

IEA Task 51 Seasonal Workshop ECMWF, Reading, 18 May 2023

Co-production of seasonal forecasts for energy applications

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WWW.WEMCOUNCIL.ORG



Energy & Meteorology are Inseparable



Warning: axis not to scale

Energy & Meteorology are Inseparable



Courtesy Elena Bertocco (WEMC)







an exceptional warm period on july with an extremely high power demand and prices (Case Study 1)

Strong hydro production forced also by the TSO

Consumption of water reservoir

Courtesy Marco Fromenton (ENEL)

Case Studies

	Case Study	Climate events	Geography	Sectoral impact	Co-designers
Í	CS1	Heat Wave 2015, and other similar extremes	Southern Europe	Energy –Thermal electricity plant cooling, demand model uncertainty	ENEL , ENEA, EURAC, KNMI
Italy	CS2	Dry Winter 2015-16 and other similar extremes	Northern Italy	Energy –Hydroelectric power production	ENEL , KNMI, ENEA, EURAC, Alperia
	CS3	Strong Winds March 2016 and other similar extreme	Southern Italy	Energy – Wind power production	ENEL , ENEA, KNMI, UEA
n & Ibia	CS4	Extreme Winds 2014- 15 and other similar extremes	Spain	Energy – Wind power production and balancing	AWS , MO, ENEL
Spair Colon	CS5	Strong El Niños	South America	Energy — Hydroelectric power production and other RE	AWS , UEA, AES Chivor, Celsia, ENEL
	CS6	Low Winds	North Sea	Energy – Offshore operations and maintenance planning	TenneT, KNMI
		Severe climate events in 'shoulder' months	North Sea	Energy – Offshore operations and maintenance planning	Shell, MO
	CS8 University of East Ar	Anomalous winter conditions	UK	Energy – Winter electricity demand	National Grid, MO
	CS9	Dry Spring and	UK	Water – Water use	Thames Water,

N 40

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	Case Study	Climate events	Geography	Sectoral impact	Co-designers
	CS7	Severe climate events in 'shoulder' months	North Sea	Energy – Offshore operations and maintenance planning	Shell, MO
	CS2	Dry Winter 2015-16 and other similar	Northern Italy	Energy –Hydroelectric power production	ENEL , KNMI, ENEA, EURAC,
	CS9	extremes	UK	Water – Water use	Alperia
\	CS3	Strong Winds March 2016 and other similar	Southern Italy	Energy – Wind power production	ENEL, ENEA, KNMI, UEA
		extreme			
	CS4	Extreme Winds 2014- 15 and other similar extremes	Spain Fac	Energy – Wind power production and balancing	AWS, MO, ENEL
- ARC	CS5	Strong El Niños	South America	Energy – Hydroelectric	AWS, UEA, AES Chivor, Celsia,
				nowor production	ENEL

Climate Services: Co-Production



Close engagement with

stakeholders is critical in transferring knowledge and instilling confidence in climate services

It follows the CO-CO-CO (Co-design, Co-development, Co-evaluation), or simply **Co-Production**

It goes beyond the traditional provider/client talk, though it boils down to **effective communication**!

Climate Services: The critical role of User Engagement



Science is key! Models need to be improved ...

... but service development should (normally) be done in **Collaboration with Users**

Source: Integrated Weather and Climate Services in Support of Net Zero Energy Transition. WMO (2022)

Assessing the value of seasonal climate forecasts



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MENU OF ECONOMIC ASSESSMENT METHODS

- *DECISION THEORY MODELS*
- o *AVOIDED COSTS*
- o **ECONOMETRIC MODELS**
- o *CONTINGENT VALUATION APPROACHES*
- PARTIAL AND GENERAL EQUILIBRIUM MODELS
- ALTERNATIVE METHODS





How to measure independence among seasonal prediction systems?

Newly developed Independency metric

The Brier Skill Score covariance (BSScov)

Starting from the definition of the Brier score a new metric has been developed, the Brier Score covariance (BScov), which estimates the relative independence of prediction systems 1 and 2:

$$BS = \frac{1}{n} \sum_{i=1}^{n} (y_i - o_i)^2$$
$$BS_{cov} = \frac{1}{n} \sum_{i=1}^{n} (y_i^1 - o_i)(y_i^2 - o_i)$$

With the same scaling of to the Brier Skill Score a positively oriented metric is computed as follows

$$BSS = 1 - \frac{BS}{BS_{ref} = clim} \qquad BSS_{cov} = 1 - \frac{BS_{cov}}{BS_{ref} = clim} \qquad \text{Alessandri et al. 2022 (in preparation)}_{Catalano et al. 2022 (in preparation)}$$

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Grand MME in SECLI-FIRM

Grant Agreement

n. 776868

Homogenization at common 1° x 1° grid, common hindcast period 1993-2016; May, November [Feb, August] start dates, 10 members for each SPS. SPSs combined using equal weights.

_	Prediction Centre	Latest System	Atmos. model	Ocean model	Initialization Atmos.	Initialization Ocean
	ECMWF, EU	SEAS5	IFS Cycle 43r1	NEMO v3.4	ERA-Interim	ORAS5
	UKMO, UK	GloSea5-GC2-LI	Unified Model (UM)	NEMO v3.4	ERA-Interim	GS-OSIA
	MF, France	System 6	ARPEGE v6.2	NEMO v3.4	ERA-interim	GLORYS2V2
	DWD, Germany	GCFS 2.1	ECHAM 6.3.05	MPIOM 1.6.3	ERA5	ORAS5
	CMCC, Italy	CMCC-SPS3.5	CAM 5.3	CanOM4	ERA5	C-GLORS 3D-VAR
	MSC, Canada	GEM-NEMO	GEM 4.8-LTS.13	NEMO 3.6 ORCA	ERA-interim	ORAS5
	MSC, Canada	CanCM4I	CanAM4	CanOM4	СМС	ORAS5
	NCAR/Miami University, USA	COLA-RSMAS- CCSM4	CAM4	POP2	NCEP CFSR	NCEP CFSR
	NCEP, USA	CFSv2	GFS	GFDL MOM4	NCEP CFSR	NCEP CFSR
	GFDL, USA	SPEAR	AM 4.0	MOMv6	NCEP CFSR	GFDL ODA
	JMA, Japan	JMA/MRI-CPS2	JMA-GSM	MRI.COM v3	JRA-55	MOVE/MRI.COM G2
2			Werde Energy &	eurac research	alperia	* * * * * * * * *

1. North

Met Office

Optimisation of the skill using Grand-MME T2m JJA (lead 1) BSS (> upper tercile)

$$BS = \frac{1}{n} \sum_{i=1}^{n} (y_i - o_i)^2$$
 $BSS = 1 - \frac{BS}{BS_{rej}}$

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BSS [**ref** = climatology]



At each grid point all possible [2047] SPS combinations are evaluated (with equal weights) and then the one that maximizes probabilistic forecasts performance is selected.







0.0

Meteorology Council

0.05

0.1

0.15

0.2





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How many/which SPS T2m JJA (lead 1) BSS (> upper tercile)

Number of SPSs in best combination



range 1-5 (1.73% ≥ 5) mean = 2.52 median = 2.0 Optimal combination is never the full (11 SPS) Grand MME





ECMWF

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Do statistical models add value to dynamical models?

Test: From a suite of 12 dynamical and 3 statistical (linear and non-linear) models create every possible 5-model combination (~2000 combinations per gridpoint). Then select the model combination with the lowest RMSE (based on the 5-multi-model average) and count how many statistical model are in this 'best model combination'.





The colors indicate the nr. of statistical models present in the best possible 5-model combination per gridpoint.

Note: the results are very sensitive to the observational products used as reference, hence we used the average of multiple reanalysis and observational products as observational estimate.

Conclusion: There are a lot of regions where one or more statistical model are present in the best possible 5-model combination. Hence, in a multi-model seasonal forecasting framework there is added value for statistical models



Some results (from Case Study 1)



Case Study Flyers

Case study 1 Heat waves in southern Europe nd energy generation

Case study 2 ry winters in northern Italy nd energy generation

Boosting decision making

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Focus: Heat waves in southern Europe for energy generation and demand

osting decision making

 The main objective of this case study is to illustrate the benefits c products for the identification of extreme summer heat wave: power system. How can ENEL effectively manage the risks associated with ext

The seasonal forecasting context

This case study focuses on seasonal forecasts of surface temper extreme summer weather such as occurred in Italy in July 2015.

The main objective of this case study is to illustrate the benefits products to identify winter conditions in the Alps and Apennines Sectoral challenges and opportunities How can ENEL and Alperia effectively manage the risks associate · Electricity price dynamics associated with air conditioning demar

The seasonal forecasting context Power price management and hedging of generation portfolio - v

This case study focuses on seasonal forecasts of precipitation a forecasts of precipitation and snow pack will be used to forecast of potential energy stored by snow and ice. How are market and asset portfolio decisions affected by the (un)a plant cooling? modating enhanced demand model uncertainty due to ext Sectoral challenges and opportunities



Optimising efficiency in hydronower production management (A

Power price management and hedging of generation portfolio -

· Prediction of gas price movements in a context of low hydroelec





Focus: A mild, dry winter 2015/16 due pressure system over the Mediterrane France - the impacts on energy genera

> Focus: During the first days of March 201 variability in the wind regime over Italy synoptic systems over the Mediterran implications for supply-demand balance

Boosting decision making The main objective of this case study is to illustrate the benefits of o products to identify variability in the wind regime that impacts on th

· How can ENEL effectively manage the risks associated with extre Boosting decision making The seasonal forecasting context

 The main objective of this case study is to illustrate the benefits of products to predict energy production in markets with high penet This case study focuses on seasonal forecasts of strong wind ever A challenge is the time sampling of such events that is usually shor for temporal downscaling of seasonal forecasts will be investigate



Sectoral challenges and opportunities Managing variable wind power production in a multi-asset system to To know in advance the expected energy production from renewat the generation with conventional plants

ase study 4

rgy generation

gh/low winds in Spain and

Focus: Sustained high and low wind a

energy generation in high penetration m













Focus: Strong El Niños in a South Ameri mix planning

Boosting decision making

 The main objective of this case study is to illustrate the benefits o
products to predict the expected amount of flow of the hydro resc As a complementary study, the case study will estimate how an o technologies can be achieved in Colombia. This could help to or such as strong El Niños when relying on a single energy source.

The seasonal forecasting context

 This case study focuses on demonstrating the impact of using se big utilities with a large proportion of hydro power in their portfolio Sectoral challenges and opportunities

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 To plan the future hydro resources during El Niño-La Niña events · To buy fossil fuels options in advance at lower prices to compen

To design a future energy mix adapted to the local climate variable



for maintenance

SECI

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Boosting decision making Focus: North Sea wind and wa

 The main objective of this case study is to illustrate the application of k han that typically used by the offshore oil and gas industry) to identify ind spring months, facilitating earlier decision-making and reduced

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Focus: Wind and wave conditions during s

months in the North Sea and energy logisti

The seasonal forecasting context Boosting decision making · The main objective of this case study is to illustrate the applic

onal forecast evaluation will consider the skill of predicting calm w tember to November) and spring (March to May) months in the N he use of vessels for offshore maintenance or supply opera This will be illustrated from the point of view of the Asset Manager or M The inter-seasonal to seasonal forecasting operations such as those involving drilling, large infrastructure installa

 Optimising the scheduling of vessel hire and personnel mana operations and maintenance planning. When should the vessel hire take place, and for what period specific offshore operation that is scheduled within the sum



Focus: The use of seasonal forecasts

This case study focuses on demonstrating the impact of using seaso circulation forecast information for the United Kingdom (UK) Natio

Sectoral challenges and opportunities

The climate forecasts will be translated into energy information, to

The grid network has a central role to play in the future energy mis

National Grid is working to meet ambitious low carbon energy targ the people who use them, and find innovative ways to enable the

Ahead of each winter, the UK grid operator must estimate the dem particular focus on peak electricity demand. This is to ensure there

Grid Operator

lemand and wind now

to meet this demand.



Focus: The use of seasonal forecasts for water management to identify periods of stress to the supply-demand balance

Boosting decision making

The water industry case studies will explore the application of seasonal forecasting to identify period The water industry case sources will explore the application of seasonal indecasing to identify periods of stress to the UK supply-demand balance. These seasonal signatures may highlight chronic or acute periods of stress many weeks out, which will affect the operational management of the water system and the experience of the consumer through supply restrictions.

The seasonal forecasting context

Boosting decision making The main objective of this case study is to illustrate the benefits of the better predict the UK winter mean electricity demand and wind potenticity demand and wind potenticity demand and wind potential.

 This case study will explore the ability to identify periods of chronic stress (prolonged excessively high demand driven by either leakage or consumption). Climatologically, these will include conditions inclaids of dry and hot summers, or drought conditions, were periods and below average wither temperatures. If such conditions were predictable at seasonal limescale, it would help to flig high demand and support perparencies in terms of capacity and demand management. The seasonal forecasting context

This case study will also explore the ability to identify acute stress (highly variable demand) including heat waves or extremely cold and/or freeze-thaw conditions. If such conditions were predictable at medium/seasonal timescale, it would help flag high variability in demand and support preparedness in terms of resilience.

Sectoral challenges and opportunities

The United Kingdom (UK) water supply market operates within the private sector comprising of a number of autonomous water companies. The sector is overseen by the Office of Water Regulation (OPWAT) which focuses or consumer regulation. The Environment Regulation Commental regulation The water businesses constantly balance supply of raw water with demand. Both supply and demand have a significant dependency on the water.

By timely identification of potential risks, we will explore whether it is possible to secure customer supp and optimise operational costs.

SECL · By identifying potential risks to the system ahead of the winter, w FIRM reduce balancing costs over the winter period







http://www.secli-firm.eu/case-studies/





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Climate Services Delivery

The exact way climate services are delivered is not critical. However, it seems users appreciate an easy to use and pleasing to the eye climate service



https://tealtool.earth



The Teal Climate Service



ECMWF



Co-developed by



https://www.inclimateservice.com

Based on award winning C3S Edu Demo http://c3s-edu.wemcouncil.org/

opernicus

European







North American Multi-Model

Teal West-Central Africa (WCA)



EU H2020 FOCUS-Africa (2020-2024)

Full-value chain Optimised Climate User-centric Services for Southern Africa

FOCUS-AFRICA



WEMC

World Energy &

Meteorology Council

Teal FA Demo – Historical indicators



Teal FA Demo – Seasonal Forecast Mock up





The Teal: https://tealtool.earth (Free version)

More info at: <u>https://www.wemcouncil.</u> <u>org/wp/teal</u>



Climate Change C3S Operational Energy Service



Supporting C3S Core Users: European Network of Transmission System Operators ENTSO-E to build the Pan European Database (PECD) v4

> Different levels of data aggregation for the PECD

A multi-variable, multi-timescale view of the climate and energy systems





CECMWF

opernicus



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