2005 National Hurricane Center Forecast Verification Report

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ABSTRACT

A verification of NHC official forecasts and model guidance for the 2005 hurricane seasons in the Atlantic and eastern North Pacific basins is presented. Forecast accuracy of official track forecasts was close to the record levels set in 2004 for the Atlantic and established new records for accuracy in the eastern Pacific. The official track forecasts consistently beat the dynamical guidance and also surpassed much of the consensus guidance. Intensity forecasts were of similar accuracy to those in previous years.

In both basins, the GUNA consensus provided the most accurate track guidance. Among the individual track guidance models, the GFDL provided the best shorter-range track forecasts in both basins. At the longer ranges, the UKMET and BAMM were strong performers in the Atlantic and eastern Pacific, respectively. For intensity, the statistical SHIPS and DSHP continue to lead the dynamical models, although even better results can be obtained from a DSHP/GFDI consensus.

1. Introduction

For all operationally-designated tropical cyclones in the Atlantic and eastern North Pacific basins, the National Hurricane Center (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

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

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 include the depression stage. For verification purposes, forecasts associated with special advisories[2] no longer supersede the original forecast issued for that synoptic time; rather, the original forecast is verified. This is a change in procedure from 2004.

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. Skill, on the other hand, represents a normalization of forecast error against some standard. Particularly useful standards are those that are independent of operations and can be applied retrospectively to historical data. 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 the year's storms were inherently "easier" to forecast than normal or otherwise unusually well-behaved.

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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.

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. While the SHIFOR5 model can be a useful benchmark, it will overestimate skill in cases where a storm interacts with (or is forecast to interact with) land. This is because there are no predictors having to do with land in the SHIFOR5 model. For example, when a major hurricane is close to landfall, it is fairly straightforward for the official forecast or a land-aware model such as the GFDL (Table 1) to anticipate weakening. SHIFOR5 on the other hand, will tend to maintain a high intensity after landfall, leading to very large SHIFOR5 errors and imply therefore a high degree of forecast skill in what was in reality a fairly easy forecast. A more appropriate intensity skill benchmark would be a SHIFOR-like model that also included a decay component. Such a model is presently under development.

Numerous objective forecast aids (guidance models) are available to help the NHC in the preparation of official track and intensity forecasts. Guidance models are characterized as either *early* or *late*, depending on whether or not they are available to the forecaster 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 an 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, although some late model information is included.

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, and attempts to correct for biases in those components.

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. 2005 season overview - Track

Table 2 presents the results of the NHC official track forecast verification for the 2005 season, along with results averaged for the previous 10-yr period 1995-2004. It was an extremely active season, and the NHC issued more Atlantic basin tropical cyclone forecasts in 2005 than in any previous year. Mean track errors ranged from 35 n mi at 12 h to 286 n mi at 120 h. It is seen that mean official track forecast errors were smaller in 2005 than for the previous 10-yr period (by roughly 15%-25% out to 72 h), and in fact, at forecast projections through 72 h the errors were close to the all-time lows set in 2004 (Franklin 2005). Since 1990, 24-72 h track forecast errors have been reduced by roughly 50% (Fig. 1). Fairly substantial vector biases were noted in 2005, with the official forecast tending to fall to the northwest of the verifying position through 72 h, and to the north and northeast of the verifying position at 4 and 5 days, respectively. These biases were about 10-35% of the mean error magnitude, somewhat larger than the long-term generally westward biases, and similar in magnitude to the biases noted in 2004. They also imply a general tendency to forecast too rapid a recurvature into the mid-latitude westerlies.

Not only were the 12-72 h forecasts more accurate in 2005 than they had been over the previous decade, but the forecasts were also more skillful. This was despite the fact that CLIPER5 errors during 2005 were slightly below normal from 12-72 h, indicating below normal forecast difficulty. 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 four seasons.

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 limited. Official track errors in 2005 for 96 and 120 h were somewhat smaller than the 2001-2004 period means, although unusually low CLIPER5 errors in 2005 at these forecast periods mean that these longer-range forecasts were less skillful in 2005 than in any previous year (Fig. 1).

Table 3a presents a homogeneous[5] verification for a selection of early models for 2005. To increase the sample size, a smaller collection of the better-performing models is given in Table 3b, and results in terms of skill for the second grouping are presented in Fig. 2. Figure 2 shows that among the dynamical models, the GFDI performed best overall out through 72 h, with the UKMI performing best at 96 and 120 h. Using the 48 h error as a benchmark, this is the third year in a row that the GFDI was the best-performing dynamical model. Some other aspects of model performance noted in 2004 were evident again in 2005. In particular, the UKMI was a weak performer from 12-48 h but strong at the longer ranges, while the GFNI continued to perform relatively poorly at all time periods. The NGPI, on the other hand, appeared to be somewhat improved over

[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.

2004 while the GFSI performance, in spite of significant off-season updates to the model, was down in 2005. It should be noted that overall, the conceptually simple BAM models were only competitive with the poorer-performing of the three-dimensional dynamical models (Table 3a).

Consensus models routinely outperform the individual models from which they are constructed, and this was true again in 2005. Historically, consensus models have also outperformed the official forecast, but in 2005 the official forecast beat the consensus models at some time periods. Overall, the GUNA consensus had the lowest errors of all the early track guidance. The FSU super-ensemble, which was the best consensus model during 2004, continued to do very well through 48 h, but was not as good as the simpler GUNA from 72-120 h. To be successful, the super-ensemble requires relatively constant model error characteristics. During 2004, both the GFS and GFDL were strong performers at the longer ranges, but both of these models performed relatively poorly at these ranges in 2005; this change may have had a negative impact on the super-ensemble during 2005. 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. The other multi-model consensus aid, CONU, differs from GUNA in that the former adds GFNI to the consensus, and it requires only two of the five possible member models to be present at any particular projection. The addition of the poor-performing GFNI caused the CONU errors to be slightly larger than GUNA in 2005. The advantage of CONU over GUNA, of course, is that it is available more often (CONU was available 90% of time at 120 h in 2005, as opposed to 49% of the time for GUNA). Finally, it is of interest to note that the GFS ensemble mean, AEMI, appeared to offer considerable value over the control GFSI at 72 h and beyond.

Although late models are not available to meet forecast deadlines, verification for a selection of these models is given in Table 4 for completeness. Model performance of the late models is naturally similar to that of the interpolated-dynamical models discussed above. Of the late models, the GFDL model performed best through 72 h, while the UKM and AEMN were superior at 96 and 120 h. As noted above, the GFS ensemble mean was significantly better than the standard GFS run at longer intervals; this behavior was not seen during 2004 and the reason for the improved performance of the ensemble is unknown. While there were some changes made to the way the tropical cyclone vortex was handled in the GFS ensembles, this change occurred around mid-season and there was no notable change in ensemble performance relative to the time of the implementation. (An alternative perspective would be to ask why the control GFSI was so degraded relative to the ensemble mean in 2005, given that the ensemble mean errors in 2004 and 2005 were quite similar.)

b. 2005 season overview - Intensity

Table 5 presents the results of the NHC official intensity forecast verification for the 2005 season, along with results averaged for the preceding 10-yr period. Mean forecast errors ranged from about 7 kt at 12 h to 22 kt at 120 h. Given the record number of category 5 hurricanes, as well as the large number of rapidly-intensifying storms, it is perhaps not surprising that the mean intensity errors in 2005 were mostly larger than the previous 10-yr means, and that there were very pronounced intensity forecast biases. At

72 h, for example, the official intensity bias was -5.0 kt, and -8.0 kt at 96 h. In contrast, long-term intensity biases are near zero. Through 72 h, SHIFOR5 forecast errors in 2005 were significantly above their previous 10-yr means, indicating that this year's storms were more difficult than normal to forecast (the increased number of landfalls notwithstanding). A review of annual errors and skill trends (Fig. 3) suggests that intensity forecast skill has improved slightly in recent seasons, even though raw errors have remained nearly constant.

Table 6a presents a homogeneous verification for a selection of early intensity models for 2005. To increase the sample size, a smaller collection of the better-performing models is given in Table 6b, and results in terms of skill for the second grouping are presented in Fig. 4. Figure 4 also includes an intensity consensus ICON, a simple average of GFDI and DSHP that outperformed either model individually and is a useful "dumb" consensus against which to measure the FSU super-ensemble. This consensus has not formally been computed operationally but is often part of the forecasters' thinking and is included here for reference. Excluding ICON, DSHP was the best performer overall, followed by FSSE and then GFDI. It is again worth noting that the FSSE is the only guidance model that is based on the previous official NHC forecast. The official intensity forecast beat all of the objective guidance, including the consensus models. While all the aforementioned models showed skill relative to SHIFOR5 overall, a second verification, one restricted to the pre-landfall portions of the actual and forecast tracks is revealing. (Recall that SHIFOR is an inappropriate skill benchmark for landfall cases because landfalls were explicitly excluded from its developmental data set.) This latter verification (Fig. 5) indicates that only SHIP/DSHP and FSSE were skillful for these over-water cases.

c. Verifications for individual storms

Forecast verifications for individual storms are given for reference in Table 7. Relative to the seasonal averages, low track forecast errors occurred for Dennis, Emily, and Rita, while Cindy, Stan, and some of the late-season "Greek" storms were not particularly well forecast. Forecasts for Katrina were near the average for the season. Additional discussion on forecast performance for individual storms can be found in NHC Tropical Cyclone Reports available at http://www.nhc.noaa.gov/2005atlan.shtml.

3. Eastern North Pacific Basin

a. 2005 season overview – Track

Table 8 presents the NHC official track forecast verification for the 2005 season; along with results averaged for the previous 10-yr period 1995-2004. Mean track errors range from 33 n mi at 12 h to 161 n mi at 120 h. It should be noted that the vast majority of the 120 h forecasts were from just two storms: Kenneth and Jova. Mean official track forecast errors were smaller in 2005 than for the previous 10-yr period (by 20%-40% from 24-120 h), and established new records for forecast accuracy at 36 h and beyond. Figure 6 (top panel) shows recent trends in track forecast accuracy for the eastern Pacific. Errors are down by roughly 20-40% for the 24-72 h forecasts since 1990, a somewhat smaller improvement than what has occurred in the Atlantic over this period but still substantial. Forecasts at all time periods were more skillful in 2005 than they had been over the previous decade (Table 8), and considerably more skillful than in 2004. Recent large year-to-year variations in skill make it difficult to discern trends (Fig. 6), although the trend in skill still appears to be upward. Track forecast biases were rather large at 96 and 120 h (to the north at roughly 1/3 of the mean error magnitude), but these represent an improvement over even larger westward biases in 2004.

Track guidance errors for the early models are given in Table 9a. Table 9b repeats the analysis, but without the FSU super-ensemble in order to obtain a larger sample size. For the latter verification, skill comparisons of selected models are shown in Fig. 7. Among the dynamical models, the GFDI performed well at the shorter ranges, while ironically, the GFNI performed very poorly early but was the best dynamical model at 4 and 5 days. None of the dynamical models stood out, and in fact they were all bested by BAMM at 72 h and beyond. There was a large separation between the consensus models (GUNA and CONU) and their constituent members, indicating substantial value in the multi-model consensus approach. In contrast to the Atlantic, however, the single-model consensus AEMI did not provide value over the GFS control. It was also not a successful year for the FSU super-ensemble, as Table 9a shows that its errors were larger than the simpler GUNA and CONU consensus models. Lastly, the official forecast was able to beat all the guidance, including the consensus models, at 72, 96, and 120 h.

A verification of late track models is given in Table 10. The GFDL performed best through 72 h, with the GFDN best thereafter. As noted above, the GFS ensemble mean in the eastern North Pacific did not provide value over the standard GFS run.

b. 2005 season overview – Intensity

Table 11 presents the results of the NHC east Pacific intensity forecast verification for the 2005 season, along with results averaged for the preceding 10-yr period. Mean forecast errors ranged from about 6 kt at 12 h to nearly 21 kt at 120 h. These errors are all within 10% of the long-term means; slightly below the long-term means through 72 h but somewhat larger at 96 and 120 h. SHIFOR5 forecast errors in 2005 were very close 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. East Pacific intensity forecasts have traditionally had a high bias; this was especially true in 2004. In 2005, however, the official forecasts had a very pronounced low bias, exceeding 13 kt at 120 h. This bias mirrored a low bias in the SHIPS model during 2005. Interestingly, the GFDI had large (17 kt at 120 h) positive bias in 2005.

Table 12a presents a homogeneous verification for early intensity models for 2005; a second verification for selected models to increase sample size is given in Table 12b and Fig. 8. Included for reference is the intensity consensus ICON, an average of GFDI and DSHP. Overall, it was not a strong year for the guidance. Only ICON showed consistent skill out through 5 days. When the FSU super-ensemble was available, it performed well through 72 h, but mostly trailed a simple consensus of the GFDI and DSHP. SHIP/DSHP outperformed the GFDI through 72 h, while the GFDI was better at the longer ranges. The official forecast occasionally beat individual intensity models, but generally was not as good as ICON.

c. Verifications for individual storms

Forecast verifications for individual storms are given for reference in Table 13. Additional discussion on forecast performance for individual storms can be found in NHC Tropical Cyclone Reports available at http://www.nhc.noaa.gov/2005epac.shtml.

4. Summary

a. Atlantic

- OFCL track accuracy was close to the record levels set in 2004. However, skill levels have changed little since 2002.
- OFCL track forecasts were better than all the dynamical guidance models, and even beat the consensus models at some time periods.
- The GFDL and UKMET provided the best dynamical track guidance. The GFS performed relatively poorly, particularly beyond 48 h. However, the GFS ensemble mean was significantly better than the control at 96 and 120 h. The FSU super-ensemble did not beat the simple arithmetic GUNA consensus, which provided the most accurate track guidance overall.
- OFCL intensity forecasts were notably superior to the best objective guidance. A simple consensus of GFDI and DSHP was superior to either model by itself. Dynamical intensity models still lag statistical techniques for predicting intensity change.

b. Eastern North Pacific

- OFCL track errors established new records for accuracy at 36 h and beyond. OFCL beat all the track guidance, including consensus models, at 72-120 h. Track biases at 4 and 5 days were improved over 2004 but are still large.
- GUNA and CONU provided the best track guidance. Among the individual models, GFDI provided the best guidance from 12-48 h, and the BAMM did so from 72-120 h.
- There was no standout among the dynamical models, and there were large differences between the dynamical models and the consensus (suggesting the dynamic models suffered from random, independent errors). The FSU super-ensemble did not do as well as the GUNA consensus.
- Neither the GFDI nor SHIP/DSHP provided consistently skillful intensity guidance, although an average of the two (ICON) did show skill. OFCL intensity errors and skill continue to show little long-term improvement. A significant low bias was present in longer-range official intensity forecasts in 2005.

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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 Office 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
AEMI	Previous cycle AEMN, adjusted	Consensus	E	Trk, Int
CONU	Average of at least 2 of GFDI, UKMI, NGPI, GFSI, and GFNI	Consensus	E	Trk
ICON	Average of GFDI and DSHP	Consensus	E	Int
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 2005 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
2005 mean OFCL error (n mi)	35.1	59.7	84.2	106.4	156.2	219.8	285.6
2005 mean CLIPER5 error (n mi)	49.0	101.6	159.8	209.9	284.5	367.6	453.2
2005 mean OFCL error relative to CLIPER5 (%)	-29	-41	-47	-49	-45	-40	-37
2005 mean OFCL bias vector (°/n mi)	313/6	314/15	318/28	319/38	312/35	353/25	043/78
2005 number of cases	591	534	478	429	338	264	207
1995-2004 mean OFCL error (n mi)[a]	42.2	75.3	106.9	137.8	202.4	235.7	310.2
1995-2004 mean CLIPER5 error (n mi)[a]	51.0	104.1	162.7	220.2	323.9	472.1	584.9
1995-2004 mean OFCL error relative to CLIPER5 (%)[a]	-17	-28	-34	-37	-38	-50	-47
1995-2004 mean OFCL bias vector (°/n mi)	271/7	279/13	288/18	302/23	290/29	338/17	021/20
1995-2004 number of cases	3400	3116	2848	2575	2117	649	535
2005 OFCL error relative to 1995-2004 mean (%)[a]	-17	-21	-21	-23	-23	-7	-8
2005 CLIPER5 error relative to 1995-2004 mean (%)[a]	-4	-2	-2	-5	-12	-22	-23

[a] Averages for 96 and 120 h are for the period 2001-2004.

Table 3a. Homogenous comparison of Atlantic basin early track guidance model errors (n mi) for 2005. 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	31.2	54.3	76.5	99.1	146.0	188.3	288.3
CLP5	46.9	99.4	159.2	208.1	271.7	302.2	391.5
GFSI	35.6	60.0	84.7	115.3	195.9	271.5	400.2
GFDI	33.9	57.3	77.5	102.0	161.5	232.6	349.7
GFNI	37.1	65.9	95.8	129.5	210.9	279.0	432.2
UKMI	38.0	65.8	94.0	118.3	170.7	215.2	**279.1**
NGPI	34.7	61.5	89.5	118.8	178.9	220.9	357.2
GUNA	**29.1**	**49.9**	**72.0**	**95.6**	148.4	**184.6**	**287.1**
CONU	**29.4**	**50.4**	**73.4**	**97.2**	151.2	**185.1**	298.7
FSSE	**29.3**	**49.3**	**71.4**	**94.9**	156.2	215.1	298.1
AEMI	35.9	61.1	85.7	112.8	180.5	237.7	**287.7**
BAMS	53.1	96.4	136.6	173.6	260.2	322.8	426.2
BAMM	37.9	67.0	94.3	122.8	199.2	266.6	396.9
BAMD	40.9	73.1	100.4	125.7	195.0	290.5	423.6
LBAR	38.5	77.2	121.5	174.0	320.0	467.0	605.6
A98E	41.5	73.1	106.6	139.9	219.8	304.9	402.2
# Cases	383	344	306	258	178	95	47

Table 3b. Homogenous comparison of a selected subset of Atlantic basin early track guidance model errors (n mi) for 2005. 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	31.0	54.2	77.3	100.2	146.1	195.6	248.4
CLP5	46.9	100.3	162.3	211.9	271.4	341.9	457.9
GFSI	35.6	60.2	85.3	116.3	198.3	275.7	359.6
GFDI	33.9	57.7	78.9	103.9	163.3	253.6	337.4
GFNI	37.1	66.1	96.8	129.6	207.9	299.4	405.4
UKMI	38.1	65.9	93.9	118.5	169.5	216.2	263.1
NGPI	34.7	61.6	90.3	118.8	178.0	236.3	324.5
GUNA	**29.1**	**50.1**	**72.5**	**96.1**	148.0	**194.7**	249.9
CONU	**29.4**	**50.6**	**74.0**	**97.7**	150.2	197.3	257.1
FSSE	**29.3**	**49.5**	**72.1**	**96.1**	156.6	219.8	261.9
AEMI	35.7	60.7	85.9	113.4	181.8	240.6	264.0
# Cases	398	358	319	268	183	110	71

Table 4. Homogenous comparison of Atlantic basin late track guidance model errors (n mi) for 2005, 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	**36.6**	**58.9**	**76.0**	**96.7**	**142.0**	218.5	296.0
GFDN	41.6	67.4	89.2	119.6	183.9	265.6	342.6
UKM	47.9	65.4	86.0	104.4	147.2	**198.0**	253.4
NGPS	39.8	63.5	90.1	116.4	162.8	218.5	274.6
GFSO	40.1	62.6	83.5	104.5	171.2	230.6	313.9
AEMN	38.2	61.8	80.1	100.2	156.4	211.0	**242.3**
CLP5	49.9	100.7	154.5	207.3	271.4	379.6	487.5
# Cases	216	189	158	139	99	64	41

Table 5. Homogenous comparison of official and SHIFOR5 intensity forecast errors in the Atlantic basin for the 2005 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
2005 mean OFCL error (kt)	6.9	10.9	13.4	15.6	20.2	20.1	21.9
2005 mean SHIFOR5 error (kt)	10.4	16.6	19.6	21.0	25.0	26.0	24.0
2005 mean OFCL error relative to SHIFOR5 (%)	-34	-34	-32	-26	-20	-23	-9
2005 OFCL bias (kt)	-0.3	-0.5	-1.6	-3.4	-5.0	-8.0	-6.9
2005 number of cases	591	534	478	429	338	264	207
1995-2004 mean OFCL error (kt)[a]	6.3	9.8	12.4	14.7	18.3	19.7	21.7
1995-2004 mean SHIFOR5 error (kt)[a]	8.0	12.4	15.7	18.2	21.3	24.6	24.4
1995-2004 mean OFCL error relative to SHIFOR5 (%)[a]	-22	-21	-21	-20	-14	-20	-11
1995-2004 OFCL bias (kt)	0.0	0.1	0.0	-0.2	0.1	0.7	0.4
1995-2004 number of cases	3392	3109	2841	2566	2115	649	535
2005 OFCL error relative to 1995-2004 mean (%)[a]	10	11	8	6	10	2	1
2005 SHIFOR5 error relative to 1995-2004 mean (%)[a]	30	34	25	15	17	6	2

[a] Averages for 96 and 120 h are for the period 2001-2004.

Table 6a. Homogenous comparison of Atlantic basin early intensity guidance model errors (kt) for 2005. Errors smaller than the NHC official forecast, if any, are shown in bold-face.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	7.7	12.2	15.0	17.1	19.2	18.7	21.4
SHF5	10.9	17.9	21.8	23.3	25.2	27.7	26.4
GFSI	11.6	18.7	23.5	26.1	29.7	34.2	27.0
GFDI	10.1	15.6	18.5	19.2	21.5	25.0	22.4
GFNI	10.7	16.7	21.5	23.8	27.5	28.3	30.5
UKMI	12.1	20.3	26.0	28.6	32.3	34.4	24.7
NGPI	11.7	18.6	23.3	25.7	28.2	30.1	21.5
SHIP	10.3	16.4	20.3	21.7	22.6	24.6	25.7
DSHP	9.1	13.2	16.3	18.7	21.0	21.4	25.3
FSSE	8.7	13.1	16.0	18.1	21.0	25.4	23.3
# Cases	332	301	270	236	174	113	70

Table 6b. Homogenous comparison of a selected subset of Atlantic basin early intensity guidance model errors (kt) for 2005. Errors smaller than the NHC official forecast, if any, are shown in bold-face. Although not computed operationally, included for reference is a simple intensity consensus model (ICON) that is an average of GFDI and DSHP.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	7.8	11.9	14.4	16.1	19.3	17.8	20.1
SHF5	10.8	17.2	20.6	21.9	24.9	26.4	23.8
GFDI	9.7	14.1	16.8	18.0	21.1	23.6	24.1
SHIP	10.2	15.9	19.0	19.8	21.6	22.3	23.6
DSHP	9.0	12.9	15.5	17.7	20.8	20.2	23.8
FSSE	8.6	12.7	15.4	17.4	21.2	23.1	23.0
ICON	8.8	12.4	14.7	16.3	19.5	20.2	21.9
# Cases	430	401	356	312	231	161	112

Table 7. Official Atlantic track and intensity forecast verifications (OFCL) for 2005 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: AL012005 ARLENE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	14.0	6.4	7.2	14.0	2.1	2.5
012	14.0	32.5	51.5	14.0	6.8	9.9
024	14.0	51.0	118.0	14.0	8.9	17.8
036	12.0	66.8	184.8	12.0	7.1	25.3
048	11.0	71.8	286.0	11.0	8.6	24.8
072	7.0	116.5	533.9	7.0	8.6	13.6
096	3.0	213.0	692.4	3.0	5.0	9.7
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL022005 BRET

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	6.0	5.0	5.0	6.0	0.8	0.0
012	4.0	34.6	37.5	4.0	3.8	11.3
024	2.0	68.9	64.4	2.0	5.0	26.5
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: AL032005 CINDY

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	12.0	9.9	11.4	12.0	1.3	2.9
012	12.0	45.0	65.0	12.0	6.3	14.5
024	11.0	83.3	127.8	11.0	6.8	22.3
036	9.0	149.8	211.7	9.0	6.7	21.0
048	7.0	235.4	319.5	7.0	13.6	13.0
072	3.0	450.2	574.8	3.0	28.3	22.3
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: AL042005 DENNIS

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	26.0	5.5	5.9	26.0	3.5	3.7
012	26.0	24.8	30.7	26.0	11.3	18.8
024	26.0	35.9	60.5	26.0	17.7	33.6
036	26.0	50.5	95.9	26.0	15.6	34.7
048	26.0	60.6	137.8	26.0	15.8	36.4
072	22.0	64.9	193.0	22.0	23.4	48.4
096	18.0	74.3	264.4	18.0	16.4	49.6
120	14.0	154.3	354.9	14.0	37.1	36.6

Verification statistics for: AL052005 EMILY

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	43.0	6.8	7.8	43.0	3.1	2.8
012	41.0	22.3	26.5	41.0	8.3	16.2
024	39.0	37.7	49.3	39.0	14.4	26.3
036	36.0	57.7	75.6	36.0	15.0	28.9
048	35.0	74.7	93.1	35.0	17.0	30.0
072	31.0	93.8	126.7	31.0	18.4	39.5
096	27.0	109.0	192.1	27.0	23.3	47.6
120	23.0	152.5	285.1	23.0	25.7	35.9

Verification statistics for: AL062005 FRANKLIN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	33.0	6.1	6.4	33.0	2.3	2.9
012	31.0	37.9	53.1	31.0	4.4	5.5
024	29.0	67.3	116.9	29.0	5.9	6.9
036	27.0	79.8	186.1	27.0	8.1	7.1
048	25.0	94.6	241.2	25.0	11.8	9.9
072	21.0	175.1	331.3	21.0	18.3	12.6
096	17.0	287.7	429.9	17.0	17.9	10.7
120	13.0	450.8	443.6	13.0	16.5	5.0

Verification statistics for: AL072005 GERT

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	8.0	2.4	10.1	8.0	0.0	1.3
012	6.0	33.8	42.5	6.0	4.2	9.5
024	4.0	54.8	73.6	4.0	1.3	14.3
036	2.0	95.3	124.7	2.0	7.5	10.5
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: AL082005 HARVEY

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	25.0	6.4	6.9	25.0	1.2	1.0
012	23.0	42.6	50.6	23.0	5.2	4.9
024	21.0	65.4	102.9	21.0	6.4	5.9
036	19.0	81.9	174.6	19.0	8.7	6.0
048	17.0	80.8	238.0	17.0	9.4	5.9
072	13.0	71.3	281.6	13.0	8.8	7.8
096	9.0	111.3	258.2	9.0	13.9	10.1
120	5.0	129.8	312.3	5.0	15.0	12.0

Verification statistics for: AL092005 IRENE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	56.0	10.5	11.2	56.0	1.1	1.5
012	54.0	40.4	55.1	54.0	3.6	5.0
024	52.0	67.9	96.4	52.0	6.8	6.7
036	50.0	102.6	133.9	50.0	8.4	8.9
048	48.0	141.9	165.2	48.0	11.0	9.7
072	44.0	200.6	223.3	44.0	10.9	12.1
096	40.0	268.1	309.6	40.0	11.4	12.5
120	36.0	345.6	402.4	36.0	11.8	11.8

Verification statistics for: AL102005 TEN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	4.0	22.9	23.5	4.0	0.0	0.0
012	2.0	117.1	120.5	2.0	7.5	8.5
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: AL112005 JOSE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	5.0	3.4	8.4	5.0	2.0	5.0
012	3.0	20.3	26.5	3.0	5.0	20.3
024	1.0	13.3	33.5	1.0	0.0	8.0
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: AL122005 KATRINA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	28.0	3.9	4.8	28.0	2.3	3.0
012	27.0	24.5	35.4	27.0	10.9	15.6
024	25.0	42.1	80.7	25.0	17.8	28.0
036	23.0	63.6	148.1	23.0	22.6	35.0
048	21.0	96.0	222.1	21.0	28.3	36.9
072	17.0	173.7	378.6	17.0	47.6	45.2
096	13.0	213.4	521.1	13.0	43.1	50.9
120	9.0	233.6	690.0	9.0	35.6	42.3

Verification statistics for: AL132005 LEE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	11.0	22.3	22.3	11.0	0.5	0.9
012	7.0	80.2	105.9	7.0	2.1	5.1
024	3.0	173.4	278.1	3.0	6.7	14.7
036	1.0	268.8	345.0	1.0	10.0	21.0
048	1.0	475.1	441.5	1.0	5.0	11.0
072	3.0	685.1	569.2	3.0	3.3	16.0
096	2.0	728.7	539.8	2.0	7.5	26.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL142005 MARIA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	36.0	8.1	8.4	36.0	1.5	2.1
012	34.0	32.8	46.0	34.0	5.6	7.1
024	32.0	56.0	85.8	32.0	6.4	8.8
036	30.0	73.8	118.5	30.0	8.0	9.6
048	28.0	85.1	146.5	28.0	8.4	9.9
072	24.0	119.6	181.2	24.0	12.3	11.0
096	20.0	156.3	200.9	20.0	12.8	11.8
120	16.0	217.6	216.6	16.0	9.4	6.9

Verification statistics for: AL152005 NATE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	20.0	5.6	7.6	20.0	1.0	1.5
012	18.0	40.6	60.5	18.0	3.3	5.0
024	16.0	72.4	129.4	16.0	6.6	8.5
036	14.0	117.9	213.9	14.0	9.6	12.0
048	12.0	170.4	318.5	12.0	12.5	14.4
072	8.0	369.9	514.6	8.0	16.9	15.0
096	4.0	753.8	699.1	4.0	10.0	8.8
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL162005 OPHELIA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	46.0	3.8	3.8	46.0	1.3	2.0
012	44.0	22.8	38.6	44.0	5.1	6.8
024	42.0	38.4	84.3	42.0	6.1	8.0
036	40.0	52.7	133.0	40.0	7.5	8.4
048	38.0	68.0	164.0	38.0	7.6	9.1
072	34.0	103.3	226.5	34.0	8.4	7.3
096	30.0	156.8	340.6	30.0	13.5	8.1
120	26.0	199.9	473.4	26.0	20.6	9.9

Verification statistics for: AL172005 PHILIPPE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	25.0	16.5	18.0	25.0	2.2	2.2
012	23.0	50.0	68.9	23.0	6.7	7.2
024	21.0	86.0	129.7	21.0	12.4	11.6
036	19.0	117.9	180.1	19.0	19.5	17.1
048	17.0	134.3	215.4	17.0	25.6	20.6
072	13.0	160.3	215.1	13.0	39.6	24.0
096	9.0	234.2	283.7	9.0	52.2	22.0
120	5.0	301.8	447.2	5.0	62.0	31.0

Verification statistics for: AL182005 RITA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	29.0	6.6	7.4	29.0	1.2	4.3
012	29.0	26.8	35.5	29.0	11.2	16.4
024	29.0	53.5	79.0	29.0	16.2	28.1
036	27.0	75.7	137.7	27.0	18.0	37.1
048	25.0	93.0	194.2	25.0	20.0	43.0
072	21.0	120.0	287.9	21.0	28.8	53.4
096	17.0	163.6	446.0	17.0	23.2	55.1
120	13.0	196.6	655.4	13.0	17.7	35.9

Verification statistics for: AL192005 NINETEEN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	8.0	11.8	12.7	8.0	1.3	1.3
012	6.0	52.7	57.9	6.0	4.2	4.8
024	4.0	83.2	104.2	4.0	11.3	9.8
036	2.0	152.8	194.4	2.0	20.0	12.5
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: AL202005 STAN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	16.0	9.4	10.5	16.0	0.0	1.6
012	14.0	43.5	47.6	14.0	6.1	12.7
024	12.0	74.4	103.8	12.0	11.3	21.2
036	10.0	104.9	183.1	10.0	15.5	20.1
048	8.0	141.8	270.6	8.0	16.3	9.4
072	4.0	234.3	465.7	4.0	27.5	24.5
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: AL212005 UNNAMED

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	0.0	-999.0	-999.0	0.0	-999.0	-999.0
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: AL222005 TAMMY

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	6.0	4.5	4.5	6.0	3.3	2.5
012	5.0	41.5	72.9	5.0	4.0	14.4
024	3.0	85.0	210.3	3.0	6.7	27.0
036	1.0	124.9	374.0	1.0	10.0	40.0
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: AL232005 TWENTY-TWO

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	3.0	2.7	2.7	3.0	0.0	1.7
012	3.0	51.5	107.4	3.0	6.7	10.0
024	3.0	73.0	200.6	3.0	11.7	15.3
036	1.0	36.4	458.2	1.0	20.0	23.0
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: AL242005 VINCE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	8.0	2.5	3.4	8.0	3.8	5.0
012	7.0	45.9	67.3	7.0	6.4	11.0
024	3.0	131.3	223.7	3.0	15.0	23.0
036	3.0	220.0	398.9	3.0	16.7	28.0
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: AL252005 WILMA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	41.0	7.0	6.9	41.0	1.5	3.0
012	39.0	29.0	47.0	39.0	11.2	13.4
024	37.0	42.2	114.0	37.0	18.2	19.0
036	35.0	60.5	182.6	35.0	22.1	25.6
048	33.0	84.1	245.4	33.0	22.0	30.9
072	29.0	135.8	313.3	29.0	29.7	41.0
096	25.0	264.0	381.5	25.0	27.0	42.0
120	21.0	382.4	425.6	21.0	24.8	56.0

Verification statistics for: AL262005 ALPHA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	10.0	1.1	1.1	10.0	0.5	1.0
012	8.0	44.8	79.6	8.0	3.1	9.1
024	6.0	81.0	186.7	6.0	0.8	16.8
036	4.0	81.8	277.6	4.0	2.5	26.3
048	2.0	26.3	405.9	2.0	12.5	23.5
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: AL272005 BETA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	17.0	7.9	9.8	17.0	2.1	3.5
012	15.0	26.8	41.0	15.0	9.7	16.8
024	13.0	55.3	86.1	13.0	13.5	17.8
036	11.0	74.1	131.1	11.0	10.9	20.0
048	9.0	90.0	165.8	9.0	11.1	18.2
072	5.0	87.9	220.8	5.0	41.0	35.8
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: AL282005 GAMMA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	21.0	14.0	15.2	21.0	1.2	1.4
012	17.0	49.0	52.6	17.0	2.6	4.8
024	13.0	95.7	102.4	13.0	7.3	9.6
036	9.0	136.9	152.6	9.0	11.7	13.6
048	5.0	161.2	197.3	5.0	17.0	18.0
072	2.0	266.7	493.0	2.0	17.5	8.5
096	6.0	285.2	629.8	6.0	22.5	6.2
120	9.0	262.9	664.6	9.0	26.1	20.9

Verification statistics for: AL292005 DELTA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	19.0	9.2	9.2	19.0	2.9	2.9
012	17.0	52.1	81.6	17.0	9.1	8.6
024	15.0	103.8	194.0	15.0	13.3	14.0
036	13.0	170.2	331.6	13.0	17.3	15.9
048	11.0	257.5	429.1	11.0	17.3	13.2
072	7.0	426.8	472.7	7.0	12.1	11.6
096	3.0	680.9	749.4	3.0	10.0	14.7
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: AL302005 EPSILON

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	37.0	2.5	2.6	37.0	2.6	2.8
012	35.0	28.9	47.3	35.0	7.7	7.5
024	33.0	53.2	114.3	33.0	11.2	11.8
036	31.0	75.3	206.2	31.0	16.1	15.7
048	29.0	94.5	314.1	29.0	21.7	18.5
072	25.0	152.3	431.5	25.0	23.2	21.1
096	21.0	293.5	591.7	21.0	23.8	18.8
120	17.0	544.1	754.1	17.0	23.5	20.2

Verification statistics for: AL312005 ZETA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	29.0	7.9	8.3	29.0	2.6	2.9
012	27.0	35.7	45.8	27.0	8.1	17.6
024	25.0	67.9	96.8	25.0	14.4	34.4
036	23.0	106.5	161.5	23.0	18.5	35.4
048	21.0	152.5	221.2	21.0	19.3	35.0
072	5.0	251.4	358.1	5.0	15.0	27.8
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 2005 season for all tropical and subtropical cyclones. Long-term averages are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
2005 mean OFCL error (n mi)	33.0	53.4	71.7	86.2	112.4	138.4	160.6
2005 mean CLIPER5 error (n mi)	39.8	76.3	115.0	149.6	219.0	272.4	332.5
2005 mean OFCL error relative to CLIPER5 (%)	-17	-30	-38	-42	-49	-49	-52
2005 mean OFCL bias vector (°/n mi)	357/2	312/3	307/7	322/16	359/23	013/46	015/55
2005 number of cases	263	233	203	177	138	110	89
1995-2004 mean OFCL error (n mi)[a]	37.3	67.8	96.9	122.8	174.5	208.3	259.1
1995-2004 mean CLIPER5 error (n mi)[a]	41.2	80.7	123.0	162.5	236.3	284.7	344.3
1995-2004 mean OFCL error relative to CLIPER5 (%)[a]	-10	-16	-21	-24	-26	-27	-25
1995-2004 mean OFCL bias vector (°/n mi)	311/4	324/5	325/6	333/7	010/10	177/23	210/25
1995-2004 number of cases	2654	2378	2096	1829	1386	355	224
2005 OFCL error relative to 1995-2004 mean (%)[a]	-11	-21	-26	-30	-36	-34	-38
2005 CLIPER5 error relative to 1995-2004 mean (%)[a]	-3	-5	-7	-8	-7	-4	-3

[a] Averages for 96 and 120 h are for the period 2001-2004.

Table 9a. Homogenous comparison of eastern North Pacific basin early track guidance model errors (n mi) for 2005. 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	27.5	47.0	65.0	79.7	104.2	117.2	144.0
CLP5	35.1	71.7	109.9	147.4	209.4	253.2	327.5
GFSI	33.3	59.5	85.6	112.7	174.6	231.5	249.4
GFDI	32.3	56.9	78.5	100.1	164.3	248.6	343.3
GFNI	39.8	72.8	99.9	122.4	158.9	207.6	257.7
UKMI	34.9	59.9	86.0	108.8	180.8	210.6	294.7
NGPI	37.8	70.1	96.8	125.3	174.0	217.6	260.9
GUNA	**26.9**	**43.7**	**61.7**	**76.9**	108.5	129.0	157.8
CONU	28.0	**46.7**	65.0	**79.5**	108.1	133.7	168.9
FSSE	28.8	49.5	71.7	93.1	114.7	150.3	177.3
AEMI	33.5	60.6	88.8	119.3	184.0	244.9	272.6
BAMS	36.6	65.4	96.0	127.4	186.3	234.1	304.6
BAMM	35.2	59.3	83.8	108.5	152.7	182.1	236.1
BAMD	37.3	66.2	94.4	120.4	162.6	196.4	232.5
LBAR	33.1	70.1	117.8	166.8	255.9	338.5	482.8
P91E	34.7	67.3	101.6	139.1	226.0	300.7	438.8
# Cases	149	134	119	105	74	48	33

Table 9b. Homogenous comparison of selected subset of eastern North Pacific basin early track guidance model errors (n mi) for 2005. 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	28.0	48.0	65.9	79.4	103.6	119.0	132.8
CLP5	34.6	71.0	109.8	146.9	215.0	262.4	319.9
GFSI	34.2	60.4	87.4	113.6	176.0	238.2	256.8
GFDI	32.0	57.1	78.4	97.6	153.1	218.0	288.9
GFNI	41.5	74.9	104.5	125.5	161.2	206.4	244.0
UKMI	36.9	63.3	89.8	113.0	173.2	221.6	297.6
NGPI	38.4	71.2	97.9	123.3	174.6	220.6	267.1
GUNA	**27.5**	**45.9**	**63.6**	**77.6**	108.3	128.1	147.5
CONU	28.7	48.9	67.3	80.6	108.9	131.7	152.1
AEMI	34.0	61.2	88.8	117.8	176.8	236.0	265.8
BAMS	35.6	63.5	94.9	125.7	182.4	235.8	293.4
BAMM	34.4	58.0	82.2	107.5	148.8	181.5	227.7
BAMD	36.9	65.3	94.1	120.8	169.0	225.2	256.0
LBAR	32.6	69.3	116.2	164.4	255.7	337.9	437.1
P91E	34.6	66.6	100.1	136.3	227.5	318.8	456.4
# Cases	172	149	135	119	93	73	53

Table 10. Homogenous comparison of eastern North Pacific basin late track guidance model errors (n mi) for 2005, 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	**29.6**	**52.5**	**72.4**	**88.0**	**136.7**	207.1	277.0
GFDN	43.3	73.7	102.6	119.3	146.1	**170.2**	**223.4**
UKM	36.3	58.9	77.1	98.5	156.3	186.2	269.5
NGPS	43.6	73.6	99.1	120.9	164.8	222.7	290.9
GFSO	38.3	58.8	81.8	105.2	165.5	224.7	262.1
AEMN	38.3	58.5	82.6	106.9	173.4	240.5	276.0
CLP5	34.8	68.6	103.8	143.9	215.2	248.6	314.8
# Cases	92	82	74	64	49	38	30

Table 11. Homogenous comparison of official and SHIFOR5 intensity forecast errors in the eastern North Pacific basin for the 2005 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
2005 mean OFCL error (kt)	5.8	10.1	13.6	16.2	18.2	19.1	20.6
2005 mean SHIFOR5 error (kt)	6.9	11.5	15.2	18.3	19.9	20.0	18.8
2005 mean OFCL error relative to SHIFOR5 (%)	-16	-12	-10	-11	-9	-4	10
2005 OFCL bias (kt)	0.4	1.0	1.0	-1.1	-5.6	-10.1	-13.5
2005 number of cases	263	233	203	177	138	110	89
1995-2004 mean OFCL error (kt)[a]	6.1	10.8	14.3	16.5	18.7	18.1	18.8
1995-2004 mean SHIFOR5 error (kt)[a]	7.3	11.9	15.5	17.9	21.3	20.5	19.3
1995-2004 mean OFCL error relative to SHIFOR5 (%)[a]	-16	-9	-8	-8	-12	-12	-3
1995-2004 OFCL bias (kt)	0.4	1.1	1.4	0.9	3.0	10.3	12.2
1995-2004 number of cases	2654	2378	2096	1829	1386	355	224
2005 OFCL error relative to 1995-2004 mean (%)[a]	-5	-6	-5	-2	-3	+6	+10
2005 SHIFOR5 error relative to 1995-2004 mean (%)[a]	-5	-3	-2	+2	-7	-2	-3

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

Table 12a. Homogenous comparison of eastern North Pacific basin early intensity guidance model errors (kt) for 2005. Errors smaller than the NHC official forecast are shown in bold-face. Although not computed operationally, included for reference is a simple intensity consensus model (ICON) that is an average of GFDI and DSHP.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	6.8	10.7	14.4	16.9	18.3	15.7	12.4
SHF5	7.3	11.8	15.5	17.6	**17.3**	**15.0**	**12.0**
GFSI	8.3	14.0	19.0	22.9	29.7	31.6	35.4
GFDI	7.9	11.8	14.8	**16.6**	19.3	16.8	12.5
GFNI	8.4	13.8	17.0	21.2	23.9	20.5	21.4
UKMI	8.2	13.7	17.9	20.9	24.3	24.0	24.3
NGPI	8.4	13.8	18.0	20.4	22.1	22.4	22.4
SHIP	7.0	10.8	**14.2**	**16.6**	19.4	18.9	16.6
DSHP	6.9	**10.5**	**13.7**	**15.8**	19.4	18.9	16.6
FSSE	7.0	**10.3**	**12.8**	**14.3**	**17.4**	17.3	17.1
ICON	6.9	**10.1**	**12.9**	**14.0**	**16.2**	**13.6**	**10.0**
# Cases	171	149	128	109	75	49	34

Table 12b. Homogenous comparison of a selected subset of eastern North Pacific basin early intensity guidance model errors (kt) for 2005. Errors smaller than the NHC official forecast are shown in bold-face. Although not computed operationally, included for reference is a simple intensity consensus model (ICON) that is an average of GFDI and DSHP.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	6.0	10.2	13.9	16.5	18.5	19.0	19.9
SHF5	7.0	11.7	15.4	18.5	20.1	20.1	**19.0**
GFDI	7.4	11.5	14.7	17.0	20.4	20.0	**17.2**
SHIP	6.6	10.6	13.9	16.6	19.4	20.5	22.1
DSHP	6.3	**10.1**	**13.4**	**16.0**	19.3	20.5	22.1
ICON	6.3	**9.8**	**12.5**	**14.5**	**17.7**	**17.3**	**16.5**
# Cases	247	220	190	165	129	102	85

Table 13. Official eastern North Pacific track and intensity forecast verifications (OFCL) for 2005 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: EP012005 ADRIAN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	12.0	18.0	18.7	12.0	2.9	3.8
012	12.0	59.0	64.1	12.0	5.0	12.4
024	10.0	65.2	113.9	10.0	6.0	20.7
036	8.0	75.4	185.3	8.0	5.6	27.0
048	6.0	109.5	263.0	6.0	8.3	40.0
072	2.0	214.9	524.0	2.0	7.5	45.0
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: EP022005 BEATRIZ

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	10.0	11.6	11.8	10.0	1.0	1.0
012	8.0	29.4	35.0	8.0	6.9	6.6
024	6.0	43.6	54.1	6.0	11.7	8.5
036	4.0	71.9	88.8	4.0	15.0	10.5
048	2.0	93.9	143.2	2.0	17.5	21.0
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: EP032005 CALVIN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	10.0	14.7	15.3	10.0	3.0	4.0
012	8.0	44.1	64.2	8.0	8.8	6.3
024	6.0	68.3	116.0	6.0	13.3	13.2
036	4.0	78.4	196.5	4.0	26.3	24.5
048	2.0	102.5	210.0	2.0	40.0	31.0
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: EP042005 DORA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	10.0	14.2	14.8	10.0	2.0	2.5
012	8.0	49.2	54.7	8.0	3.1	4.9
024	6.0	96.6	124.8	6.0	10.0	8.3
036	4.0	141.2	214.8	4.0	17.5	14.8
048	2.0	131.7	216.9	2.0	25.0	20.0
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: EP052005 EUGENE

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	10.0	18.0	21.8	10.0	0.0	1.0
012	8.0	63.4	69.1	8.0	5.6	9.8
024	6.0	86.5	113.0	6.0	9.2	17.7
036	4.0	122.9	163.5	4.0	16.3	15.3
048	2.0	180.7	262.0	2.0	12.5	20.5
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: EP062005 FERNANDA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	27.0	5.1	5.5	27.0	1.9	2.4
012	25.0	18.7	26.9	25.0	6.6	5.9
024	23.0	27.7	53.9	23.0	10.7	9.0
036	21.0	40.6	87.7	21.0	11.0	8.1
048	19.0	53.5	121.6	19.0	12.9	8.9
072	15.0	95.3	167.3	15.0	15.0	9.9
096	11.0	136.4	191.7	11.0	15.0	10.4
120	7.0	173.5	232.3	7.0	19.3	10.0

Verification statistics for: EP072005 GREG

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	19.0	4.9	5.7	19.0	0.0	0.5
012	17.0	37.3	48.0	17.0	7.6	6.5
024	15.0	71.0	91.4	15.0	13.3	11.9
036	13.0	89.4	145.2	13.0	22.3	19.1
048	11.0	111.8	195.7	11.0	27.3	23.4
072	7.0	207.9	339.9	7.0	29.3	34.1
096	3.0	451.4	453.1	3.0	15.0	30.7
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP082005 HILARY

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	25.0	10.7	10.2	25.0	0.6	0.4
012	23.0	37.0	40.4	23.0	5.9	6.5
024	21.0	58.7	76.5	21.0	8.1	10.4
036	19.0	69.6	98.9	19.0	7.9	10.3
048	17.0	72.6	121.9	17.0	9.7	13.8
072	13.0	94.2	157.8	13.0	14.2	18.7
096	9.0	114.7	185.6	9.0	17.2	19.2
120	5.0	119.6	222.4	5.0	19.0	21.2

Verification statistics for: EP092005 IRWIN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	12.0	5.2	5.2	12.0	1.3	1.3
012	10.0	21.0	25.1	10.0	6.0	7.8
024	8.0	43.3	47.7	8.0	10.0	12.5
036	6.0	73.5	85.2	6.0	15.0	22.3
048	4.0	108.3	119.1	4.0	21.3	25.0
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: EP102005 JOVA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	26.0	9.0	9.0	26.0	1.3	1.3
012	26.0	33.7	41.4	26.0	5.2	5.0
024	26.0	50.5	80.5	26.0	8.3	8.4
036	26.0	64.2	121.0	26.0	11.5	13.1
048	26.0	84.0	168.6	26.0	15.4	18.6
072	26.0	104.4	260.7	26.0	22.9	25.7
096	26.0	124.7	328.6	26.0	31.5	32.4
120	26.0	144.7	376.3	26.0	34.4	33.4

Verification statistics for: EP112005 KENNETH

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	46.0	7.3	8.0	46.0	1.7	1.8
012	46.0	28.1	35.2	46.0	7.1	7.9
024	46.0	49.5	69.3	46.0	12.4	12.2
036	46.0	69.2	106.9	46.0	16.6	15.5
048	46.0	85.9	144.2	46.0	19.2	17.0
072	46.0	106.4	213.1	46.0	19.6	16.0
096	46.0	119.2	271.4	46.0	16.3	15.0
120	45.0	154.0	326.9	45.0	13.9	10.5

Verification statistics for: EP122005 LIDIA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	7.0	15.2	15.2	7.0	0.7	1.4
012	5.0	68.8	91.4	5.0	5.0	11.4
024	3.0	143.9	218.0	3.0	10.0	20.0
036	1.0	230.0	314.8	1.0	15.0	21.0
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: EP132005 MAX

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	17.0	3.0	2.9	17.0	0.0	1.5
012	15.0	18.9	30.6	15.0	4.7	5.4
024	13.0	35.3	61.7	13.0	9.2	10.2
036	11.0	56.2	97.1	11.0	10.9	12.0
048	9.0	72.3	121.8	9.0	11.1	13.0
072	5.0	95.2	197.2	5.0	5.0	16.0
096	1.0	173.0	176.4	1.0	0.0	17.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP142005 NORMA

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	18.0	10.5	10.3	18.0	1.9	2.5
012	17.0	24.3	28.3	17.0	3.8	5.6
024	15.0	40.9	53.3	15.0	6.7	8.6
036	13.0	61.2	83.6	13.0	10.0	13.4
048	11.0	79.9	112.5	11.0	11.8	16.9
072	7.0	130.4	125.6	7.0	17.1	24.9
096	3.0	168.2	110.0	3.0	15.0	26.0
120	0.0	-999.0	-999.0	0.0	-999.0	-999.0

Verification statistics for: EP152005 OTIS

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	23.0	10.9	10.6	23.0	1.1	1.7
012	21.0	33.3	37.4	21.0	6.4	8.0
024	19.0	54.3	77.6	19.0	12.6	13.1
036	17.0	86.1	116.7	17.0	17.4	19.7
048	15.0	105.6	144.3	15.0	19.0	23.3
072	11.0	79.9	170.6	11.0	17.3	18.6
096	7.0	71.8	209.7	7.0	12.9	8.1
120	3.0	100.3	285.7	3.0	18.3	17.7

Verification statistics for: EP162005 SIXTEEN

VT (h)	NT	OFCL	CLP5	NI	OFCL	SHF5
000	18.0	6.3	6.7	18.0	2.5	2.8
012	14.0	30.2	27.2	14.0	2.5	5.0
024	10.0	61.6	59.0	10.0	5.0	12.6
036	6.0	92.9	95.0	6.0	6.7	23.0
048	5.0	82.9	142.8	5.0	7.0	26.2
072	6.0	182.0	317.9	6.0	8.3	27.3
096	4.0	357.3	456.5	4.0	8.8	34.3
120	3.0	497.5	499.2	3.0	10.0	33.0

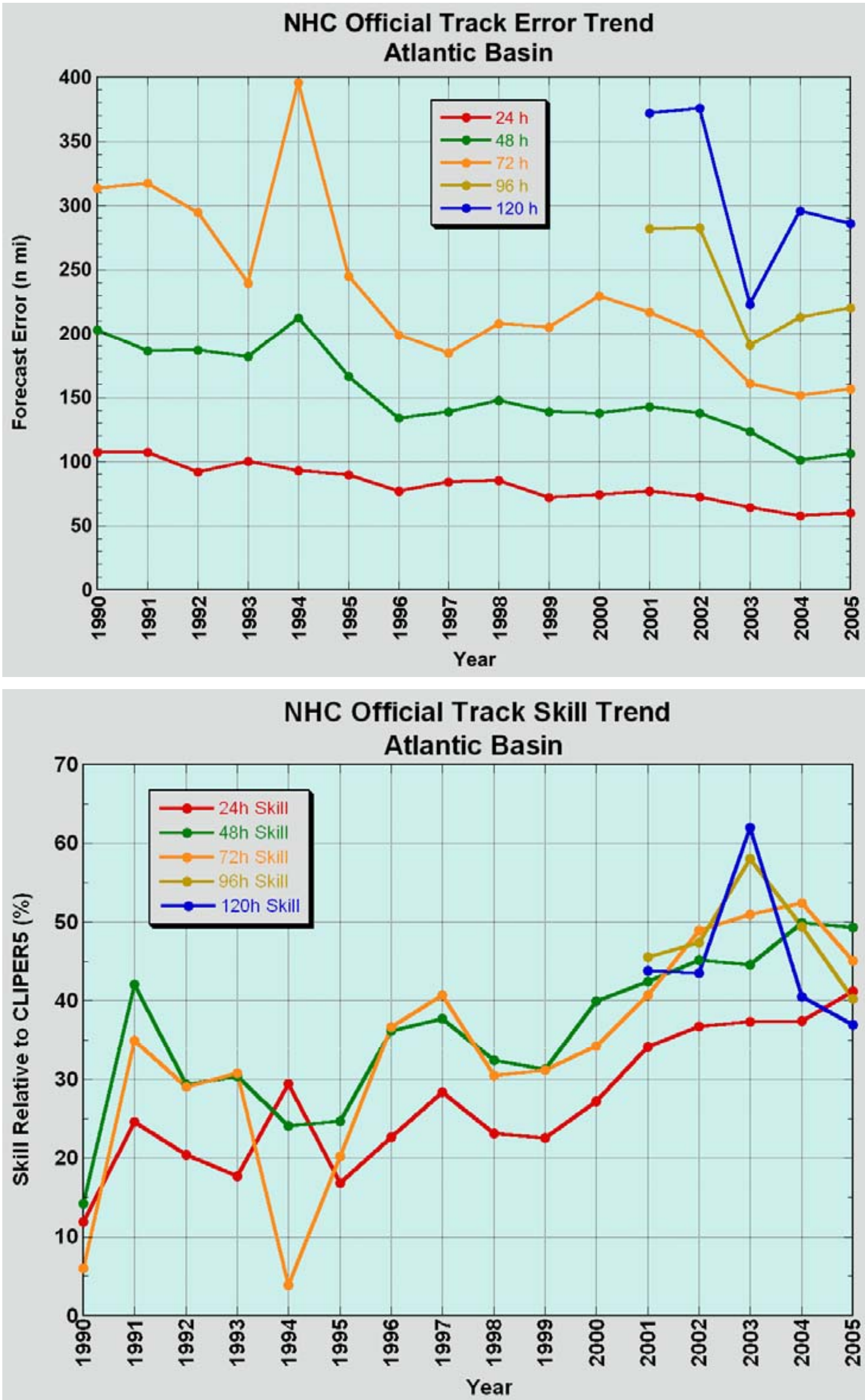

Figure 1. Recent trends in NHC official track forecast error (top) and skill (bottom) for the Atlantic basin.

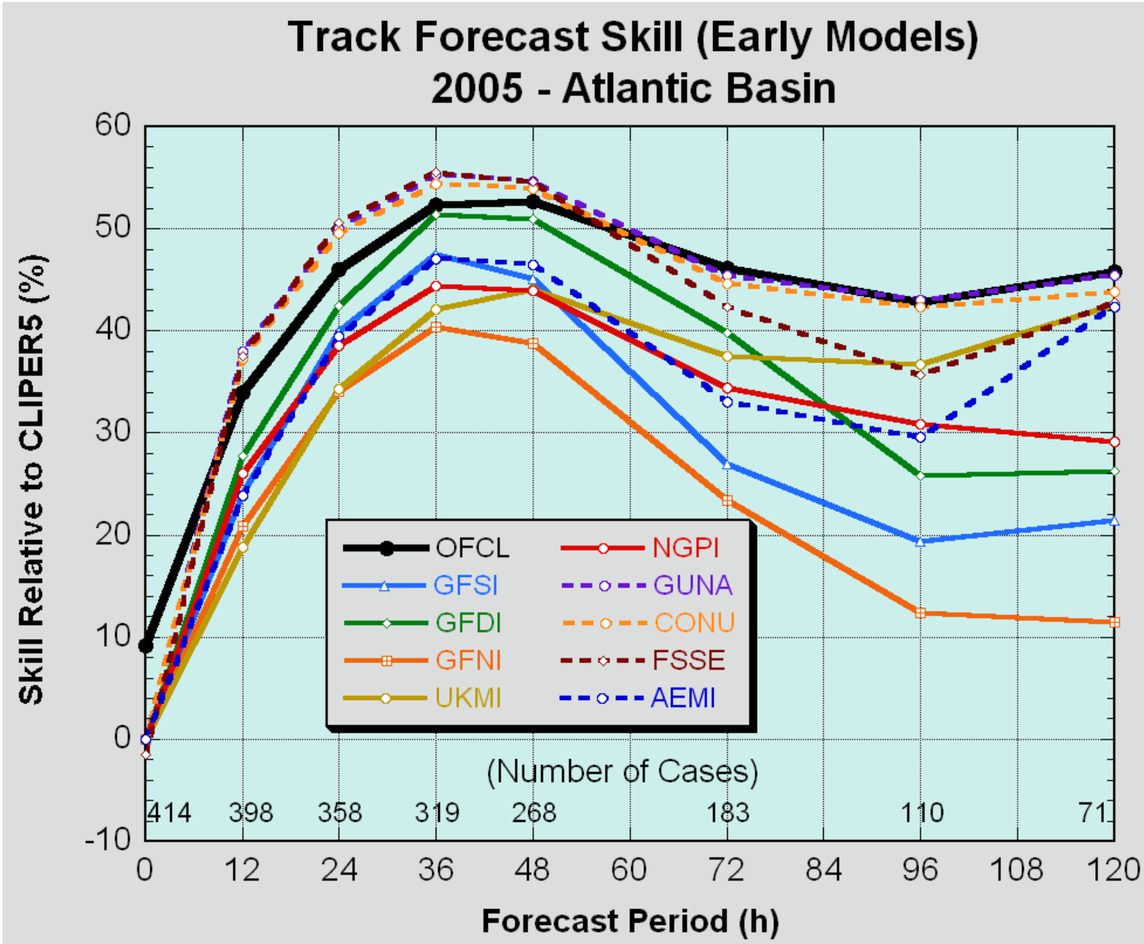

Figure. 2. Homogenous comparison for selected Atlantic basin early track guidance models for 2005.

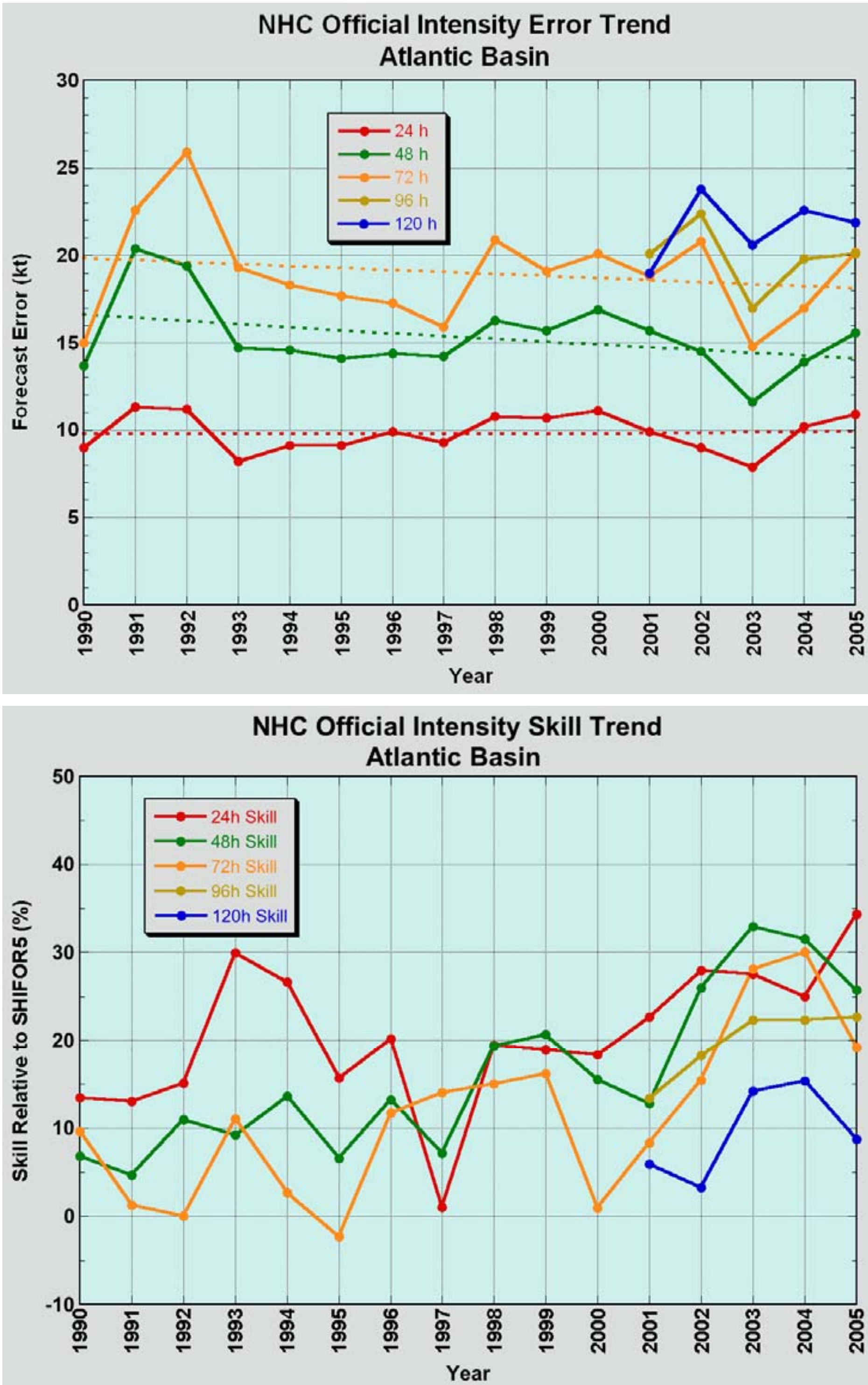

Figure 3. Recent trends in NHC official intensity forecast error (top) and skill (bottom) for the Atlantic basin.

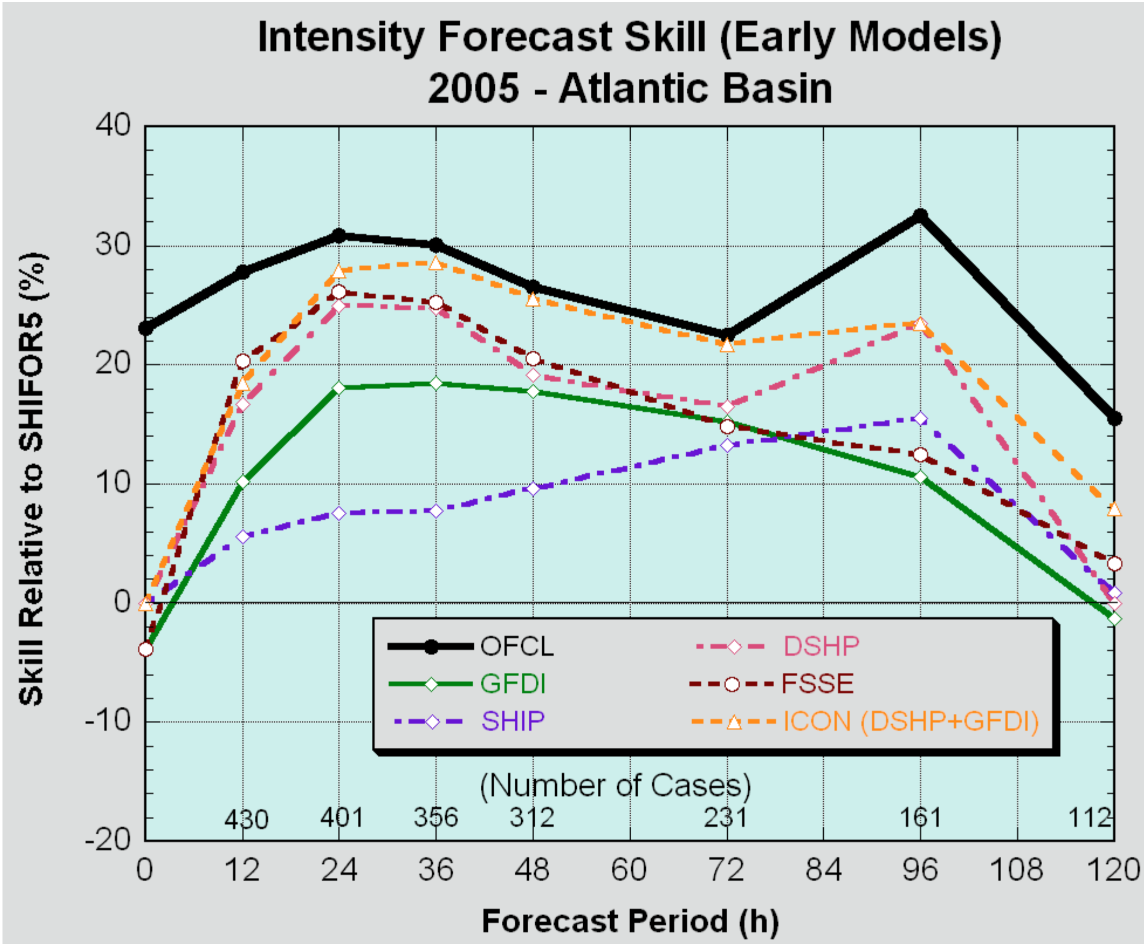

Figure. 4. Homogenous comparison for selected Atlantic basin early intensity guidance models for 2005.

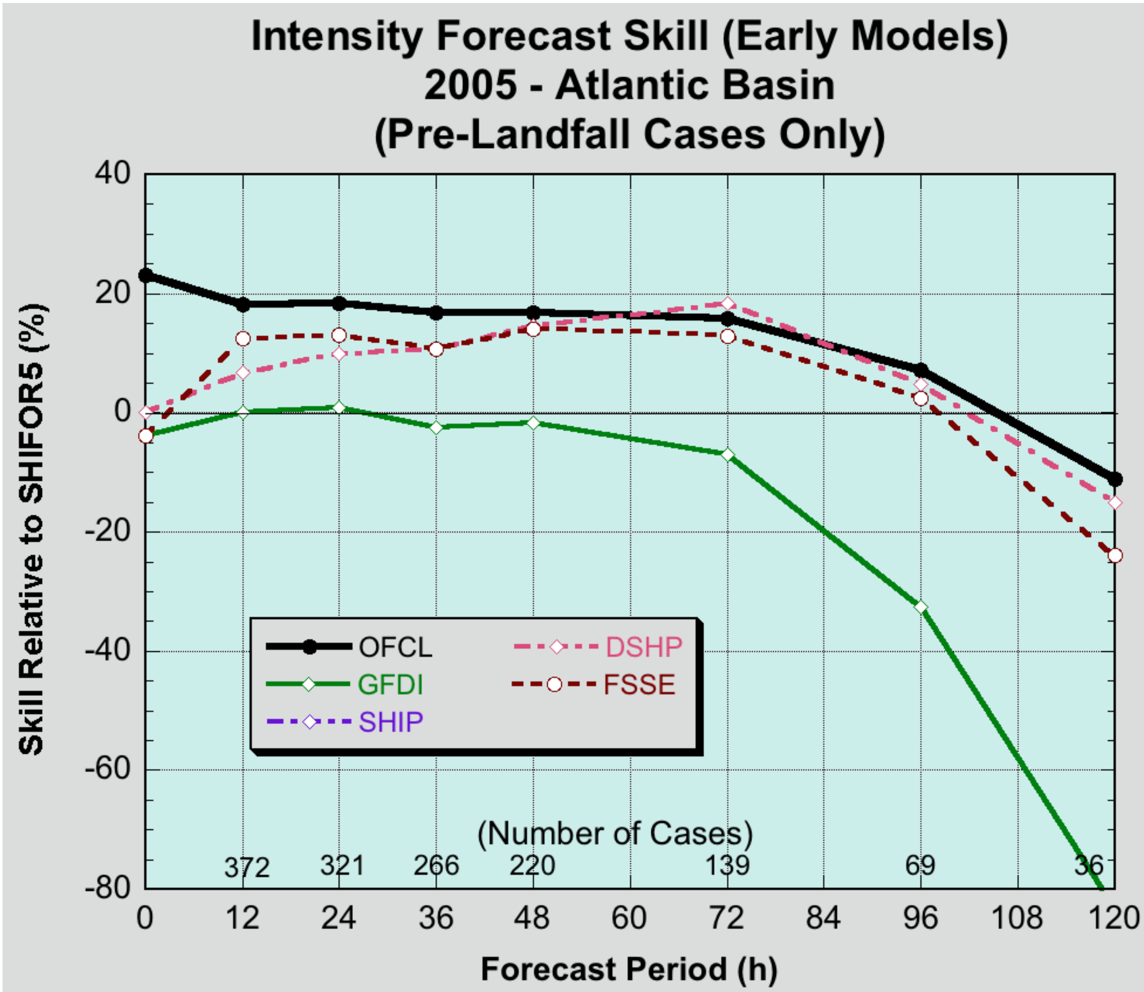

Figure. 5. Homogenous comparison for selected Atlantic basin early intensity guidance models for 2005, for pre-landfall verifications only. The pre-landfall verification sample is defined by excluding any portion of a model forecast that occurs after either the model forecast track or the verifying best track encounters land. (In such a verification, DSHP and SHIP are identical forecasts; as a result only the DSHP line is visible in the figure.)

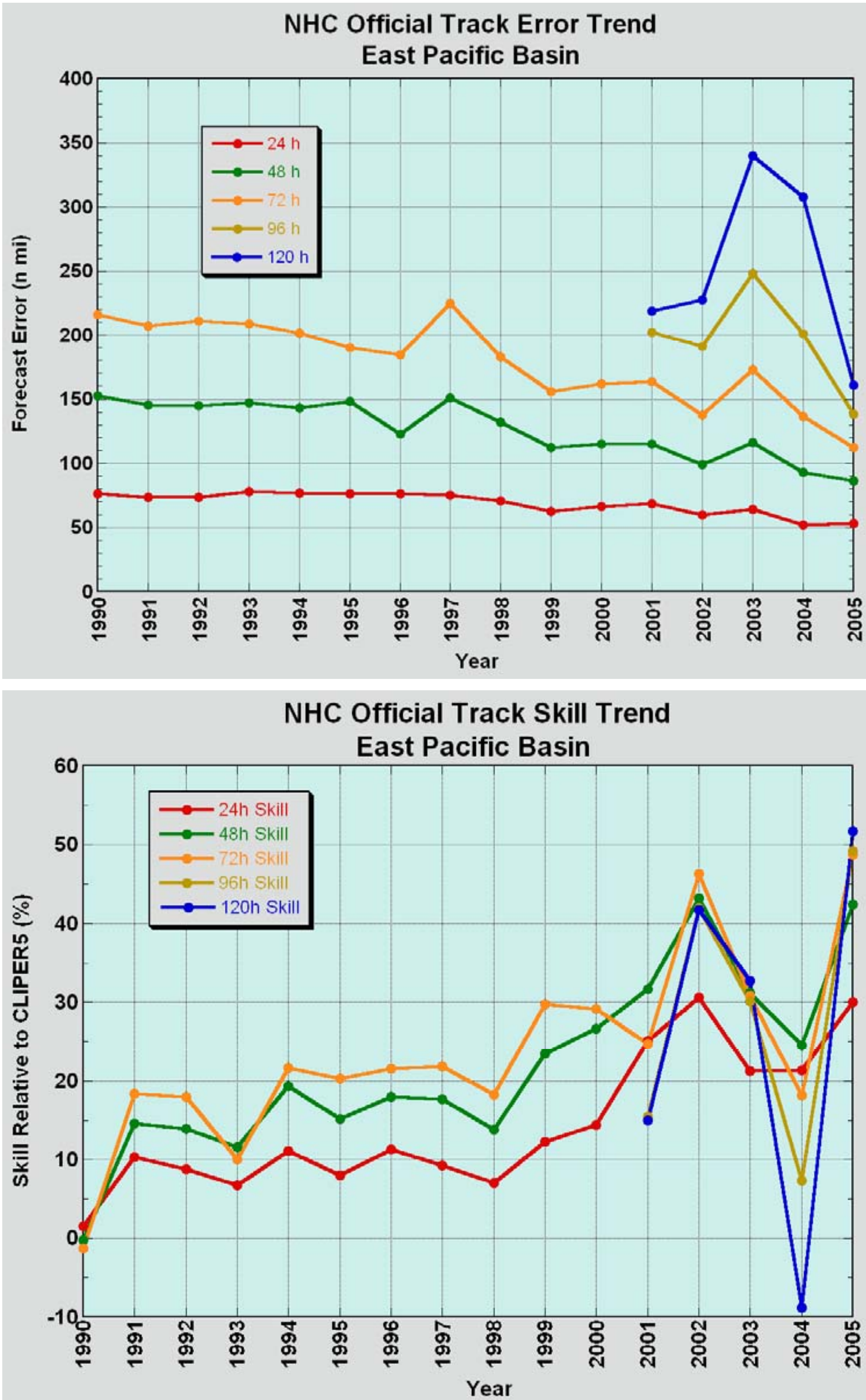

Figure 6. Recent trends in NHC official track forecast error (top) and skill (bottom) for the eastern North Pacific basin.

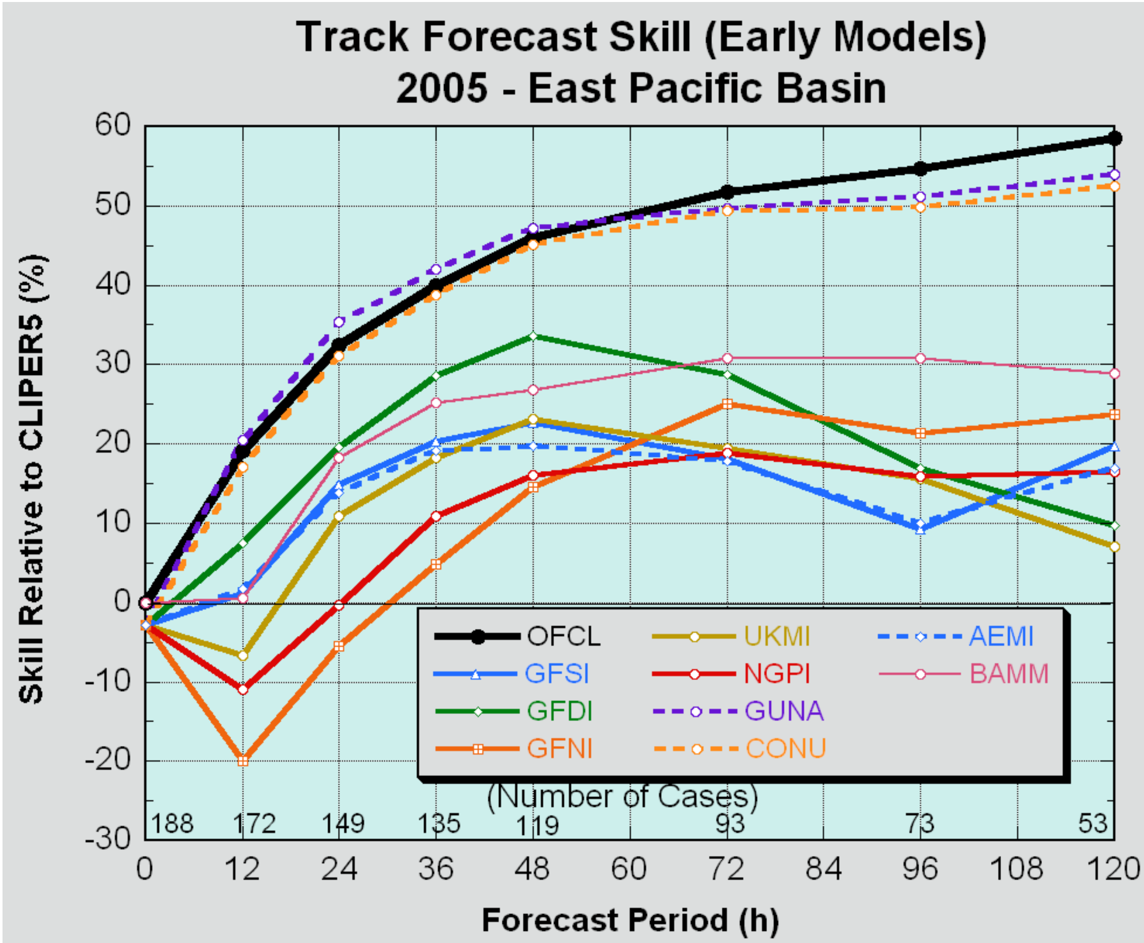

Figure. 7. Homogenous comparison for selected eastern North Pacific basin early track guidance models for 2005.

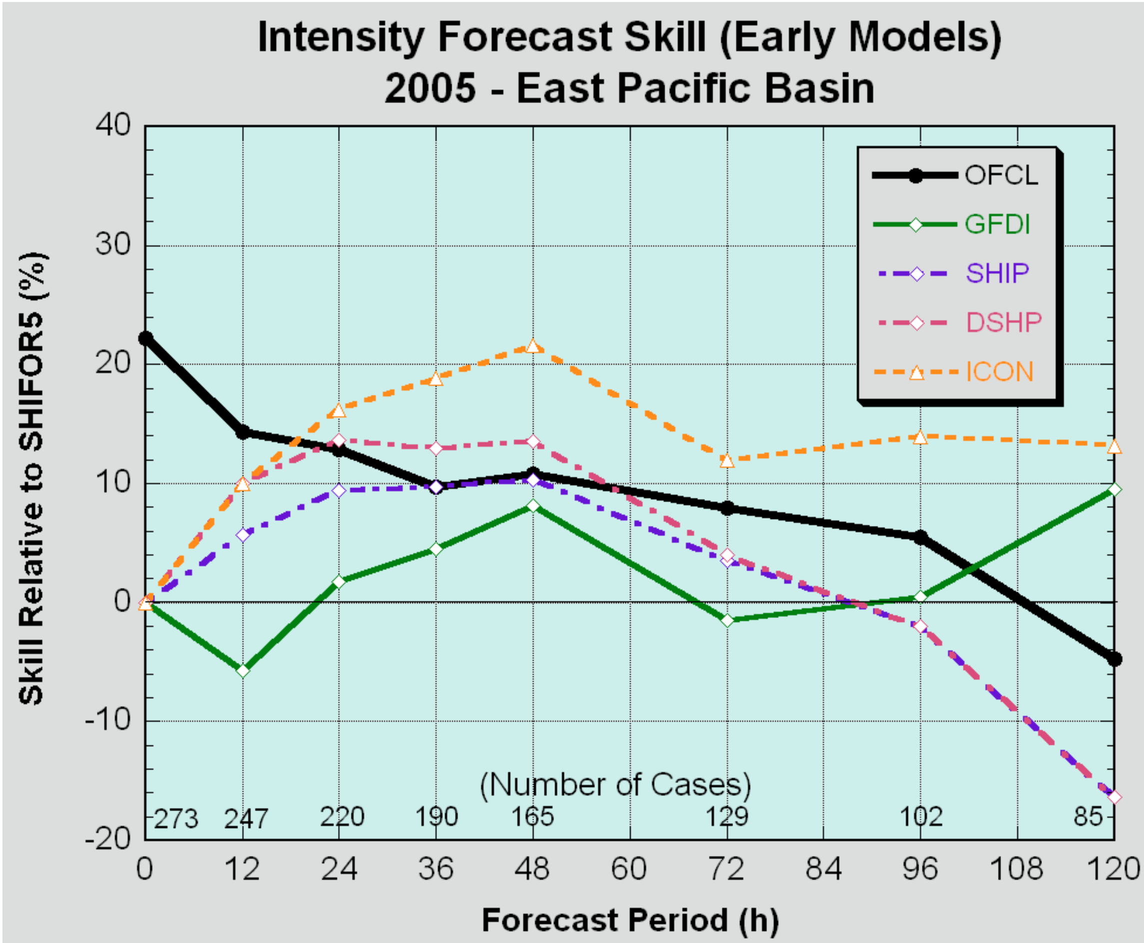

Figure. 8. Homogenous comparison for selected eastern North Pacific basin early intensity guidance models for 2005. Although not computed operationally, included for reference is a simple intensity consensus model (ICON) that is an average of GFDI and DSHP.