

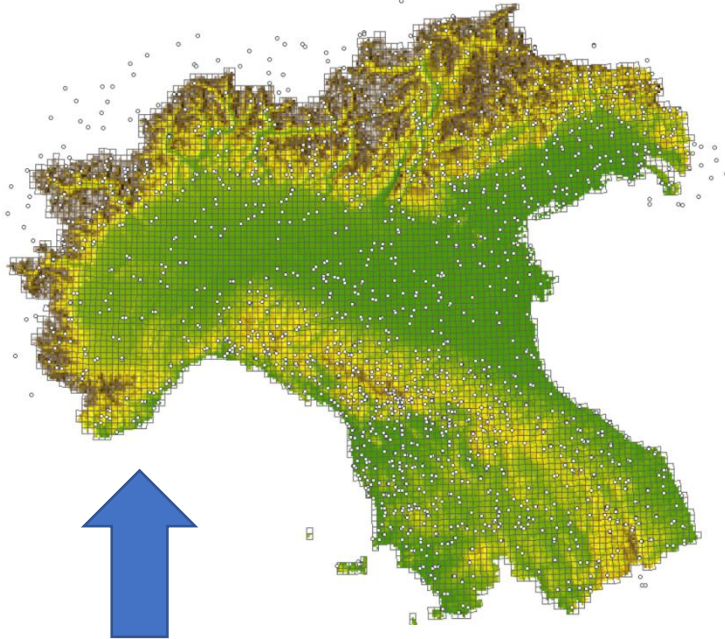
Classificazione degli eventi di precipitazione estrema sul centro-nord Italia e precursori a grande scala (project T1)

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- 2) Johannes Gutenberg-Universität Mainz
- 3) Arpae regional weather service Emilia-Romagna, Bologna

Creation of a catalogue of extreme precipitation events

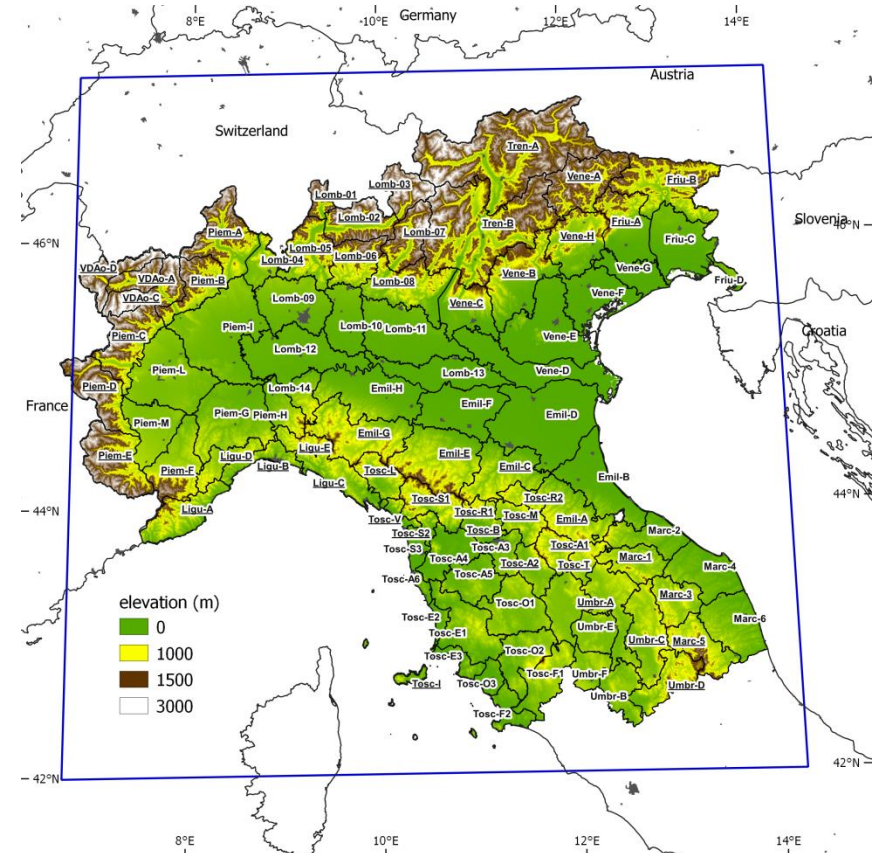
ArCis dataset gridded obs 1961-2015 (Pavan et al. 2018)



11 regional observation networks

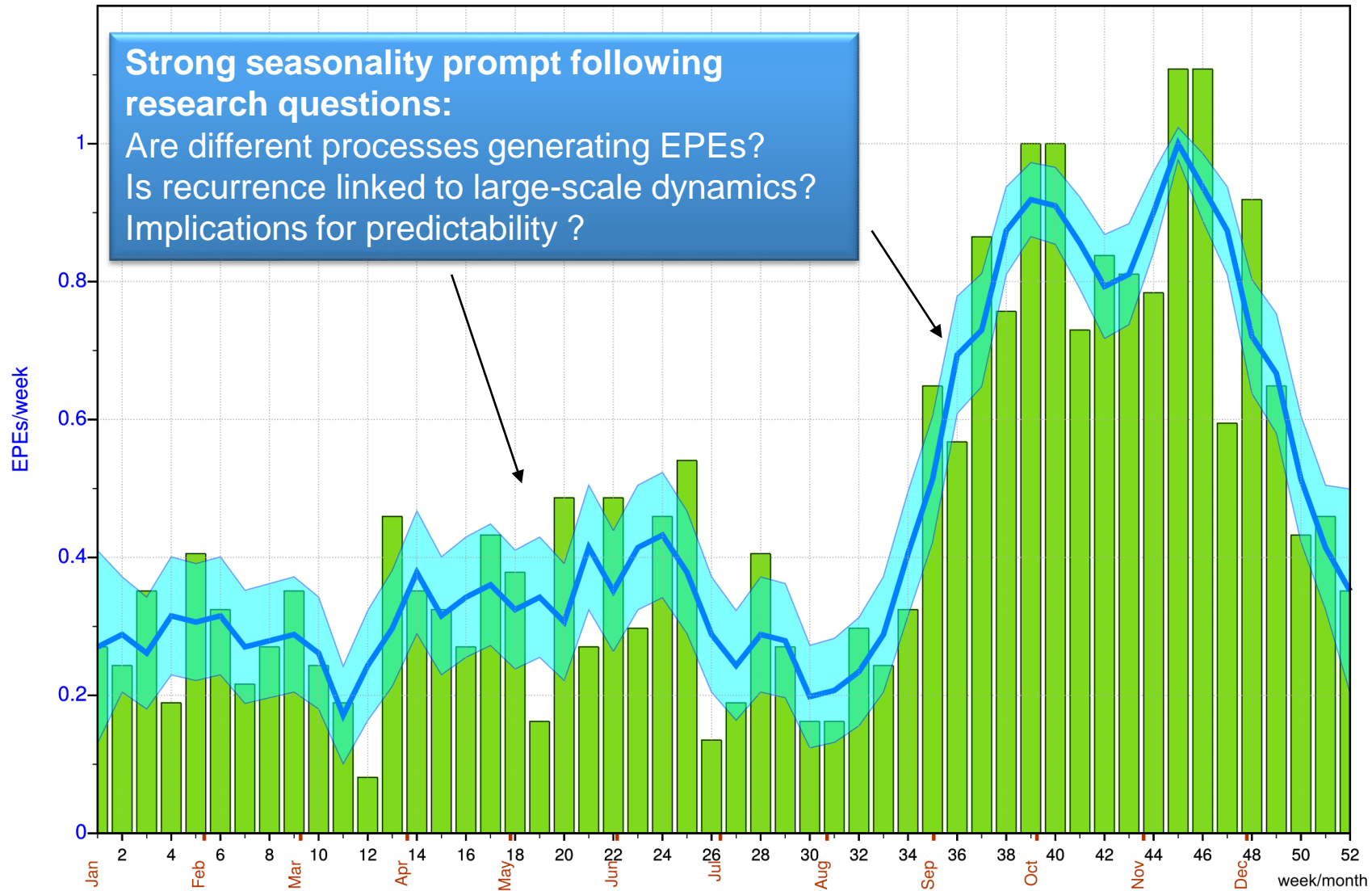


Daily precipitation values averaged over Italian civil protection warning areas



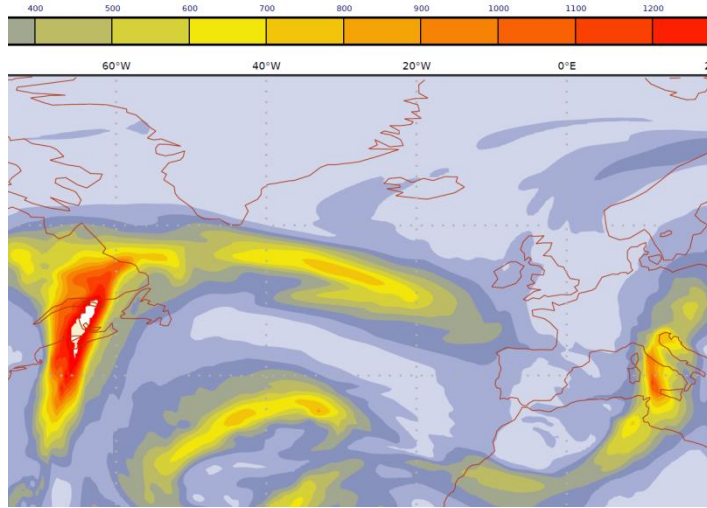
Extreme precipitation events (EPE) are defined as days with average rainfall, at least on one of the areas, exceeding 99° of climate distribution. We have found 887 days with EPE in the period 1979-2015.

EPE distribution during the year

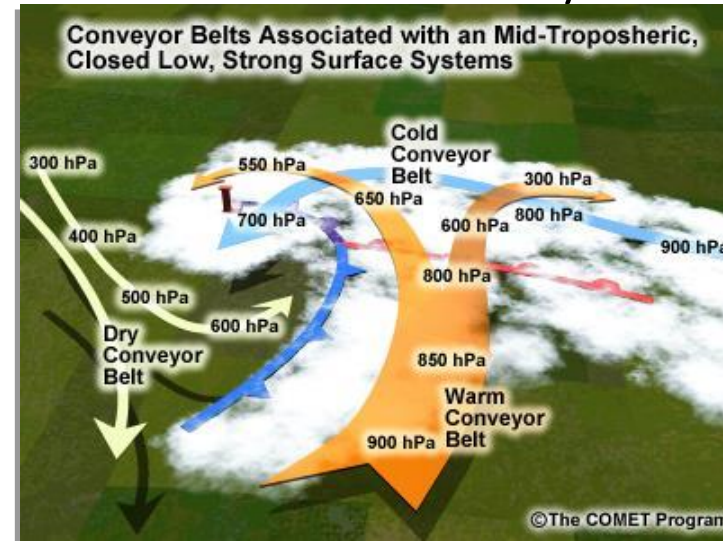


Atmospheric processes producing EPEs

Strong water vapour flux



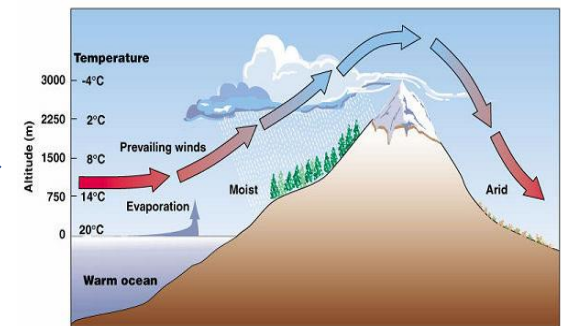
Fronts and Warm Conveyor Belt



Moist Convection



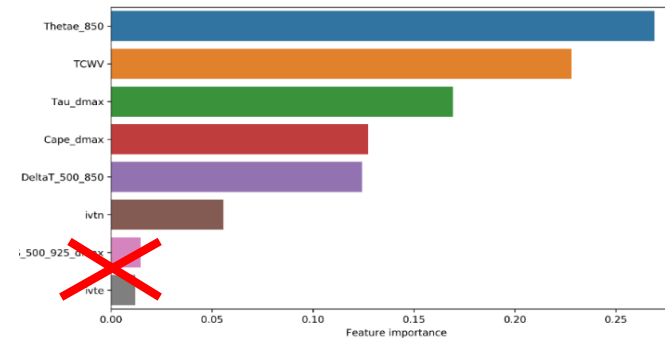
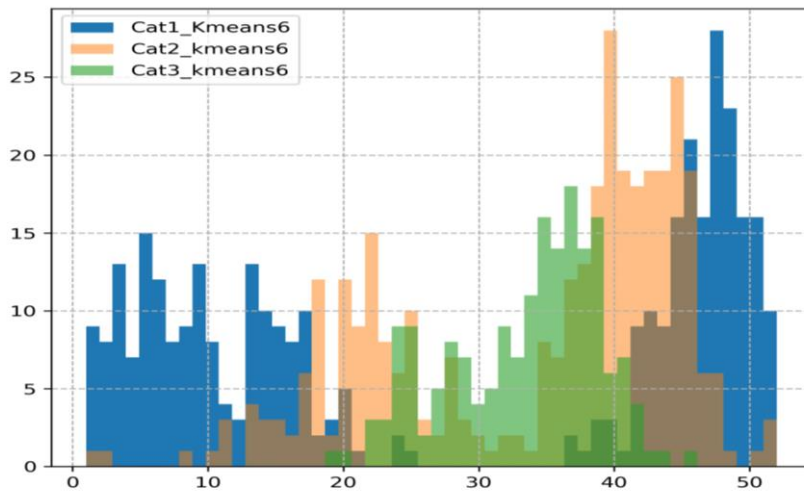
+ Orographic enhancement



Classifying EPEs using a machine learning approach

Unsupervised **k-means** clustering and **Random Forest** algorithm has been used to classify EPEs in three categories. Best configuration is based on 6 upper-level predictors derived from ERA-Interim reanalyses (1979-2015) and averaged over Central and N-Italy.

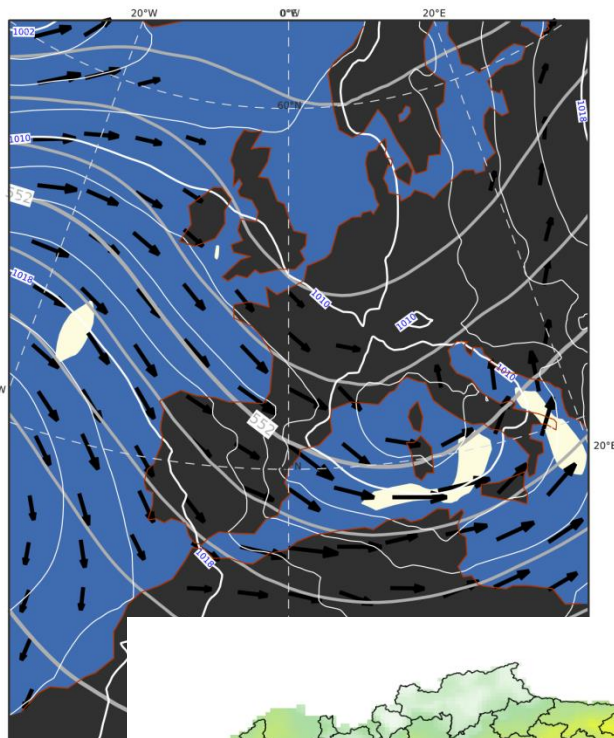
Variable	Description	Units
τ_{dmax}	Daily maximum of convective adjustment time scale	h
$CAPE_{dmax}$	Daily maximum of CAPE	J kg ⁻¹
IVTe	Daily mean of zonal component of Integrated Water Vapour transport (surface up to 300 hPa)	kg m ⁻¹ s ⁻¹
IVTn	Daly mean of meridional component of Integrated Water Vapour transport (surface up to 300 hPa)	kg m ⁻¹ s ⁻¹
Θ_{e850}	Daily mean of equivalent potential temperature at 850 hPa	K
$\Delta\Theta_{e500-850_dmin}$	Daily minimum of delta Θ_e (500 – 850)hPa	K
TCWV	Daily mean of Total Column Water Vapour	kg m ⁻²
$BS_{500_925_dmax}$	Daily maximum of wind Bulk Shear between 500 - 925hPa	m s ⁻¹



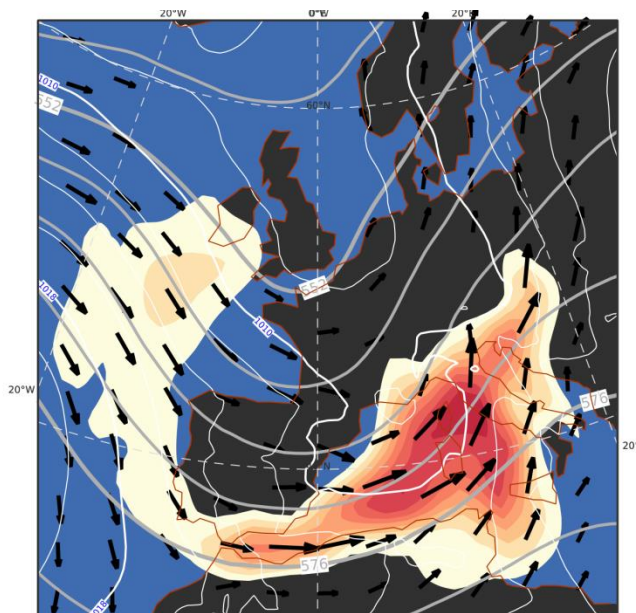
	Score	K-means 6 pred	STA (Tau, CAPE)
Silhouette		0.31	0.13

Synoptic (Z500, MSLP, IVT) and precip. composites

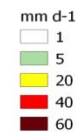
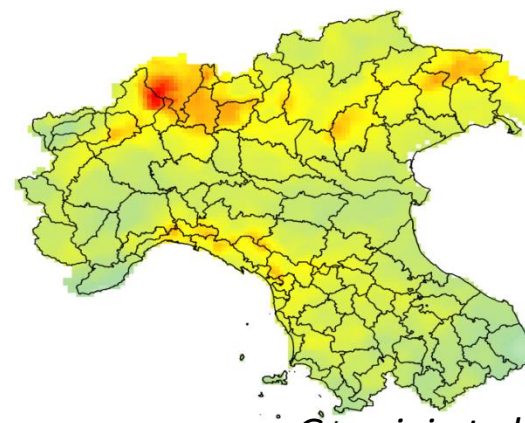
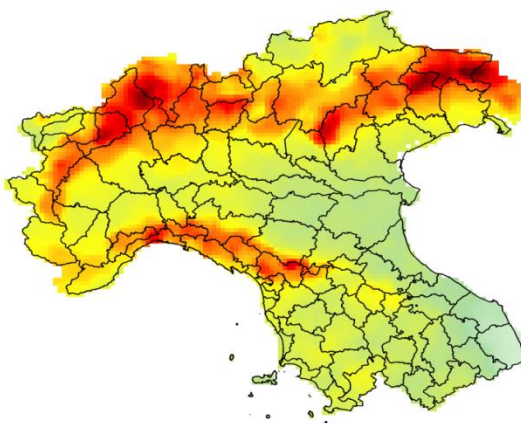
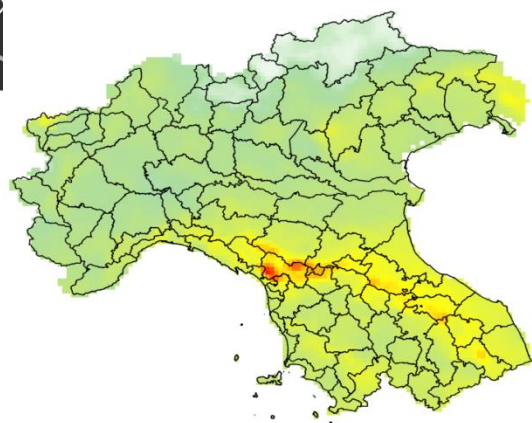
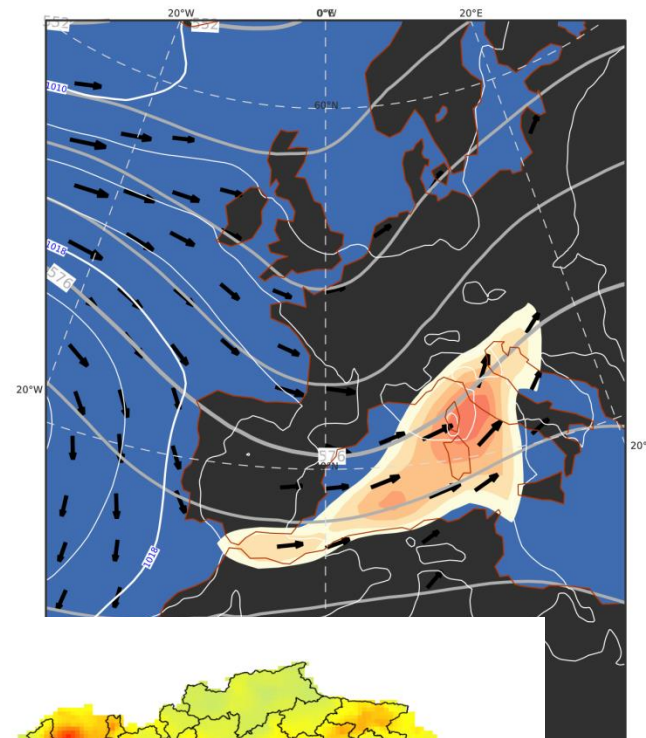
Cat1: stratiform/orographic precipitation



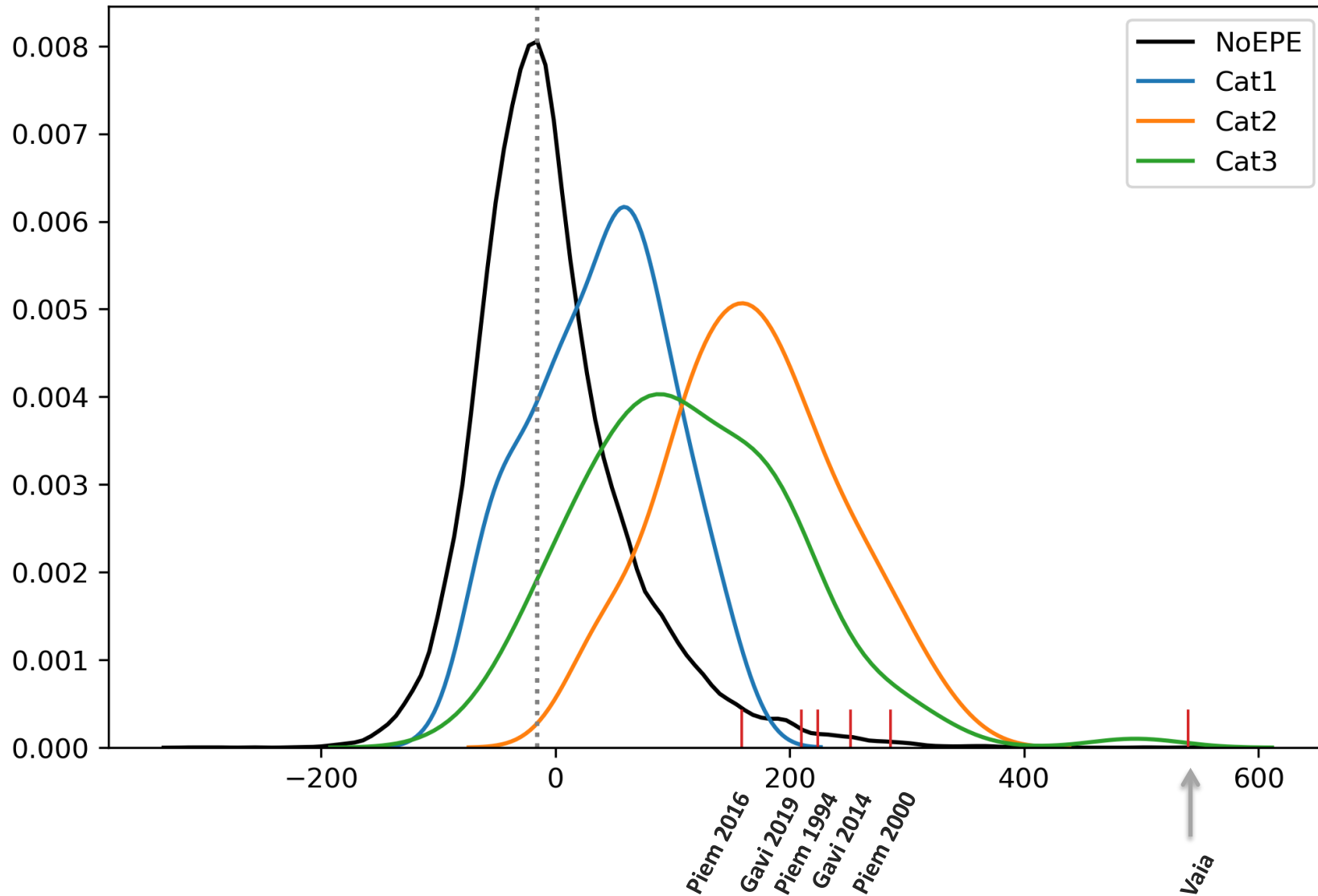
Cat2: frontal prec./neutral stability/emb conv



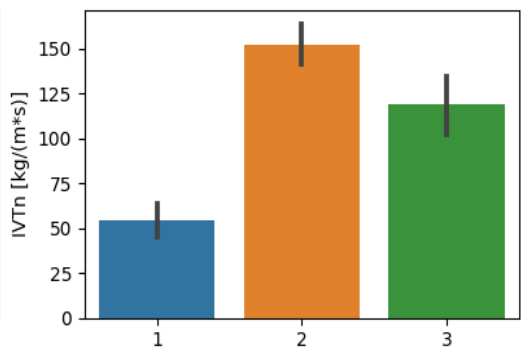
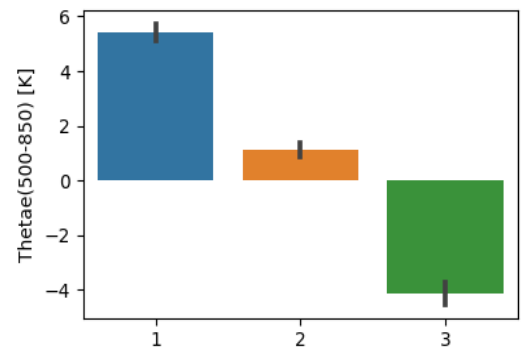
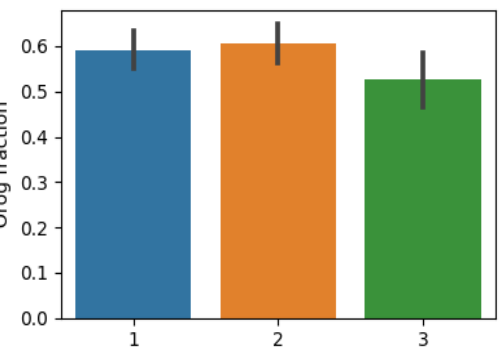
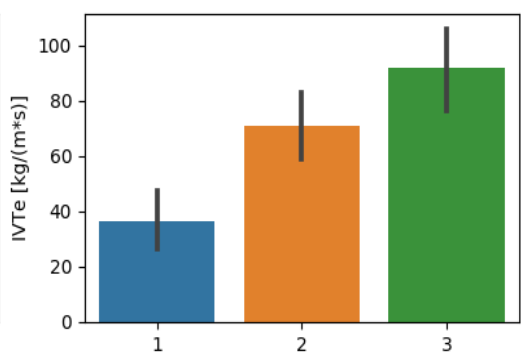
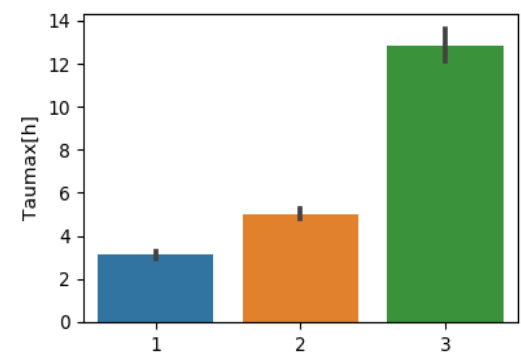
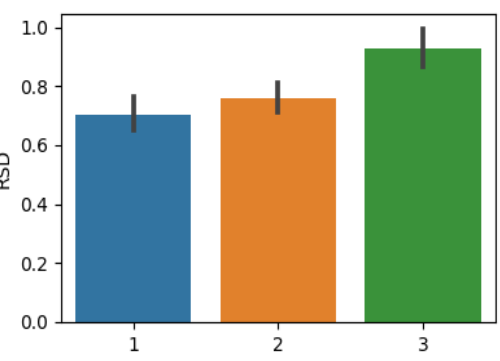
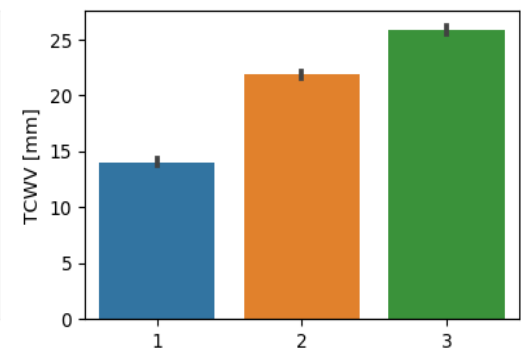
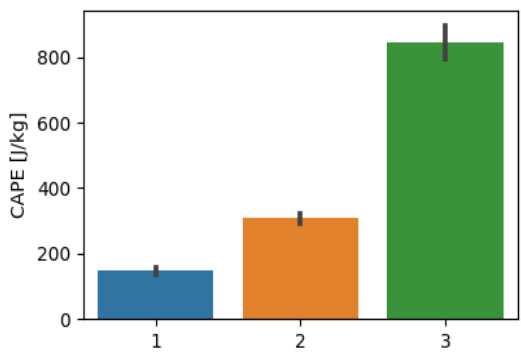
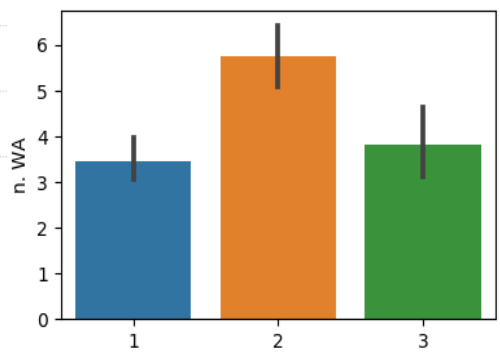
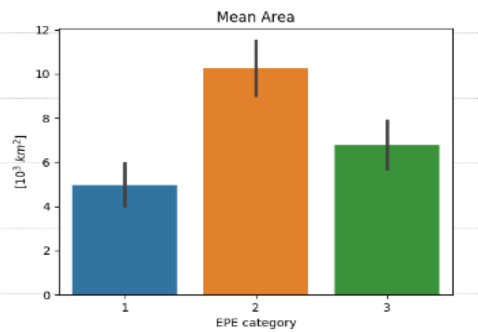
Cat3: high instability/non eq. convection



IVTn distribution in different categories

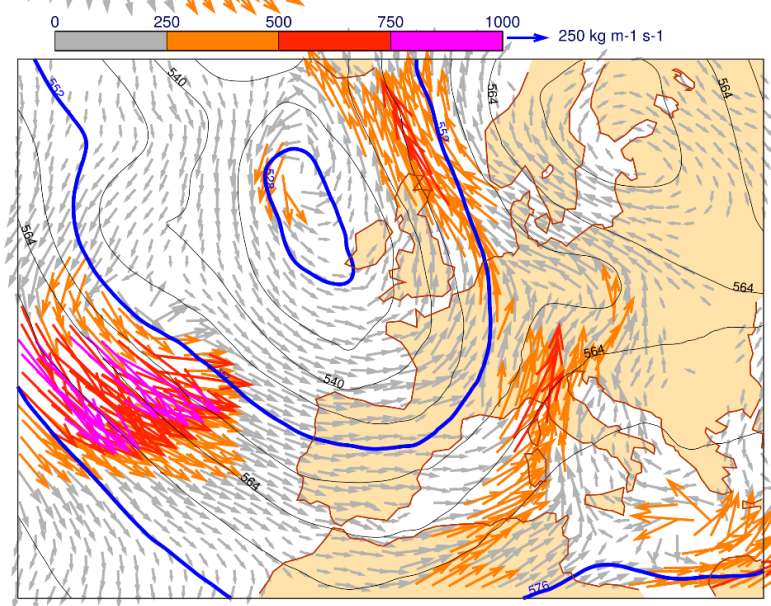
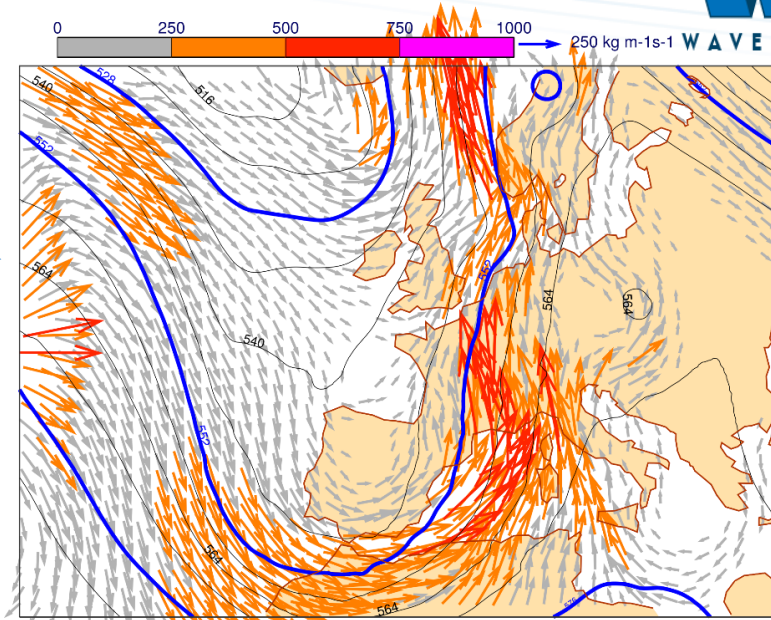
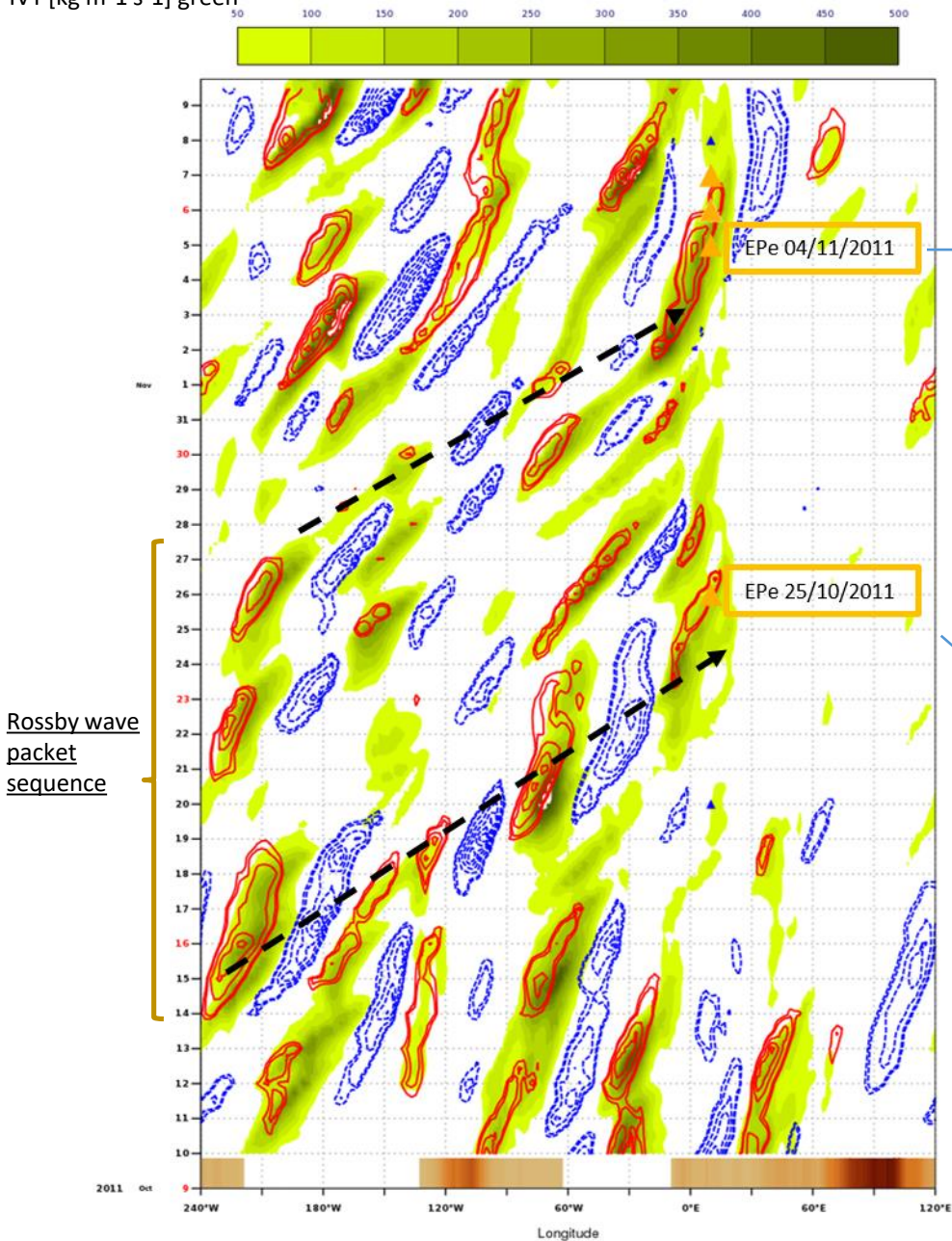


Characteristics of different categories



Case study example

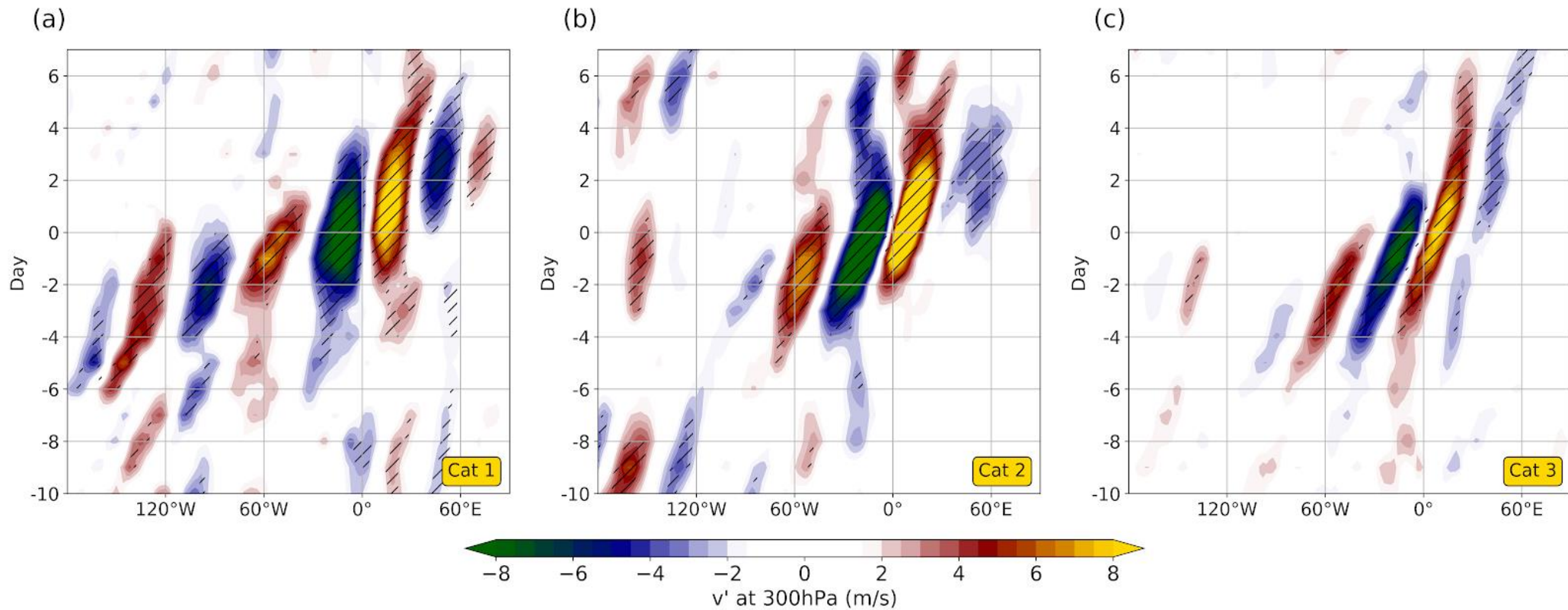
Hovmöeller diagram
Wind v-component 250hPa (red/blue cont)
IVT [kg m⁻¹ s⁻¹] green



Geopotential height @500hPa (Z) and IVT

Rossby wave packet sequence

Hovmöller composites: V' @300 hPa

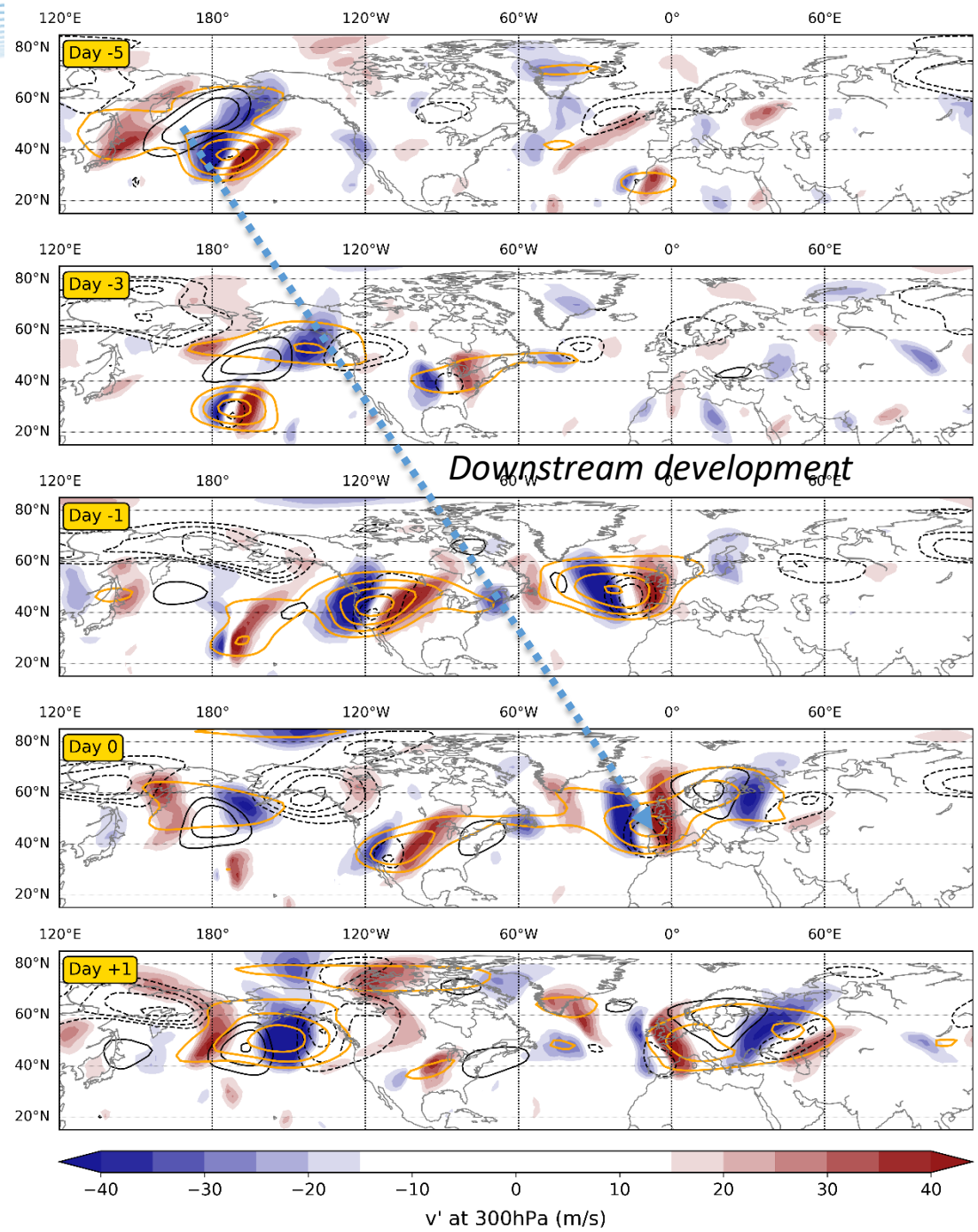


*hatches indicate statistical significance
at the 0.10 level, based on a Monte
Carlo approach*

4/11/1994 - Cat 2 (SI=0.49)

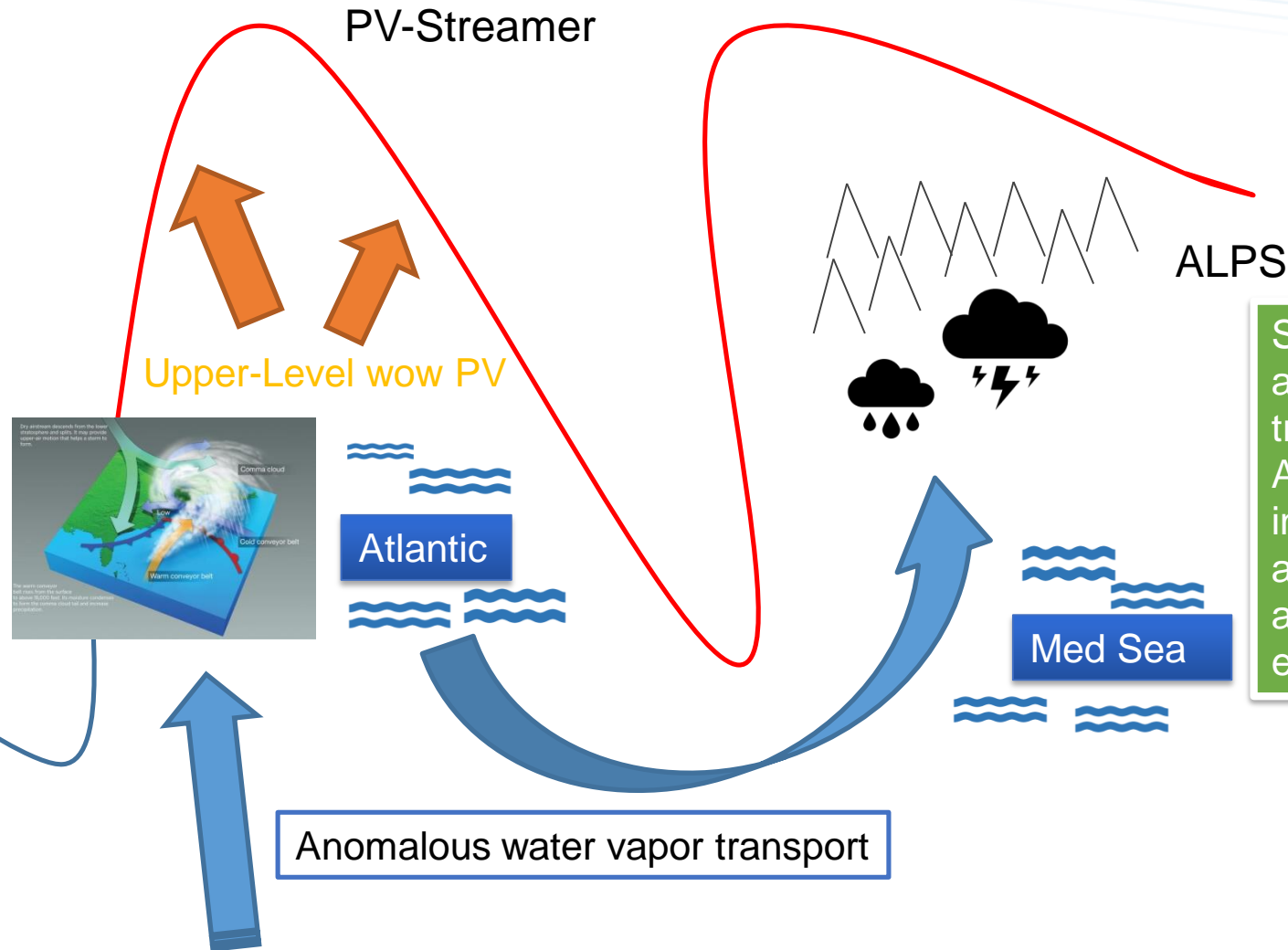
1994 Piedmont flood event....

- v' at 300hPa (color)
- RWP amplitude at 300hPa (orange)
- Z @ 500hPa (black contours)
solid/+ anomaly and dashed/-

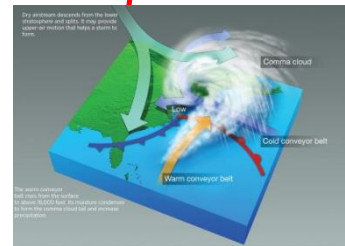


....the event started in the Pacific Ocean

Elaboration of G. Fragkoulidis



Schema linking anomalous water vapor transport in the eastern Atlantic, diabatically induced ridge building and anomalous amplification of Cat2 events



Summary

What we have found so far:

- A large dataset of EPEs (1979-2015, **887 events**)
- An objective method, based on *machine learning techniques*, to categorize EPE
- Well separated categories representing different physical processes
- Category 2 produces the largest effect due to a large-scale/convection synergy
- EPEs are usually associated with Rossby wave packets which mobilize water vapor plumes

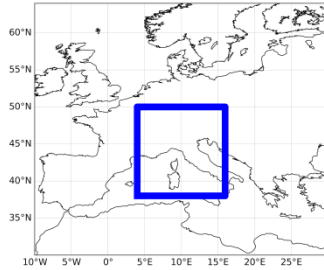
Part I

Study in progress:

- The peculiar phasing and amplification of Category 2 events
- The role of antecedent development (east Atlantic conditions)
- Seasonality and trends of EPEs and dynamical precursors
- A quantitative measure of large-scale vs mesoscale contribution to predictability
- A process based predictability index to complement NWP direct model output

Part II and III

Relation between RWP amplitude (E) and EPE



Regression between E averaged over the blue box and binned in 10 equally sizes classes and frequency of heavy precip (90° of daily accumulation, black dots) and EPEs (colored dots)

