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Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

A CLIMATE SERVICE FOR THE WIND POWER INDUSTRY WITHIN CLIM4ENERGY PROJECT

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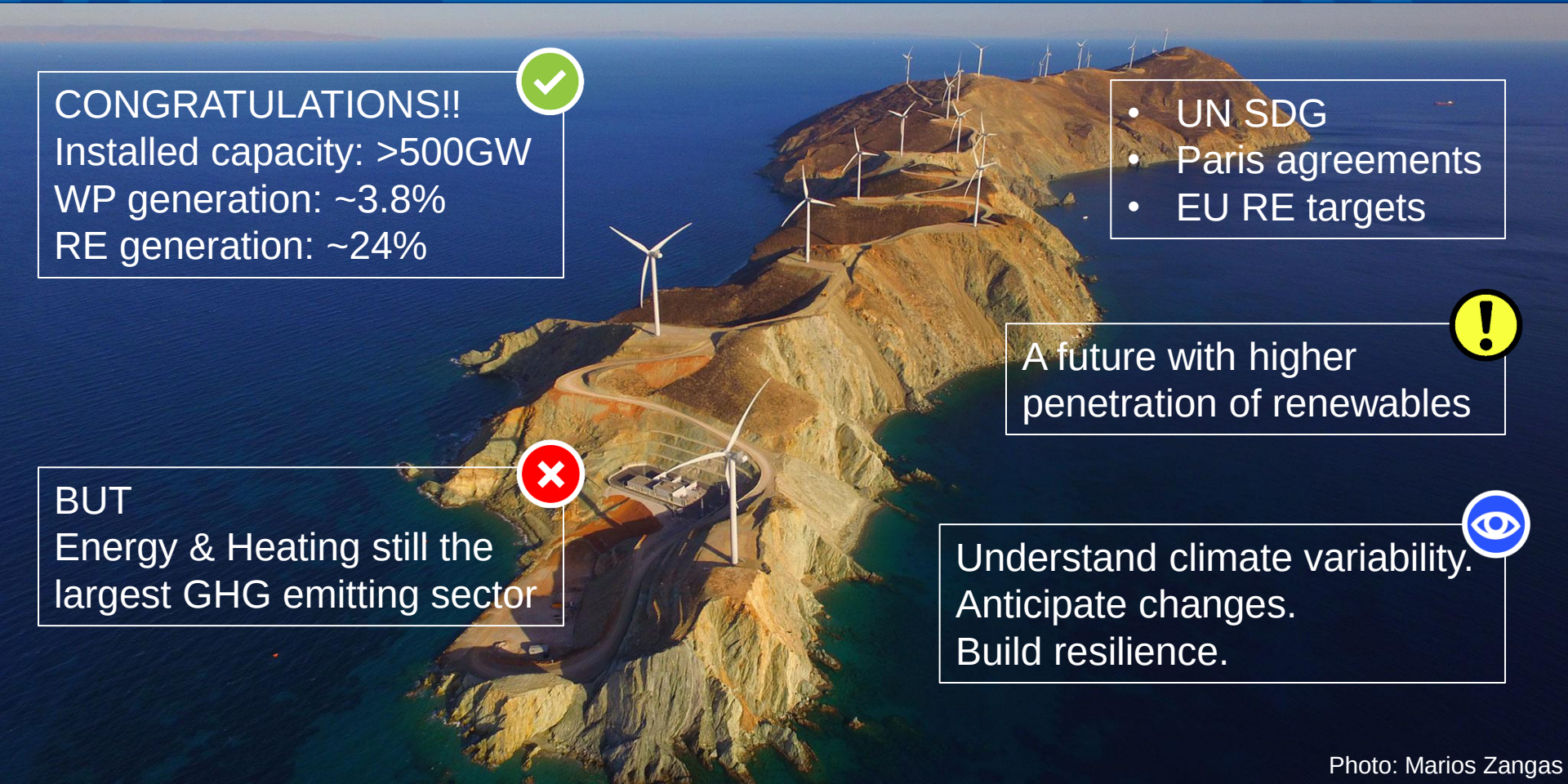
ICEM 2017
4th International Conference on Energy & Meteorology

Wind Power growth



CONGRATULATIONS!!
Installed capacity: >500GW
WP generation: ~3.8%
RE generation: ~24%

- UN SDG
- Paris agreements
- EU RE targets

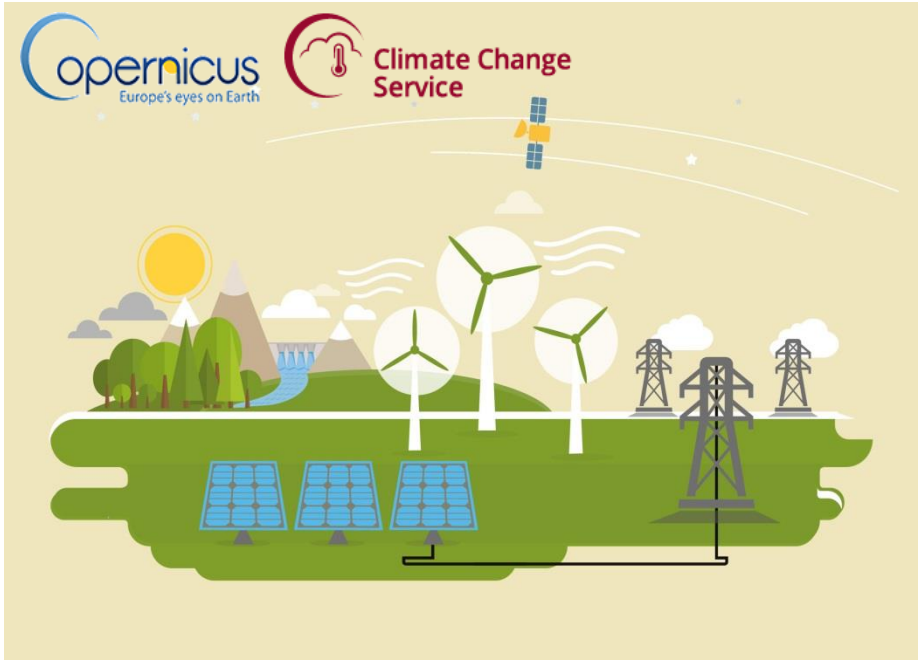
A future with higher penetration of renewables

BUT
Energy & Heating still the largest GHG emitting sector

Understand climate variability.
Anticipate changes.
Build resilience.

Photo: Marios Zangas

COPERNICUS Program



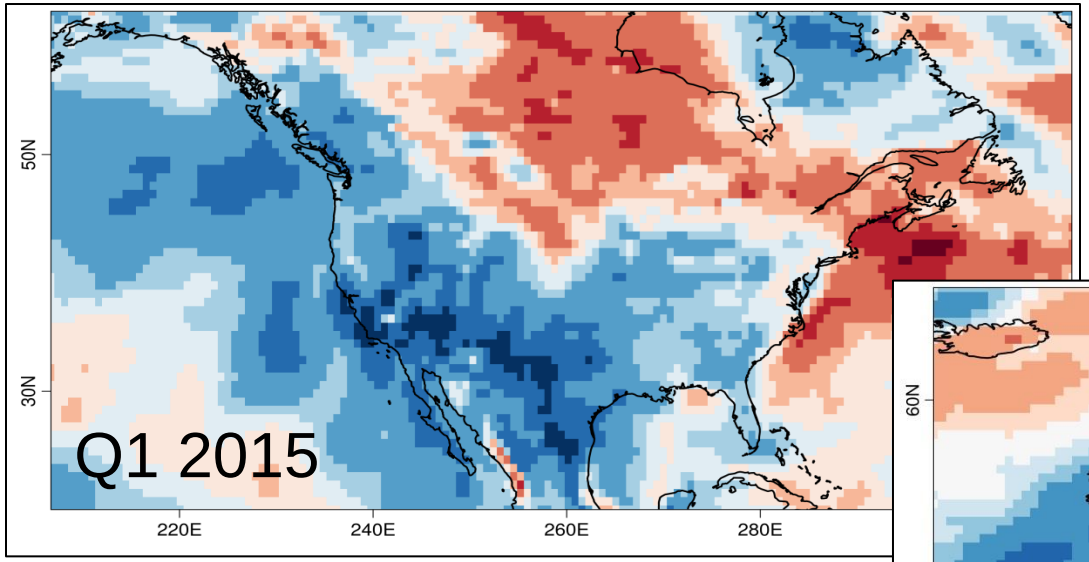
Providing a wealth of free climate data

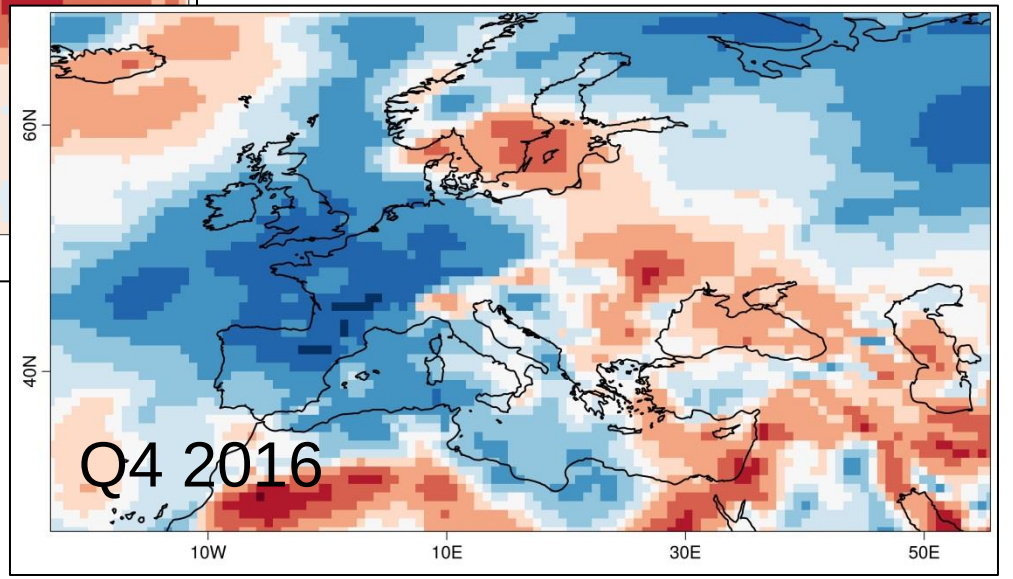
CLIM4ENERGY
Tailoring climate services
for the energy industry

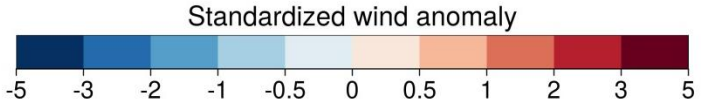
Seasonal forecast service
for wind power

clim4energy.climate.copernicus.eu

Wind droughts

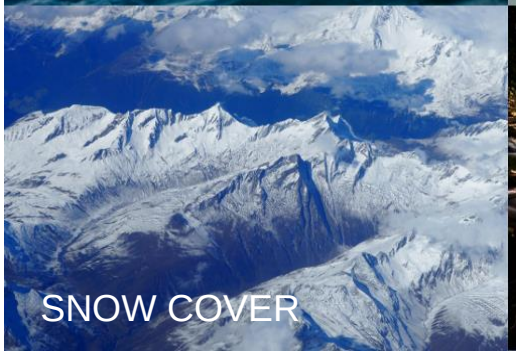


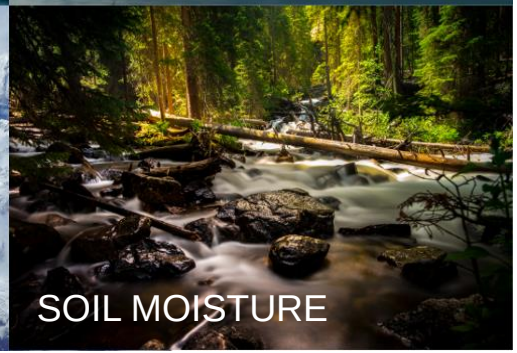




source: ERA-Interim
ref. period: 1985-2014

Can we anticipate anomalies?

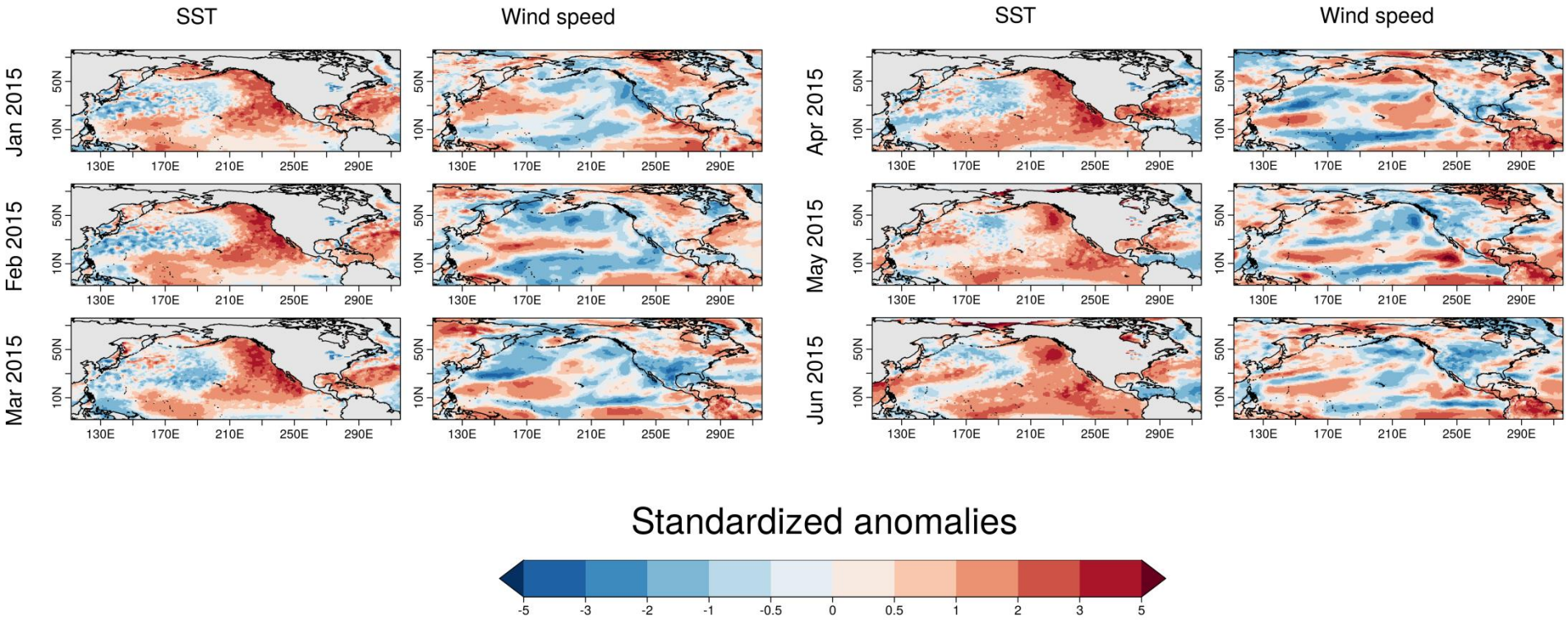




Coupled Ocean-Atmosphere Ensemble Prediction Systems

- ECMWF System4
- MeteoFrance System5
- UKMO GloSea5
- NCEP CFSv2

SST influencing Wind Speed



source: ERA-Interim
ref. period: 1981-2010

Probabilistic forecasts

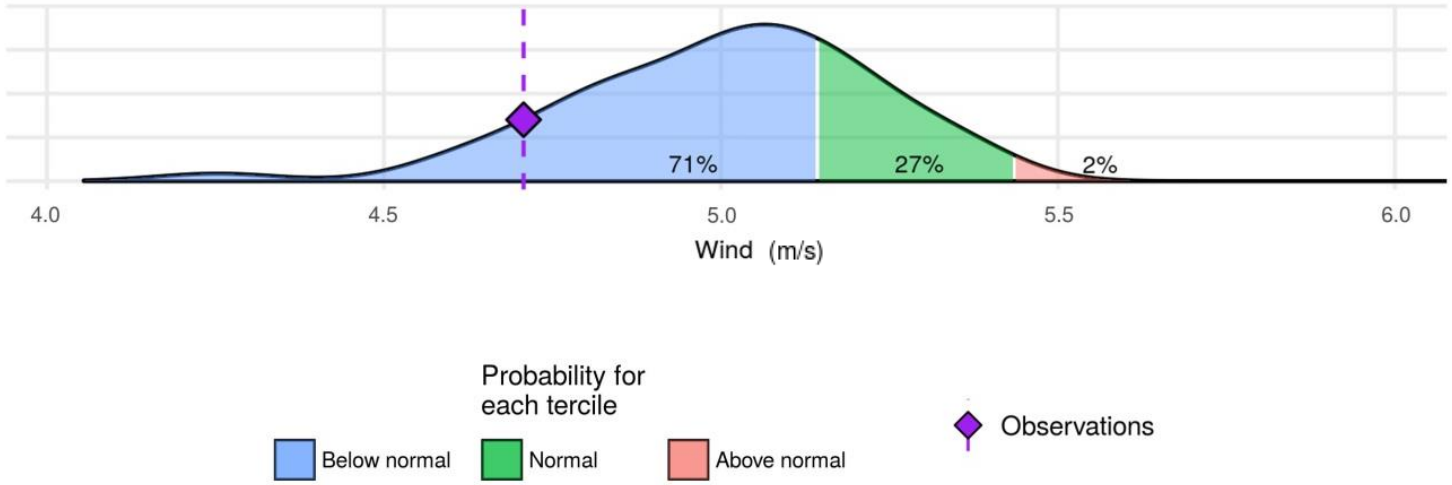
QUESTION

Will the coming season be:

- less windy than normal?
- normal?
- more windy than normal?

ANSWER

- Bias adjust model output
- Average whole season
- Distribute the ensemble members into 3 categories
- Compute probability

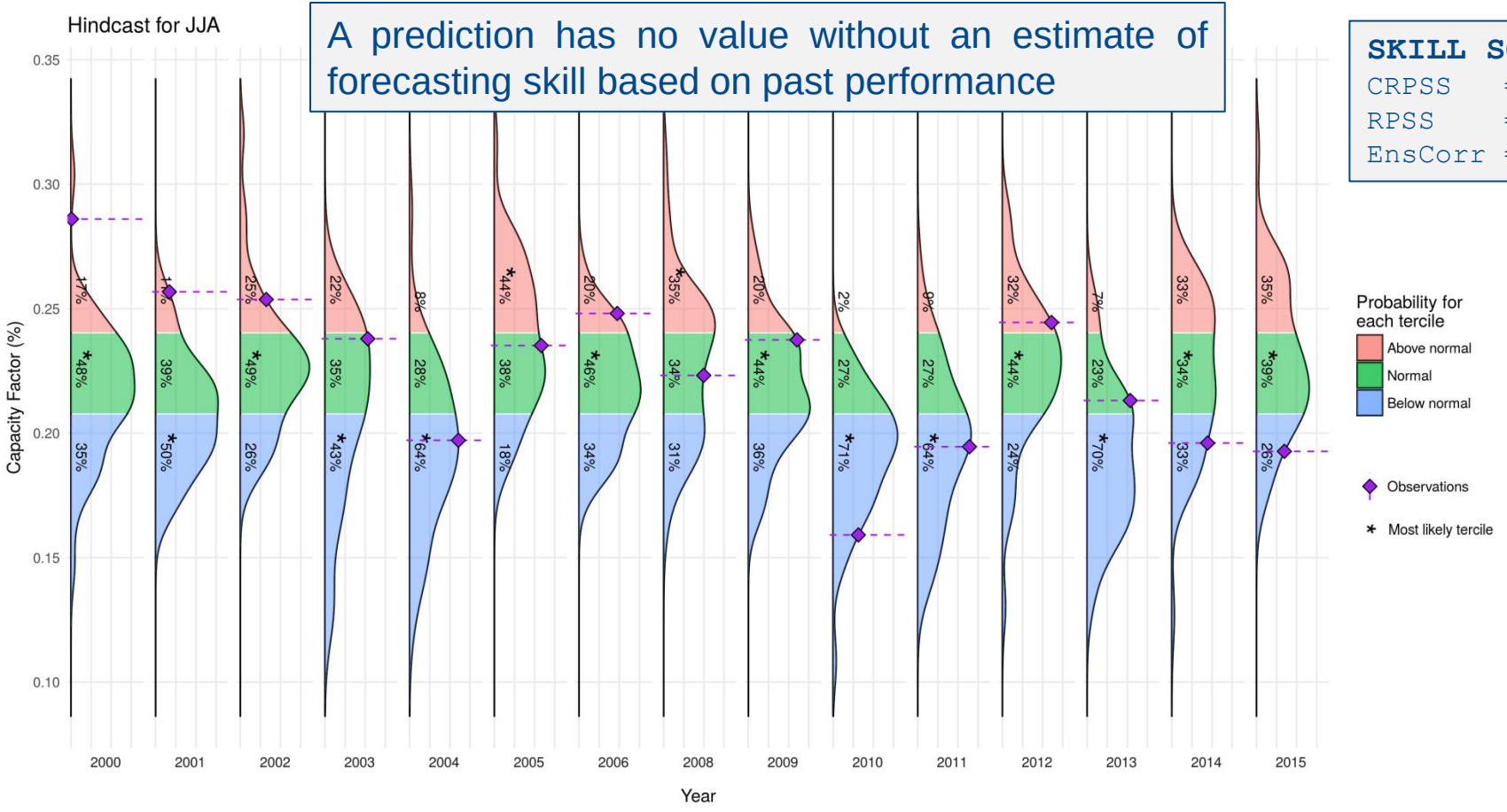


Forecast quality

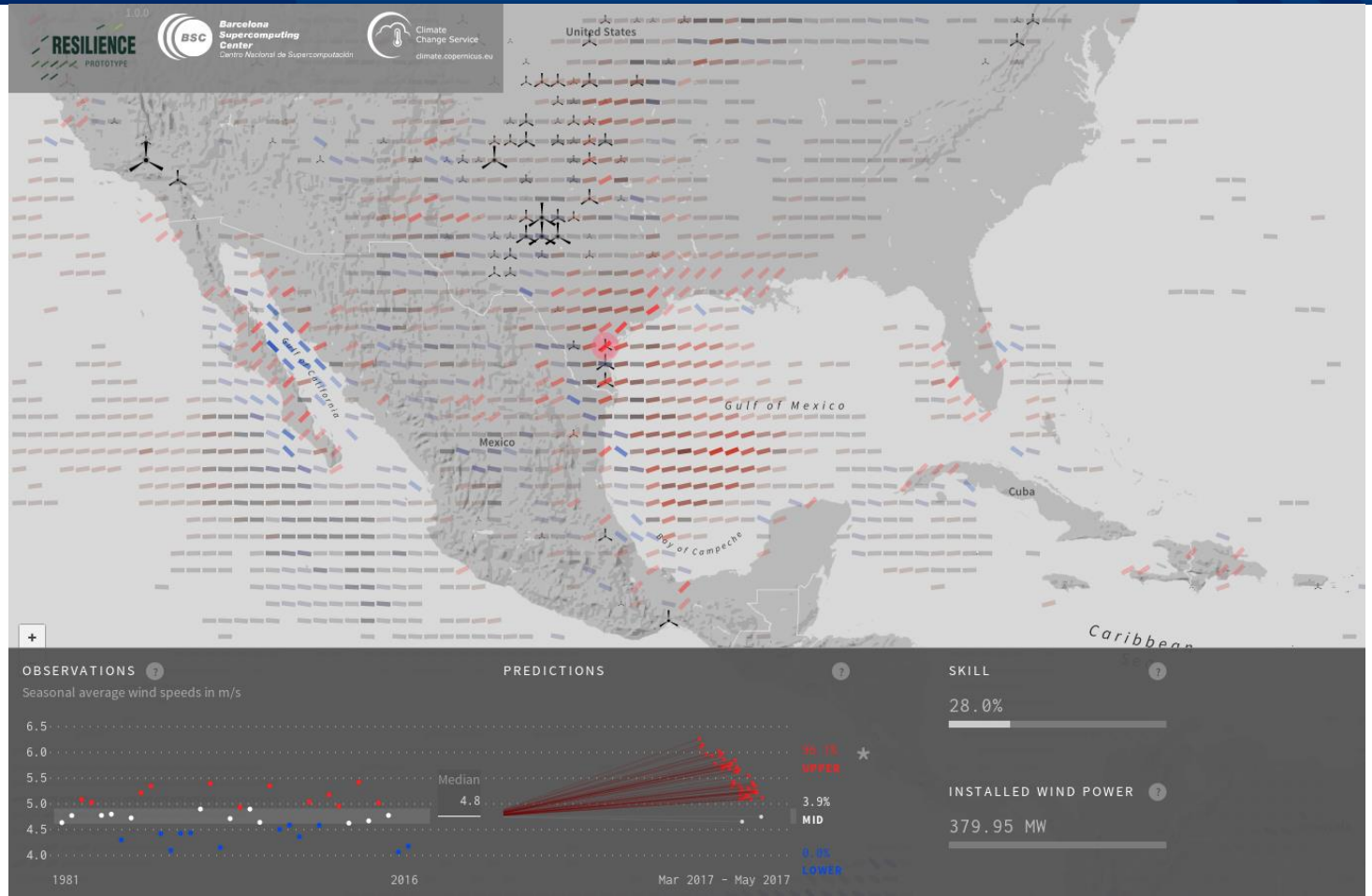
A prediction has no value without an estimate of forecasting skill based on past performance

SKILL SCORES

CRPSS = -0.01
RPSS = 0.08
EnsCorr = 0.44



RESILIENCE visualization

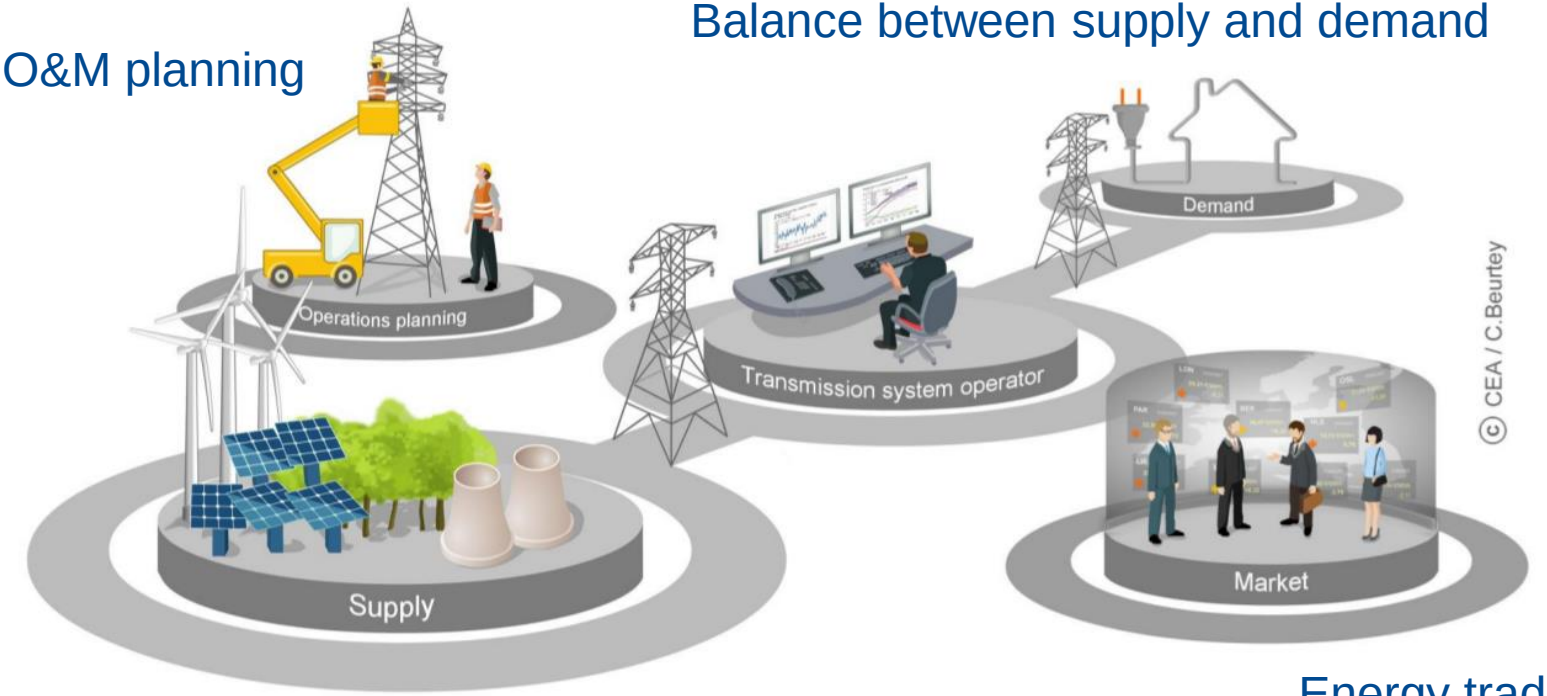


www.bsc.es/projects/earthscience/resilience/

Applications

O&M planning

Balance between supply and demand



Cash flow anticipation

Energy trading

Capacity factor indicator

Capacity Factor of an installed wind farm is a normalized energy generation indicator that explains how good the meteorological conditions have been for producing energy during a specific period.

$$CF\ (\%) = \frac{Actual\ generation}{Installed\ capacity * hours}$$

Independent of: 👍

- number of installed turbines
- nameplate capacity of installed turbines

Depends on other turbine specifications: 👎

- cut-in speed
- rated speed
- cut-out speed

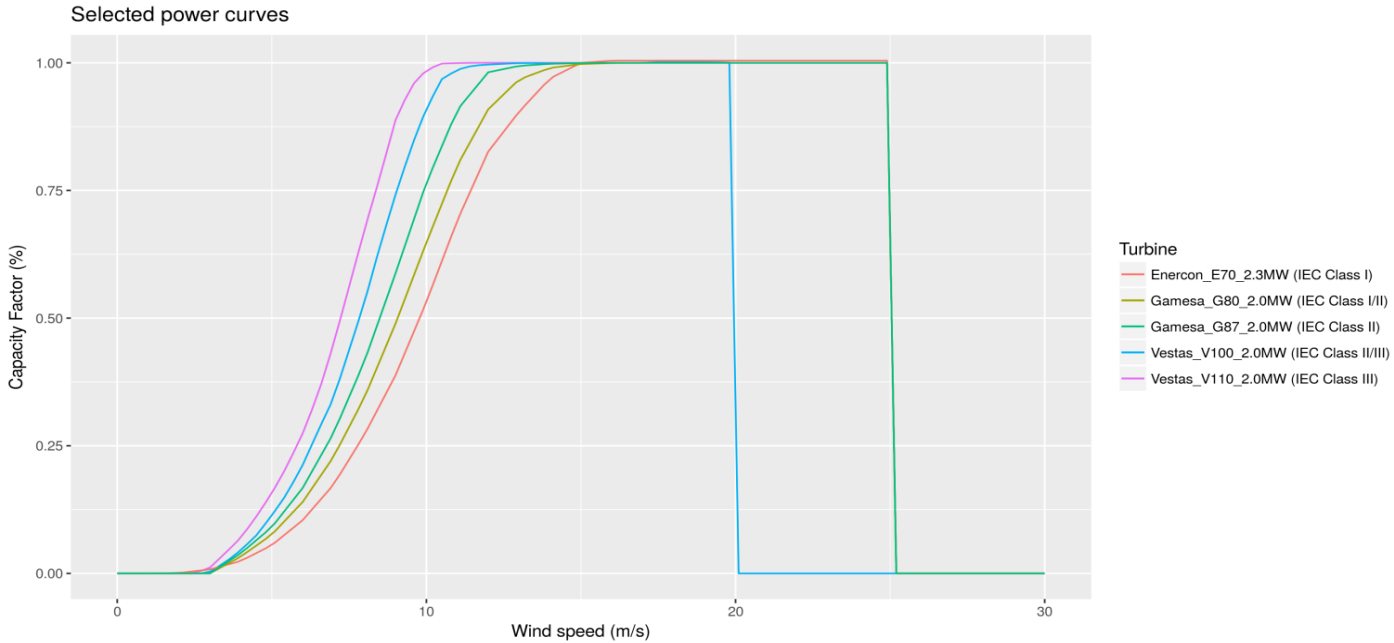
Impossible to compute a Capacity Factor that is valid for all windfarms

Turbine Classification

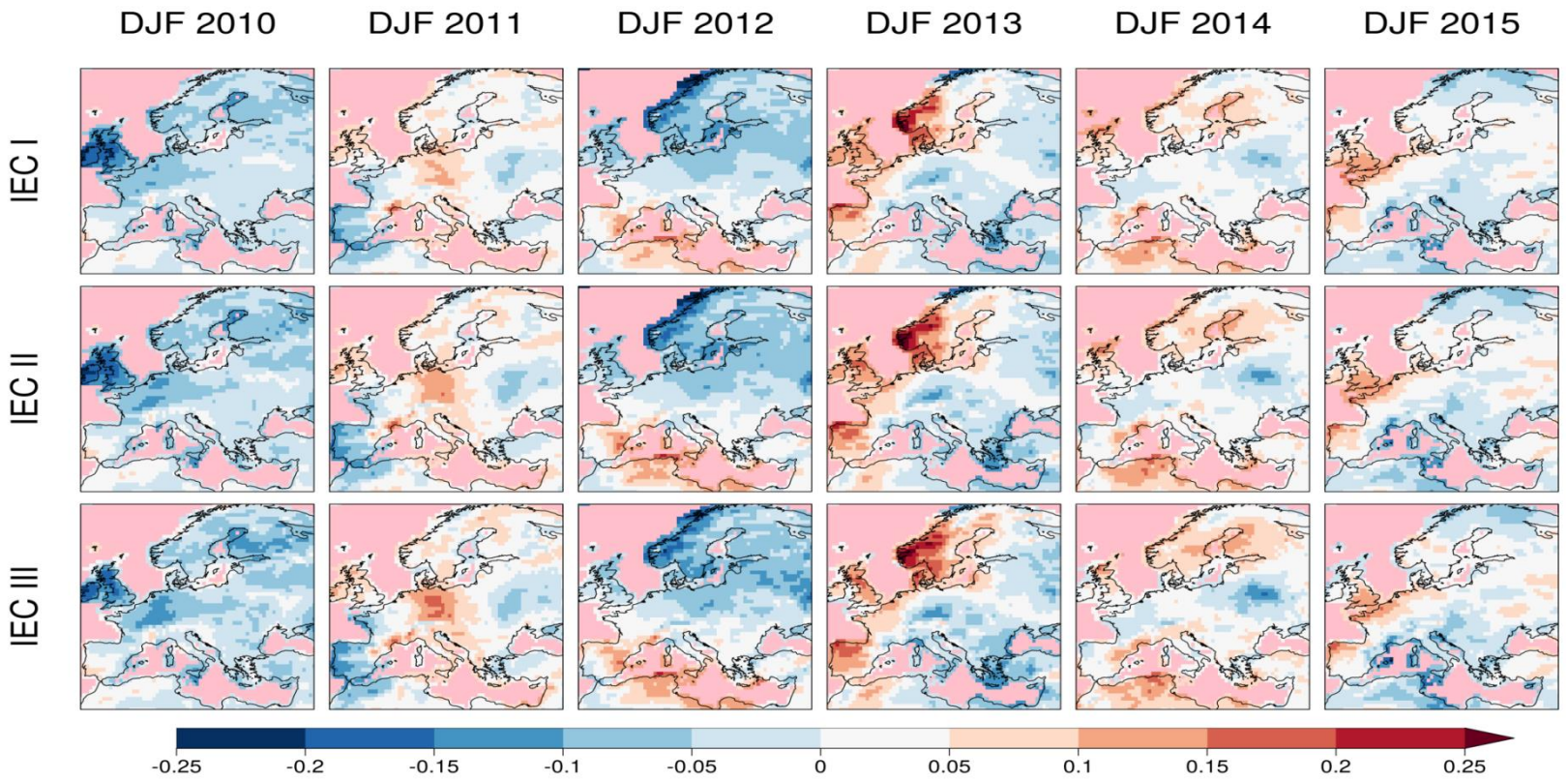
The IEC-61400-1 standard defines 3 classes of turbines.

We select one turbine model to represent each class.

	Mean wspd	Max 10' wspd	Structural loads	Rotor size	Hub height	Materials
IEC I	10 m/s	50 m/s	high	small	low	stronger
IEC II	8.5 m/s	42.5 m/s	med	med	med	
IEC III	7.5 m/s	37.5 m/s	low	big	high	weaker

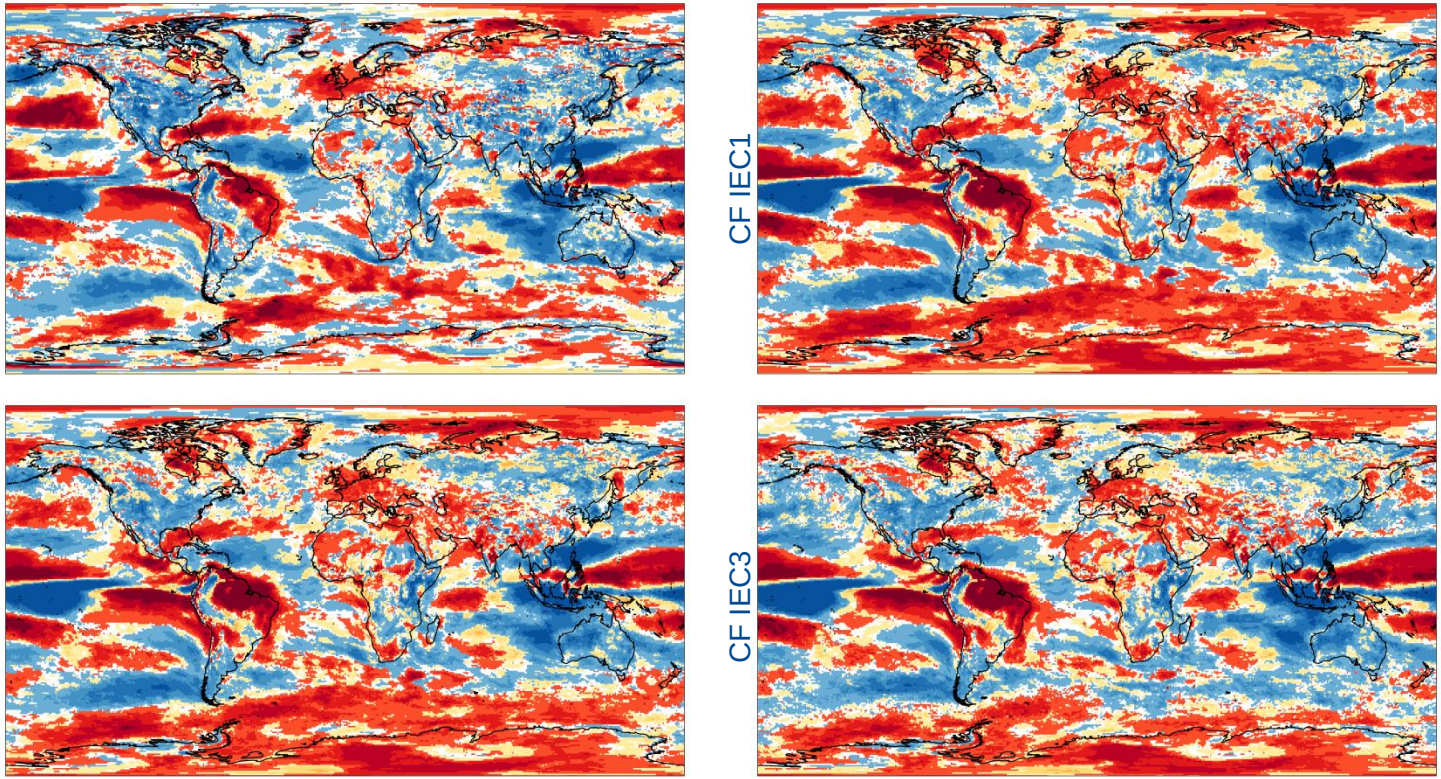


Capacity factor anomalies



Observed anomalies (ERA-Interim)

Capacity Factor forecasts



Most likely tercile
DJF 2015/16
ECMWF System4

[probability>40%]

NON-LINEAR effects

Conclusions

- Essential to understand climate variations
- Dynamical models can anticipate extreme events
- Tailored service helpful for several applications
- Assessing forecast quality is crucial before making decisions

Open questions

- Which decisions would you take in view of those forecasts?

More information

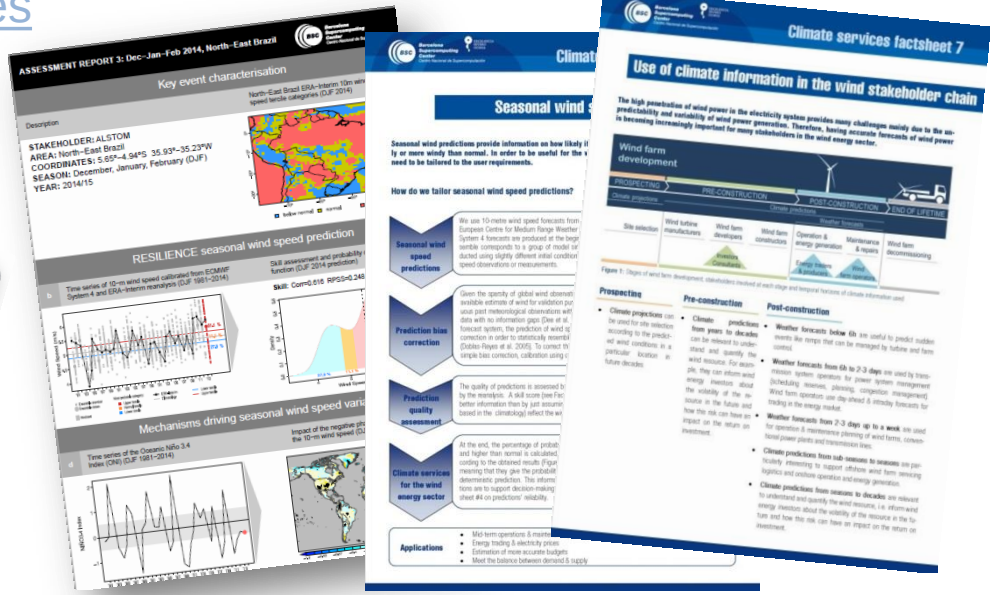
CLIM4ENERGY website

http://clim4energy.climate.copernicus.eu/

ARECS User Interface Platform:

http://www.bsc.es/ESS/arecs/resources

- Bulletins
- Factsheets
- Case studies
- Weather Roulette APP



Thank you!

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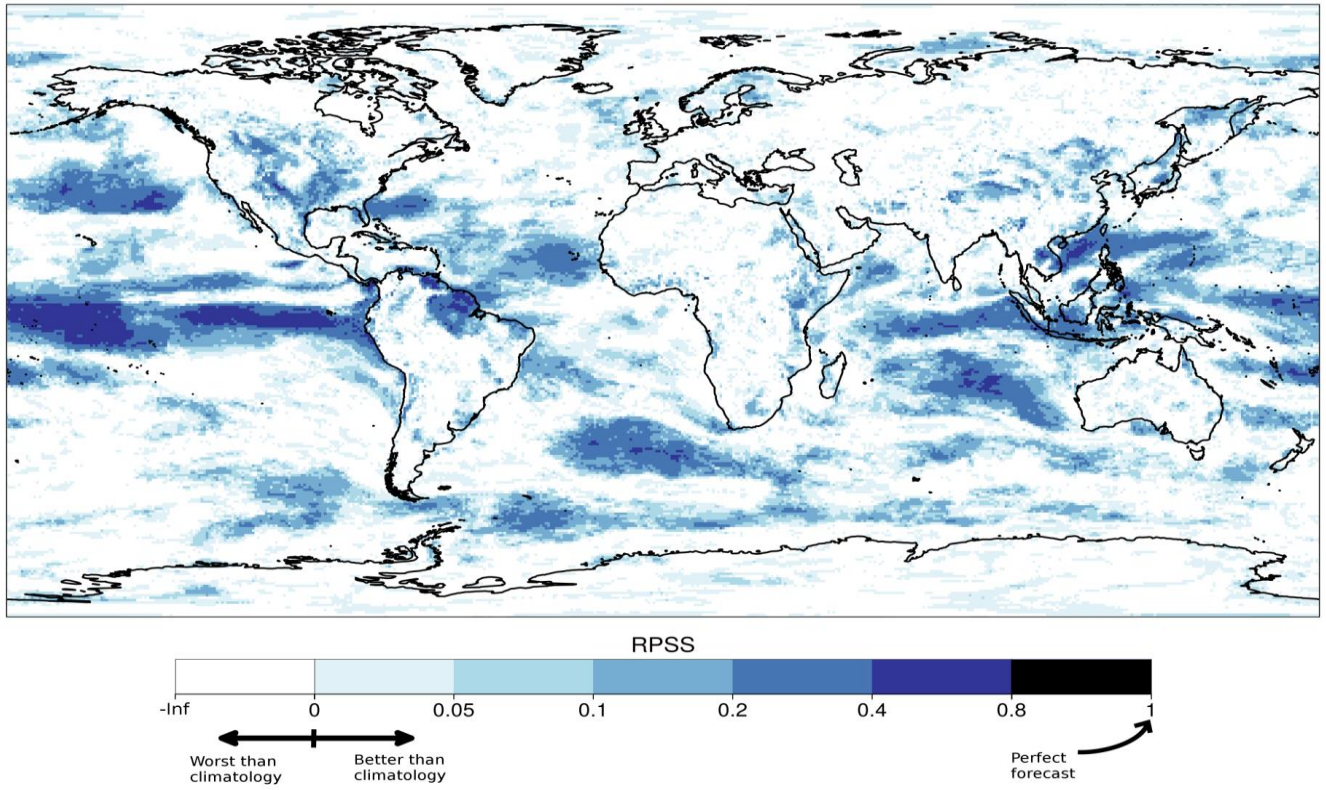
Photo: Marios Zangas

Skill assessment



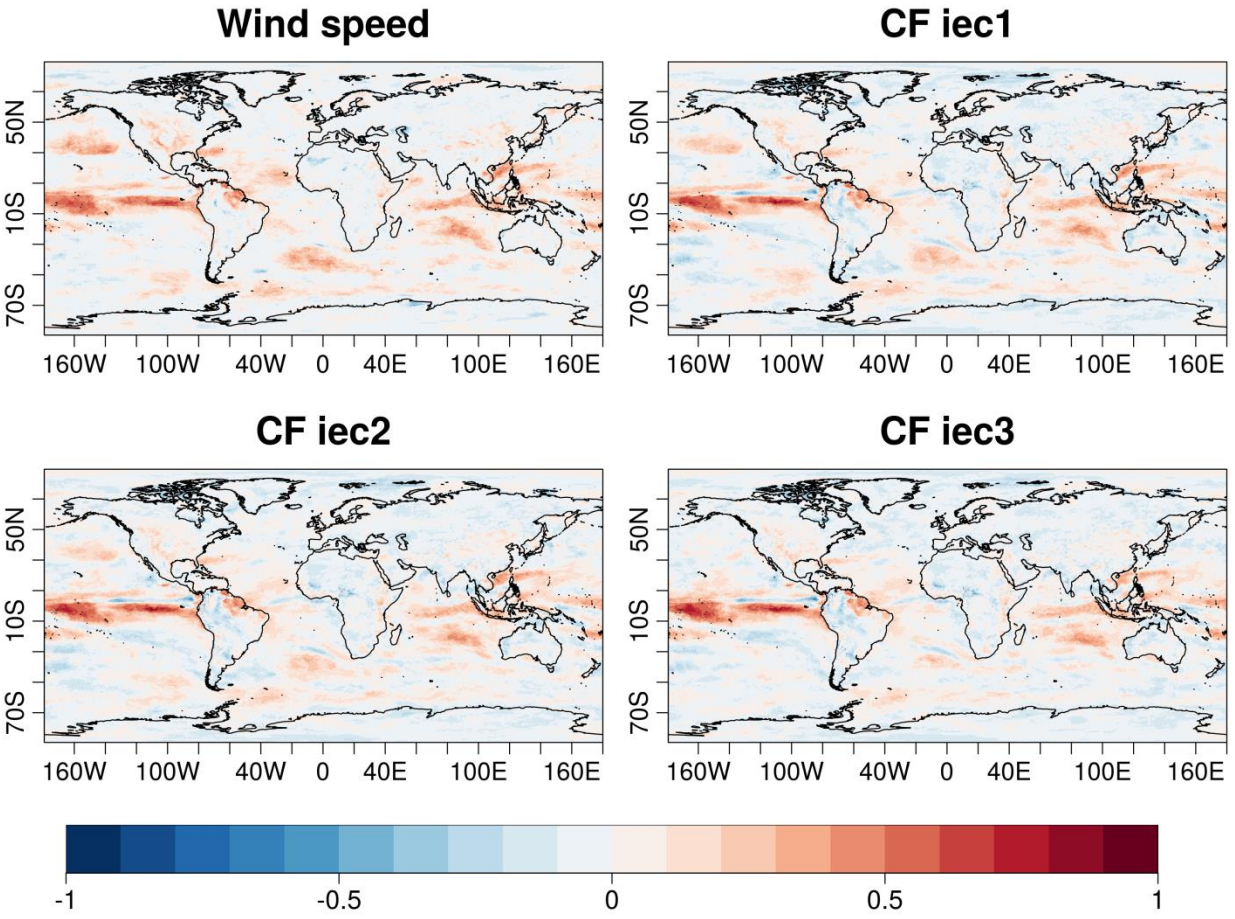
Skill assessment for DJF (1981-2013)

Displaying: Ranked Probability Skill Score [RPSS]

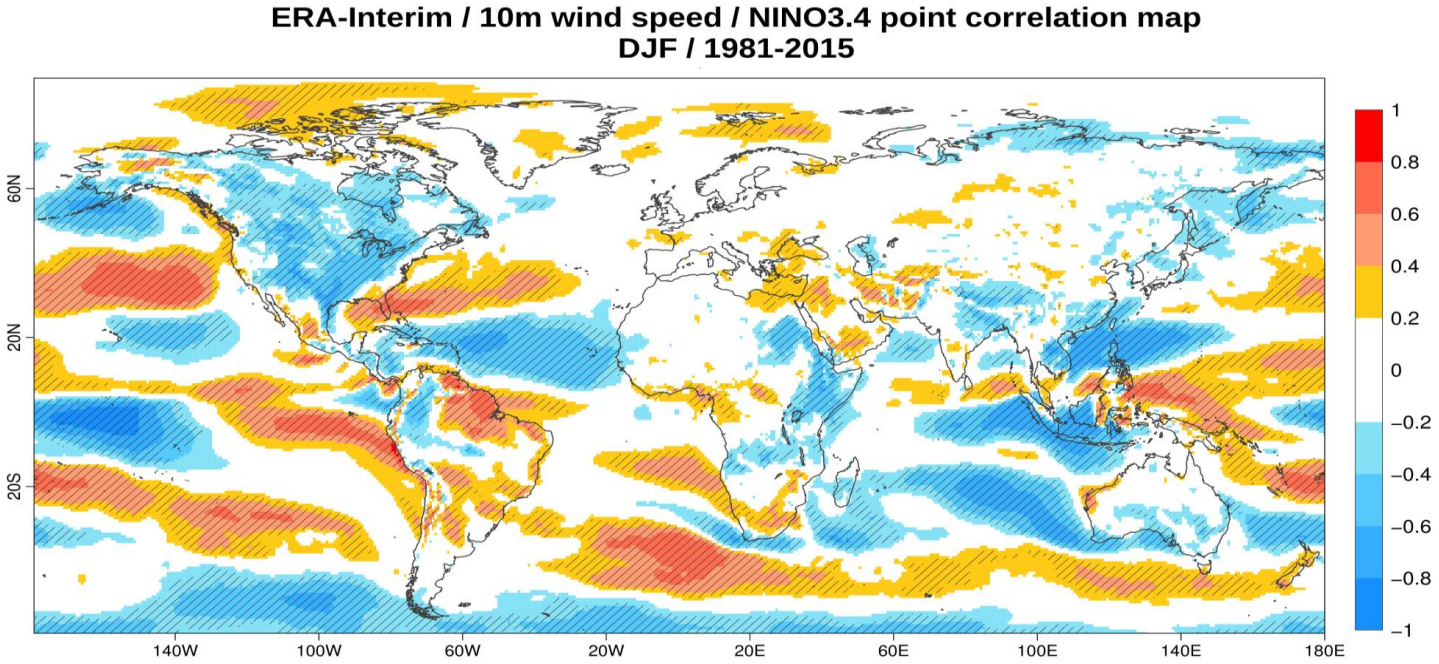
Skill assessment

Skill assessment for DJF (1981-2015)

Displaying: Ranked Probability Skill Score [RPSS]

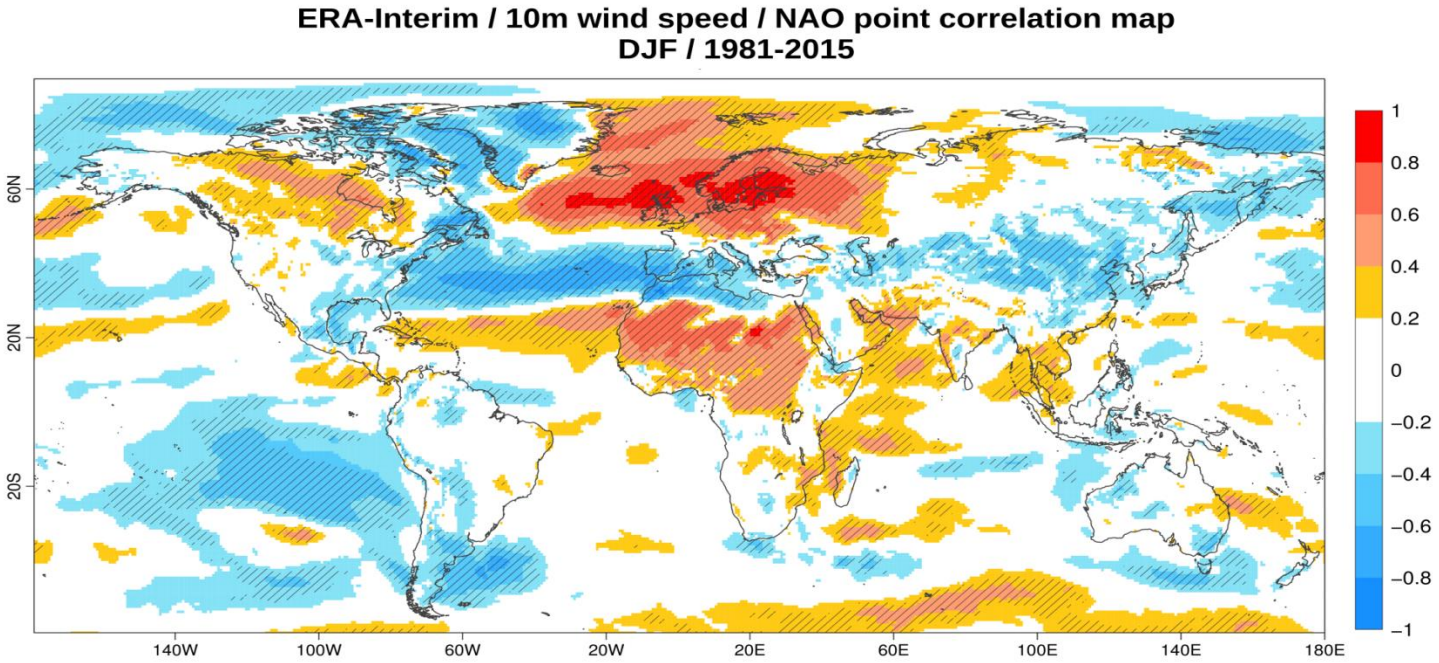


Impact of ENSO on wind



Bias correction: none
Hatched area: siginficant at 95% confidence level from a two tailed Student's t-test

Impact of NAO on wind



Bias correction: none
Hatched area: siginficant at 95% confidence level from a two tailed Student's t-test