

# Earth System Modelling and Climate Change

Rita M. Cardoso

&

RG1 - Climate change, atmosphere-land-ocean  
processes and extremes



INSTITUTO  
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Português  
do Mar e da  
Atmosfera



Ciências  
ULisboa

# RG1: Climate change: atmosphere-land-ocean processes and extremes

## Members (35)

Alexandre Ramos  
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Ana Russo  
Ana Teles-Machado  
Pedro Viterbo  
Antonio Tome  
Carlos Pires  
Carlos da Camara  
Cathy Besson  
Célia Gouveia  
Emanuel Dutra  
Isabel Trigo  
Joana Freire  
Joao Catalão  
Joao Martins  
Jose Alves  
Margarida Liberato  
Antónia Valente  
Teresa Calado  
Miguel Nogueira  
Pedro Miranda  
Pedro Mateus  
Pedro Soares (PI)  
Pedro Benevides  
Pedro Sousa  
Ricardo Trigo  
Ricardo Tomé  
Rita Cardoso  
Rui Caldeira  
Sandra Mogo  
Sandra Plecha  
Sofia Ermida  
Virgílio Bento

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Catarina Guerreiro  
Daniela Lima  
Diogo Martins  
Federico Ienna  
Gil Lemos  
Javier Cano  
Manuel Nascimento  
Maria João Chinita  
Miguel Pinto  
Pedro Guerreiro  
Riccardo Henin  
Sílvia Almeida Nunes  
Vasco Ribeiro Conde  
Ana Caldeirinha  
João Careto  
Susana Silva  
Teresa Costa

# Major research topics



## **Climate variability and climate change scenarios**

Global Climate Modeling

Regional Modeling and Climate Services

Land-atmosphere interactions

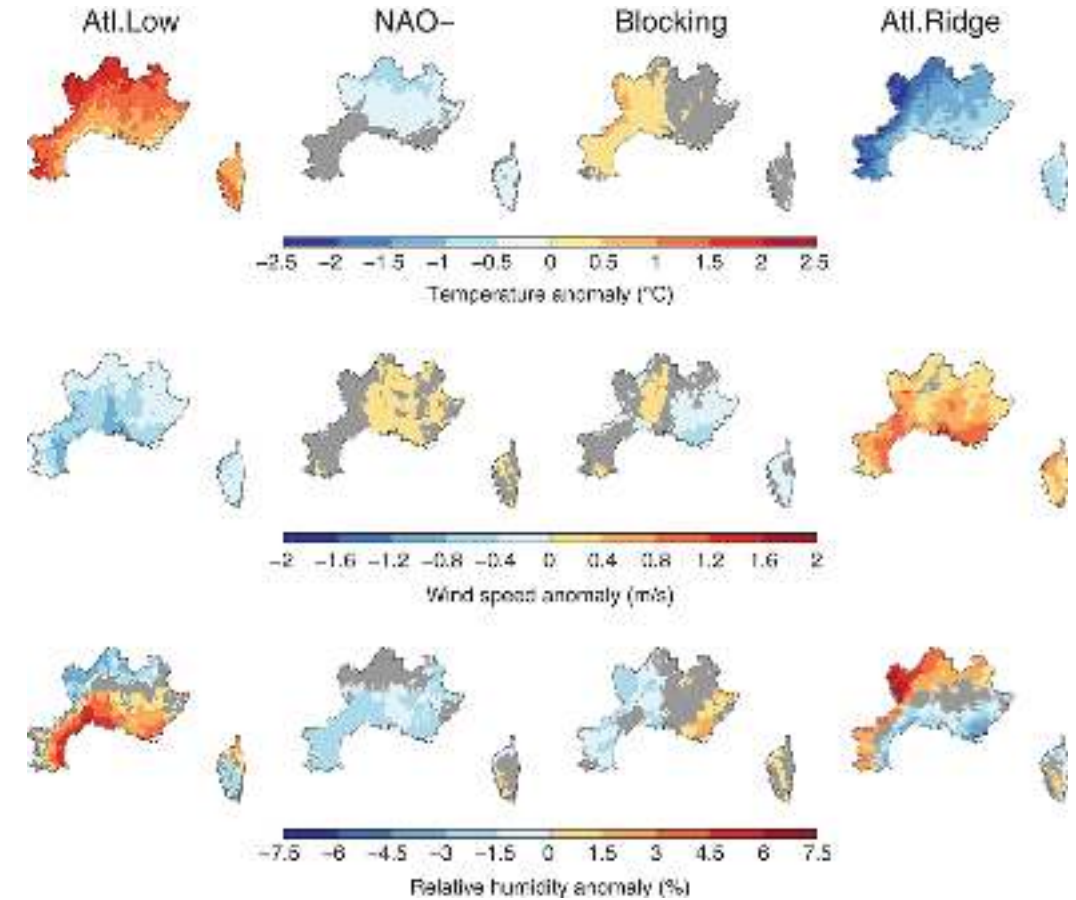
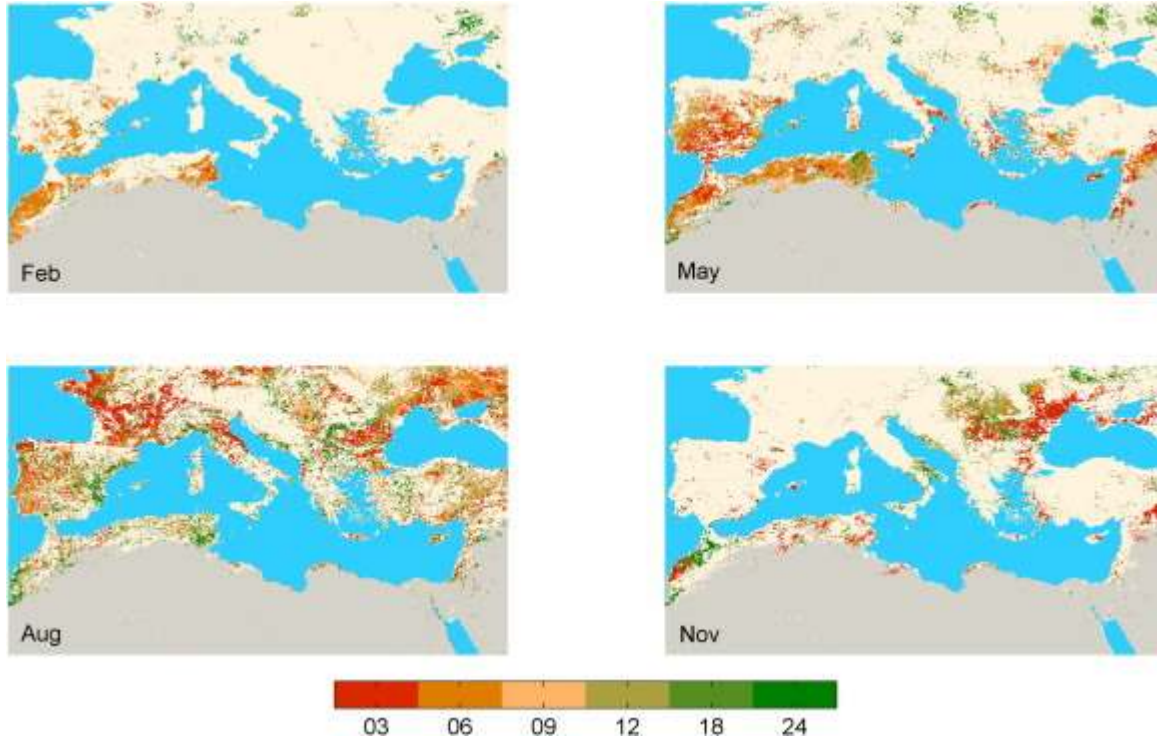
Natural hazards and extremes

## **Atmosphere-ocean processes and dynamics**

## **Ocean circulation and climate**

Remote sensing applications

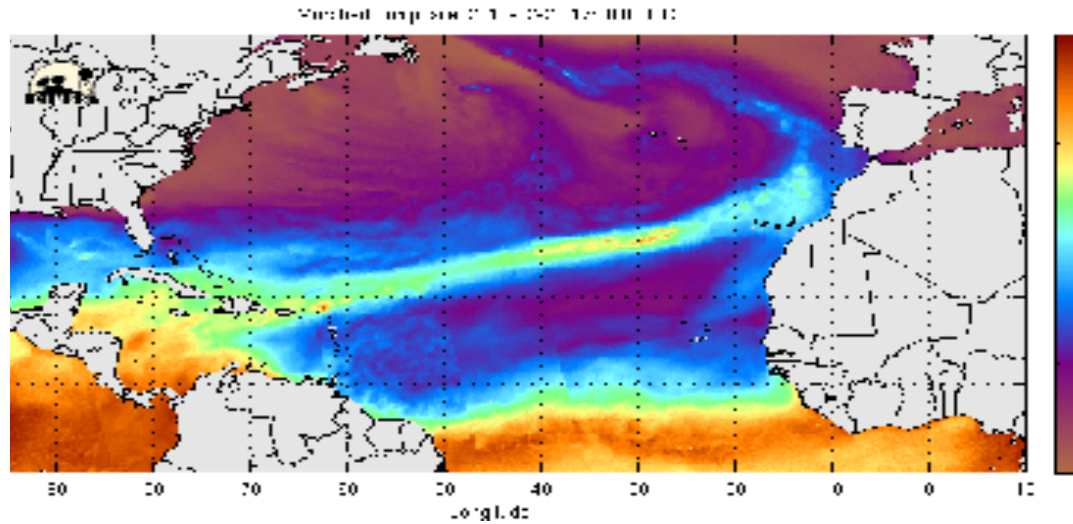
# Natural hazards and extremes



Drought impacts on vegetation activity in the Mediterranean region: an assessment using remote sensing data and multi-scale drought indicator. **Gouveia et al 2017 Global and Planetary Change.**

Daily synoptic conditions associated with large fire occurrence in Mediterranean France: evidence for a wind-driven fire regime. **Ruffault (2017) International Journal of Climatology.**

# Large Scale Synoptic Features

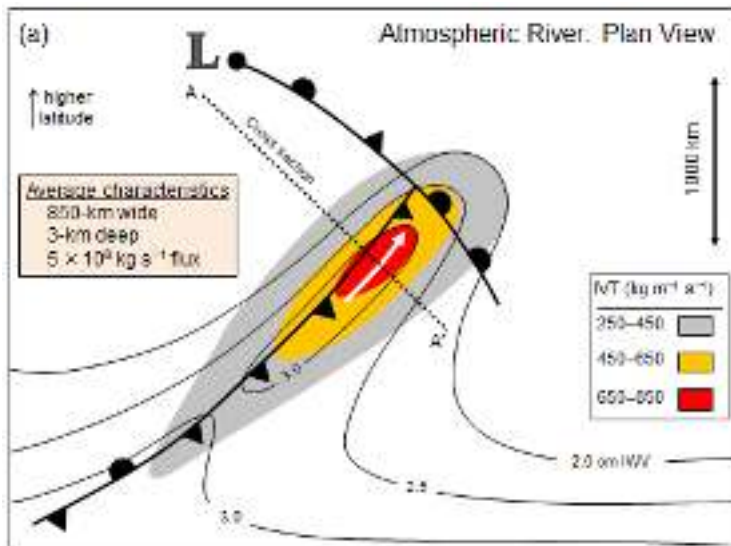


## Atmospheric Rivers

Ramos A *et al.* 2018 - Impacts of Atmospheric Rivers in Extreme Precipitation on the European Macaronesian Islands, Atmosphere

Ramos AM *et al.* 2018 - From Amazonia to southern Africa: Atmospheric moisture transport through Low Level Jets and Atmospheric Rivers. Annals of the New York Academy of Sciences

Ramos AM *et al.* 2018 - Extreme Precipitation Events in Summer in the Iberian Peninsula and Its Relationship With Atmospheric Rivers. Frontiers in Earth Sciences

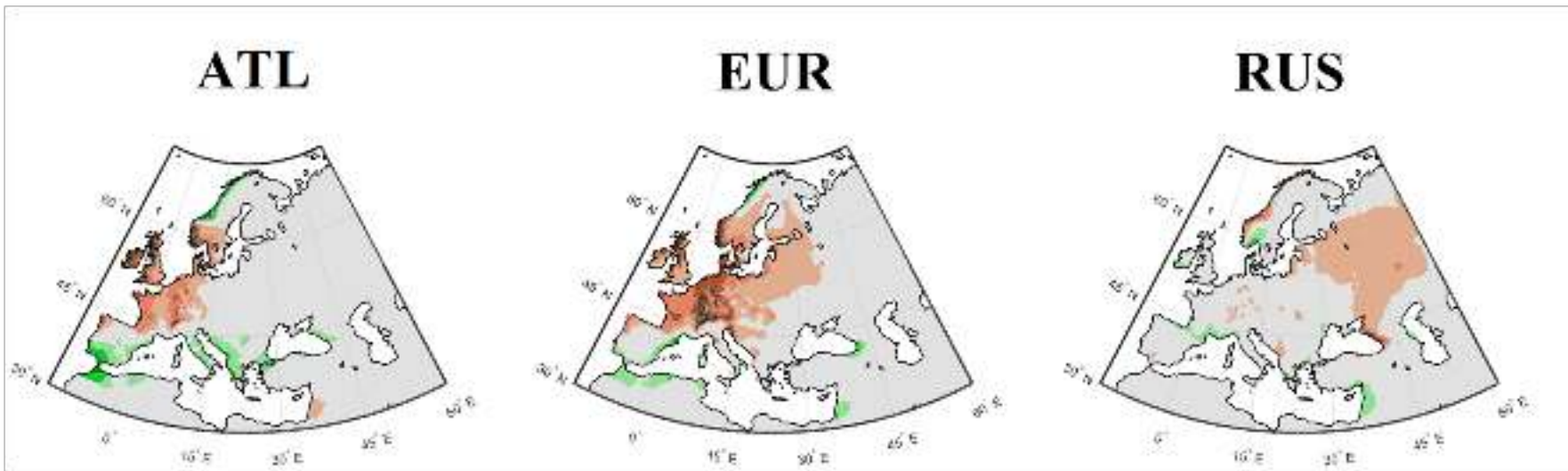


Predictability of Atmospheric Rivers in Europe  
Alexandre Ramos

# Surface anomalies in Europe

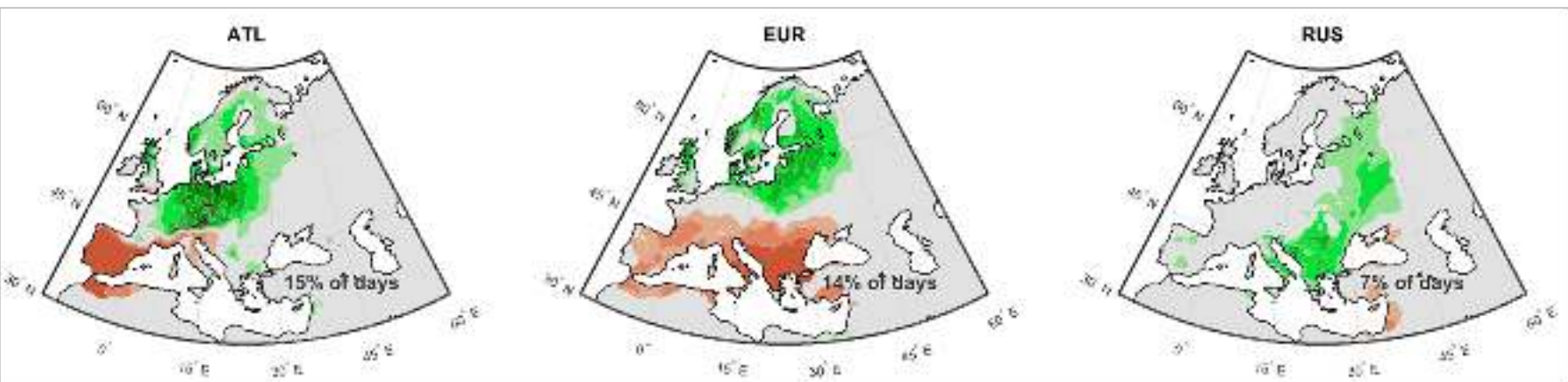
## Winter rainfall

Blockings

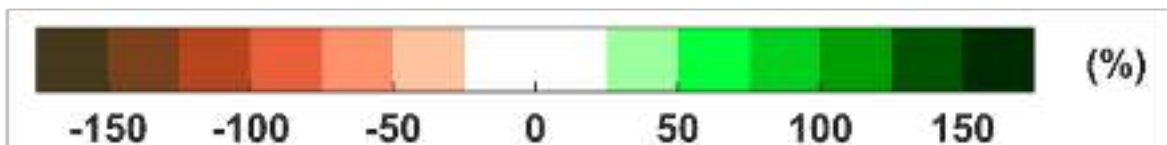


Sousa PM *et al.* 2017 - Responses of European precipitation distributions and regimes to different blocking locations. *Climate Dynamics*

Ridges

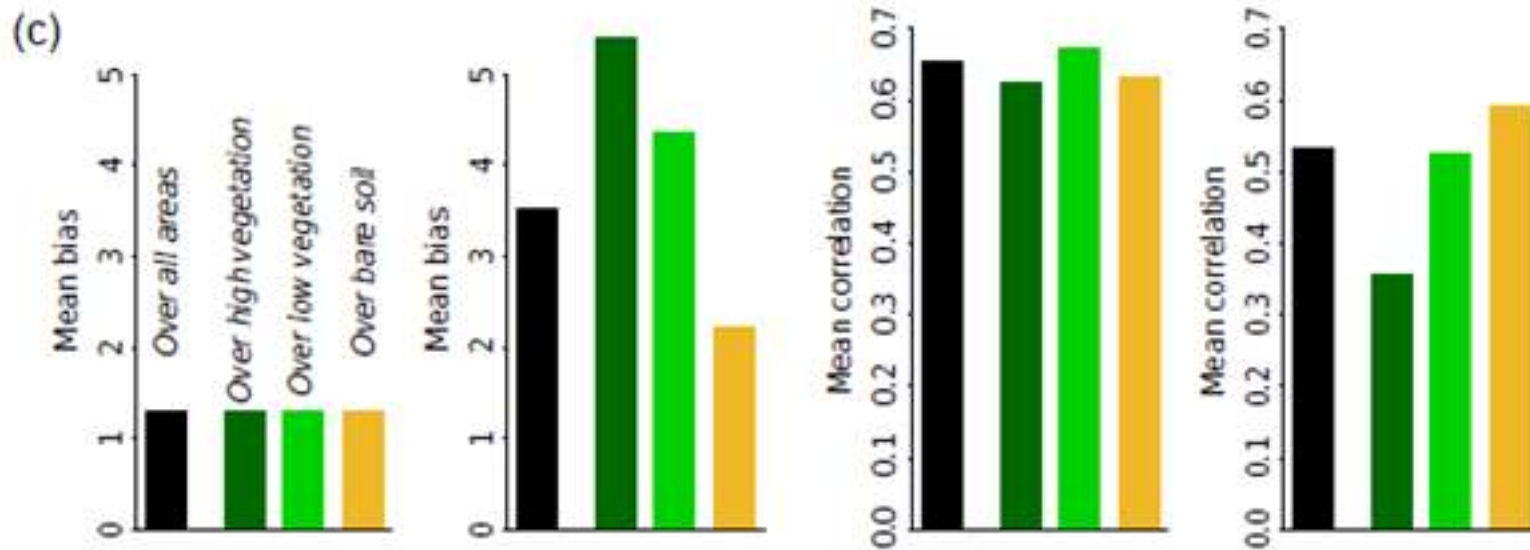
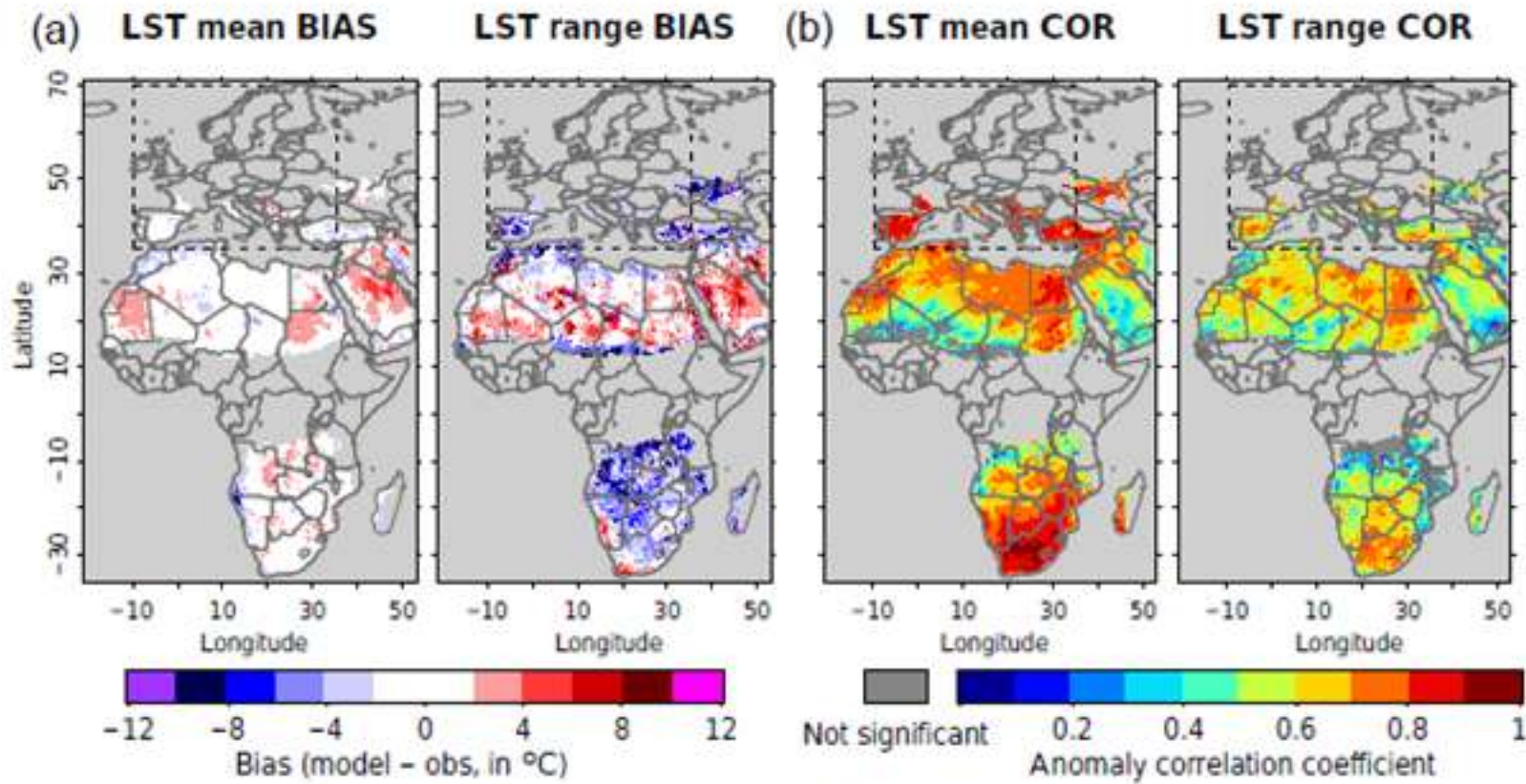


Sousa P *et al.* 2018 - European temperature responses to blocking and ridge regional patterns, *Clim. Dynamics*



# Global Modelling

## Model Development



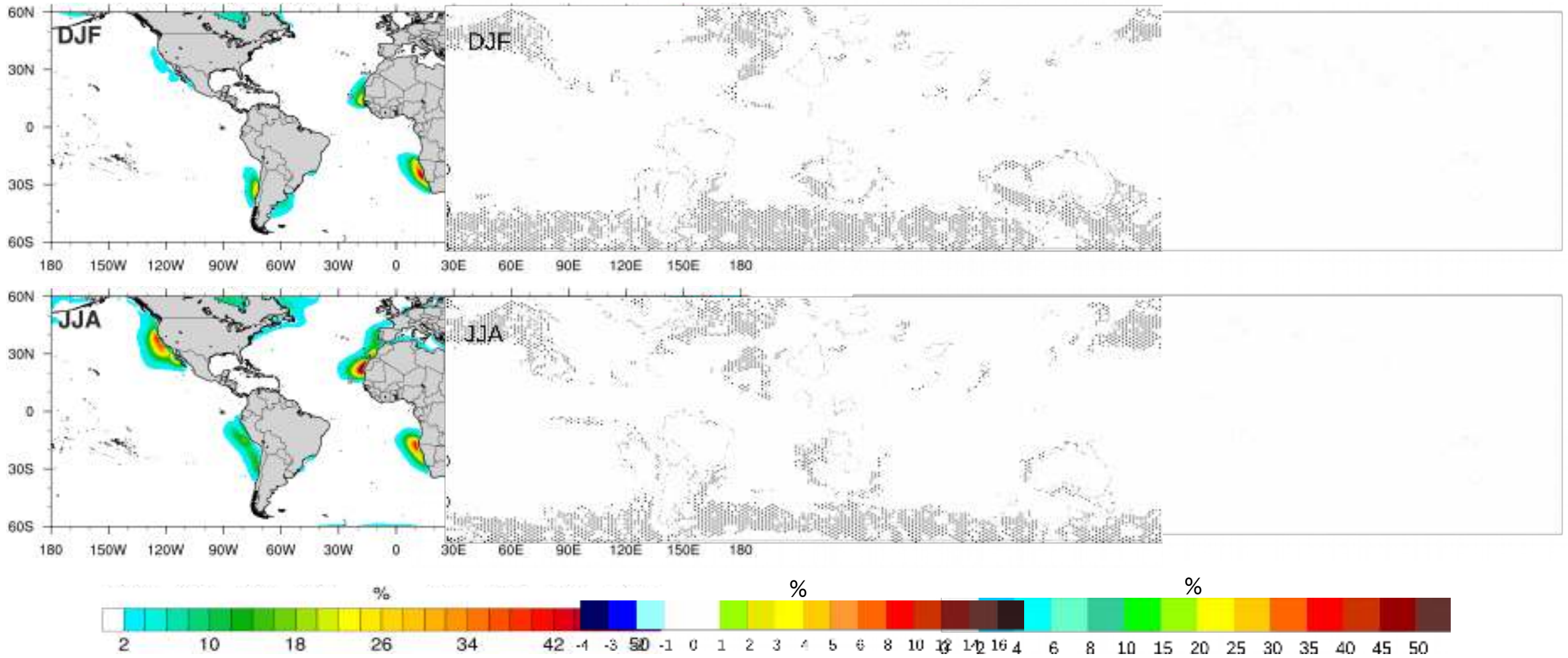
Orth *et al.* 2017 – Advancing Land Surface Model Development with Satellite-based Earth Observations. *Hydro. Earth Syst. Sci.*

# Global Modelling



## Coastal Low-Level Jets

Reanalyses Ensemble (ERA-Interim/MERRA-2/ERA5) 1980-2016      EC-Earth Ensemble (IDL/IPMA) (2071-2100) - (1971-2000)      EC-Earth Ensemble (IDL/IPMA) 1971-2000

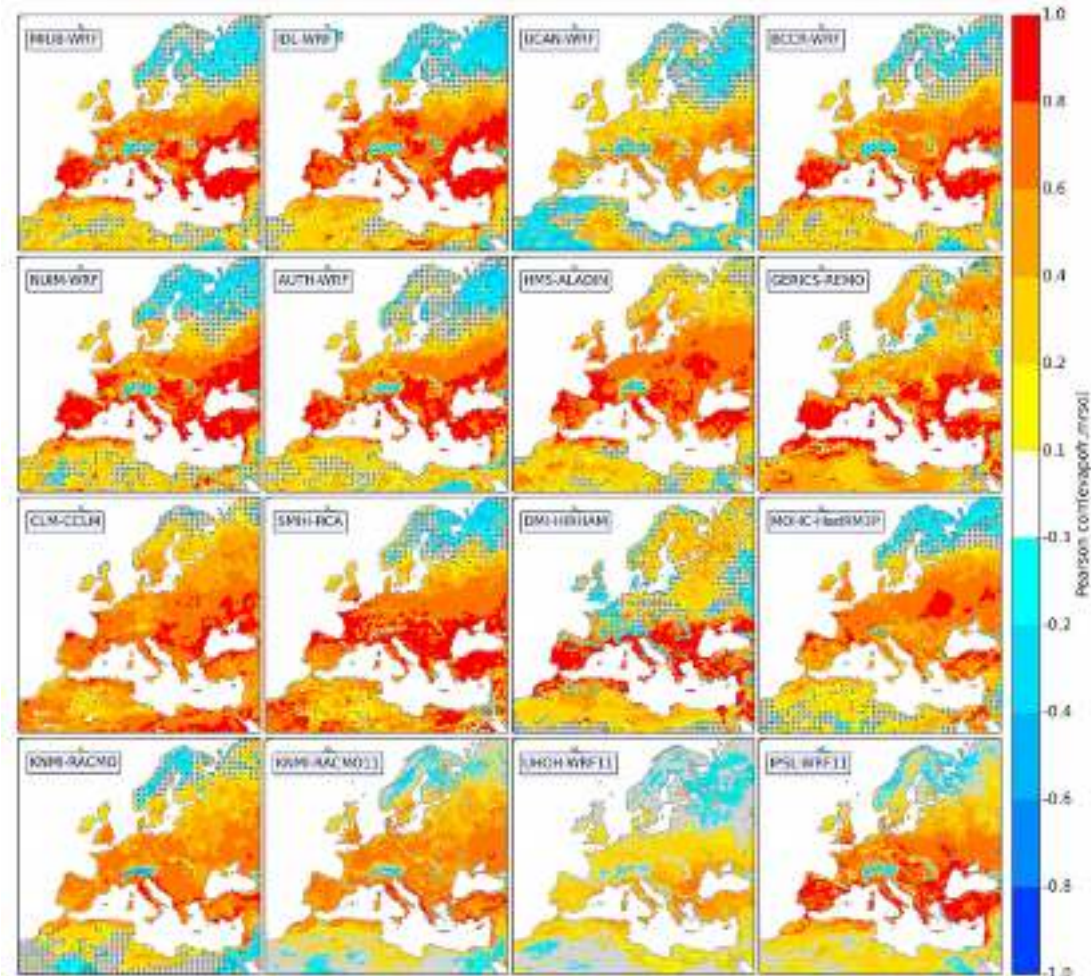
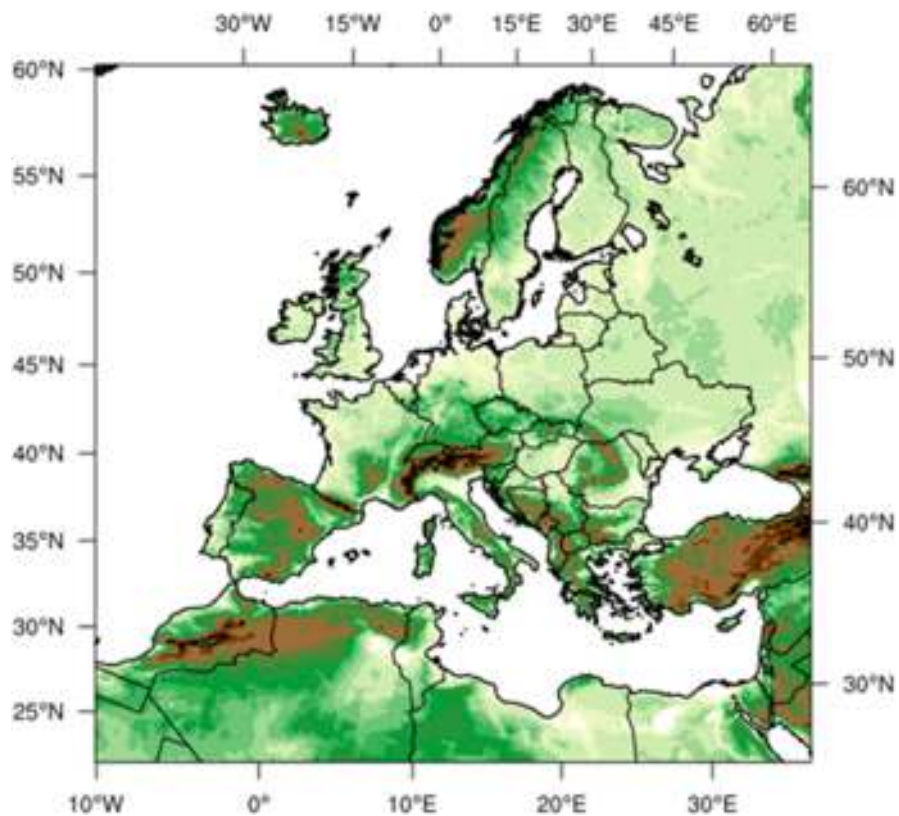


Lima et al. 2018 - A Global View of Coastal Low-Level Wind Jets Using an Ensemble of Reanalyses (*Journal of Climate*)      Semedo et al. 2016 - The impact of climate change on the global coastal low-level wind jets, EC-Earth simulations (*Global and Planetary Change*)      Semedo et al. 2016 - The impact of climate change on the global coastal low-level wind jets, EC-Earth simulations (*Global and Planetary Change*)

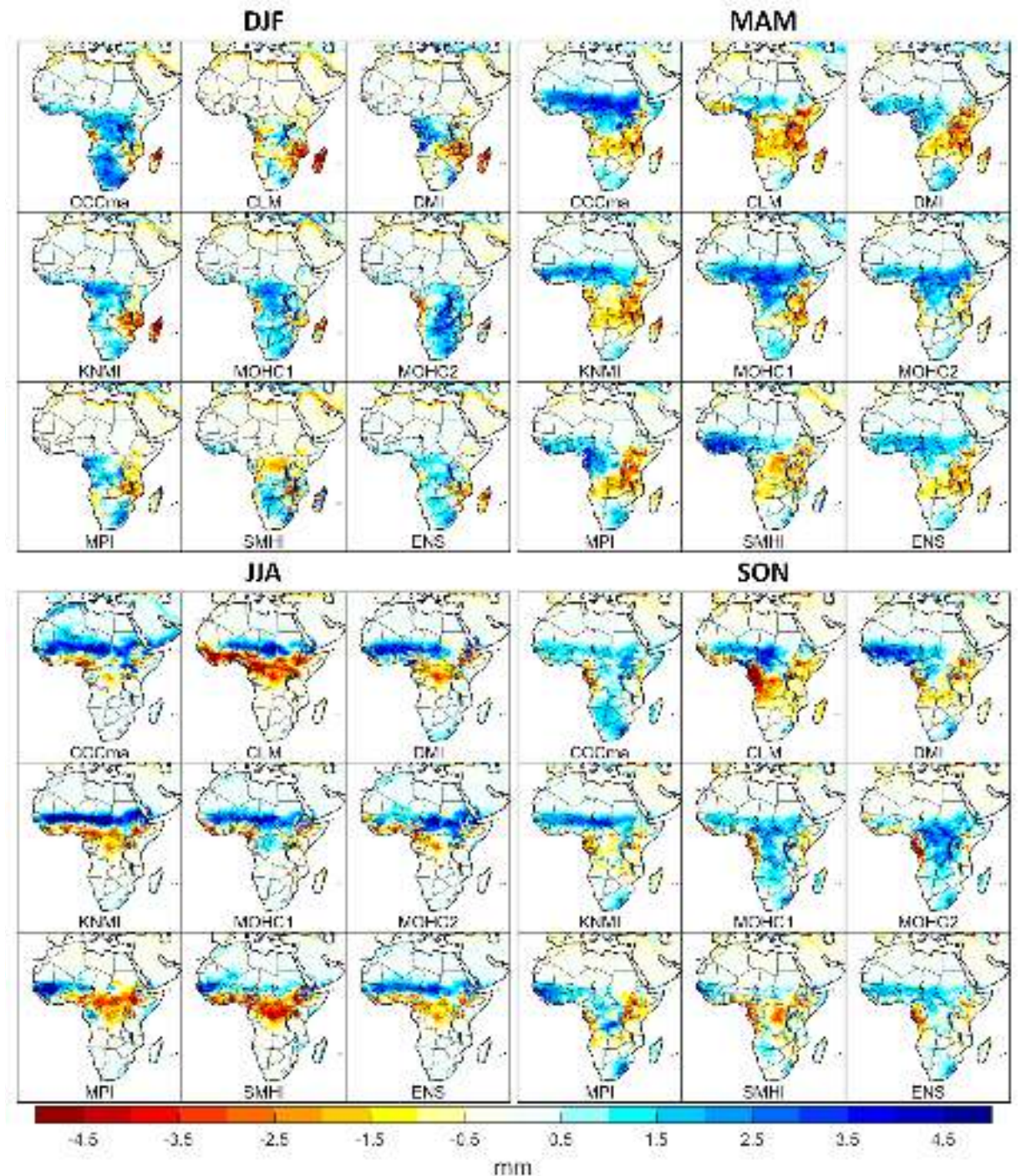
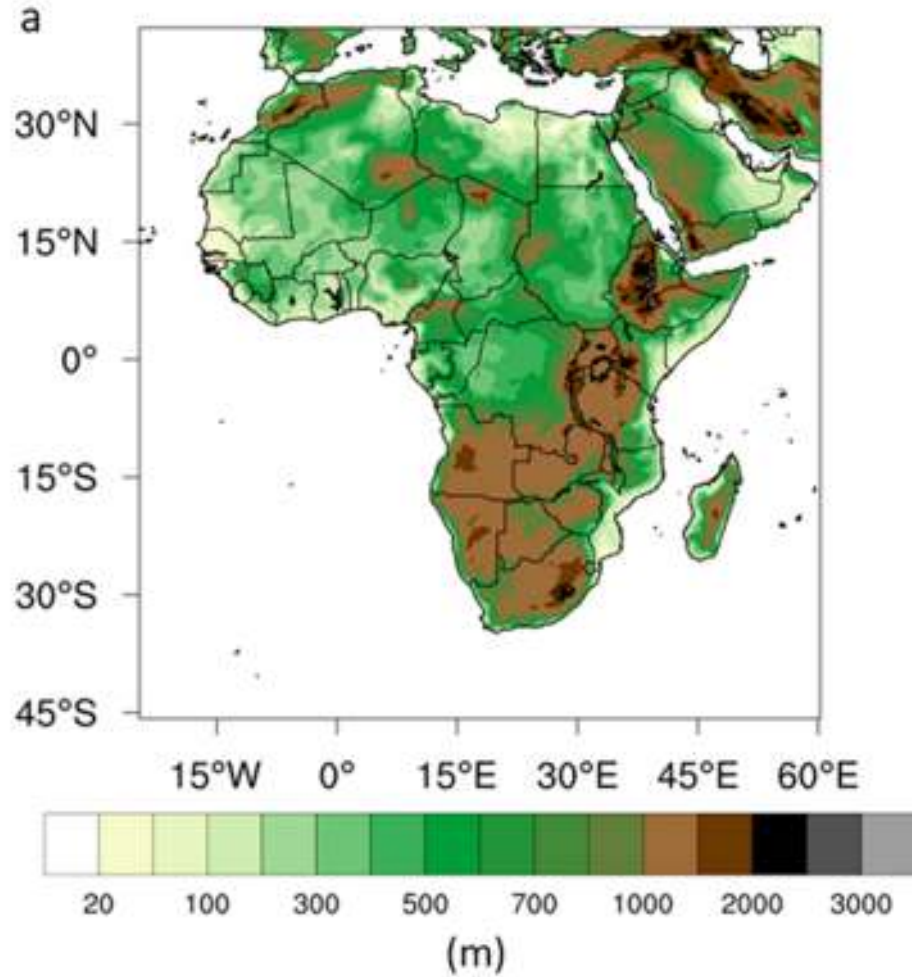


# Regional Climate Modelling - Continental Scale

## EURO-CORDEX

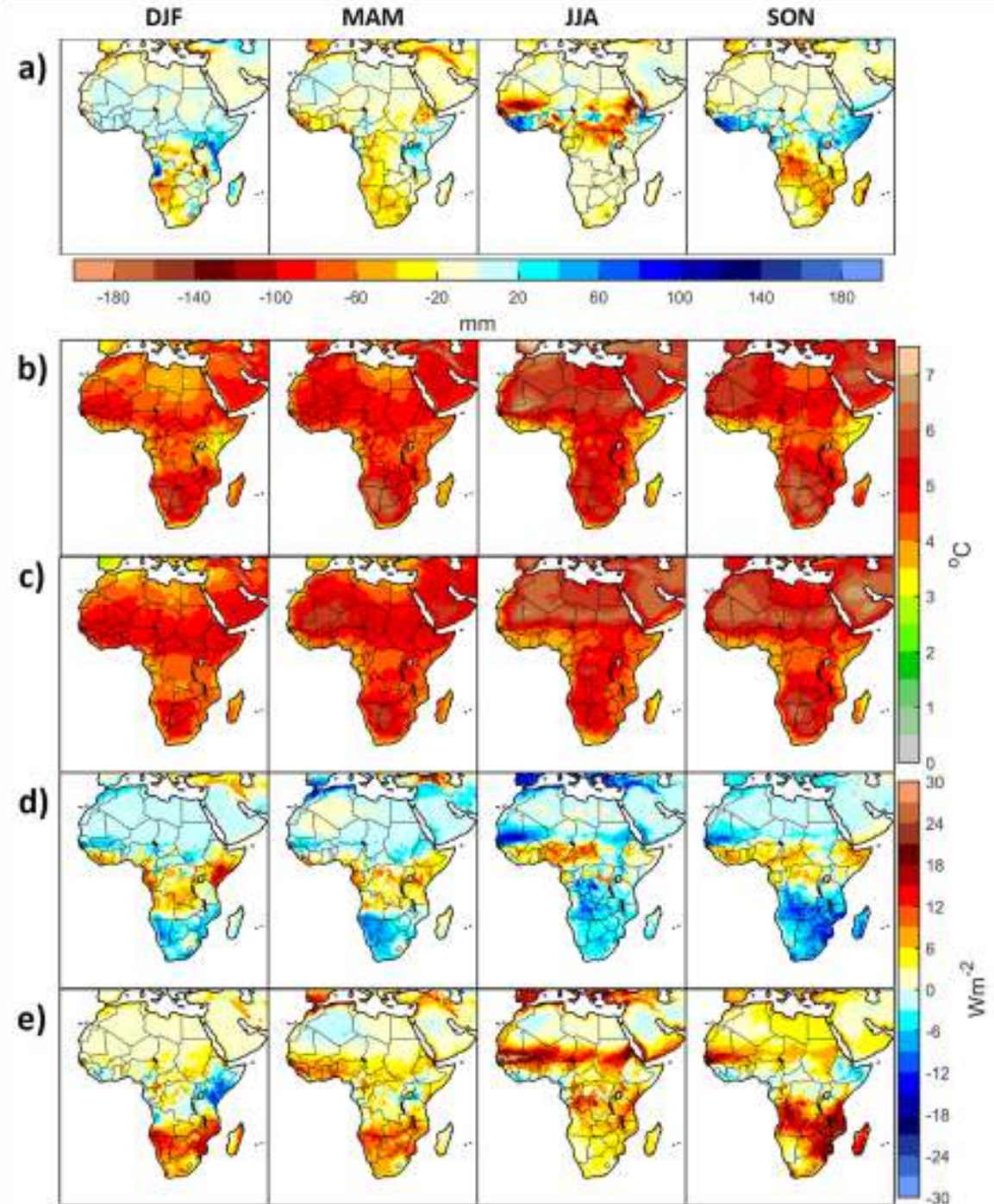
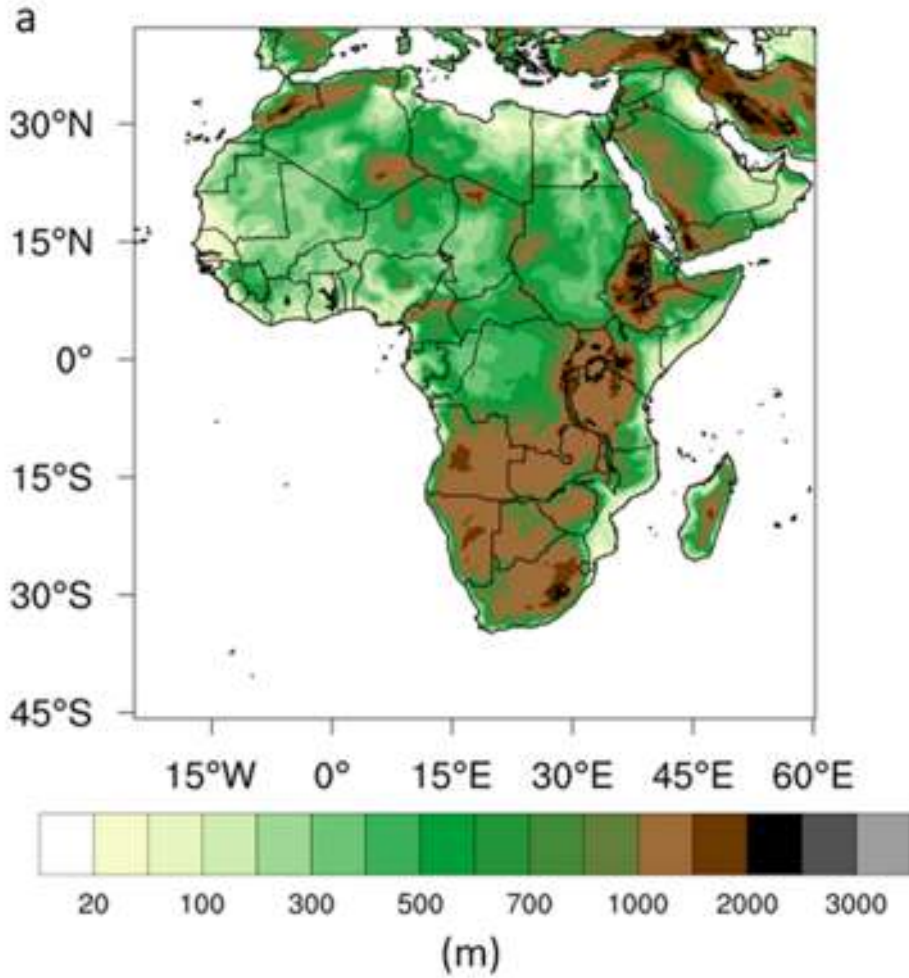


## Regional Climate Modelling - Continental Scale CORDEX - Africa



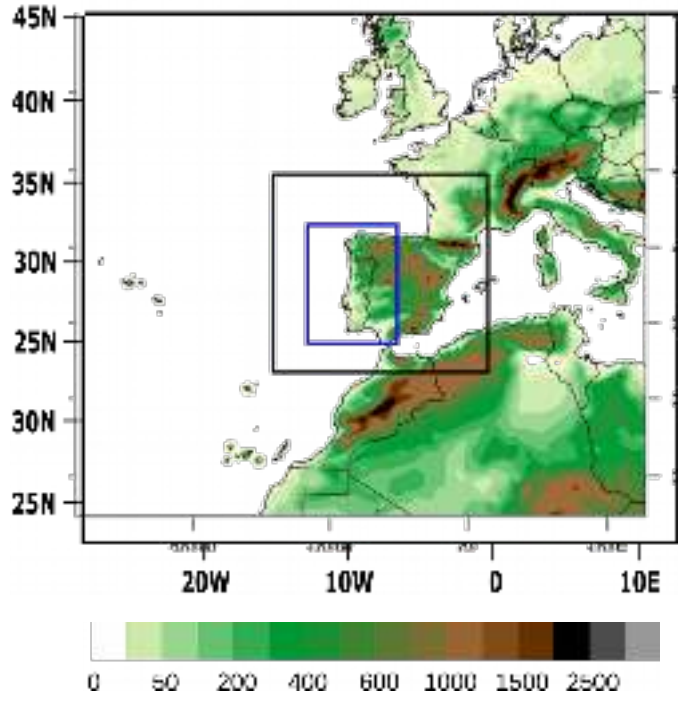
Careto JAM *et al.* 2018 - Land-Atmosphere Coupling in Africa-CORDEX: hindcast regional climate simulations. *Journal of Geophysical Research - Atmospheres*

# Regional Climate Modelling - Continental Scale CORDEX - Africa

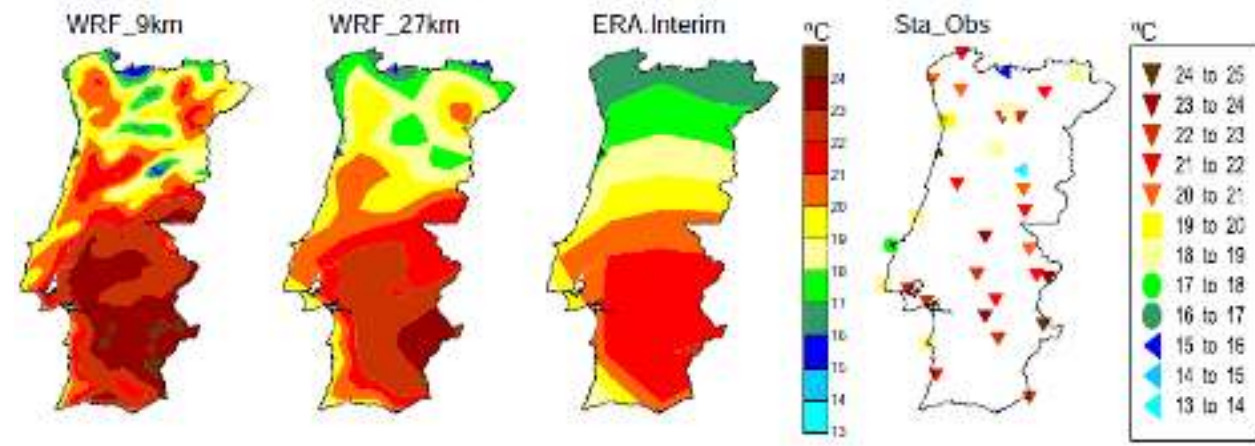


Soares PMM *et al.* 2018 - Land-Atmosphere coupling in a future climate in Africa: from model evaluation to projections based on CORDEX-Africa. *Journal of Geophysical Research - Atmospheres*

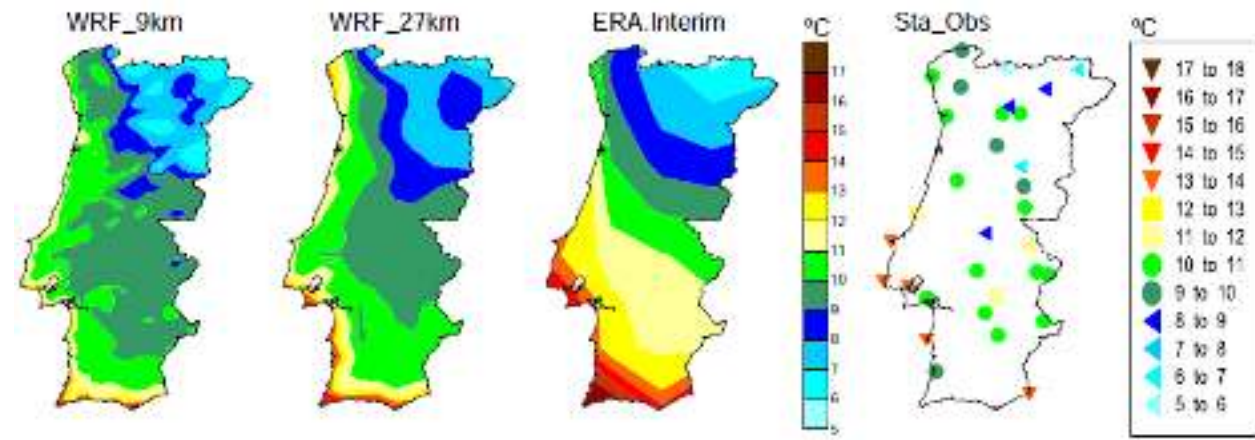
# Regional Climate Modelling



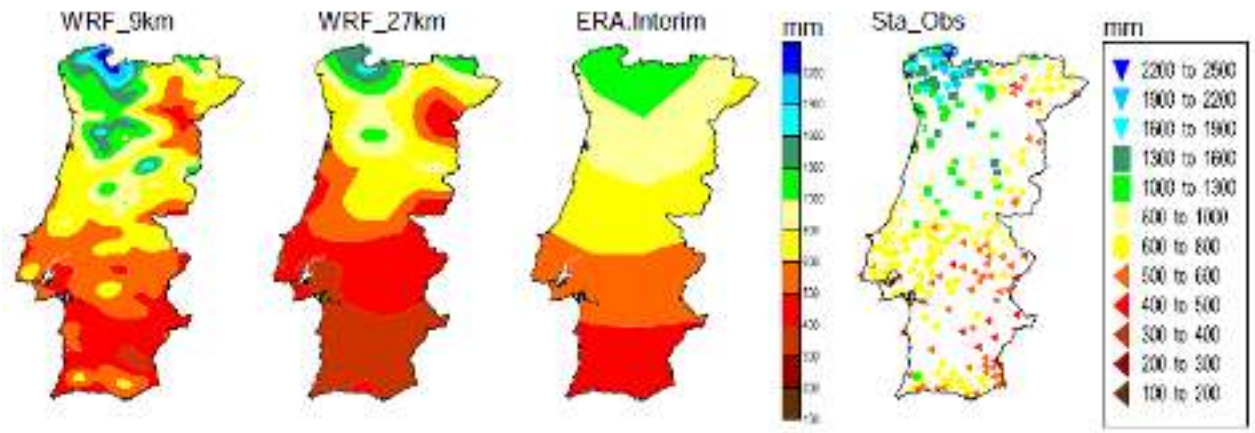
Maximum Temperature



Minimum Temperature



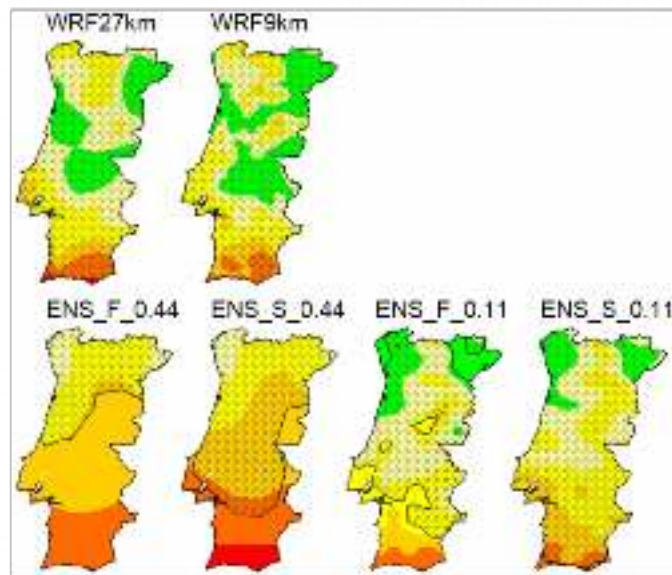
Precipitation



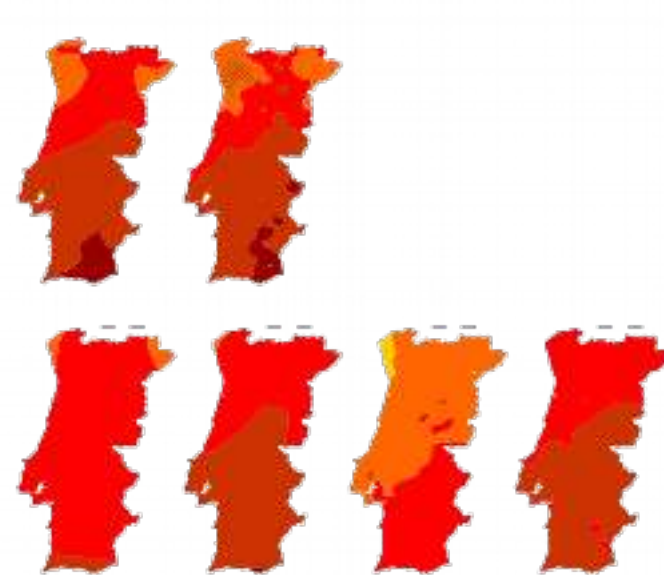
Cardoso RM *et al.* 2013 - WRF high resolution simulation of Iberian mean and extreme precipitation climate. International Journal of Climatology

Soares PMM *et al.* 2012 - WRF High Resolution Dynamical Downscaling of ERA-Interim for Portugal. Climate Dynamics

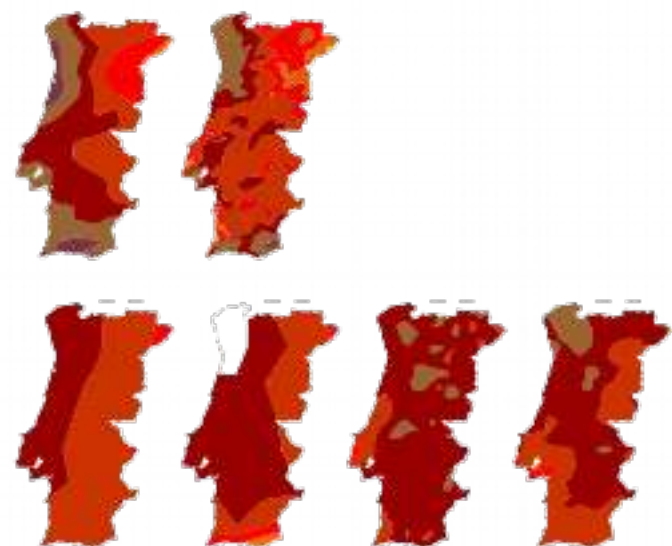
DJF



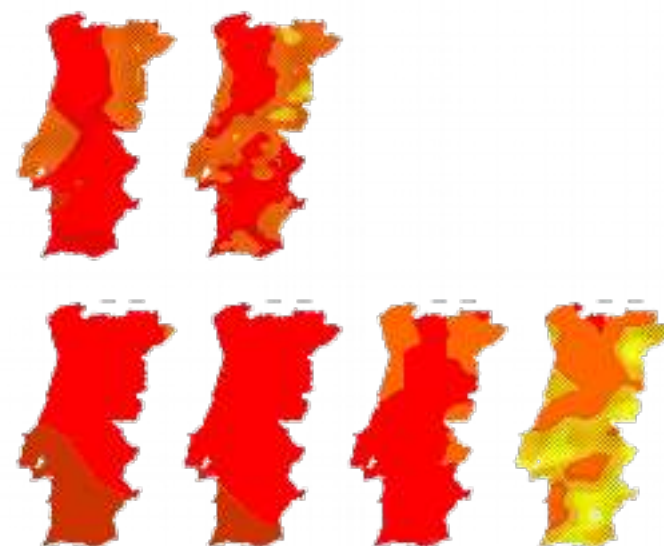
MAM



JJA



SON



# Regional Climate Modelling

## Climate Change

Soares PMM *et al.* 2017 - Future precipitation in Portugal: high-resolution projections using WRF model and EURO-CORDEX multi-model ensembles. *Clim Dyn*

Soares PMM *et al.* 2017 - Western Iberian offshore wind resources: More or less in a global warming climate? *Applied Energy*

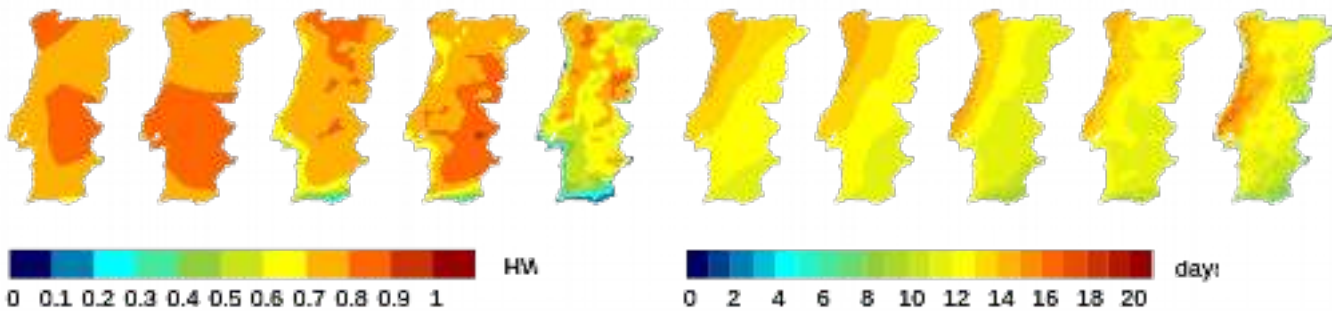
Cardoso RM *et al.* 2018 - Mean and extreme temperatures in a warming climate: EURO CORDEX and WRF regional climate high-resolution projections for Portugal. *Climate Dynamics*

Nogueira M *et al.* 2018 - High-resolution multi-model projections of onshore wind resources over Portugal under a changing climate. *Theoretical and Applied Climatology*

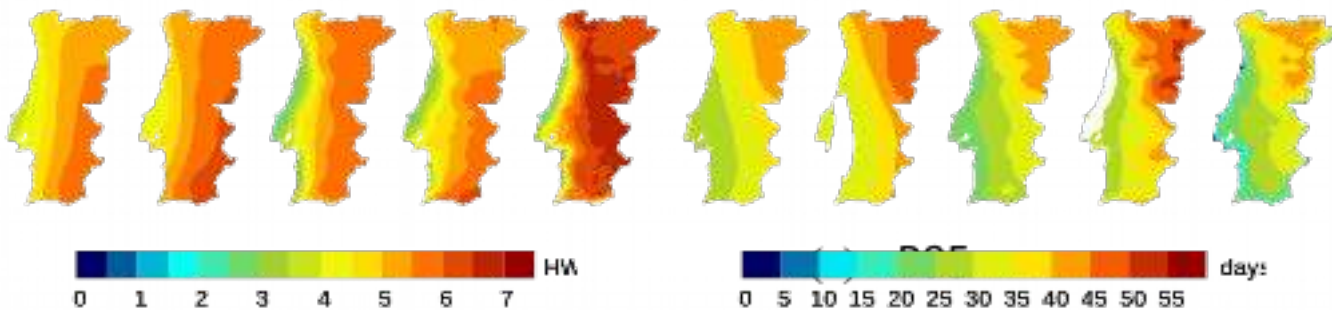
Heat wave n°

Heat wave length

1971-2000



RCP8.5

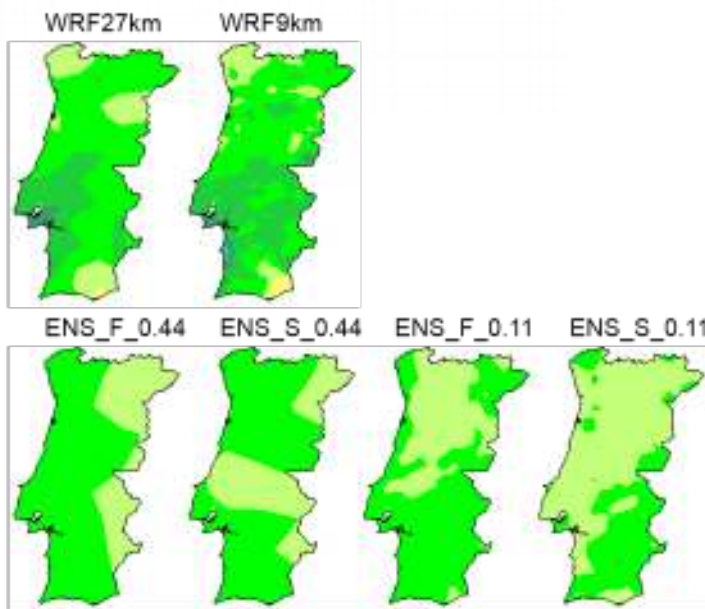


# Climate Change

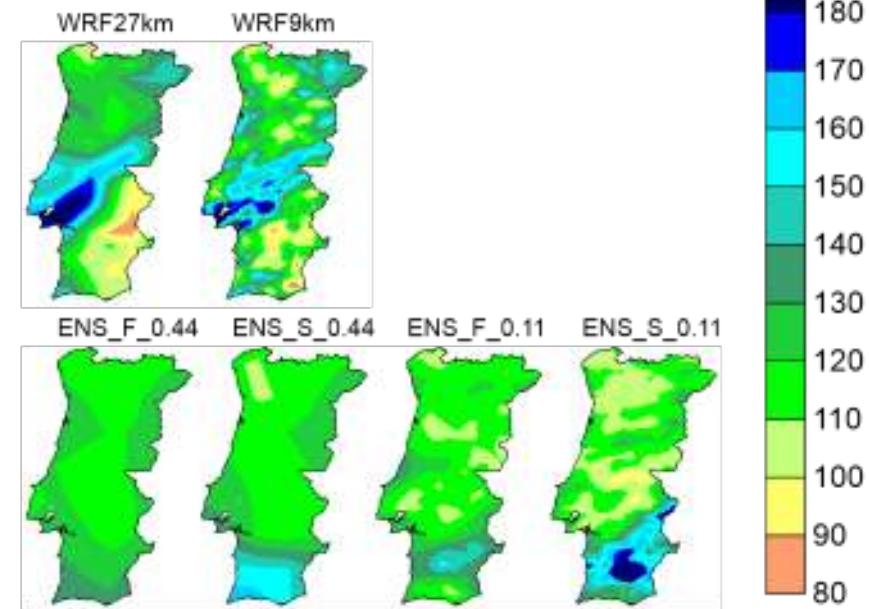
# Extreme Events

Cardoso RM et al. 2018 - Mean and extreme temperatures in a warming climate: EURO CORDEX and WRF regional climate high-resolution projections for Portugal. Climate Dynamics

Soares PMM et al. 2017 - Future precipitation in Portugal: high-resolution projections using WRF model and EURO-CORDEX multi-model ensembles. Clim Dyn



(b) P99



# Regional Climate Modelling

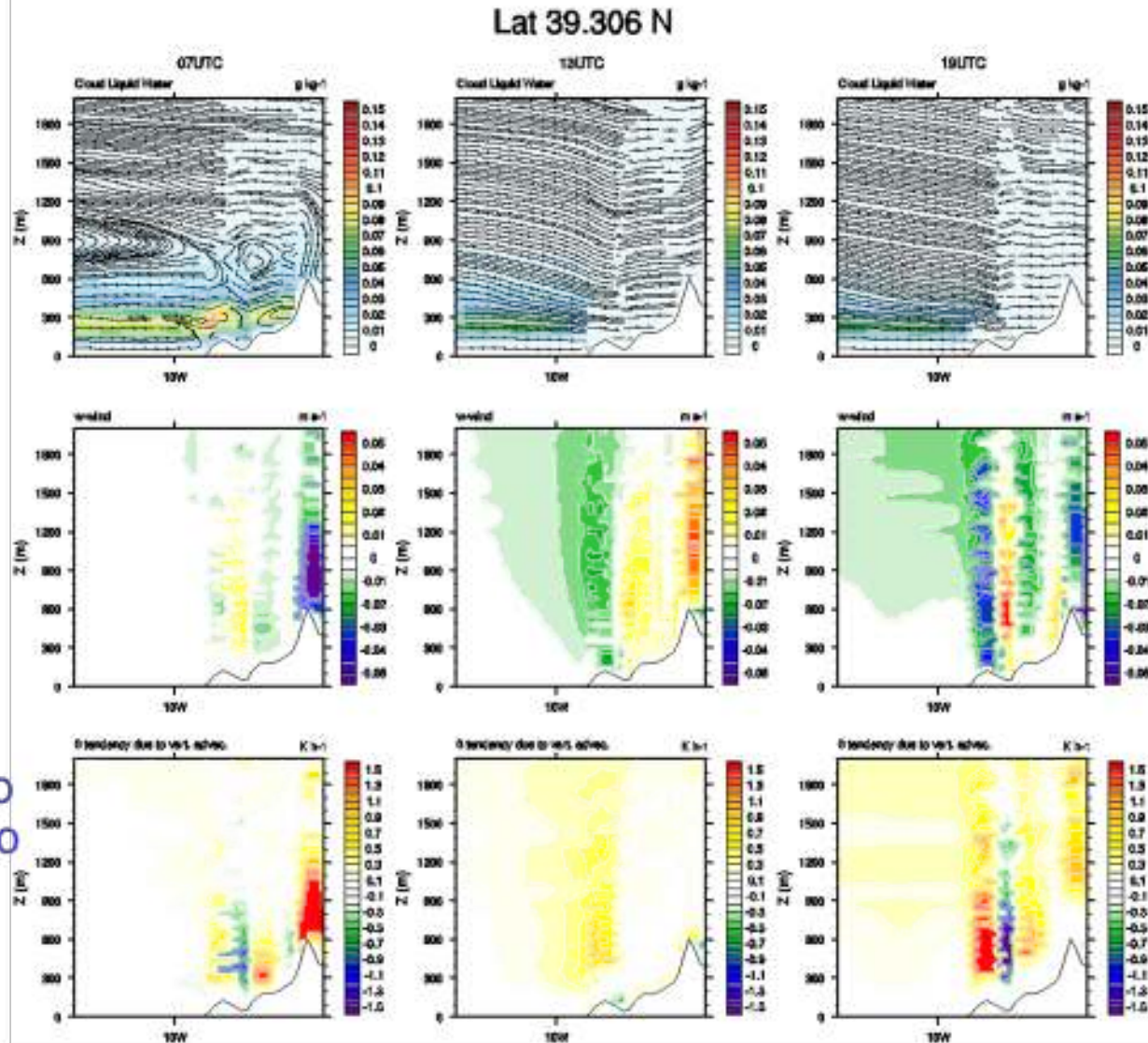
## Coastal Processes

Cloud liq. water ( $q_l$ ) e linhas de corrente

Velocidade vertical ( $w$ )

Aquecimento por advecção vertical

$$w \frac{\partial \theta}{\partial z}$$



Martins JPA *et al.* 2016 -  
The diurnal cycle of coastal cloudiness over west Iberia using Meteosat/SEVIRI and a WRF regional climate model simulation.  
International Journal of Climatology

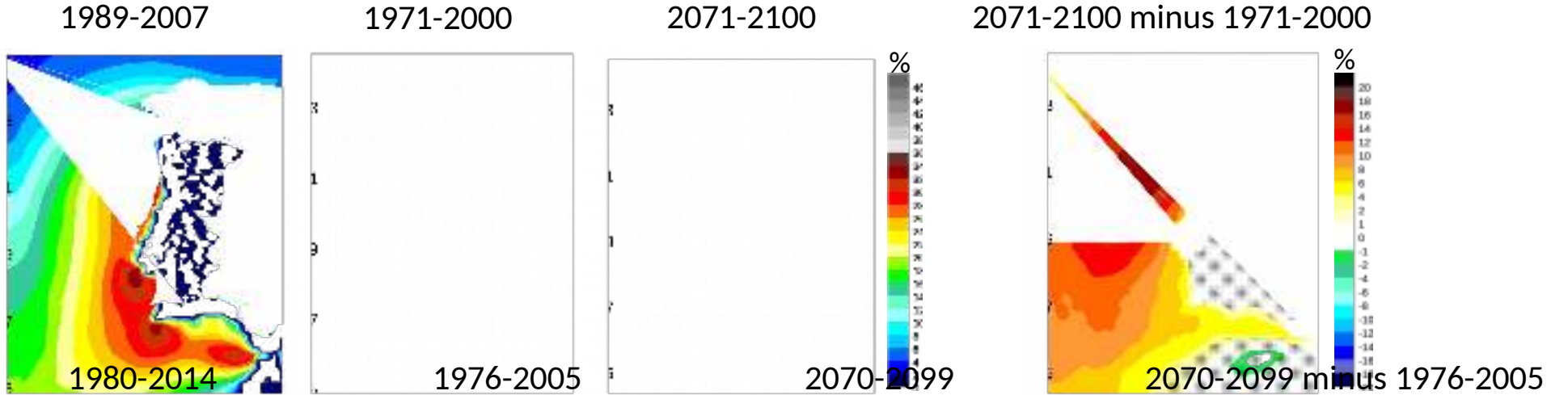
# Iberian Peninsula

## JJA – WRF

Soares et al. 2014 - Climatology of the Iberia coastal low-level wind jet weather research forecasting model high-resolution results (*Tellus A*)

and

Soares et al. 2017 - High resolution projections for the western Iberian coastal low level jet in a changing climate (*Climate Dynamics*)



## DJF – ROM

Lima et al. 2018 - A Climatological Analysis of the Benguela Coastal Low-Level Jet (*JGR-Atmospheres*)

## North Africa

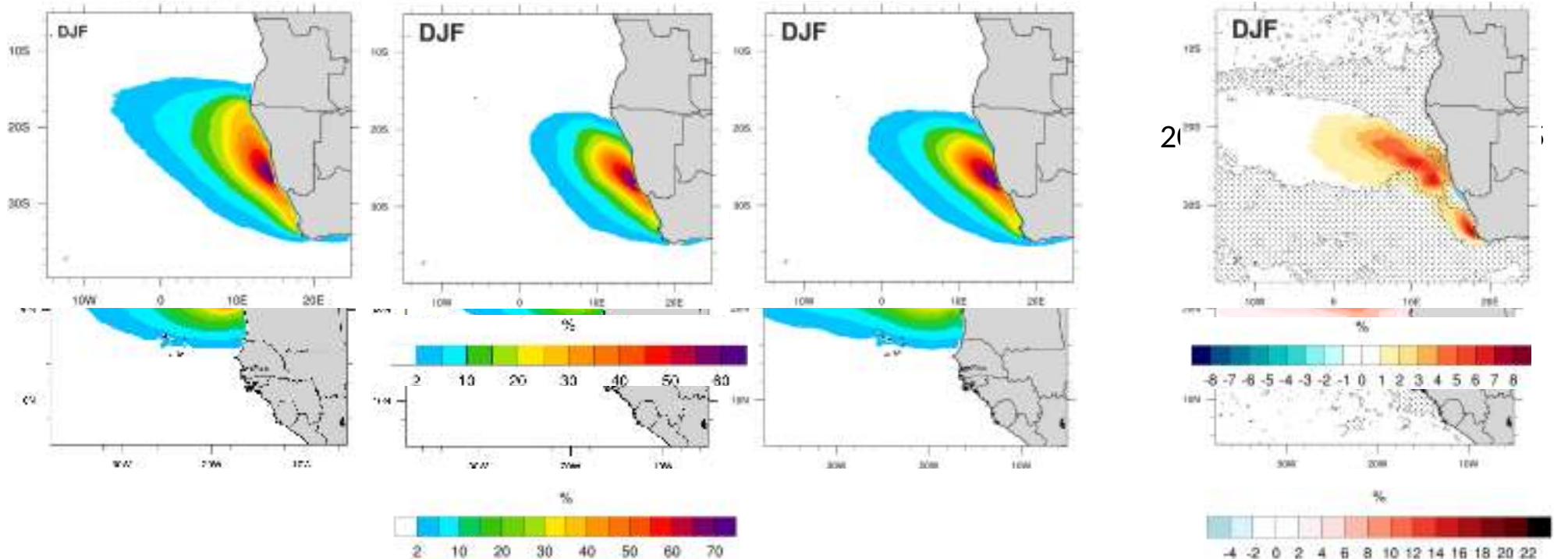
Lima et al. - How will a warming climate affect the Benguela coastal low-level wind jet? (In revision to *JGR-Atmospheres*)

## JJA – ROM

Soares et al. - The North African coastal low-level wind jet a high resolution view (*Climate Dynamics*)

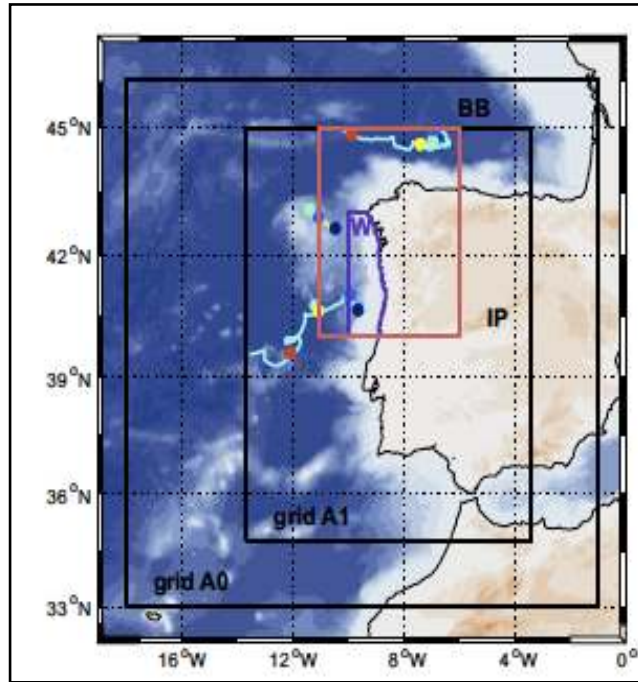
and

Soares et al. - The climate change impact on the North African offshore surface wind and coastal low-level jet: coupled and uncoupled regional climate simulations under RCP8.5 emission scenario (In revision to *Climate Dynamics*)





## Ocean Circulation Modelling

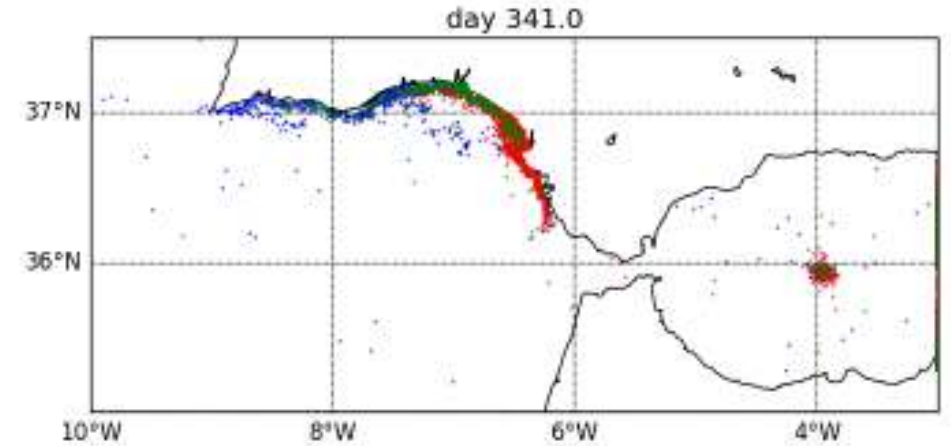


Interannual simulations with nested grids on the Iberian Margin

Teles-Machado *et al.* 2015 - On the year-to-year changes of the Iberian Poleward Current. *Journal of Geophysical Research Oceans*

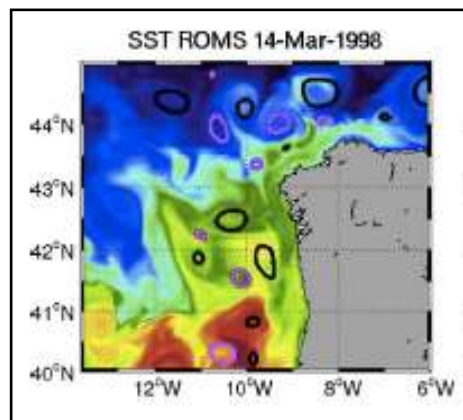
Peliz A *et al.* 2013 -The Gulf of Cadiz-Alboran Sea sub-basin: Model setup, exchange and seasonal variability. *Ocean Modelling*

## Lagrangian Modelling



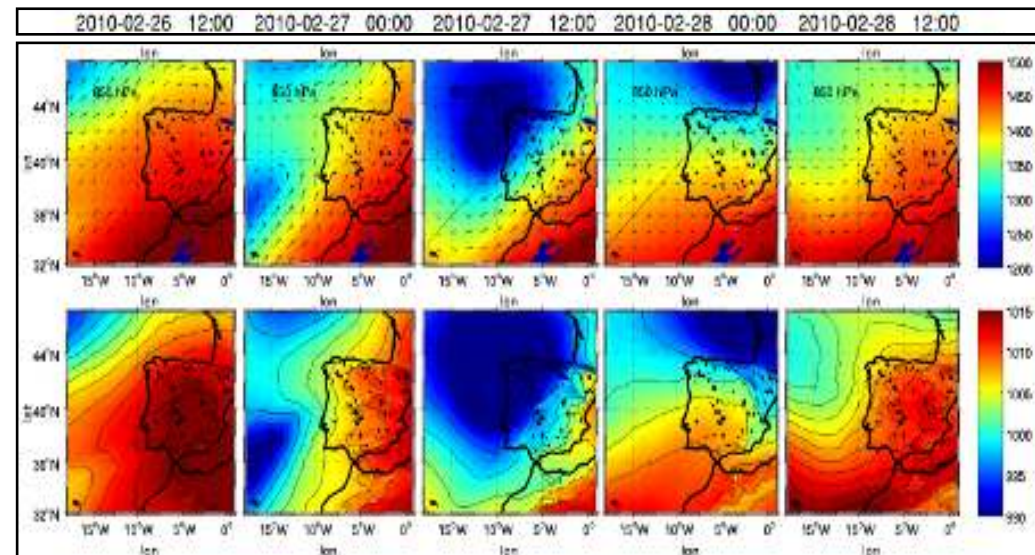
Particle dispersion studies with different applications (fish larvae, trace metals, water masses, etc)

## Eddy Tracking



Automatic eddy detection and tracking from ocean models and satellite altimetry

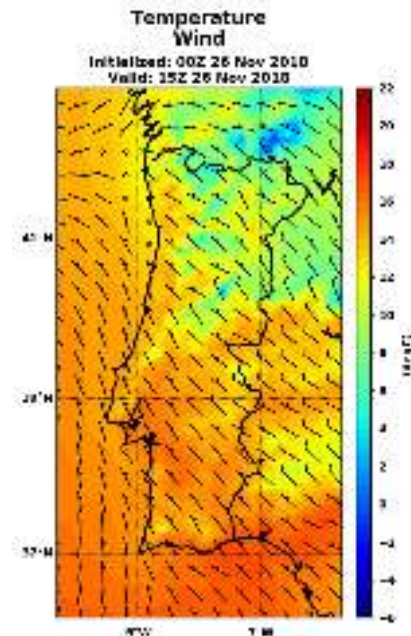
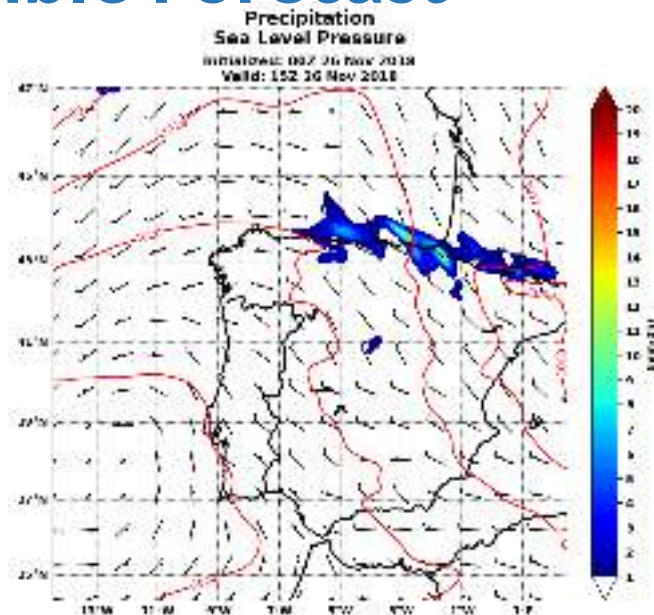
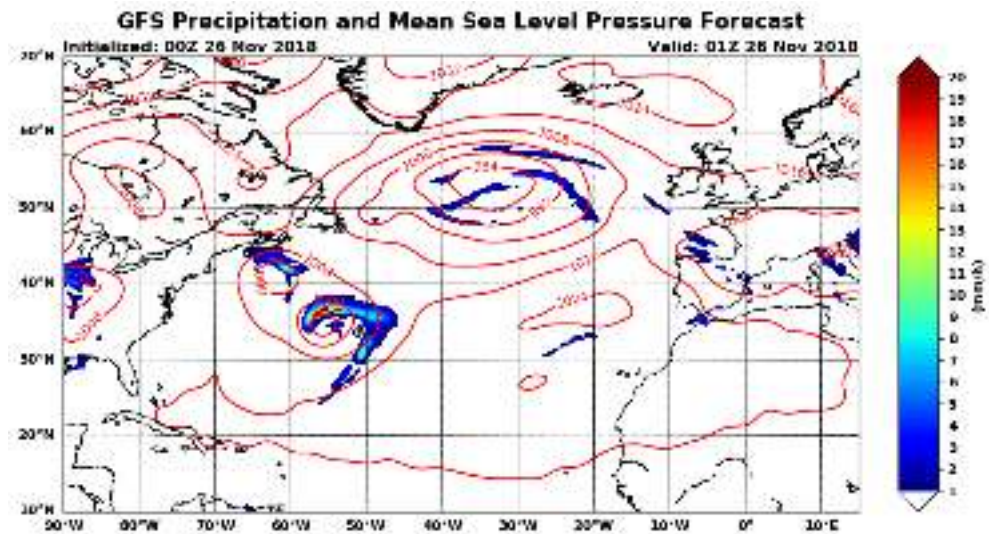
## Storm Surge Modelling



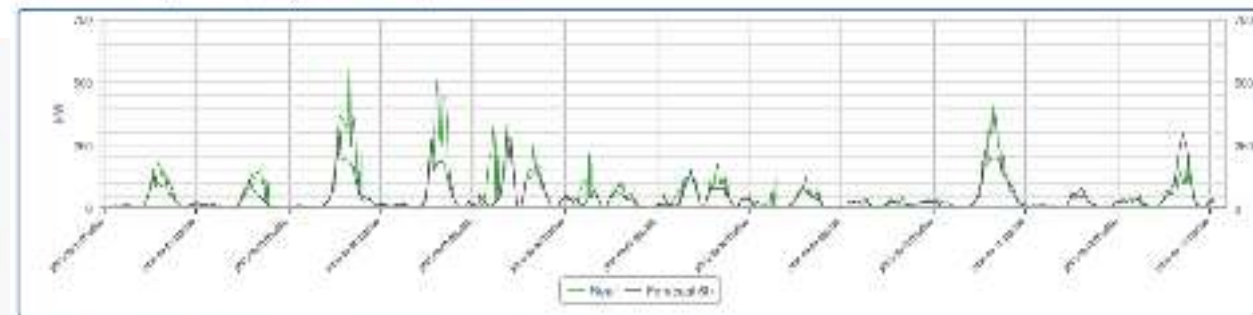
Xynthia 2010

Intense cyclone moving from SW to NE

# Daily Ensemble Forecast



Evolution of wind power forecasting until 15th of September:



Evolution of wind power forecasting after 15th of September:



**Thank you**

Daily Forecasts of Meteorological fire danger in the Zambézia province of Mozambique	Sílvia Nunes
Forecasting hourly Fire Weather Index: an application to Portugal	Miguel Pinto
Interação vento-temperatura da superfície do mar	José Alves
Simulation of extreme and high-impact winter storms in Eastern North Atlantic	Margarida Liberato
InSAR Meteorology: how high resolution initial states improve short-range weather forecasts	Pedro Miranda & Pedro Mateus
Assimilação de Dados Bayesiana e sua aplicação com distribuições de erro Gaussianas e não-Gaussianas	Carlos Pires
Impact of snow data assimilation on river discharge	Emanuel Dutra
Filling the resolution gap between global models and applications: dynamical and/or stochastic downscaling	Miguel Nogueira
Predictability of Atmospheric Rivers in Europe	Alexandre Ramos
Recirculation, stagnation and ventilation: The 2014 legionella episode	Ana Russo
Droughts feedback on summer hot days and nights over the Mediterranean	Ana Russo
Joint probability of droughts and wheat yield anomalies in Iberia	Andreia Ribeiro