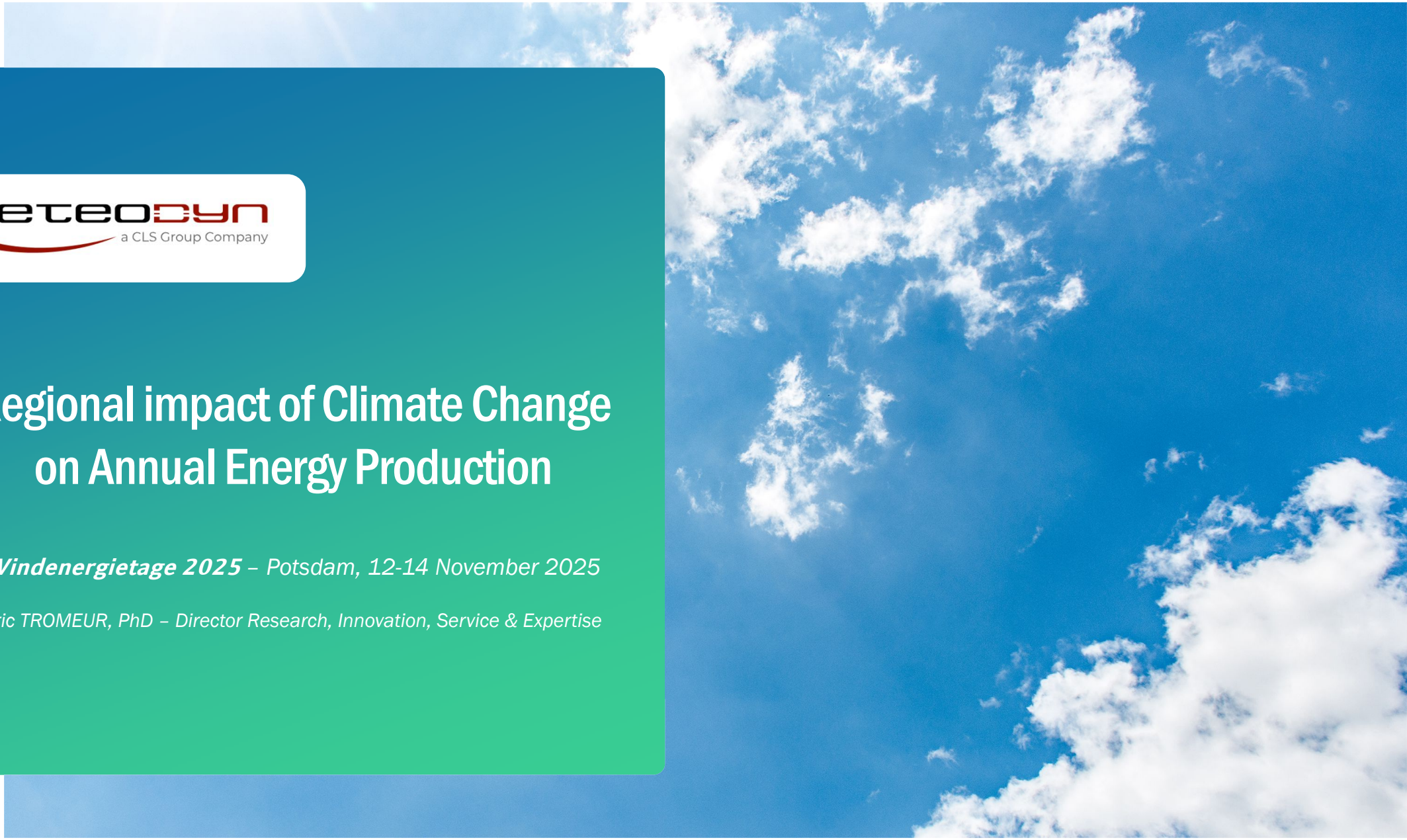
meteodyn
a CLS Group Company

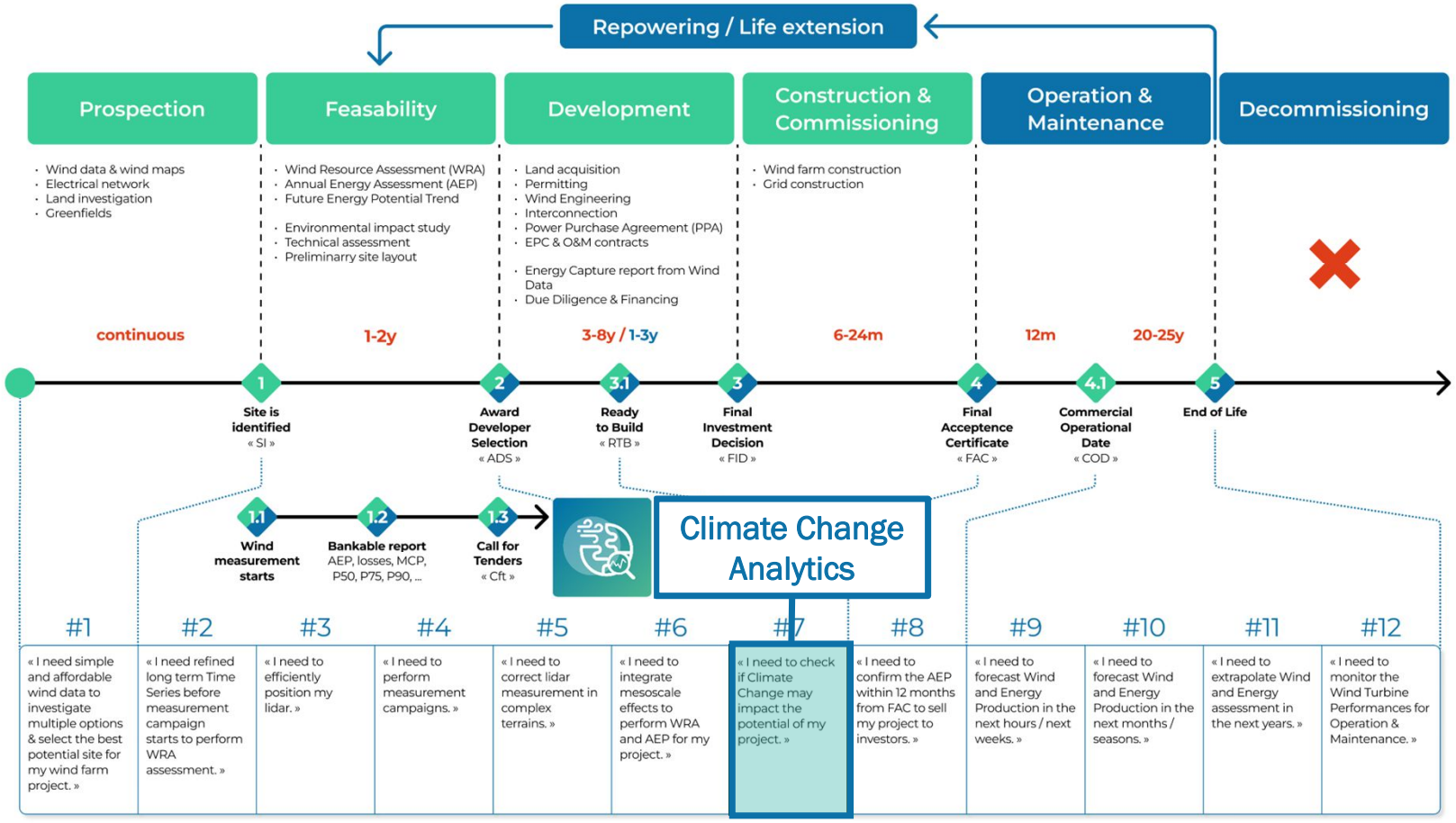
Regional impact of Climate Change on Annual Energy Production

Windenergietage 2025 – *Potsdam, 12-14 November 2025*

Eric TROMEUR, PhD – Director Research, Innovation, Service & Expertise

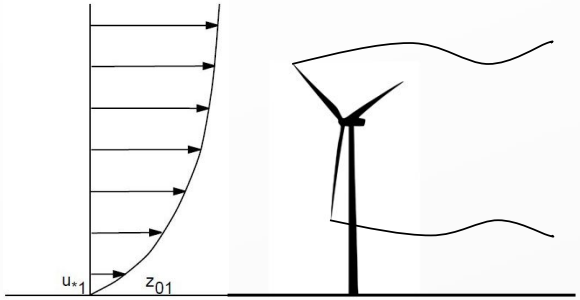


Wind Farm Life-Cycle

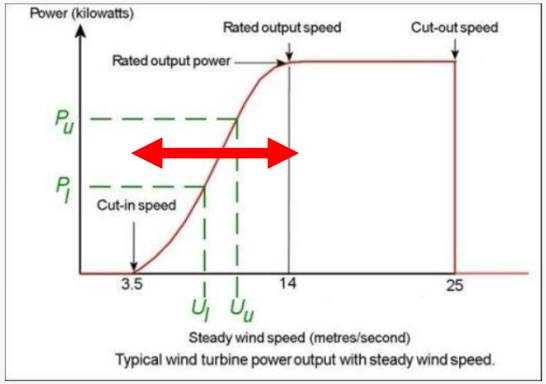


Context & Challenges

WIND FARM



WIND POWER



Typical wind turbine power output with steady wind speed.

How would the wind pattern change in the future?

Would the wind energy decrease in the future?

How could we assess climate change impacts on wind resource and energy?

Context & Challenges

- Rising
  - Global *T*
  - Sea level
  - Ocean salinity
  - Extreme events freq. and strength
- Ecosystems disruption
- Agricultural impacts
- Water resource stress

What about future wind speed tendency ?

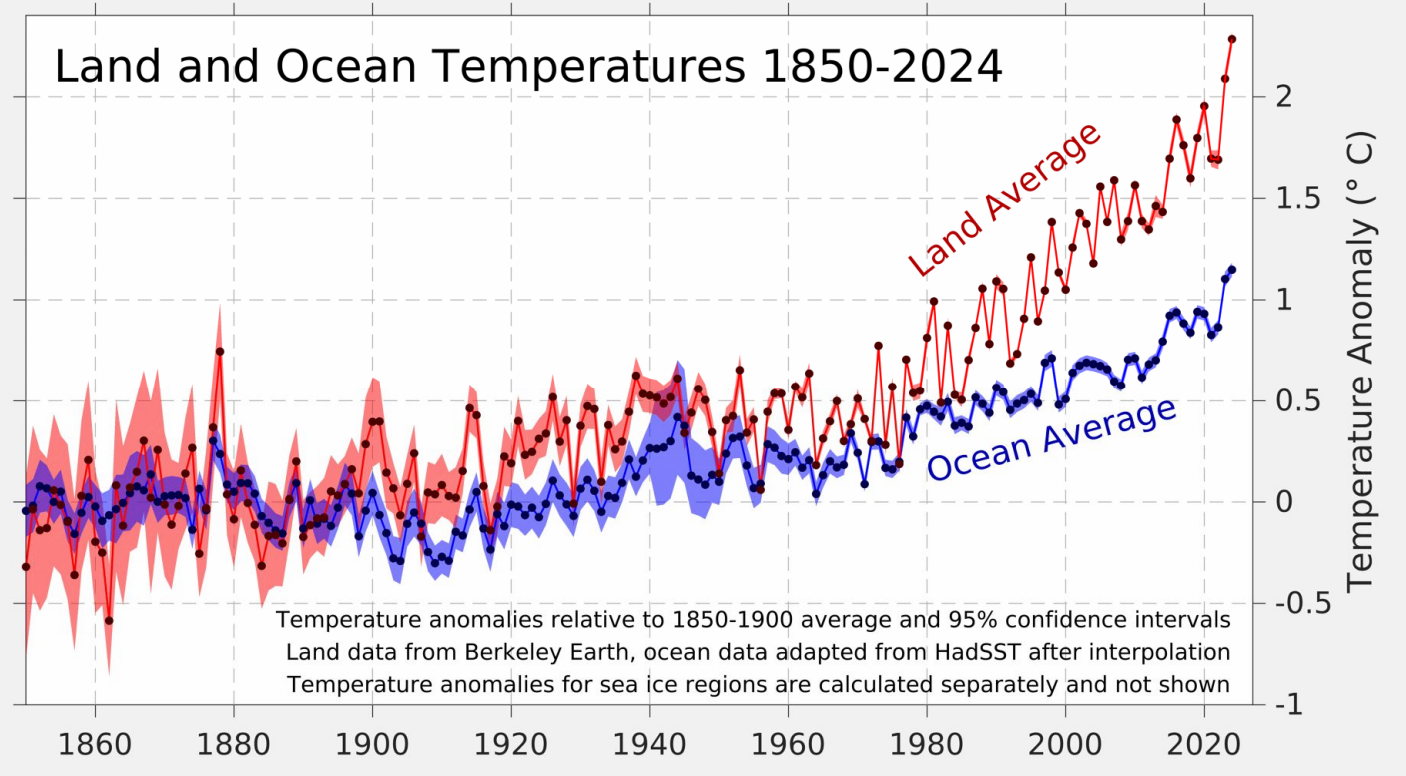
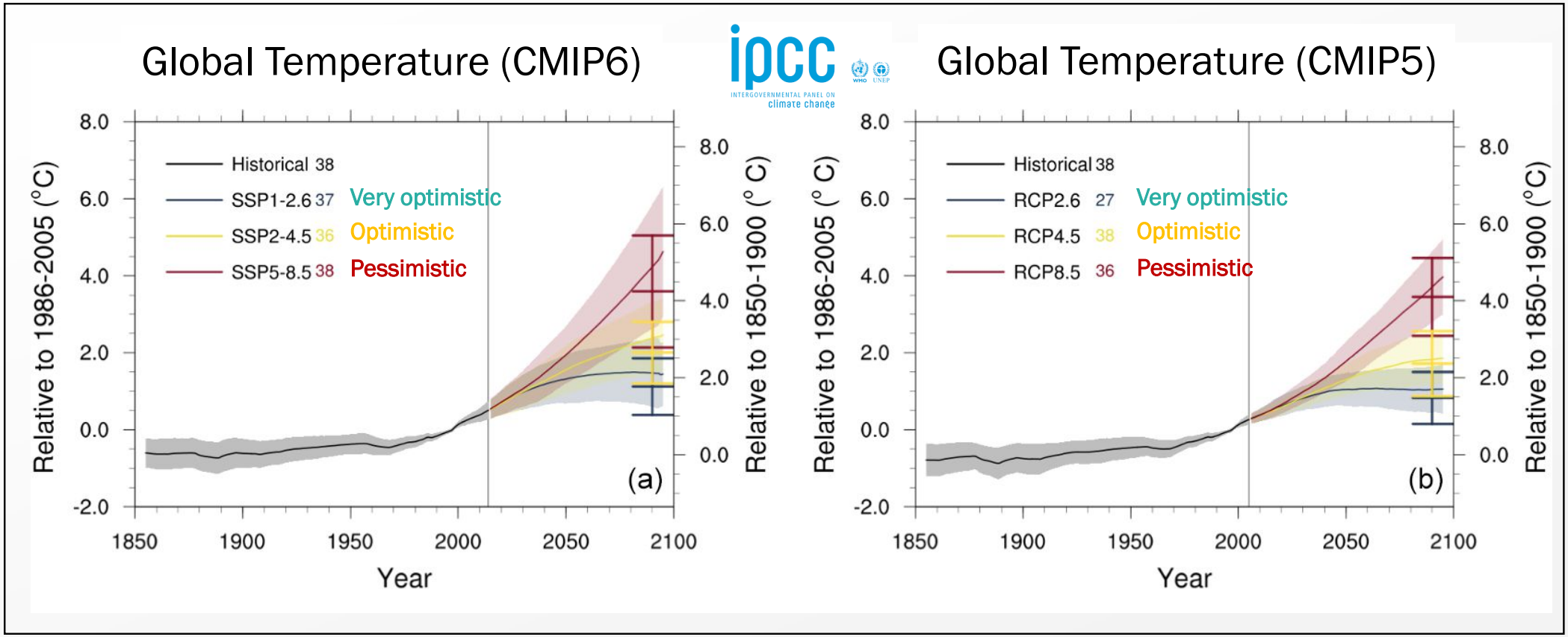


Image: berkeleyearth.org

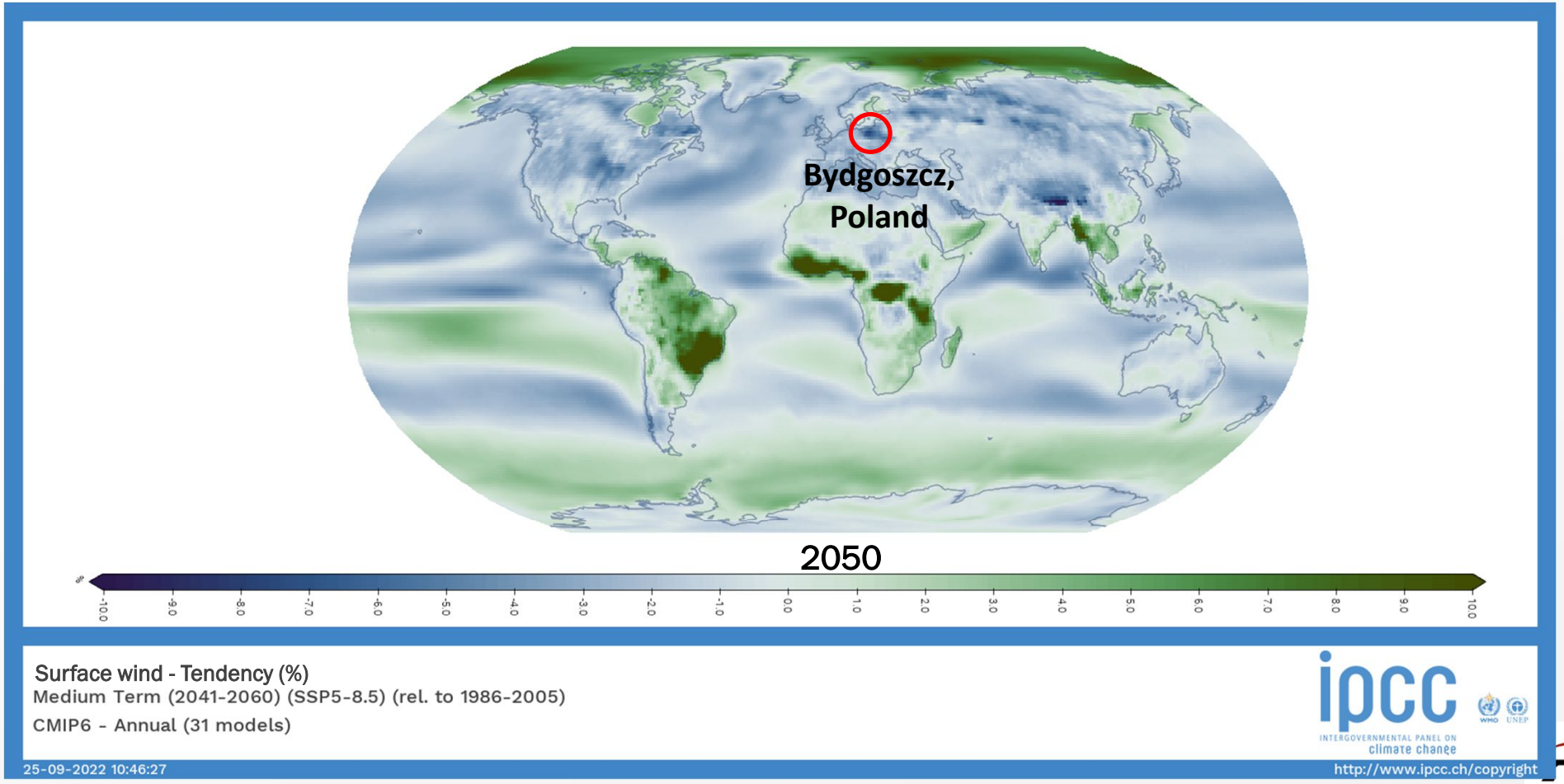
Climate Scenarios & Horizons



Tebaldi et al, Earth Syst. Dynam., 12, 253–293, 2021, https://doi.org/10.5194/esd-12-253-2021

CMIP : Coupled Model Intercomparison Project

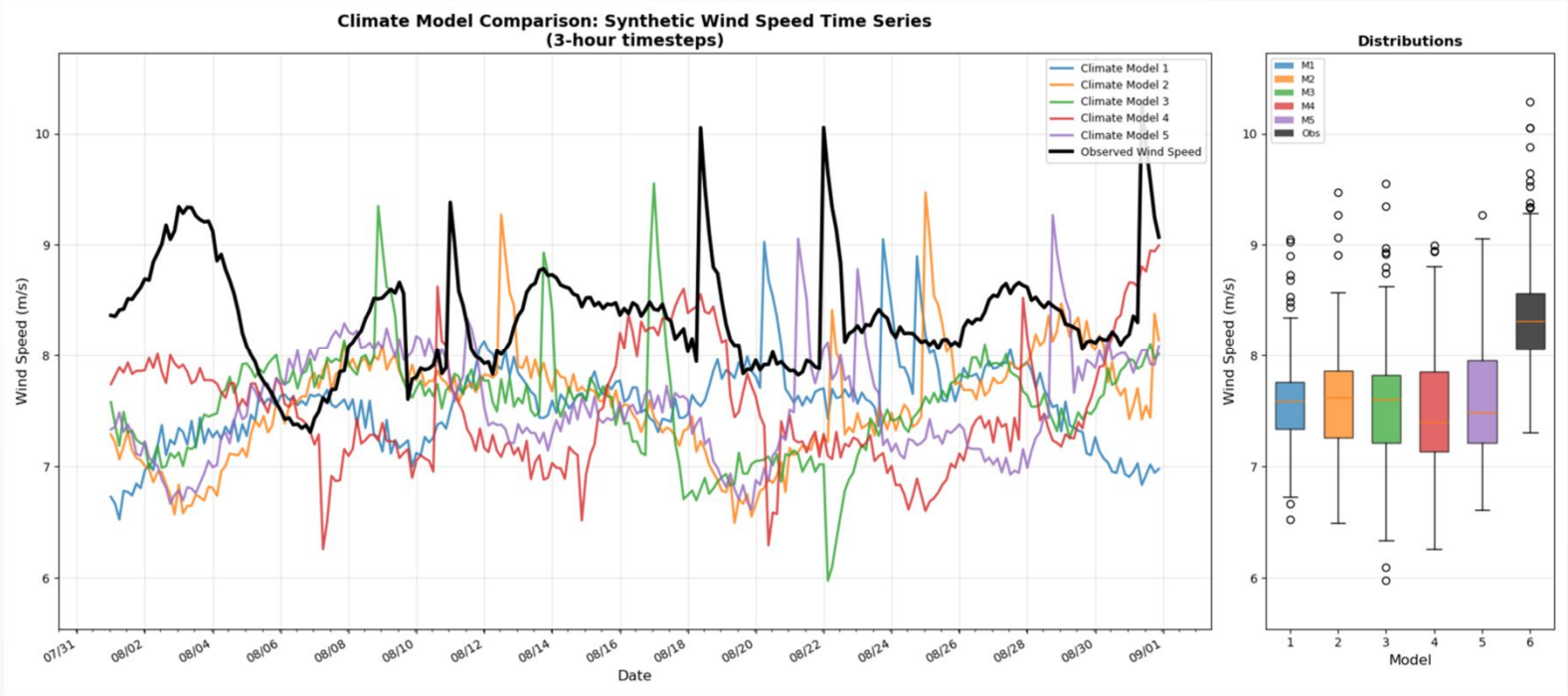
Climate Change | Case Study



Multimodel Projection Challenges

- Traditional approach:

  Equal model weights
- Similar **RMSE** across models
- Unable to **discriminate** best performers
- Large **projection uncertainties**



Need for better selection methods

Assess climate model quality

New Statistical Method for Model Selection

- **Advanced performance** metrics
- **Multiple validation** criteria
- Clear **model ranking** system
- Some models **significantly better**

Improved projection confidence !

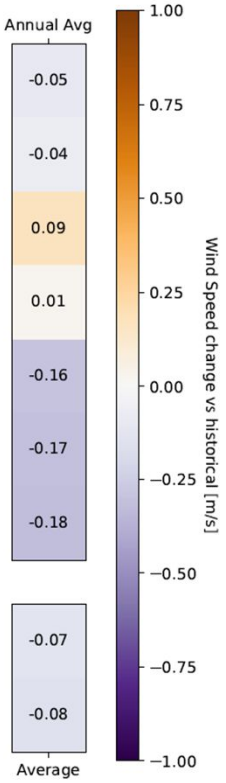
Wind Speed Change compared to historical period (m/s)

2035

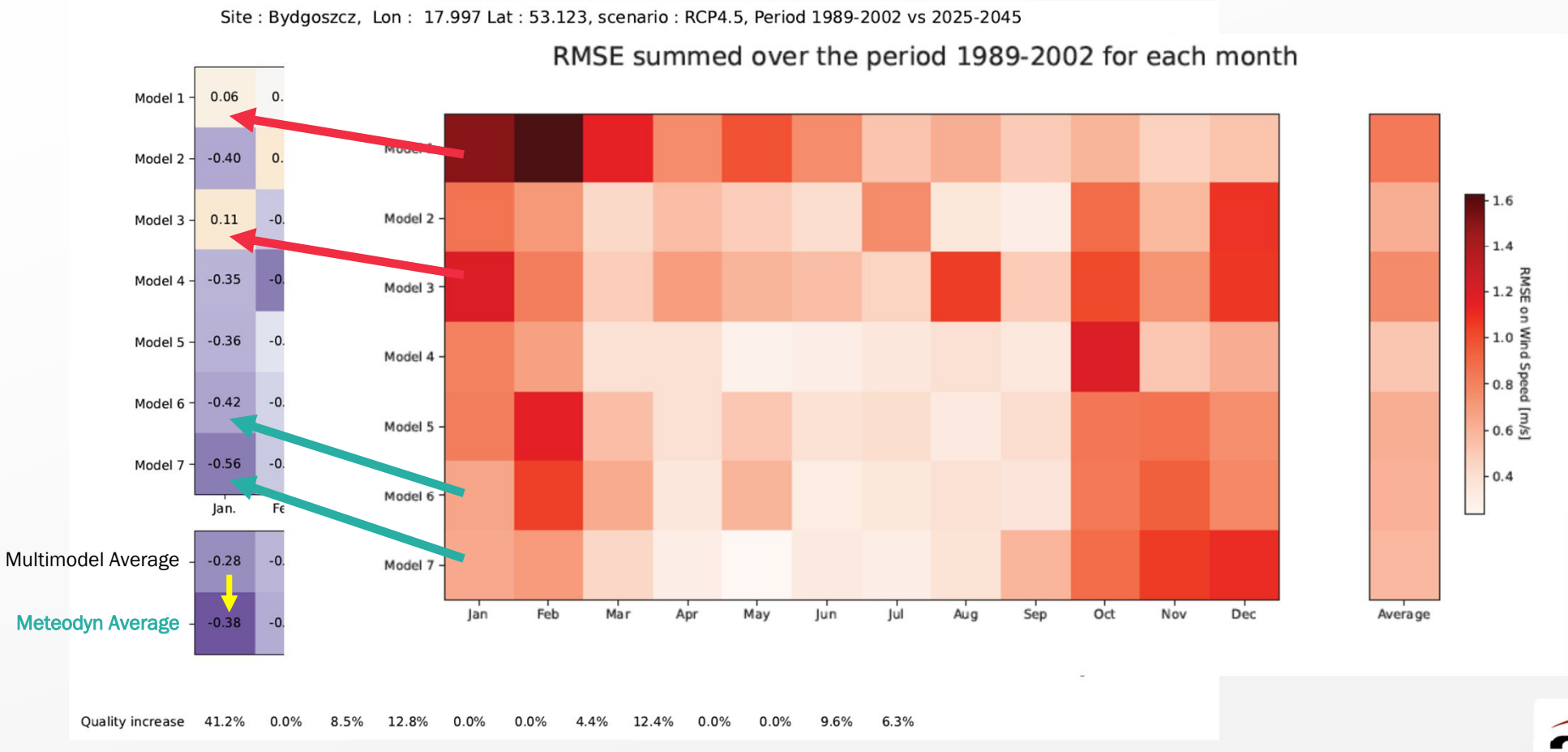
Site : Bydgoszcz, Lon : 17.997 Lat : 53.123, scenario : RCP4.5, Period 1989-2002 vs 2025-2045

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Avg
Model 1	0.06	0.00	0.28	-0.10	-0.17	-0.03	-0.33	0.12	-0.06	-0.30	-0.02	-0.08	-0.05
Model 2	-0.40	0.11	-0.10	-0.06	-0.22	0.02	0.17	-0.07	-0.36	0.15	0.38	-0.09	-0.04
Model 3	0.11	-0.28	0.09	-0.07	-0.01	0.02	0.30	-0.26	0.25	0.22	0.02	0.79	0.09
Model 4	-0.35	-0.56	-0.01	-0.05	0.14	-0.00	0.22	0.03	0.27	0.15	-0.01	0.44	0.01
Model 5	-0.36	-0.14	-0.42	0.02	-0.26	-0.08	-0.30	-0.01	-0.08	0.28	-0.37	-0.16	-0.16
Model 6	-0.42	-0.22	-0.38	-0.03	-0.16	-0.02	-0.41	-0.32	0.03	0.31	-0.15	-0.19	-0.17
Model 7	-0.56	-0.27	-0.54	-0.00	-0.32	0.08	-0.22	0.16	0.07	0.25	-0.40	-0.30	-0.18
Multimodel Average	-0.28	-0.19	-0.15	-0.04	-0.14	-0.00	-0.08	-0.05	0.02	0.15	-0.08	0.06	-0.07
Meteodyn Average	-0.38	-0.22	-0.19	-0.03	-0.14	0.00	-0.10	-0.04	0.01	0.15	-0.04	0.05	-0.08
Quality increase	41.2%	0.0%	8.5%	12.8%	0.0%	0.0%	4.4%	12.4%	0.0%	0.0%	9.6%	6.3%	

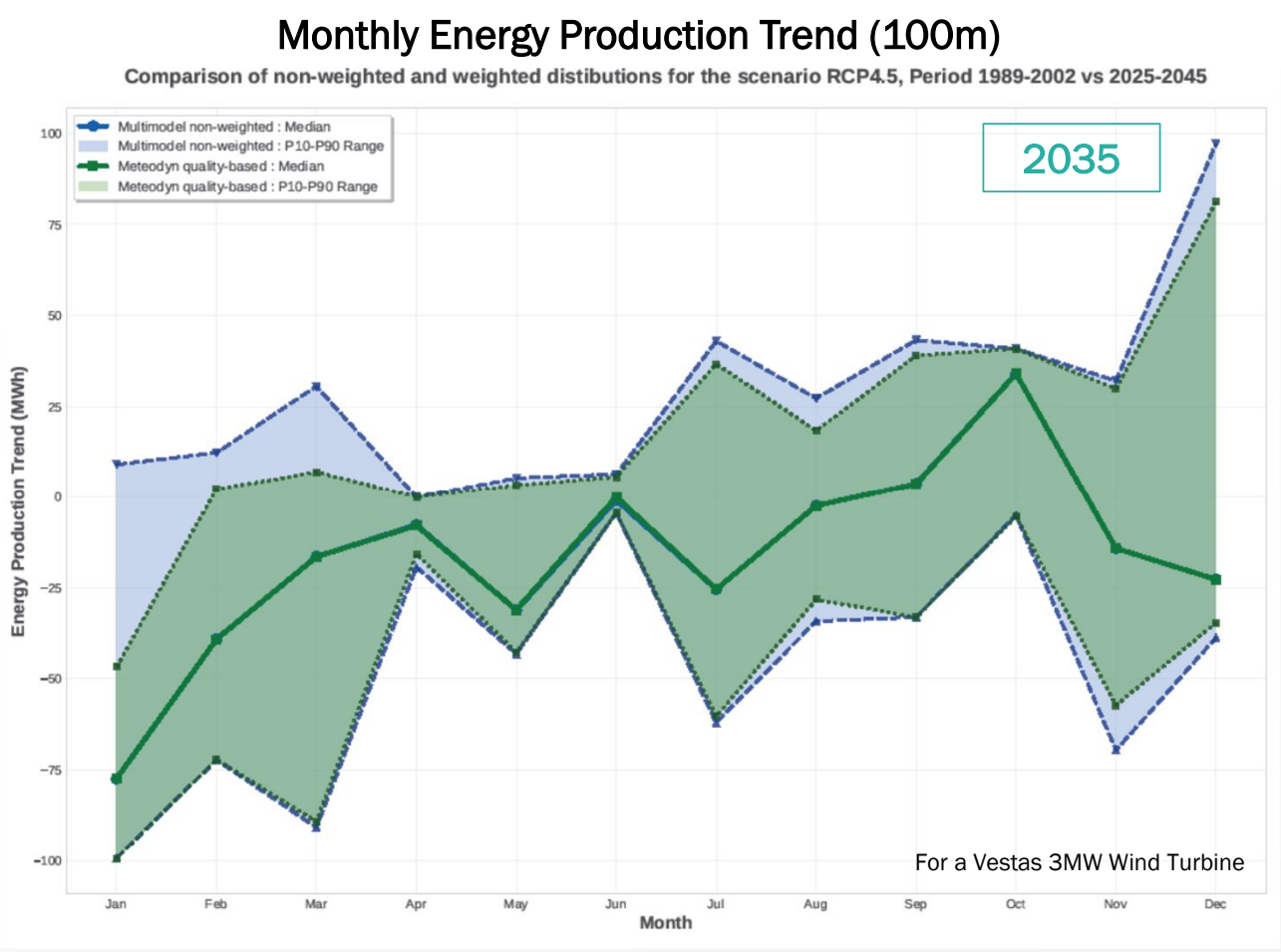
Average



New Statistical Method for Model Selection

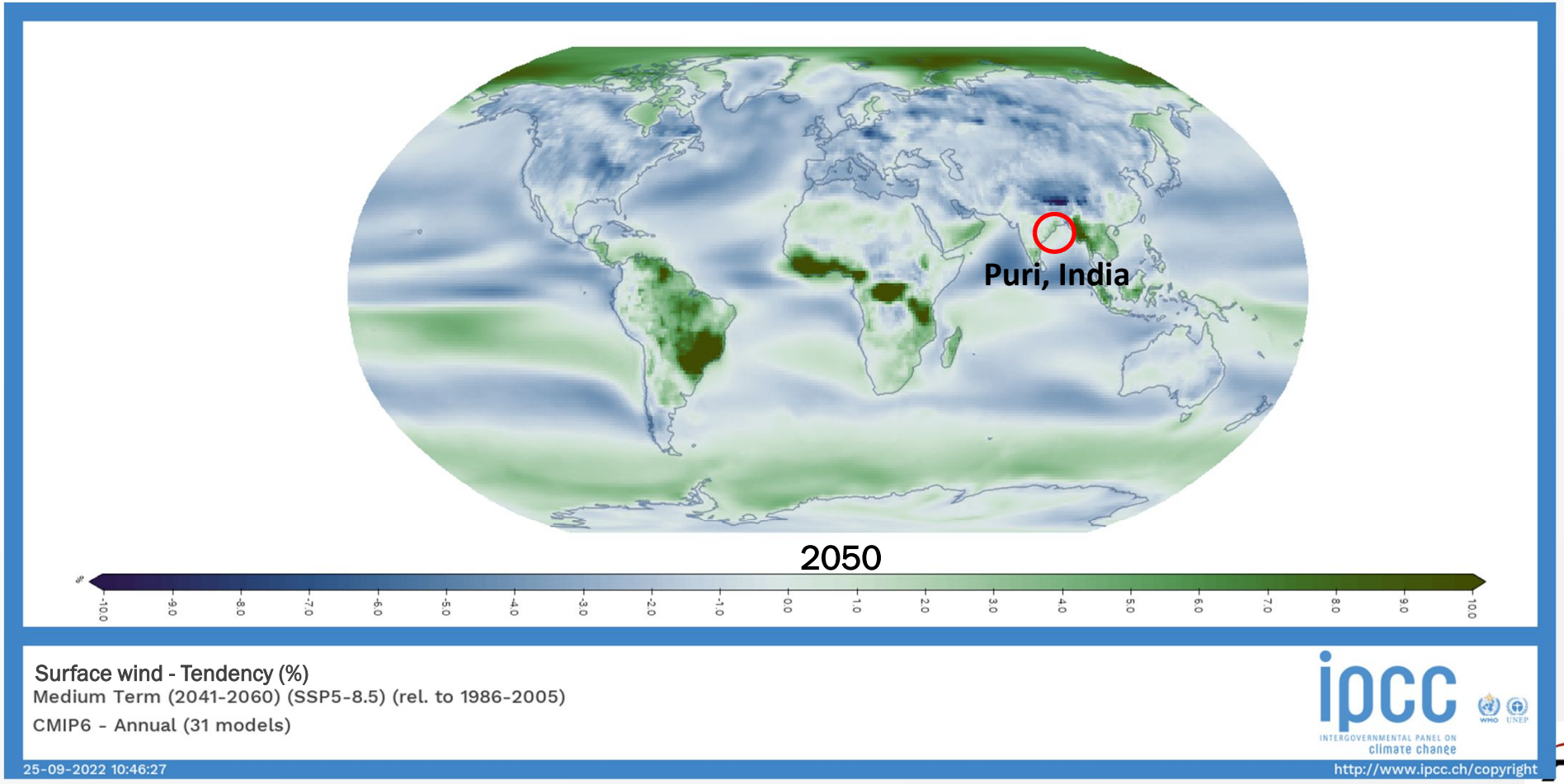


Multimodel Agreement Increasing Confidence



- **Agreement reduces uncertainty**
- **Robust signal** identification
- Enhanced **decision-making**

Climate Change | Case Study



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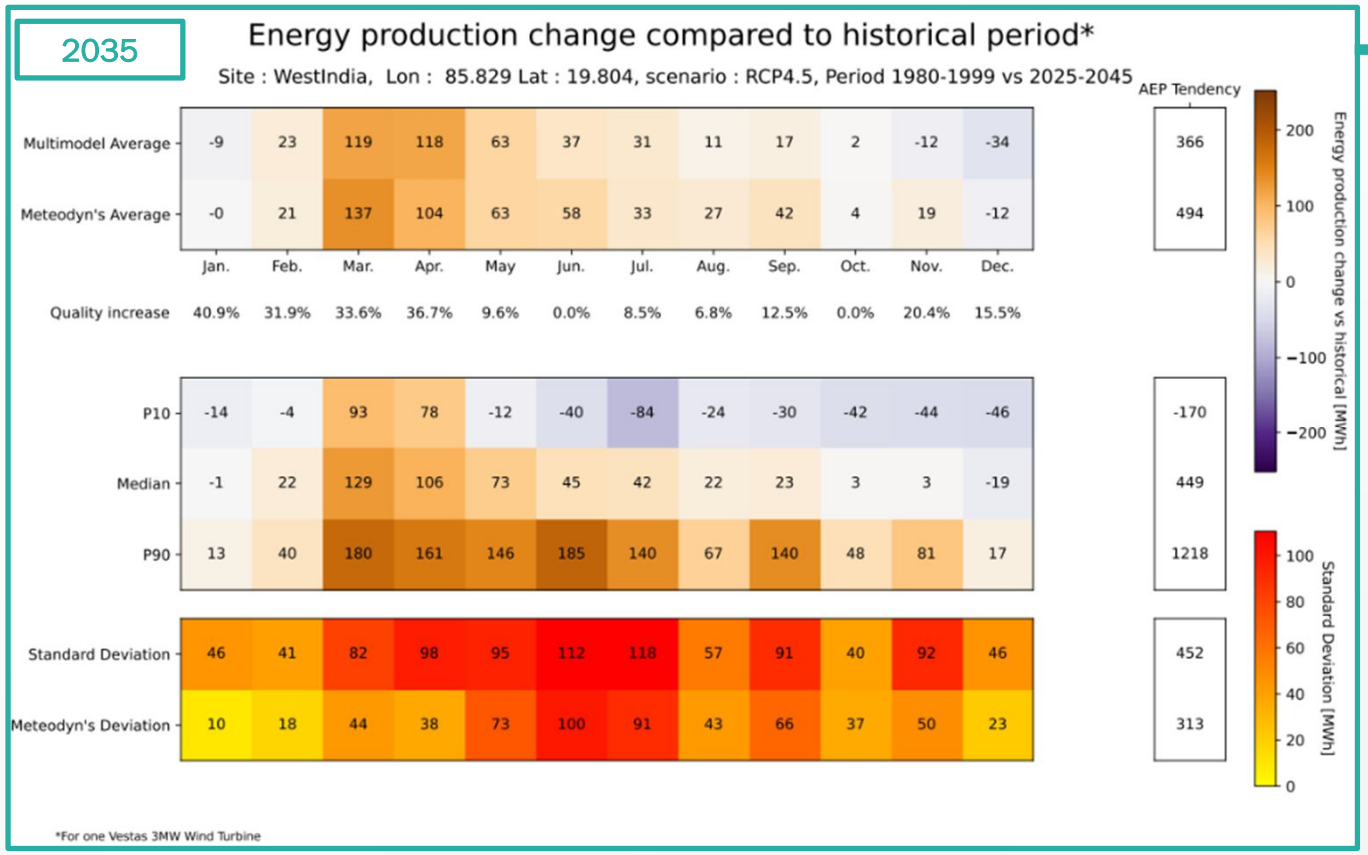

Meteodyn quality-based approach :

- Go beyond standard analysis !
- **+ 494 MWh/year** for a 3 MW wind turbine
- **+ 164 hours/year** at nominal power
- **+ 128 MWh/year** compared to a non-weighted approach
- Annual uncertainty reduced by **more than 30%**

Wind Data Portal | Climate Change Analytics (CCA)

Climate Change Analytics (CCA)

Statistical trends

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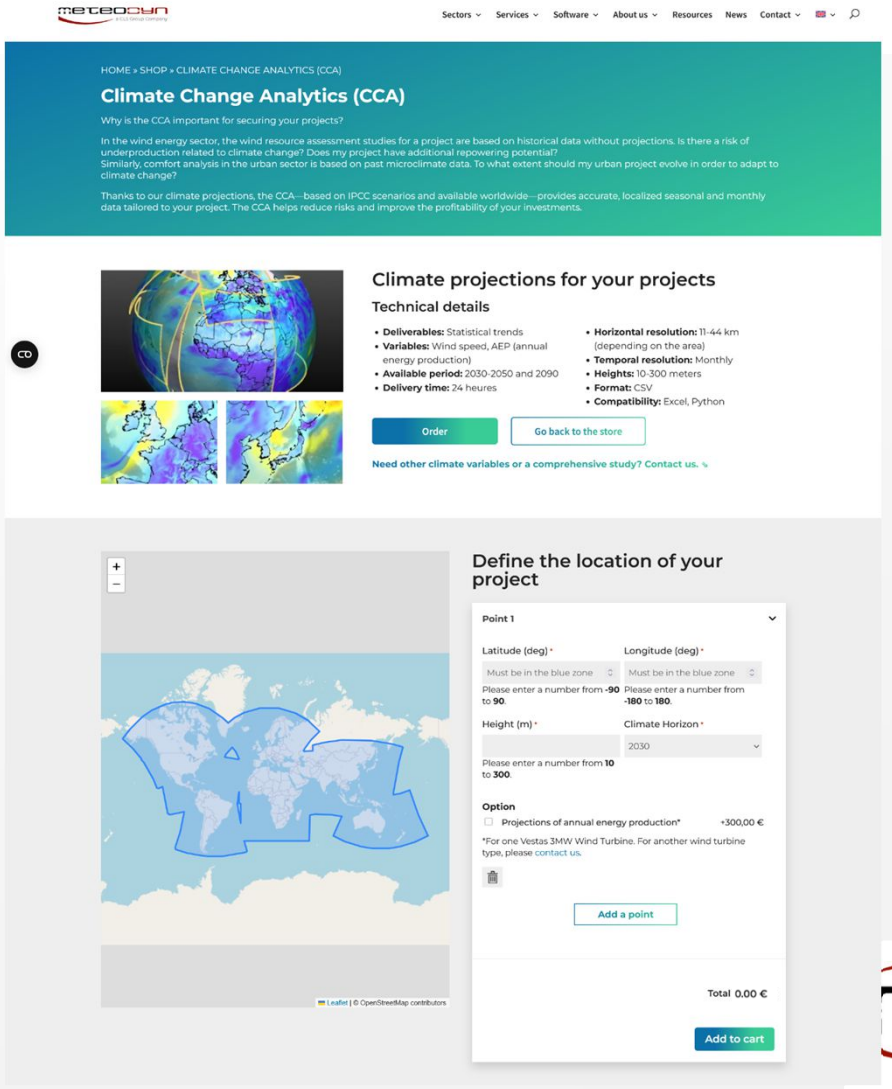
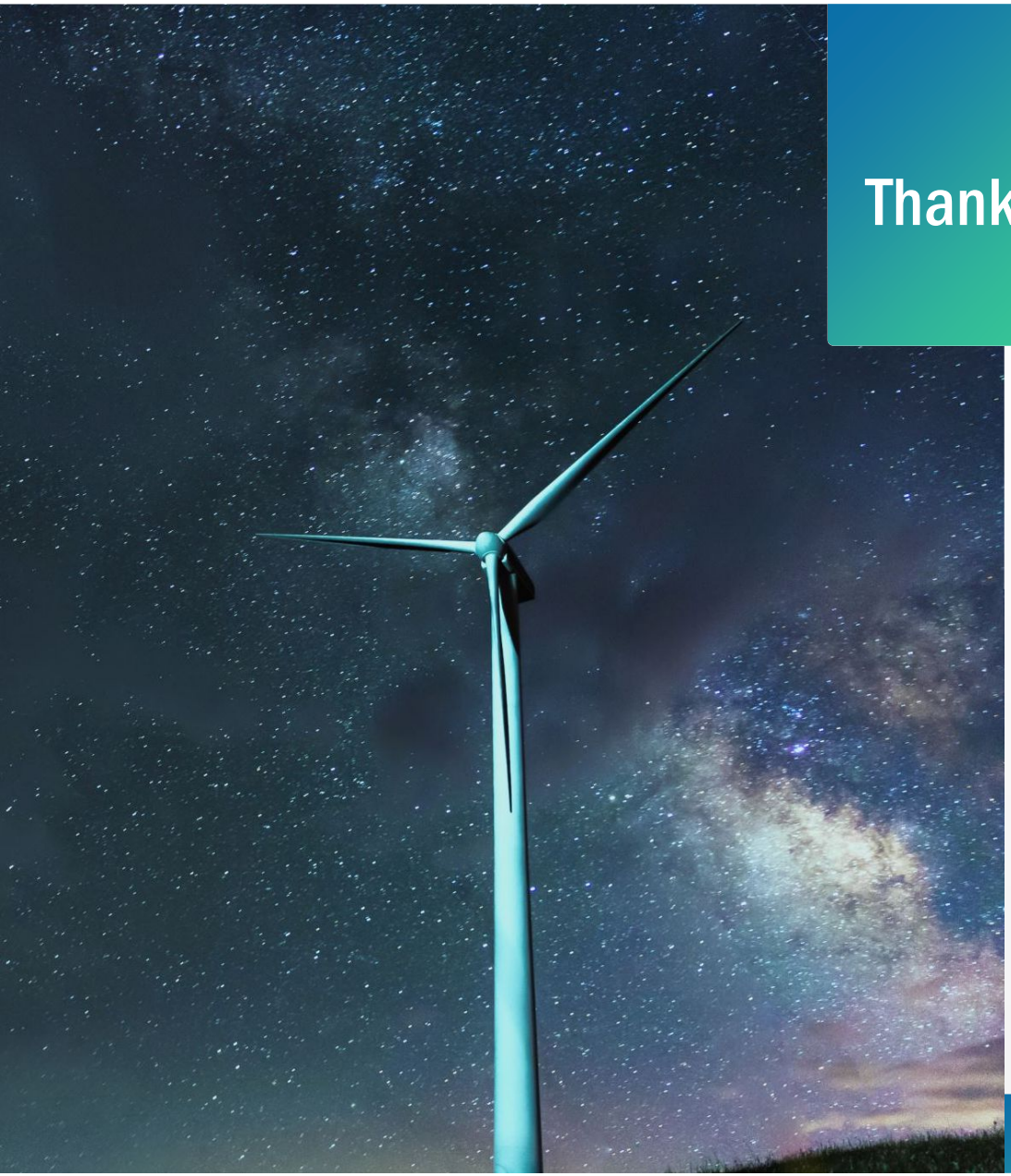
Access our accurate, localized climate projections, tailored to your project, based on IPCC scenarios and available worldwide for all heights from 10 to 300 meters.

Go beyond conventional analyses with our innovative statistical approach based on high-quality climate model analysis.

Get data ↘





Thank you!

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