The impact of climate change on submesoscale activity

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In collaboration with
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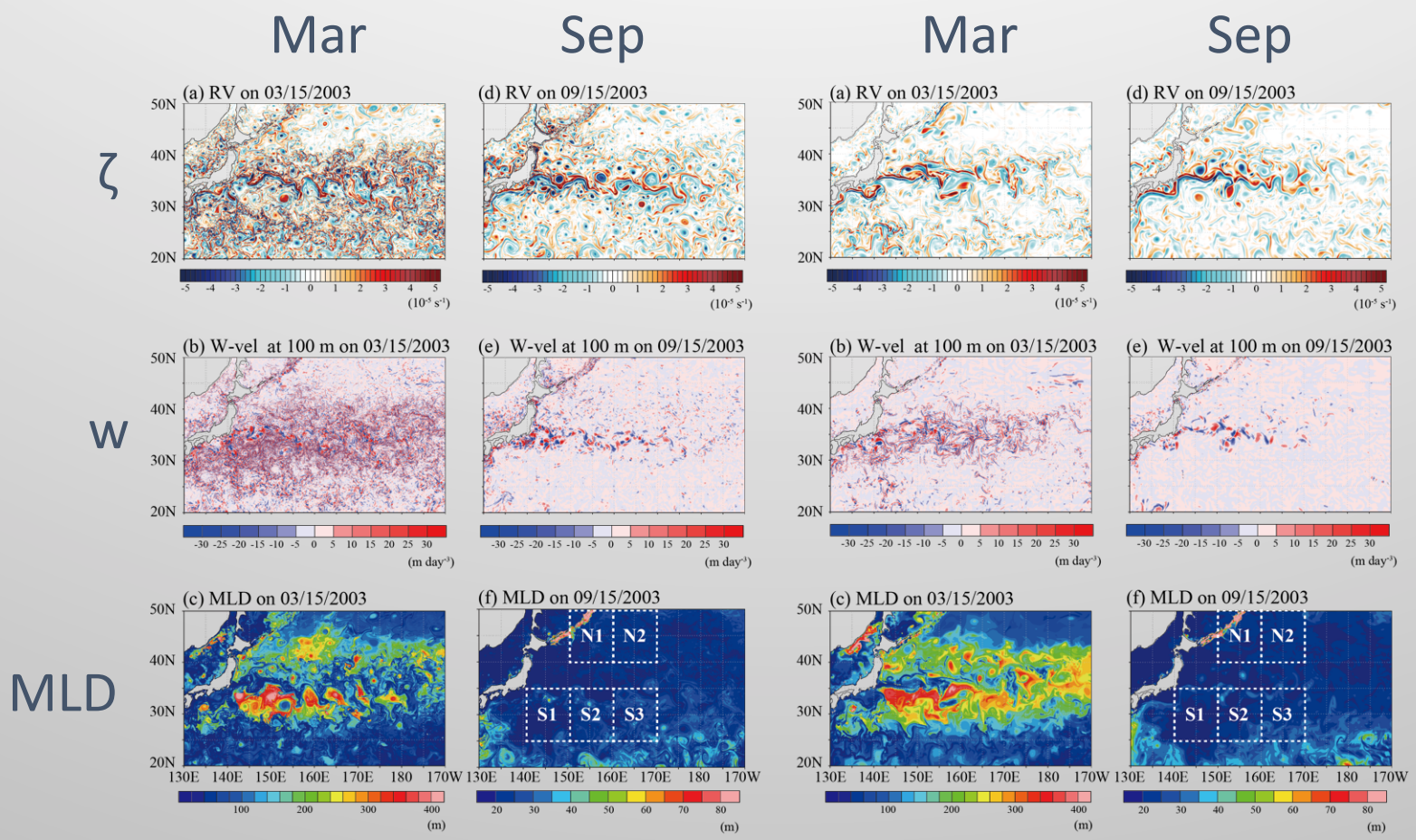


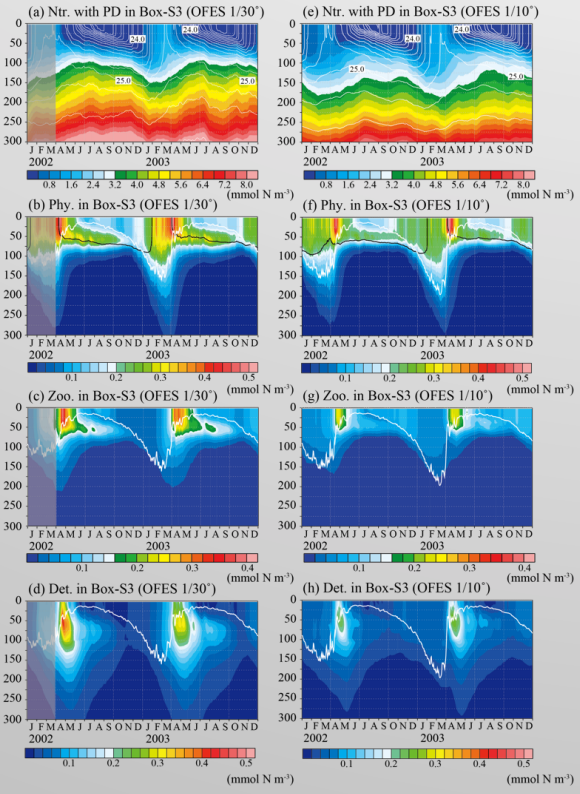
Courtesy Hide Sasaki

N

P

Z

D

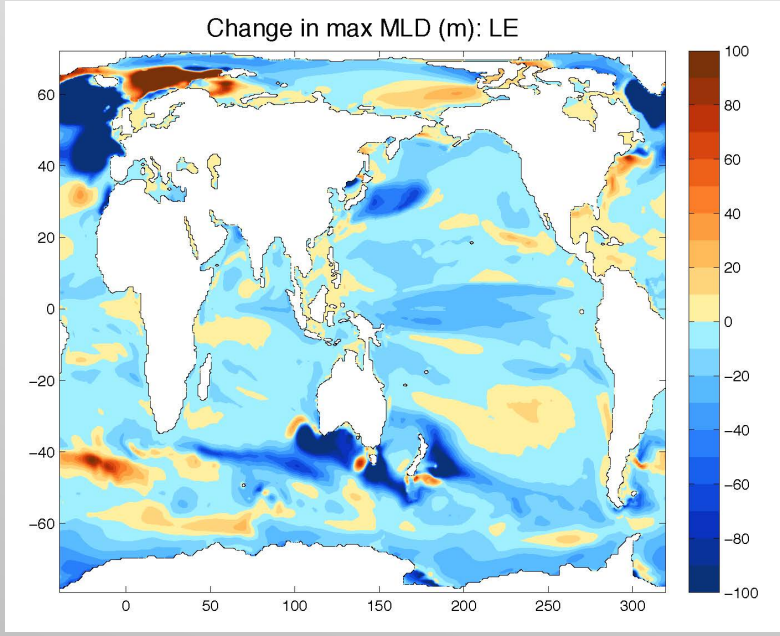


Courtesy Yoshi Sasai

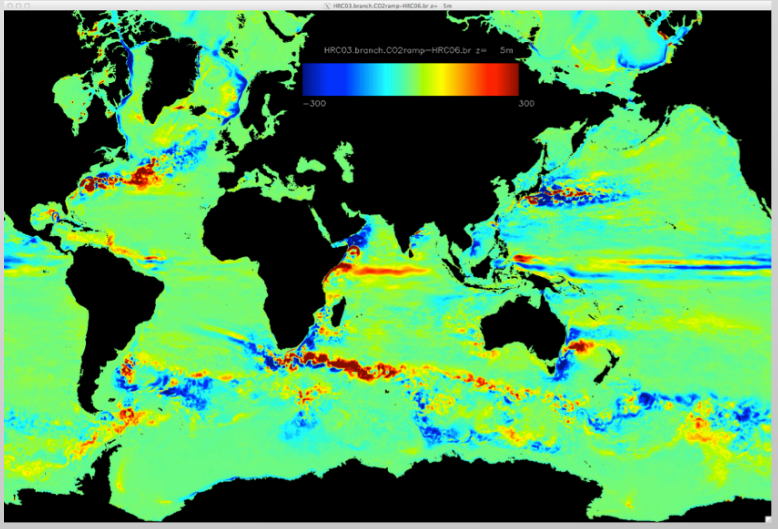
- Submesoscale features formed by ML instability
- Dependent on MLD and lateral buoyancy gradient
- Strong seasonality in submesoscale activity, ζ and w
- Induces strong seasonality in mesoscale eddies
- Impact on upper ocean heat fluxes
- Impact on biogeochemistry

A good indicator for submesoscale activity is the conversion rate of APE:

$$|\nabla b|^2 H^2$$



ΔMLD



ΔEKE

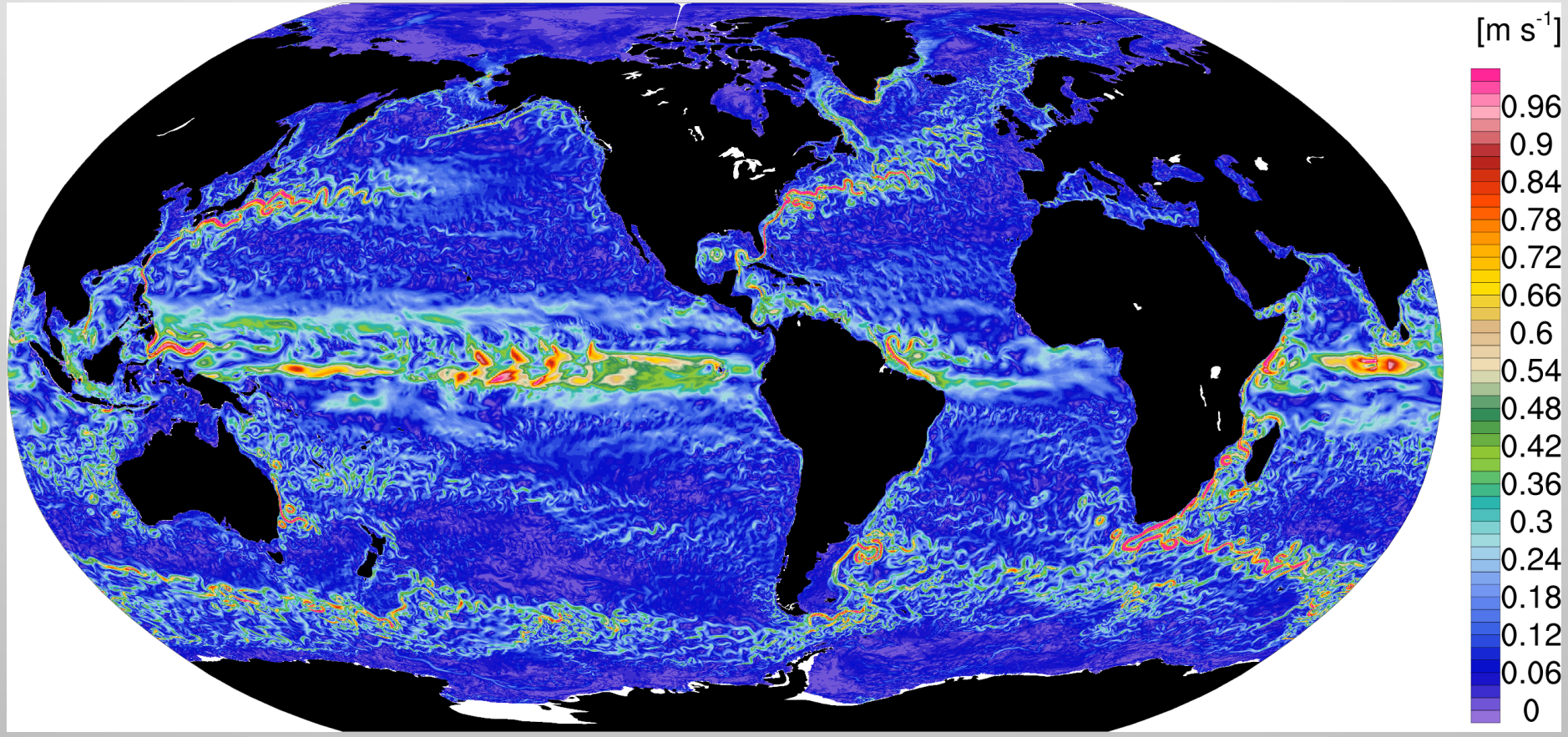
So …

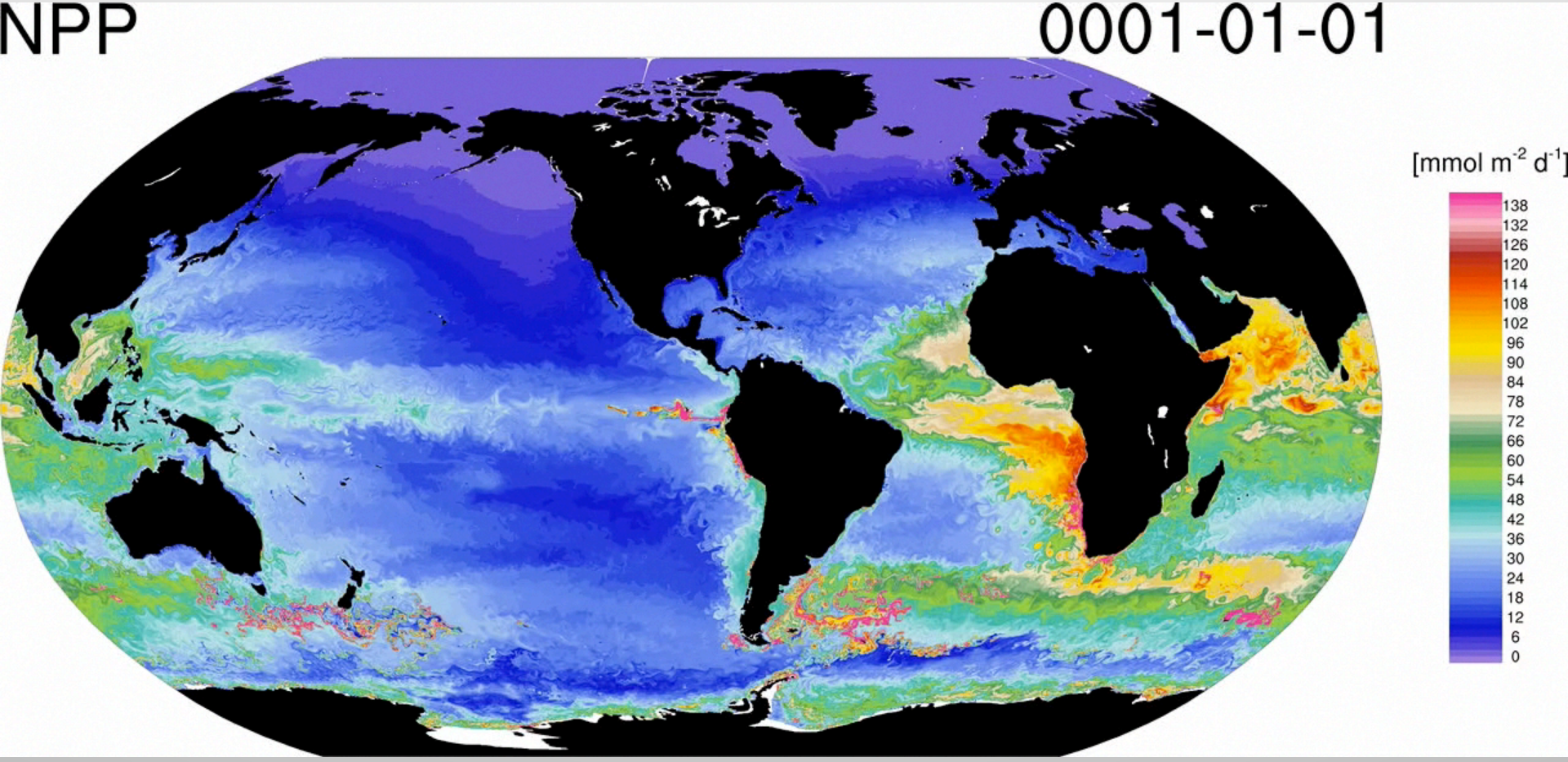
We can conjecture that under global warming

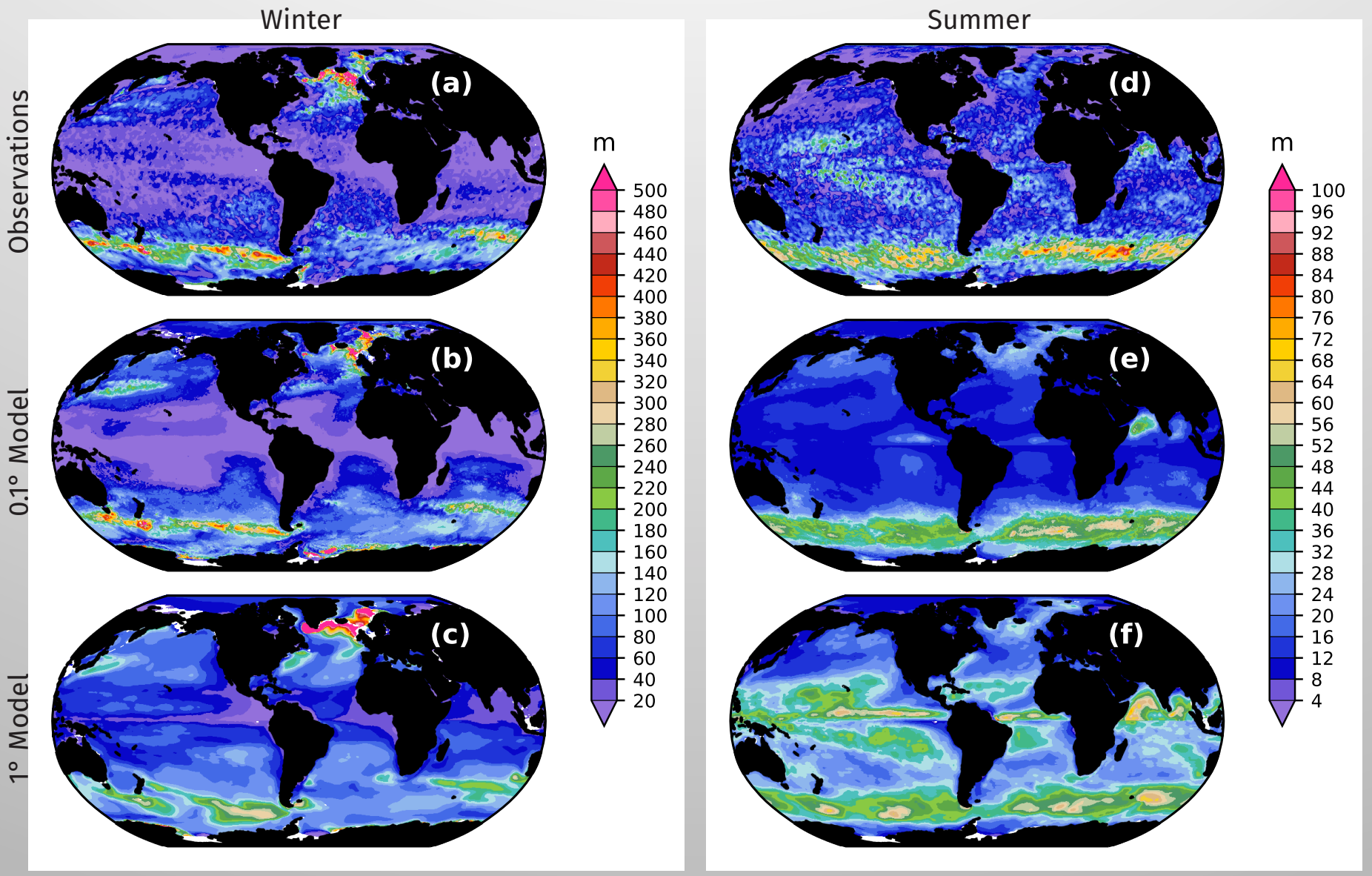
- An increase in the stratification of the near-surface ocean and decrease in mixed layer depth will lead to a reduction in submesoscale activity
- The reduction in submesoscale activity will change the spatial and temporal structure of vertical nutrient fluxes and restratification events with significant impacts on NPP.

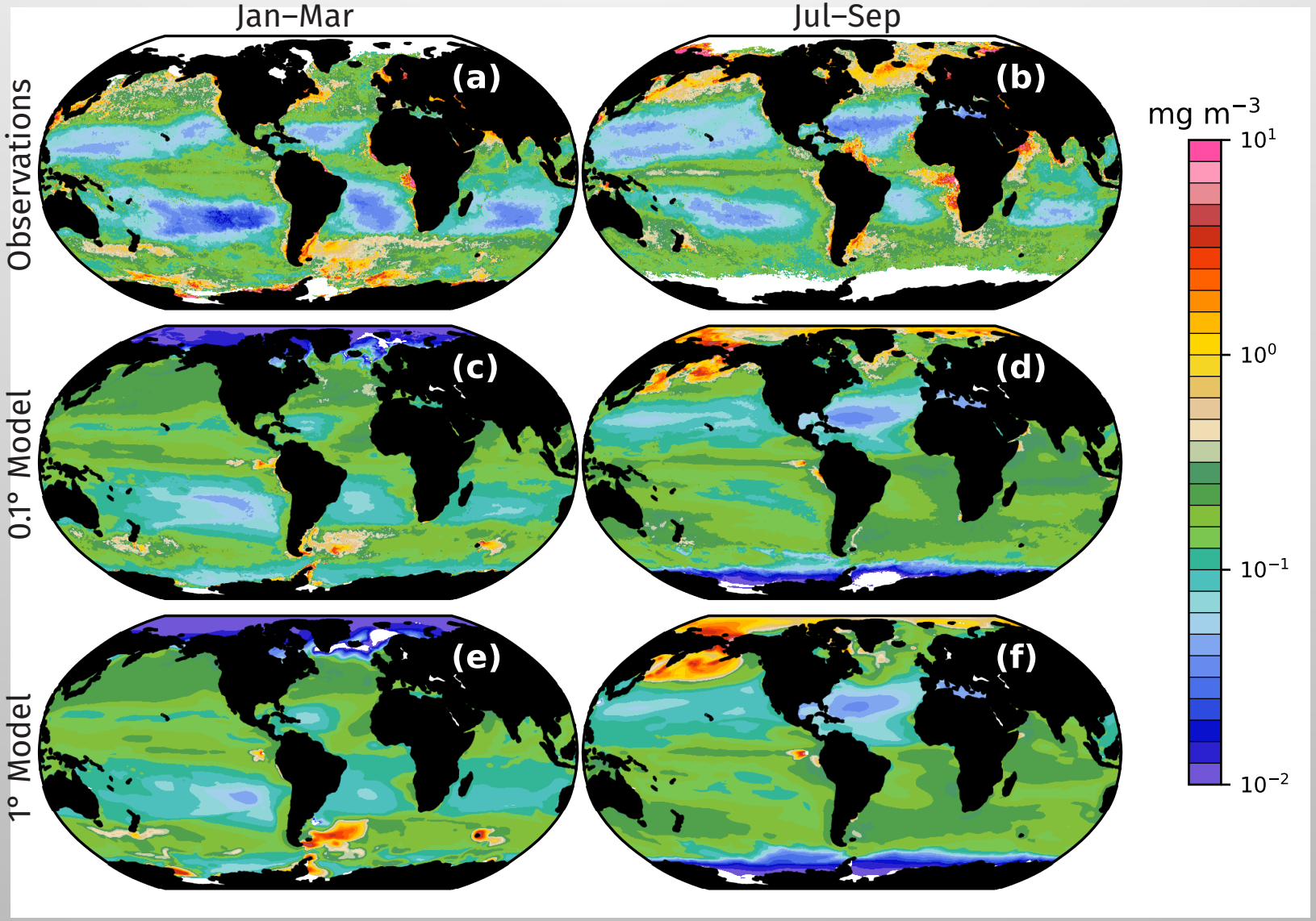
And what do we need …

- An ocean model with embedded biogeochemical model with enough resolution
- A strategy to consider the impact of global warming without the complication of natural variability

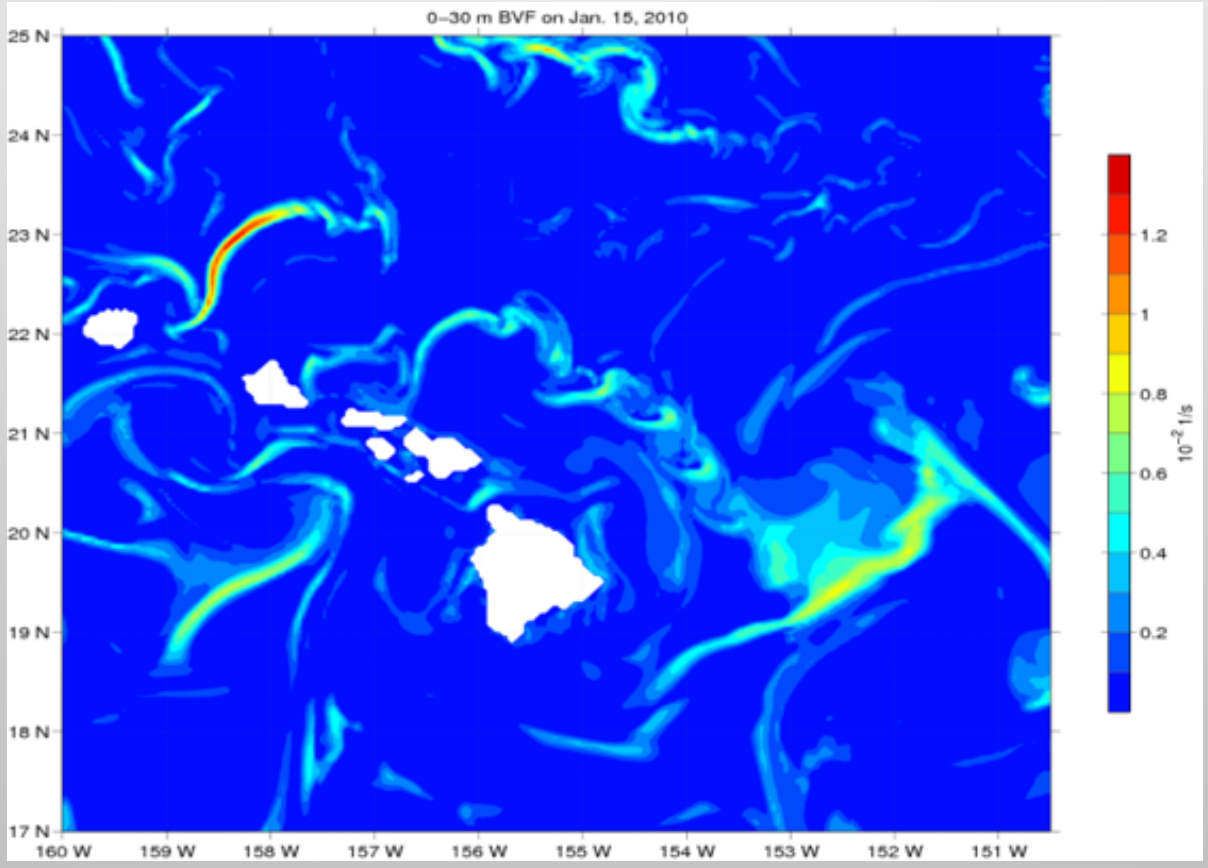

[m s-1]
0.96
0.9
0.84
0.78
0.72
0.66
0.6
0.54
0.48
0.42
0.36
0.3
0.24
0.18
0.12
0.06
0


NPP
0001-01-01
[mmol m-2 d-1]
138
132
126
120
114
108
102
96
90
84
78
72
66
60
54
48
42
36
30
24
18
12
6
0


Winter
Summer
Observations
0.1° Model
1° Model
(a)
(b)
(c)
(d)
(e)
(f)
m
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
m
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4


Jan–Mar
Jul–Sep
Observations
0.1° Model
1° Model
(a)
(b)
(c)
(d)
(e)
(f)
mg m^{-3}
10^{1}
10^{0}
10^{-1}
10^{-2}

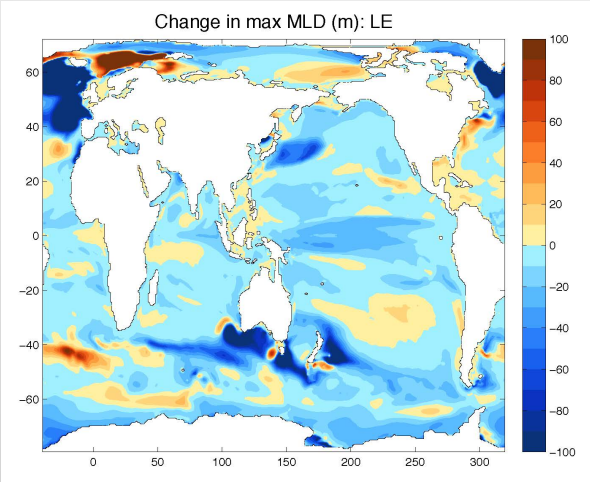
Regional model to downscale to the submesoscale

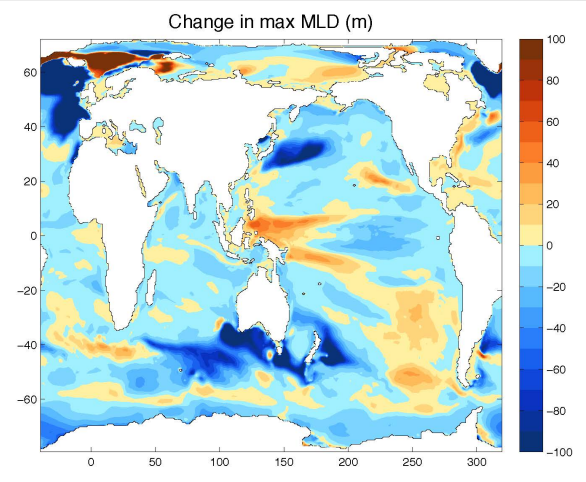


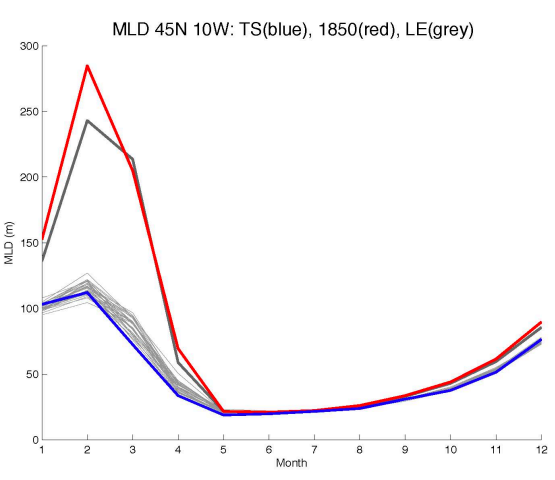
Forcing

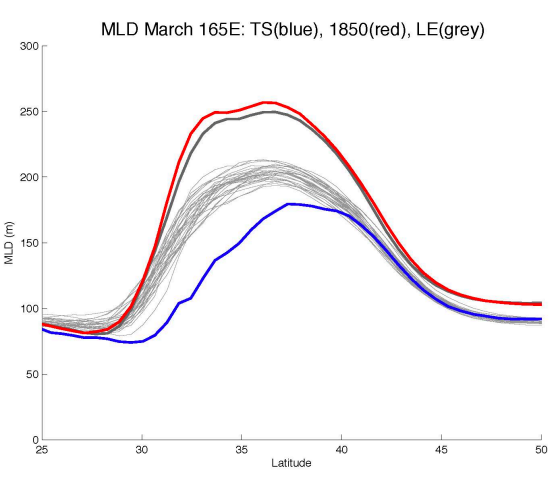
- Present Day: CORE typical year
- Future: CORE + plus anomaly in seasonal forcing got from the Large Ensemble CESM RCP 8.5 projection

Future atmospheric state: timeslice

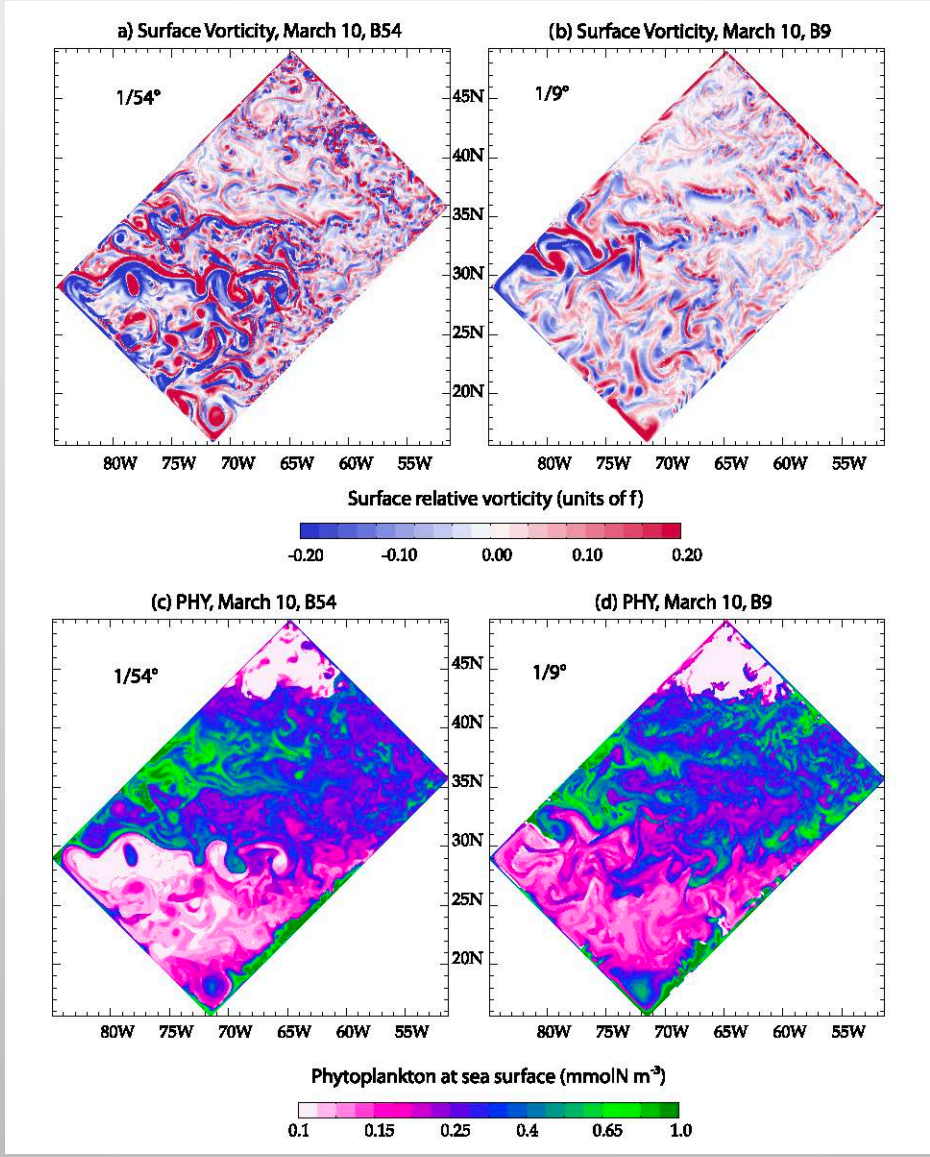




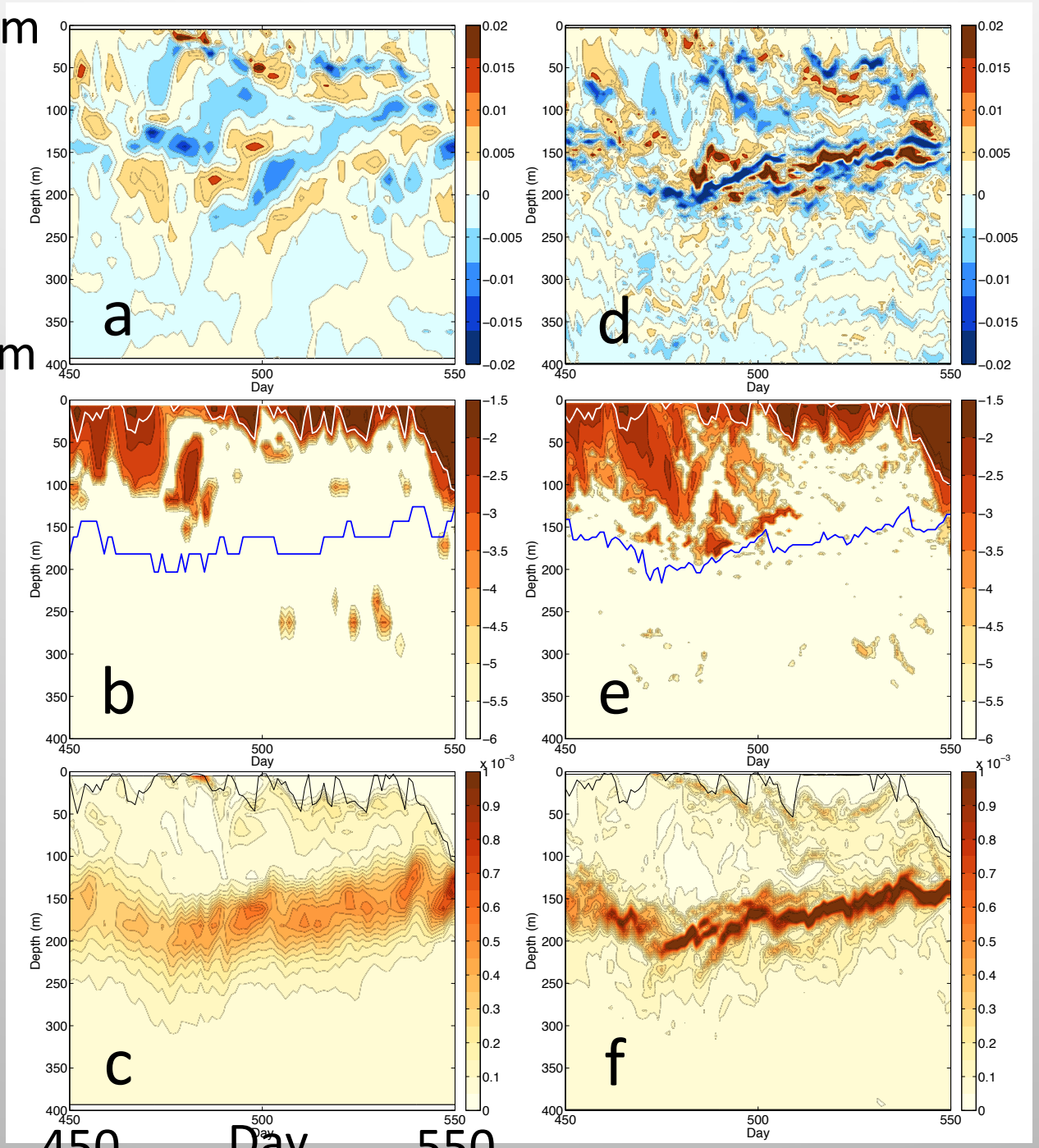




Caution:



Levy et al 2012



Don't forget the vertical

To be continued …