

Noise Measurements on off-shore Wind Turbines, Why and How

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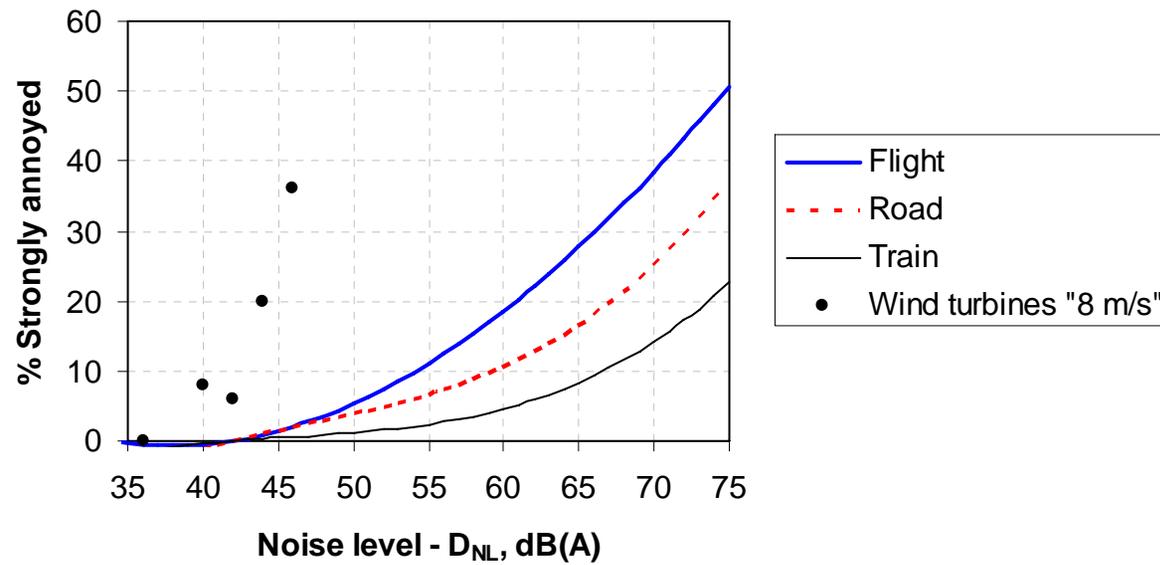
W e h e l p i d e a s m e e t t h e r e a l w o r l d

Disposition

- Why
 - Noise annoyance
 - Noise propagation
- How
 - Land based method
 - Modifications for sea based method



Noise Annoyance for different types of noise

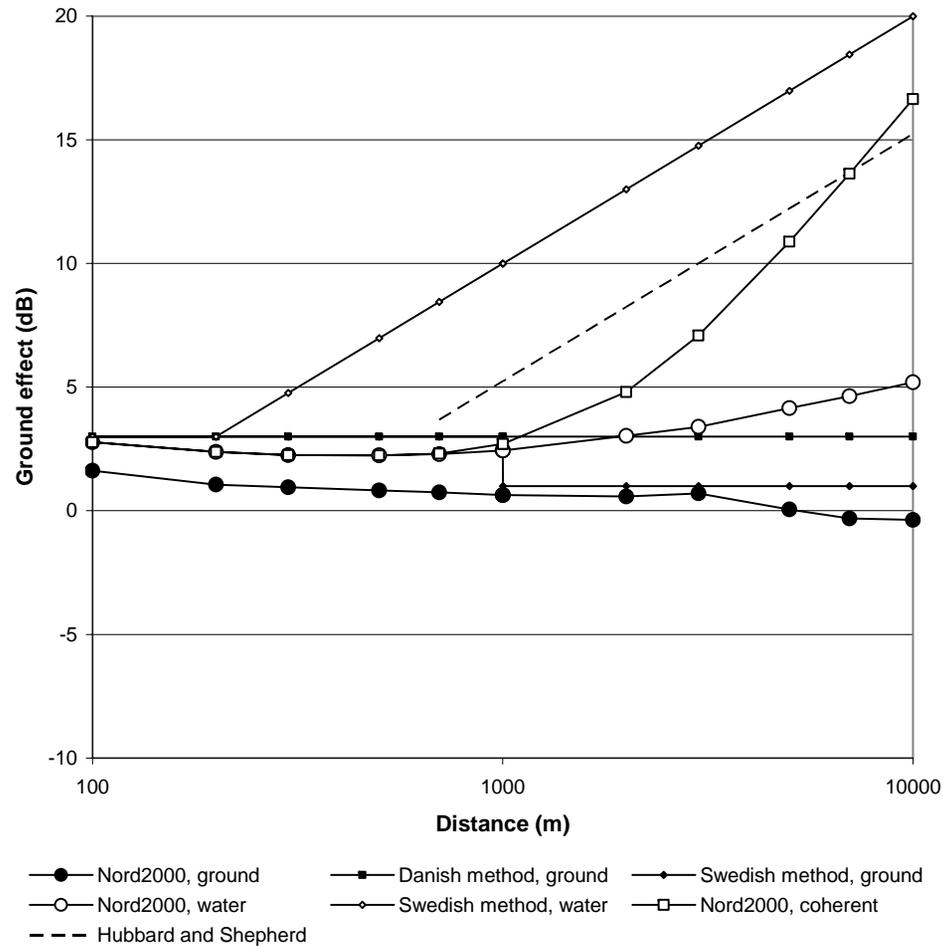


Different noise propagation models

- Danish Model; Statutory order No. 304 of 14th May 1991 “Noise from Wind Turbines” from the Danish Environmental Protection Agency (in Danish)
- Swedish model; Naturvårdsverket: *Ljud från vindkraftverk*, ISBN 91-620-6249-7, 2001
- Nord2000; a new model which can handle complex terrain with varying surface conditions and varying terrain and meteorological conditions.



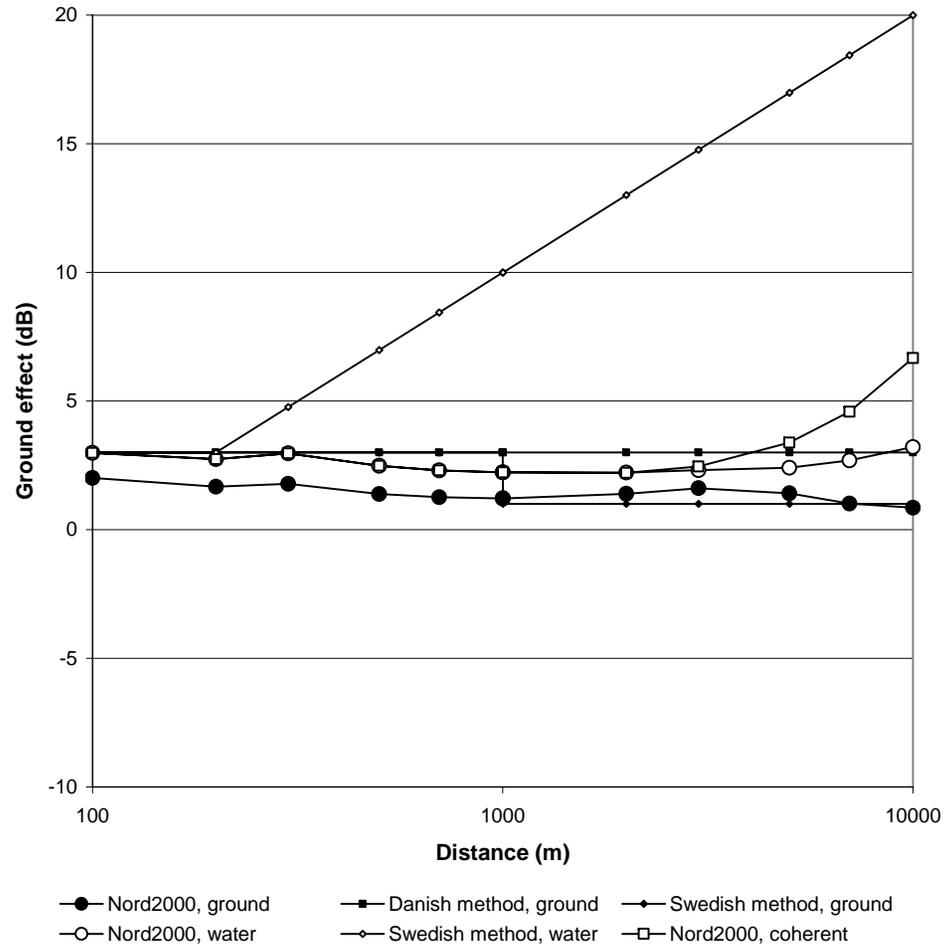
Ground effect from different models



Ground effect for a wind turbine with a hub height of 30 m predicted according to different models at propagation both over ground and water.



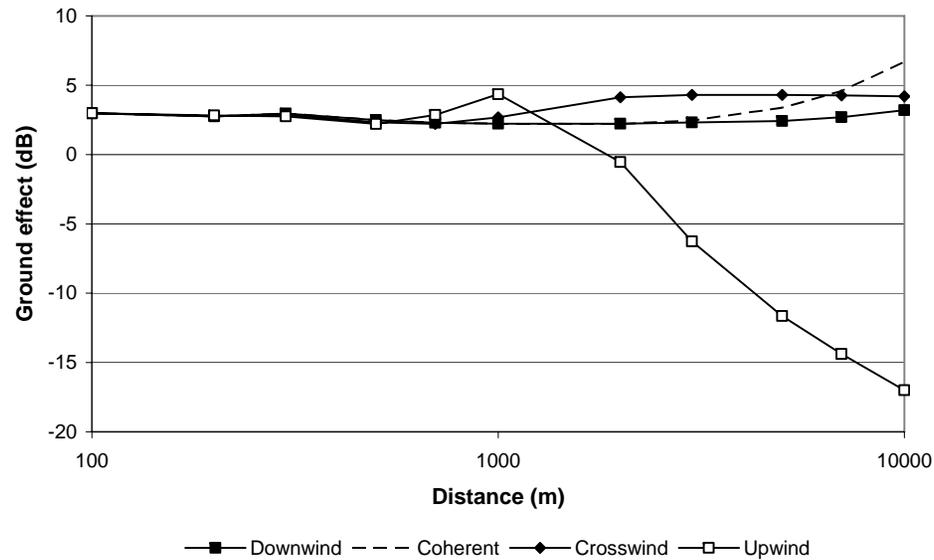
Ground effect from different models



Ground effect for a wind turbine with a hub height of 100 m calculated according to different models at propagation both over ground and water.



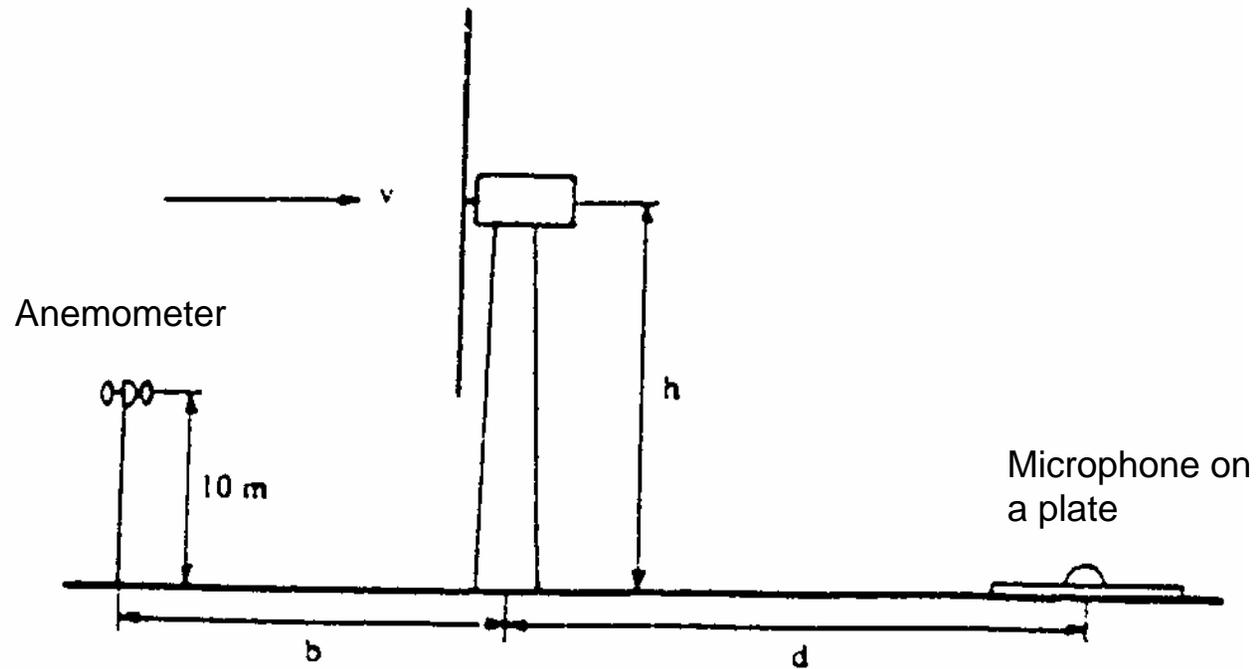
Ground effect at different wind directions



Ground effect for a wind turbine with a hub height of 100 m calculated with Nord2000 for different wind directions for propagation over water.



IEC 61400-11:2002 Noise Measurement Method



Noise Measurement



W e h e l p i d e a s m e e t t h e r e a l w o r l d

Modifications to method

- Microphone Height 3-5 m above sea level
- New calculation of sound power level

land based
$$L_{WA} = L_{Aeq,c} - 6 + 10 \cdot \log \left[\frac{4 \cdot \pi \cdot R_1^2}{S_0} \right]$$

sea based
$$L_{WA} = L_{Aeq,c} - 3 + 10 \cdot \log \left[\frac{4 \cdot \pi \cdot R_1^2}{S_0} \right]$$

- Wind protection needed
- Wind speed measurement at the microphone position



Noise measurement at sea



W e h e l p i d e a s m e e t t h e r e a l w o r l d

Conclusions

- Noise from wind turbines more annoying than e.g. traffic noise
- Noise is propagating with less damping over water
- Noise measurements are possible off-shore. (noise from waves can be a problem)
- Microphone position and met. mast position have to be changed.
- Supplementary wind protection necessary.

