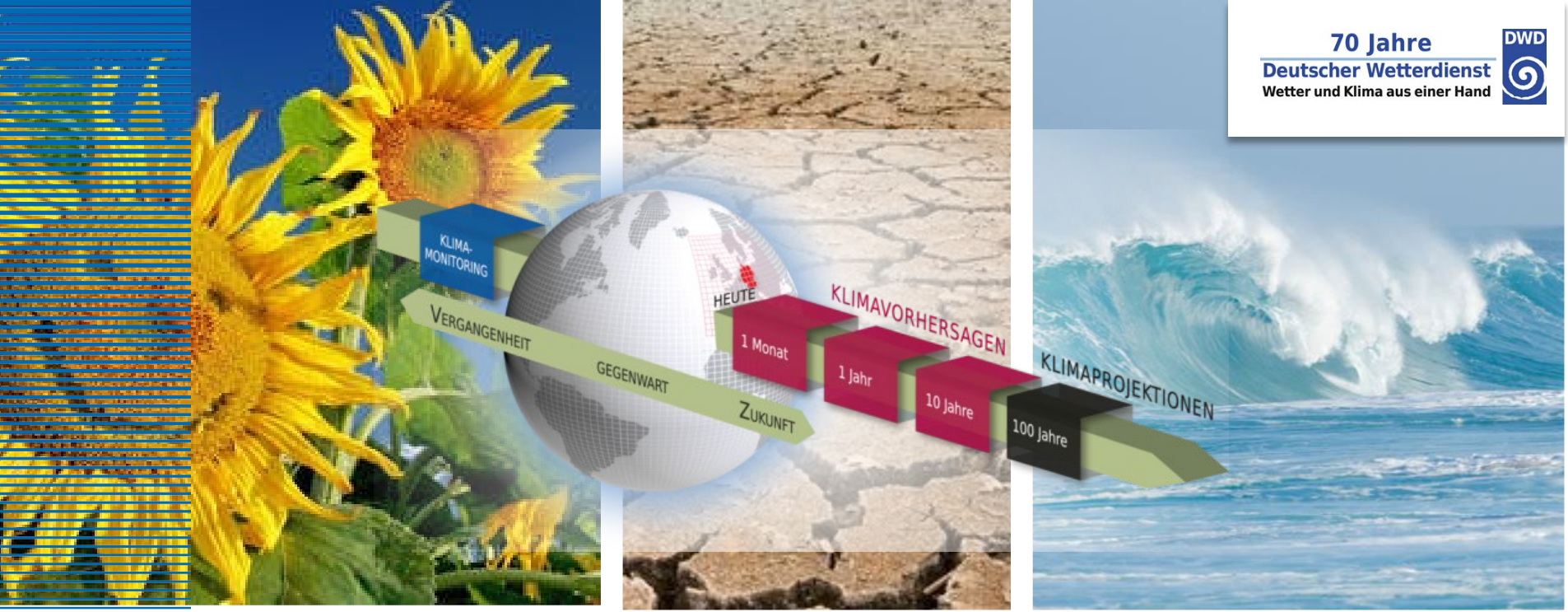


70 Jahre
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Seasonal forecast products and user interaction at DWD

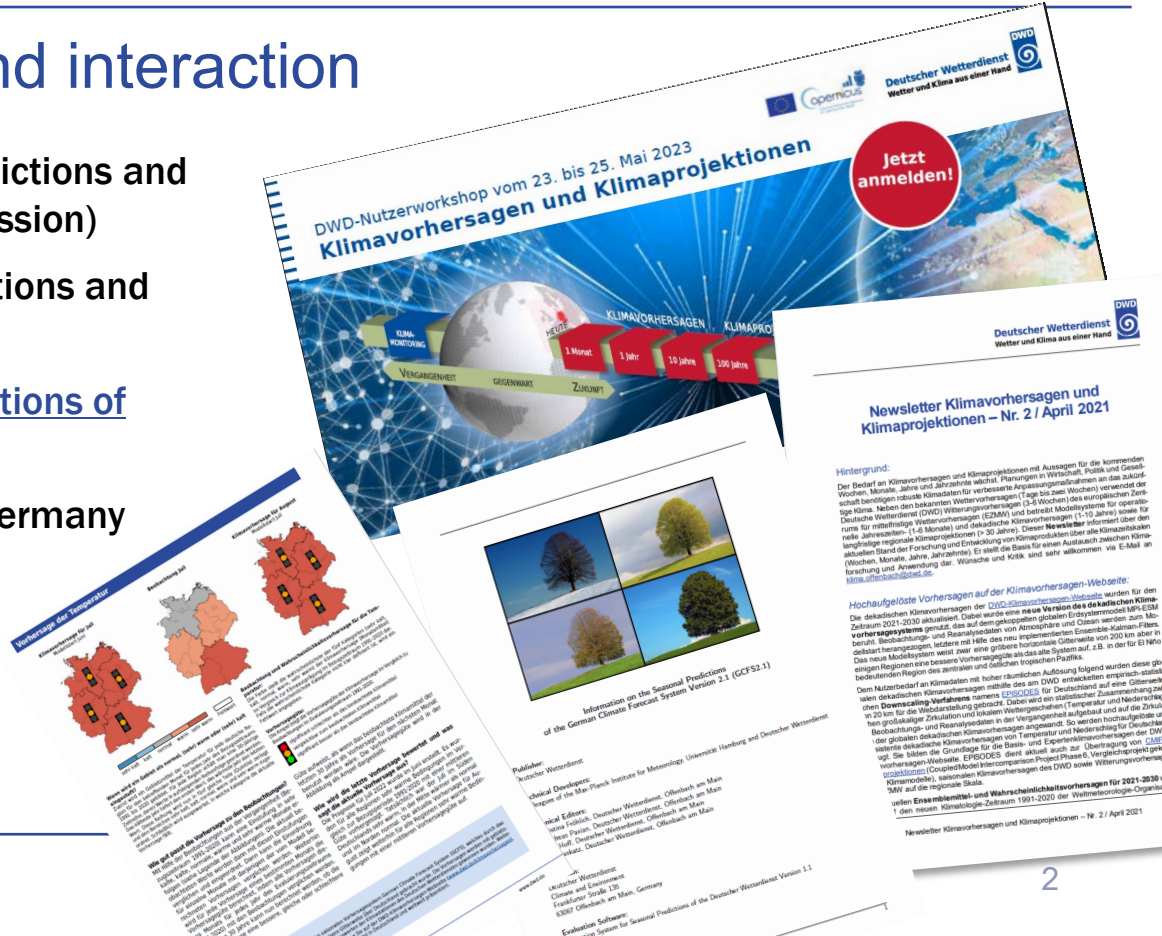
Dr. Andreas Paxian
Deutscher Wetterdienst
Zentrales Klimabüro

Seasonal Forecasting for the
Weather Driven Energy System

iea wind

User communication and interaction

- Annual **user workshop** ‚Climate predictions and climate projections‘ (talks and discussion)
- Biannual newsletter ‚Climate predictions and climate projections‘ (in German)
- Monthly **newsletter** ‚Seasonal predictions of GCFS‘ (in English)
- Monthly **climate status reports** for Germany
- **Tweets**
- **Press inquiries**
- **Surveys**
- Individual **user meetings**

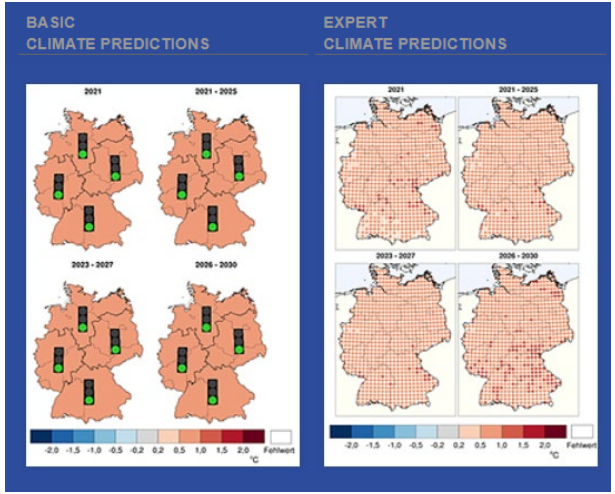


Users from different sectors

- **Humanitarian aid**
- **Insurance**
- **Health**
- **Agriculture and forestry**
- **Water**
- **Energy**

Climate predictions website (www.dwd.de/climatepredictions)

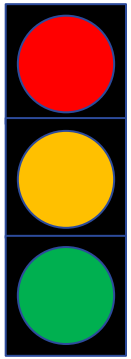
- Consistent evaluation and display of **climate predictions across all climate prediction time scales** (weeks, months, years)
- Information layers for **different user groups** (public, climate consultants, scientists, WMO)
- **Co-development with users** (workshops, surveys)



Source: DWD

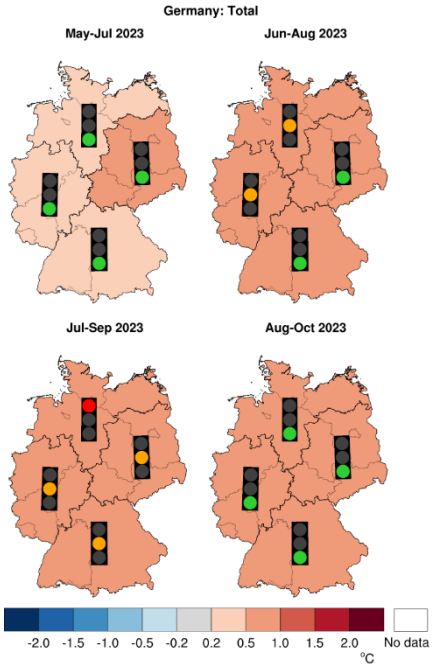
Content and display of the climate predictions website

- Common display of **climate predictions** and **prediction skill**
- **Ensemble mean** and **probabilistic predictions**
- Time series/ tables (e.g. week 2, 3, 4, 5, month 1-3, 2-4, 3-5, 4-6 or year 1, 1-5, 3-7, 6-10)
- Maps (world, Europe, Germany, German regions/ cities)
- **Temperature and precipitation** first, later further variables



- **Prediction skill scores** to evaluate ensemble mean and probabilistic predictions
- **Reference predictions**: long-term observed climatology or climate projection
- **Traffic lights**: green/ yellow/ red = significantly better/ equal/ significantly worse than the reference predictions

Basic: Ensemble mean predictions for temperature

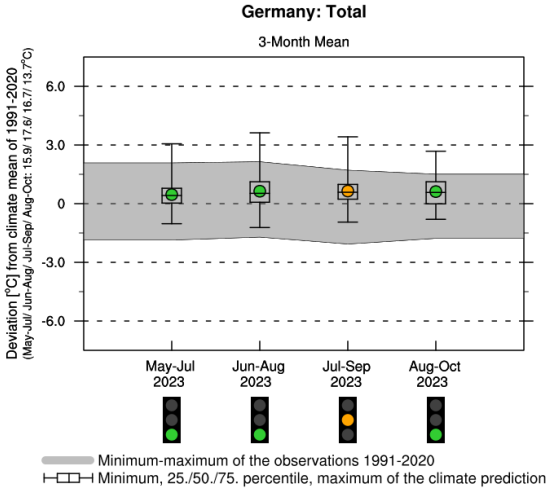


Ensemble mean prediction for temperature:
The colour represents the deviation of the ensemble mean prediction (3-month mean) from the climate mean of the time period 1991-2020.

Prediction skill:
The traffic light shows the prediction skill in the evaluation period 1991-2020:

- poor prediction quality
- satisfactory prediction quality
- relatively good prediction quality

Prediction start on 01 May 2023, generated on 04 May 2023 © DWD



Ensemble mean prediction for temperature:
The coloured dots represent the deviation of the ensemble mean prediction (3-month mean) from the climate mean of the time period 1991-2020. The box-whisker represent the distribution of the prediction ensemble. The area in gray shows the spread of the observations in the time period 1991-2020.

Prediction skill:
The traffic light shows the prediction skill in the evaluation period 1991-2020:

- poor prediction quality
- satisfactory prediction quality
- relatively good prediction quality

Prediction start on 01 May 2023, generated on 04 May 2023 © DWD

Germany: Total
Ensemble Mean Prediction in Comparison
to the Climate Mean of the Time Period 1991-2020

Time Period	Climate Mean	Climate Prediction
May-Jul 2023	15.9°C	+0.5°C (-1.0°C – +3.1°C)
Jun-Aug 2023	17.6°C	+0.6°C (-1.2°C – +3.6°C)
Jul-Sep 2023	16.7°C	+0.6°C (-0.9°C – +3.4°C)
Aug-Oct 2023	13.7°C	+0.6°C (-0.8°C – +2.7°C)

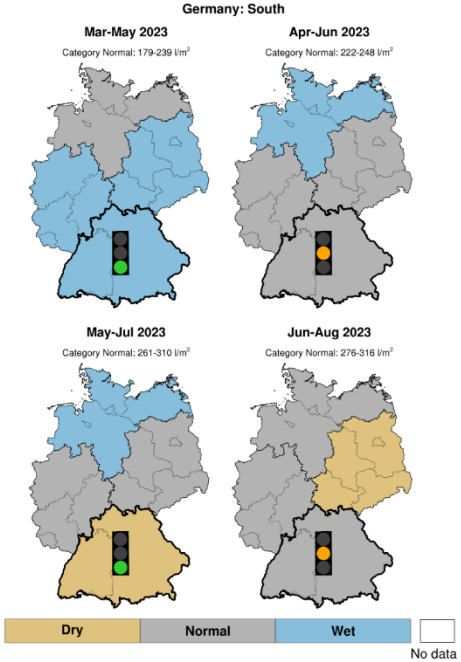
Ensemble mean prediction for temperature:
The table represents the deviation of the ensemble mean prediction (3-month mean) from the climate mean of the time period 1991-2020. Maximum and minimum of the ensemble are given in brackets.

Prediction skill:
The traffic light shows the prediction skill in the evaluation period 1991-2020:

- poor prediction quality
- satisfactory prediction quality
- relatively good prediction quality

Prediction start on 01 May 2023, generated on 04 May 2023 © DWD

Basic: Probabilistic predictions for precipitation

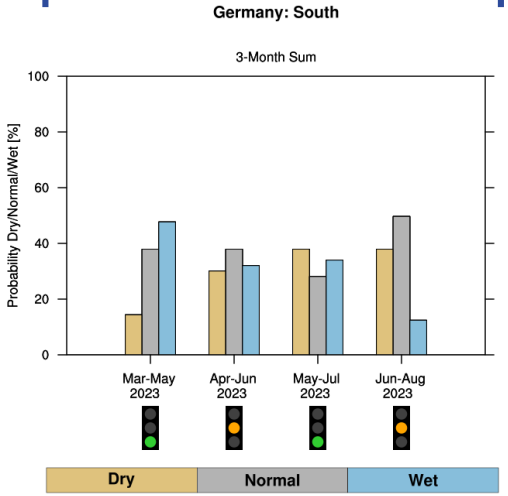


Probabilistic prediction for precipitation:
The colour represents the most probable of the three categories (Dry/Normal/Wet) of the climate prediction (3-month sum) in comparison to the climate characteristics for the time period 1991-2020.

Prediction skill:
The traffic light shows the prediction skill in the evaluation period 1991-2020:

- poor prediction quality
- satisfactory prediction quality
- relatively good prediction quality

Prediction start on 01 Mar 2023, generated on 08 Mar 2023 © DWD



Probabilistic prediction for precipitation:
The bars represent the probabilities of the three categories (Dry/Normal/Wet) of the climate prediction (3-month sum) in comparison to the climate characteristics for the time period 1991-2020. The category Normal is defined as 179-239 l/m² (Mar-May), 222-248 l/m² (Apr-Jun), 261-310 l/m² (May-Jul) and 276-316 l/m² (Jun-Aug).

Prediction skill:
The traffic light shows the prediction skill in the evaluation period 1991-2020:

- poor prediction quality
- satisfactory prediction quality
- relatively good prediction quality

Prediction start on 01 Mar 2023, generated on 08 Mar 2023 © DWD

Germany: South
Probability of the Categories Dry/Normal/Wet
in Comparison to the Climate Characteristics for 1991-2020

Time Period	Category Normal	Dry	Normal	Wet
Mar-May 2023	179 - 239 l/m²	14%	38%	48%
Apr-Jun 2023	222 - 248 l/m²	30%	38%	32%
May-Jul 2023	261 - 310 l/m²	38%	28%	34%
Jun-Aug 2023	276 - 316 l/m²	38%	50%	12%

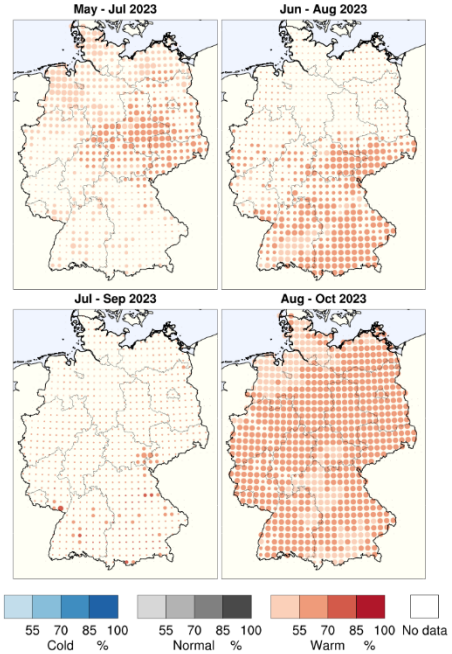
Probabilistic prediction for precipitation:
The table represents the probabilities of the three categories (Dry/Normal/Wet) of the climate prediction (3-month sum) in comparison to the climate characteristics for the time period 1991-2020.

Prediction skill:
The traffic light shows the prediction skill in the evaluation period 1991-2020:

- poor prediction quality
- satisfactory prediction quality
- relatively good prediction quality

Prediction start on 01 Mar 2023, generated on 08 Mar 2023 © DWD

Expert: Ensemble mean/ probabilistic predictions

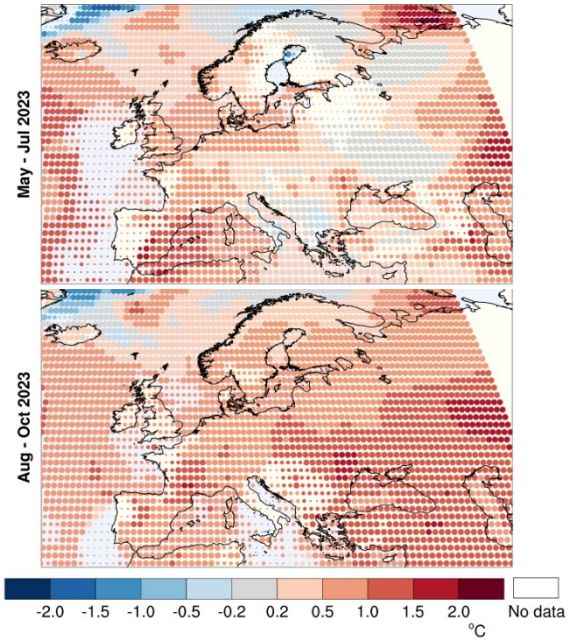


Probabilistic prediction for temperature:
The colour represents the most probable category (Cold/Normal/Warm) of the climate prediction (3-month mean) in comparison to the climate characteristics for 1991-2020. The brightness describes the probability of this category.

Prediction skill:
The size of the dots shows the skill in the evaluation period 1991-2020:

- · significantly worse than the observed climate mean
- • comparable to the observed climate mean
- ● significantly better than the observed climate mean

Prediction start on 01 May 2023, generated on 04 May 2023 © DWD

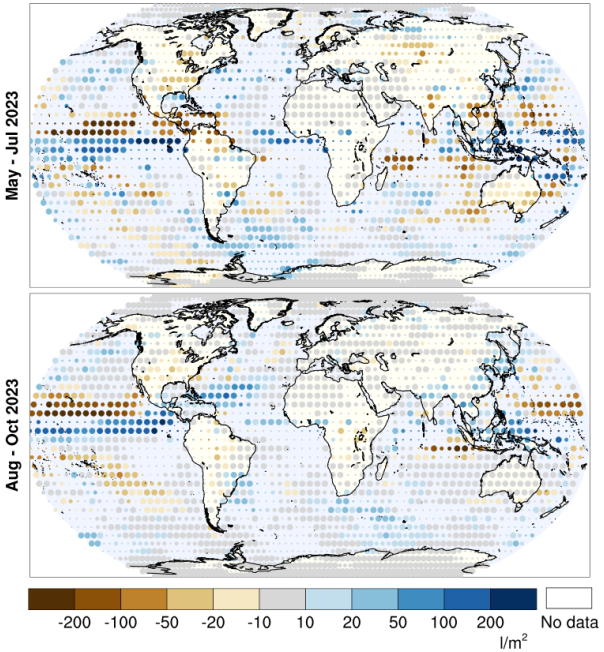


Ensemble mean prediction for temperature:
The colour represents the deviation of the ensemble mean prediction (3-month mean) from the climate mean of the time period 1991-2020.

Prediction skill:
The size of the dots shows the skill in the evaluation period 1991-2020:

- · significantly worse than the observed climate mean
- • comparable to the observed climate mean
- ● significantly better than the observed climate mean

Prediction start on 01 May 2023, generated on 04 May 2023 © DWD



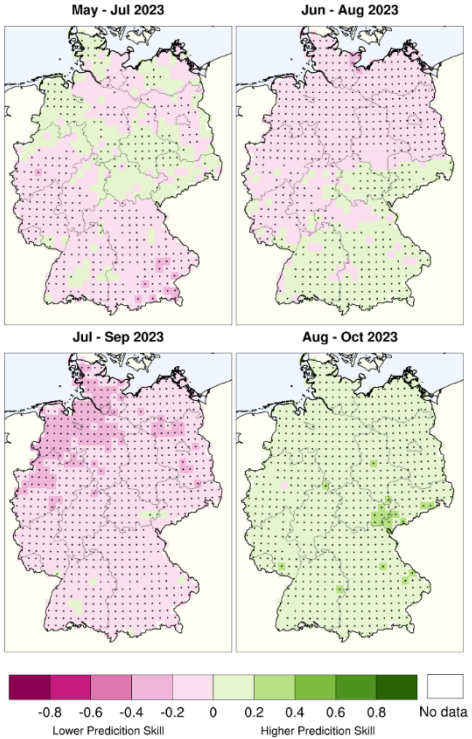
Ensemble mean prediction for precipitation:
The colour represents the deviation of the ensemble mean prediction (3-month sum) from the climate mean of the time period 1991-2020.

Prediction skill:
The size of the dots shows the skill in the evaluation period 1991-2020:

- · significantly worse than the observed climate mean
- • comparable to the observed climate mean
- ● significantly better than the observed climate mean

Prediction start on 01 May 2023, generated on 04 May 2023 © DWD

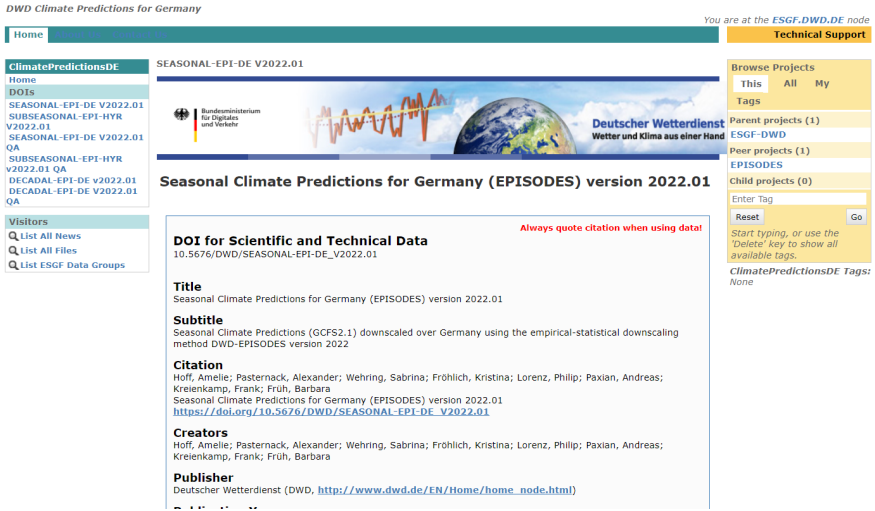
Expert prediction skill and data access



Prediction skill for temperature (RPSS):
The colour represents the skill of the climate prediction (3-month mean) in the evaluation period 1991-2020 compared to the observed climate mean as reference prediction. Dots indicate significant skill (significance level of 95%).

Prediction start on 01 May 2023, generated on 04 May 2023 © DWD

Data access (Link):
- Global model data via Copernicus
- High-resolution data for Germany soon via ESGF



What's new

Table of contents ▾

Back to Overview Basic- / Expert- / Specific climate predictions / Previous page ↩

March 2023

- Use of the new statistical method of downscaling for supplying high-resolution climate predictions in Germany - now also for the decadal climate predictions.
- Addition of subseasonal climate predictions for Europe and the world

To the top

December 2022 / January 2023

- Improvement of the calculation method of the statistically selected seasonal climate predictions has led to updated predictions for all available starting months.

To the top

October 2022

- Start of weekly publication of subseasonal climate predictions

To the top

September 2022:

- Introduction of the statistically selected seasonal climate predictions
- Inclusion of FAQs as well as of a new, simple legend and an explanatory video on the skill of climate prediction
- Update of the evaluation period for seasonal climate predictions to the period 1991–2020
- Use of a more decisive method for calculating the significance of the climate prediction skill leads to fewer yellow and more red and green traffic lights.
- Use of the new statistical method of downscaling for supplying high-resolution climate predictions in Germany.

Source: DWD, ESGF

Background information

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Basic probabilistic prediction – Time series

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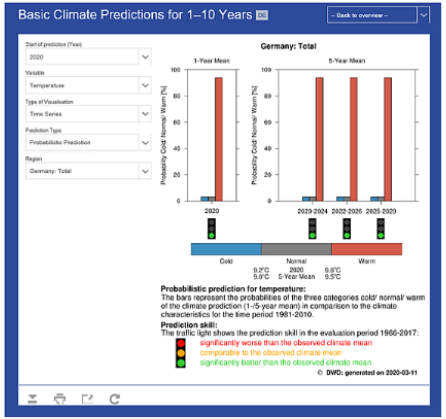


Example of a basic climate prediction: Time series presentation of the probabilistic decadal prediction for temperature.

The graphics show the predictions for temperature and the corresponding prediction skill for four time steps (here: the next year (left) and the prediction years 1–5, 3–7 and 6–10 as 5-year means (right)). Each graphic depicts the probabilistic prediction for the chosen German region (or city in the case of seasonal and decadal climate predictions). The prediction states whether high (warm, red), normal (grey) or low temperatures (cold, blue) are predicted for the given time periods and regions. The limits of these categories are defined based on the corresponding reference period (for example: 1981–2010), for which the climate characteristics are grouped in three equal-sized value ranges using the values of the 33rd and 66th terciles. The predicted probabilities of occurrence (shown in %) of the three categories are determined by how many climate simulations of the model ensemble are predicting the categories.
The graphic on the left, for example, shows the probabilities (3 %, 3 % and 94 %) with which the categories 'cold', 'normal' and 'warm' are predicted to occur in Germany in 2020 compared to the reference period 1981–2010. The graphic on the right gives the same results for the 5-year means. You can look up the exact values if you choose Table in the 'Type of Visualisation' field of the selection menu.

FAQ

Frequently Asked Questions (FAQ)

Here's where you will find brief, concise answers to frequently asked questions. Useful links for more detailed information about climate prediction are also offered.

Back to Overview Basic- / Expert- / Specific climate predictions / Previous page

How reliable is a climate prediction? What does the traffic light mean?

Reliability (or skill or quality) of a climate prediction is measured by evaluating how well a climate prediction started in the past depicts the variability actually observed. To find out whether the climate prediction is better or worse than the reference prediction often used as an alternative, the skill of the climate prediction can be compared with that of the reference prediction. The skill of basic climate predictions is represented using a traffic light system, the skill of expert climate predictions is shown by means of a dot-size system. In the case of expert climate predictions, the skill for an individual grid point should not be overestimated, it should rather be considered in the context of a larger pattern. Further information on the skill scores can be found in the section "Skill of Climate Prediction" in the background information.

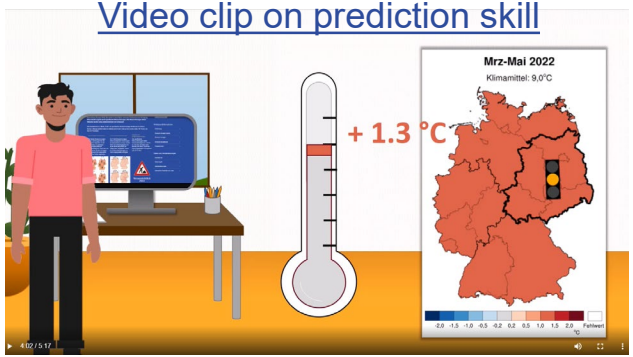
See section Skill of climate prediction

What are the uncertainties of climate prediction?

Where do I find the reference prediction that was used to determine the skill of the climate prediction?

What is the difference between an ensemble mean prediction and a probabilistic prediction?

Video clip on prediction skill



Source: DWD

Background information

- Introduction
- Climate prediction models
- Climate predictions
- Skill of climate prediction

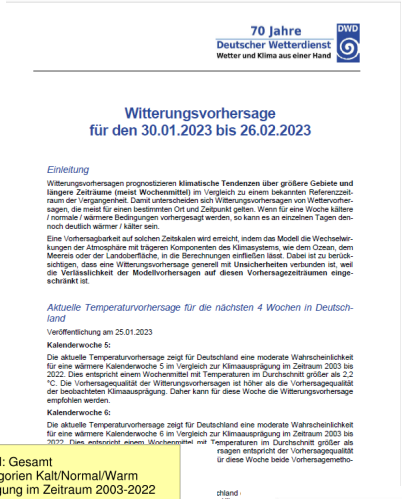
Energy-related activities

- Proposal on **seasonal forecasts for energy** with **Fraunhofer** Institute for Energy Economics and Energy System Technology (Dr. Malte Siefert):
  - **High-resolution seasonal forecasts** for **solar radiation and 100m wind speed** at sub-daily resolution for Germany
  - **Multi-model** seasonal forecasts from Copernicus (high resolution)
  - Teleconnection indices related to **energy variables or 'Dunkelflauten'**
  - Prediction skill for different start months
  - User feedback

Fraunhofer
IEE

Energy-related activities

- **Information on winter temperature forecasts for German authorities:**
  - **Newsletters** on subseasonal and seasonal temperature forecasts for Germany (based on multi-model seasonal forecasts)
  - **Data** of subseasonal temperature forecasts and forecast skill for Germany



70 Jahre Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Witterungsvorhersage für den 30.01.2023 bis 26.02.2023

Einleitung

Witterungsvorhersagen prognostizieren **klimatische Tendenzen über größere Gebiete und längere Zeiträume (meist Wochenmittel)** im Vergleich zu einem bekannten Referenzzeitraum der Vergangenheit. Damit unterscheiden sich Witterungsvorhersagen von Wettervorhersagen, die meist für einen bestimmten Ort und Zeitpunkt gelten. Wenn für eine Woche kältere / normale / wärmere Bedingungen vorhergesagt werden, so kann es an einzelnen Tagen dennoch deutlich wärmer / kälter sein.

Eine Vorhersagbarkeit auf solchen Zeitskalen wird erreicht, indem das Modell die Wechselwirkungen der Atmosphäre mit trägeren Komponenten des Klimasystems, wie dem Ozean, dem Meereis oder der Landoberfläche, in die Berechnungen einfließen lässt. Dabei ist zu berücksichtigen, dass eine Witterungsvorhersage generell mit **Unsicherheiten** verbunden ist, weil die **Verlässlichkeit der Modellvorhersagen auf diesen Vorhersagezeiträumen eingeschränkt** ist.

Aktuelle Temperaturvorhersage für die nächsten 4 Wochen in Deutschland

Veröffentlichung am 25.01.2023

Kalenderwoche 5:

Die aktuelle Temperaturvorhersage zeigt für Deutschland eine moderate Wahrscheinlichkeit für eine wärmere Kalenderwoche 5 im Vergleich zur Klimaausprägung im Zeitraum 2003 bis 2022. Dies entspricht einem Wochenmittel mit Temperaturen im Durchschnitt größer als 2,2 °C. Die Vorhersagequalität der Witterungsvorhersagen ist höher als die Vorhersagequalität der beobachteten Klimaausprägung. Daher kann für diese Woche die Witterungsvorhersage empfohlen werden.

Kalenderwoche 6:

Die aktuelle Temperaturvorhersage zeigt für Deutschland eine moderate Wahrscheinlichkeit für eine wärmere Kalenderwoche 6 im Vergleich zur Klimaausprägung im Zeitraum 2003 bis 2022. Dies entspricht einem Wochenmittel mit Temperaturen im Durchschnitt größer als

70 Jahre Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Saisonale Klimavorhersage für Januar bis Mai 2023

Einleitung:

Saisonale Klimavorhersagen prognostizieren **klimatische Tendenzen über größere Gebiete und längere Zeiträume (meist 3-Monatsmittel)** im Vergleich zu einem bekannten Referenzzeitraum der Vergangenheit. Damit unterscheiden sich saisonale Klimavorhersagen von Wettervorhersagen, die meist für einen bestimmten Ort und Zeitpunkt gelten. Wenn für drei Monate kältere / normale / wärmere Bedingungen vorhergesagt werden, so kann es an einzelnen Tagen oder Wochen dennoch deutlich wärmer/ kälter sein.

Eine Vorhersagbarkeit auf solchen Zeitskalen wird erreicht, indem das Modell die Wechselwirkungen der Atmosphäre mit trägeren Komponenten des Klimasystems, wie dem Ozean, dem Meereis oder der Landoberfläche, in die Berechnungen einfließen lässt. Dabei ist zu berücksichtigen, dass eine saisonale Klimavorhersage generell mit **Unsicherheiten** verbunden ist, weil die **Verlässlichkeit der Modellvorhersagen auf diesen Vorhersagezeiträumen eingeschränkt** ist.

Aktuelle Temperaturvorhersage für Januar bis Mai 2023 in Deutschland (basierend auf WMO- und DWD-Modellen)

Veröffentlichung am 15.12.2022

Spätwinter (Januar-März):

Die Auswertung internationaler Modellvorhersagen zeigt für Deutschland eine leichte Tendenz für einen wärmeren Spätwinter im Vergleich zur Klimaausprägung des Referenzzeitraums in der Vergangenheit. Dies entspricht einem 3-Monatsmittel für Januar bis März mit Temperaturen im Durchschnitt höher als 3,0 °C für Gesamtdeutschland.

Früher Frühling (Februar-April):

Des Weiteren wird eine moderate Wahrscheinlichkeit für einen wärmeren frühen Frühling im Vergleich zur Klimaausprägung des Referenzzeitraums vorhergesagt. Dies kommt einem 3-Monatsmittel für Februar bis April mit Temperaturen im Durchschnitt höher als 5,4 °C gleich.

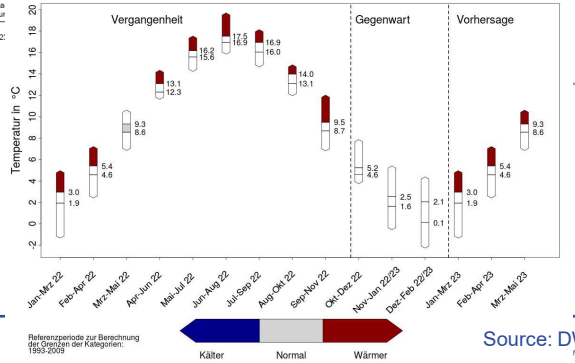
Frühling (März-Mai):

Schließlich wird eine moderate Wahrscheinlichkeit für einen wärmeren Frühling im Vergleich zur Klimaausprägung des Referenzzeitraums vorhergesagt. Dies kommt einem 3-Monatsmittel für März bis Mai mit Temperaturen im Durchschnitt höher als 9,3 °C gleich.

Deutschland: Gesamt
Wahrscheinlichkeit der Kategorien Kalt/Normal/Warm
im Vergleich zur Klimaausprägung im Zeitraum 2003-2022

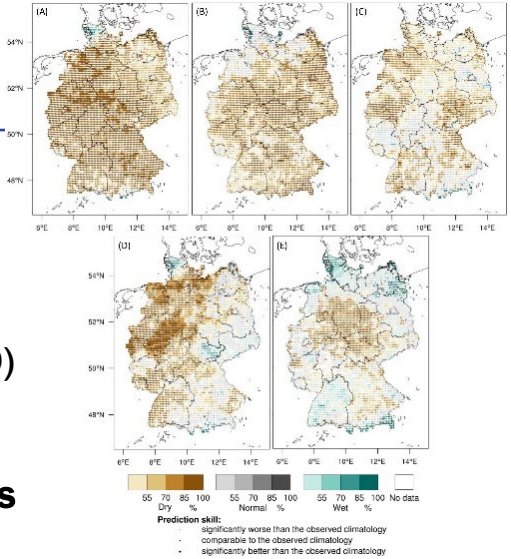
Zeitraum	Kategorie Normal	Kalt	Normal	Warm
Kalenderwoche 05 30. Jan 2023- 05. Feb 2023	-0,2 - 2,2°C	3%	37%	60%
Kalenderwoche 06 06. Feb 2023- 12. Feb 2023	-0,5 - 3,1°C	20%	28%	53%
Kalenderwoche 07 13. Feb 2023- 19. Feb 2023	0,2 - 2,0°C	14%	51%	35%
Kalenderwoche 08 20. Feb 2023- 26. Feb 2023	0,5 - 4,5°C	14%	39%	47%

Wahrscheinlichkeitsvorhersage für die Temperatur:
Die Tabelle stellt die Wahrscheinlichkeiten der drei Kategorien (Kalt/Normal/Warm) der Klimavorhersage (Wochenmittel) im Vergleich zur Klimaausprägung im Zeitraum 2003-2022 dar.
Vorhersagegüte:
Die Ampel zeigt die Vorhersagegüte im Evaluierungszeitraum 2003-2022:
schlechte Vorhersagequalität
mittlere Vorhersagequalität
relativ gute Vorhersagequalität (siehe Erklärvideo Vorhersagegüte)
Vorhersagestart am 23. Jan 2023, erstellt am 24. Jan 2023 © DWD



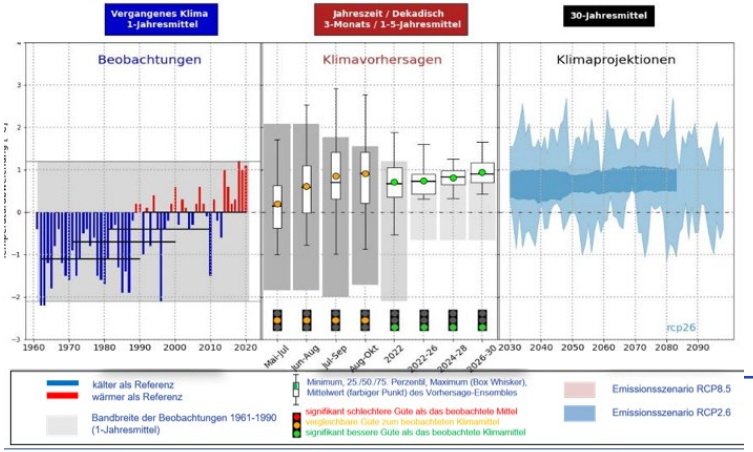
Source: DWD

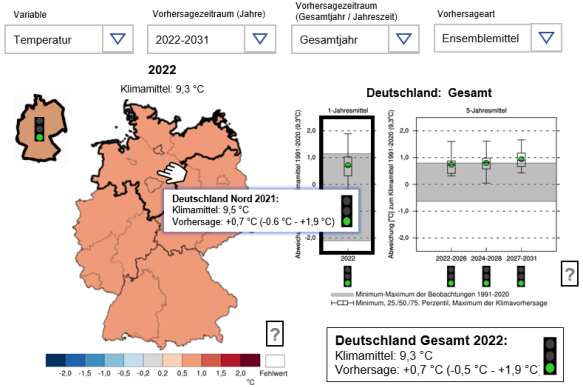
Source: Paxian et al., 2022



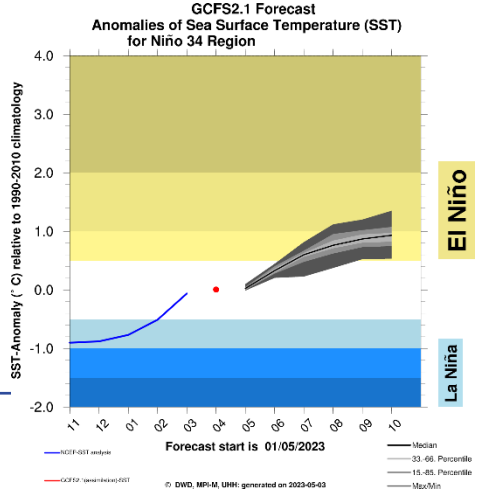
Outlook

- **Multi-year seasonal means** (e.g. 5-year summer means)
- **Further products** (e.g. drought, soil moisture, humidity, heat, El Nino, NAO)
- **Interactive elements** for basic climate predictions
- Combined timeseries of **observations, climate predictions and projections**





Source: DWD



Thank you very much for your attention!

Source: M. Kügler, DWD

Seasonal Forecasting for the Weather Driven Energy System

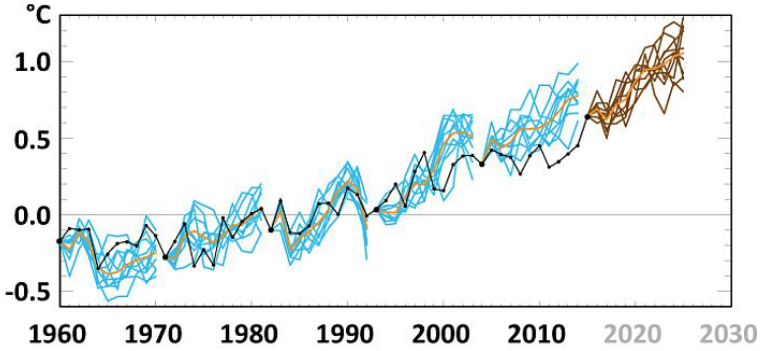
Modellkonfiguration für Klimavorhersagen

	Witterungs-vorhersagen	saisonale Klimavorhersagen	dekadische Klimavorhersagen
Klimamodell	IFS (EZMW)	GCFS2 (DWD)	MPI-ESM (DWD)
Klimavorhersagestart	jede Woche (Mo/ Do)	jeden Monat (1.)	jedes Jahr (Nov)
zeitliche Abdeckung	46 Tage	6 Monate	10 Jahre
zeitliche Aggregierung	Wochenmittel	3-Monatsmittel	1-5-Jahresmittel
räumliche Gitterweite	~36 km (global)	~100 km (global)	~200 km (global)

➔ **Statistisches Downscaling:** EPISODES ~20 km in Deutschland

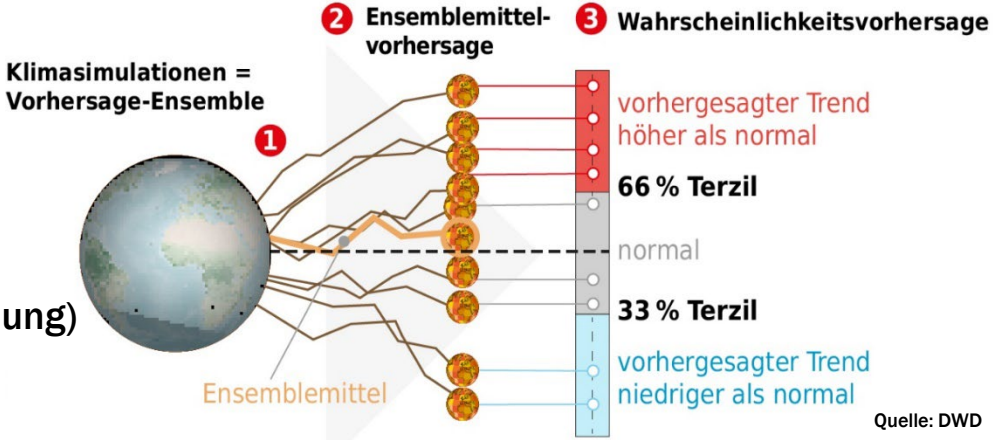
Vorhersagen und Nachhersagen

- **Nachhersage-Ensembles** vergangener Startzeitpunkte:
  - mittleres „Modellklima“
  - Bewertung der Klimavorhersagegüte



Quelle: MPI-M

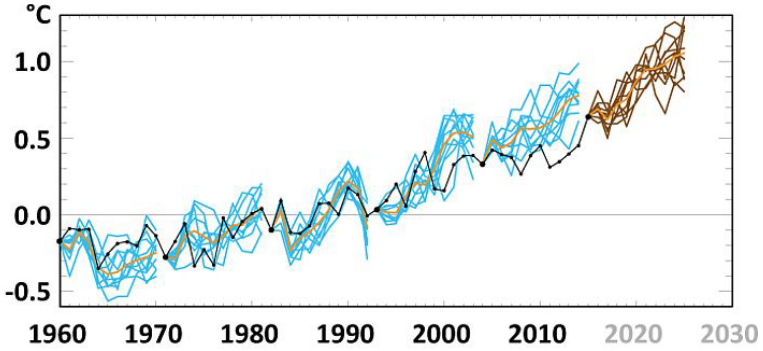
- **Klimavorhersage-Ensemble** für aktuellen Startzeitpunkt:
  - **Ensemblemittel-Klimavorhersage**: Abweichung des Ensemble-Mittelwerts
  - **Wahrscheinlichkeits-Klimavorhersage**: Terzilwahrscheinlichket (Ensemble-Verteilung)



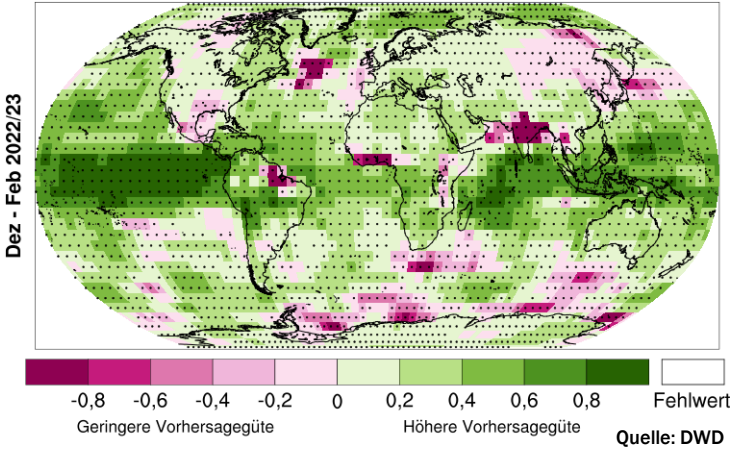
Quelle: DWD

Bewertung der Klimavorhersagegüte

- Vergleich aller Nachhersage-Ensembles mit beobachteter Variabilität
- Gütemaße für **Ensemblemittel-Klimavorhersage**
- Gütemaße für **Wahrscheinlichkeits-Klimavorhersage**
- Vergleich mit alternativen **Referenzklima-vorhersagen** (beobachtete Klimatologie)
- Güte abhängig von Variable, Zeit und Raum (Aggregierung erhöht Güte)



Quelle: MPI-M



Quelle: DWD