

WESTERN IBERIA SEA SURFACE SALINITY PATTERNS DUE TO LAND INPUTS.

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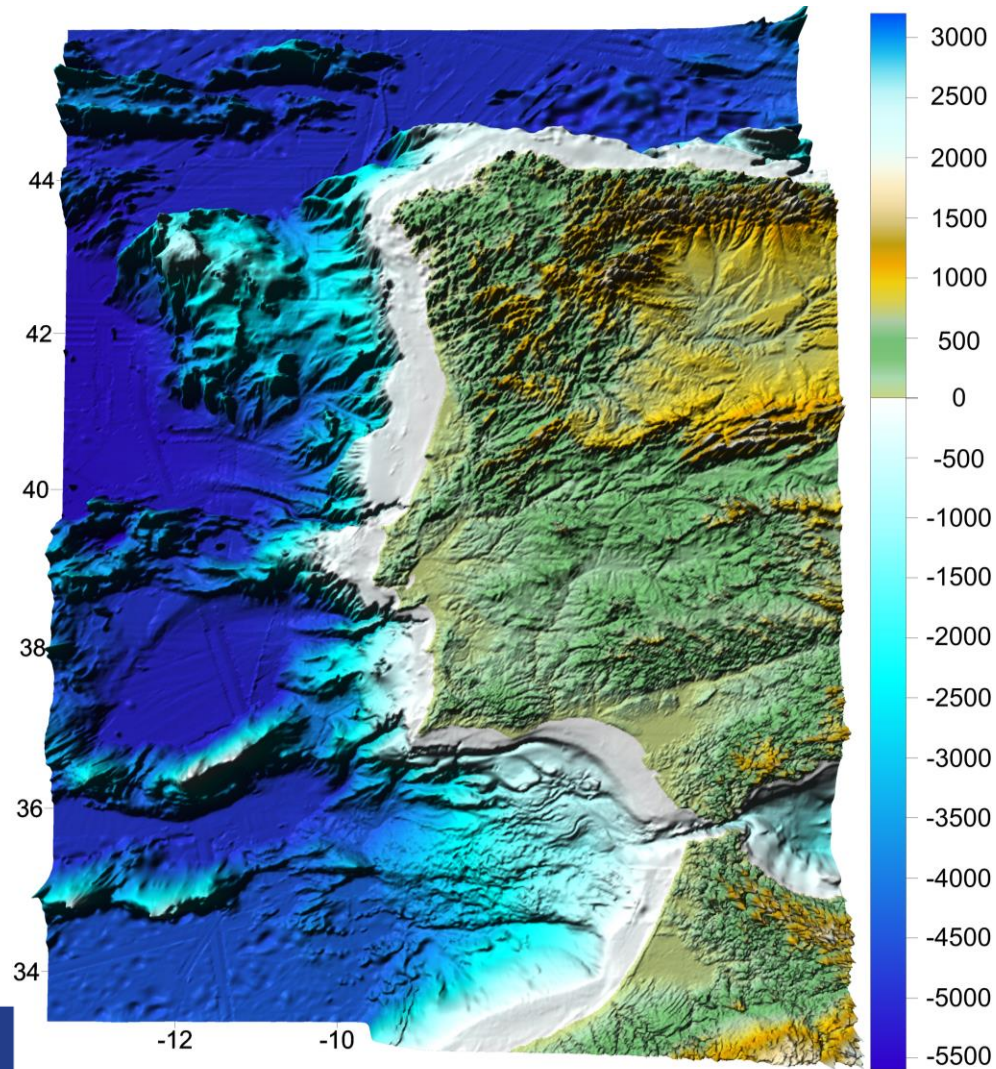
1 MARETEC – Instituto Superior Técnico – Universidade de Lisboa



2 Universidade dos Açores

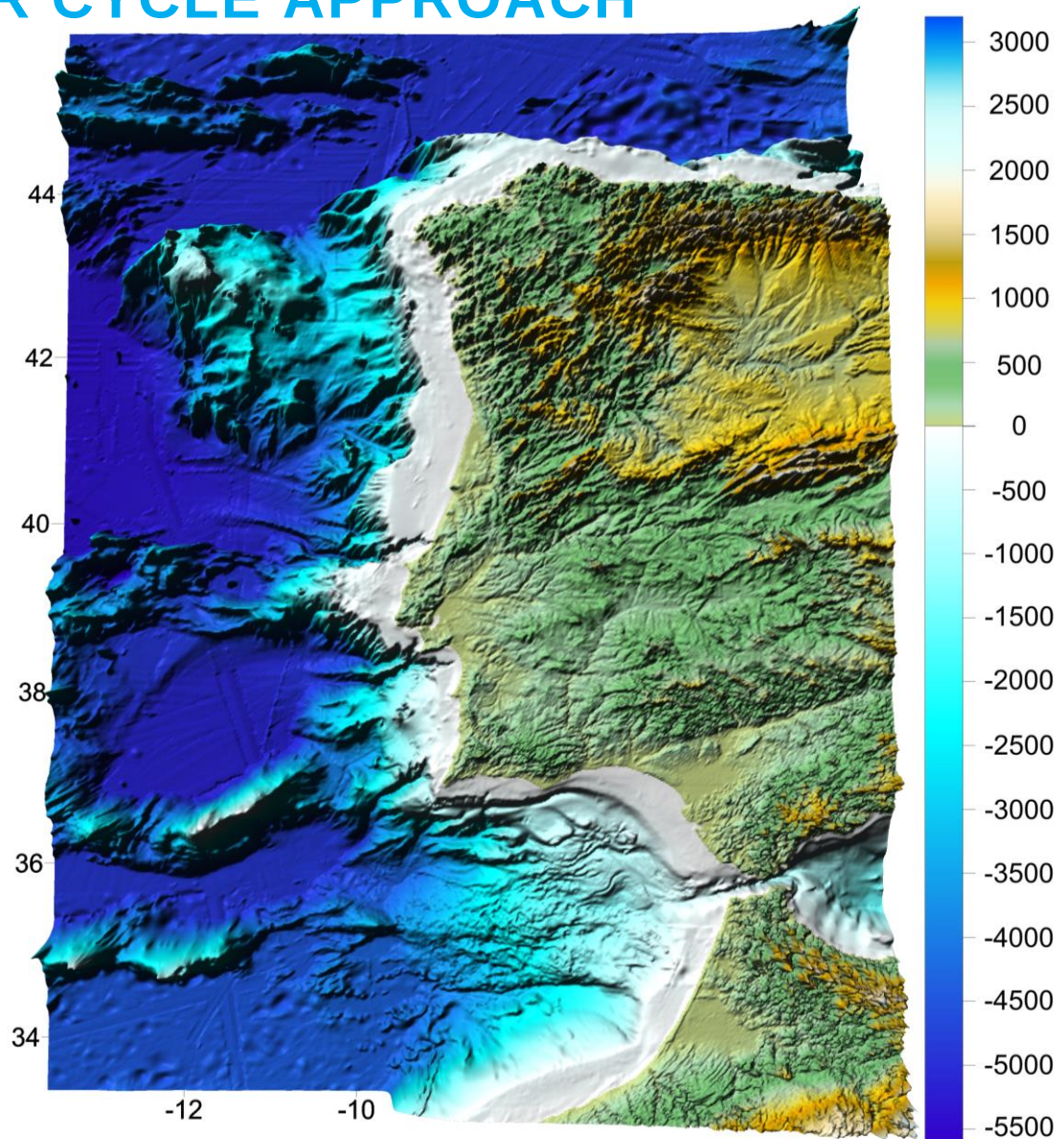


3 Instituto Português do Mar e da Atmosfera, I.P.



A PARADIGM SHIFT: INTEGRATED WATER CYCLE APPROACH

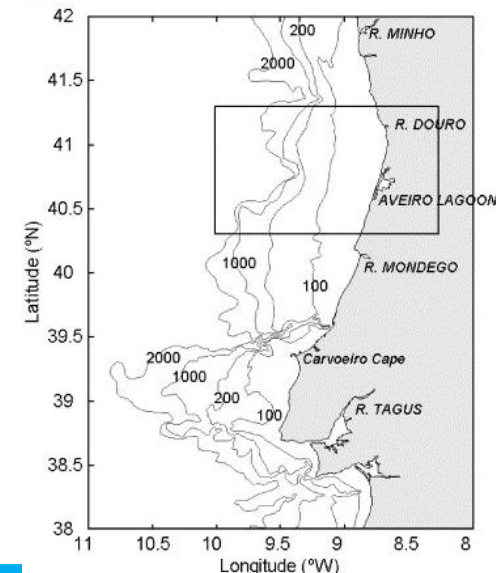
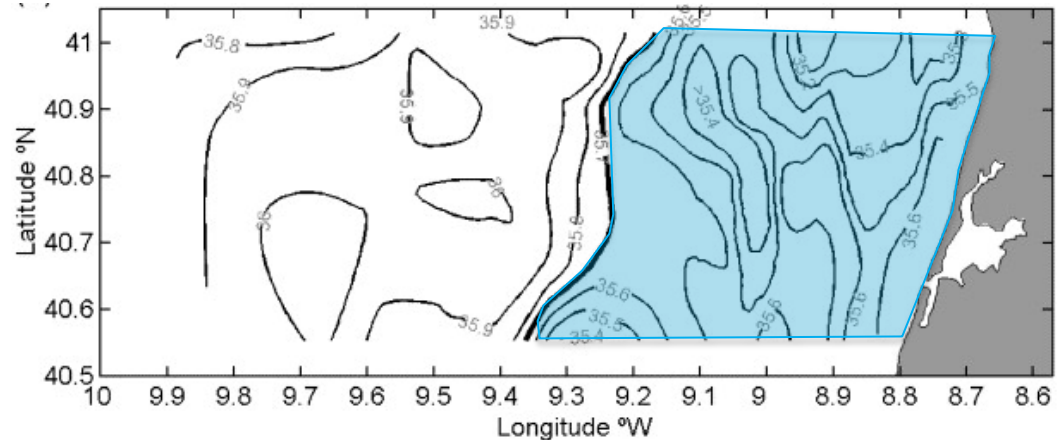
- The main objective of the present research was to **develop a methodology** and to explore the capacity to **improve** the thermohaline circulation in regional ocean model applications by a better characterisation of the **land-ocean boundary conditions** able to represent the salinity features described for the **Western Iberia** region



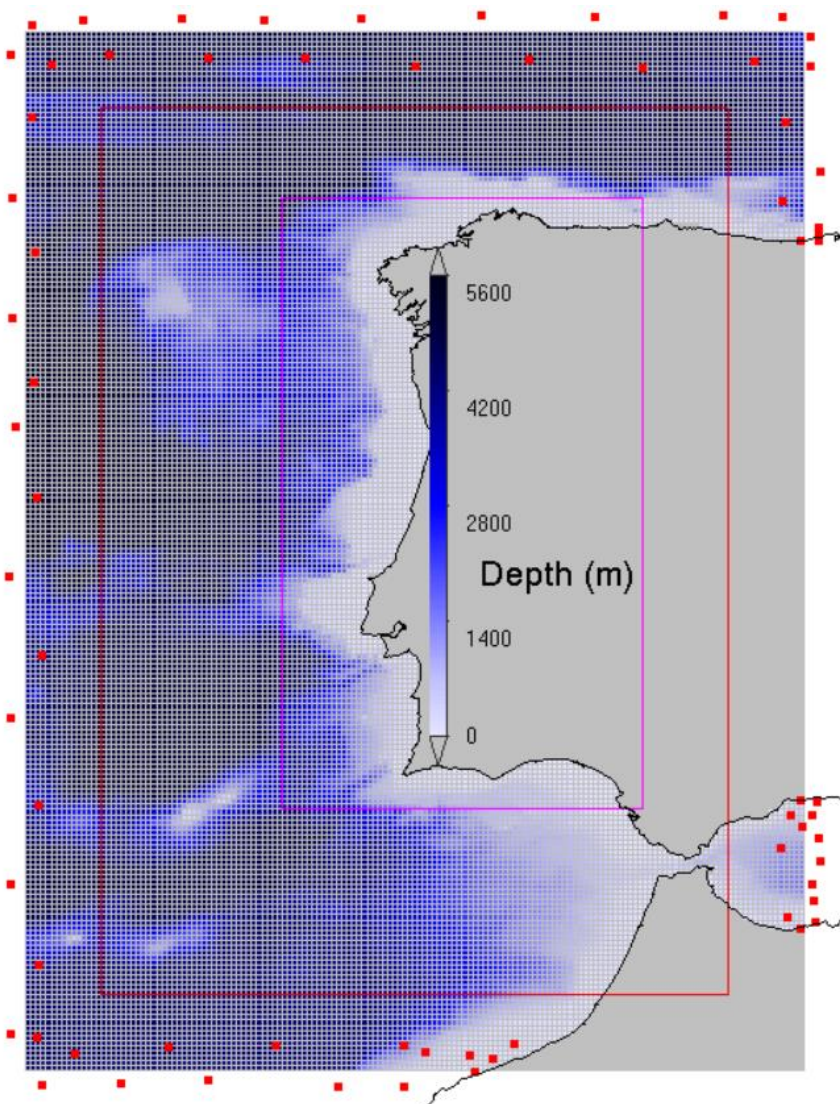
WHAT IS THE WESTERN IBERIA BUOYANT PLUME (WIBP)?

Peliz *et al.* (2002) defined the WIBP as: “the influence of the many terrestrial fresh water sources in the area (Douro, Minho and Mondego, other smaller rivers and the Galician Rias). They originate a low salinity water lens that extends along the coast. Despite the seasonal variation of runoff with significant decrease in summer, this buoyant plume is present all year round”

Peliz Á, Rosa TL, Santos AMP, Pissarra JL. Journal of Marine Systems. 2002; 35(1–2): 61-77. DOI: [10.1016/S0924-7963\(02\)00076-3](https://doi.org/10.1016/S0924-7963(02)00076-3).

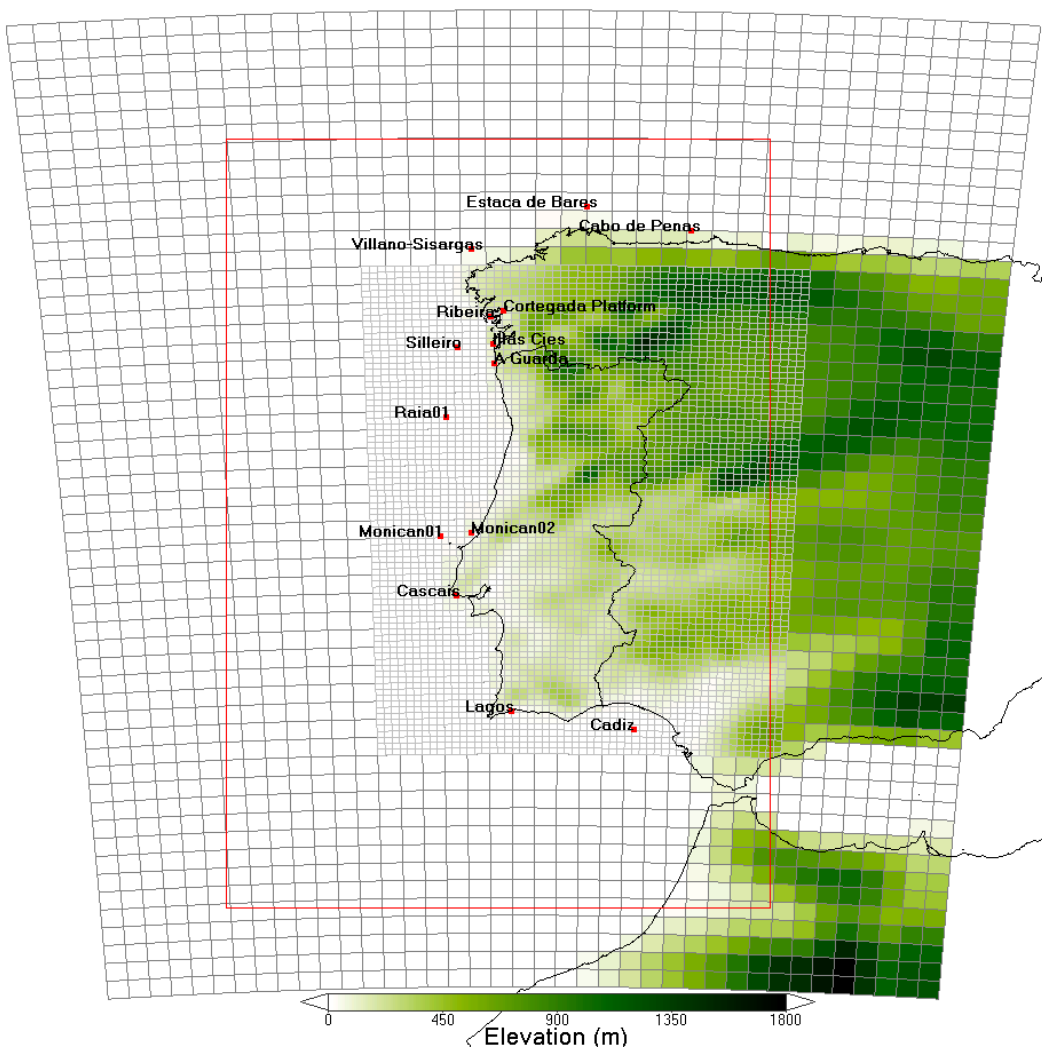


PORTUGUESE COAST OPERATIONAL MODELLING SYSTEM (PCOMS)



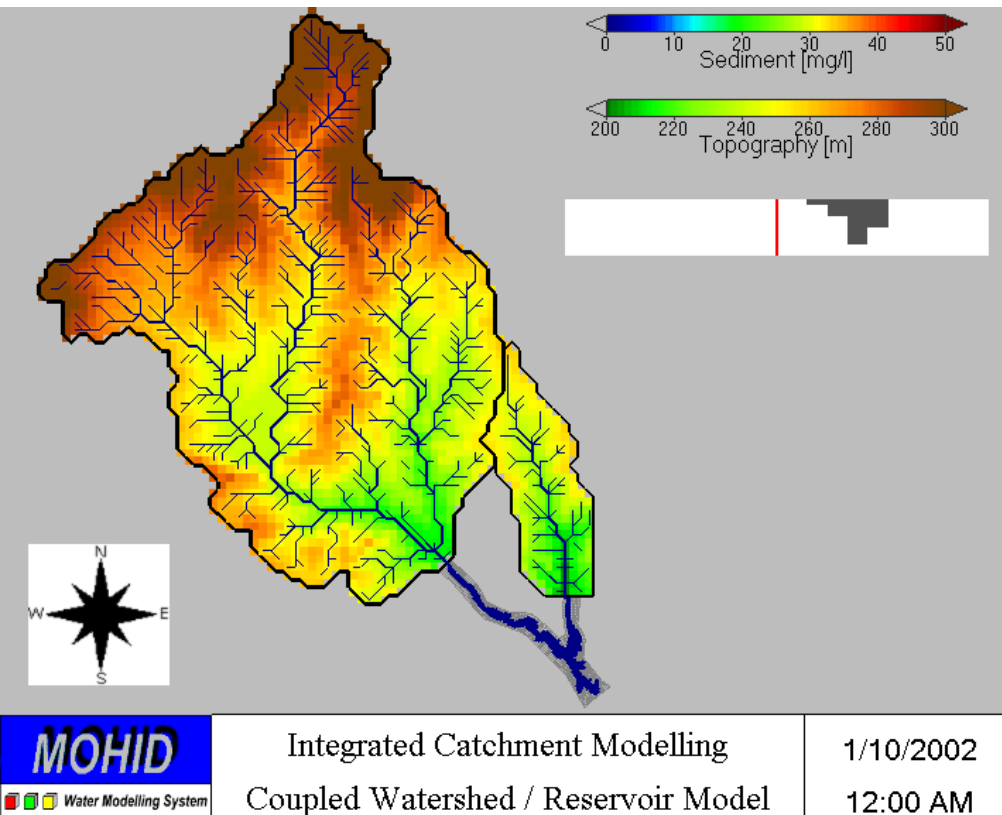
- Based on the [MOHID Water](#) model
- Downscaled from [Mercator-Océan PSY2V4](#)
- Tides from [FES2012](#)
- Two nested domains ($0.06^\circ \approx 6$ km):
 - 2D [WestIberia](#) domain: 208x155 cells
 - 3D [Portugal](#) domain: 177x125 cells
- Hybrid vertical configuration corresponding to 7 [Sigma](#) layers on top of 43 [Cartesian](#) layers
- Daily run: yesterday, today plus 4-day forecasts
- Weekly run: previous fortnight period
- NPZD biogeochemical model forced by nitrate, phosphate and oxygen 3D climatology fields from World Ocean Atlas 2009 ([WOA09](#)).
- Meteorological forcing from [MM5](#) Model application

METEOROLOGICAL FORCING



- Based on the **MM5** model
- Two nested domains with different horizontal resolution:
 - **27 km** domain:
 - **9 km** domain:
- **MOHID** atmosphere and interface water air modules use the following MM5 fields:
 - air temperature,
 - atmospheric pressure,
 - relative humidity,
 - solar radiation,
 - wind velocity X and Y components
 - downward long wave radiation.

MOHID WATERSHED MODELLING

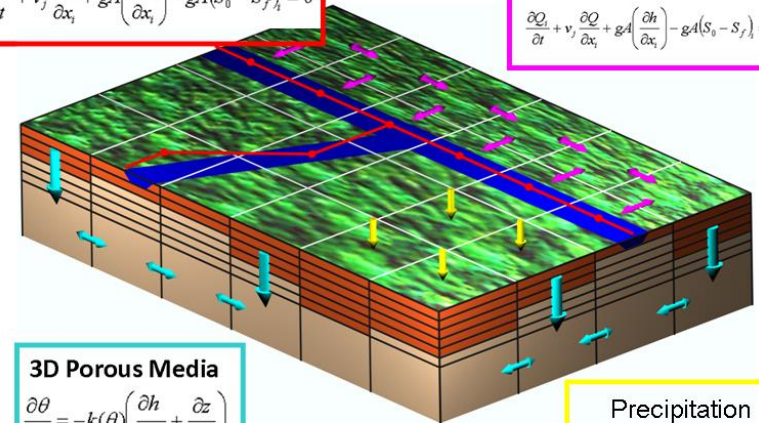


1D Drainage Network

$$\frac{\partial Q_i}{\partial t} + v_j \frac{\partial Q}{\partial x_i} + gA \left(\frac{\partial h}{\partial x_i} \right) - gA(S_0 - S_f)_i = 0$$

2D Overland Flow

$$\frac{\partial Q_i}{\partial t} + v_j \frac{\partial Q}{\partial x_i} + gA \left(\frac{\partial h}{\partial x_i} \right) - gA(S_0 - S_f)_i = 0$$



3D Porous Media

$$\frac{\partial \theta}{\partial t} = -k(\theta) \left(\frac{\partial h}{\partial x_i} + \frac{\partial z}{\partial x_i} \right)$$

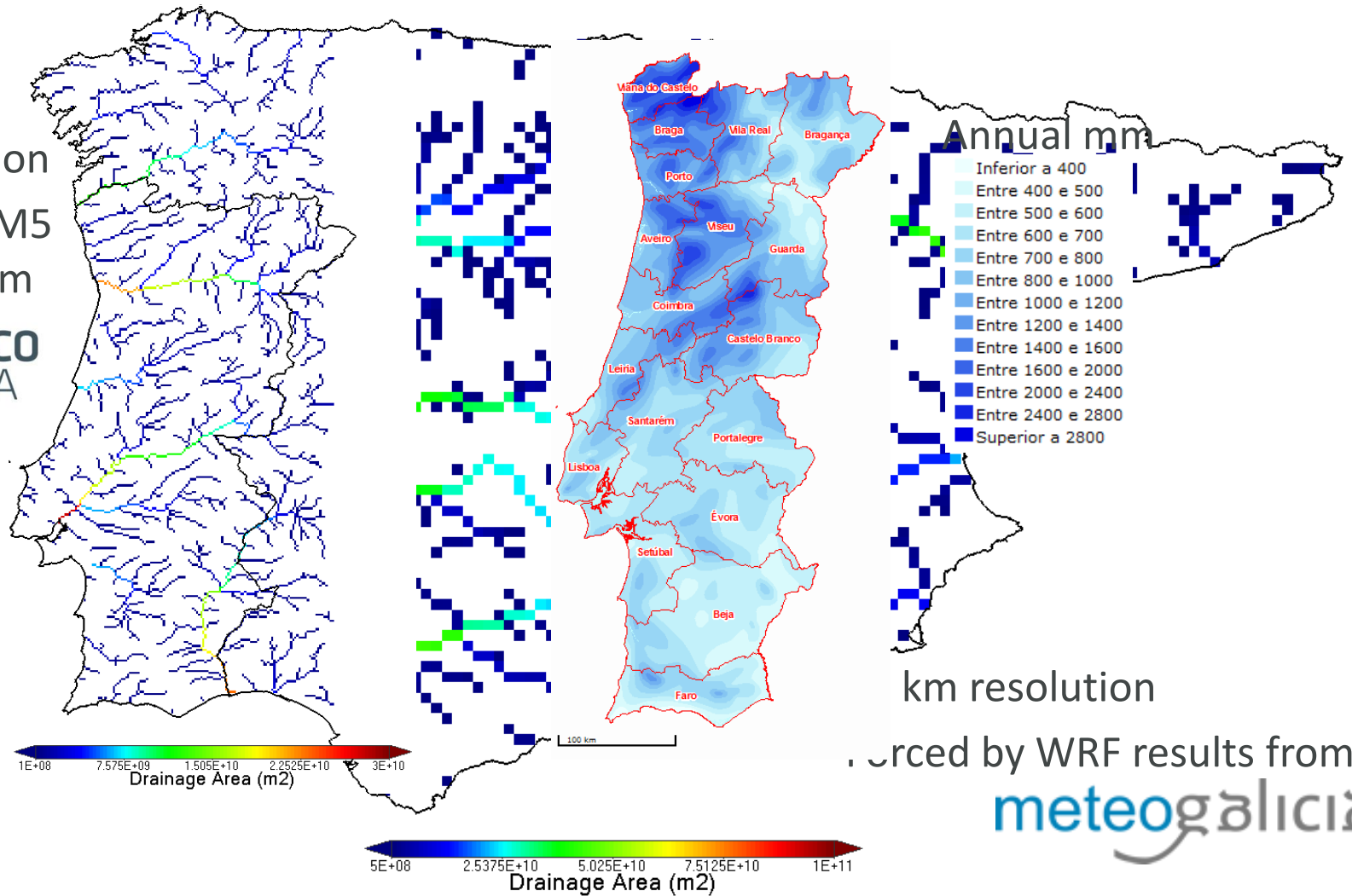
Precipitation
Variable in Time
& Space

WATERSHEDS MODELLING SETUP

Integrating operational watershed and coastal models for the Iberian Coast: Watershed model implementation – A first approach

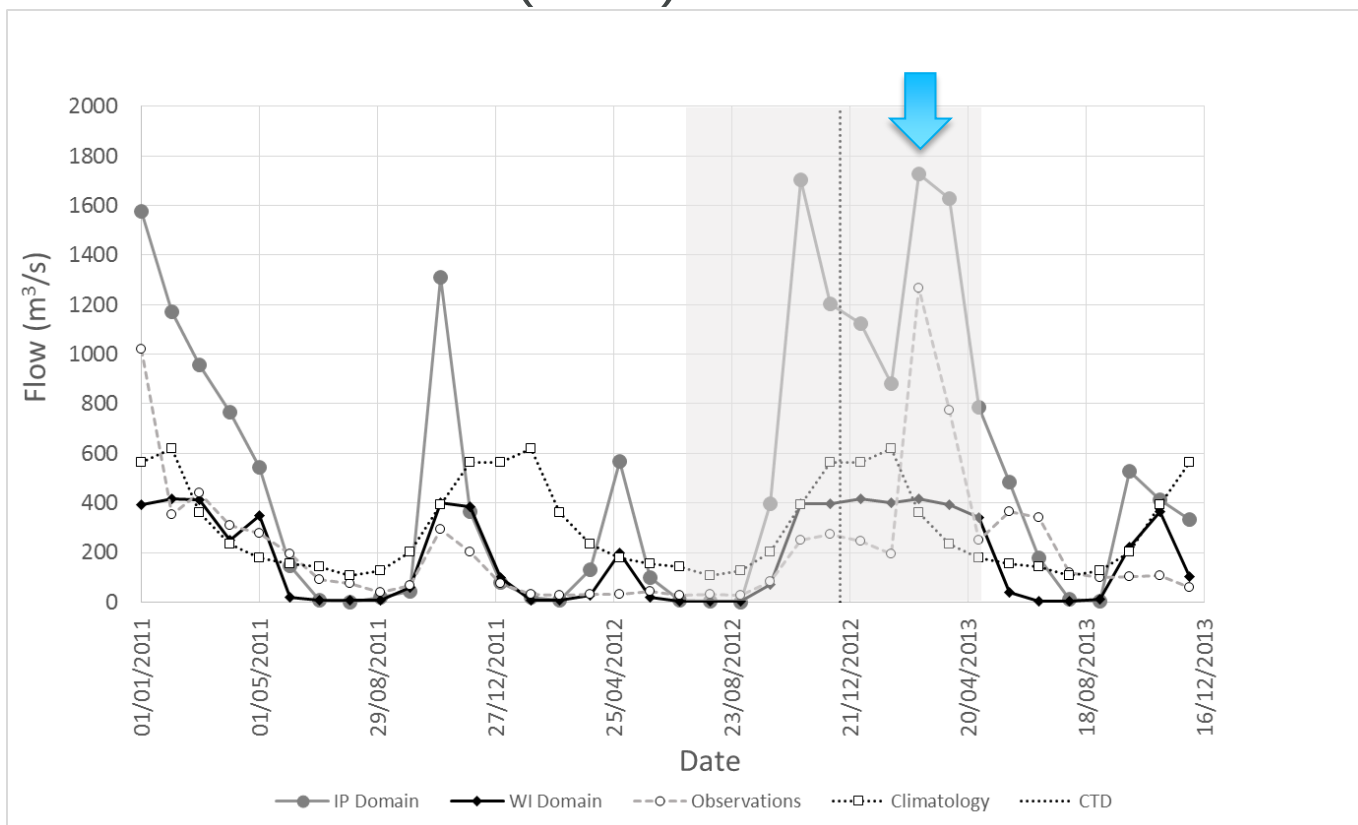
David Brito, F.J. Campuzano , J. Sobrinho, R. Fernandes, R. Neves

2 km resolution
Forced by MM5
results from



TAGUS ESTUARY MODELLING SCENARIOS

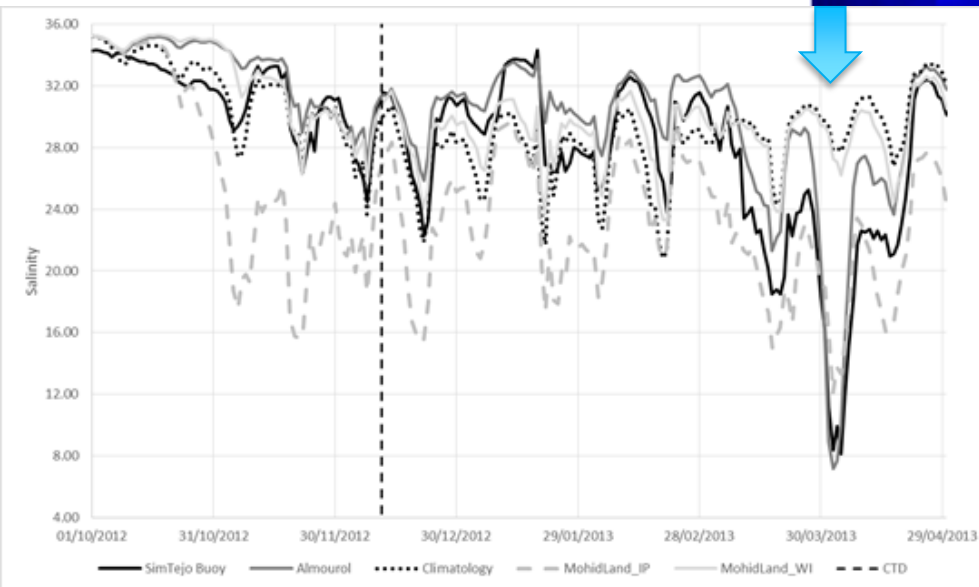
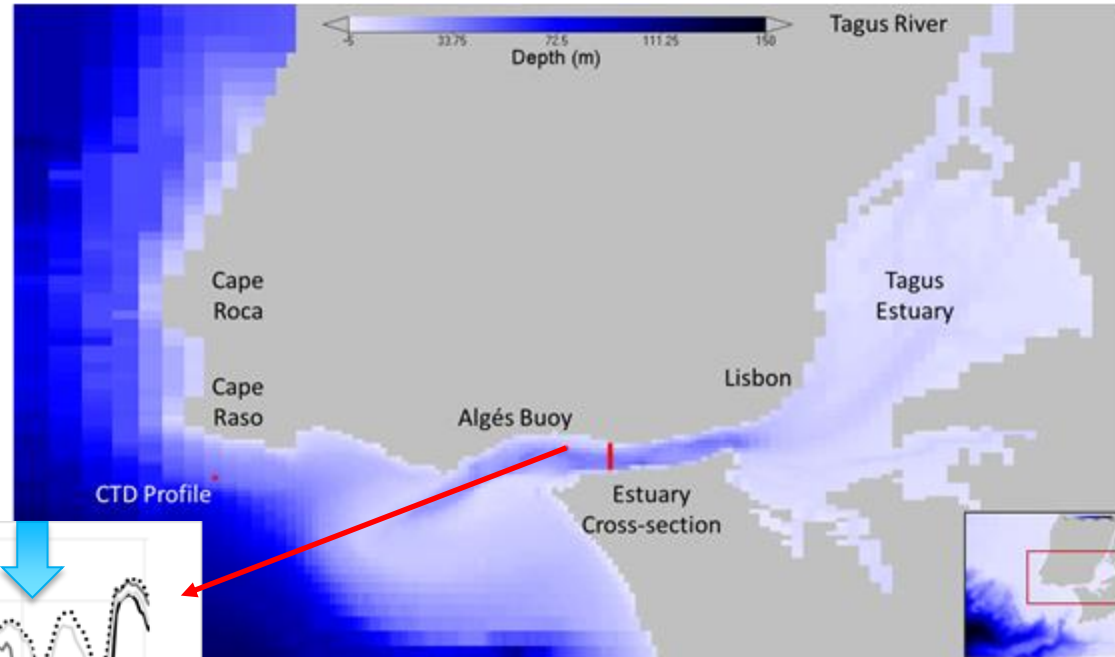
- River Hydrometric Observations (Almourol) (Source: SNIRH-APA)
- River Climatology
- MOHID Land IP (10 km)
- MOHID Land WI (2 km)



METHOD VALIDATION – ALGES BUOY

■ October 2012-April 2013

	R ²	RMSE
Algés Buoy vs Almourol	0.89	2.55
Algés Buoy vs Climatology	0.20	4.71
Algés Buoy vs MohildLand_IP	0.58	5.67
Algés Buoy vs MohildLand_WI	0.40	4.31



[Ocean Dynamics](#)

December 2016, Volume 66, [Issue 12](#), pp 1745–1756

Coupling watersheds, estuaries and regional ocean through numerical modelling for Western Iberia: a novel methodology

Authors

[Authors and affiliations](#)

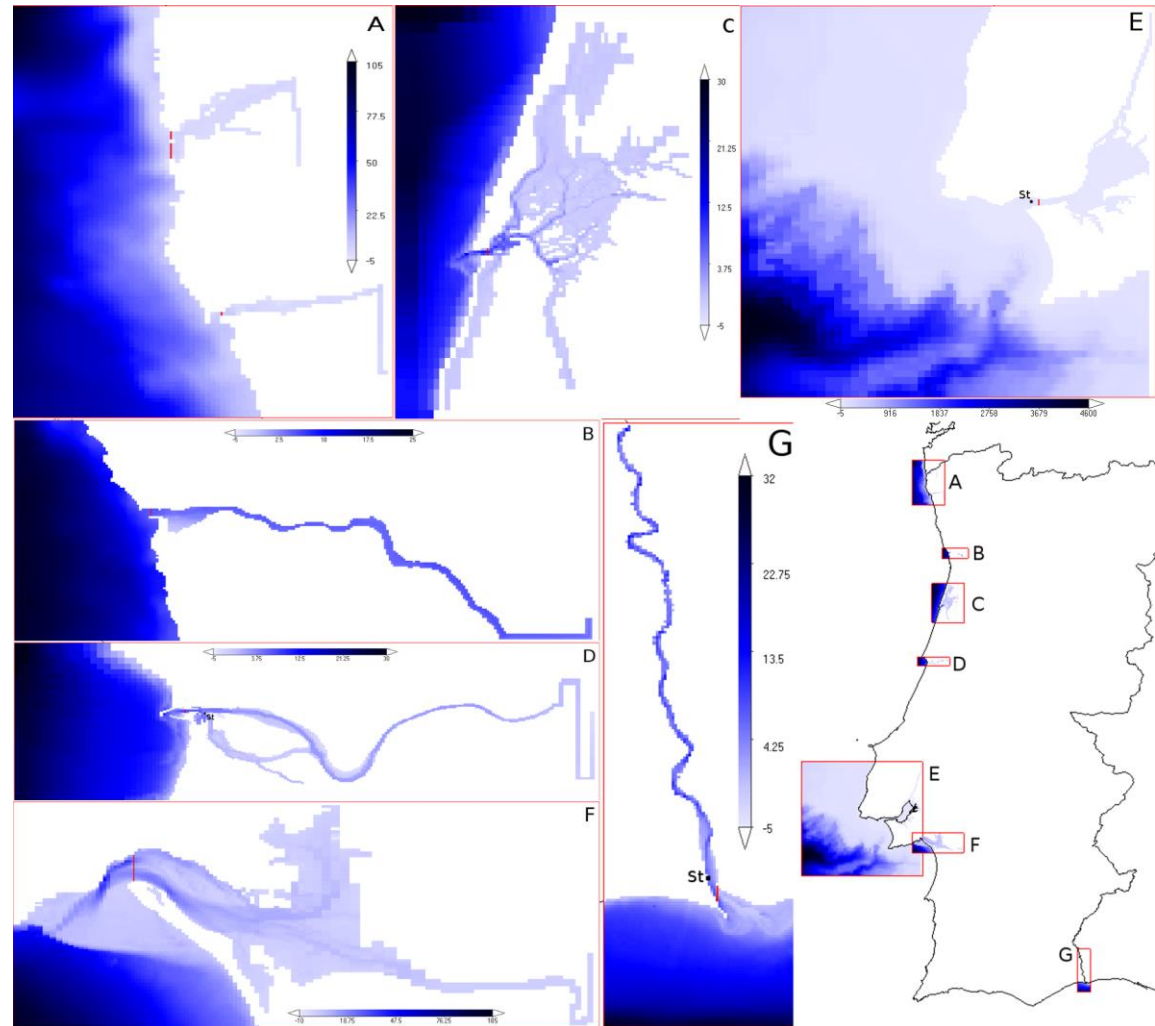
Francisco Campuzano , David Brito, Manuela Juliano, Rodrigo Fernandes, Hilda de Pablo, Ramiro Neves

Algés Buoy Data provided by



ESTUARY IMPLEMENTATION

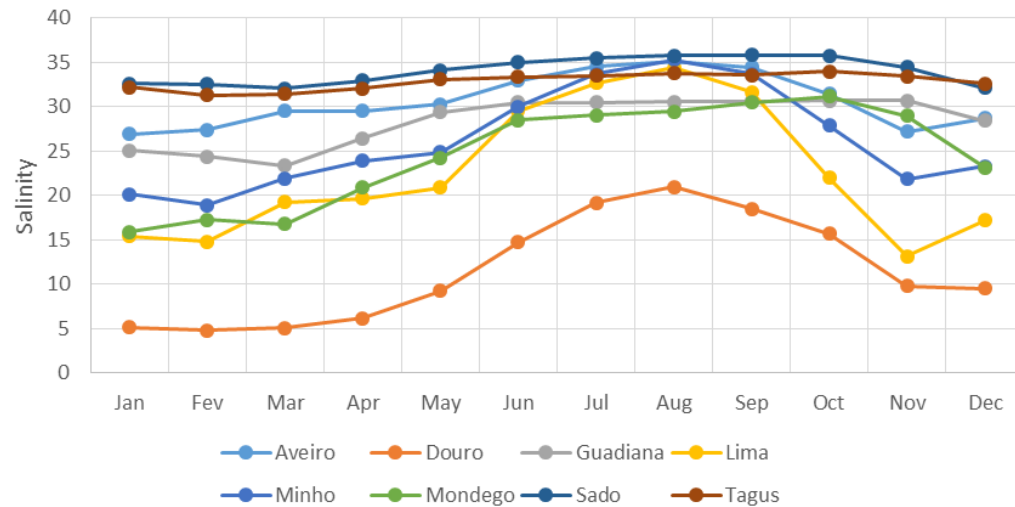
- River flow forcing:
 - A (top): Minho (MOHID Land WI)
 - A (bottom): Lima (MOHID Land WI)
 - B: Douro (SNIRH/APA)
 - C: Aveiro (MOHID Land WI)
 - D: Mondego (SNIRH/APA)
 - E: Tagus (SNIRH/APA)
 - F: Sado (MOHID Land WI)
 - G: Guadiana (SNIRH/APA)
- River temperature provided in all cases by MOHID Land WI.



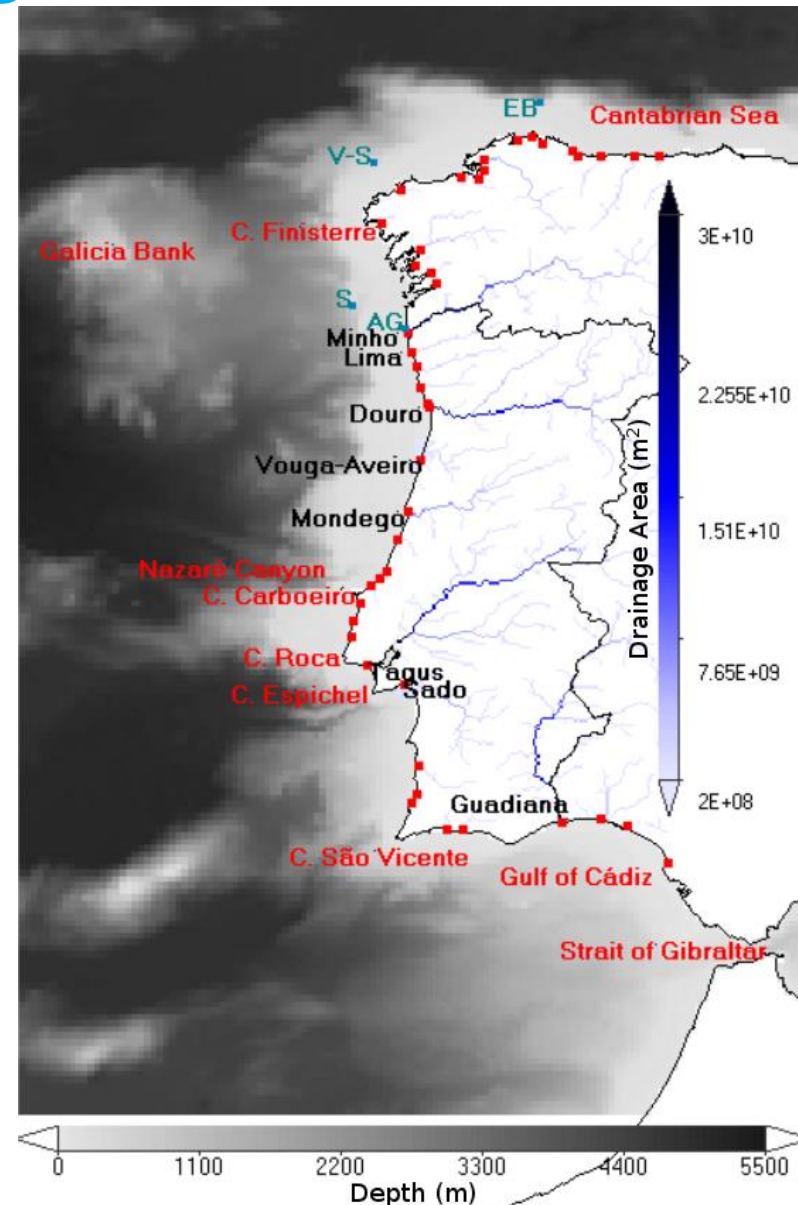
Campuzano FJ, Juliano M, Sobrinho J, de Pablo H, Brito D, Fernandes R, Neves R (accepted). Coupling Watersheds, Estuaries and Regional Oceanography through Numerical Modelling in the Western Iberia: Thermohaline Flux Variability at the Ocean-Estuary Interface. In: Estuary. W. Froneman (Ed), InTech, Rijeka, Croatia. DOI: [10.5772/intechopen.72162](https://doi.org/10.5772/intechopen.72162).

PCOMS VERSION WITH RIVERS

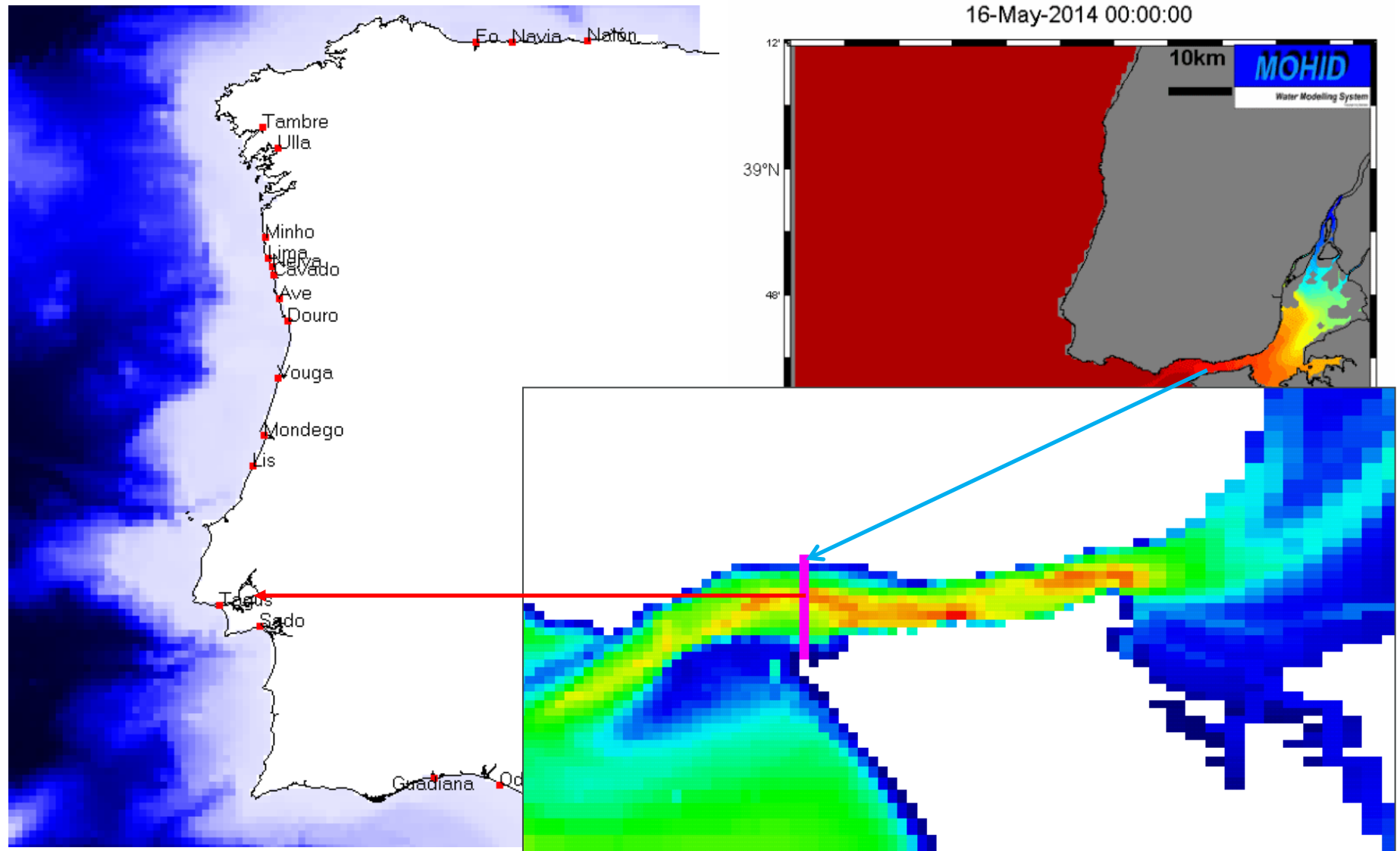
- 44 River discharges:
- 8 estuarine fluxes
- 36 direct river discharges with constant salinity value of 32



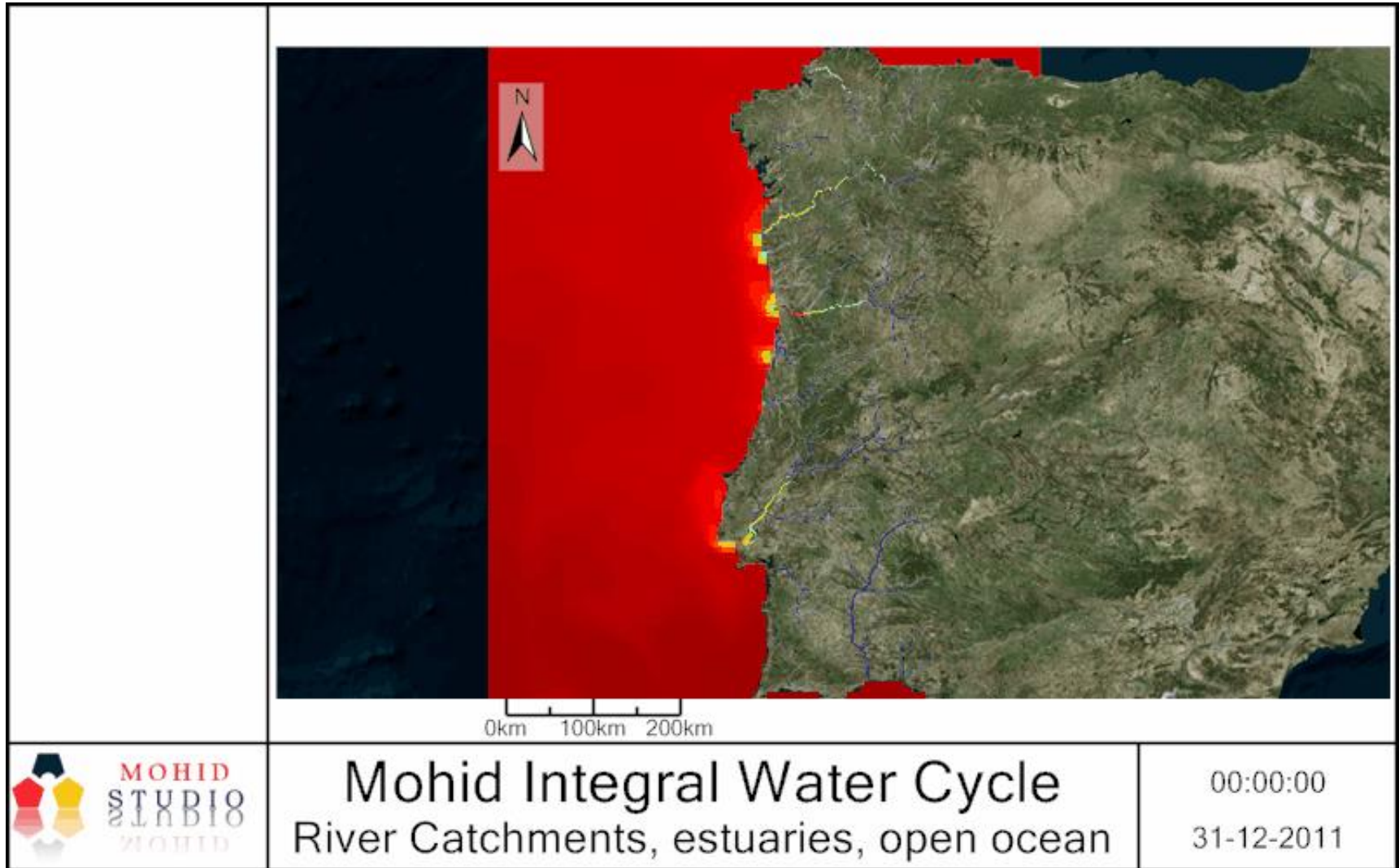
Campuzano FJ, Juliano M, Sobrinho J, de Pablo H, Brito D, Fernandes R, Neves R (2018). Coupling Watersheds, Estuaries and Regional Oceanography through Numerical Modelling in the Western Iberia: Thermohaline Flux Variability at the Ocean-Estuary Interface. In: Estuary. W. Froneman (Ed), InTech, Rijeka, Croatia. DOI: [10.5772/intechopen.72162](https://doi.org/10.5772/intechopen.72162).



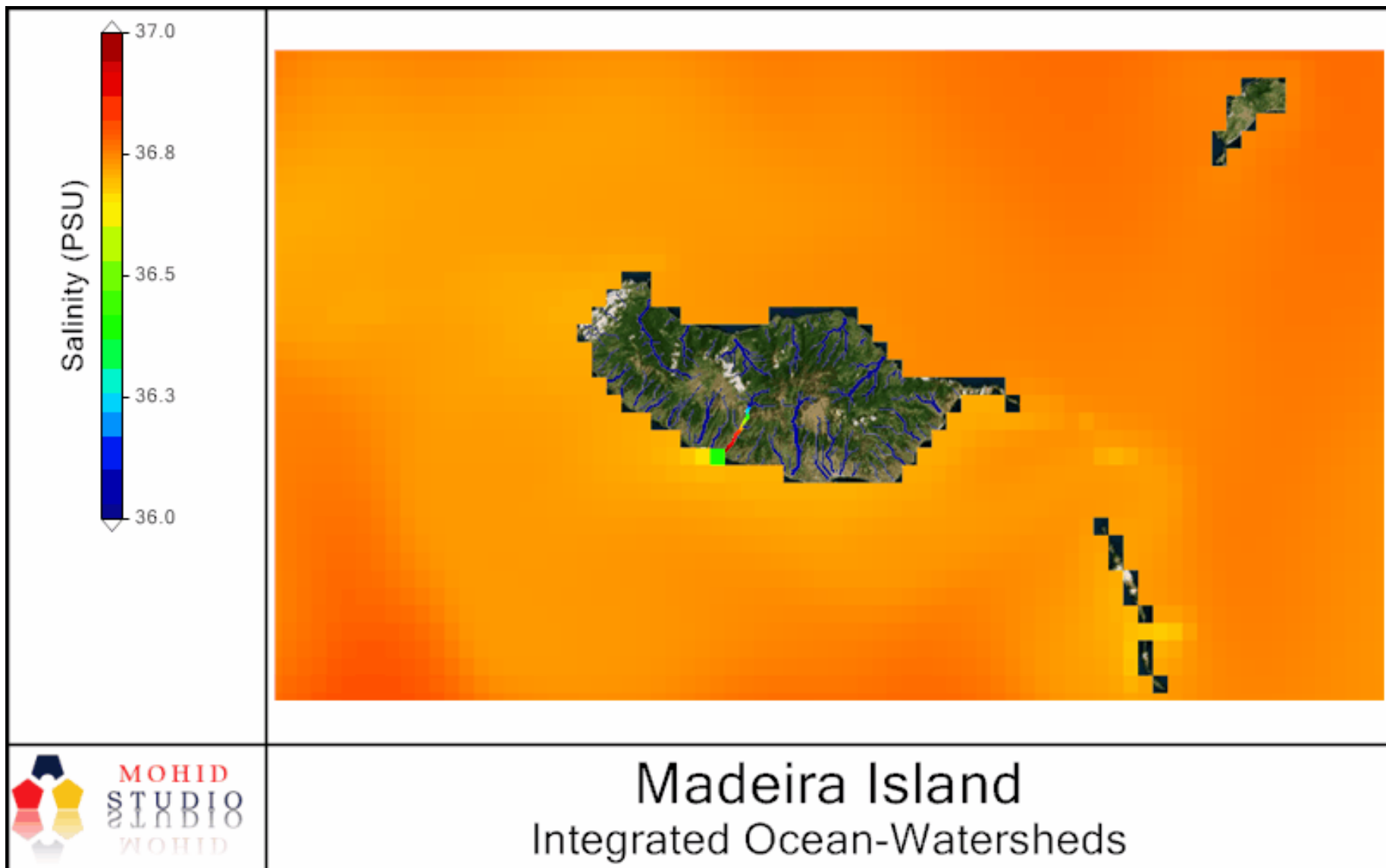
RIVER-ESTUARY-OCEAN COUPLING



MOHID INTEGRAL WATER CYCLE IN THE PORTUGUESE CONTINENTAL COAST



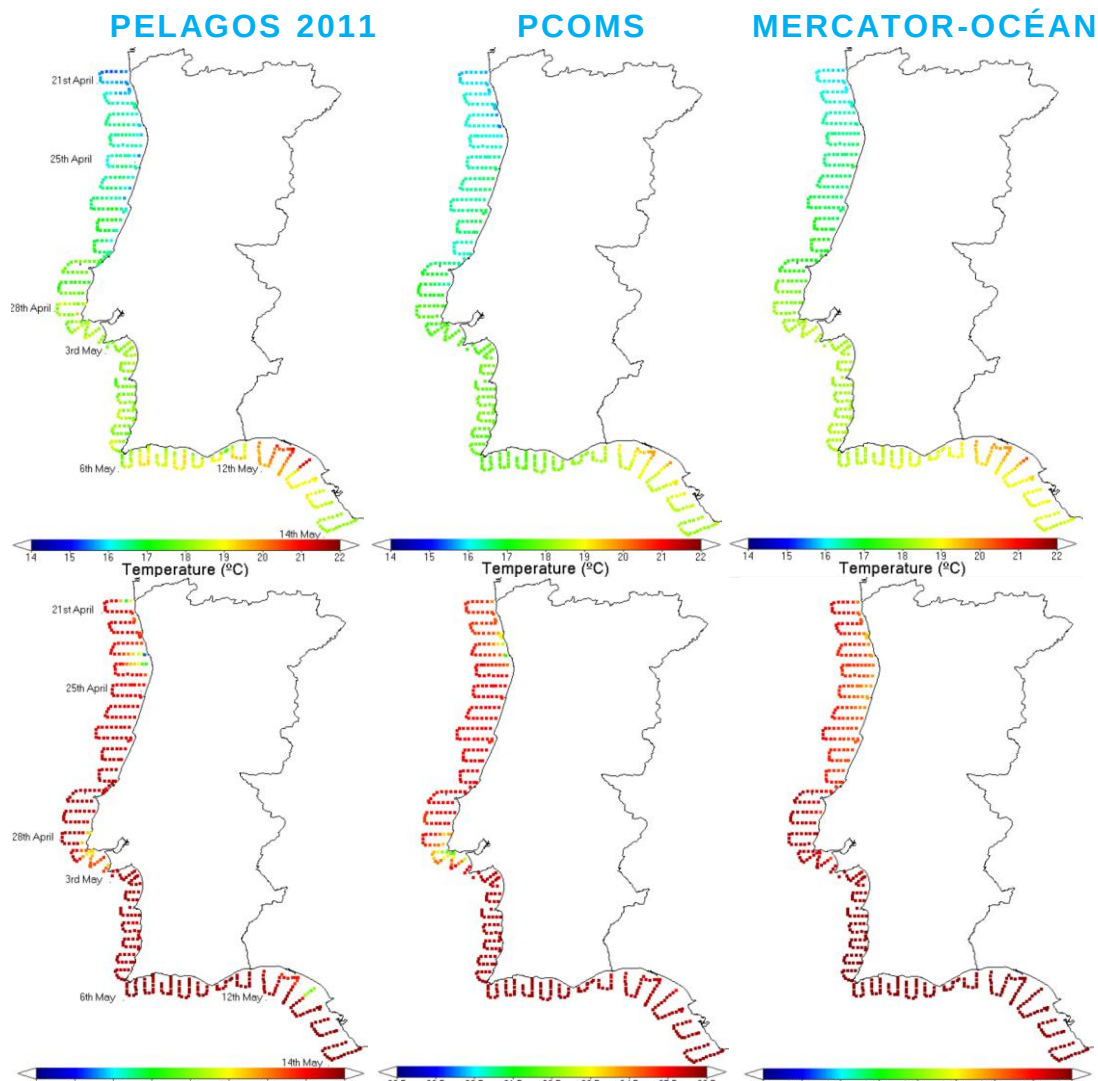
INTEGRATED OCEAN-WATERSHEDS IN MADEIRA ISLAND



PELAGOS 2011 CRUISE



Data provided
by M. M.
Angélico and P.
Oliveira from



	Temperature (°C) (N=466)				Salinity (N=466)			
	Mean (Min.-Max.)	R ²	Bias	RMSE	Mean (Min.-Max.)	R ²	Bias	RMSE
PCOMS	17.34 (15.49-19.90)	0.87	-0.44	0.66	35.66 (31.86-36.36)	0.38	-0.14	0.67
MERCATOR	17.83 (15.87-20.38)	0.89	0.05	0.42	35.87 (33.88-36.43)	0.17	0.08	0.77
PELAGOS11	17.78 (15.25-21.40)	-	-	-	35.80 (29.90-36.43)	-	-	-

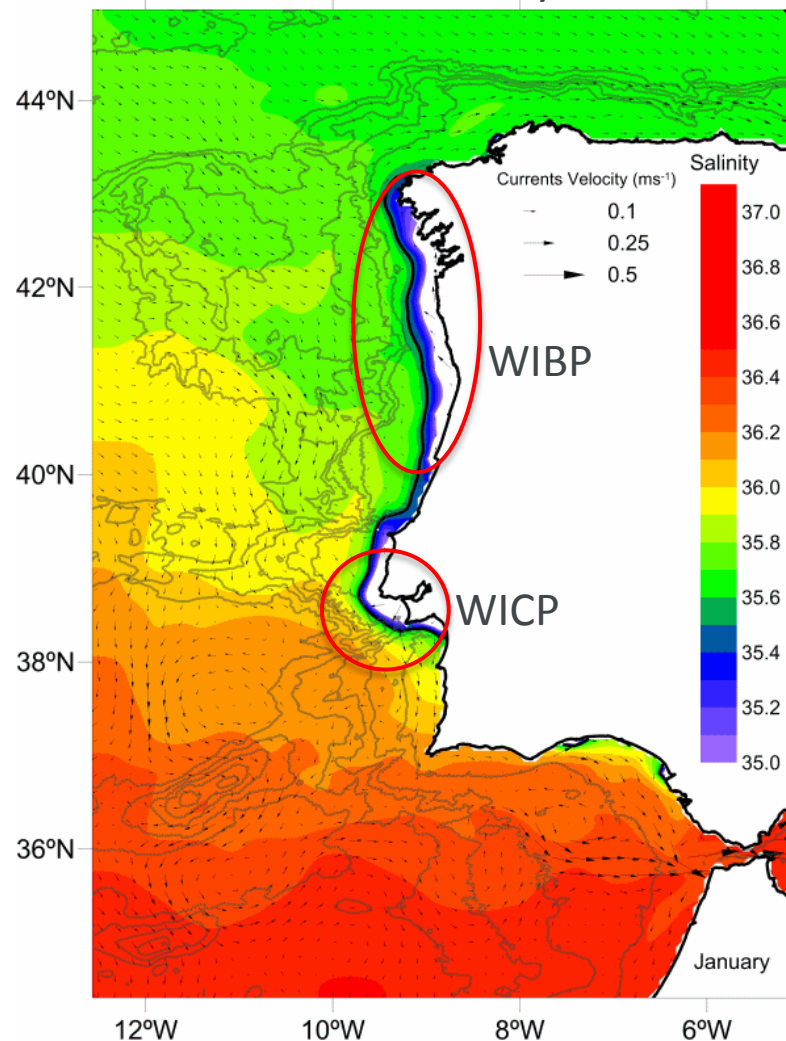
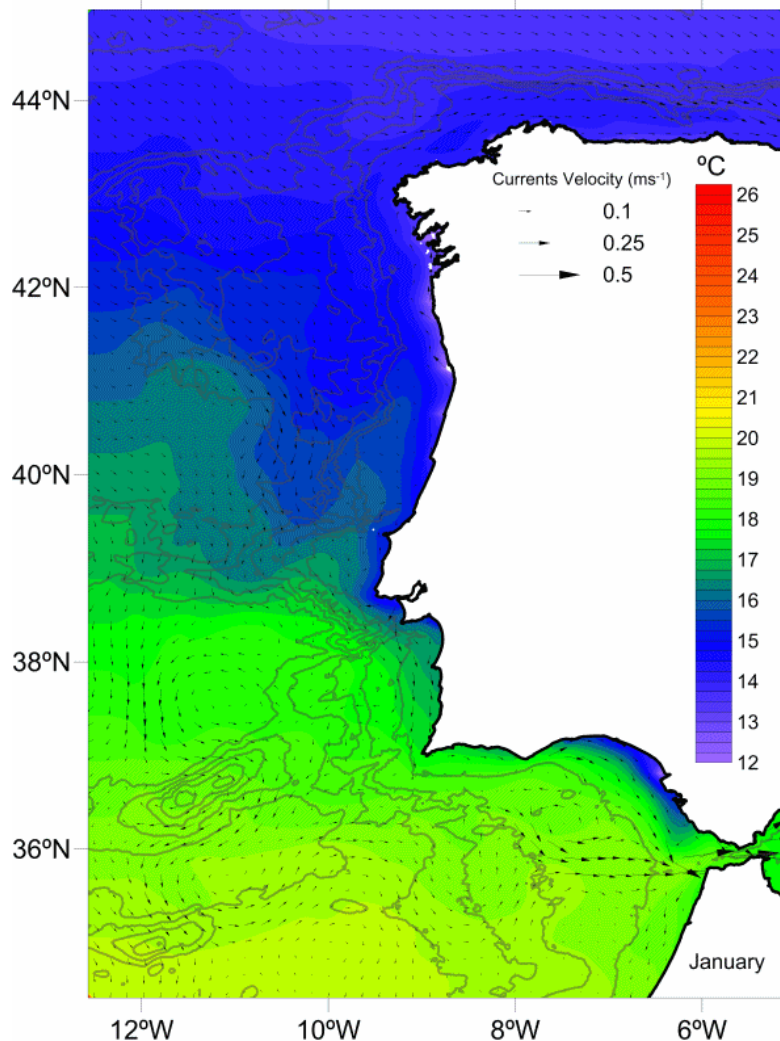
MONTHLY CLIMATOLOGY 2011-2015 PERIOD

WIBP = Western Iberia Buoyant Plume

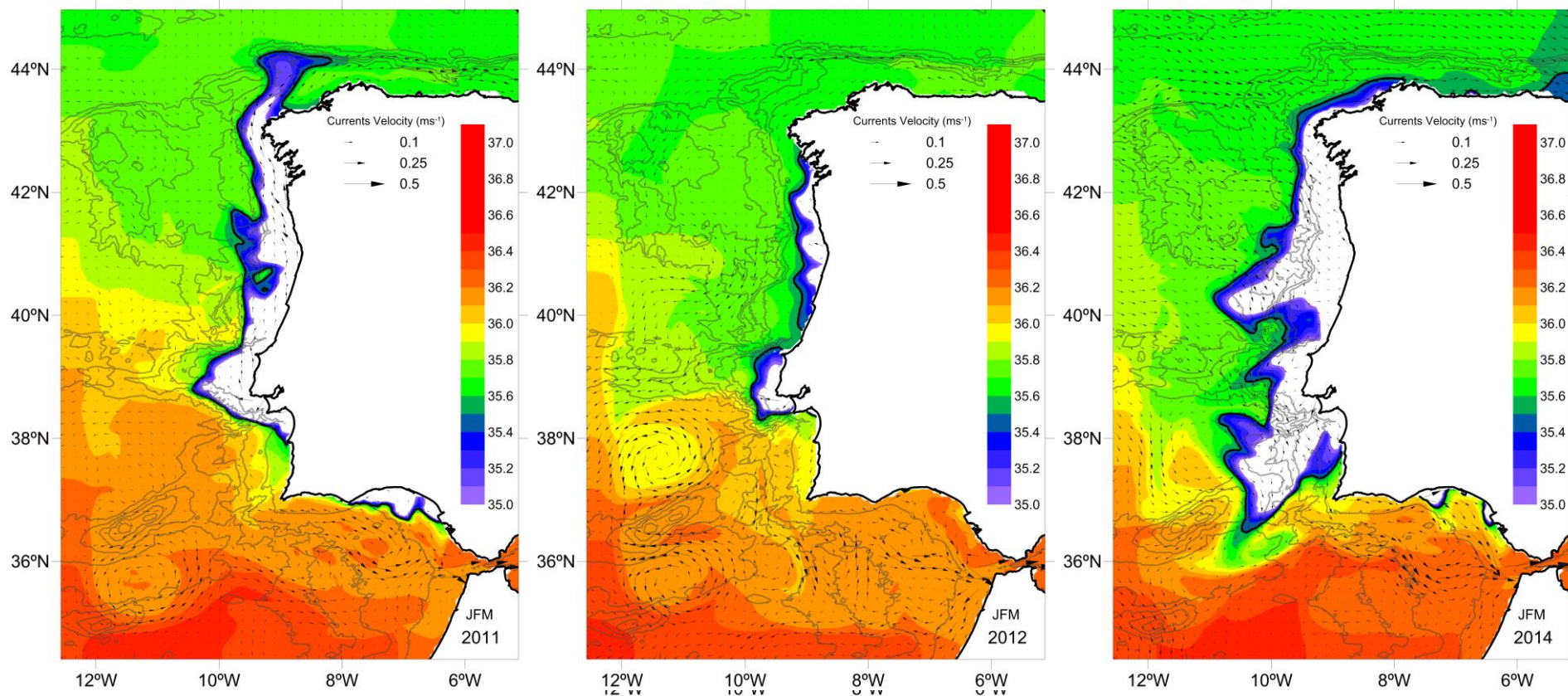
WICP = Western Iberia Central Plume

White values indicate salinity below 35

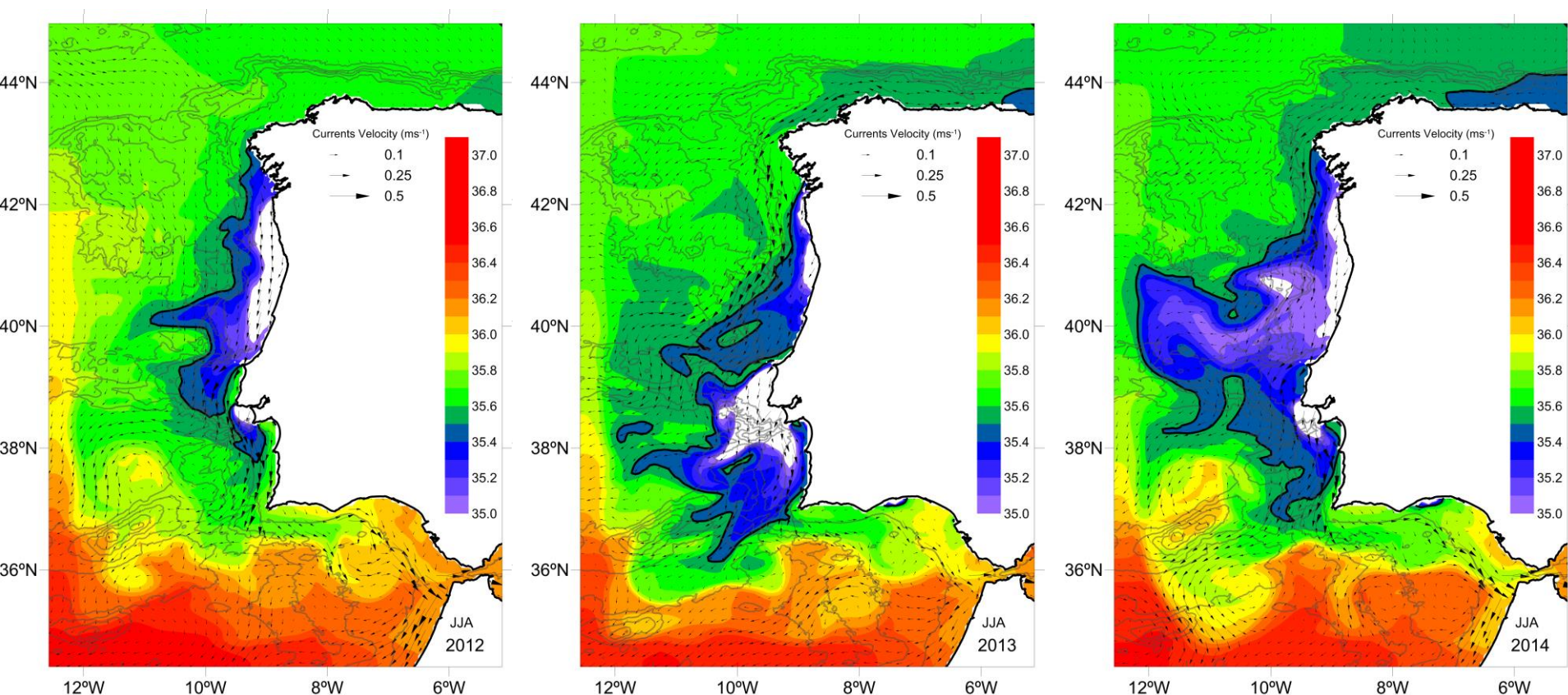
Dark line contours salinity 35.5



MEAN AND P05 SALINITY FOR RAINY SEASON (JFM)



MEAN AND P05 SALINITY FOR DRY SEASON (JJA)

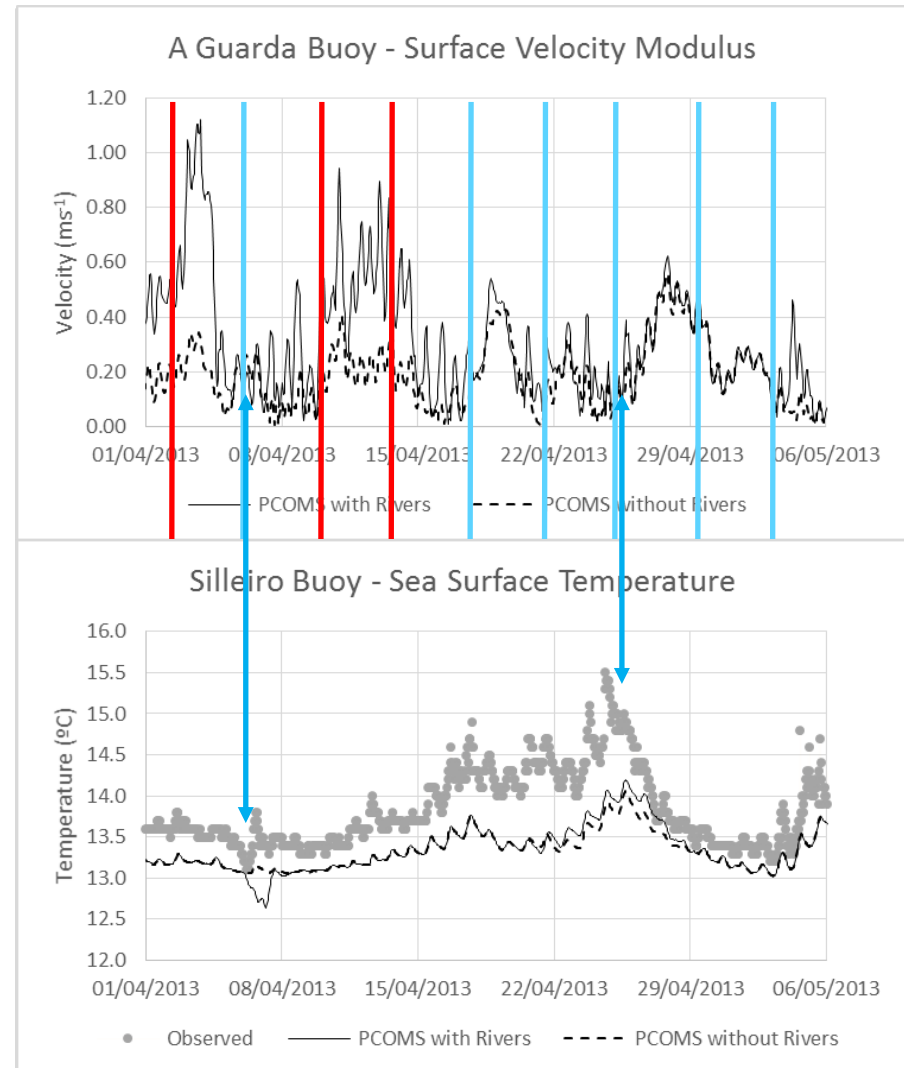
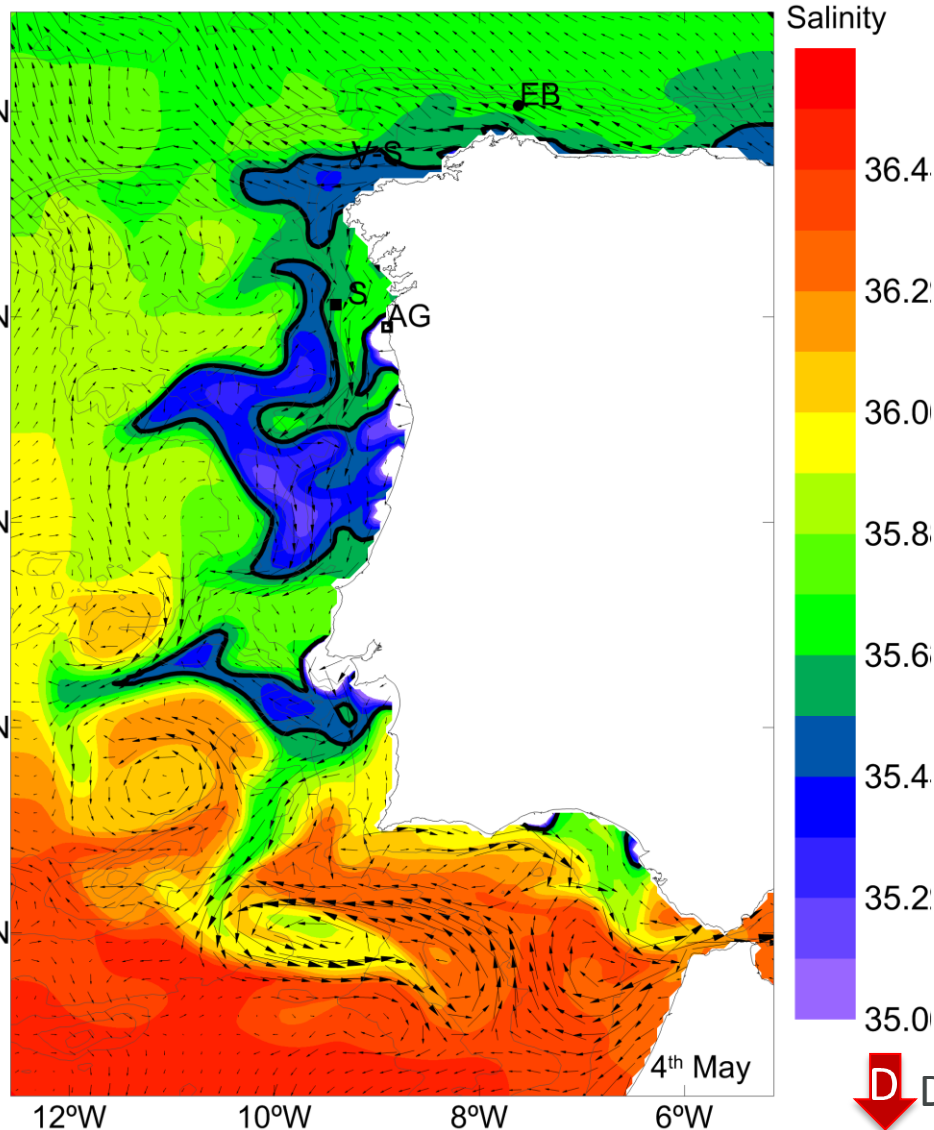


EXTREME EVENT: APRIL 2013 FLOODS



Mondego River

PCOMS - EXTREME EVENT SIMULATION

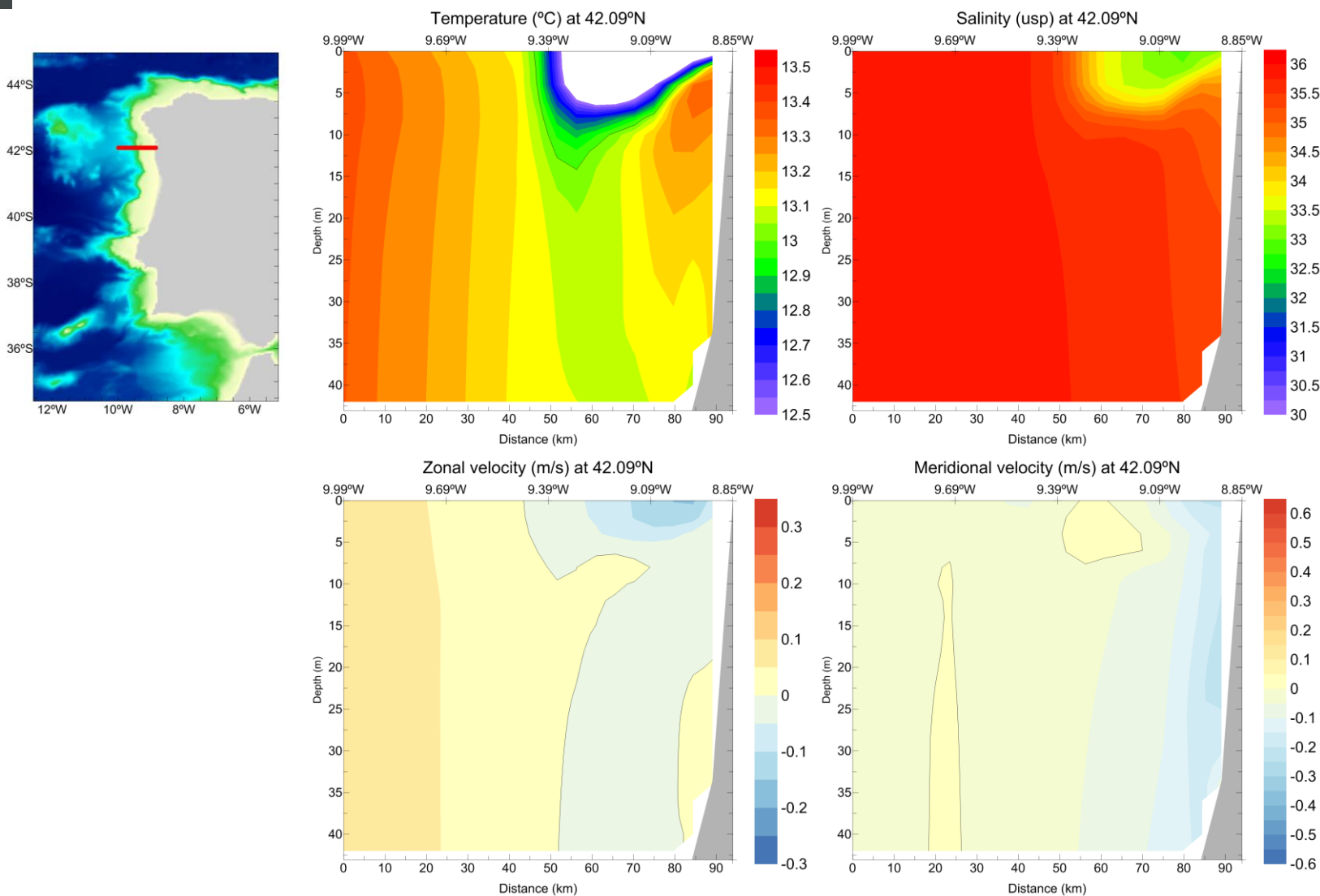


Downwelling Conditions



Upwelling Conditions

CROSS-SECTION EVOLUTION AT SILLEIRO BUOY



MAIN CONCLUSIONS:

- A novel methodology for calculating the overall inputs to the coastal area, simulate its evolution in the estuary continuum and inserting the volume and properties dynamics in a regional model was developed and tested successfully.
- Numerical modelling is currently the only tool able to represent and estimate the temporal and spatial scale of the WIBP and other estuarine plumes.
- This set of tools improve significantly salinity fields and aid to the delimitation of region of fresh water influence and salinity fronts which are relevant to fisheries management.
- The 5th percentile allow to evaluate the area influenced by the river discharges including the highly dynamic outer reaches.
- The developed methodology is generic and could be set for any region using open source data and models.



LAMBDA Study Areas

Local
Experts

Germany: HGZ

Ireland: MI

Portugal: MARETEC-IST

Spain: Puertos del Estado

UK: MetOffice



Atlantic-Iberian Biscay Irish-Ocean (IBI-MFC)

Atlantic-European North West Shelf (NWS-MFC)

Portuguese Coast Operational Modelling System (PCOMS)





Muito obrigado pela vossa atenção!
Thank you very much for your attention!

- More info in [Campuzano F \(2018\)](#). Coupling watersheds, estuaries and regional seas through numerical modelling for Western Iberia. PhD Thesis, Instituto Superior Técnico, Universidade de Lisboa, Portugal. <http://wiki.mohid.com>
- The author would like also to thank to the [initiatives](#) and [institutions](#) that contributed to this research by sharing their observations:
 - CMEMS
 - APA
 - IH
 - IPMA
 - SIMTEJO
 - PdE
 - IEO

Historic Flooding in Coimbra (Portugal)