Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

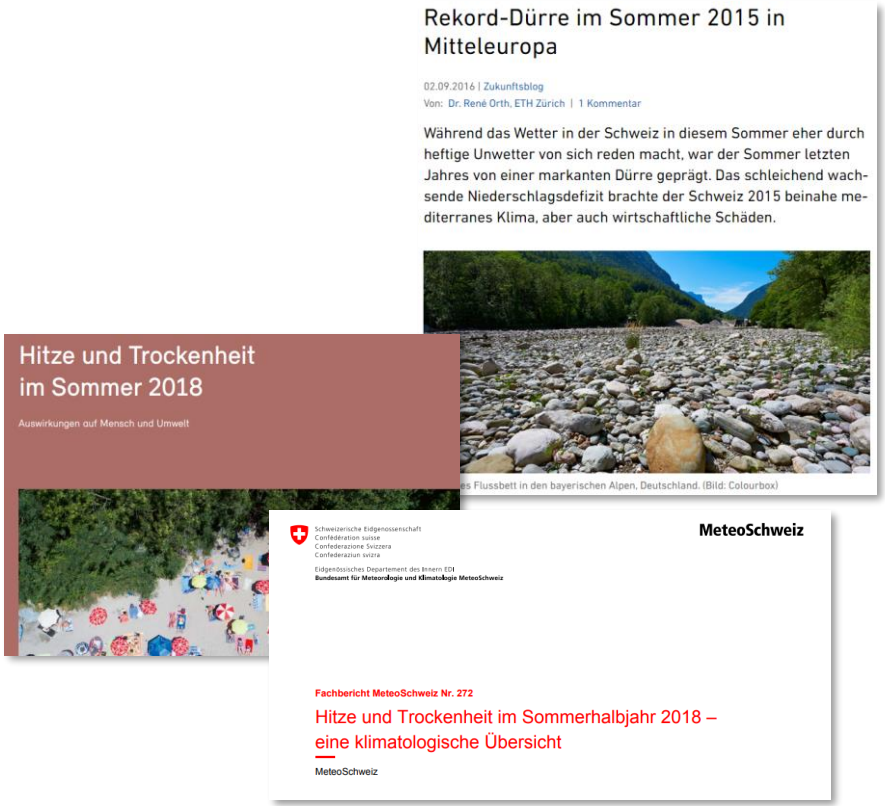
Swiss Confederation

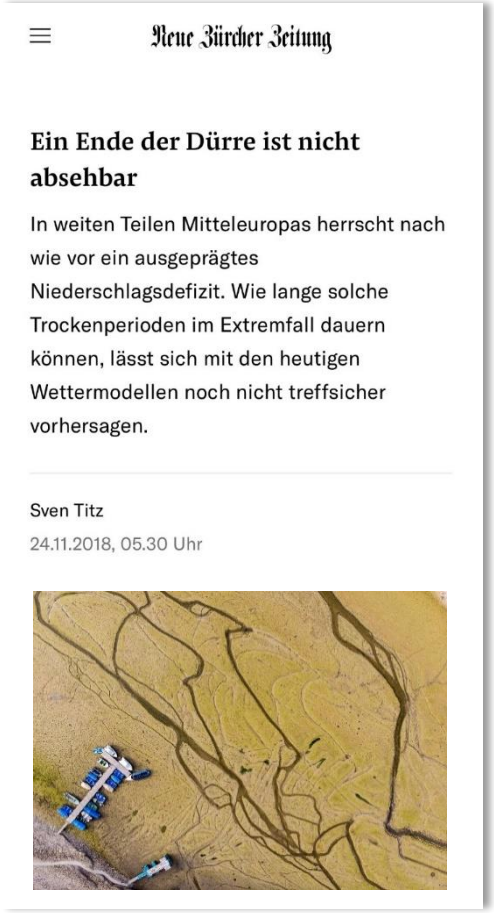
Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

Operational Drought Monitoring in Switzerland

Anke Tetzlaff, Vincent Humphrey, Annkatrin Rassl, Simon Scherrer, Christian Grams

Motivation



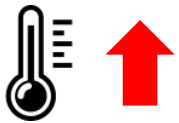
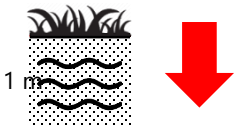


Summer Droughts in Switzerland

TOP 5 since 1981

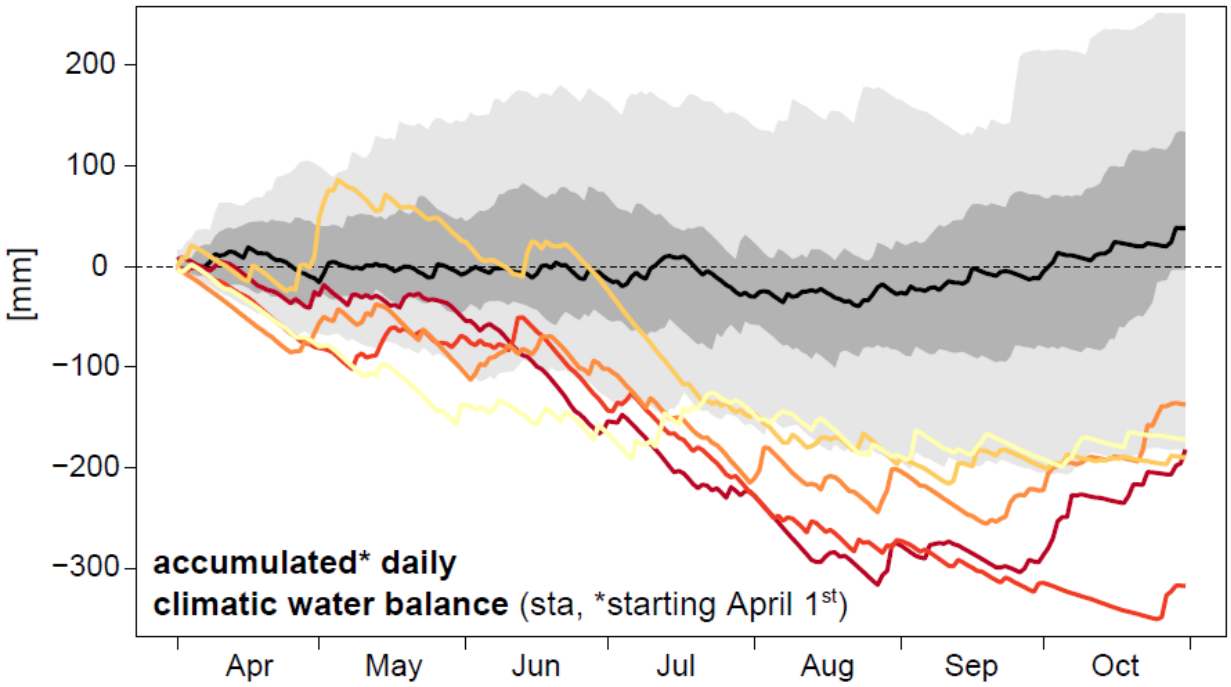
2018 2003 2020 2015 2011

Changes 1981-2020

Precipitation	Temperature	Evapotranspiration	Soil Moisture
			
–66 mm (–11 %)	+2,2 °C	≈ +60 mm (+11 %)	≈ –20 mm (–5 %)

Scherrer et al. (2022)
https://doi.org/10.1088/2515-7620/ac4fb9

Summer Droughts in Switzerland since 1981

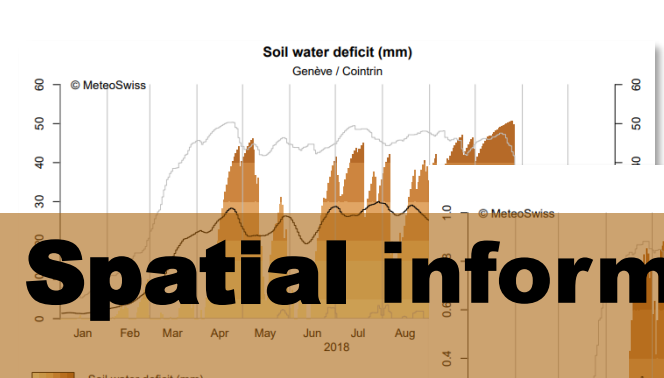


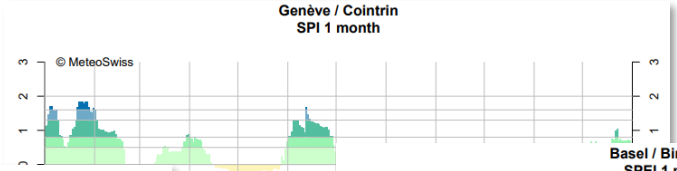
MeteoSwiss

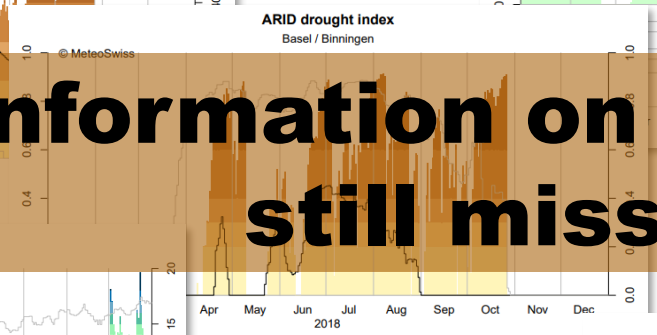
Swiss Drought Program

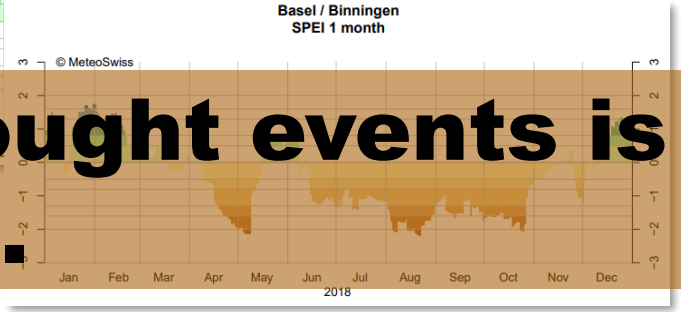
The Federal Office of Meteorology and Climatology MeteoSwiss, the Federal Office for the Environment FOEN and the Federal Office of Topography swisstopo are jointly developing a national drought monitoring and warning platform until 2027.

Existing Drought Products

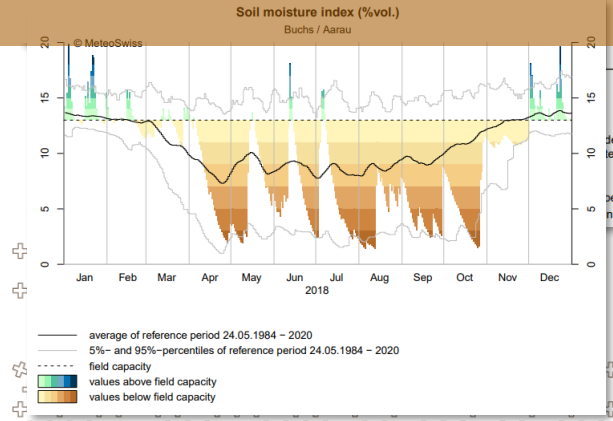


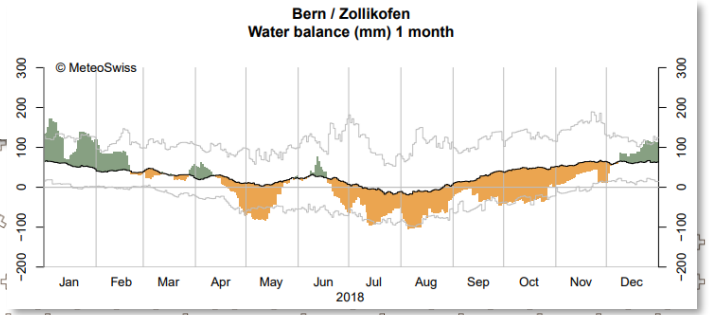






Spatial information on drought events is still missing.





CM SAF & LSA SAF Products for Drought Monitoring

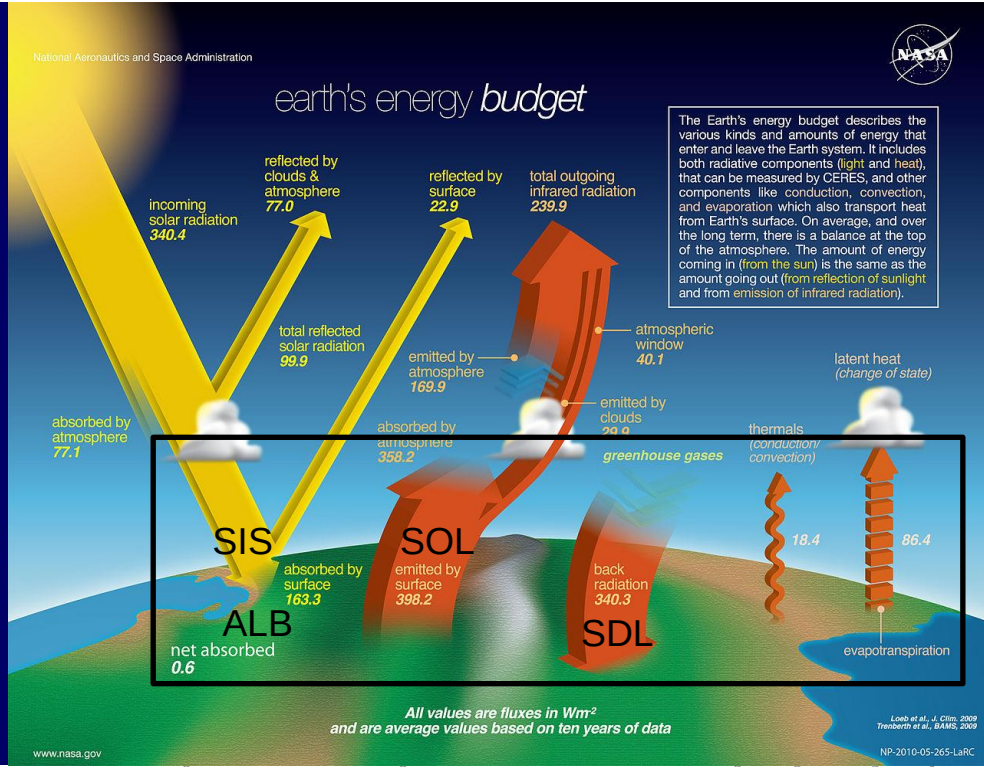
Land Flux CDR 1983-2020

EUMETSAT CM SAF

EUMETSAT LSA SAF

Joint retrieval of the entire Surface Radiation Budget and Surface Fluxes:

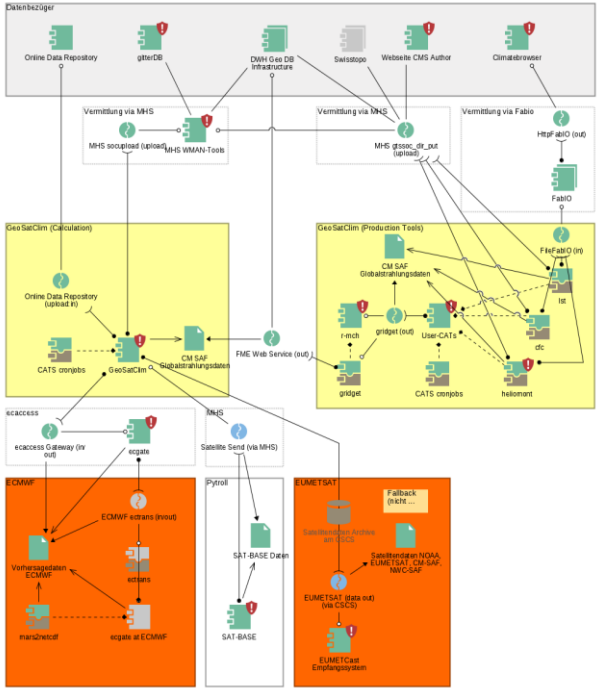
- Cloud Fraction
- Surface Radiation Budget including single components
- Land Surface Temperature
- Latent and sensible heat



Extention of LSA SAF real-time products into the past.

MeteoSwiss Operational Processing

CM SAF GeoSATClim

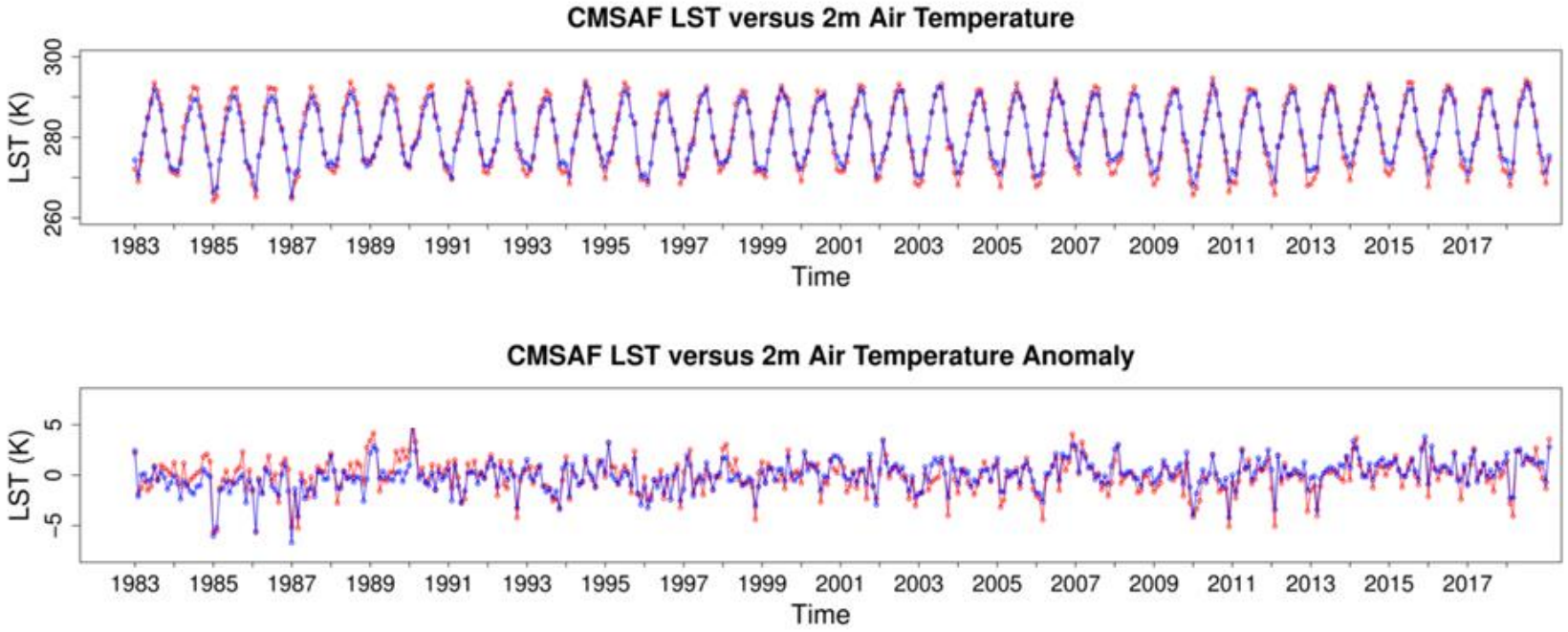


Every day at 6:00 am we generate hourly data for the previous day for Switzerland using the CM SAF software GeoSatClim «ICDR».

GeoSatClim was also used to calculate hourly, daily and monthly climatologies covering the period 1991 to 2020 «CDR».

For our climate services we need both CDR and ICDR.

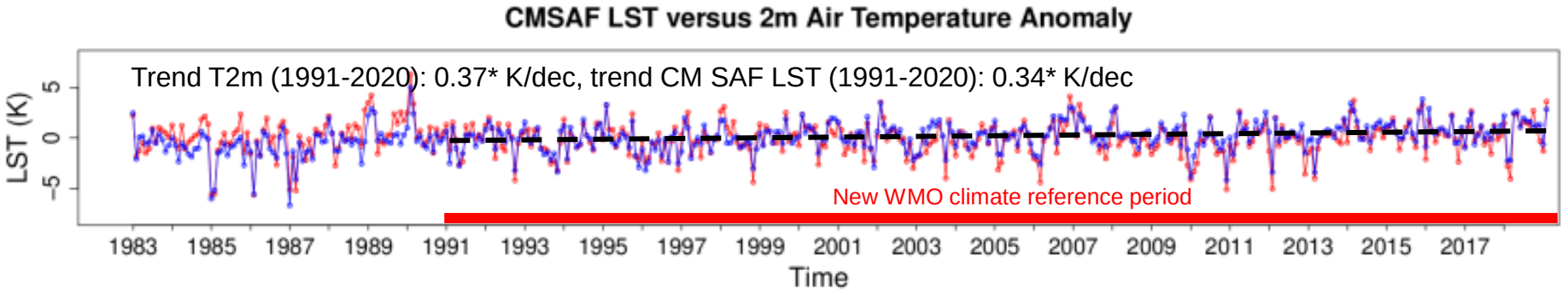
Land Surface Temperature since 1983



EUMETSAT CM SAF

EUMETSAT LSA SAF

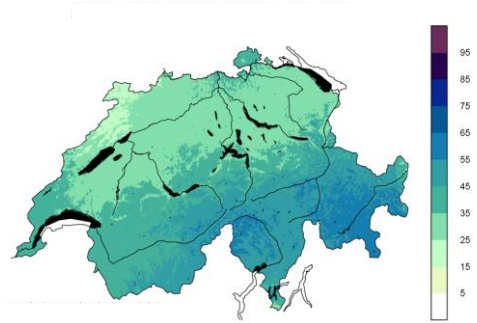
LST trends versus air temperature



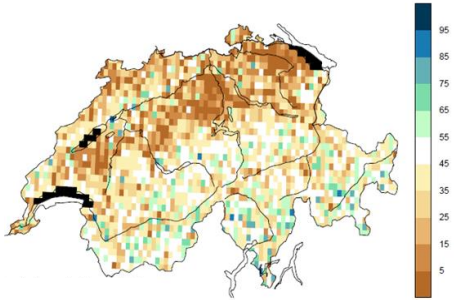
Temperature trends calculated from CM SAF LSTs for Europe are with 0.34 K/decade almost identical to trends obtained from homoginized air temperature data.

How to integrate satellite data for the national drought monitoring?

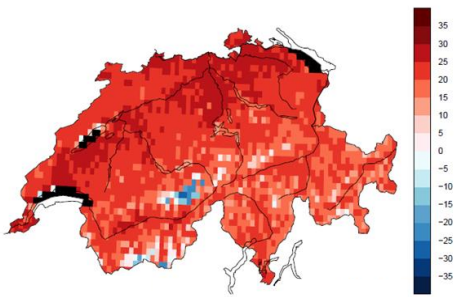
Satellite-Based Drought Indices



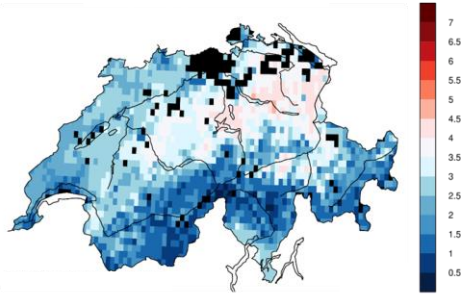
H SAF ASCAT surface **soil moisture** product



NOAA AVHRR **vegetation products**



CM SAF **land surface temperature**



LSA SAF Meteosat **evapotranspiration** products

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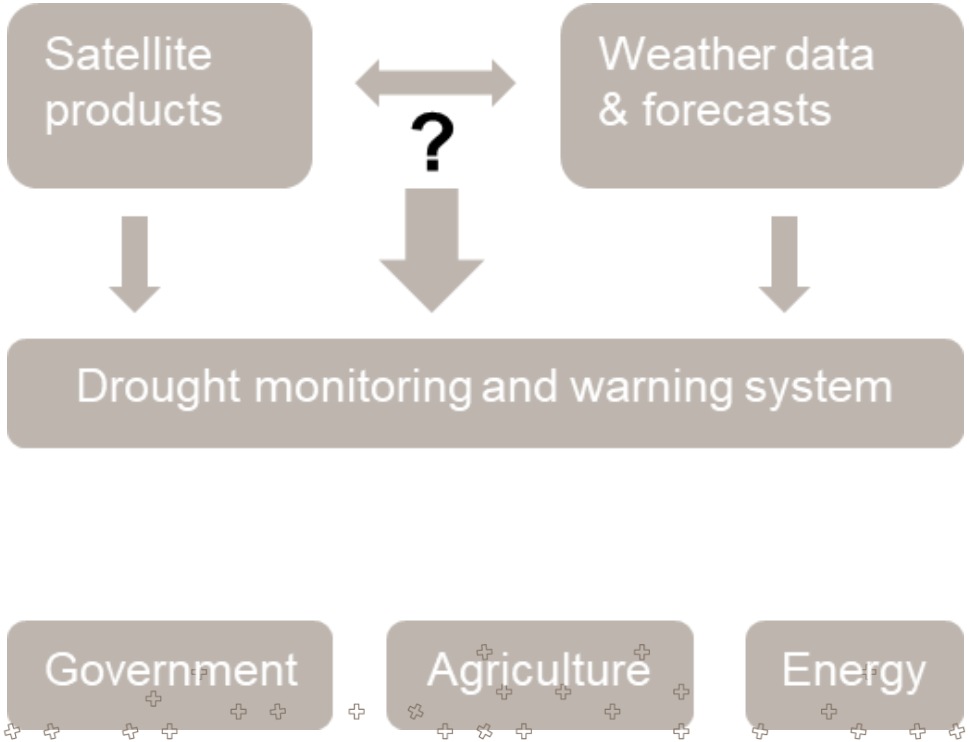
Climatological Drought Monitoring in Switzerland Using EUMETSAT SAF Satellite Data

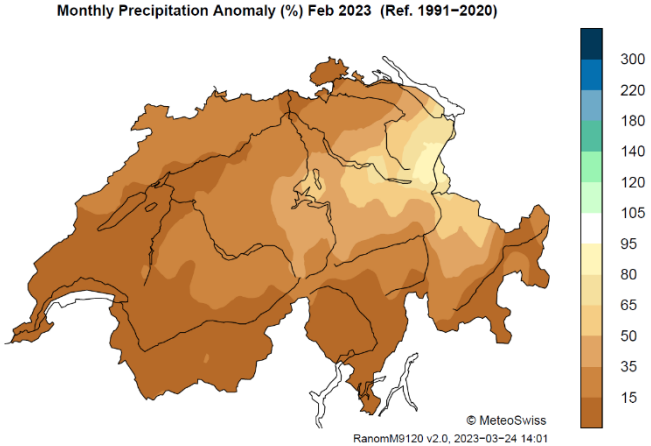
by Annkatrin Rassl [1], Dominik Michel [2], Martin Hirschi [2], Anke Duguay-Tetzlaff [1,*] and Sonia I. Seneviratne [2]

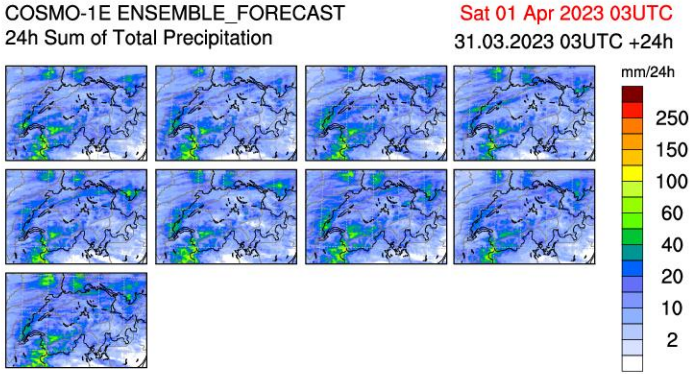
Integration of satellite products



Synergies: Seamless prediction

Historical weather data | Weather forecast





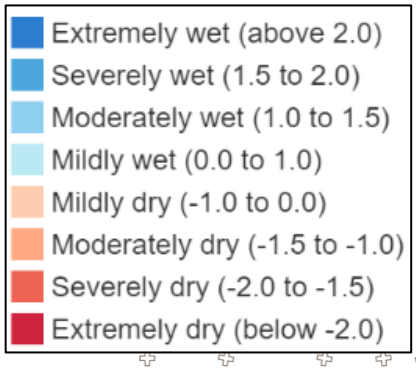
MeteoSwiss

Synergies

Historical weather data → Weather forecast

Drought indices (e.g. SPI, SPEI, …)

Warning?

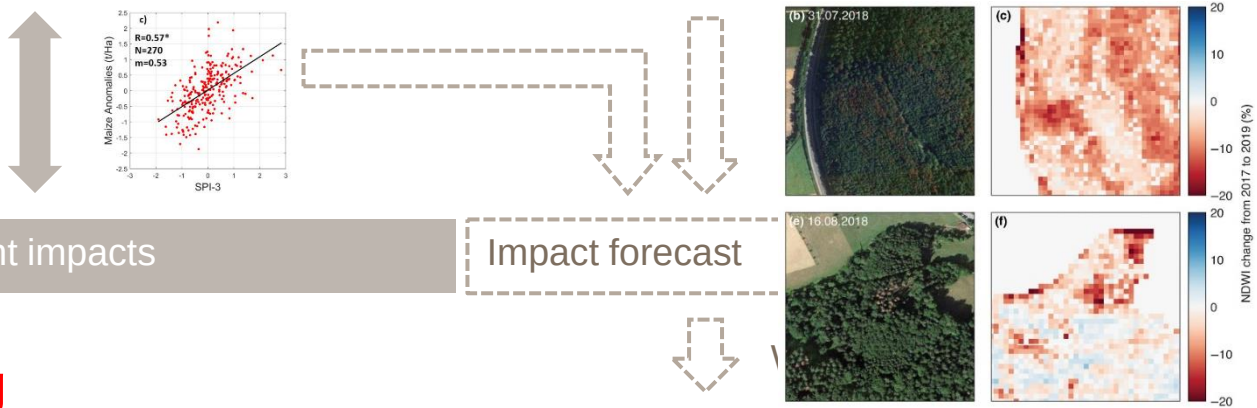


User Requirements

Historical weather data

Weather forecast

Drought indices (e.g. SPI, SPEI, …)



Historical drought impacts

Impact forecast

- Impact mapping
- High resolution
- Climate signal back to 1991

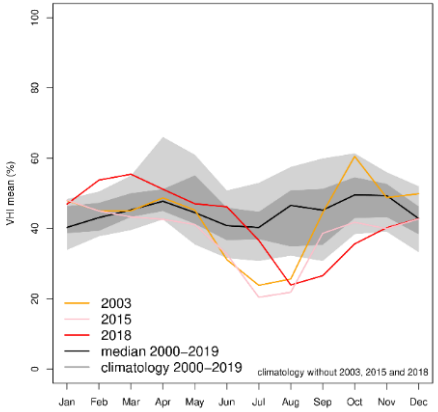
MeteoSwiss

Czech drought monitor
intersucho.cz

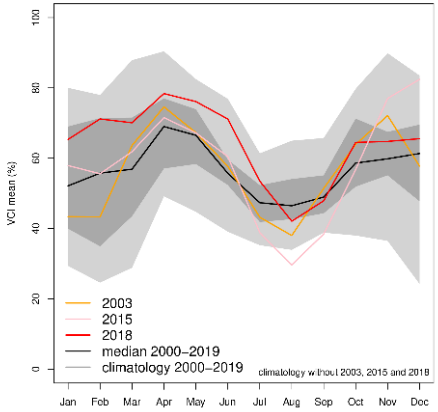
- no drought impact
- drought affected crops, yield loss up to 10%
- moderate drought damage, yield loss 10 - 30 %
- severe drought damage, yield loss 30 - 40 %
- extreme drought damage, yield loss above 40%

Vegetation Heat Index

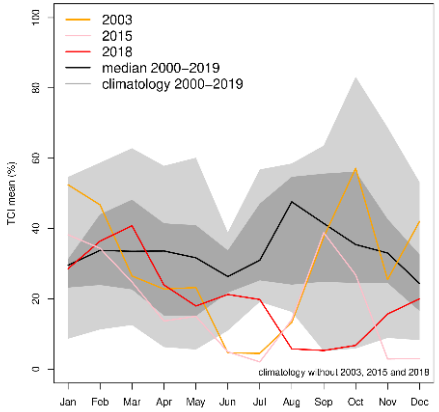
VHI



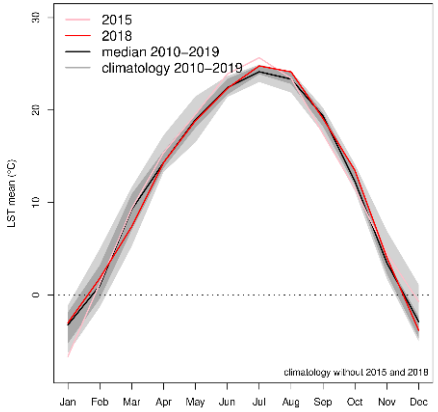
VCI



TCI



LST



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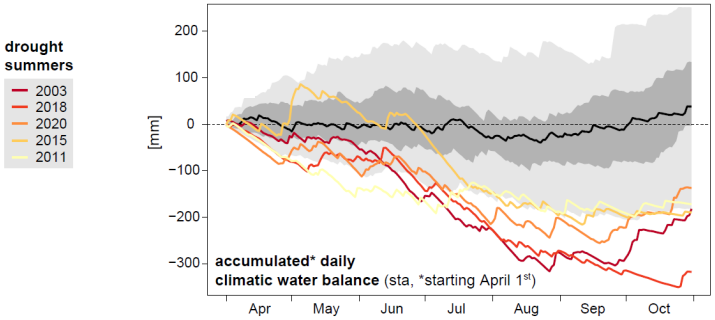
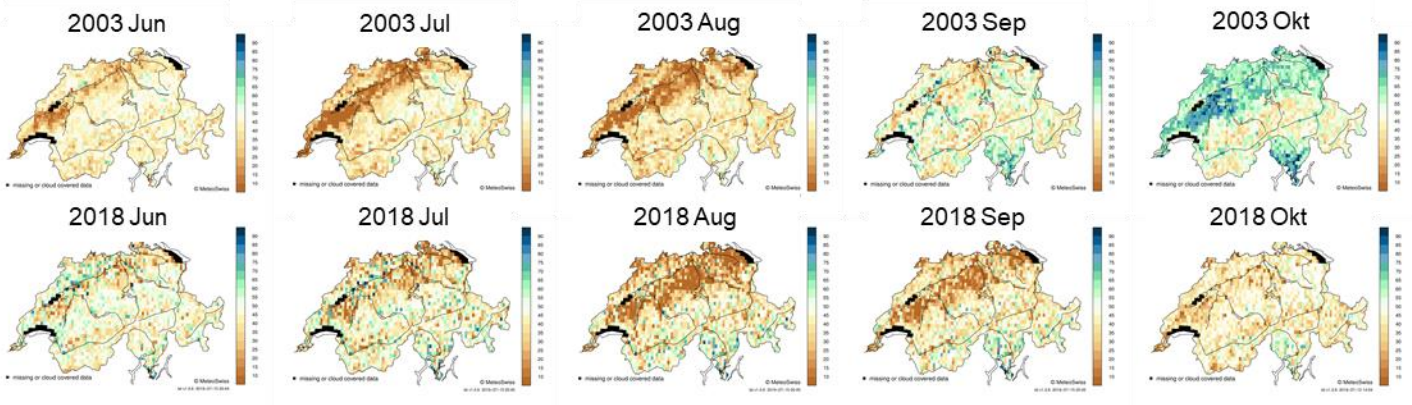
Vegetation Heat Index 2003 + 2018





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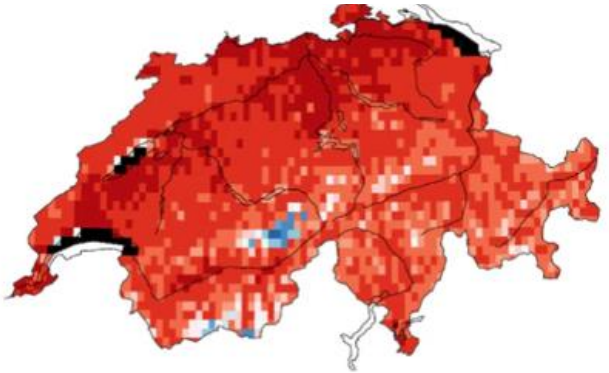
New Climate Service on Drought using the CM SAF Land Surface Temperature CDR

High Resolution

Sentinel-2 Vegetation NDVI

Climate Data back to 1991

Meteosat Land Surface Temperature



$$VCI = \frac{NDVI_{current} - NDVI_{Ref,min}}{NDVI_{Ref,max} - NDVI_{Ref,min}} \times 100\%$$

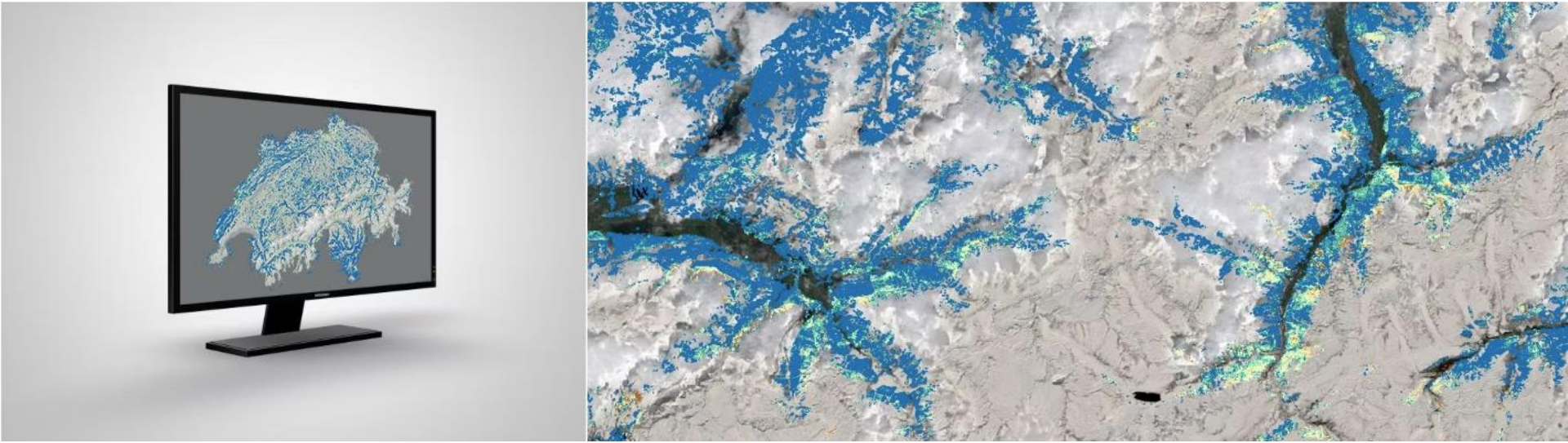
MeteoSwiss «CM SAF» ICDR

$$TCI = \frac{T_{Ref,max} - T_{current}}{T_{Ref,max} - T_{Ref,min}} \times 100\%$$

CM SAF CDR

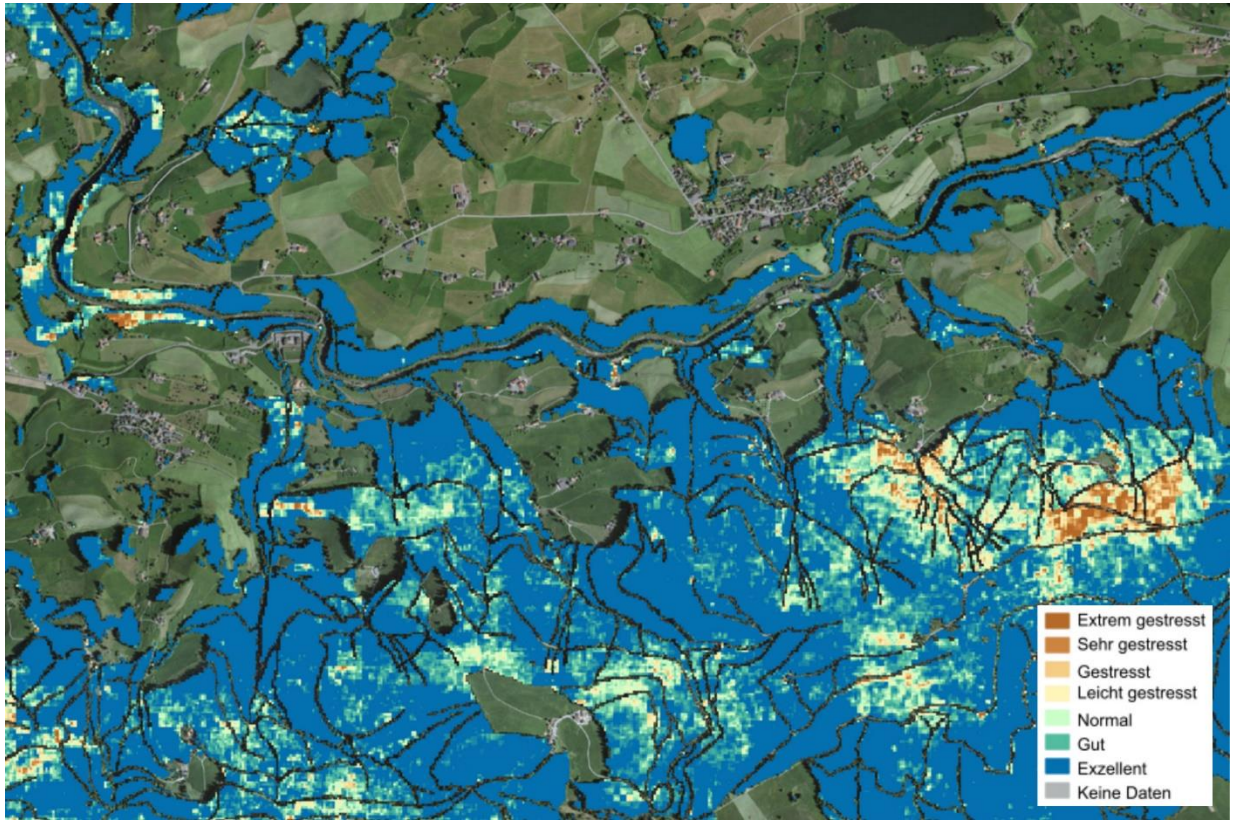
$$VHI = \alpha VCI + (1 - \alpha)TCI, \text{where } \alpha = 0.5$$

New Climate Service on Drought using Land Surface Temperature CDR

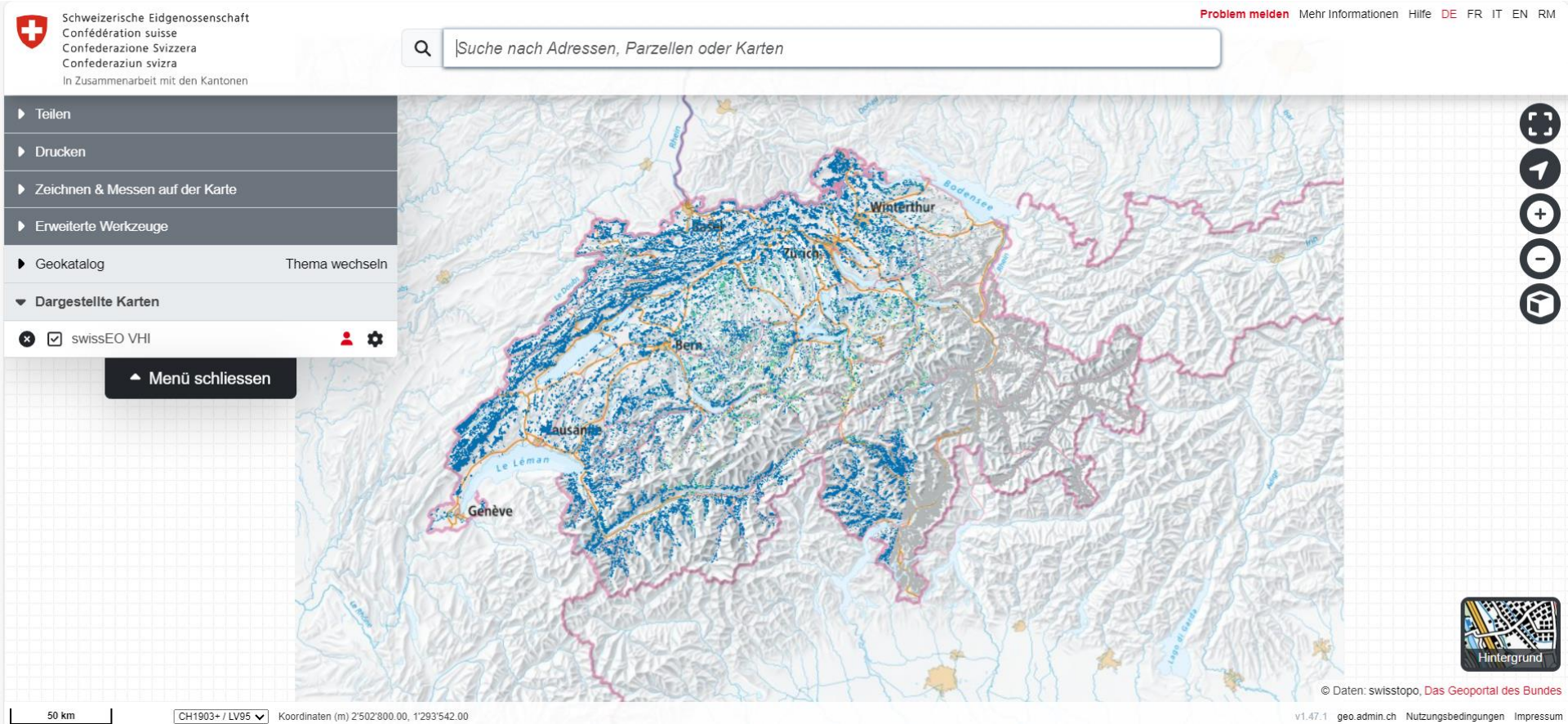


Combinging the SAF Land Surface Temperature with high resolution Sentinel vegetation data

Example: Forest Canton Zug



Example 21.09.2024



Summery

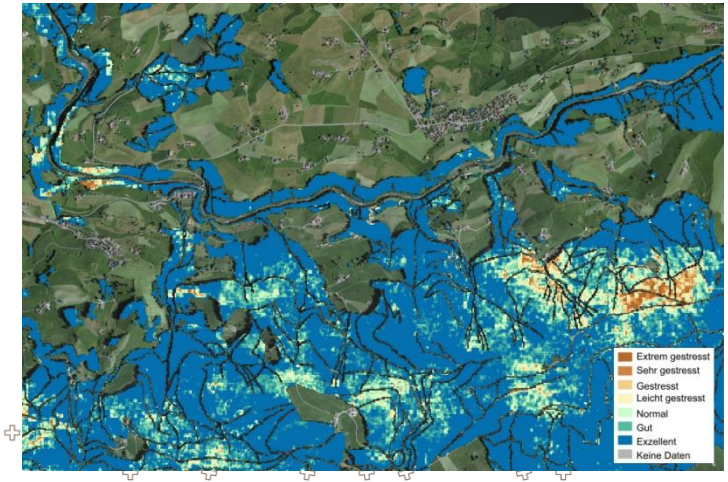
Historical weather data

Weather forecast

Drought indices (e.g. SPI, SPEI, …)

Historical drought impacts

- Impact mapping
- High resolution
- Climate signal back to 1991



Sturm et al. 2023, Global change Biology

Summary

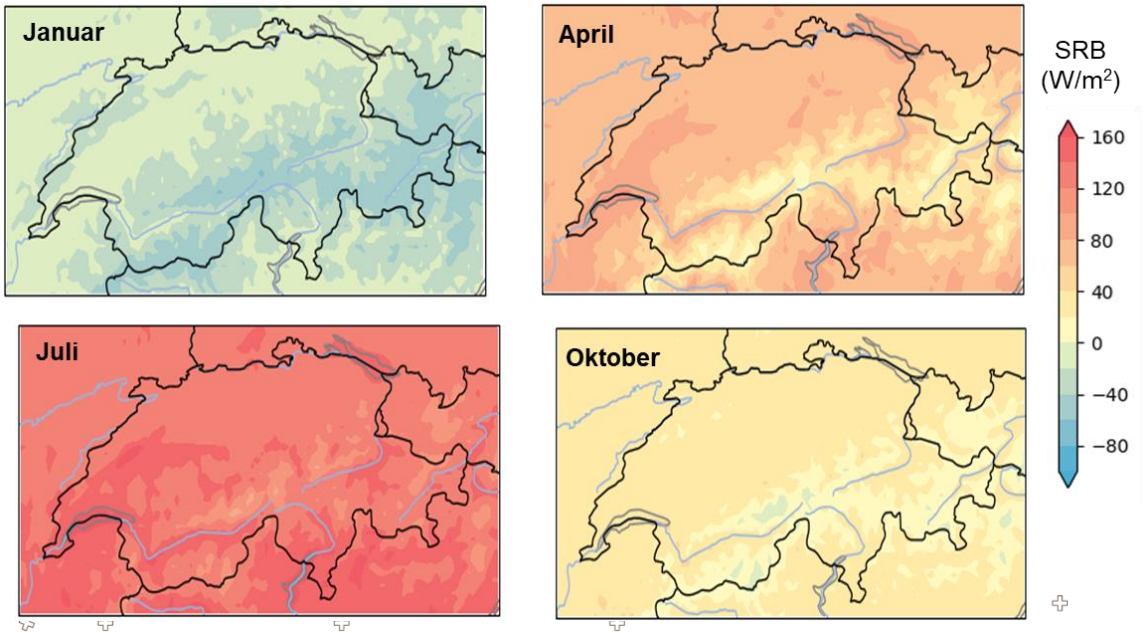
- Drought events are well depicted in combined **CM SAF & LSA SAF land surface temperature** and Sentinel **vegetation products**

- Combining satellites and weather models for drought monitoring:
  - Satellite observations: high-resolution monitoring & closer to the impacts
  - Weather models: generic & low-resolution but ability to make forecasts
- New climate service for drought monitoring: https://www.swisstopo.admin.ch/de/satellitenbilder-swisseo-vhi

SAF satellite products can well complement the station-based indicators for drought monitoring in Switzerland with spatial information.

Outlook

CM SAF Land Flux Energy Balance 1991-2020



Energy Balance and Evapotranspiration for Swiss Drought Monitoring

MeteoSwiss

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Thank you.

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