HWRF flux test

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Ocean in tropical cyclone models

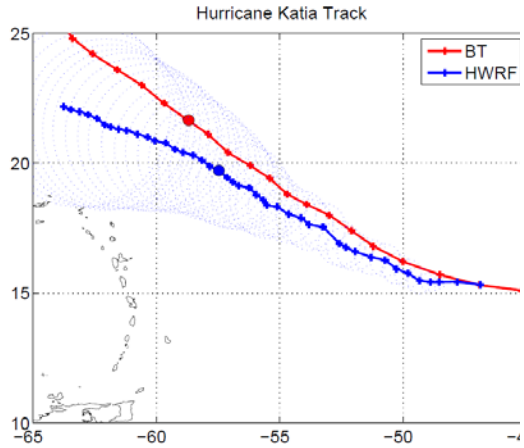
- Allows greater accuracy in
  - SST field
  - Latent/sensible heat fluxes
  - Intensity
- Crucial because SST can change rapidly in tropical cyclones
- Can represent the following processes
  - Turbulent mixing (one-dimensional)
  - Upwelling (three-dimensional)
  - Advection (three-dimensional)

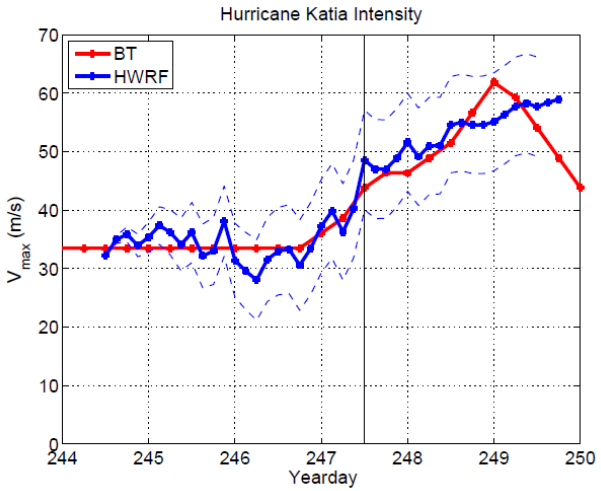
Note that in HWRF, POM is 3-D in Atlantic and 1-D in East Pac

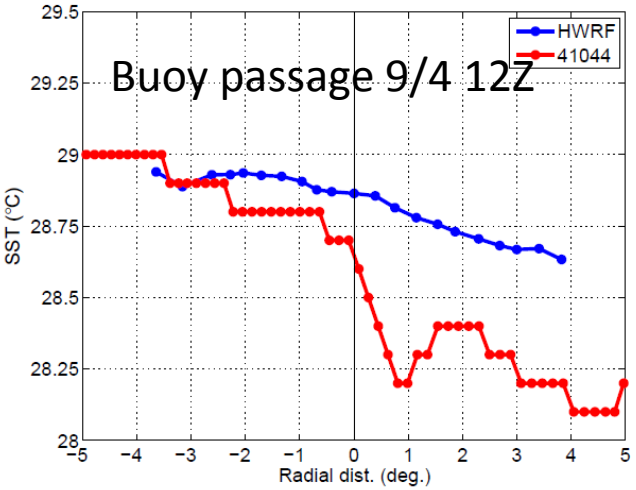
DTC Fluxes Test: Background

- HRD (Ulhorn and Cione) compared HWRF retro forecasts for 2011 against buoys and showed that HWRF ocean does not respond (=does not cool as much as obs) when storm goes by.

Katia 09/01/11 init12 Z



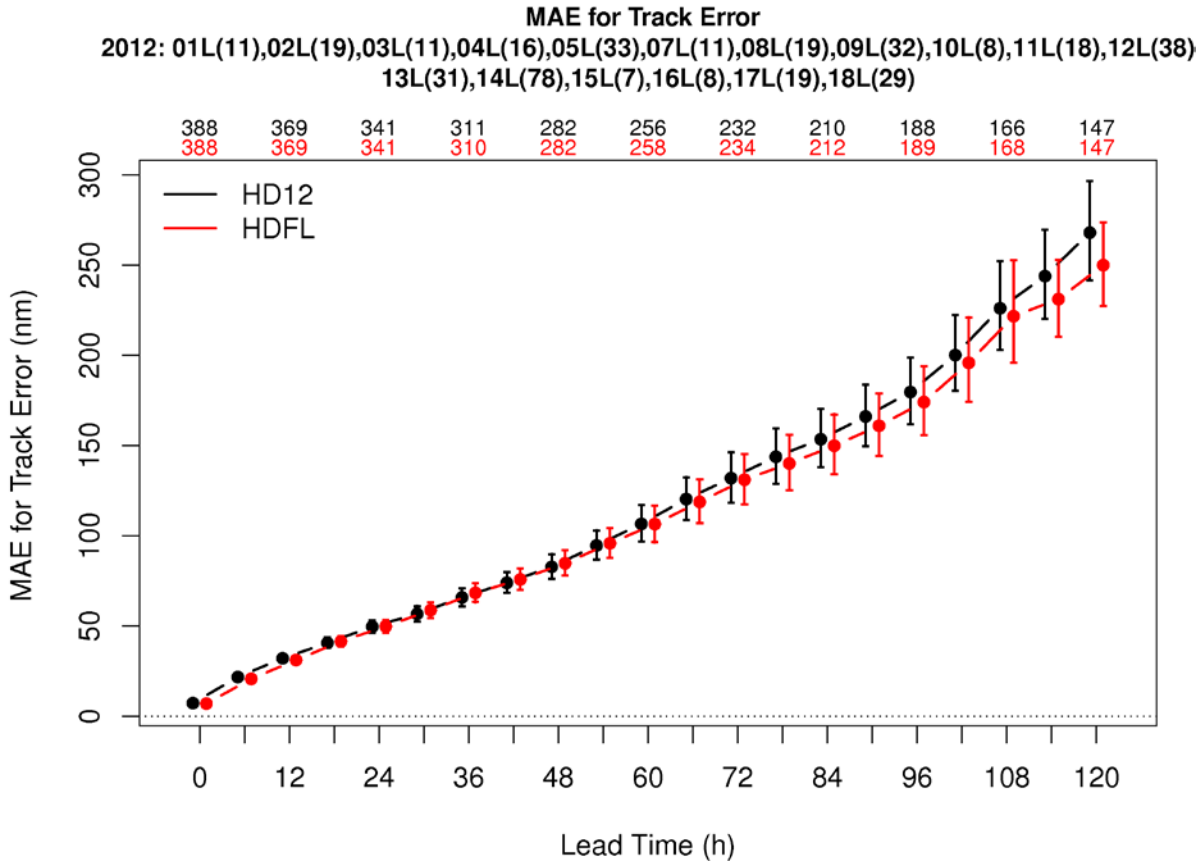




DTC Fluxes Test: Background

- HRD (Ulhorn and Cione) compared HWRF retro forecasts for 2011 against buoys and showed that HWRF ocean does not respond (=does not cool as much as obs) when storm goes by.
- URI recalled that momentum, sensible, latent fluxes from HWRF atmosphere to ocean are truncated in POM (75%) because in the past HWRF intensities were too low
- Consulted EMC and they were interested in DTC testing
- DTC ran 2012 season: control (75% fluxes) and modified (100%)
- Further analysis by URI and HRD

Atlantic track



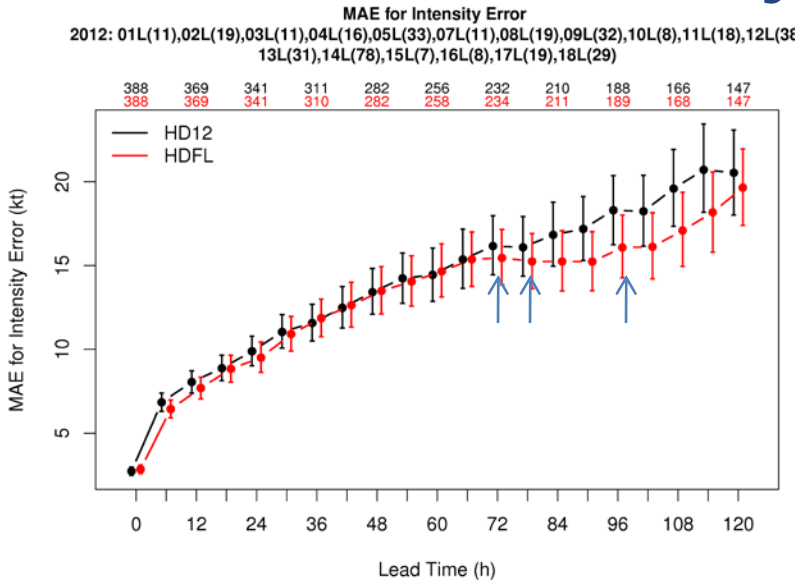
Memorize these acronyms!!

HD12: Control
HDFL: Flux Experiment

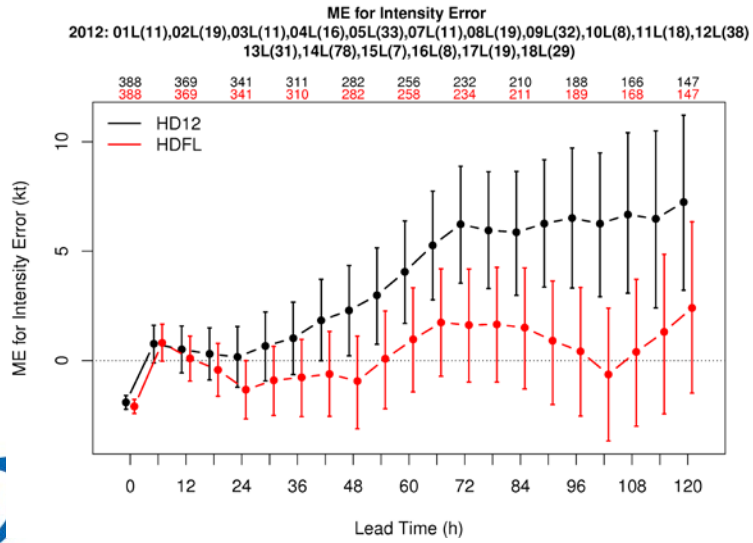
No statistically significant (SS) differences

SS (95%) is determined doing pairwise differences

Atlantic Intensity

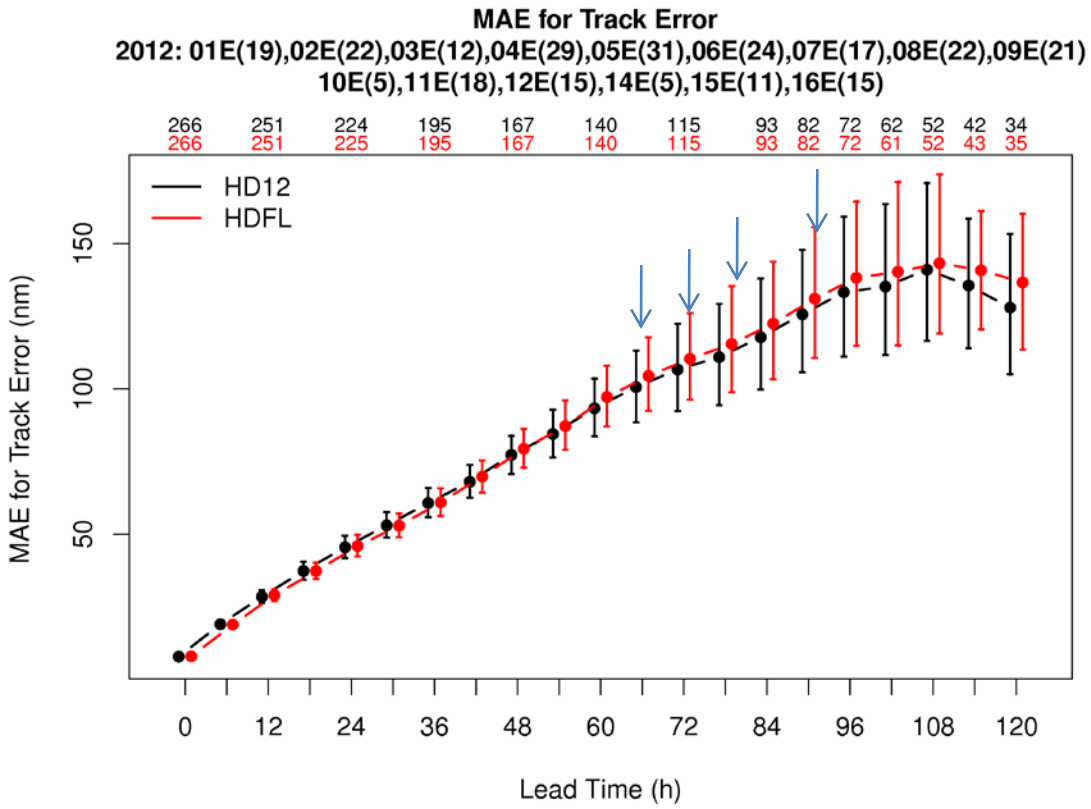


MAE: HDFL SS better at 3 lead times



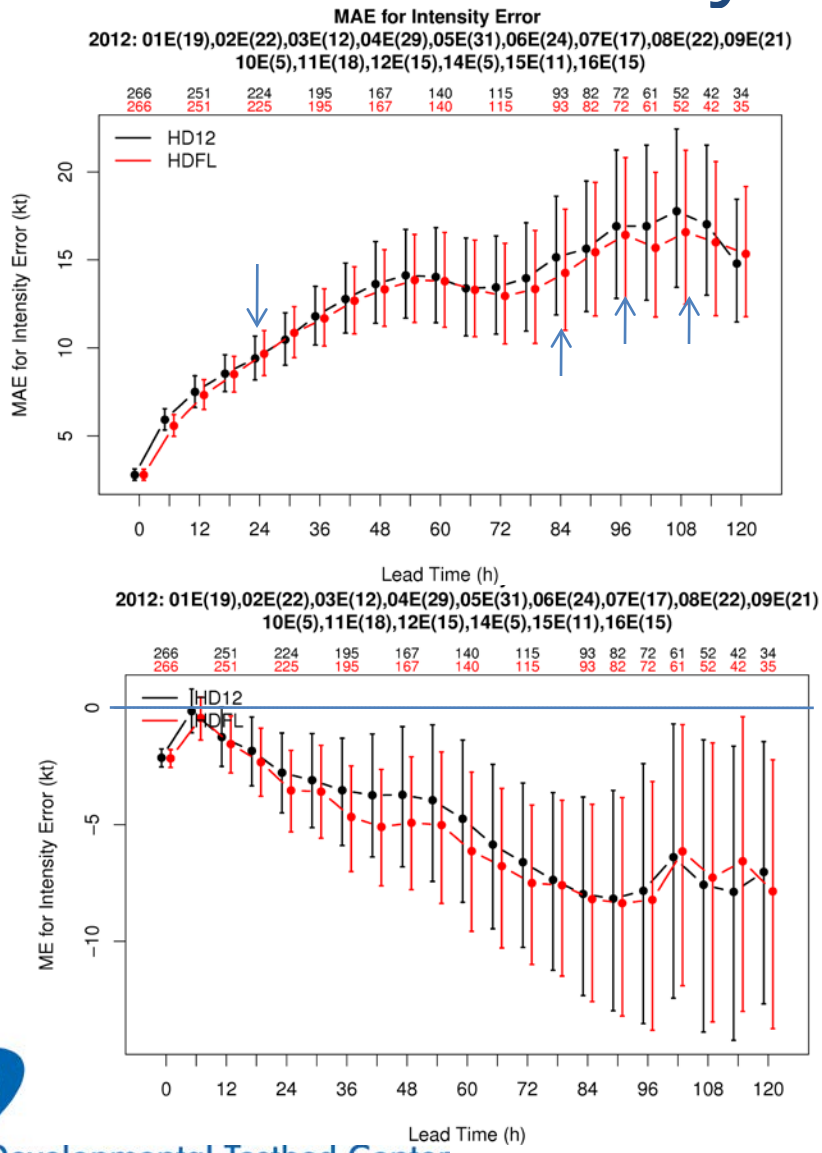
ME (bias): HD12 lowers intensity and helps overintensification at long lead times

Pacific Track



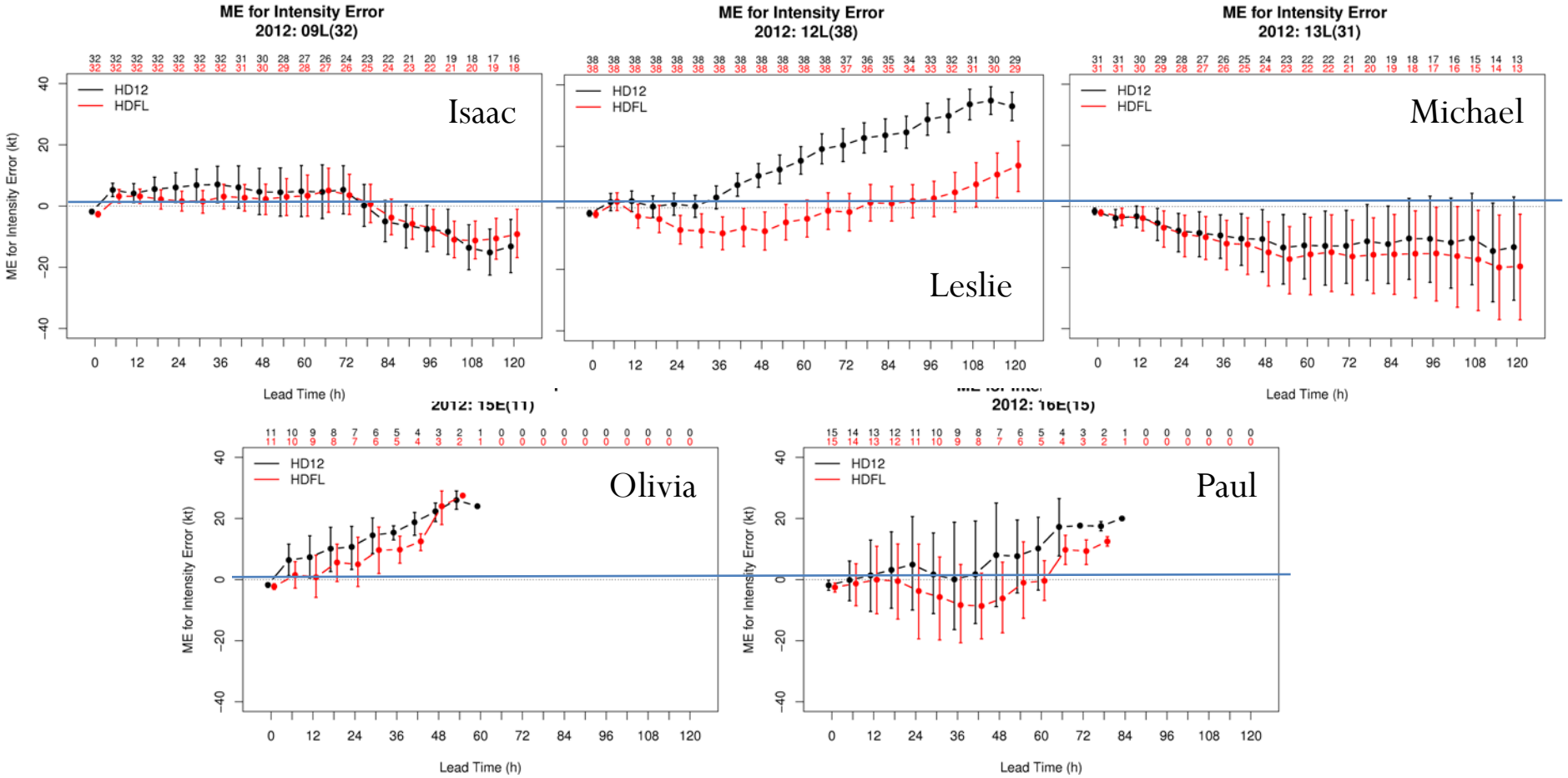
HDFL is SS worse at 4 lead times but difference is small

Pacific Intensity

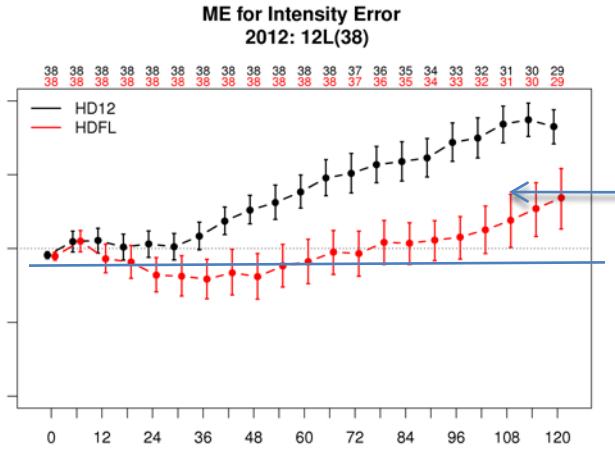


- HDFL worse at 1 lead time and better at 3
- Smaller impact on EP, perhaps because
  - POM is 1-dimensional
  - Different vertical distribution of ocean temperature

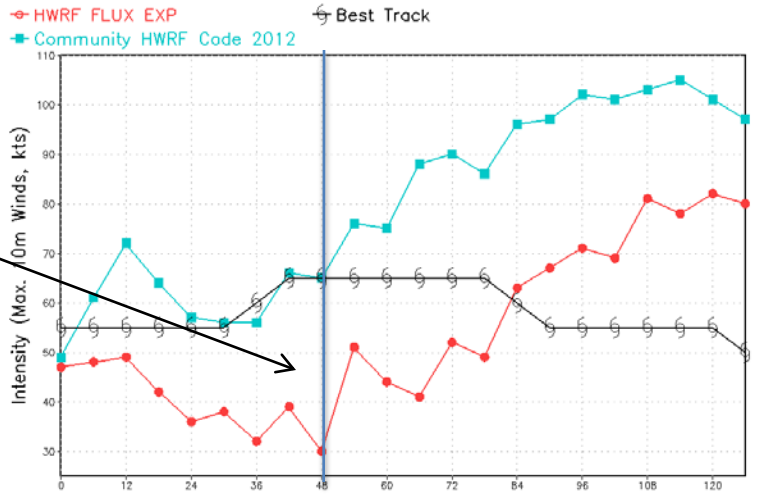
Storms with largest intensity differences

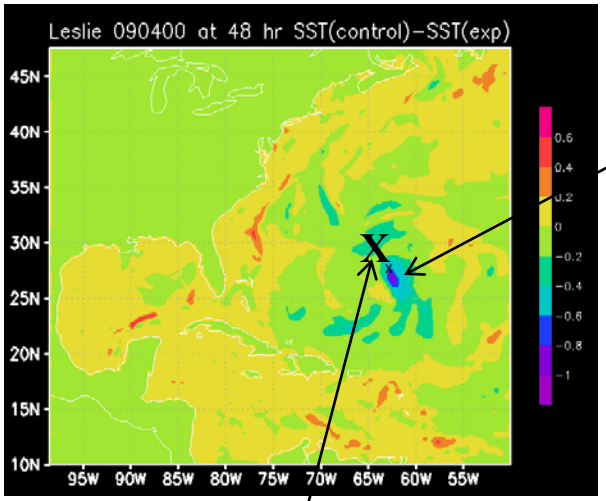


Leslie bias and 09/04 00Z case

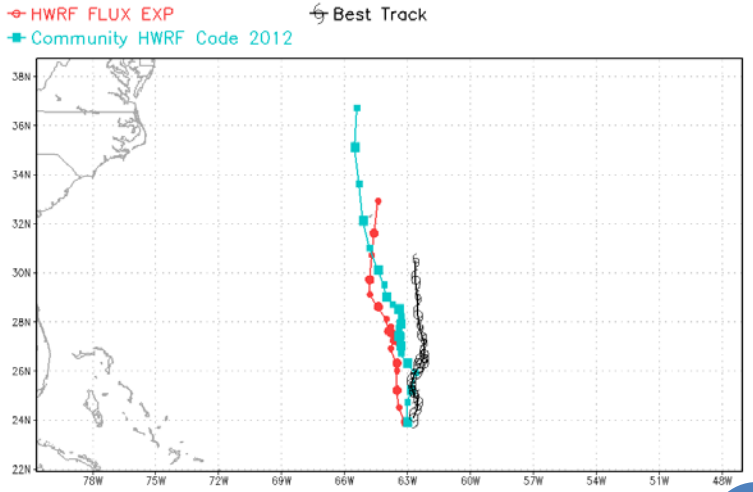


HDFL reduces intensity (as expected). Is it because of low SST under storm?





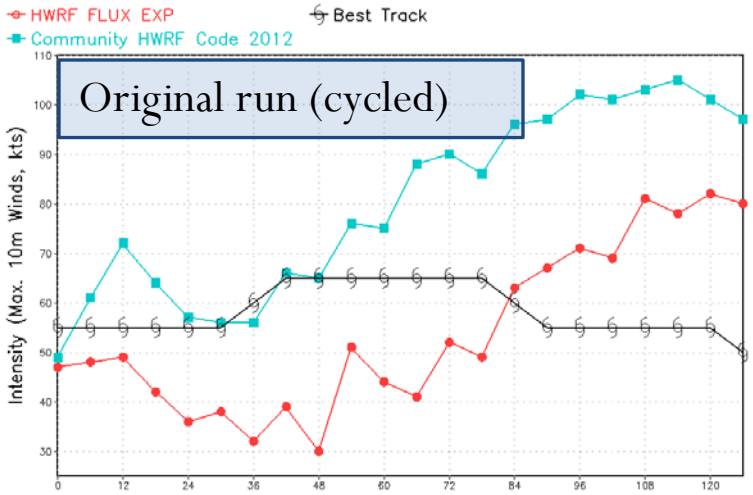
At 48 h, control has cooler SST than flux exp (contrary to linear interpretation)

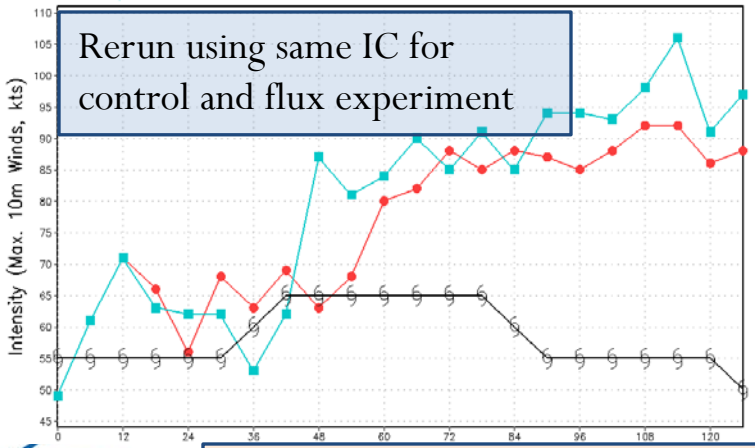


Non linearity:
- more mixing
- more cooling
- less intensity
- less mixing

X = storm center

Leslie: rerun with same IC 09/04 00Z





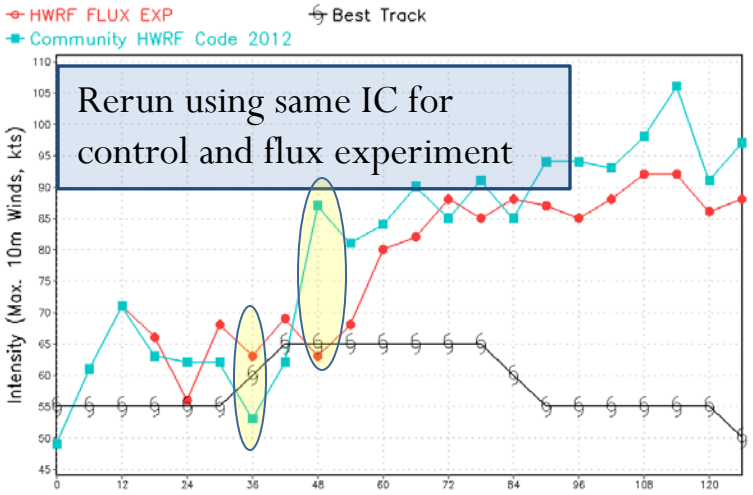
Question: How much of the difference between HDFL and HD12 for a given case is due to fluxes change as opposed to sensitivity to IC?
Method: Ran with same IC
Answer: When same IC are used, differences between HD12 and HDFL are much smaller

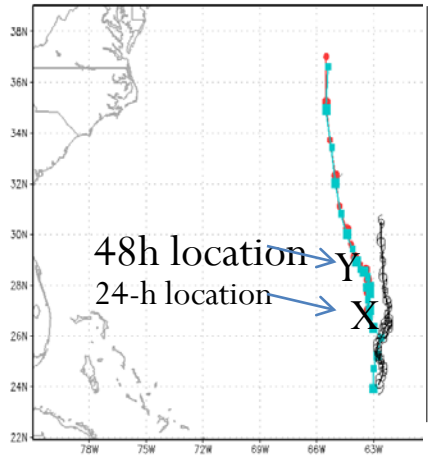
Sensitivity to IC will lead to differences that are not just because of fluxes

In each run, different fluxes make a small difference, which gets compounded by cycling

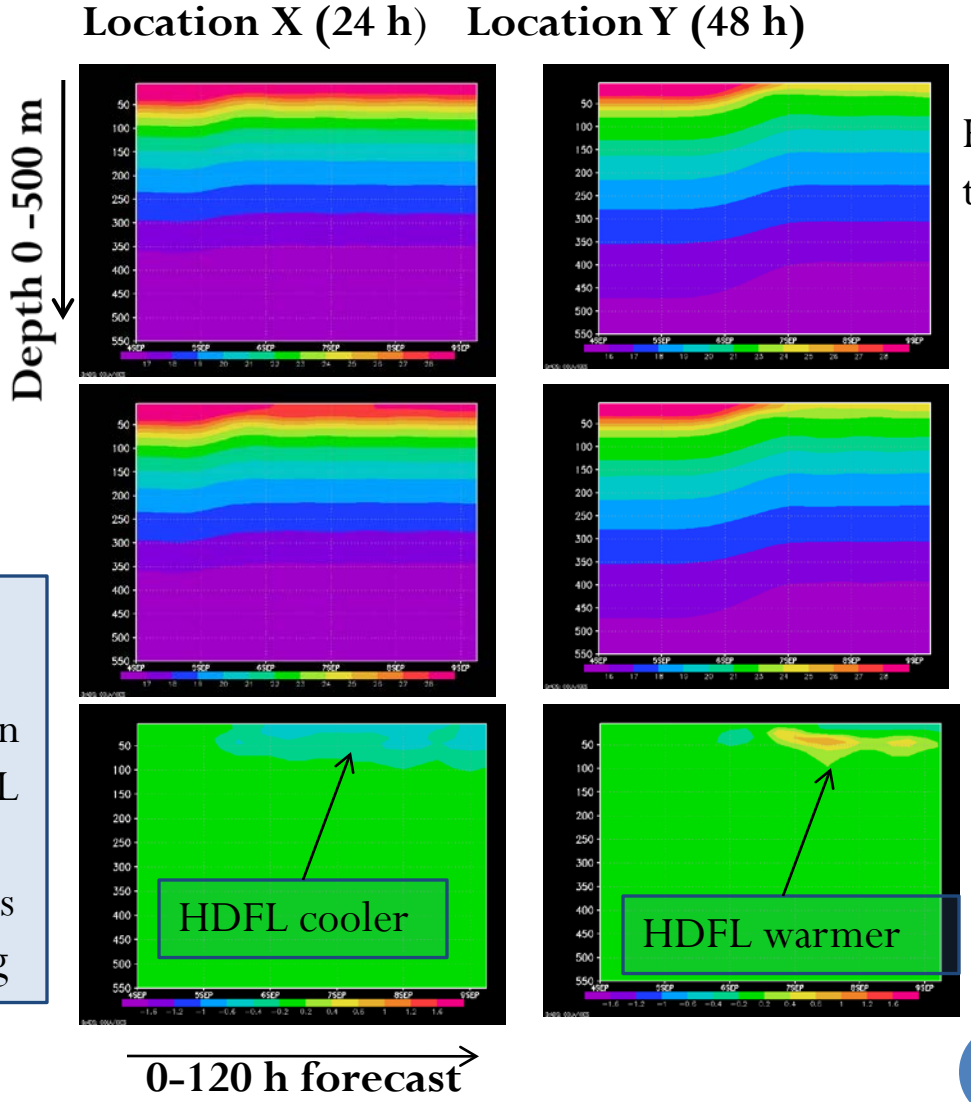
Caution should be used when differences between a pair of runs is analyze

Nonlinearity in ocean response

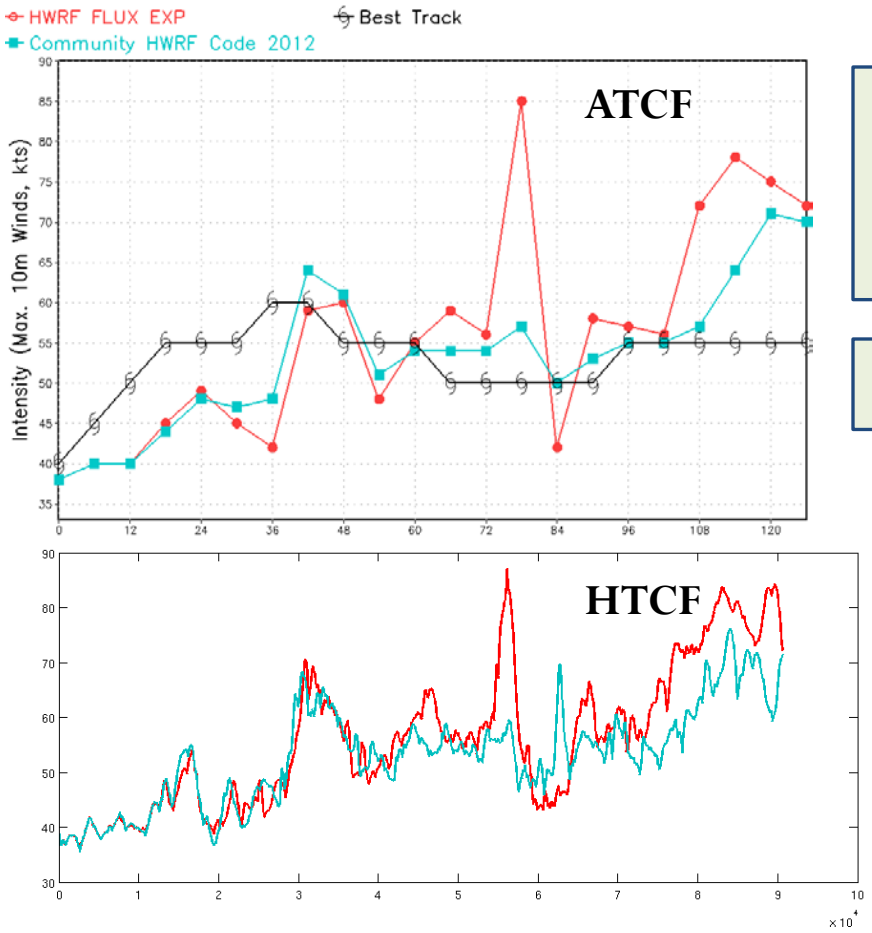




At 48h, HDFL warmer. Even though HDFL more flux, weaker winds cause cooling



Leslie initialized 08/30 18 UTC



HDFL: RI starting at 72-h (30 kt in 6 h)
HD12 does not have RI
(verified in HTCF)

Source of difference is under investigation

Final remarks

- DTC has completed the runs of control and flux experiment for entire 2012 season
- Overall the impact of the change in fluxes seem beneficial
- Website for plots: http://www.dtcenter.org/HurrWRF/graphics/HDFL-HD12/
- All runs have been archived and can be used for further
- DTC is interested in staying involved in analysis of results

Backup slides

(From Hurricane Tutorial – Rich Yablonsky from URI)

1) Vertical mixing/entrainment

ATMOSPHERE

OCEAN

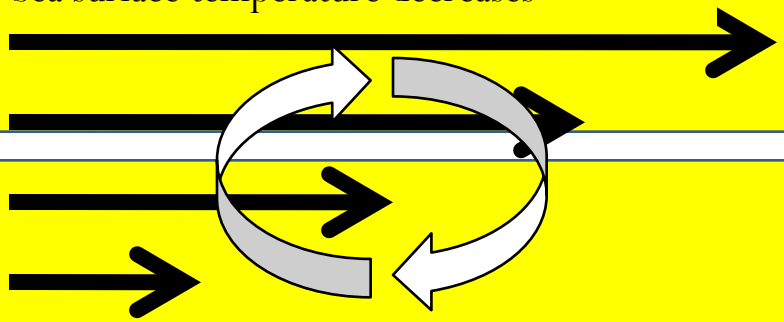
Wind stress → surface layer currents

Current shear → turbulence

Turbulent mixing → entrainment of cooler water

POM-TC uses the Mellor-Yamada 2.5 turbulence closure submodel to parameterize vertical mixing

Sea surface temperature decreases

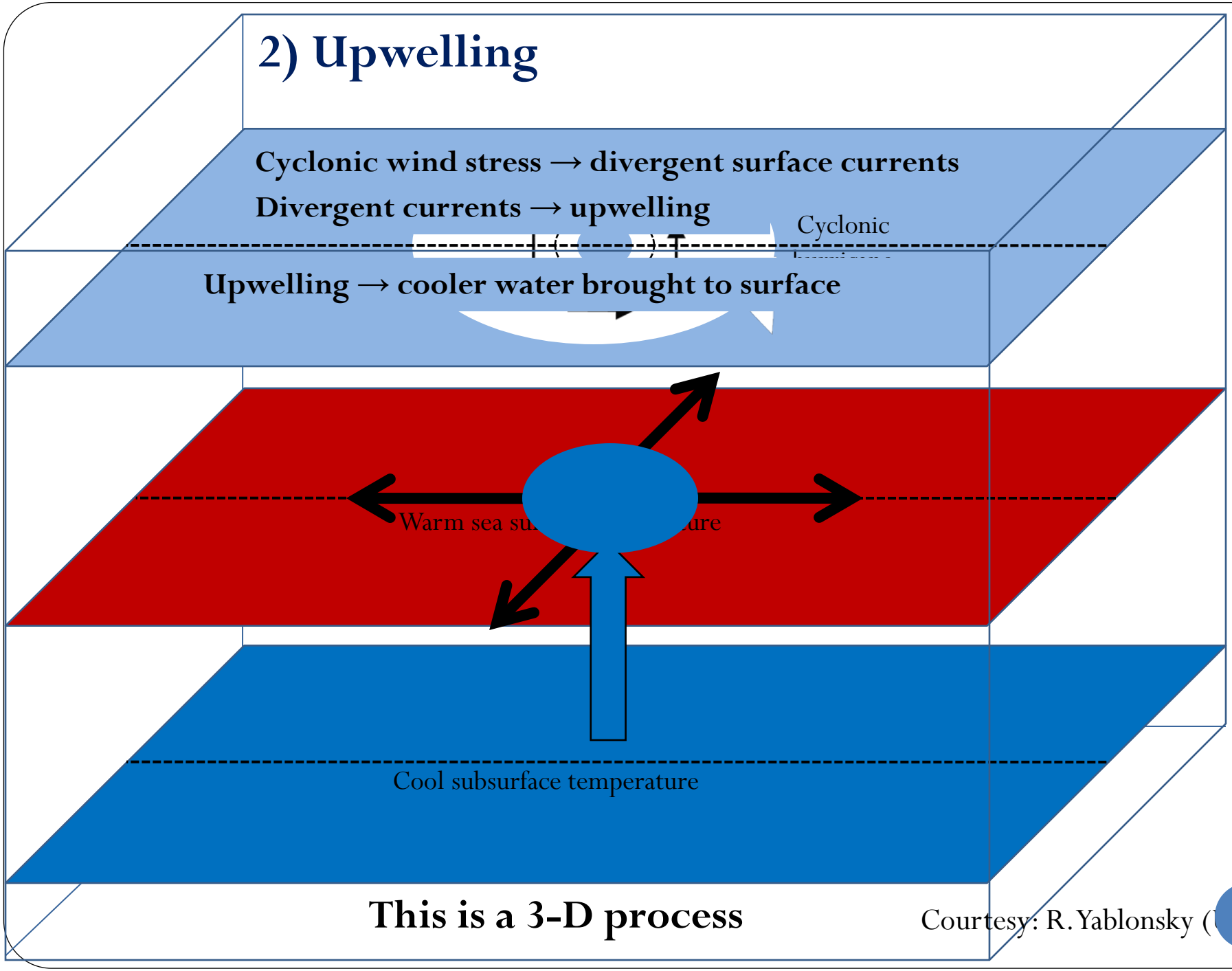


Subsurface temperature increases

This is a 1-D (vertical) process

Courtesy: R. Yablonsky (

2) Upwelling



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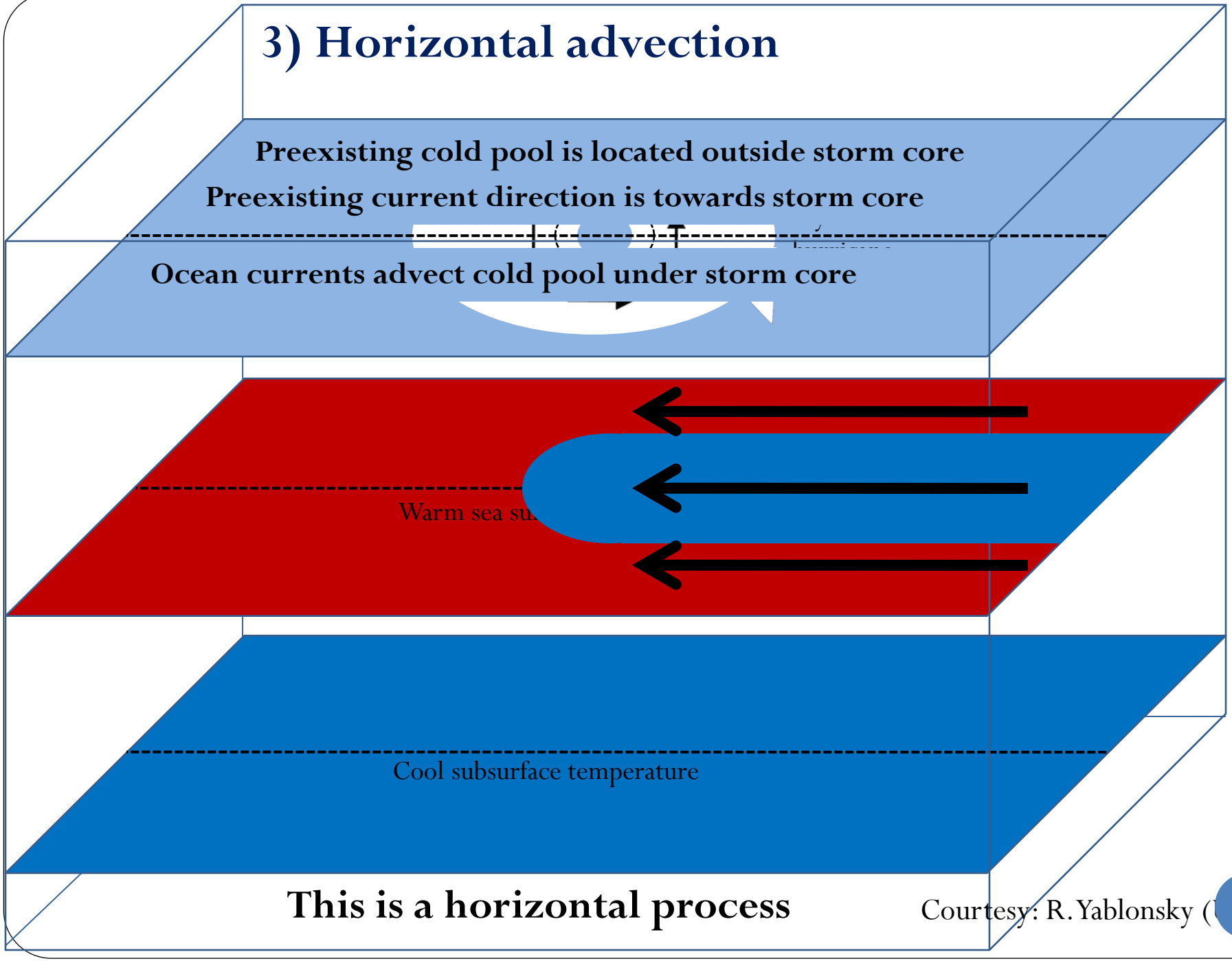
This is a 3-D process

Courtesy: R. Yablonsky (

3) Horizontal advection



ATMOSPHERE

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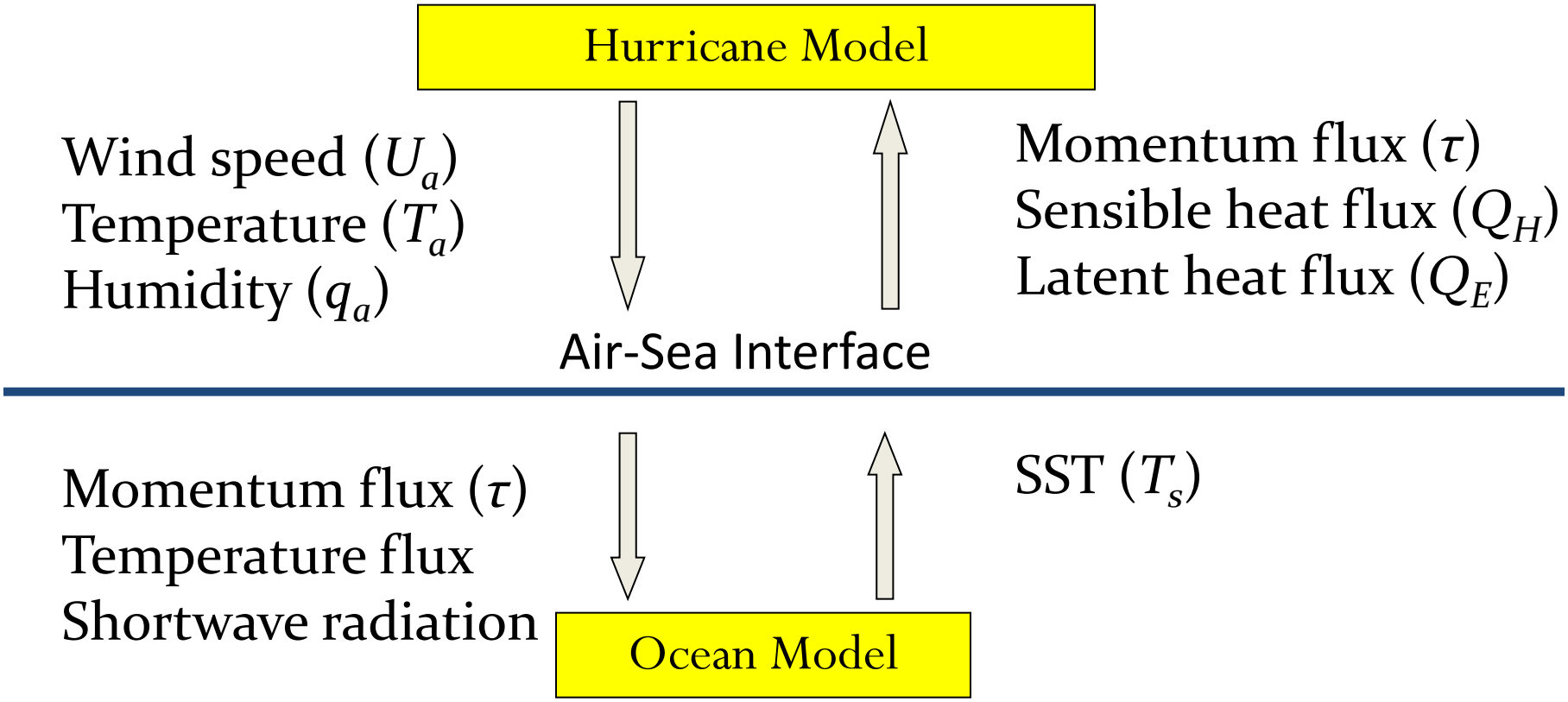
This is a horizontal process

Courtesy: R. Yablonsky (

HWRF/POM-TC Coupling



$$\tau = \rho_a C_D U_a U_a \qquad Q_H = C_H U_a (T_a - T_s) \qquad Q_E = \frac{L_V}{C_P} C_E U_a (q_a - q_s)$$

Courtesy: R. Yablonsky (U