20th Century extratropical cyclone climatology and risk assessment

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- Use long-term data to study the climatology of storms in Europe and their impacts.

- Storm Tracking using a new reanalysis dataset since the beginning of the 20th century, 1900-2010

- Combination of severity (Loss index) with trajectories and dynamics
ERA-20C released in October 2014.
1900-2010 (October to March)
1.125 x 1.125 degrees, every 3 hours.
VO - Relative Vorticity 850 hPa.
U-V - Wind components, 700 hPa and 850 hPa.
U-V - 10-meters Wind.

Franck Ayrault (1998)

- Octobre 1900 to March 2010
- Relative vorticity at 850 hPa maximum detection
- Data Filtering
- U and V components of the wind at the 850 hPa and 700 hPa (advection) (R + 200 km)
- Final trajectories longer than 600 km and 24 h.

\[
Density(i,j) = \sum(X_{ij \pm R})
\]

R = 300 km
**Method**

**Number of cyclones per winter**

**Fig.** - Number of cyclones per year for the all northern hemisphere - blue; Euro-Atlantic area (120W 60E) - red plus squares; Pacific region (120W 120E) - pink plus circles.

- Small increase in the number of storms that may reflect the increase in the amount of observational data in the reanalysis.
- More storms in the Euro-Atlantic Region (120W 60E) than in the Pacific region (120W 120E).
- Signal in the beginning of the 20th Century in the NH reflects the variations in the Pacific.
- Huge decrease in the late 60’s -80-s related with a decrease of storms in the "Euro-Atlantic" region consistent with NAO - during that period.

**North Atlantic Oscillation (NAO) index, 1864–2001 (Hurrell)**

Normalized difference of normalized (December through March average) Lisbon minus Stykkisholmur sea-level pressure.

Values normalized with respect to 1864–1983, and ascribed to the year of the January.
How can we determine the impact of a storm?

Pinto et al. 2012

\[ L_{\text{I-1}}(i, j, t) = \left( \frac{V_{ij}(t)}{V_{98,ij}} \right)^3 I(V_{ij}(t), V_{98,ij}) P_{ij} L_{ij} \]
Example 3h LI Vivivan
Example 3h LI Vivivan
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**Li highest values for each country**

- example: France - #1LI (daily maximum)
  - $t_0 = 1990-02-27$ (0h 3h 6h 9h 12h 15h 18h 21h)
  - $l_i = 264400$
$$\sum_{t_0+1}^{t_0+2} LI[t_0+1 : t_0+2]$$
Conclusions and Future work

- Good agreement between the results from the tracking algorithm and historical storms.
- Increase in the number of cyclones over the whole NH and in the Euro-Atlantic / Pacific region.
- There are two different types of LI s associated with the historical storms: spacial concentrated and higher LI or spread over a large region but moderate LI.
- LI/ Damage for a specific event results from more than one maximum of vorticity from the tracking algorithm. These weaker maximums of vorticity are usually associated with a "main" storm (for instance Vivian in France).

Future work!

- Analysis between the computed Loss index with reference values given by the reassurance company SCOR.
- Meteorological Index for each trajectory in the footprints.
Future work

Computing trajectories using as reference the "Meteorological Index" that doesn't take into account the Population.

- Dinamical composites for the trajectories of the 100 highest LI for the EMASK
  - for LI intense but conscripted to a small region
  - for LI moderate but over a large region
- Cluster of trajectories for each region using the 100 highest LI dates.
- Temporal clustering of storms (winter 1990).

Thank you
**Density genesis** (mean over 300km)

$$\text{Density}(i,j) = \text{mean}(X_{ij} \pm R)$$

**Density Lysis** (mean over 300km)
Maximum vorticity location / Mean time step per grid point

**Maximum vorticity LOCATION** - Lon/lat frequency of vorticity maximums per trajectory

- Vorticity maximum per trajectory
- mean_300km_vorticity/year

**Age** - Mean time steps per lon/lat point

- den_age
- Time_step/Counts
France