Spring and autumn impacts in 250 years of weather data

Noemi Imfeld and Stefan Brönnimann
Oeschger Centre for Climate Change Research, University of Bern, Switzerland
Institute of Geography, University of Bern, Switzerland
Correspondence: Noemi Imfeld (noemi.imfeld@giub.unibe.ch)

Abstract. ffff

1 Introduction

lalala

2 Data

2.1 Meteorolgical data

For the calculation of climate indices, we use a reconstruction of 250 years of daily mean temperature and daily precipitation sum (cite) covering a period from 1763-01-02 to 2020-12-31 with a resolution of 1 km. The meteorological fields are reconstructed using the analog resampling method, quantile mapping, and data assimilation. The meteorological fields are resampled based on the closest analogue day calculated between observations in the reference period and observations in the reconstruction periods. A detailed description of the reconstruction is found in Imfeld et al. Evaluation of the dataset shows that temperature is good, whereas precipitation skills are considerablly lower. Nevertheless, precipitation occurrence is valuable for Switzerland north of the Alps.

2.2 Phenological data

The Swiss phenological network (SPN) is operated since 1951 by the Swisss meteorological service and contains observations of phenological phases at xx locations which are conducted by voluntary observers.

Two long phenological series for cherry blossom in Liestal and horse chestnut in Geneva exist.

2.3 Additional data sets

any additional datasets?

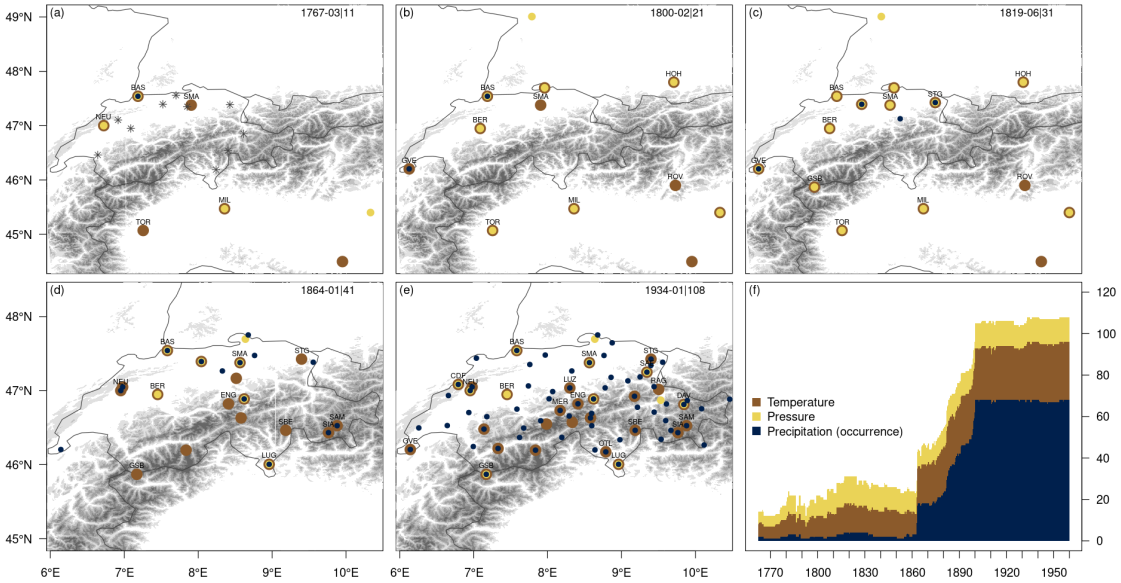

Figure 1. Phaenonetwork?

3 Methods

3.1 Phenological indices

Calibration of models

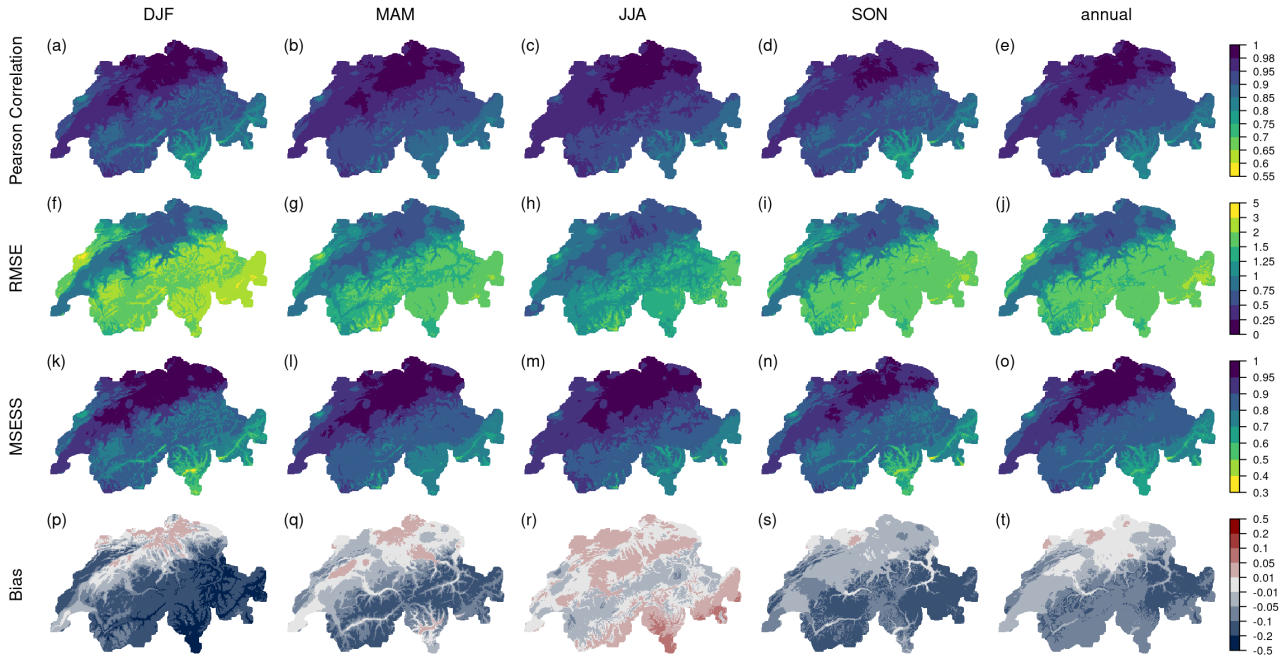

Figure 2. Cross-validation results of a network of 31 stations as in Fig. 1c for temperature anomalies during 1961-2020 for the four seasons (DJF, MAM, JJA, SON) and annually. a-e) Pearson correlation, f-j) RMSE, and k-o) MSESS, and p-t)mean bias.

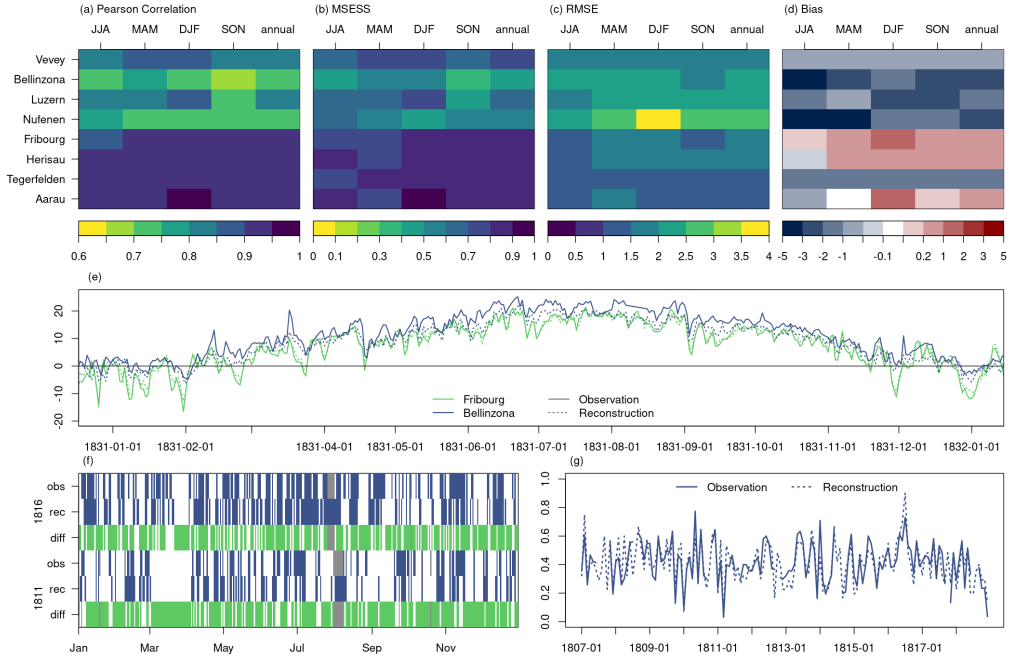

Figure 3. Evaluation of the closest grid point from the reconstruction and the observations for values with removed seasonality. a) Pearson correlation, b) RMSE, c) MSESS, and d) mean bias. Each box shows the four seasons and annual v f) Comparison of monthly wet day frequency for the period 1807 to 1818 for the data from e).

3.2 Climate indices

4 Results

4.1 Comparison to long phenological time series

4.2 Variability in phenological indices

4.3 Variability in climate indices

4.4 Co-occurrence vegetation and

4.5 Late 20th century abrupt warming

5 A series of very cold springs

6 Discussion

7 Conclusions

Late frost events impacts.

Table 1. Reported impacts of long lasting snow cover, late spring frost, and advances in spring phenology.

Time	Location	Impacts	Source
Spring	Geneva	snow impact on agriculture	**?**
April	Adelboden (BE)	abundant snow	**?**
April	Gurzelen (BE)	snow impacts on agriculture	Oekonomische Gesellschaft Bern, metadata in **?**
April	Bern (BE)	snow impacts on agriculture	Oekonomische Gesellschaft Bern, metadata in **?**
April	Bodensee	abundant rain, snowfall, hay prices increase	**?**
April/May	Appenzell-Innerrhoden	late snowmelt	**?**
May	Uri	abundant snow	**?**
June/July	Gurzelen (BE)	fresh snow at higher elevations	quoted in (**?**)
July	Bodensee	abundant rain, hail, rain impact	**?**
August	Bodensee	abundant rain, impacts of floods and high water level	**?**
Summer	Glarus	pasture yield poor: most mountain snow cover does not melt	**?**
Summer	Grindelwald (BE)	permanent snow cover	**?**
Summer	Stockhorn Massif	permanent snow cover	quoted in **?**
Summer	Rheintal (SG)	high water level	**?**
September	Gurzelen (BE)	fresh snow at higher elevations	Oekonomische Gesellschaft Bern, metadata in **?**
September	Erguel (BE)	production of vegetables/potatoes very poor	**?**

Code availability. The code for the calculation of indices and analysis is available in the supplement.

Data availability. Reconstructed daily precipitation and temperature data sets over the period 1763-01-02 to 2020-12-31 are published at the open-access repository PANGAEA (https://doi.org/xxxx;). Climate indices and the phenological reconstructions for the period 1763 to 2020 are published at the open-access repository PANGAEA (https://doi.org/xxxx;).

Author contributions. NI performed the reconstruction and the case studies and wrote the manuscript. LP created the first version of the data set for the period 1864 to 2017. YB provided the historical observations. SB provided the idea for reconstruction and supervised the process. LP, YB, and SB contributed to the manuscript.

Competing interests. The authors declare that they have no conflict of interest.

Acknowledgements. This work was funded by the Swiss National Science Foundation (project "WeaR", grant no. 188701) and by the European Commission through H2020 (ERC Grant PALAEO-RA 787574). The authors acknowledge the data provided by the projects "CHIMES" (SNF grant no. 169676) (**?**), "Long Swiss Meteorological series" funded by MeteoSwiss through GCOS Switzerland (**?**), and "DigiHom" (**?**).