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Environmental proxies for hail in northern Switzerland
-
interannual variability and links to local and global circulation

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Number of hail days in June in northern Switzerland

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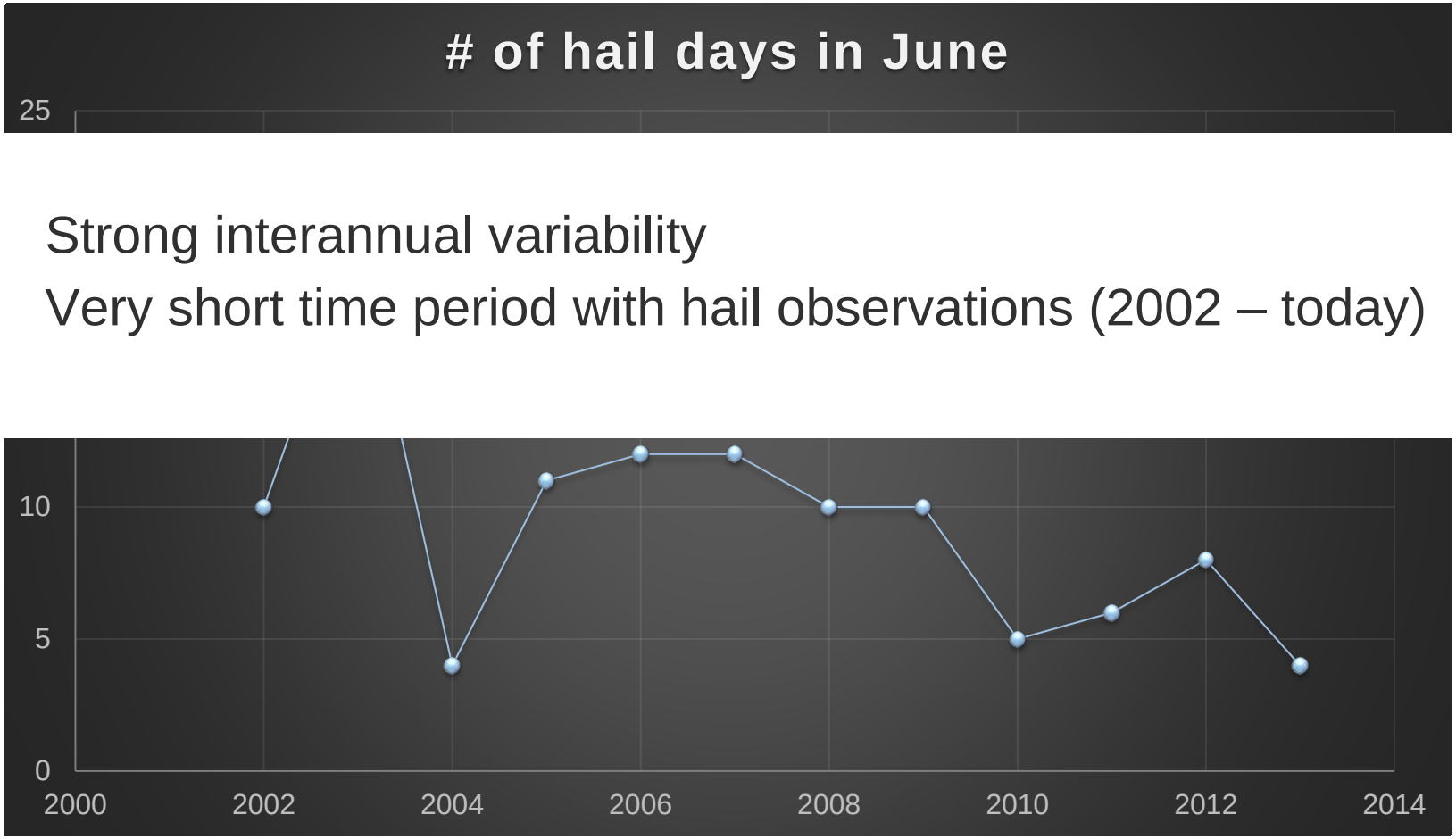


- Strong interannual variability
- Very short time period with hail observations (2002 – today)

Radar based observations

Aim

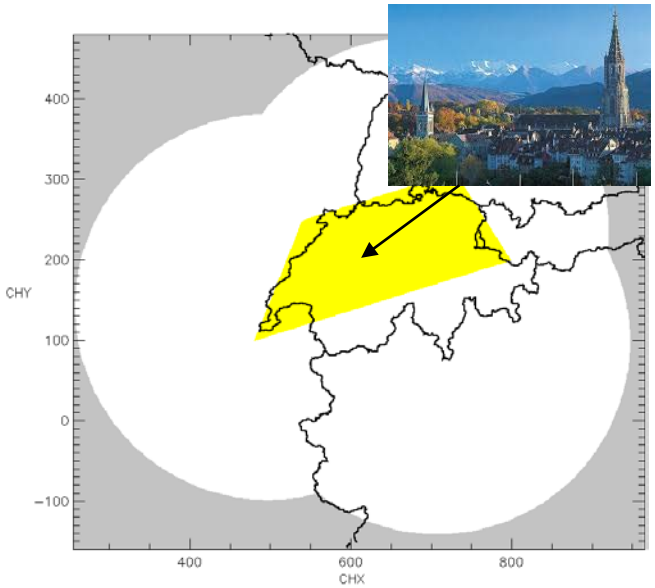
- The aim is to capture the interannual variability using a simple statistical model and coarse-resolution reanalysis data

If we are successful

- An extension of a hail time series back and forward in time beyond the observational record is possible
- Insight into the driving processes can be gained

Data and Methods

- Radar based hail observations
- Hail days defined as days with POH > 80% over >100km^2 in northern Switzerland (Nisi et al. 2015)



- Predictand: hail days per month
- Predictors: from ERA-interim
- Logistic and linear regression models
- Monthly mean CAPE from the 20th century reanalysis data averaged over Central Europe

Predictor selection

- Predictor environmental parameters based on literature
- All monthly mean anomalies to the long term climatology
- The seasonal cycle is included in the model as a separate variable (April to September)

Madonna et al. in prep.

Model selection

> Regression models:

1. Poisson model using all predictors
2. Poisson model without multicollinearities
3. Models with higher-order interactions (glmulti)
4. Two-part models (count part and zero part)
5. Linear model

Madonna et al. in prep.

Model comparison

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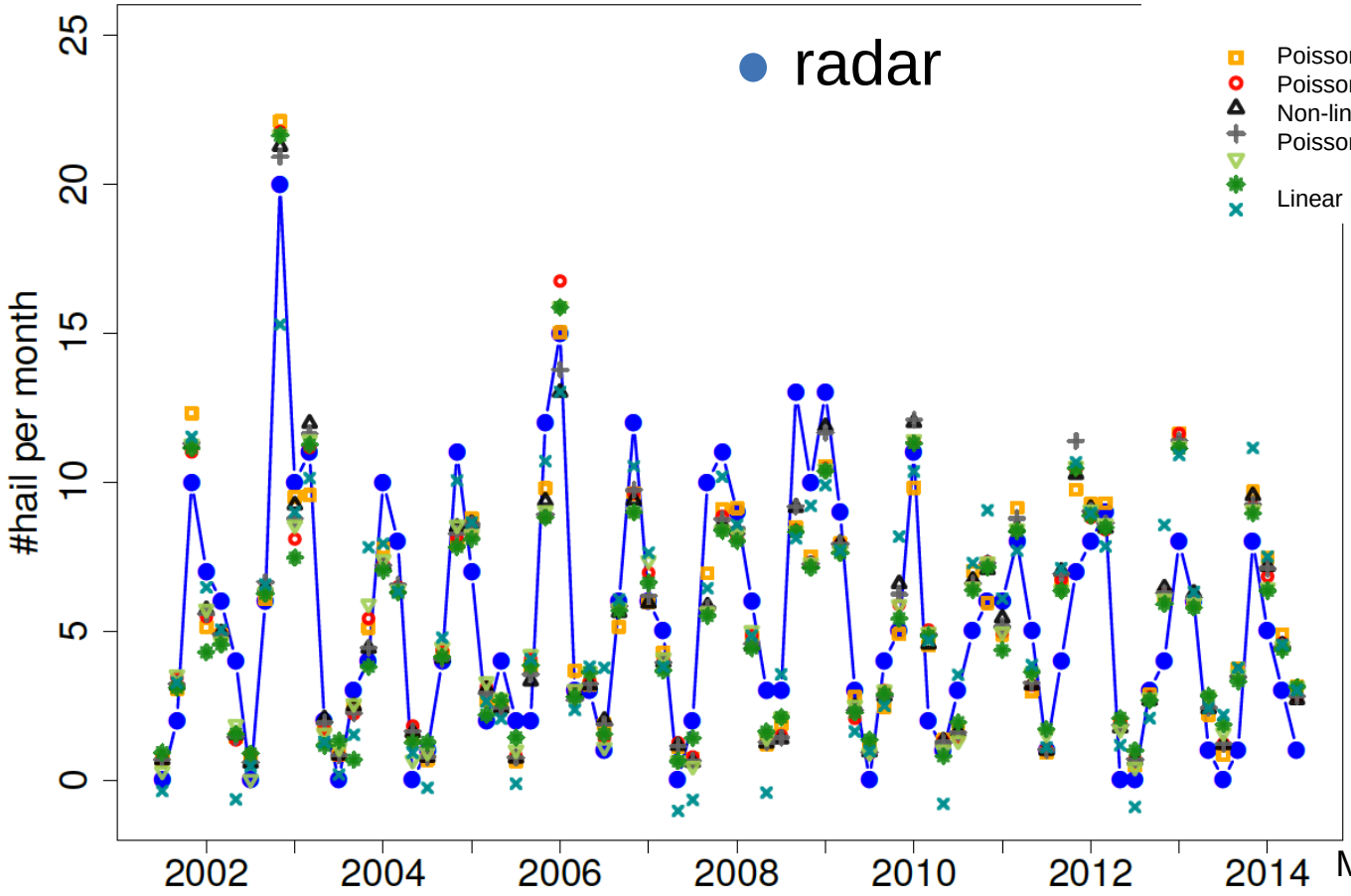

Madonna et al. in prep.

No substantial differences between the models

Model selection and comparison

- Regression models:
- Poisson model without multicollinearities ← best AIC & other measures

Final model:

$$\mu = e^{-0.75+0.136TEMP2M+0.248\ln(CAPE)+0.032SHEAR+\beta_4 SEASON}$$

Madonna et al. in prep.

Shear

→ Presentation S. Trefalt et al. Friday 9:55

Shear

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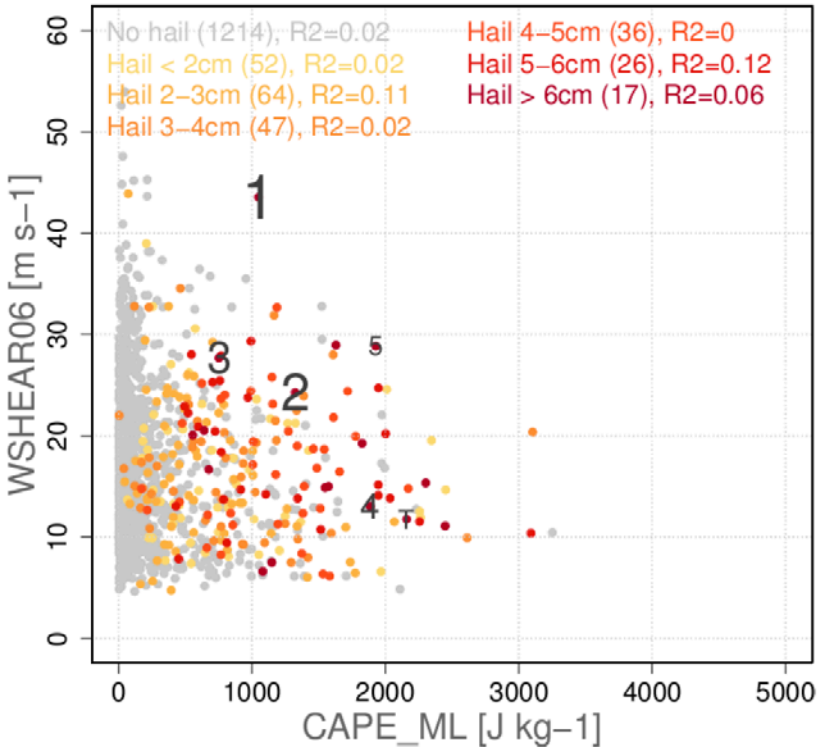

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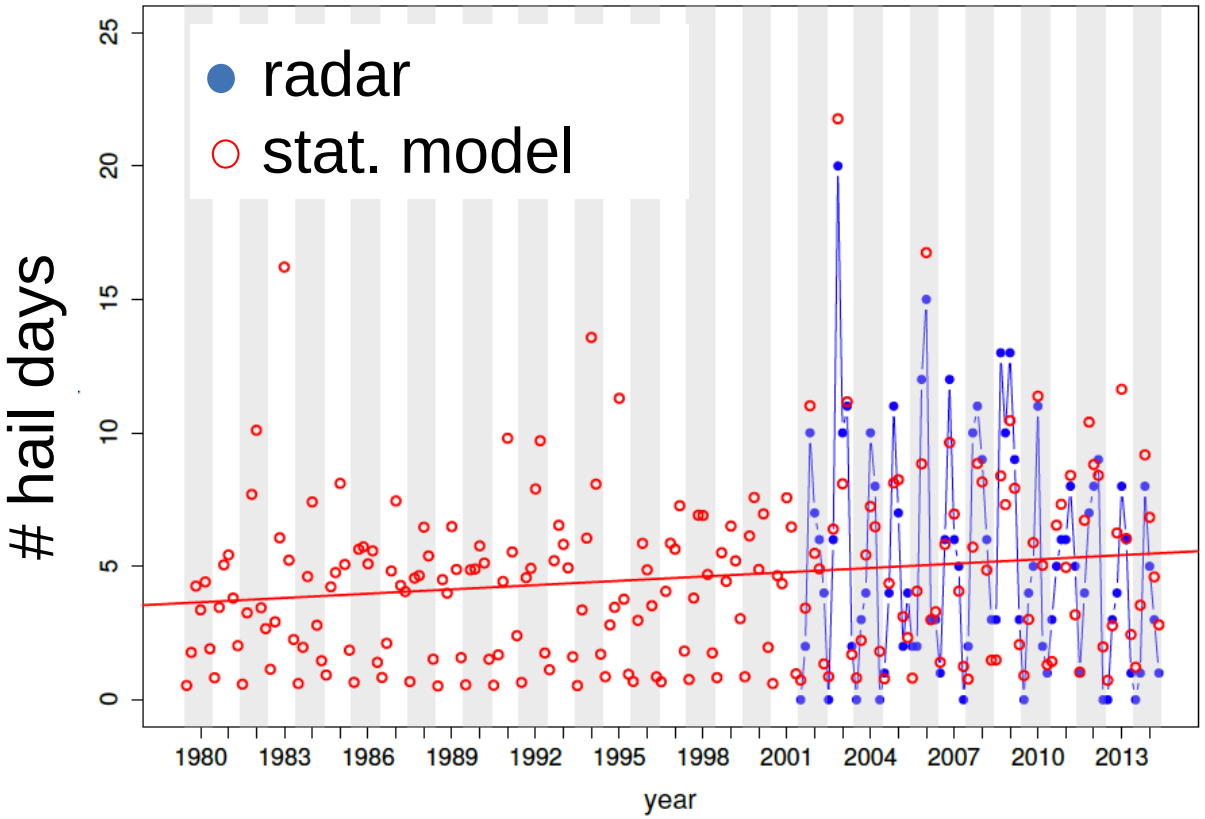
Extension of time series back in time



Positive trend, stat. sig., ~ 0.5 days per decade
Trend in ln(CAPE) and T2M

Madonna et al. in prep.

Upper-level wind and sea surface temperature anomalies

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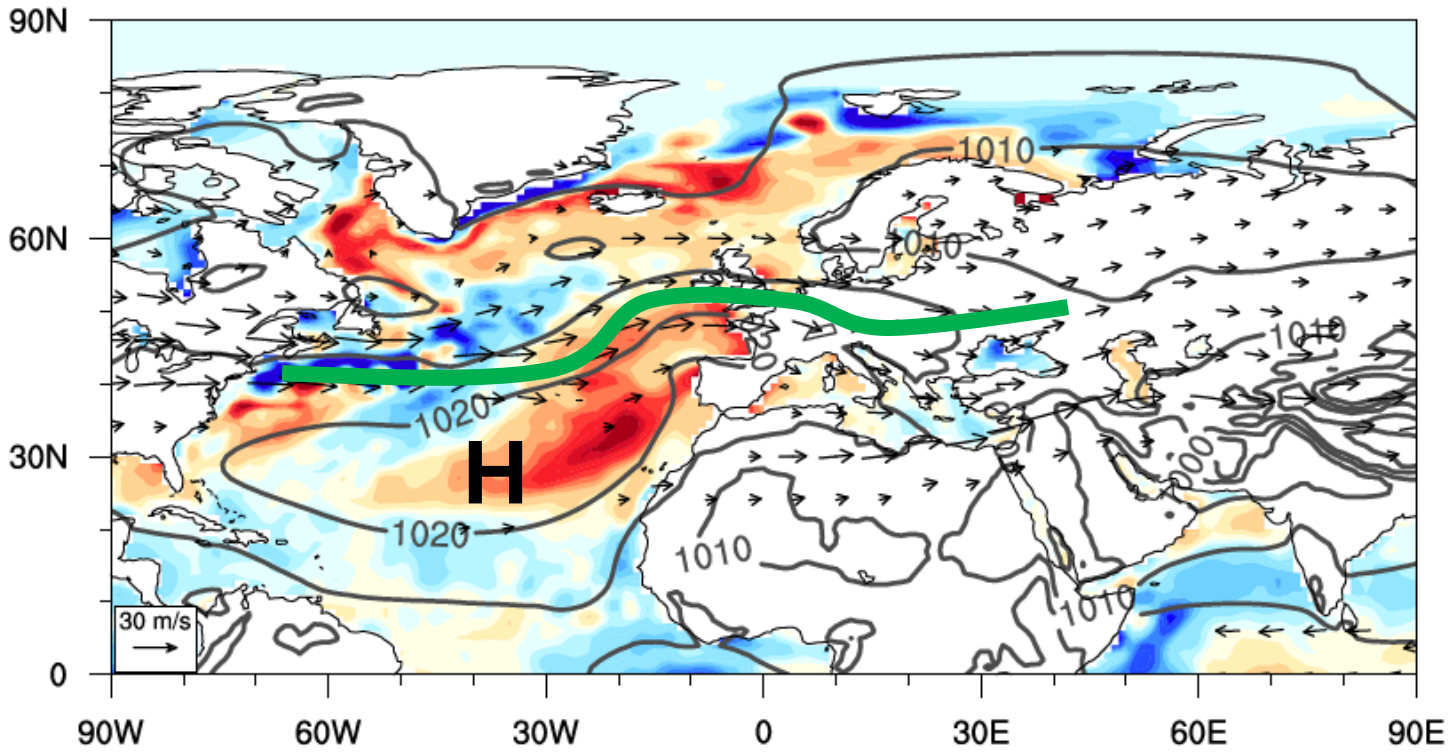

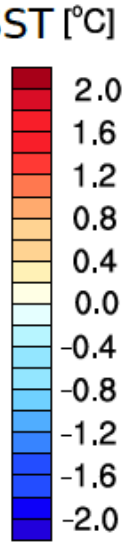

SST anomalies

MSLP

→ ppper-level winds

Upper-level wind and sea surface temperature anomalies

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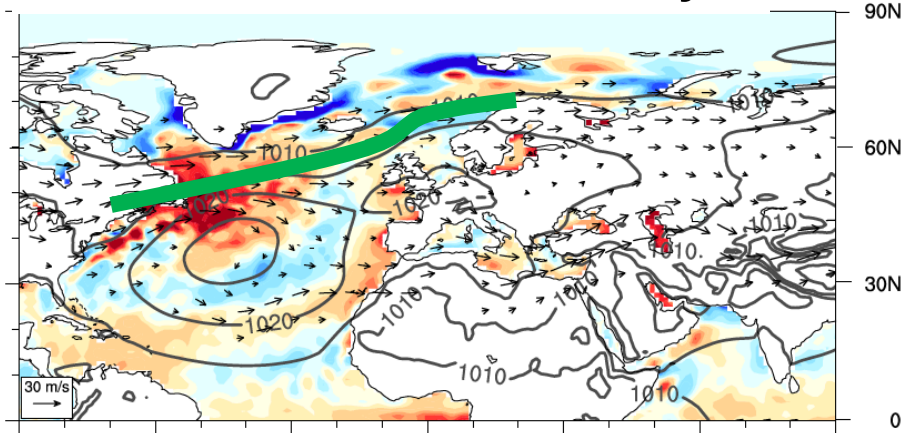
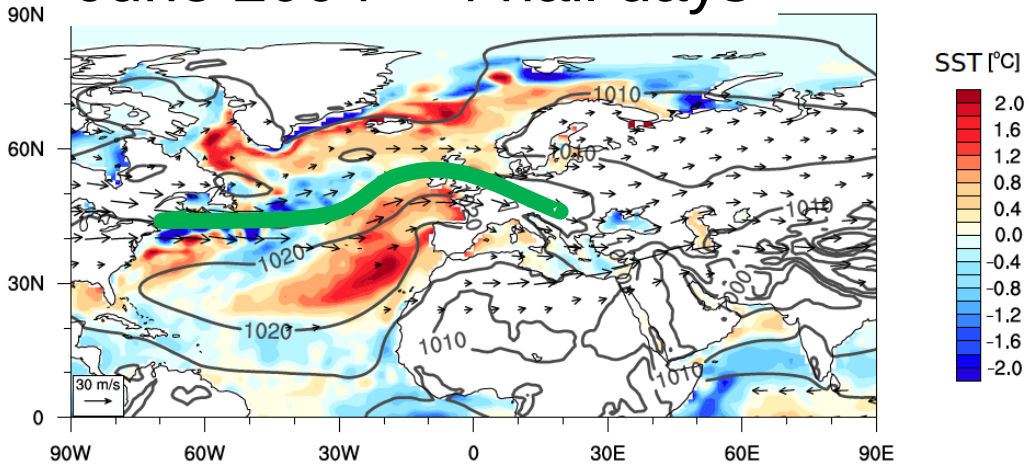
June 2006 – 12 hail days



June 2004 – 4 hail days



In June 2006

- Positive SST anomaly east of Newfoundland
- Extratropical jet located further north
- Stronger anticyclone over central Europe

CAPE over central Europe in 20CR
May through September

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CAPE over central Europe in 20CR
May through September

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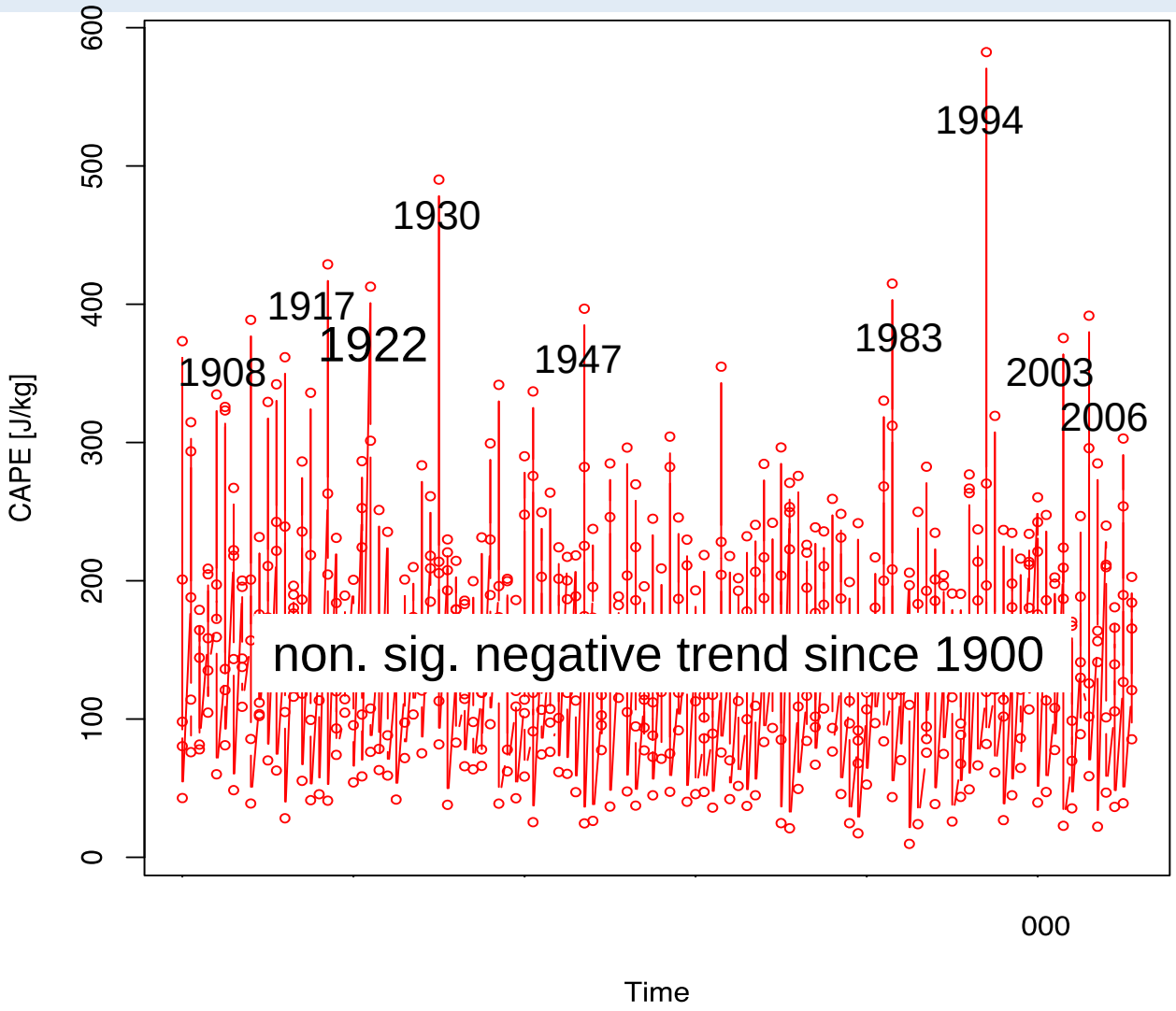
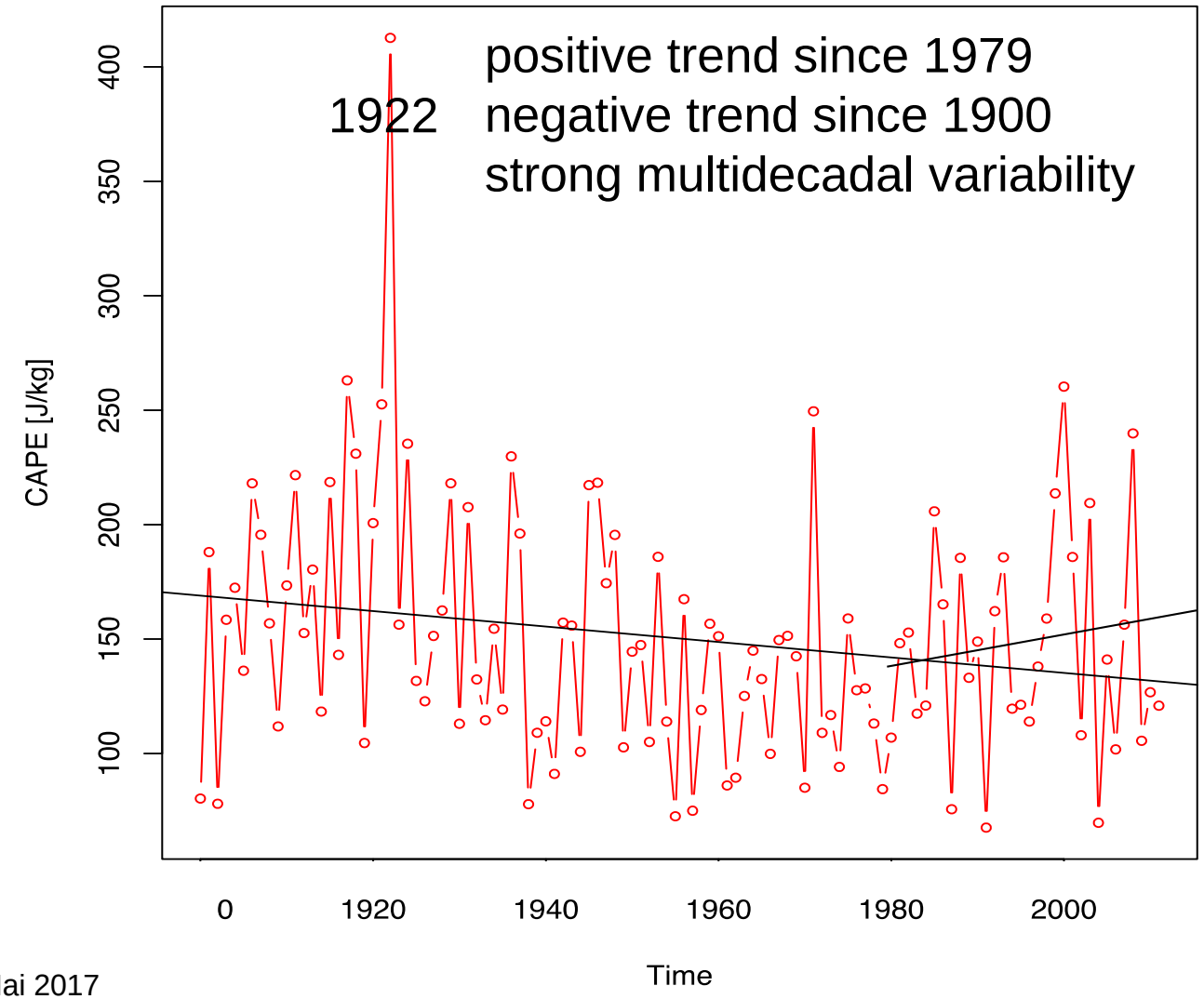


CAPE over Central Europe in May



Changes in seasonality?

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Month	Trend	Significant
May	-	95th
June	no	no
July	no	no
August	+	99th

Summary

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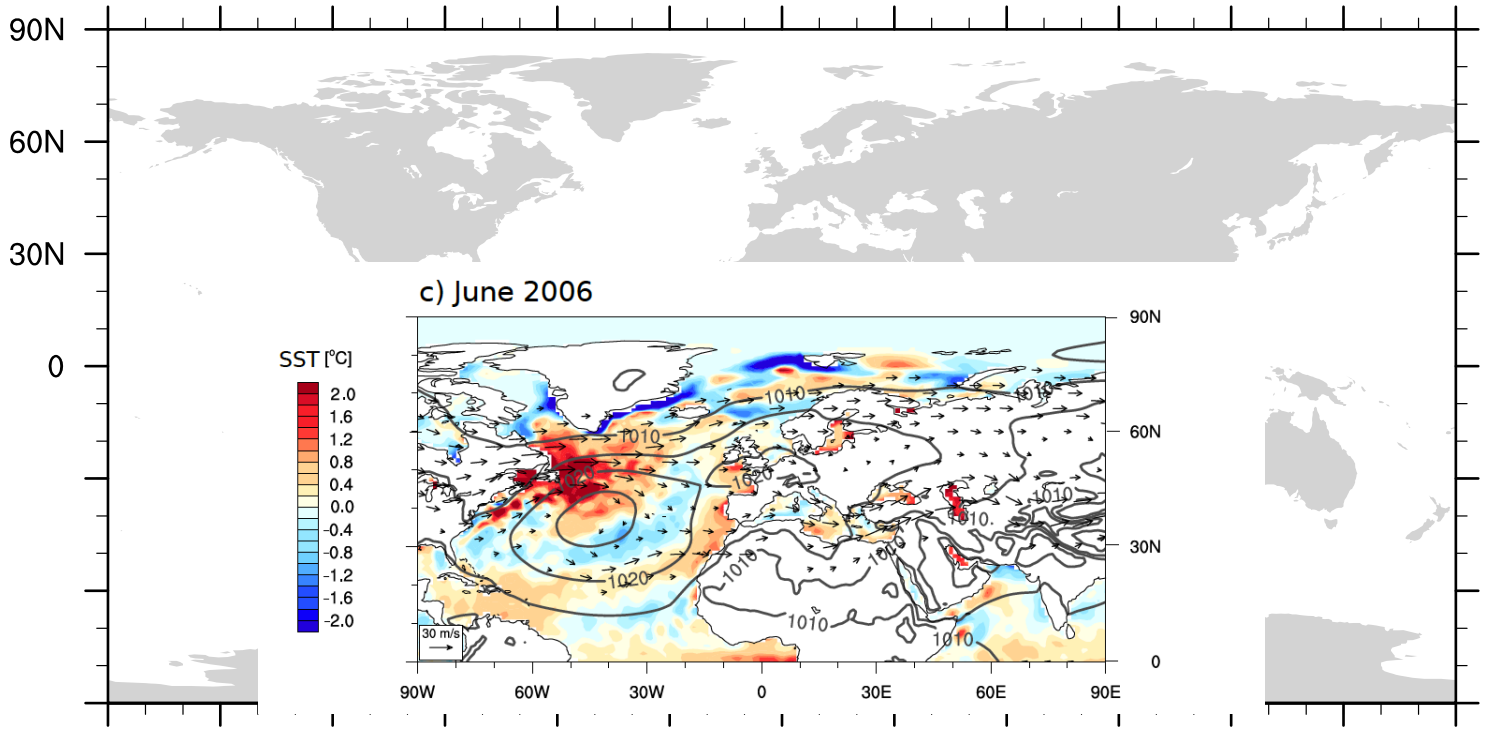
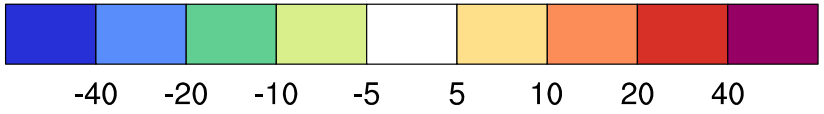
- Strong year-to-year variability of hail in northern Switzerland
- Monthly mean MLCAPE and two meter temperature are important predictors of the # of hail days per month in northern Switzerland
- Strong decadal variability of CAPE in the 20th century
- Seasonally varying trends
- Next step:
  - Verification with CERA /ERA20C

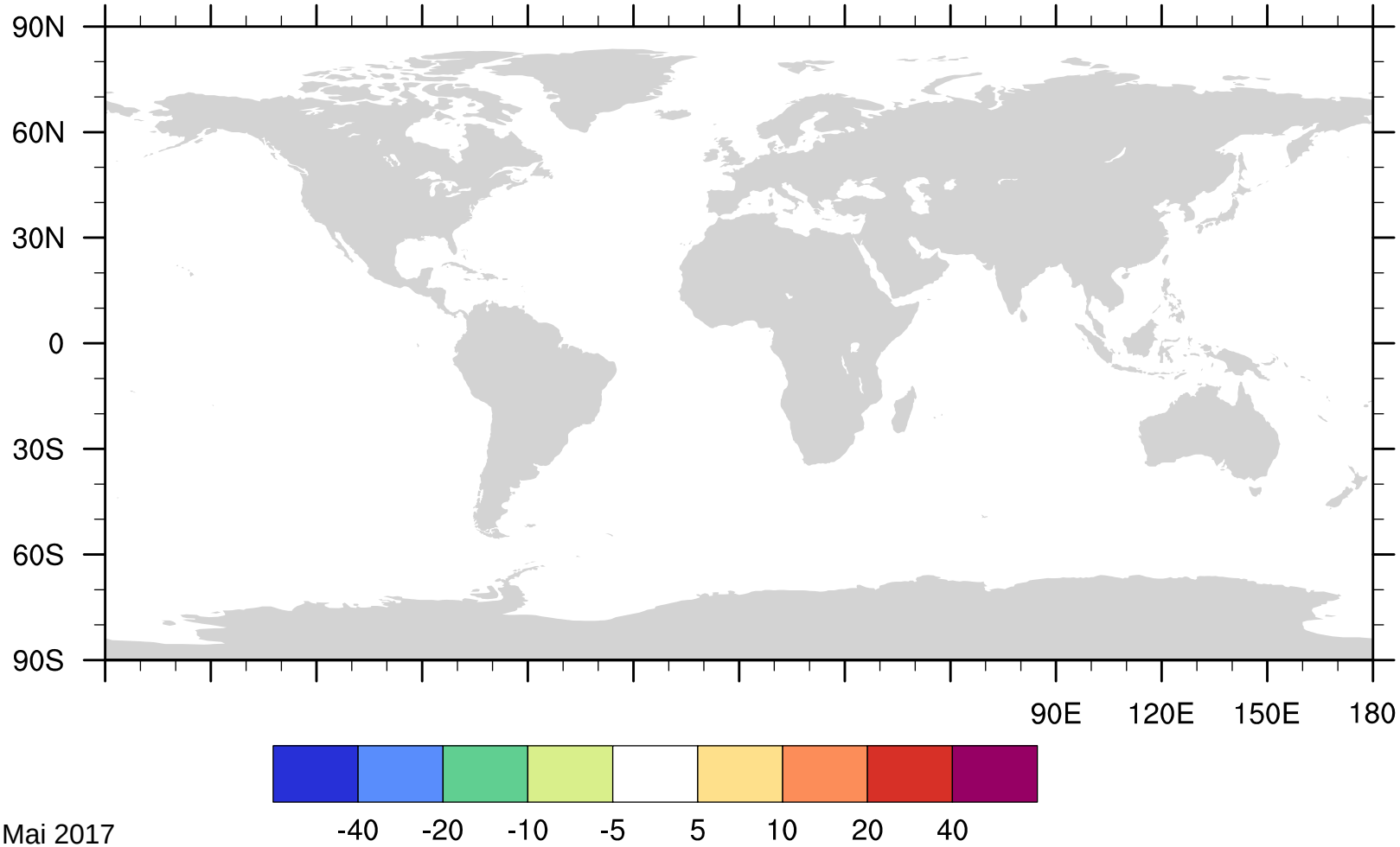
Correlation June $CAPE_{Europe}$ vs. T2M





beta ($Jkg^{-1}/°C$)

white lines: r^2 0.2,0.3,0.4,0.5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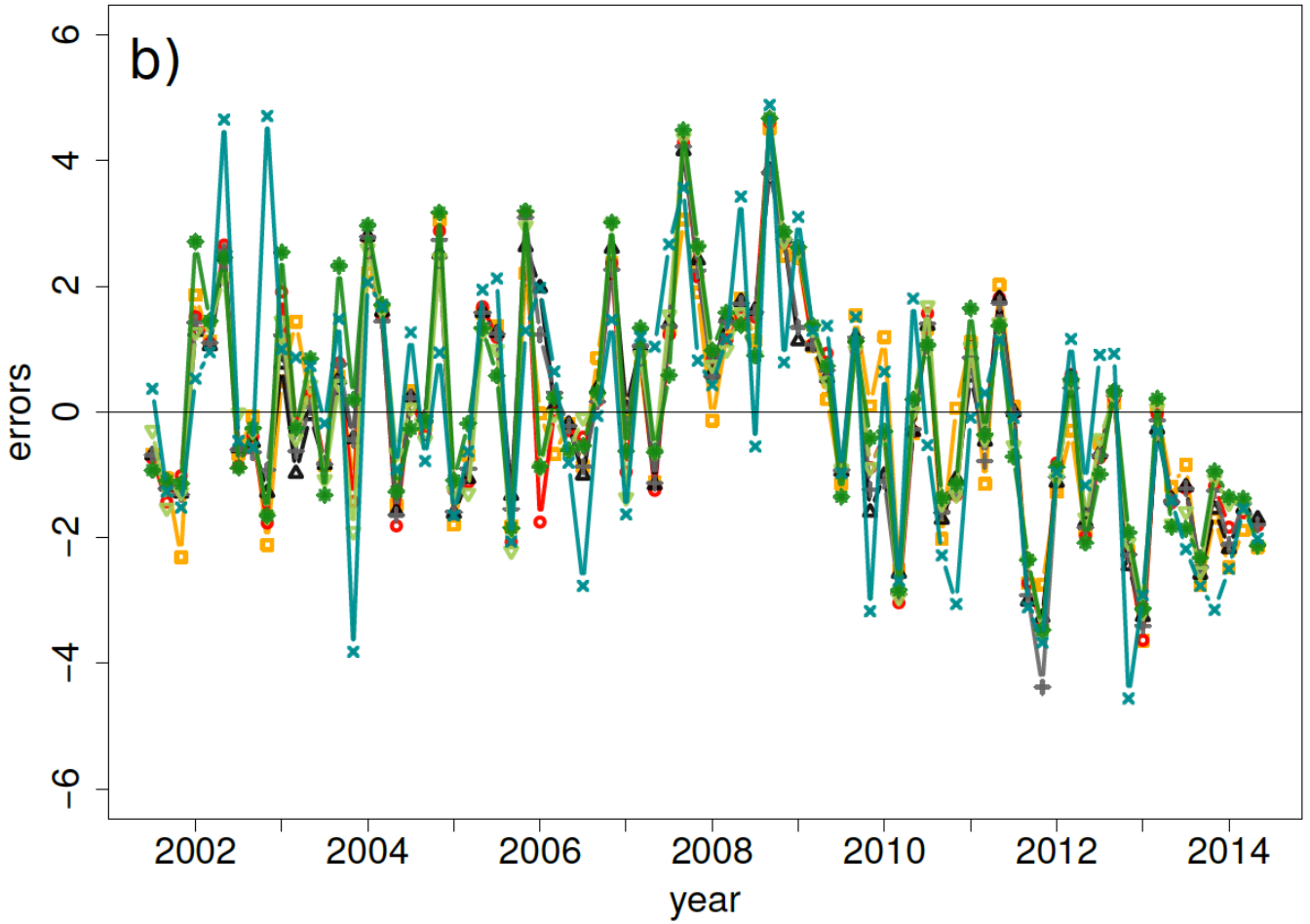
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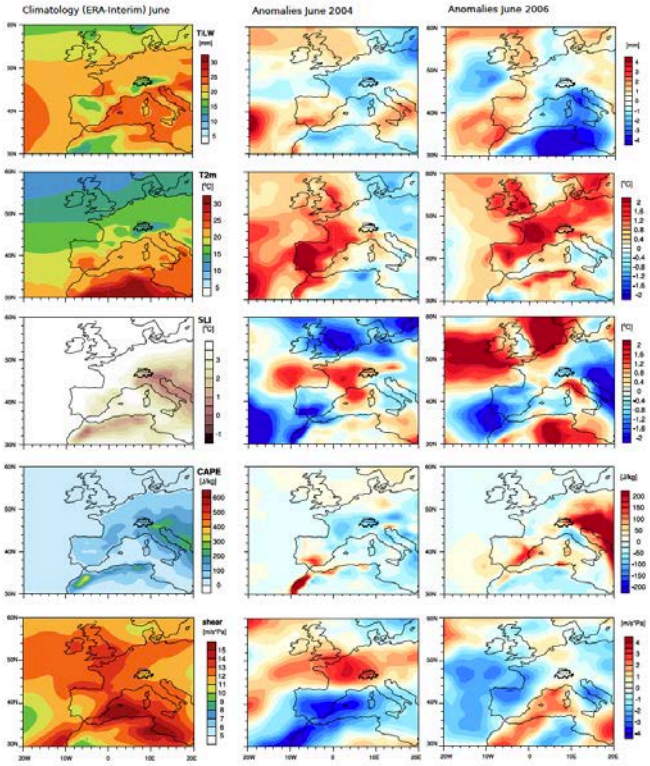
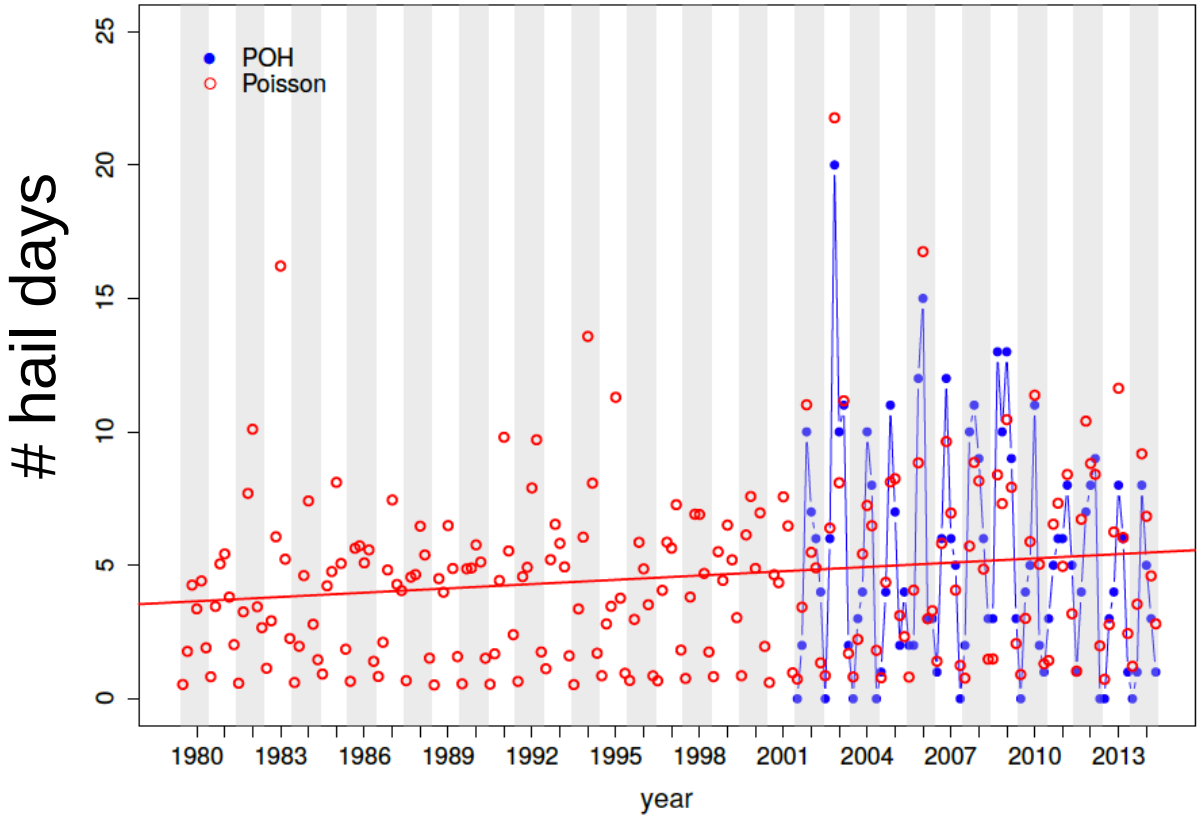


Figure 5: Fist column: June climatology of $TILW$ in mm, $T2m$ in $°C$, SLI in $°C$, $MLCAPE$ in J/kg and SH in $m/s \cdot Pa$. Second column: monthly mean anomalies of the same parameters for June 2004 (few days with hail). Third column: anomalies for June 2006 (many days with hail). The black box over Switzerland show the considered grid

Extension of time series back in time



Shear

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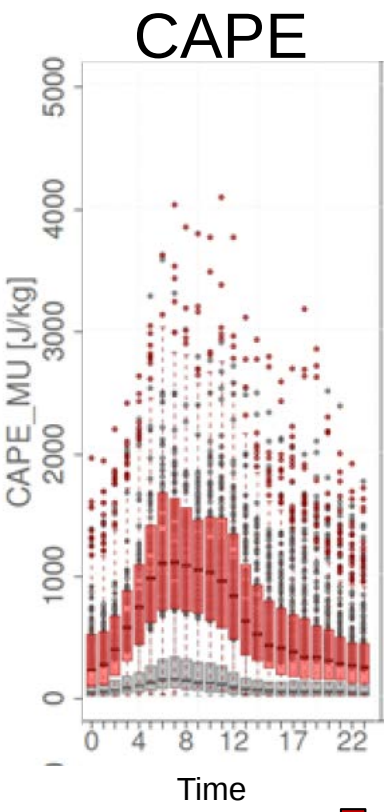

Hail days

Non-hail days

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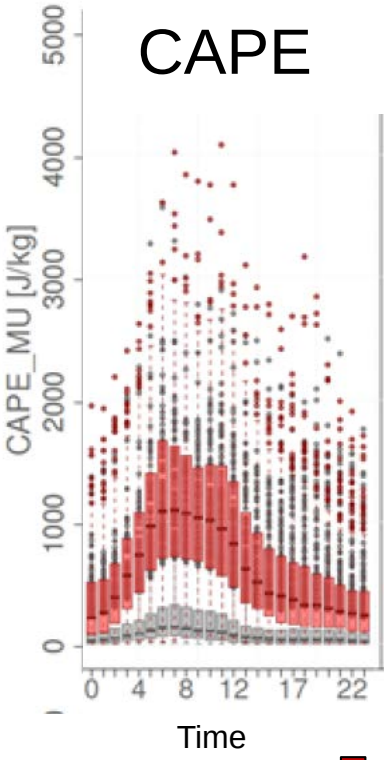
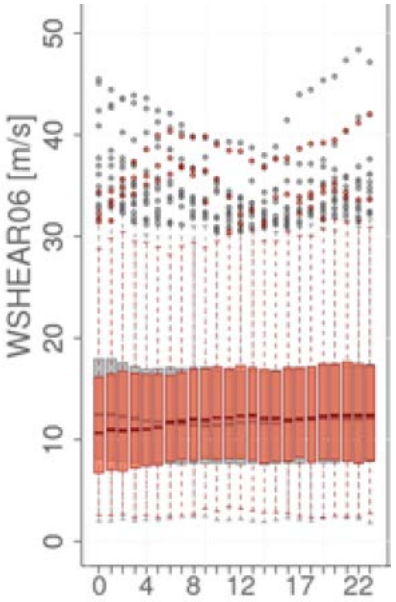
CAPE



Shear 0-6km



Hail days

Non-hail days

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