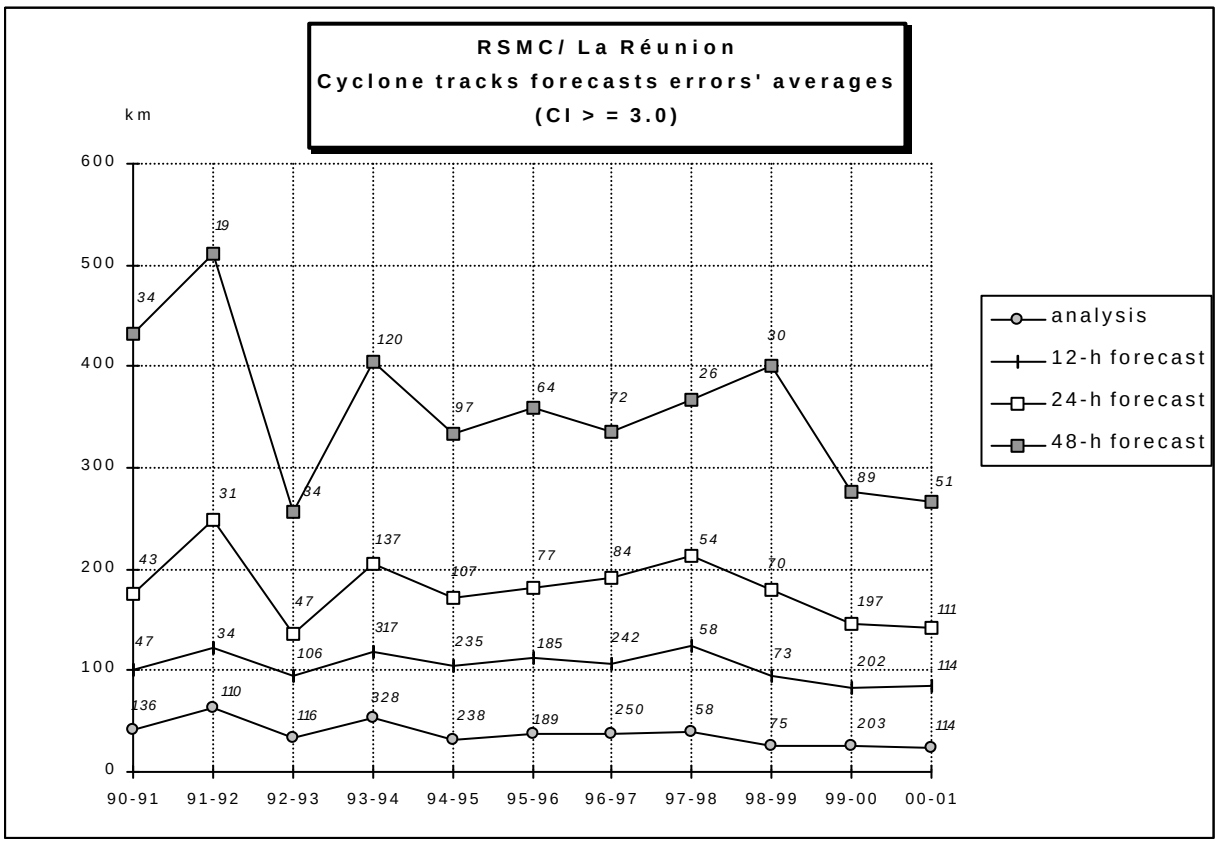
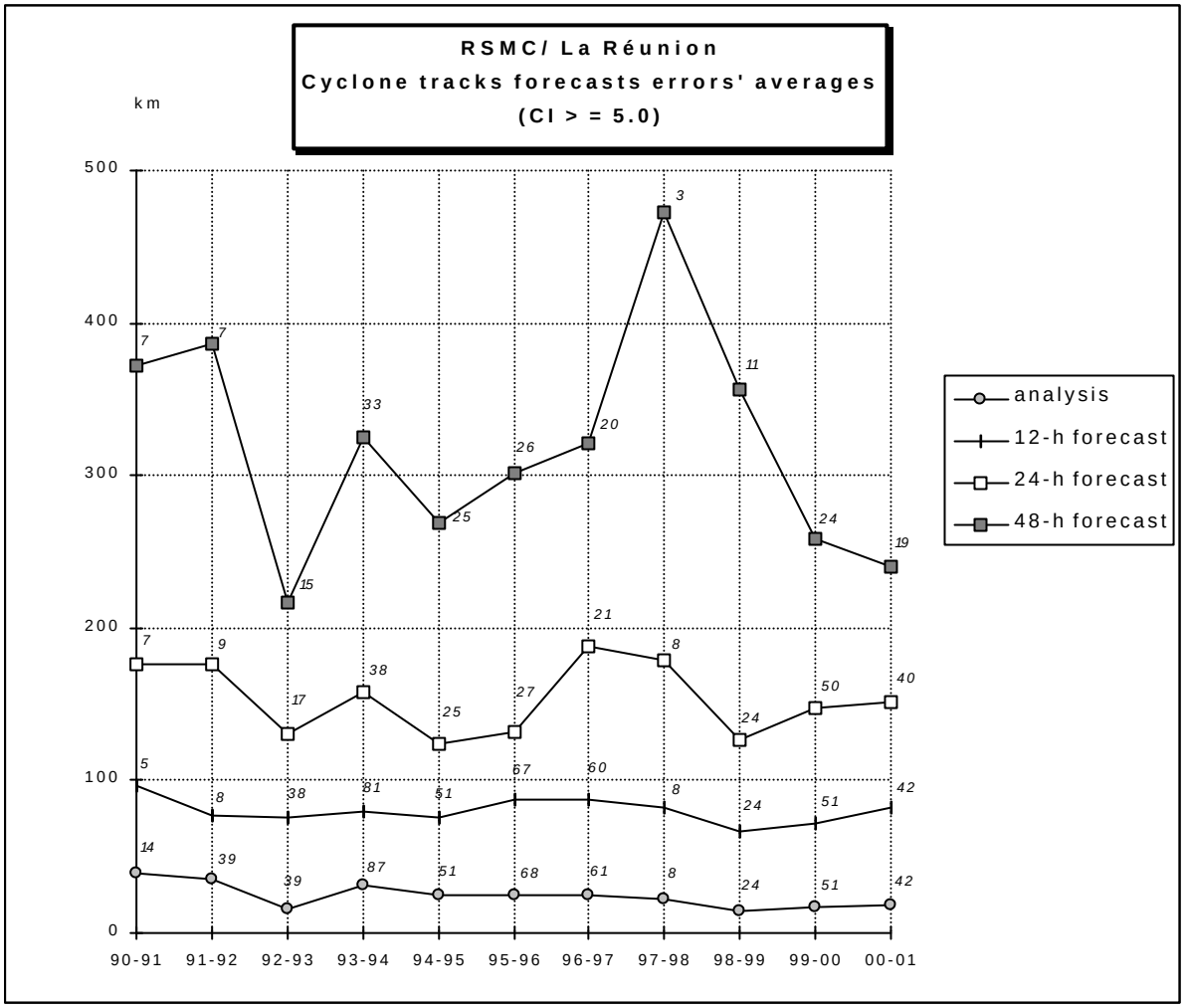
64 85 59 159 128 101 121 148 166 315 179
68 91 147 402 327 259 348 173 181 324 188
193 231 215 442 345 282 376 174 181 331 191


RSMC/ La Réunion
Cyclone tracks forecasts errors' averages
(CI > = 3.0)
km
600
500
400
300
200
100
0
90-91
91-92
92-93
93-94
94-95
95-96
96-97
97-98
98-99
99-00
00-01
analysis
12-h forecast
24-h forecast
48-h forecast
34 19 84 120 97 64 72 26 30 89 51
43 31 47 137 107 77 84 54 70 197 111
47 34 106 317 235 185 242 58 73 202 114
136 110 116 328 238 189 250 58 75 203 114



5.4 Storm surge model

In La Réunion, due to the profile of the coast and the bathymetry, storm surge is not a fundamental problem, but on some portions of the coast the risk is significant for specific tracks and situations.

A numerical storm surge model developed by Météo-France for La Réunion, has been implemented at RSMC in December 1996. It is possible to run this model in real-time whenever a tropical cyclone is forecast to affect the island. But through multiple runs of the model, the RSMC has elaborated an atlas of pre-computed storm surges which are available for graphical display on a computer and for interactive determination by the forecaster of the Maximum Envelope of Waters (MEOW) given the uncertainty in the forecast situation.

6. Operational products of the RSMC

6.1 Bulletins

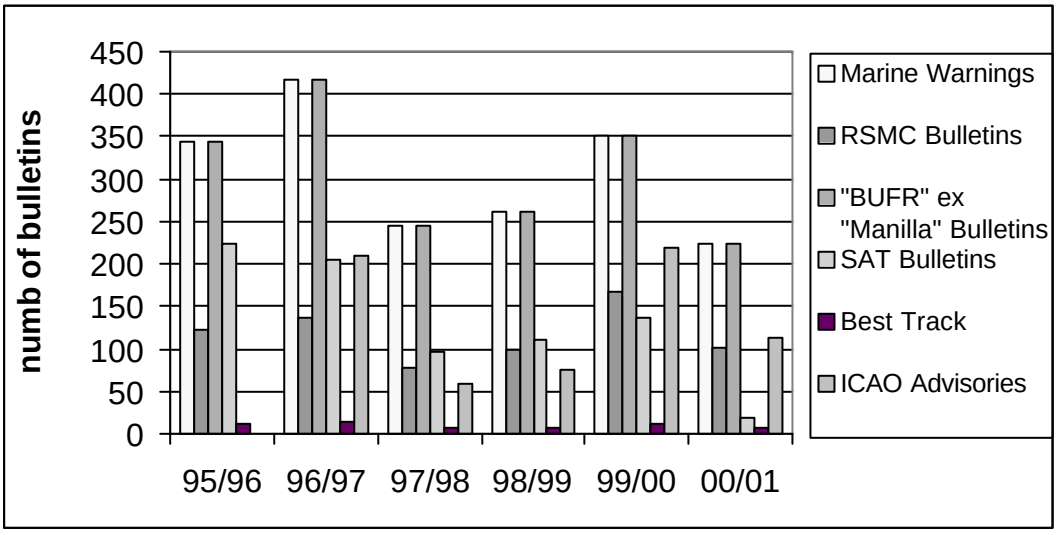
The RSMC issues different kinds of bulletins : Marine Warnings, «RSMC » Bulletins, Satellite bulletins, ICAO Advisories, « BUFR » (ex « Manilla ») bulletins, « best track » bulletins, and, since September 1999, a daily bulletin about cyclone activity in the South-West Indian ocean.

Bulletins		Headings	Dissemination time
Marine Warnings	English	**WTIO20, 22, 24**	**GTS** 00, 06, 12, 18 UTC
	French	**WTIO21**	Same
RSMC Bulletins	English	**WTIO30**	**GTS** 06, 18 UTC
	French	**WTIO31**	Same
Satellite Bulletins	English	**TPIO20**	**GTS** as soon as possible after the satellite's passage
	French	**TPIO21**	same
ICAO Advisories	English	**-** **FKIO20**	**AFTN** 00, 06, 12, 18 UTC **GTS** 00, 06, 12, 18 UTC
"BUFR" Bulletins	-	**ATIO01**	**GTS** 00, 06, 12, 18 UTC
"Best-Track" Bulletins	-	**AXIO20**	**GTS** within one month after the cyclone's death
Cyclone information Bulletin	English	**AWIO20**	**GTS** 12 UTC
	French	**AWIO21**	**GTS** 12 UTC

The « RSMC Bulletins » which are issued twice daily are the more complete bulletins. They provide, in particular, position and intensity forecasts with prognostic reasoning for the coming 48 hours.

Satellite bulletins are issued for each TIROS satellite picture of the tropical cyclones. They contain information on the position of the centre with the confidence degree, direction and speed of movement, central pressure and maximum wind speed with Dvorak T and CI numbers.

Number of bulletins issued by LA REUNION RSMC (1995-2001)



6.2 <u>MDD dissemination</u>

Some RSMC's graphical products and bulletins are disseminated on the MDD (Meteosat Data Dissemination).

6.3 Cyclone data base

At the end of each tropical cyclone season, the RSMC "best-tracks" digital data are mailed to the National Climatic Data Center (Ashville-USA) and to some other interested Centres (as the Meteorological Centre of United Kingdom in Bracknell). The access to this data base will be soon available on the RMSC website.

7. Activities of Research, Training and Communication of the RSMC

7.1 Research and development

The aim is to strengthen the RSMC forecasting capabilities through the development of new models andthrough the improvement of the objective guidance. The "Cellule Recherche Cyclone (CRC)" (Cyclone Research Unit) gives to the RSMC the capacity to undertake this vital task. The CRC has as well, the mission to improve the knowledge about the cyclones of the Indian Ocean.

Furthermore, researchers of the Region could be temporarily attached to this unit and participate to the developments.

The CRC has 3 different fields of development :

- Development of specific tools for the forecasters.

In this domain, the CRC deals with statistical models, improvement of the coupled model ARPEGE/ALADIN, and follows the ECMWF's work on the ensemble prediction system.

- Improvement of the analyse of the tropical cyclones and of the physical parametrizations in the numerical forecast models.

The CRC's goal is to keep on studying impact of the observations in the ARPEGE/Tropique (instead of the ARPEGE/Réunion), especially with the QuikScat data, as soon as they are available to be assimilated in the database in Toulouse.
The CRC will study as well the impact of the high resolution winds derived from the water vapor channel (HWW) of METEOSAT on the analyse of cyclone structures.
Furthermore, as soon as the assimiliation system with ALADIN will be ready , it will be tested with fine resolution data on the tropical cyclones (SATGEO, ERS).

Study of intensification and cyclogenesis mechanisms of the tropical cyclones is a field where the CRC must actively participate. Specific parametrizations on the convection, adapted to the cyclone environnment, and air-sea interactions with strong winds are studied in collaboration with the "Centre National de Recherche Météorologique (CNRM) " (National Centre of Meteorological Research) of Météo-France in Toulouse.

- Studies of the process to better understand the functioning of the tropical cyclones and their interaction with the environnment.

The aim of this work is to connect the precursors, in terms of potential vorticity, of the tropical cyclones in the Indian Ocean. Concurrentlly, a potential vorticity inversion method is developed.

The CRC studies as well the interactions between the oscillations (MJO, QBO, ENSO) of the Indian Ocean basin and the cyclone activity.

7.2 Training

RSMC plays a key role in the region, in the field of training activities. In particular, the RSMC organizes with the WMO, each 2 years since 1999, and during 2 weeks, a training course/workshop in English and in French for the african countries, members of the Cyclone Committee.

Furthermore, as part of the regional cooperation, the RSMC regularly receives meteorologists of the area during the 3 or 4 most active months of the cyclone season.

Because of its functions, the RMSC is brought to participate to numerous seminars or international conferences.

7.3 Annual publication

The RSMC/La Réunion publishes an annual report in French and English on the cyclone season of the South-West Indian Ocean basin. About 300 of these copies are distributed in the region (in particular to the Members of the Tropical Cyclone Committee) and further, to many meteorological offices and scientific institutes all over the world. This publication describes at length the formation, evolution and effects of each tropical cyclone observed during the season, provides best-tracks, statistics, satellite pictures, charts, and other relevant information.

APPENDIX Q

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

METEOROLOGICAL COMPONENT

1.1 SUPPORT TO THE REGIONAL METEOROLOGICAL OBSERVING SYSTEM									
TASKS		TIMESCALE				BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
		2001	2002	2003	2004				
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:								
	- Siteki					Swaziland	Swaziland		
	- Piggs Peak					Swaziland	Swaziland		
	- Nhlangano					Swaziland	Swaziland		
	- Maseru (68454)					Lesotho	No	Funds needed	
	- Qachas'nek (68456)					Lesotho	No	Funds needed	
	- Mokhohong (68458)					Lesotho	No	Funds needed	
	ii) Maintaining of the synoptic observations at 00 and 18 UTC					Members			Continuous activity
	b) Fixed Automatic Surface Stations:					Comoros			
	- Kartala (Grande Comoro)					Comoros			
	- Anjouan					Comoros	No	Funds needed	
	- Moheli					Lesotho	No	Funds needed	
	- Maseru					Lesotho	No	Funds needed	
	- Qachas'nek						No	Funds needed	
							No	Funds needed	
	c) Cyclone Warning Radar Stations								
	i) Establishment. of new stations:								
	- Maputo, Biera, Nampula, Tete								
	- Hahaya (67002)					Mozambique	No	Funds needed	
							No	Funds needed	

I. METEOROLOGICAL COMPONENT

1.1 SUPPORT TO THE REGIONAL METEOROLOGICAL OBSERVING SYSTEM

	TASKS	TIMESCALE 2001	2002	2003	2004	BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
						Comoros			
1.1.1.1 (cont'd)	ii) Replacement of cyclone warning radar					Mauritius	No	Funds needed	
	iii) Rehabilitation of radar stations:								
	- Antalha (67025					Madagascar	No	Funds needed	
	- Antananarivo (67085)					Madagascar	No	Funds needed	
	- Morondava (67117)					Madagascar	No	Funds needed	
	- Chileka (67693)					Malawi	No	Funds needed	
	- Lilongwe (67586)					Malawi	No	Funds needed	
	d) Buoys:								
	- deployment of five drifting buoys per year					France	France		
	- deployment of three drifting buoys per year					South Africa	South Africa		
	- deployment of three drifting buoys					Mozambique and Tanzania	No	Funds needed	
	e) Fixed buoy					Members	No	Funds needed	
1.1.1.2	**Upper-air Observations**								
	a) establishment of new pilot balloon stations - Anjouan (67004)					Comoros	Comoros		
	Rehabilitate - 6 pilot balloon stations in Mozambique					Mozambique	No	Funds needed	

I. METEOROLOGICAL COMPONENT

1.1 SUPPORT TO THE REGIONAL METEOROLOGICAL OBSERVING SYSTEM (cont'd)

TASKS		TIMESCALE				BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
		2001	2002	2003	2004				
1.1.1.2 (cont'd)	b) establishment of upper-air (radiowind) stations:								
	- Mzuzu (67489)					Malawi	No	Funds needed	
	Rehabilitate								
	- Tete					Mozambique	No	Funds needed	
	c) establishment of upper-air (radiosonde) stations :								
	- Mutare 67885					Zimbabwe	No	Funds needed	
	- Beira 67297 and Maputo 67341					Mozambique	No	Funds needed	
	- Matsapa (68396)					Swaziland	No	Funds needed	
	Rehabilitate								
	- Antsiranana 67009					Madagascar	No	Funds needed	
	- Farafangana 67157					Madagascar	No	Funds needed	
	- Toliary 67161					Madagascar	No	Funds needed	
	d) provision of radiosonde					Mauritius	No	Funds needed	

I. METEOROLOGICAL COMPONENT

1.1 SUPPORT TO THE REGIONAL METEOROLOGICAL OBSERVING SYSTEM (cont'd)

	TASKS	TIMESCALE 2001	2002	2003	2004	BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
1.1.2	**Space-based sub-system**								
1.1.2.1	Meteorological Satellite System								
	a) Undertake necessary steps to receive Chinese geostationary satellite and Russian Geostationary satellite (GOMS)	———	———	———	———	Members			
	b) Upgrade receiving equipment in order to make full use of possibilities offered by meteorological satellites for observational purposes in relation to tropical cyclones	———	———	———	———	Members concerned	IOC (partial funding)		
	c) Installation of Data Collection Platforms (DCPs):		———	———	———				
	- One DCP in Mozambique	———	———	———	———	Mozambique			
	- Three DCPs in Tanzania	———	———	———	———	Tanzania			
	d) Installation/ rehabilitation of DCS/DRS and MDD reception system	———	———	———	———	Botswana Swaziland			WMO Technical assistance forthcoming
	e) Rehabilitation of MDD reception system	———	———			Lesotho			WMO Technical assistance needed

I. METEOROLOGICAL COMPONENT

1.2 SUPPORT TO METEOROLOGICAL TELECOMMUNICATIONS

	TASKS	TIMESCALE				BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
		2001	2002	2003	2004				
1.2.1	Improvement of national data collection network by upgrading telecommunication equipment where necessary					Members		Members	Continuous activity
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		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		VCP	

I. METEOROLOGICAL COMPONENT

TASKS		TIMESCALE				BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
		2001	2002	2003	2004				
1.3	**MAINTENANCE**								
1.3.1	Maintenance workshop					Members	EDF (Comoros, Madagascar, Mauritius, Seychelles)	WMO and others	
1.3.2	Establishment of a regional centre					Members			
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			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 rapporteur before each session of the Committee					Members			Regularly
1.7	**FORECAST**								
1.7.1	Implementation of workstations for forecasting					Members			

II. HYDROLOGICAL COMPONENT

TASKS		TIMESCALE				BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
		2001	2002	2003	2004				
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 concerned		Members concerned	
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 cycloness					Members concerned in collaboration with the DMC Harare		Members concerned and other sources	
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

2.3 FLOOD FORECASTING SYSTEM

	TASKS	TIMESCALE 2001	2002	2003	2004	BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
2.3.1	Evaluation of existing flood forecasting systems					Members, in coordination with the RA I Working Group on Hydrology			Continuous activity
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		Members, VCP/ WMO or bilateral	
2.3.3	Establishment, improvement and/or expansion of hydrological forecasting (including flash flood) and warning systems in flood-prone areas					Members		Members	Ongoing
2.3.4	Comparison of flood forecasting system					Members		Members/WMO	Ongoing
2.3.5	Creation of a hydrological data bank for river basins, with cyclone related flood problems					Members in collaboration with DMC Harare		Members	

III. DISASTER PREVENTION AND PREPAREDNESS COMPONENT

3.1 DISASTER PREVENTION AND PREPAREDNESS

	TASKS	TIMESCALE				BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
		2001	2002	2003	2004				
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 and ensuring that adequately trained staff in disaster prevention and preparedness be available to follow up implementation of plans and warning systems	———	———	———	———	Members		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		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		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		Members	With assistance from WMO; Continuous activity

III. DISASTER PREVENTION AND PREPAREDNESS COMPONENT

TASKS		TIMESCALE				BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
		2001	2002	2003	2004				
3.2	**PROTECTION OF THE ENVIRONMENT**								
3.2.1	Maximum use of GEF should be made to protect the environment					Members		Members, GEF	With assistance from WMO and UNEP
3.3	**ISDR**								
3.3.1	Monitor activities of National Committees and/or Focal Points for ISDR					Members			

IV. RESEARCH COMPONENT

4. RESEARCH

	TASKS	TIMESCALE 2001	2002	2003	2004	BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
4.1	Undertake climatological work on various aspects of tropical cyclones under the sub-projects∗: (a) effect of sea-surface temperature on tropical cyclone activity and intensity.					Members concerned			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 warning and increased cyclone activity (see 1.6.1 above)*					Members		Members	
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		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		Members and other sources	Continuous activity
4.5	Maintain a data bank at RSMC La Réunion					RSMC La Réunion			Continuous activity

∗ With the help of RSMC - La Réunion

V. TRAINING COMPONENT

5. TRAINING

	TASKS	TIMESCALE				BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
		2001	2002	2003	2004				
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			Continuous activity
5.2	As regards meteorology, emphasis to be placed on: (a) training of technicians, particulary with respect to the operational and maintenance of electronic equipment and computers; (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; (c) forecast evolution of tropical cyclones, including the use of traditional methods and familiarization with NWP models.					Members*		WMO (regular budget, VCP, fellowships), UNDP, Members and other sources EDF	
5.3	In the field of hydrology, primary attention to be given to: (a) hydrology of flood and flood-risk evaluation[T]; (b) hydrological forecasting and warning[T].					Members		WMO (regular budget, VCP, fellowships), UNDP, Members and	

* With support of RSMC - La Réunion
T Workshop/Seminar

V. TRAINING COMPONENT

5. TRAINING (cont'd)

	TASKS	TIMESCALE				BY WHOM	RESOURCES OBTAINED	POSSIBLE RESOURCES	COMMENTS
		2001	2002	2003	2004				
5.4	Training the field of disaster preparedness of appropriate personnel in the operational of warning systems and the operation of disaster preparedness					Members		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		WMO (regular budget, VCP, fellowships), UNDP, Members and RSMC La Réunion	Continuous activity