2003 NATIONAL HURRICANE CENTER FORECAST VERIFICATION

James M. Gross

National Hurricane Center
Tropical Prediction Center
National Centers for Environmental Prediction
National Weather Service

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Introduction

Beginning this year, the National Hurricane Center (NHC) officially started to issue 5 day track and intensity forecasts every six hours for all tropical cyclones in the North Atlantic and eastern North Pacific basins. These official forecasts are verified by comparison with the final "best-track", derived from a post-storm analysis of all available position and intensity observations. The best-track data used for verification excludes the extratropical, tropical wave and remnant low stages. Climatology and persistence forecasts are used as standards for skill in comparing forecasts: the CLIPER model forecasts for track and the SHIFOR model forecasts for intensity. Please note that there are differences in errors between the 3-day and 5-day CLIPER and SHIFOR models for both basins through 72 hours due to their different formulations and developmental data sets.

Track forecast errors are the great circle distance between a forecast position and a best-track position for the same time. A tropical cyclone's intensity is defined as the maximum one-minute sustained wind speed ten meters above the ground associated with the cyclonic circulation. Forecast and best-track intensities are estimated to the nearest five knots. Intensity forecast errors are the absolute difference between the forecast wind speed and the best-track wind speed for the same time.

Objective track and intensity guidance is of two types, "late" or "early". A model is considered “late” if its forecast, initialized for a particular synoptic time, is not available to prepare the official forecast issued for that same synoptic time. Various strategies are employed to provide the forecaster with more timely guidance derived from the late models. These are the “early” models and are available at any time. Table 1 defines model abbreviations used in this report.

North Atlantic

The 2003 North Atlantic hurricane season had sixteen named tropical cyclones and five tropical depressions. This is six more named tropical cyclones than the long-term average and four more than the previous year. There were 362 official forecasts issued for tropical cyclones this year, nearly twenty-five percent more than were issued in 2002. The official forecast average track errors by cyclone are listed in Table 2.1.

Table 2.2 gives the average 3-day official and CLIPER track error for 2003 and their previous ten-year average errors. The 2003 official track forecast errors averaged across the forecast periods were nearly 21% smaller than their ten-year average. The corresponding 3-day CLIPER errors were 4% smaller when averaged in the same manner. This indicates that the official forecasts for 2003 were, on average, more skillful than the previous ten-year average. This is shown in the departure section of Table 2.2.

Although we have only two test years for comparison, Table 2.3 gives the average 5-day official and CLIPER track error for 2003 and their previous two-year average errors. The 2003 official track forecast errors averaged across the forecast periods were 21% smaller than their two-year average, while the corresponding CLIPER errors were 13% smaller when averaged in the same manner. This indicates that this year's official forecasts were also skillful, having average errors smaller than the 5-day CLIPER model, against this shorter averaging period.

In absolute terms, this year's average Atlantic official forecast errors are the smallest at all forecast periods that NHC has ever reported!

Tables 3.1 show homogeneous comparisons of selected late Atlantic track guidance models. Unlike 2002 when the Navy NOGAPS model had the smallest track errors, this year the NCEP GFDL model had the smallest average track errors of all the late track guidance at all forecast periods. The NCEP GFS model had the second smallest errors for all time periods after 24 hours. The second section of this Table shows the same late models with the addition of GEMN, the NCEP GFS ensemble mean, and AFW1, the Air Force MM5 model, both of which only forecast to 72 hours. The GEMN model's average track errors were greater than the control GFS model at all forecast periods. The Air Force's AFW1 model had largest average track errors of all these models.

A homogeneous comparison of the early Atlantic track models is displayed in Table 3.2. The consensus GUNA model had the smallest errors at all forecast periods. In general, the consensus GUNS model had the second smallest error. Of those model members making up the consensus models, the GFDI model consistently had the smallest errors. The forecasters appeared to be making good use of the GUNA consensus model since the official forecast track errors differed by less than 11 nautical miles at each forecast period.

The 2003 average official absolute wind speed errors by storm are listed in Table 4.1. Table 4.2 gives the 3-day average official and SHIFOR absolute wind speed errors for 2003 and their previous ten-year average errors. The 2003 official intensity errors had errors smaller than the SHIFOR model at all forecast periods, showing skill. From the departure section of the Table, observe that this year's official intensity forecasts averaged 21% better than their ten-year average when averaged across all forecast periods. The 3-day SHIFOR errors when averaged across all the forecast periods were 11% better than their long-term average.

Table 4.3 gives the average 5-day official and SHIFOR absolute wind speed errors for 2003 and their previous two-year average errors. The departures from these shorter averaging periods were not as good with the official forecasts averaging 16% smaller when averaged across the seven forecast periods while the SHIFOR errors were 9% better when averaged in the same manner.

Table 5 displays the absolute wind speed errors for the objective guidance from early models. The SHIPS model and its inland decay version provide the best guidance with the smallest intensity errors. Only at the 120 hour forecast period did the SHIFOR model a smaller average error. The official intensity errors were near the SHIPS errors through 72 hours, but were surprisingly better than all the guidance at day 4 and 5.

Eastern North Pacific

The eastern North Pacific 2003 hurricane season had sixteen named tropical cyclones and no tropical cyclones which only reached tropical depression stage. This

was equal to the long-term average and four more than the number that occurred in 2002. There were 258 official forecasts issued for tropical cyclones in this basin this year, slightly fewer than were issued the previous year. The average official forecast track errors by cyclone are listed in Table 6.1.

Table 6.2 gives the average 3-day official and CLIPER track errors for 2003 and the previous ten-year 3 day average official and CLIPER errors. With average errors smaller than the corresponding CLIPER errors, the official forecast has skill. As shown in the departure portion of the Table, the east Pacific official average track errors were 8% smaller than their ten-year average when averaged across the forecast periods while the corresponding 2003 CLIPER errors were nearly 6% larger their ten-year average when averaged in the same manner. Thus, the average 2003 official forecasts demonstrated increased skill at all forecast periods over their ten-year averages.

The average 5-day official and CLIPER track errors for 2003 and for the previous two years are given in Table 6.3. For this year, the official average track forecast errors show skill against their corresponding CLIPER errors at all forecast periods. Nevertheless, as shown in the departure section of the Table, the east Pacific official forecast track errors were larger than their previous two-year average after the 24 hour forecast period and 14% when averaged across the seven forecast periods. The corresponding CLIPER errors were nearly 8% larger their two-year average when averaged in the same manner.

Homogeneous comparisons of selected late east Pacific track guidance models are shown in Table 7.1. Unlike the Atlantic where the NCEP GFDL model was clearly the best late model, in this basin the smallest and next smallest errors were shared between the GFDL, the Navy NOGAPS and the UKMET model. Part of the problem with having no clear winner is the very small number of cases beyond 48 hours. As shown in the second portion of this table, the NCEP GFS model did not have a very good year in this basin and its ensemble mean was even worse. As in the Atlantic, the Air Force MM5 model did not perform well in this basin.

Table 7.2 displays a comparison of the early east Pacific track models through day 5. The GUNA consensus model had the smallest average errors, outperforming even the official forecast, after 12 hours. The GUNS model had the second smallest average errors through 4 days. When compared to the consensus models, no single component of the consensus had consistently smaller errors. Again, at the longer time periods the number of cases is quite small, reducing the confidence in these statistics.

Table 8.1 gives the 2003 average official absolute wind speed errors by storm. The average 3 day official and SHIFOR absolute wind speed errors for 2003 and their previous ten-year average errors are given in Table 8.2. Unlike the Atlantic, the official absolute intensity average errors were greater than their SHIFOR errors at the 36 and 48 hour forecast periods. In fact, they were also greater than their ten-year average official intensity errors after the 24 hour forecast period. Surprisingly, except for the 72 hour forecast period, the 2003 SHIFOR errors were smaller than their 10-year averages.

Table 8.3 gives the east Pacific average 5-day official and SHIFOR absolute wind speed errors for 2003 and their previous two-year average errors. Against the 5-day SHIFOR model, the official intensity forecasts average errors are smaller at all forecast periods showing skill. Nevertheless, as shown in the departure section of this Table, the official errors are larger than their two-year average for all forecast periods after the 24-hour forecast period.

The absolute wind speed errors for the 2003 objective intensity guidance from early models are given in Table 9. In general, as for the Atlantic basin, the SHIPS model and its decay version had the smallest absolute intensity errors at all forecast

periods. Again the number of cases after 3 days is small making the statistics at the longer forecast periods less significant.

2003 Verification Conclusions

1. The 2003 Atlantic official track forecasts had skill over CLIPER models and had errors smaller than their ten-year average errors to 3 days and smaller than their two-year average errors to 5 days. As a matter of fact, this year's official forecast average track errors were the smallest at all forecast periods that NHC has ever reported. The east Pacific official track errors also had skill over CLIPER and had errors smaller than their ten-year average errors to 3 days. Nevertheless, against the two-year average to 5 days, the east Pacific official average track errors were larger after 24 hours and CLIPER track average track errors were larger after 36 hours.

2. For the late track models, NCEP's GFDL model had the smallest average track errors for the Atlantic for all forecast periods. For the east Pacific basin, the GFDL and NOGAPS models had the smallest average track errors through 48 hours after which the GFDL and UKMET models providing the best track guidance to 5 days.

3. For the Atlantic, the NCEP GFS control track forecasts had smaller errors than its ensemble mean forecasts at all forecast periods. For the east Pacific basin, the ensemble mean forecasts were smaller than its control only at the 12 and 24 hour forecast periods.

4. For the early models, the consensus model GUNA had the smallest average track errors for the Atlantic basin at all forecast periods. Of those models included in the consensus, the GFDI model had the smallest track errors through 3 days with the GFSI model smaller thereafter. GUNA was also the best of the early models in the east Pacific through 96 hours. On average, the best early track guidance had smaller errors than the official track forecast through 72 hours in the Atlantic and after 12 hours in the east Pacific.

5. The 2003 North Atlantic official absolute intensity errors showed skill over the 3-day and 5-day SHIFOR forecasts. These intensity errors were smaller than their ten-year average to 3 days and smaller than their two-year average to 5 days. Unlike the Atlantic, the 2003 east Pacific official absolute intensity average errors were larger than the 3-day SHIFOR model and their ten-year average values after 24 hours. Against the two-year averages, the official intensity errors, while smaller than the 5-day SHIFOR model showing skill, they were larger than their two-year averages after the 24 forecast period.

6. The decay version of the SHIPS model provided the best intensity guidance for both basins with the smallest absolute intensity errors at nearly all forecast periods for both the Atlantic and east Pacific basins.

TABLE 1

MODEL ABBREVIATIONS*

OFCL – Official track and intensity forecasts

OFCI – Official Track Forecast Interpolated from the previous 6 hours

CLIP – 3-day CLImatology and PERsistence track model – CLIPER

CLP5 – 5-day CLImatology and PERsistence track model – CLIPER

A98E – NHC98 Statistical-Dynamical track model (Atl)

P91E – NHC91 Statistical-Dynamical track model (Pac)

BAMD, BAMM, BAMS – Beta Advection Model Deep, Medium, Shallow (Global)

LBAR – Limited-area sine transform BARotropic track model

AFW1 – Air Force MM5 model (Global, 12-hour)

GFDL – Geophysical Fluid Dynamics Lab GFDL track and intensity model

GFDI – Interpolated GFDL model

GFS – NCEP Global Forecasting System (Global)

GFSI – Interpolated GFS model

GEMN – GFS Ensemble Mean (Global, 12-hour)

UKM – UKMET Model (Global, 12-hour)

UKMI – Interpolated UKMET model (6- and 12-hour)

NGPS – Navy Operational Global Atmospheric Prediction System – NOGAPS (Global)

NGPI – Interpolated NGPS model

GUNS – Numerical average of the GFDI, UKMI and NGPI models

GUNA – Numerical average of the GFDI, UKMI, NGPI and GFSI models

SHFR – 3-day Statistical Hurricane Intensity FORecast Model – SHIFOR

SHF5 – 5-day Statistical Hurricane Intensity FORecast Model – SHIFOR

SHIP – Statistical Hurricane Intensity Prediction Scheme – SHIPS

DSHP – Decay SHIP (SHIPS values reduced for an OFCI forecast track over land)

* All model guidance is available every 6 hours and is applicable to both the Atlantic and Pacific basins, except where indicated.

TABLE 2.1

NORTH ATLANTIC

2003 OFFICIAL AVERAGE TRACK FORECAST ERRORS (NM) BY STORM

FORECAST ERRORS (NM) FOR al012003 ANA

	00	12	24	36	48	72	96	120
OFCL	4.7	37.3	45.7	78.9	123.0	98.2		
#CASES	13	11	9	7	5	1	0	0

FORECAST ERRORS (NM) FOR al022003 TWO

	00	12	24	36	48	72	96	120
OFCL	1.5	25.7						
#CASES	4	2	0	0	0	0	0	0

FORECAST ERRORS (NM) FOR al032003 BILL

	00	12	24	36	48	72	96	120
OFCL	12.8	54.3	93.6	136.2	176.3	554.3		
#CASES	9	9	9	7	5	1	0	0

FORECAST ERRORS (NM) FOR al042003 CLAUDETTE

	00	12	24	36	48	72	96	120
OFCL	6.6	35.7	56.9	88.8	116.7	140.1	153.8	153.6
#CASES	30	30	30	28	26	22	18	14

FORECAST ERRORS (NM) FOR al052003 DANNY

	00	12	24	36	48	72	96	120
OFCL	2.6	36.8	42.2	44.6	53.0	166.2	289.8	
#CASES	18	17	15	13	11	7	3	0

FORECAST ERRORS (NM) FOR al062003 SIX

	00	12	24	36	48	72	96	120
OFCL	24.9	19.7	55.9	146.3				
#CASES	8	6	4	2	0	0	0	0

FORECAST ERRORS (NM) FOR al072003 SEVEN

	00	12	24	36	48	72	96	120
OFCL	4.6	42.0	100.6	179.8				
#CASES	4	4	3	1	0	0	0	0

FORECAST ERRORS (NM) FOR al082003 ERIKA

	00	12	24	36	48	72	96	120
OFCL	7.4	31.1	59.5	73.2	101.5			
#CASES	10	8	6	4	2	0	0	0

FORECAST ERRORS (NM) FOR al092003 NINE

	00	12	24	36	48	72	96	120
OFCL	0.0	19.7						
#CASES	4	2	0	0	0	0	0	0

FORECAST ERRORS (NM) FOR al102003 FABIAN

	00	12	24	36	48	72	96	120
OFCL	4.2	24.5	45.1	64.3	82.7	114.1	136.3	205.9
#CASES	48	46	44	42	40	36	32	28

FORECAST ERRORS (NM) FOR al112003 GRACE

	00	12	24	36	48	72	96	120
OFCL	51.5	107.8	158.0	223.3	304.5			
#CASES	5	5	5	5	4	0	0	0

FORECAST ERRORS (NM) FOR al122003 HENRI

	00	12	24	36	48	72	96	120
OFCL	5.6	43.8	72.9	83.3	97.2	82.2	124.2	
#CASES	20	18	16	14	12	8	4	0

FORECAST ERRORS (NM) FOR al132003 ISABEL

	00	12	24	36	48	72	96	120
OFCL	5.3	21.8	38.7	52.1	59.9	80.4	104.1	145.6
#CASES	53	51	49	47	45	41	37	33

FORECAST ERRORS (NM) FOR al142003 FOURTEEN

	00	12	24	36	48	72	96	120
OFCL	18.0	57.8	64.5	105.4	156.0			
#CASES	9	7	5	3	1	0	0	0

FORECAST ERRORS (NM) FOR al152003 JUAN

	00	12	24	36	48	72	96	120
OFCL	3.7	37.6	63.1	87.4	107.6	61.4	228.6	
#CASES	16	15	13	11	9	5	1	0

FORECAST ERRORS (NM) FOR al162003 KATE

	00	12	24	36	48	72	96	120
OFCL	5.4	47.9	91.1	132.8	179.3	288.2	362.5	406.3
#CASES	49	47	45	43	41	37	33	29

FORECAST ERRORS (NM) FOR al172003 LARRY

	00	12	24	36	48	72	96	120
OFCL	7.9	28.9	43.9	56.0	76.3	113.6	190.6	
#CASES	19	17	15	13	11	7	3	0

FORECAST ERRORS (NM) FOR al182003 MINDY

	00	12	24	36	48	72	96	120
OFCL	7.7	39.7	95.3	184.2	292.0	413.6		
#CASES	14	12	10	8	6	2	0	0

FORECAST ERRORS (NM) FOR al192003 NICHOLAS

	00	12	24	36	48	72	96	120
OFCL	16.2	38.7	64.4	94.7	127.4	171.5	184.9	158.2
#CASES	41	39	37	35	33	29	25	21

FORECAST ERRORS (NM) FOR al202003 ODETTE

	00	12	24	36	48	72	96	120
OFCL	7.9	62.1	127.6	232.9	506.3	1161.8		
#CASES	13	11	9	7	5	1	0	0

FORECAST ERRORS (NM) FOR al212003 PETER

	00	12	24	36	48	72	96	120
OFCL	1.2	50.6	122.4	202.2				
#CASES	7	5	3	1	0	0	0	0

TABLE 2.2

NORTH ATLANTIC

2003 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	(hr)
OFCL	7.8	37.1	64.4	93.2	123.1	160.8	(nm)
CLIP	8.5	49.4	102.8	165.1	223.9	333.9	(nm)
#CASES	394	362	327	291	256	197	

1993 – 2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	(hr)
OFCL	11.6	44.9	81.2	115.7	150.3	224.6	(nm)
CLIP	11.9	54.3	109.4	169.0	229.4	343.8	(nm)
#CASES	3126	2919	2683	2455	2218	1812	

2003 OFFICIAL AND CLIPER AVERAGE TRACK ERROR DEPARTURE
FROM THE 1993 – 2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS

PERIOD	00	12	24	36	48	72	(hr)
OFCL DEPARTURE	-33	-17	-21	-19	-18	-28	(%)
CLIP DEPARTURE	-29	-09	-06	-02	-02	-03	(%)

TABLE 2.3

NORTH ATLANTIC

2003 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	7.8	37.1	64.4	93.2	123.1	160.8	190.6	222.6	(nm)
CLP5	8.5	49.0	103.0	164.1	221.5	333.5	466.9	616.8	(nm)
#CASES	394	362	327	291	256	197	156	125	

2001 – 2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	7.6	42.7	74.5	105.9	140.0	208.6	282.1	374.1	(nm)
CLP5	8.9	56.0	115.7	184.8	253.5	391.2	552.6	702.6	(nm)
#CASES	650	588	519	465	418	336	265	216	

2003 OFFICIAL AND CLIPER AVERAGE TRACK ERROR DEPARTURE
FROM THE 2001 – 2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL DEPARTURE	03	-13	-14	-12	-12	-23	-32	-41	(%)
CLP5 DEPARTURE	-04	-13	-11	-11	-13	-15	-16	-12	(%)

TABLE 3.1

NORTH ATLANTIC

2003 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (SELECTED LATE)

PERIOD	00	12	24	36	48	72	96	120
OFCL	7.4	34.2	60.5	86.0	110.1	144.5	173.9	220.8
CLP5*	7.7	44.4	96.8	155.5	209.2	322.1	470.7	640.5
GFS	17.5	43.0	63.9	83.0	98.8	155.1	201.5	263.1
GFDL	10.5	35.3	52.0	71.8	91.2	139.1	198.7	252.5
UKM	29.8	50.9	73.4	95.5	114.3	170.3	260.3	342.3
NGPS	21.9	38.7	62.0	83.9	109.0	159.6	229.1	290.4
#CASES	169	159	137	116	99	78	59	49

NORTH ATLANTIC

2003 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (SELECTED LATE)

PERIOD	00	12	24	36	48	72	96	120
OFCL	7.0	36.1	63.6	91.5	114.3	147.6		
CLP5*	7.2	45.3	102.0	165.8	228.2	342.9		
GFS	15.7	42.7	66.1	82.9	97.6	154.8		
GEMN	17.0	46.1	68.9	94.2	113.1	179.6		
GFDL	10.5	34.1	49.5	69.7	85.8	136.2		
UKM	28.2	49.3	72.5	100.5	121.8	188.7		
NGPS	18.4	39.2	62.0	84.2	109.8	160.3		
AFW1	35.1	79.2	117.4	174.6	205.7	295.2		
#CASES	113	105	91	76	63	46	0	0

* Although CLP5 is an early model, it is included here for reference.

TABLE 3.2

NORTH ATLANTIC

2003 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (EARLY)

PERIOD	00	12	24	36	48	72	96	120
OFCL	7.0	34.5	58.0	81.8	104.6	133.3	167.7	198.3
CLP5	7.5	46.5	99.6	158.0	214.0	330.3	477.5	633.5
A98E	7.5	42.6	78.5	119.2	170.8	301.4	477.9	592.8
BAMD	7.5	46.8	86.9	122.5	153.2	263.2	367.2	424.8
BAMM	7.5	41.2	76.2	110.1	140.2	210.8	269.4	336.6
BAMS	7.5	52.9	96.0	136.5	174.4	259.3	322.5	396.4
LBAR	7.5	40.0	78.3	118.0	156.9	272.8	406.7	520.4
OFCI	7.6	37.6	64.9	91.2	116.1	141.3	174.2	212.6
GFSI	7.6	36.7	62.0	85.9	107.8	156.1	199.9	257.4
GFDI	7.6	31.3	53.8	74.7	97.4	146.8	208.6	276.8
UKMI	7.6	40.4	73.0	103.8	129.8	192.9	276.5	332.3
NGPI	7.6	36.6	63.8	91.2	119.3	169.8	237.7	299.3
GUNS	7.6	31.1	53.8	76.4	98.3	136.1	191.5	222.4
GUNA	7.6	30.8	52.3	73.3	93.8	128.1	175.1	208.4
#CASES	267	259	243	215	183	144	111	90

* Although CLP5 is an early model, it is included here for reference.

TABLE 4.1

NORTH ATLANTIC

2003 OFFICIAL AVERAGE ABSOLUTE WIND SPEED FORECAST ERRORS (NM) BY STORM

FORECAST ERRORS (KT) FOR al012003 ANA

	00	12	24	36	48	72	96	120
OFCL	6.9	8.6	9.4	9.3	9.0	10.0		
#CASES	13	11	9	7	5	1	0	0

FORECAST ERRORS (KT) FOR al022003 TWO

	00	12	24	36	48	72	96	120
OFCL	0.0	2.5						
#CASES	4	2	0	0	0	0	0	0

FORECAST ERRORS (KT) FOR al032003 BILL

	00	12	24	36	48	72	96	120
OFCL	0.6	4.4	5.6	2.1	1.0	5.0		
#CASES	9	9	9	7	5	1	0	0

FORECAST ERRORS (KT) FOR al042003 CLAUDETTE

	00	12	24	36	48	72	96	120
OFCL	1.8	4.8	6.8	6.8	9.0	8.6	7.8	7.9
#CASES	30	30	30	28	26	22	18	14

FORECAST ERRORS (KT) FOR al052003 DANNY

	00	12	24	36	48	72	96	120
OFCL	0.3	5.0	8.3	11.2	15.0	14.3	6.7	
#CASES	18	17	15	13	11	7	3	0

FORECAST ERRORS (KT) FOR al062003 SIX

	00	12	24	36	48	72	96	120
OFCL	0.0	5.0	10.0	15.0				
#CASES	8	6	4	2	0	0	0	0

FORECAST ERRORS (KT) FOR al072003 SEVEN

	00	12	24	36	48	72	96	120
OFCL	2.5	5.0	3.3	5.0				
#CASES	4	4	3	1	0	0	0	0

FORECAST ERRORS (KT) FOR al082003 ERIKA

	00	12	24	36	48	72	96	120
OFCL	1.5	3.1	4.2	8.8	15.0			
#CASES	10	8	6	4	2	0	0	0

FORECAST ERRORS (KT) FOR al092003 NINE

	00	12	24	36	48	72	96	120
OFCL	0.0	2.5						
#CASES	4	2	0	0	0	0	0	0

FORECAST ERRORS (KT) FOR al102003 FABIAN

	00	12	24	36	48	72	96	120
OFCL	1.1	4.7	7.4	10.1	12.5	18.6	20.5	20.9
#CASES	48	46	44	42	40	36	32	28

FORECAST ERRORS (KT) FOR al112003 GRACE

	00	12	24	36	48	72	96	120
OFCL	0.0	5.0	15.0	5.0	2.5			
#CASES	5	5	5	5	4	0	0	0

FORECAST ERRORS (KT) FOR al122003 HENRI

	00	12	24	36	48	72	96	120
OFCL	1.0	5.3	7.5	7.1	7.5	8.1	2.5	
#CASES	20	18	16	14	12	8	4	0

FORECAST ERRORS (KT) FOR al132003 ISABEL

	00	12	24	36	48	72	96	120
OFCL	2.3	7.4	11.2	14.0	17.3	22.6	24.7	27.4
#CASES	53	51	49	47	45	41	37	33

FORECAST ERRORS (KT) FOR al142003 FOURTEEN

	00	12	24	36	48	72	96	120
OFCL	1.1	5.0	9.0	16.7	30.0			
#CASES	9	7	5	3	1	0	0	0

FORECAST ERRORS (KT) FOR al152003 JUAN

	00	12	24	36	48	72	96	120
OFCL	5.0	8.3	12.7	16.4	20.0	20.0	10.0	
#CASES	16	15	13	11	9	5	1	0

FORECAST ERRORS (KT) FOR al162003 KATE

	00	12	24	36	48	72	96	120
OFCL	0.4	4.4	7.2	8.6	9.8	11.6	16.7	22.6
#CASES	49	47	45	43	41	37	33	29

FORECAST ERRORS (KT) FOR al172003 LARRY

	00	12	24	36	48	72	96	120
OFCL	0.3	4.7	5.3	7.3	10.5	15.7	26.7	
#CASES	19	17	15	13	11	7	3	0

FORECAST ERRORS (KT) FOR al182003 MINDY

	00	12	24	36	48	72	96	120
OFCL	1.8	3.3	8.5	13.8	17.5	22.5		
#CASES	14	12	10	8	6	2	0	0

FORECAST ERRORS (KT) FOR al192003 NICHOLAS

	00	12	24	36	48	72	96	120
OFCL	1.2	3.7	4.7	5.4	6.8	9.5	11.0	15.0
#CASES	41	39	37	35	33	29	25	21

FORECAST ERRORS (KT) FOR al202003 ODETTE

	00	12	24	36	48	72	96	120
OFCL	2.7	5.5	9.4	12.1	10.0	0.0		
#CASES	13	11	9	7	5	1	0	0

FORECAST ERRORS (KT) FOR al212003 PETER

	00	12	24	36	48	72	96	120
OFCL	2.1	6.0	6.7	0.0				
#CASES	7	5	3	1	0	0	0	0

TABLE 4.2

NORTH ATLANTIC

2003 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	(hr)
OFCL	1.6	5.2	7.9	9.5	11.6	14.8	(kt)
SHFR	1.7	6.7	10.5	14.0	17.0	21.7	(kt)
#CASES	394	362	327	291	256	197	

1993 – 2002 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	(hr)
OFCL	2.6	6.2	9.9	12.6	15.1	18.9	(kt)
SHFR	2.6	8.0	12.5	15.9	18.7	22.1	(kt)
#CASES	3127	2913	2673	2441	2203	1812	

2003 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR DEPARTURE
FROM THE 1993 – 2002 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR

PERIOD	00	12	24	36	48	72	(hr)
OFCL DEPARTURE	–38	–16	–20	–25	–23	–22	(%)
SHFR DEPARTURE	–35	–16	–16	–12	–09	–02	(%)

TABLE 4.3

NORTH ATLANTIC

2003 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	1.6	5.2	7.9	9.5	11.6	14.8	17.0	20.6	(kt)
SHF5	1.7	6.9	11.0	14.5	17.3	20.6	21.9	24.0	(kt)
#CASES	394	362	327	291	256	197	156	125	

2001 – 2002 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	1.2	5.7	9.4	12.0	15.1	19.8	21.3	21.6	(kt)
SHF5	1.6	8.1	12.7	16.1	18.8	22.6	25.5	22.8	(kt)
#CASES	648	586	518	464	418	336	265	216	

2003 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR DEPARTURE
FROM THE 2001 – 2002 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL DEPARTURE	33	-09	-16	-21	-23	-25	-20	-05	(%)
SHF5 DEPARTURE	06	-15	-13	-10	-08	-09	-14	05	(%)

TABLE 5

NORTH ATLANTIC

2003 AVERAGE MODEL ABSOLUTE WIND SPEED ERROR (KT)
FOR A HOMOGENEOUS SAMPLE (EARLY)

PERIOD	00	12	24	36	48	72	96	120
OFCL	1.5	5.3	7.8	9.5	11.1	14.6	17.5	19.6
SHF5	1.7	6.7	11.0	14.6	16.7	19.8	22.0	23.8
OFCI	1.7	6.0	8.0	10.2	12.0	14.7	18.3	20.4
SHIP	1.7	6.2	9.4	12.0	12.8	15.0	19.4	26.0
DSHP	1.7	5.7	7.5	9.5	10.6	13.7	19.9	26.8
GFDI	1.7	8.2	11.8	14.3	16.6	20.7	23.8	26.6
GFSI	1.7	7.7	11.7	15.0	18.6	25.5	31.5	33.3
#CASES	291	281	266	236	200	152	121	100

TABLE 6.1

EAST PACIFIC

2003 OFFICIAL AVERAGE TRACK FORECAST ERRORS (NM) BY STORM

FORECAST ERRORS (NM) FOR ep012003 ANDRES

	00	12	24	36	48	72	96	120
OFCL	5.7	24.9	59.0	107.8	166.7	298.1	435.6	604.9
#CASES	22	20	18	16	14	10	6	2

FORECAST ERRORS (NM) FOR ep022003 BLANAC

	00	12	24	36	48	72	96	120
OFCL	9.2	27.9	54.5	80.4	108.4	173.7	215.3	265.4
#CASES	22	20	18	16	14	10	6	2

FORECAST ERRORS (NM) FOR ep032003 CARLOS

	00	12	24	36	48	72	96	120
OFCL	20.6	79.2	156.7	224.4				
#CASES	7	5	3	1	0	0	0	0

FORECAST ERRORS (NM) FOR ep042003 DOLORES

	00	12	24	36	48	72	96	120
OFCL	9.4	34.0	58.7	80.8				
#CASES	8	6	4	2	0	0	0	0

FORECAST ERRORS (NM) FOR ep052003 ENRIQUE

	00	12	24	36	48	72	96	120
OFCL	6.0	47.2	87.6	114.4	120.1	144.0		
#CASES	14	12	10	8	6	2	0	0

FORECAST ERRORS (NM) FOR ep062003 FELICIA

	00	12	24	36	48	72	96	120
OFCL	11.4	37.3	52.6	74.2	112.1	187.5	194.9	141.7
#CASES	22	20	18	16	14	10	6	2

FORECAST ERRORS (NM) FOR ep072003 GUILLERMO

	00	12	24	36	48	72	96	120
OFCL	4.9	33.9	57.3	78.3	90.5	142.9	217.4	226.6
#CASES	21	19	17	15	13	9	5	1

FORECAST ERRORS (NM) FOR ep082003 HILDA

	00	12	24	36	48	72	96	120
OFCL	12.9	49.2	85.0	106.5	116.2	137.7	220.5	
#CASES	18	16	14	12	10	6	2	0

FORECAST ERRORS (NM) FOR ep092003 IGNACIO

	00	12	24	36	48	72	96	120
OFCL	9.5	19.3	29.4	47.9	65.6	91.7	120.6	265.8
#CASES	22	20	18	16	14	10	6	2

FORECAST ERRORS (NM) FOR ep102003 JIMENA

	00	12	24	36	48	72	96	120
OFCL	9.4	33.0	50.2	61.9	80.9	149.9	223.7	286.4
#CASES	9	9	9	9	9	9	9	9

FORECAST ERRORS (NM) FOR ep112003 KEVIN

	00	12	24	36	48	72	96	120
OFCL	7.6	31.6	58.6	97.2	124.8			
#CASES	11	9	7	5	3	0	0	0

FORECAST ERRORS (NM) FOR ep122003 LINDA

	00	12	24	36	48	72	96	120
OFCL	12.6	26.7	47.0	71.2	95.5	152.0		
#CASES	15	13	11	9	7	3	0	0

FORECAST ERRORS (NM) FOR ep132003 MARTY

	00	12	24	36	48	72	96	120
OFCL	9.5	41.8	83.7	120.2	155.8	248.0	398.6	670.1
#CASES	23	22	20	18	16	12	8	4

FORECAST ERRORS (NM) FOR ep142003 NORA

	00	12	24	36	48	72	96	120
OFCL	5.7	31.6	61.8	88.0	107.7	139.3	195.0	293.0
#CASES	31	29	27	25	23	19	15	11

FORECAST ERRORS (NM) FOR ep152003 OLAF

	00	12	24	36	48	72	96	120
OFCL	18.6	53.4	99.6	140.2	161.8	160.4	244.0	
#CASES	19	17	15	13	11	7	3	0

FORECAST ERRORS (NM) FOR ep162003 PATRICIA

	00	12	24	36	48	72	96	120
OFCL	11.2	34.5	62.1	89.1	113.4	177.4	276.5	325.7
#CASES	23	21	19	17	15	11	7	3

TABLE 6.2

EAST PACIFIC

2003 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	(hr)
OFCL	9.7	35.6	64.3	91.4	116.1	173.0	(nm)
CLIP	10.3	42.0	84.0	133.6	179.3	274.0	(nm)
#CASES	287	258	228	198	169	118	

1993 - 2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	(hr)
OFCL	11.2	38.1	70.5	101.4	129.2	183.3	(nm)
CLIP	11.4	41.8	81.6	124.9	166.8	242.7	(nm)
#CASES	2986	2796	2540	2274	2020	1582	

2003 OFFICIAL AND CLIPER AVERAGE TRACK ERROR DEPARTURE
FROM THE 1993 - 2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS

PERIOD	00	12	24	36	48	72	(hr)
OFCL DEPARTURE	-13	-07	-09	-10	-10	-06	(%)
CLIP DEPARTURE	-10	00	03	07	07	13	(%)

TABLE 6.3

EAST PACIFIC

2003 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	9.7	35.6	64.3	91.4	116.1	173.0	248.2	340.0	(nm)
CLP5	10.3	41.6	83.7	132.6	181.7	274.7	401.1	532.9	(nm)
#CASES	287	258	228	198	169	118	73	36	

2001 - 2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	9.4	37.6	64.2	87.0	107.5	151.0	196.9	223.3	(nm)
CLP5	10.4	47.3	92.6	137.3	179.7	250.6	320.6	368.0	(nm)
#CASES	622	567	507	450	396	299	210	143	

2003 OFFICIAL AND CLIPER AVERAGE TRACK ERROR DEPARTURE
FROM THE 2001 - 2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL DEPARTURE	03	-05	00	05	08	15	26	52	(%)
CLP5 DEPARTURE	-01	-12	-10	-03	01	10	25	45	(%)

TABLE 7.1

EAST PACIFIC

2003 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (SELECTED LATE)

PERIOD	00	12	24	36	48	72	96	120
OFCL	9.2	32.2	61.2	90.7	111.3	155.2	261.1	452.2
CLP5*	10.2	38.7	77.4	123.4	160.7	212.4	356.4	640.0
GFS	19.3	48.3	78.1	108.7	137.8	195.9	275.9	255.8
GFDL	14.9	40.8	65.5	92.7	113.1	162.9	201.1	175.2
UKM	33.4	65.2	82.0	114.0	121.9	179.1	195.0	317.4
NGPS	22.5	44.6	62.2	92.6	115.3	197.0	202.6	525.5
#CASES	101	91	71	61	50	23	9	2

EAST PACIFIC

2003 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (SELECTED LATE)

PERIOD	00	12	24	36	48	72	96	120
OFCL	9.0	31.8	60.1	91.4	112.2	149.2		
CLP5*	9.8	39.3	76.3	124.1	161.7	218.7		
GFS	19.8	53.0	86.6	118.1	151.3	196.2		
GEMN	22.8	48.6	78.0	120.3	172.0	224.8		
GFDL	15.1	43.9	70.6	103.1	120.9	190.4		
UKM	30.2	67.1	73.0	108.7	126.1	173.7		
NGPS	21.7	44.9	56.0	85.0	112.3	176.8		
AFW1	31.3	75.6	124.1	191.4	266.3	303.2		
#CASES	73	65	47	39	33	14		

* Although CLP5 is an early model, it is included here for reference.

TABLE 7.2

EAST PACIFIC

2003 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (EARLY)

PERIOD	00	12	24	36	48	72	96	120
OFCL	8.9	32.7	60.4	87.5	110.5	156.0	218.5	372.4
CLP5	9.4	39.8	83.1	132.6	174.3	231.6	386.5	776.3
P91E	9.4	38.7	74.0	115.2	149.1	198.2	294.8	477.7
BAMD	9.4	48.1	94.0	144.6	196.0	261.4	424.0	632.5
BAMM	9.4	44.2	85.7	132.4	185.7	258.7	335.5	397.0
BAMS	9.4	49.4	92.3	145.1	201.5	297.8	403.0	323.2
LBAR	9.4	42.1	84.7	137.6	195.2	272.6	394.6	606.9
OFCI	9.4	35.9	64.7	94.4	119.7	171.3	276.4	425.0
GFSI	9.4	42.3	75.7	107.1	134.9	205.4	271.6	212.2
GFDI	9.4	36.6	65.7	94.6	118.9	172.0	188.4	193.6
UKMI	9.4	46.9	85.8	106.0	126.1	172.8	223.9	426.9
NGPI	9.4	35.5	66.4	99.9	124.6	190.0	221.3	449.3
GUNS	9.4	34.5	62.5	84.7	103.0	150.0	172.7	275.4
GUNA	9.4	33.6	59.8	80.7	96.2	129.9	165.2	257.0
#CASES	157	126	114	102	83	41	19	3

TABLE 8.1

EAST PACIFIC

2003 OFFICIAL AVERAGE ABSOLUTE WIND SPEED FORECAST ERRORS (KT) BY STORM

FORECAST ERRORS (KT) FOR ep012003 ANDRES

	00	12	24	36	48	72	96	120
OFCL	8.4	8.5	6.4	4.4	6.4	11.5	5.0	2.5
#CASES	22	20	18	16	14	10	6	2

FORECAST ERRORS (KT) FOR ep022003 BLANAC

	00	12	24	36	48	72	96	120
OFCL	0.5	4.3	9.2	11.9	14.3	19.0	15.8	2.5
#CASES	22	20	18	16	14	10	6	2

FORECAST ERRORS (KT) FOR ep032003 CARLOS

	00	12	24	36	48	72	96	120
OFCL	4.3	12.0	11.7	10.0				
#CASES	7	5	3	1	0	0	0	0

FORECAST ERRORS (KT) FOR ep042003 DOLORES

	00	12	24	36	48	72	96	120
OFCL	1.9	5.0	13.8	20.0				
#CASES	8	6	4	2	0	0	0	0

FORECAST ERRORS (KT) FOR ep052003 ENRIQUE

	00	12	24	36	48	72	96	120
OFCL	1.4	4.6	8.5	12.5	11.7	5.0		
#CASES	14	12	10	8	6	2	0	0

FORECAST ERRORS (KT) FOR ep062003 FELICIA

	00	12	24	36	48	72	96	120
OFCL	0.2	3.0	5.8	6.9	9.6	8.5	7.5	5.0
#CASES	22	20	18	16	14	10	6	2

FORECAST ERRORS (KT) FOR ep072003 GUILLERMO

	00	12	24	36	48	72	96	120
OFCL	0.5	3.7	8.2	13.7	18.5	19.4	16.0	10.0
#CASES	21	19	17	15	13	9	5	1

FORECAST ERRORS (KT) FOR ep082003 HILDA

	00	12	24	36	48	72	96	120
OFCL	0.0	3.8	6.8	14.2	20.5	31.7	30.0	
#CASES	18	16	14	12	10	6	2	0

FORECAST ERRORS (KT) FOR ep092003 IGNACIO

	00	12	24	36	48	72	96	120
OFCL	2.0	7.3	15.3	24.7	32.5	27.5	5.0	0.0
#CASES	22	20	18	16	14	10	6	2

FORECAST ERRORS (KT) FOR ep102003 JIMENA

	00	12	24	36	48	72	96	120
OFCL	1.1	8.3	13.9	15.6	17.2	24.4	30.6	38.3
#CASES	9	9	9	9	9	9	9	9

FORECAST ERRORS (KT) FOR ep112003 KEVIN

	00	12	24	36	48	72	96	120
OFCL	0.5	3.3	6.4	12.0	15.0			
#CASES	11	9	7	5	3	0	0	0

FORECAST ERRORS (KT) FOR ep122003 LINDA

	00	12	24	36	48	72	96	120
OFCL	0.7	6.5	15.9	22.8	22.9	15.0		
#CASES	15	13	11	9	7	3	0	0

FORECAST ERRORS (KT) FOR ep132003 MARTY

	00	12	24	36	48	72	96	120
OFCL	1.1	6.6	9.0	10.8	11.3	12.5	24.4	38.8
#CASES	23	22	20	18	16	12	8	4

FORECAST ERRORS (KT) FOR ep142003 NORA

	00	12	24	36	48	72	96	120
OFCL	0.2	5.5	11.1	15.2	19.5	22.1	16.3	11.4
#CASES	31	29	27	25	22	19	15	11

FORECAST ERRORS (KT) FOR ep152003 OLAF

	00	12	24	36	48	72	96	120
OFCL	4.5	8.8	16.0	24.2	33.2	33.6	31.7	
#CASES	19	17	15	13	11	7	3	0

FORECAST ERRORS (KT) FOR ep162003 PATRICIA

	00	12	24	36	48	72	96	120
OFCL	1.1	9.3	16.1	21.5	25.7	30.0	29.3	23.3
#CASES	23	21	19	17	15	11	7	3

TABLE 8.2

EAST PACIFIC

2003 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	(hr)
OFCL	1.7	6.1	10.7	14.9	18.5	20.7	(kt)
SHFR	1.9	6.8	10.8	14.7	17.9	22.8	(kt)
#CASES	287	258	228	198	168	118	

1993 - 2002 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	(hr)
OFCL	2.1	6.1	11.0	14.7	17.2	20.2	(kt)
SHFR	2.2	7.4	12.3	16.3	19.5	22.4	(kt)
#CASES	2985	2785	2521	2266	2012	1585	

2003 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR DEPARTURE
FROM THE 1993 - 2002 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR

PERIOD	00	12	24	36	48	72	(hr)
OFCL DEPARTURE	-19	00	-03	01	08	02	(%)
SHFR DEPARTURE	-14	-08	-12	-10	-08	02	(%)

TABLE 8.3

EAST PACIFIC

2003 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	1.7	6.1	10.7	14.9	18.5	20.7	18.6	20.1	(kt)
SHF5	1.9	6.7	10.8	15.2	19.5	23.3	21.4	21.3	(kt)
#CASES	287	258	228	198	168	118	73	36	

2001 - 2002 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	1.4	6.2	11.0	14.4	16.0	18.1	18.0	18.5	(kt)
SHF5	1.6	7.3	12.2	15.3	17.3	21.4	20.1	18.1	(kt)
#CASES	620	566	505	448	394	298	209	142	

2003 OFFICIAL AND CLIPER AVERAGE TRACK ERROR DEPARTURE
FROM THE 2001 - 2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL DEPARTURE	21	-02	-03	03	16	14	03	09	(%)
SHF5 DEPARTURE	19	-08	-11	-01	13	09	06	18	(%)

TABLE 9

EAST PACIFIC

2003 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (EARLY)

PERIOD	00	12	24	36	48	72	96	120
OFCL	1.9	6.6	11.2	15.9	19.9	21.2	20.2	22.0
SHF5	2.1	7.2	11.4	15.8	20.4	23.9	25.7	22.7
OFCI	2.1	7.7	12.0	16.1	19.0	20.1	20.2	23.7
SHIP	2.1	7.6	12.1	16.5	20.8	22.0	17.1	18.8
DSHP	2.1	7.2	11.5	15.4	18.8	18.6	17.1	18.8
GFDI	2.1	7.9	11.7	15.9	20.5	24.4	20.0	10.7
GFSI	2.1	8.2	13.2	17.2	20.8	23.0	18.5	19.5
#CASES	214	204	182	162	129	71	31	10