

# Climate services for clean energy

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# Context and motivation

- ▶ Renewable energy is growing fast to decarbonize the energy system.
- ▶ Both energy supply and demand are strongly influenced by atmospheric conditions and its evolution over time in terms of climate variability and climate change.

Like 15M

Thursday, Aug 30th 2018 1PM 25°C 4PM 26°C 5-Day Forecast

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### ADVERTISEMENT

## Britain's turbines are producing 40% less energy as wind 'disappears' for six weeks across the UK causing record low electricity production

- Britain got 15 per cent of its power from wind last year — twice as much as coal
- Since the start of June, wind farms have been producing almost no electricity
- The 'wind drought' has seen July 2018 be 40% less productive than July 2017
- In the still weather, solar energy has increased by 10% to help cover the drop-off



By [JOE PINKSTONE FOR MAILONLINE](#)

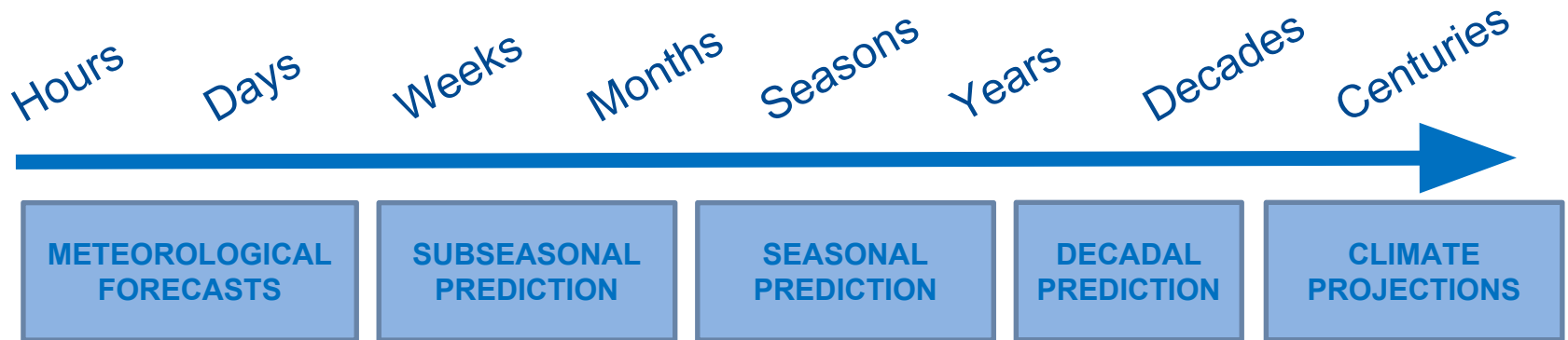
PUBLISHED: 15:48 BST, 18 July 2018 | UPDATED: 17:29 BST, 18 July 2018

# Context and motivation

- ▶ The energy sector routinely uses weather forecast up to several days.
- ▶ But beyond this time horizon, past climatological records are used to estimate risks.

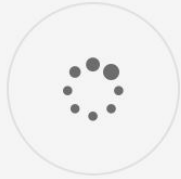


Met mast on Gwynt y Môr offshore wind farm  
(source: solar wheel)



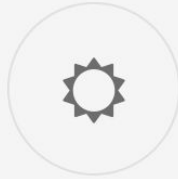
# S2S4E objective

# Objective



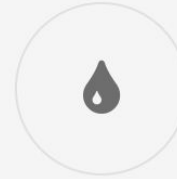
## WIND POWER

Wind speed and capacity  
factor predictions



## SOLAR POWER

Solar radiation and capacity  
factor predictions



## HYDROPOWER

Prediction and changes in  
inflow predictions



## ENERGY DEMAND

Temperature and consumption  
rates predictions

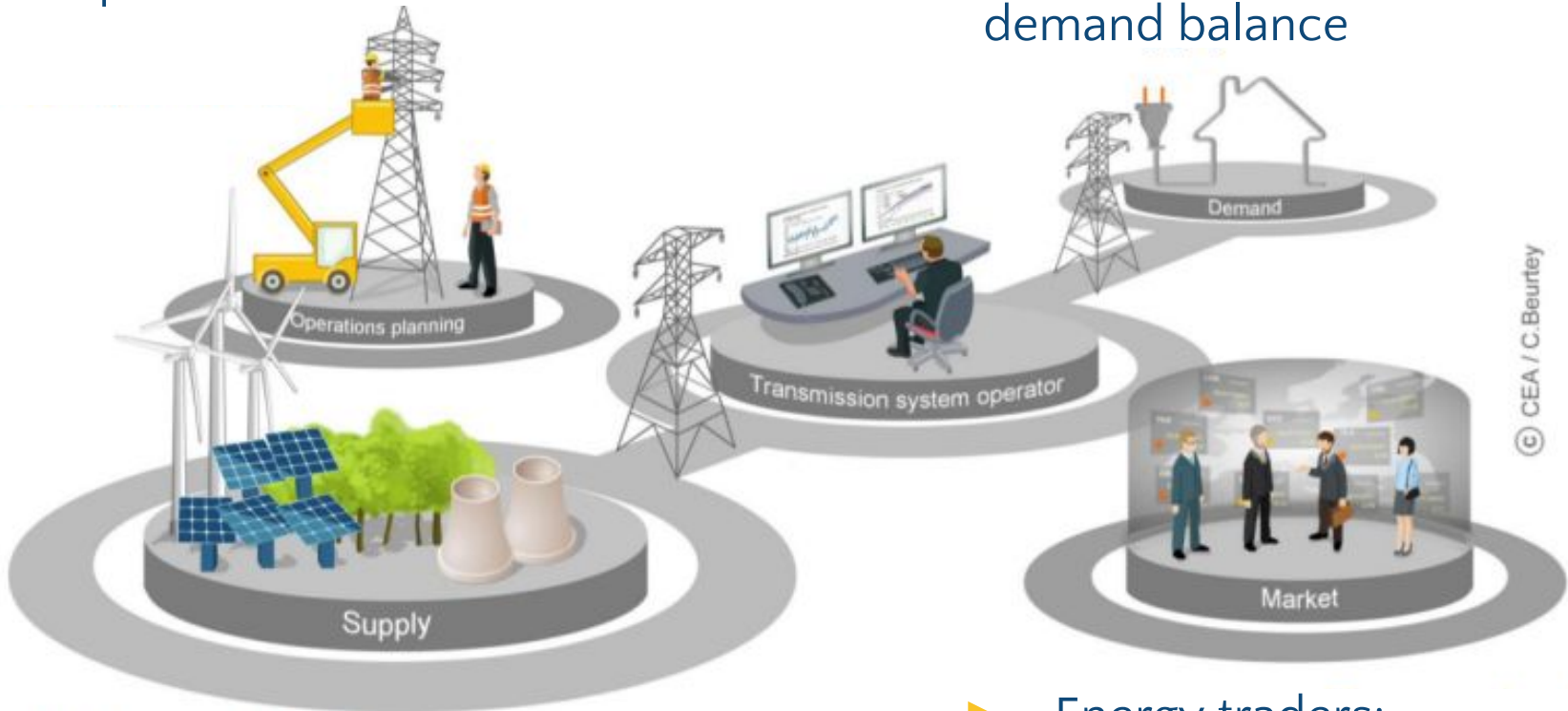
Offer an innovative service that improves RE variability management by:

- ▶ developing new research methods and exploring the frontiers of atmospheric predictions for the upcoming weeks and months.
- ▶ co-designing a Decision Support Tool (DST) that for the first time integrates sub-seasonal to seasonal (S2S) climate predictions to inform RE generation and electricity demand.

# Applications

- ▶ O&M teams:  
plan maintenance tasks

- ▶ TSO:  
guarantee supply and demand balance



- ▶ Plant owners:  
anticipate revenues and cash flow

- ▶ Energy traders:  
forecast electricity prices

# Challenges and opportunities

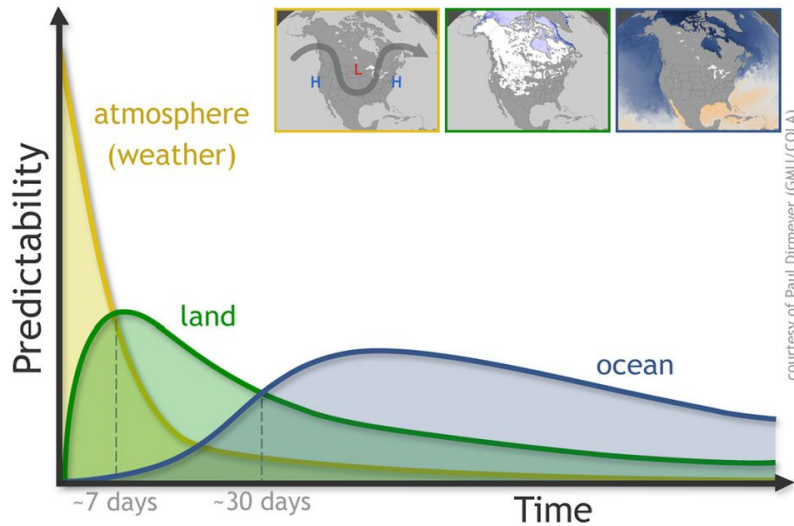
# Components of the Earth System





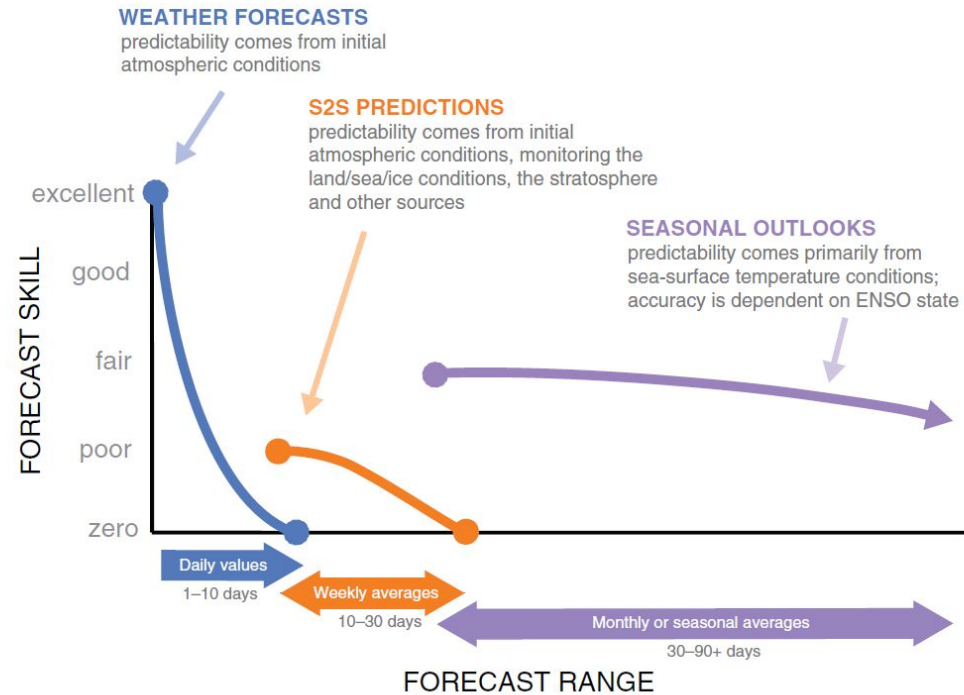
# S2S Forecast ranges and skill

## ► Predictability sources:



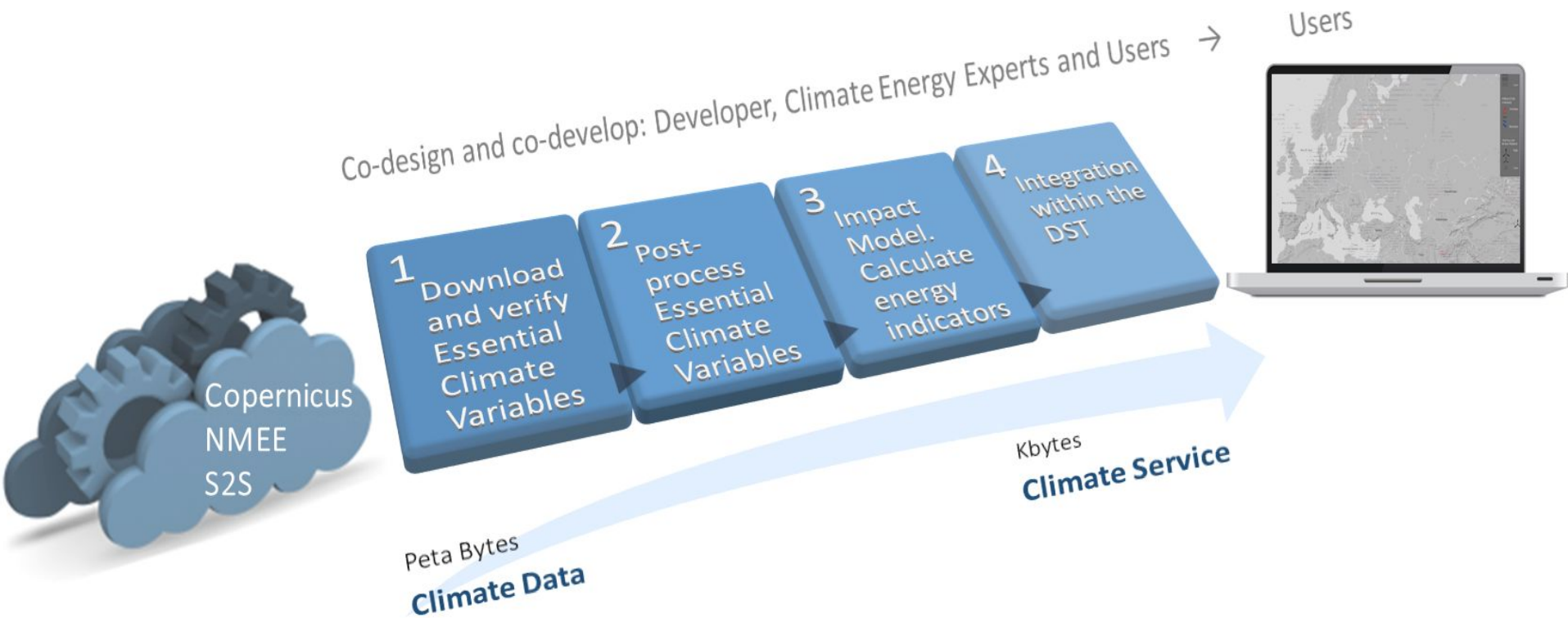
(Source: Mariotti et al. 2018 )

## ► Skill estimates:



(Source: White et al., 2017 )

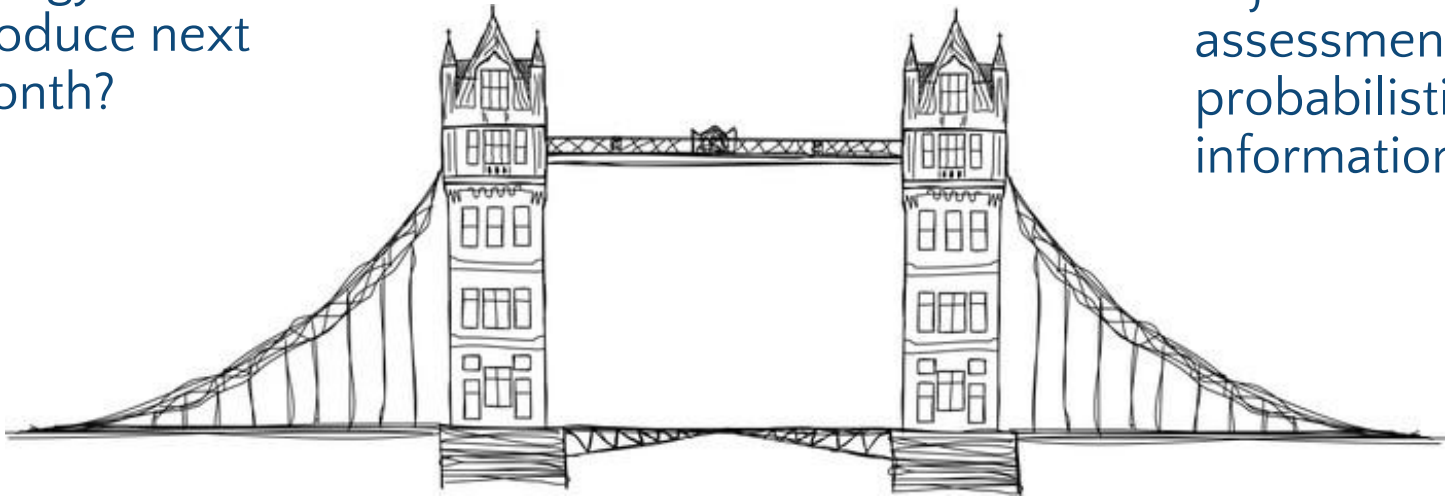
# From data to information and to service



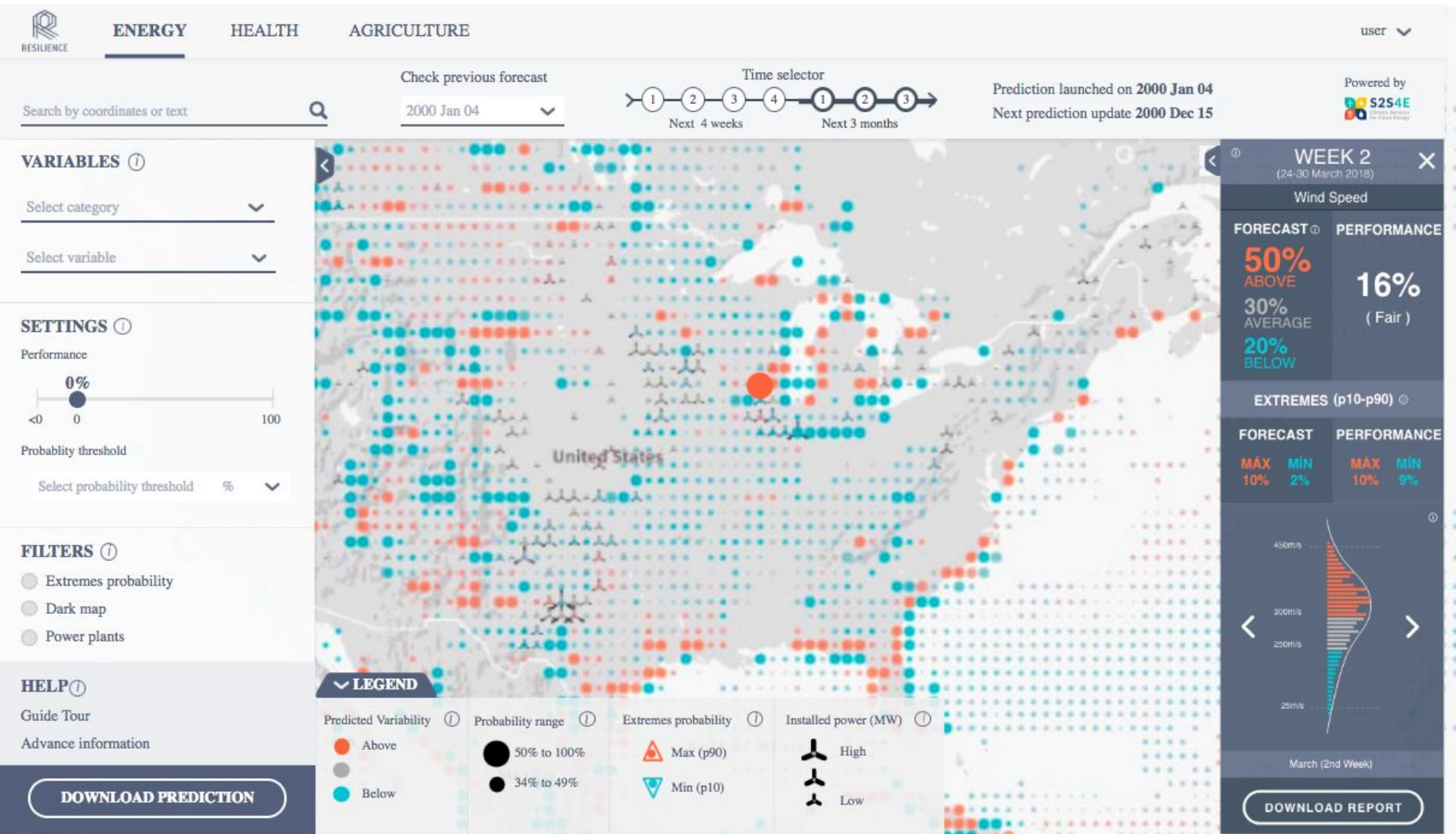
# Climate services

▶ **User:** How much energy will I produce next month?

▶ **Scientist:** Bias adjustment, skill assessment, probabilistic information, etc.



# Decision Support Tool



<http://www.bsc.es/ess/resilience/map.htm>

# Methodology and first results

# First year results

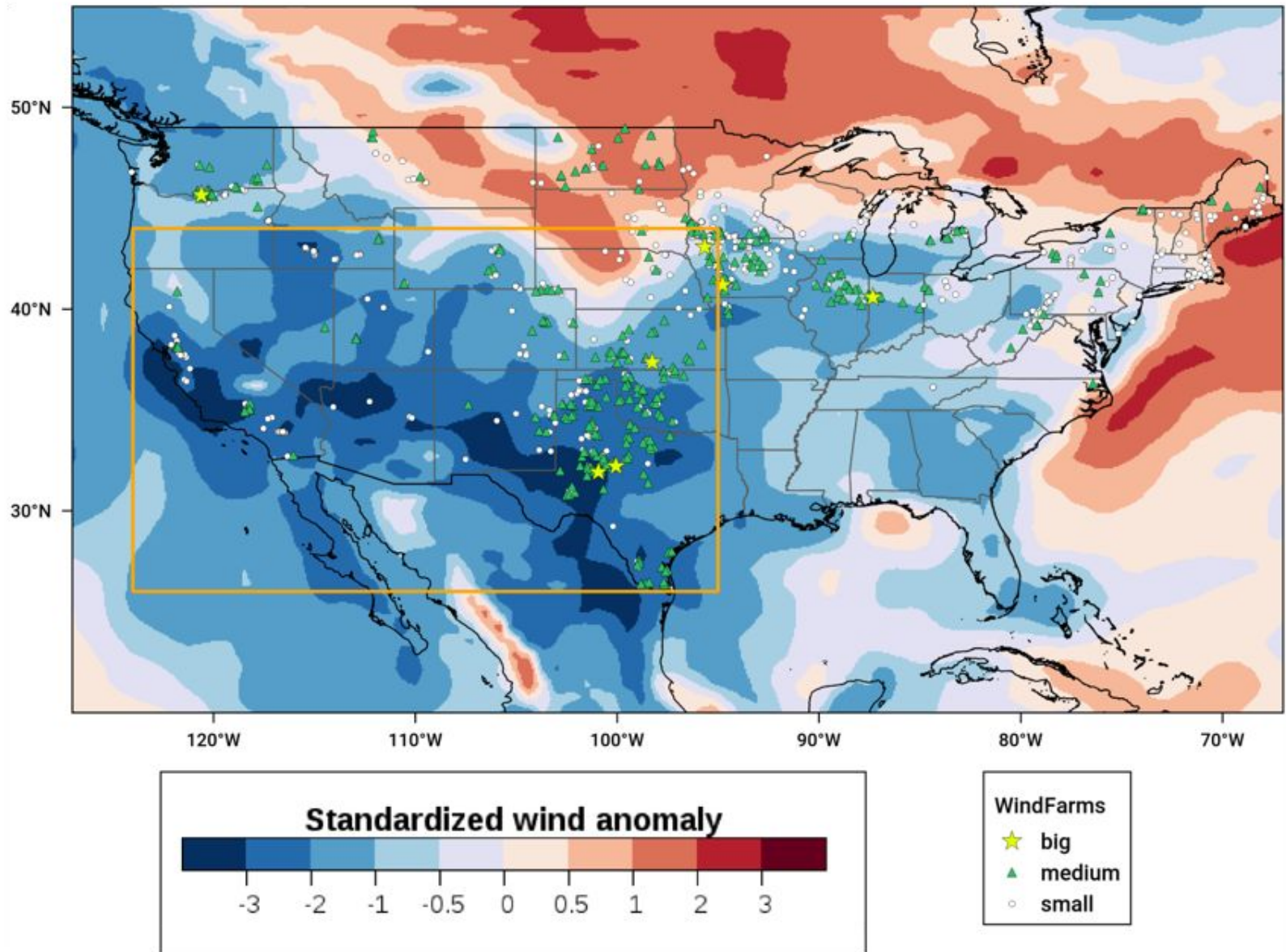
- ▶ Evaluation of 5 reanalyses: climatology, trends and interannual variability in 4 ECVs (wind, t2m, precipitation & solar radiation).
- ▶ Impact of climate variability on RE generation and demand (see poster PA11D-0819)
- ▶ 8 case studies

# Case study 6

## US wind drought - JFM 2015

### Seasonal forecasts

# Wind anomaly Q1 2015





# Event impacts



“US clean energy suffers from lack of wind”

*Financial Times, September 2015.*

“El Niño Buffers U.S. Wind Power Dreams”

*Wall Street Daily, September 2015.*

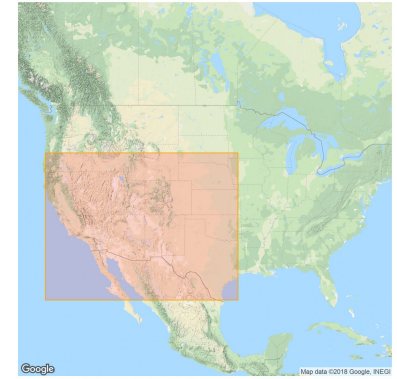
“El Niño blowing down wind projections in US”

*Fierce Energy, July 2015.*

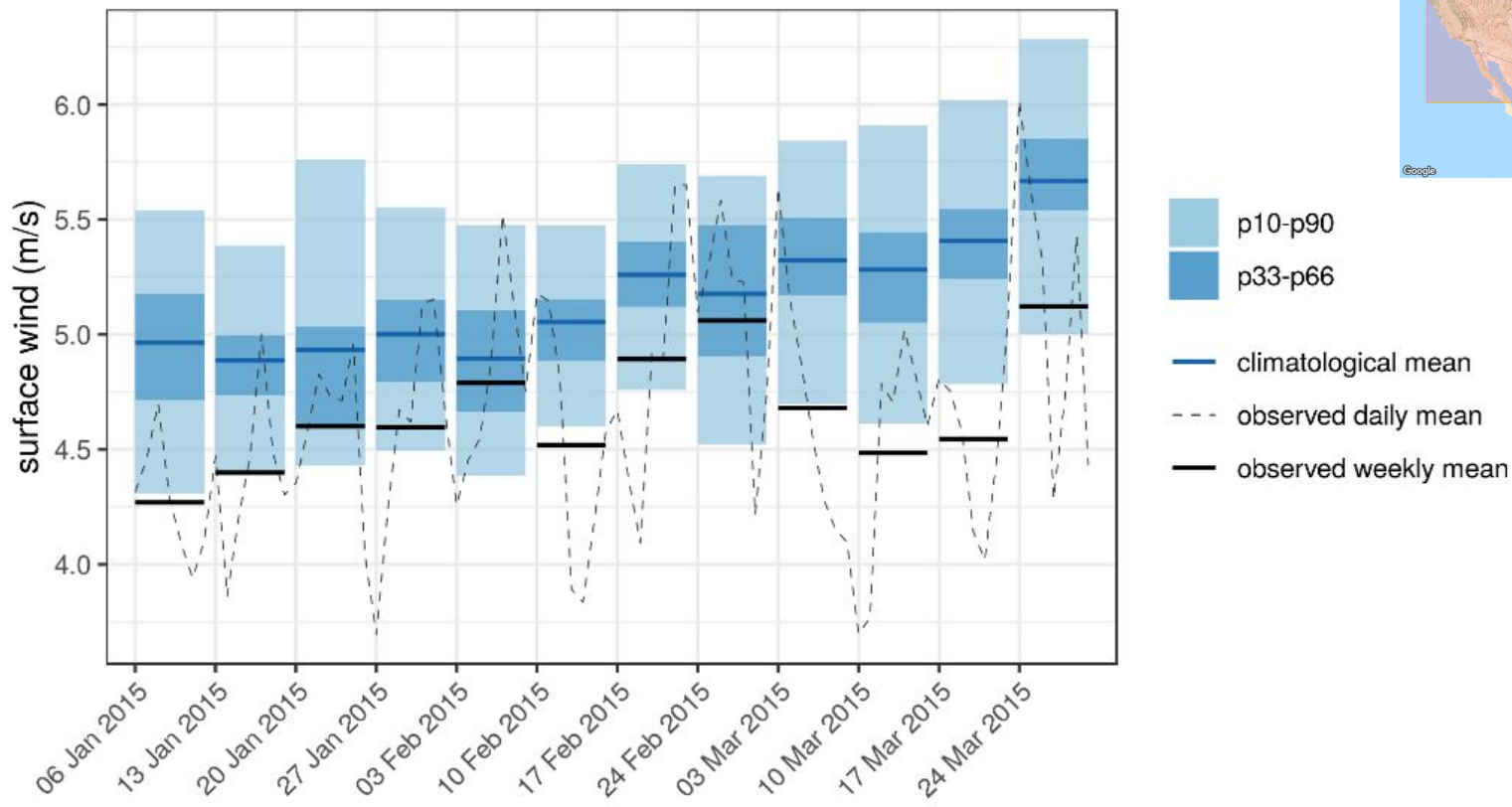
“We never anticipated a drop-off in the wind resource as we have witnessed over the past six months”

*David Crane, RNG, September 2015.*

# Widespread and extended in time

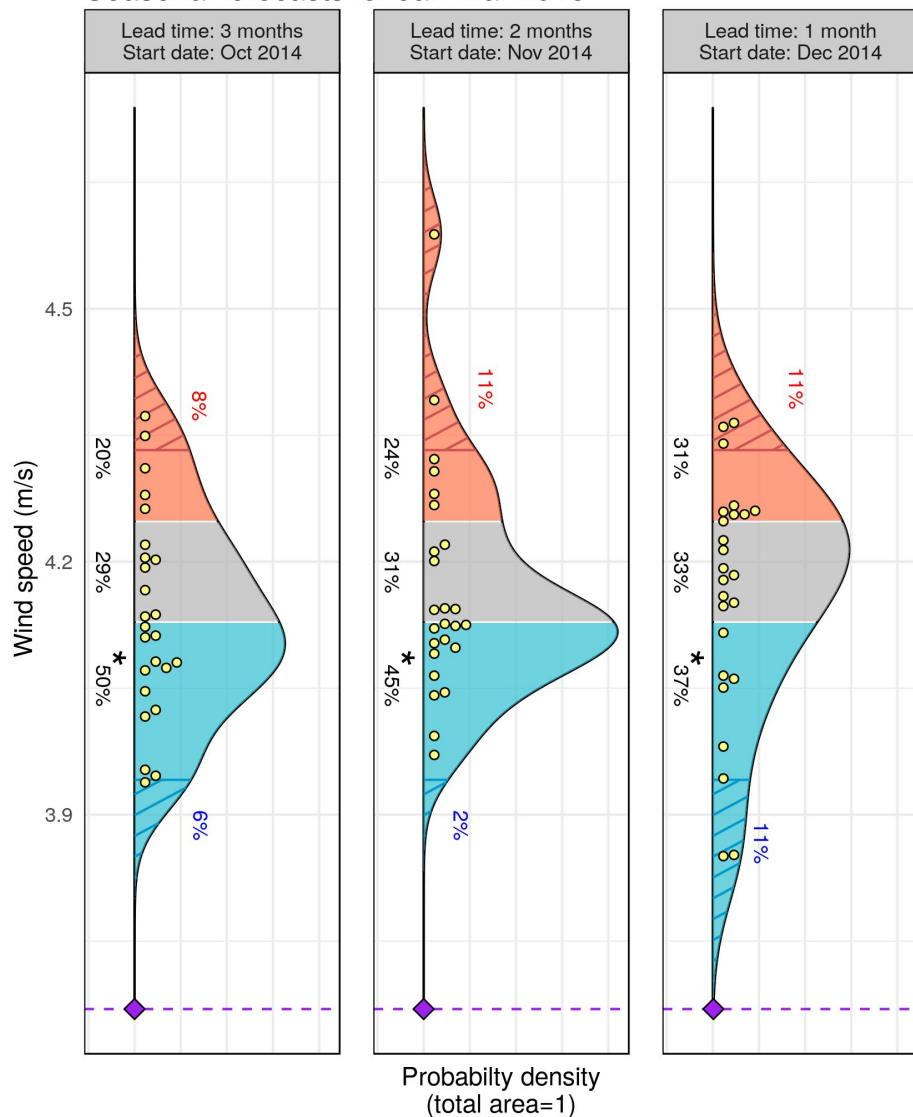


Observed weekly means and climatology



# Fcsts available 3 to 1 months ahead

Seasonal forecasts for Jan-Mar 2015



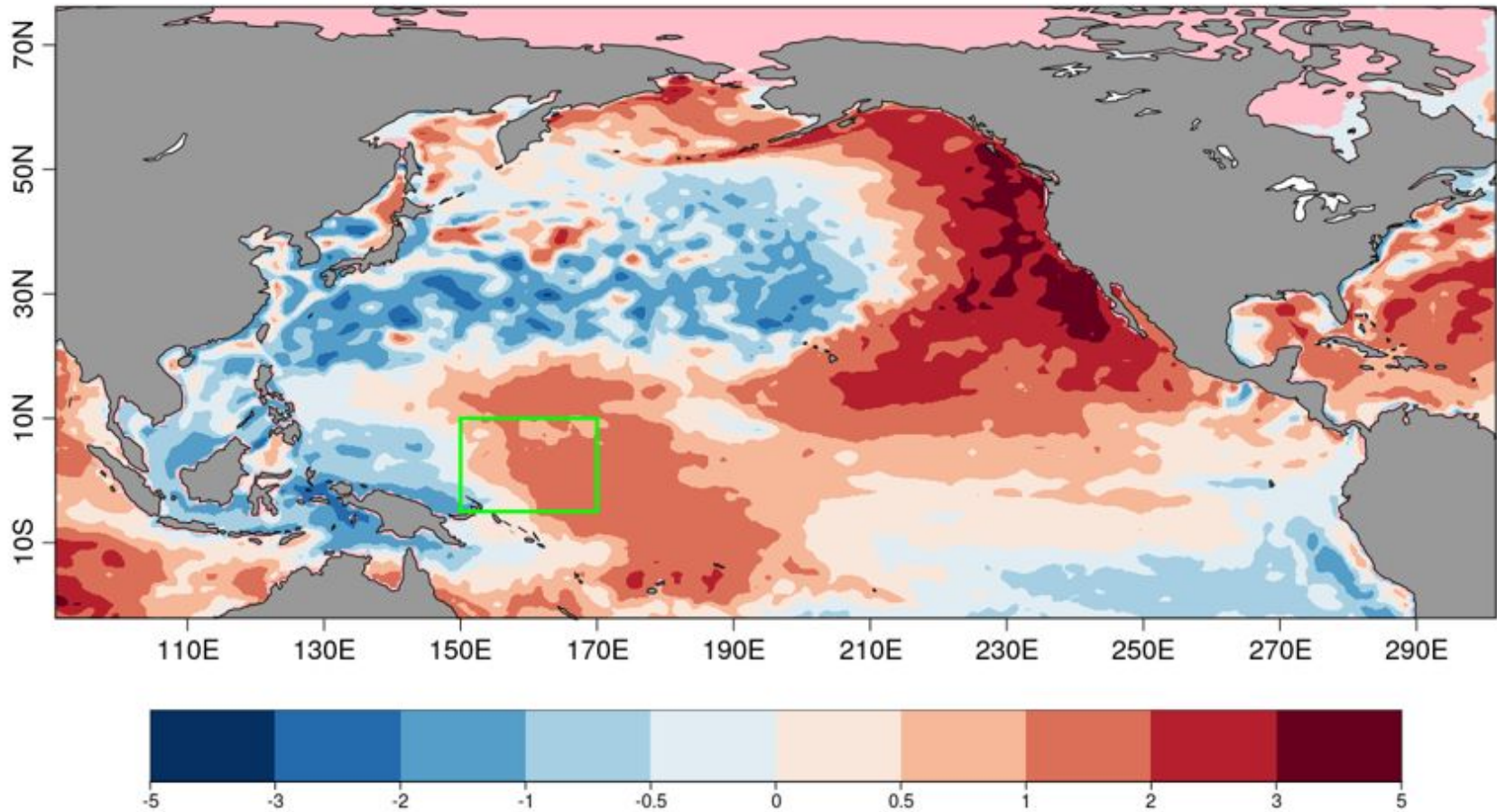
## Associated Skill Scores

	Start Date		
	Oct	Nov	Dec
<b>RPSS</b>	0.35	0.39	0.35
<b>BS P10</b>	-0.07	-0.27	-0.16
<b>BS P90</b>	0.1	0.04	0.07
<b>CRPSS</b>	0.14	0.11	0.14
<b>EnsCorr</b>	0.55	0.54	0.51

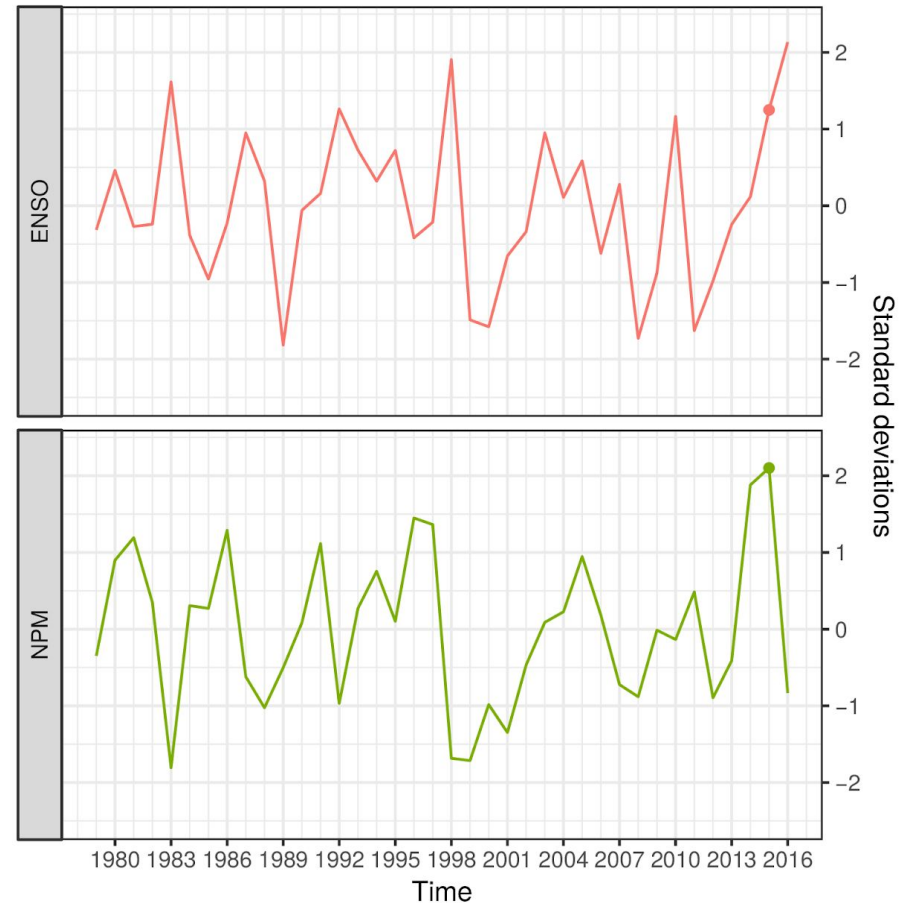
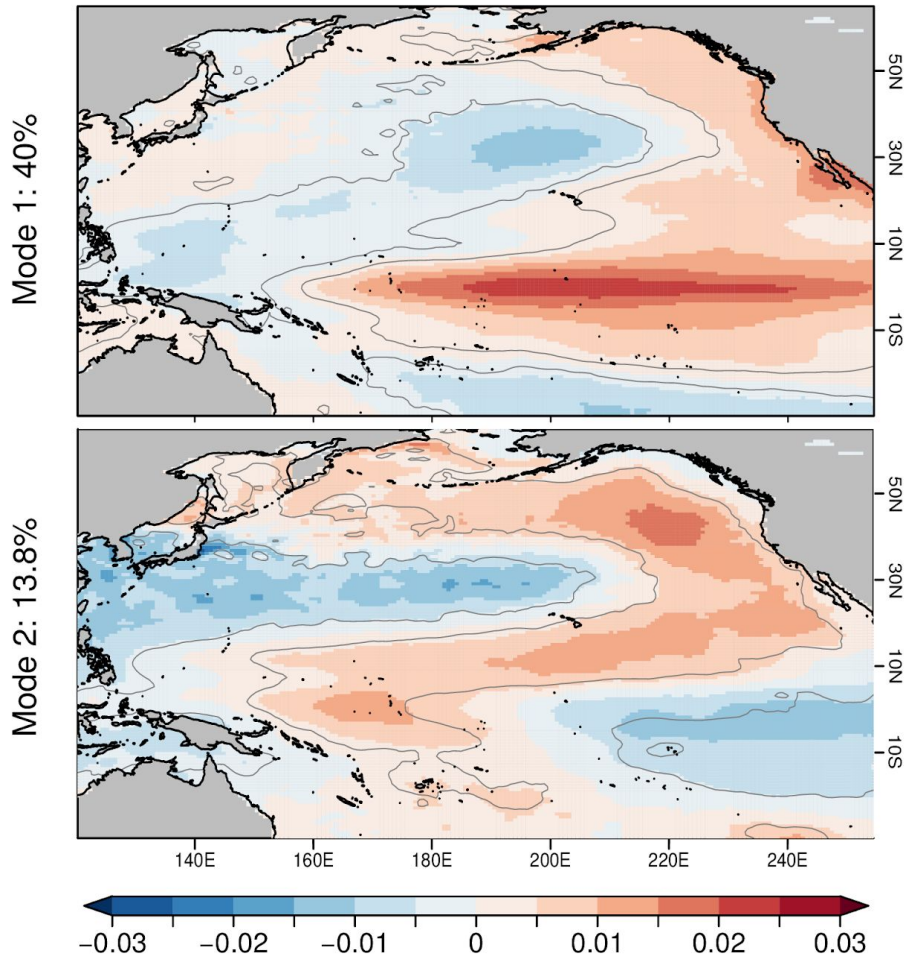
Which decisions would you make in view of those forecasts?

# Why this happened?

Standardized SST anomalies for Q1 2015



# ENSO and NPM state



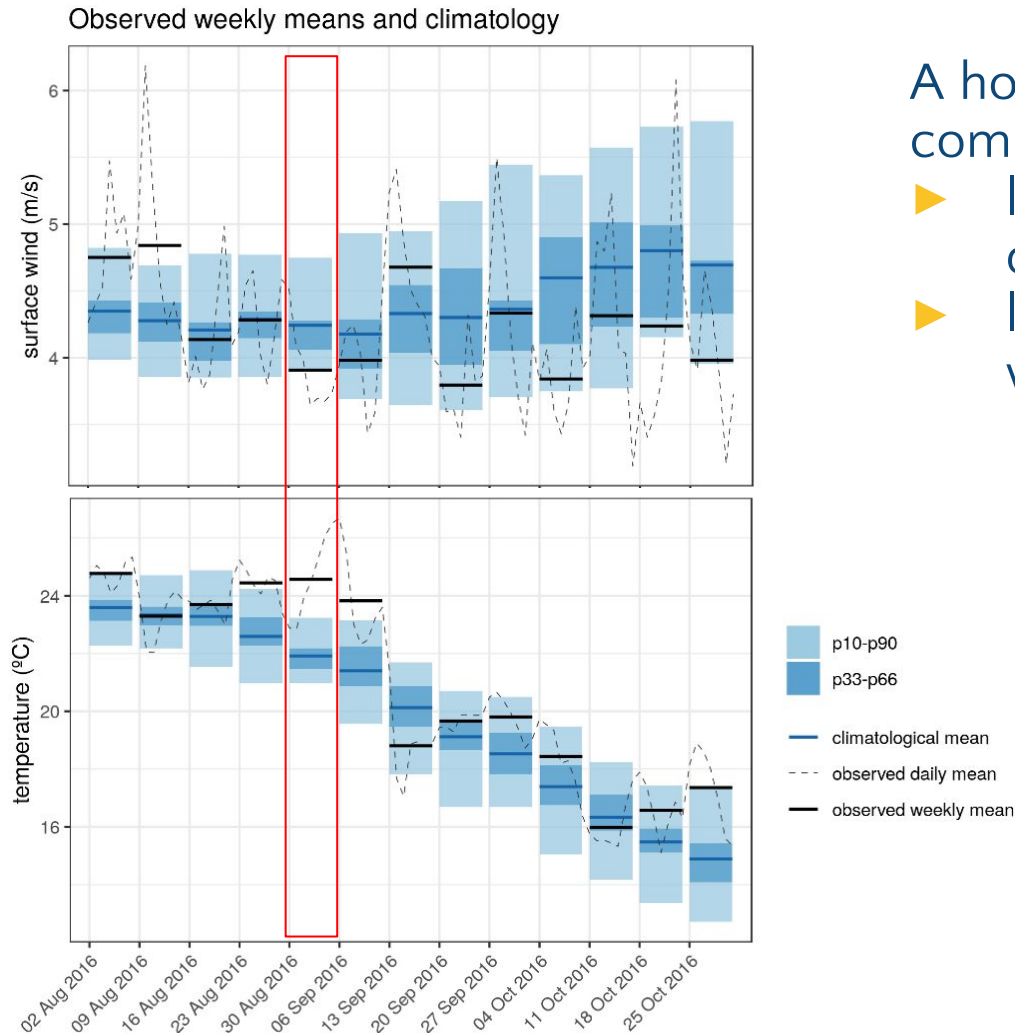
Lledó et al., 2018: Investigating the effects of Pacific sea surface temperatures on the wind drought of 2015 over the United States.

# Case study 3

## Heat wave and wind drought in Spain - Sep 2016

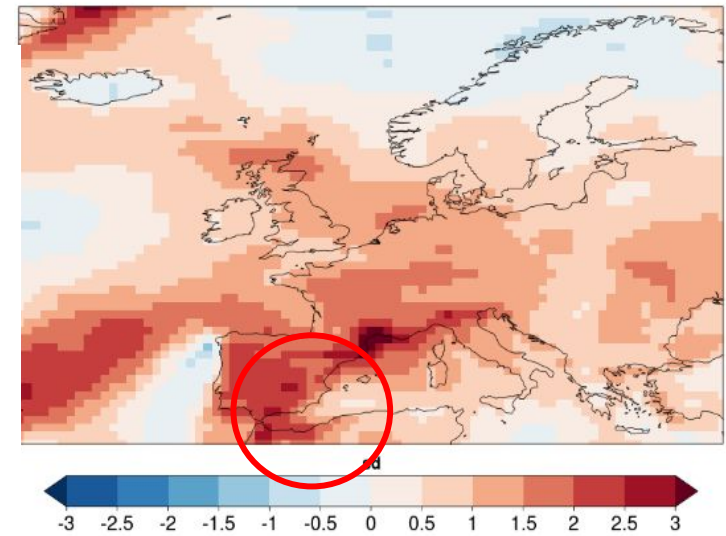
### Subseasonal forecasts

# Heat wave and wind drought in Spain. Sep 2016



A hot spell over Europe created a combination of:

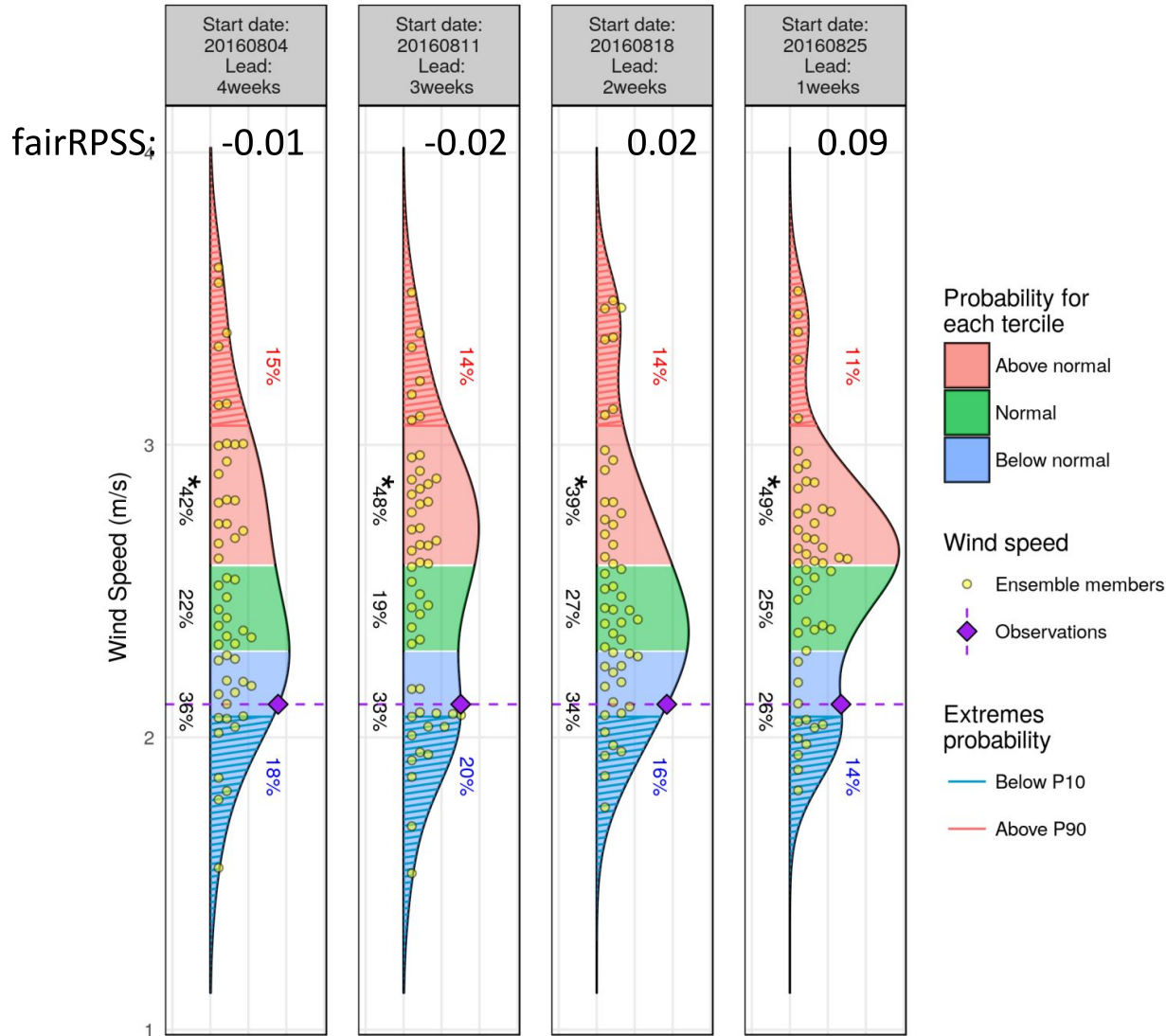
- ▶ large increase in electricity demand
- ▶ lower than usual hydro and wind power generation



Surface wind and temperature anomalies for the week  
30/08/2016-5/09/2016. ERA-Interim with respect to climatology  
(1981-2017)

# Wind speed forecasts

Forecasts for week starting 2016-08-30

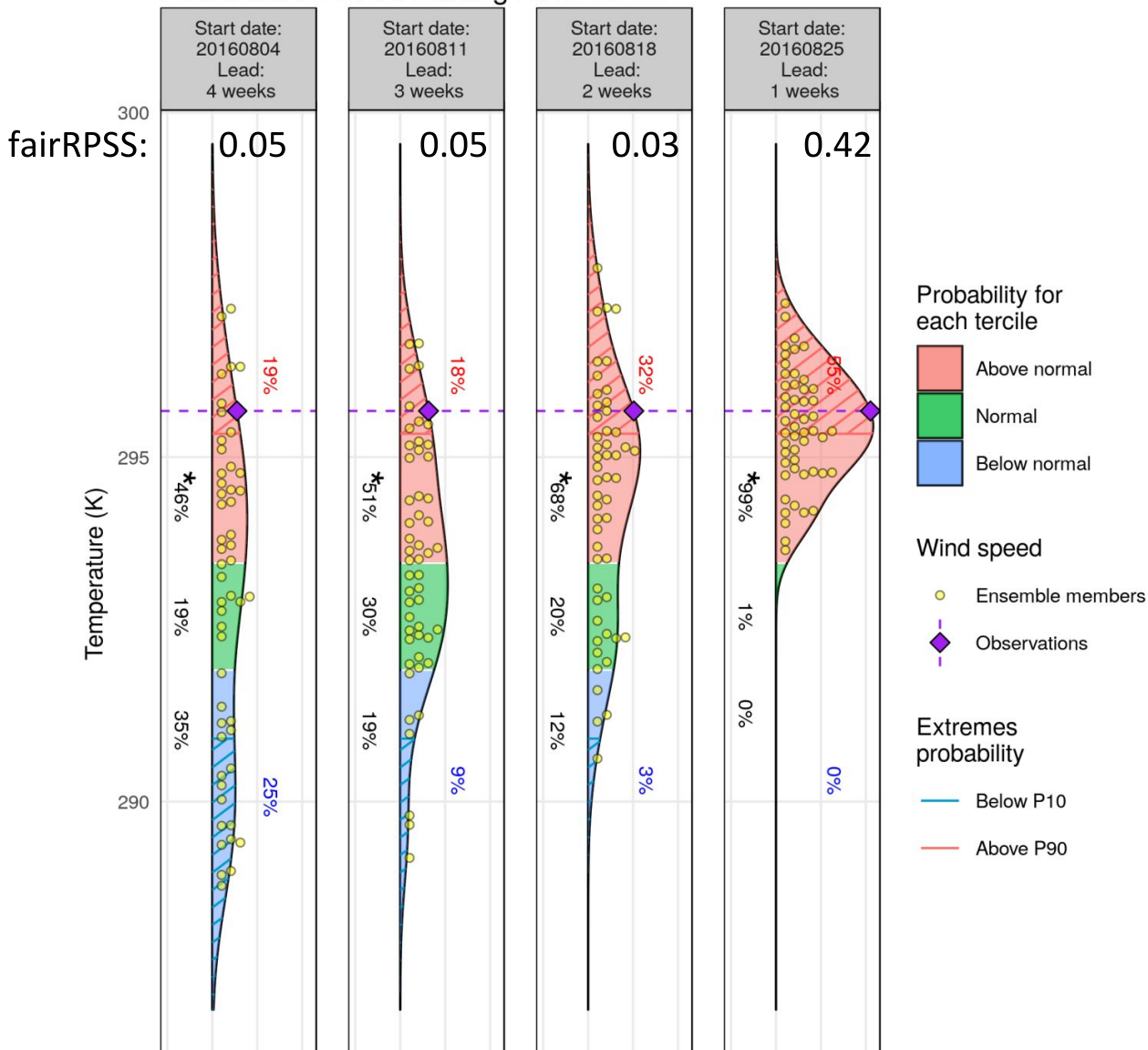


System: ECMWF monthly prediction system  
 Reanalysis: ERA-Interim  
 Bias adjusted –calibrated  
 Hindcast: 1996-2015  
 Lat= 40.5 N/Lon = 358.5 E



# Temperature forecasts:

Forecasts for week starting 2016-08-30



System: ECMWF monthly prediction system  
 Reanalysis: ERA-Interim  
 Bias adjusted –calibrated  
 Hindcast: 1996-2015  
 Lat= 40.5 N/Lon = 358.5 E

# Final remarks

- ▶ Climate prediction systems have improved in the last decade. Lets promote their usage for specific applications!
- ▶ There is a long way between climate data and services
- ▶ Case studies help scientists and users close the gap

# Future work

- ▶ Improve skill through multi-model ensembles
- ▶ Improve skill through large-scale teleconnection patterns and weather regimes

**Thank you**  
**Get in touch for more**  
**information!**



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