Mesoscale eddy properties in the Mediterranean sea from high resolution models.

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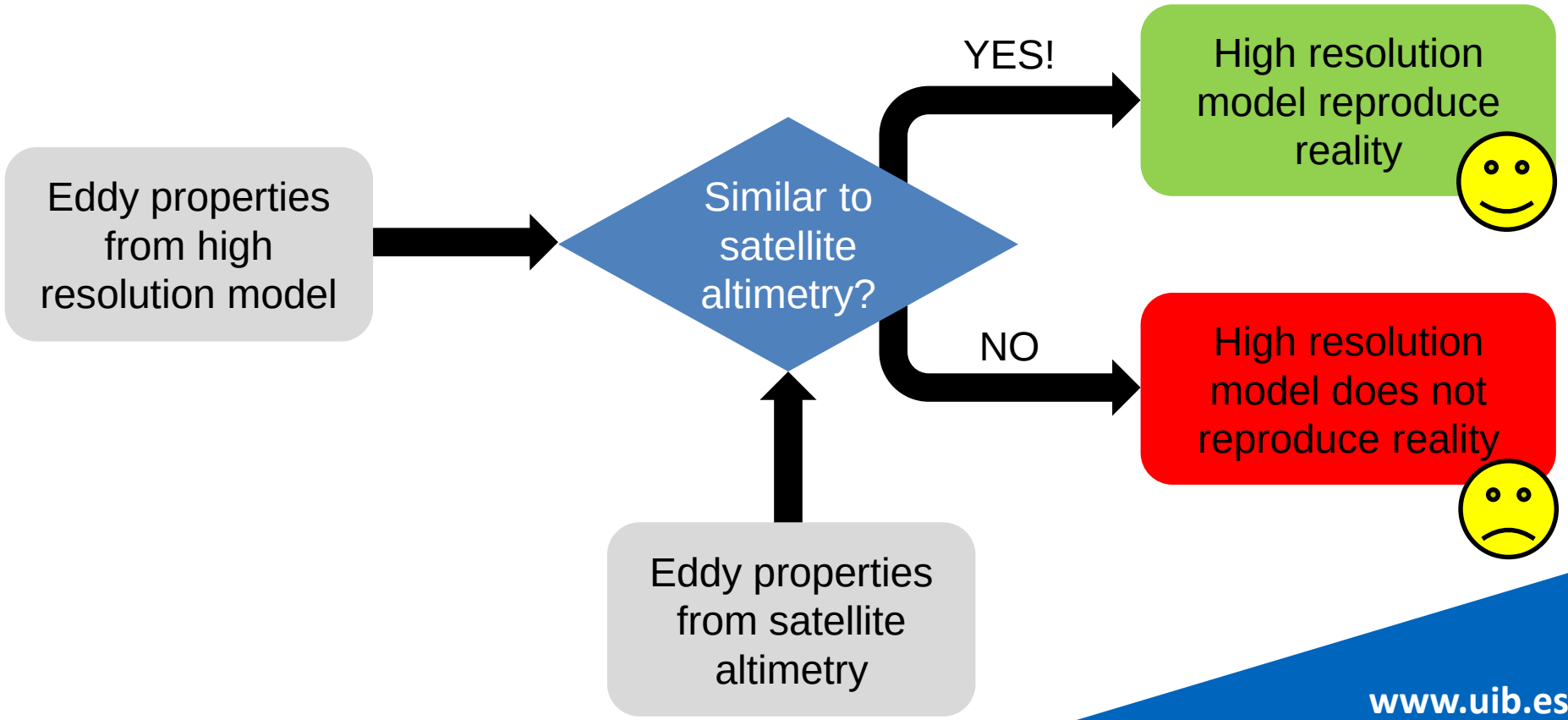
CSIC Consejo Superior de Investigaciones Científicas

Universitat de les Illes Balears

Motivation

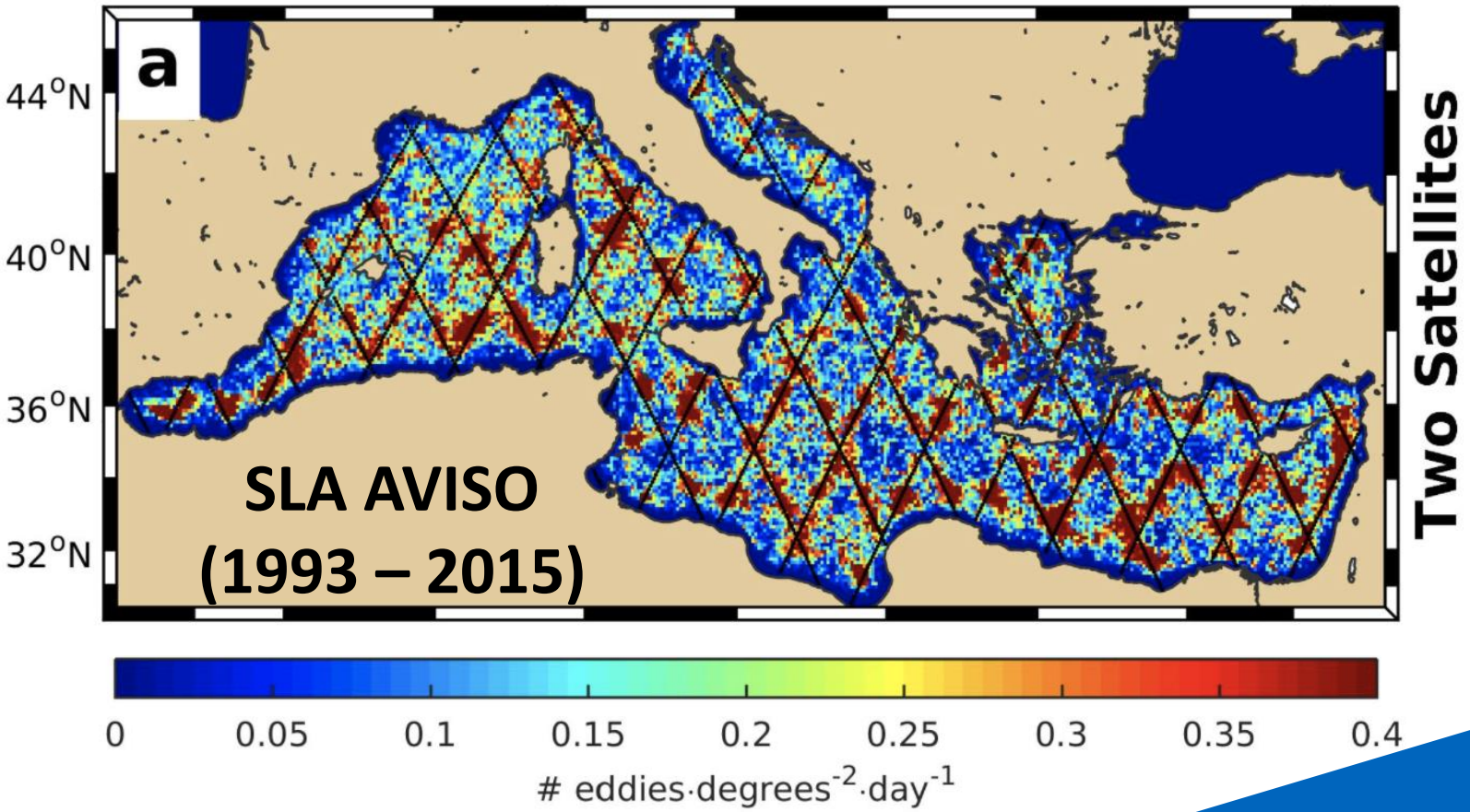
The common approach to assess the capabilities of a model in reproducing mesoscale eddies:



Motivation

However, when computing the # of eddies*…

Mediterranean



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

Motivation

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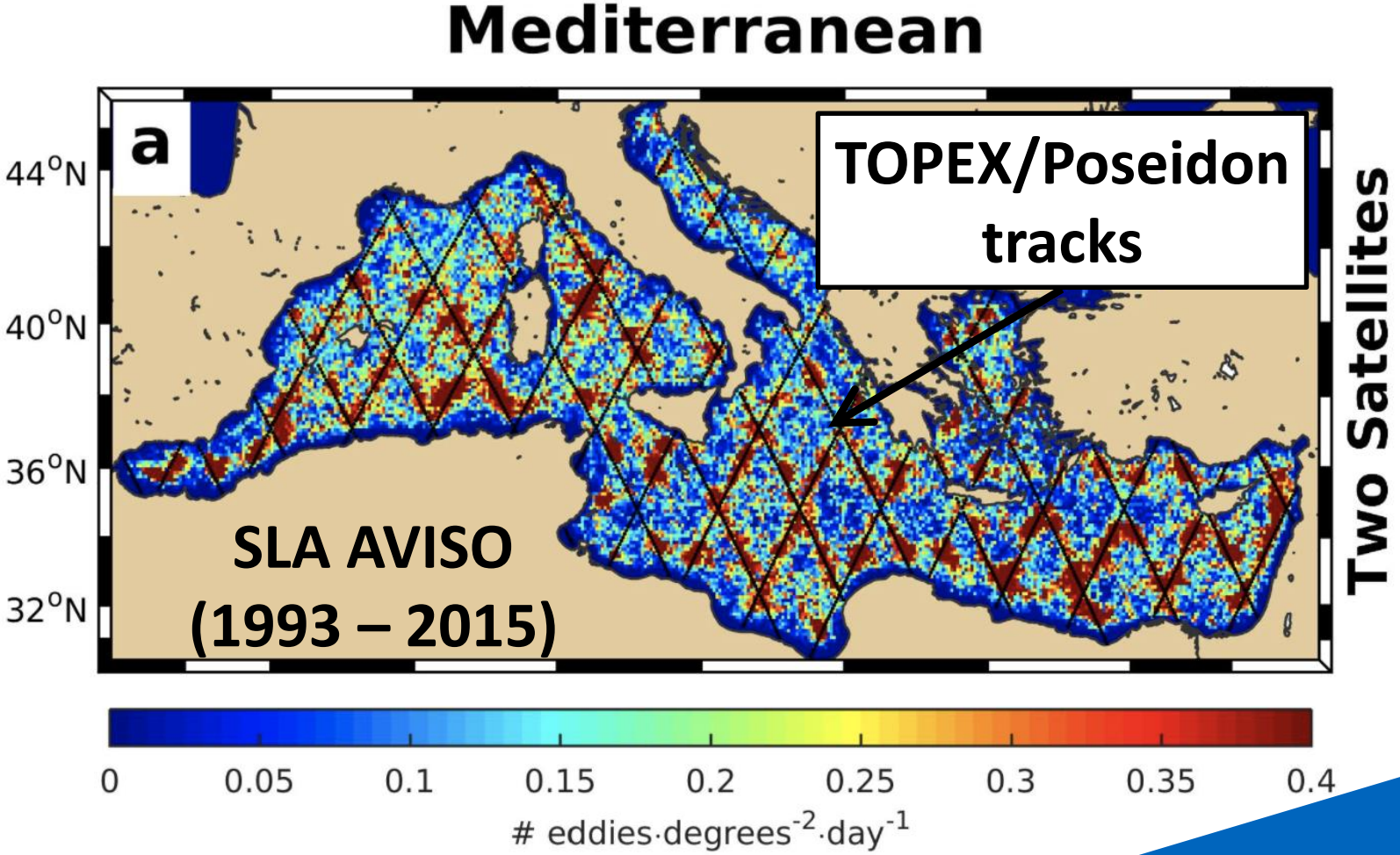

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Motivation

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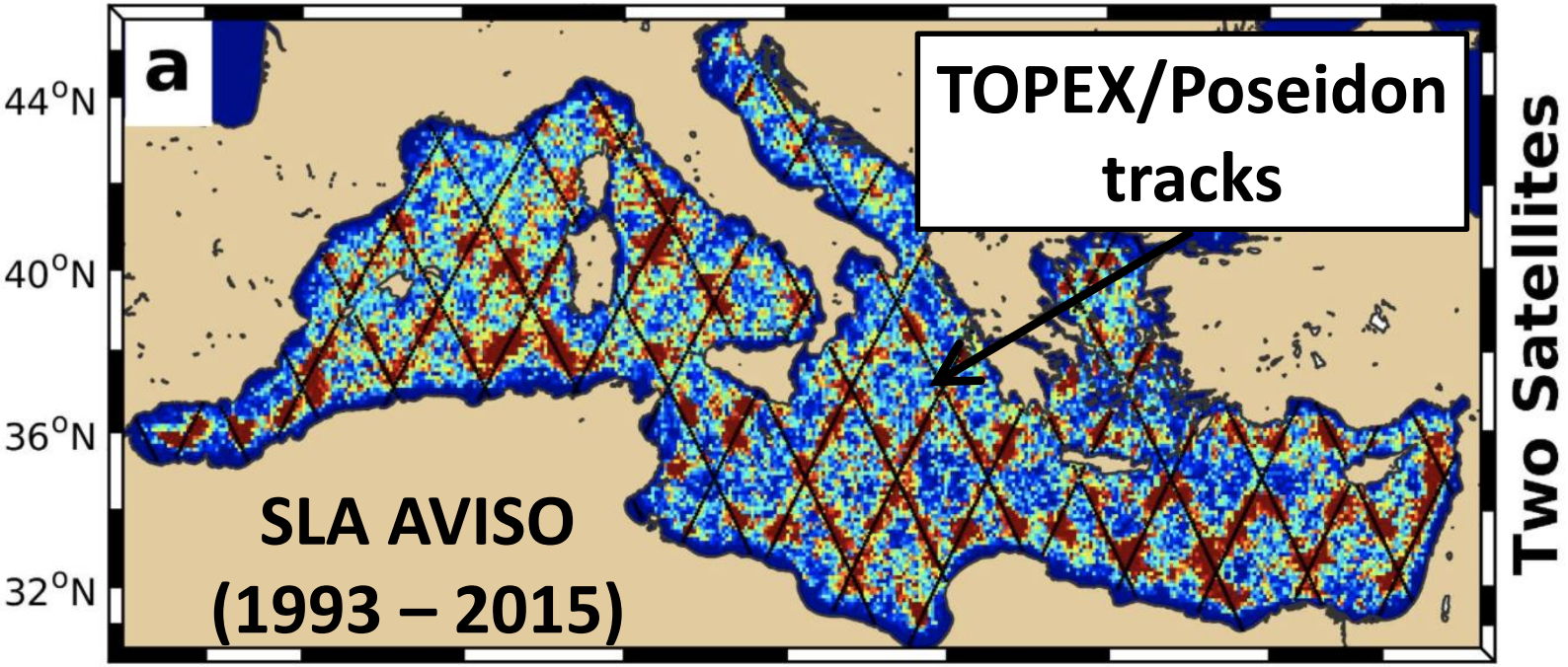
Mediterranean

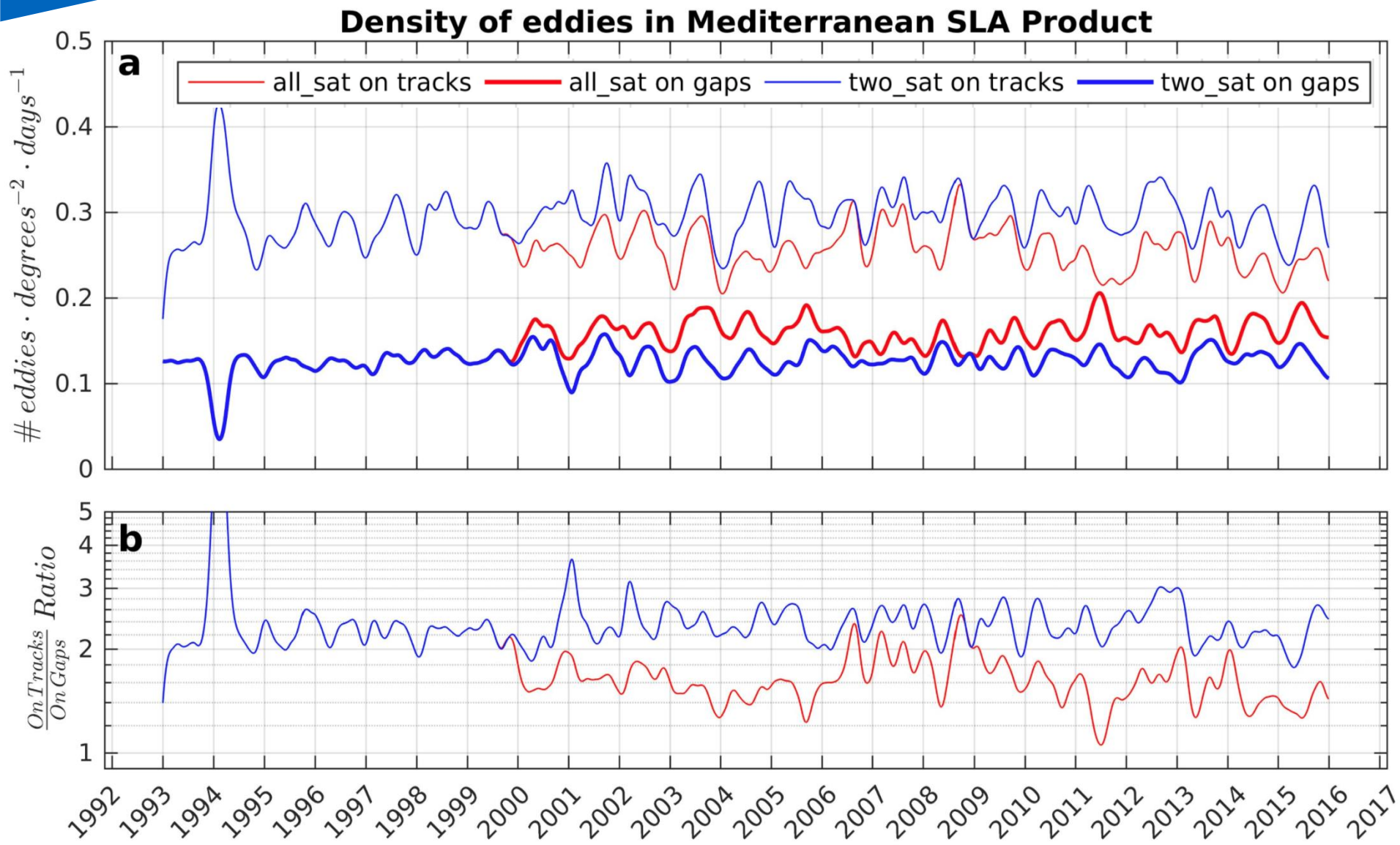


# of eddies along tracks ≃ 2 x # of eddies in gaps

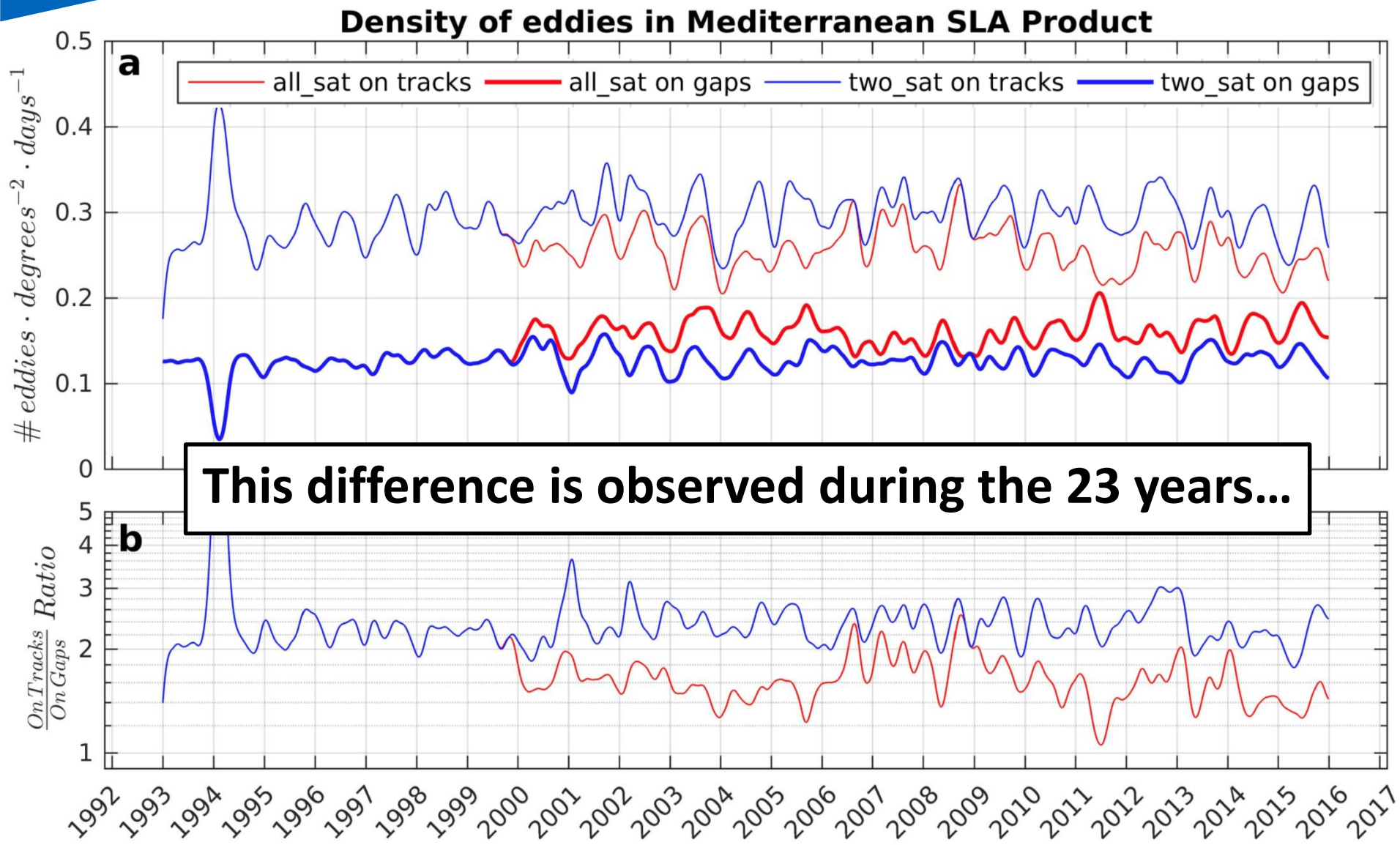
eddies·degrees^{-2}·day^{-1}

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

Motivation

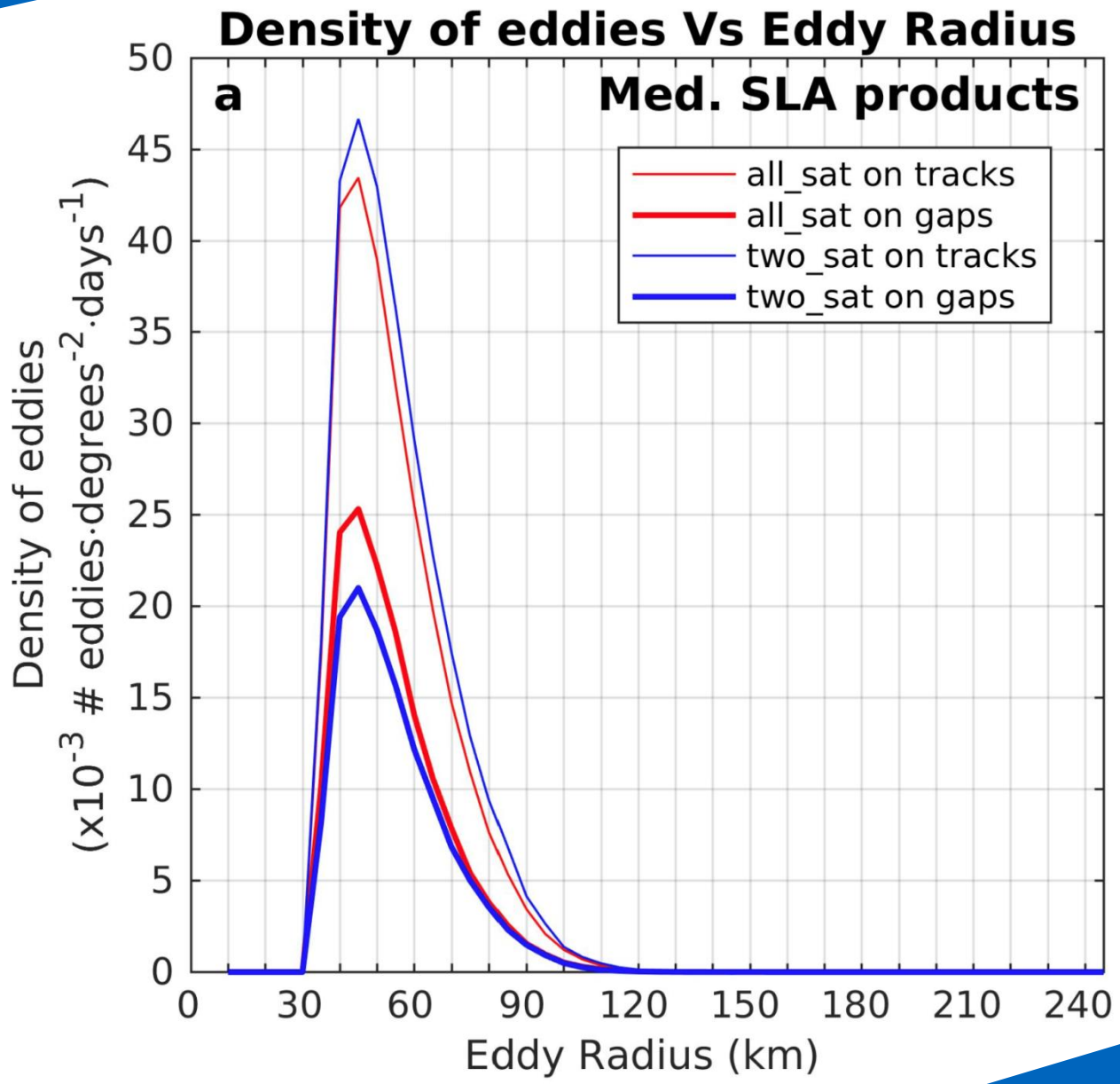

Density of eddies in Mediterranean SLA Product
a
all_sat on tracks
all_sat on gaps
two_sat on tracks
two_sat on gaps
eddies · degrees^{-2} · days^{-1}
0
0.1
0.2
0.3
0.4
0.5
b
$\frac{On\ Tracks}{On\ Gaps}$ Ratio
1
2
3
4
5
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

Motivation

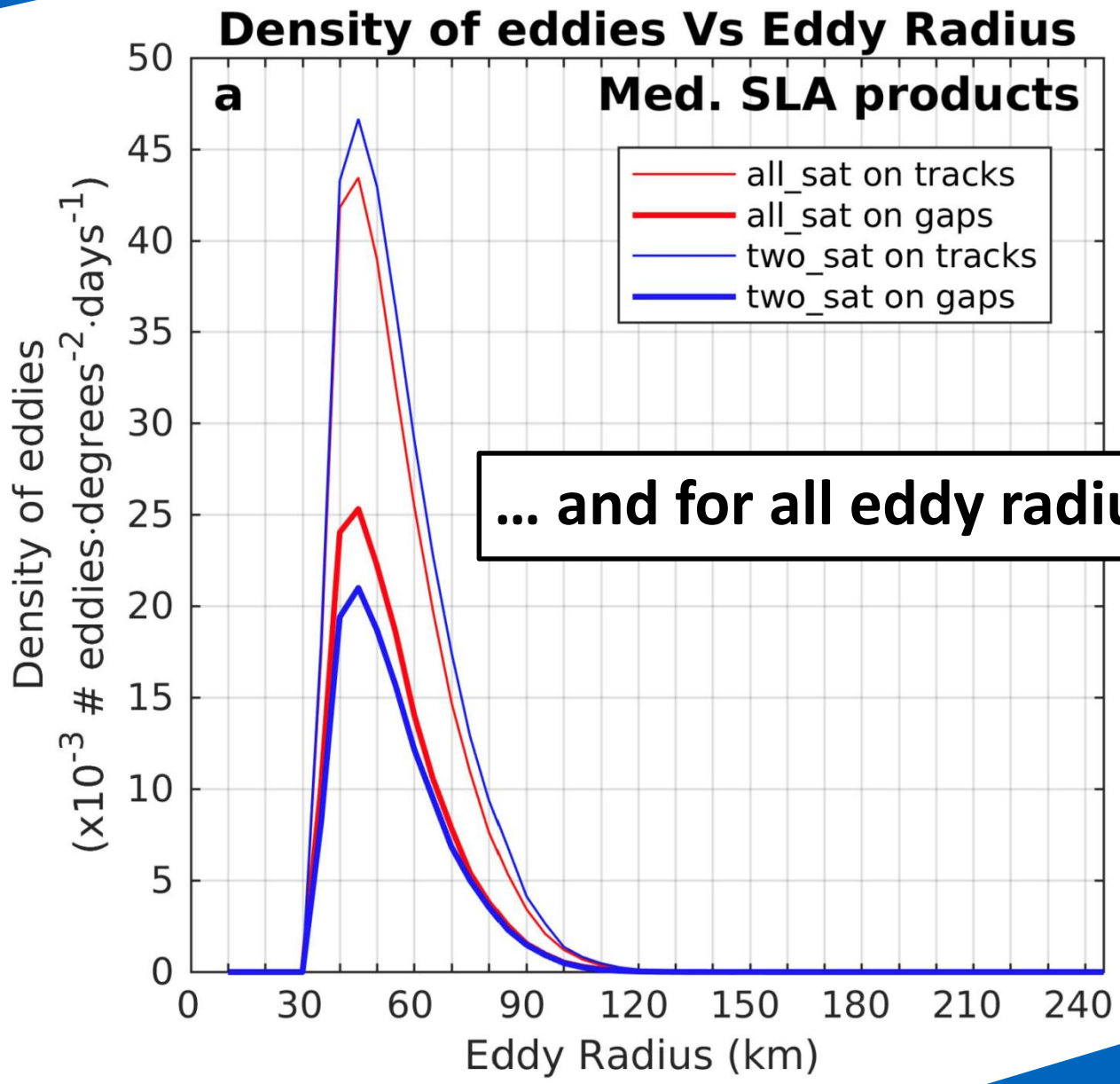


This difference is observed during the 23 years…

Motivation

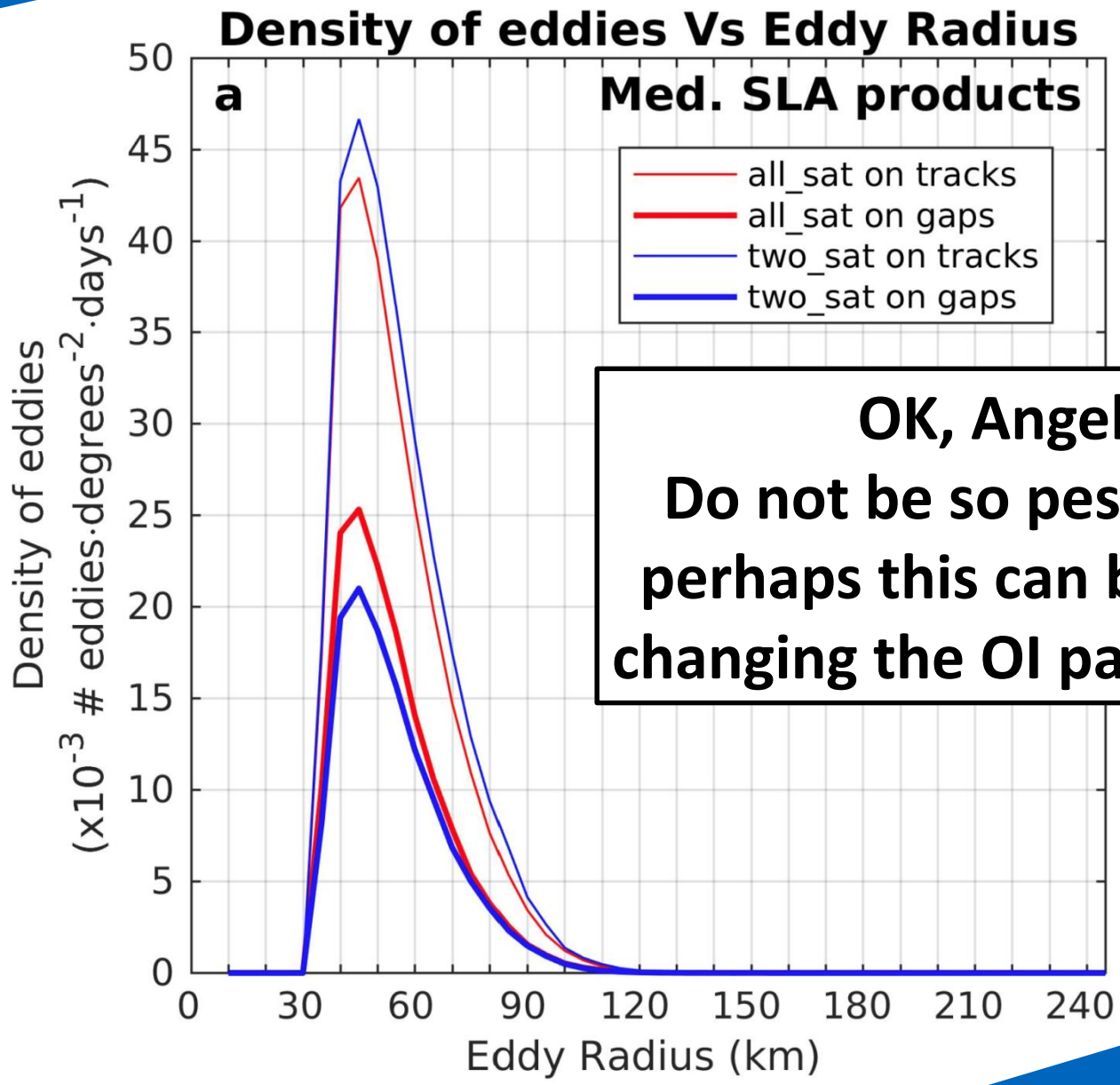

Density of eddies Vs Eddy Radius
a
Med. SLA products
all_sat on tracks
all_sat on gaps
two_sat on tracks
two_sat on gaps
Density of eddies
(x10-3 # eddies·degrees-2.days-1)
Eddy Radius (km)
0
5
10
15
20
25
30
35
40
45
50
0
30
60
90
120
150
180
210
240

Motivation



… and for all eddy radius!

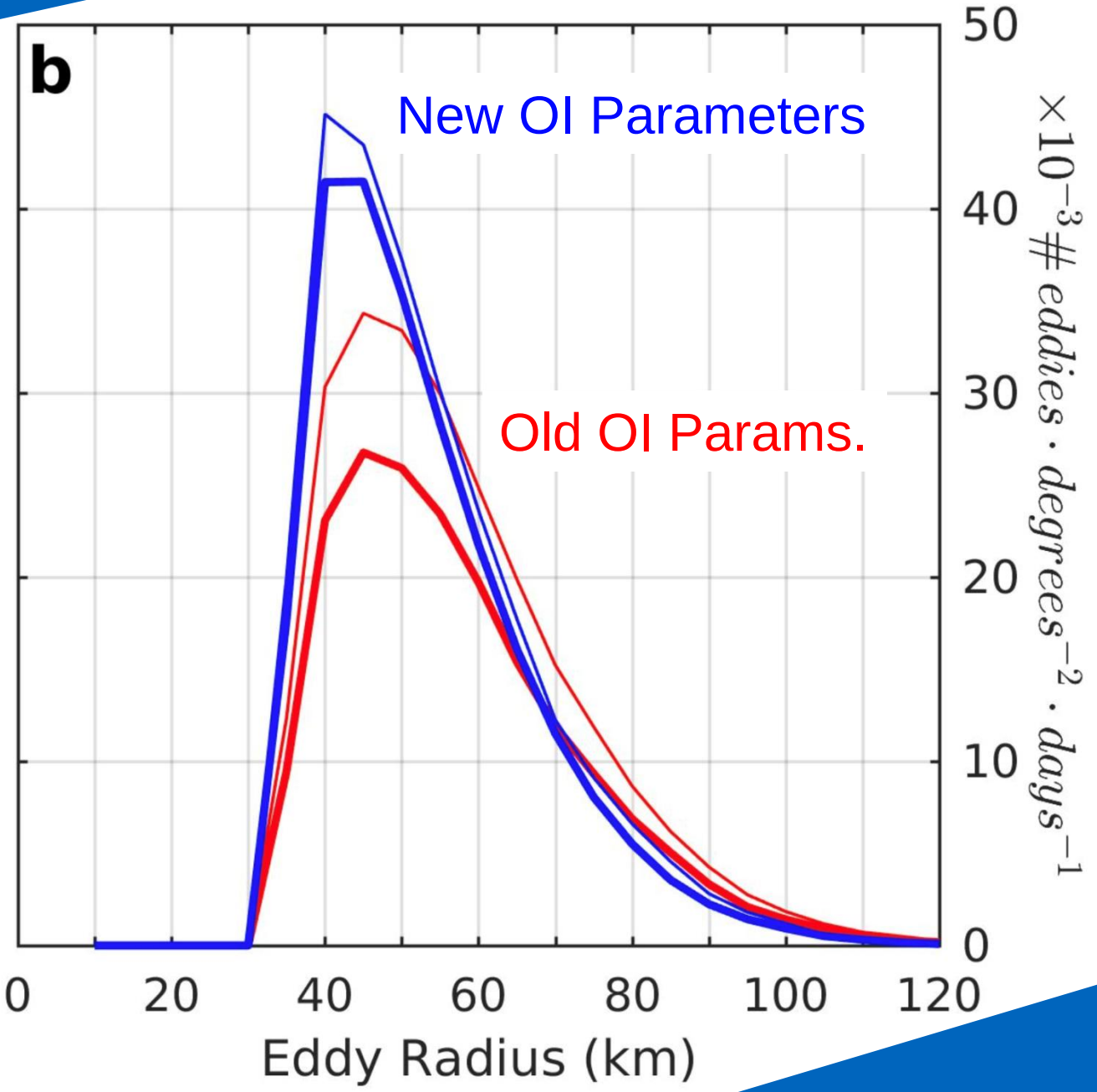
Motivation



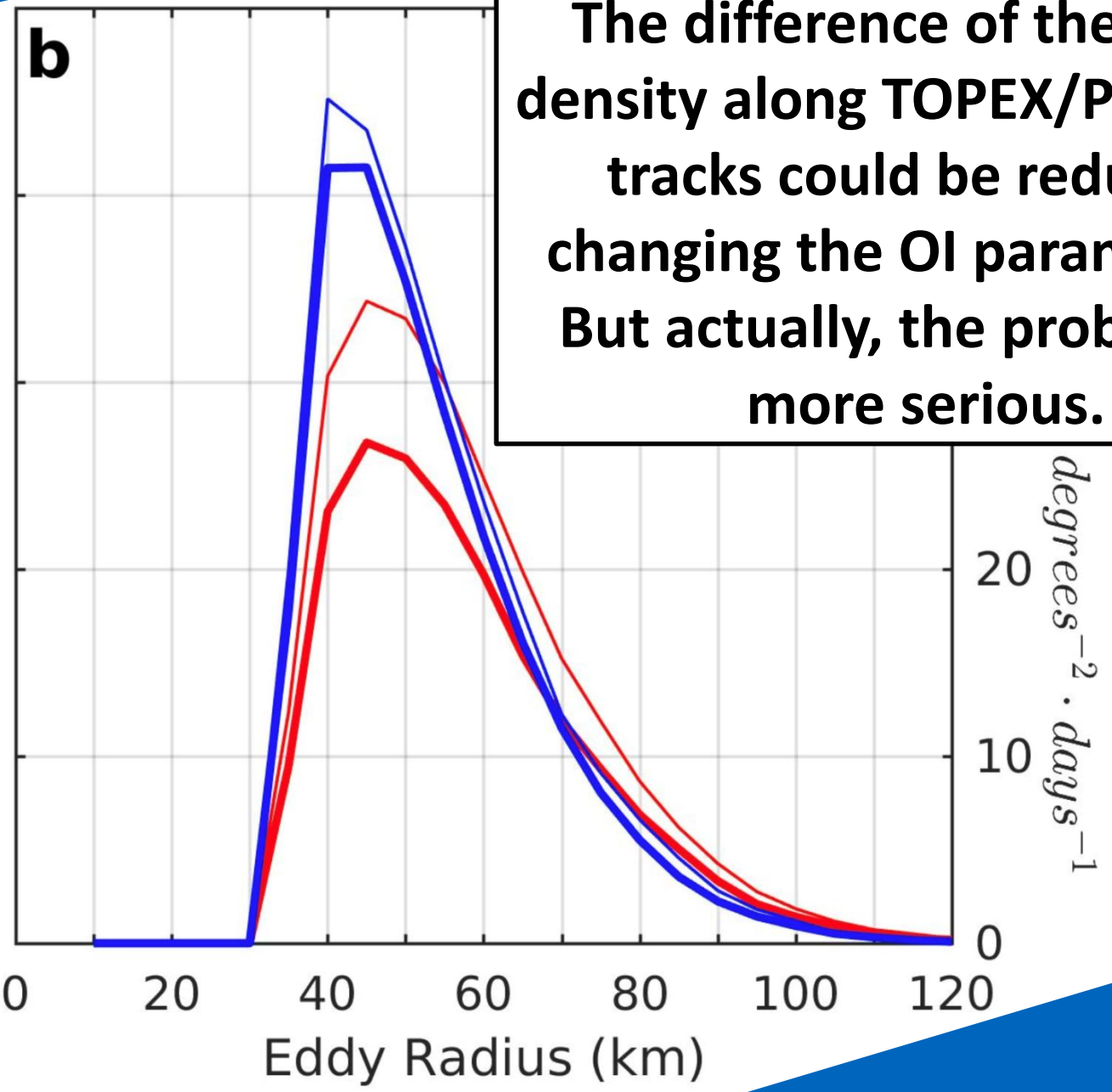
OK, Angel!

Do not be so pessimistic, perhaps this can be solved changing the OI parameters!

Motivation

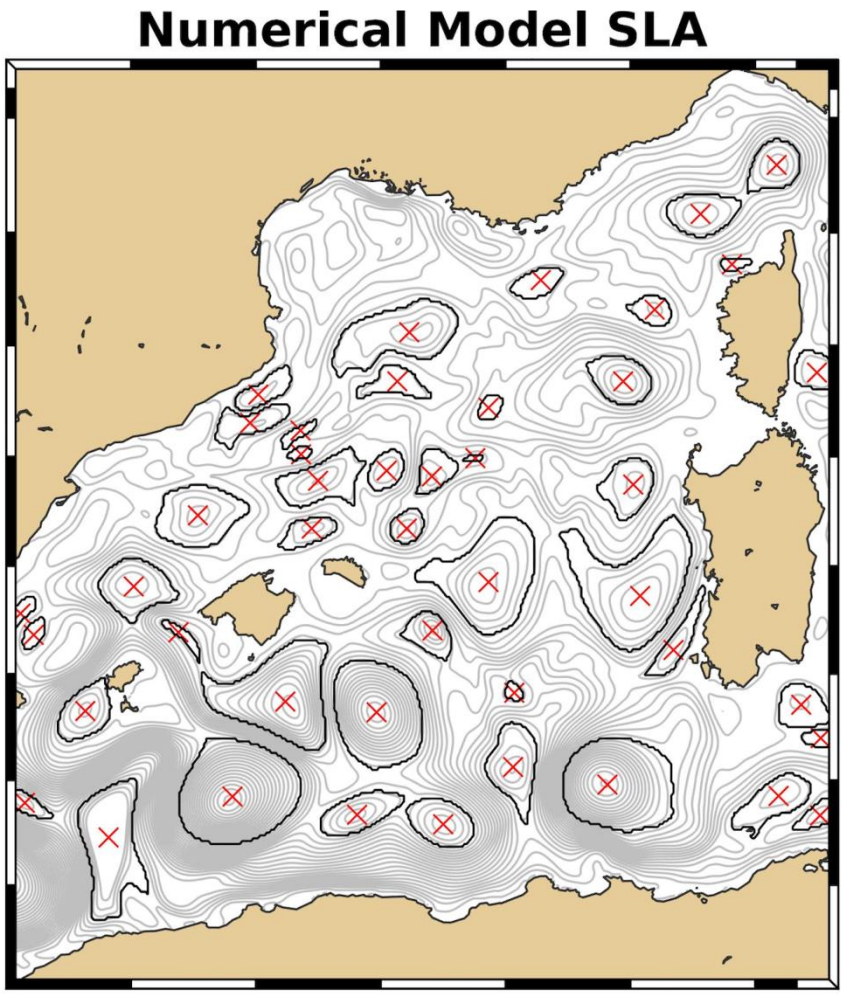

b
New OI Parameters
Old OI Params.
0
20
40
60
80
100
120
Eddy Radius (km)
0
10
20
30
40
50
$\times 10^{-3}\, \#\, eddies \cdot degrees^{-2} \cdot days^{-1}$

Motivation

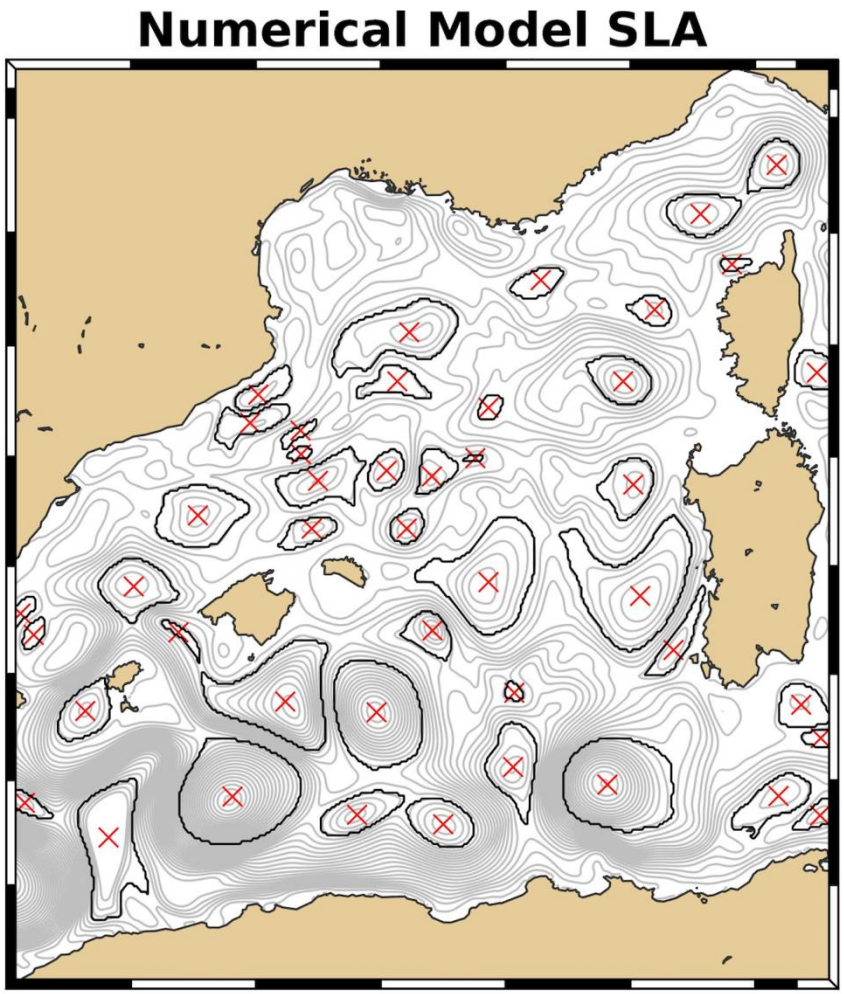


The difference of the eddy density along TOPEX/Poseidon tracks could be reduced changing the OI parameters. But actually, the problem is more serious.

Motivation

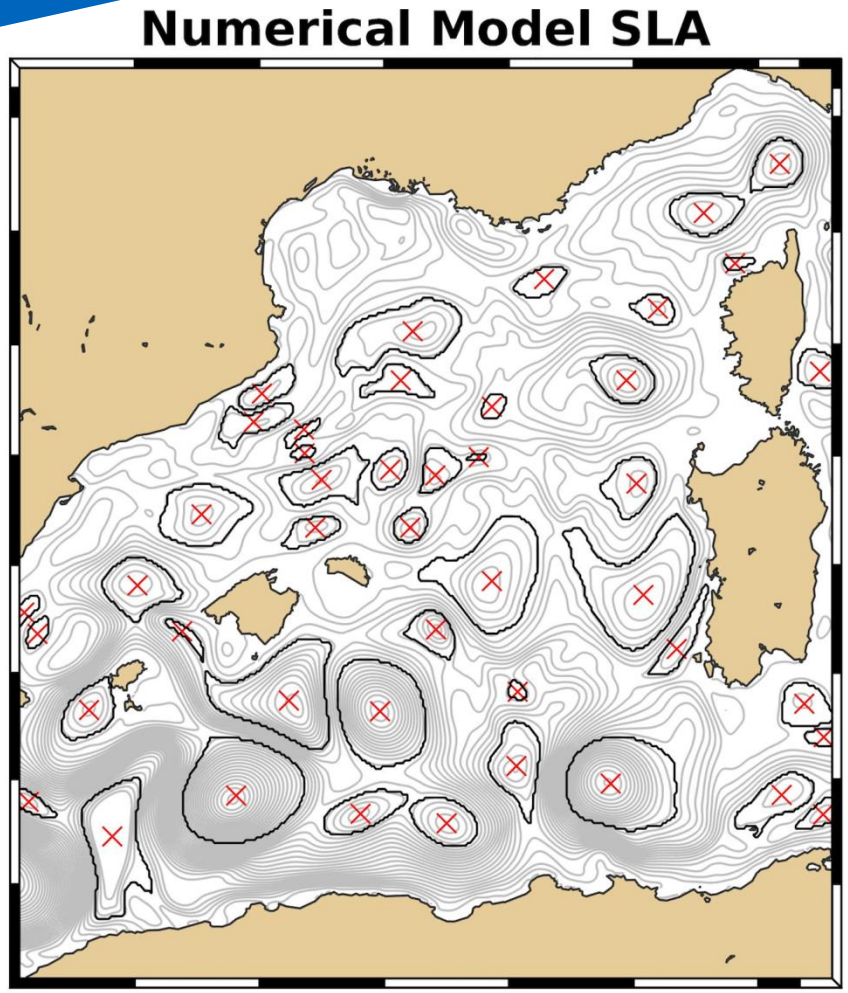


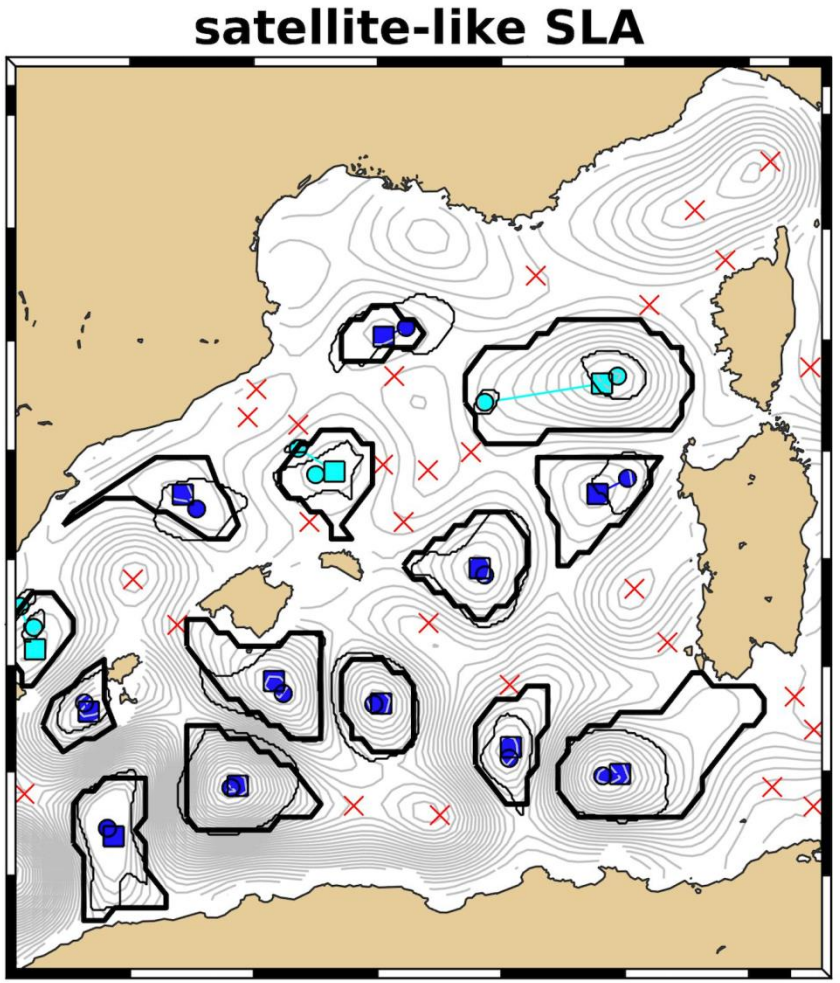
Motivation



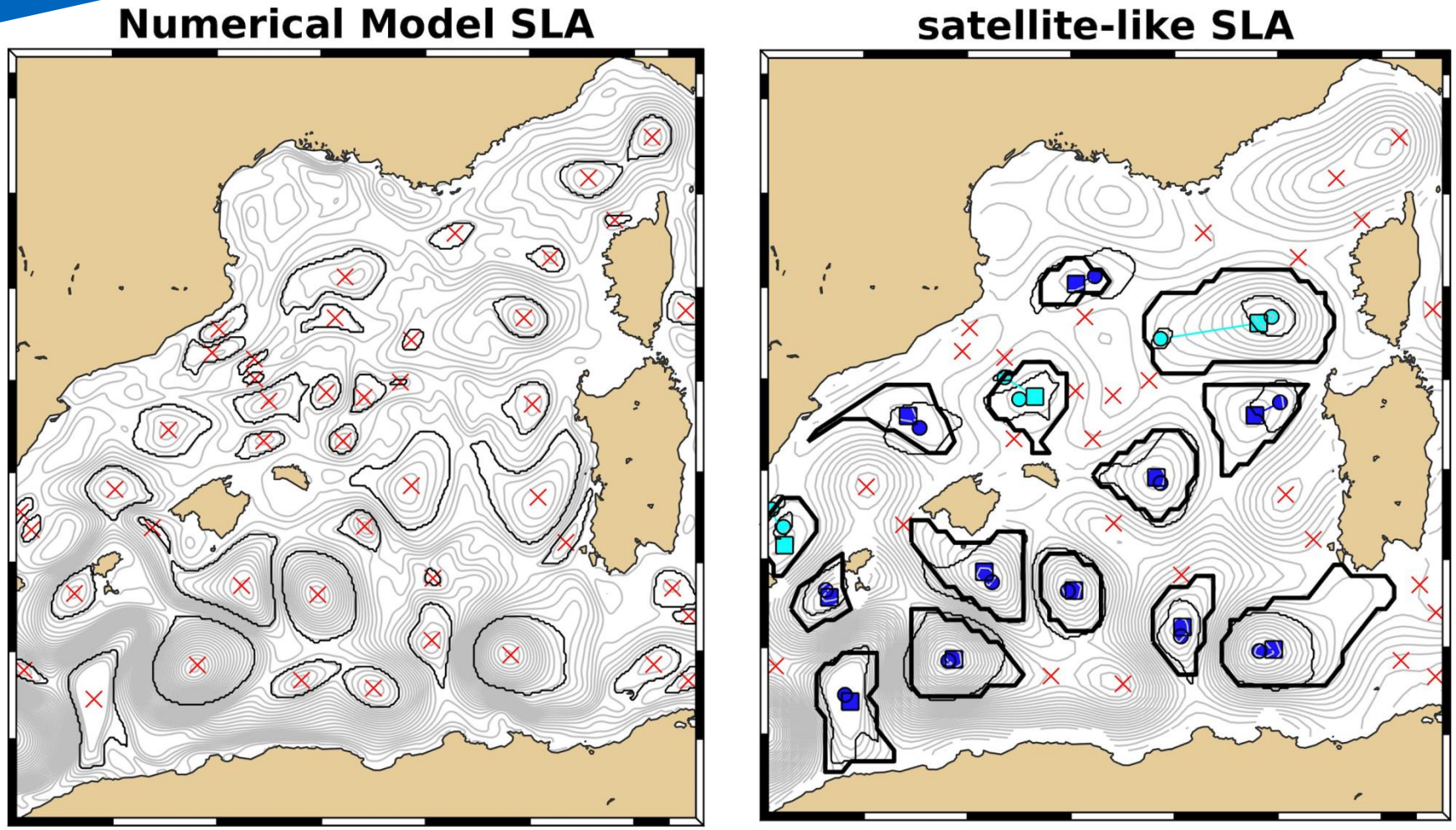
1) Extract satellite tracks.
2) Apply OI algorithm on the AVISO grid points

Motivation





Motivation



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

Angel Amores and Gabriel Jordà

Mon, 09 Apr, 13:30–13:45, Room 1.85

Approach

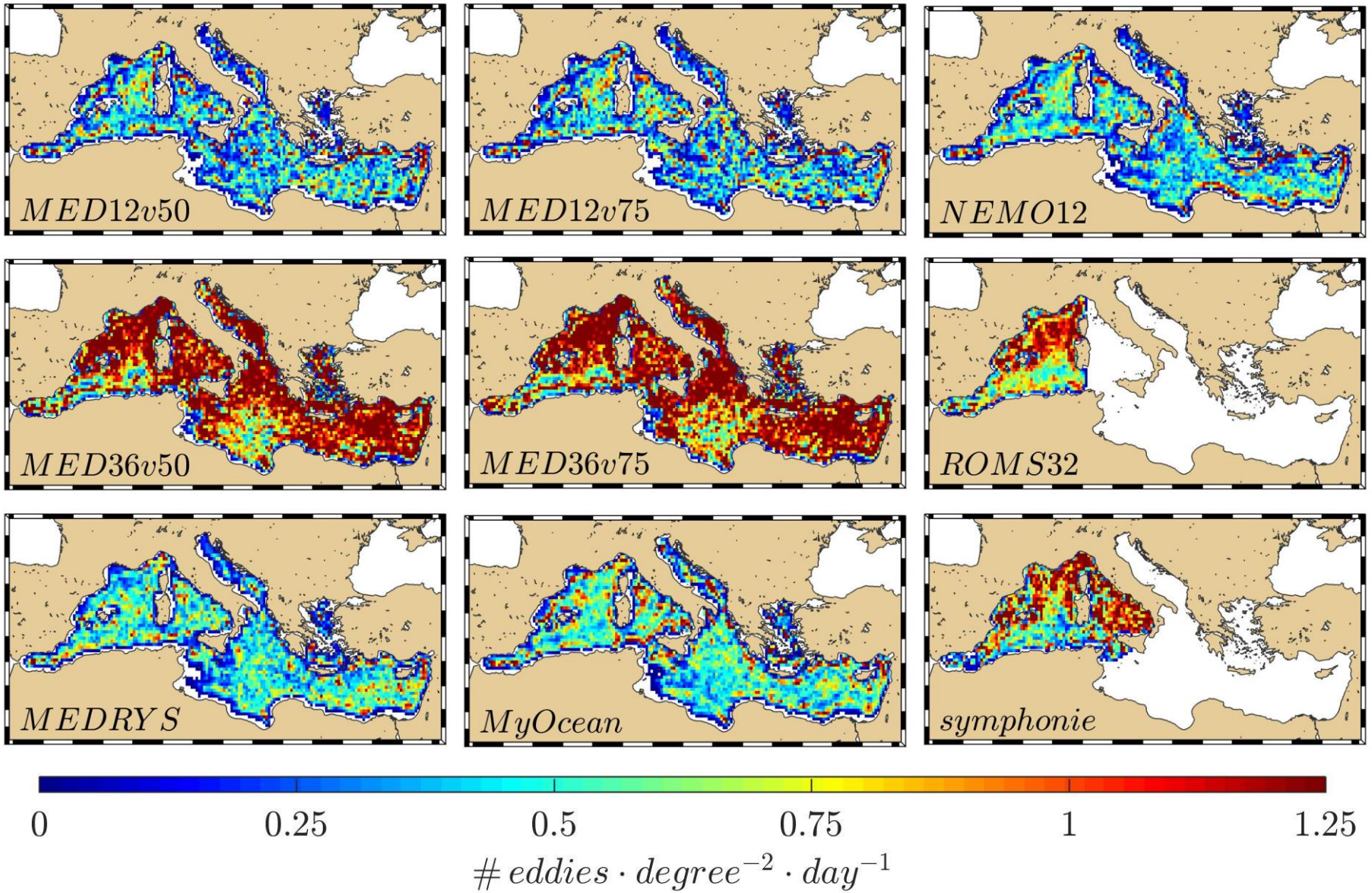
→ Eddy properties from satellite observations are not reliable.

→ We analyze the **eddy properties from an ensemble of 9 high resolution numerical simulations** to determine the role of:

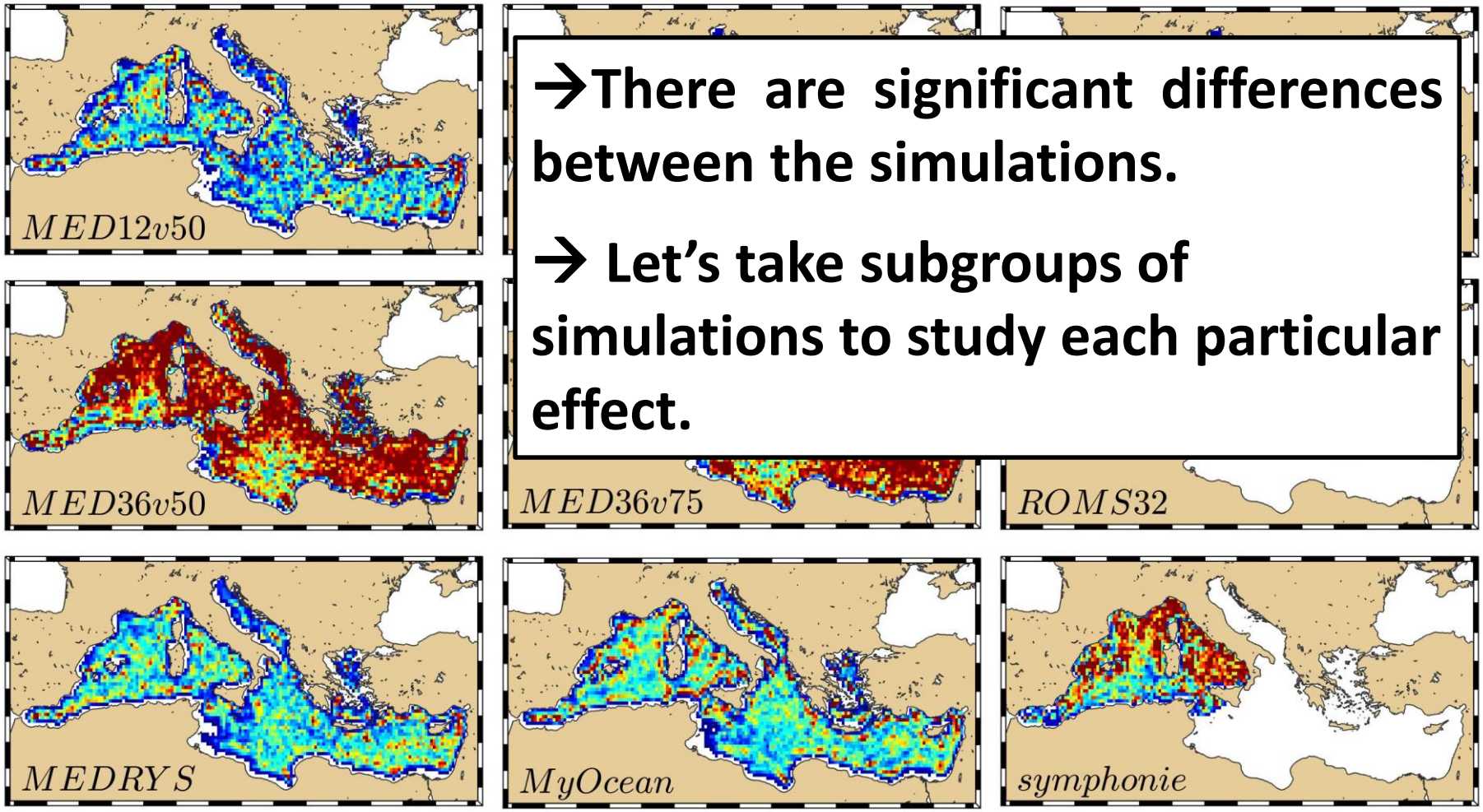
- Horizontal resolution.
- Vertical resolution.
- Data assimilation.
- …

in defining the eddy properties.

Distribution # of eddies.



Distribution # of eddies.



→There are significant differences between the simulations.

→ Let's take subgroups of simulations to study each particular effect.

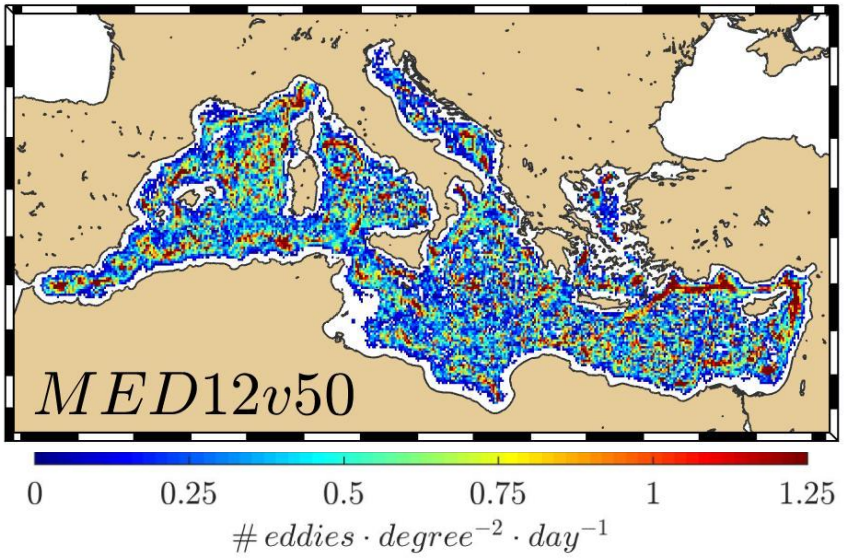
Spatial Resolution

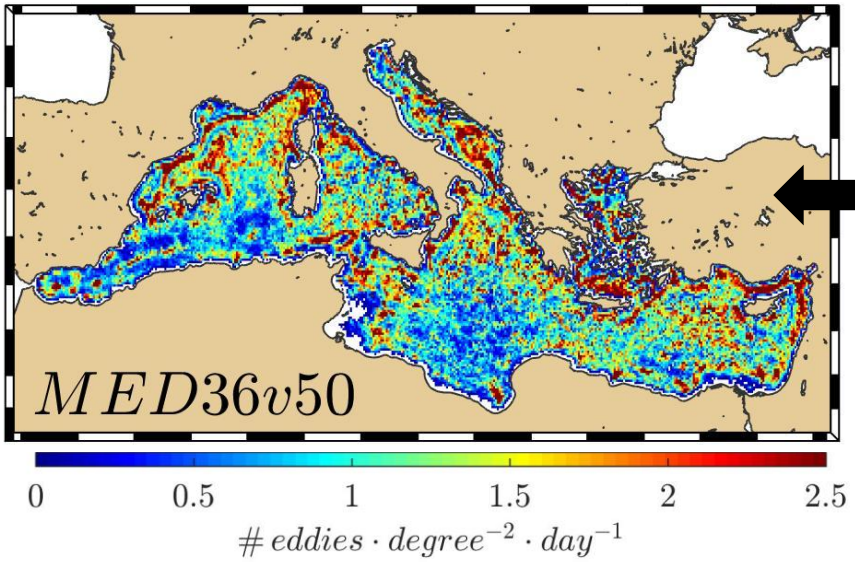
→ 4 different NEMO simulations only modifying **horizontal** and **vertical** resolution:

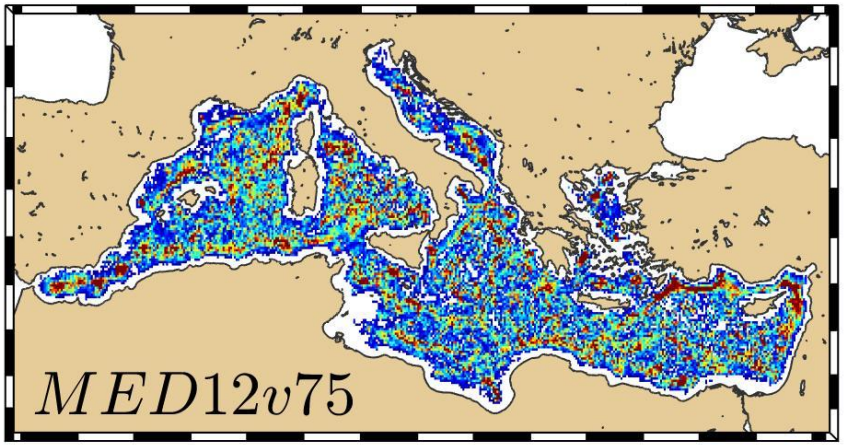
- MED12v50.
- MED12v75.
- MED36v50.
- MED36v75.

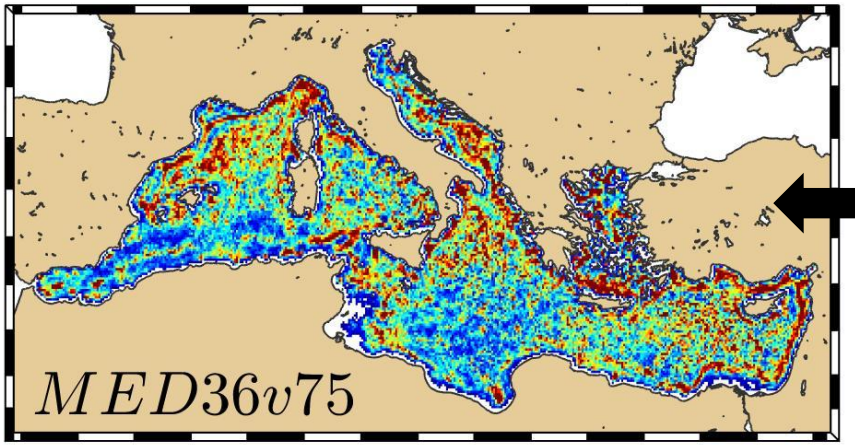
Resolution

of eddies





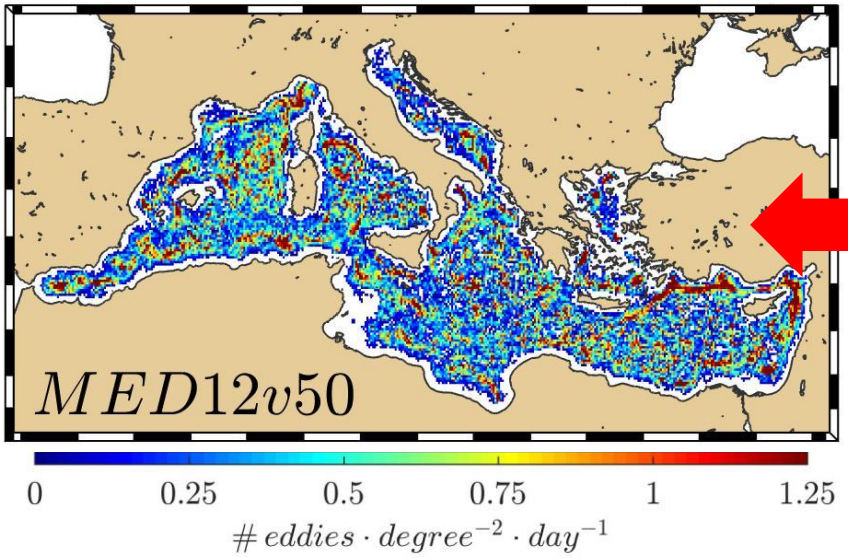


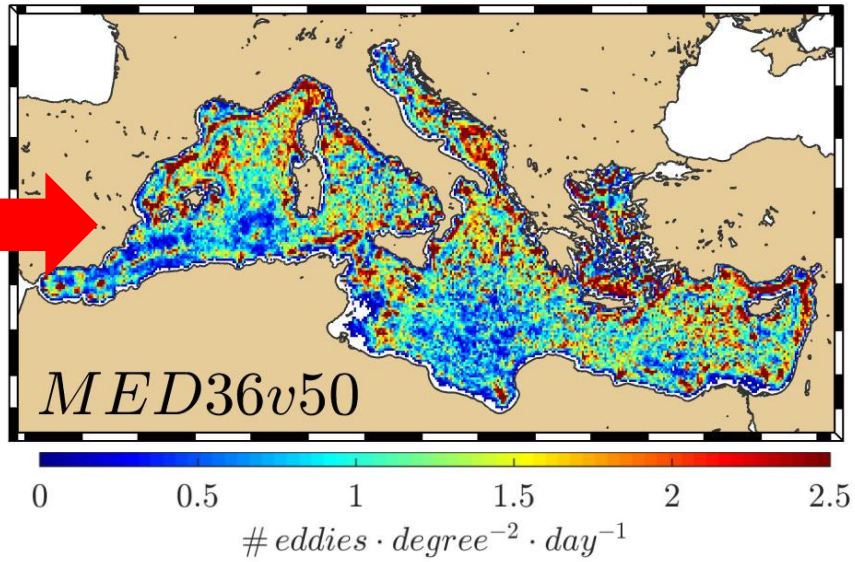


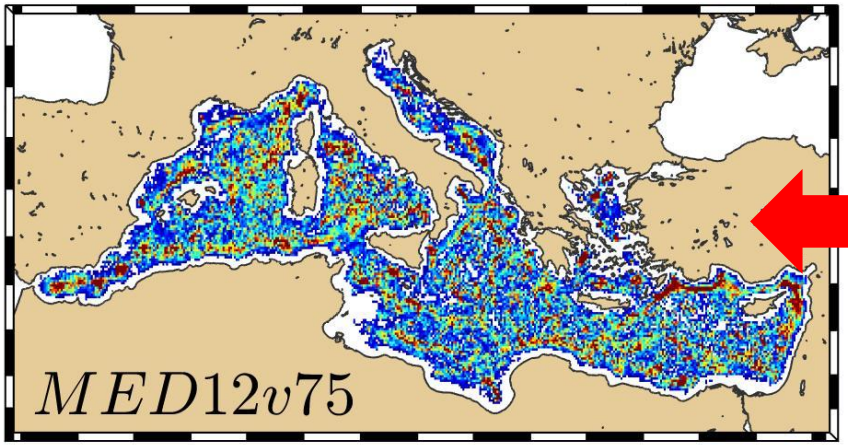
Color scale 2 times larger!!

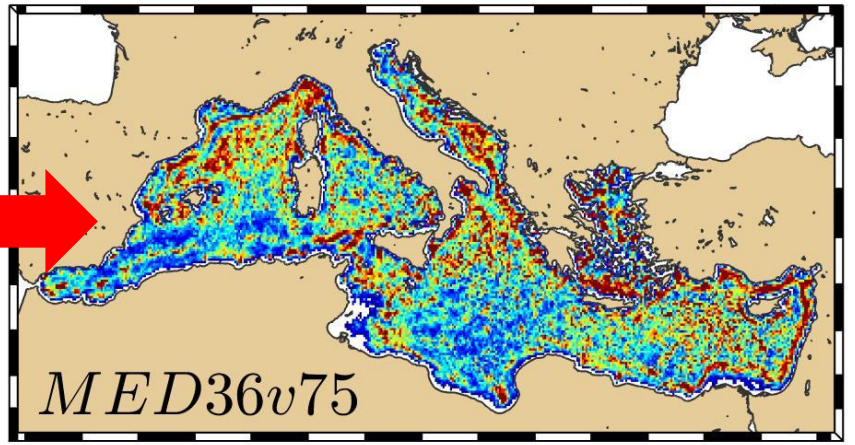
Resolution

of eddies





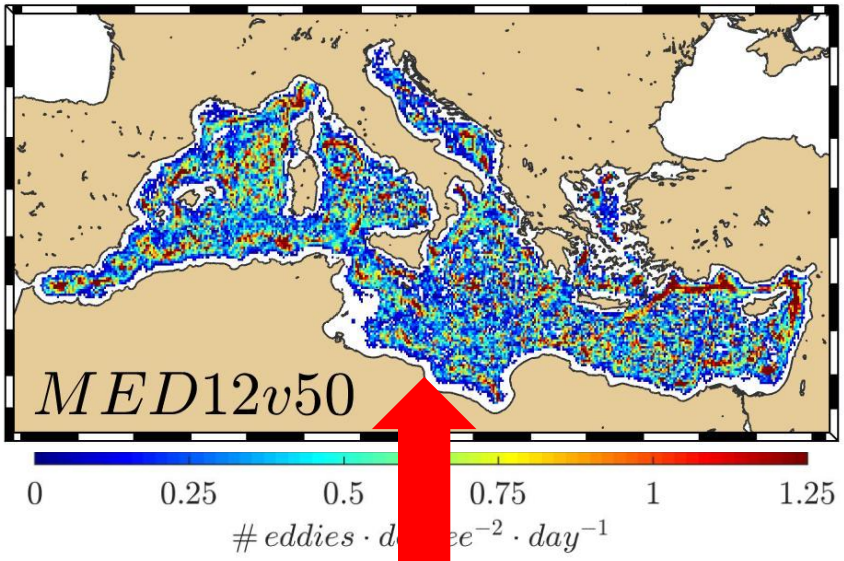


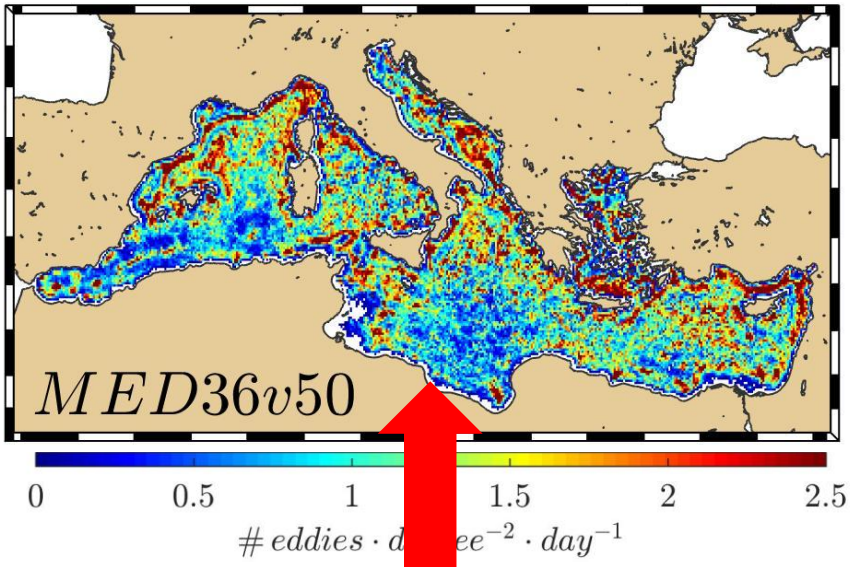


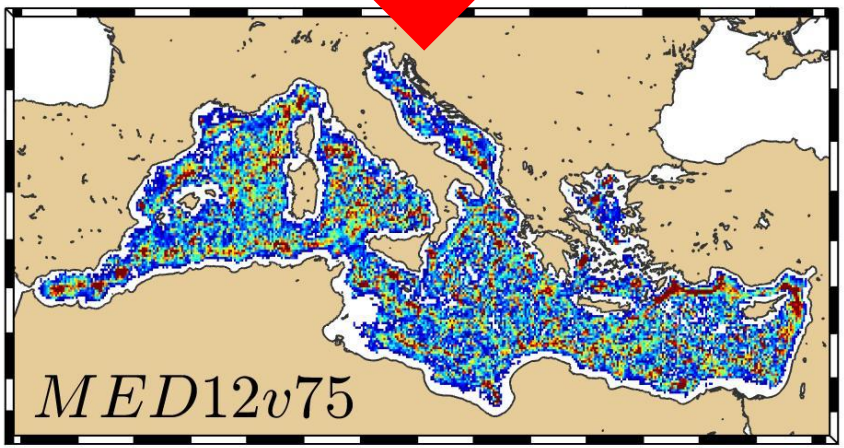
There are differences with the horizontal resolution.

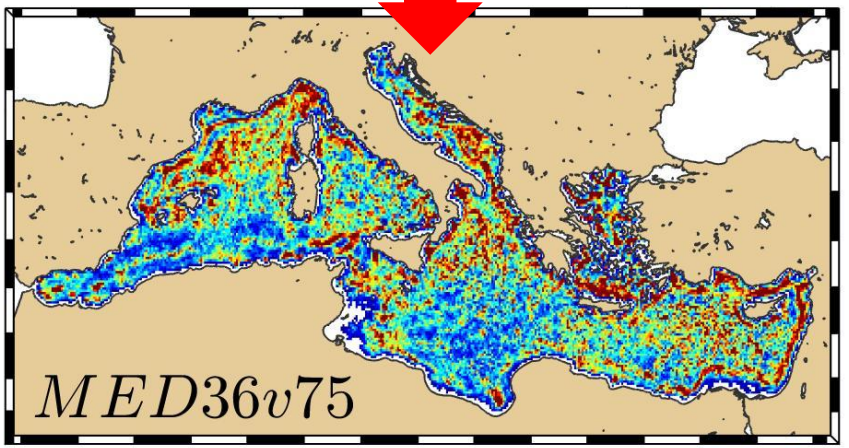
Resolution

of eddies





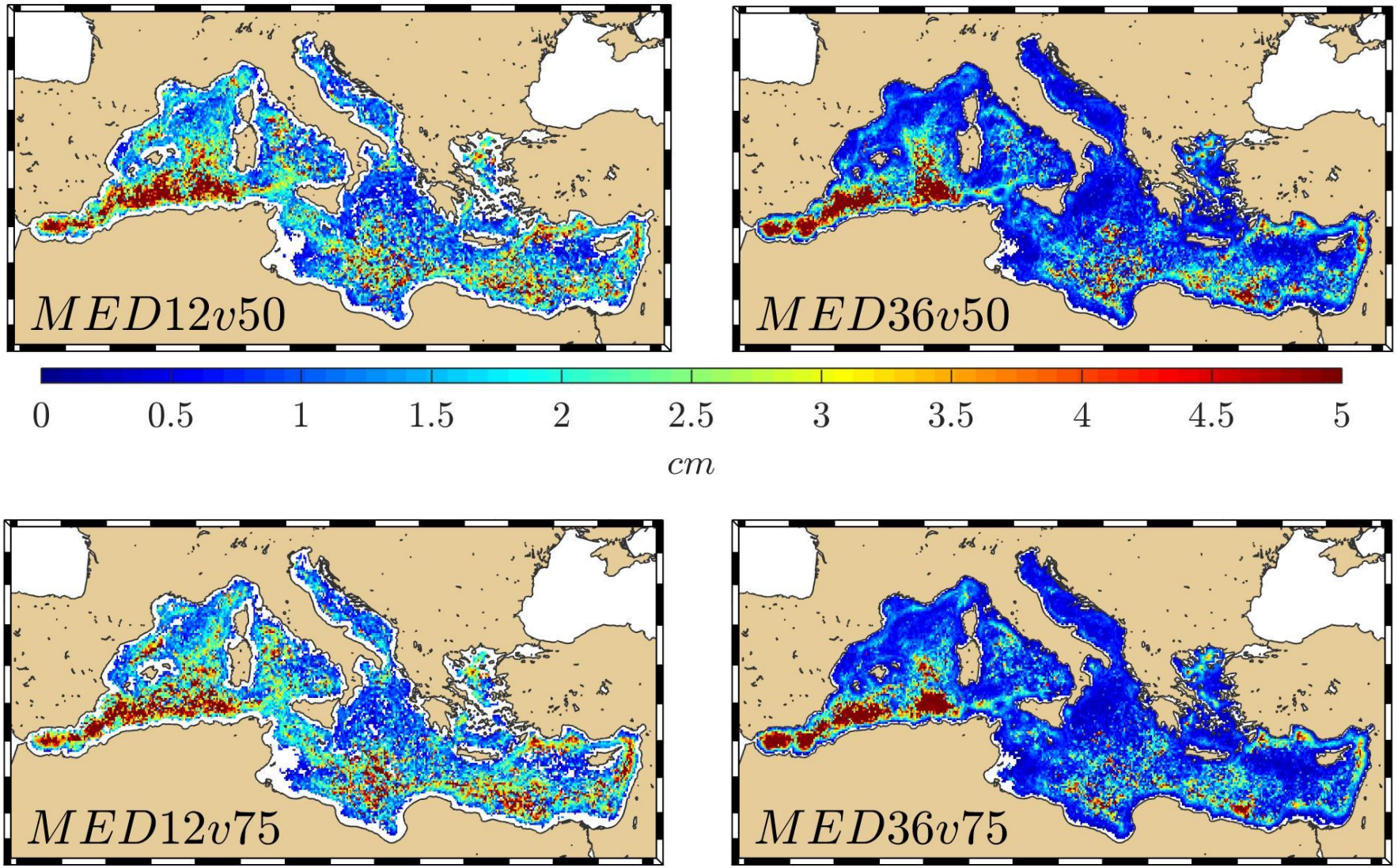




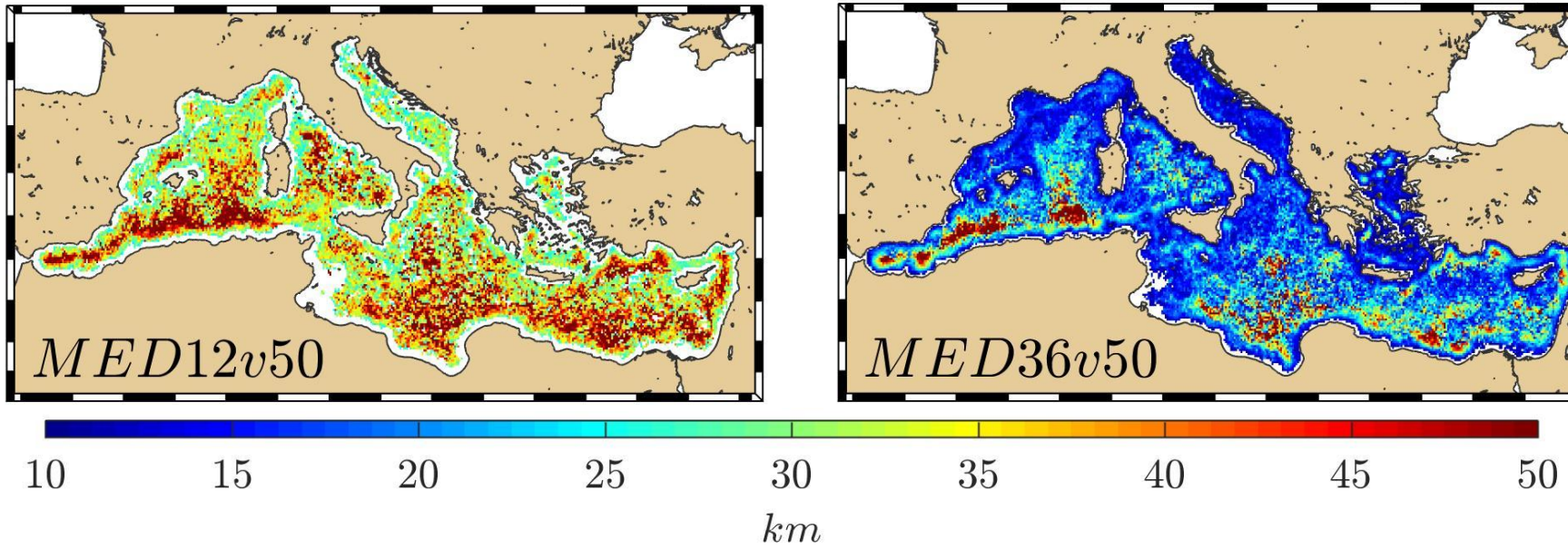
There are “not” differences with the vertical resolution.

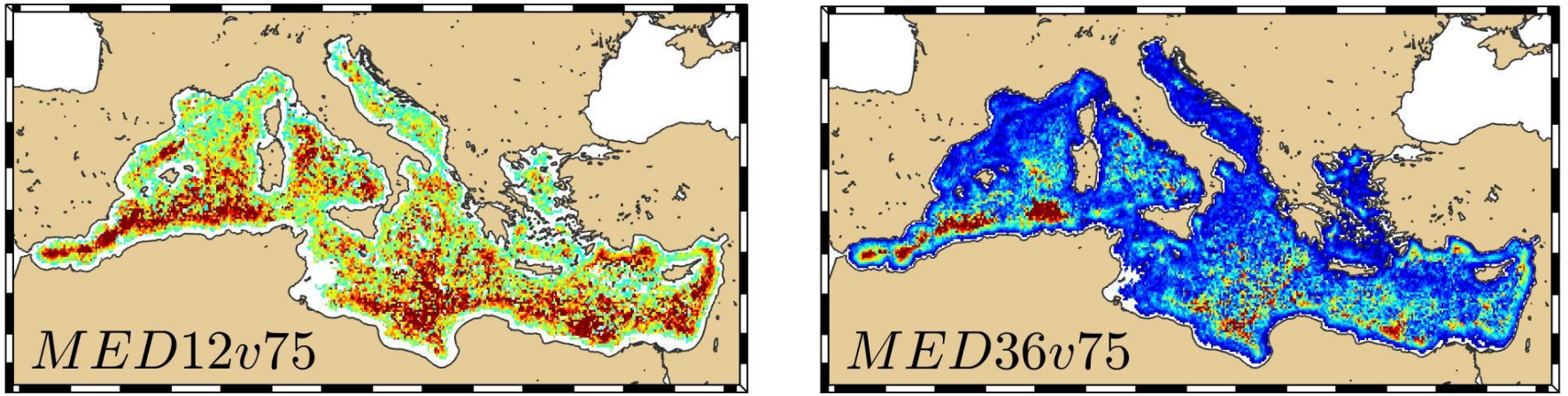
Resolution

Eddy Amplitude

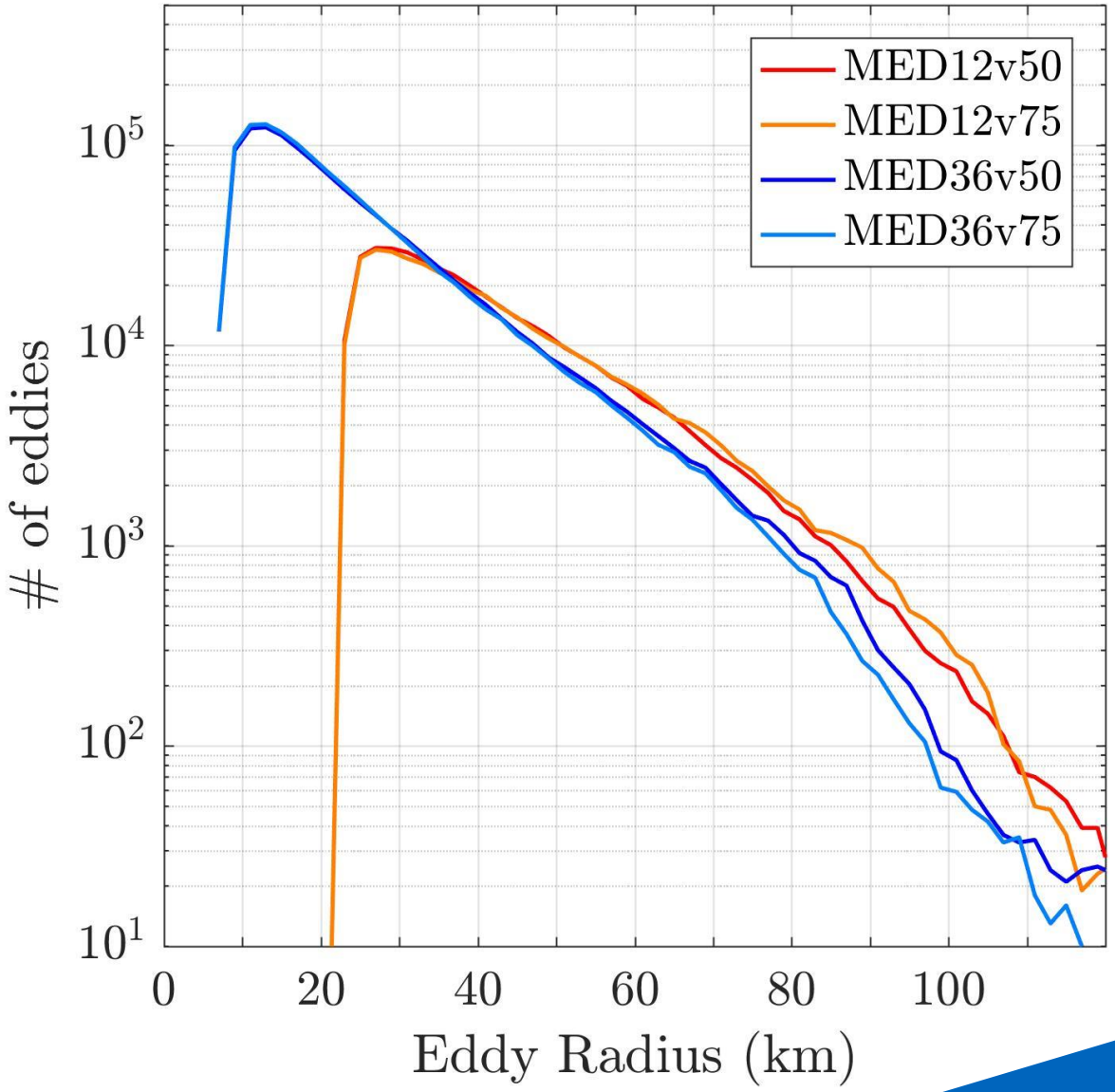


Eddy Radius

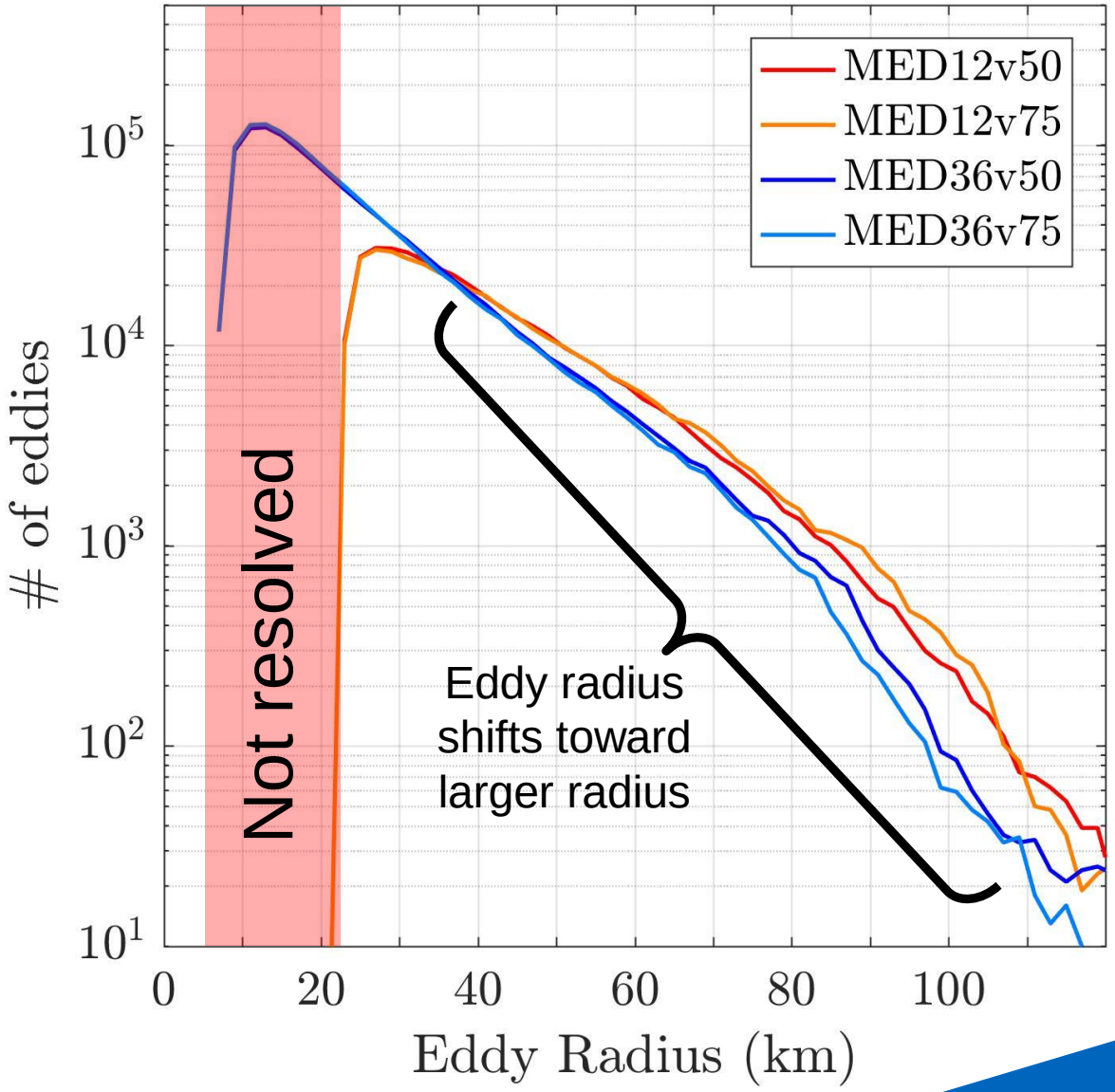

MED12v50
MED36v50
10
15
20
25
30
35
40
45
50
km


MED12v75
MED36v75

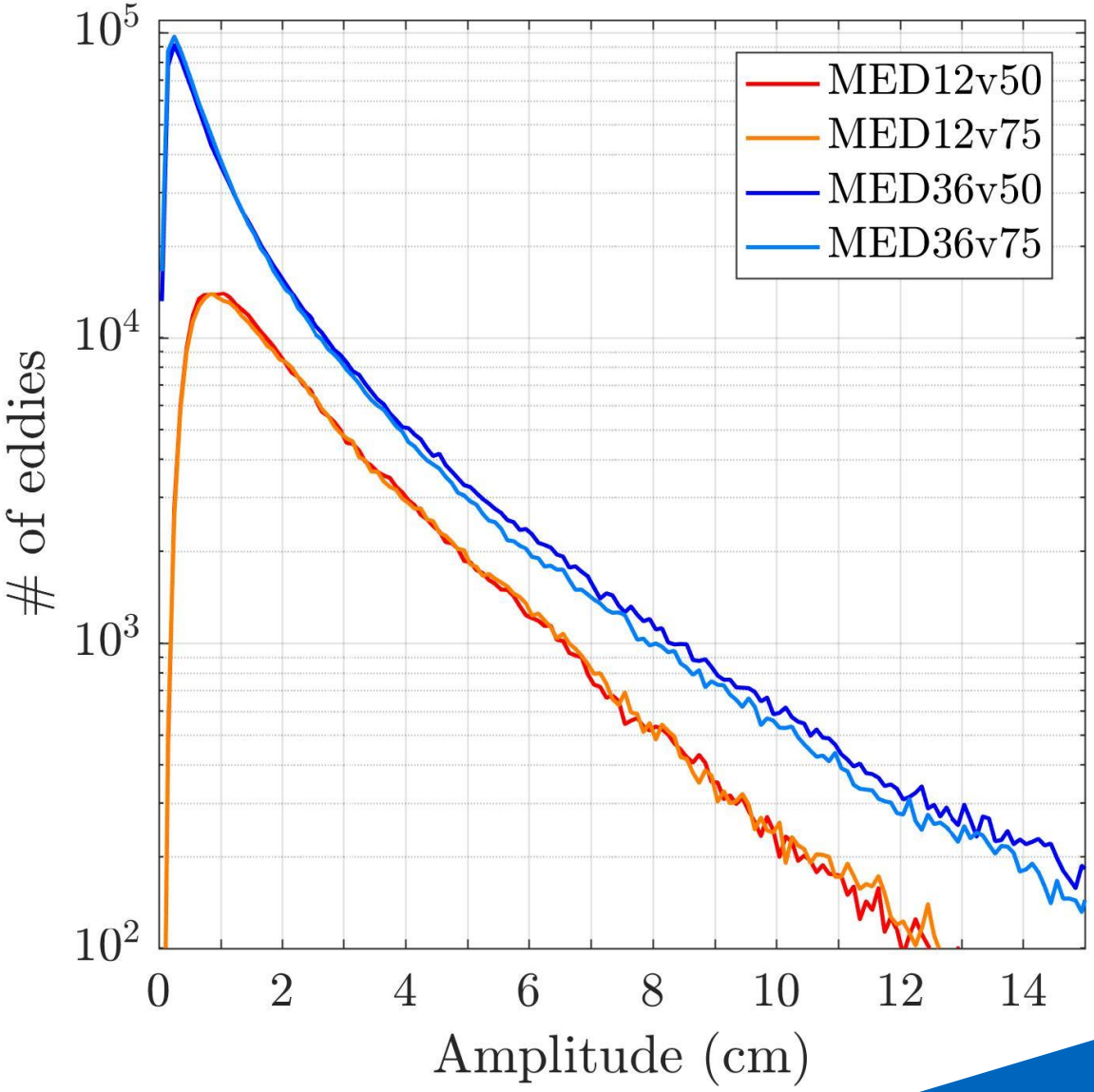
Eddy Radius


MED12v50
MED12v75
MED36v50
MED36v75
# of eddies
10^5
10^4
10^3
10^2
10^1
0
20
40
60
80
100
Eddy Radius (km)

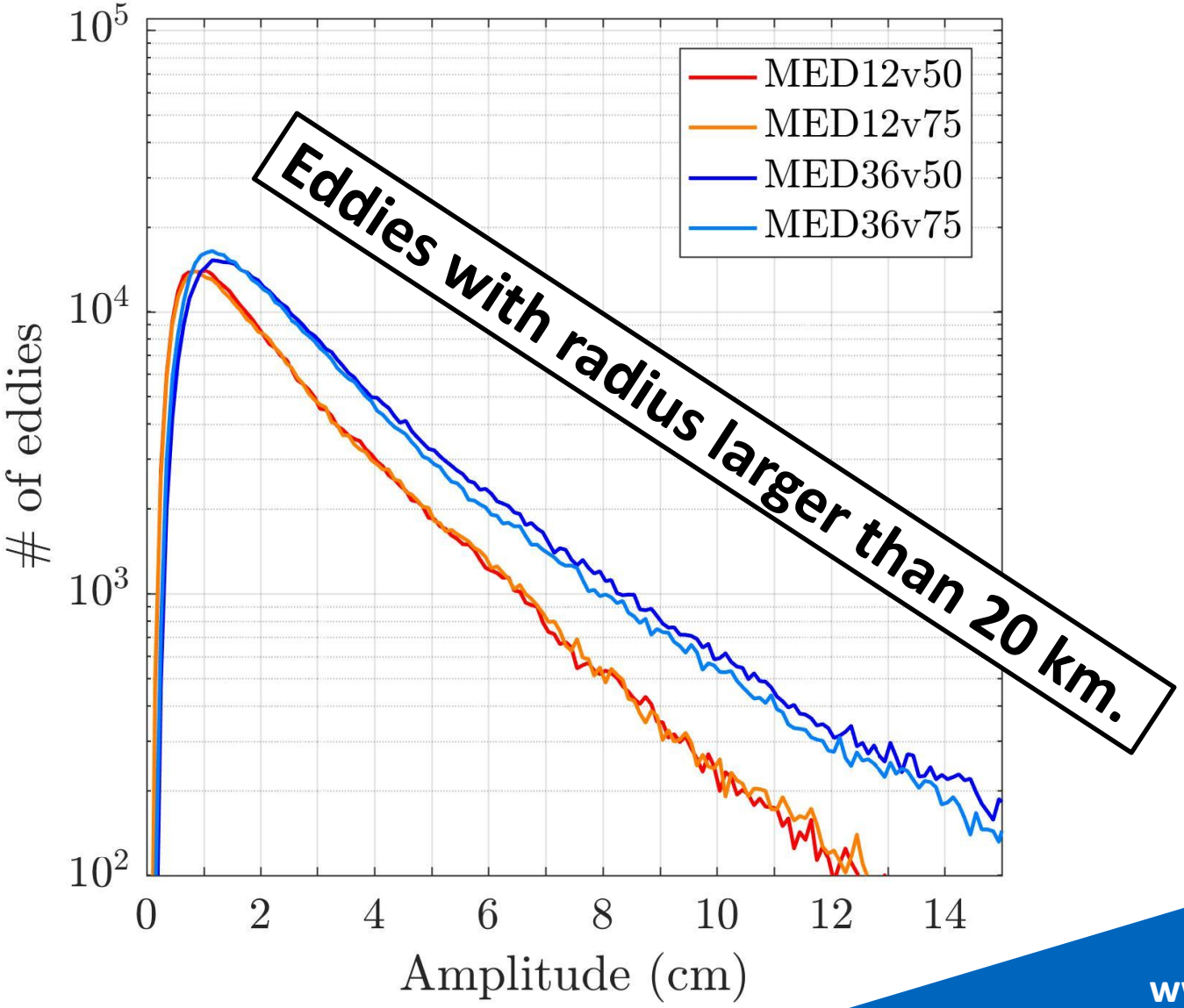
Eddy Radius


MED12v50
MED12v75
MED36v50
MED36v75
Not resolved
Eddy radius
shifts toward
larger radius
# of eddies
10^5
10^4
10^3
10^2
10^1
0
20
40
60
80
100
Eddy Radius (km)

Eddy Amplitude



Eddy Amplitude



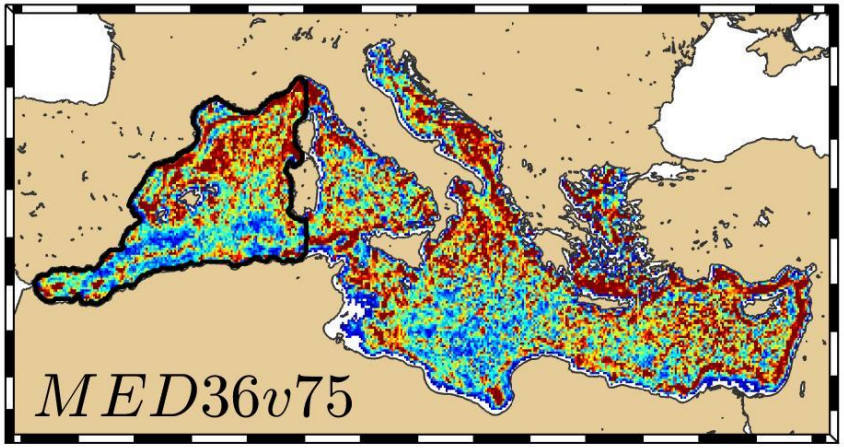
Model dependence

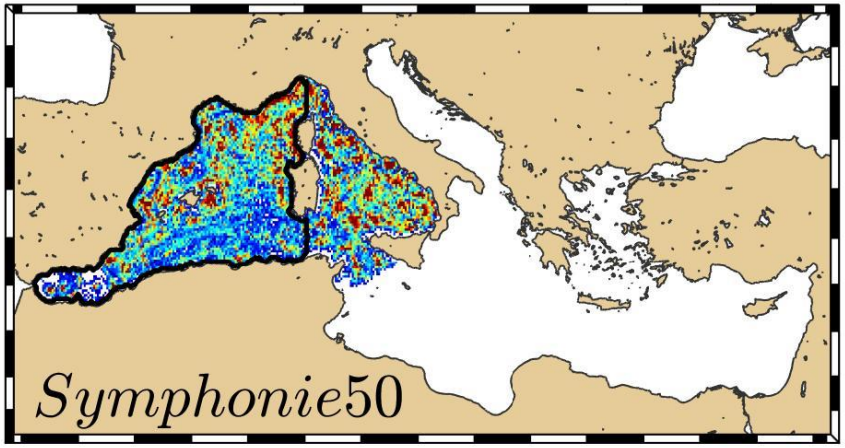
→ 3 different numerical models…

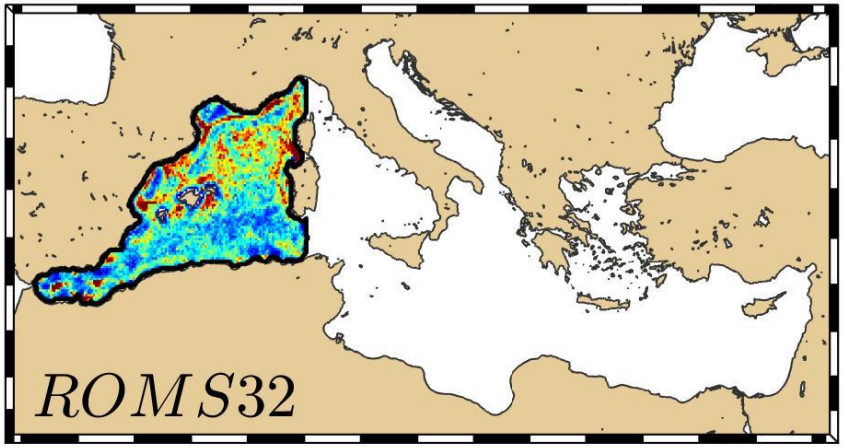
Model	Resolution	Simulated time
ROMS	1/32 degrees	21 years
Symphonie	1/32 degrees	3 years
MED36v75	1/36 degrees	11 years

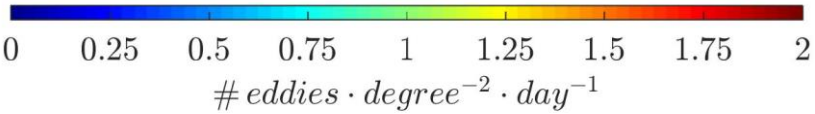
… that cover different areas.

of eddies

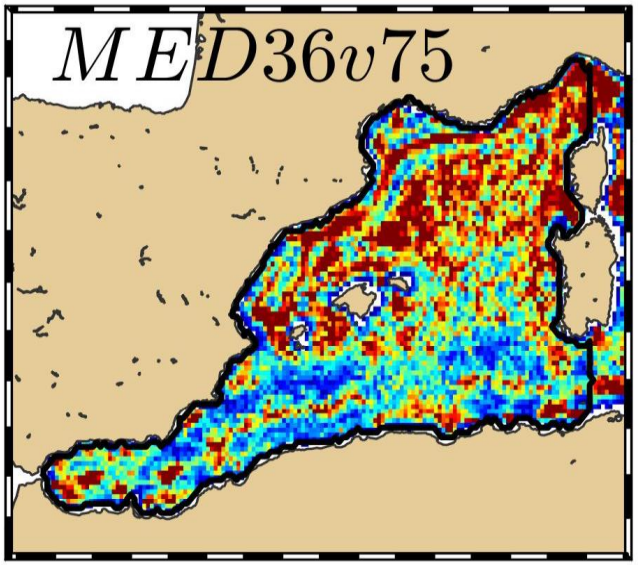

MED36v75

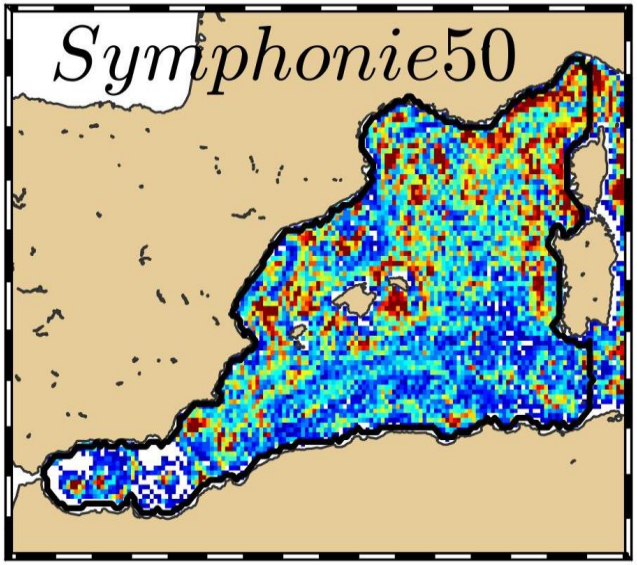

Symphonie50

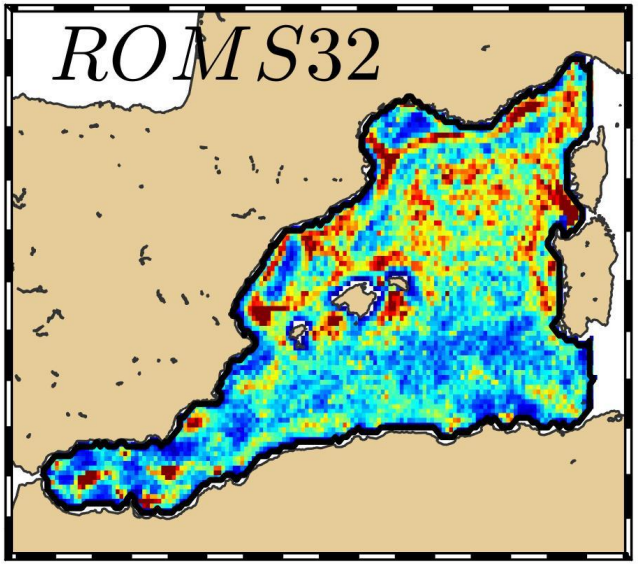

ROMS32

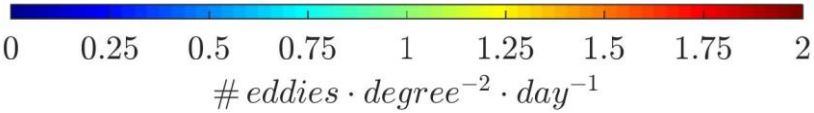

0 0.25 0.5 0.75 1 1.25 1.5 1.75 2
eddies · degree^{-2} · day^{-1}

of eddies

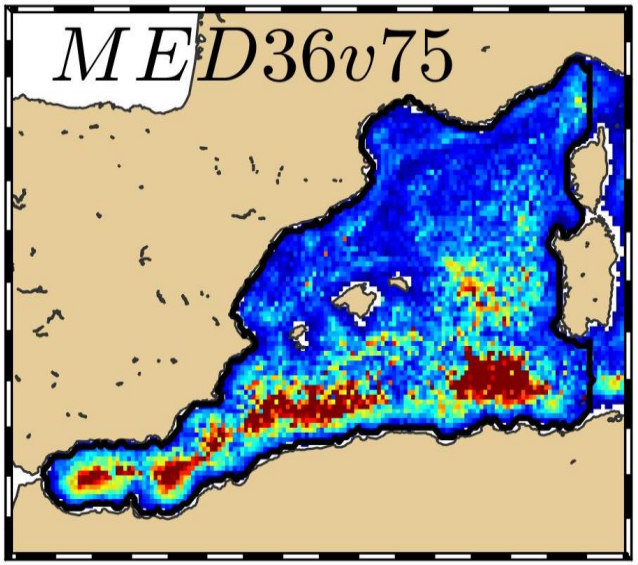

MED36v75

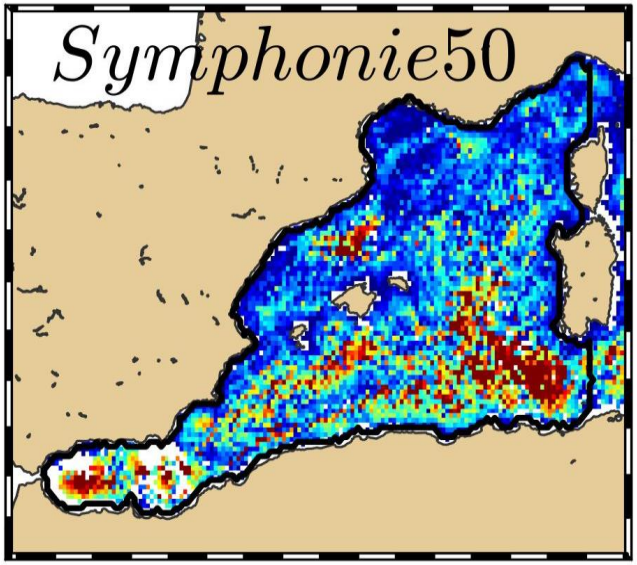

Symphonie50

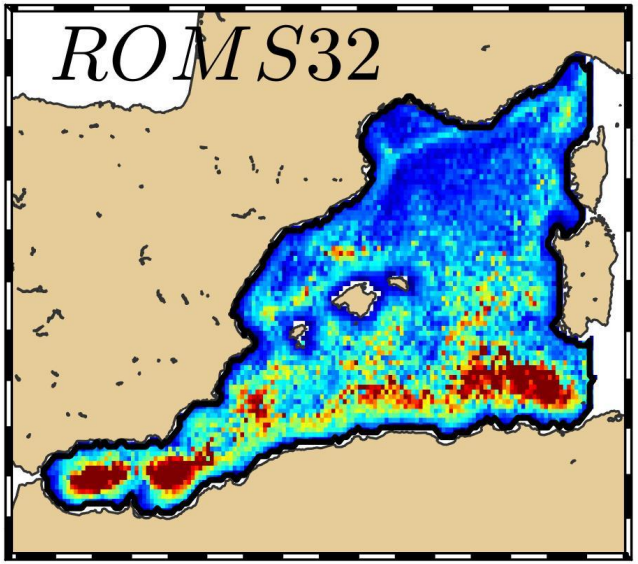

ROMS32

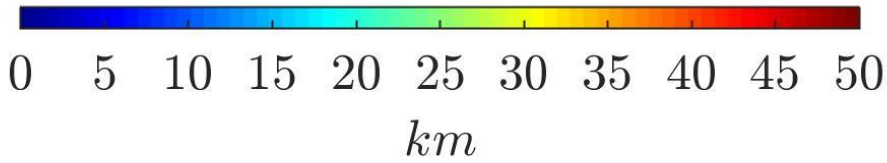

0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
eddies · degree^{-2} · day^{-1}

Eddy Radius



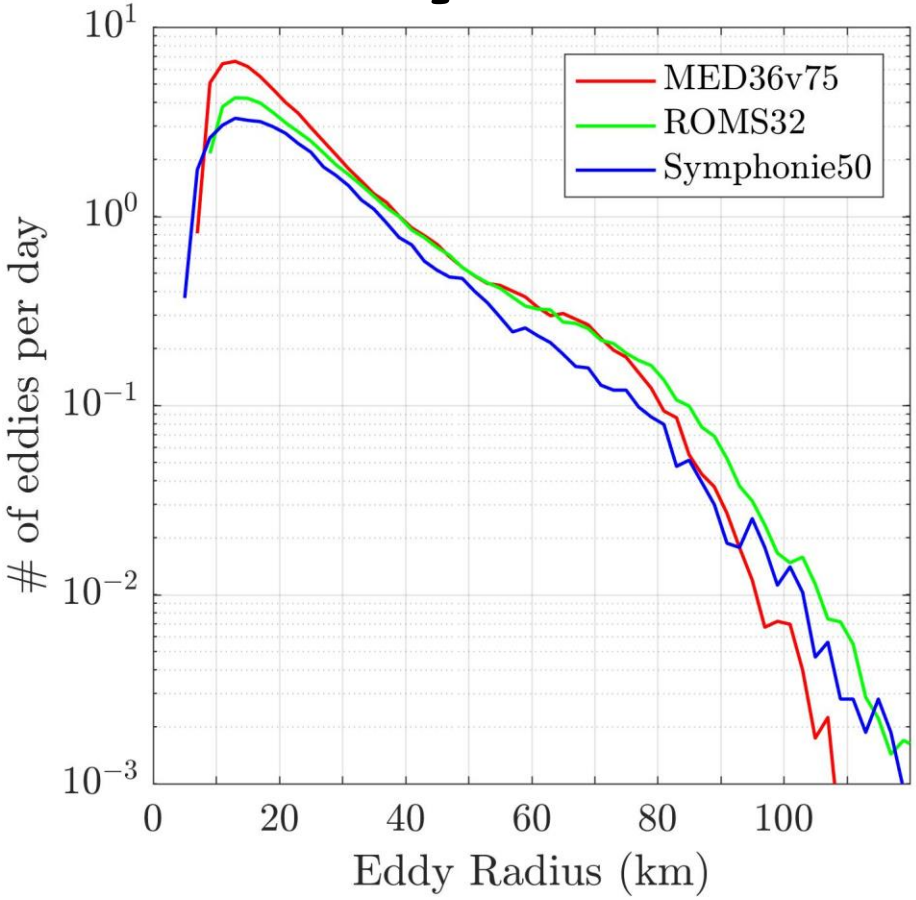




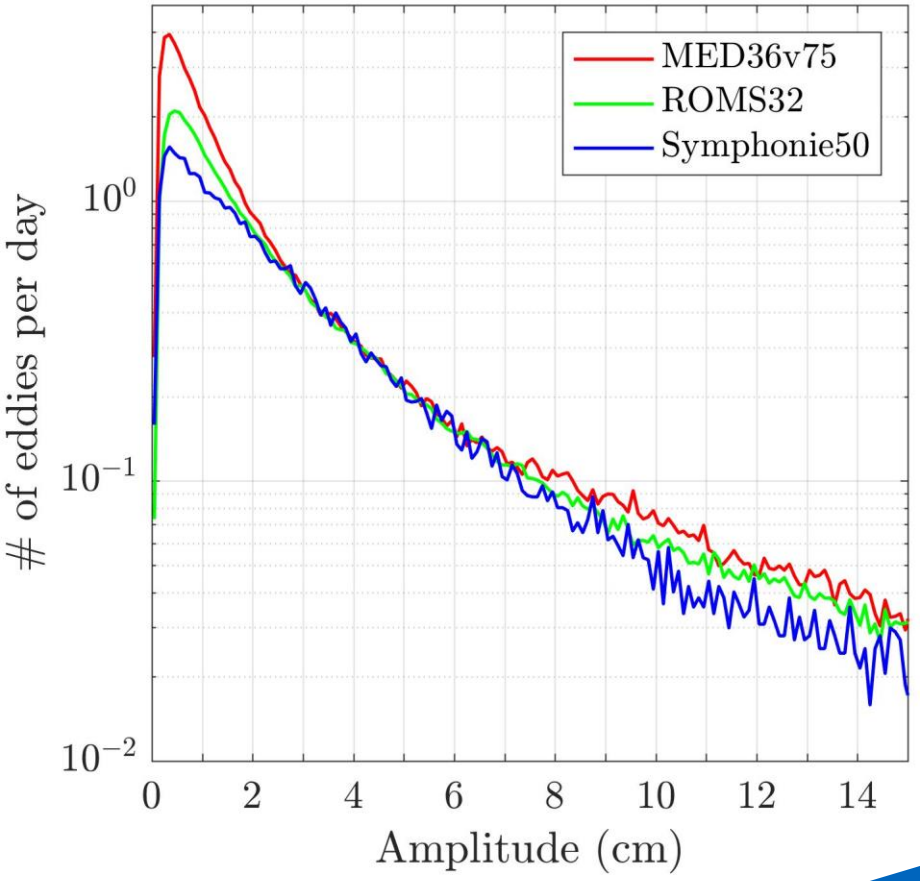


Model

Eddy Radius



Eddy Amplitude



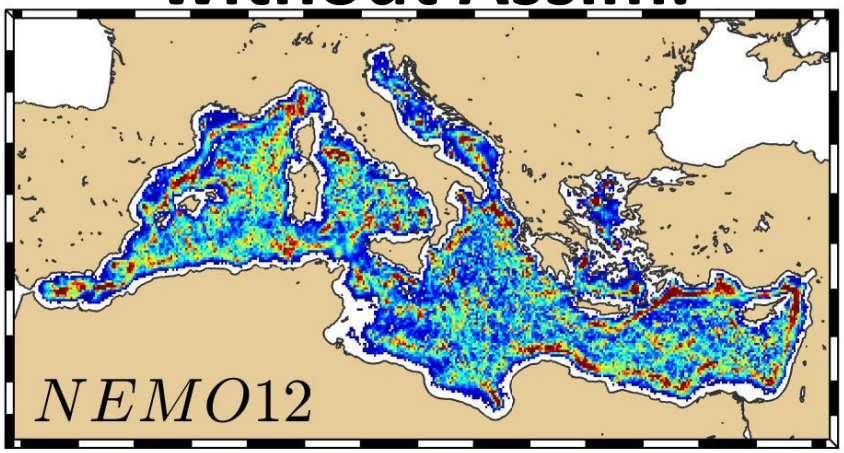
Data Assimilation

→ 3 different NEMO simulations with/without data assimilation:

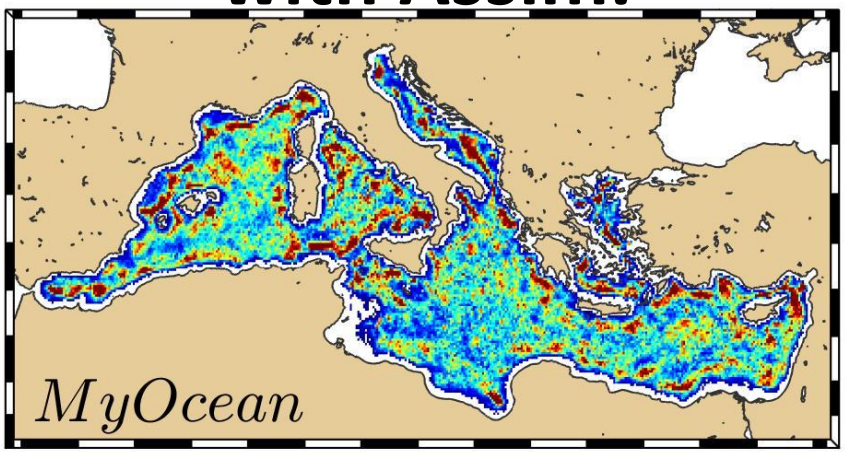
Model	Resolution	Assimilation
NEMO12	1/12 degrees	NO
MyOcean	1/12 degrees	YES
MEDRYS	1/16 degrees	YES

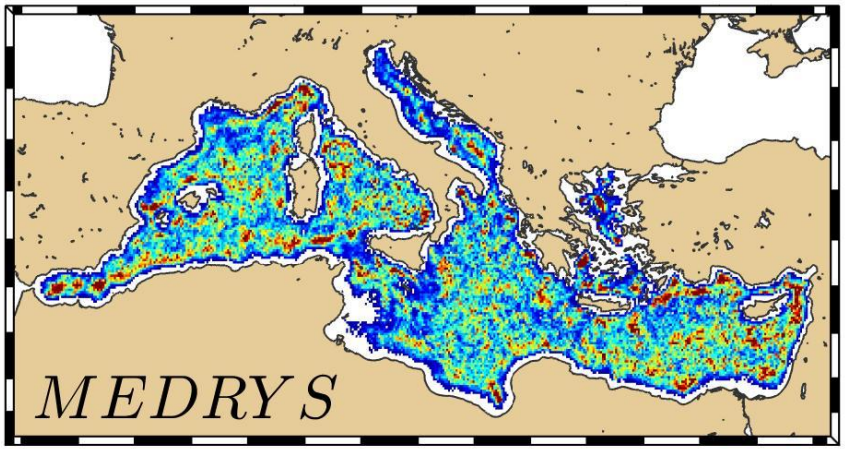
of eddies

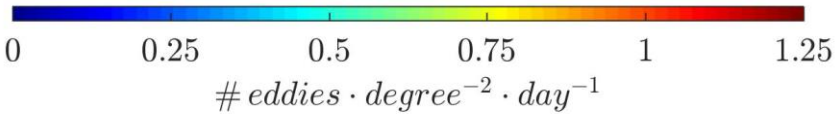
without Assim.



with Assim.

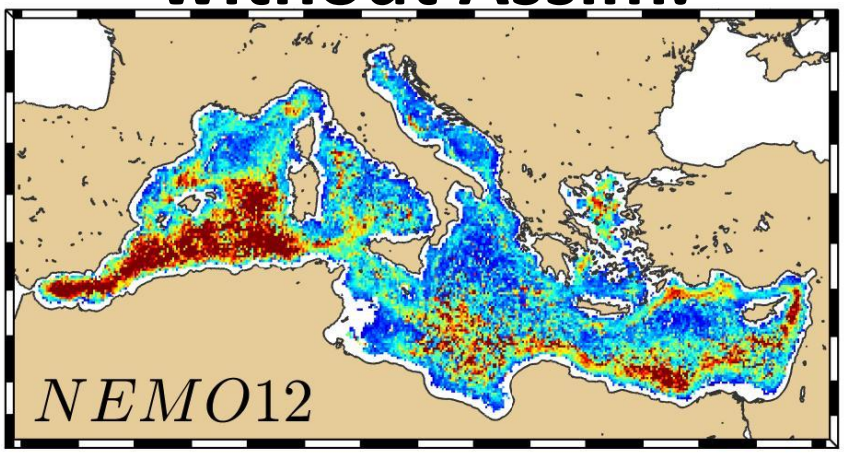




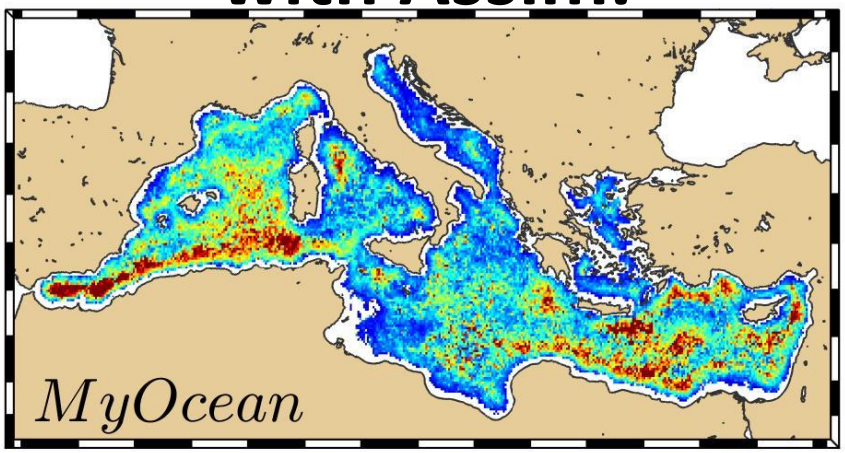


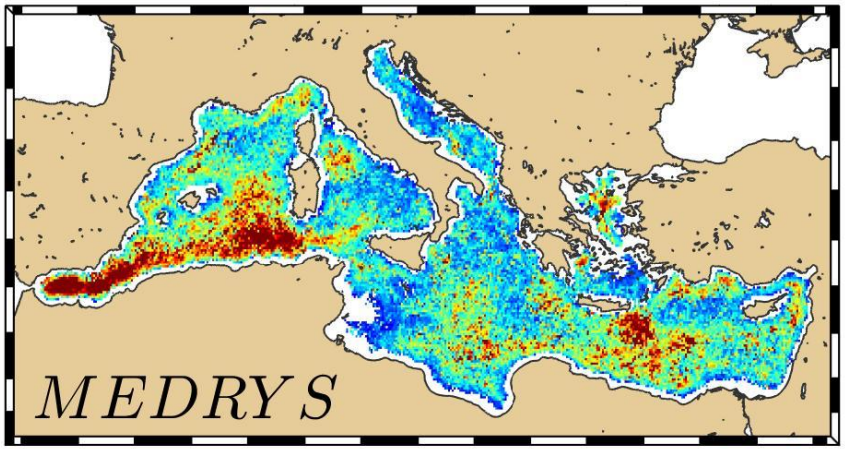
Eddy Amplitude

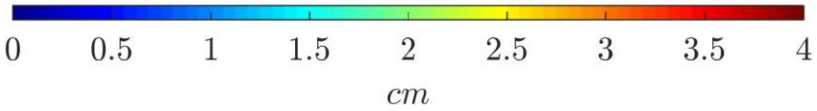
without Assim.



with Assim.

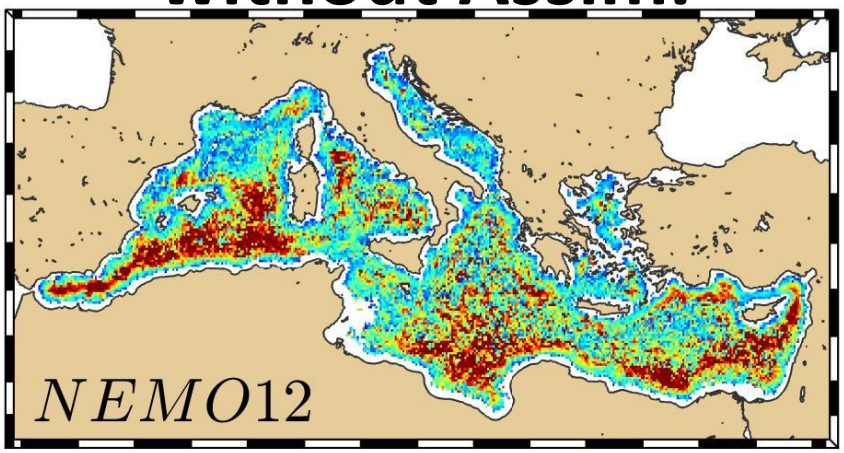




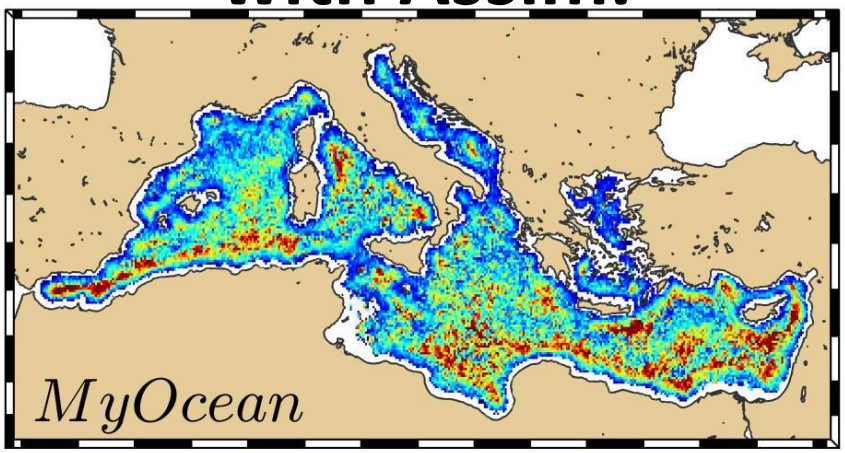


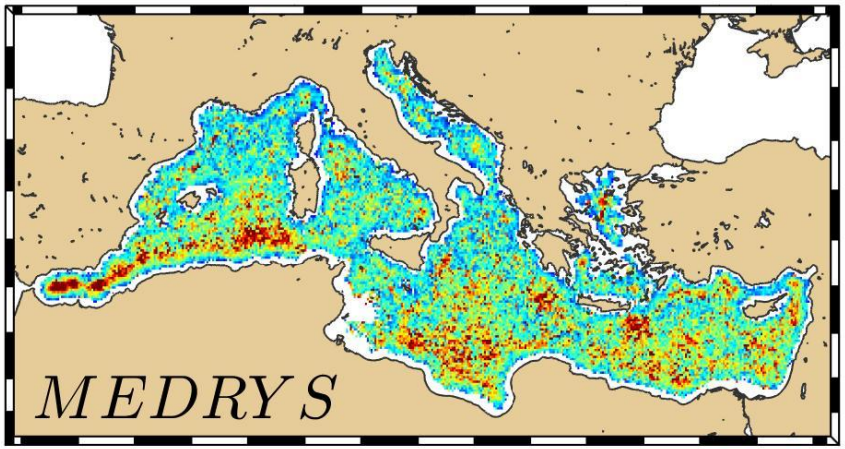
Eddy Radius

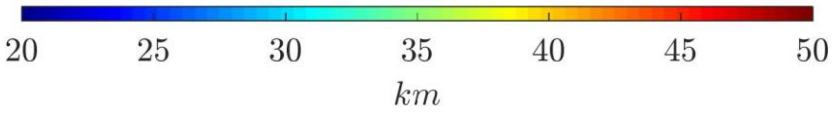
without Assim.



with Assim.

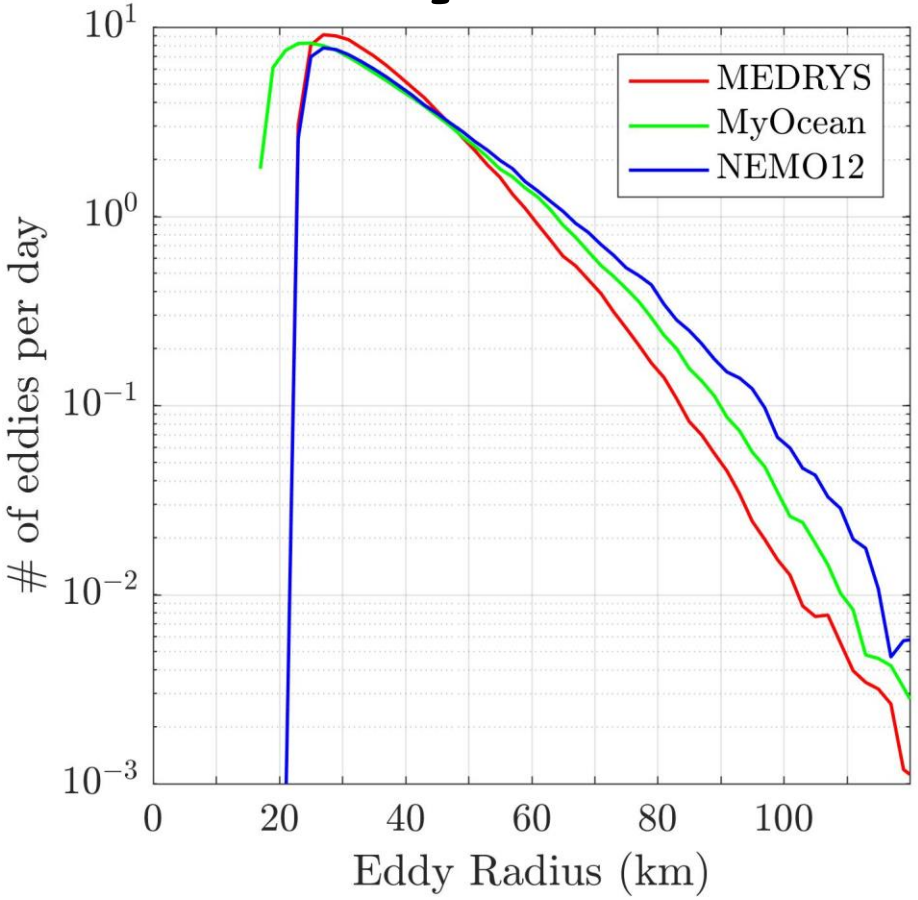




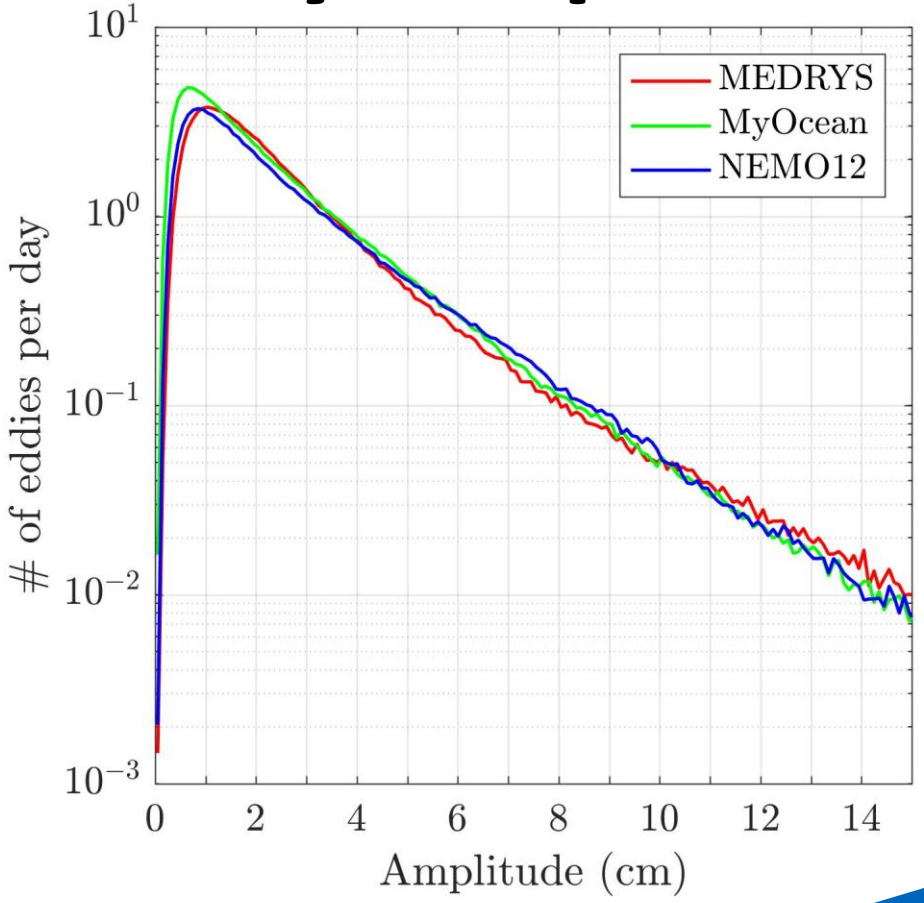


Data Assim.

Eddy Radius



Eddy Amplitude



Conclusions

- The **eddy properties from satellite altimetry cannot be trusted** to take them as a reference to compare the high resolution models.
- The **horizontal resolution strongly defines the eddy properties** in terms of eddy radius.
- The **vertical resolution is not a limiting factor** as long as the upper layers are correctly represented.
- Data assimilation does not improve (modify) the eddy properties.

Suggested approach in study the eddy properties:

- Let's create an ensemble of high resolution simulations combining different forcings, data assimilation, … and define the eddy properties as the properties observed in all (the majority) of the simulations.