Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

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

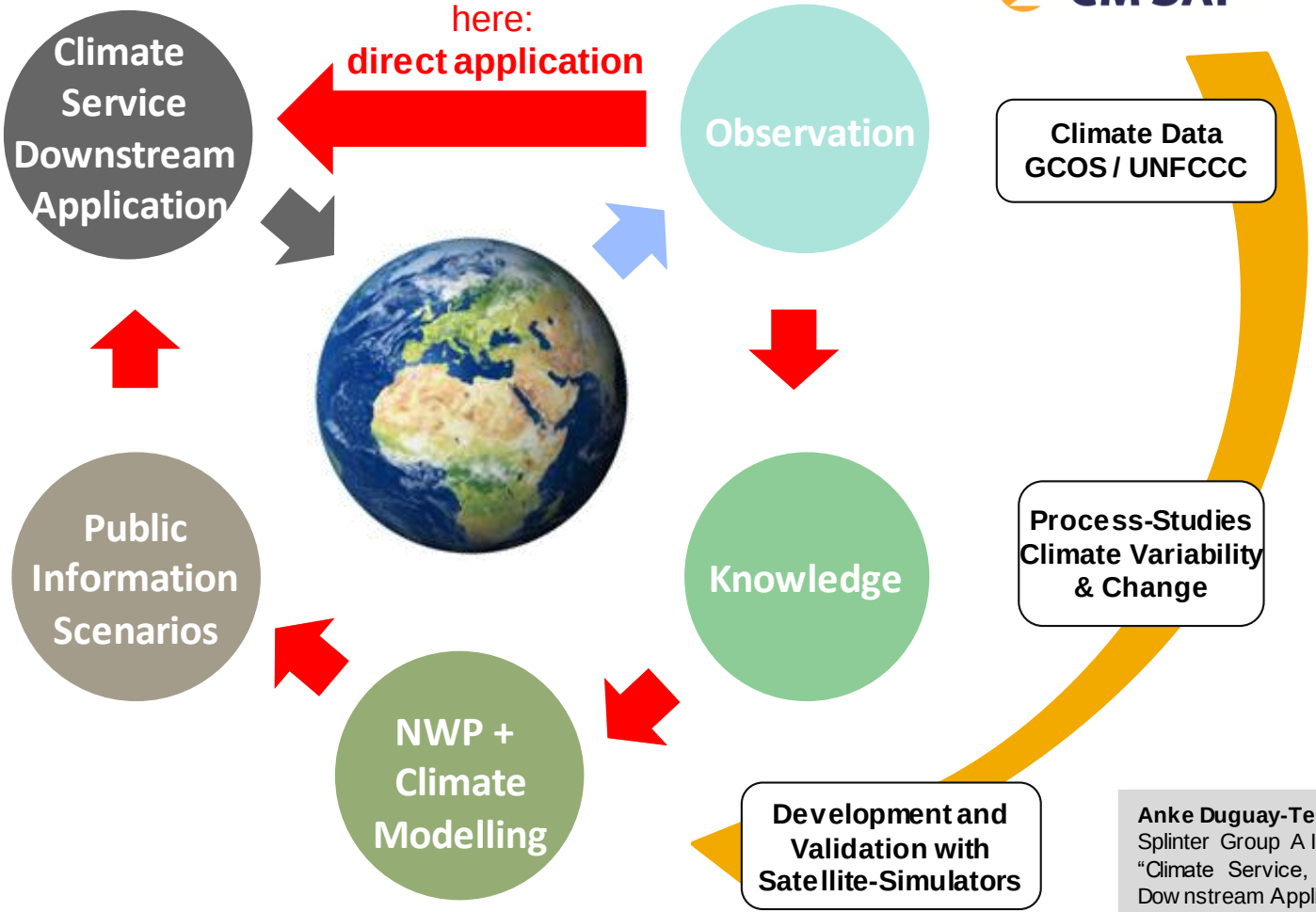
MeteoSwiss

HEAT SHIELD

CM SAF data for heat mapping in Europe

Ana Casanueva **Sven Kotlarski** Anke Duguay-Tetzlaff

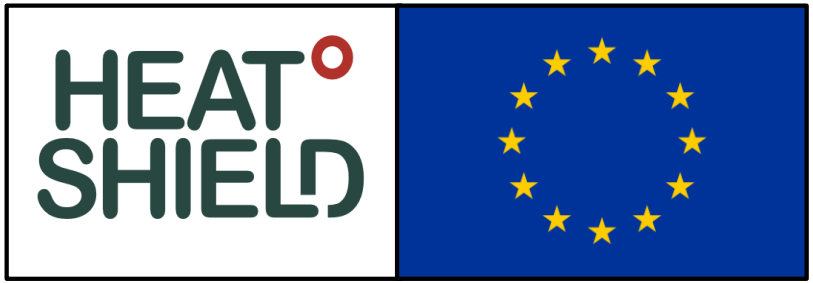
sven.kotlarski@meteoswiss.ch



CM SAF

Anke Duguay-Tetzlaff
Splinter Group A I
"Climate Service, Climate Monitoring, Downstream Applications"

The HEAT-SHIELD project



- EU Horizon 2020
- 01/2016 - 12/2020
- 20 partners
- ***www.heat-shield.eu***

Main Objective:

Reduction of heat stress and heat impacts on the European work force

Improved **heat forecasts, heat projections, heat warnings and adaptation measures**

MeteoSwiss

- **21st Century heat exposure projections** (European scale)
- Prototype of an **early warning system for heat exposure for the upcoming 4 weeks** (European scale)

-> «**Climate Services**» products

A worker's heat exposure

Wet Bulb Globe Temperature (WGBT)

- Most widely used heat stress index for working people
- Derivable from **standard meteorological variables**
- Can be interpreted for different **physiological settings**, **clothings** and **working environments**

Full implementation («WBGT in the sun») considers

Temperature

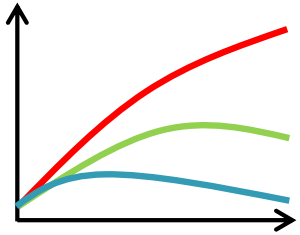
Humidity

Wind

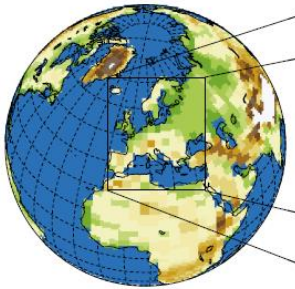
Solar radiation

Climate projections:
The standard processing chain

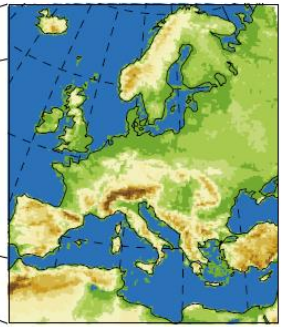
Greenhouse gas scenario



GCM
~ 150 km



RCM
~ 10-50 km

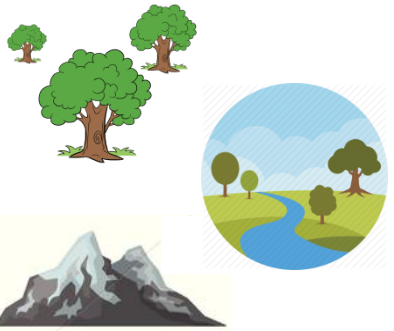


WCRP CORDEX
www.cordex.org
~70 simulations

Spatial scale

Climate model biases

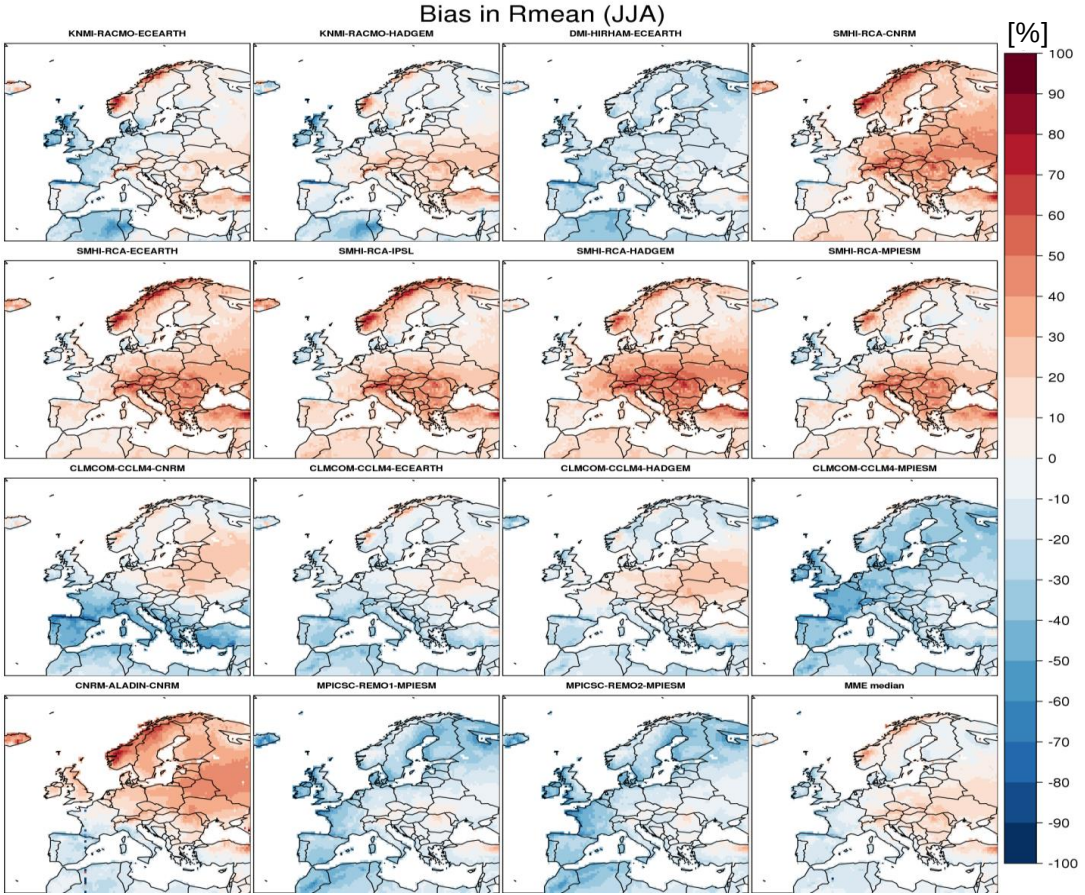
Impact
Local to regional scale



Here:
Daily maximum heat stress at site scale

Climate model biases in JJA global radiation

1981-2010



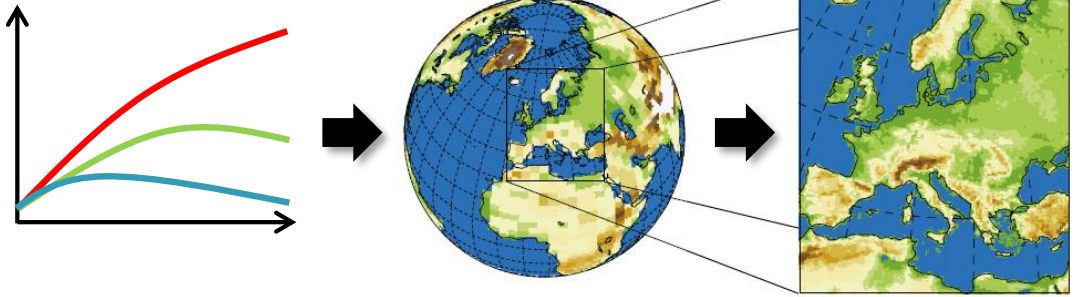
Reference: WFDEI *(Weedon et al. 2014)*
ERA-Interim corrected with NASA/GEWEX Surface Radiation Budget data (SRB; Stackhouse Jr. et al., 2011).
50km horiz. resolution.

Climate projections:
The standard processing chain

Greenhouse gas scenario

GCM
~ 150 km

RCM
~ 10-50 km



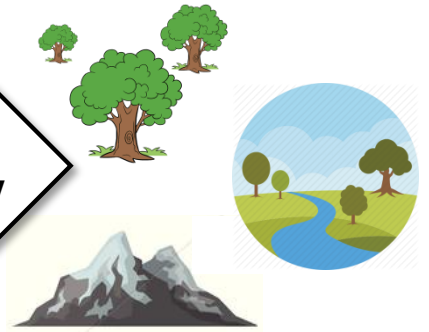
WCRP CORDEX
www.cordex.org

Spatial scale

Translation:
Quantile Mapping

Climate model biases

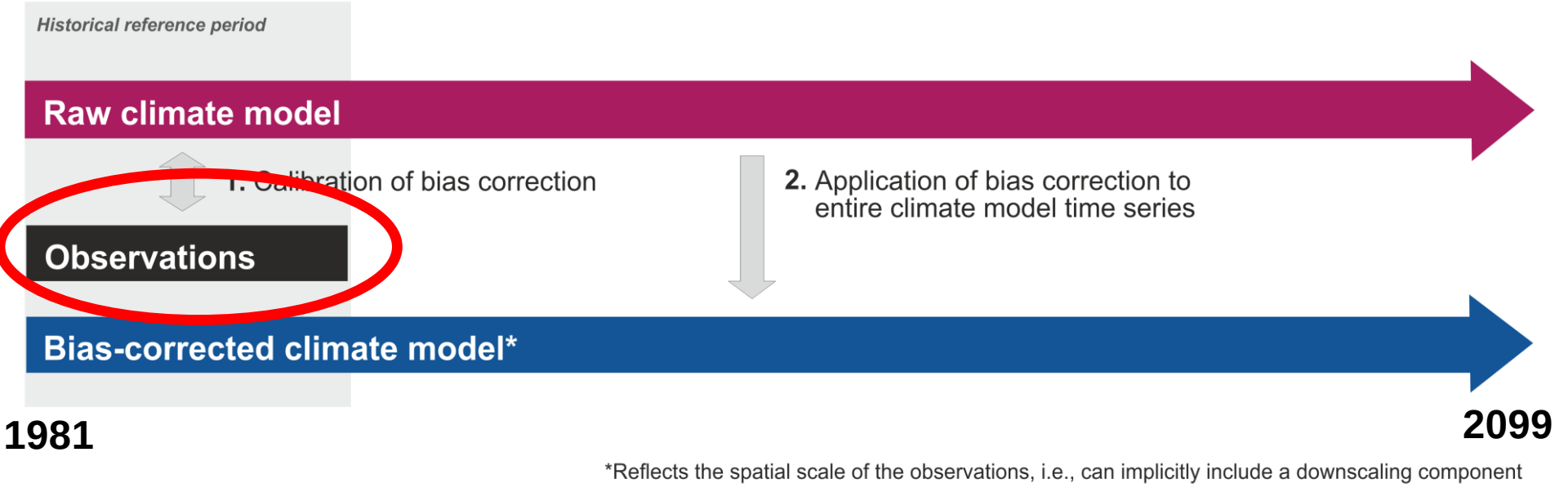
Impact
Local to regional scale



...

Bias adjustment by Quantile Mapping

Distribution-based adjustment of simulated data towards observations



*Reflects the spatial scale of the observations, i.e., can implicitly include a downscaling component

Challenge 1

Collect **daily** observations at a large number of European sites for **all required variables** and **for a climatological** period (>30 years)

Observational reference data

Temperature

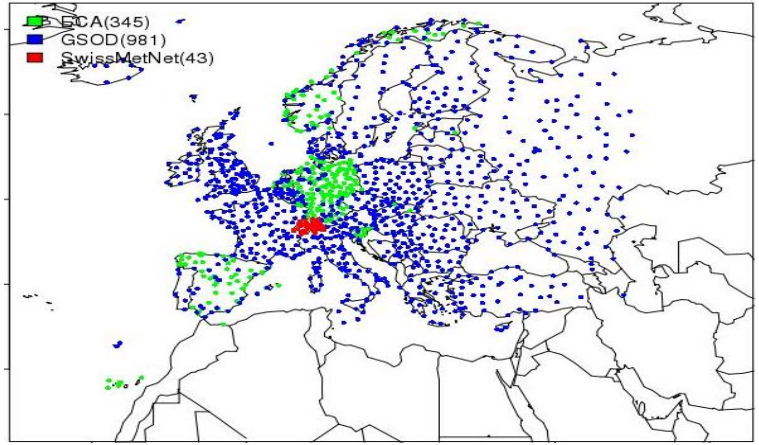
Dew point temperature

Wind

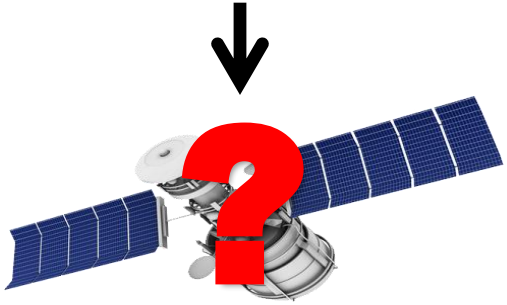
Station data (1370 European stations)

Merge of three data sets

ECA,GSOD, SwissMetNet



Solar radiation



SARAH satellite data

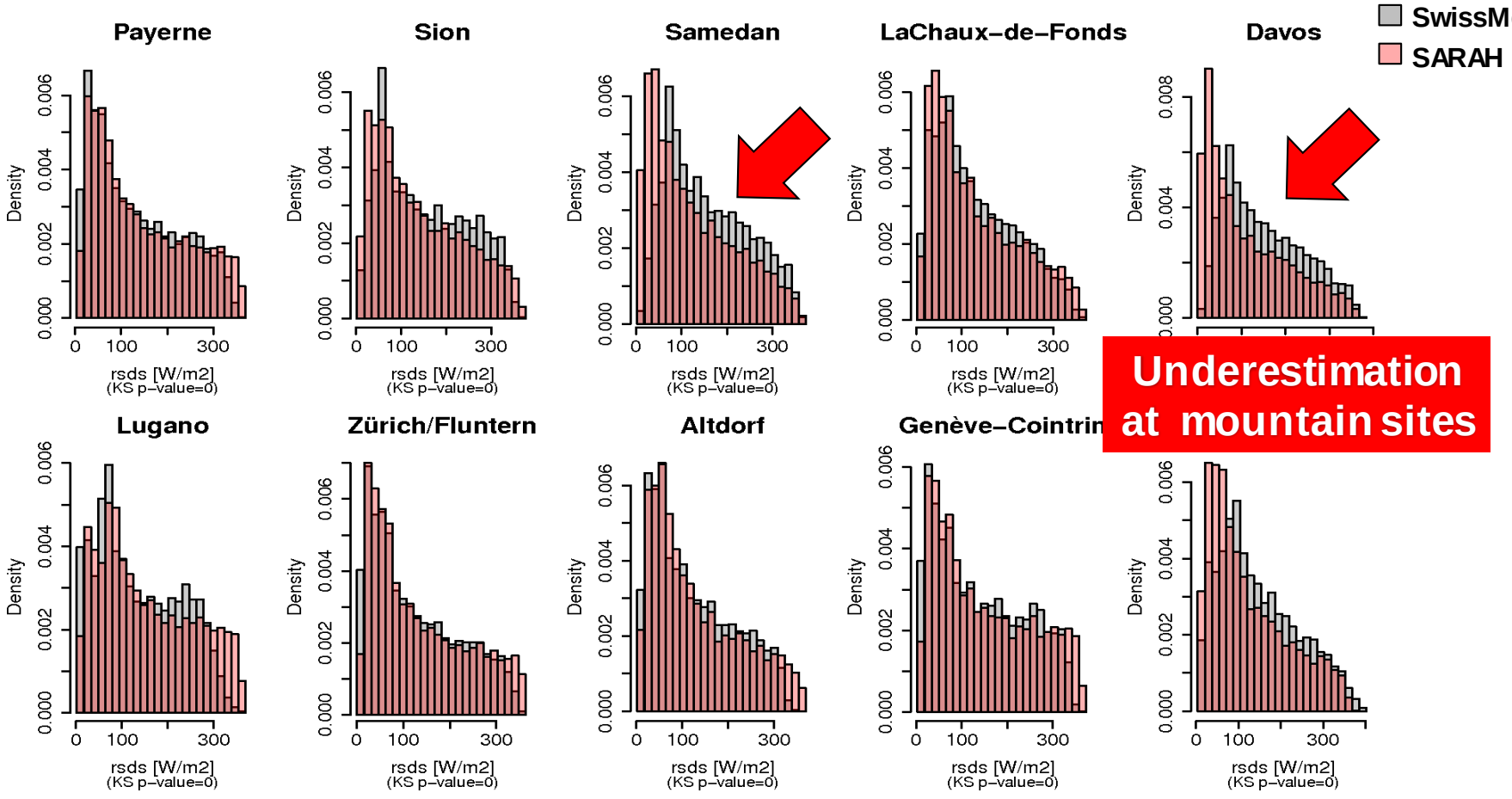
- Daily global radiation since 1983
- 0.05° grid (5 km)
- Closest grid to station

Challenge 2

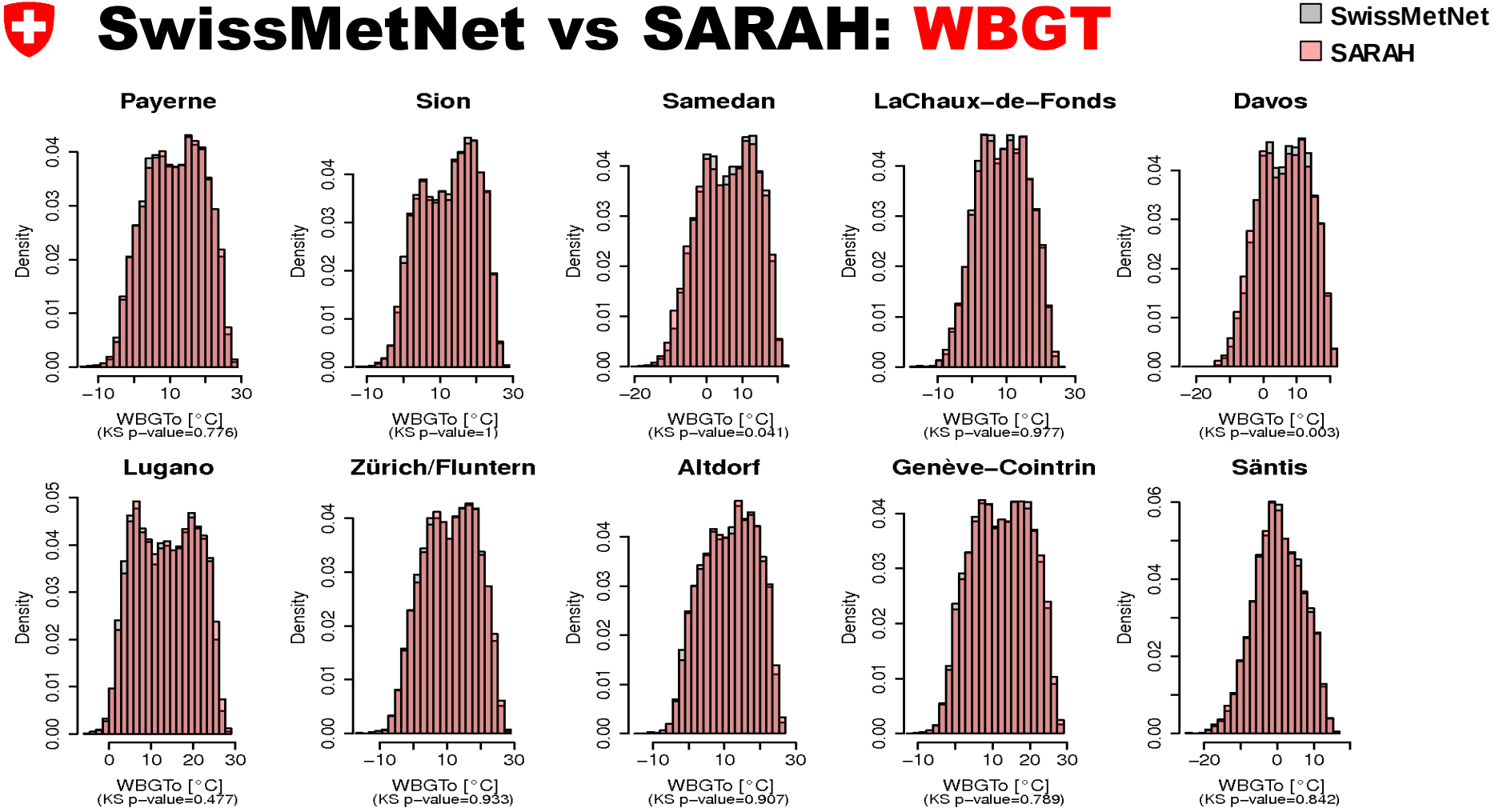
Does it make sense to combine data from **stations** (temperature, dew point, wind) with **gridded** solar radiation?

Validation of the approach for Swiss stations
(global radiation available)

SwissMetNet vs SARAH: solar radiation



SwissMetNet vs SARAH: WBGT



Challenge 3

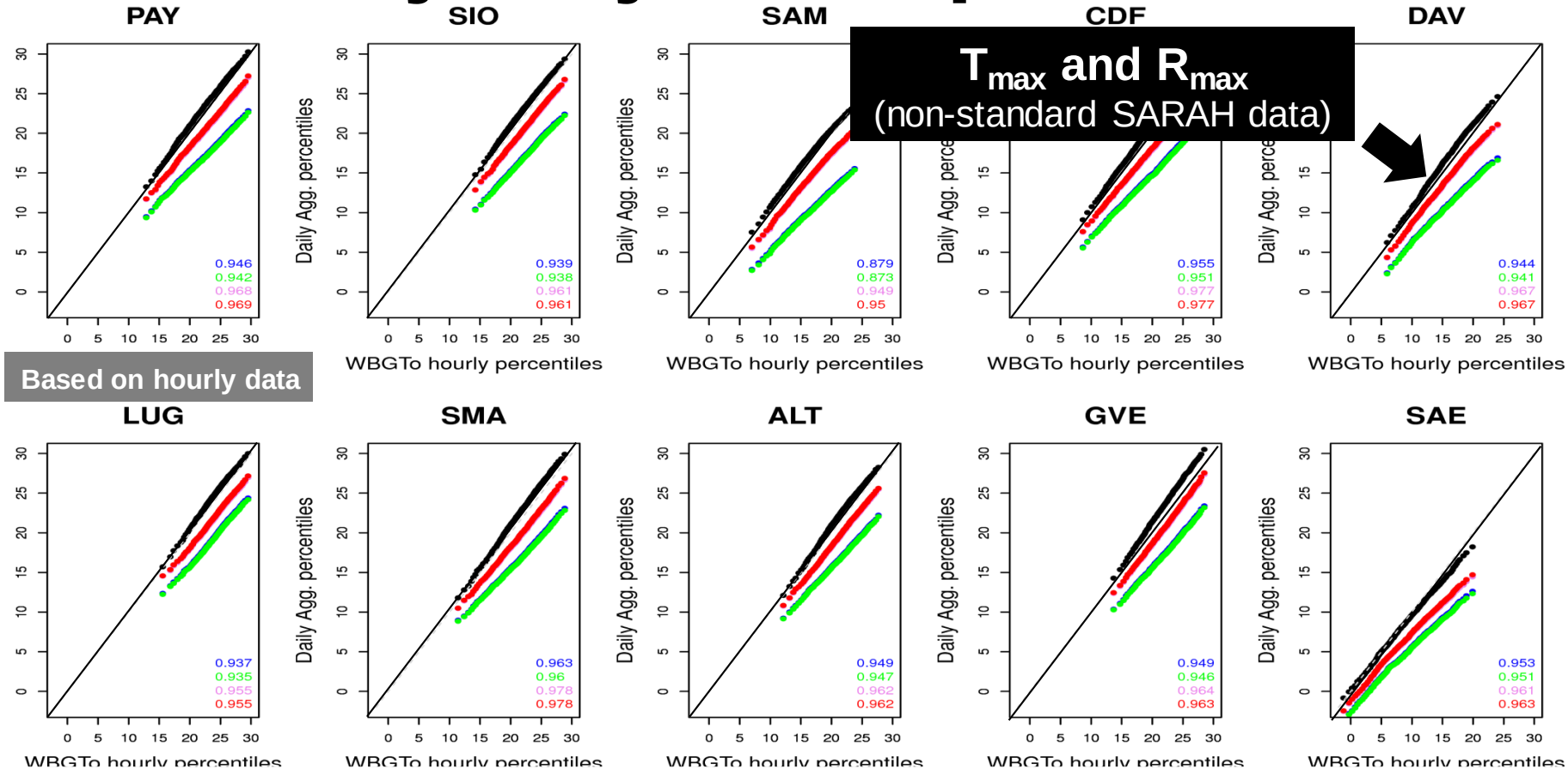
Station and gridded data provide **daily means** (and in some cases **daily max**)

Can we still derive
daily maximum heat stress?

Sensitivity analysis: Q-Q-plots of WGBT

Based on aggregated daily data

T_{max} and R_{max}
(non-standard SARAH data)



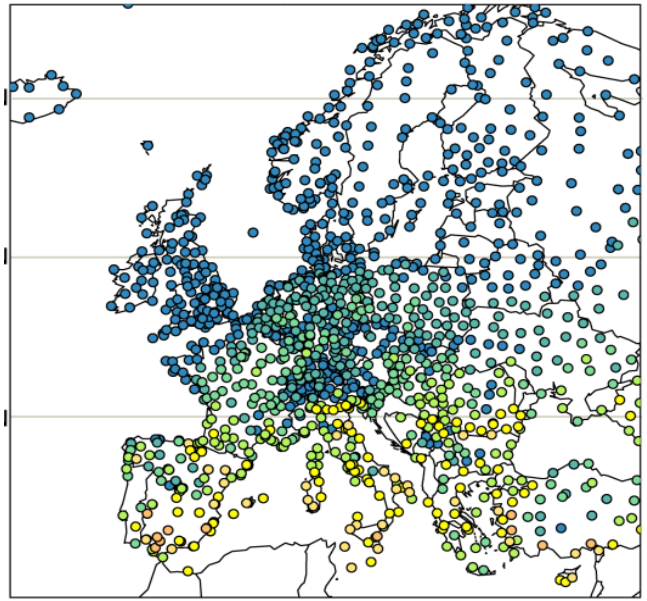
Based on hourly data

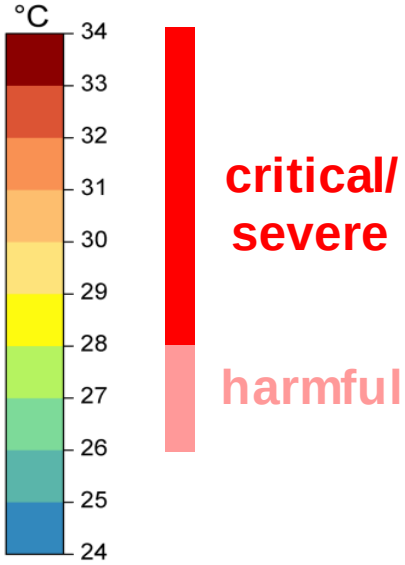
WBGTo(Tmean, Rmean, 15h) WBGTo(Tmean, Rmean 12h) WBGTo(Tmax, Rmean,12h) WBGTo(Tmax, Rmean,15h) WBGTo(Tmax, Rmax,12h)

RESULTS

Summer maximum WBGT

Observations (1981-2010)



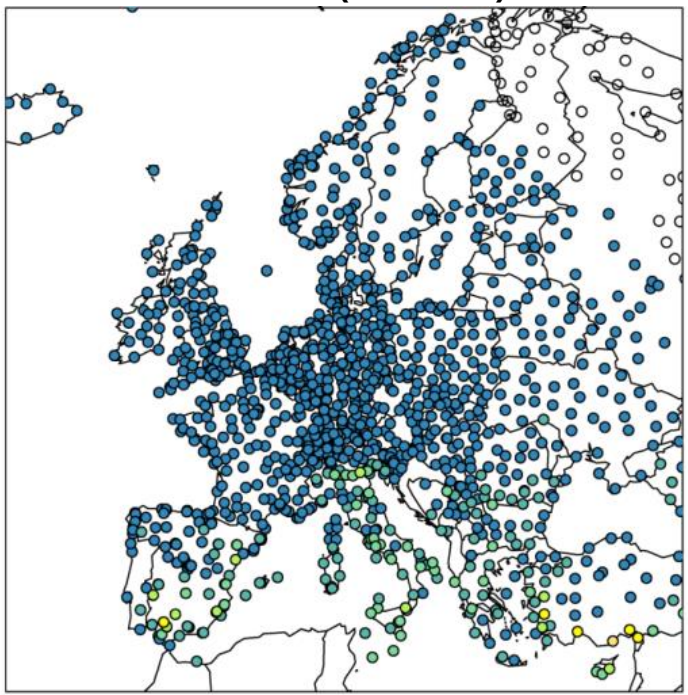


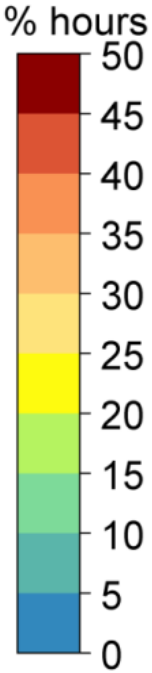
Summer maximum heat stress will increase by the end of the Century at all locations and will regularly reach critical levels in Southern Europe

Casanueva et al., Regional Environmental Change, submitted

Productivity losses due to heat stress

Observations (1981-2010)





Major productivity losses, especially in Southern Europe

Casanueva et al., Regional Environmental Change, submitted

Conclusions

- **HEAT-SHIELD:** Reduction of heat stress and heat impacts on the European work force
- Long term **climate change projections of heat stress** on European scale

- Bias-adjustment of climate model data requires **high-quality observational reference**
- Solar radiation: Site measurements not available at required scale
- **SARAH product** turned out to be extremely useful for climatological series.

Thanks to Anke Duguay-Tetzlaff and Jörg Trentmann

- **Expertise and help** of CM-SAF community (here: in-house) was essential
- Points to improve on
  - Overview on and documentation of available datasets
  - Quality of data in mountainous terrain
  - High temporal resolution

Thank you