20th Century extratropical cyclone climatology and risk assessment

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5th Workshop of Europena Storms 1st Sept 2015

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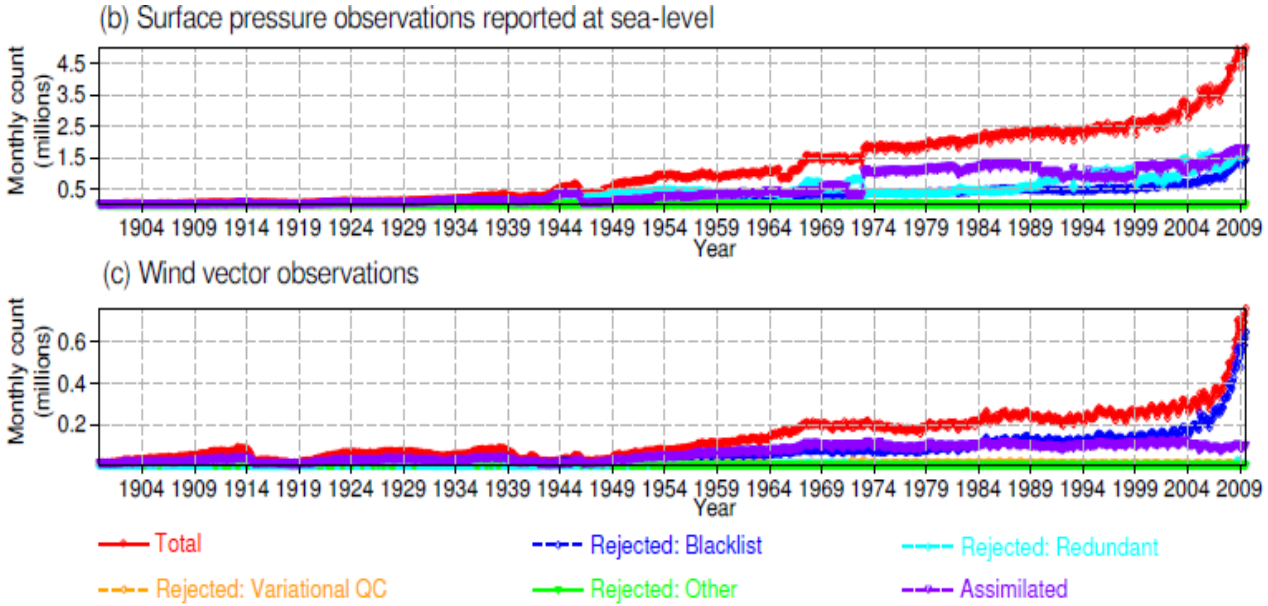
-Use long-term data to study the climatology of storms in Europe and their impacts.

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

-Combination of severity (Loss index) with trajectories and dynamics

ERA-20C

- 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.VO
- U-V - Wind components, 700 hPa and 850 hPa.
- U-V - 10-meters Wind.



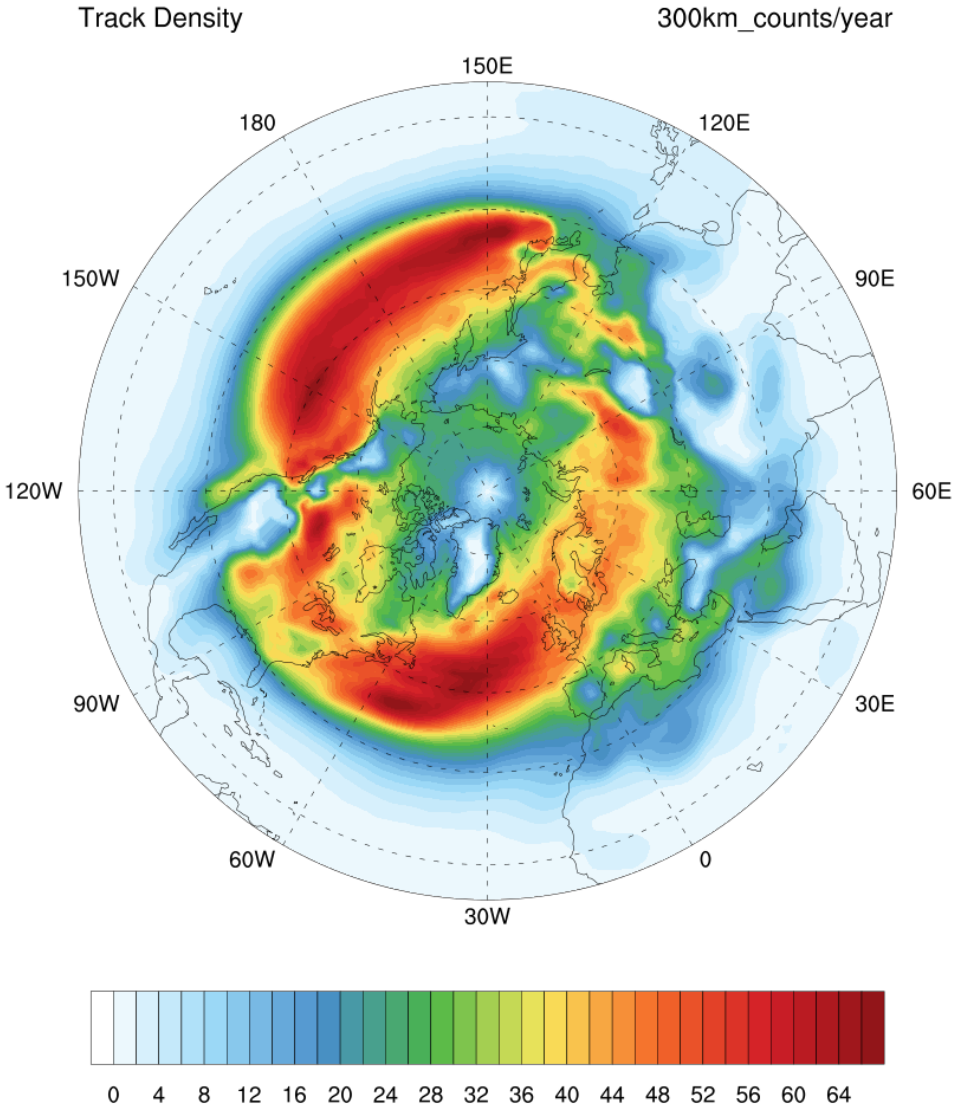
From: Poli, P., Hersbach, H., Tan, D., Dee, D., Th´epaut, J.-N., Simmons, A., Peubey, C., Laloyaux, P., Ko- mori, T., Berrisford, P., Dragani, R., Tr´emolet, Y., Holm, E., Bonavita, M., Isaksen, L. and Fisher, M. (2013). The data assimilation system and initial performance evaluation of the ecmwf pilot re-analysis of the 20th-century assimilating surface observations only (era-20c). Ecmwf era report series, ECMWF, Shinfield Park, Reading.

Tracking algorithm

- 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 700h Pa (advection) (R $\pm$ 200km)
- Final trajectories longer then 600km and 24h.

$$Density(i,j) = sum(X_{ij \pm R}) \quad (1)$$

R=300km



Method

Number of cyclones per winter

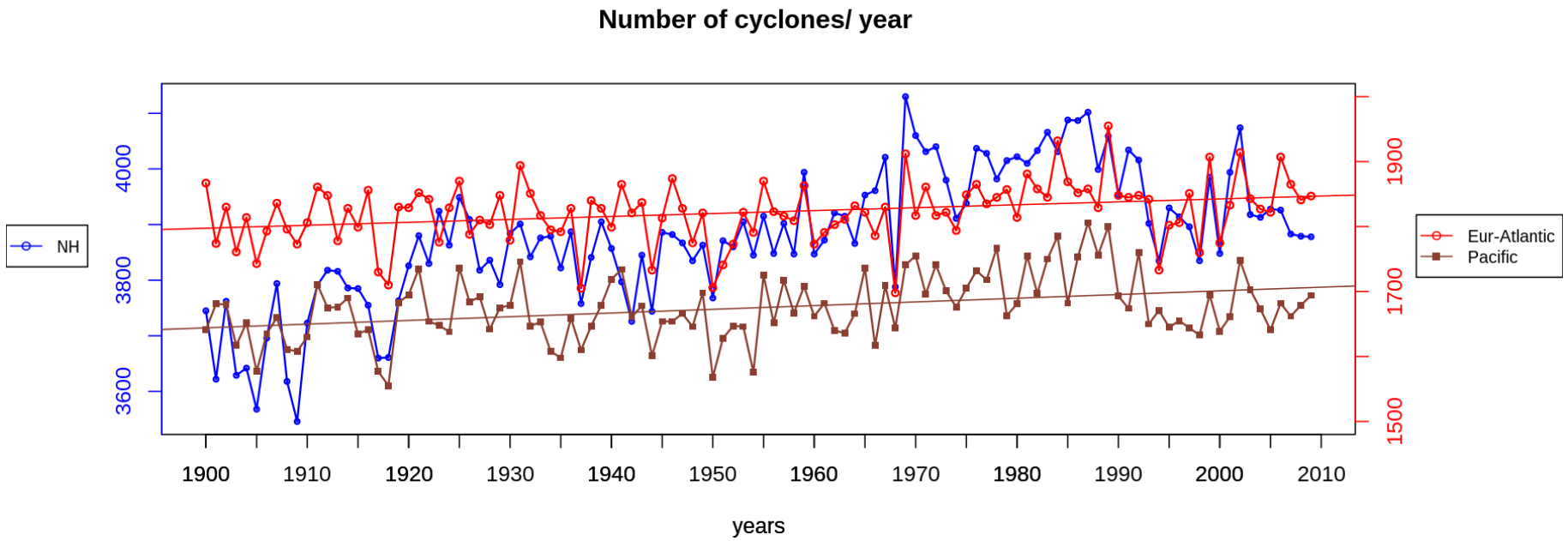
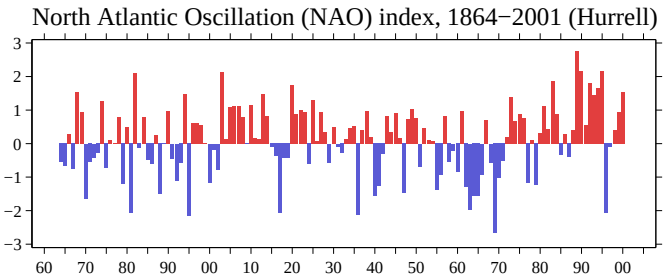


Fig.-Number os cyclones per year for the all northern hemisphere -blue;
Euro-Atlatic area (120W 60E) -red plus squares ; Pacific region (120W 120E) - pink plus circles



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.

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- 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 begining 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

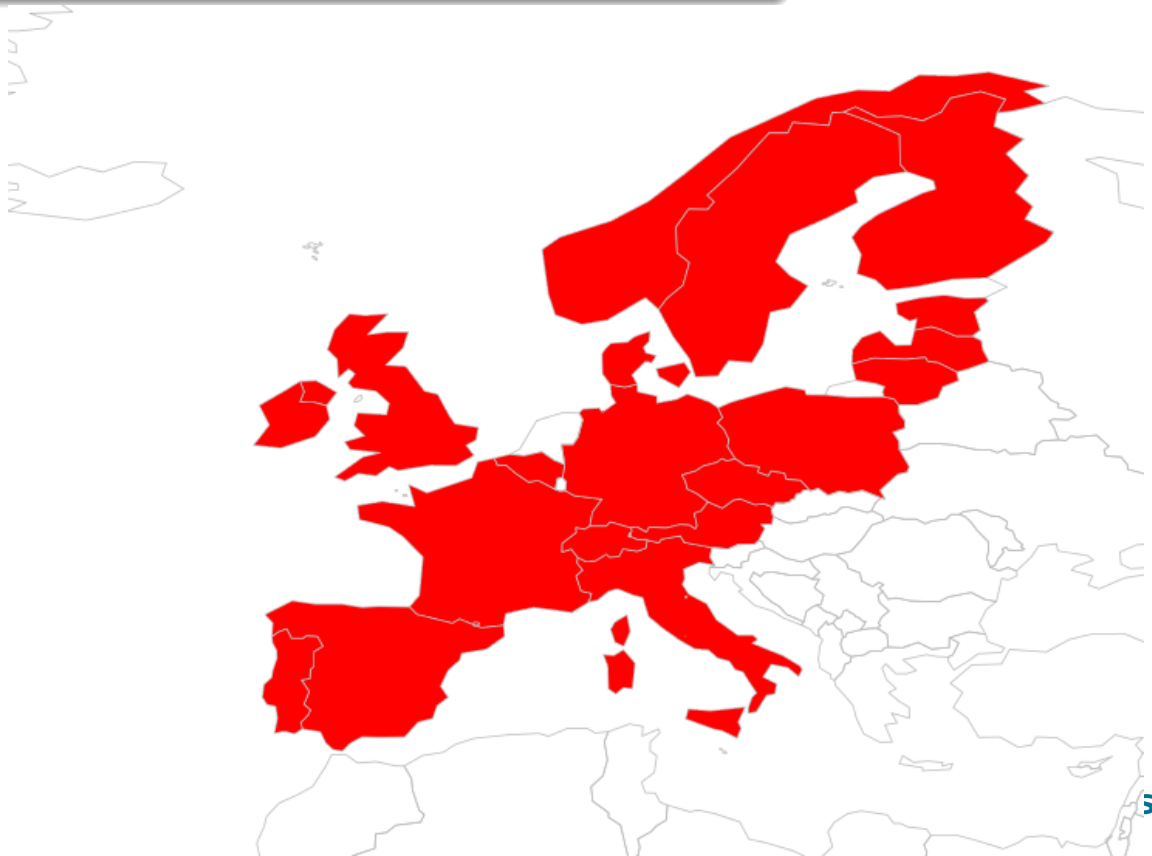
Emask and countries

How can we determine the impact of a storm?

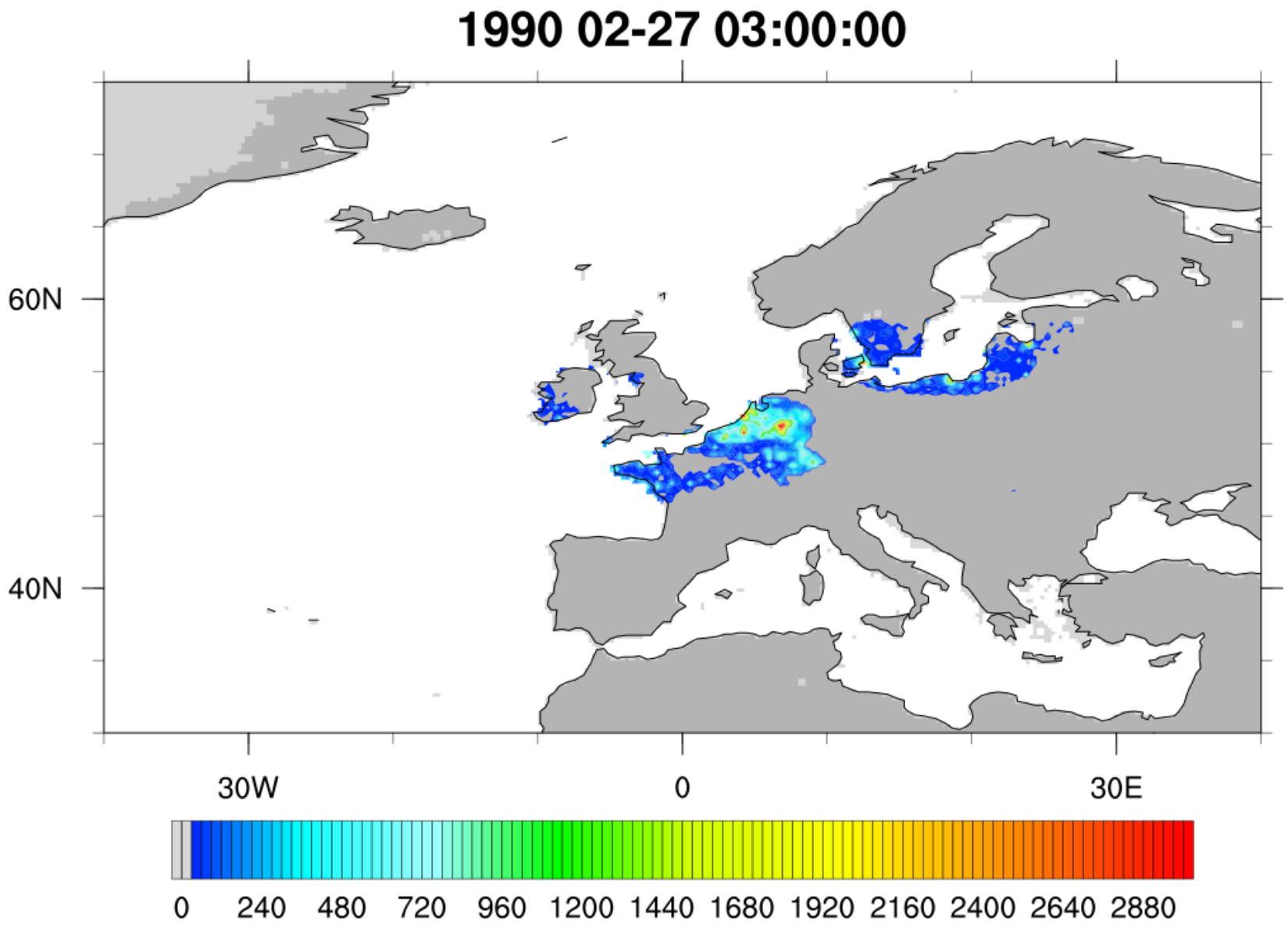
Pinto et al. 2012

$$LI\_1(i,j,t) = \left(\frac{V_{ij}(t)}{V98_{ij}}\right)^3 I_{(V_{ij}(t),V98_{ij})} P_{ij}\ L_{ij} \qquad (2)$$

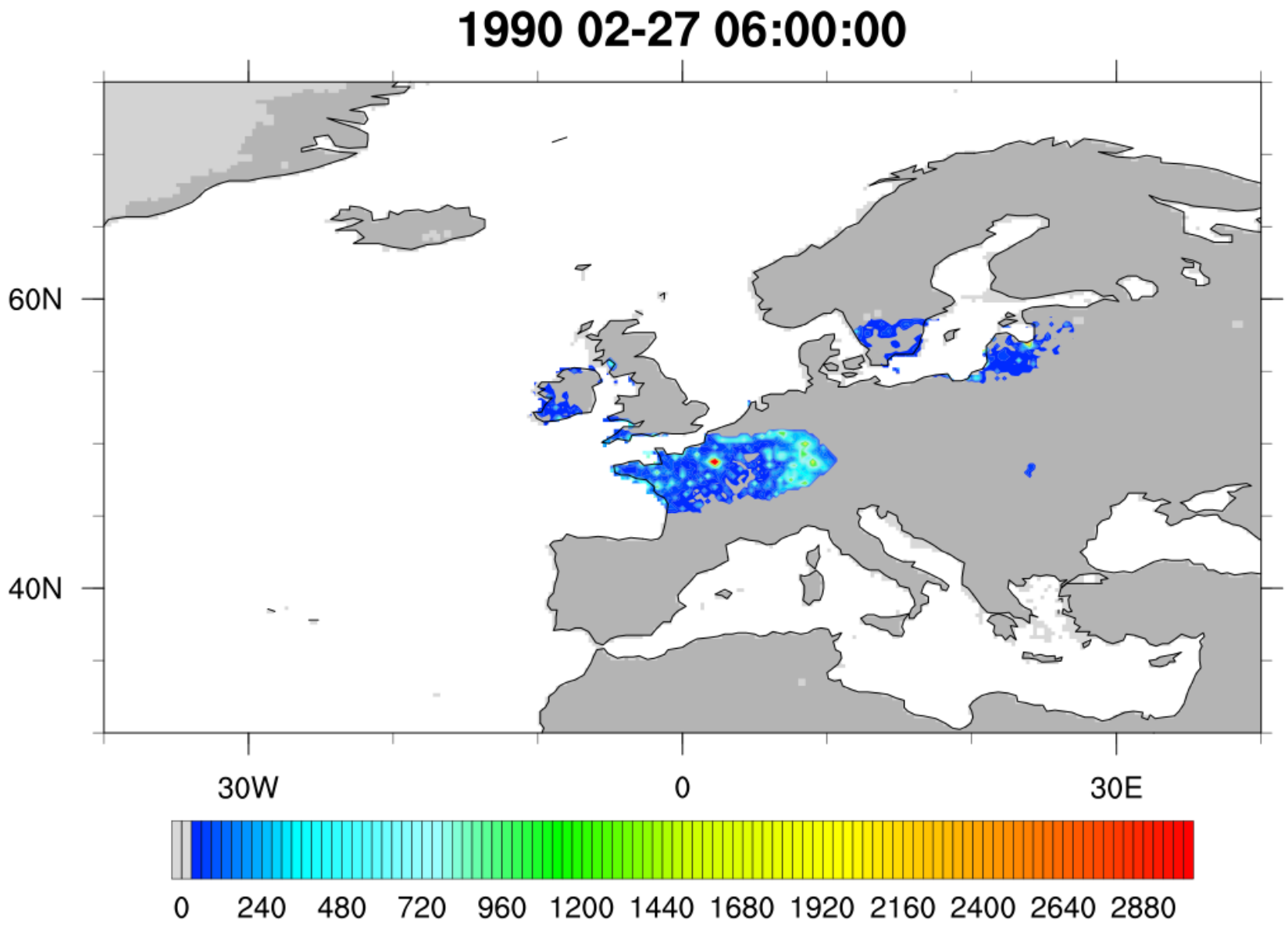
Austria,
Belgium,
Czech Republic,
Denmark,
Estonia,
Finland,
France,
Germany,
Ireland,
Lithuania,
Latvia,
Norway,
Poland,
Portugal,
Spain,
Sweden,
Switzerland,
United Kingdom.



Example 3h LI Vivivan



Example 3h LI Vivivan



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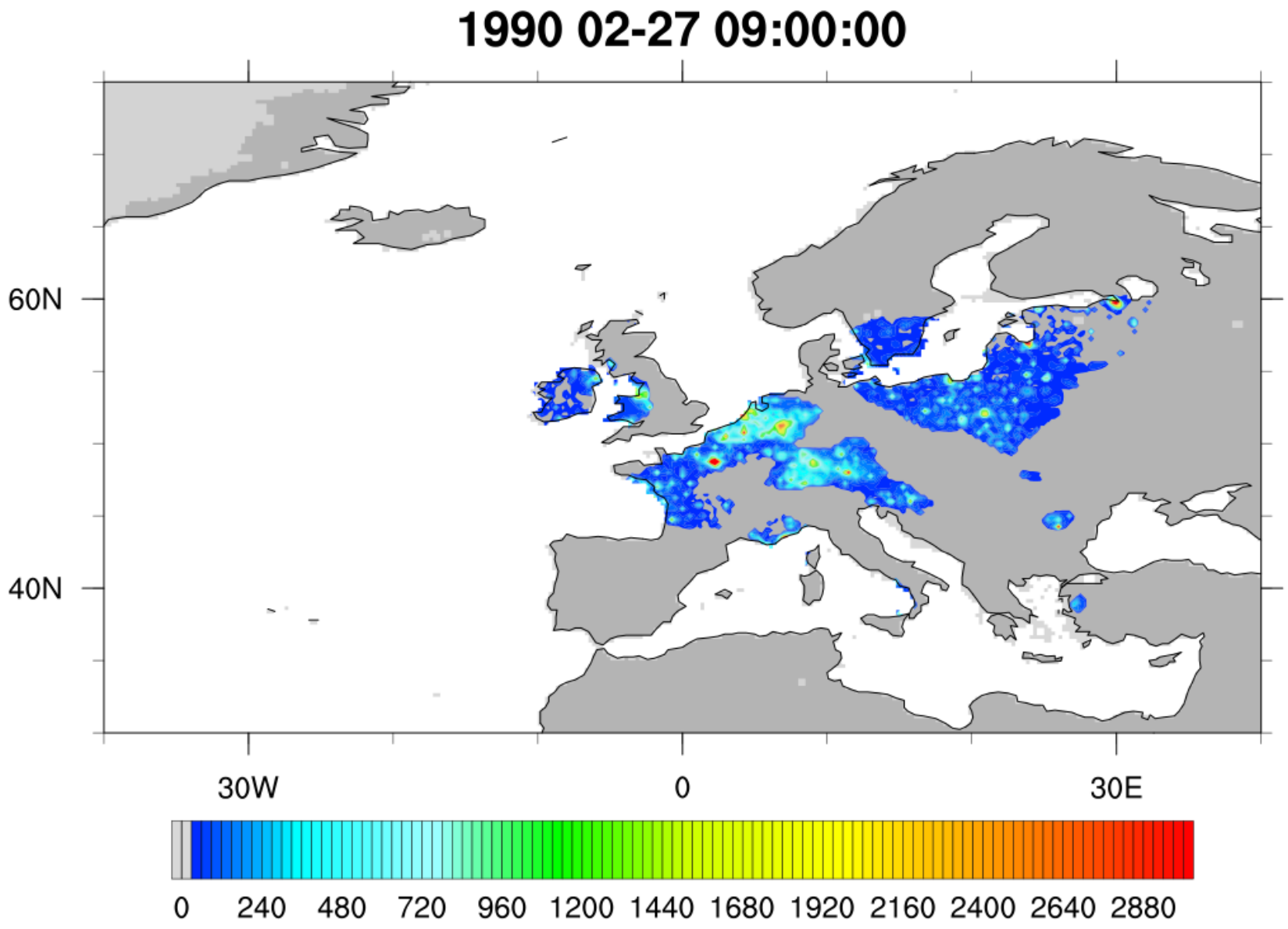

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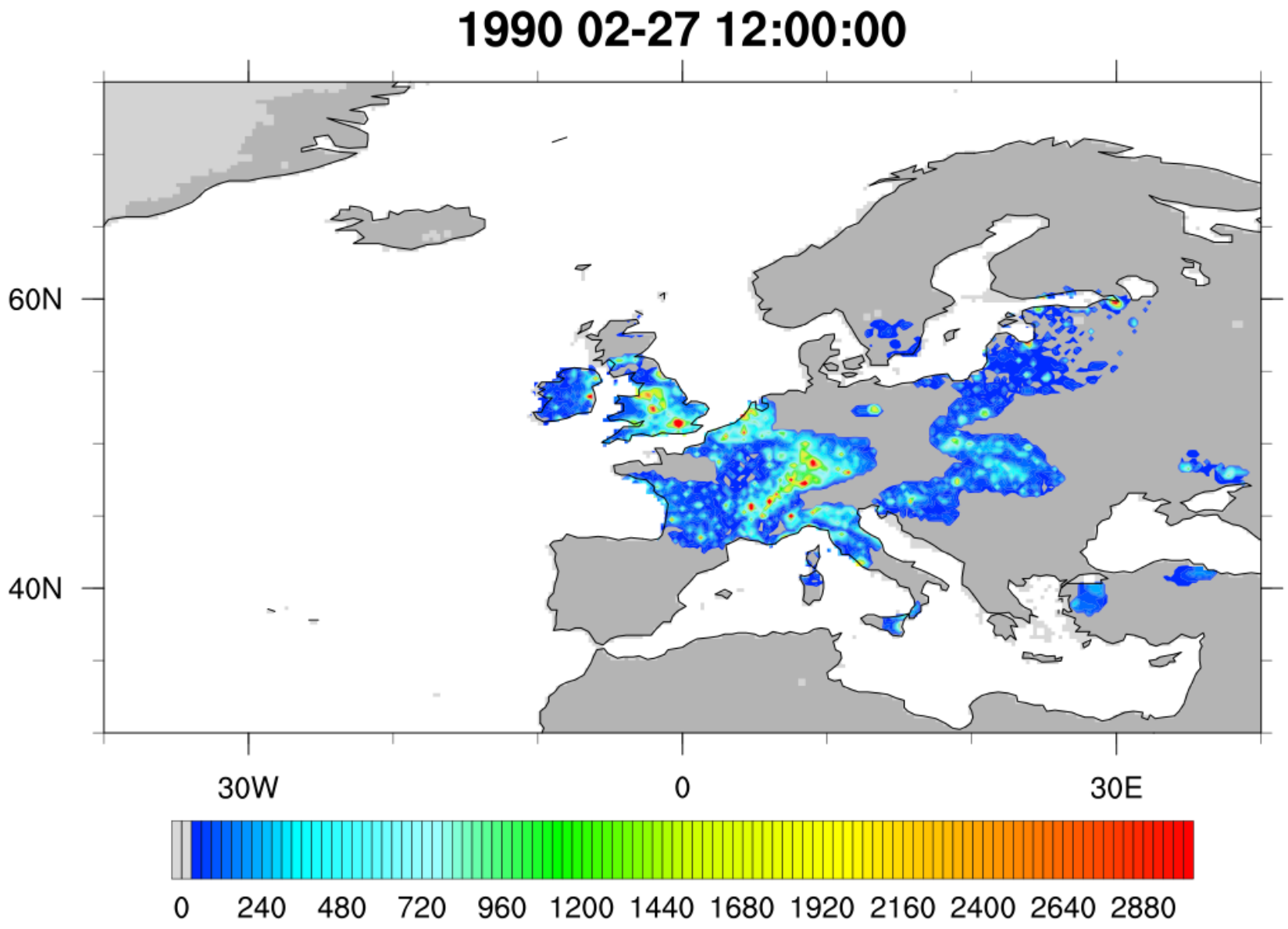

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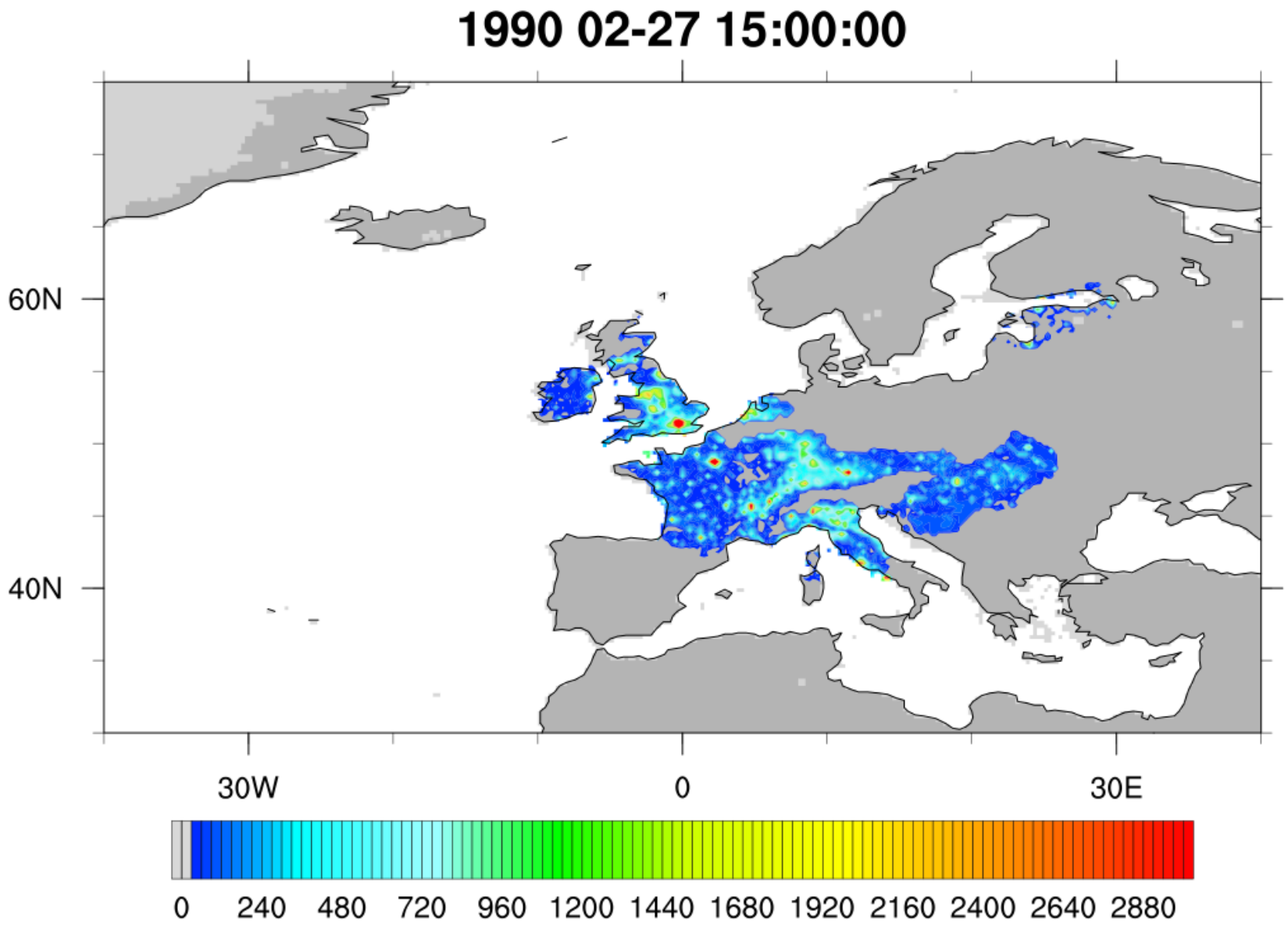
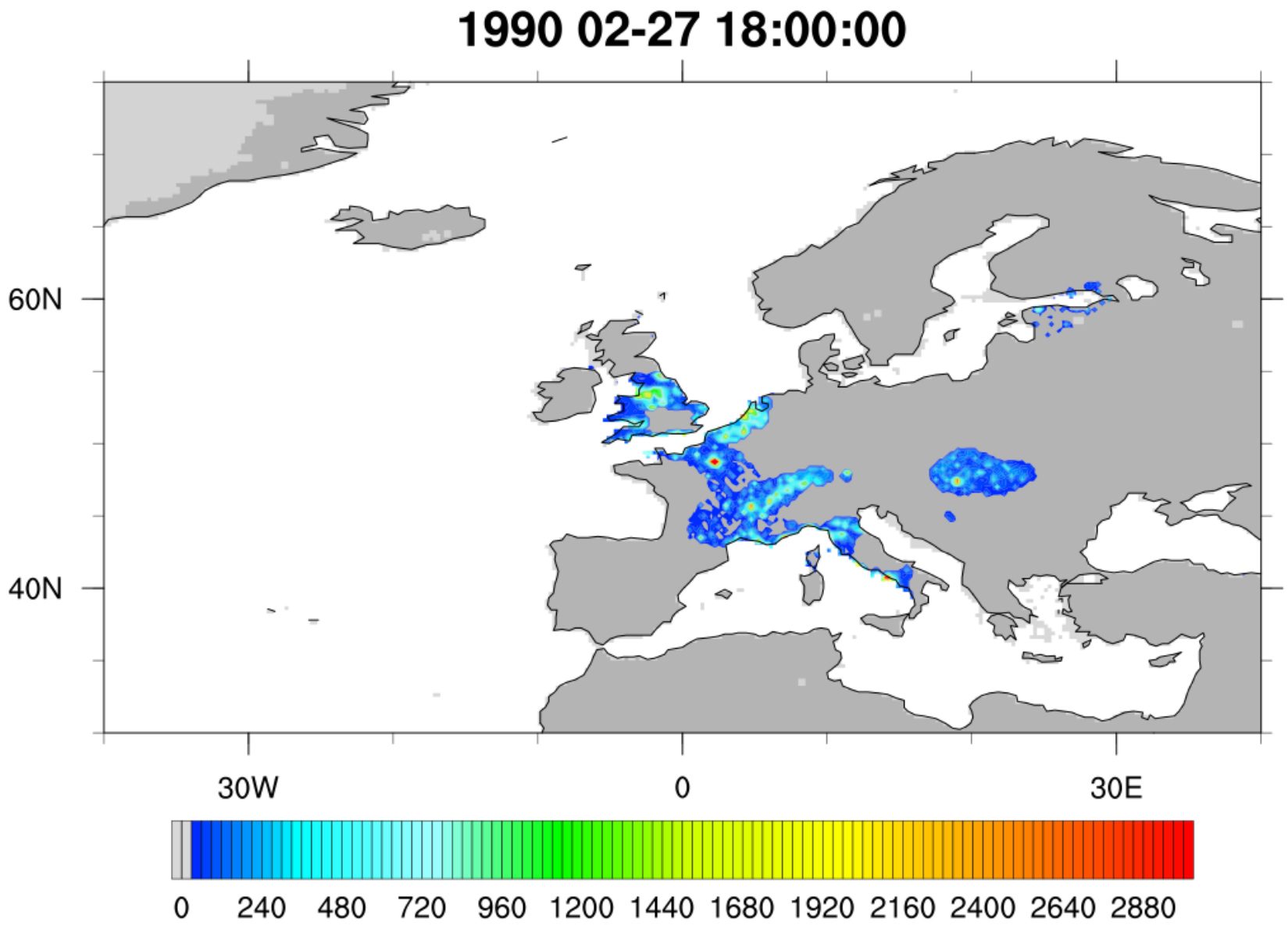
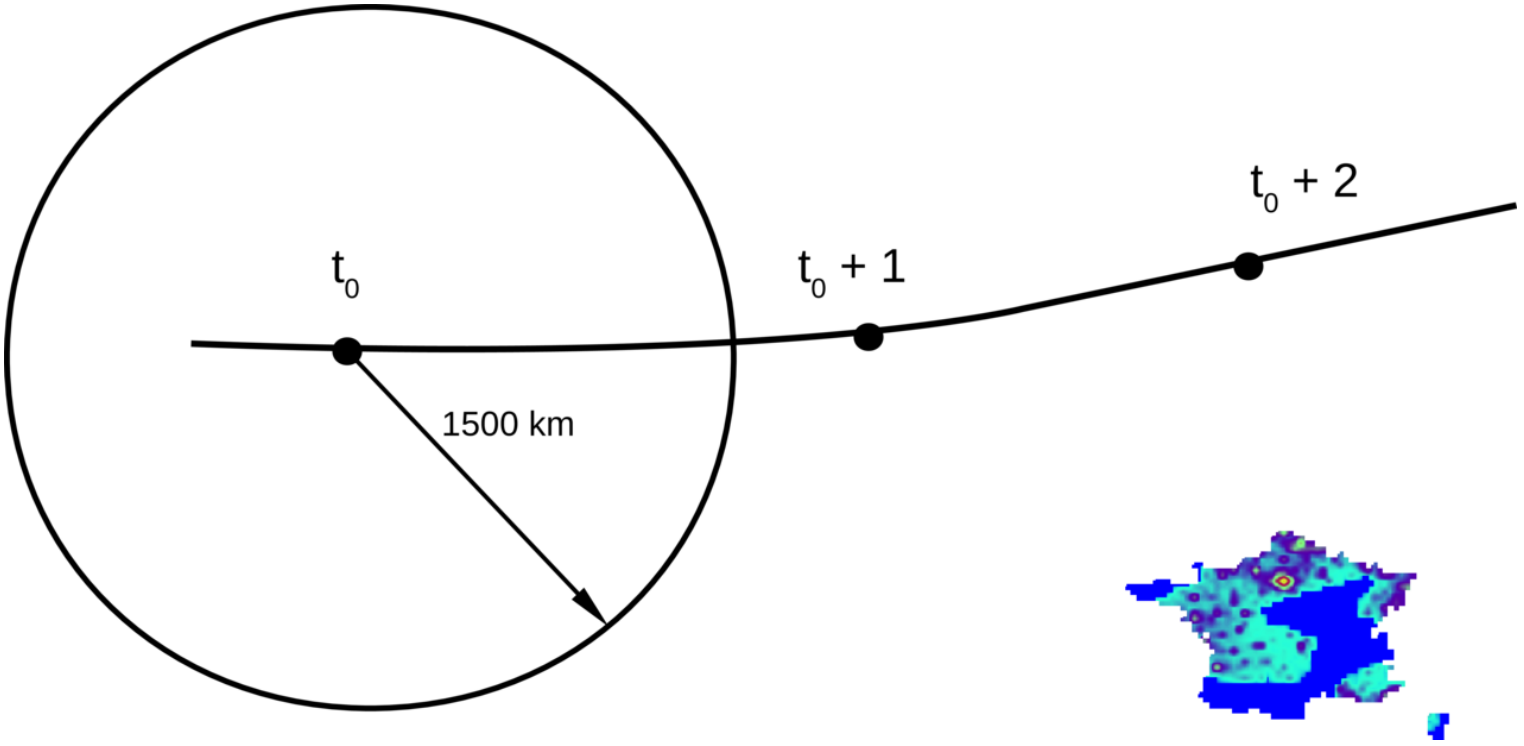


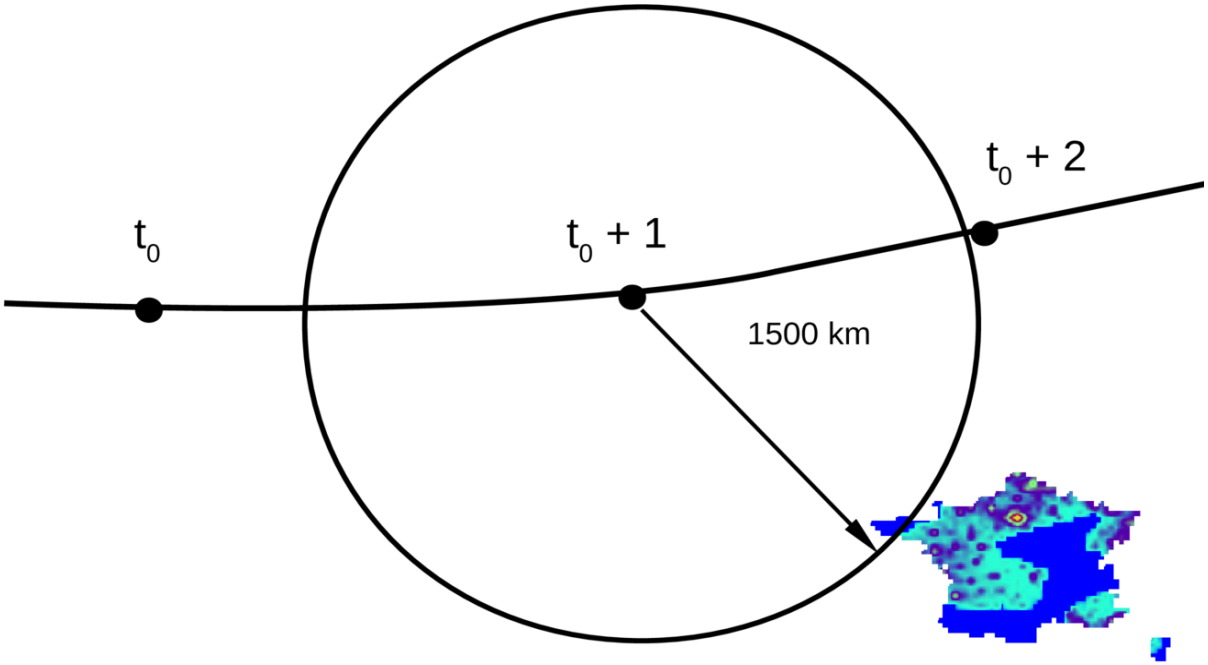
Example 3h LI Vivivan

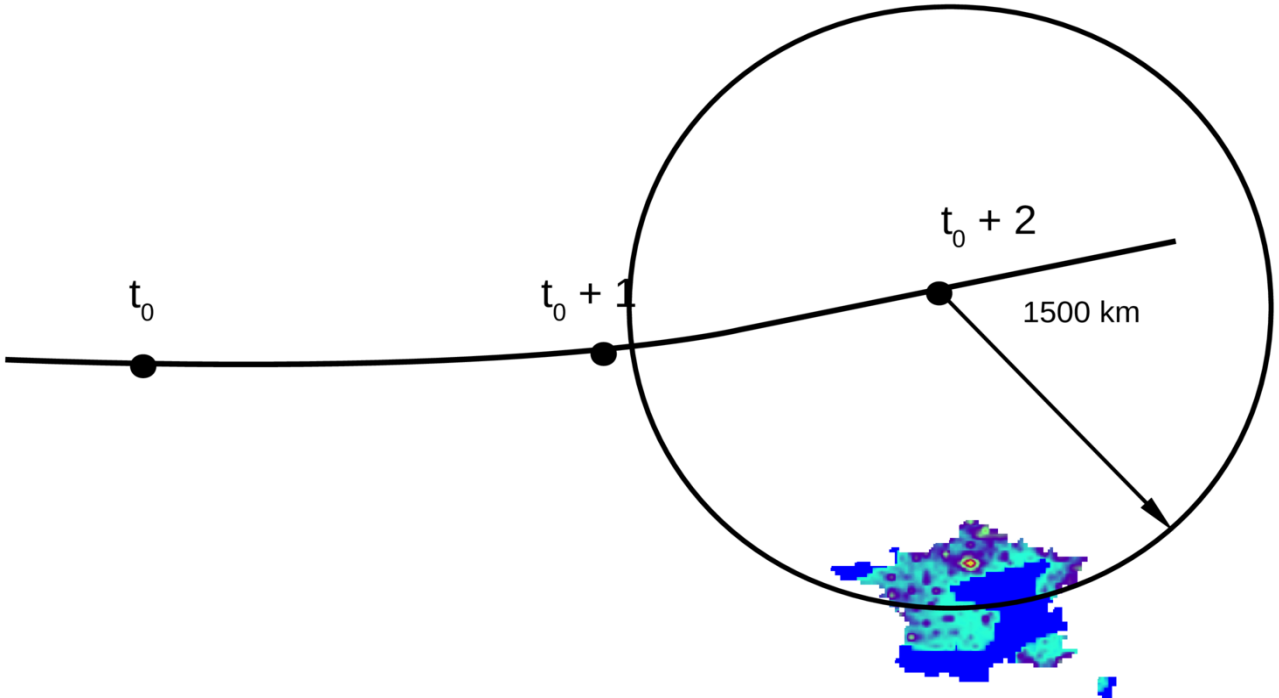


Trajectories

- **Li highest values for each country**
  - example: France - #1LI (daily maximum)
    - t0 =1990-02-27 (0h 3h 6h 9h 12h 15h 18h 21h) ;
    - li=264400

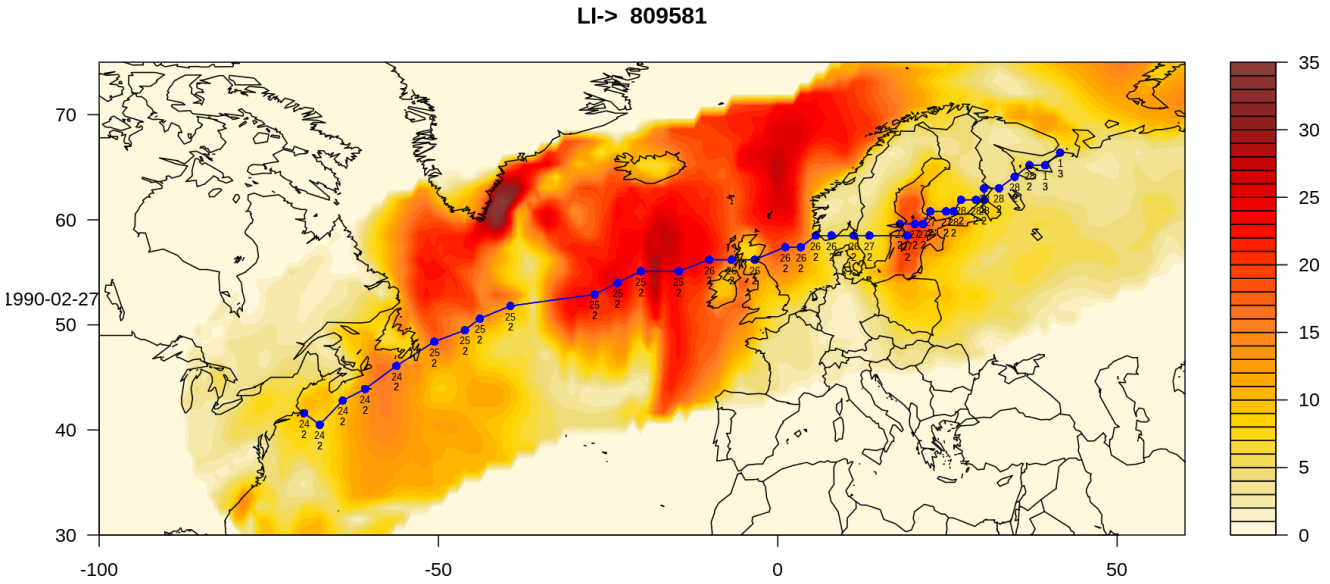


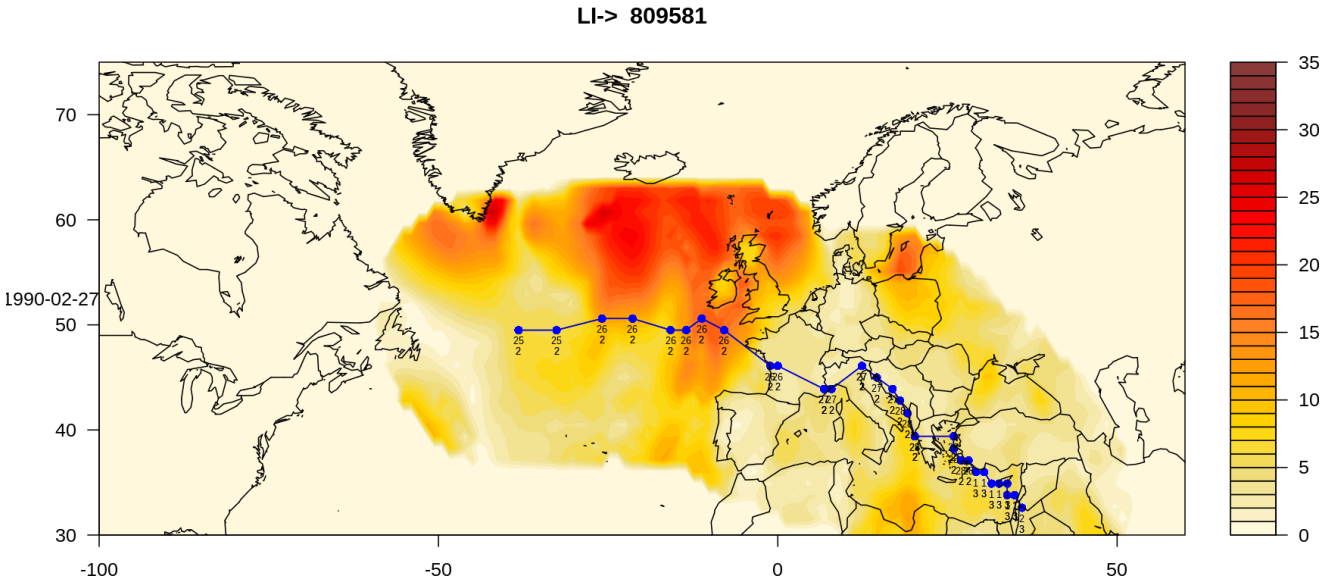




$$\sum^{A} LI[t_0 + 1 : t_0 + 2] \quad (3)$$

Footprint France





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

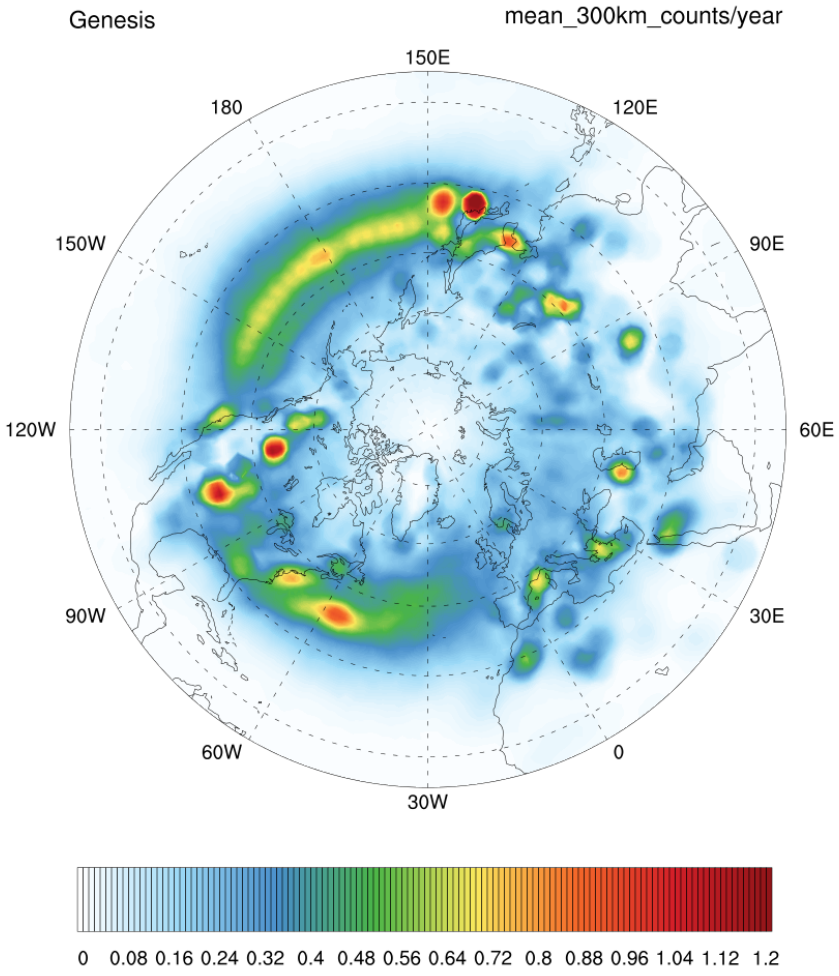
- Computing trajectories using as reference the "Meteorological Index" that doesn't take into account the Population.
  - Dinamical composites for the trajectories of the 100 highest LI for the EMASK
    - for LI intense but conscripted to a small region
    - for LI moderate but over a large region
  - Cluster of trajectories for each region using the 100 highest LI dates.
  - Temporal clustering of storms (winter 1990).

Thank you

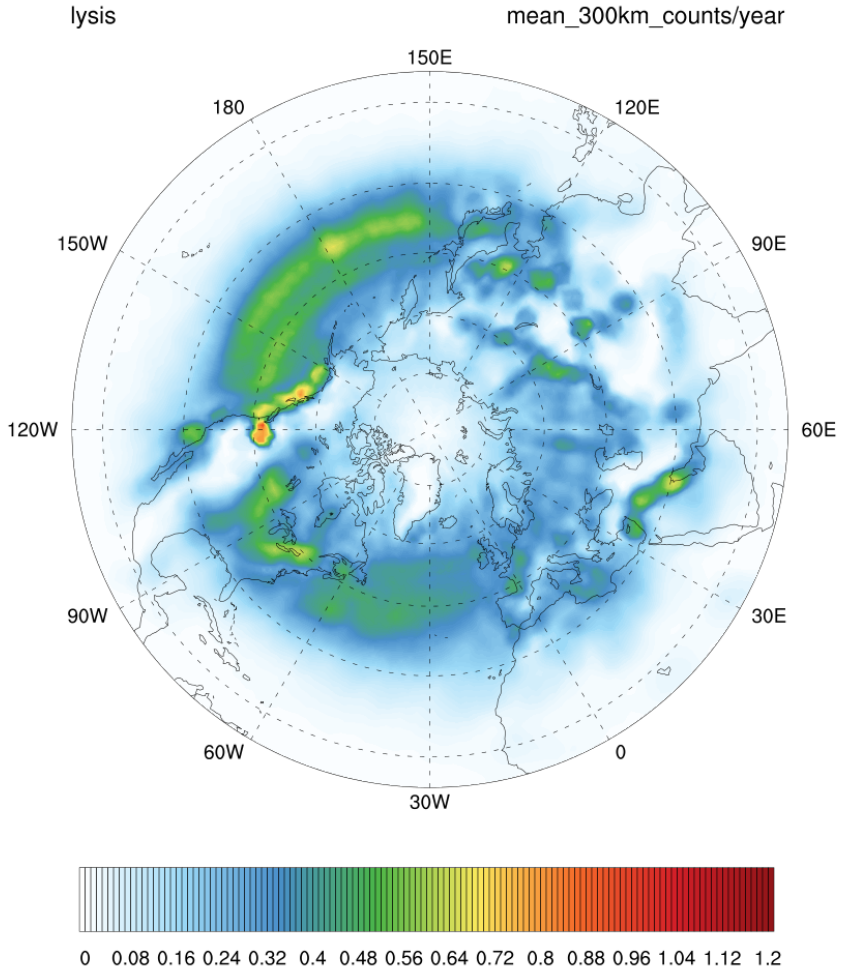
extra

Genesis Lysis

Density genesis (mean over 300km)



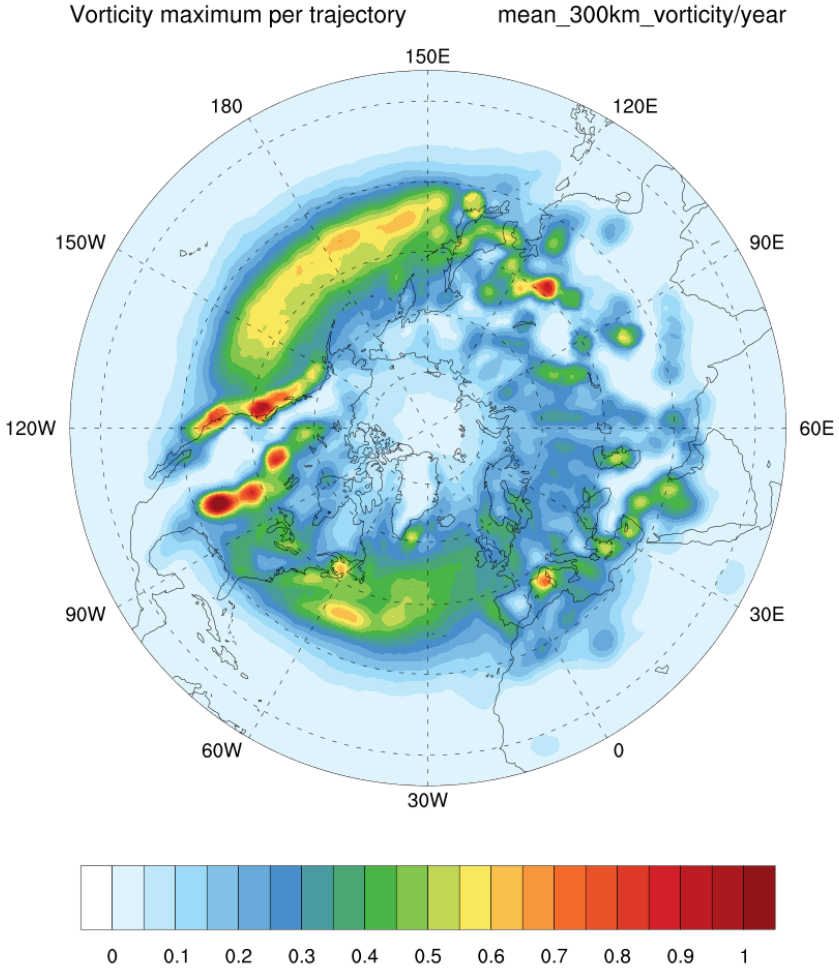
Density Lysis (mean over 300km)



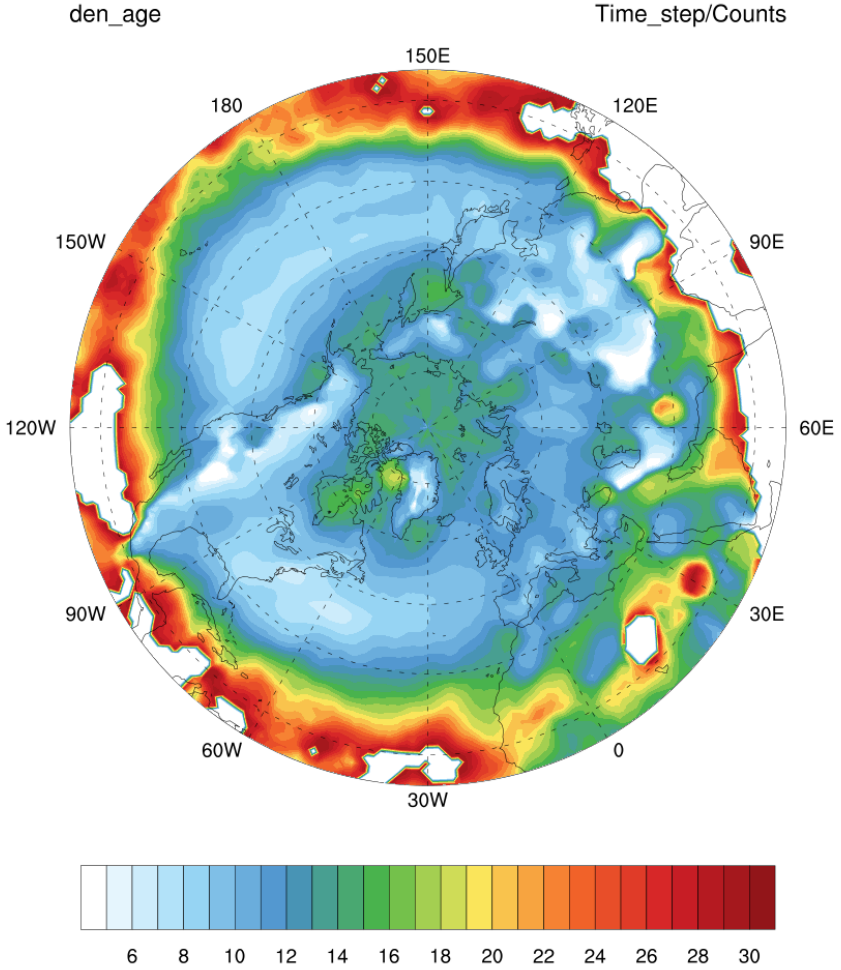
$$Density(i,j) = mean(X_{ij\pm R}) \quad (4)$$

Maximum vorticity location/ Mean time step per grid point

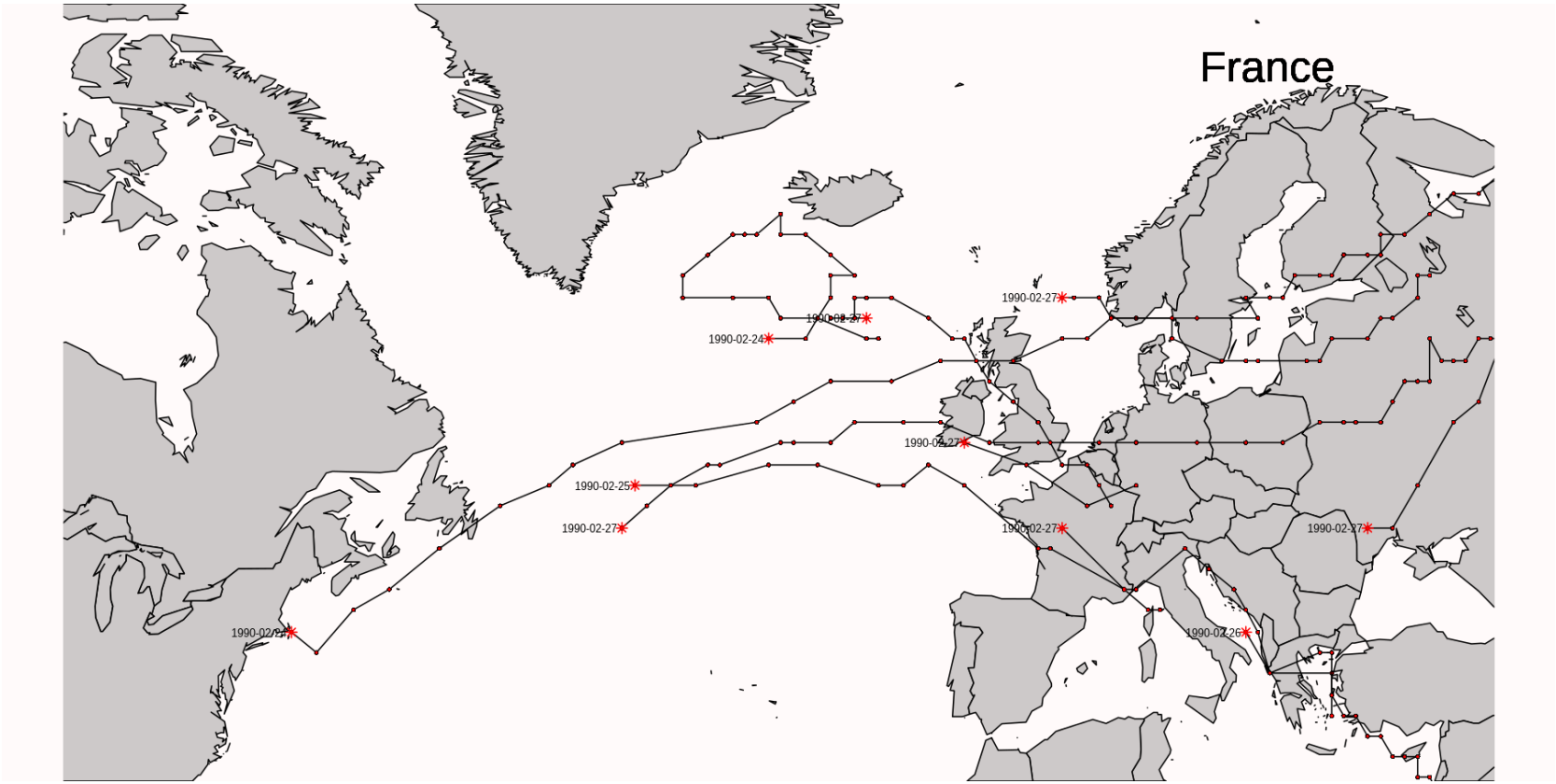
Maximum vorticity LOCATION - Lon/lat frequency of vorticity maximums per trajectory



Age- Mean time steps per lon/lat point



France


France
1990-02-27
1990-02-24
1990-02-27
1990-02-25
1990-02-27
1990-02-27
1990-02-27
1990-02-26