International Conferences on Subseasonal to Decadal Prediction, Boulder 19 Sept 2018

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Subseasonal to seasonal climate predictions for energy: the S2S4E project

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Context and motivation

- Both energy supply and demand are strongly influenced by meteorological conditions and their 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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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

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Context and motivation

- Energy sector routinely uses weather forecast up to several days. Beyond this time horizon, climatological data are used.

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

Hours Days Weeks Months Seasons Years Decades

MEDIUM RANGE FORECAST	SUBSEASONAL PREDICTION	SEASONAL PREDICTION	CLIMATE PROJECTION

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S2S4E objective

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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

- S2S4E will offer an innovative service to improve RE variability management by developing new research methods exploring the frontiers of weather conditions for future weeks and months.

- The main output of S2S4E will be a user co-designed Decision Support Tool (DST) that for the first time integrates sub-seasonal to seasonal (S2S) climate predictions with RE production and electricity demand.

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Applications

Weather forecast	Climate predictions		Decadal	Climate projections or multidecadal
	Sub-seasonal	Seasonal		
1-15 days	10 d-1 month	1-6 months	1-30 years	20-100 years

Applications for wind/solar/hydro generation

Post-construction decisions

Energy producers: commit energy sales for next day

Grid operators: Market prices and grid balance

Energy traders: Anticipate energy prices

Plant operators: planning for cleaning and maintenance

Post-construction decisions

Energy producers: Resource management strategies

Energy traders: Resource effects on markets

Plant operators: Planning for maintenance works, especially offshore wind O&M

Plant investors: anticipate cash flow, optimize return on investments

Pre-construction decisions

Power plant developers: Site selection. Future risks assessment.

Investors: Evaluate return on investments

Policy-makers: Assess changes to energy mix

River-basin managers: understand ... ge the river flow

Applications for demand

Daily operation decisions

Grid operators:

Anticipate hot/cold days.

Schedule power plants to reinforce supply.

Energy traders: Anticipate energy prices.

Mid-term planning

Grid operators:

Anticipate hotter/colder seasons

Schedule power plants to reinforce supply.

Energy traders:

Anticipate energy prices.

Long-term planning

Grid operators:

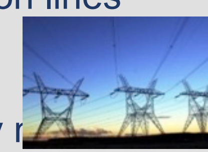
Anticipate addition of more capacity.

Adaptation of transmission lines

Policy-makers:

Plan addition of more capacity.

Understand changes to energy r



S2S4E project

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Challenges and opportunities

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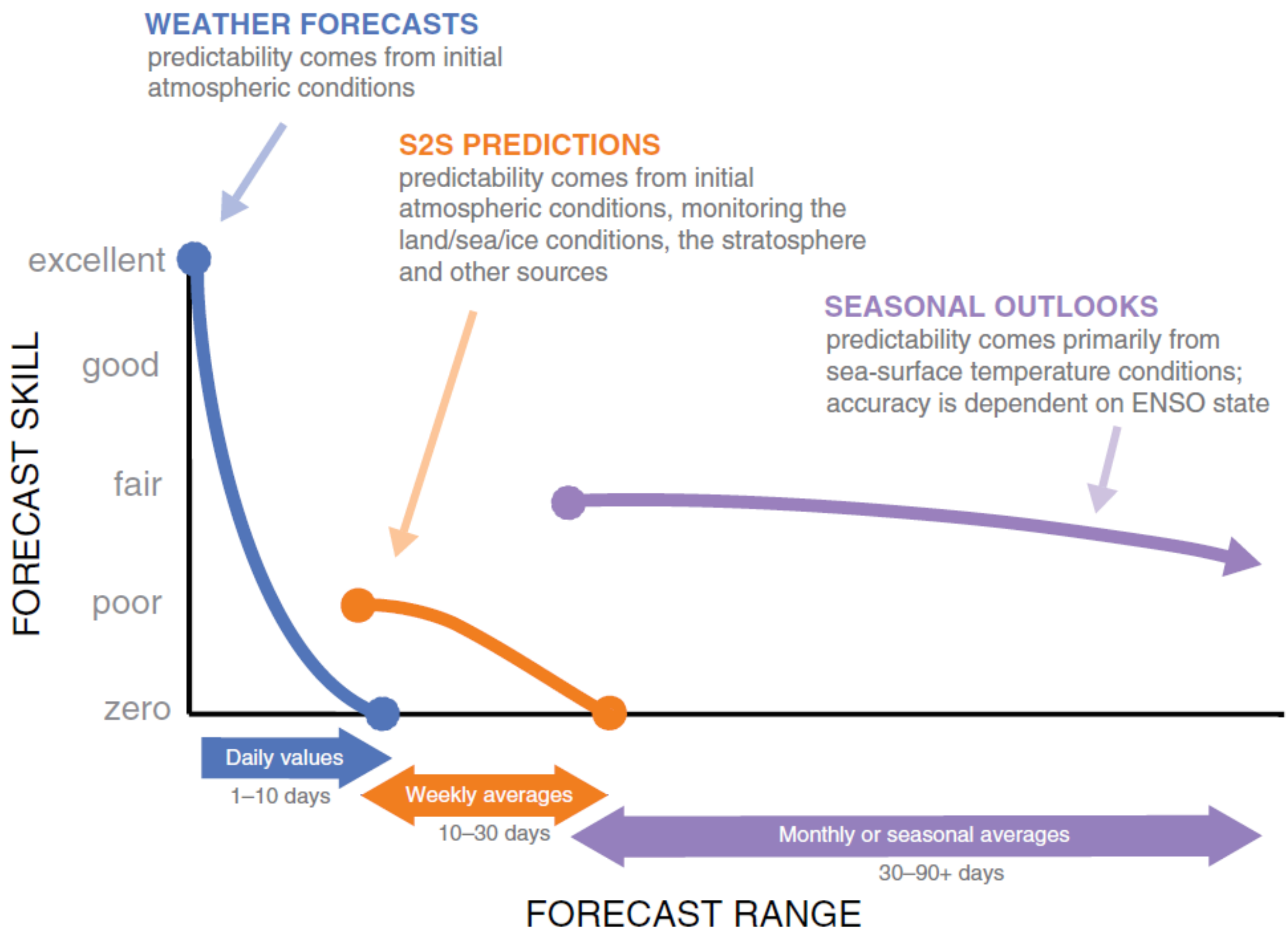
S2S Forecast ranges and



Qualitative estimate of forecast skill based on forecast range from short-range weather forecasts to long-range seasonal predictions, including potential sources of predictability. Relative skill is based on differing forecast averaging periods. (Source: White et al., 2017)

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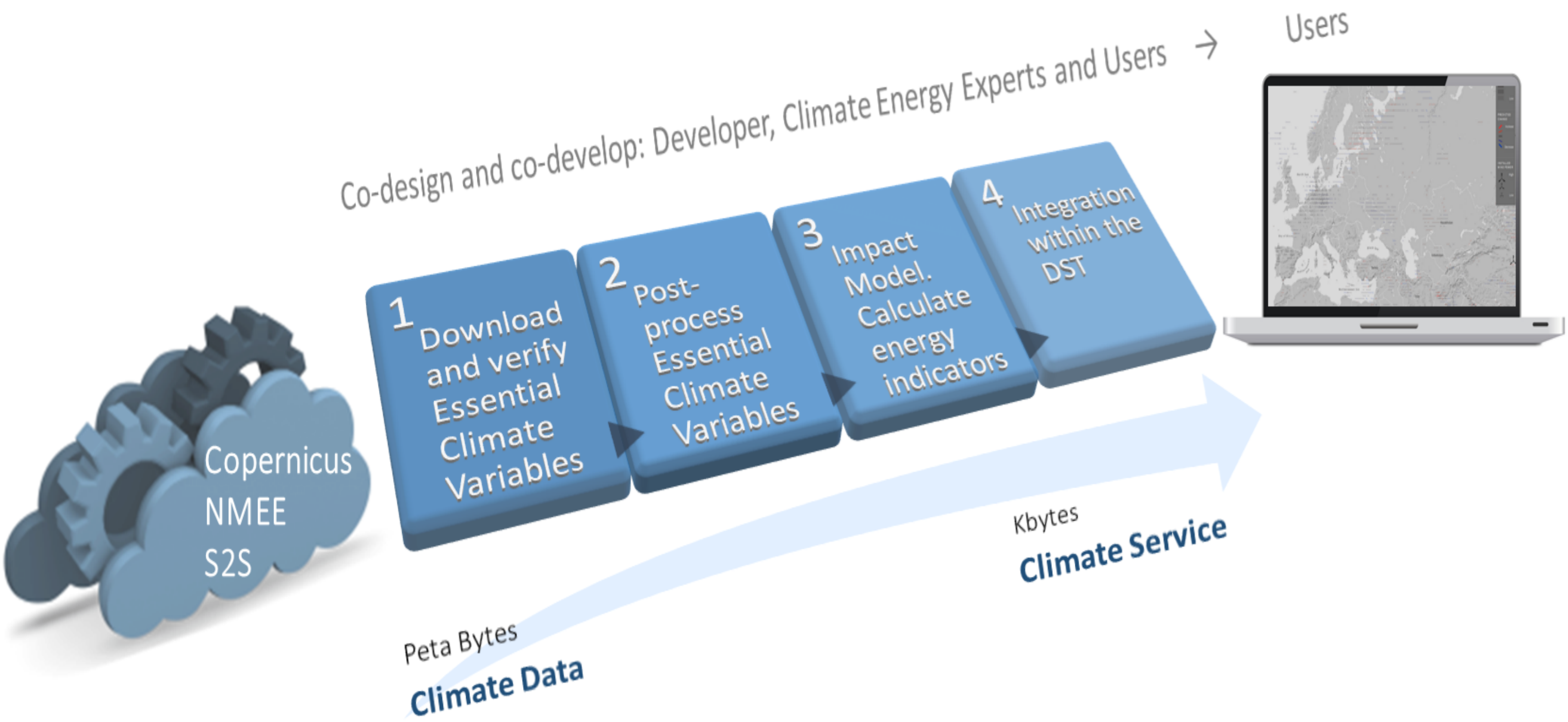
From data to service



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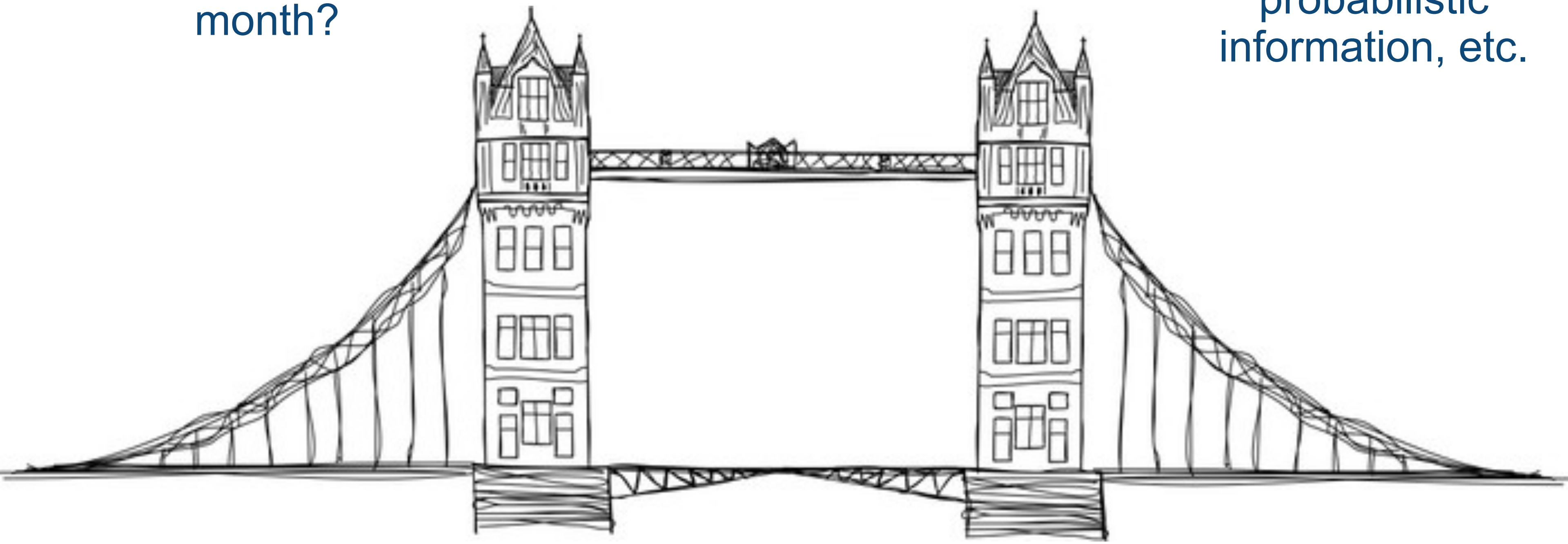
Climate services

- **User**: How much energy will I produce next month?
- **Scientist**: Skill assessment, bias adjustment, probabilistic information, etc.



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Methodology and first results

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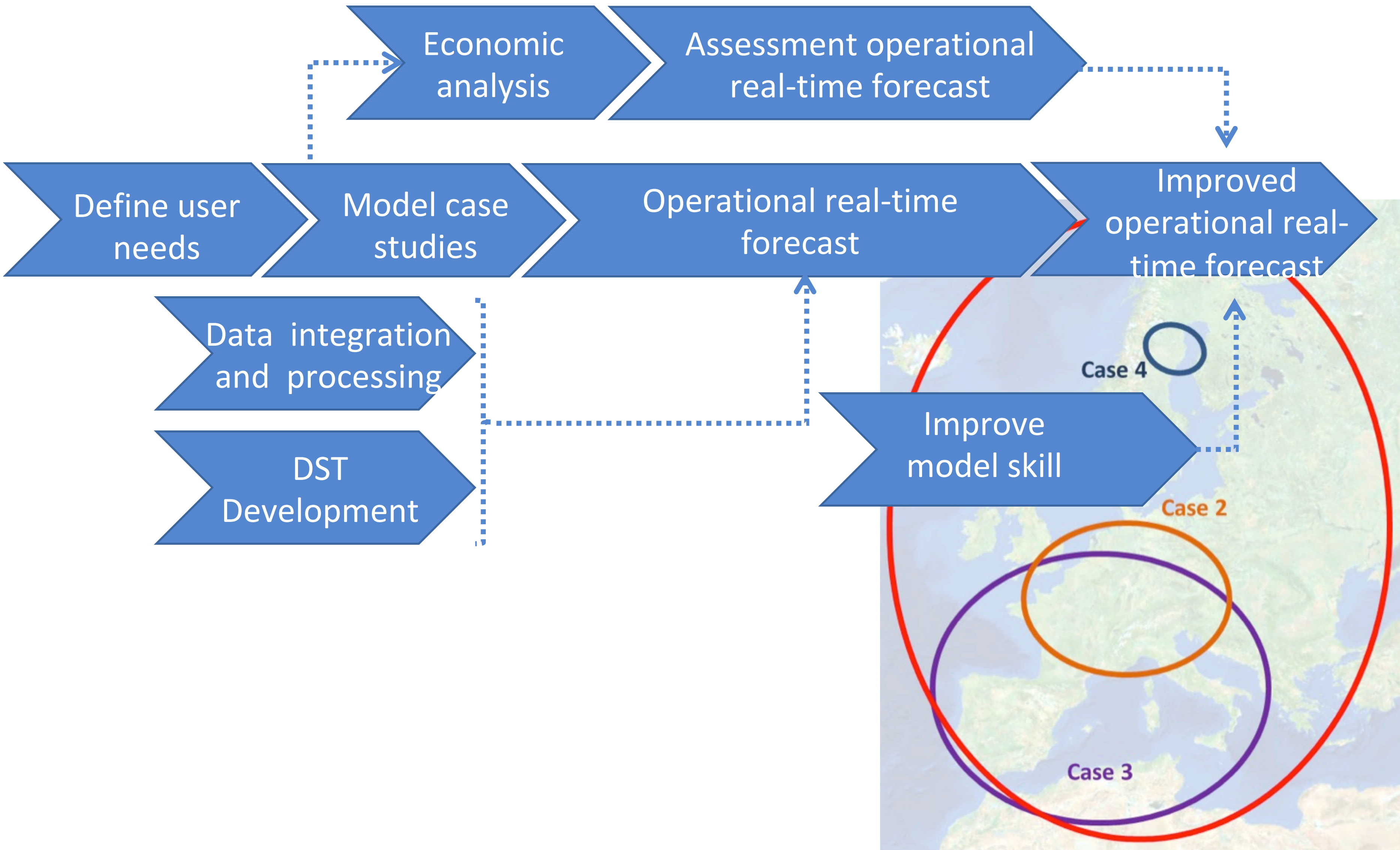
Methodology



First results

- **Reanalyses comparison: trends, interannual variability, etc.**
  - **ERA – Interim**
  - **MERRA-2**
  - **JRA – 55**
  - **NCEP - R2**
  - **ERA – 5**

Poster presentation: Analysing the uncertainty of reanalyses to assess the predictability at S2S time- scales of key climate and energy variables for the energy sector. Wed 19th Sep P-A4-02

- **Case Studies:**

1. **Wind drought in the US, Jan-Mar 2015**

   Poster presentation: Wind drought episodes in the US and Europe: the power of case studies . Wed 19th Sep Foothills Lab P-B4-04

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

2. **Heat wave and wind drought in Spain, Sept 2016**

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Case study: wind drought in US

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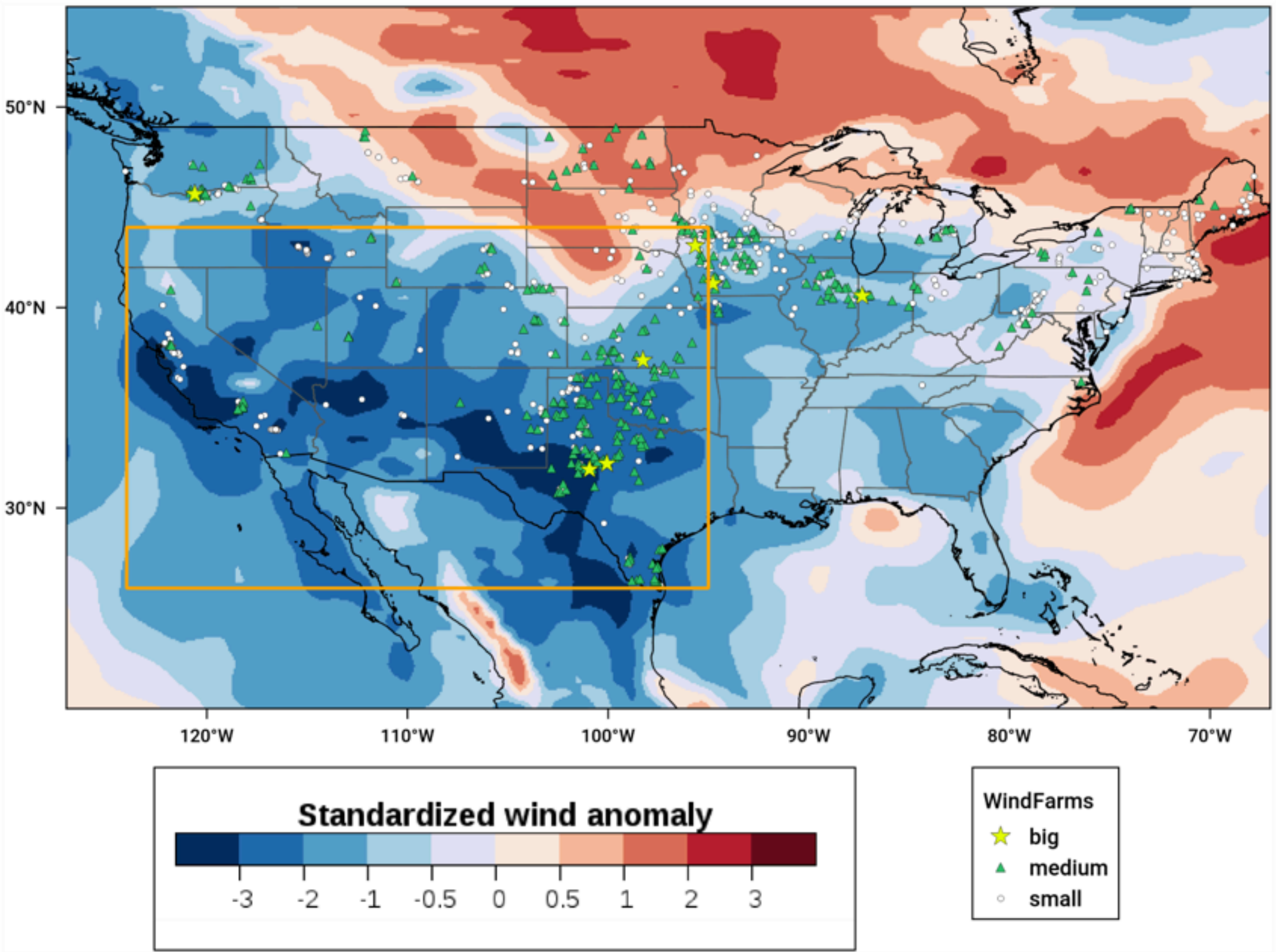
Wind drought in US

During the first quarter of 2015 the United States experienced a widespread and extended episode of low surface wind speeds. This episode had a strong impact on wind power generation. Some wind farms did not generate enough cash for their steady payments, and the value of wind farm assets decreased.



Wind speed anomalies reflecting the wind drought over the United States for the first trimester of 2015. The US wind farm fleet is also shown.

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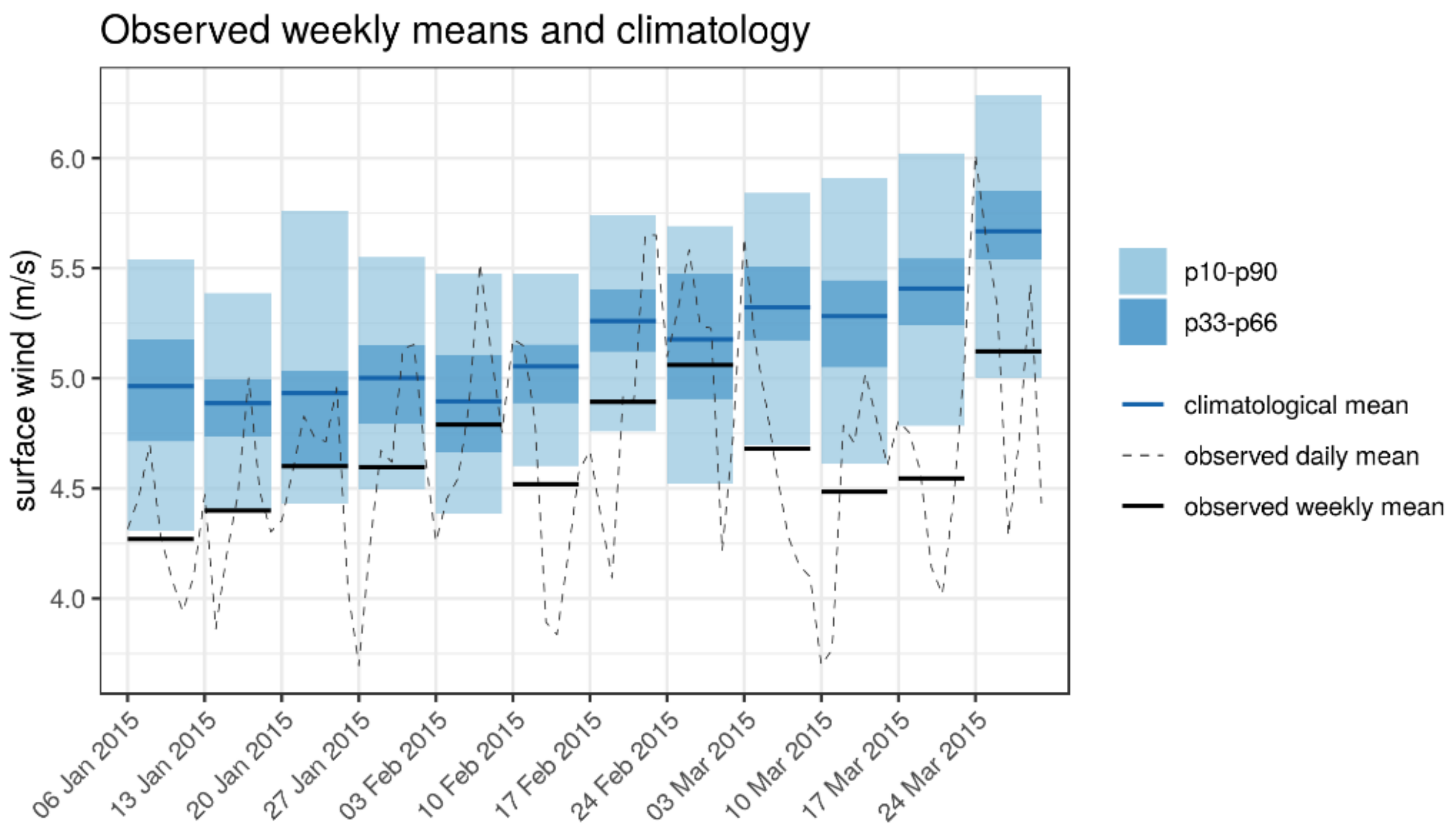

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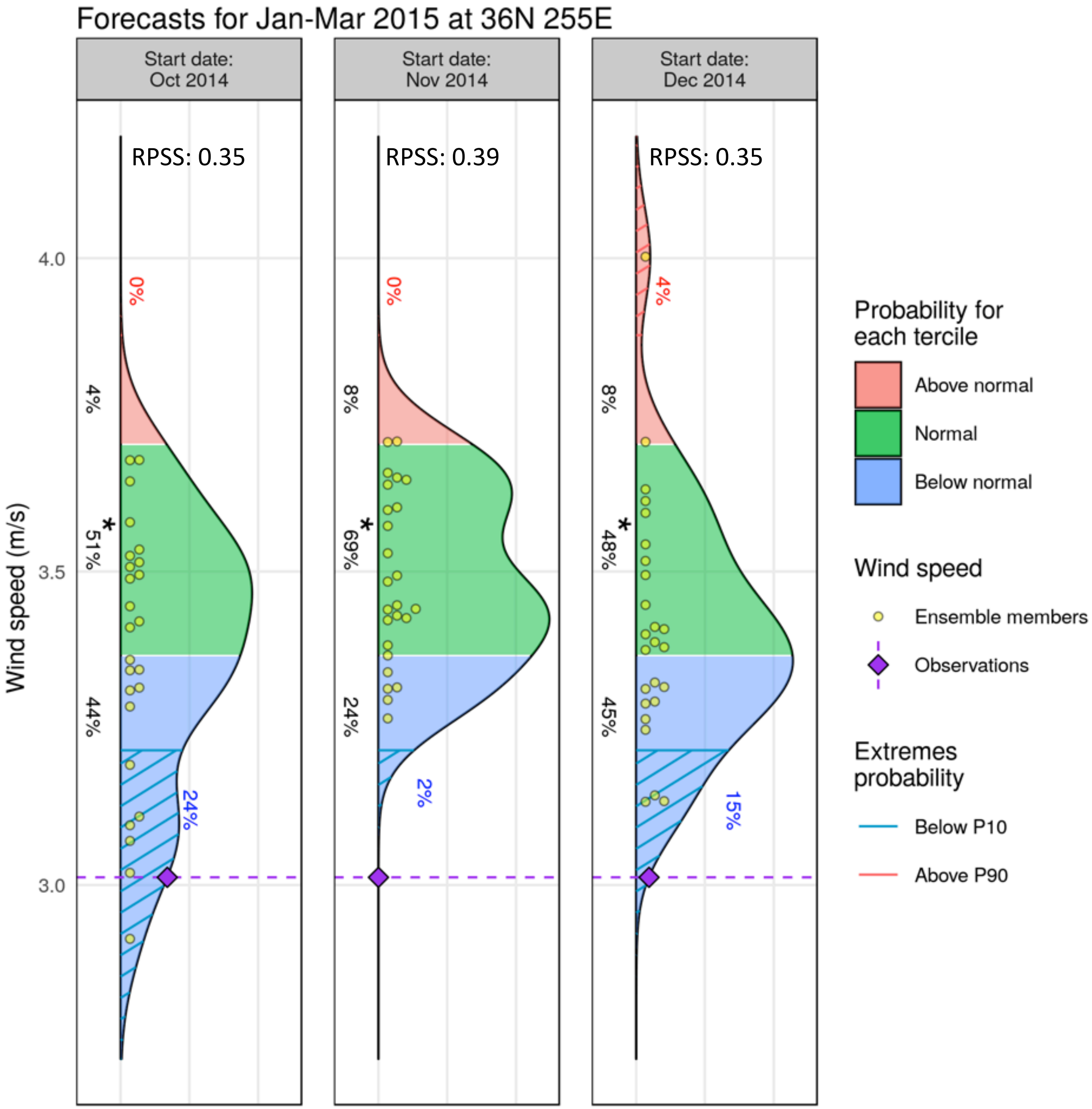
Available seasonal forecast



System: ECMWF SEAS5
Reanalysis: ERA-Interim
Bias adjusted –calibrated
Hindcast: 1993-2015
Lat= 36 N/Lon = 255 E

Which decisions would you take in view of those forecasts?

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Case study: heat wave and wind drought in Spain. Sep 2016

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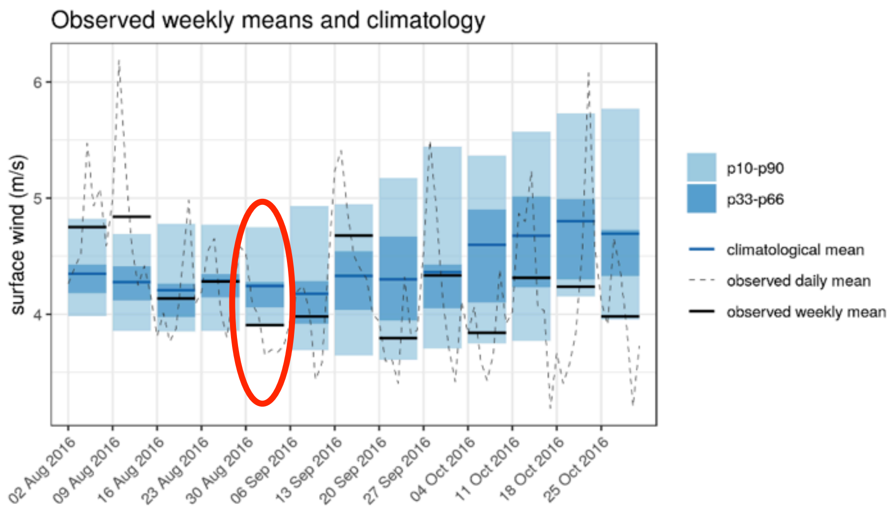
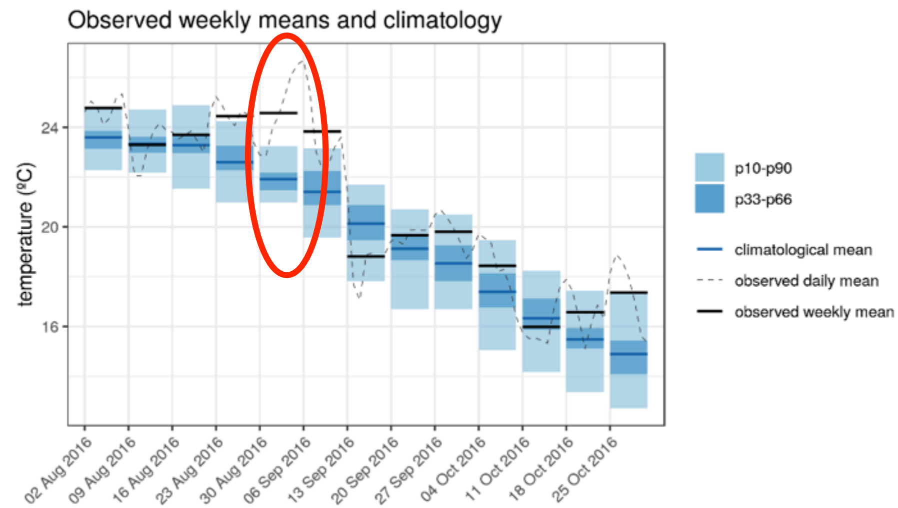
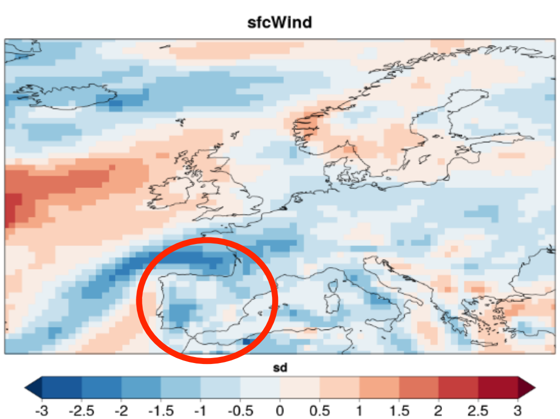
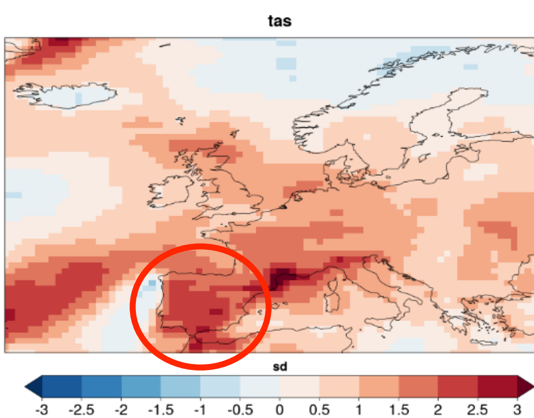
Heat wave and wind drought in Spain. Sep 2016

The hot spell over Europe created a combination of large increase in electricity demand and lower than usual hydro and wind power generation.









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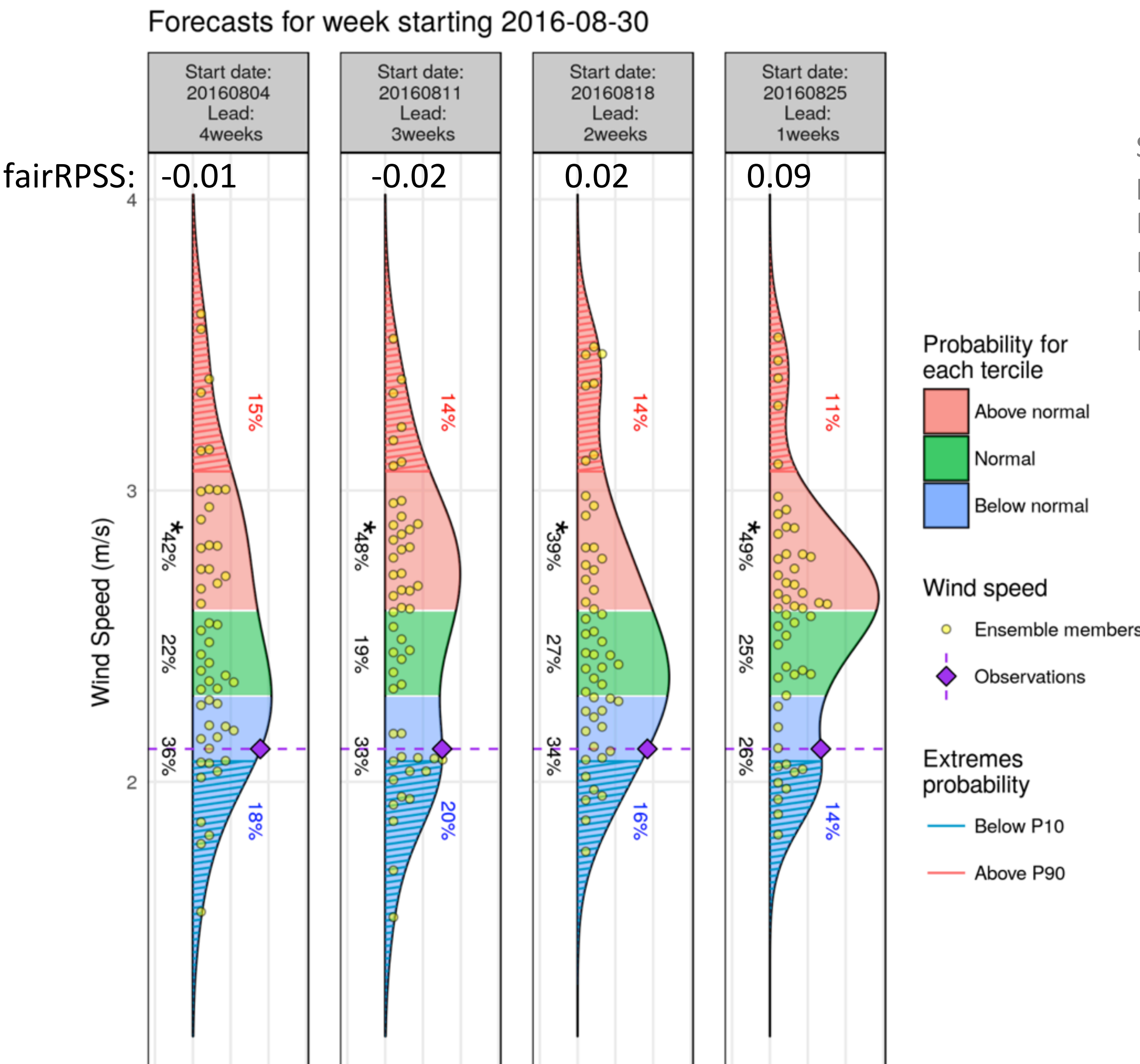
Surface wind and temperature standardized anomalies for the week 30/08/2016-5/09/2016.
ERA-Interim with respect to climatology (1981-2017)

Forecast available: wind speed



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

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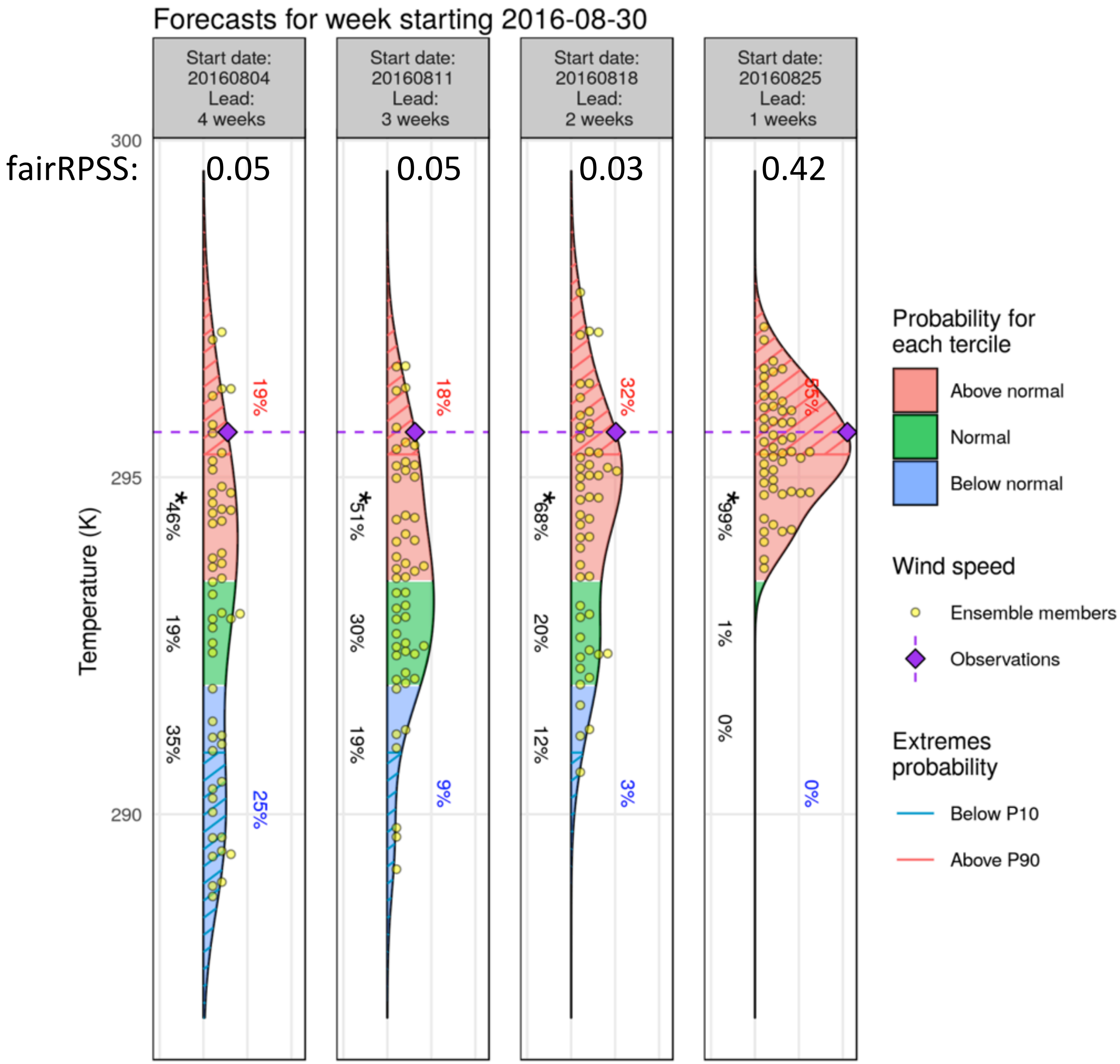
Forecast available: temperature



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

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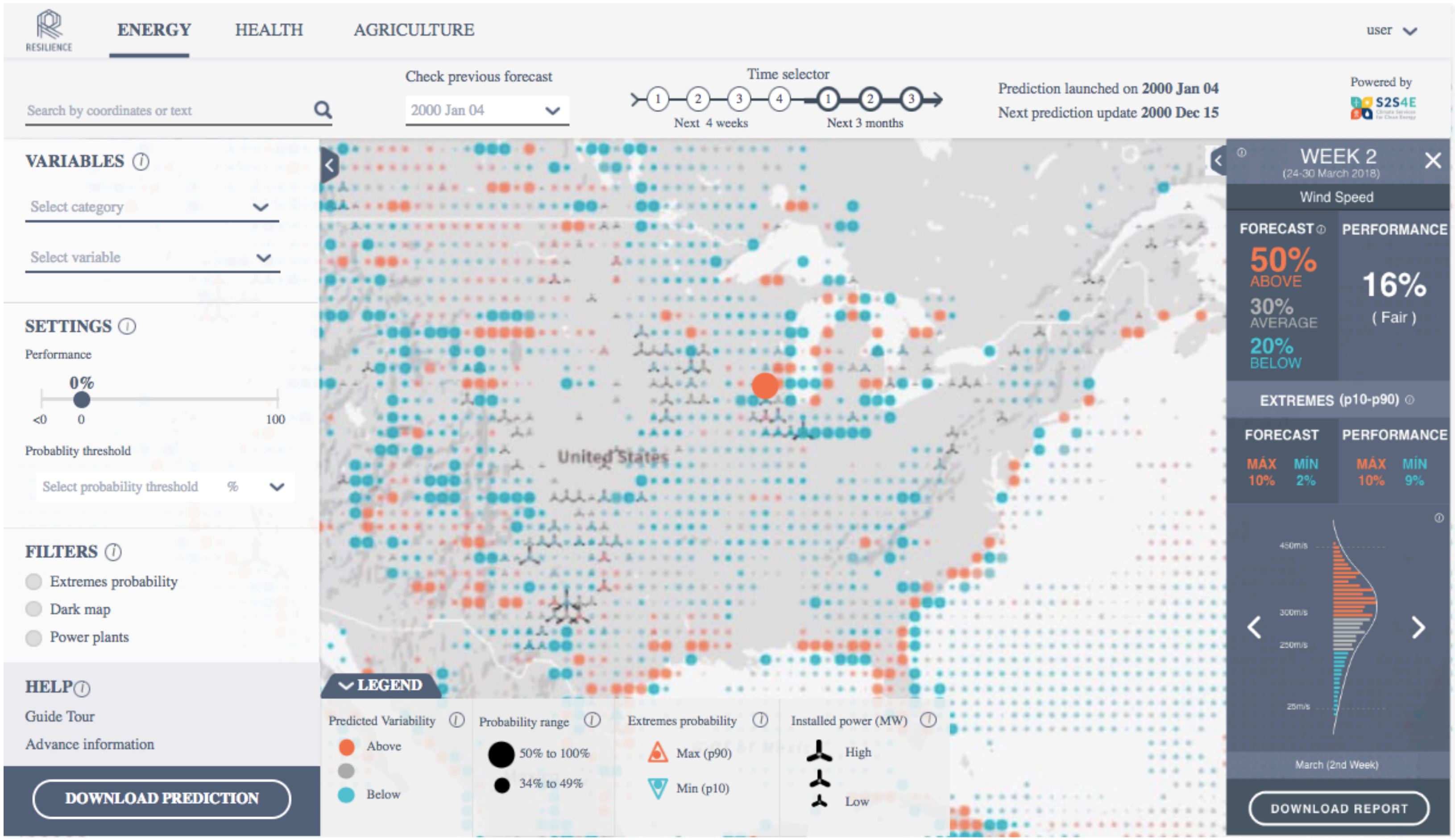
Decision Support Tool



http://www.bsc.es/ess/resilience/map.html

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Final remarks

- Climate prediction systems have improved in the last decade demonstrating that probabilistic forecasting can inform better decision making at some temporal scales and regions
- Alongside the model development process, climate predictions need to be evaluated on past years to provide robust information before making decisions
- Tailored service helpful for several applications
- Interdisciplinary groups enhance the interaction with users to co-develop a service

Future work:

- multi-model ensembles
- to improve the utility of forecasts by incorporating skillful information of the large-scale teleconnection patterns at different time scales

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Thank you

Get in touch for more information!

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