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Technical Report No. 311

SUMMARY of TROPICAL CYCLONE ACTIVITY and FORECASTS in the 1998-9 SOUTHERN HEMISPHERE SEASON

by

J.T. Heming

May 2000

The Met.Office

Excelling *in weather services*

FORECASTING PRODUCTS

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SUMMARY of TROPICAL CYCLONE ACTIVITY and FORECASTS in the 1998-9 SOUTHERN HEMISPHERE SEASON

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1. INTRODUCTION

A summary of tropical cyclone activity in the southern hemisphere for the 1998-9 season is presented below together with an assessment of the performance of the global model in predicting the tracks of these tropical cyclones.

Tropical cyclones are experienced in the South Indian Ocean, tropical seas to the west, north and east of Australia and the western and central South Pacific Ocean. For the purpose of tropical cyclone verification the southern hemisphere is divided in to two basins; the South-West Indian (west of 90°E) and Australian (east of 90°E). Mean error statistics for each basin are presented together with a table of statistics for the whole southern hemisphere. The global model produces a 6-day forecast every 12 hours. Verification is performed at 24 hour intervals up to forecast time T+120.

The global model resolution in operation during the season was 0.83°x 0.55°x 30 levels. This is equivalent to a horizontal resolution of 93km x 62km at the equator. The tropical cyclone verification scheme identifies the centre of a tropical cyclone in the model by locating a local maximum of relative vorticity at 850hPa. A surface fitting technique is used to locate the centre accurately.

The terms used in the statistics tables are explained below :-

Possibly verified - No. of forecasts fulfilling requirements 1, 2 & 4 below.
Detection Rate - Percentage of possibly verified forecasts which also fulfil requirement 3 below.
Mean DX - Mean of positional errors in the East-West direction.
Mean DY - Mean of positional errors in the North-South direction.
Mean AT - Mean of positional errors in the Along Track direction.
Mean CT - Mean of positional errors in the Cross Track direction.
Skill - Percentage skill of model against CLIPER.
Mean DPE - Mean of direct positional errors.
All errors are measured in kilometres except where indicated.

(*) 1. Observed maximum wind at least 31 knots at the verifying time.
2. Forecast tropical cyclone centre equatorwards of 45 degrees.
3. Forecast tropical cyclone centre relative vorticity above a critical limit for verification (0.65×10^{-4} per second).
4. Observation within 6 hours of verifying time present for use in verification.

Forecast skill is defined as:-
(CLIPER DPE - Model DPE) / CLIPER DPE x 100%

Positive skill indicates the model forecast is better than CLIPER.
Negative skill indicates the CLIPER forecast is better than the model.

A diagrammatic explanation of other error statistics and their sign conventions can be found in Appendix A. Full details of the TC verification scheme can be found in ***NWP Gazette, Vol.1, No.2, December 1994***.

Advisory positions from RSMCs La Réunion and Nadi, Fiji, Bureau of Meteorology, Australia and JTWC Hawaii were used as verifying observations of storm location when track verification was carried out immediately after a storm had ended. Best track data from RSMCs La Réunion and Nadi, Fiji, Bureau of Meteorology, Australia and Met. Service, New Zealand have been obtained for this season's storms and the track forecasts verified again. Statistics for verification against best-track observations are presented in detail. Some statistics for verification against real-time observations are included for the purposes of a comparison. Some mean error statistics for last season are also included for the purposes of a comparison. Forecast tracks are only verified when a depression reaches tropical storm status.

2. TROPICAL CYCLONE ACTIVITY

	SWI	AUS	TOTAL
Tropical Depressions (<34 knots)	3(3)	3(2)	6(5)
Tropical Storms (>34 knots, <64 knots)	4(7)	11(12)	15(19)
Hurricanes/typhoons (>64 knots)	2(2)	10(11)	12(13)
Total	9(12)	24(25)	33(37)

Basin name abbreviations:- SWI = South-West Indian (west of 90°E)
AUS = Australian (east of 90°E)

The number in brackets indicates the figure for the 1997-8 season.
N.B. 10-minute averaged wind speeds from RSMCs used when available. Data from JTWC is only used when other data is unavailable and maximum wind speeds are scaled to make them equivalent to the RSMC 10-minute averages.

3. SUMMARY OF ALL SOUTHERN HEMISPHERE STORMS

3.1 South-West Indian Basin Storms

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	47	35	29	23	19	15
Detection Rate (%)	100	100	97	100	100	100
Mean DX	6	-26	-76	-139	-141	-37
Mean DY	15	62	98	100	57	95
Mean AT	-14	16	68	82	91	12
Mean CT	7	37	48	62	27	35
Mean Skill (%)	****	16	26	42	****	****
1997-8 Skill (%)	****	26	27	46	****	****
Mean DPE	50	139	245	339	347	443
1997-8 DPE *	79	215	464	694	848	435
RT DPE #	37	146	253	341	341	447

* DPE for all South-West Indian storms in 1997-8 season

\# DPE calculated using real time observations as opposed to best track.

Comments :

A plot of the observed tracks of all storms in this basin can be found in Fig. 1.

There were less tropical cyclones in this basin this season than in 1997-8, but the number of forecasts verified was higher since the cyclones were longer-lived. Forecast errors were significantly lower than 1997-8 at all forecast times except T+120, although skill scores were not higher. There was a slight left-of-track and fast bias in forecasts. Figs. 2 and 3 show forecast errors and skill scores for the last few seasons. Forecast errors were the lowest ever achieved. Skill scores maintained the previous season's good scores.

3.2 Australian Basin Storms

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	148	106	71	46	29	16
Detection Rate (%)	100	100	99	98	93	94
Mean DX	-2	-42	-127	-174	-213	-165
Mean DY	11	15	-18	-62	-78	9
Mean AT	-5	-44	-57	-73	5	122
Mean CT	7	-21	-138	-222	-261	-263
Mean Skill (%)	****	31	30	25	****	****
1997-8 Skill (%)	****	48	48	48	****	****
Mean DPE	52	150	277	401	506	542
1997-8 DPE *	66	175	305	437	525	654
RT DPE #	43	148	275	402	519	561

* DPE for all Australian storms in 1997-8 season

\# DPE calculated using real time observations as opposed to best track.

Comments :

A plot of the observed tracks of all storms in this basin can be found in Figs. 4 and 5.

There were slightly less tropical cyclones and a lot less verifiable forecasts this season than in 1997-8 in the Australian basin. This was due to much less activity on the eastern (Pacific Ocean) side of the basin. Forecast errors were slightly lower than last season's values at all forecast times and were the lowest ever achieved. However, skill scores were slightly lower than last season. There was a right-of-track bias in forecasts. Fig. 6 and 7 show forecast errors and skill scores for the last few seasons.

3.3 Combined Statistics for whole Southern Hemisphere

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	195	141	100	69	48	31
Detection Rate (%)	100	100	98	99	96	97
Mean DX	0	-38	-113	-162	-183	-101
Mean DY	12	26	16	-7	-23	52
Mean AT	-7	-29	-21	-21	41	67
Mean CT	7	-6	-85	-126	-142	-114
Mean Skill (%)	****	27	29	33	****	****
1997-8 Skill (%)	****	45	44	48	****	****
Mean DPE	51	147	268	380	440	492
1997-8 DPE *	68	182	327	465	546	649
RT DPE #	41	148	269	381	446	504

* DPE for all southern hemisphere storms in 1997-8 season

\# DPE calculated using real time observations as opposed to best track.

Comments :

Figs. 8 and 9 show forecast errors and skill scores and Figs. 10 and 11 along-track and cross-track errors over the last few seasons.

Forecast errors were on average 19% lower than last season's values and were the best figures ever achieved. However, Skill scores against CLIPER were lower than last season. Cross track errors were similar to previous seasons, but along track errors were reduced to very small values compared to the 1997-8 season which had a marked slow bias..

There was little difference between figures derived using real-time and best track data.

Further Tropical Cyclone Information

The Met. Office pages on the World Wide Web contain information on tropical cyclone forecasting at the Met. Office. Monthly bulletins of tropical cyclone activity and forecasts are held together with observed and forecast track information of recent storms, track prediction error statistics, lists of names, images, movies and photographs and details of advances made in tropical cyclone track prediction at the Met. Office.

The Met. Office web site is:- **http://www.met-office.gov.uk**
Tropical Cyclone information can be found under the section "Education".

The information above is also available on ***Metnet*** under Julian Heming's home page. Contact Julian Heming (**jheming@meto.gov.uk**) for further information on tropical cyclone forecasting at the Met. Office.

Previous Reports

Seasonal summaries of tropical cyclone activity and forecasts have been issued since the 1994-5 southern hemisphere season:-

Southern Hemisphere 1994-5 : Forecasting Systems Technical Note No.2
Northern Hemisphere 1995 : Forecasting Systems Technical Note No.4
Southern Hemisphere 1995-6 : Forecasting Systems Technical Note No.6
Northern Hemisphere 1996 : Forecasting Systems Technical Note No.7
Southern Hemisphere 1996-7 : Forecasting Systems Technical Note No.8
Northern Hemisphere 1997 : Forecasting Systems Technical Note No.9
Southern Hemisphere 1997-8 : Forecasting Systems Technical Note No.12
Northern Hemisphere 1998 : Forecasting Systems Technical Note No.13

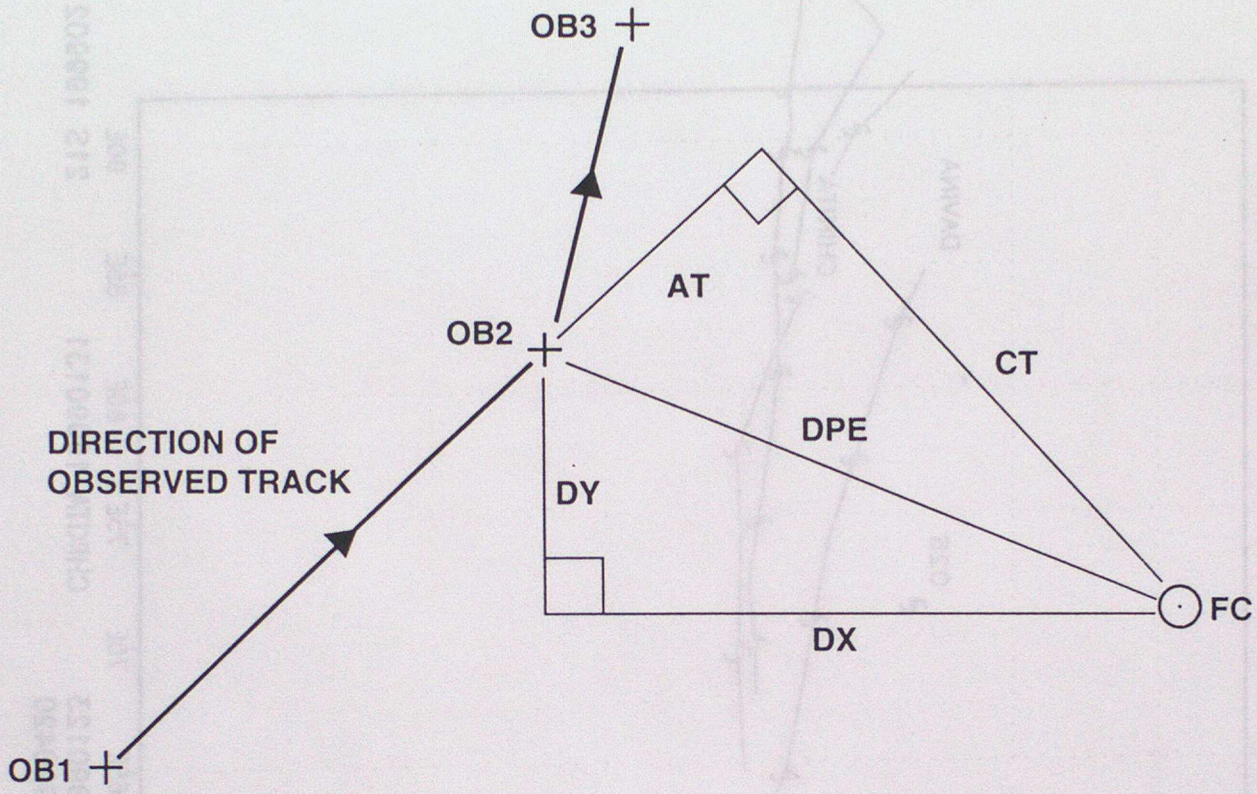
The reports can also be found on-line under the "Forecast Verification" section of the tropical cyclone pages on the Met. Office web site and on ***Metnet***.

Acknowledgements

CLIPER models for various basins were supplied by Mr.S.Lord, NMC, Washington, USA and Mr.C.Mauck, FNOC, Monterey, USA.
GrADS software used to produce track plotting charts was supplied by Mr.S.Lord and Dr.M.Fiorino.
Best track observations for the southern hemisphere were supplied by RSMC Météo-France, La Réunion, Bureau of Meteorology, Australia, RSMC Nadi, Fiji and Met. Service Ltd, New Zealand.

APPENDIX A

Diagrammatic Explanation of Forecast Errors



OB1-3 : Observed positions
FC : Forecast position verifying against observation OB2
DPE : Direct positional error
DX : Error in the East-West direction
DY : Error in the North-South direction
AT : Error in the Along Track direction
CT : Error in the Cross Track direction

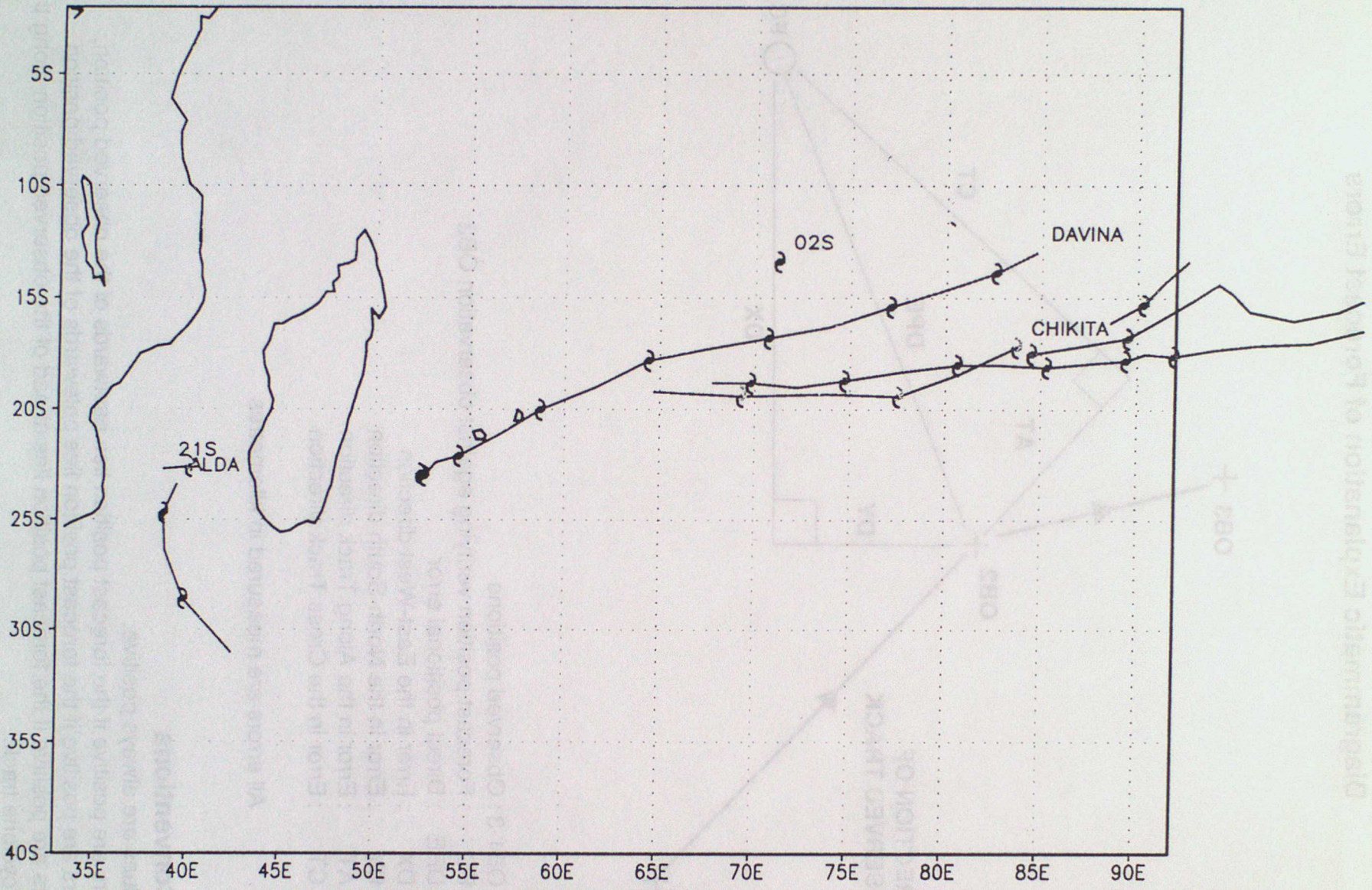
All errors are measured in kilometres

Sign Conventions

DPE values are always positive.
DX errors are positive if the forecast position lies eastwards of the observed position.
DY errors are positive if the forecast position lies polewards of the observed position.
AT errors are positive if the forecast position lies ahead of the observed position along the tropical cyclone track.
CT errors are positive if the forecast position lies right of the observed track in the northern hemisphere and left of the observed track in the southern hemisphere.

Figure 1

OBSERVED TRACKS of TROPICAL CYCLONES in the SOUTH–WEST INDIAN BASIN



02S 19981001 ALDA 19990117 DAMIEN 19990123 CHIKITA 19990131 21S 19990214
DAVINA 19990305 EVRINA 19990328 HAMISH 19990420

KEY to DATE of FIRST SYMBOL

24 HOURLY BEST TRACK OBSERVED POSITIONS

SYMBOLS REPRESENT 127 POSITIONS

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Figure 2

South-West Indian Tropical Cyclone Forecast Positional Errors

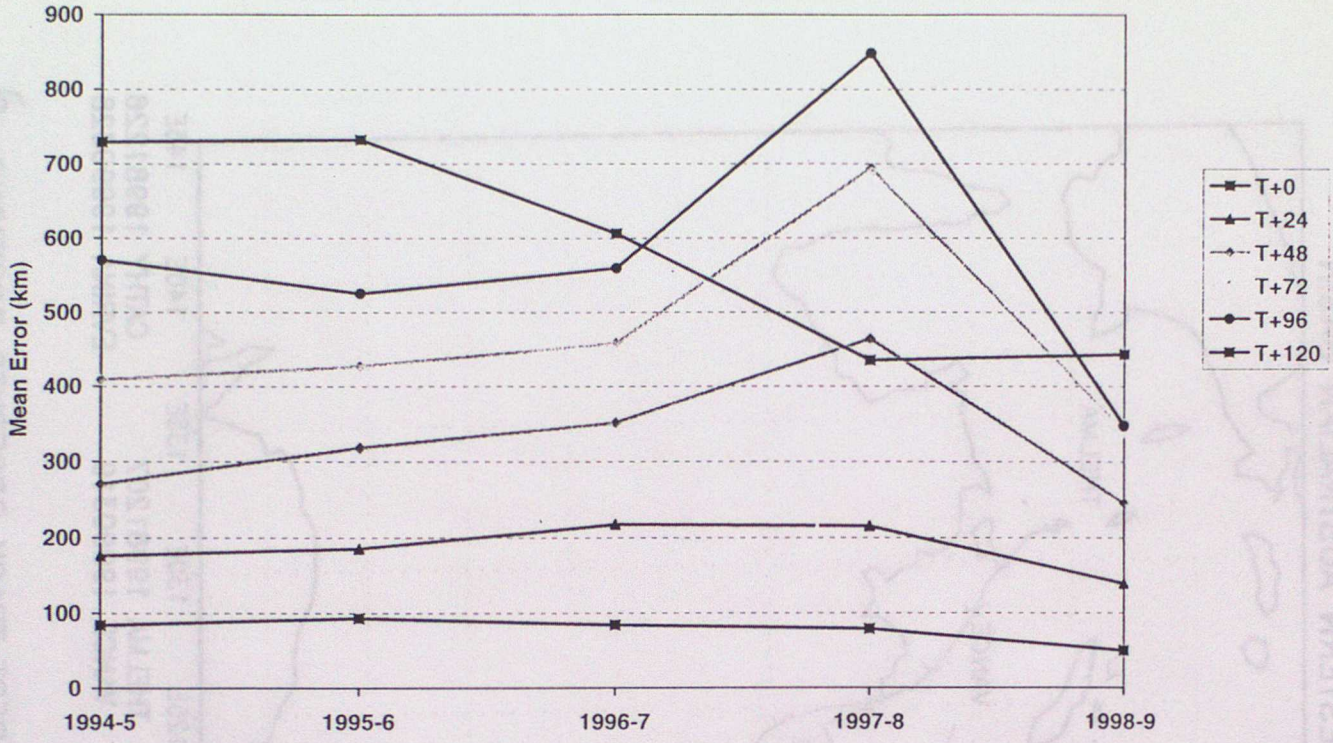


Figure 3

South-West Indian Tropical Cyclone Forecast Skill against CLIPER

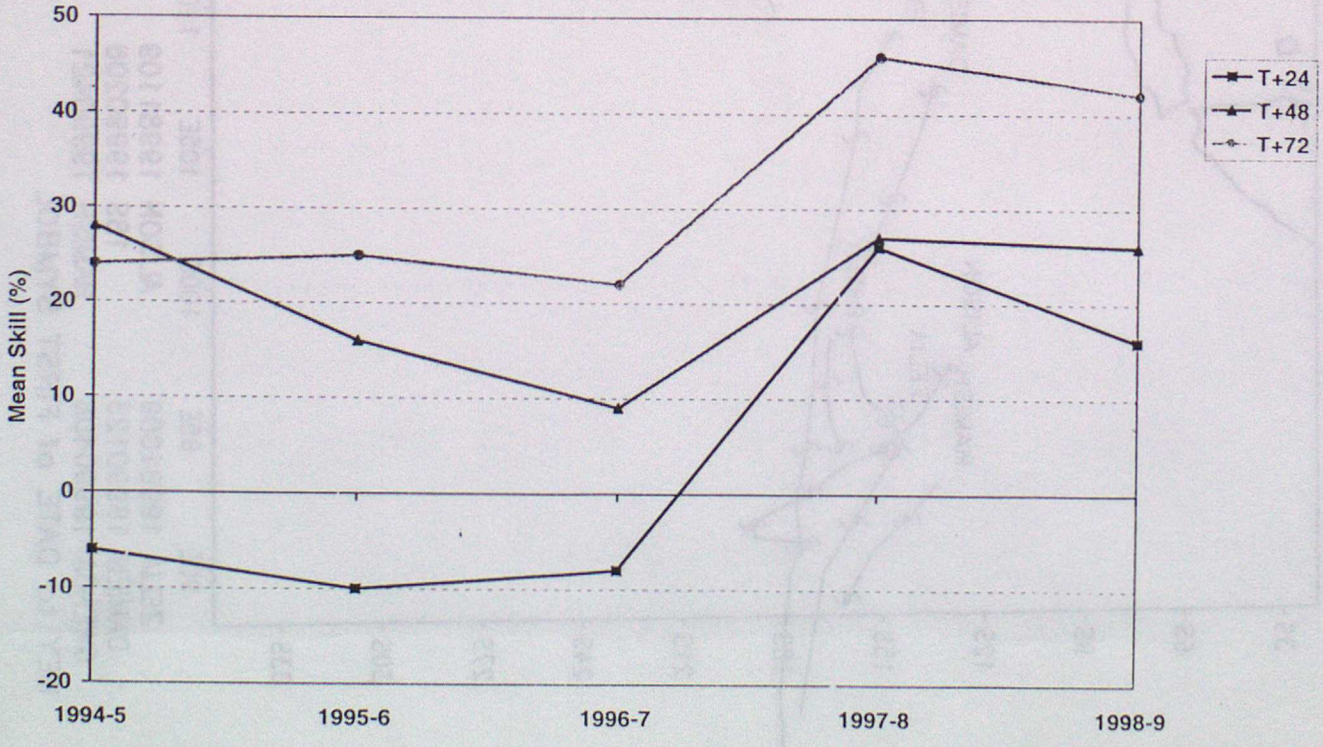
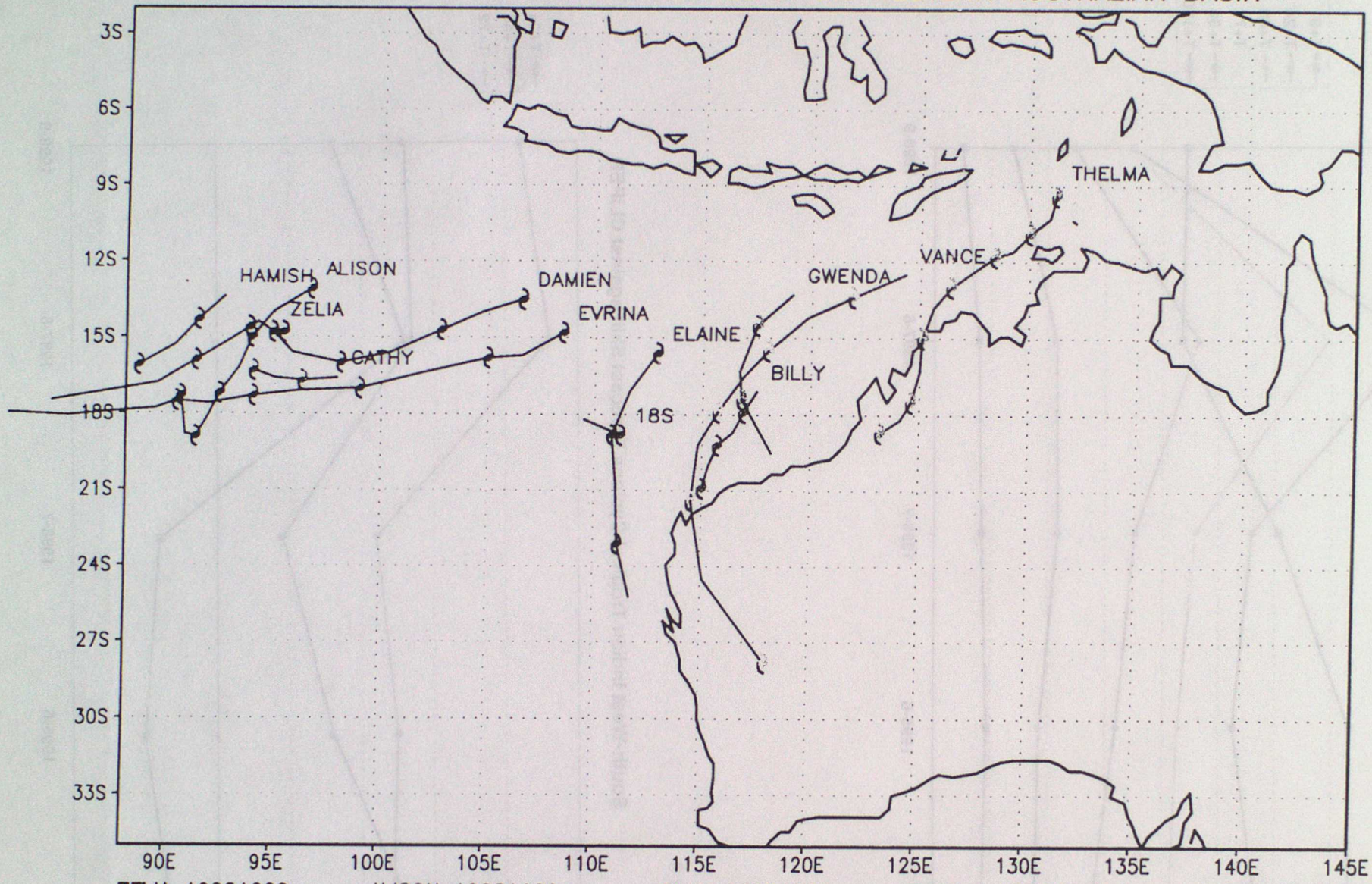


Figure 4

OBSERVED TRACKS of TROPICAL CYCLONES in the WESTERN AUSTRALIAN BASIN



ZELIA 19981009 ALISON 19981109 BILLY 19981204 THELMA 19981207 CATHY 19981226
DAMIEN 19990123 18S 19990206 ELAINE 19990317 VANCE 19990319 EVRINA 19990328
GWENDA 19990406 HAMISH 19990421

KEY to DATE of FIRST SYMBOL

24 HOURLY BEST TRACK OBSERVED POSITIONS

SYMBOLS REPRESENT 00Z POSITIONS

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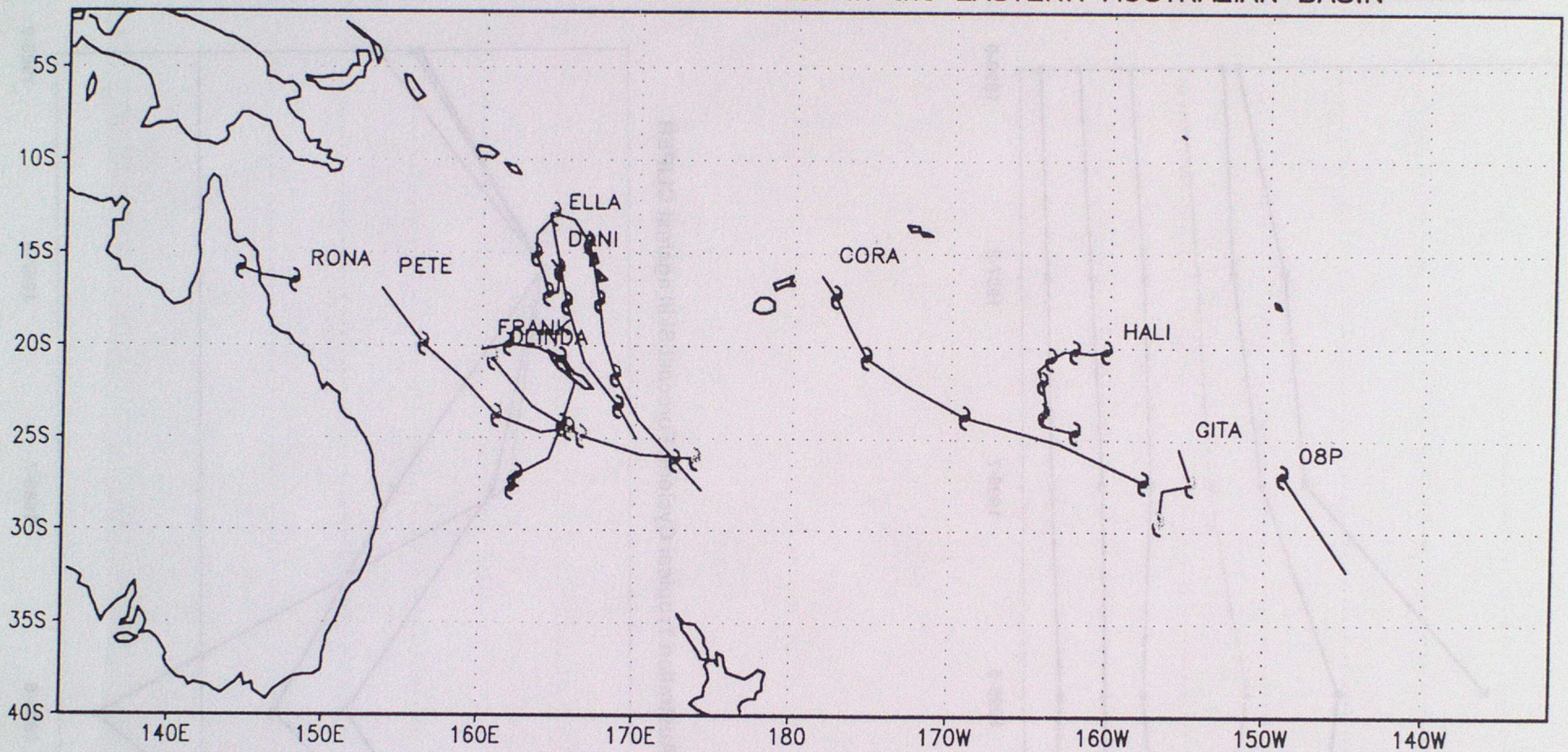
Figure 5

OBSERVED TRACKS of TROPICAL CYCLONES in the EASTERN AUSTRALIAN BASIN



08P 19981223 CORA 19981225 DANI 19990115 OLINDA 19990122 PETE 19990123
ELLA 19990212 RONA 19990211 FRANK 19990219 GITA 19990228 HALI 19990313
KEY to DATE of FIRST SYMBOL

24 HOURLY BEST TRACK OBSERVED POSITIONS
SYMBOLS REPRESENT 00Z POSITIONS

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Figure 6

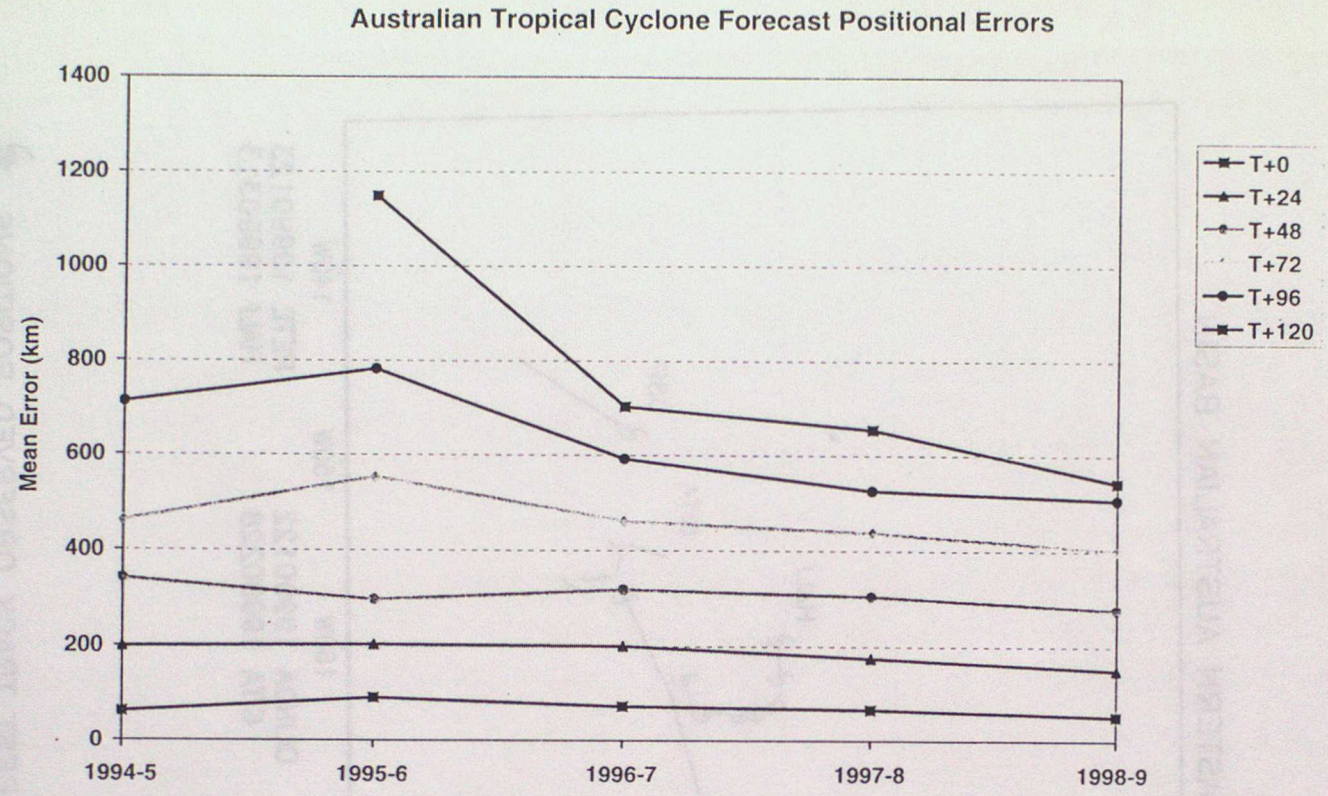

Figure 7

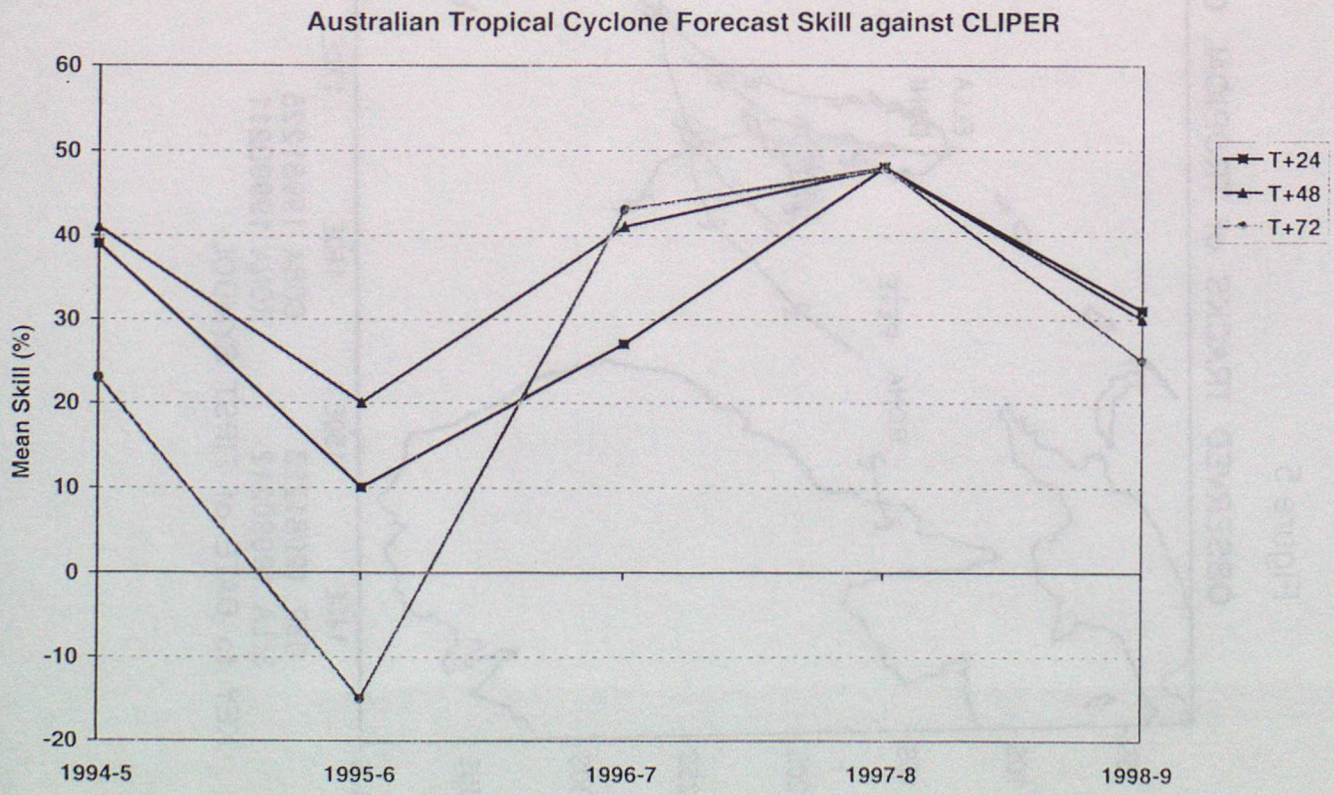

Figure 8

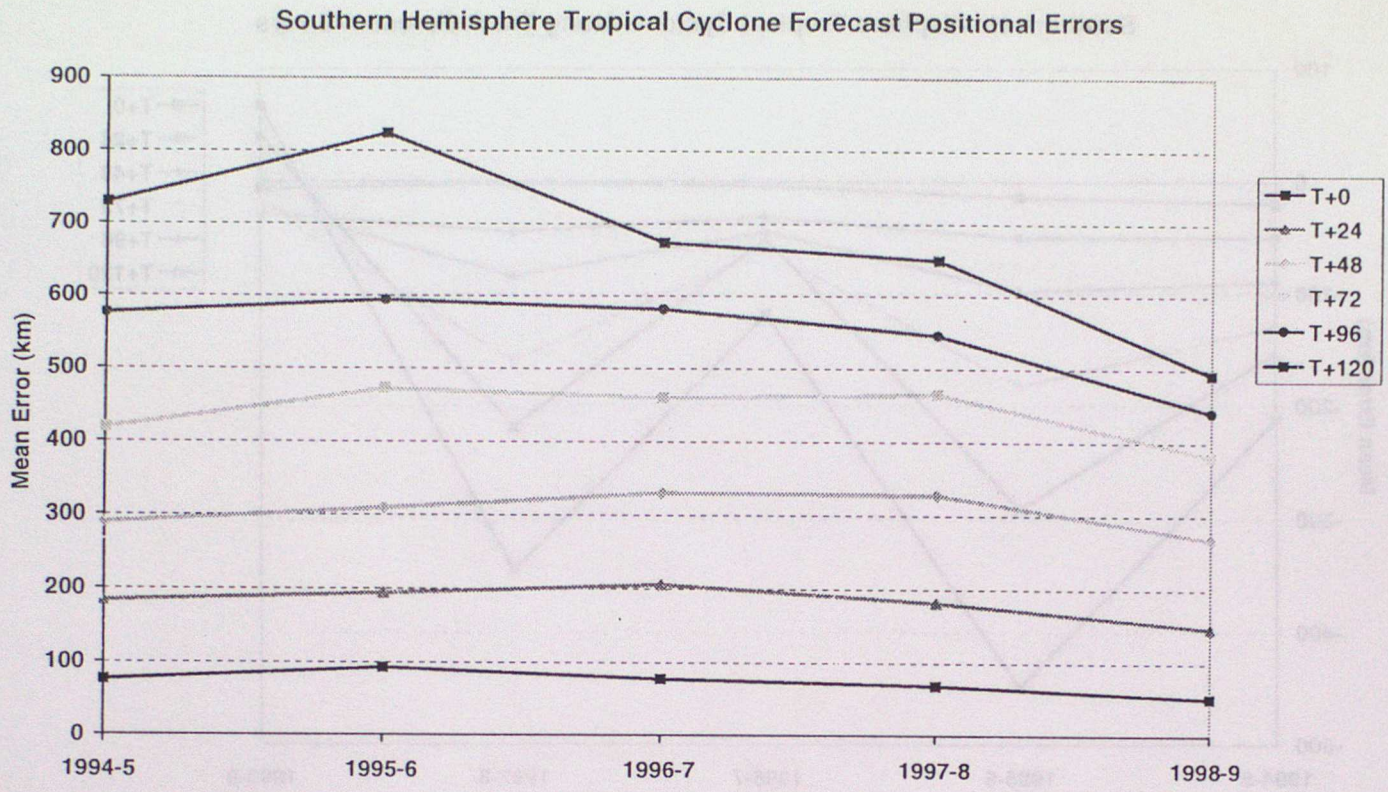

Figure 9

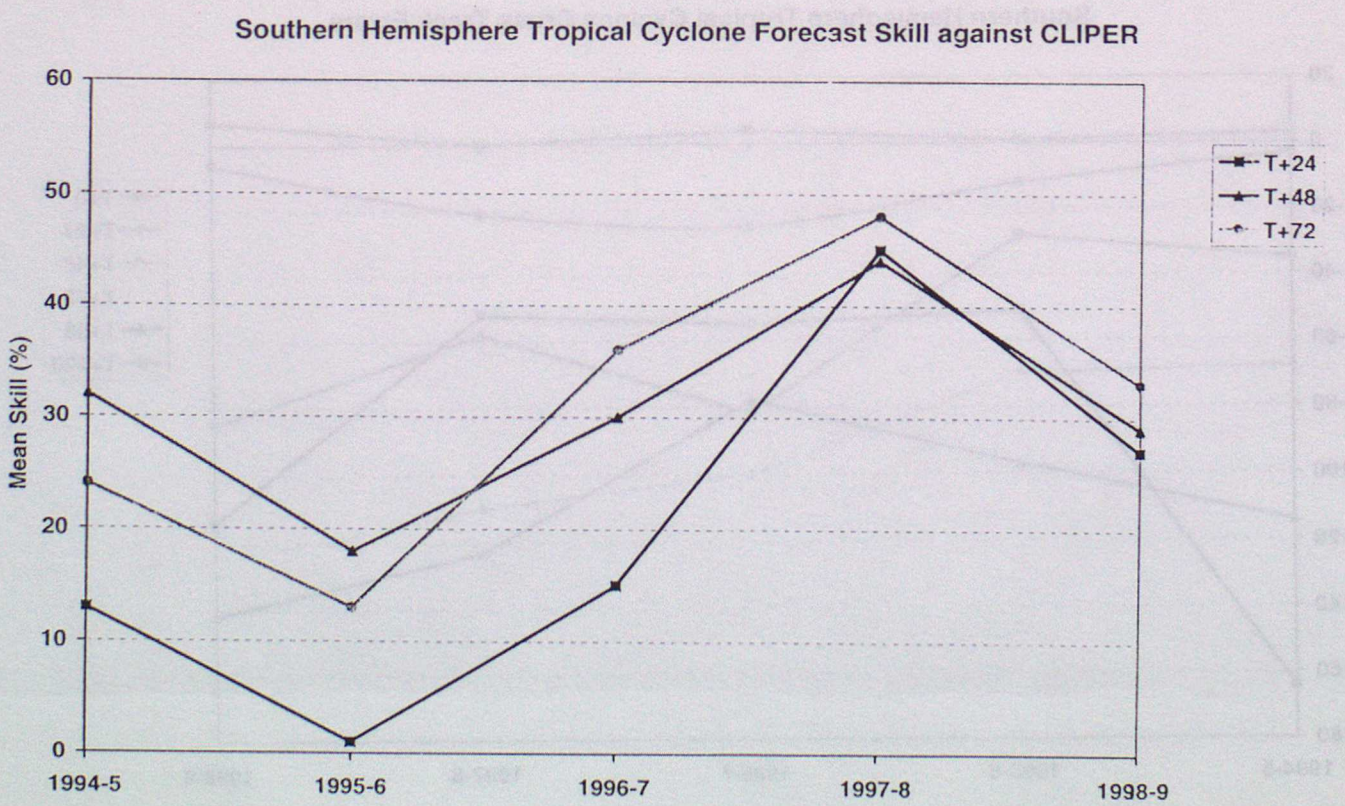

Figure 10

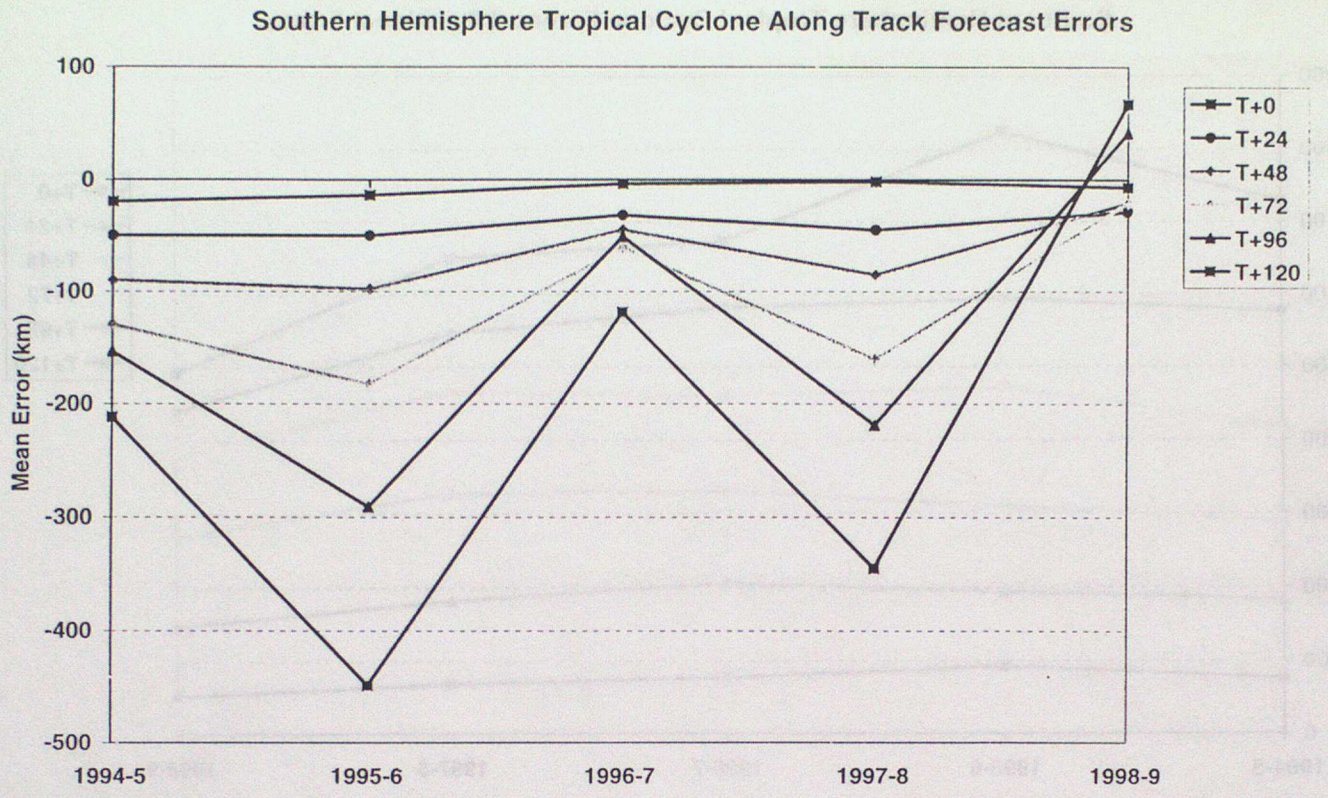
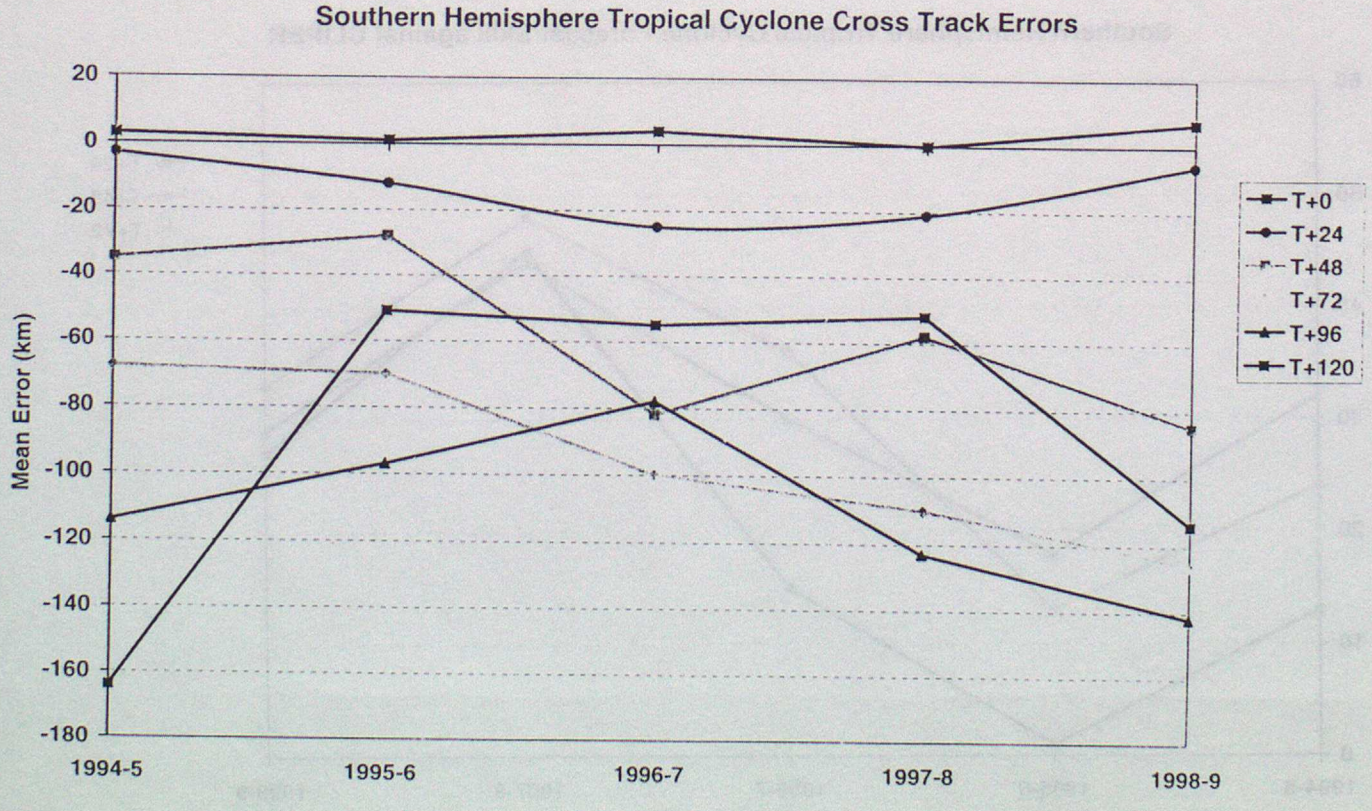
Figure 11