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Real-time oceanography and extreme events

David Griffin, Madeleine Cahill and Jim Mansbridge.
CSIRO Marine and Atmospheric Research

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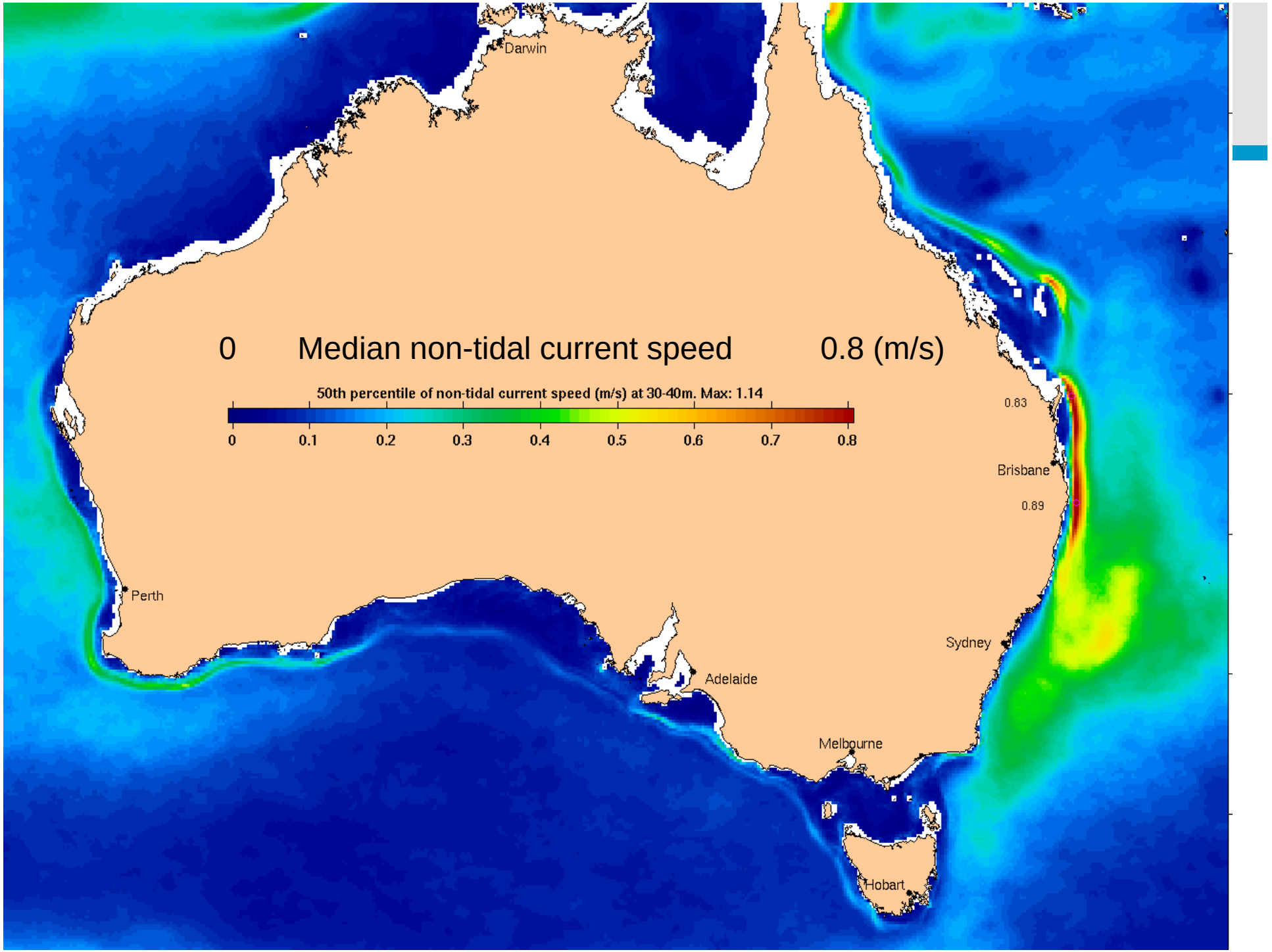
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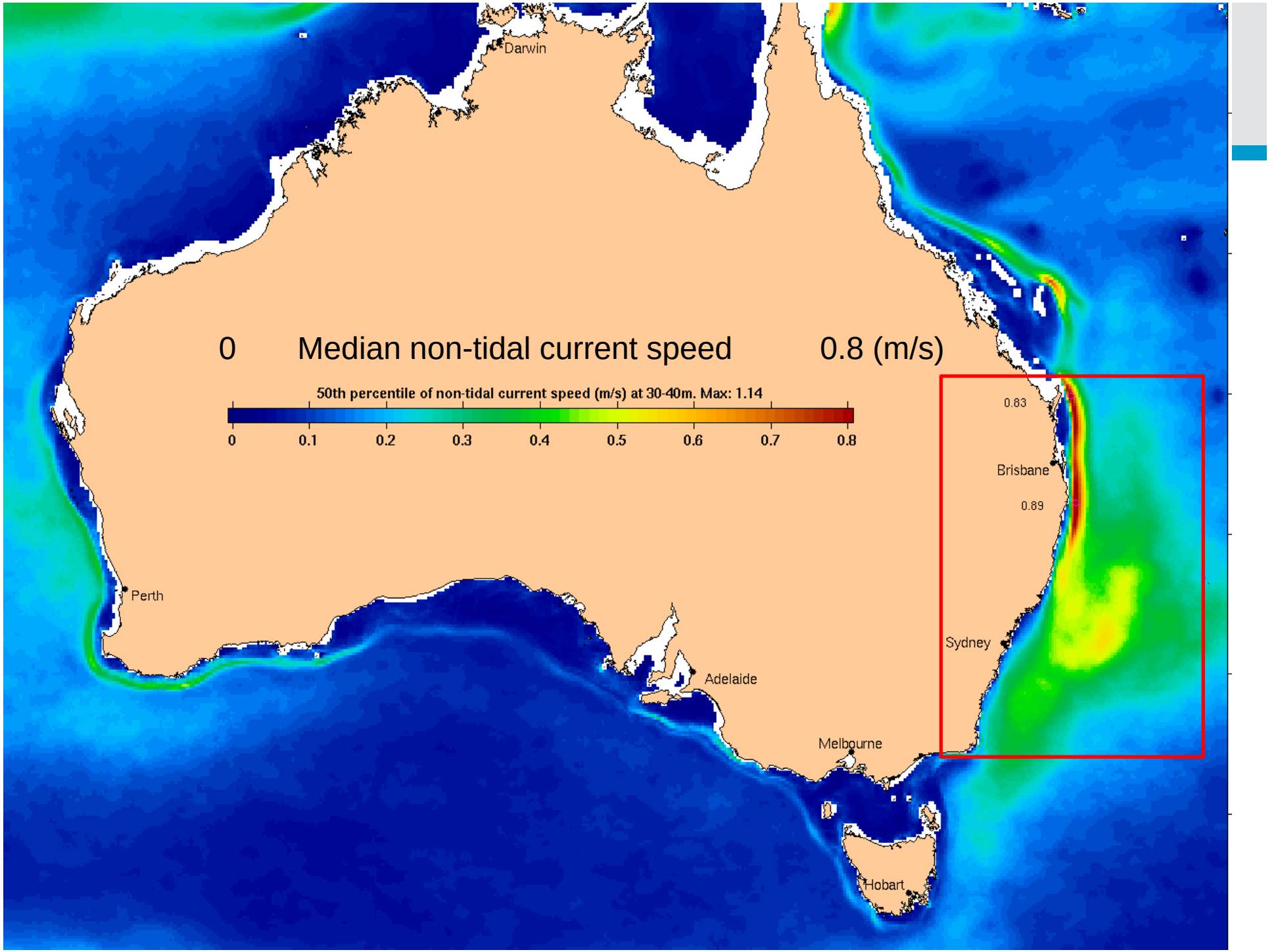
50th percentile of non-tidal current speed (m/s) at 30-40m. Max: 1.14
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Darwin
0.83
Brisbane
0.89
Perth
Sydney
Adelaide
Melbourne
Hobart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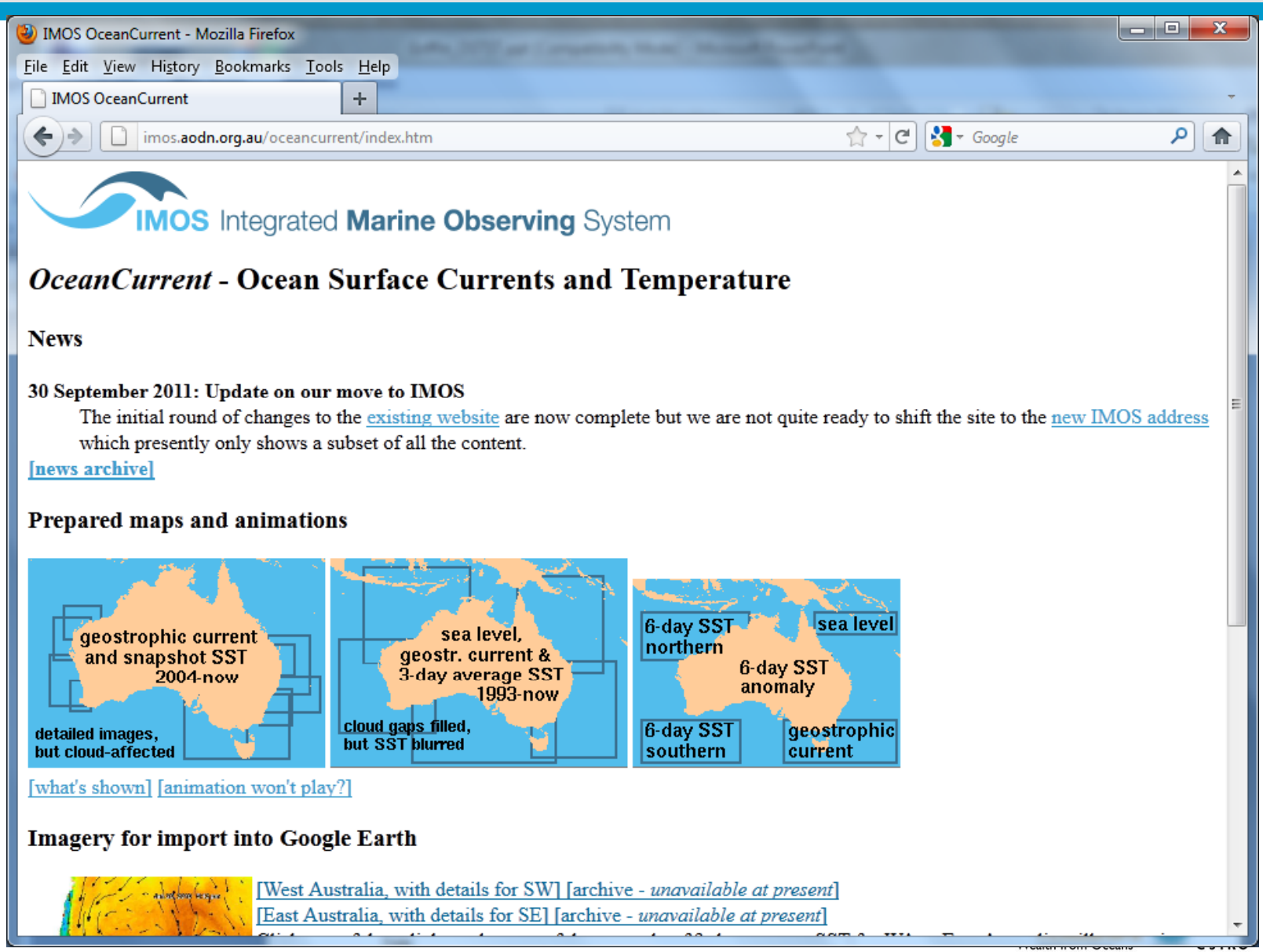
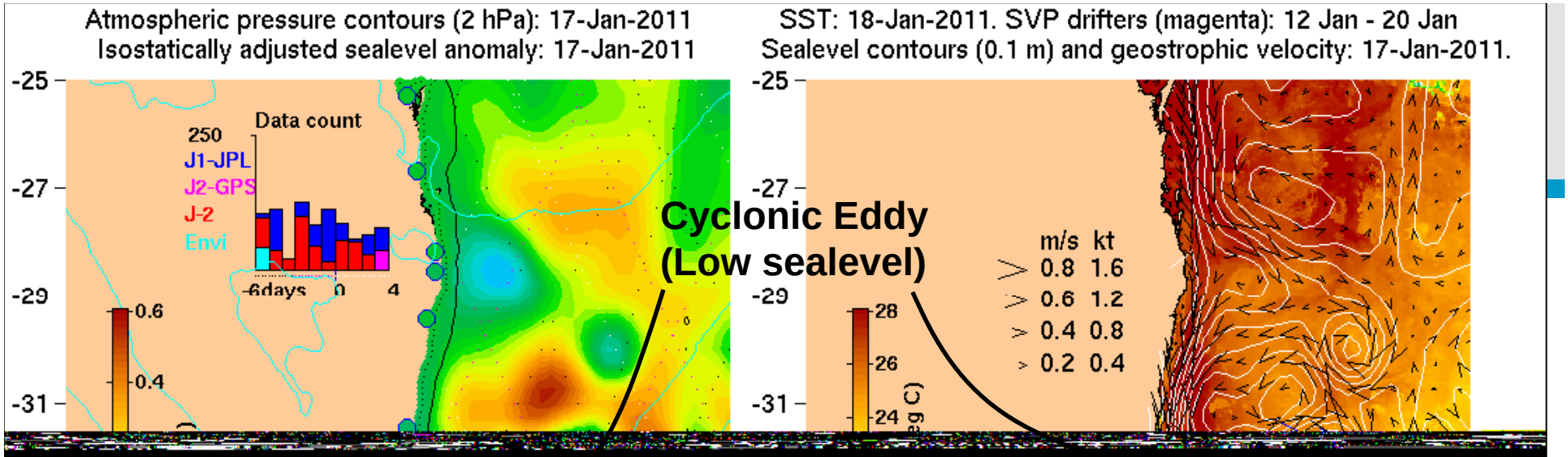
Sydney
Brisbane
0.83
0.89

imos.aodn.org.au/oceancurrent





Is it extraordinary?

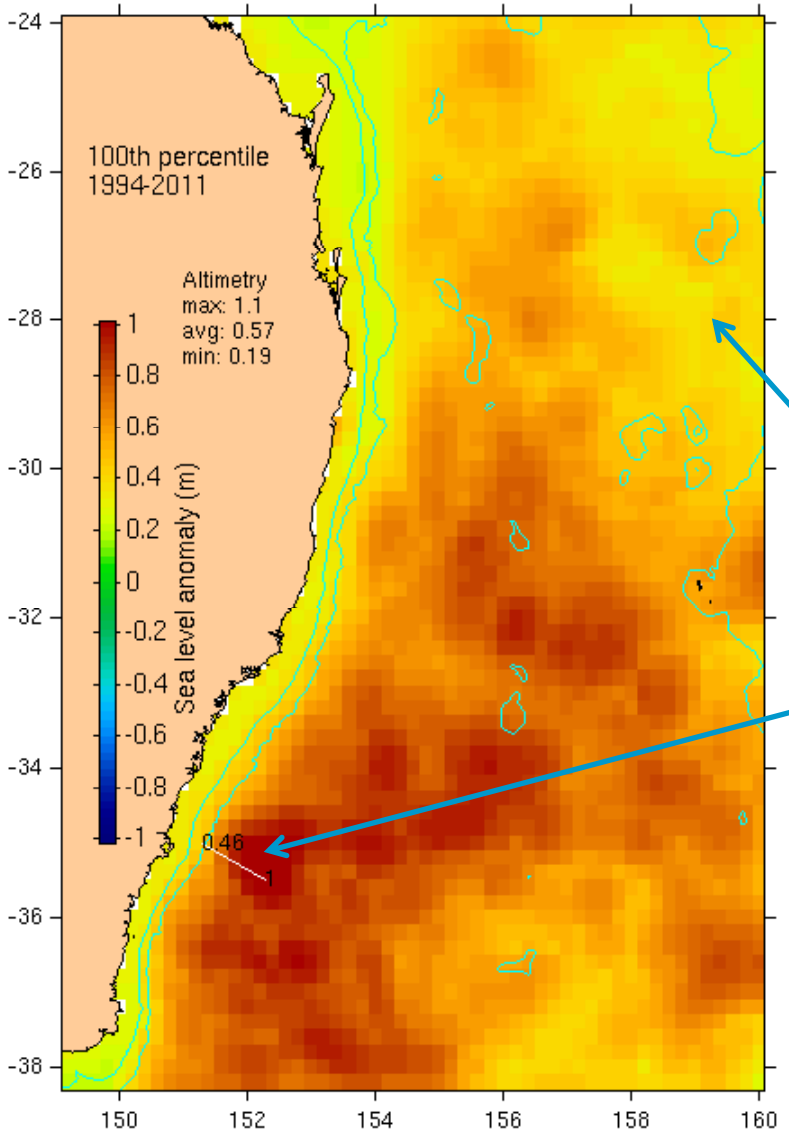
Lets look at some history

Maximum (in 1994-2011) gridded altimetric (+ filtered tidegauge) sea level anomaly:

+1m

SSHA

-1m



wide range:

0.3m

to

1.1m

Extraordinariness cannot be judged from a single SSHA map.

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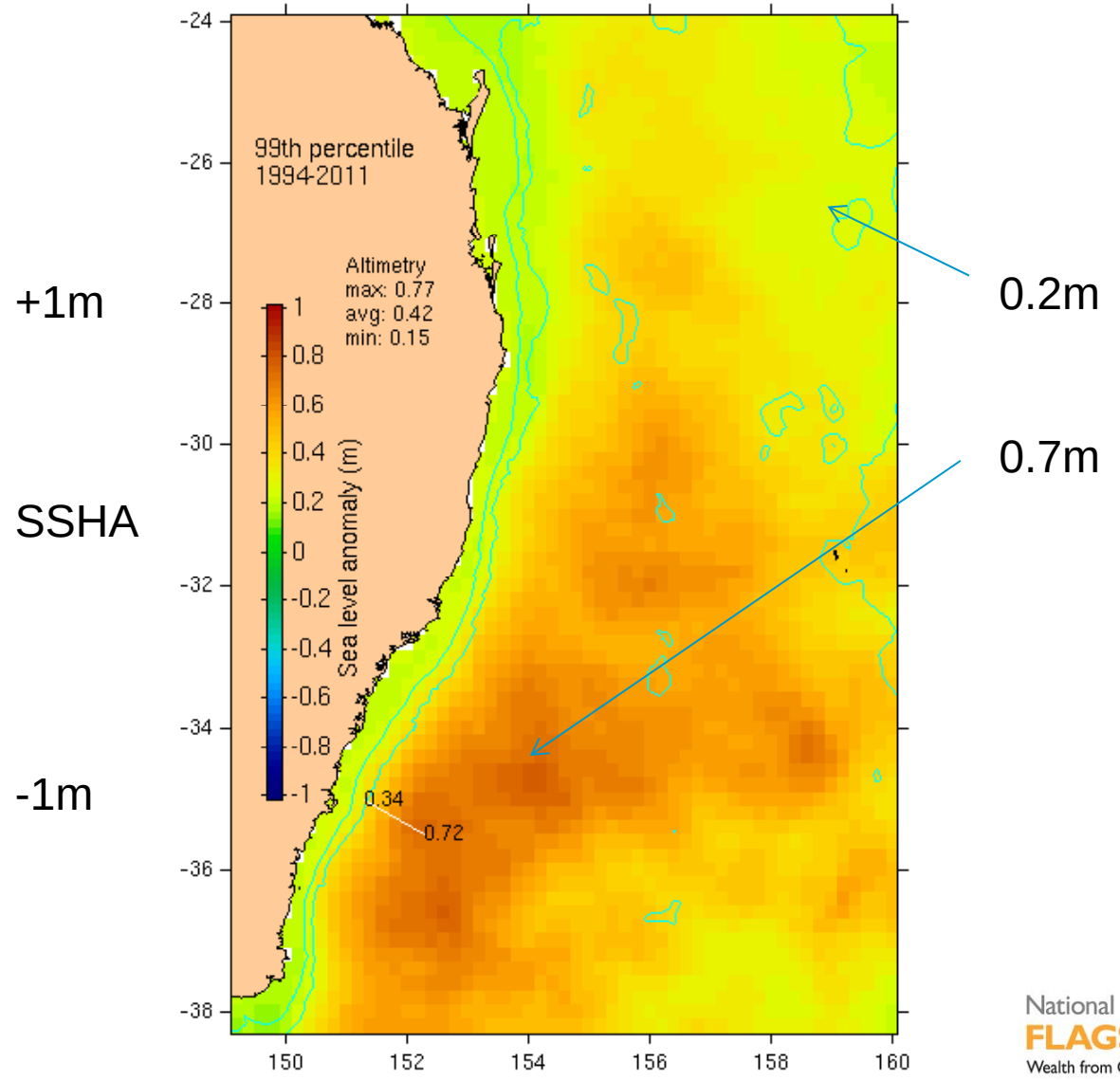
99th percentile anomaly (exceeded 1% of time) NB: 30% less than 100th percentile



+1m

SSHA

-1m

0.2m

0.7m

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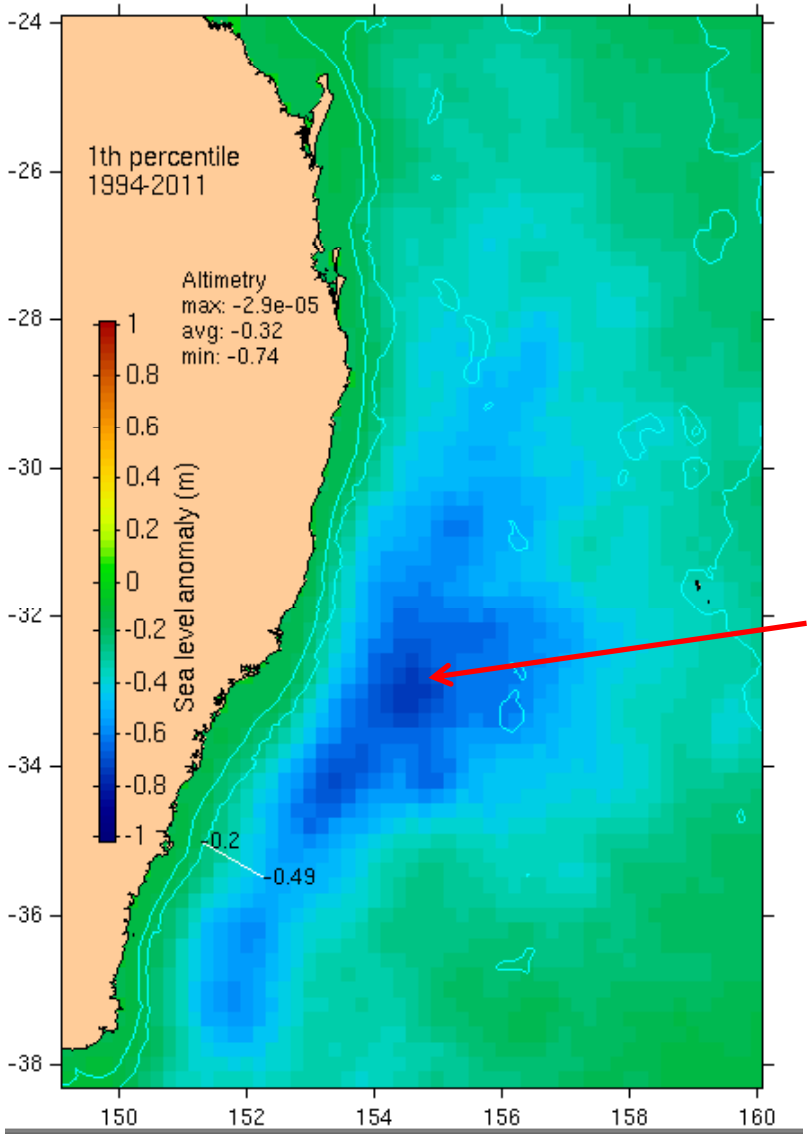
1st percentile anomaly (exceeded 99% of time)

+1m

SSHA

-1m



-0.7m

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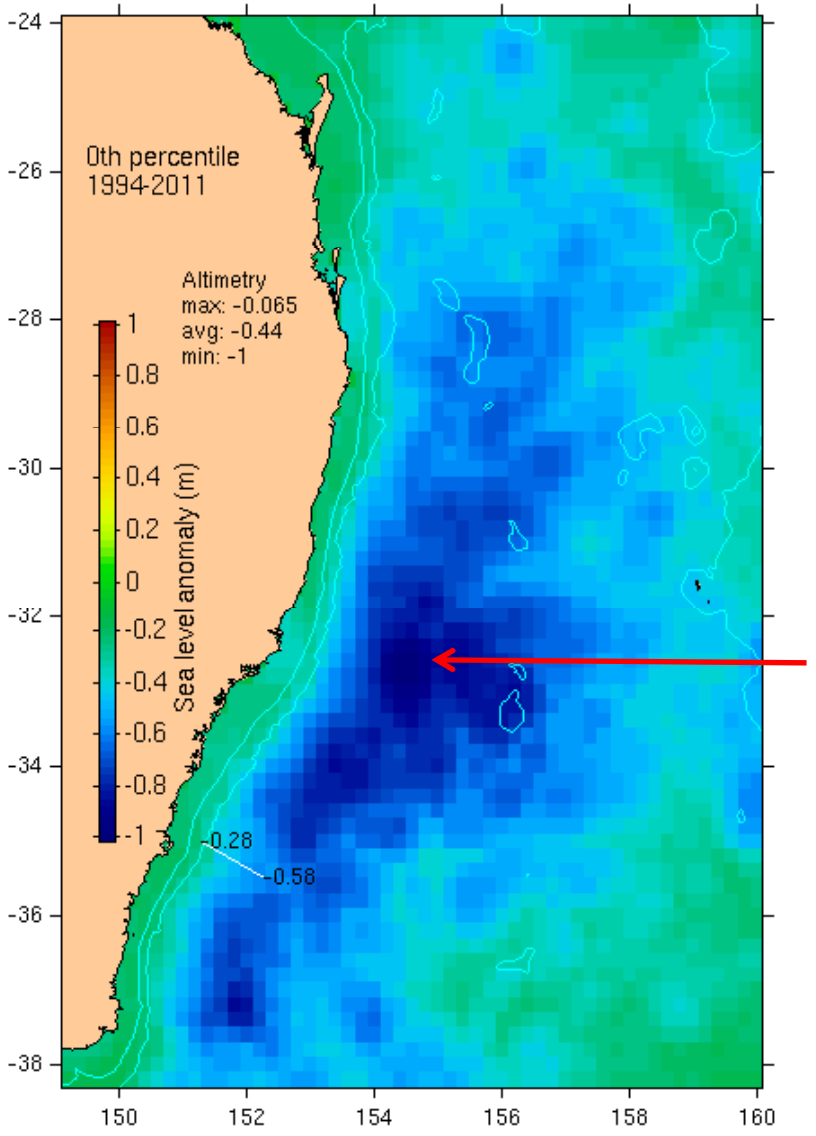
Minimum elevation (0 %-ile) is 30% more extreme than 1st %-ile



-1m

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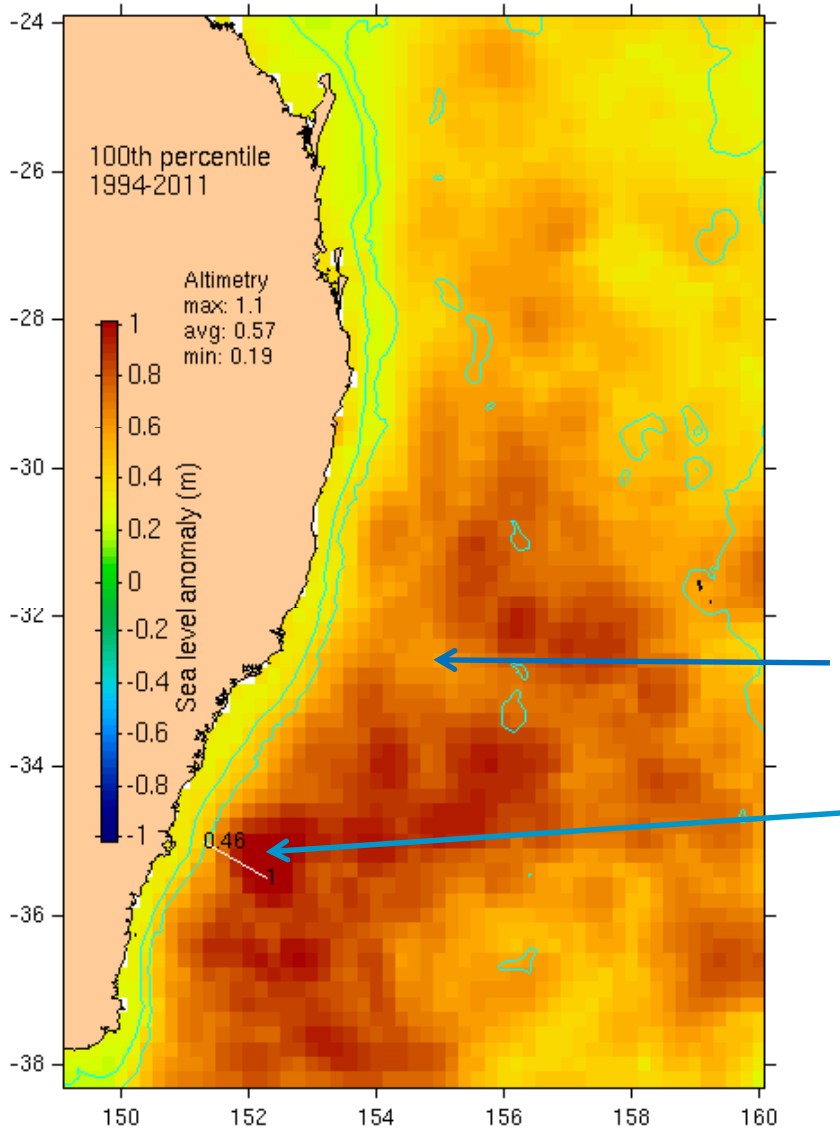
Maximum anomaly map again.
highest highs are south of the lowest lows

+1m

SSHA

-1m



Low low

High high

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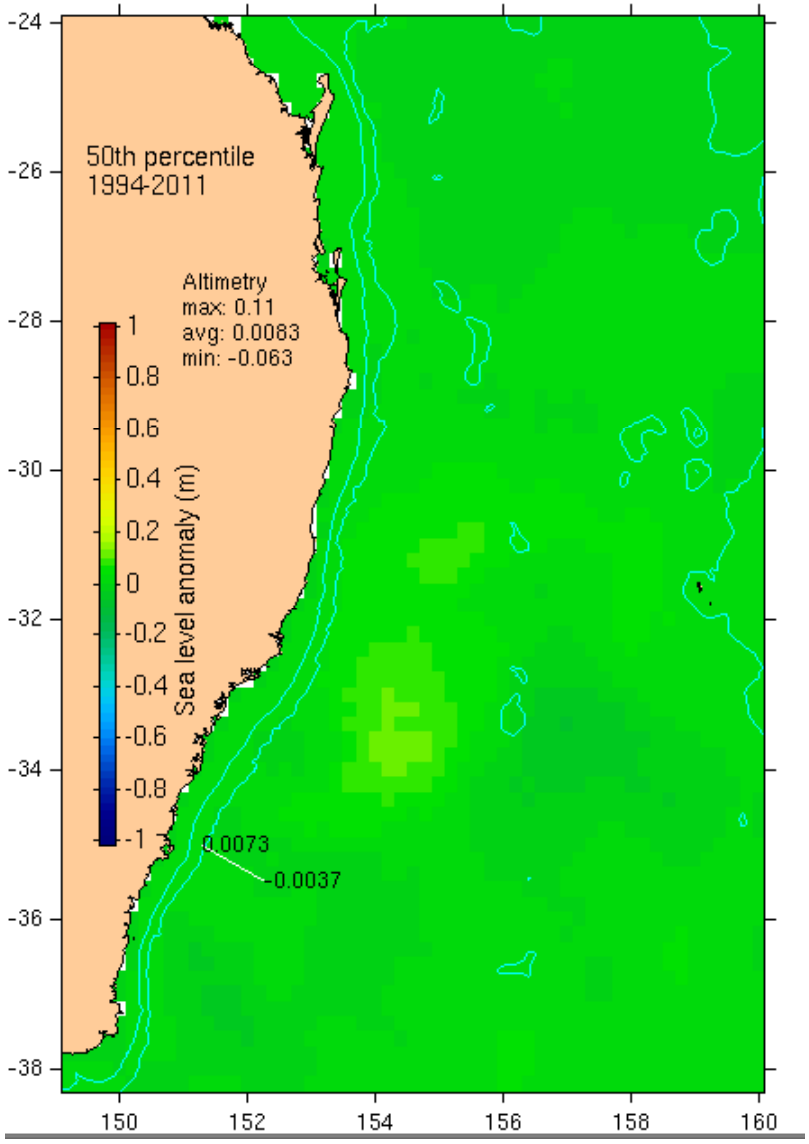
Median elevation (50th percentile) near zero – i.e. distribution is fairly symmetric

+1m

SSHA

-1m



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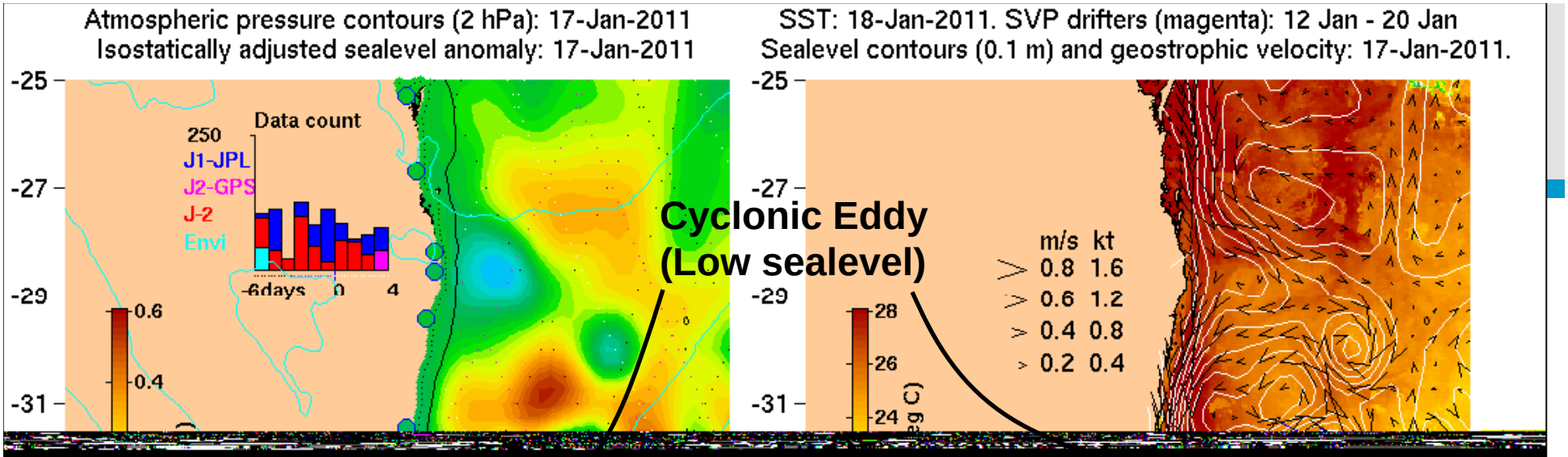
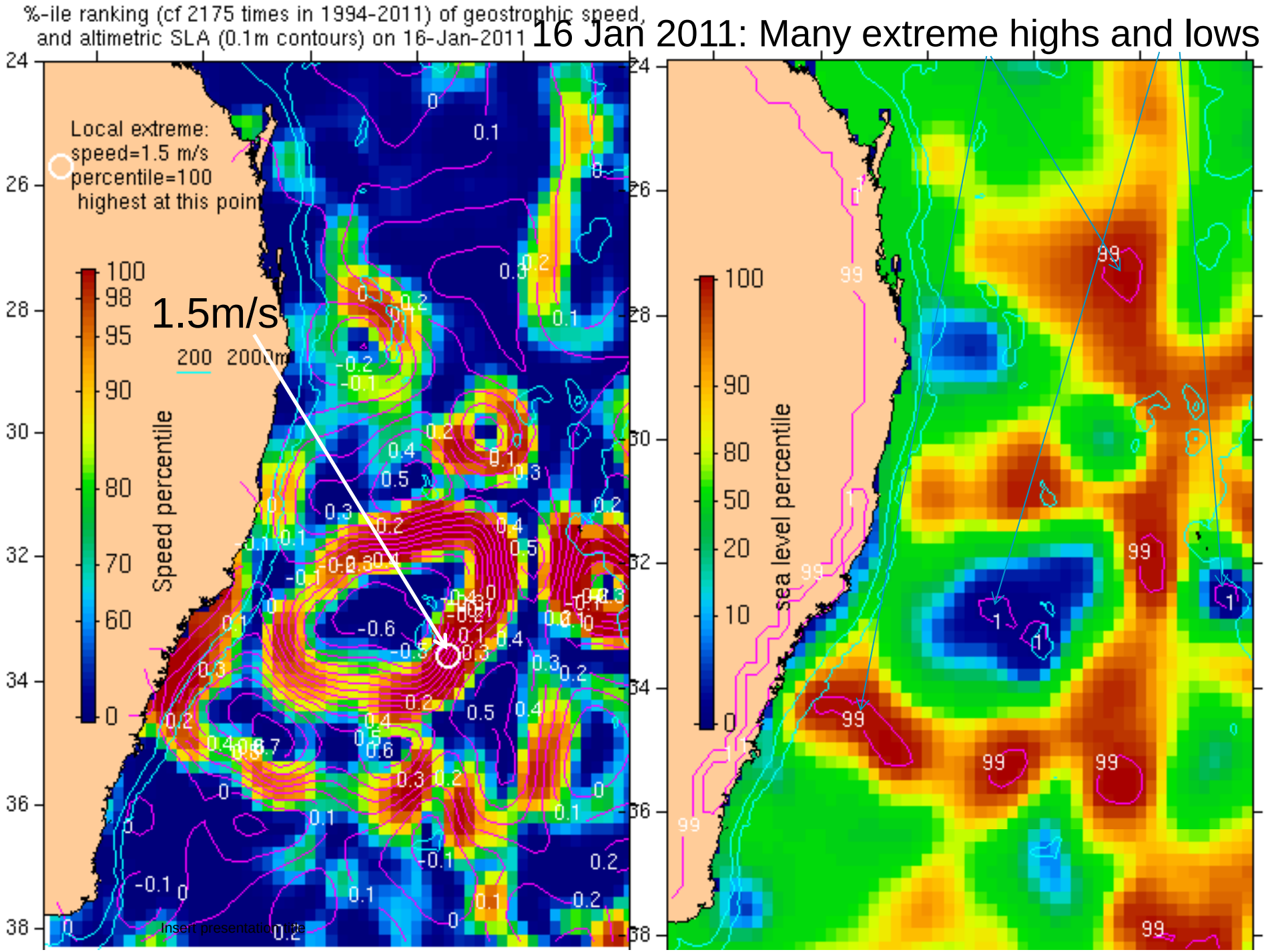
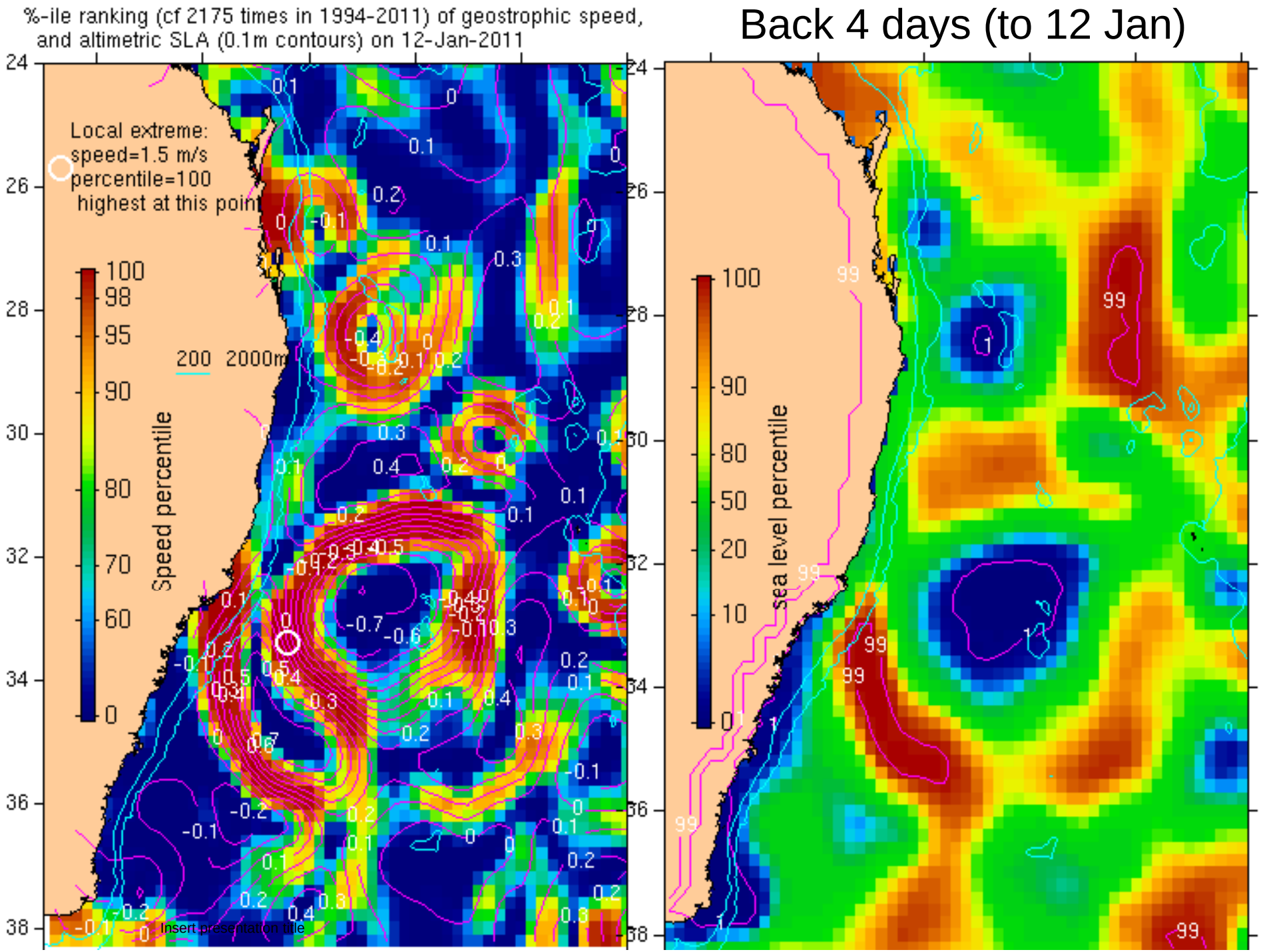
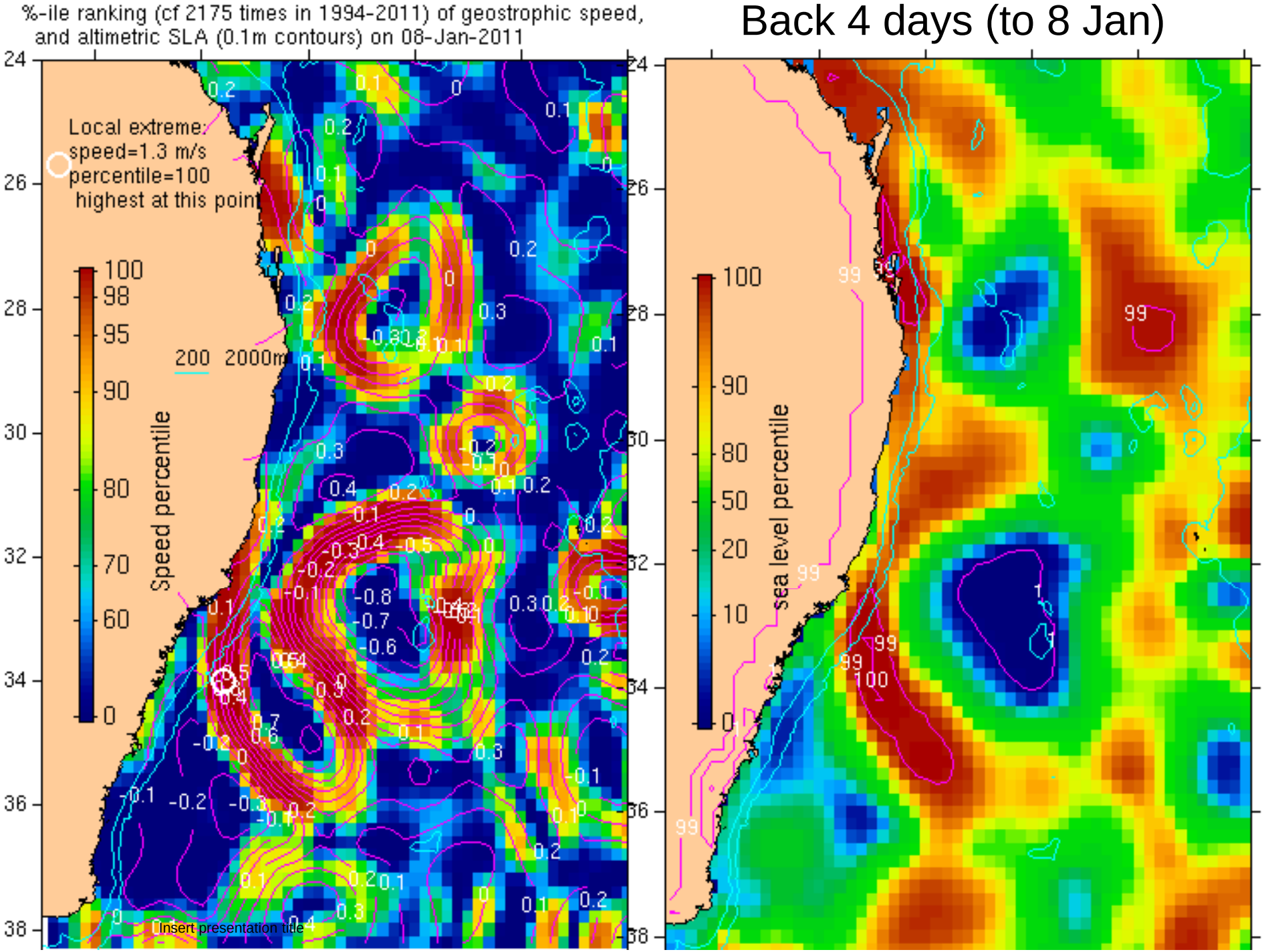


Is it extraordinary?

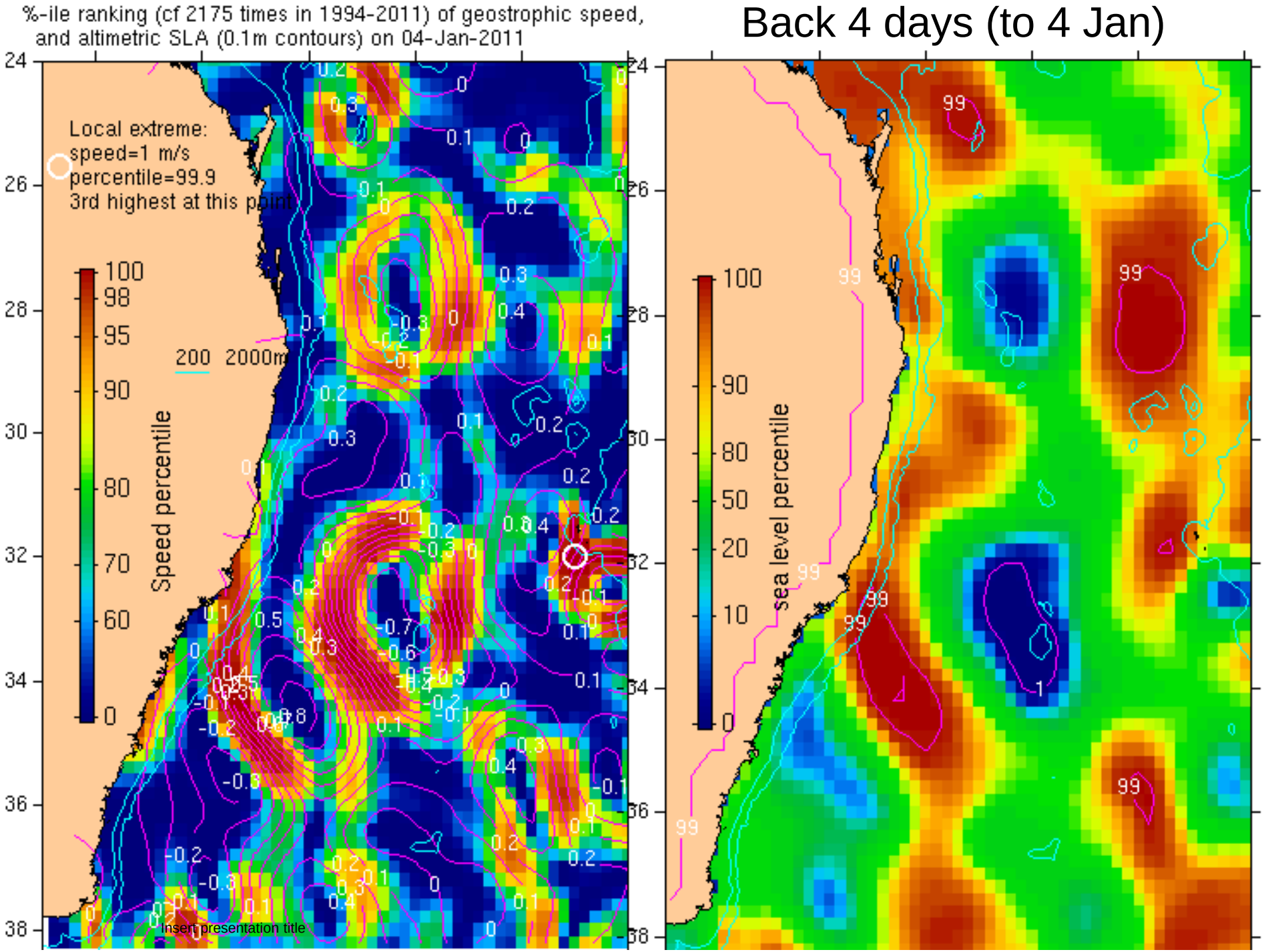

%-ile ranking (cf 2175 times in 1994-2011) of geostrophic speed,
and altimetric SLA (0.1m contours) on 16-Jan-2011
16 Jan 2011: Many extreme highs and lows
Local extreme:
speed=1.5 m/s
percentile=100
highest at this point
1.5m/s
200 2000m
Speed percentile
100
98
95
90
80
70
60
0
sea level percentile
100
90
80
50
20
10
0
24
26
28
30
32
34
36
38


%-ile ranking (cf 2175 times in 1994-2011) of geostrophic speed,
and altimetric SLA (0.1m contours) on 12-Jan-2011
Local extreme:
speed=1.5 m/s
percentile=100
highest at this point
Speed percentile
100
98
95
90
80
70
60
0
200
2000m
Back 4 days (to 12 Jan)
sea level percentile
100
90
80
50
20
10
0
24
26
28
30
32
34
36
38

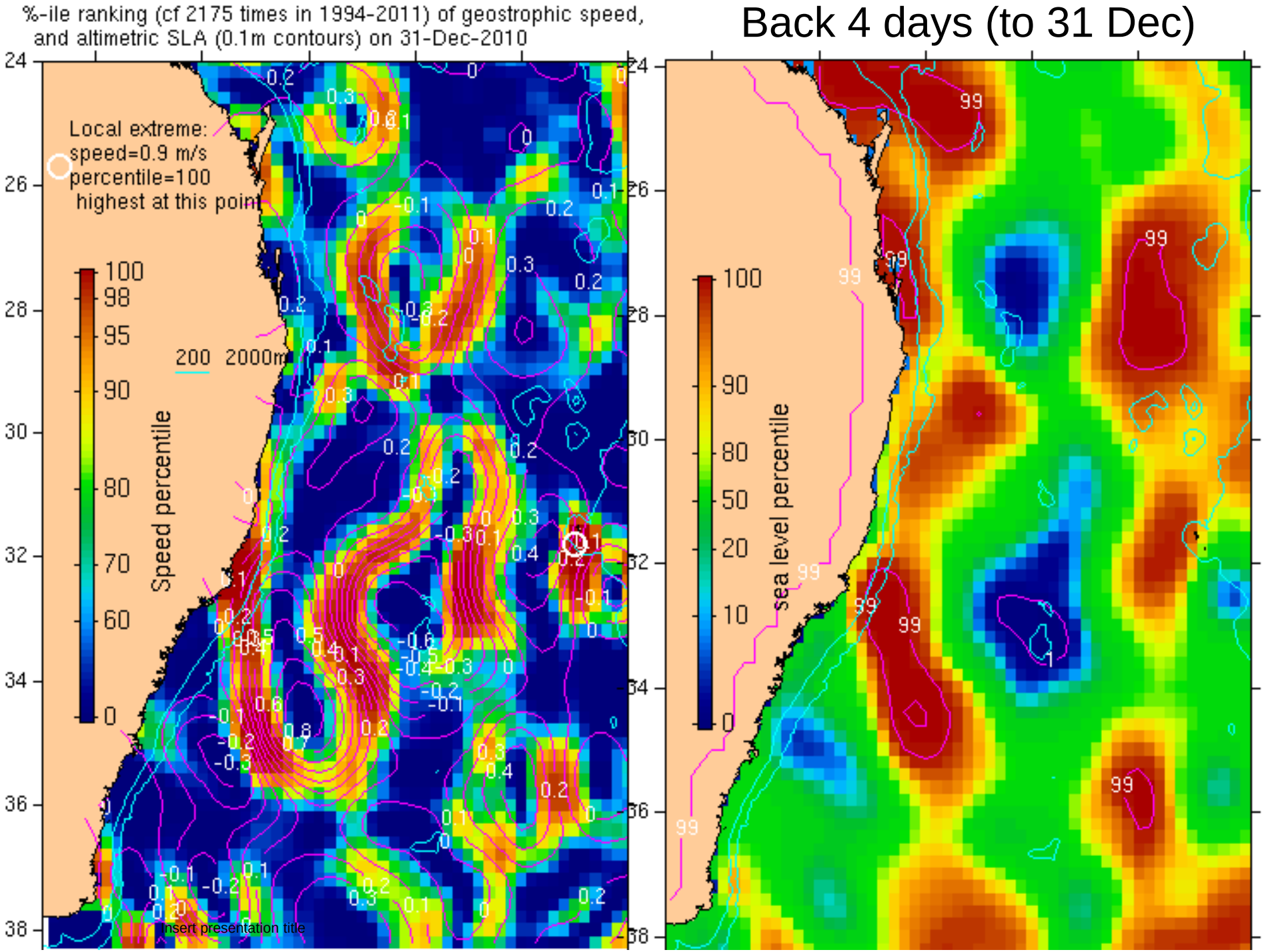
Back 4 days (to 8 Jan)



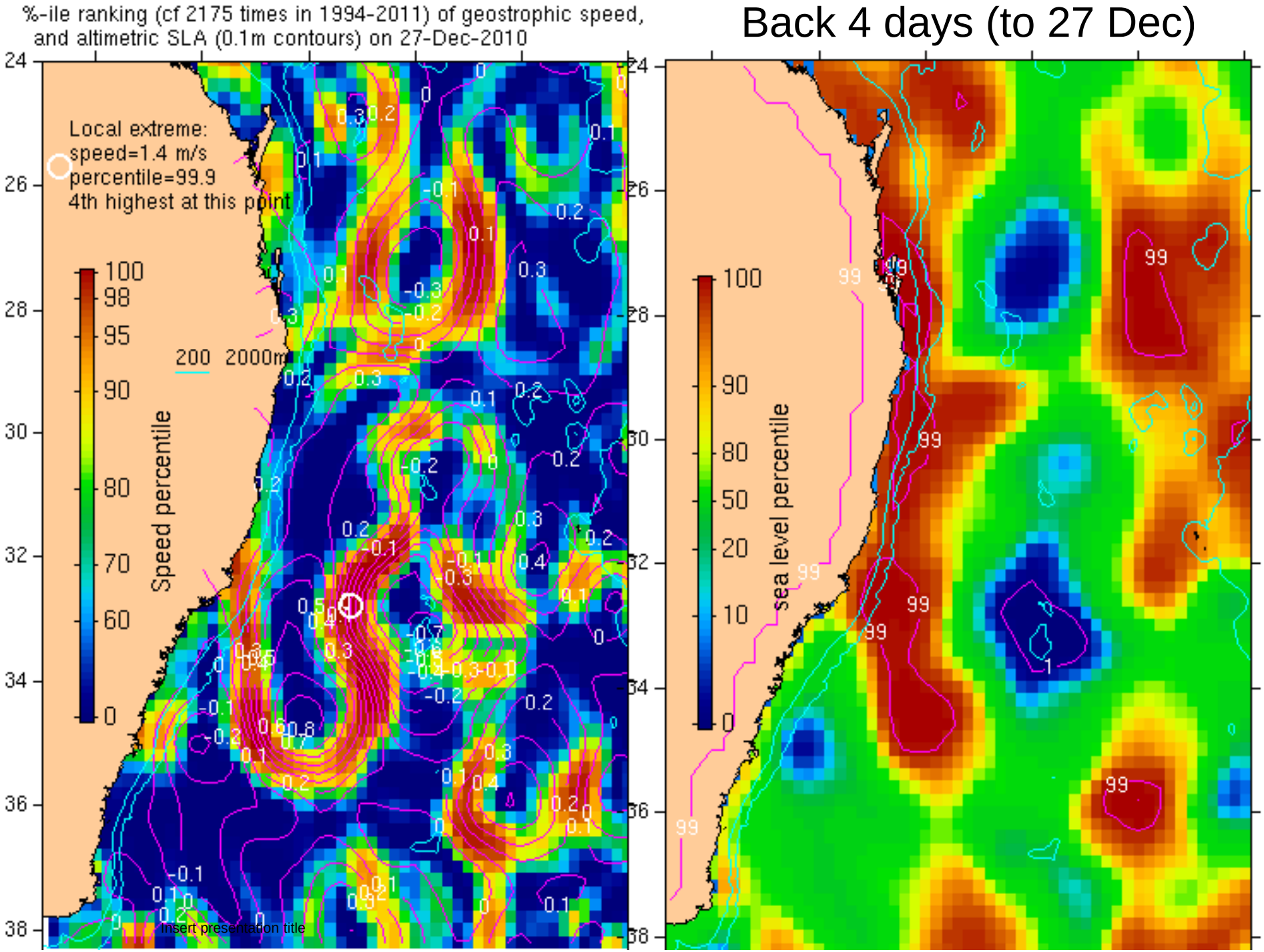
Back 4 days (to 4 Jan)



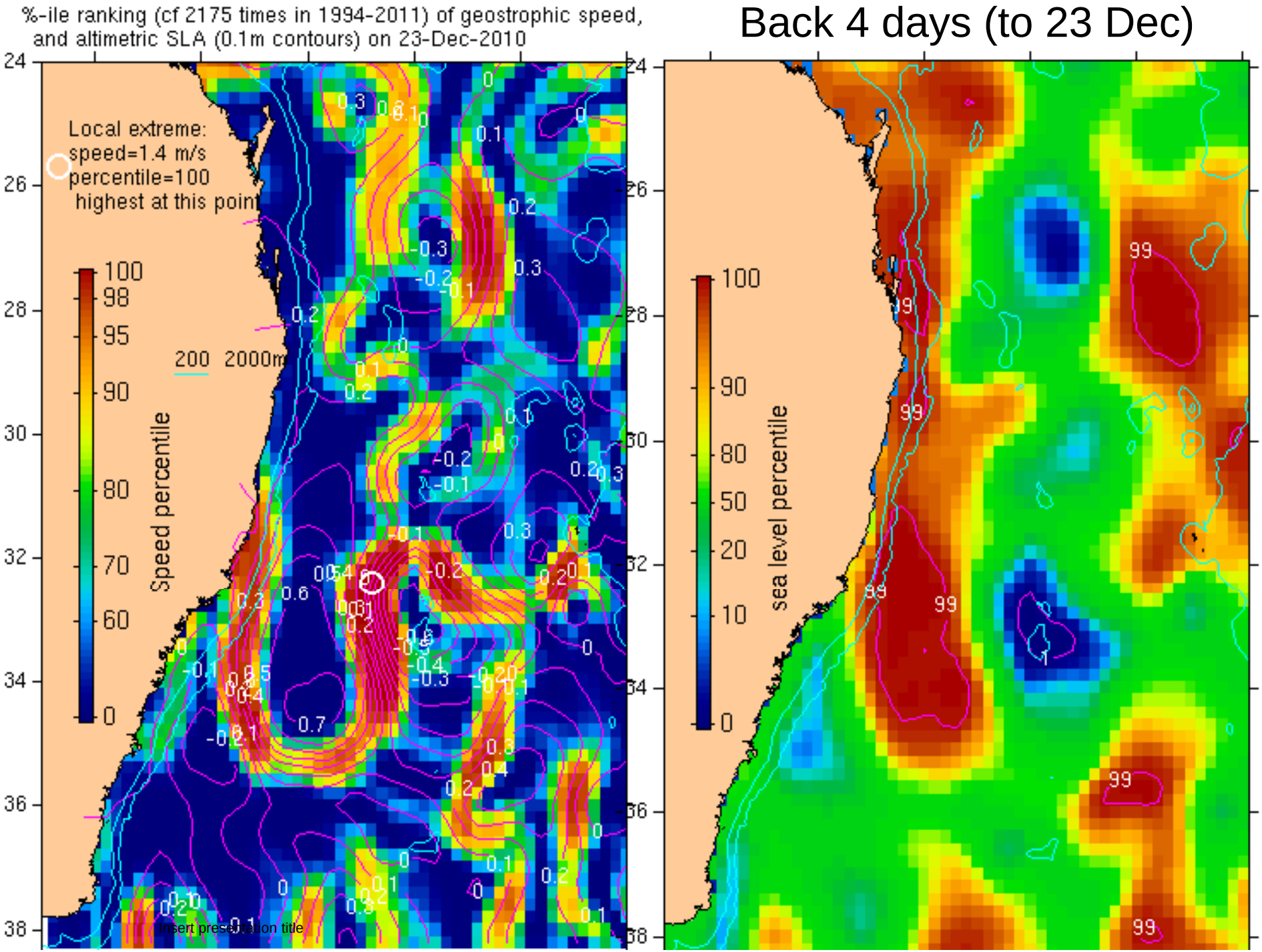
Back 4 days (to 31 Dec)



Back 4 days (to 27 Dec)

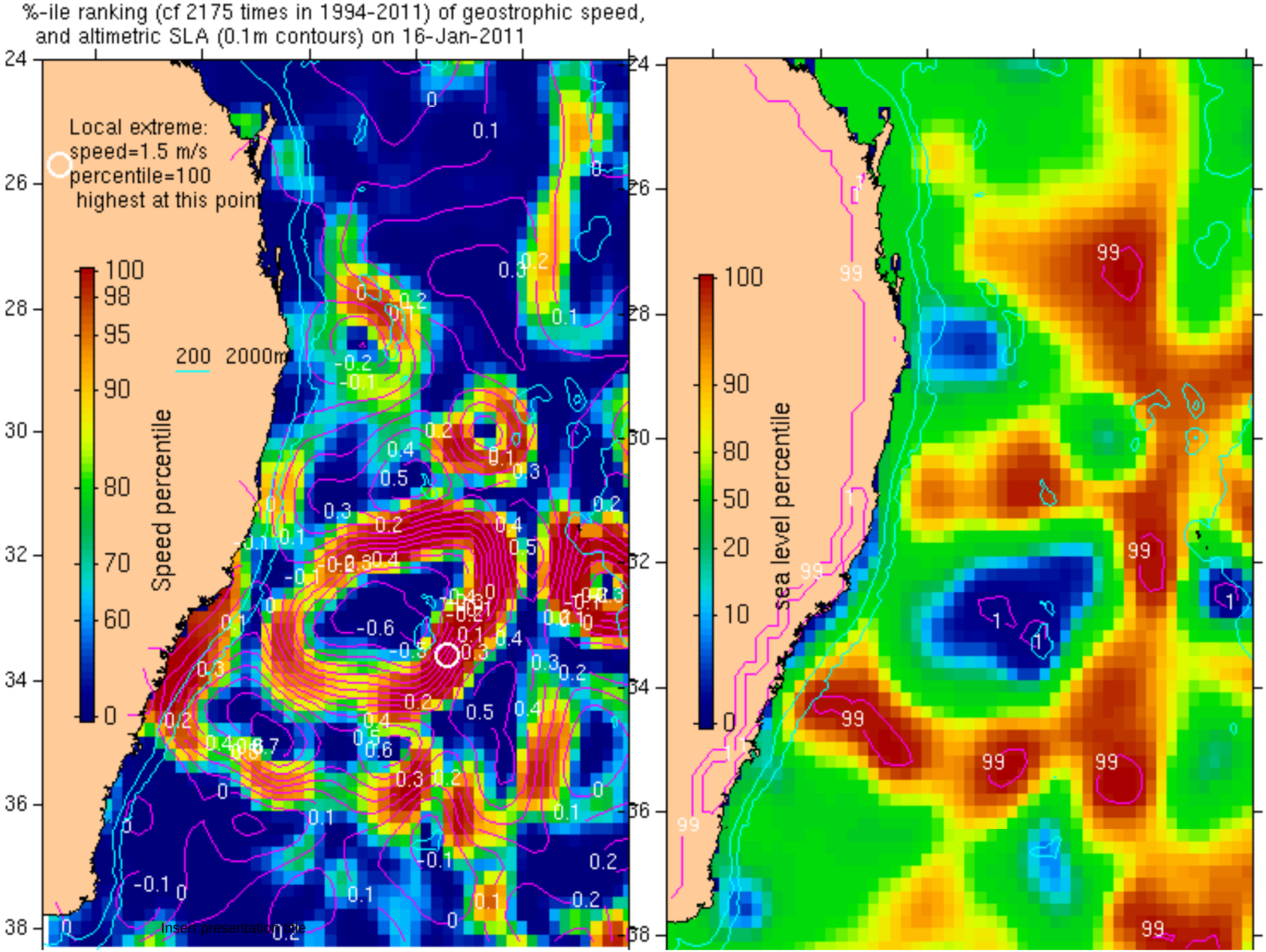


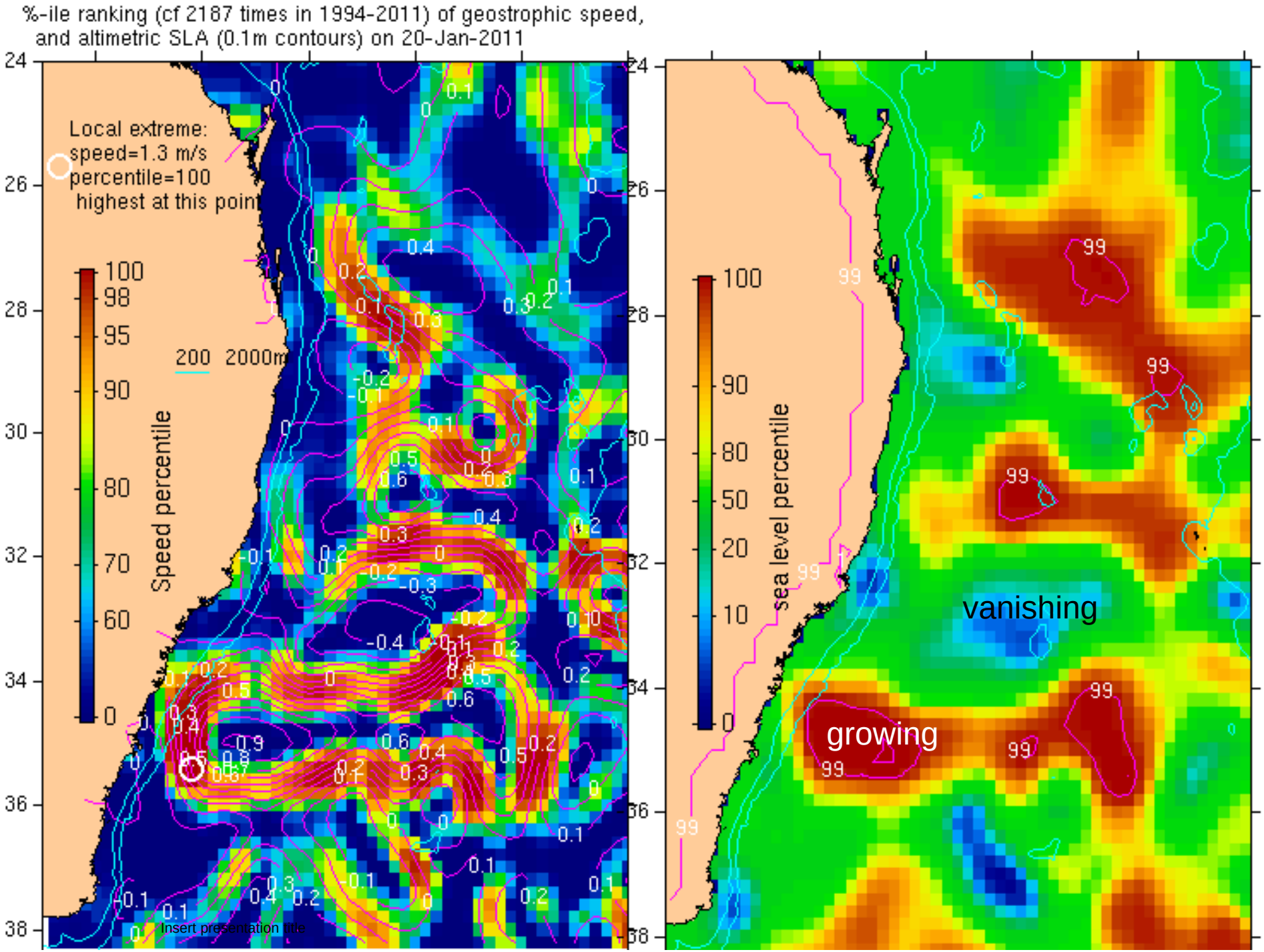
Back 4 days (to 23 Dec)

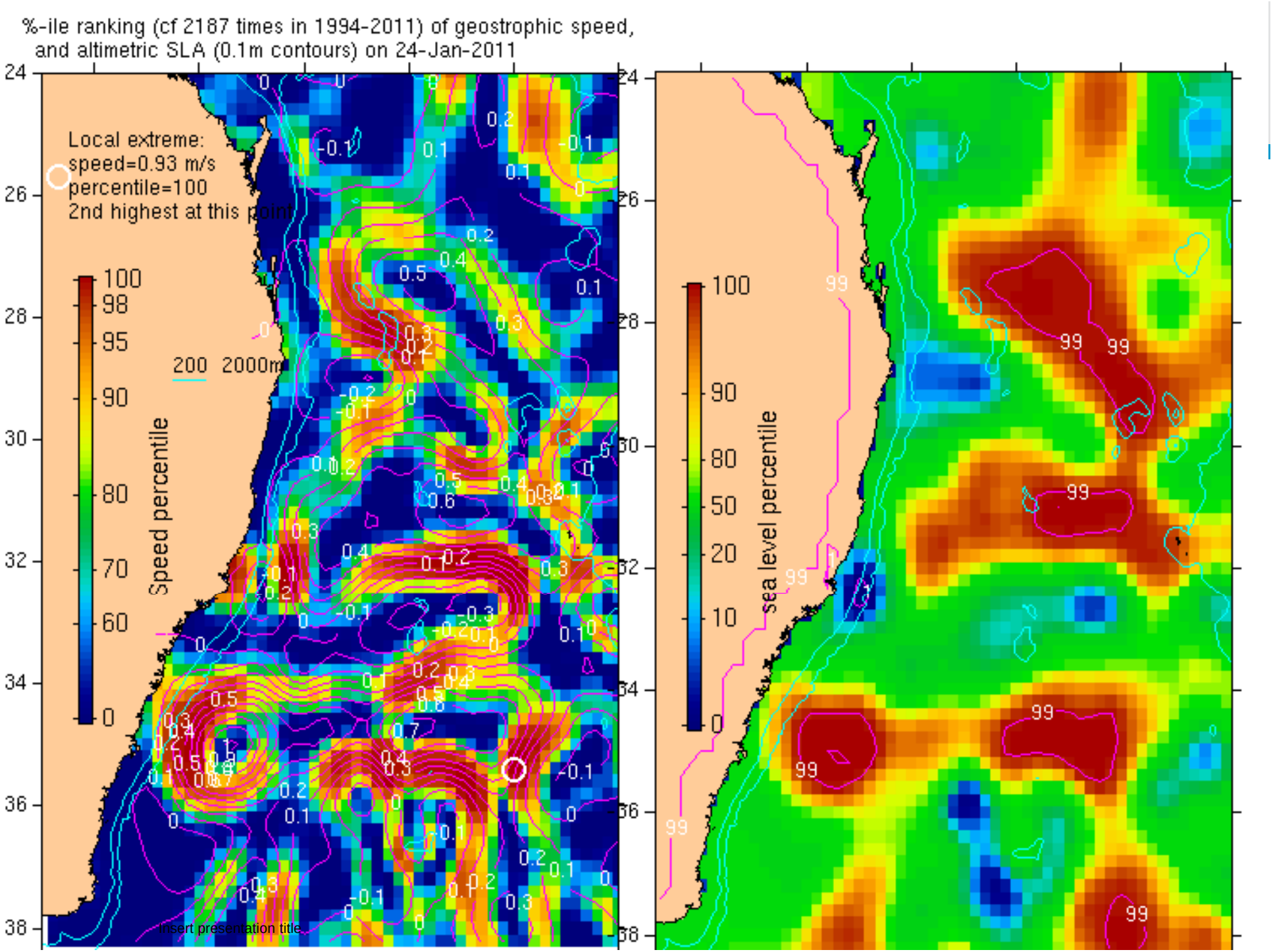


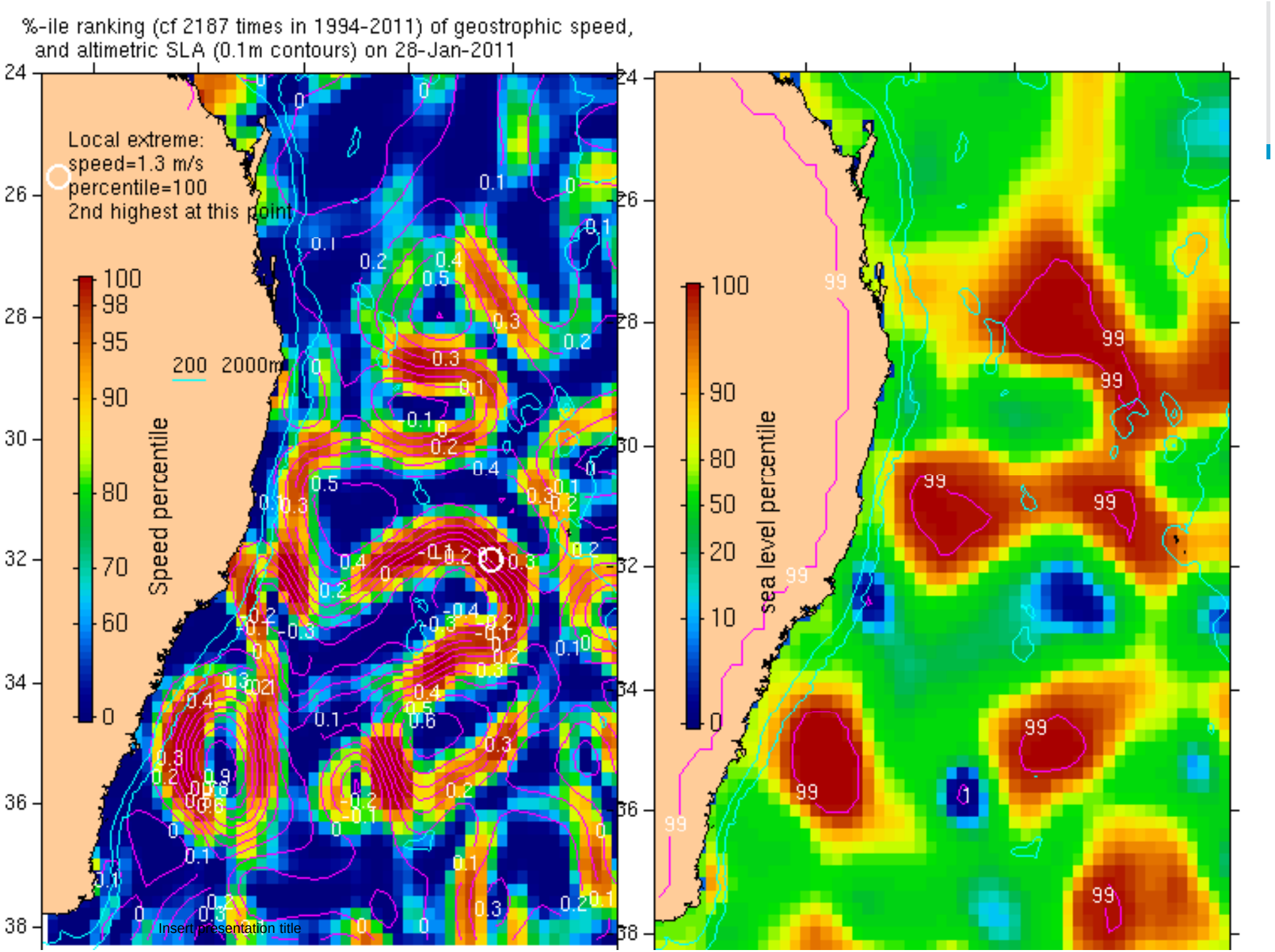
That high sea level all along the coast was not a ‘storm surge’

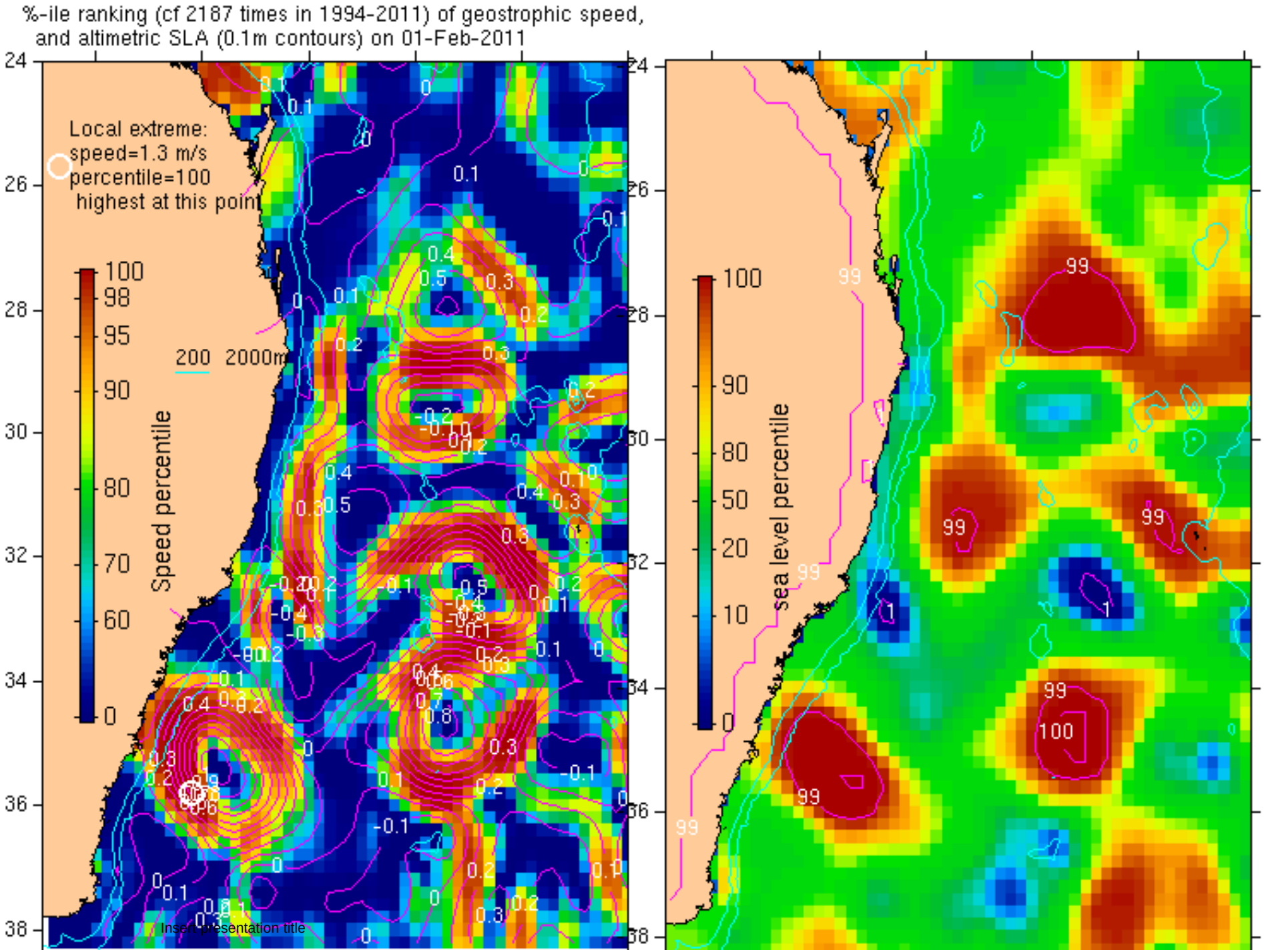
- Coastal sea level was very high. Anomaly of nearshore current was zero. Odd situation – still needs investigation.
- Lets now go back to 16 Jan then step forward.

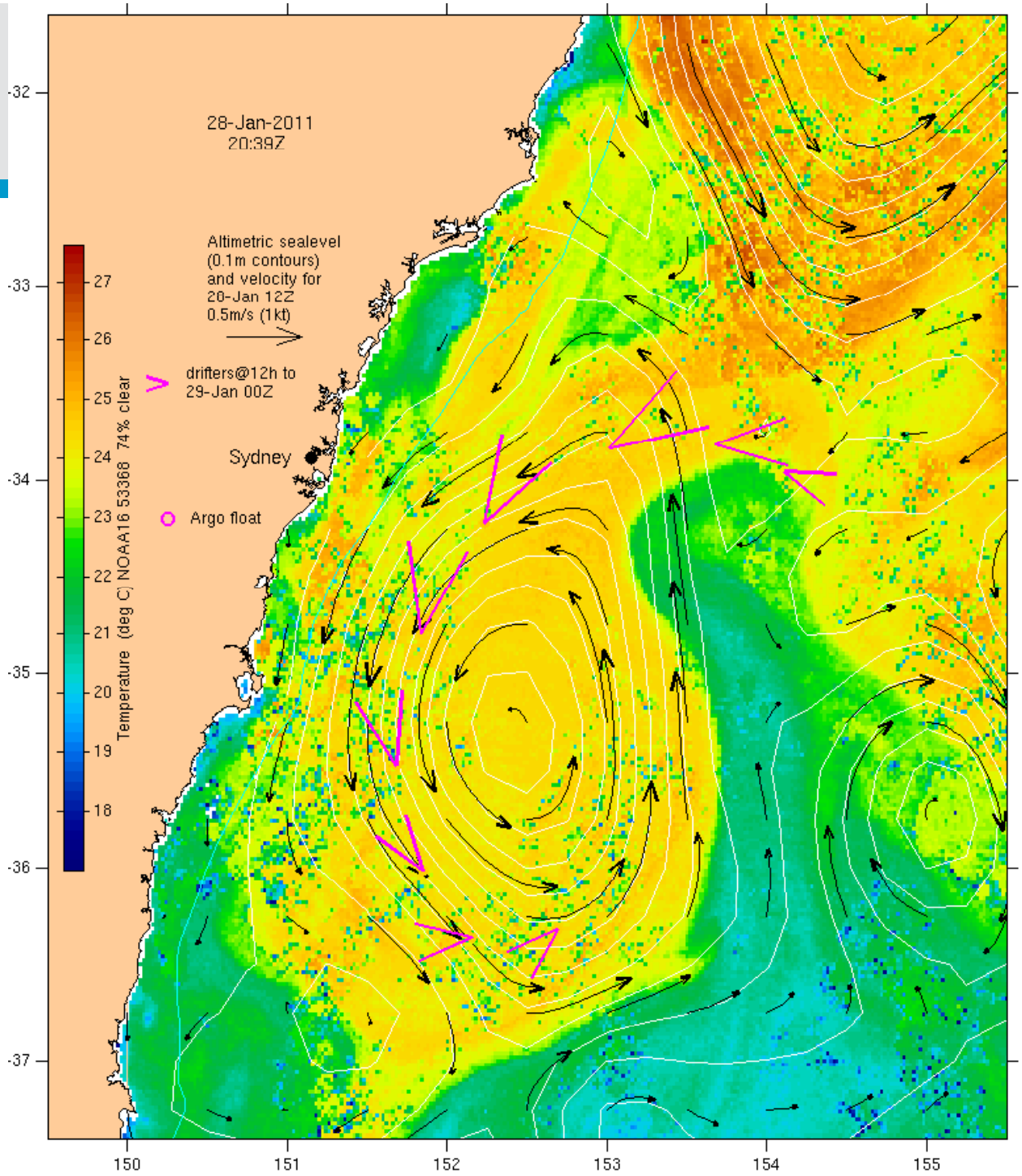

%-ile ranking (cf 2175 times in 1994-2011) of geostrophic speed,
and altimetric SLA (0.1m contours) on 16-Jan-2011
Local extreme:
speed=1.5 m/s
percentile=100
highest at this point
100
98
95
90
80
70
60
0
Speed percentile
200 2000m
100
90
80
50
20
10
0
sea level percentile
24
26
28
30
32
34
36
38


%-ile ranking (cf 2187 times in 1994-2011) of geostrophic speed,
and altimetric SLA (0.1m contours) on 20-Jan-2011
Local extreme:
speed=1.3 m/s
percentile=100
highest at this point
200
2000m
Speed percentile
100
98
95
90
80
70
60
0
sea level percentile
100
90
80
50
20
10
0
vanishing
growing
24
26
28
30
32
34
36
38


%-ile ranking (cf 2187 times in 1994-2011) of geostrophic speed,
and altimetric SLA (0.1m contours) on 24-Jan-2011
Local extreme:
speed=0.93 m/s
percentile=100
2nd highest at this point
200 2000m
Speed percentile
100
98
95
90
80
70
60
0
sea level percentile
100
90
80
50
20
10
0
24
26
28
30
32
34
36
38


%-ile ranking (cf 2187 times in 1994-2011) of geostrophic speed,
and altimetric SLA (0.1m contours) on 28-Jan-2011
Local extreme:
speed=1.3 m/s
percentile=100
2nd highest at this point
200 2000m
Speed percentile
100
98
95
90
80
70
60
0
sea level percentile
100
90
80
50
20
10
0
24
26
28
30
32
34
36
38


%-ile ranking (cf 2187 times in 1994-2011) of geostrophic speed,
and altimetric SLA (0.1m contours) on 01-Feb-2011
Local extreme:
speed=1.3 m/s
percentile=100
highest at this point
100
98
95
90
80
70
60
0
Speed percentile
200 2000m
100
90
80
50
20
10
0
sea level percentile
24
26
28
30
32
34
36
38



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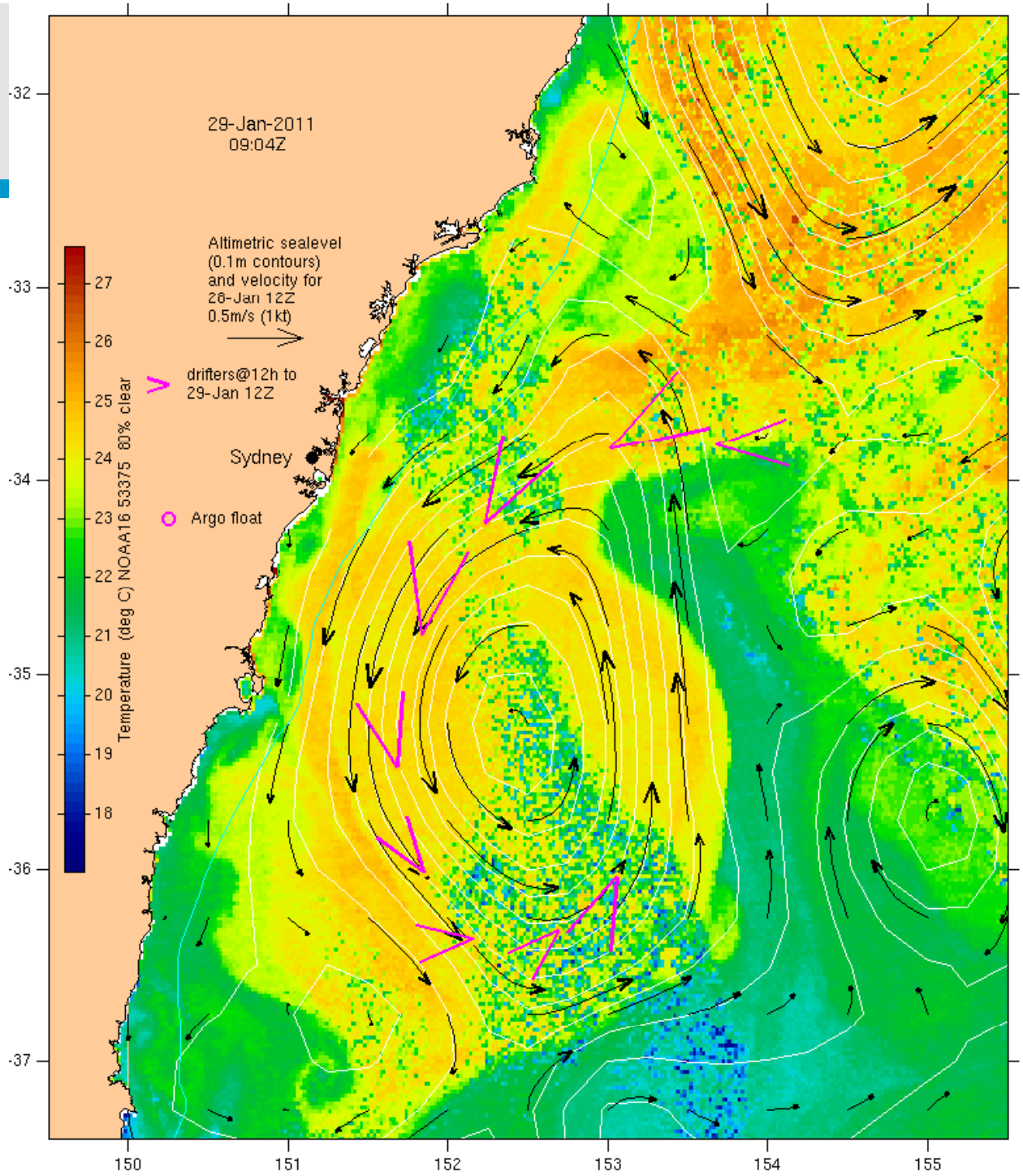

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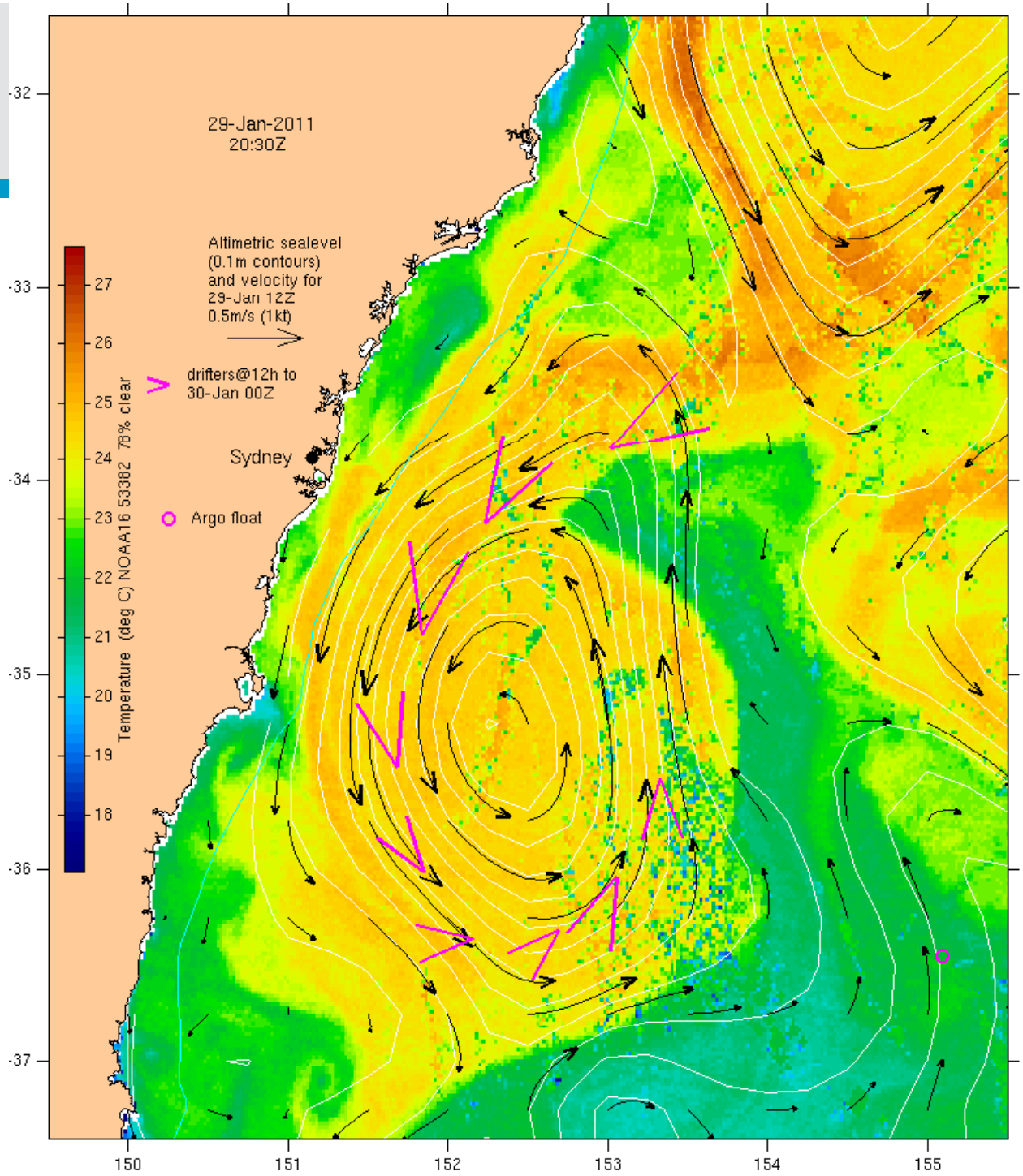

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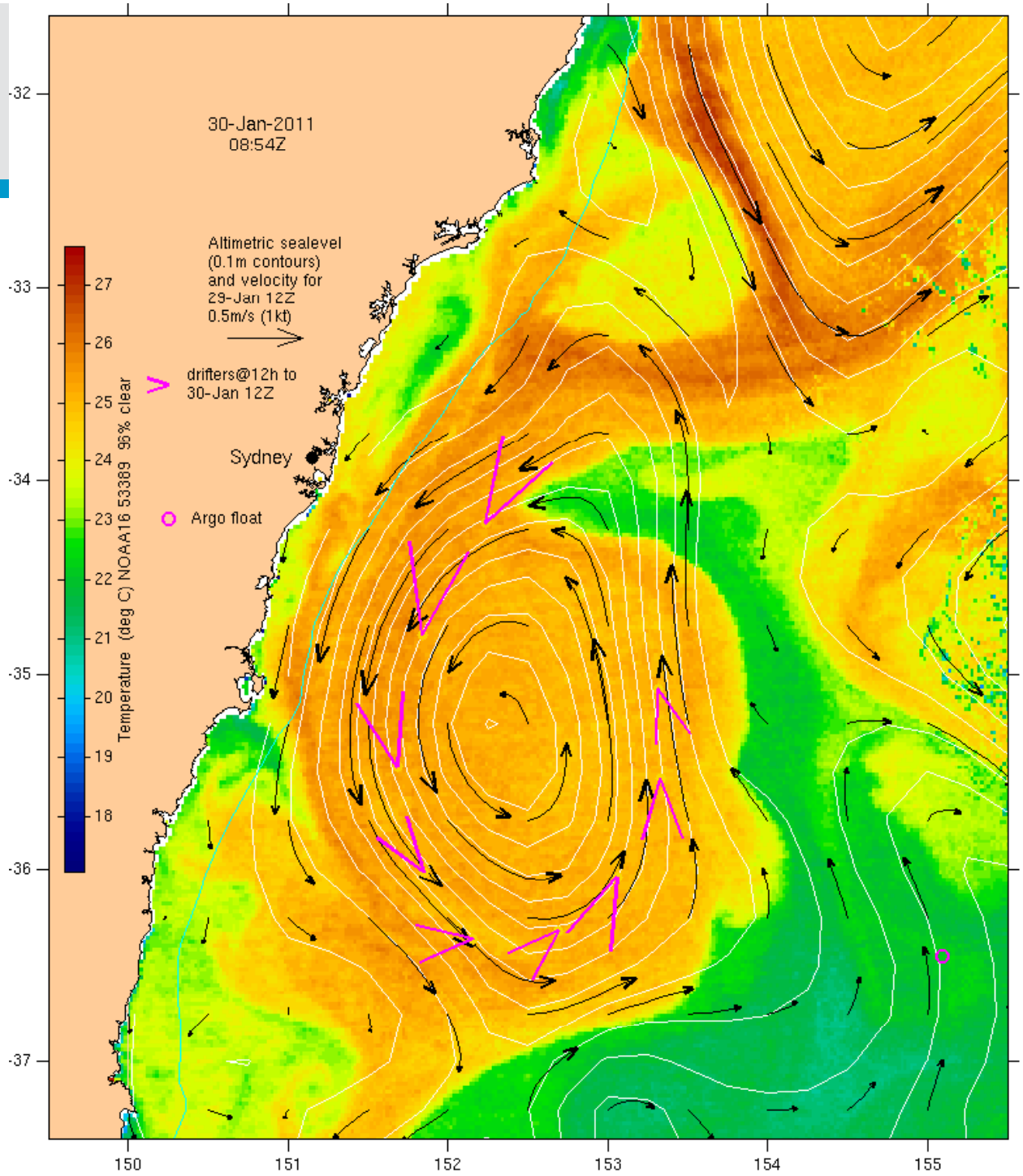

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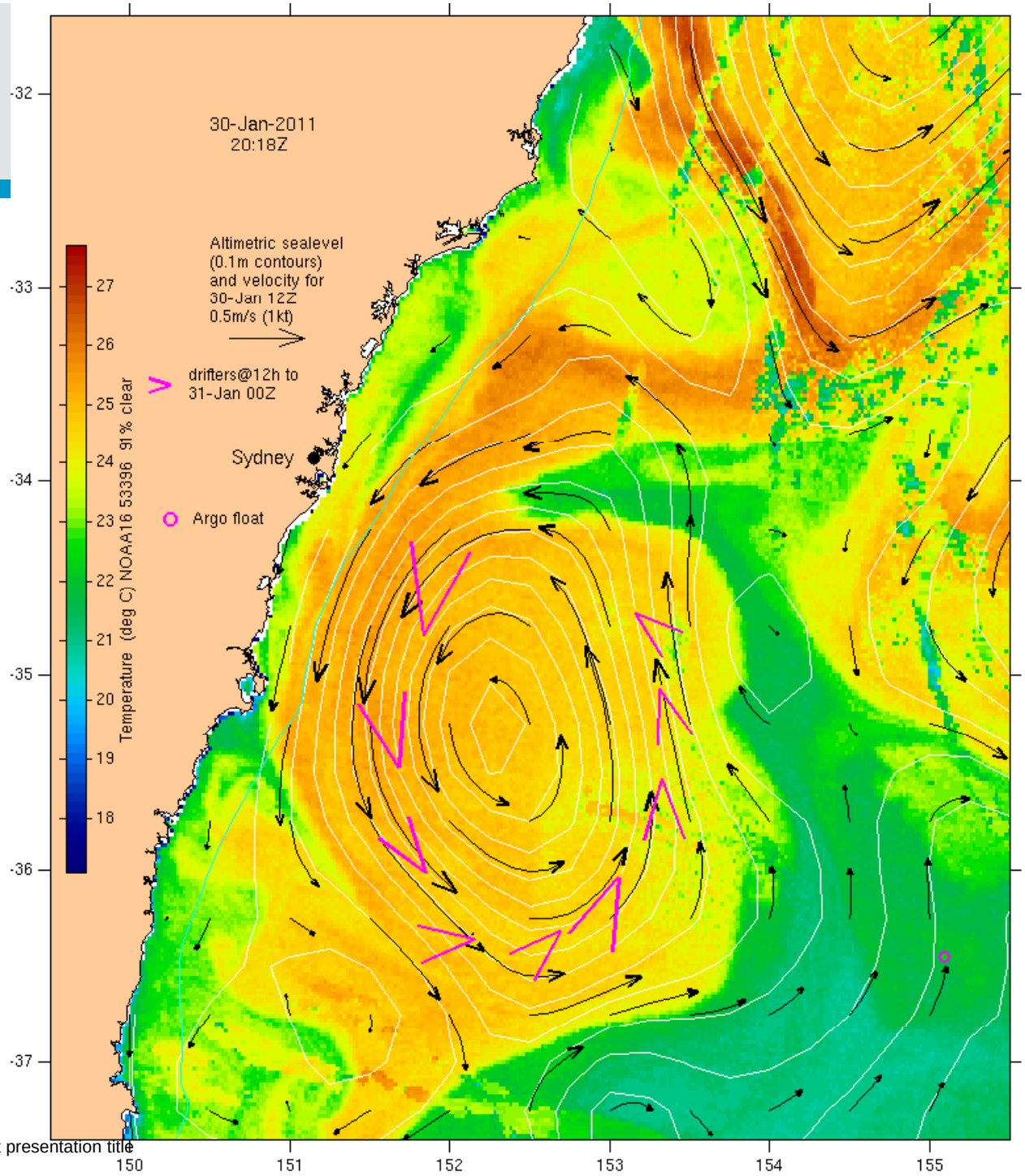

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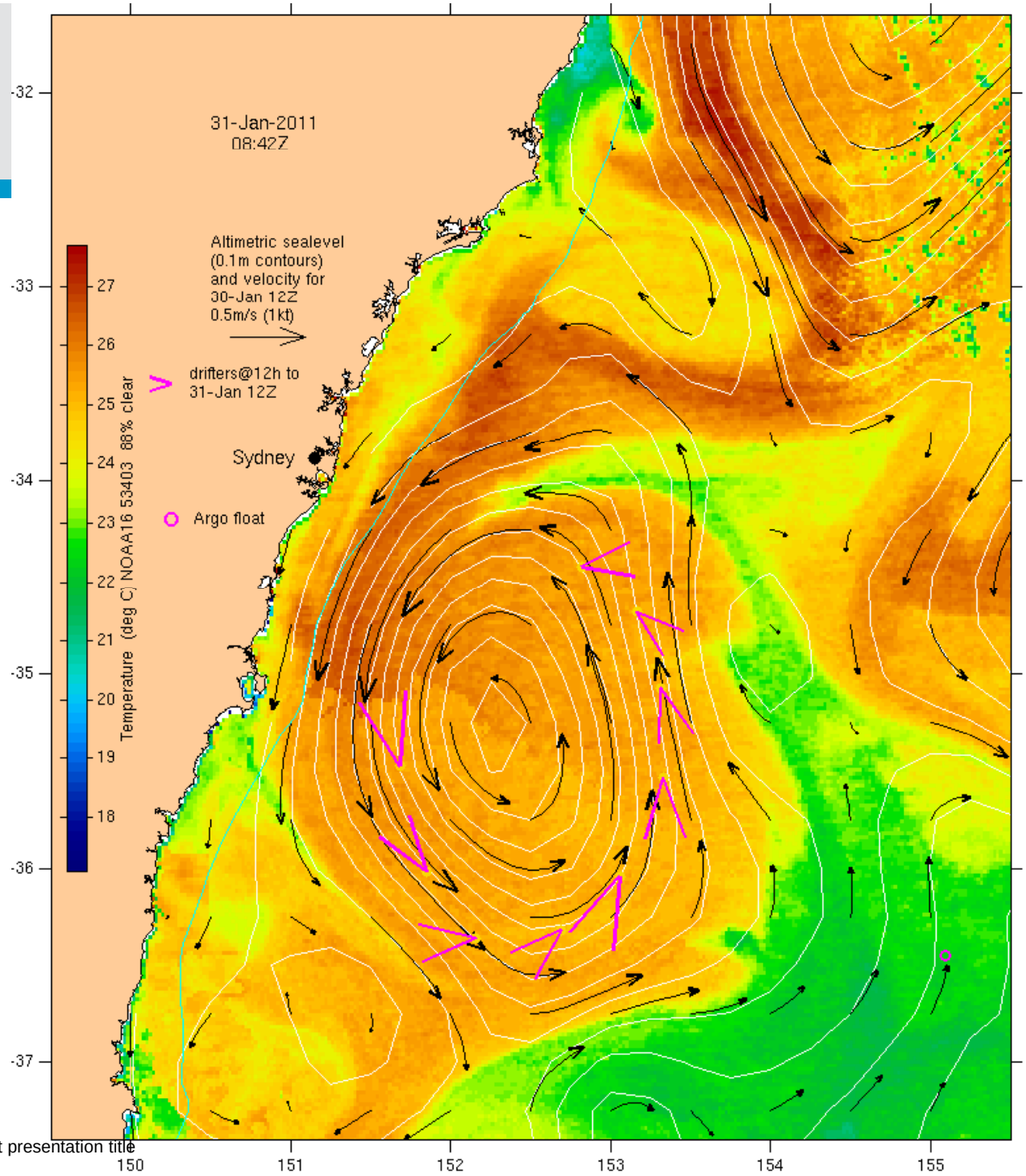

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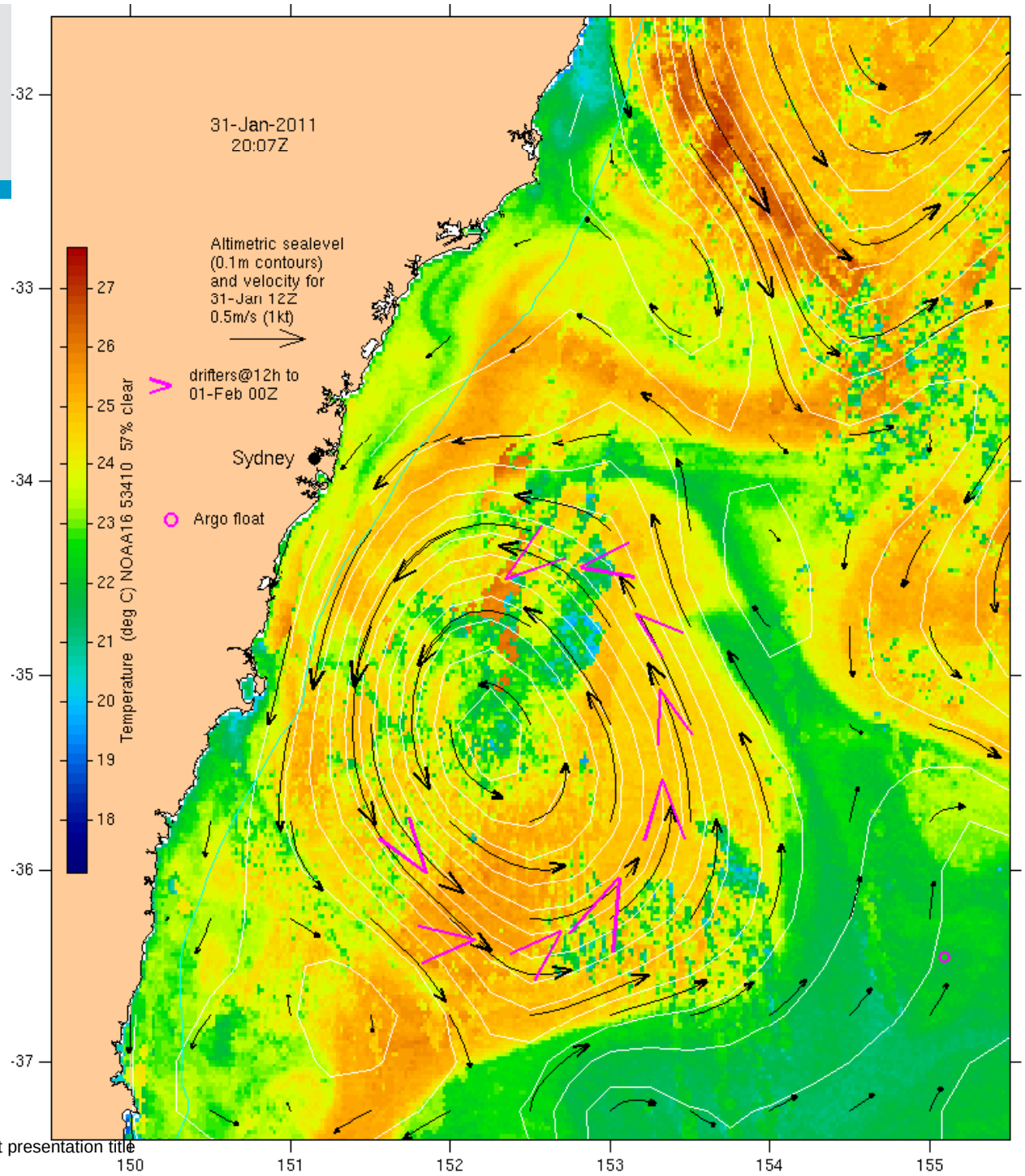

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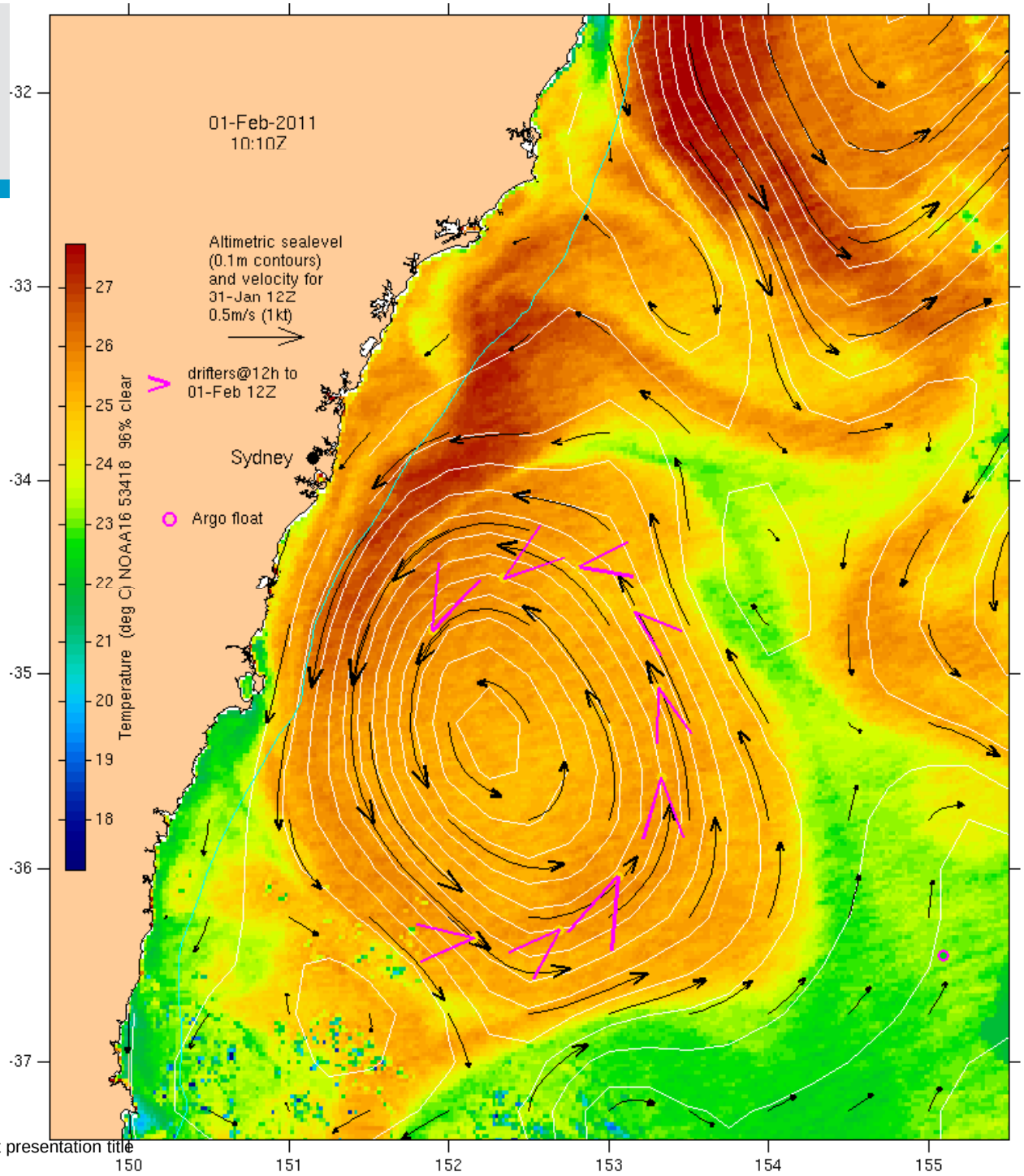

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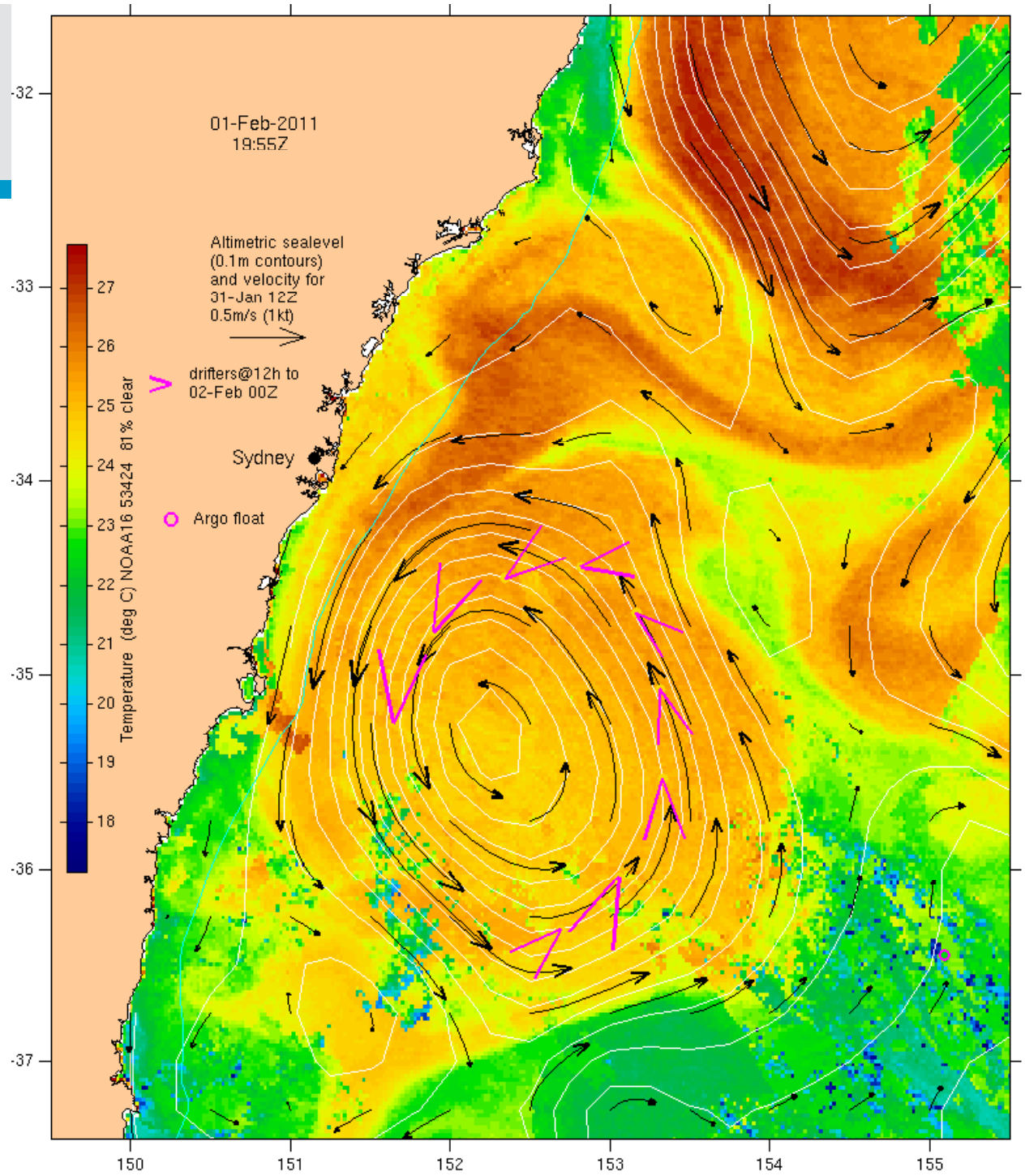

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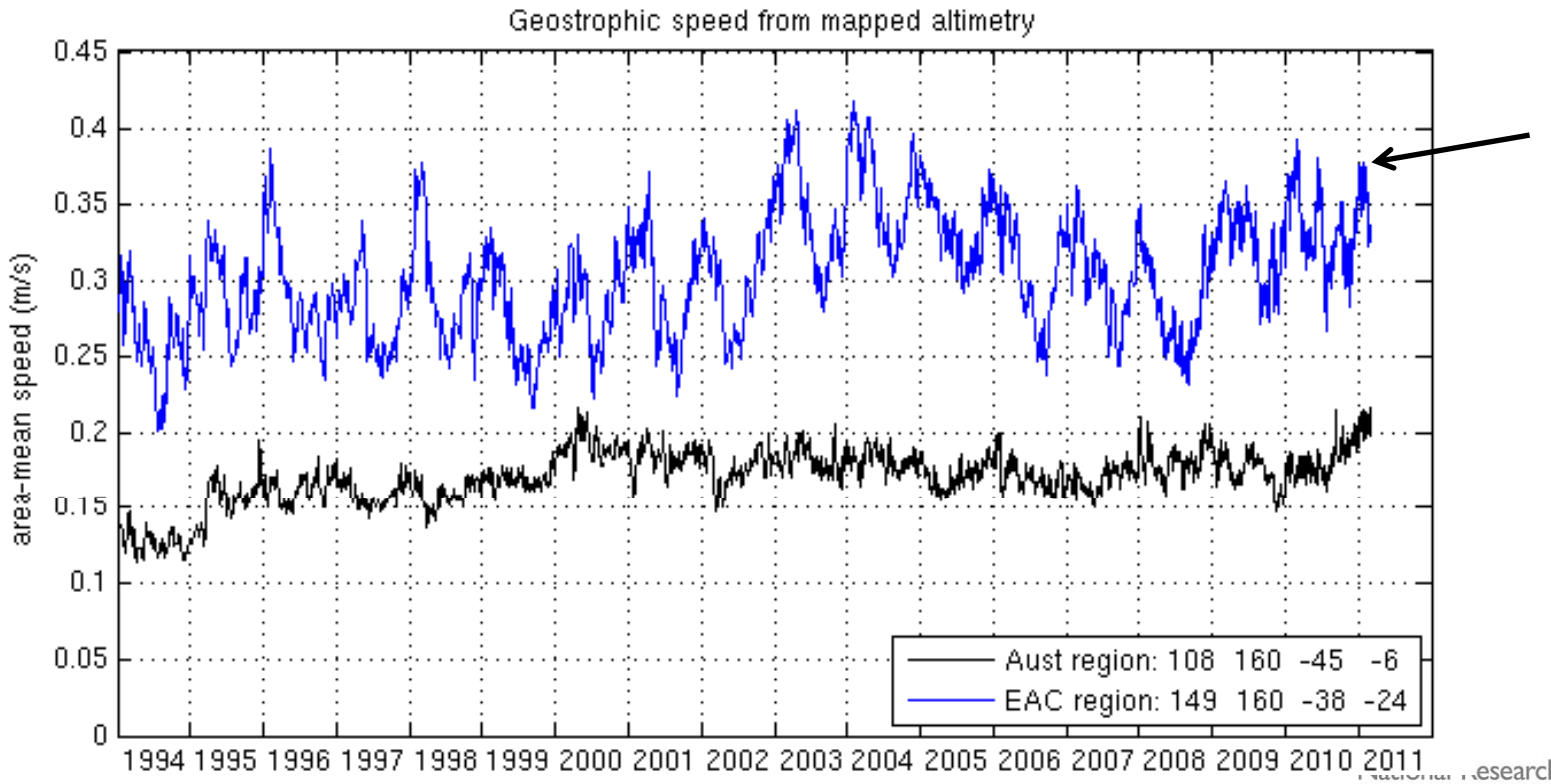
So, that's how a record-breaking East Australian Current warm-core eddy was born

- Existence of strong coastal currents obvious to all mariners
- What is the link to the extreme La Nina?
- The area-average current speed usually has a January maximum off SE Aust:



SE Aust 2011 not extreme

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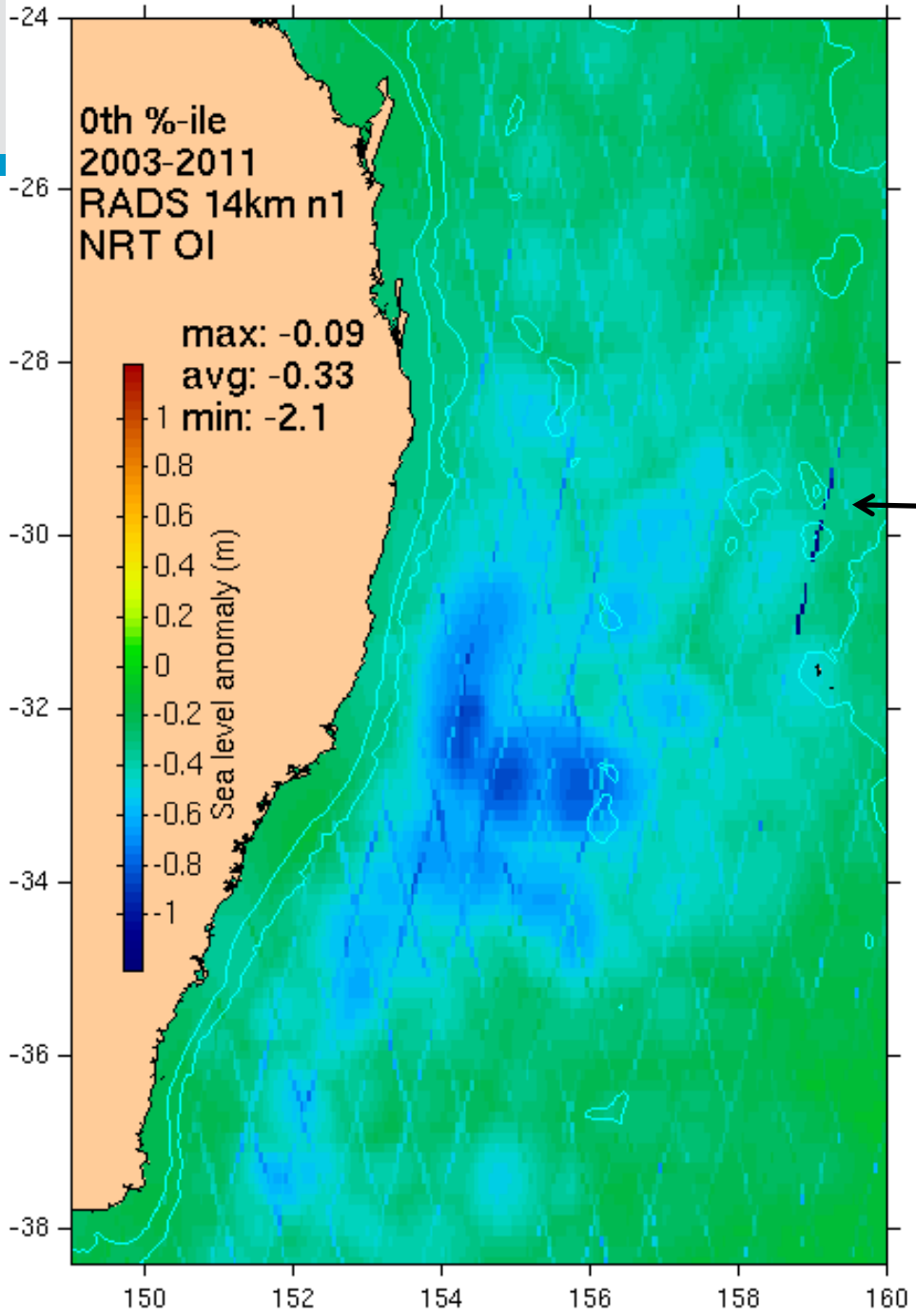
Back to the question of quality control:

- New approach (for us) to real-time QC:
- Reject data by comparing with historic extrema
- Eg: *at each point in space* use only
  1.5*min < SSHA <1.5*max
- Much more discriminating than spatially invariant limits
- But: how do the stats of track data compare with stats of maps?



A: very closely:
Min of tracks~=
min of maps.

Only 1 bad Envisat track in
RADS at present:
SSHA = -2m
(=3*minimum)
not edited by standard RADS editing

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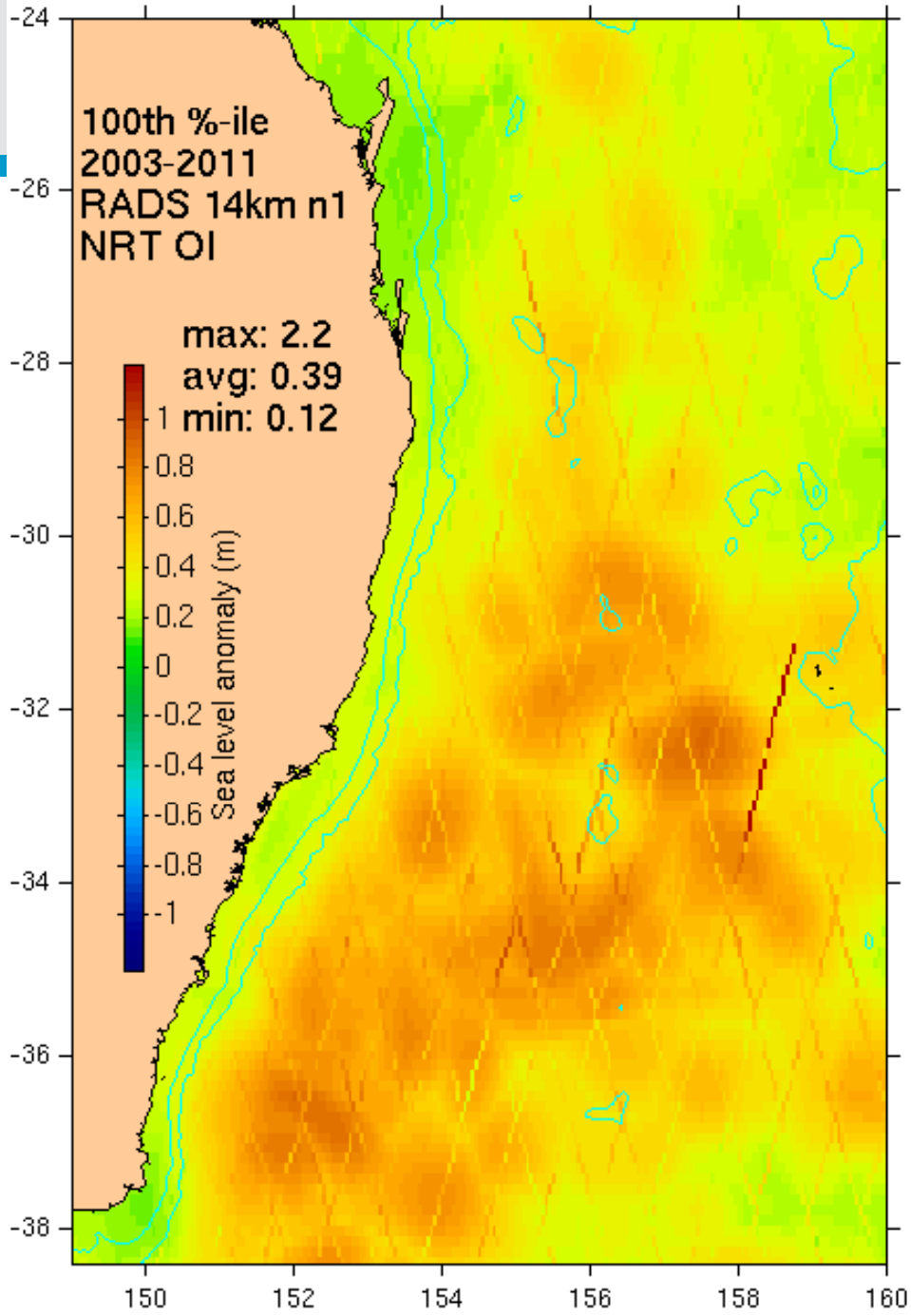

Max values:
Same result

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Discussion

- It is tempting not to focus on the extreme values in a data set, or to think much about the shape of the distribution function, and how it varies in space.
- Extreme values in Near-Real-Time data are often errors: indeed, some erroneous NRT maps were found during the production of this talk.
- By definition, the genuine extreme values are rare, and pose a challenge to automatic quality control.
- But it is essential not to be lazy here. (Modellers might be reluctant to assimilate unseen values into an operational model).
- For operational oceanography to become a reality, we must build systems that do not fail when they are most needed .

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Thankyou

- We thank the many people and agencies (ESA, EuMetSat, CNES, NASA, NOAA, Argo, Drifter program) for the data shown here.
- We look forward to including Altika in similar analyses
- …and to getting CryoSat2 data closer to real time

- Our URL again: imos.aodn.org.au/oceancurrent

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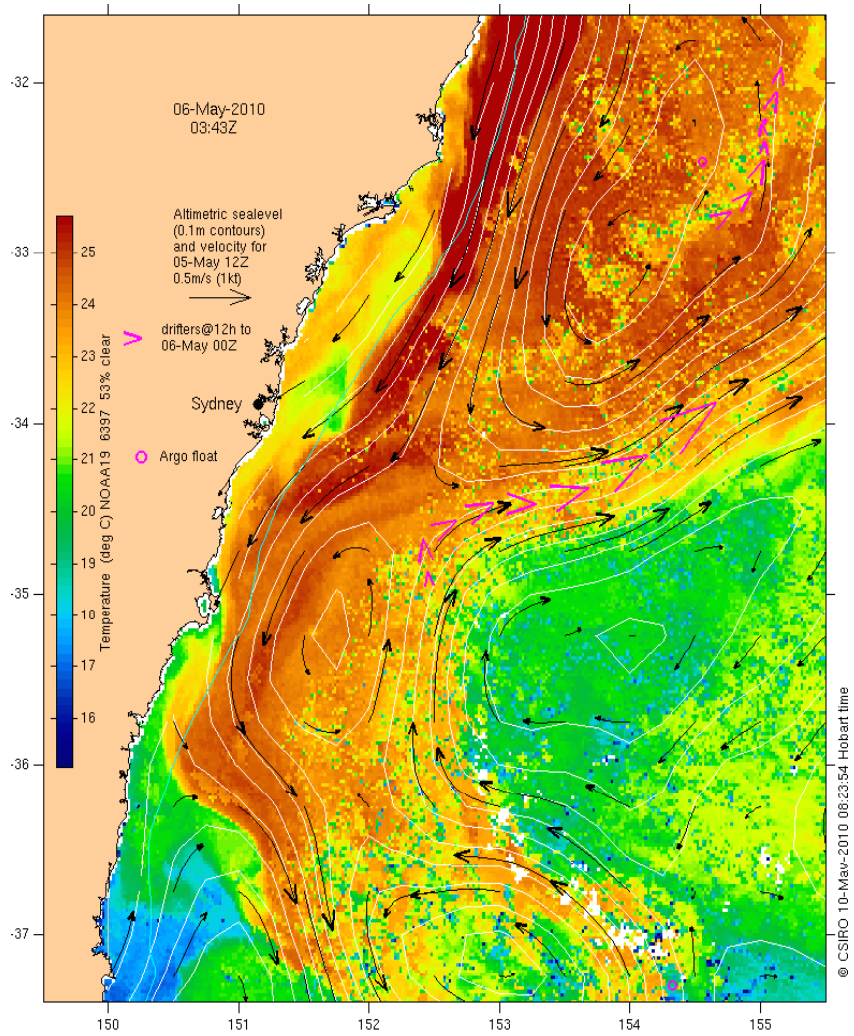

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