

A night photograph of a Venetian canal, likely the Grand Canal, with numerous lights reflecting on the water's surface. The scene is dark, with the primary light sources being the streetlights and building lights along the canal's edges. The water is dark, and the reflections create a series of vertical lines of light. In the background, a large, illuminated building is visible, possibly a church or a government building. The overall atmosphere is serene and historic.

Vorticity Patterns Offshore of the Venetian Lagoon from HF Radar Observations

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*Andrea Mazzoldi*⁴

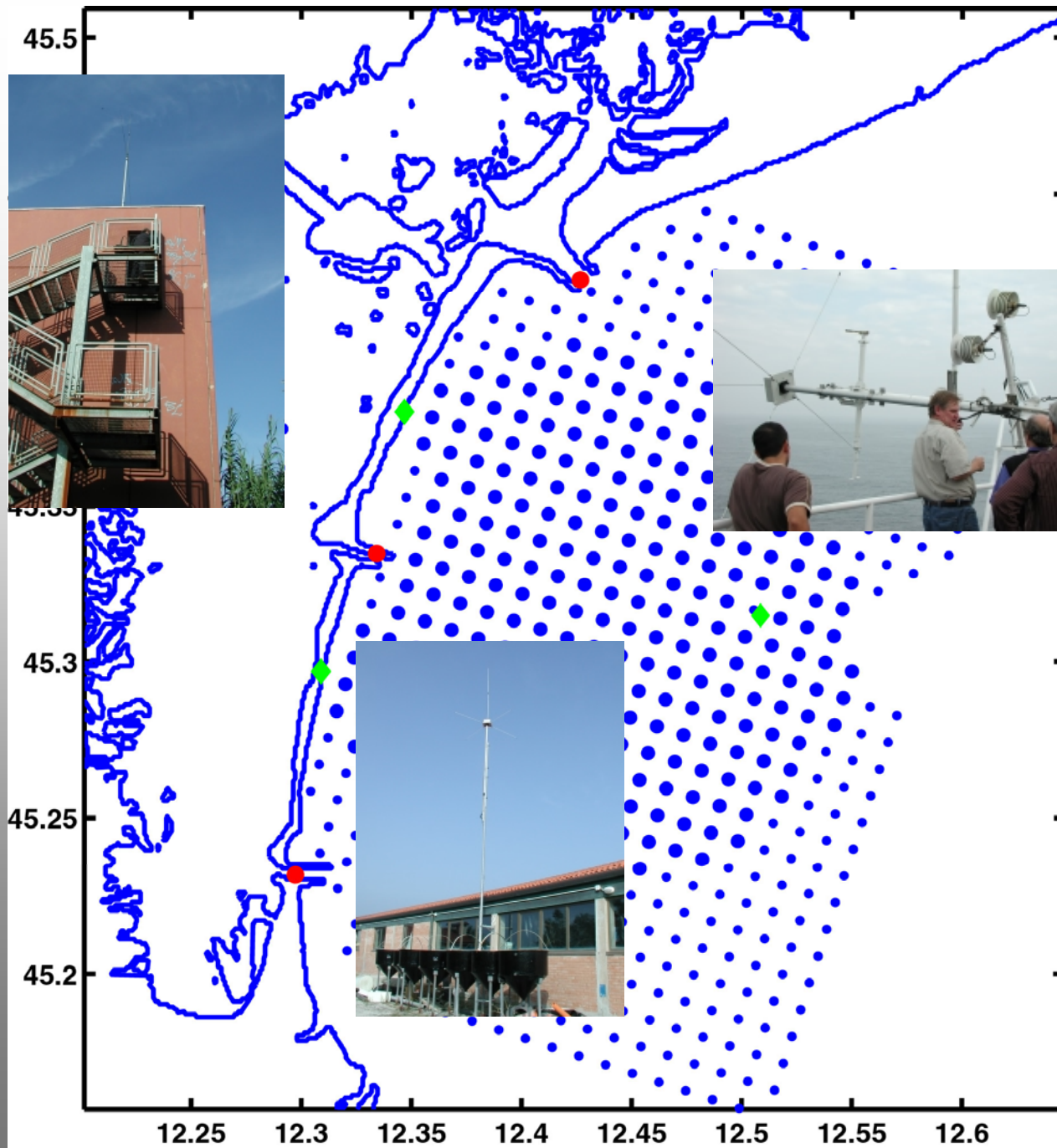
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² Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS, Sgonico (Trieste), Italy

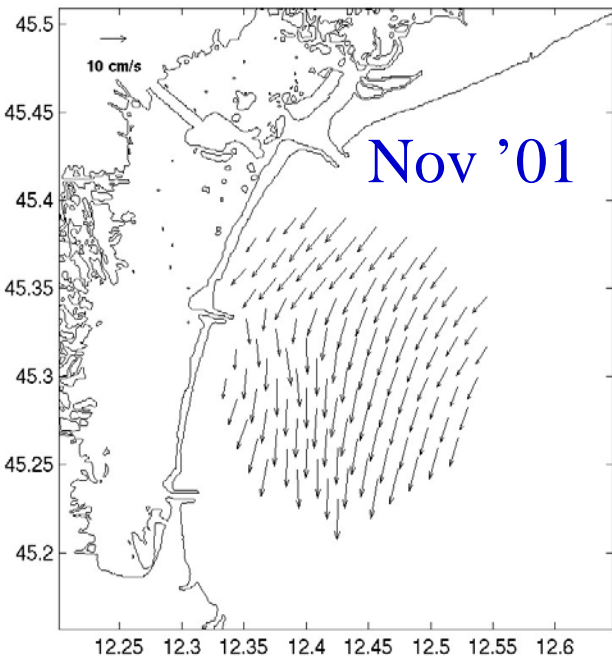
³ Escuela Superior Politécnica del Litoral, Guayaquil, Ecuador, presently at OGS, Sgonico (Trieste), Italy

⁴ ISMAR-CNR, Venice, Italy

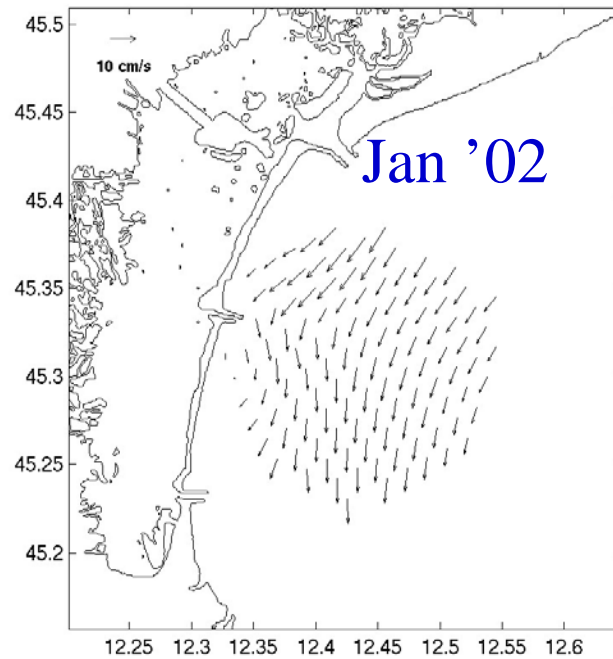
**HF radar data set:
November 2001–
October 2002**



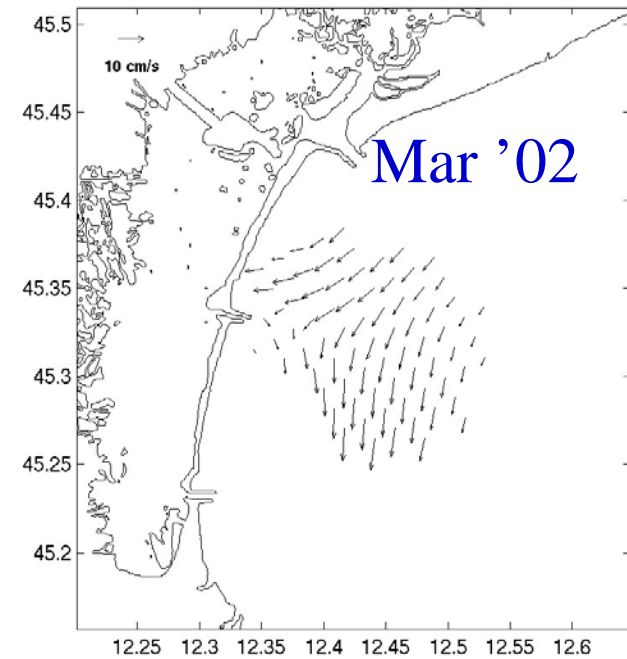
November 2001



January 2002

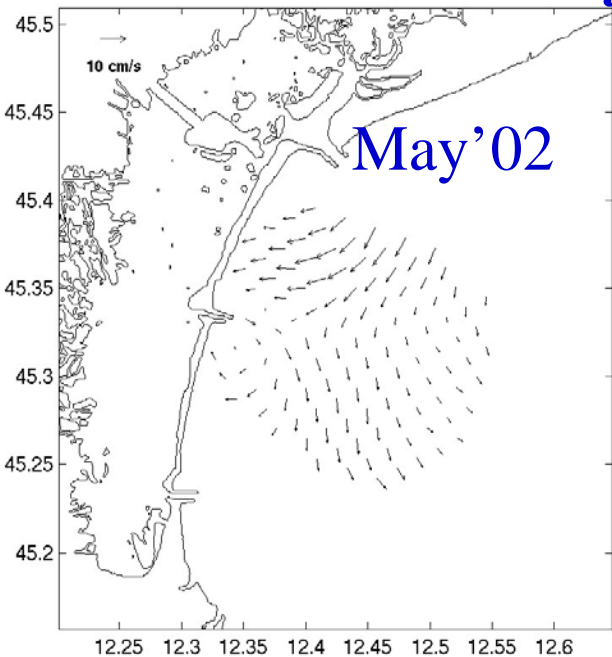


March 2002

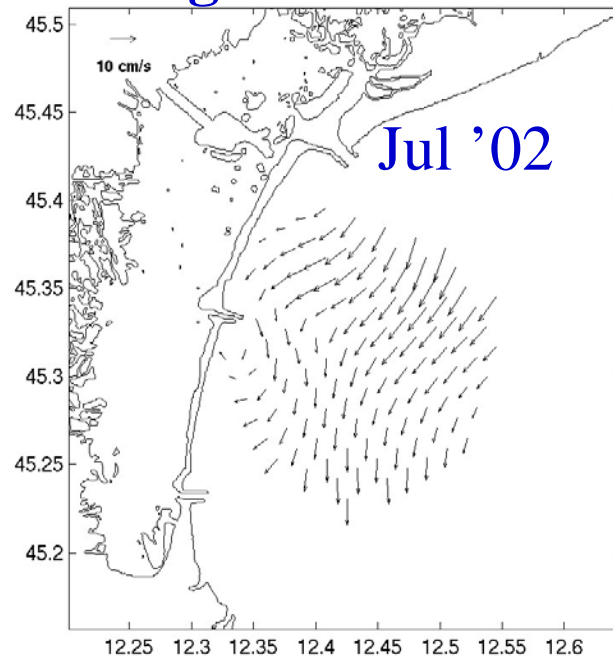


Monthly Averages

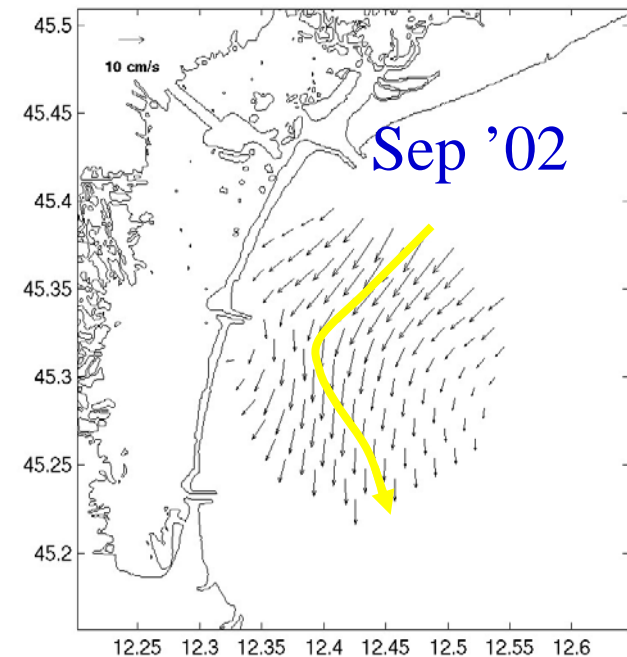
May 2002



July 2002

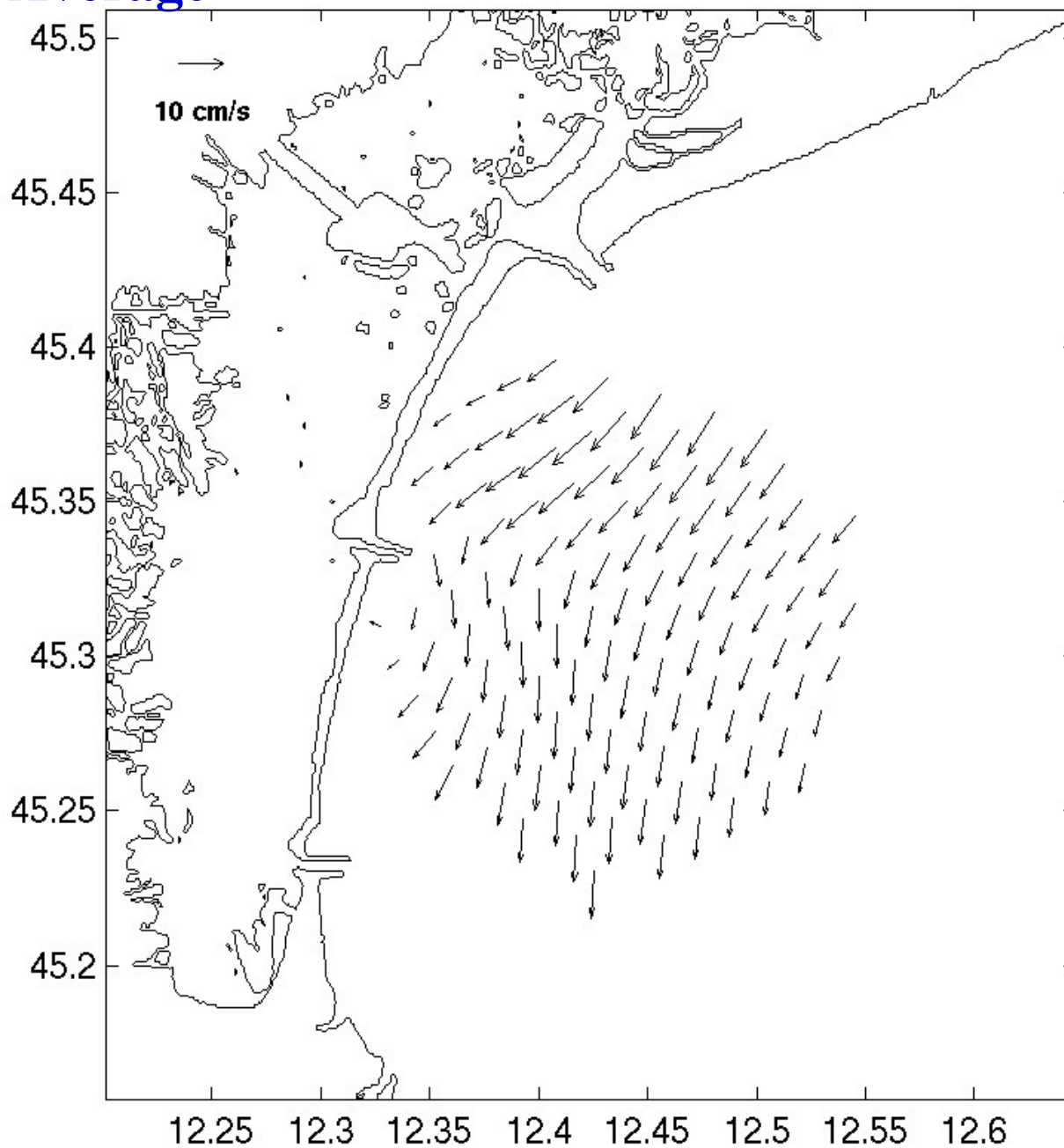


September 2002

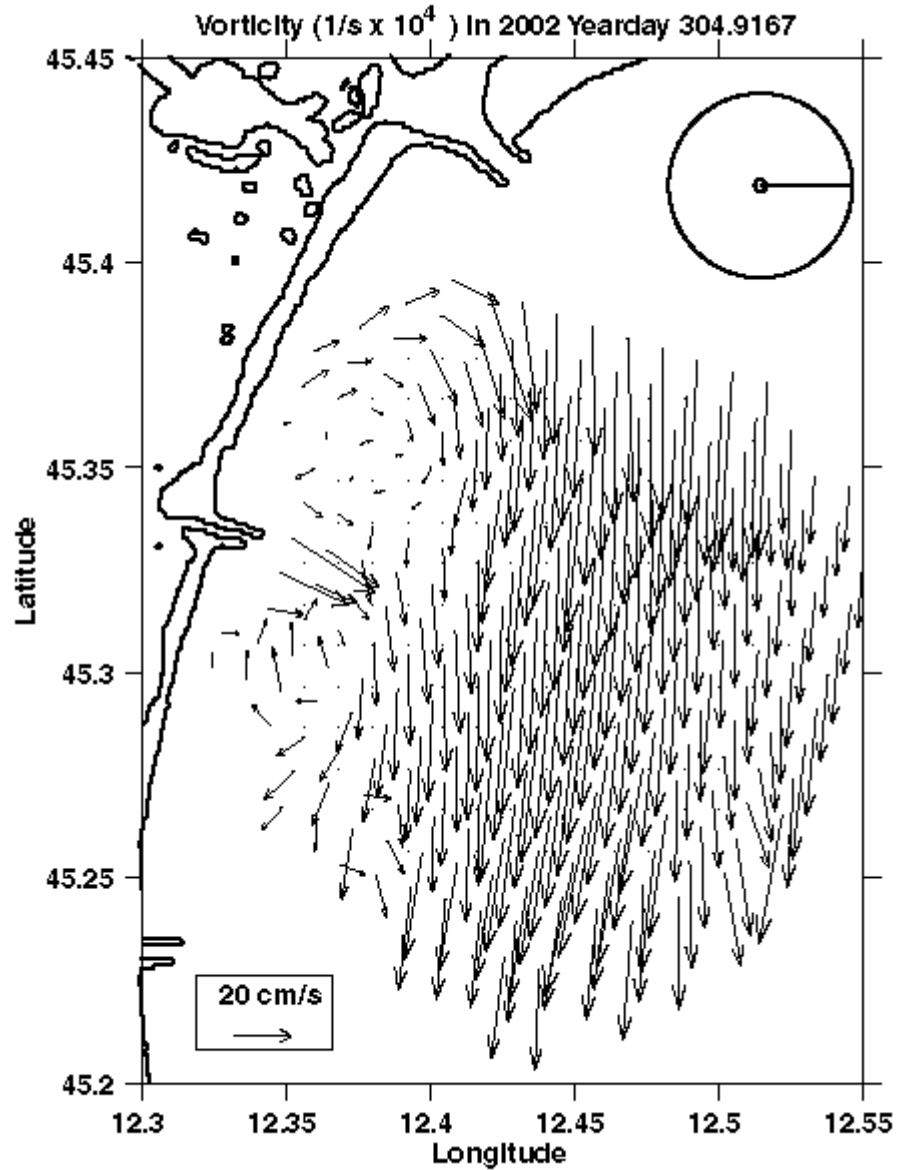


Annual Average

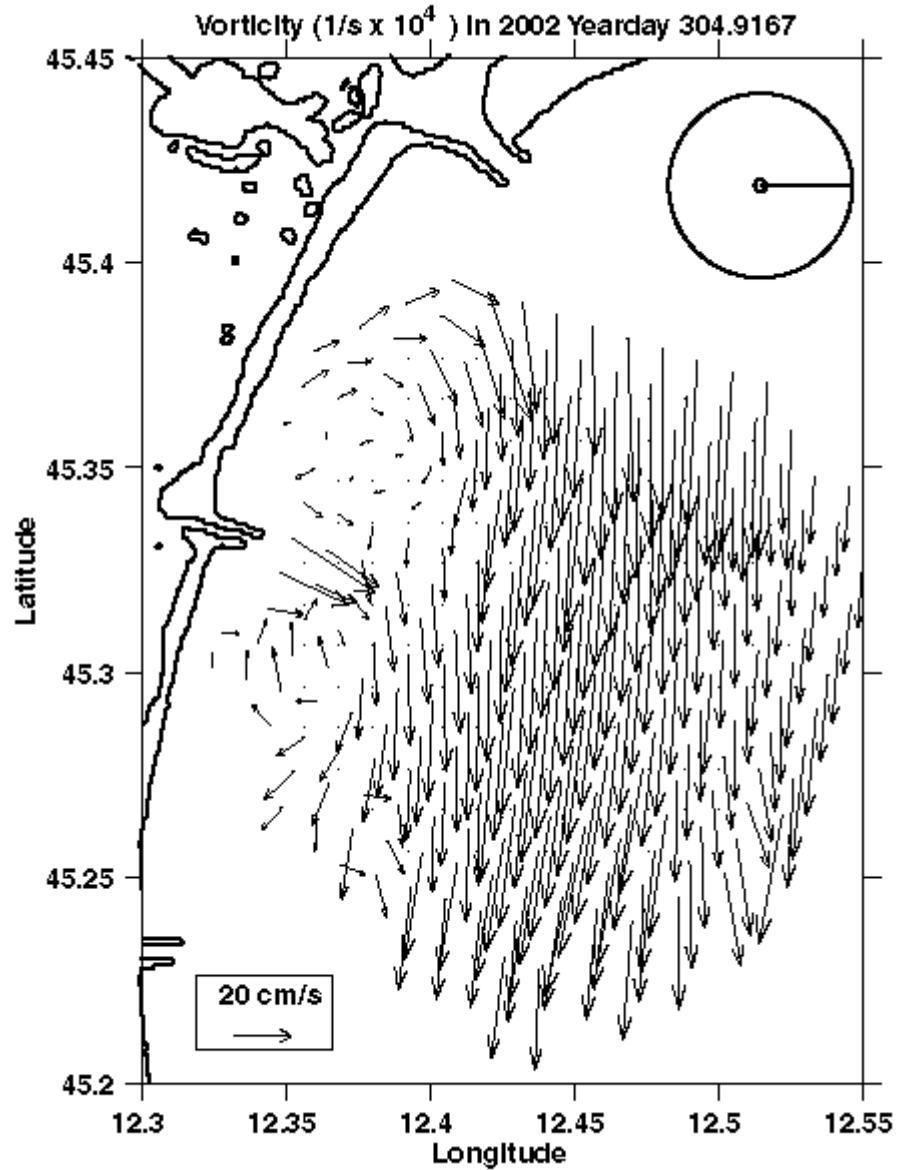
November 2001 – October 2002



Snapshots: Small Eddies



Snapshots: Small Eddies



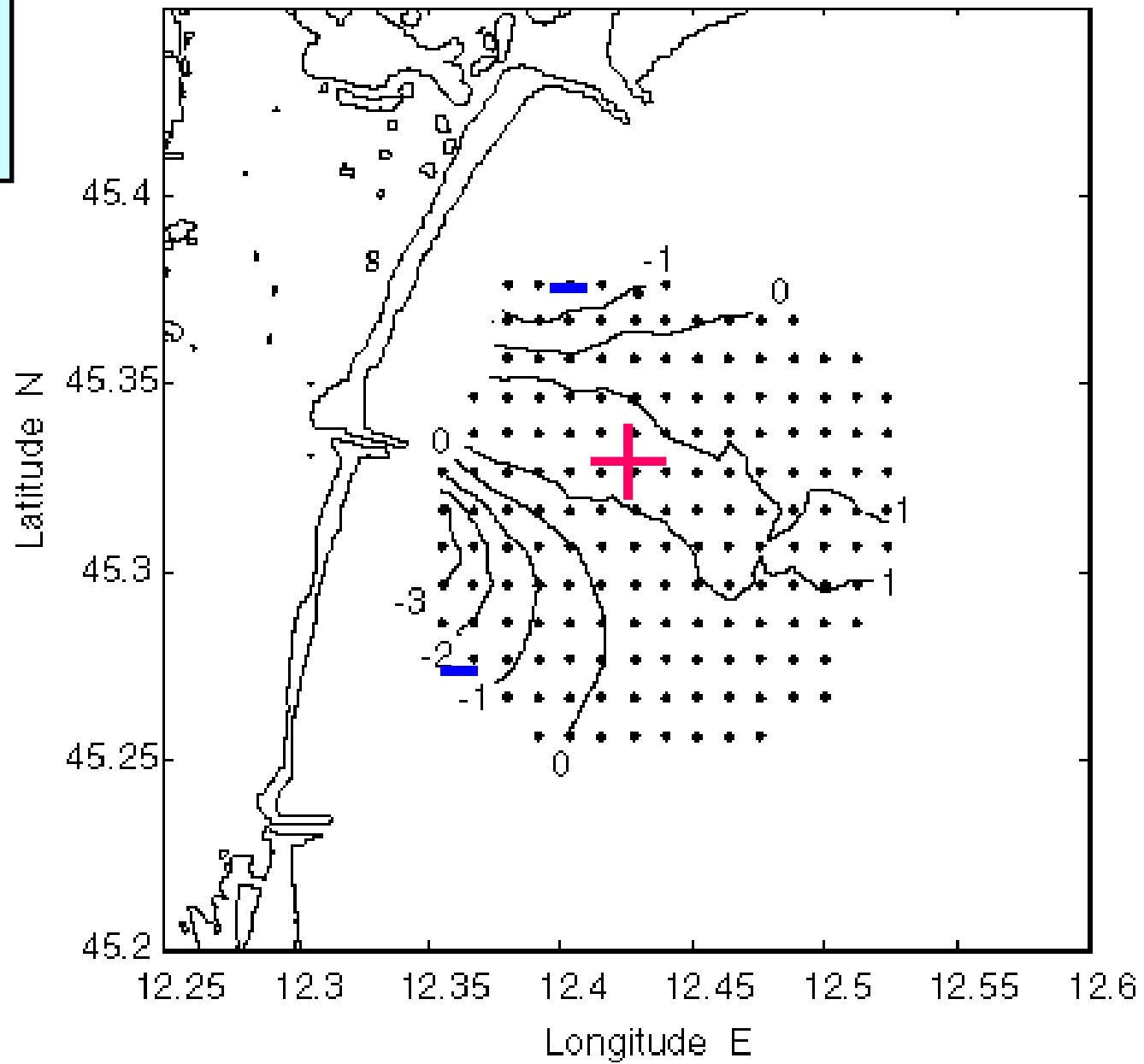


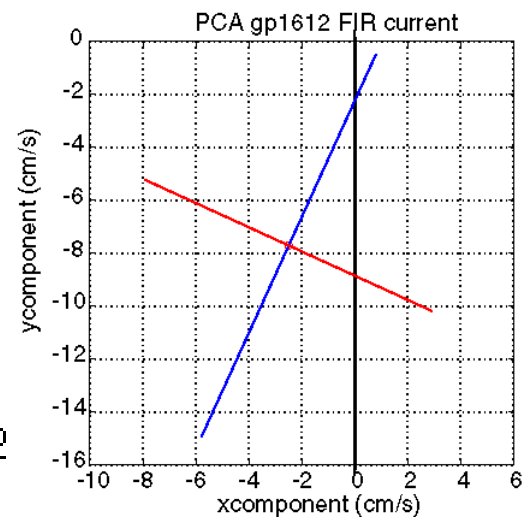
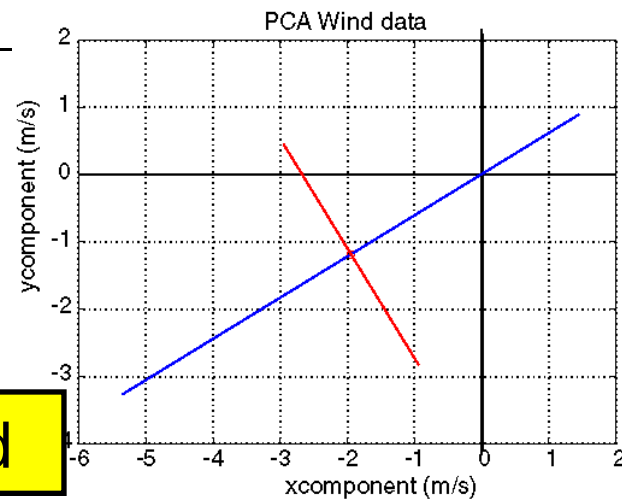
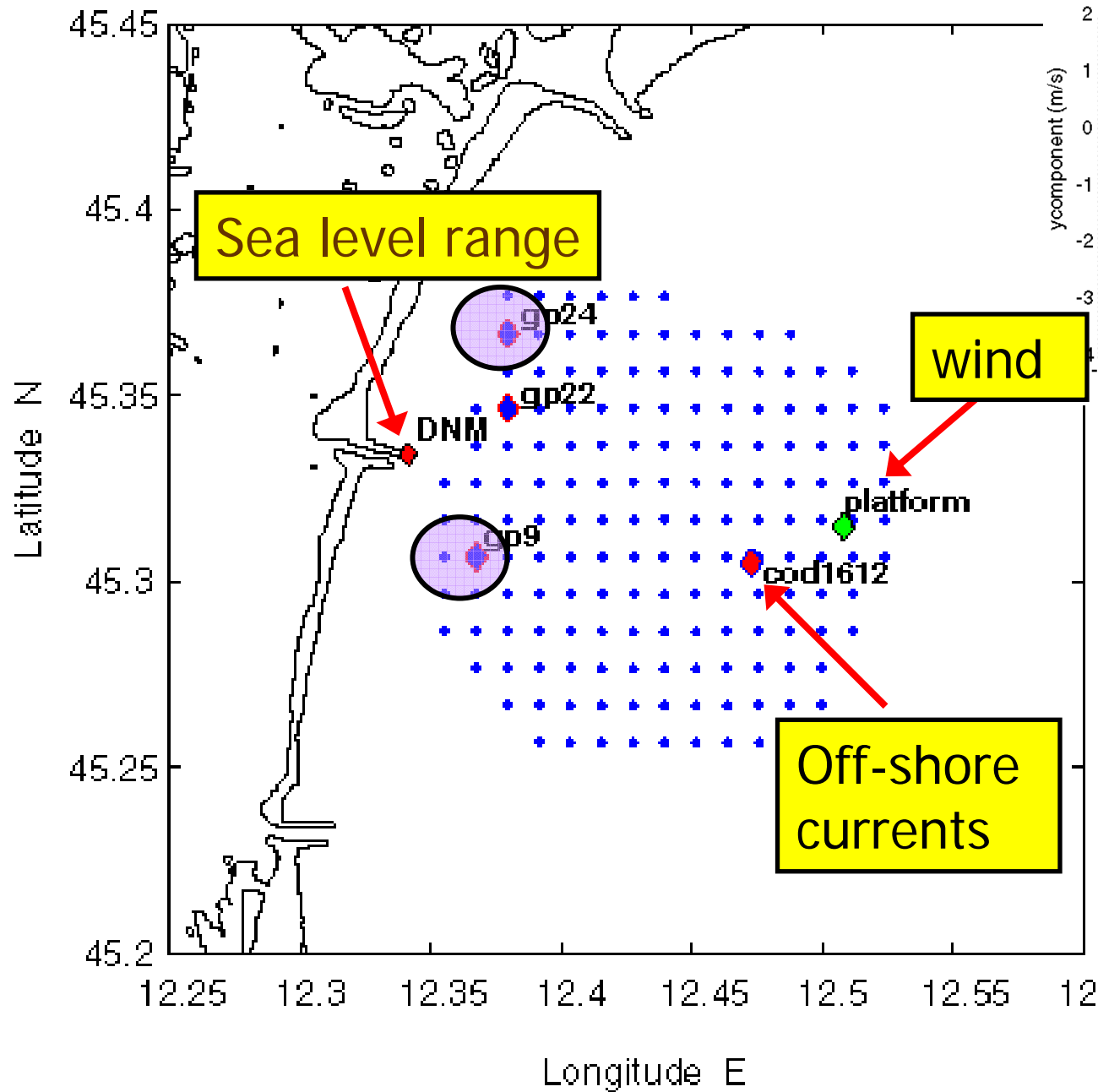
$$\mathbf{Vorticity} = \partial v / \partial x - \partial u / \partial y$$

- 2-dim plane fit of u and v over a 5 km scale
- u and v are residual (detided), low-passed current components
- time step: 1 hour

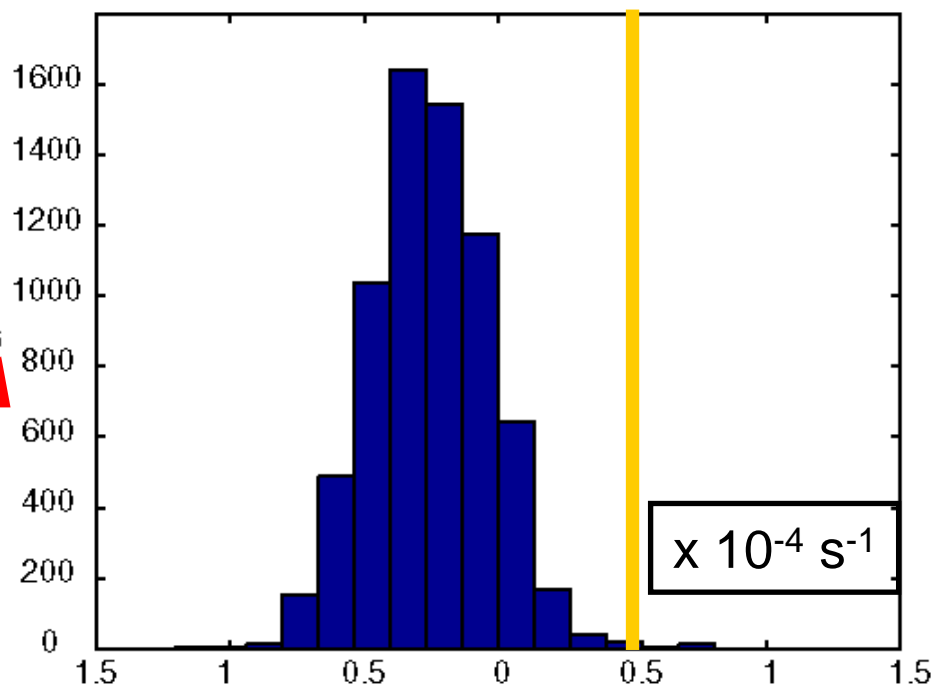
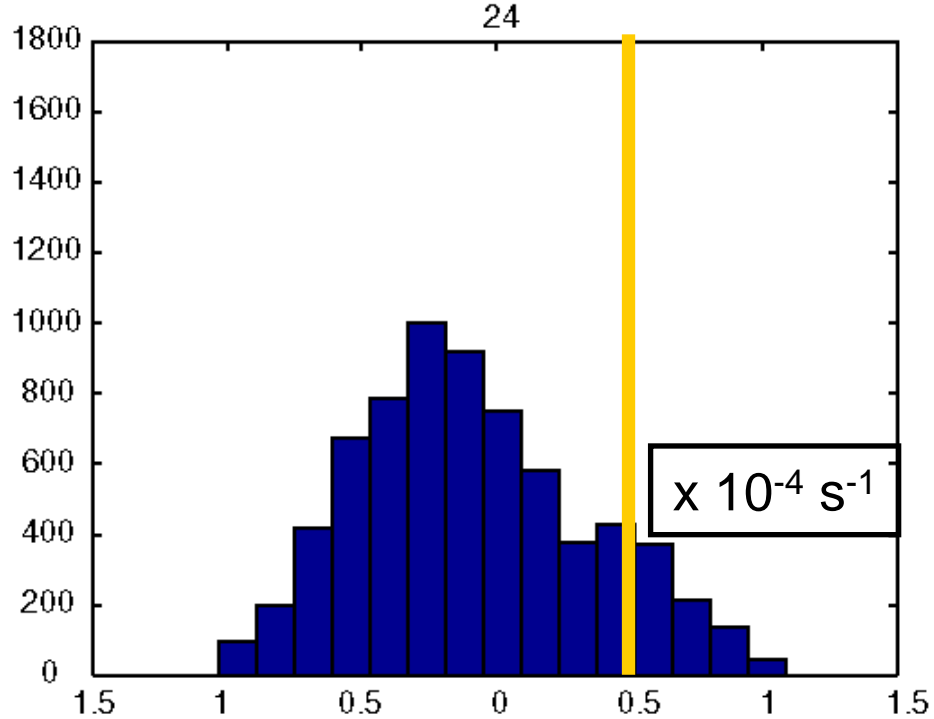
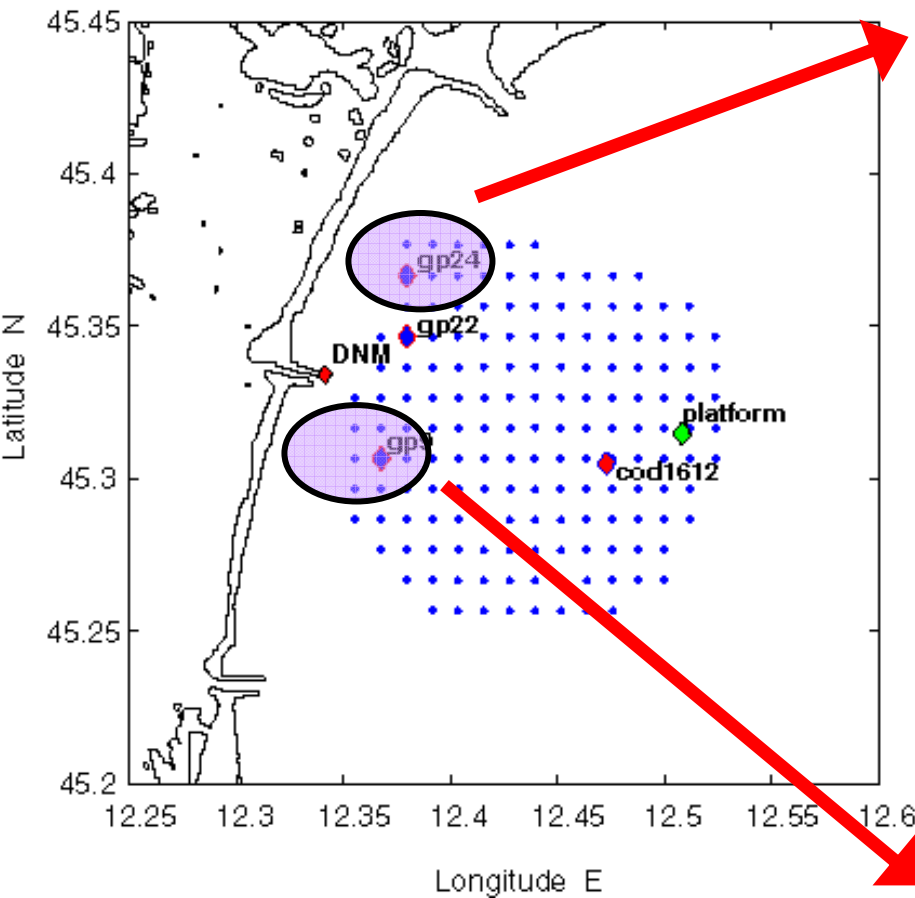
Annual
mean
vorticity

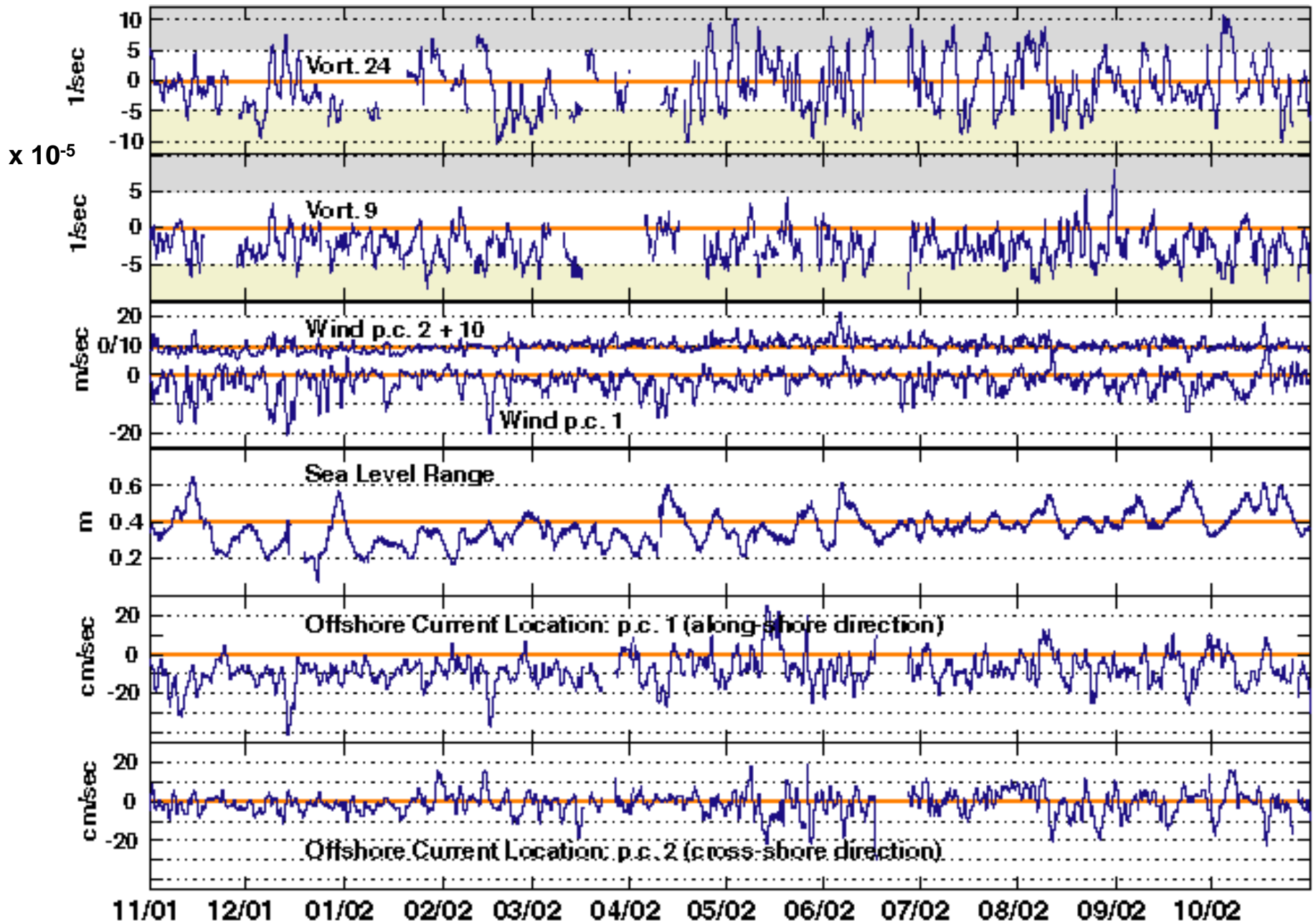
Unit scale: $1e-5 \text{ s}^{-1}$



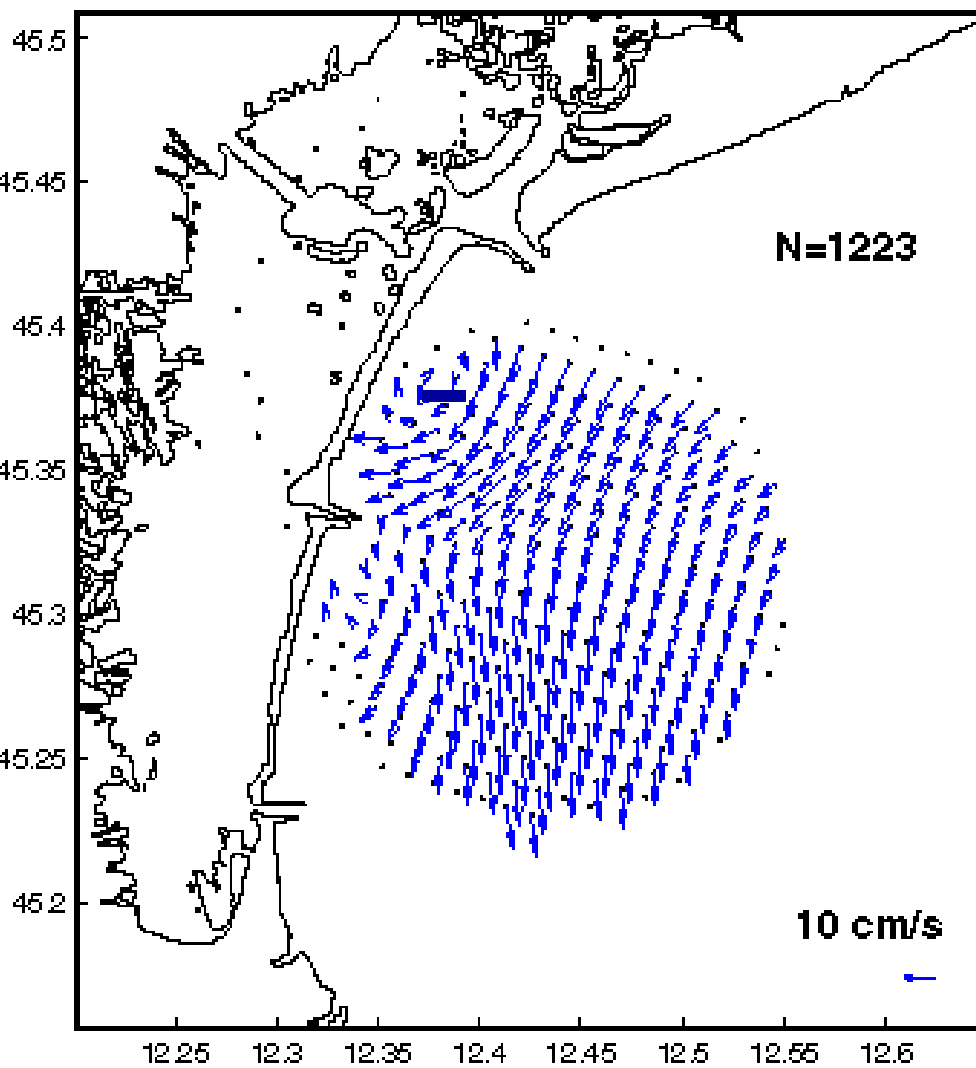


Annual vorticity distribution

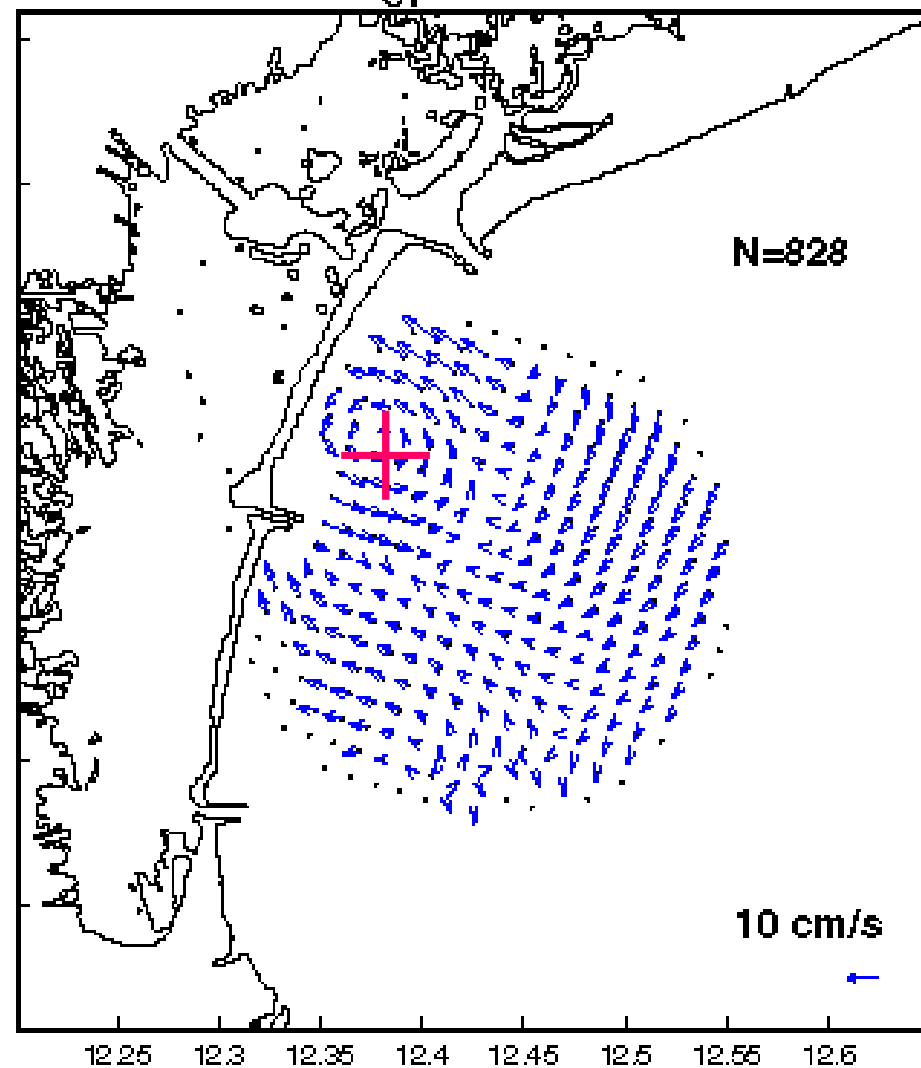




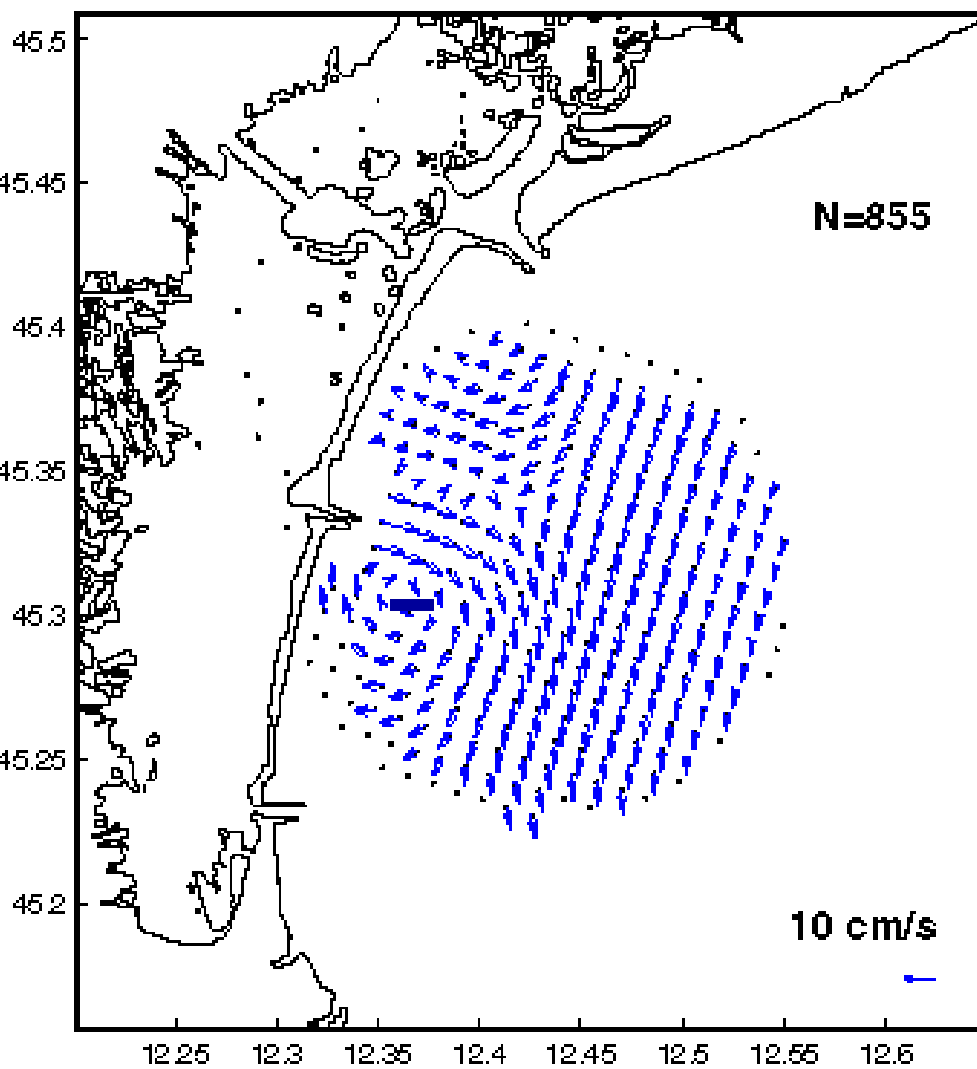
Vort. gp24 < $-5e-5$



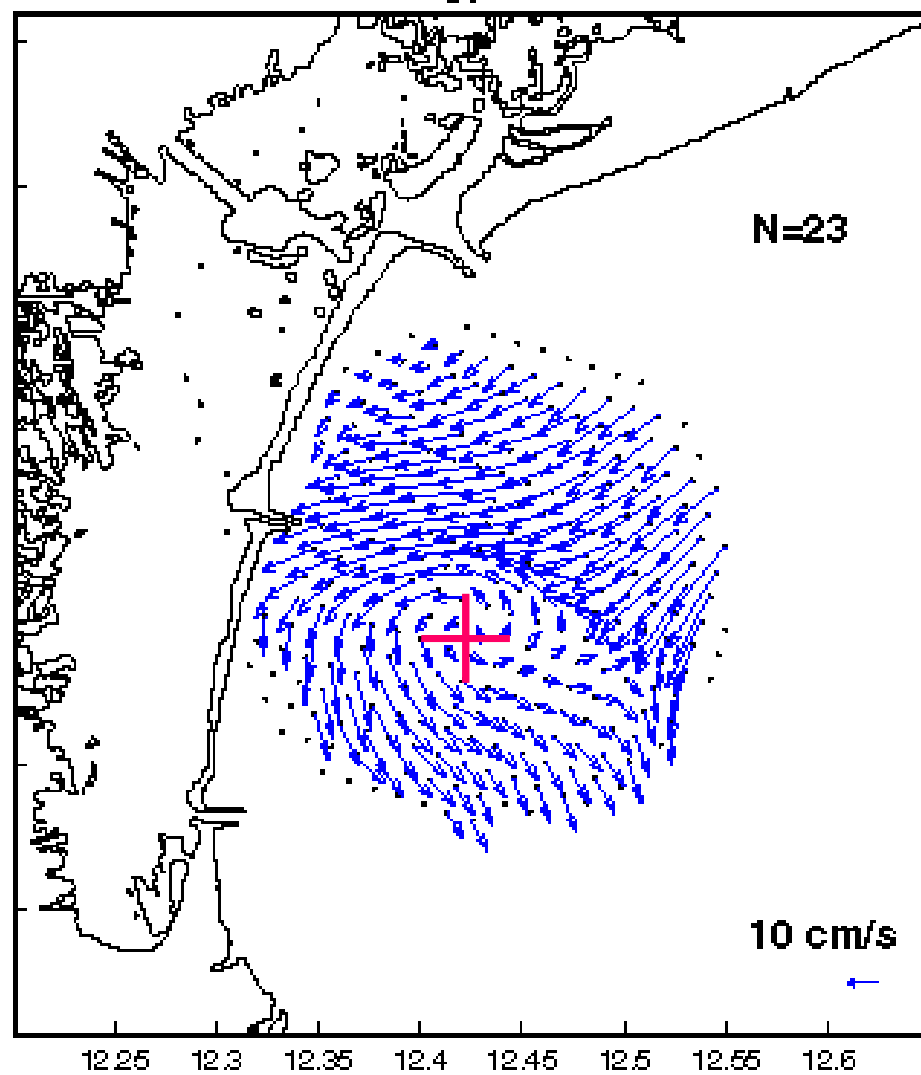
Vort. gp24 > $5e-5$



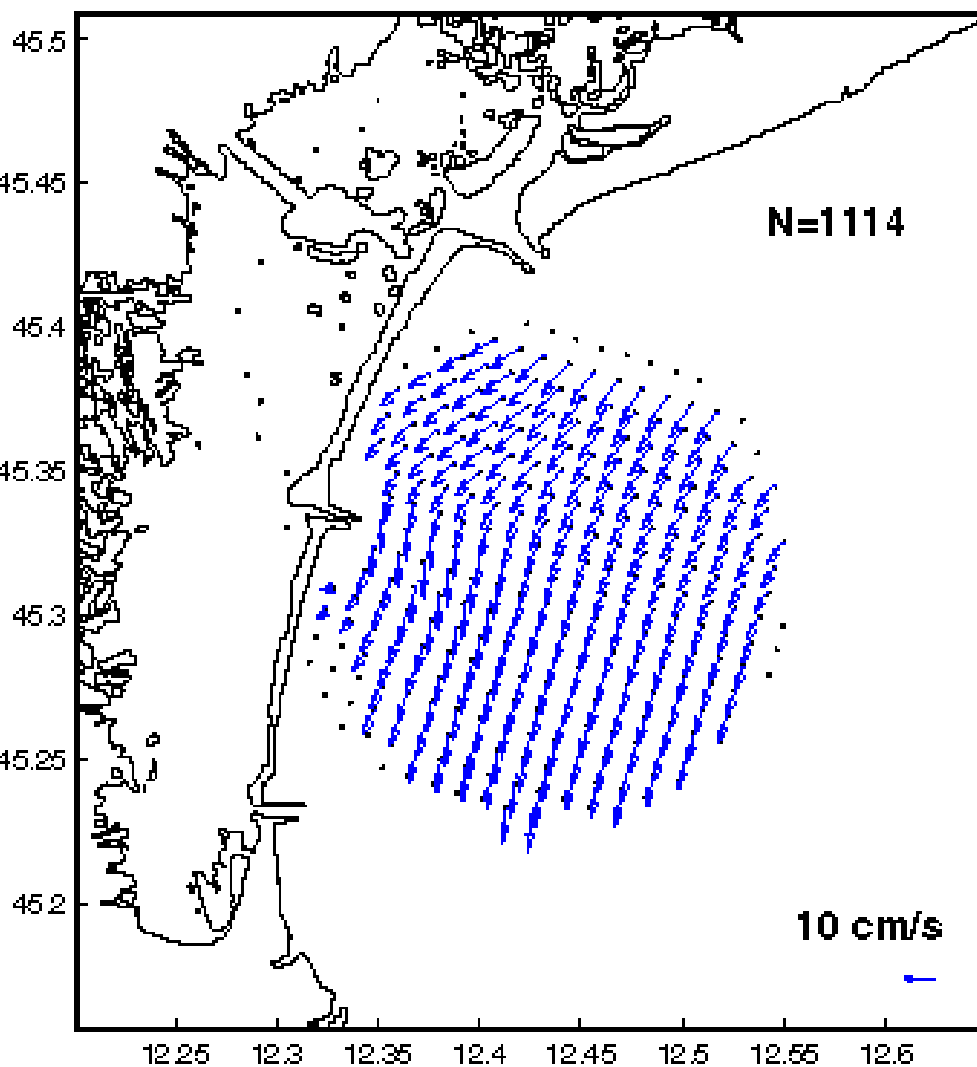
Vort. gp09 $< -5e-5$



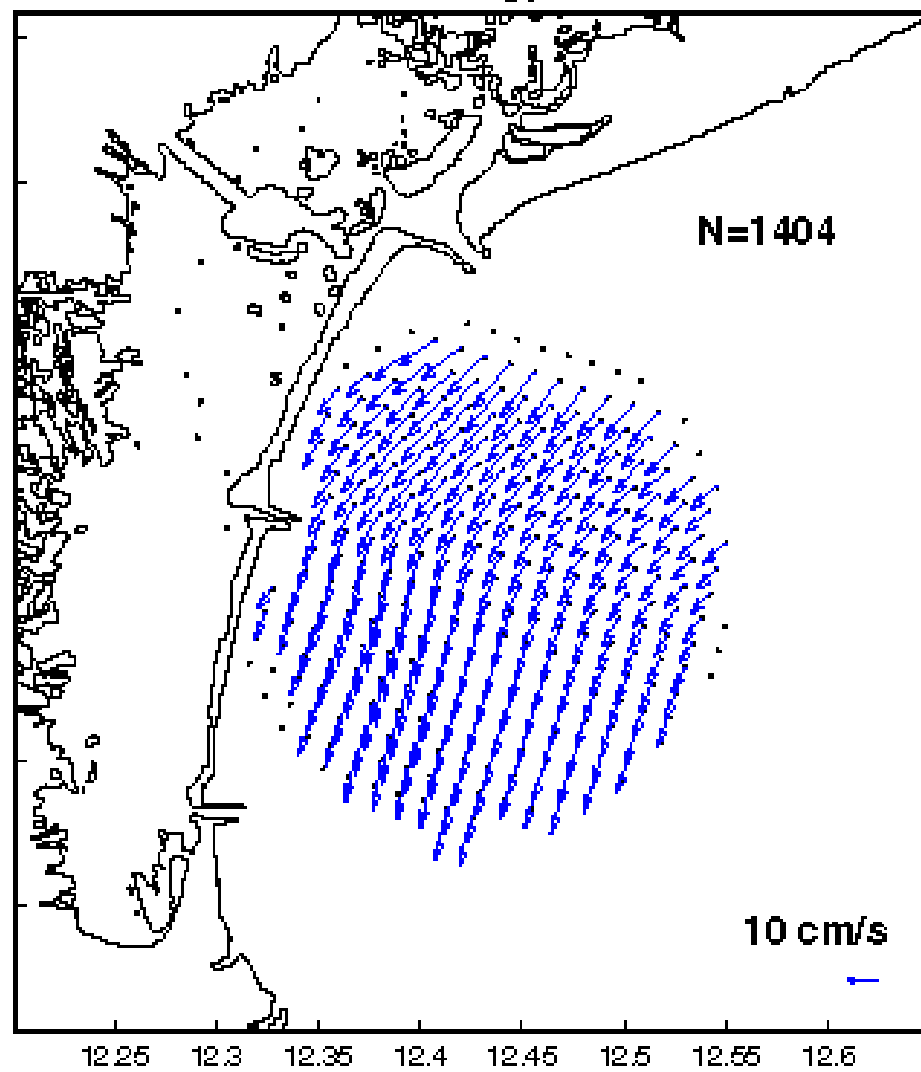
Vort. gp09 $> 5e-5$



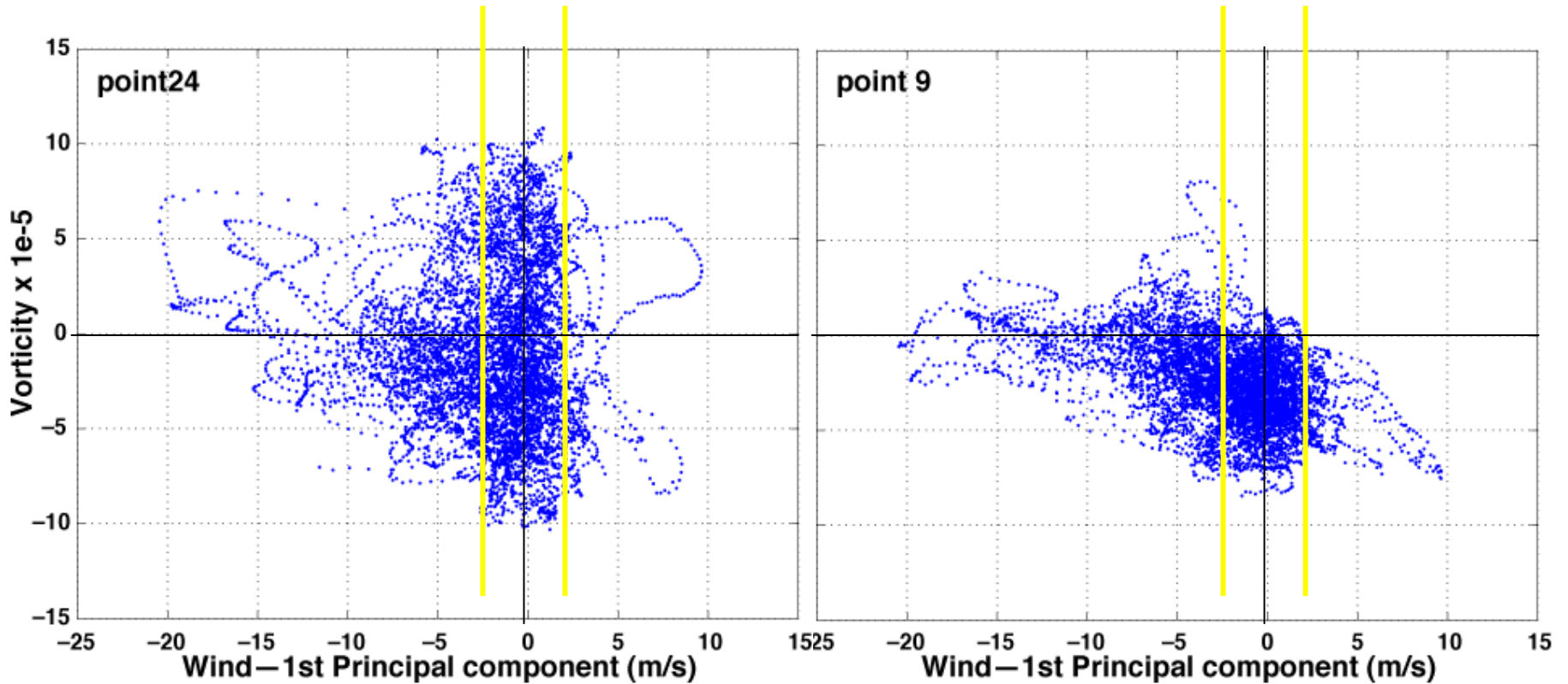
$-1e-5 < \text{Vort. gp24} < 1e-5$



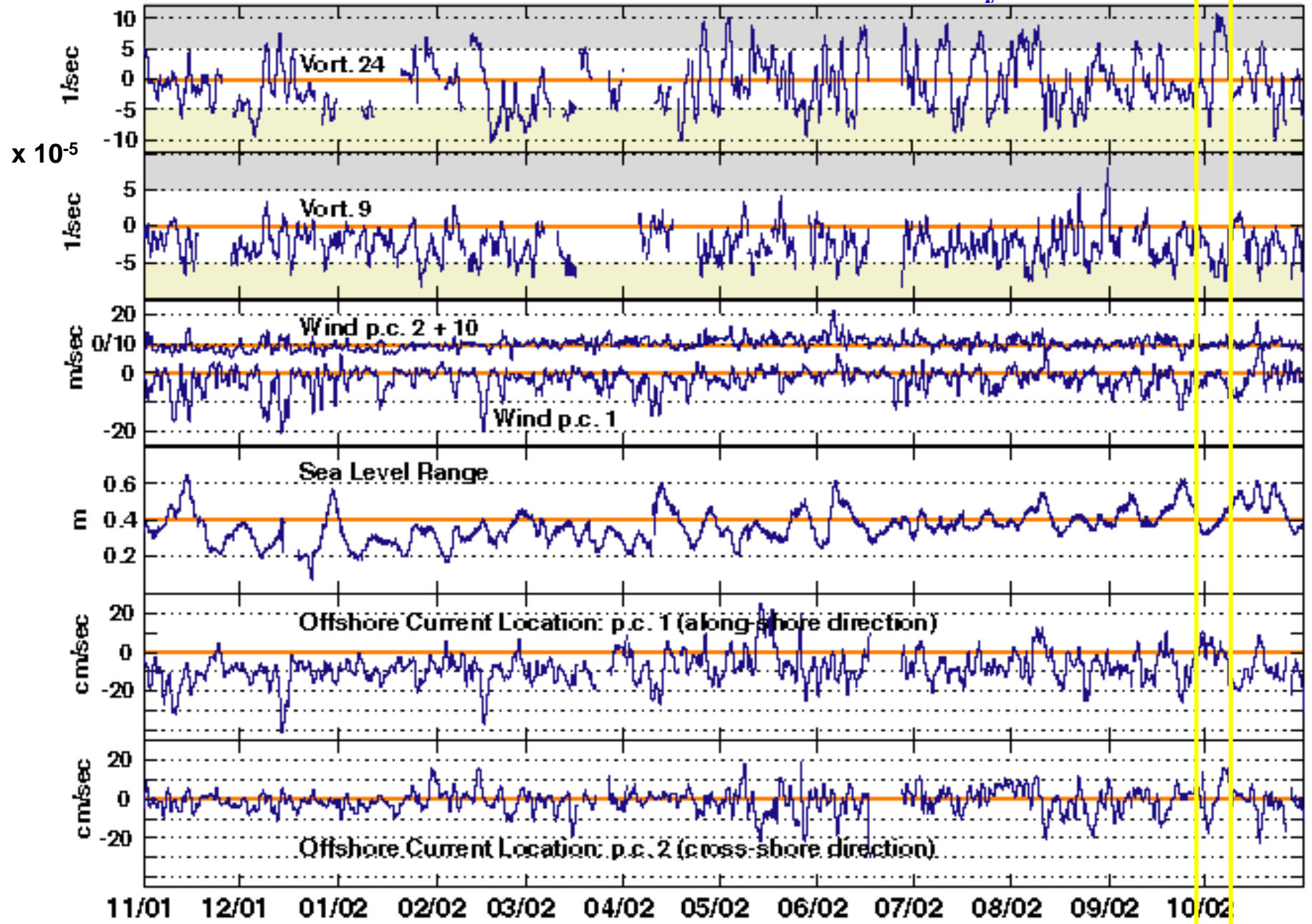
$-1e-5 < \text{Vort. gp09} < 1e-5$



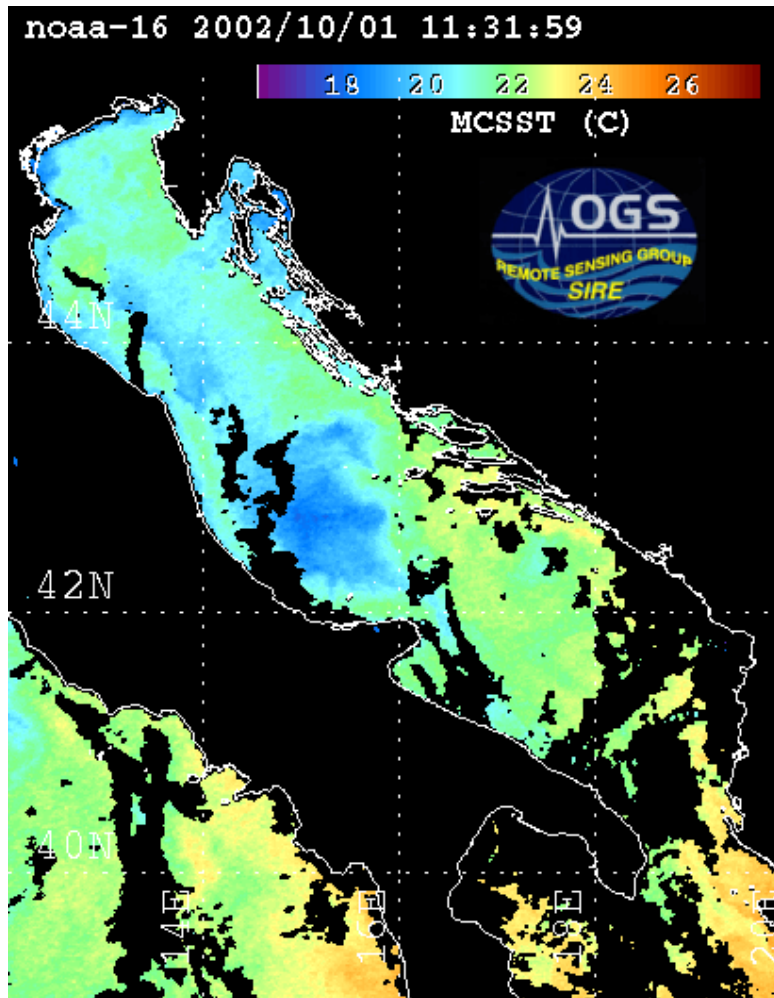
Low wind is needed to observe the strongest eddies.



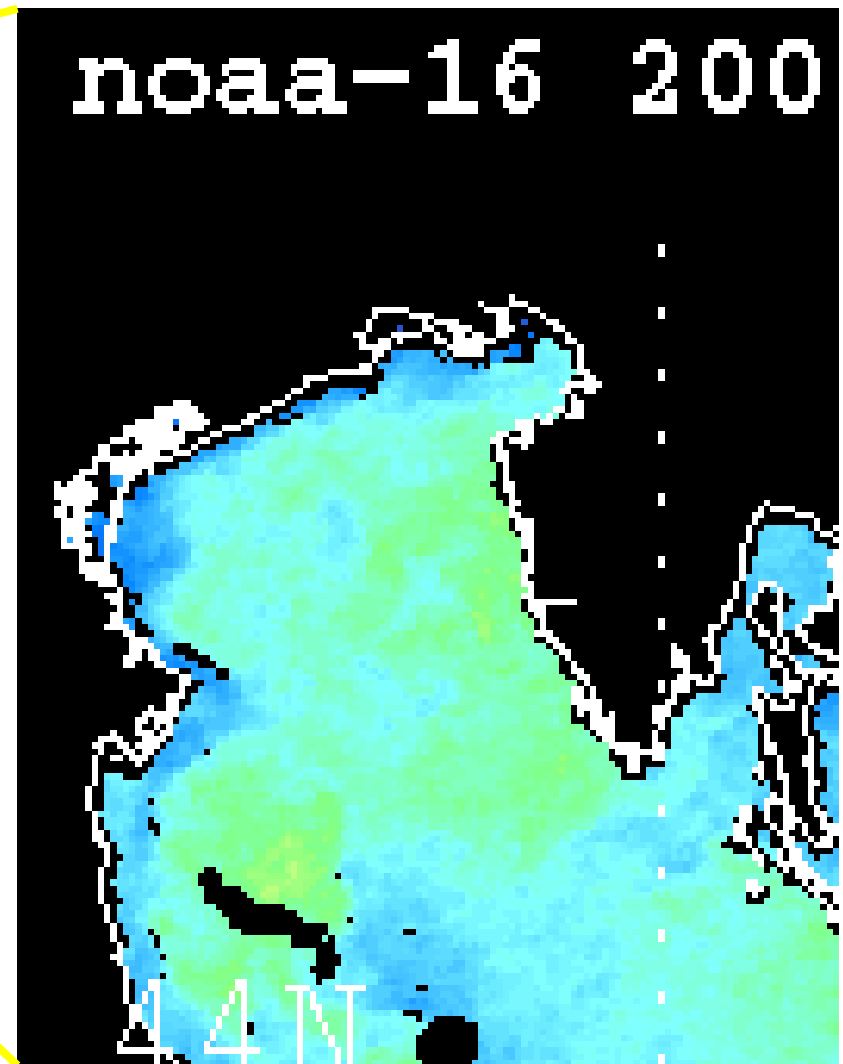
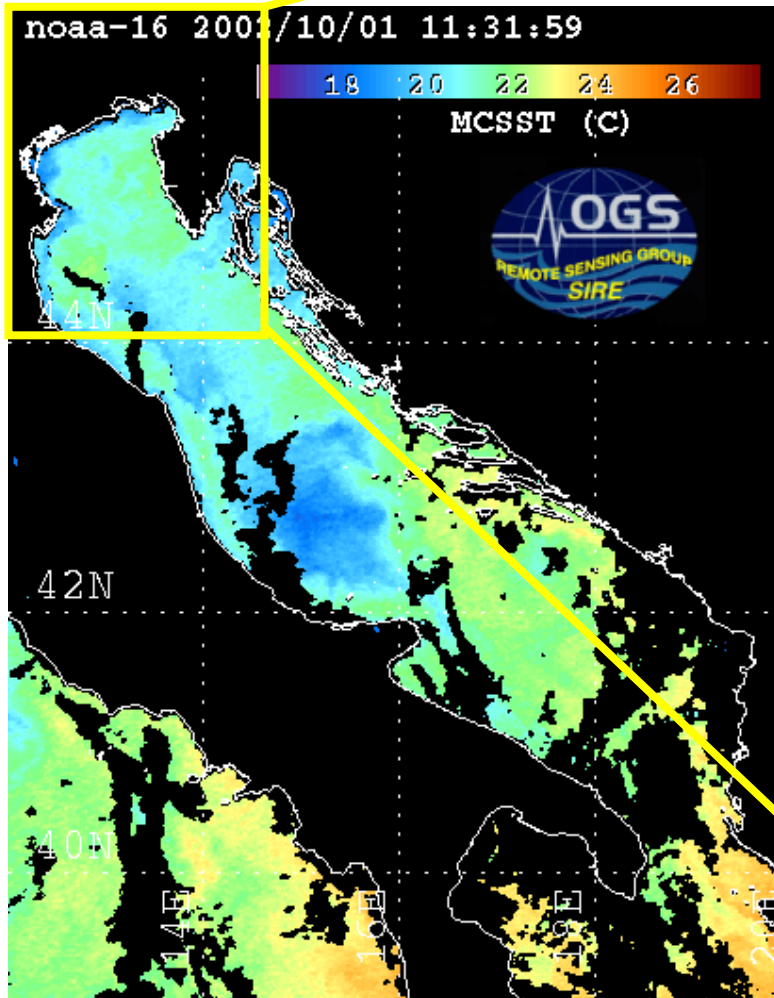
Case Study: 1 Oct 2002



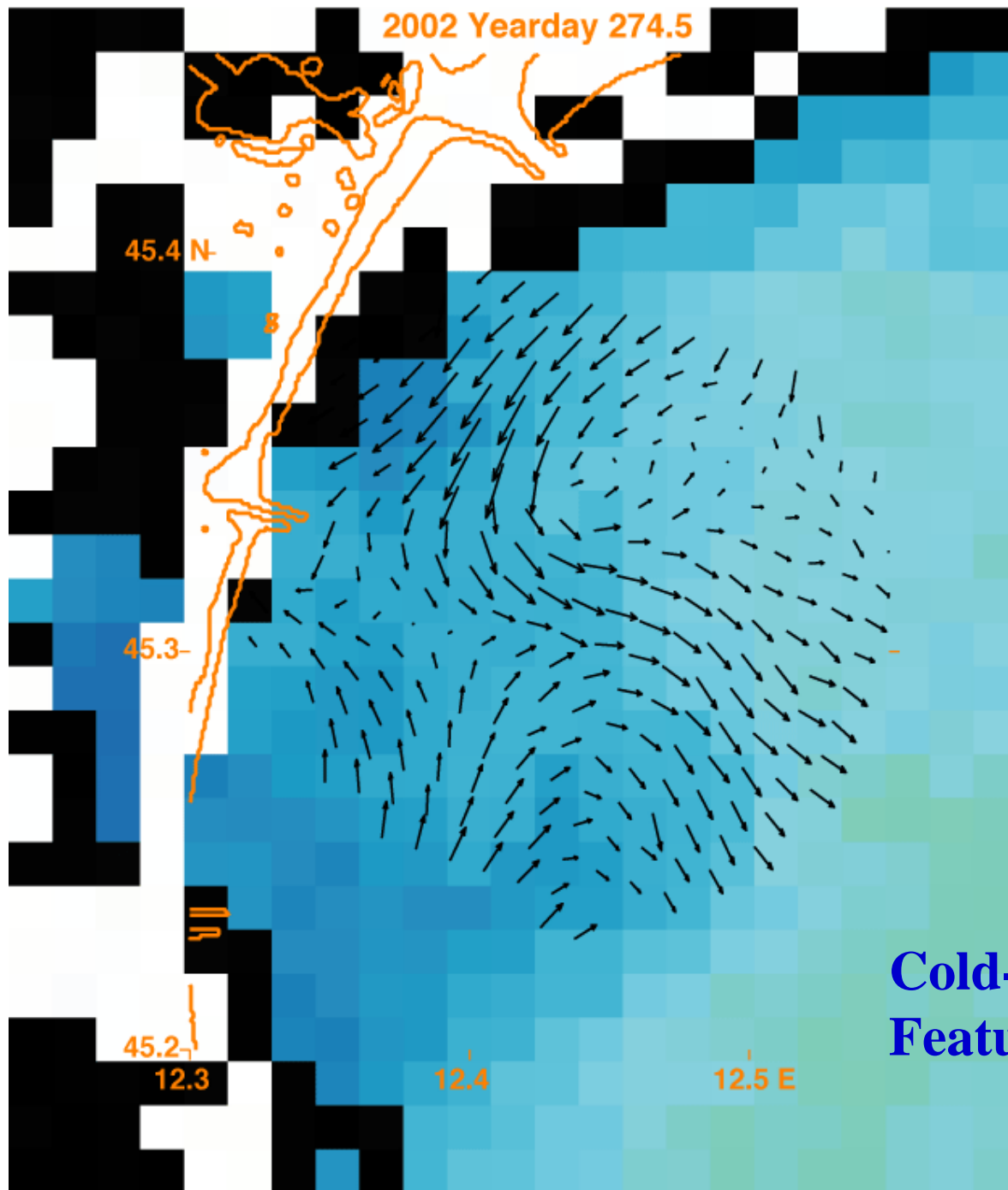
QuickTime™ and a decompressor are needed to see this picture.



**What was happening
in the larger region
during the 1 Oct 02
event?**



**Cold-Water, Mesoscale
Feature Offshore Venice**



**Cold-Water, Mesoscale
Feature Offshore Venice**

2002 Yearday 274.5

45.4 N

45.3

45.2

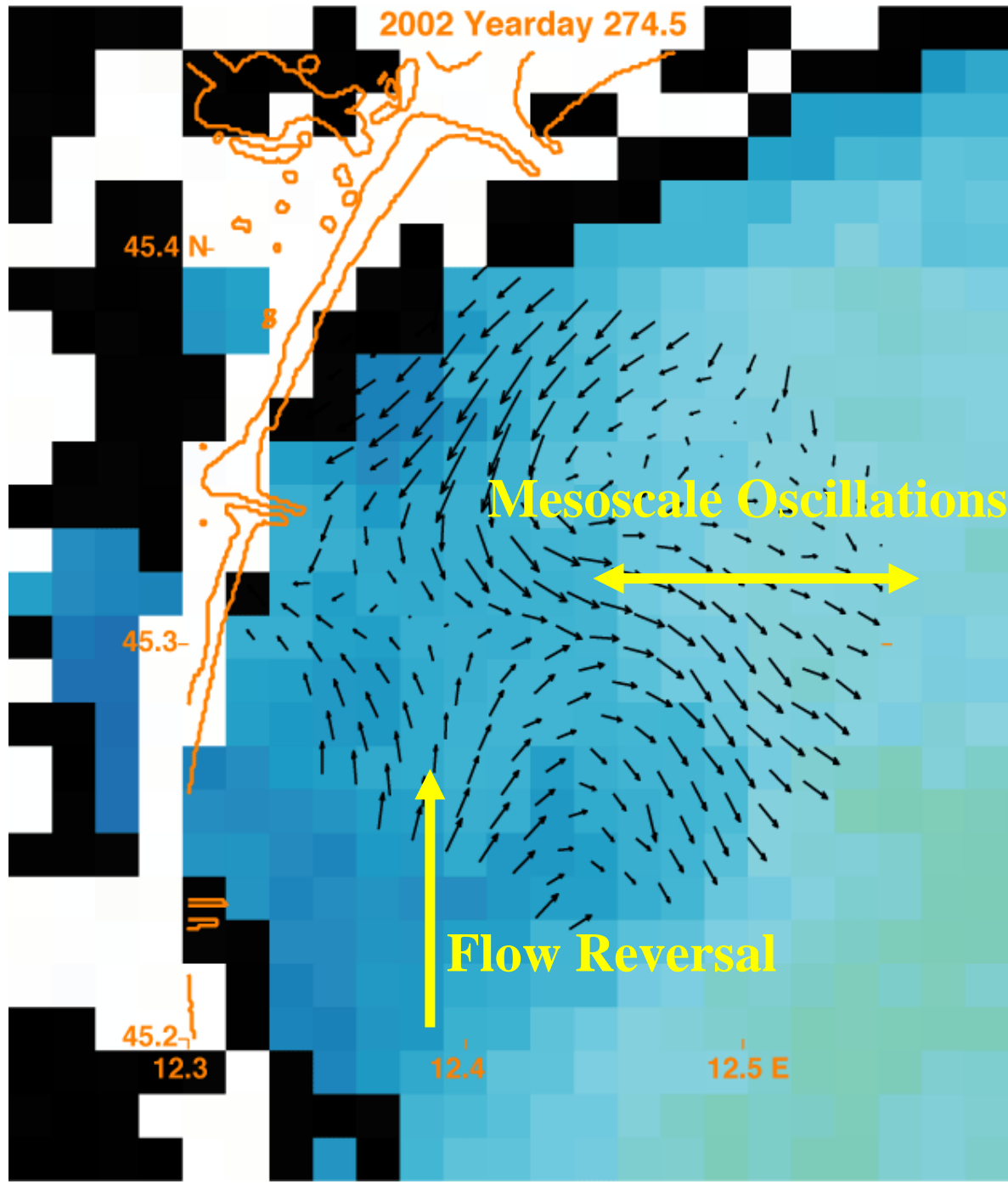
12.3

12.4

12.5 E

Mesoscale Oscillations

Flow Reversal



Conclusions:

1. **Small-scale eddies in HF radar data can be identified based on objective calculations of vorticity**
2. **Small-scale eddies not clearly associated with dipole features generated by inlet flows**
3. **Regional-scale flow reversals and mesoscale meanders + coastline “bumps” are a more likely cause**

