Regime-dependent COSMO model evaluation: the spatial distribution of water cycle parameters

QUEST meeting 1-2/10/2009

Tom Akkermans

Overview

Evaluated parameters: *3-hourly*: Integrated water vapour [kg/m²], cloudbase height [m], *6-hourly*: accumulated precipitation [mm/6h].

Evaluation period: 2007-2008

Evaluation method: *regime-dependent*: data is classified into discrete number (10) of regimes which reflect the atmospheric circulation. Model output minus observation (bias) is calculated and averaged for each of the regimes

**Classification** into regimes: according to a derivation of the Jenkinson-Collison technique

Regionalisation in 3 subdomains

IWV and cloudbase height: Differentiation in North, Central, and South Germany.

J.-C. classification scheme is adapted for each of these smaller domains.
Grey points are calculation points for three smaller J.-C. Grids.

Black points are the regionalised GPS observations
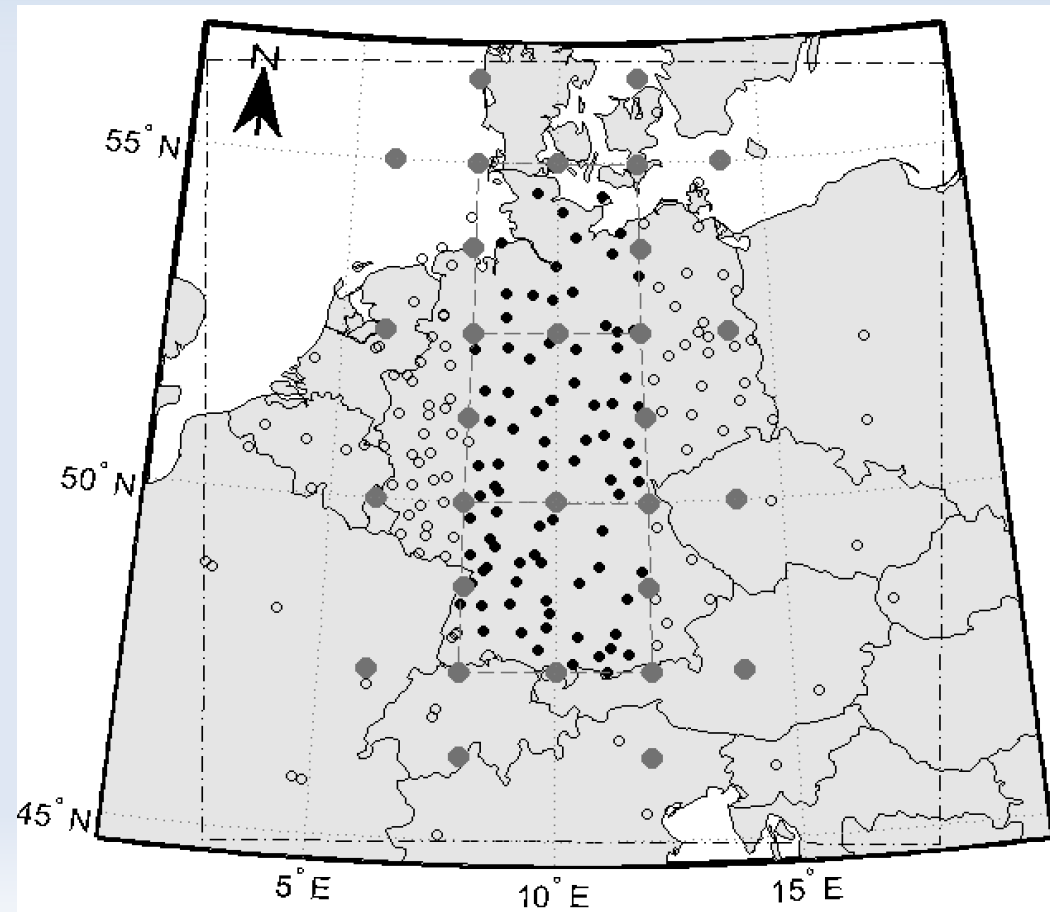
IWV: regional results

Multiple Comparison of Means test

Evaluated model: COSMO-DE

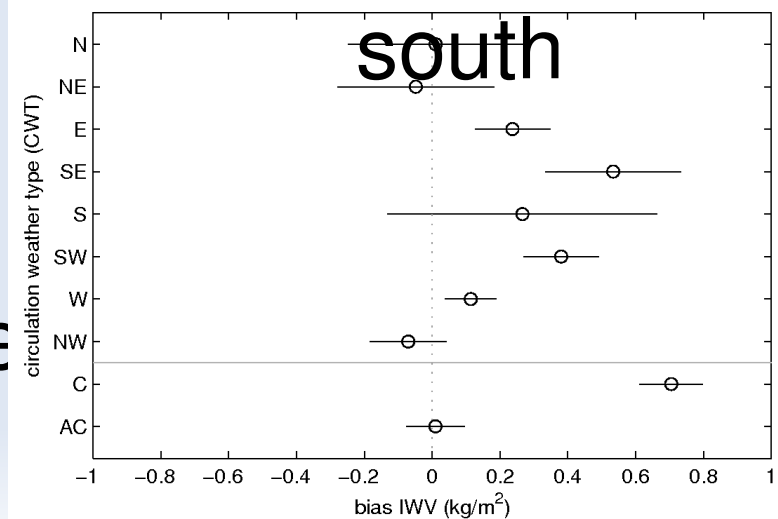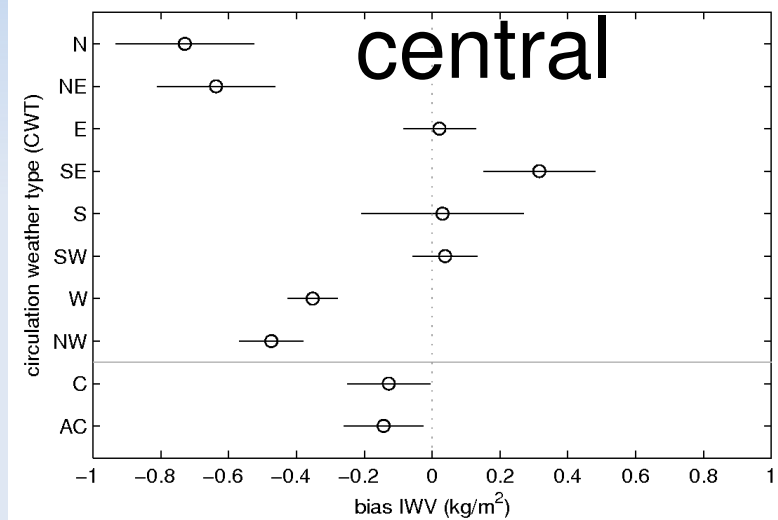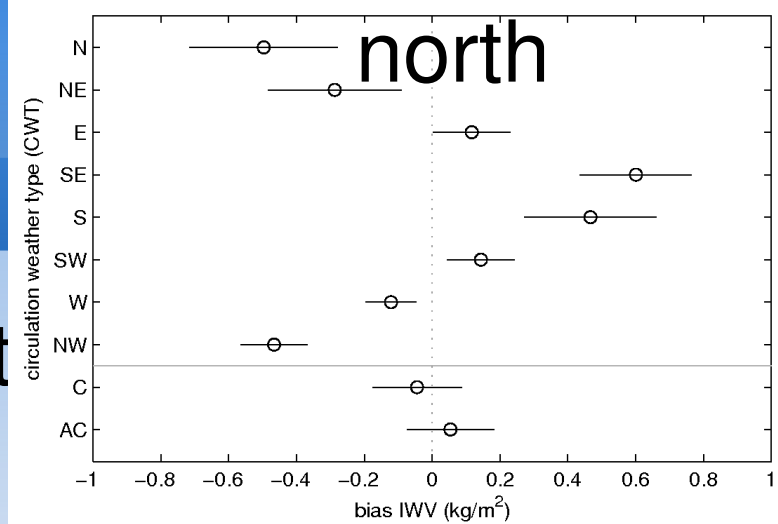Classification scheme: 850hPa

Variable: model minus obs (bias)

North and **Central** Germany behave more or less the same

Southern Germany: no underestimations, remarkable overestimation in cyclonic regime

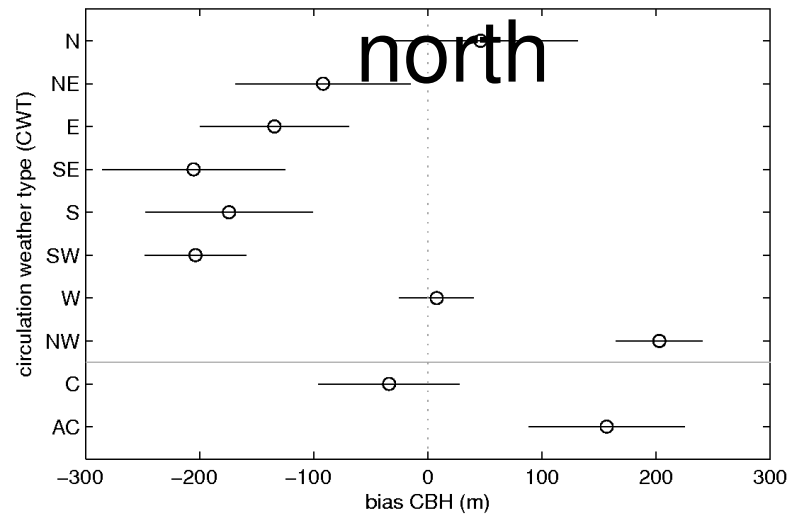# CBH: regional results

Multiple Comparison of Means test

Same model, classification, and variable

Seasonal approach needed because of big differences

Here: **WINTER** months

Regions behave different

In **North Germany**, the northwestern CWT shows overestimation, the southern CWTs underestimation
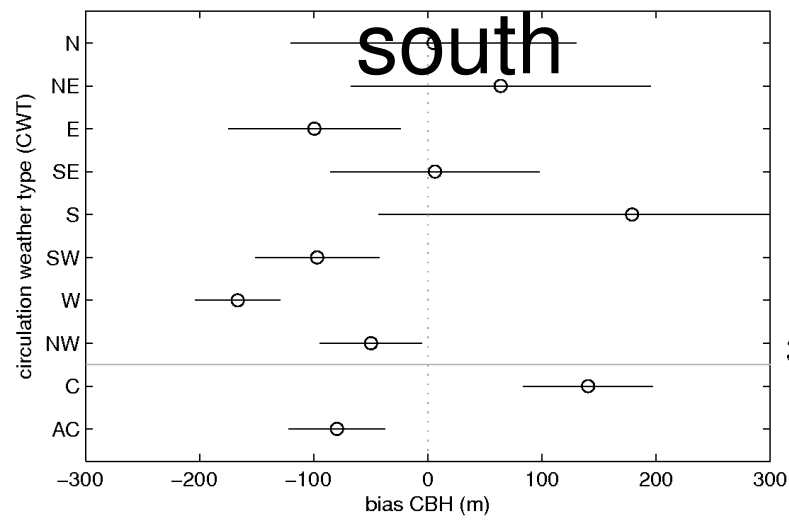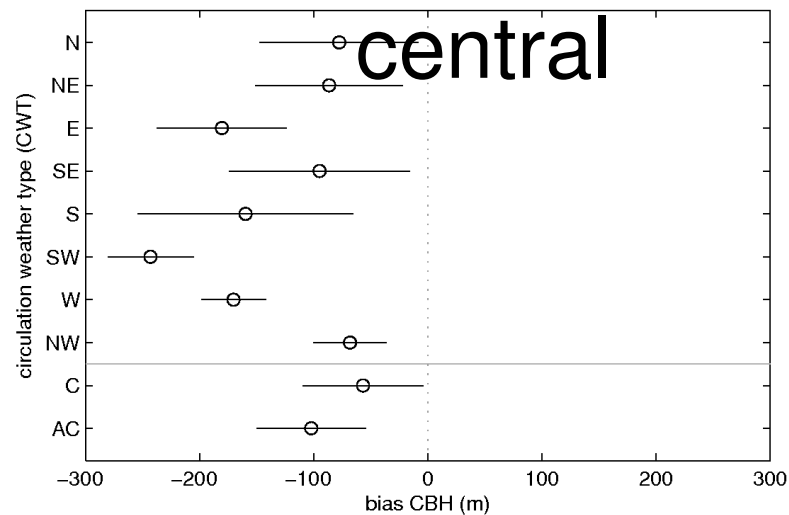
CBH: regional results

Here: **SUMMER** months

Less significant inter-CWT differences (cfr, overlap in MCM intervals)
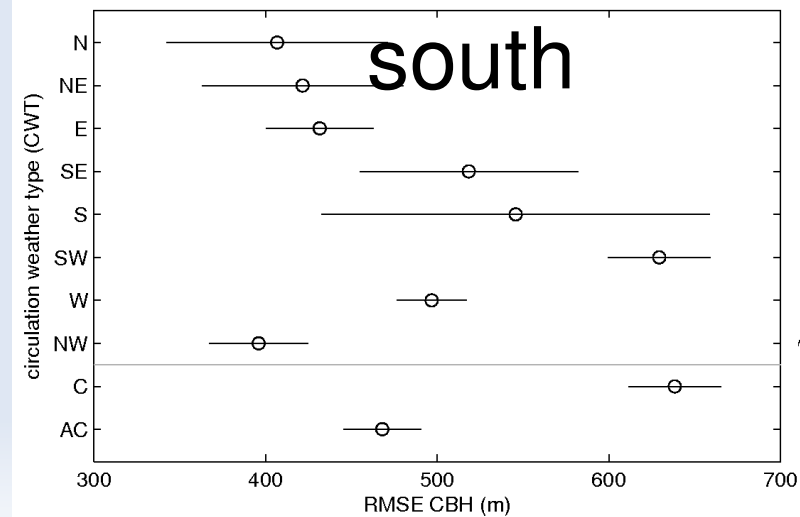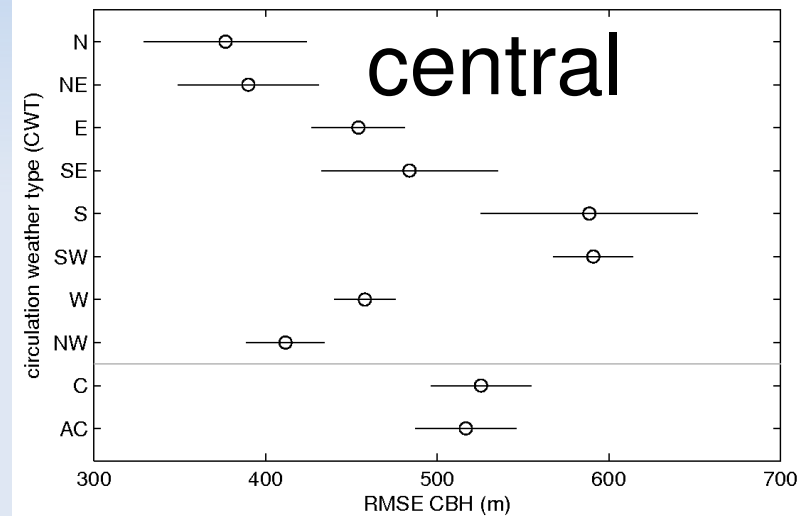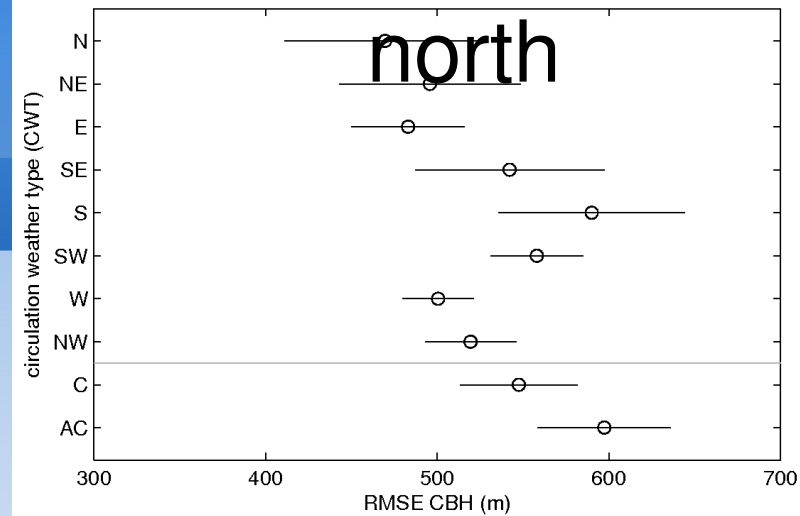
Mostly overestimation if biased
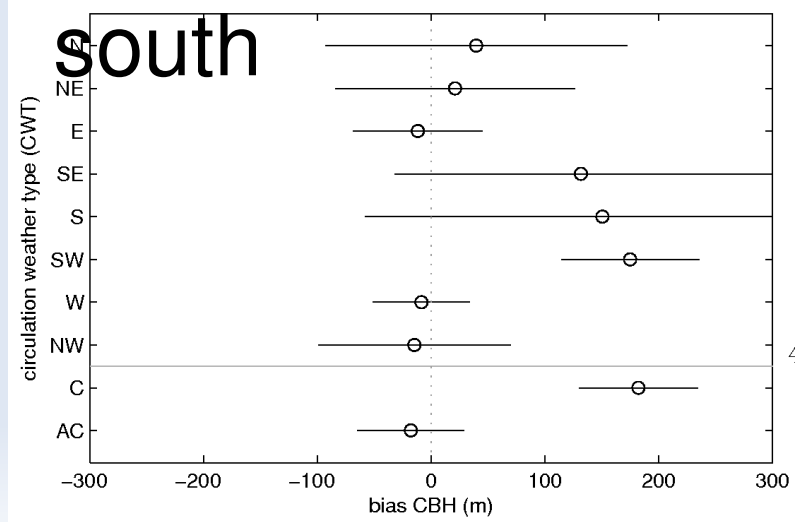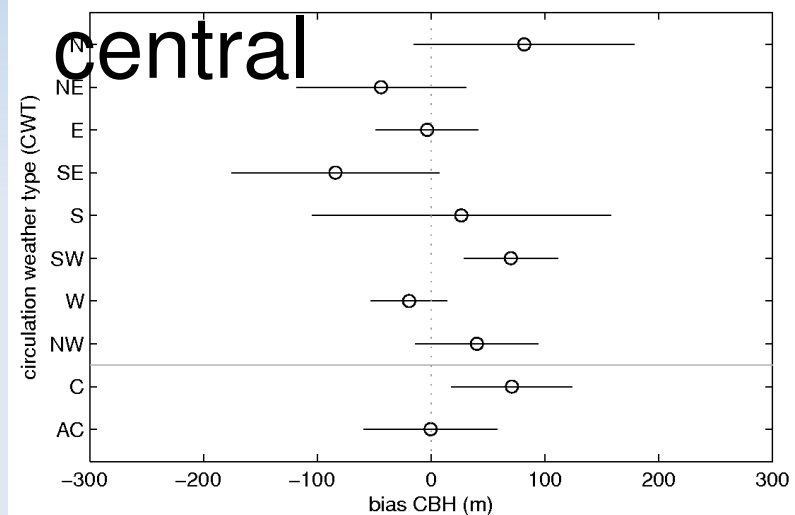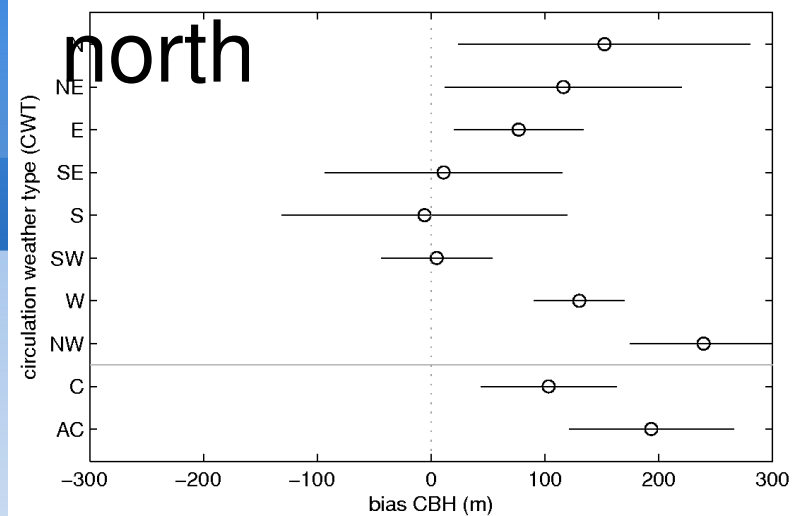
CBH: regional results

Same model and classification

Variable: Root Mean Square Error (RMSE)

No seasonal approach necessary

CWT dependency pattern: not to confuse with the one of IWV bias! (cfr peaks in S en SW instead of SE)

Accumulated precipitation

Instead of calculating one representative bias/rmse value, **bias composits** are made for each of the circulation weather types (regimes).

Also here, splitting data up in winter and summer months is necessary

Composits allow for detection of spatial fixated biases (cfr orographically induced precipitation)

Unclear composits when number of cases in particular regime is not sufficient, and hence the random events dominate the spatial fixated events

Also 2 case-studies with zoom on Thüringer Wald
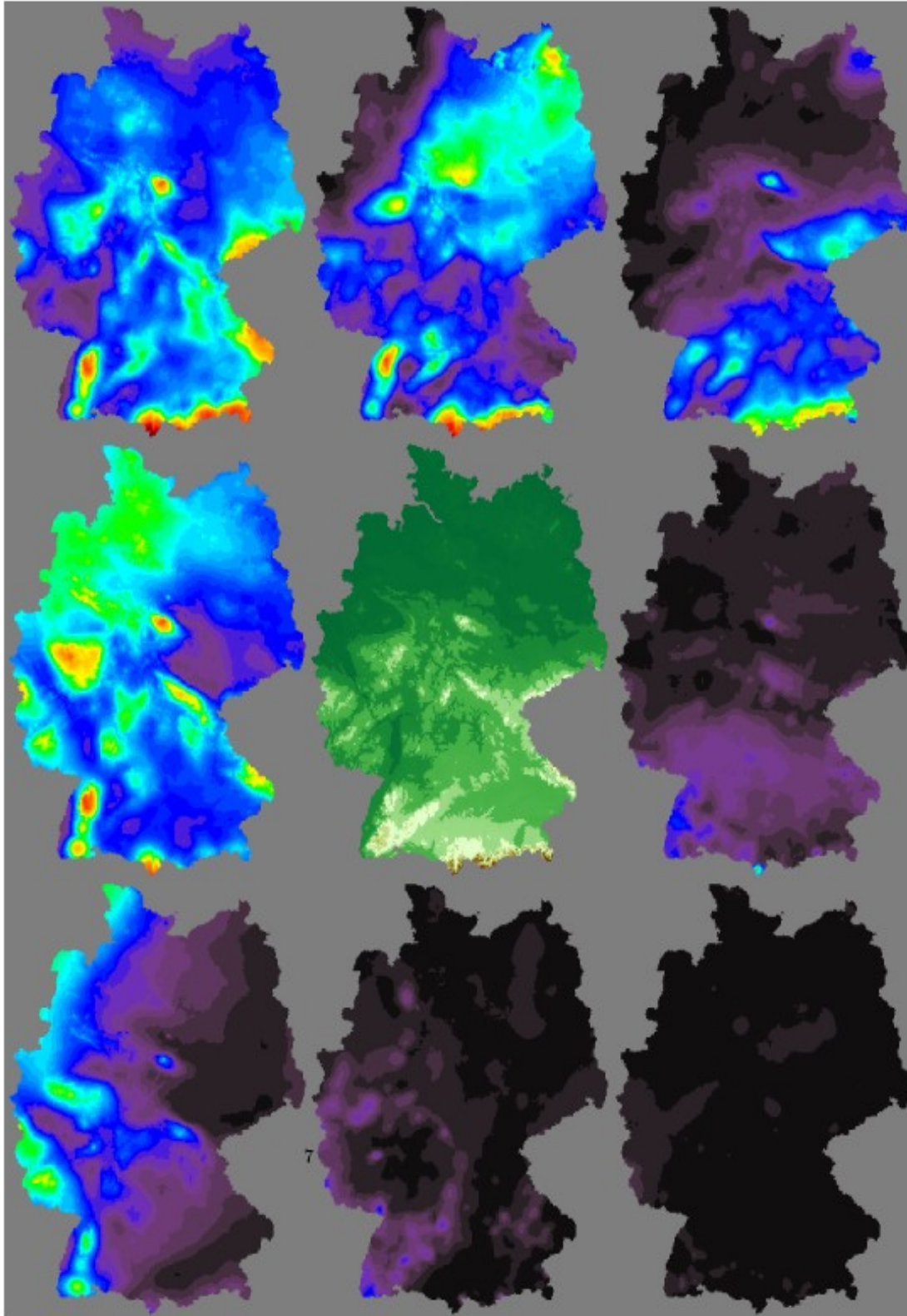
RANIE1 obs
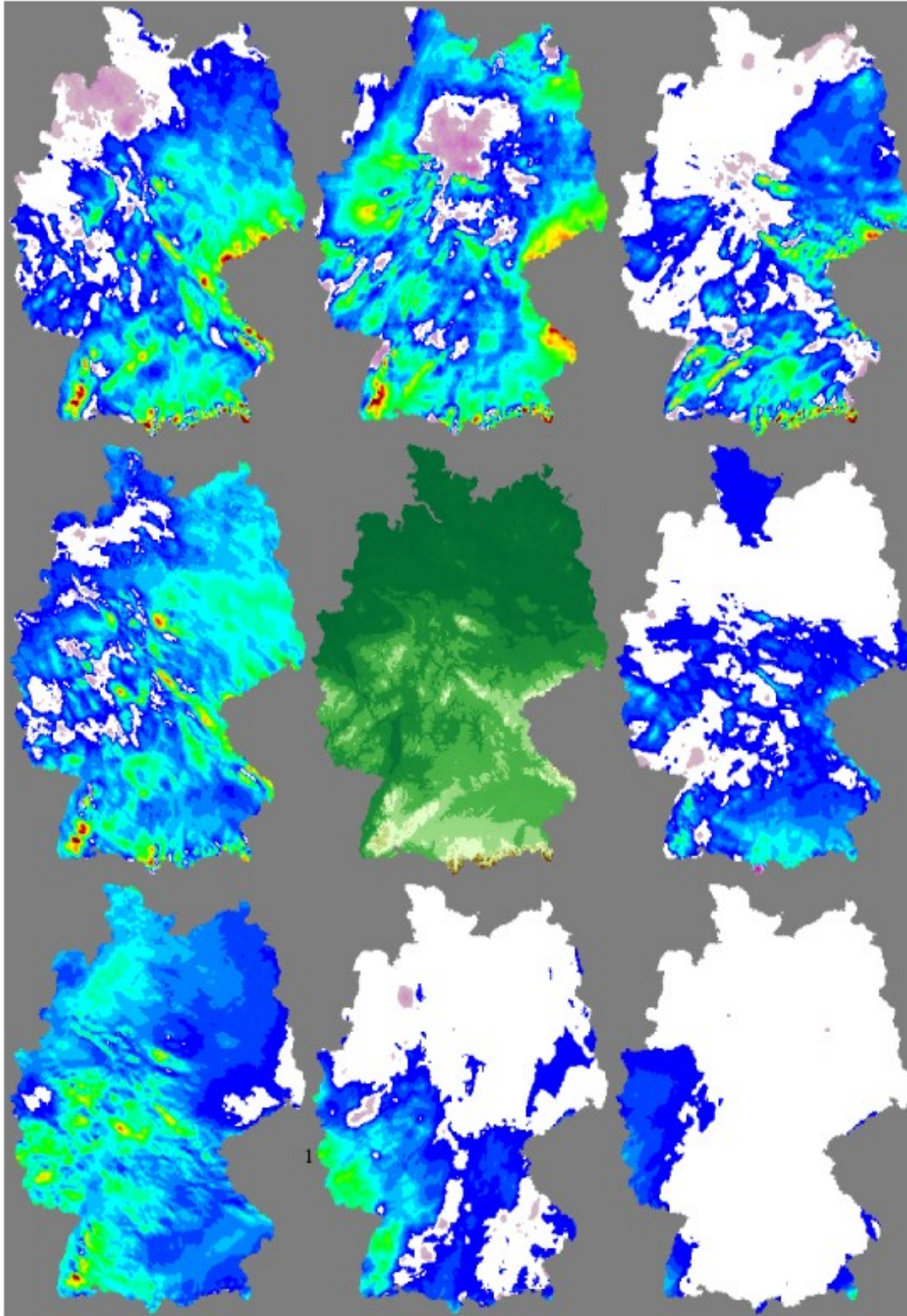
COSMO-DE

Example:
Northern CWT

Season: **SUMMER**

Digital Elevation
Model
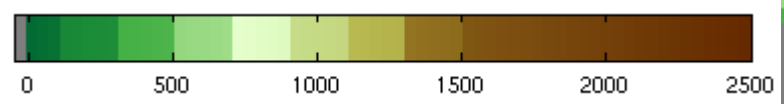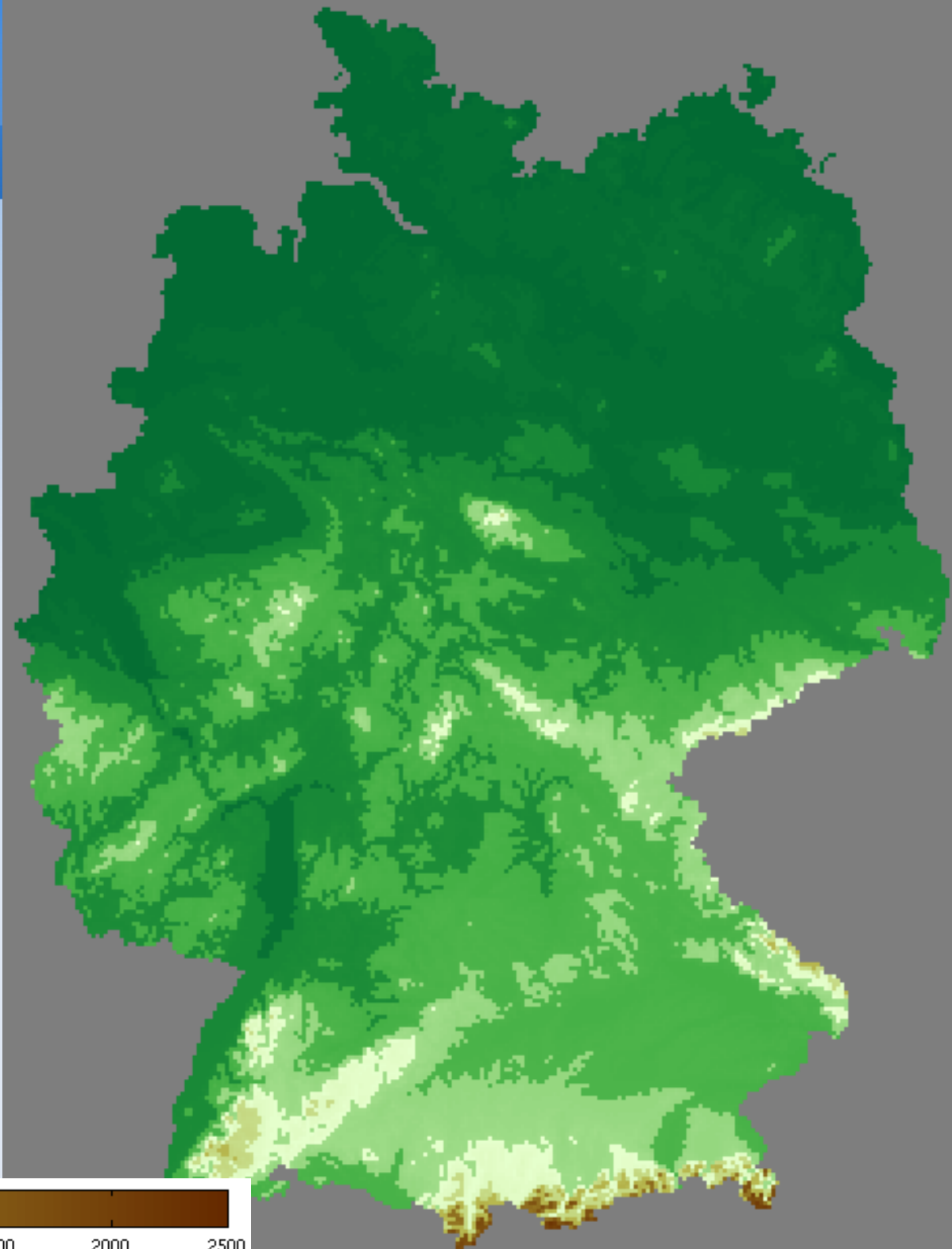
Example:
Northern CWT

Season: **SUMMER**

Observations
(RANIE1 rain
gauges)
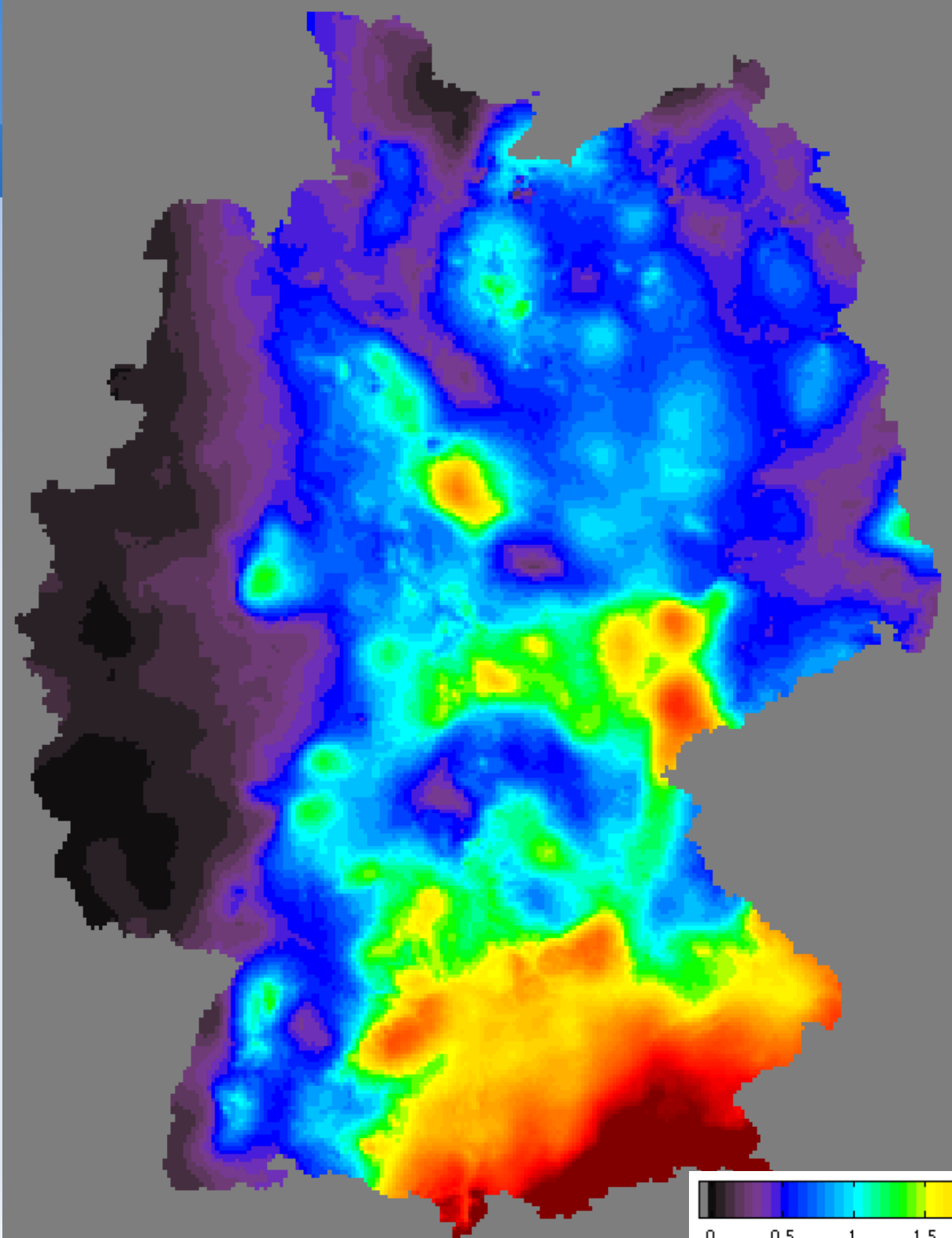
Example:
Northern CWT

Season: **SUMMER**

Model output
(COSMO-DE)
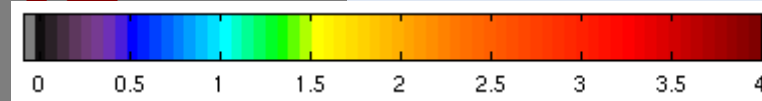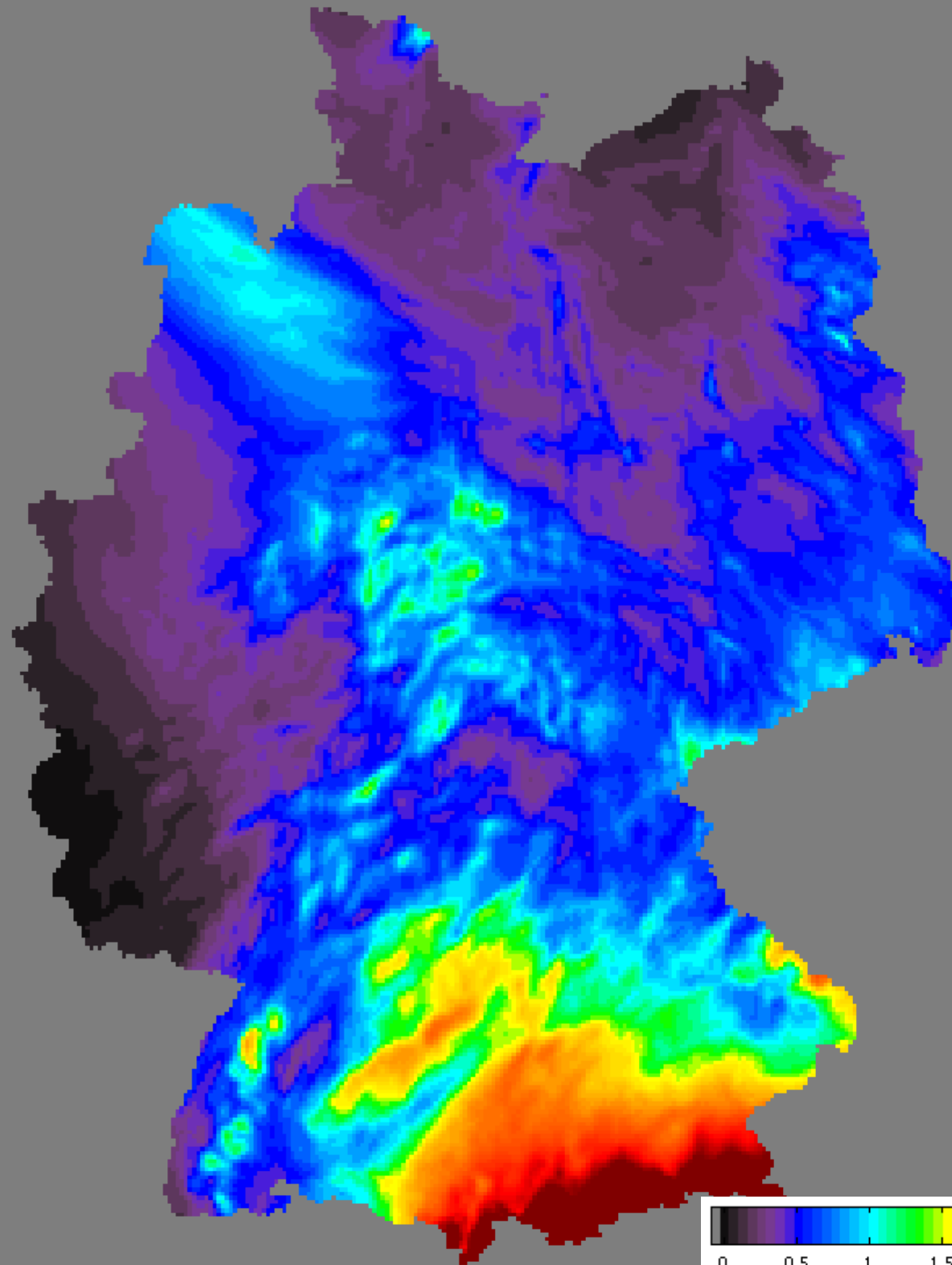
Example:
Northern CWT

Season: **SUMMER**

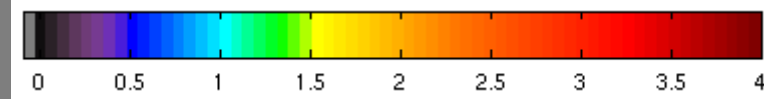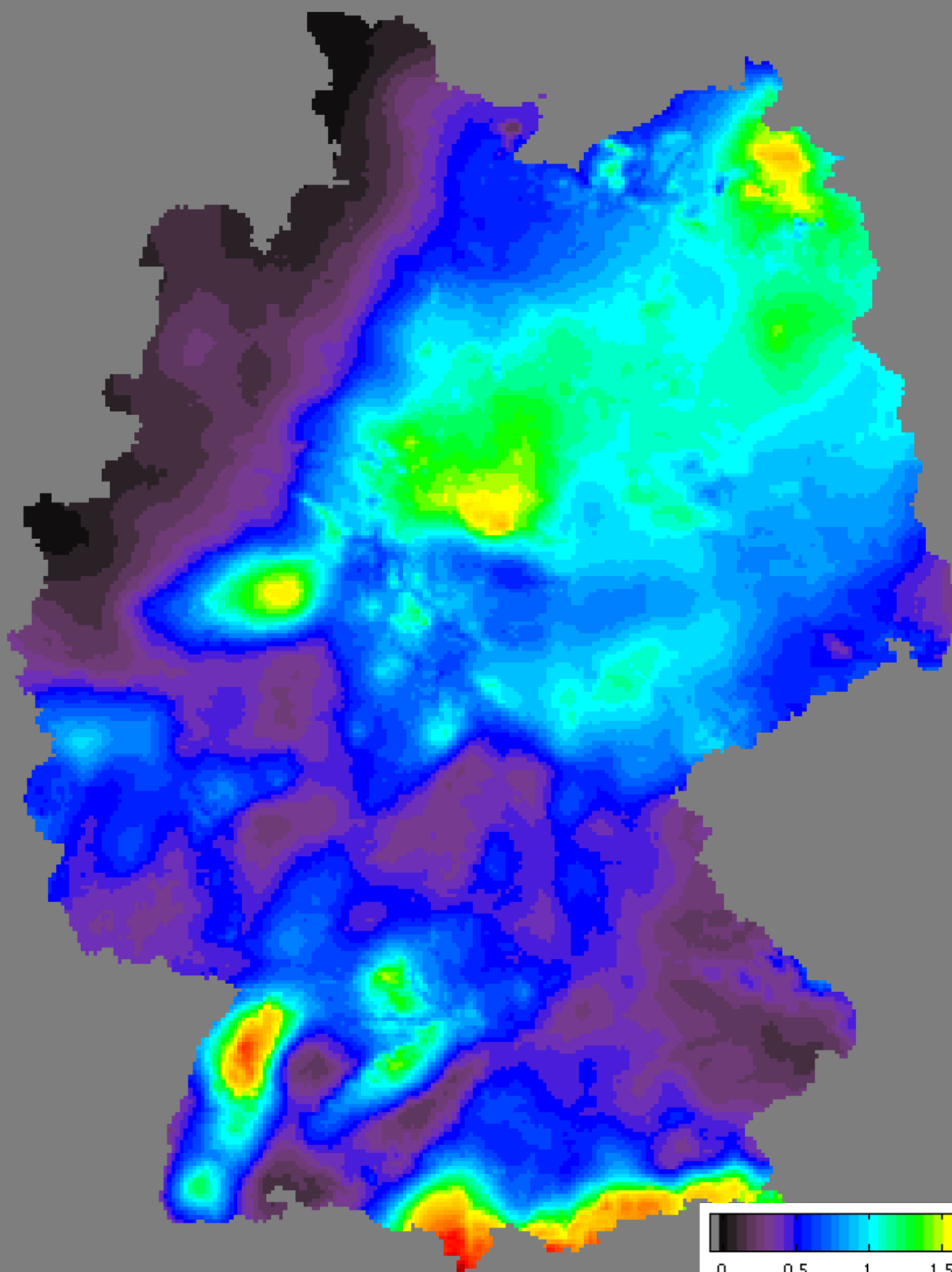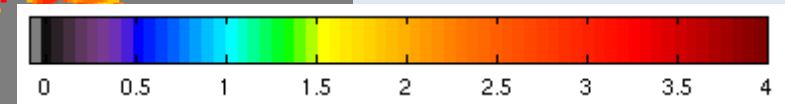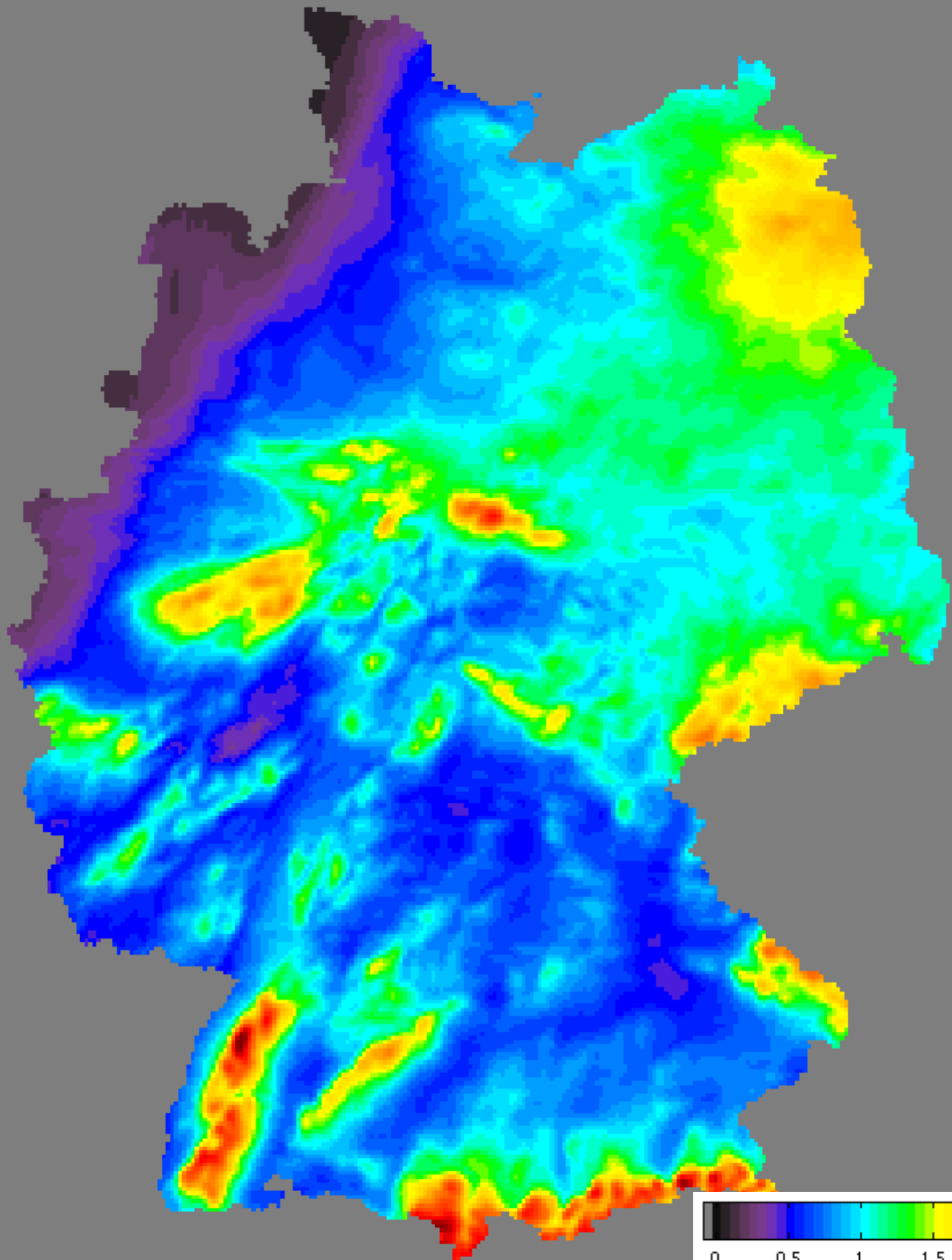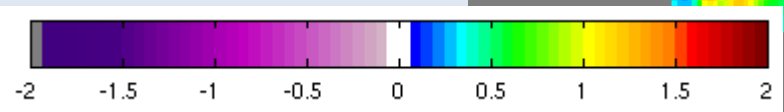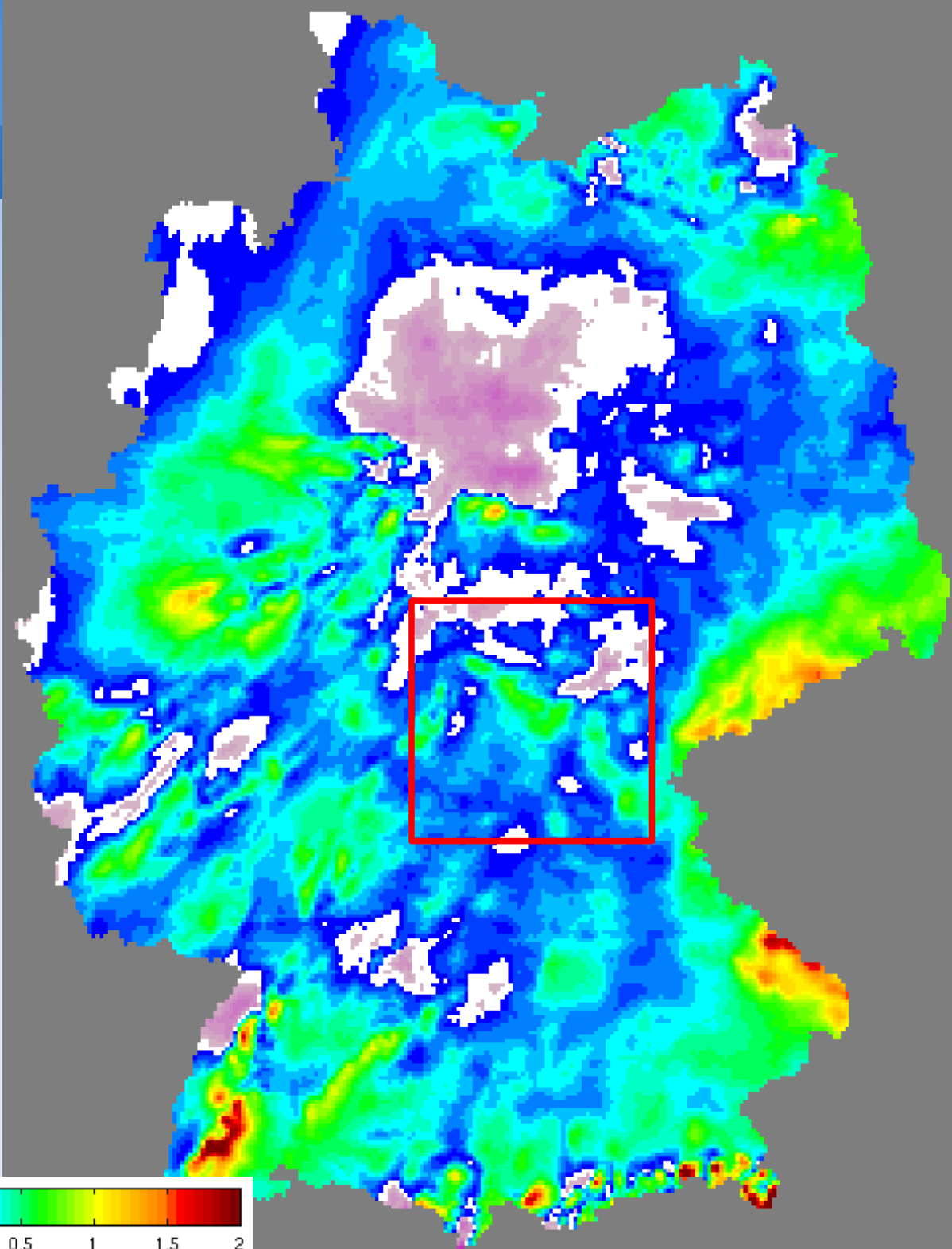Bias (model minus observation)

Example:
Northern CWT

Season: **WINTER**

Digital Elevation
Model

| 0 | 500 | 1000 | 1500 | 2000 | 2500 |
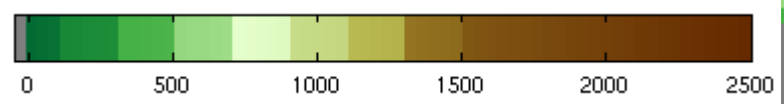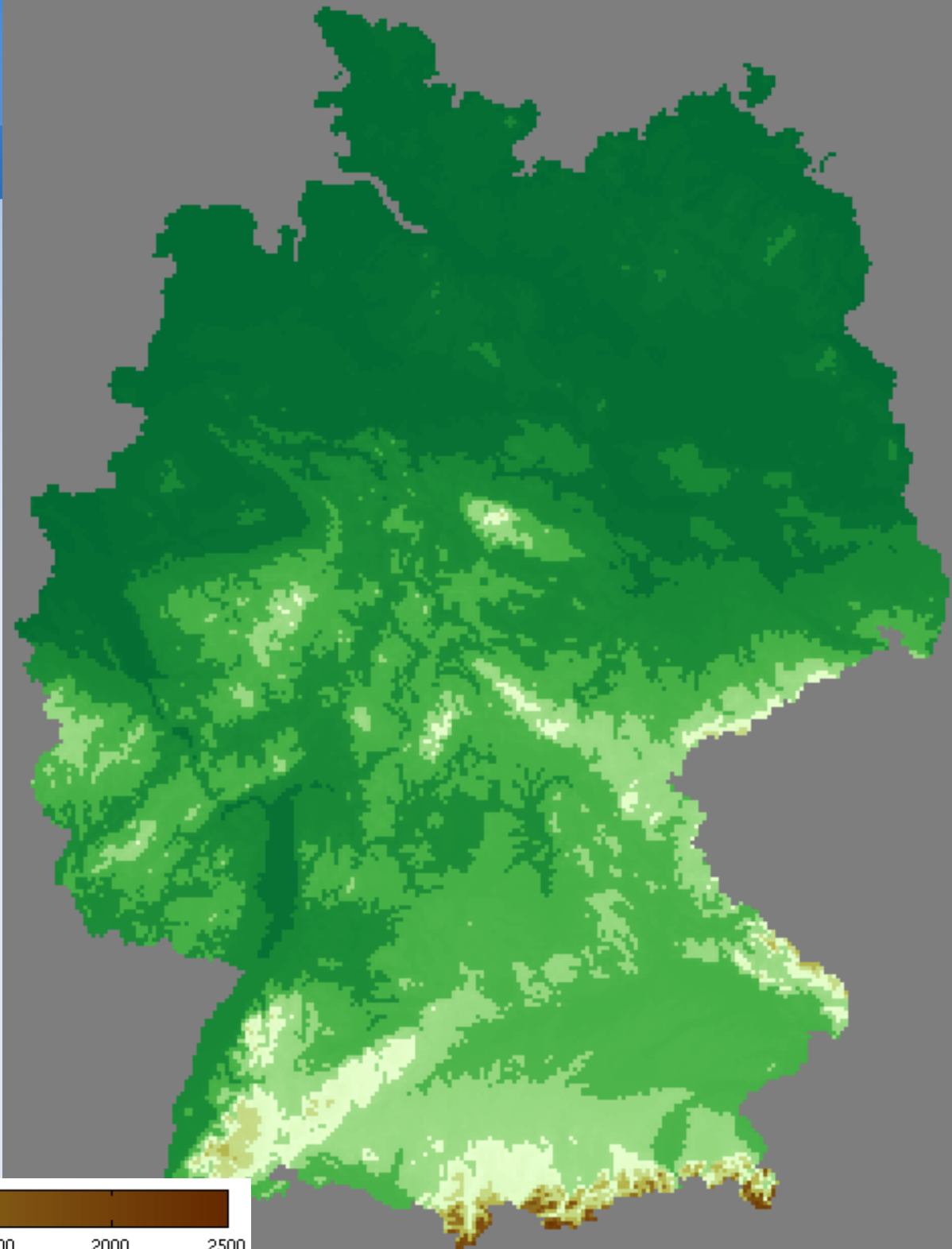
Example:
Northern CWT

Season: **WINTER**

Observations
(RANIE1 rain
gauges)

Example:
Northern CWT

Season: **WINTER**

Model output
(COSMO-DE)

Example:
Northern CWT

Season: **WINTER**

Bias (model minus observation)

Example:
Northern CWT

Season: **WINTER**

Digital Elevation
Model
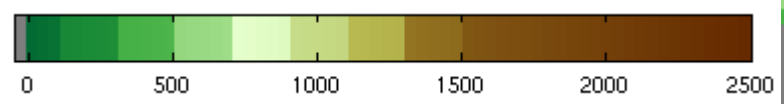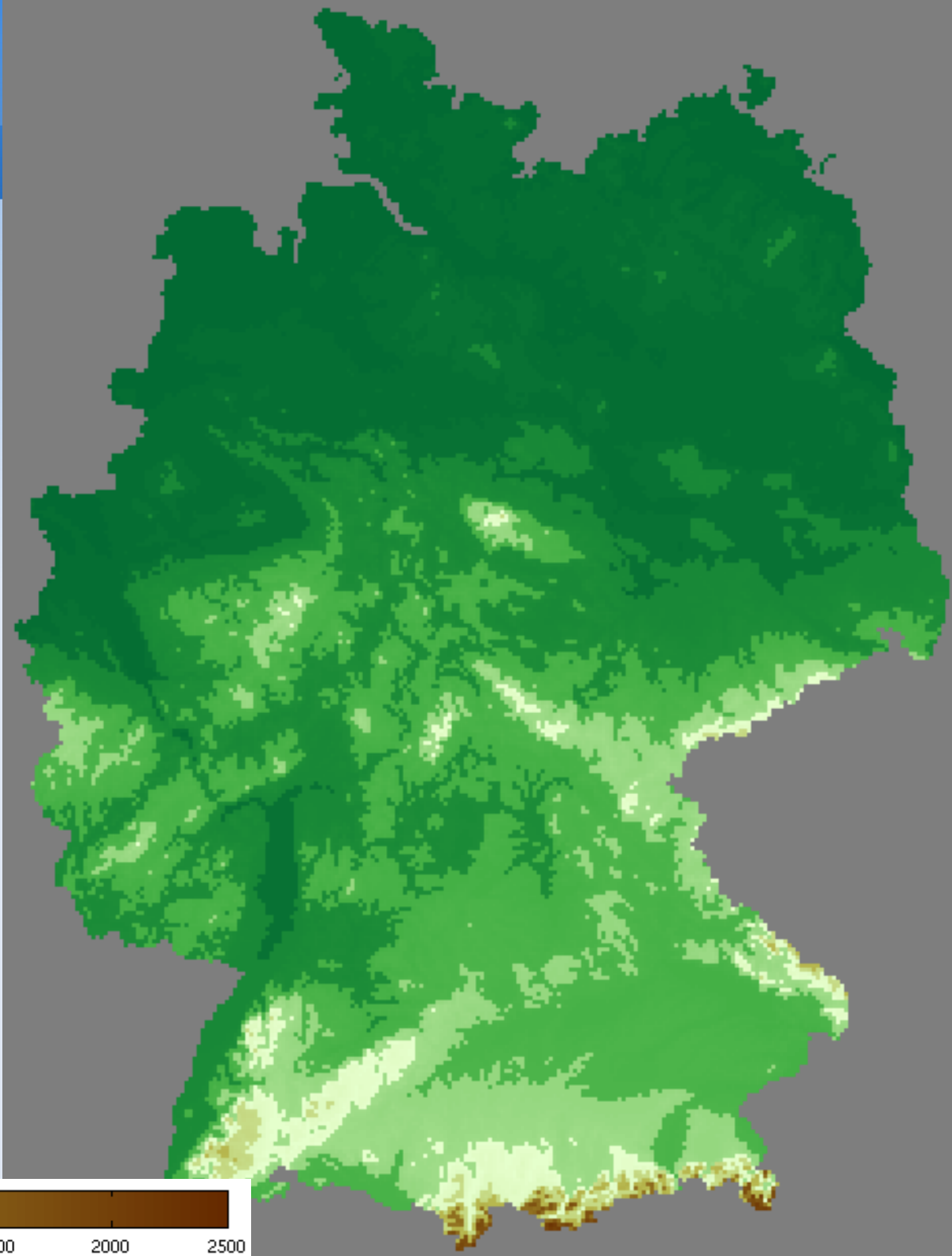
Precipitation: results

Big differences between seasons

CWT can be interpreted as the dominant airflow direction, hence lee- and windward sides are known

In **wintertime**: orographic features are responsible for most of the bias: overestimations at/around mountain and hill crests, underestimations at lee- and windward side

In **summertime**, the relation with orography is less clear, and bias is more depending on other factors (which?)

Case study Thüringer Wald

8 directional CWT's and their respective **bias** composits, centered around the DEM of the study area
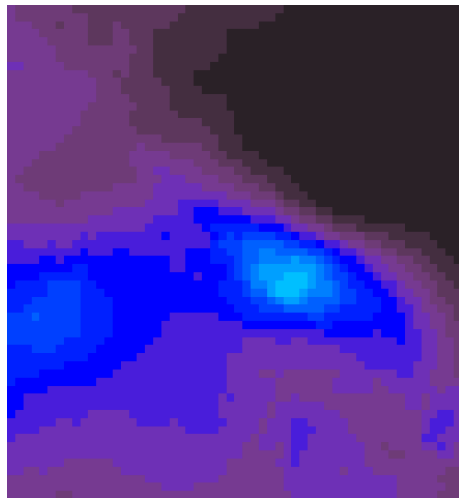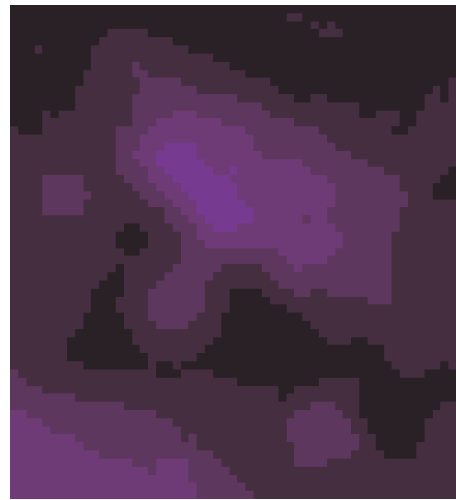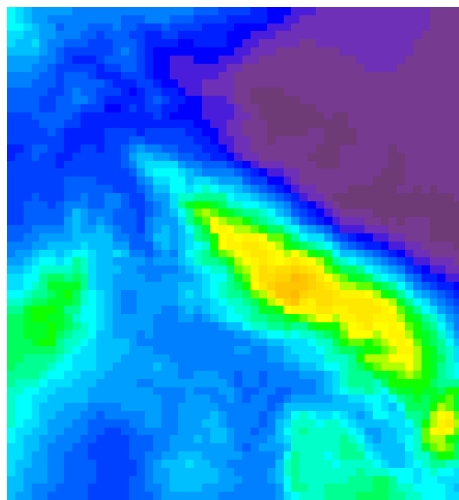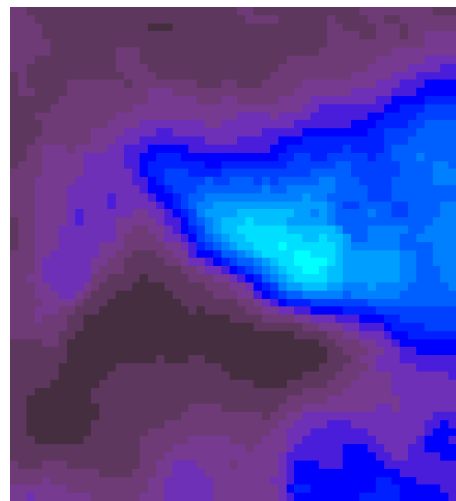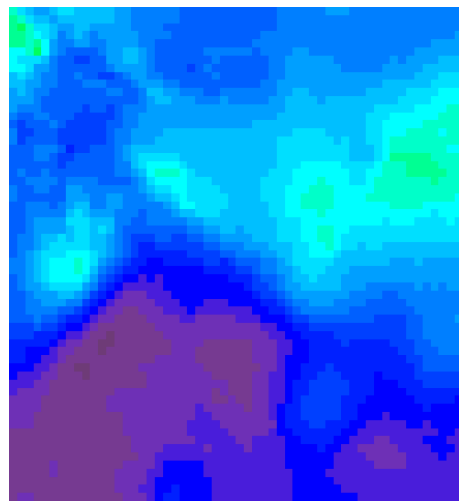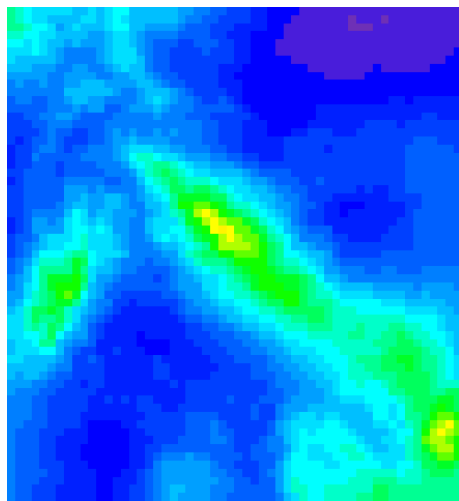
Season**: winter**
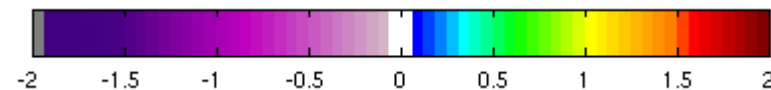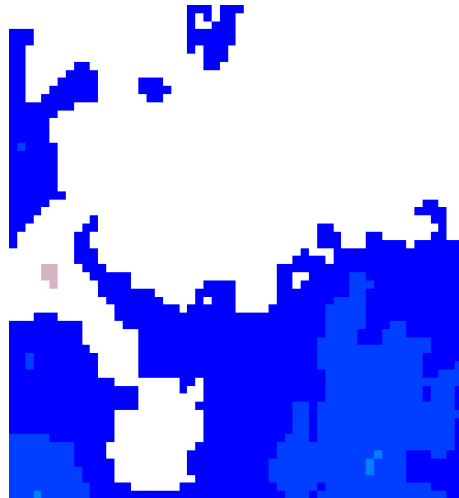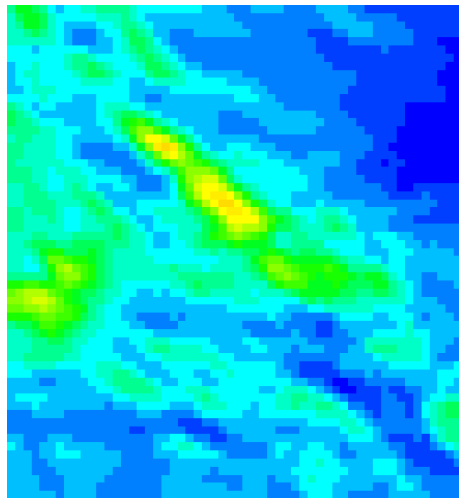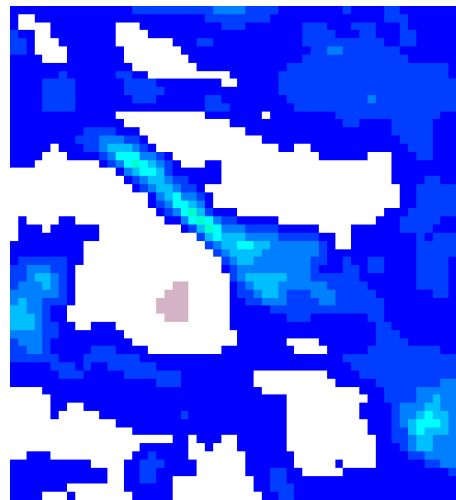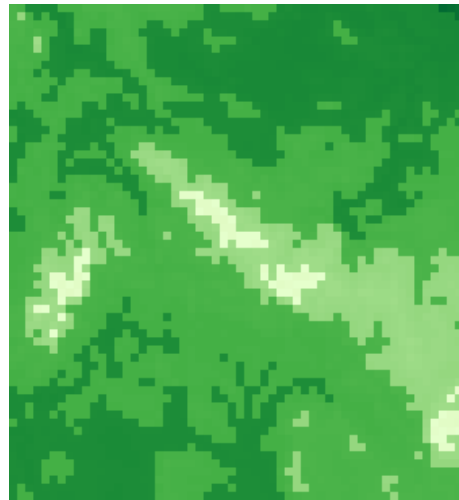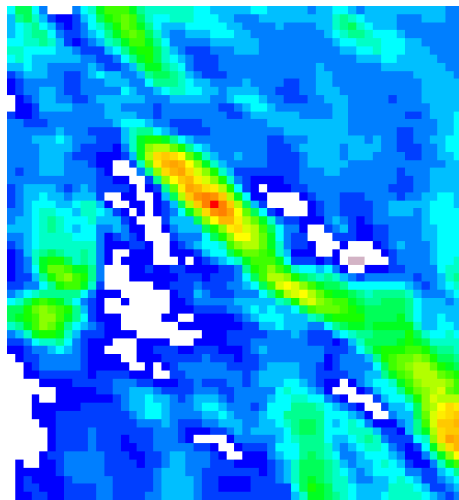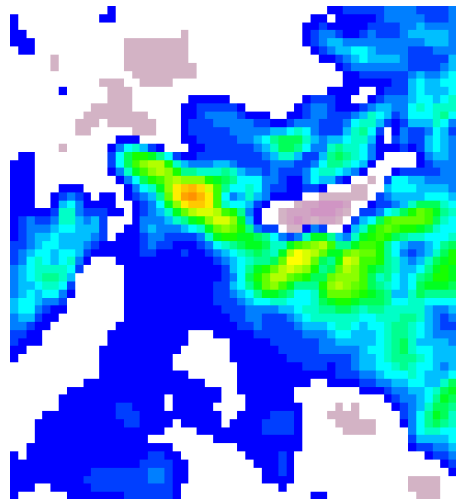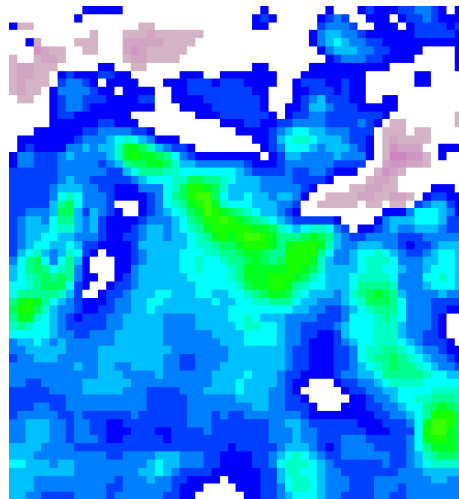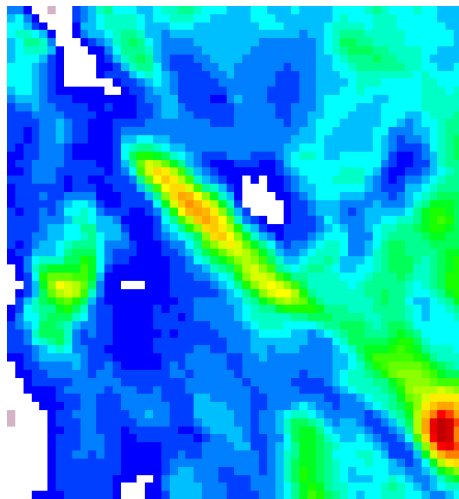
Case study Thuringer Wald

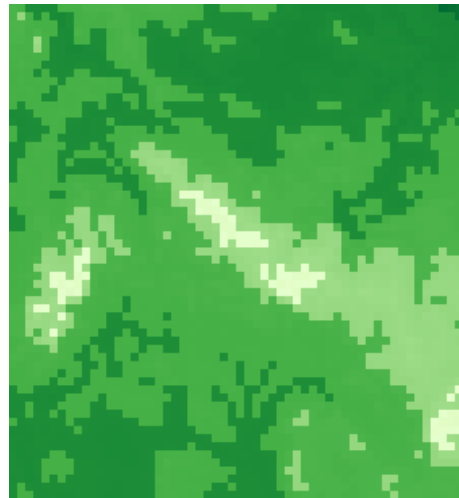RANIE1 rain gauge **observations** per CWT regime

Season**: winter**

observed precipitation
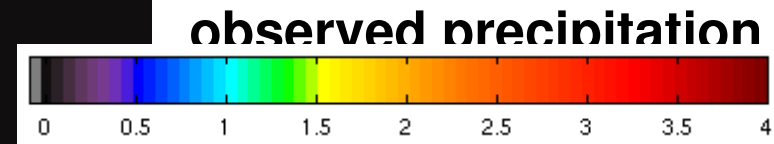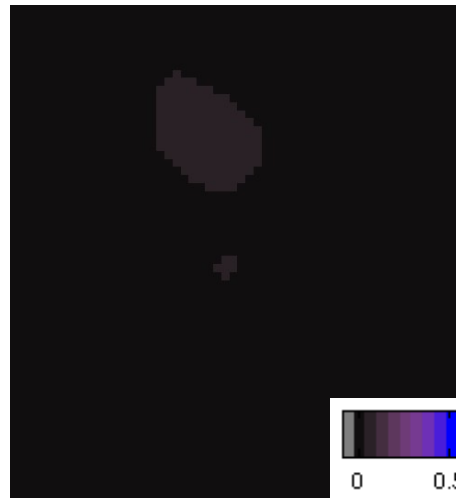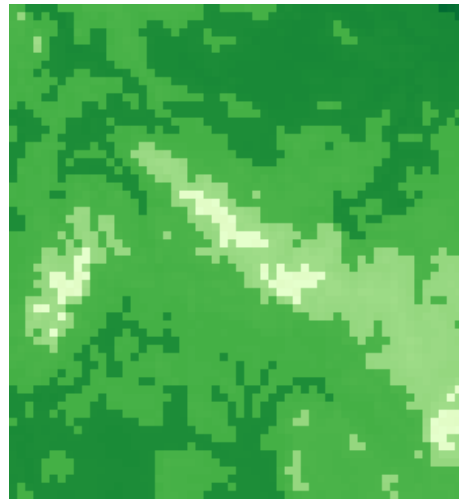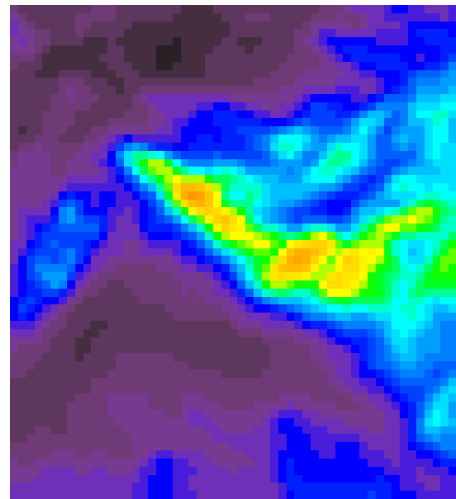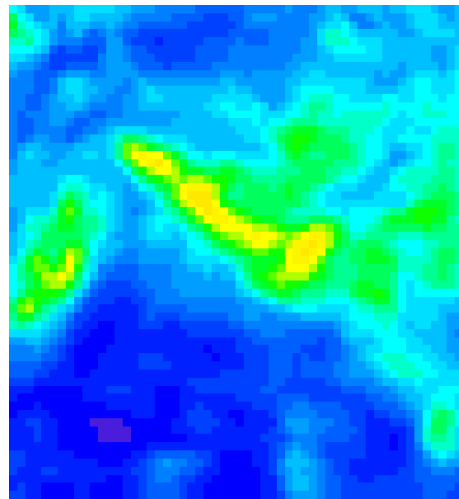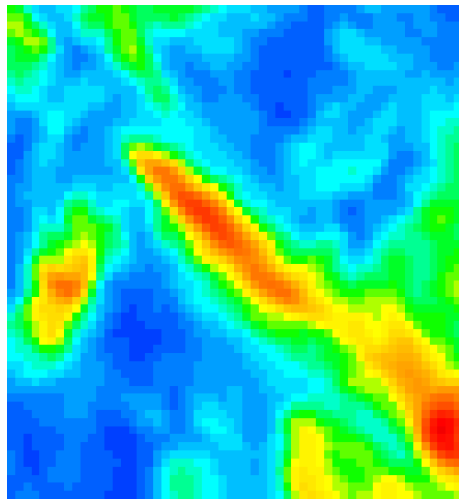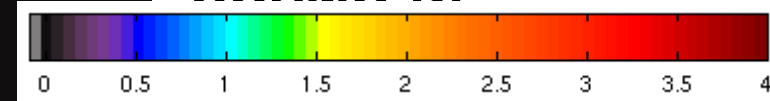
Case study
Thuringer
Wald

COSMO-DE **model output** per CWT regime

Season: **winter**
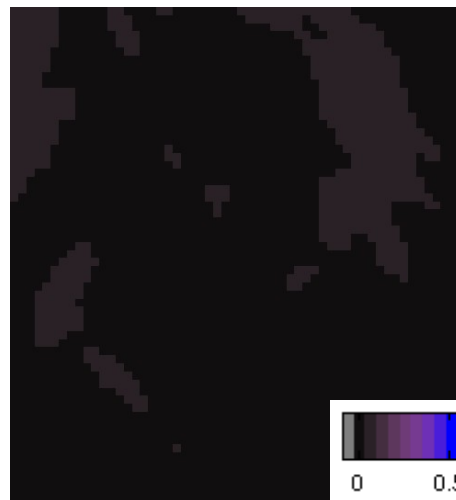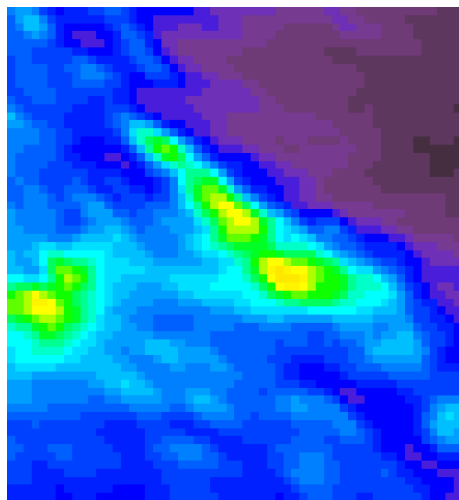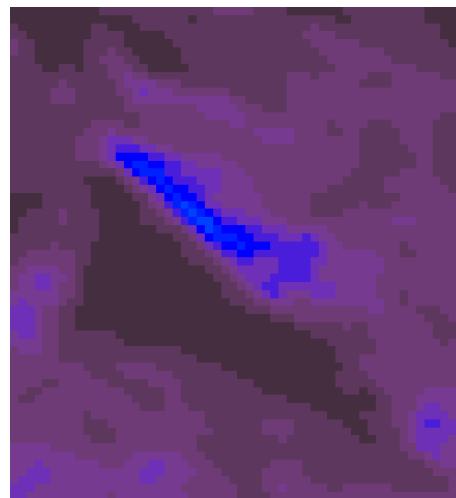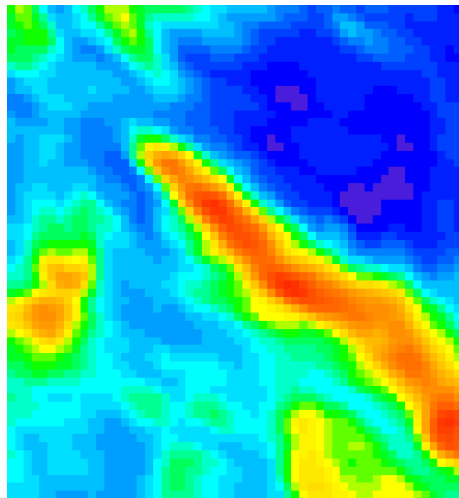
COSMO-DE

Precipitation: Thüringer Wald

COSMO-DE overestimates in general, cfr higher values of accumulated precipitation on all pixels especially at the crest (compared to RANIE observations).

Overestimation is significantly higher on the Thüringer Wald Gebirge hill crest

Apparently, the bias is not uniformly distributed over the orographic features (which indicates that solid precipitation cannot be only cause). Maybe the bias is related to interaction between modelled airflow and microphysics.
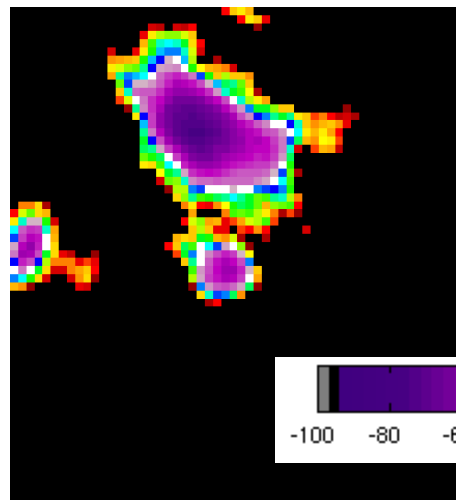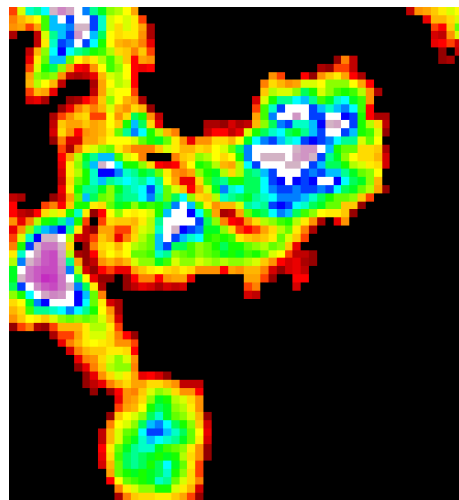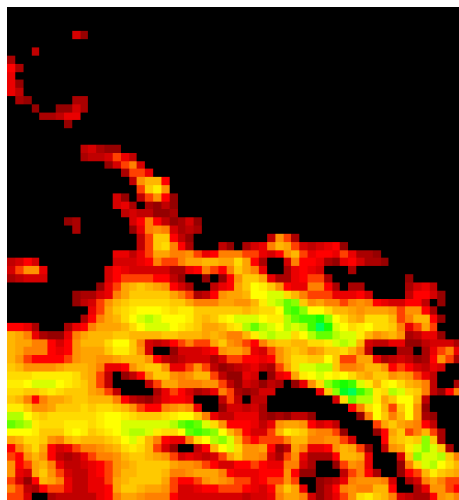
Vielen Dank!

Extra slides:

Case study Thüringer Wald
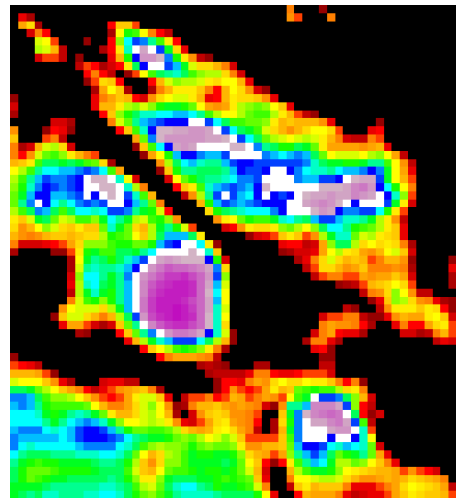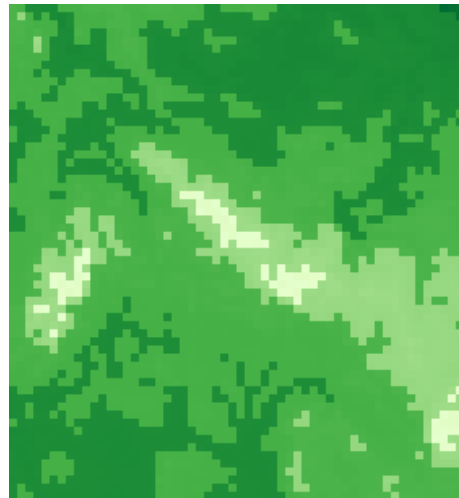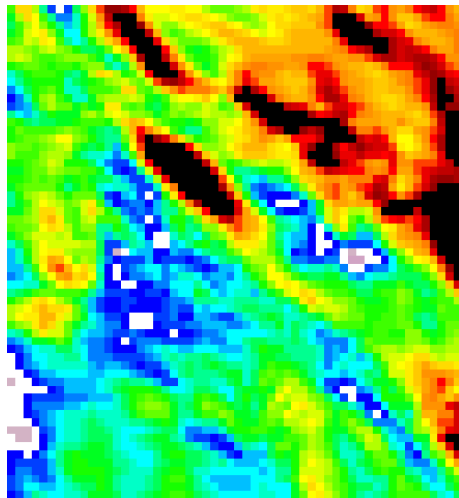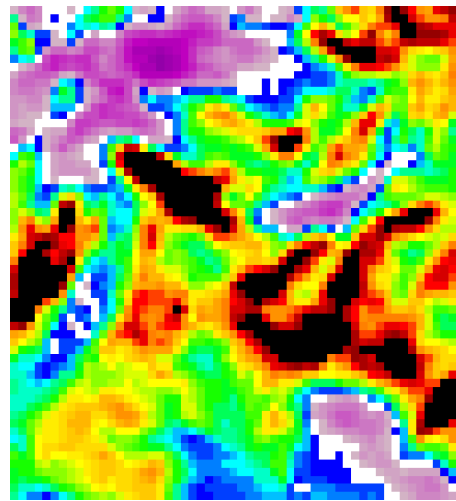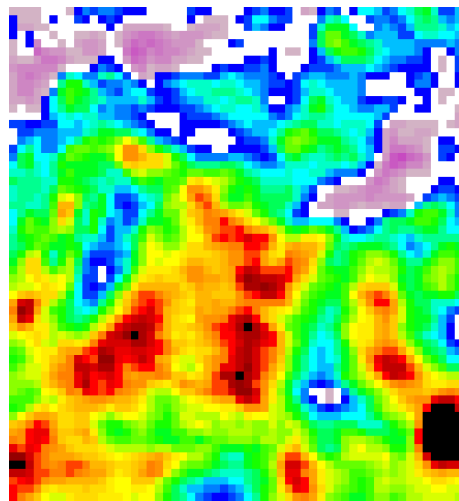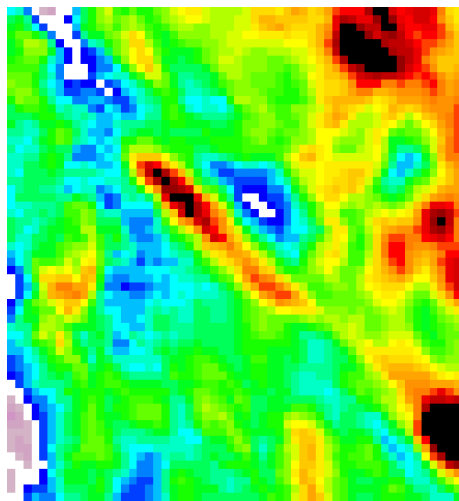
relative bias:
(model-obs)/obs

Season: **winter**

relative bias (%)

-100 -80 -60 -40 -20 0 20 40 60 80 100