COAMPS-TC: 2018 Performance and Future Plans

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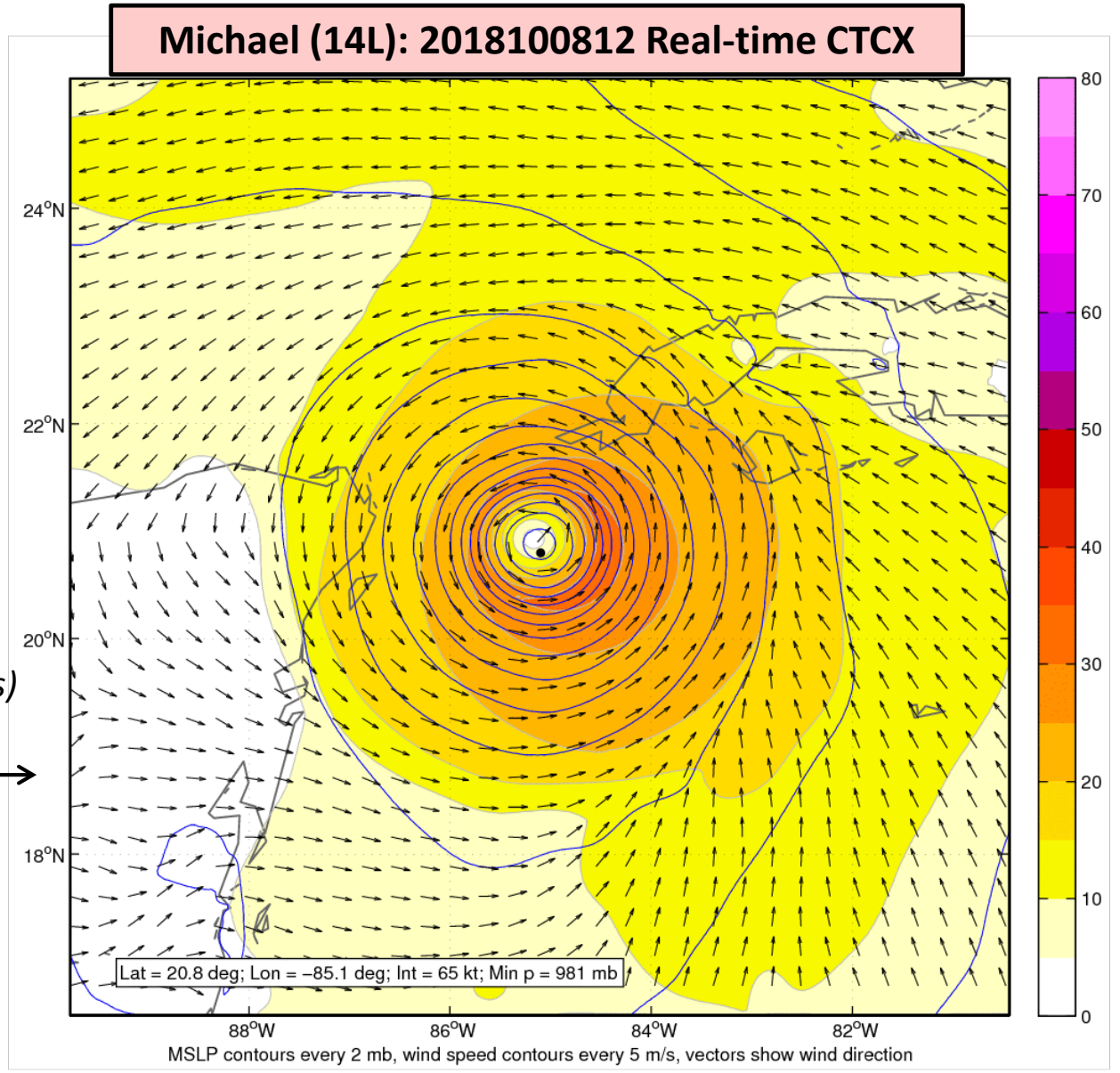
HFIP Annual Review Meeting: 6 November 2018

10-m wind speed (m/s, colors)
10-m wind direction (arrows)
MSLP (blue contours)
4-km storm following grid
Lead times 0 to 60 h



Acknowledgements: Sponsors ONR, NRL, NOAA HFIP

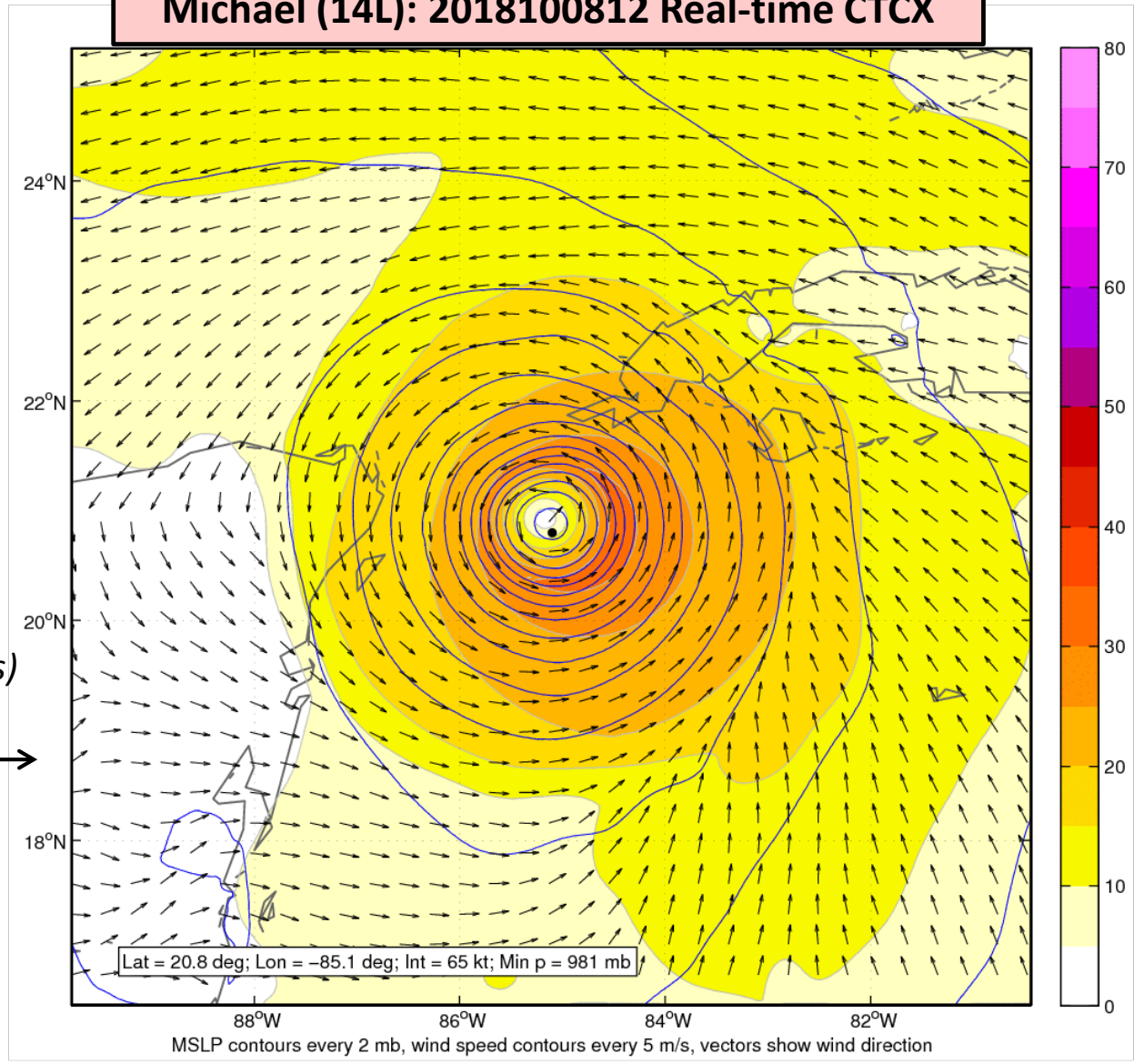
COAMPS-TC: 2018 Performance and Future Plans

	Forecast Peak Intensity					
Init. time	CTCX	HWRF	HMON	DSHP	LGEM	Init. Intensity
2018100706	120	115	85	66	52	30
2018100712	74	81	51	66	53	30
2018100718	92	115	97	80	75	40
2018100800	119	120	99	86	84	50
2018100806	103	116	111	82	79	60
2018100812	**122**	**111**	**97**	**87**	**87**	**65**
2018100818	116	109	111	81	82	70
2018100900	118	106	114	81	81	75
2018100906	113	105	101	85	86	80
2018100912	116	108	113	96	97	90
2018100918	123	125	131	108	111	105
2018101000	116	127	134	113	113	110
2018101006	122	116	125	116	115	115
2018101012	130	130	120	125	125	125
Average	***113***	***113***	***106***	***91***	***89***	

CTCX consistently indicated intensification up to landfall as Category 4 Hurricane

10-m wind speed (m/s, colors)
10-m wind direction (arrows)
MSLP (blue contours)
4-km storm following grid
Lead times 0 to 60 h

Michael (14L): 2018100812 Real-time CTCX



Introduction & Performance History

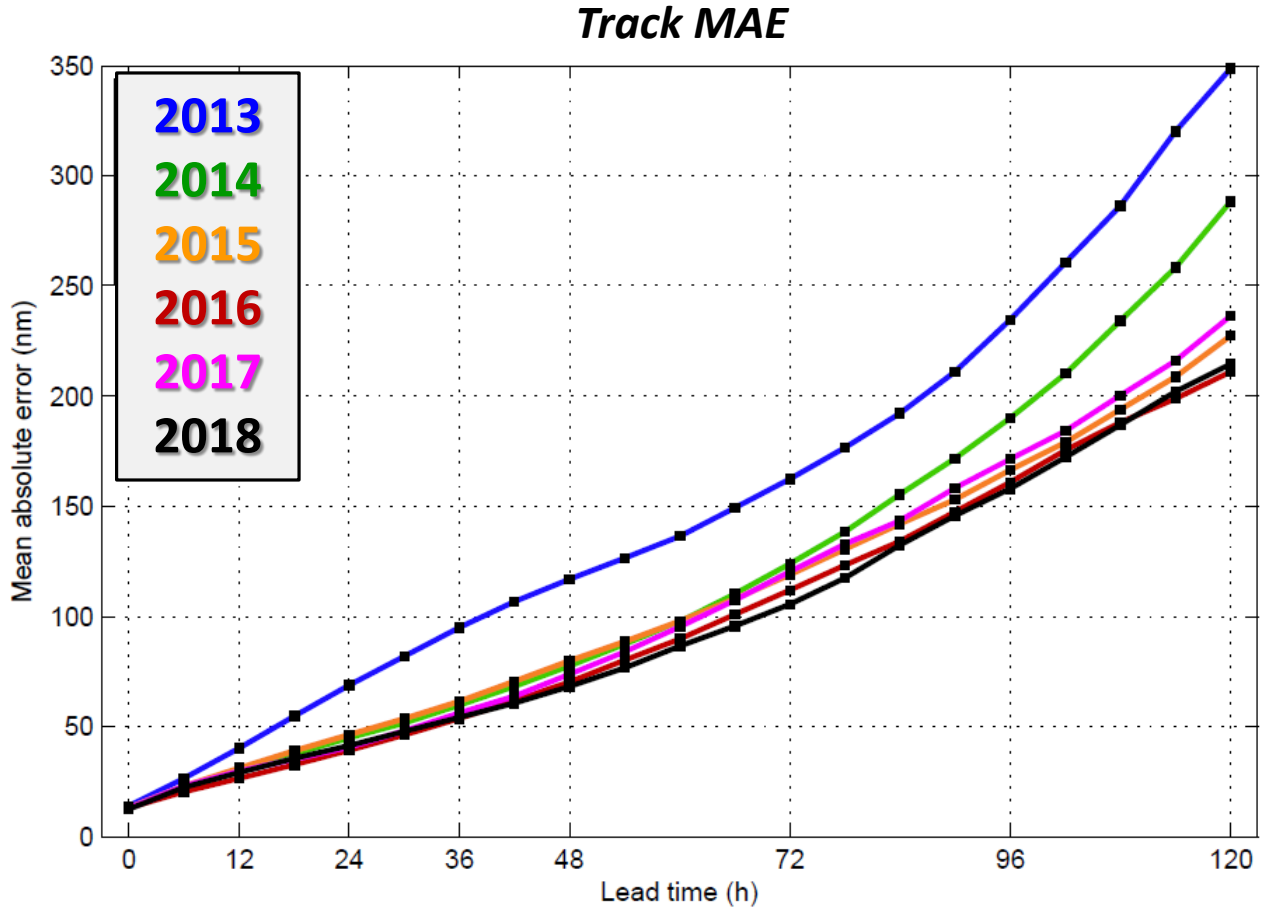
2018 Deterministic COAMPS-TC basics

- 36/12/4 km atmospheric model
- Physical parameterizations optimized for TC prediction (updated in for 2018 version)
- Cold start with inserted synthetic TC vortex
- Fully coupled to 7.5 km NCOM ocean model

Real-time Deterministic COAMPS-TC runs

- **CTCX**: GFS ICs/LBCs, NRL real-time demo
- **COTC**: NAVGEM ICs/LBCs, FNMOC ops

CTCX: AL/EP/CP/WP



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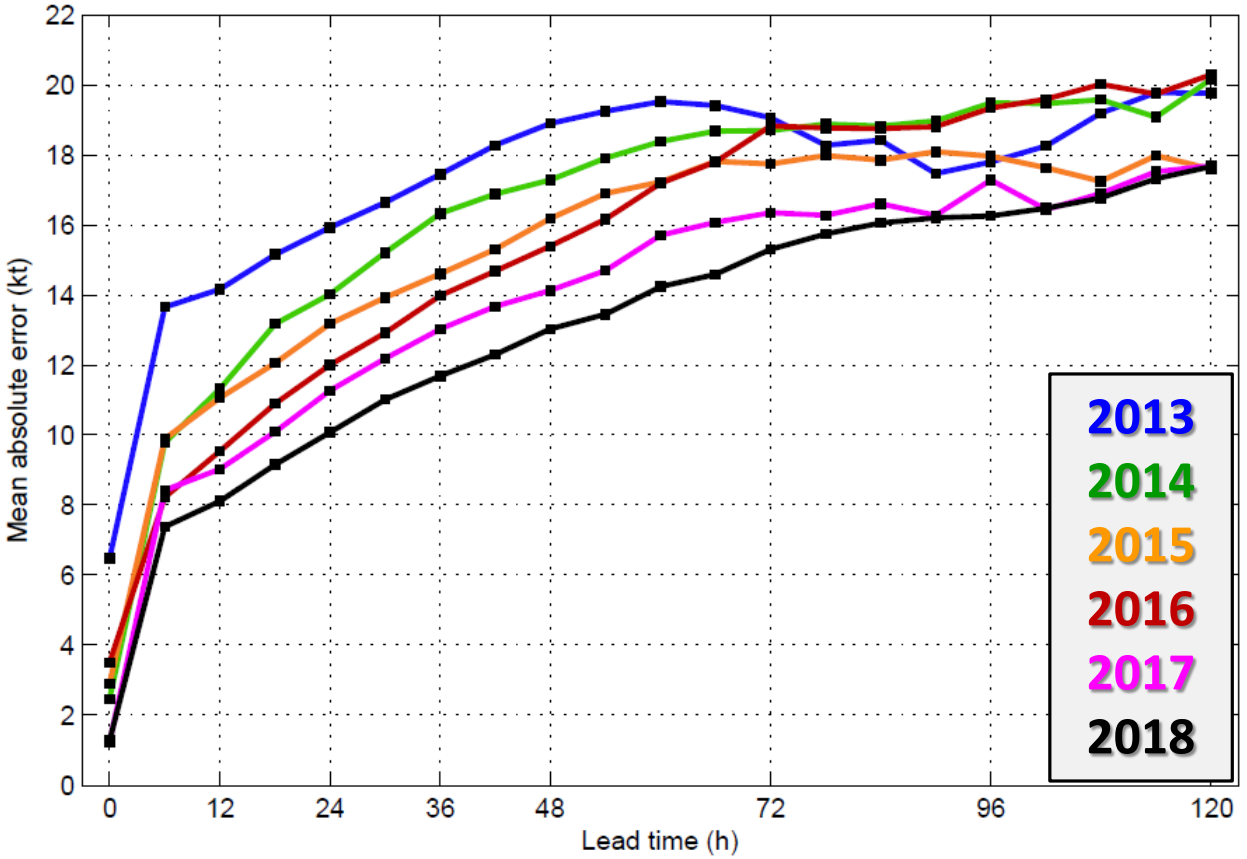
Intensity MAE



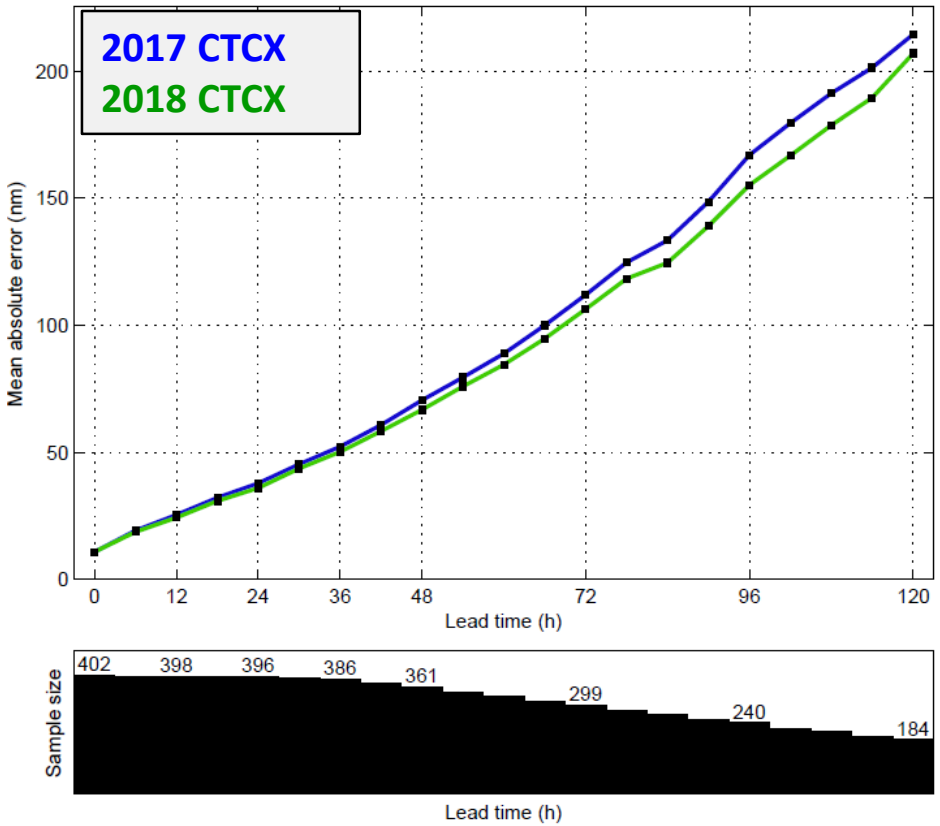
Consistent model performance improvements with yearly updates to the operational deterministic system

Deterministic COAMPS-TC 2018 Model

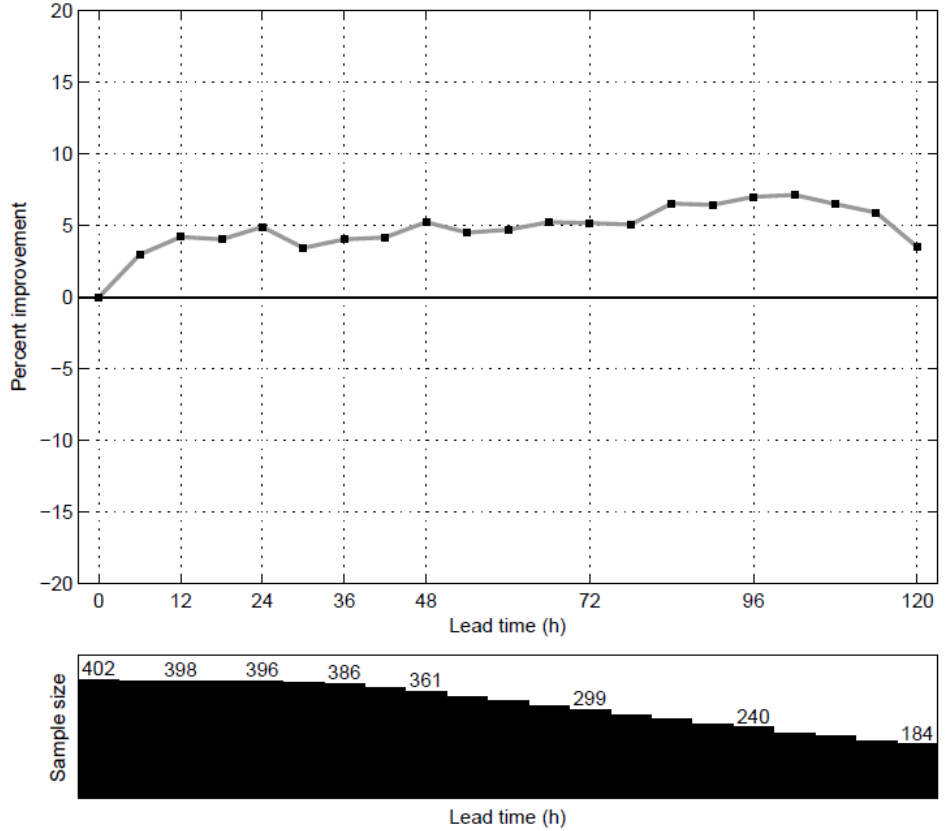
Features of the 2018 model compared to the 2017 model

- The shallow cumulus parameterization is changed to significantly reduce the exchange of heat and moisture between the boundary layer and lower free troposphere
- Snow is treated the same as ice by the radiation scheme, interactive with both shortwave and longwave radiation

Track MAE



% improvement of 2018 CTCX w.r.t. 2017 CTCX



Track MAE improved by ~5%

2015-2017 AL/EP/CP Retrospective Cases

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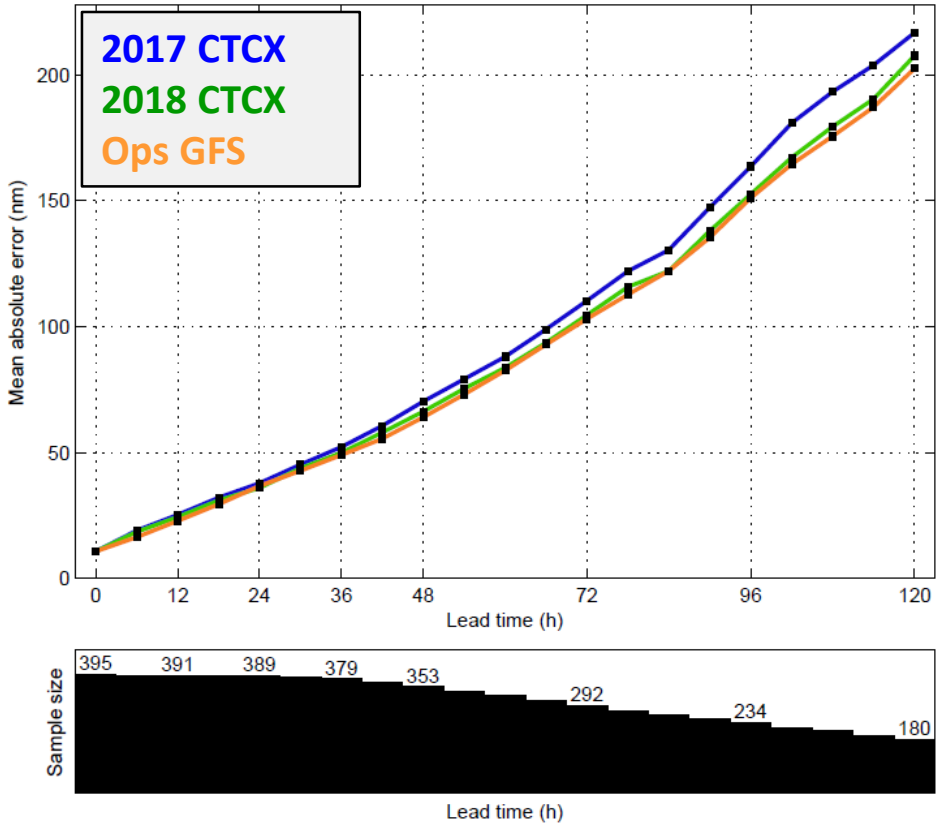

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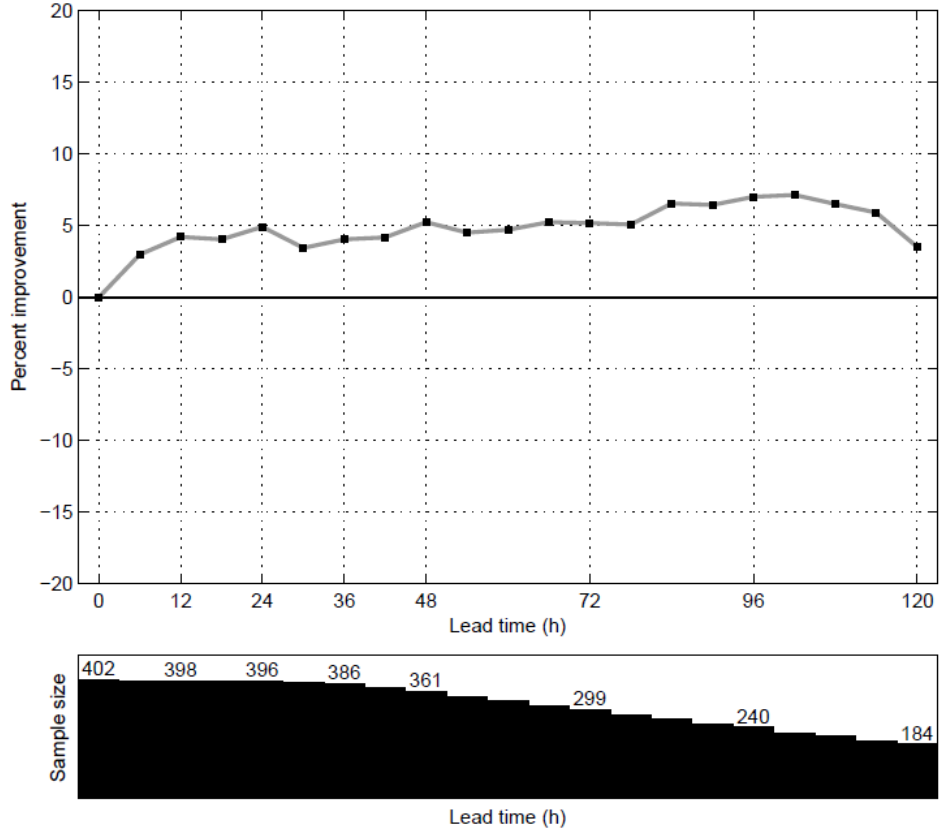

Track MAE improved by ~5%

2018 CTCX track MAE similar to GFS

2015-2017 AL/EP/CP Retrospective Cases

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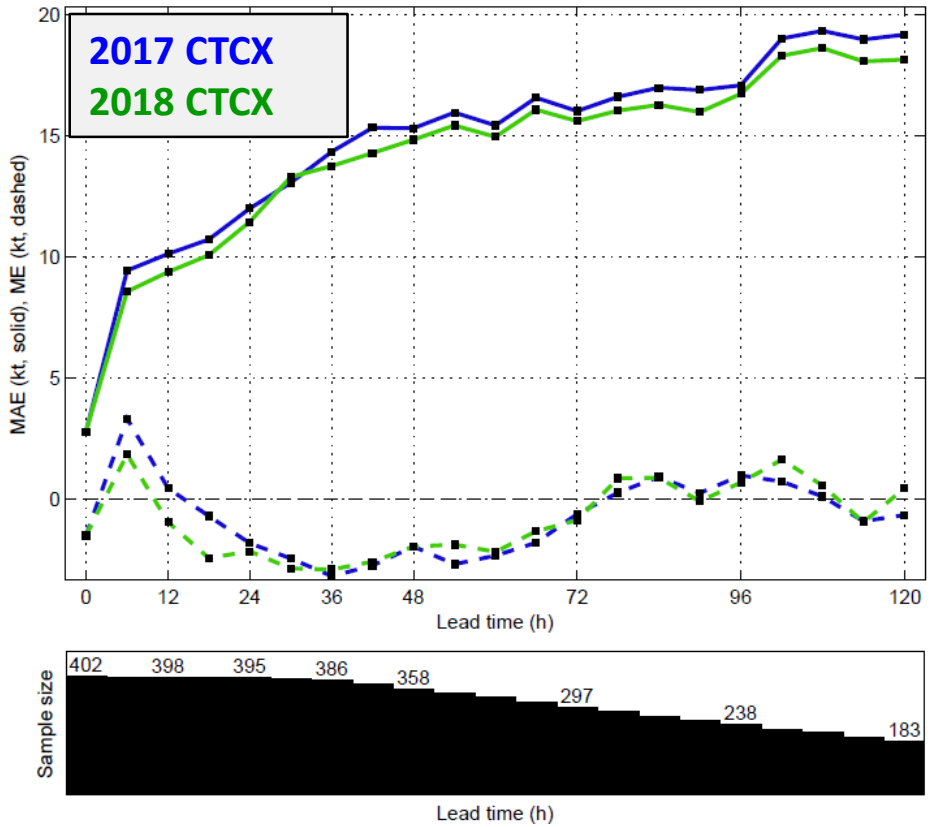
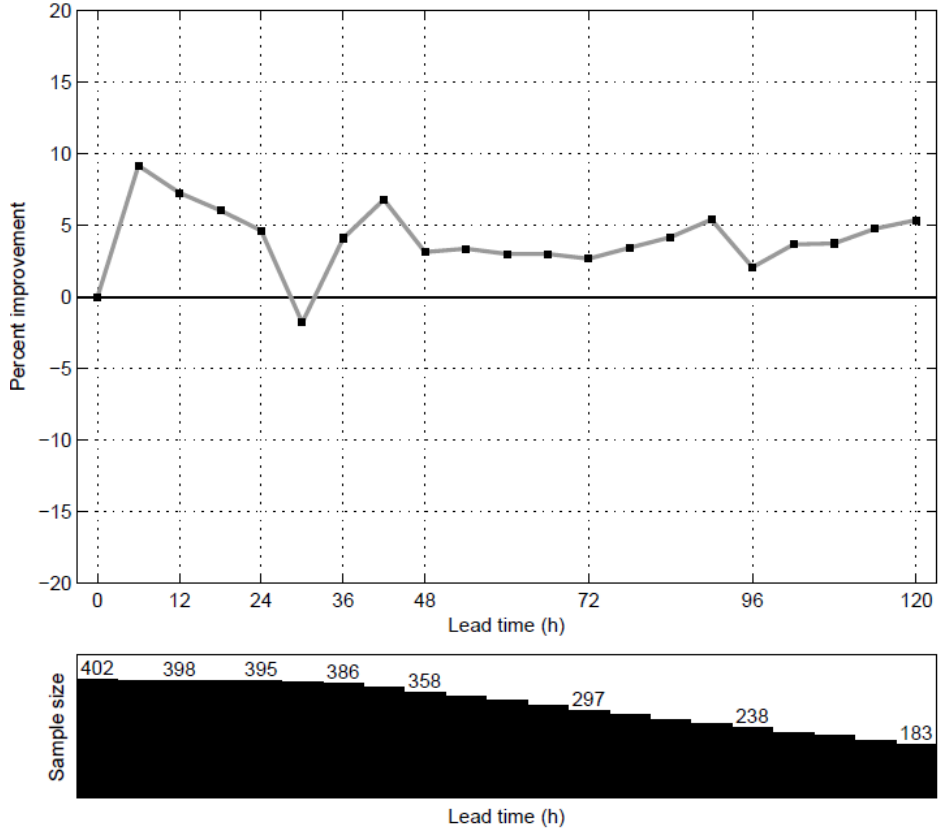
Intensity MAE (solid) and ME (dashed)



% improvement of 2018 CTCX w.r.t. 2017 CTCX



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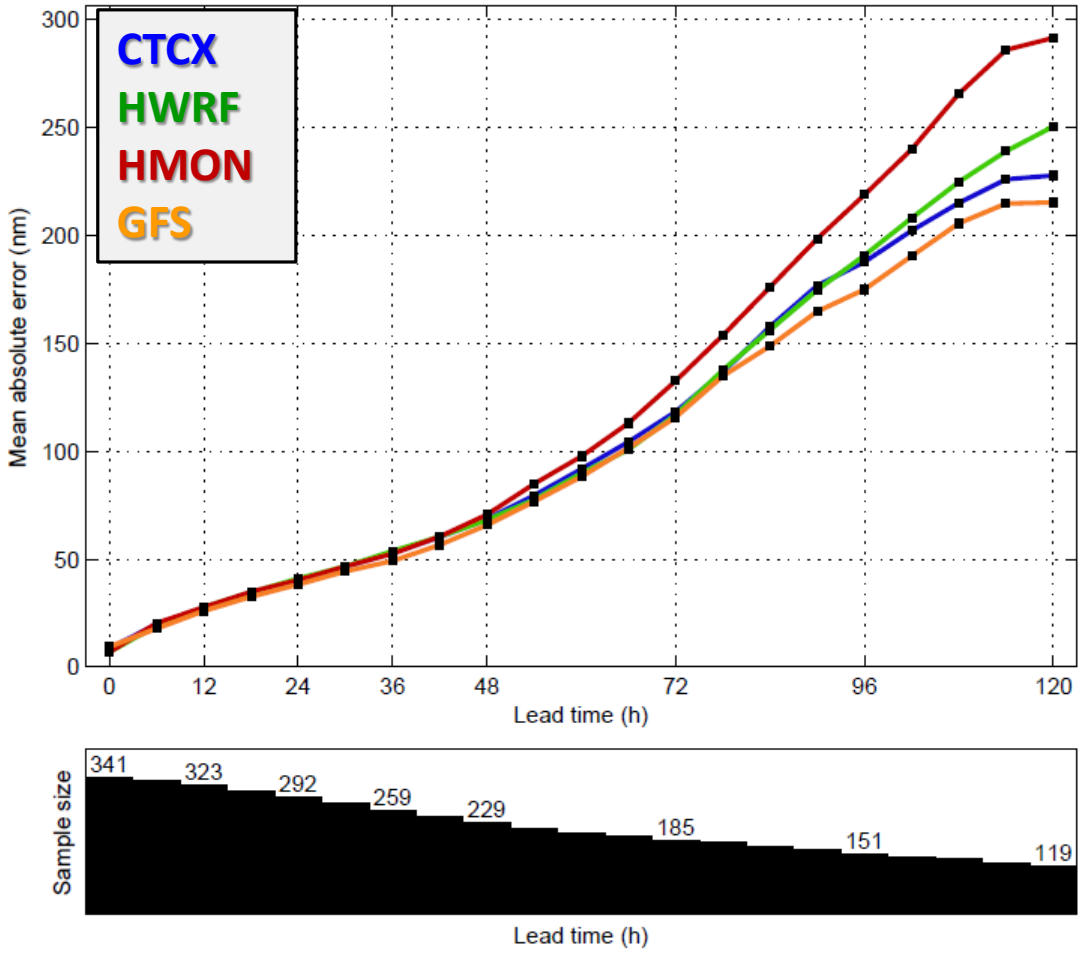
2015-2017 AL/EP/CP Retrospective Cases

2018 Real-time Deterministic Forecast Performance

2018 Atlantic: 01L-15L

Track MAE



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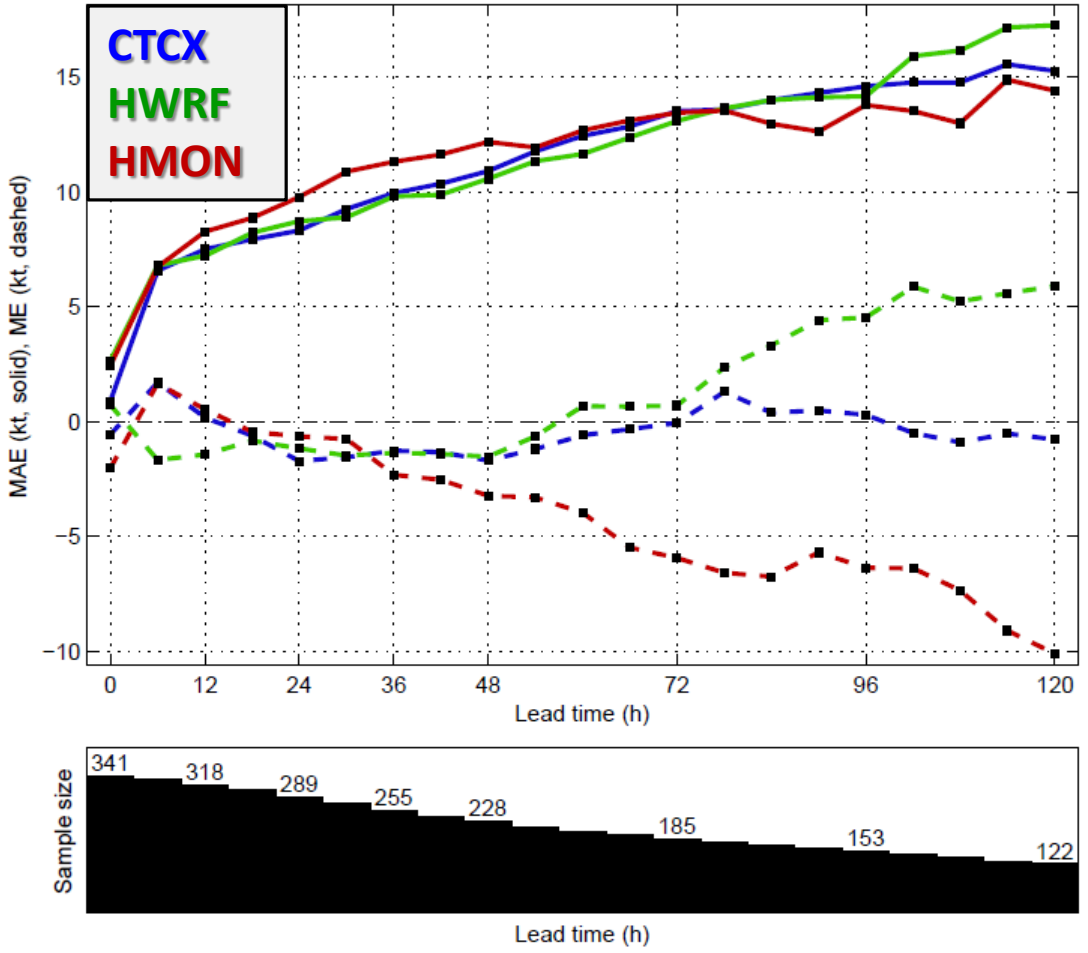
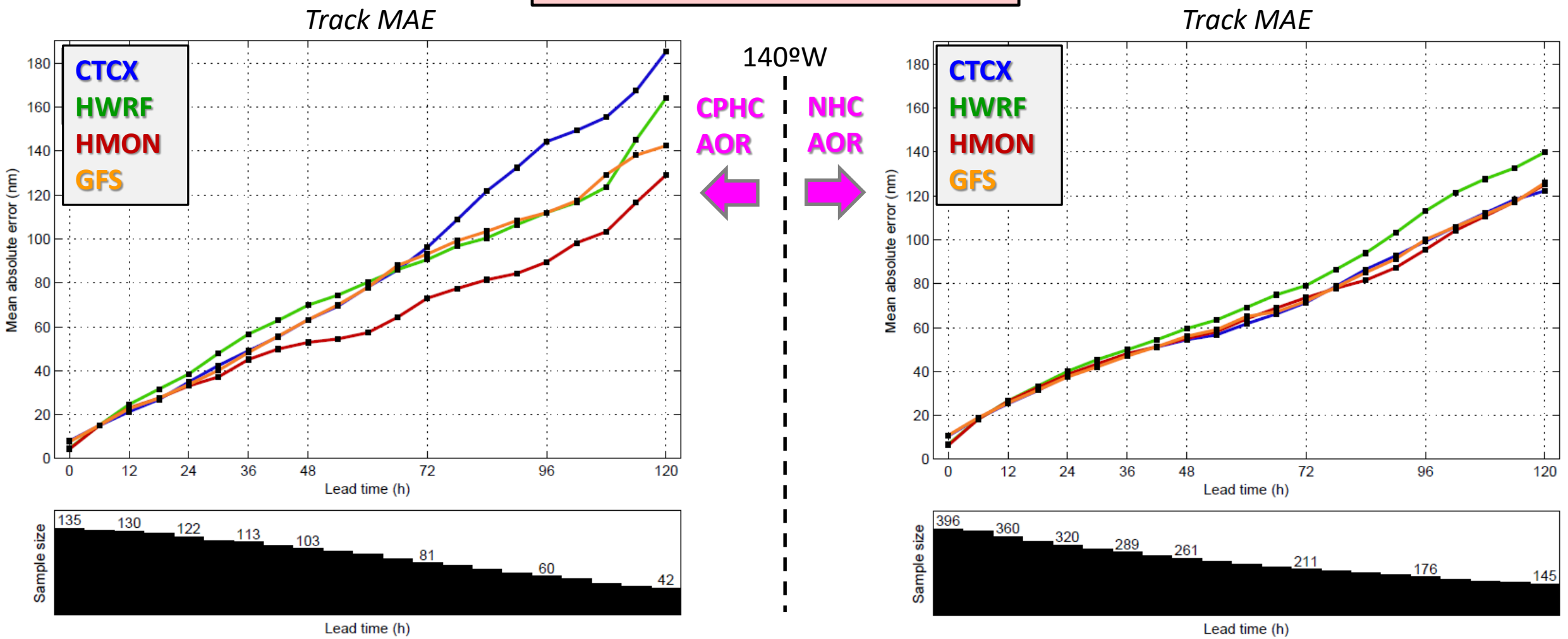


CTCX track MAE just a little behind GFS at long leads

CTCX has good MAE and is nearly unbiased

2018 Real-time Deterministic Forecast Performance

2018 EP&CP: 01E-24E, 01C

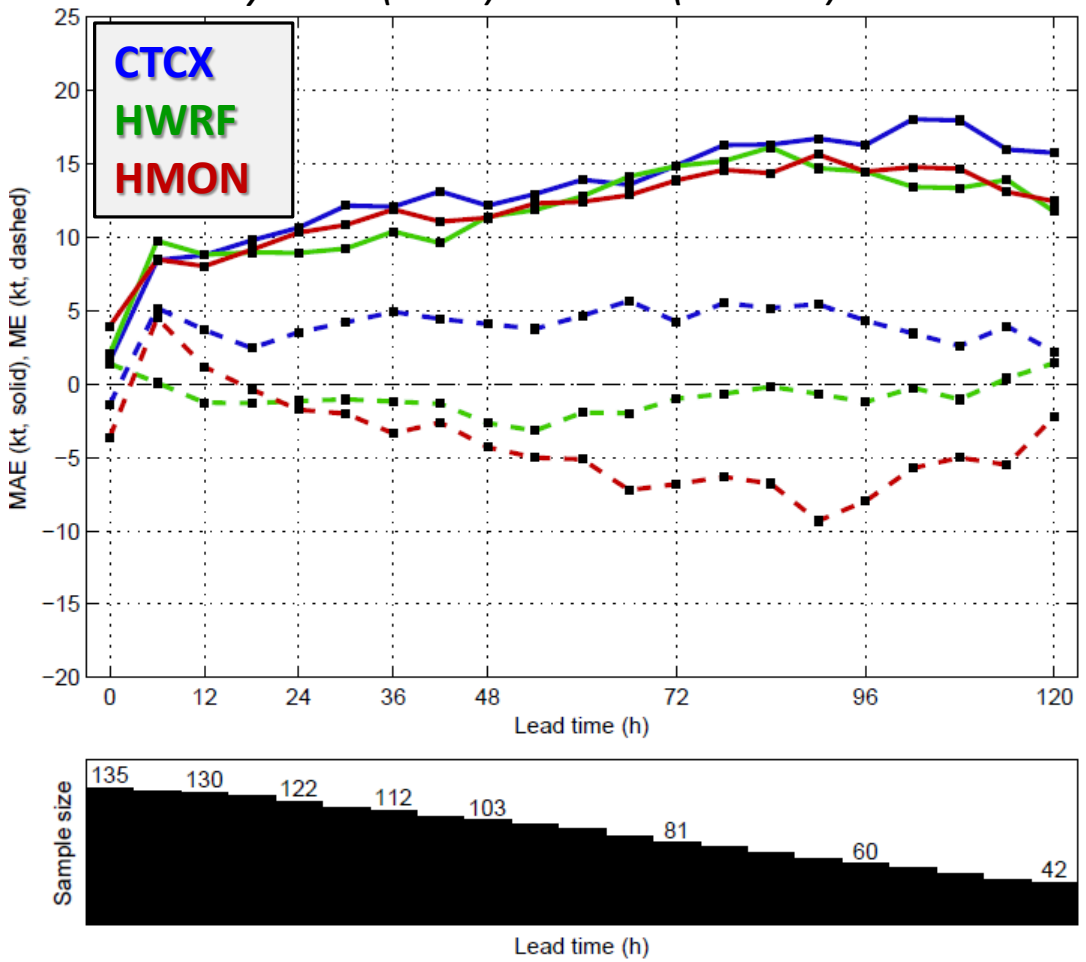


CTCX track MAE same as GFS in NHC AOR, but diverges from GFS at long leads in CPHC AOR

2018 Real-time Deterministic Forecast Performance

2018 EP&CP: 01E-24E, 01C

Intensity MAE (solid) and ME (dashed)

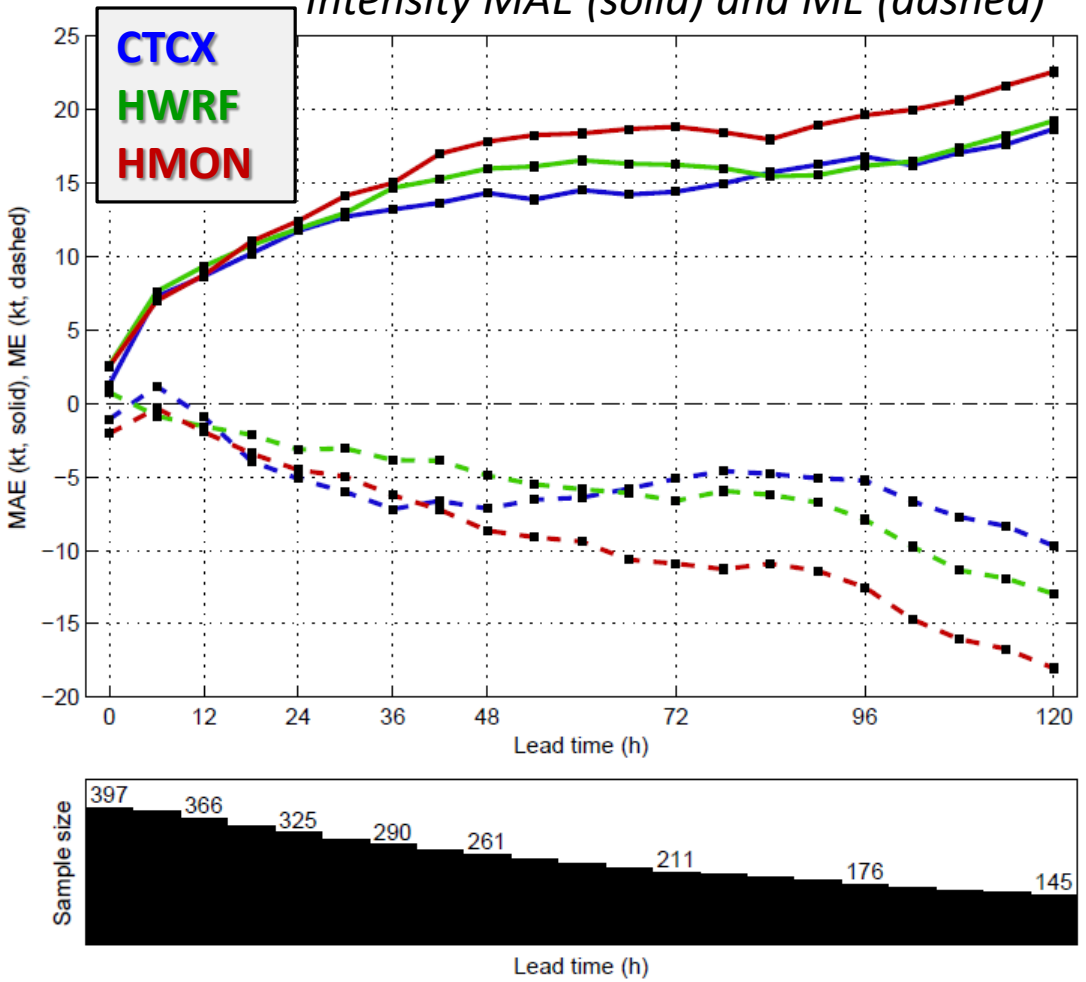


140ºW

CPHC AOR

NHC AOR

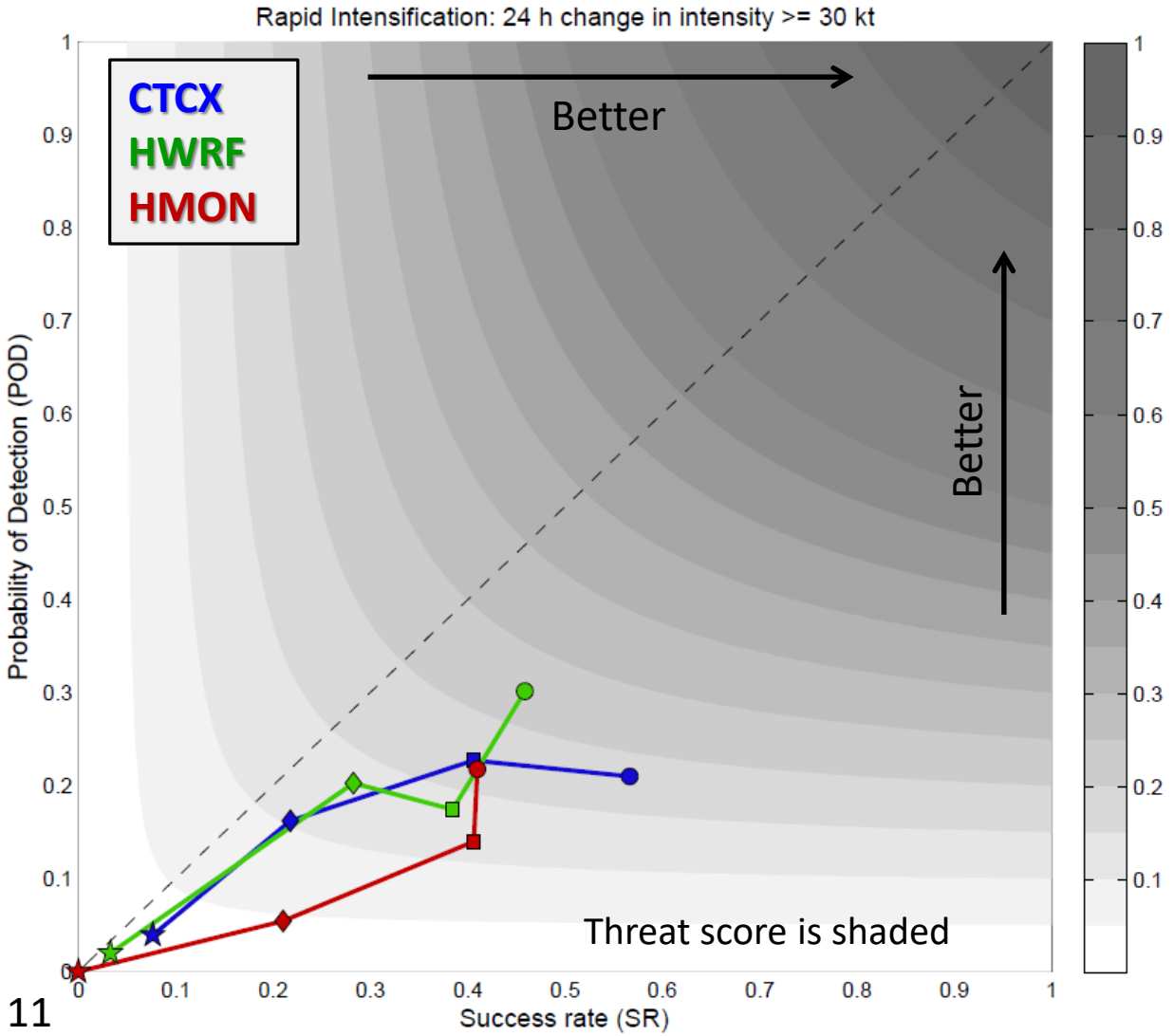
Intensity MAE (solid) and ME (dashed)



CTCX intensity forecasts performed very well in NHC AOR, but high bias was an issue in CPHC AOR

2018 Real-time Deterministic Forecast Performance

2018 AL,EP&CP: 01L-15L, 01E-24E, 01C



CTCX and other regional models somewhat better with RI in 2018 w.r.t. recent years

RI observed

RI forecast	*Yes*	*No*
Yes	**HIT**	**FA**
No	**MISS**	**CR**

tau = 0–24 h through 18–42 h
tau = 24–48 h through 42–66 h
tau = 48–72 h through 66–90 h
tau = 72–96 h through 96–120 h

Success rate (high is good)

SR = HIT / (HIT + FA)

Prob. of Detection (high is good)

POD = HIT / (HIT + MISS)

Threat Score (high is good)

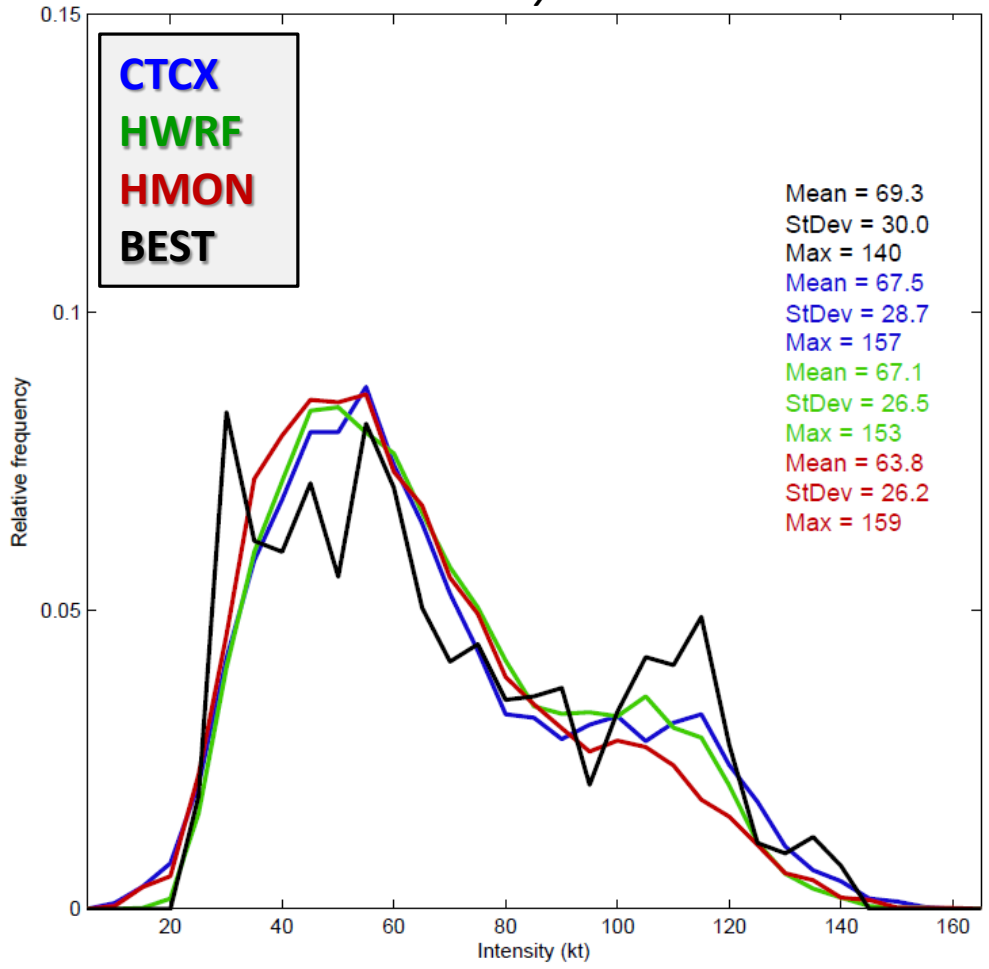
TS = HIT / (HIT + MISS + FA)

	0–24 h	24–48 h	48–72 h	72–96 h
Sample Size	2705	2184	1780	1742
prob(RI observed)	0.097	0.079	0.042	0.029
prob(RI forecast)	0.036	0.044	0.031	0.015
prob(RI forecast)	0.064	0.036	0.030	0.017
prob(RI forecast)	0.051	0.027	0.011	0.009

2018 Real-time Deterministic Forecast Performance

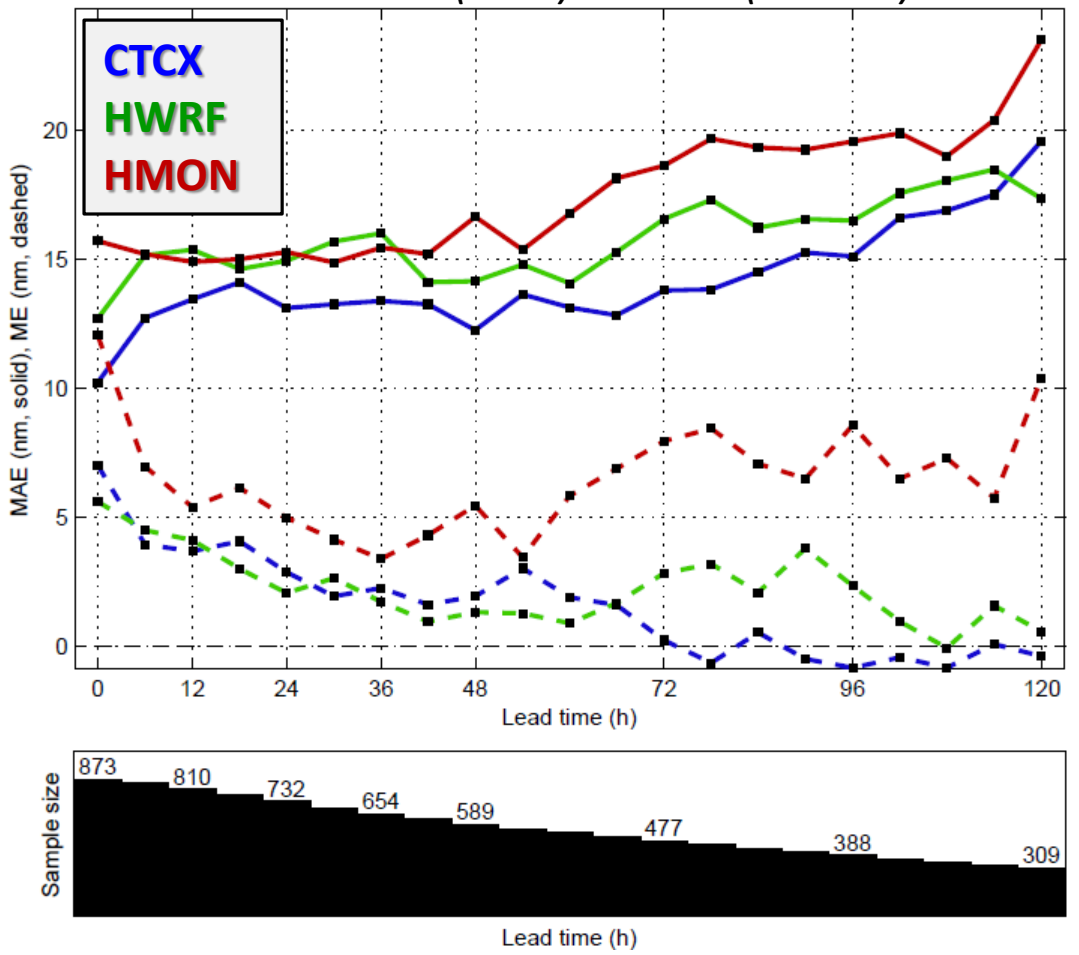
2018 AL,EP&CP: 01L-15L, 01E-24E, 01C

Forecast intensity distribution



CTCX most aggressive in predicting Cat 4/5

Rmax MAE (solid) and ME (dashed)



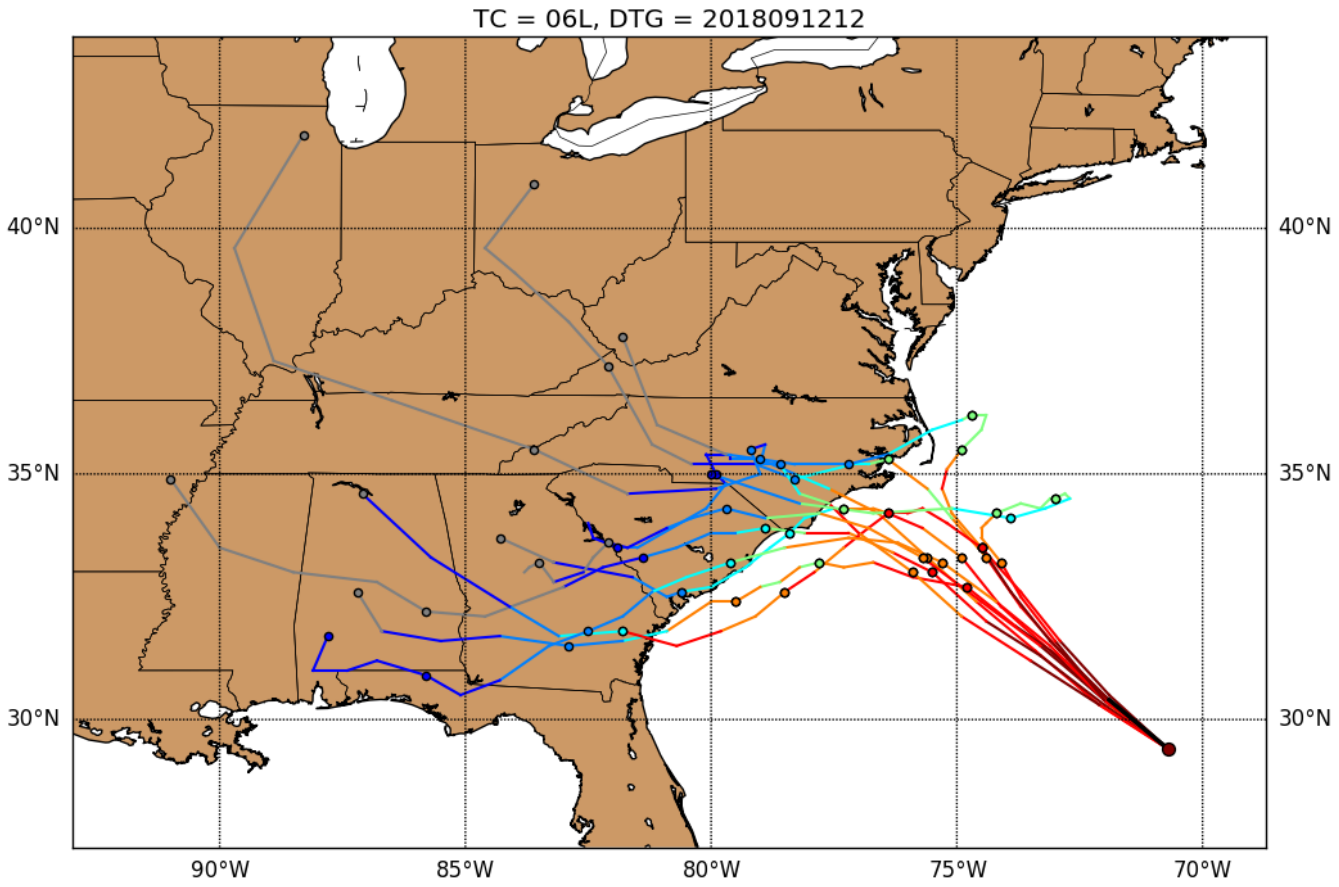
CTCX performs well in predicting Rmax

COAMPS-TC EPS

COAMPS-TC EPS Configuration

- 1 unperturbed control + 10 perturbed members
- Synoptic-scale IC, vortex scale IC, and lateral BC perturbations
- Uncoupled COAMPS-TC with simple SST-cooling parameterization
- 36/12/4 km resolution, same as 2018 ops deterministic COAMPS-TC
- New for 2018: Refinements to initial vortex perturbations, Perturbed drag coefficient vs wind speed curve for each ensemble member
- **CTCX EPS to run in real-time at FNMOC in 2019, 2 slots at 00z and 12z**

Florence (06L) example: 2018091212



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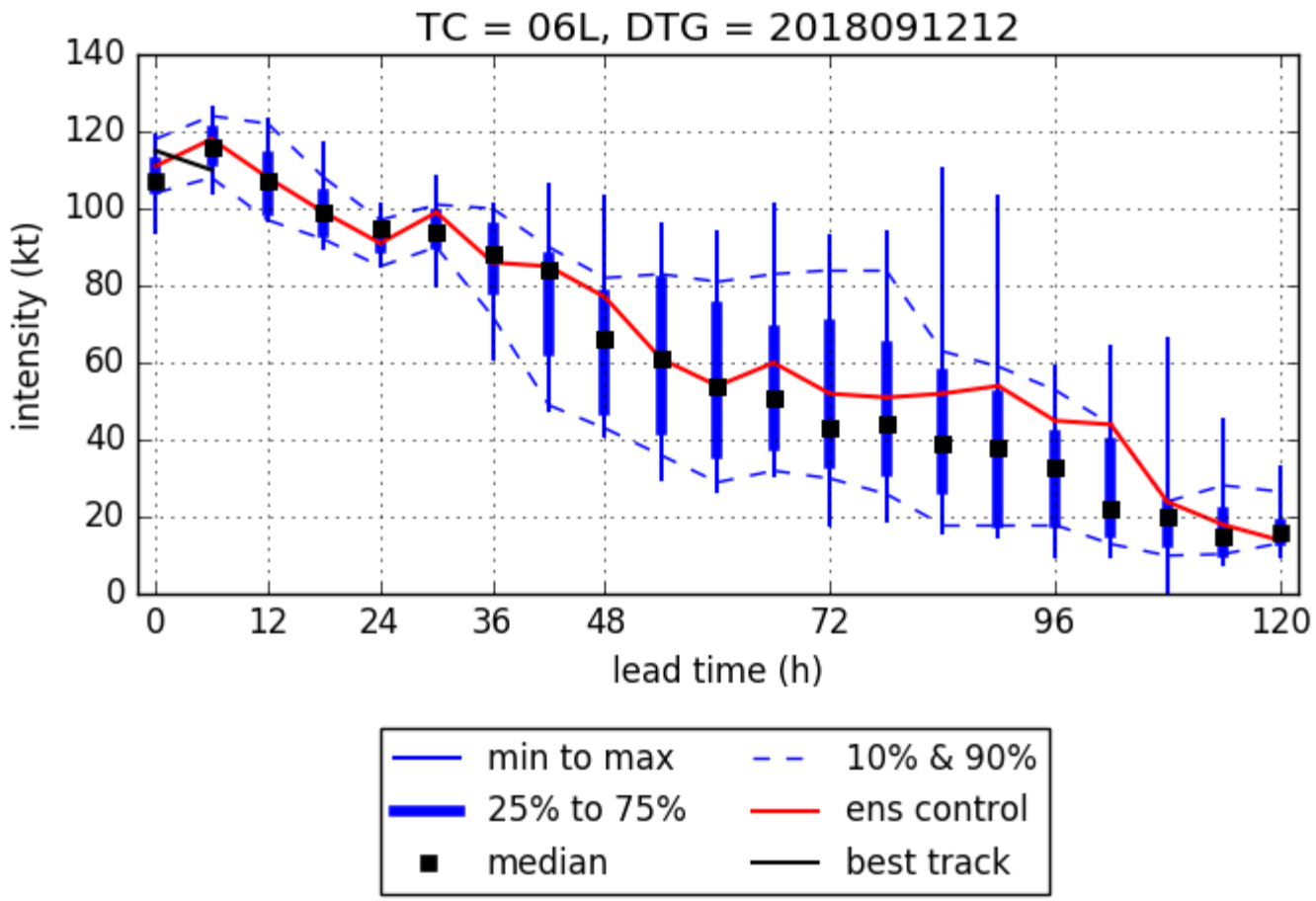

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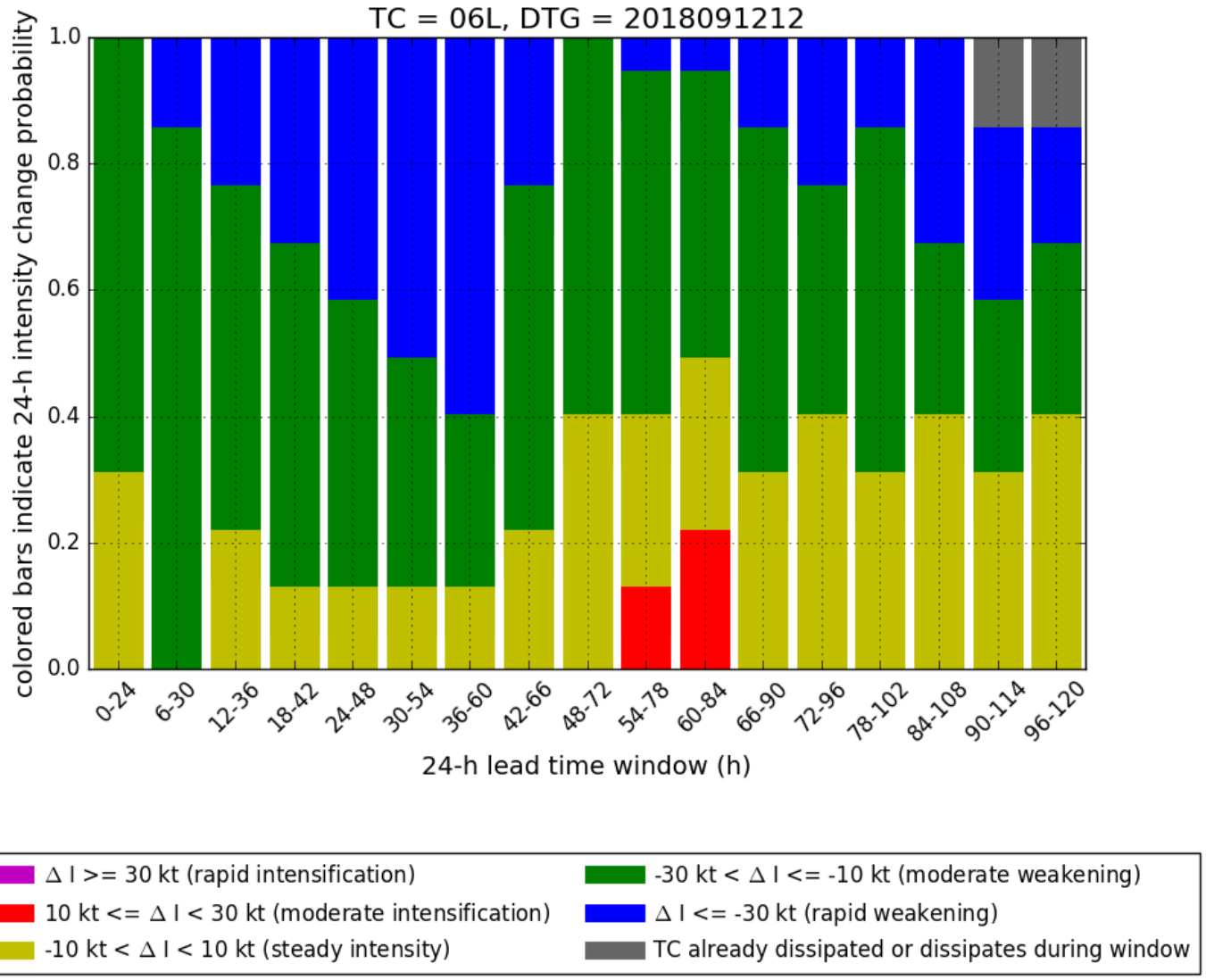


Ocean Coupling

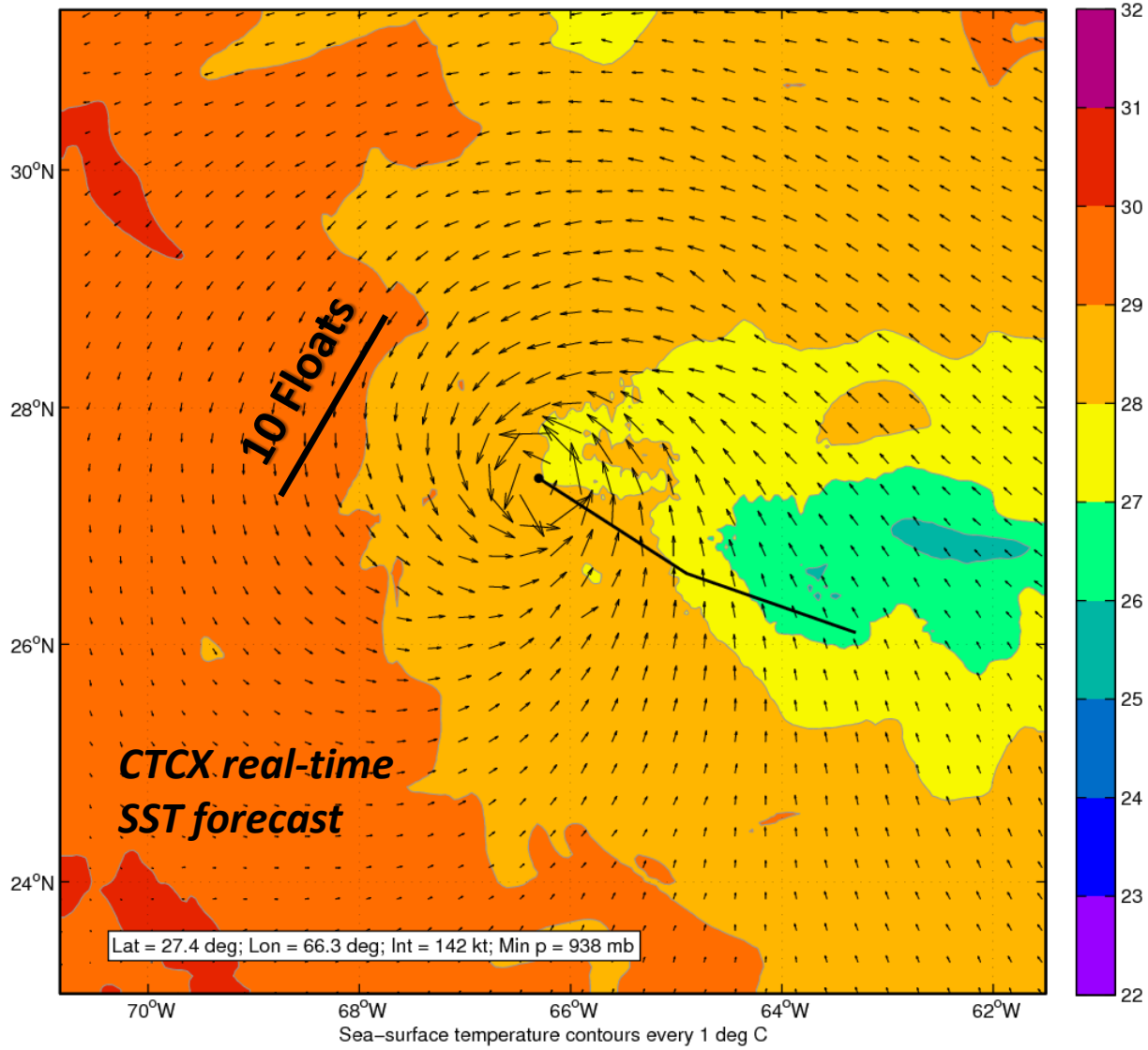
Deterministic model air-ocean coupling

- For both CTCX and COTC, atmospheric model coupled to NCOM for all basins worldwide
- NCOM cold-started from HYCOM global ICs
- Testing cycling ocean DA using NCODA for 2019 deterministic model
- Experimenting with air/ocean/wave coupling

Model validation opportunity: 10 ALAMO floats were deployed in front of Florence by USNA (via USAF) →

Pre-storm SST: **29-30ºC**

Florence (06L) example: 2018091106, tau = 12 h



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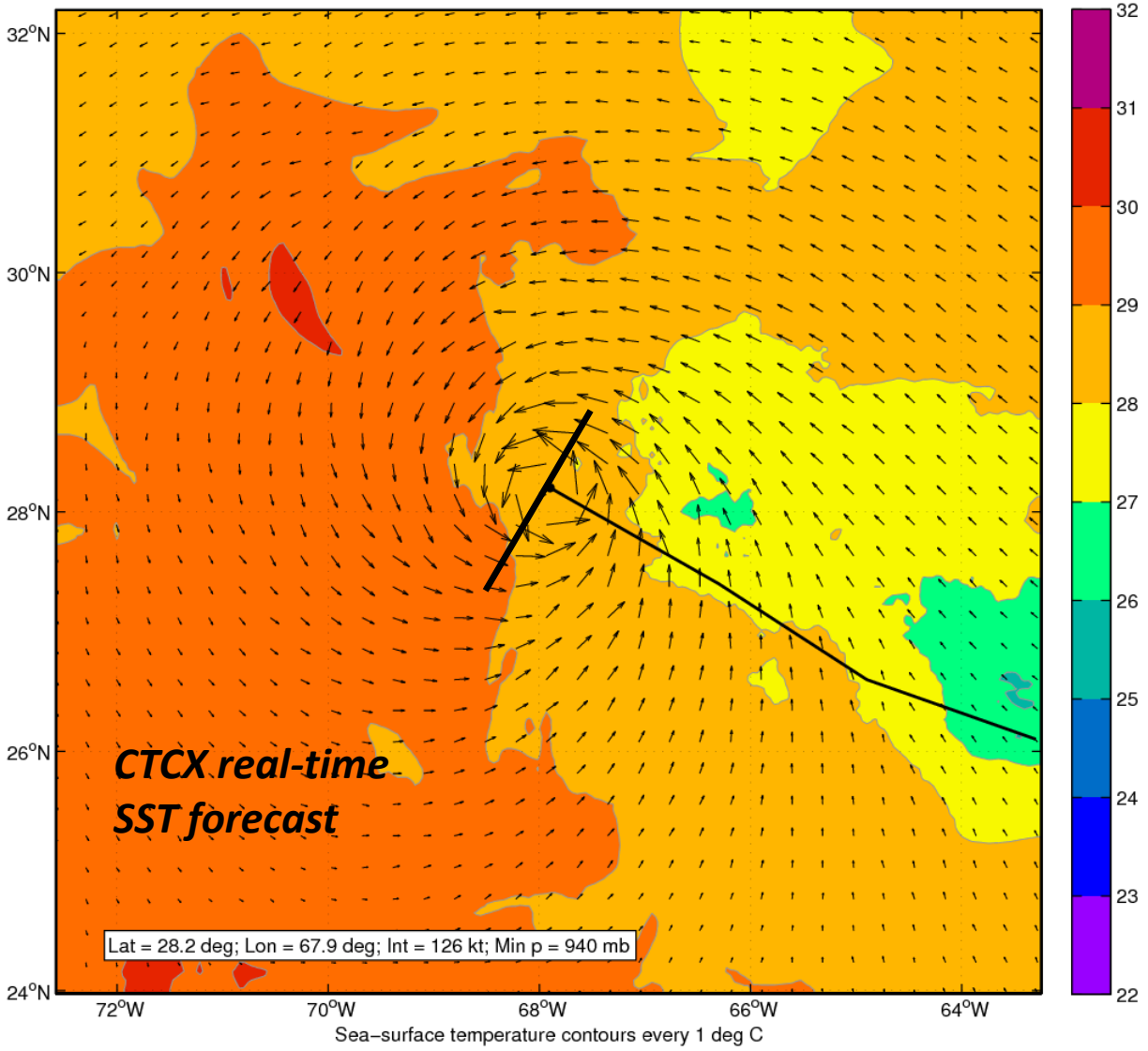
Pre-storm SST: **29-30ºC**
Under-storm SST: **28-29ºC**

Florence (06L) example: 2018091106, tau = 18 h



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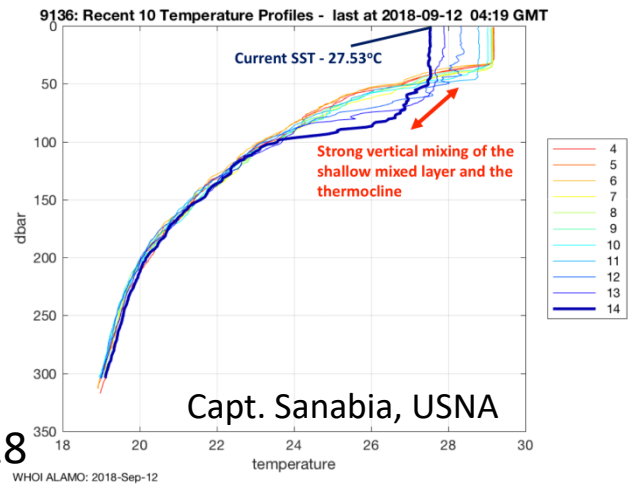
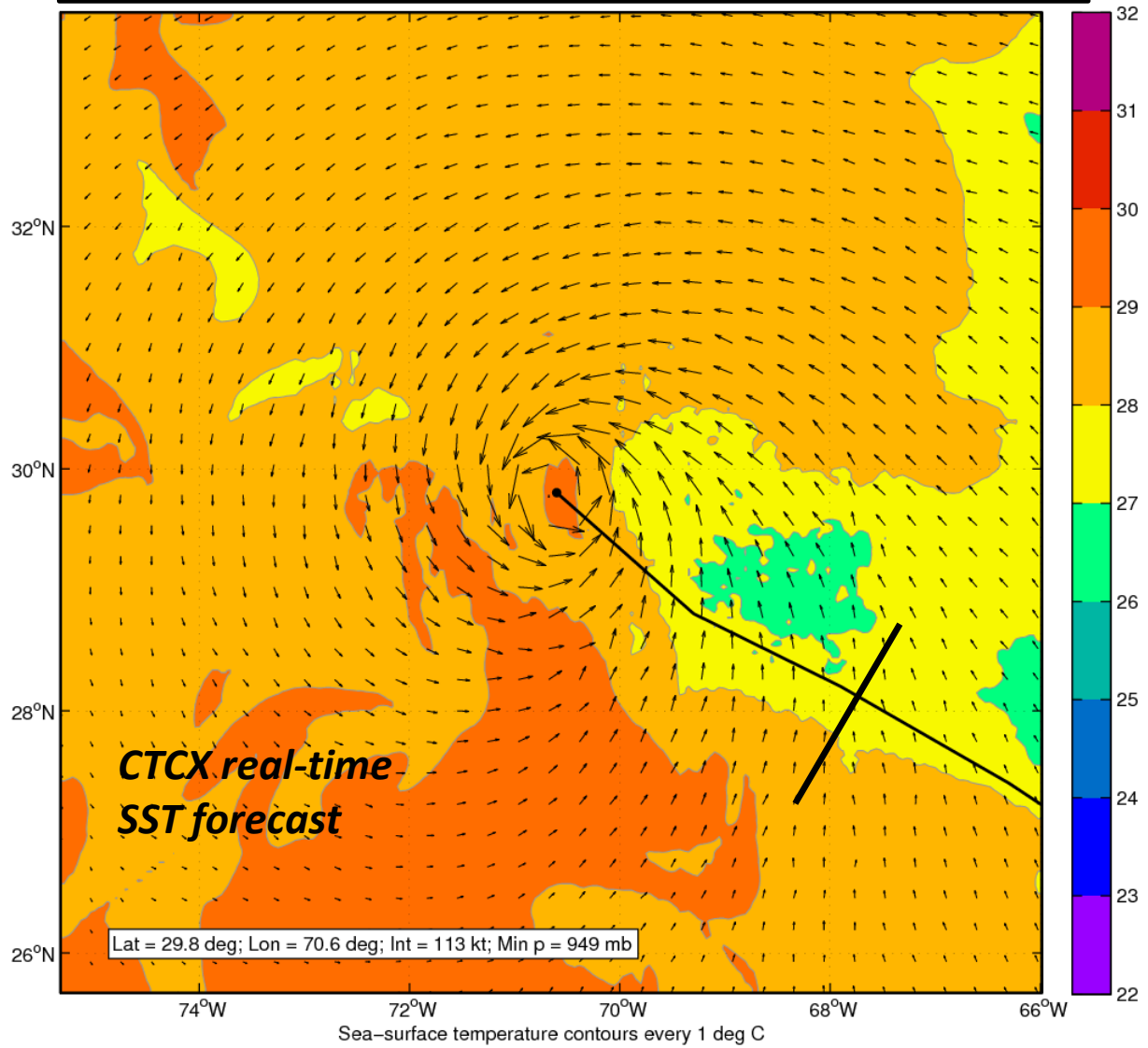


Pre-storm SST: **29-30ºC**
Under-storm SST: **28-29ºC**
Post-storm SST: **27-28ºC**

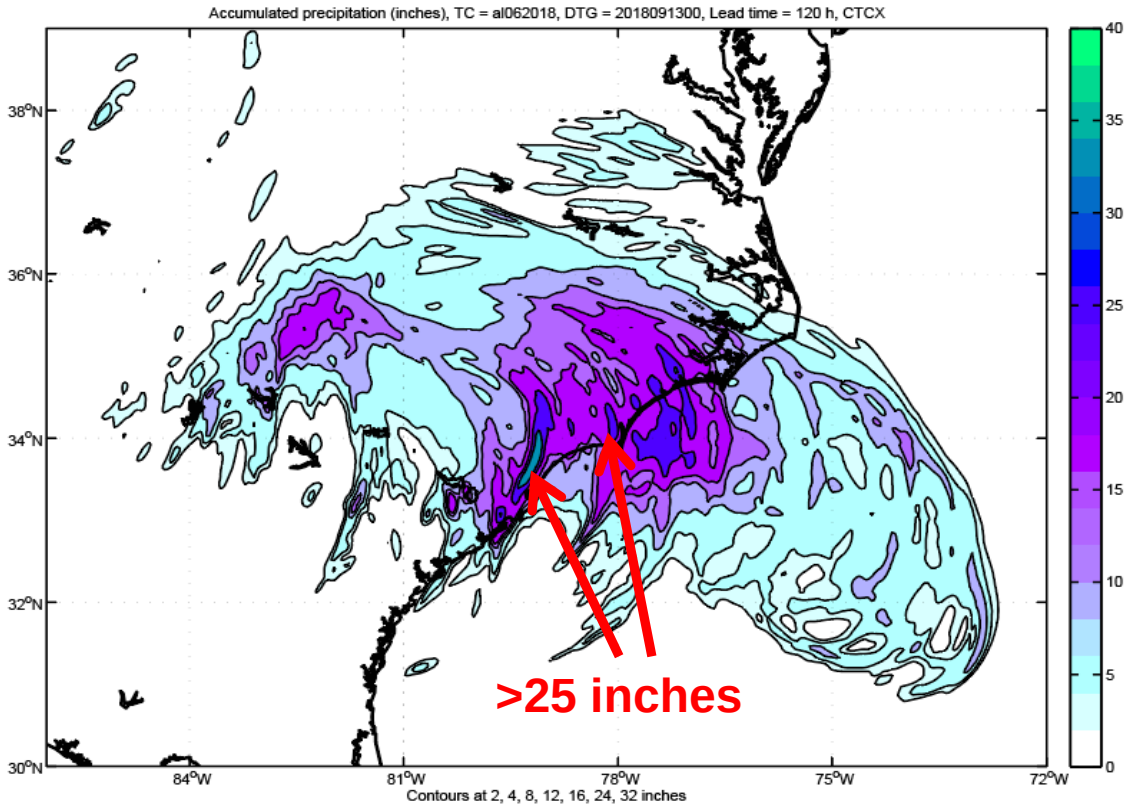
Florence (06L) example: 2018091106, tau = 30 h



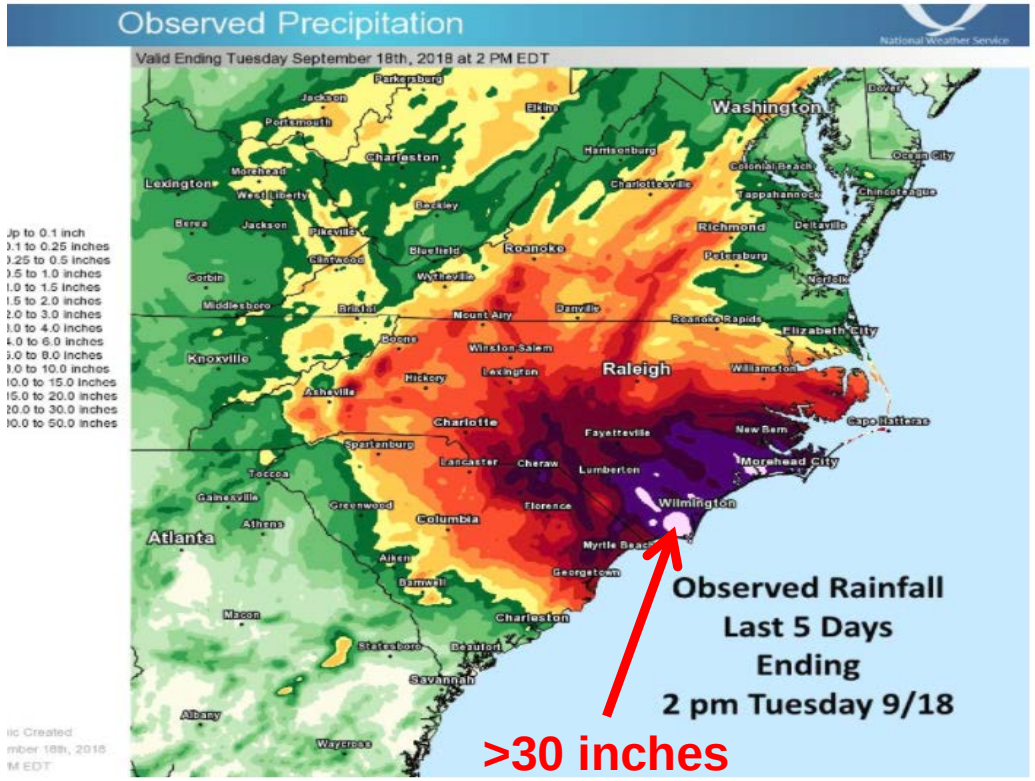
Rainfall Prediction

Florence (06L) example: 2018091300

Real-time CTCX 5-day forecast precipitation



NWS Observed Precipitation (13-18 Sep)



CTCX 5-day accumulated precipitation forecast captures observed heavy precipitation over the Carolinas

U.S. NAVAL RESEARCH LABORATORY

Summary

COAMPS-TC makes high-quality predictions of track & intensity for TCs worldwide …

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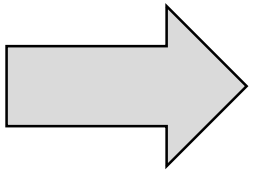
- CTCX EPS: **NRL real-time demo** (06L only)



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2019 Real-time COAMPS-TC

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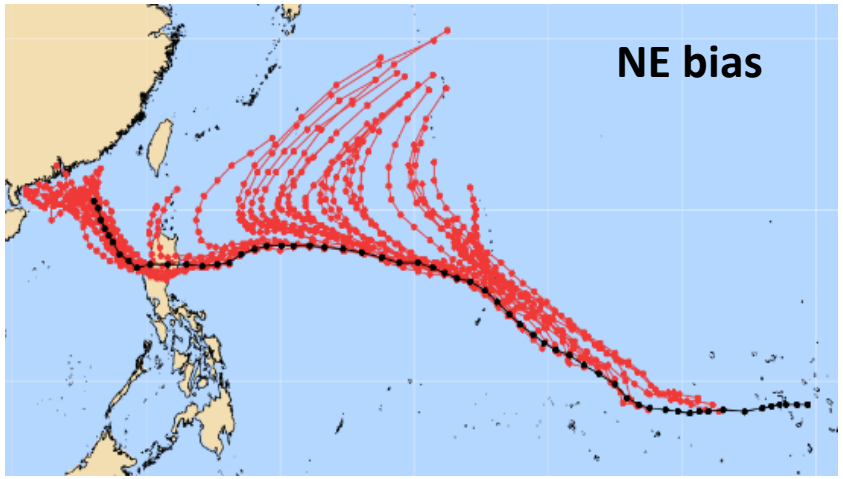
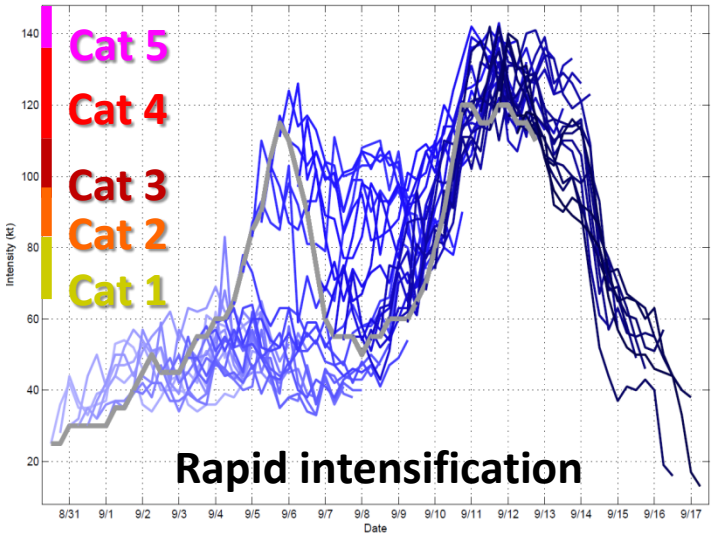
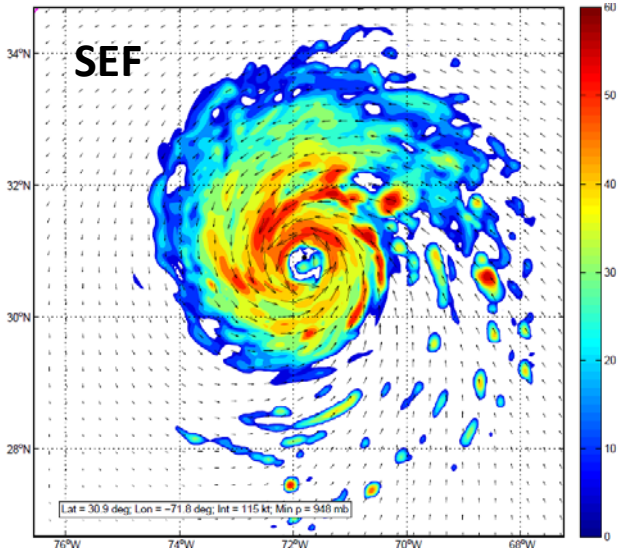
- Deterministic CTCX: **Ops at FNMOC**
- CTCX EPS: **FNMOC real-time demo**

… but there are still forecast challenges to address







Future Plans for Deterministic COAMPS-TC

2019:

- Model upgrade possibilities (CTCX & COTC)
  - Cycling Ocean DA
  - Deep and shallow cumulus parameterization
  - Initialization refinements
- Test CTCX with FV3GFS(?)
- Real-time demo of experimental COAMPS-TC (?)

2020 & 2021:

- Resolution: 36/12/4/1.33 km or 12/4/1.33 km, 60L
- Physics: Double-moment microphysics, scale-aware convection, unified sub-grid scale cloud and turbulence parameterization
- Initialization: Storm-scale cycling DA with 4DVAR or ENKF featuring cloudy radiance DA
- Coupling: Full air-ocean-wave coupling
- Postprocessing: Statistical postprocessing of EPS and deterministic intensity forecasts