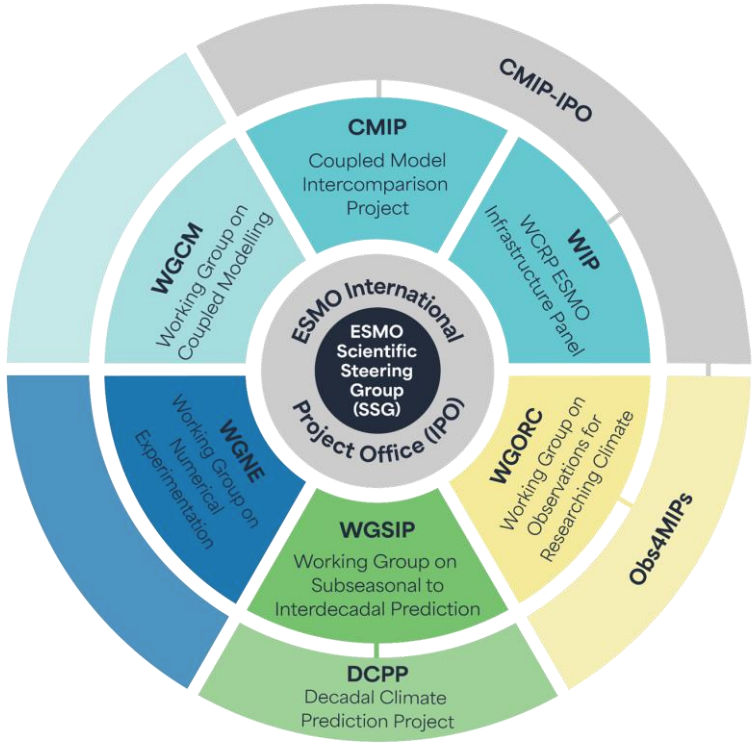
Climate data use and the connection between local observation networks and global outputs

ESMO SSG Co-Chairs:

- **Baylor Fox-Kemper (Brown University, USA)**
- Susann Tegtmeier (University of Saskatchewan, Canada)

ESMO IPO:

- Based at the German Climate Computing Centre (DKRZ) in Hamburg



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What is ESMO? The Newest WCRP Core Project

That coordinates and advances all WCRP **observational, data assimilation** and **modelling**

Modelling Community in ESMO

Working Group on Coupled Modelling (WGCM)
- Development and review of coupled climate models
- Prototypes of observational use

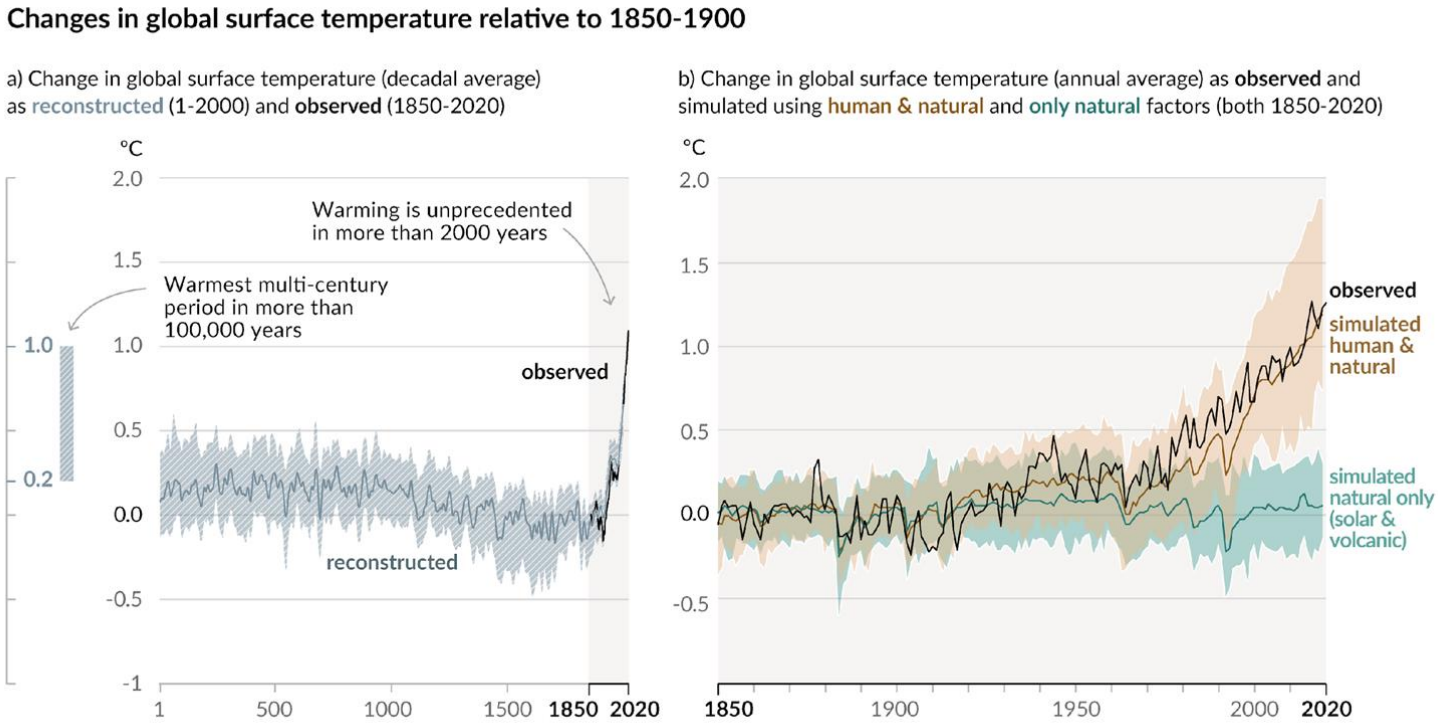
Working Group on Numerical Experimentation (WGNE)
- Development of Earth system models (design, implementation, errors, revisions)
- Prototypes of observational use

Coupled Model Intercomparison Project (CMIP)
- Understanding of past, present and future climate changes
- **Projections** are "blind" to observations, only evaluation & attribution use observations

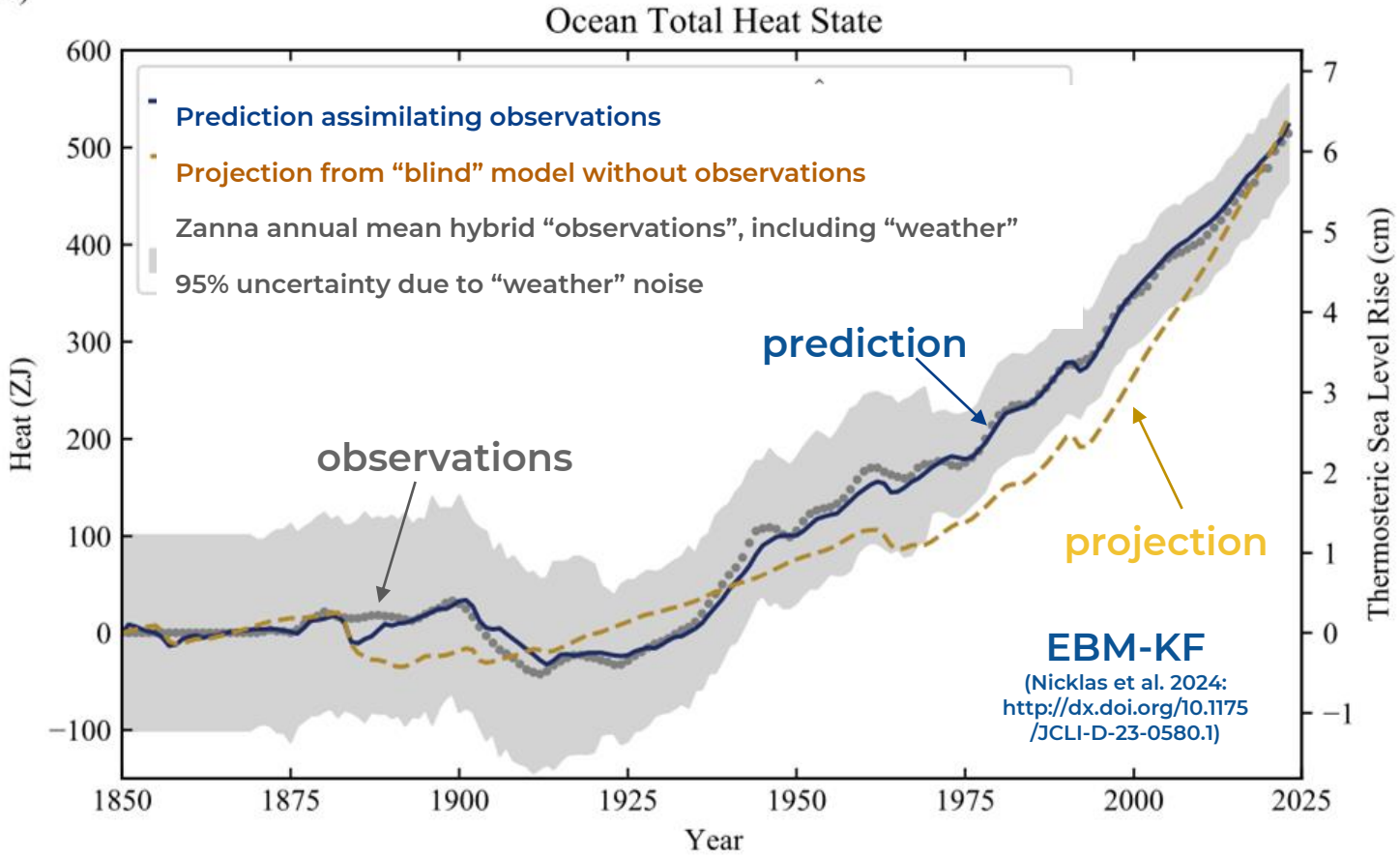
Working Group on Subseasonal to Interdecadal Prediction (WGSIP)
Numerical Experimentation for Seasonal to Interannual variability and predictability
- **Predictions** draw on observations for forcing, initialization, and assimilation

Using Observations for Projection Evaluation and Attribution

Two of the most important figures in climate change science:



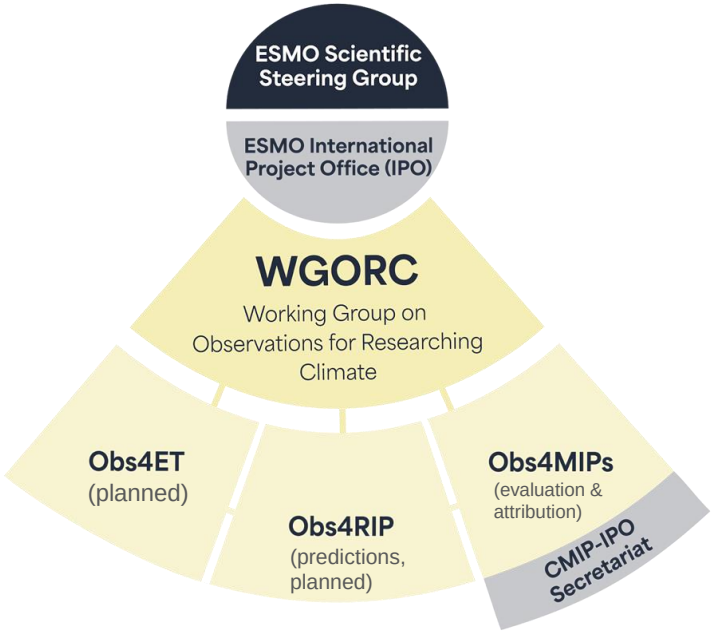
b) Initialization and Data Assimilation for Predictions



Working Group on Observations for Researching Climate (WGORC)

WGORC is newly established, there will be a **kickoff meeting** in December 2025! (Reading, UK)

- A new **ESMO** **working group** on **climate observation data** and act as a facilitator for **collaboration across diverse research and industry sectors.**
- WGORC will focus on curating and sharing **forcing, evaluation, and attribution** observation data (Obs4MIPs)
- WGORC will focus on advancing **reanalysis, initialization, and prediction** observation data (Obs4RIP)
- WGORC will explore **emerging technologies (ET)**, such as machine learning and km-scale observations (Obs4ET)
- **Local information** may ultimately inform WGORC, in collaboration with partners such as the WMO observational networks. **Equity concerns** are paramount.



Observational Community in WCRP and external activities

WCRP topic-specific observational groups

GSOP
- CLIVAR Global Synthesis and Observations Panel

GDAP
- GEWEX Data and Analysis Panel

GASS
- GEWEX Global Atmospheric System Studie

APARC activities on
- Stratospheric ozone
- Temperature Trends

CLiC activities on
- Sea Ice Processes
- Permafrost Carbon Network

Examples of External Partners

WMO GAW
- Global Atmosphere Watch Programme

WMO GCOS
- Global Climate Observing System

IOC GOOS
- Global Ocean Observing System

CEOS/CGMS WG Climate
- Committee for Earth Observation Satellites / Coordination Group of Meteorological Satellites

CORDEX
Coordinated Regional Climate Downscaling Experiment

is the connection between CMIP and downscaled local and regional climate impact Information

Starting with CMIP output, the CORDEX domain teams runs regional weather and climate projections.

The connection between CMIP and CORDEX is one-way: from CMIP models to local simulations.

Working together with local and regional experts and stakeholders, CORDEX simulations are compared with local observations and applied to address local causes for concern.

CORDEX DOMAINS

Domains

- Region 1: South America
- Region 2: Central America
- Region 3: North America
- Region 4: Europe (EURO)
- Region 5: Africa
- Region 6: South Asia
- Region 7: East Asia
- Region 8: Central Asia
- Region 9: Australasia
- Region 10: Antarctica
- Region 11: Arctic
- Region 12: Mediterranean (MED)
- Region 13: Middle East North Africa (MENA)
- Region 14: South-East Asia (SEA)

ESMO Earth System Modelling and Observations

WCRP World Climate Research Programme

ESMO
Earth System Modelling and Observations

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CMIP Co-Chairs:

- Helene Hewitt (UK Met Office)
- John Dunne (NOAA Geophysical Fluid Dynamics Laboratory, USA)

ESMO coordinates both models and observations related to climate

WGORC is the new **observation-focused** working group within ESMO

WGORC is tasked with better use of observations to inform **forecasts & reanalyses** (e.g., El Nino)

WGORC is tasked with better use of observations to inform **evaluation & attribution** (e.g., CMIP)

CORDEX **downscales** CMIP models for information on **impacts on local and regional** scales, but the use of observations is one-way from global to local

Extra Slides

Climate data interpolation and the contribution of local observation networks to global outputs

We therefore considered CMIP’s work, which provides considerable input into the IPCC process and operates at a global scale, and noting your interaction with climate data (put loosely) to provide insights on the following two areas:

How interpolation or coupling systems are used/done to produce CMIP-related outputs, ensuring that any reanalysis safeguards and leads to high-quality outputs.

A recognition of the role and contribution of local and regional data into CMIP’s global output, again this is a segway to discussions on supporting and recognising local and regional observation/data frameworks.

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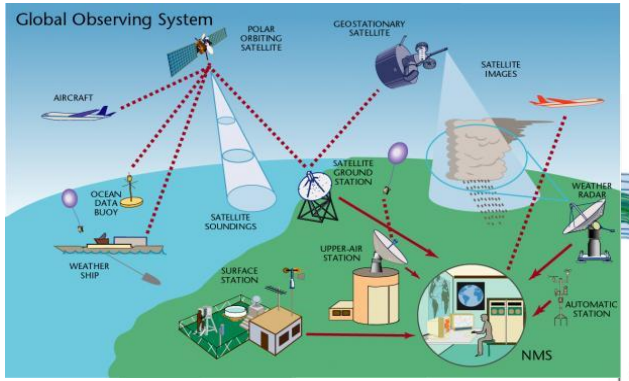
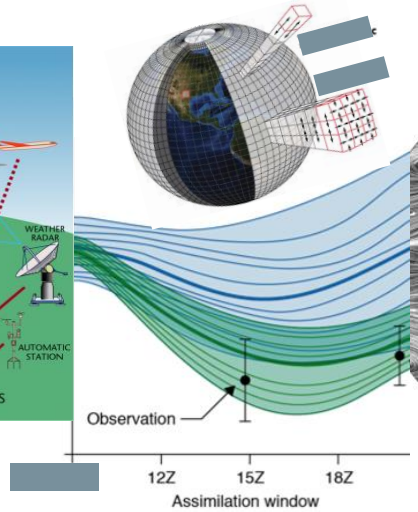
(1) **Advancing predictions (e.g., El Nino forecasts) and projections (e.g., CMIP) of the Earth system** on time scales from weeks to centuries and furthering model-observation integrated frameworks.

(2) **Improve monitoring, understanding, and attribution of Earth system changes and impacts** with robust uncertainty quantification through the synthetic use of models and observations.

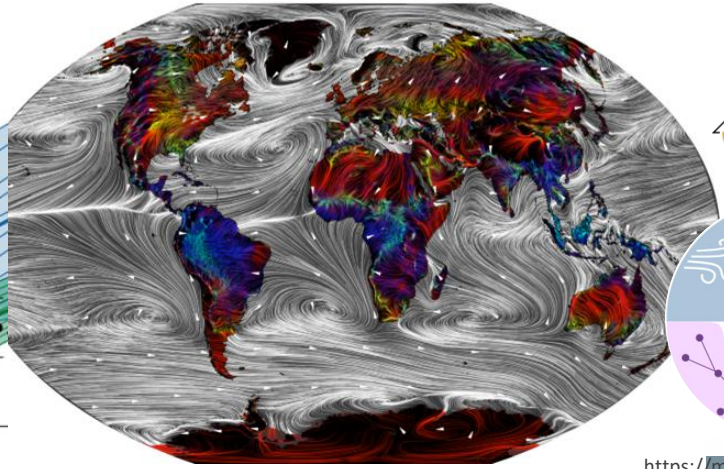
(3) **Advancing and harnessing emerging technologies** in modelling and observations.



WMO Global Observing system



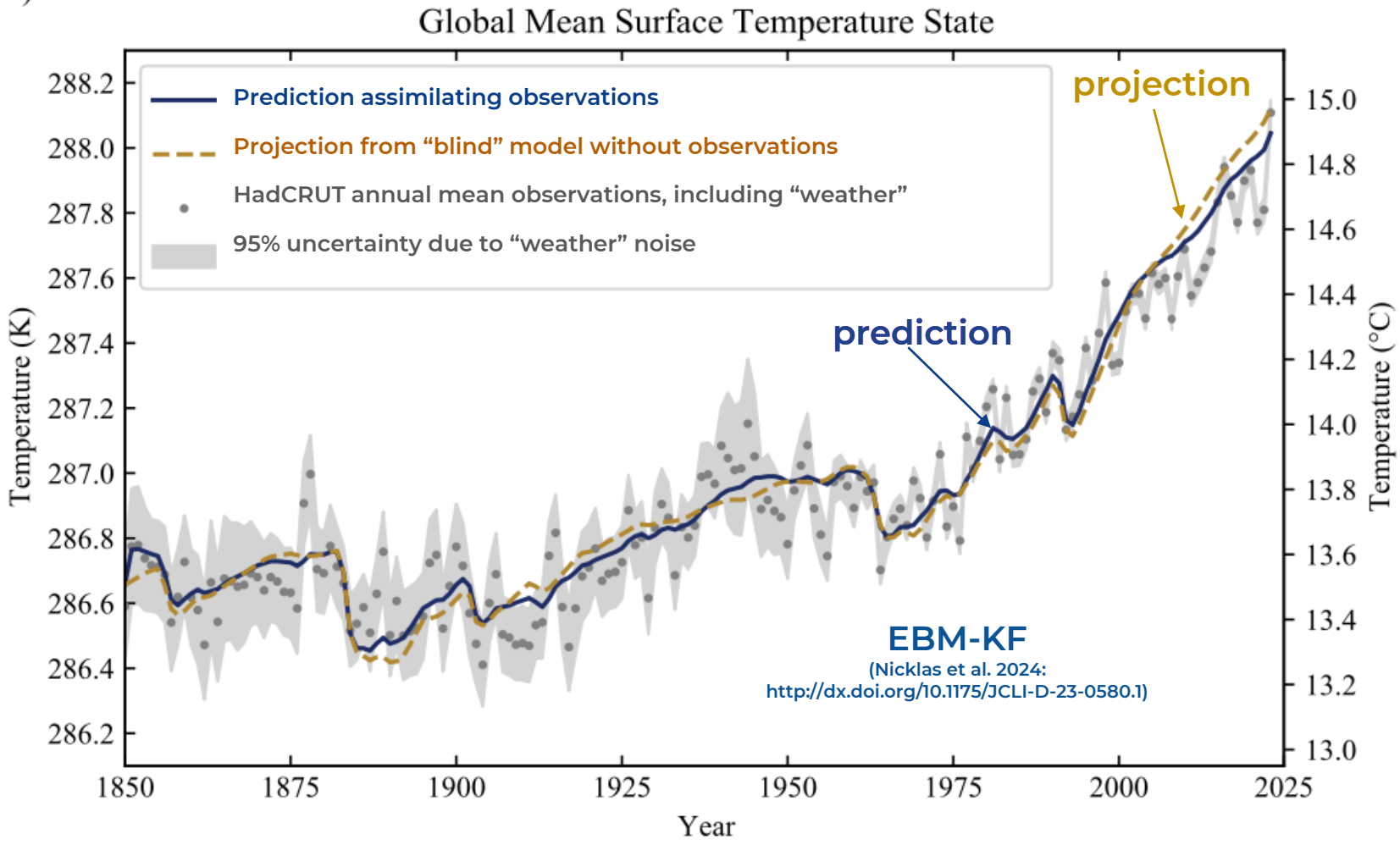
Cambridge University Press Climate Model and ECMWF Data Assimilation schematic



Kling and Ackerly, 2020

https://machineclimate.de/

Initialization and Data Assimilation



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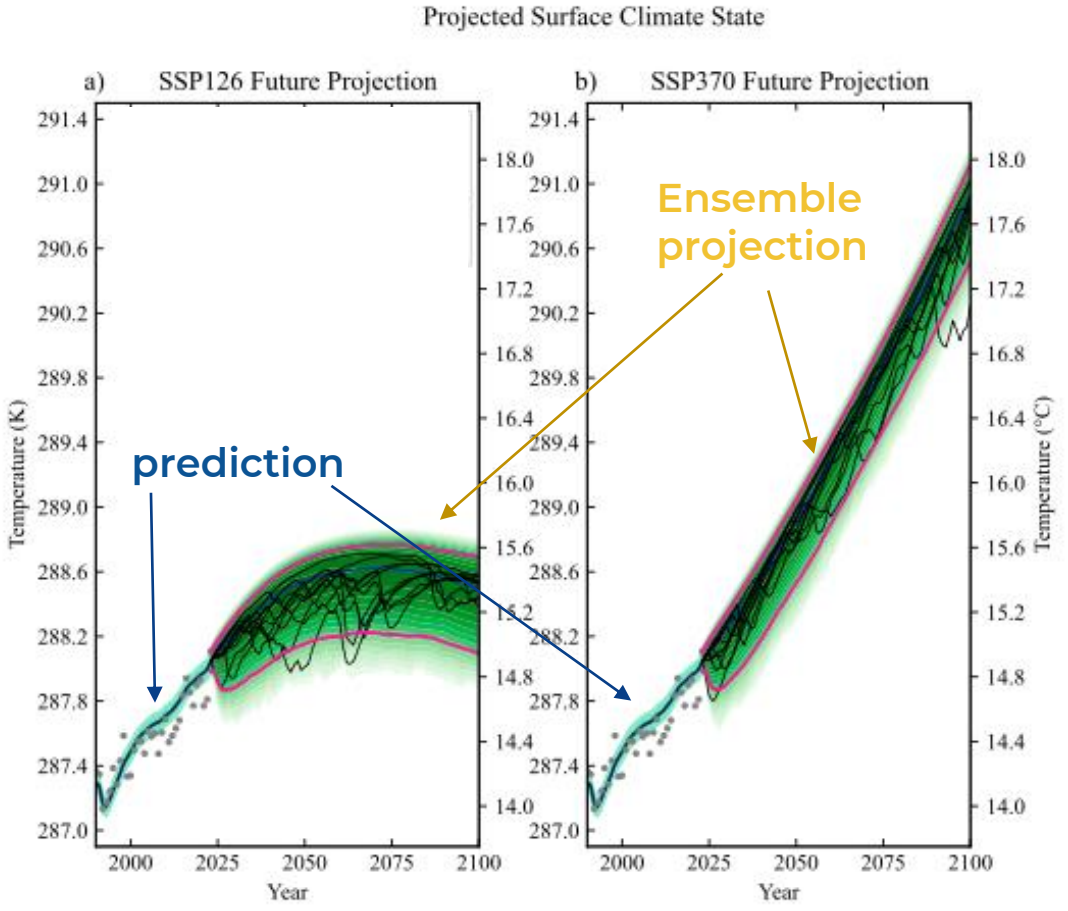

The projections beyond the historical period are more clearly distinguished from predictions.

In CMIP projections, future events such as emissions scenarios, and in this case volcanoes, are not known but are sampled across an ensemble of illustrative outcomes.

EBM-KF

(Nicklas et al. 2024: http://dx.doi.org/10.1175/JCLI-D-23-0580.1)

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