Enhancement of SHIPS Using Passive Microwave Imager Data—2005 Testing

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NHC Points of Contact:

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Outline

I. Intro -
Components of SHIPS-MI forecast

II. Results from 1988-2004 training sample

III. Results from 2005

IV. Webpage examples

***SHIPS-MI* Forecast Intensity Change (DELV)** = **Sample Mean** + **Climatology and Persistence**

MSW0	Initial Max Sustained Winds
PER	Persistence (previous 12-h intensity change)
VPER	MSW0 x Persistence
EDAY	Function of Julian Day
USPD	Zonal Component of Storm Motion

Environmental Terms

POT	MPI - MSW0 (Potential for further intensification)
POT2	POT squared
SHRD	200-850 hPa wind shear
SHRDLAT	SHRD x LAT
MSWSHRD	MSW0 x SHRD
EPOS	θ_E excess of a lifted parcel
T200	200 hPa temperature
Z850	850 hPa vorticity
PSLV	Pressure at the Steering Level

Microwave Terms

MEANH19	0-100 km Mean 19 GHz Horizontal TB
MAXH19	0-100 km Maximum 19 GHz Horizontal TB

In E. Pacific:

Latitude and 200 hPa Divergence added

PSLV and VPER removed

Recent Progress

Training sample size expanded substantially

Now 1988-2004 (~1600 24-h forecasts)

Previously 1995-2003 (~900 24-h forecasts)

Code tested at NHC

Ingest TMI and SSM/I near real time TBs

Read SHIPS predictors from lsdiag.dat file

Compute microwave predictors

Generate SHIPS-MI forecast

Write text output

Results from Training Sample

MI training sample now goes back to 1988

IR+OHC adjustment in SHIPS goes back to 1995

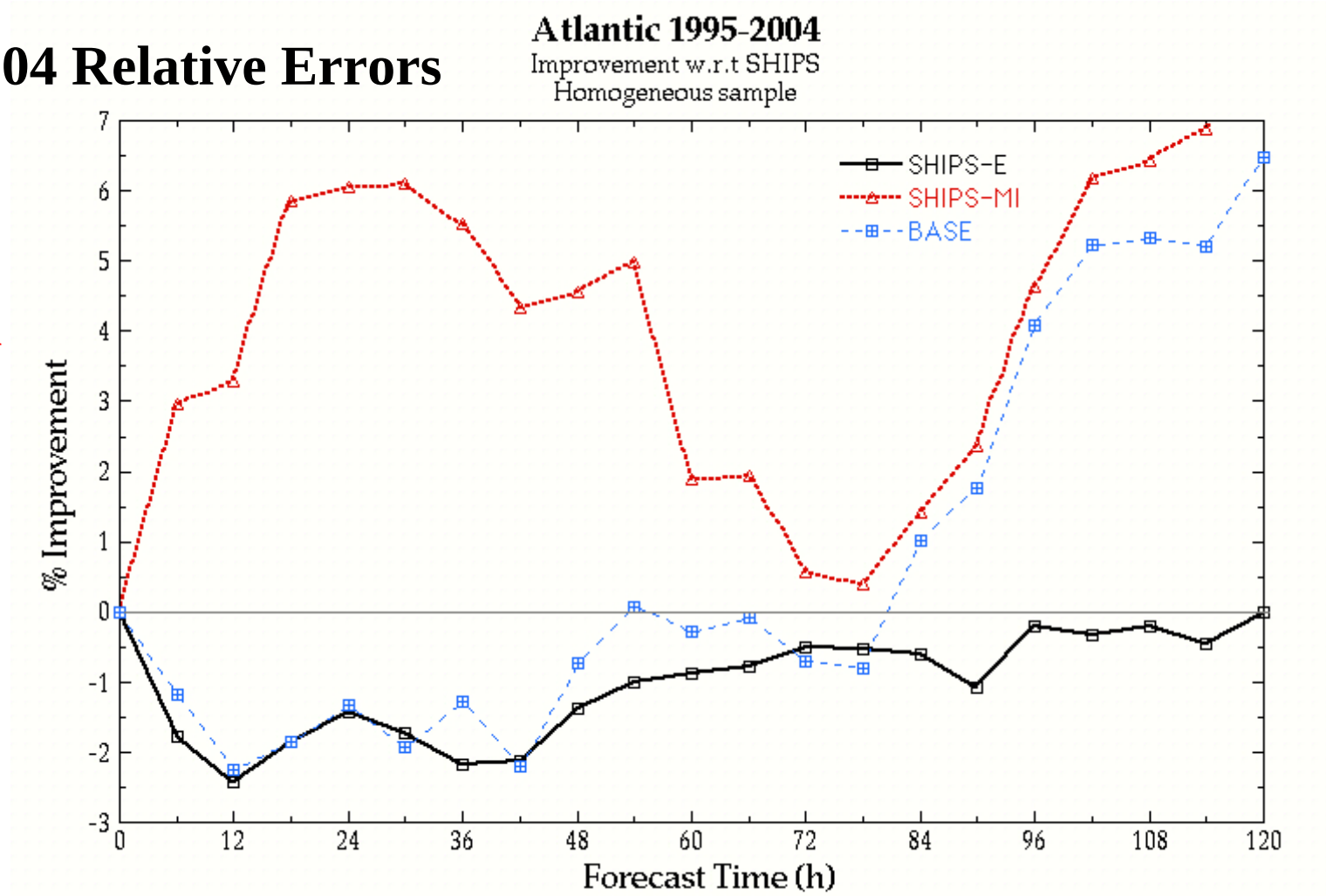
Comparisons between SHIPS-MI and SHIPS use *1995-2004 subset of training sample*

- homogeneous, dependent sub-sample

- landfall cases are excluded

1995-2004 Relative Errors

Normalized relative to errors from the 2005 operational SHIPS coefficients



SHIPS-E is the 2005 operational model *without* IR or Oceanic Heat Content adjustment

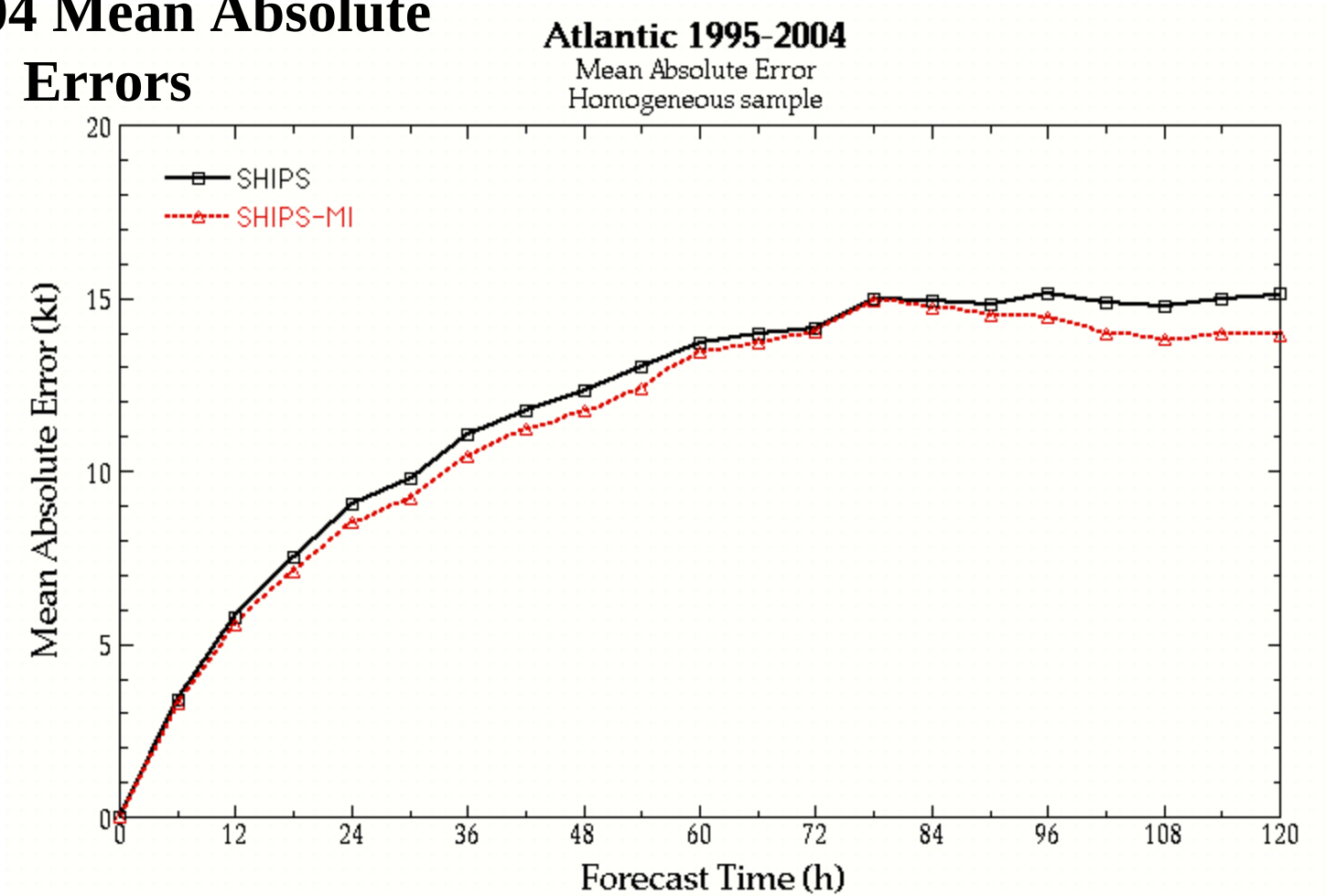
BASE has the same predictors as SHIPS-MI, except microwave predictors are excluded

Sample size is small at 60 h and beyond; improvement there is not meaningful

Improvement due to MI is greater than improvement due to IR and OHC

1995-2004 Mean Absolute Errors

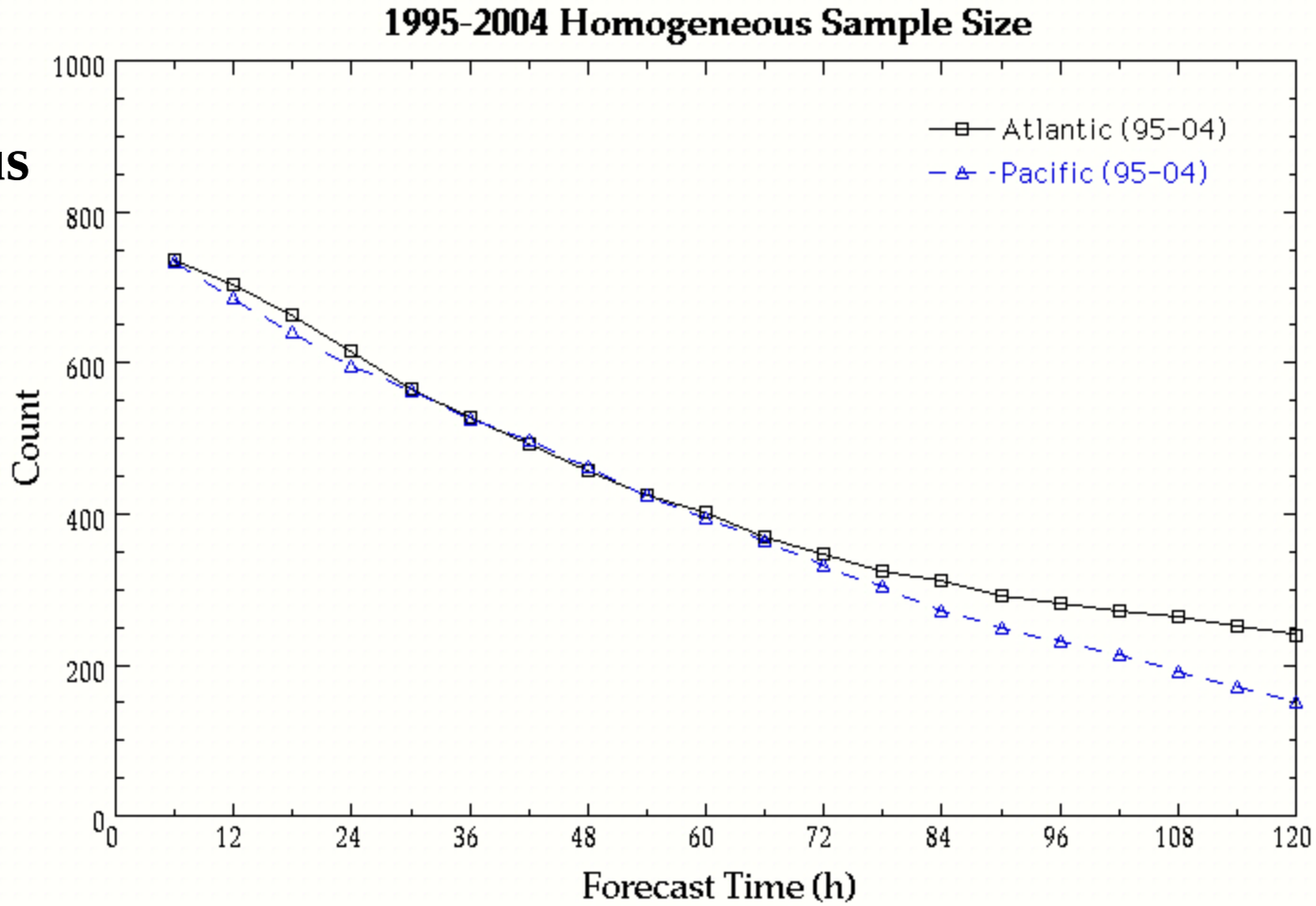
Same data as previous plot, except errors are not normalized



Sample size is small at 60 h and beyond; improvement there is not meaningful

SHIPS-MI improves over SHIPS through 48 h, essentially matches SHIPS after that

1995-2004 homogeneous sample size

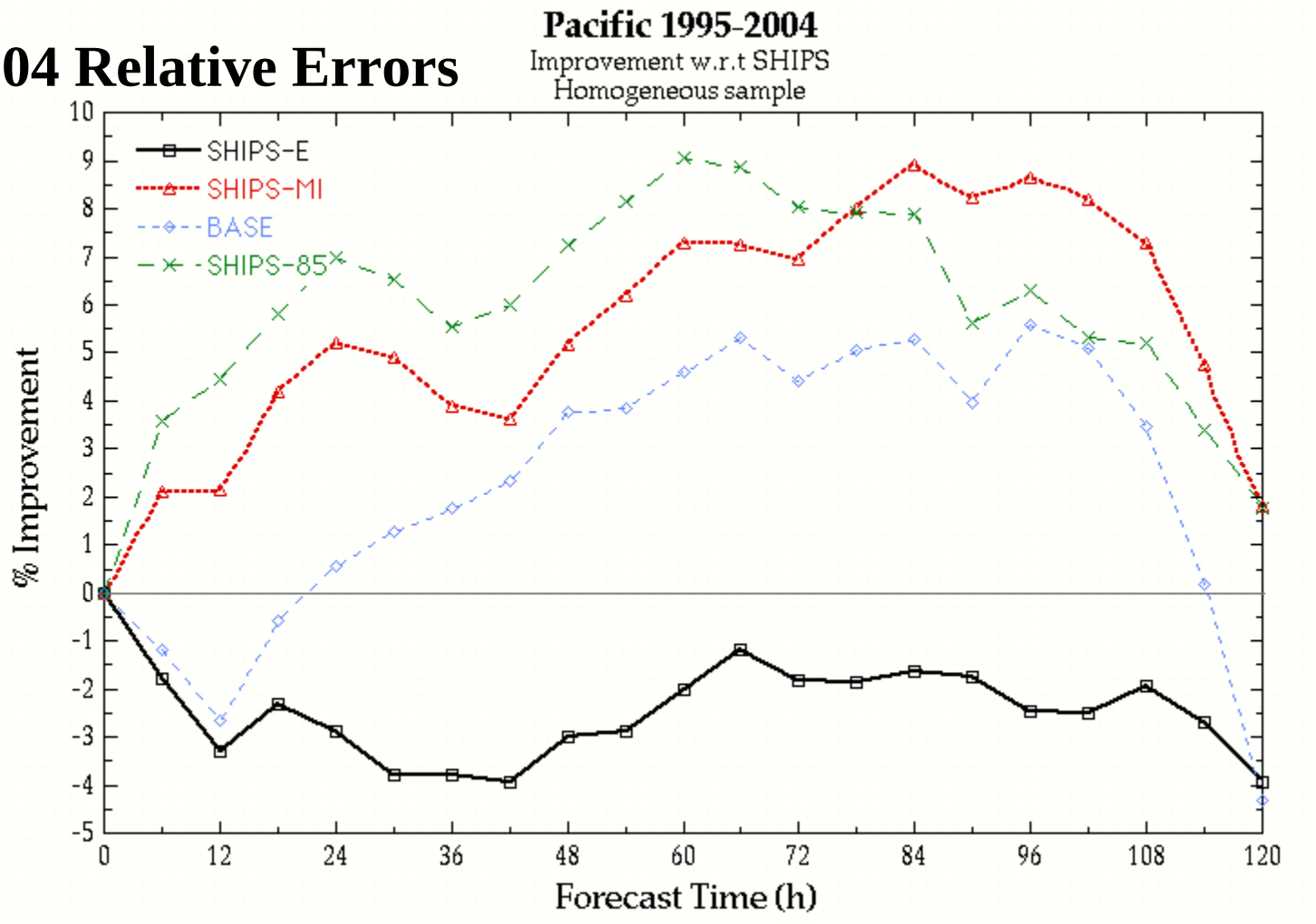


Sample size for a *homogeneous*, *dependent* sample 1995-2004 (no jack-knifing applied)

1995-2004 includes the IR+OHC adjustment to the operational SHIPS (only IR in E. Pacific)

1995-2004 Relative Errors

Normalized relative to errors from the 2005 operational SHIPS coefficients



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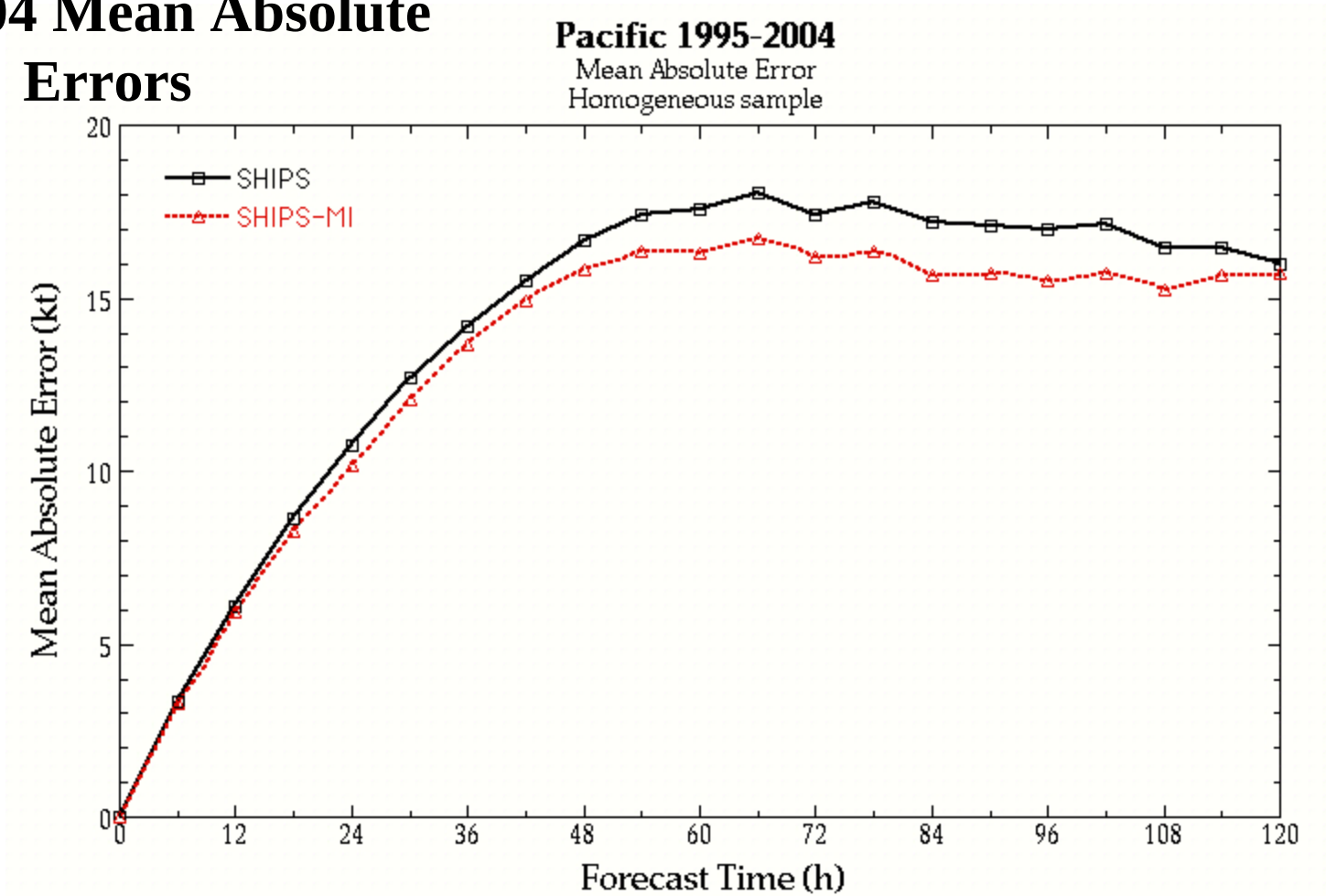
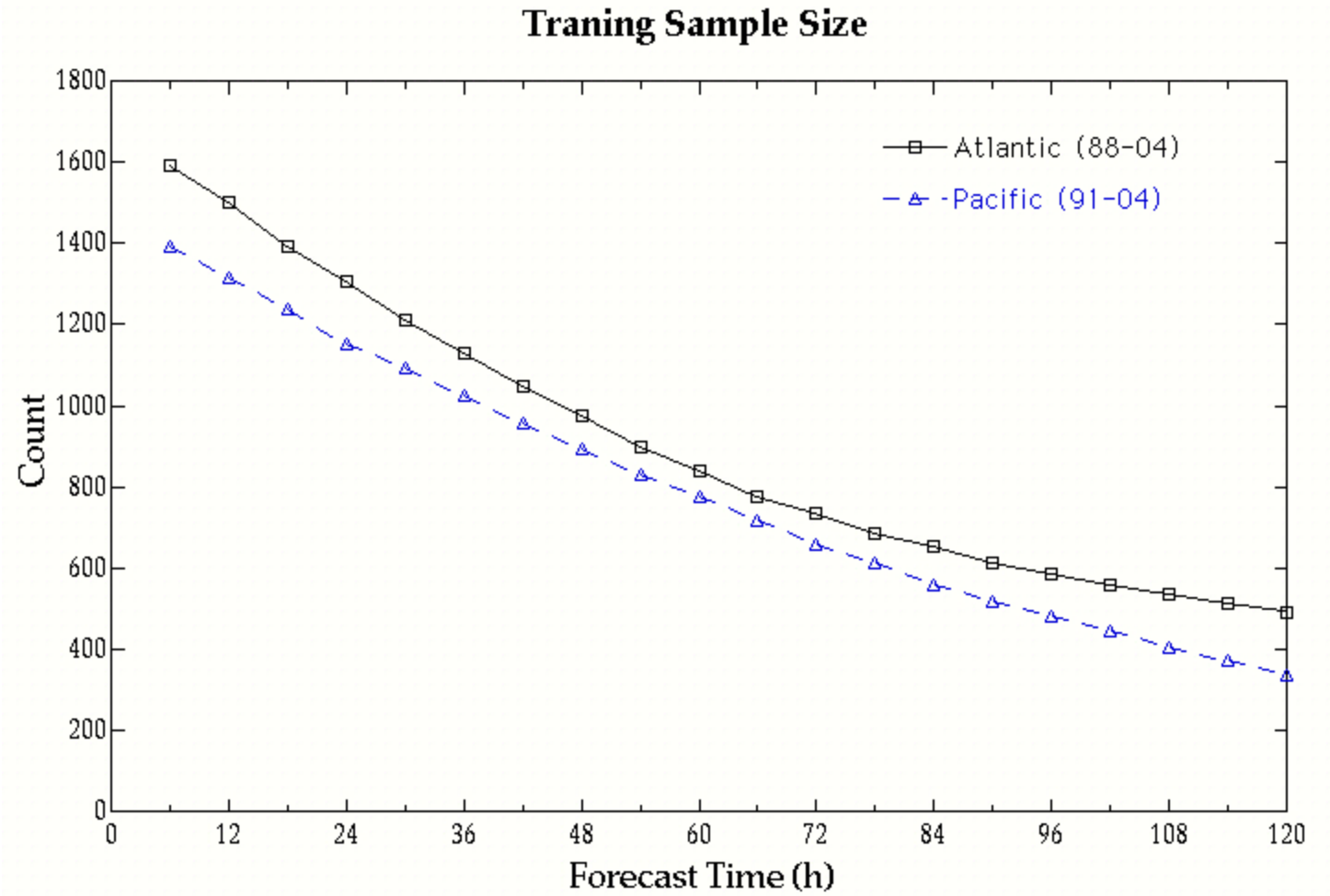


Sample size is small at 60 h and beyond; improvement there is not meaningful

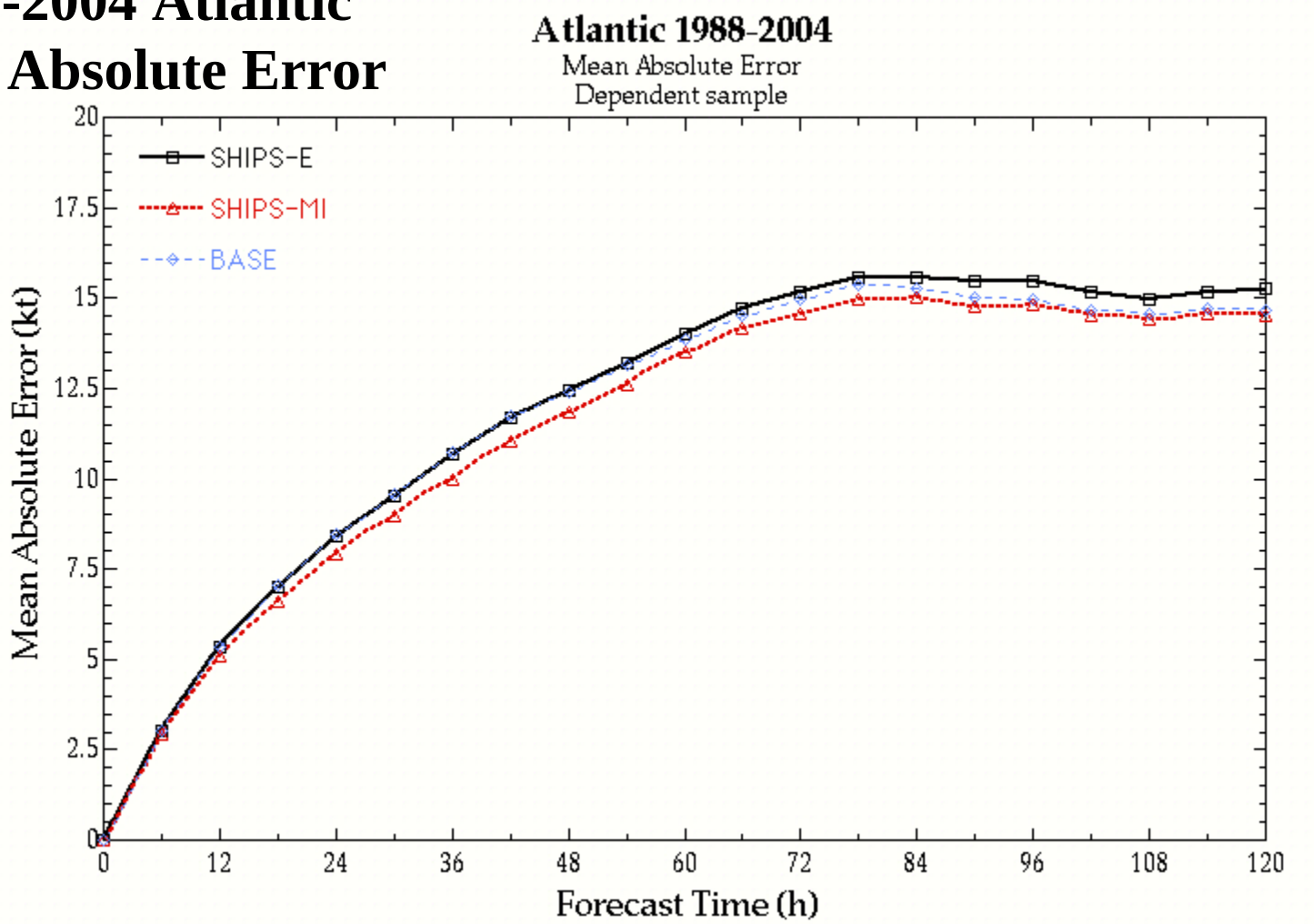
SHIPS-MI improves over SHIPS through 48 h, essentially matches SHIPS after that

1988-2004 Training Sample Size



Mean Absolute Errors for a ***homogeneous, dependent*** sample 1988-2004 (no jack-knifing applied)

1988-2004 Atlantic Mean Absolute Error



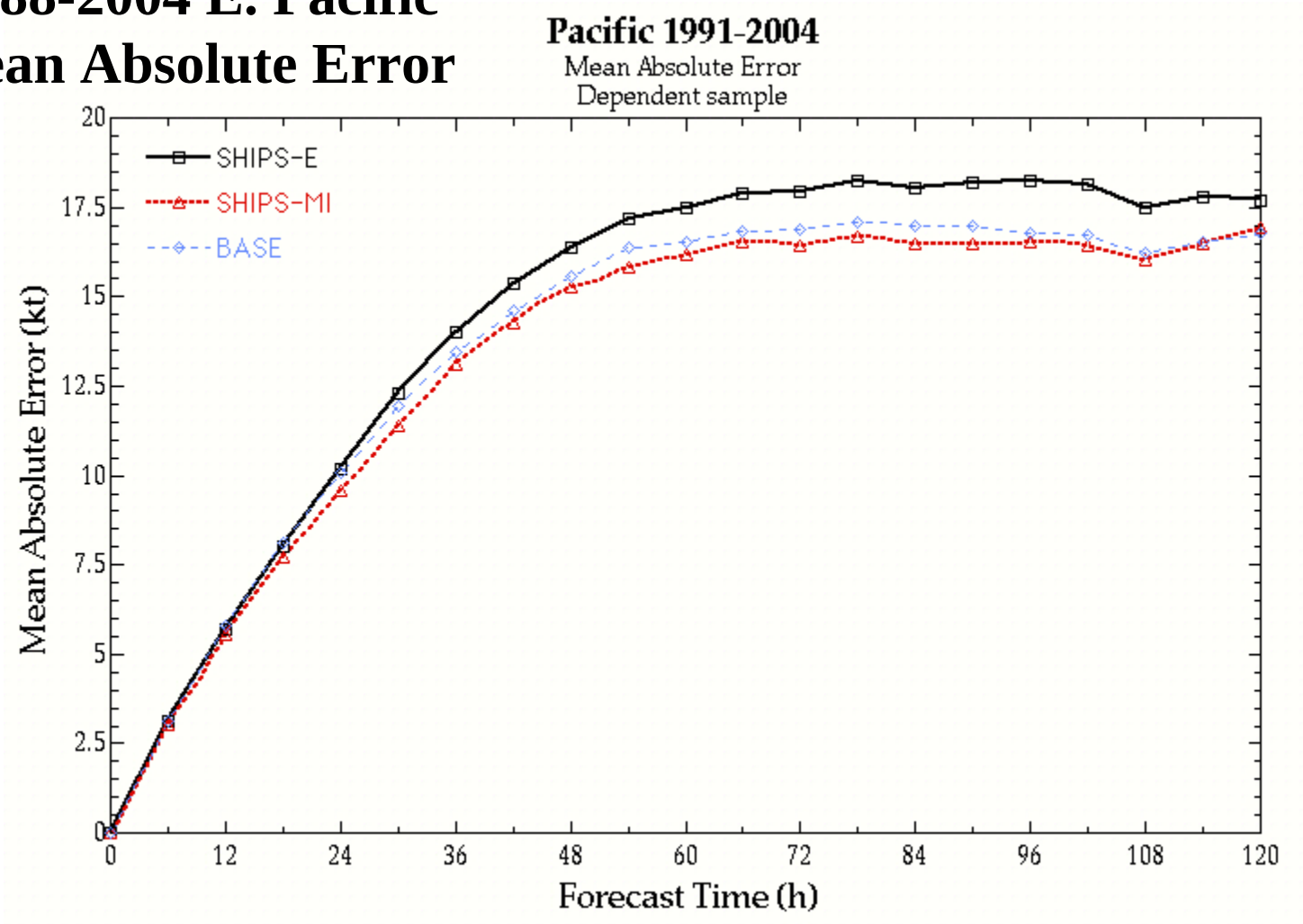
Mean Absolute Errors for a *homogeneous, dependent* sample 1988-2004 (no jack-knifing applied)

SHIPS-E is the 2005 operational model *without* IR or Oceanic Heat Content adjustment

BASE has the same predictors as SHIPS-MI, except microwave predictors are excluded

Note that this is the entire SHIPS-MI training sample, but SHIPS uses a larger training sample, so SHIPS-MI (and BASE) has an unfair advantage in computing errors from this sample; this especially matters at long forecast periods where sample size is small

1988-2004 E. Pacific Mean Absolute Error



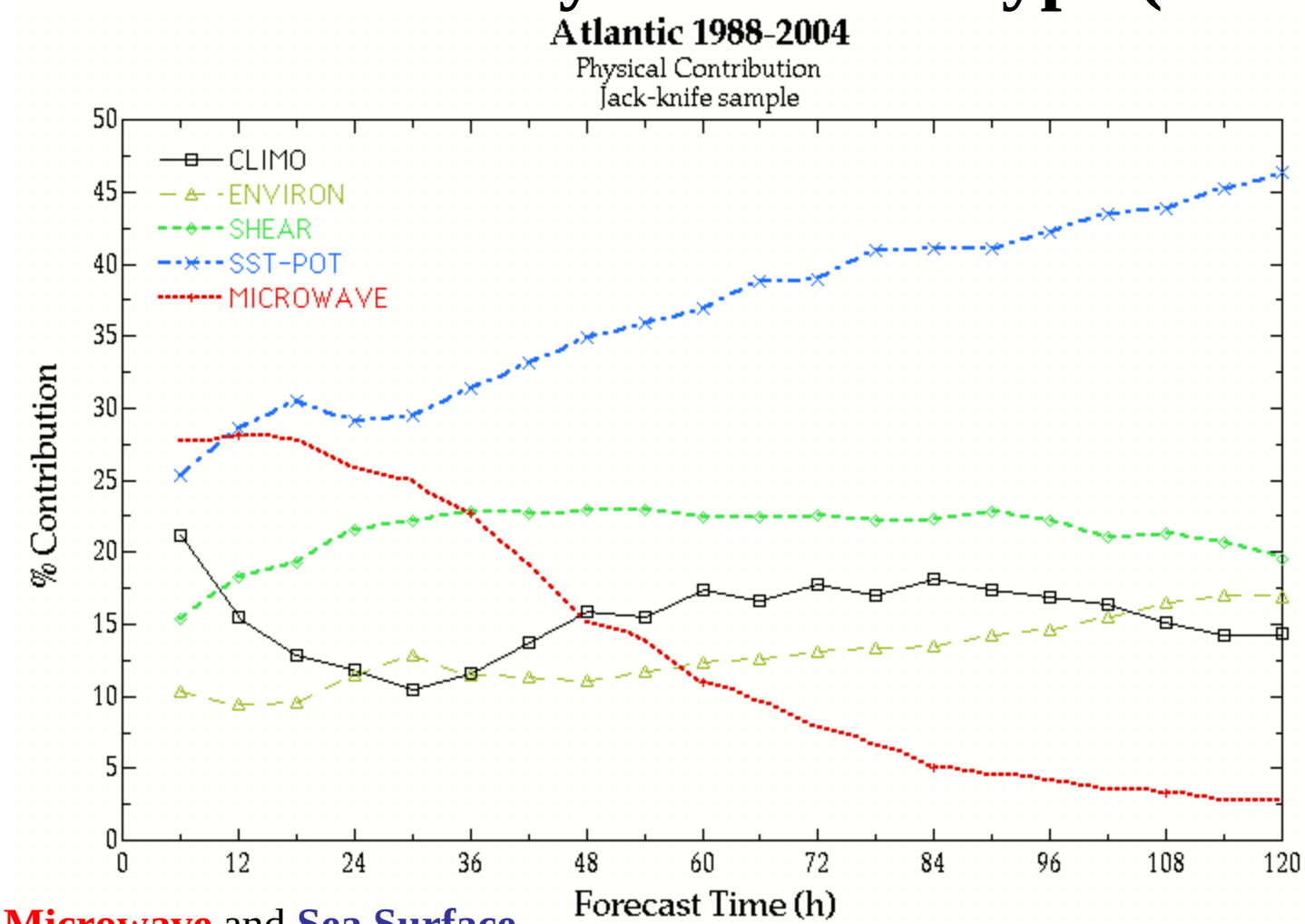
Mean Absolute Errors for a *homogeneous*, *dependent* sample 1991-2004 (no jack-knifing applied)

SHIPS-E is the 2005 operational model *without* IR adjustment

BASE has the same predictors as SHIPS-MI, except microwave predictors are excluded

Note that this is the entire SHIPS-MI training sample, but SHIPS uses a larger training sample, so SHIPS-MI (and BASE) has an unfair advantage in computing errors from this sample; this especially matters at long forecast periods where sample size is small

Contribution by Predictor Type (ATL)



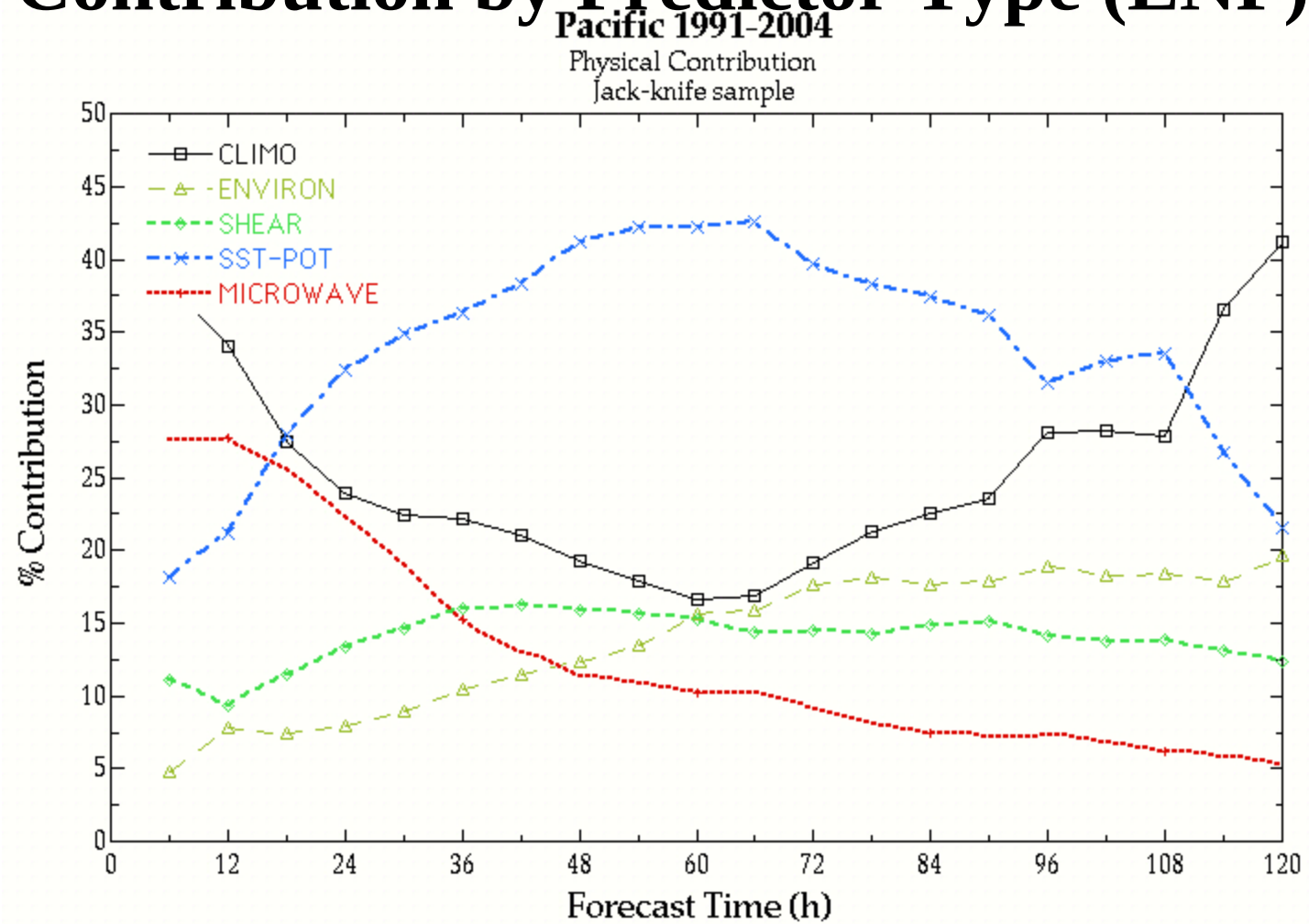
Microwave and **Sea Surface Temperature** predictors are most important through 24 h

Contribution from **microwave** decreases rapidly after 36 h

SST contribution increases with time

Shear terms are second most important (behind **SST**) after 36 h

Contribution by Predictor Type (ENP)



SST and **CLIPER** terms (primarily LATITUDE) are most important in E. Pac.; LAT is not included in Atlantic version

Persistence especially important for short range, Latitude especially important for long range

Shear much less important than in Atlantic

Microwave has less impact at 18-54 h than in Atlantic

2005 Atlantic Results

Data collected in real time

Forecasts re-generated in 2006, after expanding training sample back to 1988

Verification based on operational intensities, *not* best tracks

Some scripting and network issues caused missing forecasts

- Should have had fcsts at 30-40% of synoptic times
- Instead had fcsts at 25% of synoptic times

2005 RMS Errors (ATL)

	12-h	**24-h**	**36-h**	**48-h**	**72-h**	**96-h**	**120-h**
# fcsts	*115*	*103*	*94*	*85*	*71*	*58*	*45*
SHIPS-MI	**8.5**	**12.4**	**16.0**	**19.3**	**21.9**	**22.5**	**27.7**
SHIPS	8.7	12.6	16.4	18.7	21.3	21.7	26.3
OFCL	7.4	11.1	14.6	17.7	20.9	22.9	28.4
SHIFOR	9.2	14.0	18.8	21.0	24.8	25.4	25.5

Landfalls excluded

Operational estimates used for verification

2005 Bias (ATL)

	12-h	24-h	36-h	48-h	72-h	96-h	120-h
SHIPS-MI	**-0.1**	**0.1**					
SHIPS	-0.9	-1.1	-0.6	-2.1	-3.7	-3.2	-3.4
OFCL	0.2	-0.5	0.0	-2.7	-4.9	-5.1	-4.9
SHIFOR	-0.8	-1.6	-2.1	-5.0	-6.6	-6.3	-6.7

Landfalls excluded

Operational estimates used for verification

Negligible bias

In 2005, SHIPS-MI tended to nudge forecasts a few kt in the right direction, compared to SHIPS

Individual 2005 Storms

36-h RMS errors for those storms that had at least ten SHIPS-MI forecasts:

Storm	# fcsts	**SHIPS-MI**	SHIPS	OFCL	SHIFOR
Emily	13	**24.9**	27.3	18.5	33.5
Irene	15	**12.3**	8.6	8.8	8.2
Maria	12	**8.7**	9.9	12.3	10.5
Epsilon	13	**15.2**	17.6	17.1	15.1

For various reasons, only a few storms had 10+ SHIPS-MI 36-h forecasts

- scripting or network problems at UAH

- SSM/I at bad time in GOM / W. Carrib, too late for fcsts

2005 errors (ATL)

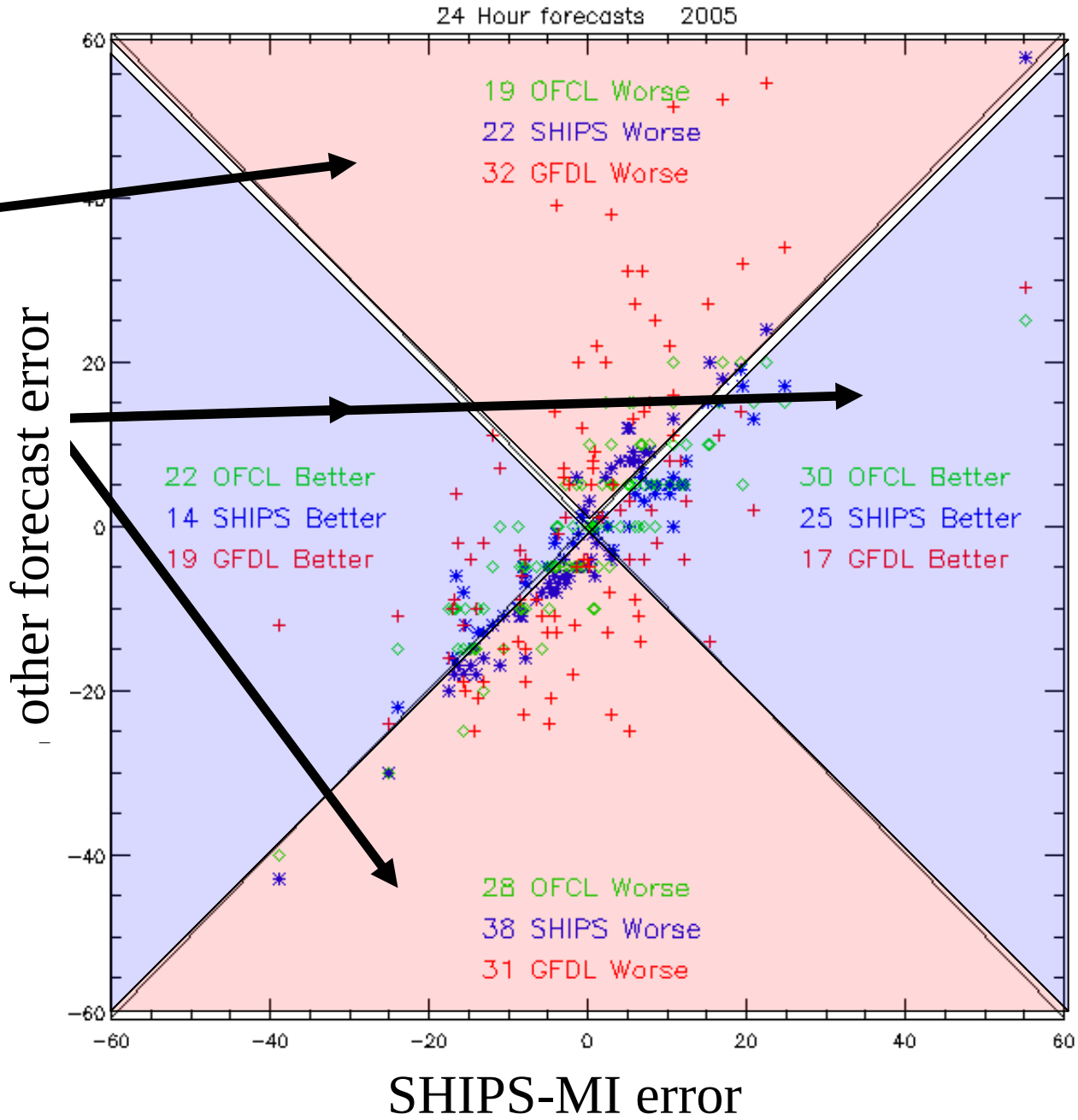
For 24-h fcsts:

SHIPS-MI is better ~60% of time

SHIPS is better ~40% of time

Usually only a few kt difference

Most improvement is for large under-forecasts



Webpage Examples

Page is under development, hope to have it online with real time forecasts in 2006

User capable of altering input predictor values, generate new forecast

Example:

- If you don’t believe the shear is accurate, input a new value
- Test to see how much impact an extreme predictor value will have

Webpage Example

Storm Name: FRANCES

Date: 8/31

Time: 18Z

Storm ID Quick Reference:

142

	A	B	C	D
PREDICTORS	Model Input	Original Run	Sample Mean	Standard Deviation
Climatological				
MSWO	120	120	55.921	26.8904
Persistence (kts/12hr)	10	10	--	--
VPER (kt^2)	1200	1200	183.203	651.973
Latitude (degrees)	20.3	20.3	23.7204	6.23738
SST				
SST (°C)	29.72	29.72		--
MPI (kt)	157.9142	157.8370	--	--
POT (kt)	37.9142	37.837	82.1659	32.2423
POT² (kt^2)	1437.48	1431.64	7789.81	5019.89
Shear				
SHRD (kt)	17.15	7.15	17.8646	9.17661
SHRDLAT (kt)	6.10496825174825	2.54522	7.66343	5.40742
MSWSHRD (kt^2)	2058	858	991.327	681.59
Environmental				
EPOS (°C)	13.3	13.3	11.7089	3.68188
T200 (°C)	-52.3	-52.3	-53.3318	1.71155
Z850 (s^(-1))*10^(-5)	34	34	25.9216	54.4645
Microwave				
MEANH19	255.392	255.392	204.675	25.1524
MAXH19	273.643	273.643	244.018	27.0061

Submit | Restore Defaults

A) User can change any of the input predictor values

In this example, the user increases SHEAR by 10 kt

For reference, the:

B) original forecast value

C) training sample mean

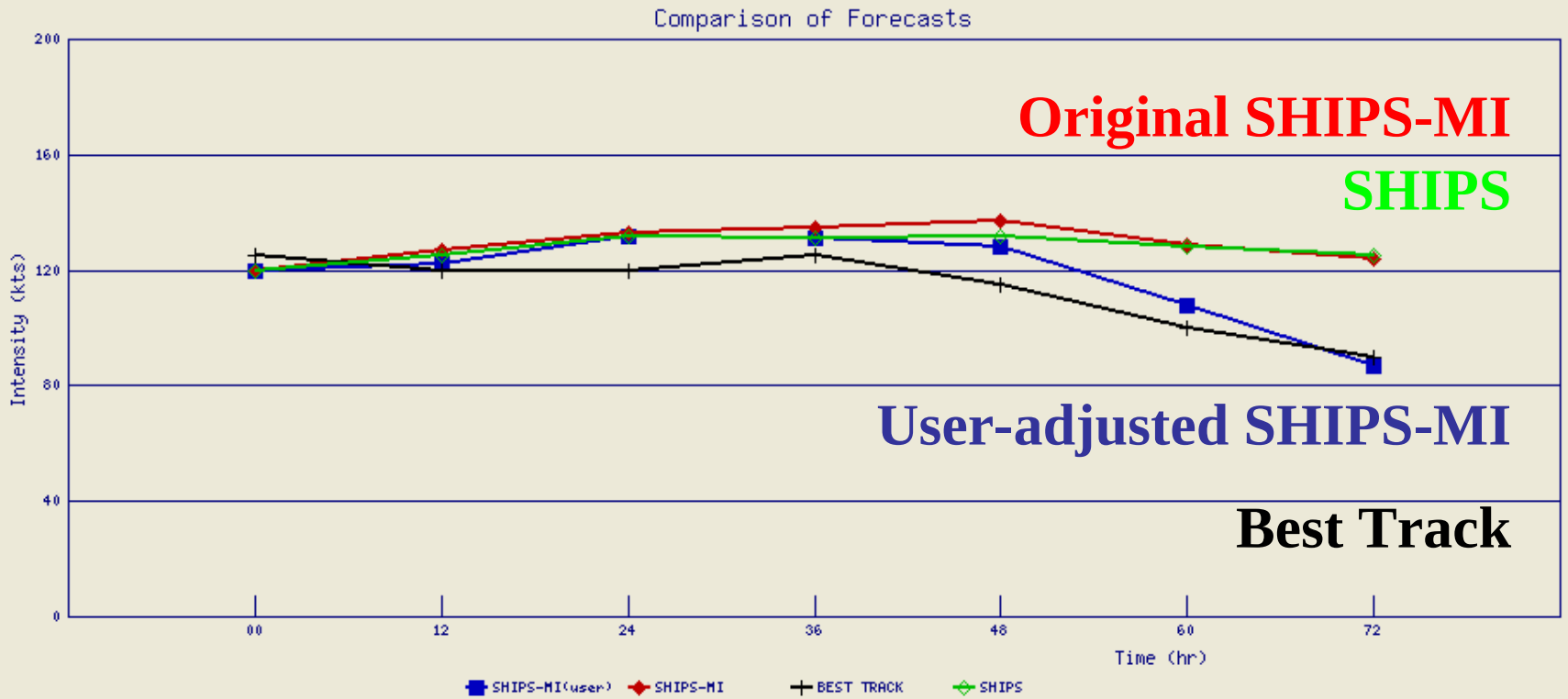
D) standard deviation

are listed

Webpage Example

FORECAST VERIFICATION (kts)

	00	12	24	36	48	60	72
BEST TRACK :	125	120	120	125	115	100	90
SHIPS:	120	125	132	131	132	128	125
SHIPS-MI:	120	127	133	135	137	129	124
SHIPS-MI(user):	120	122	132	131	128	108	87

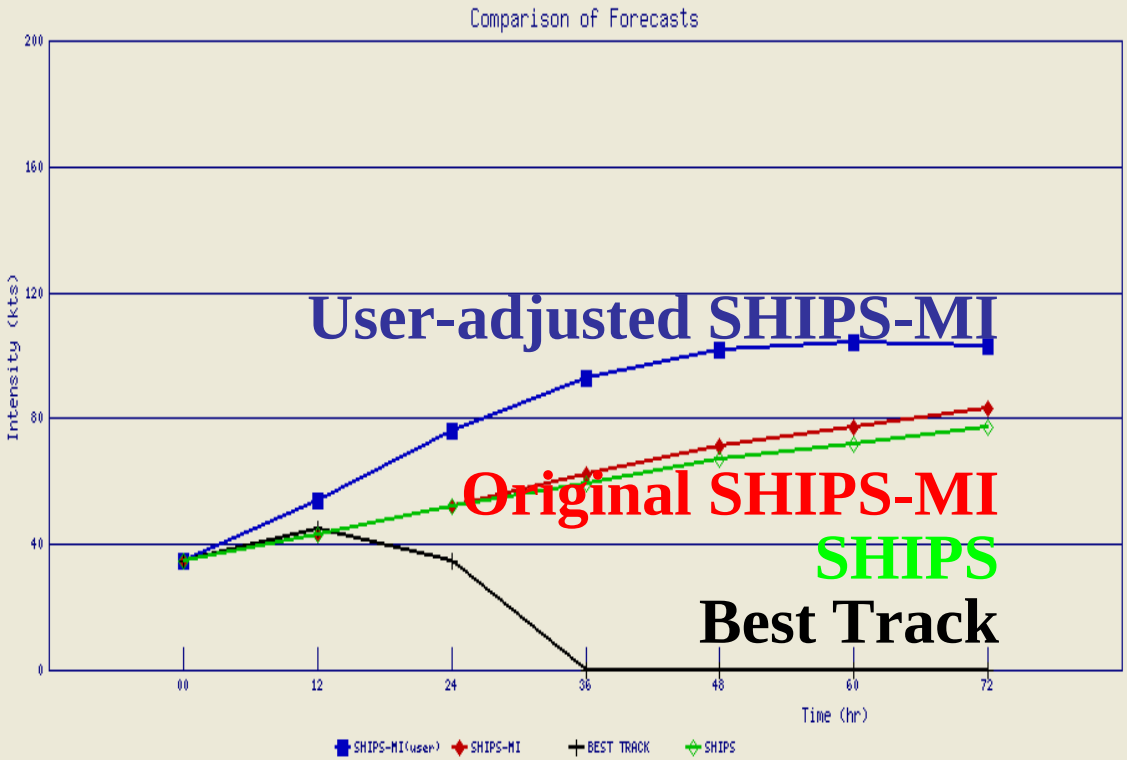


The extra 10 kt Shear causes extra 37 kt weakening by 72-h

Impact from MI predictors

FORECAST VERIFICATION (kts)

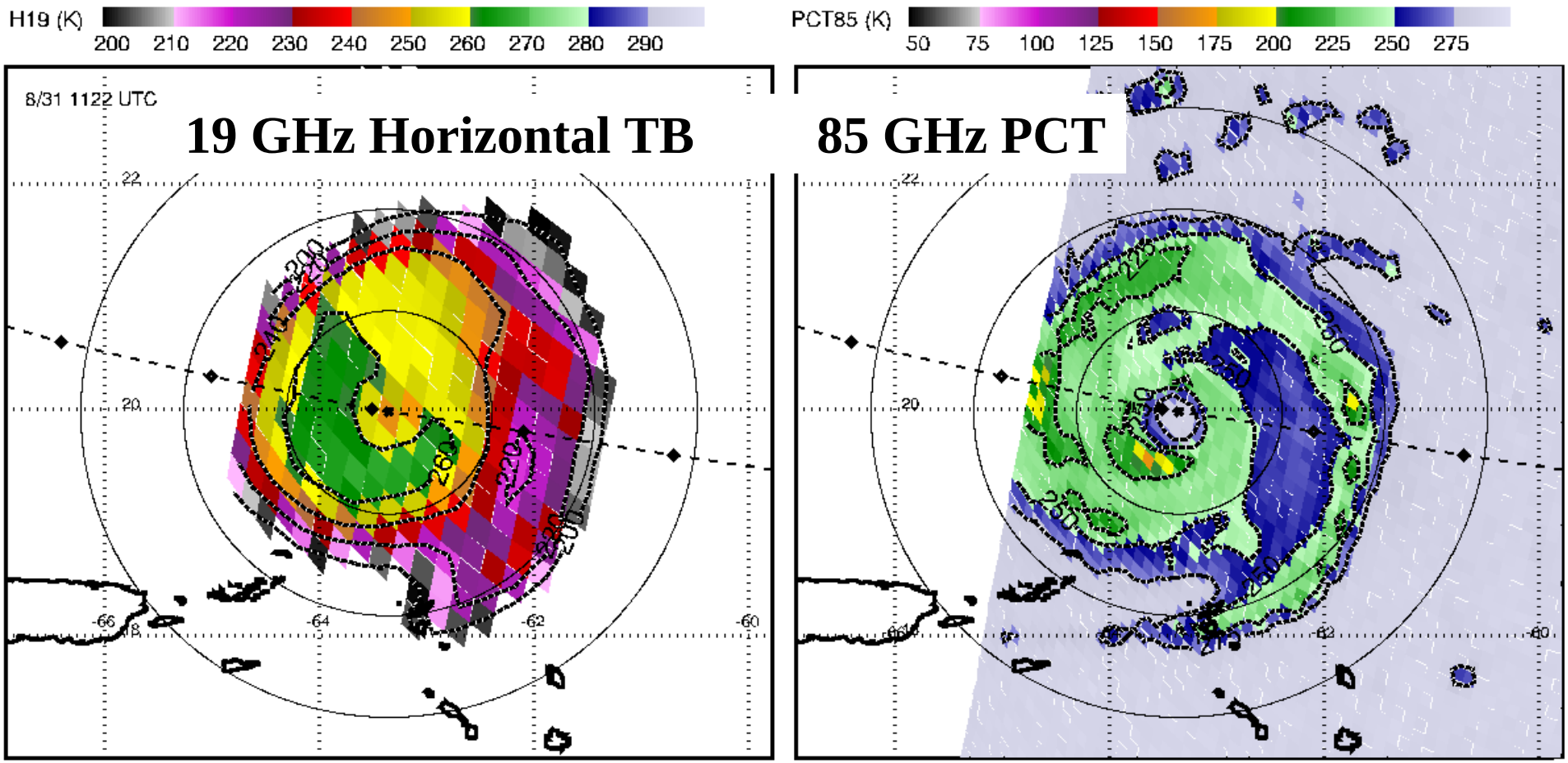
	00	12	24	36	48	60	72
BEST TRACK :	35	45	35	0	0	0	0
SHIPS:	35	43	52	59	67	72	77
SHIPS-MI:	35	43	52	62	71	77	83
SHIPS-MI(user):	35	54	76	93	102	104	103



Changing from common values for microwave predictors to the *maximum* reasonable values:

Increases forecast by:
~10 kt at 12 h
~25 kt at 24 h
~30 kt at 36-48 h

Example Strong Positive Microwave Signal



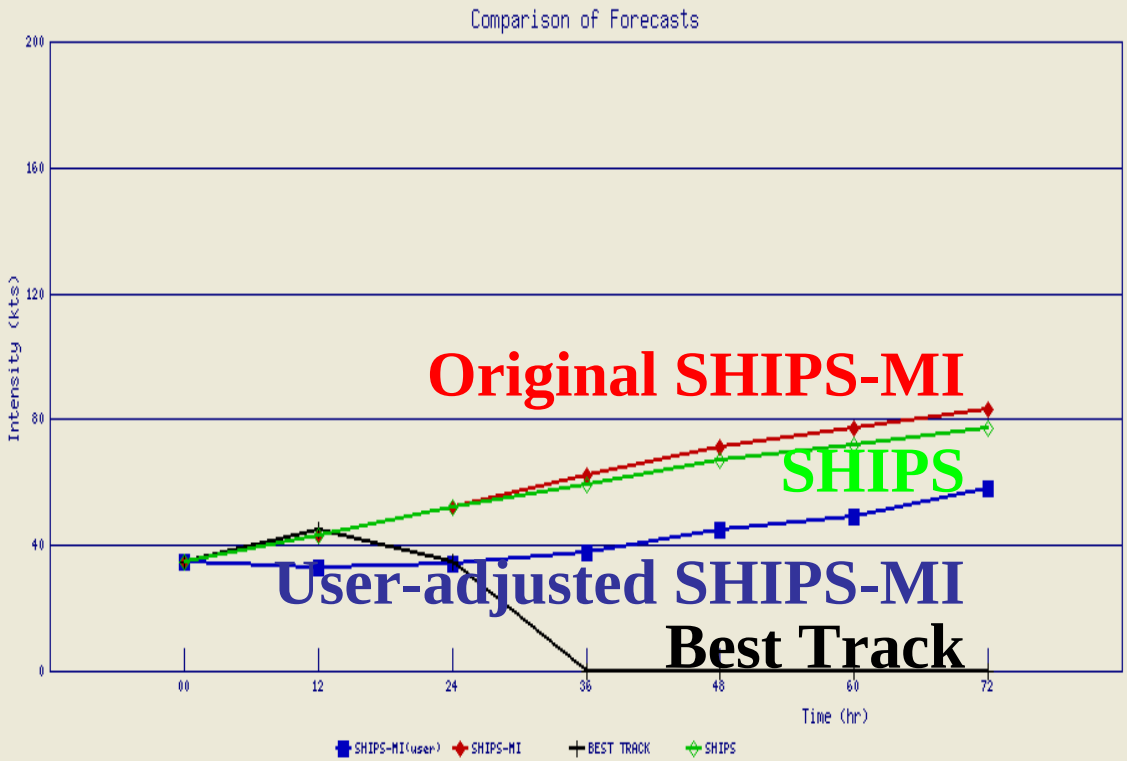
Hurricane Frances, 31 August 2004

MEANH19 = 259 K

Impact from MI predictors

FORECAST VERIFICATION (kts)

	00	12	24	36	48	60	72
BEST TRACK:	35	45	35	0	0	0	0
SHIPS:	35	43	52	59	67	72	77
SHIPS-MI:	35	43	52	62	71	77	83
SHIPS-MI(user):	35	33	34	38	45	49	58



Changing from common values for microwave predictors to the *minimum* reasonable values:

Decreases forecast by:
~10 kt at 12 h
~20 kt at 24 h
~25 kt at 36-48 h