UNIVERSITÄT BERN

Compound precipitation and wind extremes

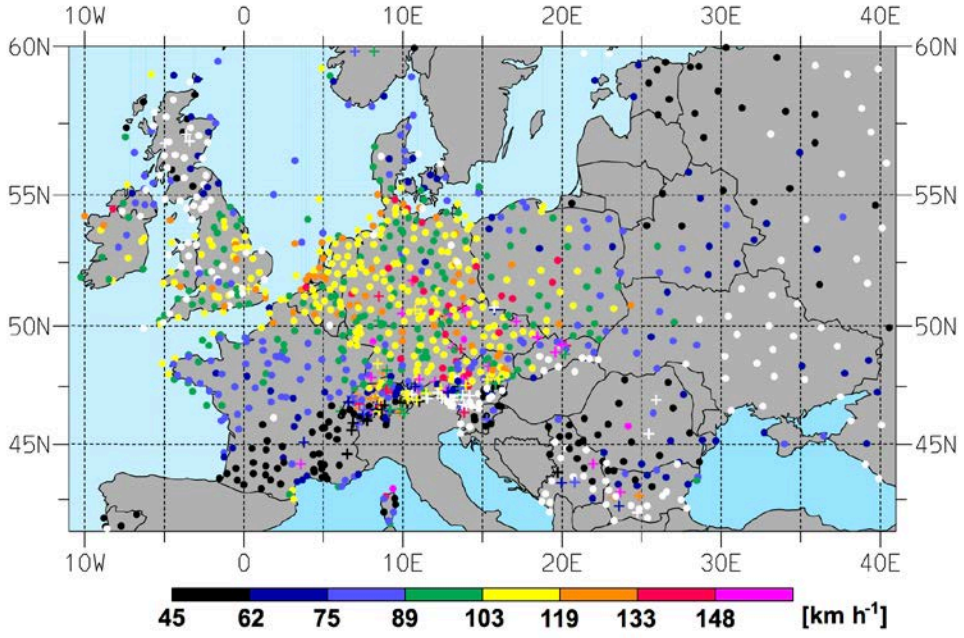
Olivia Martius[1], Stephan Pfahl[2], Clément Chevalier[3]

[1]OCCR / Mobiliar Lab for Natural Risks
Universität Bern

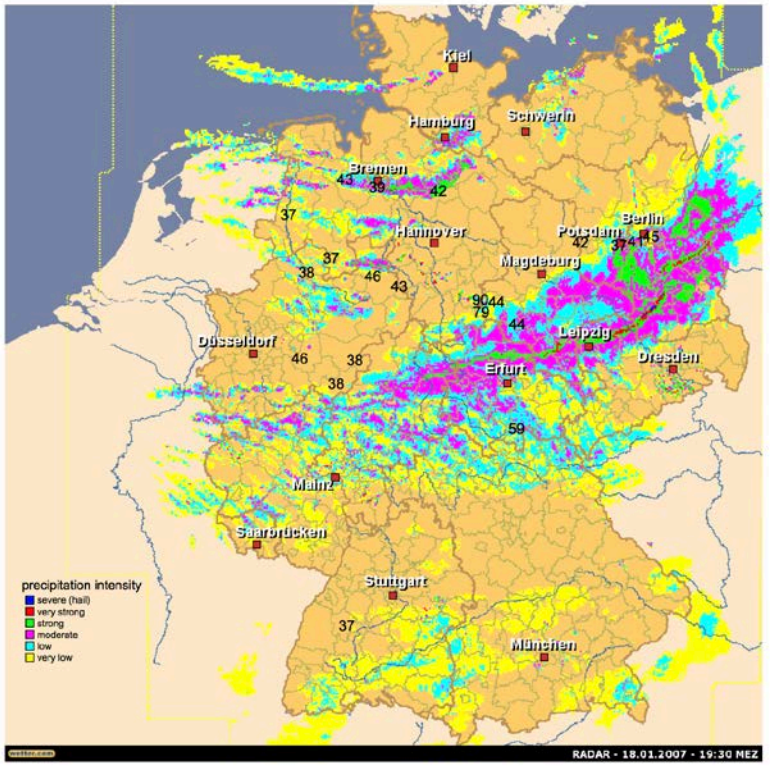
[2]IAC ETH

[3]Universität Zürich

Precipitation and wind gusts during Storm Kyrill



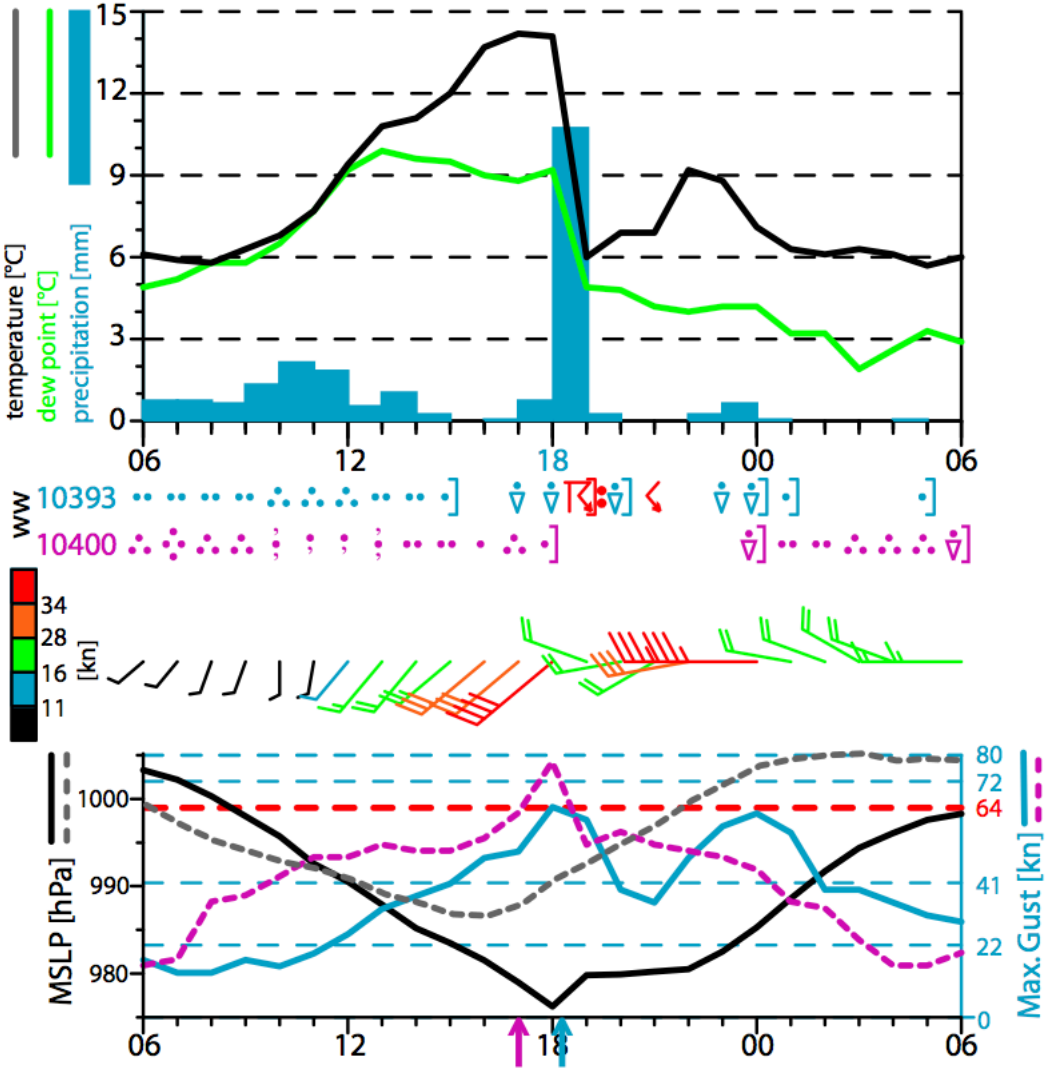
Maximum wind gusts



18:30 UTC 18 January radar reflectivity
24-h precipitation accumulation (numbers)

Fink et al. 2009

Precipitation and wind gusts during Storm Kyrill



Lindenberg

Lindenberg (blue)
Düsseldorf (magenta)

Fink et al. 2009

Aim

> Climatological analysis and quantification of the joint occurrence of daily precipitation and wind extremes using Era-Interim

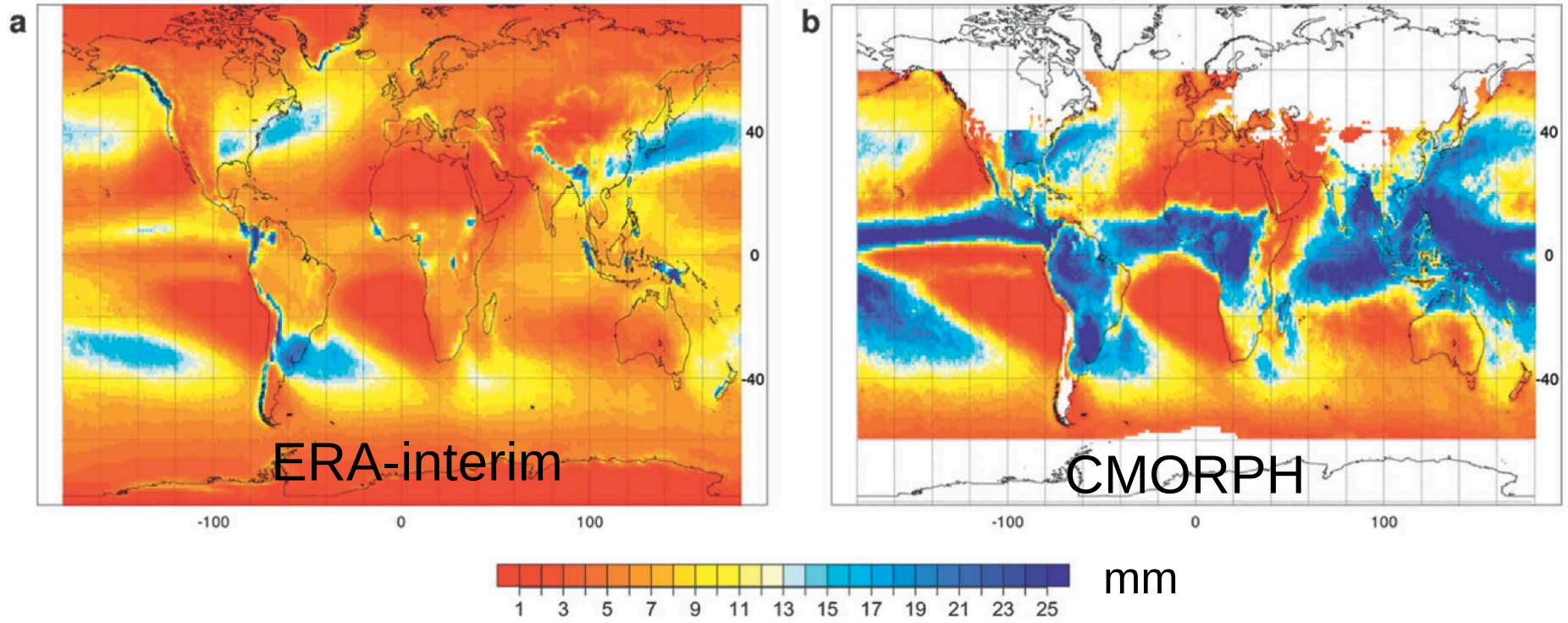
Data

- ERA-interim daily precipitation and wind extremes (1979 – 2013) interpolated to a 1° by 1° grid
- Seasonal 98th percentiles
- Converted to binary (extreme = 1 / non-extreme=0) time series per grid point → input for logistic regression

Precipitation extremes

UNIVERSITÄT BERN

99th percentile of 6 hourly precipitation



Pfahl and Wernli 2012

Statistical approach

- Logistic regression model:

$$\text{logit}(p(t)) = b_0 + b_1 \text{Gust}(t)$$

$$\text{logit}(p(t)) := \log \frac{p(t)}{(1 - p(t))}$$

$$p(t) := P(\text{precip}(t) = 1 \mid \text{Gust}(t))$$

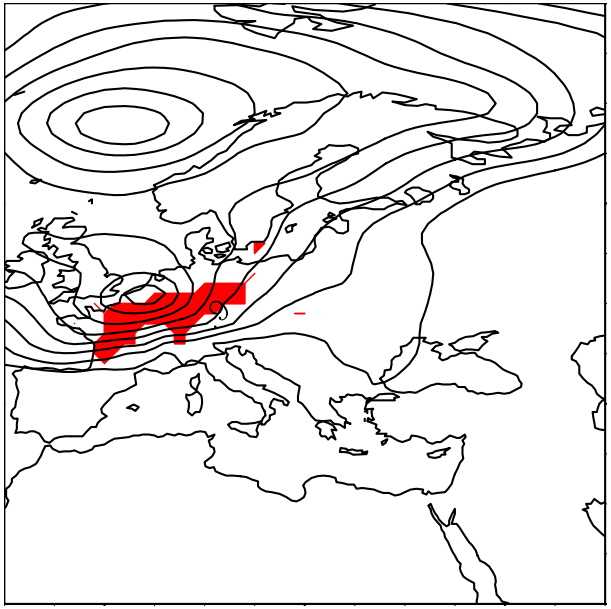
- p(t) is the probability of observing an extreme precipitation event at time t given the wind gust at time t

- The odds ratio exp(b1) is a multiplicative factor that increases or decreases the odds of an extreme precipitation event

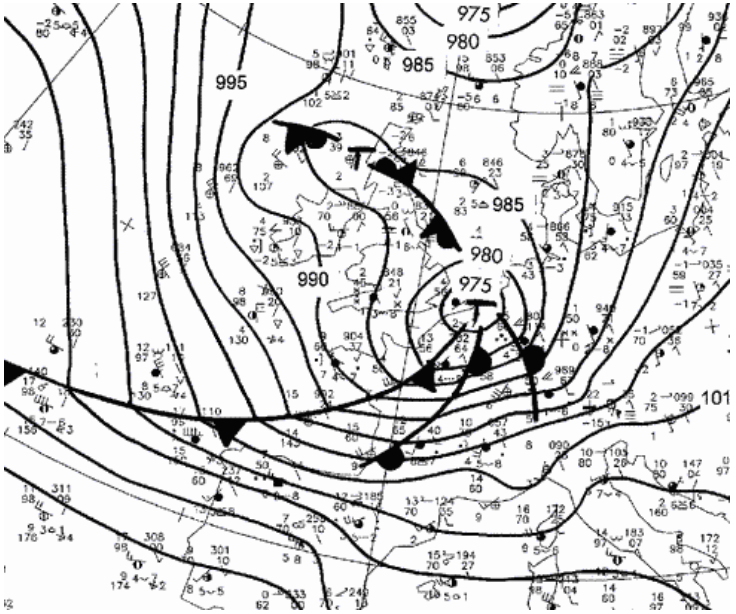
Storm Joachim December 2011

UNIVERSITÄT BERN

16 December 2011

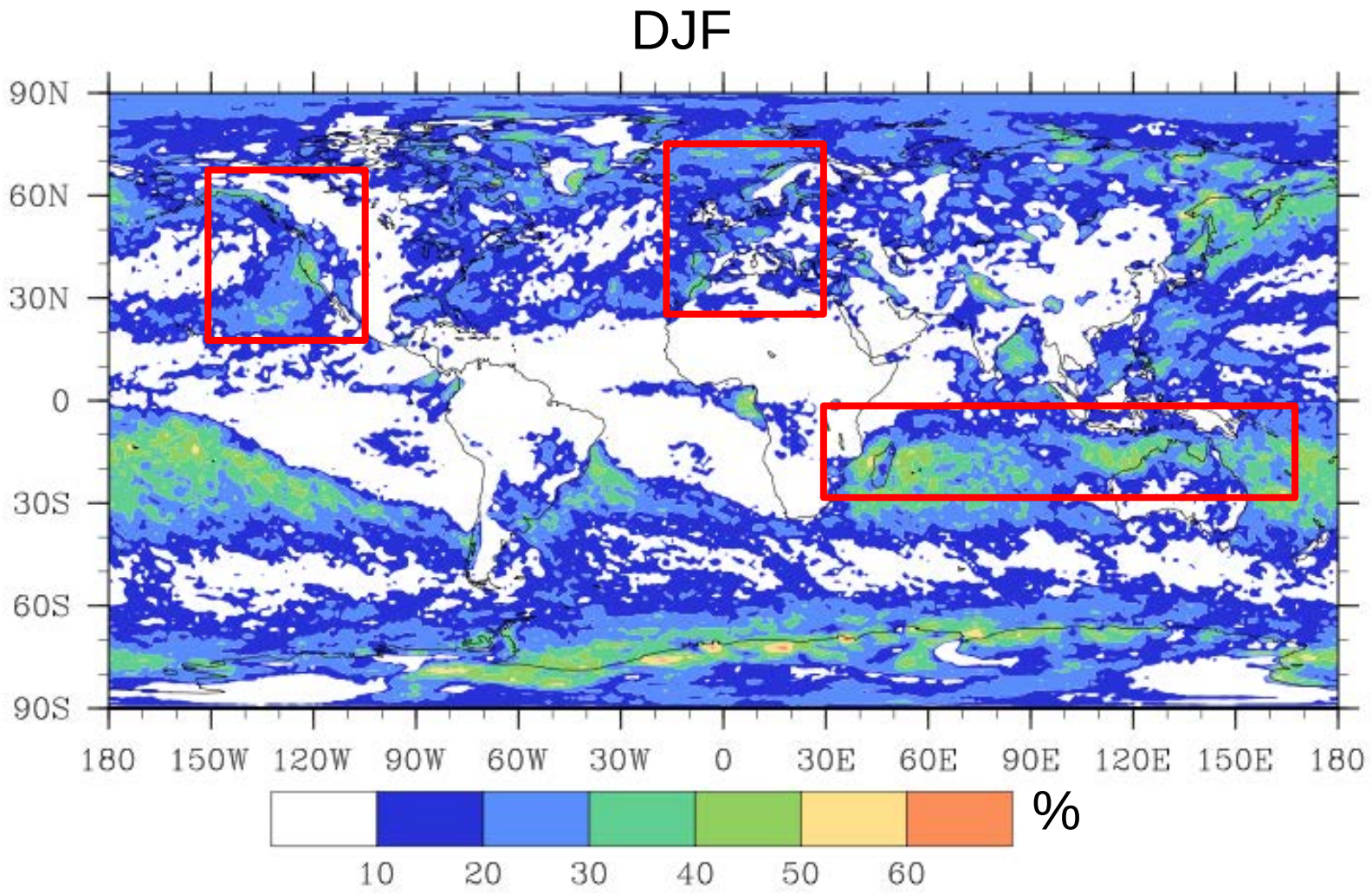


DWD surface analysis

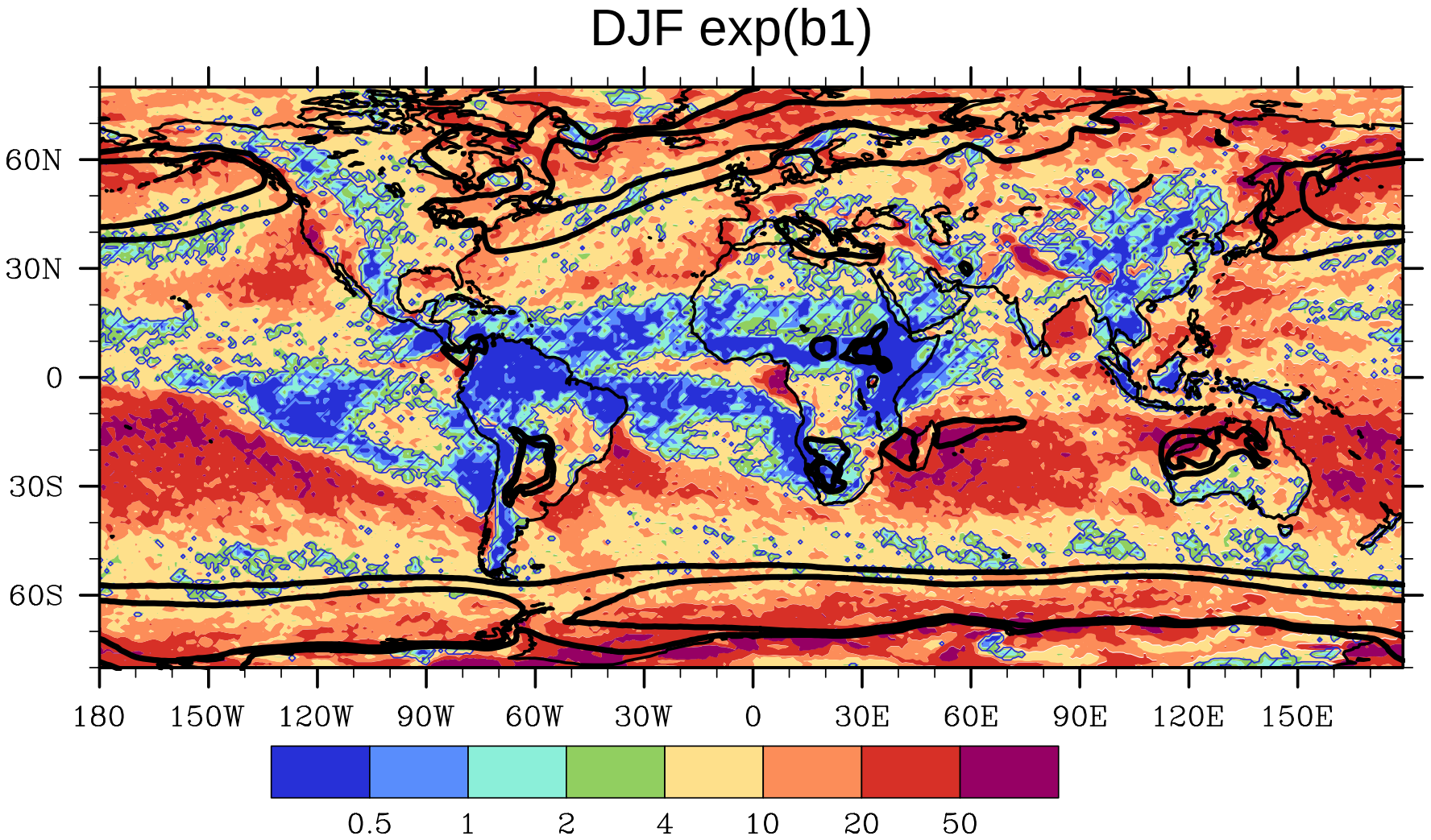


Black contours: MSLP at 6UTC December 16
Red area: concurrent precipitation and wind extremes

Percentage of compound extremes

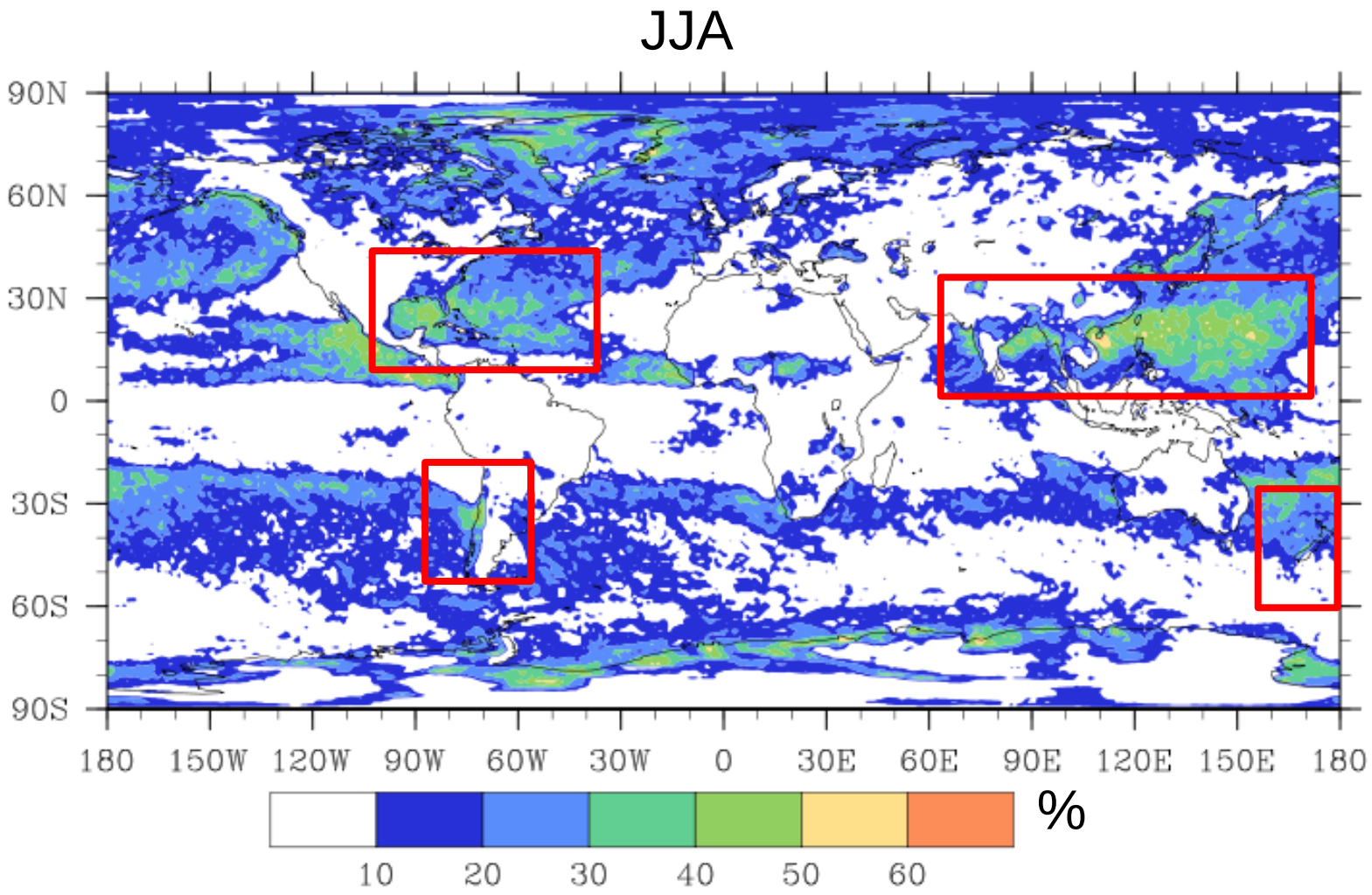


Significant association

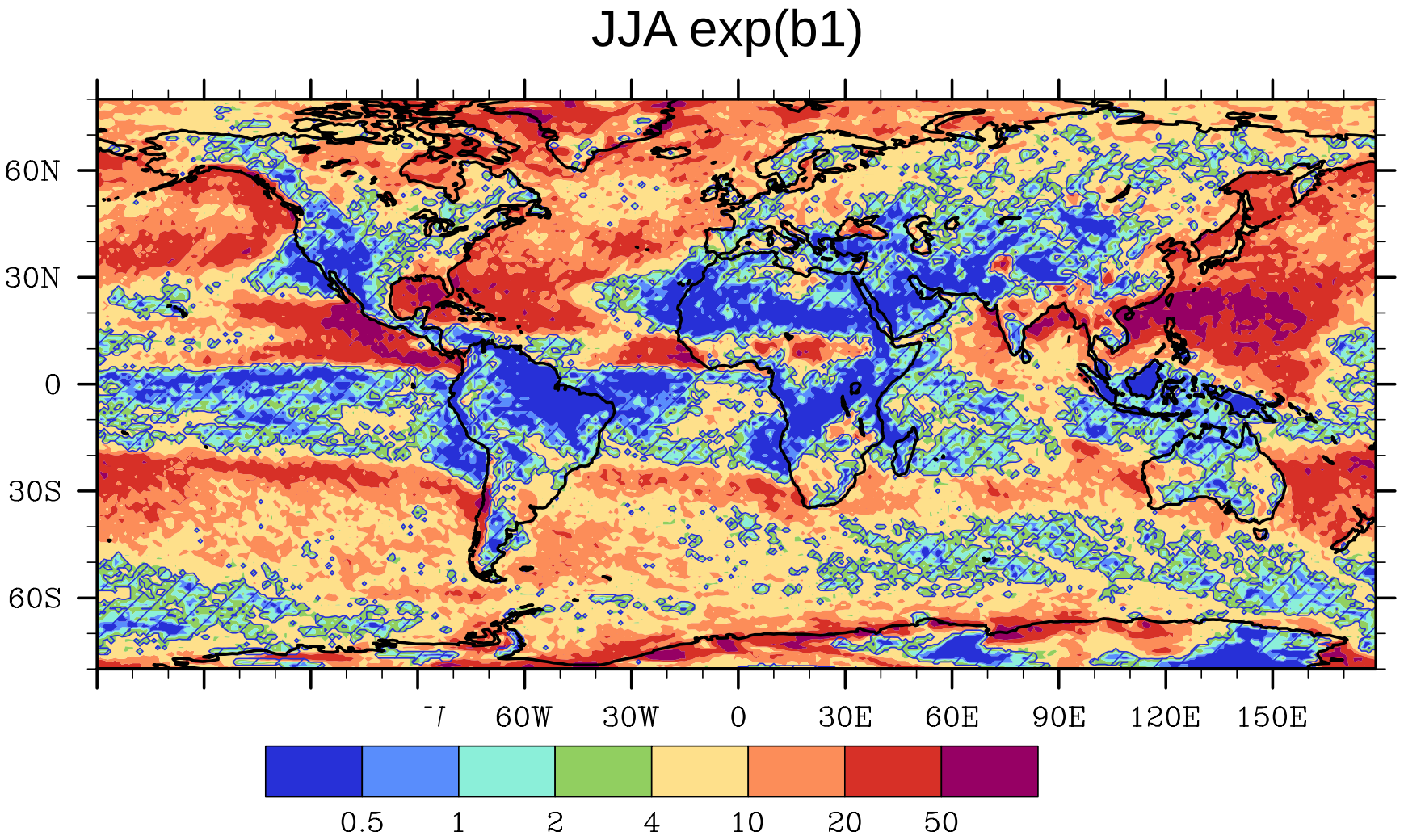


Black contours: cyclone frequency (Wernli and Schwierz 2006)
Hatched areas not significant

Percentage of compound extremes

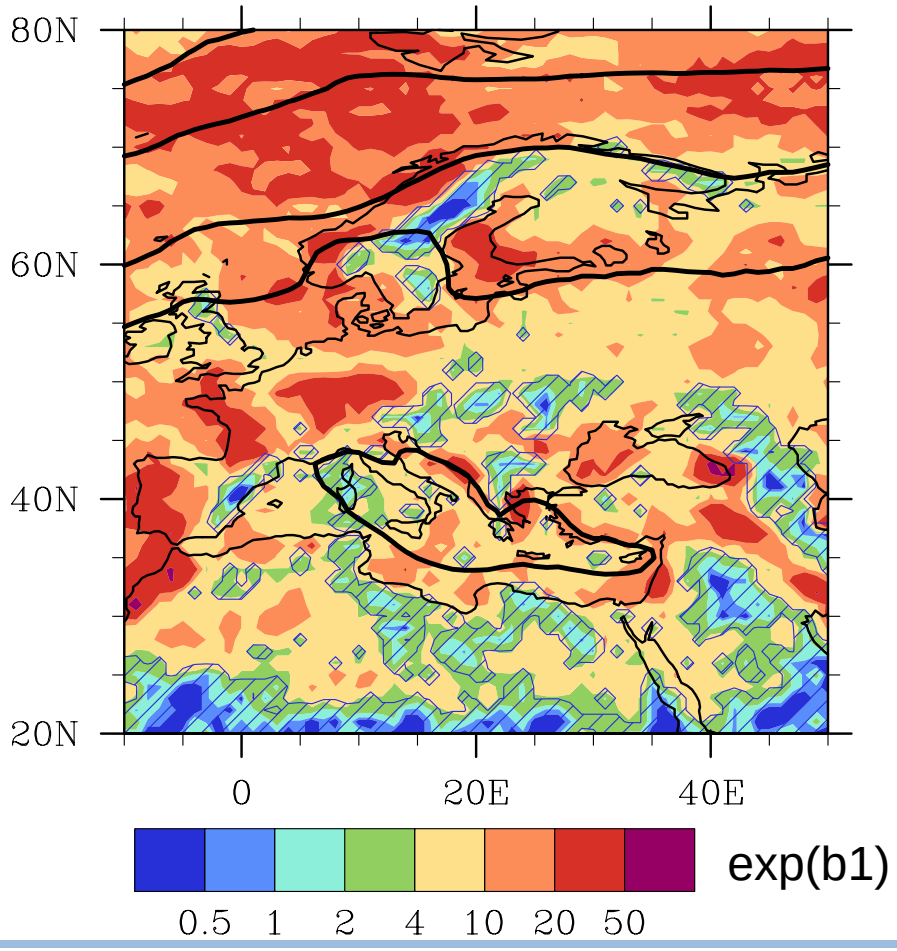


Significant association



Black contours: cyclone frequency (Wernli and Schwierz 2006)
Hatched areas not significant

Joint occurrence of precipitation and wind extremes over Europe in winter



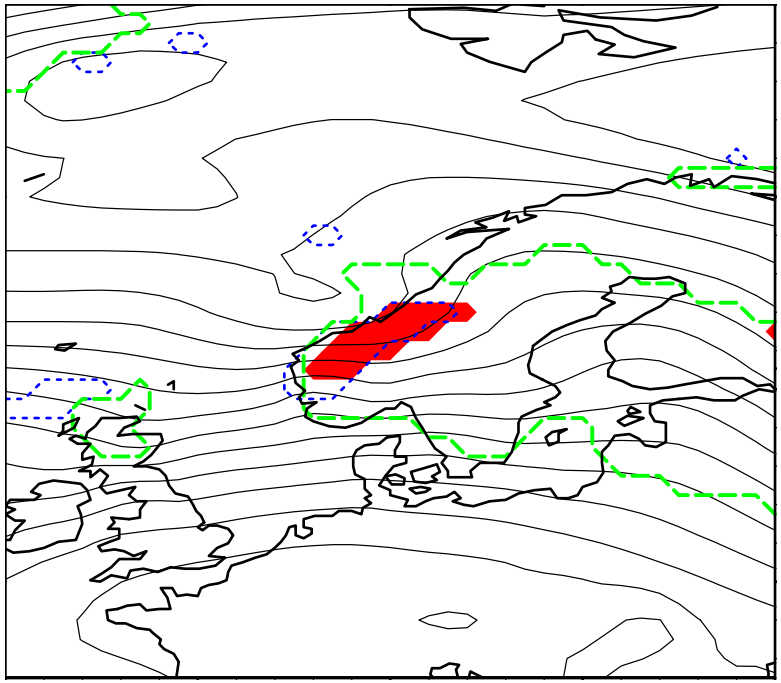
$$\text{logit}(p(t)) = b_0 + b_1 \text{Gust}(t)$$

Black contours: cyclone frequency (Wernli and Schwierz 2006)

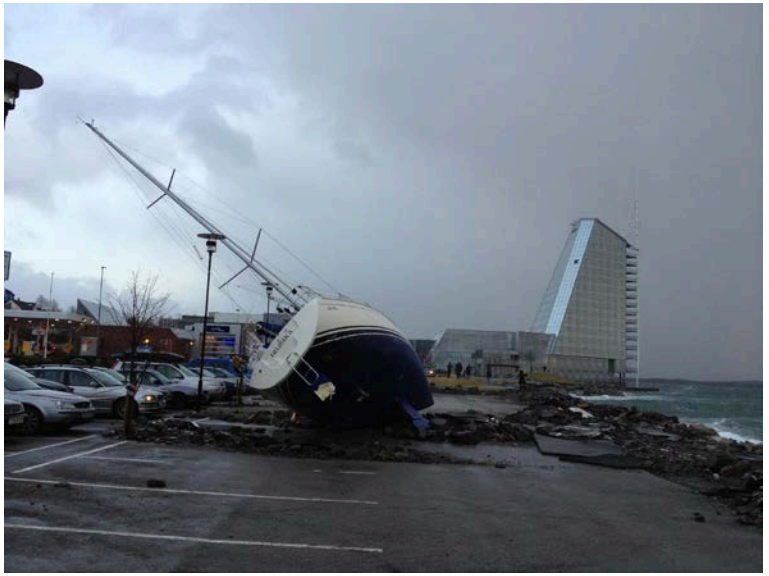
Hatched areas not significant

Storm Dagmar

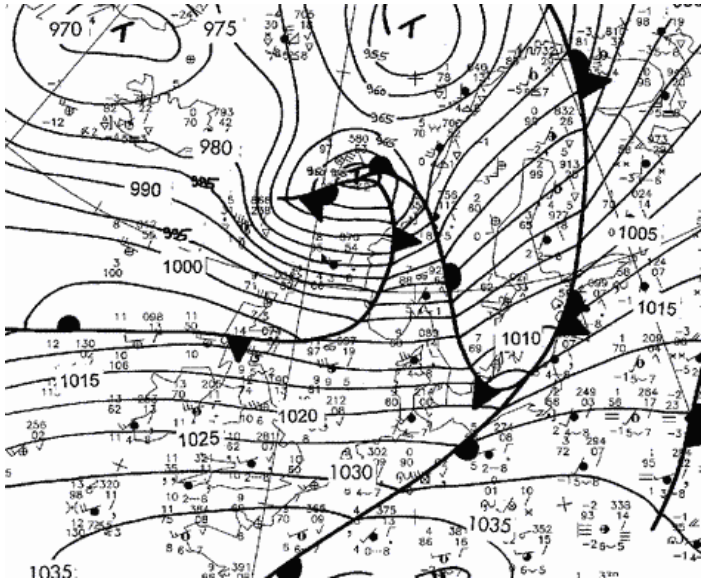
25 December 2011



Green line: wind extremes
Blue line: precipitation extremes
Red area: concurrent extremes



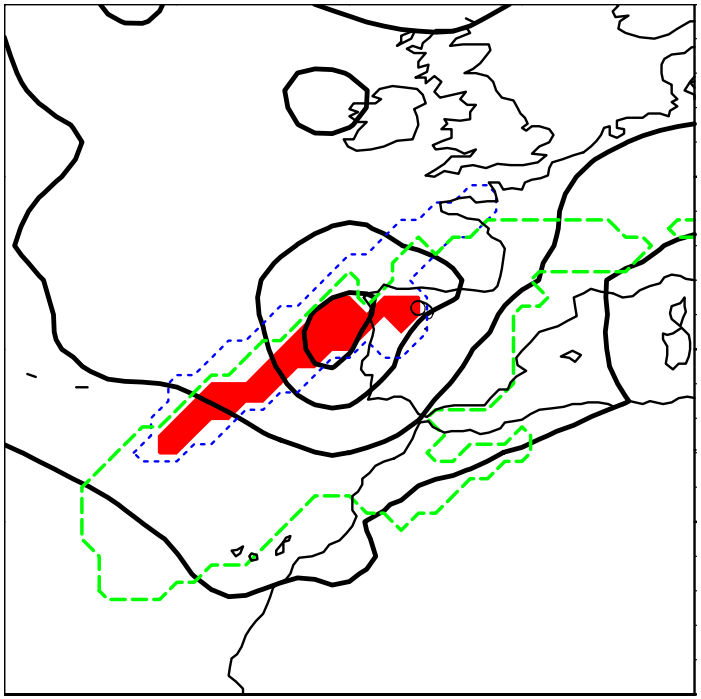
DWD surface analysis



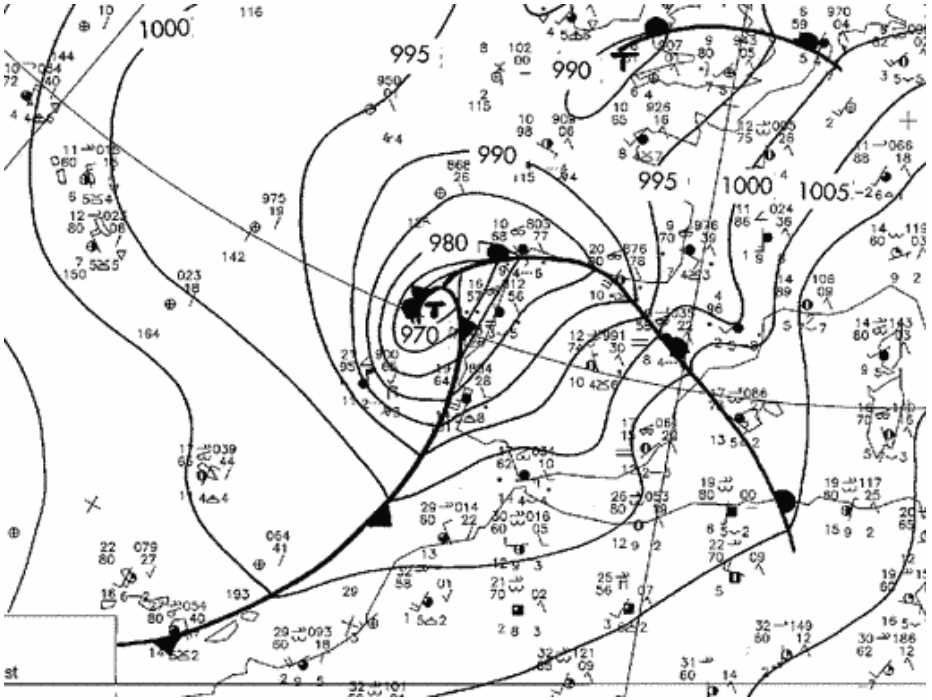
Storm Xynthia

UNIVERSITÄT BERN

27 February 2010



DWD surface analysis



Green line: wind extremes
Blue line: precipitation extremes
Red area: concurrent extremes

Summary and conclusion

UNIVERSITÄT BERN

- Statistically significant co-occurrence of wind and precipitation extremes
- Absolute values:
  - DJF up to 35% along the west coast of Europe and up to 40% along the west coast of North America and along the west coast of Australia
  - JJA similar values along the west coast of New Zealand and South America and in the tropical cyclone areas
- Strong spatial variability
- Strong seasonal variability