

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 120¹ 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 advisories² 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 CLIPER5³, 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.

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 homogeneous⁵ 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|-------------|-------------|-------------|-------|--------------|--------------|
| | 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|-------------|-------------|-------------|-------|--------------|-------|
| | 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|-------------|-------------|-------------|--------------|--------------|--------------|
| | 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|------|------|------|------|------|------|
| | 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|------|------|------|------|------|------|
| | 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 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) | 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|-------------|-------------|-------------|-------|-------|-------|
| | 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|-------------|-------------|-------------|-------|-------|-------|
| | 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|-------------|-------------|-------------|--------------|--------------|--------------|
| | 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | 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.

| Model ID | Forecast Period (h) | | | | | | |
|----------|---------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | 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 |

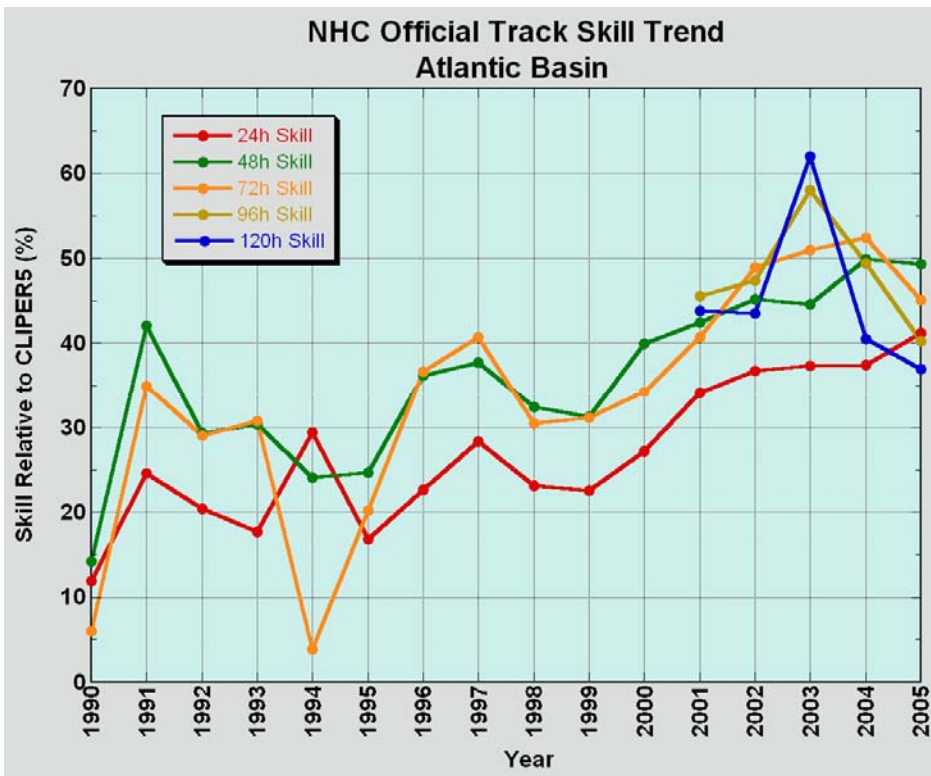
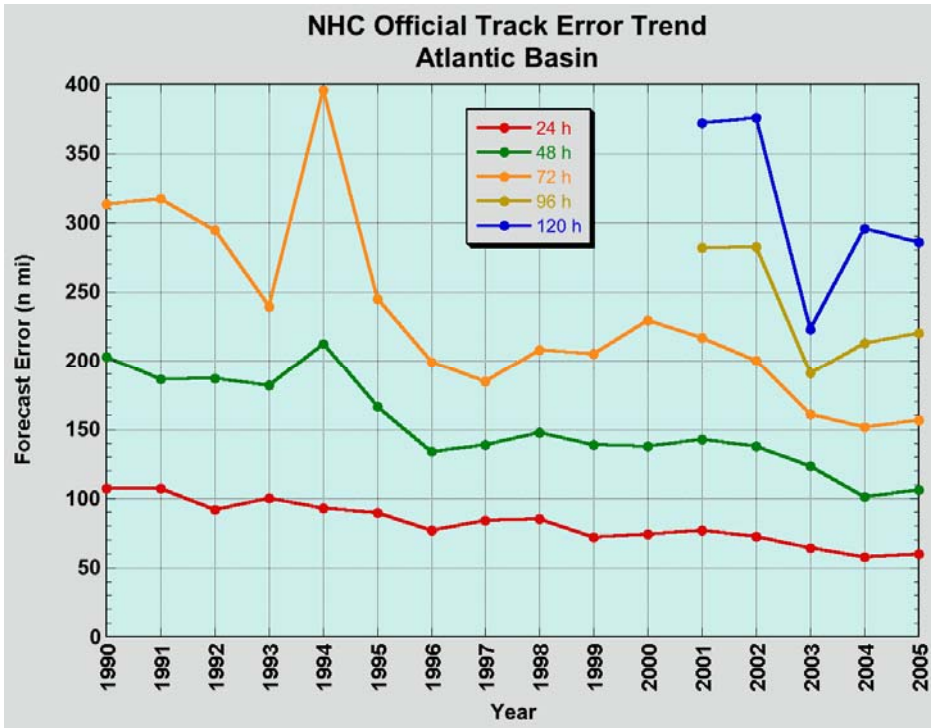


Figure 1. Recent trends in NHC official track forecast error (top) and skill (bottom) for the Atlantic basin.

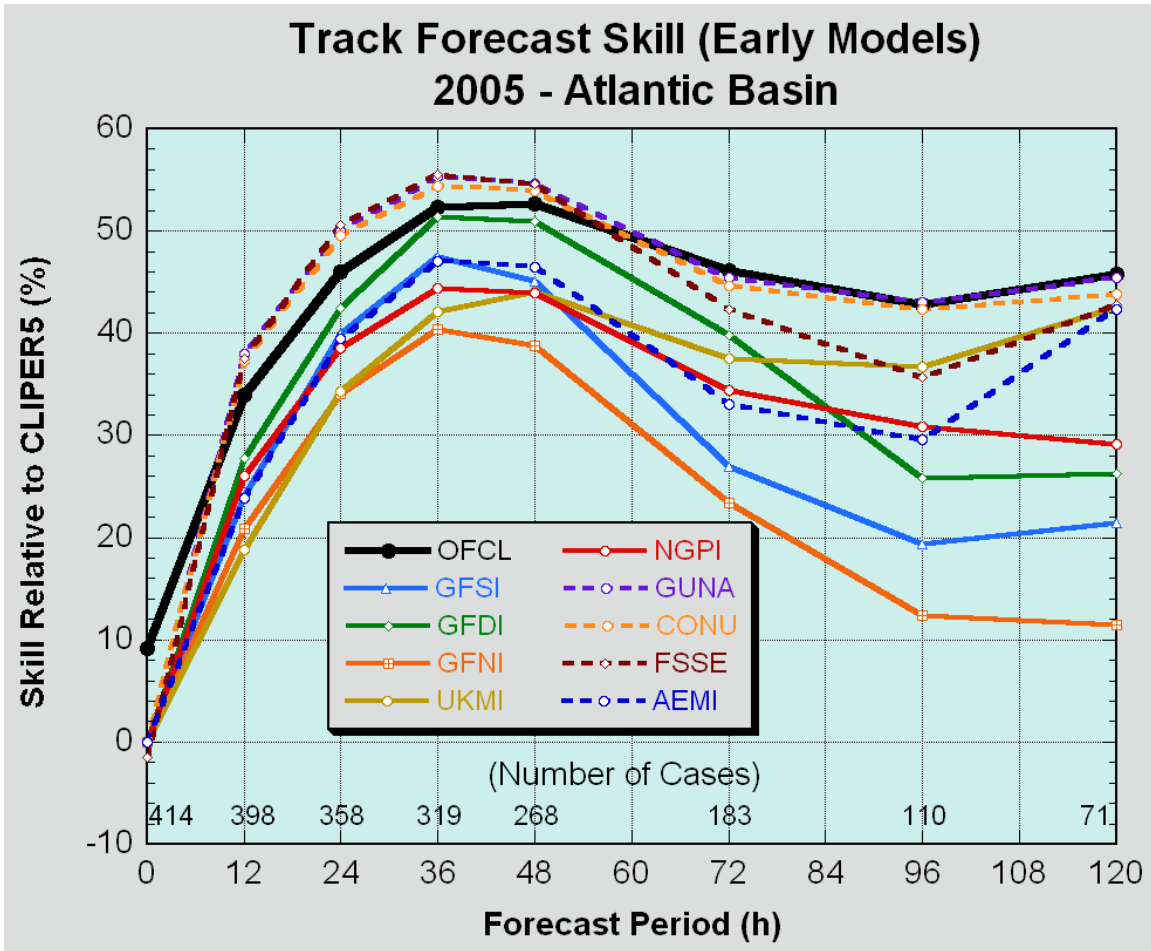


Figure. 2. Homogenous comparison for selected Atlantic basin early track guidance models for 2005.

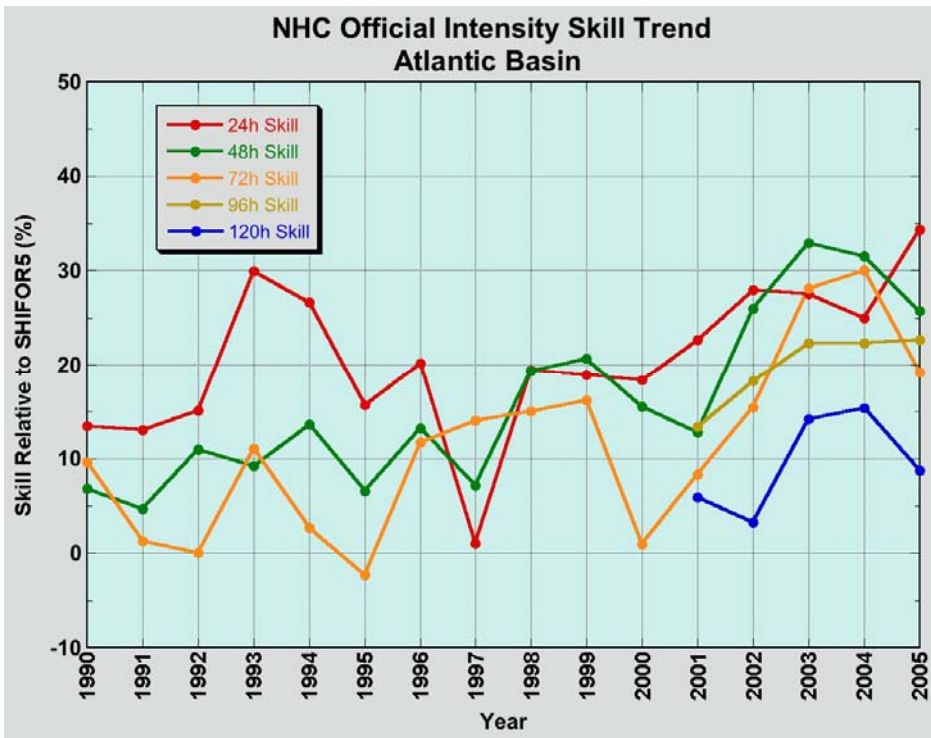
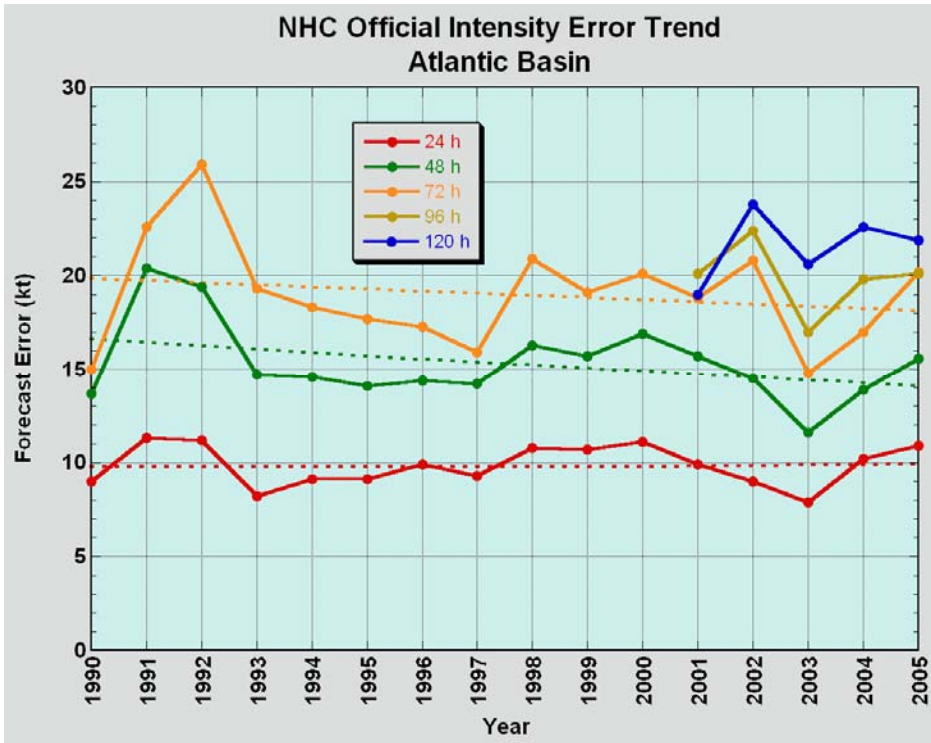


Figure 3. Recent trends in NHC official intensity forecast error (top) and skill (bottom) for the Atlantic basin.

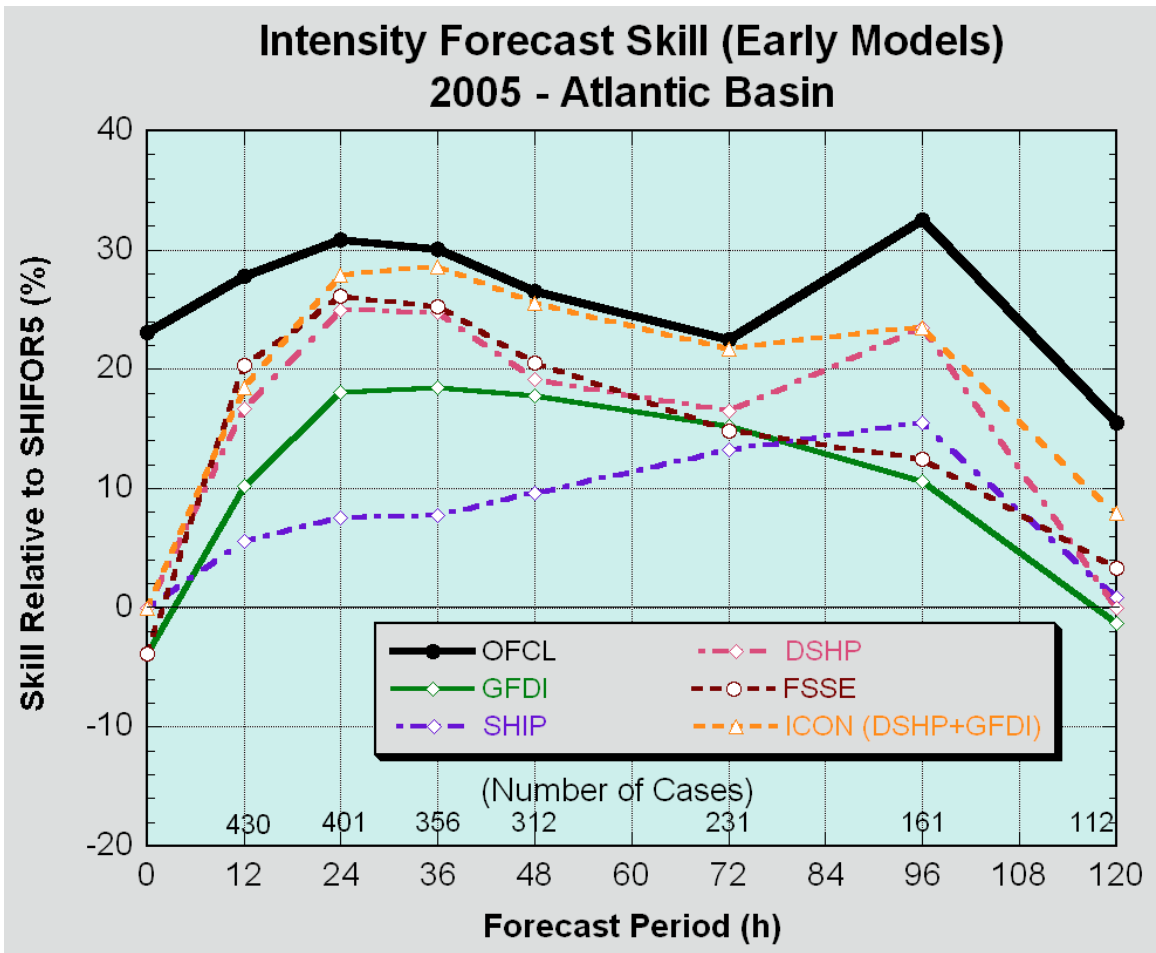


Figure. 4. Homogenous comparison for selected Atlantic basin early intensity guidance models for 2005.

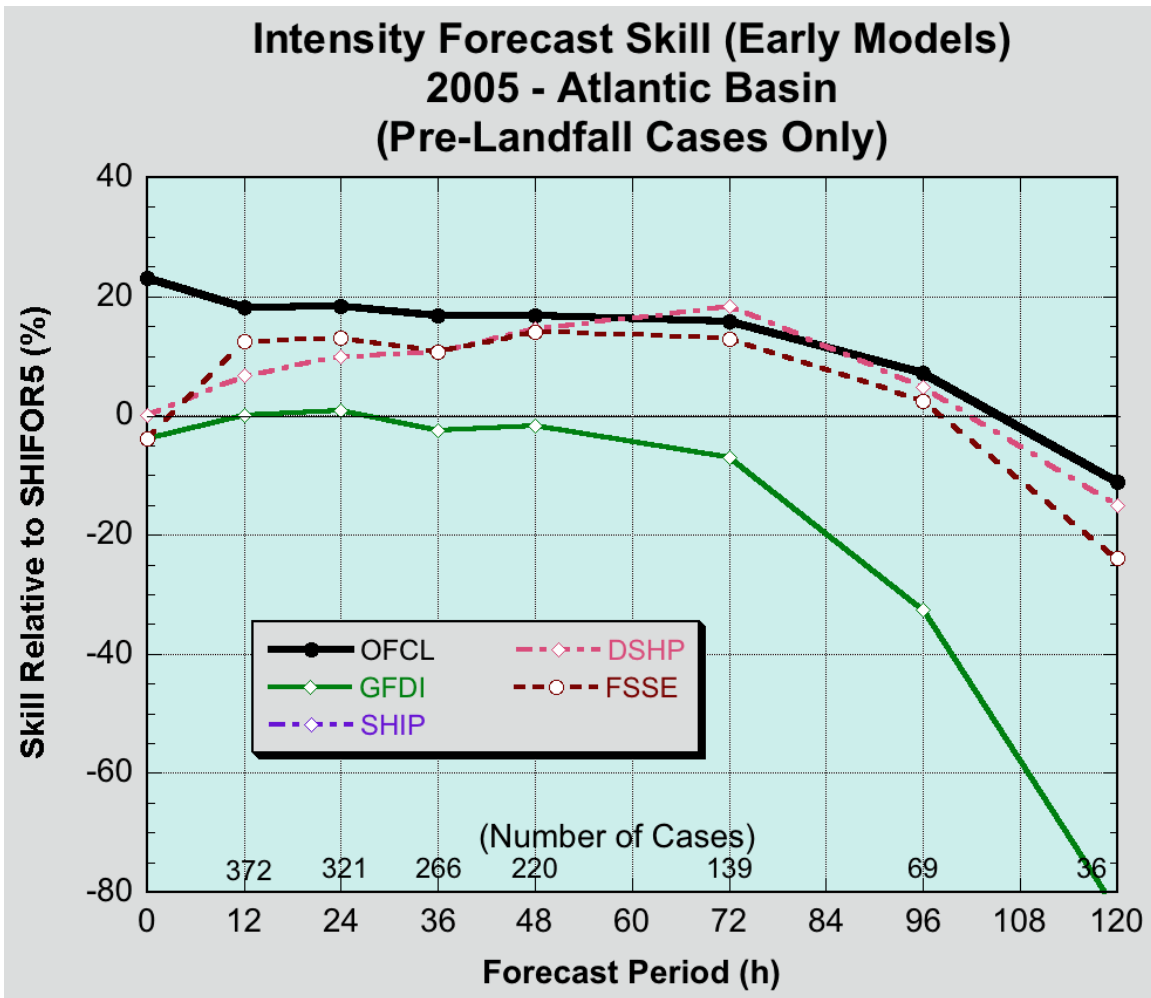


Figure. 5. Homogenous comparison for selected Atlantic basin early intensity guidance models for 2005, for pre-landfall verifications only. The pre-landfall verification sample is defined by excluding any portion of a model forecast that occurs after either the model forecast track or the verifying best 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.)

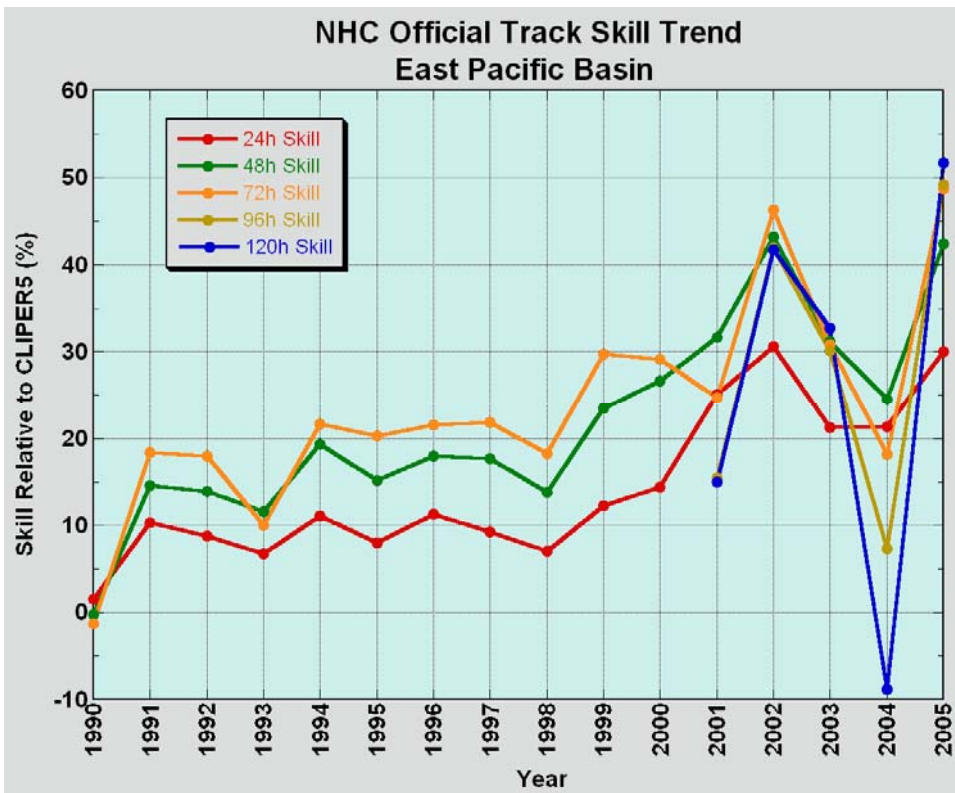
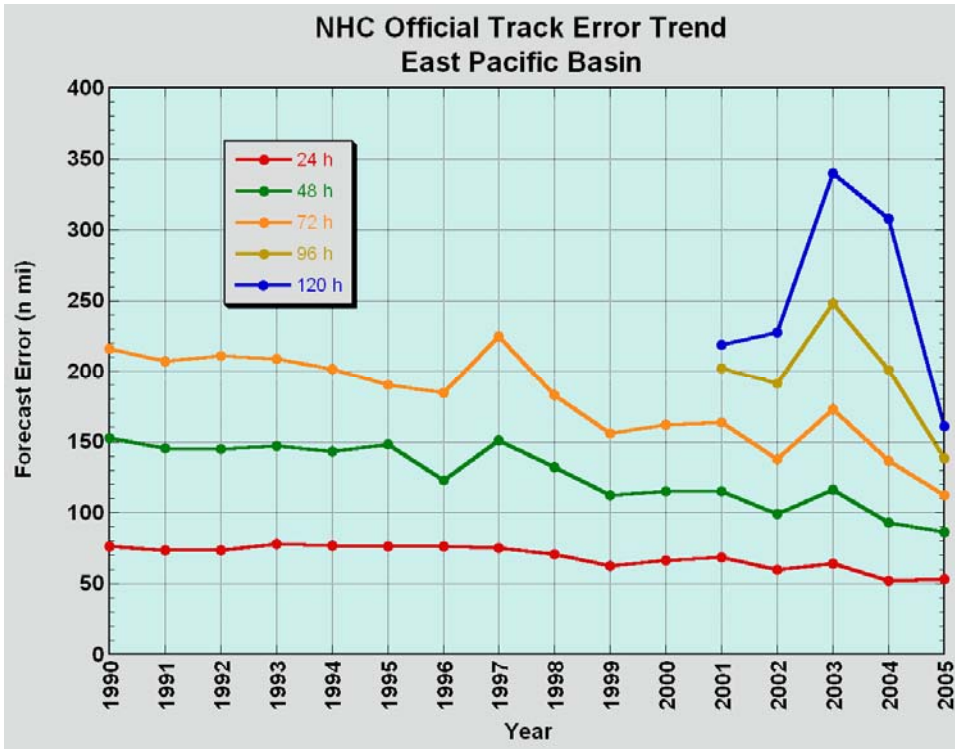


Figure 6. Recent trends in NHC official track forecast error (top) and skill (bottom) for the eastern North Pacific basin.

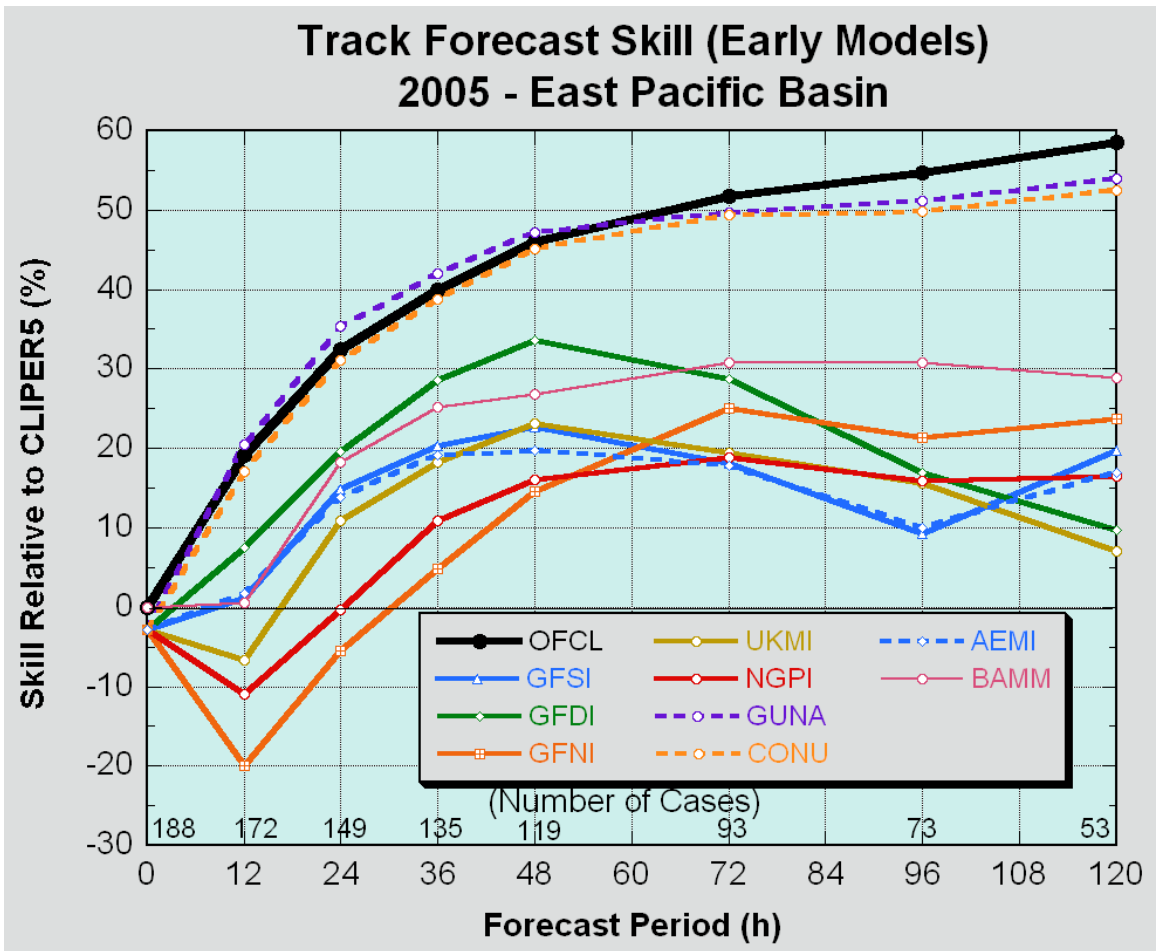


Figure. 7. Homogenous comparison for selected eastern North Pacific basin early track guidance models for 2005.

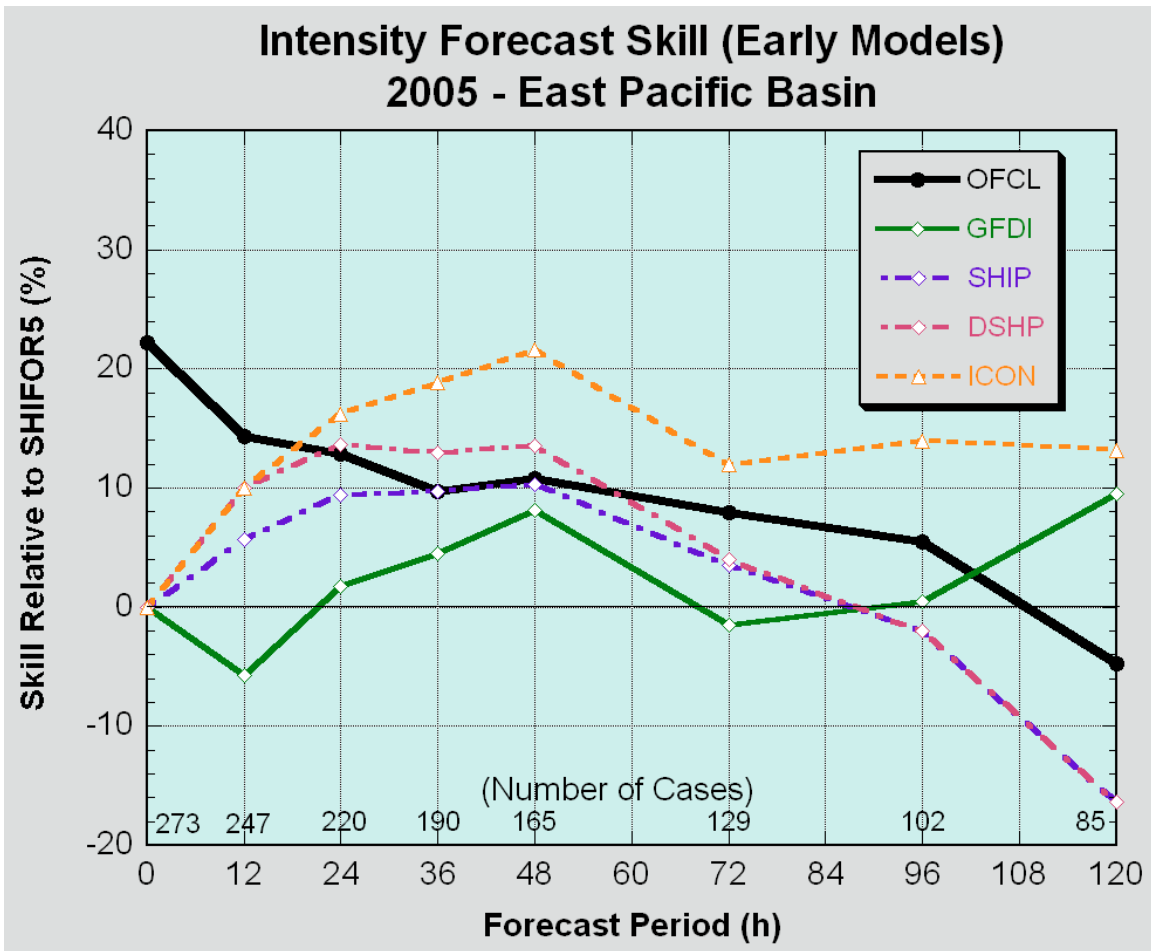


Figure. 8. Homogenous comparison for selected eastern North Pacific basin early intensity guidance models for 2005. Although not computed operationally, included for reference is a simple intensity consensus model (ICON) that is an average of GFDI and DSHP.