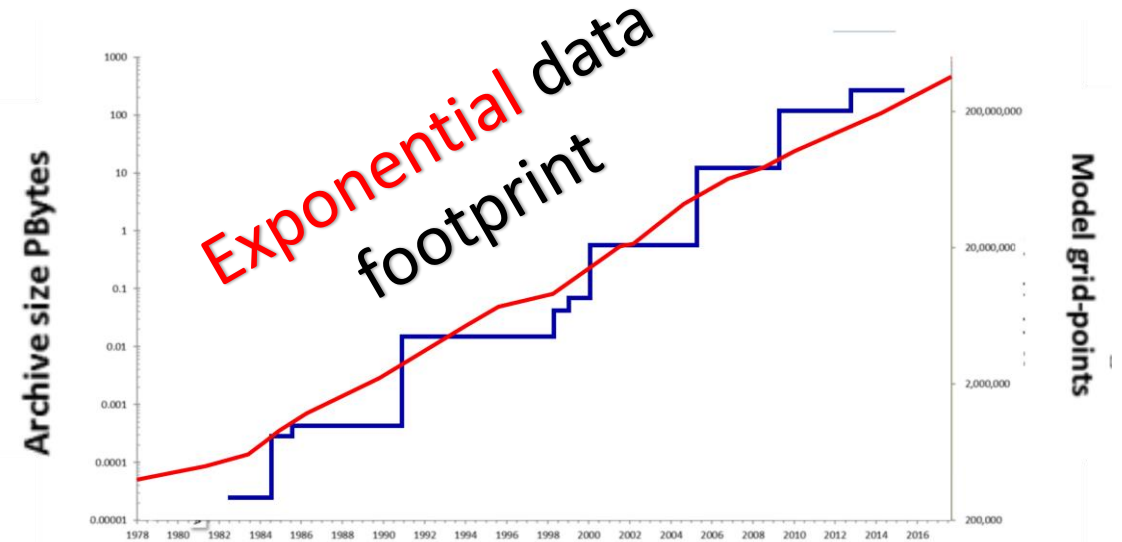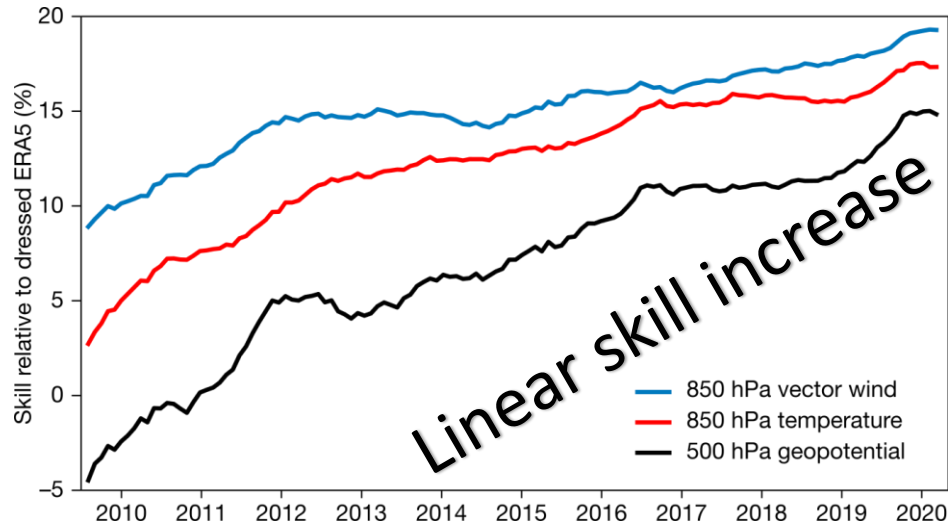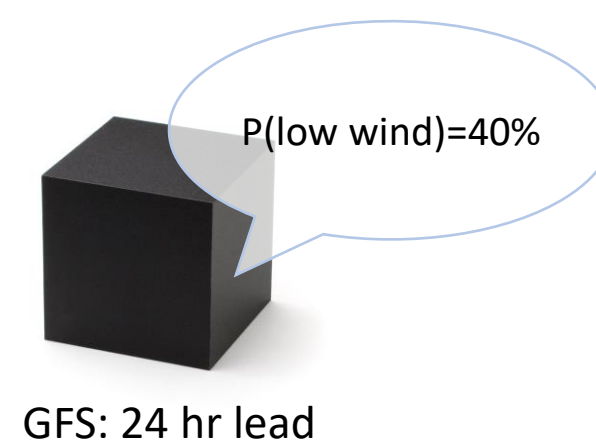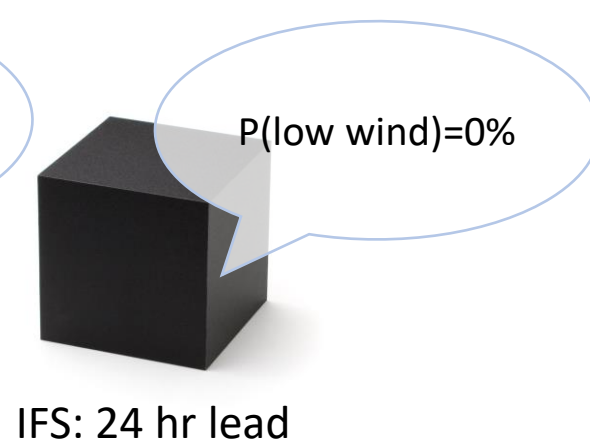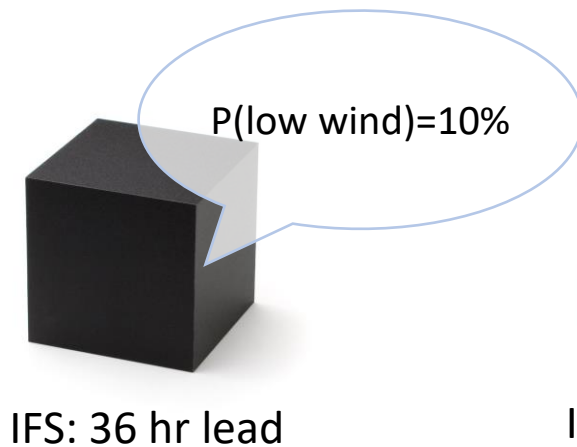# Doing more with what we have

Operationalising precursor analysis to add narrative to forecasts

- **Josh Dorrington** and Christian Grams (KIT)

- Federico Grazzini (LMU)

- Laura Ferranti, Linus Magnusson, Frédéric Vitart (ECMWF)

NWP is getting **better**... but also more **complicated**

Linear skill increase

Exponential data footprint

Forecasts are becoming (already are?) a **black box**: How can we analyse them **critically**?

P(low wind)=10%

P(low wind)=0%

P(low wind)=40%

IFS: 36 hr lead

IFS: 24 hr lead

GFS: 24 hr lead

Every weather event has a story

- Those stories contain useful information!

Value

Value

Precursor analysis

Forecasts

Extreme flooding

Atmospheric river

Rossby wave packet

Extratropical transition
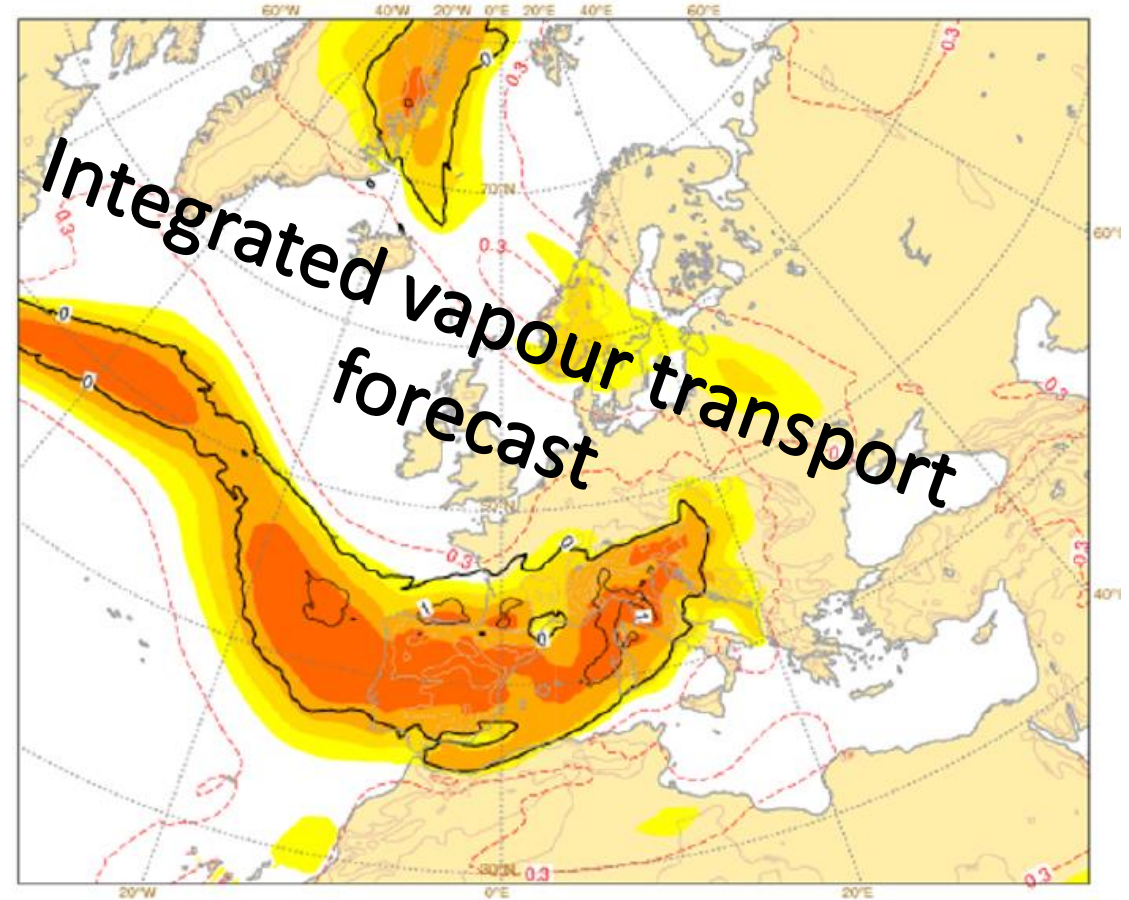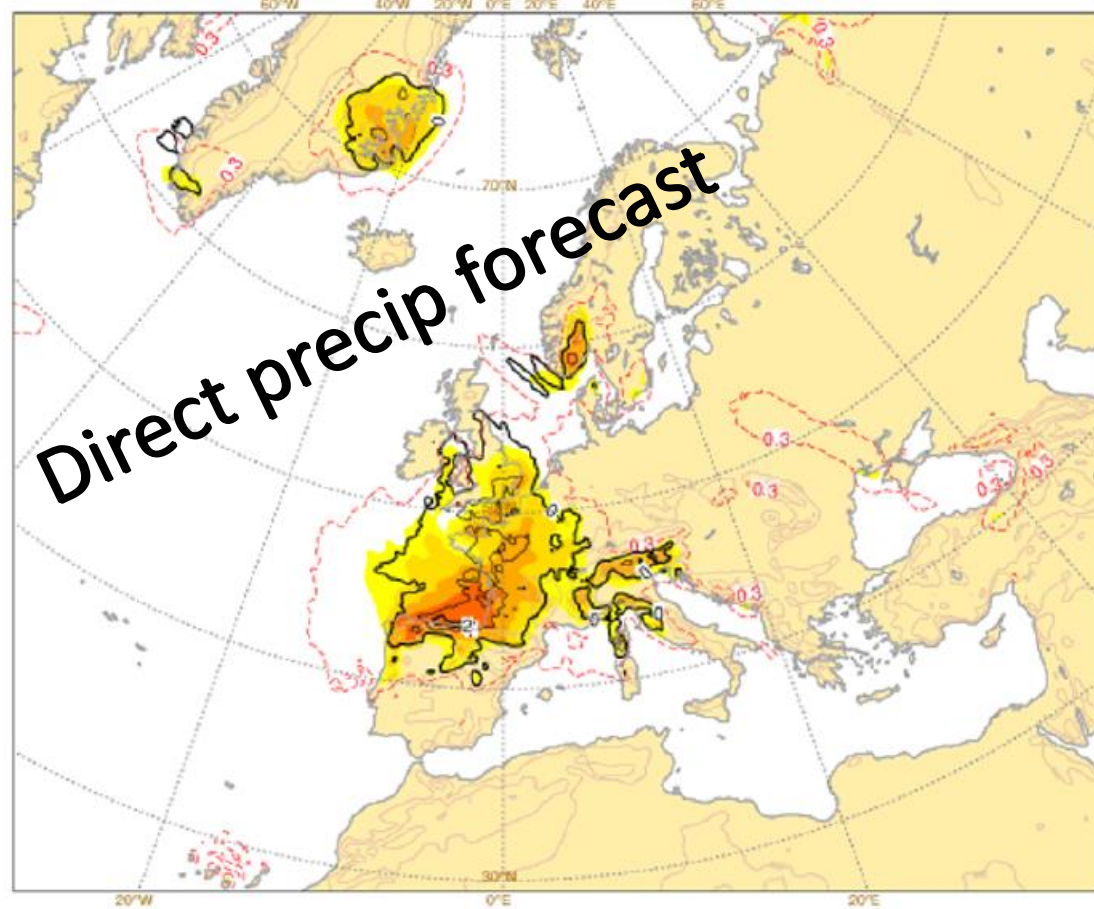
One possible precursor chain for North Italian floods
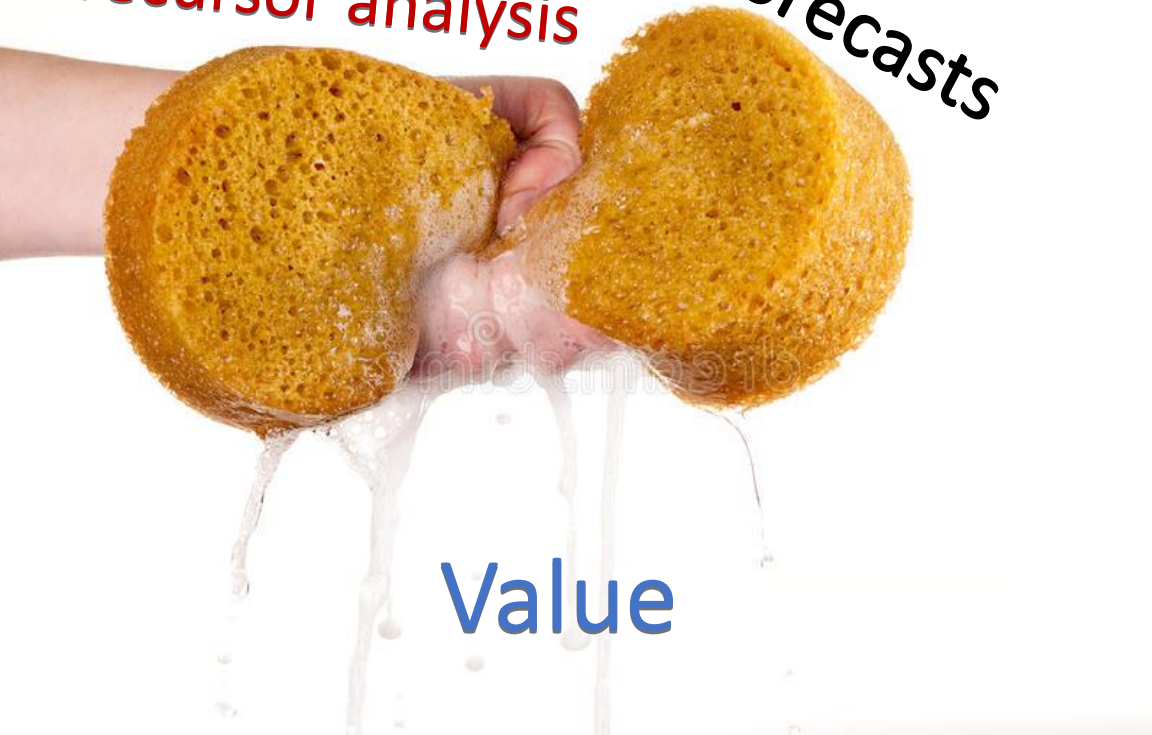
Every weather event has a **story**

- *Why* do ensemble members diverge?

- *Which* steps do we trust models to get right?

- Can we use **dynamical forecasts** to statistically model **downstream events**?

Extreme flooding

Atmospheric river

Rossby wave packet

Extratropical transition

One possible precursor chain for North Italian floods

Direct precip forecast

Integrated vapour transport forecast

Extreme Forecast Index, +96h

Storm Alex, 03.10.2020

500mm precip in 12 hr!

We are learning a lot about the **physics that drive extremes**

But how **accessible** is that knowledge?

Barriers to translating science into impacts

Academia

End-users

Scientific Paper

Large data volumes

Non-standard variables

Tools and data unavailable

Not generalisable

Usable product?

Our project: Operationalising precursors

- Develop an **open-source tool** for precursor identification

- Compile a **database** of observational and forecast precursors

- Focus on **scalar indices** to minimise data footprint

- Assess **predictive value** of precursors

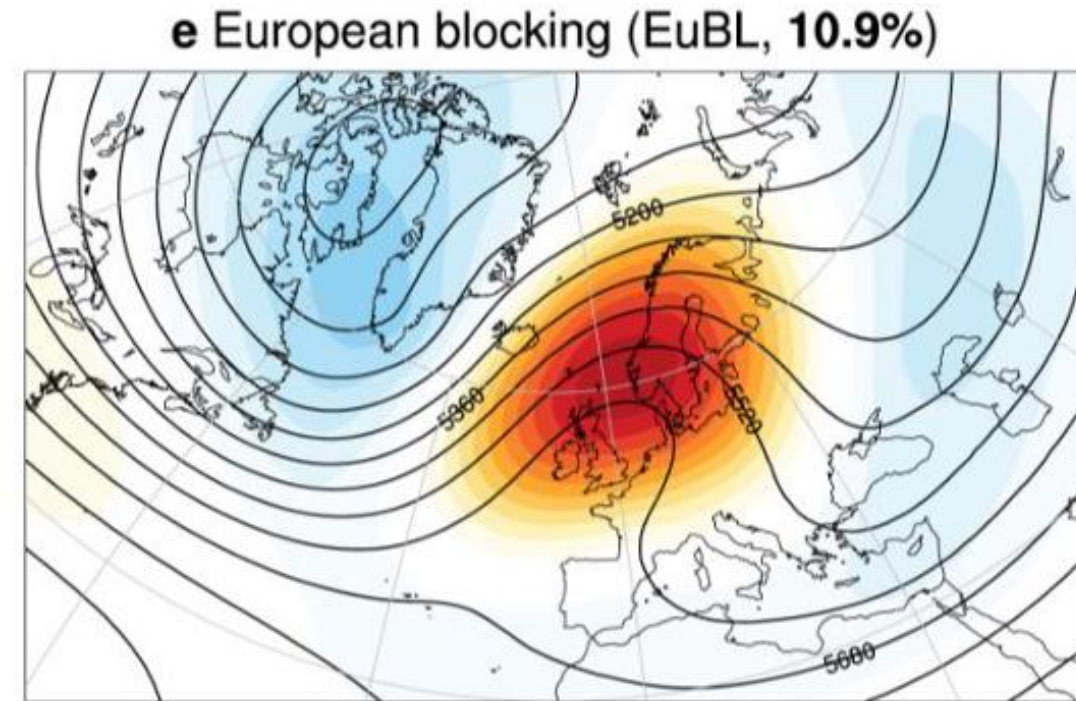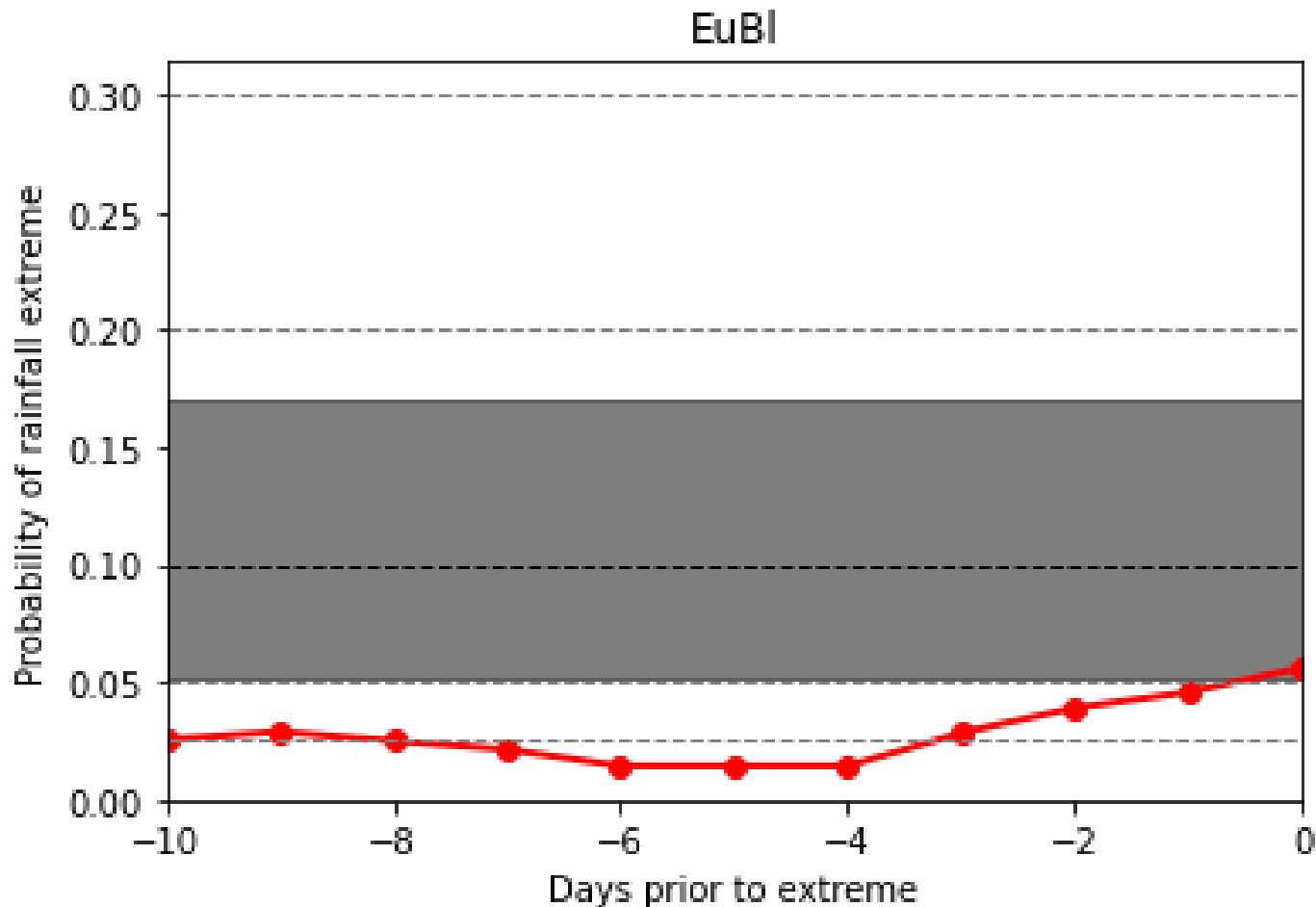- Produce a (prototype) **precursor product**

Example: Extreme Autumn rainfall in Northern Italy

- **Event definition:** Exceedance of 90th percentile seasonally detrended, 5 day average rainfall over Northern Italy, during SON
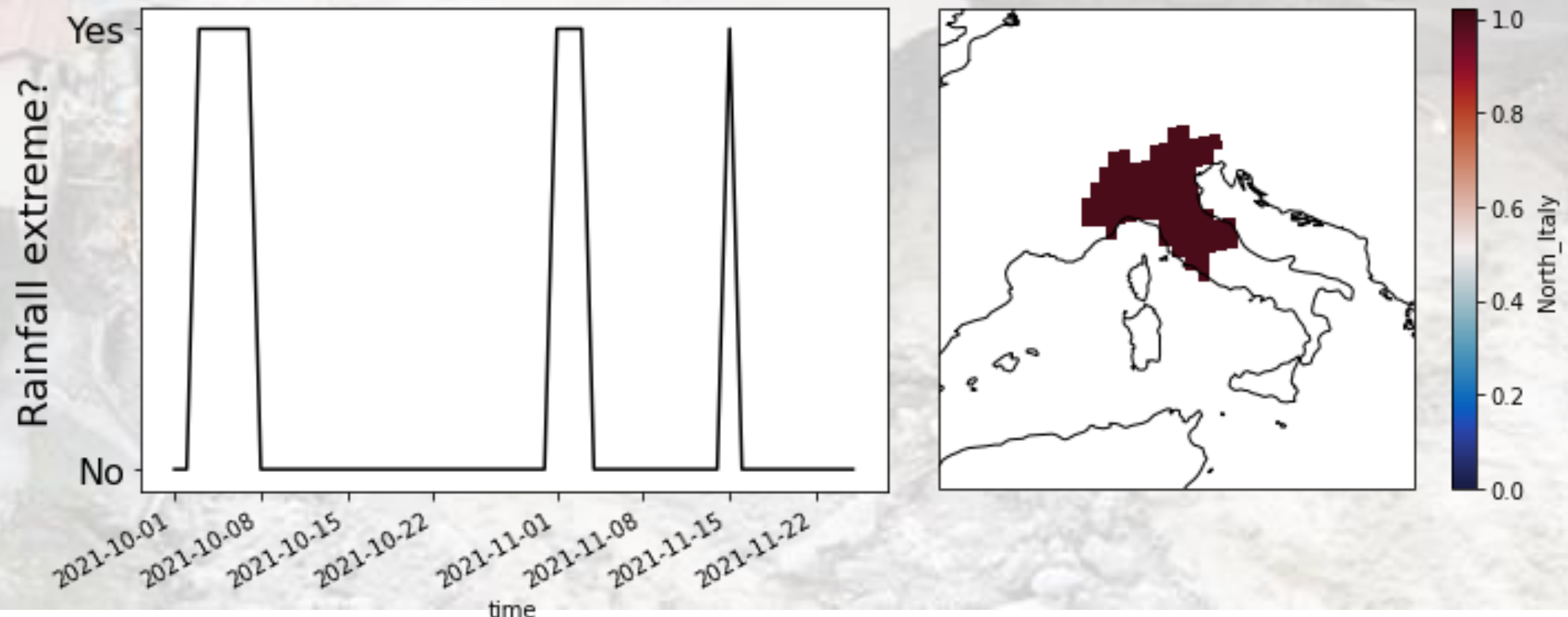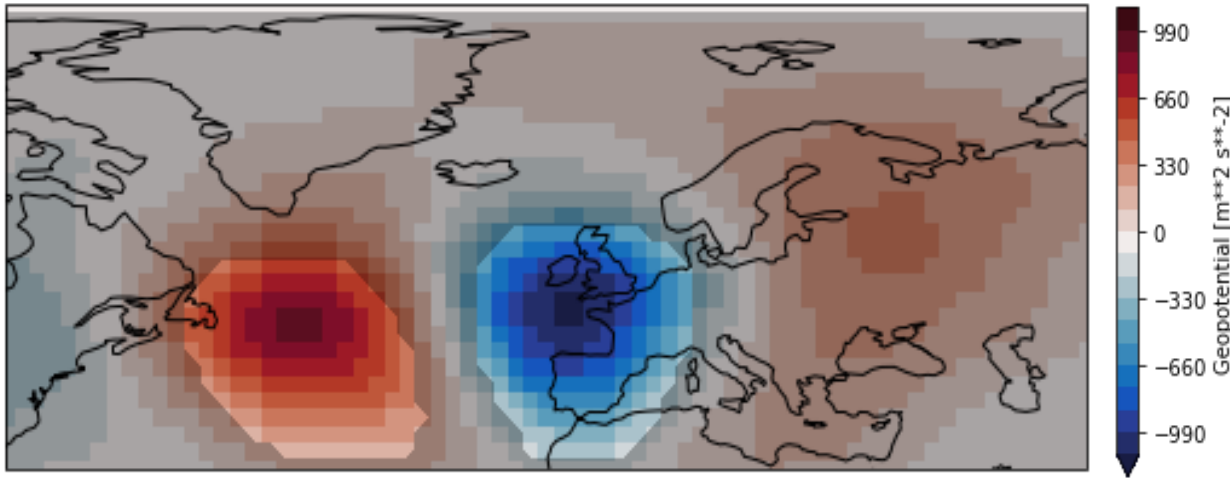
Regime impacts:

Extreme is >4x less likely 5 days after a European blocking event
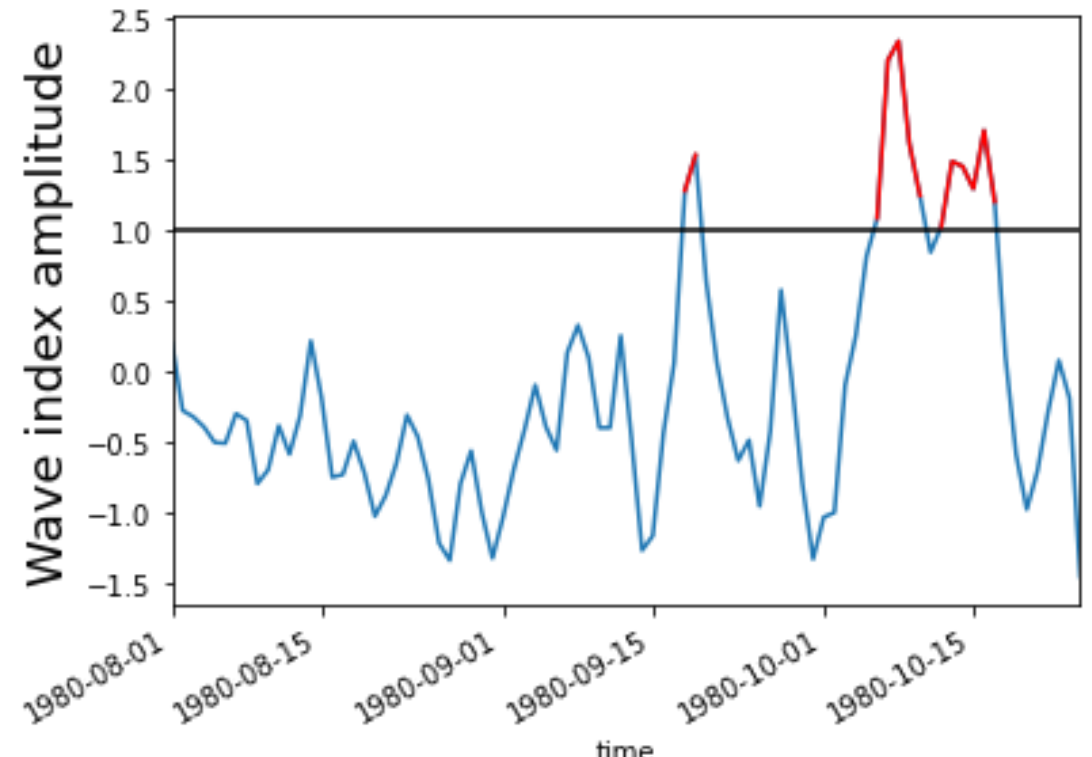

e European blocking (EuBL, **10.9%**)

Event-targeted indices:

We can automatically identify precursors for an extreme in field data:
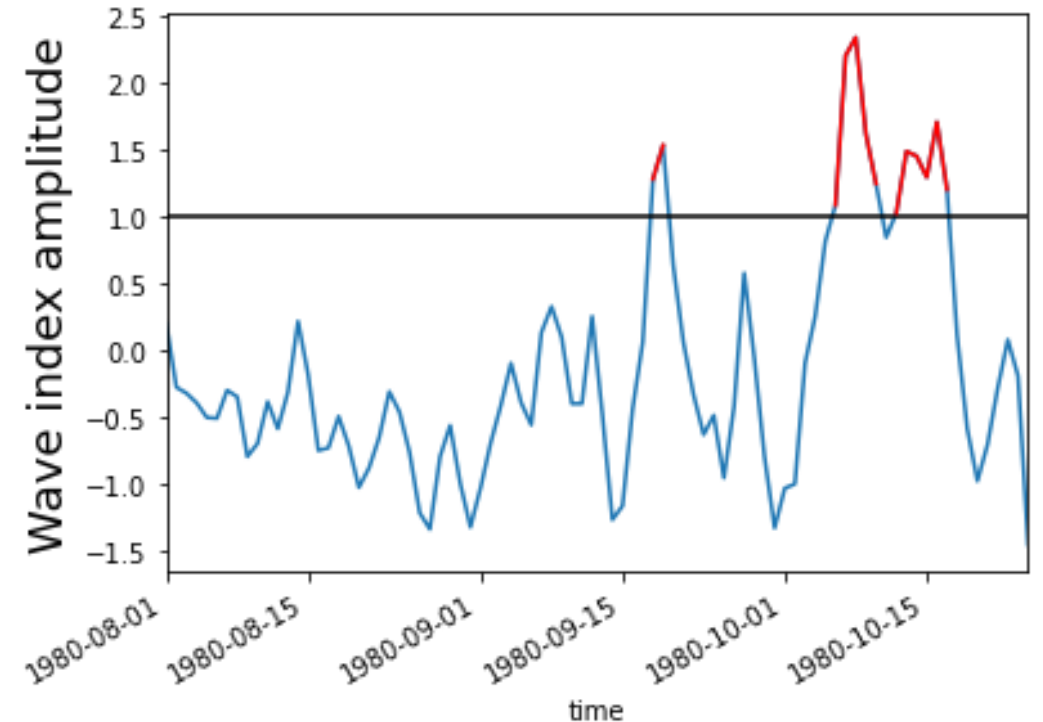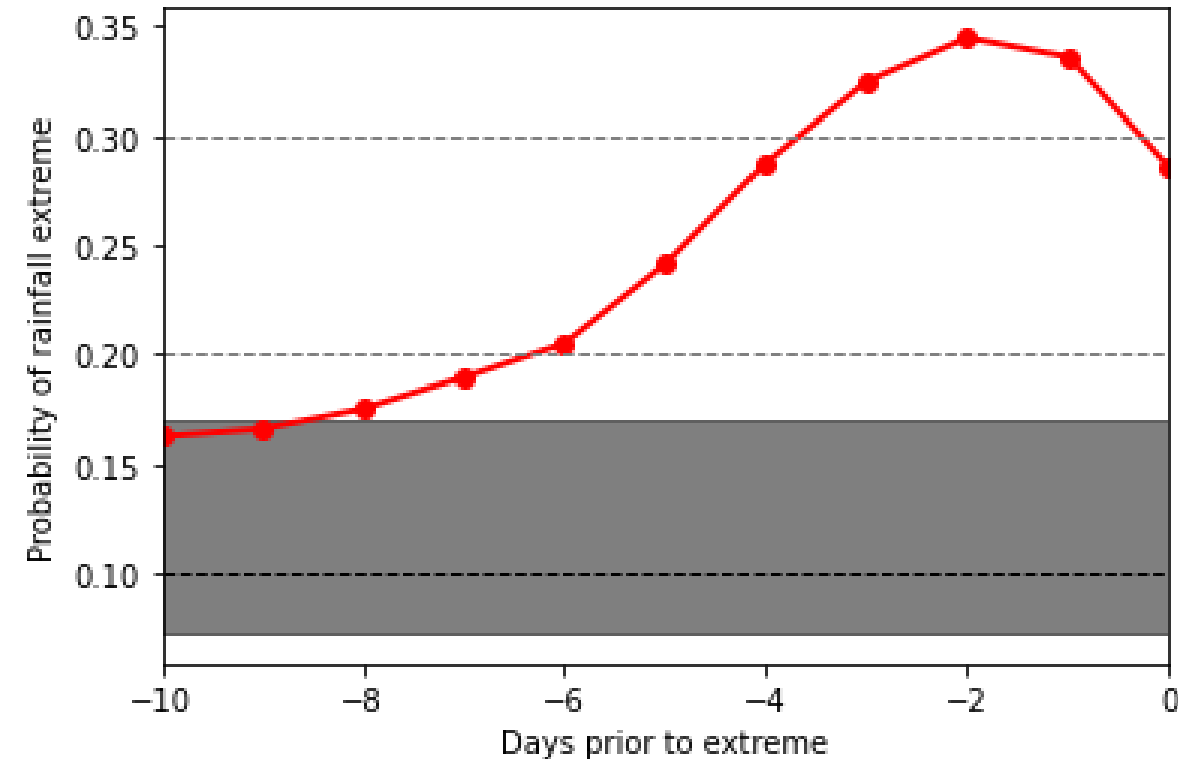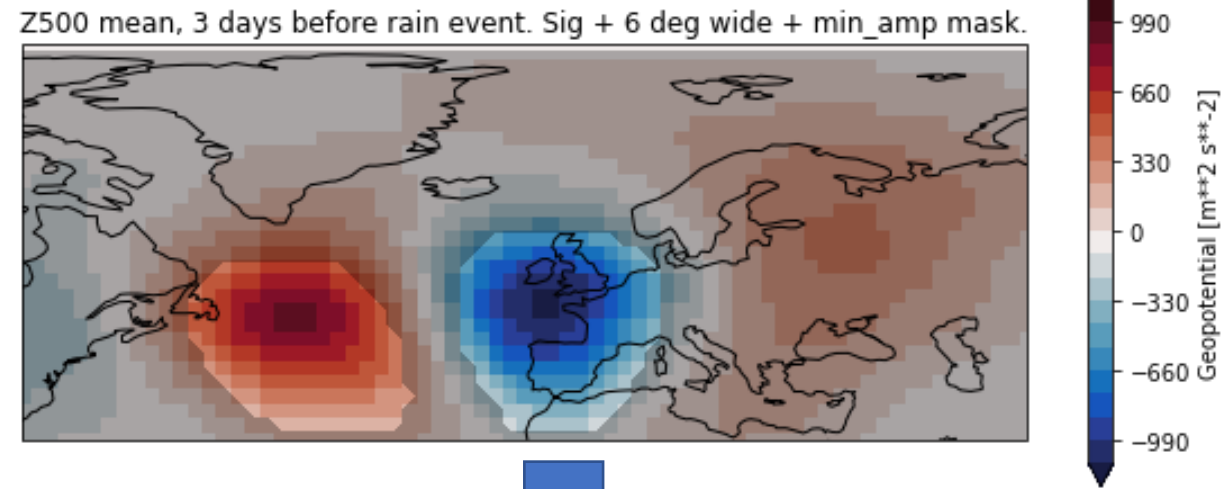

(Z500 anomaly composite, 3 days before an extreme).
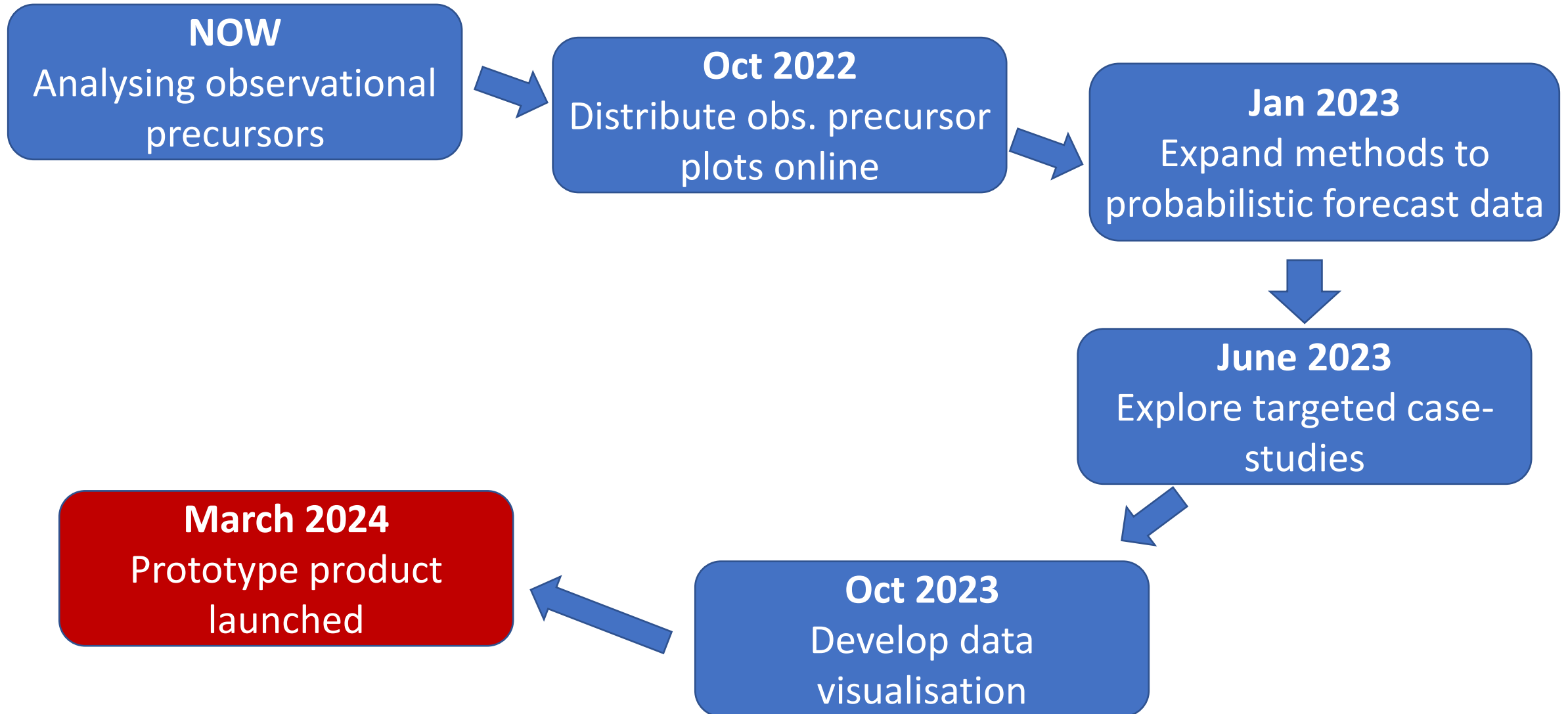
And we can reduce them to a scalar summary index:

When this index is active:

an event in 6 days is 2x more likely
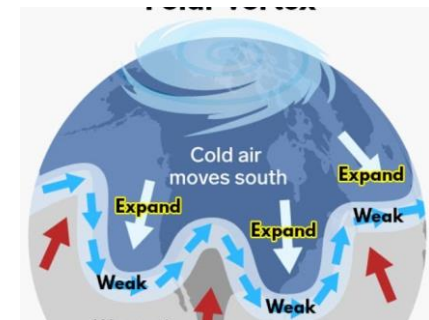
an event in 2 days is 3x more likely

Z500 mean, 3 days before rain event. Sig + 6 deg wide + min_amp mask.

Project timeline

NOW
Analysing observational precursors

Oct 2022
Distribute obs. precursor plots online

Jan 2023
Expand methods to probabilistic forecast data

June 2023
Explore targeted case-studies

Oct 2023
Develop data visualisation

March 2024
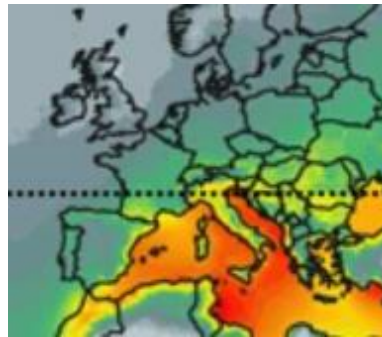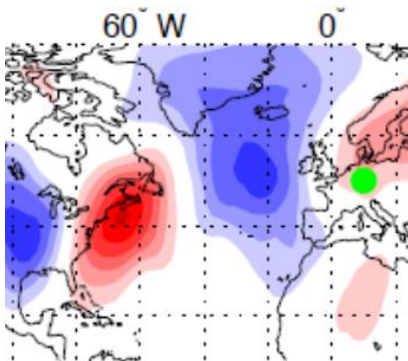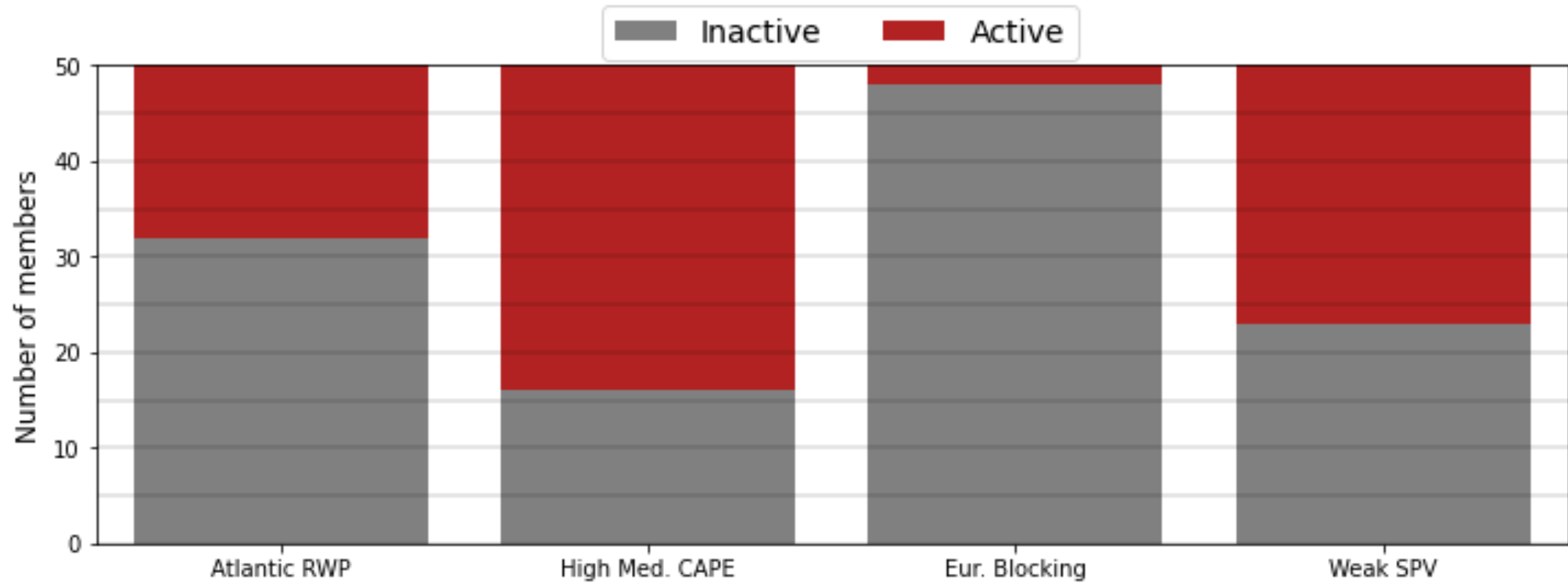Prototype product launched

What might this actually look like?

1: An activity monitor
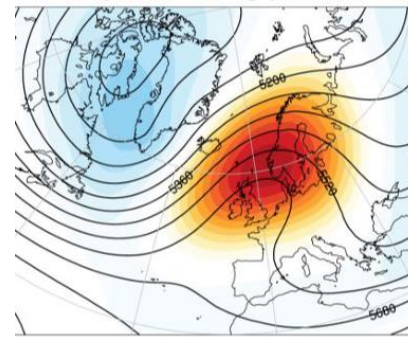
2: An automatic process summary

Not real data

Ensemble event analysis: 90th Percentile Precip exceedance over North Italy

- 10/50 ensemble members predict an event at +96h

- Of those 10:
  - 10 predict extreme Mediterranean CAPE at +84h and +96h
  - 10 predict an atmospheric river over the domain at +96h
  - 7 predict an Atlantic Rossby wave packet at +24h **(!)**

- Of the other 40:
  - 28 predict extreme Mediterranean CAPE at +96h
  - 20 predict an atmospheric river over the domain at +96h
  - 5 predict an Atlantic Rossby wave packet at +24h **(!)**

(!) This process is generated too infrequently in the current model

3: A process-based statistical prediction

Not real data
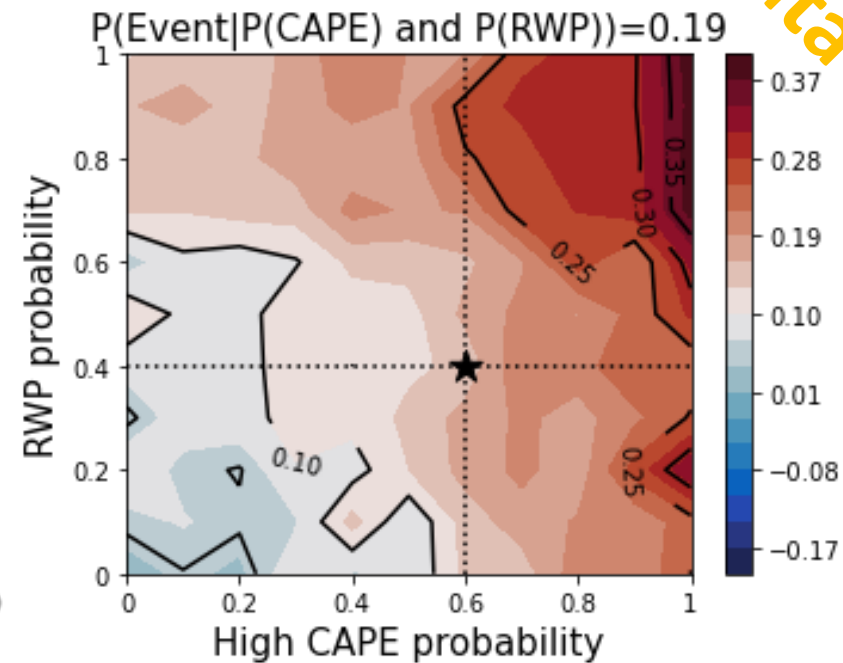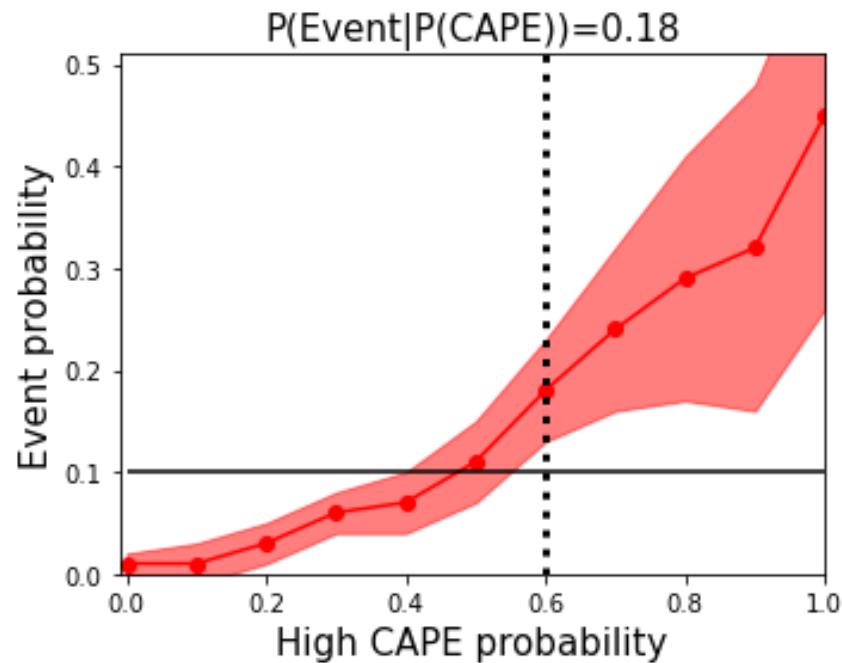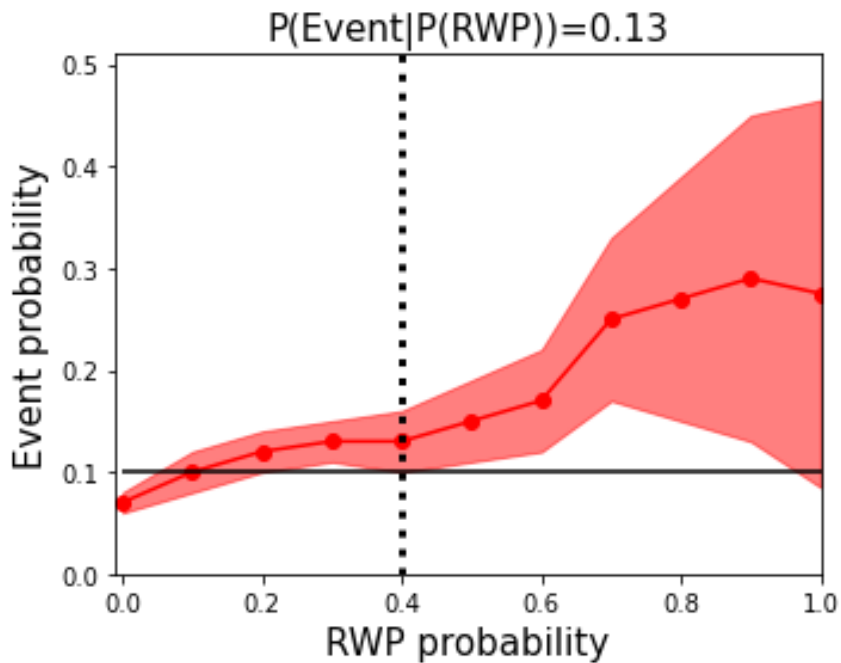
Direct probability of event at t+96: **0.1**

Statistical probability of event at t+96, using **CAPE** at t+96 and **RWP** at t+24: **0.19**

Closing the knowledge loop is vital!

Model developers

End-users

Genuinely improving the value of forecasts requires collaboration with end-users from the early stages of a project

What I want from you: Feedback!

What's your threshold for useful skill?

What kind of information do you wish you had?

What would you like to see in this kind of product?

What is limiting your ability to make good weather decisions?

joshua.dorrington@kit.edu

Which ideas I've discussed are especially (un)interesting to you?

What temporal and spatial scales do you care about?

… Also, case studies!

- I'm looking for applied examples to use as test cases during development

- Let me know about the real-world decisions you have to make, and the lead times, areas, and thresholds involved.

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- Focusing primarily on precipitation (but droughts and heatwaves also of interest)

- This will make our precursor database more useful!