2002 NATIONAL HURRICANE CENTER FORECAST VERIFICATION

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Introduction

Every six hours, the National Hurricane Center (NHC) issues 72-hour track and intensity forecasts for all tropical cyclones in the North Atlantic and eastern North Pacific basins. 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. Again, this year, the tropical and subtropical depression stage is included in the verification. 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.

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.

This is the second year that NHC tested its ability and that of the objective guidance to make 96 and 120 hour track and intensity forecasts for tropical cyclones. While these forecasts have been verified along with the other track and intensity forecasts, they are strictly unofficial. In addition, new 5-day CLIPER and SHIFOR forecast models were developed for both basins to measure the skill of these extended forecasts. Please note that there are differences in errors between the old and new CLIPER and SHIFOR models for both basins through 72 hours due to their different formulations and developmental data sets.

North Atlantic

The 2002 North Atlantic hurricane season had twelve named tropical cyclones and two tropical depressions. This is two more named tropical cyclones than the long-term average and three less than the previous year. There were 287 official forecasts issued for tropical cyclones this year, slightly less than were issued in 2001. The official forecast average track errors by cyclone are listed in Table 2.1. Table 2.2 gives the average official, 3-day and 5-day CLIPER track error for 2002 and the previous ten-year average official and 3-day CLIPER error. The 2002 official track

forecast errors averaged across the forecast periods were nearly 11% smaller than their ten-year average, even though the corresponding 3-day CLIPER errors were 6% larger when averaged in the same manner. This indicates that the official forecasts for 2002 were, on average, more skillful than the previous ten-year average. This is shown in the departure section of Table 2.2.

As in 2001, the experimental average day 4 and 5 official track forecasts were also skillful, surpassing their average 5-day CLIPER errors by 50%. The last section of Table 2.2 shows the average official track error for 2001 and 2002. It is remarkable that the 2002 day 4 and 5 average track errors were nearly identical to the 2001 day 4 and 5 track errors. As in 2001, the two-year average error at day 4 and 5 increased at essentially the same linear rate as the error between the initial time and day 3.

Tables 3.1 show homogeneous comparisons of selected late Atlantic track guidance models. Unlike 2001 when the NCEP GFS model had the smallest track errors, the Navy NOGAPS model this year had the smallest average track errors of all the late track guidance for all forecast periods. 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. In comparison to the other late models, the ensemble mean forecasts seemed to reflect the poor performance of the control run of the GFS model this year in the Atlantic basin. The Air Force MM5 model had large average track errors.

A homogeneous comparison of the early Atlantic track models is displayed in Table 3.2. The consensus models, GUNS and GUNA, had the smallest errors at all forecast periods, never differing on average by more than 3 nautical miles at each forecast period. The forecasters appeared to be making good use of the early models since the official forecast track errors differed, at most, from the consensus models by only 12 nautical miles at each forecast period.

The 2002 average official absolute wind speed errors by storm are listed in Table 4.1. Table 4.2 gives the average official, 3-day and 5-day SHIFOR absolute wind speed errors for 2002 and the previous ten-year average official and 3-day SHIFOR errors. The 2002 official intensity errors showed skill over the SHIFOR models at all forecast periods. From the departure section of the Table, observe that this year's official intensity forecasts averaged 11% better than their ten-year average when averaged across the first four forecast periods, but were 8% worse at 72 hours. The 2002 3-day SHIFOR errors averaged in the same manner were 5% better than their long-term average, when averaged across all the forecast periods.

At day 4 and 5, the 2002 average official absolute intensity errors increased nearly 2 knots per day from the 3-day value. Nevertheless, when averaged with last year's results, as shown in the last section of Table 4.2, the two-year average error for this period was essentially constant, averaging about 21.5 knots.

Table 5 displays the absolute wind speed errors for the objective guidance from early models. Surprisingly, the interpolated GFS model had on average skillful intensity forecasts having the same or smaller intensity errors than the SHIFOR model at all forecast periods. This was the first time that a fully dynamic, global model demonstrated this kind of skill. GFSI also had smaller errors than the SHIPS model at nearly all forecast periods.

Eastern North Pacific

The eastern North Pacific 2002 hurricane season had twelve named tropical cyclones and four tropical depressions. This was four named tropical cyclones less than the long-term average and three less than the number that occurred in 2001. There were 275 official forecasts issued for tropical cyclones in this basin this year, slightly fewer than were issued last year. The average official forecast track errors by cyclone are listed in Table 6.1. Table 6.2 gives the average official, 5-day and 3-day CLIPER track errors for 2002 and for the previous ten-year average official and 3-day CLIPER errors. As shown in the departure portion of the Table, the east Pacific official forecast track errors were smaller than their ten-year average for all forecast periods by an average 20%. The corresponding 2002 CLIPER errors were nearly 2% larger their ten-year average for all time periods. Thus, the average 2002 official forecasts demonstrated increased skill at all forecast periods over their ten-year averages.

As in the Atlantic, the experimental day 4 and 5 official track forecasts were skillful, surpassing their average 5-day CLIPER errors by 47%. The average official track error for the past two years is shown in the last section of Table 6.2. Though not as close as the Atlantic, the 2002 day 4 and 5 average track errors were similar to their two-year average error. Also for the east Pacific basin, the two-year average error at day 4 and 5 increased at essentially the same linear rate as the error between the initial time and 3 days. The east Pacific average track error growth rate was nearly a third less than the Atlantic.

Homogeneous comparisons of selected late east Pacific track guidance models are shown in Table 7.1. Unlike the Atlantic this year where the Navy NOGAPS model was the best model, the NCEP GFS model had the smallest track errors from 36 hours to the end of the forecast period. For the 12 and 24 forecast periods, the GFDL model average errors were within 6 nm of the GFS model. As shown in the second section of this Table, the NCEP GFS ensemble mean track had smaller errors than the control GFS model run from the 36 to 72 hour forecast period and was within 2 nm of the control at the earlier periods. 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, through the 96 hours. The GUNS model had the second smallest average error until the 48 hour forecast period, after which the interpolated GFS model, GFSI, had smaller track errors. Ultimately, GFSI had the smallest average track error at day 5.

Table 8.1 gives the 2002 average official absolute wind speed errors by storm. The average official, 5-day and 3-day SHIFOR absolute wind speed errors for 2001 and the previous ten-year average official and 3-day SHIFOR errors are given in Table 8.2. As in the Atlantic, the official intensity errors showed skill over the SHIFOR models for all forecast periods. From the departure section of the Table, it can be seen that the official forecast intensity errors were slightly larger than their ten-year averages by 3% when averaged across the five forecast periods. The corresponding 3-day SHIFOR errors were also 3% larger their ten-year average when averaged in the same manner. Thus, the 2002 absolute intensity official forecasts may have been worse, on average, because this season’s tropical cyclones were more difficult to predict.

For 2002 the 4 and 5 day absolute intensity errors appeared to become smaller after 3 days as do the SHIFOR errors. Nevertheless, as shown in the last section of Table 8.2, when averaged with the 2001 results, the two-year average error for this period is essentially constant, averaging 18.2 knots for days 3 through 5. This result is similar to the two-year Atlantic average intensity errors at day 4 and 5.

The absolute wind speed errors for the objective guidance from early models are given in Table 9. The SHIPS model and its decay version had the smallest absolute intensity errors, except at the 36 and 48 hour forecast periods when the 5-day SHIFOR model had smaller errors. There is little difference between the intensity forecasts of the SHIPS and decay SHIPS since very few tropical cyclones had forecast tracks over land. These intensity models all had smaller errors at day 4 and 5 than at day 3. The statistically based objective intensity guidance appeared to have a similar error growth rate pattern as the official absolute intensity error.

2002 Conclusions

1. Like last year, the 2002 North Atlantic and eastern North Pacific official track forecasts through 3 days had skill over the 3-day and 5-day CLIPER models and had errors smaller than their ten-year average errors at all forecast periods.

2. The Navy NOGAPS model had the smallest average track errors of the late models for the Atlantic for all forecast periods. For the east Pacific basin, the GFDL model had the smallest average track errors through 24 hours with the NCEP GFS model smaller afterwards.

3. The NCEP GFS ensemble mean track forecast had the smallest errors of the late models for the east Pacific, even surpassing the GFS control run from the 36 to 72 hour forecast periods. It did not perform as well in the Atlantic basin.

4. For the early models, the consensus models of GUNS and GUNA had the smallest track errors for the Atlantic basin at all forecast periods. GUNA was 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 forecast through 72 hours in the Atlantic and through 96 hours in the east Pacific.

5. The 2002 North Atlantic and eastern North Pacific official absolute intensity errors showed skill over the 3-day and 5-day SHIFOR forecasts. The Atlantic intensity errors were smaller than their ten-year average through 48 hours, while the east Pacific errors were larger between the 24 and 48 hour forecast periods.

6. For the first time in the Atlantic basin, the interpolated GFS model had skillful average intensity forecasts at all forecast periods. SHIPS model and its decay version provided the best early objective intensity guidance for the east Pacific basin.

Day 4 and 5 Experimental Forecast Conclusions

These conclusions are based on limited number of cases of forecasting tropical cyclones at day 4 and 5 for 2001 and 2002.

1. The official Atlantic and east Pacific average track forecasts for day 4 and 5 forecasts had skill relative to the 5-day CLIPER model. The errors at these longer forecast periods had nearly the same error growth rate as the track error between initial time and 3 days. This error growth rate for the east Pacific was nearly a third less than that growth rate for the Atlantic basin.

2. For both basins, the forecast track guidance was excellent at these longer forecast periods, especially from NCEP GFS model and the new consensus models.

3. The official Atlantic and east Pacific absolute intensity errors for the day 4 and 5 forecasts, while showing skill over the 5-day SHIFOR model, became essentially constant after day 3 for the Atlantic and day 2 for the east Pacific basins.

4. In general, SHIPS model and its decay version provided the best early objective intensity guidance for the Atlantic and eastern Pacific basins. It was unusual that the interpolated GFS model provided excellent intensity forecasts at all forecast periods for the Atlantic in 2002.

Discussion of Absolute Intensity Error Growth Rate at Day 4 and 5

When the last two years are averaged for both basins, there appears a tendency for the official forecast and the statistically based objective intensity forecasts average absolute intensity errors to approach constant values at the longer forecast periods. This behavior is quite different from the track errors whose growth rate is nearly linear across all the forecast periods. Many explanations have been proposed to explain this effect.

One explanation proposes that there are simply not enough cases at these longer forecast periods to determine the true nature of the error growth rate.

Another thought claims that this constant error at the longer forecast periods was due to the verification procedure. This procedure captures the tropical cyclone intensification properly from depression to hurricane stage, but essentially ends when the tropical cyclone dissipates at sea, transitions to an extratropical system or makes landfall. This becomes especially relevant at the longer forecast periods. Perhaps a better approach would be to verify all tropical cyclone intensities, using a background or environment constant value of 10 or 15 knots when no best track value is defined. Exactly how extratropical transition would be handled in this regard remains problematic.

A third theory suggests that there is no inherent skill in intensity forecasting at the longer forecast periods. This occurs because tropical cyclone intensity is essentially bounded between 25 knots at a minimum and 160 knots at a maximum. At the longer forecast periods, the intensity forecasts simply converge to a climatological mean.

These explanations or others will require more cases and investigation before the cause of this apparent constant absolute intensity error growth rate at these longer forecast periods can be resolved.

Final Conclusion

Based on the last two years of successful forecasting tropical cyclone tracks and intensities at day 4 and 5, NHC will begin issuing official tropical cyclone track and intensity forecasts at these extended periods beginning with the 2003 hurricane season.

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

2002 OFFICIAL AVERAGE TRACK FORECAST ERRORS (NM) BY STORM

FORECAST ERRORS (NM) FOR al012002 ARTHUR

	00	12	24	36	48	72	96	120
OFCL	2.9	65.8	100.9	104.3	73.1			
#CASES	9	7	5	3	1	0	0	0

FORECAST ERRORS (NM) FOR al022002 BERTHA

	00	12	24	36	48	72	96	120
OFCL	12.6	37.4	66.2	101.1	163.3			
#CASES	12	10	8	6	1	0	0	0

FORECAST ERRORS (NM) FOR al032002 CRISTOBAL

	00	12	24	36	48	72	96	120
OFCL	10.5	50.9	109.2	241.1	409.1	461.2		
#CASES	13	11	9	7	5	1	0	0

FORECAST ERRORS (NM) FOR al042002 DOLLY

	00	12	24	36	48	72	96	120
OFCL	7.4	51.8	81.1	115.5	147.7	227.9	310.3	429.0
#CASES	25	23	21	19	17	13	9	5

FORECAST ERRORS (NM) FOR al052002 EDOUARD

	00	12	24	36	48	72	96	120
OFCL	4.7	28.5	57.9	77.4	83.5	171.2	245.2	
#CASES	20	18	16	14	12	8	4	0

FORECAST ERRORS (NM) FOR al062002 FAY

	00	12	24	36	48	72	96	120
OFCL	8.5	56.3	77.3	104.1	179.8			
#CASES	8	8	6	4	2	0	0	0

FORECAST ERRORS (NM) FOR al072002 SEVEN

	00	12	24	36	48	72	96	120
OFCL	6.2	42.7	97.4					
#CASES	5	3	1	0	0	0	0	0

FORECAST ERRORS (NM) FOR al082002 GUSTAV

	00	12	24	36	48	72	96	120
OFCL	15.7	50.0	67.6	67.4	102.9	209.0		
#CASES	16	14	12	10	8	4	0	0

FORECAST ERRORS (NM) FOR al092002 HANNA

	00	12	24	36	48	72	96	120
OFCL	7.0	54.6	112.4	189.1	219.8	187.9		
#CASES	12	12	11	9	7	3	0	0

FORECAST ERRORS (NM) FOR al102002 ISIDORE

	00	12	24	36	48	72	96	120
OFCL	2.8	34.0	62.1	74.9	99.1	168.7	242.4	329.8
#CASES	42	40	37	35	34	33	29	25

FORECAST ERRORS (NM) FOR al112002 JOSEPHINE

	00	12	24	36	48	72	96	120
OFCL	8.1	33.1	35.2	47.8				
#CASES	7	5	3	1	0	0	0	0

FORECAST ERRORS (NM) FOR al122002 KYLE

	00	12	24	36	48	72	96	120
OFCL	6.3	40.0	67.9	101.3	140.6	227.5	337.6	431.2
#CASES	88	86	84	82	80	76	70	64

FORECAST ERRORS (NM) FOR al132002 LILI

	00	12	24	36	48	72	96	120
OFCL	9.8	33.1	60.8	88.7	117.0	148.9	169.3	269.5
#CASES	45	42	38	34	32	28	25	25

FORECAST ERRORS (NM) FOR al142002 FOURTEEN

	00	12	24	36	48	72	96	120
OFCL	8.6	63.8	145.6	245.5	379.0			
#CASES	10	8	6	4	2	0	0	0

TABLE 2.2

NORTH ATLANTIC

2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	7.3	41.4	72.2	103.7	137.5	200.1	282.2	375.8	(nm)
CLIP	8.9	56.5	113.3	177.1	243.3	384.7			(nm)
CLP5	8.9	55.3	113.6	185.7	256.2	413.9	574.9	724.5	(nm)
#CASES	312	287	257	228	201	166	137	119	

1992 - 2001 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	12.1	45.2	82.4	117.8	153.1	230.3			(nm)
CLIP	12.2	53.8	108.8	168.5	229.2	343.7			(nm)
#CASES	2990	2800	2583	2371	2149	1752	0	0	

2002 OFFICIAL AND CLIPER AVERAGE ERROR DEPARTURE
FROM THE 1992 - 2001 OFFICIAL AND CLIPER AVERAGE TRACK ERROR

PERIOD	00	12	24	36	48	72	(hr)
OFCL DEPARTURE	-40	-08	-12	-12	-10	-13	(%)
CLIP DEPARTURE	-27	+05	+04	+05	+06	+12	(%)

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

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	7.7	42.8	74.6	105.9	140.0	208.6	282.1	374.1	(nm)
CLP5	9.0	56.1	115.7	184.8	253.5	391.2	552.6	702.6	(nm)
#CASES	651	589	520	465	418	336	265	216	

TABLE 3.1

NORTH ATLANTIC

2002 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (SELECTED LATE)

PERIOD	00	12	24	36	48	72	96	120
OFCL	6.0	38.6	70.7	102.1	128.6	182.8	259.9	311.3
CLP5*	8.0	53.5	110.9	180.5	253.4	404.0	526.0	579.2
GFS	16.8	45.2	72.4	102.7	125.8	189.1	278.1	383.4
GFDL	11.1	43.0	70.8	98.5	126.6	187.1	268.0	402.0
UKM	20.3	44.7	68.5	102.6	125.4	173.9	282.3	334.7
NGPS	25.0	40.7	61.4	86.2	110.5	163.0	235.2	265.2
#CASES	138	129	116	101	79	60	44	29

NORTH ATLANTIC

2002 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (SELECTED LATE)

PERIOD	00	12	24	36	48	72	96	120
OFCL	5.6	36.3	66.3	94.0	111.2	185.1		
CLP5*	7.4	52.2	108.0	179.1	258.6	419.7		
GFS	16.1	43.9	70.0	97.4	108.6	179.8		
GEMN	17.5	44.5	74.7	100.2	116.4	181.0		
GFDL	10.7	40.9	67.1	89.1	106.8	179.7		
UKM	20.2	44.2	64.0	101.9	115.9	175.4		
NGPS	25.0	39.0	59.1	80.6	94.6	152.6		
AFW1	19.4	52.0	87.3	117.1	135.4	237.0		
#CASES	120	111	99	85	64	51	0	0

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

TABLE 3.2

NORTH ATLANTIC

2002 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (EARLY)

PERIOD	00	12	24	36	48	72	96	120
OFCL	6.4	40.6	69.9	97.6	120.2	179.6	237.8	308.3
CLP5	8.3	54.0	111.3	181.3	248.1	416.3	533.9	619.9
A98E	8.3	50.3	85.4	128.0	172.1	321.0	388.8	453.5
BAMD	8.3	53.5	94.9	141.4	179.9	294.2	377.2	482.5
BAMM	8.3	44.6	77.1	110.7	140.1	228.0	303.5	395.1
BAMS	8.3	55.0	93.9	125.6	149.5	208.0	258.2	323.2
LBAR	8.3	47.5	84.8	126.7	166.8	268.2	318.7	471.3
OFCI	8.4	46.6	79.3	109.7	129.4	196.5	269.2	332.4
GFSI	8.4	46.4	78.9	109.5	134.4	219.9	310.4	411.5
GFDI	8.4	44.8	75.1	108.8	134.8	213.6	294.3	468.0
UKMI	8.4	47.4	82.6	120.3	134.9	192.8	329.2	387.3
NGPI	8.4	48.4	71.7	107.2	132.1	206.4	285.8	358.7
GUNS	8.4	41.7	67.7	97.0	111.8	167.9	244.5	320.7
GUNA	8.4	40.7	66.3	94.0	110.3	169.8	242.3	319.9
#CASES	241	226	205	180	143	109	73	53

TABLE 4.1

NORTH ATLANTIC

2002 OFFICIAL AVERAGE ABSOLUTE WIND SPEED FORECAST ERRORS (KT) BY STORM

FORECAST ERRORS (KT) FOR al012002 ARTHUR

	00	12	24	36	48	72	96	120
OFCL	0.6	4.3	7.0	5.0	5.0			
#CASES	9	7	5	3	1	0	0	0

FORECAST ERRORS (KT) FOR al022002 BERTHA

	00	12	24	36	48	72	96	120
OFCL	2.5	7.0	7.5	7.5	5.0			
#CASES	12	10	8	6	1	0	0	0

FORECAST ERRORS (KT) FOR al032002 CRISTOBAL

	00	12	24	36	48	72	96	120
OFCL	1.9	2.7	3.9	3.6	5.0	0.0		
#CASES	13	11	9	7	5	1	0	0

FORECAST ERRORS (KT) FOR al042002 DOLLY

	00	12	24	36	48	72	96	120
OFCL	0.0	4.6	8.8	11.6	14.4	14.6	11.7	12.0
#CASES	25	23	21	19	17	13	9	5

FORECAST ERRORS (KT) FOR al052002 EDOUARD

	00	12	24	36	48	72	96	120
OFCL	0.5	3.6	5.9	7.1	10.8	17.5	22.5	
#CASES	20	18	16	14	12	8	4	0

FORECAST ERRORS (KT) FOR al062002 FAY

	00	12	24	36	48	72	96	120
OFCL	3.1	11.9	17.5	13.8	12.5			
#CASES	8	8	6	4	2	0	0	0

FORECAST ERRORS (KT) FOR al072002 SEVEN

	00	12	24	36	48	72	96	120
OFCL	0.0	3.3	5.0					
#CASES	5	3	1	0	0	0	0	0

FORECAST ERRORS (KT) FOR al082002 GUSTAV

	00	12	24	36	48	72	96	120
OFCL	2.2	5.0	6.7	9.0	11.9	22.5		
#CASES	16	14	12	10	8	4	0	0

FORECAST ERRORS (KT) FOR al092002 HANNA

	00	12	24	36	48	72	96	120
OFCL	4.2	3.8	3.6	4.4	7.1	6.7		
#CASES	12	12	11	9	7	3	0	0

FORECAST ERRORS (KT) FOR al102002 ISIDORE

	00	12	24	36	48	72	96	120
OFCL	1.0	7.5	13.8	19.3	25.9	38.3	48.8	45.4
#CASES	42	40	37	35	34	33	29	25

FORECAST ERRORS (KT) FOR al112002 JOSEPHINE

	00	12	24	36	48	72	96	120
OFCL	0.0	4.0	6.7	5.0				
#CASES	7	5	3	1	0	0	0	0

FORECAST ERRORS (KT) FOR al122002 KYLE

	00	12	24	36	48	72	96	120
OFCL	0.4	4.0	7.1	9.6	12.2	14.5	13.1	13.3
#CASES	88	86	84	82	80	76	70	64

FORECAST ERRORS (KT) FOR al132002 LILI

	00	12	24	36	48	72	96	120
OFCL	1.8	8.2	12.5	12.6	13.1	22.9	21.8	31.6
#CASES	45	42	38	34	32	28	25	25

FORECAST ERRORS (KT) FOR al142002 FOURTEEN

	00	12	24	36	48	72	96	120
OFCL	1.0	5.0	13.3	18.8	27.5			
#CASES	10	8	6	4	2	0	0	0

TABLE 4.2

NORTH ATLANTIC

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

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	1.1	5.5	9.0	11.3	14.5	20.8	22.4	23.8	(kt)
SHFR	1.5	7.4	12.0	15.6	18.0	22.0			(kt)
SHF5	1.5	7.5	12.5	16.7	19.6	24.6	27.4	24.6	(kt)
#CASES	312	287	257	228	201	166	137	119	

1992 - 2001 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	2.8	6.3	10.1	13.0	15.6	19.3			(kt)
SHFR	2.8	8.2	12.7	16.1	19.1	22.5			(kt)
#CASES	2991	2794	2572	2357	2127	1749	0	0	

2002 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR DEPARTURE
FROM THE 1992 - 2001 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR

PERIOD	00	12	24	36	48	72	(hr)
OFCL DEPARTURE	-61	-13	-11	-13	-07	+08	(%)
SHFR DEPARTURE	-46	-10	-06	-03	-06	-02	(%)

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	649	587	519	464	418	336	265	216	

TABLE 5

NORTH ATLANTIC

2002 AVERAGE MODEL ABSOLUTE WIND SPEED ERROR (KT)
FOR A HOMOGENEOUS SAMPLE (EARLY)

PERIOD	00	12	24	36	48	72	96	120
OFCL	1.1	5.4	8.8	10.8	14.1	20.8	23.3	26.2
SHF5	1.6	7.6	12.3	16.6	20.1	25.4	28.0	24.3
OFCI	1.6	6.7	9.0	11.7	15.0	20.9	23.0	26.9
SHIP	1.6	7.5	11.8	15.3	18.9	26.7	32.4	35.1
DSHP	1.6	6.9	9.8	12.8	16.6	24.5	28.8	32.3
GFDI	1.6	9.5	13.7	16.3	18.3	24.7	28.9	38.5
GFSI	1.6	7.6	11.4	14.7	17.7	21.6	23.1	23.0
#CASES	263	246	221	193	165	133	107	82

TABLE 6.1

EAST PACIFIC

2002 OFFICIAL AVERAGE TRACK FORECAST ERRORS (NM) BY STORM

FORECAST ERRORS (NM) FOR ep012002 ALMA

	00	12	24	36	48	72	96	120
OFCL	10.4	36.6	56.9	67.6	77.4	110.4	214.0	244.4
#CASES	32	30	28	26	24	20	16	12

FORECAST ERRORS (NM) FOR ep022002 BORIS

	00	12	24	36	48	72	96	120
OFCL	8.6	36.5	73.2	133.5	216.2	279.2		
#CASES	13	11	9	7	5	1	0	0

FORECAST ERRORS (NM) FOR ep032002 THREE

	00	12	24	36	48	72	96	120
OFCL	20.6	80.6	105.2	184.5				
#CASES	8	6	4	2	0	0	0	0

FORECAST ERRORS (NM) FOR ep042002 CRISTINA

	00	12	24	36	48	72	96	120
OFCL	12.6	35.2	54.4	68.6	82.6	104.6	114.0	155.7
#CASES	30	28	26	24	22	18	14	10

FORECAST ERRORS (NM) FOR ep052002 DOUGLAS

	00	12	24	36	48	72	96	120
OFCL	8.4	40.2	61.0	80.1	77.6	163.6	284.7	435.4
#CASES	25	23	21	19	17	13	9	5

FORECAST ERRORS (NM) FOR ep062002 ELIDA

	00	12	24	36	48	72	96	120
OFCL	5.9	27.1	52.0	63.0	68.1	79.7	104.7	154.3
#CASES	27	27	25	23	21	17	13	9

FORECAST ERRORS (NM) FOR ep072002 SEVEN

	00	12	24	36	48	72	96	120
OFCL	20.5	63.8	68.2	68.1				
#CASES	8	6	4	2	0	0	0	0

FORECAST ERRORS (NM) FOR ep082002 FAUSTO

	00	12	24	36	48	72	96	120
OFCL	5.4	25.4	44.4	59.1	78.7	122.4	189.8	276.2
#CASES	26	26	24	22	20	16	14	10

FORECAST ERRORS (NM) FOR ep092002 GENEVIEVE

	00	12	24	36	48	72	96	120
OFCL	8.1	36.7	56.8	76.6	91.4	123.5	206.7	367.5
#CASES	26	24	22	20	18	14	10	6

FORECAST ERRORS (NM) FOR ep102002 HERNAN

	00	12	24	36	48	72	96	120
OFCL	6.1	28.0	47.3	69.6	97.2	134.8	144.5	126.1
#CASES	30	28	26	24	22	18	14	10

FORECAST ERRORS (NM) FOR ep112002 ELEVEN

	00	12	24	36	48	72	96	120
OFCL	10.4	49.5	99.4	150.5	183.4			
#CASES	12	10	8	6	4	0	0	0

FORECAST ERRORS (NM) FOR ep122002 ISELLE

	00	12	24	36	48	72	96	120
OFCL	10.9	40.0	73.8	118.4	162.7	266.3	471.8	
#CASES	20	18	16	14	12	8	4	0

FORECAST ERRORS (NM) FOR ep132002 JULIO

	00	12	24	36	48	72	96	120
OFCL	8.3	70.3	140.6					
#CASES	5	3	1	0	0	0	0	0

FORECAST ERRORS (NM) FOR ep142002 KENNA

	00	12	24	36	48	72	96	120
OFCL	3.2	28.0	40.1	65.9	92.6	173.8	425.0	
#CASES	17	15	13	11	9	5	1	0

FORECAST ERRORS (NM) FOR ep152002 LOWELL

	00	12	24	36	48	72	96	120
OFCL	2.8	42.1	76.7	116.4	151.5	206.4	213.9	208.3
#CASES	13	13	13	13	13	13	8	8

FORECAST ERRORS (NM) FOR ep162002 SIXTEEN

	00	12	24	36	48	72	96	120
OFCL	6.6	39.2	97.2	153.3	257.9			
#CASES	9	7	5	3	1	0	0	0

TABLE 6.2

EAST PACIFIC

2002 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	8.6	36.4	59.6	81.4	99.0	137.4	191.4	227.9	(nm)
CLIP	9.7	43.7	83.5	128.2	166.5	241.4			(nm)
CLP5	9.7	45.5	90.3	138.3	182.3	270.1	371.5	418.9	(nm)
#CASES	301	275	245	216	188	143	103	70	

1992 - 2001 OFFICIAL AND CLIPER AVERAGE TRACK ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	11.9	38.6	72.0	104.6	135.1	193.4			(nm)
CLIP	12.0	41.7	81.2	124.5	167.6	247.5			(nm)
#CASES	3340	3156	2898	2609	2343	1869	0	0	

2002 OFFICIAL AND CLIPER AVERAGE ERROR DEPARTURE
FROM THE 1992 - 2001 OFFICIAL AND CLIPER AVERAGE TRACK ERROR

PERIOD	00	12	24	36	48	72	(hr)
OFCL DEPARTURE	-27	-06	-17	-22	-27	-29	(%)
CLIP DEPARTURE	-19	+05	+03	+03	-01	-02	(%)

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	

TABLE 7.1

EAST PACIFIC

2002 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (SELECTED LATE)

PERIOD	00	12	24	36	48	72	96	120
OFCL	8.6	34.7	55.4	73.4	91.3	127.4	183.0	182.1
CLP5*	9.6	45.5	91.4	138.9	179.3	259.7	349.8	394.0
GFS	18.0	42.0	58.9	76.7	87.6	125.0	156.1	162.0
GFDL	12.5	36.7	57.8	78.5	101.0	147.7	204.2	231.2
UKM	21.4	40.3	64.3	89.5	108.4	142.0	192.9	232.4
NGPS	25.7	41.2	69.5	87.1	104.9	162.9	220.6	256.2
#CASES	125	112	96	87	73	53	36	19

EAST PACIFIC

2002 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (SELECTED LATE)

PERIOD	00	12	24	36	48	72	96	120
OFCL	8.2	34.8	54.0	71.7	89.8	117.6		
CLP5*	9.3	44.3	91.7	141.2	181.1	262.5		
GFS	17.6	41.7	56.0	73.4	86.0	120.2		
GEMN	18.1	41.7	58.0	69.1	78.0	101.8		
GFDL	12.0	35.9	56.7	78.2	102.0	147.3		
UKM	22.1	40.9	65.1	88.7	106.3	136.3		
NGPS	25.7	40.7	68.2	85.2	105.1	161.6		
AFW1	29.7	65.7	83.7	99.3	120.1	142.5		
#CASES	110	99	85	78	66	47	0	0

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

TABLE 7.2

EAST PACIFIC

2002 AVERAGE MODEL TRACK ERROR (NM)
FOR A HOMOGENEOUS SAMPLE (EARLY)

PERIOD	00	12	24	36	48	72	96	120
OFCL	7.6	31.6	54.5	71.8	83.5	125.4	173.5	173.0
CLP5	8.2	41.3	89.1	135.9	177.4	275.8	365.5	404.4
P91E	8.2	39.3	82.5	121.2	145.7	203.9	257.8	253.6
BAMD	8.2	41.7	73.5	98.3	112.5	156.3	195.9	232.5
BAMM	8.2	35.9	62.5	84.2	99.5	137.7	161.5	175.8
BAMS	8.2	41.6	71.2	95.5	115.7	166.3	214.2	248.8
LBAR	8.2	34.9	65.2	101.5	132.4	206.0	237.7	261.4
OFCI	8.2	33.3	58.9	78.5	94.5	141.0	185.4	188.8
GFSI	8.2	34.8	59.4	75.5	86.0	128.0	156.7	174.8
GFDI	8.2	35.0	65.7	91.8	113.0	161.2	220.8	240.4
UKMI	8.2	36.7	68.1	93.3	118.2	164.4	195.8	254.5
NGPI	8.2	39.5	69.1	92.4	114.9	177.7	219.1	252.7
GUNS	8.2	31.5	56.9	78.4	98.6	143.6	186.9	225.3
GUNA	8.2	29.4	51.1	68.1	83.1	118.1	155.3	185.0
#CASES	201	197	186	165	140	107	61	32

TABLE 8.1

EAST PACIFIC

2002 OFFICIAL AVERAGE ABSOLUTE WIND SPEED FORECAST ERRORS (KT) BY STORM

FORECAST ERRORS (KT) FOR ep012002 ALMA

	00	12	24	36	48	72	96	120
OFCL	2.0	5.7	10.2	12.5	14.4	14.8	16.3	22.9
#CASES	32	30	28	26	24	20	16	12

FORECAST ERRORS (KT) FOR ep022002 BORIS

	00	12	24	36	48	72	96	120
OFCL	1.5	5.9	9.4	12.9	17.0	10.0		
#CASES	13	11	9	7	5	1	0	0

FORECAST ERRORS (KT) FOR ep032002 THREE

	00	12	24	36	48	72	96	120
OFCL	0.0	4.2	8.8	17.5				
#CASES	8	6	4	2	0	0	0	0

FORECAST ERRORS (KT) FOR ep042002 CRISTINA

	00	12	24	36	48	72	96	120
OFCL	0.8	5.5	8.3	11.7	15.2	20.0	16.1	6.0
#CASES	30	28	26	24	22	18	14	10

FORECAST ERRORS (KT) FOR ep052002 DOUGLAS

	00	12	24	36	48	72	96	120
OFCL	1.2	3.3	6.7	9.7	12.1	11.9	9.4	3.0
#CASES	25	23	21	19	17	13	9	5

FORECAST ERRORS (KT) FOR ep062002 ELIDA

	00	12	24	36	48	72	96	120
OFCL	1.9	8.7	17.4	20.2	18.1	15.9	13.5	13.9
#CASES	27	27	25	23	21	17	13	9

FORECAST ERRORS (KT) FOR ep072002 SEVEN

	00	12	24	36	48	72	96	120
OFCL	0.0	1.7	3.8	5.0				
#CASES	8	6	4	2	0	0	0	0

FORECAST ERRORS (KT) FOR ep082002 FAUSTO

	00	12	24	36	48	72	96	120
OFCL	3.1	7.5	12.7	15.2	18.3	25.9	18.6	19.5
#CASES	26	26	24	22	20	16	14	10

FORECAST ERRORS (KT) FOR ep092002 GENEVIEVE

	00	12	24	36	48	72	96	120
OFCL	0.2	4.6	8.9	10.8	11.4	20.0	33.0	41.7
#CASES	26	24	22	20	18	14	10	6

FORECAST ERRORS (KT) FOR ep102002 HERNAN

	00	12	24	36	48	72	96	120
OFCL	0.2	8.6	17.3	23.3	25.0	21.1	24.3	27.0
#CASES	30	28	26	24	22	18	14	10

FORECAST ERRORS (KT) FOR ep112002 ELEVEN

	00	12	24	36	48	72	96	120
OFCL	0.0	4.5	14.4	23.3	22.5			
#CASES	12	10	8	6	4	0	0	0

FORECAST ERRORS (KT) FOR ep122002 ISELLE

	00	12	24	36	48	72	96	120
OFCL	0.3	4.2	8.4	13.6	17.9	25.6	22.5	
#CASES	20	18	16	14	12	8	4	0

FORECAST ERRORS (KT) FOR ep132002 JULIO

	00	12	24	36	48	72	96	120
OFCL	3.0	1.7	20.0					
#CASES	5	3	1	0	0	0	0	0

FORECAST ERRORS (KT) FOR ep142002 KENNA

	00	12	24	36	48	72	96	120
OFCL	2.9	14.7	25.8	39.5	52.2	61.0	5.0	
#CASES	17	15	13	11	9	5	1	0

FORECAST ERRORS (KT) FOR ep152002 LOWELL

	00	12	24	36	48	72	96	120
OFCL	0.0	3.1	6.2	7.7	7.7	8.1	5.0	11.9
#CASES	13	13	13	13	13	13	8	8

FORECAST ERRORS (KT) FOR ep162002 SIXTEEN

	00	12	24	36	48	72	96	120
OFCL	0.0	1.4	3.0	3.3	5.0			
#CASES	9	7	5	3	1	0	0	0

TABLE 8.2

EAST PACIFIC

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	6.1	11.7	15.6	17.8	19.4	17.6	18.4	(kt)
SHFR	1.3	7.6	12.9	16.9	19.7	20.6			(kt)
SHF5	1.2	7.5	13.0	16.7	19.0	23.8	22.0	21.3	(kt)
#CASES	301	275	245	216	188	143	103	70	

1992 - 2001 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERRORS
FOR A HOMOGENEOUS SAMPLE

PERIOD	00	12	24	36	48	72	96	120	(hr)
OFCL	2.4	6.2	10.9	14.4	16.8	19.9			(kt)
SHFR	2.4	7.4	12.2	16.0	19.0	22.0			(kt)
#CASES	3340	3143	2862	2595	2317	1868	0	0	

2002 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR DEPARTURE
FROM THE 1992 - 2001 OFFICIAL AND SHIFOR AVERAGE ABSOLUTE WIND SPEED ERROR

PERIOD	00	12	24	36	48	72	(hr)
OFCL DEPARTURE	-50	-02	+07	+08	+06	-03	(%)
SHFR DEPARTURE	-46	+03	+06	+06	+04	-06	(%)

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	

TABLE 9

EAST PACIFIC

2002 AVERAGE MODEL ABSOLUTE WIND SPEED ERROR (KT)
FOR A HOMOGENEOUS SAMPLE (EARLY)

PERIOD	00	12	24	36	48	72	96	120
OFCL	1.3	6.3	12.1	16.2	18.2	19.3	18.9	18.7
SHF5	1.3	7.5	13.5	17.5	20.1	24.2	24.0	23.9
OFCI	1.3	7.6	12.9	16.8	19.1	20.2	19.5	21.8
SHIP	1.3	7.5	13.5	18.6	20.9	21.1	20.1	18.6
DSHP	1.3	7.4	13.3	18.6	20.9	21.1	20.1	18.6
GFDI	1.3	8.6	14.3	19.3	22.5	22.3	20.6	23.6
GFSI	1.3	10.8	20.2	28.0	33.9	38.0	38.5	38.2
#CASES	218	214	192	165	143	110	70	39