1993 NATIONAL HURRICANE CENTER FORECAST VERIFICATION

Miles Lawrence and James Gross
National Hurricane Center
January 6, 1993

Abstract

The National Hurricane Center issues a 72-hour track and intensity forecast, every six hours, for all tropical cyclones in the Atlantic and eastern Pacific basins. Forecasts are verified by comparison with a best-track post analysis of all available track and intensity data. Verification statistics for 1993 are presented.

1. Atlantic

There were 118 official forecasts issued for tropical storms and hurricanes in the Atlantic basin in 1993. The average track errors by storm are listed in Table 1.1 along with the yearly average for all storms and a comparison with the previous ten-year average. This year's track errors are smaller than the previous ten-year average, ranging from 01% smaller at 24 hours to 22% smaller at 72 hours.

Forecasts are also issued for tropical depression, sub-tropical and a few extra-tropical cyclones. For 1993, the inclusion of these forecasts in the verification results in double the number of cases and an increase in error size of up to 27% at 72 hours.

Tables 1.2.1, 1.2.2 ~~AND~~ and 1.2.3 are homogeneous comparisons of various track guidance models. Table 1.2.1 includes models that are operationally available (within 1.5 hours from the 0-hour forecast time) every 6 hours. The deep and medium BAM models have the smallest errors after 12 hours. They are even smaller than the official errors, in part because of the absence of a requirement for the models to maintain a "continuity" from the previous 6-hour forecast.

Table 1.2.2 includes the QLM and the GFDL model, along with most of the models from Table 1.2.1. These dynamic models are run every 12-hours and require timely input from a global-spectral model and are not operationally available until about 5 hours from 0-hour. A homogeneous comparison including these less frequent dynamic models seriously reduces the number of cases. However, it is noted that the QLM and the GFDL models both have rather small errors, especially at 36 and 48 hours. Table 1.2.3 includes the Aviation track model (AVNO), but not the QLM (including the QLM would have further reduced the number of cases). AVN0 is almost competitive with the BAMM and GFDL models at 24 through 48 hours and the number of cases falls below 10 at 72 hours. It is instructive to note the large difference in the VICBAR 72 hour errors between the slightly different data sets in Tables 1.2.2 and 1.2.3. This sensitivity to small changes in the cases selected implies a large uncertainty to this error data.

Official maximum one-minute wind speed forecast errors are given in

Table 1.3. The bias (mean) for the year fluctuates around 0.0 knots for different forecast periods, while the previous 10-year average bias is consistently negative at all periods. The mean absolute error is at least 10% smaller than the previous 10-year average at all periods. Tables 1.4.1 and 1.4.2 are homogeneous comparisons of biases and absolute errors for various intensity guidance models. The SHIFOR statistical-climatological model continues to remain competitive.

2. Eastern Pacific

Tables 2.1 through 2.4 are similar verification statistics for the eastern Pacific basin. Table 2.1 shows that the 1993 average official track errors are at least 10% smaller than the 1988-1992 average at all forecast periods. Official track errors are considerably smaller in the eastern Pacific than in the Atlantic.

Track model comparisons are given in Tables 2.2.1, 2.2.1 and 2.2.3. CLIPER model errors in the eastern Pacific are also smaller than in the Atlantic and neither the official errors nor the dynamical model errors show the improvement over CLIPER that they do in the Atlantic. The statistical-dynamical NHC91 is more competitive in this basin and even the statistical-synoptic PSS is competitive with the dynamical models. Again, as in the Atlantic, the GFDL model shows great promise.

Official intensity errors show a negative bias in 1993 that is somewhat larger than the average of the previous 5 years and the mean absolute error is larger than the previous 5-year average in the early forecast periods. The intensity guidance models errors are all larger than the official errors.

Table 1.1. Official average track forecast errors (nautical miles) by storm, Atlantic, 1993, excluding extratropical, subtropical and tropical depression stages.

	forecast period (hours)					
name	0	12	24	36	48	72
T.S. Arlene	6	32	-	-	-	-
(no. of cases)	(4)	(2)	(0)	(0)	(0)	(0)
T.S. Bret	13	40	63	111	165	311
	(20)	(17)	(15)	(15)	(13)	(9)
T.S. Cindy	14	24	35	57	67	-
	(9)	(7)	(5)	(3)	(1)	(0)
H. Emily	11	46	98	145	169	216
	(41)	(39)	(37)	(35)	(33)	(29)
T.S. Dennis	15	37	48	64	71	-
	(12)	(10)	(8)	(6)	(4)	(0)
H. Floyd	26	75	227	358	496	-
	(12)	(10)	(8)	(6)	(4)	(0)
Gert	11	41	81	101	132	263
	(14)	(8)	(6)	(6)	(5)	(3)
H. Harvey	27	81	308	-	-	-
	(6)	(4)	(2)	(0)	(0)	(0)
1993 average	14	46	99	142	179	240
	(118)	(97)	(81)	(71)	(60)	(41)
1983-1992 average	16	52	100		201	308
1993 departure from 1983-1992 average	-12%	-12%	-01%		-11%	-22%

Table 1.2.1. Track model homogeneous comparison, Atlantic, 1993, errors in nautical miles.

	forecast period (hours)				
model	12	24	36	48	72
Official	48	97	136	182	252
BAM(deep)	50	91	129	173	220
BAM(medium)	54	96	126	165	202
BAM(shallow)	64	113	147	195	261
CLIPER	57	120	189	270	398
NHC90	51	96	139	186	308
VICBAR	50	97	143	194	327
(number of cases)	(110)	(102)	(90)	(80)	(59)

Table 1.2.2. Track model homogeneous comparison, Atlantic, 1993, errors in nautical miles.

	forecast period (hours)				
model	12	24	36	48	72
Official	44	91	142	194	243
BAM(medium)	45	88	140	187	192
CLIPER	54	116	197	286	362
GFDL	41	82	131	153	222
NHC90	50	90	135	193	310
QLM	52	88	129	173	248
VICBAR	45	89	142	203	299
(number of cases)	(29)	(28)	(27)	(22)	(14)

Table 1.2.3. Track model homogeneous comparison, Atlantic, 1993, errors in nautical miles.

	forecast period (hours)				
model	12	24	36	48	72
Official	40	73	104	159	265
Aviation Model	52	78	118	175	237
BAM(medium)	41	70	98	136	225
CLIPER	48	92	151	224	278
GFDL	41	72	105	122	153
NHC90	45	82	121	185	250
VICBAR	43	78	124	184	158
(number of cases)	(30)	(28)	(26)	(21)	(9)

Table 1.3. Official wind speed forecast errors (knots), Atlantic, 1993. Error = forecast - observed.

	forecast period (hours)					
	0	12	24	36	48	72
1993 mean	-1.7	+0.5	+1.5	+1.8	-0.1	-3.8
1993 mean absolute	4.3	6.4	10.0	12.0	14.3	18.4
max. absolute error	-25	-30	-35	-35	-40	-45
(no. of cases)	(118)	(97)	(81)	71)	(59)	(41)
1983-1992 mean	-1.4	-1.6	-2.4		-4.4	-4.8
1983-1992 mean absolute	4.8	7.8	11.5		16.4	20.7
1993 departure from 1982-1991 mean absolute	-10%	-18%	-13%		-12%	-11%

Table 1.4.1 Intensity model homogeneous comparisons, Atlantic, 1993, mean errors (knots).

	forecast period (hours)				
	12	24	36	48	72
Official	+0.8	+1.7	+1.9	+0.1	-0.8
SHIFOR	+0.0	-0.3	+0.2	-1.0	-1.1
SHIPS	+0.9	+2.5	+4.2	+4.0	+6.1
(no. of cases)	(95)	(80)	(70)	(58)	(40)
Official	+2.1	+3.3	+2.0	+1.5	-1.0
SHIFOR	+1.4	+1.2	+1.2	-0.1	-1.2
SHIPS	+2.8	+4.3	+4.7	+4.8	+8.3
GFDL	-0.3	-3.5	-3.9	-5.3	-4.7
(no. of cases)	(30)	(25)	(21)	(15)	(7)

Table 1.4.2 Intensity model homogeneous comparisons, Atlantic, 1993, mean absolute errors (knots), Atlantic, 1993.

	forecast period (hours)				
	12	24	36	48	72
Official	6.2	9.9	12.1	14.4	17.8
SHIFOR	8.2	10.5	10.9	12.3	17.4
SHIPS	8.1	10.9	12.4	13.3	15.3
(no. of cases)	(95)	(80)	70)	(58)	(40)
Official	5.3	8.7	12.4	15.5	18.3
SHIFOR	6.4	8.1	9.3	9.9	14.3
SHIPS	6.6	9.0	12.0	13.6	16.6
GFDL	10.7	14.6	14.8	14.7	18.2
(no. of cases)	(30)	(25)	(21)	(15)	(7)

Table 2.1. Official average track forecast errors (nautical miles), by storm, eastern Pacific, 1993, excluding extratropical, subtropical and tropical depression stages.

	forecast period (hours)					
storm	0	12	24	36	48	72
H. Adrian	10	34	64	91	118	139
(no. of cases)	(22)	(20)	(18)	(16)	(14)	(10)
T.S. Beatriz	24	53	97	-	-	-
	(5)	(3)	(1)	(0)	(0)	(0)
H. Calvin	14	65	134	206	283	405
	(15)	(13)	(11)	(9)	(7)	(3)
H. Dora	8	31	54	77	86	87
	(19)	(17)	(15)	(13)	(11)	(7)
H. Eugene	8	39	82	131	182	320
	(26)	(26)	(25)	(23)	(21)	(17)
H. Fernanda	7	22	45	62	77	105
	(18)	(18)	(18)	(18)	(18)	(18)
H. Greg	8	31	57	87	120	187
	(50)	(48)	(46)	(44)	(42)	(38)
H. Hilary	9	39	70	106	143	241
	(34)	(32)	(30)	(28)	(26)	(22)
T.S. Irwin	23	29	-	-	-	-
	(3)	(1)	(0)	(0)	(0)	(0)
H. Jova	8	17	32	44	63	112
	(23)	(21)	(19)	(17)	(15)	(11)
H. Kenneth	8	31	56	75	92	127
	(41)	(39)	(37)	(35)	(33)	(29)
H. Lidia	11	48	84	121	171	294
	(20)	(18)	(16)	(14)	(12)	(8)
T.S. Max	18	54	124	169	247	-
	(9)	(5)	(4)	(3)	(2)	(0)
T.S. Norma	18	73	45	-	-	-
	(6)	(4)	(2)	(0)	(0)	(0)
1993 average	10	35	66	95	125	186
	(291)	(265)	(242)	(220)	(201)	(163)
1988-1992 average	14	40	73	109	144	207
1993 departure from 1988-1992 average	-29%	-12%	-10%	-13%	-13%	-10%

Table 2.2.1. Track model homogeneous comparison, eastern Pacific, 1993, errors in nautical miles.

model	forecast period (hours) 12	24	36	48	72
Official	40	73	107	141	204
BAM(deep)	45	85	127	170	243
BAM(medium)	45	85	122	157	229
BAM(shallow)	50	93	133	173	247
CLIPER	40	78	121	159	220
NHC91	38	72	106	141	215
PSS	38	76	118	157	221
(number of cases)	(276)	(269)	(256)	(243)	(201)

Table 2.2.2. Track model homogeneous comparison, eastern Pacific, 1993, errors in nautical miles.

model	forecast period (hours) 12	24	36	48	72
Official	42	73	105	140	211
BAM(medium)	44	85	121	159	235
CLIPER	39	78	118	157	220
NHC91	38	73	106	144	218
QLM	50	91	131	173	236
(number of cases)	(128)	(125)	(120)	(116)	(96)

Table 2.2.3. Track model homogeneous comparison, eastern Pacific, 1993, errors in nautical miles.

model	forecast period (hours) 12	24	36	48	72
Official	XX	66	105	120	177
Aviation Model	59	100	161	196	313
BAM(medium)	47	81	124	136	178
CLIPER	38	75	136	153	208
GFDL	44	70	92	113	188
NHC91	37	66	110	129	212
(number of cases)	(31)	(28)	(27)	(25)	(21)

Table 2.3. Official wind speed forecast errors (knots), eastern Pacific, 1993. Error = forecast - observed

	forecast period (hours)					
	0	12	24	36	48	72
1993 mean	-0.7	-1.3	-2.8	-4.2	-5.7	-7.0
1993 mean absolute	2.8	7.8	13.7	17.4	18.7	19.7
(no. of cases)	(291)	(265)	(242)	(220)	(199)	(163)
1988-1992 mean		-1.3	-1.8	-2.7	-3.7	-3.2
1988-1992 mean absolute		6.2	11.3	14.8	17.4	20.0
1993 departure from 1988-1992 mean absolute		+26%	+21%	+18%	+07%	-02%
1992 mean		-0.8	-0.5	-1.0	-0.9	+0.6
1992 mean absolute		6.8	11.1	14.0	16.0	19.0
(no. of cases)		(524)	(507)	(482)	(437)	(377)
1991 mean	-0.9	-0.0	-0.6	-1.6	-2.4	-4.6
1991 mean absolute	2.7	6.4	11.4	15.3	18.1	21.7
(no. of cases)	(345)	(305)	(281)	(257)	(232)	(182)
1990 mean	-1.1	-2.0	-3.2	-4.6	-6.0	-5.5
1990 mean absolute	3.6	7.1	11.2	15.1	17.8	20.6
(no. of cases)	(451)	(416)	(380)	(343)	(306)	(235)
1989 mean	-0.7	-1.7	-2.7	-4.1	-8.8	-11.6
1989 mean absolute	4.5	7.9	12.7	17.0	21.1	21.0
(no. of cases)	(215)	(215)	(182)	(150)	(118)	(77)
1988 mean	-2.1	-2.7	-3.4	-4.5	-6.0	-2.7
1988 mean absolute	3.2	6.5	10.2	13.3	16.1	17.5
(no. of cases)	(170)	(170)	(147)	(126)	(108)	(75)

Table 2.4.1 Intensity model homogeneous comparisons, eastern Pacific, 1993, mean error (knots).

	forecast period (hours) 12	24	36	48	72
Official	-1.3	-2.8	-4.2	-5.7	-7.0
SHIFOR	-3.8	-8.3	-12.8	-16.3	-20.8
(no. of cases)	(265)	(242)	(220)	(199)	(163)
Official	-1.9	-4.5	-2.2	-1.4	-6.3
SHIFOR	-5.1	-10.9	-11.3	-11.9	-18.1
AVNO	-57.8	-62.0	-58.4	-57.7	-53.2
GFDL	-21.5	-25.8	-26.2	-21.3	-13.9
(no. of cases)	(31)	(28)	(25)	(21)	(15)

Table 1.4.2 Intensity model homogeneous comparisons, eastern Pacific, 1993, mean absolute error (knots).

	forecast period (hours) 12	24	36	48	72
Official	7.8	13.7	17.4	18.7	19.7
SHIFOR	8.6	14.5	19.0	22.5	25.9
(no. of cases)	(265)	(242)	(220)	(199)	(163)
Official	10.6	16.6	21.8	23.8	15.0
SHIFOR	12.9	18.6	22.0	24.6	24.5
AVNO	57.8	62.0	58.4	57.7	53.2
GFDL	23.8	28.6	29.4	31.3	19.8
(no. of cases)	(31	(28)	(25)	(21)	(15)