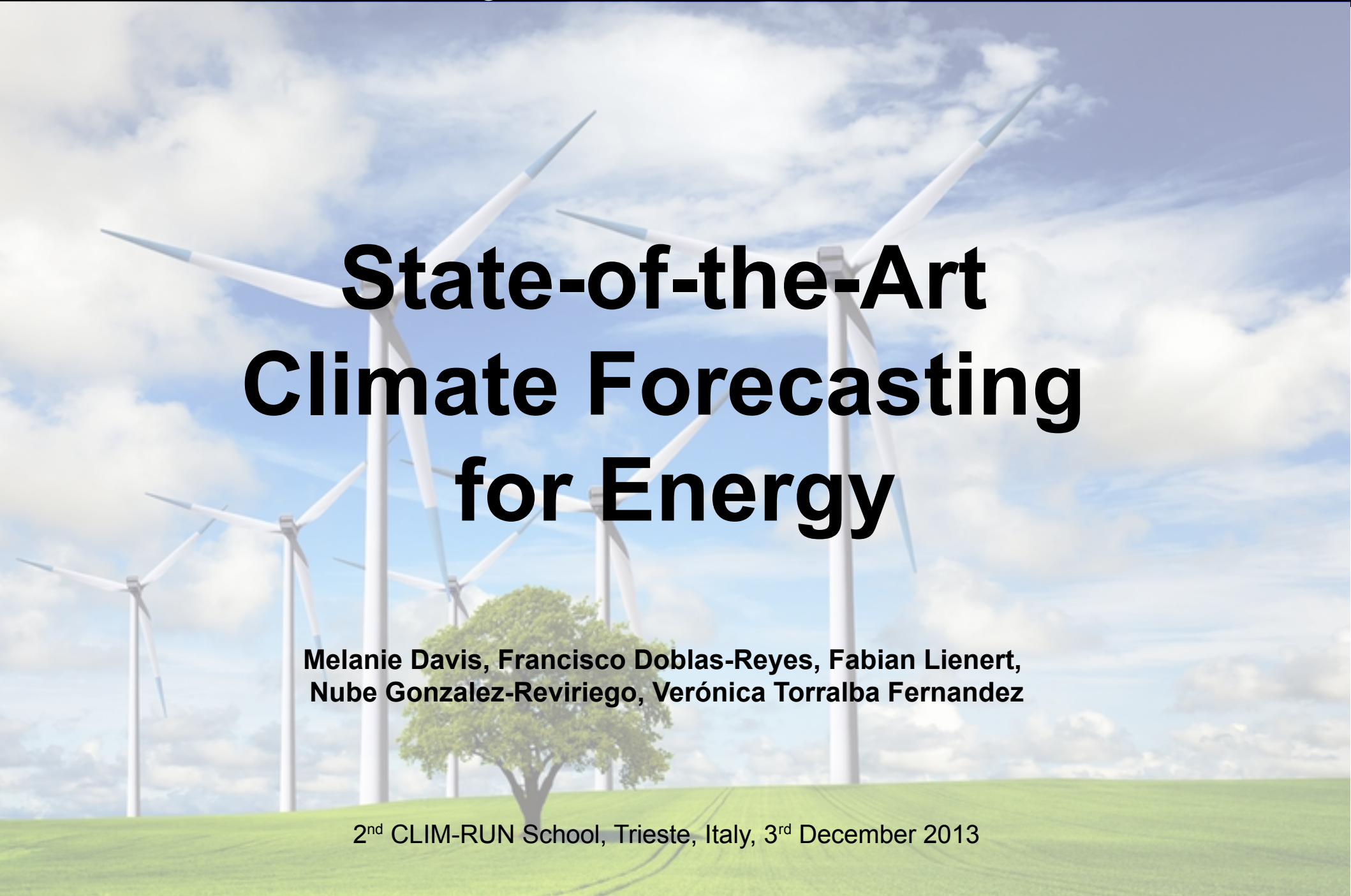


State-of-the-Art Climate Forecasting for Energy

Melanie Davis, Francisco Doblas-Reyes, Fabian Lienert, Nube Gonzalez-Reviriego, Verónica Torralba Fernandez

2nd CLIM-RUN School, Trieste, Italy, 3rd December 2013

CLIMATE WORLD

EU projects:
CLIM-RUN, www.climrun.eu
EUPORIAS, www.euporias.eu
SPECS, www.specs-fp7.eu

Initiatives:
Climate Services Partnership, www.climate-services.org

ENERGY WORLD

EU projects:
NEWA: New European Wind Atlas
WIRE: Weather Intelligence for Renewable Energy

Initiatives:
IRENA: International Renewable Energy Agency's Global Atlas for Solar and Wind, www.irena.org/globalatlas/

ECOMS: European Climate Observations and Monitoring for Services

(CLIMATE)

WMO: GFCS

Global Framework for Climate Science

Horizon 2020

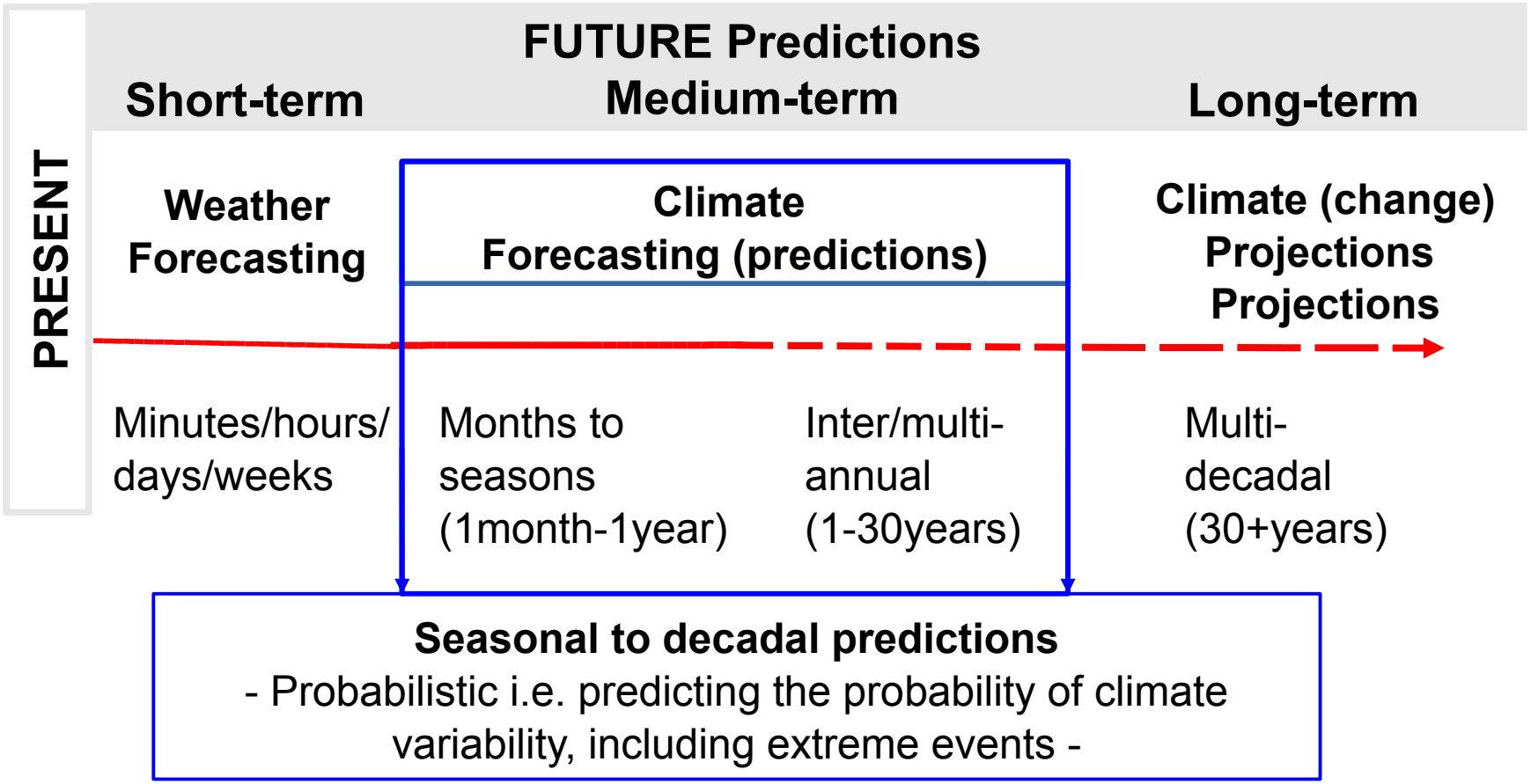
Research funding programme

EERA: European Energy Research Association

(ENERGY)

Started 2008, lead by Professor Francisco Doblas-Reyes,

16 members (4 Phd, 6 Post-doc, 3 Technical, 2 Support, 1 Programme Coordinator)



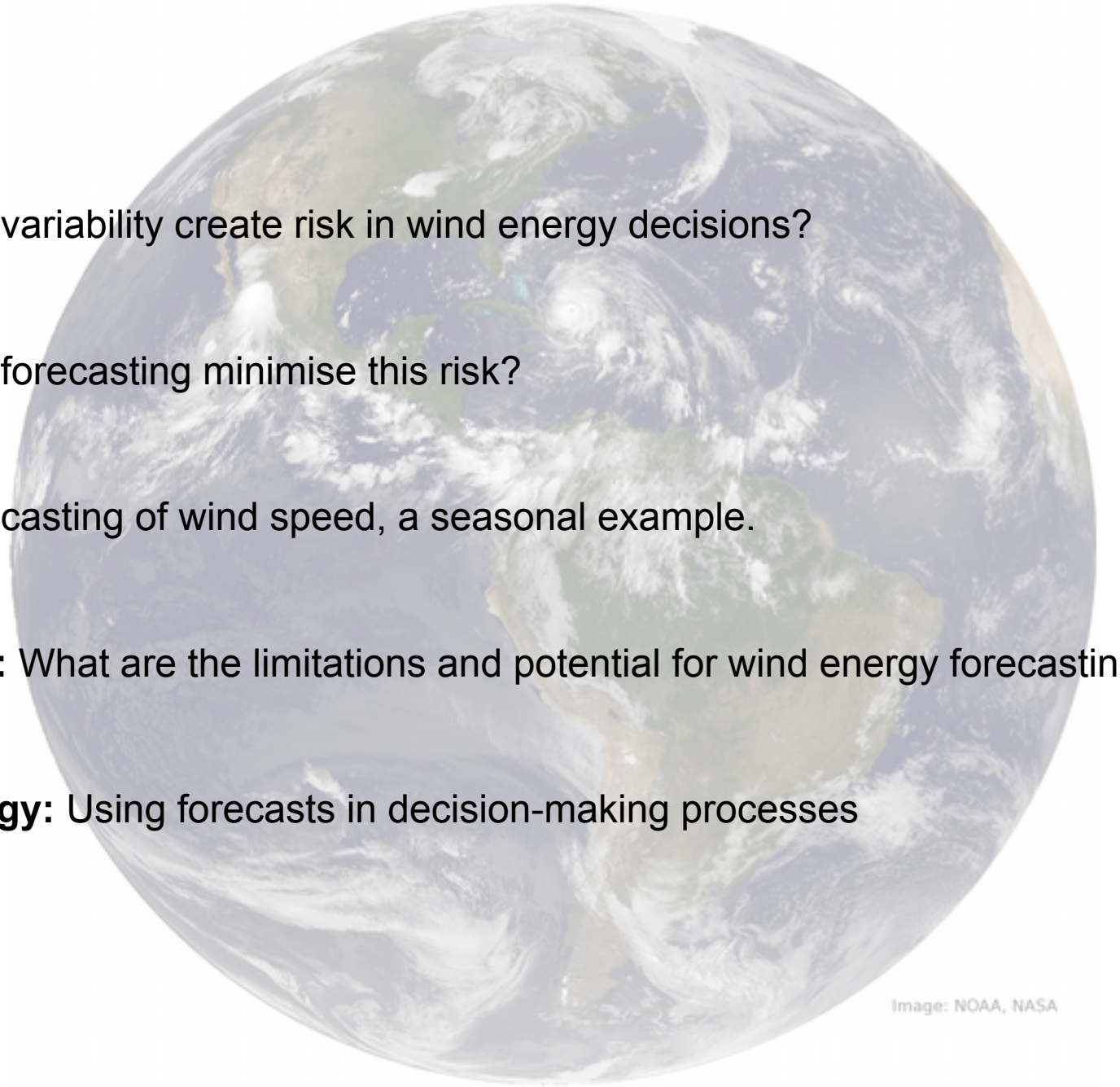
Problem: How can climate variability create risk in wind energy decisions?

Solution: How can climate forecasting minimise this risk?

Methodology: Climate forecasting of wind speed, a seasonal example.

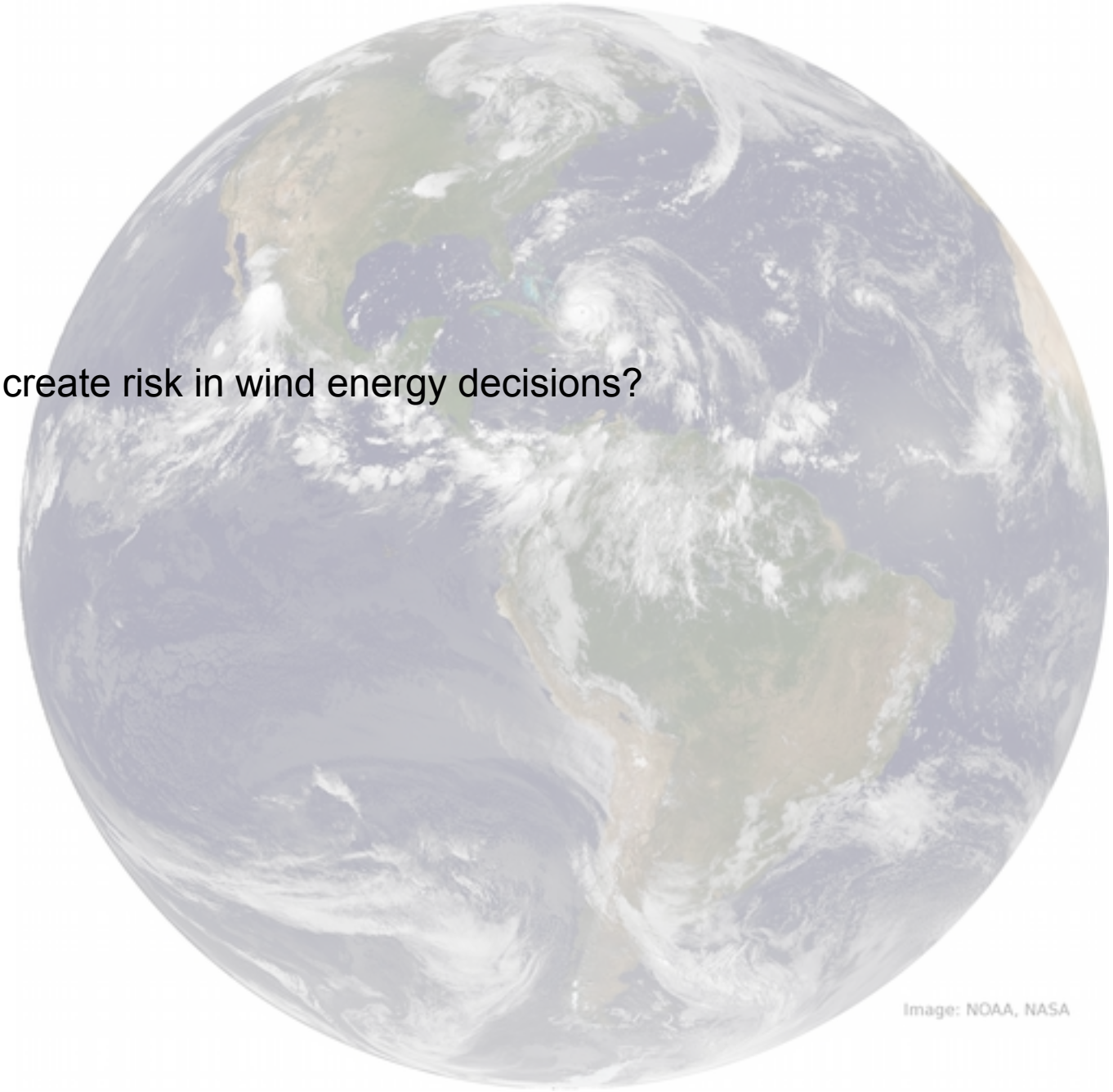
Caveats/Further research: What are the limitations and potential for wind energy forecasting?

Climate Services for Energy: Using forecasts in decision-making processes



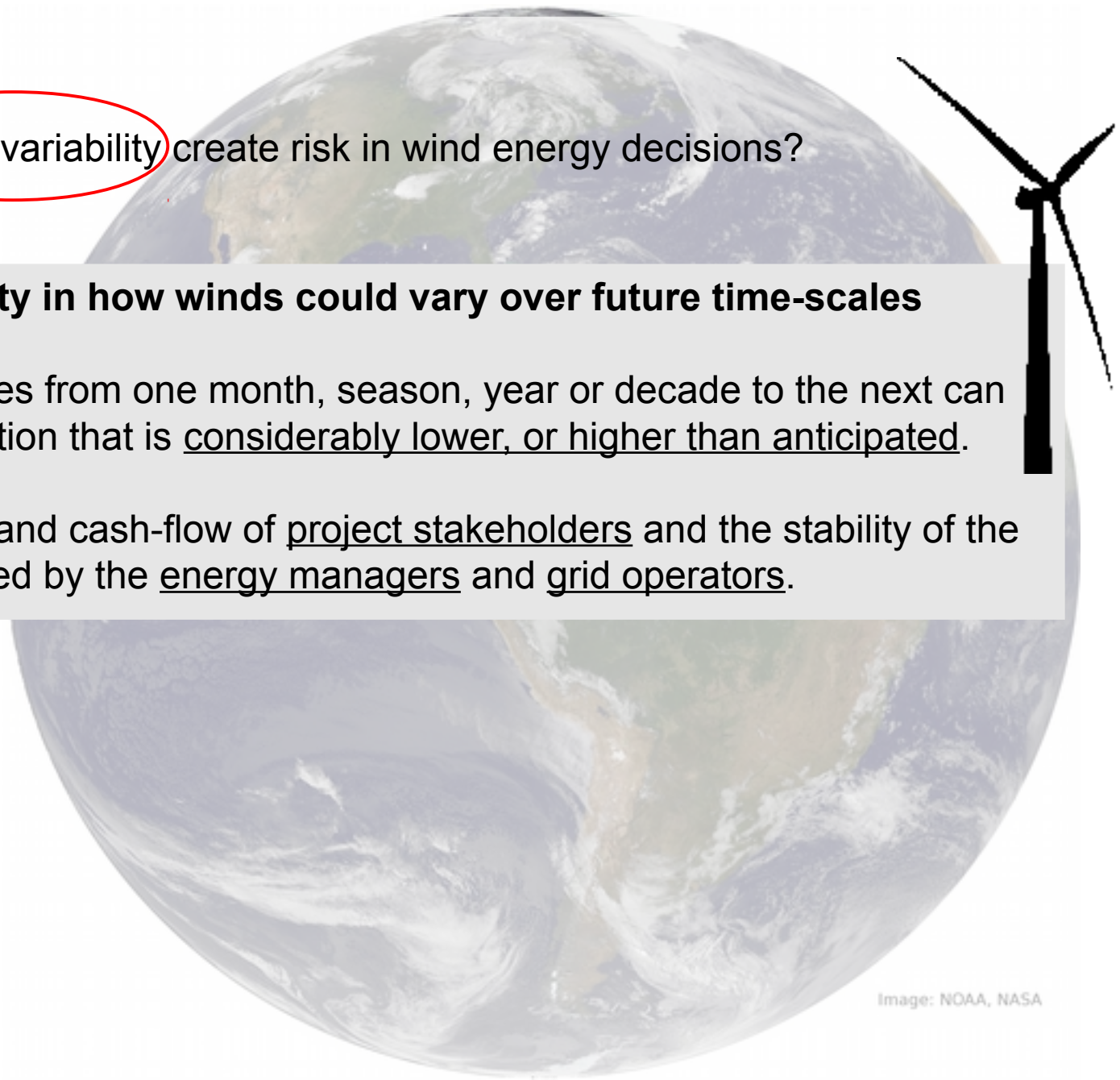
PROBLEM

How can climate variability create risk in wind energy decisions?



Problem:
Climate variability risk in wind decisions

Problem: How can climate variability create risk in wind energy decisions?



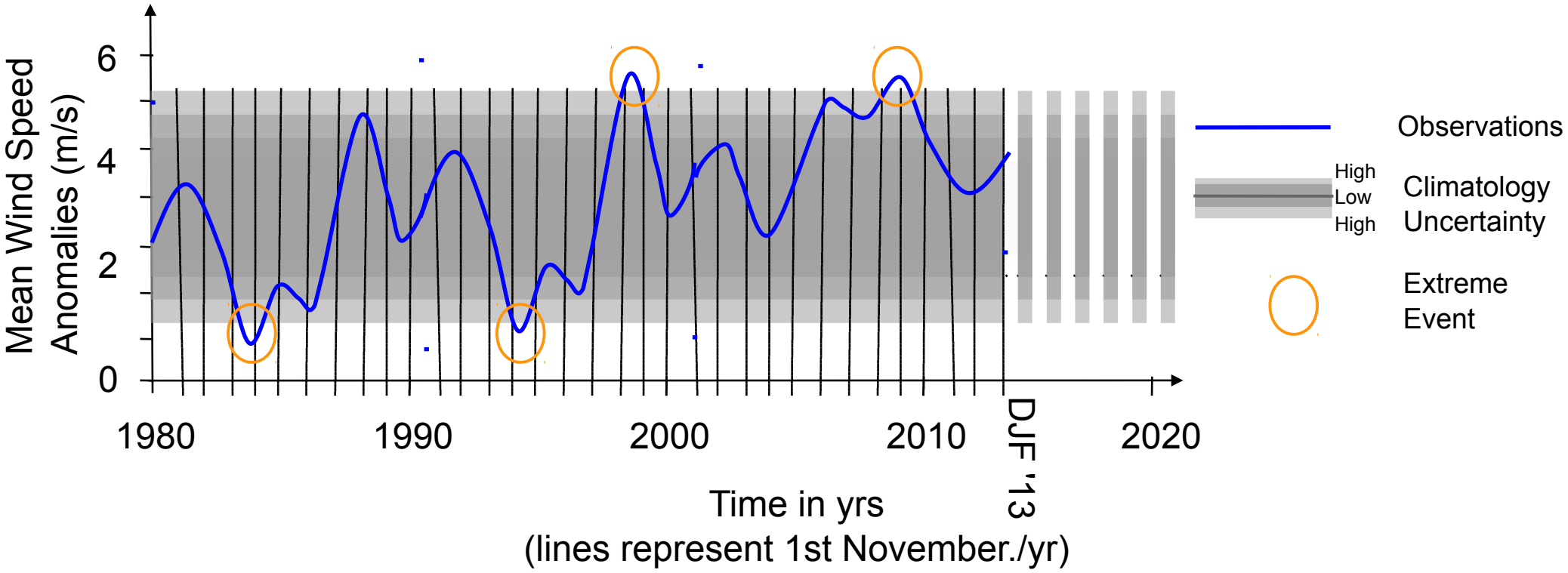
Large uncertainty in how winds could vary over future time-scales

- Variation in wind regimes from one month, season, year or decade to the next can result in power generation that is considerably lower, or higher than anticipated.

- Risk to the profitability and cash-flow of project stakeholders and the stability of the energy system controlled by the energy managers and grid operators.

Problem: How can climate variability create risk in wind energy decisions?

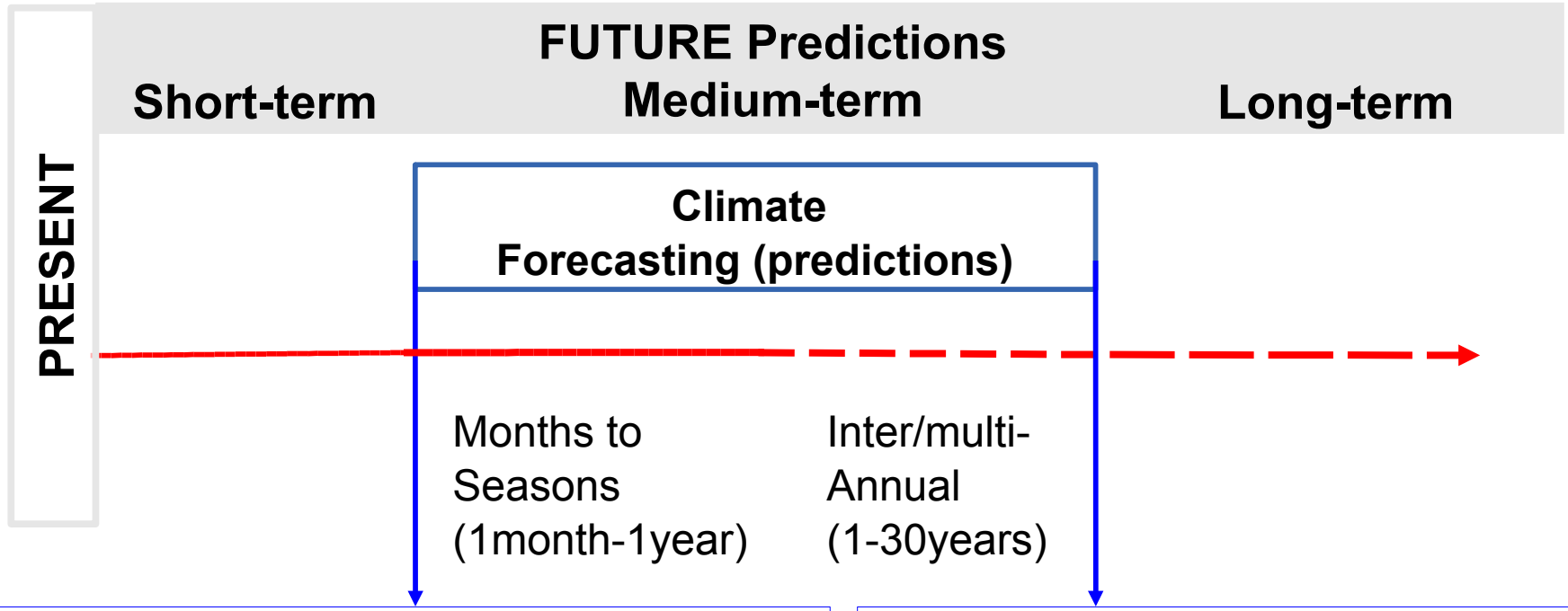
Seasonal Example: Winter (DJF) Variability in Wind Resource at Site X



-High uncertainty of future wind resource variability -

- Likelihood extreme events is unknown -

Problem:
Climate variability risk in wind decisions



OPERATIONAL decisions
(Wind farm/grid operator, trader)

Energy generation – balancing resources, trading penalties, extremes, insurance?
Maintenance – offshore most vulnerable

PLANNING decisions
(Policy maker, energy planning, grid development)

Market strategies – incentives, energy mix
Spatial planning – balancing resources, reinforce/redesign distribution network

INVESTMENT decisions

Site selection – robust resource assessments, portfolio design
Revenue – robust projections, volatility over time, insurance? (debt financing)

Problem:
Climate variability risk in wind decisions

RENEWABLE ENERGY WORLD.COM

Monday, October 07, 2013

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PROTECTING CLEAN ENERGY PIONEERS FOR OVER 25 YEARS

Wind Blows German Power Swings to Five-Year High

Rachel Morison and Julia Mengewein, Bloomberg

February 22, 2013 | 6 Comments

"Day-ahead **prices turned negative** for the first time in December [2012], amid **above-average wind output,** low demand due to **higher than average temperatures for the season."**

RWE AG, Germany's second biggest utility, "benefited from a substantial improvement"

Cumulus Energy Fund, a hedge fund surged 39 percent in December

In addition to the one-day market, utilities, banks and hedge funds trade electricity several years ahead.

"There used to be 50 extreme hours in a year and by 2020 it will be the new normal where you have 200 to 300 freaky hours"

SOLUTION

How can climate forecasting minimise this risk?

Solution:
Climate forecasting of wind resources

GUIDANCE/ RISK MANAGEMENT	ACTION/ RISK MINIMISATION

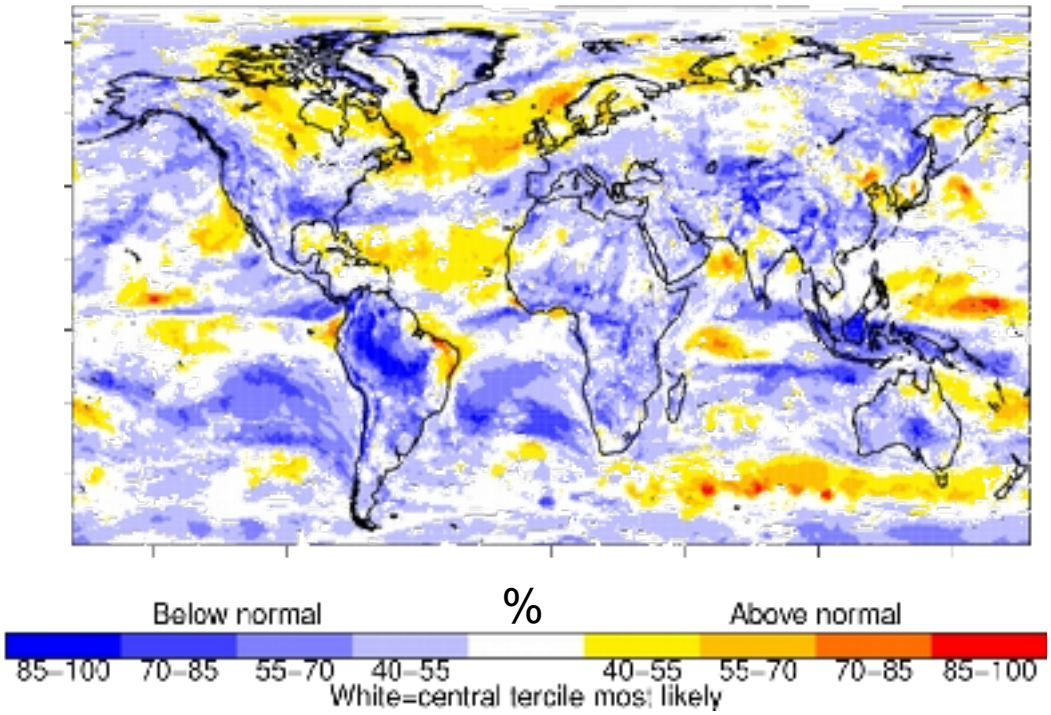
Planning decisions	Operational decisions
Investment decisions	

- *Robust assessments*
- *Contingency plans*
- *Early-warning systems*

- *Monitoring*
- *Mobilise resources*
- *Prepare measures*

- *Instruction*
- *Action*

Solution:
Climate forecasting of wind resources

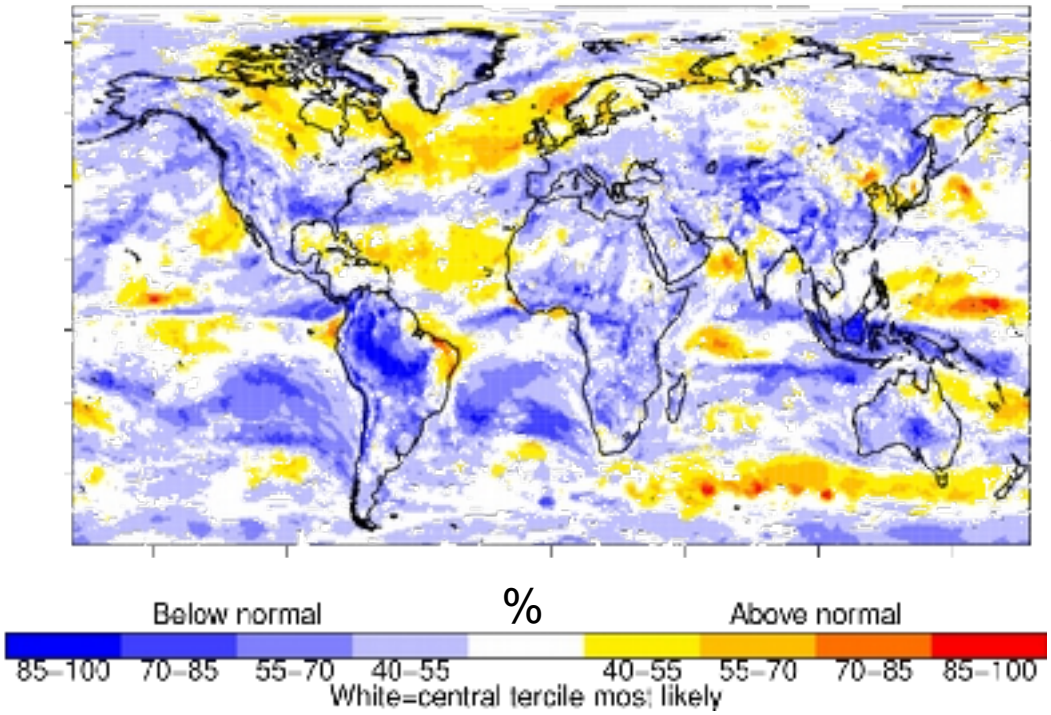


Winter 2012 wind **forecast**
Probability of the most likely wind speed tercile (%)

Climate forecast system: ECMWF S4
10m wind speed forecast
1 month forecast lead time

Winter 2012 wind **observations**

Solution:
Climate forecasting of wind resources



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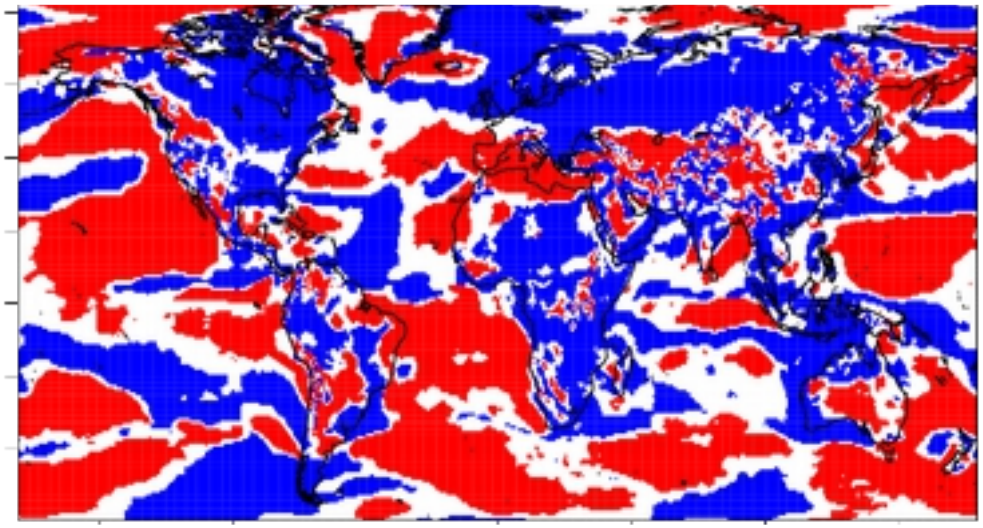
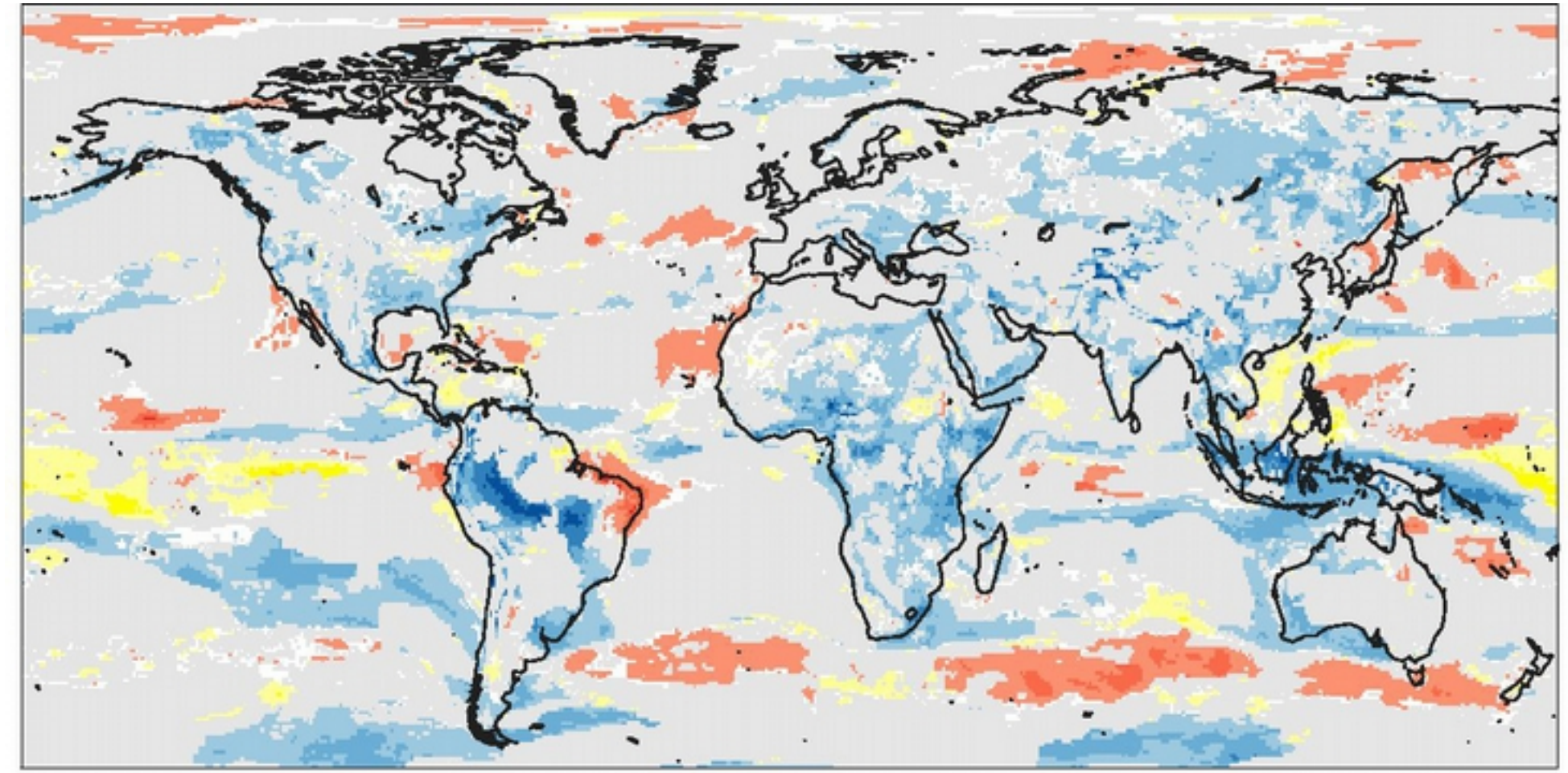


Winter 2012 wind **observations**

Solution:
Climate forecasting of wind resources

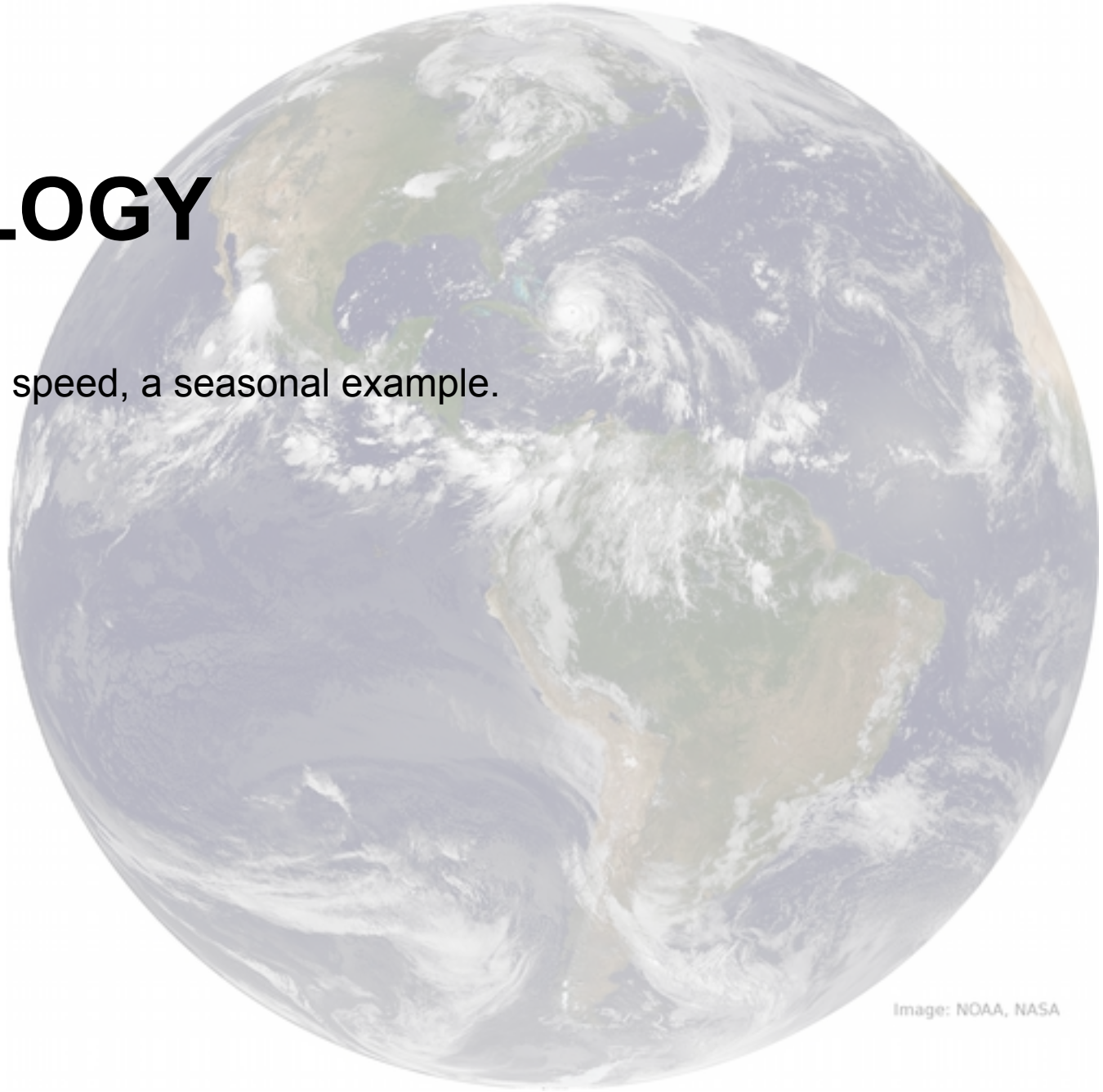
Winter 2012 wind **forecast against observation:**
Probability of the most likely wind speed tercile (%).
Grey shows regions that *did not* correspond.

Climate forecast system: ECMWF S4
10m wind speed forecast
1 month forecast lead time



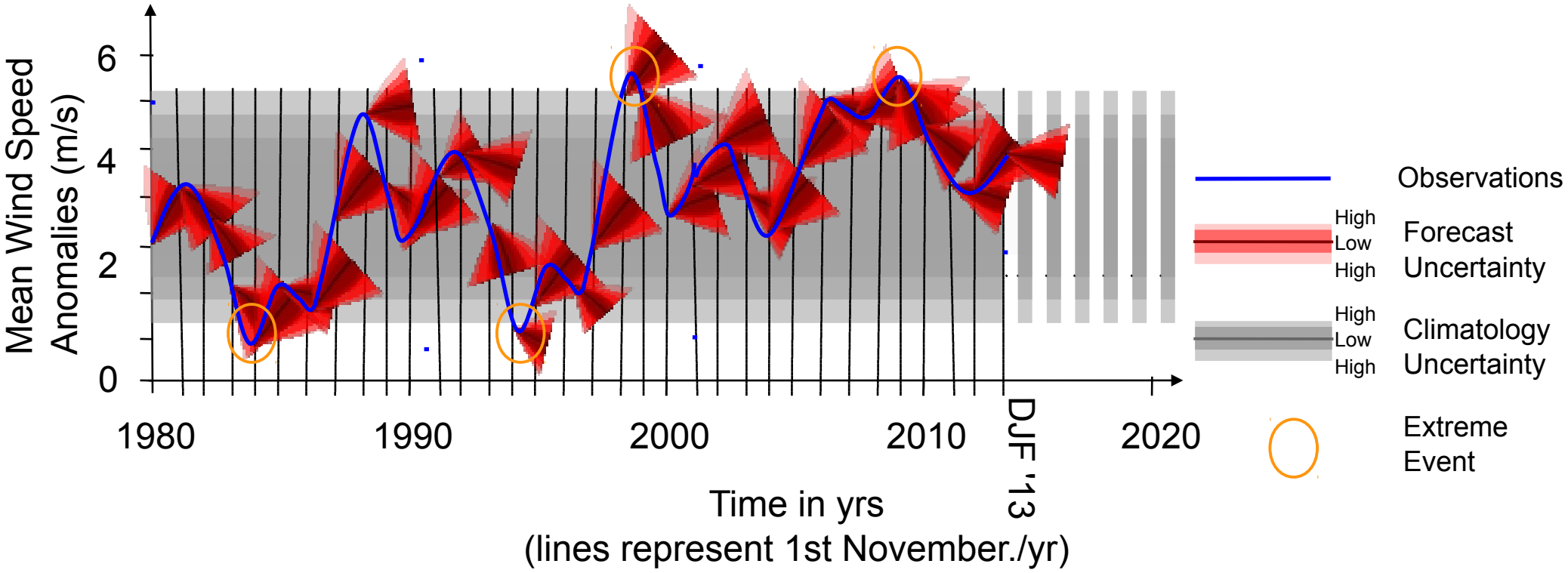
METHODOLOGY

Climate forecasting of wind speed, a seasonal example.



Solution: How can climate forecasting minimise the risk of wind variability?

Seasonal Example: Winter (DJF) Variability in Wind Resource at Site X

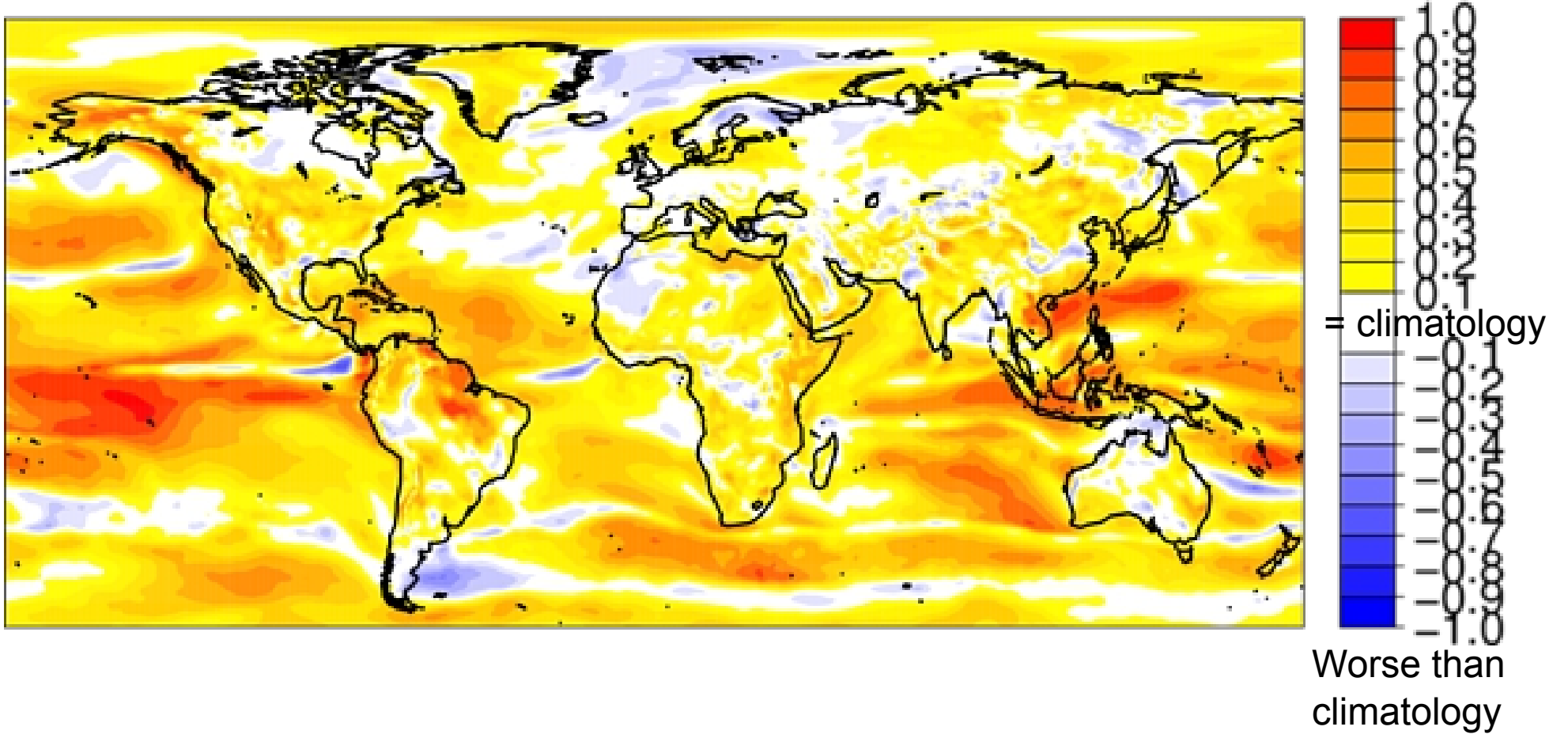


- Reduced uncertainty of future wind resource variability -

- Identify likelihood extreme events -

Winter wind forecast **verification**

Ability of climate forecast system to predict global wind speed in winter



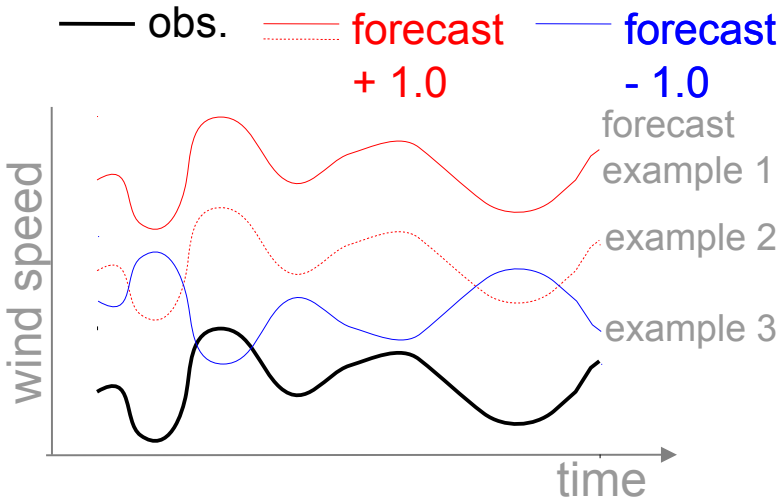
Climate forecast system: ECMWF S4
10m wind speed forecast
1 month forecast lead time

Baseline verification period 1981-2011
ERA-Interim reanalysis data used for past “observations”
- more representative with real observations

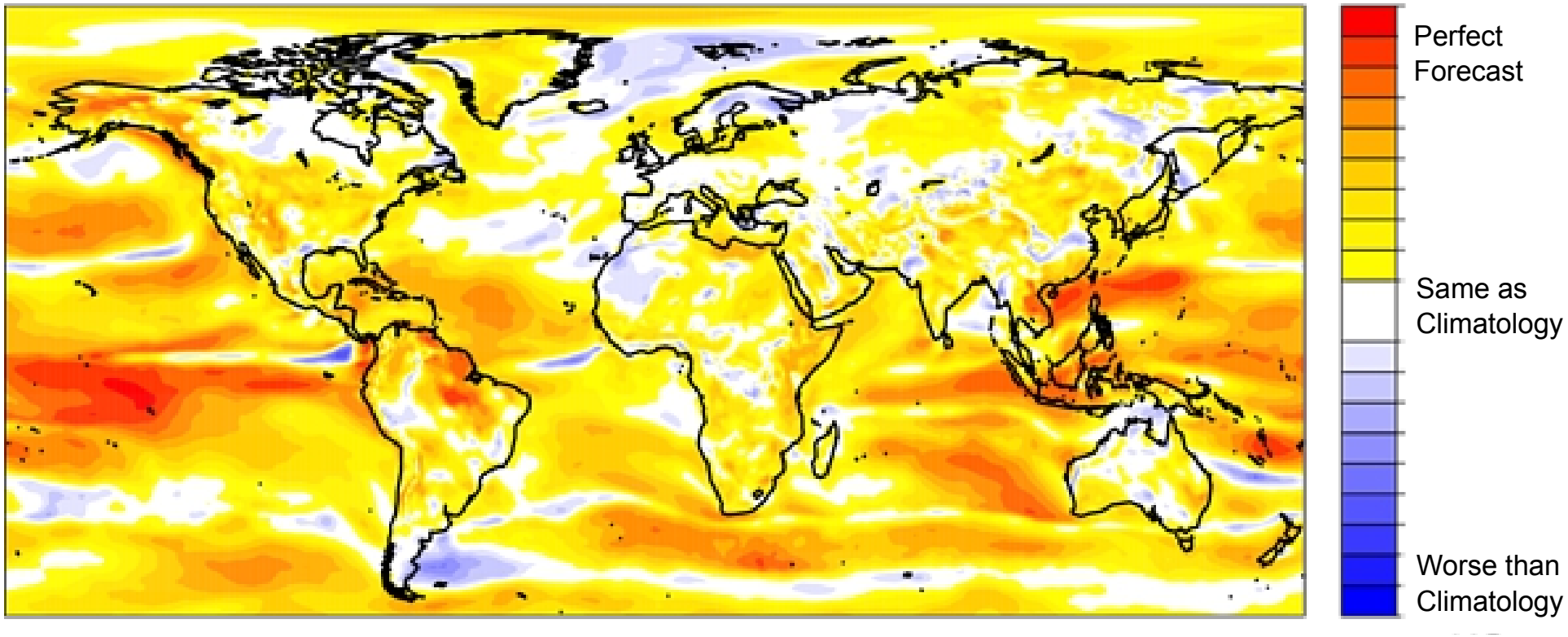
Methodology:
Climate forecasting of wind resources

Verification type I:

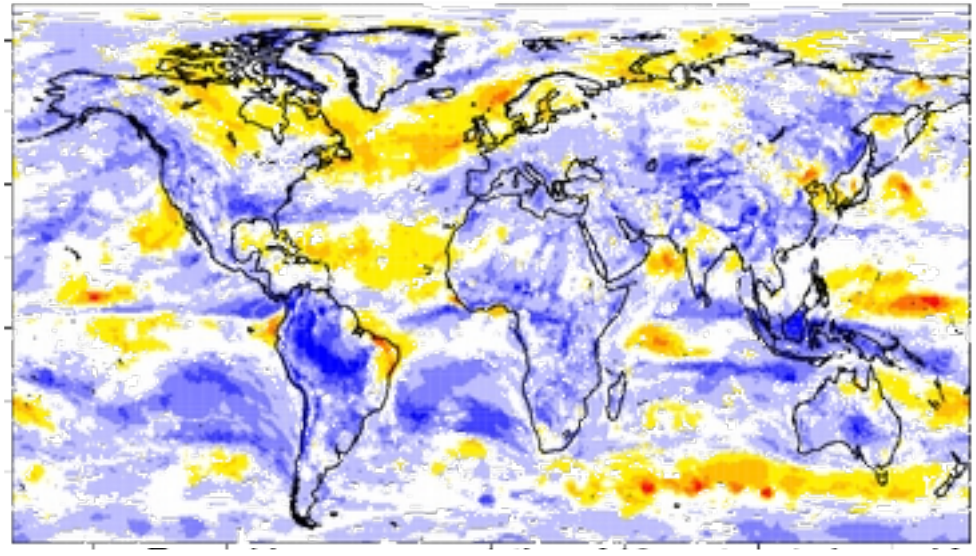
Can the wind forecast *mean* tell us about the wind resource variability <u>at a specific time</u>?



Winter season (December, January February) 1981-2011, **1 month** forecast lead time

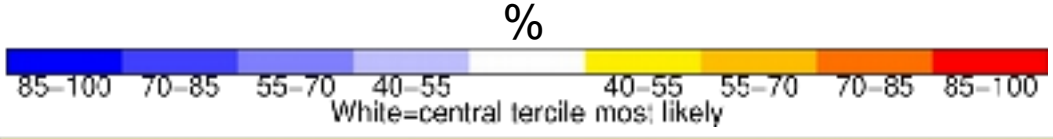


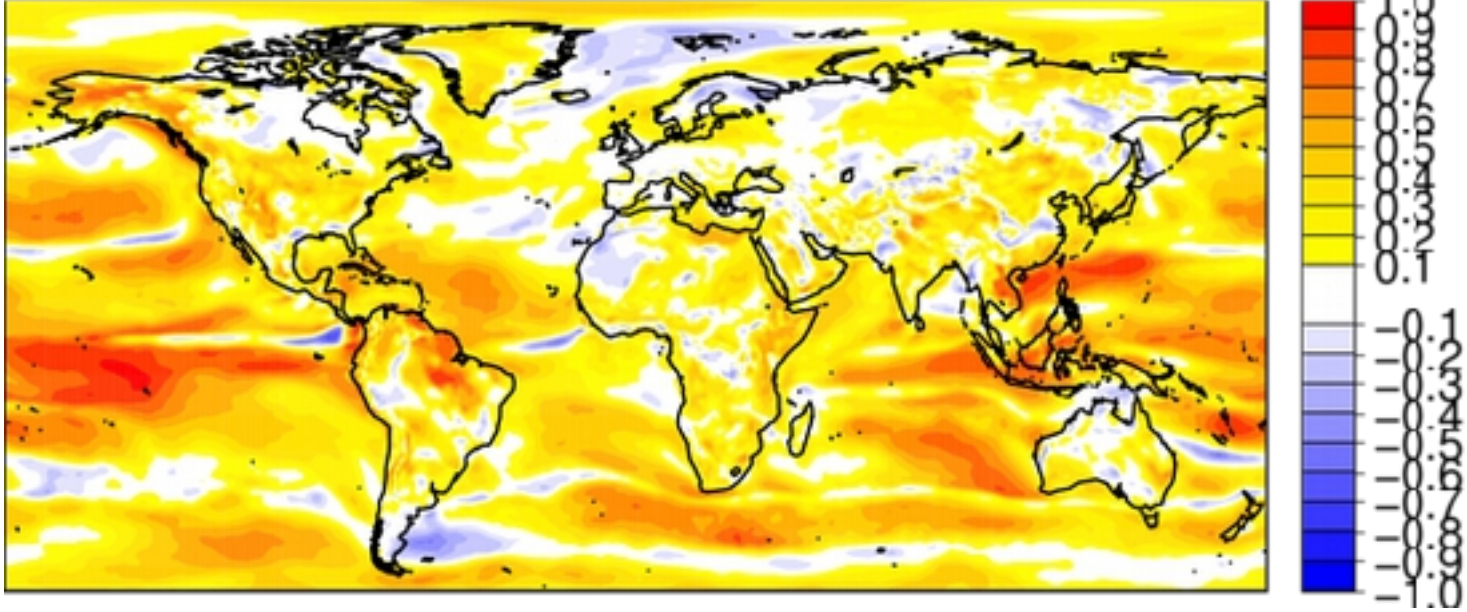
Methodology:
Climate forecasting of wind resources



Winter 2012 wind **forecast**
Probability of the most likely wind speed tercile (%)

Climate forecast system: ECMWF S4
10m wind speed forecast
1 month forecast lead time



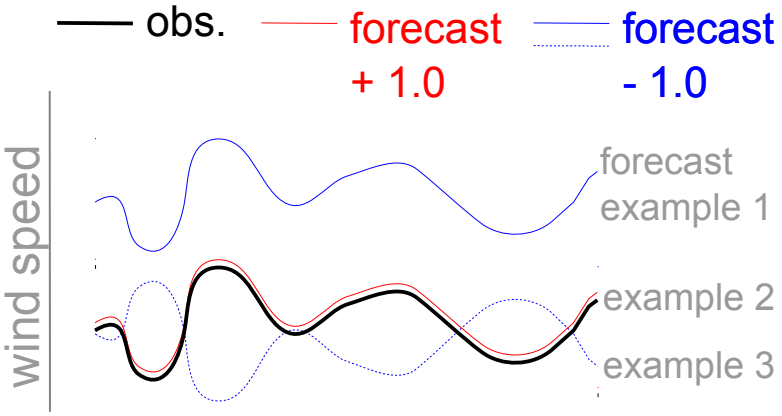


Winter wind forecast **verification**

Methodology:
Climate forecasting of wind resources

Verification type II:

Can the wind forecast *distribution* tell us about the magnitude of the wind resource variability, and its uncertainty <u>at a specific time</u>?



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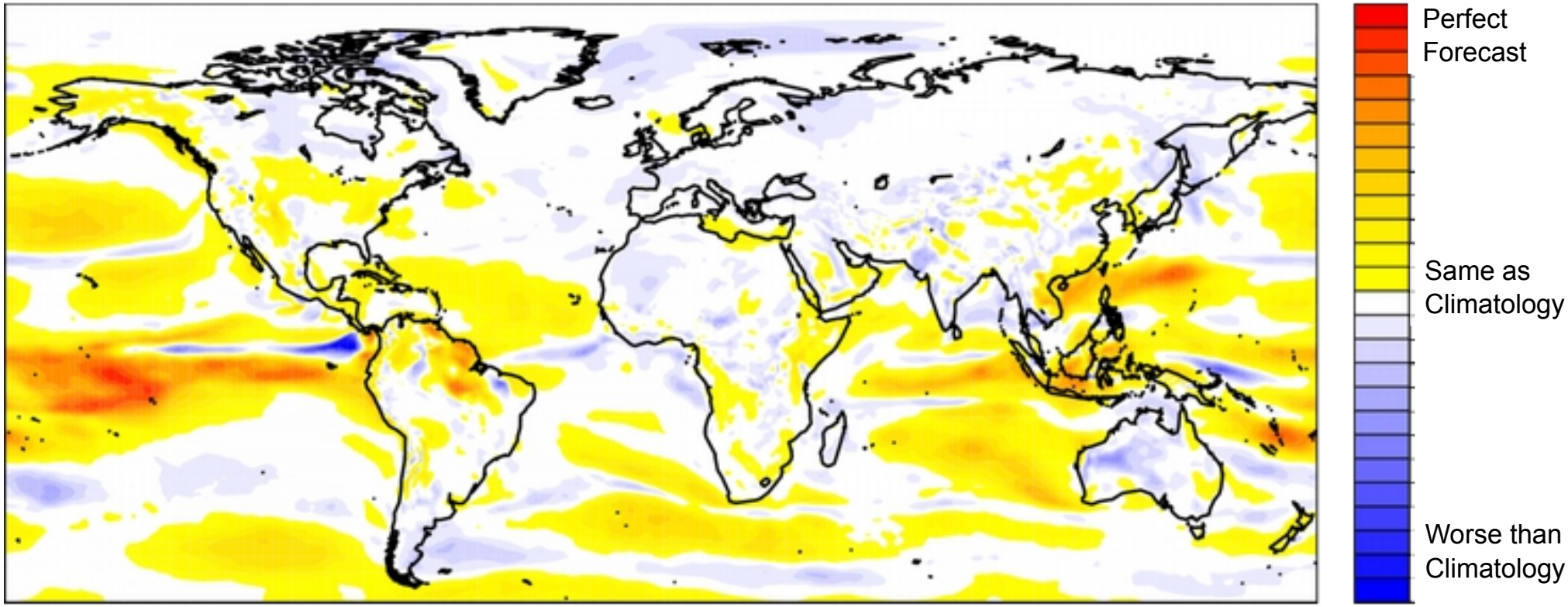
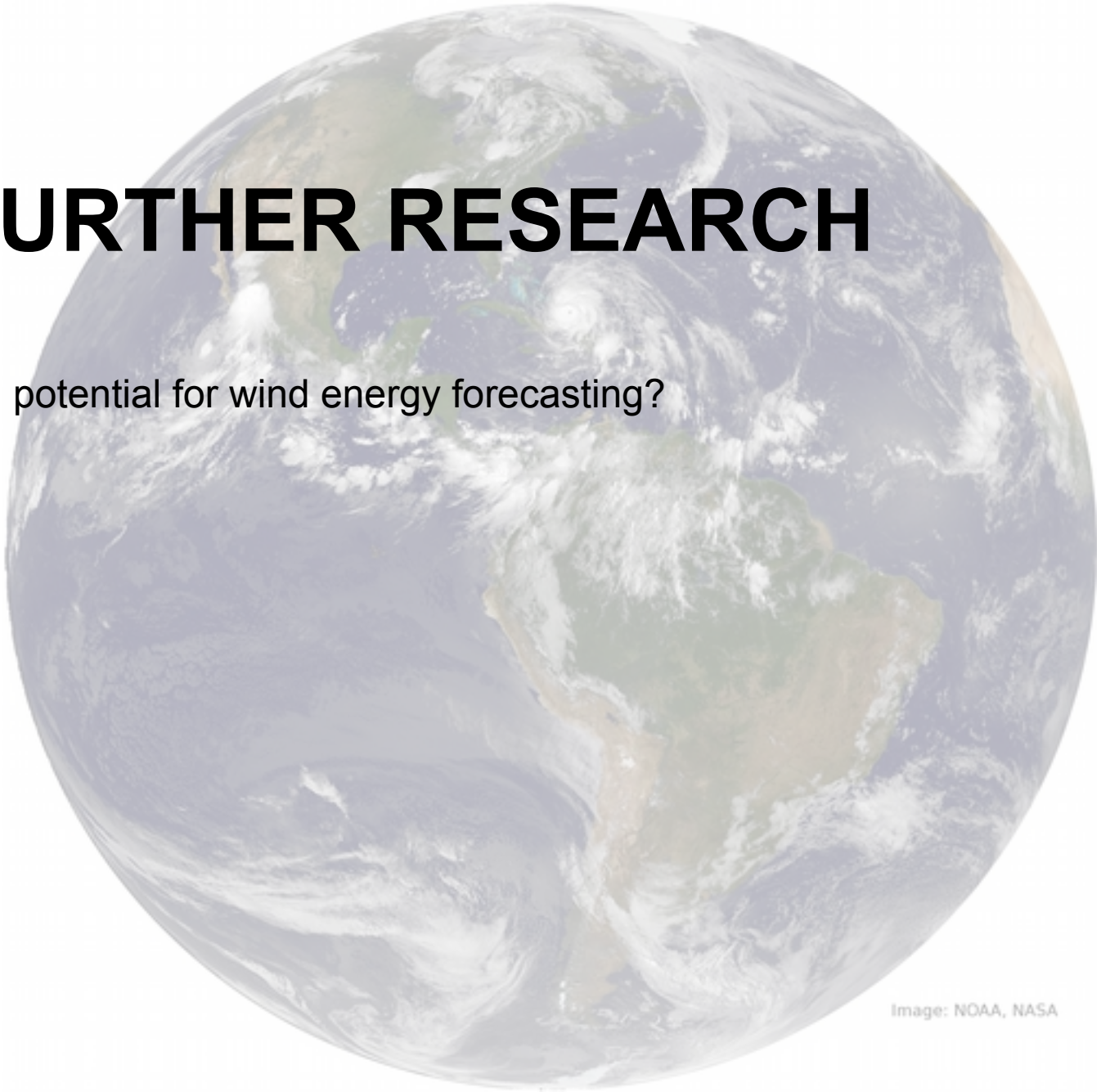


CAVEATS/FURTHER RESEARCH

What are the limitations and potential for wind energy forecasting?



Caveats and further research:
Climate forecasting for wind energy

Caveats

1. 10m wind not representative of wind turbine hub height.

2. Lack of relevant, observational wind data for robust validations of forecast skill: reanalysis data used instead.

3. Seasonal wind forecasts assessed with a single climate model with 15 ensemble members: a multi-model approach is needed with more ensemble members.

Further research

1. Multi-model approach needed for a more robust forecast skill assessment.

2. Seasonal wind forecasts to be made down to site-specific scales.

3. Collaborations needed to run seasonal wind forecasts with wind energy models to get power outputs.

4. Explore the potential of decadal wind forecasts for wind energy sector.

Conclusions:

Climate forecasting for wind energy

1. Wind forecasting over seasonal to decadal timescales can help to minimise risk of future wind variability on operational, planning and investment decisions

2. Some global regions are more vulnerable to wind resource variability over seasonal timescales than others

3. Although wind forecast skill is limited in some regions, there are others that show good potential (more so for predicting the resource variability than magnitude)

4. There is scope for significant improvement with further research and better observational datasets.

5. Seasonal wind forecasting is an emerging climate service within the energy/renewable energy sector, whilst decadal wind forecasts are yet to be explored.

CLIMATE SERVICES FOR ENERGY

Using forecasts in decision-making processes

Is the end user engaged? Do they identify the need for climate forecasts?

STAGE 1: Create need

- How can this benefit you?

STAGE 2: Make product/service useful and usable

- Easy to understand: clear visualisations, communications
- Guidance for use in specific decisions

STAGE 3: Build trust

- Effective communication
- Understand limitations
- Probabilistic information: benefit with time

yr.no

Search in forecasts for Norway and the world:

SEARCH

Enter a place name, e.g. Stavanger, Rest or Beijing. Advanced search

nrk Meteorologisk institutt

Front page > Italy > Friuli-Venezia Giulia > Trieste

Weather forecast for

Trieste, Friuli-Venezia Giulia (Italy)

Updated at 20:04. **Next update around 9:00.**

Add to My places 9

Forecast as PDF

- Overview
- Hour by hour
- Long term
- Statistics
- Værkart

RELEVANT PLACES

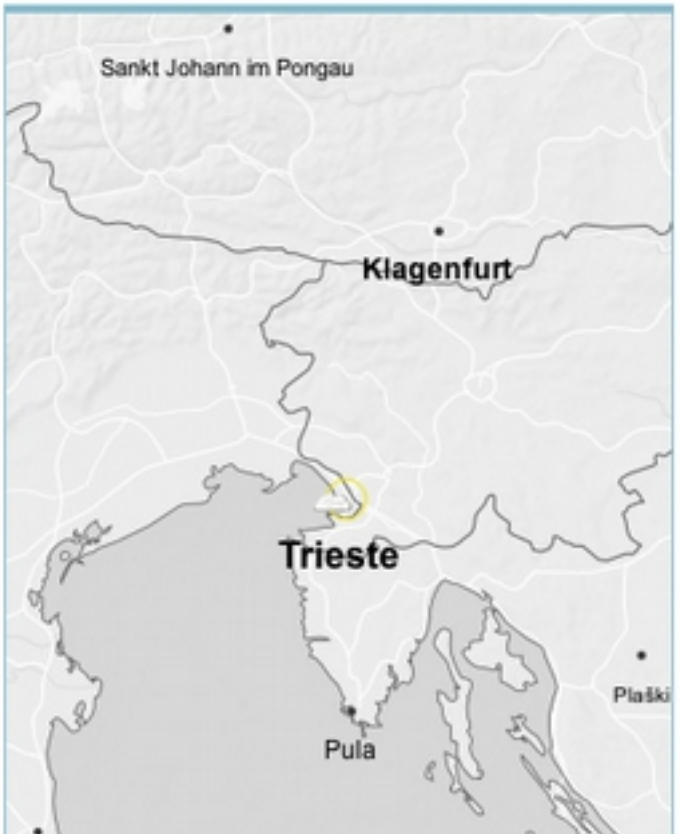
- Trieste
- Sagunto
- Barcelona
- Cadaqués
- Bilbao
- San Sebastian
- Pamplona
- Huesca
- Begur
- Granada

Today, Tuesday 03/12/2013

Time	Forecast	Temp.	Precipitation	Wind
04:00–07:00		3°	0 mm	Moderate breeze, 9 m/s from east-northeast
07:00–13:00		2°	0 mm	Moderate breeze, 6 m/s from east-northeast
13:00–19:00		8°	0 mm	Moderate breeze, 7 m/s from east-northeast
19:00–01:00		3°	0 mm	Gentle breeze, 5 m/s from east-northeast

Tomorrow, Wednesday 04/12/2013

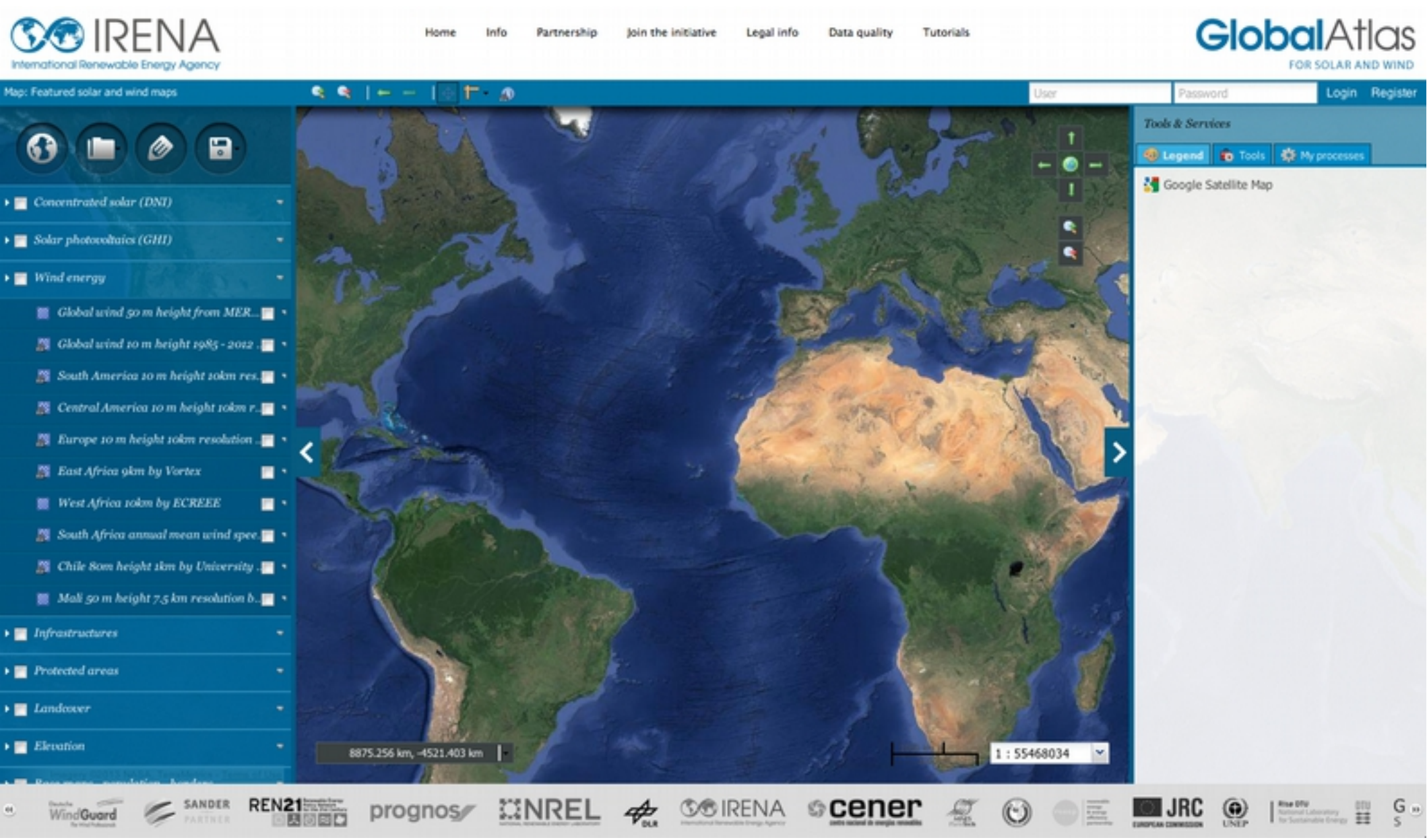
Time	Forecast	Temp.	Precipitation	Wind
01:00–07:00		1°	0 mm	Light breeze, 3 m/s from east-northeast
07:00–13:00		0°	0 mm	Light breeze, 3 m/s from east-northeast
13:00–19:00		11°	0 mm	Calm, 1 m/s



Advancing Renewable Energy with Climate Services (ARECS)

Join the initiative at: **www.arecs.org**

- Seasonal and decadal, wind and solar forecast information
- Provide feedback, register your needs
- Receive a quarterly seasonal wind forecast newsletter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Wind energy
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Global wind 10 m height 1985 - 2012 ...
South America 10 m height 10km res...
Central America 10 m height 10km r...
Europe 10 m height 10km resolution ...
East Africa 9km by Vortex
West Africa 10km by ECREEE
South Africa annual mean wind spee...
Chile 80m height 1km by University ...
Mali 50 m height 7.5 km resolution b...
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Tools & Services
Legend
Tools
My processes
Google Satellite Map
8875.256 km, -4521.403 km
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Goiás
Brasilia
Nuestra Señora de La Paz
Bolivia
Minas Gerais

THANK YOU

melanie.davis@ic3.cat

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CLIM-RUN, www.climrun.eu (GA n° 265192)
EUPORIAS, www.euporias.eu (GA n° 308291)
SPECS, www.specs-fp7.eu (GA n° 308378)