INNOVATIVE MEASUREMENT TECHNOLOGIES FOR MET-OCEAN AND SOIL CONDITIONS

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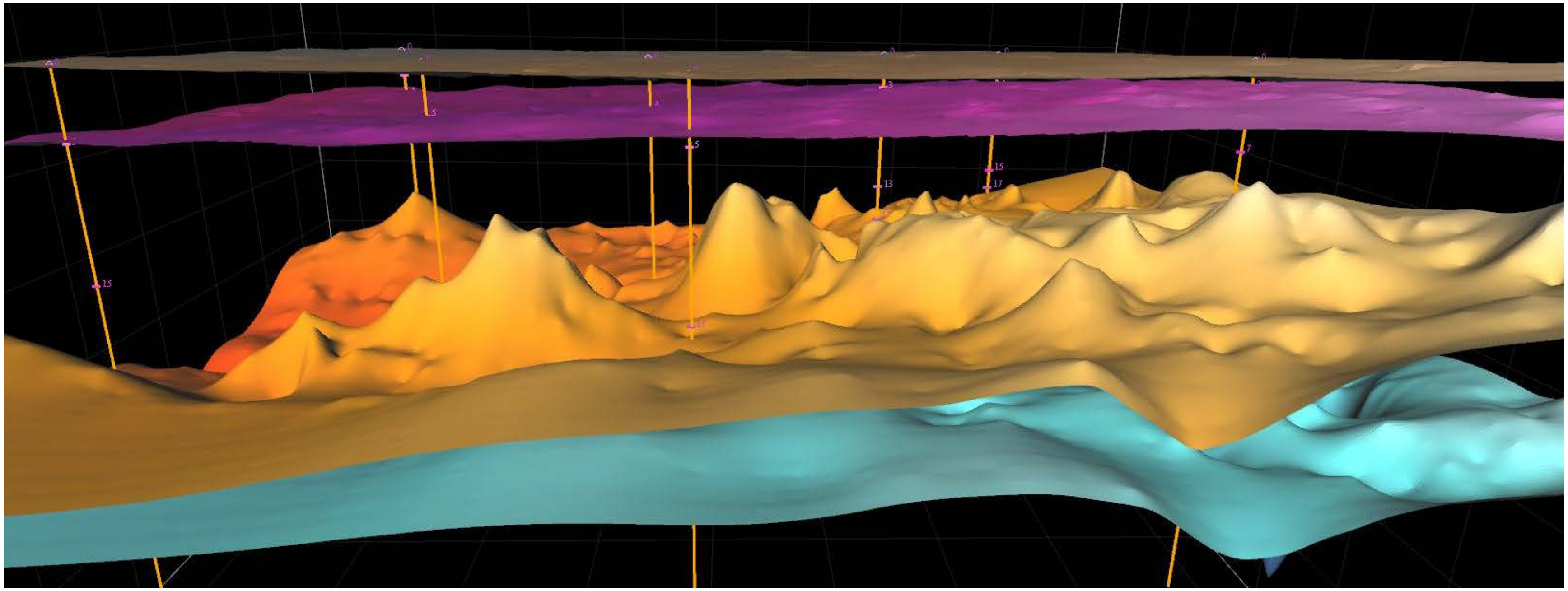


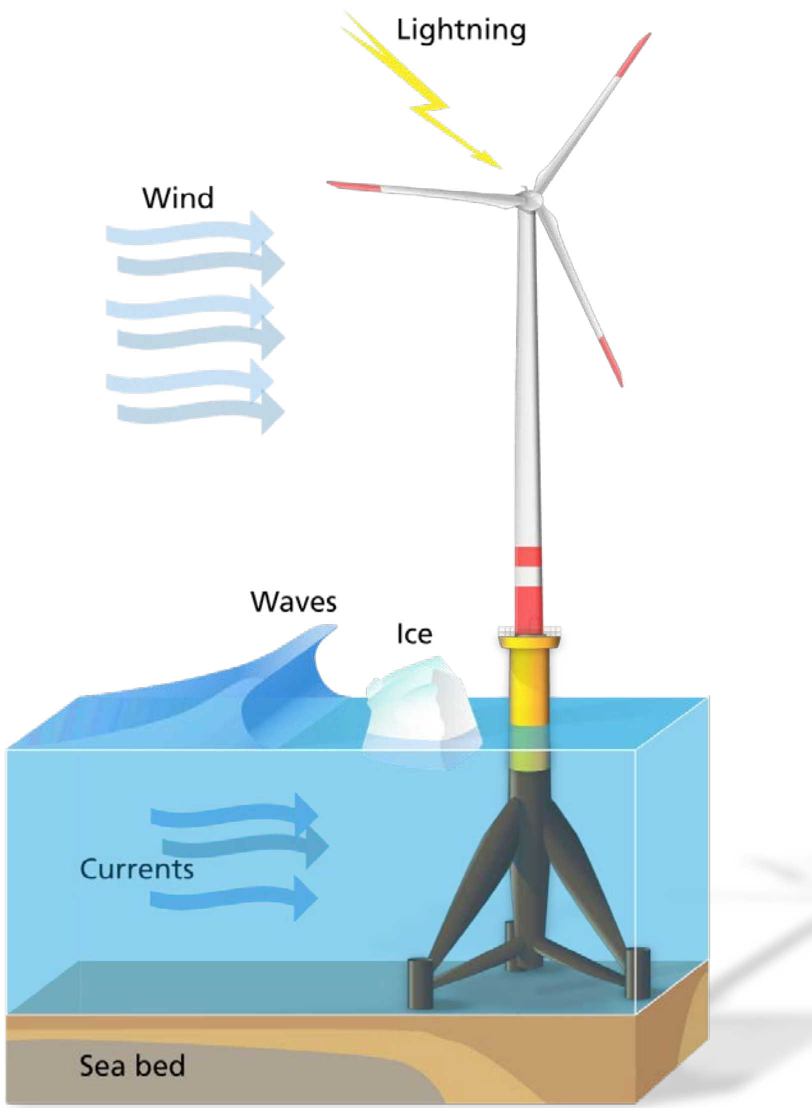
EERA DeepWind'2015, Trondheim, Norway

CONTENTS

- Data requirements and measurement methods
- Wind: Wind Lidar Buoy
- Subsoil conditions: Digital multichannel seismic system
- Conclusion

Offshore wind data requirements for environmental conditions

- Offshore wind has specific requirements to measure environmental data
- These call for tailored measurement technologies
- Different data are necessary at different stage of the project



Environmental conditions in offshore wind projects

Project development

- Wind climatology in hub height, very accurate
- Basic information on waves, current, ice,…
- Subsoil conditions

Project planning

- Soil parameters at each site
- Design base (wind, waves, current, ice, …) for basic design
- Long-term climatology (wind, waves, currents) for T&I, O&M planning

Installation

- Forecasts for waves and wind
- Online measurement data waves and wind

O&M

- Forecasts for waves and wind
- Wind data for monitoring
- Scour Monitoring
- Wind data for performance optimisation

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Challenges to measurement technologies for offshore wind

- Currently used methods
  - Standard oceanographic and meteorological methods
  - Adapted from onshore wind (e.g. met masts)
- Deficits
  - Not adjusted to requirements, not accurate enough
  - Too expensive
- Innovative, tailored methods for the applications in offshore wind
- Two examples:
  - Wind measurements with Lidar buoy
  - Seismic surveys with digital multichannel seismic system

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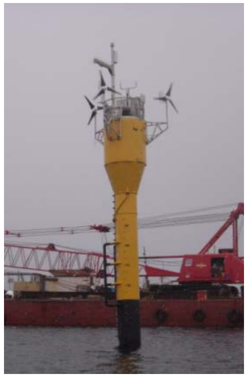
Challenge: Wind measurements for resource assessment

- Wind speed at hub height (e.g. 100m)
- Very high accuracy required (2-3%)
- Standard solution: Offshore met mast (from onshore wind and met-ocean research)
- Innovative measurement method: Floating wind Lidar
- Much cheaper and more flexible
- Also suitable for deep water

Floating Lidar

- Development of suitable systems has made considerable progress
- Realisations vary in adapted lidar technology, buoy concepts, data handling, power supply, …
- … as well as in the consideration of motion effects





[Selected floating-lidar systems –
© system manufactureres / providers]

Fraunhofer IWES Wind Lidar Buoy

- Dimensions: 7.2 m height, 2.55 m diameter, 4.7 t weight
- Buoy design based on marine light buoy with decades of track record
- Fully enclosed, integrated Lidar device
- Redundant power supply and large storage
- Motion-correction algorithm developed by Fraunhofer IWES
- Developed and validated for two different Lidar systems (Leosphere and Zephir)

© Fraunhofer IWES, Photograph: Caspar Sessler

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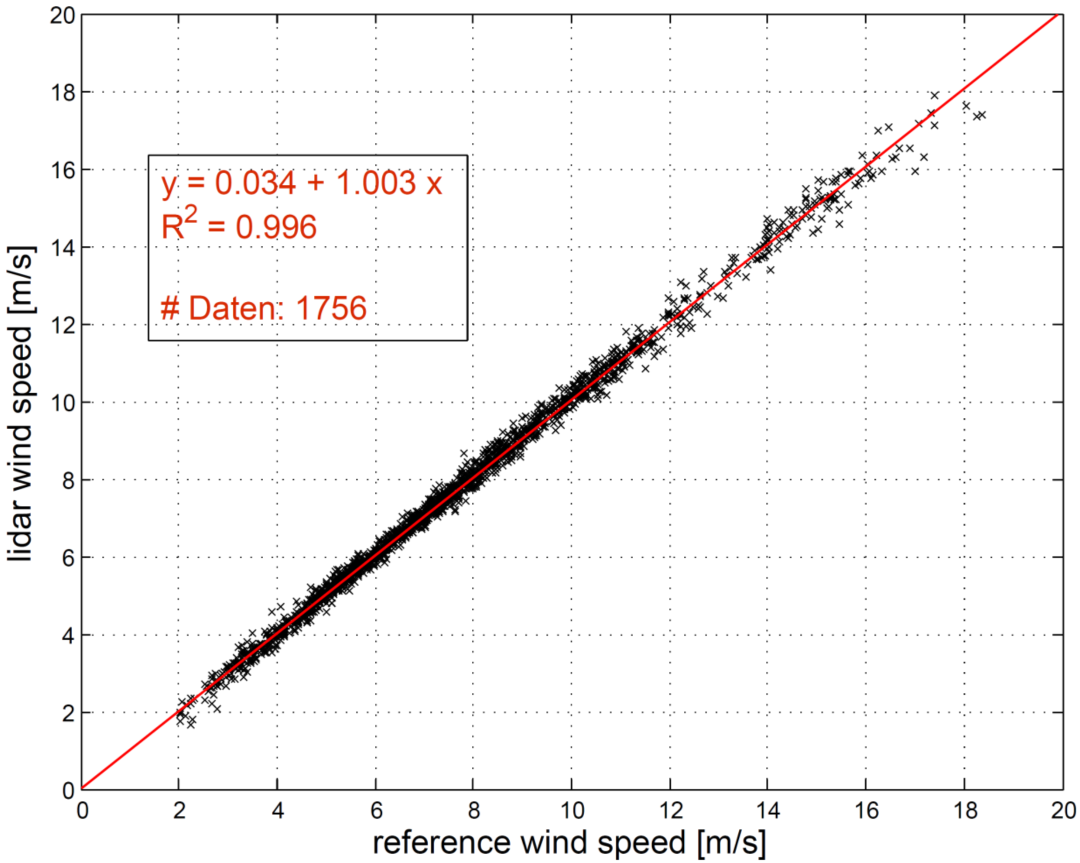
Accuracy (Leosphere Lidar)



Correlation between Fraunhofer IWES Lidar Buoy and Fino 1:

- 100 m measurement height
- 10-min-mean (horizontal) wind speeds

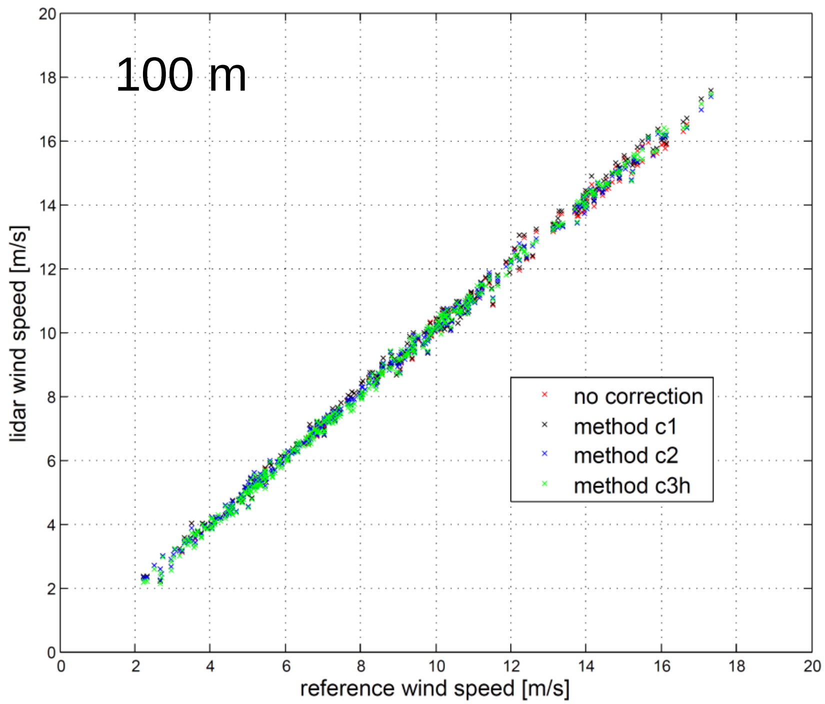
Slope: 1,003

Offset: 0,034

R^2: 0,996

→ very good correlation

Motion correction



Application of motion correction (for limited dataset)

- further improves the correlation

	#data	m [-]	C [m/s]	R^2	k [-]	R^2
No correction (Leosphere)	375	1.0039	0.0538	0.9969	1.0092	0.9968
Corrected (Leoshere)	375	1.0170	- 0.0880	0.9978	1.0083	0.9977

Applied linear models:

$y = mx + C$

$y = kx$

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Fraunhofer IWES Bouy Offshore Test at FINO1 – Results

	Fraunhofer IWES Wind-Lidar-Buoy w. Leosphere Lidar	OWA Acceptance Criteria *
Monthly System Availability – 1 Month Average	(Aug.) 97% (Sept.) 99%	≥ 90%
Overall System Availability – Campaign Average	98%	≥ 95%
Mean Wind Speed – Slope	1.01	0.98 – 1.02
Mean Wind Speed – Coefficient of Determination	1.00	> 98

* see: Carbon Trust Offshore Wind Accelerator roadmap for the commercial acceptance of floating LIDAR technology, CTC819 Version 1.0, 21 November 2013

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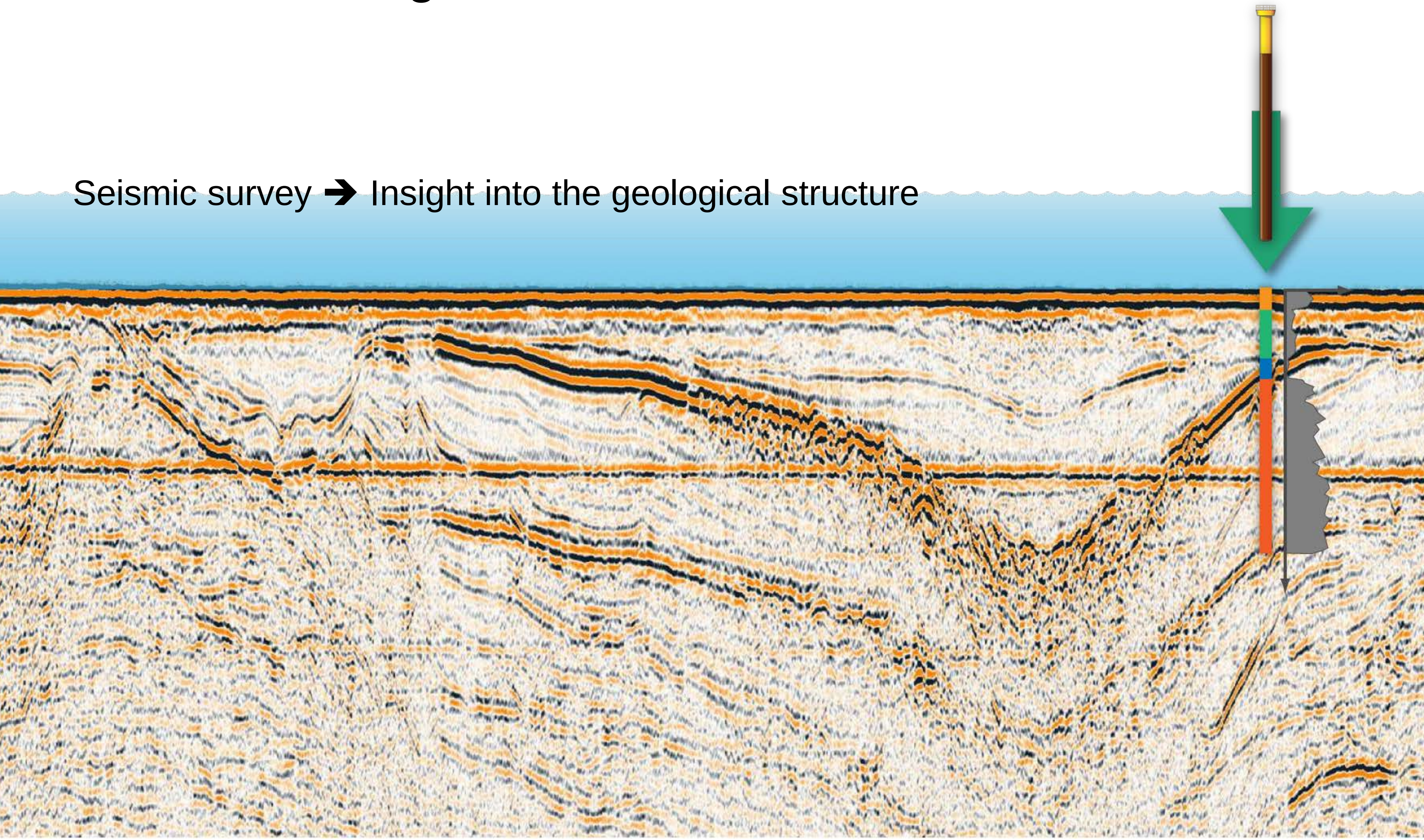
Subsoil investigation

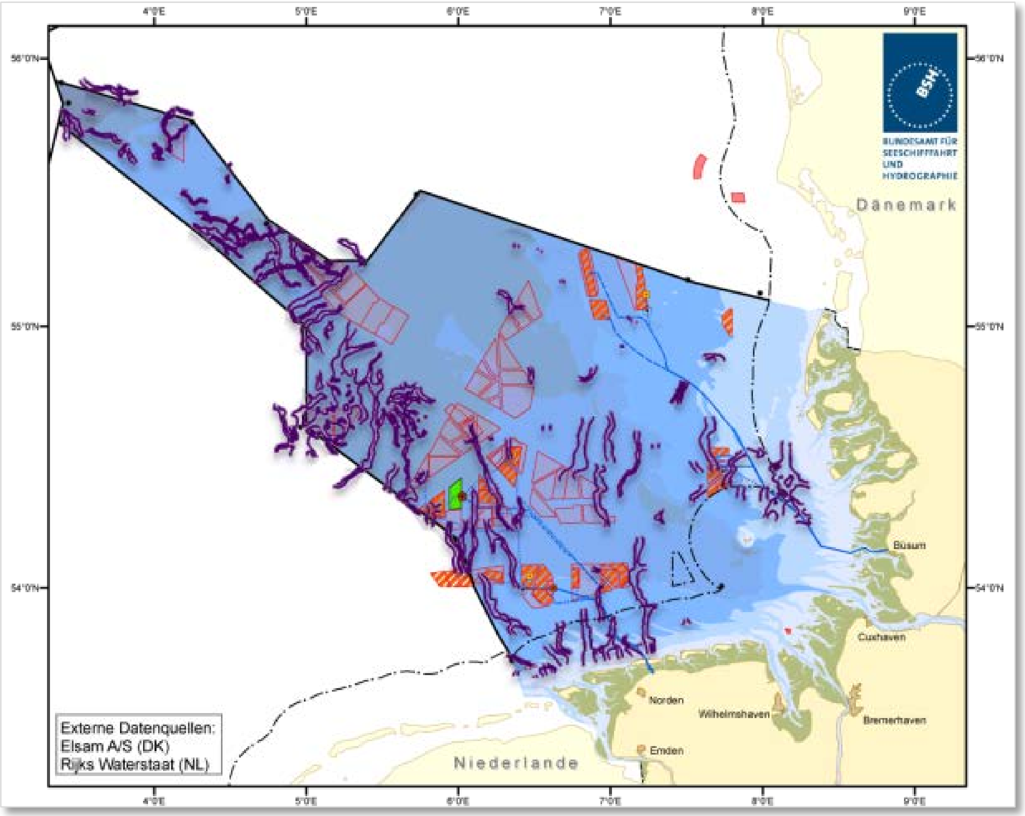
Seismic survey ➔ Insight into the geological structure



Subsoil investigation

Subglacial valleys in the North Sea - with significant risk of small-scale variations in subsoil conditions

In the Baltic Sea geolgogical conditions tend to be even more complex



Map: BSH; Valley overlay: BGR

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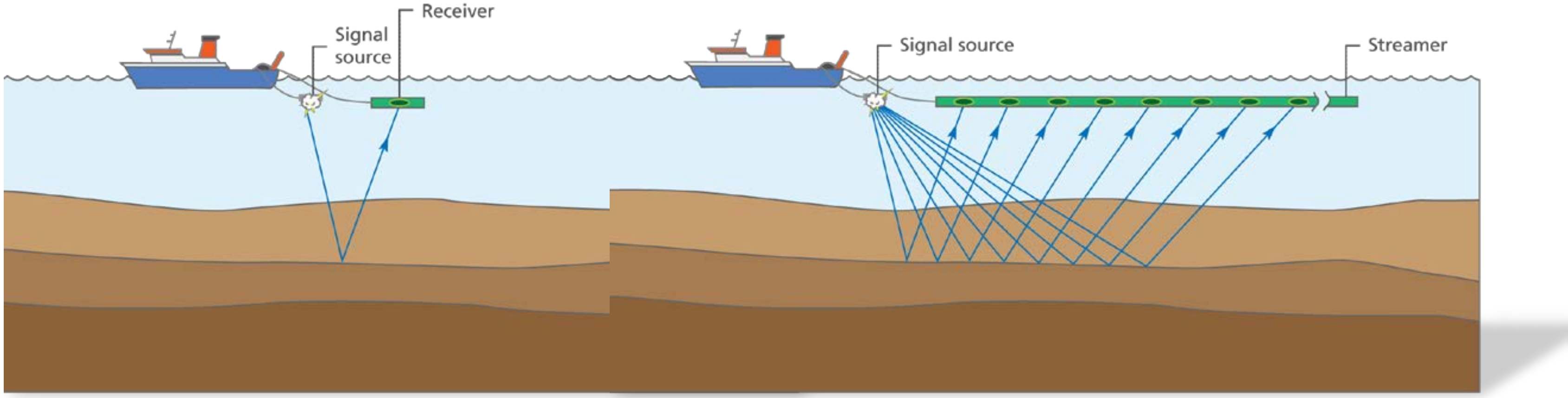
Challenge: Measuring subsoil conditions for foundation design

- Penetration at least up to foundation depth
- High signal to noise ratio
- Suitable for slopes of subglacial valleys



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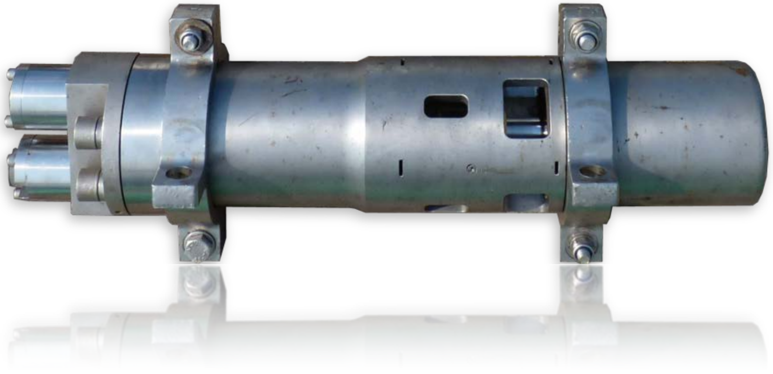
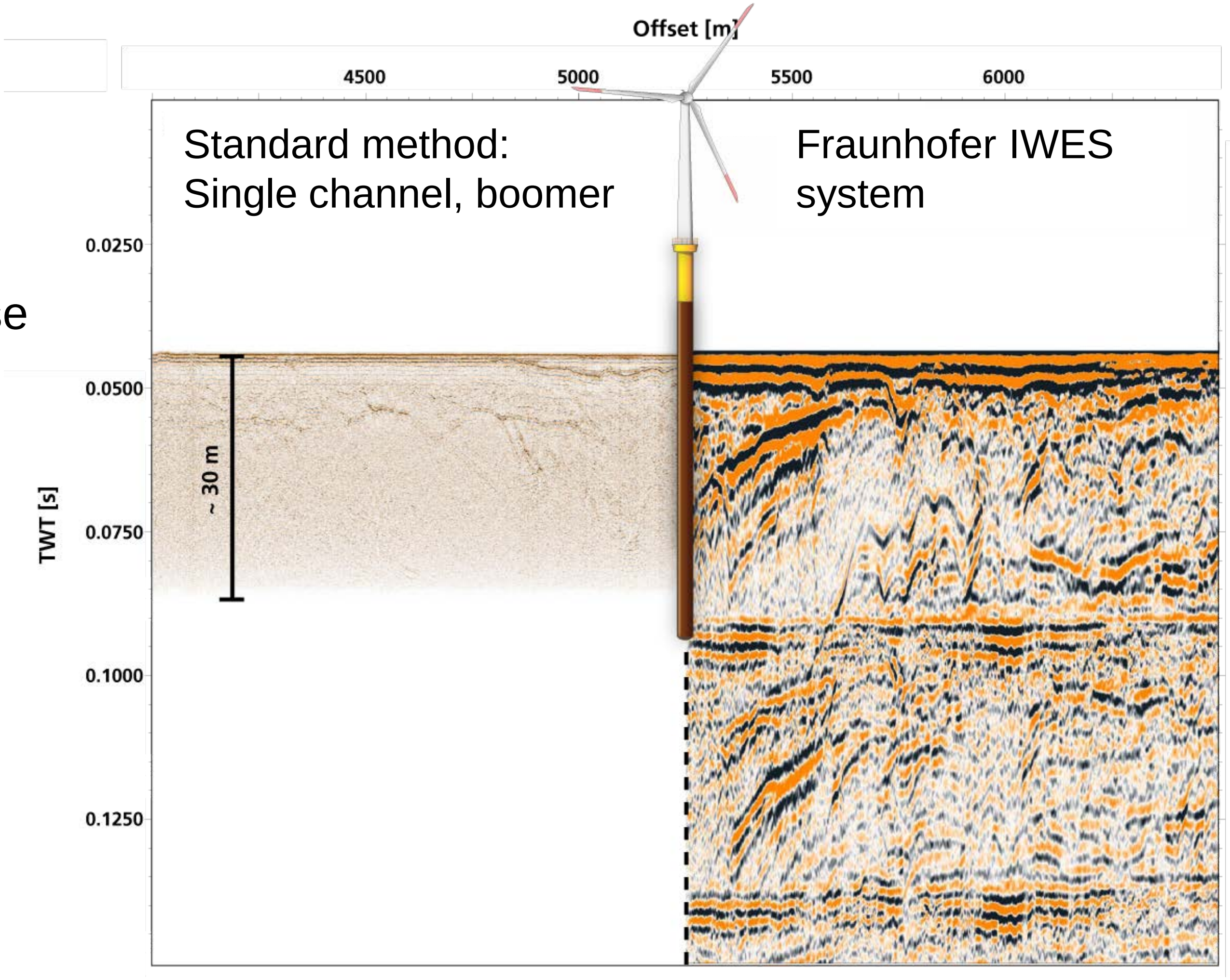
Fraunhofer IWES multi-channel seismic system:

- Streamer especially designed
  for shallow water conditions (< 100m)
- Fully digital, 60 channels
- High performance signal source
  (unique **Micro** GI-Gun)
- Low noise emission



Multi- vs. single channel seismic

- Enhanced signal penetration (100 - 200 m)
- High signal to noise ratio
- Imaging of slopes



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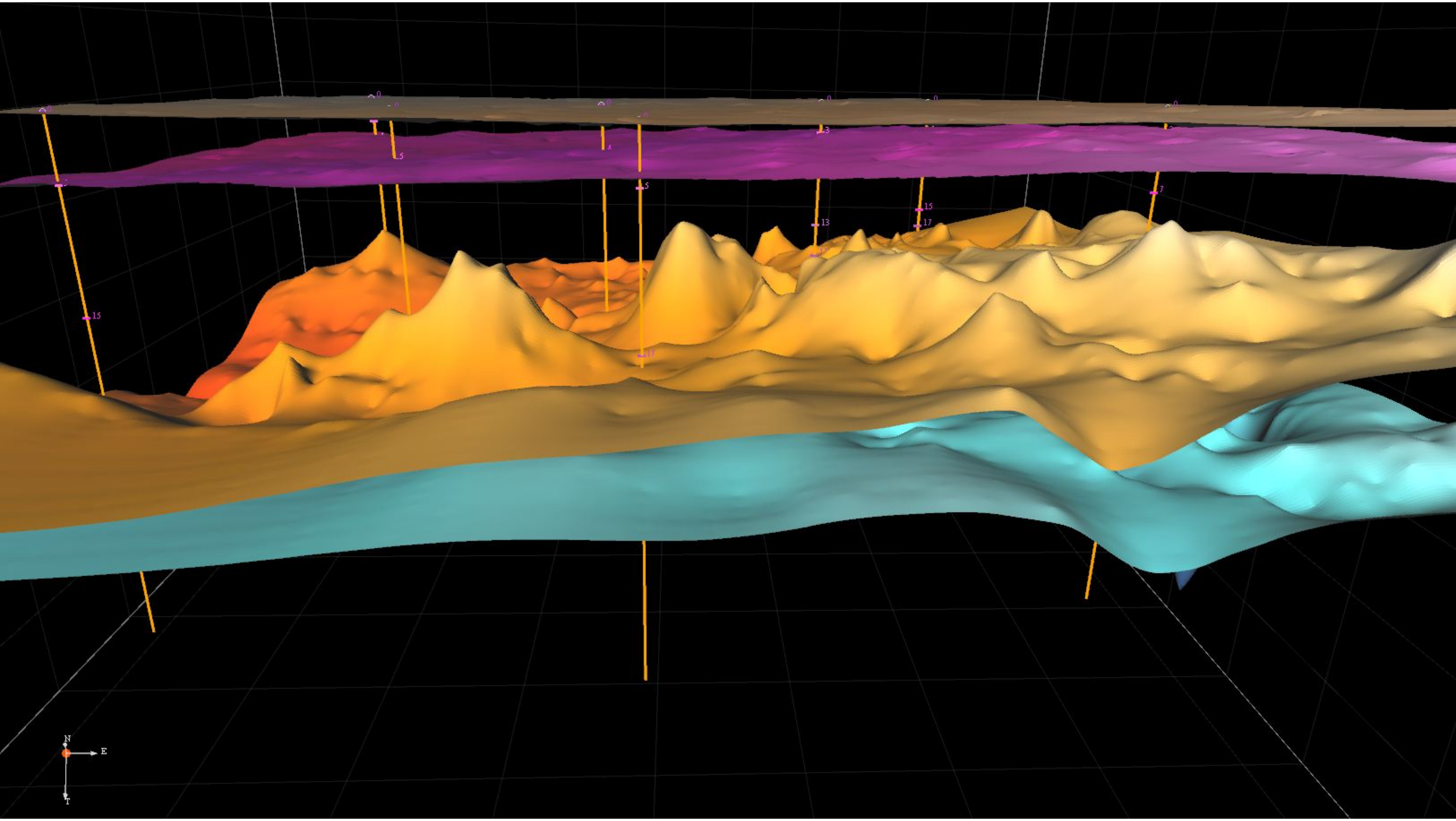
Geological subsoil model



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Conclusion

- Knowledge of environmental conditions is of paramount importance in all phases of an offshore wind farm project
- There are challenges to measurement technology which call for new, innovative methods tailored to the needs of offshore wind
- Example 1: Wind Lidar buoy provides a much cheaper, more flexible solution for any water depth compared to met masts
- Example 2: Digital multichannel seismic allows sufficient penetration depth, very good slope recognition and signal to noise ratio compared to standard methods

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Outlook

Project develop-ment

- Wind climatology in hub height, very accurate
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Project planning

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Design parameters?

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Scanning Lidar?

RAVE Offshore Wind R&D

International Conference on R&D for Offshore Wind Energy in the North Sea

October 13-15, 2015

Bremerhaven, Germany

Call for abstracts coming soon!

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THANKS FOR YOUR ATTENTION

Questions?

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HESSEN

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