30 March 2021

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

Forecast quality assessment for climate services based on S2S prediction

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with contributions from Joaquín Bedia, Nicola Cortesi, Nube González, Carlo Lacagnina, Llorenç Lledó, Raül Marcos, Núria Pérez, Jaume Ramón, Albert Soret, Marta Terrado, Verónica Torralba, Ilaria Vigo and many more

S2S4E Climate Services for Clean Energy

EUCP European Climate Prediction system

ICREA

Barriers to use climate forecasts in applications

Some lim ons for the use of climate forecas ent socio-economic

Possible solution: to adapt the climate forecasts into a message to be integrated in decision-making.

Lack o

Difficult interpretation

Lack of expert synthesis

Climate services

Goal: the development and oration of climate based on forecasts for -making and al, regional and na

- **Implementat** production and co

Forecast quality is an integral part of the service to the user

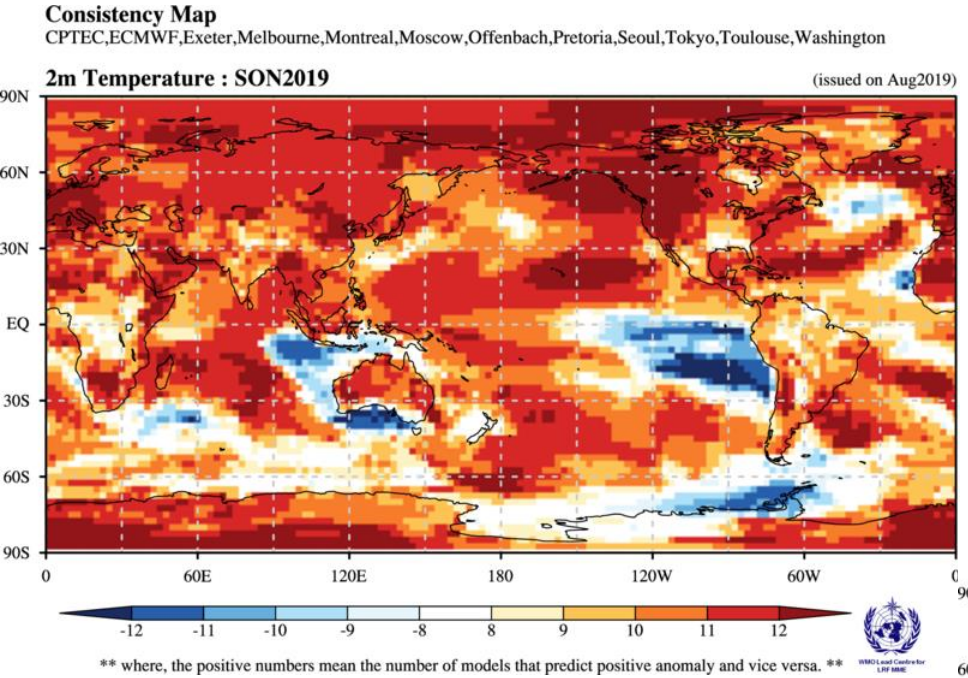
Forecast requirements identified by users

- Targeted products need to become widely available, easy to access and understood by different professionals
- Need to understand how the information provided can be used and integrated in decisions and activities.
- Added value of predictions needs to be better understood. The chain of predictability source needs to be established.
- Need to reduce uncertainty. The skill is too low to base decisions on them, since the uncertainty is high.
- Better explanation of the link between predictions and climate change projections.
- The information needs to be reliable enough.
- Maybe need for fine spatial resolutions or allow for urban areas.

Forecast quality is an integral part of the service to the user because it is inseparable from the forecast product

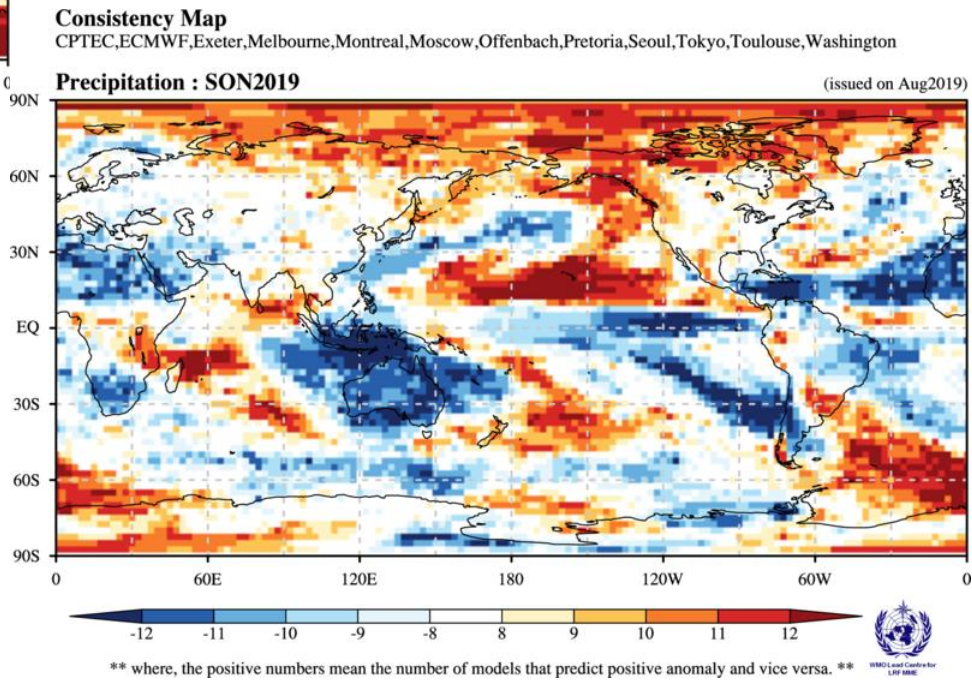
Extracted from project deliverables of EUCP (D6.4), PRIMAVERA (D11.6) and EUPORIAS (D12.3). Additional sectoral comments in user engagement by S2S4E, APPLICATE, MED-GOLD, HIATUS and VISCA.

Users look for climate forecasts online



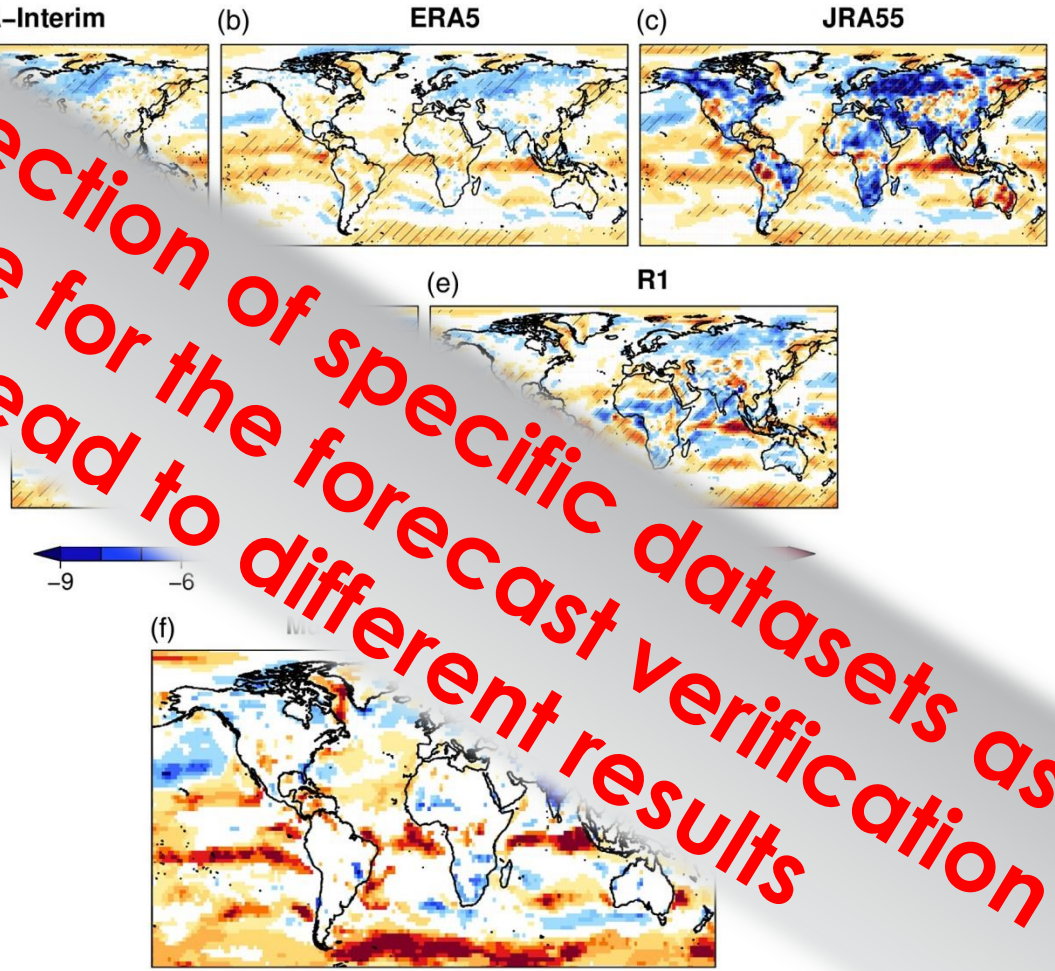
But some elements are missing:

- Quality assurance
- Traceability
- Interpretation



Observational uncertainty is relevant to users

10-m wind speed trend (in percentage of the mean wind) for five reanalyses and agree[illegible] in the multi-reanalysis (MR) in DJF over 1981-2017.



The election of specific datasets as reference for the forecast verification can lead to different results

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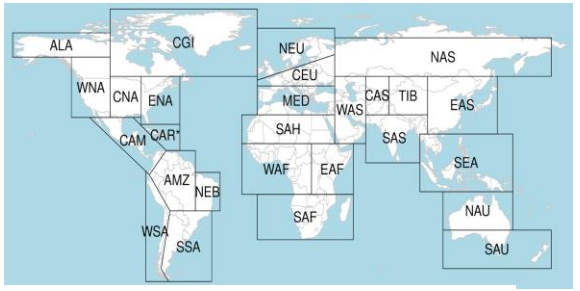
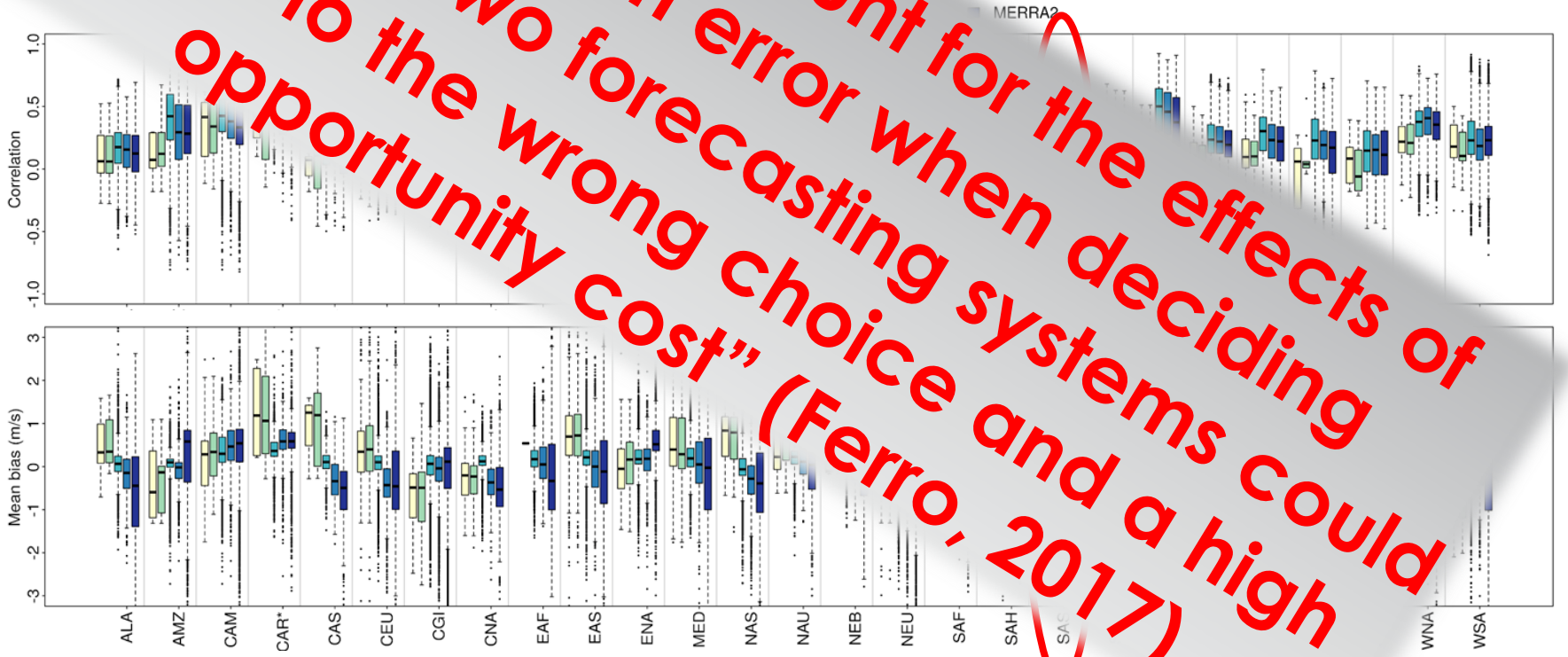
Ramon et al. (2019, QJRMS)

Obs tional uncertainty in verification

Verificati ound-based observational dataset The use of both types of dat wind energy users as th nt of impact mo ents.





"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)

ECMWF SEAS5 Period: 1981-2016

Season: DJF Start date: 1st Nov

A non-trivial climatology definition

There is a large heterogeneity in the real-time subseasonal systems: different initialisations, hindcasts periods, etc.

Limited samples (even in the hindcasts) lead to: lack of robustness in forecast quality estimates, definition of the climatology, bias adjustment, etc.

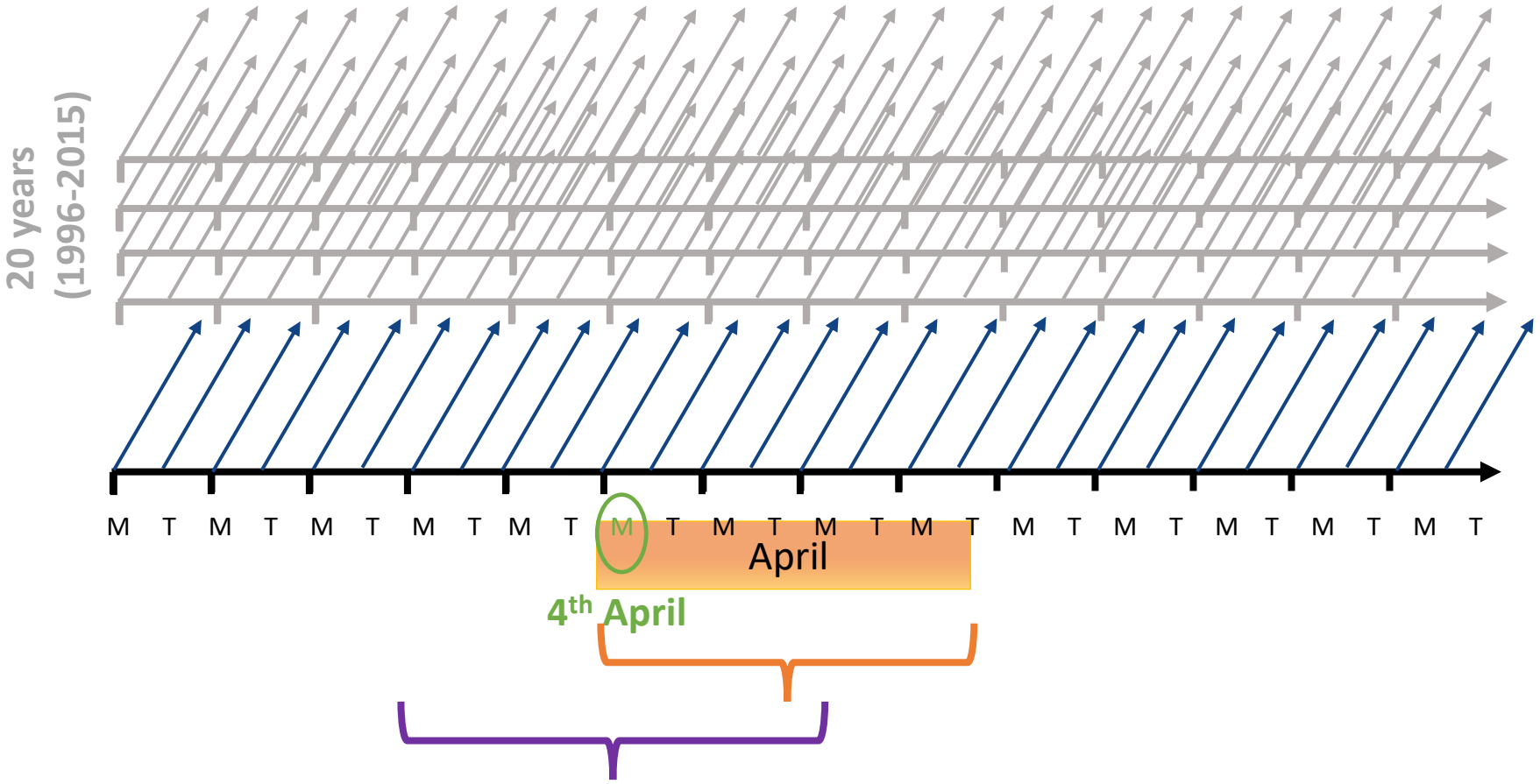
Forecast

Hindcasts

Status on 2020-10-27	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rfc size
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fixed	1981-2013	6/month	3*11
CMA (babj)	d 0-60	T266L56	4	2/week	on the fly	past 15 years	2/week	4
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fixed	1981-2010	every 5 days	5
CNRM (lfpw)	d 0-47	T255L91	25	weekly	fixed	1993-2017	every 7 days	10
ECCC (cwao)	d 0-32	39 km L45	21	weekly	on the fly	1998-2017	weekly	4
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week	11
HMCR (rums)	d 0-61	1.1x1.4 L28	20	weekly	on the fly	1985-2010	weekly	10
JMA (rjtd)	d 0-33	TI479/TI319L100	50	weekly	fixed*	1981-2010	2/month	13
KMA (rksl)	d 0-60	N216L85	4	daily	on the fly	1991-2016	4/month	3
NCEP (kwbc)	d 0-44	T126L64	16	daily	fixed	1999-2010	daily	4
UKMO (egrr)	d 0-60	N216L85	4	daily	on the fly	1993-2016	4/month	7

Manrique-Suñén et al. (MWR, 2020)

A non-trivial climatology definition



Weekly: 1 start date, 20 years
Monthly: All start dates in a calendar month, 8/9 start dates, 20 years
Monthly running window: Running window with 4 start dates before and after the target week, 9 start dates, 20 years

A non-trivial climatology definition

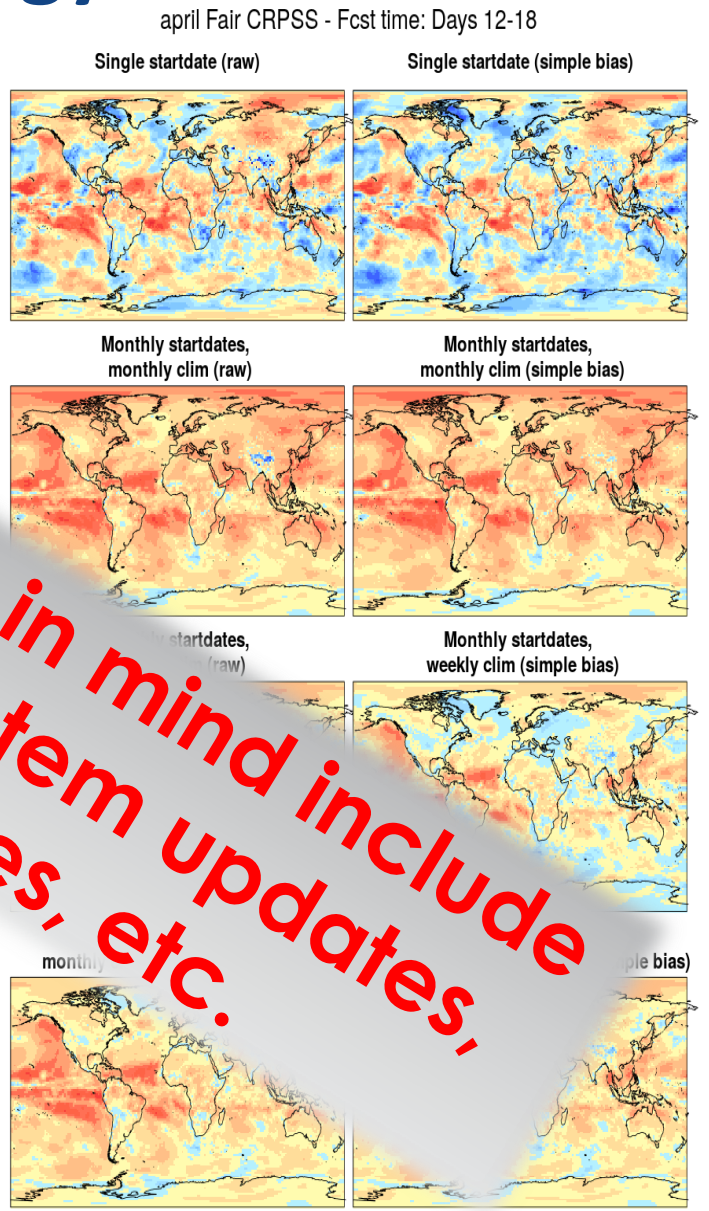
Other aspects to bear in mind include forecast timeliness, system updates, multi-model choices, etc.

ECMWF
Period:
Reference:
Variable: 2-m tem

kly: too noisy

Monthly runni
but weekly for t
adjustment: lower skill ,
too noisy for the adjustment

Monthly running window: more credible quality estimates



Manrique-Suñén et al. (MWR, 2020)

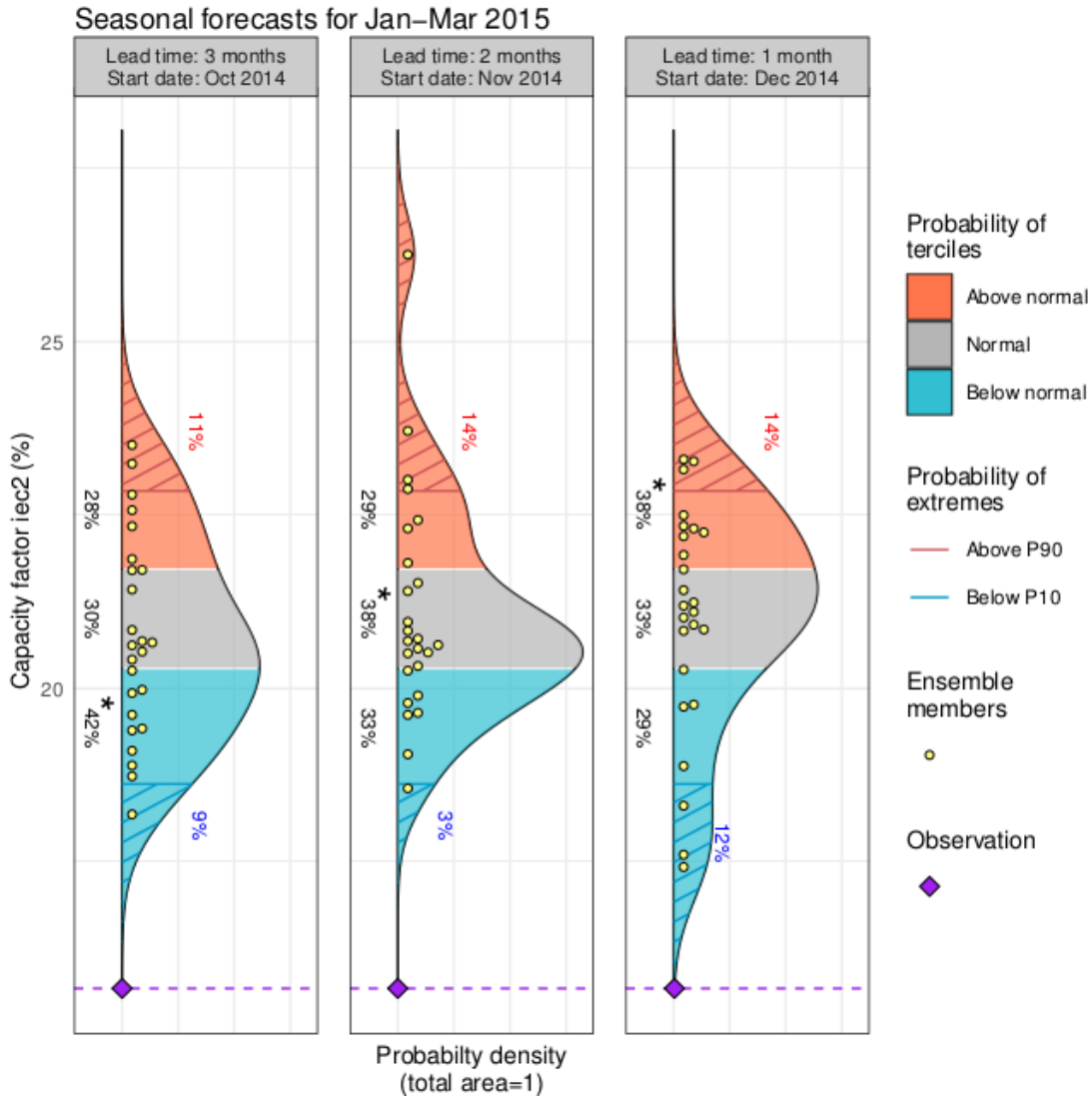
Evaluation and quality control

The Cop icus Climate Change Service is developing the evaluation and quality OC) function of the climate data store to:

- Pr verarching EQC service for the whole CDS
- [uality assessment of both datasets and prod

Forecast quality assessment is a part of the evaluation and quality control function

Seasonal prediction of wind capacity factor



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 trimester of 2015, ECMWF SEAS5, reanalysis: ERA-Interim, hindcasts over 1993-2015.

	Oct	Nov	Dec
RPSS	0.23	0.25	0.24
BS P10	–0.18	–0.23	–0.16
BS P90	0.06	0	0.03
CRPSS	0.11	0.08	0.08
EnsCorr	0.5	0.45	0.42

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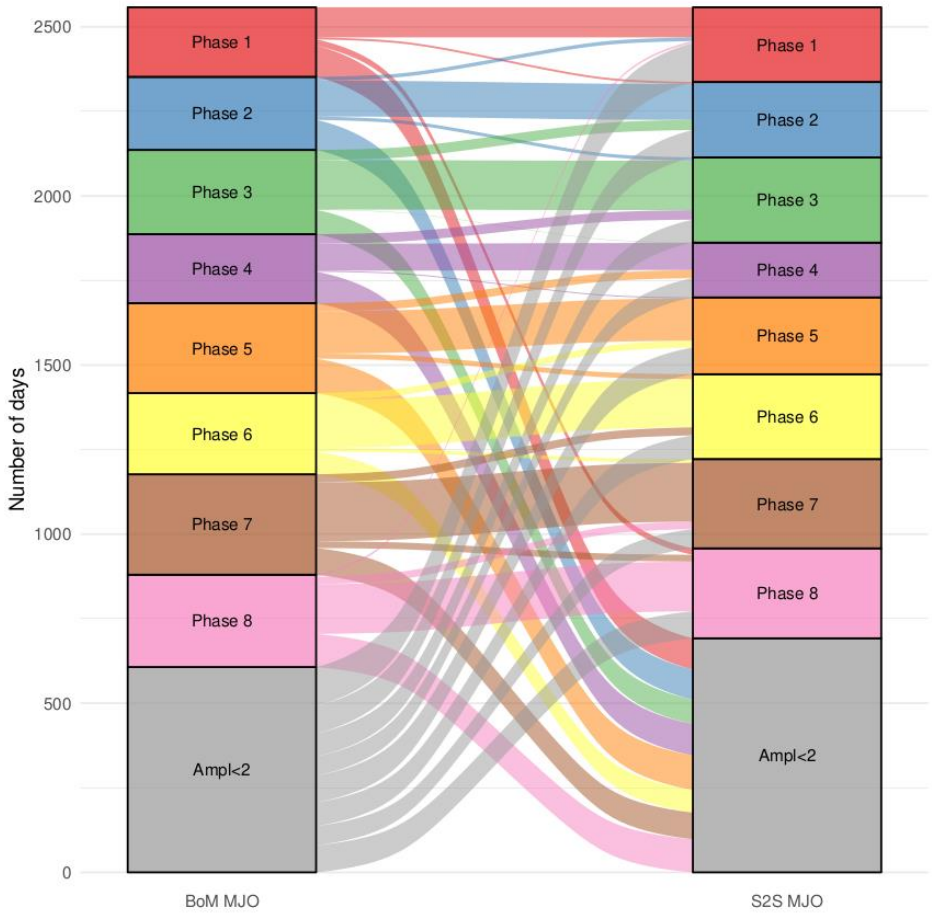
L. Lledó

Do not underestimate the power of an image

Observational uncertainty needs to be conveyed to users. The MJO phases for amplitudes above 2 from the BoM and S2S indices are compared over 1981-2017 and the challenge to verify the predictions illustrated. The days with amplitudes below 2 in both indices have been omitted.



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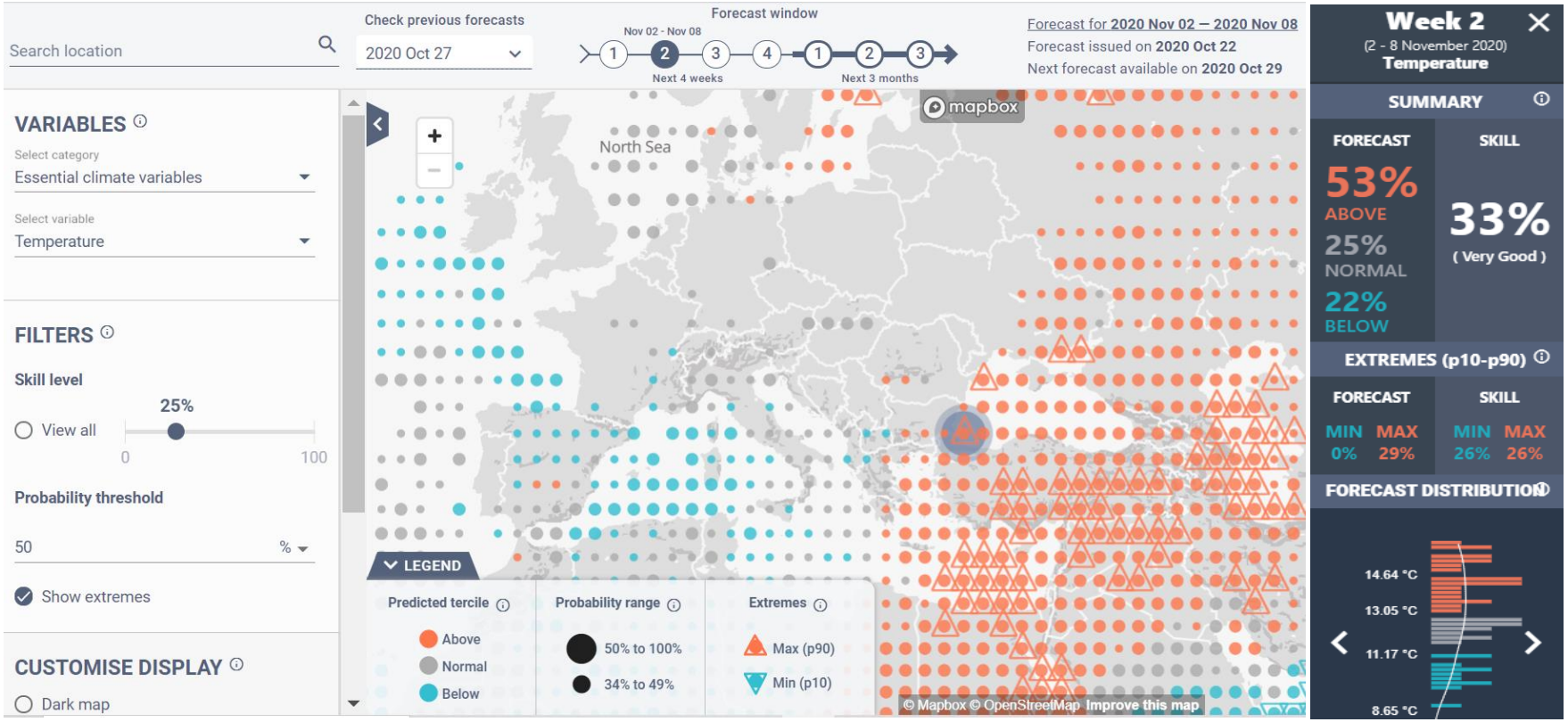
Lledó and Doblas-Reyes (2020, MWR)

Prototypical climate services for energy

S2S4E is developing a decision support tool for the renewable energy sector based on Copernicus climate forecasts, S2S, and NCEP operational predictions co-designed with the industry for periodic updates on the state of relevant climate variables.



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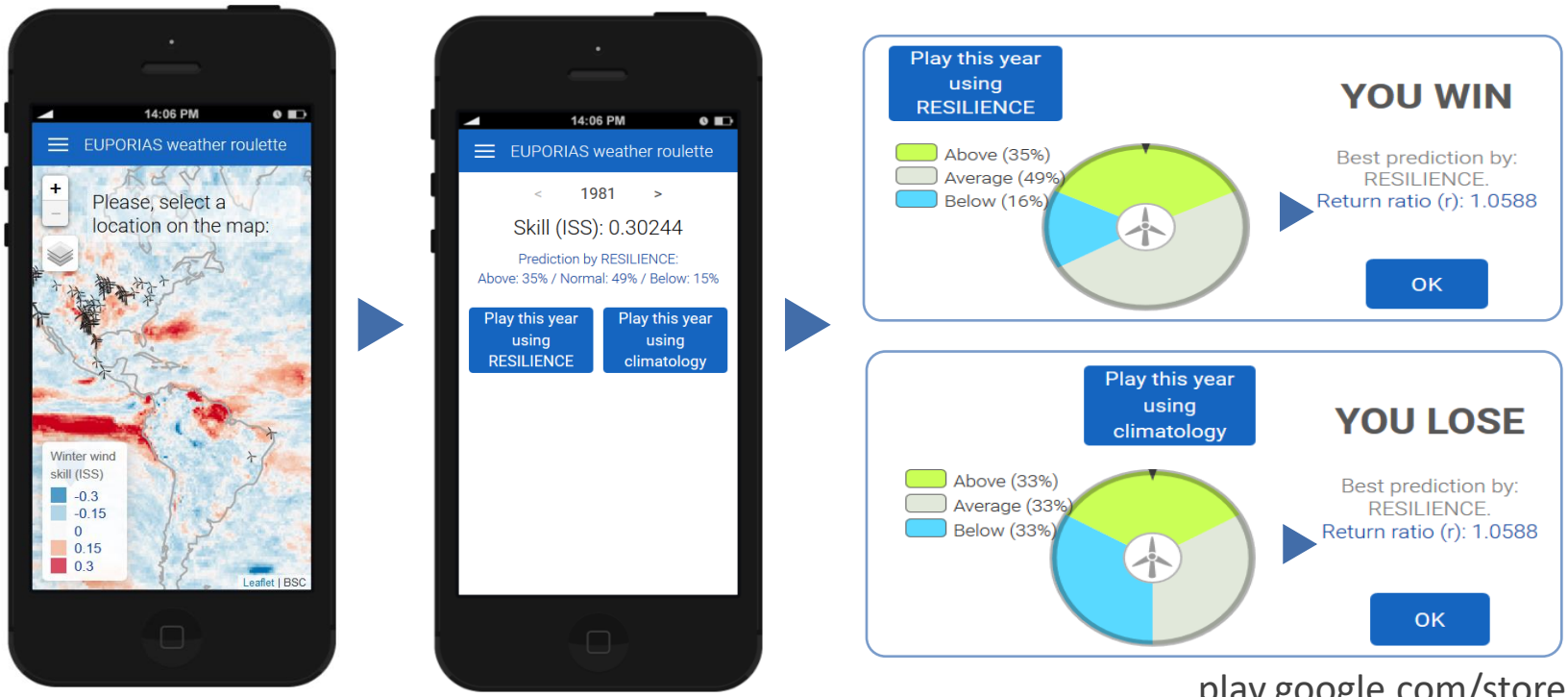
Subseasonal-to-Seasonal S2S Prediction Project

The communication challenge

Gamification is useful to illustrate the challenges of using and the value of seasonal climate predictions addressed to the wind energy sector:

- Play against a reference taken from climatological frequencies.
- The bets are proportional to the predicted probabilities.
- The amount invested in the observed category is multiplied by 3.



play.google.com/store/apps

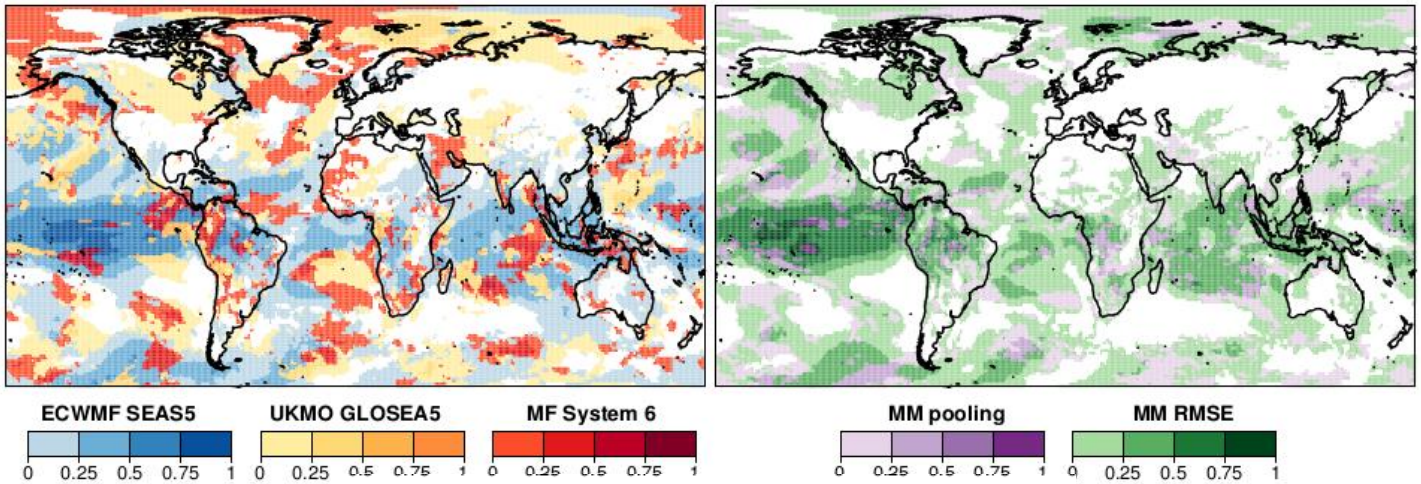
demo.predictia.es/roulette-app/mobile.html

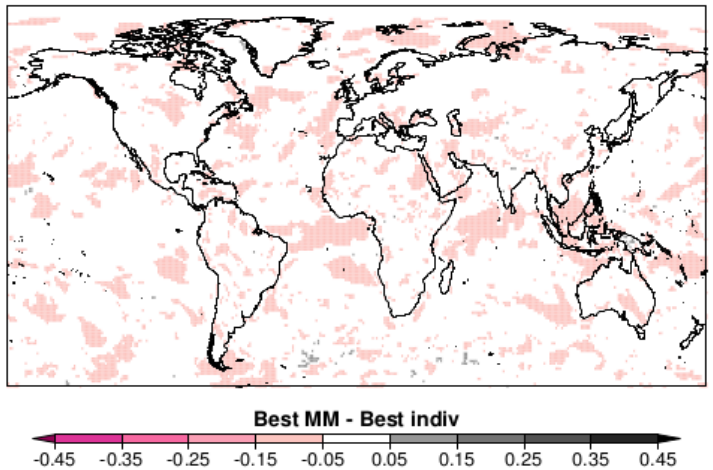
Terrado et al. (2019, BAMS)

Multi-model climate prediction

However, users do not always understand why multi-model is the preferable option.

CRPSS of DJF two-metre temperature for C3S forecasts initialized in November, all systems bias adjusted (MVA) compared to a simple and weighted multi-model (as inverse function of RMSE). Bottom gain of the best multi-model with respect to the best single system. Verified against ERA Interim for 1993-2015.





The non-exhaustive list of relevant elements

- Observational uncertainty: comparison between reanalyses in a forecast verification context.
- Definition of standard procedures: standards are less common than one would expect.
- Traceability and quality control: quality control and reproducibility of data and products is increasingly important in the research community, but its operational aspects are not solved yet.
- User indicators: indicators do not have the same level of skill as the meteorological variables.
- Interpretation and communication: users are often not experts, and even when they are it is easy to misunderstand the existing information. Communication is a challenge
- Synthesis and narratives: how to deal with multiple lines of evidence in the message constructions.