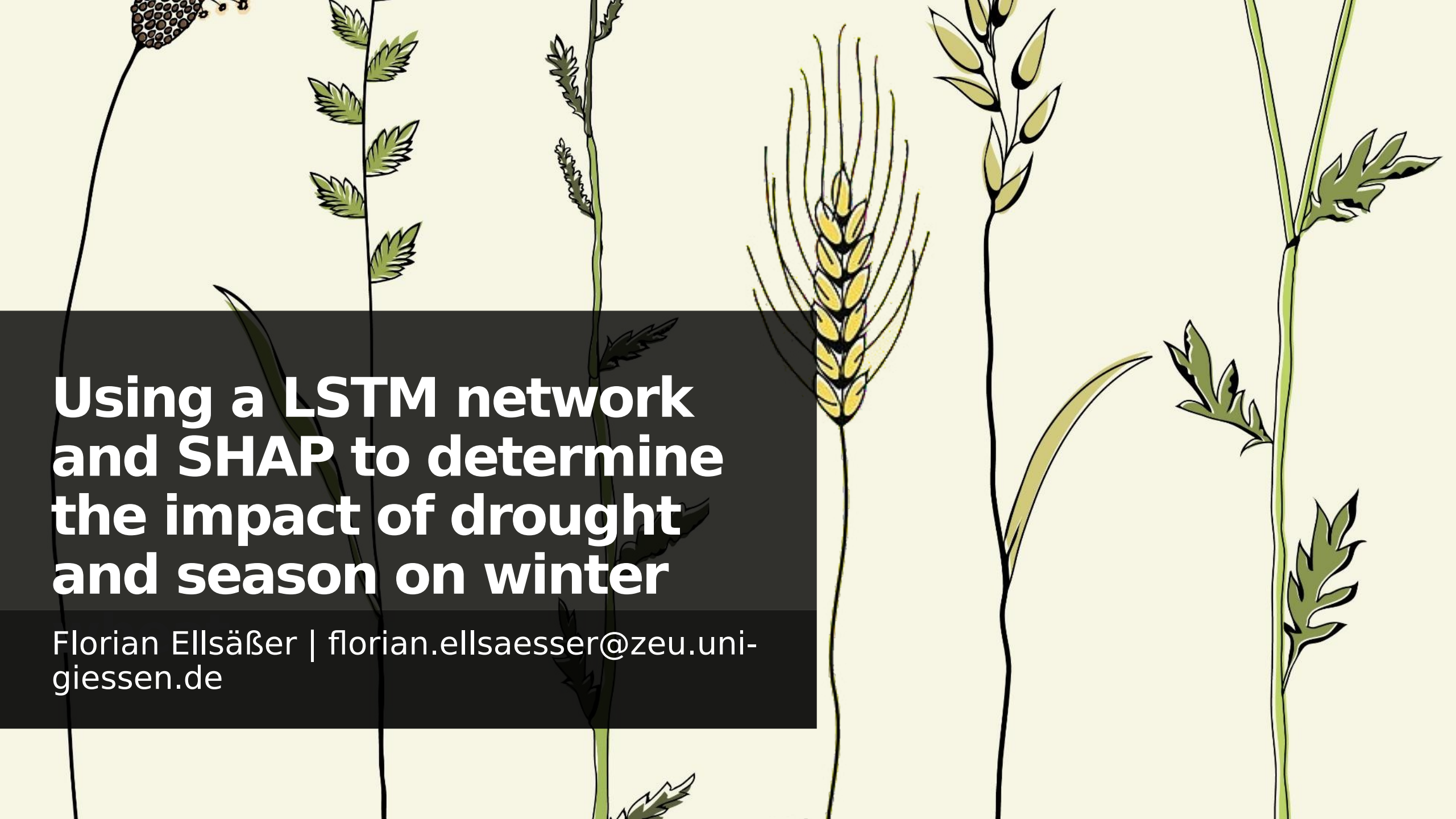


Using a LSTM network and SHAP to determine the impact of drought and season on winter

Florian Ellsäßer | florian.ellsaesser@zeu.uni-giessen.de

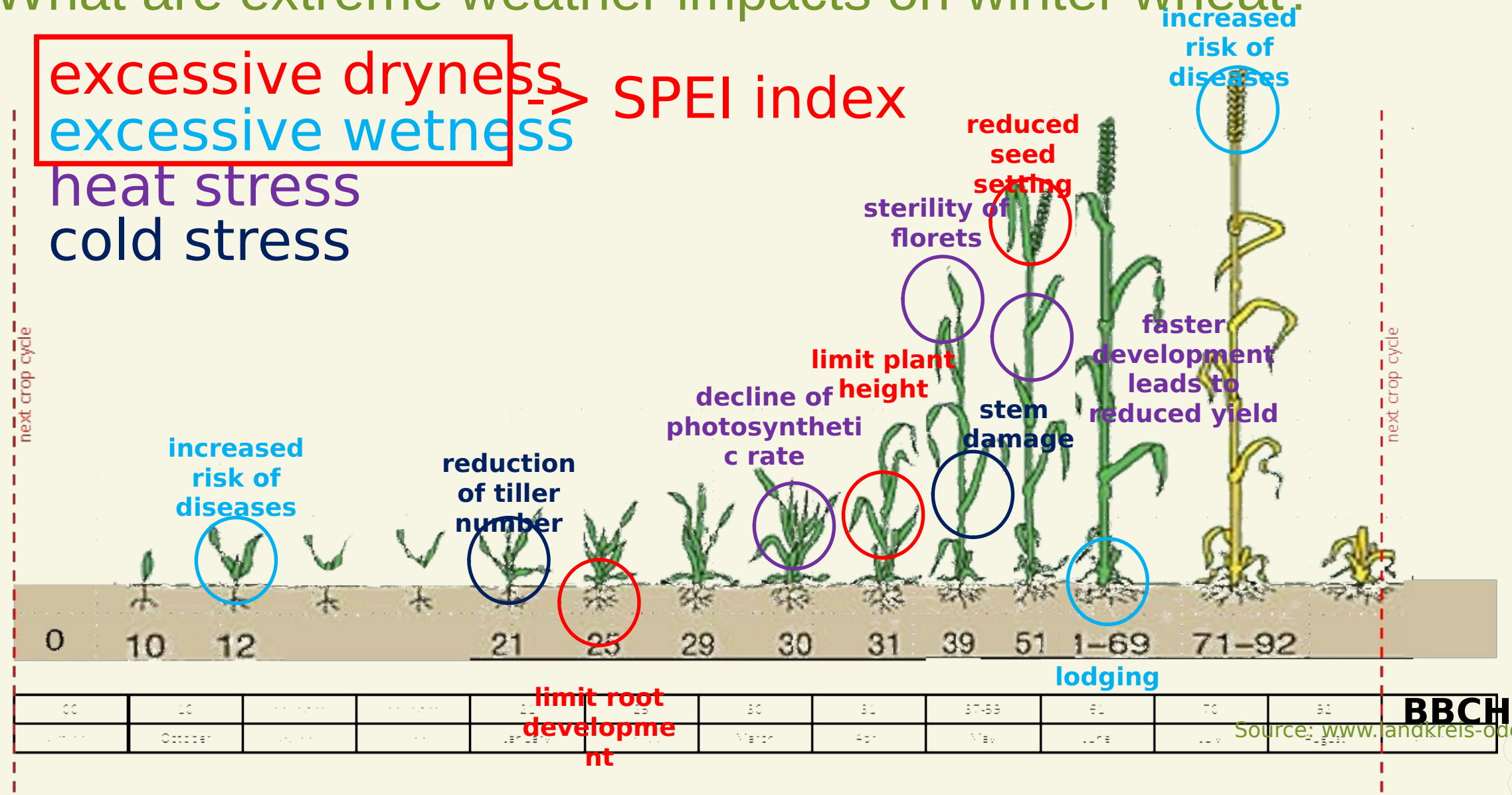
Extreme weather events are going to increase with climate change.

- Therefore droughts and heat waves are going to be come more common.
- These events have large impacts on crops.
- Estimating this impact and the attribution to weather events is difficult.

What are extreme weather impacts on winter wheat?

excessive dryness
excessive wetness
heat stress
cold stress

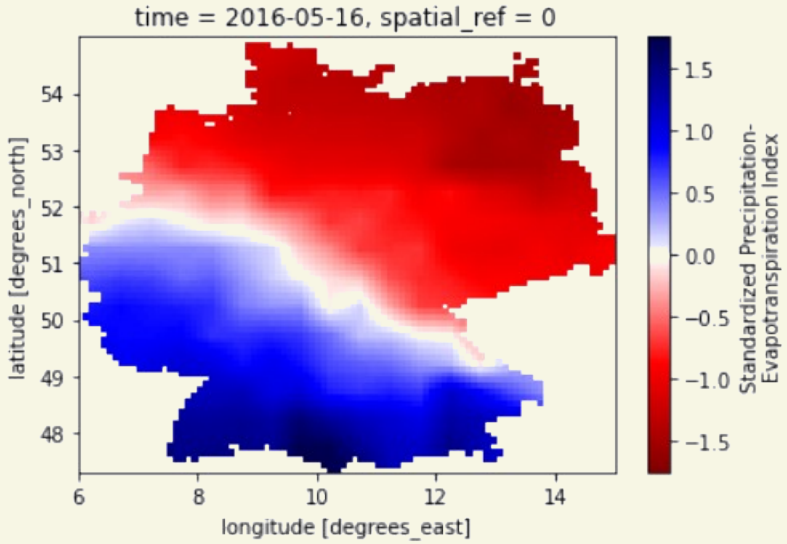
-> SPEI index



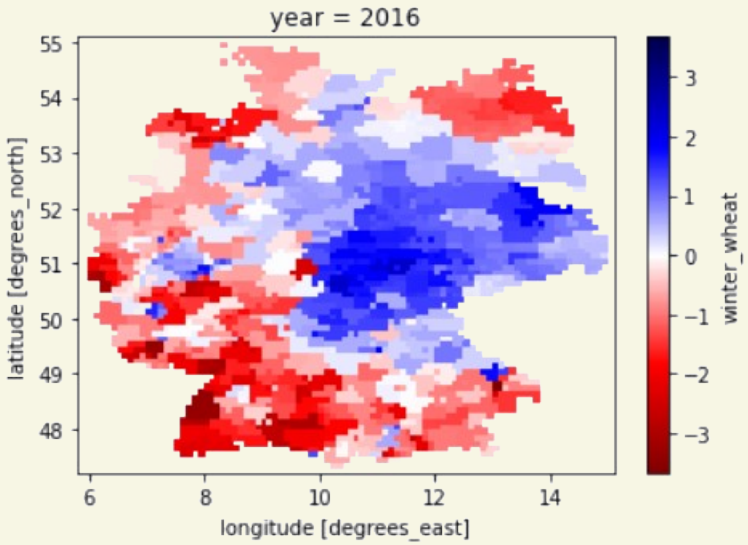
Source: www.landkreis-oder-spree.de

The data available for this analysis:

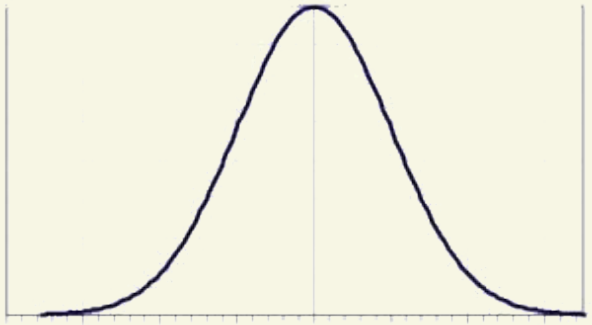
SPEI index



Yield anomaly index

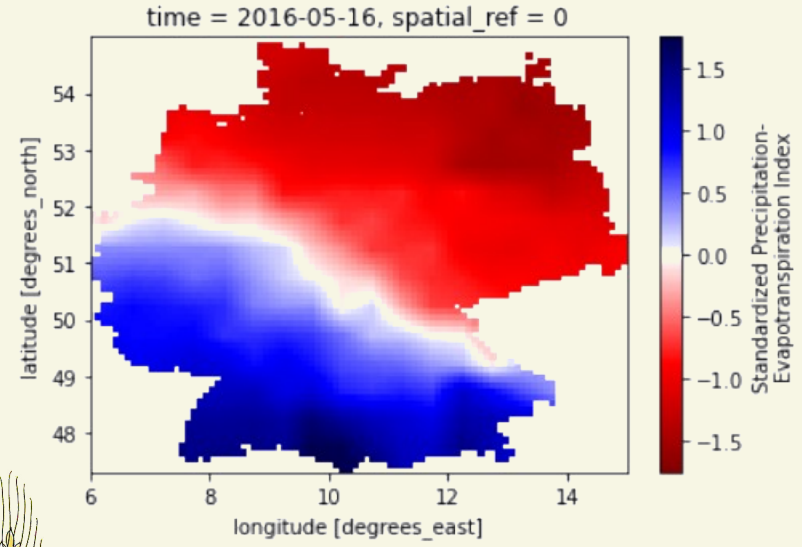


both are standardized!

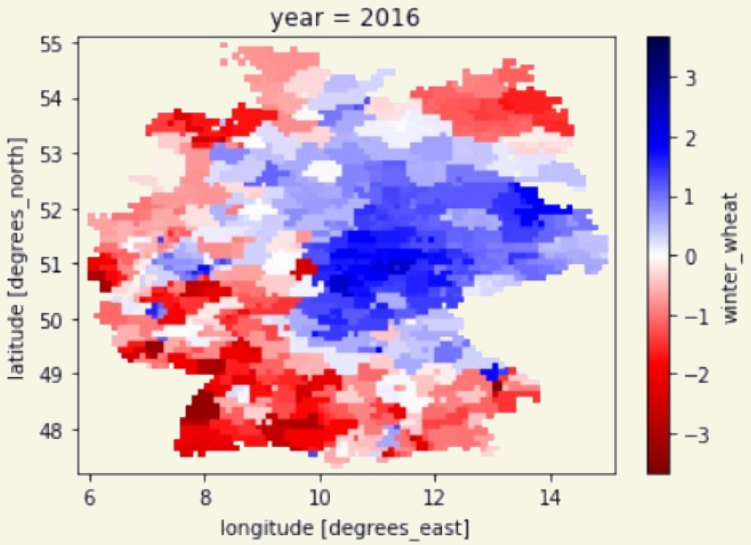


Basic idea: predict yield anomaly index from SPEI:

SPEI index



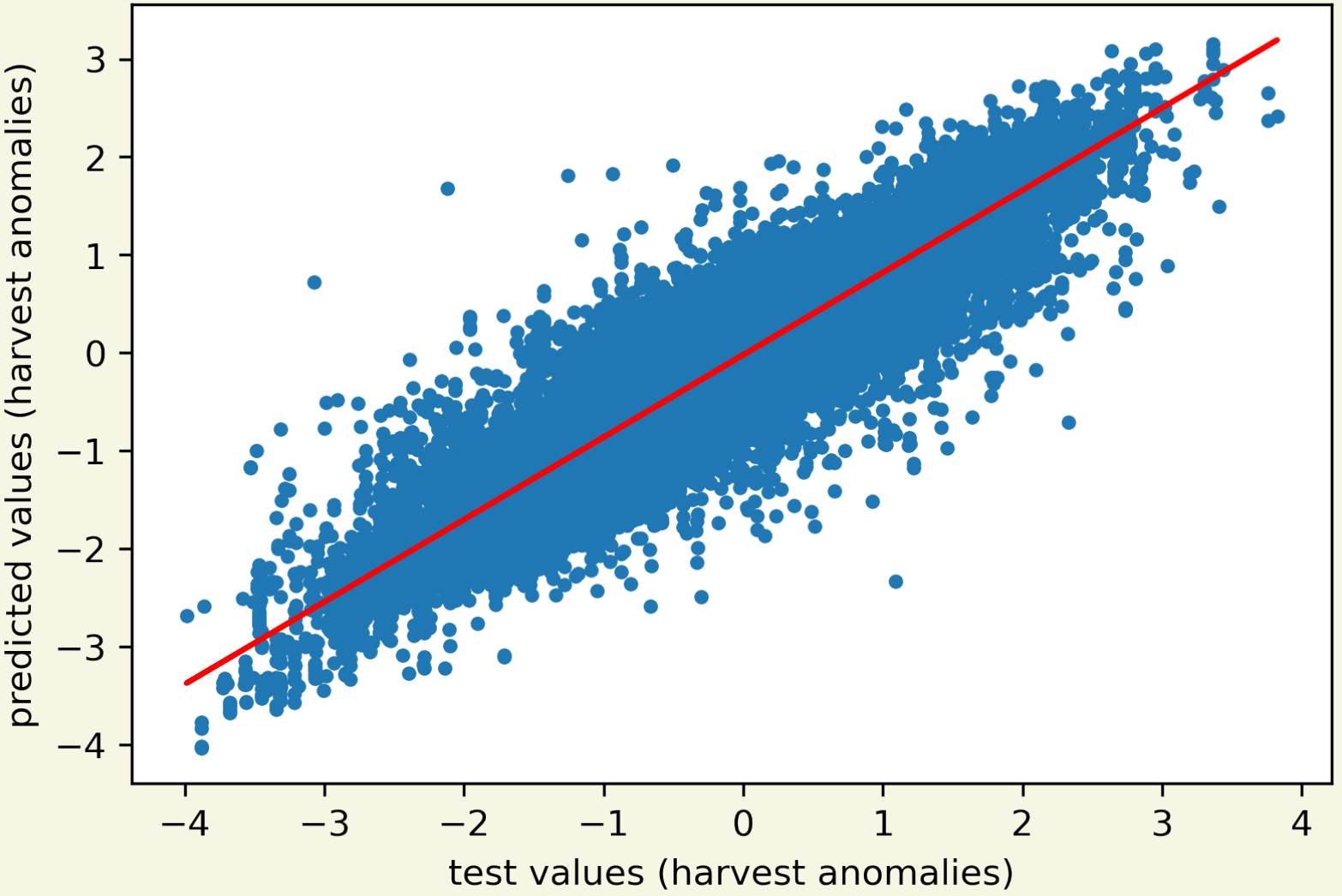
Yield anomaly index



Monthly SPEI for the 24 months before harvest

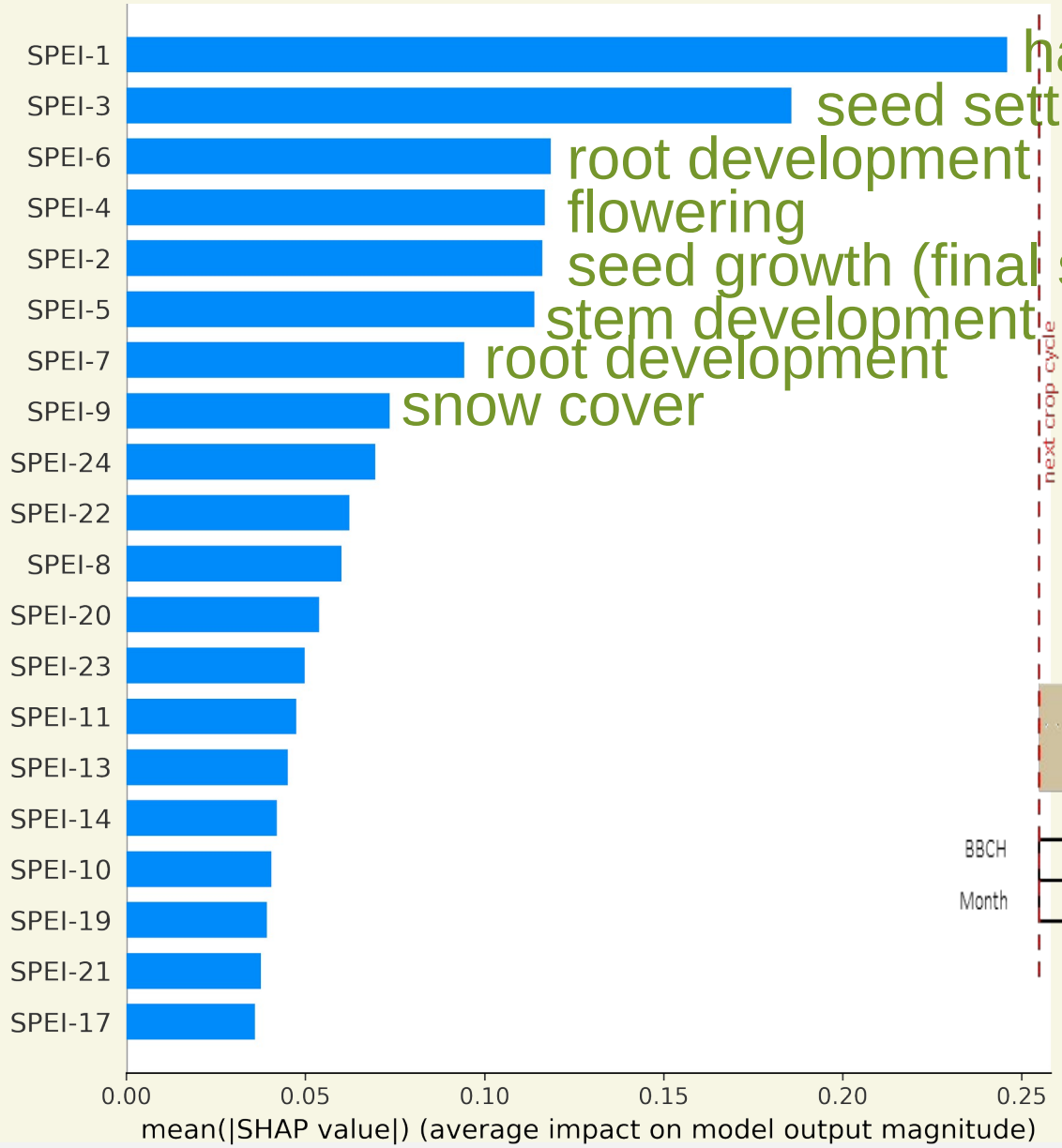
index	SPEI1	SPEI2	SPEI3	SPEI4	SPEI5	...	SPEI15	SPEI16	SPEI17	SPEI18	SPEI19	SPEI20	SPEI21	SPEI22	SPEI23
0.253998	-0.0661195	-0.782966	-0.826135	-1.37727	2.07509	...	-0.57584	-0.950108	-1.30758	-0.224126	-0.619107	1.02814	1.31124	0.194965	-2.49109
0.202103	0.331495	0.61942	-0.57584	-0.950108	-1.30758	...	0.919671	-2.06848	0.94181	1.81799	0.515882	-2.43713	-0.612407	-0.506765	-0.719052
0.481554	-1.07016	0.163858	0.919671	-2.06848	0.94181	...	0.0469507	-0.269022	-0.442812	-0.140853	0.142117	-1.05013	0.16098	2.09446	-0.0281459

LSTM network to predict yield anomaly from 24 months of SPEI




```
n predictions: 45036
slope: 1.0041306202293778
intercept: 0.020708794448
r: 0.9189115846806463
r²: 0.8443985004602965
p-value: 0.0
standard error: 0.0020312
```

SHAP to analyze feature importance.



harvest month

seed setting

root development

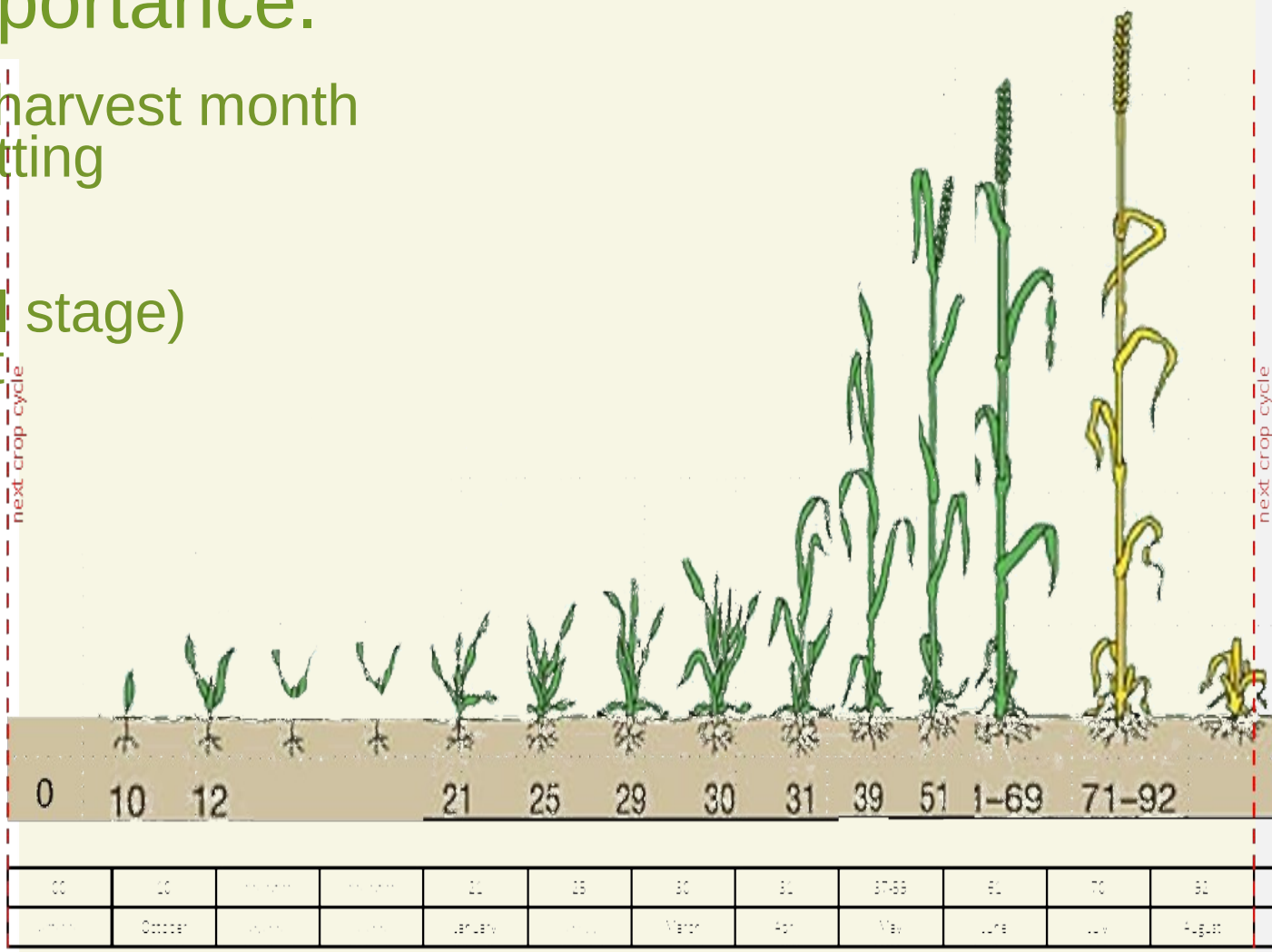
flowering

seed growth (final stage)

stem development

root development

snow cover



Outlook and possible improvements:

More data:

- Heat stress index
- Soil moisture index (in different depth)
- …