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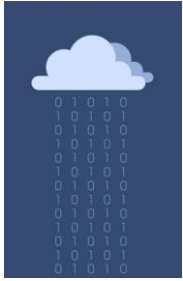
Forecast Quality of Climate Extreme Predictions and its Relevance for Climate Services

Francisco Doblas-Reyes

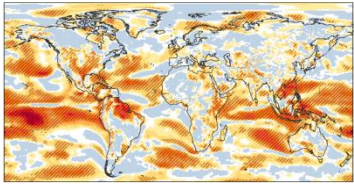
V. Agudetse, C. Delgado-Torres, M.G. Donat, N. González-Reviriego, P. De Luca, N. Milders, A.G. Muñoz, Ll. Palma, N. Pérez-Zanón, J. Ramon, B. Solaraju-Murali, A. Soret and V. Torralba

24 April 2023

Same definitions



- **Climate data:** numerical values representing ECVs and associated magnitudes; includes metadata



- **Climate product:** the result of processing climate data according to the available climate knowledge



- **Climate information:** climate product put in context and generated in a co-production process with the user

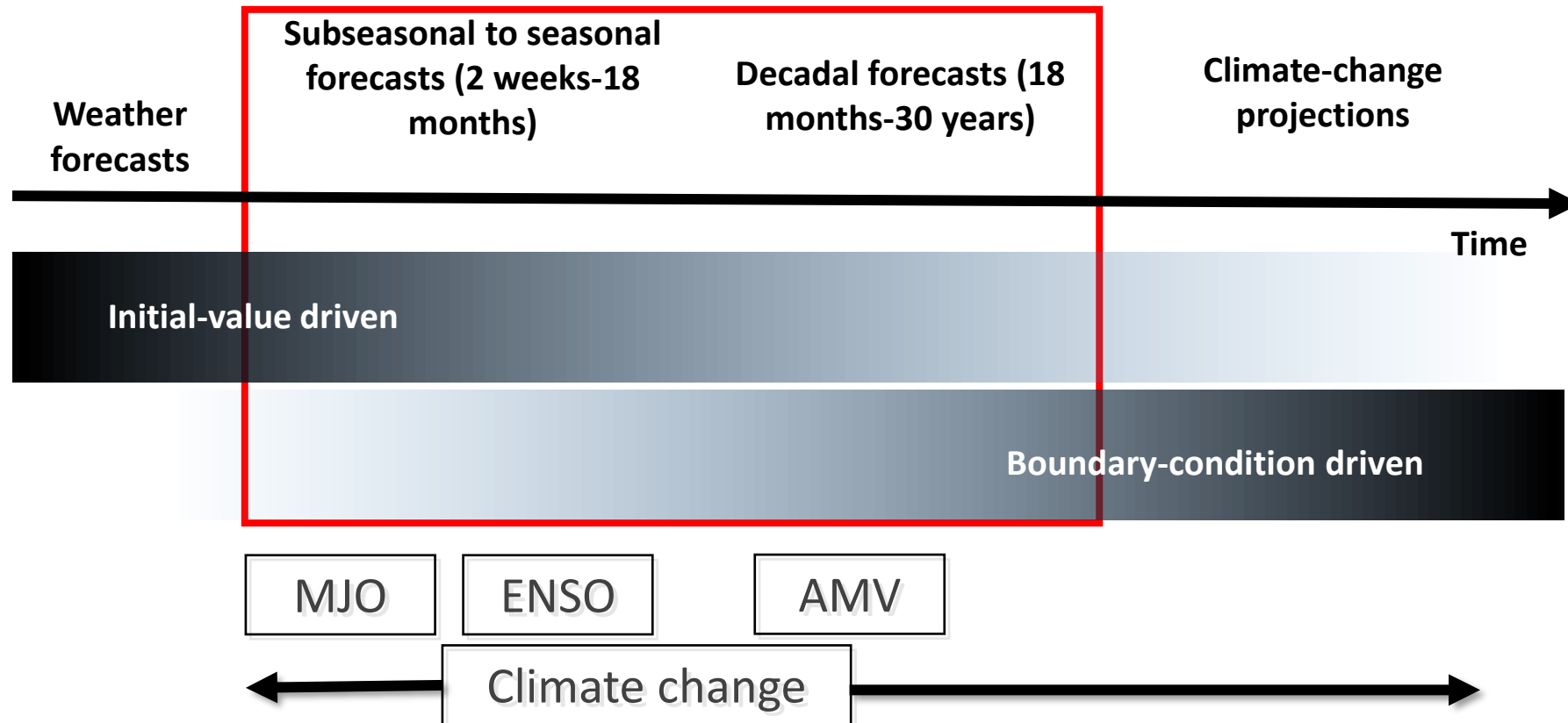


- **Climate service:** ensemble of processes through which both climate data and information are generated

Time scales

Observations, process-based or dynamical forecast systems, empirical models, process understanding, are all key pieces to build climate forecasts.

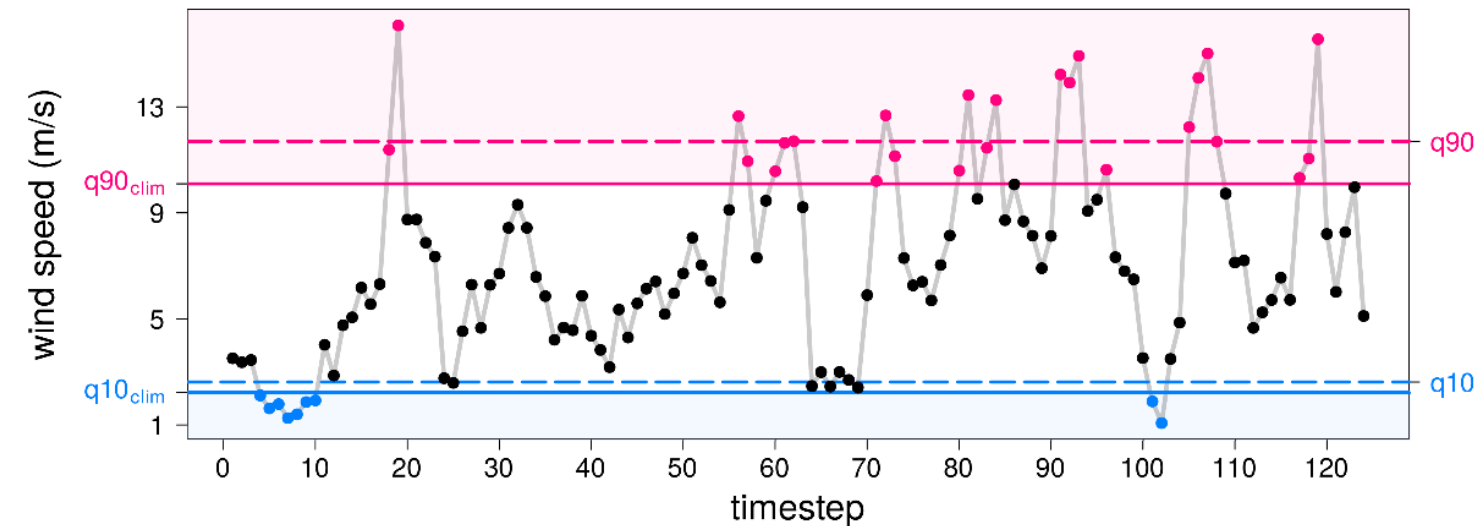
Dynamical forecast systems are used as the standard, but it is reductionist.



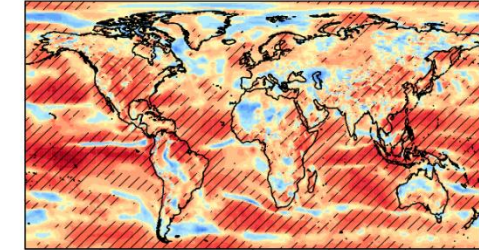
Seasonal climate prediction of extremes

Correlation of seasonal predictions of DJF 10-metre wind speed from ECMWF SEAS4 starting on the first of November over 1993-2016.

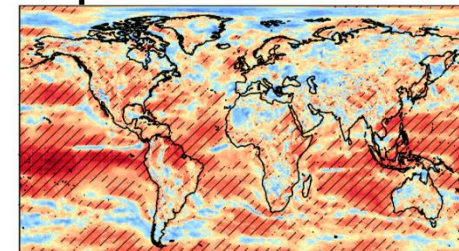
- q90, q10: seasonal percentiles of each specific year
- fbq10, faq90: fraction of time above the climatological percentile in each year



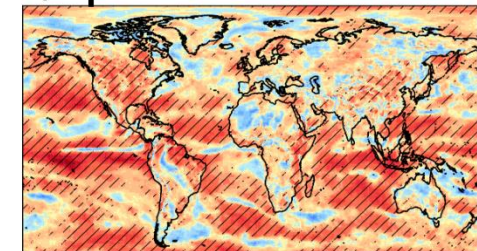
a) mean



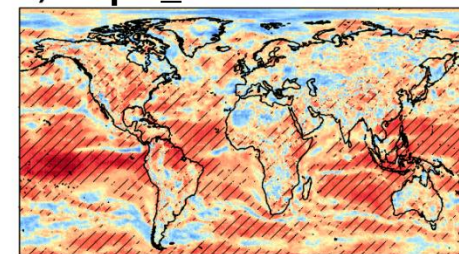
b) q10



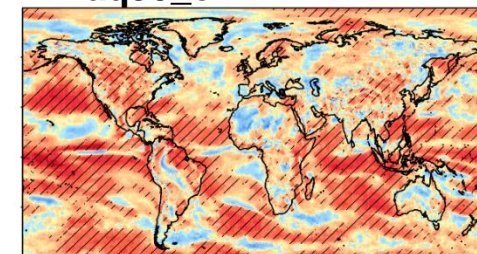
c) q90



d) fbq10_clim



e) faq90_clim

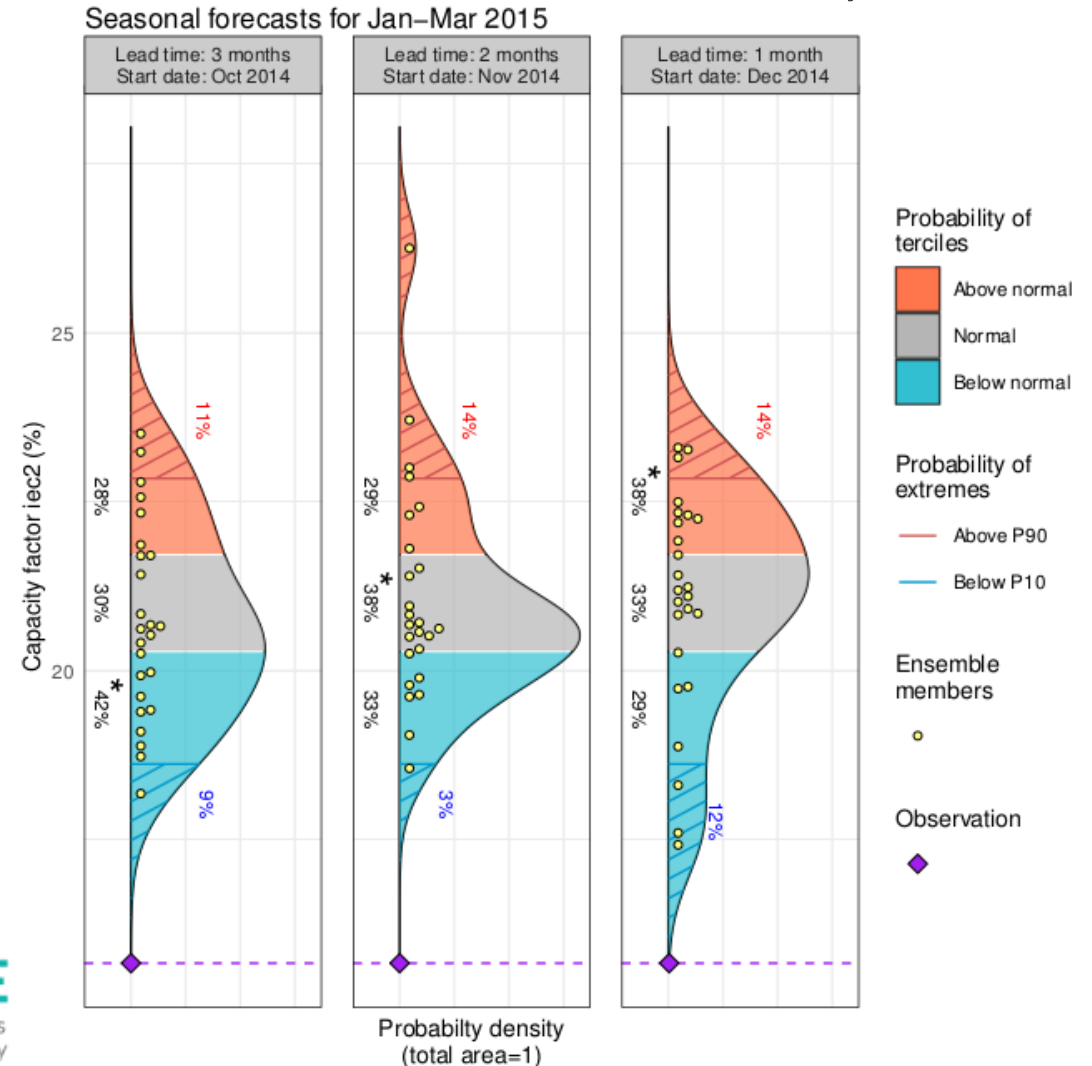


User-oriented forecasts

Co-design implies predicting what the user is interested in.

Seasonal predictions of DJF **capacity factor** over North America (124-95°W, 26-44°N) starting on the first of October, November and December for the first season of 2015, ECMWF SEAS5, reanalysis: ERA-Interim, hindcasts over 1993-2016.

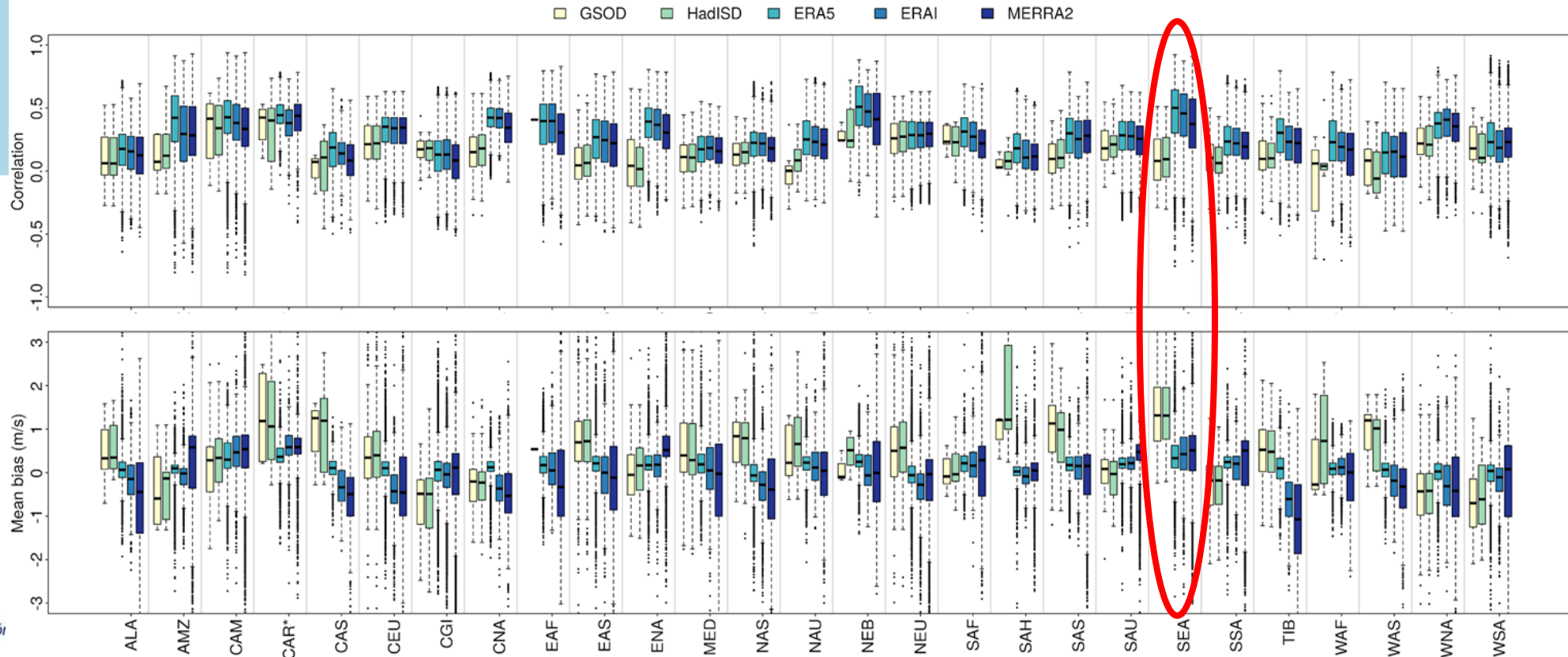
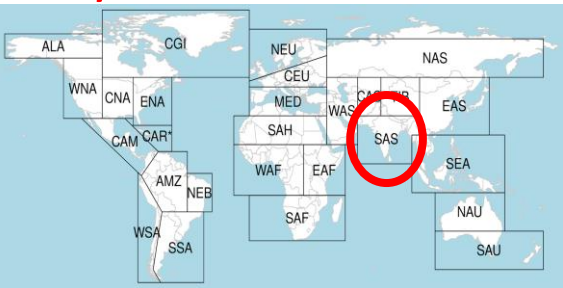
	Oct	Nov	Dec
<i>RPSS</i>	0.23	0.25	0.24
<i>BS P10</i>	-0.18	-0.23	-0.16
<i>BS P90</i>	0.06	0	0.03
<i>CRPSS</i>	0.11	0.08	0.08
<i>EnsCorr</i>	0.5	0.45	0.42



Beware of the observational uncertainty

Verification of 10-metre wind speed with two ground-based observational datasets and three reanalyses. The use of both types of datasets is very informative for wind energy users as they use them for the development of impact models and the long-term resource assessments.

“Failing to account for the effects of observation error when deciding between two forecasting systems could lead to the wrong choice and a high opportunity cost” (Ferro, 2017)

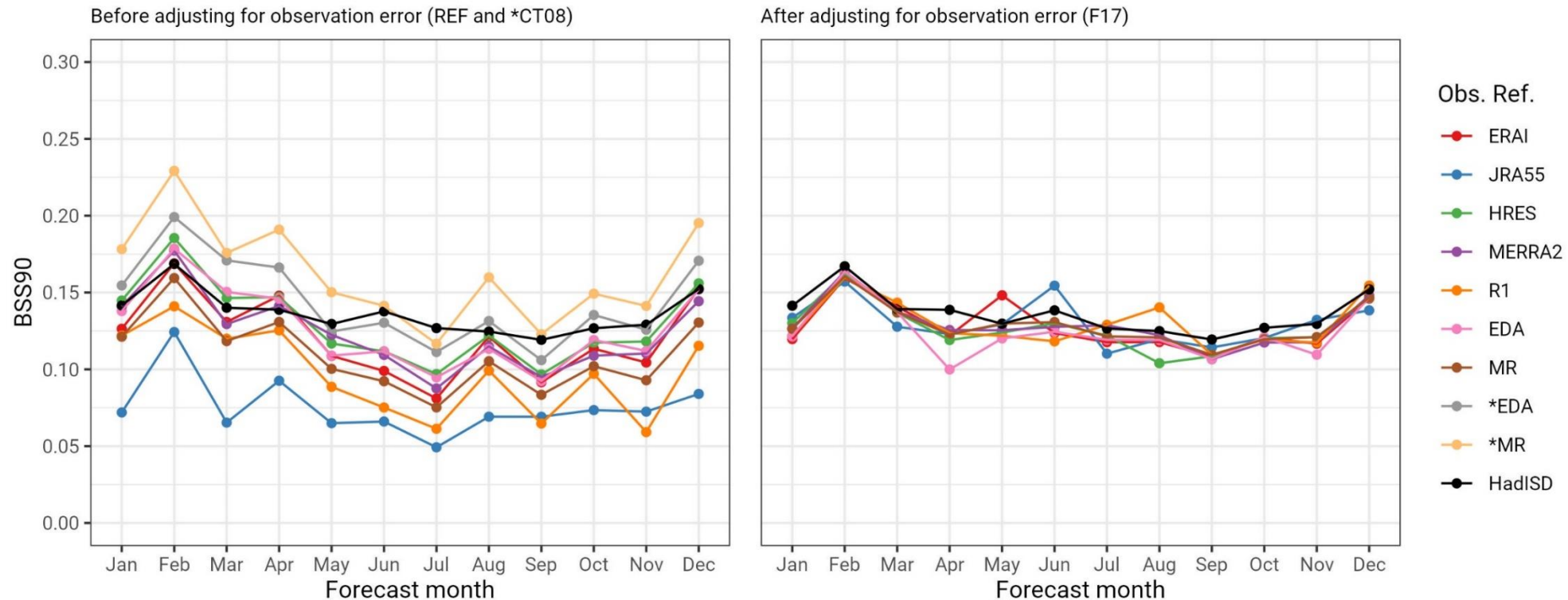


Torralba et al. (in preparation)

Beware of the observational uncertainty

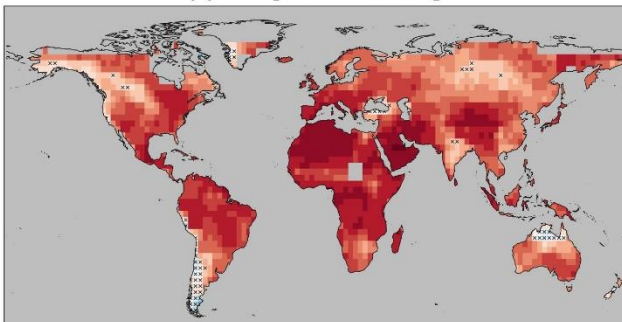
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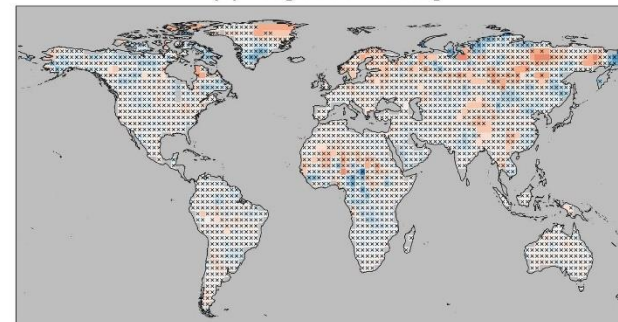


Multi-model decadal prediction

(a) TAS [fract+ = 95.9%]

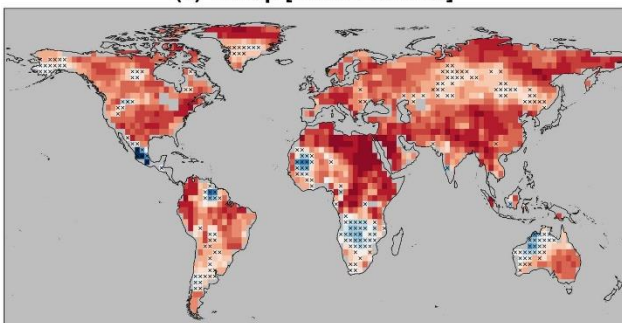


(b) PR [fract+ = 4.2%]

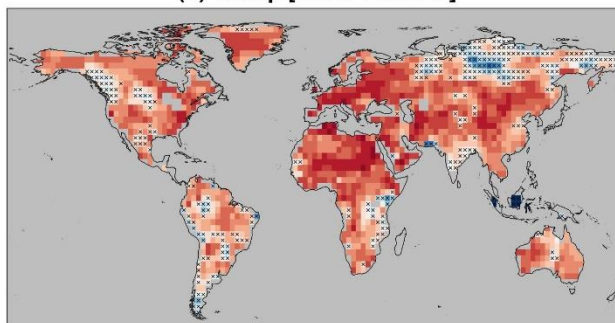


RPSS (3 cat.; BEST-REGEN)
for DCP, 1-5 forecast
years, **169 members, 13**
DCPP forecast systems
(significance random walk)

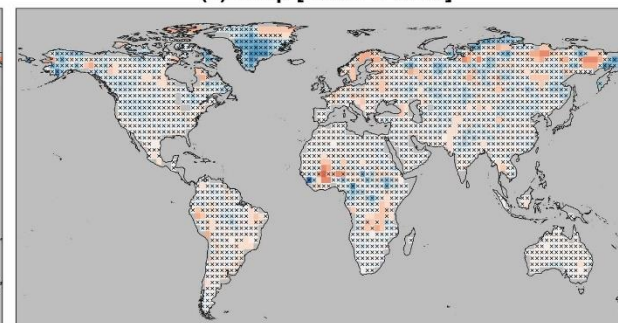
(c) TN10p [fract+ = 84.1%]



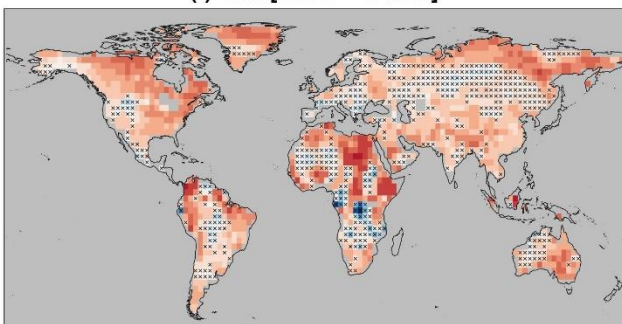
(d) TX90p [fract+ = 81.7%]



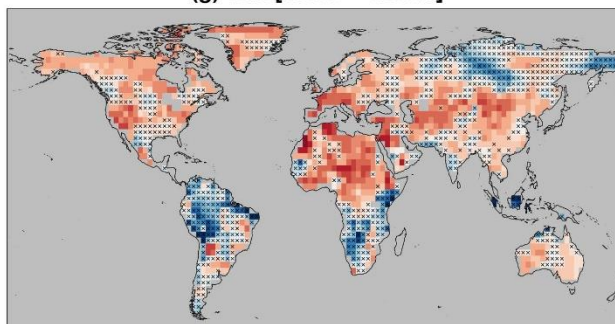
(e) R95p [fract+ = 9.2%]



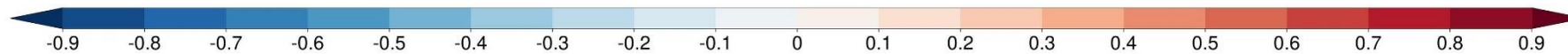
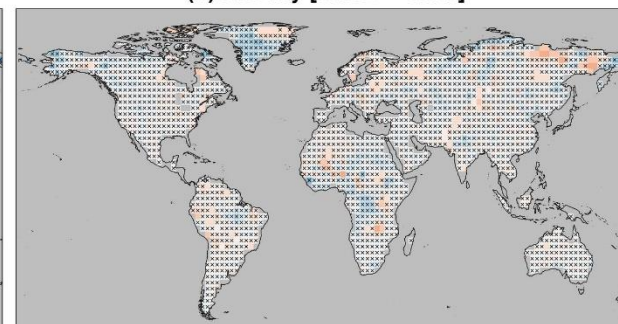
(f) TNn [fract+ = 64.8%]



(g) TXx [fract+ = 50.8%]

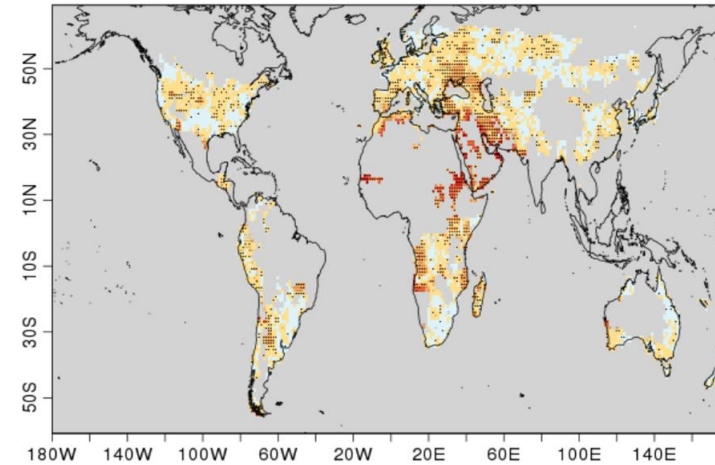
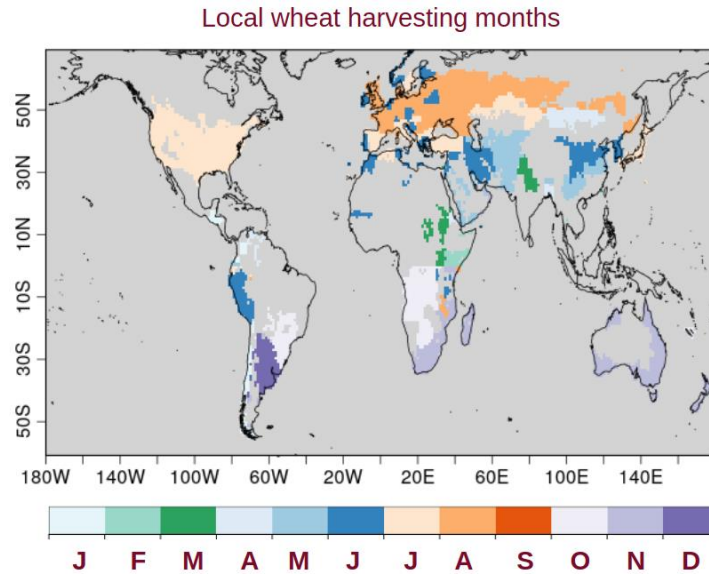


(h) Rx5day [fract+ = 4.6%]



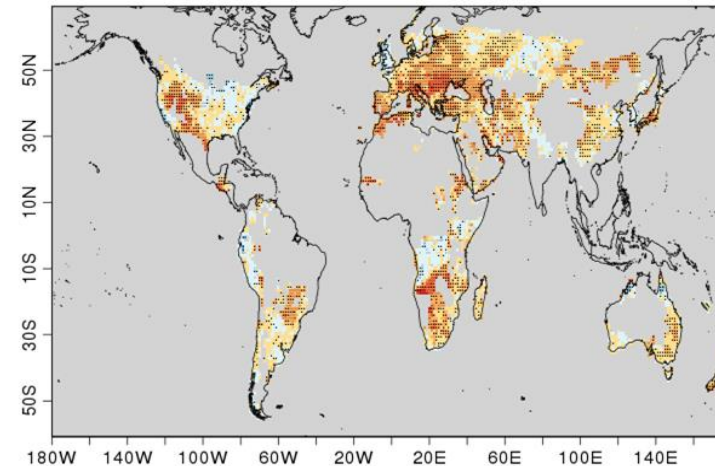
Forecasts for crop yield

Decadal predictions contribute to services in different sectors using indicators based on extreme climate indicators to which they are sensitive.



SPEI6

RPSS (3 categories)



HMDI3

Indicators:

- Drought: Standardized Precipitation Evapotranspiration Index (**SPEI6**)
- Heat stress: Heat Magnitude Day Index (**HMDI3**)

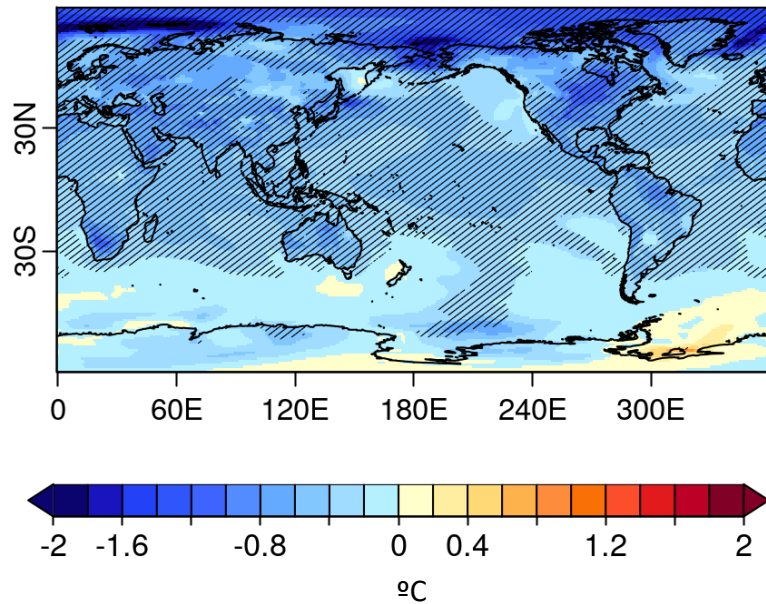
Volcanoes as unavoidable extremes

Explosive volcanoes are not included in the climate-change projections but create signatures that could last from years to decades.

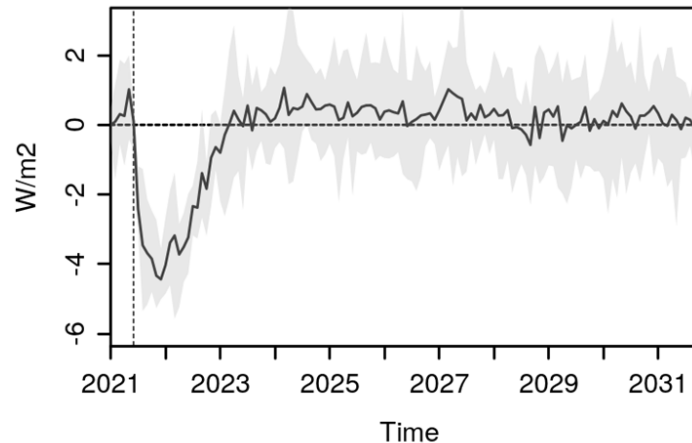
Results from the Decadal Prediction Volcanic Response Readiness Exercise (VolRes-RE).

A 2xEl Chichón eruption is set in April 2022 for the EC-Earth3 decadal forecast started in late 2021 and the difference with respect to DCPD-A made.

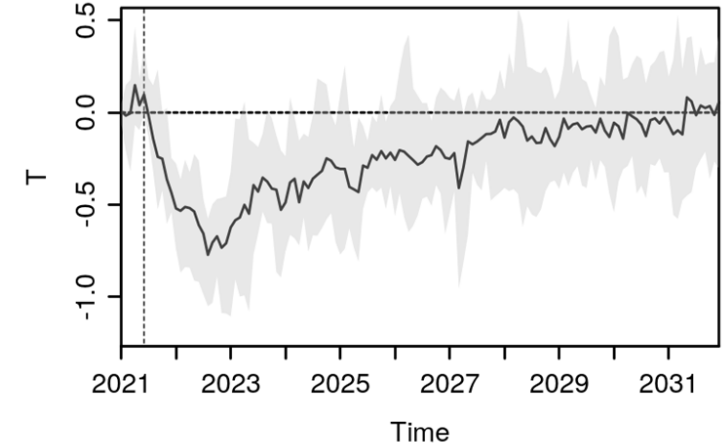
TAS YR2-5



a) Global Mean TOA



b) Global Mean Surface Temp.



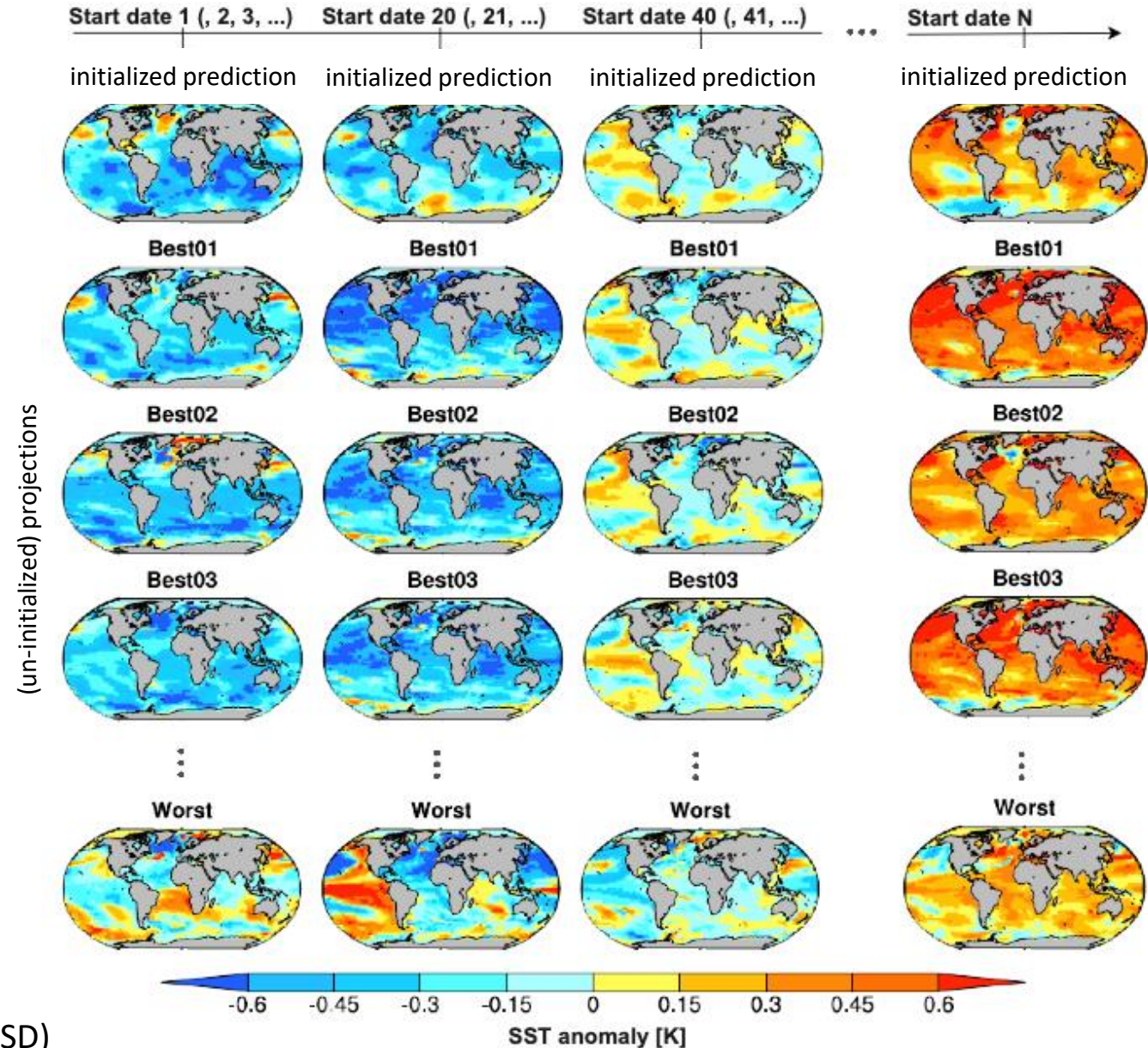
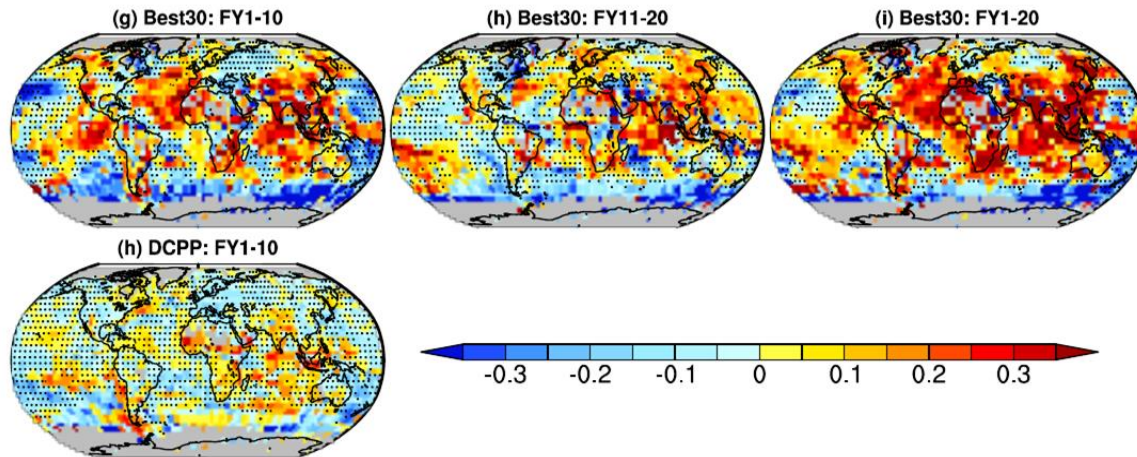
Beyond decadal: Near-term climate information

Projections: **223 members** from 35 models

Decadal predictions: **93 members** from 9 models

Sub-selecting the 30 projections members in closest agreement with the predictions over common years 1-9 or with the observations over the previous 9 years

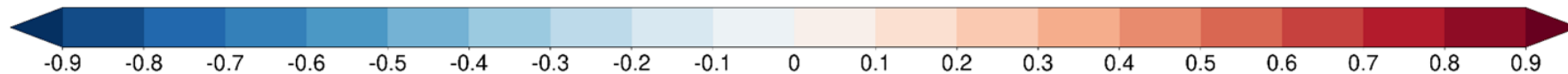
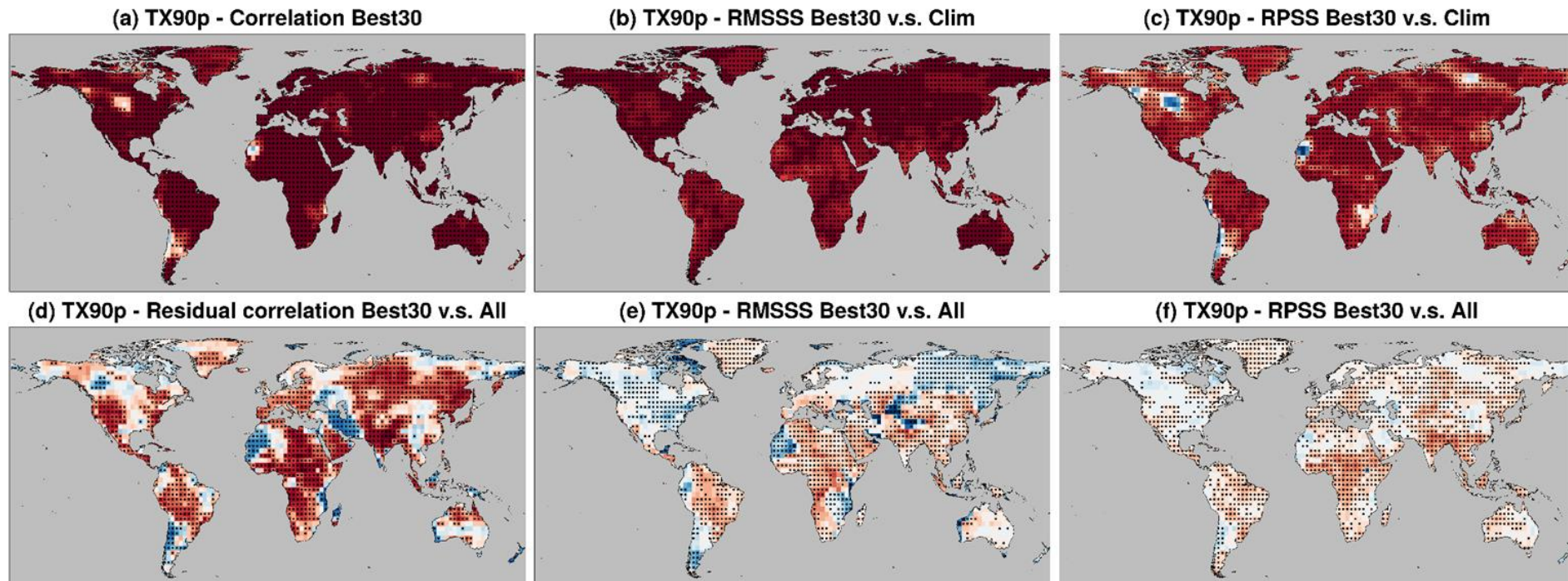
- Substantial multi-decadal predictability
- Constrained projections can be more skillful



Near-term seamless climate information

Skill of 20-year projections using previous observations to select a 30-member ensemble.

- Heterogeneous improvements with respect to the full ensemble of historical simulations
- Verification of the methods is important to the users



The context for a climate service

- Better links, collaboration and knowledge sharing among the increasing, and currently fragmented, community of practice. The current supply-driven approach is more likely to improve climate data, but not necessarily to contribute to better informed decisions. **Direct interaction would allow identifying improvement areas and emerging user needs** (role for climate services).
- Better interaction between **providers and users** and more effort to build local competences.
- Improving usefulness and usability of the products and **moving towards demand-driven** (instead of demand-relevant):
 - enhancing **credibility** with a more transparent approach of the corresponding climate services
 - enhancing **salience** by improving the skill, user interaction
 - enhancing **legitimacy** by creating independent quality assurance including the different stakeholders involved in the process
- Find a space for those **forecast intermediaries** (national meteorological services, which have been using subjective methods, consider a balance between subjective and objective forecasts).




Early
Warnings
for All

Extreme scaling: User interface to climate information




How long before a generative chatbot will be trained with the latest forecast information?

F What is the probability of the occurrence of an El Niño event in October 2023?

 As an AI language model, I do not have access to real-time weather data beyond my knowledge cut-off date of September 2021. The prediction for October 2023 is highly uncertain and depends on many complex changes in ocean temperatures and atmospheric patterns.

El Niño events typically occur every 2-7 years, but their frequency varies widely. However, based on historical records and current climate data, meteorologists and climate scientists may make predictions about the likelihood of an El Niño event occurring in October 2023.

F What is the probability of lower than normal maize crop yield in Tanzania in the period 2023-2027?

 The probability of lower than normal maize crop yield in Tanzania in the period 2023-2027 is difficult to predict with certainty as it depends on various factors, including weather conditions, pests and diseases, availability of inputs such as seeds and fertilizers, and socio-economic factors such as market prices and government policies.  

However, there are several factors that could potentially affect maize crop yields in Tanzania. For instance, climate change could lead to unpredictable weather patterns, which could negatively impact crop yields. Additionally, pests and diseases could also affect crop yields if they are not effectively controlled.

GPT-4's capabilities and limitations create significant and novel safety challenges, and we believe careful study of these challenges is an important area of research given the potential societal impact. This report includes an extensive system card (after the Appendix) describing some of the risks we foresee around bias, disinformation, over-reliance, privacy, cybersecurity, proliferation, and more. It also describes interventions we made to mitigate potential harms from the deployment of GPT-4, including adversarial testing with domain experts, and a model-assisted safety pipeline.

Tanzania during the period 2023-2027 and statistical analysis is required to accurately predict them.

countries are

particularly vulnerable to crop failure and food insecurity, and efforts to support sustainable agricultural practices and increase resilience to climate change are essential to ensure food security and livelihoods.



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