POTENTIAL WIND LOSS EVENTS OVER THE IBERIAN PENINSULA: RANKING, MULTI-DECADAL VARIABILITY AND SELECTED CASE STUDIES

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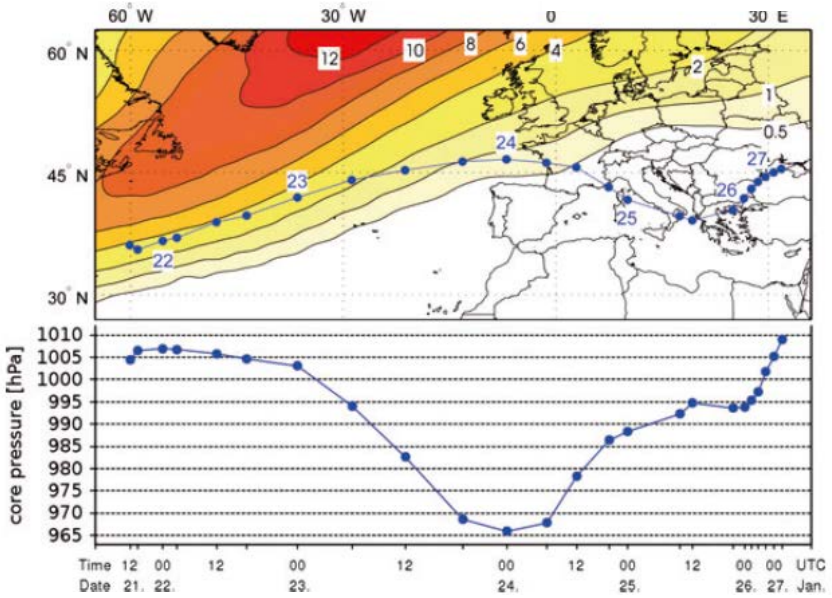
1. Motivation

- Recent severe windstorms caused substantial economic losses and fatalities over the Iberian Peninsula including **Klaus** (January 2009, Liberato et al., 2011), **Xynthia** (February 2010, Liberato et al., 2013), **Gong** (January 2013, Liberato, 2014) and **Stephanie** (2014, Ferreira et al., 2014). Winter 13/14 – storm surges damages in harbors and costal areas.
- **The objetive** is to study large-scale atmospheric conditions and cyclone tracks during the top-100 potential wind losses events over **Iberia Peninsula.**

Example of Klaus



Liberato et al., 2011

2. Methods and Dataset

Dataset

- Reanalysis from NCEP-NCAR (1948 to 2015) - T62 resolution 1.875º).
- Daily maxima of the 4 x 6-hourly instantaneous 10m-wind data
- 6-hourly mean sea level pressure

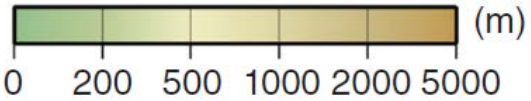
Potential wind loss (MI)

$$\mathrm{MI(area)}=\sum_{i=1}^{N}\sum_{j=1}^{M}\left(\frac{v_{ij}}{v_{ij}^{98}}\right)^3 * I(v_{ij}, v_{ij}^{98})$$

$$I(a,b) = \begin{cases} 0 & a < b \\ 1 & a > b \end{cases}$$

v_{ij}= daily maximum wind speed at grid point ij

v_{ij}^{98}= 98th percentile calculated for the winter 1979-2011 at grid point ij



Pinto et al., 2012. Clim. Res. ***Karremann et al. 2016, ASL***

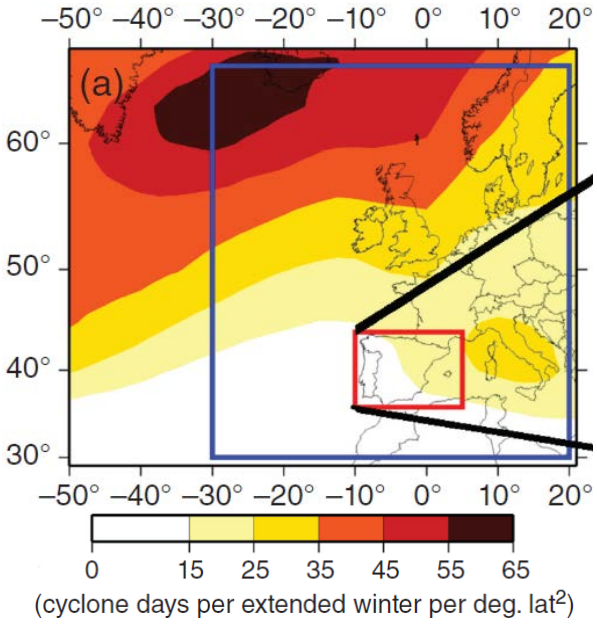
2. Methods and Dataset

Storm detecting and tracking scheme

o Detecting and tracking algorithm first developed by Murray & Simmonds (1991) and adapted by Pinto *et al.* (2005).

Storms associated with potential loss over the Iberian Peninsula

Selected domain



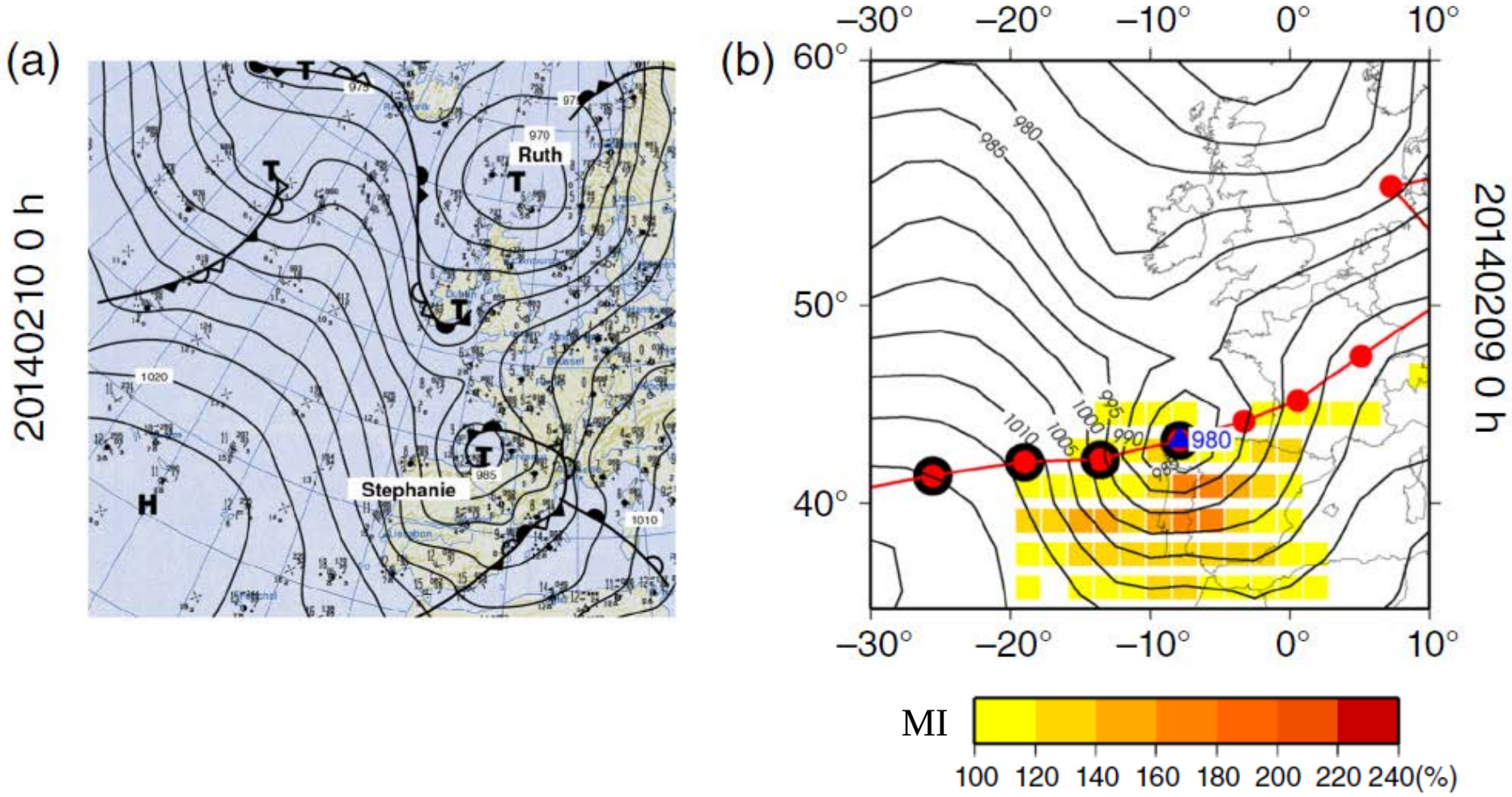
30ºN-65ºN, 30ºW-20ºE

Karremann et al. 2016, ASL

- For the potential wind loss in the Iberian Peninsula (MI) ranking, the cyclone tracks that are located on the event day within 30ºN-65ºN, 30ºW-20ºE and they are preliminary assigned to the event.
- These cyclone tracks and associated windstorm footprints are analyzed and the cyclone which matches best with the windstorm footprint (timing and overlap) is selected as potentially responsible for the MI.

3. Results – Top #1 Event

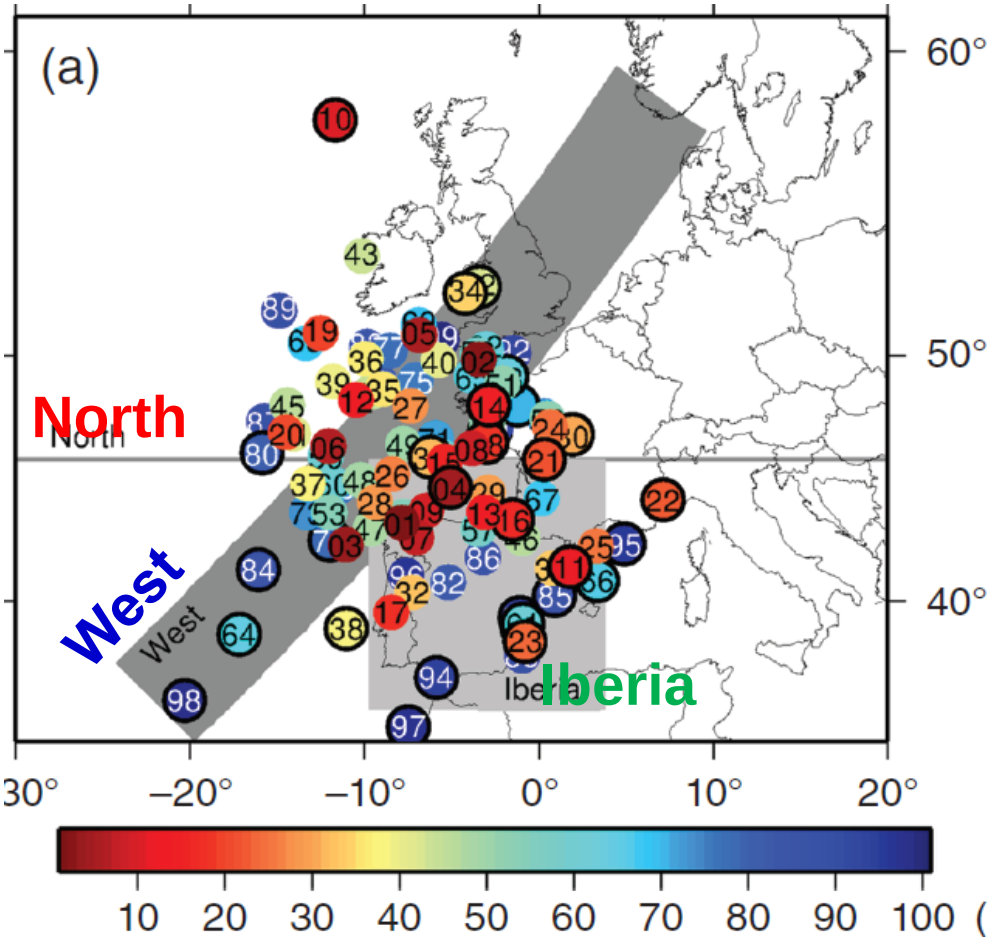
Stephanie (9-2-2014)



Karremann et al. 2016

3. Results – Cyclones Pmin position TOP #100

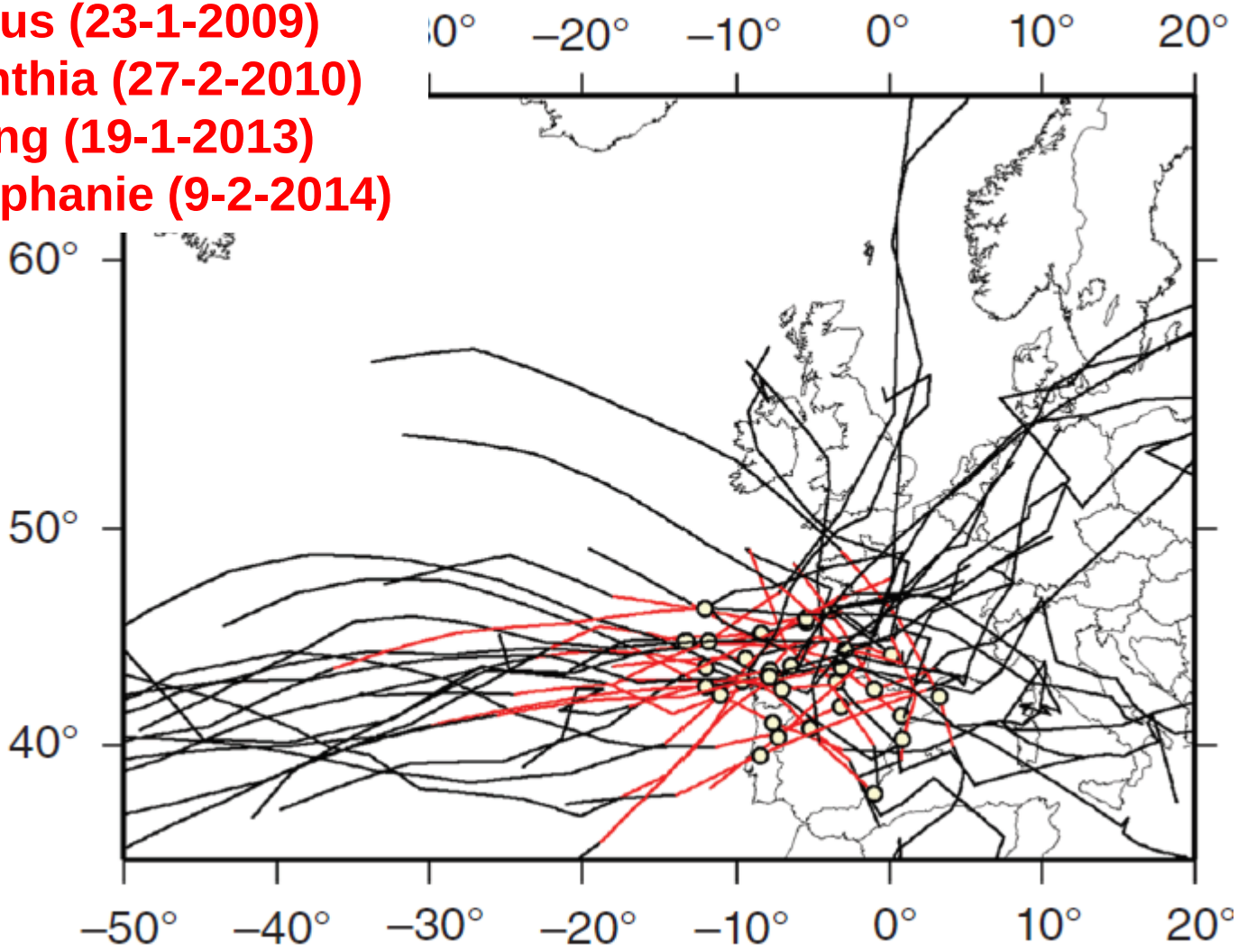
Position of minimum pressure of identified cyclones responsible for potential wind losses at the top #100 events.



- **Iberia – cyclones crossing the IP (31 events);**
- **West - cyclones crossing from SW to NE (11 events);**
- **North - cyclones crossing from W to E in zonal path (28 events)**
- **Hybrid - characterized by a co-occurrence of a high and a low pressure centre on opposite sides of Iberia (30 events**

3. Results – Group Iberia (31 events)

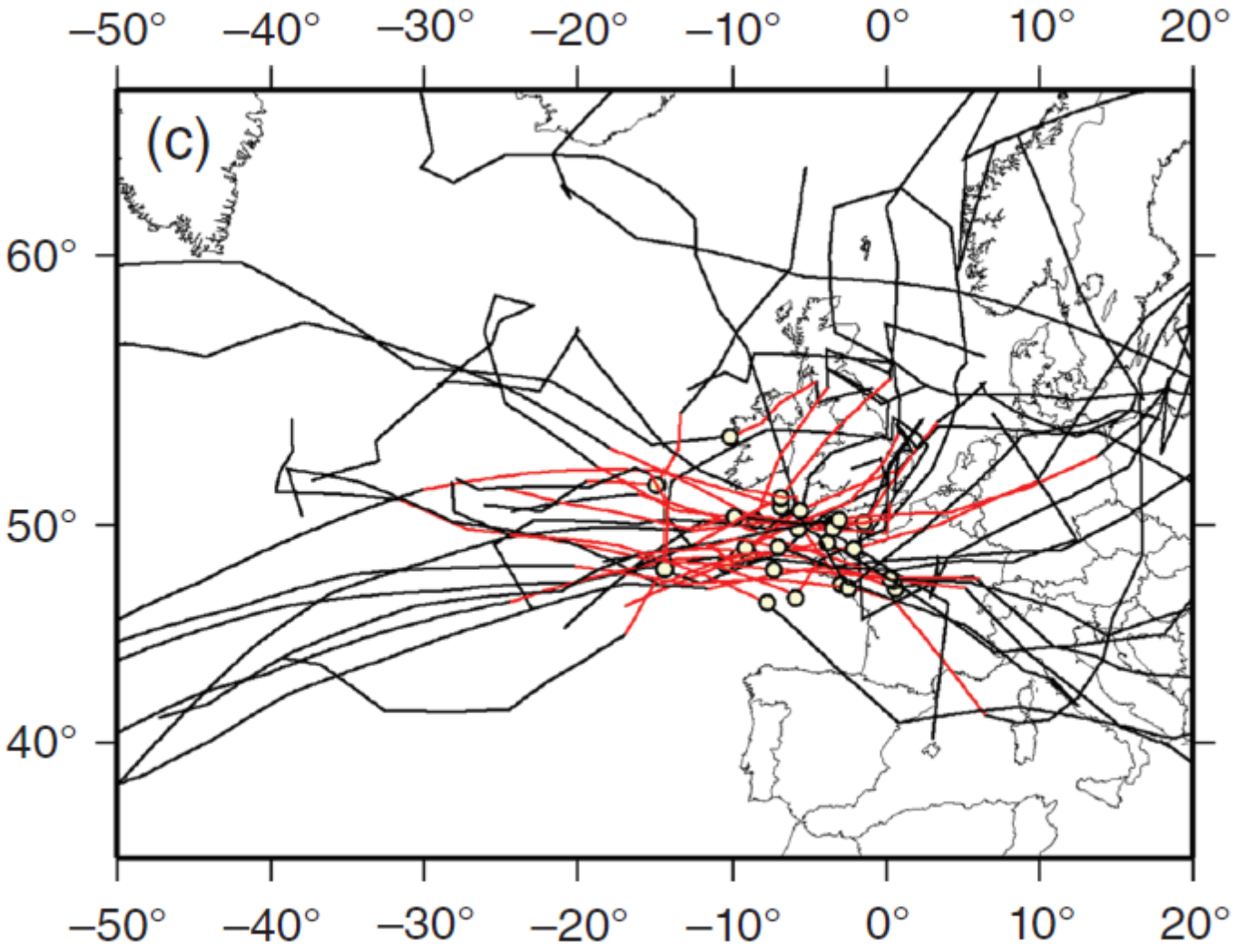
Top 6: Klaus (23-1-2009)
Top 9: Xynthia (27-2-2010)
Top 7: Gong (19-1-2013)
Top 1: Stephanie (9-2-2014)



Position of minimum pressure (yellow dot) and cyclone track during the event day (red)

Karremann et al. 2016

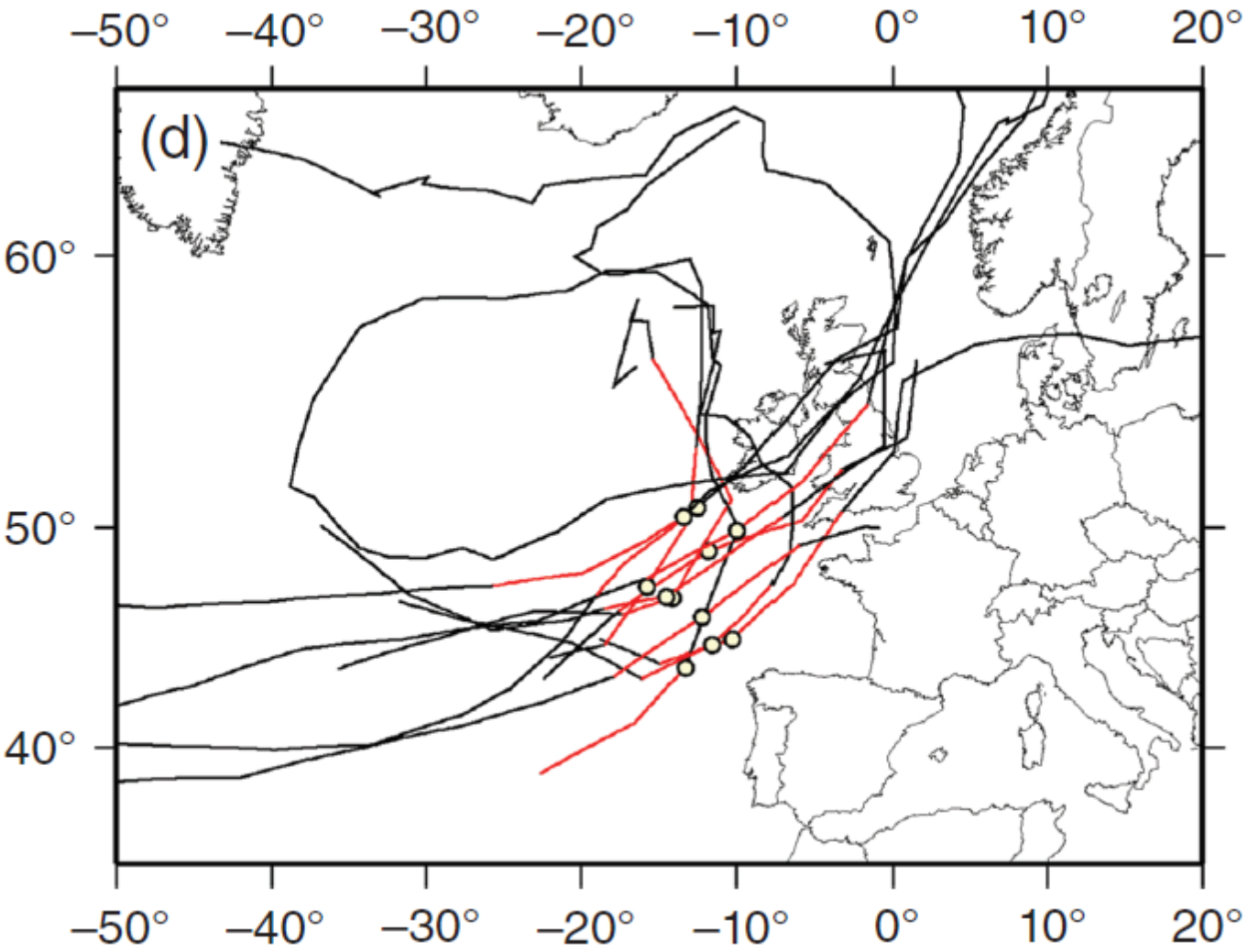
3. Results – Group North (28 events)



Position of minimum pressure (yellow dot) and cyclone track during the event day (red)

Karremann et al. 2016

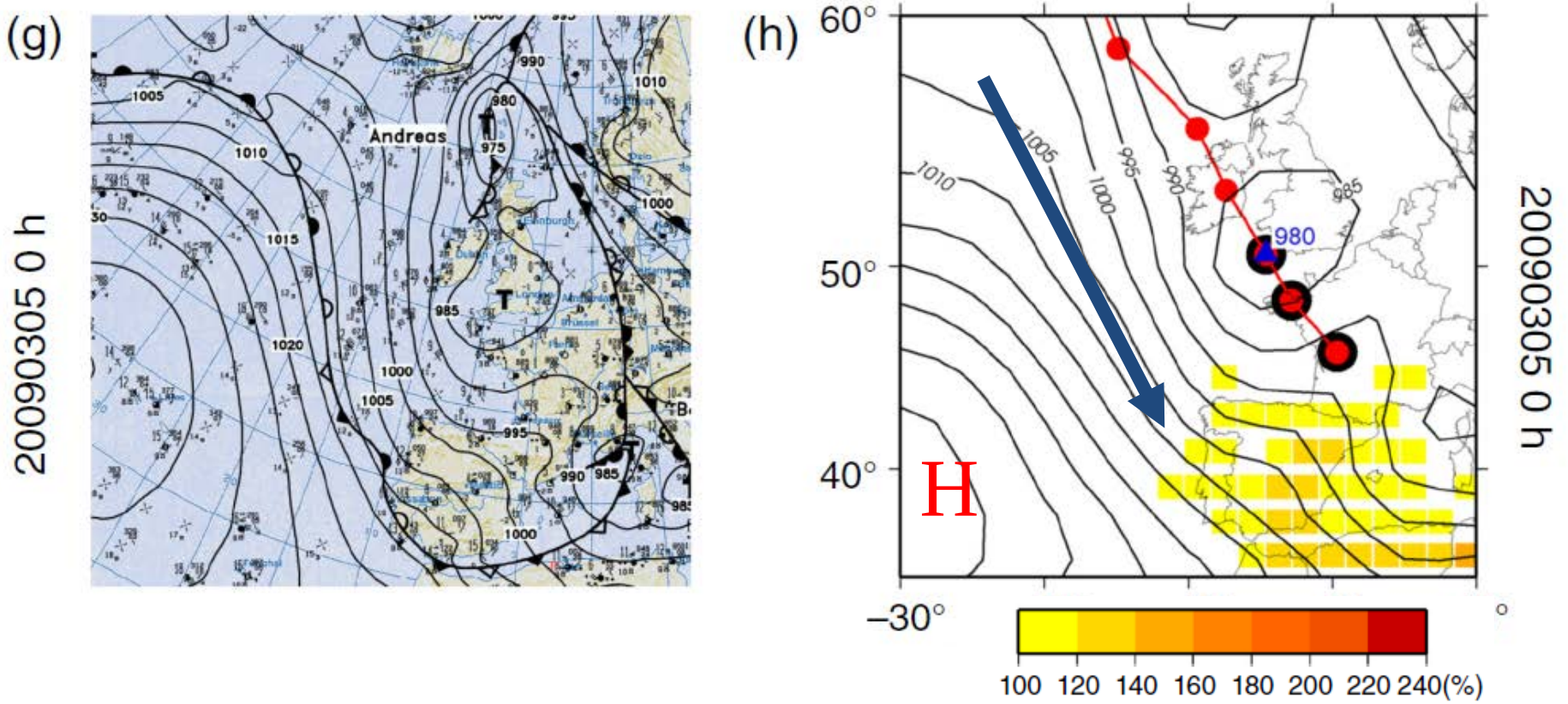
3. Results – Group West (11 events)



Position of minimum pressure (yellow dot) and cyclone track during the event day (red)

Karremann et al. 2016

3. Results – Group Hybrid (30 events)

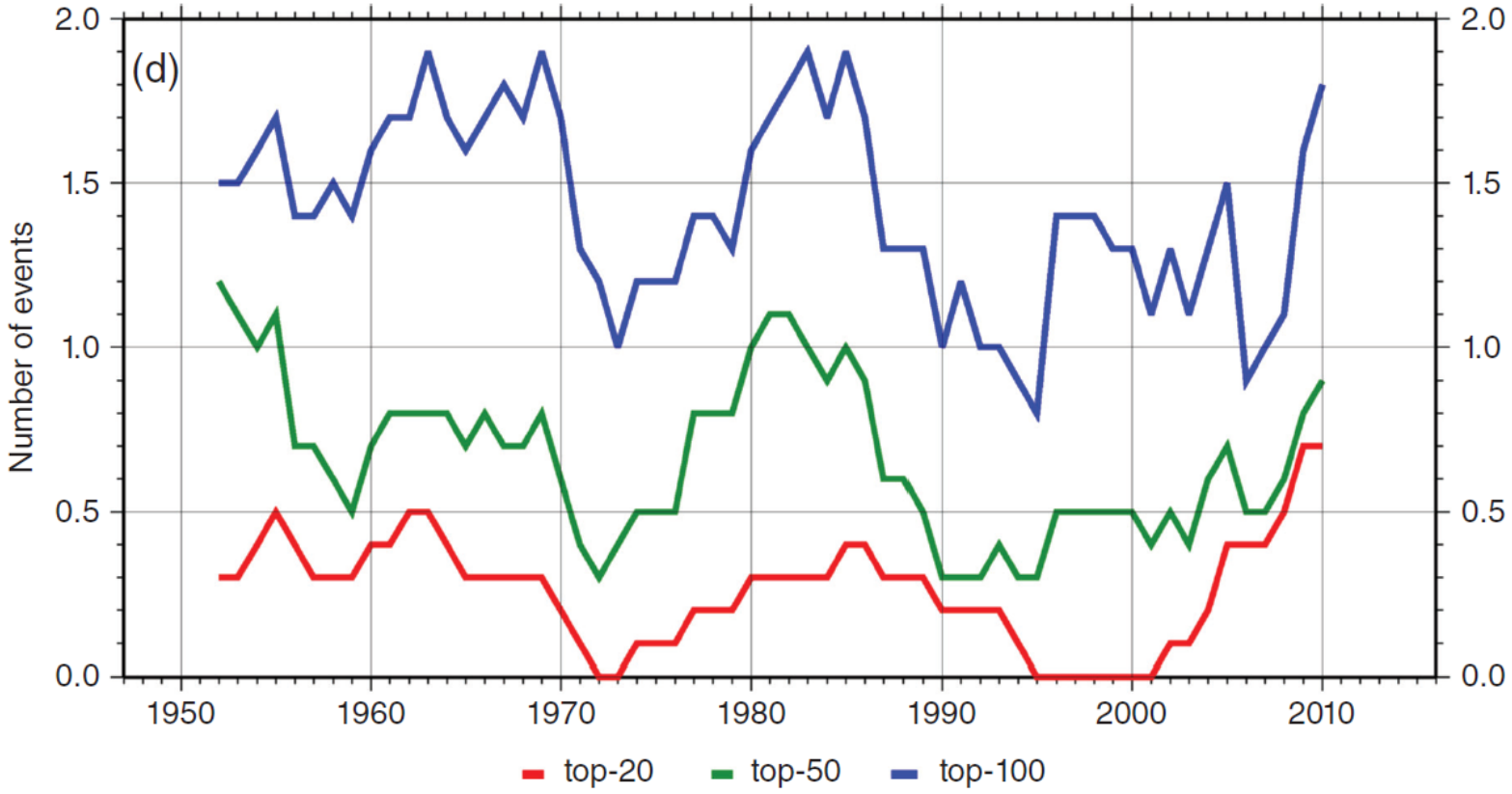


This group is usually characterized by a **co-occurrence** of a **high** and a **low pressure centre** on opposite sides of Iberia, leading to a **pronounced MSLP gradient** and **strong winds** over the region.

Karremann et al. 2016

3. Results - Number of events per winter

Multi-decadal variability in the number of events (10 year running mean)



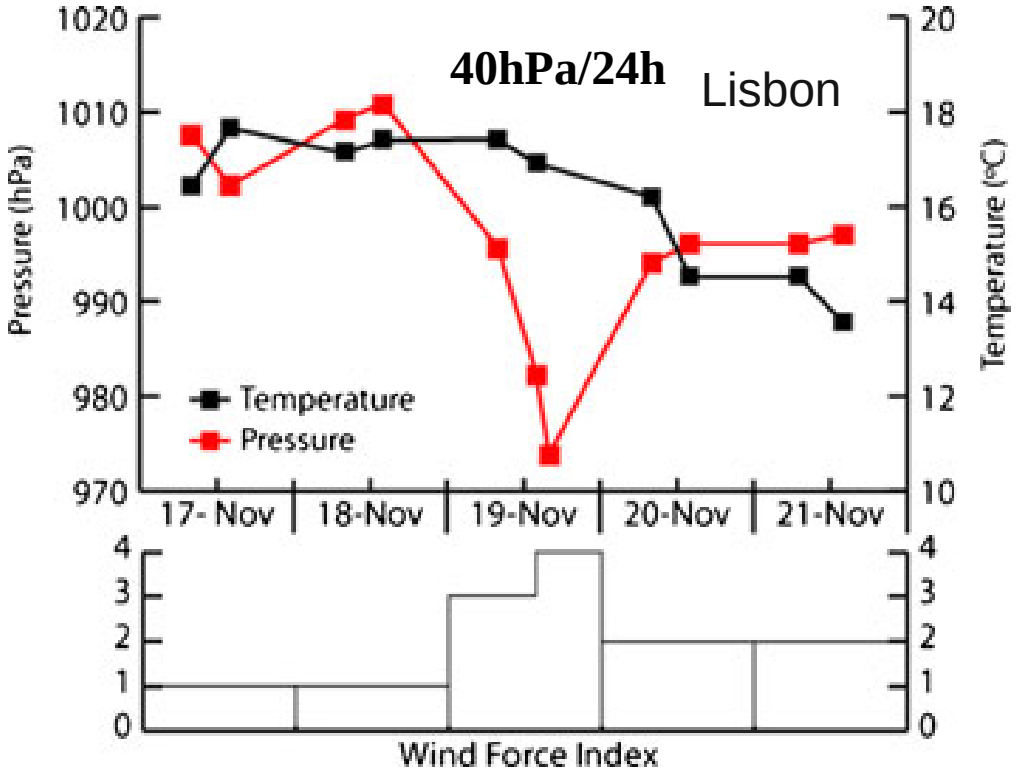
Peak in recent years is quite prominent in the top 20 cases.

Karremann et al. 2016

4. Historical case studies

The storm of November 1724

The observations were made in Lisbon between 1 November 1724 and 11 January 1725. Pressure and temperature were registered twice a day, wind force only one value per day.



Wind Index: **1** gentle breeze; **4** violent

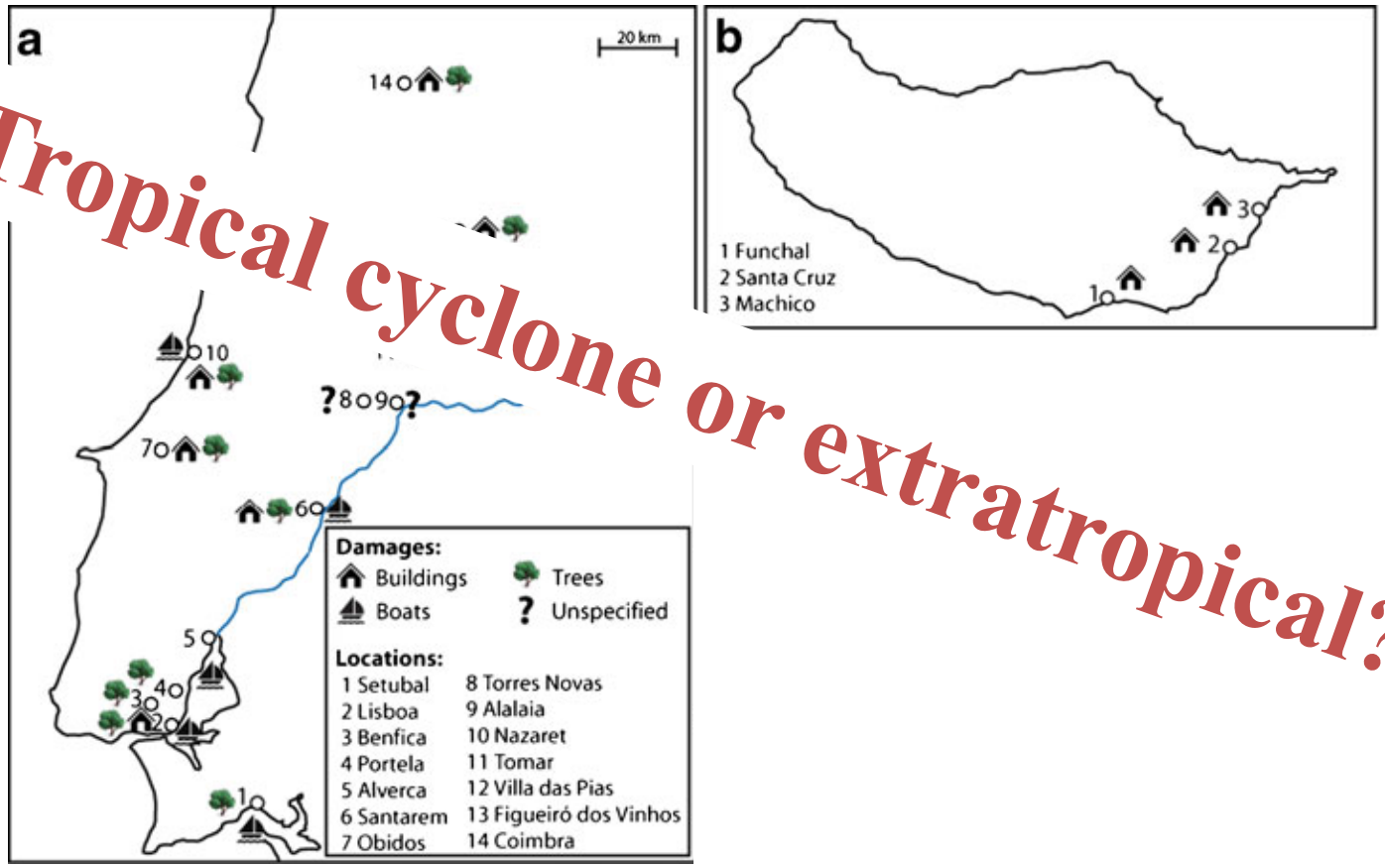
To put into context, comparing with the largest decreases of atmospheric pressure in 24 h in Lisbon during the 1863–2006 period it was the second largest decrease being the first one the 28 November 1879.

The first meteorological measurements in the Iberian Peninsula
Dominguez-Castro et al., 2013, Climatic Change

4. Historical case studies

The storm of November 1724 (Damages)

Locations affected in Portugal and in Madeira



Tropical cyclone or extratropical?

Trajectory of hurricane Vince according to Franklin (2006) and 1842 storm trajectory estimation by Vaquero et al. (2008)

The first meteorological measurements in the Iberian Peninsula
Dominguez-Castro et al., 2013, Climatic Change

4. Historical case studies

The storm of 15th February 1941

Maximum wind speed (km/h)

Locations in Portugal	
Lisbon	127
Praia da Rocha (Algarve)	130
Portimão (Algarve)	150
Santiago do Cacem (South of Lisbon)	119
Penhas Douradas (Serra Estrela)	148
Coimbra	133
Guarda	126
Porto	130
San Sebastian	180

Property damage. Elaborated by the author from local press data

Property damage

1. **Vilanova de Famalicão**: almost totally damaged.
2. **Guimarães**: factory destroyed.
3. **Paços de Ferreira**: electricity supply destroyed.
4. **Porto**: major damage to barracks of the Artillery Regiment.
5. **Espinho**: destroyed hangers in the airfield.
6. **Serra da Estrela (Covilhã)** Extreme damage. Villages blocked by snowdrifts for three days after the storm.
7. **Leiria** district: hundreds of chimneys blown down.
   Maceira: cement factory destroyed.
8. **Bombarral**: theater destruction.
9. **Arruda dos Vinhos**: hospital chimney blown down.
10. **Malveira**: trucks were blown off a railway line.
11. **Sintra**: hangers destroyed.
12. **Lisbon**: damaged schools, 1,000 damage incidents reported to the fire brigade. Olival and Campolide neighborhoods almost destroyed.
    Cabo Ruivo: plane sunk at the seaplane airfield, English airport manager drowned.
    Campolide: devastated ceramic factory.
13. **Vendas Novas**: major damage to the School of Artillery.
14. **Reliquias**: damaged houses and chimneys blown over.

Zumaya (Guipúzcoa – Spain): three carriages of a stalled electrical train blown off a viaduct over the River Urola. 20 died and 120 injured.

R. Muir-Wood: **The 1941 February 15th windstorm in the Iberian Peninsula,** Trébol, 56 (2011), pp. 4-13

4. Historical case studies

The storm of 15th February 1941

Forestry damage. Elaborated by the author from local press data

Forestry damage

1. **Caminha and Esposende**: devastated whole forests.
2. **Mata do Buçaco**: 285 great acacia trees blown down.
3. **Estoi, Beja, Caldas da Rainha and Porto**: trees in public gardens devastated.
4. **Coimbra**: 27 hectares of unique primal forest blown down and 1000 great cedars lost.
5. **Gaia**: 40,000 trees lost.
6. **Proença a Nova**: 300,000 trees blown down.
7. **Alcoentre**: blocked for three days by numerous eucalyptus trees on the roads.
8. **Tremês**: lost 80% of olive trees of an estimated 100,000 specimens.
9. **Lisbon**: Botanical Gardens, hundred of destroyed trees.
10. **Prazeres (Lisbon cemetery)**: 300 large cypresses fell in the cemetery.
11. **Évora**: 10,000 eucalyptus trees and 20,000 pines blown down in the Mata Nacional de Virtudes.
12. **Funcheira**: 500 fruit and olive trees blown down.
13. **Quarteira**: 150 olive trees.
14. **Moncarapacho, Pechão, Fuzeta and Tavira**: thousands of olive trees.

Cádiz, Sevilla, Córdoba y Jaén (Andalusia - Spain): thousands of olive trees.

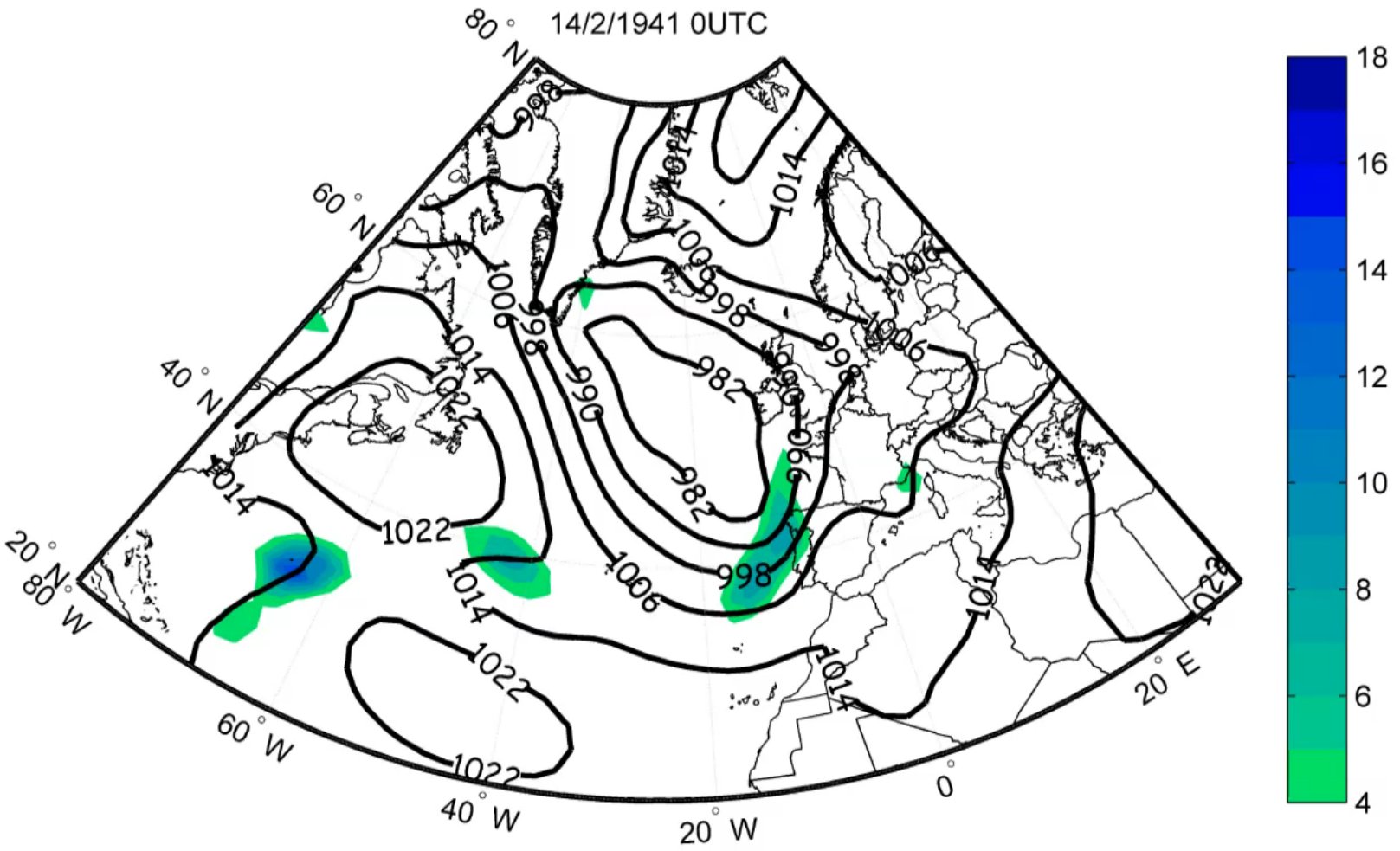
Human Fatalities IP

The windstorm occurred through the afternoon into the early evening on a Saturday, without proper warning and many people were outside in the storm. **A total of at least 130 people are known to have died in the storm.**

R. Muir-Wood: **The 1941 February 15th windstorm in the Iberian Peninsula,** Trébol, 56 (2011), pp. 4-13

4. Historical case studies

The storm of 15th February 1941



SLP and 6-hourly precipitation from 20CR

5. Summary and Conclusions

- We characterize the **large-scale atmospheric conditions** and cyclone tracks during the **top-100 potential losses over Iberia** associated with **wind events**.

- Based on 65 years of reanalysis data, events are classified into **four groups.**

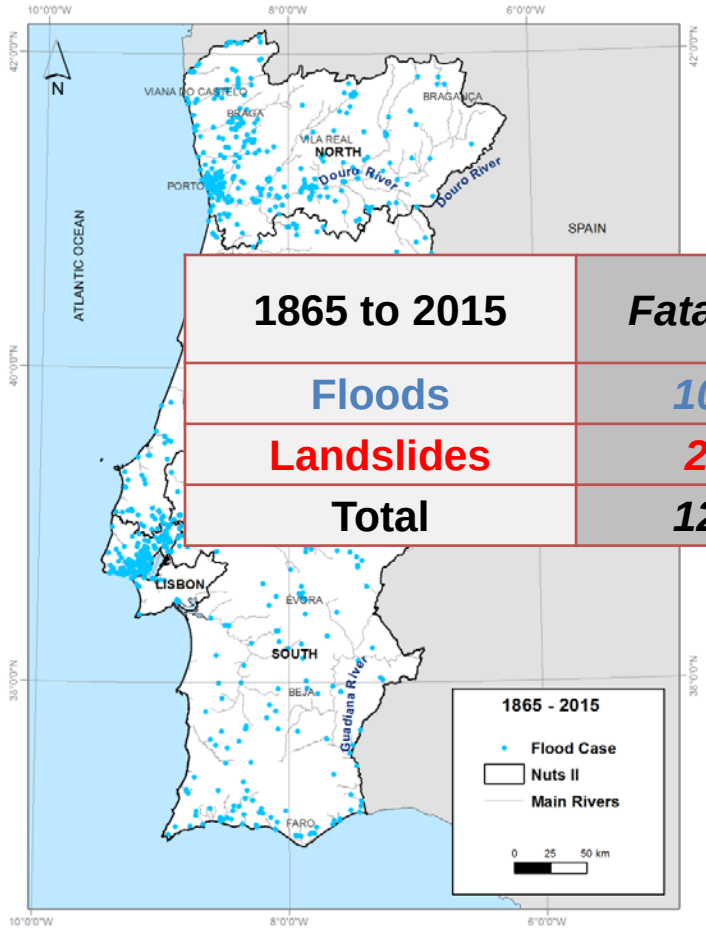
- Generally, **‘Iberia’ events** are the **most frequent** (31–45% for top-100 vs top-20), while **‘West’** events **are rare (10–12%).**

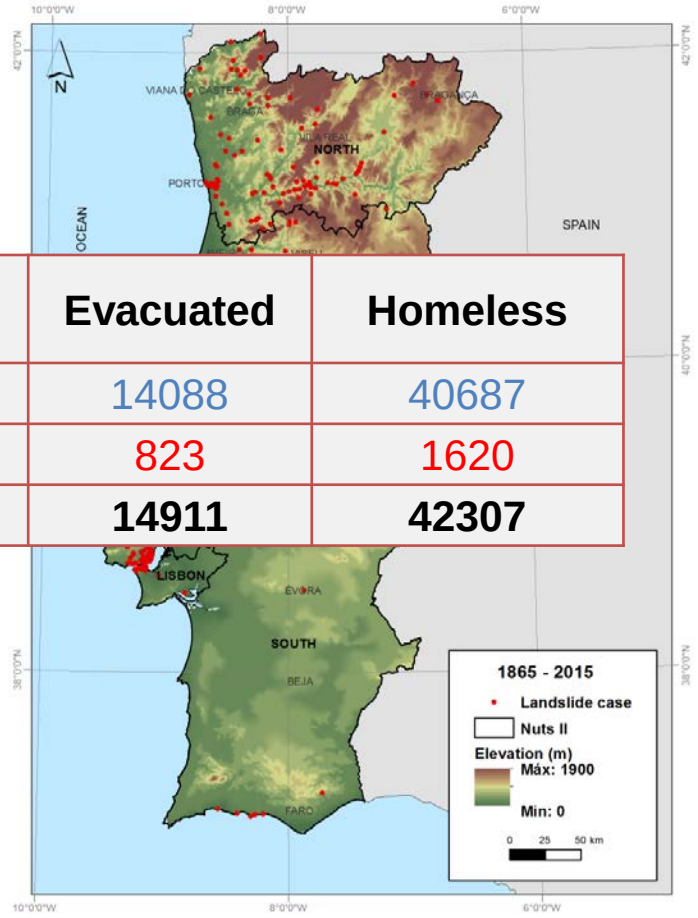
- This study documents that **damaging wind storms over Iberia are not rare events**, and their frequency of occurrence undergoes **multi-decadal variability**.

- Importance of studying more historical cases in the context of computing the return period of the extreme wind storms.

6. Future Work

- Newspaper sources can be an useful tool in finding the impacts of this wind storms historical cases
- A good example of newspapers sources, can be found in **historical floods and landslide** in Portugal that are already geo-reference between 1865 to 2015 (DISASTER and FORLAND PROJECTS).





1865 to 2015	*Fatalities*	Injured	Evacuated	Homeless
Floods	*1018*	479	14088	40687
Landslides	*237*	434	823	1620
Total	*1255*	913	14911	42307

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