

Portugal – an Atlantic extreme weather lab

2017

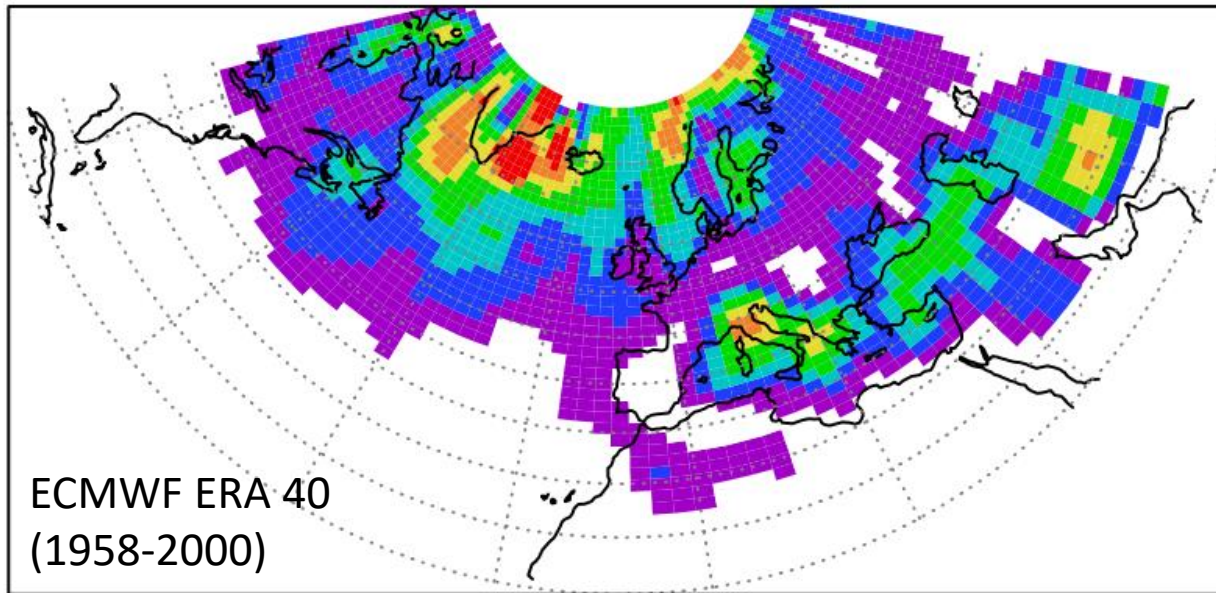
Nuno Moreira (nuno.moreira@ipma.pt)

6th HIGH-LEVEL INDUSTRY-SCIENCE-GOVERNMENT DIALOGUE ON ATLANTIC INTERACTIONS

ALL-ATLANTIC SUMMIT ON INNOVATION FOR SUSTAINABLE MARINE DEVELOPMENT

AND THE BLUE ECONOMY: FOSTERING ECONOMIC RECOVERY IN A POST-PANDEMIC WORLD

Spatial distribution of positions where **rapid cyclogenesis** reach their minimum central pressure

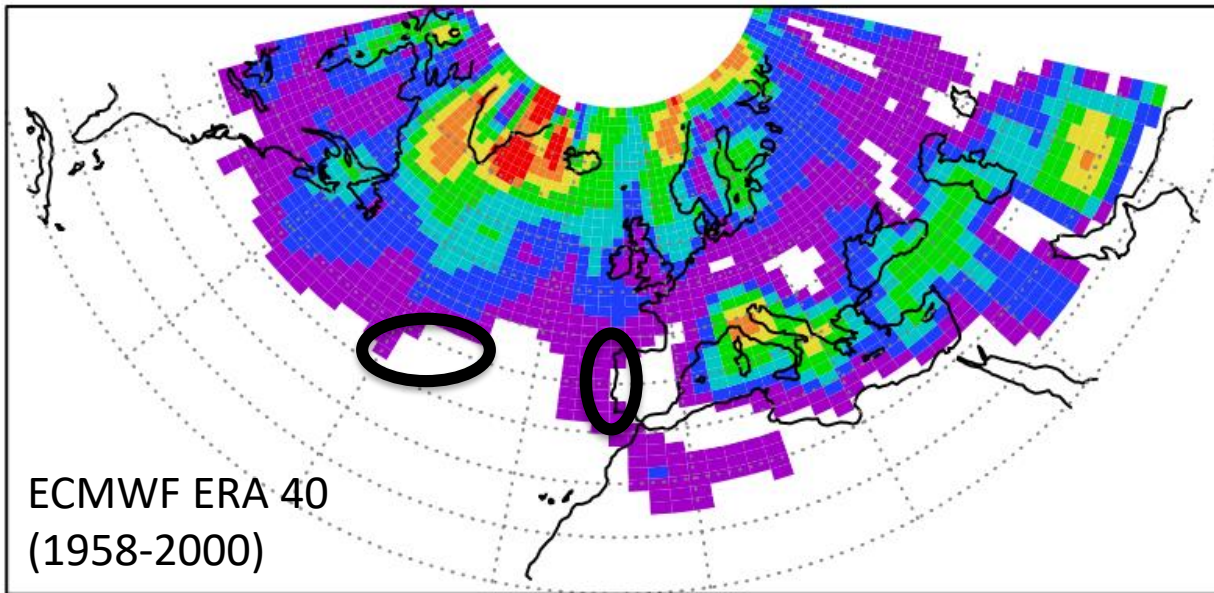


Events per DJFM season:



Source: Trigo, I., 2006: Climatology and interannual variability of storm-tracks in the Euro-Atlantic sector: a comparison between ERA-40 and NCEP/NCAR reanalyses. *Climate Dynamics* volume 26, pages127–143.

Spatial distribution of positions where **rapid cyclogenesis** reach their minimum central pressure



Events per DJFM season:



Azores and
mainland Portugal

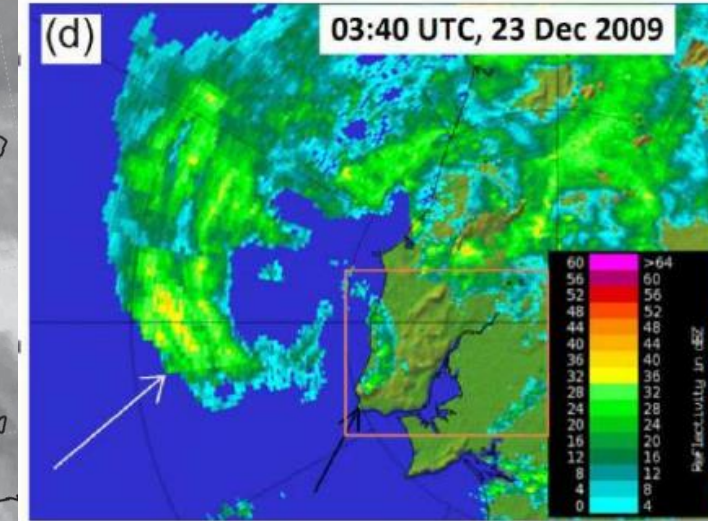
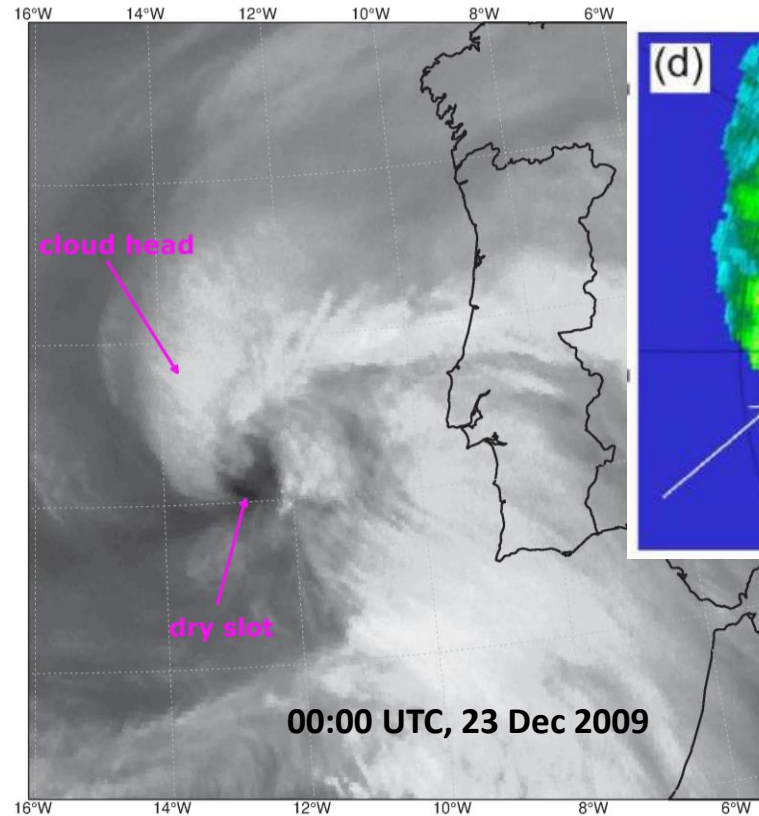
On average:

1 rapid cyclogenesis
every
1 or 2 wet seasons

Source: Trigo, I., 2006: Climatology and interannual variability of storm-tracks in the Euro-Atlantic sector: a comparison between ERA-40 and NCEP/NCAR reanalyses. Climate Dynamics volume 26, pages127–143.

... affected by sting jets of extra-tropical storms...

Example of a rapid cyclogenesis with a **sting jet** over mainland



Source: Pinto, P. and Belo-Pereira, M., 2020: Damaging Convective and Non-Convective Winds in Southwestern Iberia during Windstorm Xola. *Atmosphere*, 11(7), 692.

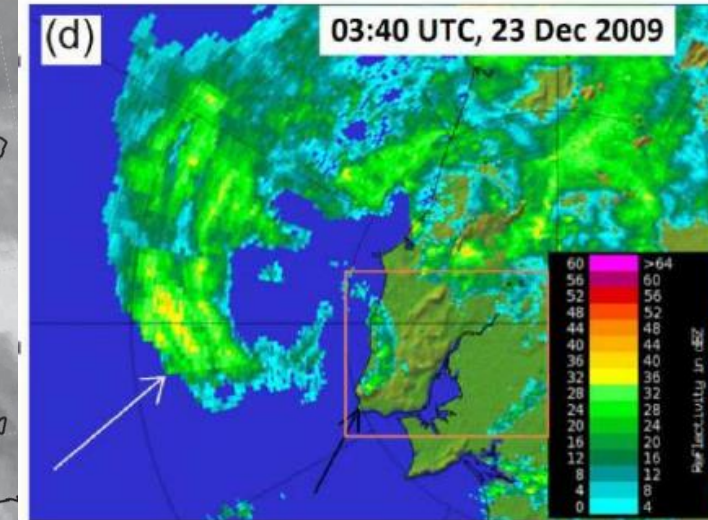
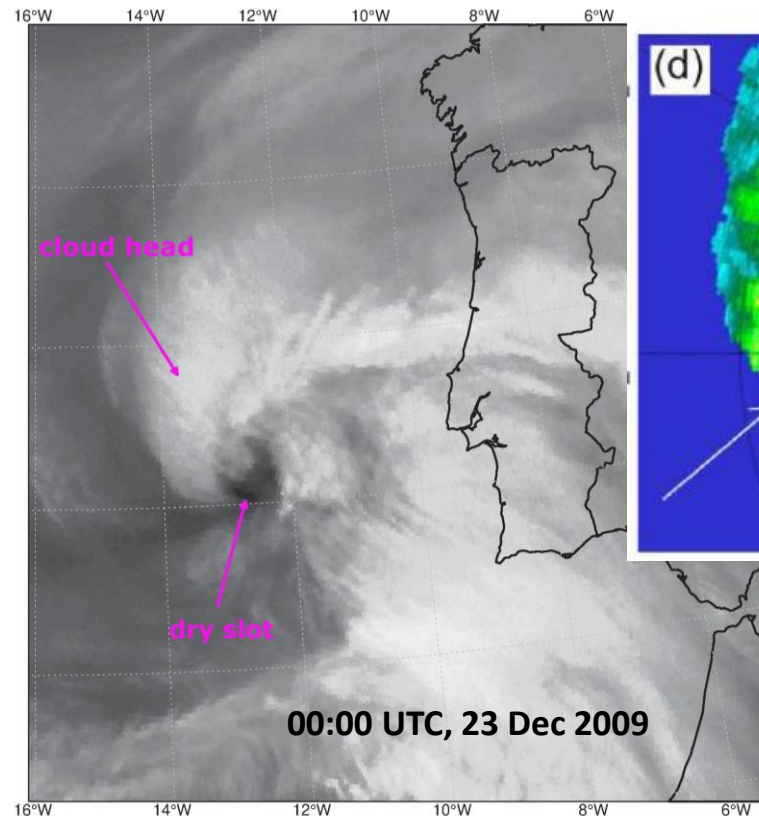
... affected by sting jets of extra-tropical storms...

Example of a rapid cyclogenesis with a **sting jet** over mainland

Maximum wind gusts:

Official station
140 km/h

Private station
203 km/h
(in the most affected area)



Source: Pinto, P. and Belo-Pereira, M., 2020: Damaging Convective and Non-Convective Winds in Southwestern Iberia during Windstorm Xola. Atmosphere, 11(7), 692.

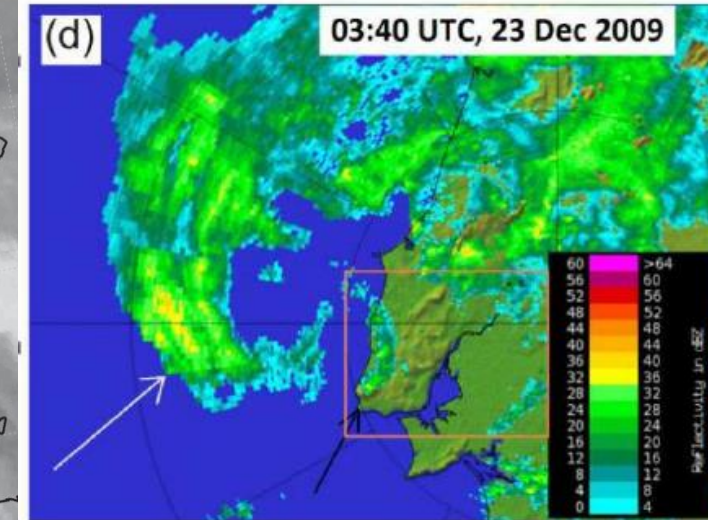
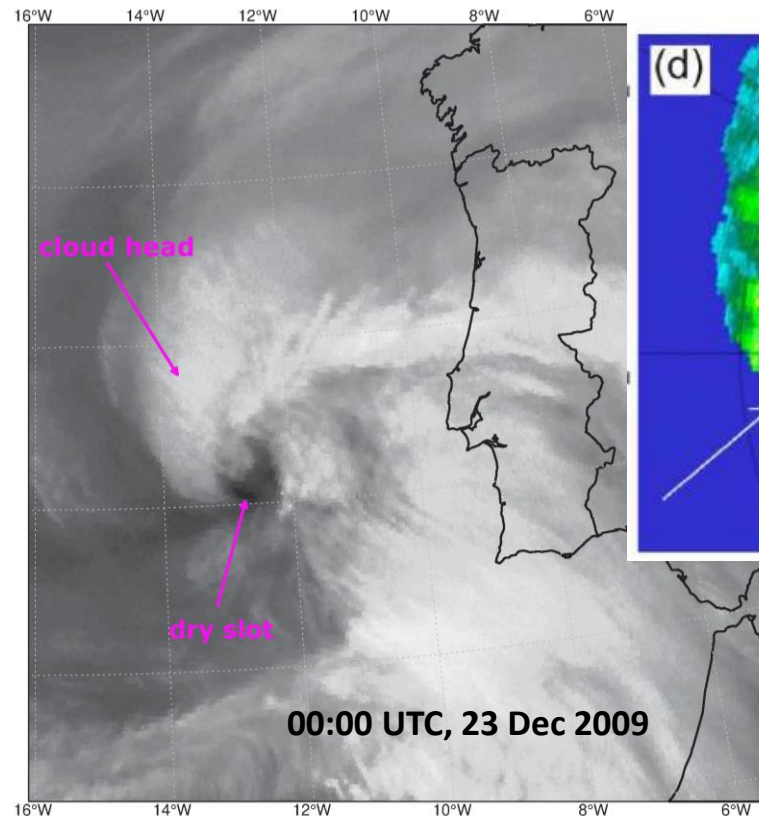
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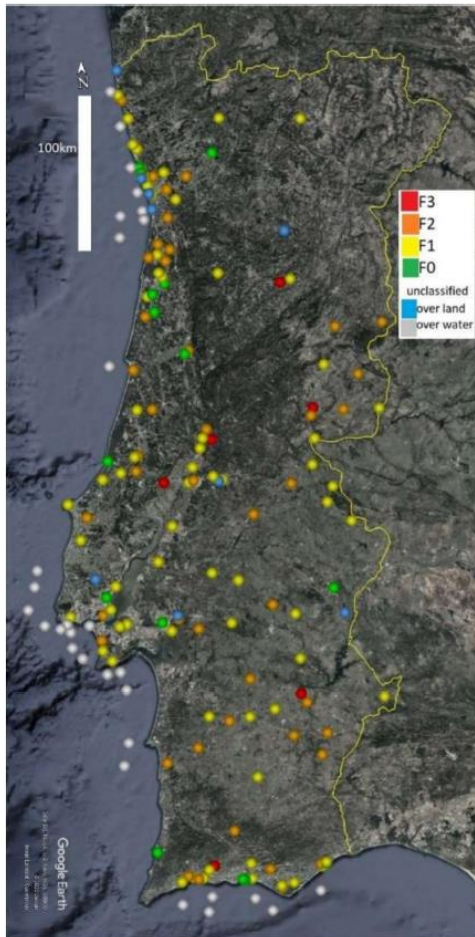
Official station
140 km/h

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203 km/h
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More than
100 million €
of economic
losses

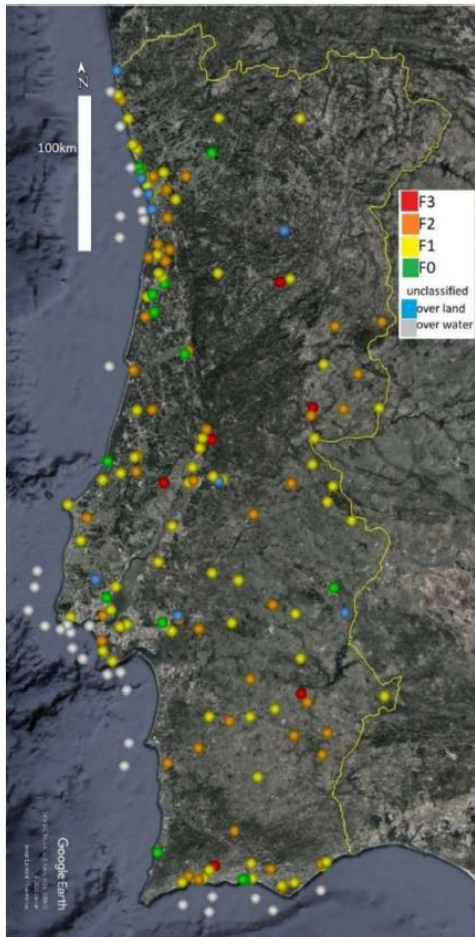
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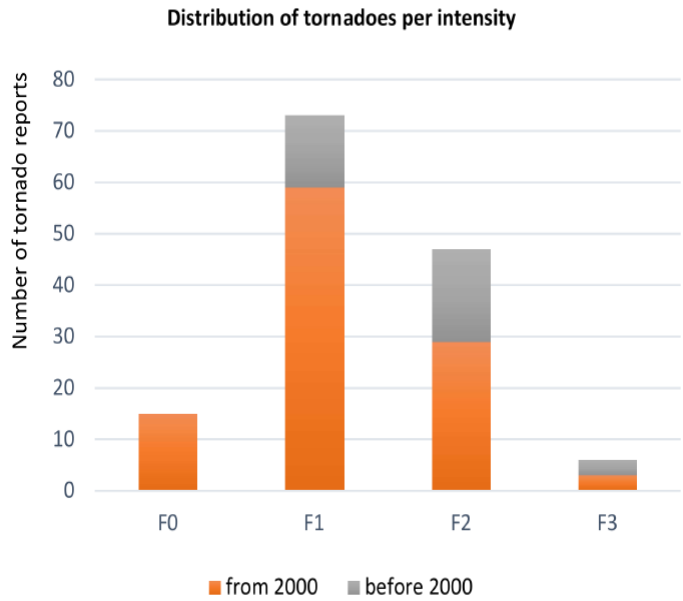
184 reported tornadoes
Last **20** years (1jan2000 - 1jan2020)
Average of almost **10/year**

Data Collection:

Leitão, P. and Pinto, P., 2020: Tornadoes in Portugal: An Overview. Atmosphere, 11(7), 679.

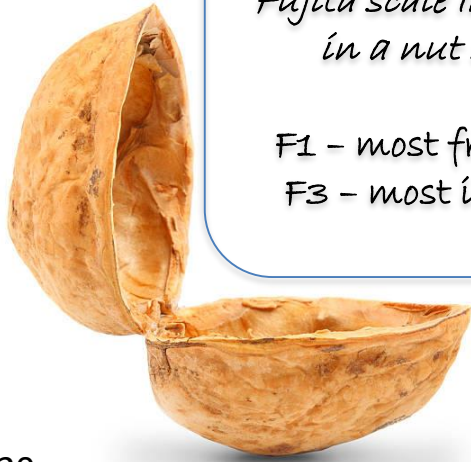


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Portuguese Tornadoes Fujita scale Intensity in a nut shell

F1 - most frequent
 F3 - most intense



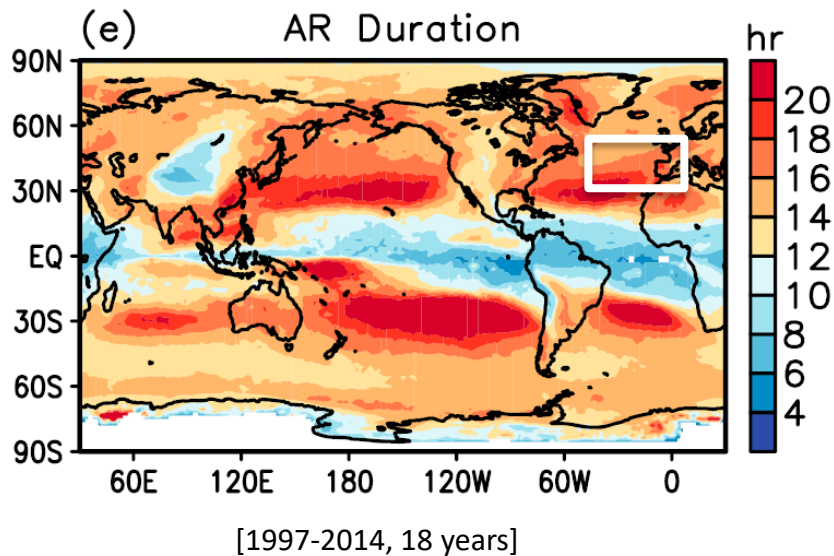
Based on 141 reported tornadoes until 1jan 2020

Data Collection:

Leitão, P. and Pinto, P., 2020: Tornadoes in Portugal: An Overview. Atmosphere, 11(7), 679.

F3 example:

Belo-Pereira, M., Andrade, C. and Pinto, P., 2017: A long-lived tornado on 7 December 2010 in mainland Portugal. Atmos. Res., 185, 202–215.

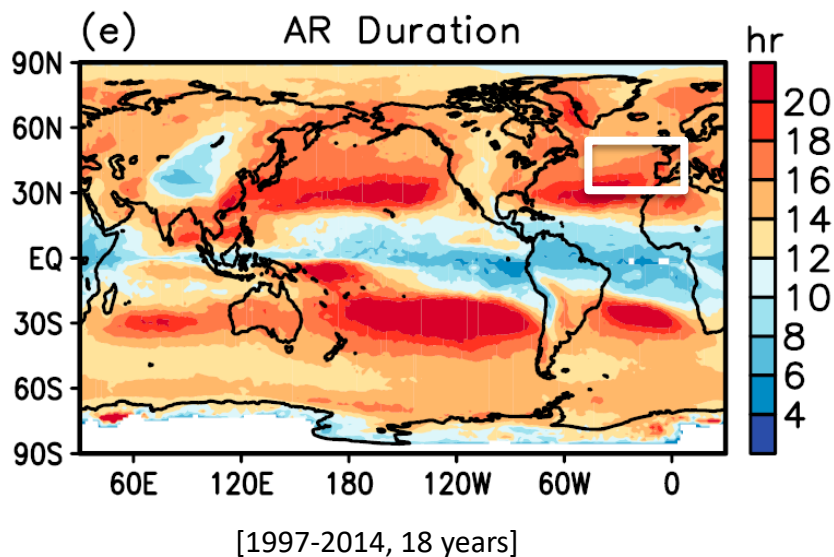


Mean duration of
atmospheric rivers in
Mainland Portugal,
Azores and Madeira

16 to 20 hours

Sources:

- Guan, B. and Waliser, D., 2015: Detection of atmospheric rivers: Evaluation and application of an algorithm for global studies. *J. Geophys. Res. Atmos.*, 120, 12,514–12,535, doi:10.1002/2015JD024257.



Atmospheric Rivers Frequency

Azores: **9-12% of the time**

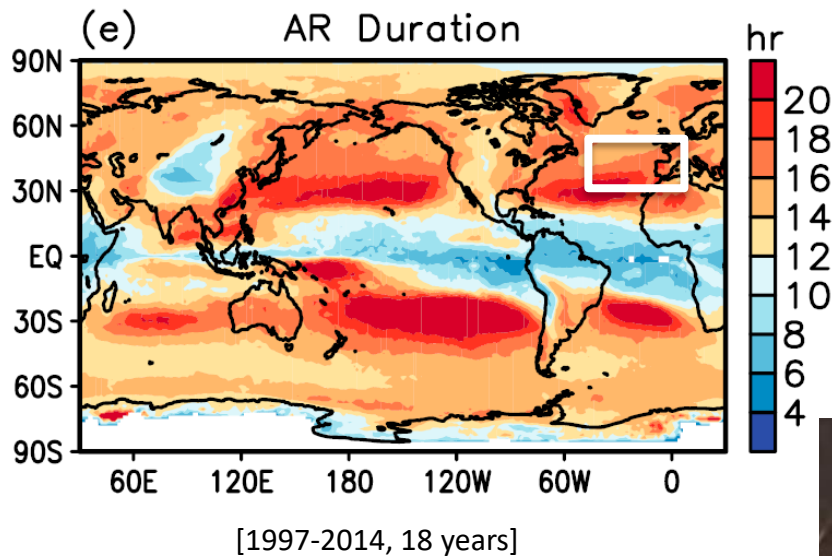
Mainland/Madeira: **6-9% of the time**

Mean duration of atmospheric rivers in Mainland Portugal, Azores and Madeira

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Atmospheric Rivers Frequency

Azores: **9-12% of the time**

Mainland/Madeira: **6-9% of the time**



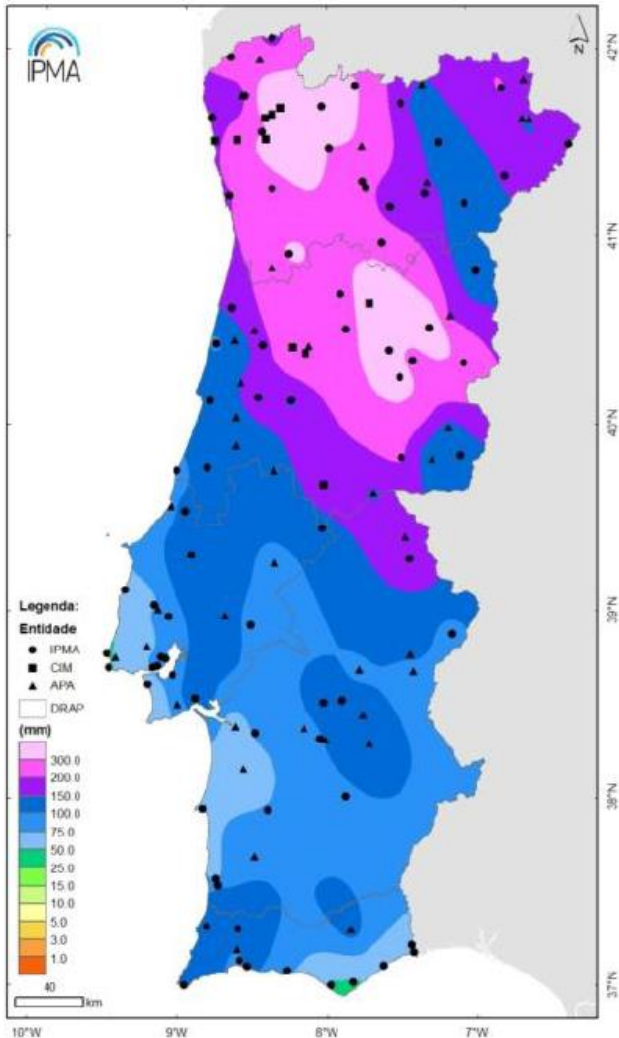
Tragic Flash Flood in Madeira
20 Feb 2010

42 casualties
1000 million € of economic losses

Atmospheric River with an embedded Mesoscale Convective System

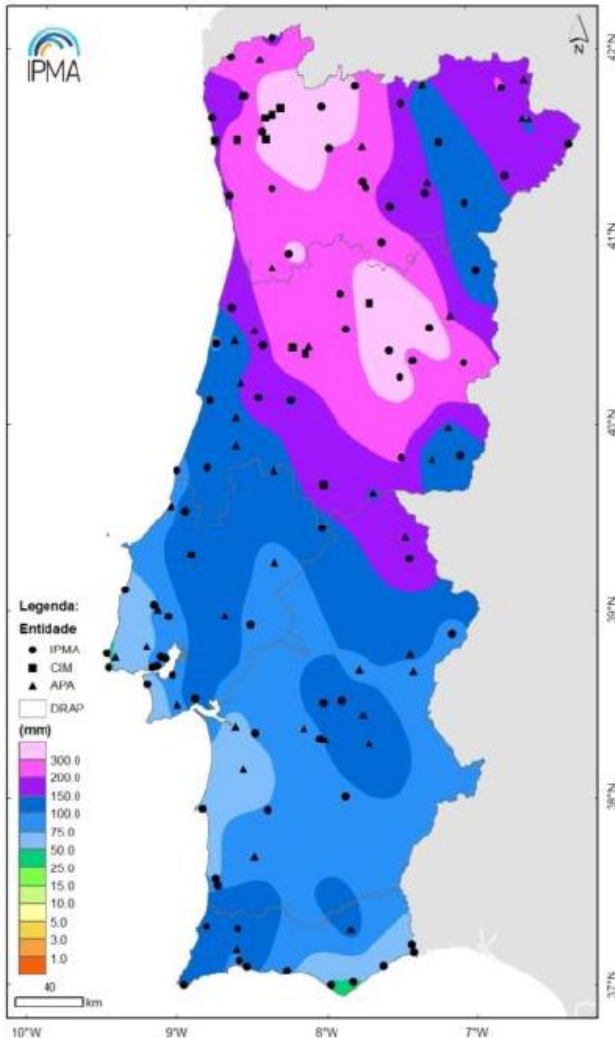
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- http://www.eumetrain.org/resources/flash_flood_madeira.html



Heavy and prolonged
Precipitation event
15 to 22 December 2019
Related to **3 named storms:**
Daniel, Elsa and Fabien

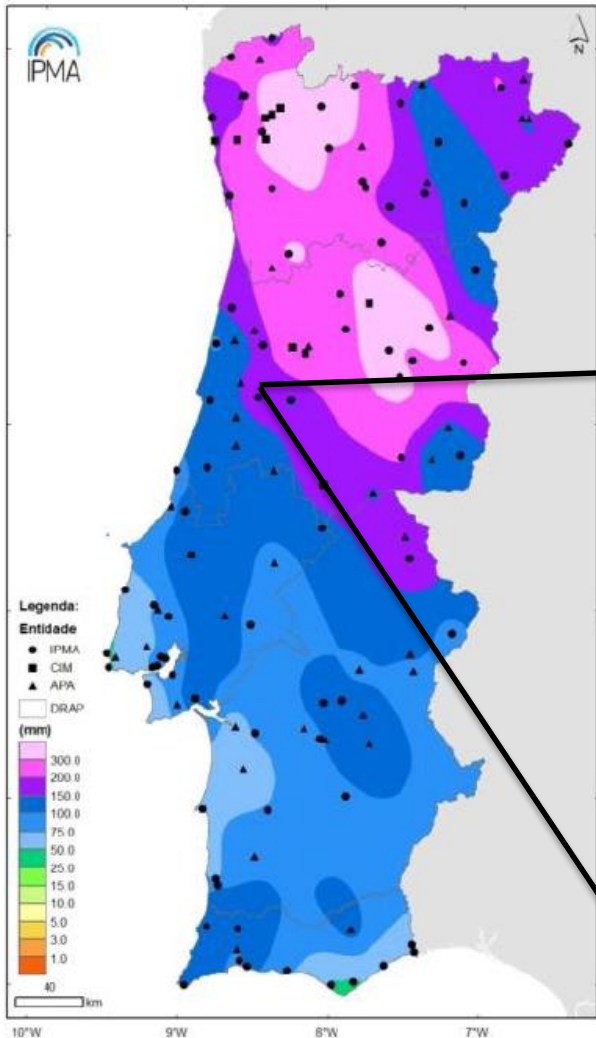
Coelho, F., Silva, A., Cota, T., Cabrinha, C., Rio, J., Lopes, M., Moreira, N., Narciso, P., Pinto, P., Correia, S., Barroso, C., 2020: Tempestades Daniel, Elsa e Fabien – Portugal Continental – 15 a 22 de dezembro de 2020. IPMA report (*in Portuguese*).



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Maximum
Total Precipitation
in excess of:
200 mm in 2 days (19-20)
400 mm in 8 days (15-22)

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400 mm in 8 days (15-22)



51 million €
of economic
losses

https://www.saudemais.tv/uploads/cache/noticia_0000002134-711x400.jpg
<https://www.tsf.pt/portugal/economia/tempestade-elsa-fez-prejuizos-de-9-milhoes-de-euros-agricultores-recebem-subsidios-11730287.html>
<https://expresso.pt/economia/2020-02-06-Tempestades-Elsa-e-Fabien-causaram-danos-cobertos-por-seguros-de-42-milhoes>

Coelho, F., Silva, A., Cota, T., Cabrinha, C., Rio, J., Lopes, M., Moreira, N., Narciso, P., Pinto, P., Correia, S., Barroso, C., 2020: Tempestades Daniel, Elsa e Fabien – Portugal Continental – 15 a 22 de dezembro de 2020. IPMA report (in Portuguese).

The Azores are usually affected by tropical cyclones.

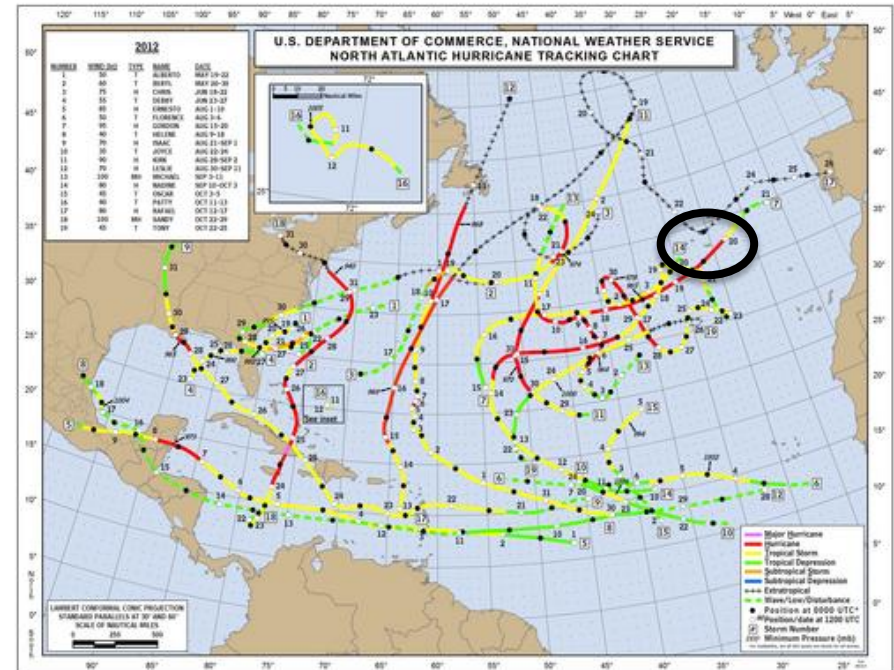
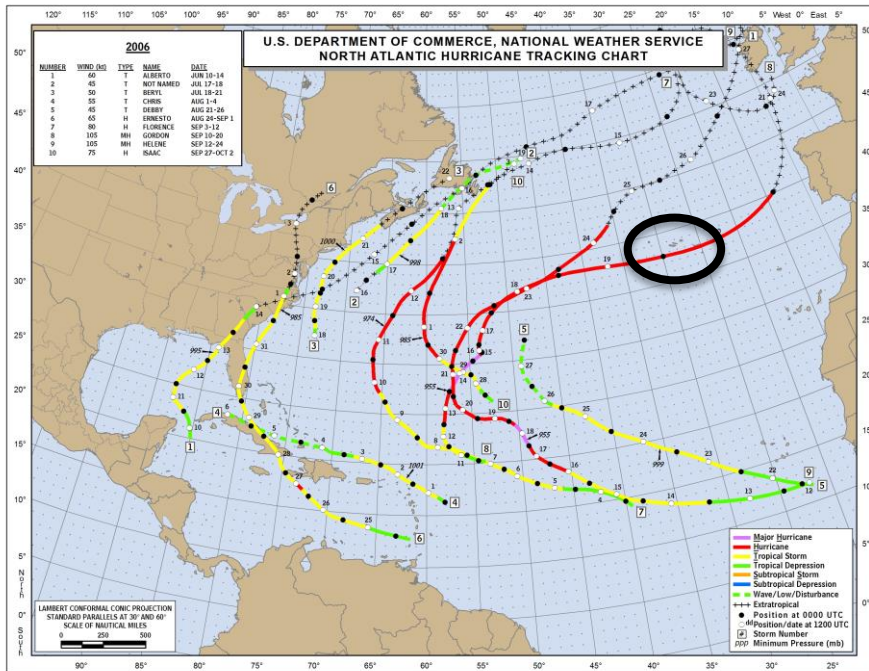
However, in recent years ...

... there were some Portuguese “Firsts” on tropical cyclones.

Two Hurricanes with the same name affected
Azores Eastern Group in 2006 and 2012

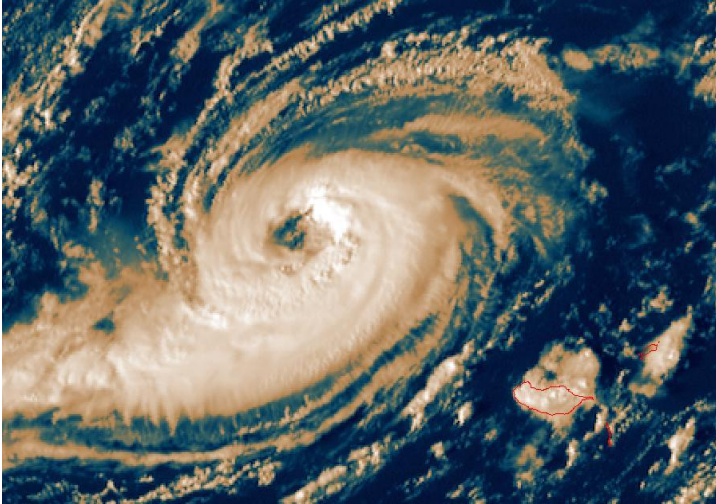
Gordon (cat 3)
Cat 1 in the Azores 20 SEP 2006

Gordon (cat 2)
Cat 1 in the Azores 19-20 AUG 2012



Source: <https://www.nhc.noaa.gov/data/tcr/>

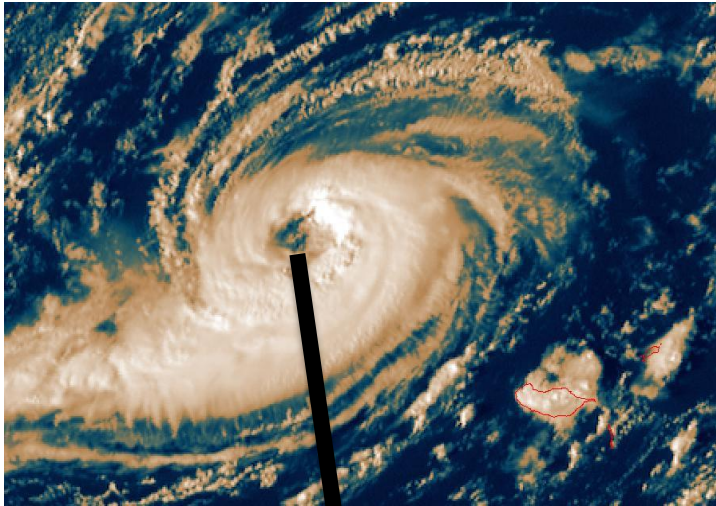
MSG, HRV image, 9 Oct 2005, 15:45 UTC



In 2005, Vince was a **hurricane** around **200 km** northwest of **Madeira** Island

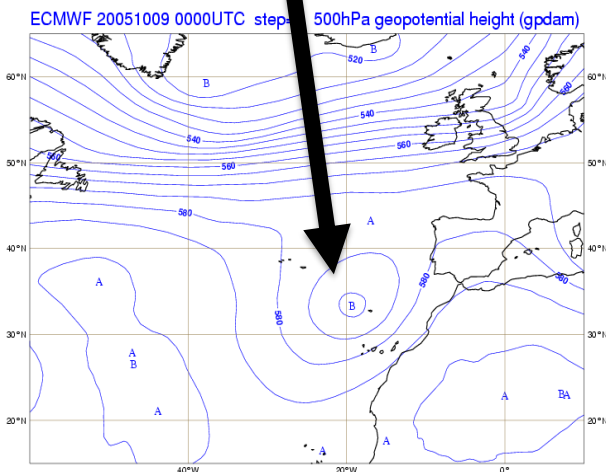
and was the **first** known **tropical cyclone** to reach the **Iberian Peninsula**

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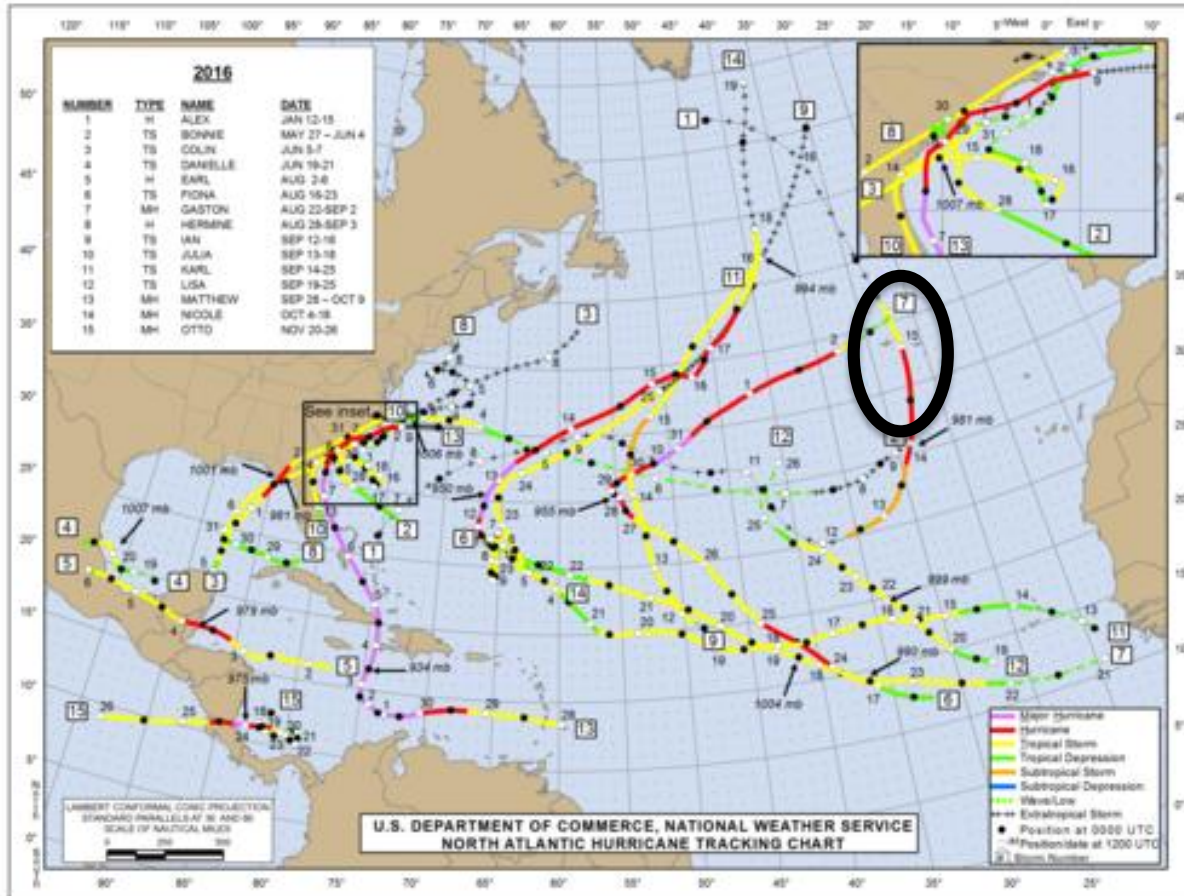


In 2005, Vince was a **hurricane** around **200 km** northwest of **Madeira** Island

and was the **first** known **tropical cyclone** to reach the **Iberian Peninsula**



- Tropical Cyclone “First warning” outside Azores
- Wake up call for hybrid storms
- Tropical Cyclone embedded in extra-tropical trough
- SST of 23-24 °C



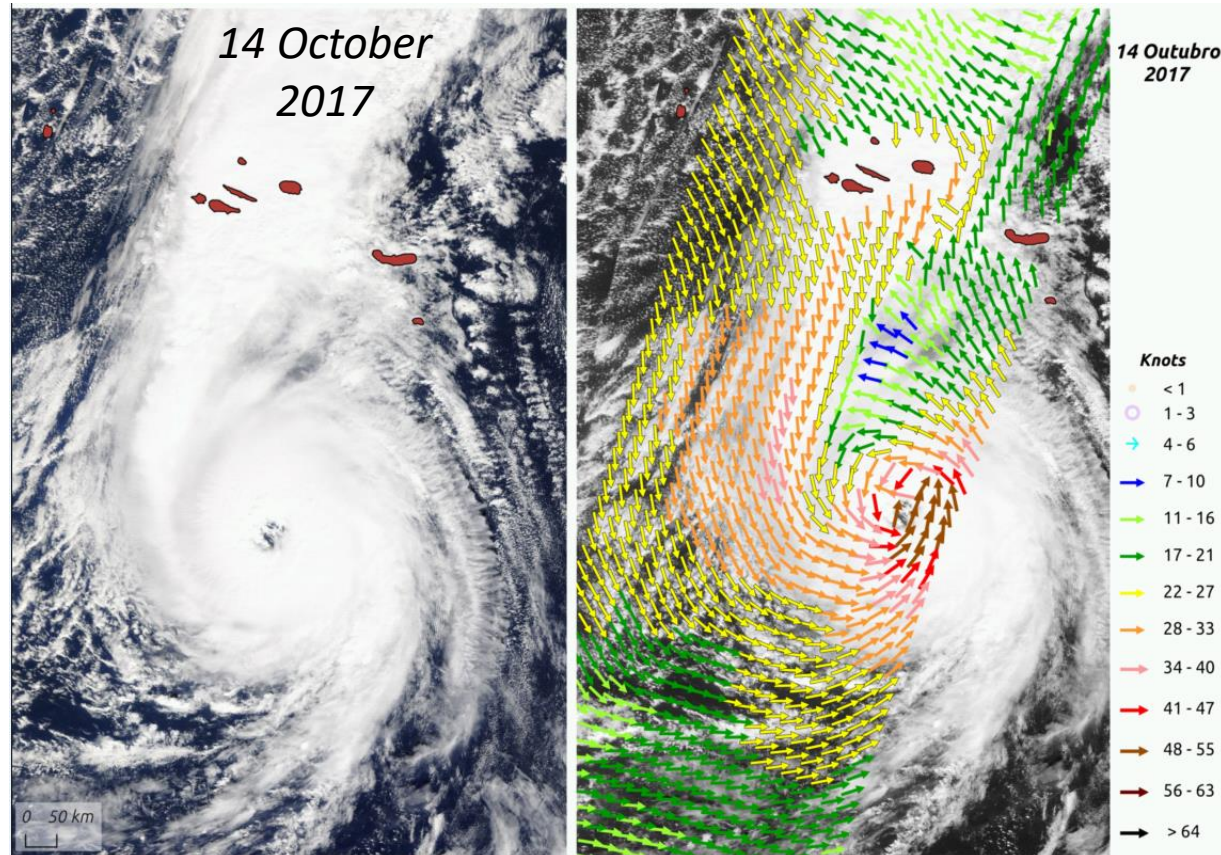
In 2016, Alex was the **first hurricane** in the Atlantic in **January**

passed through Azores Archipelago (mainly between Islands)

Source: National Hurricane Center (NHC)

The **most eastern category 3 hurricane in the Atlantic**

Passed to the south of the Azores and to the west of mainland (also affected Ireland)



MODIS True color composite [Terra] and, on the right, ASCAT 10m Wind [Metop-B]

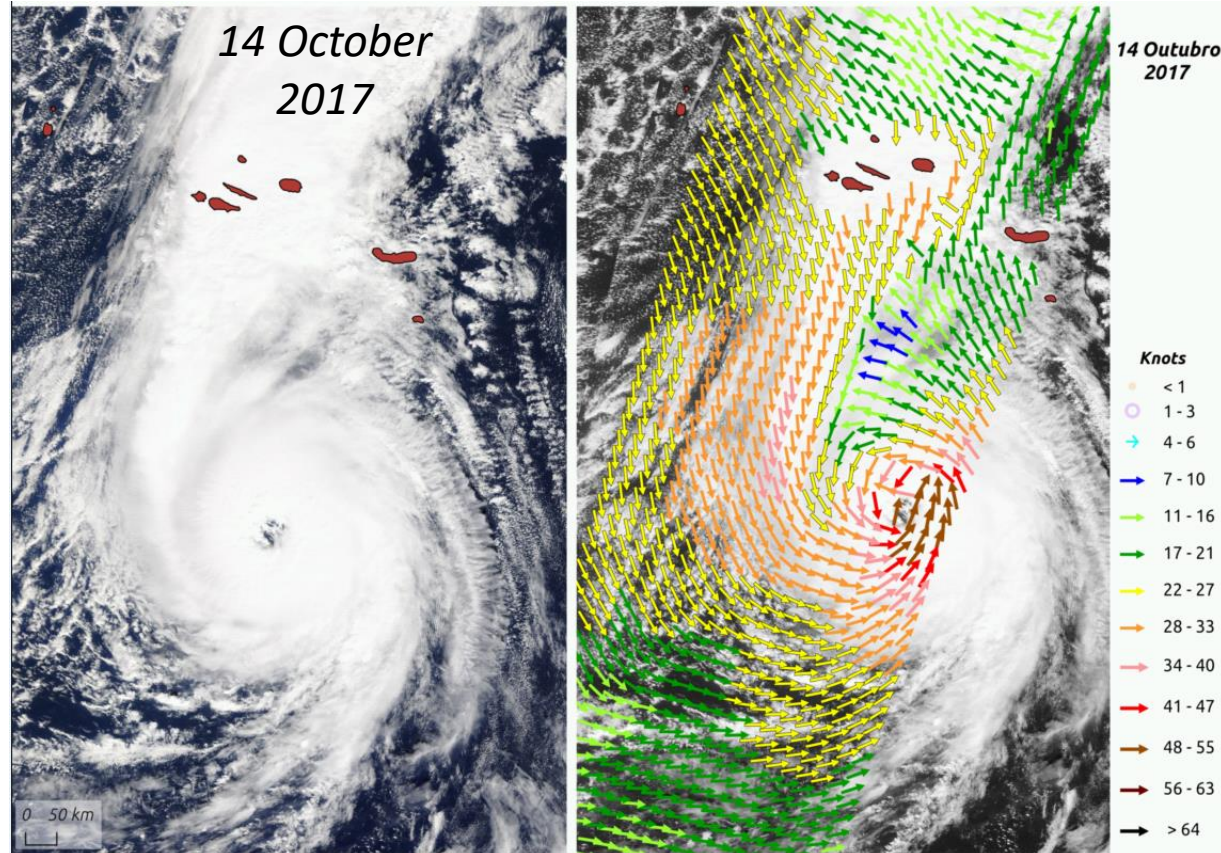
Sources:

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- ASCAT data by Simões, N. and Monteiro, I. (IPMA)

The **most eastern category 3 hurricane in the Atlantic**

Passed to the south of the Azores and to the west of mainland (also affected Ireland)

Had a devastating impact on wildfires in mainland, that originated 50 victims

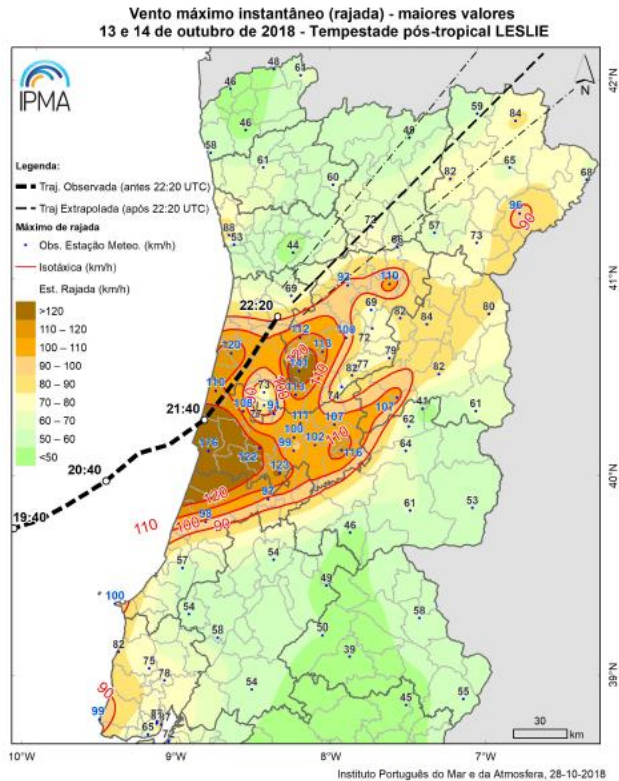


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- Novo I., Pinto P., Rio J. and Gouveia C., 2018: Fires in Portugal on 15th October 2017: a catastrophic evolution, Advances in Forest Fire Research 2018 – D. X. Viegas (Ed.), Chapter 1, 57 – 70, doi.org/10.14195/978-989-26-16-506 5.

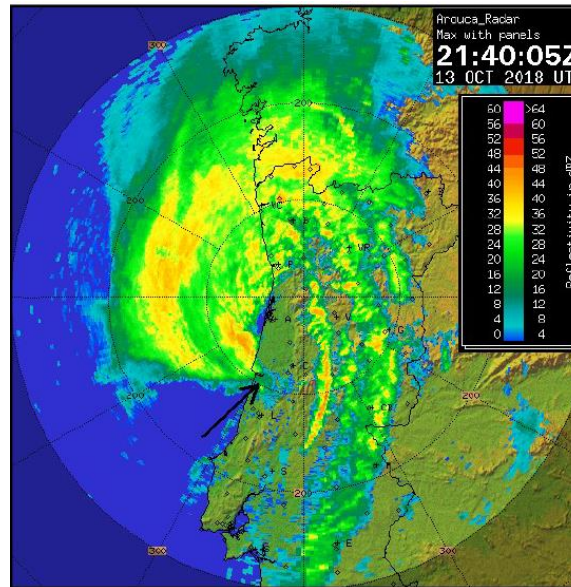
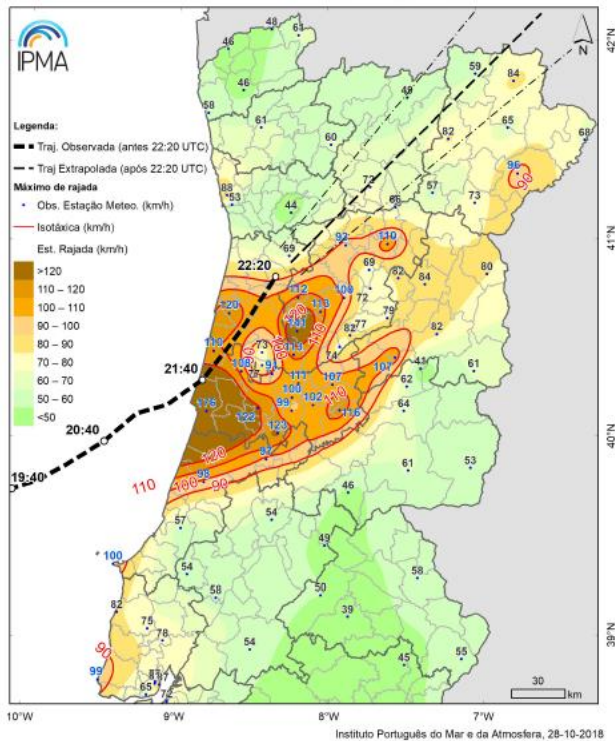
The closest ever Hurricane off the coast of mainland Portugal
Transitioned and made **landfall as a post-tropical storm**



Source: Pinto, P., Novo, I., Lopes, M.J., Silva, A., Cota, T., Neto, J., 2018: Tempestade Leslie. IPMA Technical Report (in Portuguese)

The closest ever Hurricane off the coast of mainland Portugal
 Transitioned and made **landfall as a post-tropical storm**

Vento máximo instantâneo (rajada) - maiores valores
 13 e 14 de outubro de 2018 - Tempestade pós-tropical LESLIE



Stronger winds were related to a **sting jet**

Highest wind gust (**176 km/h**) ever recorded officially in Portugal

Source: Pinto, P., Novo, I., Lopes, M.J., Silva, A., Cota, T., Neto, J., 2018: Tempestade Leslie. IPMA Technical Report (in Portuguese)

Tropical cyclone	Affected region	Date	Total Economic Losses (million €)
Ex-Hurricane Leslie	Mainland	13-14 OUT 2018	120
Hurricane Lorenzo	Azores west group	02 OCT 2019	330



**Economic Losses of 450 million €
due to 2 storms
in less than 1 year**

Sources:

- <https://zap.aeiou.pt/lorenzo-prejuizos-330-milhoes-euros-285996>
- <https://www.noticiasaminuto.com/pais/1337365/leslie-a-tempestade-que-causou-prejuizos-de-120-milhoes>
- <http://business.turismodeportugal.pt/pt/Gerir/covid-19/Paginas/medidas-de-apoio-economia.aspx>

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~50% of a
governmental support measure
(1000 million €)
released in June 2020 for
small and medium-sized enterprises
due to the **COVID-19** pandemic



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FACT:

- Extreme weather has large impacts in society and in the economy

AS:

- Extreme weather will continue (and likely to increase in frequency)

THEREFORE:

- Society must increase preparedness to face and adapt to extreme weather

ALSO AS:

- Better observations and better forecasts can reduce impacts in real-time

SO DEFINITELY:

- Meteorological Services outputs will benefit from research and improved observations

THANK YOU!