Impact of the Anomalously Warm Gulf of Mexico on Hurricane Michael (2018) Intensity

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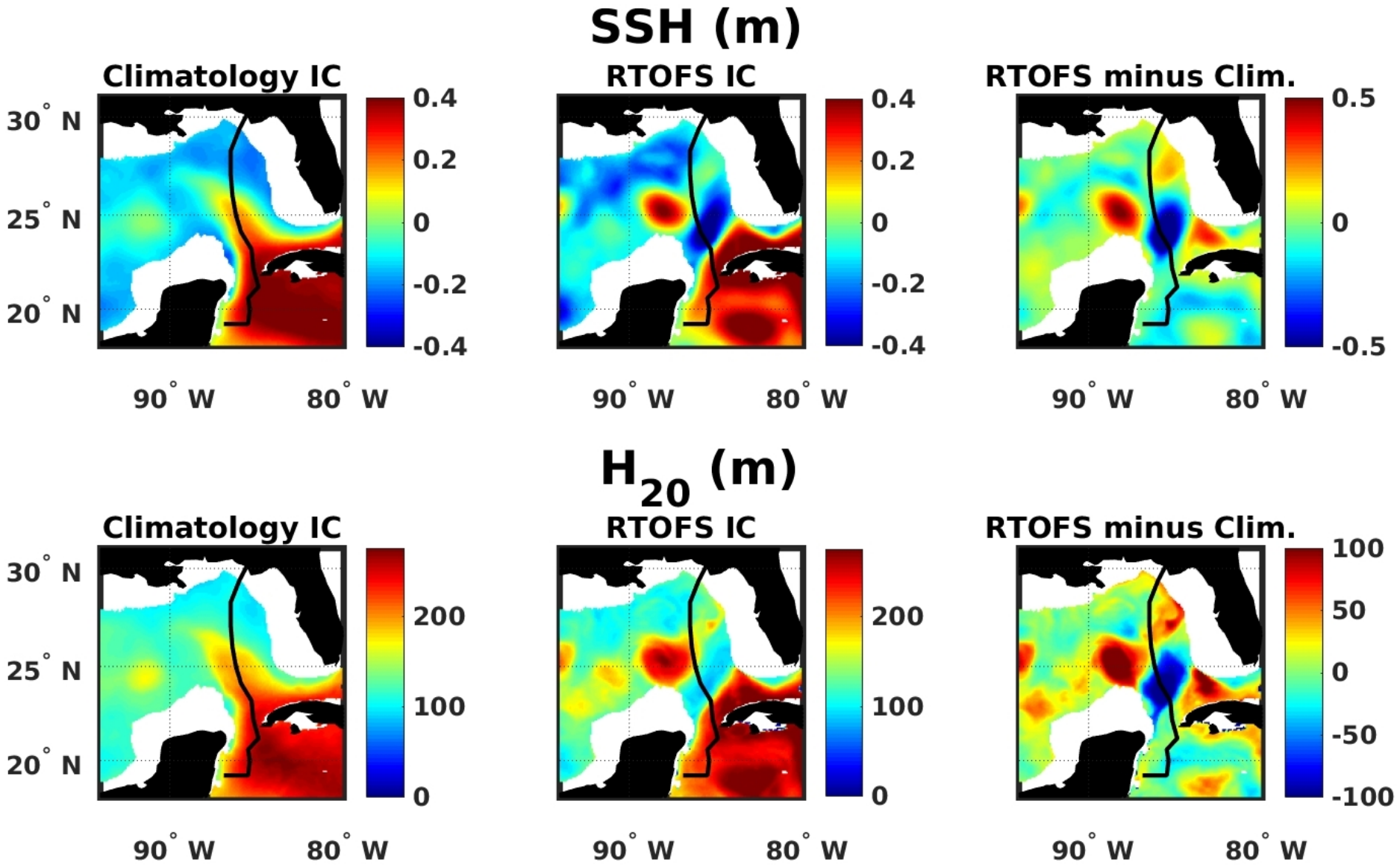
- The abnormally warm conditions in the Gulf of Mexico likely contributed to the intensification of Michael
- How big was this contribution?

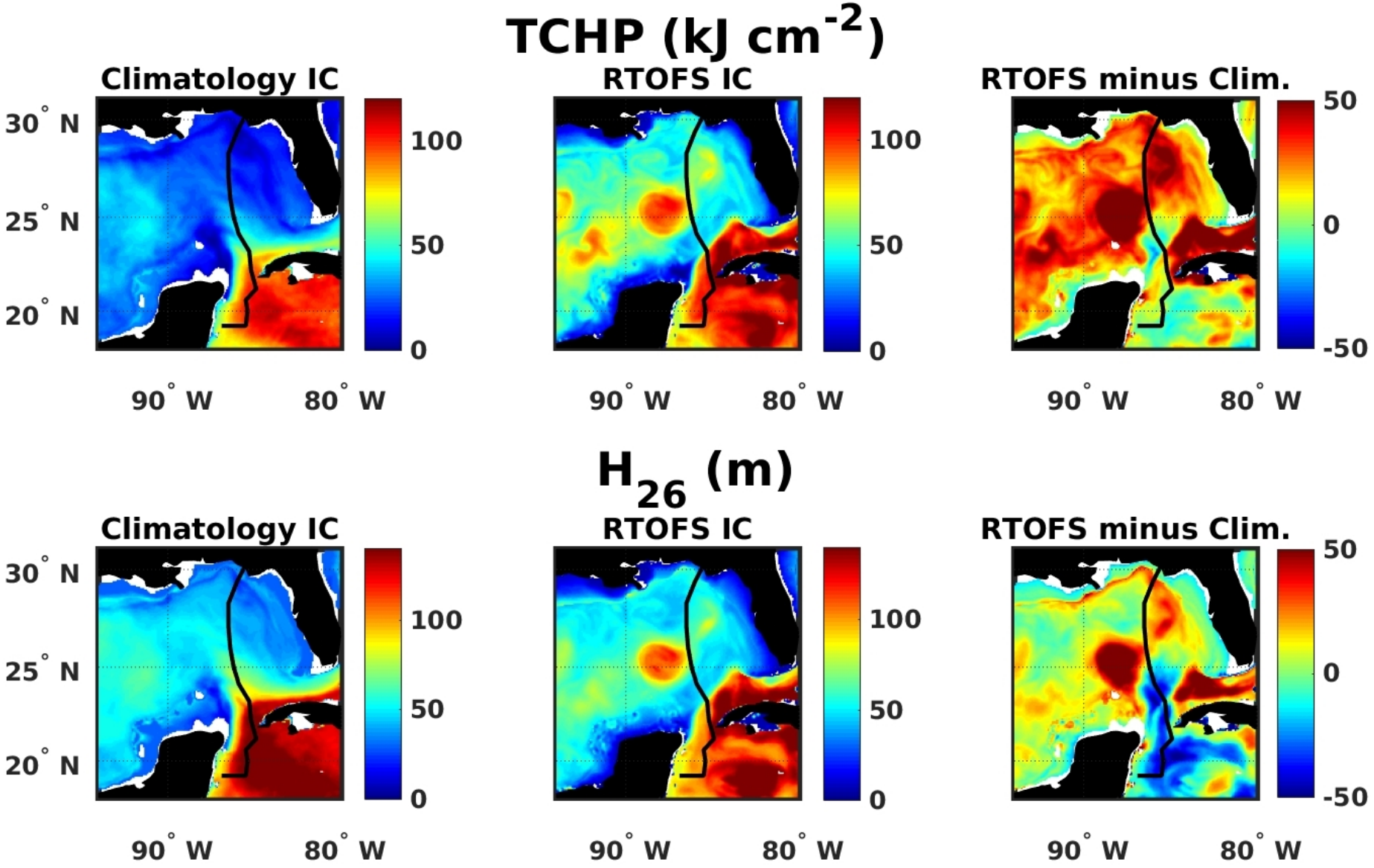
Approach

- Perform idealized twin experiments:
  - Use HYCOM ocean model to generate a balanced ocean climatological analysis to initialize the coupled prediction system
    - Run HYCOM simulation over the North Atlantic hurricane domain with strong relaxation of 3-D model fields to Navy GDEM4 climatology
  - Compare coupled forecasts initialized by climatology to the same forecasts produced by NOAA/EMC that were initialized by the realistic RTOFS (Real-Time Ocean Forecast System) ocean analysis product produced by EMC.
    - Used the HWRF-HYCOM coupled prediction system (M. Le Hénaff)
  - Outline:
    - Compare the RTOFS analysis to climatology
    - Present two forecast cycles for Michael, RTOFS versus climatology IC
    - Look at time series of ocean coupling parameters along the storm track

Climatology vs. RTOFS IC: Dynamics

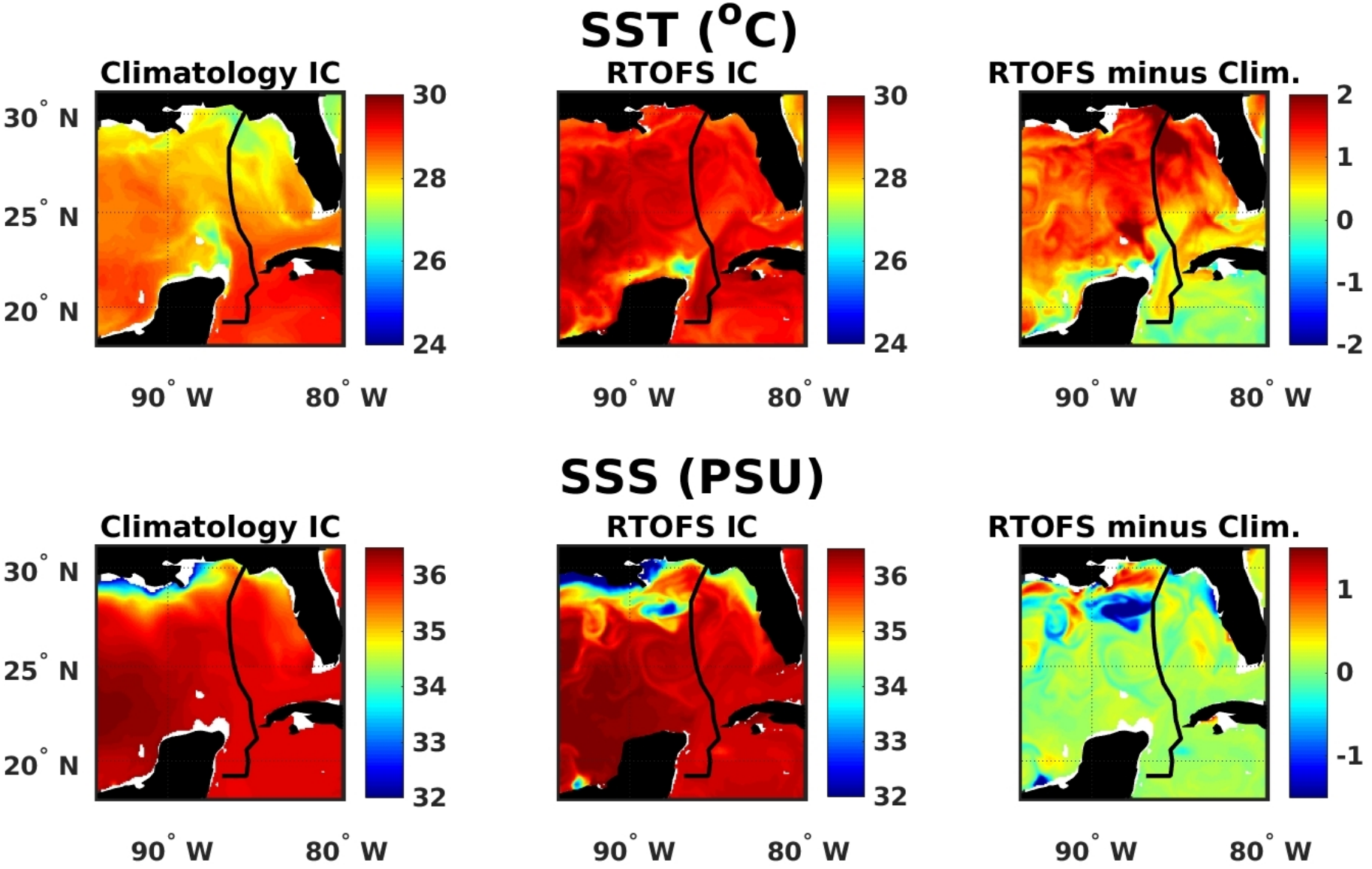


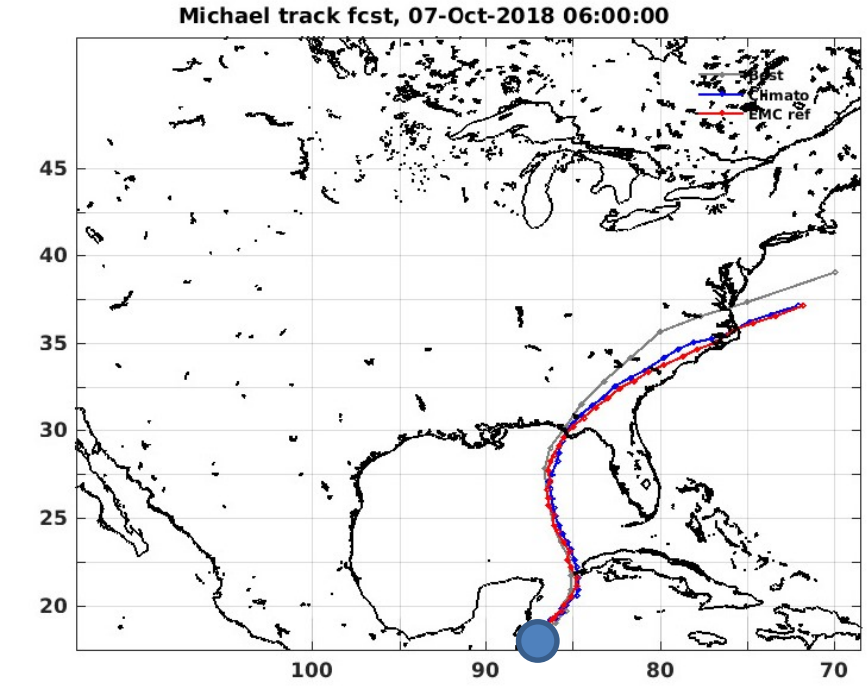
Climatology vs. RTOFS IC: Heat Potential

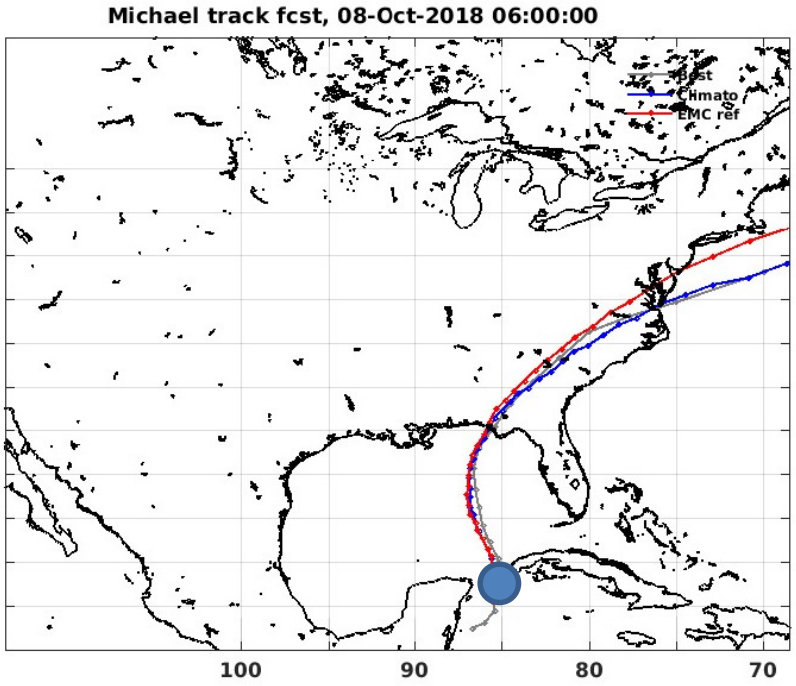


Michael, 7 October 2018

Climatology vs. RTOFS IC: Surface Fields




Michael track fcst, 07-Oct-2018 06:00:00
Best
Clmato
EMC ref
45
40
35
30
25
20
100
90
80
70


Michael track fcst, 08-Oct-2018 06:00:00
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EMC ref
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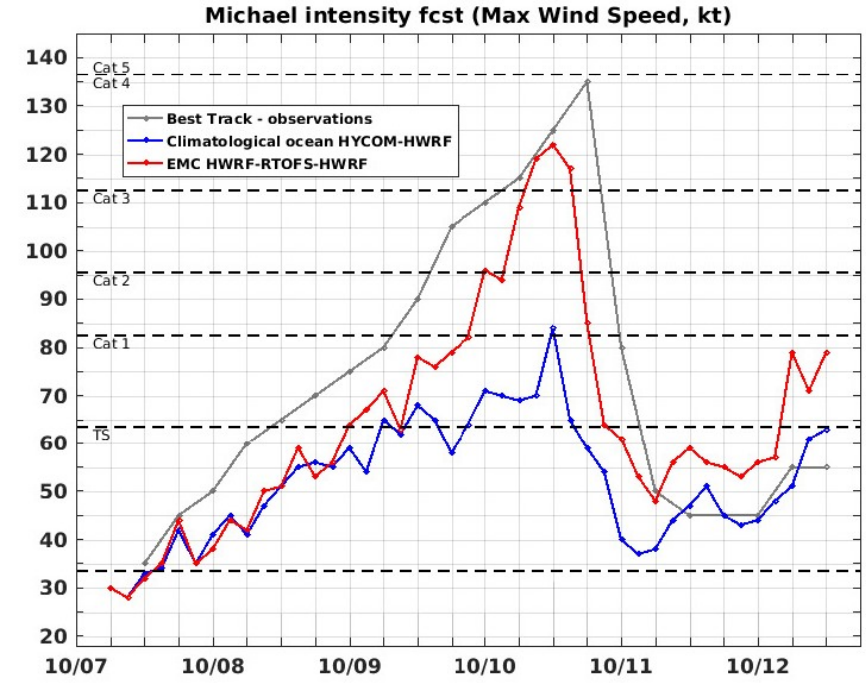
Michael intensity fcst (Max Wind Speed, kt)
Cat 5
Cat 4
Cat 3
Cat 2
Cat 1
TS
Best Track - observations
Climatological ocean HYCOM-HWRF
EMC HWRF-RTOFS-HWRF
140
130
120
110
100
90
80
70
60
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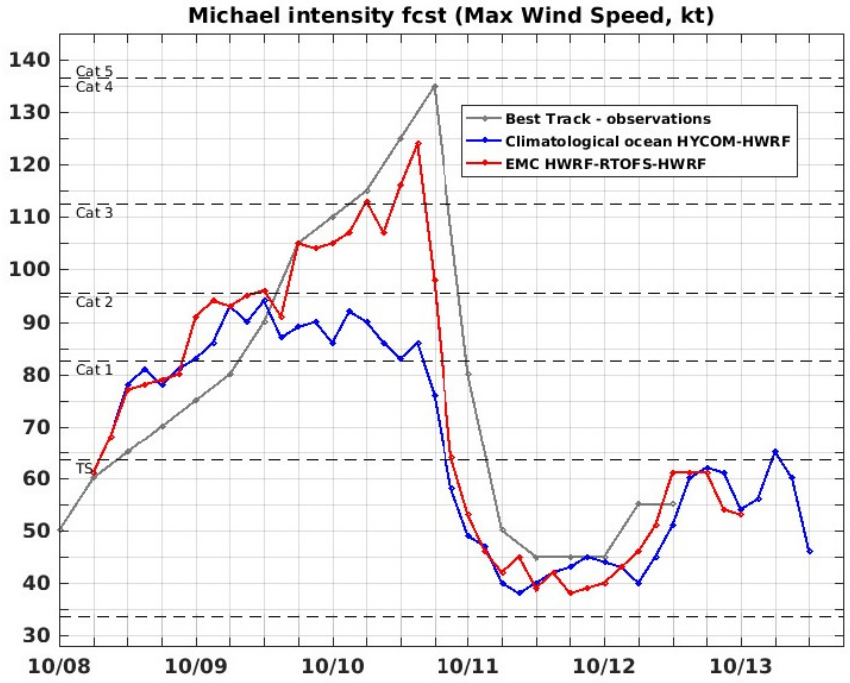
20
10/07
10/08
10/09
10/10
10/11
10/12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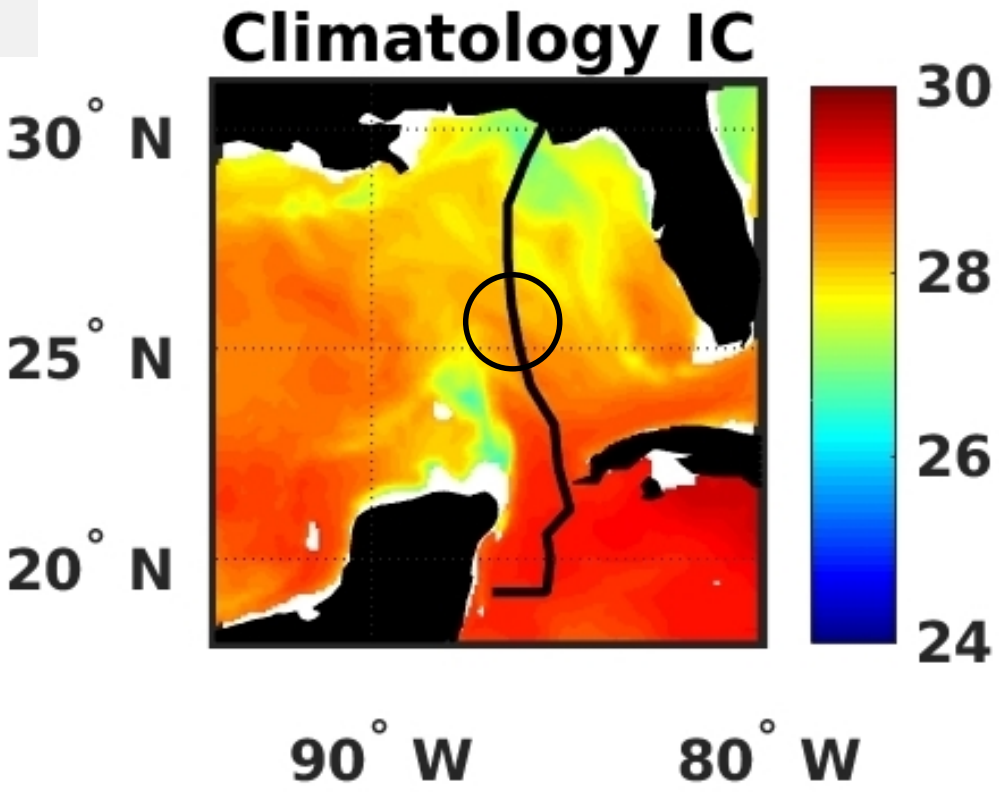
10/10
10/11
10/12
10/13

Ocean Coupling along the Track

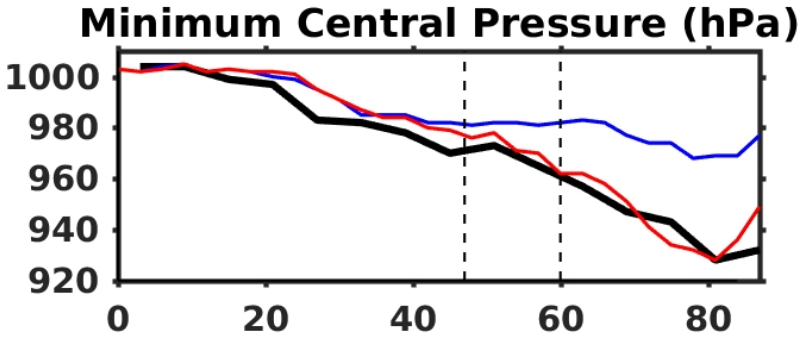
Calculate time series of mean air-sea flux parameters over the inner-core region as the storm moves northward.

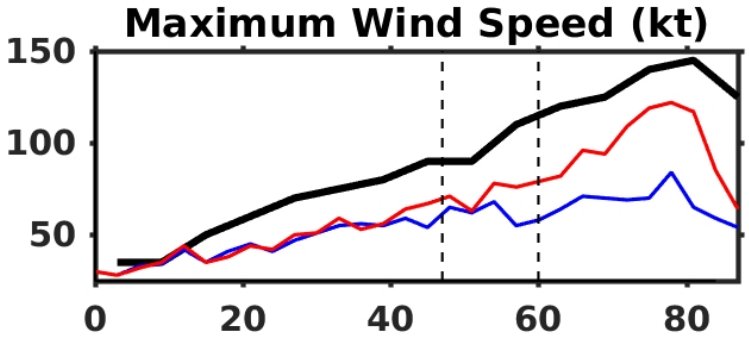
Averaging is performed over a circle with an approximate radius of $2.5R_{MAX}$ (see Figure) that follows the storm.

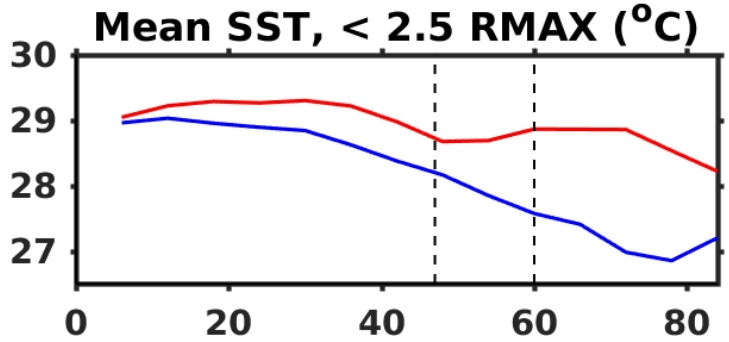


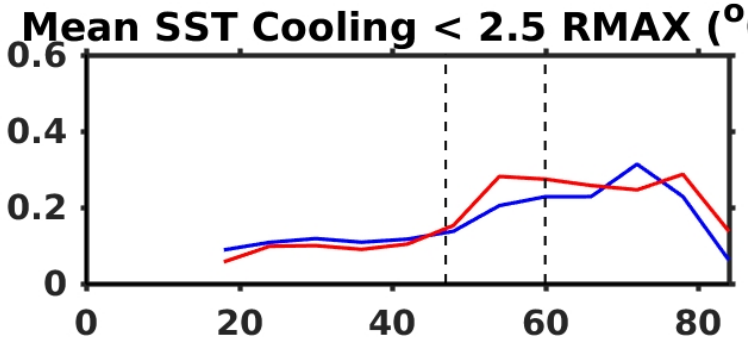
Ocean Coupling time series along the Track

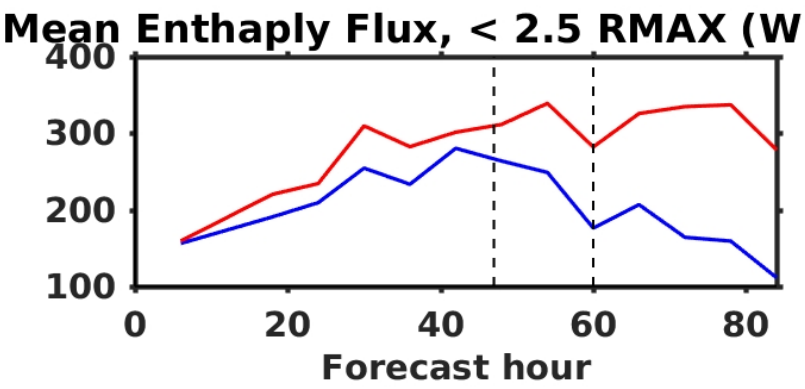
0600 UTC, 7 October 2018 forecast cycle

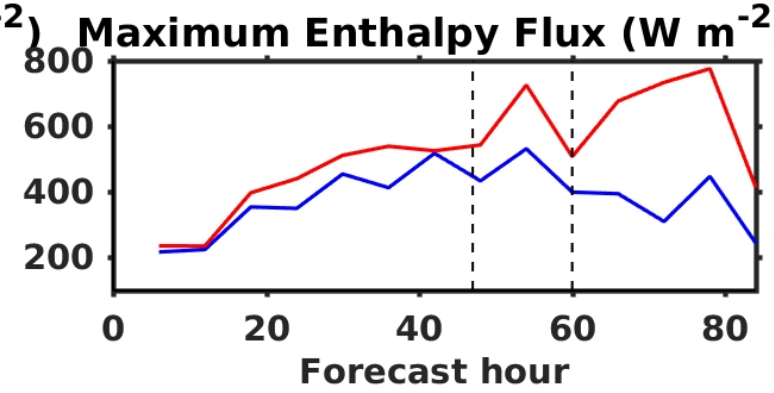




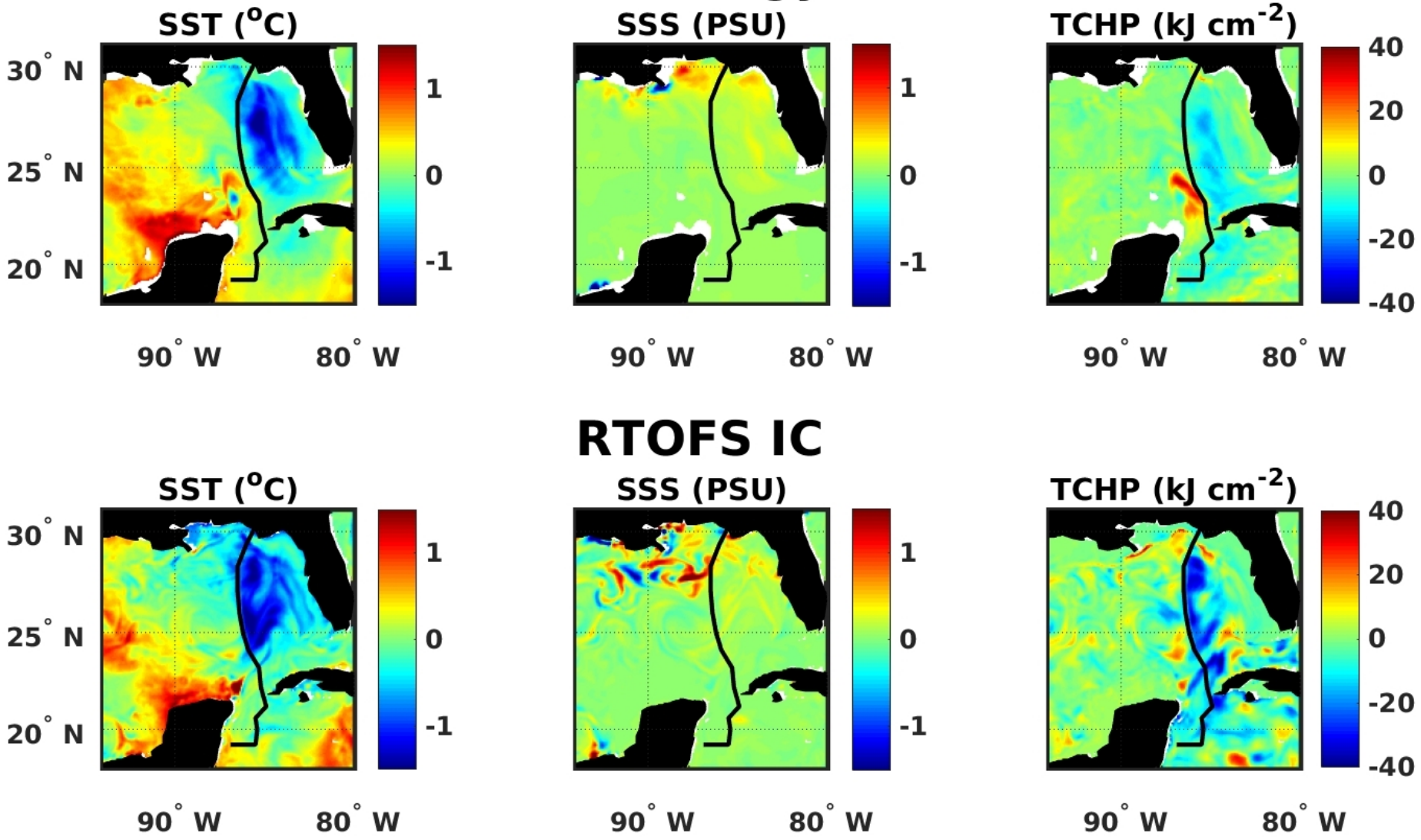








Ocean Fields after Landfall



Summary of Michael Results

- The anomalously warm water encountered by the storm in the northeastern Gulf of Mexico enabled a major hurricane to form prior to landfall.
    - Realistic IC => model storm reaches cat 4
    - Climatological IC => model storm reaches cat 1-2
- SST cooling rate did not differ significantly between the two cases. The differences in pre-storm SST and upper ocean heat content were primarily responsible for the intensity difference
- Additional experiments are planned to quantitatively assess the impact of different ocean observing systems for improving ocean model initial conditions and subsequent intensity forecasts