2008 National Hurricane Center Forecast Verification Report

James L. Franklin
National Hurricane Center
NOAA/NWS/NCEP/Tropical Prediction Center

2 April 2009

Modified 20 April 2009 to correct DSHP entries in Table 6a

ABSTRACT

It was a relatively busy Atlantic hurricane season, with 373 official forecasts issued in 2008; 149 of these forecasts verified at 120 h. The NHC official track forecasts in the Atlantic basin set records for accuracy at all times from 12-120 h in 2008. Official forecast skill was also at record levels in 2008 for all forecast lead times. On average, the skill of the official forecasts was very close to that of the consensus models, but slightly below the best of the dynamical models. The EMXI exhibited the highest skill, with the GHMI second. NGPI and EGRI were the poorer performing major dynamical models in 2008. Among the consensus models, TVCN (the variable-member consensus that includes EMXI) performed the best overall.

Official intensity errors for the Atlantic basin in 2008 were below the previous 5-yr means, and set records at 72-120 h. Decay-SHIFOR errors in 2008 were also below normal. Despite the success at the longer lead times, official intensity errors have remained essentially unchanged over the last 20 years, while skill has been relatively flat over the past several seasons. Among the individual intensity guidance models, the LGEM performed best in 2008. ICON, a simple four-model consensus of DSHP, LGEM, HWRF, and GHMI, was superior to each of the models it comprises; ICON was also superior to the corrected consensus model FSSE.

There were 311 official forecasts issued in the eastern North Pacific basin in 2008, although only 52 of these verified at 120 h. This level of forecast activity was near average. NHC official track forecast errors set records at 24-72 h. The official forecast beat the individual dynamical models at all lead times, and for good measure beat the consensus at 96 and 120 h. Among the guidance models with sufficient availability, GHMI performed best overall, although HWFI and NGPI performed better at 120 h. The EMXI also performed very well but had availability issues at the longer forecast periods. The TVCN consensus significantly outperformed its individual member models.

For intensity, the official forecast mostly beat the individual models and even beat the consensus at 12 and 36 h. Official intensity biases turned sharply negative at 96-120 h; a similar behavior was noted in 2007. The best model at most forecast times was statistical in nature, and DSHP provided the most skillful guidance overall. The four-model intensity consensus ICON performed very well.

The 2008 season marked the second year of operational availability of the HWRF regional hurricane model. The model has been competitive with the GFDL, but in general has not yet attained the skill of the GFDL. A combination of the two models, however, generally was superior to either one alone.

Experimental probabilistic forecasts of tropical cyclogenesis (i.e., the likelihood of tropical cyclone formation from a particular disturbance within 48 h) continued in 2008. In-house forecasts were produced in 10% increments while the public forecasts were expressed in terms of categories ("low", "medium", or "high"). Results over the two-year experimental period 2007-8 showed that the numerical probabilities had reasonable reliability.

Table of Contents

1. Introduction

For all operationally-designated tropical or subtropical cyclones in the Atlantic and eastern North Pacific basins, the National Hurricane Center (NHC) issues an "official" forecast of the cyclone's center location and maximum 1-min surface wind speed. Forecasts are issued every 6 hours, and contain projections valid 12, 24, 36, 48, 72, 96, and 120 h after the forecast's nominal initial time (0000, 0600, 1200, or 1800 UTC)[1]. At the conclusion of the season, forecasts are evaluated by comparing the projected positions and intensities to the corresponding post-storm derived "best track" positions and intensities for each cyclone. A forecast is included in the verification only if the system is classified in the final best track as a tropical (or subtropical[2]) cyclone at both the forecast's initial time and at the projection's valid time. All other stages of development (e.g., tropical wave, [remnant] low, extratropical) are excluded[3]. For verification purposes, forecasts associated with special advisories do not supersede the original forecast issued for that synoptic time; rather, the original forecast is retained[4]. Except where noted to the contrary, all verifications in this report include the depression stage.

It is important to distinguish between *forecast error* and *forecast skill*. Track forecast error, for example, is defined as the great-circle distance between a cyclone's

---

[1] The nominal initial time represents the beginning of the forecast process. The actual advisory package is not released until 3 h after the nominal initial time, i.e., at 0300, 0900, 1500, and 2100 UTC.

[2] For the remainder of this report, the term "tropical cyclone" shall be understood to also include subtropical cyclones.

[3] Possible classifications in the best track are: Tropical Depression, Tropical Storm, Hurricane, Subtropical Depression, Subtropical Storm, Extratropical, Disturbance, Wave, and Low.

[4] Special advisories are issued whenever an unexpected significant change has occurred or when watches or warnings are to be issued between regularly scheduled advisories. The treatment of special advisories in forecast databases changed in 2005 to the current practice of retaining and verifying the original advisory forecast.

forecast position and the best track position at the forecast verification time. Skill, on the other hand, represents a normalization of this forecast error against some standard or baseline. Expressed as a percentage improvement over the baseline, the skill of a forecast s_f is given by

$$s_f(\%) = 100 * (e_b - e_f) / e_b$$

where e_b is the error of the baseline model and e_f is the error of the forecast being evaluated. It is seen that skill is positive when the forecast error is smaller than the error from the baseline.

To assess the degree of skill in a set of track forecasts, the track forecast error can be compared with the error from CLIPER5, a climatology and persistence model that contains no information about the current state of the atmosphere (Neumann 1972, Aberson 1998)[5]. Errors from the CLIPER5 model are taken to represent a "no-skill" level of accuracy that is used as the baseline (e_b) for evaluating other forecasts[6]. 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. The current version of CLIPER5 is based on developmental data from 1931-2004 for the Atlantic and from 1949-2004 for the eastern Pacific.

Particularly useful skill standards are those that do not require operational products or inputs, and can therefore be easily applied retrospectively to historical data. CLIPER5 satisfies this condition, since it can be run using persistence predictors (e.g., the storm's current motion) that are based on either operational or best track inputs. The

---

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

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

best-track version of CLIPER5, which yields substantially lower errors than its operational counterpart, is generally used to analyze lengthy historical records for which operational inputs are unavailable. It is more instructive (and fairer) to evaluate operational forecasts against operational skill benchmarks, and therefore the operational versions are used for the verifications discussed below.[7]

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 is assessed using Decay-SHIFOR5 (DSHIFOR5) as the baseline. The DSHIFOR5 forecast is obtained by initially running SHIFOR5, the climatology and persistence model for intensity that is analogous to the CLIPER5 model for track (Jarvinen and Neumann 1979, Knaff et al. 2003). The output from SHIFOR5 is then adjusted for land interaction by applying the decay rate of DeMaria et al. (2006). The application of the decay component requires a forecast track, which here is given by CLIPER5. The use of DSHIFOR5 as the intensity skill benchmark was introduced in 2006. On average, DSHIFOR5 errors are about 5-15% lower than SHIFOR5 in the Atlantic basin from 12-72 h, and about the same as SHIFOR5 at 96 and 120 h.

NHC also issues forecasts of the size of tropical cyclones; these "wind radii" forecasts are estimates of the maximum extent of winds of various thresholds (34, 50, and 64 kt) expected in each of four quadrants surrounding the cyclone. Unfortunately, there is insufficient surface wind information to allow the forecaster to accurately analyze the

[7] On very rare occasions, operational CLIPER or SHIFOR runs are missing from forecast databases. To ensure a complete homogeneous verification, post-season retrospective runs of the skill benchmarks are made using operational inputs. Furthermore, if a forecaster makes multiple estimates of the storm's initial motion, location, etc., over the course of a forecast cycle, then these retrospective skill benchmarks may differ slightly from the operational CLIPER/SHIFOR runs that appear in the forecast database.

size of a tropical cyclone's wind field. As a result, post-storm best track wind radii are likely to have errors so large as to render a verification of official radii forecasts misleading at best, and no verifications of NHC wind radii are therefore included in this report. In time, as our ability to measure the surface wind field in tropical cyclones improves, it may be possible to perform a meaningful verification of NHC wind radii forecasts.

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 National Weather Service/Global Forecast System (GFS) model is not complete and available to the forecaster until about 16Z, or about an hour after the NHC forecast is released. Consequently, 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 also given.

Multi-layer dynamical models are generally, if not always, late models. Fortunately, a technique exists to take the most recent 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 smoothed and then adjusted, or shifted, so that the 6-h forecast (valid at 12Z) would 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, mostly for historical reasons, as *interpolated* models[8]. The adjustment algorithm is invoked as long as the most recent available late model is not more than 12 h old, e.g., a 00Z late model could be used to form an interpolated model for the subsequent 06Z or 12Z forecast cycles, but not for the subsequent 18Z cycle. Verification procedures here make no distinction between 6 h and 12 h interpolated models.[9]

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. Briefly, *dynamical* models forecast by solving the physical equations governing motions in the atmosphere. Dynamical models may treat the atmosphere either as a single layer (two-dimensional) or as having multiple layers (three-dimensional), and their domains may cover the entire globe or be limited to specific regions. The interpolated versions of dynamical model track and intensity forecasts are also sometimes referred to as dynamical models. *Statistical* models, in contrast, do not consider the characteristics of the current atmosphere explicitly but instead are based on historical relationships between storm behavior and various other parameters. *Statistical-dynamical* models are statistical in structure but use forecast parameters from dynamical models as predictors. *Consensus* models are not true forecast models *per se*, but are

---

[8] When the technique to create an early model from a late model was first developed, forecast output from the late models was available only at 12 h (or longer) intervals. In order to shift the late model's forecasts forward by 6 hours, it was necessary to first interpolate between the 12 h forecast values of the late model – hence the designation "interpolated".

[9] The UKM and EMX models are only run out to 120 h twice a day (at 0000 and 1200 UTC). Consequently, roughly half the interpolated forecasts from these models are 12 h old.

merely combinations of results from other models. One way to form a consensus is to simply average the results from a collection (or "ensemble") of models, but other, more complex techniques can also be used. The FSU "super-ensemble", for example, combines its individual components on the basis of past performance and attempts to correct for biases in those components (Williford et al. 2003). A consensus model that considers past error characteristics can be described as a "weighted" or "corrected" consensus. Additional information about the guidance models used at the NHC can be found at http://www.nhc.noaa.gov/modelsummary.shtml.

The verifications described in this report are based on forecast and best track data sets taken from the Automated Tropical Cyclone Forecast (ATCF) System on 10 February 2009[10]. Verifications for the Atlantic and eastern North Pacific basins are given in Sections 2 and 3 below, respectively. Section 4 discusses NHC's in-house probabilistic genesis forecasts, an experimental program that began in 2007. Section 5 summarizes the key findings of the 2008 verification and previews anticipated changes for 2009.

[10] In ATCF lingo, these are known as the "a decks" and "b decks", respectively.

2. Atlantic Basin

a. 2008 season overview – Track

Figure 1 and Table 2 present the results of the NHC official track forecast verification for the 2008 season, along with results averaged for the previous 5-yr period 2003-2007. In 2008, the NHC issued 373 tropical cyclone forecasts[11], a number very close to the average over the previous five years (380). Mean track errors ranged from 28 n mi at 12 h to 192 n mi at 120 h. It is seen that mean official track forecast errors were smaller in 2008 than during the previous 5-yr period (by 17%-30%), and in fact, the forecast projections at all lead times established new all-time lows. Over the past 15 years or so, 24-72 h track forecast errors have been reduced by about 50% (Fig. 2). Vector biases were mostly westward (i.e., the official forecast tended to fall to the west of the verifying position) and were most pronounced at the middle lead times (e.g., about 30% of the mean error at 48 h). Examination of Table 3b reveals that official forecast biases closely tracked those of the TVCN consensus. Track forecast skill in 2008 ranged from 38% at 12 h to 64% at 120 h (Table 2), and new records for skill also were set at all forecast lead times (Fig. 2).

Table 3a presents a homogeneous[12] verification for the official forecast along with a selection of early models for 2008. In order to maximize the sample size for comparison with the official forecast, a guidance model had to be available at least two-thirds of the time at both 48 h and 120 h. For the early track models, this requirement

---

[11] This count does not include forecasts issued for systems later classified to have been something other than a tropical cyclone at the forecast time.

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

resulted in the exclusion of AEMI. The sample also excludes models that are close variants of a sample member (e.g., TVCC is a variant of TVCN). Vector biases of the guidance models are given in Table 3b. Results in terms of skill are presented in Fig. 3. The figure shows that official forecast skill was very close to that of the consensus models. The best-performing dynamical model in 2008 was EMXI, whose performance exceeded that of the consensus models as well as that of the official forecast. This is the second year in a row that an individual model beat the Atlantic basin track consensus (in 2007 both GFSI and EGRI did so). The GHMI[13] also performed well, with skill just below or comparable to that of the consensus models. In the middle of the pack were HWFI and GFSI, while the NGPI, GFNI, and EGRI exhibited somewhat less skill.

A separate homogeneous verification of the primary consensus models is shown in Fig. 4. The figure shows that the best consensus model in 2008 was TVCN, the variable component consensus that includes EMXI. It was not a good year for corrected consensus models; TVCC had less skill than TVCN, CGUN had less skill than GUNA, and FSSE was outperformed by each of the three simple consensus models. This illustrates the difficulty of using the past performance of models to derive operational corrections: the sample of forecast cases is too small, the range of meteorological conditions is too varied, and model characteristics are insufficiently stable to produce a robust developmental data sample on which to base the corrections.

Although not shown here, the GFS ensemble mean (AEMI) trailed its control run by a wide margin through 72 h, had roughly equal skill at 96 h, but showed some enhanced skill at 120 h. The ECMWF ensemble mean trailed its control run at all time

[13] For track, GHMI is identical to GFDI (see Table 1).

periods (also not shown). While multi-model ensembles continue to provide consistently useful tropical cyclone guidance, the same cannot yet be said for single-model ensembles.

Although late models are not available to meet forecast deadlines, for completeness verification of a selection of these models is given in Table 4. As the EMX is only run at 0000 and 1200 UTC, this homogeneous verification is restricted to those initial times. Performance of the late models was largely similar to that of the interpolated-dynamical models discussed above. It is of interest that, compared to its peers, the performance of the late EGRR is better than that of the early EGRI. This suggests that EGRI is suffering from the fact that half of its forecasts are 12 h, rather than 6 h interpolations.

Atlantic basin 48-h official track error, evaluated for tropical storms and hurricanes only, is a forecast metric tracked under the Government Performance and Results Act of 1993 (GPRA). In 2008, the GPRA goal was 109 n mi and the verification for this metric was 88.5 n mi.

b. 2008 season overview – Intensity

Figure 5 and Table 5 present the results of the NHC official intensity forecast verification for the 2008 season, along with results averaged for the preceding 5-yr period. Mean forecast errors in 2008 ranged from about 7 kt at 12 h to about 17 kt at 120 h. These errors were close to the 5-yr means through 48 h and substantially below the 5-yr means after that. In fact, the 72-120 h intensity errors set records for accuracy. Forecast biases were small at all lead times. Decay-SHIFOR5 errors were also below normal at 48 h and beyond. It is interesting and somewhat counterintuitive that this occurred in a year for which 9.1% of all 24 h intensity changes qualified as rapid strengthening[14], whereas during the period 2003-7, only 5.9% of all 24 h intensity changes qualified. It is possible that the relatively low decay-SHIFOR5 errors were due to the large fraction of forecast (and verifying) tracks that encountered land. Intensity error and skill trends are shown in Fig. 6, where it is seen that there has been virtually no net change in error and only a modest increase in skill over the past 15-20 years.

Table 6a presents a homogeneous verification for the official forecast and the primary early intensity models for 2008. Intensity biases are given in Table 6b, and forecast skill is presented in Fig. 7. The official forecasts on average showed greater skill than any of the individual guidance models through 36 h and again at 96 h. Among those models, the most consistently strong performance came from LGEM. The GHMI performed well early and late, but showed little or even negative skill from 36 to 72 h. It was not a strong year for either HWFI or DSHP. HWFI in particular had a large positive forecast bias beyond 48 h. DSHP, on the other hand, had a negative bias, which is to be expected in a year with above-normal intensification rates. Overall, the guidance was less skillful in 2008 than in 2007 (a relatively quiet season).

There were two consensus intensity models available to the Hurricane Specialists in 2008: ICON and FSSE. ICON, a simple consensus of HWFI/GHMI/DSHP/LGEM, was computed operationally for the first time this season, and its success is readily apparent in Fig. 7; the skill of ICON far exceeded that of its constituent models as well as that of the corrected consensus FSSE. Because two of the member models of ICON are dynamic and two are statistical, the combination likely benefits from a high degree of

---

[14] Following Kaplan and DeMaria (2003), rapid intensification is defined as a 30 kt increase in maximum winds in a 24 h period, and corresponds to the 5^{th} percentile of all intensity changes in the Atlantic basin.

independence among its members. The performance of ICON offers some hope that official intensity forecast verifications will soon show an increase in accuracy. On the other hand, it is worth noting that the skill of ICON (and the intensity models generally) is far less impressive when the effects of landfall are removed from the evaluation. This is done by restricting the sample to only those verification times when the both the forecast storm and the actual storm had not yet encountered land. With this restriction, none of the individual models had skill beyond 48 h, and the official forecast was mostly superior to even ICON (not shown). This indicates that the subjective judgment of the Hurricane Specialist is still playing an essential role in the intensity forecast process, and that the objective guidance still has far to go.

c. Verifications for individual storms

Forecast verifications for individual storms are given in Table 7. Mean track errors were relatively constant over the course of the season, apart from Ike (which had below average errors) and Josephine and Omar (which had above average errors). For intensity, Gustav, Omar, and Paloma were problematic. Gustav's errors were affected by track forecasts that called for less land interaction than what actually occurred, an under-forecast rapid intensification episode, and unexpected weakening in the Gulf of Mexico. Unsurprisingly, neither Omar's nor Paloma's rapid strengthening and subsequent rapid weakening episodes were adequately anticipated. Additional discussion on forecast performance for individual storms can be found in NHC Tropical Cyclone Reports available at http://www.nhc.noaa.gov/2008atlan.shtml.

3. Eastern North Pacific Basin

a. 2008 season overview – Track

Figure 8 and Table 8 present the NHC official track forecast verification for the 2008 season in the eastern North Pacific, along with results averaged for the previous 5-yr period 2003-7. There were 311 official forecasts issued in the eastern North Pacific basin in 2008, although only 52 of these verified at 120 h. This level of forecast activity was near average. Mean track errors ranged from 31 n mi at 12 h to 161 n mi at 120 h, and were mostly 15%-30% below the 5-year means. New records for accuracy were set at 24-72 h. CLIPER5 errors were also below but somewhat closer to their long-term means, resulting in mean forecast skill that was higher than normal throughout the forecast period. Figure 9 shows recent trends in track forecast accuracy and skill for the eastern North Pacific. Errors have been reduced by roughly 30-50% for the 24-72 h forecasts since 1990, a somewhat smaller, but still substantial, improvement than what has occurred in the Atlantic. Forecast skill in 2008 was not quite as high as in 2007, but a general upward trend that began near the end of the last decade is still evident. Forecast biases were smaller than normal through 48 h, but significantly larger than normal at 96 and 120 h. Long-range forecast vector biases for individual storms were overwhelmingly oriented to the east, southeast, or south.

Table 9a presents a homogeneous verification for the official forecast and the early track models for 2008, with vector biases of the guidance models given in Table 9b. Skill comparisons of selected models are shown in Fig. 10. Note that the sample becomes very small by 120 h. Several models (EMXI, EGRI, AEMI, FSSE, GUNA, and TCON) were eliminated from this sample because they did not meet the two-thirds availability threshold. Among the surviving dynamical models, the GHMI performed best, and HWFI also did reasonably well. None of the models had skill at 120 h. The multi-model consensus TVCN provided significant value over the models it comprises; indeed, the power of a multi-model consensus traditionally is much stronger for the eastern North Pacific than for the Atlantic. On the other hand, the GFS ensemble mean (AEMI, not shown) was not superior to its control run except at 96 and 120 h.

A separate verification of the primary multi-model consensus aids is given in Figure 11. TVCN performed best overall. Neither of the corrected consensus models (FSSE and TVCC) distinguished themselves.

A verification of selected late track models, including EMX, is given in Table 10. The results generally mirror the verification of the early models. The EMX performed nearly as well as the GFDL at some time periods.

b. 2008 season overview – Intensity

Figure 12 and Table 11 present the results of the NHC eastern North Pacific intensity forecast verification for the 2008 season, along with results averaged for the preceding 5-yr period. Mean forecast errors were 6 kt at 12 h and increased to 18 kt by 120 h. These errors were generally below the 5-yr means, although decay-SHIFOR5 forecast errors in 2008 were below their 5-yr means by a similar amount. A review of error and skill trends (Fig. 13) indicates little net change in intensity error since 1990, although there has been a slight increase in forecast skill. Eastern North Pacific intensity forecasts have traditionally had a high bias, but in 2008 the official forecast biases were mostly negative (and fairly substantial at 96-120 h).

Figure 14 and Table 12a present a homogeneous verification for the primary early intensity models for 2008. The official forecast beat all the individual guidance models through 72 h, but was beaten by DSHP at the longer ranges. DSHP provided the best guidance overall, being surpassed only by GHMI at 36 and 48 h, and was the only guidance to show skill beyond 72 h. The ICON consensus also beat the individual models through 72 h. Interestingly, all the model guidance had a low forecast bias (Table 12b), although DSHP's low bias was the smallest of the group. DSHP forecasts were also more aggressive, relative to the other guidance, in both 2007 and 2006.

The above sample excludes FSSE because it did not meet the two-thirds availability requirement. However, a homogeneous comparison of FSSE against the simple ICON consensus (not shown) reveals that ICON had lower average errors at all forecast times. In 2007, FSSE was slightly better than ICON through 72 h and about the same thereafter.

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/2008epac.shtml.

4. Genesis Forecasts

The NHC routinely issues Tropical Weather Outlooks (TWOs) for both the Atlantic and eastern North Pacific basins. The TWOs are text products that discuss areas of disturbed weather and their potential for tropical cyclone development during the following 48 hours. In 2007, the NHC began producing in-house experimental probabilistic tropical cyclone genesis forecasts. Forecasters subjectively assigned a probability of genesis (0 to 100%, in 10% increments) to each area of disturbed weather described in the TWO, where the assigned probabilities represented the NHC forecaster's subjective determination of the chance of TC formation during the 48 h period following the nominal TWO issuance time.

Verification was based on NHC best-track data, with the time of genesis defined to be the first tropical cyclone point appearing in the best track. Verifications for the Atlantic and eastern North Pacific basins for 2008 are given in Table 14. In the Atlantic, the correlation between the forecast and verifying genesis percentages was only fair, with a notable over-forecast bias at the higher likelihoods. In the eastern North Pacific, the relationship between forecast and verifying genesis rates was improved over 2007 but still somewhat uneven.

Combined results for the two-year period 2007-8 are given in Table 15 and illustrated in Fig. 15. The figure suggests that division of the probability space into 10%-wide bins results in uneven reliability for genesis forecasts of 60% or higher (although the sample at these frequencies is small). Consequently, a decision has been made to keep these quantitative genesis forecasts internal to NHC again in 2009. A division of the probability space into three bins, however, does appear to offer sufficient separation and reliability to be useful (Table 16). Binned categorical forecasts were issued publicly in 2008 through the experimental Graphical Tropical Weather Outlook (although with slightly different bins than shown in the table). Based on these results, a three-tiered categorical genesis forecast will become operational in the graphical and text Tropical Weather Outlook in 2009.

5. Looking Ahead to 2009

a. Track Forecast Cone Sizes

The National Hurricane Center track forecast cone depicts the probable track of the center of a tropical cyclone, and is formed by enclosing the area swept out by a set of circles along the forecast track (at 12, 24, 36 h, etc.) The size of each circle is set so that two-thirds of historical official forecast errors over the most-recent 5-year sample fall within the circle. The circle radii defining the cones in 2009 for the Atlantic and eastern North Pacific basins (based on error distributions for 2004-8) are given below. In the Atlantic, the cone circles will be only slightly smaller than they were last year. The eastern North Pacific circles will be about 10% smaller in 2009.

Track Forecast Cone Two-Thirds Probability Circles for 2009 (n mi)		
Forecast Period (h)	**Atlantic Basin**	**Eastern North Pacific Basin**
12	36	36
24	62	59
36	89	85
48	111	105
72	167	148
96	230	187
120	302	230

b. Consensus Models

In 2008, NHC changed the nomenclature for many of its consensus models. The new system defines a set of consensus model identifiers that remain fixed from year to year. The *specific members* of these consensus models, however, will be determined at the beginning of each season and may vary from year to year.

Some consensus models require all of their member models to be available in order to compute the consensus (e.g., GUNA), while others are less restrictive, requiring only two or more members to be present (e.g., TVCN). The terms “fixed” and “variable” can be used to describe these two approaches, respectively. In a variable consensus model, it is often the case that the 120 h forecast is based on a different set of members than the 12 h forecast. While this approach greatly increases availability, it does pose consistency issues for the forecaster.

The consensus model composition for 2009 is unchanged from 2008 and is given below:

NHC Consensus Model Definitions For 2009			
Model ID	**Parameter**	**Type**	**Members**
GUNA	Track	Fixed	GFSI EGRI NGPI GHMI
TCON	Track	Fixed	GFSI EGRI NGPI GHMI HWFI
ICON	Intensity	Fixed	DSHP LGEM GHMI HWFI
TVCN	Track	Variable	GFSI EGRI NGPI GHMI HWFI GFNI EMXI
IVCN	Intensity	Variable	DSHP LGEM GHMI HWFI GFNI
CGUN	Track	Fixed (corrected)	GFSI EGRI NGPI GHMI
TCCN	Track	Fixed (corrected)	GFSI EGRI NGPI GHMI HWFI
TVCC	Track	Variable (corrected)	GFSI EGRI NGPI GHMI HWFI GFNI EMXI

Acknowledgments:

The author gratefully acknowledges Chris Sisko of TPC, keeper of the NHC forecast databases, and Hurricane Specialist Dan Brown for maintaining the genesis forecast database.

6. References

Aberson, S. D., 1998: Five-day tropical cyclone track forecasts in the North Atlantic basin. *Wea. Forecasting,* **13**, 1005-1015.

DeMaria, M., J. A. Knaff, and J. Kaplan, 2006: On the decay of tropical cyclone winds crossing narrow landmasses, *J. Appl. Meteor.*, **45**, 491-499.

Jarvinen, B. R., and C. J. Neumann, 1979: Statistical forecasts of tropical cyclone intensity for the North Atlantic basin. NOAA Tech. Memo. NWS NHC-10, 22 pp.

Kaplan, J., and M. DeMaria, 2003: Large-scale characteristics of rapidly intensifying tropical cyclones in the North Atlantic basin. *Wea. Forecasting,* **18**, 1093-1108.

Knaff, J.A., M. DeMaria, B. Sampson, and J.M. Gross, 2003: Statistical, five-day tropical cyclone intensity forecasts derived from climatology and persistence. *Wea. Forecasting*, **18**, 80-92.

Neumann, C. B., 1972: An alternate to the HURRAN (hurricane analog) tropical cyclone forecast system. NOAA Tech. Memo. NWS SR-62, 24 pp.

Williford, C.E., T. N. Krishnamurti, R. C. Torres, S. Cocke, Z. Christidis, and T. S. V. Kumar: Real-Time Multimodel Superensemble Forecasts of Atlantic Tropical Systems of 1999. *Mon. Wea. Rev.*, **131**, 1878-1894.

List of Tables

Table 1. National Hurricane Center forecasts and models for the 2008 season.

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
HWRF	Hurricane Weather and Research Forecasting 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, automated tracker	Multi-layer global dynamical	L	Trk, Int
EGRR	United Kingdom Met Office model with subjective quality control applied to the tracker	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
NAM	NWS/NAM	Multi-level regional dynamical	L	Trk, Int
AFW1	Air Force MM5	Multi-layer regional dynamical	L	Trk, Int
EMX	ECMWF global model	Multi-layer global 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

ID	Name/Description	Type	Timeliness (E/L)	Parameters forecast
CLP5	CLIPER5 (Climatology and Persistence model)	Statistical (baseline)	E	Trk
SHF5	SHIFOR5 (Climatology and Persistence model)	Statistical (baseline)	E	Int
DSF5	DSHIFOR5 (Climatology and Persistence model)	Statistical (baseline)	E	Int
OCD5	CLP5 (track) and DSF5 (intensity) models merged	Statistical (baseline)	E	Trk, Int
SHIP	Statistical Hurricane Intensity Prediction Scheme (SHIPS)	Statistical-dynamical	E	Int
DSHP	SHIPS with inland decay	Statistical-dynamical	E	Int
OFCI	Previous cycle OFCL, adjusted	Interpolated	E	Trk, Int
GFDI	Previous cycle GFDL, adjusted	Interpolated-dynamical	E	Trk, Int
GHMI	Previous cycle GFDL, adjusted using a variable intensity offset correction that is a function of forecast time. Note that for track, GHMI and GFDI are identical.	Interpolated-dynamical	E	Trk, Int
HWFI	Previous cycle HWRF, 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
EGRI	Previous cycle EGRR, 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
EMXI	Previous cycle EMX, adjusted	Interpolated-dynamical	E	Trk, Int
GUNA	Average of GFDI, EGRI, NGPI, and GFSI	Consensus	E	Trk
CGUN	Version of GUNA corrected for model biases	Corrected consensus	E	Trk

ID	Name/Description	Type	Timeliness (E/L)	Parameters forecast
AEMI	Previous cycle AEMN, adjusted	Consensus	E	Trk, Int
FSSE	FSU Super-ensemble	Corrected consensus	E	Trk, Int
TCON	Average of GHMI, EGRI, NGPI, GFSI, and HWFI	Consensus	E	Trk
TCCN	Version of TCON corrected for model biases	Corrected consensus	E	Trk
TVCN	Average of at least two of GFSI EGRI NGPI GHMI HWFI GFNI EMXI	Consensus	E	Trk
TVCC	Version of TVCN corrected for model biases	Corrected consensus	E	Trk
ICON	Average of DSHP, LGEM, GHMI, and HWFI	Consensus	E	Int
IVCN	Average of at least two of DSHP LGEM GHMI HWFI GFNI	Consensus	E	Int

Table 2. Homogenous comparison of official and CLIPER5 track forecast errors in the Atlantic basin for the 2008 season for all tropical cyclones. Averages for the previous 5-yr period are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
2008 mean OFCL error (n mi)	27.7	48.3	68.6	88.2	126.9	159.8	191.8
2008 mean CLIPER5 error (n mi)	44.9	98.7	165.8	235.2	349.1	448.3	536.2
2008 mean OFCL skill relative to CLIPER5 (%)	38	51	59	63	64	64	64
2008 mean OFCL bias vector (°/n mi)	281/6	279/13	277/22	279/30	265/37	284/22	355/33
2008 number of cases	346	318	288	261	221	177	149
2003-2007 mean OFCL error (n mi)	34.0	58.2	82.2	106.2	154.2	207.5	272.5
2003-2007 mean CLIPER5 error (n mi)	46.6	96.6	152.6	205.9	301.0	393.1	480.2
2003-2007 mean OFCL skill relative to CLIPER5 (%)	27	40	46	48	49	47	43
2003-2007 mean OFCL bias vector (°/n mi)	307/7	312/15	316/23	320/32	317/33	328/29	001/38
2003-2007 number of cases	1742	1574	1407	1254	996	787	627
2008 OFCL error relative to 2003-2007 mean (%)	-19	-17	-17	-17	-18	-23	-30
2008 CLIPER5 error relative to 2003-2007 mean (%)	-4	2	9	14	16	14	12

Table 3a. Homogenous comparison of Atlantic basin early track guidance model errors (n mi) for 2008. 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	26.2	45.5	65.3	85.6	129.8	164.3	181.0
OCD5	44.1	102.1	175.0	250.7	362.7	425.5	525.4
GFSI	31.9	54.2	76.4	105.2	158.3	195.9	235.1
GHMI	29.4	49.1	68.4	87.9	**125.4**	175.9	215.5
HWFI	30.9	53.1	77.9	102.7	142.9	197.3	244.1
GFNI	34.0	61.7	88.1	111.2	161.1	206.6	235.8
NGPI	31.6	57.2	84.0	111.3	163.7	213.7	248.8
EGRI	33.2	59.6	88.8	119.7	178.5	244.3	299.0
EMXI	26.3	**41.9**	**58.6**	**74.7**	**119.3**	**154.2**	**180.8**
FSSE	27.0	**45.3**	65.9	87.0	131.1	172.6	**177.9**
TCON	26.4	**44.5**	**64.6**	86.0	**128.0**	**164.0**	187.3
TVCN	**26.1**	**43.2**	**62.1**	**82.4**	**121.7**	**156.3**	**177.6**
GUNA	26.9	45.6	65.7	87.2	131.9	167.5	189.4
LBAR	32.4	59.9	92.6	123.1	161.8	197.8	251.5
BAMS	49.3	92.7	135.8	174.8	237.0	267.6	265.7
BAMM	36.0	65.6	98.0	131.6	174.9	222.7	246.3
BAMD	34.1	59.1	90.9	122.4	157.9	226.6	267.9
# Cases	200	188	176	151	115	88	63

Table 3b. Homogenous comparison of Atlantic basin early track guidance model bias vectors (º/n mi) for 2008.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	276/006	280/012	279/020	275/030	268/038	322/021	046/035
OCD5	210/002	149/003	062/009	040/021	033/097	042/239	049/398
GFSI	314/010	316/015	315/016	293/018	260/018	101/015	090/084
GHMI	291/003	304/009	302/016	306/024	348/039	017/078	039/140
HWFI	302/009	302/017	302/024	293/030	329/027	037/069	055/160
GFNI	234/010	250/018	262/029	266/040	272/055	293/051	022/063
NGPI	288/009	290/019	294/031	294/041	282/065	312/058	027/087
EGRI	221/007	222/017	228/030	233/047	227/073	215/086	210/086
EMXI	240/005	228/011	224/016	234/024	242/041	243/030	219/024
FSSE	295/004	280/008	270/013	271/019	274/029	297/025	011/029
TCON	289/006	287/013	285/020	277/028	278/032	353/019	057/071
TVCN	271/006	273/012	274/020	271/028	271/035	321/019	052/055
GUNA	283/006	281/012	279/019	274/028	269/036	307/017	058/050
LBAR	314/002	302/018	301/035	300/053	299/061	260/050	193/081
BAMS	282/022	274/039	267/055	263/075	253/112	247/114	207/067
BAMM	259/010	253/016	247/021	243/033	235/053	213/054	137/081
BAMD	285/001	007/002	045/005	160/005	170/015	144/027	100/093
# Cases	200	188	176	151	115	88	63

Table 4. Homogenous comparison of selected Atlantic basin late track guidance model errors (n mi) for 2008. Errors from OCD5, an early model, are shown for comparison. The smallest error at each time period is displayed in boldface.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OCD5	43.3	99.3	168.8	241.3	374.7	472.8	565.8
GFDL	29.9	48.8	66.7	83.3	123.3	196.5	255.0
HWRF	32.6	53.4	72.7	95.5	141.7	205.5	281.5
GFDN	35.3	59.4	85.1	108.9	159.0	222.3	280.5
EGRR	33.3	48.5	73.3	101.0	146.9	194.1	220.6
NGPS	32.4	56.5	82.9	107.6	161.6	224.2	297.2
GFSO	37.7	60.1	77.5	97.1	139.0	184.4	218.7
EMX	**25.6**	**37.7**	**53.8**	**67.0**	**101.5**	**135.6**	**156.4**
# Cases	131	122	109	102	83	63	48

Table 5. Homogenous comparison of official and Decay-SHIFOR5 intensity forecast errors in the Atlantic basin for the 2008 season for all tropical cyclones. Averages for the previous 5-yr period are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
2008 mean OFCL error (kt)	7.1	10.4	12.1	13.6	14.6	13.8	17.2
2008 mean Decay-SHIFOR5 error (kt)	8.7	12.4	14.7	15.6	16.9	17.7	18.9
2008 mean OFCL skill relative to Decay-SHIFOR5 (%)	18	16	17	12	13	22	8
2008 OFCL bias (kt)	0.4	1.3	1.6	2.2	3.1	1.6	1.3
2008 number of cases	346	318	288	261	221	177	149
2003-7 mean OFCL error (kt)	6.7	10.0	12.3	14.3	18.2	19.7	21.8
2003-7 mean Decay-SHIFOR5 error (kt)	8.0	11.7	14.9	17.7	21.2	23.9	24.5
2003-7 mean OFCL skill relative to Decay-SHIFOR5 (%)	16	14	17	19	14	17	11
2003-7 OFCL bias (kt)	0.0	0.1	-0.5	-1.2	-2.2	-3.9	-4.8
2003-7 number of cases	1742	1574	1407	1254	996	787	627
2008 OFCL error relative to 2003-7 mean (%)	6	4	-2	-5	-20	-30	-21
2008 Decay-SHIFOR5 error relative to 2003-7 mean (%)	9	6	-1	-11	-20	-26	-23

Table 6a. Homogenous comparison of selected Atlantic basin early intensity guidance model errors (kt) for 2008. Errors smaller than the NHC official forecast are shown in boldface.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	7.3	10.6	12.5	14.0	15.3	14.0	17.9
OCD5	8.7	12.4	14.9	15.6	17.0	18.3	19.6
HWFI	8.4	11.8	13.6	14.8	19.2	19.9	21.5
GHMI	8.5	11.5	14.7	17.3	18.3	14.9	**15.2**
DSHP	8.5	11.7	13.8	14.7	17.7	20.1	21.1
LGEM	8.9	12.0	13.4	**13.8**	**14.5**	15.1	**16.0**
ICON	7.8	**10.1**	**11.5**	**12.2**	**13.8**	**12.8**	**13.7**
FSSE	8.4	11.3	13.4	14.8	15.8	14.2	17.9
# Cases	306	284	256	219	178	144	118

Table 6b. Homogenous comparison of selected Atlantic basin early intensity guidance model biases (kt) for 2008. Biases smaller than the NHC official forecast are shown in boldface.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	0.7	1.9	2.5	3.8	4.8	2.7	4.9
OCD5	**-0.6**	**-1.3**	**-2.3**	-3.8	-6.0	-8.5	-8.4
HWFI	-1.6	**-1.6**	**-0.1**	**2.7**	8.0	9.3	12.2
GHMI	**0.1**	**1.5**	4.3	7.1	9.1	6.8	**3.1**
DSHP	-0.7	**-1.2**	**-1.1**	**-2.0**	**-4.1**	-8.5	-10.1
LGEM	-0.9	-1.9	**-2.1**	**-2.5**	**-2.3**	-2.9	**-2.4**
ICON	**-0.5**	**-0.6**	**0.5**	**1.6**	**3.0**	**1.5**	**1.0**
FSSE	-0.7	**-0.5**	**0.0**	**0.4**	**1.3**	**1.1**	**3.7**
# Cases	306	284	256	219	178	144	118

Table 7. Official Atlantic track and intensity forecast verifications (OFCL) for 2008 by storm. CLIPER5 and Decay-SHIFOR5 forecast errors are given for comparison and indicated collectively as OCD5. The 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: AL012008 ARTHUR

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	6	7.1	10.9	6	0.0	1.7
012	4	35.7	65.3	4	2.5	3.5
024	2	89.3	166.7	2	0.0	1.5
036	0	-999.0	-999.0	0	-999.0	-999.0
048	0	-999.0	-999.0	0	-999.0	-999.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL022008 BERTHA

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	69	5.3	5.3	69	0.3	0.6
012	67	24.4	42.0	67	6.4	6.7
024	65	42.6	98.9	65	10.7	11.3
036	63	61.3	168.1	63	11.5	12.5
048	61	82.1	228.7	61	10.7	12.0
072	57	118.4	280.2	57	11.2	11.4
096	53	164.3	285.7	53	10.9	9.9
120	49	200.0	341.3	49	10.3	10.7

Verification statistics for: AL032008 CRISTOBAL

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	18	1.2	1.7	18	2.2	2.5
012	16	28.2	34.2	16	5.3	6.5
024	14	49.6	75.9	14	6.4	7.1
036	12	69.7	117.3	12	6.3	8.2
048	10	96.1	159.3	10	7.5	6.1
072	6	99.0	250.4	6	11.7	9.8
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL042008 DOLLY

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	18	6.4	6.8	18	1.4	1.1
012	18	29.7	53.2	18	4.4	5.4
024	18	42.5	99.3	18	4.4	10.2
036	16	52.8	129.4	16	5.3	13.5
048	10	51.0	152.5	10	6.0	17.7
072	9	95.5	182.8	9	8.9	11.7
096	5	144.0	356.3	5	6.0	13.0
120	2	236.3	479.3	2	5.0	11.0

Verification statistics for: AL052008 EDOUARD

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	9	4.4	4.4	9	1.7	2.2
012	8	29.1	39.3	8	6.3	9.0
024	6	31.1	86.0	6	7.5	14.3
036	4	48.6	133.7	4	7.5	16.3
048	2	66.9	241.3	2	5.0	14.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL062008 FAY

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	34	1.8	2.3	34	1.5	1.6
012	34	22.8	35.8	34	4.1	6.2
024	34	31.4	80.4	34	7.8	7.7
036	34	45.8	141.1	34	8.5	7.7
048	34	61.6	207.8	34	9.7	8.6
072	34	102.3	340.4	34	10.0	12.8
096	30	144.6	509.3	30	12.2	13.9
120	26	220.6	623.9	26	12.9	12.9

Verification statistics for: AL072008 GUSTAV

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	32	2.2	2.6	32	3.1	3.1
012	32	22.7	37.0	32	13.6	13.5
024	32	41.9	86.0	32	18.1	19.0
036	32	65.0	154.2	32	19.1	20.7
048	32	84.8	229.0	32	20.3	21.4
072	28	124.4	369.7	28	21.8	29.0
096	24	136.7	461.3	24	21.0	35.3
120	20	149.2	521.2	20	36.3	40.5

Verification statistics for: AL082008 HANNA

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	40	10.9	10.8	40	1.6	1.6
012	38	44.6	62.8	38	5.1	6.8
024	36	82.8	138.8	36	8.5	9.4
036	34	112.4	218.8	34	11.2	11.2
048	32	125.2	285.9	32	14.4	12.1
072	28	170.6	395.2	28	14.6	10.0
096	24	200.8	482.3	24	9.2	9.1
120	20	212.8	534.8	20	12.0	11.9

Verification statistics for: AL092008 IKE

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	52	7.3	7.4	52	1.1	1.3
012	50	16.8	35.2	50	7.8	8.8
024	48	31.4	80.3	48	10.7	12.6
036	46	46.1	130.6	46	13.0	16.8
048	44	59.3	184.4	44	14.1	18.1
072	40	90.9	328.6	40	17.3	22.6
096	36	121.3	518.0	36	18.1	27.6
120	32	166.3	777.2	32	23.4	27.8

Verification statistics for: AL102008 JOSEPHINE

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	16	7.9	8.0	16	1.9	2.2
012	14	34.8	35.3	14	3.9	7.4
024	12	78.0	68.2	12	6.3	9.4
036	10	131.2	106.3	10	11.5	14.7
048	8	198.6	159.4	8	11.3	18.6
072	4	306.8	292.5	4	21.3	25.3
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL112008 KYLE

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	14	2.5	3.2	14	2.5	2.5
012	12	32.1	60.0	12	4.2	6.0
024	10	44.0	141.6	10	4.0	7.5
036	8	58.9	274.0	8	3.1	6.5
048	6	72.6	396.8	6	3.3	6.8
072	2	68.4	634.0	2	5.0	5.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL122008 LAURA

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	9	4.8	4.8	9	0.0	0.6
012	7	20.2	38.7	7	3.6	2.7
024	5	31.0	103.2	5	8.0	3.8
036	3	36.5	225.6	3	11.7	10.3
048	1	17.6	341.9	1	10.0	16.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL132008 MARCO

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	6	3.3	3.3	6	1.7	3.3
012	4	24.0	25.7	4	15.0	14.0
024	2	27.7	30.5	2	22.5	19.5
036	0	-999.0	-999.0	0	-999.0	-999.0
048	0	-999.0	-999.0	0	-999.0	-999.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL142008 NANA

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	7	7.1	7.1	7	0.0	0.7
012	5	32.5	36.1	5	2.0	3.8
024	3	41.6	34.5	3	5.0	8.0
036	1	67.6	88.2	1	5.0	7.0
048	0	-999.0	-999.0	0	-999.0	-999.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL152008 OMAR

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	20	5.6	6.6	20	5.0	5.3
012	18	42.4	82.2	18	12.2	17.7
024	16	83.9	167.2	16	15.0	20.4
036	14	113.8	319.2	14	19.3	22.7
048	12	165.8	535.2	12	26.3	28.8
072	8	279.8	1004.9	8	14.4	23.9
096	4	471.8	1372.3	4	10.0	13.8
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL162008 SIXTEEN

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	6	7.5	8.6	6	0.8	1.7
012	4	17.4	39.4	4	5.0	6.8
024	2	29.7	79.3	2	15.0	15.5
036	0	-999.0	-999.0	0	-999.0	-999.0
048	0	-999.0	-999.0	0	-999.0	-999.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: AL172008 PALOMA

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	17	9.4	9.4	17	6.5	6.8
012	15	30.6	45.4	15	14.0	20.1
024	13	58.4	90.3	13	19.6	30.6
036	11	79.8	135.8	11	22.7	38.1
048	9	104.8	194.9	9	28.3	39.4
072	5	171.4	282.4	5	36.0	37.6
096	1	172.6	362.3	1	50.0	16.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Table 8. Homogenous comparison of official and CLIPER5 track forecast errors in the eastern North Pacific basin for the 2008 season for all tropical cyclones. Averages for the previous 5-yr period are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
2008 mean OFCL error (n mi)	30.9	47.5	63.7	78.0	107.6	138.8	161.4
2008 mean CLIPER5 error (n mi)	40.8	72.9	110.7	148.3	207.2	245.8	283.6
2008 mean OFCL skill relative to CLIPER5 (%)	24	34	42	47	48	43	43
2008 mean OFCL bias vector (°/n mi)	284/1	201/2	200/4	214/6	167/20	142/47	123/76
2008 number of cases	275	239	205	175	124	85	53
2003-7 mean OFCL error (n mi)	31.9	55.1	77.4	97.9	136.2	180.1	226.1
2003-7 mean CLIPER5 error (n mi)	38.5	75.4	115.5	153.2	222.4	279.7	340.4
2003-7 mean OFCL skill relative to CLIPER5 (%)	17	26	32	36	38	35	33
2003-7 mean OFCL bias vector (°/n mi)	311/3	300/6	298/11	299/18	296/19	310/18	317/25
2003-7 number of cases	1282	1129	979	849	620	439	293
2008 OFCL error relative to 2003-7 mean (%)	-3	-14	-18	-20	-21	-23	-29
2008 CLIPER5 error relative to 2003-7 mean (%)	6	-3	-4	-3	-7	-12	-17

Table 9a. Homogenous comparison of eastern North Pacific basin early track guidance model errors (n mi) for 2008. Errors smaller than the NHC official forecast are shown in boldface.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	31.2	46.4	61.5	73.2	103.9	115.5	133.1
OCD5	39.9	71.1	109.0	145.5	201.2	232.7	254.5
GFSI	36.2	59.0	83.7	110.6	196.9	293.4	435.6
GHMI	31.7	51.5	67.5	84.5	134.1	213.0	297.6
HWFI	36.5	58.5	79.0	103.1	163.8	218.7	271.0
NGPI	40.2	67.4	87.7	109.6	159.7	219.3	259.4
TVCN	**29.4**	**44.4**	**58.1**	**71.1**	**100.2**	134.9	169.1
LBAR	39.4	79.1	125.7	175.6	299.1	453.2	676.5
BAMD	44.4	78.7	110.0	136.7	196.6	235.6	295.1
BAMM	38.8	66.0	95.0	126.5	200.6	277.9	356.4
BAMS	39.9	67.5	93.7	117.0	173.0	231.1	337.8
# Cases	219	185	157	131	84	50	20

Table 9b. Homogenous comparison of eastern North Pacific basin early track guidance model bias vectors (º/n mi) for 2008.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	310/002	231/002	213/004	212/005	173/016	142/037	125/057
OCD5	312/008	301/016	298/024	298/034	282/075	283/068	279/045
GFSI	183/006	177/017	174/031	170/050	168/113	162/191	149/283
GHMI	074/009	066/016	048/019	044/026	064/047	070/105	090/160
HWFI	338/013	329/026	321/040	315/057	306/111	316/130	334/157
NGPI	139/004	133/014	136/025	128/035	121/049	089/102	085/146
TVCN	108/002	122/006	130/010	133/014	140/027	114/061	107/115
LBAR	340/019	329/057	322/102	321/150	323/255	347/345	024/558
BAMD	320/021	314/043	308/066	300/090	283/150	276/164	263/177
BAMM	341/017	322/031	305/049	289/075	265/145	245/200	225/253
BAMS	028/011	360/012	312/016	278/036	246/096	224/144	214/193
# Cases	219	185	157	131	84	50	20

Table 10. Homogenous comparison of eastern North Pacific basin late track guidance model errors (n mi) for 2008. Errors from OCD5, an early model, are shown for comparison. The smallest errors at each time period are displayed in boldface.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OCD5	39.8	69.8	106.7	147.5	231.5	256.9	406.0
GFDL	**30.1**	**45.7**	**54.1**	**68.5**	**97.1**	**146.0**	198.4
HWRF	35.3	55.1	67.0	80.8	157.0	230.6	290.7
GFDN	40.3	68.5	97.3	123.9	160.5	164.6	239.6
EGRR	44.0	64.9	82.4	101.7	149.8	176.0	**158.6**
NGPS	38.8	57.3	73.4	94.1	127.0	182.8	381.1
GFSO	40.9	61.0	74.0	107.3	158.2	238.7	435.0
EMX	36.1	48.2	59.2	75.6	123.6	178.3	348.4
# Cases	103	85	69	55	30	16	5

Table 11. Homogenous comparison of official and Decay-SHIFOR5 intensity forecast errors in the eastern North Pacific basin for the 2008 season for all tropical cyclones. Averages for the previous 5-yr period are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
2008 mean OFCL error (kt)	6.0	9.8	11.9	12.9	15.7	17.6	18.0
2008 mean Decay-SHIFOR5 error (kt)	6.9	11.1	14.2	15.6	16.3	18.0	18.3
2008 mean OFCL skill relative to Decay-SHIFOR5 (%)	13	11	16	17	3	2	1
2008 OFCL bias (kt)	0.4	0.5	-0.3	-2.9	-6.2	-11.6	-11.8
2008 number of cases	275	239	205	175	124	85	53
2003-7 mean OFCL error (kt)	6.2	10.4	13.9	16.3	18.7	19.2	19.1
2003-7 mean Decay-SHIFOR5 error (kt)	7.0	11.3	14.9	17.6	20.3	20.9	20.7
2003-7 mean OFCL skill relative to Decay-SHIFOR5 (%)	11	7	6	7	7	8	7
2003-7 OFCL bias (kt)	0.9	2.2	3.2	3.0	3.7	2.0	-1.2
2003-7 number of cases	1282	1129	979	848	620	439	293
2008 OFCL error relative to 2003-7 mean (%)	-3	-6	-14	-21	-16	-14	-6
2008 Decay-SHIFOR5 error relative to 2003-7 mean (%)	-1	-2	-5	-11	-20	-14	-12

Table 12a. Homogenous comparison of eastern North Pacific basin early intensity guidance model errors (kt) for 2008. Errors smaller than the NHC official forecast are shown in boldface.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	6.0	9.9	11.9	12.7	16.1	17.2	17.1
OCD5	6.8	11.1	14.3	15.6	16.6	**17.0**	**15.8**
HWFI	7.7	11.6	14.4	16.0	19.1	21.3	22.4
GHMI	7.3	10.6	12.5	14.0	17.7	22.4	21.8
DSHP	6.4	10.3	13.2	14.5	16.9	**16.2**	**14.5**
LGEM	6.8	10.6	13.3	14.8	17.5	18.8	17.6
ICON	6.3	**9.4**	**11.4**	12.8	**15.4**	17.5	**16.8**
# Cases	268	233	202	170	117	77	48

Table 12b. Homogenous comparison of eastern North Pacific basin early intensity guidance model biases (kt) for 2008.

	Forecast Period (h)						
Model ID	12	24	36	48	72	96	120
OFCL	0.5	0.4	-0.3	-3.4	-6.6	-12.4	-10.2
OCD5	0.6	1.9	3.0	2.4	0.7	-4.2	-4.5
HWFI	-1.2	-2.4	-2.7	-3.4	-4.3	-10.2	-14.7
GHMI	-2.2	-3.9	-4.7	-6.9	-13.2	-18.1	-16.2
DSHP	0.1	-0.4	-1.1	-3.3	-6.7	-10.2	-7.0
LGEM	-0.7	-2.4	-4.1	-7.0	-10.3	-14.4	-13.1
ICON	-0.8	-2.0	-2.9	-4.9	-8.4	-12.9	-12.6
# Cases	268	233	202	170	117	77	48

Table 13. Official eastern North Pacific track and intensity forecast verifications (OFCL) for 2008 by storm. CLIPER5 (CLP5) and SHIFOR5 (SHF5) forecast errors are given for comparison and indicated collectively as OCD5. The 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: EP012008 ALMA

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	7	1.7	1.7	7	2.1	2.9
012	5	24.4	39.7	5	9.0	11.0
024	3	55.0	97.2	3	6.7	11.0
036	1	85.4	158.9	1	0.0	22.0
048	0	-999.0	-999.0	0	-999.0	-999.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP022008 BORIS

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	29	9.7	9.9	29	2.1	2.1
012	27	28.2	35.4	27	7.2	7.3
024	25	52.0	69.8	25	9.4	9.2
036	23	73.4	102.6	23	13.3	11.3
048	21	99.7	132.5	21	16.0	12.5
072	17	152.1	188.6	17	21.5	12.4
096	13	169.6	163.2	13	22.7	12.6
120	9	157.6	172.7	9	18.9	10.2

Verification statistics for: EP032008 CRISTINA

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	12	9.8	13.6	12	1.7	1.3
012	10	18.7	31.6	10	7.5	6.9
024	8	36.1	62.4	8	6.9	7.9
036	6	50.7	108.6	6	6.7	8.8
048	4	62.9	133.7	4	5.0	5.3
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP042008 DOUGLAS

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	9	8.5	9.3	9	0.6	0.6
012	7	41.4	41.4	7	2.9	1.9
024	5	72.9	65.8	5	10.0	4.4
036	3	122.0	104.3	3	15.0	7.7
048	1	191.2	150.1	1	10.0	11.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP052008 FIVE

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	7	31.6	35.6	7	0.0	0.0
012	5	92.6	97.3	5	3.0	4.8
024	3	124.0	98.2	3	6.7	8.0
036	1	187.0	56.7	1	15.0	19.0
048	0	-999.0	-999.0	0	-999.0	-999.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP062008 ELIDA

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	30	8.4	9.1	30	1.2	1.8
012	28	28.1	32.4	28	5.5	7.8
024	26	45.4	57.2	26	9.6	13.0
036	24	52.9	86.2	24	11.3	14.0
048	22	54.0	125.6	22	12.7	12.6
072	18	52.4	179.7	18	15.3	12.4
096	14	135.2	220.9	14	17.9	18.2
120	10	241.8	272.9	10	17.0	17.5

Verification statistics for: EP072008 FAUSTO

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	27	15.0	17.0	27	1.3	1.3
012	25	39.9	57.5	25	5.0	5.8
024	23	52.7	97.7	23	7.2	7.7
036	21	65.4	145.2	21	7.6	8.6
048	19	78.6	191.6	19	5.3	10.5
072	15	125.7	266.3	15	6.3	11.0
096	11	169.2	312.8	11	10.9	13.3
120	7	206.1	411.0	7	11.4	13.3

Verification statistics for: EP082008 GENEVIEVE

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	24	8.6	9.9	24	0.4	0.4
012	22	30.4	35.8	22	5.7	6.4
024	20	41.7	60.5	20	11.8	12.6
036	18	53.4	85.8	18	11.1	15.4
048	16	62.4	111.6	16	9.4	14.6
072	12	87.6	139.8	12	7.9	11.3
096	8	110.2	168.7	8	10.0	16.0
120	4	117.5	229.0	4	11.3	12.0

Verification statistics for: EP092008 HERNAN

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	25	7.3	8.4	25	1.4	1.6
012	23	24.0	32.8	23	6.7	9.0
024	21	41.6	61.6	21	10.7	15.1
036	19	67.0	85.9	19	13.2	16.9
048	17	81.6	107.1	17	17.6	17.9
072	13	87.0	100.9	13	24.2	20.8
096	9	65.4	110.1	9	26.7	15.7
120	5	62.4	121.3	5	27.0	6.8

Verification statistics for: EP102008 ISELLE

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	14	9.8	9.5	14	1.1	1.1
012	12	39.7	45.5	12	3.3	3.3
024	10	68.6	80.7	10	2.5	7.7
036	8	95.2	125.5	8	5.0	14.8
048	6	116.0	155.4	6	8.3	19.7
072	2	117.0	186.8	2	15.0	28.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP112008 JULIO

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	13	9.7	8.8	13	1.2	2.3
012	11	31.3	37.4	11	3.2	4.9
024	9	59.4	84.5	9	4.4	2.8
036	7	89.9	117.1	7	3.6	2.7
048	5	116.4	169.7	5	4.0	3.4
072	1	159.5	345.6	1	10.0	23.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP122008 KARINA

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	5	3.8	3.8	5	0.0	1.0
012	3	17.5	23.9	3	5.0	11.0
024	1	17.9	30.5	1	10.0	19.0
036	0	-999.0	-999.0	0	-999.0	-999.0
048	0	-999.0	-999.0	0	-999.0	-999.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP132008 LOWELL

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	19	17.0	17.1	19	3.2	3.4
012	17	29.8	47.0	17	4.7	5.1
024	15	40.7	85.5	15	7.3	7.9
036	13	57.6	142.0	13	10.4	11.5
048	11	75.1	198.7	11	12.7	12.5
072	7	128.7	260.7	7	18.6	22.1
096	3	277.9	317.0	3	15.0	21.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP142008 MARIE

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	23	10.5	10.7	23	0.4	0.4
012	21	28.5	42.6	21	5.0	6.4
024	19	45.6	82.7	19	10.3	12.1
036	17	74.1	141.2	17	11.8	15.4
048	15	105.6	189.4	15	12.0	17.2
072	11	168.6	309.8	11	10.0	12.0
096	7	215.4	406.9	7	5.7	5.0
120	3	182.3	364.8	3	6.7	6.7

Verification statistics for: EP152008 NORBERT

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	35	8.8	9.0	35	2.9	3.0
012	33	24.2	38.9	33	9.5	10.1
024	31	33.1	75.0	31	16.0	15.4
036	29	39.7	122.0	29	17.2	19.0
048	27	49.9	165.1	27	16.5	19.4
072	23	80.3	239.2	23	16.3	20.4
096	19	94.2	305.6	19	20.5	31.2
120	15	129.9	350.1	15	22.3	33.9

Verification statistics for: EP162008 ODILE

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	17	11.6	11.3	17	0.9	1.2
012	15	35.2	41.1	15	7.7	5.8
024	13	55.5	65.4	13	12.7	12.6
036	11	69.5	82.7	11	17.3	20.3
048	9	88.9	105.3	9	20.0	32.4
072	5	151.0	161.8	5	30.0	36.4
096	1	236.6	292.8	1	35.0	7.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP172008 SEVENTEEN

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	5	25.6	27.7	5	0.0	0.0
012	3	54.2	62.5	3	3.3	5.3
024	1	88.7	21.4	1	5.0	14.0
036	0	-999.0	-999.0	0	-999.0	-999.0
048	0	-999.0	-999.0	0	-999.0	-999.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Verification statistics for: EP182008 POLO

VT (h)	NT	OFCL	OCD5	NI	OFCL	OCD5
000	10	10.8	10.8	10	2.0	2.5
012	8	26.1	33.8	8	4.4	3.9
024	6	36.5	61.8	6	8.3	12.5
036	4	59.2	82.9	4	13.8	21.5
048	2	106.7	128.8	2	20.0	34.0
072	0	-999.0	-999.0	0	-999.0	-999.0
096	0	-999.0	-999.0	0	-999.0	-999.0
120	0	-999.0	-999.0	0	-999.0	-999.0

Table 14a. Verification of experimental in-house probabilistic genesis forecasts for the Atlantic basin in 2008.

Atlantic Basin Genesis Forecast Reliability Table		
Forecast Likelihood (%)	**Verifying Genesis Occurrence Rate (%)**	**Number of Forecasts**
0	5	129
10	5	231
20	14	56
30	36	50
40	55	31
50	55	31
60	56	25
70	77	13
80	50	12
90	40	5
100	-	0

Table 14b. Verification of experimental in-house probabilistic genesis forecasts for the eastern North Pacific basin in 2008.

Eastern North Pacific Basin Genesis Forecast Reliability Table		
Forecast Likelihood (%)	**Verifying Genesis Occurrence Rate (%)**	**Number of Forecasts**
0	2	55
10	27	143
20	34	58
30	27	48
40	36	28
50	58	33
60	75	12
70	71	14
80	57	7
90	100	1
100	-	0

Table 15a. Verification of experimental in-house probabilistic genesis forecasts for the Atlantic basin for the period 2007- 2008.

Atlantic Basin Genesis Forecast Reliability Table		
Forecast Likelihood (%)	**Verifying Genesis Occurrence Rate (%)**	**Number of Forecasts**
0	2	321
10	5	428
20	13	185
30	29	126
40	41	69
50	39	51
60	56	48
70	69	26
80	60	20
90	69	13
100	100	1

Table 15b. Verification of experimental in-house probabilistic genesis forecasts for the eastern North Pacific basin for the period 2007-2008.

Eastern North Pacific Basin Genesis Forecast Reliability Table		
Forecast Likelihood (%)	**Verifying Genesis Occurrence Rate (%)**	**Number of Forecasts**
0	2	123
10	19	254
20	32	163
30	41	78
40	50	40
50	71	48
60	81	27
70	79	19
80	67	12
90	100	4
100	100	1

Table 16a. Verification of experimental in-house binned probabilistic genesis forecasts for the Atlantic basin in 2008.

Atlantic Basin Genesis Forecast Reliability Table			
Forecast Likelihood (%)	**Expected Genesis Occurrence Rate (%)**	**Verifying Genesis Occurrence Rate (%)**	**Number of Forecasts**
0-20	8	6	416
30-50	38	46	112
60-100	69	58	55

Table 16b. Verification of experimental in-house binned probabilistic genesis forecasts for the eastern North Pacific basin in 2008.

Eastern North Pacific Basin Genesis Forecast Reliability Table			
Forecast Likelihood (%)	**Expected Genesis Occurrence Rate (%)**	**Verifying Genesis Occurrence Rate (%)**	**Number of Forecasts**
0-20	10	23	256
30-50	39	39	109
60-100	69	71	34

List of Figures

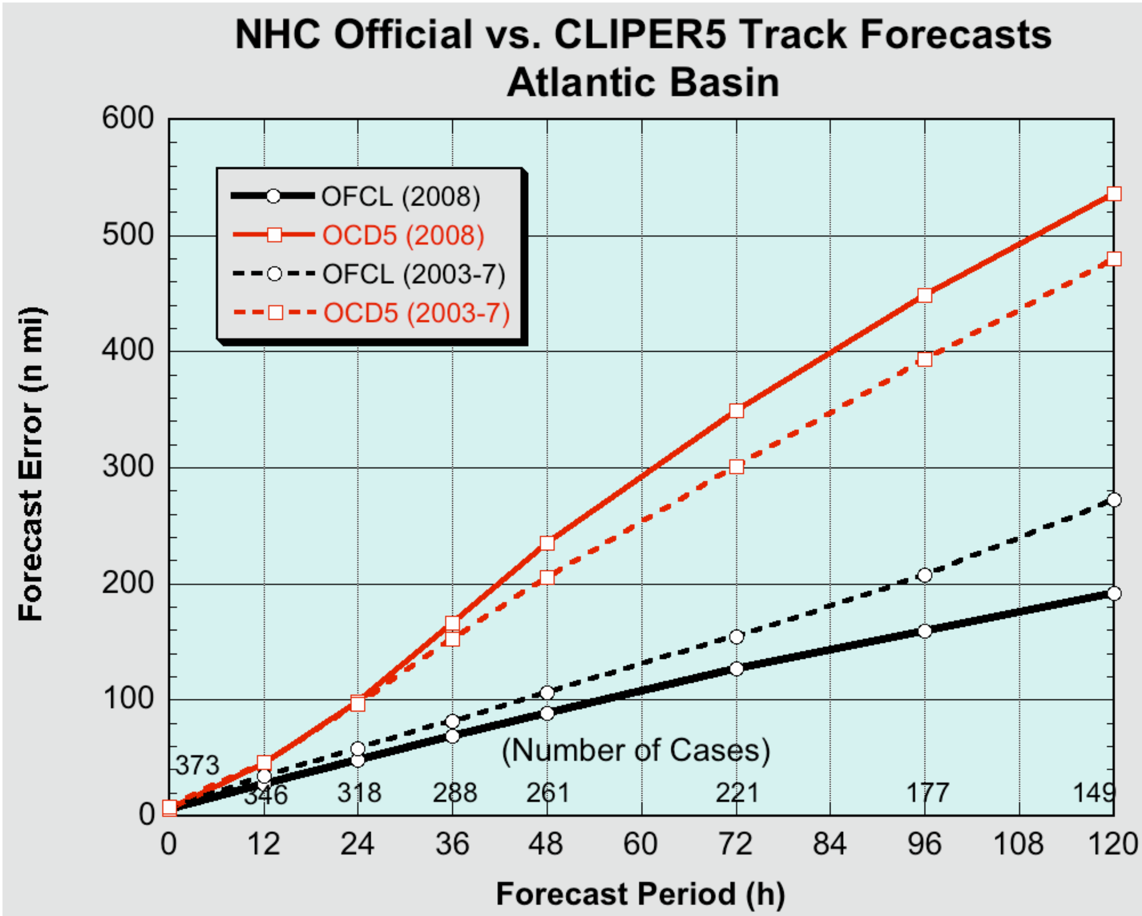


Figure 1. NHC official and CLIPER5 (OCD5) Atlantic basin average track errors for 2008 (solid lines) and 2003-2007 (dashed lines).

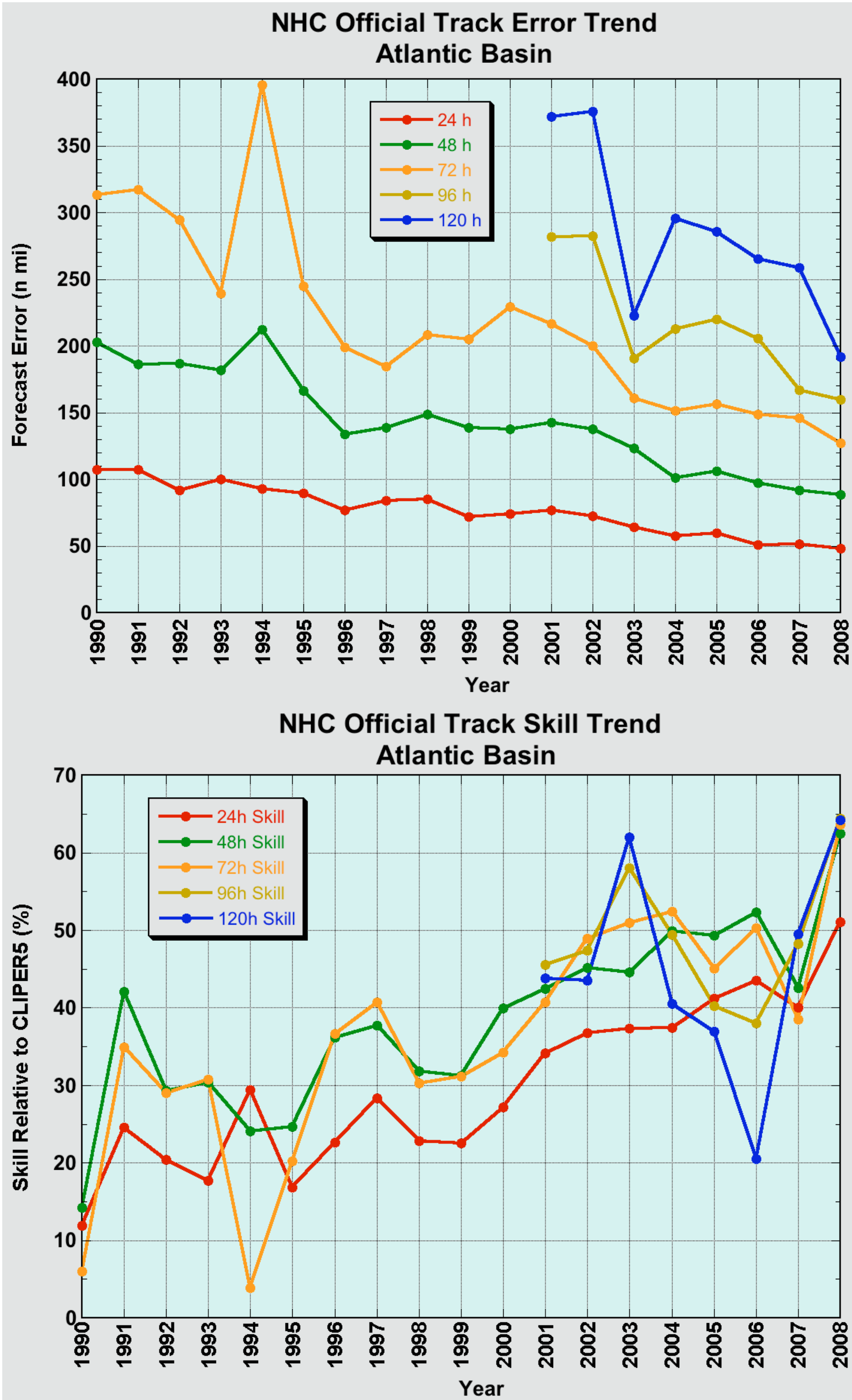


Figure 2. Recent trends in NHC official track forecast error (top) and skill (bottom) for the Atlantic basin.

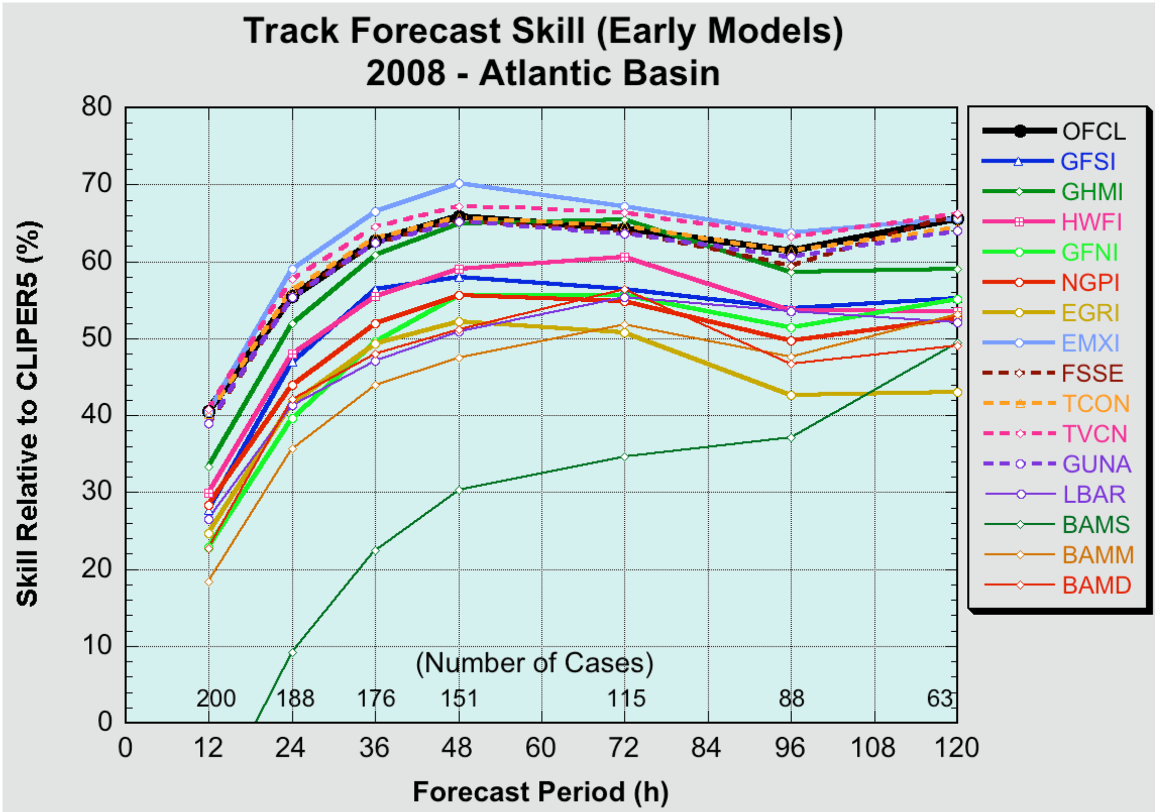


Figure. 3. Homogenous comparison for selected Atlantic basin early track guidance models for 2008. This verification includes only those models that were available at least 2/3 of the time (see text).

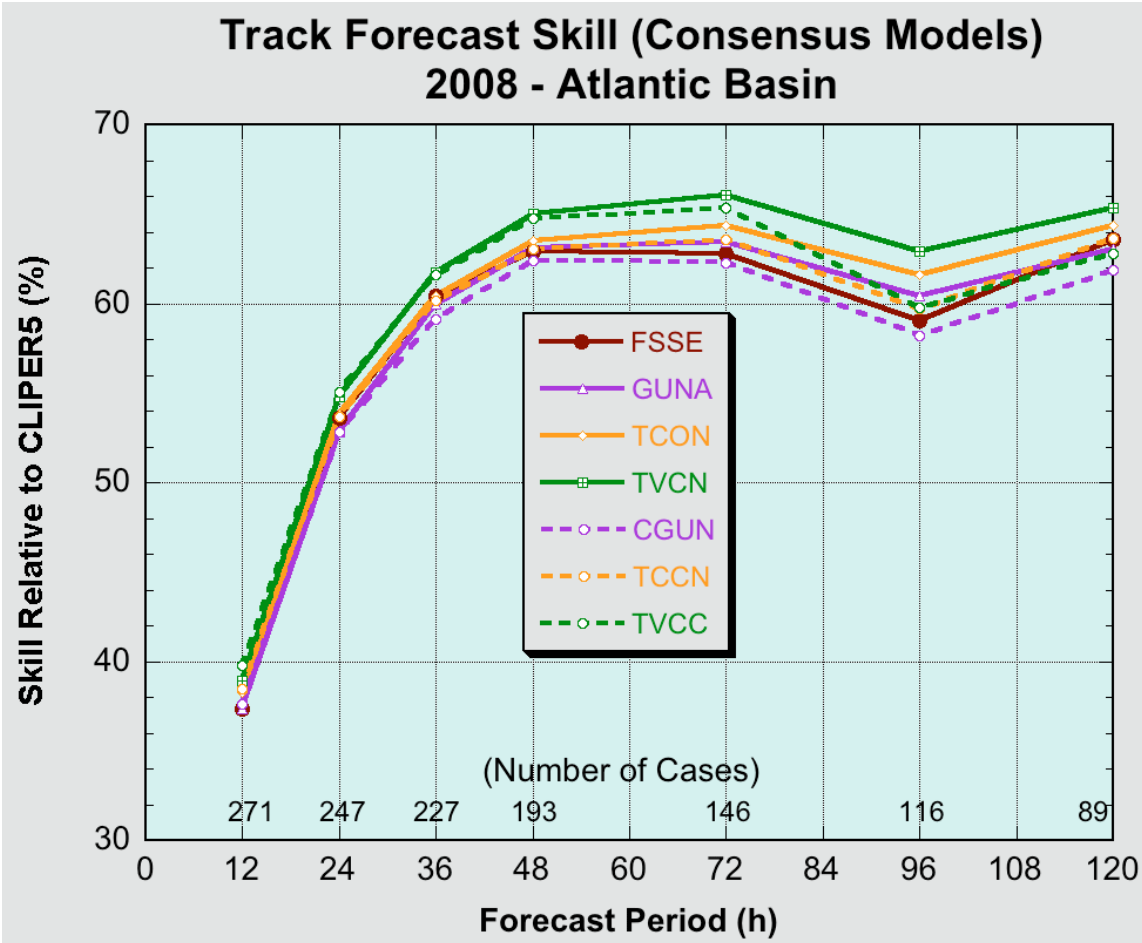


Figure 4. Homogenous comparison of the primary Atlantic basin track consensus models for 2008.

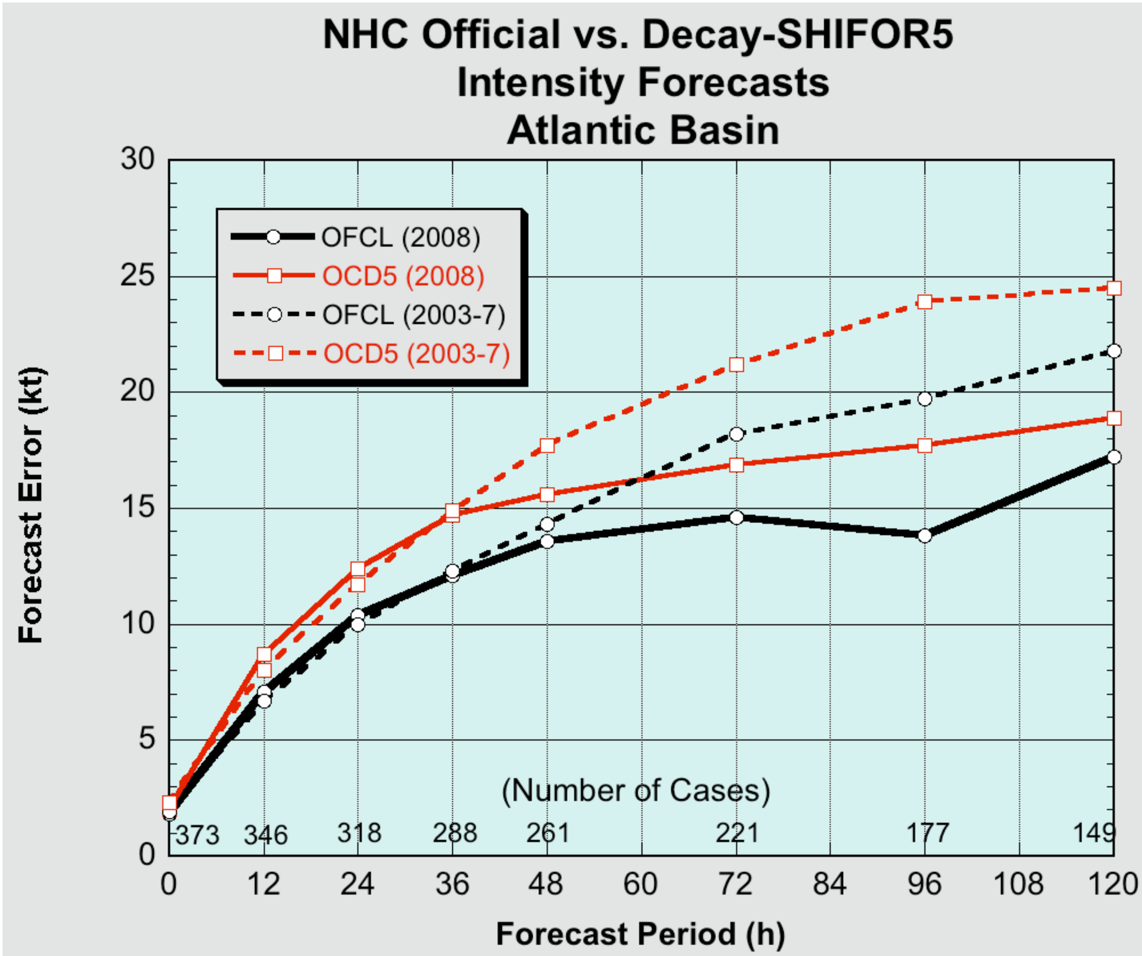


Figure 5. NHC official and Decay-SHIFOR5 (OCD5) Atlantic basin average intensity errors for 2008 (solid lines) and 2003-2007 (dashed lines).

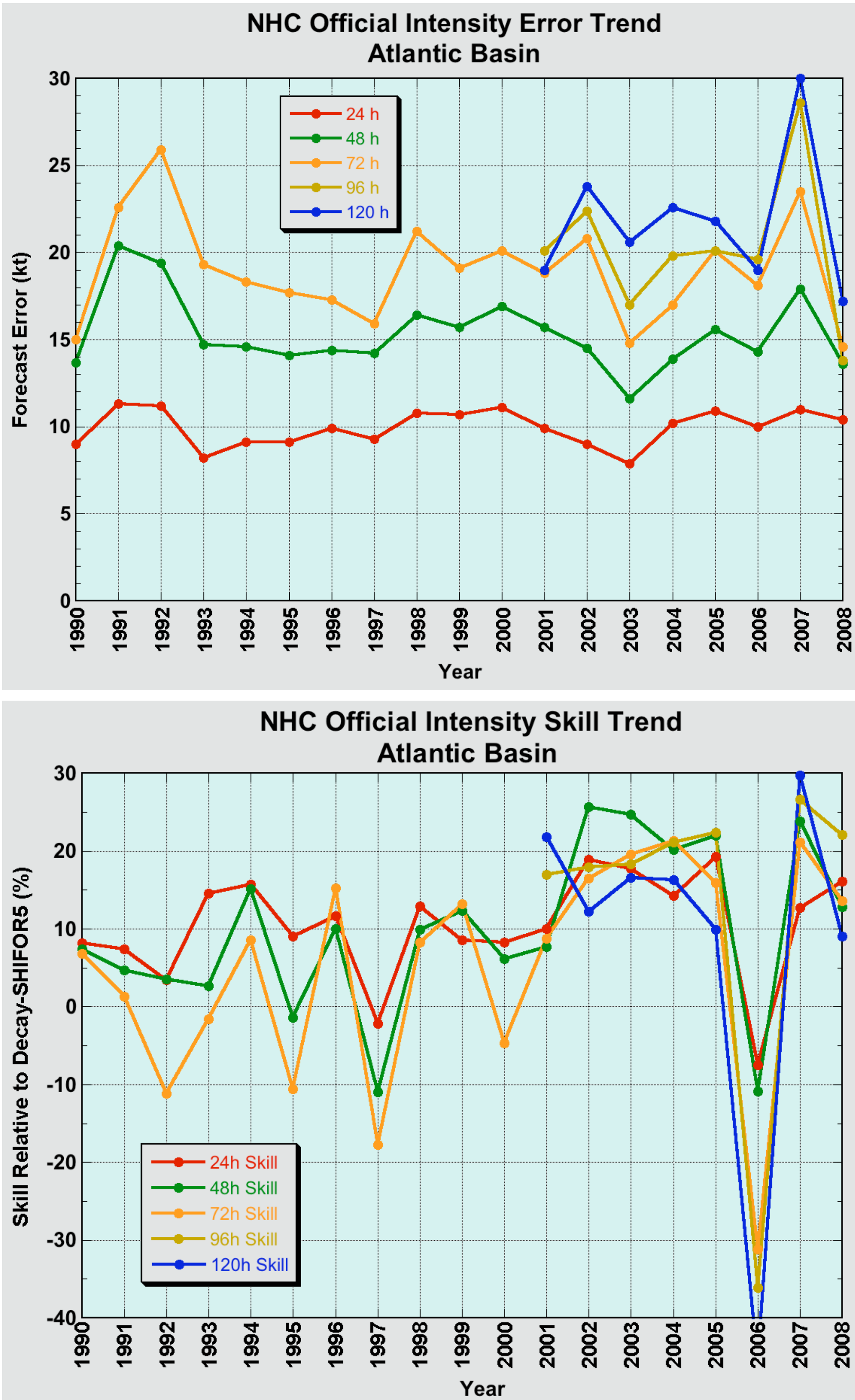


Figure 6. Recent trends in NHC official intensity forecast error (top) and skill (bottom) for the Atlantic basin.

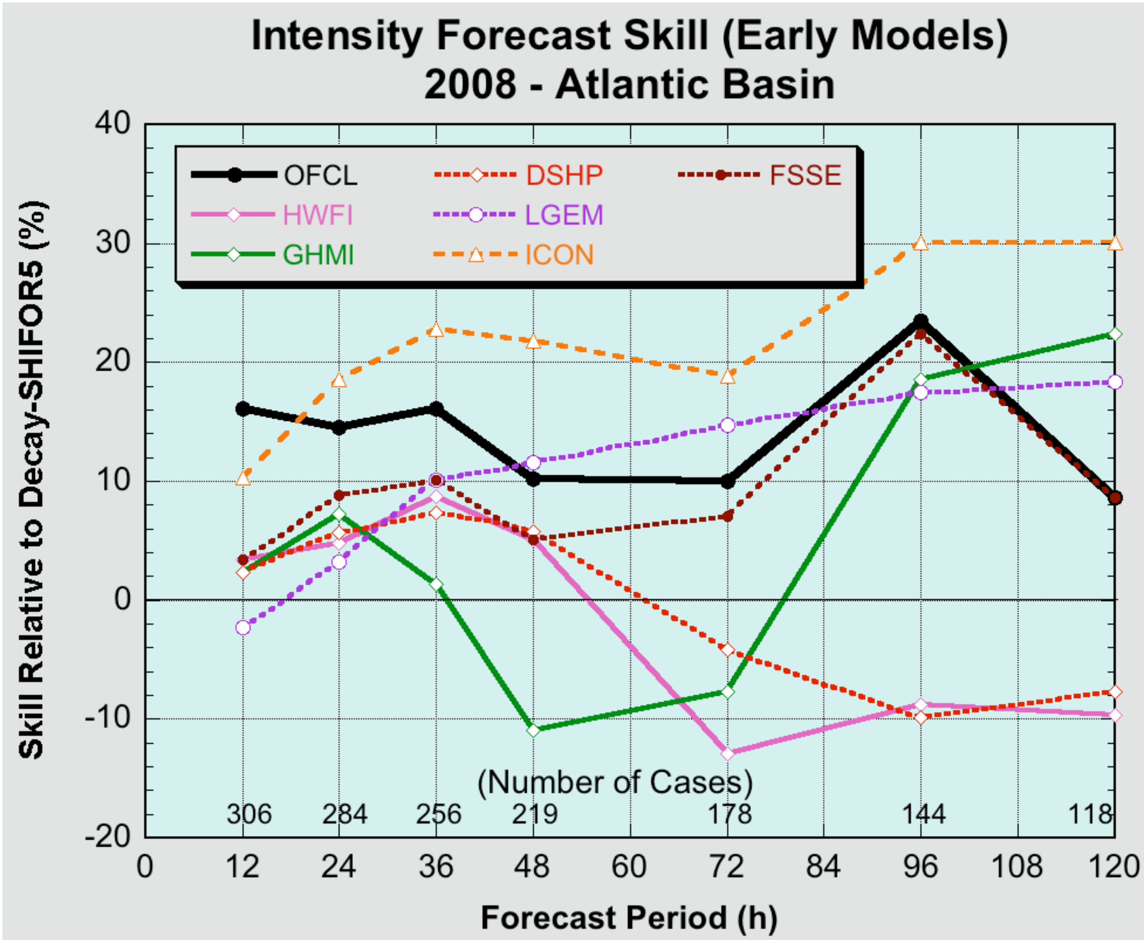


Figure. 7. Homogenous comparison for selected Atlantic basin early intensity guidance models for 2008.

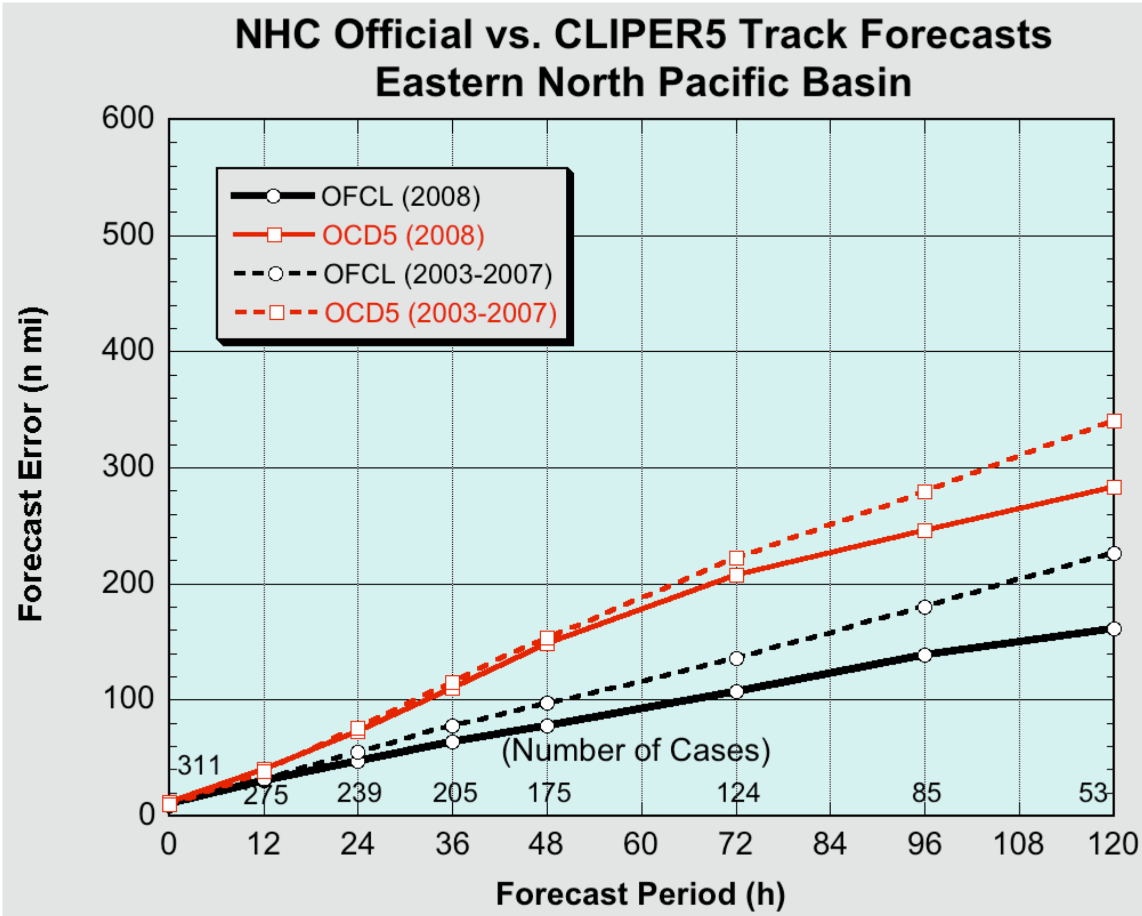
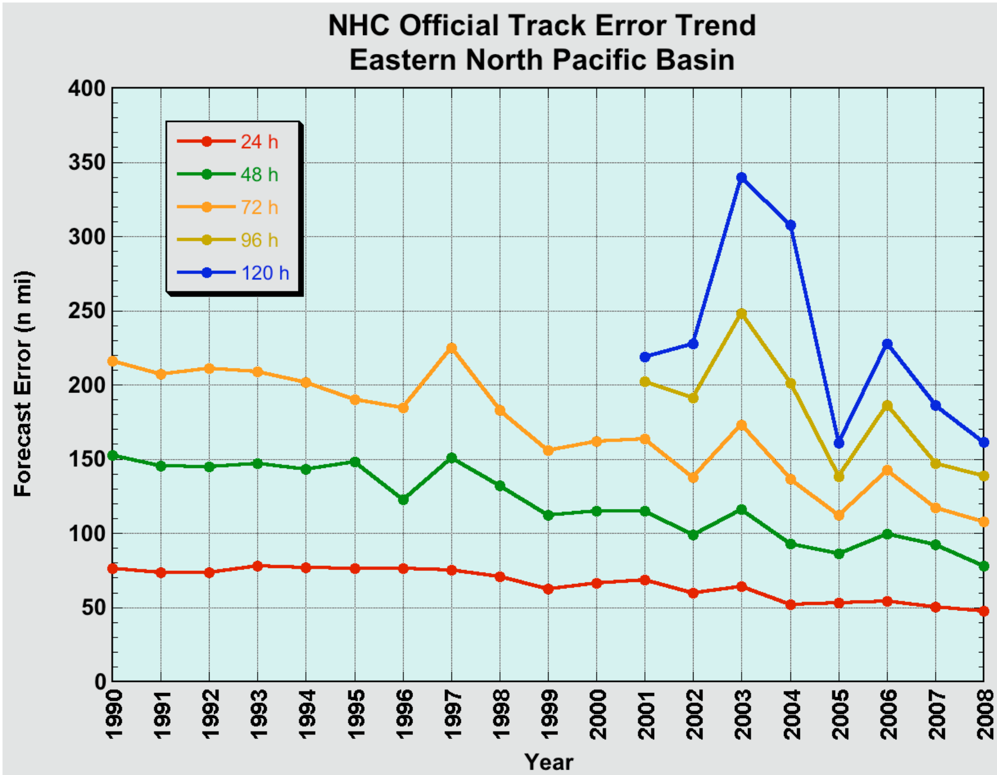


Figure 8. NHC official and CLIPER5 (OCD5) eastern North Pacific basin average track errors for 2008 (solid lines) and 2003-2007 (dashed lines).



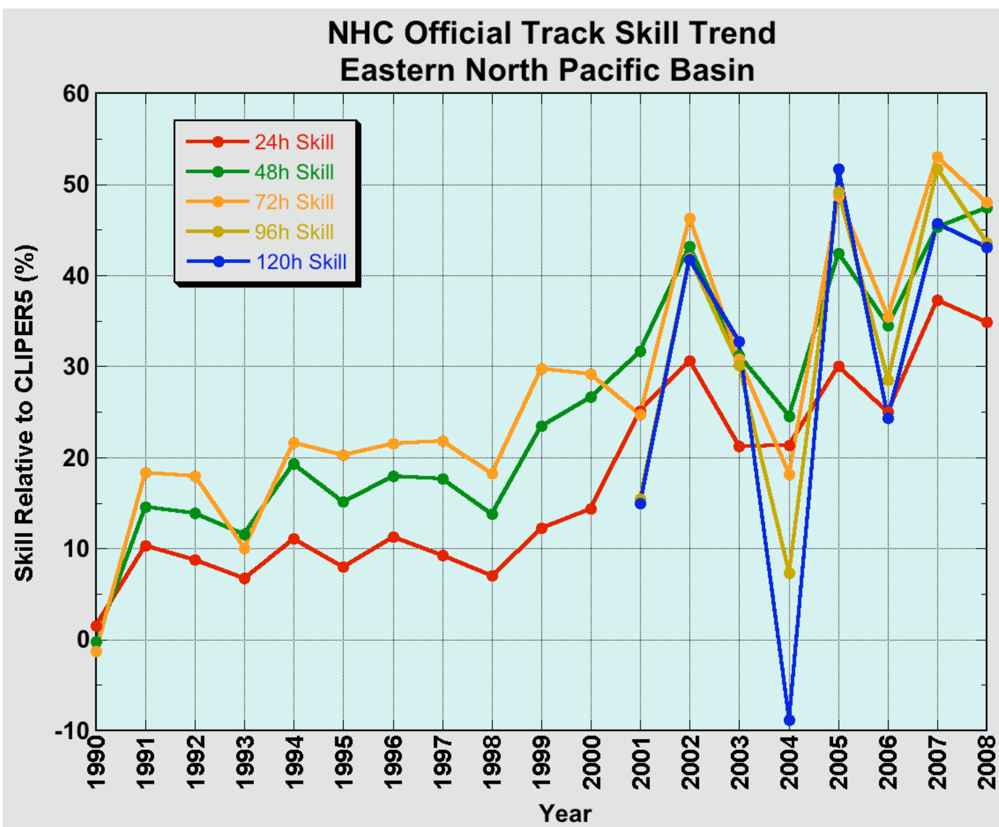


Figure 9. Recent trends in NHC official track forecast error (top) and skill (bottom) for the eastern North Pacific basin.

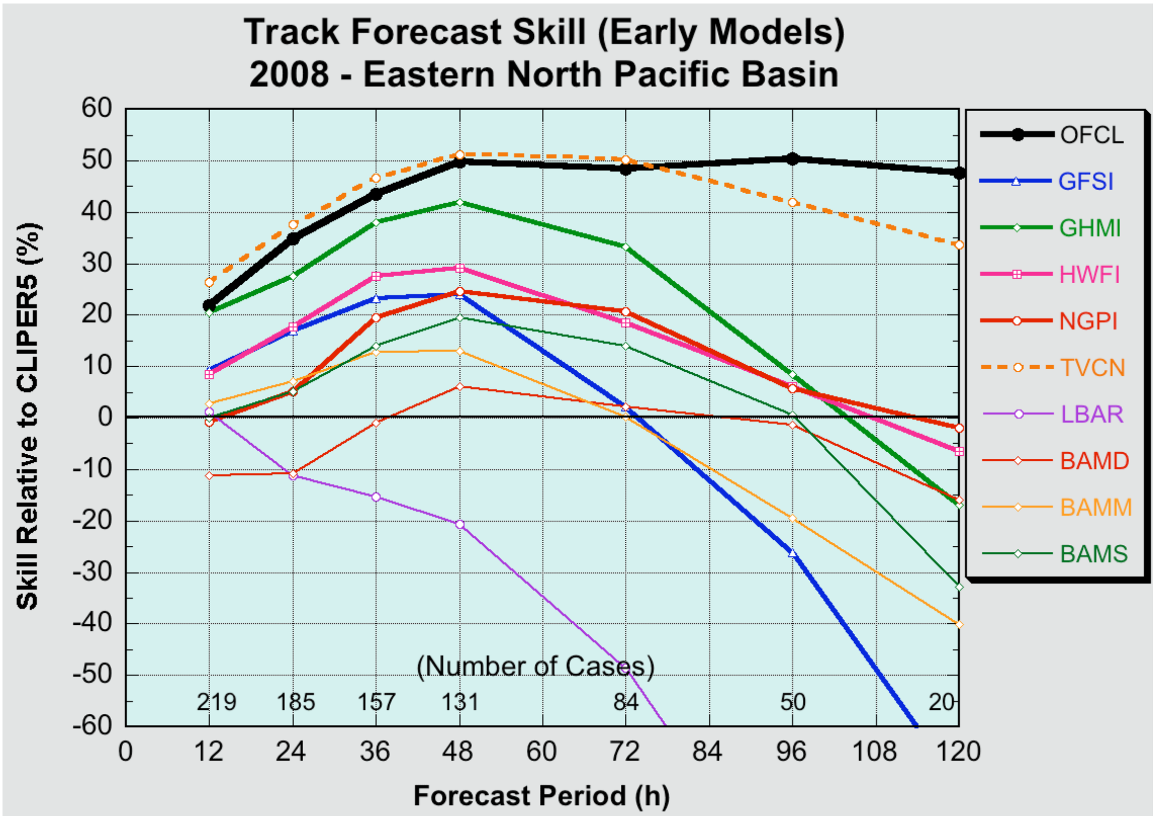


Figure. 10. Homogenous comparison for selected eastern North Pacific early track models for 2008. This verification includes only those models that were available at least 2/3 of the time (see text).

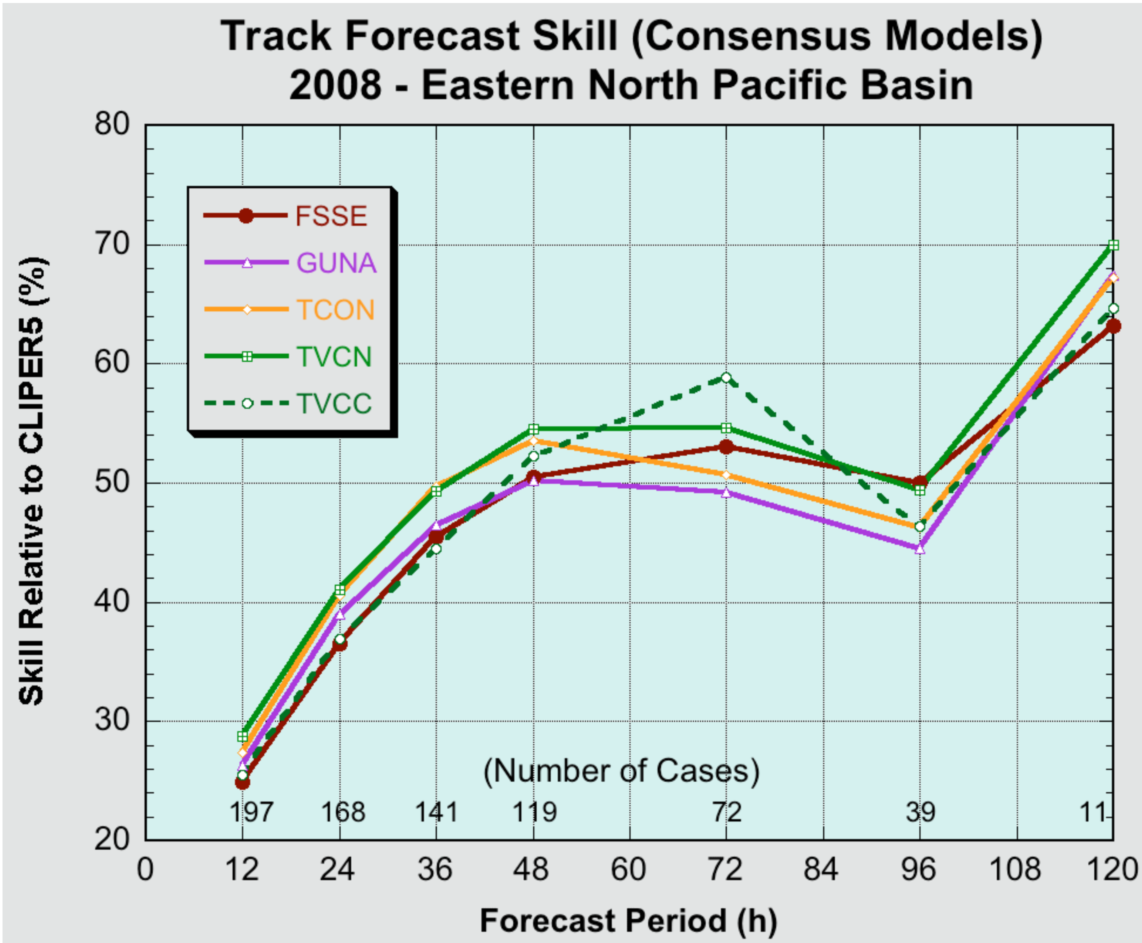


Figure 11. Homogenous comparison of the primary eastern North Pacific basin track consensus models for 2008.

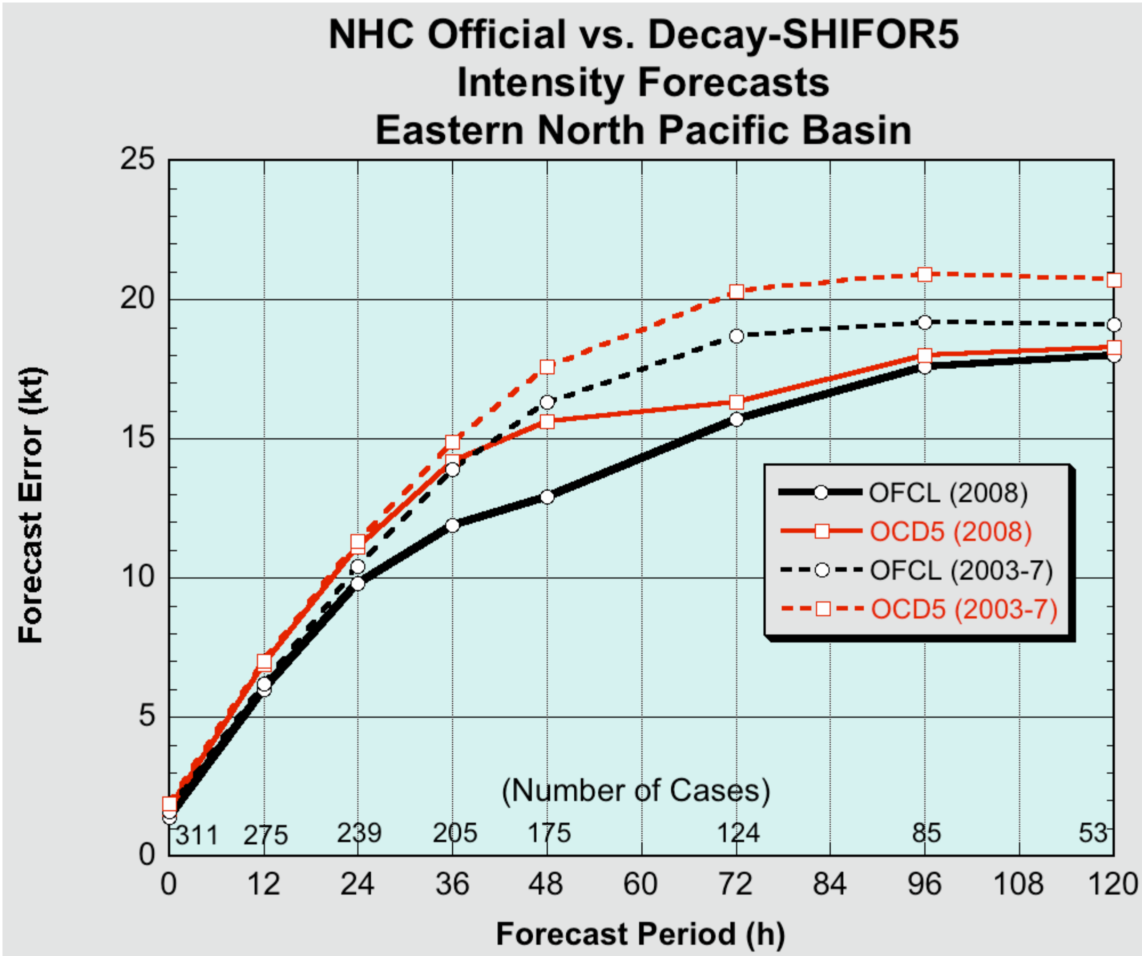


Figure 12. NHC official and Decay-SHIFOR5 (OCD5) eastern North Pacific basin average intensity errors for 2008 (solid lines) and 2003-2007 (dashed lines).

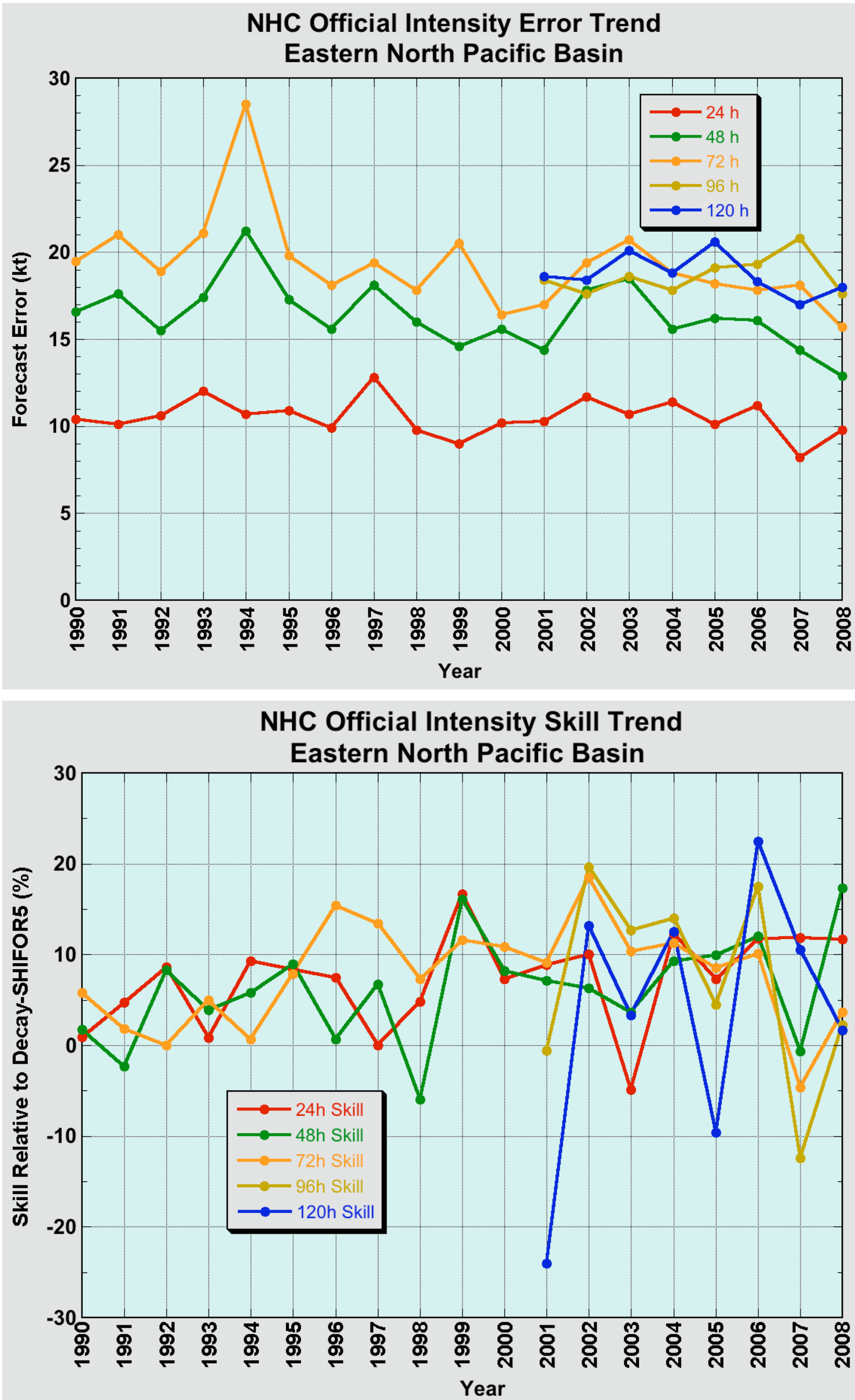


Figure 13. Recent trends in NHC official intensity forecast error (top) and skill (bottom) for the eastern North Pacific basin.

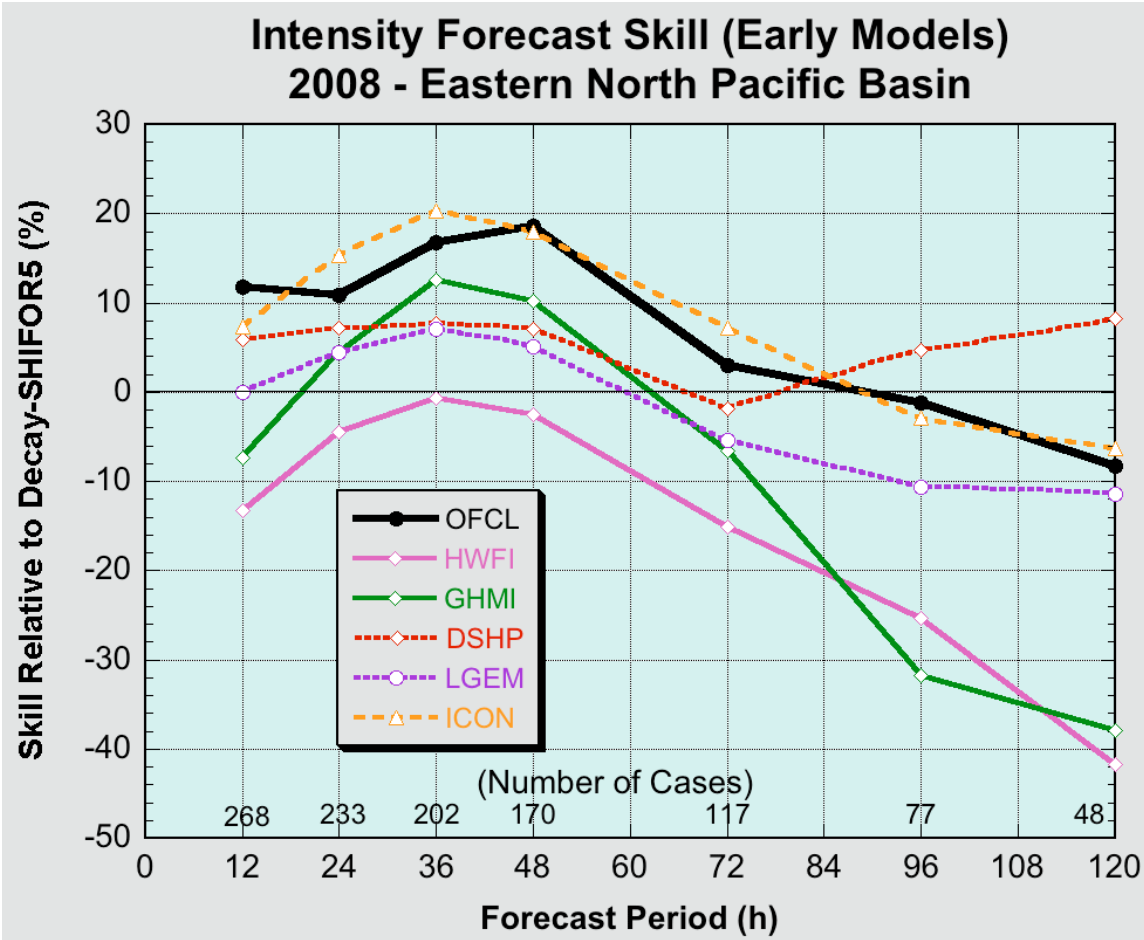


Figure 14. Homogenous comparison for selected eastern North Pacific basin early intensity guidance models for 2008.

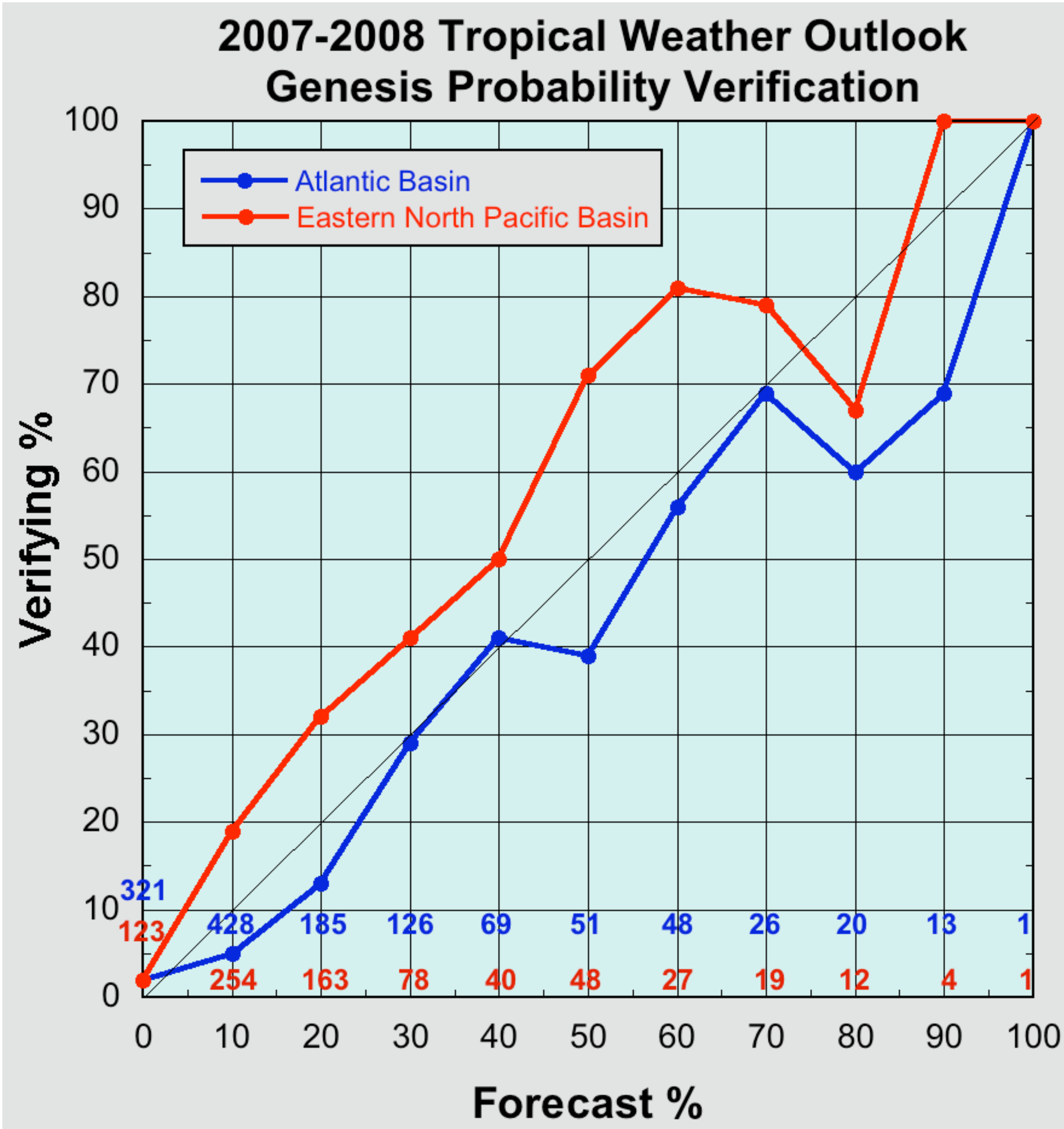


Figure 15. Reliability diagram for experimental Atlantic (blue) and eastern North Pacific (red) probabilistic tropical cyclogenesis forecasts for the period 2007-8. The number of forecasts for each basin at each level of likelihood is given along the bottom of the figure. Perfect reliability is indicated by the thin diagonal black line.