The Response of the Northwest Atlantic Ocean to Climate Change

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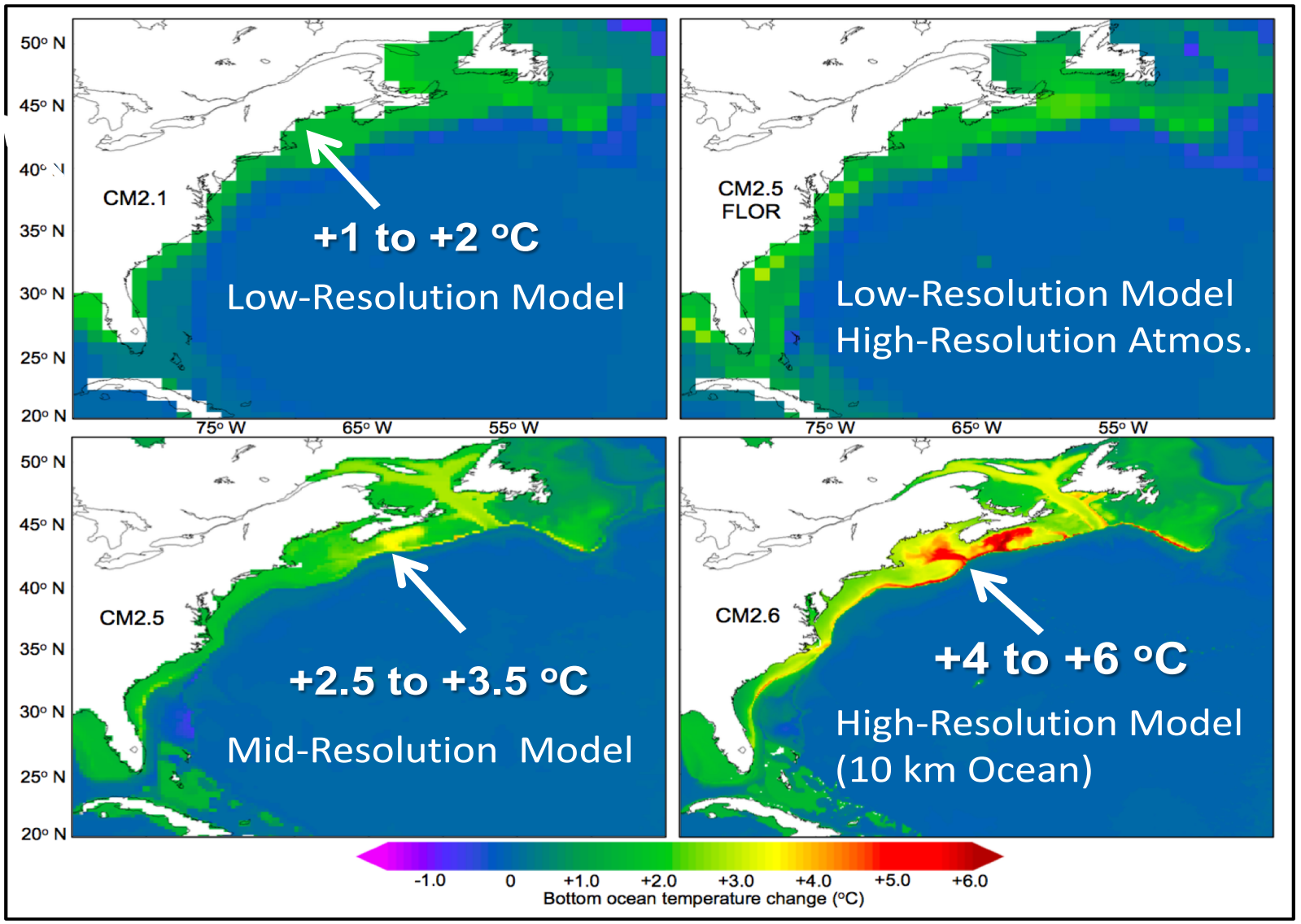
Projected Bottom Temperature Warming

Projections with Different Resolution GFDL GCMs

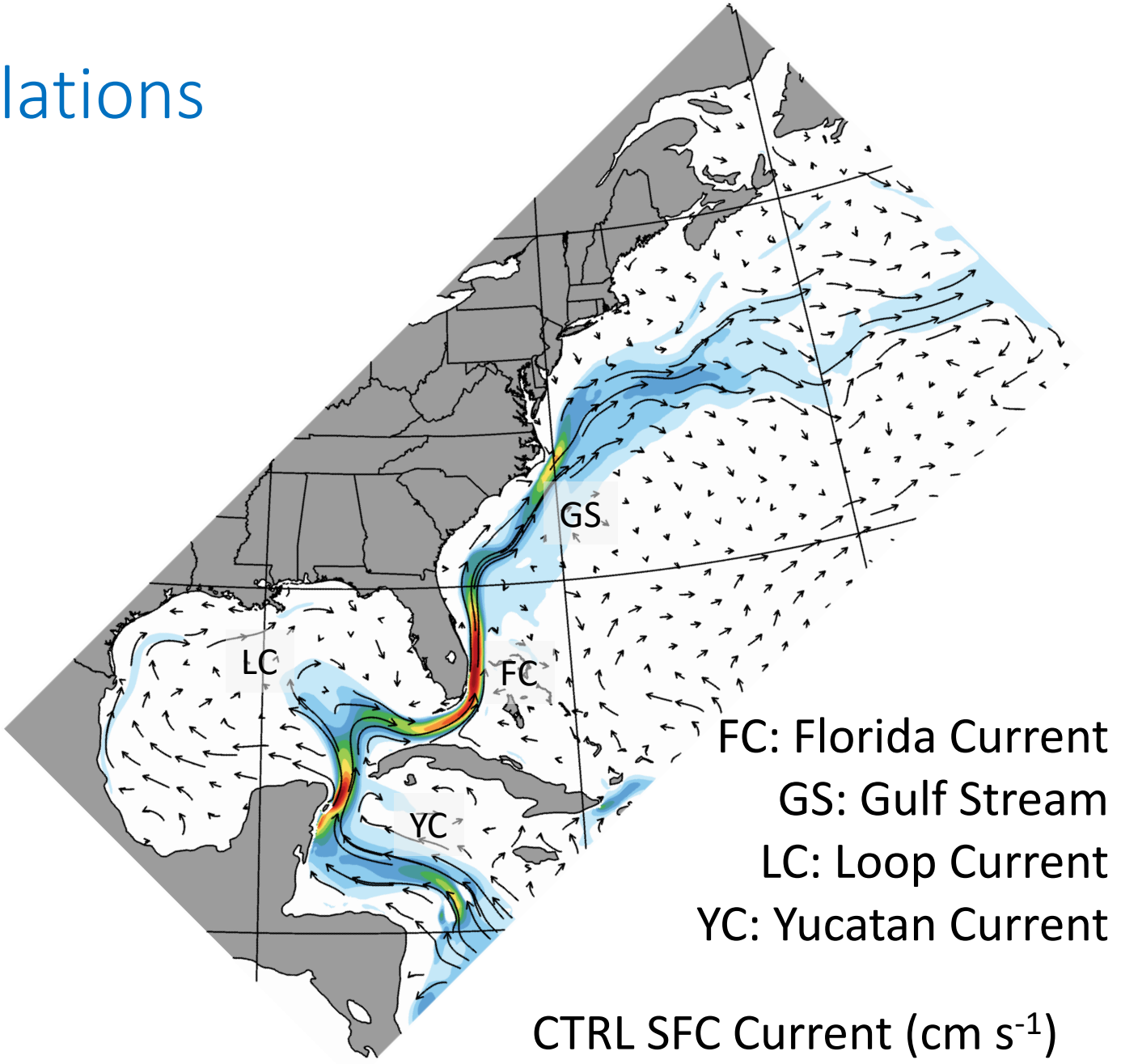
Extreme warming in the Gulf of Maine attributed to a northward shift of the Gulf Stream



Saba et al. 2016 JGR Oceans

Regional Climate Simulations

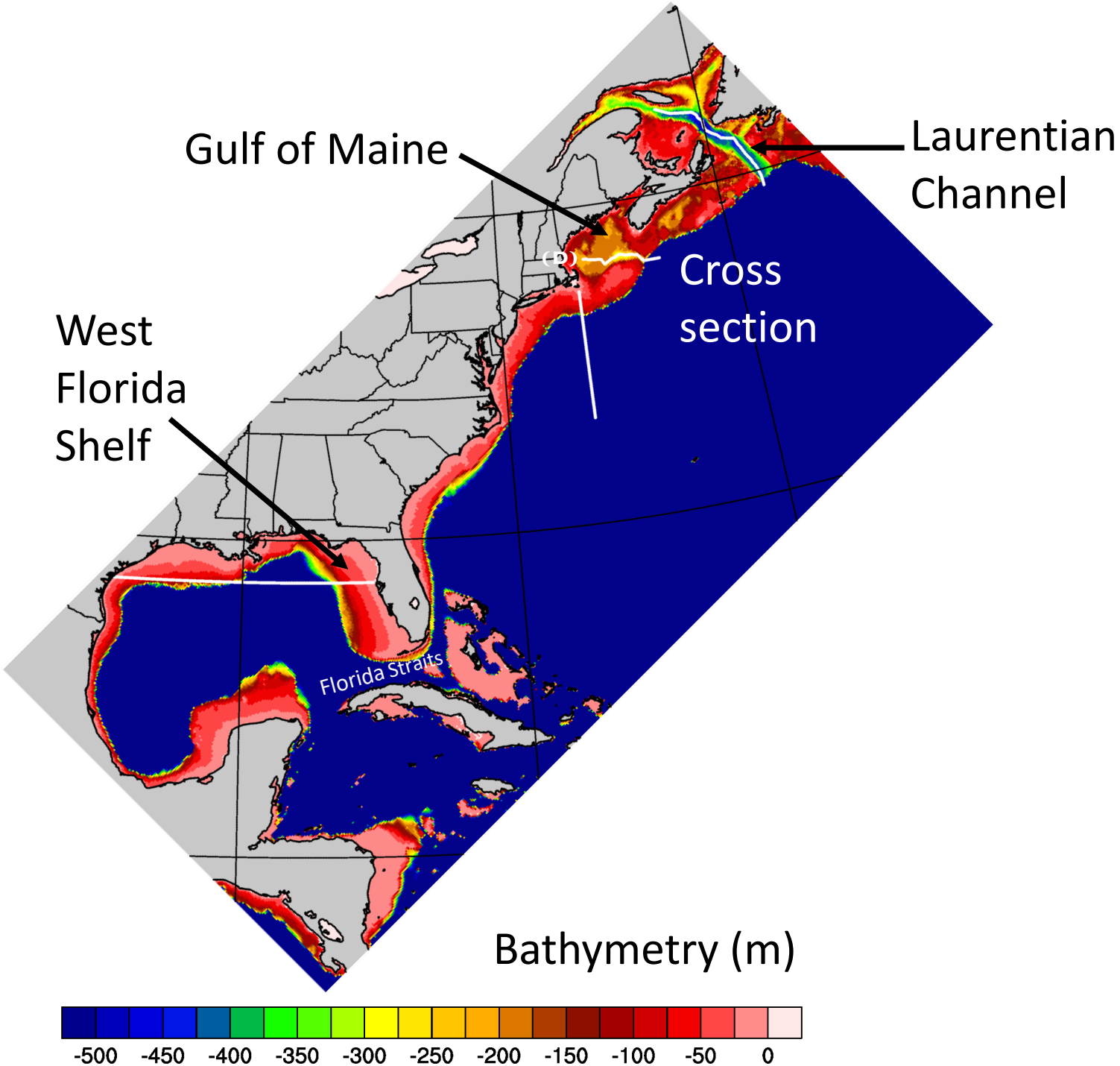
- ROMS: 7 KM NW Atlantic
- First Conduct Control hindcast simulation
  - Forced with observed boundary conditions
    - side (SODA) and
    - surface (CORE)
    - river runoff
  - 15-year spin-up
  - 30-year simulation
    1976-2005
- Currents well simulated



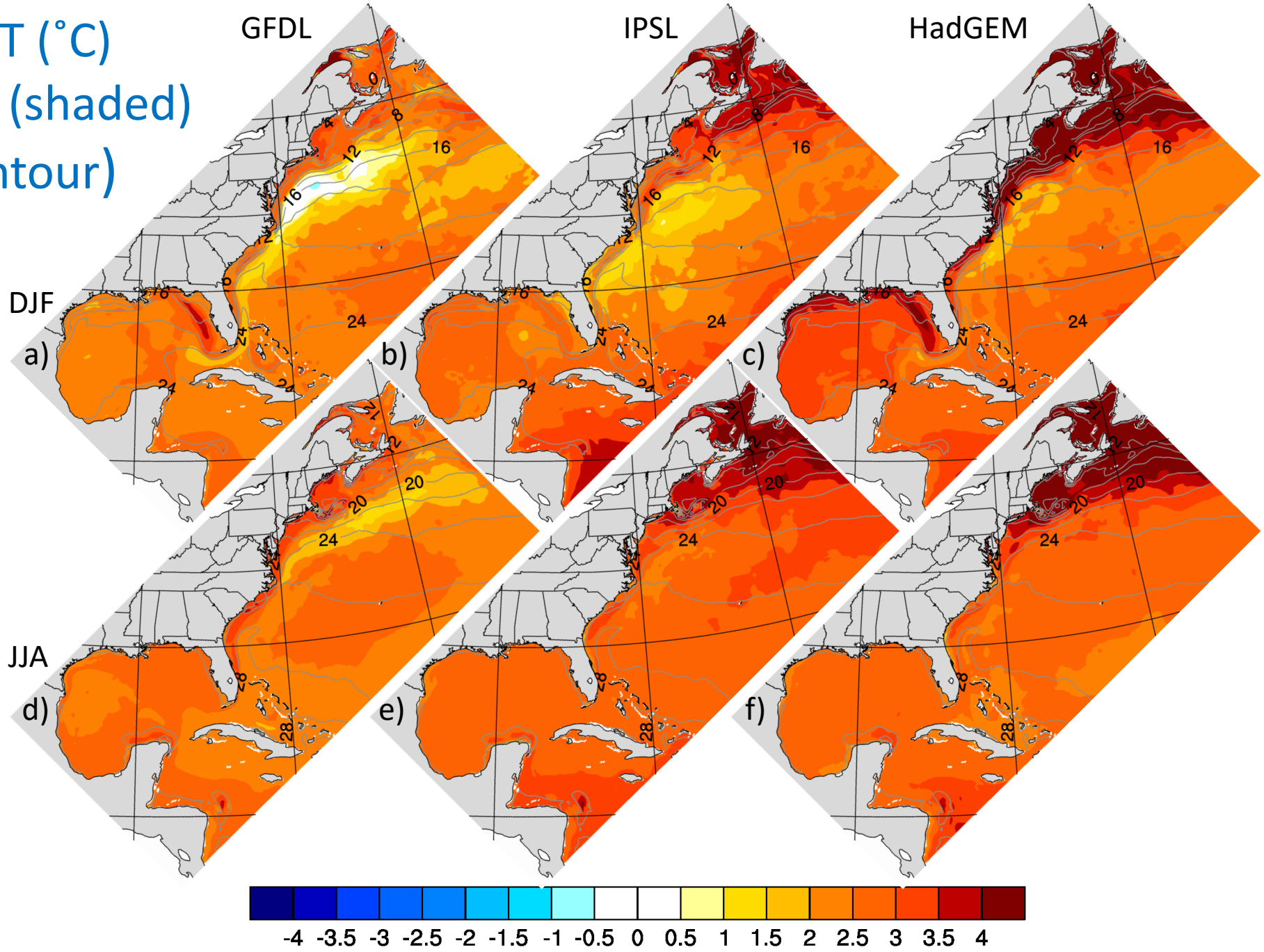
Regional Climate Change Experiments

- Driven by 3 CMIP5 GCMS:
  - GFDL, IPSL, HadGEM
  - With RCP8.5 forcing
- "Delta Method" Forcing:

  2070-2099 – 1976-2005
- Added to a Control Run
- Climate Change Responses
  - Difference between 3 RCP8.5 forced runs and the Control



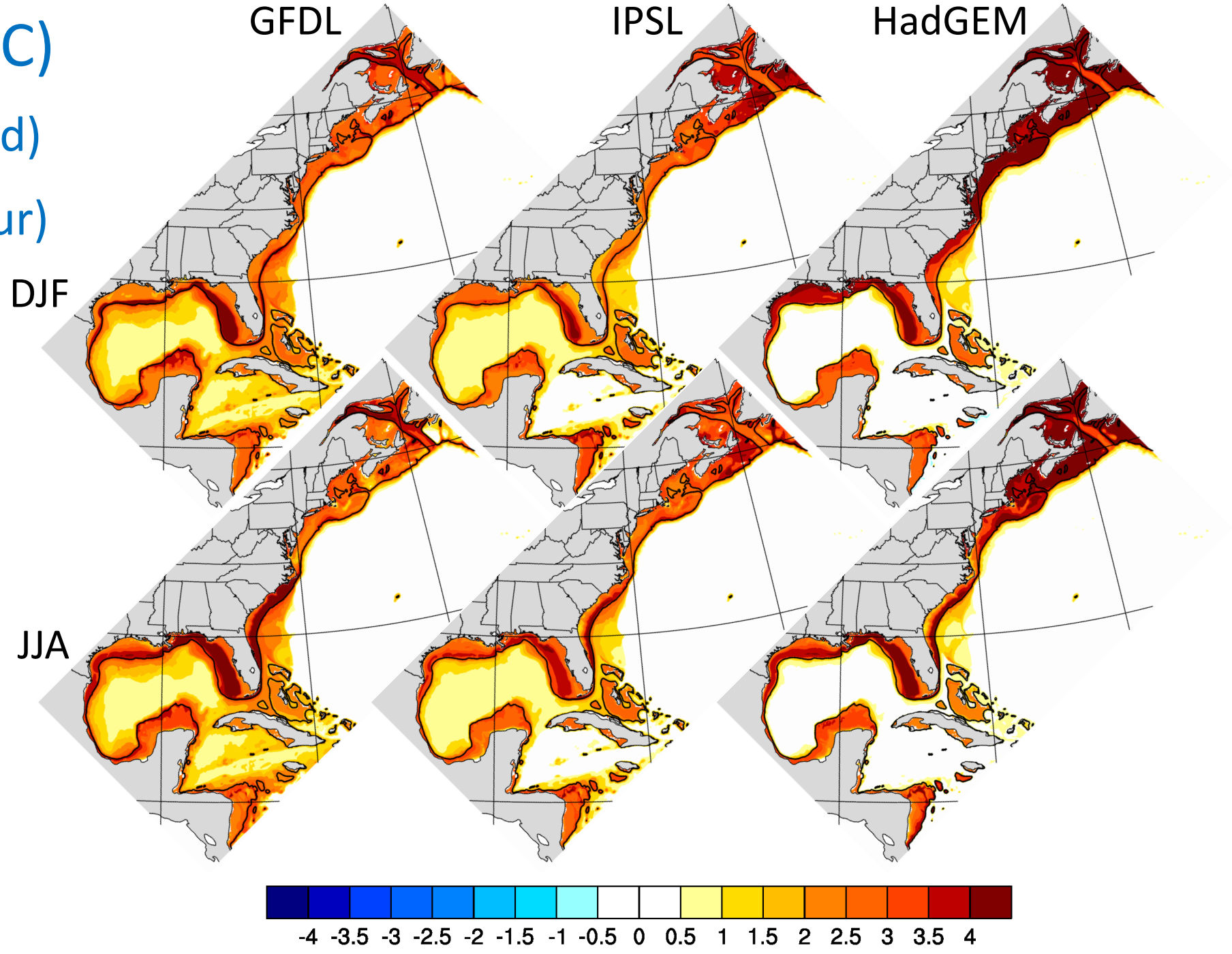
ROMS SST (°C)
RCP8.5-CTRL (shaded)
CTRL (contour)



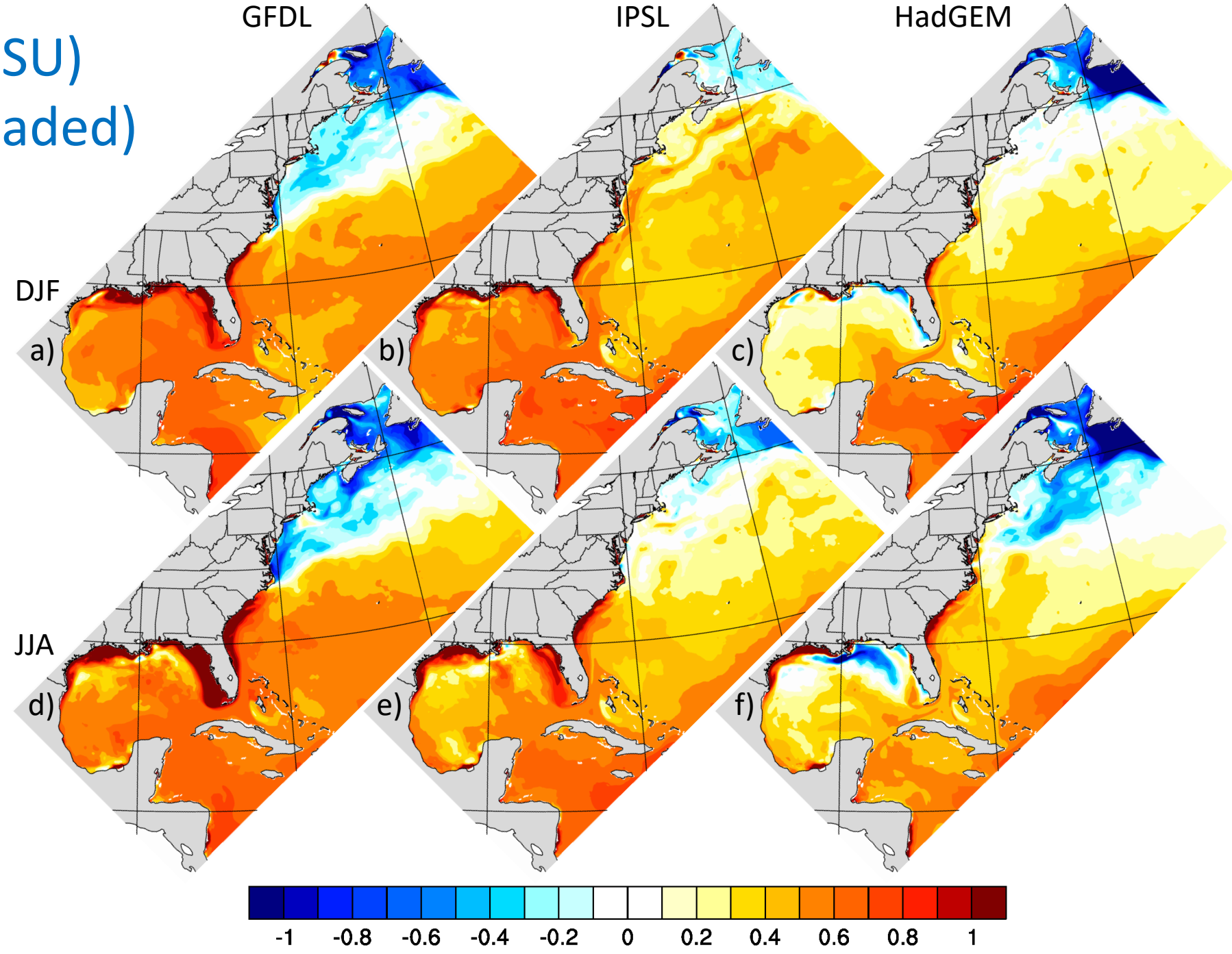
Bottom Temp (˚C)

RCP8.5-CTRL (shaded)

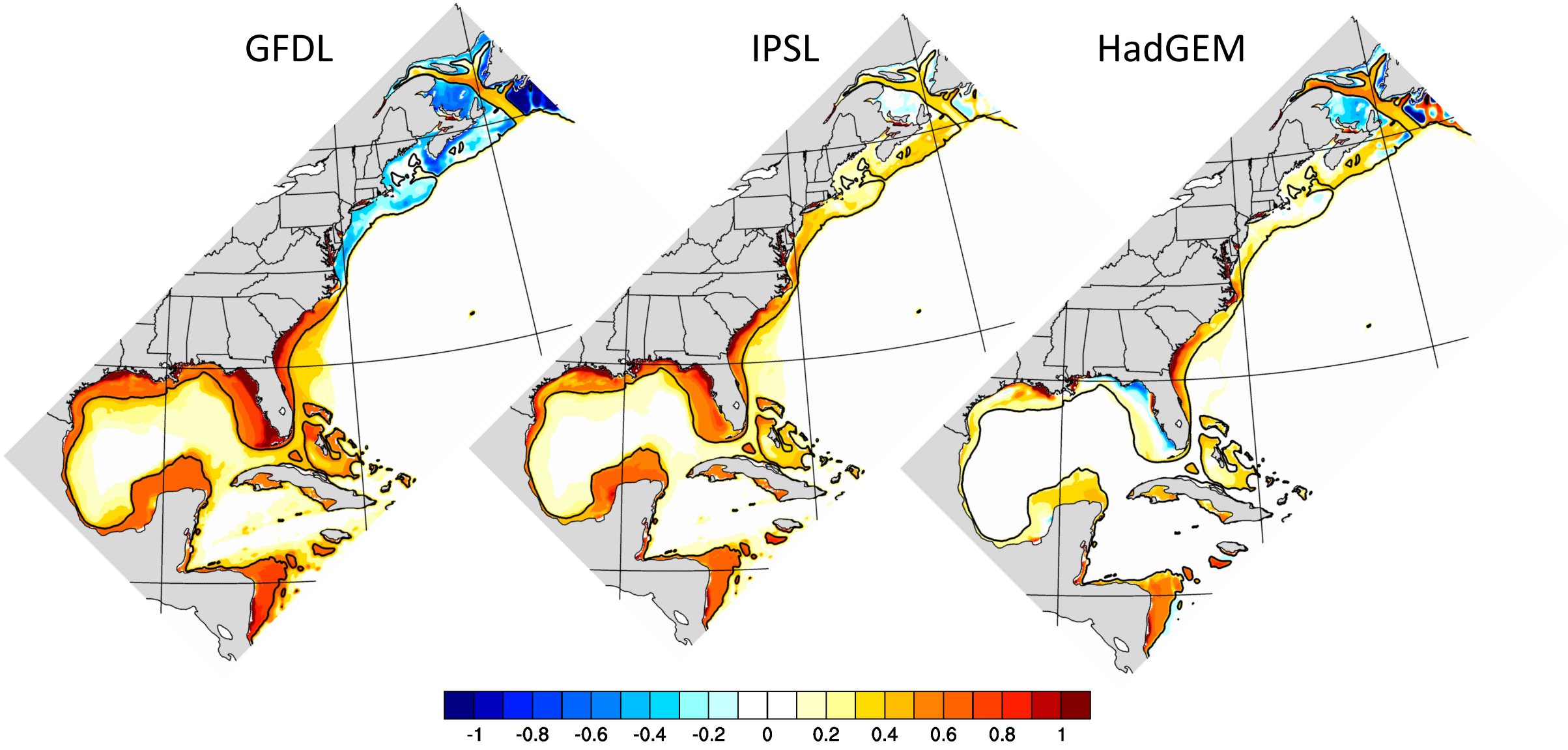
200m depth (contour)



SFC Salinity (PSU)
RCP8.5-CTRL (shaded)

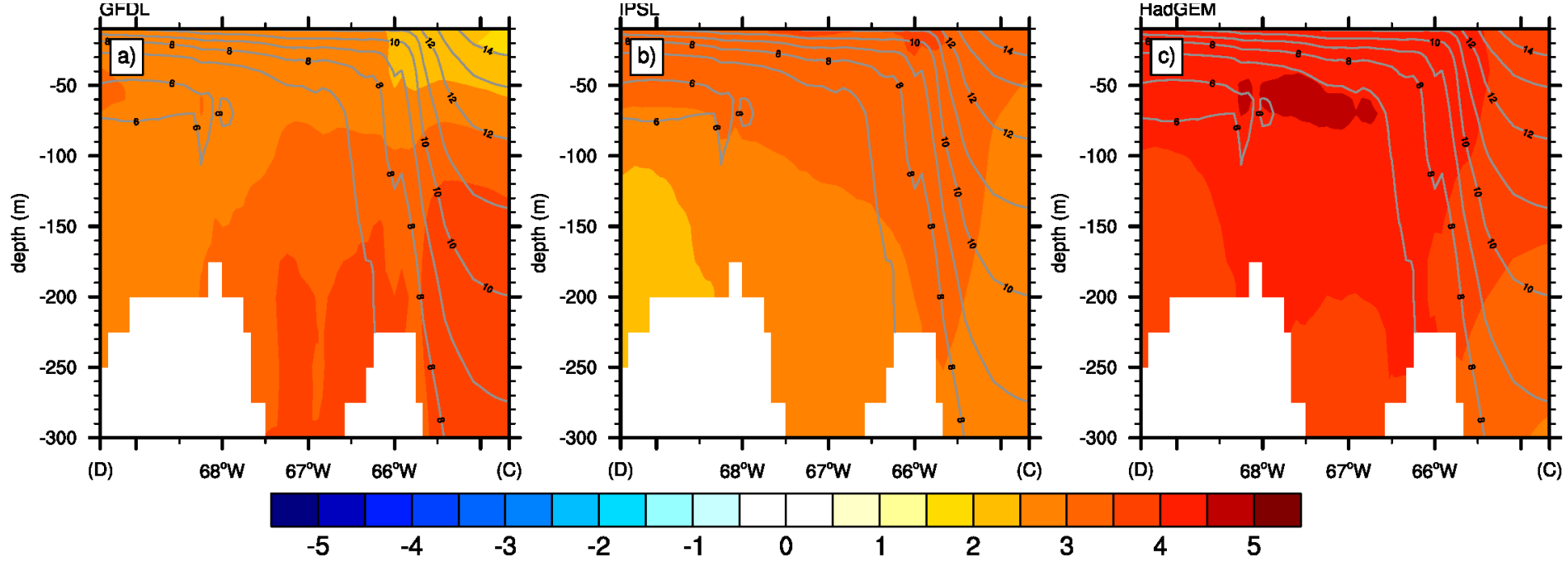


Bottom Salinity (PSU) in DJF
RCP8.5-CTRL (shaded), 200m depth (contour)



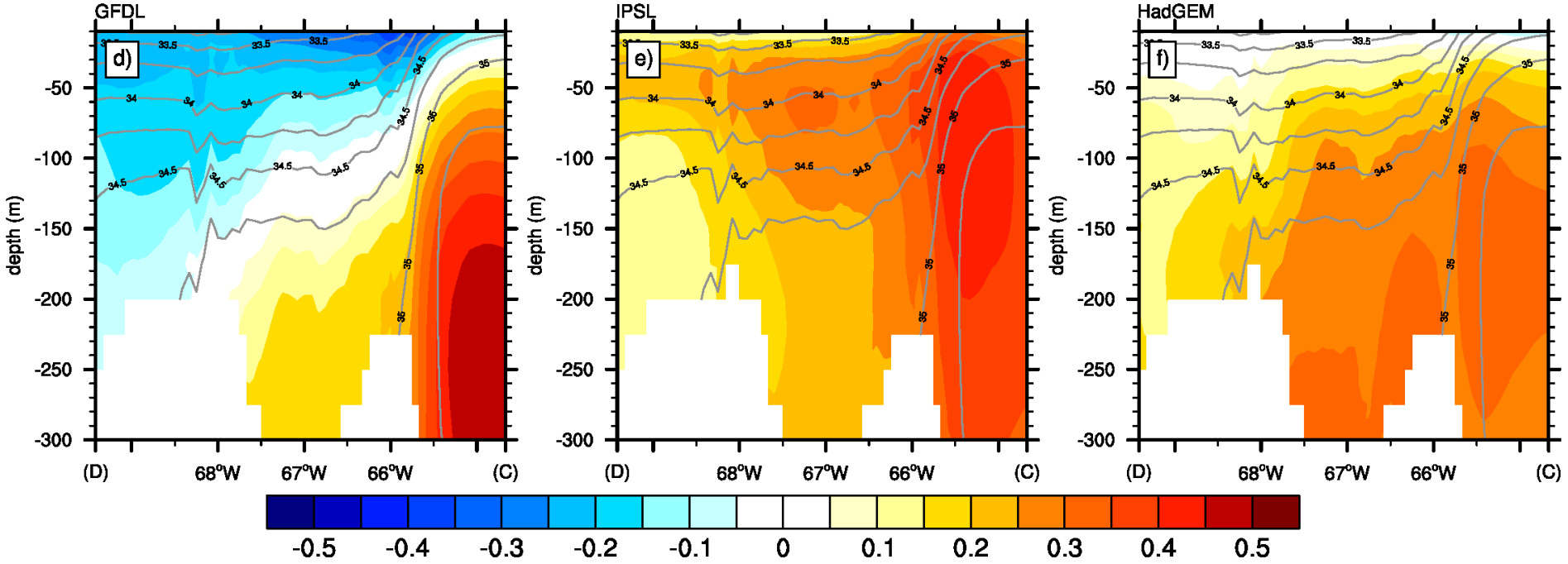
Gulf of Maine Cross Section

Temp (°C)

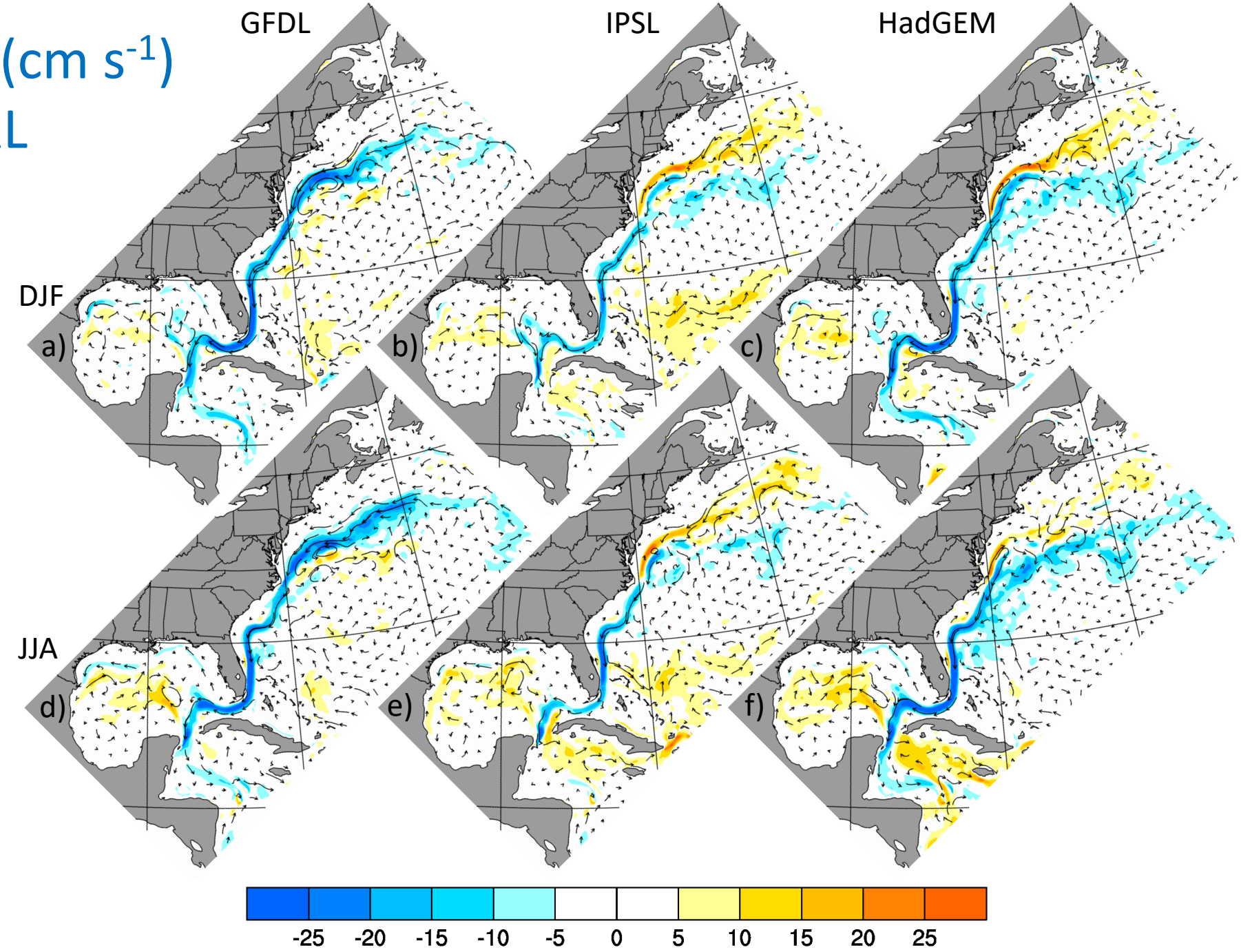


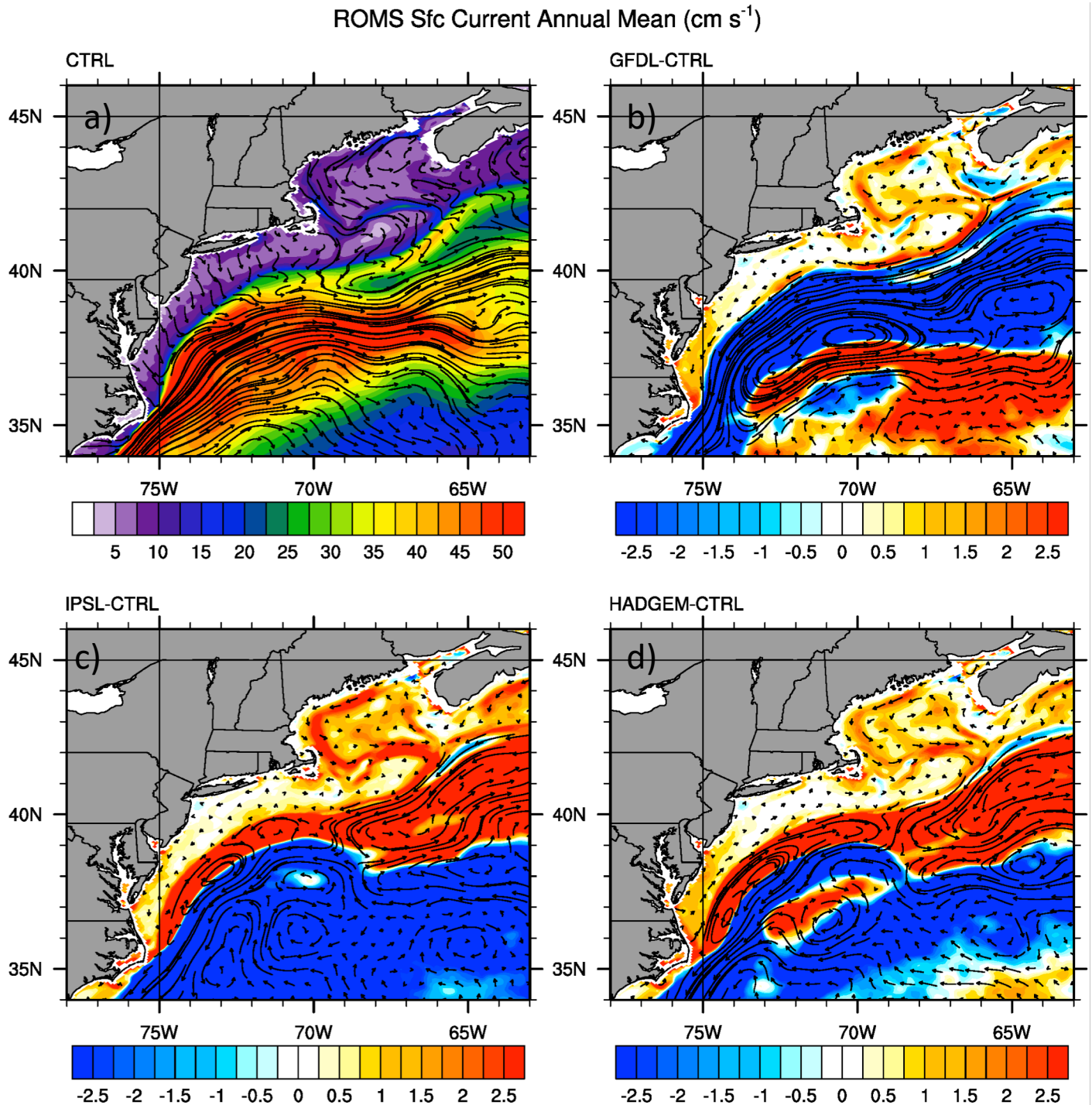
Salinity (PSU)

Annual Mean

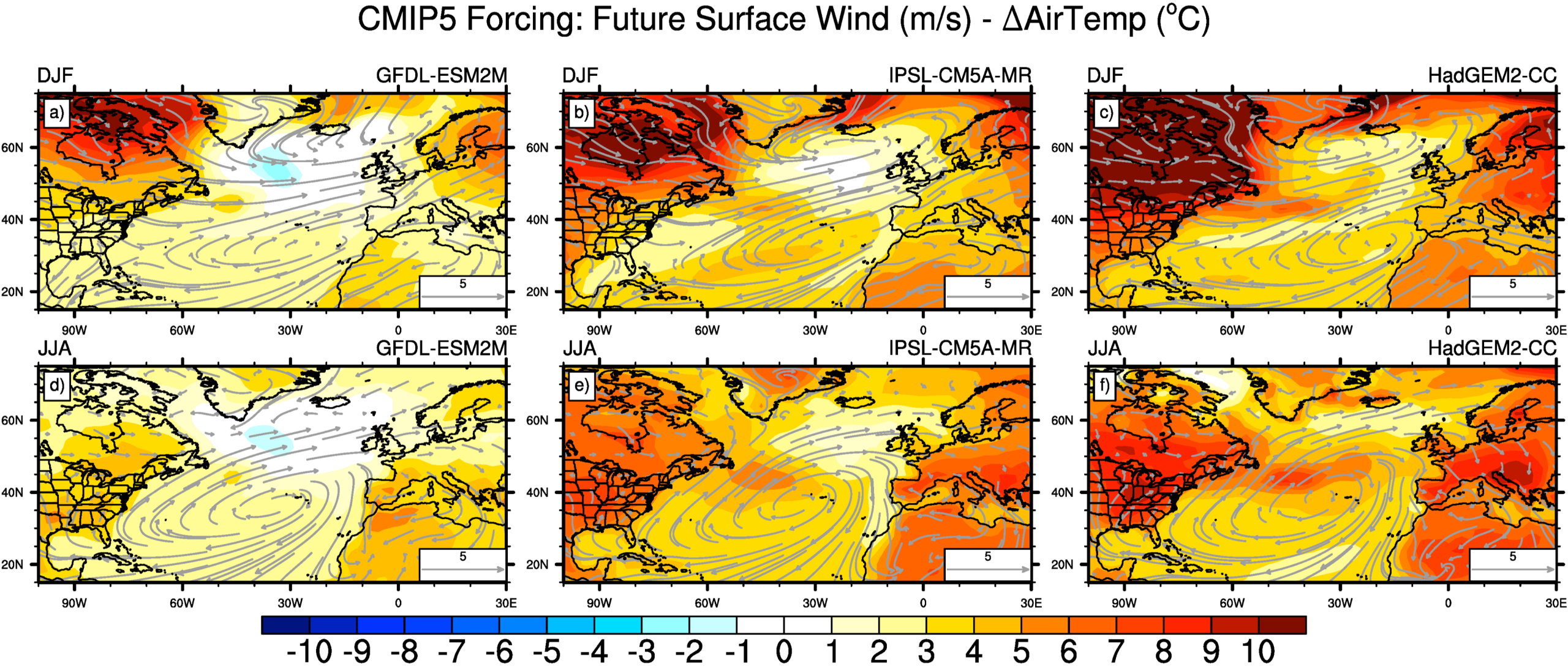


Surface Currents (cm s^{-1})
RCP8.5-CTRL




ROMS Sfc Current Annual Mean (cm s-1)
CTRL
a)
GFDL-CTRL
b)
IPSL-CTRL
c)
HADGEM-CTRL
d)
45N
40N
35N
75W
70W
65W
5 10 15 20 25 30 35 40 45 50
-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5

Air Temp (˚C) (RCP8.5-Historical shaded) and RCP8.5 winds



CMIP5 GCM Response (RCP8.5-historical) Currents (vector) and Temperature (°C)

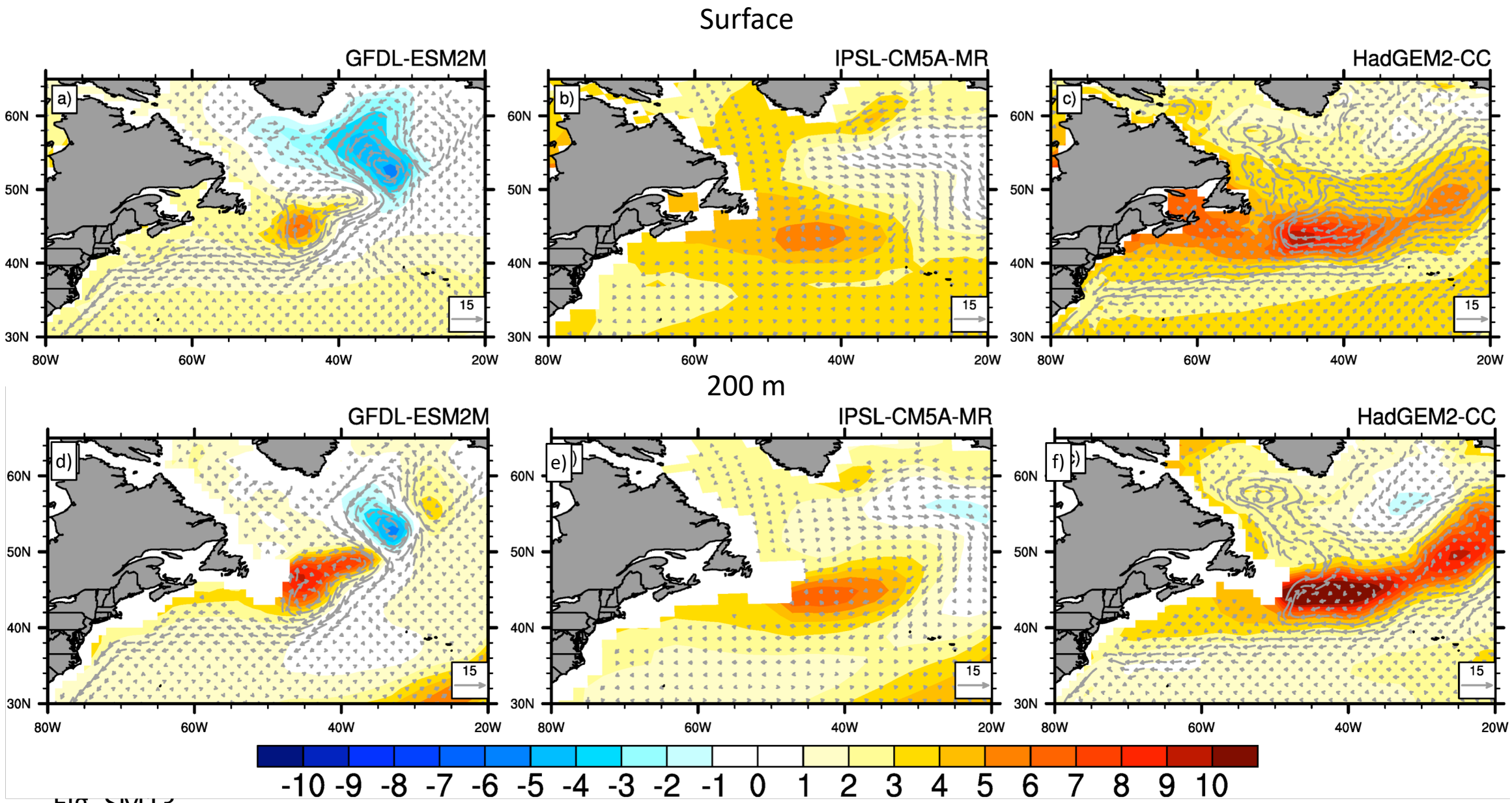
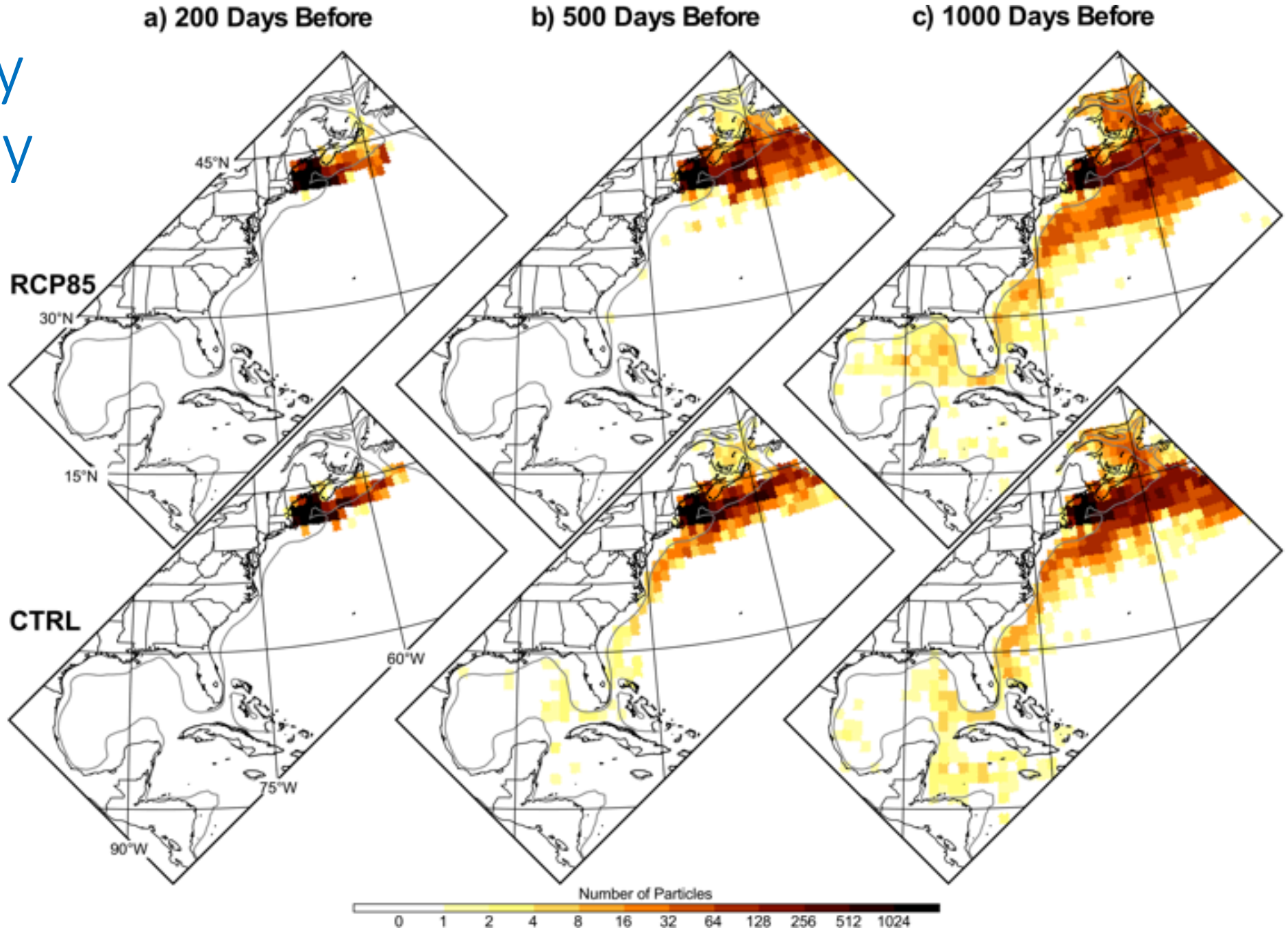


Fig. SM13

Back Trajectory Particle Density

- ~30,00 particles released in Gulf of Maine
- 41.63-44.61°N, 69.90-65.96°W
- 145.3-327.41 m



Summary

- Response: both large-scale forcing, e.g.
  - Slowing of western boundary current system and reduced warming in the Gulf stream region
  - Warming in northern part of the domain GFDL < IPSL <HadGEM
- Regional changes: mesoscale dynamics and coastal interactions
  - response function of depth strongly influences nearshore regions
  - GFDL-ROMS response is greater at depth than other two models
    - Influences bottom temperature & salinity and thus stratification
- Not apparent northward shift of Gulf Stream, especially GFDL-ROMS
- Why warming?
  - Heating over land advected by atmosphere over adjacent ocean
  - Advection of very warm water in North Atlantic towards coast
- While high resolution allows for better representation of the large-scale and regional circulation, it doesn’t guarantee the same climate change response