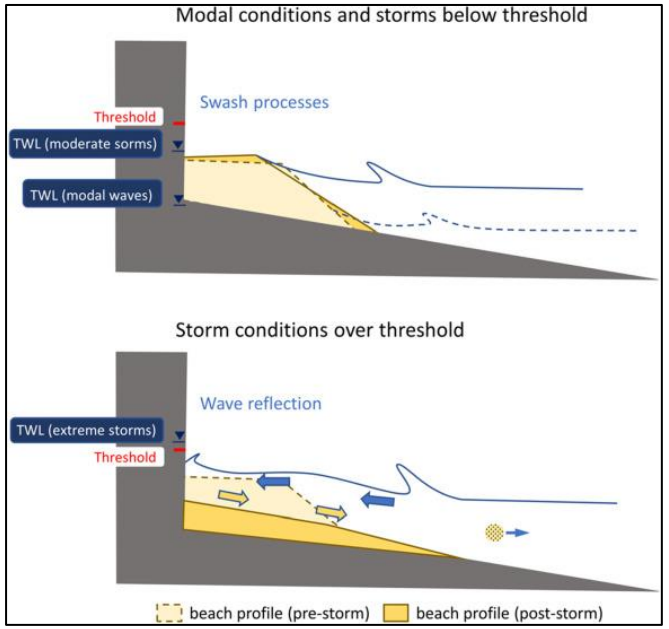
Research Challanges and priorities at FCUL

Ricardo Machado Trigo



Research Challanges and priorities at FCUL

(Extreme events under Climate Change)

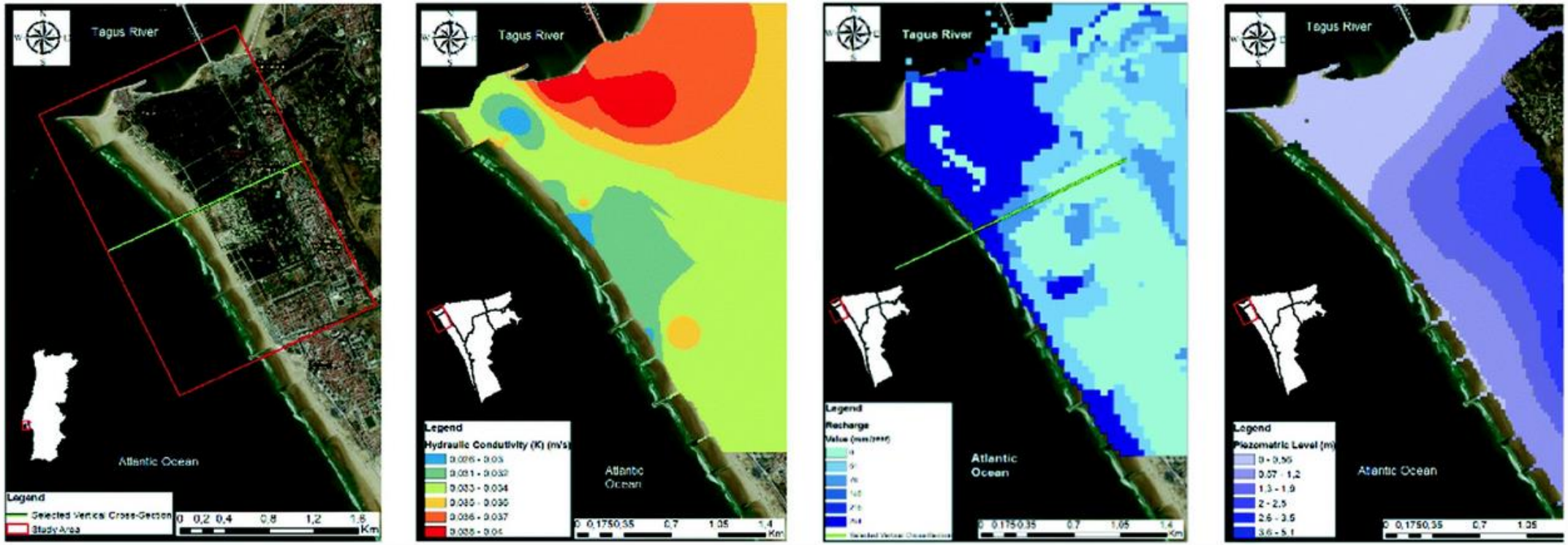
1. Aquifer Contamination by Extreme Coastal Floods
2. Morphological Thresholds
3. Advancement of remote sensing technologies

Geology
(Coastal Env.)

4. Increasing frequency of droughts (Precip vs Evapot)
5. The role of Atmospheric Rivers in extreme events

Geophysics
(Climatology)

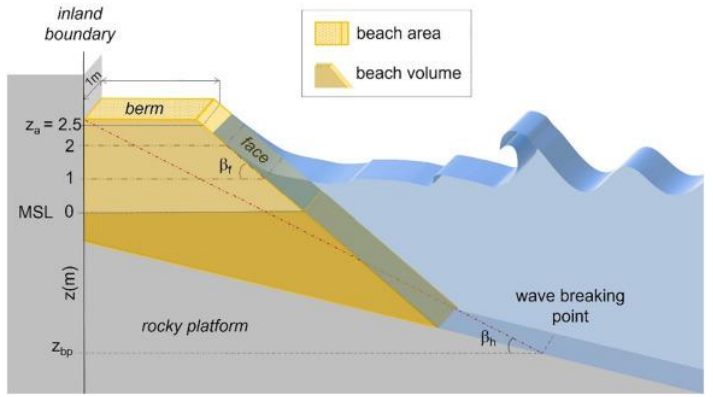
1) Aquifer Contamination by Extreme Coastal Floods
Costa da Caparica, Almada (Portugal)

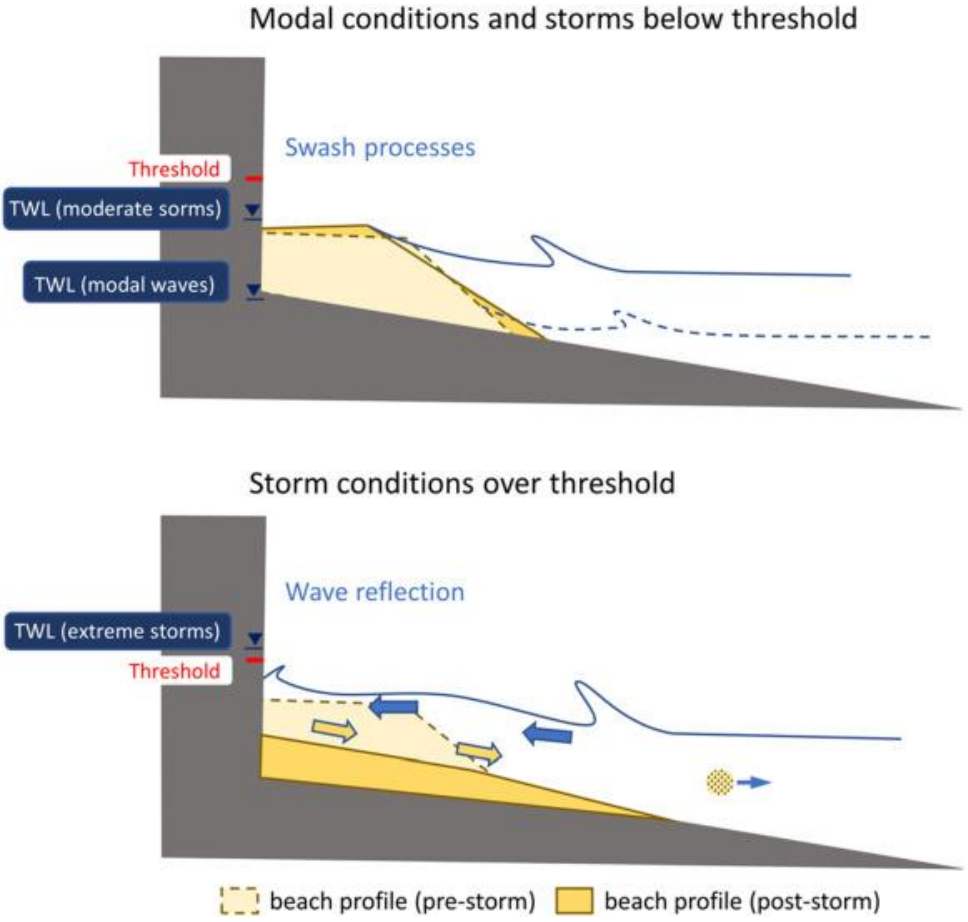


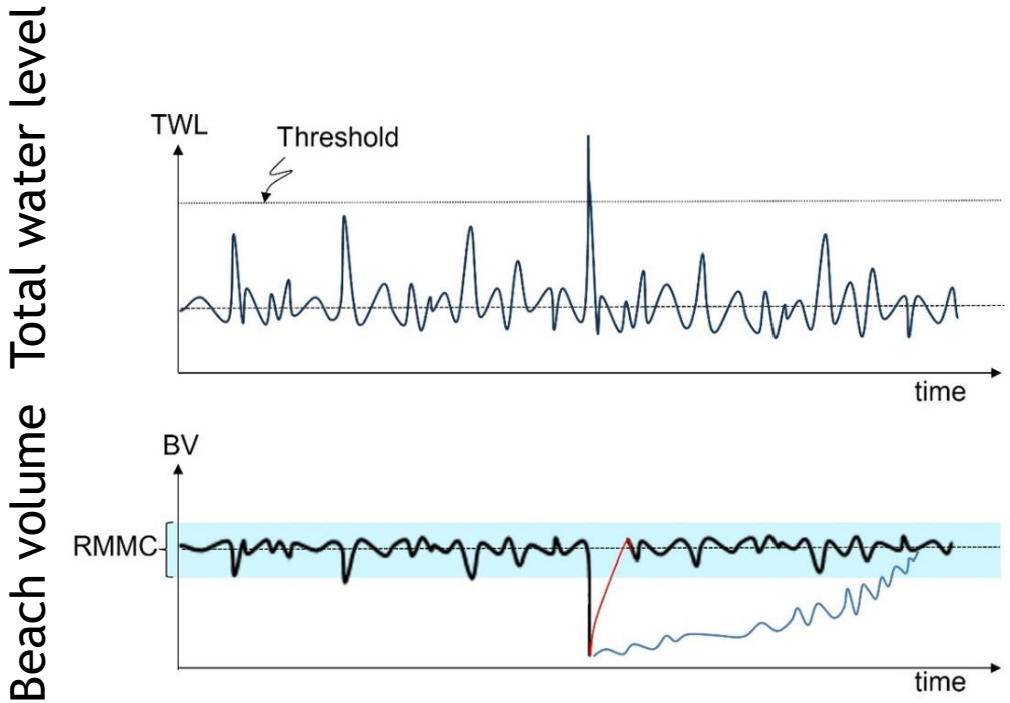
Location and limits of the study area; spatial distribution of the hydraulic conductivity; variation of the direct recharge of the aquifer; piezometric map of the study area; (from left to right)

2) Morphological Thresholds

We investigate conditions leading to abrupt morphological changes in rock-bounded platform beaches







3) Emerging challenges associated with the advancement of remote sensing technologies

More data + New techniques

AI and **ML** -> new data-driven approaches

Satellite
UAV
Video

Example

benchmark the accuracy of satellite-derived shoreline observations across different methods and coastal environments

communications earth & environment

ARTICLE

https://doi.org/10.1038/s43247-023-01001-2 OPEN

Benchmarking satellite-derived shoreline mapping algorithms

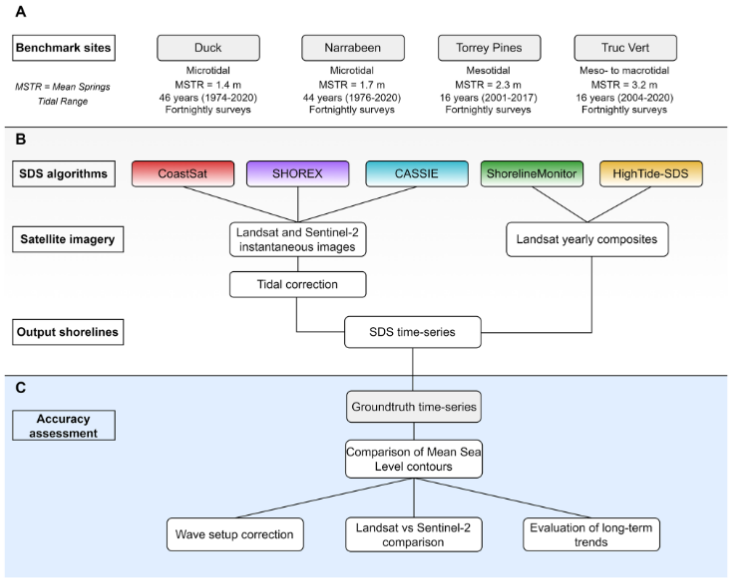
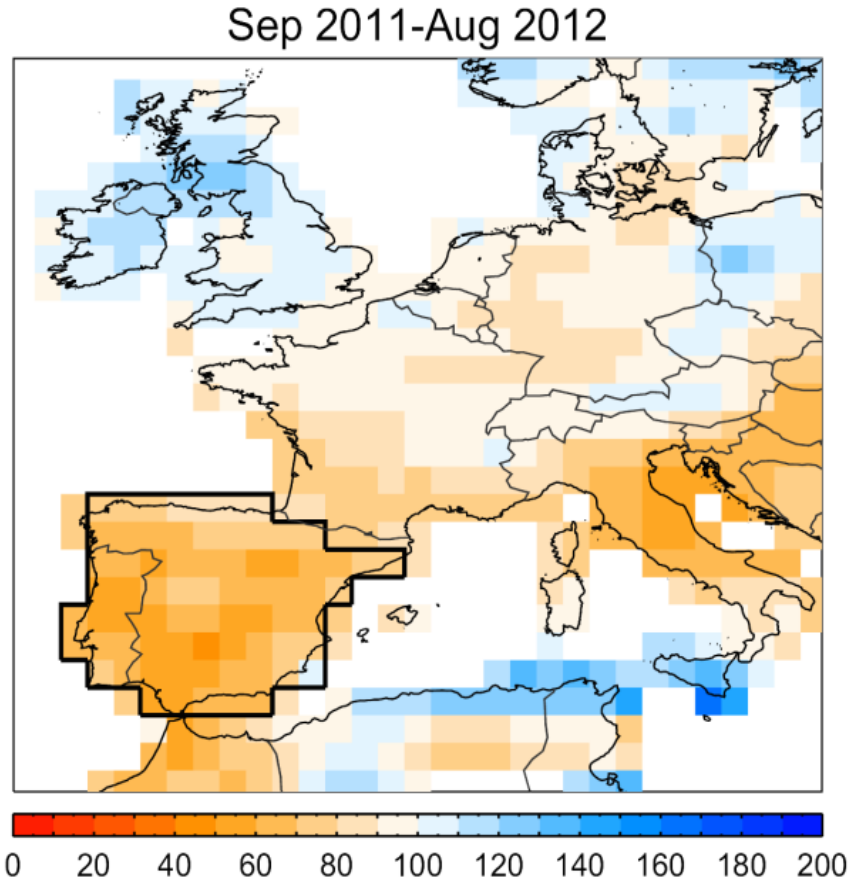
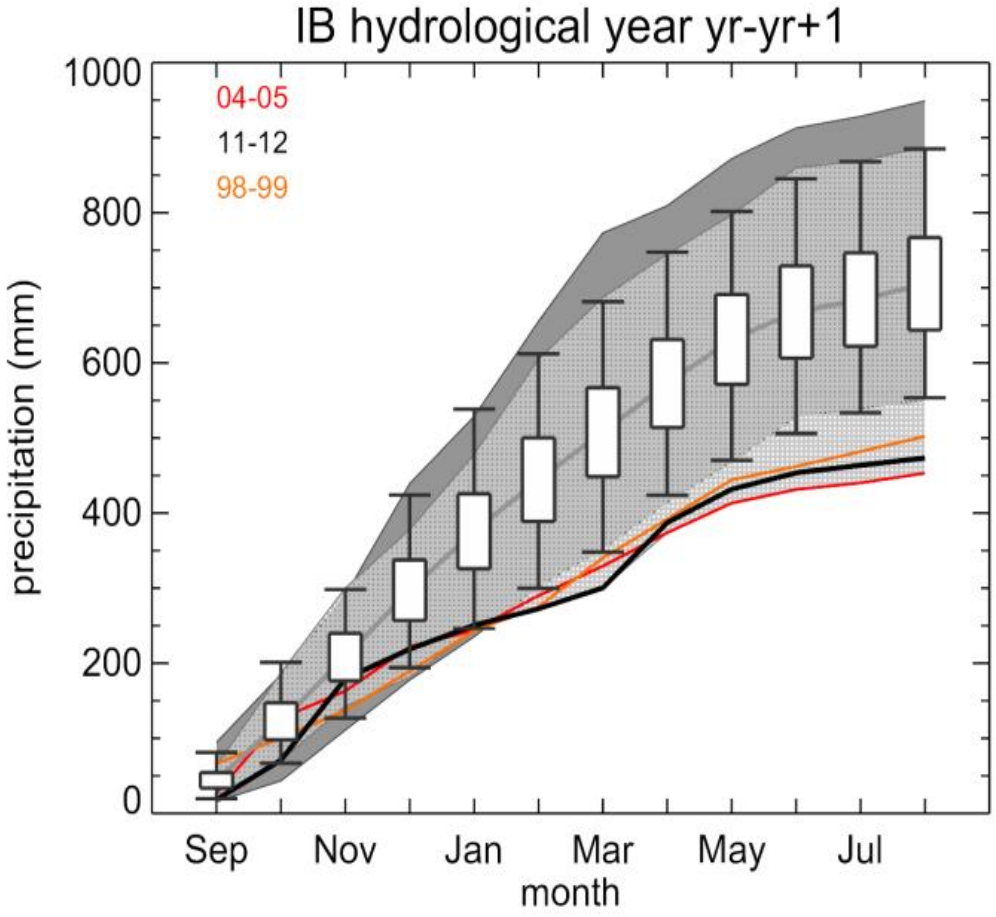


Fig. 2 Flowchart of the developed methodology to assess the accuracy of the SDS algorithms. A Description of the four sites with long-term shoreline change datasets used as benchmarks. **B** The five SDS algorithms evaluated in this study and their outputs. **C** The evaluation methodology; all algorithms were evaluated against the groundtruth observations of the MSL contour. CoastSat, SHOREX and CASSIE provide instantaneous shorelines from individual satellite images for which we could compare the Landsat and Sentinel-2 accuracies as well as the effect of wave setup corrections. The full methodology and benchmarking software are publicly available at https://github.com/SatelliteShorelines/SDS_Benchmark.

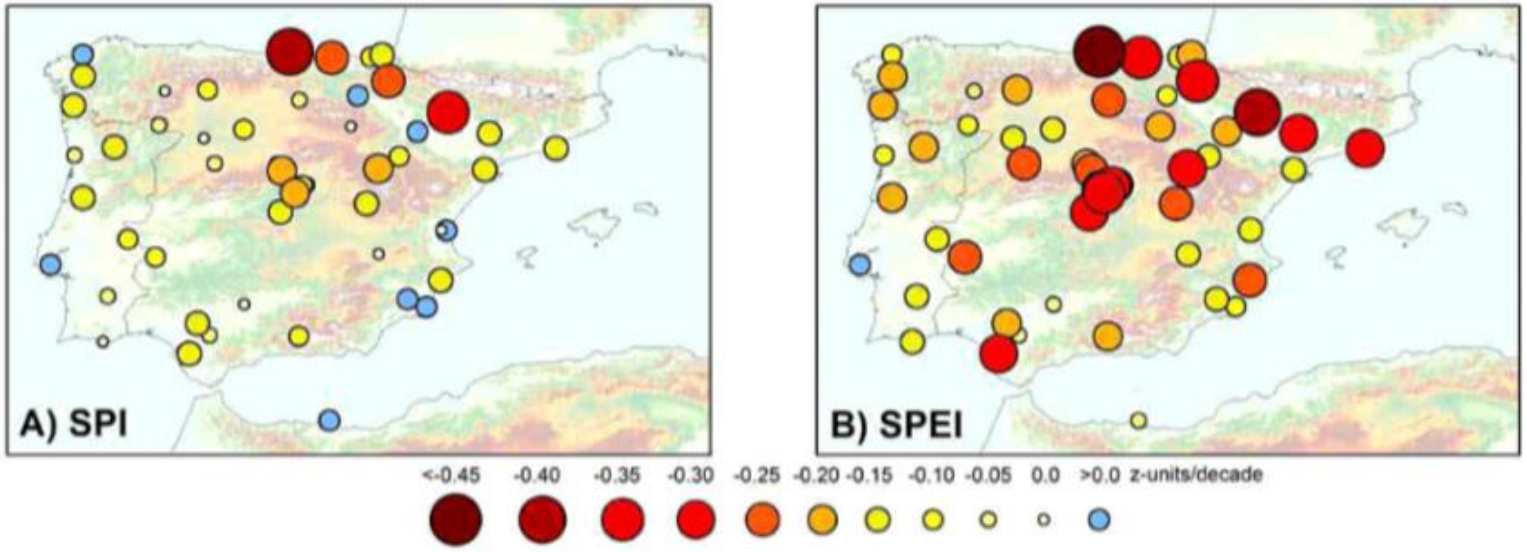
4. Increasing frequency of droughts (Precipitation only)

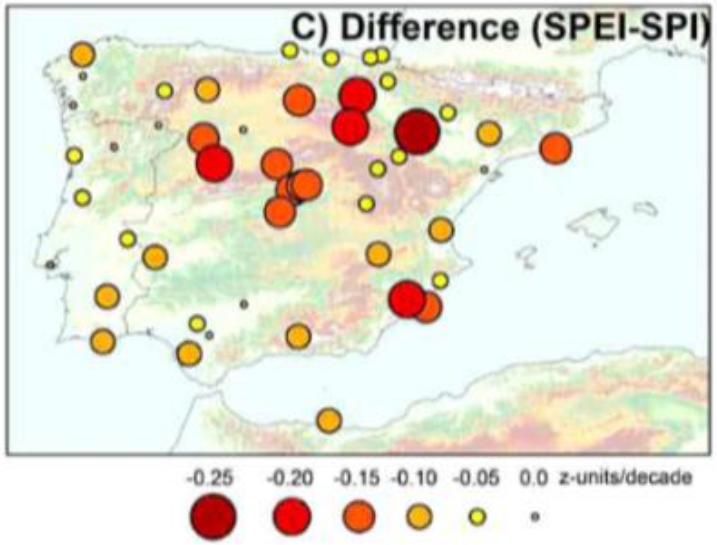




Trigo et al. (2013)

4. Increasing frequency of droughts (Precipitation vs Evapotransp)

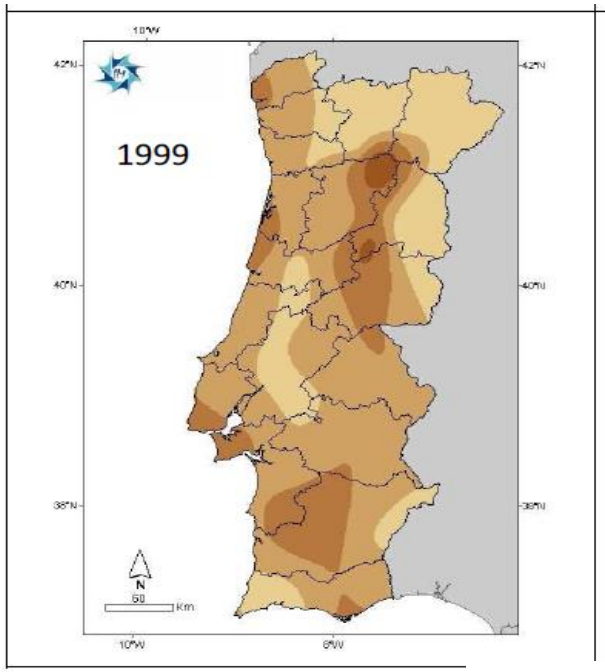


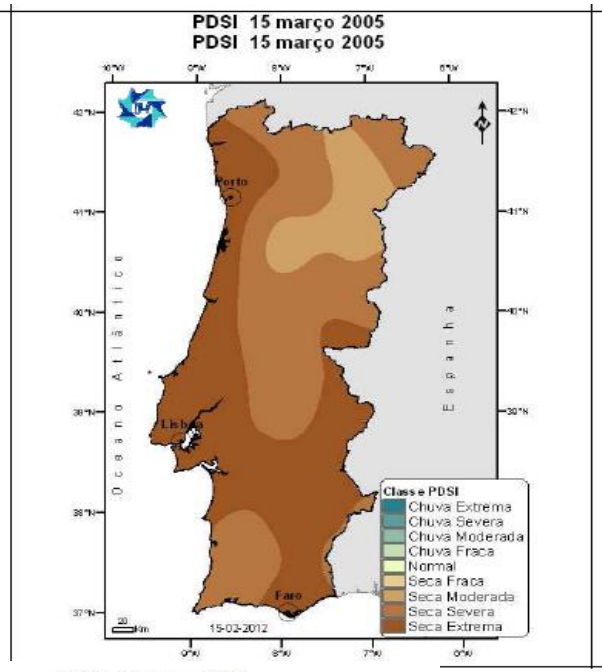


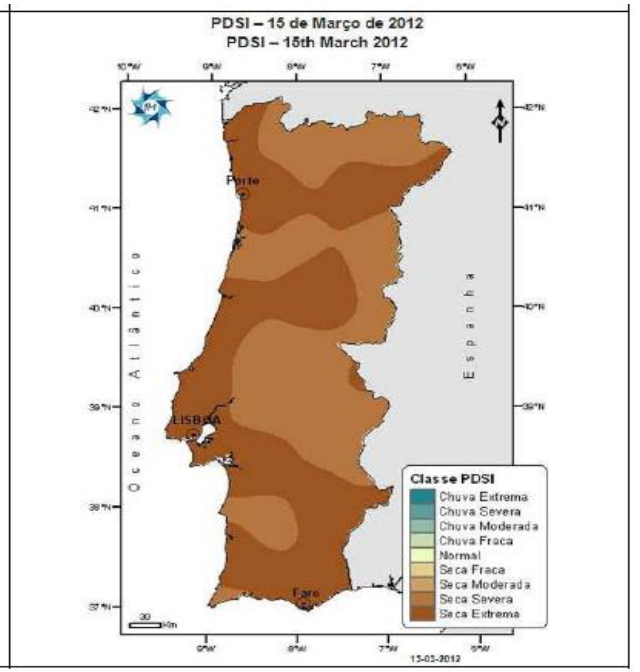
Drought severity has been aggravated by greater evaporative demand by the atmosphere since 1960s.

The SPEI indicates increased drought severity relative to the SPI

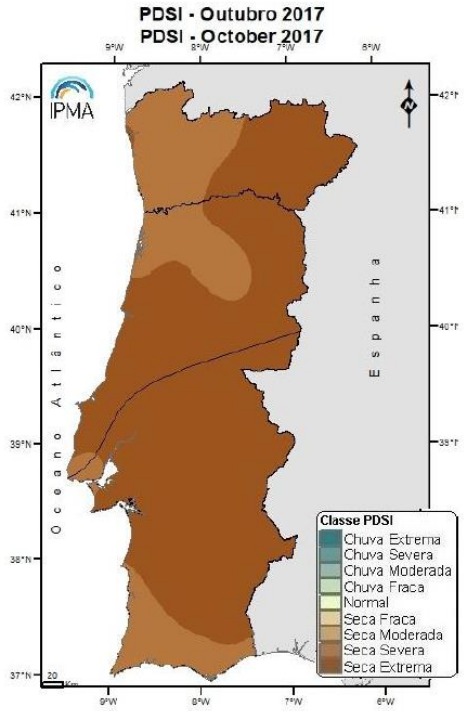
(Vicente-Serrano et al., 2014)

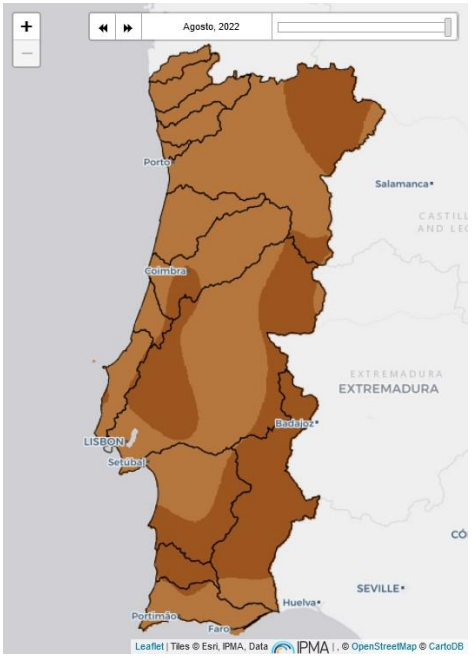






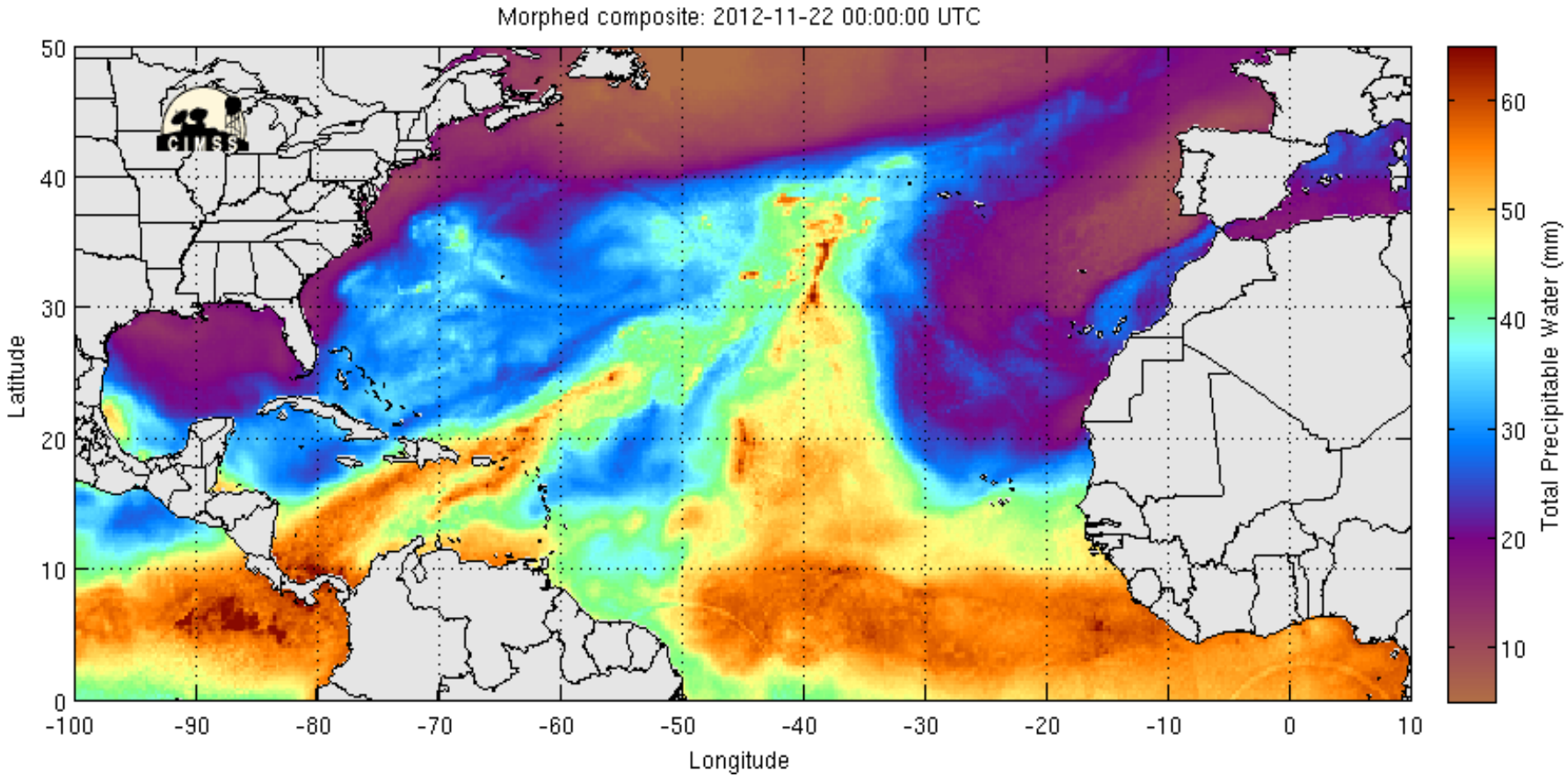
The **4 strongest Droughts** in Portugal (PDSI) have occurred since 2000, according to **IPMA**.





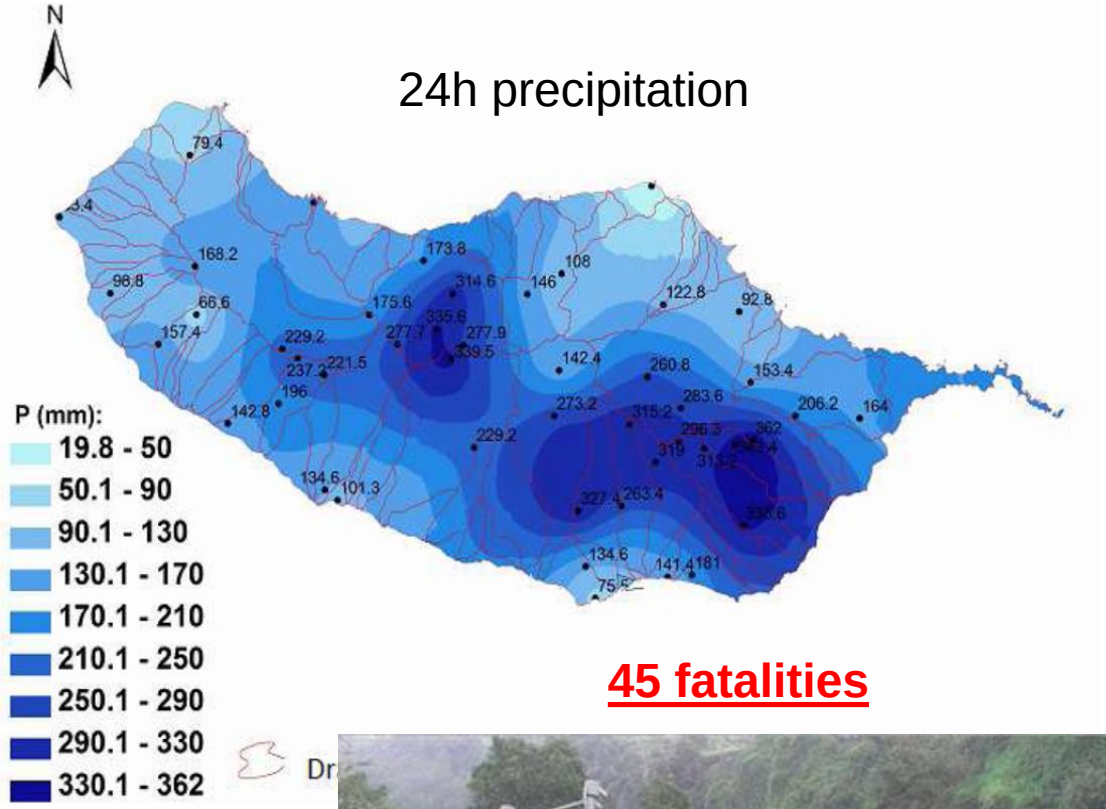
July 2022

5. The role of Atmospheric Rivers in extreme events



Ciências ULisboa

I) Madeira (20 February 2010)



45 fatalities

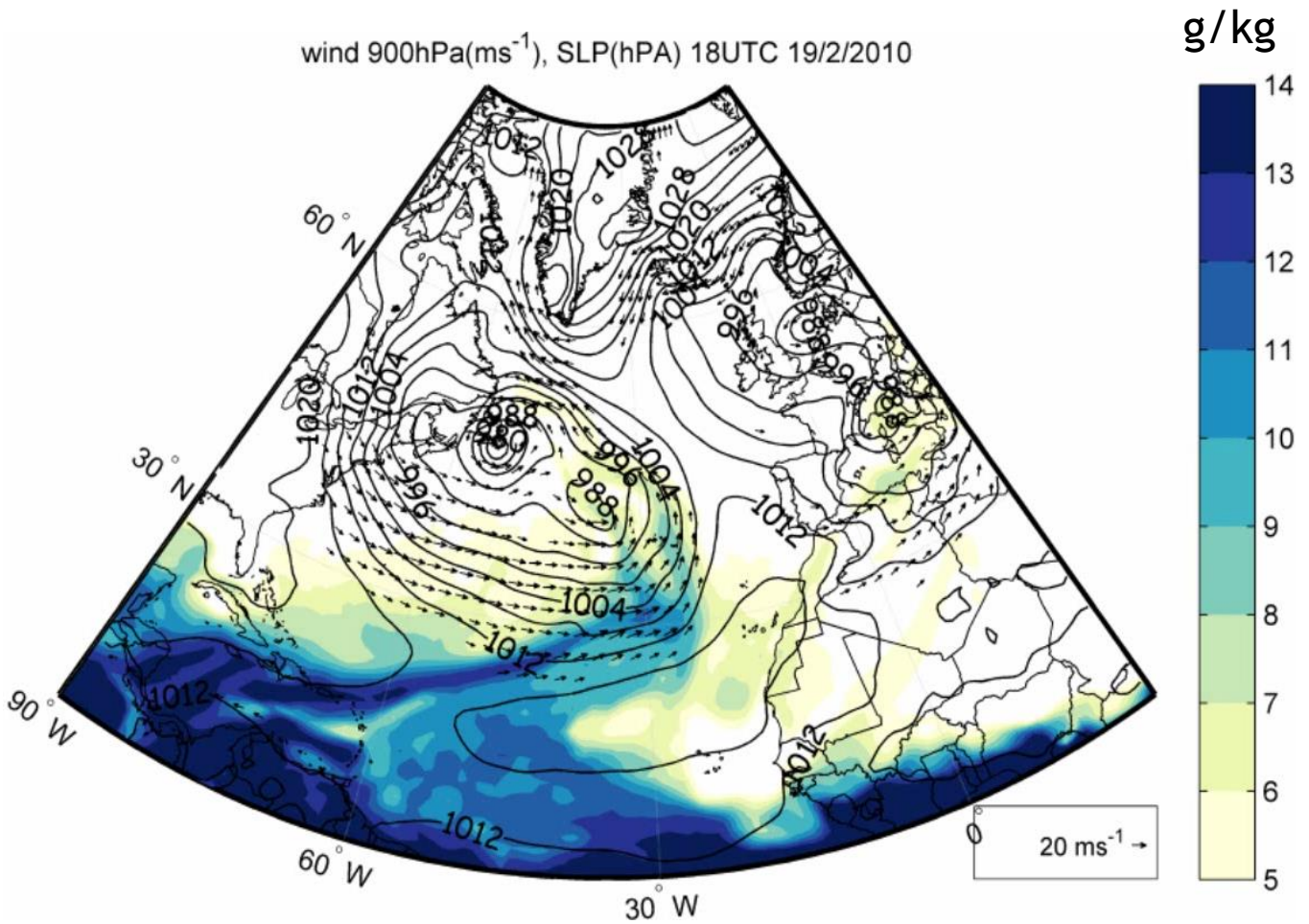
Nat. Hazards Earth Syst. Sci., 12, 715–730, 2012
www.nat-hazards-earth-syst-sci.net/12/715/2012/
doi:10.5194/nhess-12-715-2012

Natural Hazards and Earth System Sciences

The 20 February 2010 Madeira flash-floods: synoptic analysis and extreme rainfall assessment

M. Fragoso[1], R. M. Trigo[2], J. G. Pinto[3], S. Lopes[1,4], A. Lopes[1], S. Ulbrich[3], and C. Magro[4]

I) Madeira (February 2010



Specific humidity 900hPa (g/kg) , wind 900hPa (m/s) and SLP (hPa)

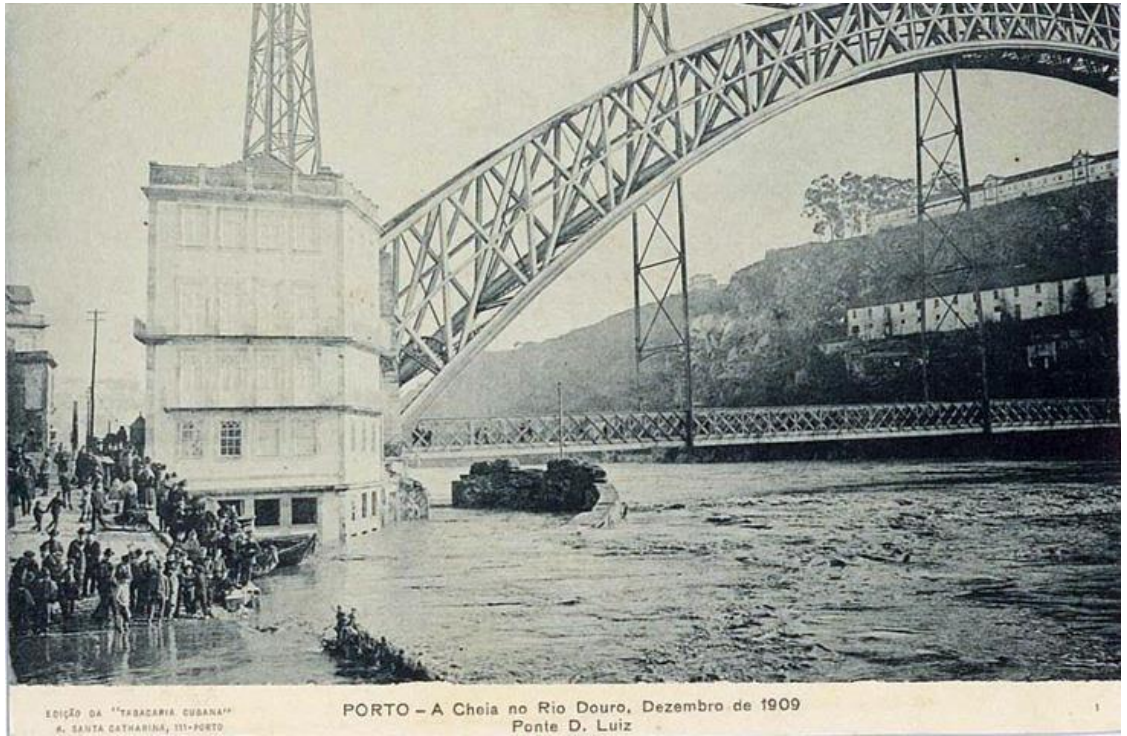
II) December 1909 - Largest floods in 200 years in river Douro

Nat. Hazards Earth Syst. Sci., 16, 371–390, 2016
www.nat-hazards-earth-syst-sci.net/16/371/2016/
doi:10.5194/nhess-16-371-2016

Natural Hazards and Earth System Sciences
Open Access
EGU

Spatial impact and triggering conditions of the exceptional hydro-geomorphological event of December 1909 in Iberia

S. Pereira[1], A. M. Ramos[2], J. L. Zêzere[1], R. M. Trigo[2], and J. M. Vaquero[3]



2) December 1909 - Largest floods in 200 years in river Douro

130 floods and 5 landslides

Total affected people: **3876**

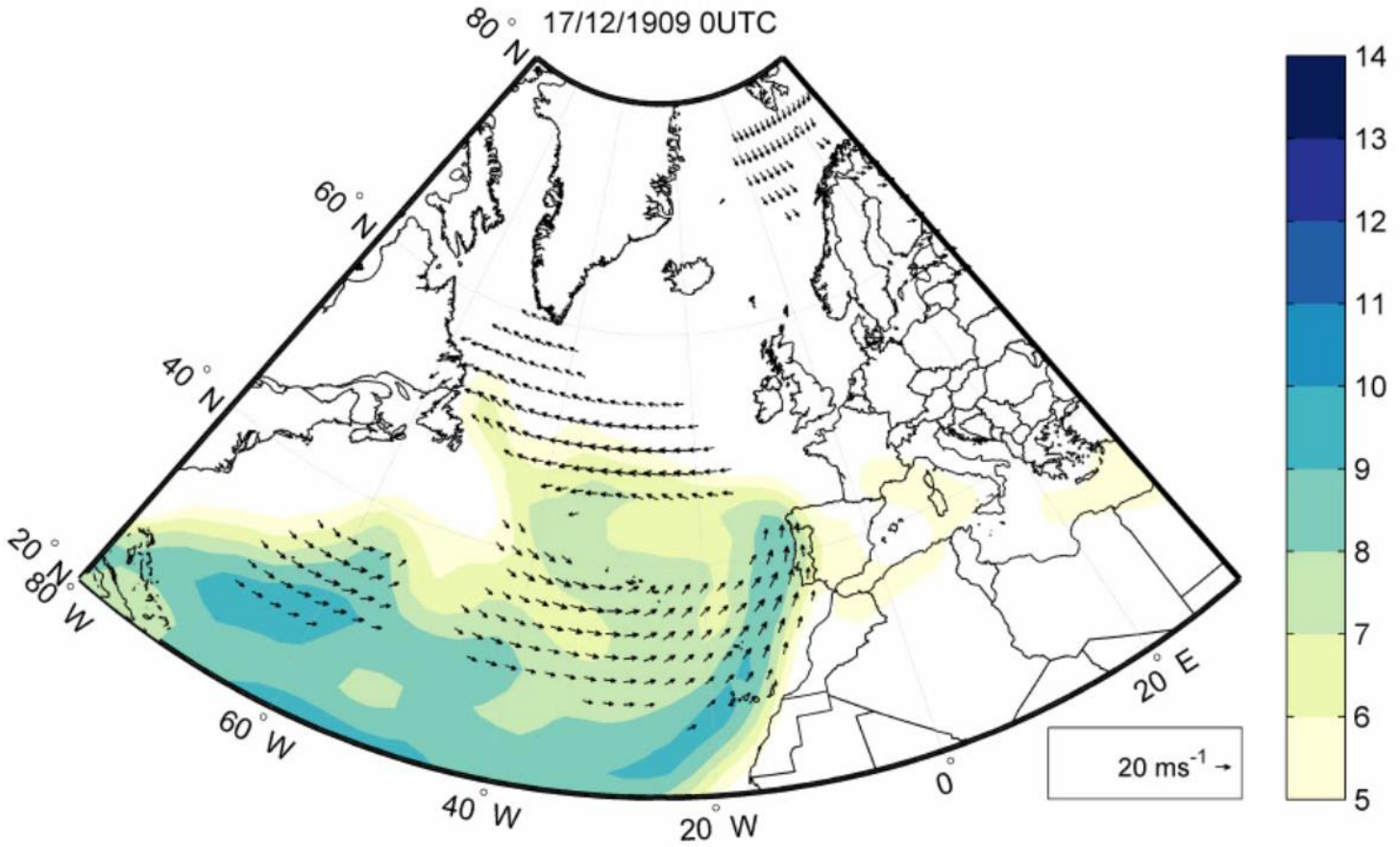
Total fatalities: **89 (57 floods and 32 landslides)**

(Pereira et al., 2016, NHESS)

2) December 1909 - Largest floods in 200 years in river Douro

Specific humidity 900hPa (g/kg)
wind 900hPa (m/s)

Winds shown only above 12.5m/s



Ciências ULisboa

(Pereira et al., 2016, NHESS)

Atmospheric Rivers and Precipitation Europe

Average AR fraction in (%) in each month

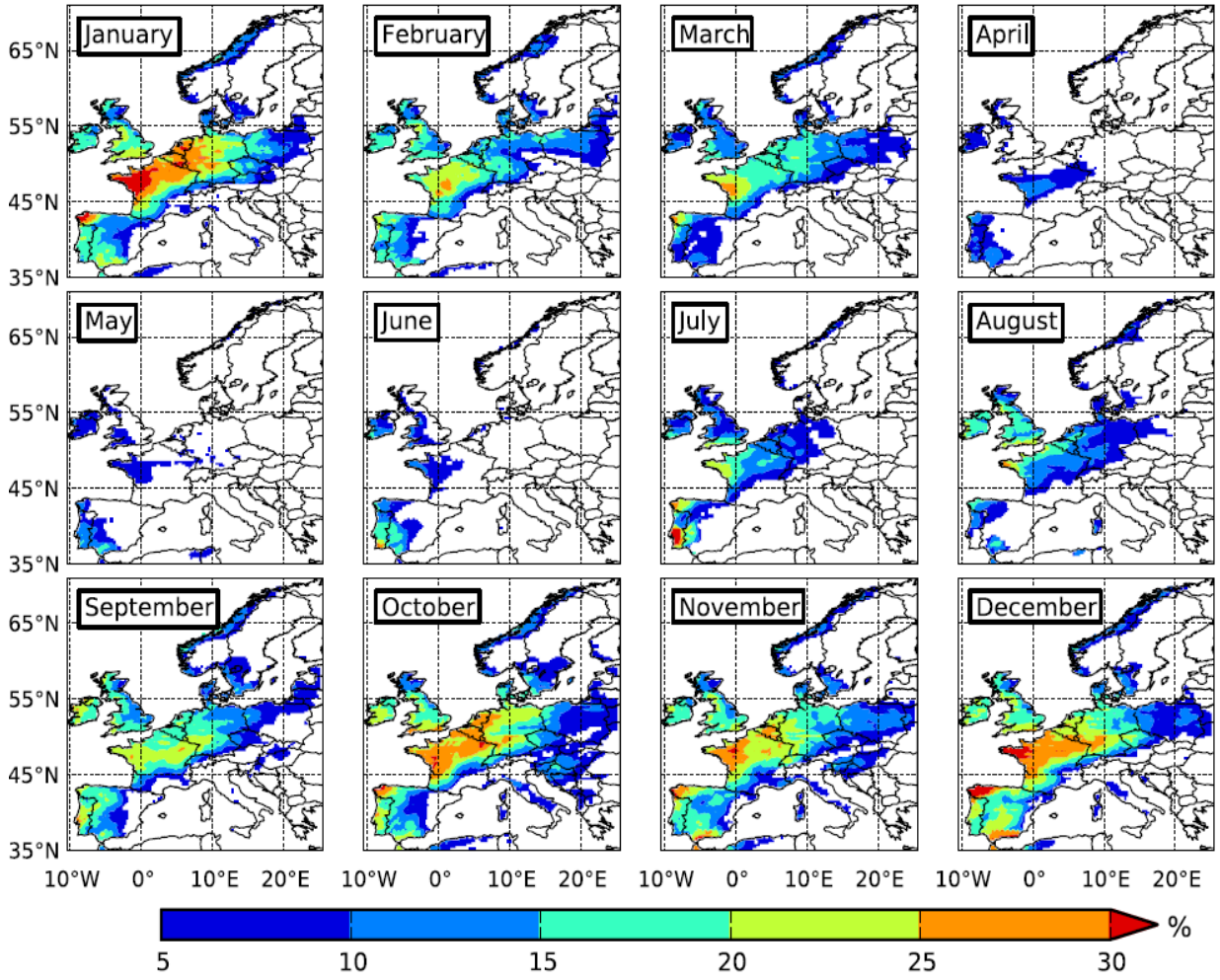
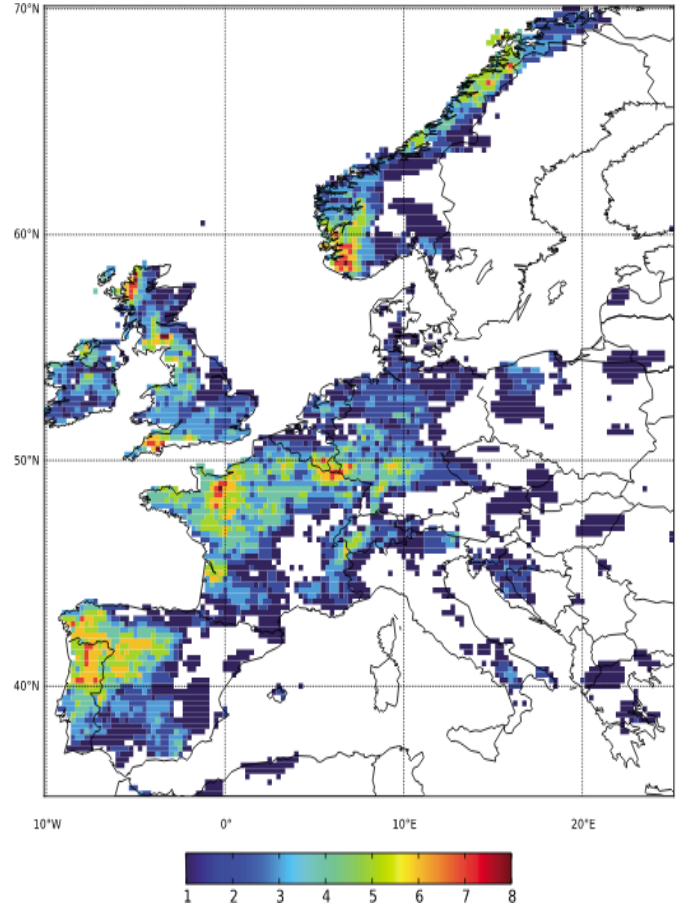


Fig. 2. The average AR fraction (in%) in each month from Europe over the period 1979–2012.

(Lavers and Villarini, 2015)

TOP10 Annual Maxima related to ARs



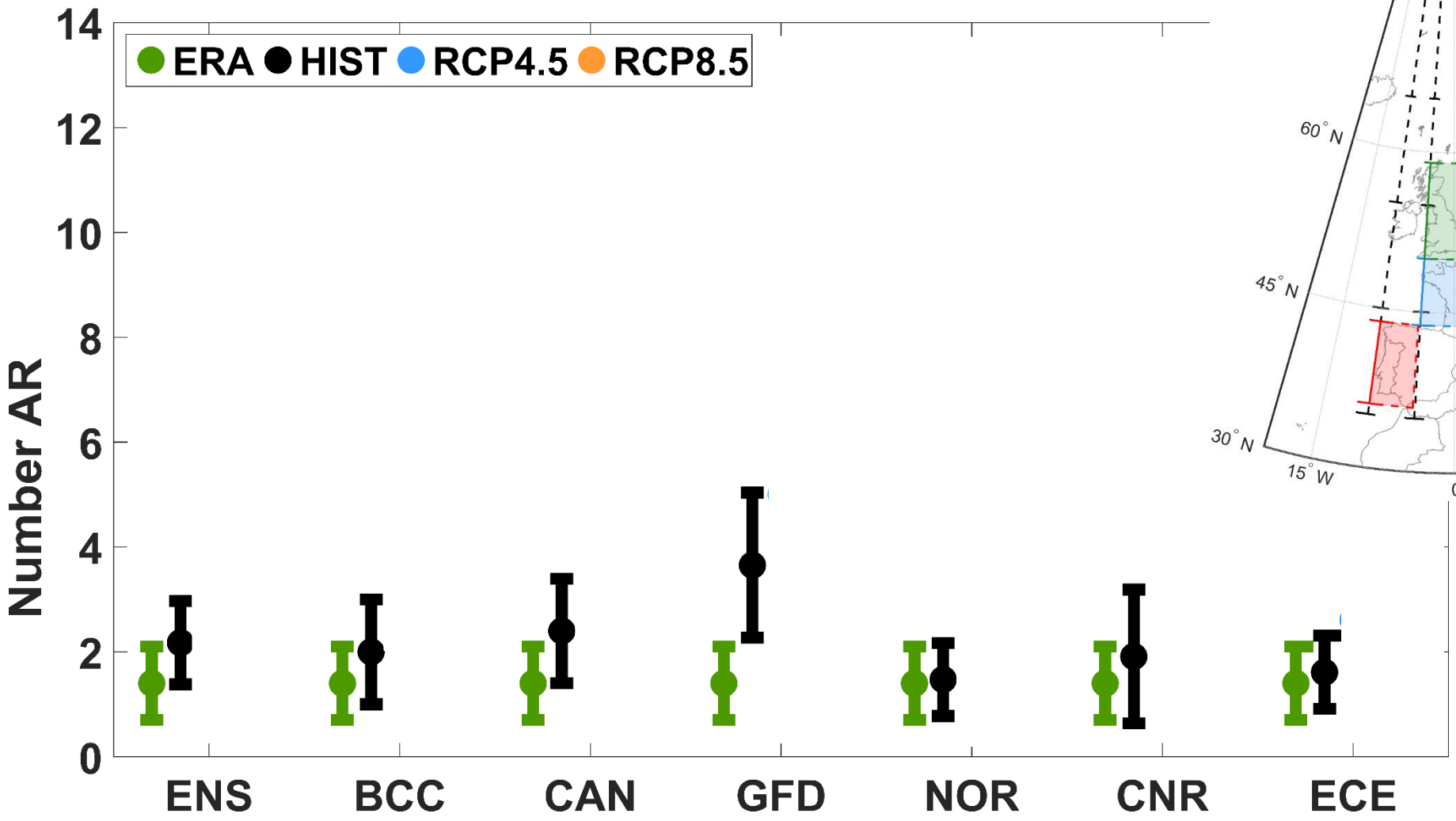
Lavers and Villarini, 2013

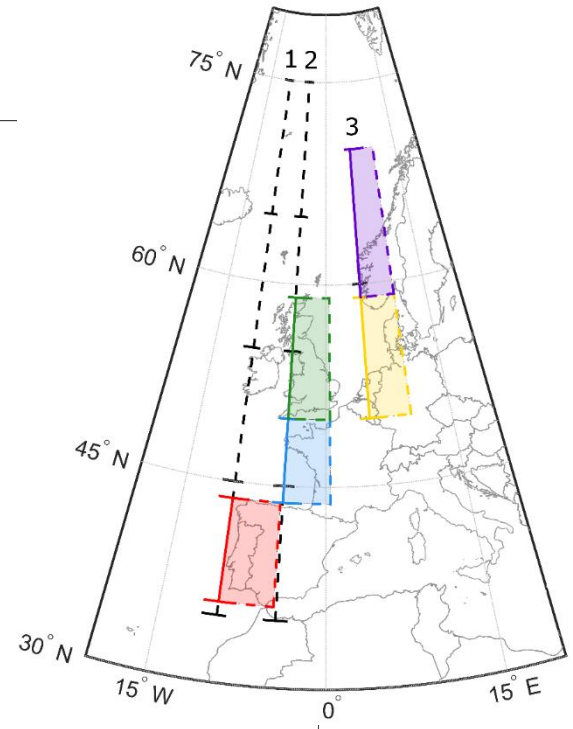
Atmospheric Rivers – Future Climate

Extended winter months

CMIP5

Iberian Peninsula – ARs frequency





(Ramos et al., 2016, GRL)

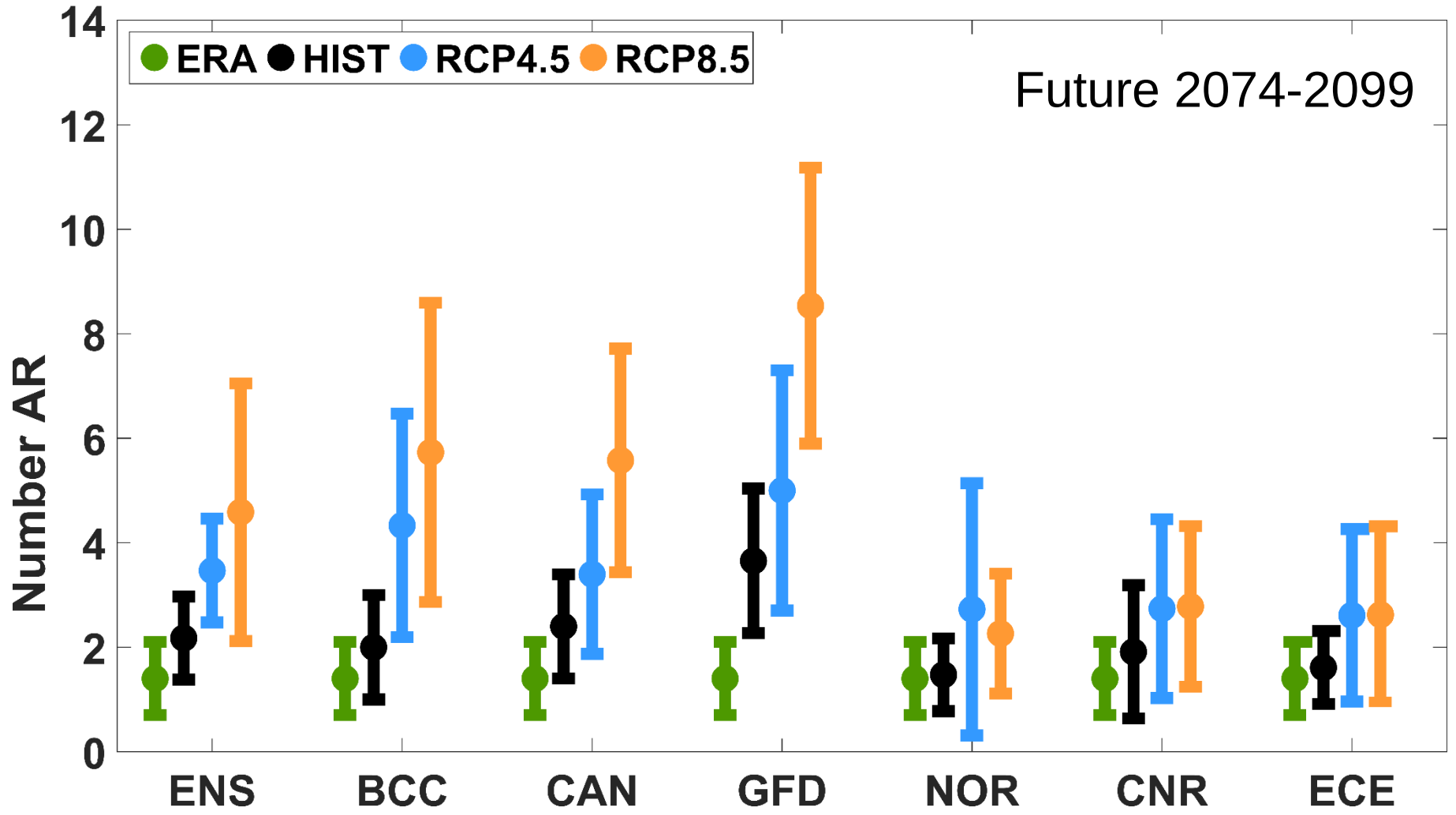
Ciências ULisboa

Atmospheric Rivers – Future Climate

Extended winter months

CMIP5

Iberian Peninsula – ARs frequency

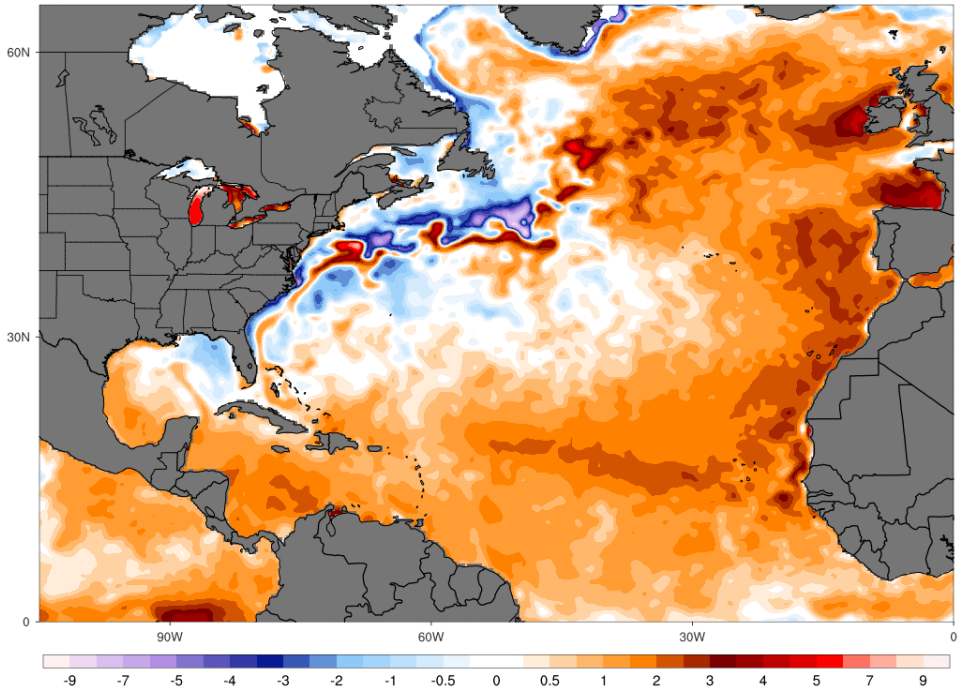


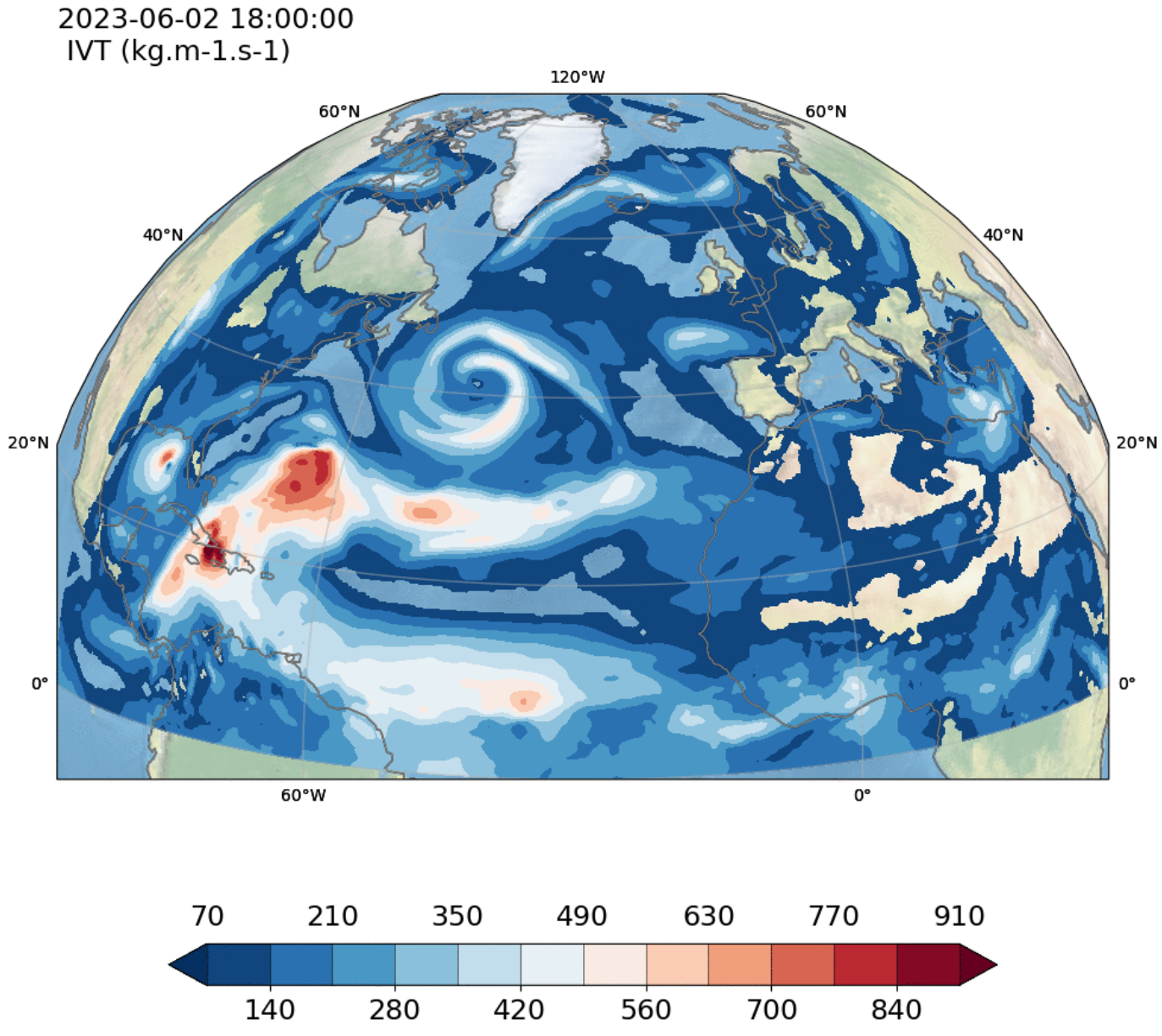
(Ramos et al., 2016, GRL)

Ciências ULisboa

New absolute maximum precipitation recorded on the **6 June 2023** in Madeira with 500mm/24h

Previous maxima since 1860 were all lower than 400mm/24h !





Takeaway messages

1) **A significant fraction of western Europe's precipitation is due to the impact of just a few AR per year**, mostly with a strong W-E orientation.

2) This impact is particularly relevant for top rank precipitation days, including many flood events in **Portugal, Spain and France**.

3) Several major historical flood events such as the historical maxima of **Duero (1909)** and **Tagus (1876)** were clearly associated with ARs

4) **Climate Change scenarios** point toward an **increase of ARs frequency** at all latitudes, including Iberian Peninsula and France

Thanks!

Ciências ULisboa