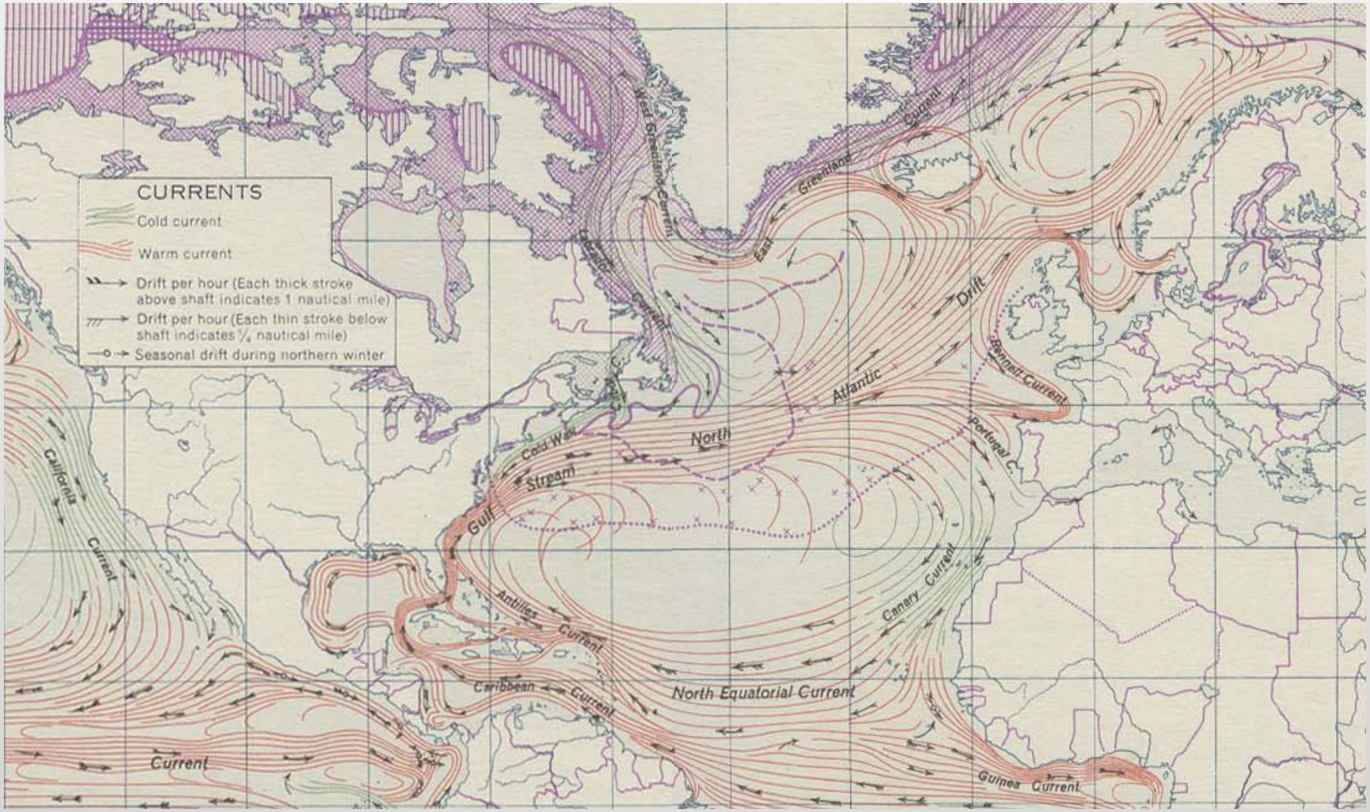
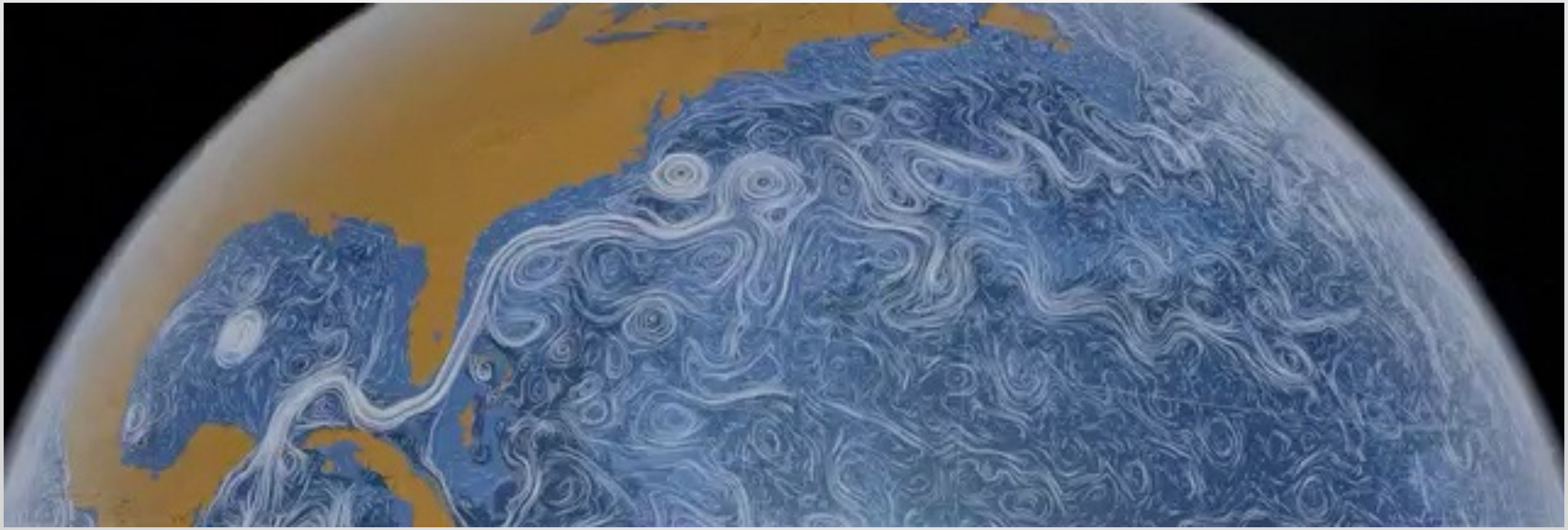
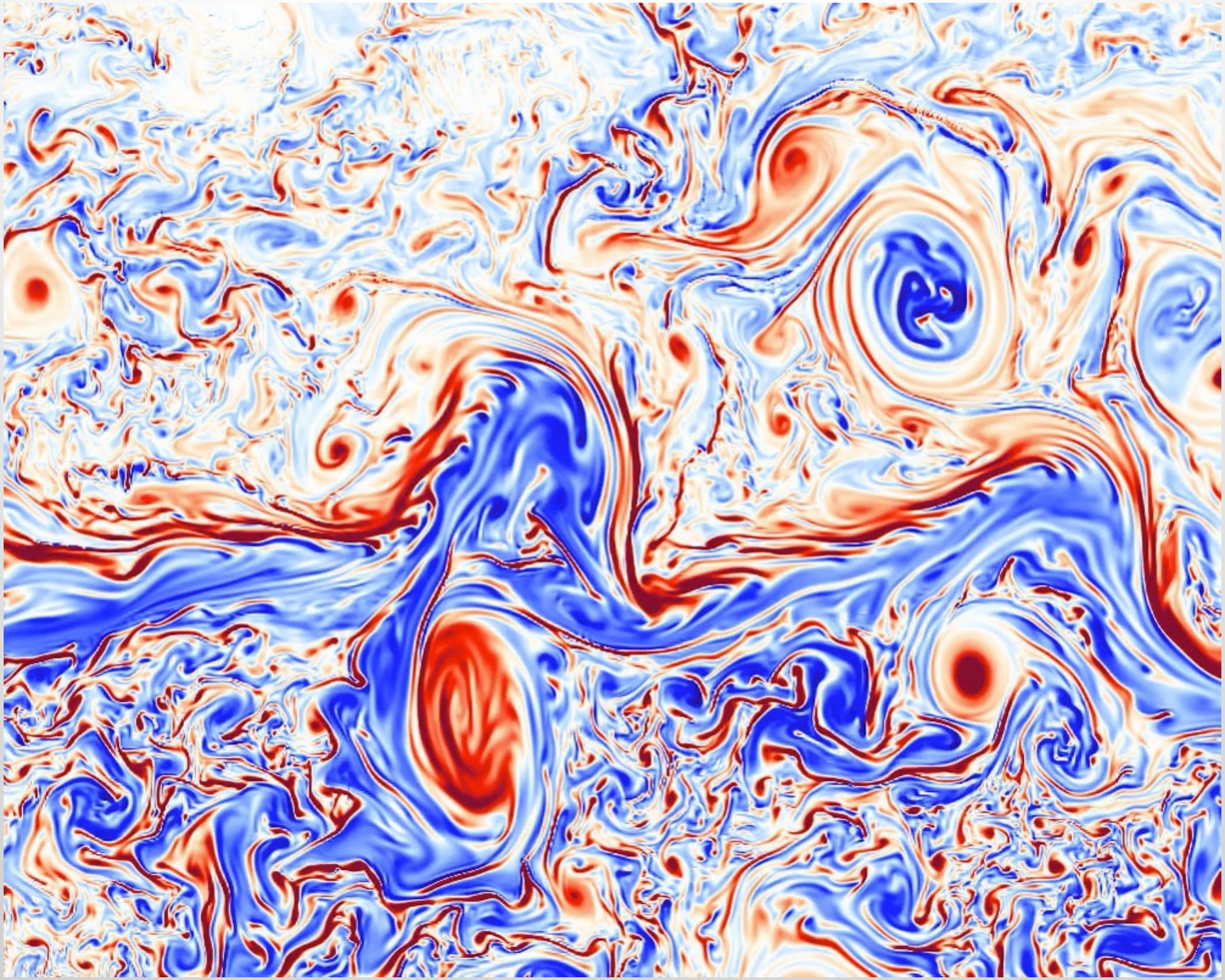
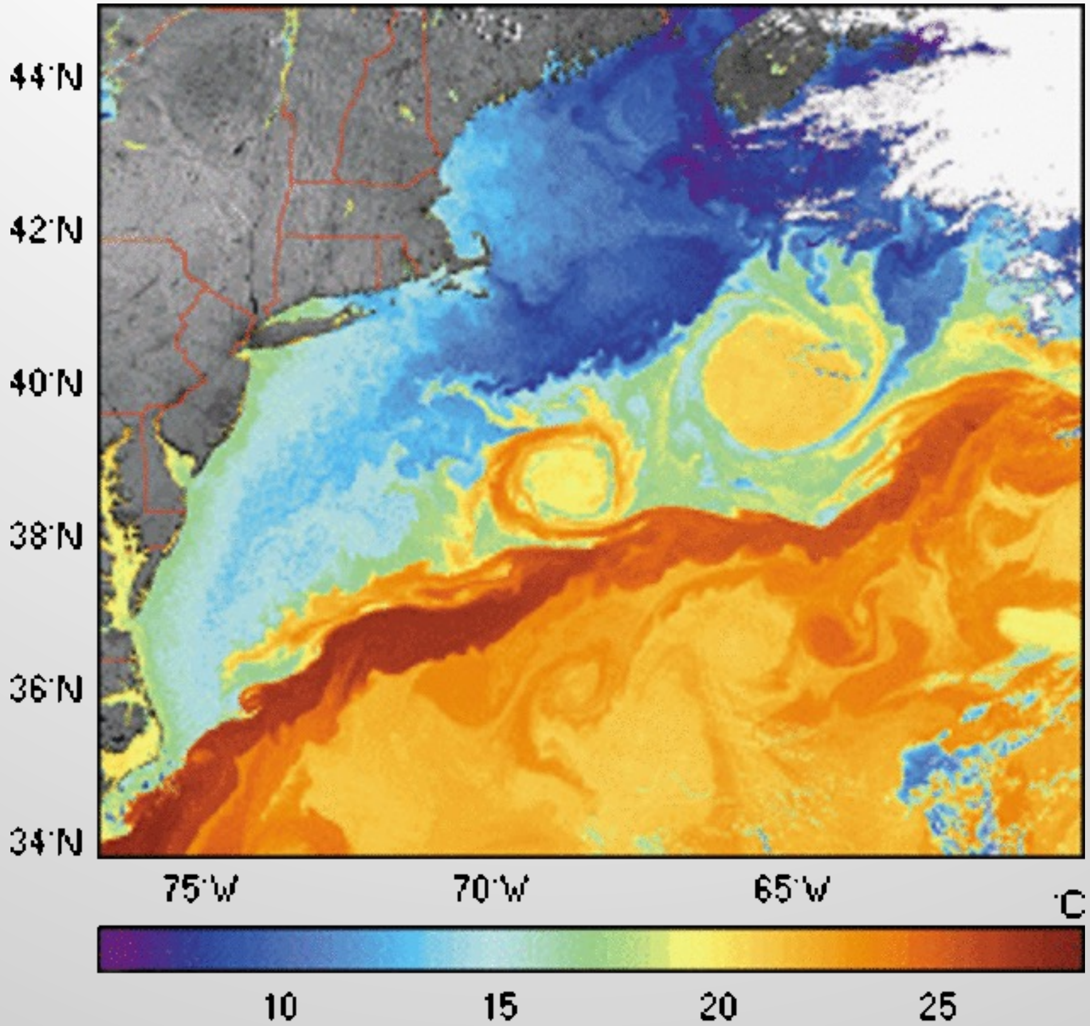

CURRENTS
Cold current
Warm current
Drift per hour (Each thick stroke above shaft indicates 1 nautical mile)
Drift per hour (Each thin stroke below shaft indicates ¼ nautical mile)
Seasonal drift during northern winter
West Greenland Current
East Greenland Current
Labrador Current
Cold Wall
Gulf Stream
North Atlantic Drift
Rennell Current
Portugal C.
California Current
Canary Current
Antilles Current
Caribbean Current
North Equatorial Current
Current
Guinea Current



NASA



Jon Gula



44°N
42°N
40°N
38°N
36°N
34°N
75°W
70°W
65°W
°C
10
15
20
25

Ocean fronts impact on atmosphere

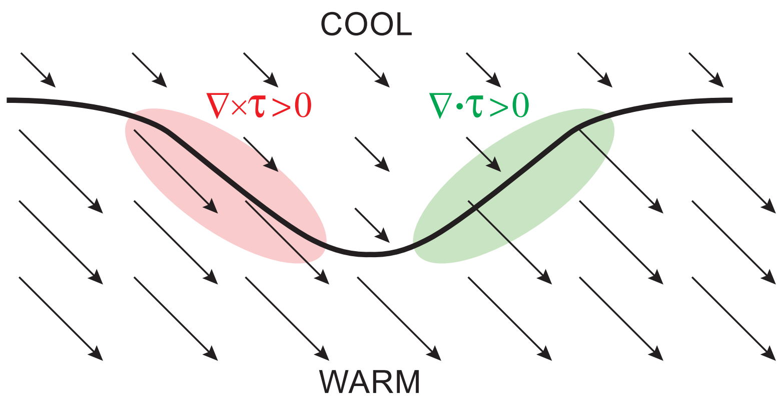
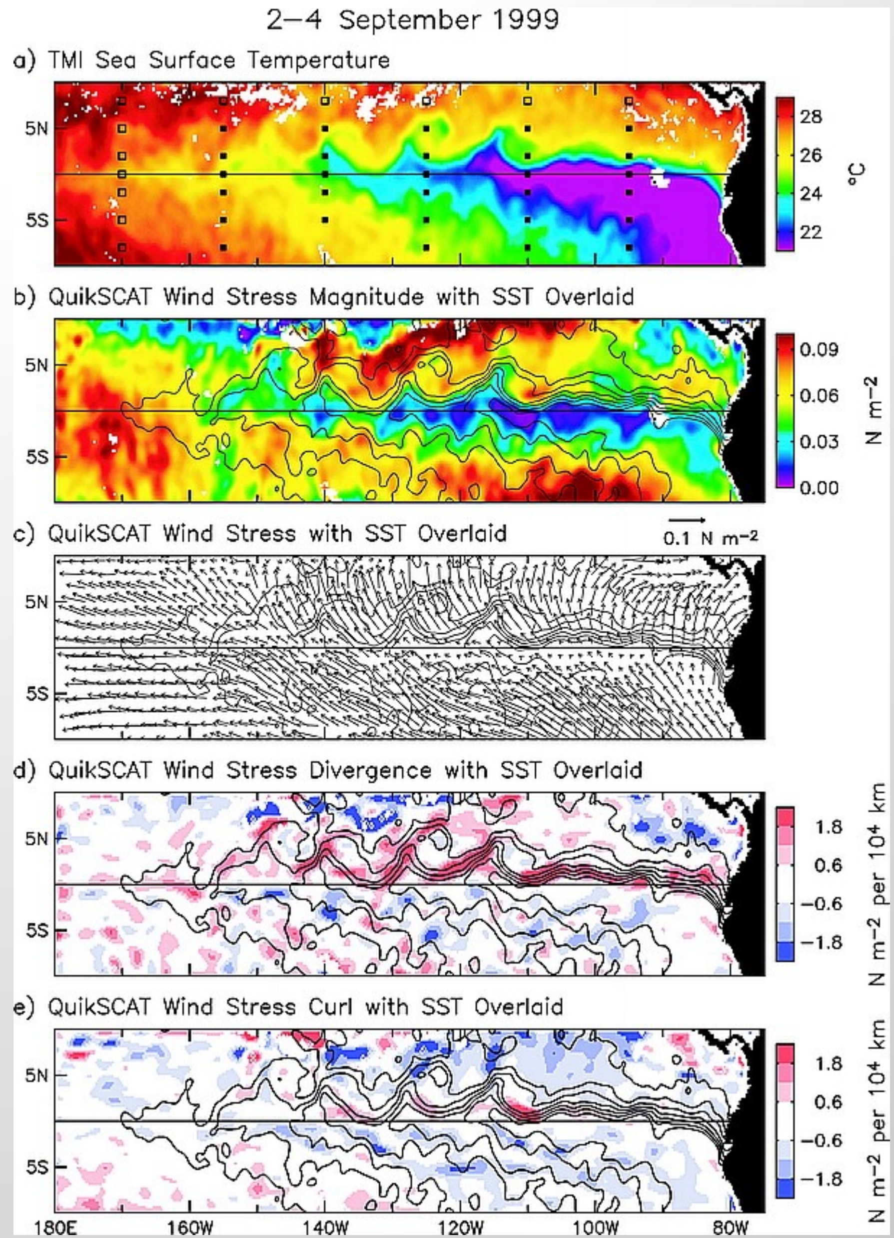


Fig. S6. Schematic illustration of the divergence and curl of the wind stress τ resulting from spatial variations of the SST effects on the surface winds summarized in Fig. S5. Near a meandering SST front (heavy black line), surface wind speeds are lower over cool water and higher over warm water, shown qualitatively by the lengths of the vectors. Acceleration where winds blow across isotherms generates divergence, $\nabla\cdot\tau$ (green area). Lateral variations where winds blow parallel to isotherms generate curl, $\nabla\times\tau$ (red area). The magnitudes of the divergence and curl perturbations are proportional to the magnitudes of the downwind and crosswind SST gradients, respectively (see Fig. 4 in the text).

Chelton et al Science 2004 (supp.)



Chelton et al J. Climate 2001

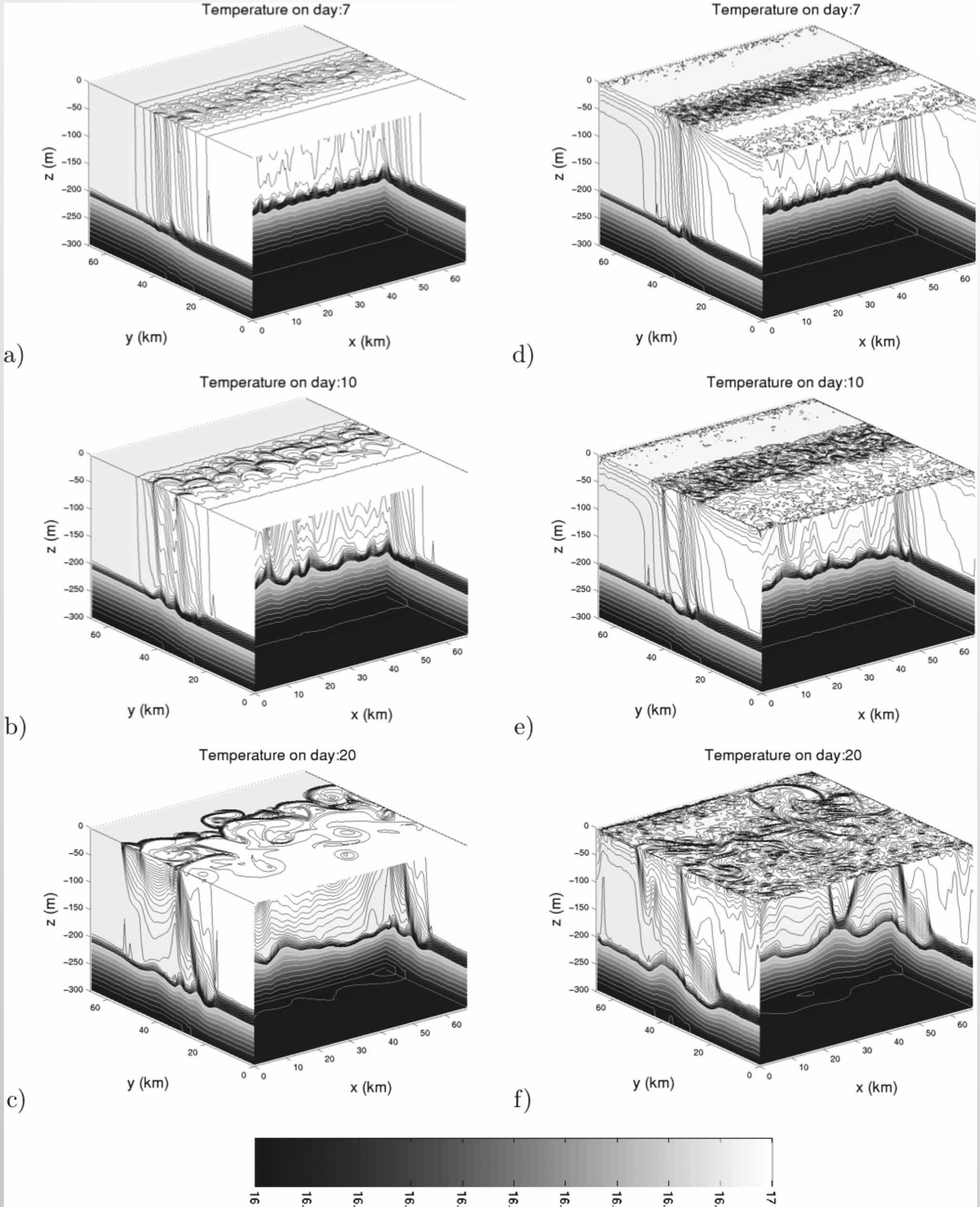
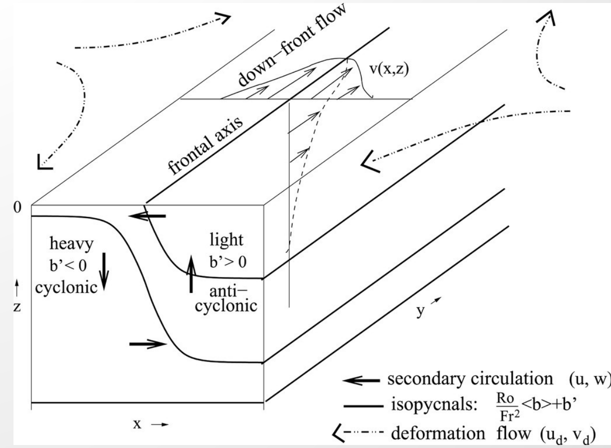
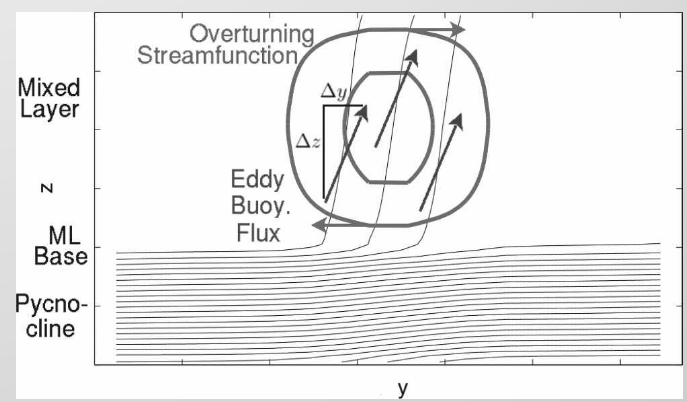


FIG. 2. Temperature (°C) during two typical simulations of a ML front spinning down: (a)–(c) no diurnal cycle and (d)–(f) with diurnal cycle and convective adjustment. (Black contour interval = 0.01°C; white contour interval = 0.1°C.)





$$w'b'_{max} \sim cH^2|\nabla b|^2/|f|$$

We conjecture that under global warming

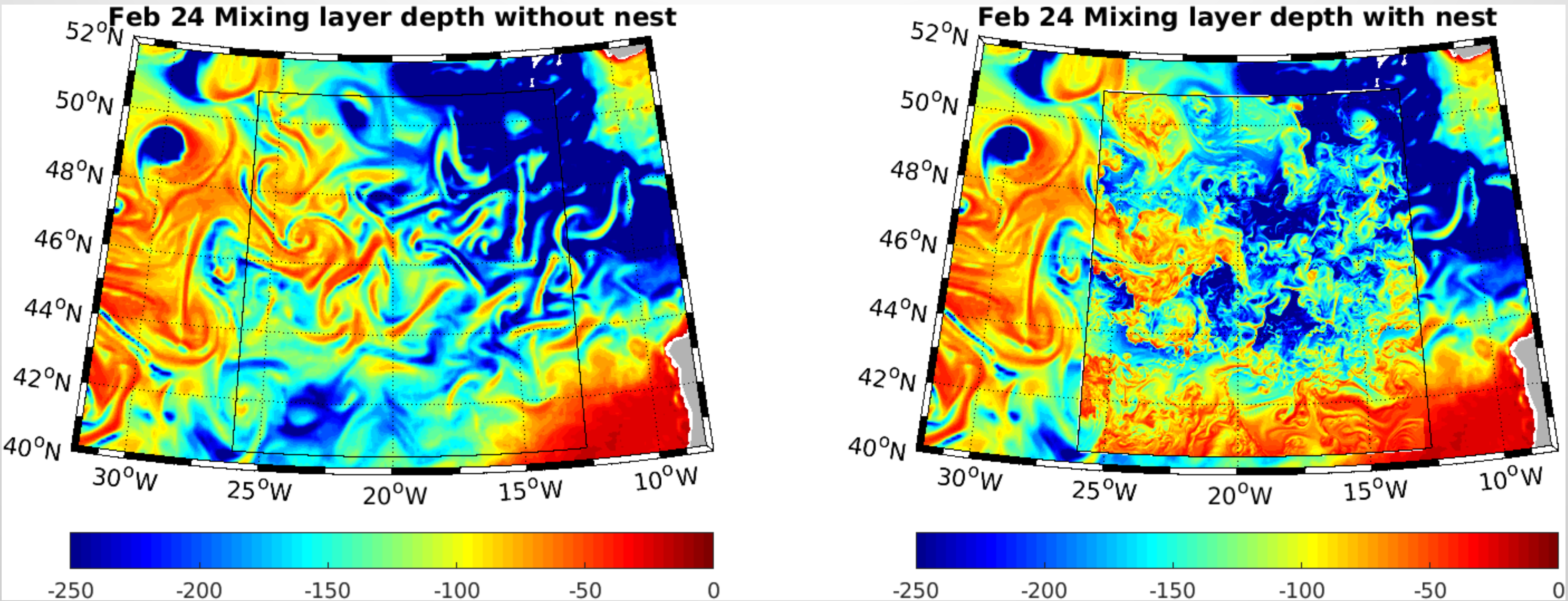
- An increase in the stratification of the near-surface ocean and decrease in mixed layer depth will lead to a reduction in submesoscale activity
- The reduction in submesoscale activity will change the spatial and temporal structure of vertical heat and nutrient fluxes.

- Does the presence of the submesoscale **change** the change caused by global warming?

Forcing of 1/10 degree (10km) POP

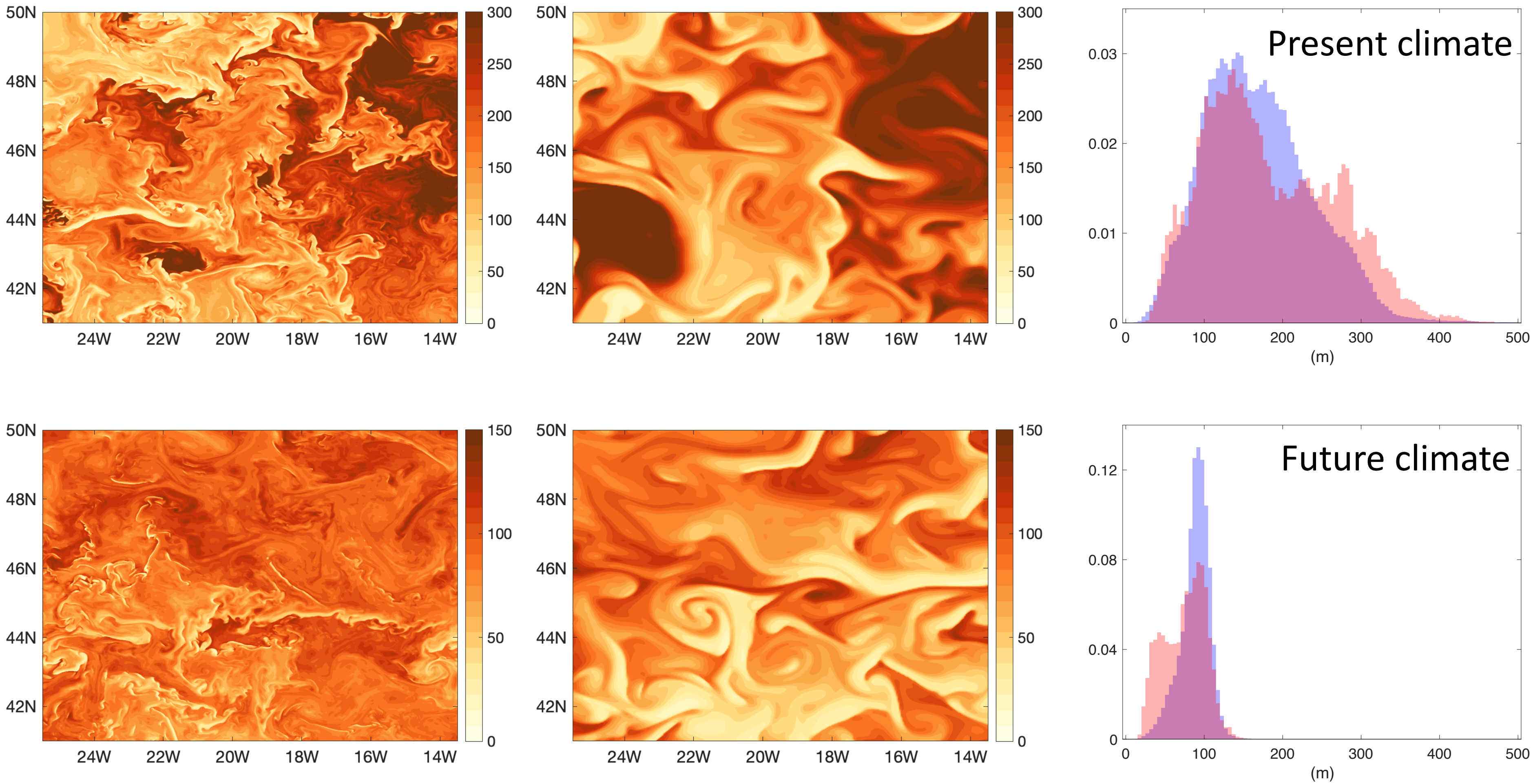
- ❑ Present Day: CORE typical year
- ❑ Future: CORE + plus anomaly in seasonal forcing got from the Large Ensemble CESM RCP 8.5 projection

Downscale both climate states to the submesoscale using regional model (ROMS) run with 1/100 degree (1.25km) resolution

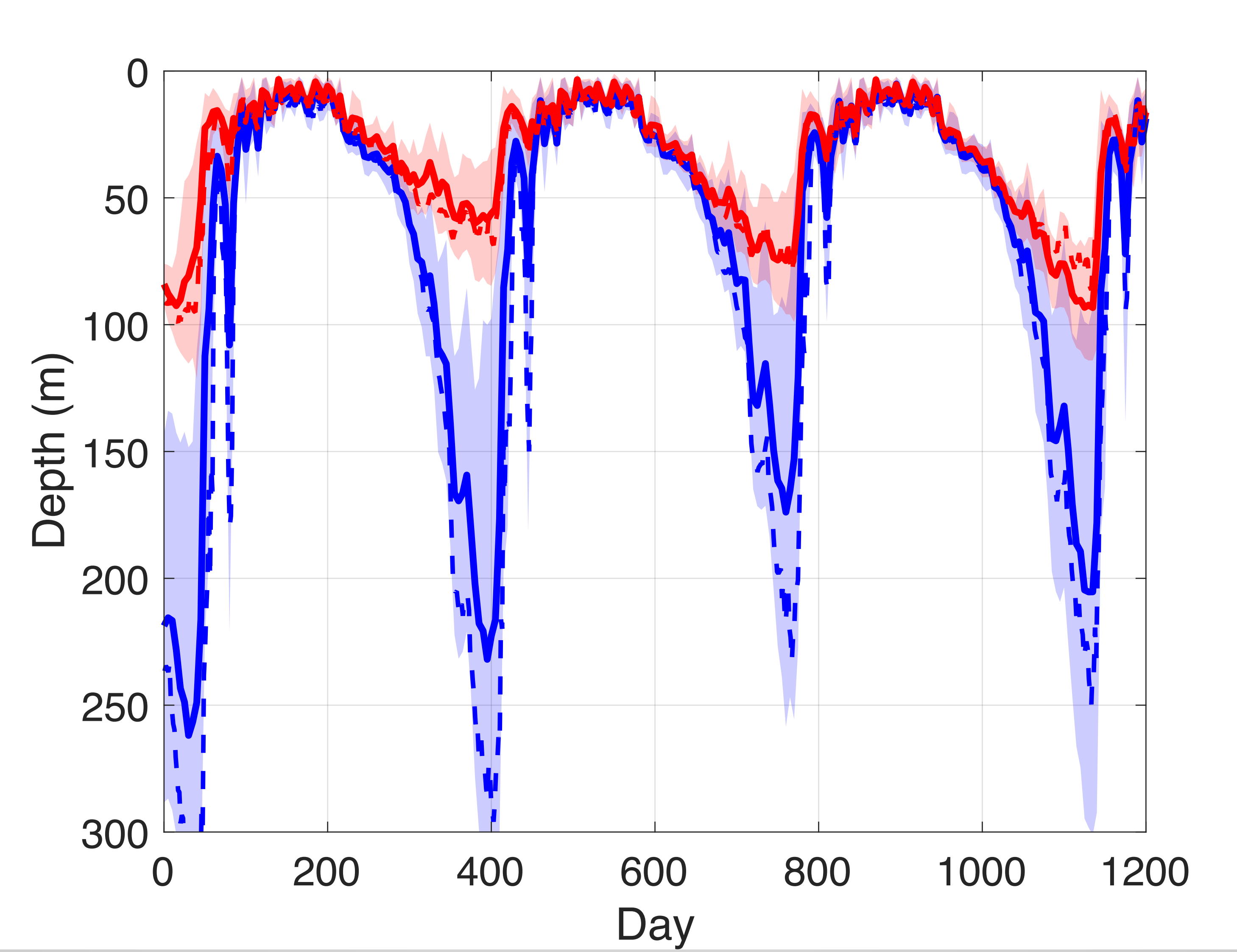

Feb 24 Mixing layer depth without nest
52°N
50°N
48°N
46°N
44°N
42°N
40°N
30°W
25°W
20°W
15°W
10°W
-250
-200
-150
-100
-50
0
Feb 24 Mixing layer depth with nest
52°N
50°N
48°N
46°N
44°N
42°N
40°N
30°W
25°W
20°W
15°W
10°W
-250
-200
-150
-100
-50
0

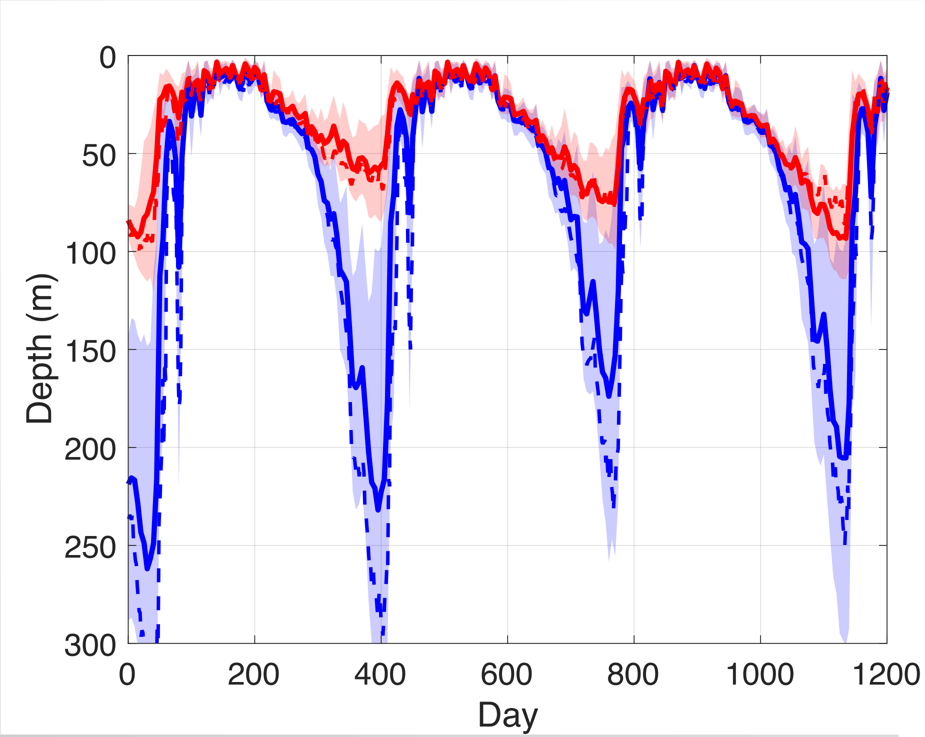
MLD 15 Feb

1.25km Viscous

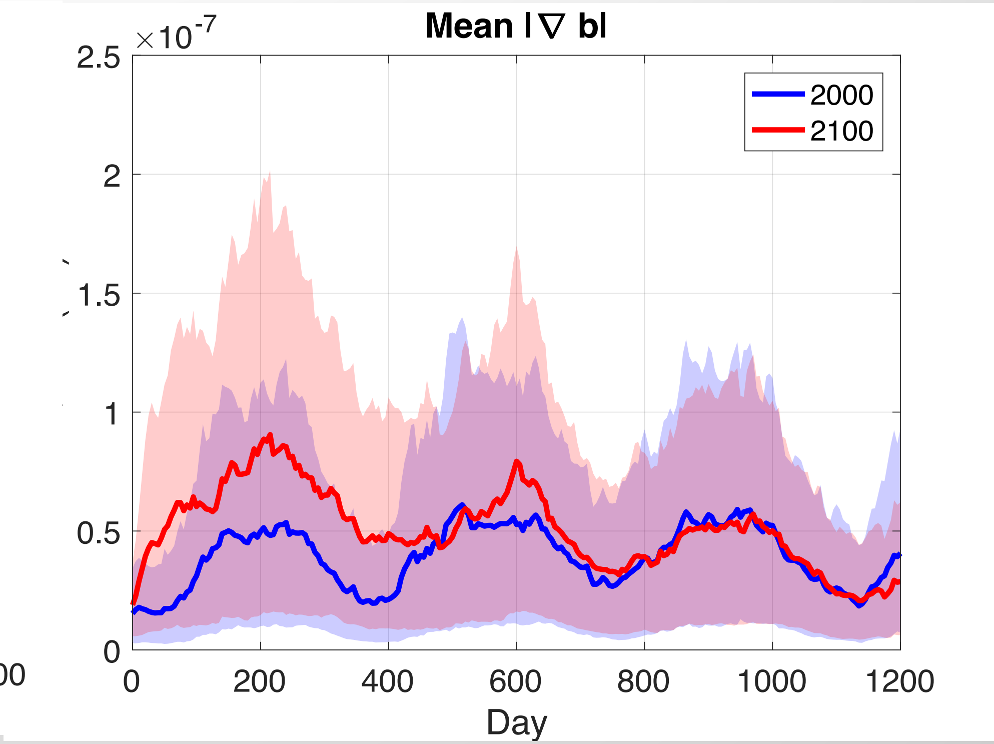


MLD





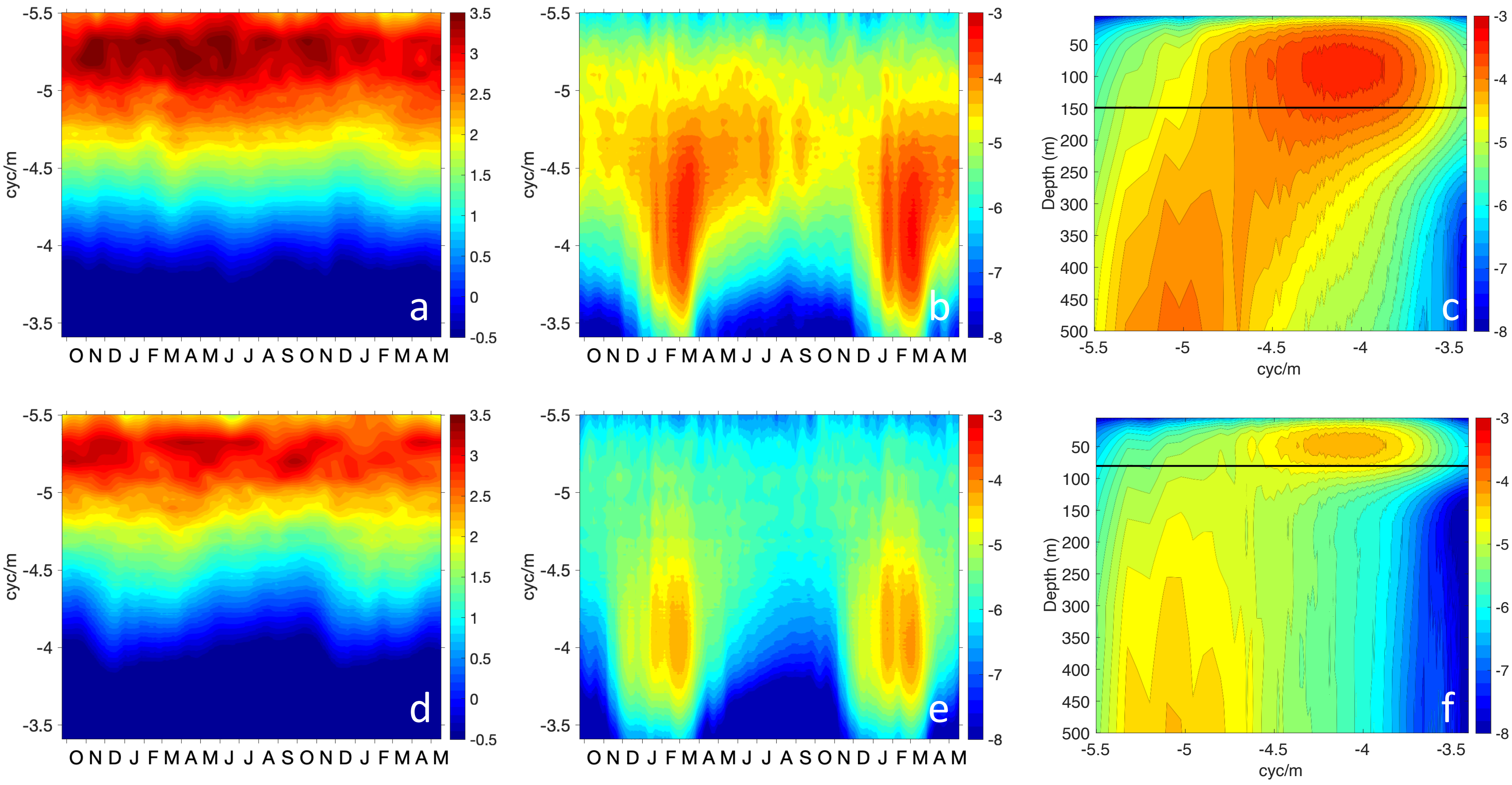
Depth (m)
Day
0
50
100
150
200
250
300
0
200
400
600
800
1000
1200



Mean I∇ bI
×10-7
2000
2100
Day
0
0.5
1
1.5
2
2.5
0
200
400
600
800
1000
1200

Spectra

15 Feb



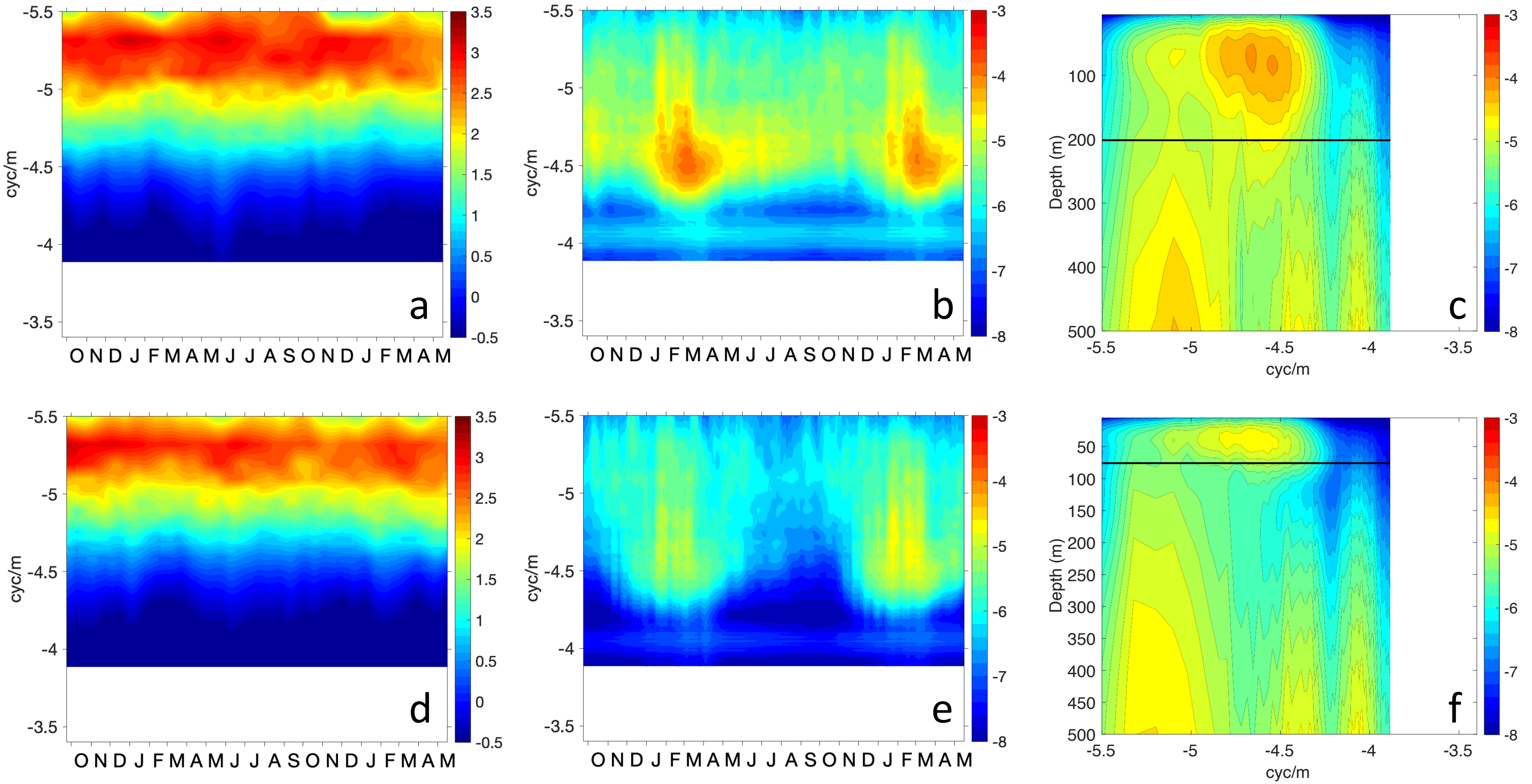
u,v

w

w

Viscous

15 Feb

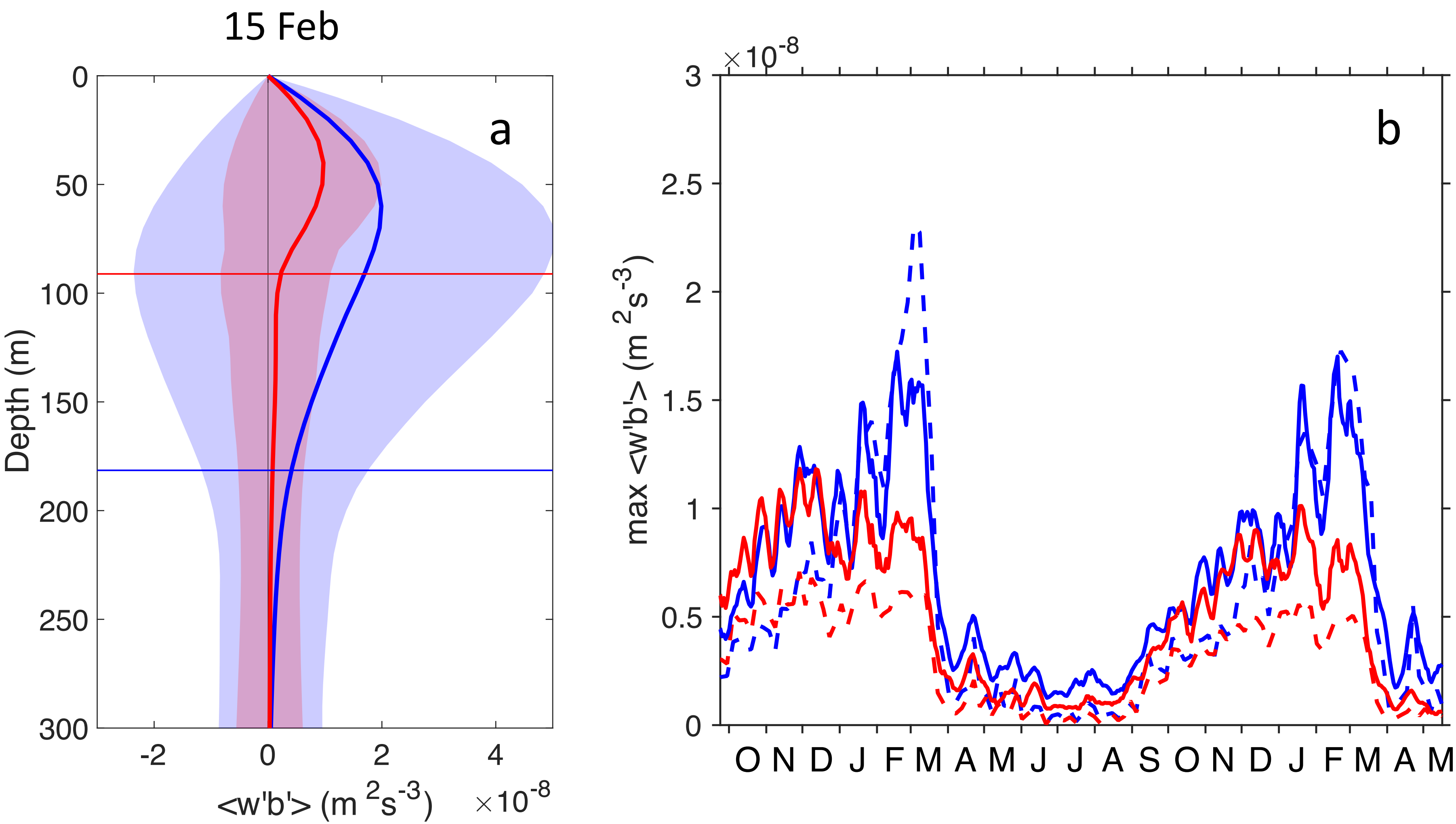


u,v

w

w

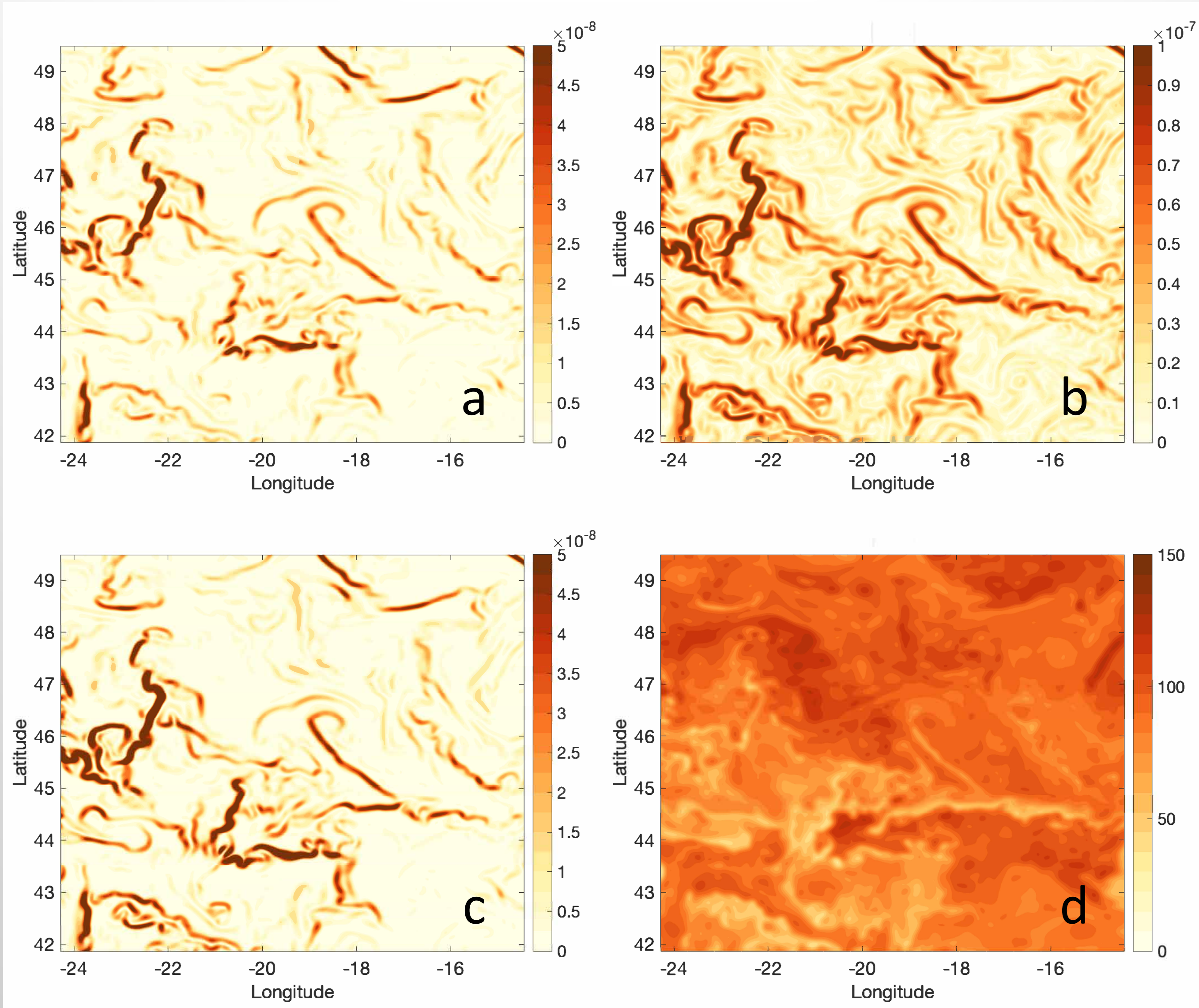
<w'b'>



FFH scaling $w'b'_{max} \sim cH^2|\nabla b|^2/|f|$

FFH

|∇b|

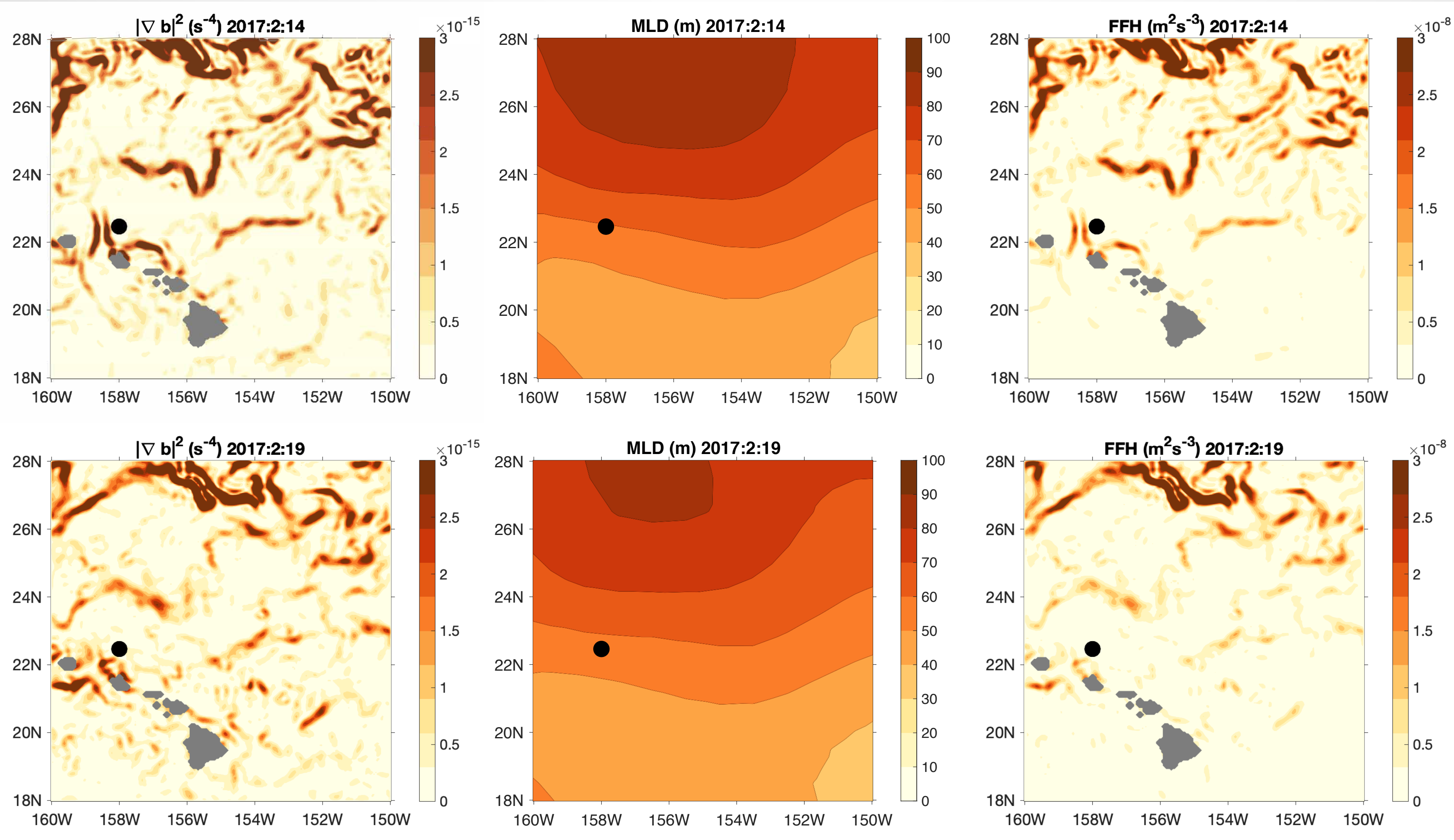


FFH2

H

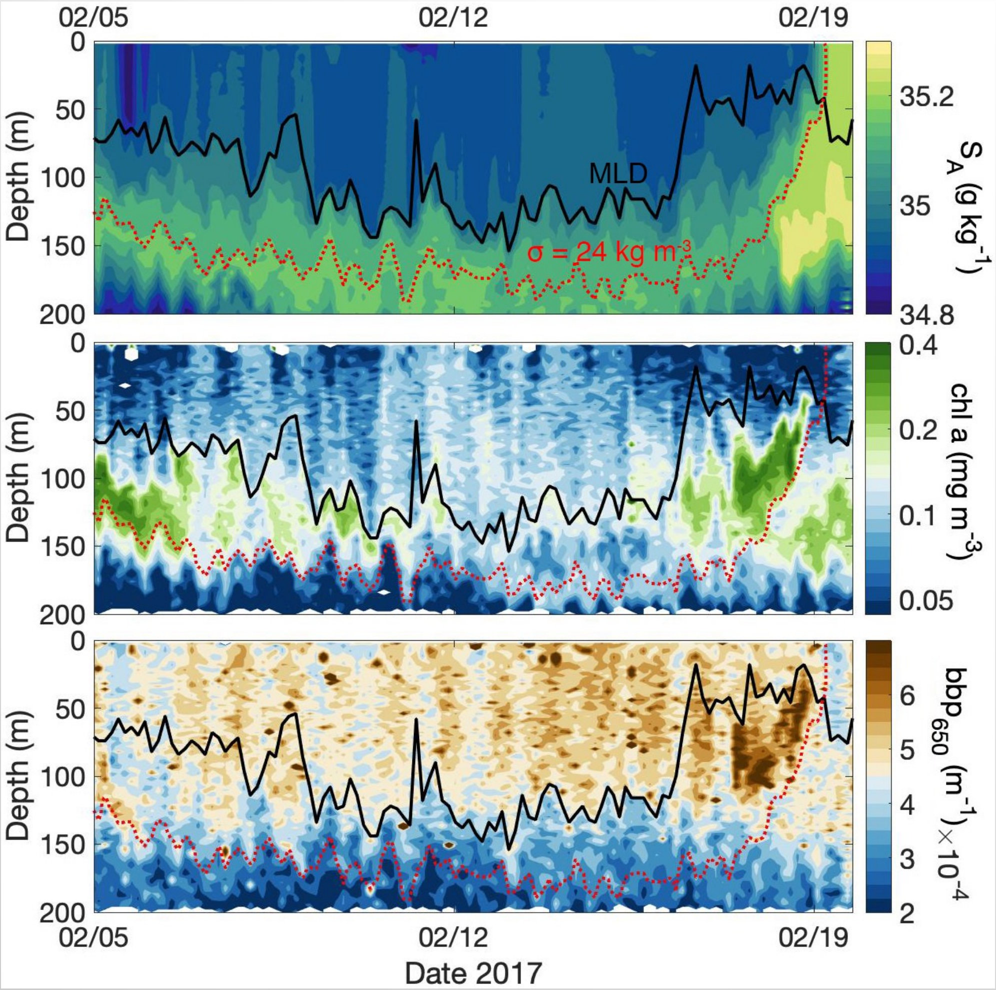
$$w'b'_{max} \sim cH^2|\nabla b|^2/|f|$$

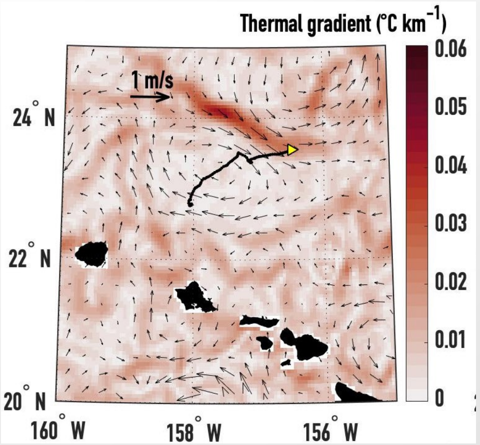
∇SST^2 MLD FFH

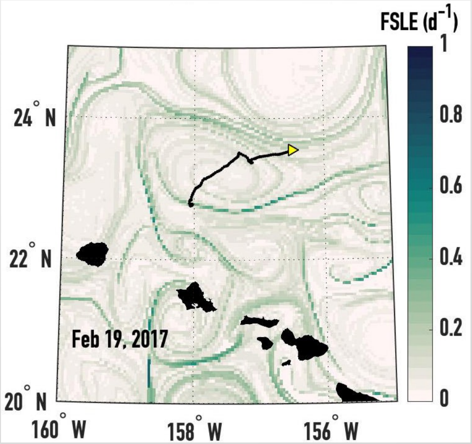


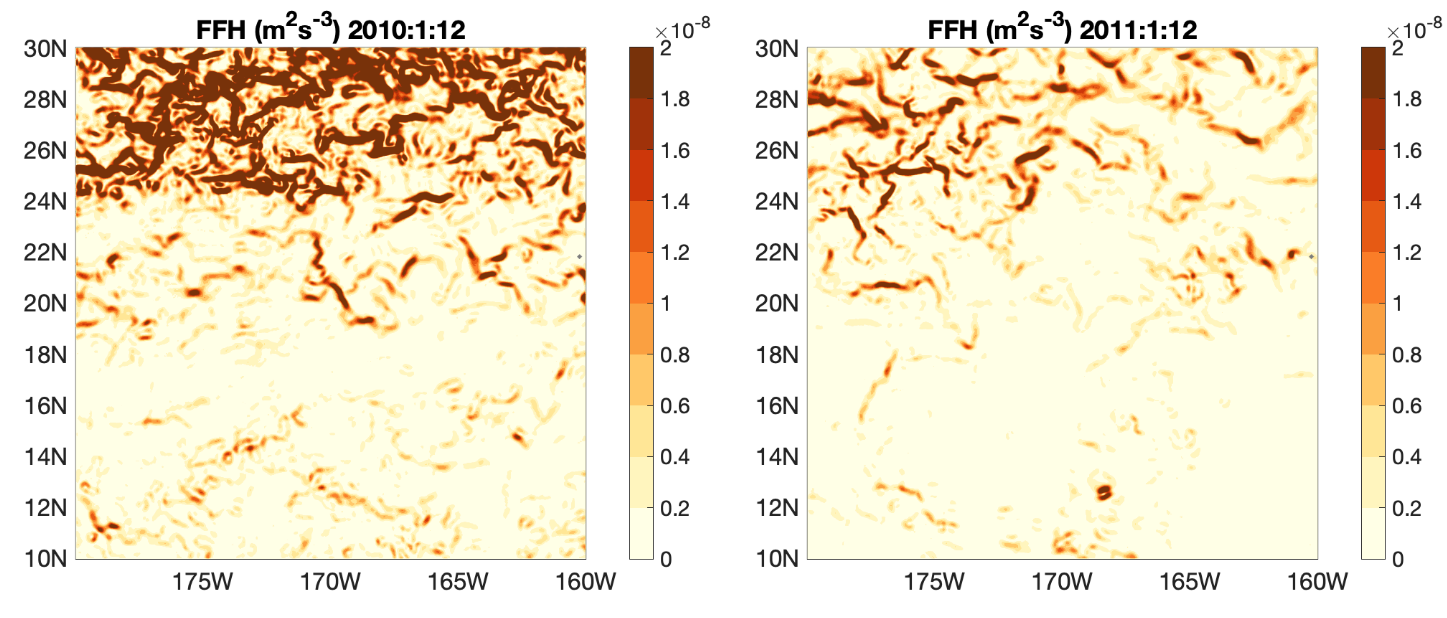
14 Feb

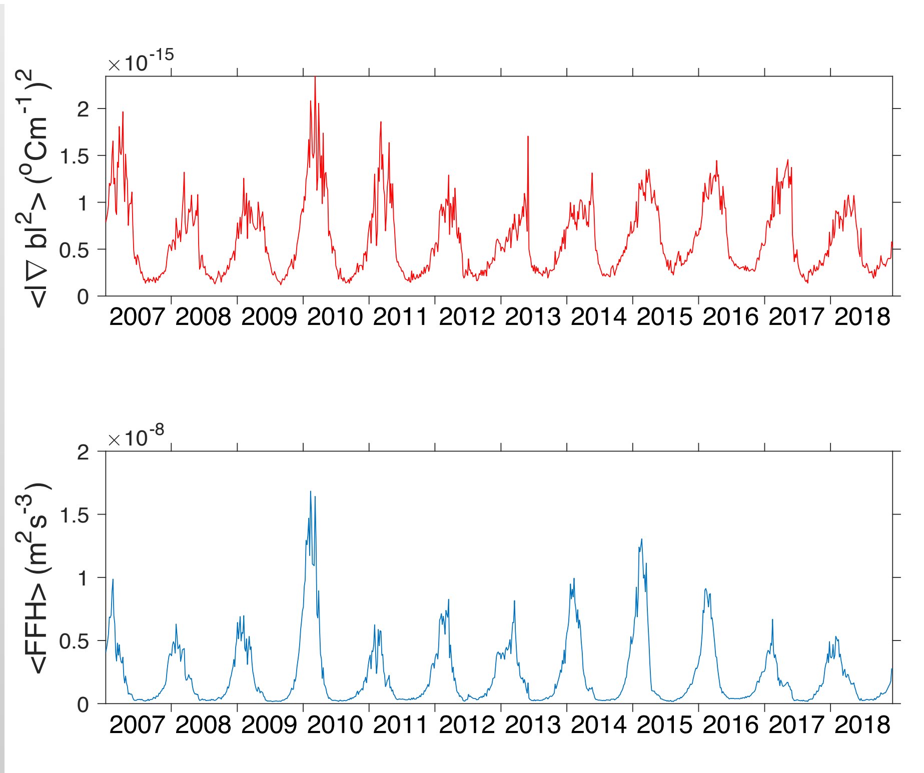
19 Feb


02/05
02/12
02/19
Depth (m)
MLD
σ = 24 kg m-3
S_A (g kg-1)
chl a (mg m-3)
bbp_{650} (m-1) ×10-4
Date 2017


Thermal gradient (°C km-1)
1 m/s
24° N
22° N
20° N
160° W
158° W
156° W


FSLE (d-1)
24° N
22° N
20° N
160° W
158° W
156° W
Feb 19, 2017


FFH (m2s-3) 2010:1:12
FFH (m2s-3) 2011:1:12
×10-8
30N
28N
26N
24N
22N
20N
18N
16N
14N
12N
10N
175W
170W
165W
160W
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0


<|∇ b|2> (oCm-1)2
×10-15
<FFH> (m2s-3)
×10-8
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

The impact of climate change on submesoscale activity

Kelvin Richards, Jay Brett and Kate Feloy (UH)
Dan Whitt, Matthew Long, Frank Bryan (NCAR)

Richards et al JGR 2021