Sensitivity of West Florida Shelf Simulations to Initial and Boundary Conditions Provided by HYCOM Data-Assimilative Ocean Hindcasts

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Goals

- **Assess impact of GODAE ocean hindcasts on coastal simulations nested within them**
  - **Compare non-assimilative nested simulations of the West Florida Shelf (WFS) against moored ADCP velocity and temperature observations**
  - **Influence of Loop Current and eddies on WFS Circulation**
  - **Impact of nesting boundary location**
- **Demonstrate positive impacts of GODAE products**
- **Demonstrate limitations of GODAE products**
- **Provide feedback for improving GODAE hindcasts**

Approach

- **Nested WFS simulations using HYCOM**
- **Nest in experimental HYCOM outer model products**
  - **Three data-assimilative ocean hindcasts**
    - **ATL-OI: Atlantic optimum interpolation hindcast**
      - **0.08° Atlantic domain**
      - **SSHA OI, Cooper-Haines vertical projection, SST relaxation**
    - **GoM-NCODA: Gulf of Mexico NCODA hindcast**
      - **0.04° GoM domain nested in model-generated Atlantic Ocean climatology**
    - **Global-NCODA: global NCODA hindcast**
      - **0.08°, fully global**
  - **One non-assimilative ocean simulation**
    - **GoM-free: Same domain as GoM-NCODA**

WFS Nested Simulations

- **Major changes from outer models:**
  - **COAMPS (27km) atmospheric forcing**
  - **Different vertical coordinate discretization strategy**
    - **Add layers to increase vertical resolution over the shelf**
    - **Use level (pressure) coordinates over the shelf**
      - **Tests revealed reduced pressure gradient error**
        - » **Classical seamount problem**
        - » **Unforced, initially at-rest WFS simulations**
- **Run for 2004-2005**
- **Evaluation**
  - **Compare simulated velocity to ADCP velocity measurements at USF COMPS moorings**
  - **Compare simulated temperature to measurements at these same moorings.**
  - **These fields sampled during model simulations**

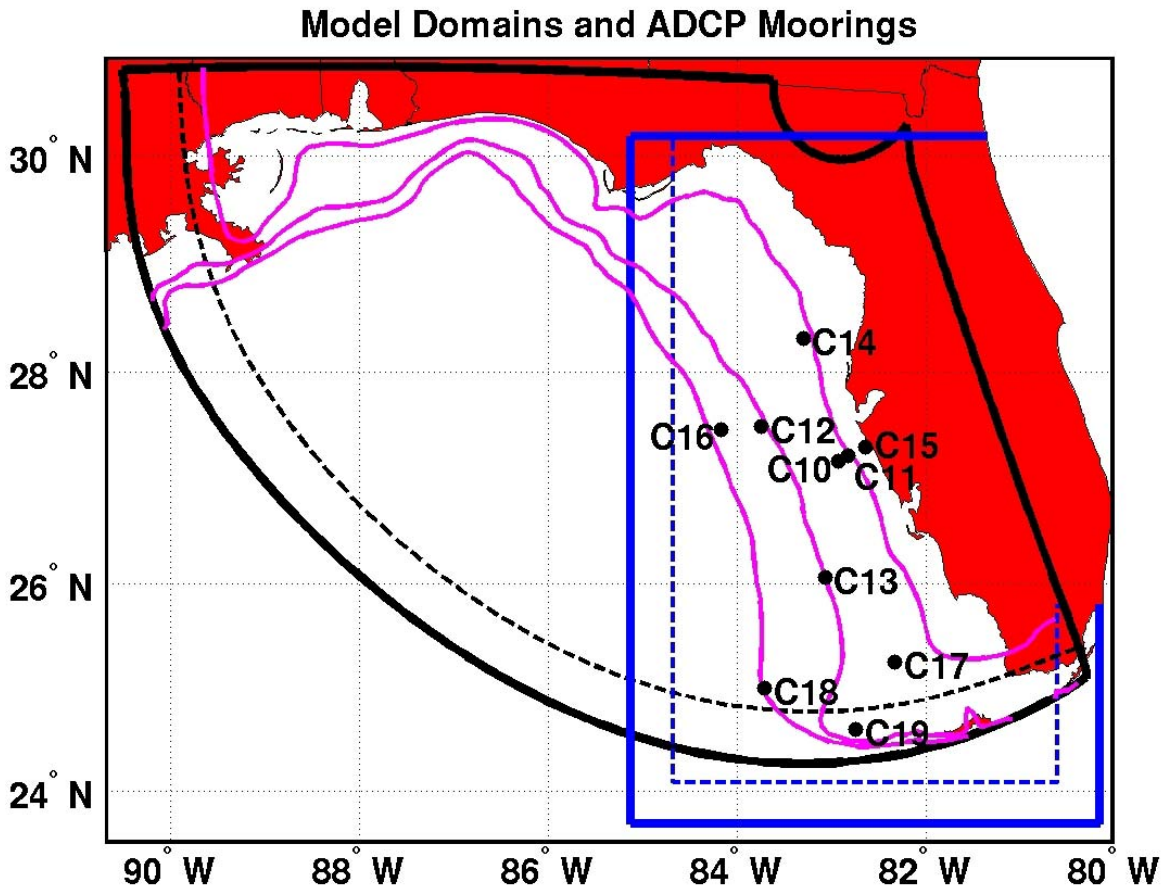
USF Curvilinear Domain (black)

Mercator Domain (blue)

20, 50, 100 m isobaths (magenta)

Nesting boundaries (dashed)

USF ADCP moorings shown



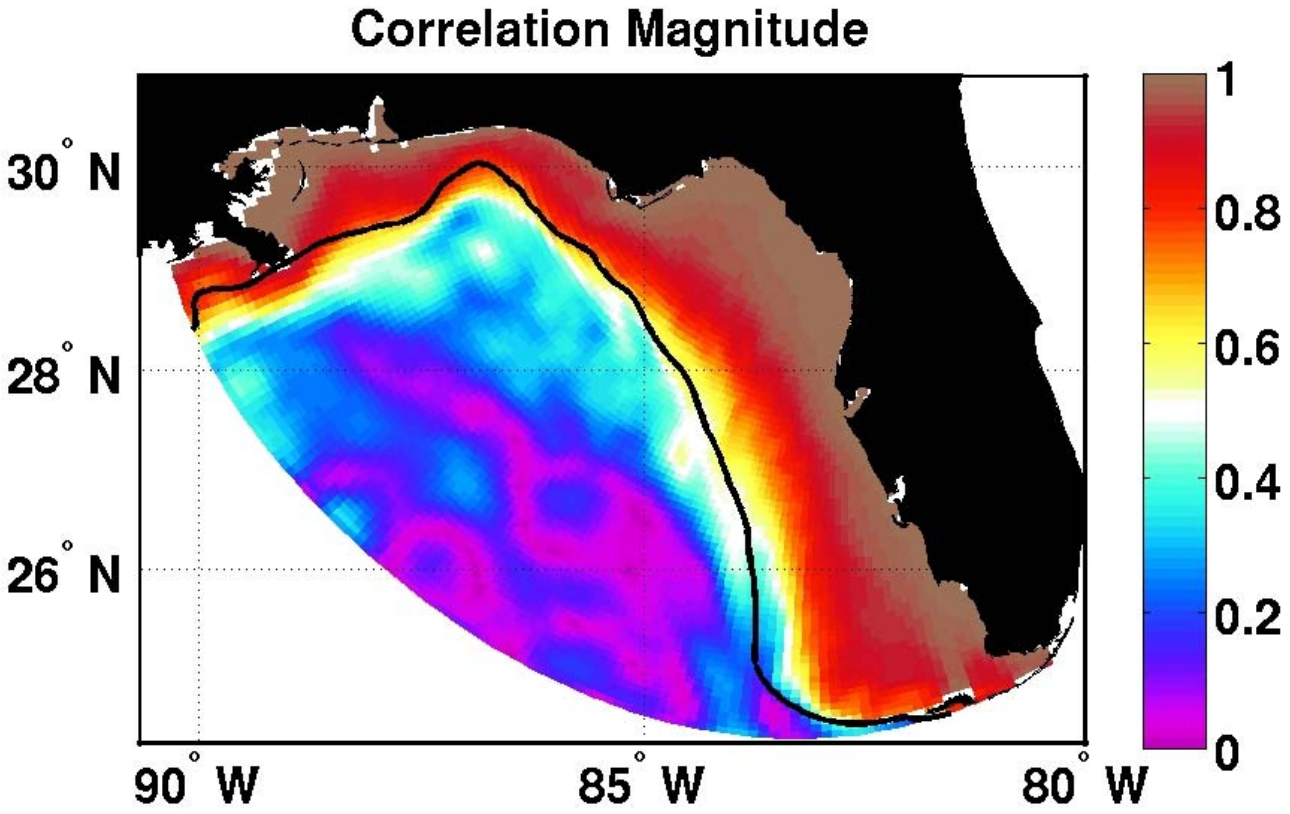
Two model domains illustrate impact of nesting boundary location on nested simulations along central WFS

Inner Shelf: wind-driven (deterministic)

Offshore: eddy and LC variability (stochastic)

Middle/outer shelf: transition region

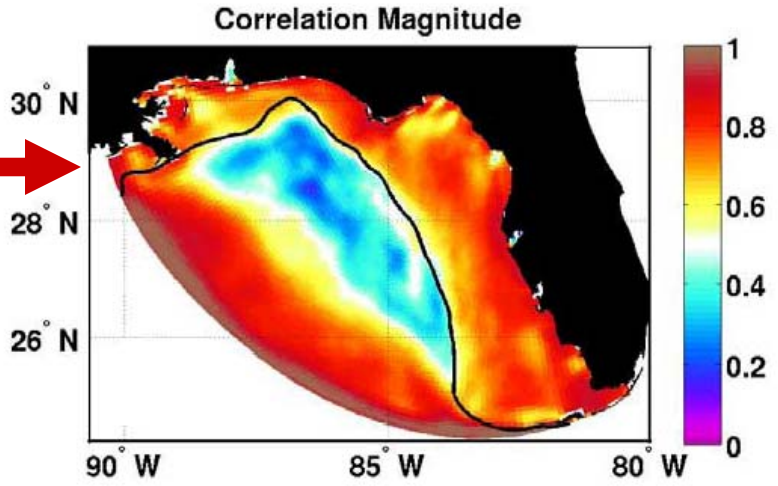
Solutions uncorrelated where stochastic LC and eddy variability dominates



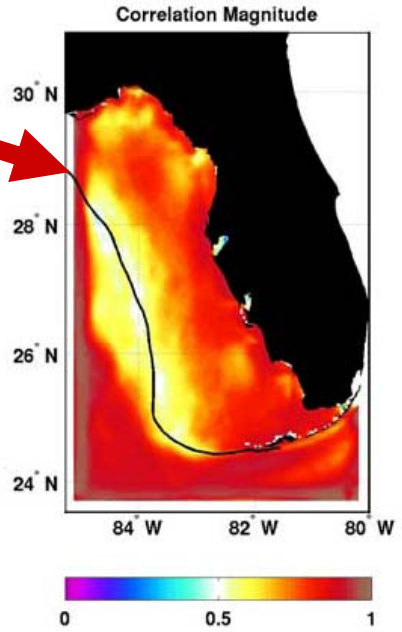
Surface velocity vector correlation magnitude between two nested experiments:

GoM-free (non-assimilative) vs. GoM-NCODA (assimilative)

Boundary conditions do not constrain nested model flow variability over continental slope and near the shelfbreak



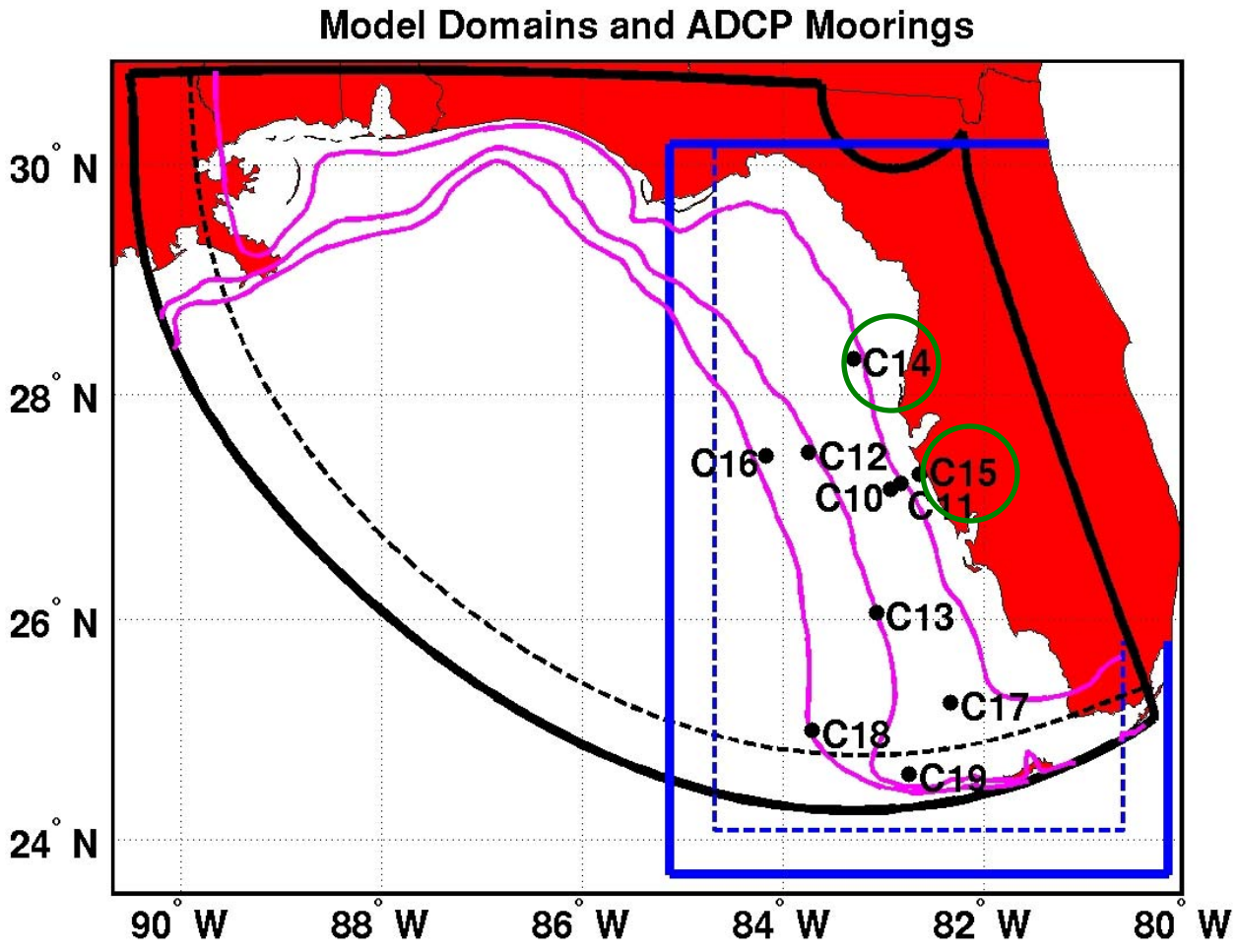
Boundary conditions partly constrain flow variability



Vector correlation magnitude, Surface velocity, 2004-2005
GoM-NCODA
Nested simulation vs. outer model

Analyze sensitivity of the inner shelf to boundary conditions

Problem: vel. and temp. time series have numerous gaps

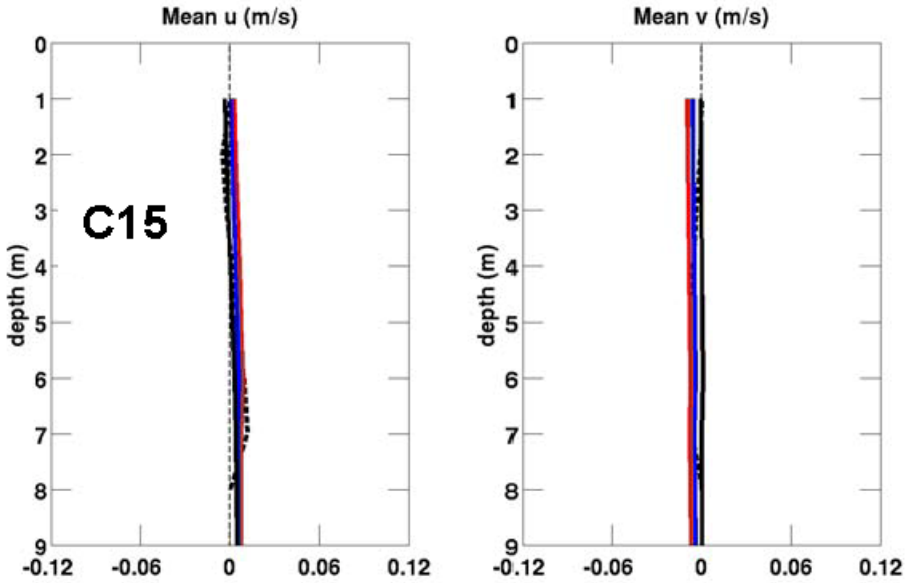


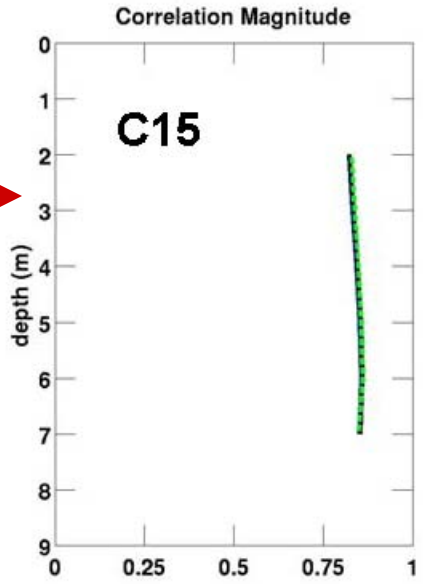
Analyze velocity at C15 (2004-2005) and T at C14 (Dec. 2004 through 2005)

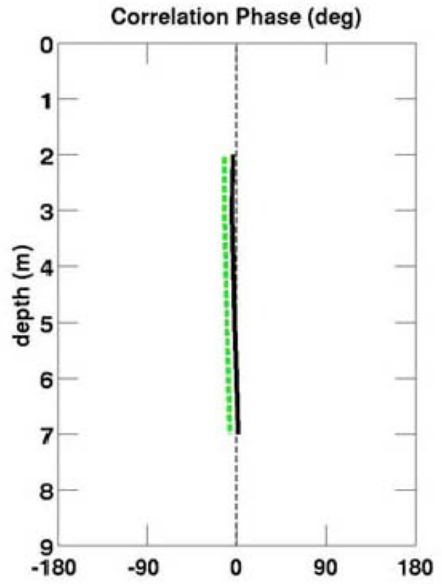
Mean u and v (simulated and observed)

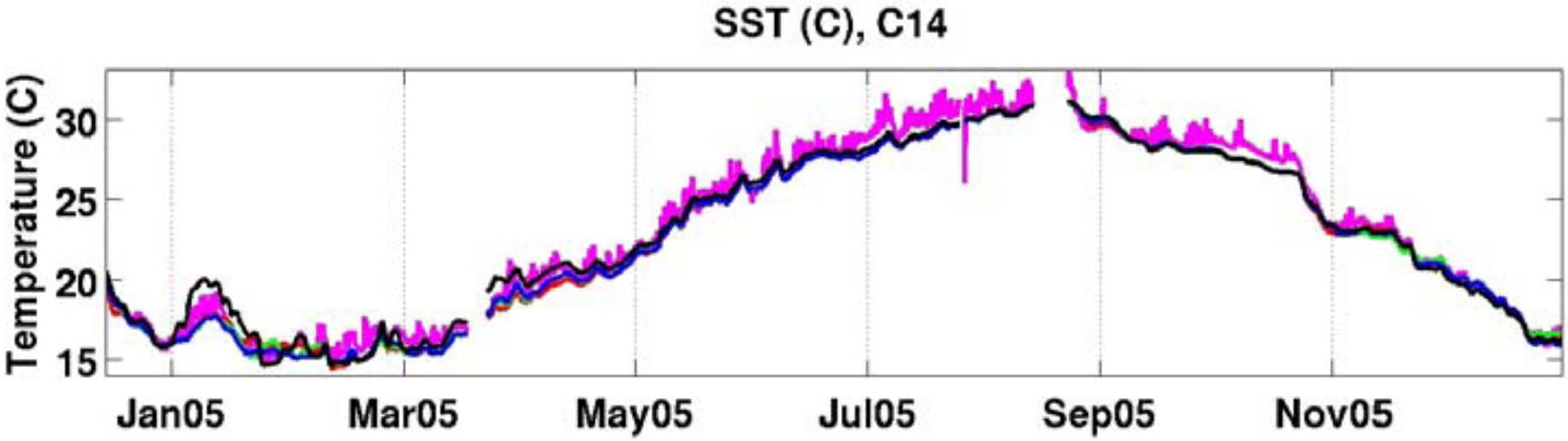
Velocity fluctuations not sensitive to boundary conditions

Velocity vector correlation magnitude and phase (simulated vs. observed)







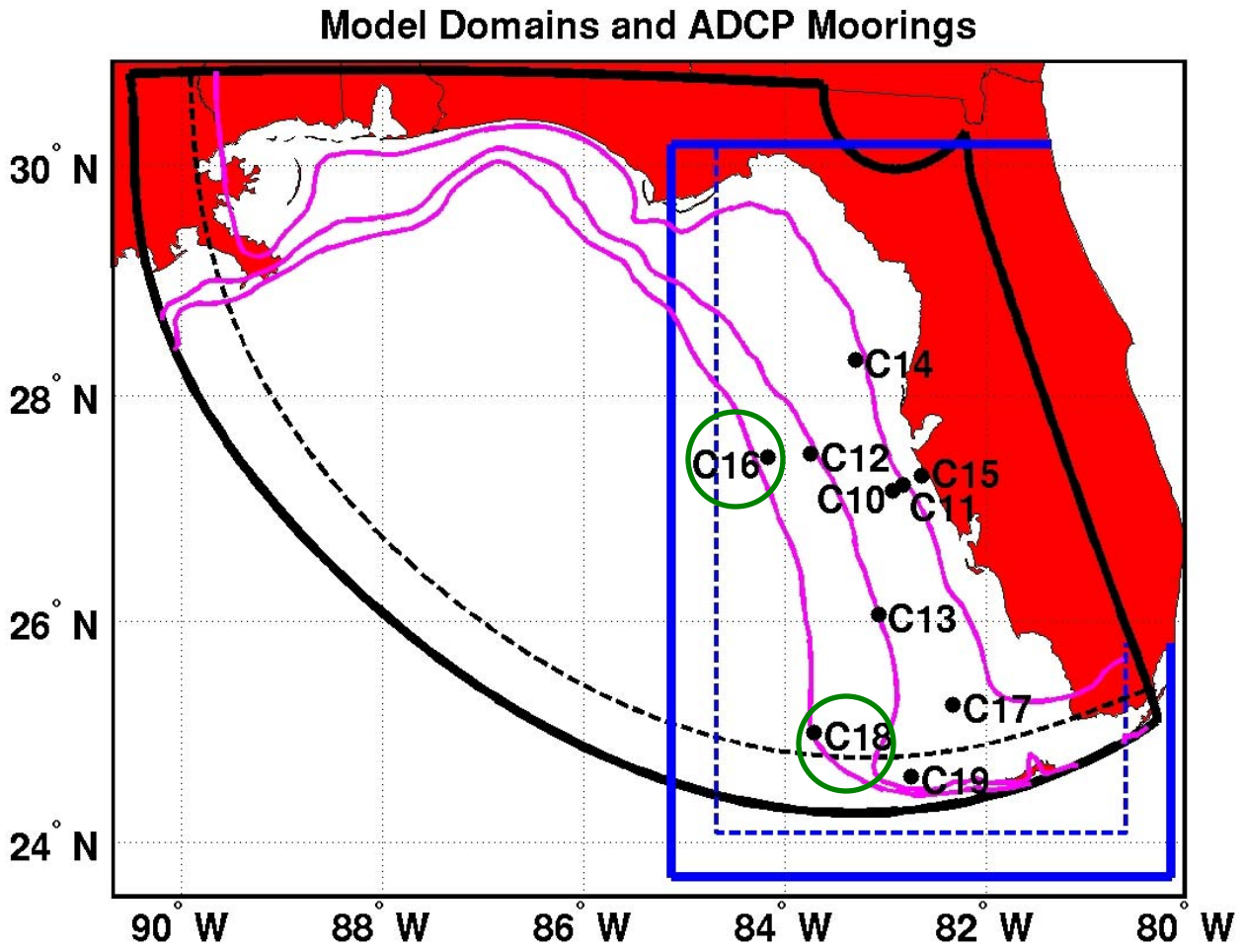


Sea surface temperature fluctuations generally not sensitive to boundary conditions

Exception during January 2005 when simulation nested in GLB-NCODA produces higher temperature

Observations are colored magenta

Analyze sensitivity of the outer shelf to boundary conditions

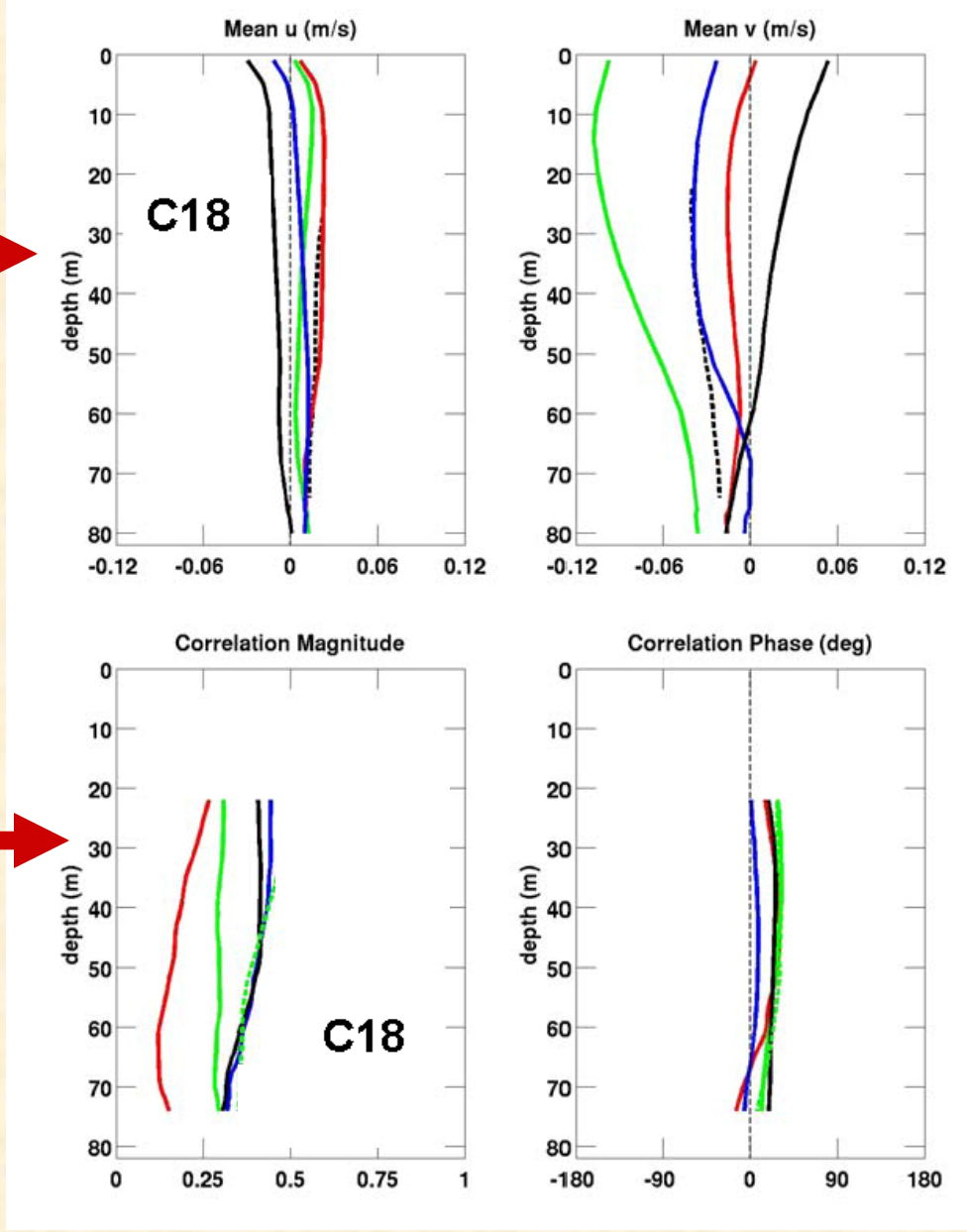


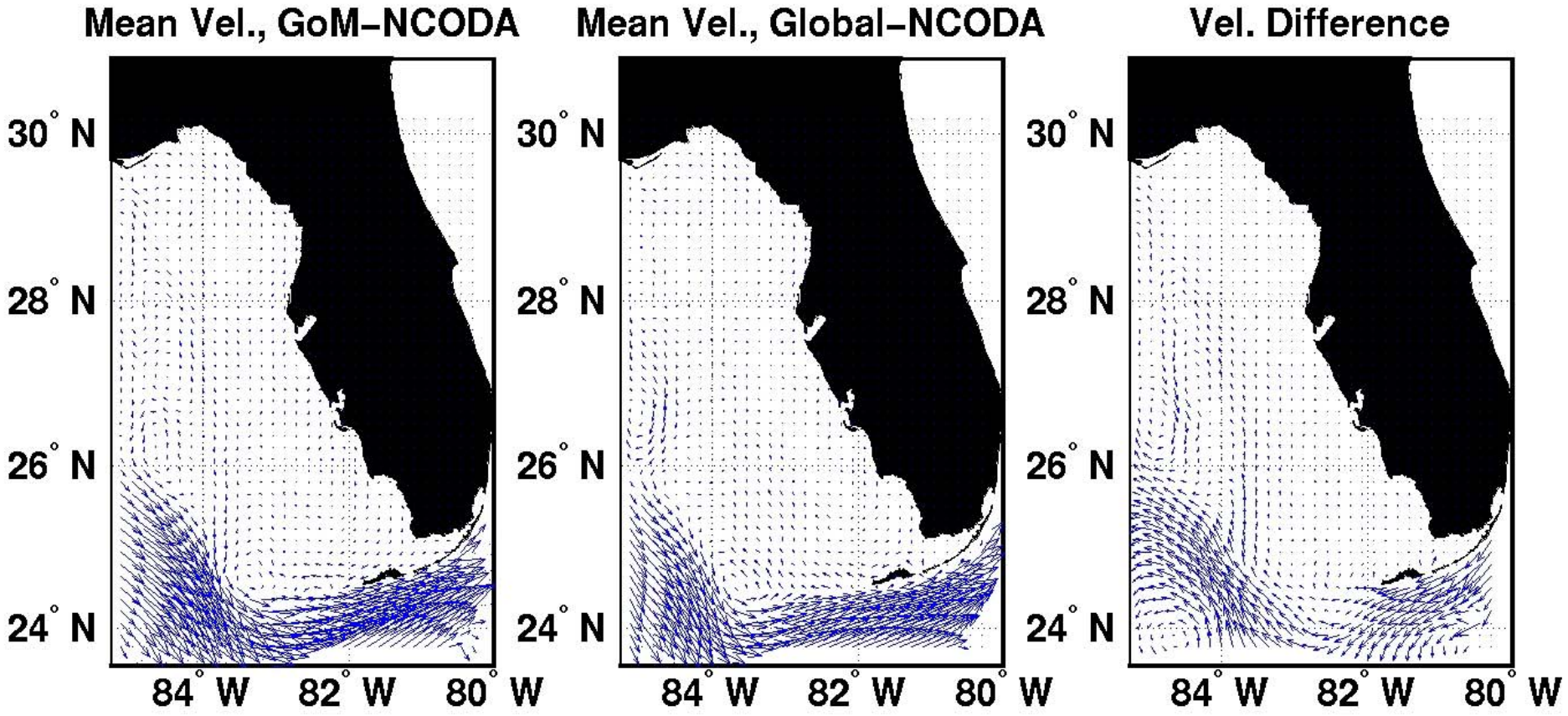
Analyze velocity at:
C16 (Dec. 2004-Dec. 2005)
C18 (Dec. 2004-June 2005)

Mean u and v (simulated and observed)

GoM-free
GoM-NCODA
ATL-OI
GLB-NCODA
Observed (black dashed)

Velocity vector correlation magnitude and phase (simulated vs. observed)

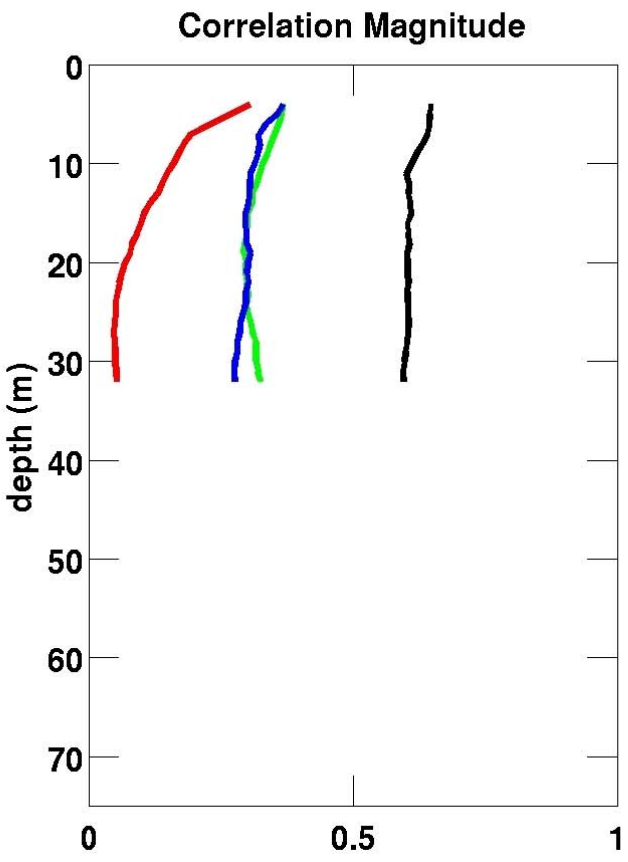




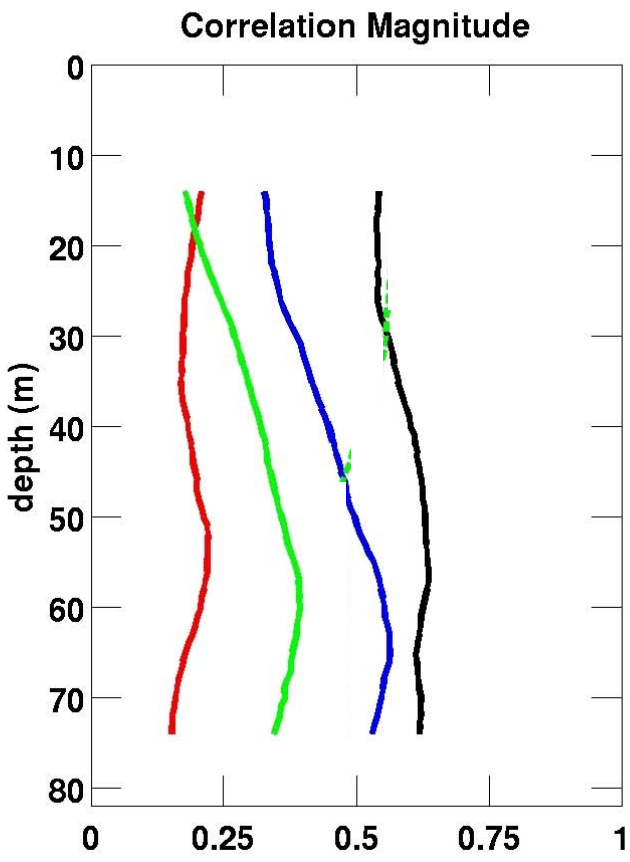
Mean surface velocity, Dec. 2004 through 2005

Difference in LC transport responsible for inducing the difference in mean flow along the outer shelf

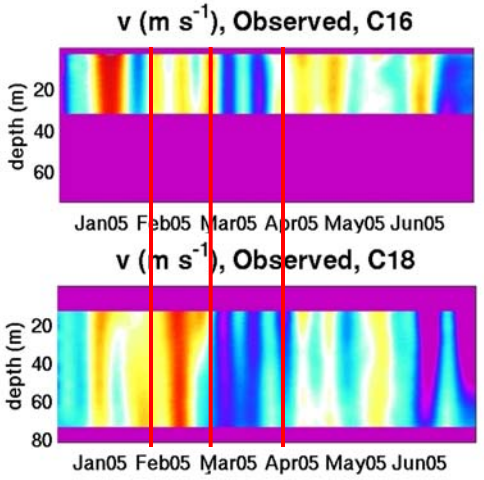
C16



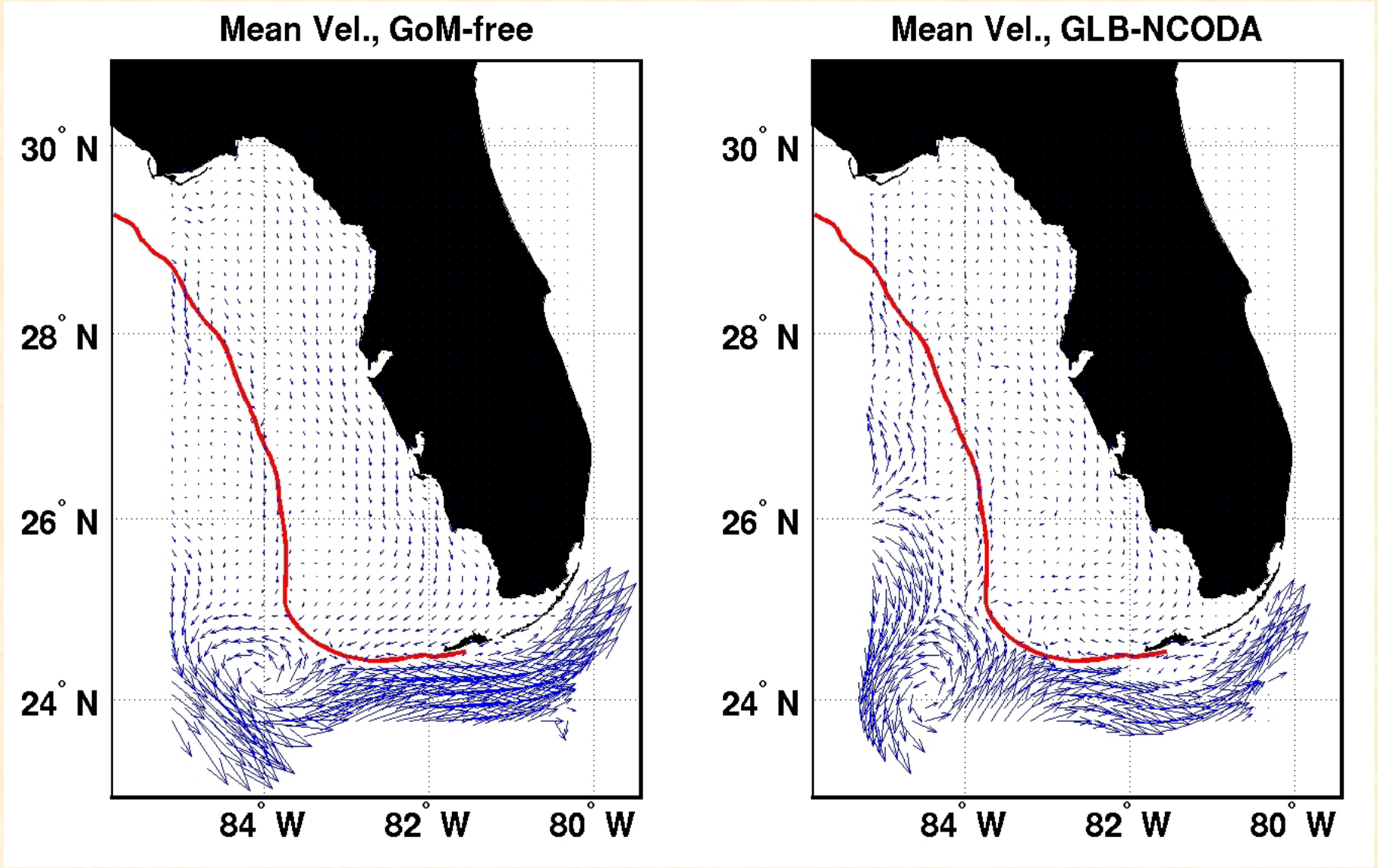
C18

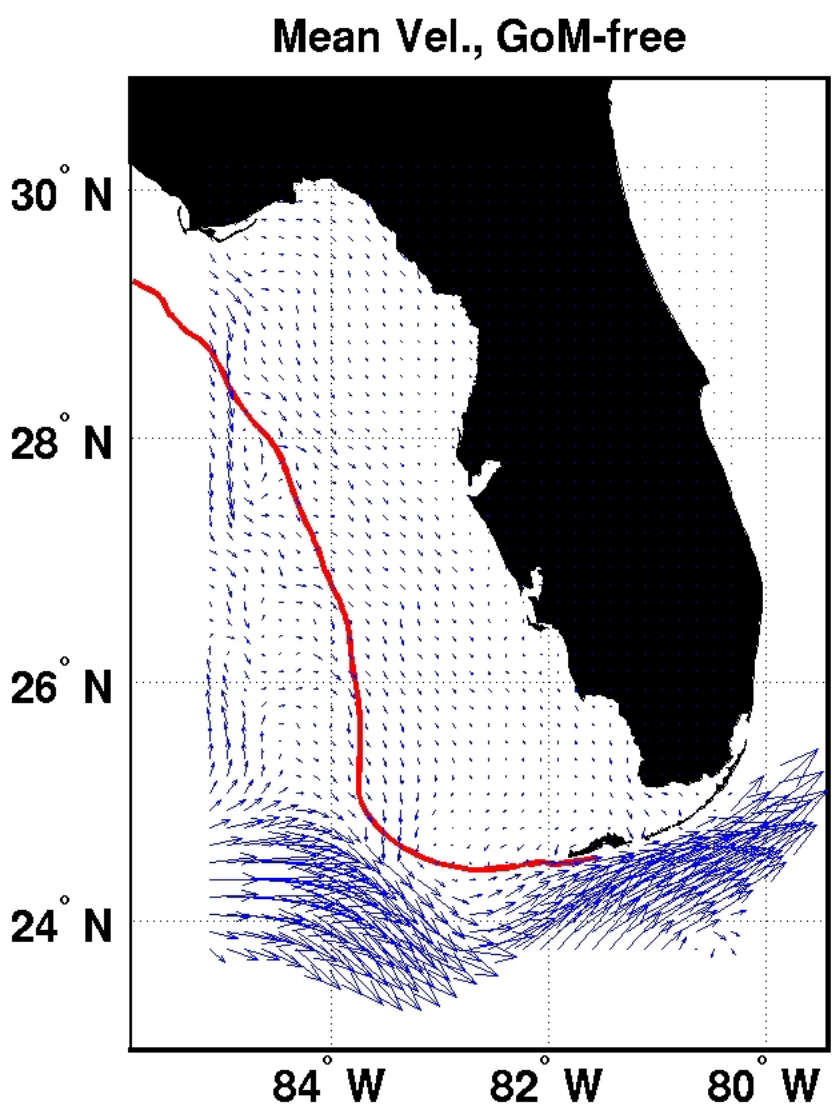


GoM-free
GoM-NCODA
ATL-OI
GLB-NCODA



Vector correlation magnitude, Dec. 2004 through June 2005, simulated vs. obs.


Mean Vel., GoM-free
Mean Vel., GLB-NCODA
30° N
28° N
26° N
24° N
84° W
82° W
80° W


Mean Vel., GoM-free
30° N
28° N
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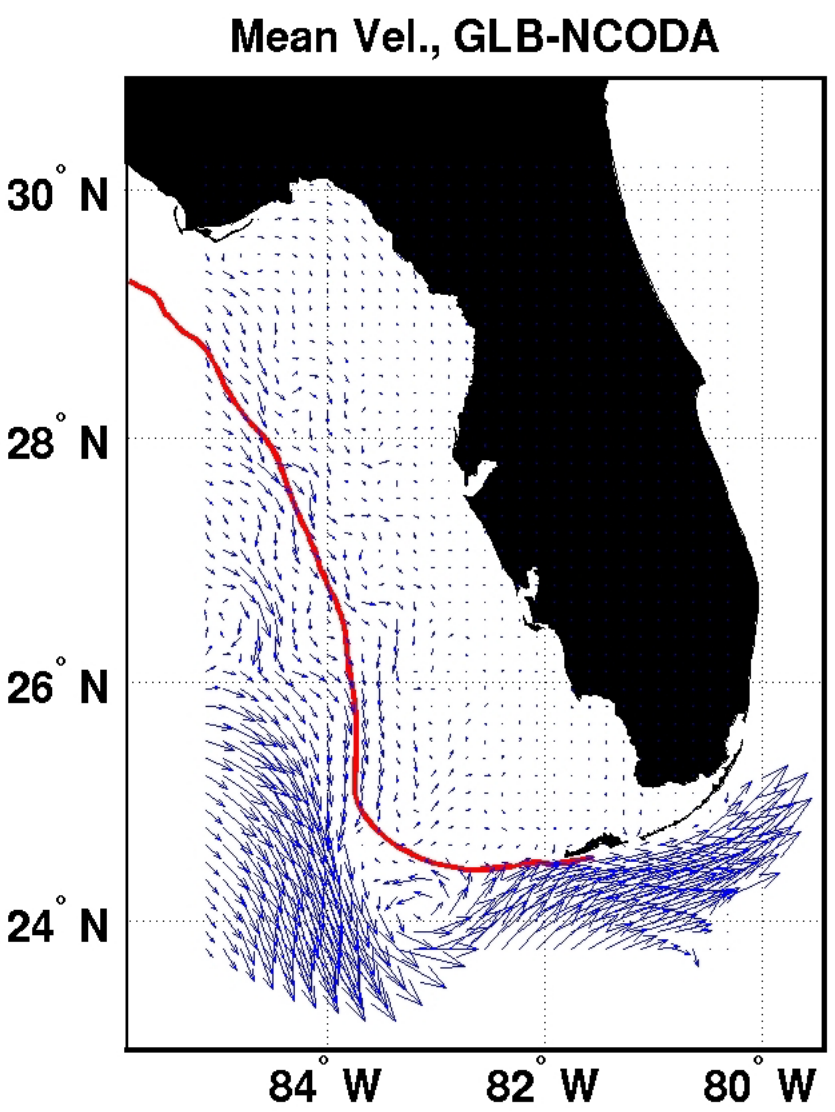
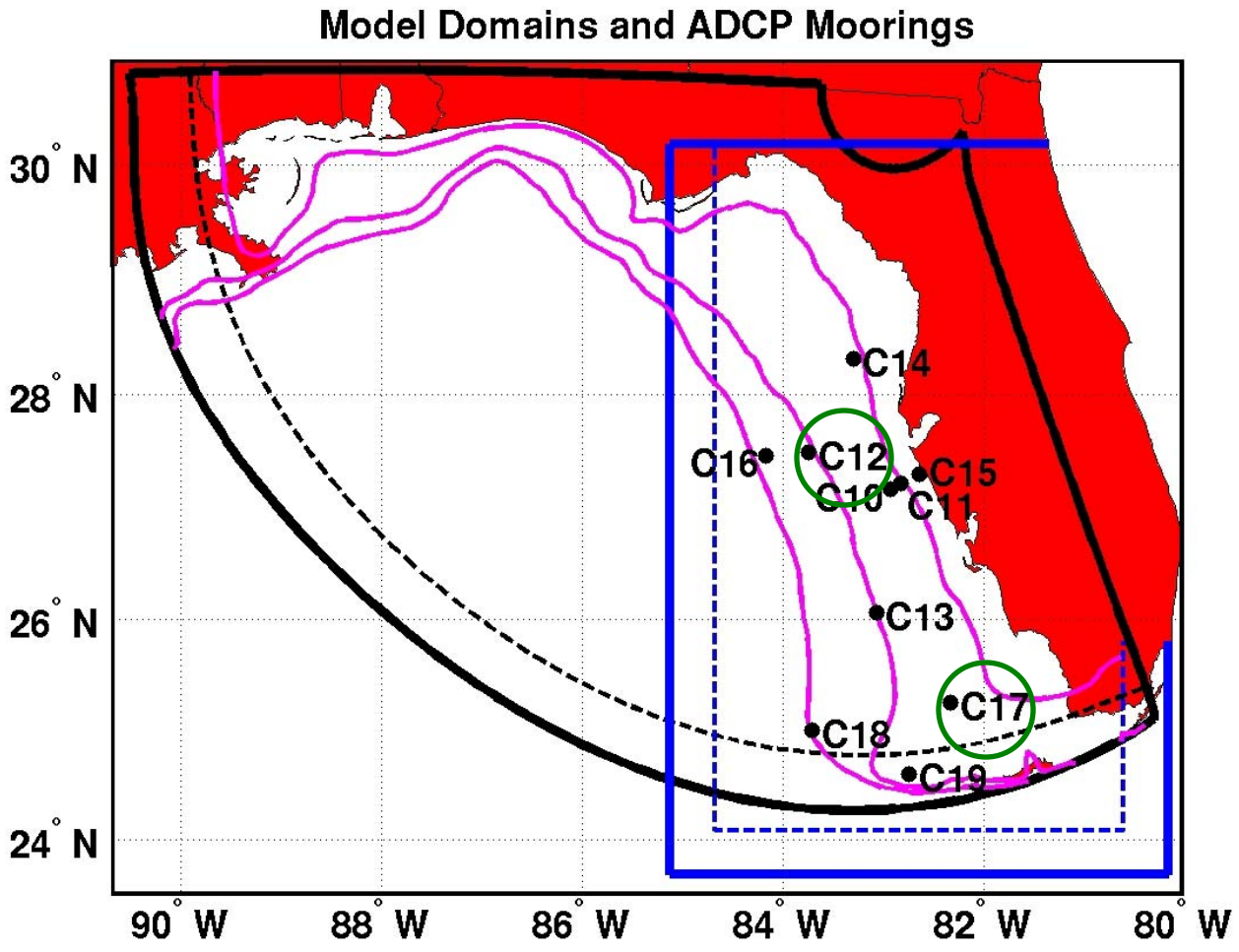
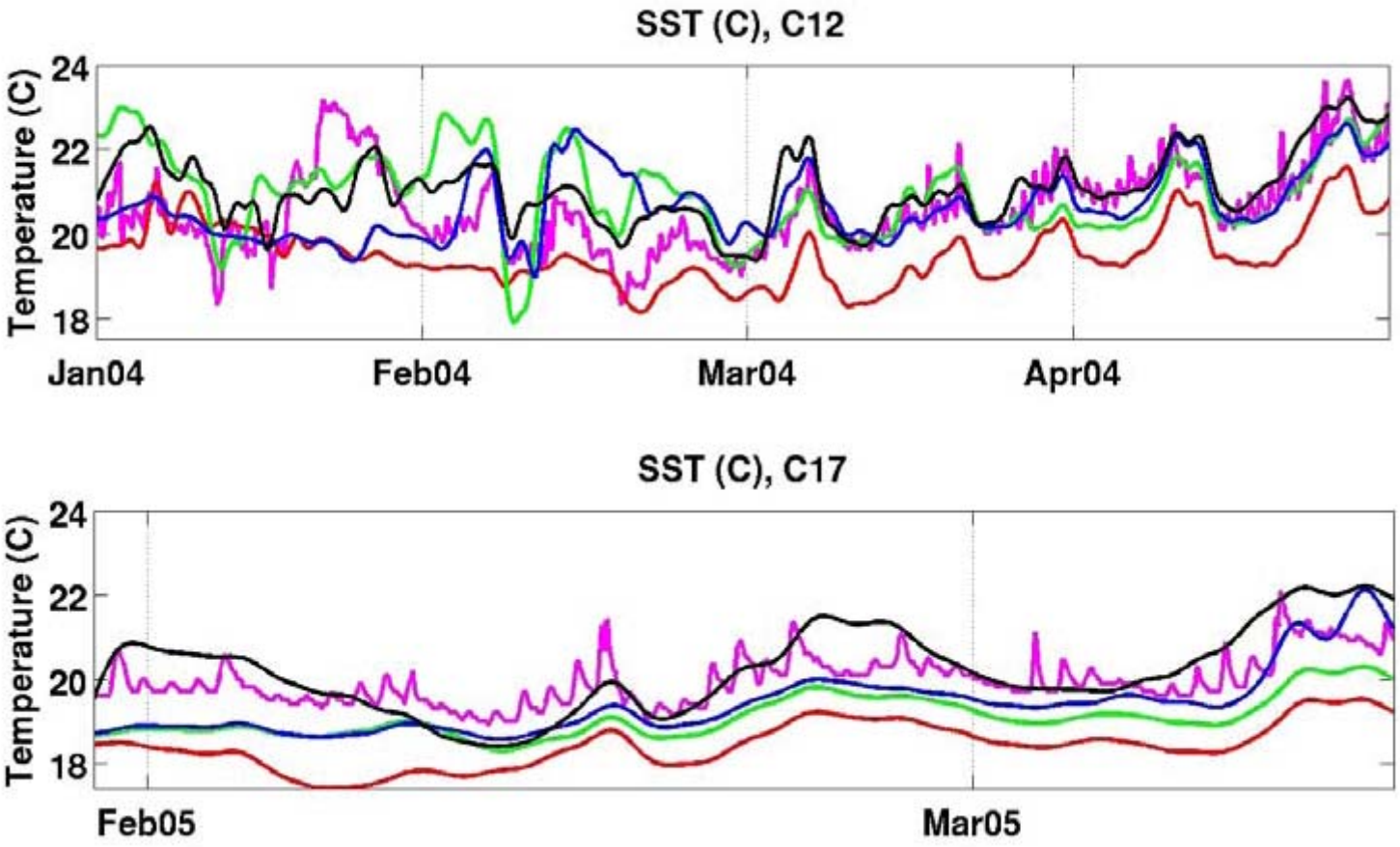

Mean Vel., GLB-NCODA
30° N
28° N
26° N
24° N
84° W
82° W
80° W

Analyze sensitivity of temperature to boundary conditions



Analyze T sensitivity at C12 and C17



GoM-free
GoM-NCODA
ATL-OI
GLB-NCODA
Observations

Cold bias in GoM-free

Results

- **Assess impact of GODAE ocean hindcasts on coastal simulations nested within them**
  - **Influence increases with distance from coast as importance of stochastic eddy variability increases**
- **Demonstrate positive impacts of GODAE products**
  - **LC interaction with shelf at SW end of WFS**
  - **Reduced temperature bias in nested models**
- **Demonstrate limitations of GODAE products**
  - **LC transport difference between GoM-NCODA and GLB-NCODA although both produced the same path**
- **Provide feedback for improving GODAE hindcasts**
  - **Feature location generally good**
  - **Improvements needed in boundary current transport, vertical T-S structure of the upper ocean (improved observational coverage should help)**