VORTEX

How reanalysis can reduce wind resource long-term assessment uncertainty

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Vortex R&D
(also ECI, University Oxford)

In collaboration with
Pau Casso & Elies Campmany Vortex
and contributions of x
Stephan Shaba, Mark Zagar, Vestas

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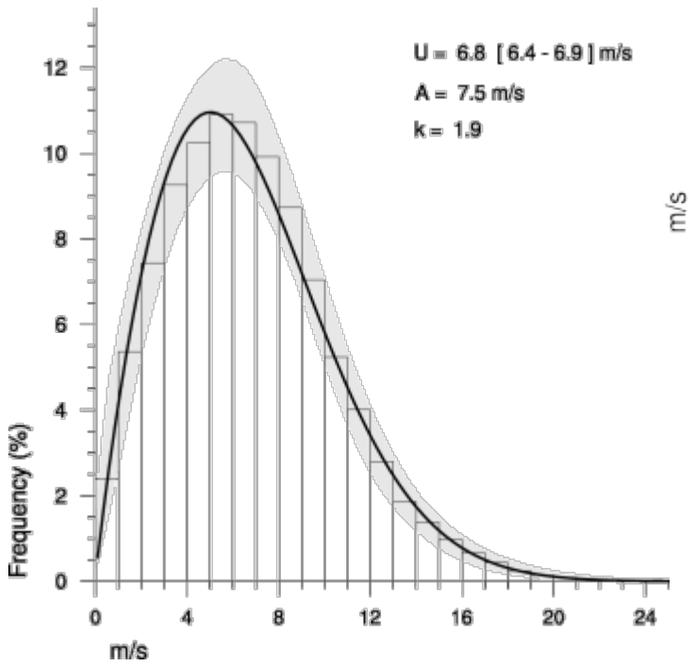
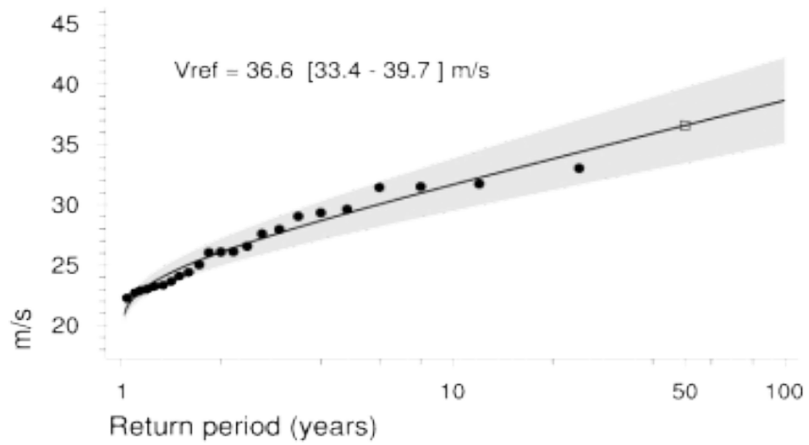
Silver Spring 7 -11 May 2012

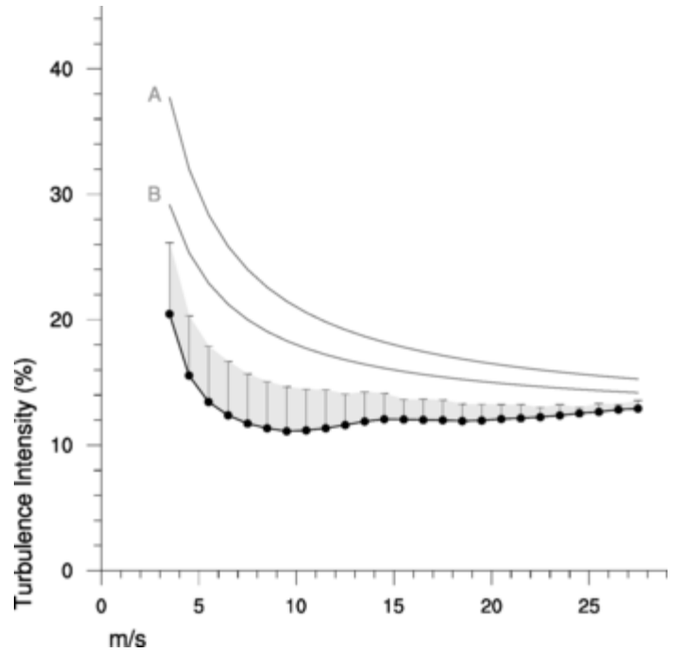
About Vortex

- Climate information service focus on Wind Energy industry
- HQ in Barcelona, Spain
- Modeling Core is WRF and our sources Re-Analysis
- Operationally: CFSR & MERRA; testing: ERA-Interim
- CPU intense factory
- Screening, micrositting, long-term reference series, extremes

About Vortex

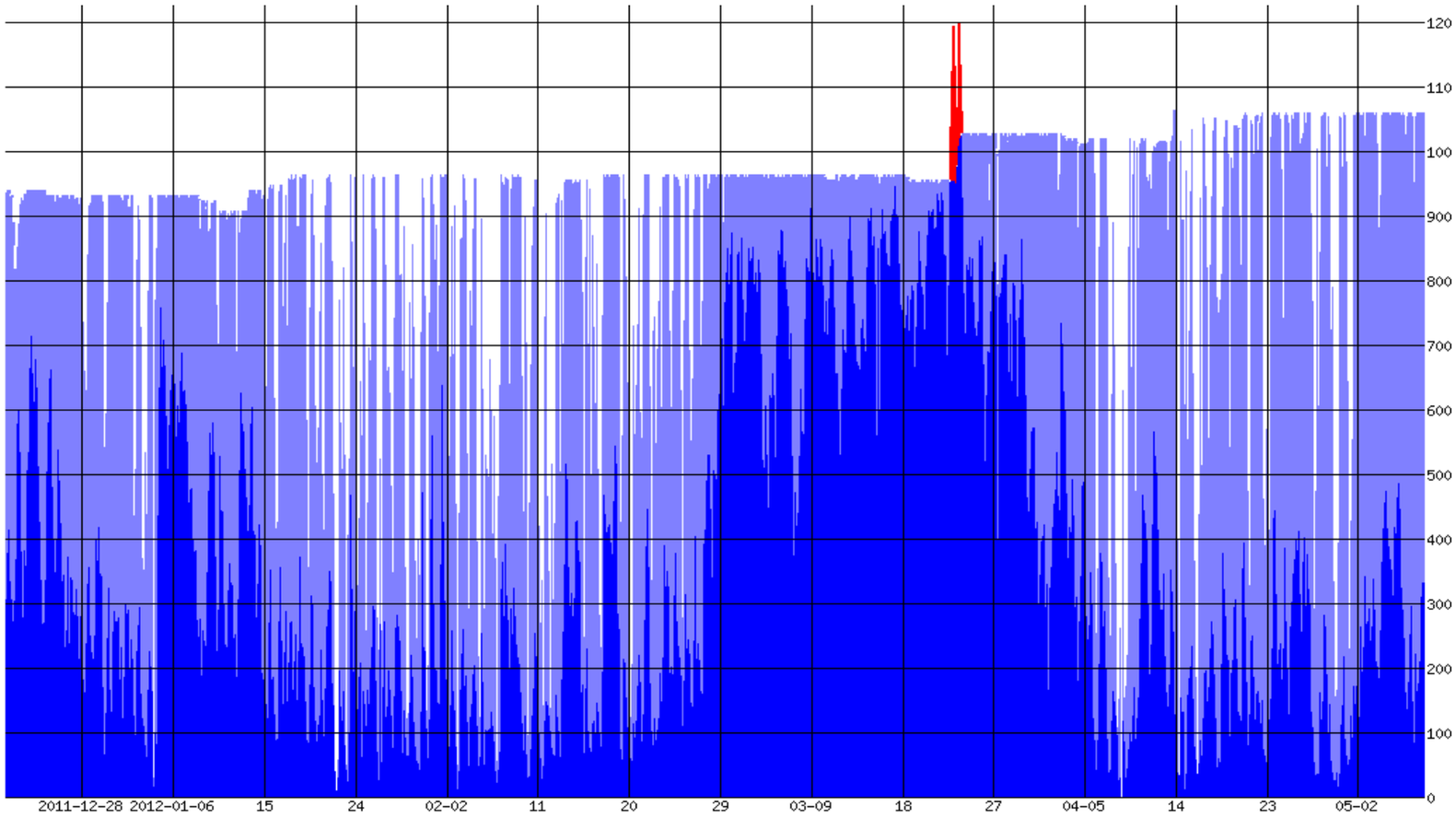






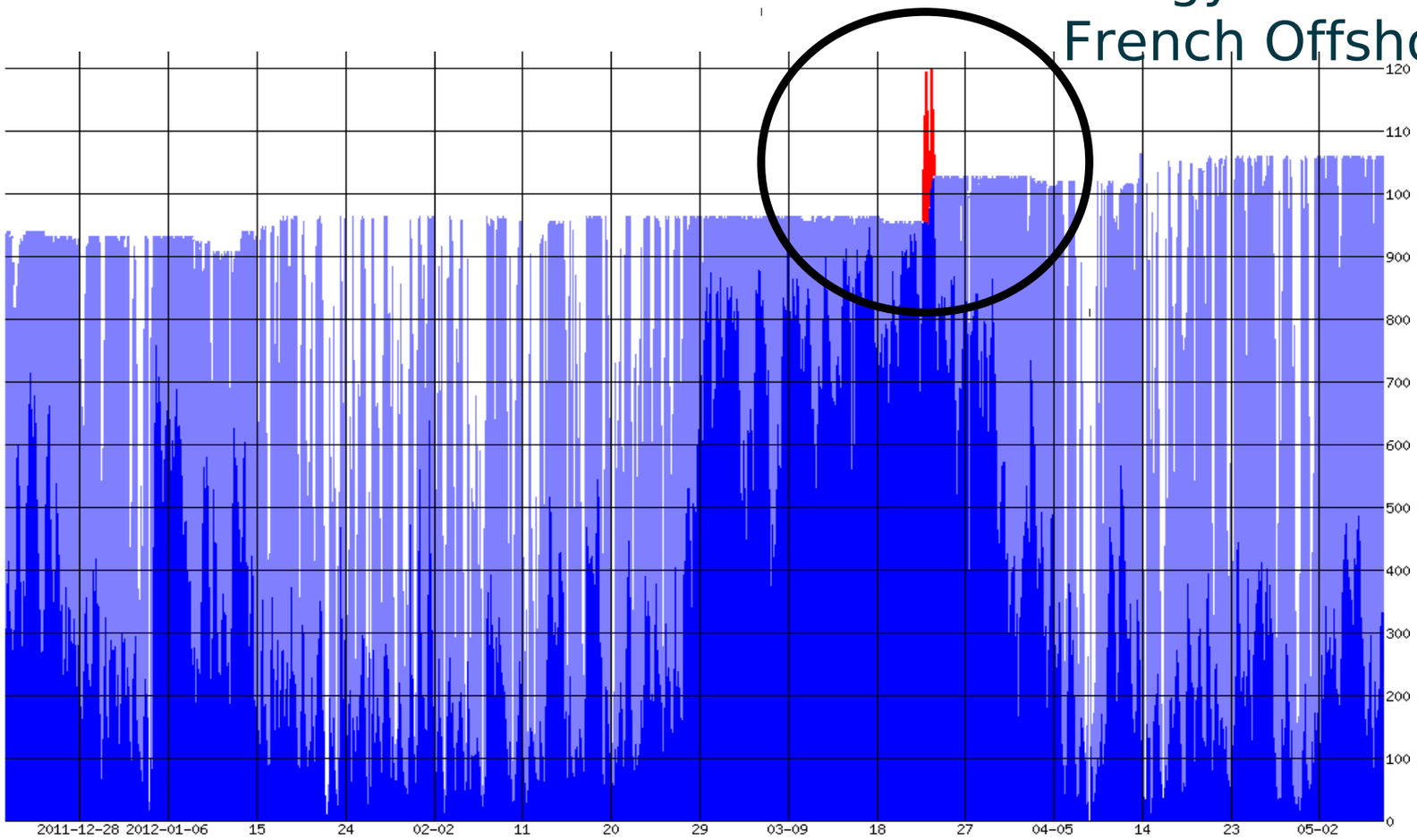
Who uses the services

- Manufacturers: Siemens, Suzlon, Gamesa, Alstom, Clipper
- Developers: Dong, E-On, Mainstream, Iberdrola, Acciona, RWE, EDF
- Consultant: Natural Power, GH-GL, Dewi
- And many SME's



Daily Vortex Cluster CPU load [%], 6 months

Energy Auction in Brazil +
French Offshore tender



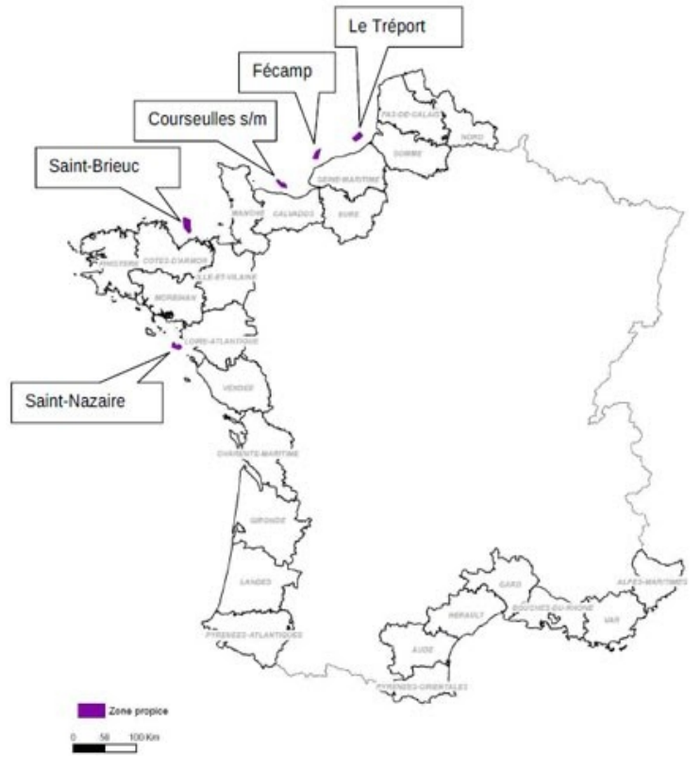
Daily Vortex Cluster CPU load [%], 6 months

- French offshore tender, 2011

3GW of new wind energy capacity at a cost of about €3.5m per megawatt, adding "that represents an investment programme of €10bn"

- Tender Specification: Use MESOSCALE modeling

- Implicitly means: Use Re-Analysis



- Global Wind Atlas Initative by Risoe/DTU & NREL funded by Danish Energy Agency

Jake Badger, Risoe/DTU, Poster UA-6

About the rest of this presentation

- Motivation
- Climate Control *from wind analyst* perspective
- Re-analysis adoption
- Comments and *my* questions

Motivation

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How much energy the windfarm will produce year to year?

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Financing

Motivation

the future & the risk

How much energy the windfarm will produce year to year?

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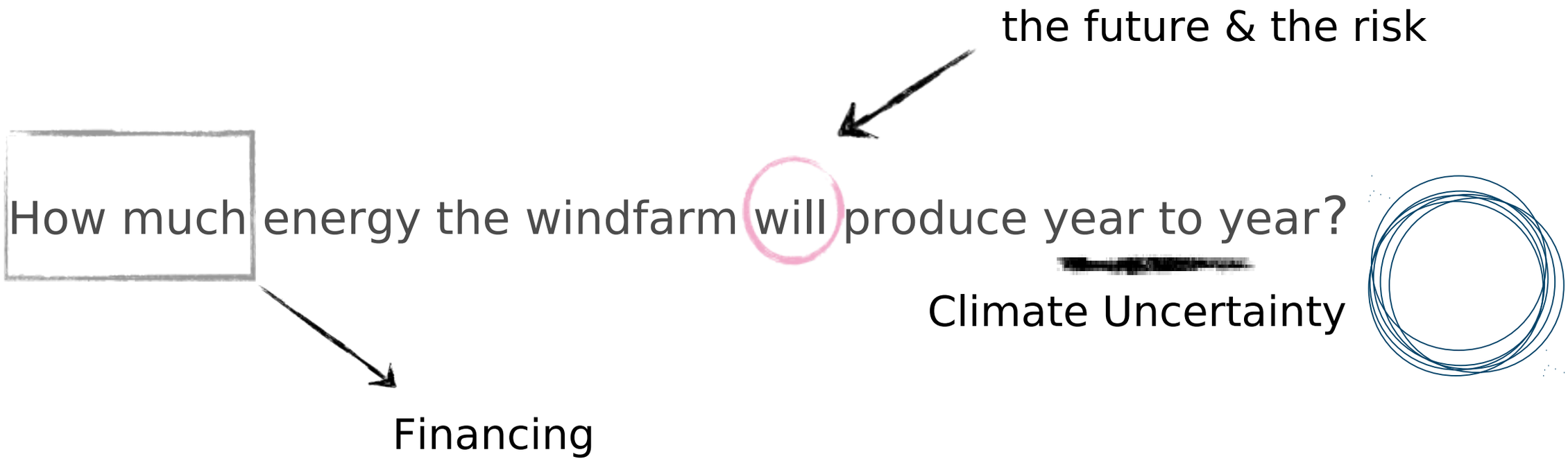

the future & the risk
How much energy the windfarm will produce year to year?
Climate Uncertainty
Financing

Motivation

the future & the risk

How much energy the windfarm will produce year to year?

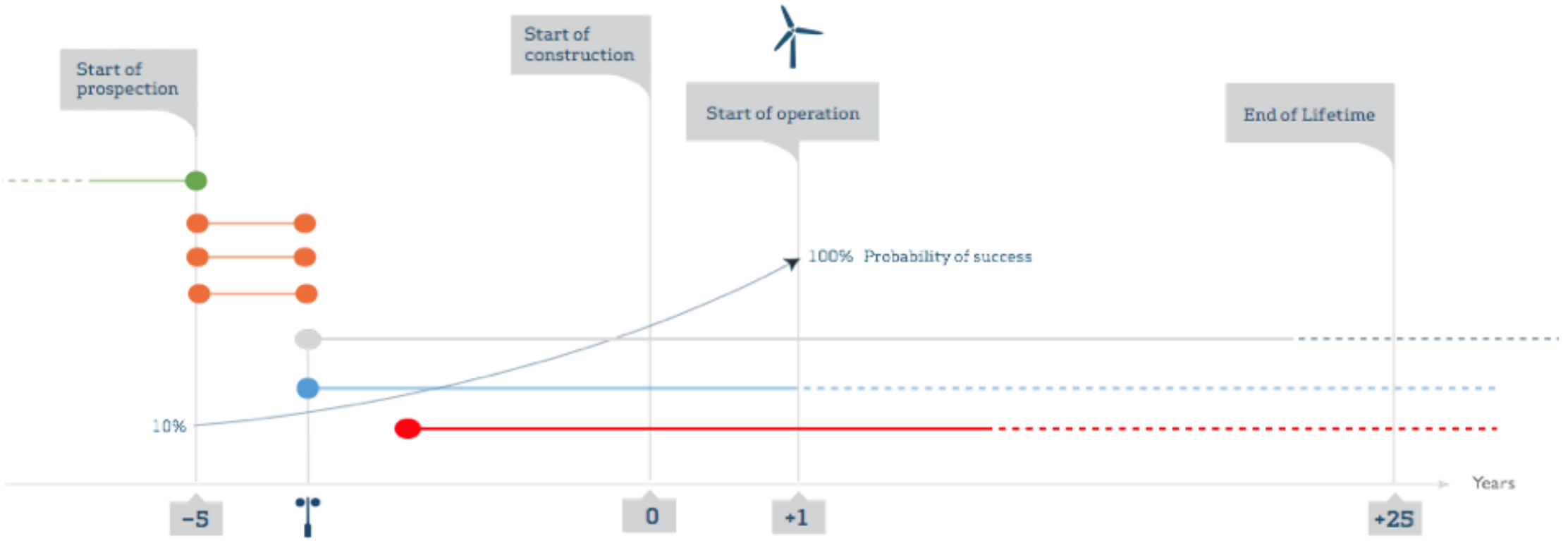
Site Specific

Climate Uncertainty

Financing

Motivation

How uncertainty affects the project development?



Motivation

How windfarm average production (AEP) is estimated?

Available information ⟹ P50 Yield estimate

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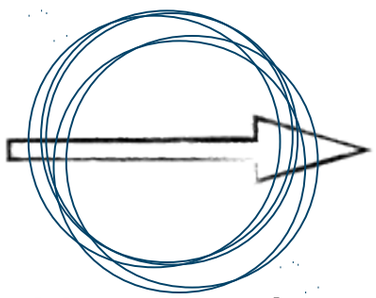


P50 Yield estimate

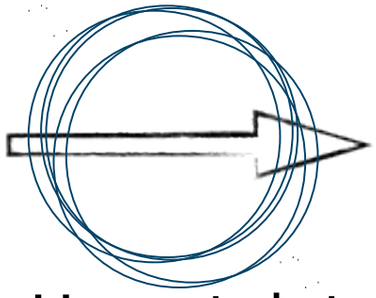
Uncertainty

Motivation

How windfarm average production (AEP) is estimated?

Available information

Uncertainty

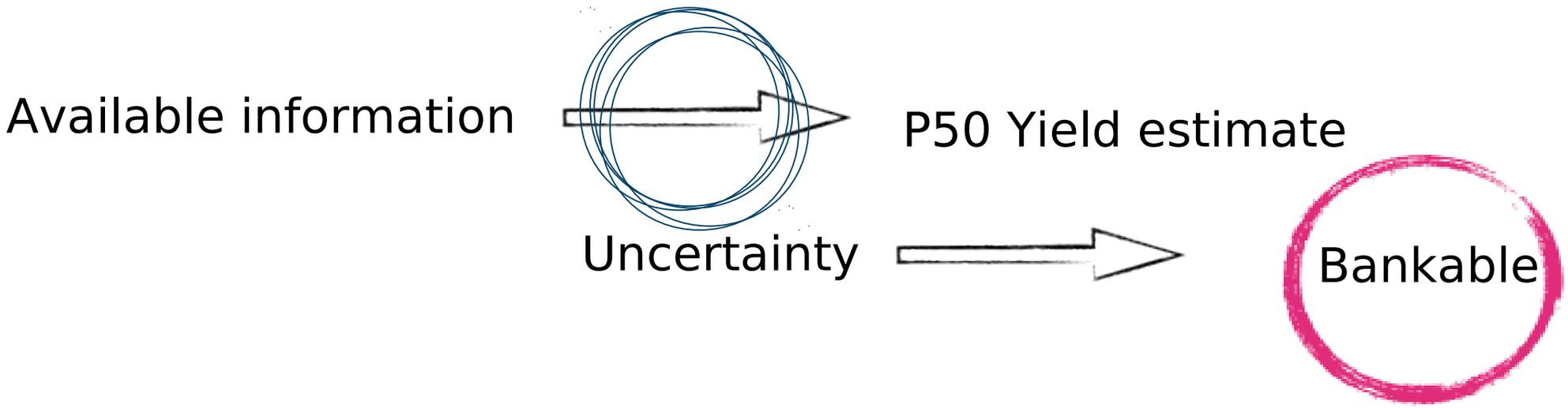


P50 Yield estimate

P90 Yield estimate

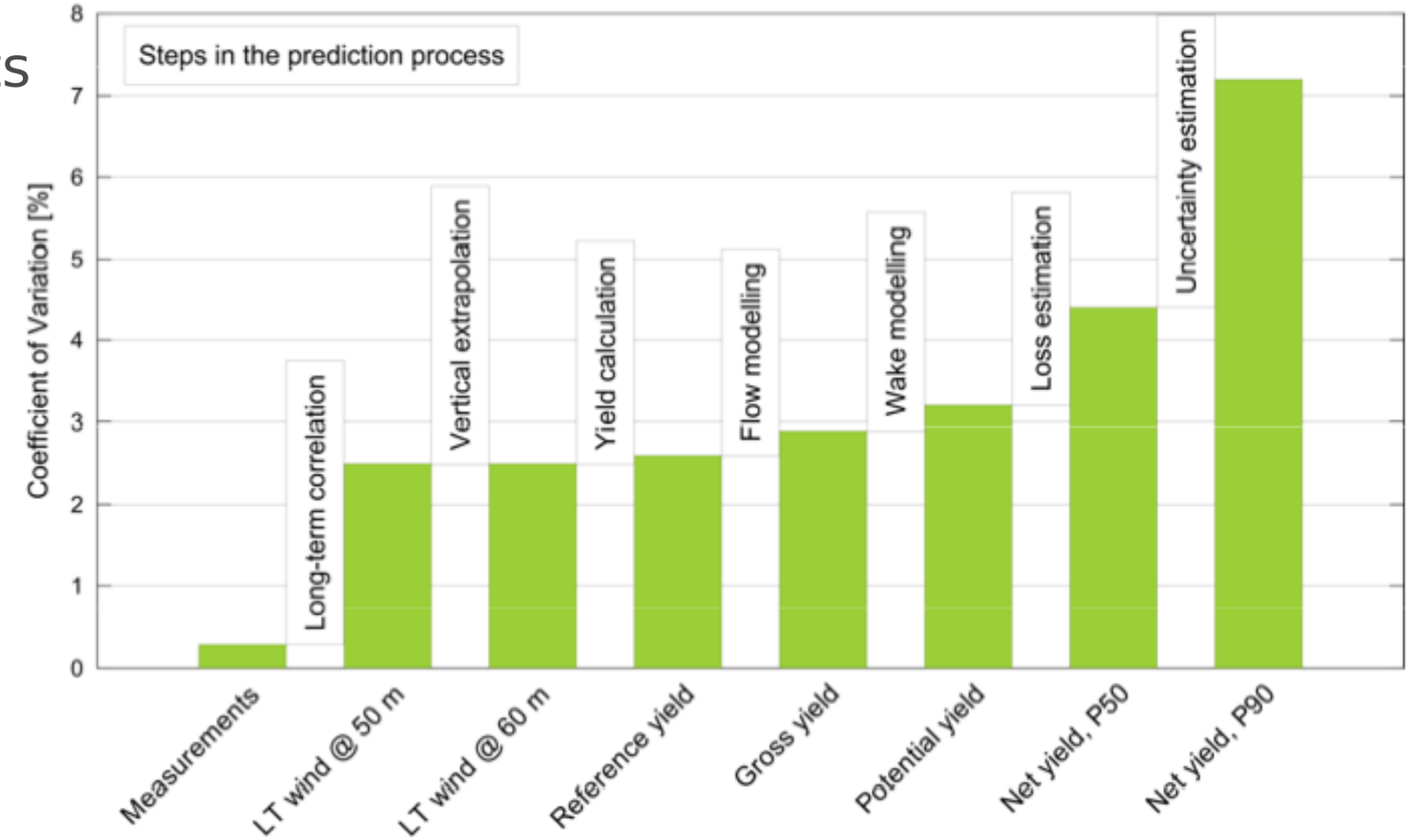
Motivation

How windfarm average production (AEP) is estimated?



Motivation

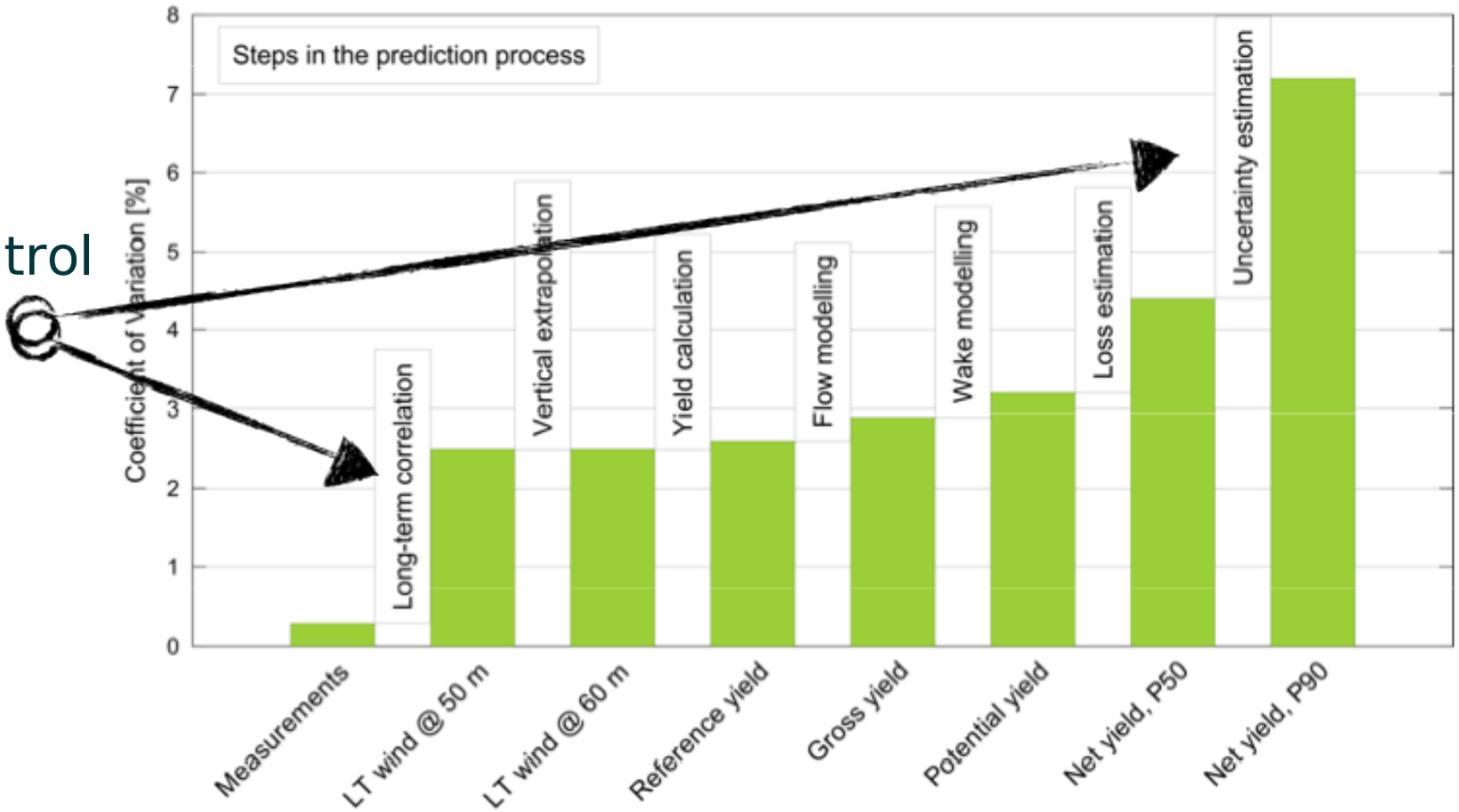
- Some figures: EWEA Resource Workshop Micrositing Exercise *
- 37 participants



(*) Niels G. Mortensen, Risø DTU, EWEA Wind Resource Assessment Technology Workshop 2011

Motivation

Climate Control



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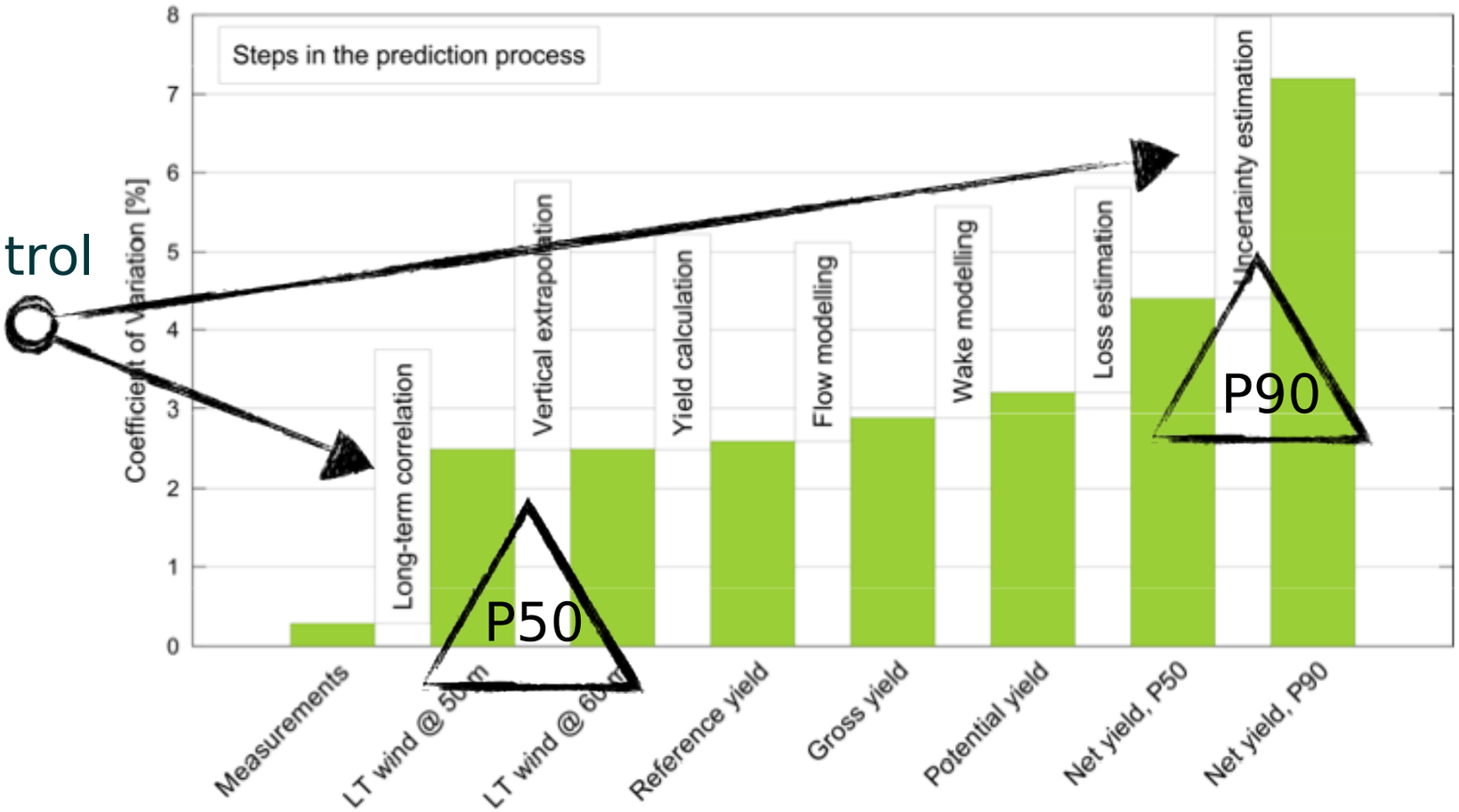

Climate Control

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- Demand of information is increasing with offshore & emerging markets

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Wind Mast
2-3 years

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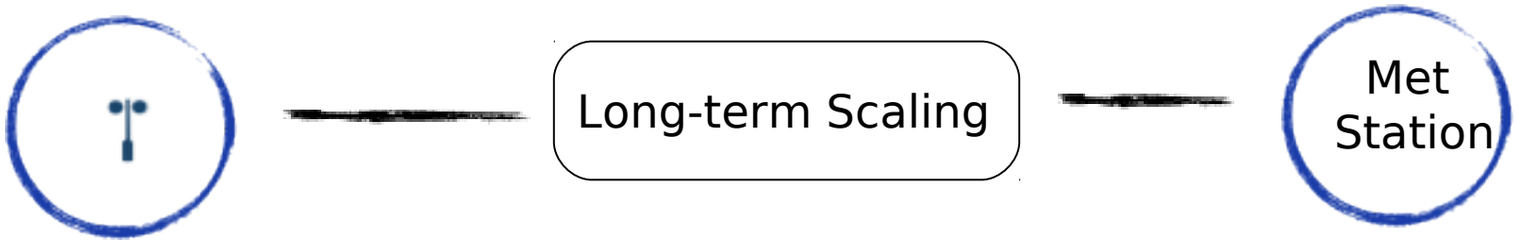

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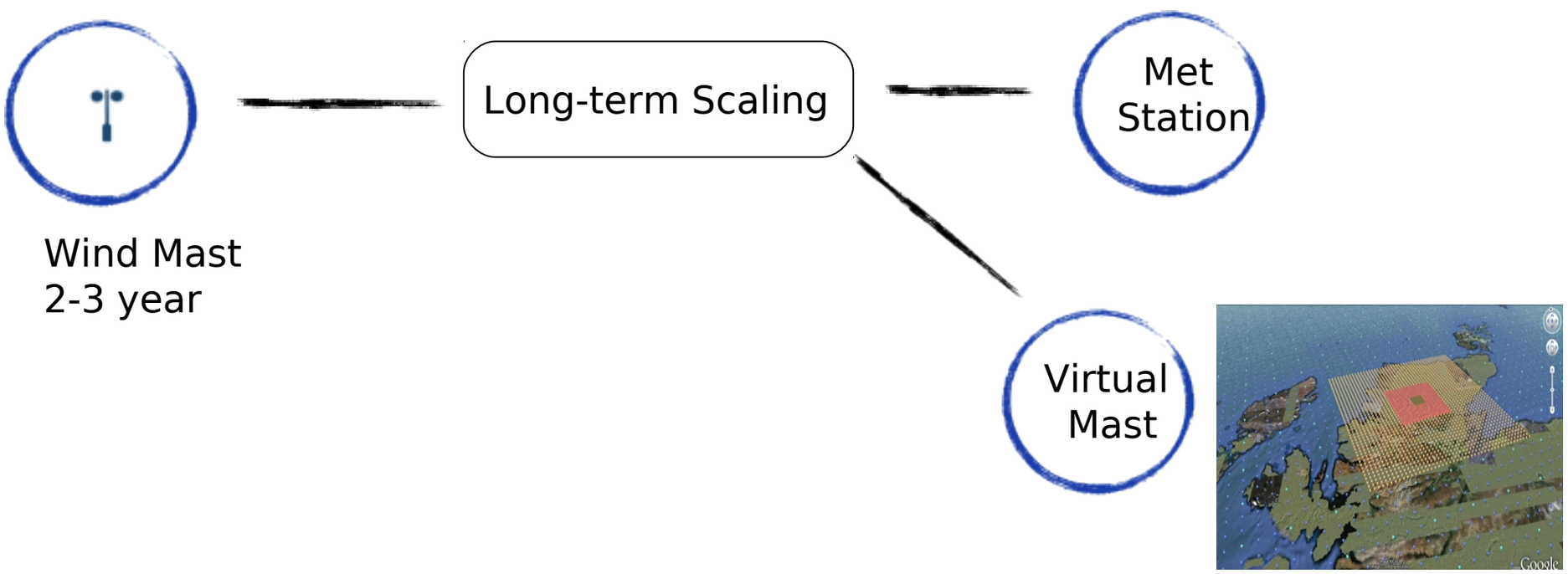

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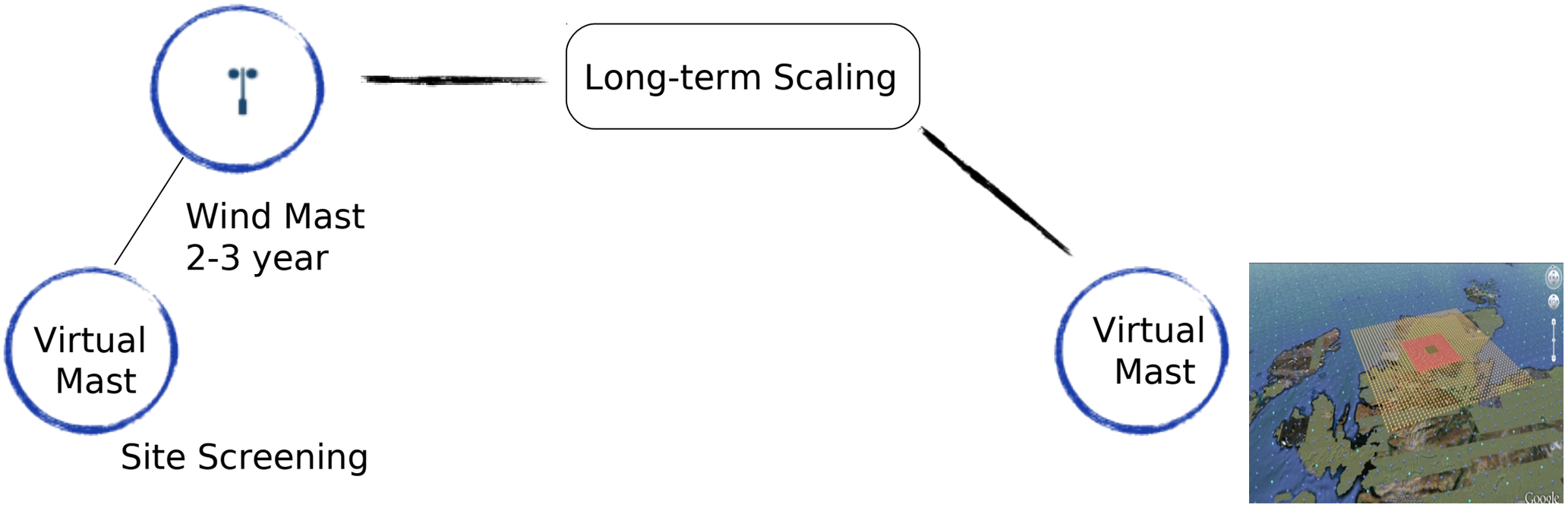

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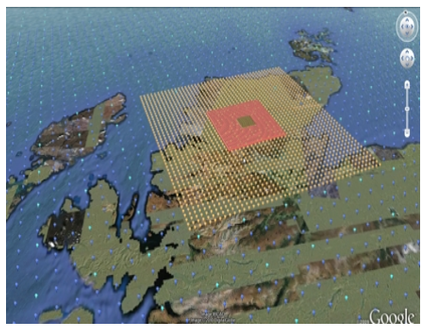
Long-term Scaling

Project Refinanced

Virtual Mast

Site Screening

Virtual Mast



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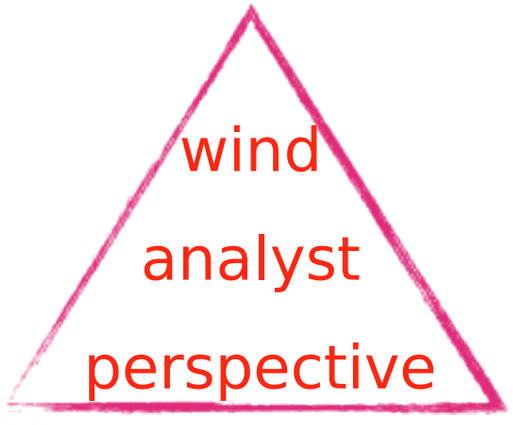


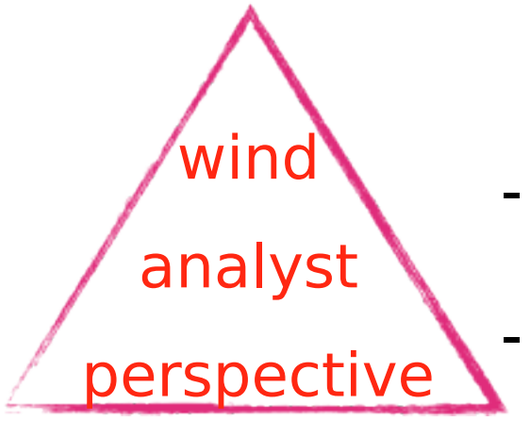
- Precision is a must
- Decision making involved: investment and refinancing
- Large responsibility
- Site specific analysis
- Engineering approach (fast and secure solutions)

Climate Control

Climate Control

- Modulation across scales
- Extreme events (anomalies)
- Phases / Dipoles
- Teleconnection / Bridges

Climate Control



- How statistics are changing in time ?

- Is there any first and second order statistics shifting ?

- How to estimate a P50 figure ?

- How a year is likely to be different from our P50 estimate ?

Reanalysis adoption

- RE-Analysis are now adopted and employed directly or via downscaled derived products
- Latest generations and downscaled products have been crucial to overcome initial barriers

- Lack of understanding and dialogue
- Criticism is sometime not very well formulated
- Mid-latitude perspective and other myths

Reanalysis adoption

Reject & distance

Coarse Products
No CPU enough

Reanalysis adoption

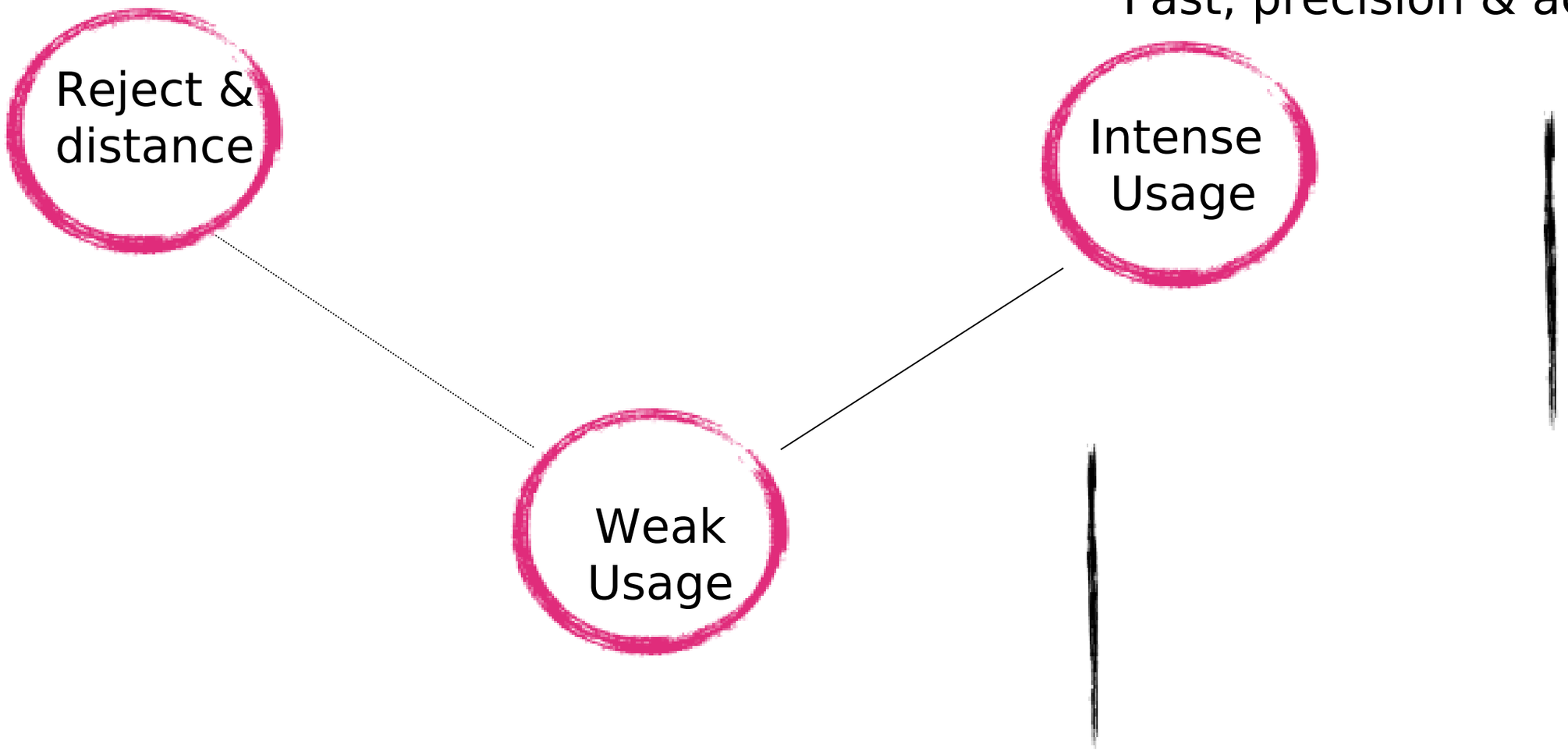
Reject & distance

Weak Usage

Research
Offshore R&D

Reanalysis adoption

Scales are converging
Fast, precision & accuracy



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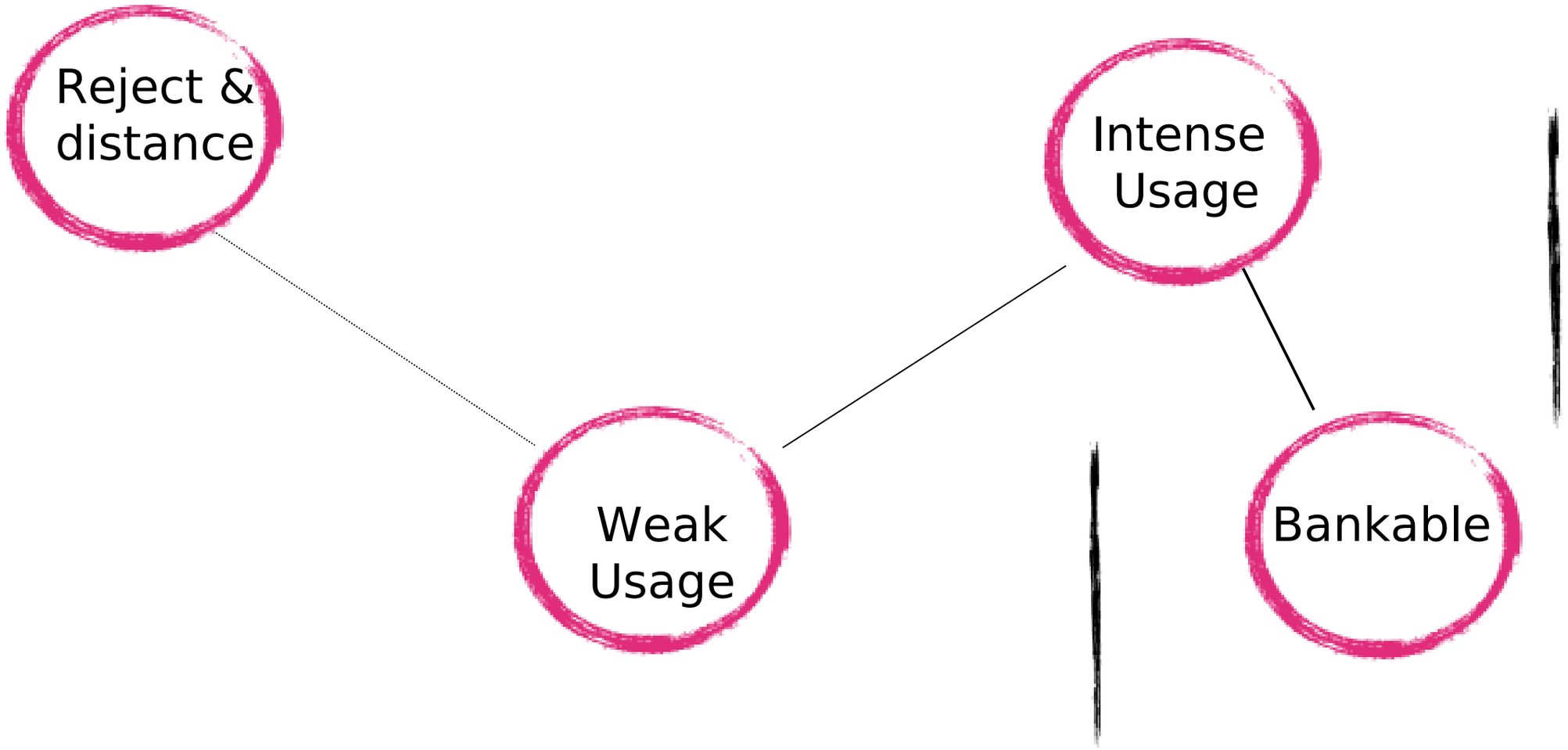
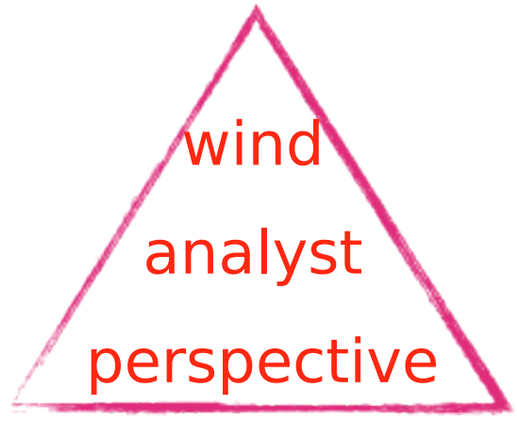


Reanalysis adoption

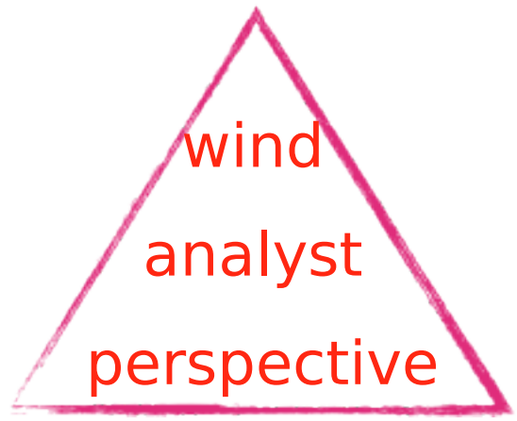
- More crossover dialogue
- More guidelines to standardized usage
- More references on validation

Reanalysis adoption



- Can we get an accurate representation of the reality without direct site measurements?
- Do they virtual time series pick the right amplification of pbl wind climate variability?
- Do they show time in-consistence, change in structure, artificial trends?
- How the fact that there are different sources can help reduce uncertainty?

Reanalysis adoption



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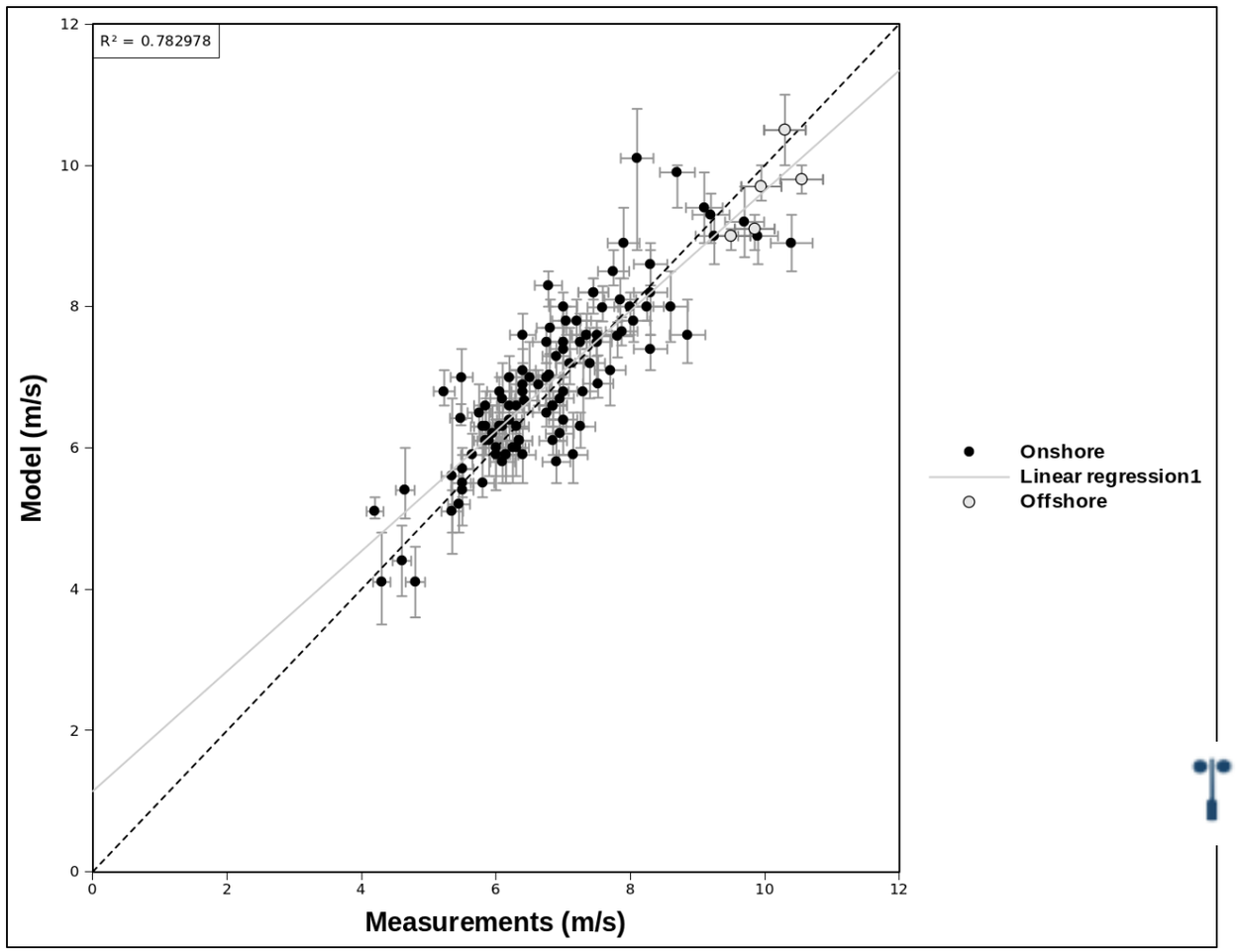
- How the fact that there are different sources can help reduce uncertainty?
- Which is the best re-analysis?

Reanalysis adoption

- Can we get an accurate representation of the reality without direct site measurements? Yes, we can and we do it

Reanalysis adoption

- Can we get an accurate representation of the reality without direct site measurements? Yes



WRF 100m 365 days, CFSR
115 Wind Masts, 50-110m

wind energy industry standards
NDA

Reanalysis adoption

- Can we get an accurate representation of the reality without direct site measurements? Yes

	MAE (*)	
	m/s	[%]
Mean	0.8	5.7

(*) outliers are removed

WRF 100m 365 days, CFSR
115 Wind Masts, 50-110m

- wind energy industry standards
- NDA

Reanalysis adoption

- Can we get an accurate representation of the reality without direct site measurements? Yes

	Correlation	
	Monthly	Daily
>80% sites	0.85	0.75

(*) outliers are removed

WRF 3Km 3-6 years, CFSR
340 Wind Masts, 50-110m

- wind energy industry standards
- Feedbacks from clients

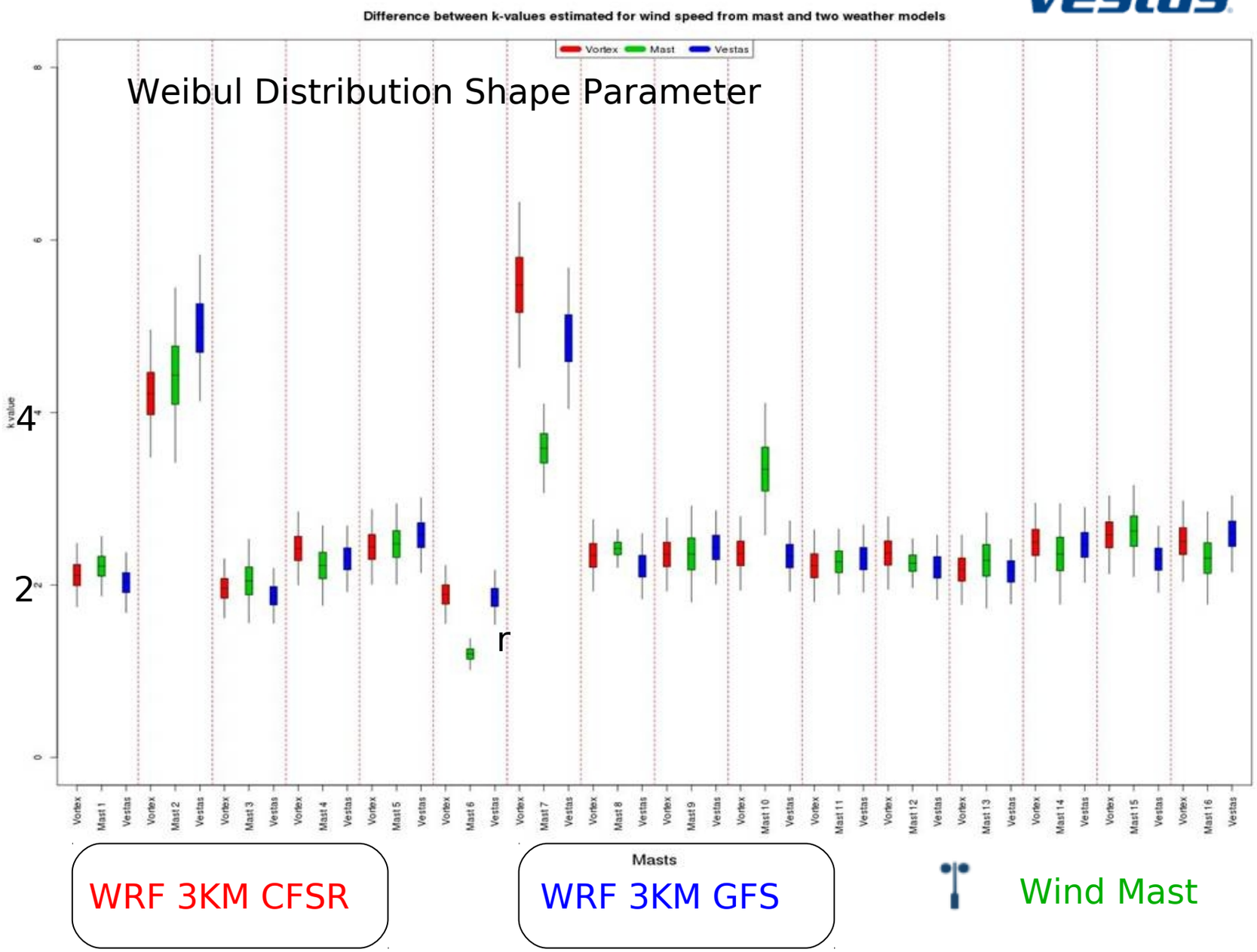
Reanalysis adoption

Z (m)	No of sites
<200	9
200 - 400	1
400 - 600	3
> 600	3

Proximity to coast (Km)	No of sites
<25	6
(25-50)	1
(>50-100)	4
>100	5

Complexity	No of sites
1	9
2	5
3	2

Vestas



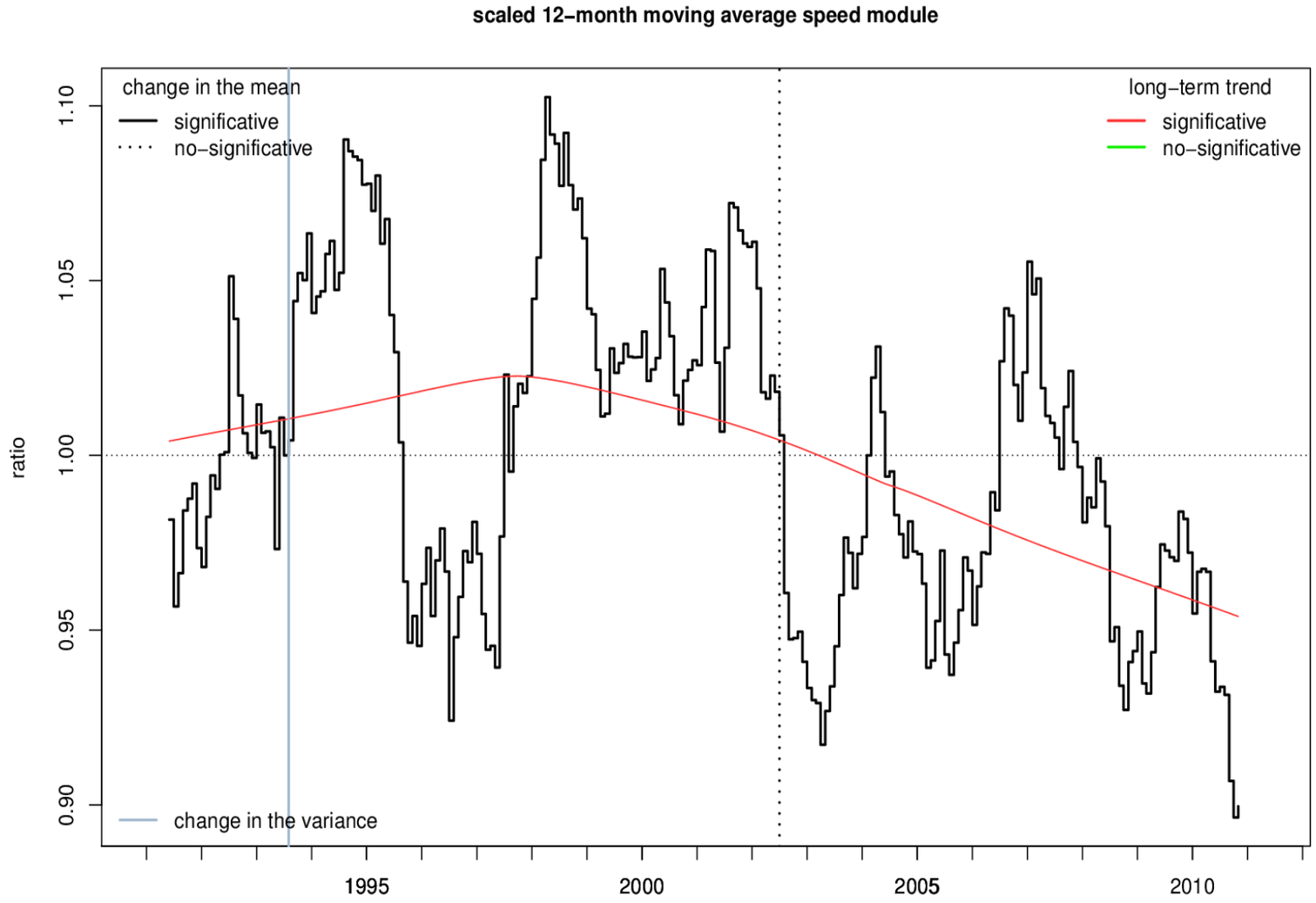
WRF 3KM CFSR

WRF 3KM GFS

Wind Mast

Reanalysis adoption

Do they show time in-consistence, change in structure, artificial trends?



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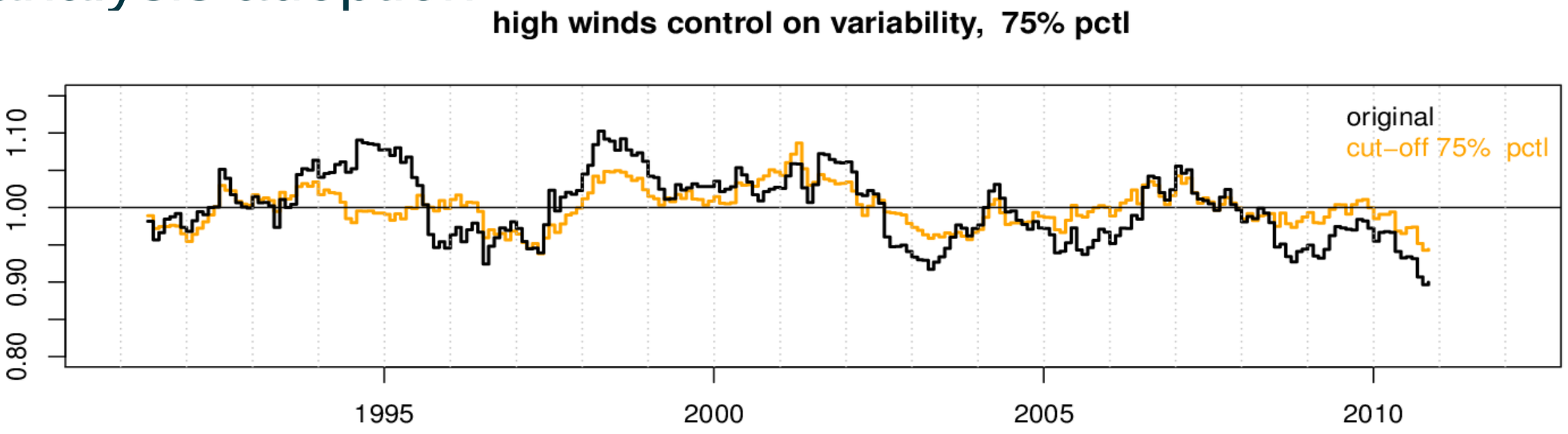

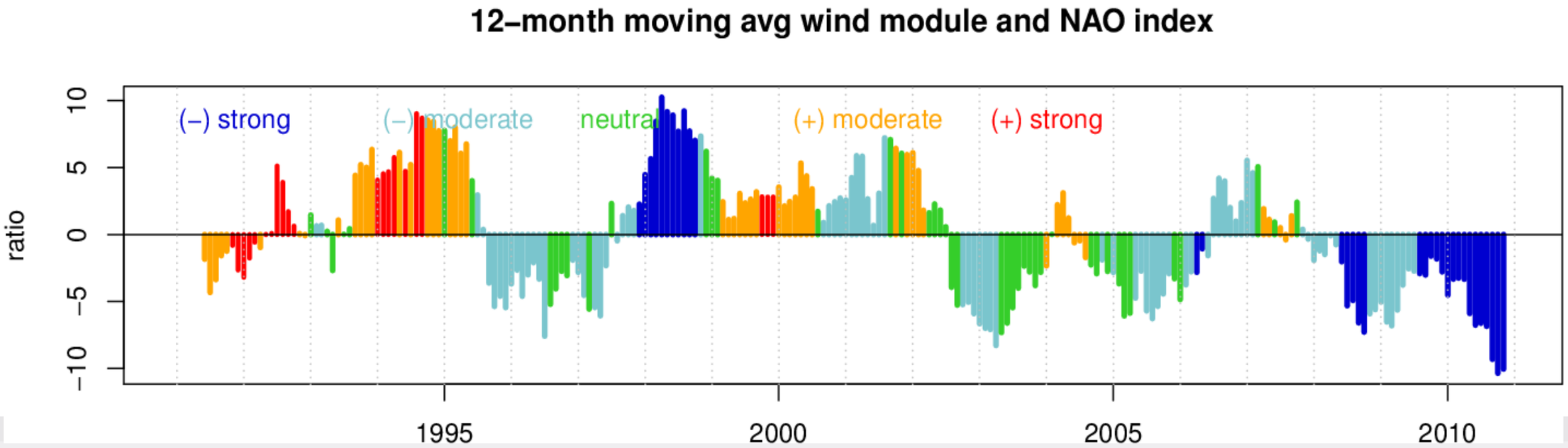

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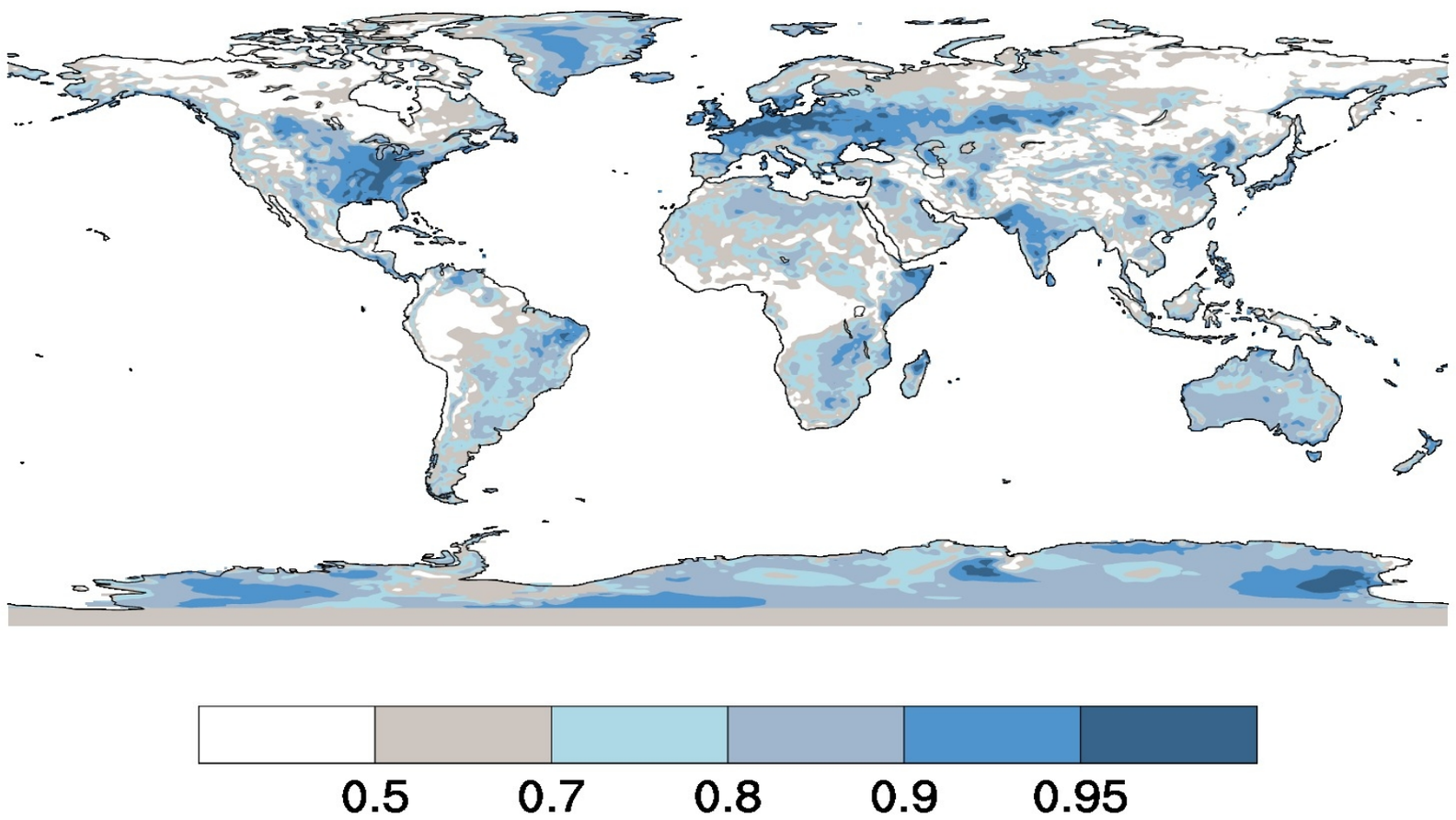

Correlation MERRA and CFSR 12-moving avg 2000-2010

Final comments

- We now have more resources to inject climate uncertainty control to our site specific studies
- With new markets, the lack of long-term data is more significant
- Virtual time series will become an unofficial standard soon
- Re-analysis are getting closer to our scales ...
- Dynamic downscaling can complete the remaining gap for the reanalysis
- [...]

My questions: some issues

- Seasonal cycle: Indian Monsoon
- Bias North/Baltic Sea → PBL stability
- Low level jets under-prediction, a common issue
- How to assess inhomogeneities ?
- Re-analysis: overloaded information?