2004 National Hurricane Center Forecast Verification Report

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ABSTRACT

A verification of NHC official forecasts and model guidance for the 2004 hurricane seasons in the Atlantic and eastern North Pacific basins is presented. Track forecasts in both basins from 12-72 h set records for accuracy this year, although track skill has changed little over the past three seasons. The FSU super-ensemble provided the best guidance for both track and intensity in the Atlantic; however, this model generally arrives after the forecast has been made, limiting its usefulness in the forecast process. In the east Pacific, the best track guidance was provided by the GUNA and CONU consensus models. The only dynamical model to show consistent track forecast skill in the east Pacific was GFDI.

1. Introduction

For all operationally-designated tropical cyclones in the Atlantic and eastern North Pacific basins, the NHC issues an "official" forecast of the cyclone's center position and maximum 1-min surface wind speed. These forecasts are issued every 6 hours, and each contains projections valid 12, 24, 36, 48, 72, 96, and 120[1] h after the forecast's nominal initial time (0000, 0600, 1200, or 1800 UTC). At the conclusion of the season, the forecasts are evaluated by comparing the forecast positions and intensities to the corresponding post-storm derived "best track" positions and intensities for each cyclone. Forecasts are included only if the system was a tropical or subtropical cyclone at both the forecast and the verifying time; all other stages of development (e.g., extratropical, tropical wave, remnant low) are excluded. The verifications reported here

[1] NHC began making 96 and 120 h forecasts in 2001, although they were not released publicly until 2003.

include the depression stage. For verification purposes, forecasts associated with special advisories[2] supersede the original forecast issued for that synoptic time.

It is important to distinguish between *forecast error* and *forecast skill*. Track forecast error is defined as the great-circle distance between a cyclone's forecast position and the best track position at the forecast verification time. To assess the degree of *skill* in a set of track forecasts, the track forecast error can be compared with the error from CLIPER5[3], a climatology and persistence model that contains no information about the current state of the atmosphere (Neumann 1972, Aberson 1998). Errors from the CLIPER5 model are taken to represent a "no-skill"[4] level of accuracy that can be used as a baseline for evaluating other forecasts. If CLIPER5 errors are unusually low during a given season, for example, it indicates that that season's storms were inherently "easier" to forecast than normal or otherwise unusually well-behaved.

Forecast intensity error is defined as the absolute value of the difference between the forecast and best track intensity at the forecast verifying time. Skill in a set of intensity forecasts can be assessed using a model such as SHIFOR5 (Jarvinen and Neumann 1979, Knaff et al. 2003), the climatology and persistence model for intensity that is analogous to the CLIPER5 model for track.

Numerous objective forecast aids (guidance models) are available to help the NHC Hurricane Specialists in the preparation of their official track and intensity forecasts. Guidance models are characterized as either *early* or *late*, depending on

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[2] Special advisories are issued whenever an unexpected significant change has occurred or when watches or warnings are to be issued between regularly scheduled advisories.

[3] CLIPER5 and SHIFOR5 are 5-day versions of the original 3-day CLIPER and SHIFOR models.

[4] To be sure, some "skill", or expertise, is required to properly initialize the CLIPER model.

whether or not they are available to the Hurricane Specialist during the forecast cycle. For example, consider the 1200 UTC (12Z) forecast cycle, which begins with the 12Z synoptic time and ends with the release of the official forecast at 15Z. The 12Z run of the NWS/Global Forecast System (GFS) model is not complete and available to the forecaster until about 16Z, or about an hour after the forecast is released - thus the 12Z GFS would be considered a late model since it could not be used to prepare the 12Z official forecast. This report focuses on the verification of early models.

Multi-layer dynamical models are generally, if not always, late models. Fortunately, a simple technique exists to take the latest available run of a late model and adjust its forecast to apply to the current synoptic time and initial conditions. In the example above, forecast data for hours 6-126 from the previous (06Z) run of the GFS would be adjusted, or shifted, so that the 6-h forecast (valid at 12Z) would exactly match the observed 12Z position and intensity of the tropical cyclone. The adjustment process creates an "early" version of the GFS model for the 12Z forecast cycle that is based on the most current available guidance. The adjusted versions of the late models are known, for historical reasons, as *interpolated* models.

A list of models is given in Table 1. In addition to their timeliness, models are characterized by their complexity or structure; this information is contained in the table for reference, but a complete description of the various model types is beyond the scope of this report. Briefly, *dynamical* models forecast by solving the physical equations governing motions in the atmosphere. These may treat the atmosphere either as a single layer (two-dimensional) or as having many layers (three-dimensional), and their domains may cover the entire globe or be limited to specific regions. The interpolated versions of dynamical models are also sometimes referred to as dynamical models. *Statistical* models, in contrast, do not consider the physics of the atmosphere but instead are based on historical relationships between storm behavior and various other parameters. *Consensus* models are not true forecast models per se, but are merely combinations of results from other models. One way to form a consensus model is to simply average the results from a sample of models, but other, more complex techniques can give better results. The FSU super-ensemble, for example, weights its individual components on the basis of past performance.

Verifications for the Atlantic and eastern North Pacific basins are given in sections 2 and 3 below, respectively. Conclusions are summarized in section 4.

2. Atlantic Basin

a. 2004 season overview - Track

Table 2 presents the results of the NHC official track forecast verification for the 2004 season; along with results averaged for the previous 10-yr period 1994-2003. Mean track errors ranged from 33 n mi at 12 h to 295 n mi at 120 h. It is seen that mean official track forecast errors were smaller in 2004 than for the previous 10-yr period (by roughly 25%-30% out to 72 h), and in fact, all-time records for forecast accuracy were set at all time periods through 72 h. Over the past 15 years, 12-72 h track forecast errors have been reduced by 50% (Fig. 1). Fairly substantial northwest vector biases were noted in 2004 (i.e., the official forecast tended to fall to the northwest of the verifying position) of about 25-35% of the mean error magnitude. These biases were somewhat larger than the long-term generally westward biases.

Not only were the 12-72 h forecasts more accurate in 2004 than they had been over the previous decade, but the forecasts were also more skillful. A comparison of forecast errors relative to CLIPER5 shows that 12-72 h forecast skill was roughly 40% higher in 2004 than over the preceding decade. However, an examination of annual skill trends (Fig. 1) suggests that following a sharp increase in skill in the late 1990's, forecast skill has changed little over the past three seasons. The record low forecast errors set in 2004 are at least partly attributable to the nature of the season, which featured slowly moving storms as well as numerous storms traversing the deep tropics, i.e., systems typically associated with low CLIPER5 errors.

The NHC began making 96 and 120 h forecasts in 2001 (although they were not released publicly until 2003), so the "long-term" record for these forecast periods is rather short. Official track errors in 2004 for 96 and 120 h were somewhat smaller than the 2001-2003 period means, although the unusually low CLIPER5 errors in 2004 indicate that these longer-range forecasts were slightly less skillful in 2004 than in previous years (Fig. 1).

Table 3 presents a homogeneous[5] verification for a selection of early models for 2004. Results (in terms of skill) are presented graphically for selected models in Fig. 2. Among the dynamical models, the GFDI performed best overall in 2004, although the GFSI was very close behind, and in fact had slightly lower errors at 96 and 120 h. Using the 48 h error as a benchmark, this is the second year in a row that the GFDI was the best-performing dynamical model. The NGPI and GFNI performed relatively poorly at all time periods this year, while the UKMI performed poorly at the early times but was

[5] Verifications comparing different forecast models are referred to as *homogeneous* if each model is verified over an identical set of forecasts cycles. Only homogeneous model comparisons are presented in this report.

competitive at 72 h and beyond. The NGPI and GFNI performed so poorly, in fact, that they were beaten by the much simpler BAMM and BAMD models. The official forecast was better than all of these individual dynamical models at all time periods.

Consensus models generally outperform the individual models from which they are constructed, and this was true again in 2004. The consensus models were generally superior to the official forecast as well. The FSU super-ensemble had the lowest errors of all the early track guidance at all time periods. The GUNA consensus performed nearly as well, and has the advantage that it is available to the forecaster earlier than the super-ensemble. In fact, the super-ensemble generally arrives a short time *after* the forecast is prepared, limiting its usefulness. It is also worth noting that the FSU super-ensemble has as one of its components the previous NHC official forecast – blurring the distinction between objective guidance and the Hurricane Specialist's final subjective forecast.

Late model verifications are given in Tables 4a and 4b, for selected models that project to 120 h and 72 h, respectively. The latter sample is quite small and should not be used to draw conclusions about models that project to 120 h. Model performance of the late models is naturally similar to that of the interpolated-dynamical models discussed above. Of the late models, the GFS and GFDL models performed best in 2004. Of note is the lack of value in the GFS ensemble mean relative to the standard GFS run; this is attributable primarily to the reduced resolution of the GFS ensembles. It is also seen that the Canadian, Eta, and Air Force MM5 models performed relatively poorly in 2004.

b. 2004 season overview - Intensity

Table 5 presents the results of the NHC official intensity forecast verification for the 2004 season, along with results averaged for the preceding 10-yr period. Mean forecast errors ranged from about 7 kt at 12 h to nearly 23 kt at 120 h. The table shows that mean intensity errors in 2004 were mostly within about 10% of the previous 10-yr means, and that intensity biases were small. SHIFOR5 forecast errors in 2004 were mostly 10%-20% larger than their previous 10-yr means, which indicates that this year's storms were somewhat more difficult than normal to forecast. A review of annual errors and skill trends (Fig. 3) suggests that intensity forecast skill has improved slightly over the past few seasons, even though raw errors have remained nearly constant.

Table 6 presents a homogeneous verification for a selection of early intensity models for 2004. Results in terms of skill are presented graphically in Fig. 4. Of the dynamical models, only the two GFDL variants (GFDI and GFNI) were consistently skillful. The statistical DSHP model outperformed the GFDLs out to 72 h but did not do as well at the longer ranges. The official intensity forecast beat all of the guidance except for the FSU super-ensemble.

c. Verifications for individual storms

Forecast verifications for individual storms are given for reference in Table 7. Relative to the seasonal averages, relatively low track forecast errors occurred for Bonnie, Frances, Jeanne, and Karl, while Alex, Danielle, Lisa, and Nicole were not particularly well forecast. Forecasts for Charley and Ivan were near the average for the season.

While numerous records for accuracy were set in 2004, forecasts for Hurricane Charley garnered considerable attention for a perceived lack of accuracy, with many residents of the Charlotte Harbor area reported to have expressed surprise at the hurricane's landfall, despite the fact that a hurricane warning had been in effect there for 23 h. This surprise apparently resulted from an unwarranted focus on specific NHC forecast track positions issued in the final 24 h before landfall, which showed Charley's track intersecting the coastline in the Tampa area. Charley's landfall at Cayo Costa was about 60 n mi south as measured along the coastline from Tampa. Yet the forecast errors at Charley's landfall were not unusually large; the 12 h forecast verifying at 1800 UTC 13 August had an error of 29 n mi, better than 45% of all 12 h forecasts issued in 2004, and the 24 h error verifying at the same time was only 40 n mi, better than 64% of the 24 h forecasts issued in 2004. The potential for a large apparent landfall error had been anticipated; the NHC Tropical Cyclone Discussion product accompanying the initial Florida hurricane warning stated "Because Charley is expected to approach the west coast of Florida at a sharply oblique angle...it is unusually difficult to pinpoint Charley's landfall...as small errors in the track forecast would correspond to large errors in the location and timing of landfall." No one near the landfall location should have been unprepared for the arrival of Charley. Neither should they have been unprepared for a category 4 hurricane. The NHC intensity forecast made 24 h prior to landfall indicated that Charley would strengthen to category 3. NHC routinely recommends in off-season training sessions for decision makers to prepare for one category higher than the NHC is forecasting, due to known limitations in intensity forecast skill. Charley's rapid strengthening just prior to landfall well illustrates the need for such preparations.

Additional discussion on forecast performance for individual storms can be found in NHC Tropical Cyclone Reports available at http://www.nhc.noaa.gov/2004atlan.shtml.

3. Eastern North Pacific Basin

a. 2004 season overview – Track

Many of the trends noted above for track errors in the Atlantic were also evident in the eastern Pacific verifications. Table 8 presents the NHC official track forecast verification for the 2004 season; along with results averaged for the previous 10-yr period 1994-2003. Mean track errors range from 31 n mi at 12 h to 308 n mi at 120 h. Mean official track forecast errors were smaller in 2004 than for the previous 10-yr period (by roughly 20%-30% out to 72 h), and as in the Atlantic, all-time records for forecast accuracy were set through 72 h. Figure 5 (top panel) shows recent trends in track forecast accuracy for the eastern Pacific. Errors are down by about 1/3 over the past 15 years, a somewhat smaller improvement than what has occurred in the Atlantic over this period. Interestingly, however, raw track errors in the Atlantic and Pacific were very similar in magnitude in 2004. The 12-72 h forecasts were also more skillful in 2004 than they had been over the previous decade (Table 8). In spite of the record low errors, Fig. 5 suggests that there has been (at best) no increase in skill over the past three seasons; a similar plateau of skill was noted in the Atlantic.

Forecasts for the 96 and 120 h periods in 2004 were not as impressive. The 120 h track error in 2004 showed only modest skill (17%) and was 25% worse than the previous 3-yr mean. These forecasts also had a westerly bias of nearly 50% of the mean error magnitude. It should be noted, however, that there were only 45 verifying forecasts at 120 h, due to the relatively short life cycle of this year's Pacific cyclones, and therefore the results may not be representative.

Track guidance errors for the early models are given in Table 9. Skill comparisons are shown in Fig. 6. Only three models performed well, and two of these were consensus models[6]. Of the dynamical models, only the GFDI was consistently skillful. The GFSI was particularly disappointing, showing little or no skill at any time period, a result that is difficult to understand given the model's strong performance in the Atlantic. The strong performance of the consensus models CONU and GUNA is all the more remarkable for the generally dismal performance of the models they are constructed from. An examination of individual model biases is illustrative of the power of the consensus approach. The 48-h biases for the CONU members in 2004 were as follows: GFDI (332°/16 n mi), UKMI (324°/54 n mi), NGPI (006°/22 n mi), GFSI (233°/80 n mi), and GFNI (167°/25 n mi). Each quadrant of the compass is represented by at least one model, resulting in a significant cancellation of errors. The official forecast error in 2004 was quite close to that of the GFDI (perhaps by accident) as well as the consensus models (by design). The remainder of the early track guidance performed poorly in 2004.

A verification of late track models is given in Table 10. The GFDL performed best at most time periods by a fairly wide margin. Although the sample is quite small, the GFS ensemble mean in the eastern North Pacific did provide value over the standard GFS run.

b. 2004 season overview – Intensity

[6] The FSU super-ensemble is not available in the eastern North Pacific.

Table 11 presents the results of the NHC east Pacific intensity forecast verification for the 2004 season, along with results averaged for the preceding 10-yr period. Mean forecast errors ranged from about 7 kt at 12 h to nearly 19 kt at 120 h. These errors are comparable to the previous 10-yr means. SHIFOR5 forecast errors in 2004 were also comparable to their long-term means. A review of annual errors and skill scores (not shown) indicates that little net change in either intensity error or skill has occurred over the past 15 years. The leveling off of forecast error beyond 72 h is likely an artifact of the east Pacific climatology, in which many storms decay over cold water within a few days of genesis.

One item of concern is a systematic high bias in the official forecasts, reaching 7 kt at 120 h in 2004 (and 13.5 kt over the preceding three years); such a bias was not present in the SHIPS or GFDL guidance in 2004 and may indicate an overly aggressive forecast philosophy. In fact, the standard verification rules, which exclude the dissipating and remnant low stages of development from the verification sample, mask the true magnitude of this problem.

Table 12 presents a homogeneous verification for a selection of early intensity models for 2004. Results (in terms of skill) are presented graphically in Fig. 7. The GFDI and GFNI were not quite as skillful in the east Pacific as they were in the Atlantic. The best intensity guidance was SHIPS, which beat the official forecast by a small margin.

c. Verifications for individual storms

Forecast verifications for individual storms are given for reference in Table 13. Readers are referred to the Tropical Cyclone Reports for discussion of forecast issues specific to individual storms.

4. Summary

a. Atlantic

- OFCL track accuracy continued to improve. Forecasts from 12-72 h had record low errors. However, skill levels have changed little since 2002.
- OFCL track forecasts were better than all the dynamical guidance models, but not as good as the consensus models.
- The FSU super-ensemble provided the best track guidance. Improved timeliness would allow this model have more of an impact on the forecast process. The best dynamical guidance was provided by the GFDI, followed closely by GFSI.
- The FSU super-ensemble also provided the best intensity guidance. GFDL and DSHP errors were comparable.

b. Eastern North Pacific

- OFCL track errors continued a modest improvement trend, but skill levels have not improved over the past few seasons.
- GUNA and CONU, followed by GFDI, provided the best track guidance. OFCL track forecast skill was comparable to these models.

- GFSI had no track forecast skill. All of the global models performed poorly through 72 h.
- GFDL and SHIPS provided the only skillful intensity guidance. OFCL intensity errors and skill continue to show little long-term improvement. A significant high bias was present in official intensity forecasts in 2004.

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Table 1. National Hurricane Center forecasts and models.

ID	Name/Description	Type	Timeliness (E/L)	Parameters forecast
OFCL	Official NHC forecast			Trk, Int
GFDL	NWS/Geophysical Fluid Dynamics Laboratory model	Multi-layer regional dynamical	L	Trk, Int
GFSO	NWS/Global Forecast System (formerly Aviation)	Multi-layer global dynamical	L	Trk, Int
AEMN	GFS ensemble mean	Consensus	L	Trk, Int
UKM	United Kingdom Met Service model	Multi-layer global dynamical	L	Trk, Int
NGPS	Navy Operational Global Prediction System	Multi-layer global dynamical	L	Trk, Int
GFDN	Navy version of GFDL	Multi-layer regional dynamical	L	Trk, Int
CMC	Environment Canada global model	Multi-level global dynamical	L	Trk, Int
ETA	NWS/Eta	Multi-level regional dynamical	L	Trk, Int
AFW1	Air Force MM5	Multi-layer regional dynamical	L	Trk, Int
BAMS	Beta and advection model (shallow layer)	Single-layer trajectory	E	Trk
BAMM	Beta and advection model (medium layer)	Single-layer trajectory	E	Trk
BAMD	Beta and advection model (deep layer)	Single-layer trajectory	E	Trk
LBAR	Limited area barotropic model	Single-layer regional dynamical	E	Trk
A98E	NHC98 (Atlantic)	Statistical-dynamical	E	Trk
P91E	NHC91 (Pacific)	Statistical-dynamical	E	Trk
CLP5	CLIPER5 (Climatology and Persistence model)	Statistical baseline	E	Trk
SHF5	SHIFOR5 (Climatology and Persistence model)	Statistical baseline	E	Int
SHIP	Statistical Hurricane Intensity Prediction Scheme (SHIPS)	Statistical	E	Int
DSHP	SHIPS with inland decay	Statistical	E	Int

ID	Name/Description	Type	Timeliness (E/L)	Parameters forecast
OFCI	Previous cycle OFCL, adjusted	Interpolated	E	Trk, Int
GFDI	Previous cycle GFDL, adjusted	Interpolated-dynamical	E	Trk, Int
GFSI	Previous cycle GFS, adjusted	Interpolated-dynamical	E	Trk, Int
UKMI	Previous cycle UKM, adjusted	Interpolated-dynamical	E	Trk, Int
NGPI	Previous cycle NGPS, adjusted	Interpolated-dynamical	E	Trk, Int
GFNI	Previous cycle GFDN, adjusted	Interpolated-dynamical	E	Trk, Int
GUNA	Average of GFDI, UKMI, NGPI, and GFSI	Consensus	E	Trk
CONU	Average of at least 2 of GFDI, UKMI, NGPI, GFSI, and GFNI	Consensus	E	Trk
FSSE	FSU Super-ensemble	Weighted consensus	E	Trk, Int

Table 2. Homogenous comparison of official and CLIPER5 track forecast errors in the Atlantic basin for the 2004 season for all tropical and sub-tropical cyclones. Long-term averages are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
2004 mean OFCL error (n mi)	33	58	80	101	151	213	295
2004 mean CLIPER5 error (n mi)	43	91	146	201	311	413	495
2004 mean OFCL error relative to CLIPER5 (%)	-24%	-37%	-46%	-50%	-51%	-49%	-40%
2004 mean OFCL bias vector (°/n mi)	298/10	305/21	307/29	312/37	311/43	321/51	352/76
2004 number of cases	389	363	335	307	267	228	194
1994-2003 mean OFCL error (n mi)[a]	44	78	112	146	217	248	319
1994-2003 mean CLIPER5 error (n mi)[a]	53	107	166	226	333	521	671
1994-2003 mean OFCL error relative to CLIPER5 (%)[a]	-17%	-27%	-33%	-36%	-35%	-52%	-53%
1994-2003 mean OFCL bias vector (°/n mi)	263/7	271/12	279/17	294/21	276/28	071/8	128/22
1994-2003 number of cases	3172	2894	2636	2368	1929	421	341
2004 OFCL error relative to 1994-2003 mean (%)[a]	-26%	-27%	-29%	-31%	-30%	-14%	-7%
2004 CLIPER5 error relative to 1994-2003 mean (%)[a]	-19%	-15%	-12%	-11%	-6%	-21%	-26%

[a] Averages for 96 and 120 h are for the period 2001-2003.

Table 3. Homogenous comparison of Atlantic basin early track guidance models for 2004. Errors smaller than the NHC official forecast are shown in bold-face.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	29.4	50.8	69.9	93.4	136.6	182.0	251.8
CLP5	39.6	85.9	141.2	196.7	301.9	382.7	489.4
GFSI	33.2	56.7	79.4	102.8	156.5	202.7	296.1
GFDI	31.1	55.7	77.0	99.1	151.3	207.1	312.2
GFNI	37.8	68.0	96.6	131.1	188.1	243.7	340.1
UKMI	38.0	66.1	91.8	118.5	161.6	210.1	323.7
NGPI	37.3	66.6	93.0	124.9	189.0	250.2	354.7
GUNA	**29.3**	**49.8**	**67.0**	**86.6**	**125.0**	**170.5**	264.9
CONU	30.0	51.9	70.1	**91.0**	**130.5**	**178.1**	270.1
FSSE	**27.9**	**47.0**	**63.3**	**84.4**	**125.1**	**162.3**	**241.6**
BAMS	50.1	92.2	130.3	166.1	230.1	254.4	328.1
BAMM	38.8	65.4	92.0	120.6	184.8	227.0	320.3
BAMD	38.8	66.4	91.3	113.5	175.6	233.9	324.1
LBAR	33.7	59.4	87.0	117.5	188.8	261.6	383.5
A98E	36.9	65.9	93.8	126.4	239.0	342.2	483.5
# Cases	294	272	259	238	194	148	110

Table 4a. Homogenous comparison of Atlantic basin late track guidance models for 2004, for selected models with projections out to at least 120 h. Errors from CLP5, an early model, are shown for comparison. The smallest errors at each time period are displayed in bold-face.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
GFDL	**35.9**	**59.1**	79.8	98.3	**130.1**	182.7	270.6
GFDN	42.5	69.7	92.6	121.3	174.2	227.1	319.1
UKM	44.2	71.9	92.0	114.5	138.5	184.0	270.6
NGPS	42.7	70.3	92.2	120.4	173.7	223.9	317.0
GFSO	37.8	60.5	**78.4**	**96.9**	136.5	**177.6**	**258.5**
AEMN	42.2	63.3	78.6	98.2	141.3	192.1	280.1
CLP5	40.9	86.7	136.7	185.4	277.6	364.2	480.2
# Cases	149	137	122	112	91	69	59

Table 4b. Homogenous comparison of Atlantic basin late track guidance models for 2004, for selected models with projections out to at least 72 h. Errors from CLP5, an early model, are shown for comparison. The smallest errors at each time period are displayed in bold-face.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
GFDL	**26.1**	47.2	70.2	92.0	130.7		
GFDN	32.9	57.4	87.0	120.0	168.0		
UKM	30.6	53.7	81.7	100.5	128.3		
NGPS	33.7	54.6	81.8	106.6	161.2		
GFSO	28.8	**44.1**	59.8	75.1	**116.0**		
AEMN	32.5	45.5	**58.4**	**74.8**	123.2		
CMC	48.5	64.4	86.5	111.2	161.8		
ETA	38.9	74.1	108.7	139.0	171.7		
AFW1	52.3	80.0	110.5	144.0	227.6		
CLP5	32.4	76.4	122.0	157.5	247.4		
# Cases	64	61	56	51	41		

Table 5. Homogenous comparison of official and SHIFOR5 intensity forecast errors in the Atlantic basin for the 2004 season for all tropical and sub-tropical cyclones. Long-term averages are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
2004 mean OFCL error (kt)	7.4	10.2	12.4	13.9	17.0	19.8	22.6
2004 mean SHIFOR5 error (kt)	8.8	13.6	17.3	20.3	24.3	25.5	26.7
2004 mean OFCL error relative to SHIFOR5 (%)	-16%	-25%	-28%	-32%	-30%	-23%	-16%
2004 OFCL bias (kt)	0.8	0.5	0.2	-0.1	-0.4	-2.0	-3.1
2004 number of cases	389	363	335	307	267	228	194
1994-2003 mean OFCL error (kt)[a]	6.1	9.7	12.3	14.8	18.5	19.7	21.2
1994-2003 mean SHIFOR5 error (kt)[a]	7.9	12.2	15.5	17.9	20.8	24.1	23.1
1994-2003 mean OFCL error relative to SHIFOR5 (%)[a]	-23%	-21%	-21%	-17%	-11%	-18%	-8%
1994-2003 OFCL bias (kt)	-0.2	0.0	-0.1	-0.1	0.4	2.1	2.4
1994-2003 number of cases	3163	2886	2625	2356	1928	421	341
2004 OFCL error relative to 1994-2003 mean (%)[a]	21%	5%	1%	-6%	-8%	1%	7%
2004 SHIFOR5 error relative to 1994-2003 mean (%)[a]	11%	11%	12%	13%	17%	6%	16%

[a] Averages for 96 and 120 h are for the period 2001-2003.

Table 6. Homogenous comparison of Atlantic basin early intensity guidance models for 2004. Errors smaller than the NHC official forecast are shown in bold-face.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	8.0	10.9	13.1	13.7	15.0	19.7	25.9
SHF5	9.4	14.5	18.2	21.3	24.3	26.1	28.9
GFSI	10.3	15.8	18.9	22.2	26.8	31.6	36.6
GFDI	9.1	12.3	14.7	16.4	21.2	26.0	29.1
GFNI	9.6	13.7	15.9	17.9	20.3	20.4	26.9
UKMI	10.6	16.4	20.2	24.0	28.8	32.8	38.5
NGPI	10.6	15.6	18.6	20.8	24.3	27.3	33.4
SHIP	9.4	14.7	18.4	20.8	23.0	25.4	27.5
DSHP	8.6	12.3	14.4	15.2	18.4	29.9	36.5
FSSE	**7.8**	11.4	**12.9**	**13.0**	**13.6**	**17.1**	**24.6**
# Cases	243	224	216	198	161	116	97

Table 7. Official Atlantic track and intensity forecast verifications (OFCL) for 2004 by storm. CLIPER5 (CLP5) and SHIFOR5 (SHF5) forecast errors are given for comparison. Number of track and intensity forecasts are given by NT and NI, respectively. Units for track and intensity errors are n mi and kt, respectively.

Verification statistics for: AL012004 ALEX

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	24.0	5.2	5.9	24.0	1.3	1.5
012	22.0	43.6	60.1	22.0	10.5	9.9
024	20.0	73.9	143.9	20.0	14.0	15.4
036	18.0	104.0	237.9	18.0	20.3	18.3
048	16.0	162.9	304.7	16.0	27.8	19.7
072	12.0	257.4	504.5	12.0	40.0	25.3
096	8.0	260.4	740.0	8.0	42.5	27.8
120	2.0	221.6	626.5	2.0	42.5	27.5

Verification statistics for: AL022004 BONNIE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	18.0	6.4	7.0	18.0	0.0	0.3
012	16.0	42.6	48.3	16.0	7.8	8.4
024	14.0	75.1	135.3	14.0	10.4	15.2
036	11.0	86.6	284.8	11.0	11.8	22.3
048	9.0	78.4	434.6	9.0	10.6	26.7
072	5.0	105.7	795.8	5.0	8.0	41.2
096	2.0	594.6	612.6	2.0	7.5	40.5
120	5.0	1038.1	189.0	5.0	36.0	55.8

Verification statistics for: AL032004 CHARLEY

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	22.0	5.9	5.9	22.0	0.7	2.0
012	20.0	37.3	53.0	20.0	7.0	8.9
024	18.0	70.6	129.8	18.0	9.2	14.7
036	16.0	89.2	200.7	16.0	14.4	16.7
048	14.0	82.8	258.1	14.0	19.3	19.3
072	10.0	176.1	393.9	10.0	25.0	25.1
096	6.0	459.4	587.3	6.0	22.5	20.8
120	2.0	776.6	968.7	2.0	7.5	23.5

Verification statistics for: AL042004 DANIELLE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	33.0	5.9	6.5	33.0	0.6	1.4
012	31.0	36.5	47.0	31.0	6.1	6.5
024	29.0	64.6	104.1	29.0	10.5	12.8
036	27.0	103.3	176.7	27.0	13.3	18.7
048	25.0	147.7	260.4	25.0	16.0	23.4
072	21.0	231.7	424.4	21.0	22.6	34.2
096	17.0	332.2	547.0	17.0	23.5	39.0
120	13.0	451.8	666.5	13.0	22.7	37.3

Verification statistics for: AL052004 EARL

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	9.0	7.6	7.6	9.0	2.2	2.2
012	7.0	51.6	51.3	7.0	4.3	4.4
024	5.0	110.1	120.8	5.0	6.0	6.6
036	3.0	170.7	203.8	3.0	3.3	6.0
048	1.0	217.1	251.4	1.0	20.0	6.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL062004 FRANCES

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	53.0	4.5	6.0	53.0	2.5	2.8
012	53.0	19.9	27.3	53.0	6.5	8.0
024	53.0	36.1	57.7	53.0	10.4	13.0
036	53.0	52.3	95.6	53.0	12.9	16.8
048	52.0	65.8	143.8	52.0	14.9	21.2
072	48.0	79.6	266.1	48.0	14.3	27.1
096	44.0	100.2	402.3	44.0	13.9	29.3
120	40.0	128.3	535.4	40.0	16.3	25.4

Verification statistics for: AL072004 GASTON

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	15.0	4.4	5.1	15.0	3.7	3.3
012	13.0	18.8	35.0	13.0	7.7	9.8
024	11.0	35.6	76.3	11.0	12.7	19.6
036	9.0	53.9	110.3	9.0	11.7	26.3
048	9.0	66.2	165.5	9.0	6.7	29.9
072	7.0	159.5	321.5	7.0	5.0	32.0
096	3.0	258.3	347.8	3.0	10.0	22.7
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL082004 HERMINE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	7.0	3.1	4.0	7.0	2.9	4.3
012	5.0	32.0	77.0	5.0	3.0	9.0
024	3.0	110.5	209.8	3.0	5.0	15.7
036	1.0	158.2	330.3	1.0	10.0	18.0
048	0.0	-999.0	-999.0	0.0	-999.0	-999.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL092004 IVAN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	65.0	3.3	3.4	65.0	0.9	1.8
012	63.0	23.9	25.4	63.0	9.1	11.3
024	61.0	46.9	50.9	61.0	11.7	16.5
036	59.0	78.9	86.0	58.0	12.7	20.0
048	56.0	108.4	120.8	56.0	12.0	22.2
072	52.0	161.4	174.6	52.0	15.4	24.6
096	48.0	222.2	231.3	48.0	24.4	27.8
120	44.0	289.0	295.6	44.0	35.7	35.9

Verification statistics for: AL102004 TEN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	1.0	43.1	43.1	1.0	0.0	0.0
012	0.0	-999.0	-999.0	0.0	-999.0	-999.0
024	0.0	-999.0	-999.0	0.0	-999.0	-999.0
036	0.0	-999.0	-999.0	0.0	-999.0	-999.0
048	0.0	-999.0	-999.0	0.0	-999.0	-999.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL112004 JEANNE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	56.0	4.0	4.0	56.0	2.6	3.7
012	56.0	24.0	33.4	56.0	6.5	9.3
024	56.0	41.2	71.8	56.0	8.8	14.1
036	55.0	57.2	121.2	55.0	10.4	17.7
048	53.0	72.1	185.7	53.0	11.4	21.6
072	49.0	123.1	326.2	49.0	17.4	26.0
096	45.0	211.1	460.7	45.0	22.3	24.9
120	41.0	327.8	581.7	41.0	22.9	22.6

Verification statistics for: AL122004 KARL

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	33.0	9.9	9.9	33.0	2.9	2.7
012	31.0	37.4	52.1	31.0	10.6	10.9
024	29.0	64.7	112.6	29.0	11.2	13.8
036	27.0	83.9	189.4	27.0	10.7	14.8
048	25.0	101.0	265.2	25.0	12.6	16.1
072	21.0	117.7	395.6	21.0	16.0	21.4
096	17.0	125.2	498.4	17.0	13.2	23.0
120	13.0	147.2	549.4	13.0	11.2	21.9

Verification statistics for: AL132004 LISA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	54.0	12.6	12.5	54.0	3.6	3.5
012	52.0	43.7	54.1	52.0	6.8	7.3
024	50.0	74.7	106.7	50.0	9.4	10.1
036	48.0	98.6	163.0	48.0	12.8	12.9
048	44.0	129.7	212.4	44.0	13.2	14.3
072	42.0	198.7	282.6	42.0	14.0	11.6
096	38.0	245.6	399.0	38.0	15.1	13.7
120	34.0	325.0	523.1	34.0	14.6	15.1

Verification statistics for: AL142004 MATTHEW

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	8.0	2.8	6.5	8.0	1.9	3.8
012	7.0	42.0	56.3	7.0	5.7	9.7
024	5.0	63.0	63.7	5.0	4.0	7.4
036	3.0	123.0	138.5	3.0	5.0	20.3
048	1.0	229.0	308.0	1.0	10.0	23.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL152004 NICOLE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	7.0	14.0	14.8	7.0	0.7	0.7
012	5.0	100.4	116.8	5.0	3.0	4.2
024	3.0	163.9	279.2	3.0	6.7	5.7
036	1.0	143.5	384.9	1.0	10.0	18.0
048	0.0	-999.0	-999.0	0.0	-999.0	-999.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL162004 OTTO

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	8.0	5.1	5.1	8.0	0.6	1.3
012	8.0	33.5	54.1	8.0	2.5	5.3
024	6.0	70.9	144.4	6.0	2.5	4.8
036	4.0	103.4	278.6	4.0	5.0	8.8
048	2.0	159.0	394.4	2.0	5.0	4.5
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Table 8. Homogenous comparison of official and CLIPER5 track forecast errors in the eastern North Pacific basin for the 2004 season for all tropical and sub-tropical cyclones. Long-term averages are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
2004 mean OFCL error (n mi)	31	52	73	93	136	201	308
2004 mean CLIPER5 error (n mi)	36	69	103	140	211	295	373
2004 mean OFCL error relative to CLIPER5 (%)	-16%	-24%	-29%	-34%	-36%	-32%	-17%
2004 mean OFCL bias vector (°/n mi)	052/1	225/2	264/10	277/23	273/58	266/92	266/149
2004 number of cases	212	184	158	135	97	72	45
1994-2003 mean OFCL error (n mi)[a]	38	70	100	127	180	210	247
1994-2003 mean CLIPER5 error (n mi)[a]	42	85	130	177	256	341	401
1994-2003 mean OFCL error relative to CLIPER5 (%)[a]	-10%	-17%	-23%	-28%	-30%	-39%	-39%
1994-2003 mean OFCL bias vector (°/n mi)	307/5	316/8	318/13	319/20	327/27	153/41	173/62
1994-2003 number of cases	2746	2474	2196	1928	1476	283	179
2004 OFCL error relative to 1994-2003 mean (%)[a]	-20%	-26%	-28%	-27%	-24%	-4%	25%
2004 CLIPER5 error relative to 1994-2003 mean (%)[a]	-15%	-19%	-21%	-21%	-17%	-14%	-7%

[a] Averages for 96 and 120 h are for the period 2001-2003.

Table 9. Homogenous comparison of eastern North Pacific basin early track guidance models for 2004. Errors smaller than the NHC official forecast are shown in bold-face.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	27.3	45.2	65.8	84.1	119.3	183.1	287.7
CLP5	32.0	60.0	92.4	130.9	220.6	327.1	460.7
GFSI	36.6	63.3	95.5	132.3	212.8	323.8	476.7
GFDI	28.8	46.8	66.2	87.4	129.6	198.7	**255.8**
GFNI	40.2	68.2	90.9	108.4	147.8	208.0	351.9
UKMI	35.1	63.7	90.5	116.2	171.7	227.0	426.0
NGPI	35.9	61.2	85.6	107.0	148.3	199.7	**246.3**
GUNA	27.4	**44.8**	**61.4**	**80.1**	126.5	183.5	290.2
CONU	28.5	45.7	**61.6**	**77.4**	**117.4**	**174.8**	**281.6**
BAMS	39.4	67.0	102.7	143.4	253.7	406.6	617.1
BAMM	36.6	65.1	100.7	137.6	217.4	358.3	542.4
BAMD	41.9	77.7	117.4	158.3	237.8	333.5	447.6
LBAR	33.9	69.2	113.2	155.4	249.1	331.8	446.2
P91E	31.8	55.7	81.3	108.1	183.4	284.9	430.9
# Cases	154	124	111	93	64	37	20

Table 10. Homogenous comparison of eastern North Pacific basin late track guidance models for 2004, for selected models with projections out to at least 120 h. Errors from CLP5, an early model, are shown for comparison. The smallest errors at each time period are displayed in bold-face.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
GFDL	**31.5**	**45.2**	**66.9**	**79.5**	**121.4**	**177.2**	279.1
GFDN	42.1	71.6	96.6	123.0	148.0	216.8	294.0
UKM	45.8	67.9	90.0	115.8	160.3	259.8	328.6
NGPS	39.7	67.4	91.1	109.3	145.4	178.3	**218.6**
GFSO	43.3	60.2	82.8	110.7	185.0	327.7	467.8
AEMN	45.3	51.6	69.7	87.1	134.6	209.2	302.9
CLP5	32.8	63.7	96.2	143.9	246.2	352.5	450.5
# Cases	59	46	40	36	26	15	10

Table 11. Homogenous comparison of official and SHIFOR5 intensity forecast errors in the eastern North Pacific basin for the 2004 season for all tropical and sub-tropical cyclones. Long-term averages are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
2004 mean OFCL error (kt)	6.6	11.4	14.4	15.6	18.8	17.8	18.8
2004 mean SHIFOR5 error (kt)	7.6	13.0	16.3	17.2	21.2	20.7	21.5
2004 mean OFCL error relative to SHIFOR5 (%)	-13%	-13%	-12%	-9%	-12%	-14%	-13%
2004 OFCL bias (kt)	0.9	2.3	2.9	2.2	3.6	5.6	7.0
2004 number of cases	212	184	158	135	97	72	45
1994-2003 mean OFCL error (kt)[a]	6.0	10.7	14.5	17.1	19.9	18.2	18.8
1994-2003 mean SHIFOR5 error (kt)[a]	7.1	11.8	15.7	18.5	22.3	20.4	18.7
1994-2003 mean OFCL error relative to SHIFOR5 (%)[a]	-16%	-9%	-8%	-8%	-10%	-11%	0%
1994-2003 OFCL bias (kt)	0.3	0.8	0.9	0.2	1.9	11.5	13.5
1994-2003 number of cases	2736	2457	2186	1919	1478	283	179
2004 OFCL error relative to 1994-2003 mean (%)[a]	10%	7%	-1%	-9%	-6%	-2%	0%
2004 SHIFOR5 error relative to 1994-2003 mean (%)[a]	7%	10%	4%	-7%	-5%	1%	15%

[a] Averages for 96 and 120 h are for the period 2001-2003.

Table 12. Homogenous comparison of eastern North Pacific basin early intensity guidance models for 2004. Errors smaller than the NHC official forecast are shown in bold-face.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	6.7	12.1	15.4	15.7	17.5	18.6	16.9
SHF5	7.6	13.7	17.7	17.6	20.5	19.2	17.8
GFSI	9.7	17.2	23.5	26.1	28.0	28.0	33.4
GFDI	8.2	12.7	**15.3**	16.5	**16.8**	21.0	24.1
GFNI	6.8	12.4	17.1	18.0	19.5	**17.8**	33.5
UKMI	9.5	16.8	22.5	25.0	27.8	26.8	33.2
NGPI	9.4	16.8	22.4	24.0	26.9	27.4	31.3
SHIP	6.7	**12.0**	**14.7**	**14.4**	**16.7**	**16.7**	**14.7**
DSHP	6.7	**12.0**	**14.5**	**14.4**	**16.7**	**16.7**	**14.7**
# Cases	135	107	97	81	57	33	16

Table 13. Official eastern North Pacific track and intensity forecast verifications (OFCL) for 2004 by storm. CLIPER5 (CLP5) and SHIFOR5 (SHF5) forecast errors are given for comparison. Number of track and intensity forecasts are given by NT and NI, respectively. Units for track and intensity errors are n mi and kt, respectively.

Verification statistics for: EP012004 AGATHA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	10.0	11.5	11.7	10.0	2.0	2.0
012	8.0	26.2	45.7	8.0	7.5	9.4
024	6.0	46.2	109.1	6.0	13.3	15.2
036	4.0	67.4	188.9	4.0	11.3	12.5
048	2.0	110.8	259.4	2.0	5.0	0.5
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP022004 TWO

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	6.0	15.4	14.4	6.0	2.5	2.5
012	4.0	16.8	26.0	4.0	3.8	2.8
024	2.0	50.4	64.6	2.0	2.5	2.5
036	0.0	-999.0	-999.0	0.0	-999.0	-999.0
048	0.0	-999.0	-999.0	0.0	-999.0	-999.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP032004 BLAS

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	11.0	8.3	12.3	11.0	2.3	2.7
012	9.0	46.1	72.8	9.0	8.3	8.8
024	7.0	91.3	160.9	7.0	11.4	13.4
036	5.0	133.9	265.9	5.0	15.0	11.2
048	3.0	159.9	378.8	3.0	15.0	11.3
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP042004 CELIA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	28.0	5.1	5.8	28.0	3.6	2.9
012	26.0	30.0	27.4	26.0	5.4	6.5
024	24.0	59.6	50.4	24.0	7.9	10.4
036	22.0	90.9	84.9	22.0	8.4	12.3
048	20.0	116.8	117.8	20.0	7.8	11.9
072	15.0	163.8	208.8	15.0	7.7	18.7
096	12.0	207.8	282.2	12.0	6.3	17.3
120	8.0	284.0	304.1	8.0	9.4	20.1

Verification statistics for: EP052004 DARBY

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	21.0	5.8	6.3	21.0	1.2	2.1
012	21.0	19.3	26.8	21.0	7.1	9.4
024	19.0	35.9	55.8	19.0	11.3	16.7
036	17.0	57.6	89.2	17.0	12.9	22.1
048	15.0	80.5	126.9	15.0	14.7	25.3
072	11.0	127.4	115.8	11.0	21.4	26.0
096	7.0	206.2	188.9	7.0	30.7	26.9
120	3.0	332.9	296.2	3.0	40.0	33.3

Verification statistics for: EP062004 SIX

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	1.0	29.6	29.6	1.0	5.0	5.0
012	0.0	-999.0	-999.0	0.0	-999.0	-999.0
024	0.0	-999.0	-999.0	0.0	-999.0	-999.0
036	0.0	-999.0	-999.0	0.0	-999.0	-999.0
048	0.0	-999.0	-999.0	0.0	-999.0	-999.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP072004 ESTELLE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	8.0	0.0	0.0	8.0	0.0	0.0
012	8.0	35.7	34.8	8.0	4.4	6.0
024	8.0	60.4	64.9	8.0	10.6	11.8
036	8.0	83.4	78.7	8.0	13.1	15.6
048	8.0	130.9	93.8	8.0	13.8	16.0
072	8.0	220.1	159.2	8.0	21.3	24.9
096	6.0	228.6	178.9	6.0	24.2	25.5
120	2.0	328.6	229.1	2.0	30.0	34.5

Verification statistics for: EP082004 FRANK

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	12.0	14.9	14.9	12.0	0.4	1.3
012	10.0	32.2	37.8	10.0	7.5	12.3
024	8.0	53.5	73.9	8.0	18.1	24.3
036	6.0	63.2	84.6	6.0	21.7	28.2
048	4.0	65.3	71.9	4.0	21.3	19.8
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP092004 NINE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	12.0	5.2	4.2	12.0	0.8	0.4
012	10.0	27.0	40.1	10.0	1.5	2.9
024	8.0	54.9	94.4	8.0	5.0	4.9
036	6.0	91.2	173.3	6.0	9.2	7.8
048	4.0	135.3	300.0	4.0	8.8	8.8
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP102004 GEORGETTE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	17.0	11.6	11.9	17.0	0.3	0.6
012	15.0	29.7	41.1	15.0	6.0	6.0
024	13.0	44.5	78.1	13.0	9.6	8.7
036	11.0	56.5	120.9	11.0	11.8	10.8
048	9.0	57.8	160.2	9.0	12.2	12.0
072	5.0	40.8	308.0	5.0	20.0	21.6
096	1.0	101.8	450.7	1.0	10.0	36.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP112004 HOWARD

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	24.0	8.8	9.3	24.0	2.9	3.1
012	22.0	31.5	34.6	22.0	9.3	10.9
024	20.0	46.2	68.8	20.0	15.5	19.1
036	18.0	64.5	98.0	18.0	20.3	24.1
048	16.0	87.5	143.9	16.0	24.4	26.8
072	12.0	123.3	215.2	12.0	26.7	25.3
096	8.0	183.9	253.8	8.0	19.4	16.9
120	4.0	192.9	239.7	4.0	12.5	20.5

Verification statistics for: EP122004 ISIS

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	34.0	13.8	14.5	34.0	2.6	2.6
012	32.0	34.2	40.3	32.0	5.9	6.5
024	30.0	55.2	71.0	30.0	10.0	10.0
036	28.0	71.9	104.9	28.0	12.0	12.1
048	26.0	98.0	145.9	26.0	13.3	12.6
072	22.0	155.1	242.7	22.0	10.2	10.1
096	18.0	271.1	371.7	18.0	10.0	9.8
120	12.0	501.5	452.7	12.0	8.8	8.4

Verification statistics for: EP132004 JAVIER

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	36.0	4.6	5.0	36.0	0.6	1.3
012	34.0	24.0	27.3	34.0	7.9	7.9
024	32.0	42.5	50.6	32.0	14.7	13.9
036	30.0	60.2	78.0	30.0	19.2	17.6
048	28.0	71.2	114.9	28.0	21.6	20.3
072	24.0	104.6	223.3	24.0	27.5	27.5
096	20.0	136.8	315.2	20.0	25.0	29.8
120	16.0	196.4	413.2	16.0	27.2	28.3

Verification statistics for: EP142004 KAY

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	7.0	8.3	12.7	7.0	0.7	2.1
012	5.0	44.4	42.2	5.0	6.0	5.0
024	3.0	73.2	66.9	3.0	11.7	15.7
036	1.0	100.7	13.3	1.0	20.0	24.0
048	0.0	-999.0	-999.0	0.0	-999.0	-999.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP152004 LESTER

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	8.0	8.3	7.6	8.0	1.9	3.1
012	6.0	38.4	36.6	6.0	7.5	9.3
024	4.0	82.9	60.9	4.0	3.8	7.3
036	2.0	134.8	103.6	2.0	15.0	18.5
048	0.0	-999.0	-999.0	0.0	-999.0	-999.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP162004 SIXTEEN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	4.0	6.8	6.8	4.0	1.3	0.0
012	2.0	105.0	84.9	2.0	5.0	1.0
024	0.0	-999.0	-999.0	0.0	-999.0	-999.0
036	0.0	-999.0	-999.0	0.0	-999.0	-999.0
048	0.0	-999.0	-999.0	0.0	-999.0	-999.0
072	0.0	-999.0	-999.0	0.0	-999.0	-999.0
096	0.0	-999.0	-999.0	0.0	-999.0	-999.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

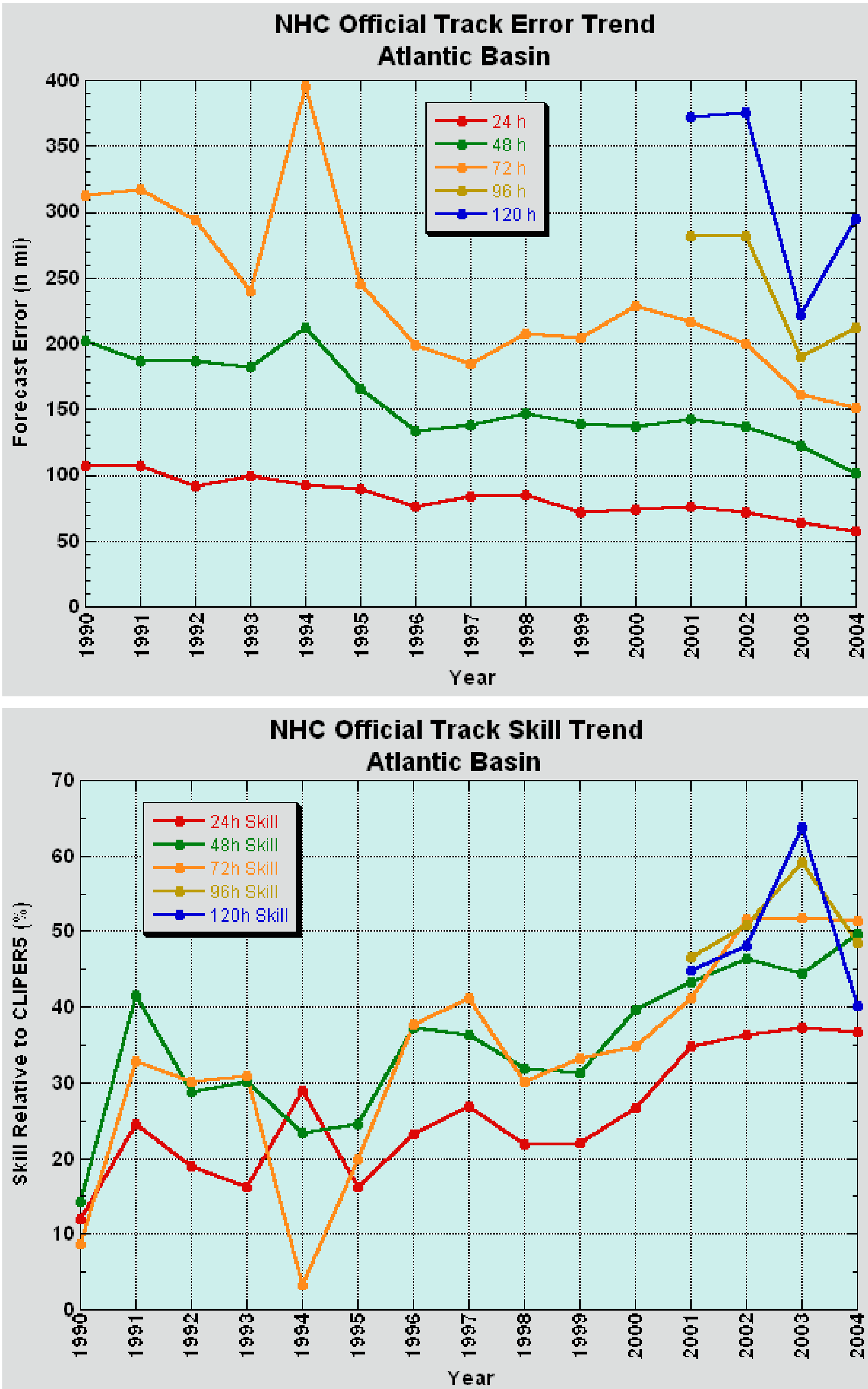


Figure 1. Recent trends in NHC official track forecast error (top) and skill (bottom) for the Atlantic basin.

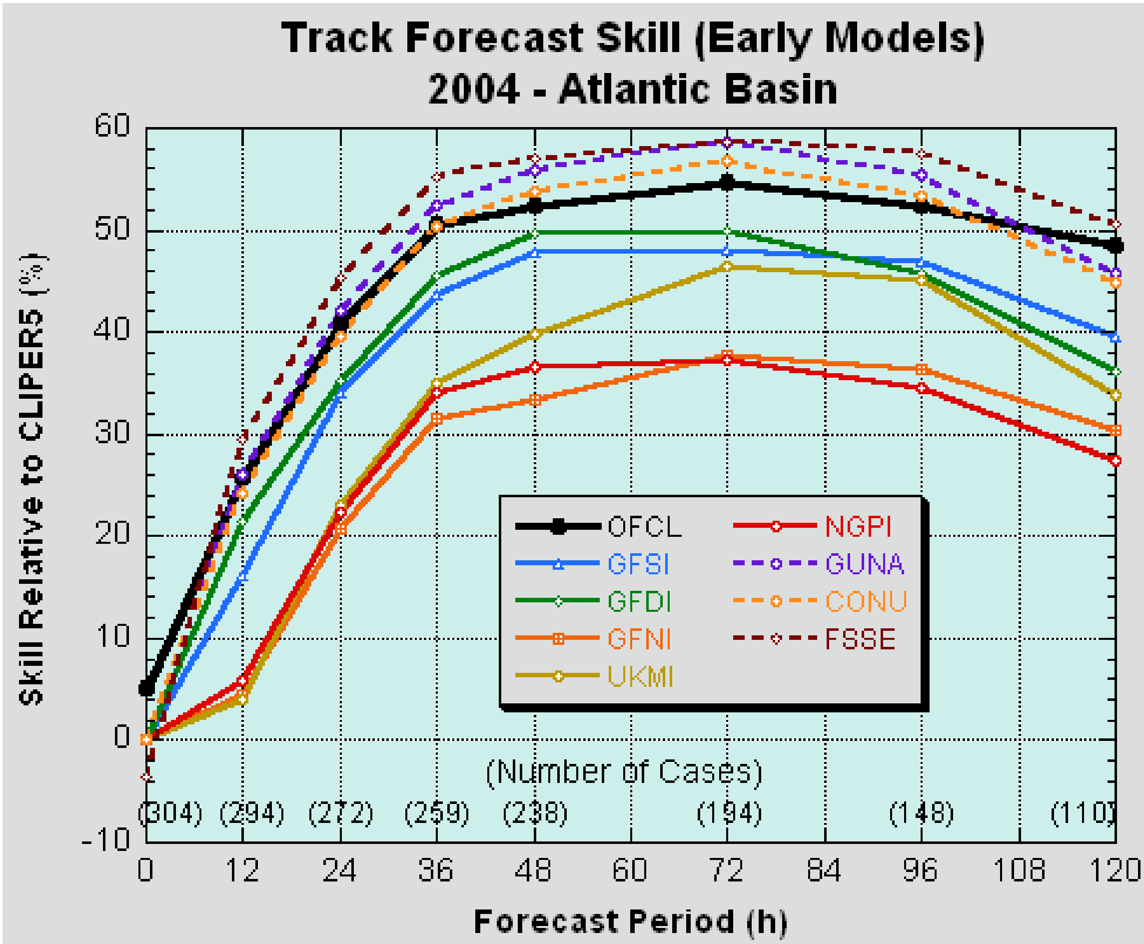
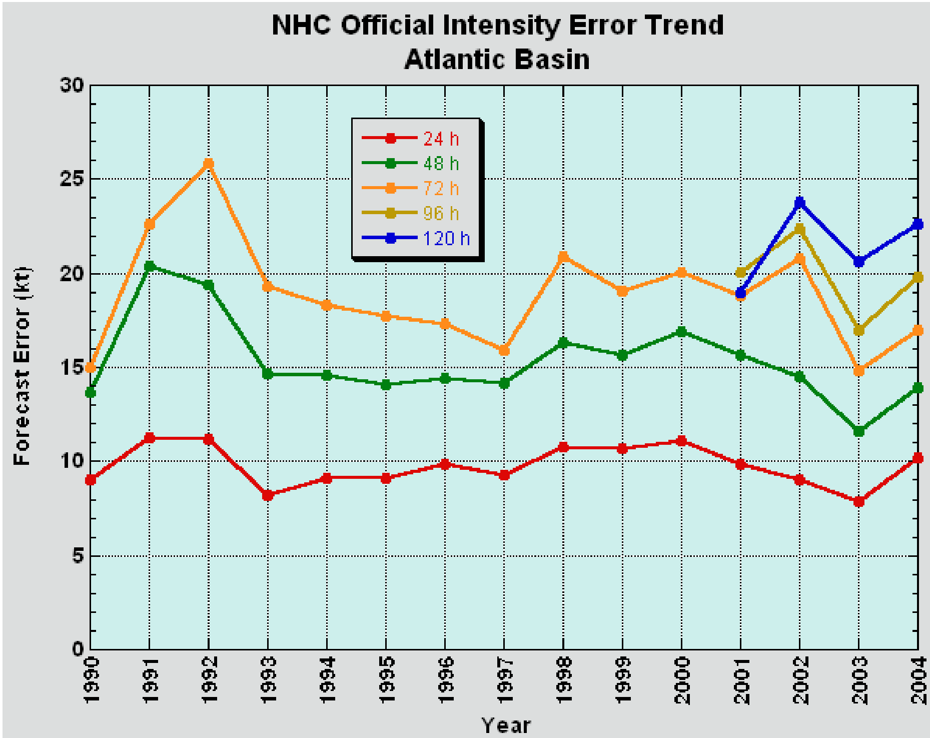


Figure. 2. Homogenous comparison for selected Atlantic basin early track guidance models for 2004.



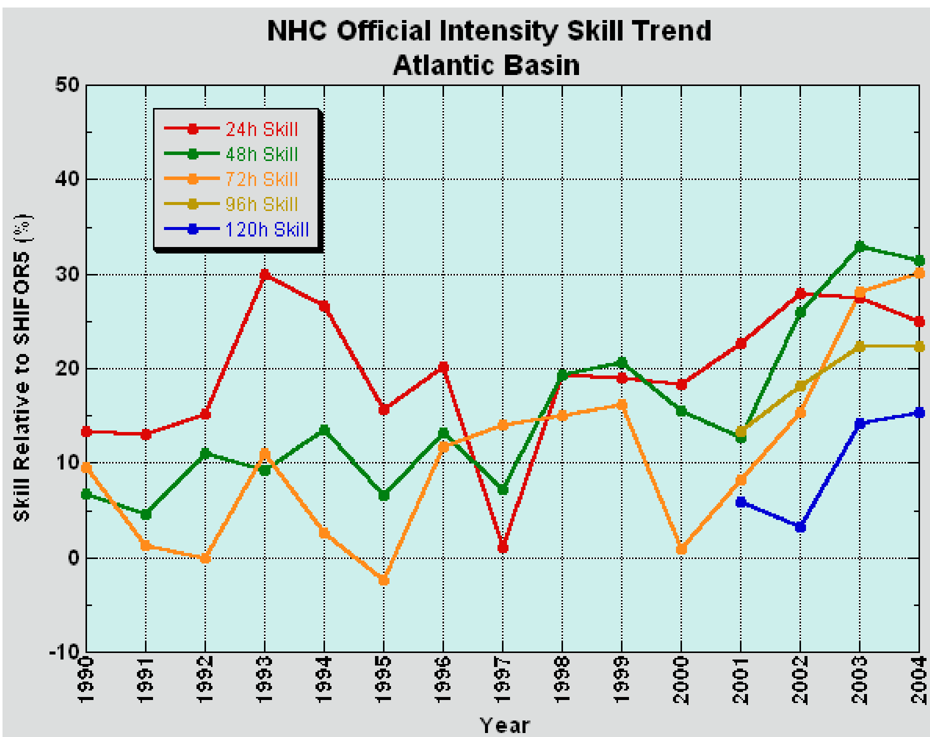


Figure 3. Recent trends in NHC official intensity forecast error (top) and skill (bottom) for the Atlantic basin.

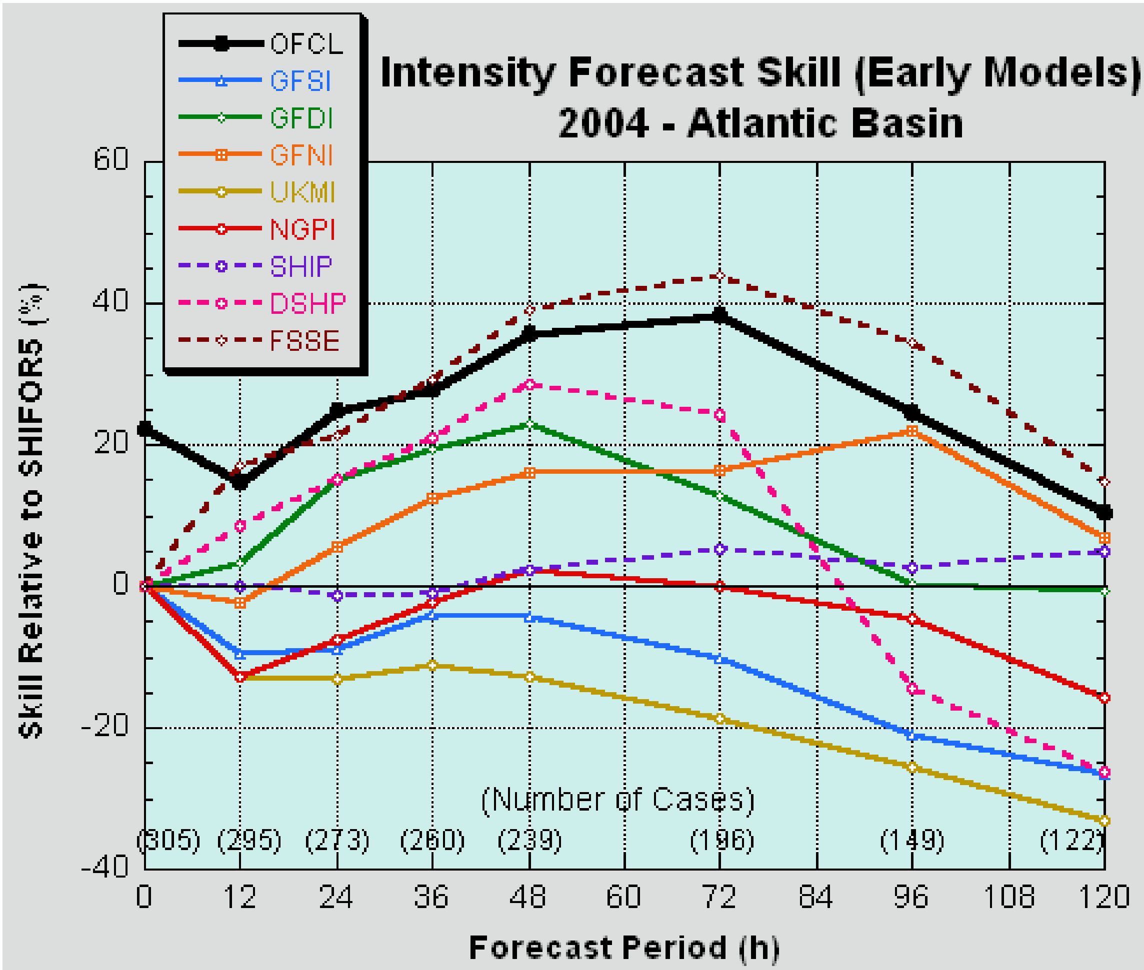


Figure. 4. Homogenous comparison for selected Atlantic basin early intensity guidance models for 2004.

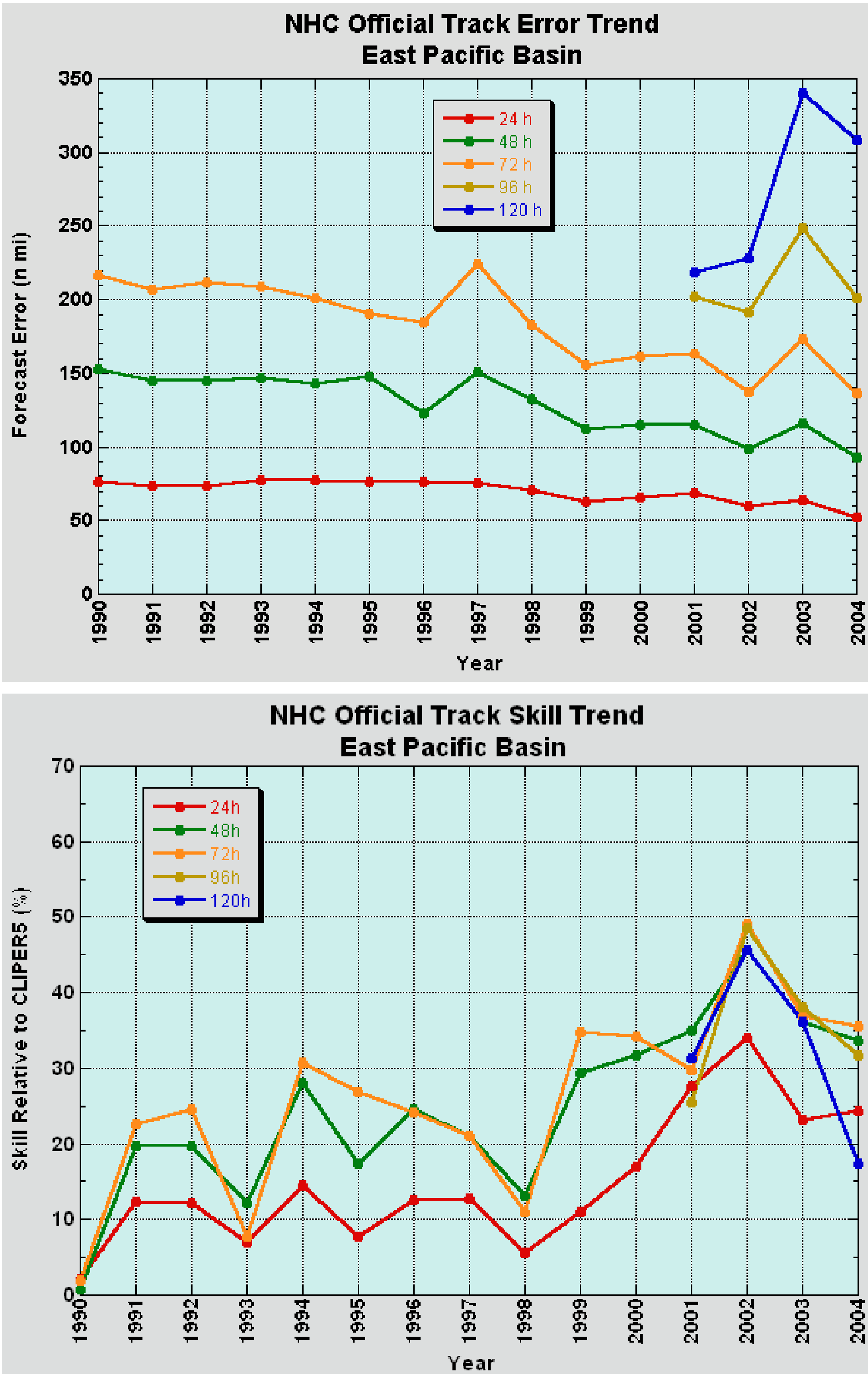


Figure 5. Recent trends in NHC official track forecast error (top) and skill (bottom) for the eastern North Pacific basin.

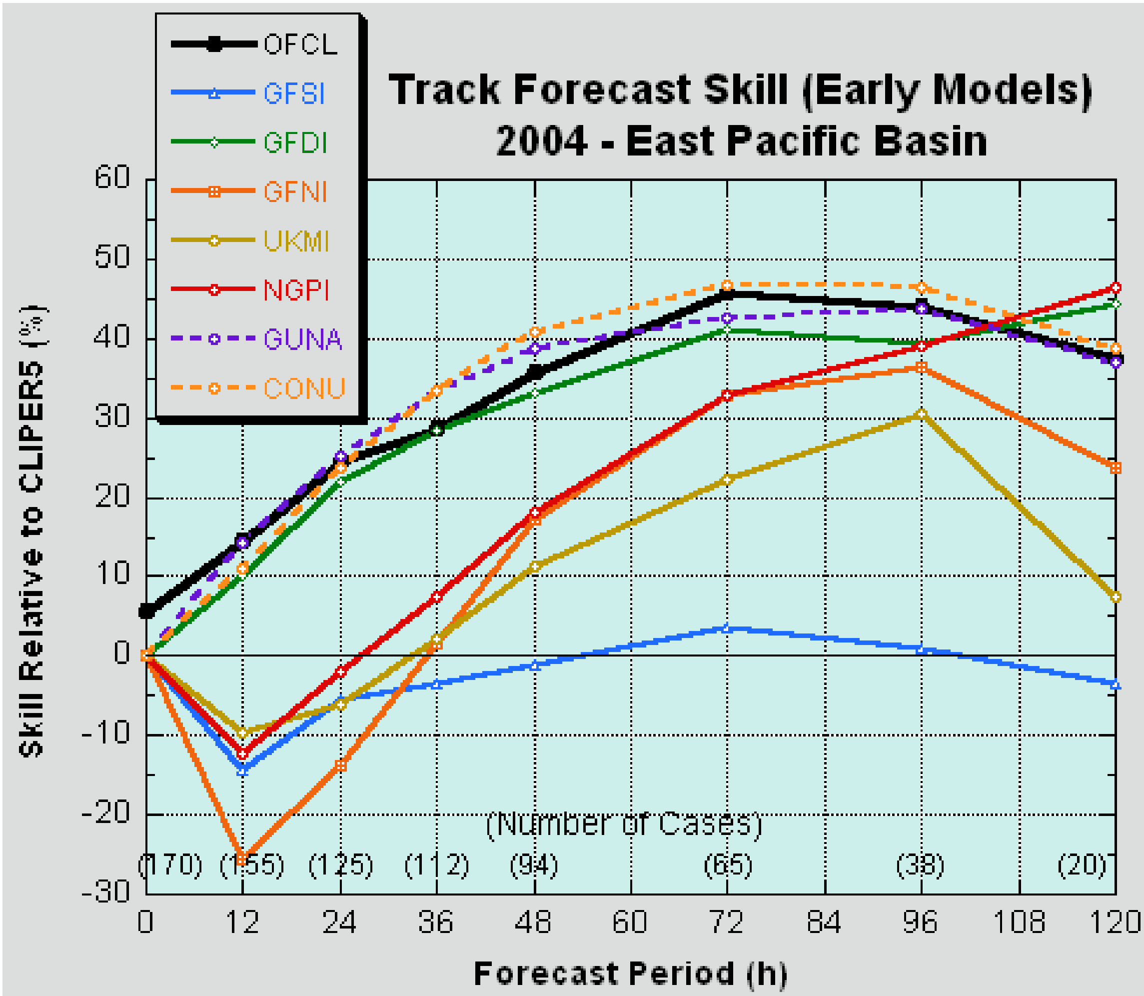


Figure. 6. Homogenous comparison for selected eastern North Pacific basin early track guidance models for 2004.

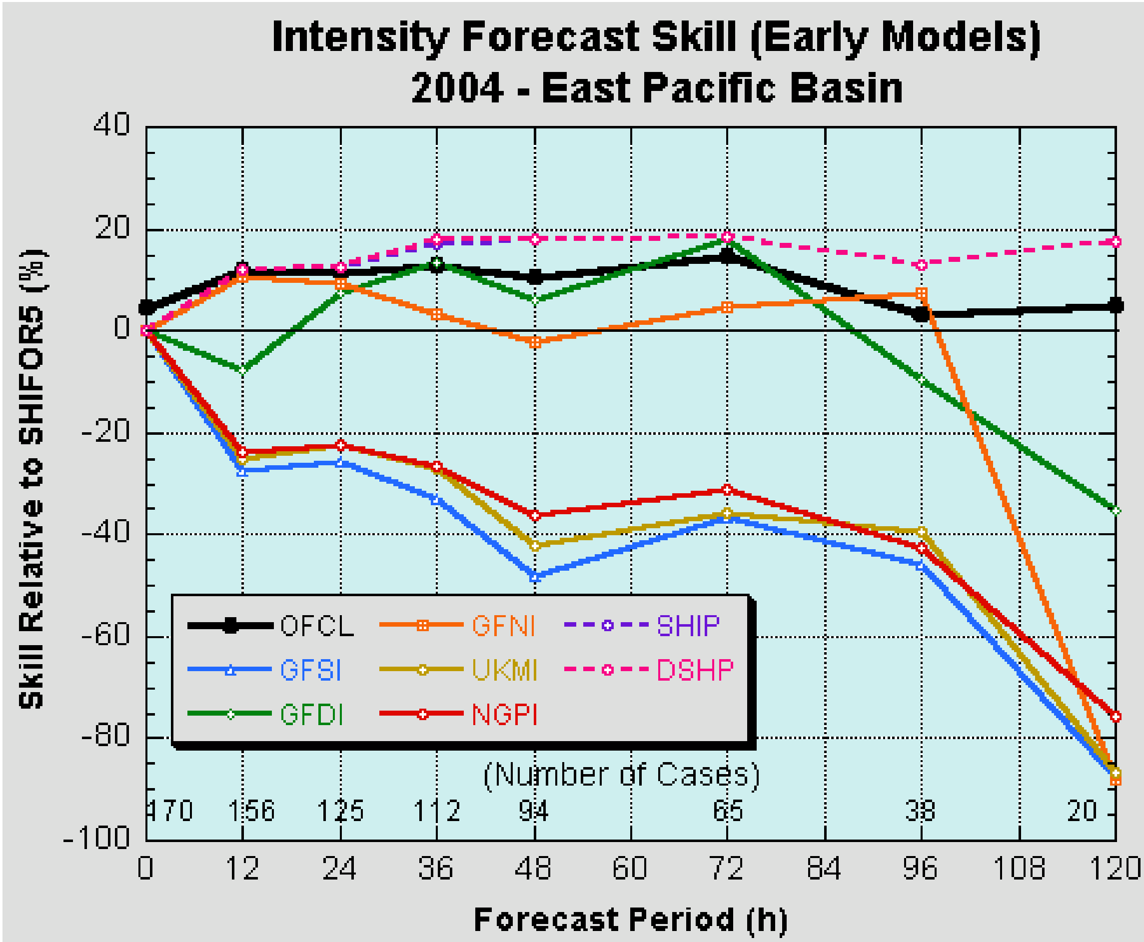


Figure. 7. Homogenous comparison for selected eastern North Pacific basin early intensity guidance models for 2004.