Up to which extent can we characterize ocean eddies using present-day altimetric products?

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Motivation

Satellite Sea Level Anomaly (SLA) products

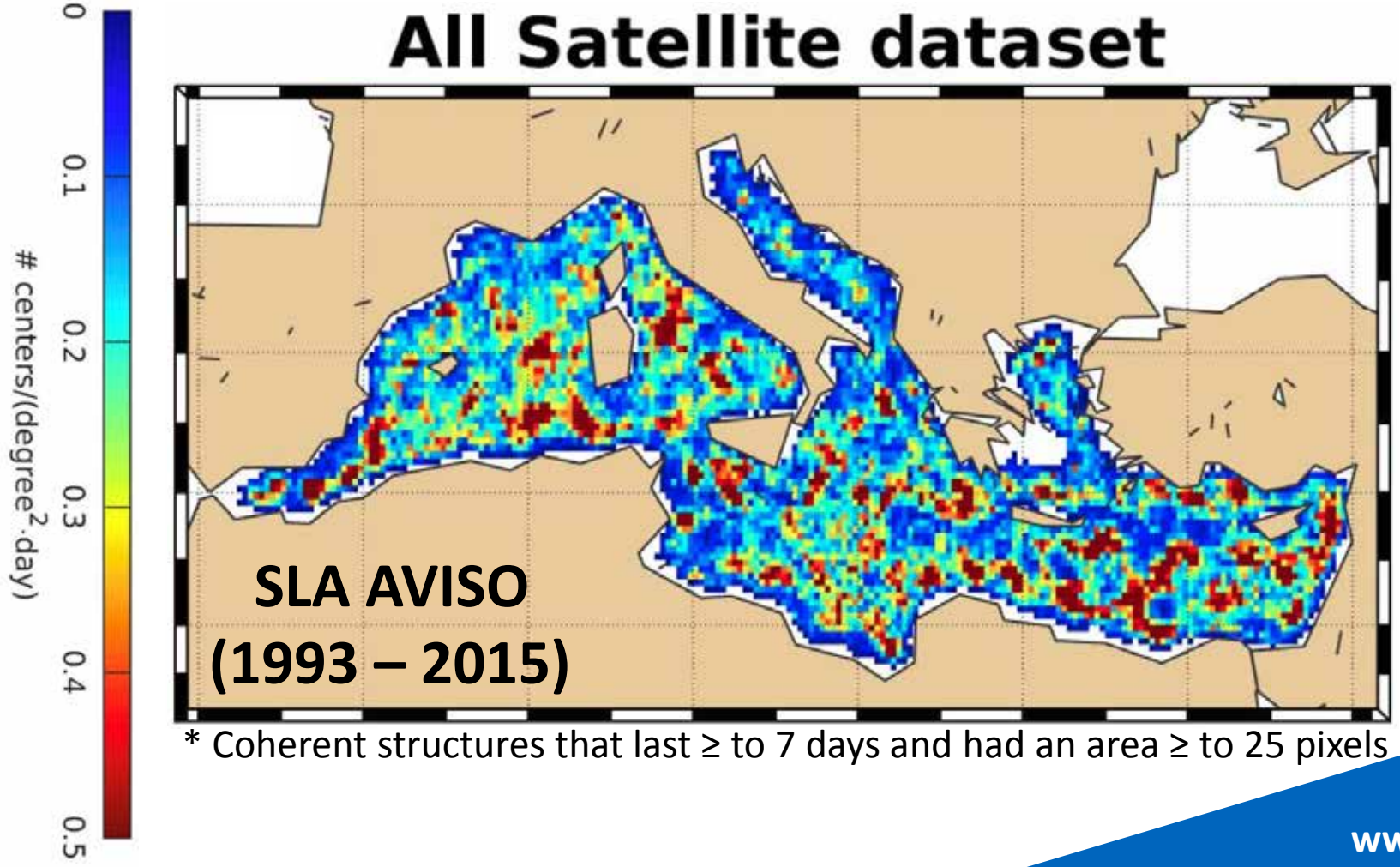
+

Eddy Detection and Tracking Algorithms:

- Statistics of eddy properties (density, amplitude, …).
- Horizontal structure at surface (2D).
- 3D structure combining SLA with Argo profiles.
- Computation of eddy transport (volume, heat, salt, …).
- …

Motivation

Computing the # of eddies* in the Mediterranean:



* Coherent structures that last ≥ to 7 days and had an area ≥ to 25 pixels

Motivation

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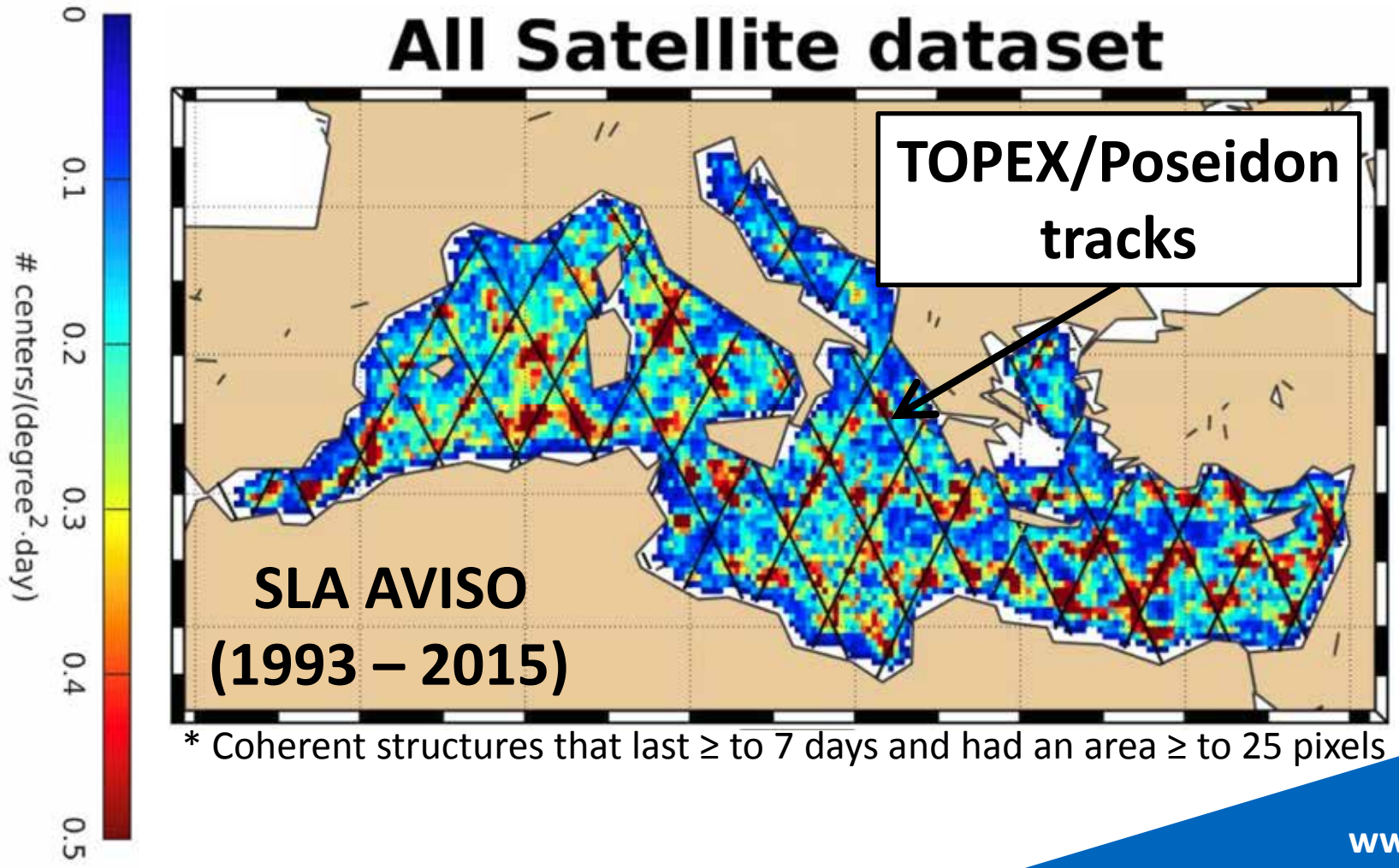

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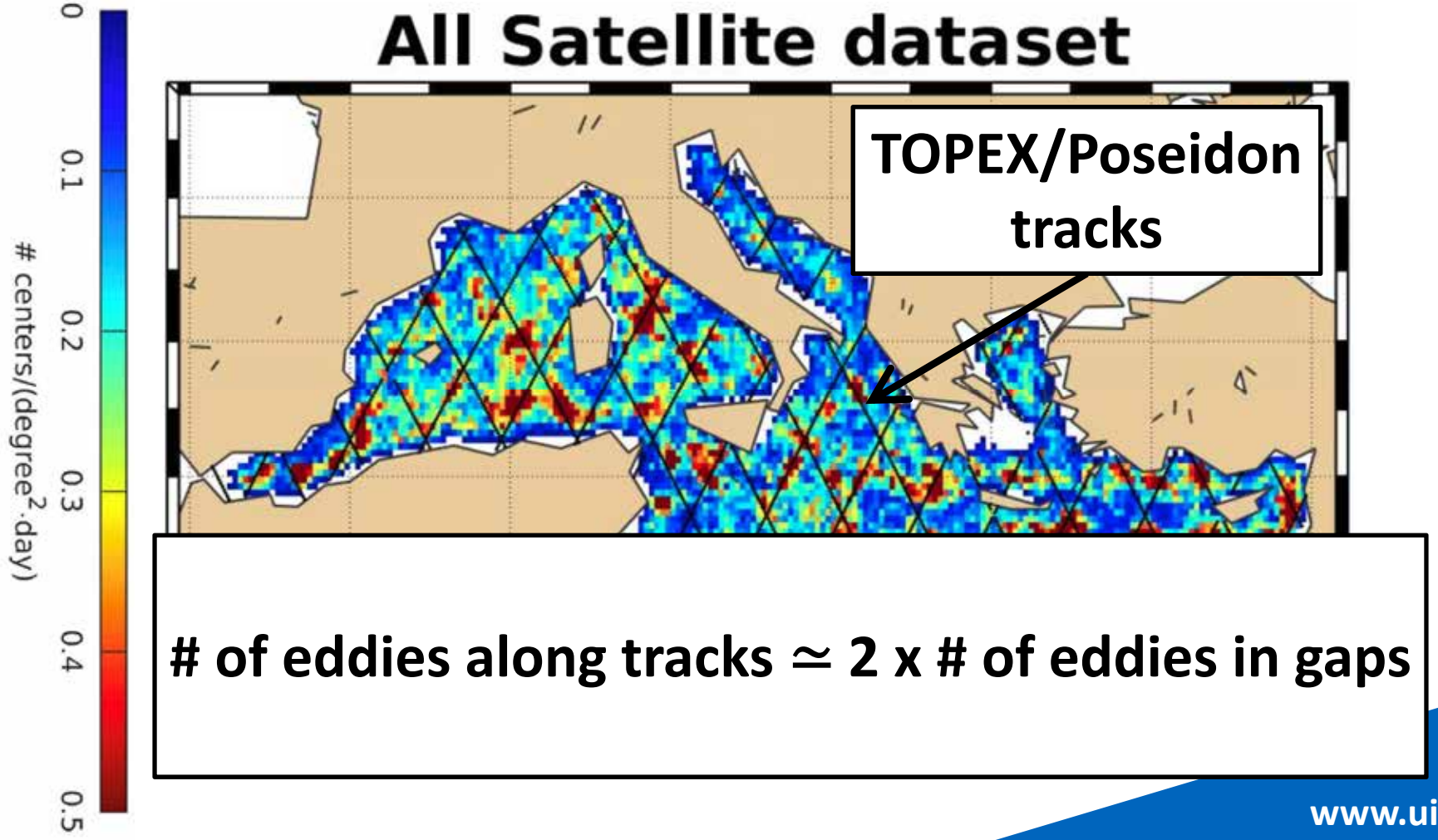


# of eddies along tracks ≃ 2 x # of eddies in gaps

Methodology

SLA from High Res. Model

Truth

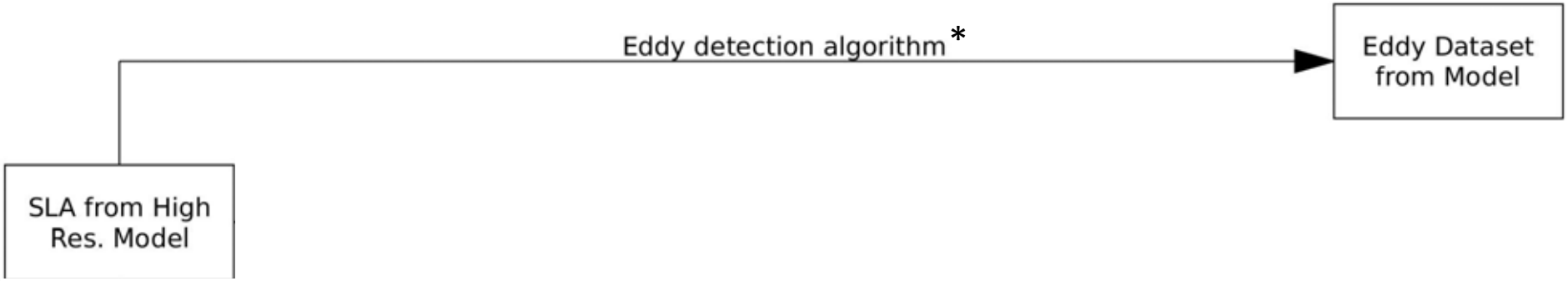
Methodology

Two regions:

SLA from High Res. Model

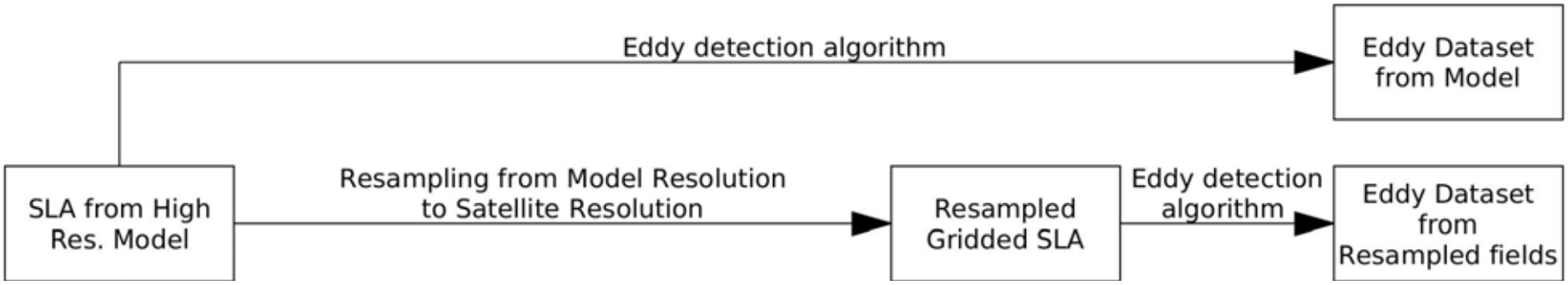
- **Mediterranean sea**:
  - NEMO.
  - 10 years of daily fields.
  - **dx = 1/32°**
  - 75 vertical levels.
- **North Atlantic ocean**:
  - NATL60.
  - 13 months of daily fields.
  - **dx = 1/60°**
  - 300 vertical levels.

Methodology

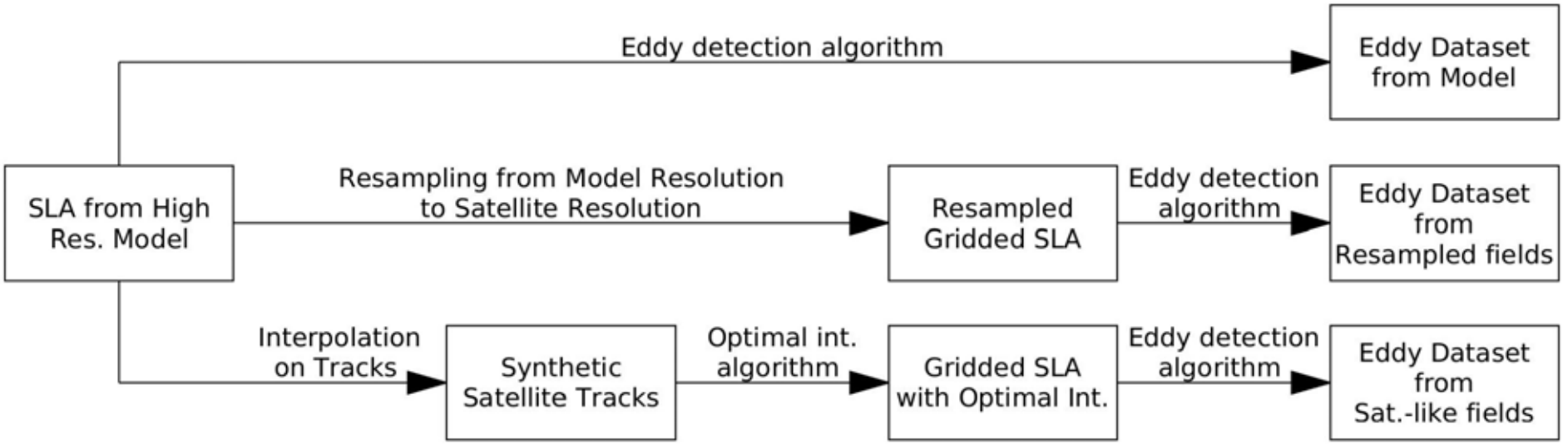


* Faghmous, J. H., I. Frenger, Y. Yao, R. Warmka, A. Lindell, and V. Kumar (2015),
A daily global mesoscale ocean eddy dataset from satellite altimetry,
Sci. Data, 2, doi:10.1038/sdata.2015.28

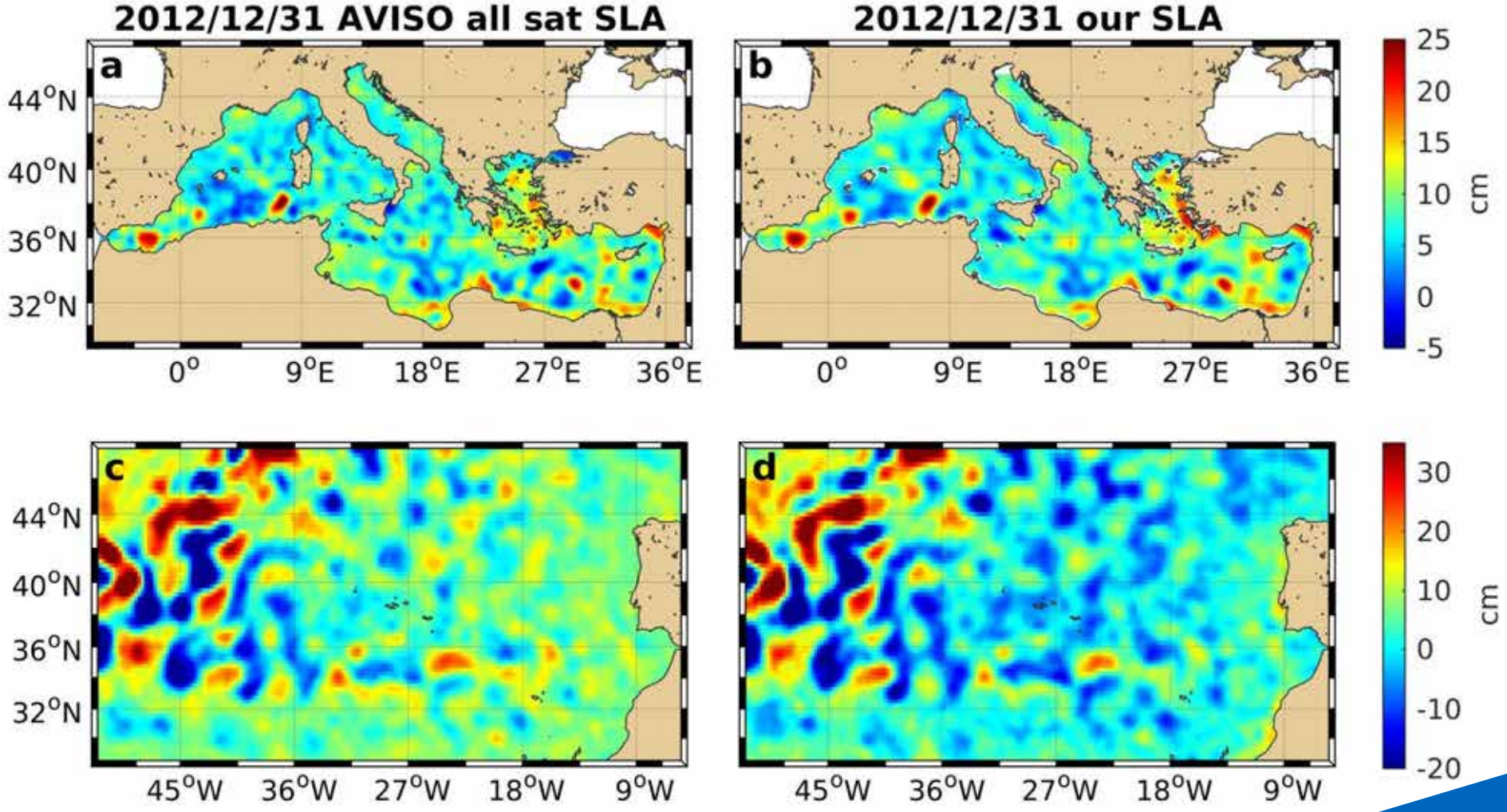
Methodology



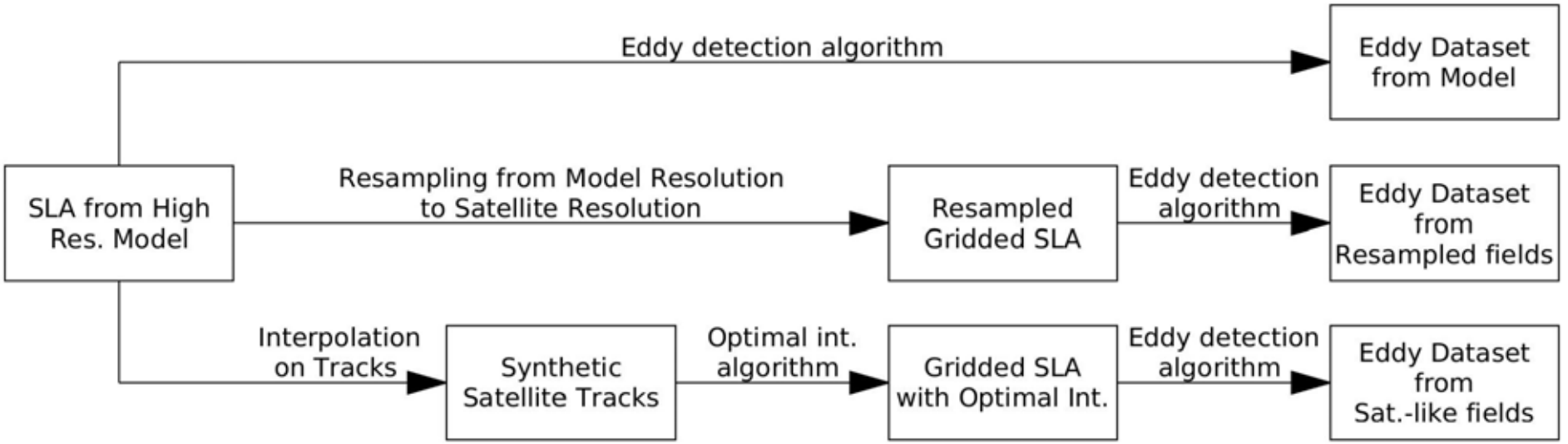
Methodology



Methodology



Methodology



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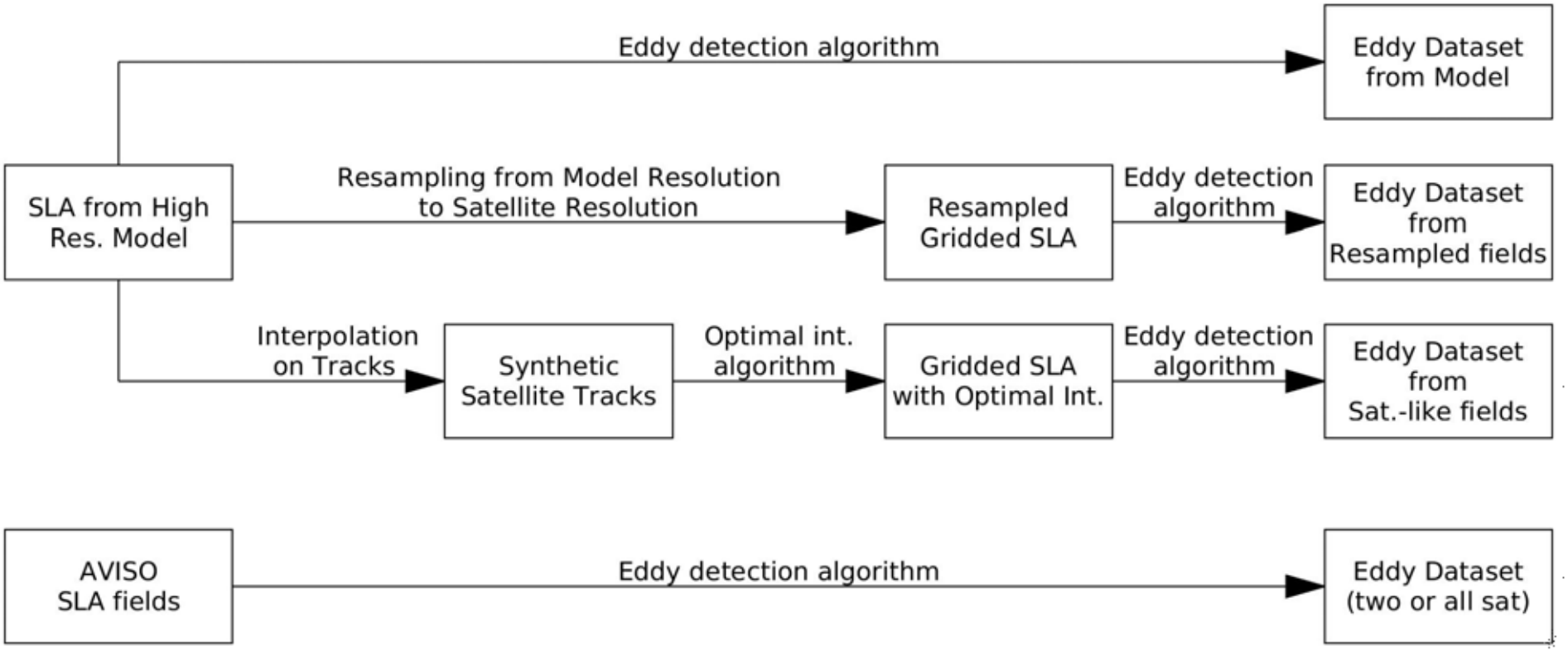
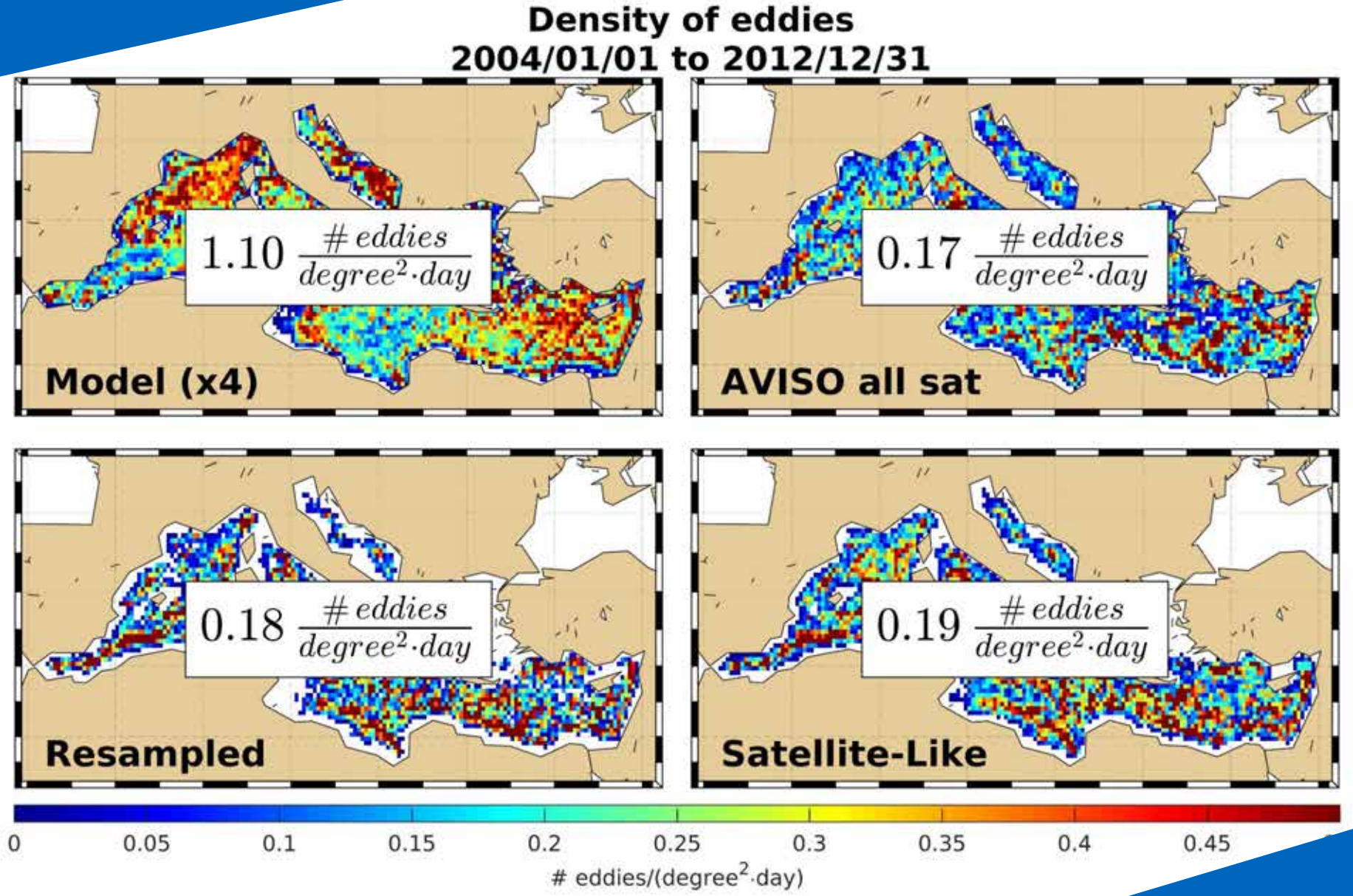
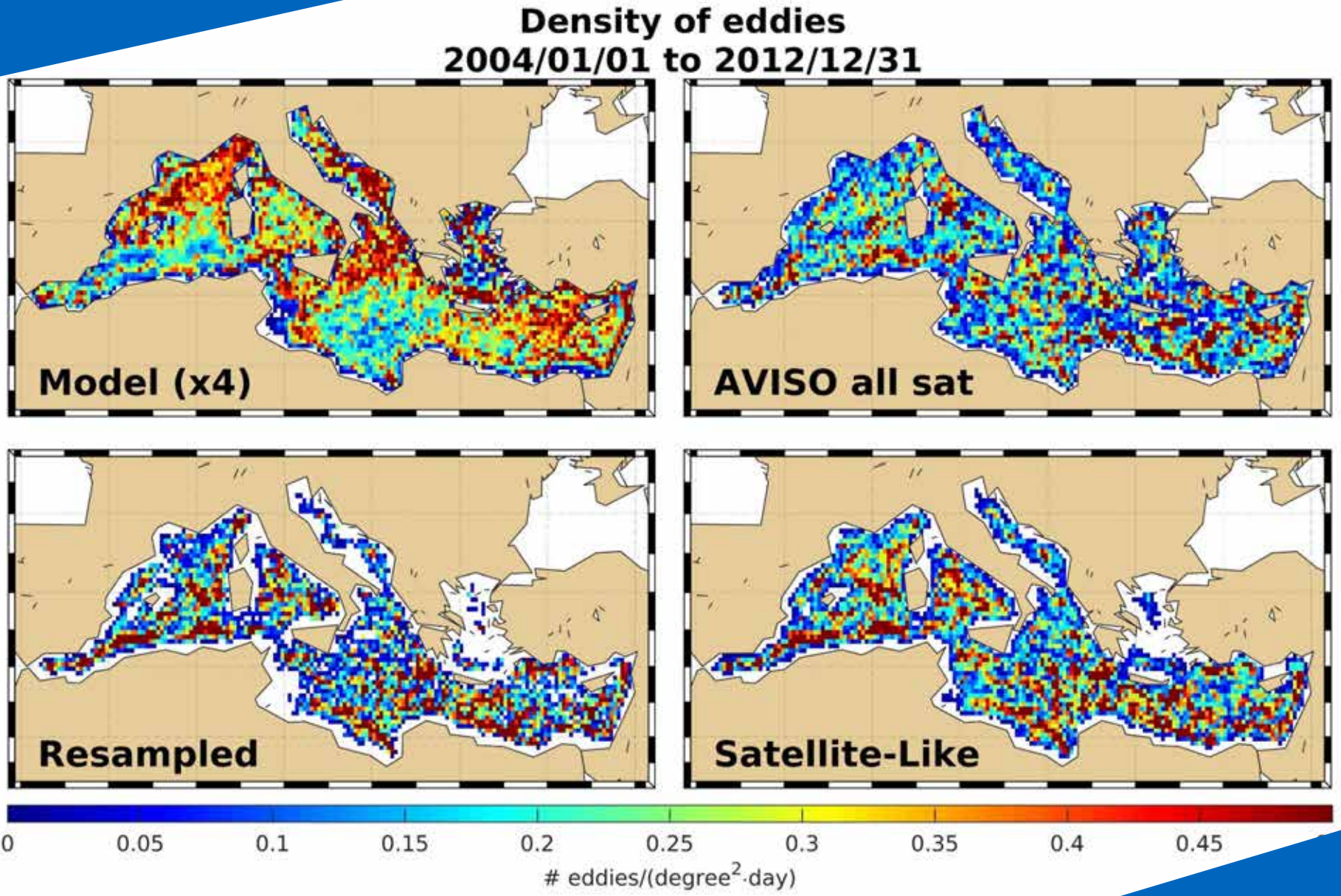


Results

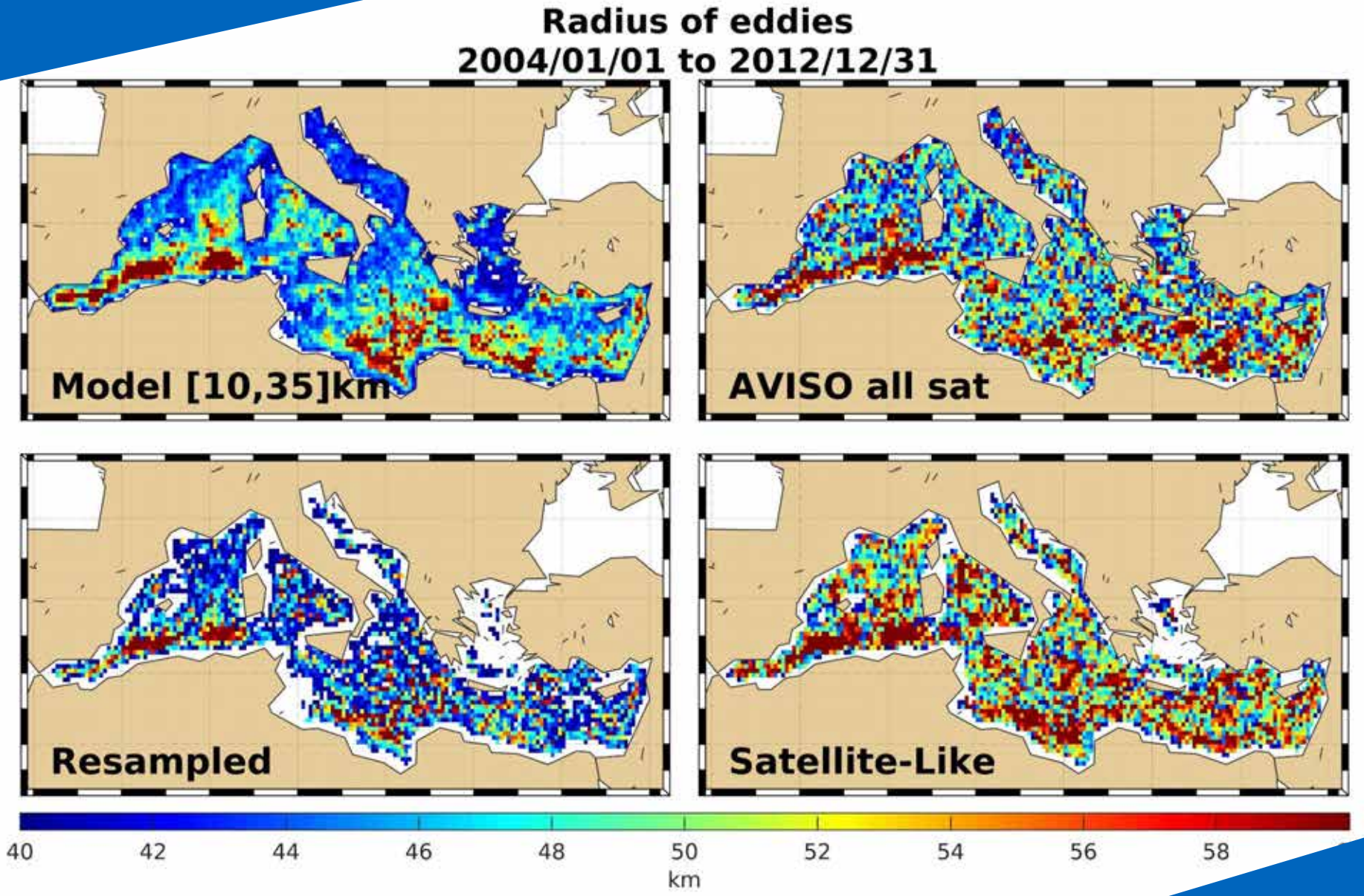
Results


Density of eddies
2004/01/01 to 2012/12/31
1.10 $\frac{\#\,eddies}{degree^2 \cdot day}$
Model (x4)
0.17 $\frac{\#\,eddies}{degree^2 \cdot day}$
AVISO all sat
0.18 $\frac{\#\,eddies}{degree^2 \cdot day}$
Resampled
0.19 $\frac{\#\,eddies}{degree^2 \cdot day}$
Satellite-Like
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
eddies/(degree^2·day)

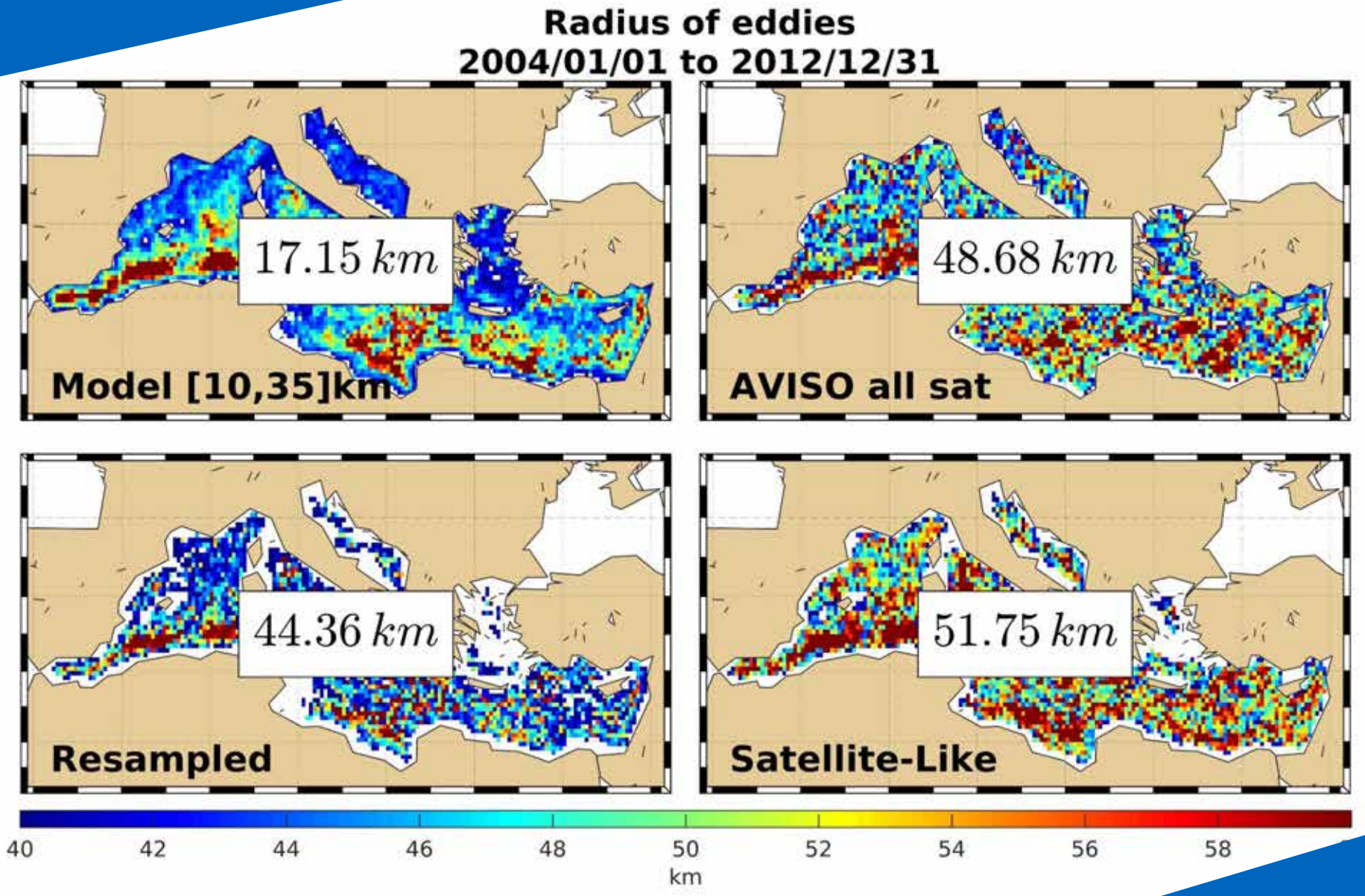
Results


Density of eddies
2004/01/01 to 2012/12/31
Model (x4)
AVISO all sat
Resampled
Satellite-Like
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
eddies/(degree^2·day)

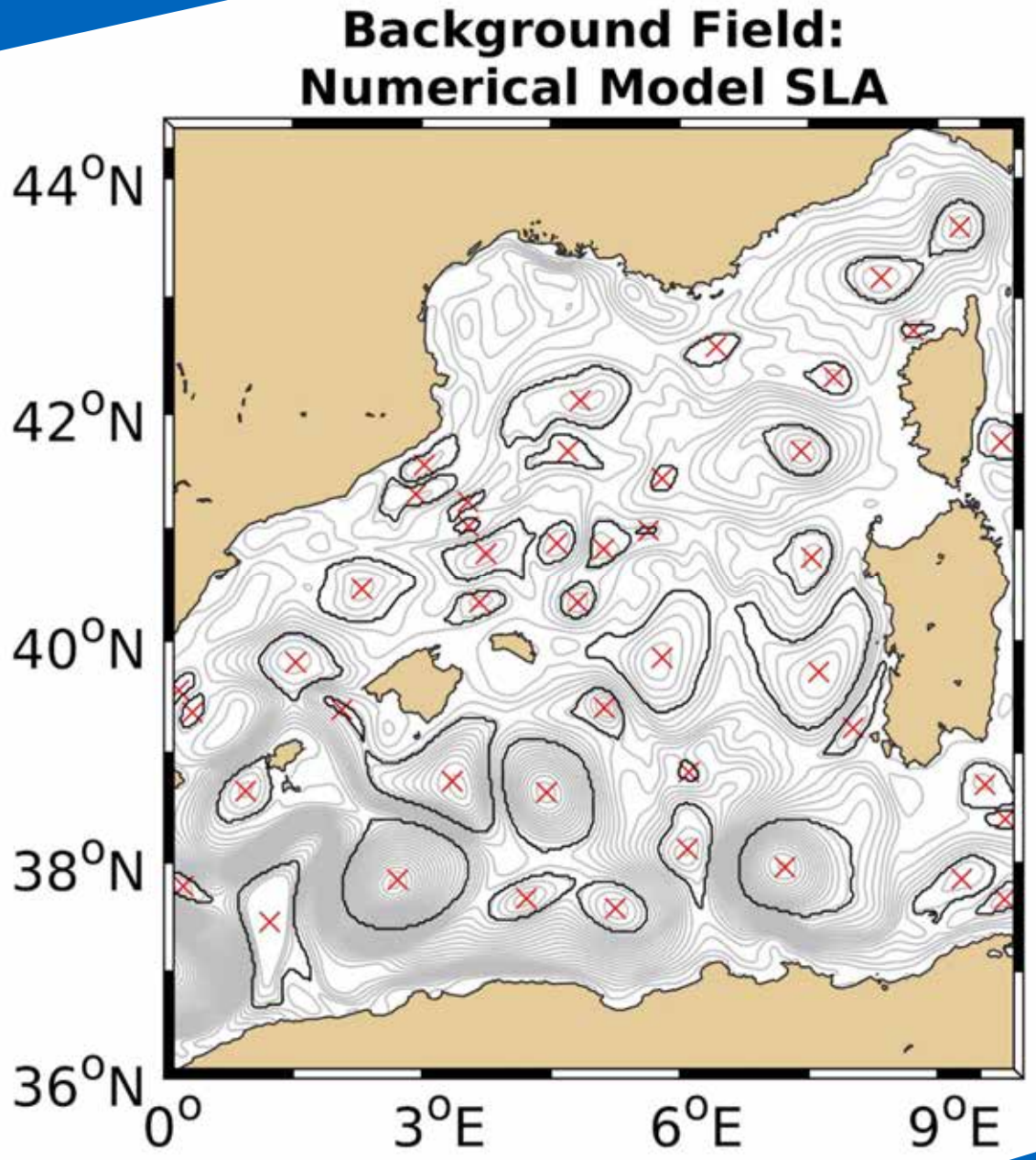
Results


Radius of eddies
2004/01/01 to 2012/12/31
Model [10,35]km
AVISO all sat
Resampled
Satellite-Like
40
42
44
46
48
50
52
54
56
58
km

Results

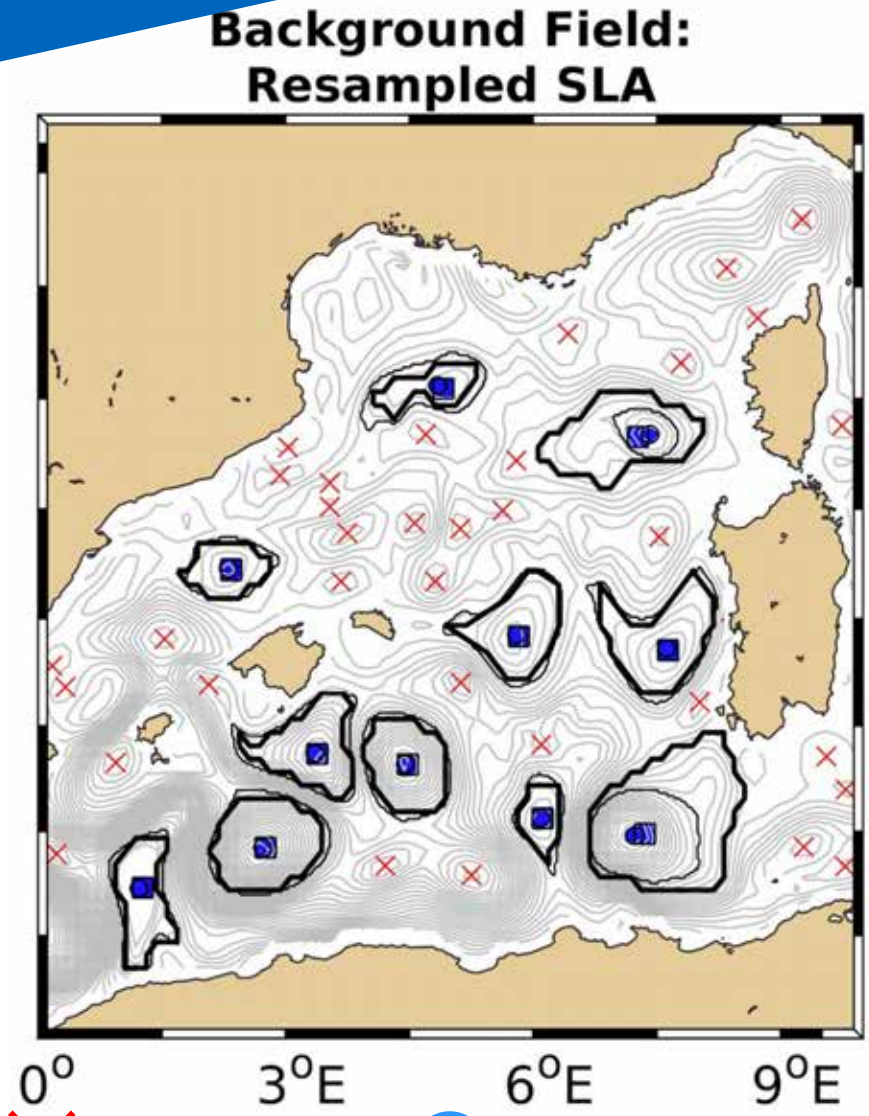

Radius of eddies
2004/01/01 to 2012/12/31
17.15 km
Model [10,35]km
48.68 km
AVISO all sat
44.36 km
Resampled
51.75 km
Satellite-Like
40
42
44
46
48
50
52
54
56
58
km

Results



Eddies:
Area > 25 pixels
Life > 7 days

Results

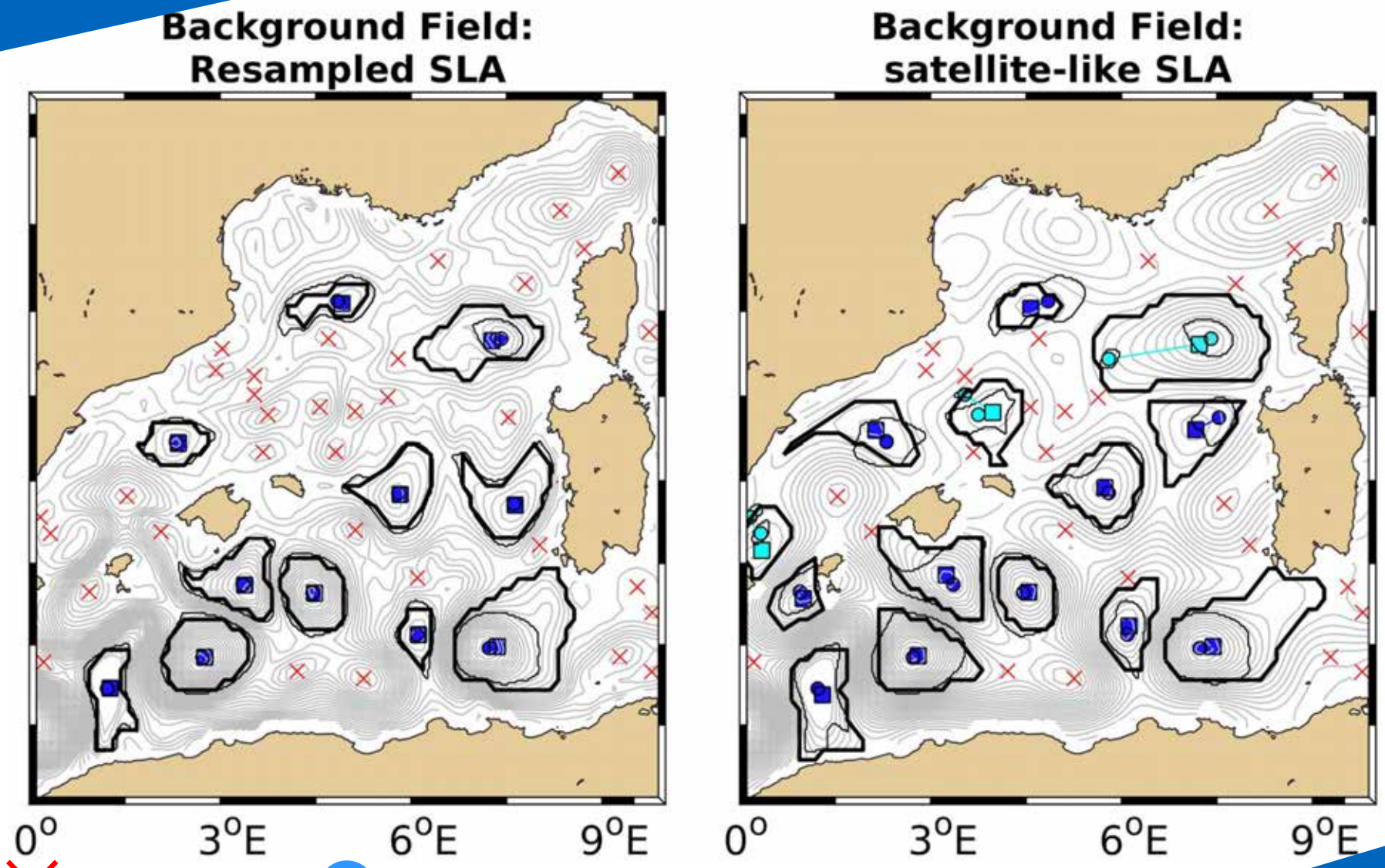


Not detected

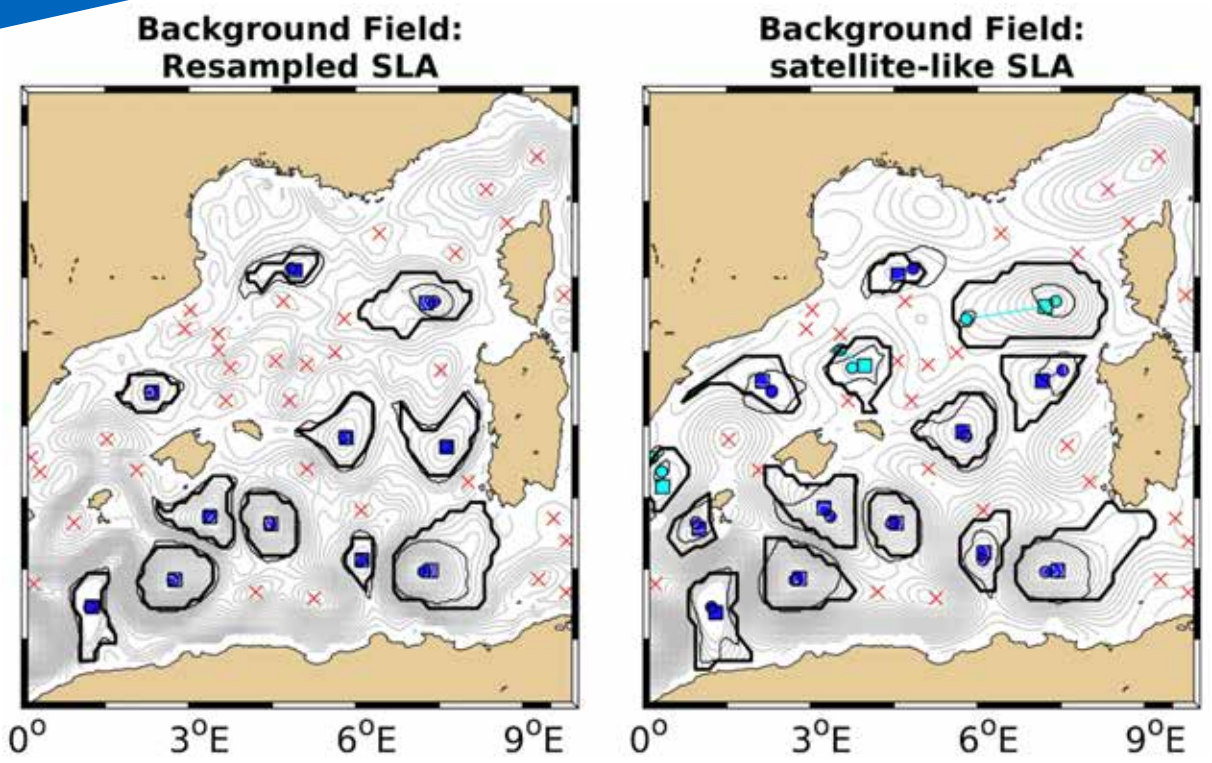
Related eddy center from model

Eddy center in gridded product

Results


Background Field:
Resampled SLA
Background Field:
satellite-like SLA
0°
3°E
6°E
9°E
0°
3°E
6°E
9°E
Not detected
Related eddy center from model
Eddy center in gridded product

Results



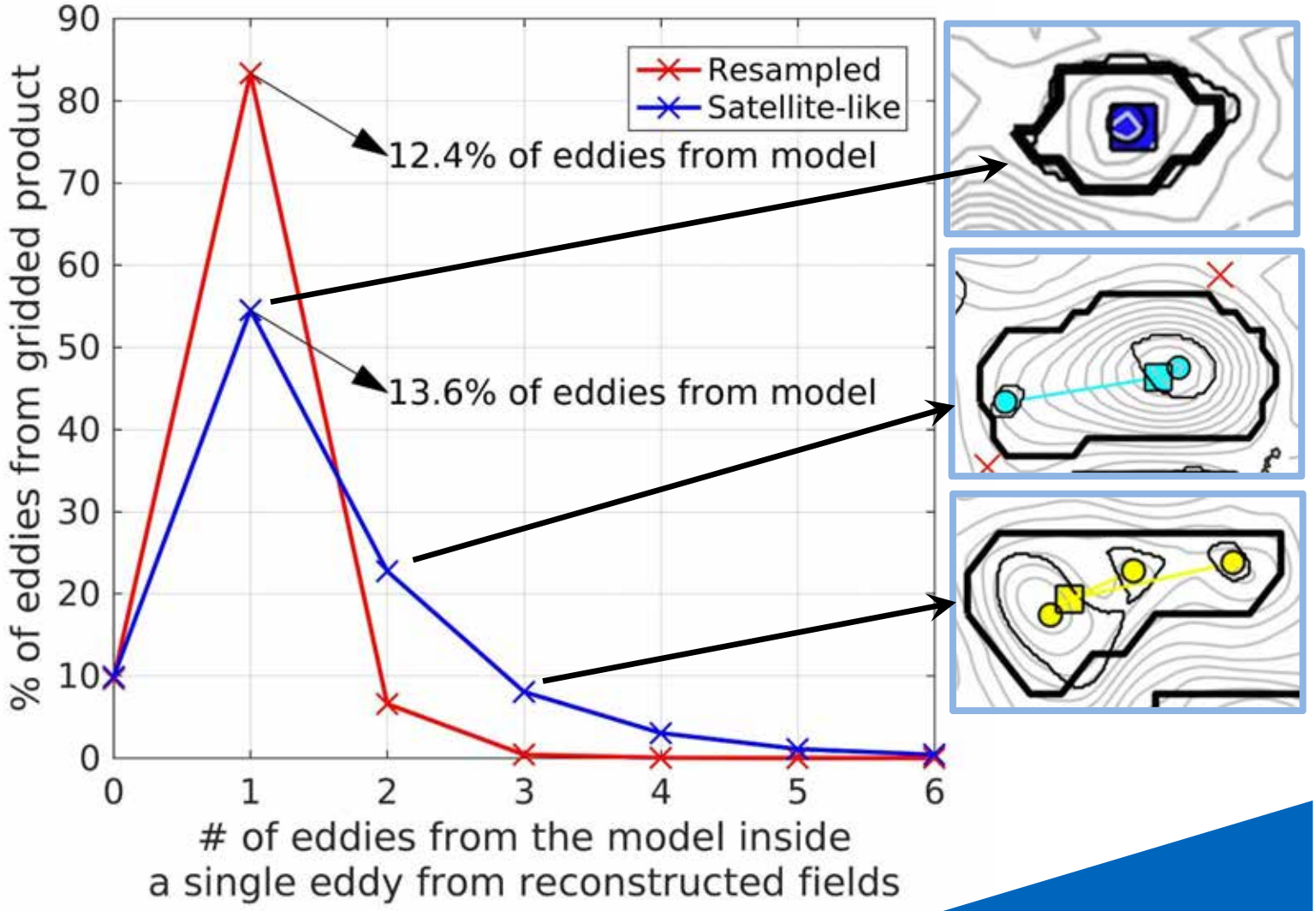
85 % **75 %**

of eddies from model are **not detected** in the

Resampled SLA **Satellite-like SLA**

Results

How are distributed the 15% / 25% of remaining eddies?



Results

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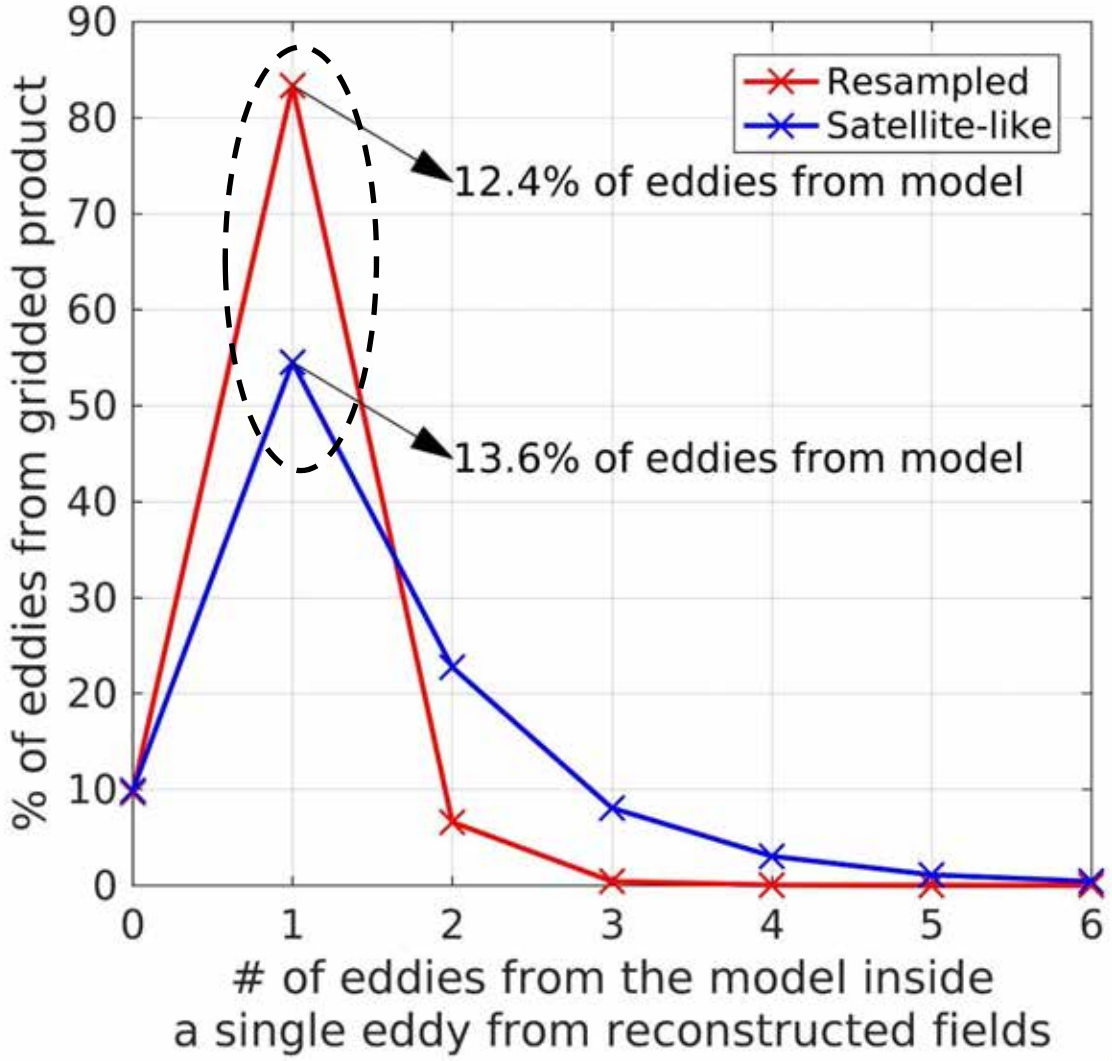
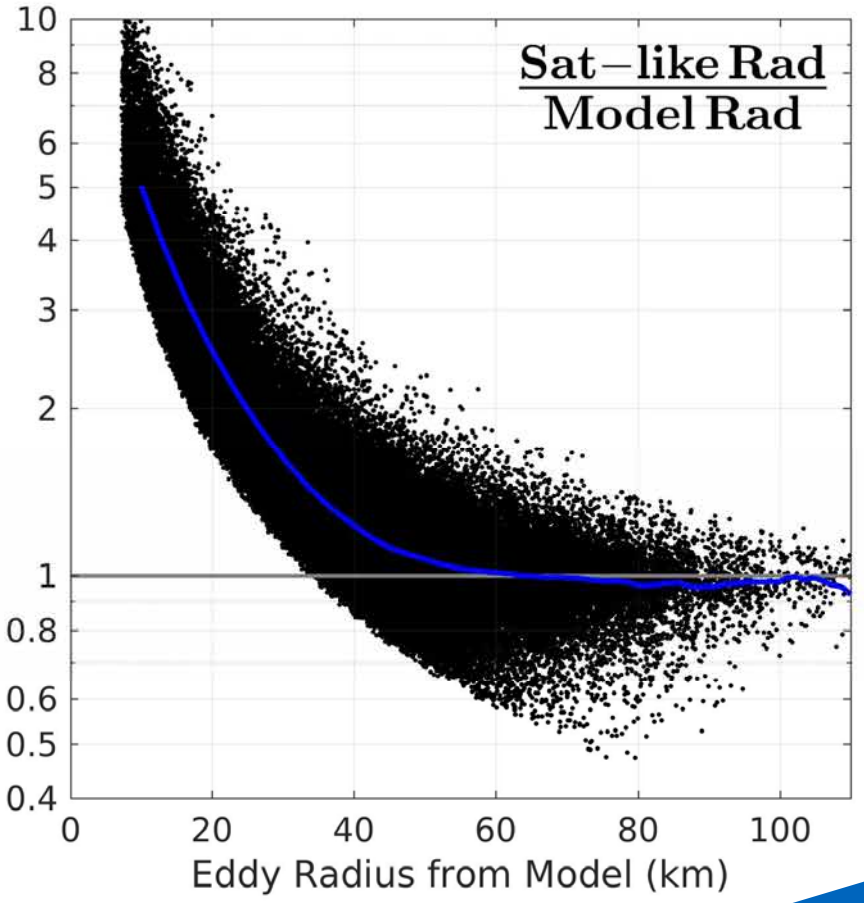


Results

13 % of eddies from model are **identified as a single eddy** but…

how well are their properties reproduced?



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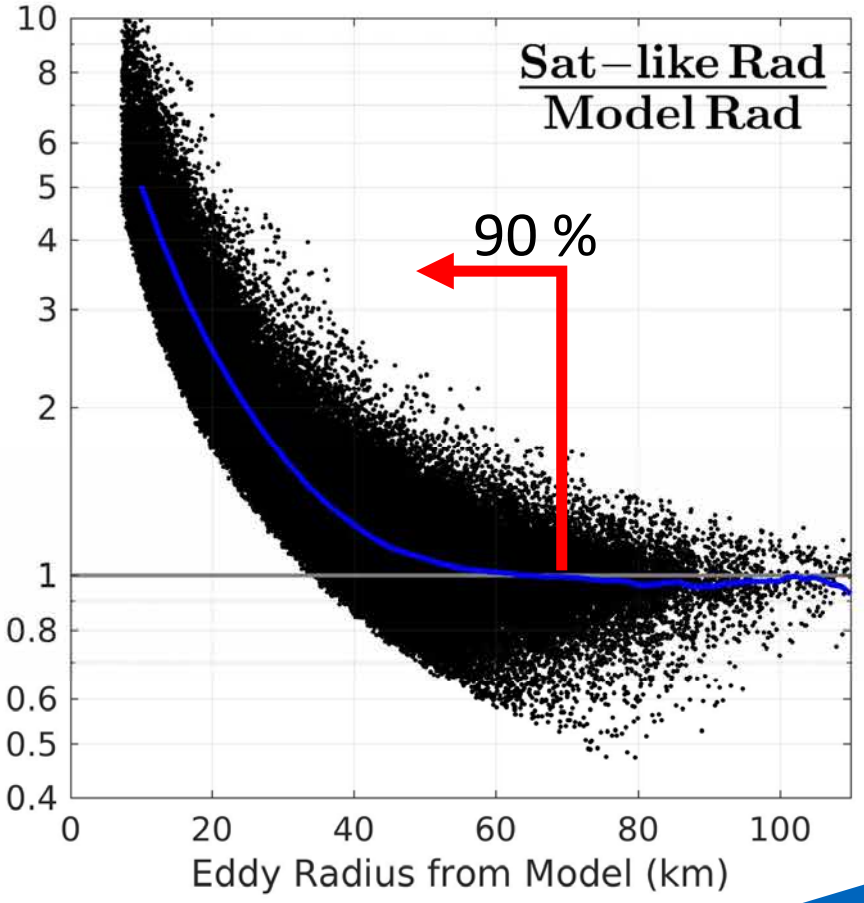

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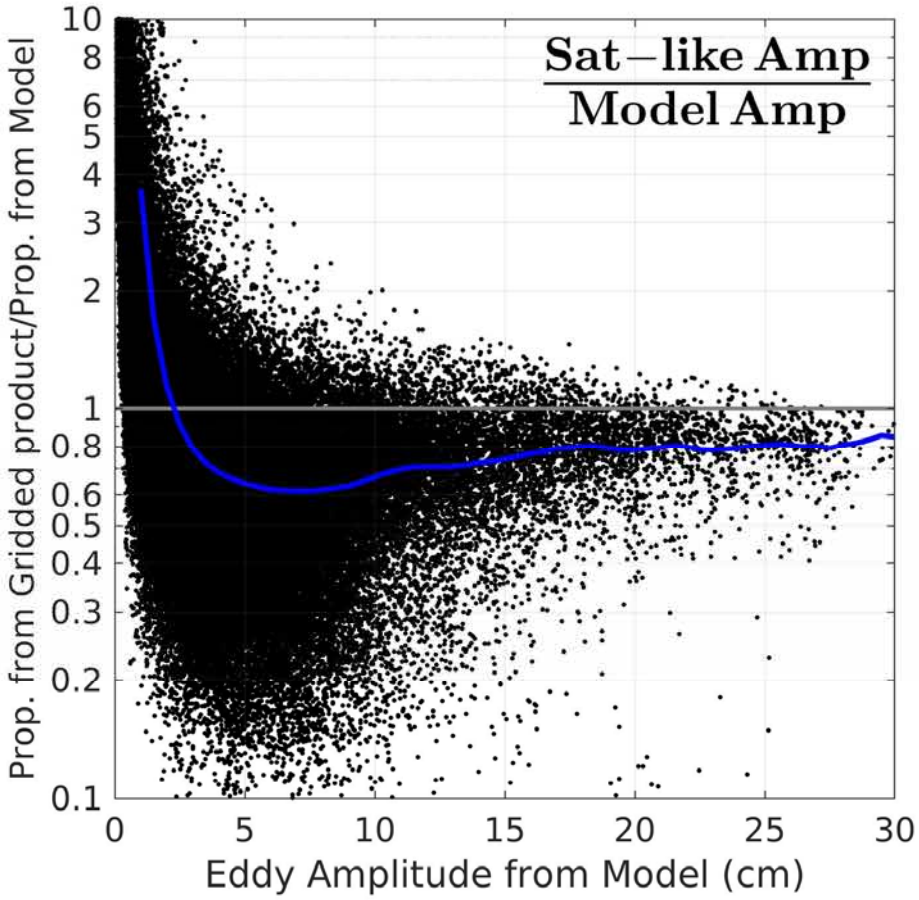
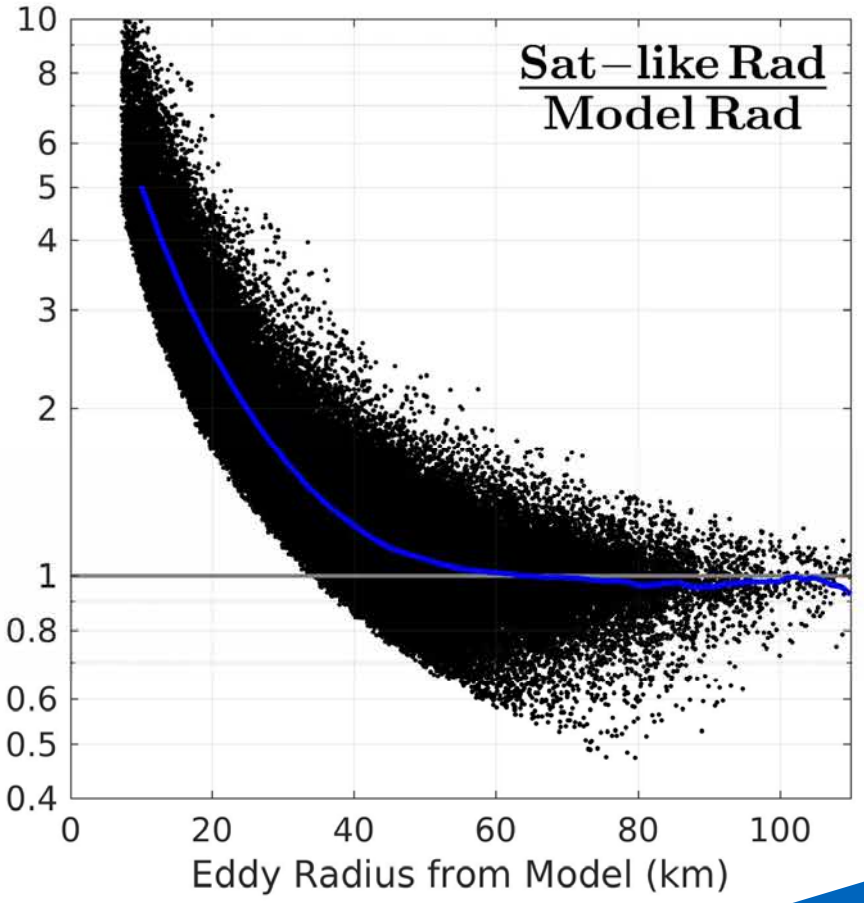
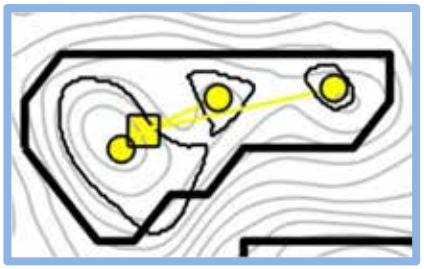




Conclusions

- **SLA gridded products** based on altimetry **cannot capture most of the eddy field characteristics**:
  - Resolution of the maps → unresolved scales.
  - Satellite track separation → loss of eddy signal.
  - Mapping Algorithm → merging eddies.



- **75% of eddies are not identified** in SLA sat. product…
- … and only a **13% of the identified eddies correspond to a single eddy**.
- From this 13%, 90% of them have a radius larger than the real one.

Thank you
for
your attention

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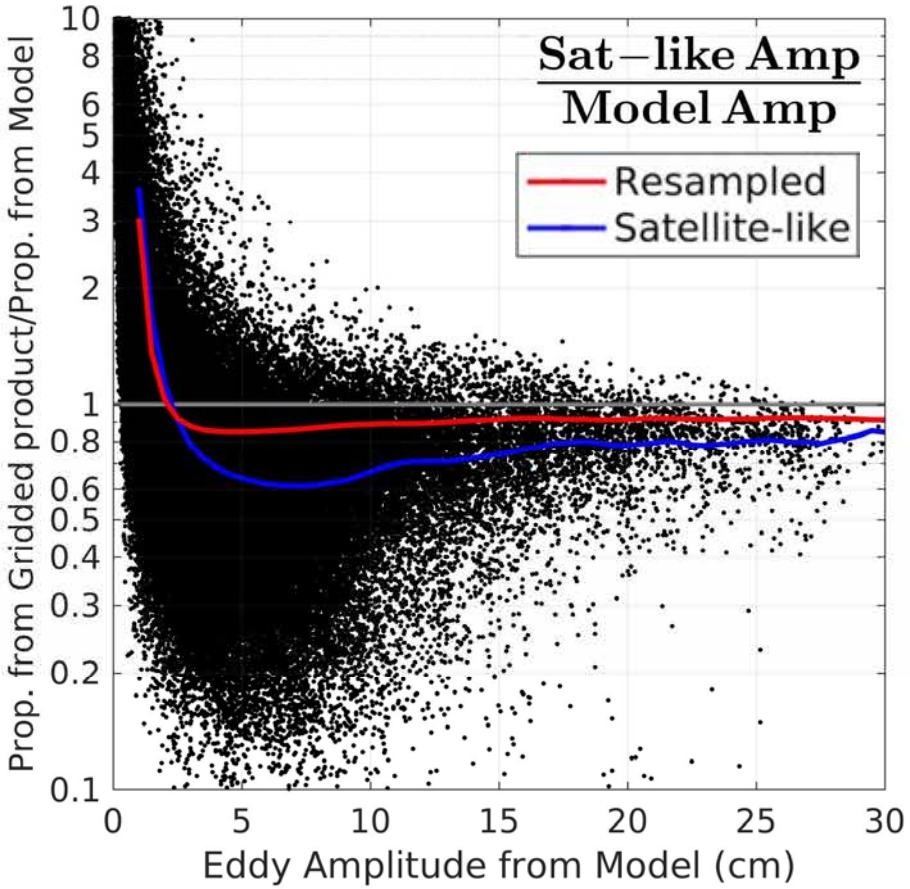
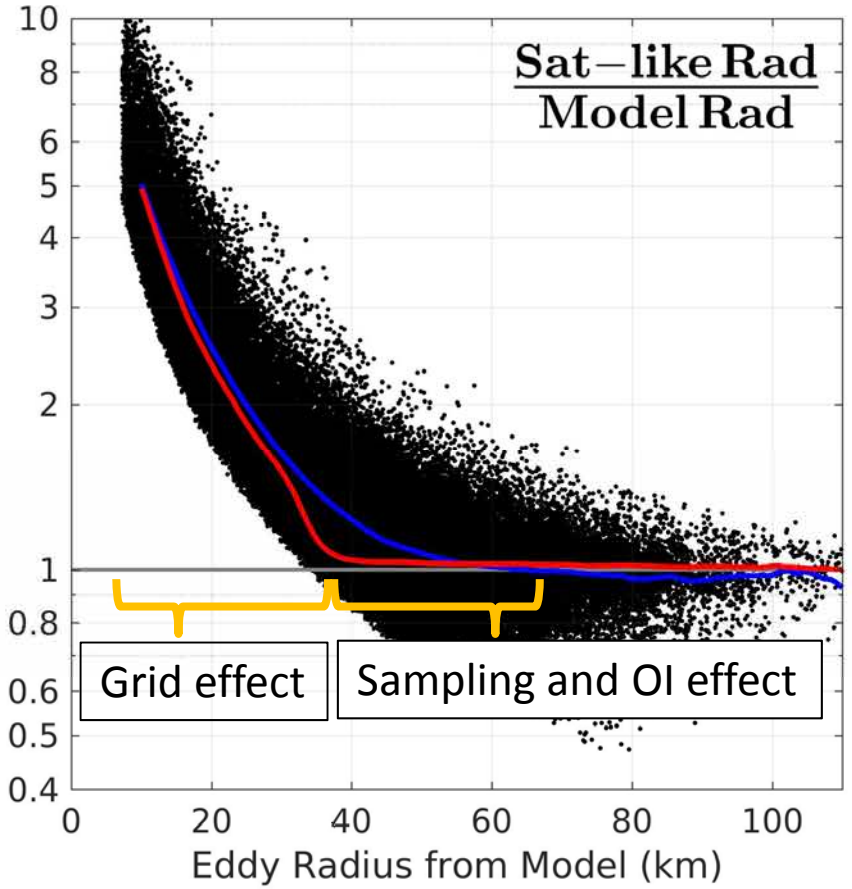
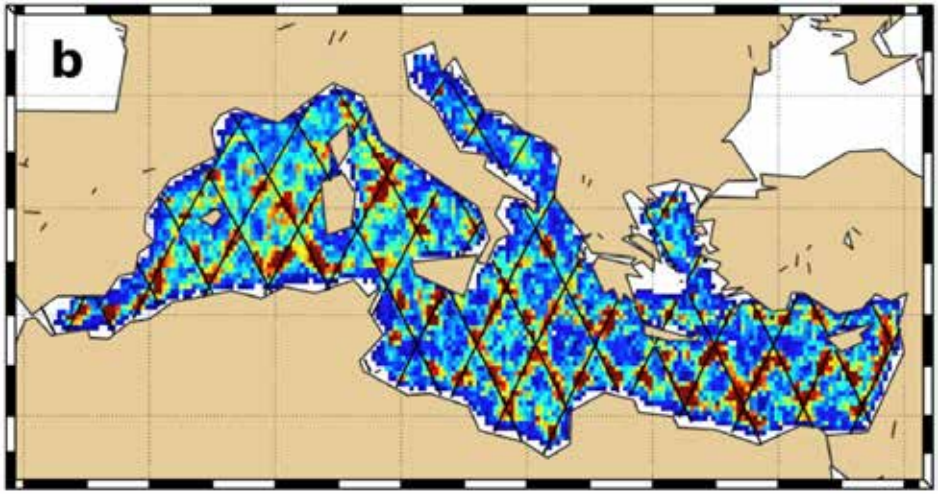
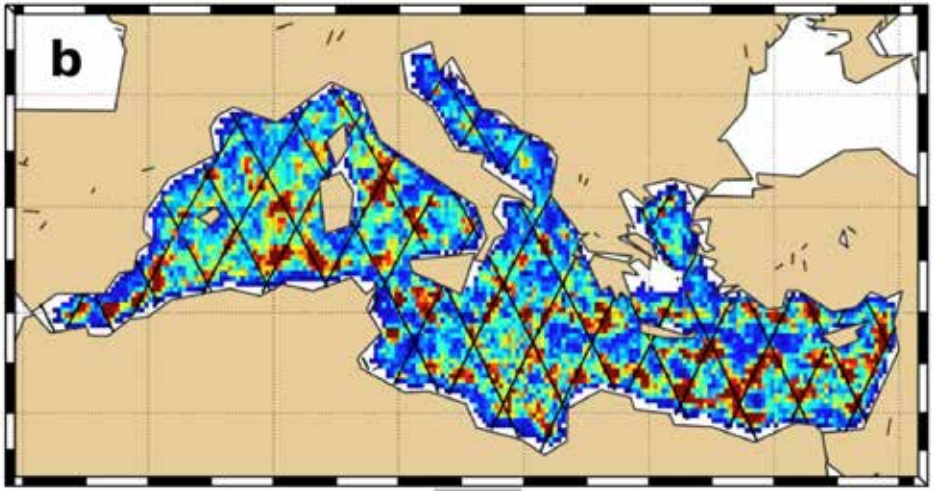


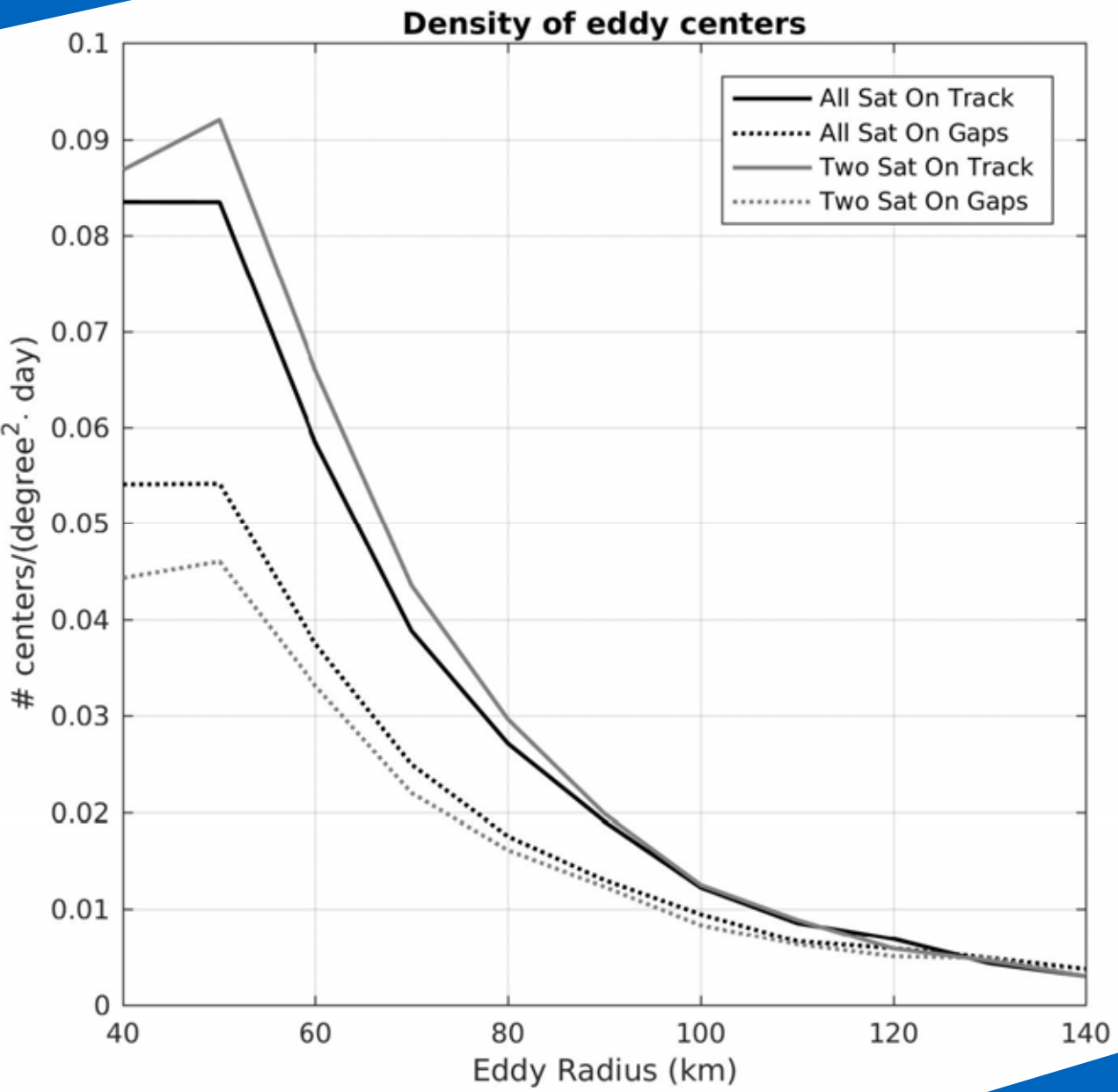


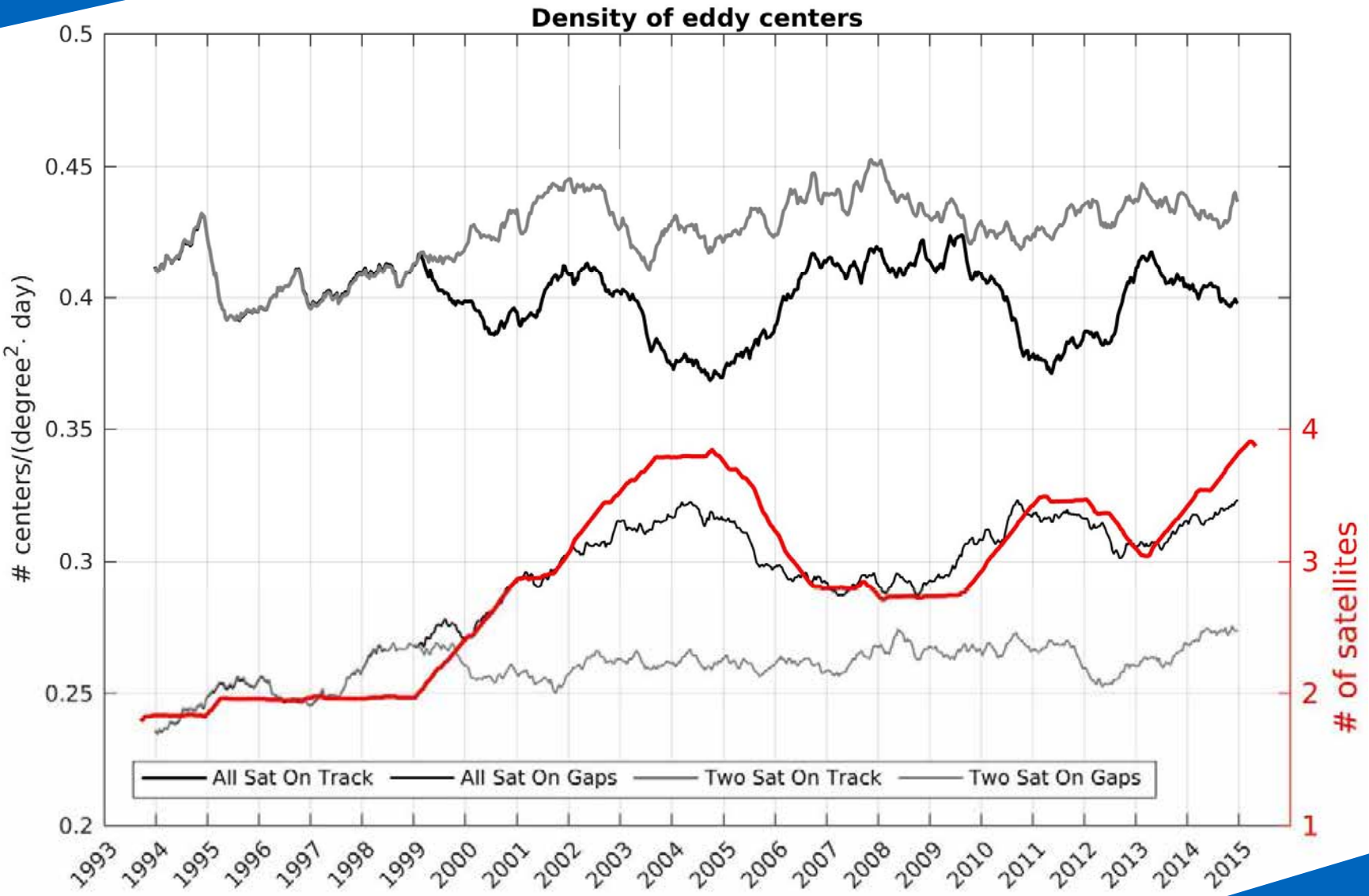
Two Satellite dataset



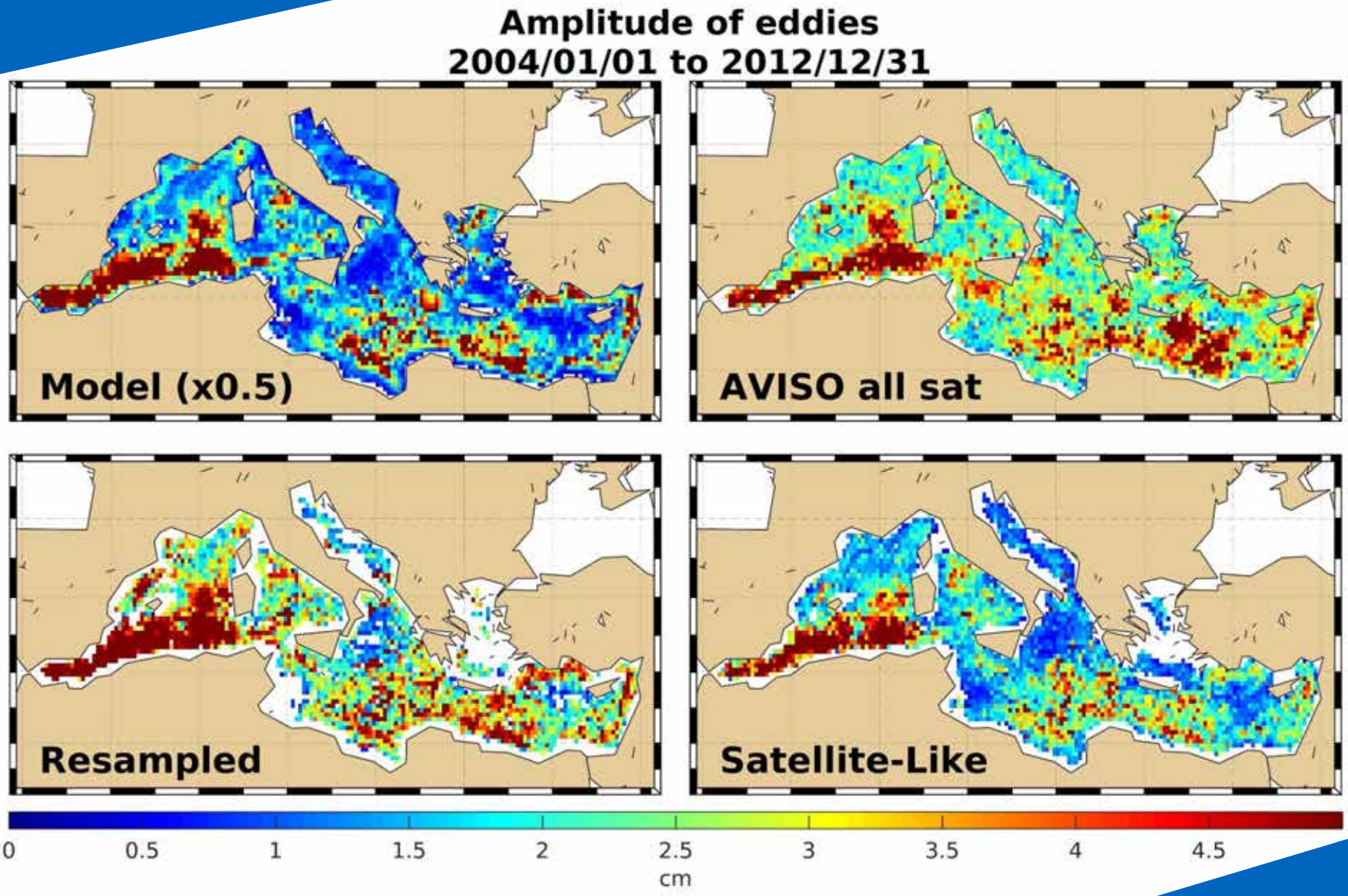
All Satellite dataset



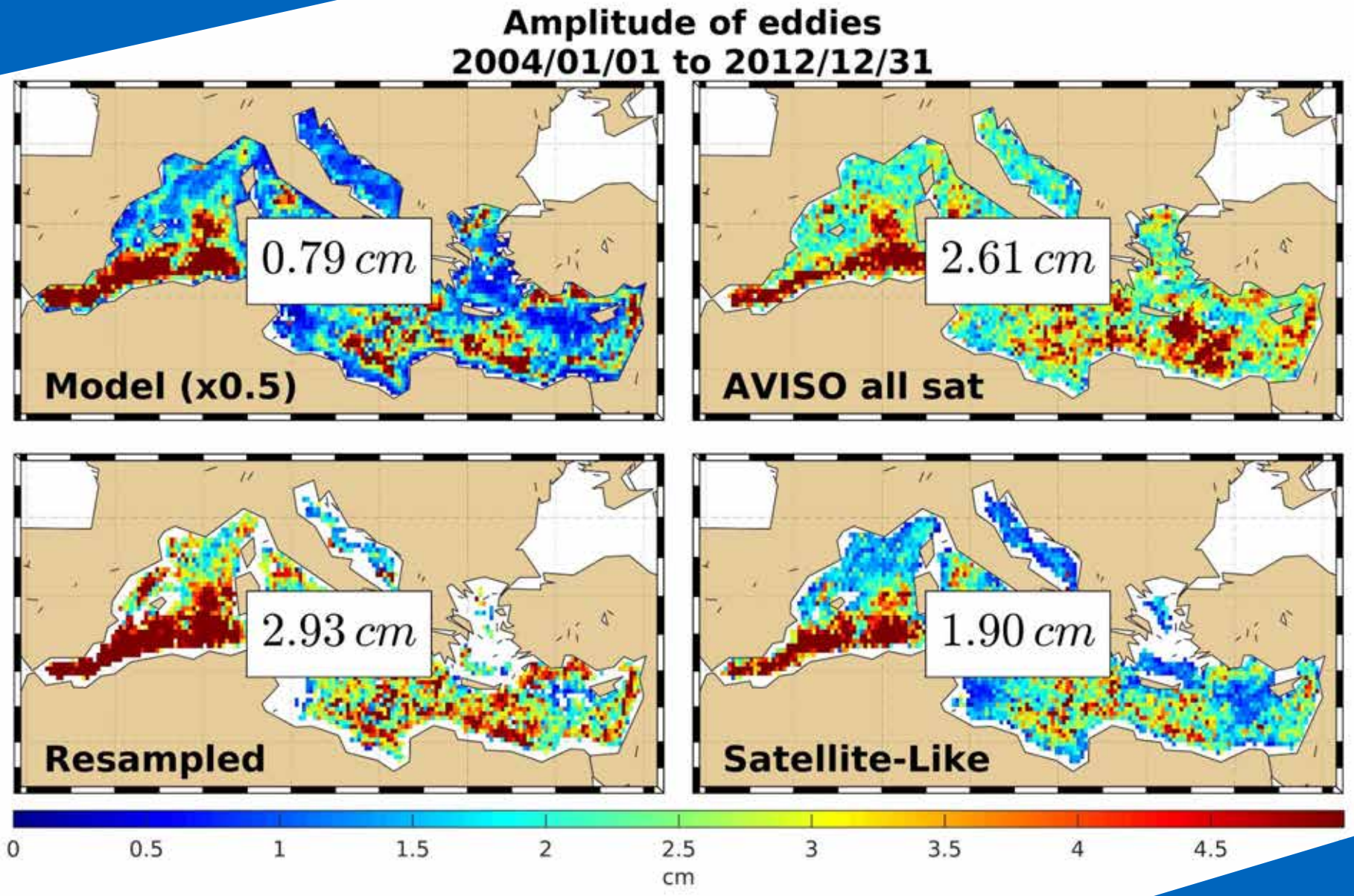

Density of eddy centers
All Sat On Track
All Sat On Gaps
Two Sat On Track
Two Sat On Gaps
centers/(degree^2. day)
Eddy Radius (km)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
40
60
80
100
120
140


Density of eddy centers
centers/(degree^2· day)
of satellites
All Sat On Track
All Sat On Gaps
Two Sat On Track
Two Sat On Gaps
0.5
0.45
0.4
0.35
0.3
0.25
0.2
4
3
2
1
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

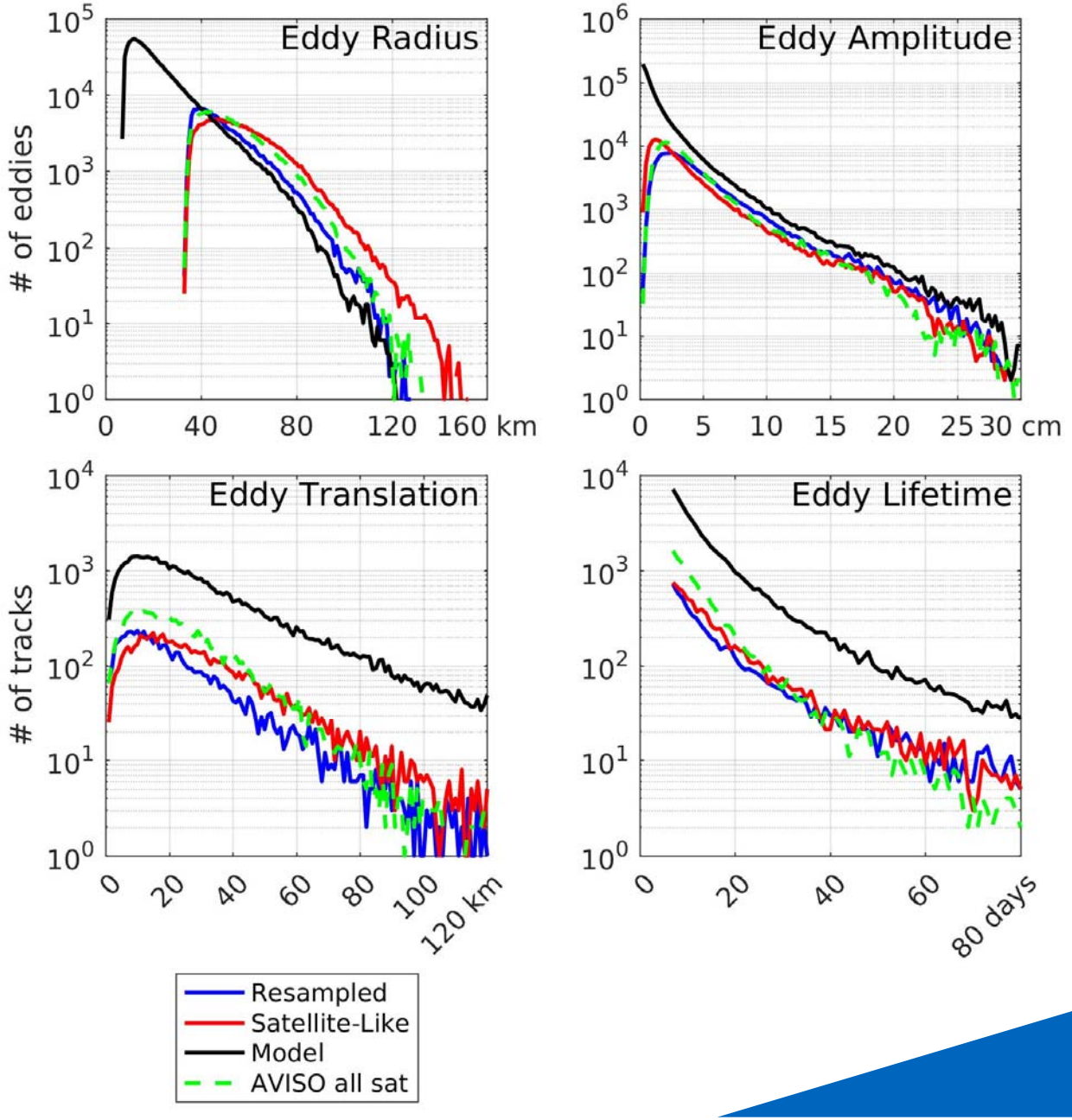
Results


Amplitude of eddies
2004/01/01 to 2012/12/31
Model (x0.5)
AVISO all sat
Resampled
Satellite-Like
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
cm

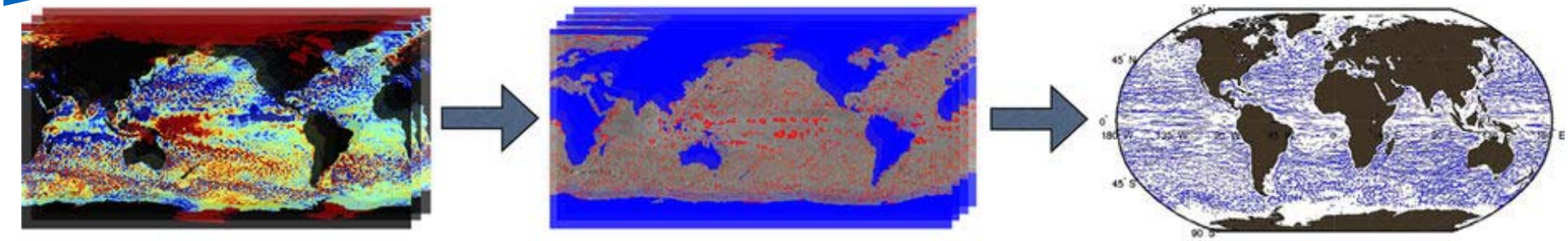
Results

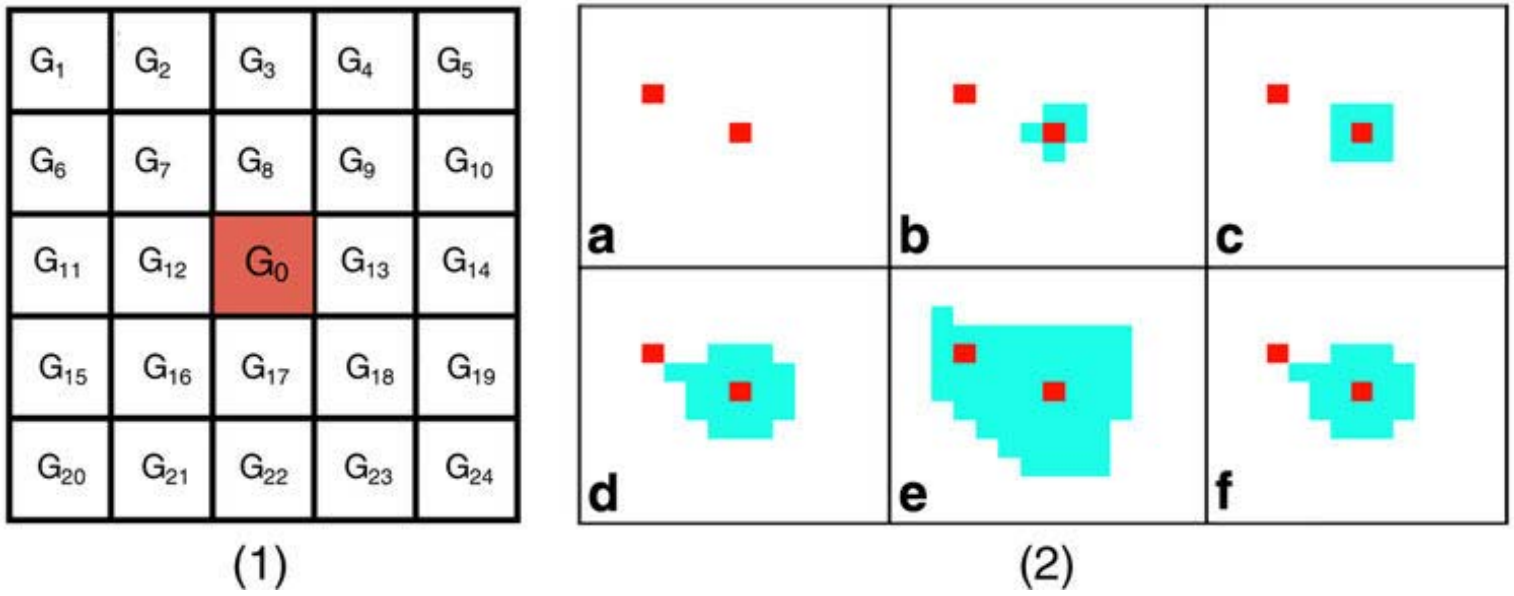

Amplitude of eddies
2004/01/01 to 2012/12/31
0.79 cm
Model (x0.5)
2.61 cm
AVISO all sat
2.93 cm
Resampled
1.90 cm
Satellite-Like
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
cm

Results


Eddy Radius
# of eddies
10^5
10^4
10^3
10^2
10^1
10^0
0
40
80
120
160 km
Eddy Amplitude
10^6
10^5
10^4
10^3
10^2
10^1
10^0
0
5
10
15
20
25 30 cm
Eddy Translation
# of tracks
10^4
10^3
10^2
10^1
10^0
0
20
40
60
80
100
120 km
Eddy Lifetime
10^4
10^3
10^2
10^1
10^0
0
20
40
60
80 days
Resampled
Satellite-Like
Model
AVISO all sat

Results





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