High Resolution Nested HYCOM Simulations of the West Florida Shelf

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Initial Goal

- **Evaluate HYCOM as a Coastal Ocean Model**
  - **Preliminary evaluation**
    - **HYCOM still under development as a coastal model**
      - **e.g. no tidal forcing**
    - **Study response to atmospheric forcing and Loop Current over the continental shelf**
  - **Focus on:**
    - **Sensitivity to vertical coordinate type**
      - **Level versus sigma**
    - **Sensitivity to vertical resolution**
    - **Sensitivity to vertical mixing choice**
      - **KPP**
      - **MY2.5**
    - **Evaluate new KPP bottom b. l. parameterization**

Nested WFS Simulation

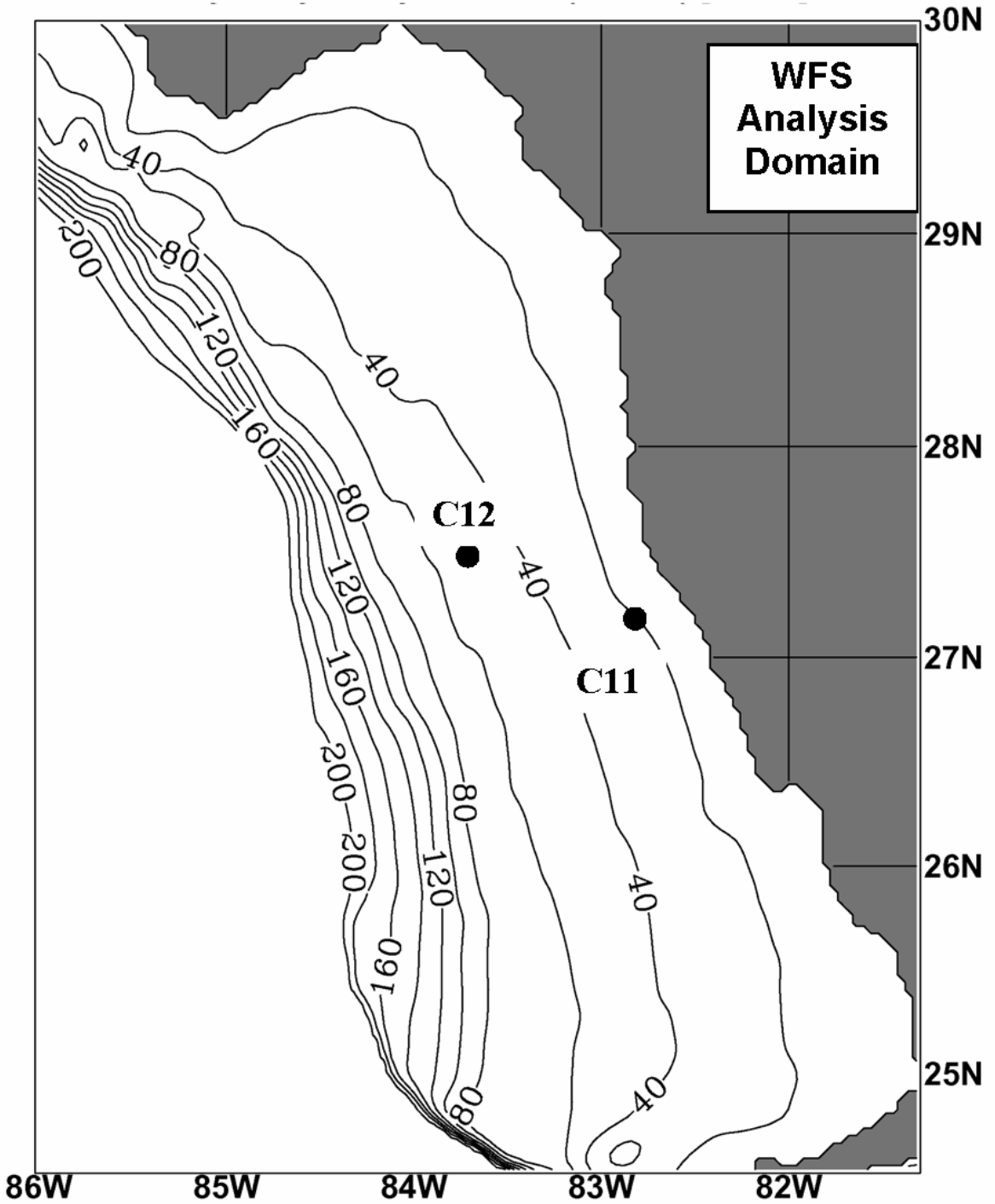
- Configuration
  - 1/25 degree Mercator grid
  - 5m coastline, 10m minimum depth
  - No assimilation
  - Forcing
    - 3-hr NOGAPS + ECMWF mean
  - Free-running with SSS relaxation to GDEM3
  - Initial/boundary conditions
    - IAS climatological simulation run by T. Townsend
      - Free-running
      - Also 1/25 degree
      - Used year 10 of the model beginning 1 Jan.
  - Run for 1 Jan. – 31 Aug. 2002

WFS Bathymetry

Subregion of full nested basin

Time series analysis stations C11 and C12 are shown

Synthetic moorings are deployed at these stations – observations are sampled every 40 minutes.

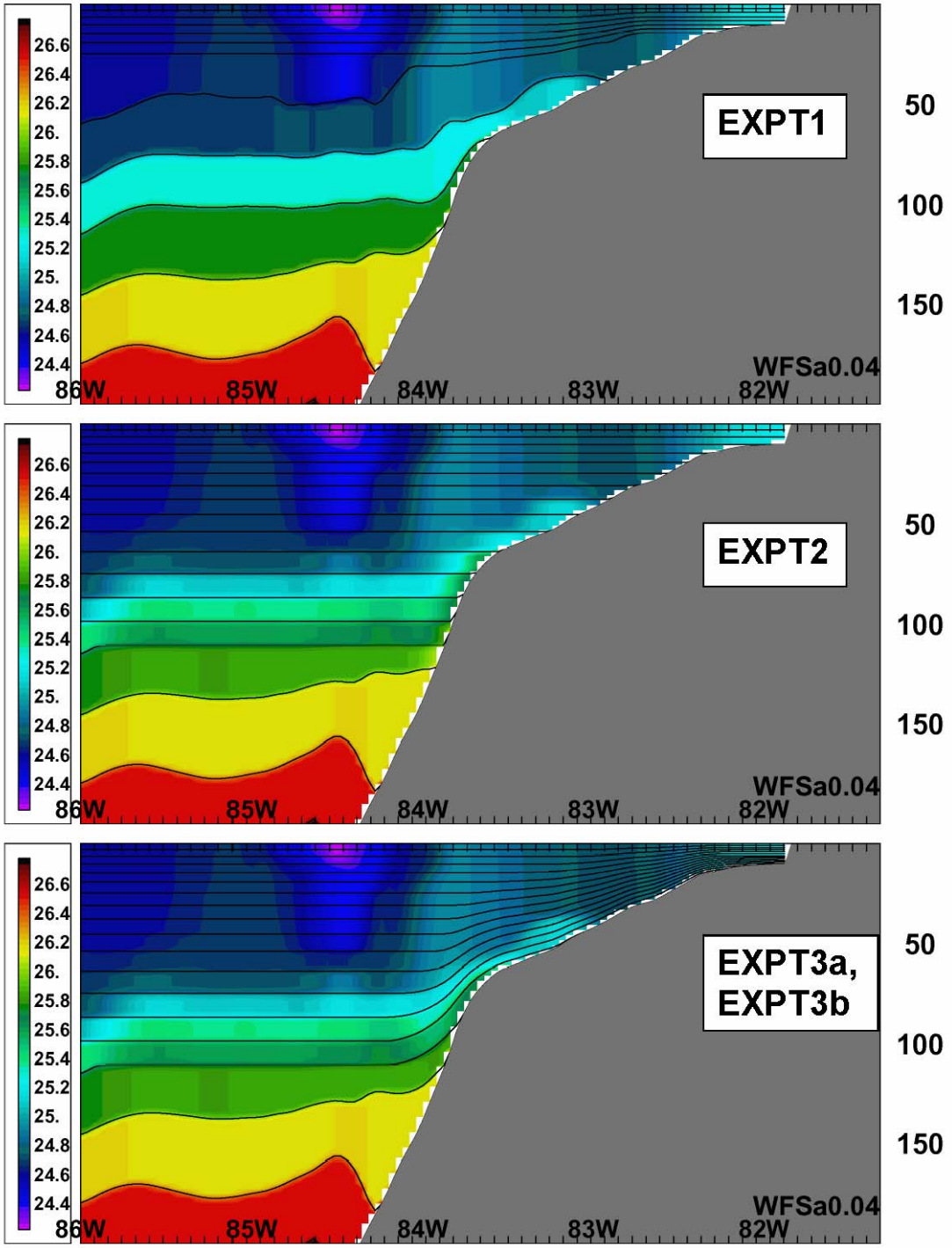


Vertical Coordinate Choices

- Original IAS model (22 layers in IAS)
  - Thin surface z layer preferred for basin-scale simulations
  - Provides poor surface to bottom resolution over middle and outer shelf
- 28-layer, z coordinates over the shelf
- 28-layer, sigma coordinates over the shelf

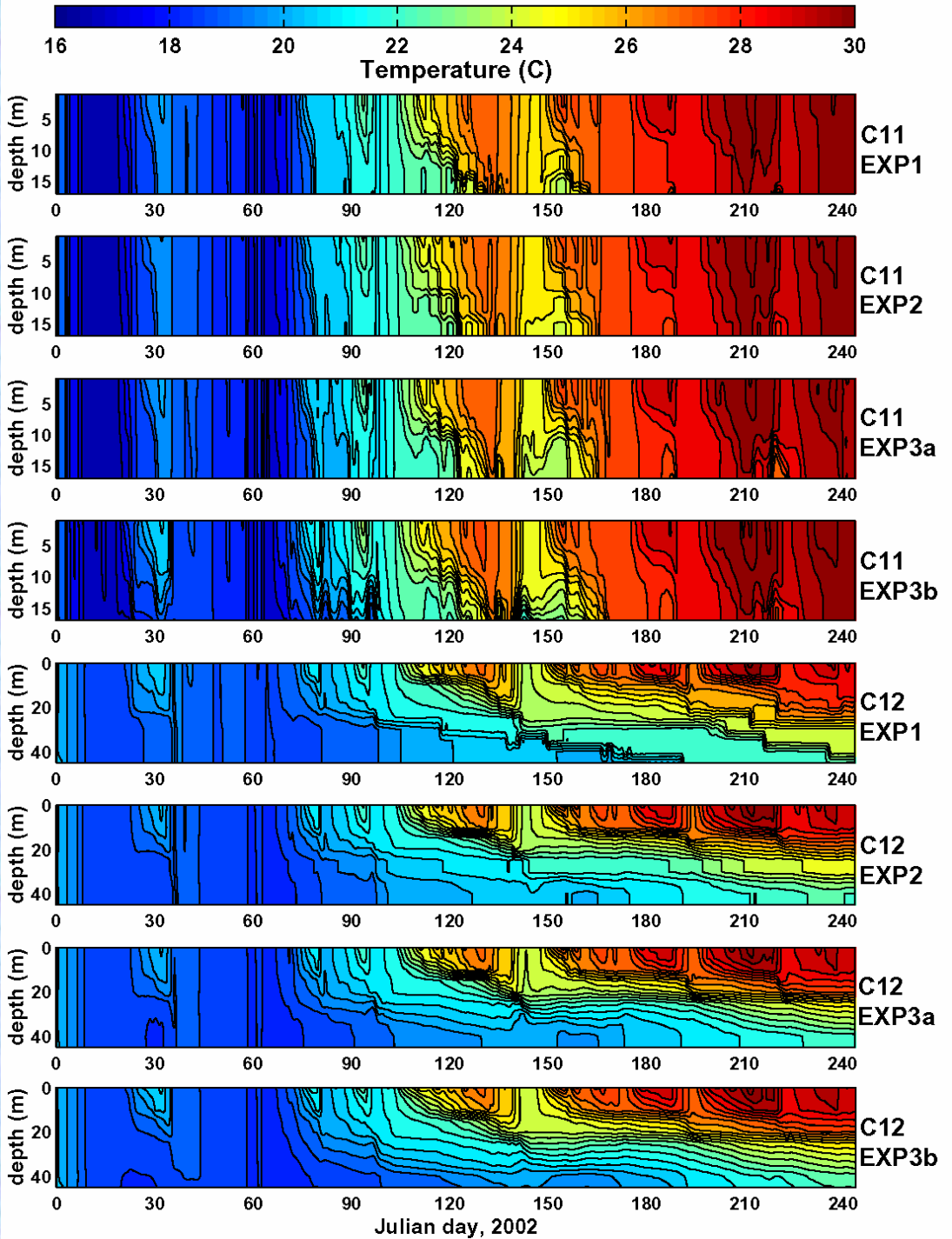
Initial Conditions at 27N from the IAS Model

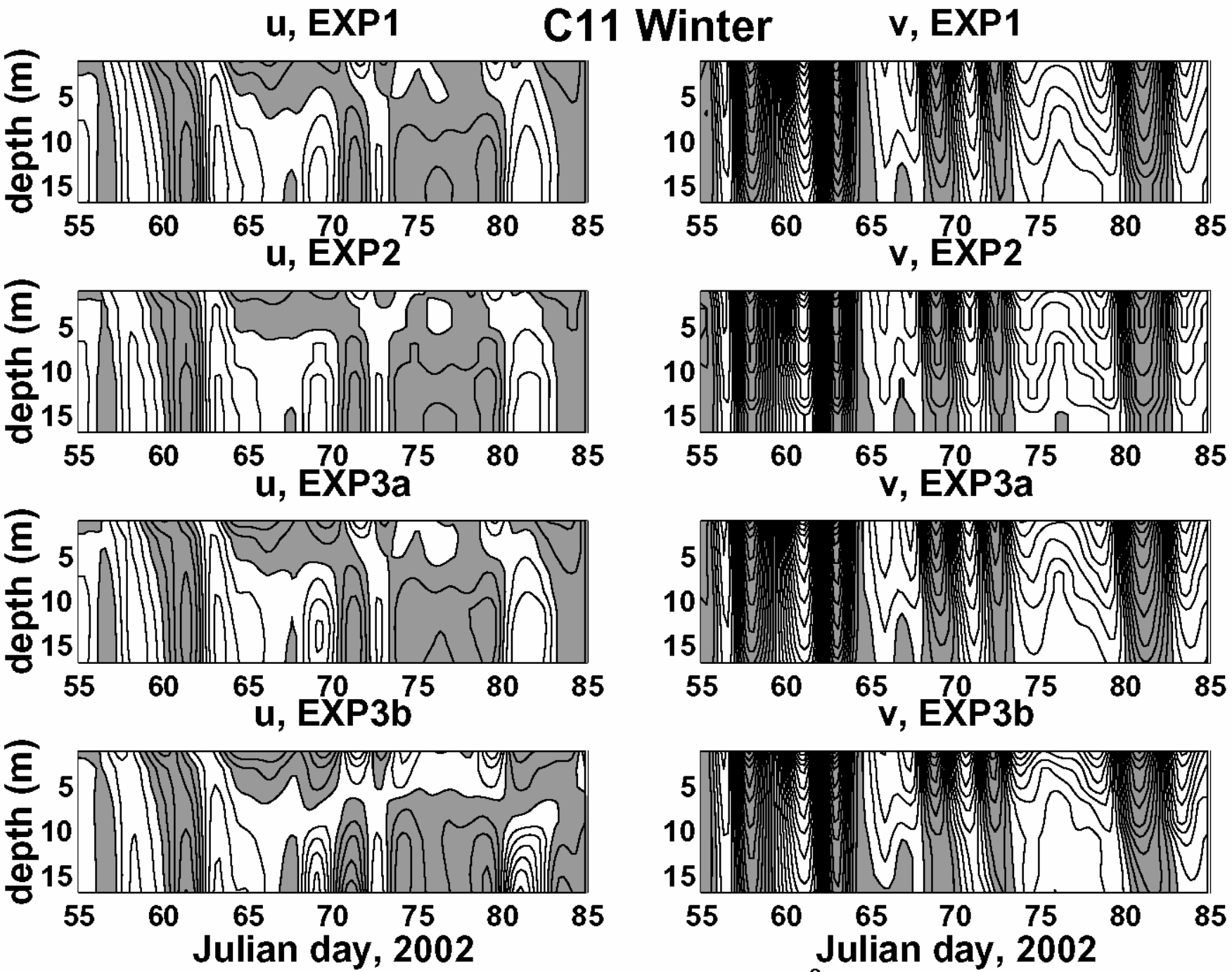
Illustrates 3 vertical coordinate choices and the 4 WFS experiments

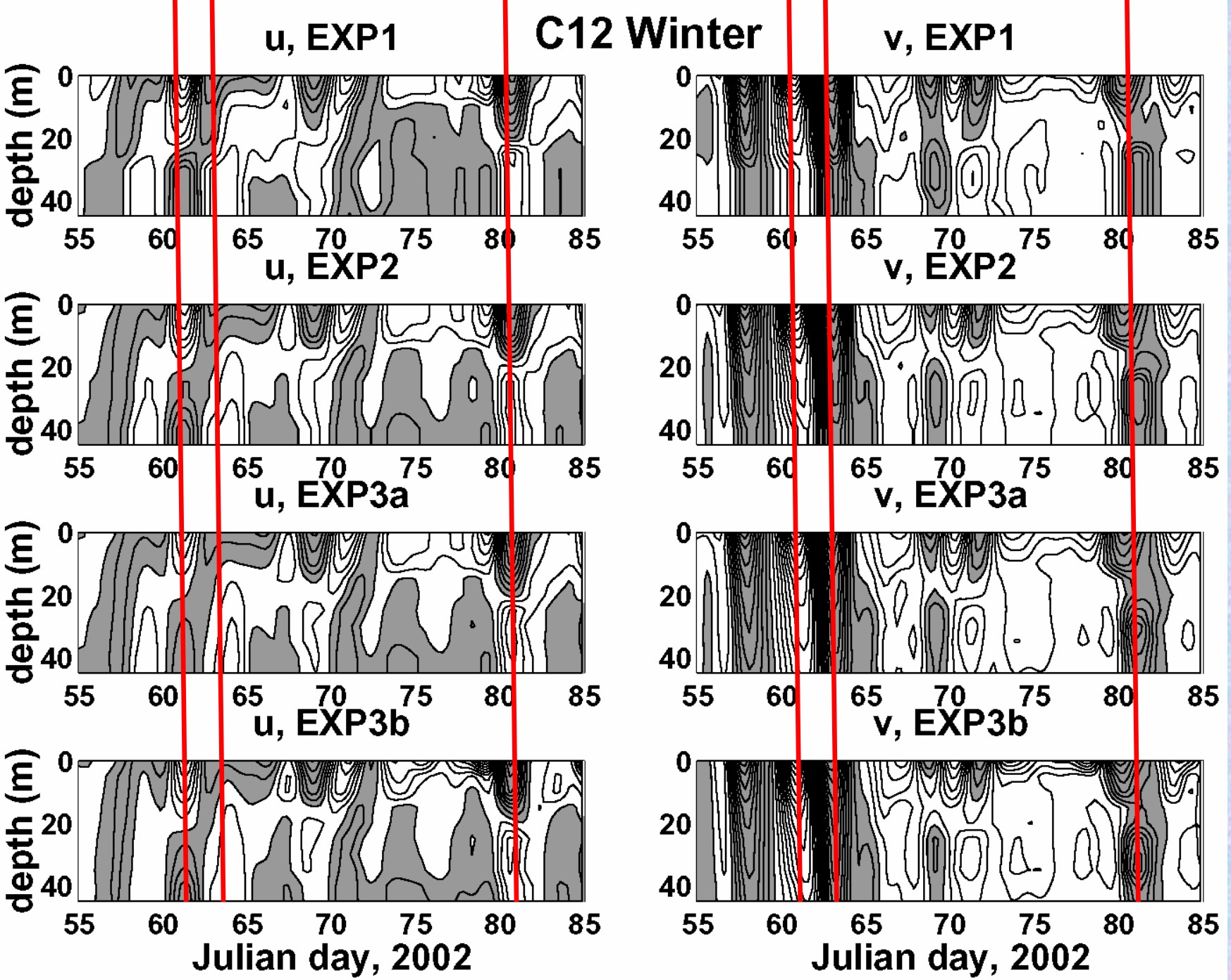


Analysis

- Time-depth variability at C11, C12
- Statistical intercomparison at C11, C12
- SSH maps, upwelling vs. downwelling events
- Cross-sections, two upwelling events
  - Unstratified
  - Stratified
- Loop Current forcing event
- Pressure gradient term of momentum equation


16
18
20
22
24
26
28
30
Temperature (C)
depth (m)
5
10
15
0
30
60
90
120
150
180
210
240
C11
EXP1
C11
EXP2
C11
EXP3a
C11
EXP3b
0
20
40
C12
EXP1
C12
EXP2
C12
EXP3a
C12
EXP3b
Julian day, 2002


u, EXP1
C11 Winter
v, EXP1
u, EXP2
v, EXP2
u, EXP3a
v, EXP3a
u, EXP3b
v, EXP3b
depth (m)
5
10
15
55
60
65
70
75
80
85
Julian day, 2002
contour interval: 0.025 m s^{-2}

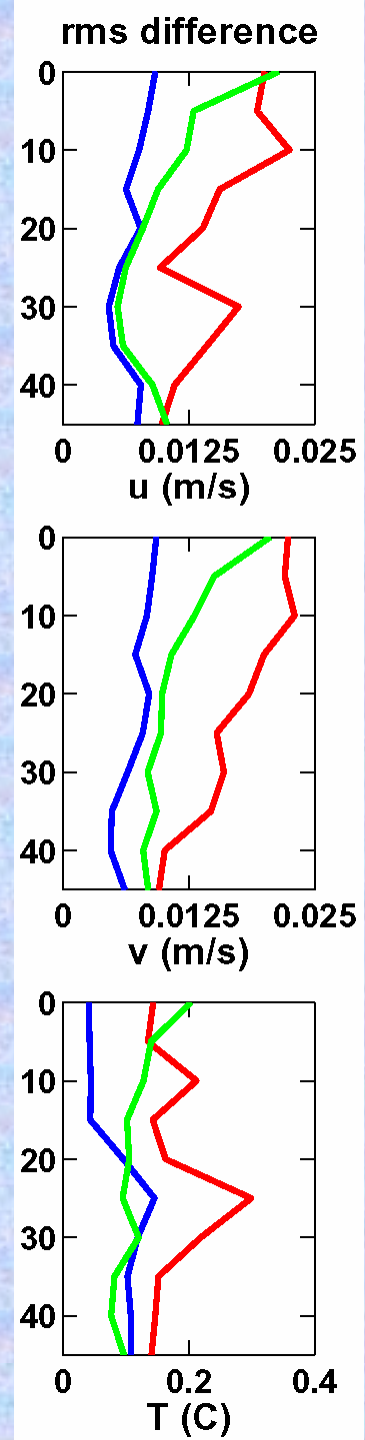

C12 Winter
u, EXP1
v, EXP1
u, EXP2
v, EXP2
u, EXP3a
v, EXP3a
u, EXP3b
v, EXP3b
depth (m)
0
20
40
55
60
65
70
75
80
85
Julian day, 2002
contour interval: 0.025 m s^{-2}

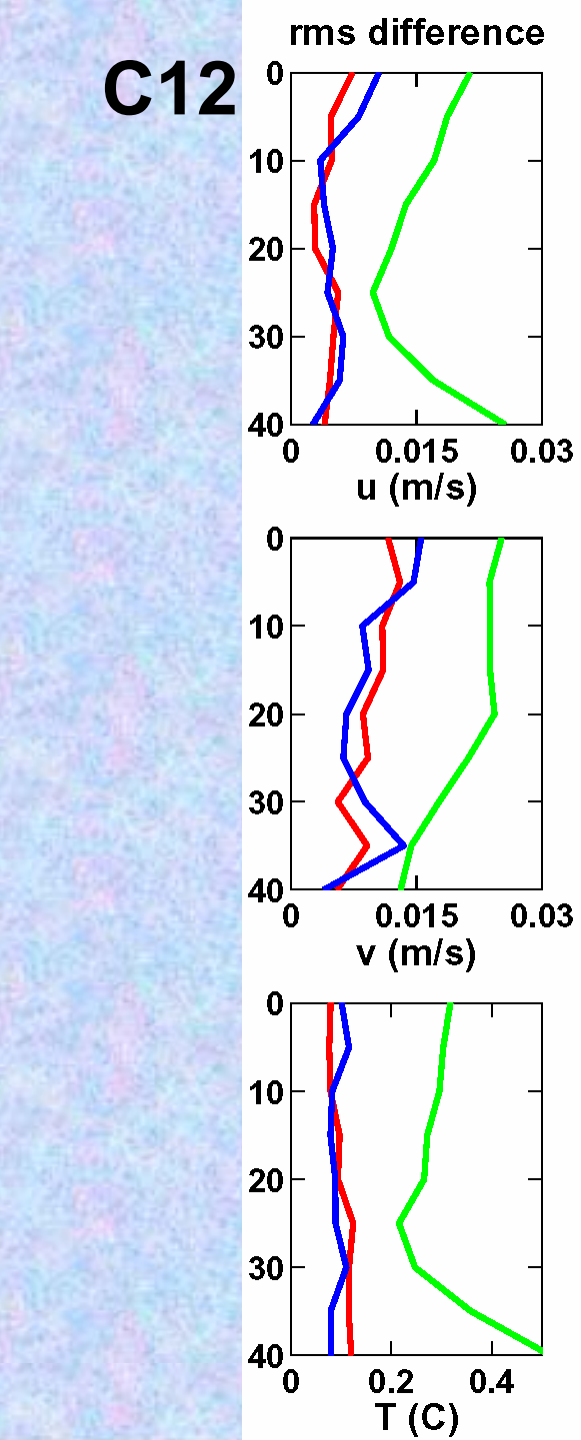
RMS Differences

EXP1-EXP3a

EXP2-EXP3a

EXP3b-EXP3a



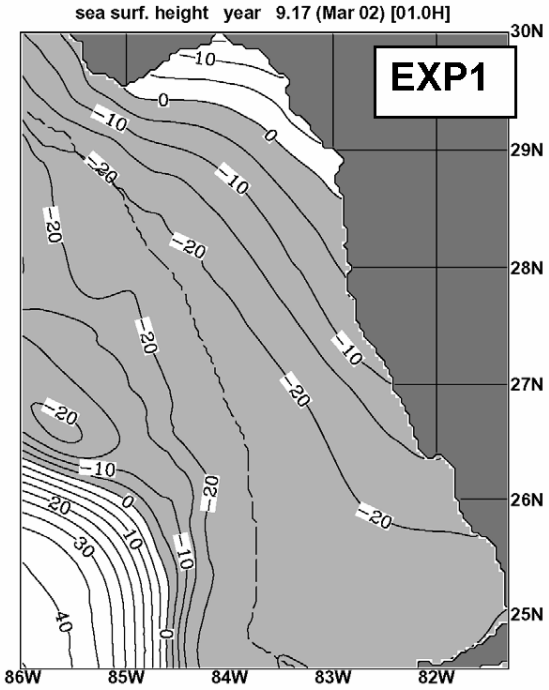


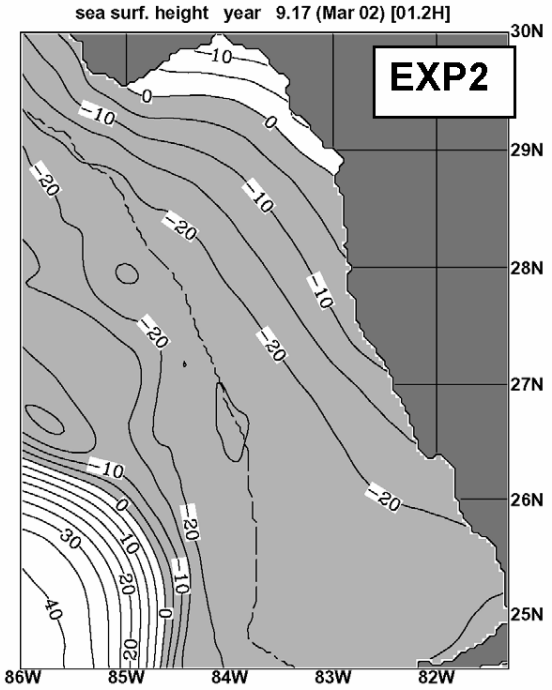
SSH Maps

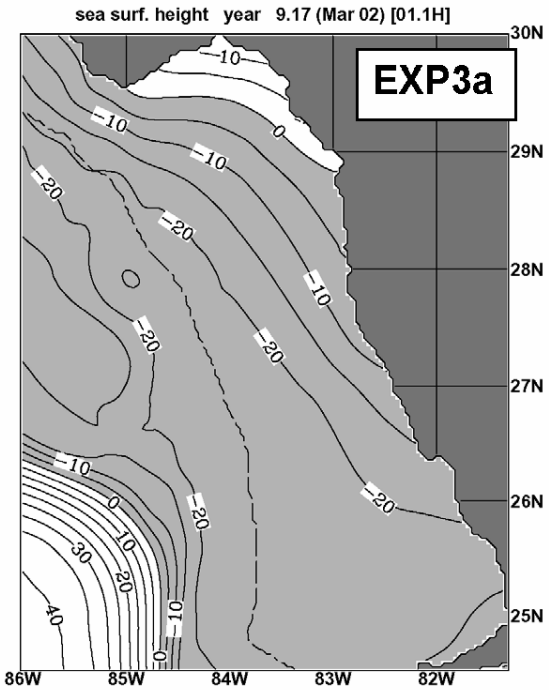
Downwelling Event

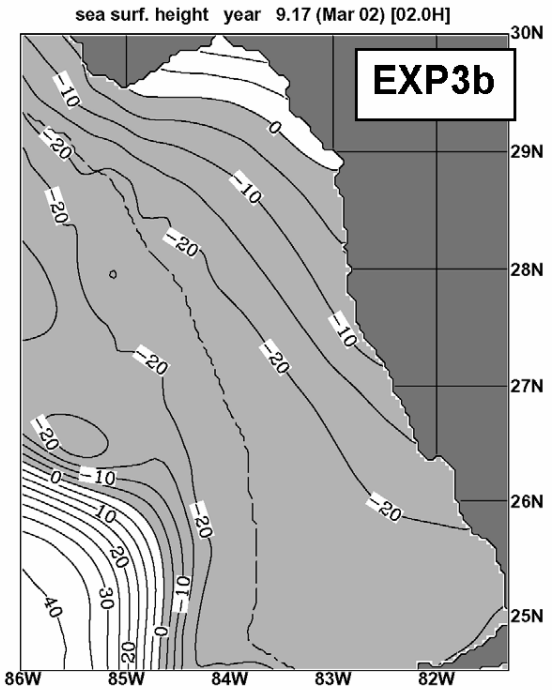
2 March 2002

Negative values are shaded







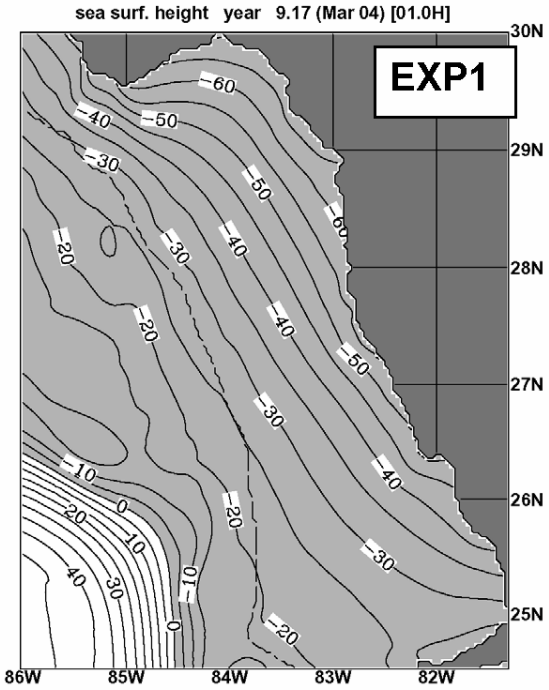


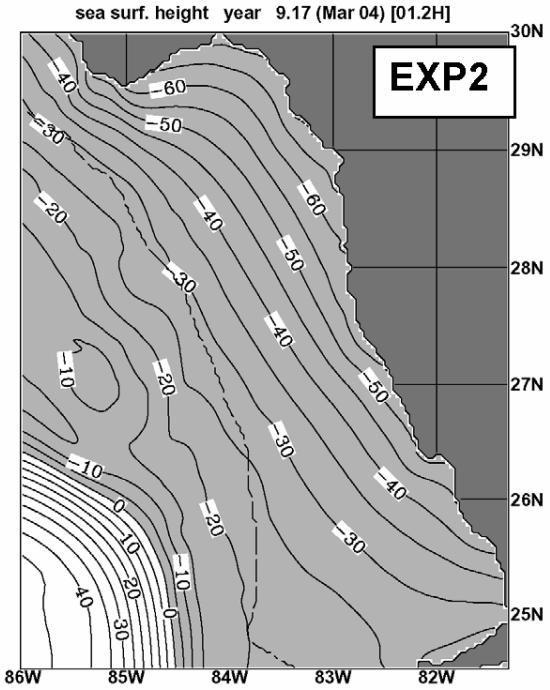
SSH Maps

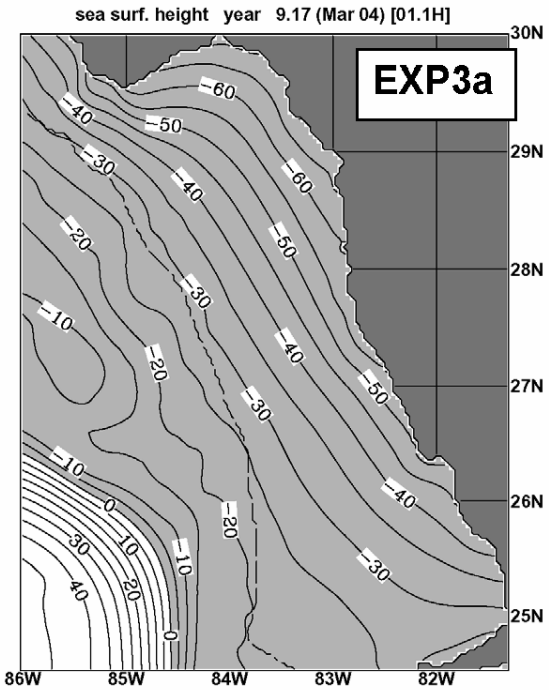
Upwelling Event

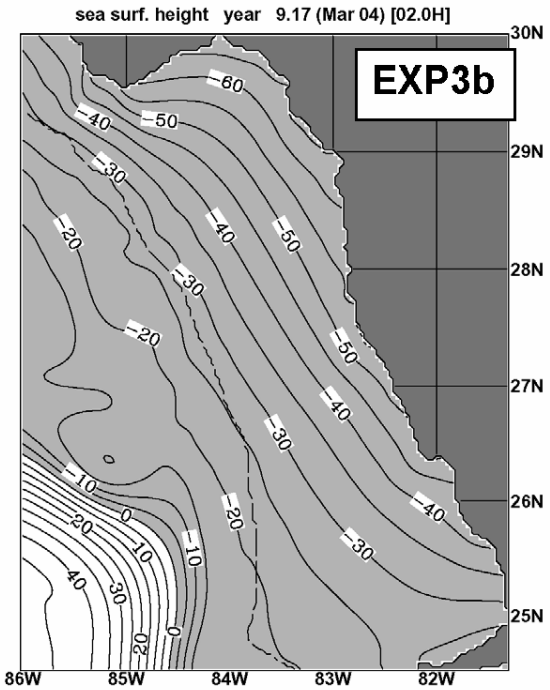
4 March 2002

Negative values are shaded





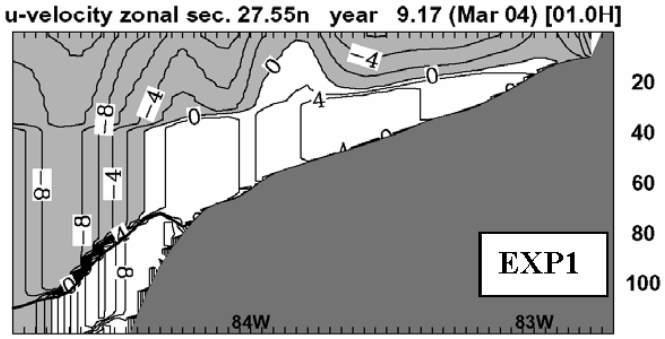


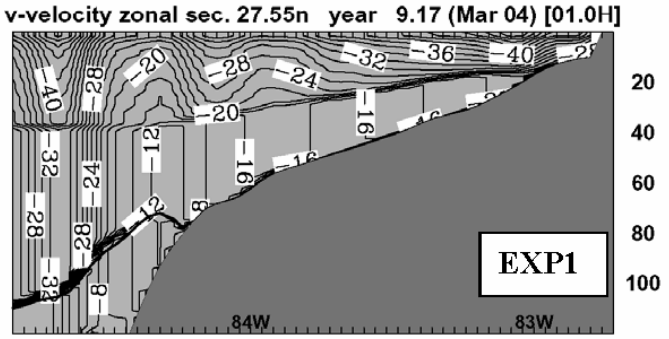


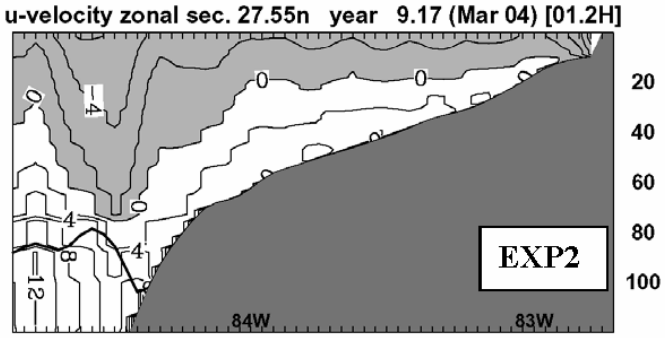
u (left)
v (right)

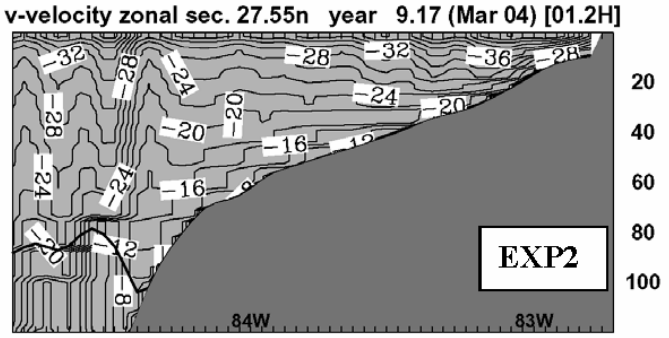
Upwelling Event, no stratification 4 March 2002

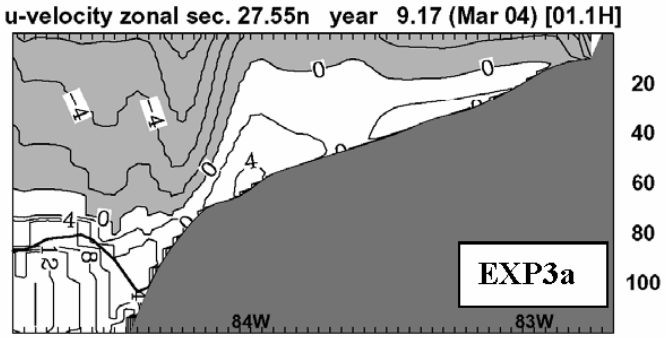
Negative values are shaded

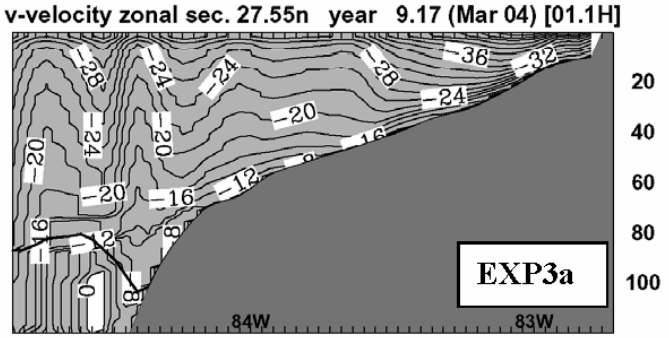


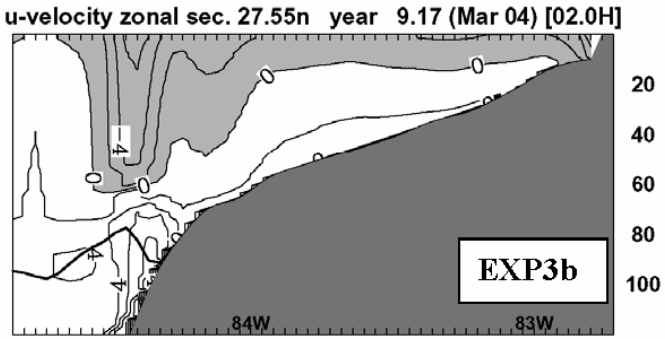


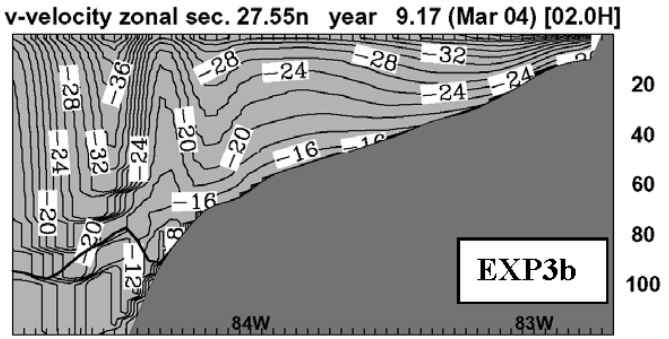






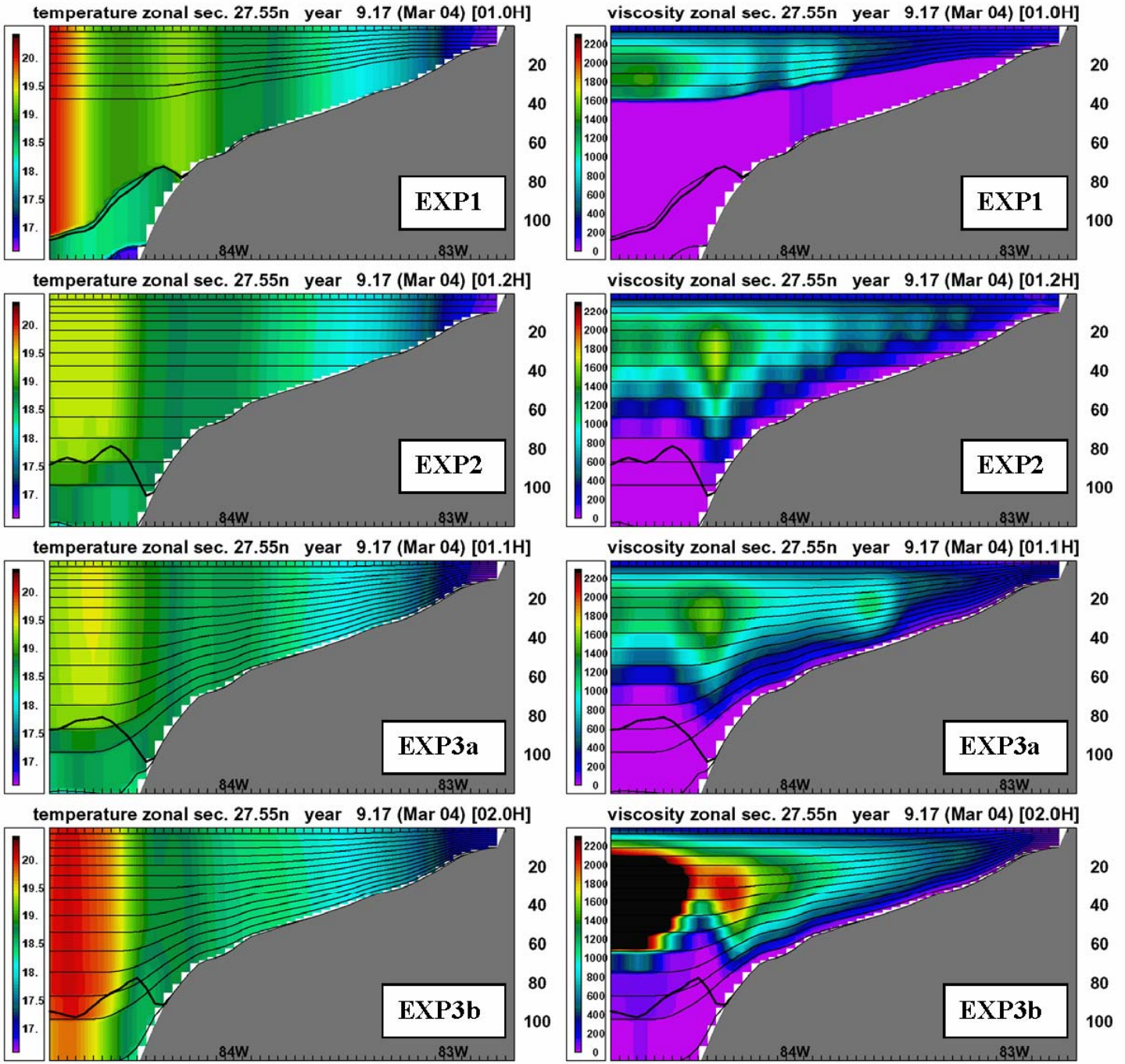






T (left)
K_M (right)

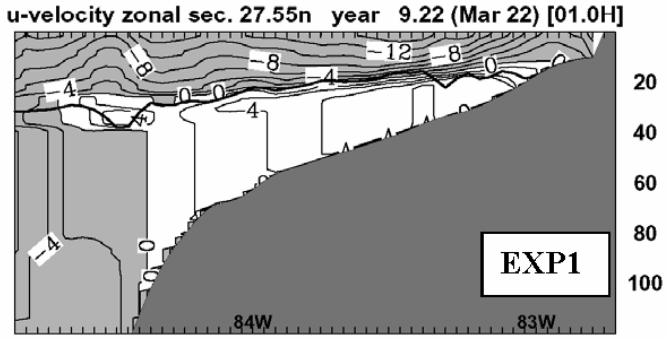
Upwelling event, no stratification 4 March 2002

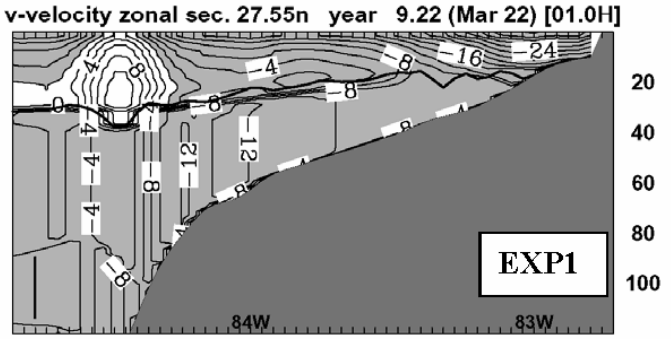


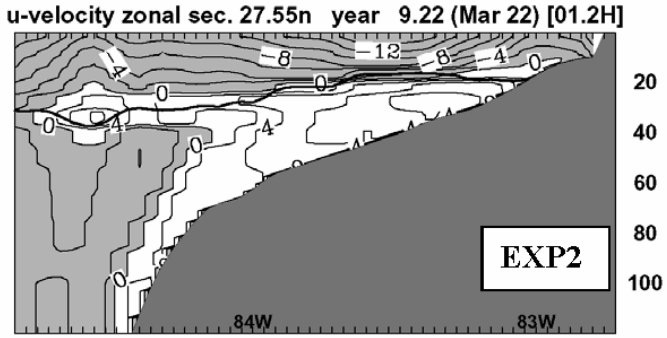
u (left)
v (right)

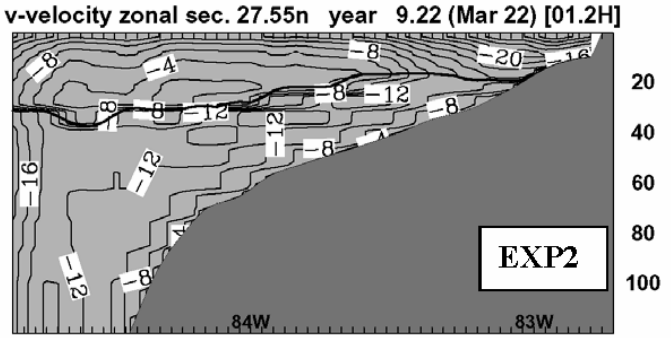
Upwelling Event with stratification 22 March 2002

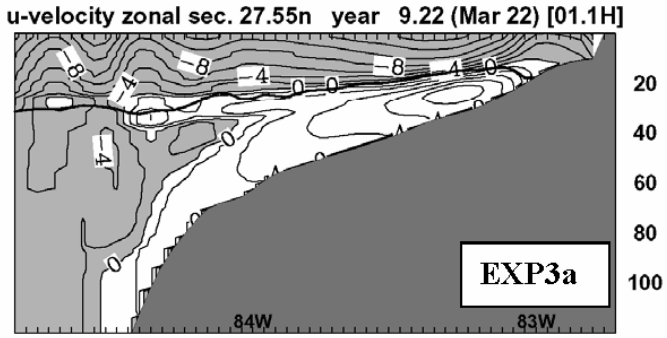
Negative values are shaded

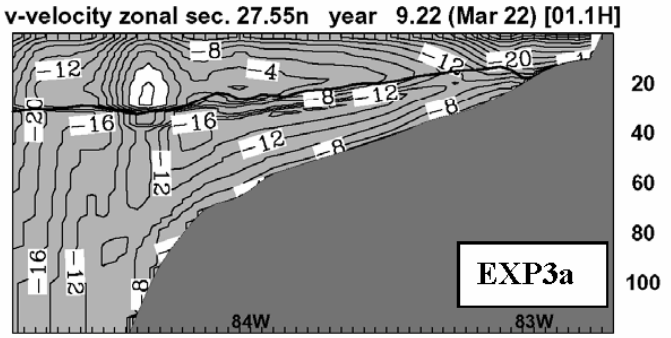


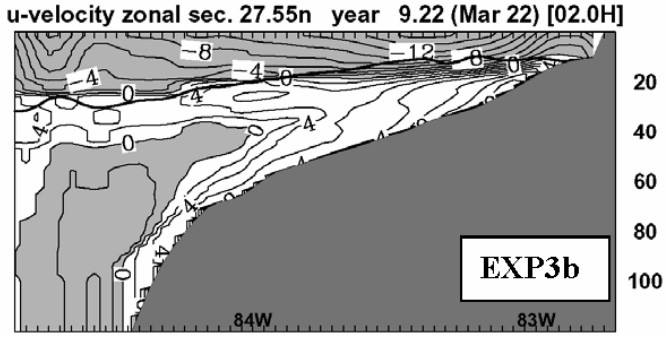


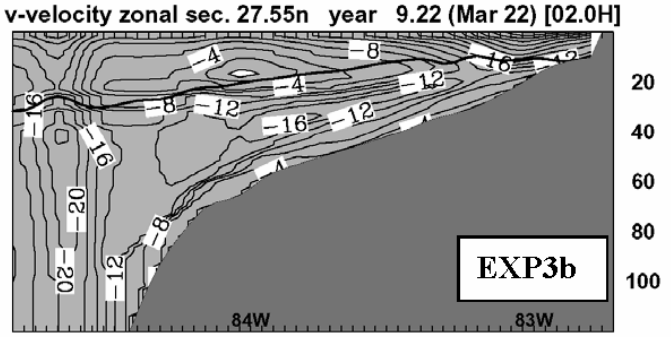






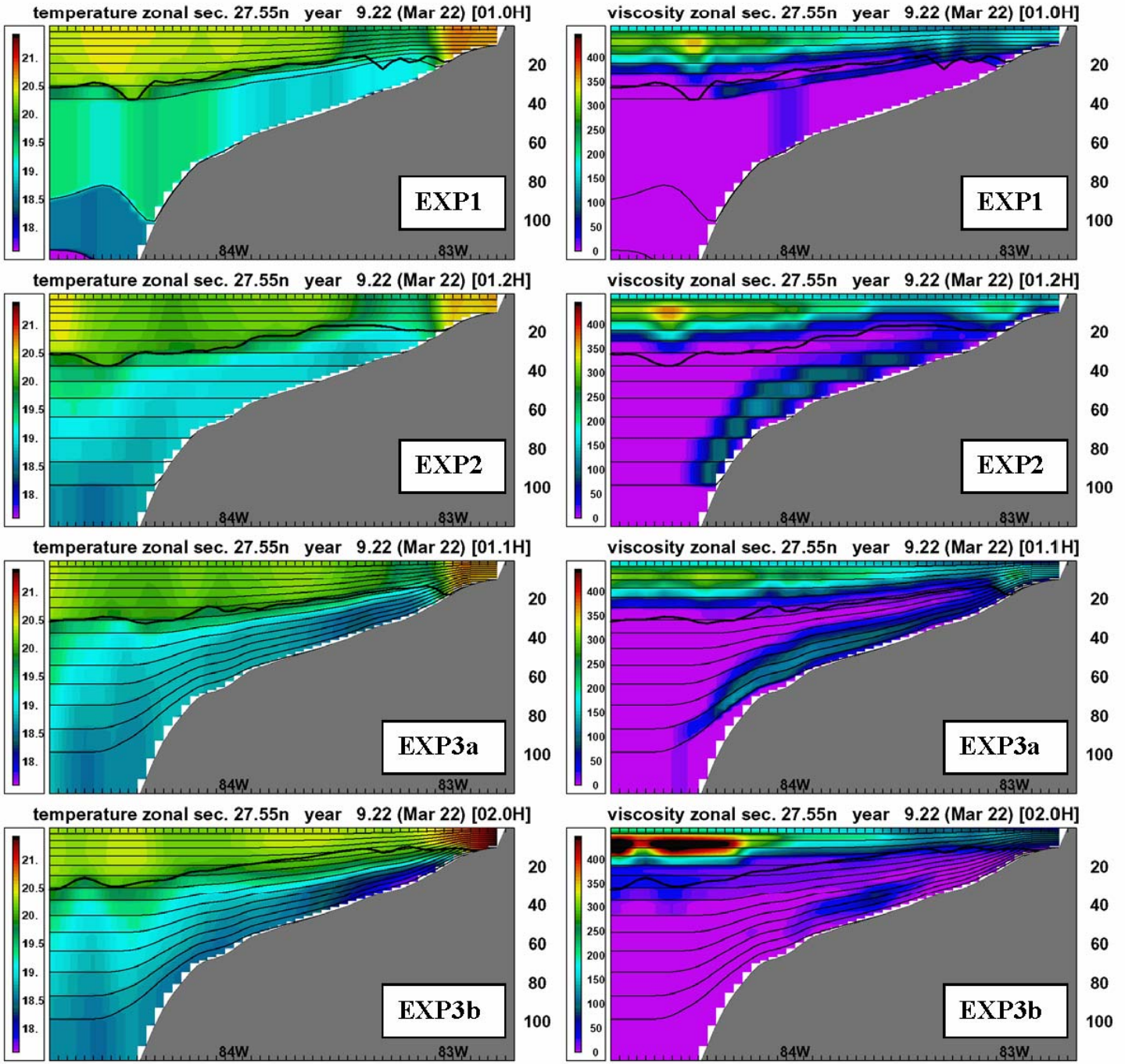






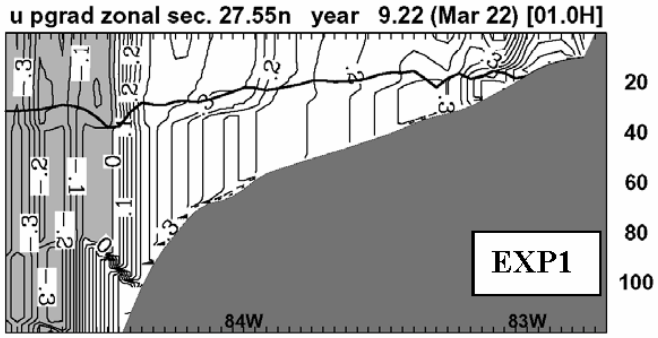
T (left)
K_M (right)

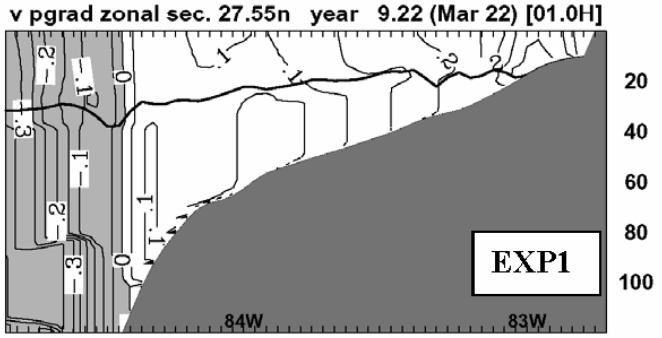
Upwelling event with stratification 22 Mar. 2002

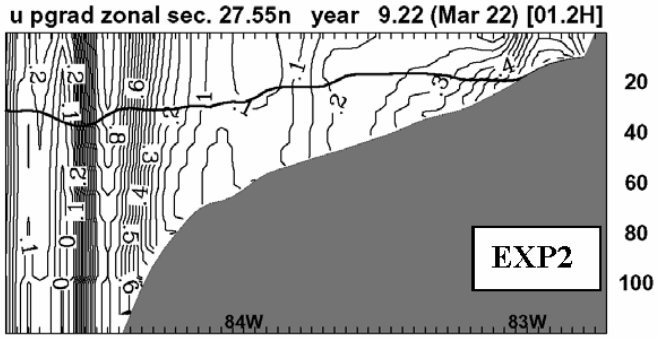


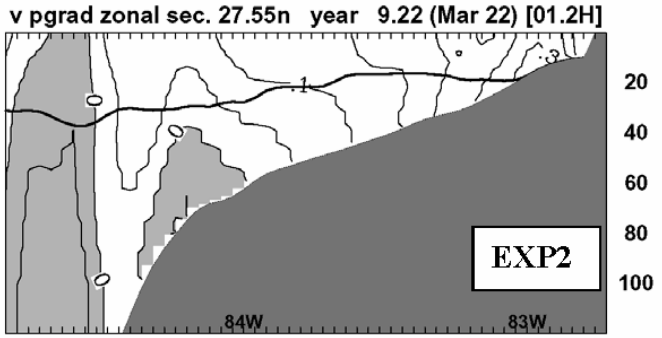
Pressure Gradient Term: x (left) y (right)

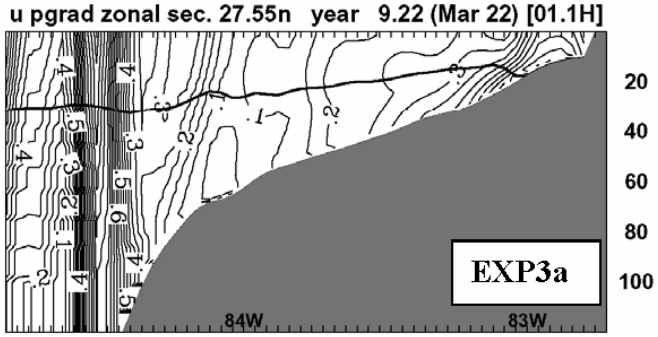
Negative values are shaded

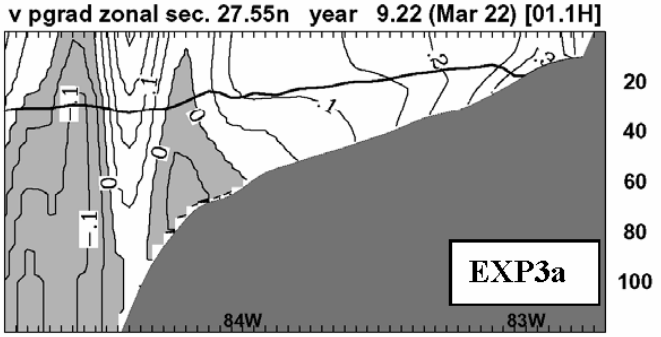


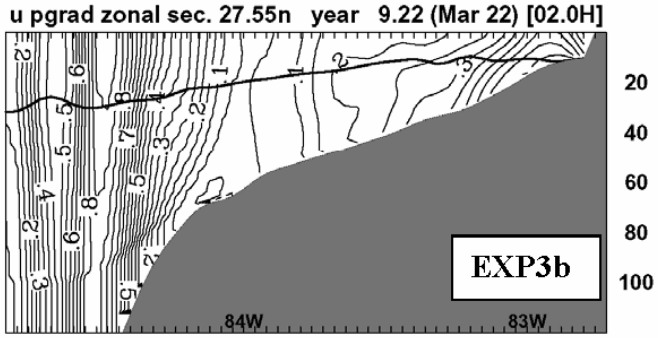


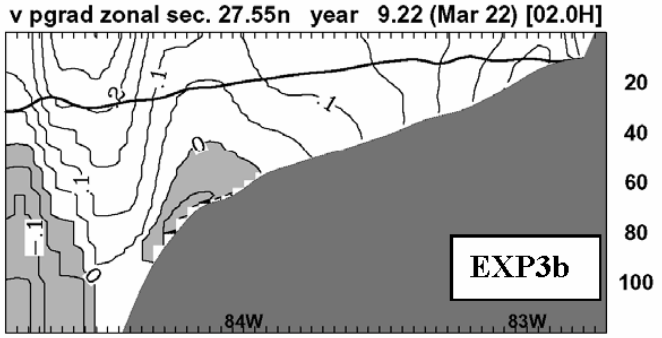










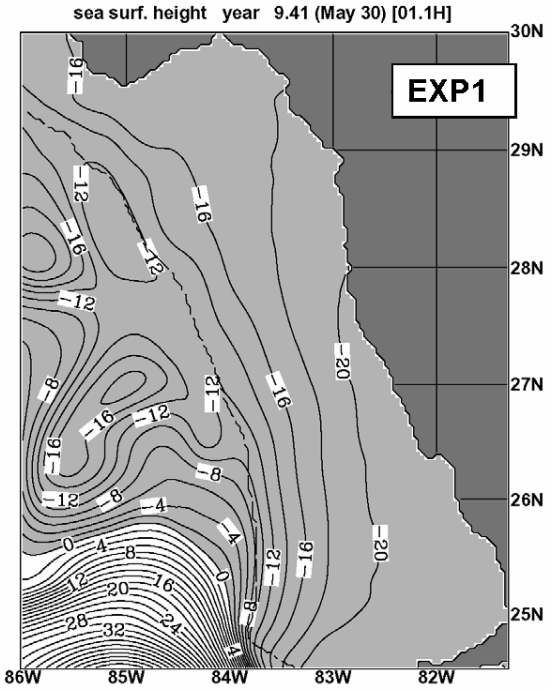


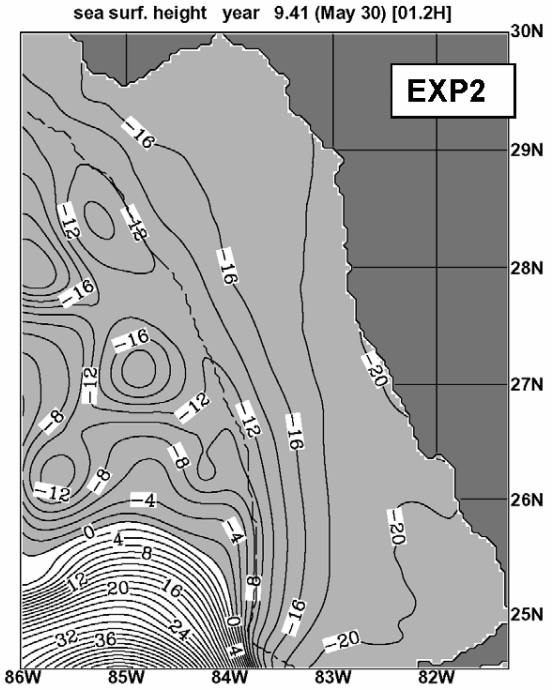
SSH Maps

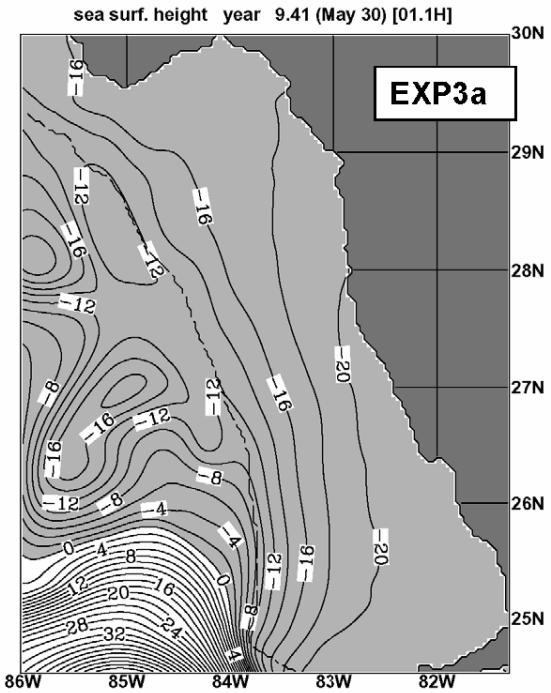
Loop Current Forcing Event

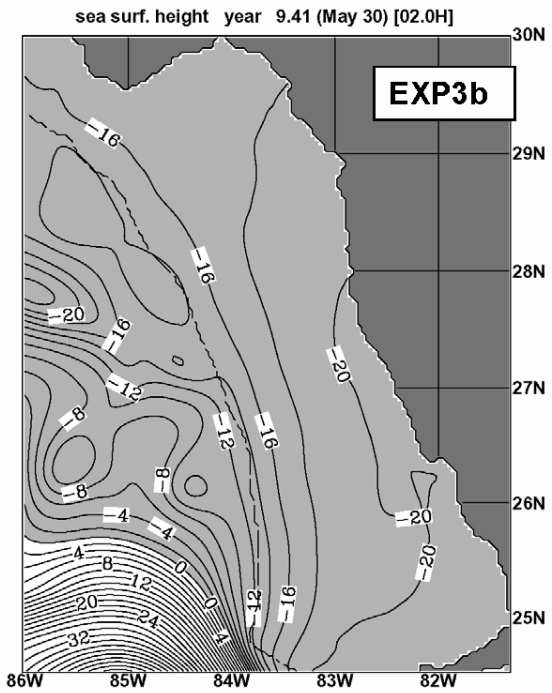
30 May 2002

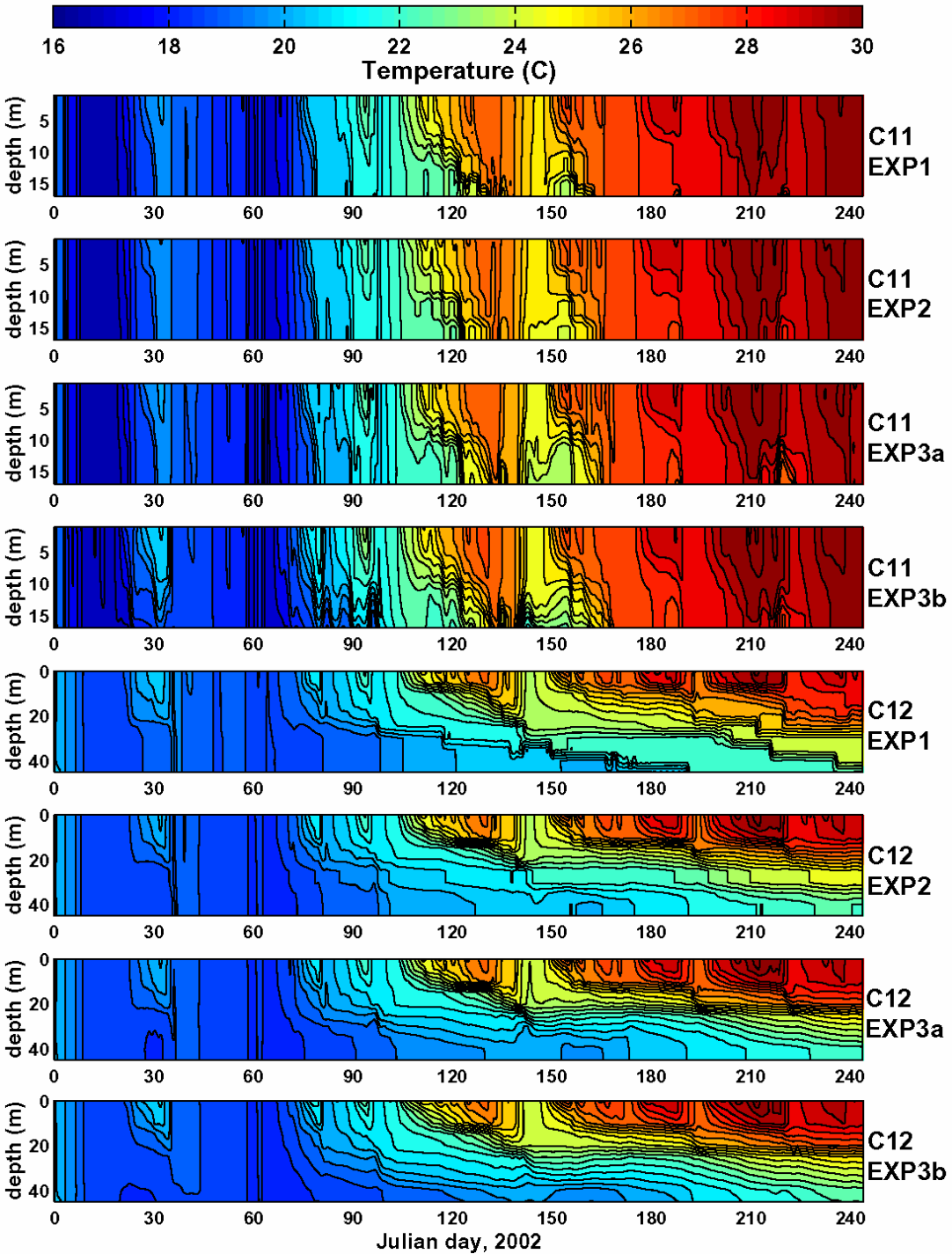
Negative values are shaded







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Temperature (C)
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C11
EXP2
C11
EXP3a
C11
EXP3b
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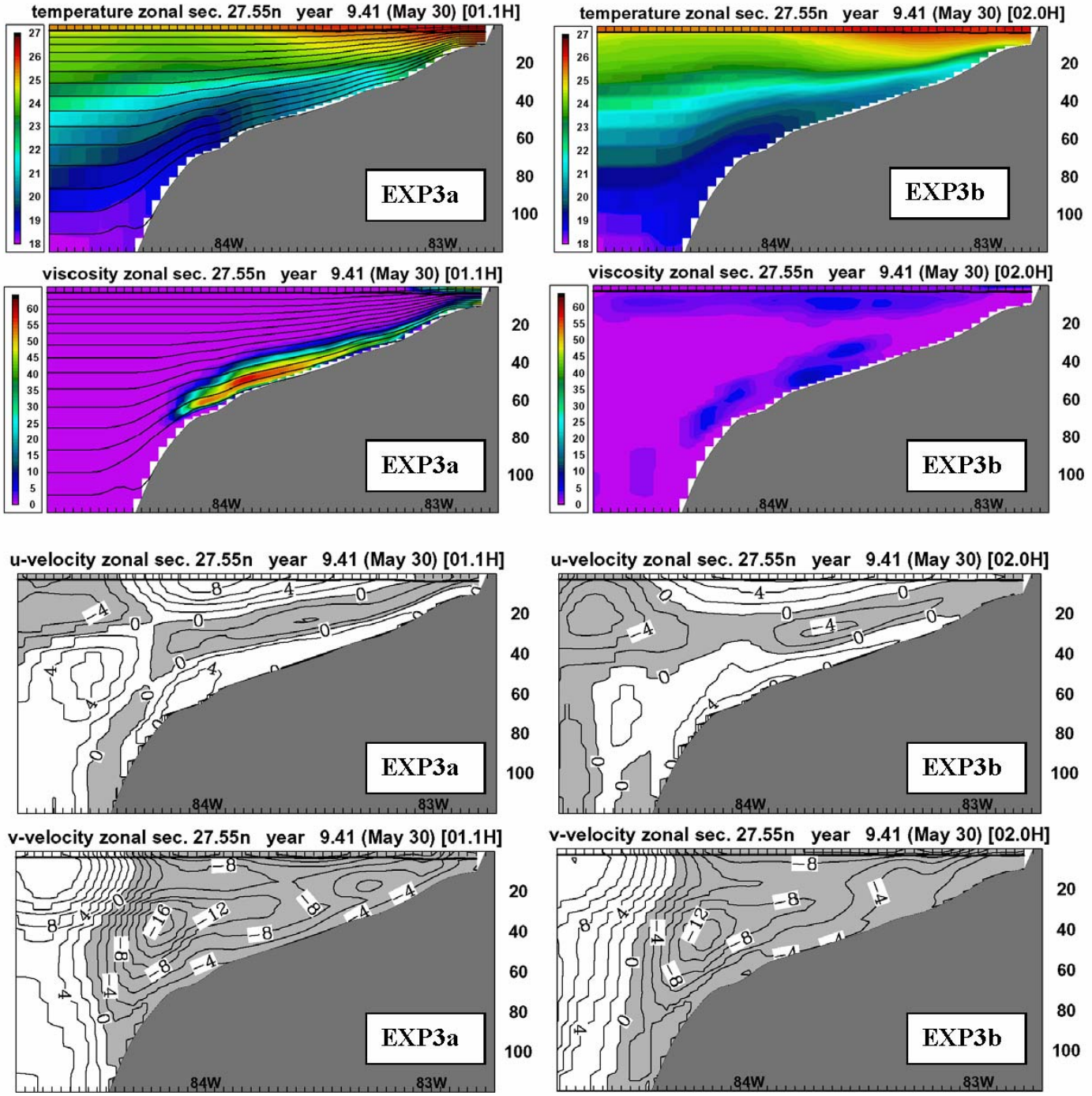
C12
EXP1
C12
EXP2
C12
EXP3a
C12
EXP3b
Julian day, 2002

T,K_M,u,v

Loop Current Forcing Event 30 May 2002

Negative values are shaded



Summary

- HYCOM appears to be performing reasonably well (qualitatively) as a coastal model
- The KPP bottom b. l. parameterization appears to be performing well, although it may need tuning
- Both vertical resolution and vertical mixing choice significantly influence the solutions
  - Bottom b. l. not resolved
- Vertical coordinate type (z vs. sigma) has a smaller influence
  - Pressure gradient error associated with sigma coordinates does not appear to be large

Future Plans

- HYCOM hurricane simulations
  - With Nick Shay, Daniel Jacob, Shuyi Chen, Wei Zhao
- Continue HYCOM evaluation over WFS
  - Collaboration with R. Weisberg
  - Evaluate HYCOM improvements (e.g. tidal forcing)
- Other collaborations
- Several other HYCOM proposals pending or in preparation