GFSV16 Impact on NCEP Operational Hurricane Model Forecast Systems (HWRF/HMON)

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HWRF/HMON Downstream Upgrades for GFSV16 and RTOFS

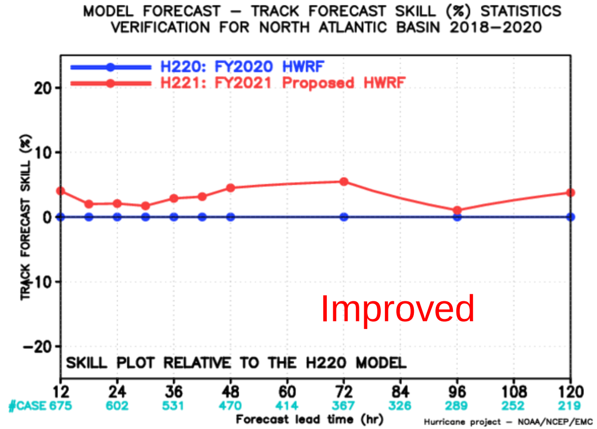
- Upstream data input: GFSV16 (Feb. 2021) and RTOFS (Nov. 2020)
- H221/M221: HWRF/HMON driven by GFSV16 and RTOFS
- H220/M220: Current operational HWRF/HMON
- Experiment Period: Most of the TCs in 2018-2020 for NATL, 2019-2020 for EPAC

H221: HWRF (with GFS v16) vs H220: Operational HWRF

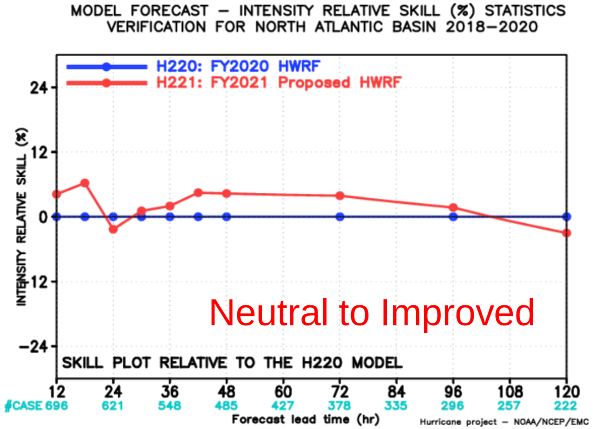
Track Forecast Skill

Intensity Forecast Skill

NATL

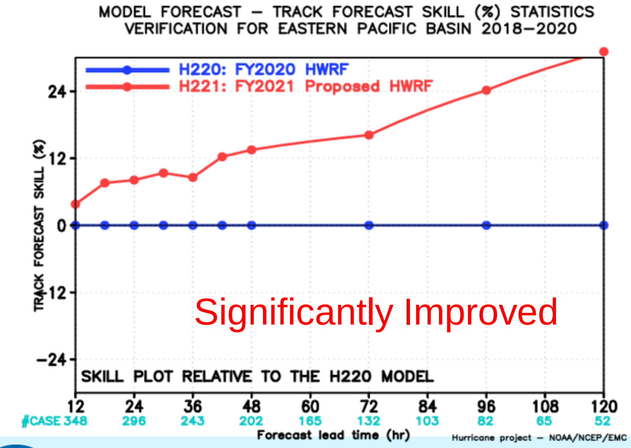


Improved

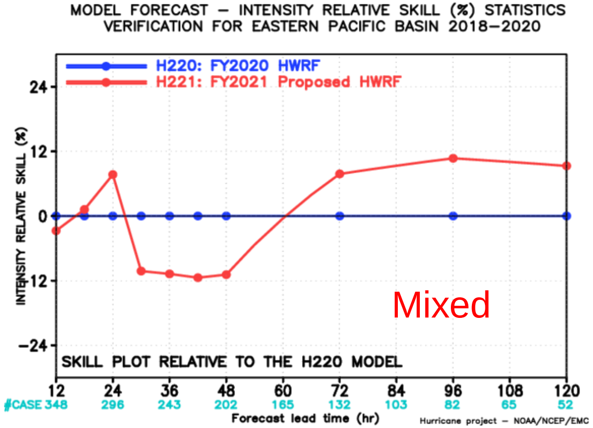


Neutral to Improved

EPAC



Significantly Improved



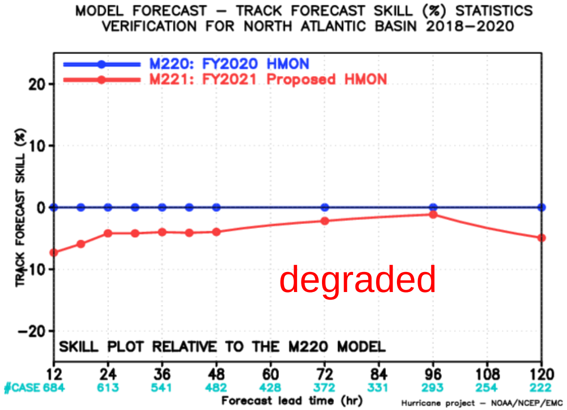
Mixed

M221: HMON (with GFS v16) vs M220: Operational HMON

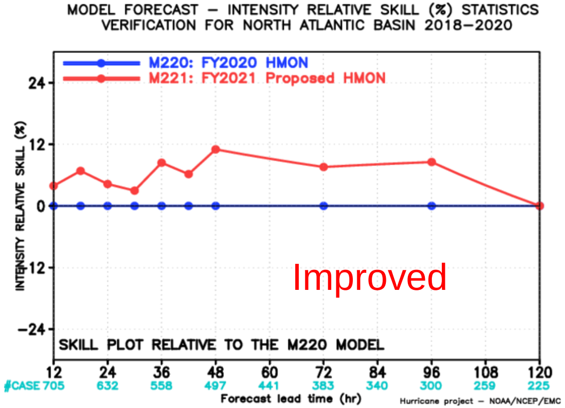
Track Forecast Skill

Intensity Forecast Skill

NATL

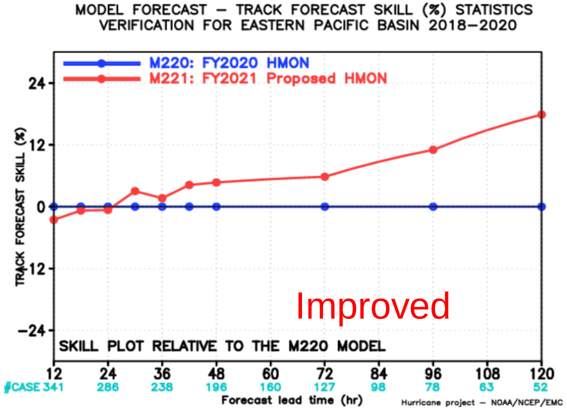

MODEL FORECAST – TRACK FORECAST SKILL (%) STATISTICS
VERIFICATION FOR NORTH ATLANTIC BASIN 2018–2020

degraded

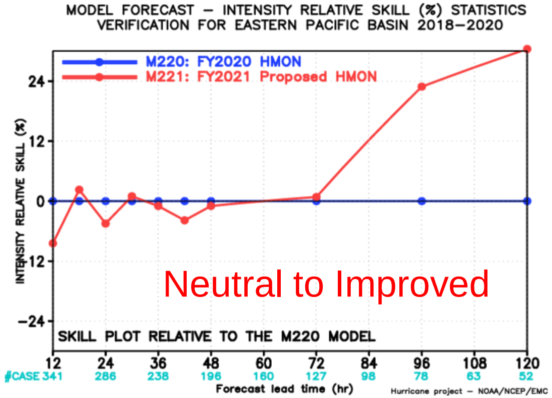

MODEL FORECAST – INTENSITY RELATIVE SKILL (%) STATISTICS
VERIFICATION FOR NORTH ATLANTIC BASIN 2018–2020

Improved

EPAC

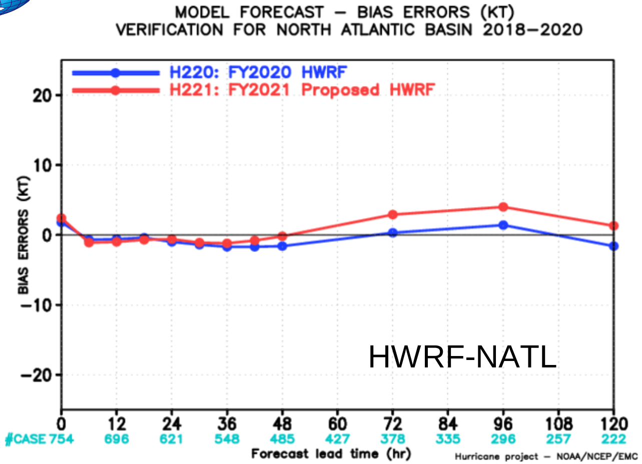

MODEL FORECAST – TRACK FORECAST SKILL (%) STATISTICS
VERIFICATION FOR EASTERN PACIFIC BASIN 2018–2020

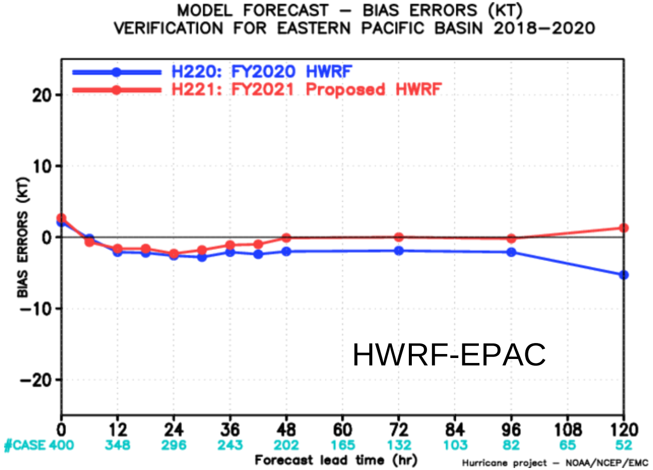
Improved

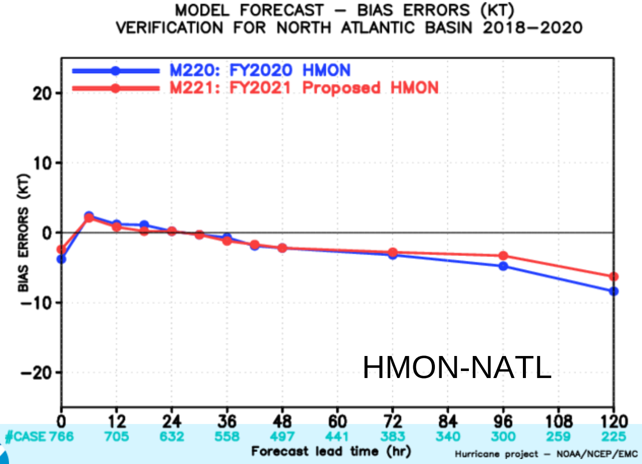

MODEL FORECAST – INTENSITY RELATIVE SKILL (%) STATISTICS
VERIFICATION FOR EASTERN PACIFIC BASIN 2018–2020

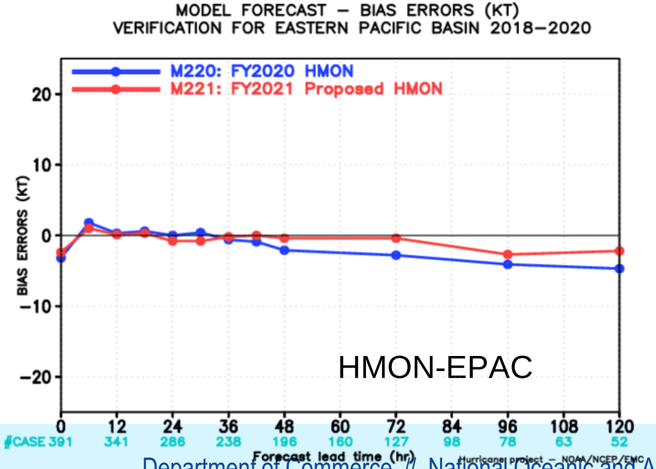
Neutral to Improved

Model Intensity Bias Comparisons


MODEL FORECAST – BIAS ERRORS (KT)
VERIFICATION FOR NORTH ATLANTIC BASIN 2018–2020


MODEL FORECAST – BIAS ERRORS (KT)
VERIFICATION FOR EASTERN PACIFIC BASIN 2018–2020

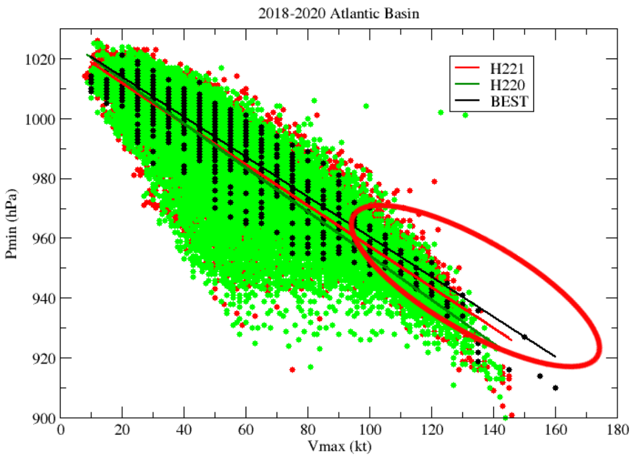

MODEL FORECAST – BIAS ERRORS (KT)
VERIFICATION FOR NORTH ATLANTIC BASIN 2018–2020


MODEL FORECAST – BIAS ERRORS (KT)
VERIFICATION FOR EASTERN PACIFIC BASIN 2018–2020

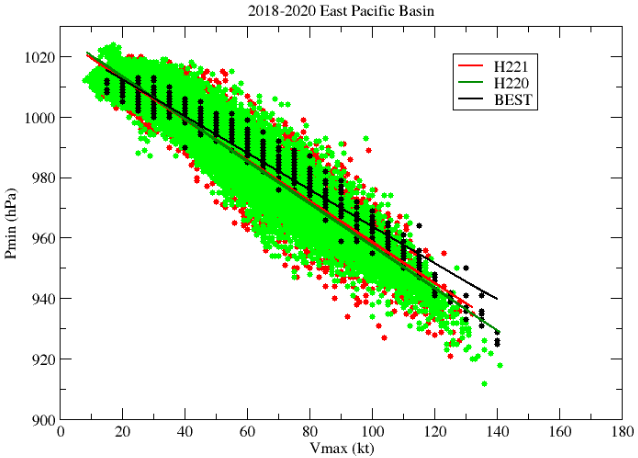
Pressure-Wind Relationship Comparisons

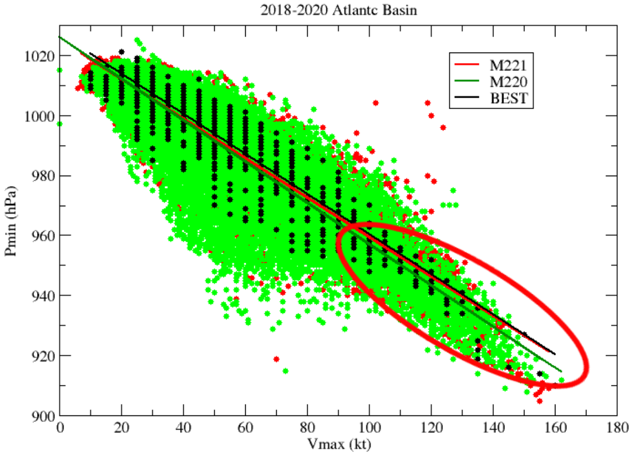
NATL

EPAC

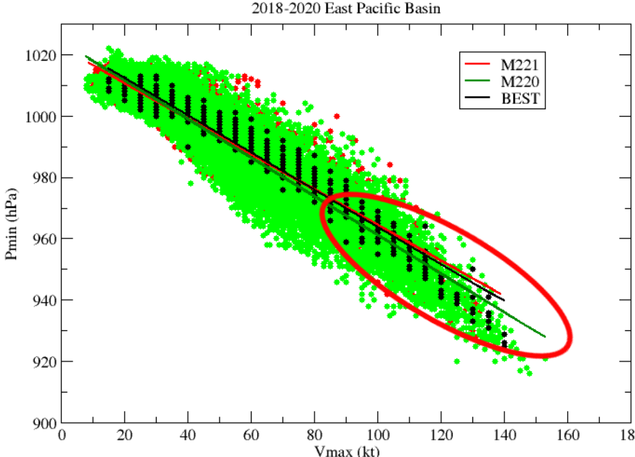


HWRF





HMON



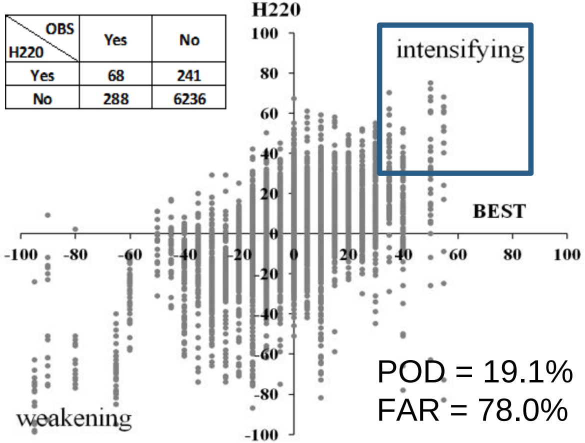
Rapid Intensification (RI) POD/FAR HWRF

H220

H221

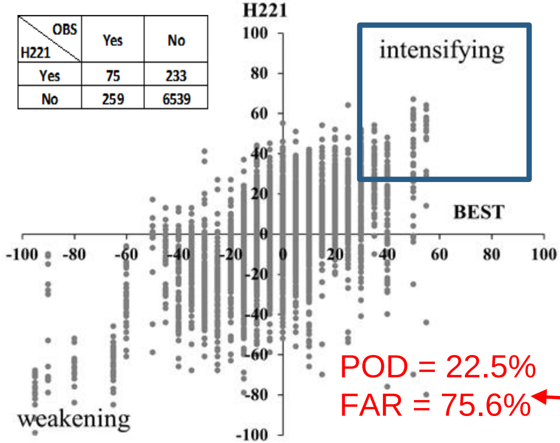
NATL

OBS / H220	Yes	No
Yes	68	241
No	288	6236



POD = 19.1%
FAR = 78.0%

OBS / H221	Yes	No
Yes	75	233
No	259	6539



POD = 22.5%
FAR = 75.6%

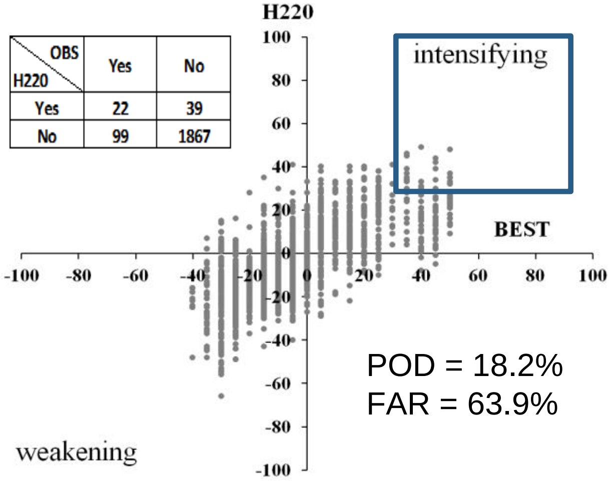
Larger POD and smaller FAR

RI: >30 kt Vmax increase in 24hr

$$POD = O_Y F_Y/(O_Y F_Y+O_Y F_N)$$
$$FAR = O_N F_Y/(O_Y F_Y+O_N F_Y)$$

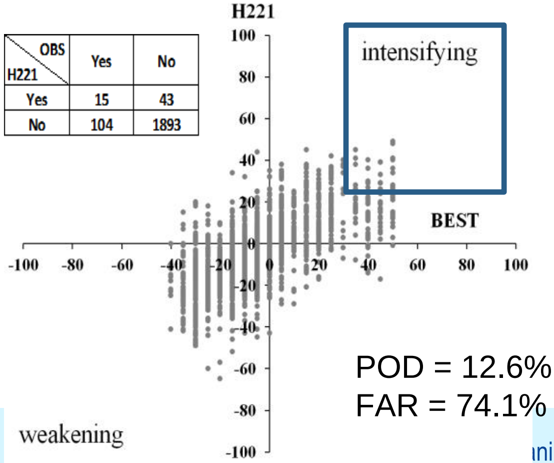
EPAC

OBS / H220	Yes	No
Yes	22	39
No	99	1867



POD = 18.2%
FAR = 63.9%

OBS / H221	Yes	No
Yes	15	43
No	104	1893



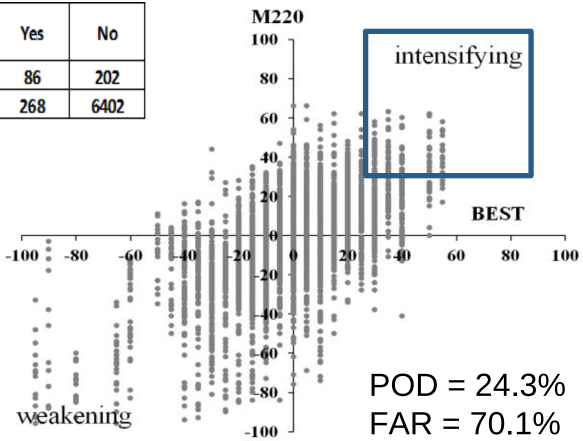
POD = 12.6%
FAR = 74.1%

Rapid Intensification (RI) POD/FAR HMON

M220

M221

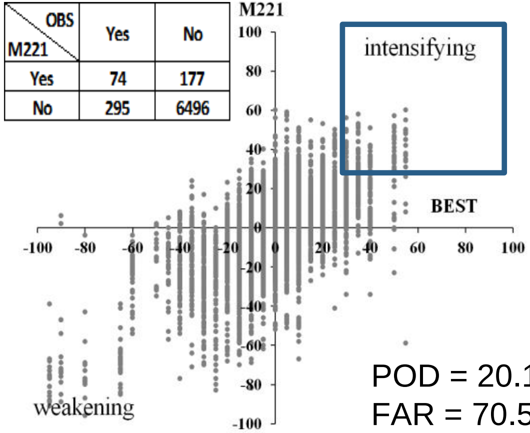
OBS \ M220	Yes	No
Yes	86	202
No	268	6402



POD = 24.3%
FAR = 70.1%

NATL

OBS \ M221	Yes	No
Yes	74	177
No	295	6496

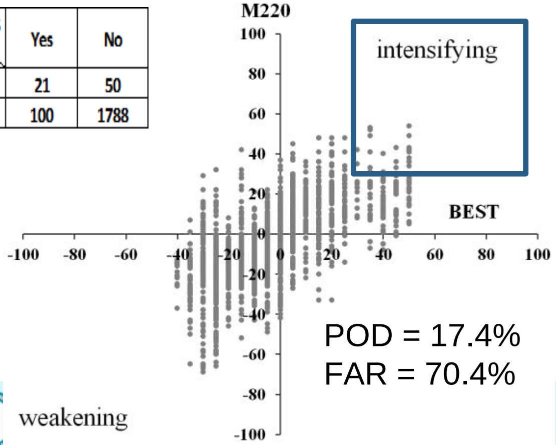


POD = 20.1%
FAR = 70.5%

RI: >30 kt Vmax increase in 24hr

$$POD = O_Y F_Y/(O_Y F_Y + O_Y F_N)$$
$$FAR = O_N F_Y/(O_Y F_Y + O_N F_Y)$$

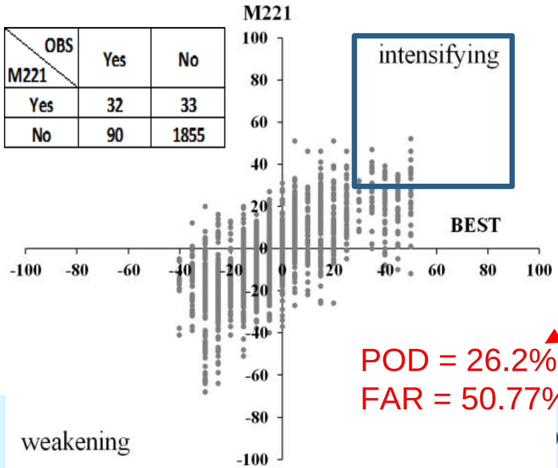
OBS \ M220	Yes	No
Yes	21	50
No	100	1788



POD = 17.4%
FAR = 70.4%

EPAC

OBS \ M221	Yes	No
Yes	32	33
No	90	1855



POD = 26.2%
FAR = 50.77%

Larger POD and smaller FAR

GFSV16 Downstream Impact on Hurricane Forecast Models

Impact on HWRF

	Track Forecast	Intensity Forecast	P-W relationship	RI POD/FAR
NATL	Positive at all lead times (~5%)	Positive at most of the lead times, except for marginally negative at day 1 and 5.	Improved	Improved POD/FAR
EPAC	Significantly positive at all lead times, >20% at day 4-5	Neutral overall. Negative between hrs 30-60 but positive for longer lead times at Days 3-5.	Neutral	Degraded POD/FAR

Impact on HMON

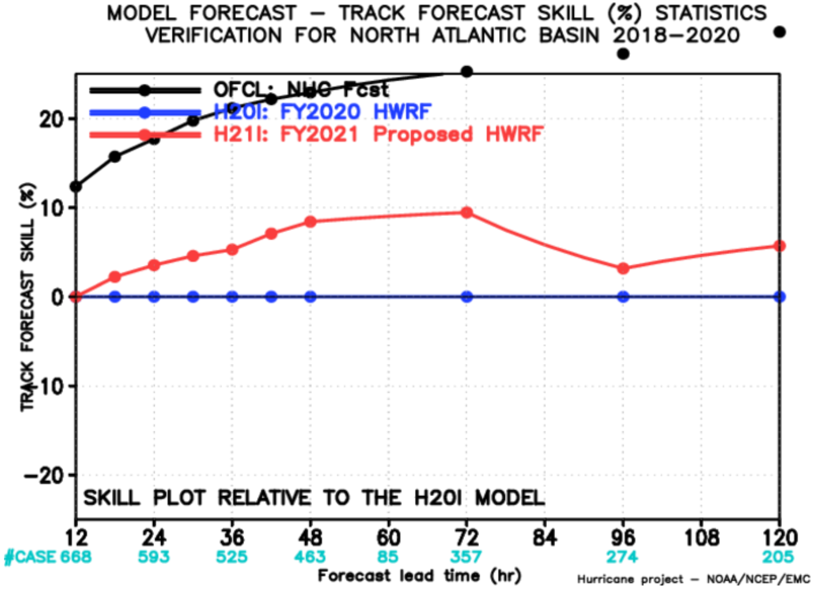
	Track Forecast	Intensity Forecast	P-W relationship	RI POD/FAR
NATL	Negative at all lead times after day-1 (<~5%)	Positive at all lead times, ~10% between day 2-4	Improved	Degraded POD Neutral FAR
EPAC	Significantly positive after day 1, >10% at day 4-5	Neutral before day 3, Significantly positive at day 4 and 5 (>20%)	Improved	Improved POD/FAR

Note: H221/M221 Produce stronger storms than H220/M220

Backup Slides

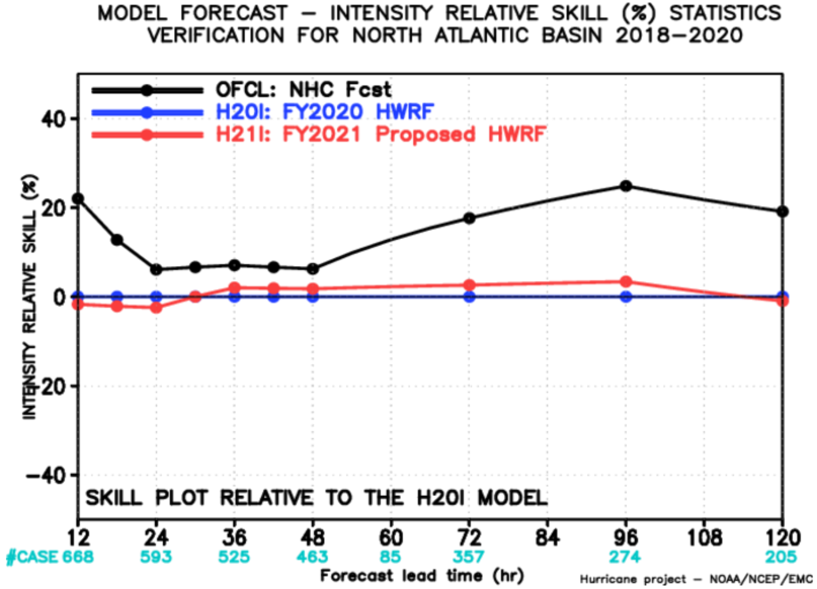
H221: HWRF (with GFS v16) vs H220: Operational HWRF

NATL Basin, Early Model Verification


MODEL FORECAST – TRACK FORECAST SKILL (%) STATISTICS
VERIFICATION FOR NORTH ATLANTIC BASIN 2018–2020

SKILL PLOT RELATIVE TO THE H20I MODEL

Hurricane project – NOAA/NCEP/EMC


MODEL FORECAST – INTENSITY RELATIVE SKILL (%) STATISTICS
VERIFICATION FOR NORTH ATLANTIC BASIN 2018–2020

SKILL PLOT RELATIVE TO THE H20I MODEL

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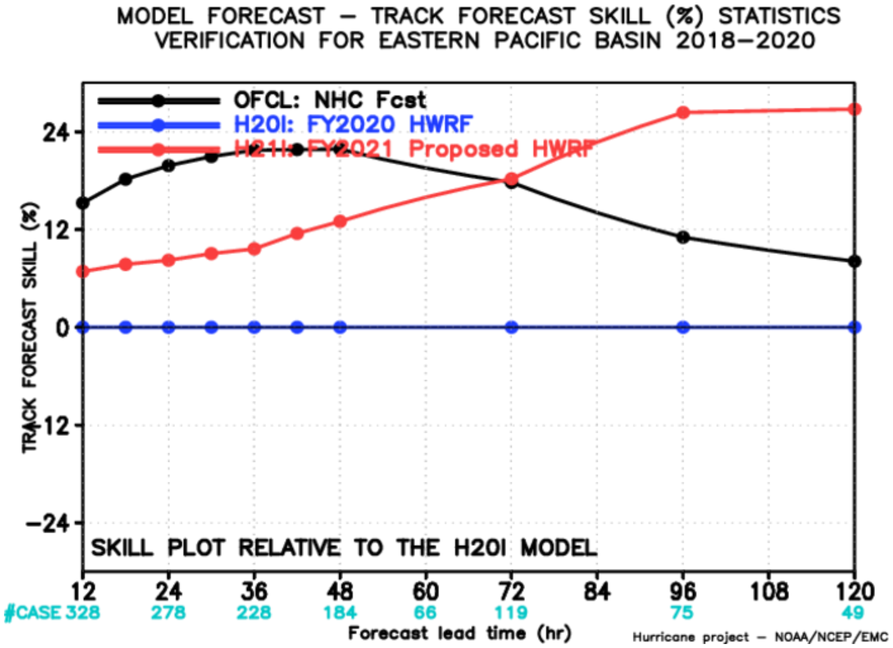
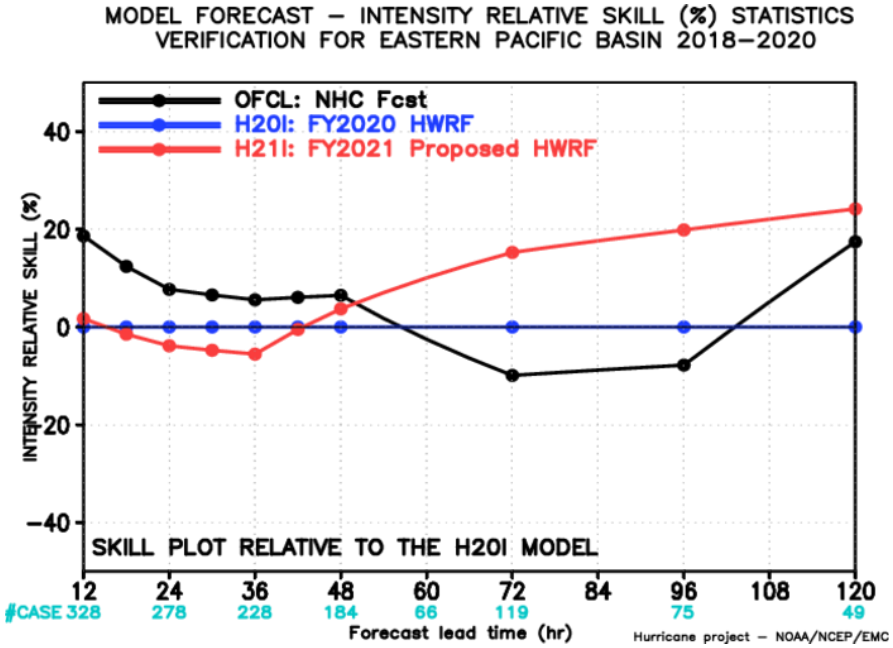
H221: HWRF (with GFS v16) vs H220: Operational HWRF

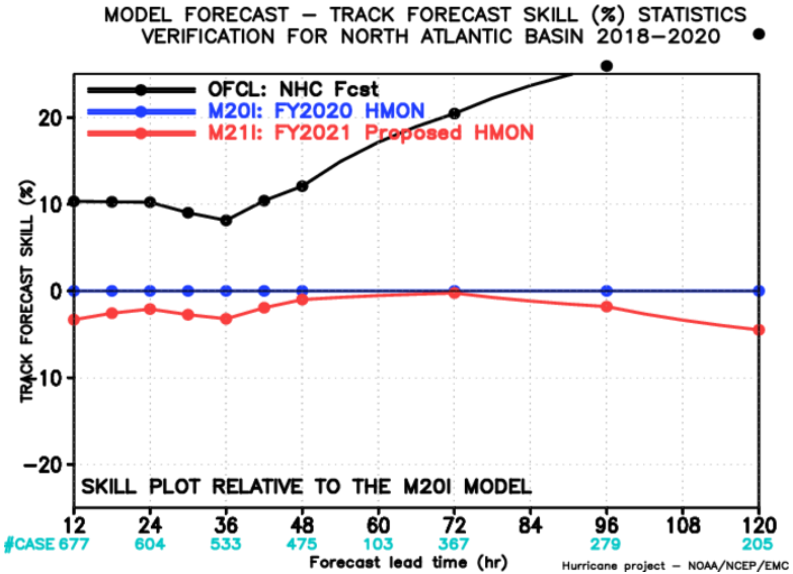
EPAC Basin Early Model Verification

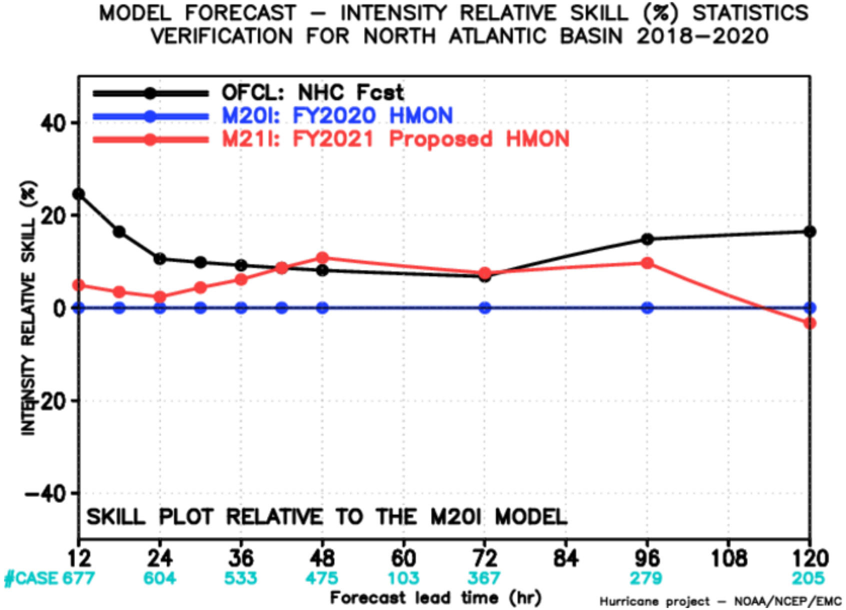

MODEL FORECAST – TRACK FORECAST SKILL (%) STATISTICS
VERIFICATION FOR EASTERN PACIFIC BASIN 2018–2020


MODEL FORECAST – INTENSITY RELATIVE SKILL (%) STATISTICS
VERIFICATION FOR EASTERN PACIFIC BASIN 2018–2020

M221: HMON (with GFS v16) vs M220: Operational HMON

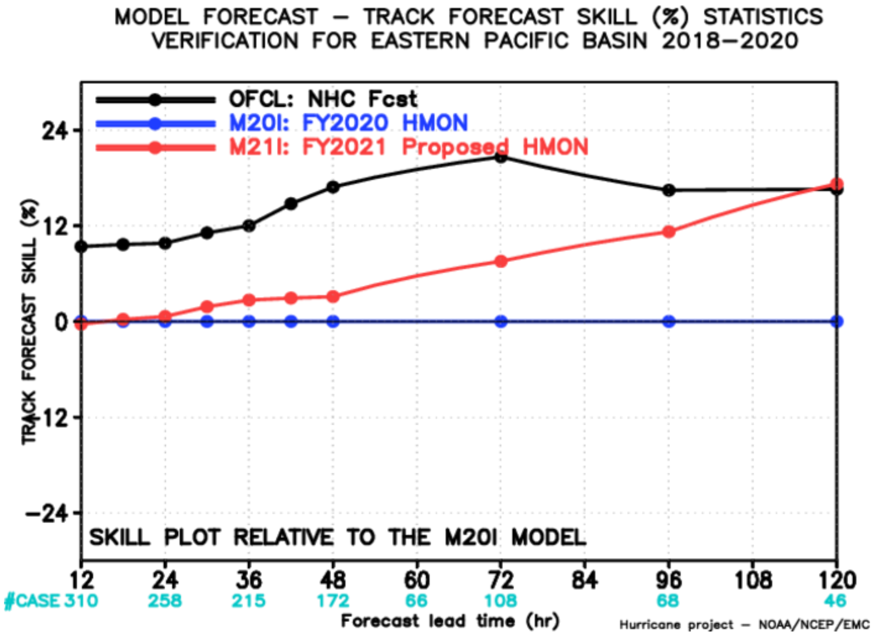
NATL Basin, Early Model Verification

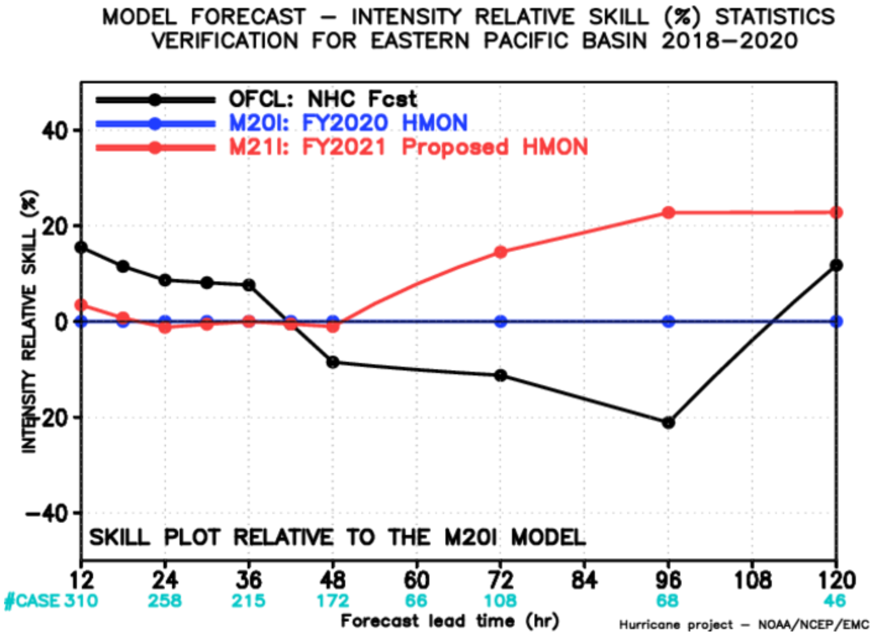




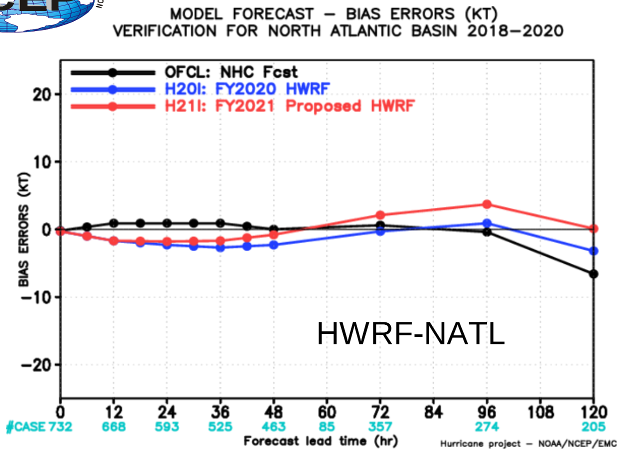
M221: HMON (with GFS v16) vs M220: Operational HMON

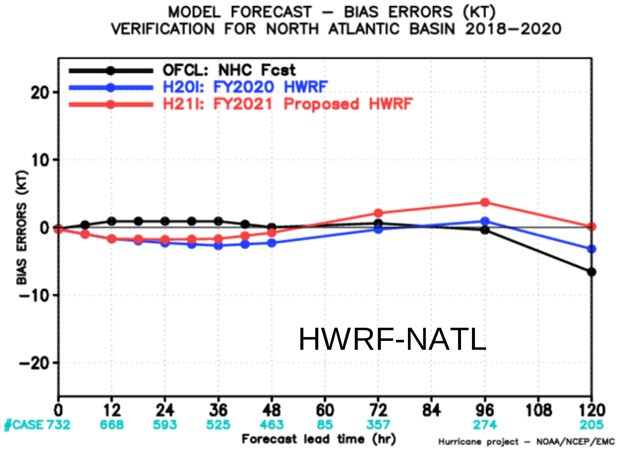
EPAC Basin, Early Model Verification

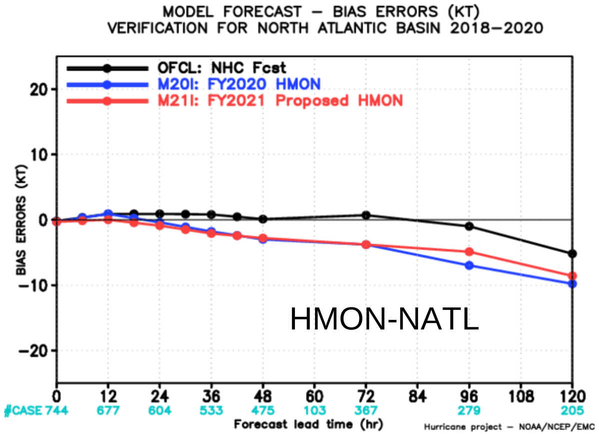


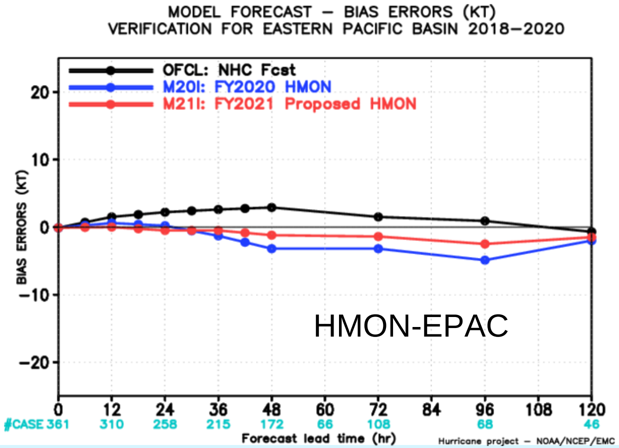


Model Intensity Bias Comparisons, Early Model

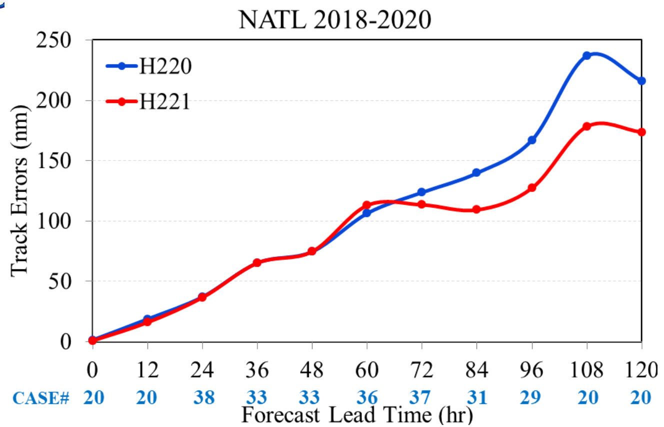

MODEL FORECAST – BIAS ERRORS (KT)
VERIFICATION FOR NORTH ATLANTIC BASIN 2018–2020

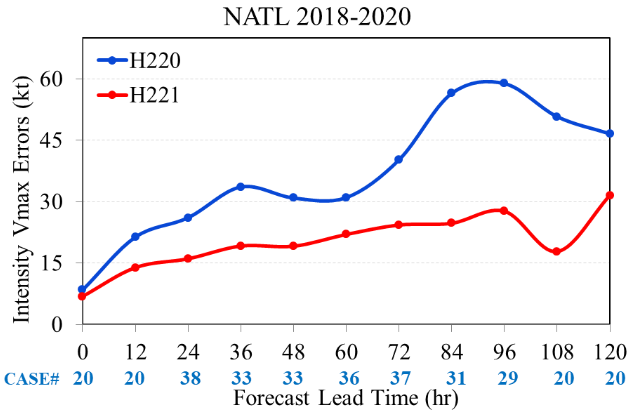

MODEL FORECAST – BIAS ERRORS (KT)
VERIFICATION FOR NORTH ATLANTIC BASIN 2018–2020

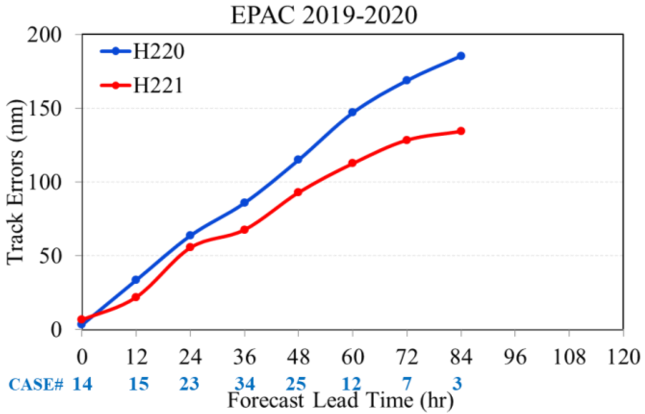

MODEL FORECAST – BIAS ERRORS (KT)
VERIFICATION FOR NORTH ATLANTIC BASIN 2018–2020

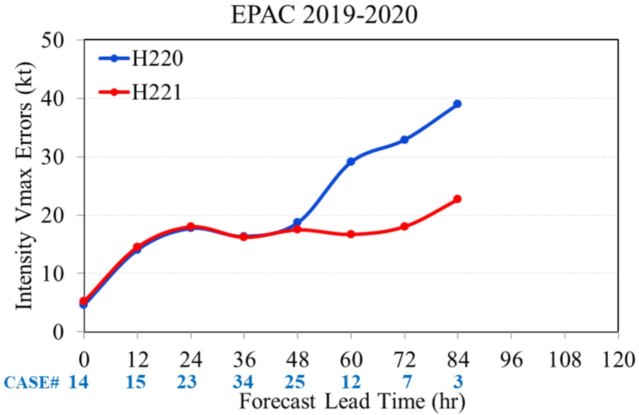

MODEL FORECAST – BIAS ERRORS (KT)
VERIFICATION FOR EASTERN PACIFIC BASIN 2018–2020

Verification for Rapid Intensification Cycles only, HWRF

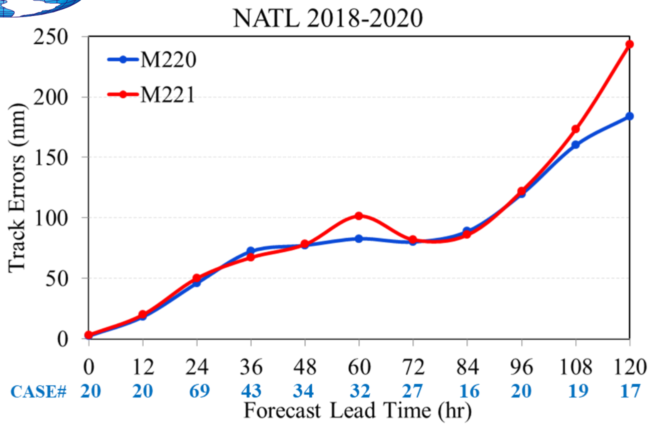


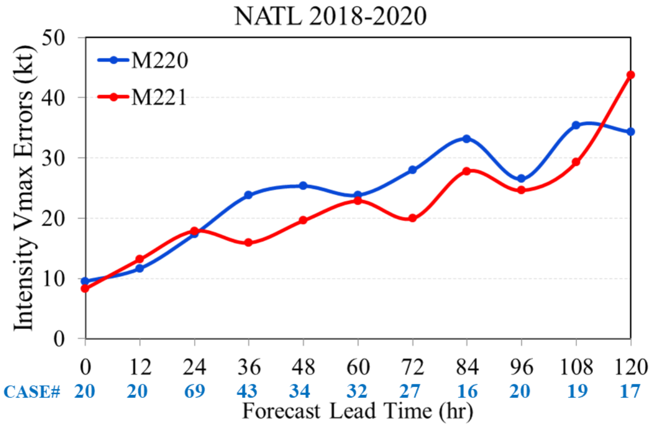


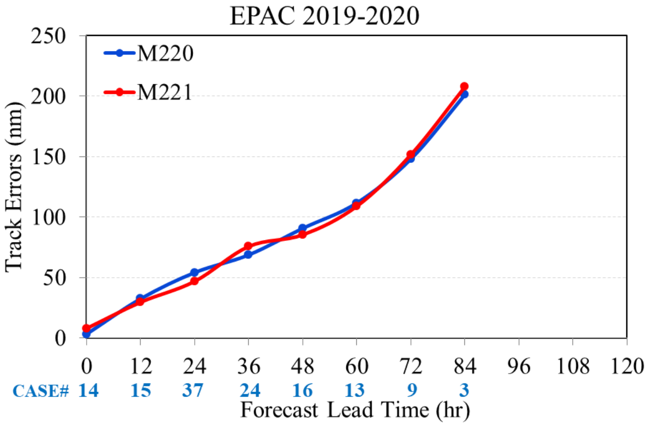


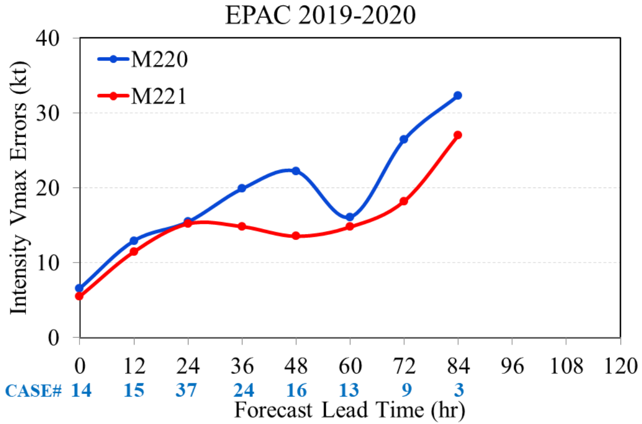


Verification for Rapid Intensification Cycles only, HMON









HWRFRI performance -- NATL

	H220	H221
Success cycle Rate[1]	31% (33%)	30% (35%)
False cycle Rate[2]	69% (61%)	73% (65%)

1. % of 5-day periods with observed RI events most of which predicted by model (pod>0.5)
2. % of cycles predicting RI events most of which are not observed in data (FAR>0.5)
3. RI threshold: 30 knots/Day (20 knots/Day)

RI performance -- EPAC

	H220	H221
Success cycle Rate[1]	21% (40%)	11% (36%)
False cycle Rate[2]	49% (53%)	60% (56%)

1. % of 5-day periods with observed RI events most of which predicted by model (pod>0.5)
2. % of cycles predicting RI events most of which are not observed in data (FAR>0.5)
3. RI threshold: 30 knots/Day (20 knots/Day)

HMON RI performance -- NATL

	M220	M221
Success cycle Rate[1]	27% (39%)	25% (31%)
False cycle Rate[2]	61% (63%)	69% (57%)

1. % of 5-day periods with observed RI events most of which predicted by model (pod>0.5)
2. % of cycles predicting RI events most of which are not observed in data (FAR>0.5)
3. RI threshold: 30 knots/Day (20 knots/Day)

HMON RI performance -- EPAC

	M220	M221
Success cycle Rate[1]	26% (51%)	37% (40%)
False cycle Rate[2]	67% (60%)	47% (53%)

1. % of 5-day periods with observed RI events most of which predicted by model (pod>0.5)
2. % of cycles predicting RI events most of which are not observed in data (FAR>0.5)
3. RI threshold: 30 knots/Day (20 knots/Day)