On the inversion of submesoscale information to correct mesoscale velocity

March 10, 2011

Outline

The objective is to explore the feasability of using submesoscale tracer information to controle ocean dynamic fields

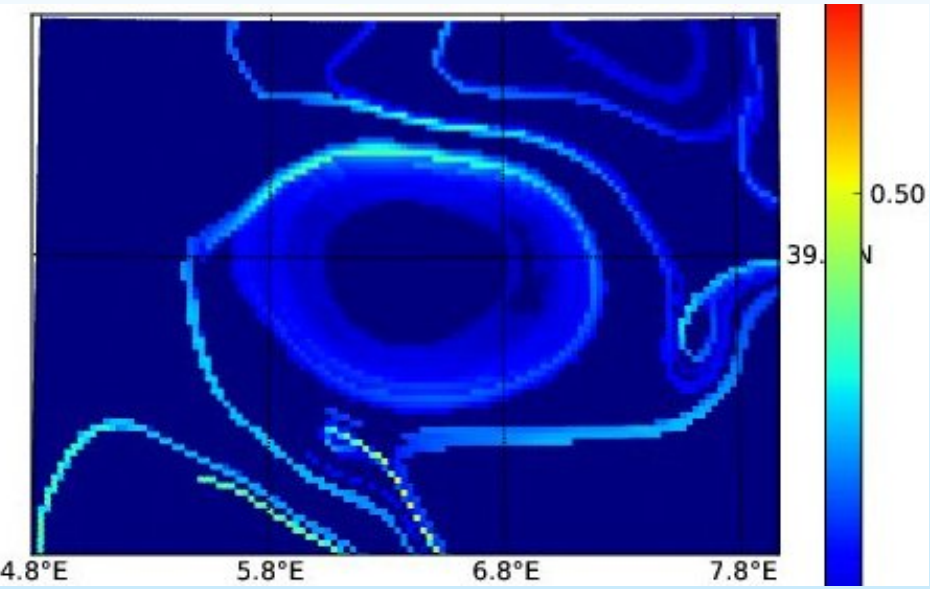
- Comparison of FSLE and Chlorophyll or SST patterns (d'Ovidio et al, 2004)
- Inversion of submesoscale FSLE (Finite-size Lyapunov Exponents) images to mesoscale velocity
- Inversion of submesoscale SST images to mesoscale velocity

Data set

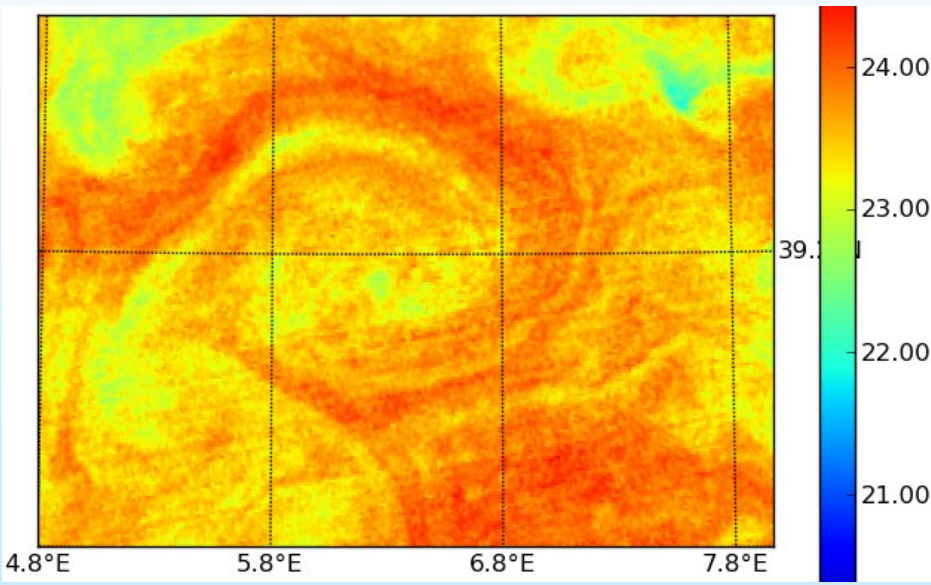
- **Region**: Mediterranean Sea, from $4.8^o E$ to $8^o E$, from $38.2^o N$ to $40.^o N$
- **Time Range**: from 1998 to June 2009, 595 velocity maps
- **Velocity fields**: AVISO altimeter data
- **Resolution**: $1/8^o$, grid points: 26*17
- **FSLE Resolution**: $1/48^o$, grid points: 119*86

- **SST field**: Data from MODIS captor, L2 product
- **Resolution**: $1/100^o$

Comparison between FSLE fields and SST

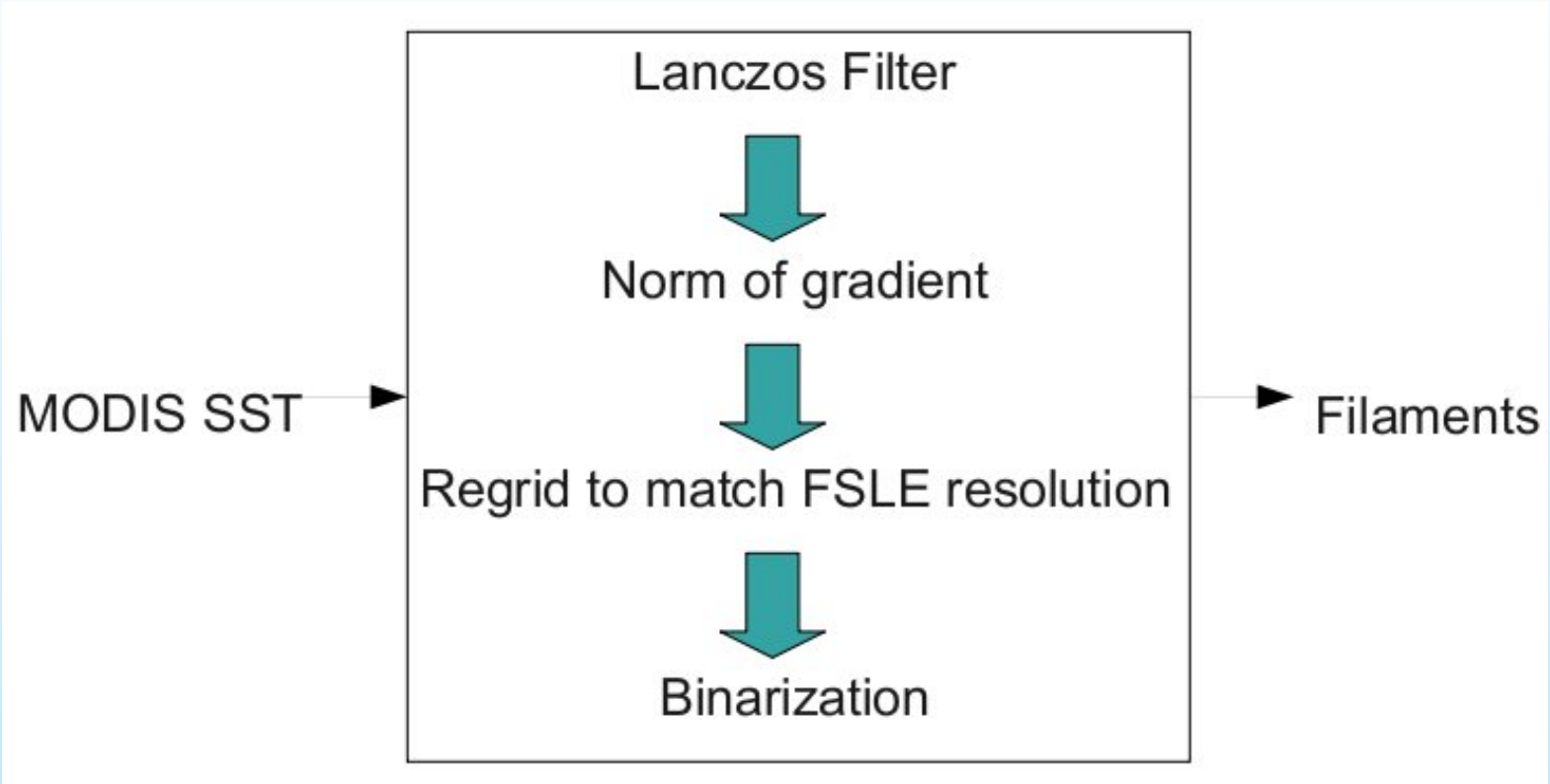


FSLE, June 30, 2004

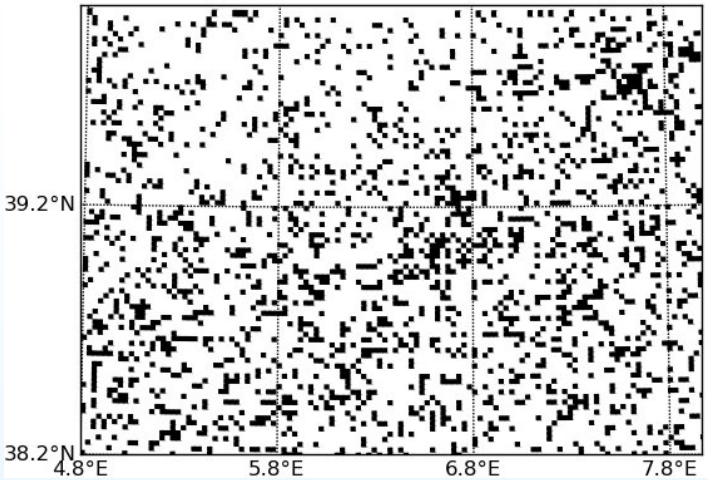


Sea Surface Temperature, July 03, 2004

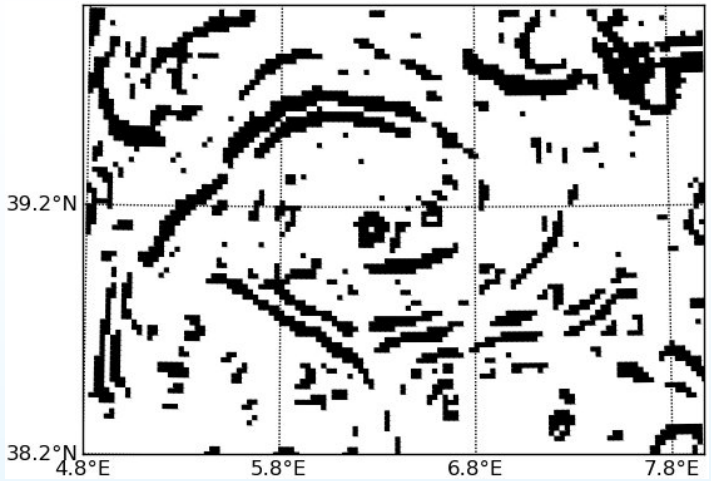
Method to detect filaments in SST image



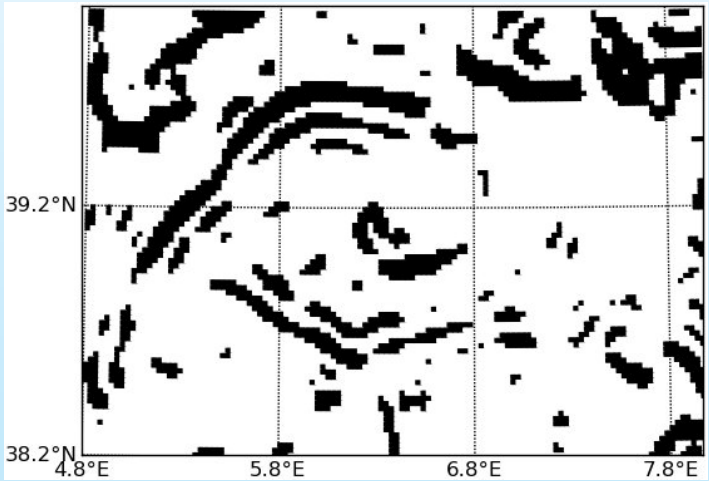
Method to detect filaments in SST image



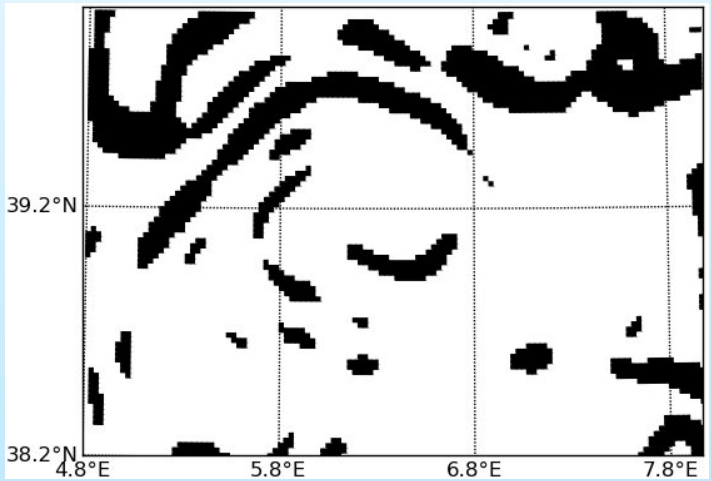
SST without filtering



SST with λ=10 Lanczos filter



SST with λ=15 Lanczos filter



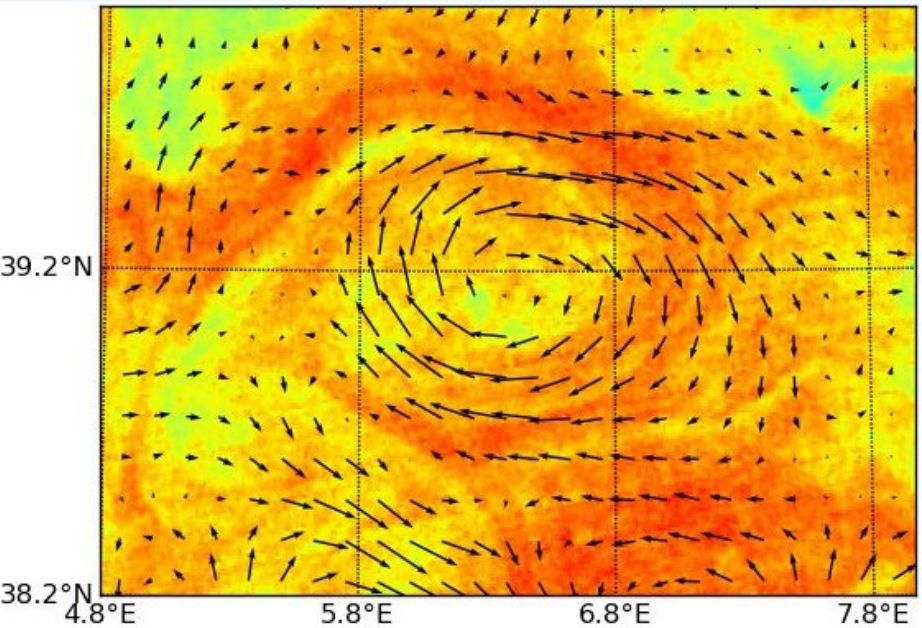
SST λ=25 Lanczos filter

Minimizing the cost function using a simulated annealing algorithm

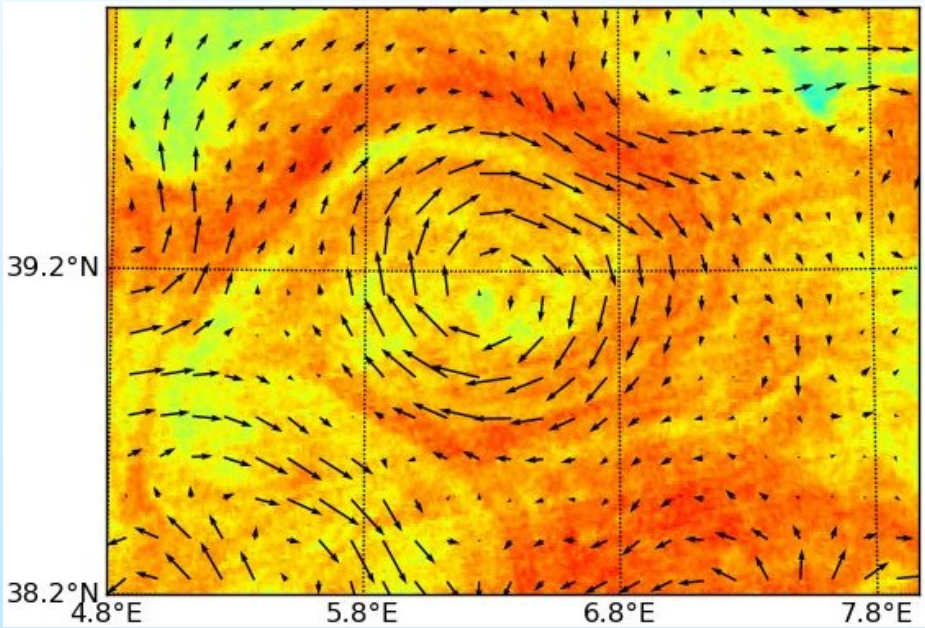
- Cost function: $J = \|\hat{\lambda}_{fsle} - \hat{\lambda}_{tracer}\| \times (1 + log\left(\frac{\|u\|}{\|u_{aviso}\|}\right))$
- First estimate: Aviso velocity field
- Perturbation: background velocity error simulated by drawing from the Gaussian Probability distribution
- Amplitude of perturbation evolves with the cost function: $\gamma = \alpha \times (J - J_0)$
- Probability of accepting uphill move: $p = exp(-\delta J/T)$ with $T = \beta \times (J - J_0)$

Comparison between Aviso velocity and the corrected one

Correction of the mesoscale velocity minimizing the previous cost function:
$\alpha = \frac{1}{300}$, $\beta = \frac{1}{10}$, $J_0 = 0$

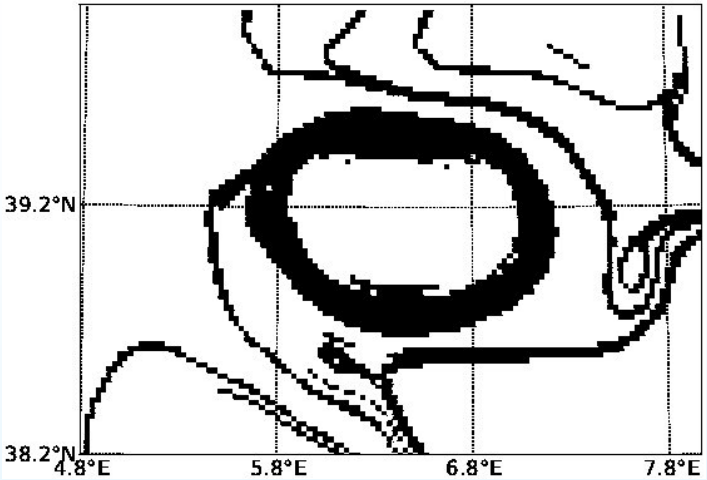


Aviso velocity, June 30, 2004, $J = 0.32$

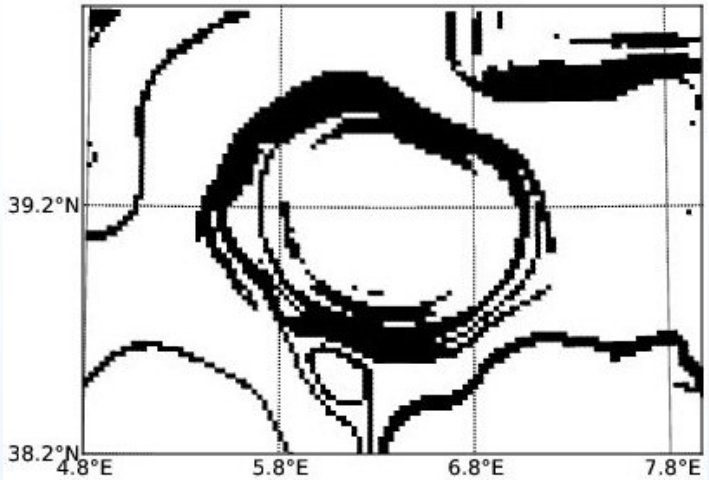


Corrected velocity, $J = 0.23$

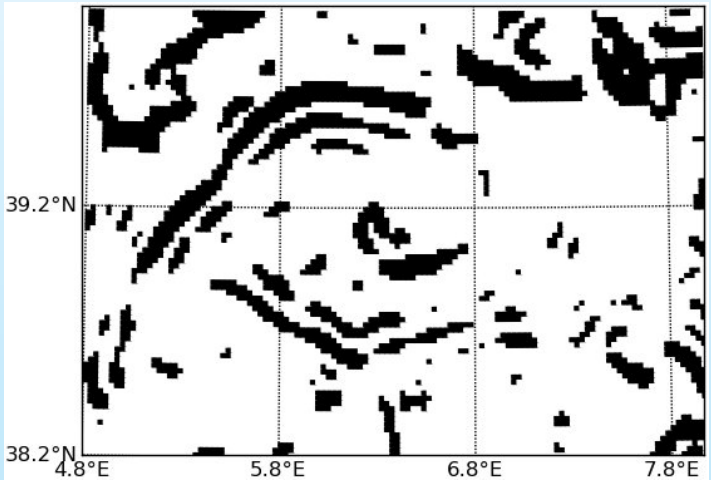
Comparison between Aviso velocity and the corrected one



FSLE from Aviso velocity, June 30, 2004



FSLE from Corrected velocity



Filaments from tracer