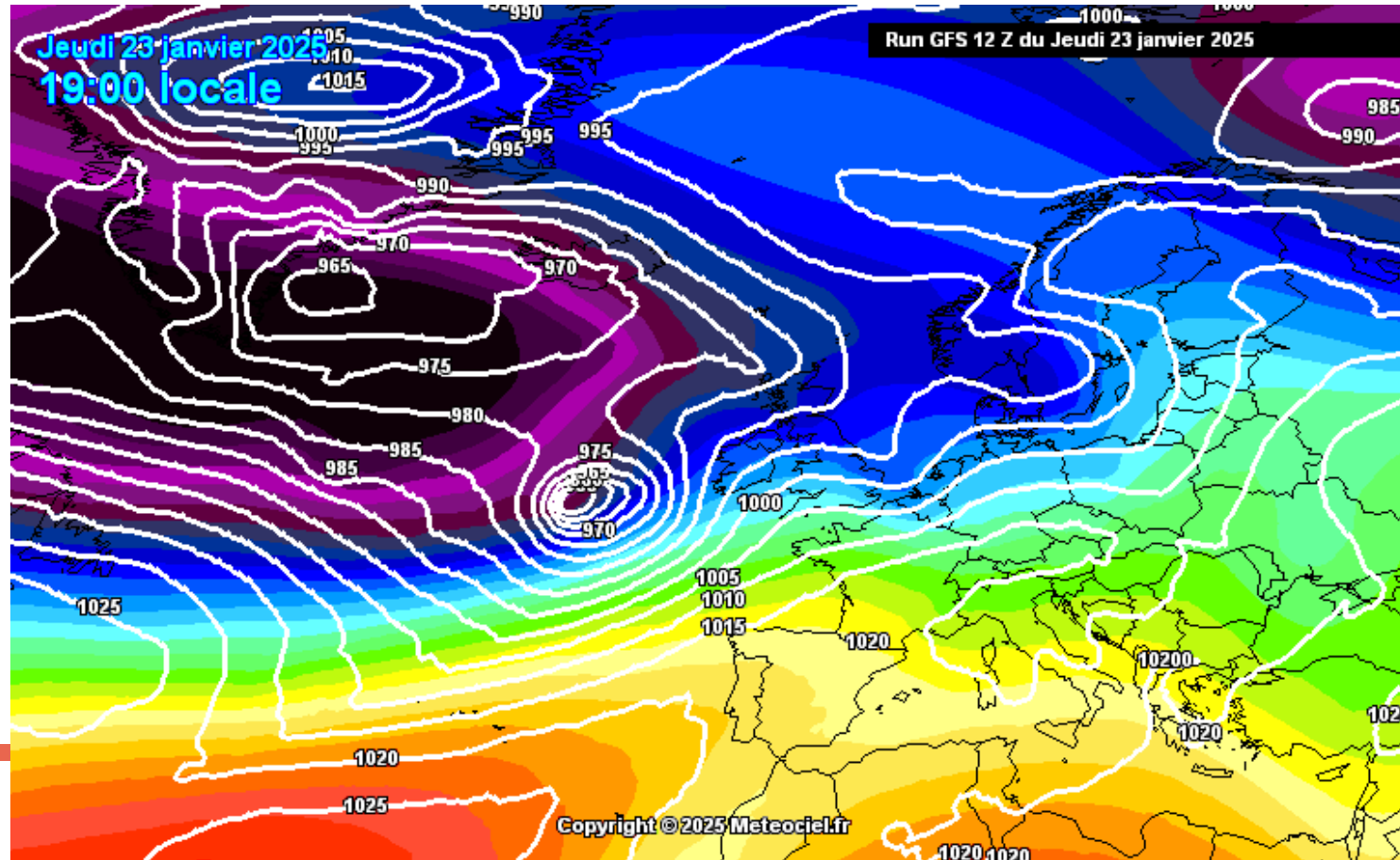# Analysis of the insurance impacts of storm clusters: A case study with Generali France

Laura HASBINI

With Pascal YIOU, Laurent BOISSIER, Arthur PERRINGAUX

Animation of storms
Eowyn, Herminia, Ivo
[MeteoCiel, 2025]

Impact of storms - Litterature

Physical perspective

- Full temporal and spatial characterization of the storm
  (Storm track, surface/upper-level metrics)
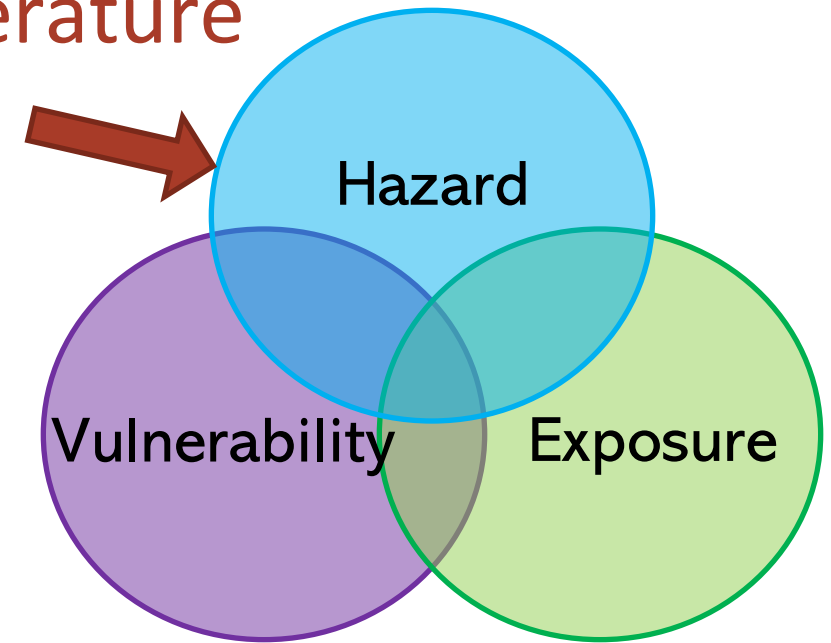- Estimation of losses with meteorological variables

$$SSI = \sum_{Surface} \left(\frac{v_{max}}{v_{98}} - 1\right)^3$$

- No separation of hazard/vulnerability/exposure

[Klawa and Ulbrich 2003, NHESS] [Leckebusch et al. 2008, Meteorol. Z.]
[Lockwood et al. 2022, NHESS] [Gliksman et al. 2023, NHESS]
[Little et al. 2023, Nat. Commun] [Priestley et al. 2023, NHESS]

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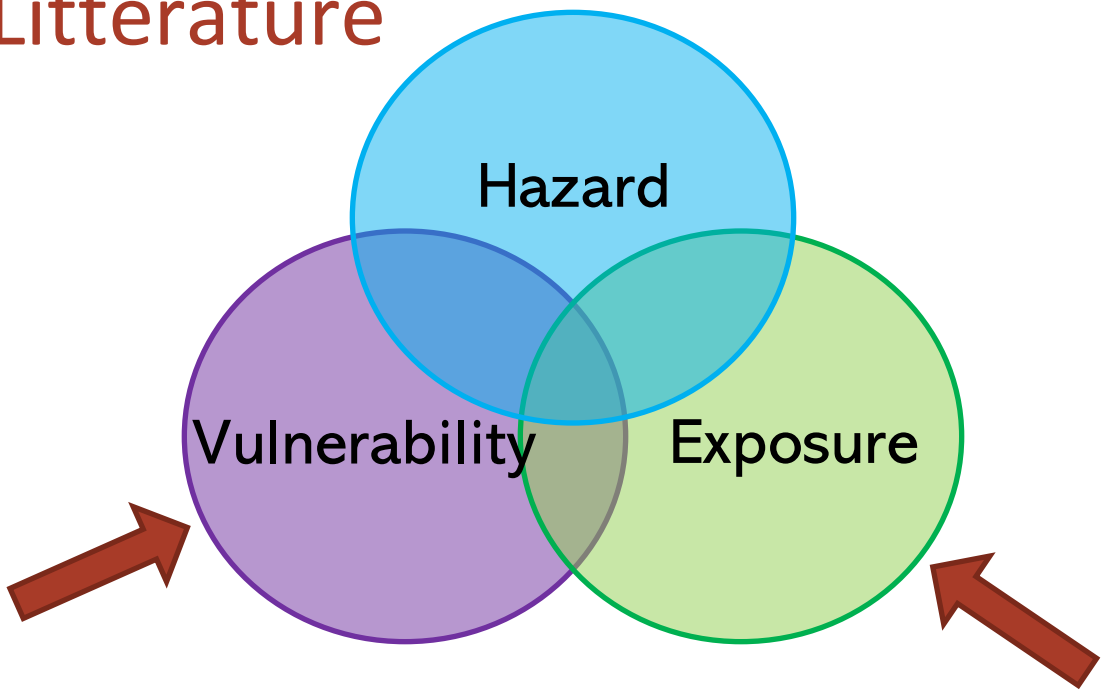$$SSI = \sum_{Surface} \left(\frac{v_{max}}{v_{98}} - 1 \right)^3$$

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Insurance perspective

- Restricted definition of the storm (landing date, wind surface fields)
- Observed historical losses or simulated with cat models
- Division of hazard/vulnerability/exposure

[Prahl et al. 2015, NHESS] [Fonseca et al. 2024, Nat. Hazards] [Moemken et al. 2024, NHESS] [Severino et al. 2024, NHESS]

Hazard

Vulnerability

Exposure

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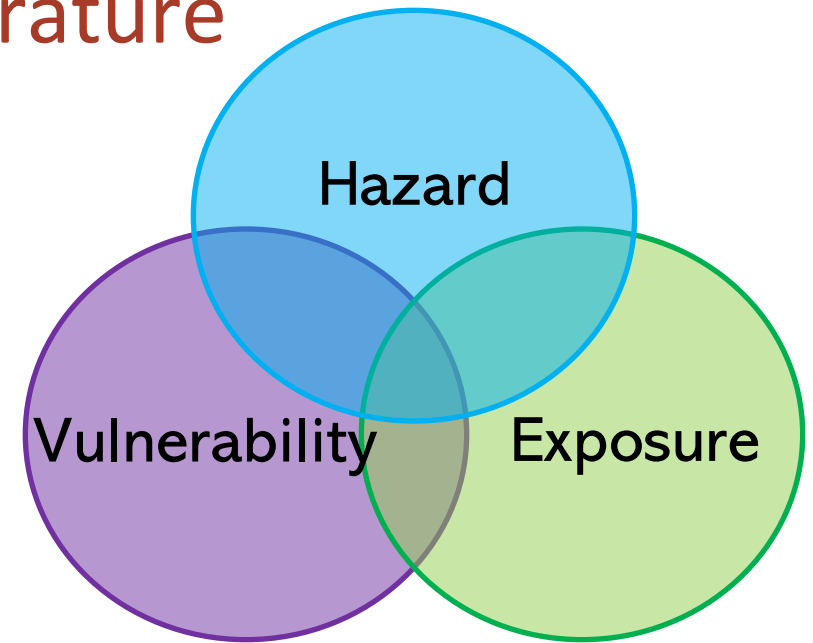[Klawa and Ulbrich 2003, NHESS] [Leckebusch et al. 2008, Meteorol. Z.]
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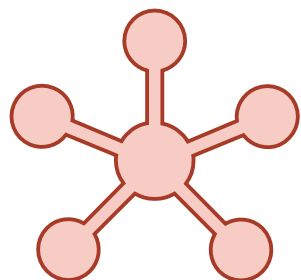- Division of hazard/vulnerability/exposure

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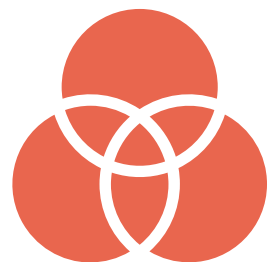
Hazard

Vulnerability

Exposure

Combining both approach
→ Characterize high-resolution claims using physical event

Can we better interpret the losses associated with storm clustering?
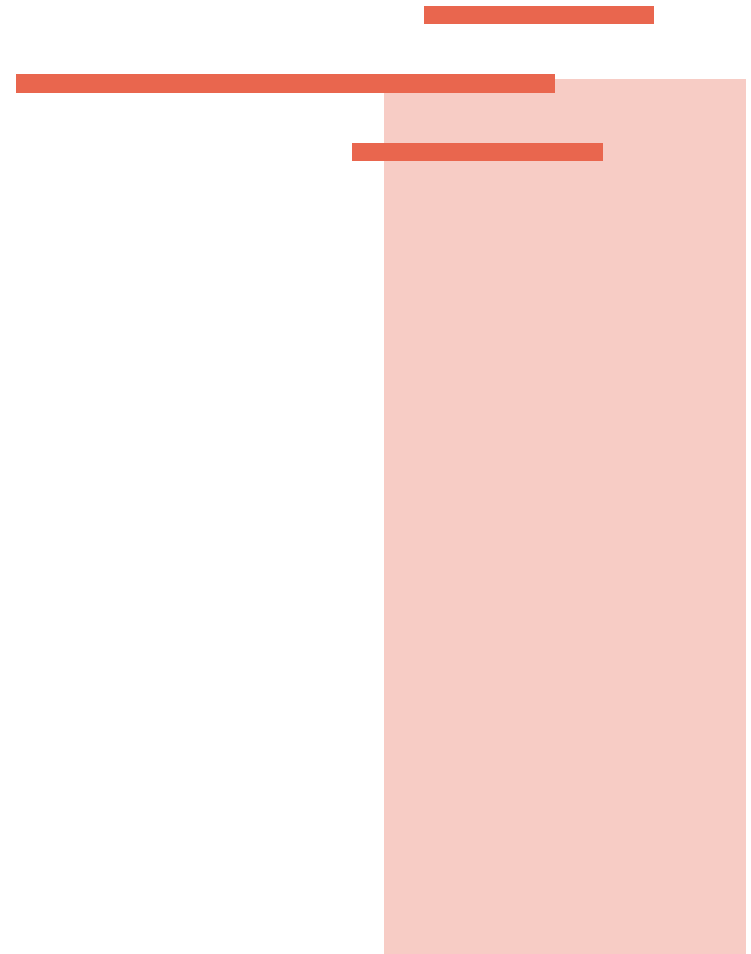
Part I
Association of claims to storms
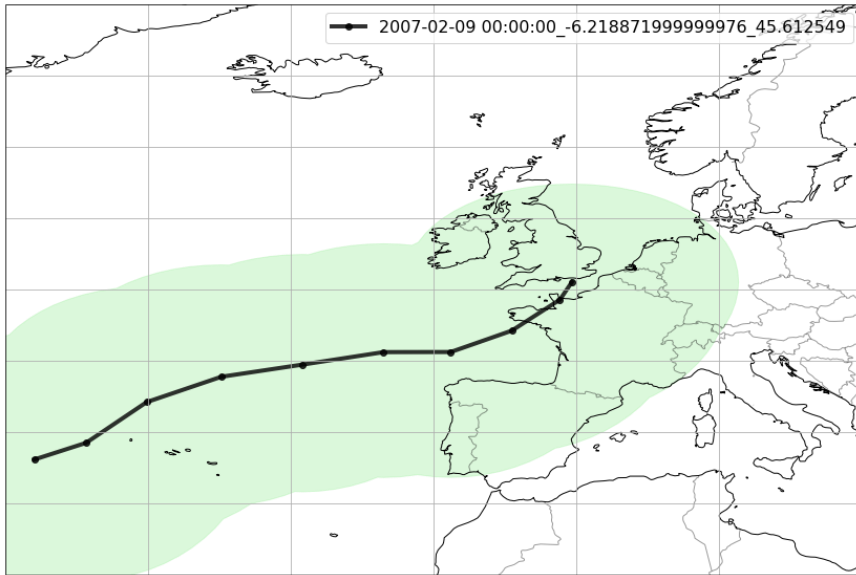
Part II
Impact of storm clustering

Objectives :

- Link high-resolution claims to storm events
- Go beyond event case studies and characterize all the storms events
- Look for physical mechanism explaining some enhanced impact
- Better characterize storm clustering and its impact

Association of claims to storms
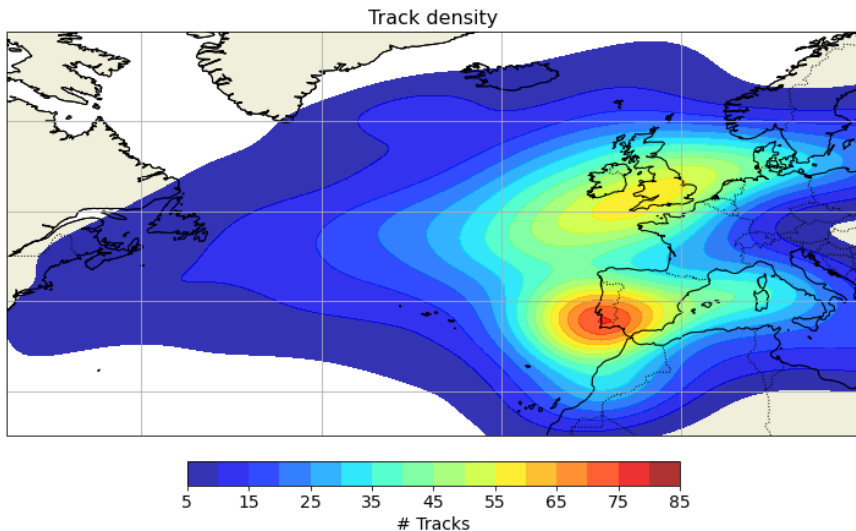
The hazard : European Windstorm

ERA5
TRACK Algorithm [Hodges, 1999], 850hPa relative vorticity (ξ_{850}^{max}) T42

Usual trackings :
→ $life\ time > 48h$; $displacement > 1000km$; $\xi_{850}^{max} > 10^5 s^{-1}$

Need to capture smaller or fast-moving depression
→ $life\ time > 24h$

Capture only tracks impacting France
→ Filter with a moving radius 1300km intersecting France

4439 storms over the period [1979-2024DJF]

Insurance Data

Claims
Latitude	*XX*
Longitude	*XX*
Date	*XX*
Peril	*windstorm/flood/thunderstorm/water damage*
Entity	*GIARD/EQUITE*
State	*Closed/Out of order/Opened*
Line of Business	*Residential/Industrial/Commercial/Car/Agriculture*
Occupancy	*Owner/Renter*
Gross cost	*XX*

Insurance Data

Claims

213 174 claims [1998-2024]
[Winter September-April]

+ Remove inflation

Latitude	*XX*
Longitude	*XX*
Date	*XX*
Peril	***windstorm****/flood/thunderstorm/water damage*
Entity	***GIARD****/EQUITE*
State	***Closed****/Out of order/**Opened***
Line of Business	***Residential****/Industrial/Commercial/Car/Agriculture*
Occupancy	*Owner/Renter*
Gross cost	*XX*

Association Method

1 Claim
0 Storm

Step 1:

Select all the storms such that :

$$d_{storm} - X_b\ Days < d_{claim} < d_{storm} + X_a\ Days$$

1 Claim
Several Storms

Step 2:

If a claim is associated to more than 1 storm, choose one based on a following method :
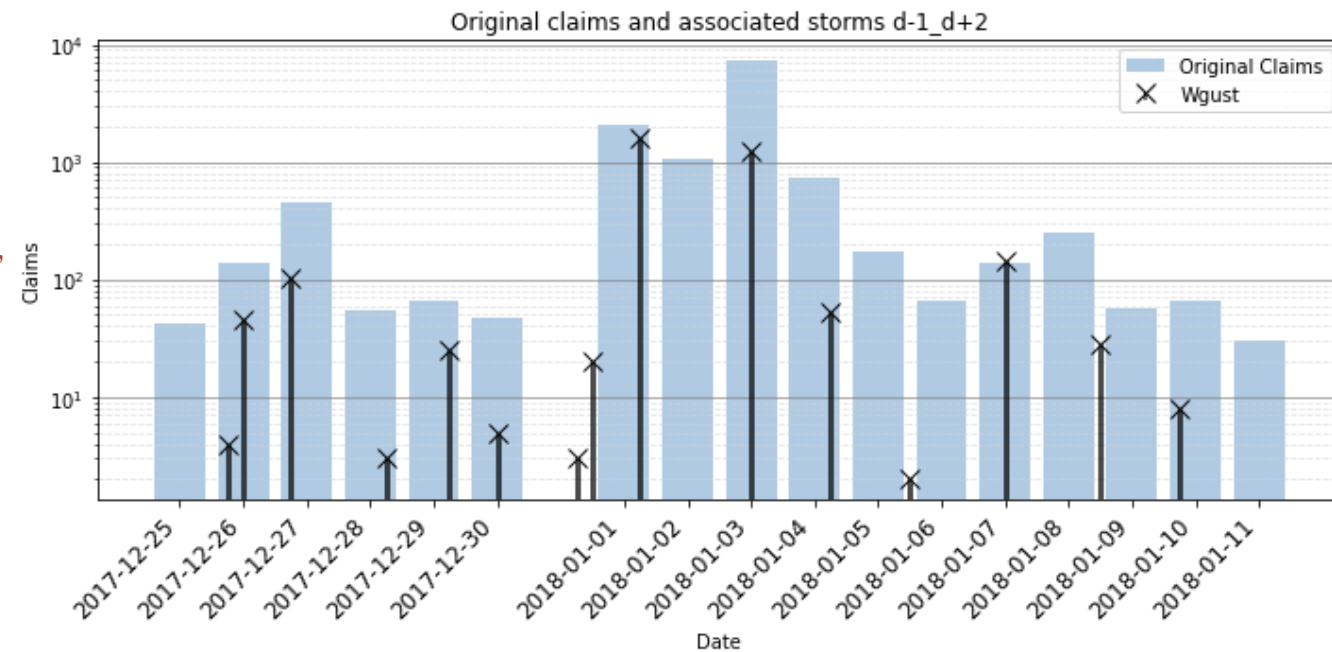
- The minimal distance with the storm track (unique-dist)
- The maximal SSI_FRA (unique-SSI)
- The maximal windgust (unique-wgust)

Original claims

Association Method

1 Claim
0 Storm

1 Claim
Several Storms

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1 Storm

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Step 3:

If a storm is associated with less than n_{min_claims}:
Move its claims to the nearest storm (date)

Original claims and associated storms d-1_d+2

Legend: Original Claims, × Wgust

Y-axis: Claims. X-axis: Date

Association Method

1 Claim
0 Storm

1 Claim
Several Storms

1 Claim
1 Storm

1 Claim
1 Storm

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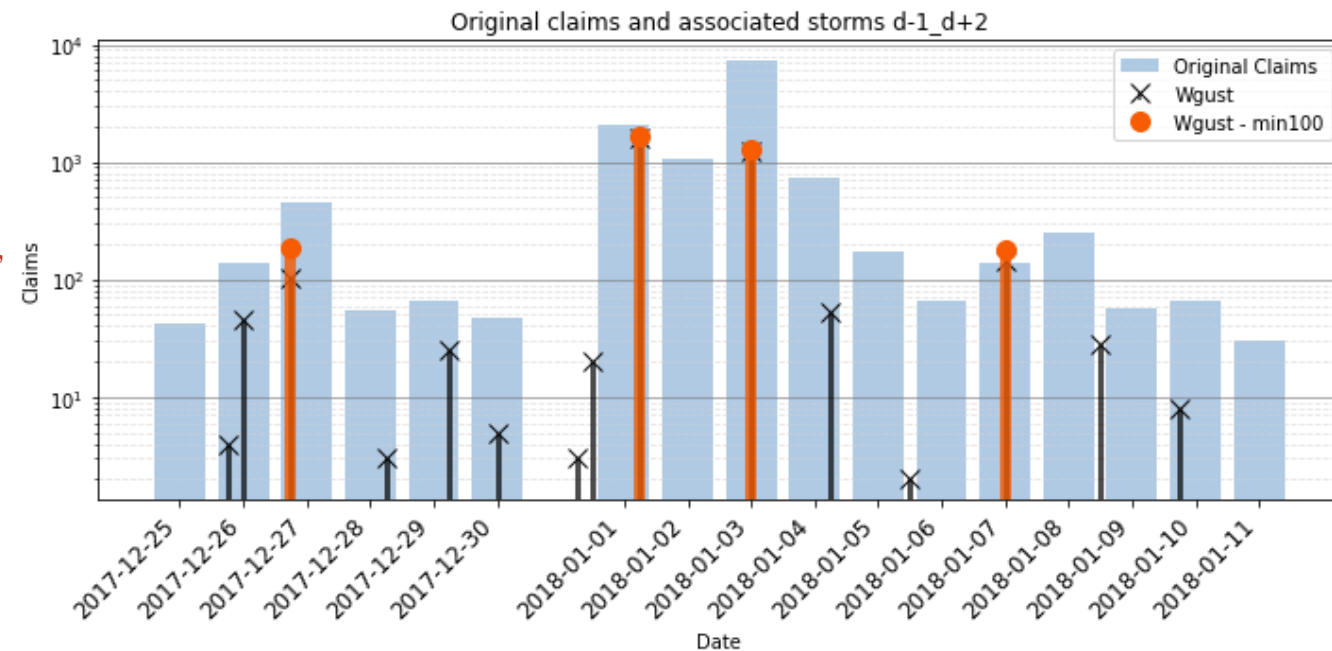
Sensitivity of the association

Tunable parameters/functions :
- Association window (X_b, X_a)
- Association method $(wgust, dist, SSI_{FRA})$
- Minimal number of claims n_{min_claims}

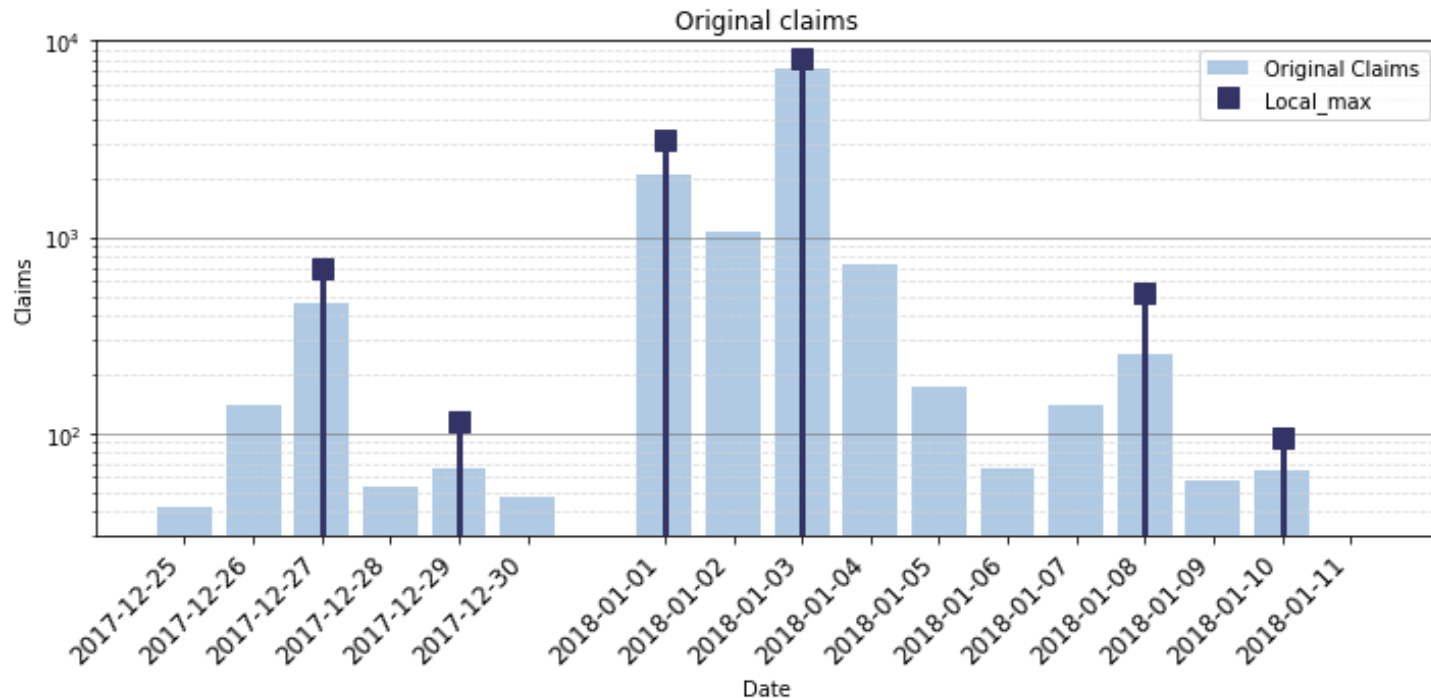Evaluate with respect to claim's local maxima

Tuning metrics :
- Precision

$$\max_i(\min_j(landing\_date_i - local\_max_j))$$

- Frequency

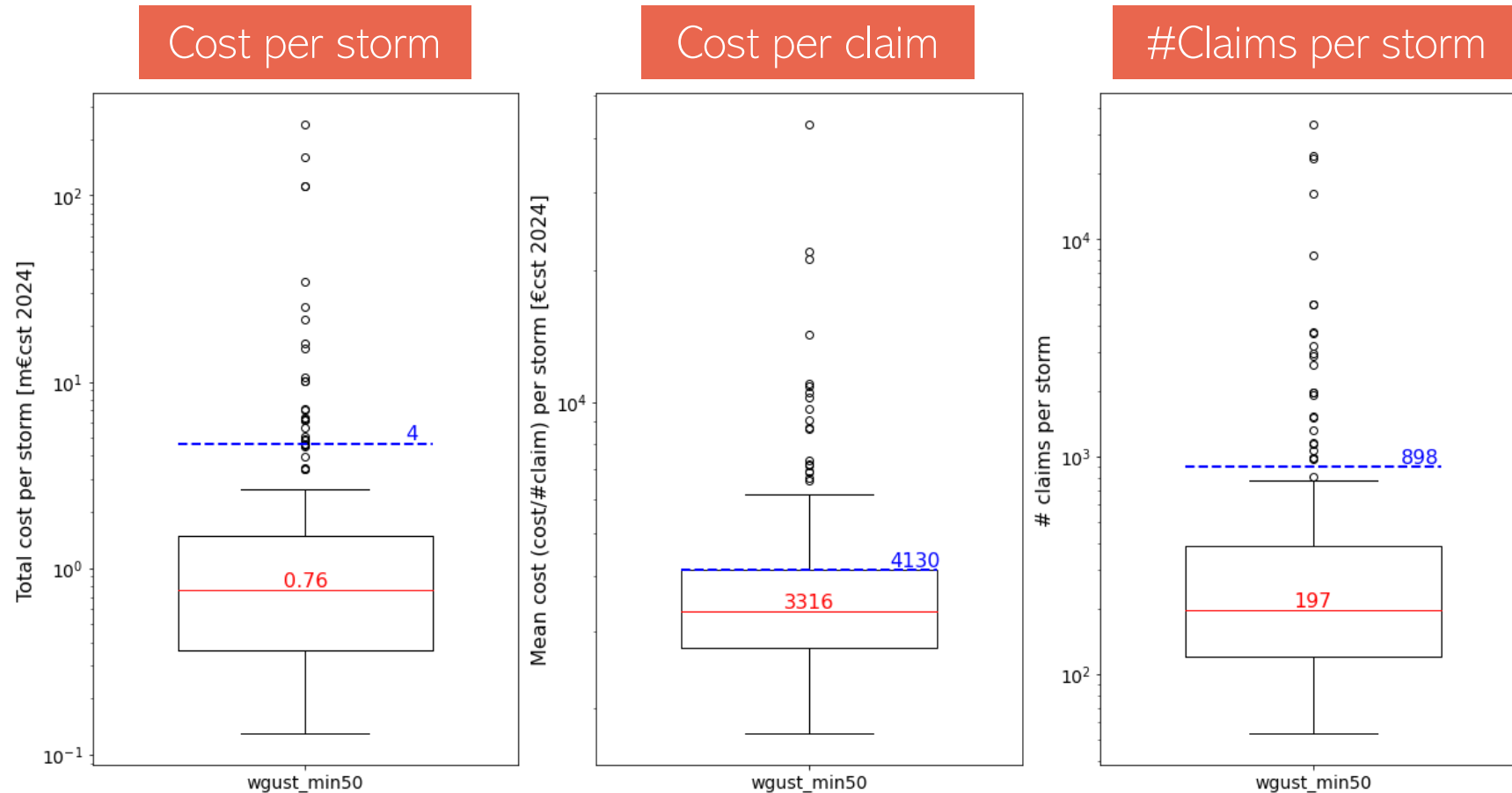$$\#storms - \#local\_max$$

- Completeness

$$\% \, nb\_claims \quad ; \quad \% \, loss$$

$$X_b = 1 \qquad X_a = 3$$
$$method = wgust \qquad nb\_claims = 50$$

Original claims

Statistics of the association

With $X_b = 1, X_a = 3 \; method = wgust, \min\_claims = 50$

194 924 claims (**91%** total number of claims); **90%** of the total losses captured

217 storms associated with impact

Impact of storm clustering
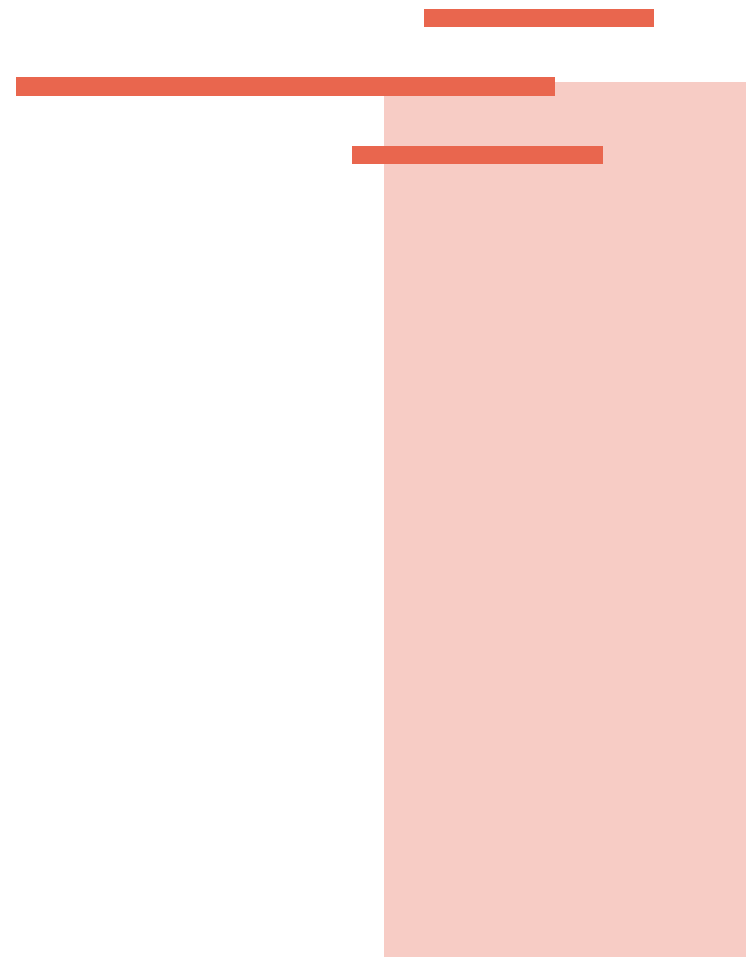
Storm Clustering - Litterature

Absolute definitions

- Cyclones occuring in a given region in a given time period.
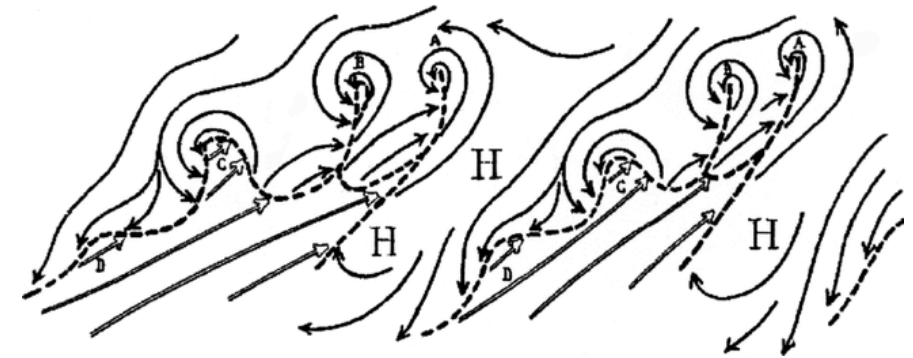- Storm tracks with common impact area (radius of 300, 700km)

[Pinto et al. 2014, J. Geophys. Res. Atmos.] [Pinto et al. 2016, Tellus A]
[Dacre and Pinto 2020, NPJ] [Priestley et al. 2020, QJR Meteorol Soc.]

Relative definitions

- Variability of regional cyclone occurrences with respect to a mean.
- Dispersion from a Poisson mode

$$\psi = \frac{Var(Y)}{E(X)} - 1$$

[Mailier et al. 2006, MWR] [Vitolo et al. 2009, Meteorol. Z.]
[Economou et al. 2015, QJR Meteorol Soc.]

[Mailier et al., 2006]

Storm count in the North-Atlantic Storm track

45N, 60W

December 1990   January 1991   February 1991   March 1991

(a) Entrance

55N, 0E

December 1990   January 1991   February 1991   March 1991
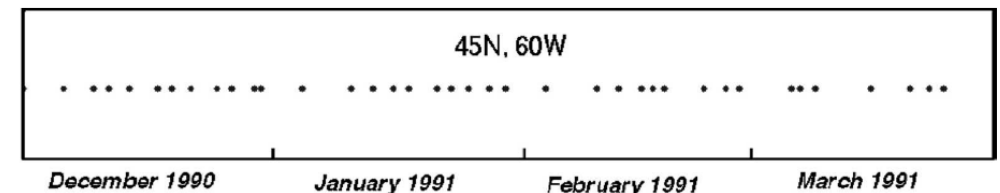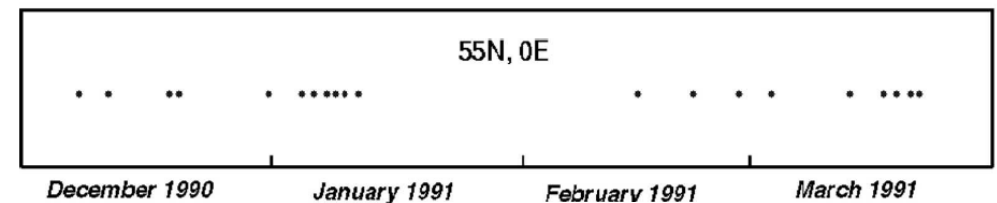
(b) Exit

[Mailier et al., 2006]

Definition : Cluster of storms

Physical perspective

- Storm tracks with common impact area (radius r)
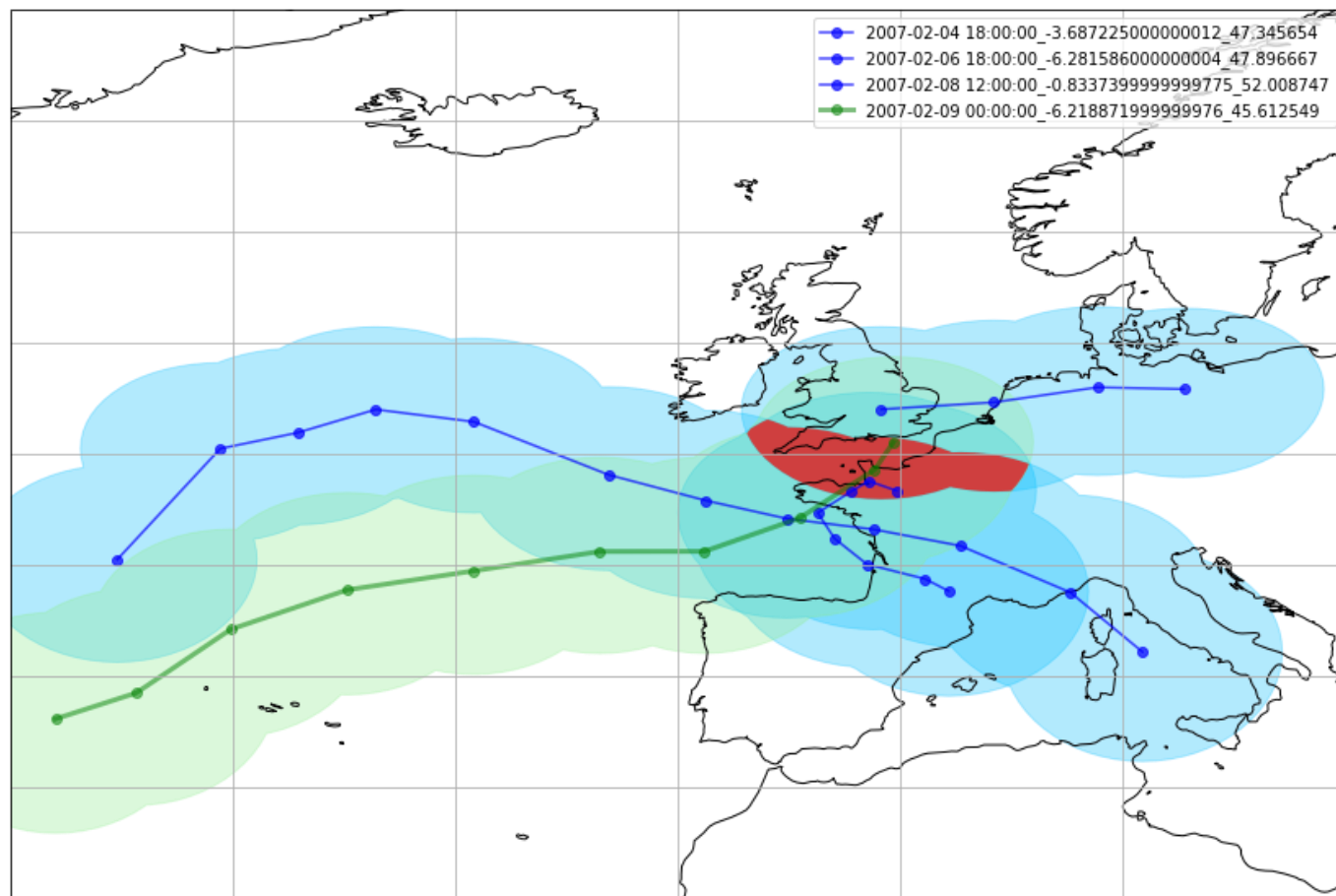
➤ Choose $r = 700km$
Intersection is forced over France

Insurance perspective

- Temporal window for reinsurance storm definition (96h for Generali)

➤ Choose sliding $window = 96h$

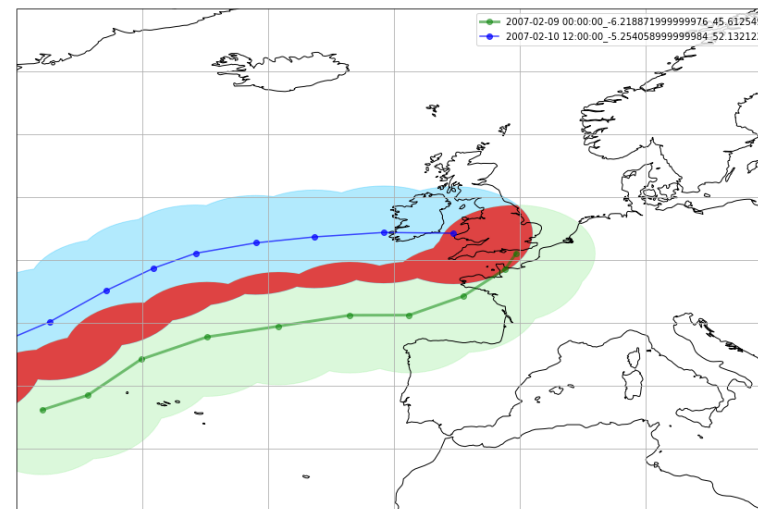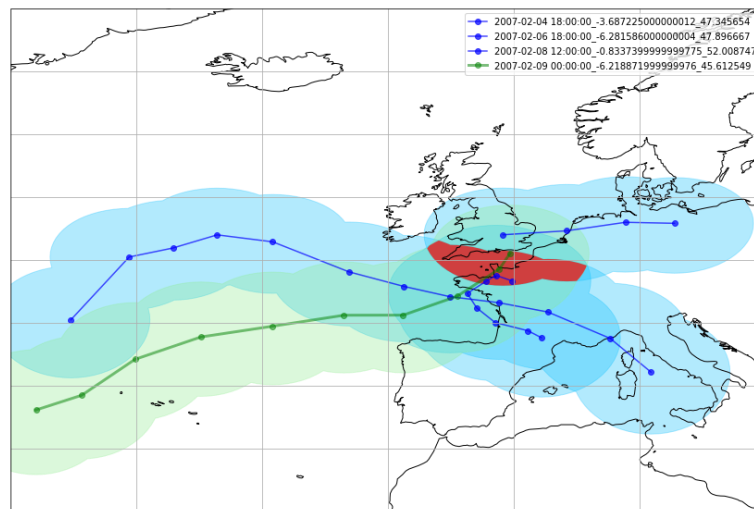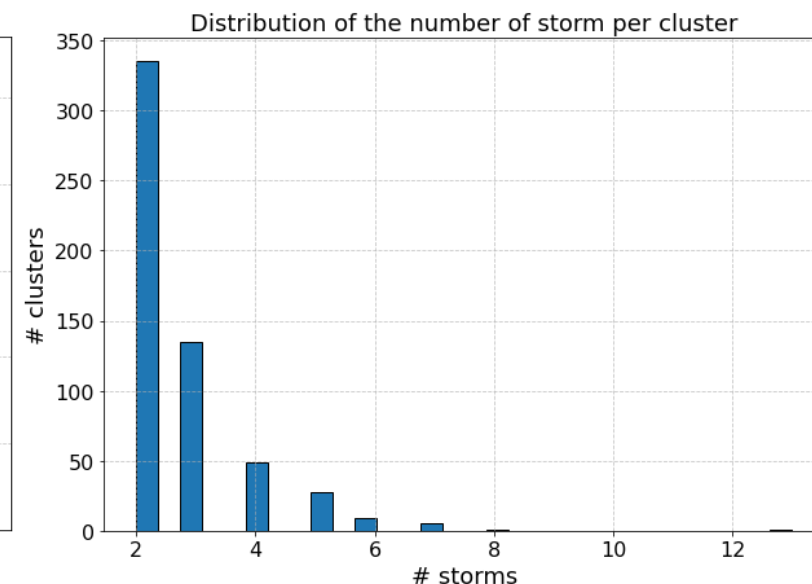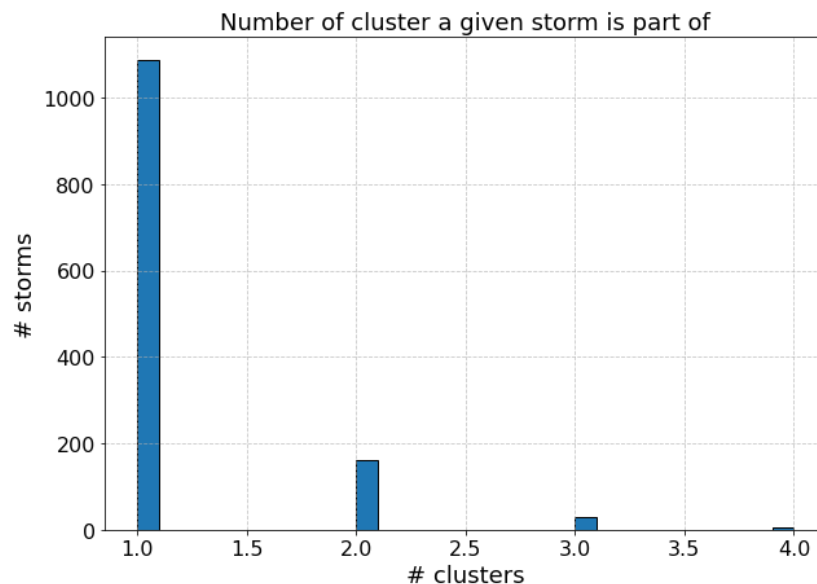**29%** storms in clusters

Definition : Cluster of storms

⚠ A storm can be part of several clusters

Physical perspective

- Storm tracks with common impact area (radius r)

➡ Choose $r = 700km$
Intersection is forced over France

Insurance perspective

- Temporal window for reinsurance storm definition (96h for Generali)

➡ Choose sliding $\mathbf{window} = 96h$

29% storms in clusters

Number of cluster a given storm is part of

Distribution of the number of storm per cluster

High-Impact clusters

Definition :
Clusters in which at least 2 storms are responsible for claims (Similar to Lothar/Martin)
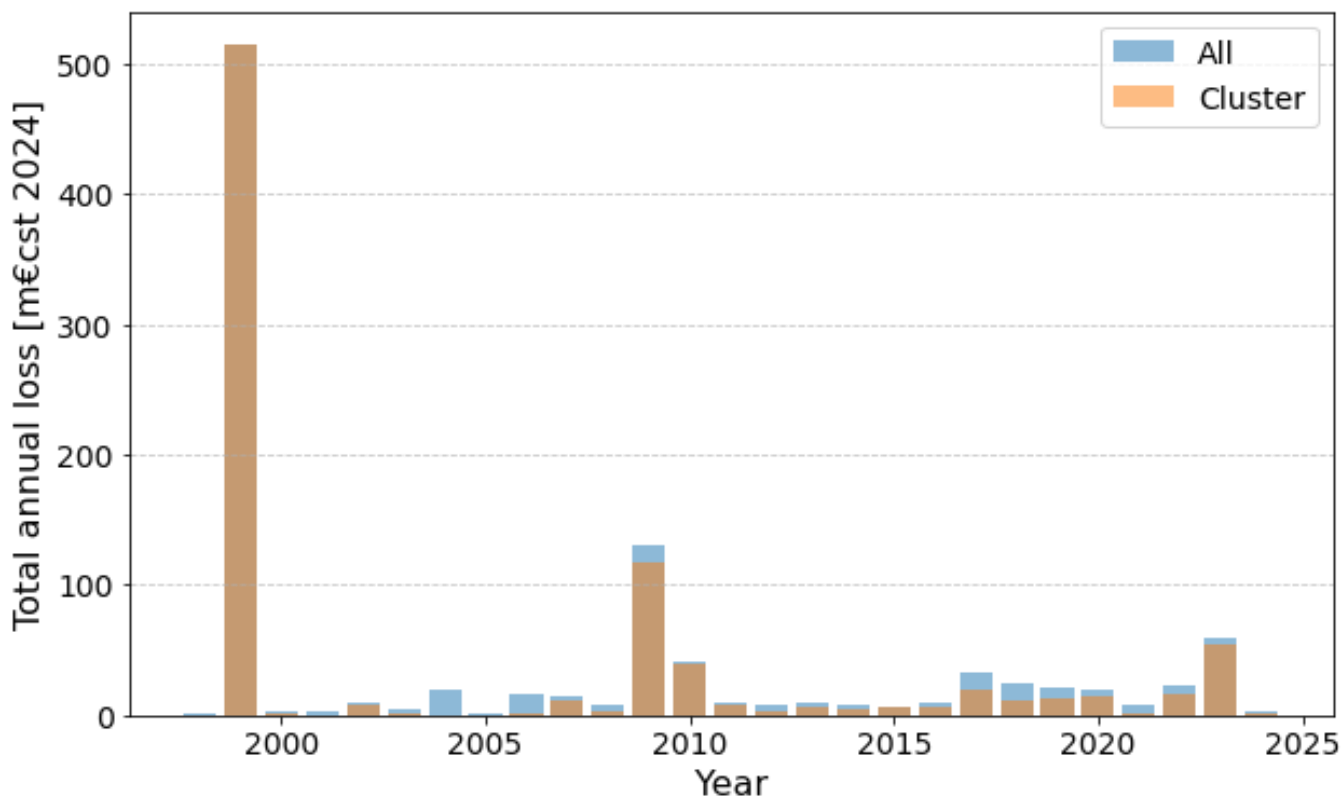
Research Questions :
- How much of the historical losses are associated with clustering ?
- How are costs distributed within a cluster?

217 storms are associated with an impact
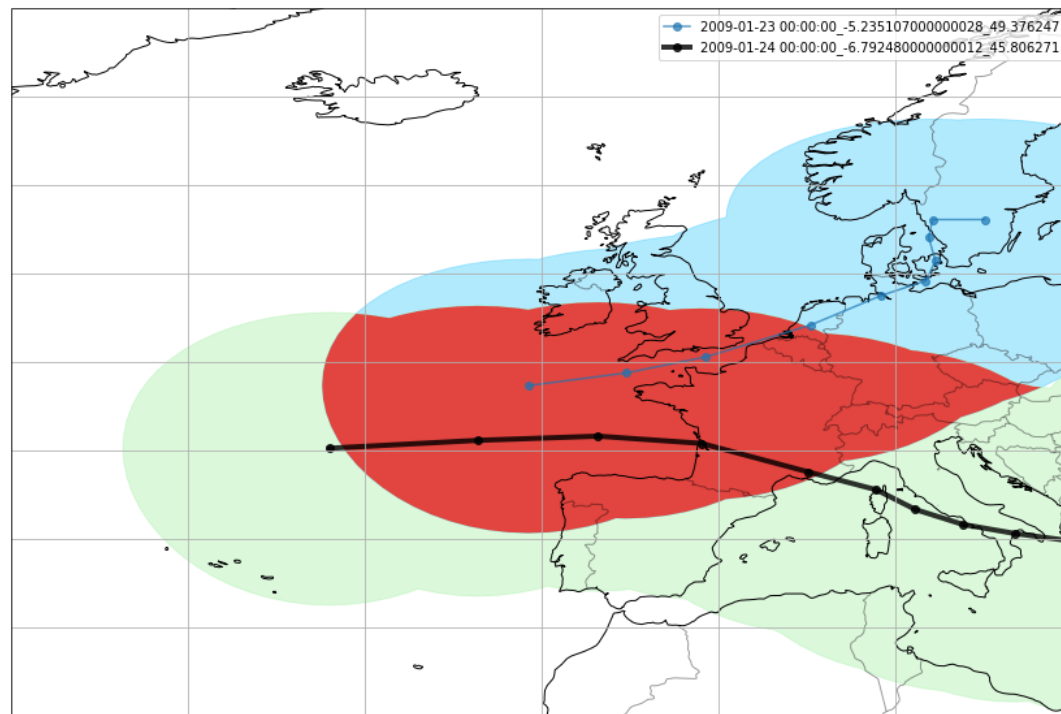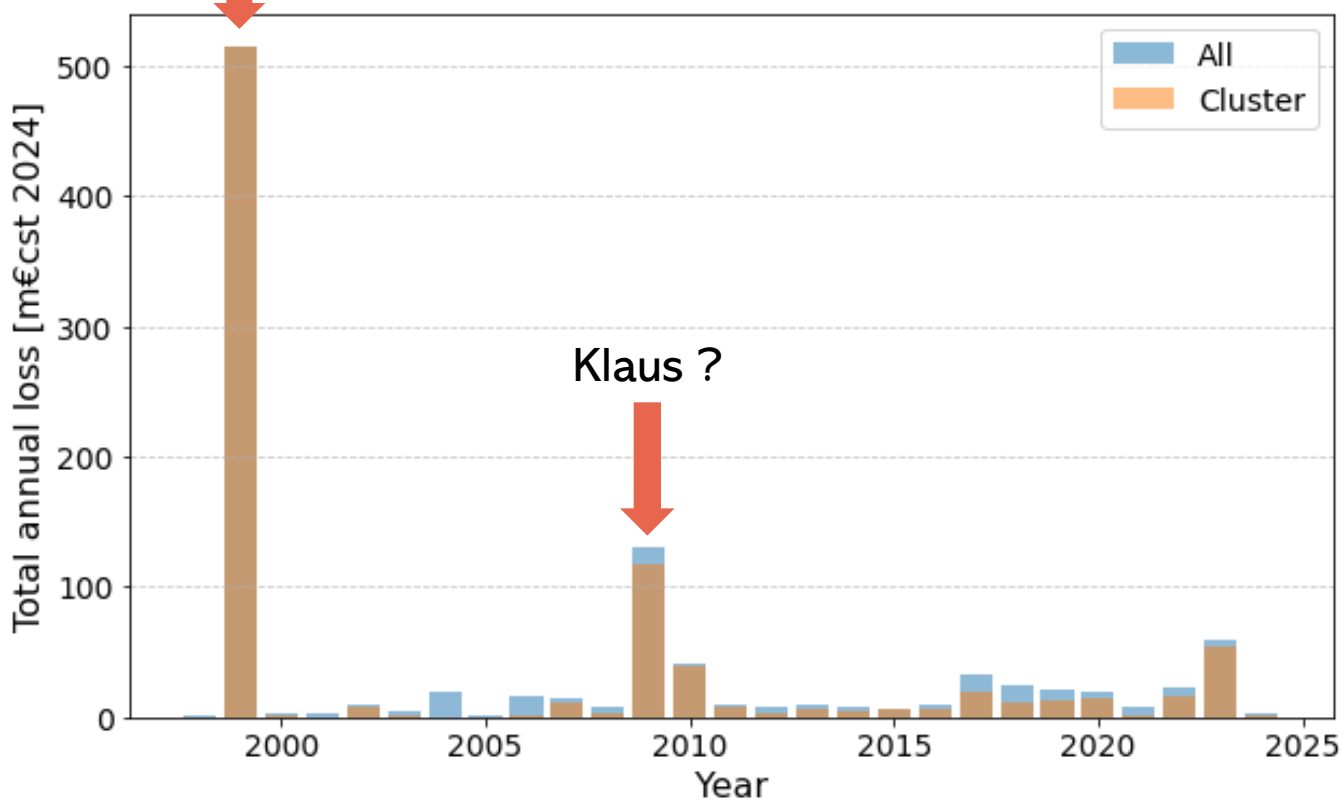**107** storms with impact are in **50** « high impact » clusters

High-Impact clusters

- **85%** of the loss is associated to clustered events

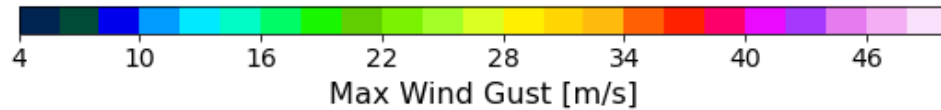- The most costly events seems to be in clusters

High-Impact clusters
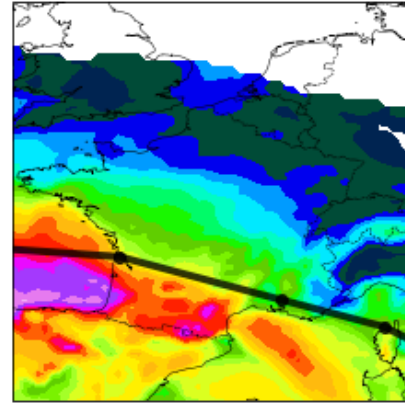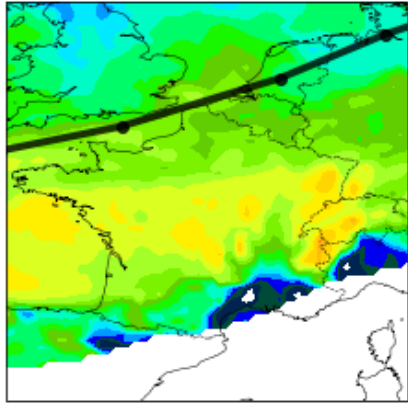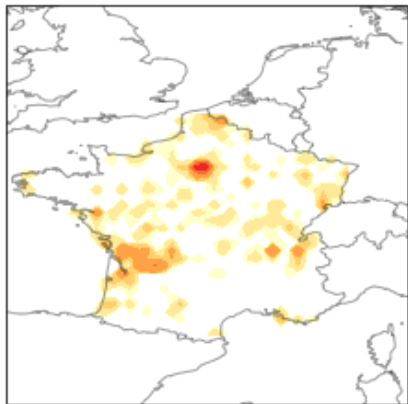
High-Impact clusters

2009-01-23 00:00:00_-5.235107000000028_49.376247   2009-01-24 00:00:00_-6.792480000000012_45.806271

Max Wind Gust [m/s]
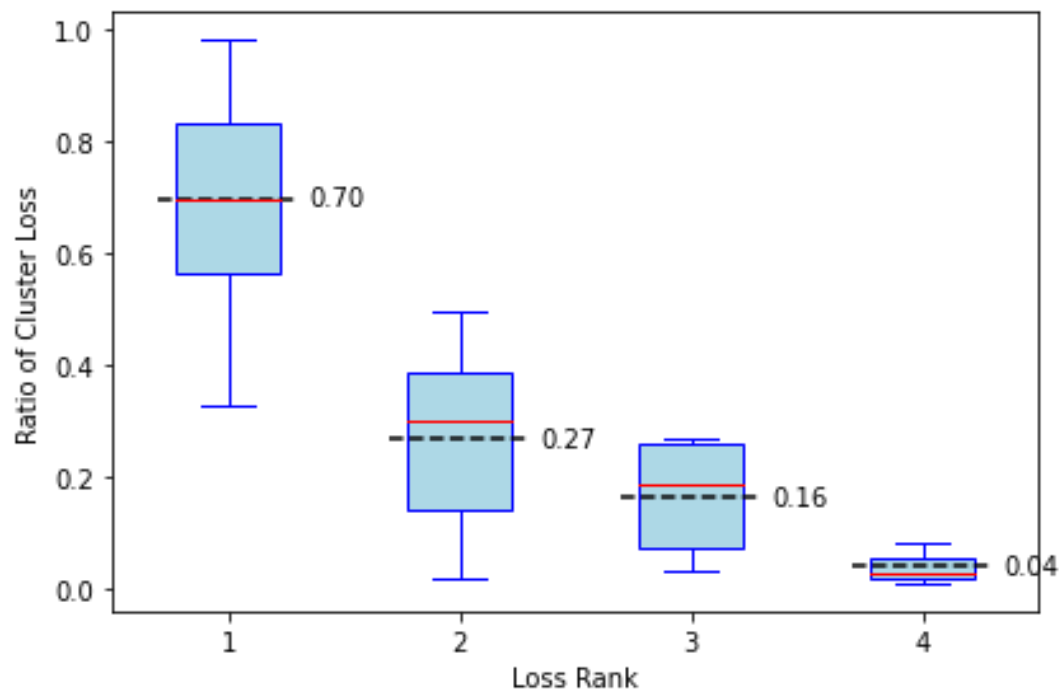
1518 Claims   23405 Claims

Number of claims
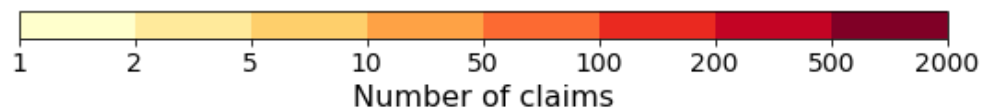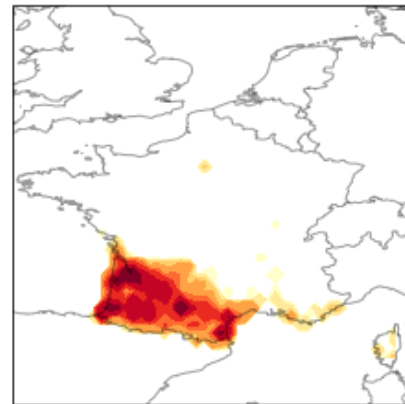
2 consequences :

- Overestimation of the losses associated to Klaus (24/01/2009)

- Underestimation of the impact of clustering

Smaller ETC should also be considered
Caution must be taken when assigning damage to storms
→ The most known one is not necessary the one causing the damage

High-Impact clusters

- Loss concentrated over one storm responsible for, in average 70% of the loss

- 2nd storm is still associated to non-negligeable losses

High-Impact clusters

Insurance impact metrics :
- Claim : *nb_claims*
- Loss : *total_losses*

Physical impact metrics :
- Occurrence : *storm_landing_date*
- Severity :

$$\text{SSI}_{\text{FRA}} = \sum_{x \in FRA} \left(\frac{wgust_{max}}{wgust_{98th}} - 1 \right)^3 \; if \; wgust_{max} \geq wgust_{98th}$$

- Explosivity :

$$\text{NDR}_{24}^{max} = \max(\frac{\text{DR}_{24h}}{24 \; hPa} * \frac{\sin(60°)}{\sin(\phi)})$$

High-Impact clusters

Insurance impact metrics :
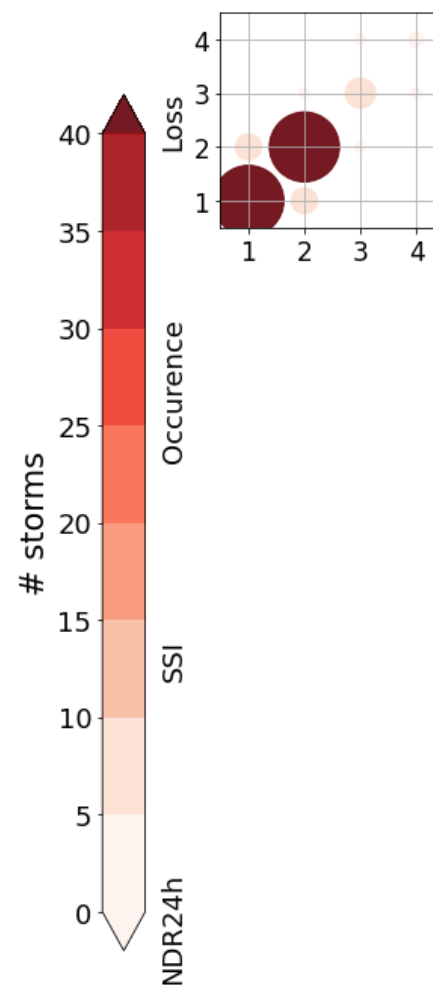
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Ranking Correlation on High-Impact clusters

High-Impact clusters

Insurance impact metrics :
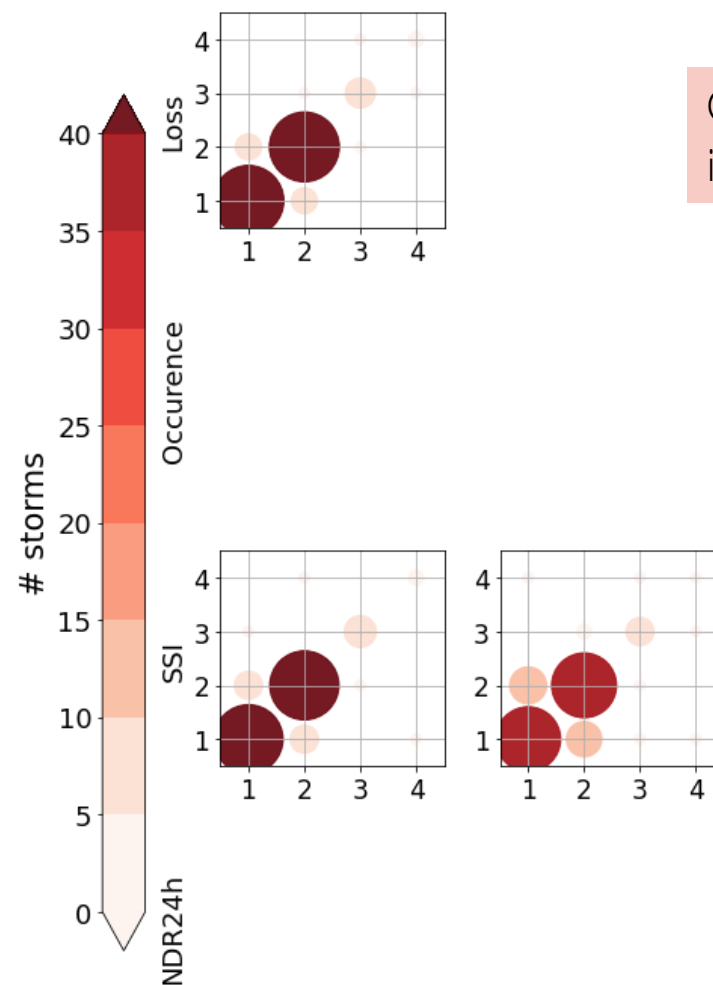- Claim : *nb_claims*
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$$\text{NDR}_{24}^{max} = \max(\frac{\text{DR}_{24\text{h}}}{24 \; hPa} * \frac{\sin(60°)}{\sin(\phi)})$$

Ranking Correlation on High-Impact clusters

Good correlation between the impact metrics

High-Impact clusters

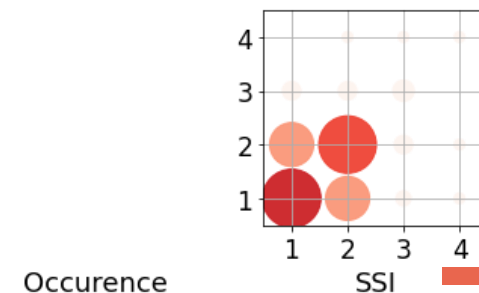## Insurance impact metrics :
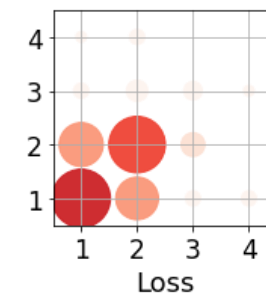- Claim : *nb_claims*
- Loss : *total_losses*

Physical impact metrics :
- Occurrence : *storm_landing_date*
- Severity :

$$\text{SSI}_{\text{FRA}} = \sum_{x \in FRA} \left(\frac{wgust_{max}}{wgust_{98th}} - 1 \right)^3 \; if \; wgust_{max} \geq wgust_{98th}$$

- Explosivity :

$$\text{NDR}_{24}^{max} = \max\left(\frac{\text{DR}_{24h}}{24 \; hPa} * \frac{\sin(60°)}{\sin(\phi)} \right)$$

Ranking Correlation on High-Impact clusters

Possible link between the explosivity, severity and damage

High-Impact clusters

Insurance impact metrics :
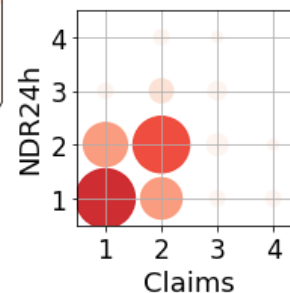- Claim : *nb_claims*
- Loss : *total_losses*
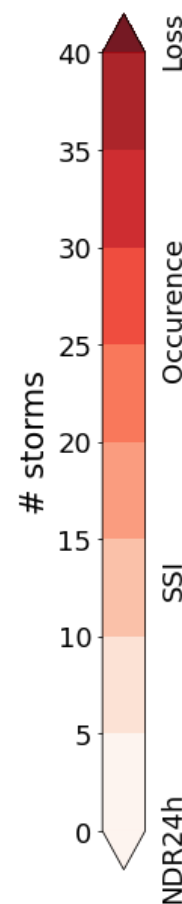
Physical impact metrics :
- Occurrence : *storm_landing_date*
- Severity :

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- Explosivity :

$$\text{NDR}_{24}^{max} = \max(\frac{\text{DR}_{24h}}{24\ hPa} * \frac{\sin(60°)}{\sin(\phi)})$$

Storm arrival order related not related to the other metrics

High-Impact clusters

Insurance impact metrics :

- Claim : *nb_claims*
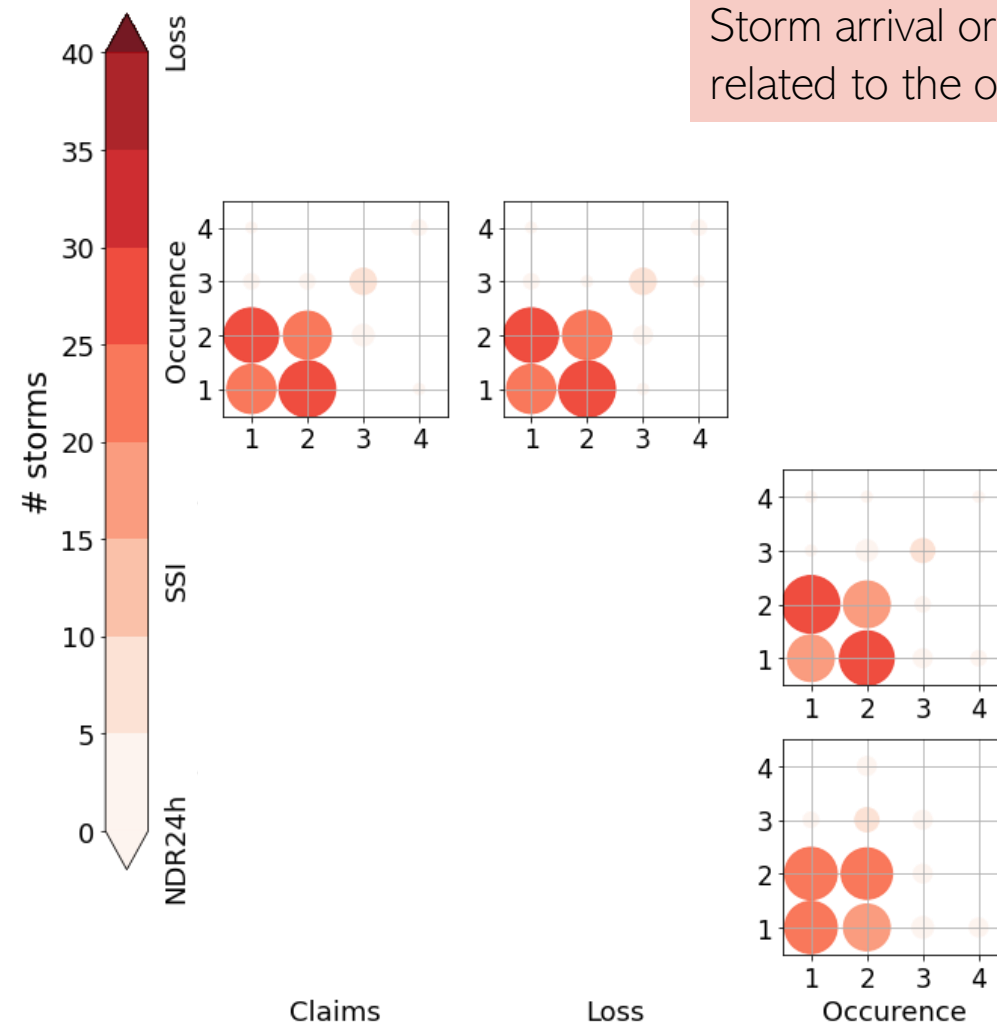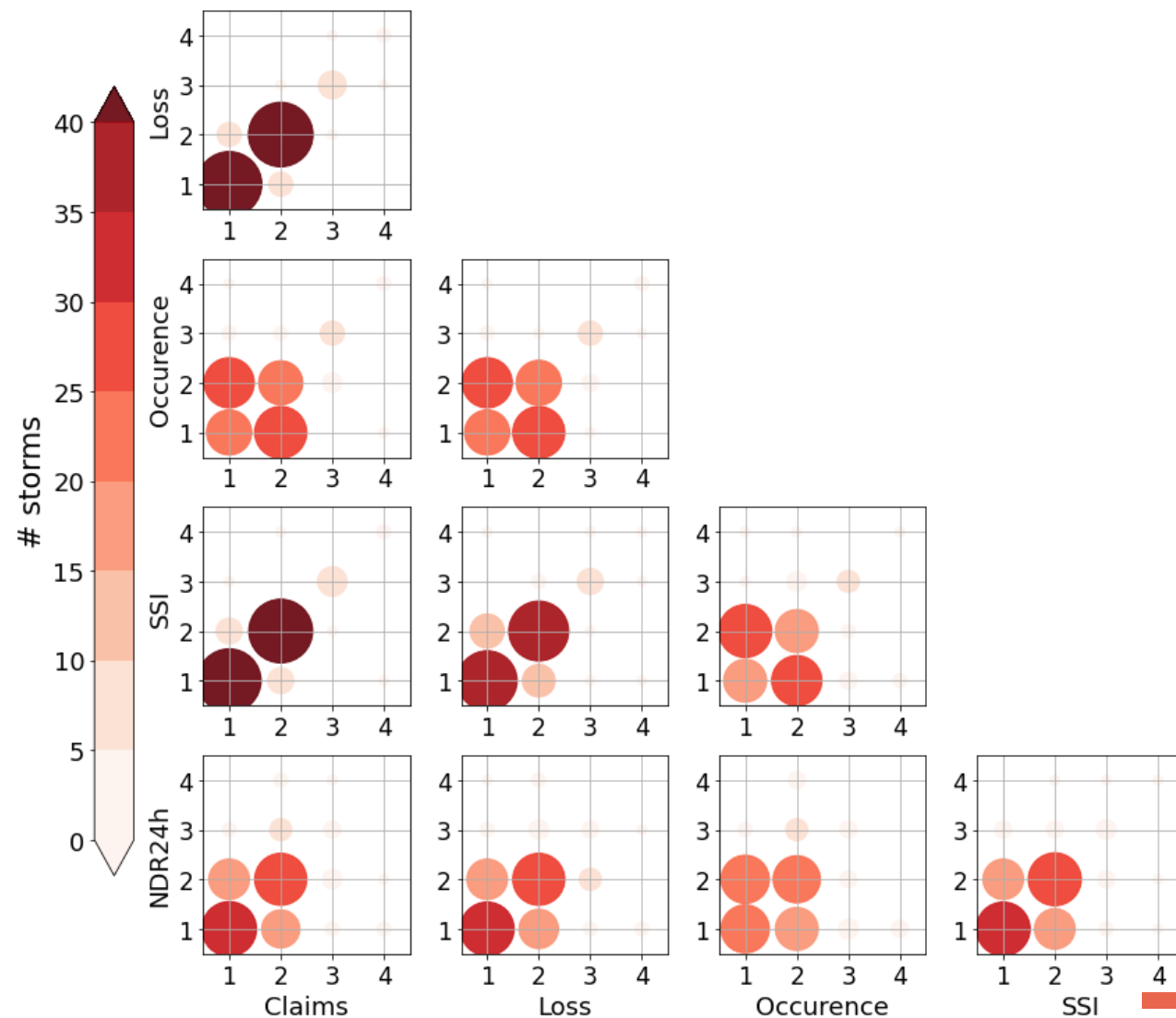- Loss : *total_losses*

Physical impact metrics :

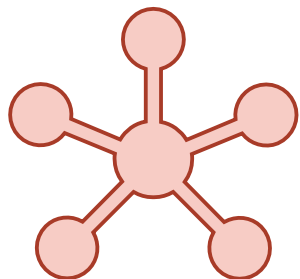- Occurrence : *storm_landing_date*
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- Explosivity :

$$\text{NDR}_{24}^{max} = \max(\frac{\text{DR}_{24h}}{24 \, hPa} * \frac{\sin(60°)}{\sin(\phi)})$$

Ranking Correlation on High-Impact clusters

Conclusions

- **Association of high-resolution claims to storm events**
  - Automatic and optimized association
  - Capture all storms, even smaller scale ones

- **Clusters of storms : an aggravating factor**
  - Main responsible for losses
  - Can distinguish between the impact of individual storms in a cluster
  - SSI correlated with the number of claims and losses in clusters
  - Damage is not linked to the arrival order

Perpectives

Physical	Insurance
• Identify preferred configurations for storm clustering • Estimate the damage linked to « high-impact » clusters using physical parameters • Investigate the representation of "high-impact" clusters in future climate (CMIP6)	• Estimate the additional cost linked to clustering • Construct vulnerability curves Operational goals : ❖ Better represent most extreme events if they happen to be clustered ❖ Verify the performances of vulnerability curves with/without clustering ❖ Estimate future risk

Thanks for your attention

GENERALI

LSCE
LABORATOIRE DES SCIENCES DU CLIMAT
& DE L'ENVIRONNEMENT