Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

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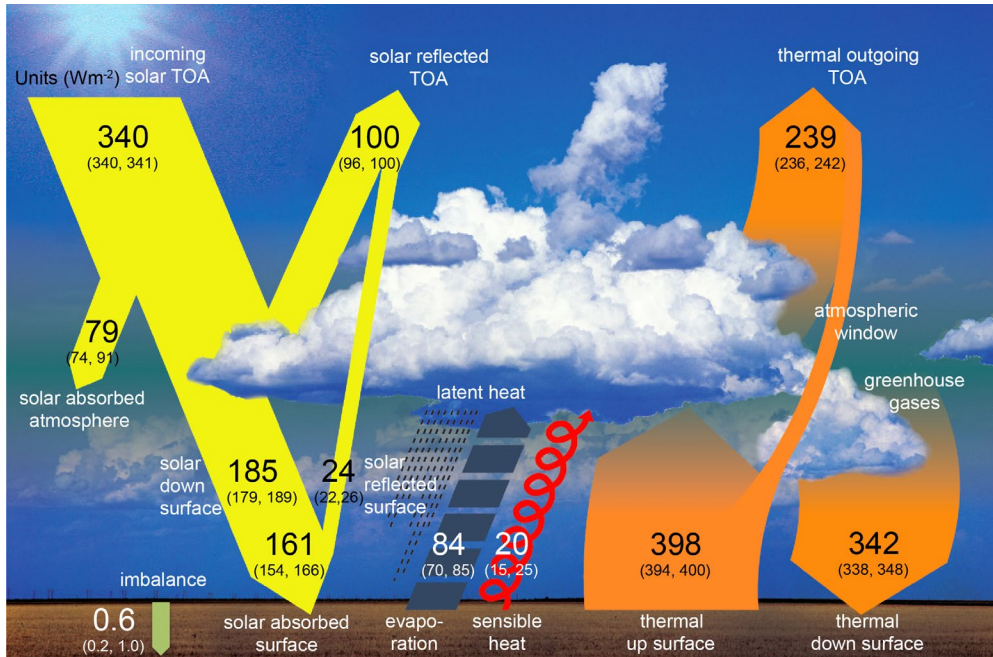**Federal Office of Meteorology and Climatology MeteoSwiss**

EUMETSAT
CM SAF
CLIMATE MONITORING

CM SAF Land Surface Temperature and Applications at MeteoSwiss

A. Duguay-Tetzlaff, A. Burgstall, Q. Bourgeois, M. Begert, R. Stöckli
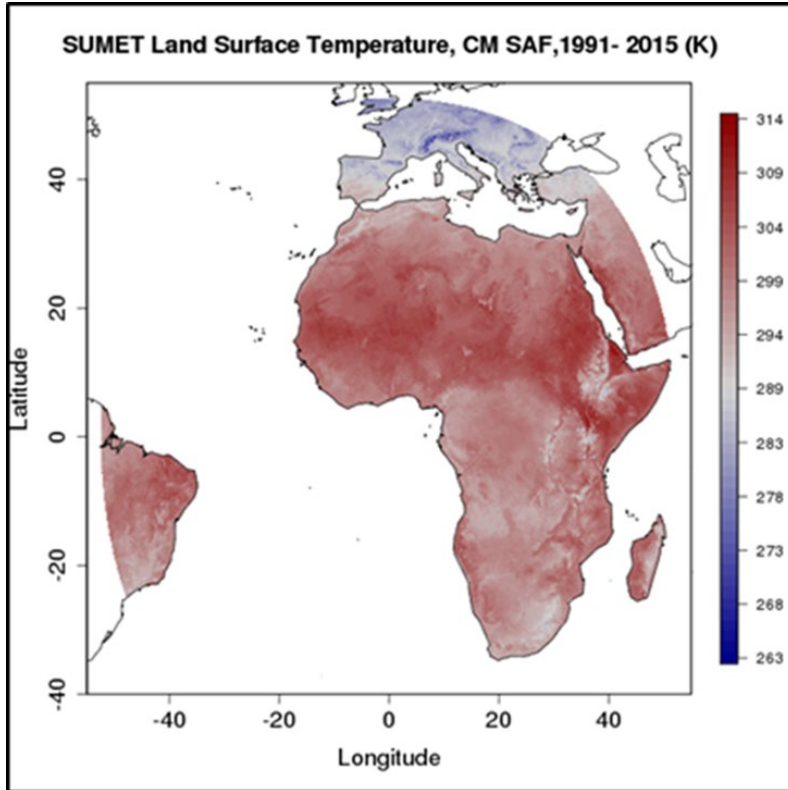
SUMET Meteosat Surface Radiation CDRs

Joint retrieval of all components of the surface radiation and fluxes:

- Consistent algorithms
- Similar boundary conditions

Land Surface Temperature CDR

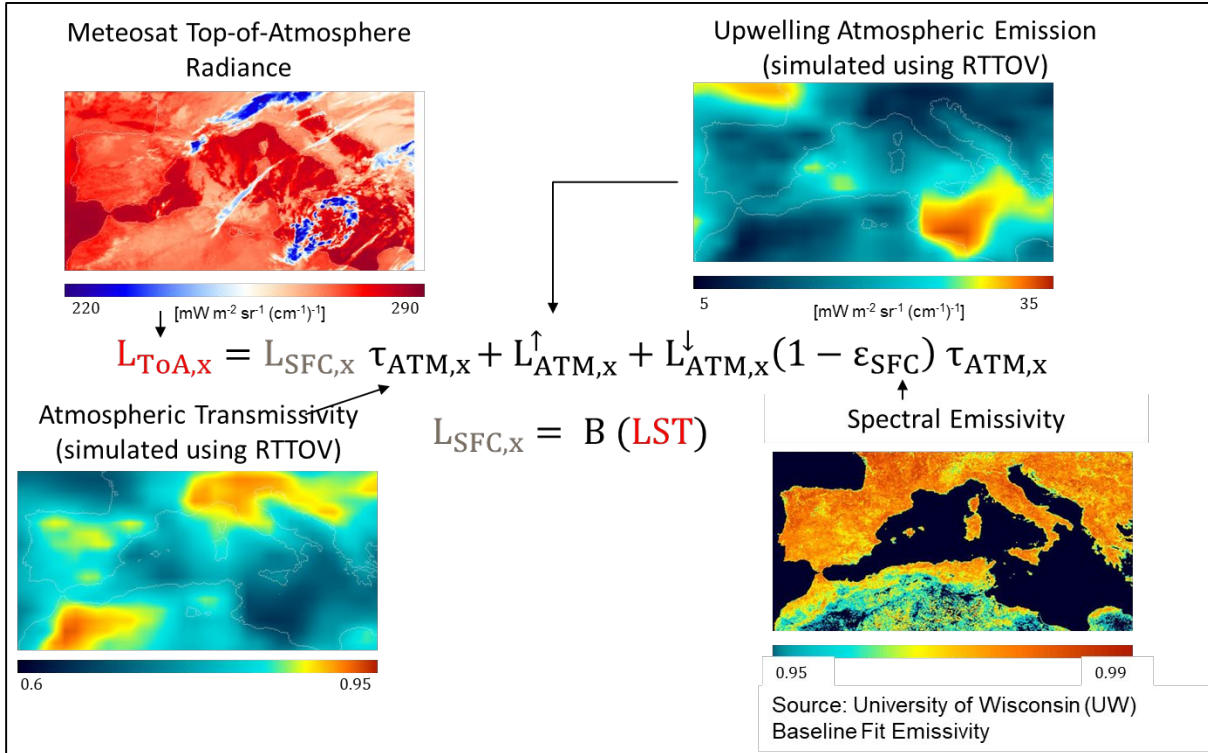Long-term CDR back to 1991 spanning the two generations of Meteosat sensors.

SUMET Land Surface Temperature, CM SAF,1991- 2015 (K)

- Hourly & monthly diurnal cycle
- 0.05° lat & lon grid
- 1983-2020 (2nd release 2022)
- Clear sky Land Surface Temperature
- All sky Outgoing Longwave Radiation

https://www.cmsaf.eu/

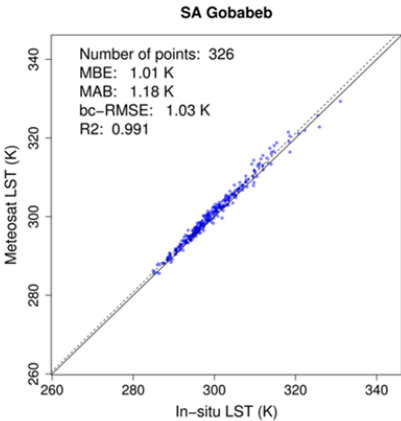# Land Surface Temperature CDR

Meteosat Top-of-Atmosphere Radiance

Upwelling Atmospheric Emission (simulated using RTTOV)

220 [mW m^{-2} sr^{-1} (cm^{-1})$^{-1}$] 290

5 [mW m^{-2} sr^{-1} (cm^{-1})$^{-1}$] 35

$$L_{ToA,x} = L_{SFC,x}\,\tau_{ATM,x} + L^{\uparrow}_{ATM,x} + L^{\downarrow}_{ATM,x}(1 - \varepsilon_{SFC})\,\tau_{ATM,x}$$

Atmospheric Transmissivity (simulated using RTTOV)

$$L_{SFC,x} = B(LST)$$

Spectral Emissivity

0.6 0.95

0.95 0.99

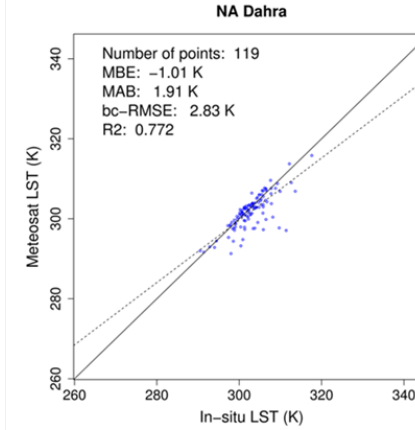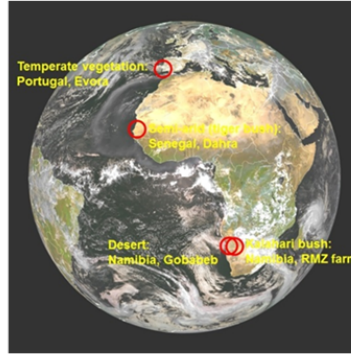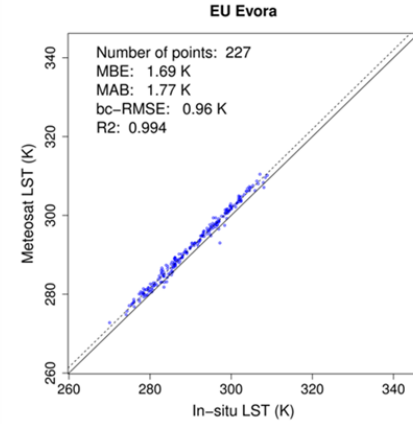Source: University of Wisconsin (UW) Baseline Fit Emissivity

Single channel LST retrieval for MFG and MSG to ensure temporal consistency.

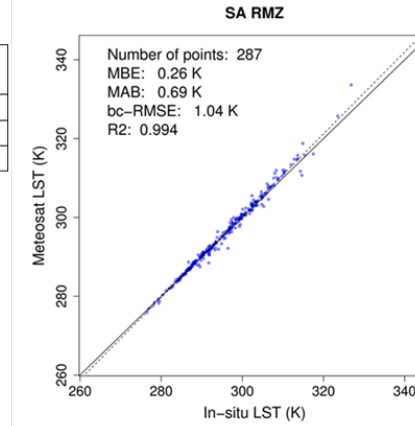Depends on external fields to estimate the atmospheric state and the surface emissivity.
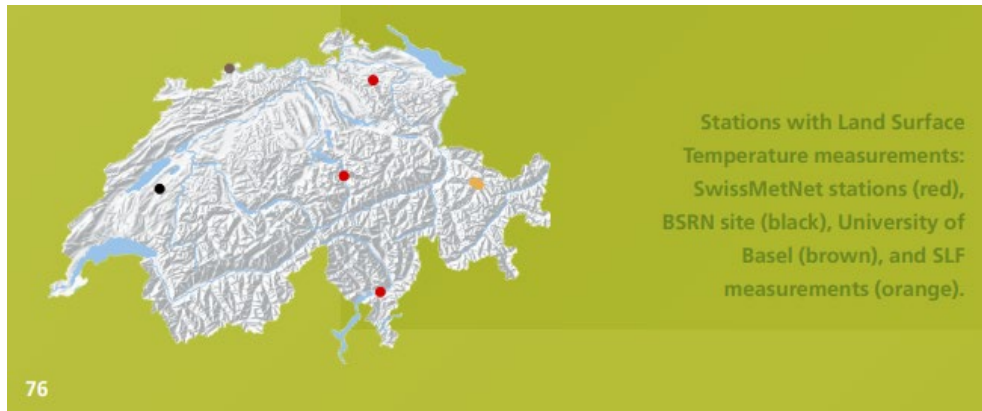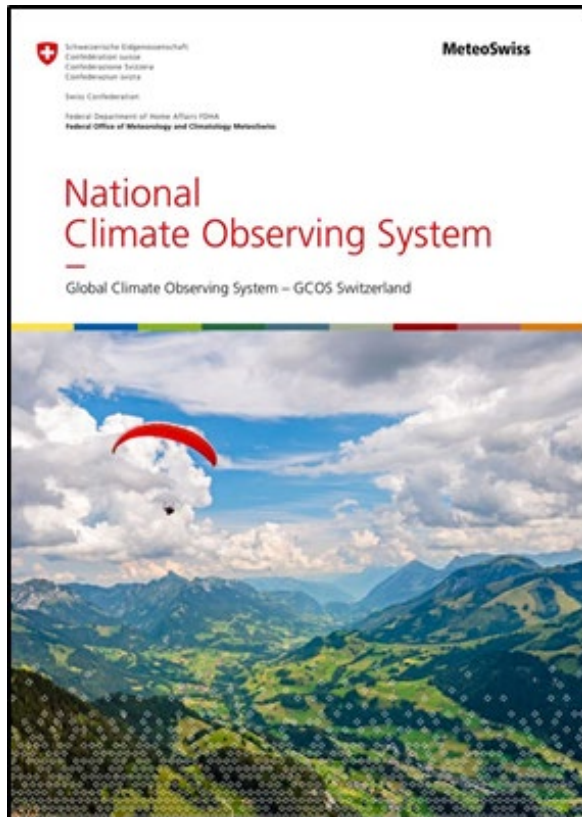
Land Surface Temperature CDR

EU Evora
Number of points: 227
MBE: 1.69 K
MAB: 1.77 K
bc-RMSE: 0.96 K
R2: 0.994

NA Dahra
Number of points: 119
MBE: −1.01 K
MAB: 1.91 K
bc-RMSE: 2.83 K
R2: 0.772

Temperate vegetation:
Portugal, Evora

Savannah (near Sahel):
Senegal, Dahra

Desert:
Namibia, Gobabeb

Kalahari bush:
Namibia, RMZ farm

SA Gobabeb
Number of points: 326
MBE: 1.01 K
MAB: 1.18 K
bc-RMSE: 1.03 K
R2: 0.991

SA RMZ
Number of points: 287
MBE: 0.26 K
MAB: 0.69 K
bc-RMSE: 1.04 K
R2: 0.994

	Achieved Accuracy & Precision Physical LST model		
	Hourly	Daily	Monthly
Bias	0.8 K	0.7 K	0.8 K
Bc-RMS*	1.6 K	1.2 K	0.5 K

*bias-corrected root-mean-square difference

Essential Climate Variable ECV

Essential **C**limate **V**ariable

Stations with Land Surface Temperature measurements: SwissMetNet stations (red), BSRN site (black), University of Basel (brown), and SLF measurements (orange).
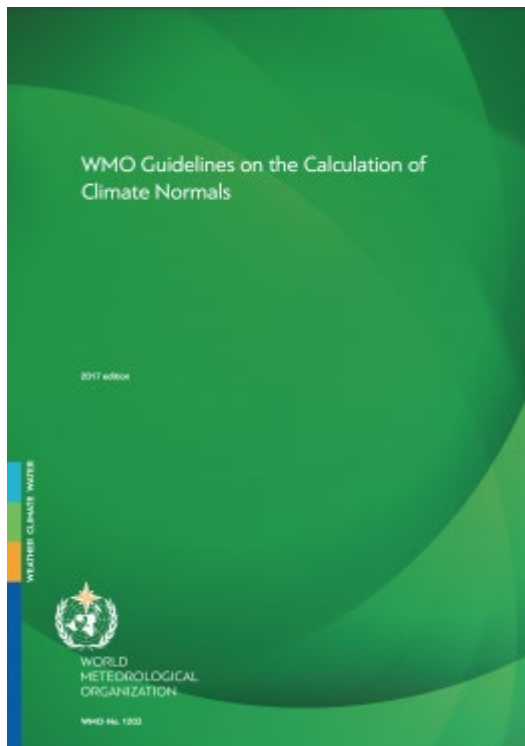
76

Land surface temperature based on Meteosat satellite data in Switzerland (Geneva)
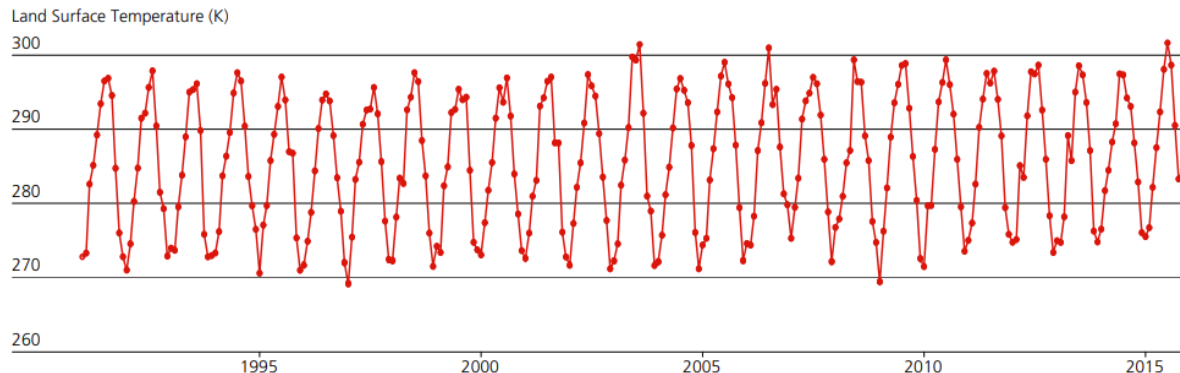
Climate Monitoring

WMO New Climate Normal 1991-2020

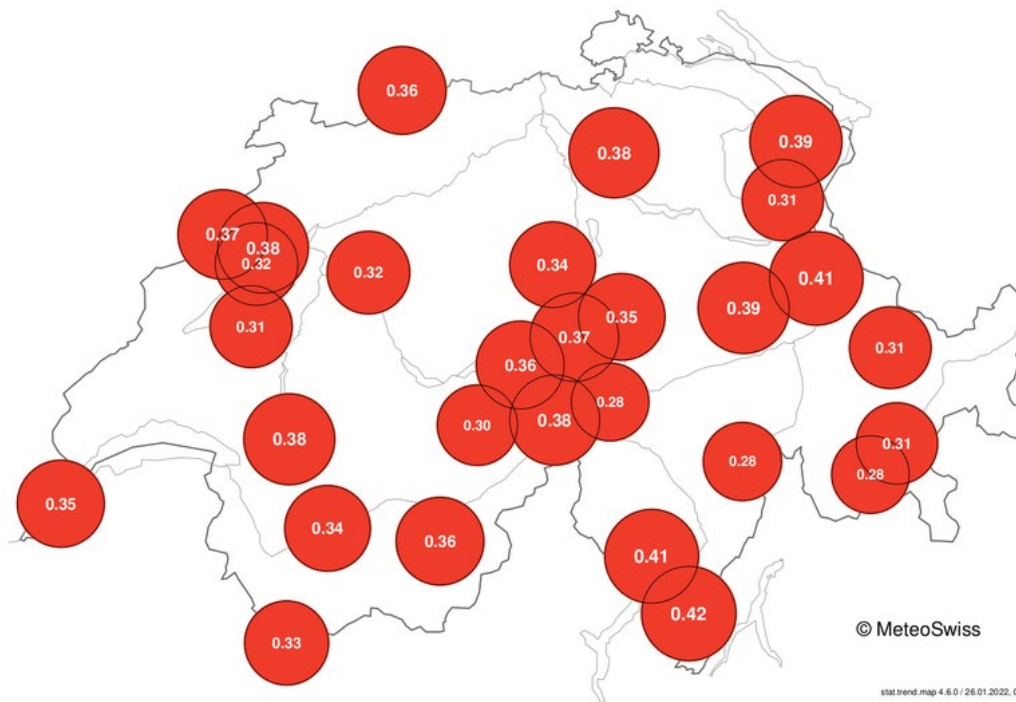- benchmark or reference against which conditions (especially current or recent conditions) can be assessed

- they are widely used as an indicator of the conditions likely to be experienced in a given location.

CM SAF LST v2.0 record length covers new WMO Climatological Normal

Station-based temperature trends

Annual temperature trends [°C/decade]
1991-2020

© MeteoSwiss

Satellite LST-based temperature trends

Switzerland 0.31 °C/decade
Trend of bias: 0.31 K per decade (p < 0.05)

Luzern 0.37 °C/decade
Trend of bias: 0.37 K per decade (p < 0.05)
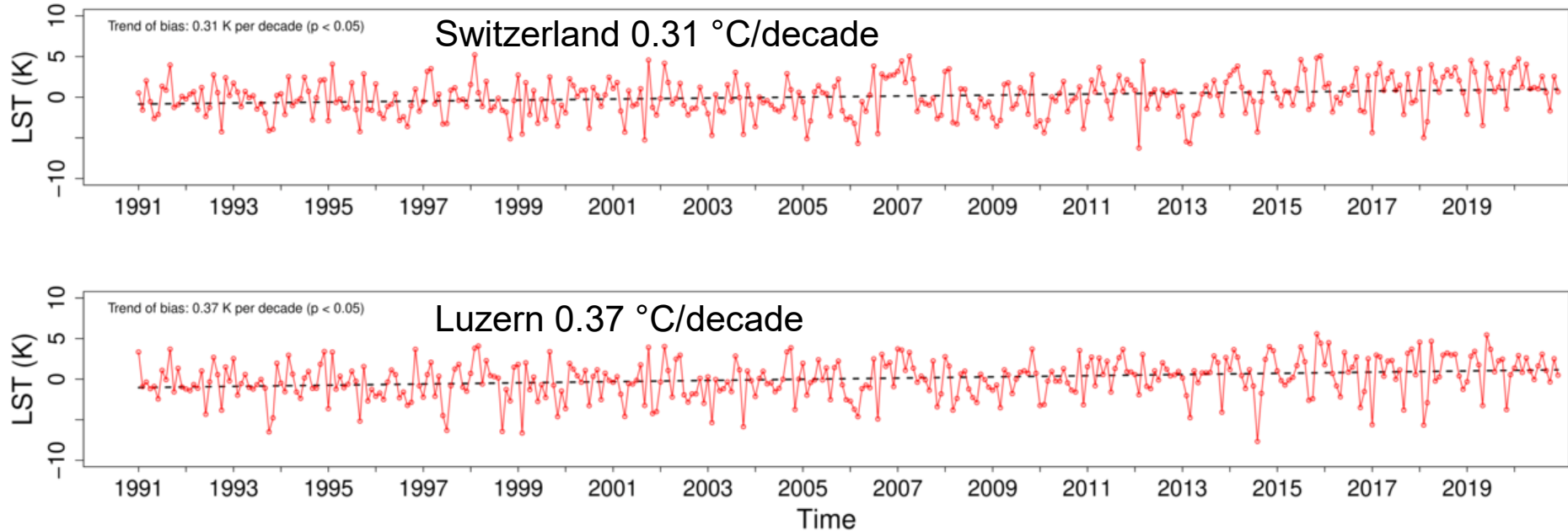
CM SAF Land Surface Temperature as a complementary temperature measure to confirm climate change!

Satellite LST-based temperature trends
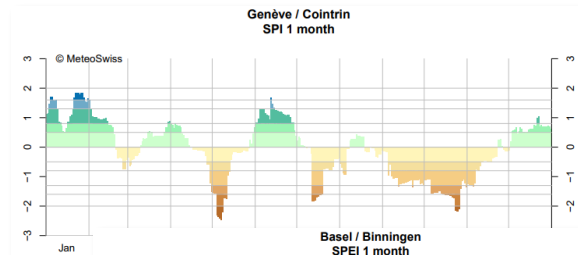

Swiss Mountains 0.14 °C/decade

Trend of bias: 0.14 K per decade (not signif.)
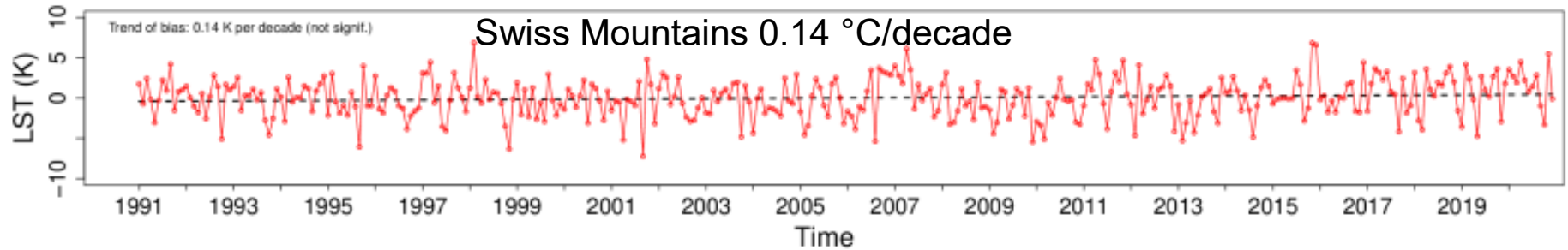
Elevation depended warming? ➜ High resolution ESA CCI LST data to confirm trends over Swiss Mountains.
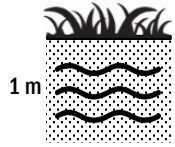
Drought Monitoring

MeteoSwiss Drought Monitoring
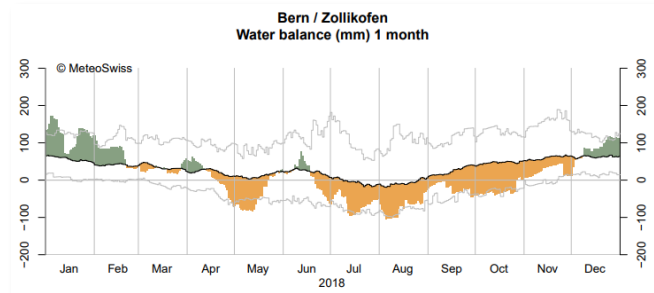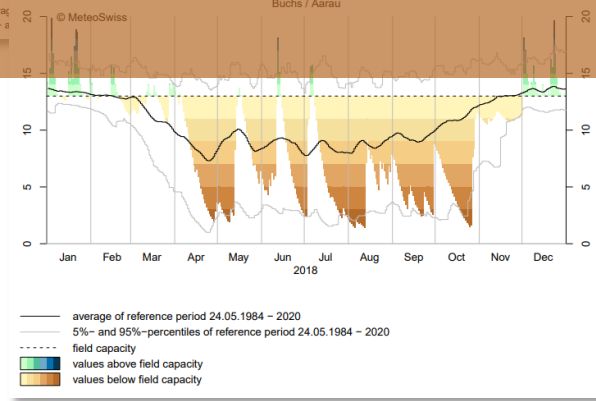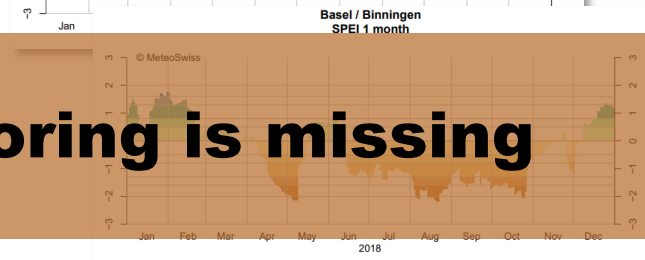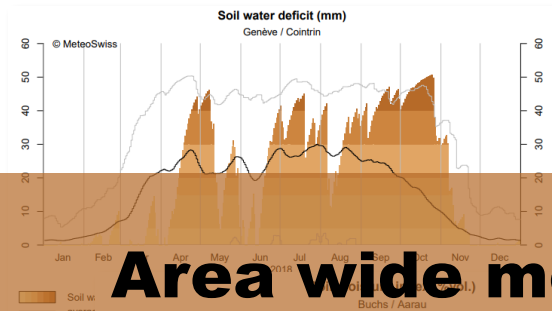
Area wide monitoring is missing

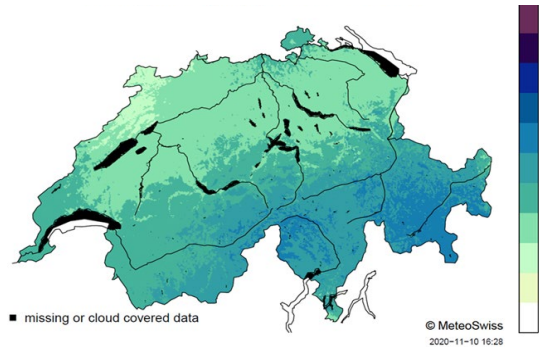# Climatological Drought Monitoring
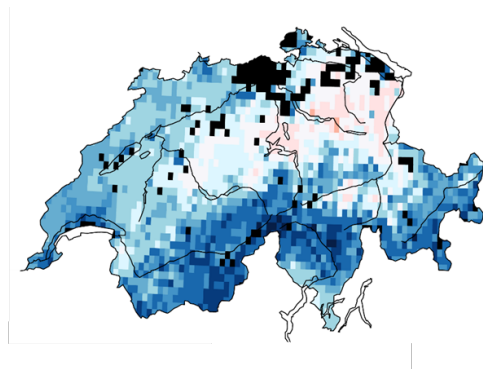
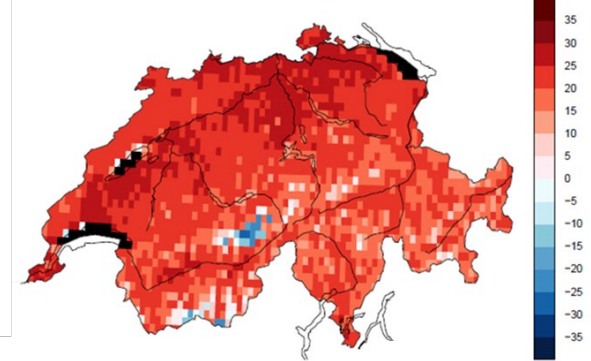Soil Moisture

Evapotranspiration

Temperature

H SAF SWI

CM SAF SAF ET
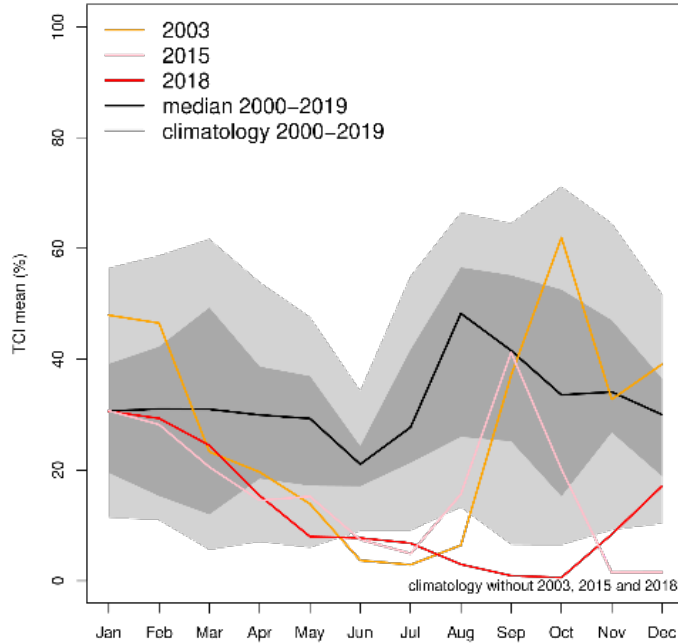
CM SAF & LSA SAF LST

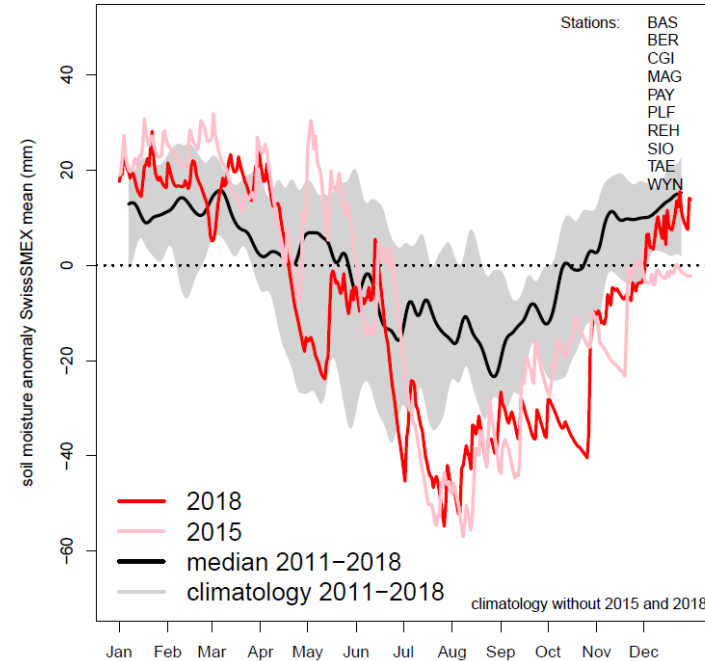**ASCAT   2007-2020**

Meteosat 1983-2020

Meteosat 1983-2020

Climatological Drought Monitoring

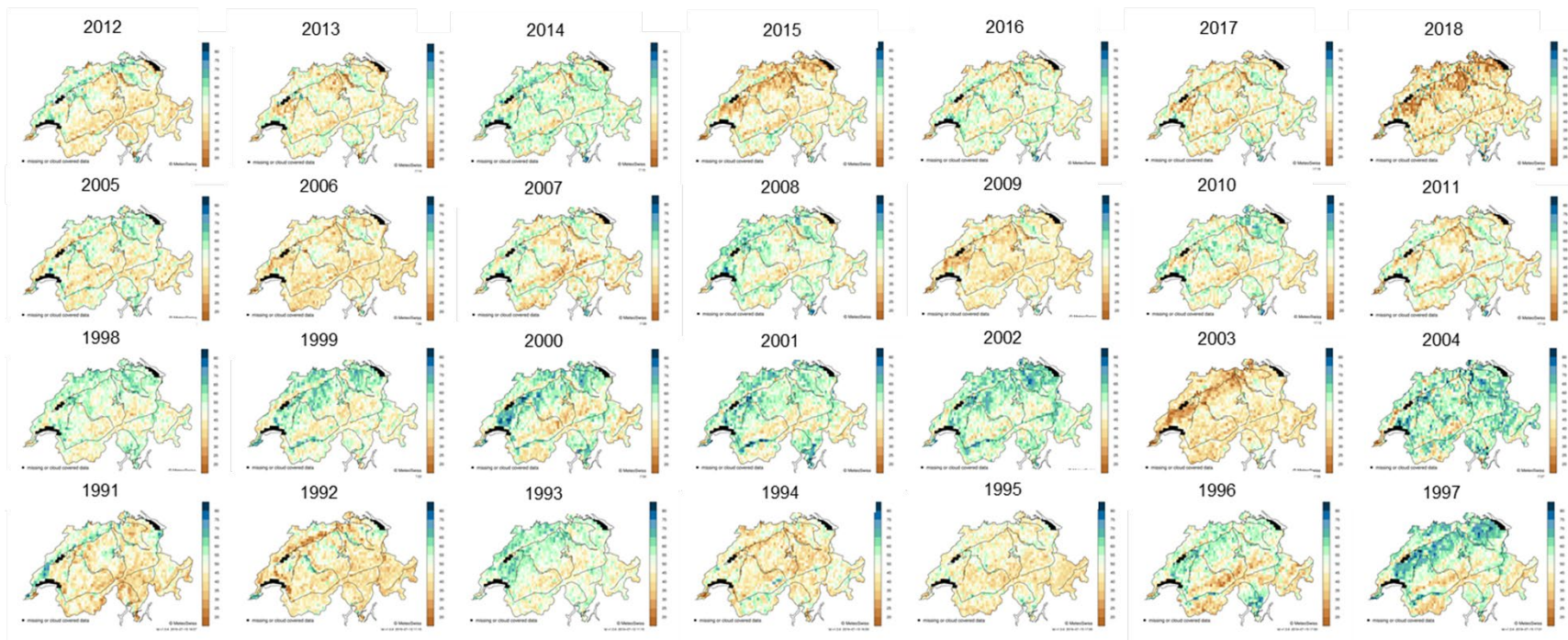## Temperature Condition Index (TCI)

Soil Moisture

Seasonal evolution of monthly (**right**) Temperature Condition Index (TCI) and (**left**) Soil Moisture averaged over all stations in Switzerland.
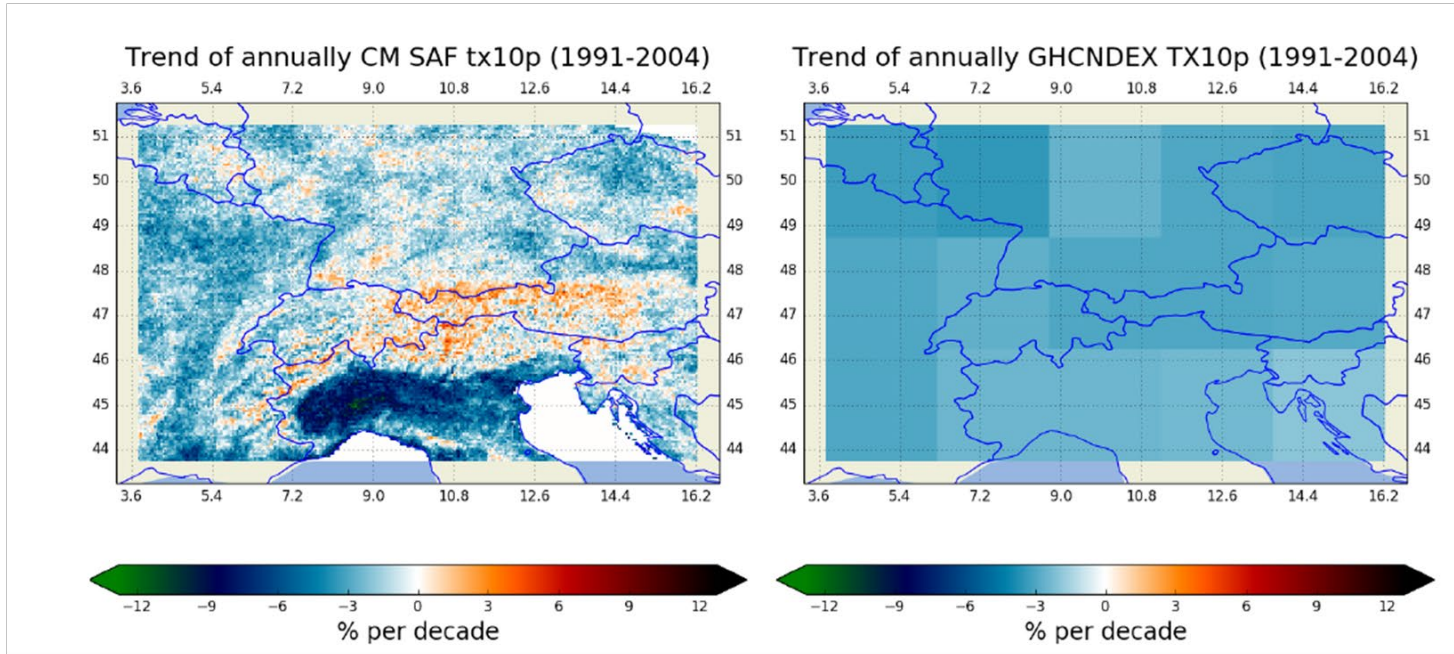
Vegetation Heat Index (VHI) in Switzerland using CM SAF LST & NOAA NDVI

Outlook: Climate Indicators

Number of Cool Days (percentage of days when T < 10th percentile)

@ Veronika Pörtge, UK MetOffice Hadley Centre
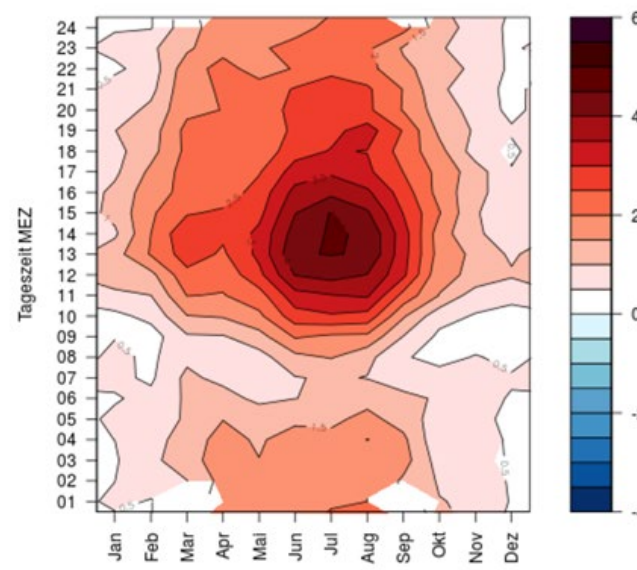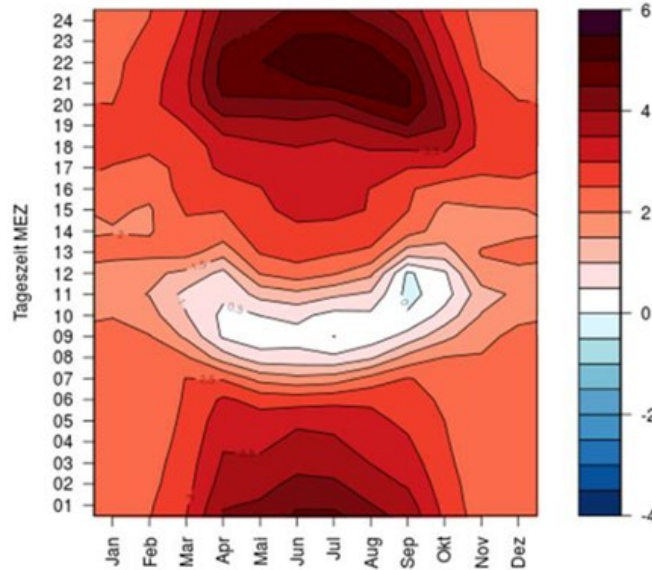
Outlook: Urban Heat

2m Air Temperature   CM SAF MSG 3 km LSTs

UHI Basel 2004-2020   SUHI Basel 2004-2020

Mapping the spatial extent of urban heat islands in Switzerland

Outlook CM SAF LST CDR

- 2022: Release of the new CM SAF LST TCDR v. 2.0 covering the new WMO norm period 1991 to 2020

- Statistical tuning of the CM SAF versus LSA SAF SEVIRI LST real-time data

- Quasi-global GeoRing LST by combining GOES, Meteosat and Himawari

Requirements

- Consistent and stable CDRs

- WMO Norm period 1991-2020

- High resolution LST CDR (1km)

- LST CDR and real time data with 100% similar algorithm

How can we best combine ESA CCI and CM SAF LSTs?