Ocean Model Impact Tiger Team (OMITT)

Chair and co-chair

H.-S. Kim, G. Halliwell

Team

P. Black, N. Bond, S. Chen, J. Cione, M. Cronin, J. Dong, I. Ginis, B. Jaimes, S. Jayne, B. Liu, L. Miller, E. Sanabia, N. Shay, V. Tallapragada, B. Thomas, E. Uhlhorn, and L. Zhu

Institutions

EMC, NESDIS, DTC, HRD/AOML, PhoD/AOML, PMEL, USNA, Navy, URI, UM, JISAO/UW, and WHOI

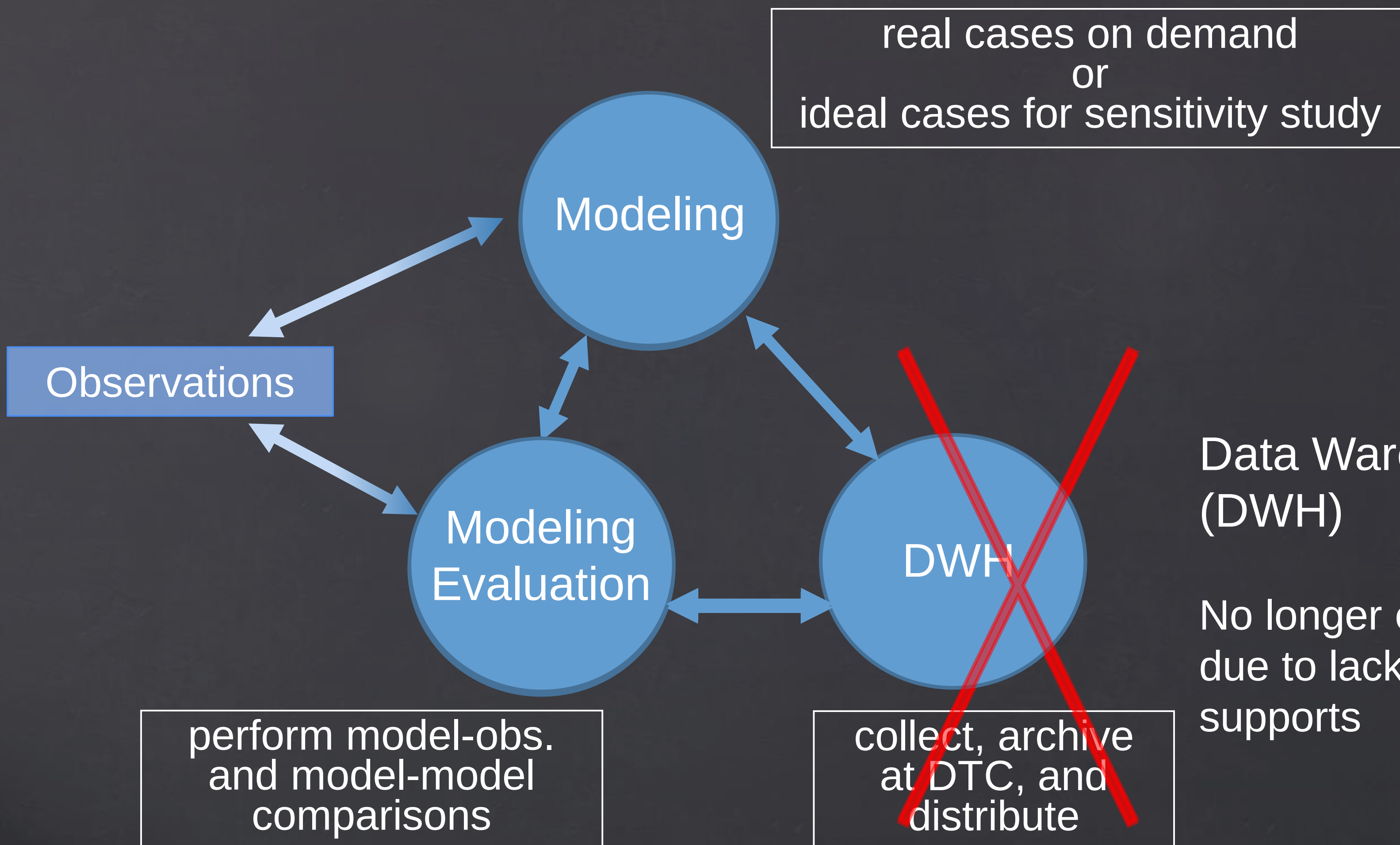
Wednesday November 18, 2015

HFIP Annual Meeting

Overview

1. Group and Tasks – Update
2. Storms Proposed to Study - Update
3. Activity Summary
4. Ocean Impact Study – Preliminary Results
5. Summary
6. Future Plans

1. Groups and Tasks: Update



Data Ware House (DWH)

No longer exists due to lack of supports

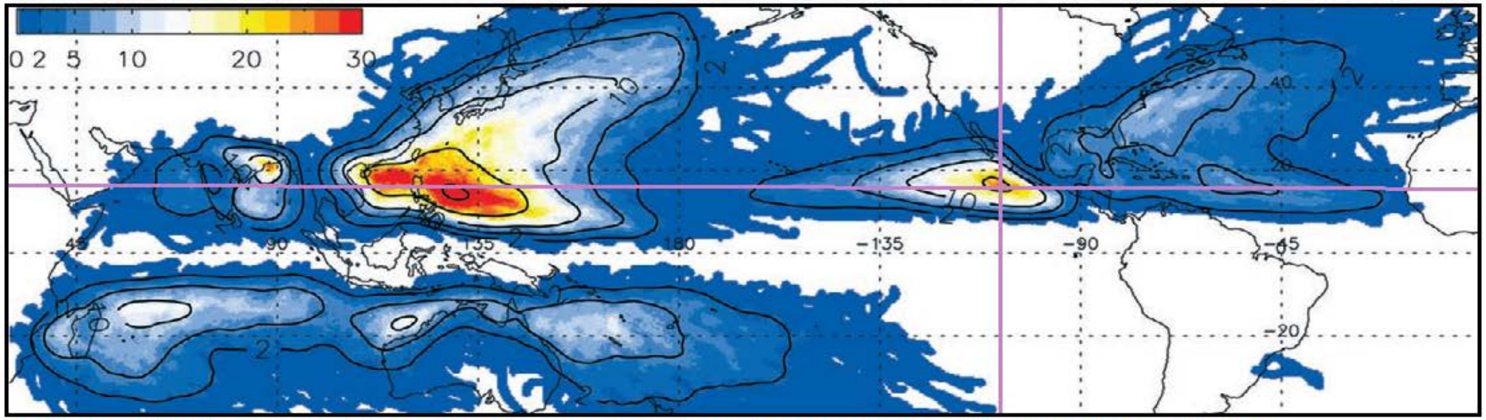
2. Storms of interest (priority in yellow)

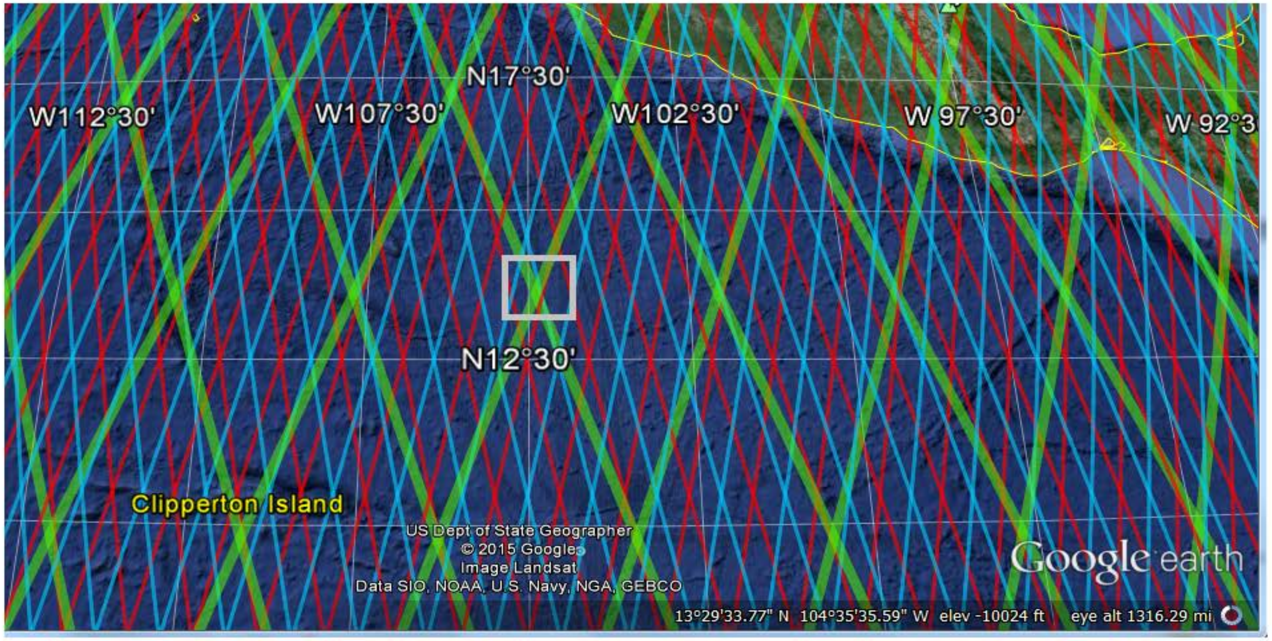
#	Year	Storm (basin)		Period and area	Ocean data	Atm. Data
1	2014	**Edouard (ATL)**		9/12 18Z (pre) 9/15 18Z (in) 9/17 18Z (post) Area: 22-30N, 60-48W	AXBT, AXCP, AXCTD, RS	Flight data (Coyote, HS3 & P3)
2	2015	**EPac – Blanca, Dolores, Patricia**		5/31 – 6/9; 7/11 – 7/18; 10/21-1024	RS	RS, Flight data (Patricia)
3	2014	**Julio (EPac)**		Aug. 4 – 15	AXBT, ALAMO, RS	RS, Flight data
4	2014	**Iselle (EPac)**		Aug. 4 – 15	AXBT, ALAMO	RS, Flight data
5	2014	**Gonzalo (ATL)**		Sep 12, 15 and 17	Seaglider	RS, Flight data
6	2013	Soulik (WNP)		Aug. 8 – 10	RS	None (?)
7	2013	Haiyan (WNP)		Nov. 5 – 10	RS	None (?)
8	2012	**Isaac (ATL)**		8/16 (pre) 8/26 – 28 (in), 8/30 (post) Area: GOM	AXBT, AXCP, (AX)CTD, RS	RS, Flight data

3. Activity Summary

1. Coupled HWRF-HYCOM package for Ideal Case Study w/ 1D & 3D
2. HYCOM merged with HWRF-Ocean-Wave system
3. Diagnostic script package (in Python)
4. Ocean Impact Investigations for Edouard, Blanca, Julio, Iselle, and Isaac:
    a) Langmuir mixing impact on the ocean response (Ginis)
    b) Sensitivity study to initial temperature profiles (Chen)
    c) OSSE experiments (Halliwell)
5. NOAA Next Gen Hurricane Observing Capability AoA Workshop
    a) Recommend concurrent atmospheric and oceanic profiling
    b) Data assimilation in a coupled sense
6. Request submitted to TPOS2020, of a air-sea observation mooring at MDR in EPac
7. Attending national conferences and meetings - AMS annual, 69TH IHC, and WAF/NWS conference
8. OMITT session at Ocean Science Meeting 2016

Request submitted to TPOS2020, of a air-sea observation mooring at MDR in EPac





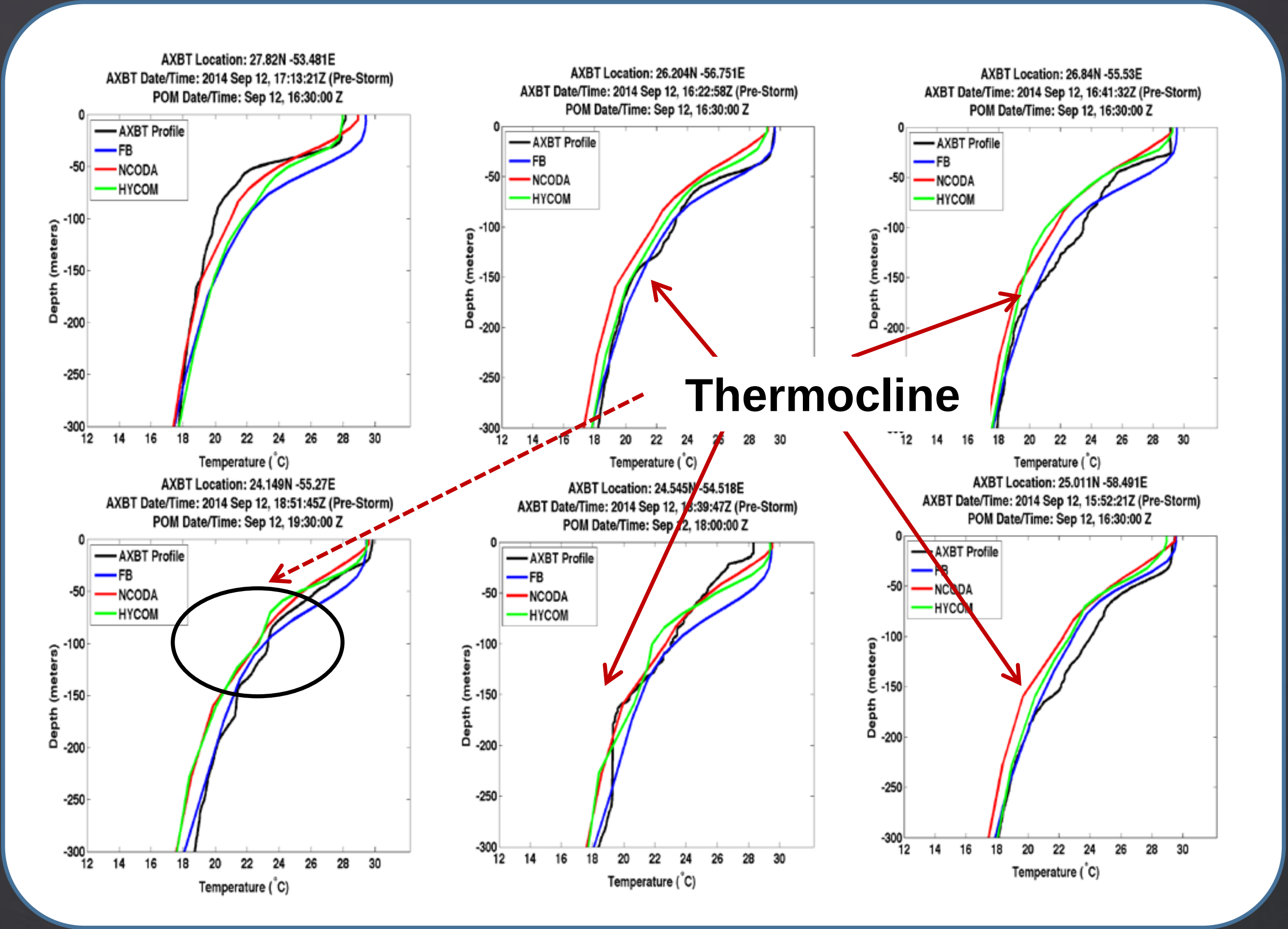
Knapp et al. (2008)

Proposed location: (104.5W,~14N)

4. Ocean Impact Investigations – Preliminary Results

Edouard (2014): Initial Conditions
Upper oceanic structure

- FB* is warmer SST (<1.3C) and has deeper MLD (< 50m) than observations.
- HYCOM (RTOFS) has generally cooler SST (<-0.5C) and shallower MLD (< 20m) than observations.
- NCODA has similar or warmer SST, but persistently shallower MLD than HYCOM.
- None of analyses has the thermocline, except HYCOM (weak)

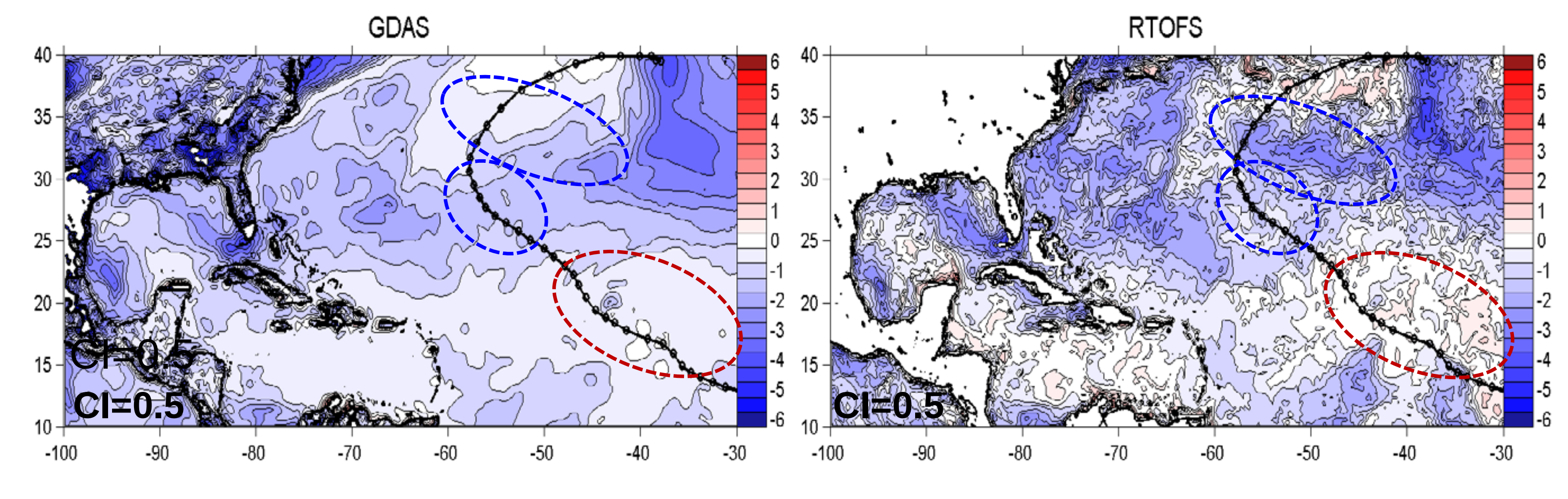


* employed in POM: Feature Model + Climatology Field + GDAS SST

4. Ocean Impact Investigations – Preliminary Results

Edouard (2014) Initial Condition
air-sea interface, Ta - Ts

18Z 2014/9/12

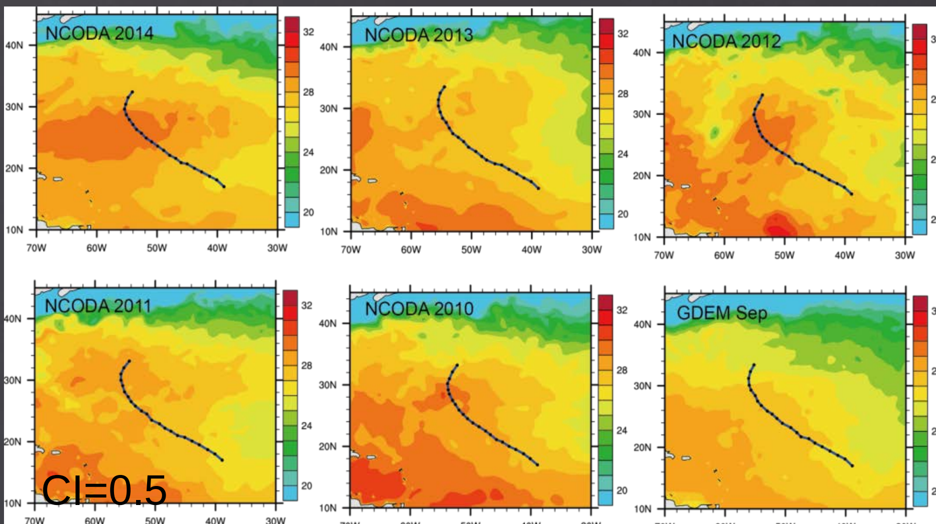


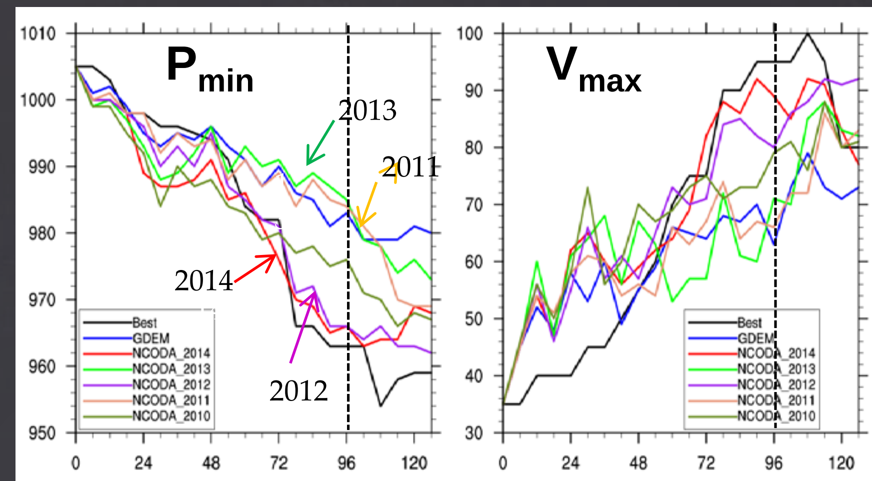
- GDAS SST sets domain-wide stable thermal condition in the near surface layer, showing extensive area of *O*(1.5~2.0^{o}C, warm) of ΔT along the Edouard track, and the warmest at 25-29N for the intensification.

4. Ocean Impact Investigations – Preliminary Results

Edouard (2014)

Sensitivity study for Initial SST and Warm Pool's location, size, and strength





Sources:

- NCODA SST from 2010-2014
- GDEM September climatology

For example, at 96 h, wrt BT
ΔPmin = 4 hPa (2014/2012) *vs*. 28 hPa
ΔVmin = -15 kt (2014/2012) *vs*. -30 kt

Better Intensity Forecast

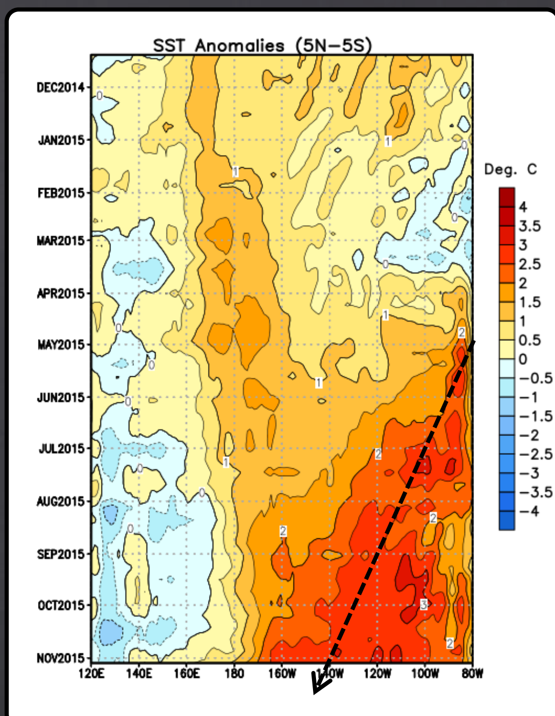
- Larger and warmer beneath the storm
- Stronger temperature gradient along the track

4. Real Case Study – Preliminary

Eastern North Pacific 2015

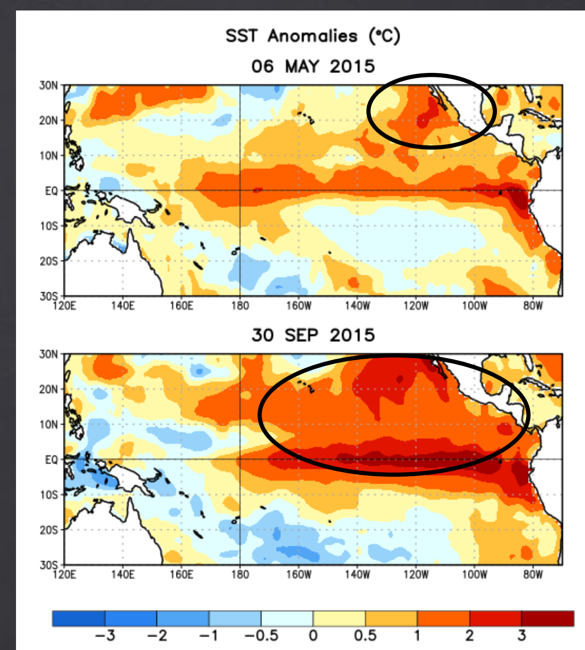
Importance of Intra-Seasonal Conditions

El Nino
Early season – NiNo index 1-2
Mid and Late season – NiNo index 3-4



ENSO: Recent Evolution, Current Status and Predictions
By CPC/NCEP, November 9, 2015

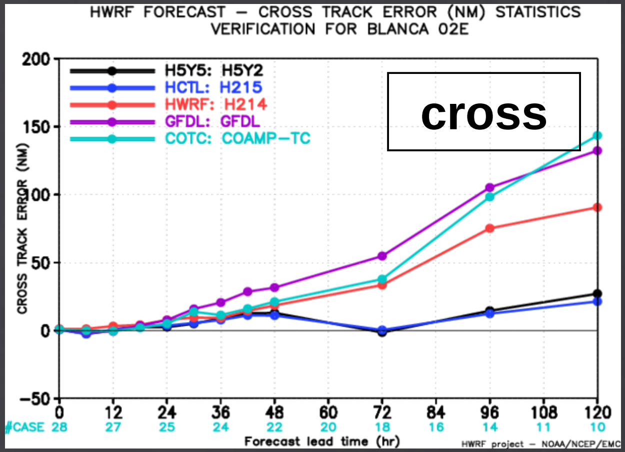
Also, body of warm water residing at 20N, expanding southwestward over time ➔ set up unseasonally warm SST in the tropics.

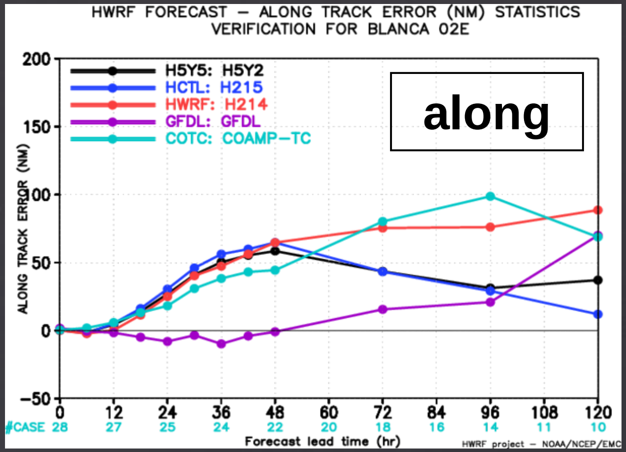


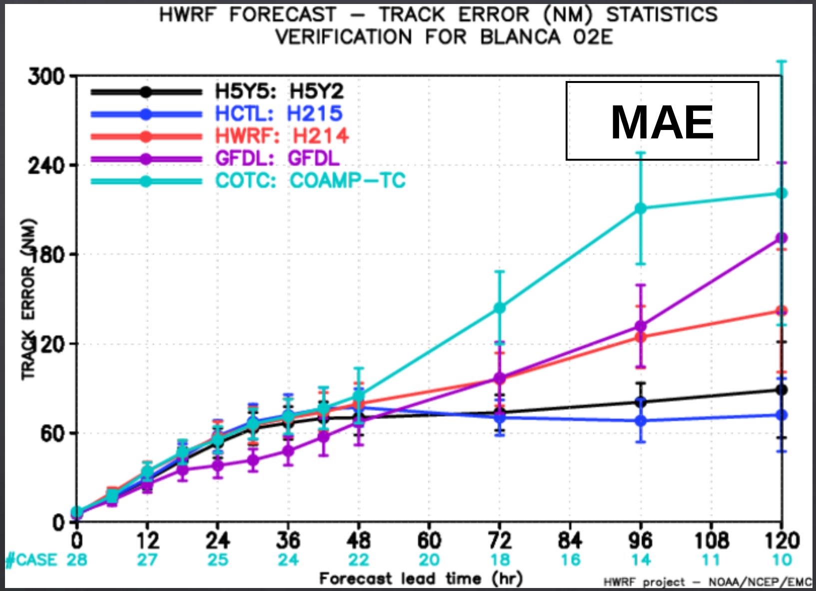
Further extends favorable conditions for TCs in later season.

4. Real Case Study – 3D Ocean Model & Impact

Blanca (02E) – Track Forecast Verification







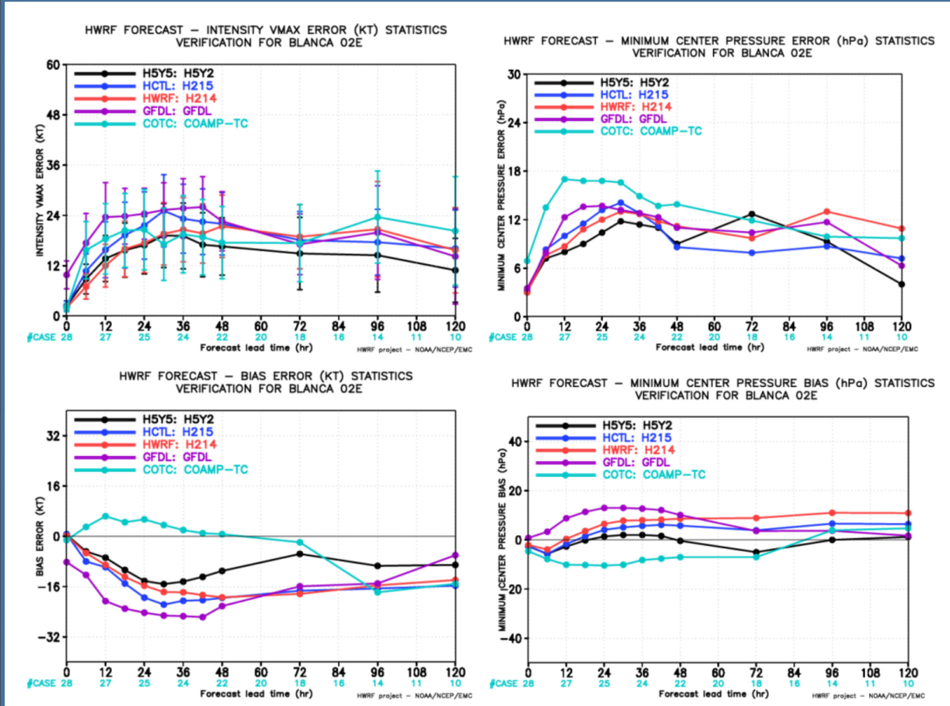
Cf. non-HWRF runs,

- Bias magnitude similar
- Weak eastward bias
- Faster translation speed for early lead hours (< 48h)
- Similar MAE, O(<30 nm)

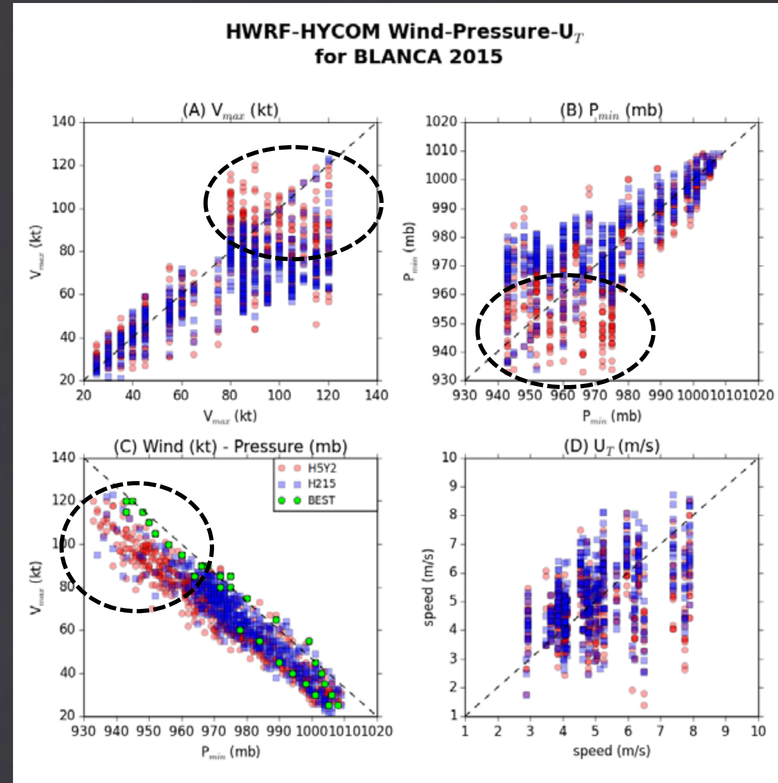
2015 HWRF with coupled HYCOM and POM perform similarly. However, the former is slightly better for earlier lead hours but worse for later times.

4. Real Case Study – 3D Ocean Model & Impact

Blanca (02E)
Intensity Forecast Verification



V_{max} (kt) P_{min} (hPa)



Scatter plots for V_{max}, P_{min}, and U_T

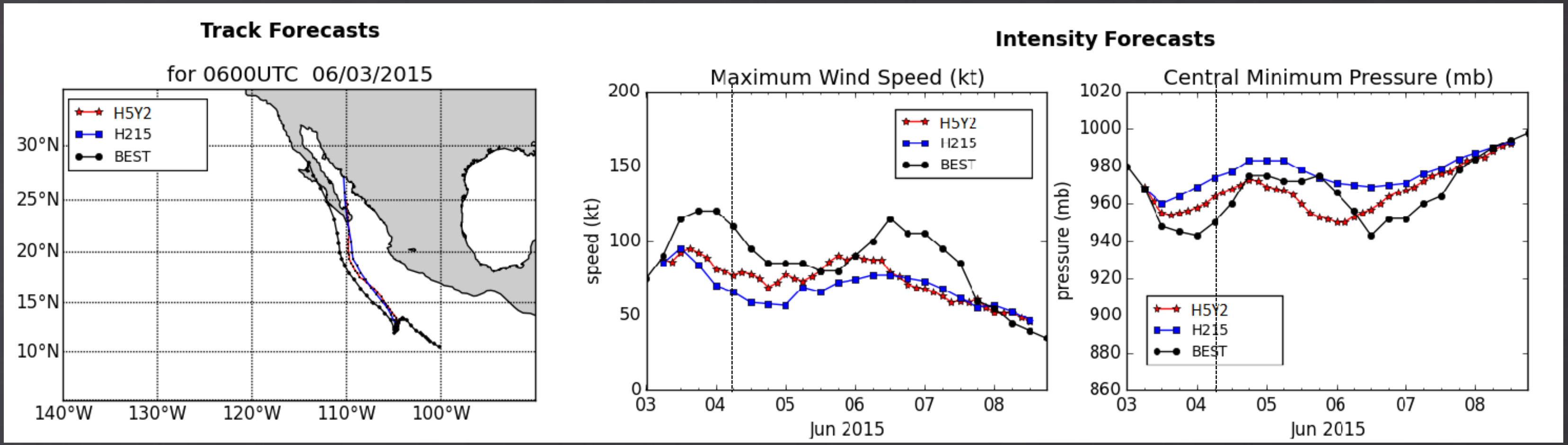
2015 HWRF coupling HYCOM performs best for early lead hours, cf POM coupling, H214 and non-HWRF's, as much as 12 kt (12h cf GFDL) or 11 hPa (12h cf COTC).

- Intensity: Between HYCOM (red) and POM coupling (blue), the former performs better at higher winds or lower pressure.
- U_T: Over-estimate for slow and under-estimate for fast moving storm (more so for HYCOM).

4. Real Case Study - 3D Ocean Model and Impact

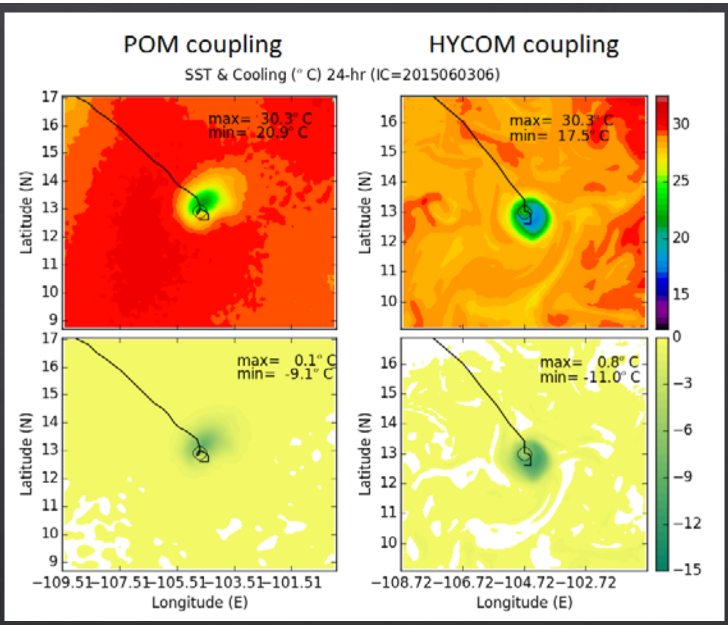
Blanca (2015): SST Cooling & Intensity

More SST cooling but better intensity



SST

Instant. cooling



- POM shows slower moving storm and less cooling at its footprint.
- However, the cooling rate afterwards is higher for POM than HYCOM.
- SST cooling over 24 h (entire cycle):
  9.1 (3.6-17.6)°C for POM
  11.0 (3.6-13.1)°C for HYCOM

4. Real Case Study - 3D Ocean Model and Impact

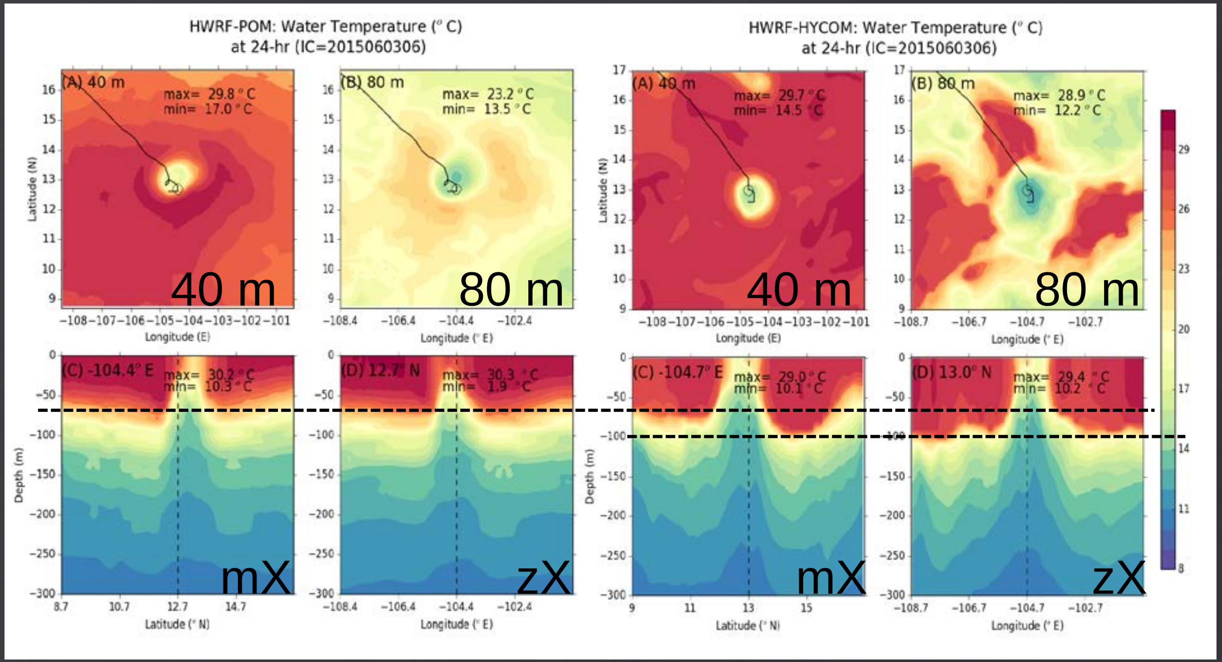
Blanca (2015): Upper Oceanic Conditions & Intensity

- Reason for better intensity forecasts for HYCOM coupling is deeper upper layer, *eps*., in the near field.
- Shallower and colder upper layer conditions for POM are consistent with IC.

Hence,

- <u>Climatology-based IC's are not able to capture meso-scale features and the ongoing seasonal conditions, *e.g. El Nino*</u>.

POM HYCOM



Depth of 26°C (dash horizontal lines) is ~40m difference

➔ ~O(16%) OHC difference

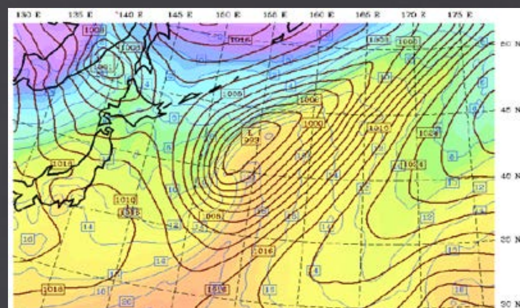
mX: Meridional Section through a storm center
zX: Zonal Section through a storm center

4. Ideal Case Study - SST and Impact

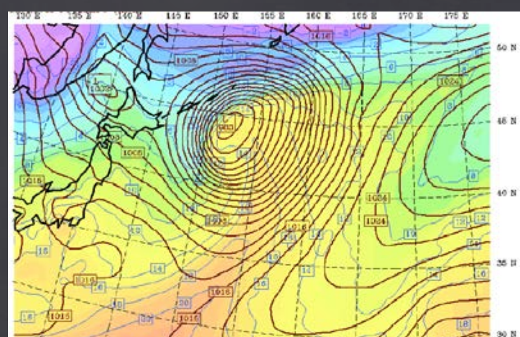
TC's Extratropical Transition: Sensitivity to SST

Typhoon Tokage, using WRF (Bond et al. 2010)

Control

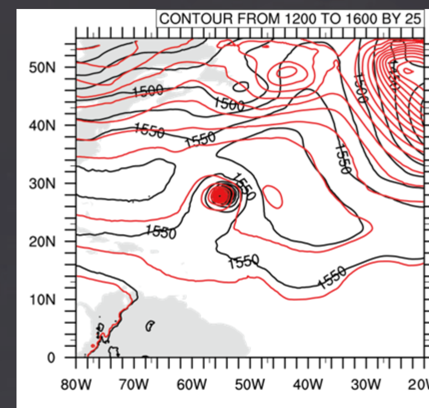


Cold Perturbation (1-1.5°C) between 30-40 N extending east of Japan

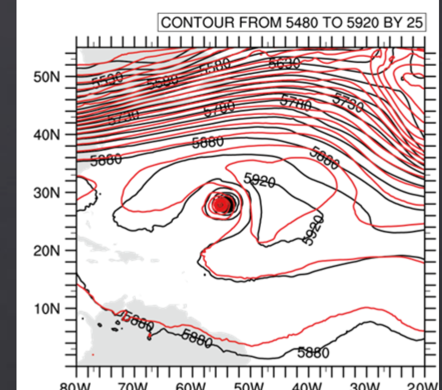


- Warm SST perturbation – slightly weaker cyclone ~2 d after transition.
- Cold SST perturbation – stronger cyclone by 10 hPa Pmin.

Hurricane Edouard, using HWRF-HYCOM (Dong et al. 2015)



850 hPa at 96h



500 hPa at 96h

GFS SST (black)
SST=27 (red)

Mid-latitude Jet Stream gets stronger with warmer SST than GFS

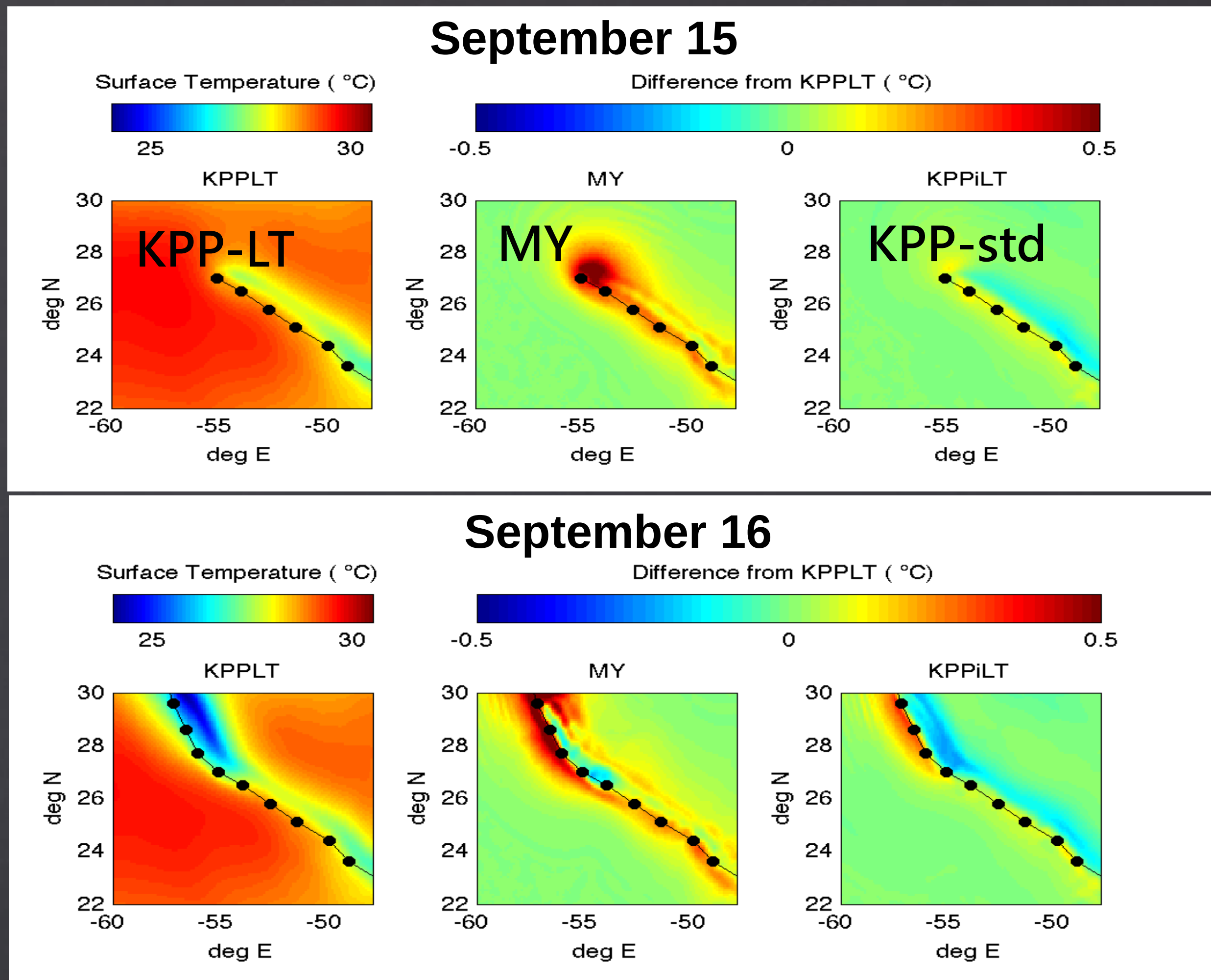
5. Summary

- Importance of Initial Conditions
  Intra-seasonal variability as well as meso-scale variability should be realized.
- Air-sea temperature difference sets up different thermal structure at t=0.
- <u>Blanca (2015), Eastern North Pacific</u>
  Intensity forecasts vs. SST cooling – more complicated:
  - Depends on thickness of the oceanic upper layer, hence MLD or thermocline should be accurately represented.
    - Positive impact w/ deeper MLD.
  - Found different translation speeds between POM and HYCOM.
    - Slower with HYCOM than POM.
  - Found that instantaneous cooling is higher and slower post-storm cooling rate for HYCOM. Opposite for POM.
- <u>Edouard (2014), North Atlantic</u>
  Intensity forecasts vs. SST field
  - Location, strength and size of warm pool play important role.
  - Location, strength of the Gulf Stream (weaker for GDAS).

Finally,
OMITT activities helped improve HYCOM coupling and operational transition of HYCOM possible in 2016 or 2017.

Langmuir Turbulence Impact on the Ocean Response

KPP-LT vs KPP-df and MY in Hurricane Edouard (2014)



KPP-df: KPP default
KPP-LT: KPP w/ Langmuir Turbulence

6. Future Plans

Near Future Activity

- Continue analyses for Edouard (2014) and Blanca (2015) toward publications
- Complete Ideal Case Studies for Edouard and Blanca, by including seasonal variability in ICs
- Do HYCOM/POM impact analyses for upcoming HWRF T&E
- Help improvement of atmospheric DA

Improvement of the ocean component

- Complete 3-way coupling, including implementation of non-linear currents-waves interaction (Stokes drift, Langmuir mixing) in the HYCOM ocean component
- Implement Data Assimilation (DA) to the HYCOM ocean component
- Implement coupled DA