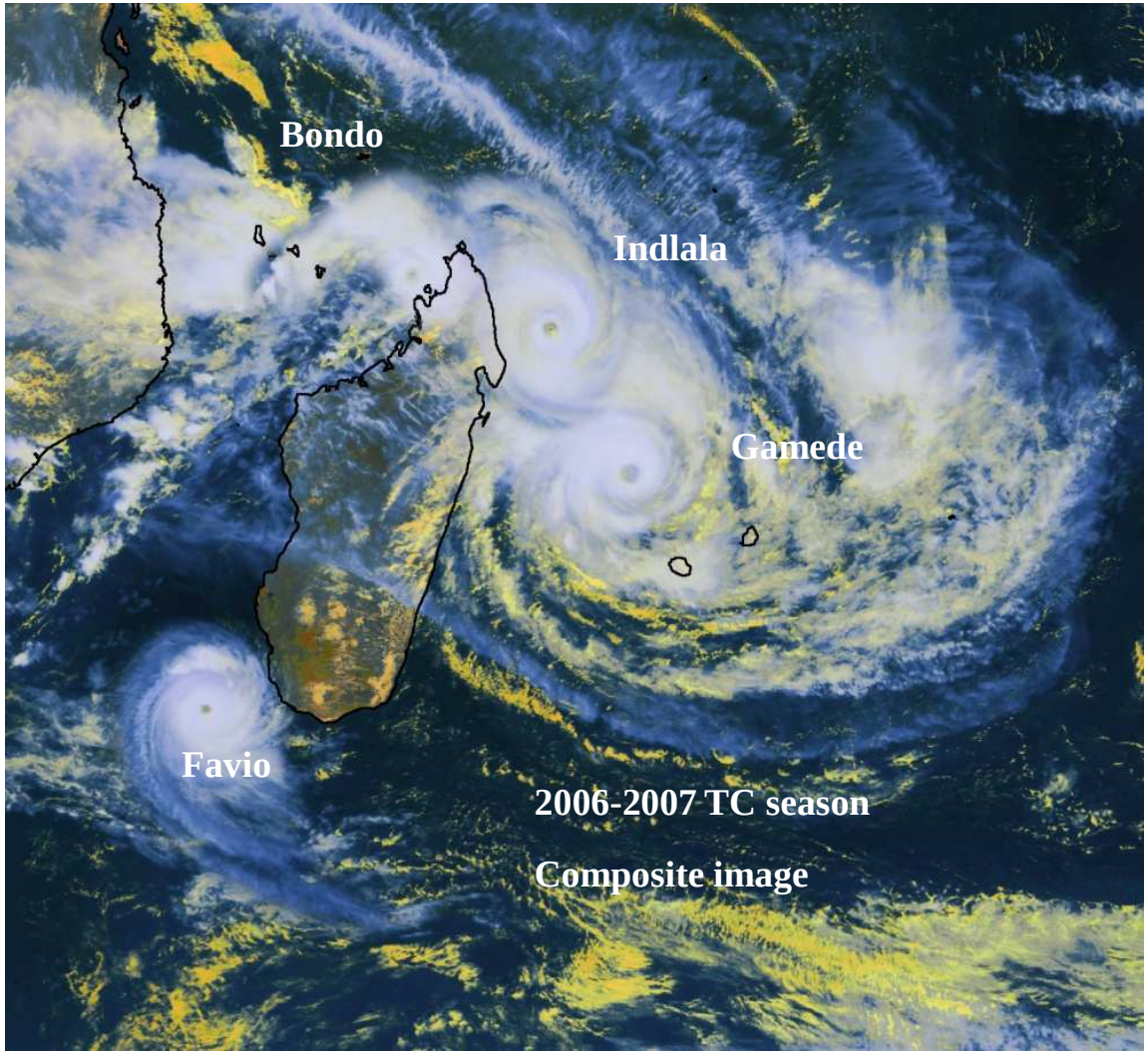
The SouthWest Indian Ocean cyclone basin



Sébastien Langlade

Tropical cyclone forecaster – RSMC La Reunion

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OUTLINE

1. Introduction- Global cyclonic activity

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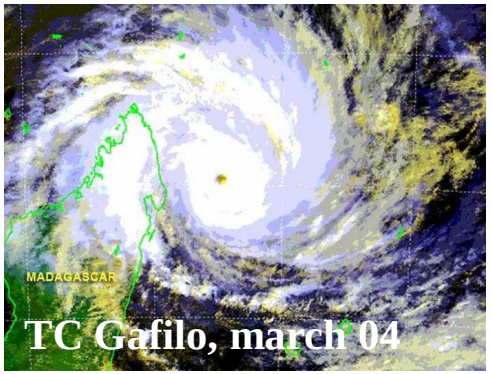
Basic definitions

DEFINITIONS:

A tropical cyclone is the generic term for a non-frontal synoptic scale low-pressure system over tropical or sub-tropical waters with organized convection (i.e. thunderstorm activity) and definite cyclonic surface wind circulation (Holland 1993)

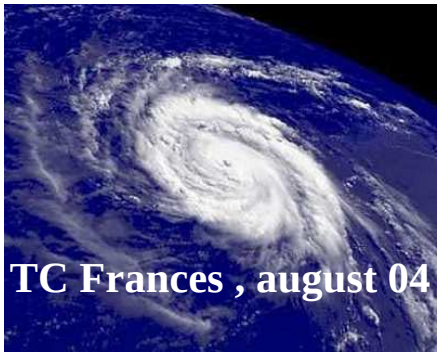


TC Gafilo, march 04

Max wind < 34 kt → Tropical depression

33 kt < max wind < 64 kt → Tropical storm

Max wind > 63 kt → **"hurricane"** (north ATL, NEPAC)


TC Frances , august 04

"typhoon" (the NWPAC west of the dateline)

"severe tropical cyclone" (the SWPAC and SEI east of 90E)

"severe cyclonic storm" (the North IND)

"tropical cyclone" (the SWIO)

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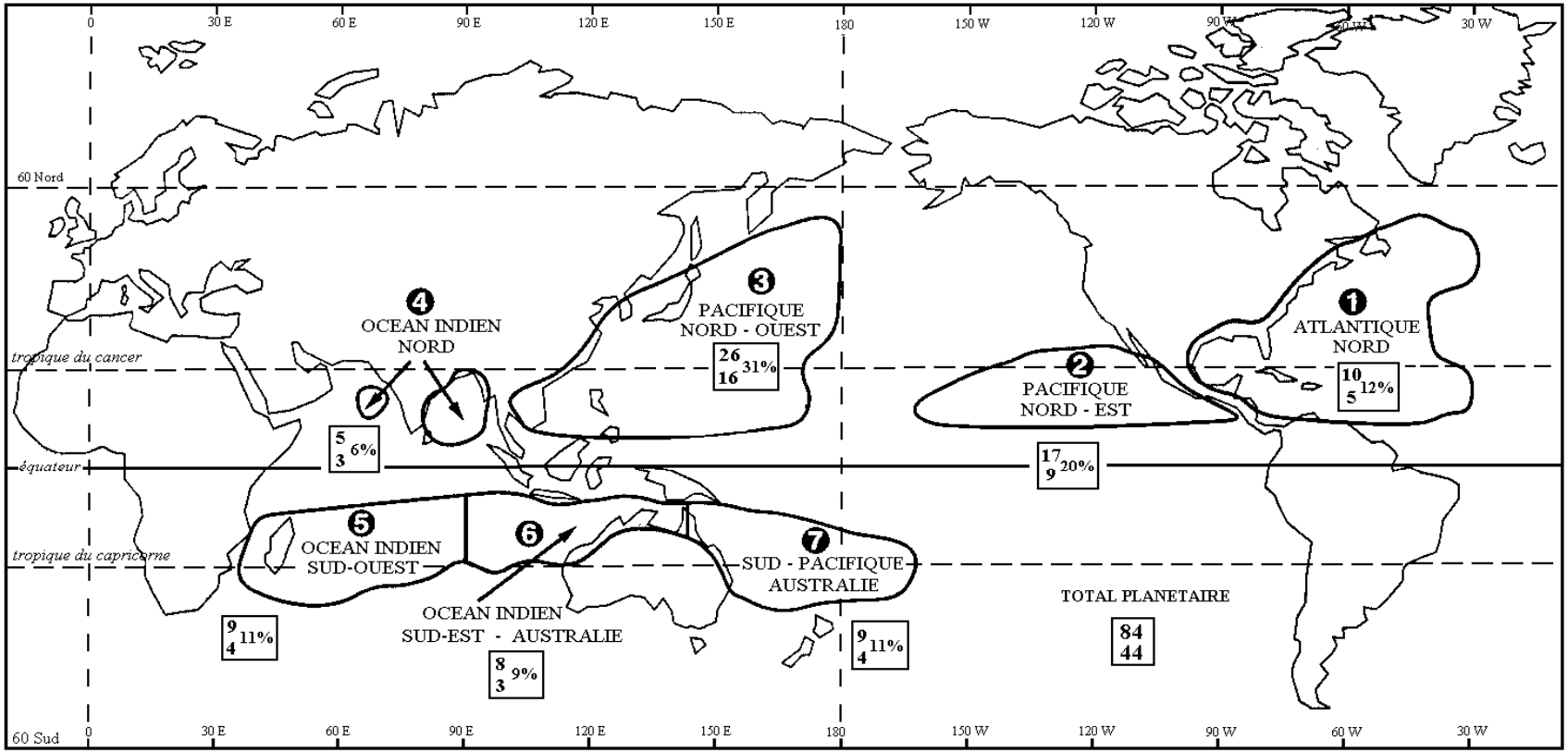
Cyclone basins



Statistiques sur la période 1968-1990

$\begin{matrix} A \\ B \end{matrix}$ C%

A : *Nombre annuel moyen de tempêtes et cyclones tropicaux*

B : *Nombre annuel moyen de cyclones tropicaux*

C : *Pourcentage de la population mondiale (tempêtes et cyclones)*

D'après Charles J. Neumann, in Global Guide of Tropical Cyclone Forecasting, WMO/TD N°560, 1993.

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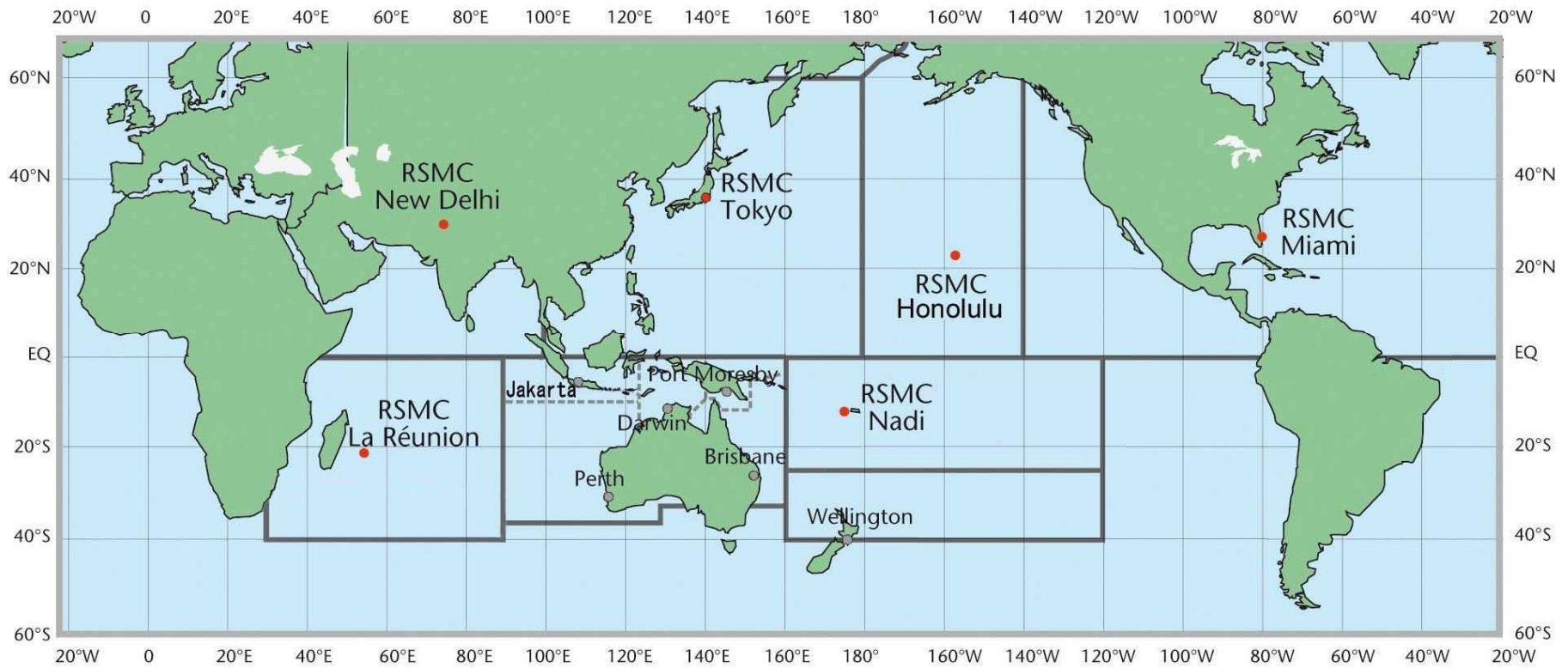
Tropical cyclone: a major threat for life and properties

World cyclone watch

TCP, tropical cyclones programme, programme of the World Weather Watch created in 1972 by WMO



A specific organisation leaded by WMO : 6 RSMCs (Regional Specialized Meteorological Centres) and 6 TCWCs (Tropical Cyclone Warning Centres)

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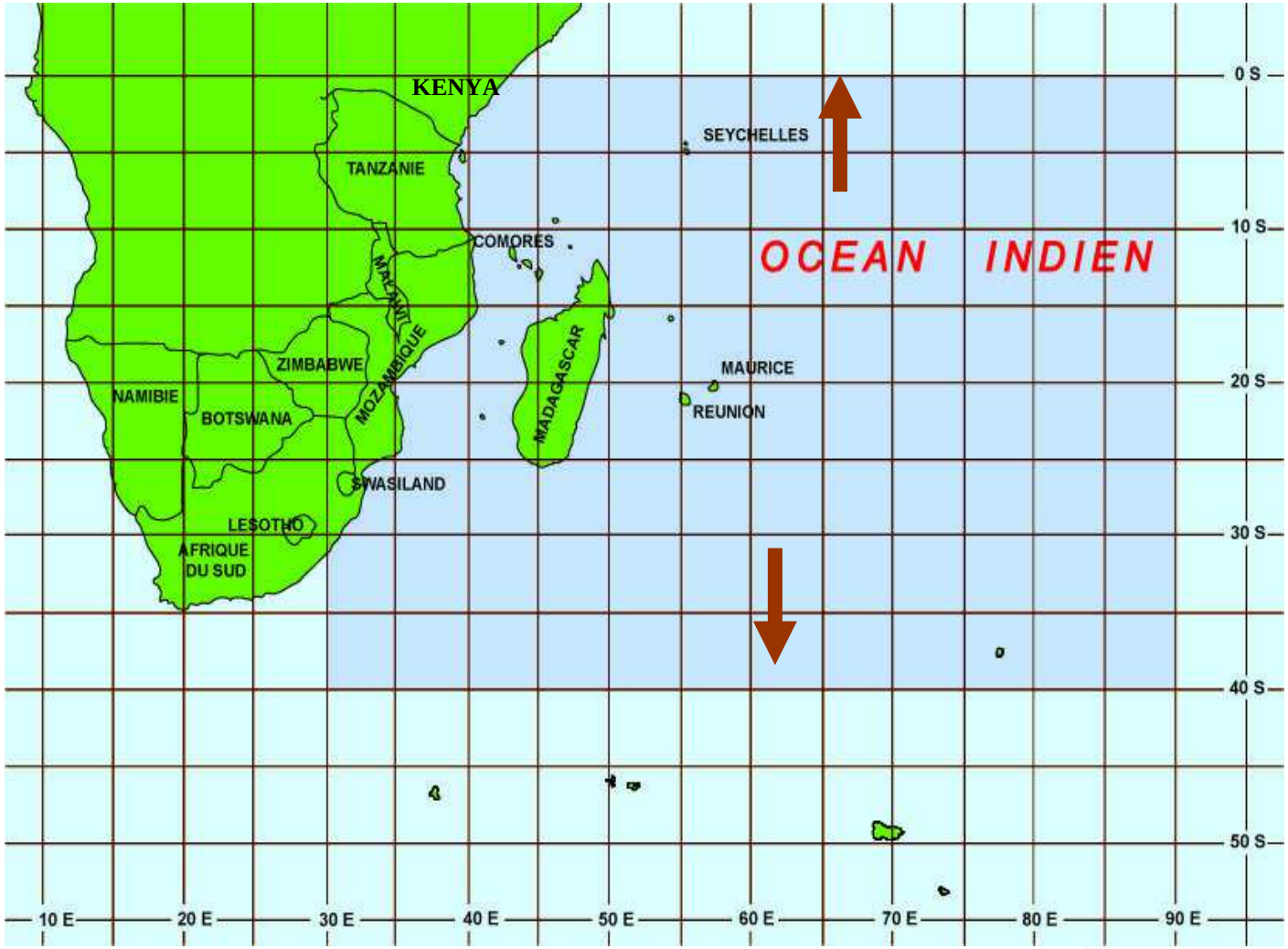
The South West Indian Ocean cyclone basin



• **<u>Sept 1985</u>:**

East border shift

from 80°E to 90°E

Area of Responsability extended southwards (30S →40S) and northwards (5S→ 0) since september 2003.

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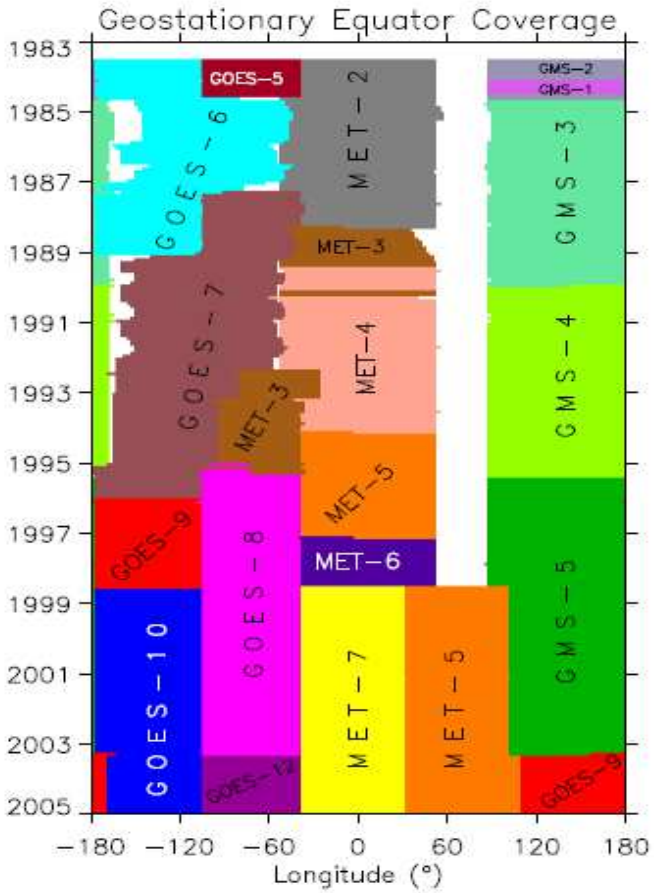
The South West Indian Ocean cyclone basin



Knapp and Kossin (2007)

- Partial geostationnary coverage until may 1998 !

- TC tracking and analysis based mainly on polar imagery before 1998

- Satellite imagery reception issues and the lack of digital imagery until late 1990→ inconsistencies in the TC data base

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Dvorak scale used in the South West Indian Ocean

Practices in the SWIO :

- *Dvorak scale used since 1981/1982*
- *Wind-Pressure relationship: Courtney&Knaff (2011/2012) – Atkinson & Holliday (1977) used before*
- *Criteria: average wind (10mn)*

Modifications in September 1999 :

- Conversion factor between 1 min and 10 min winds changes from 0,80 to **0,88**
- Gust factor changes from 1,5 to **1,41**.

Recommandations from Harper et.al (2010):

Conversion factor from 1min to 10 min is **0.93** (open sea)

Gust factor for a 3 sec gust associated with a 10 min average wind is **1.23** (open sea)

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Classification of tropical disturbances in the South West Indian Ocean basin

WIND FORCE		***STAGE***
No clear circulation center		***Disturbance area***
< 28 kt (< 51 km/h)		***Tropical disturbance***
28-33 kt (51-63 km/h)		***Tropical depression***
34-47kt (**63**-88 km/h)	***NAMING***	***Moderate tropical storm***
48-63 kt (89-117 km/h)		***Severe tropical storm***
64-89 kt (**118**-165 km/h)		***Tropical cyclone***
90-115kt (166-212 km/h)		***Intense tropical cyclone***
> 115 kt (> 212 km/h)		***Very intense tropical cyclone***

The wind force is averaged over 10 mn.

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Naming in the South West Indian Ocean

TC names 2015/2016

Names	Provided by
Annabelle	Seychelles
Bohale	Lesotho
Corentin	France
Daya	Kenya
Emeraude	Mauritius
Fantala	Madagascar
Gao	Botswana
Hassina	Comoros
Inacio	Mozambique
Juma	Malawi
Ketiwe	Zimbabwe
Lalelani	Swaziland
Moabi	South Africa
Naima	Tanzania
Octave	France
Piera	Madagascar
Quizito	Mozambique
Richard	Seychelles
Sofia	Kenya
Tatiana	Mauritius
Umboni	Malawi
Vela	Tanzania
Wayne	South Africa
Xaba	Lesotho
Yazid	Comoros
Zenani	Swaziland

List changing on 1st july

List of names defined during the Tropical Cyclone Comitee (TCC, every 2 years), among the propositions of the 15 members

Naming criteria (Op. plan 2012):

- ***Gale force winds (observed or estimated) present near the low pressure center in a significant portion of the cyclonic circulation.***
- ***Both tropical or subtropical disturbances can be named.***

Naming :

- **Mauritius east of 55E**
- **Madagascar west of 55E**

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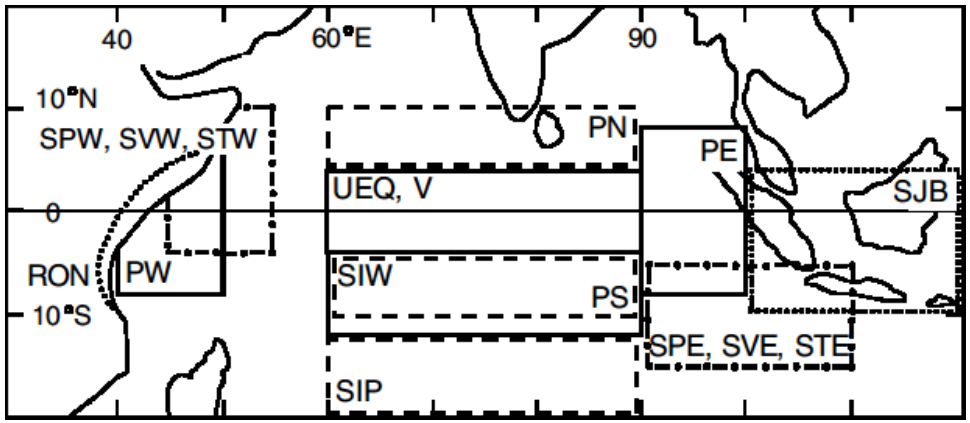
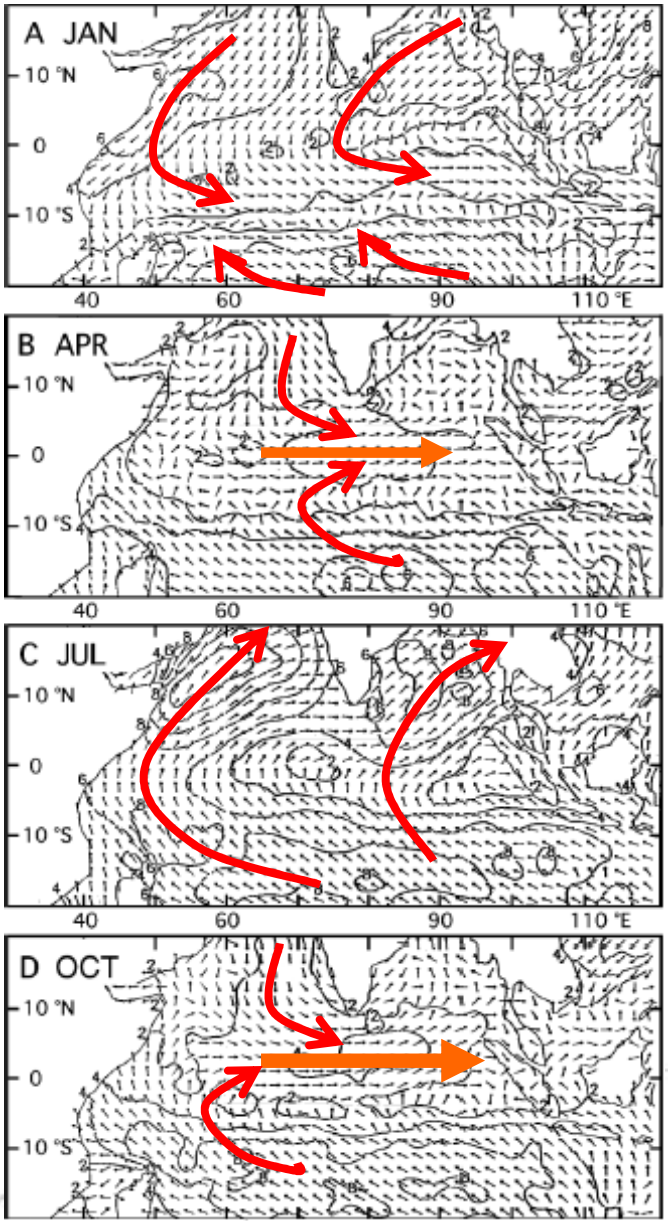
Equatorial wind patterns

Hastenrath etal., 2004





• Annual cycle dominated by the shift between the southern and norther summer monsoon : seasonnal shift of the inter-hemispheric pressure gradient .

•Equatorial westerlies: enhanced with strong east-west gradient pressure with weak near equatorial southern trade winds

Summer monsoon

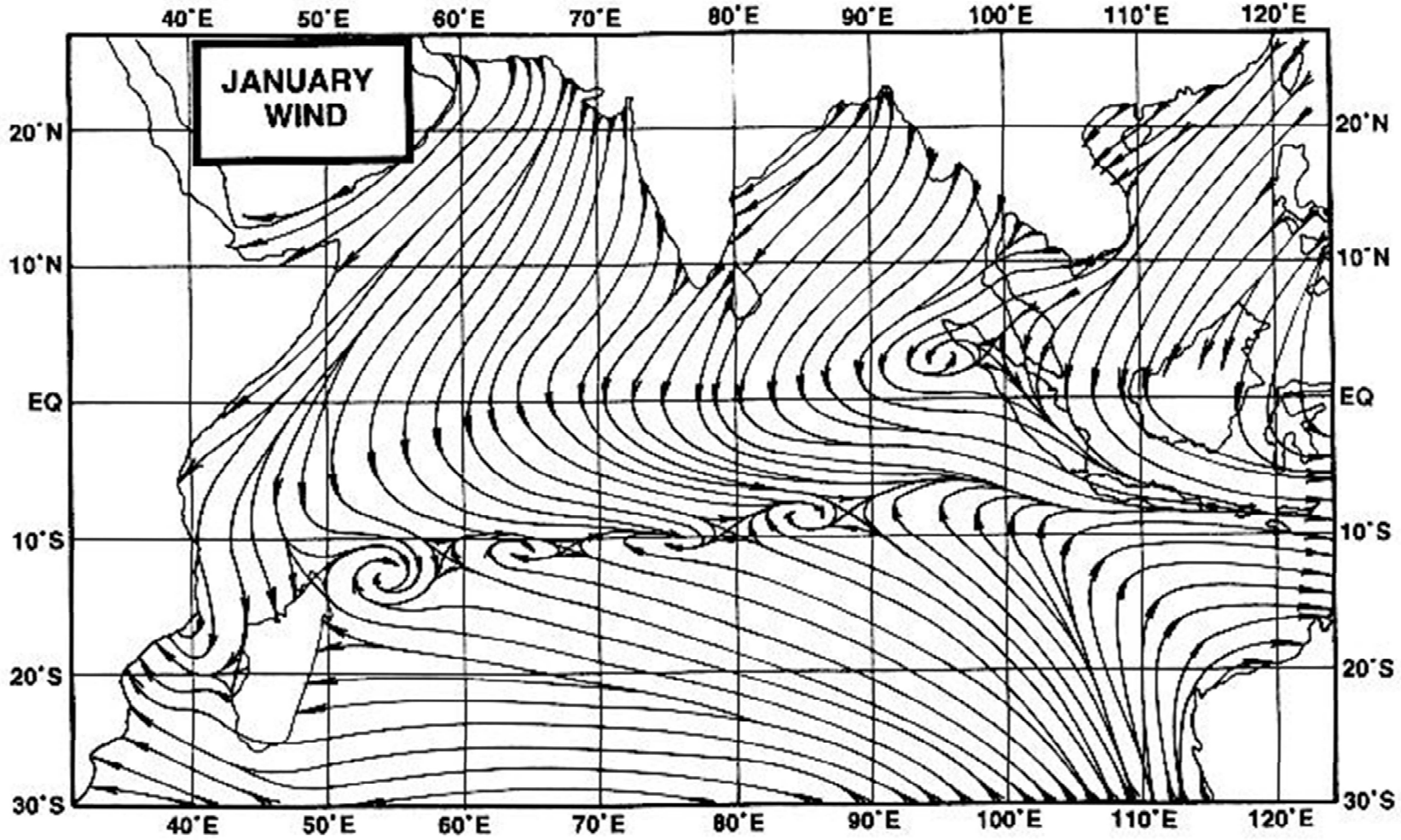
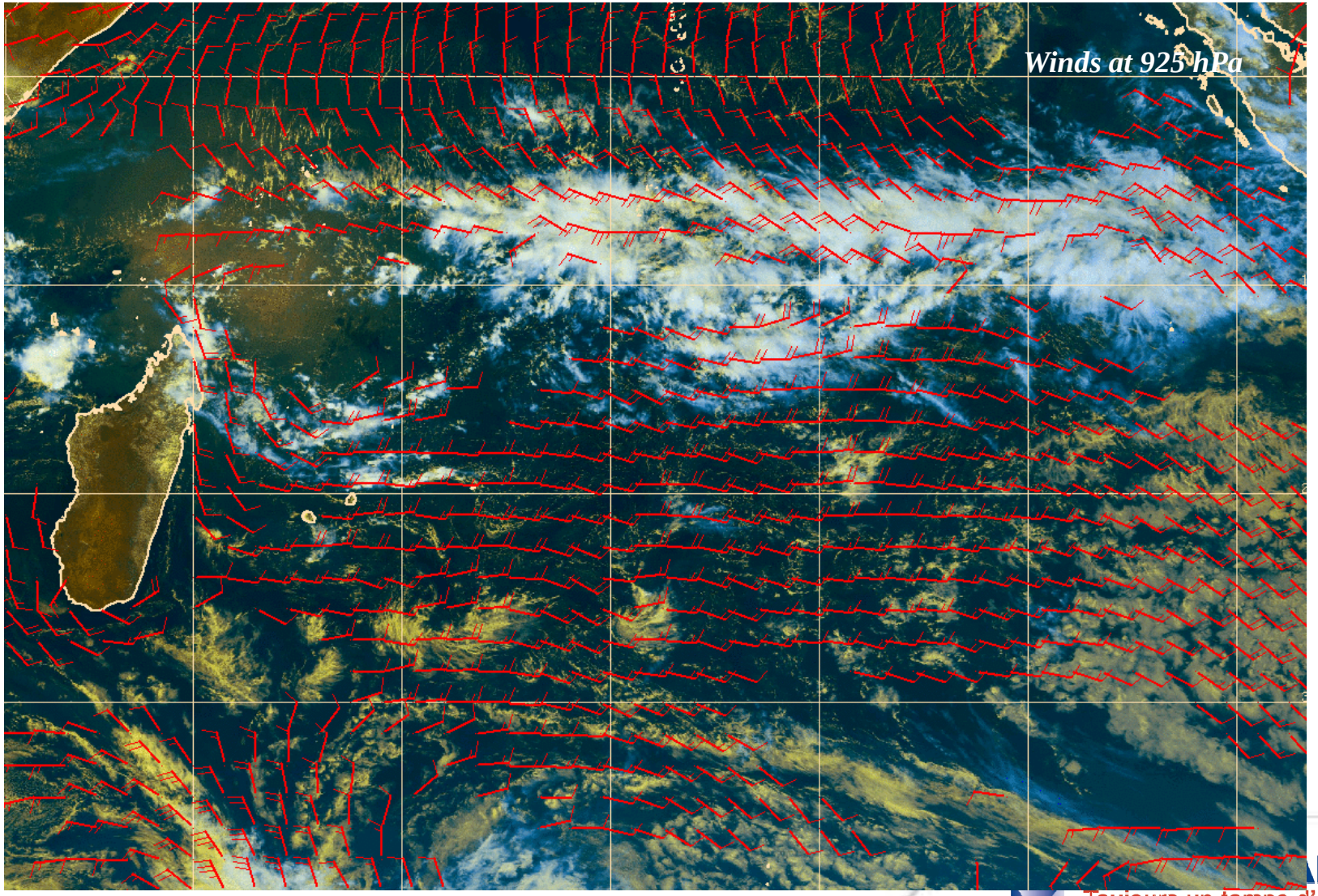


Figure 2.6. Mean surface level streamline analyses over the Indian Ocean for January (Sadler, 1975).

Example



Boreal summer monsoon

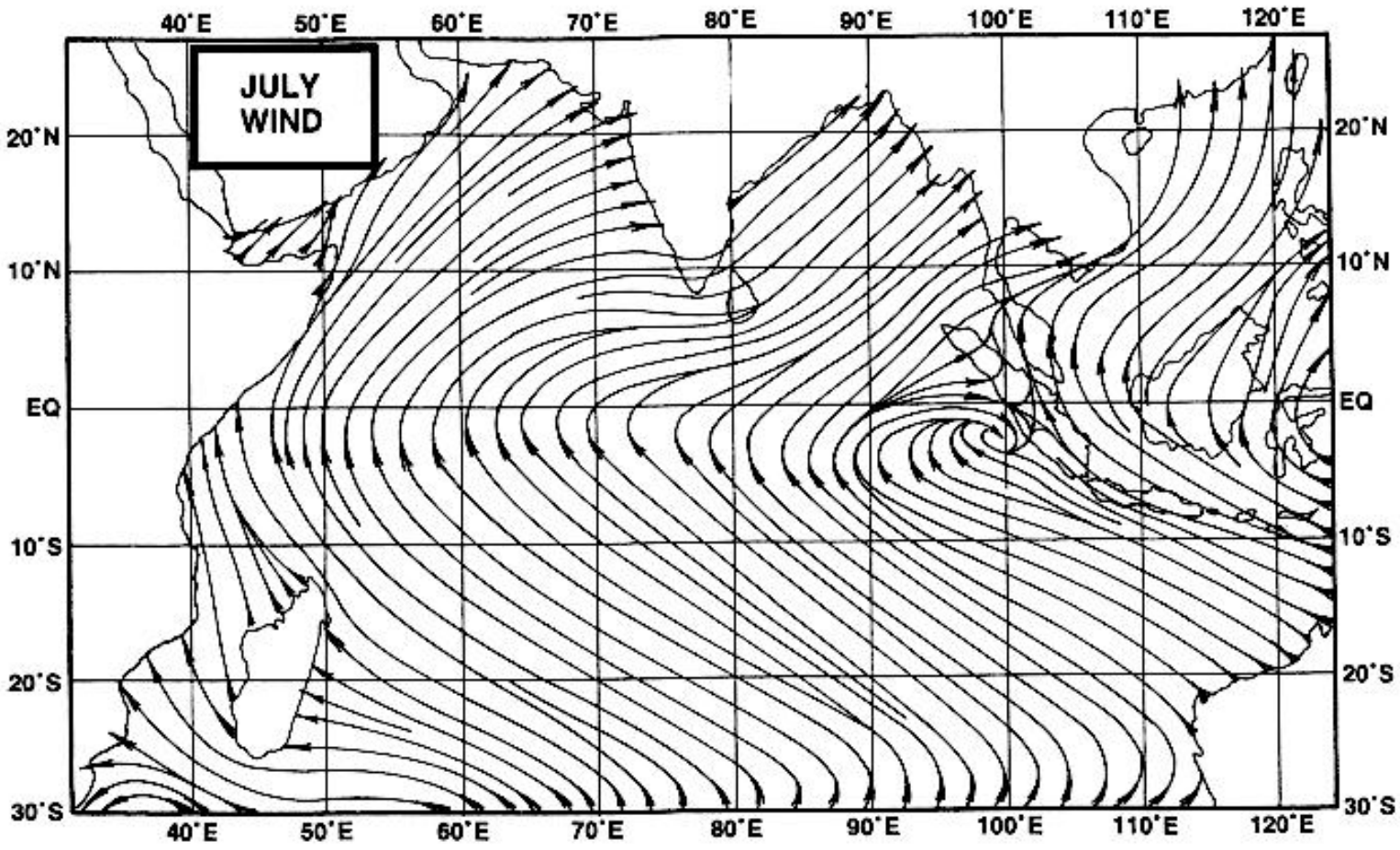
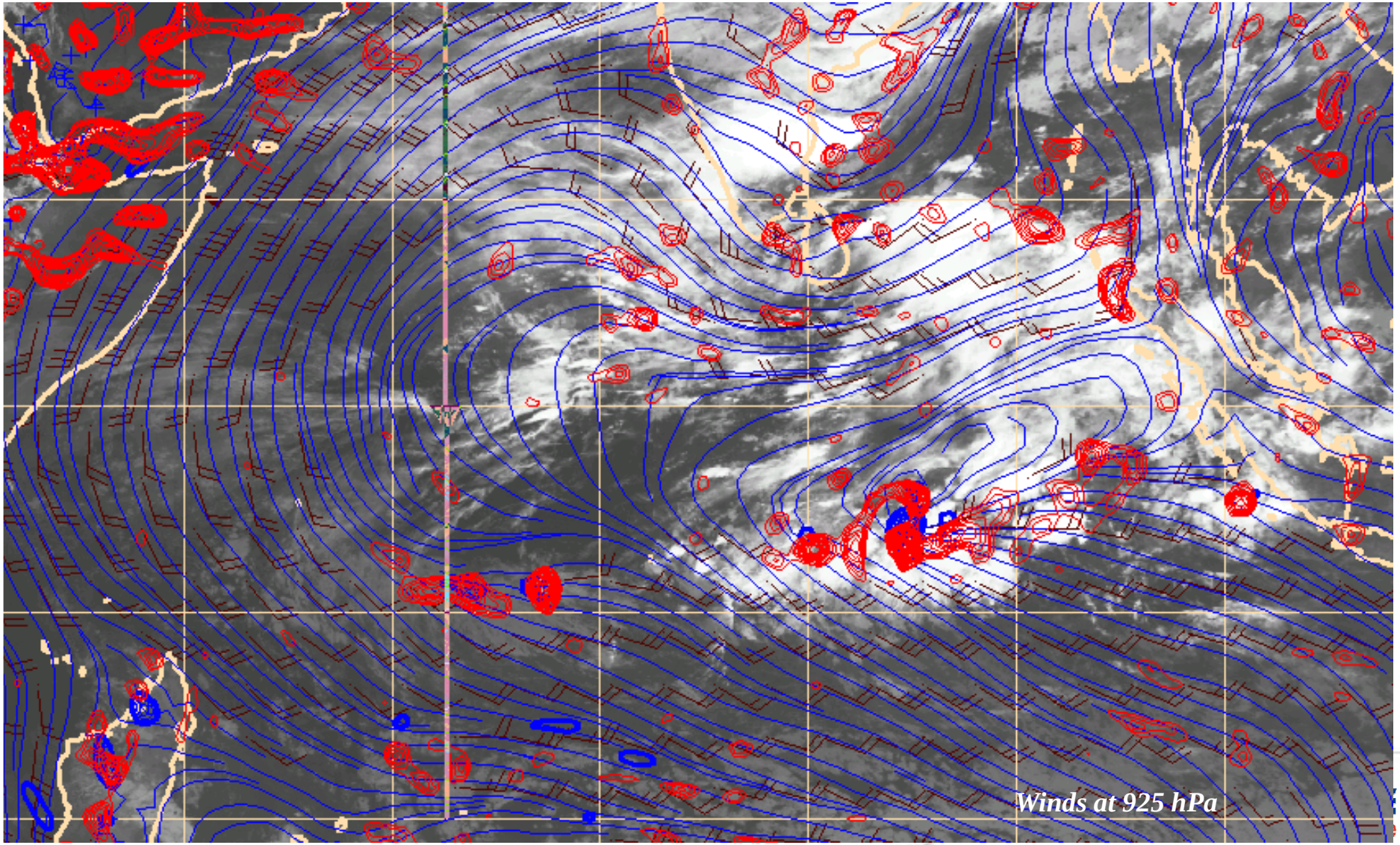


Figure 2.8. Mean surface level streamline analyses over the Indian Ocean for July (Sadler, 1975).

Example



Winds at 925 hPa

Austral spring winds pattern

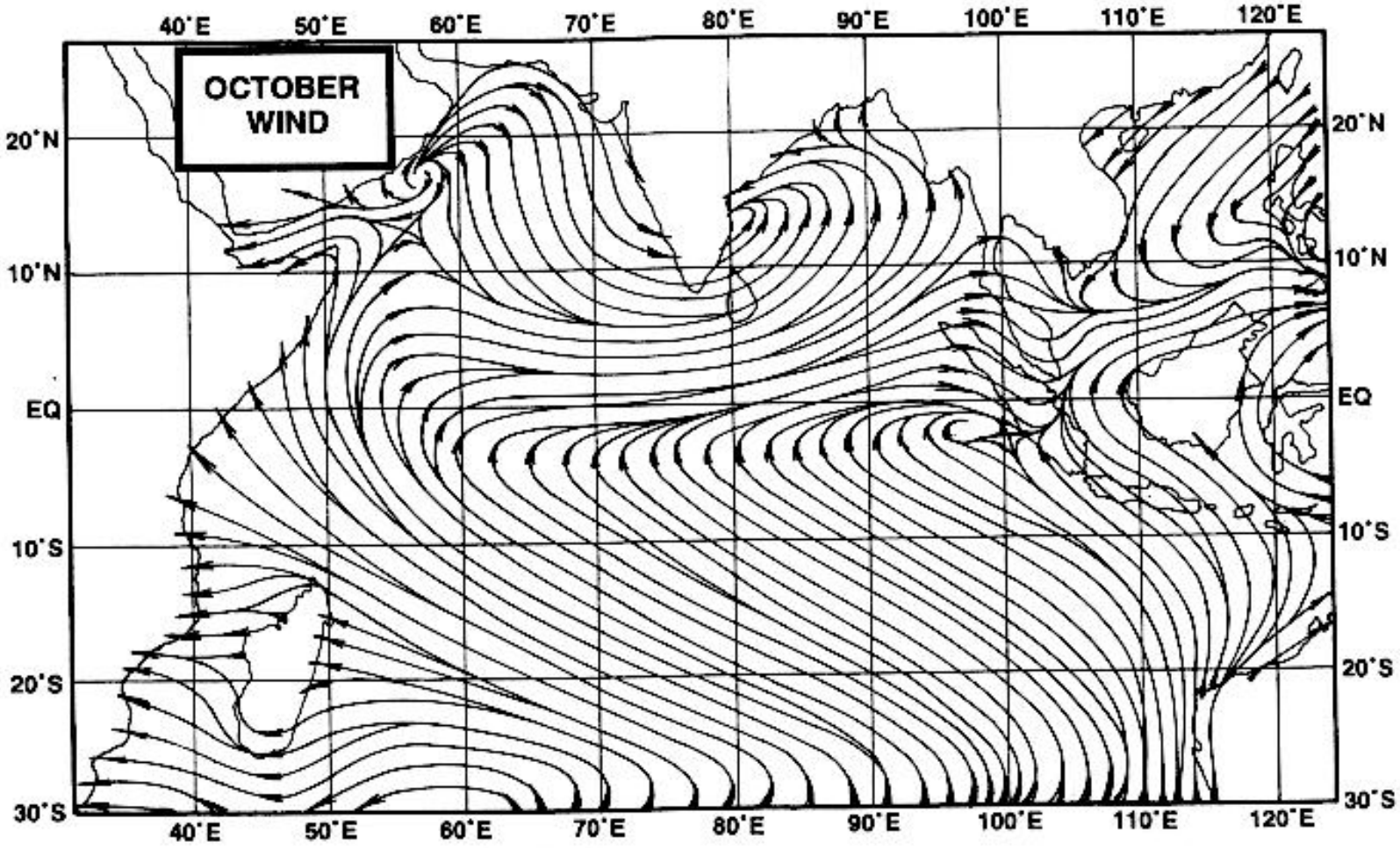
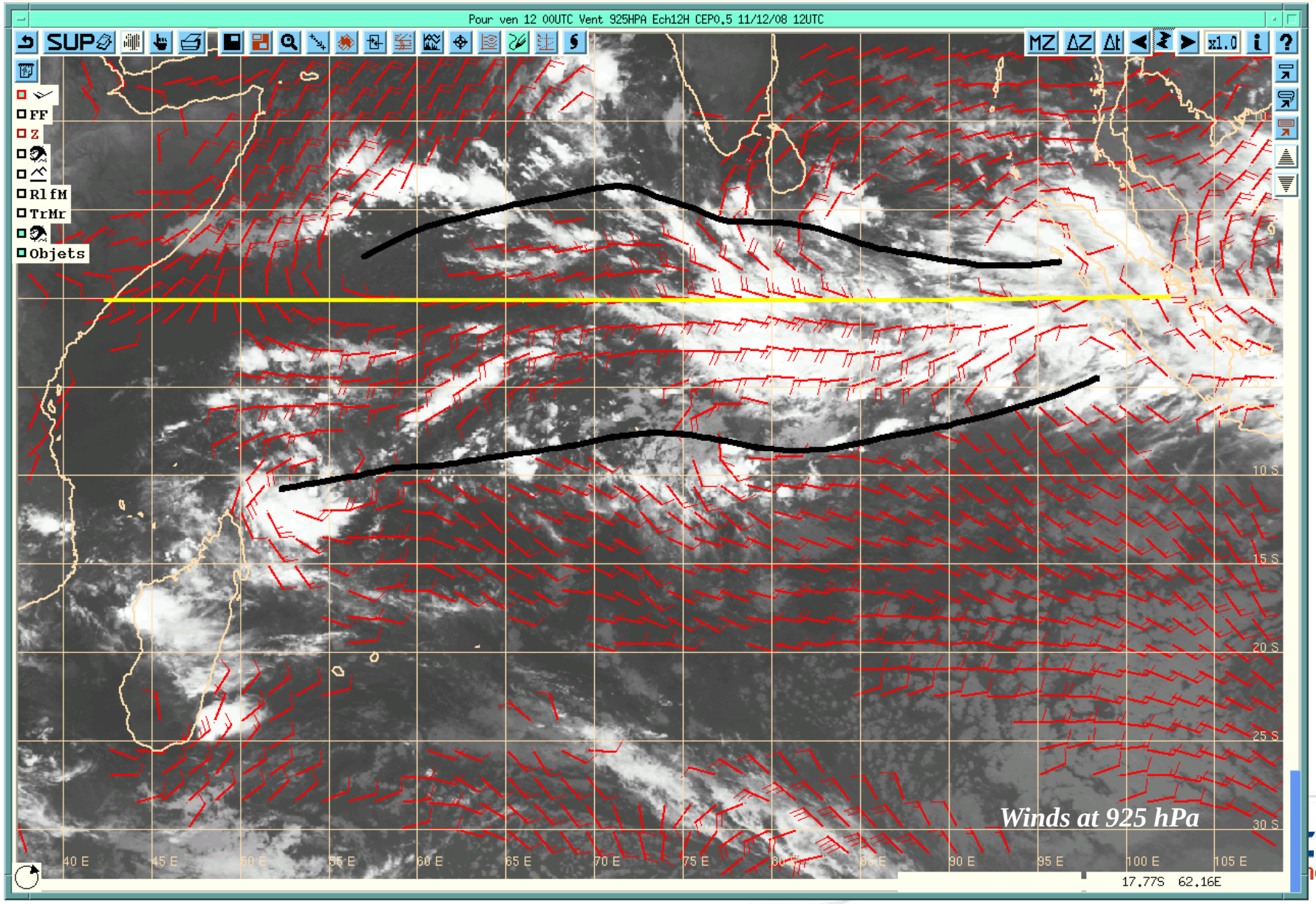


Figure 2.9. Mean surface level streamline analyses over the Indian Ocean for October (Sadler, 1975).

Example


Pour ven 12 00UTC Vent 925HPA Ech12H CEP0.5 11/12/08 12UTC
SUP
MZ
ΔZ
Δt
x1.0
FF
Z
RlfM
TrMr
Objets
10 S
15 S
20 S
25 S
30 S
40 E
45 E
50 E
55 E
60 E
65 E
70 E
75 E
80 E
85 E
90 E
95 E
100 E
105 E
17.77S 62.16E
Winds at 925 hPa

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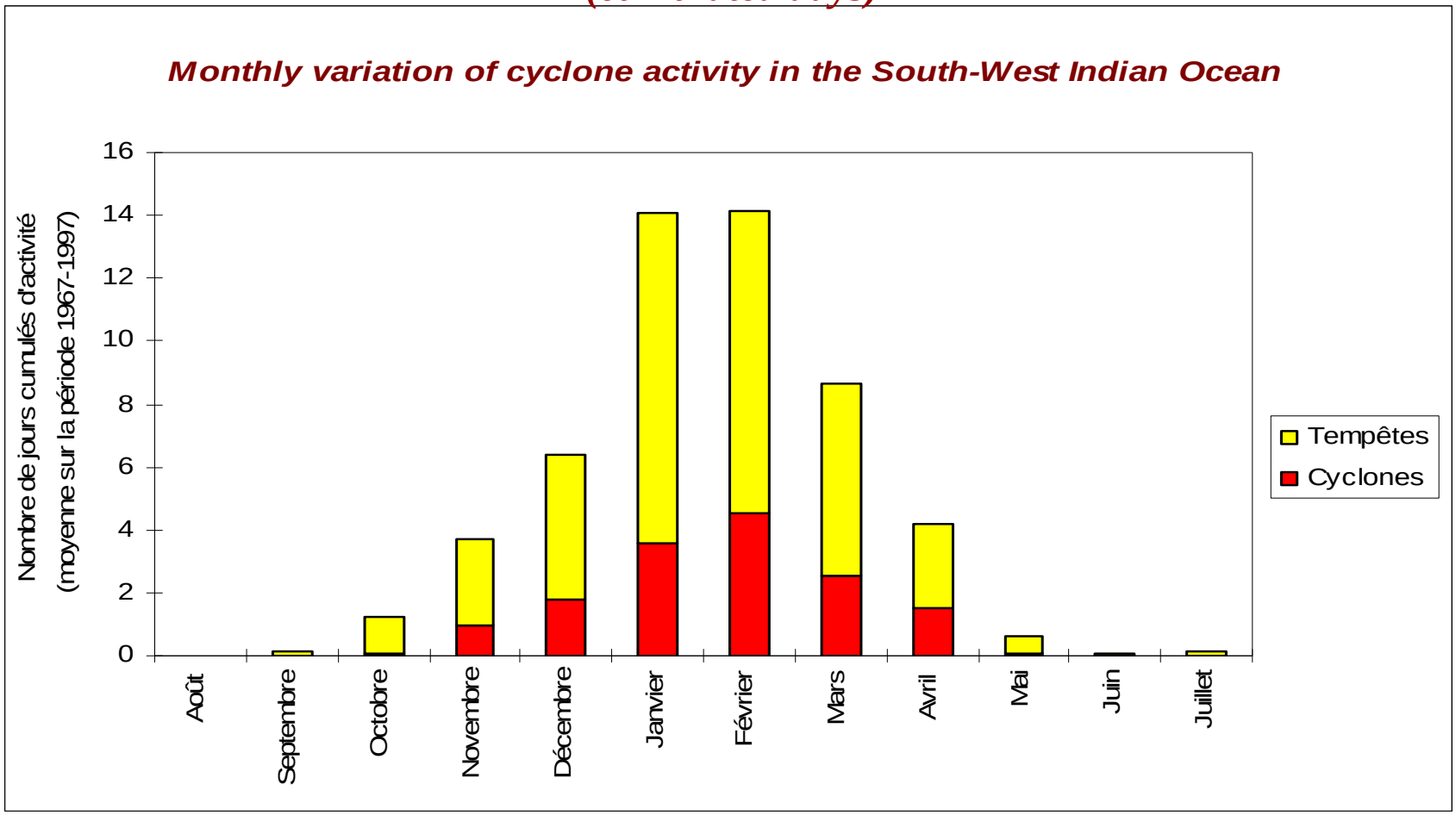
Monthly variation in cyclone activity

(cumulated days)

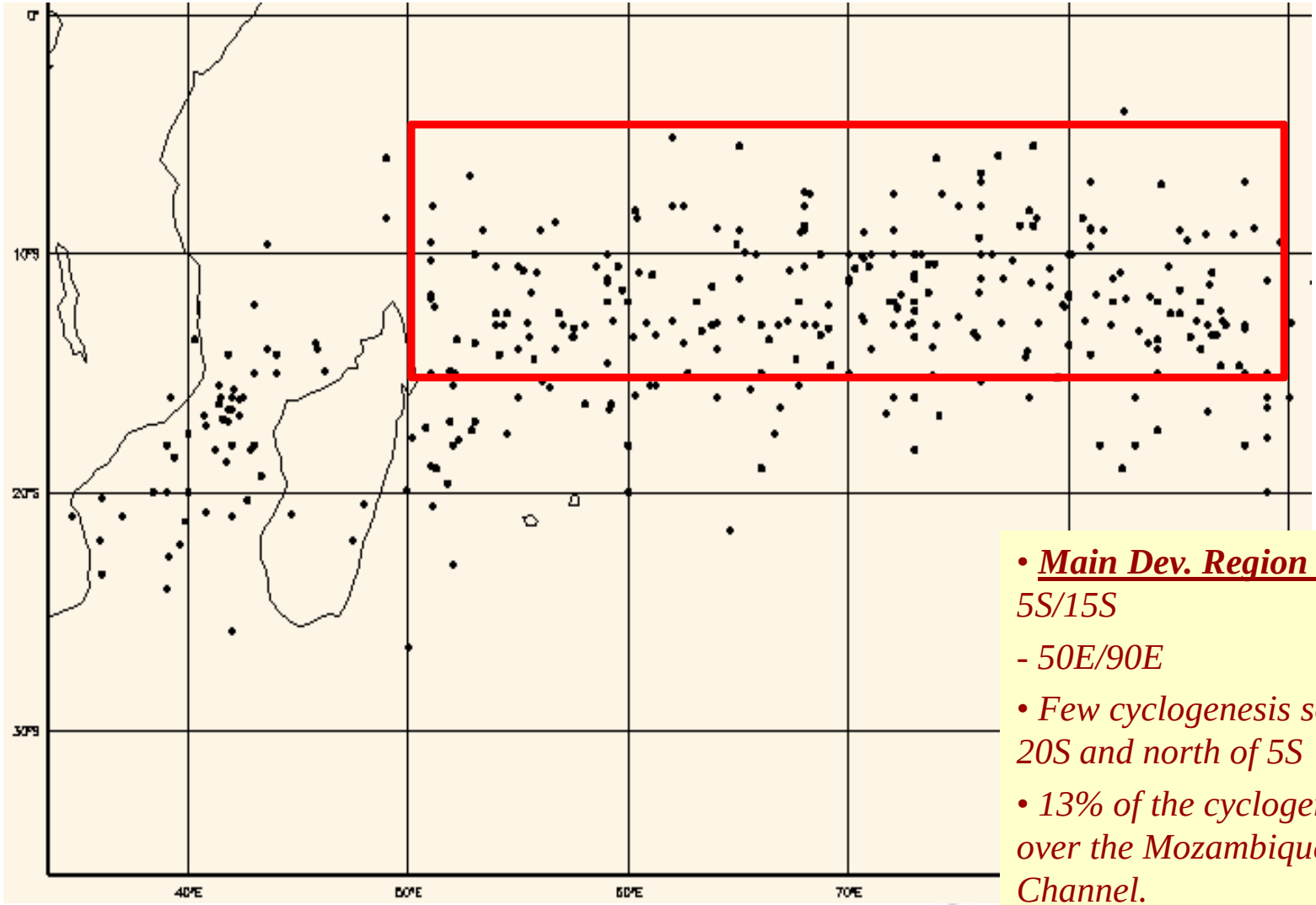


Each saison : 1 july to 30 june, since july 2002 (before :1 august to 31 july). 9/10 of tropical disturbances are formed from the 15th of november to the 30th of april, period usually called « official cyclonic season »

First and last cyclogenesis over the basin

Over the 67-10 period	Date of season's start	Date of season's end
Most early	15 august 1996	16 january 1983
First quantille	End september-early october	End march
Mediane	**15 november**	**18 april**
Last quintille	10 december	11 may
Most lately	16 janvier 1987	25 july 1997

Cyclogenesis over the basin from 1966 to 2000



- ***Main Dev. Region*** *~ 5S/15S*
- *50E/90E*
- *Few cyclogenesis south of 20S and north of 5S*
- *13% of the cyclogenesis over the Mozambique Channel.*

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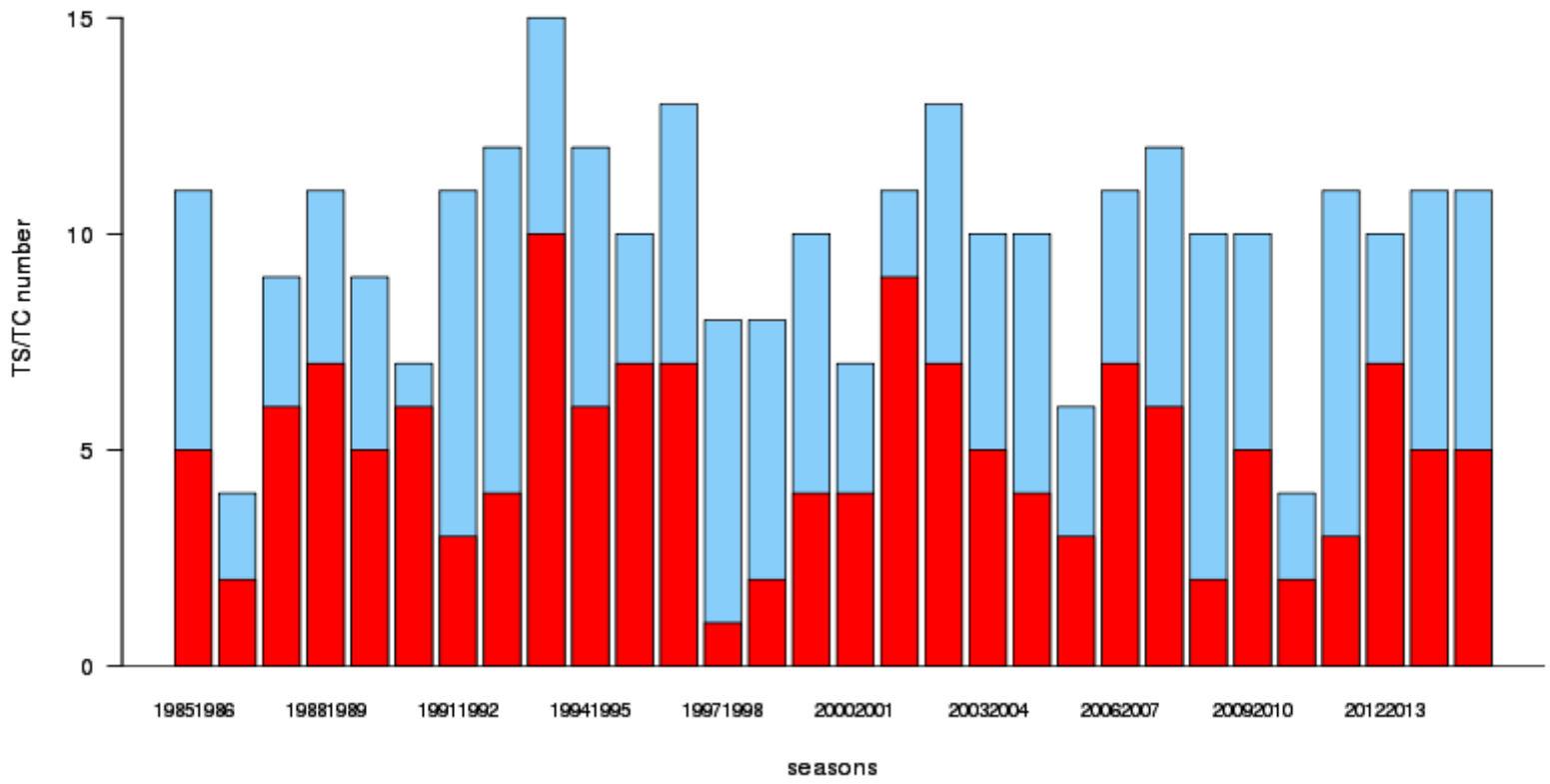
Inter-annual distribution of number of tropical storms and cyclones



Average values since 85/86 : 9.9 named systems with 5 TC

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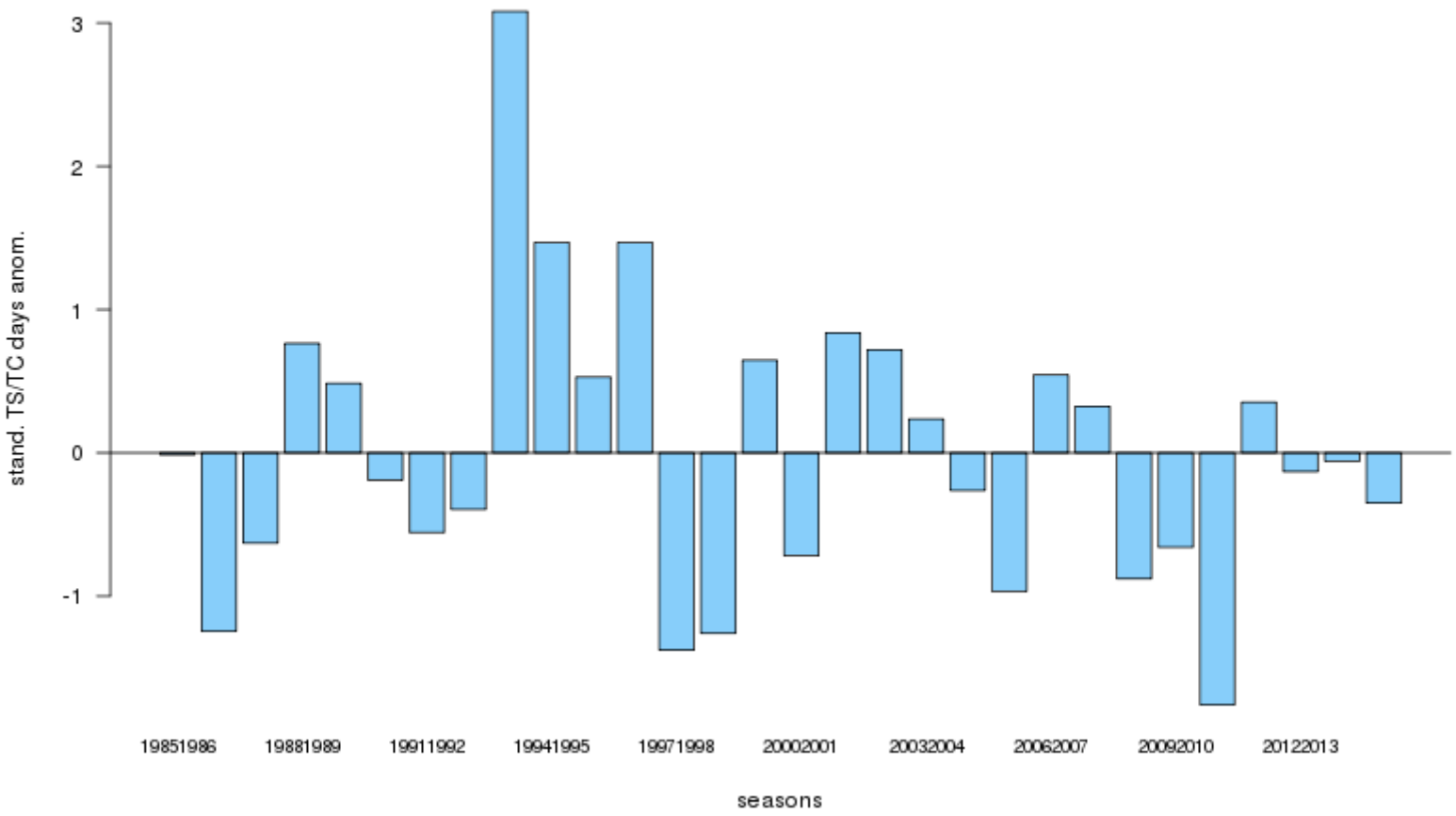
Inter-annual variation in cyclone activity



Average values since 85/86 : 43.5 for TS/TC days / 14.7 for TC

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Inter-annual variation in cyclone activity

Saison	Ace	jour_tt_ct	jour_ct	nb_tt_ct	nb_ct	Qualificatif	MEI	SIOD	AAO	QBO-50	QBO-30
19851986	-0.2	0.1	0.0	0.6	0.0		-0.2	0.3	0.0	0.9	1.0
19861987	-1.3	-1.2	-1.3	-2.2	-1.4	**inf.**	1.3	0.0	-0.2	-0.2	-0.8
19871988	-0.7	-0.5	-0.5	-0.2	0.5	**inf.**	0.8	-0.1	0.2	0.5	0.7
19881989	0.2	0.8	0.6	0.6	0.9	**sup.**	-1.2	-0.2	0.5	0.4	0.0
19891990	0.3	0.6	0.4	-0.2	0.0		0.4	-0.4	-0.1	-1.1	-0.4
19901991	-0.6	-0.2	-1.0	-1.0	0.5	**inf.**	0.4	0.5	-0.1	0.9	0.9
19911992	-0.4	-0.5	-0.3	0.6	-0.9		1.7	-1.0	-1.0	-0.4	-1.1
19921993	-0.3	-0.4	-0.4	0.6	-0.5		0.9	1.2	-0.3	0.2	0.9
19931994	2.8	3.0	2.1	2.1	2.3	**sup.**	0.4	0.2	0.6	0.2	-0.6
19941995	1.2	1.4	1.0	0.9	0.5	**sup.**	1.0	-0.8	0.4	-0.1	0.7
19951996	0.9	0.6	0.9	0.2	0.9	**sup.**	-0.5	-0.1	0.3	0.3	-0.4
19961997	1.4	1.5	1.1	1.3	0.9	**sup.**	-0.2	0.7	-0.2	-1.1	-0.1
19971998	-1.5	-1.3	-1.8	-0.6	-1.8	**inf.**	2.6	-1.6	0.1	0.7	0.1
19981999	-1.1	-1.1	-1.3	-0.6	-1.4	**inf.**	-1.1	1.4	0.8	-0.6	0.2
19992000	0.6	0.6	0.5	-0.2	-0.5	**sup.**	-1.1	0.0	0.8	1.0	0.6
20002001	-0.5	-0.7	-0.2	-1.4	-0.5	**inf.**	-0.6	0.8	-0.6	-0.3	-1.1
20012002	1.6	0.9	1.9	0.6	1.8	**sup.**	0.0	-0.6	0.5	-0.6	0.6
20022003	0.6	0.7	0.5	0.9	0.9	**sup.**	0.9	-0.5	-0.2	0.7	0.0
20032004	0.3	0.3	0.2	0.2	0.5		0.3	0.6	-0.3	-0.8	-0.1
20042005	0.1	-0.2	0.2	0.2	-0.5		0.7	0.2	0.1	0.9	0.1
20052006	-0.8	-0.8	-0.8	-1.4	-0.9	**inf.**	-0.5	1.2	-0.3	-1.6	-1.0
20062007	0.9	0.5	1.5	0.2	0.9	**sup.**	0.6	1.3	-0.1	1.1	0.4
20072008	0.5	0.4	0.1	0.9	0.5	**sup.**	-1.2		0.5	-1.7	-0.6
20082009	-1.2	-1.0	-1.4	0.2	-1.4	**inf.**	-0.6		0.7	1.0	1.0
20092010	-0.6	-0.9	-0.4	-0.2	0.0	**inf.**	1.2		-0.4	-0.1	-1.3
20102011	-1.9	-1.8	-1.8	-2.6	-1.4	**inf.**	-1.6		0.3	0.9	1.0
20112012	-0.1	0.0	0.0	0.2	-0.9		-0.7		0.7	0.1	-1.1
20122013	-0.3	-0.1	-0.1	0.2	0.9		0.0		0.1	-1.3	-0.2
20132014	0.1	-0.4	0.0	0.2	0.0		-0.1		0.2	1.3	1.1
20142015	0.0	-0.3	0.2	0.6	0.0		0.6		0.7	-1.4	-2.0

No obvious link between TC activity in the SWIO and identified large scale oscillations

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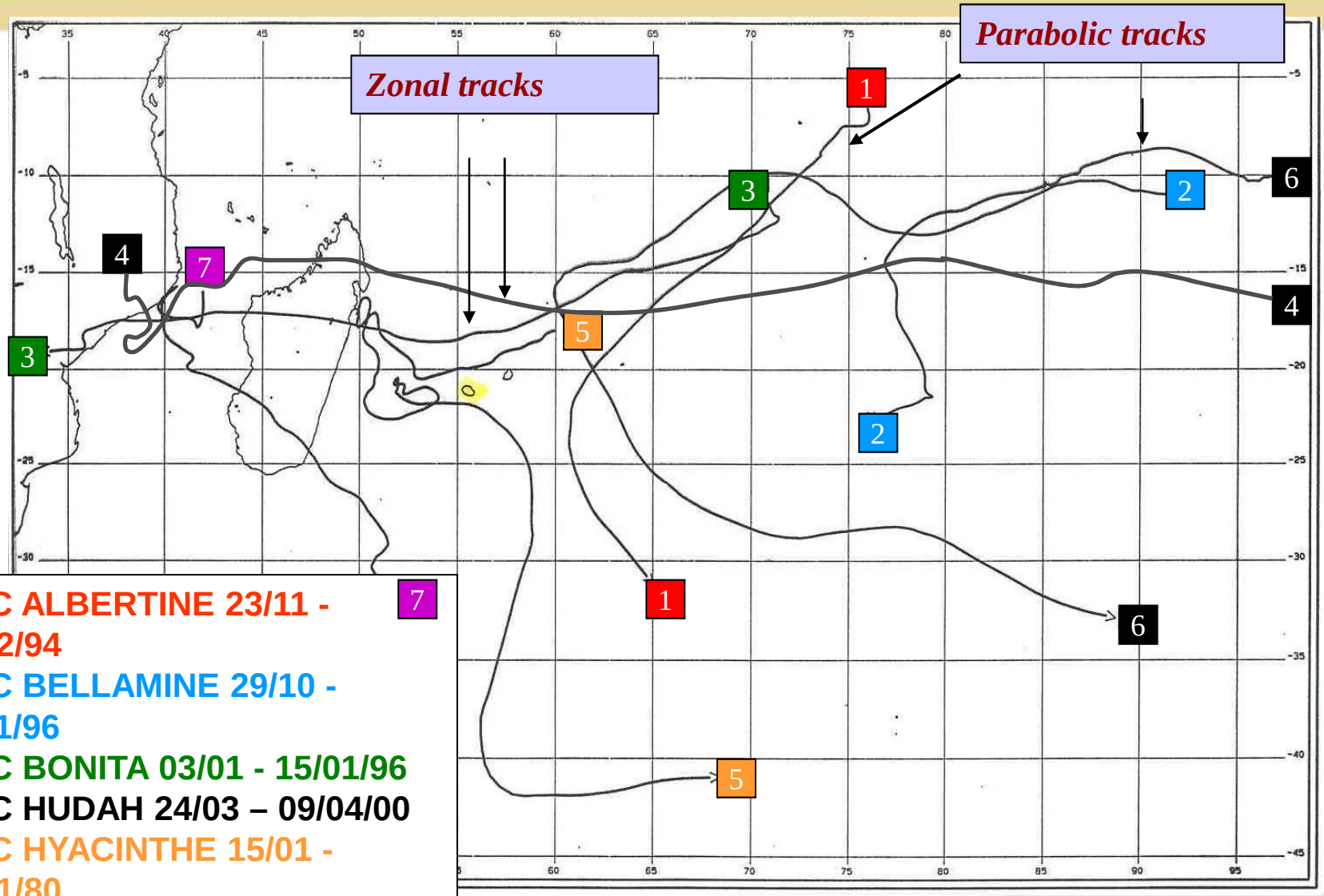
Some typical tracks



1. TC ALBERTINE 23/11 - 03/12/94
2. TC BELLAMINE 29/10 - 12/11/96
3. TC BONITA 03/01 - 15/01/96
4. TC HUDAH 24/03 – 09/04/00
5. TC HYACINTHE 15/01 - 31/01/80
6. TC ODILLE 29/03 - 17/04/94
7. TS DESSILIA 16/01 - 24/01/93

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Some typical tracks

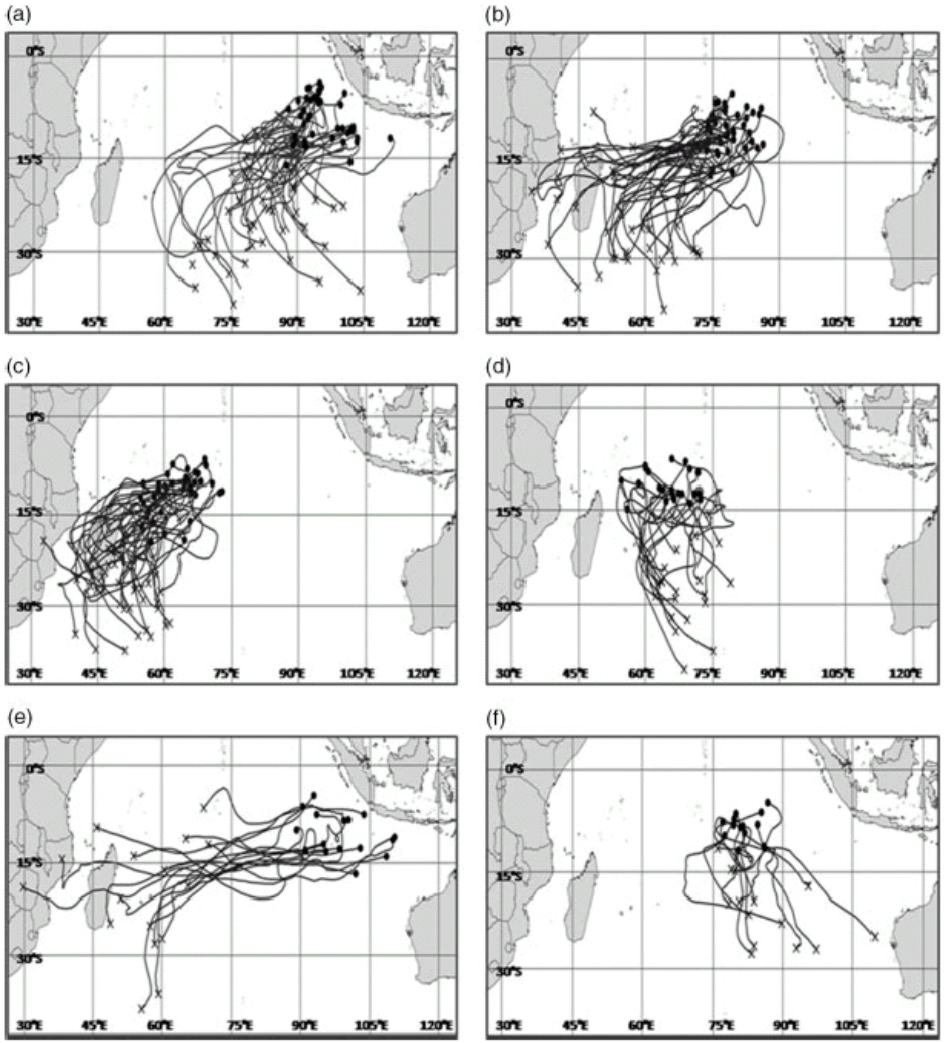

Figure 2. Six TC trajectory clusters, arranged according to group size, within the main development regions for the southern Indian Ocean between 54°E and 110°E. a) C1, eastern genesis/southwest–south movement; b) C2, central/west-southwest; c) C3, western/west-southwest; d) C4, western/south-southeast; e) C5, eastern/west; f) C6, central/south-southeast.

Ash & Matyas, 2010

6 TC trajectory clusters according to track shape and genesis location

TC formed out of the Mozambique channel only considered !

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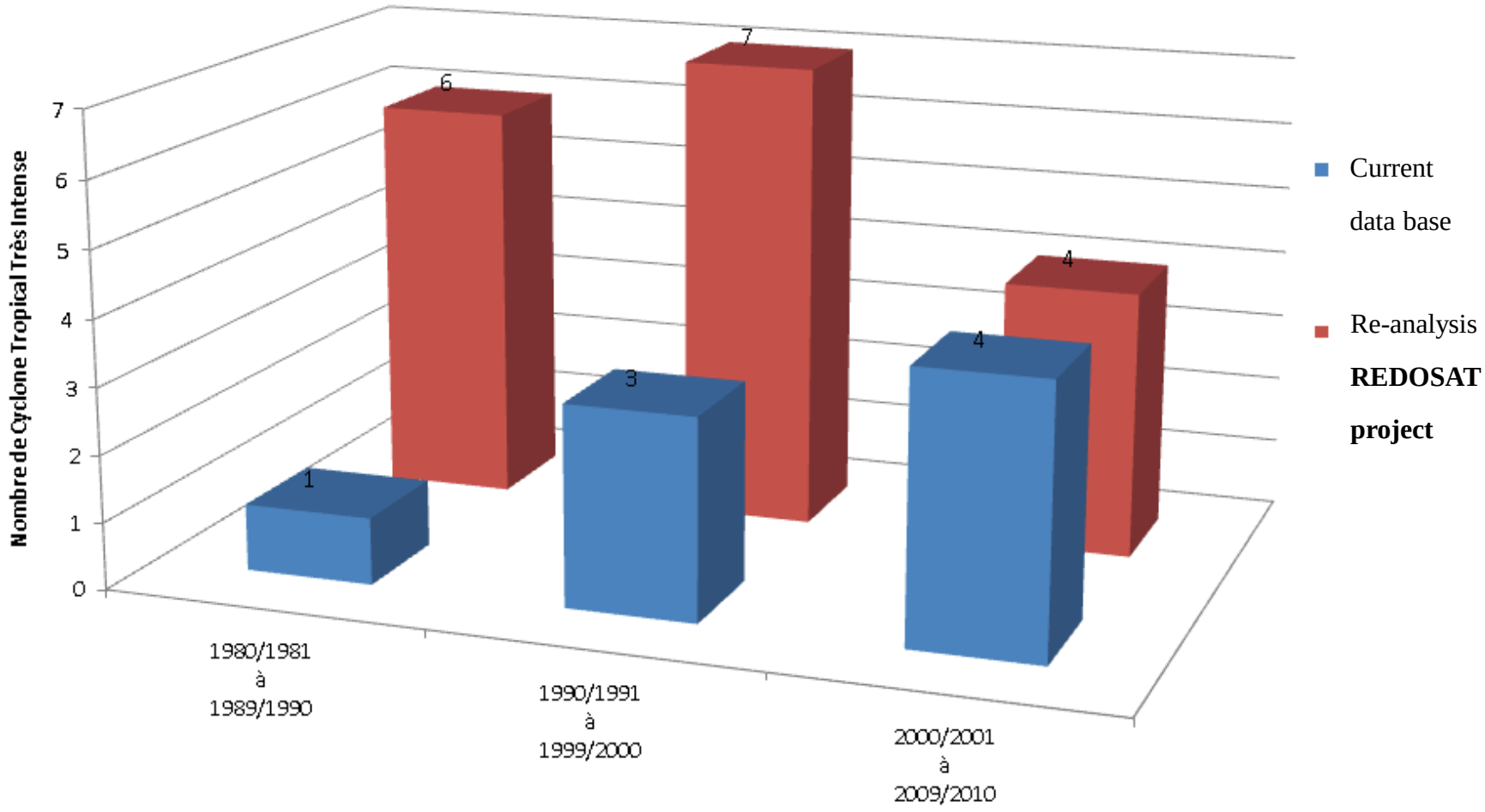
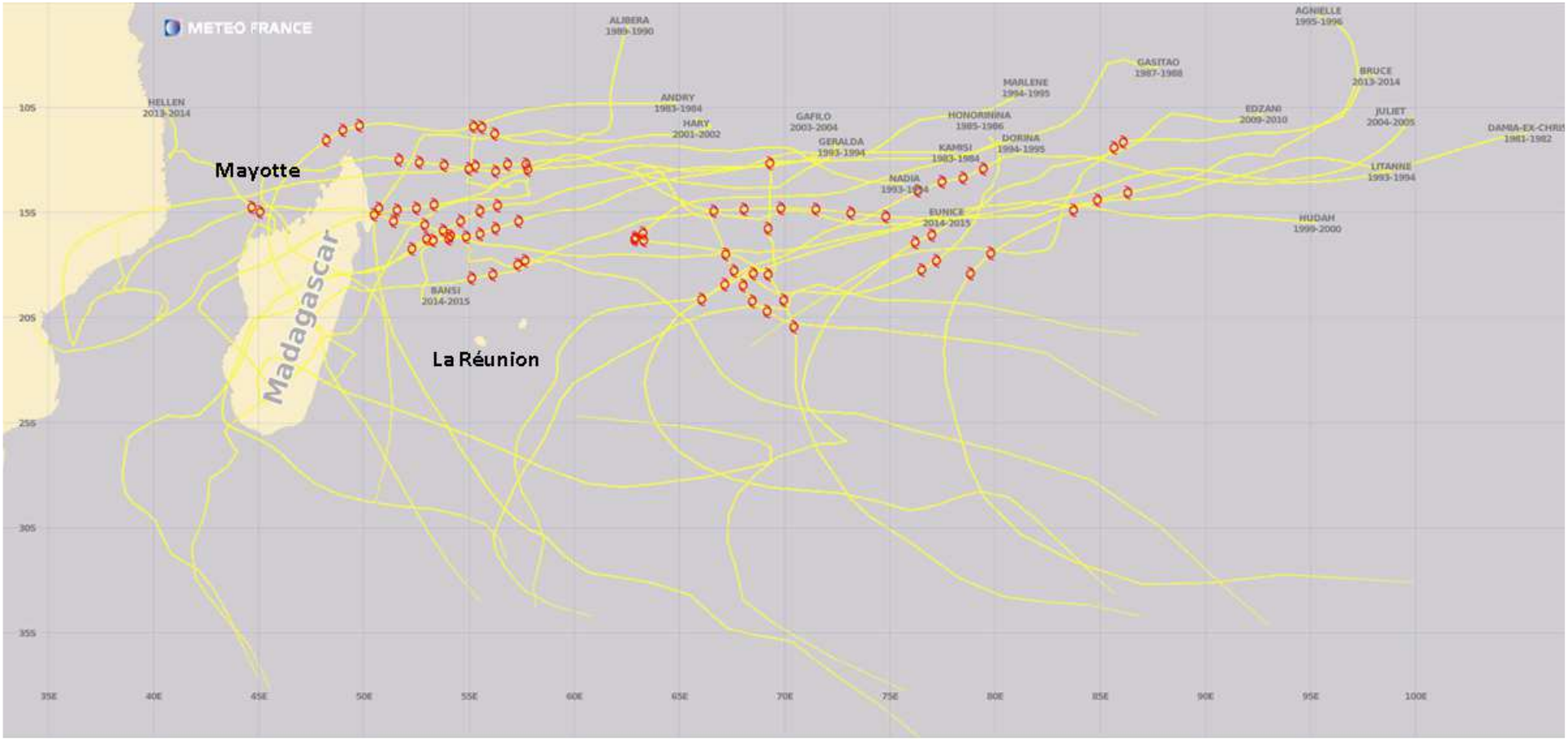
Very Intense Tropical Cyclone

Very Intense Tropical Cyclone number: Evolution during the last 3 decades



Very Intense Tropical Cyclone



Tracks of the 21 VITC observed since 78/79. TC symbol indicates location at the VITC strength.

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Some remarkable obs in the SW Indian Ocean

Minimum pressure recorded:

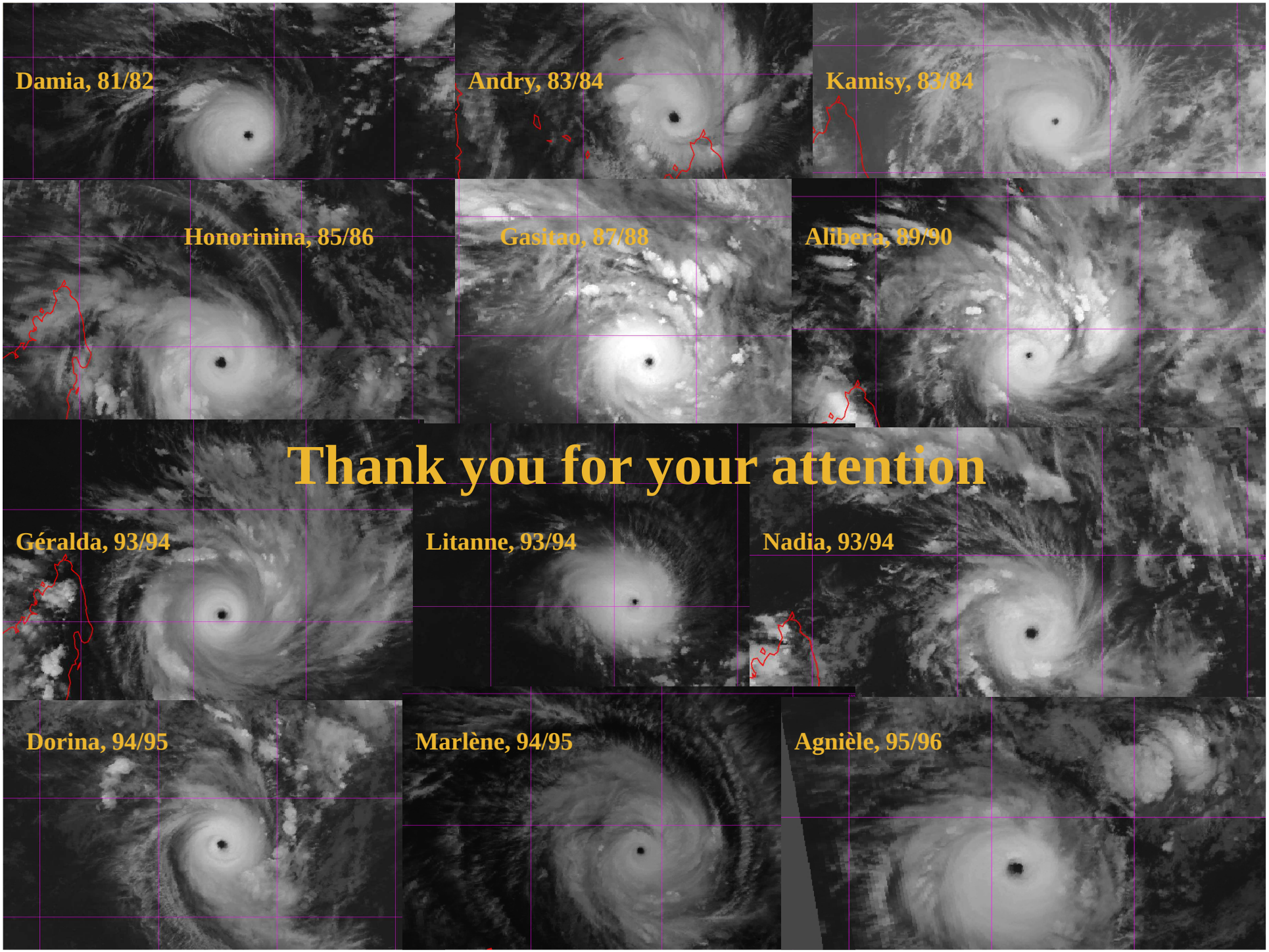
- **932 hPa** at Tromelin with *Lydie* in 1973
- **933 hPa** at Rodrigues with *Monique* in 1968

Max wind gusts recorded:

- **280 km/h** at Mauritius with *Gervaise* in 1975
- **278 km/h** at Rodrigues with *Monique* in 1968
- **277 km/h** at La Reunion with *Dina* in 2002 (montainous area)
- **223 km/h** at La Reunion with *Jenny* in 1962

Maximum amount of rainfall recorded:

- **1825 mm in 24 h** at La Reunion with Denise in 1966 (world record)
- **4869 mm in 4 days** at La Reunion with Gamede in 2007 (world record)
- **6083 mm in 15 days** at La Reunion with Hyacinthe in 1980 (world record)


Damia, 81/82
Andry, 83/84
Kamisy, 83/84
Honorinina, 85/86
Gasitao, 87/88
Alibera, 89/90
Thank you for your attention
Géralda, 93/94
Litanne, 93/94
Nadia, 93/94
Dorina, 94/95
Marlène, 94/95
Agnièle, 95/96