SOCIB Balearic Islands Coastal Observing and Forecasting System

DOWNSCALING CMEMS MEDITERRANEAN MODEL OVER THE WESTERN BASIN: IMPACTS ON MEAN FLOWS AND MESOESCALE EDDIES

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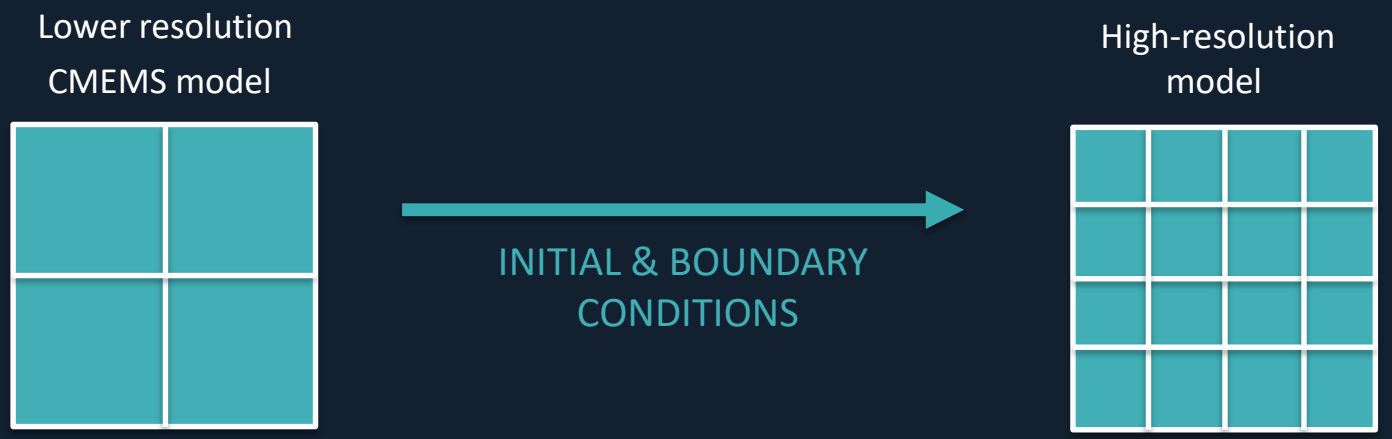
DOWNSCALING

Procedure to generate **high-resolution** regional simulations taking initial and boundary conditions from a lower resolution model



From large to local scales

Why?

→ better representation of transports and exchanges of heat, fresh water and biogeochemical tracers

→ better support to local applications: maritime safety, coastal environmental management, marine resources management,…

CMEMS Ocean Model Expected Evolutions

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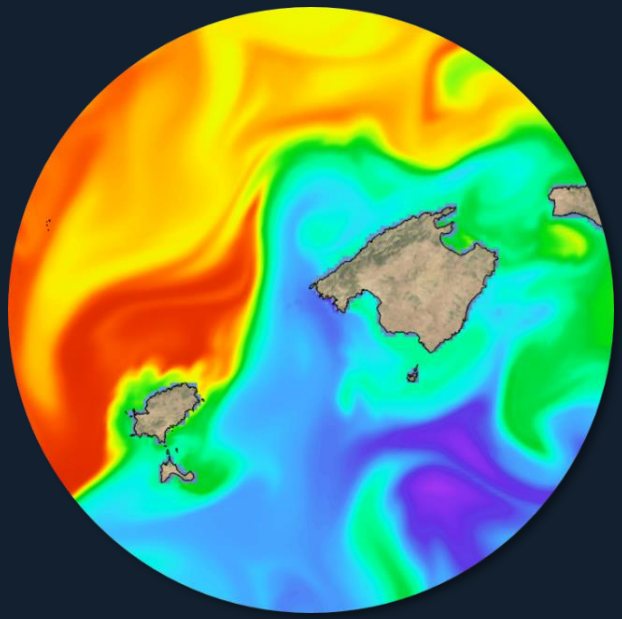
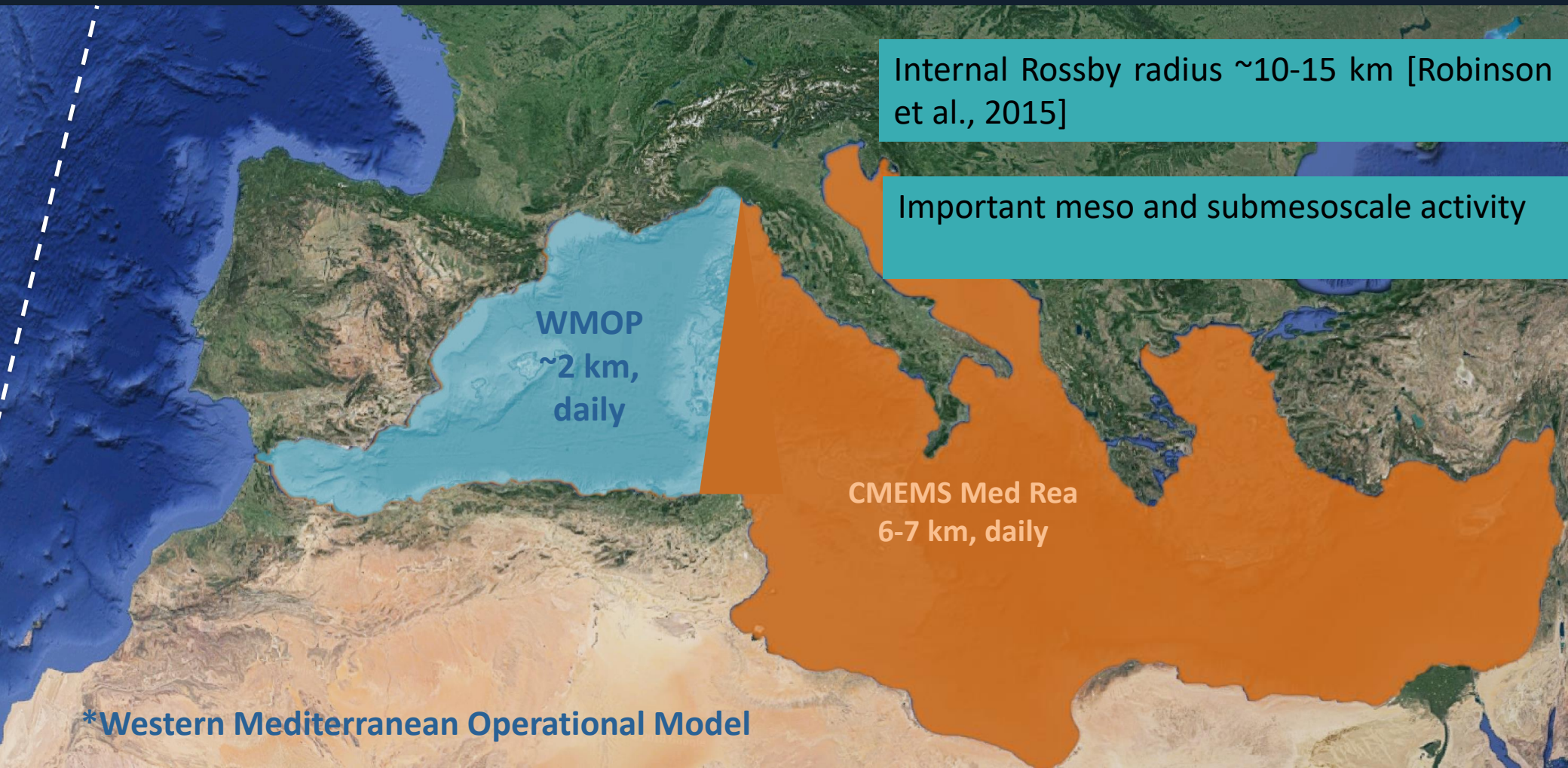
Where?



SOCIB's high-resolution numerical model

WMOP: a high-resolution numerical model nested in the CMEMS Mediterranean model (CMEMS Med Rea)



SOCIB's high-resolution numerical model

WMOP: a high-resolution numerical model nested in the CMEMS Mediterranean model (CMEMS Med Rea)

	WMOP [Juza et al., JOO, 2016]	CMEMS Med Rea [Simoncelli et al., 2014]
Hydrodynamics	ROMS	NEMO
Spatial domain	Western Mediterranean (Gibraltar to Sardinia-Corsica)	Entire Mediterranean
Horizontal & vertical resolution	2km (~1/50º) 32 σ-levels	6-7 km (1/16º) 72 z-levels
Data assimilation	No (free run)	SST+SLA + T-S profiles (OceanVar)
Surface forcings	HIRLAM model (3h, 5km)	ERAInterim (ECMWF; 6h, 70km)
Initial & boundary conditions	CMEMS Med Rea (daily)	GLO_MFC (Climatology, atlantic)
Simulation period	2009-2015	1987-2015 (analyzed over 2009-2015)

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Multi-platform perspective

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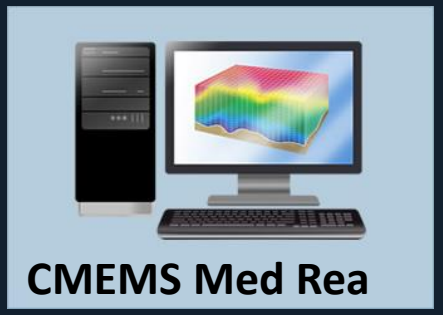
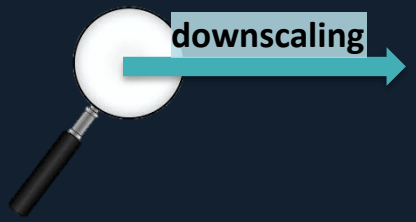
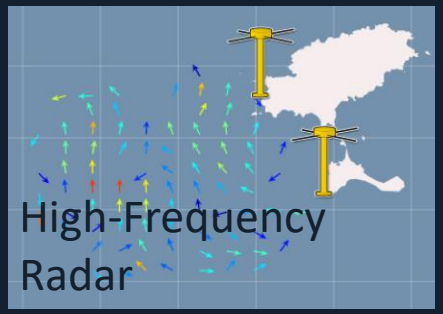
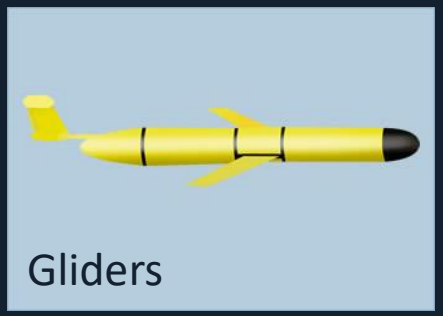
Numerical Models

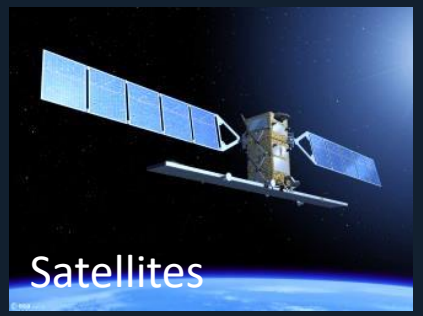




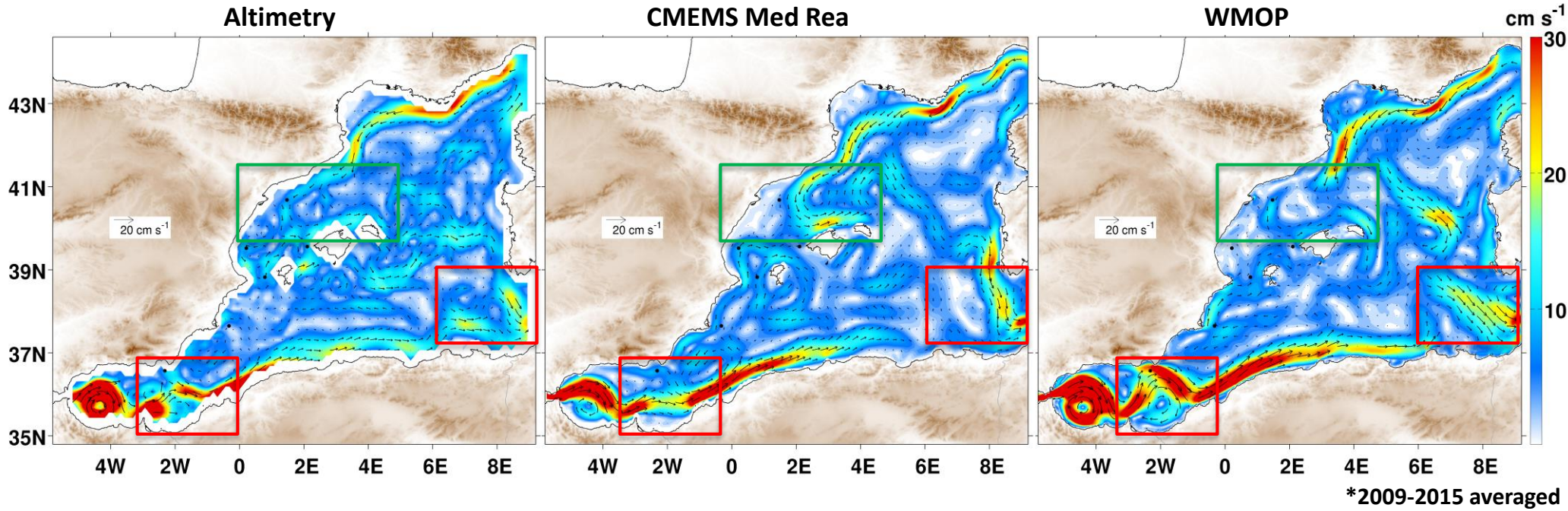
Observations







Surface mean circulation



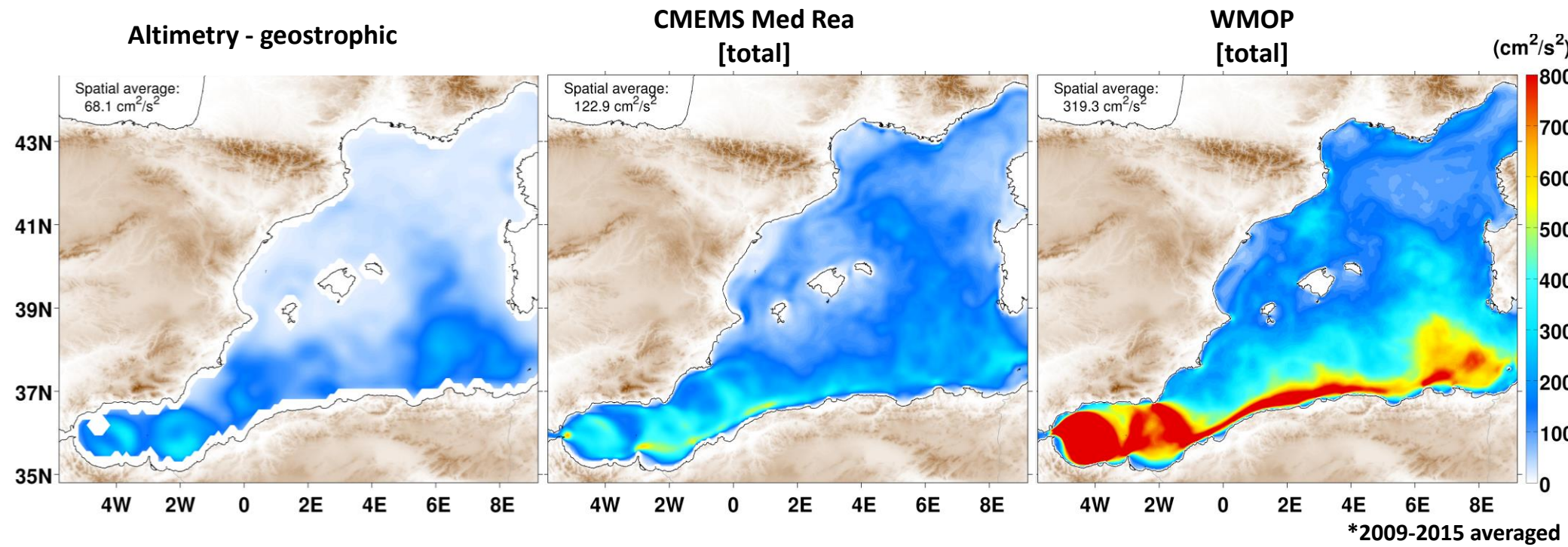
Overall consistency between both models and altimetry in terms of the major circulation features: Northern Current, Alboran Sea Gyres & Algerian Current.

Improvement of the Northern Current recirculation north of Balearic Islands in WMOP with respect to CMEMS Med Rea.

Stronger signature of the Eastern Alboran Gyre in WMOP.

Southward flow West of Sardinia better represented in CMEMS Med Rea

Eddy Kinetic Energy (EKE)

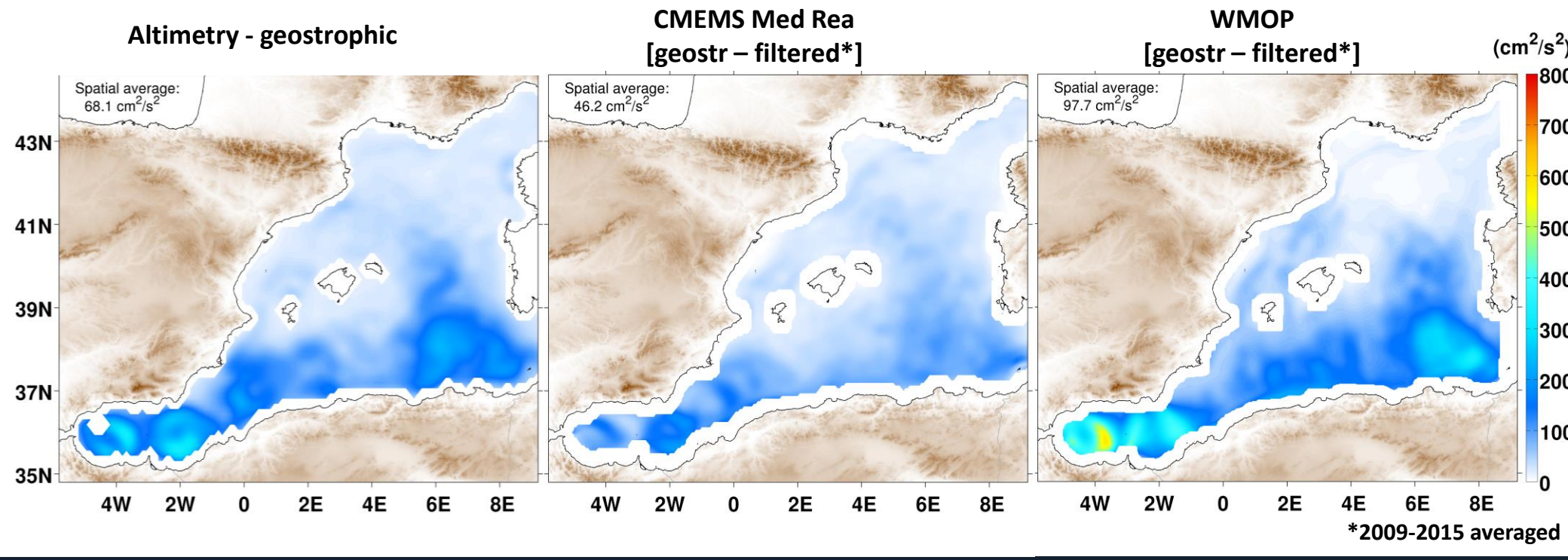


EKE much larger for WMOP than for CMEMS Med Rea. Both are much more energetic than estimates derived from altimetry.

→ importance of ageostrophic processes & small scale variability not resolved by altimetry

Proper validation against altimetry must consider only geostrophic velocities and spatially and temporally filtered model fields.

Eddy Kinetic Energy (EKE)



*Filtered: 45 km and 10-days moving averaged

Eddy activity simulated by CMEMS Med Rea and WMOP remains slightly under- and over-estimated, respectively, with respect to altimetry.

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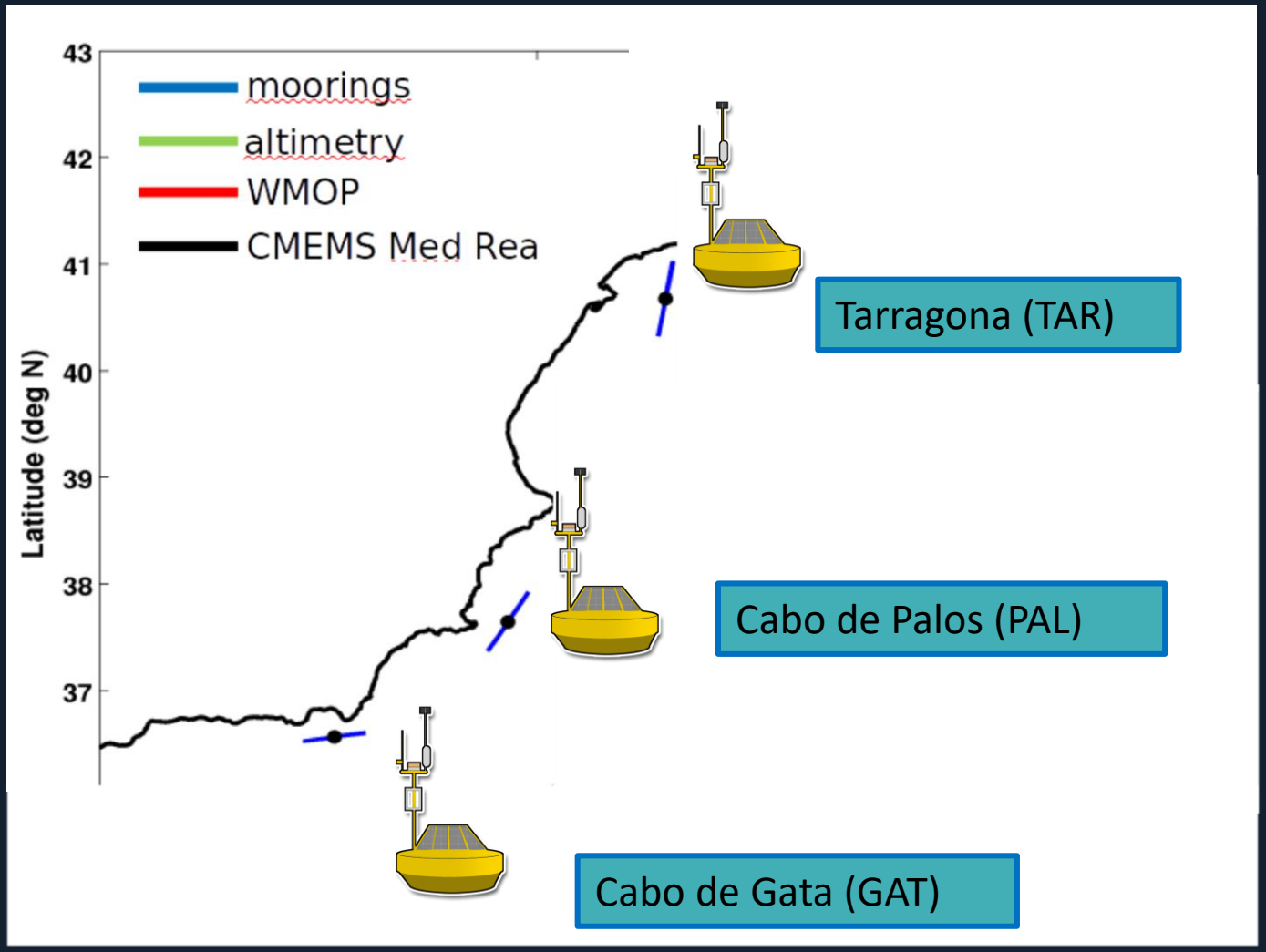
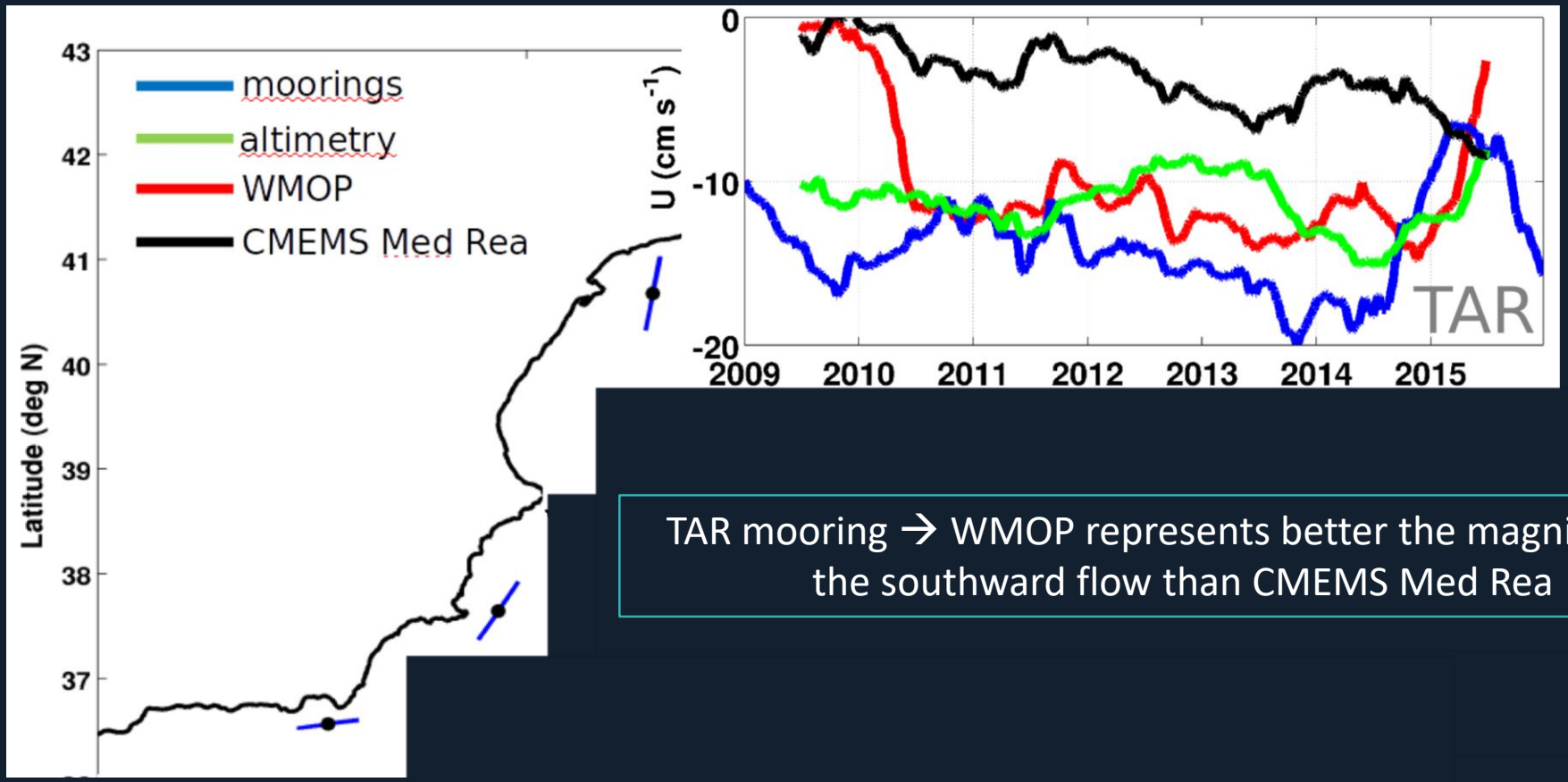
Inter-annual changes of surface currents

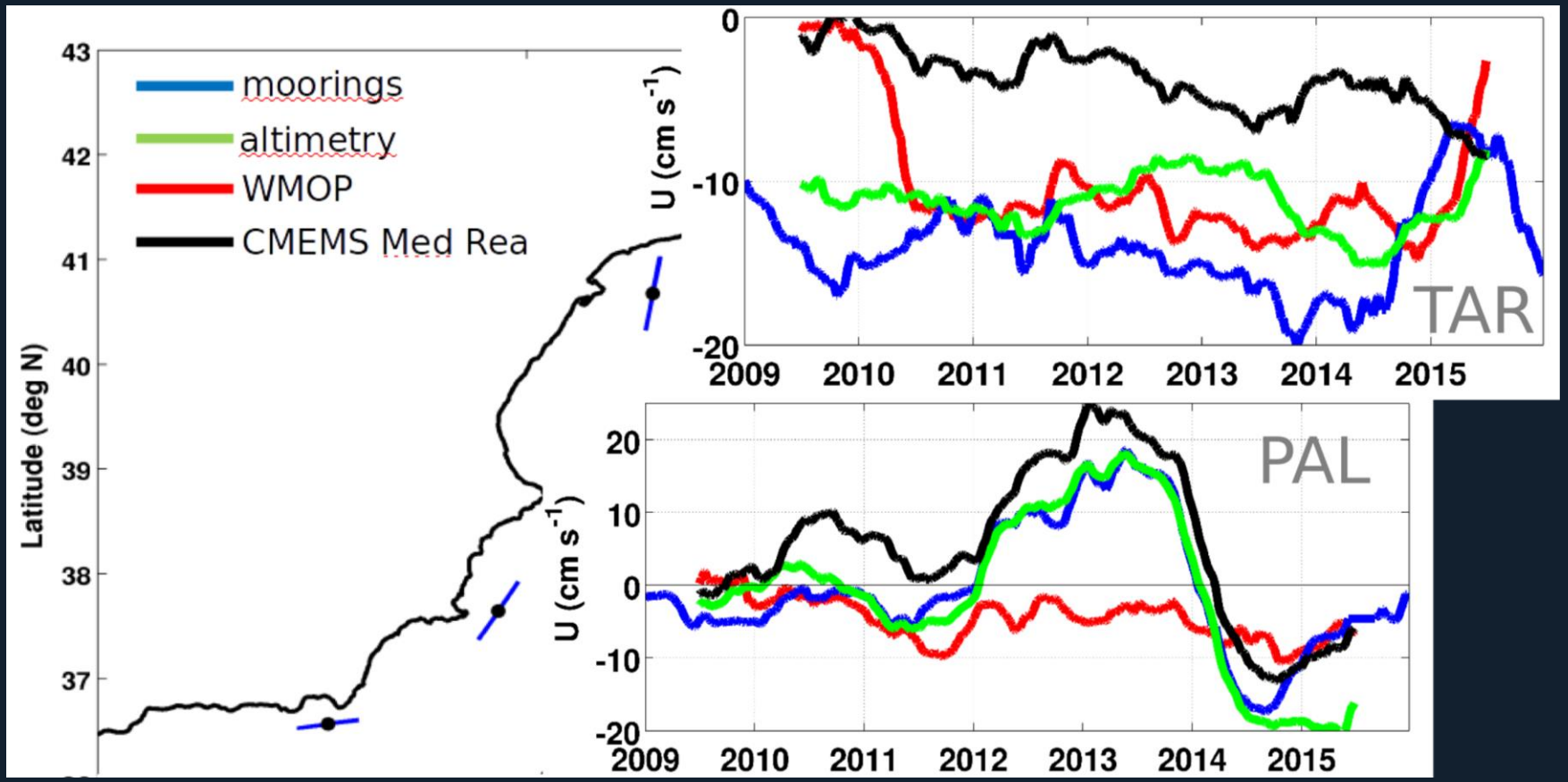


Inter-annual changes of surface currents



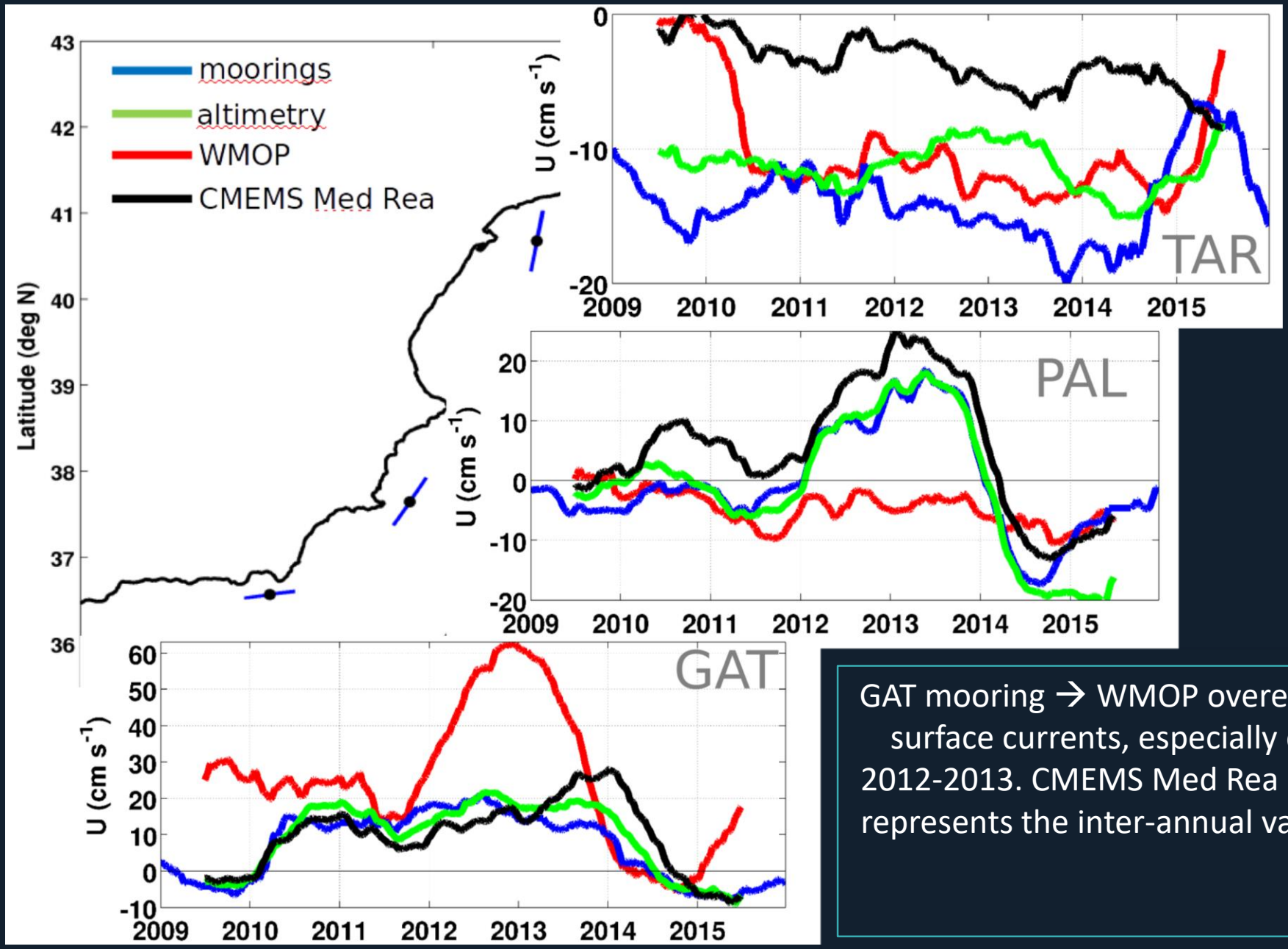
TAR mooring → WMOP represents better the magnitude of the southward flow than CMEMS Med Rea

Inter-annual changes of surface currents



PAL mooring → CMEMS Med Rea properly represents the inter-annual variability of surface currents, especially the 2012-2013 northward event, whereas WMOP does not.

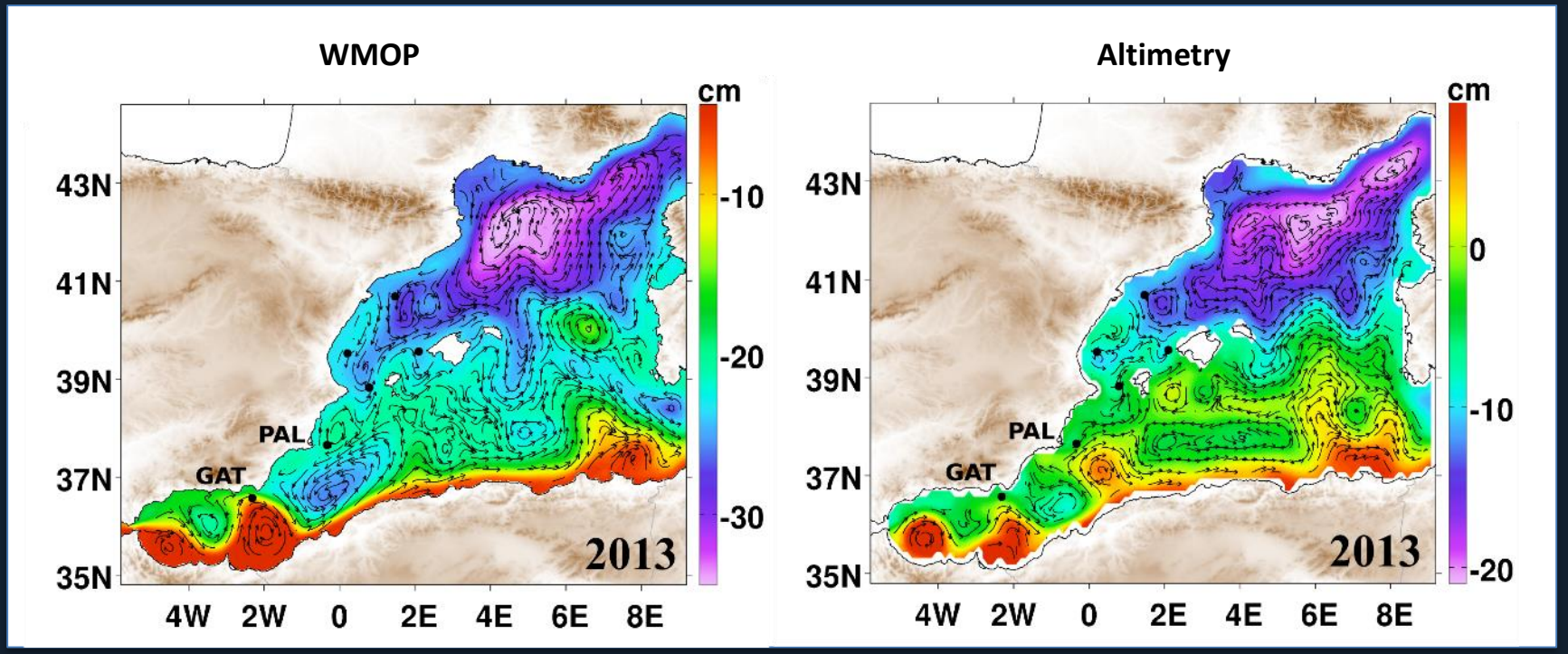
Inter-annual changes of surface currents



GAT mooring → WMOP overestimates surface currents, especially during 2012-2013. CMEMS Med Rea properly represents the inter-annual variability.

Importance of mesoscale structures

Surface circulation annual-means



WMOP fails to represent the eddy close to PAL mooring

WMOP overestimates the size of the EAG in GAT mooring

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Coastal areas monitored by HF Radar

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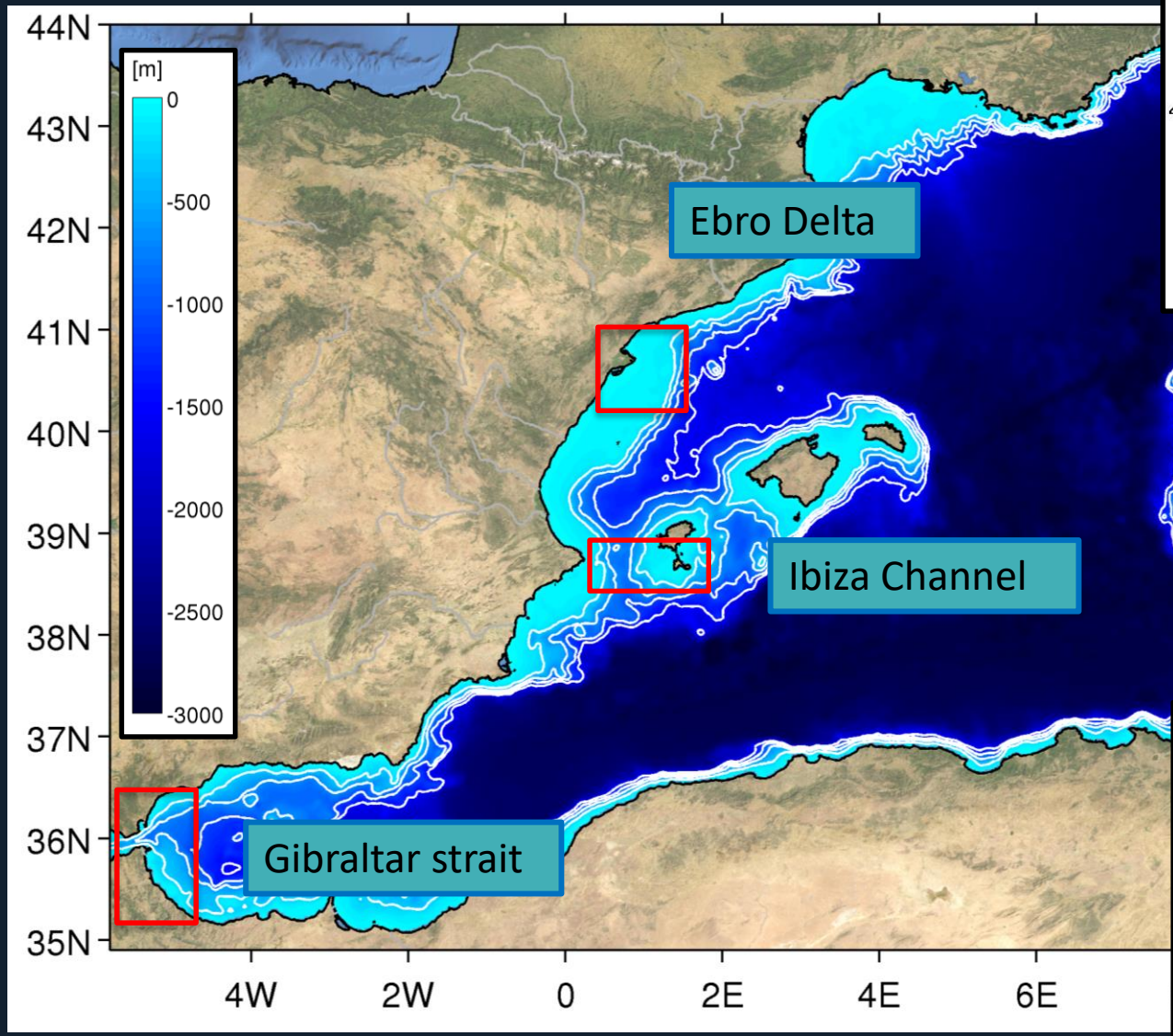
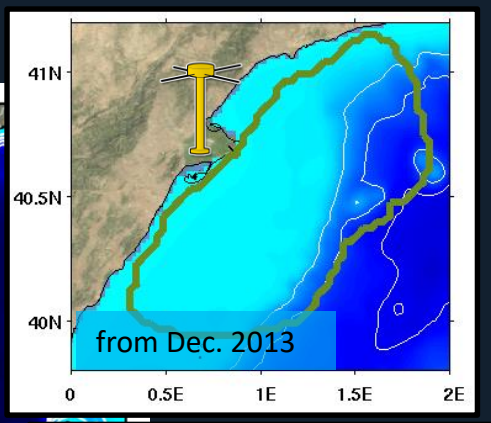
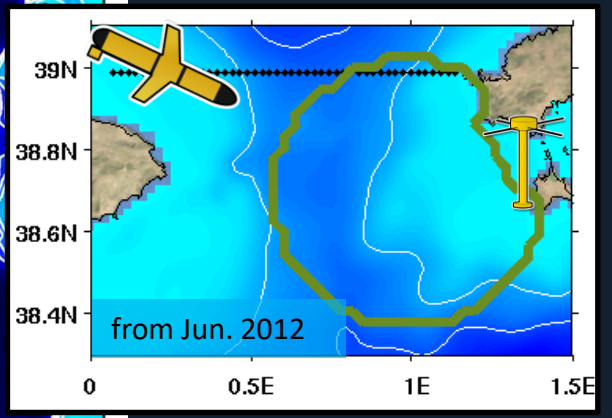
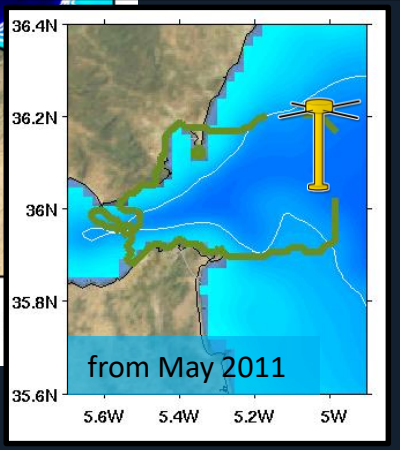
Puertos del Estado









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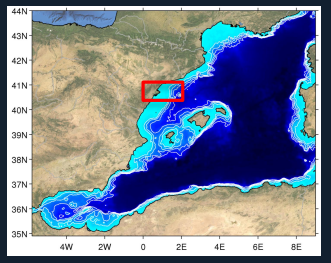
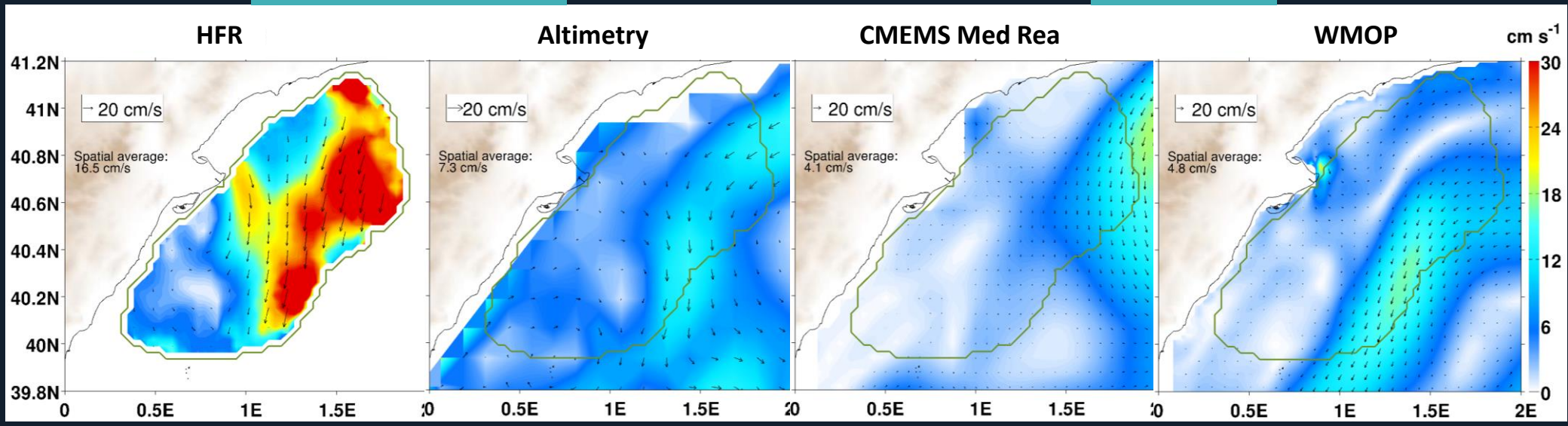
Ebro Delta



OBSERVATIONS

Dec. 2013- Dec. 2015 mean

MODELS



Both models and altimetry underestimate the intensity of the Northern Current (NC) in the Ebro Delta region

WMOP improves the position of the NC compared to CMEMS Med Rea

WMOP represents some current amplification at the mouth of Ebro river

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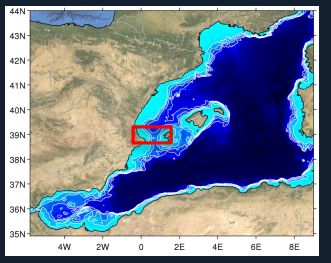
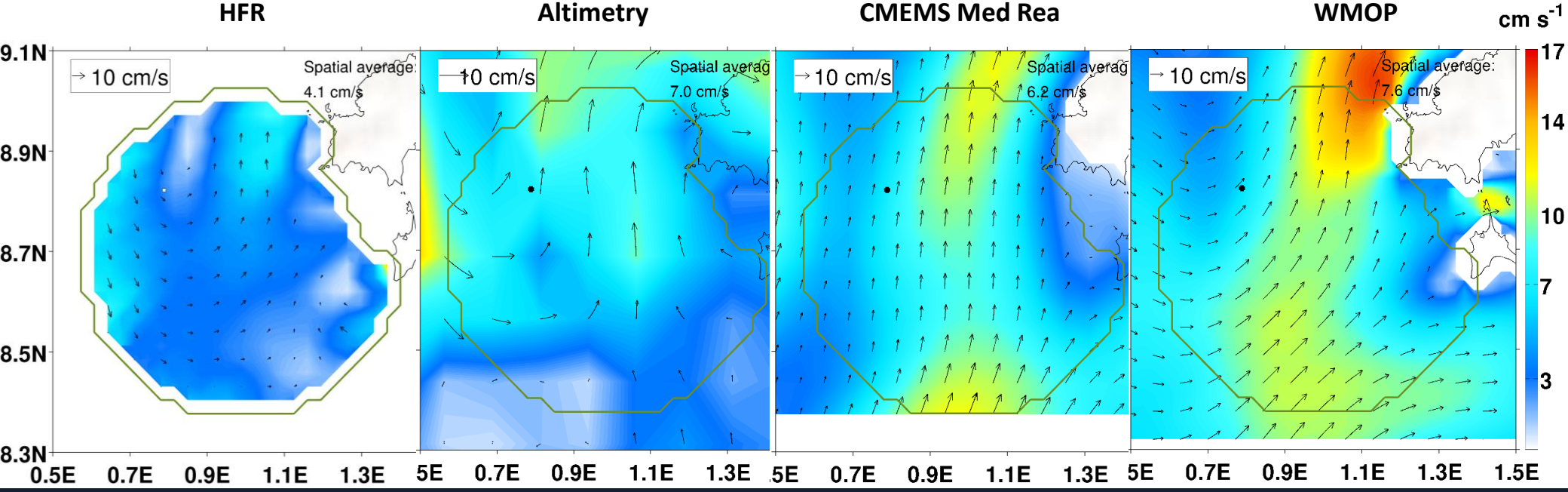
Ibiza Channel



OBSERVATIONS

Jun. 2012- Dec. 2015 mean

MODELS



WMOP reproduces the meridional surface flow reversal described by observations, contrarily to CMEMS Med Rea model

Both models overestimate intensities of currents compared to HFR estimates

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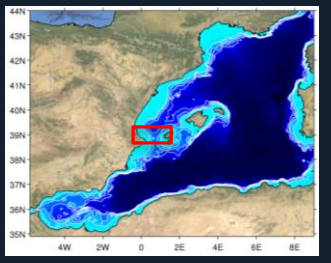
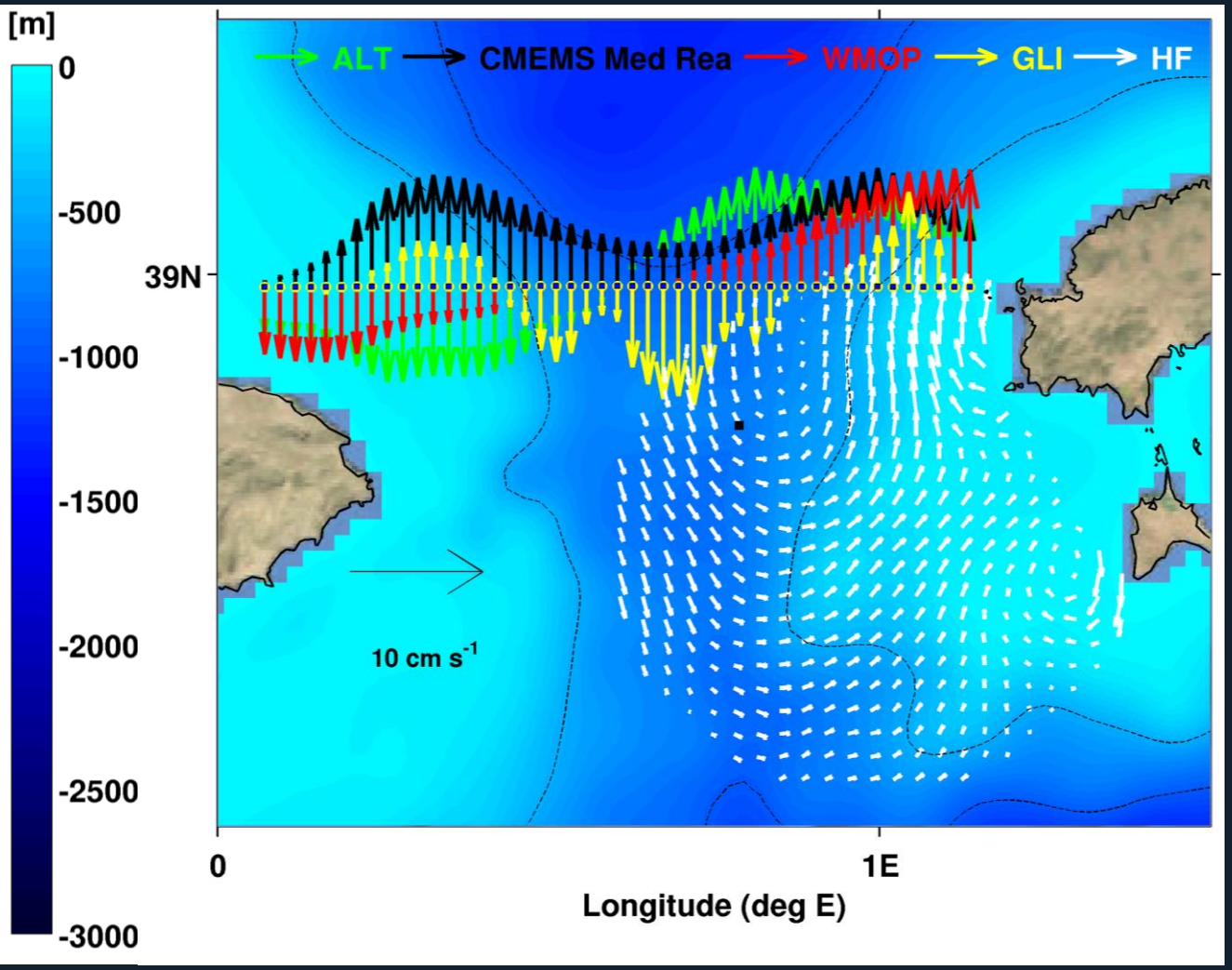
Only during gliders samplings!! 2011-2015

Ibiza Channel





Gliders represents a central southward flow with northward flows at the flanks of the Channel, which agrees with HFR observations

CMEMS MedRea produces a mean northward flow over the whole section

WMOP (and altimetry) represent the reversal of the meridional flow but not in the correct position

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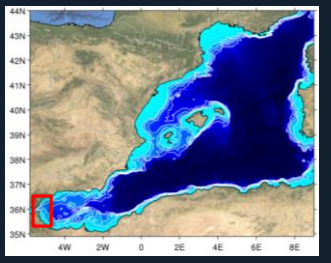
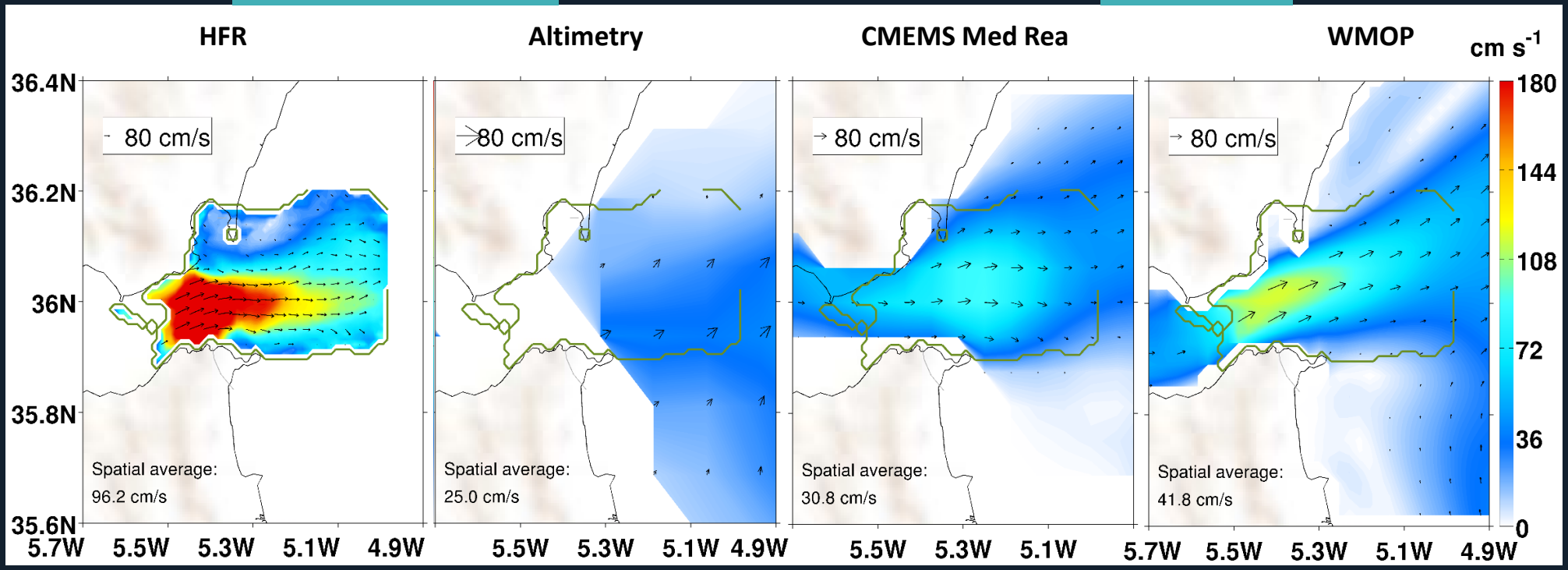
Gibraltar Strait



OBSERVATIONS

May 2011- Dec. 2015 mean

MODELS



The surface current amplification in the Strait is represented in both models, with a more accurate description in WMOP than in CMEMS Med Rea, though still underestimated with respect to observations.

The shadow area observed in the northern part of the HF radar coverage is not captured in the simulations.

Abundance, size & propagation of eddies

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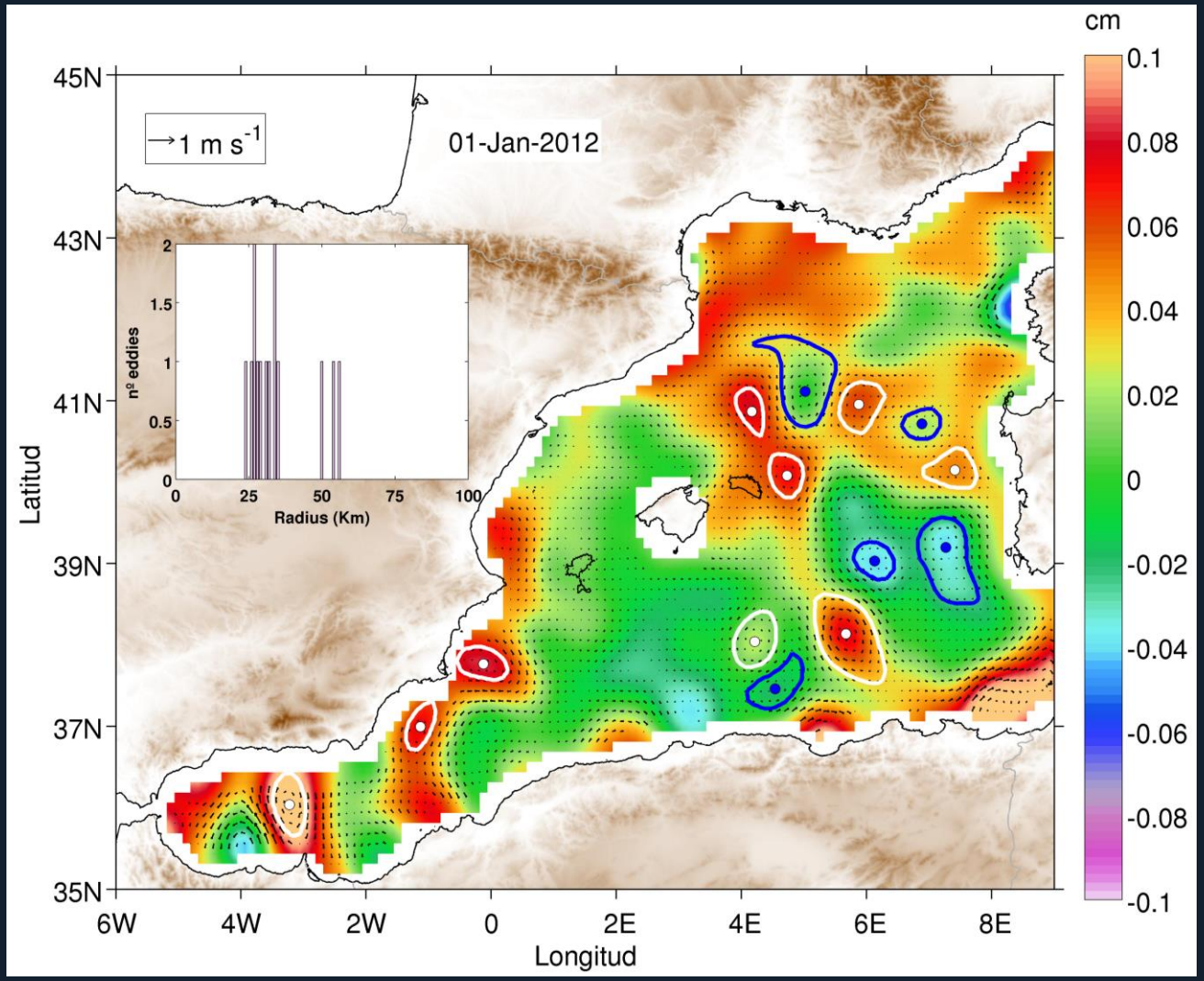
Automated eddy detection:

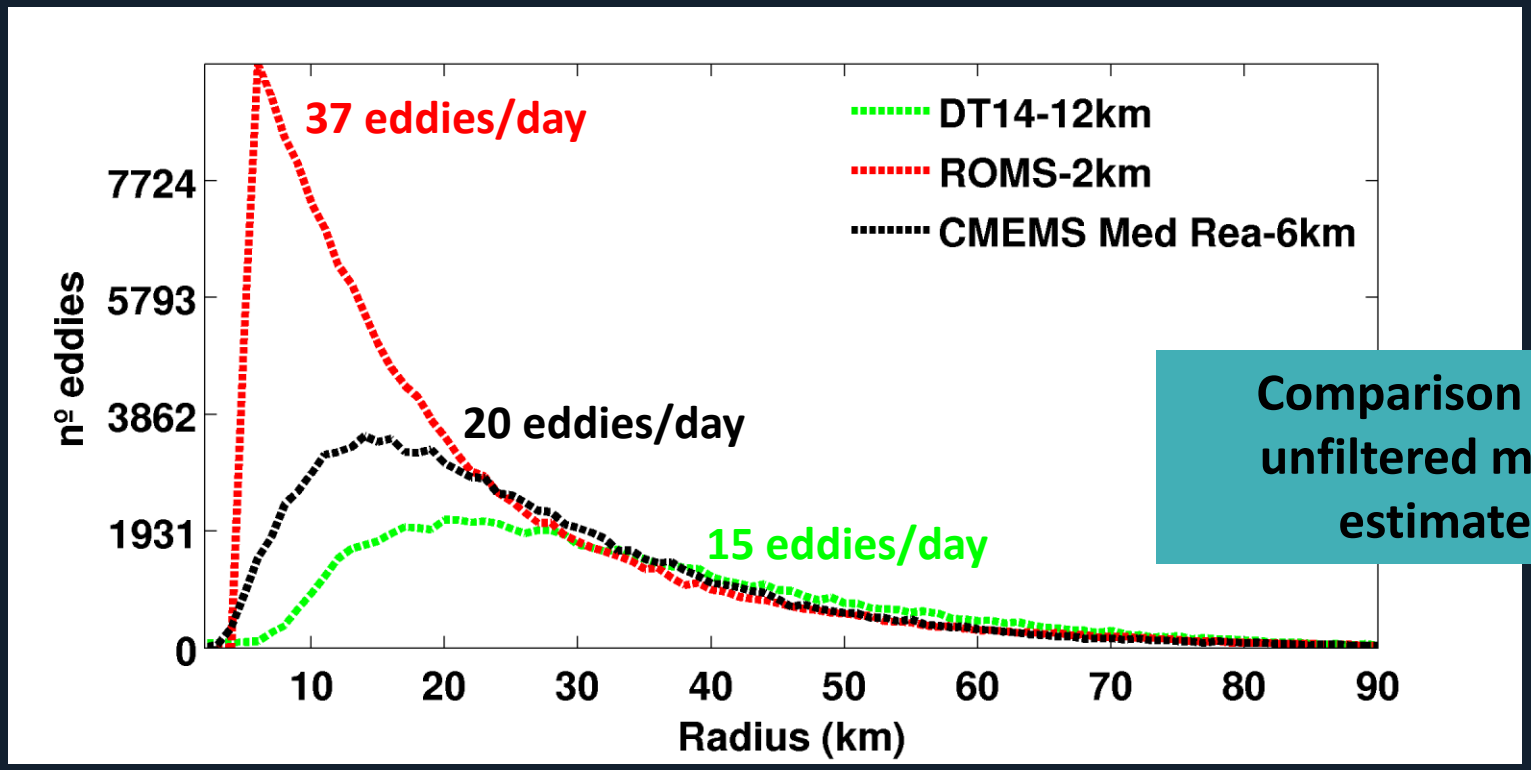
[Mason et al., 2014] tracking algorithm, based on closed contours of SLA.

The code is applied to SLA fields from both models and altimetry datasets:



Abundance & size of eddies

- Downscaling effects on eddies



Comparison with unfiltered model estimates

The higher resolution in WMOP leads to a large increase in the number of detected eddies

Abundance & size of eddies

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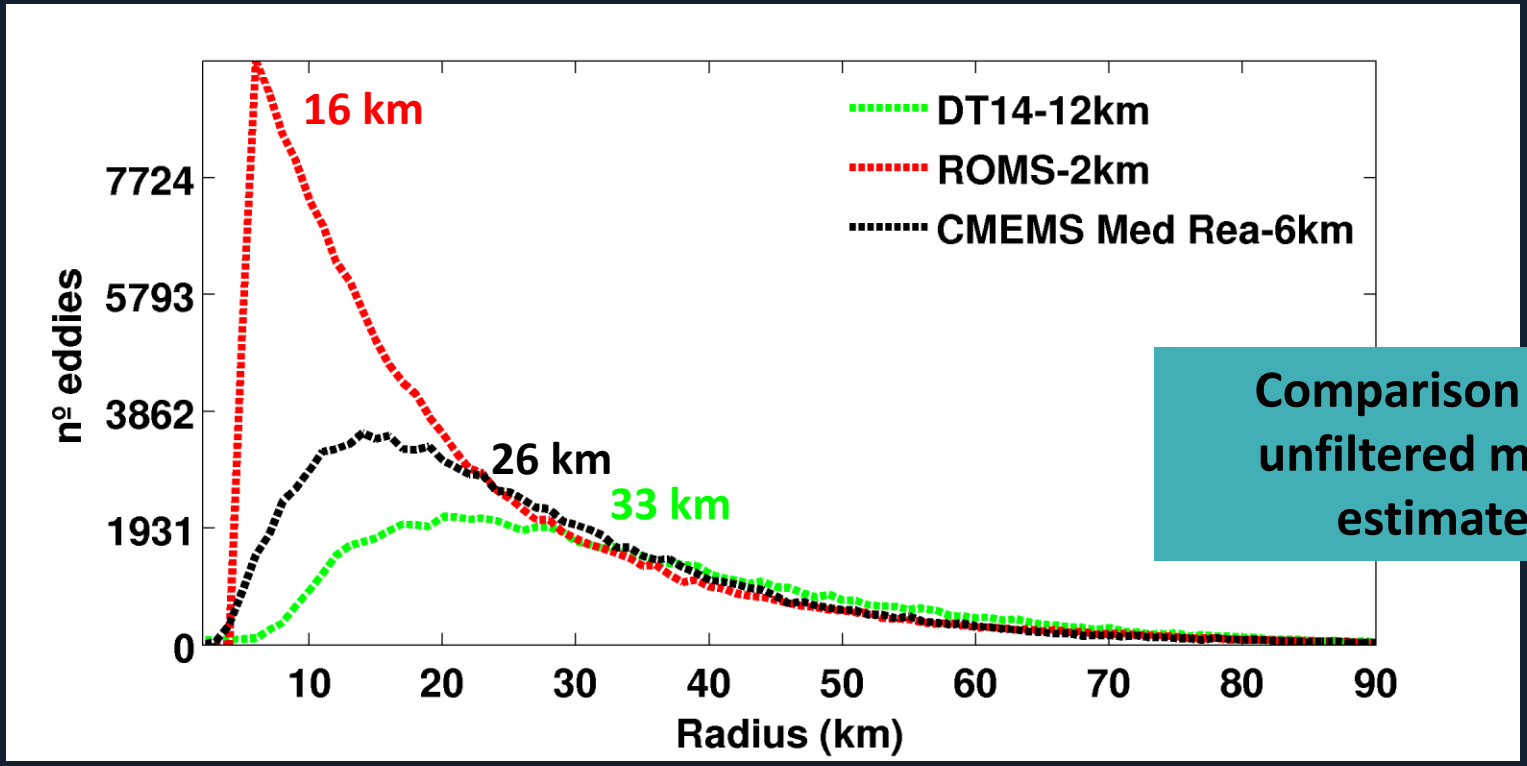
- Downscaling effects on eddies

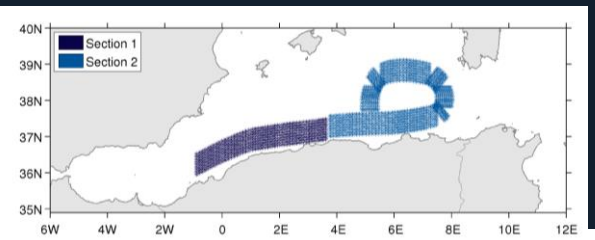


Comparison with unfiltered model estimates

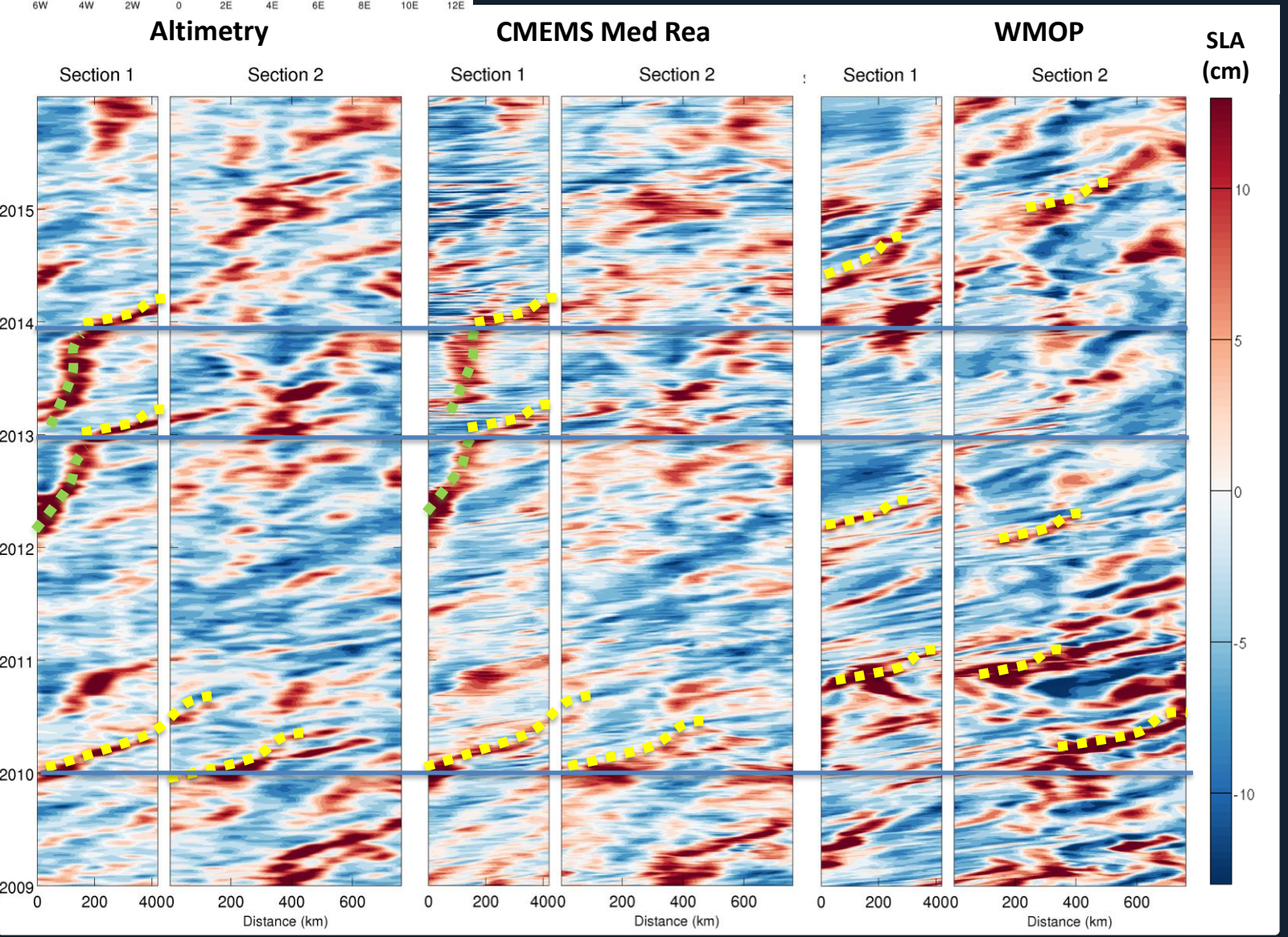
The higher resolution in WMOP leads to a large increase in the number of detected eddies

The mean radius of eddies decreases with the grid resolution

Propagation of eddies



[Escudier et al., 2016]



All sources show, at least, one large eddy per year which moves at **~5km/day.**

WMOP eddies are not synchronous with observations, contrarily to CMEMS model

WMOP is not able to reproduce the lower propagation velocities reported by observations **~1km/day**

TAKE-HOME MESSAGES

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- WMOP improves the **MEAN FLOWS** north of Balearic Islands and in narrow channels as the Gibraltar Strait and Ibiza Channel with respect to CMEMS Med Rea.

- The inter-annual variability of surface currents, which is significantly impacted by the variability of mesoscale structures, is better represented in CMEMS Med Rea than WMOP due to the lack of data assimilation in the latter.

- WMOP (free run) it is not able to properly reproduce **MESOESCALE EDDIES** at the right times and locations, which makes **DATA ASSIMILATION** necessary also in the high-resolution model.

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THANKS FOR YOUR ATTENTION

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Abundance & size of eddies

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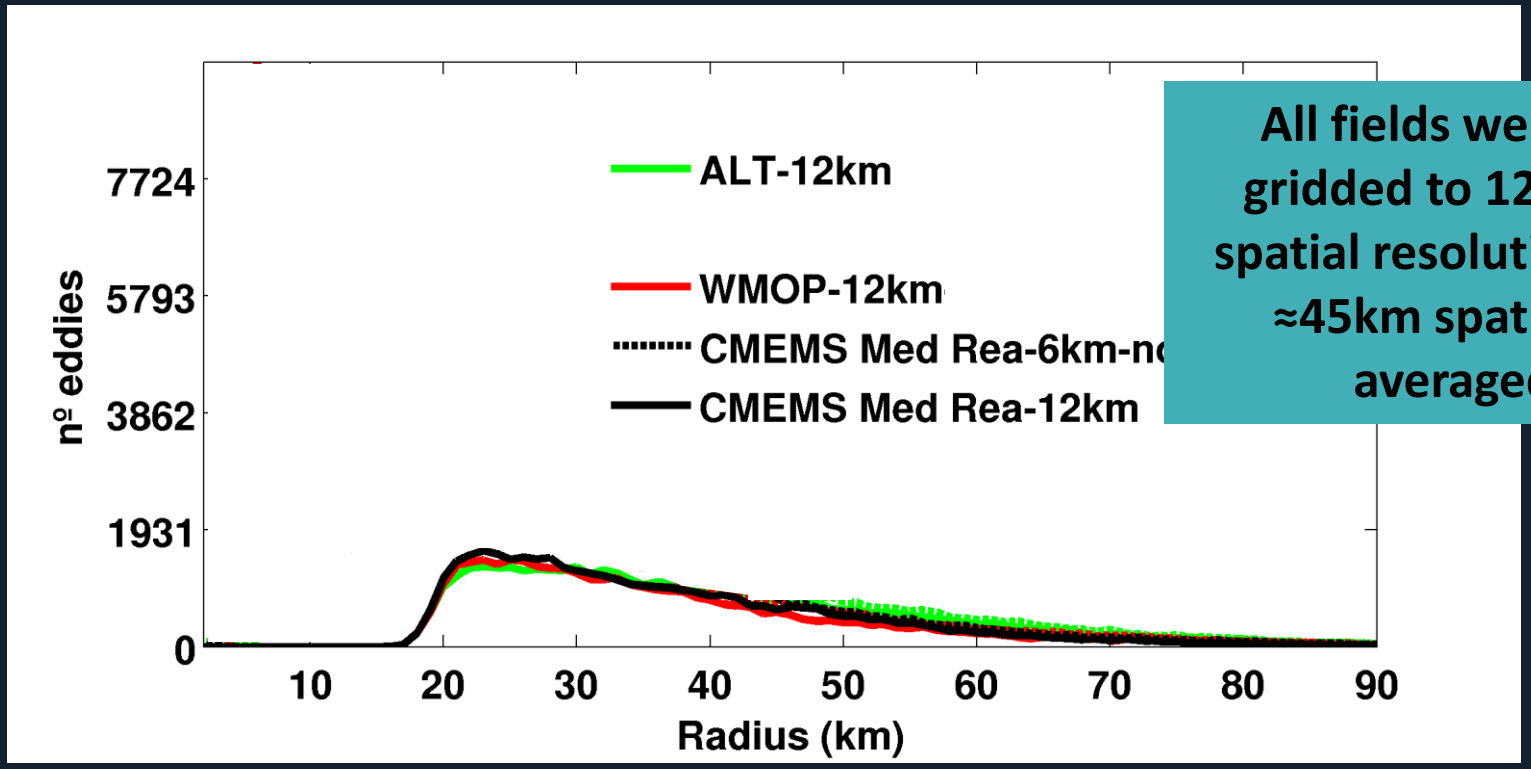
- Eddy tracker as a validation procedure



All fields were re-gridded to 12km of spatial resolution and ≈45km spatially-averaged

The number of eddies produced by both models coincides with observations when spatial filters are applied to match the resolution of altimetry

All datasets report around 8 eddies of 40km radius per day.

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Table 1 Glider missions distributed from 2011 to 2016. There are 37 missions in total. Except during 2011, all the seasons were sampled.

	2011	2012	2013	2014	2015	2016
Jan	X					
Feb	X		X	X	X	X
Mar					X	X
Apr	X	X	X	X		
May	X	X			X	X
Jun	X		X			
Jul		X	X	XX	X	X
Aug						
Sep		X	X		X	X
Oct				X	X	
Nov		X	X		X	X
Dec		X	X	X		

- Both models are statistically in agreement with observations regarding the size and abundance of large **MESOESCALE EDDIES** observed by altimetry.