Algorithmen in der Direkten Anwendung

Update

NK

January 5, 2015

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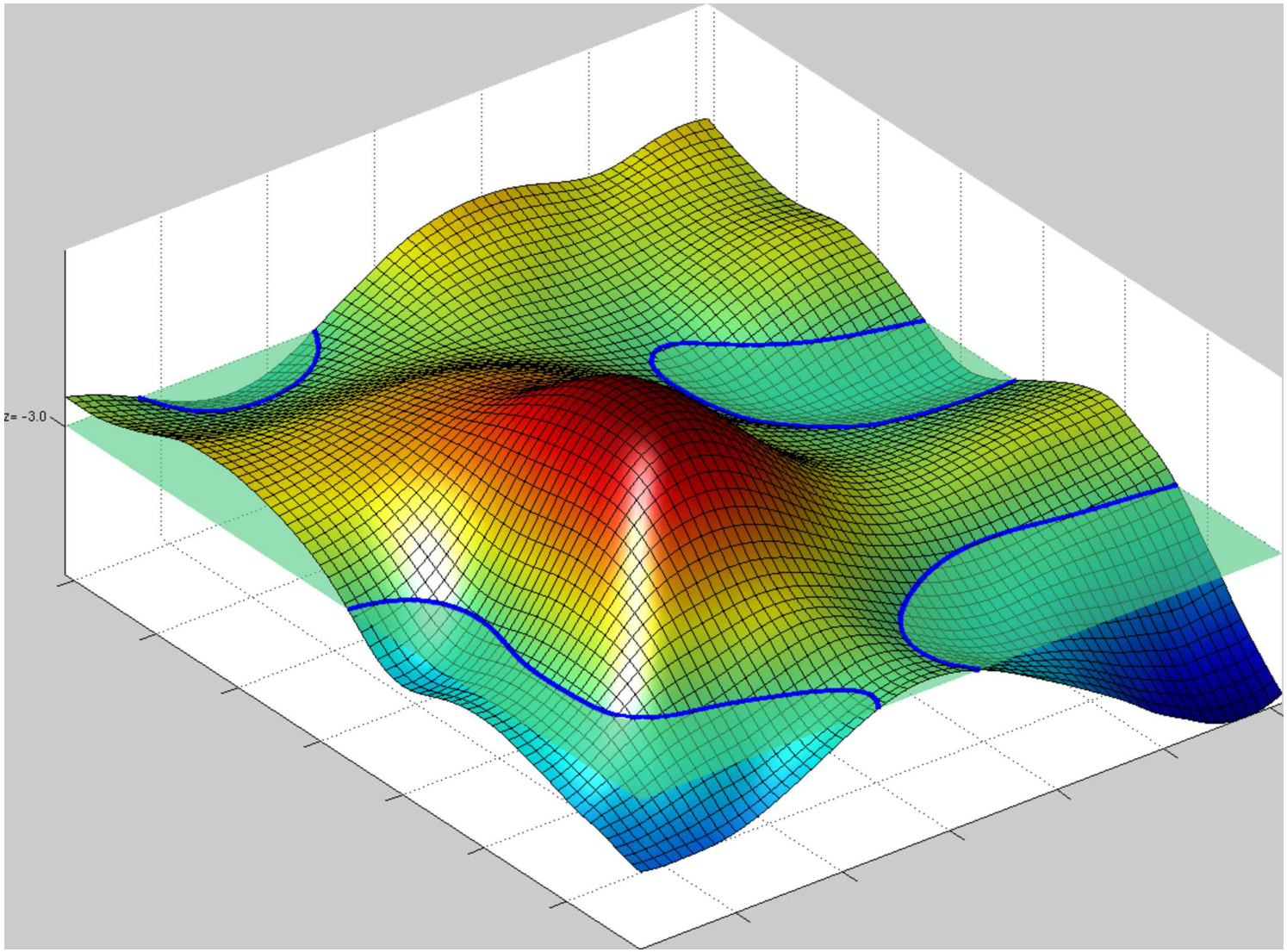
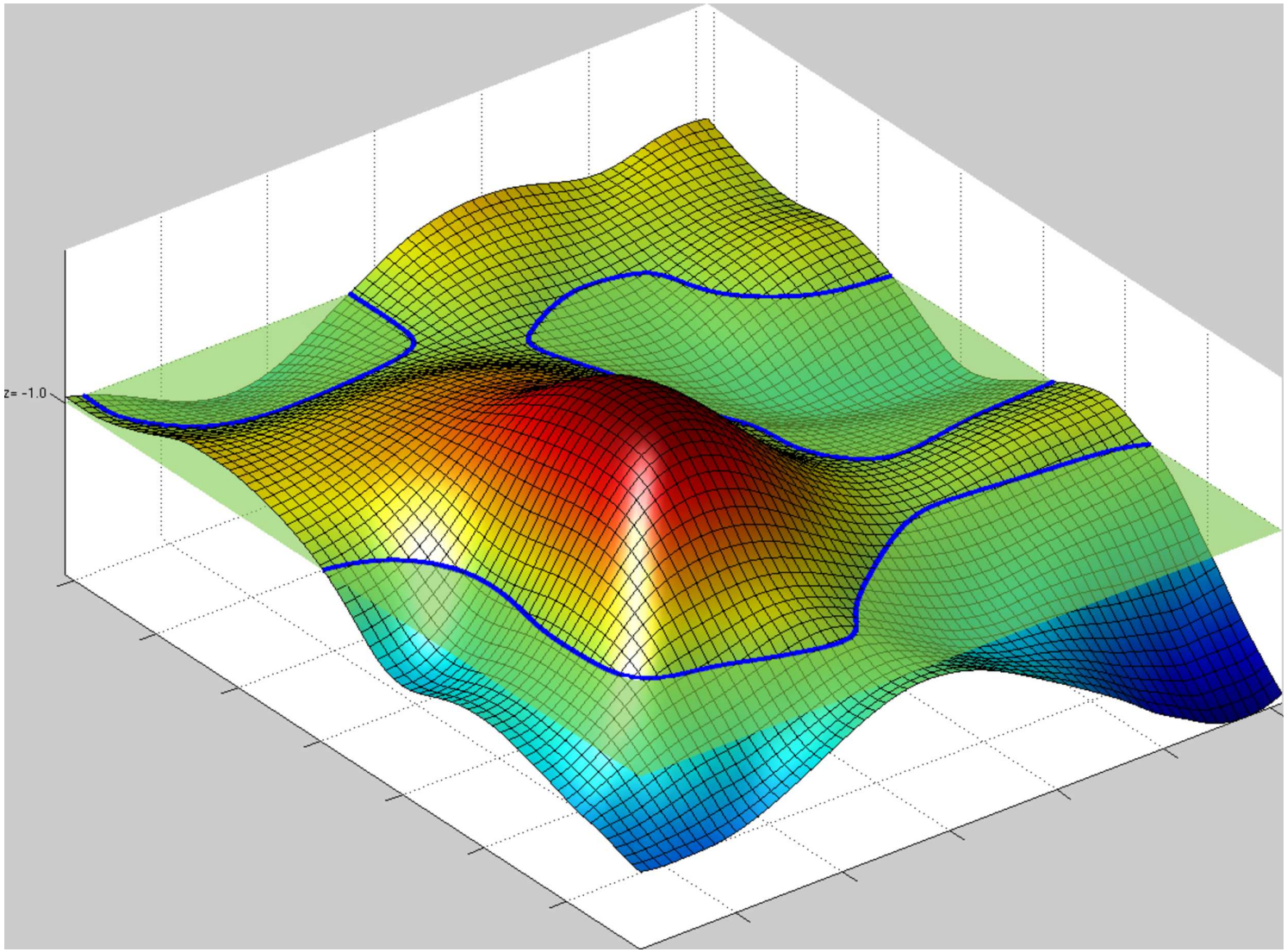
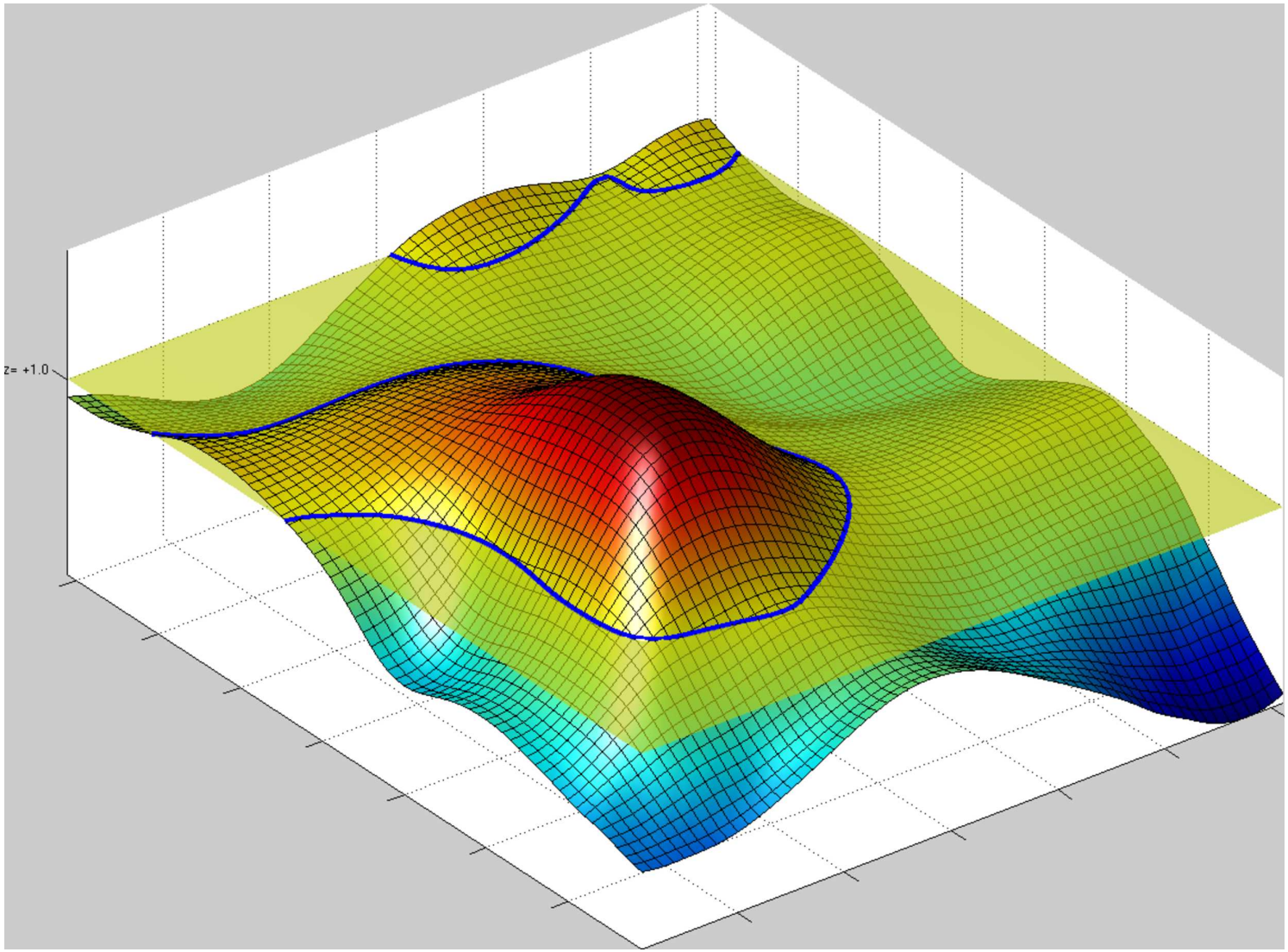
SSH-based detection



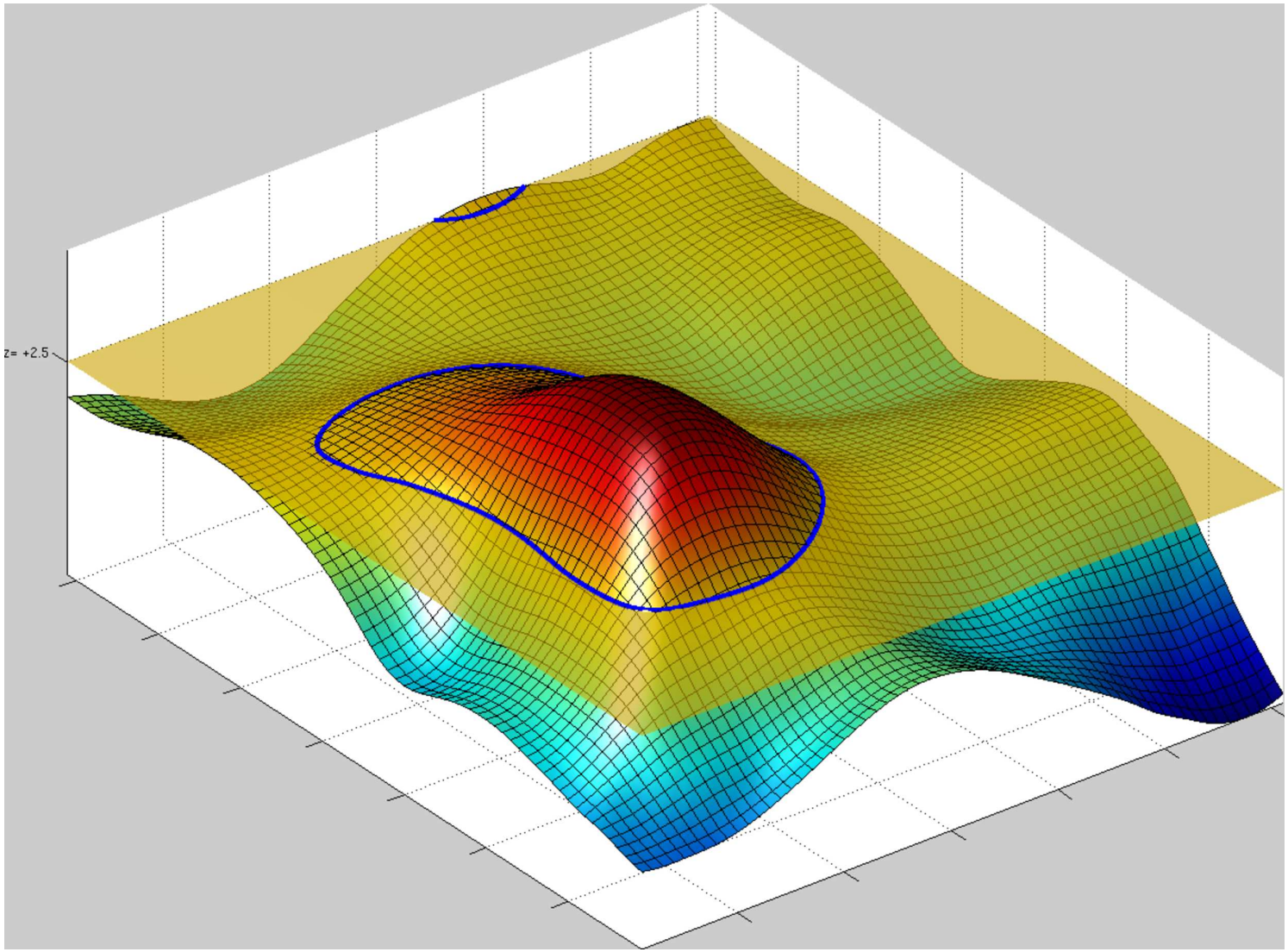
SSH-based detection



SSH-based detection

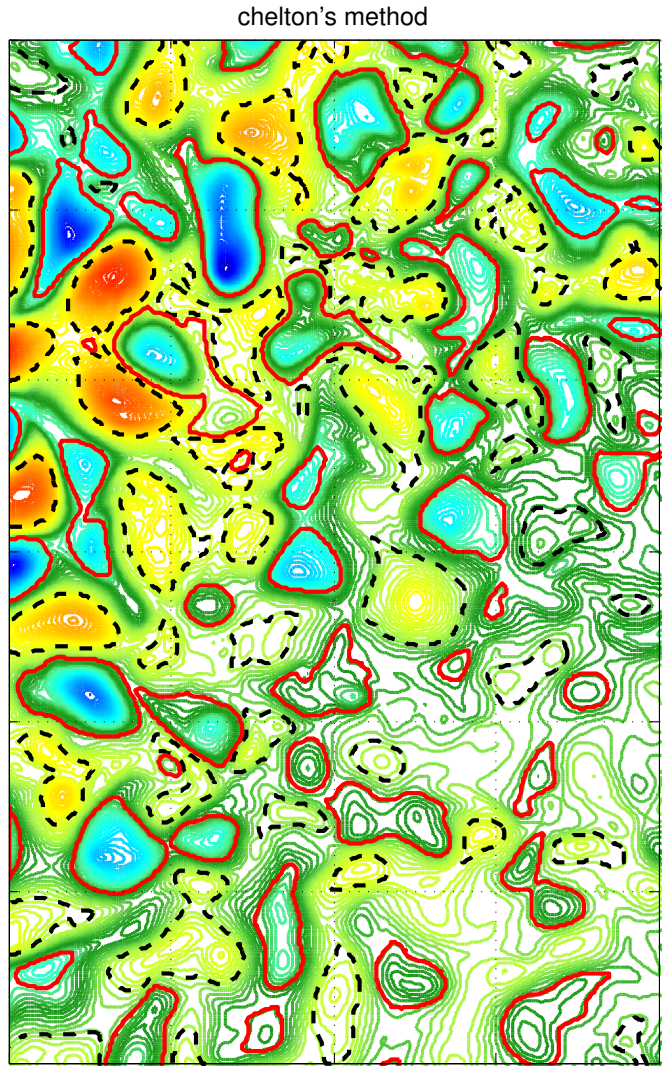


SSH-based detection

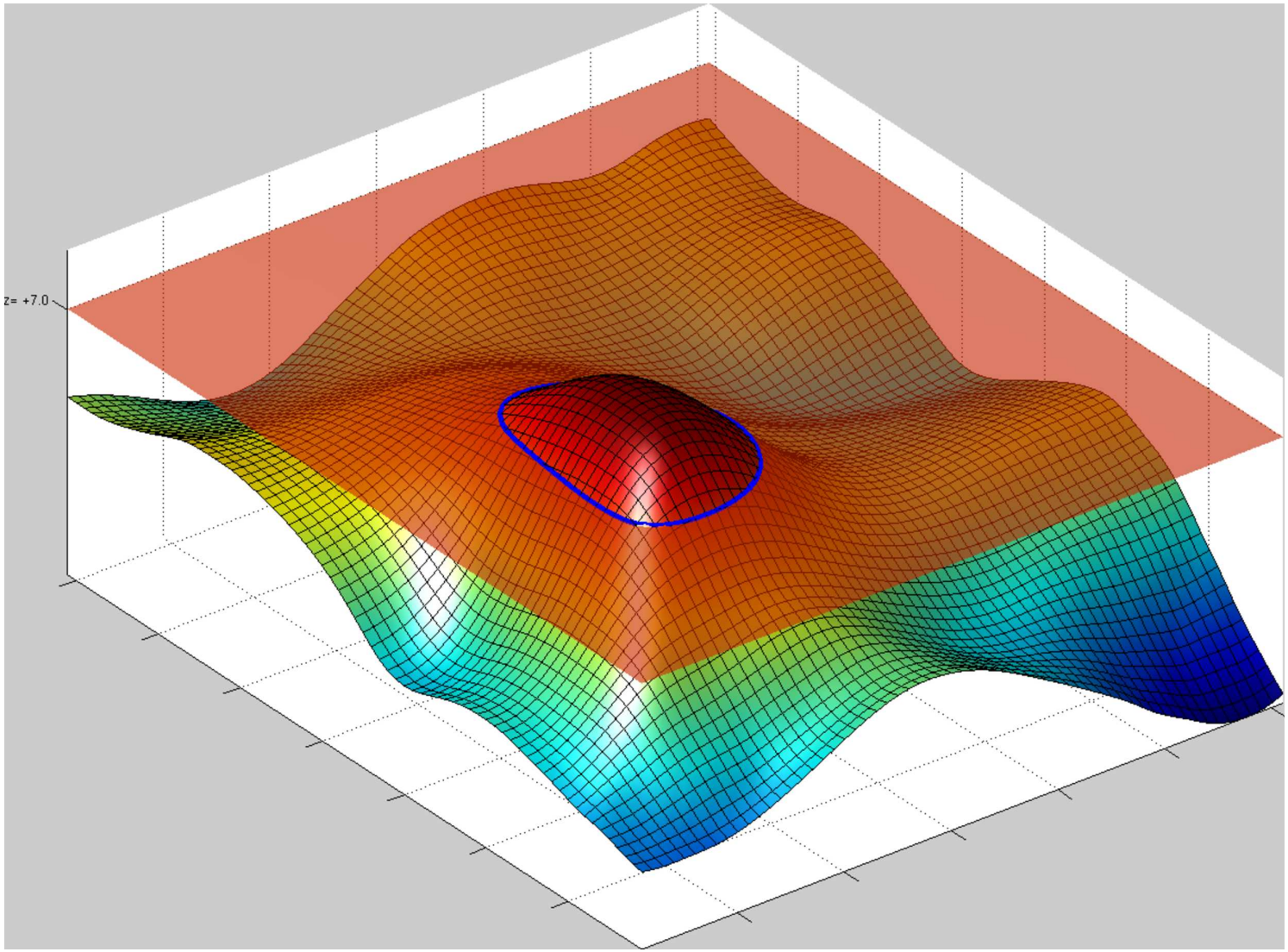


does found contour qualify?

(1) The SSH values of all of the pixels are above (below) a given SSH threshold for anticyclonic (cyclonic) eddies.
(2) There are at least 8 pixels and fewer than 1000 pixels comprising the connected region.
(3) There is at least one local maximum (minimum) of SSH for anticyclonic (cyclonic) eddies.
(4) The amplitude of the eddy is at least 1 cm (see below).
(5) The distance between any pair of points within the connected region must be less than a specified maximum.

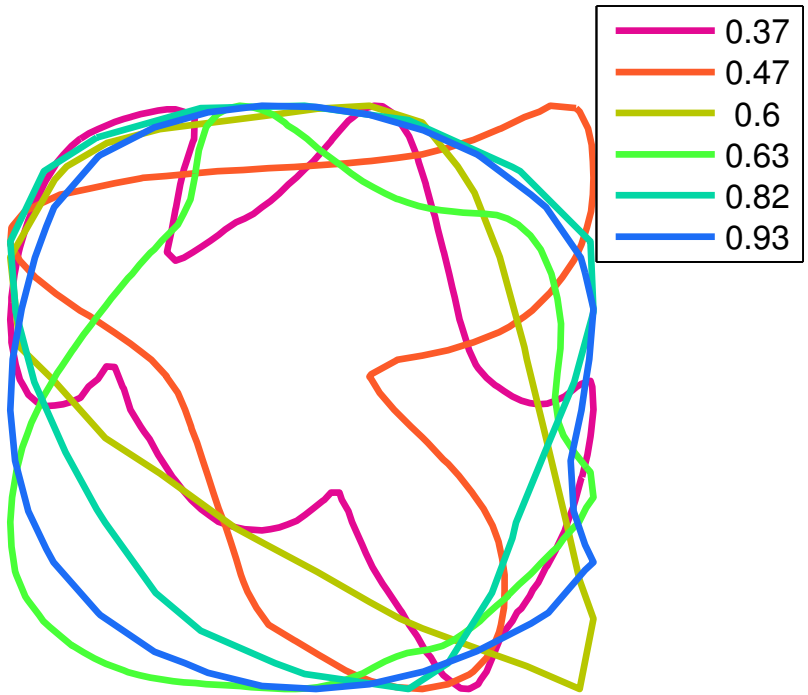


new approach: demand circular shapes

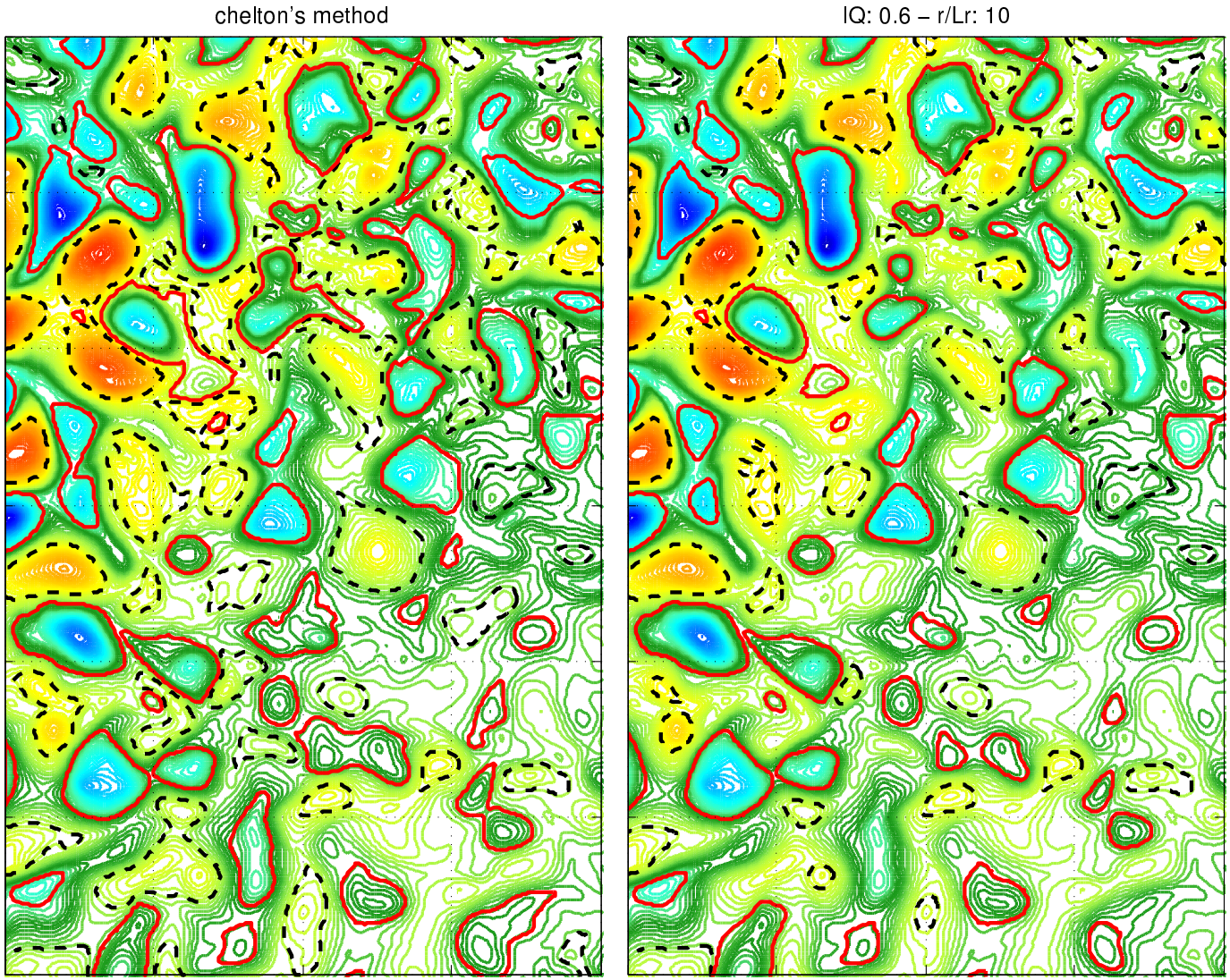


Isoperimetric Quotient

$$IQ = A/A_c = \frac{4\pi A}{c}$$



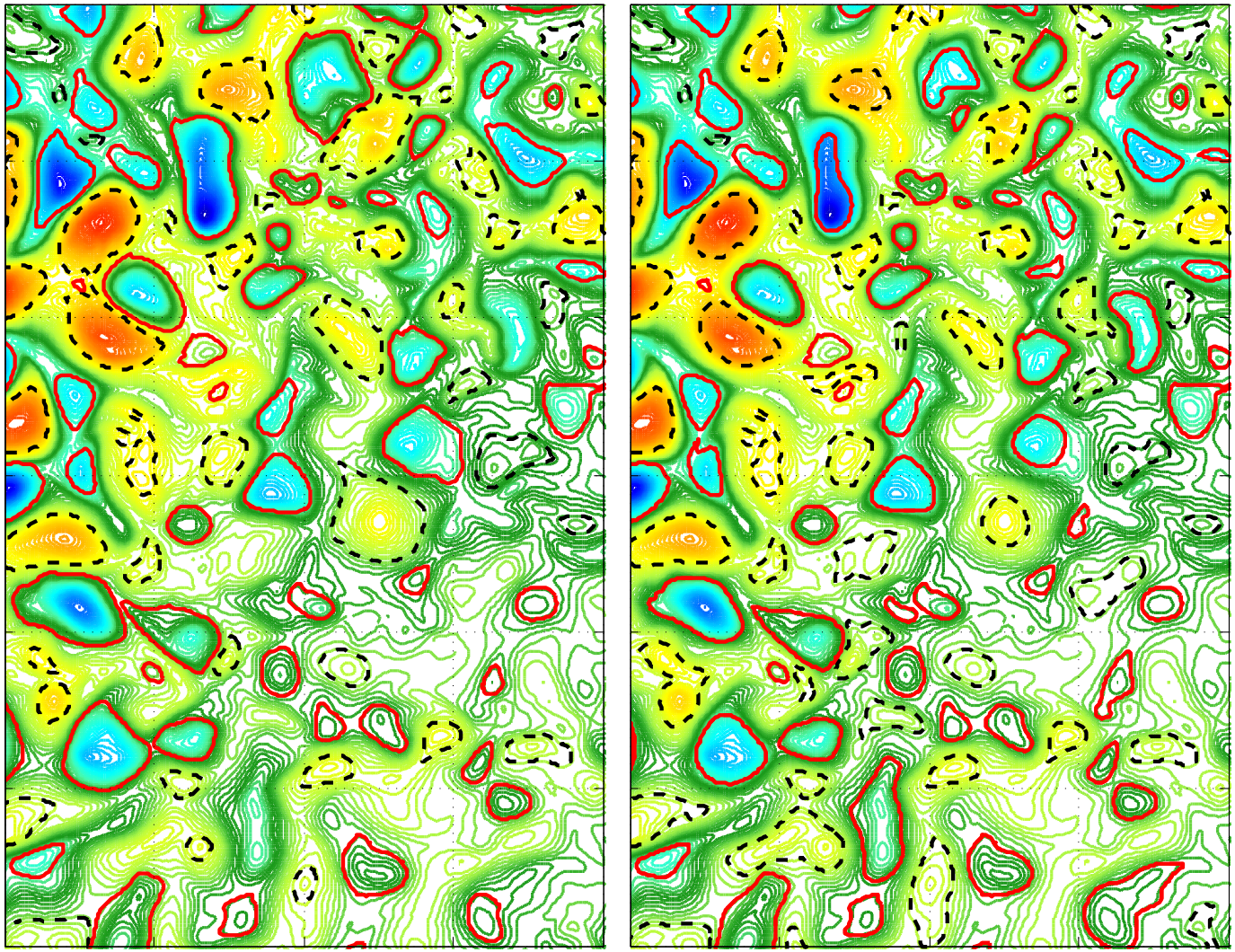
new problem: deformed eddies get rejected



solution: allow more deformation but limit hor. scale

IQ: 0.6 – r/Lr: 10

IQ: 0.55 – r/Lr: 4



Tracking

1. Build distance matrix $\mathbf{D}(old, new)$ between all eddies($t = now - dt$) to all eddies($t = now$).
2. Flag all $\mathbf{D}(old, new) >$ threshld.
3. Flag all not meeting a *similarity criterion* (function of scale and amplitude).
4. $min(\mathbf{D})$ in both directions.
   - agreement: eddy is tracked!
     $\rightarrow$ append to respective track in running archive.
   - no new eddy agrees with old eddy: eddy just died..
     $\rightarrow$ if age $\geq$ threshold, write track to archive, else delete!
   - no old eddy agrees with new eddy: a new eddy was born
     $\rightarrow$ initiate new track in running archive.

Tracking

1. Build distance matrix $\mathbf{D}(old, new)$ between all eddies($t = now - dt$) to all eddies($t = now$).
2. Flag all $\mathbf{D}(old, new) >$ threshld.
3. Flag all not meeting a **similarity criterion** (**function of scale and amplitude**).
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     $\rightarrow$ append to respective track in running archive.
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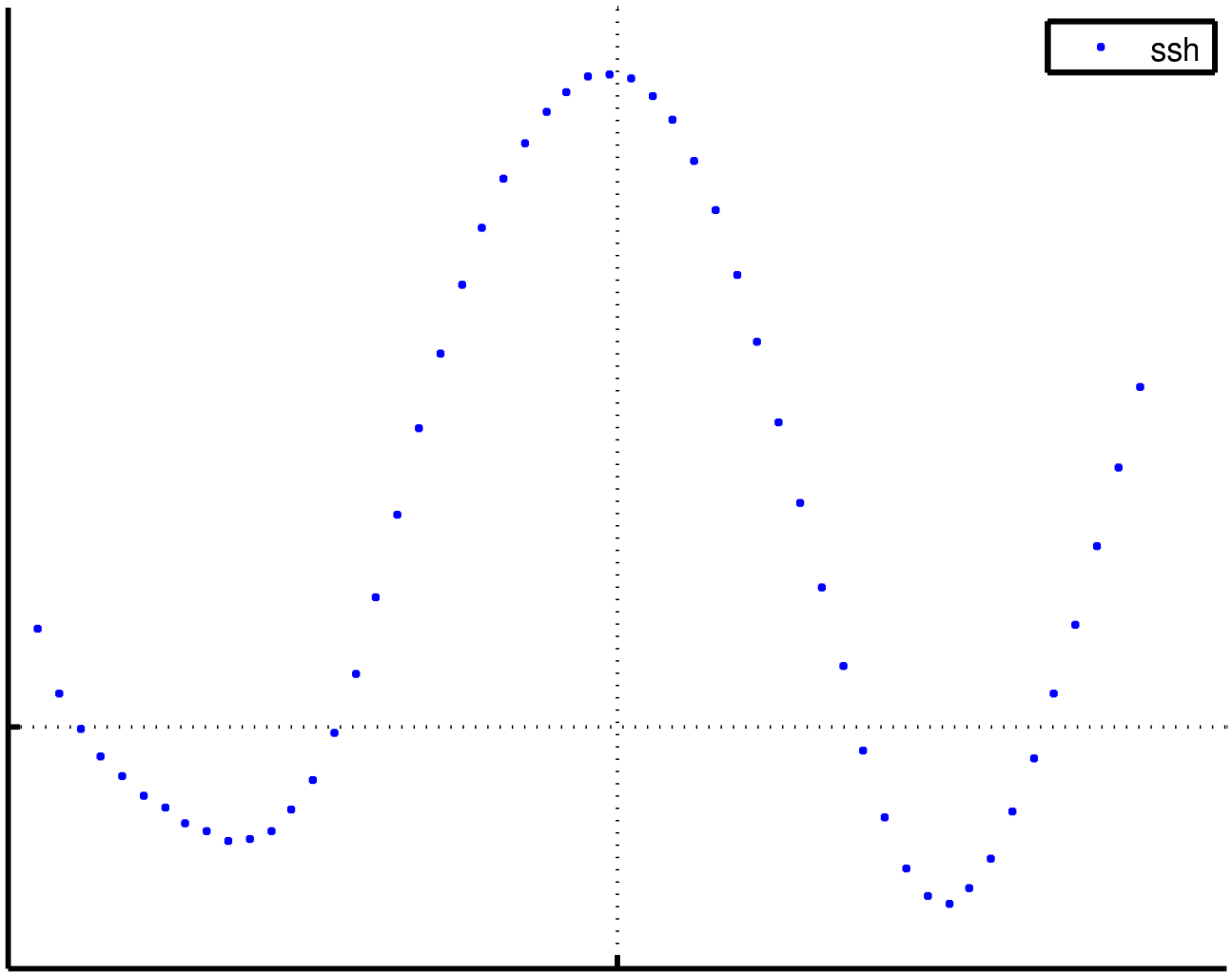
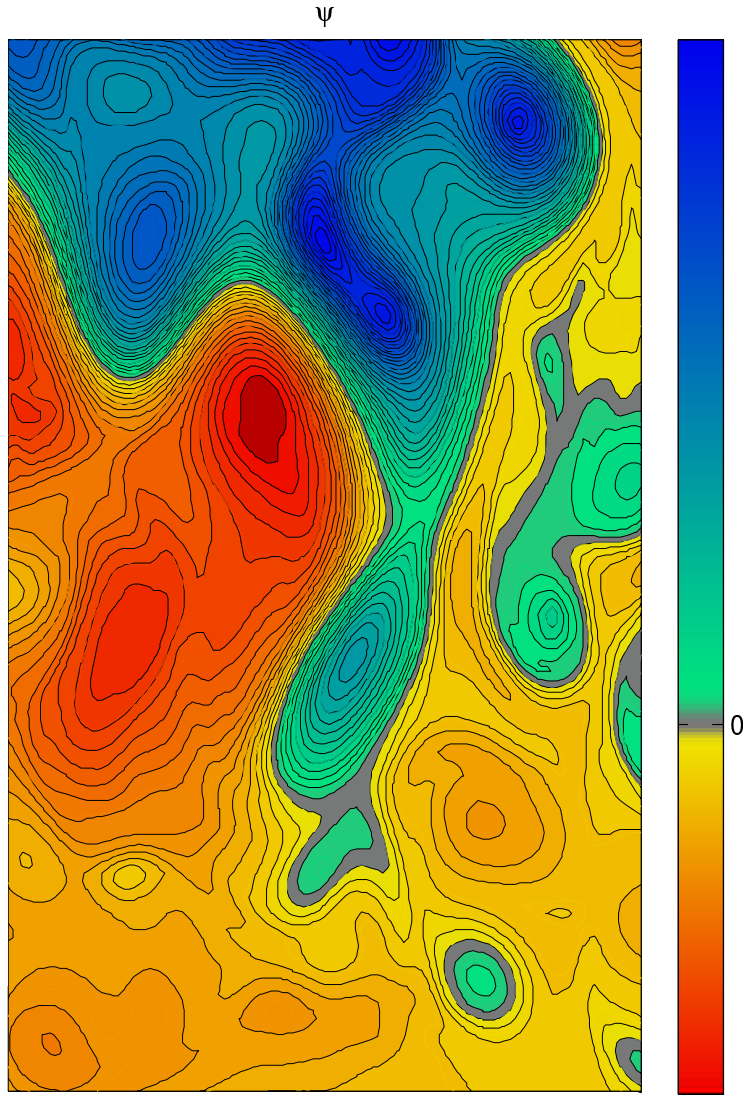
     $\rightarrow$ initiate new track in running archive.

What is the scale and amplitude of an eddy ???

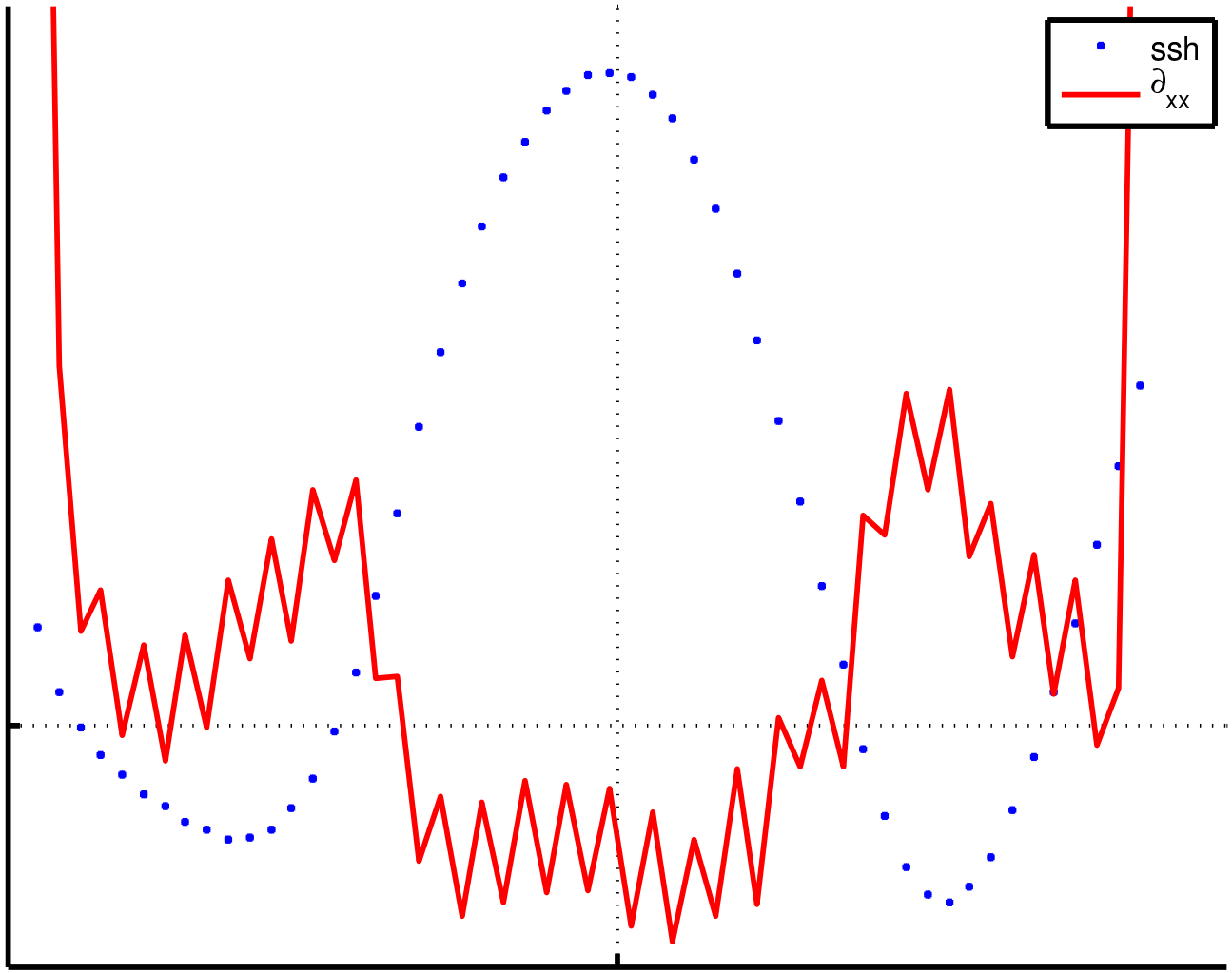


example: meander

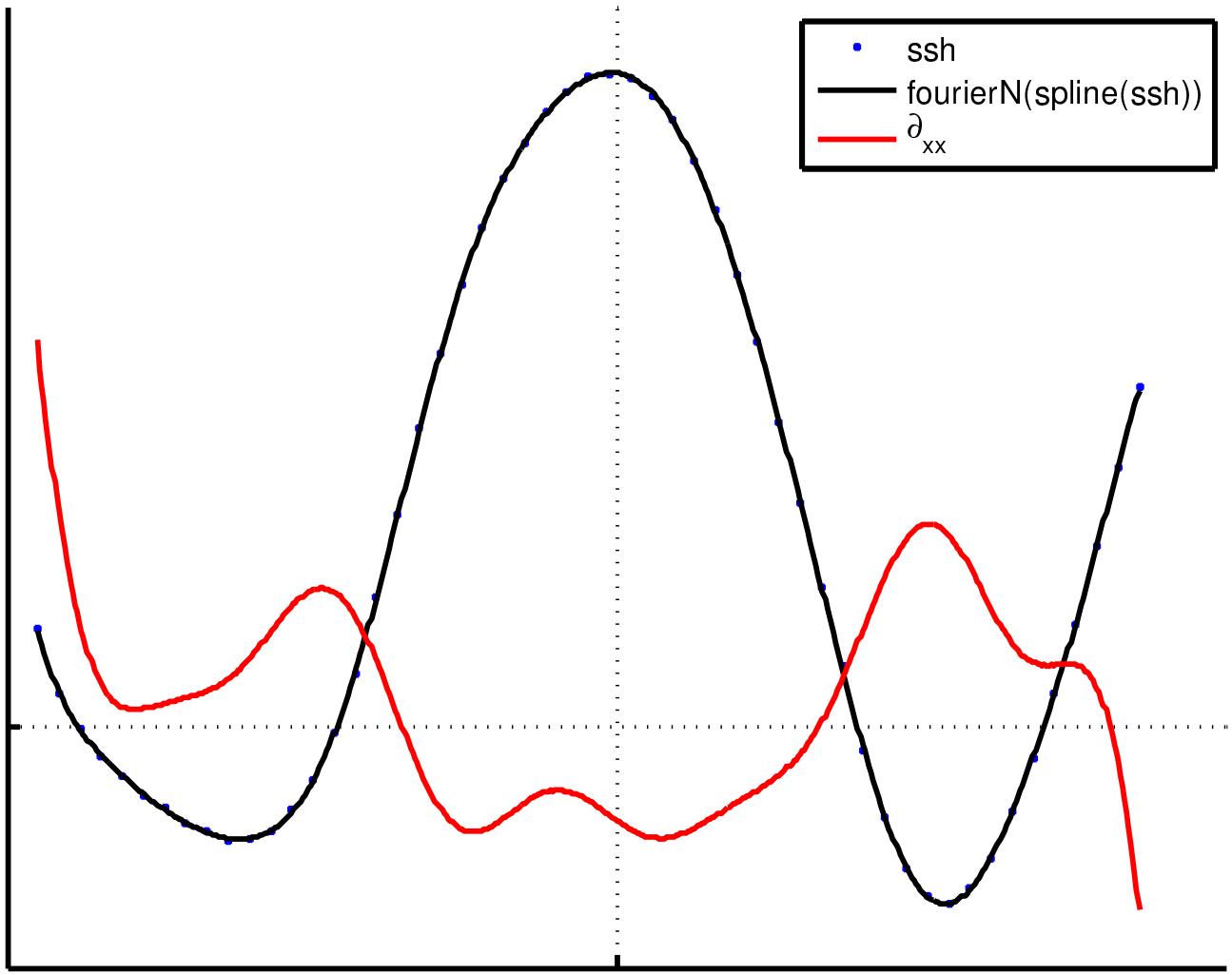


Problem: coarse resolution

$\partial_x \sim \mathbf{U}$, $\partial_{xx} \sim \boldsymbol{\omega}$

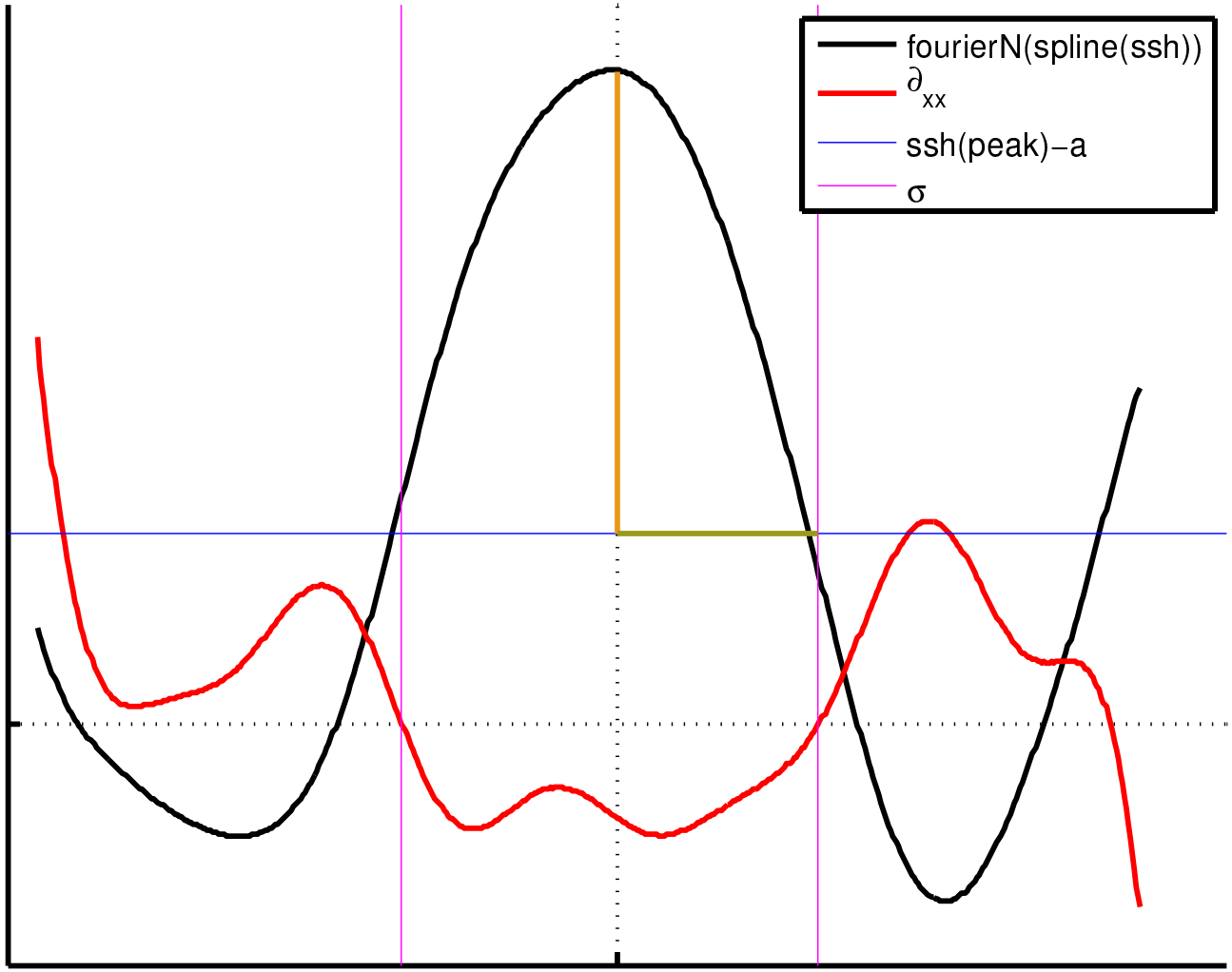


Solution: Interpolate and use Fourier Series for differentials

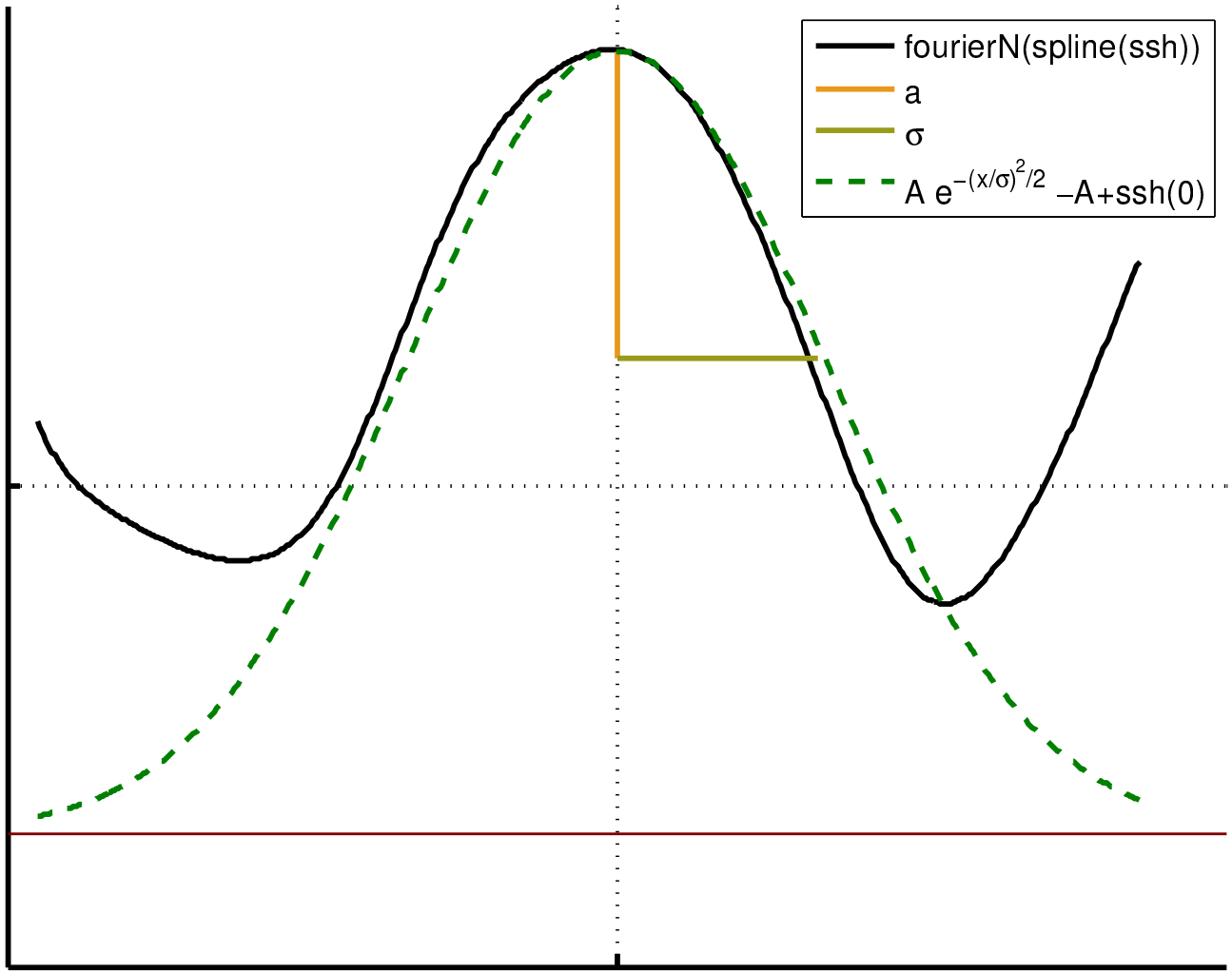


Assuming gauss shape: $Ae^{\left(-x^2/2\sigma^2\right)}$; $a = A(1 - e^{-1/2})$

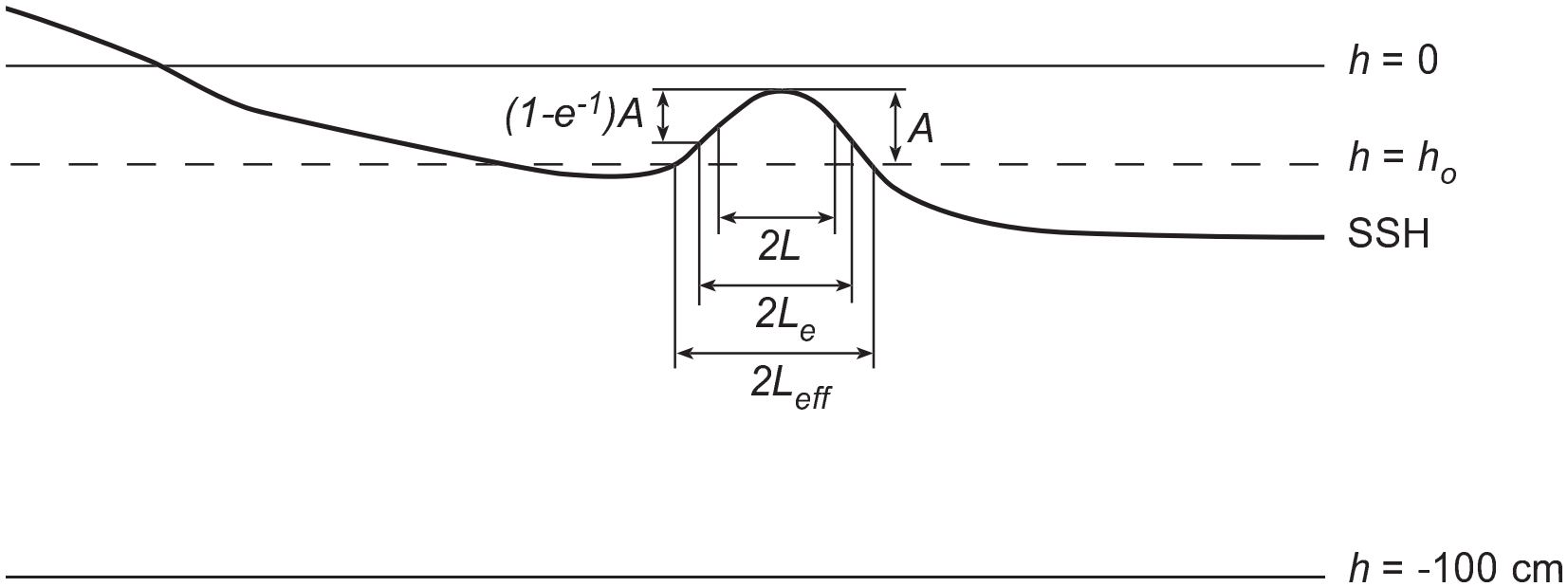
All shape-defining parameters for the *similarity criterion* are determined!



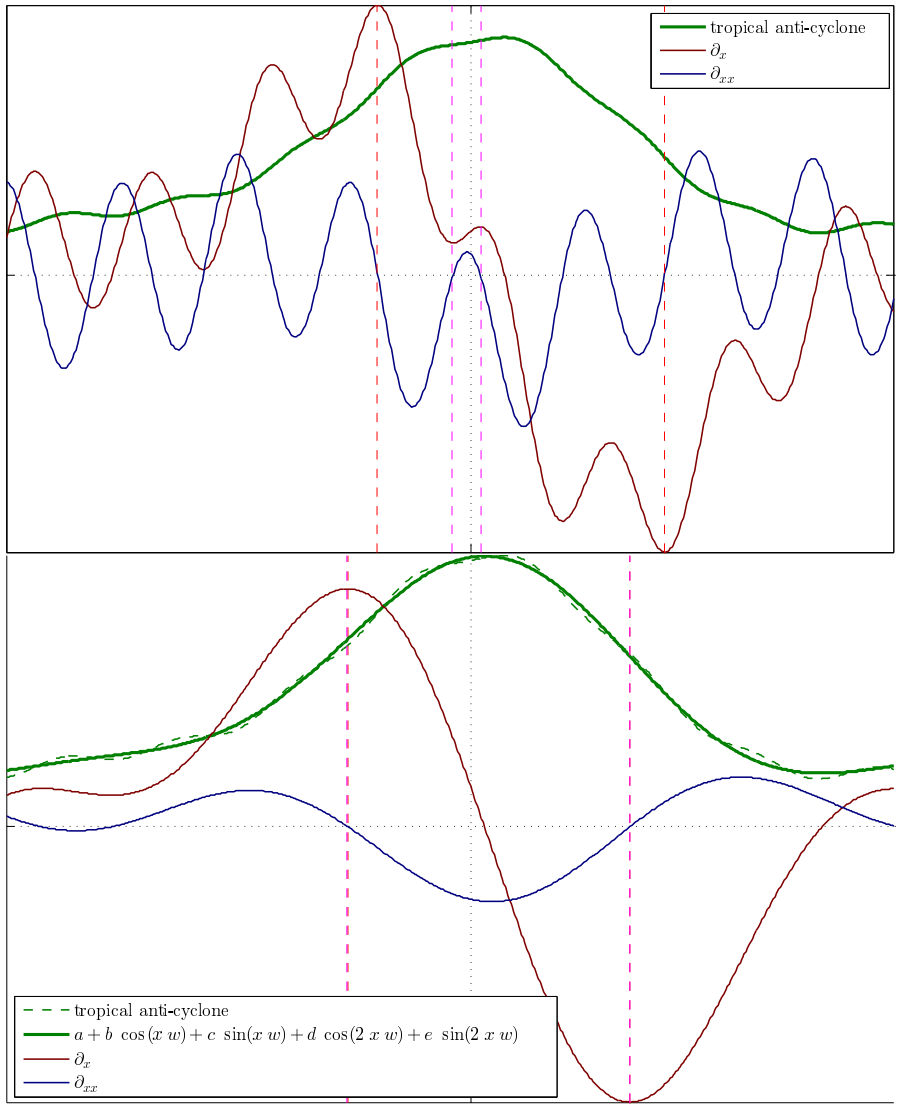
Note: Gauss shape assumption not necessary for this method.



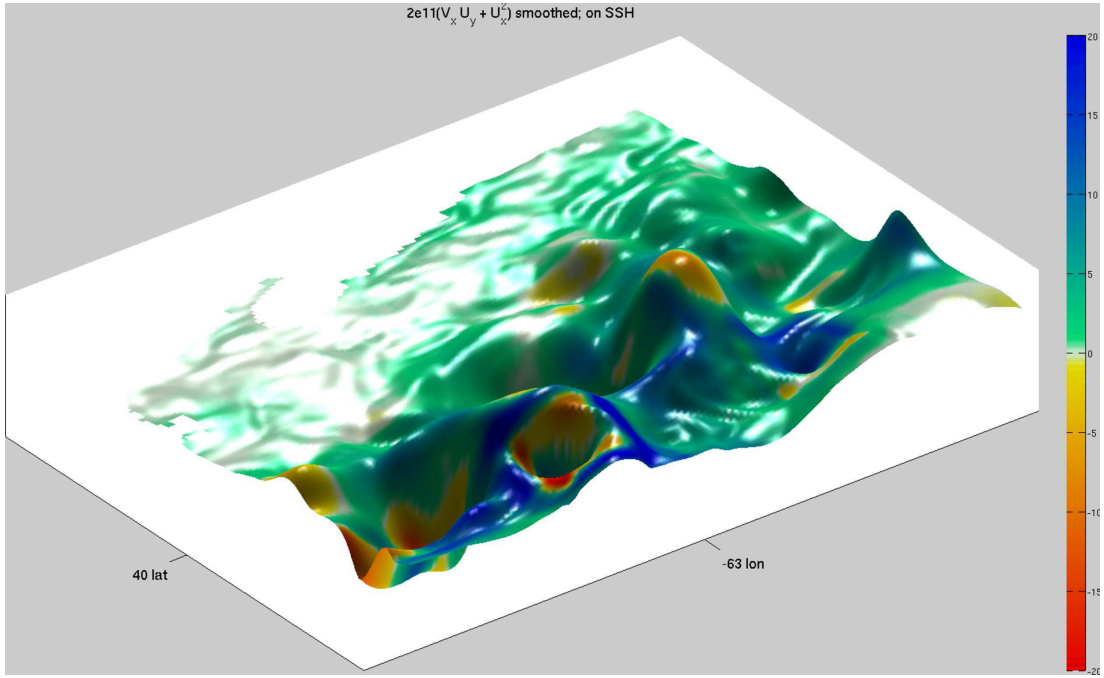
Chelton et al. define 4 different eddy scales.



problematic: broad flat *wobbly* eddies



Okubo-Weiss

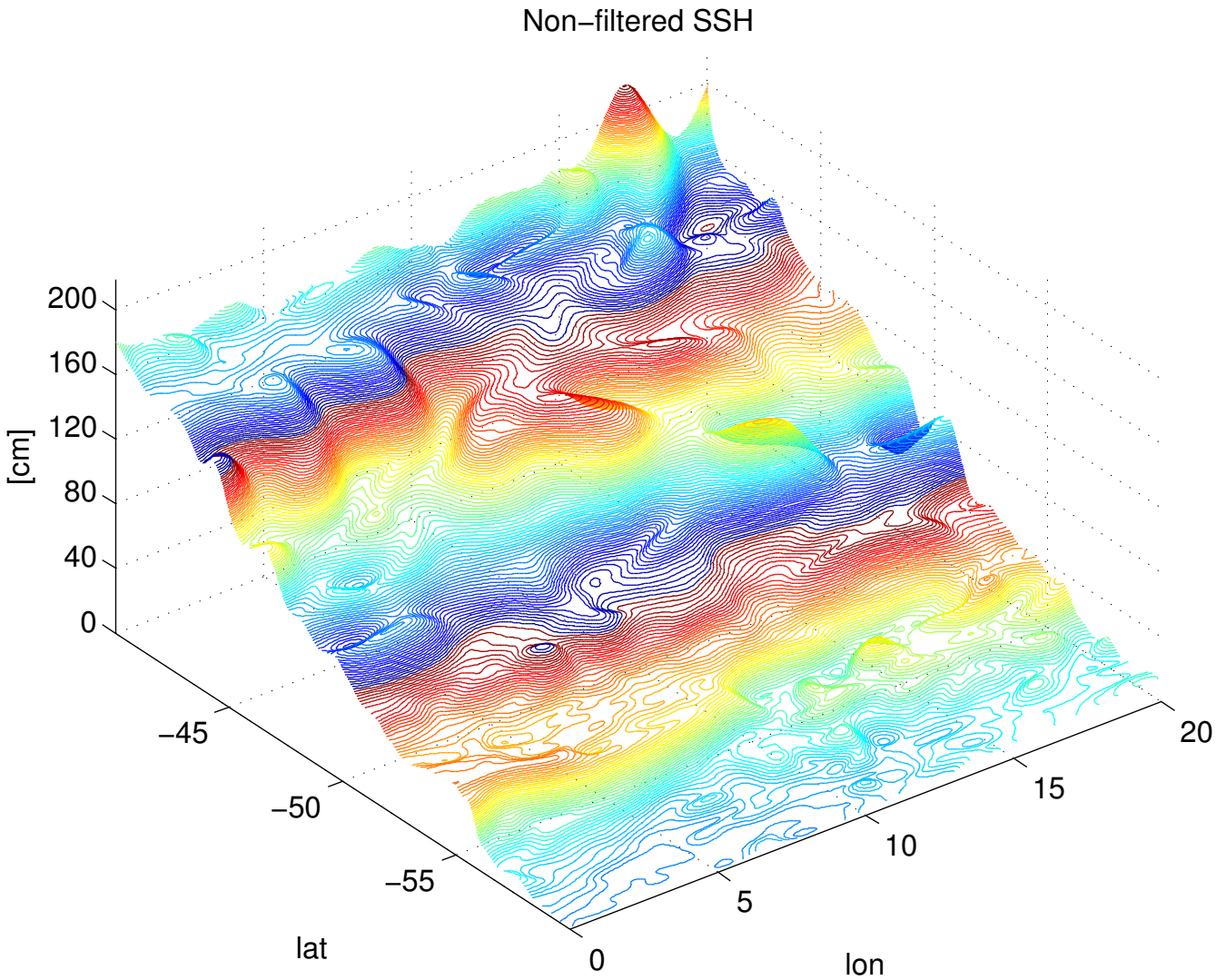


use eigenvalues of 2d deformation tensor to detect vortex:

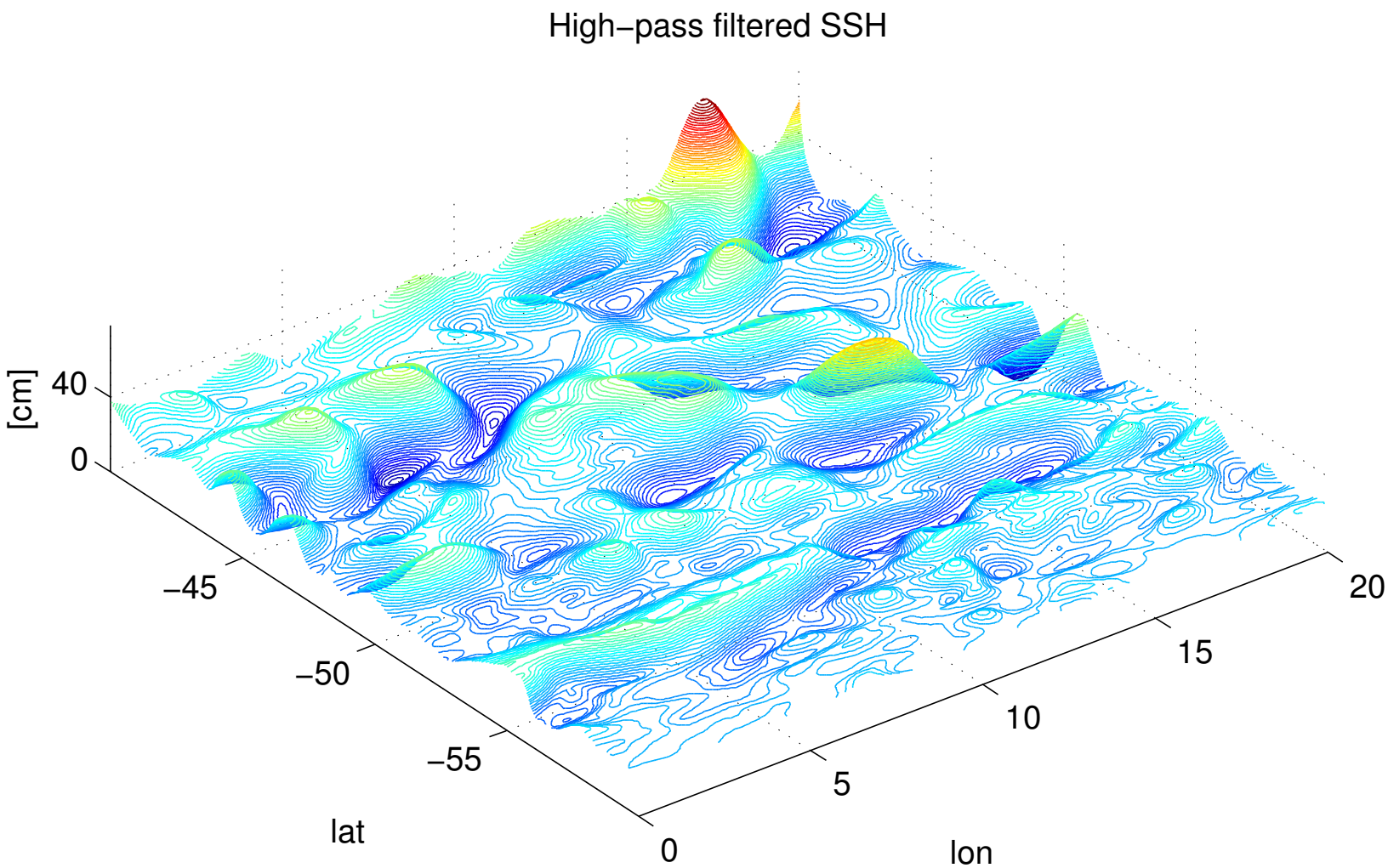
$$det(\lambda \mathbf{I} - \boldsymbol{\nabla} \mathbf{u}) = 0$$

$$\lambda^2 = OW/2 = 2u_x^2 + v_x u_y$$

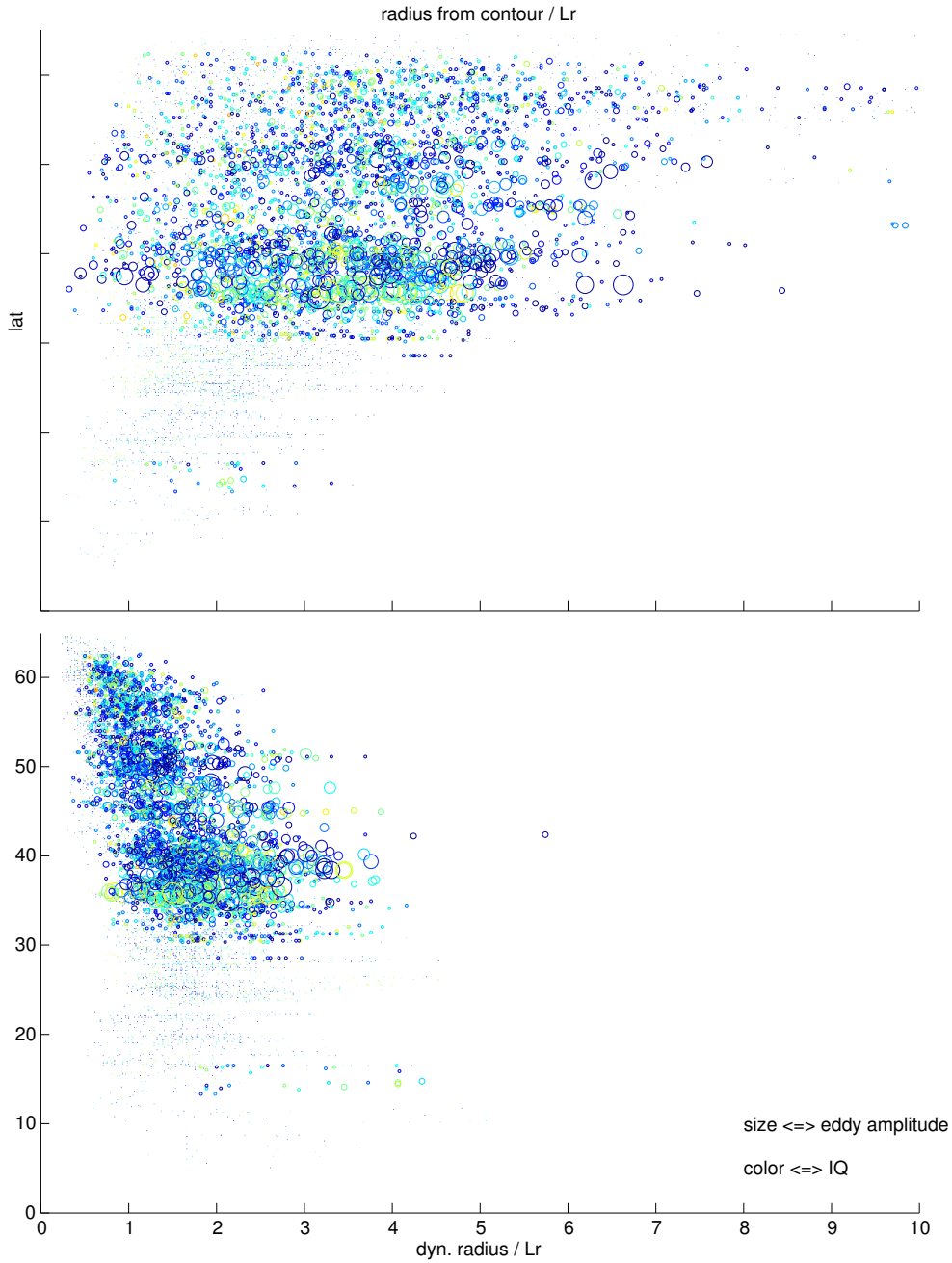
Removing larger scale signals important for Chelton's method.

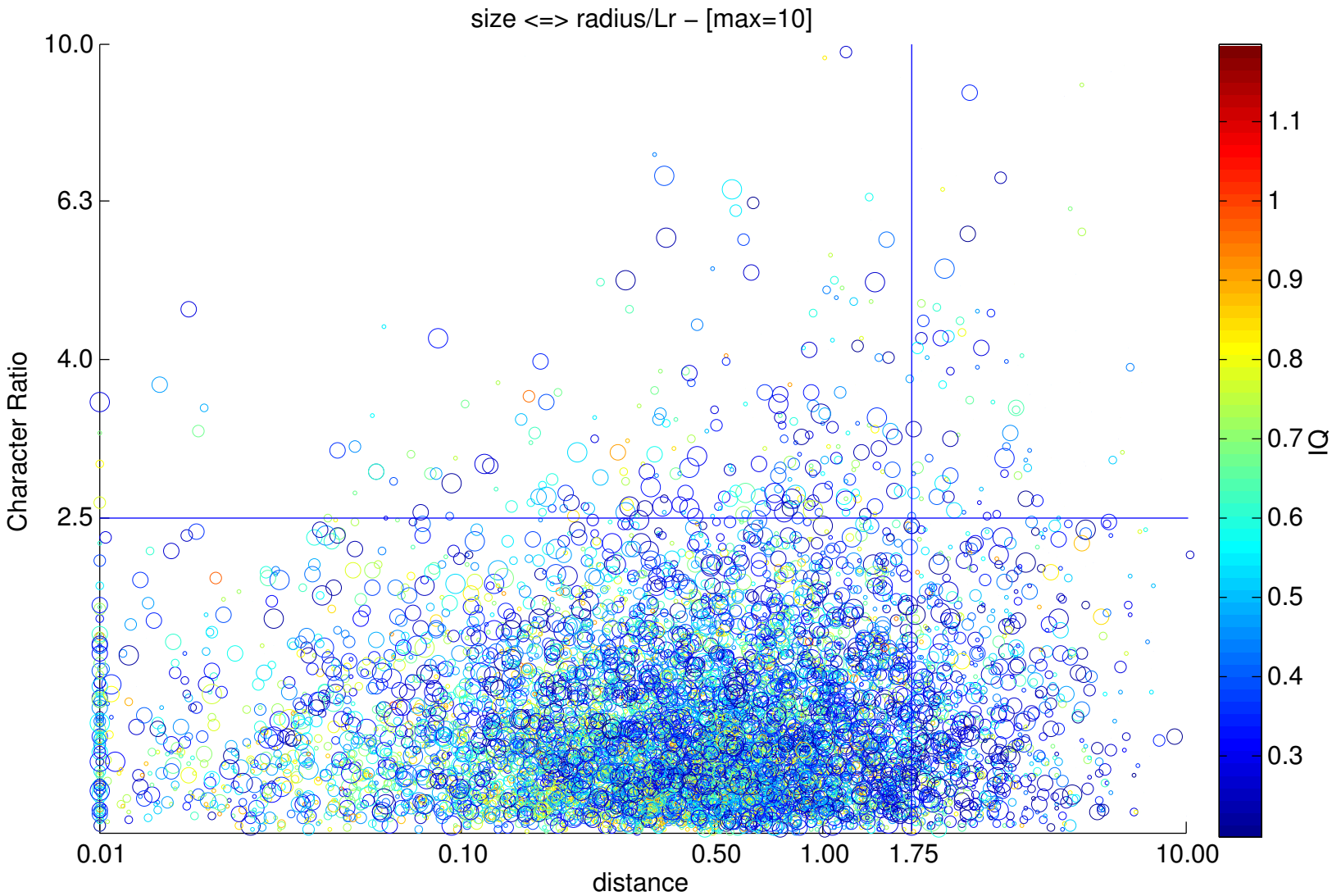


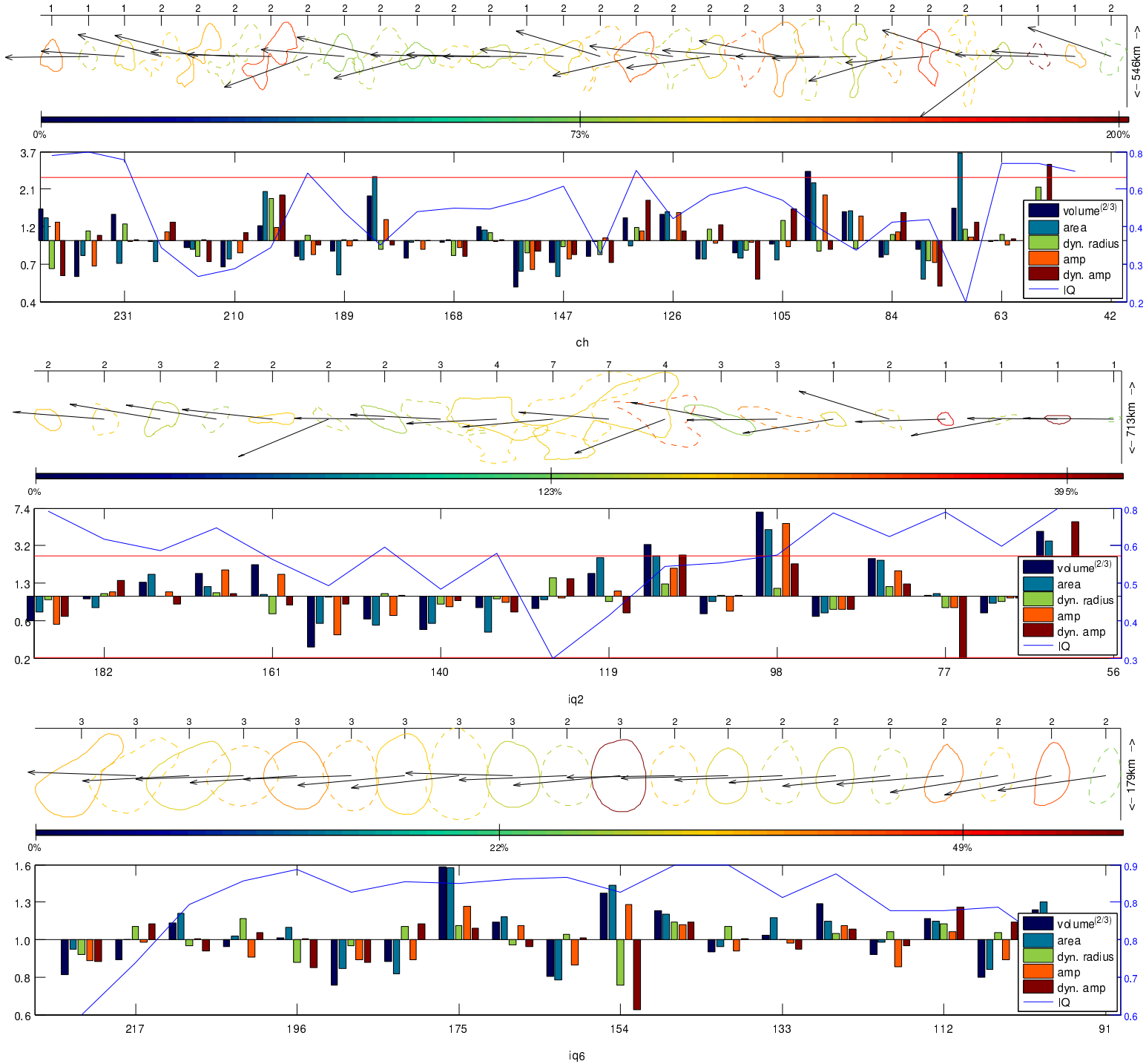
easiest: subtract annual mean

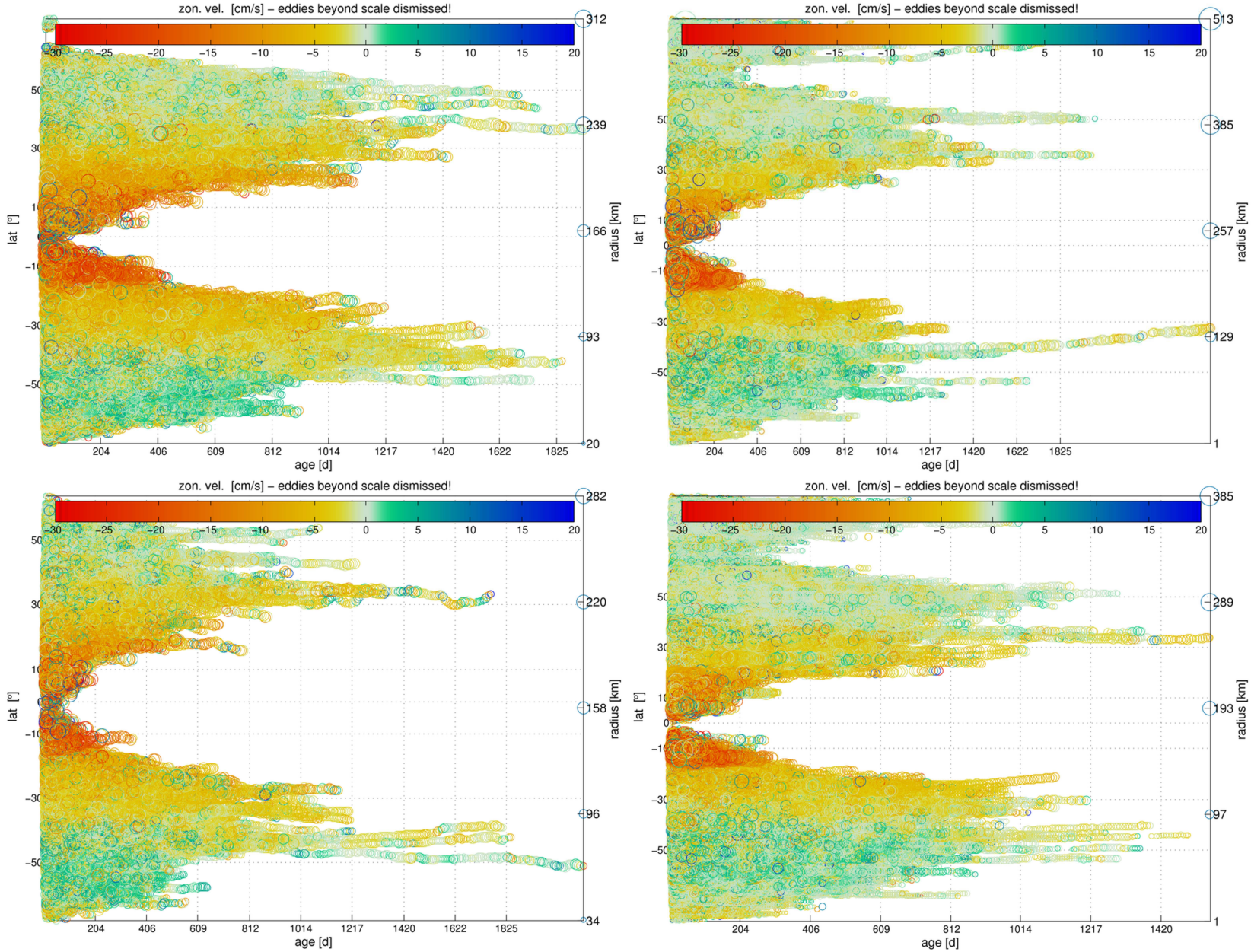


finding a suitable scale threshold

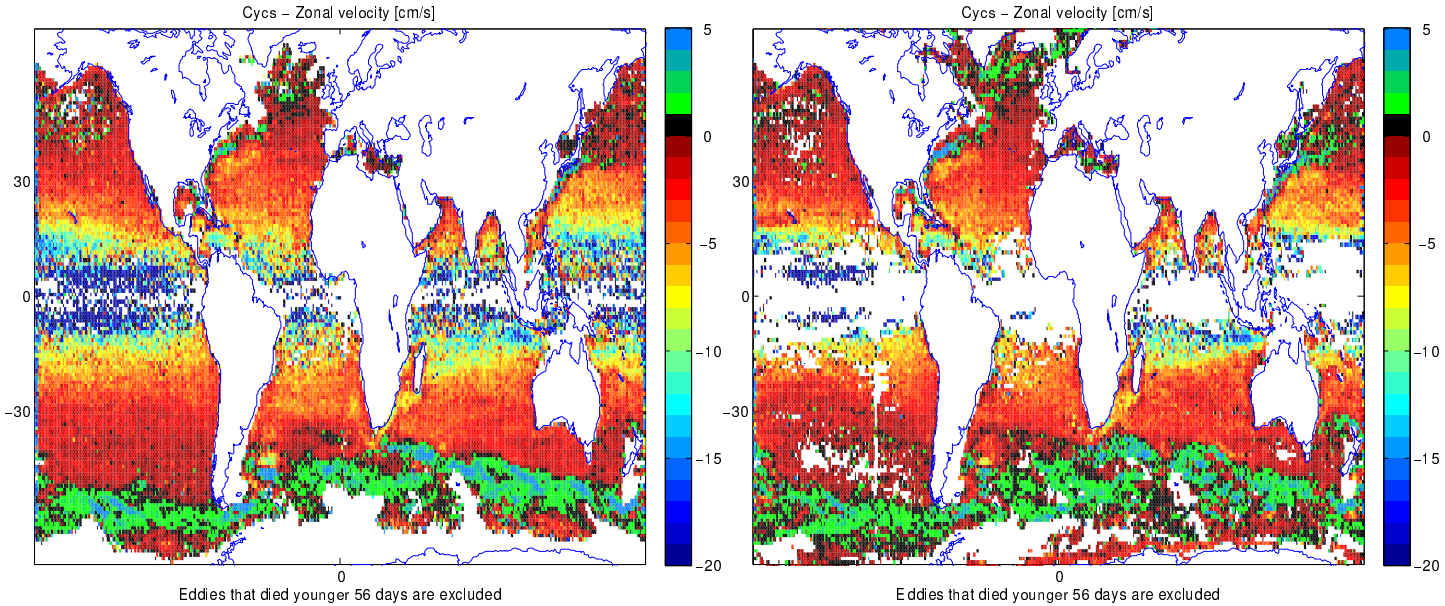


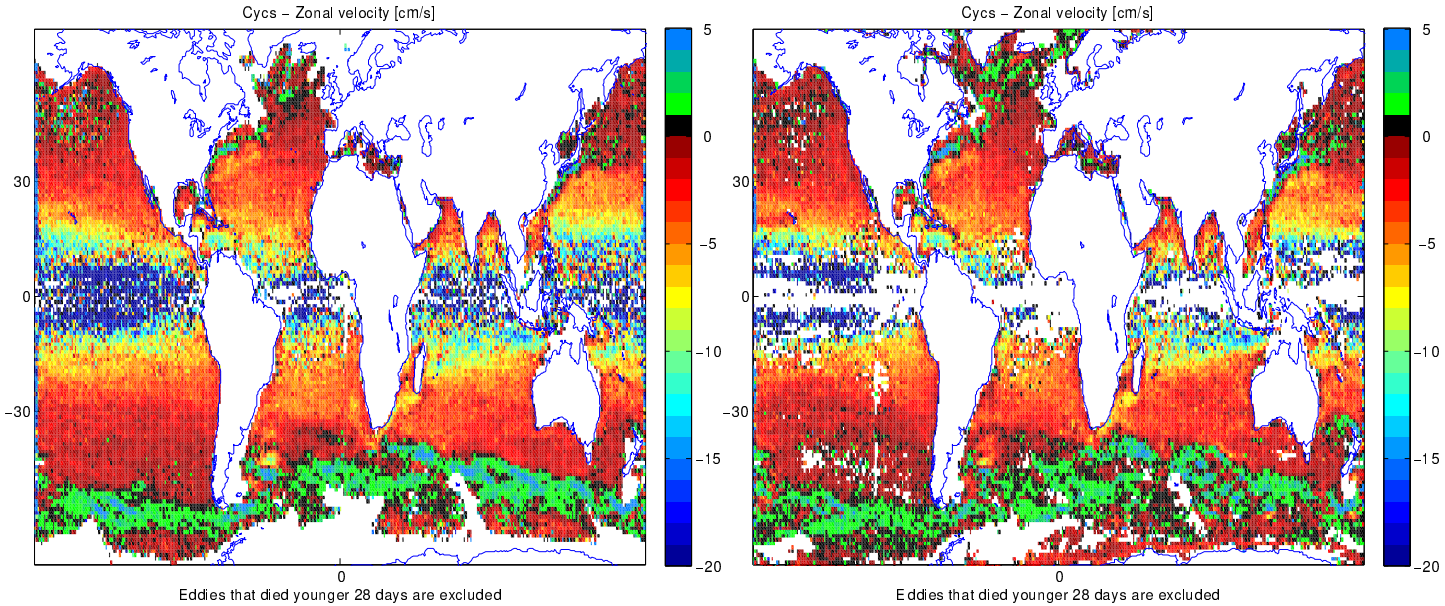

size <=> radius/Lr – [max=10]
10.0
6.3
4.0
2.5
Character Ratio
0.01
0.10
0.50
1.00
1.75
10.00
distance
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
IQ


1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 3 3 2 2 2 2 1 1 1 2
<- 546km ->
0%
73%
200%
3.7
2.1
1.2
0.7
0.4
0.8
0.6
0.4
0.3
0.2
231 210 189 168 147 126 105 84 63 42
volume(2/3)
area
dyn. radius
amp
dyn. amp
IQ
ch
2 2 3 2 2 2 2 3 4 7 7 4 3 3 1 2 1 1 1 1
<- 713km ->
0%
123%
395%
7.4
3.2
1.3
0.6
0.2
0.8
0.6
0.5
0.4
0.3
182 161 140 119 98 77 56
volume(2/3)
area
dyn. radius
amp
dyn. amp
IQ
iq2
3 3 3 3 3 3 3 3 3 3 2 3 2 2 2 2 2 2 2 2 2 2
<- 179km ->
0%
22%
49%
1.6
1.3
1.0
0.8
0.6
0.9
0.8
0.8
0.7
0.6
217 196 175 154 133 112 91
volume(2/3)
area
dyn. radius
amp
dyn. amp
IQ
iq6


zon. vel. [cm/s] – eddies beyond scale dismissed!
lat [°]
age [d]
radius [km]
312
239
166
93
20
zon. vel. [cm/s] – eddies beyond scale dismissed!
lat [°]
age [d]
radius [km]
513
385
257
129
1
zon. vel. [cm/s] – eddies beyond scale dismissed!
lat [°]
age [d]
radius [km]
282
220
158
96
34
zon. vel. [cm/s] – eddies beyond scale dismissed!
lat [°]
age [d]
radius [km]
385
289
193
97
1

	aviso	pop
me	U	U
chelton	U	U





	aviso	pop
me	zonal mean U	zonal mean U
chelton	zonal mean U	zonal mean U

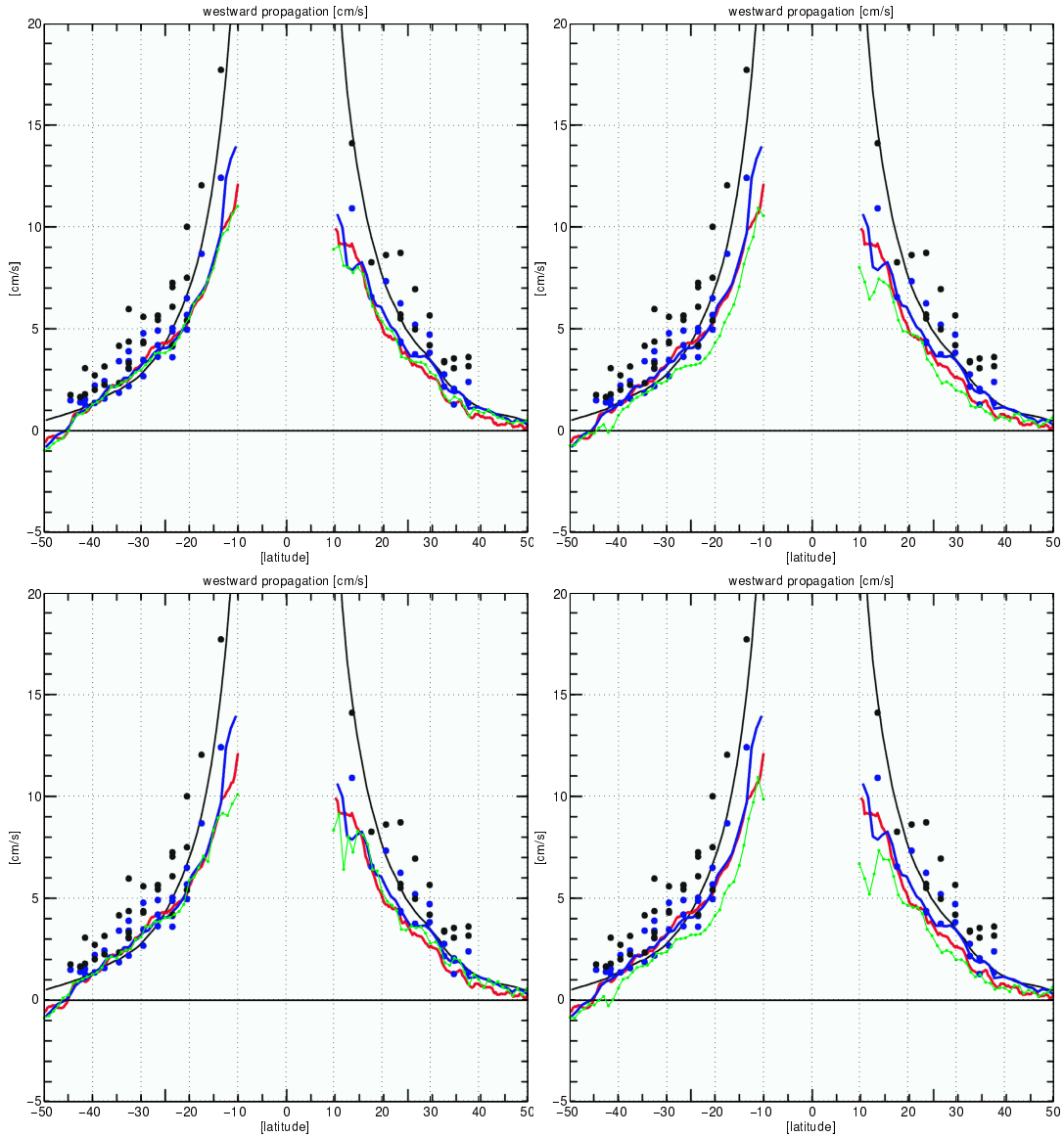
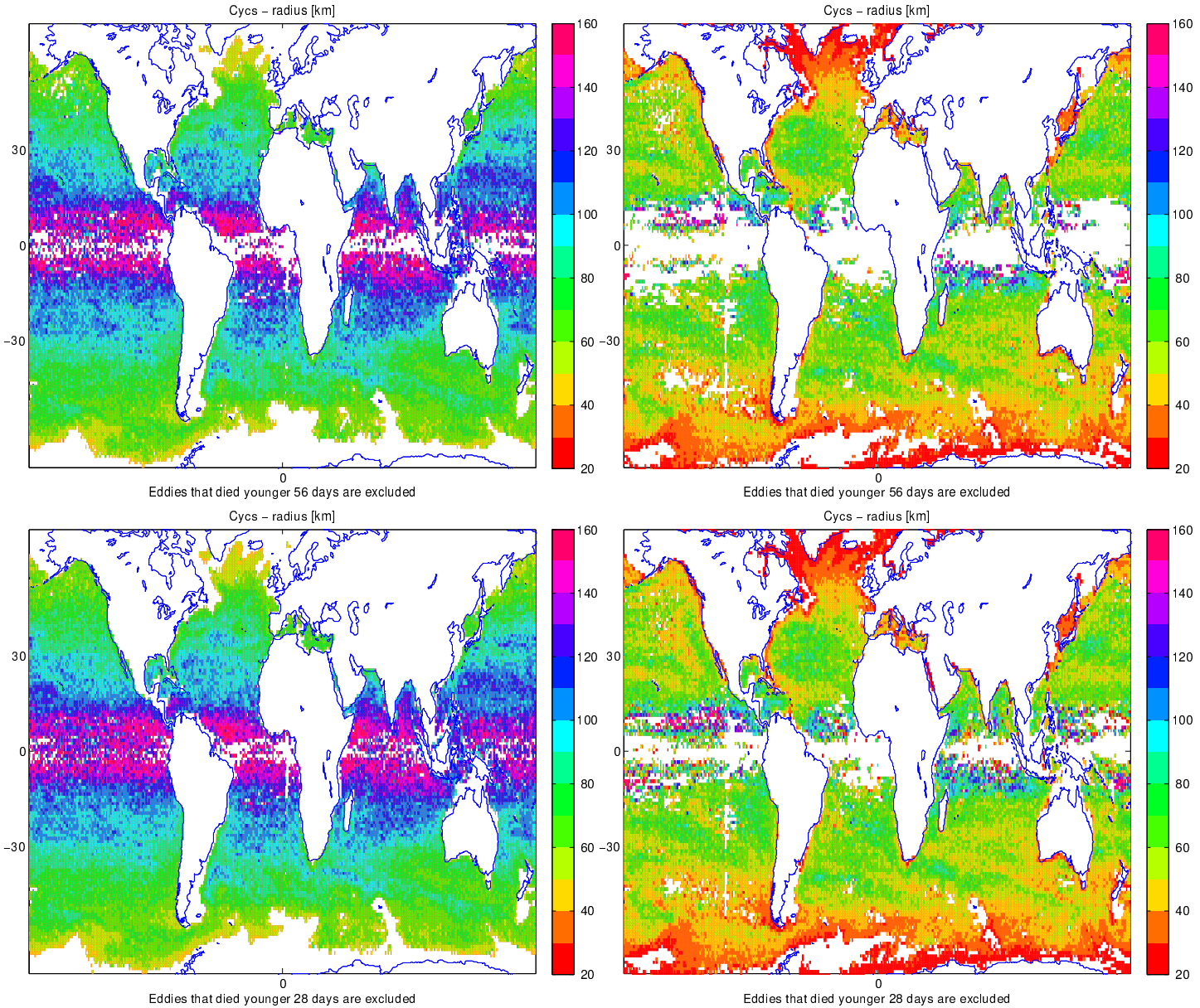
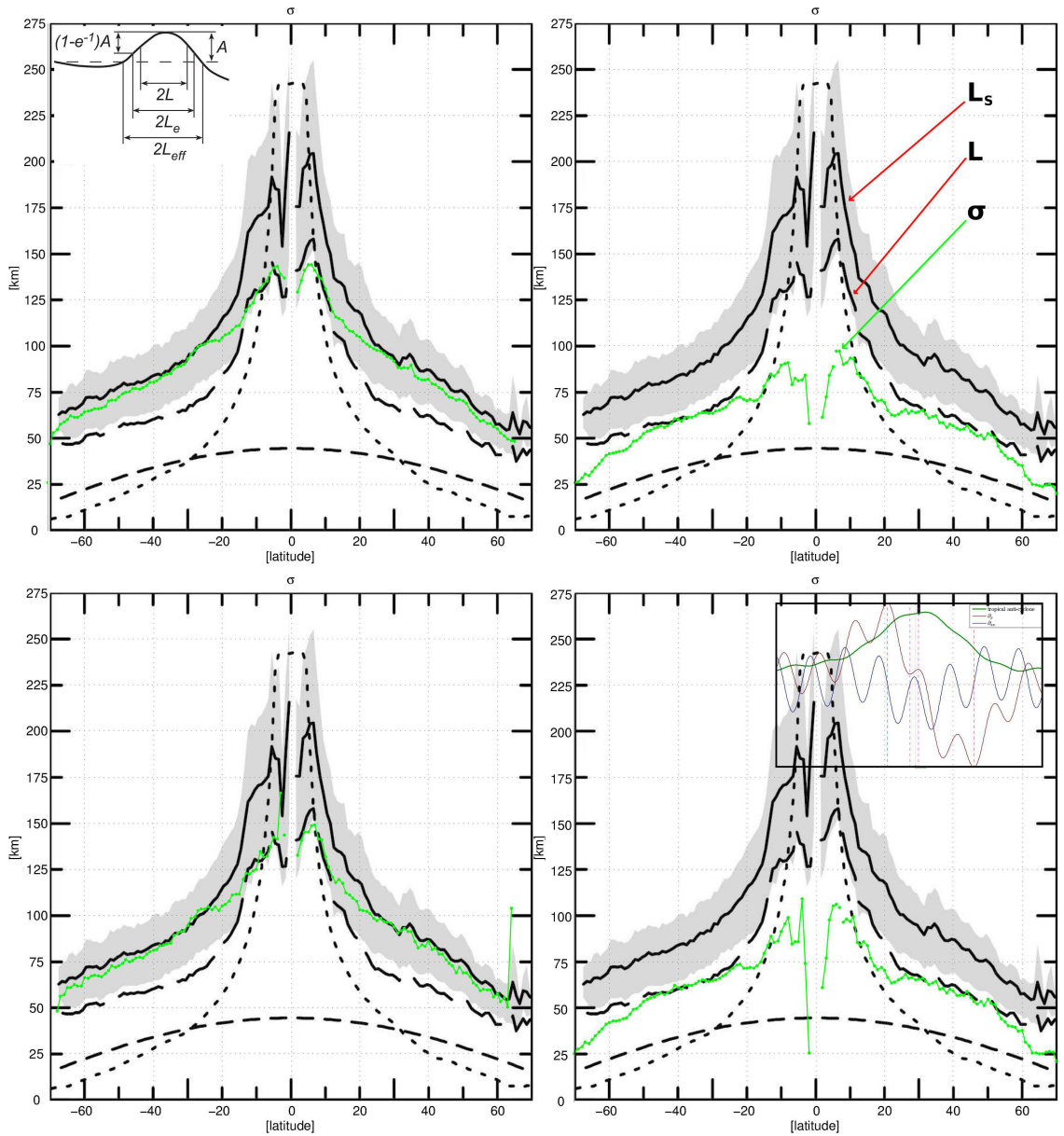


Figure: black dots: Radon transforms of 20x10 high-pass filtered SSH elds along the 45 zonal sections. Red dots: means of U along those sections (age $\geq$ 16 weeks). red line: zonalmean(U). blue line: space-time-lagged cross-correlation (Fu 2009).

	aviso	pop
me	σ	σ
chelton	σ	σ



	aviso	pop
me	zonal mean σ	zonal mean σ
chelton	zonal mean σ	zonal mean σ



to-do-matrix

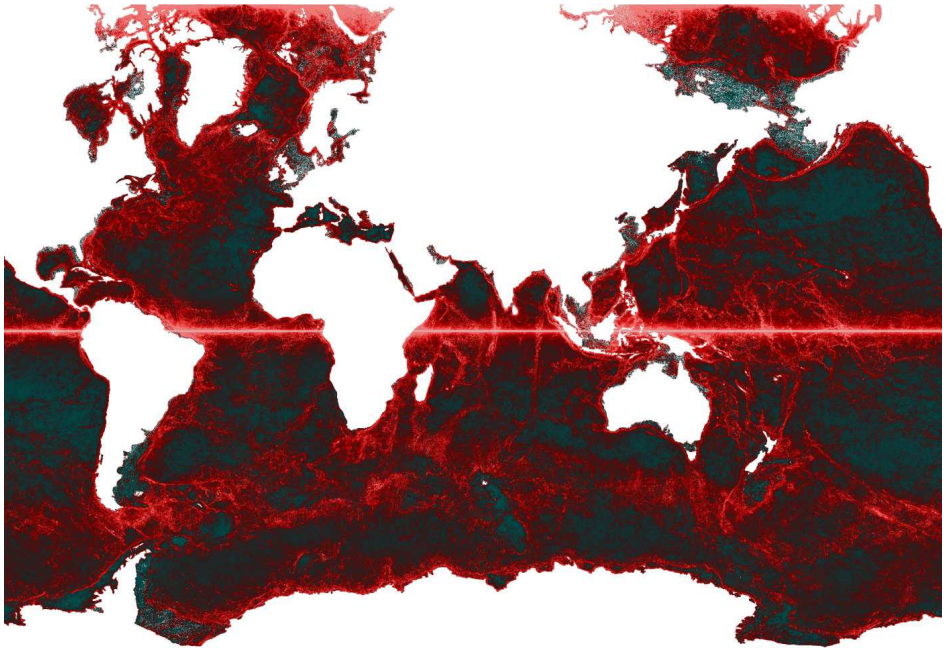
	pop	aviso	comparison
U	[3]	[1, 2]	[3]
scale	[3]	[1, 2]	[3]
method Chelton	N	[1],N	N
method R^2	[3]	n/a	n/a
method OW	[3]	[2]	[3]
method IQ	N	N	N
net U	N	N	N
steering level	N	n/a	n/a
$p(z)$	N	n/a	n/a
f/H	N		
remap pop2avi			
drop buoys into eddies			
go 3d			

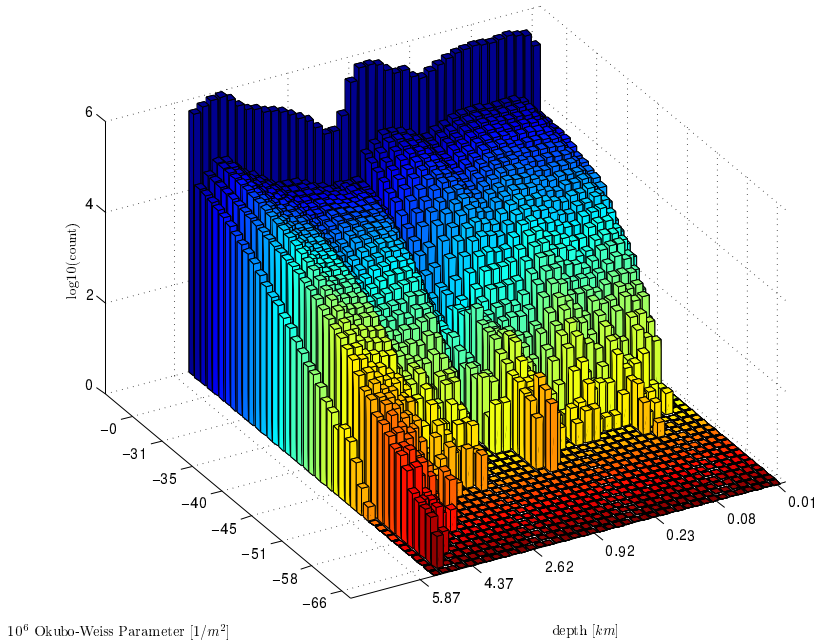
[1] Chelton, D. B., Schlax, M. G., and Samelson, R. M. Global observations of nonlinear mesoscale eddies. *Prog. Oceanogr. 91*, 2 (Oct. 2011), 167–216.

[2] Chelton, D. B., Schlax, M. G., Samelson, R. M., and de Szoeke, R. a. Global observations of large oceanic eddies. *Geophys. Res. Lett. 34*, 15 (Aug. 2007), L15606.

[3] Petersen, M. R., Williams, S. J., Maltrud, M. E., Hecht, M. W., and Hamann, B. A three-dimensional eddy census of a high-resolution global ocean simulation. *J. Geophys. Res. Ocean. 118*, 4 (Apr. 2013), 1759–1774.

Which depth to take mean current from?





14–Oct–1913