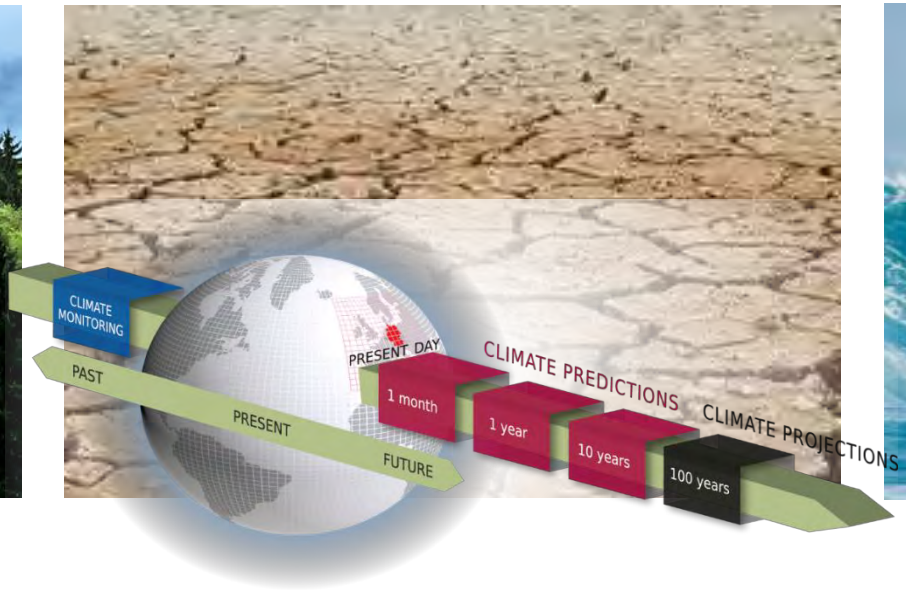
Framework Partnership Agreement for Copernicus User Uptake

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



User-Tailored Climate Predictions
–
The DWD Climate Predictions Website

Birgit Mannig, Andreas Paxian,Klaus Pankatz,
Amelie Hoff, Miriam Tivig, Katja Reinhard, Katharina Isensee, Sabrina Wehring, Alexander Pasternack[1], Philip Lorenz, Frank Kreienkamp, Barbara Früh
Deutscher Wetterdienst; [1]Freie Universität Berlin

Why this website?

User-friendly information portal on climate predictions

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Who are the users?

Sector specific users, using either data and / or end results

Why this website?

User-friendly information portal on climate predictions

Who are the users?

Sector specific users, using either data and / or end results

We work towards a…

…seamless predicton approach:

➔ **Timescales**

Seamless Approach: Timescales

Climate predictions for three timescales

- ➔ **Decadal**
- ➔ **Seasonal**
- ➔ **Subseasonal**

weeks
3, 4,
5, 6

months
1-3, 2-4,
3-5, 4-6

years
1, 1-5,
3-7, 6-10

https://www.dwd.de/climatepredictions

Two layers of complexity

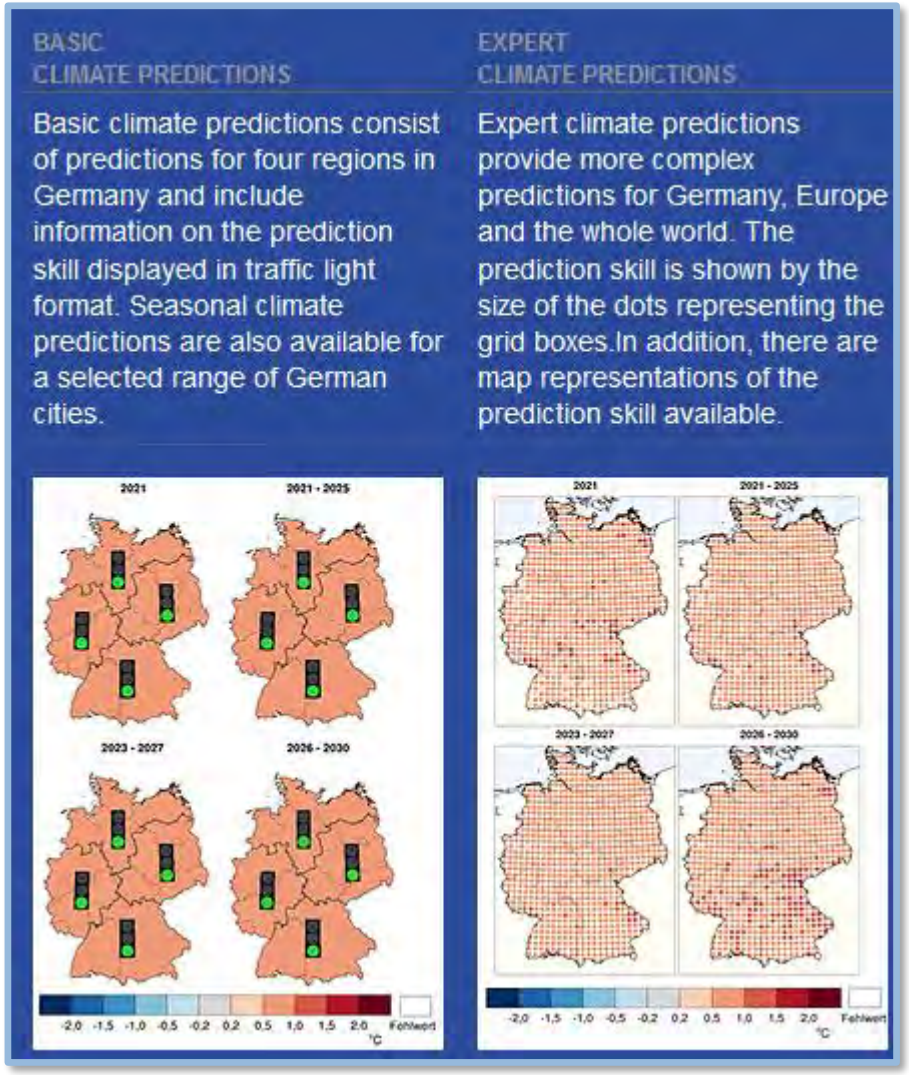
Basic climate predictions (Germany only)

+

Expert climate predictions

(+ Background information)

https://www.dwd.de/climatepredictions

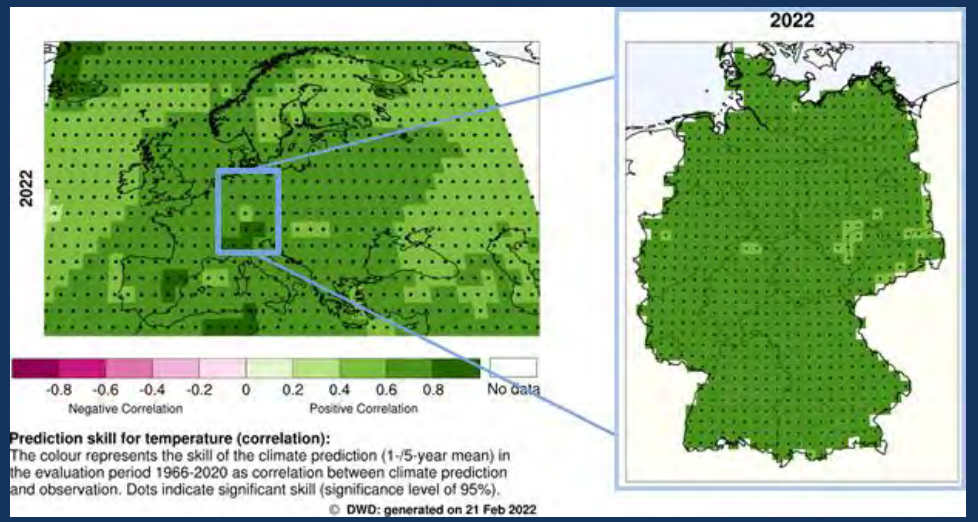


Three Regions (with different resolution)

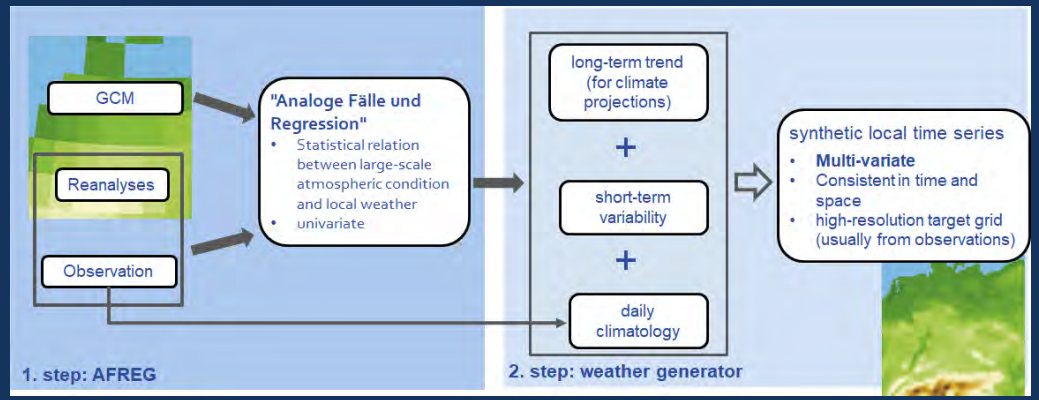
- ➔ **World (5°)**
- ➔ **Europe (2°)**
- ➔ **Germany (~ 20km)**

Additionally for basic climate predictions:

Fieldmeans of four German **Regions**



Downscaling with EPISODES



Kreienkamp, F. et al., 2019

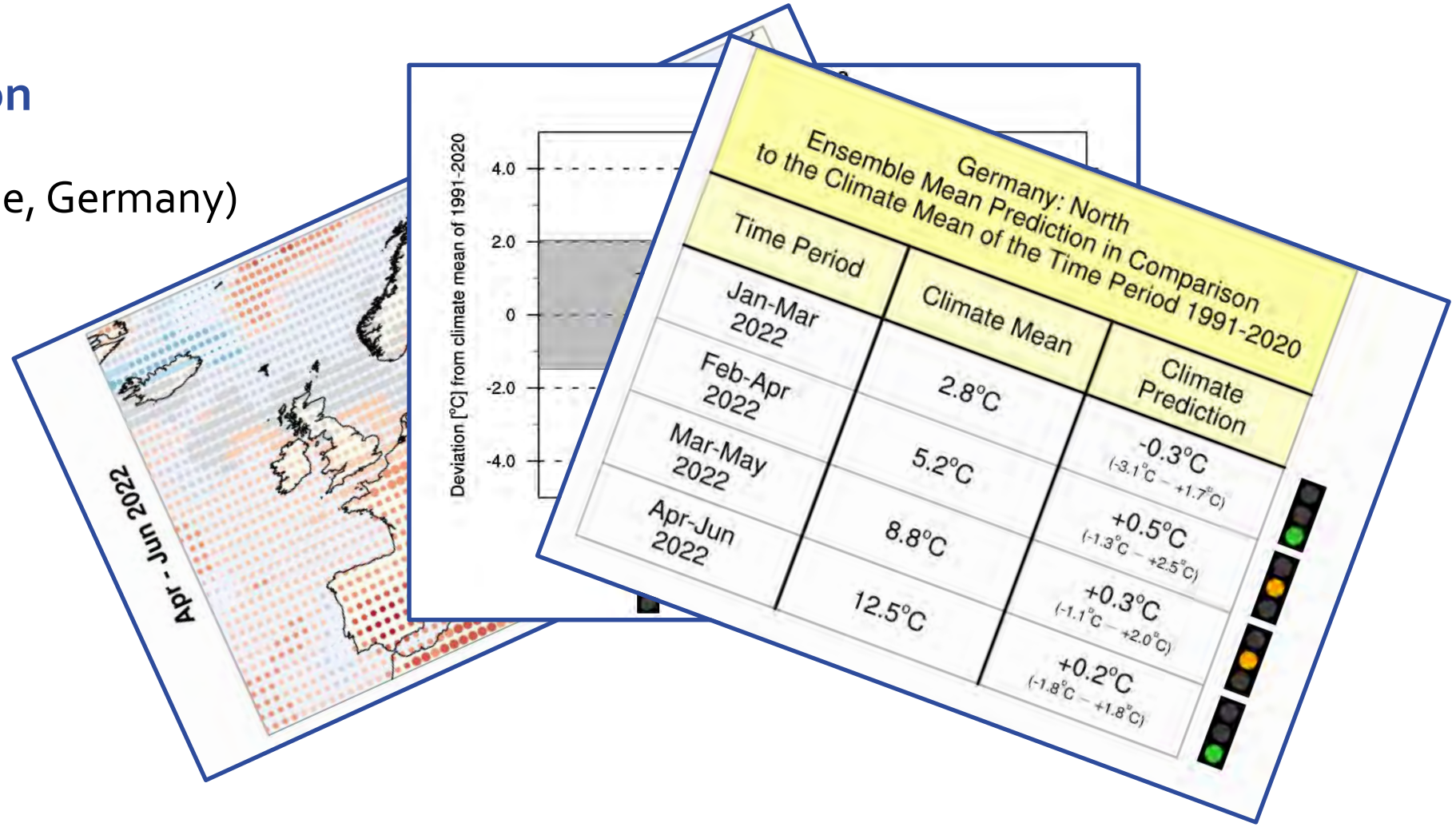
Types of Visualisation

- ➔ **Maps** (World, Europe, Germany)
- ➔ **Timeseries**
- ➔ **Tables**

Variables:

- ➔ **Temperature**
- ➔ **Precipitation**

…more to come!

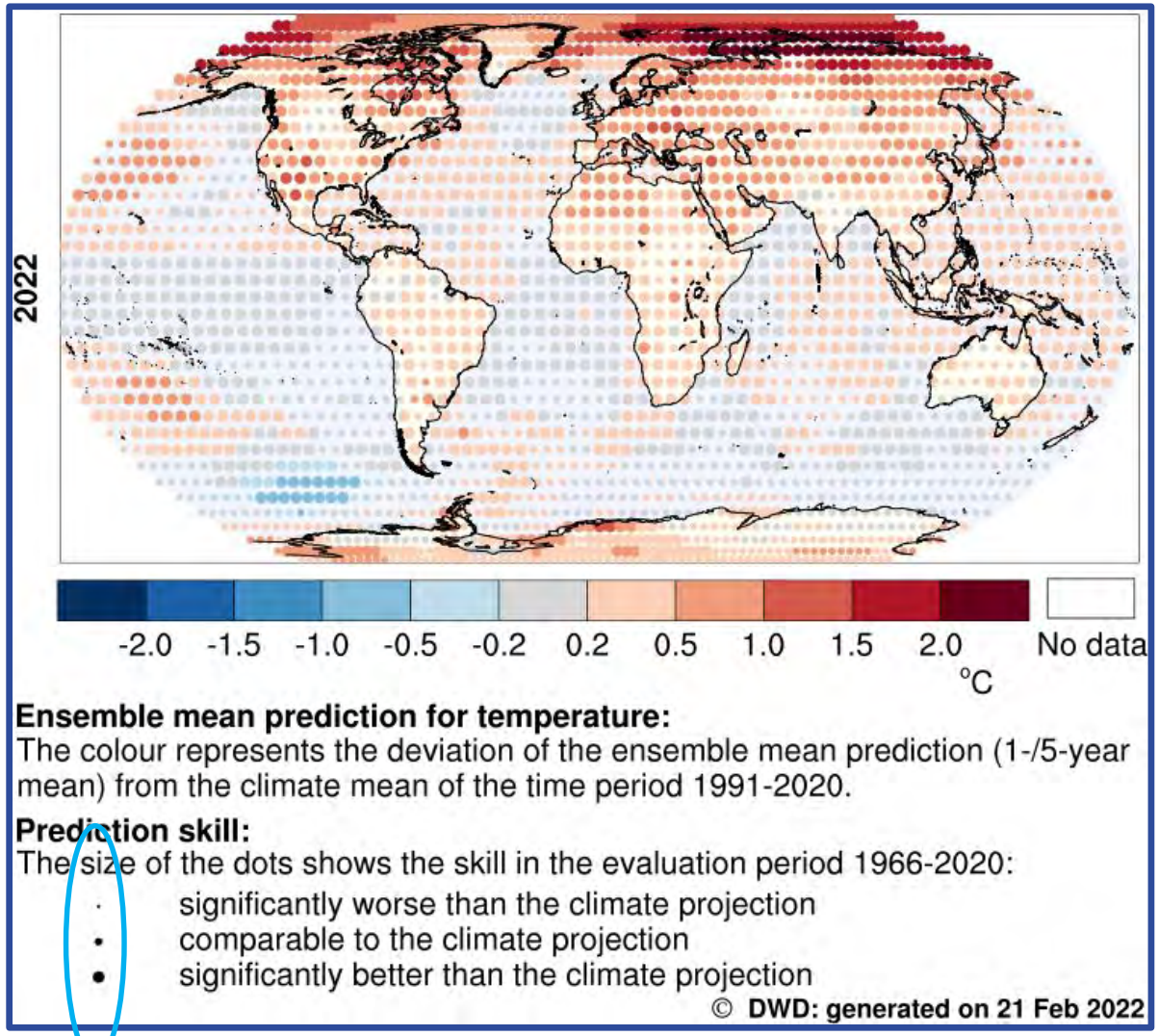


Prediction Types

➔ **Ensemble mean** and **probabilistic** predictions

Our Principle

➔ Combined display of prediction and **skill**



Prediction Types

➔ **Ensemblemean** and **probabilistic** predictions

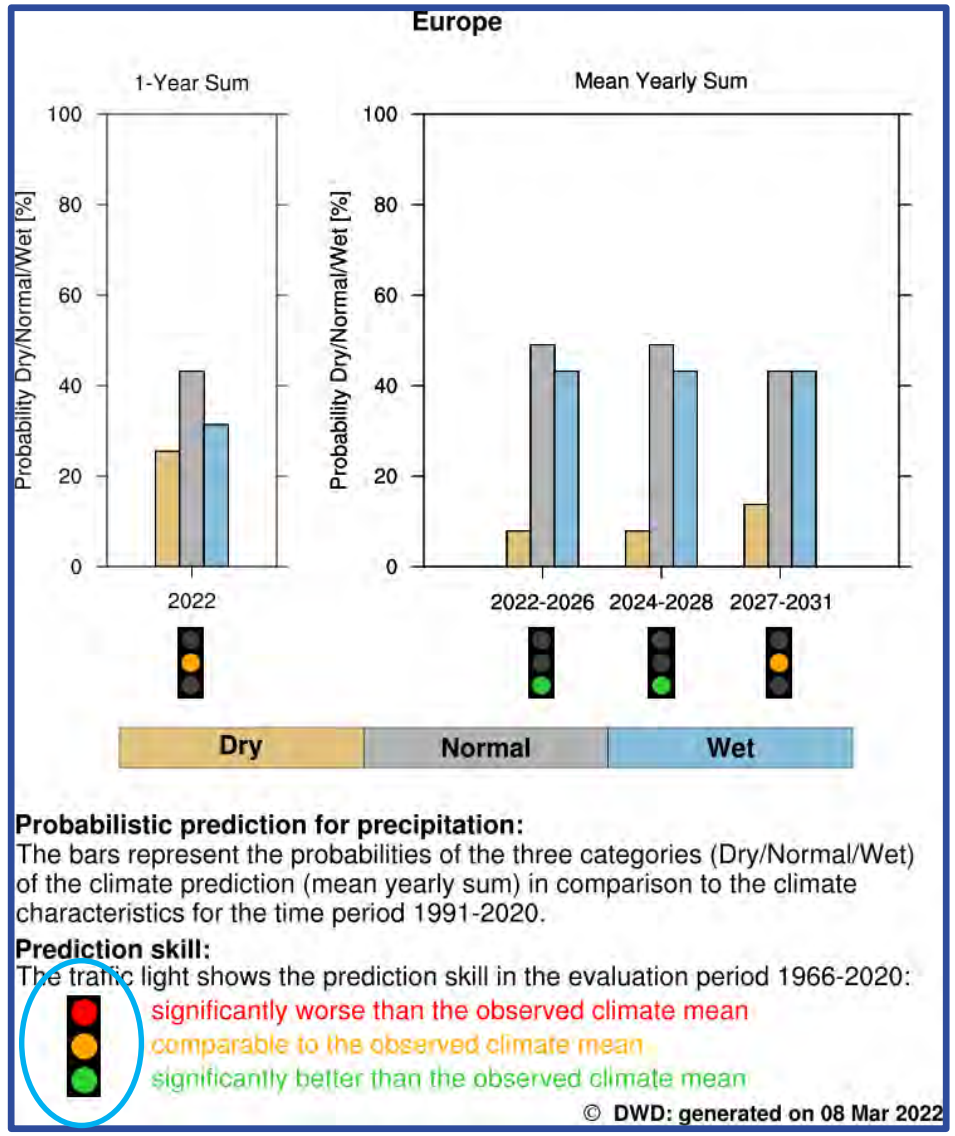
Our Principle

➔ Combined display of prediction and **skill**

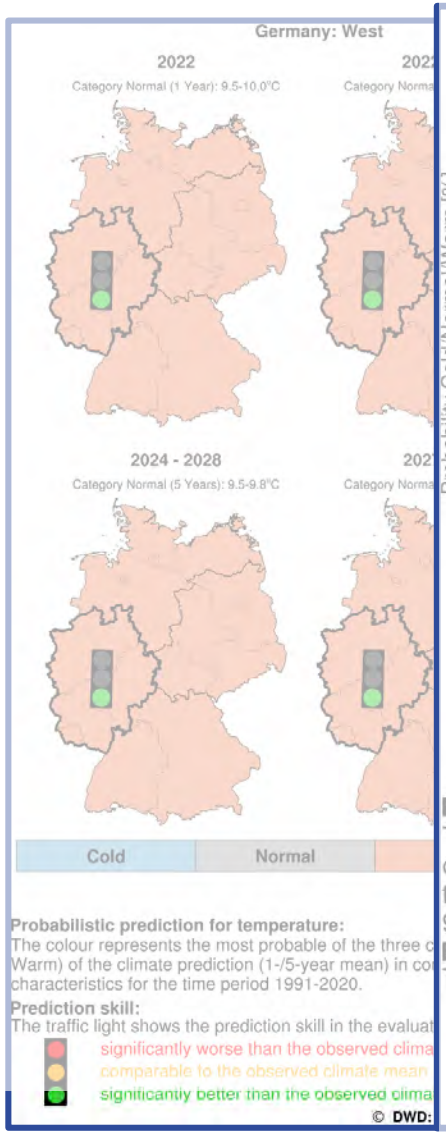
- ➔ Ensemble mean: **MSESS**
- ➔ Probabilistic predictions: **RPSS**
- ➔ Reference prediction: observed climate mean and climate projection (decadal predictions)
- ➔ Correlation maps (Category: Expert Climate Prediction Skill)

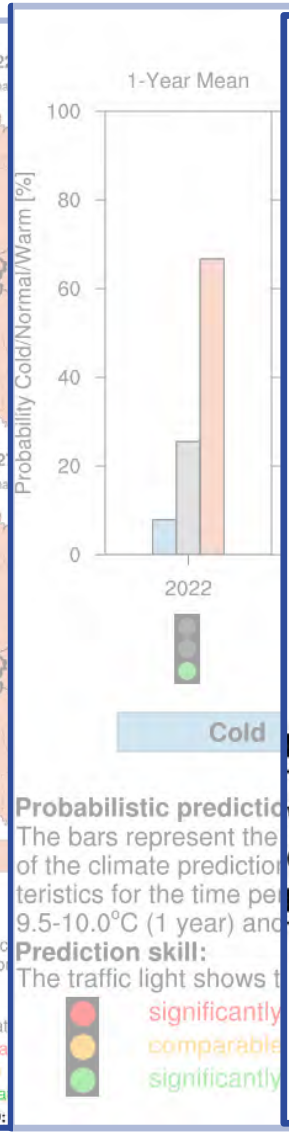
Info

Statistical postprocessing of decadal predictions: Recalibration (Pasternack et al., 2018, 2021)



LET'S TAKE A CLOSER LOOK…





Germany: West
Probability of the Categories Cold/Normal/Warm
in Comparison to the Climate Characteristics for 1991-2020

Time Period	Category Normal	Cold	Normal	Warm
2022	9.5 - 10.0°C	8%	25%	67%
2022-2026	9.5 - 9.8°C	2%	2%	96%
2024-2028	9.5 - 9.8°C	2%	8%	90%
2027-2031	9.5 - 9.8°C	2%	2%	96%

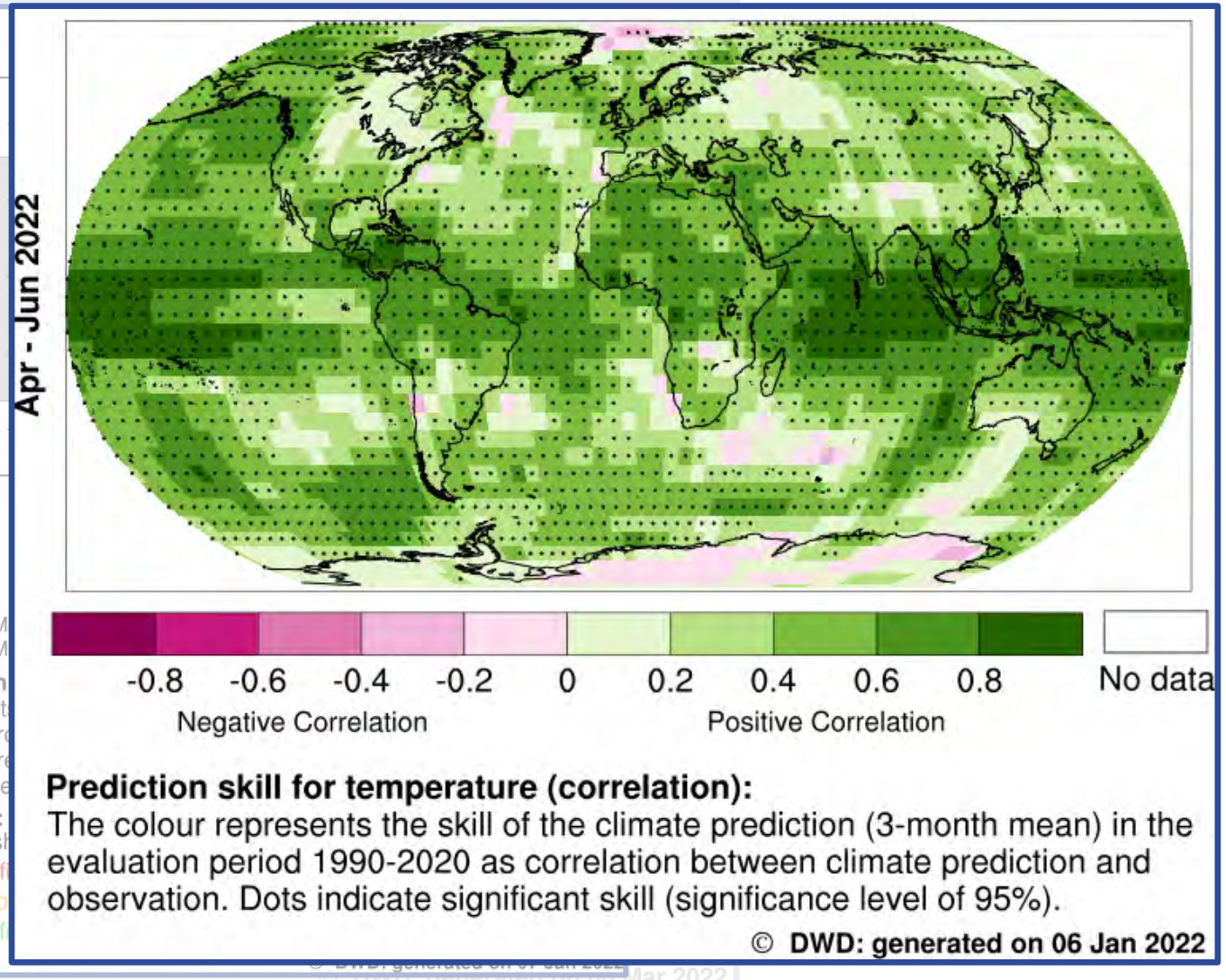
Probabilistic prediction for temperature:
The table represents the probabilities of the three categories (Cold/Normal/Warm) of the climate prediction (1-/5-year mean) in comparison to the climate characteristics for the time period 1991-2020.

Prediction skill:
The traffic light shows the prediction skill in the evaluation period 1966-2020:

significantly worse than the observed climate mean
comparable to the observed climate mean
significantly better than the observed climate mean

© DWD: generated on 08 Mar 2022

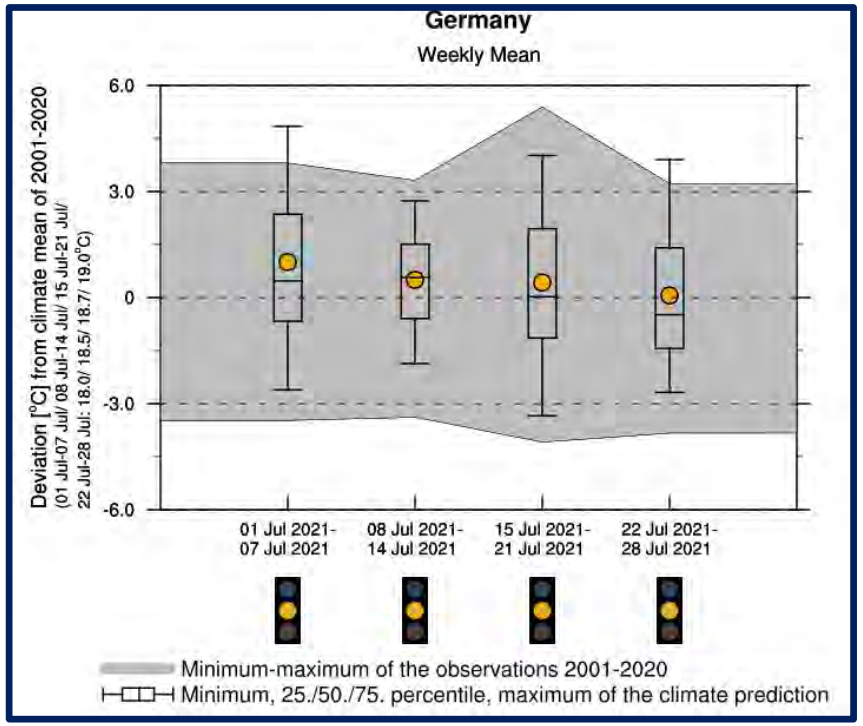
Basic probability prediction



Expert climate predictions

Future Plans

➔ Subseasonal predictions (preoperational)



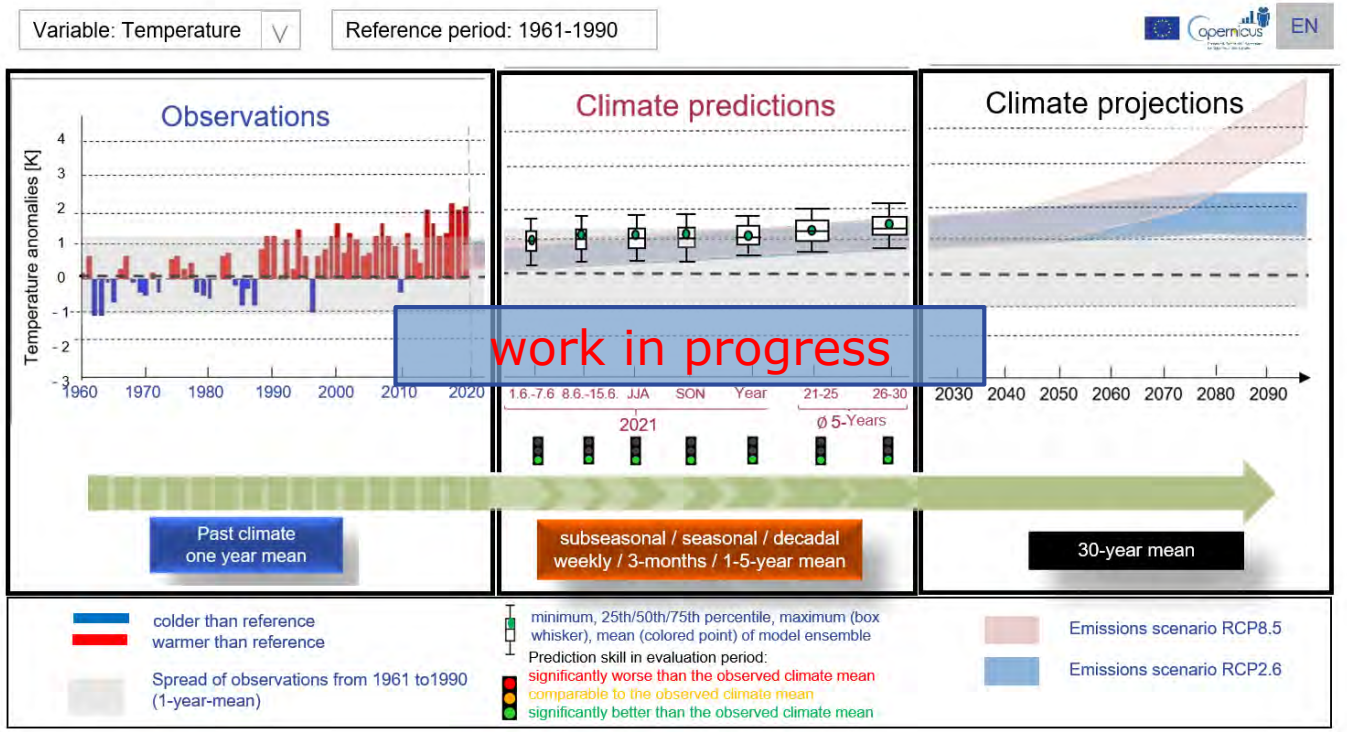
Future Plans

➔ Subseasonal predictions (preoperational)

➔ Multi-year seasonal means

Future Plans

- ➔ Subseasonal predictions (preoperational)
- ➔ Multi-year seasonal means
- ➔ A seamless timeseries
  - ➔ Including observations & climate projections



Future Plans

- ➔ Subseasonal predictions (preoperational)
- ➔ Multi-year seasonal means
- ➔ A seamless timeseries
  - ➔ Including observations & climate projections
- ➔ Drought indices & ENSO
- ➔ Updated model version for our next decadal prediction in 2023
- ➔ Multi-model ensembles

user engagement

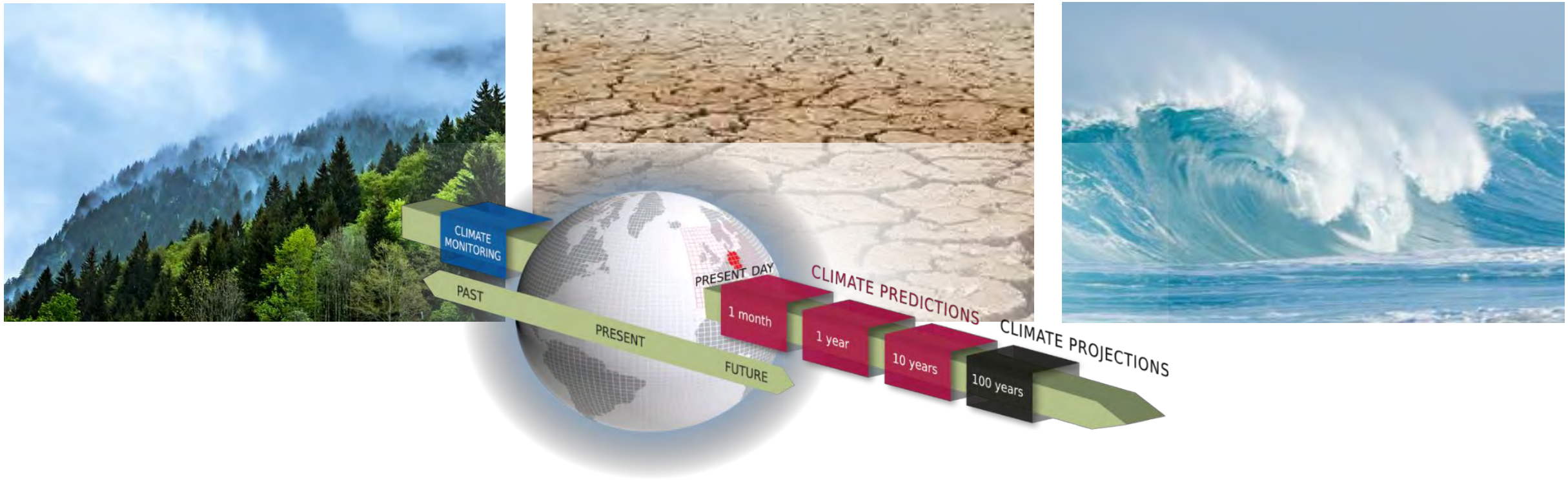
Summary

https://www.dwd.de/climatepredictions

- **High demand** for climate predictions on subseasonal, seasonal and decadal time scales from manifold (German) users from business, politics and society.
- Website provides information on climate predictions which is **consistent** on three timescales and it is **developed in close collaboration with our users**.
- Our mission: meet **users' needs**, enhance their **understanding** of climate predictions, and create awareness of the importance of the prediction skill.
- Work in progress!

Thank you!

birgit.mannig@dwd.de


CLIMATE MONITORING
PAST
PRESENT
FUTURE
PRESENT DAY
1 month
1 year
10 years
100 years
CLIMATE PREDICTIONS
CLIMATE PROJECTIONS

Appendix

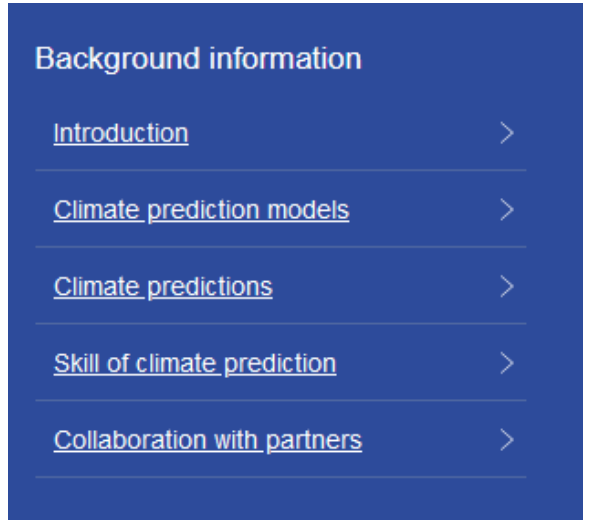
Model Configurations (since 2021)

	Subseasonals	Seasonals	Decadals
climate model	IFS (ECMWF)[1]	GCFS2.1 (DWD)[2]	MPI-ESM (DWD)
spatial resolution	~36 km	~100 km	~200 km
initializations	weekly (Mon & Thu)	monthly (1.)	yearly (Nov)
temporal coverage	46 days	6 months	10 years
prediction ensemble	51 simulations	50 simulations	16 simulations
hindcast ensemble	11 simulationen	30 simulationen	16 simulatons
available hindcasts	20 years BP	1990-today	1961-today

[1] https://www.ecmwf.int/en/forecasts/documentation-and-support/extended-range-forecasts
[2] https://www.dwd.de/EN/ourservices/seasonals_forecasts/project_description.html
[3] Pohlmann, H., Müller, W.A., Kulkarni, K., Kameswarrao, M., Matei, D., Vamborg, F.S.E., et al. (2013). Improved forecast skill in the tropics in the new MiKlip decadal climate predictions. Geophys. Res. Lett. 40, 5798–5802. doi: 10.1002/2013GL058051 ;
[3] Brune, S., Nerger, L., Baehr, J. (2015). Assimilation of oceanic observations in a global coupled Earth system model with the SEIK filter. Ocean Modell. 96, 254–264. doi: 10.1016/j.ocemod.2015.09.011

Details on Predictions and Evaluations

- Observation Data: ERA5, GPCC, GPCP, HYRAS, DWD-CDC[1]
- Evaluation period: dependent on available hindcasts; 1961-2020 for decadal predictions
- Skill measures:
  - Ensemble-Mean prediction: Pearson Correlation Coefficient and Mean Squared Error Skill Score (MSESS)[2]
  - Probability prediction: Ranked Probability Skill Score (RPSS)[3]
- Bootstrapping & significance test at 95% confidence level



All details on our website, "Background information"

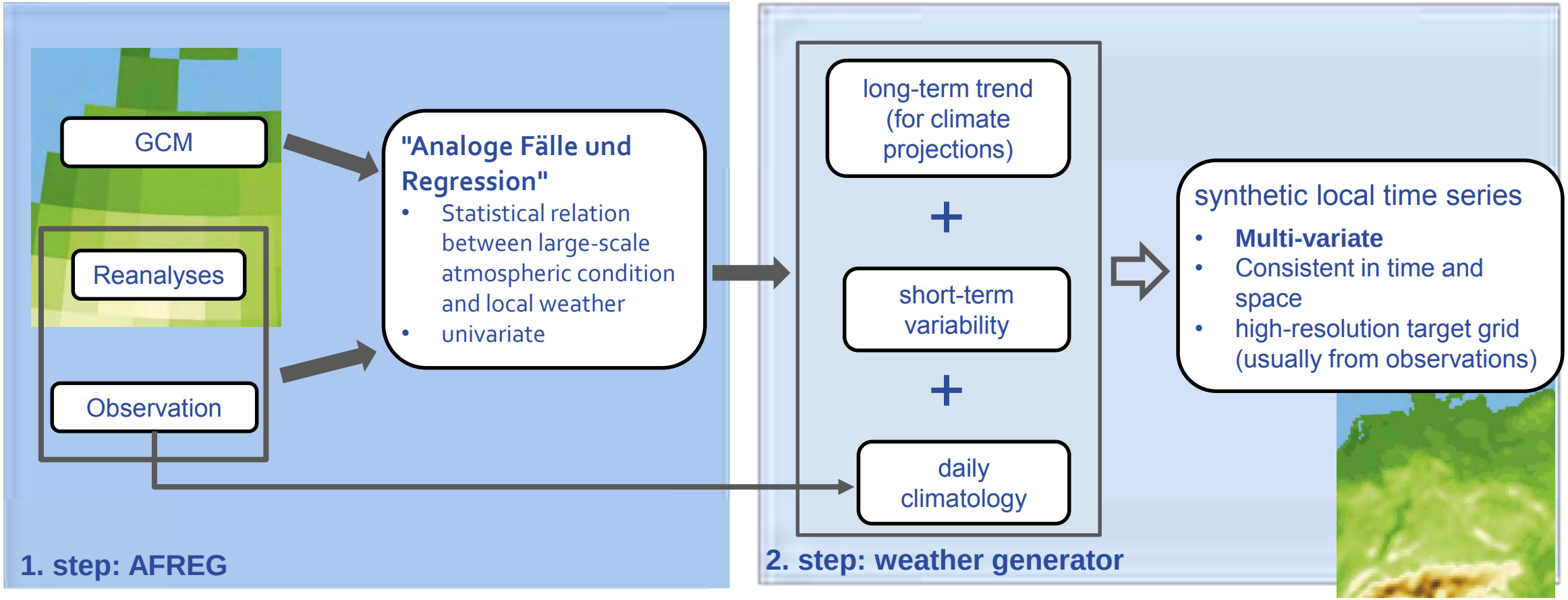
[1] Details: https://www.dwd.de/EN/ourservices/kvhs_en/help/1_bkgrd_info/05_skill/start_node.html ; "What observations are used for comparison?"

[2] Goddard, L., A. et al., 2013: A verification framework for interannual-to-decadal predictions experiments. – Climate Dyn. 40, 245–272. DOI:10.1007/s00382-012-1481-2.

[3] Ferro, C.A.T., Richardson, D.S., Weigel, A.P. (2008). On the effect of ensemble size on the discrete and continuous ranked probability scores. Meteor. Appl. 15, 19-24. doi: 10.1002/met.45.

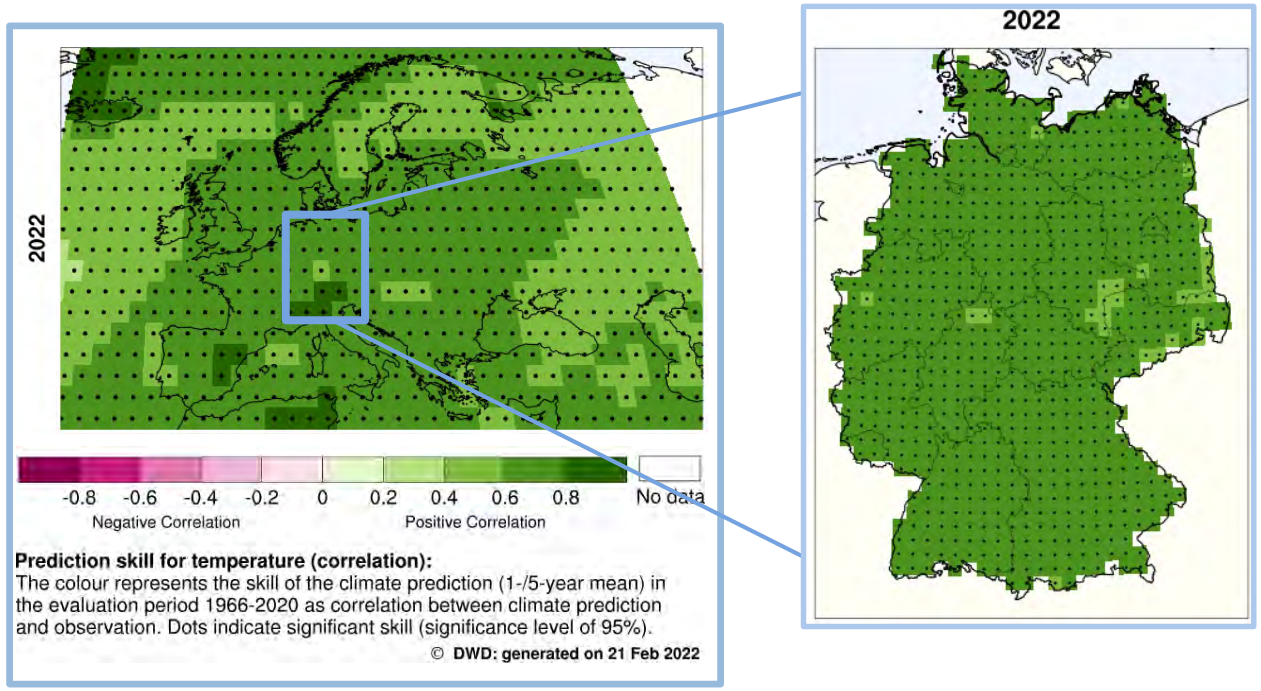
EPISODES

EPISODES is an **empirical-statistical downscaling** method developed at the Deutscher Wetterdienst based on a perfect-prognosis approach. We apply it to sub-seasonal, seasonal, and decadal predictions.



Kreienkamp, F., Paxian, A., Früh, B. et al. Evaluation of the empirical–statistical downscaling method EPISODES. Clim Dyn 52, 991–1026 (2019). https://doi.org/10.1007/s00382-018-4276-2

Statistical Downscaling with EPISODES



- Empirical-statistical downscaling method
- Downscaling possible for all variables with high-resolution observation data
- Preservation of skill from large-scale model

Configuration:

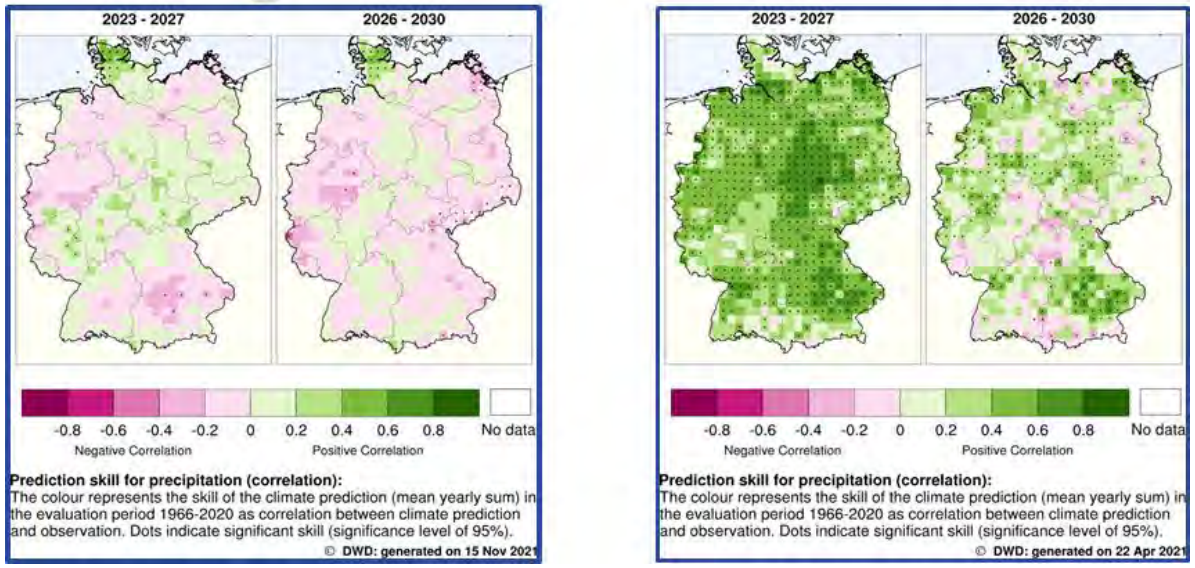
- GCM: MPI/ESM – LR
- Reanalysis data: NCEP/NCAR
- Observation Data: HYRAS[1]
- Spatial resolution: originally 5km
- Regression built in timeperiod 1951-2015

1 Rauthe, M., Steiner, H., Riediger, U., Mazurkiewicz, A., Gratzki, A. (2013). A Central European precipitation climatology - Part I: generation and validation of a high-resolution gridded daily data set (HYRAS). Meteorol. Z. 22, 235–256. doi: 10.1127/0941-2948/2013/0436

Reducing systematic errors of decadal ensemble predictions

- Recalibration method DeFoReST (Pasternack et al. 2018)
- Parametric correction of
  - Lead-time dependent errors (drift)
  - Start time dependent errors (trend)
  - Conditional bias
  - Ensemble spread
- Measurement for optimization: continuous ranked probability score (CRPS)
- Since 2021: estimation of model coefficients by non-homogeneous boosting (Paternack et al. 2021)

Recalibration



A. Pasternack, H. W. Rust, J. Bhend, M. Liniger, W. A. Müller: Parametric Decadal Climate Forecast Recalibration, Geosci. Model Develop., 2018.
A. Pasternack, A., Grieger, J., Rust, H.W., Ulbrich, U. (2021). Recalibrating decadal climate predictions – what is an adequate model for the drift? Geosci. Model Dev. 14, 4335–4355. doi: 10.5194/gmd-14-4335-2021, 2021.