

**I) Chances and limitations of measuring wind and turbulence profiles
by acoustic remote sensing**

II) Offshore wind and turbulence data

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I) Chances and limitations of measuring wind and turbulence profiles by acoustic remote sensing

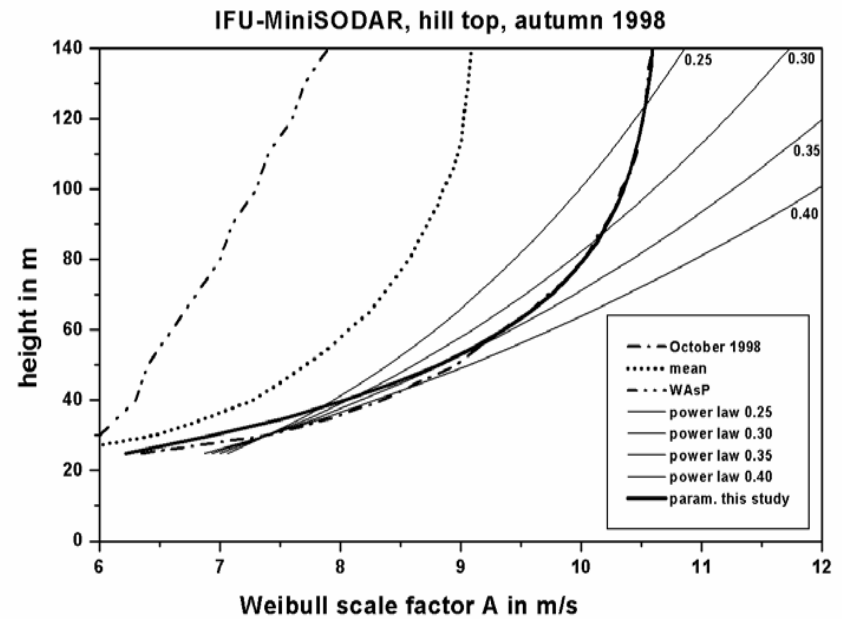
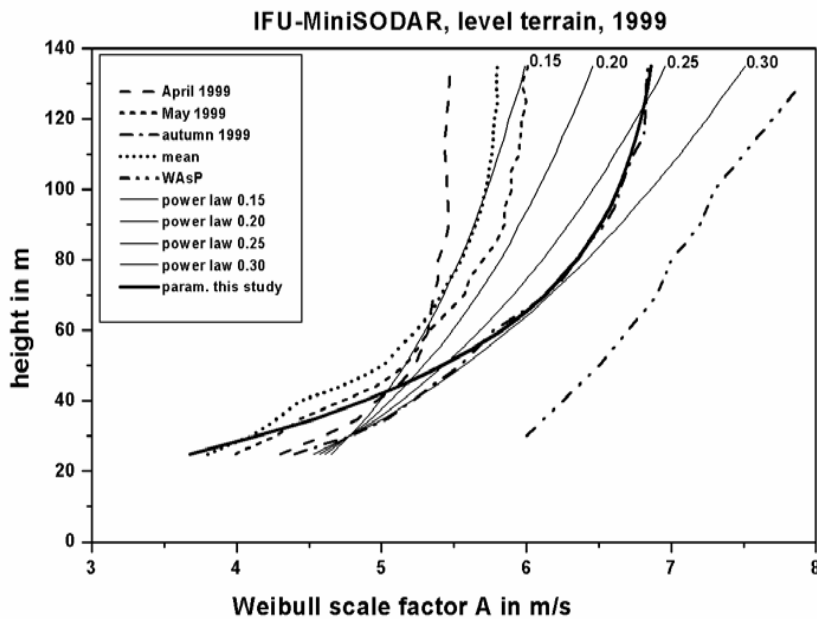
Chances (of profile measurements in general)

Results from the EU-project WISE

**Funded by the European Union under Grant NNE5-2001-297
(partners: ECN, Risø, Univ. of Salford, IMK-IFU, DEWI, Windtest-KWK, CRES)**

SODAR measurements against standard vertical extrapolations

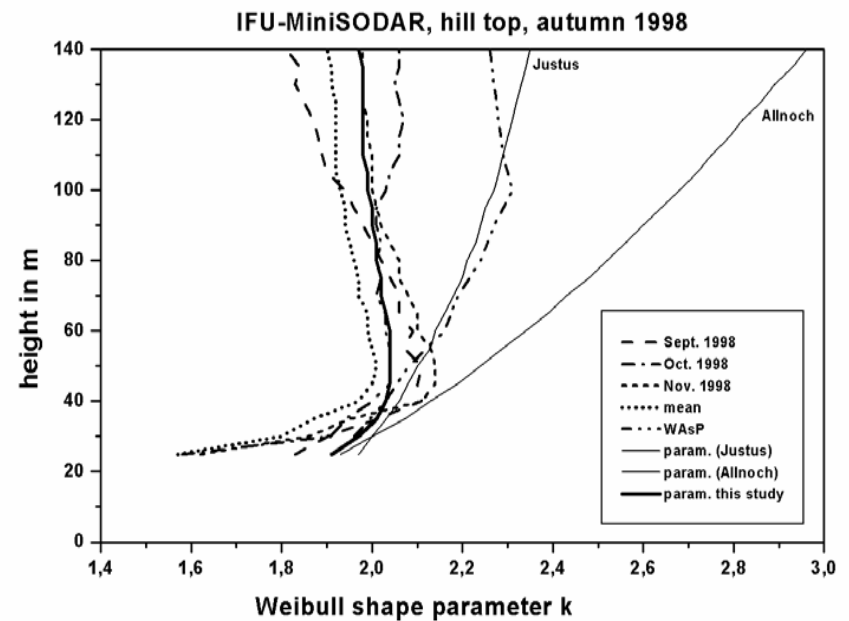
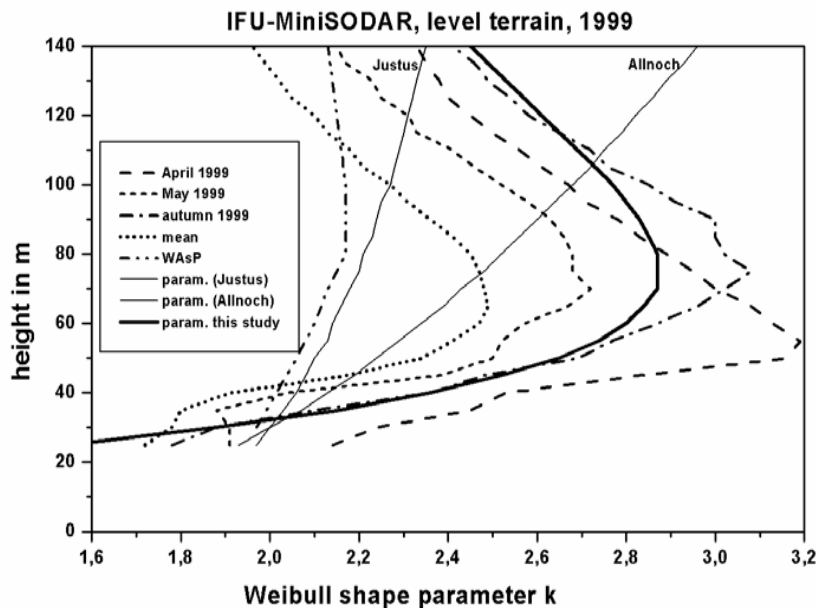
wind speed (scale factor of Weibull distribution)



(Emeis 2001)

SODAR measurements against standard vertical extrapolations

wind variance (shape factor of Weibull distribution)

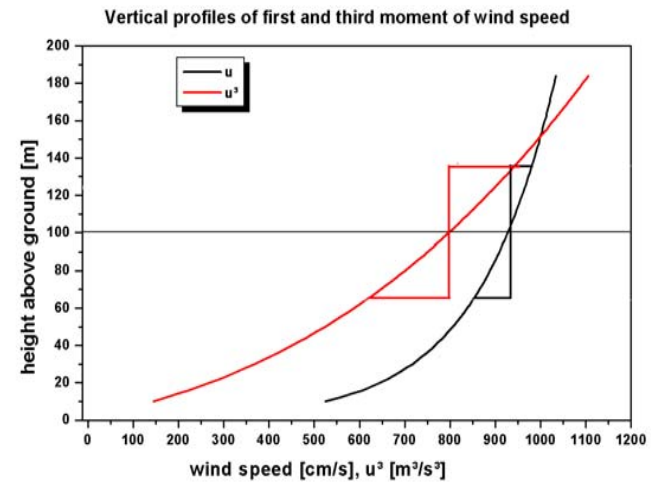
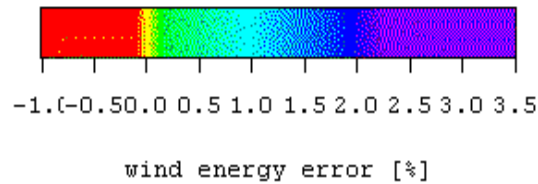
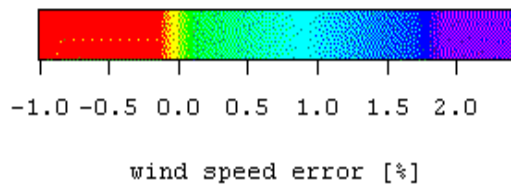
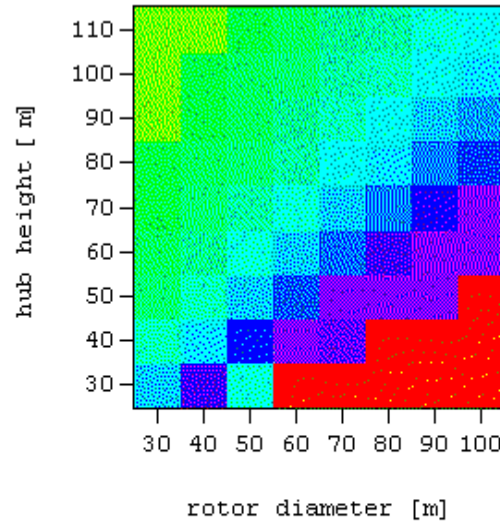
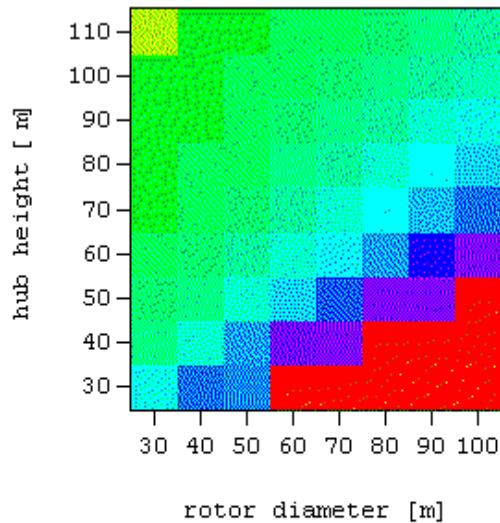


(Emeis 2001)

Differences between point and SODAR (profile) measurements

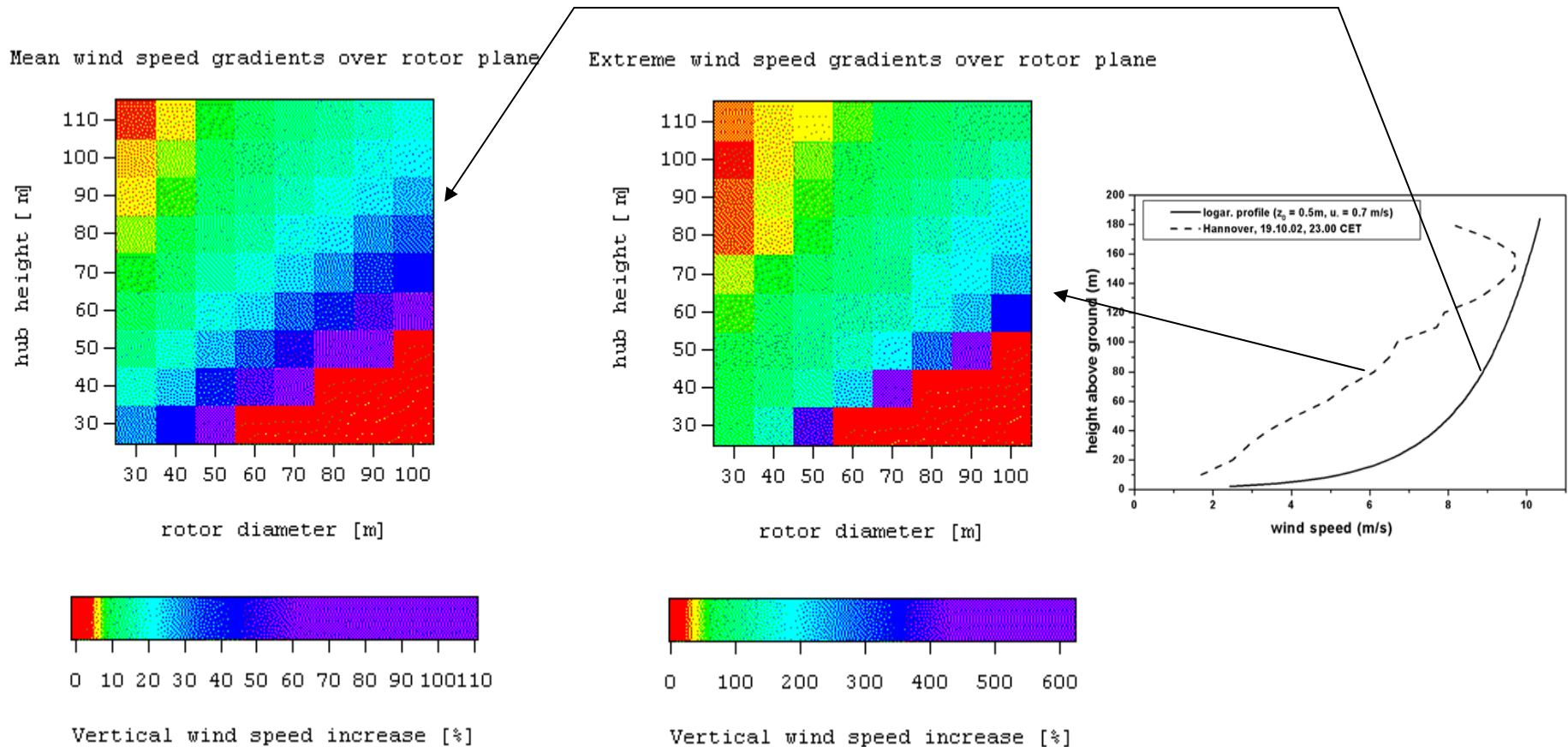
rotor plane mean wind speed and energy output

wind speed error point-profile measurement wind energy error point-profile measurement



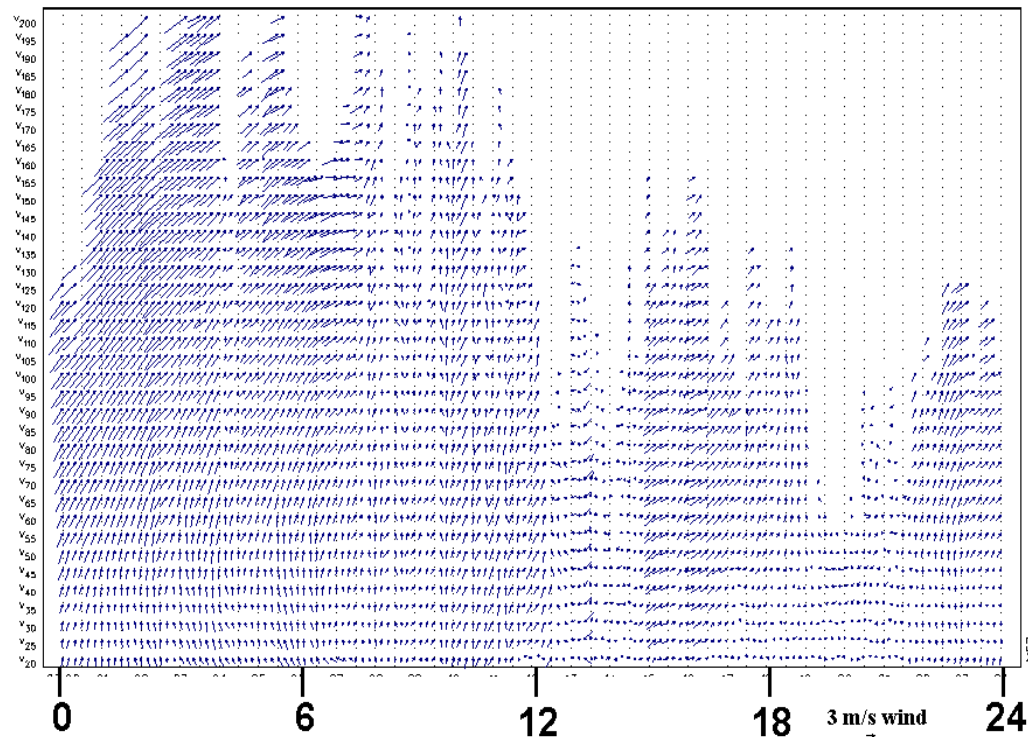
Differences between point and SODAR (profile) measurements

vertical wind speed increase over rotor plane



Turning of wind direction from SODAR measurements

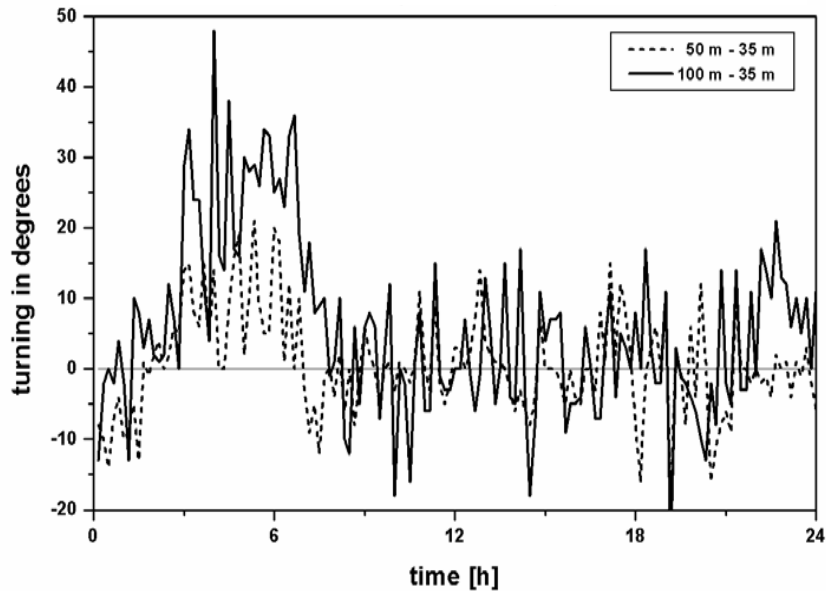
IFU-MiniSODAR, June 23, 1999



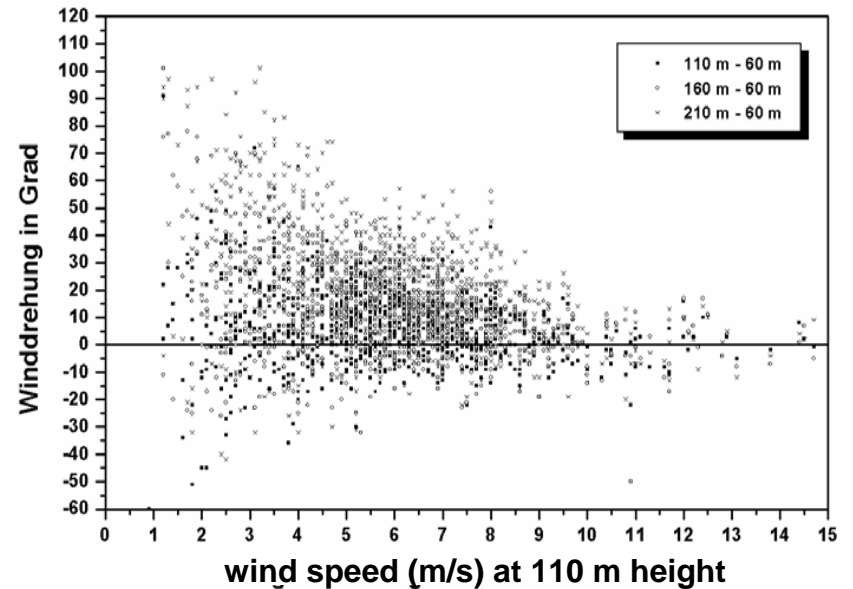
Observed turning of winds (extreme case)

Turning of wind direction from SODAR measurements

diurnal variation wind turning (monthly mean)



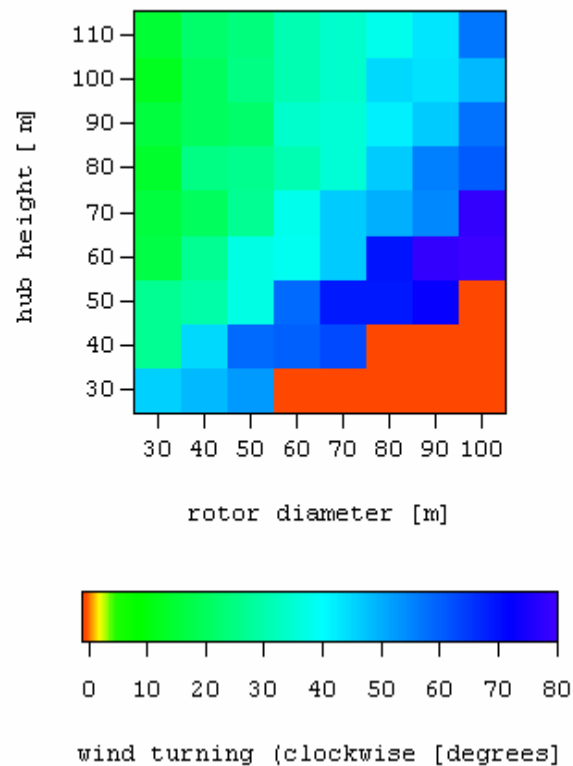
correlation wind speed – wind turning



Observed turning of winds

Turning of wind direction from SODAR measurements

Extreme turning of wind direction over rotor plane



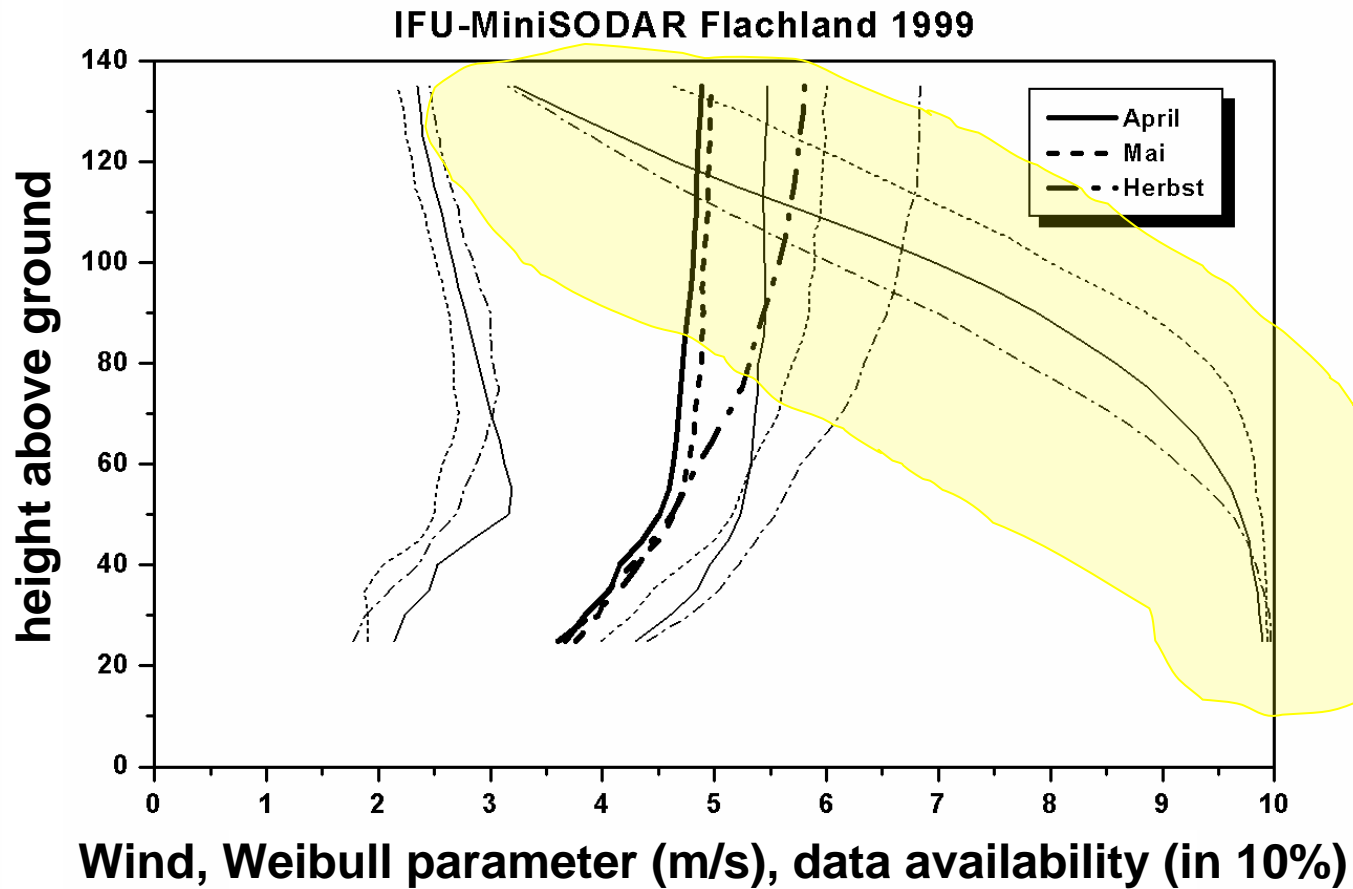
I) Chances and limitations of measuring wind and turbulence profiles by acoustic remote sensing

Limitations (especially for acoustic remote sensing)

Results from the EU-project WISE

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SODAR data availability



Circumstances that cause unreliable SODAR data

- a) well-mixed boundary layer in the late afternoon
- b) rain, snow
- c) very strong winds
- d) external noise
- e) fixed echos

Filtering techniques to detect and handle unreliable data

- a) SNR too low (high sigma w)
- b) high backscatter, negative vertical velocity
- c) SNR too low, high background noise level
- d) SNR too low, high background noise level
- e) high backscatter, wind speed too low

Operational parameter under which SODARs deliver reliable data

calm place, no obstacles, no precipitation, not too strong winds

II) Offshore wind and turbulence data

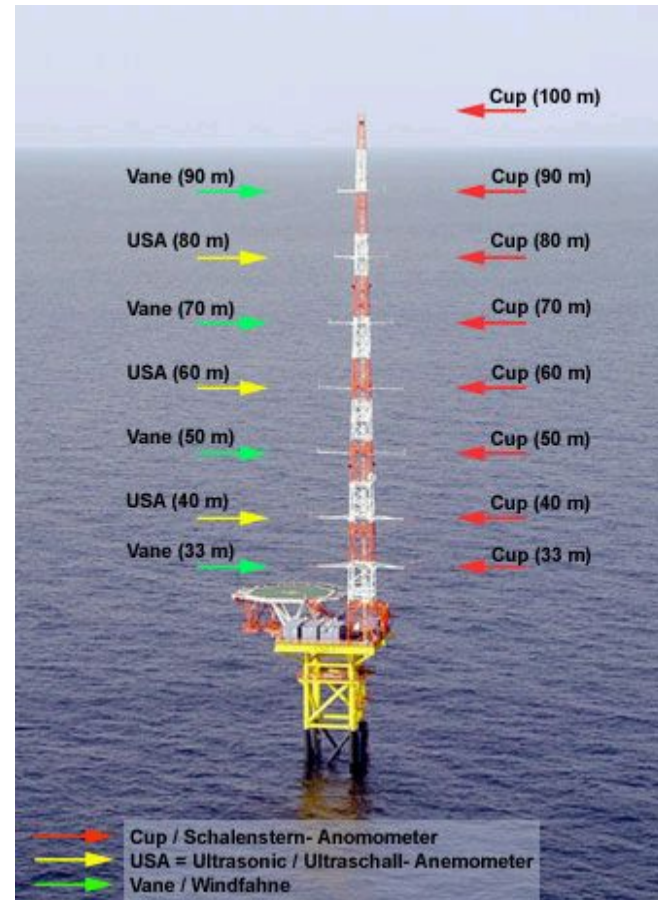
**This data is presented here as possible evaluation data
for satellite offshore wind mappings**

**Results from FINO1-measurements (running since Sept. 2003)
in the German Bight 45 km off the coast**

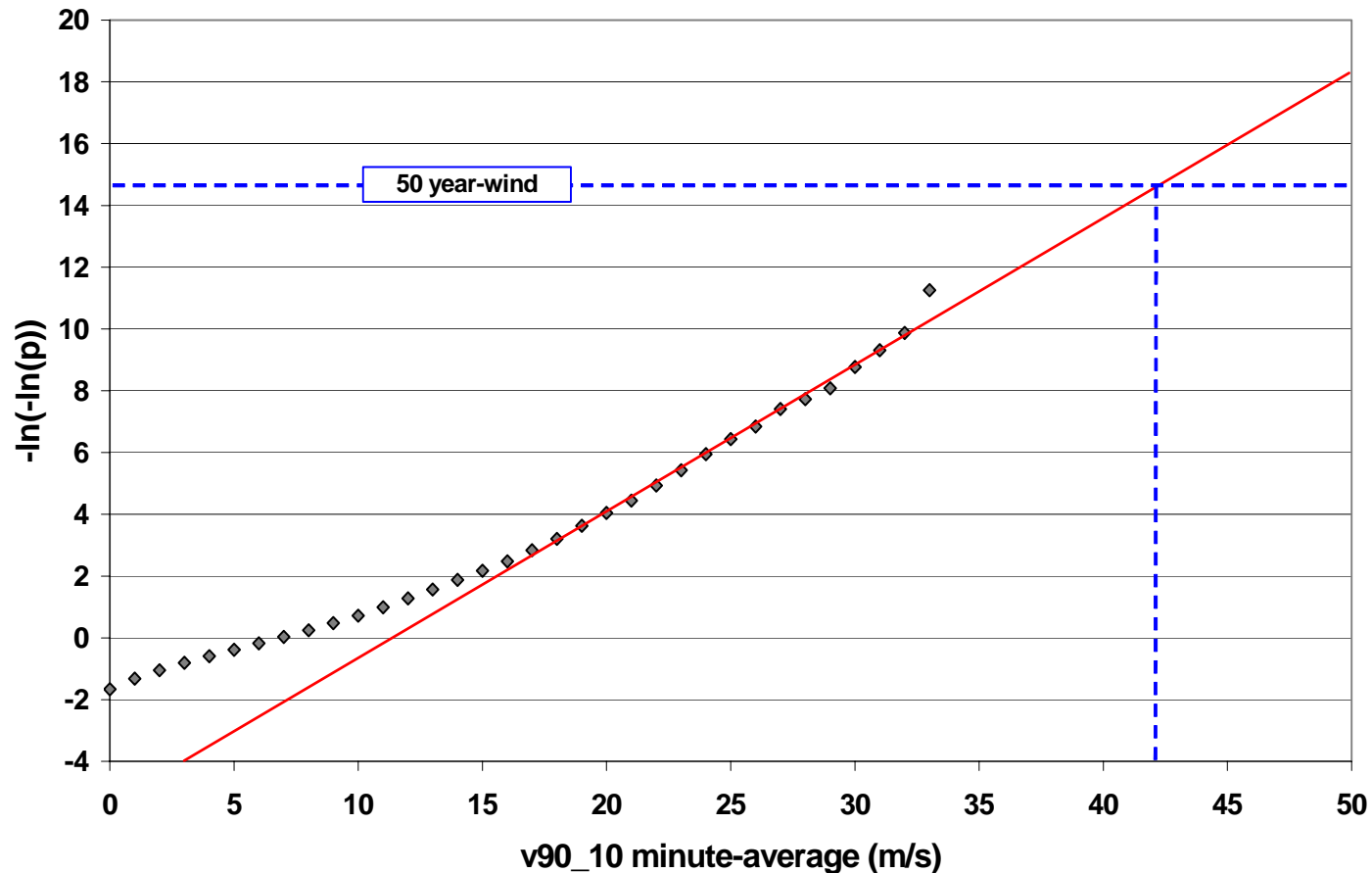
**Funded by the German Ministry for the Environment (BMU)
under Grant 0329961 (project: OWID, partners: IMK-IFU, DEWI, DEWI-OCC,
GE Wind, Multibrid, Repower, Enercon)**

FINO1 research platform

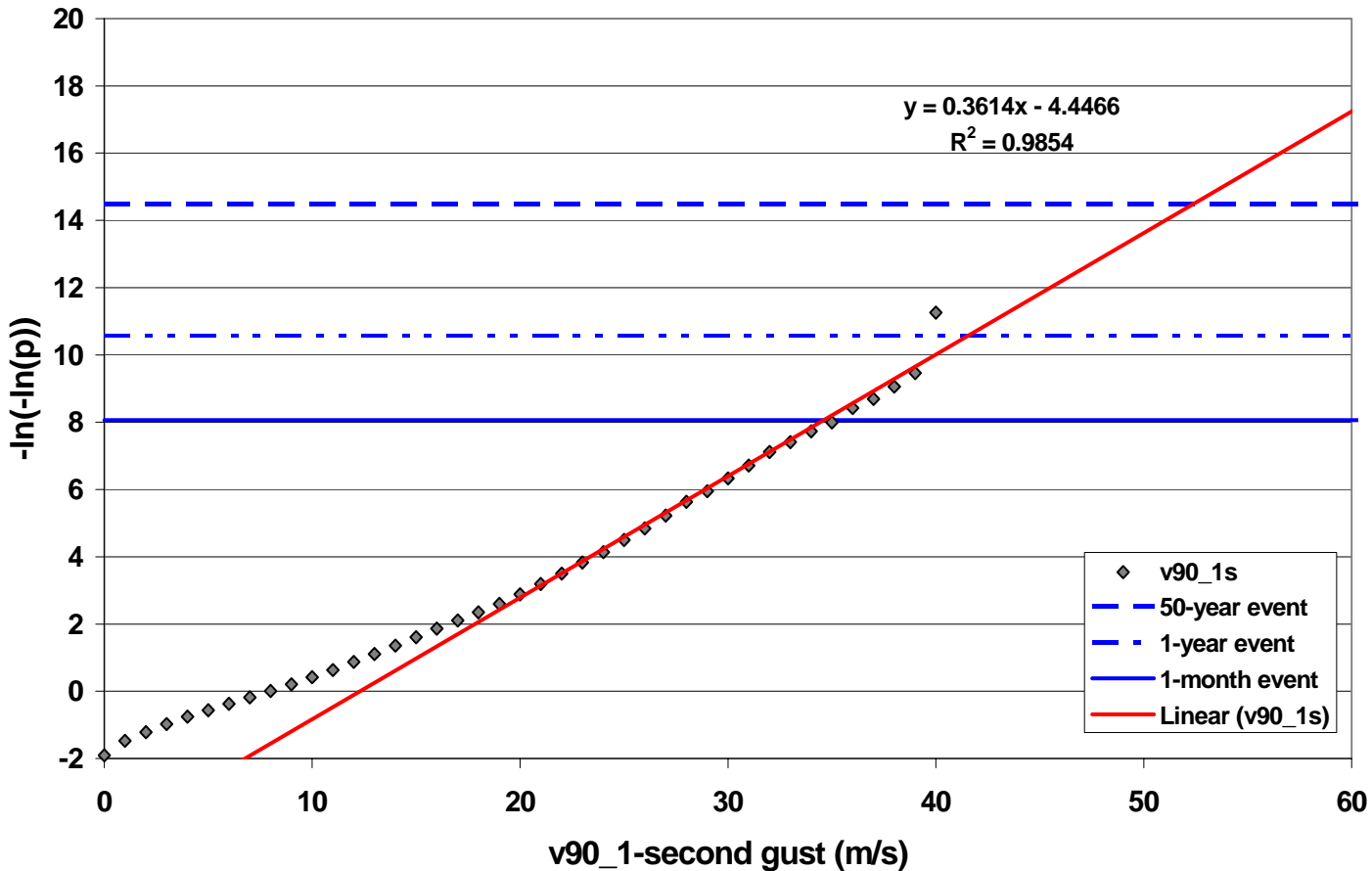
- Measuring of wind components from 33 to 100m
 - Monitoring of all standard meteorological parameters
 - Measuring of structural loads
 - Oceanographic measurements
 - Biological measurements
 - Located 45km north of the island of Borkum
- ⇒ Long running measurements since September 2003



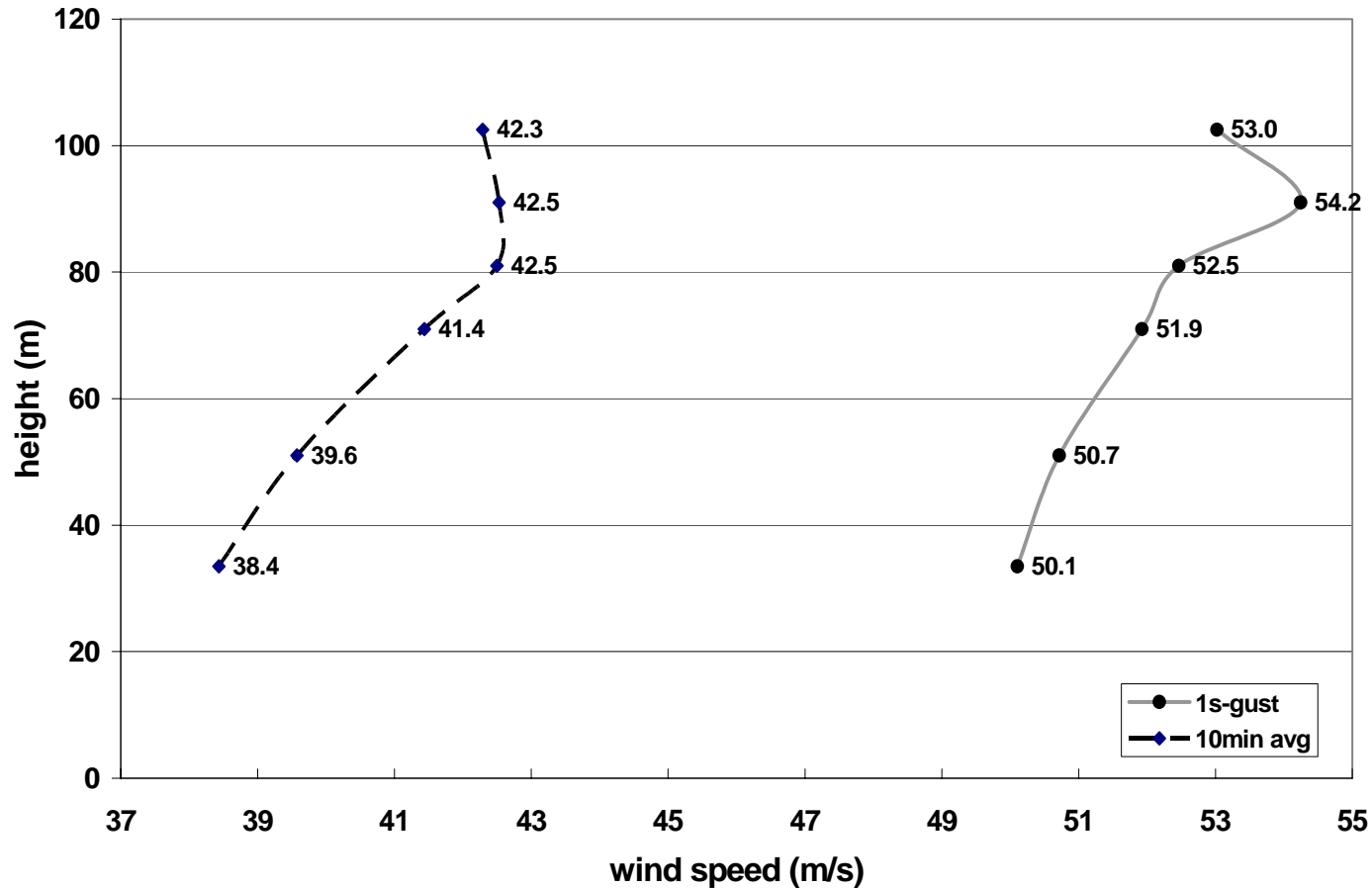
Extrapolation of the 50-year **mean** wind speed at FINO1 [p: cumulative frequency of 10-minute averages]



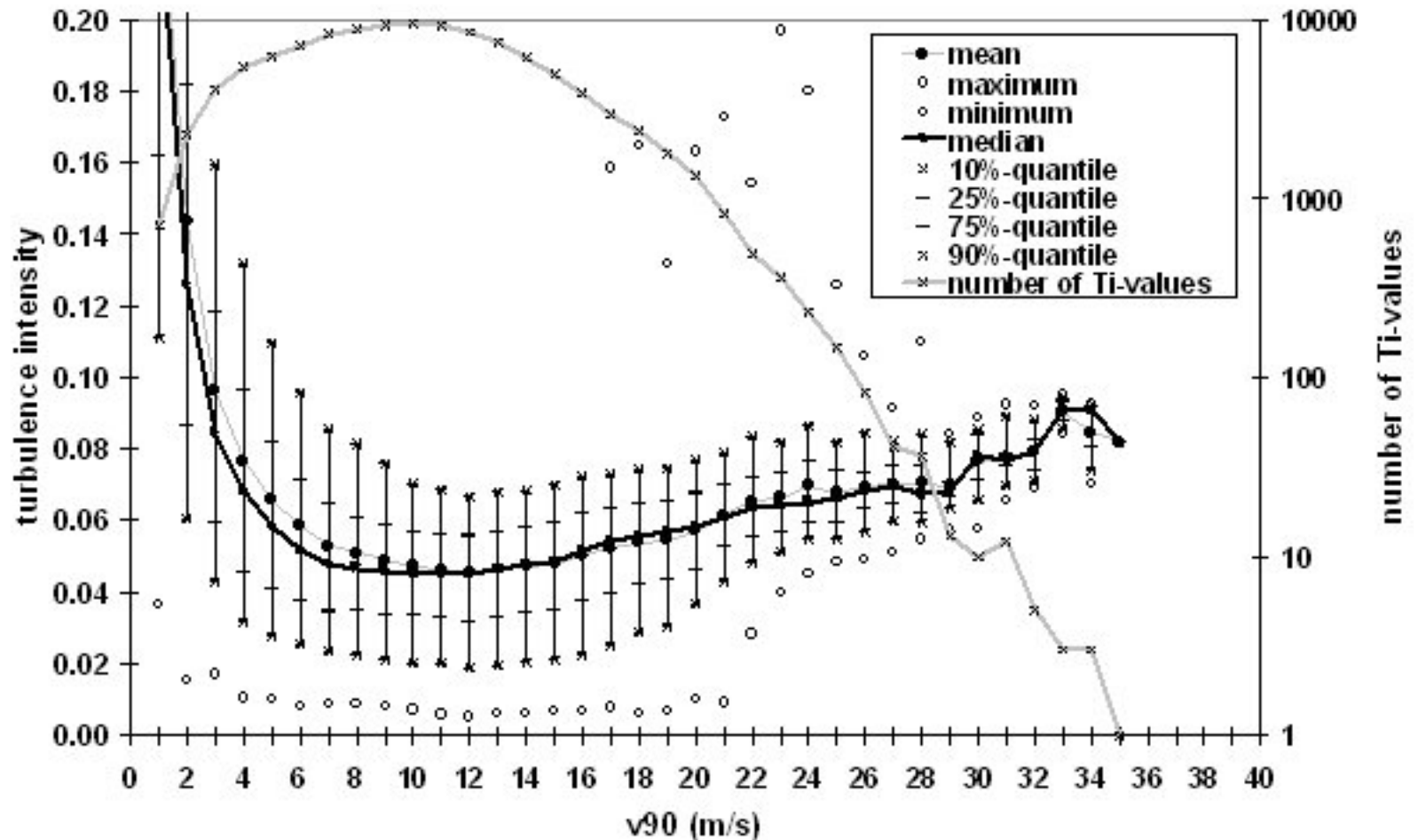
Extrapolation of the 50-year **gust** wind speed at FINO1 [p: cumulative frequency of 10-minute averages]



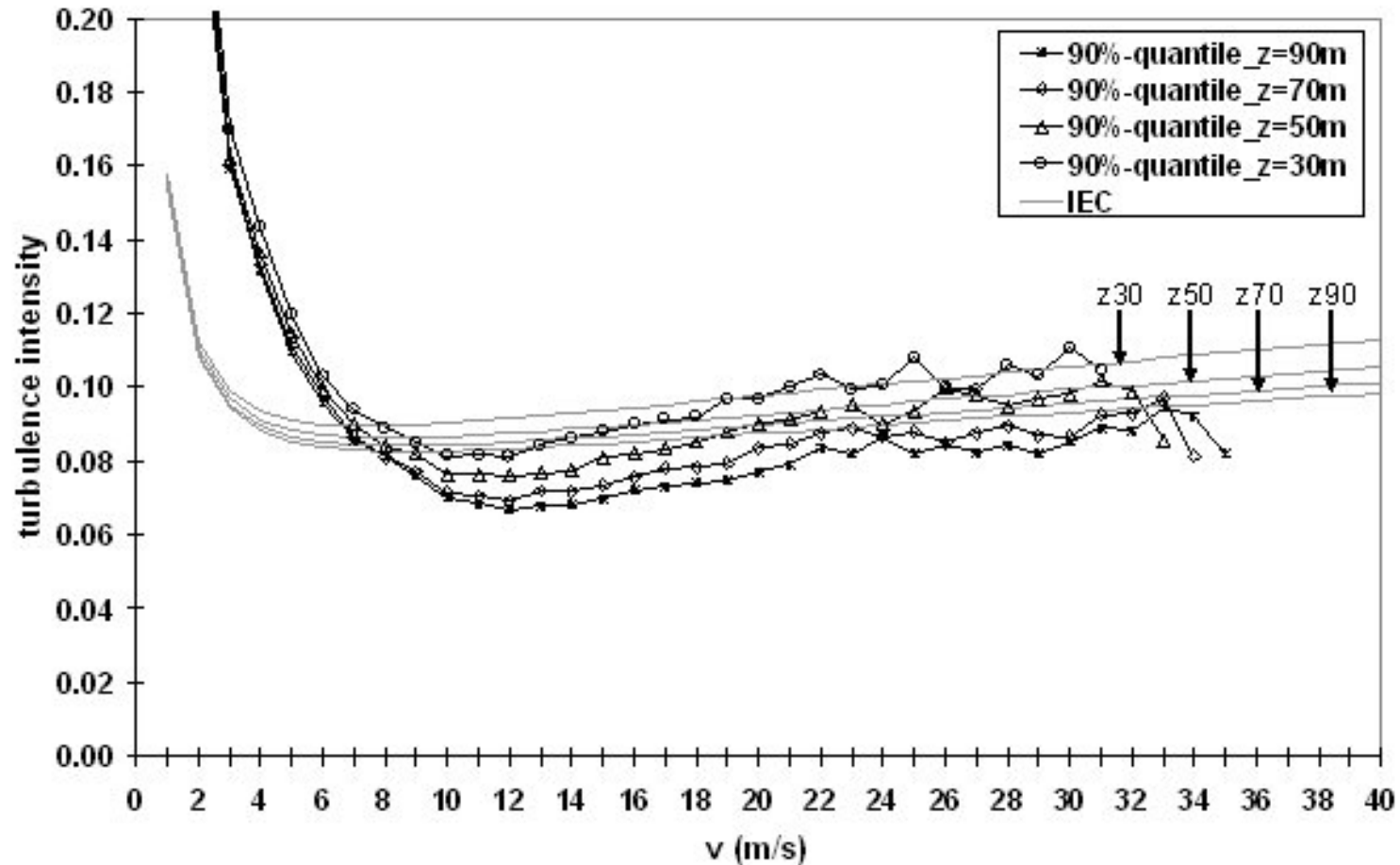
Vertical profiles of extrapolated 50-year mean and gust wind speeds at FINO1 (2004-2005, excluded: 280-350°)



Turbulence intensity as function of mean wind speed at FINO1



90%quantile of turbulence intensity as function of mean wind speed at FINO1, comparison against norm (IEC 61400-3)





Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft
