

Large-eddy simulation study of effects of clearing in forest on wind turbines

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Acknowledgements



Outline

- **SOWFA by NREL**
- **Implementation of the forest**
- **Test case**
- **Conclusion**
- **Further outlook**

SOWFA by NREL

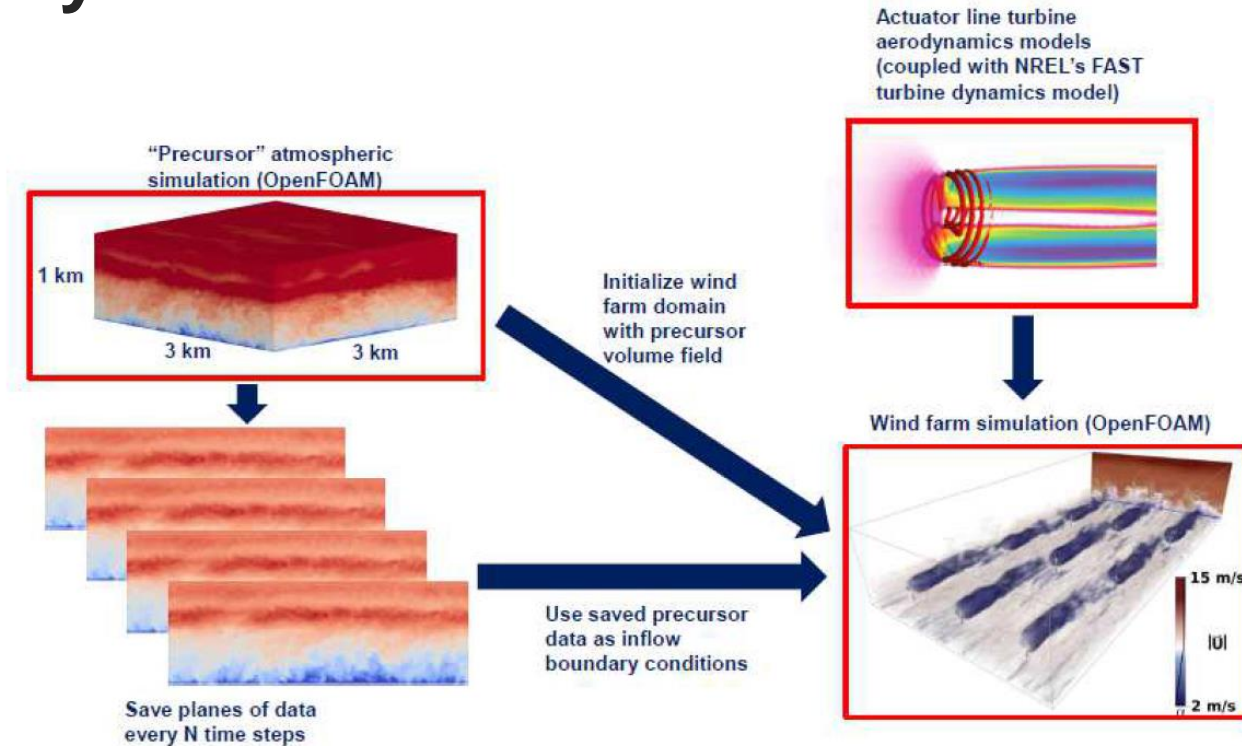


Figure: Overview SOWFA, source NREL

Implementation of the forest

- Add terms to the transport equations

- Momentum

$$F_{f,i} = -C_D a_f U \bar{u}_i$$

- Potential temperature

$$S_h = \frac{\partial}{\partial z} (Q_h \exp(-\gamma A_c))$$

$$A_c = \int_z^h a_f dz$$

Model by: Schumann and Shaw, 1992

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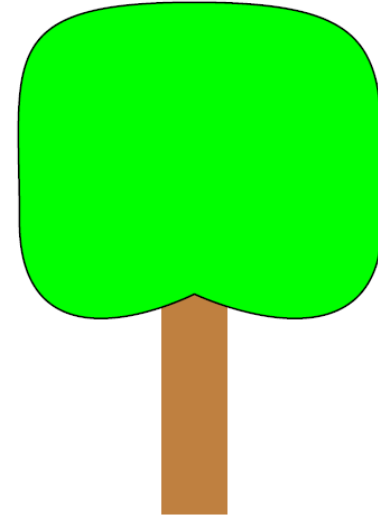
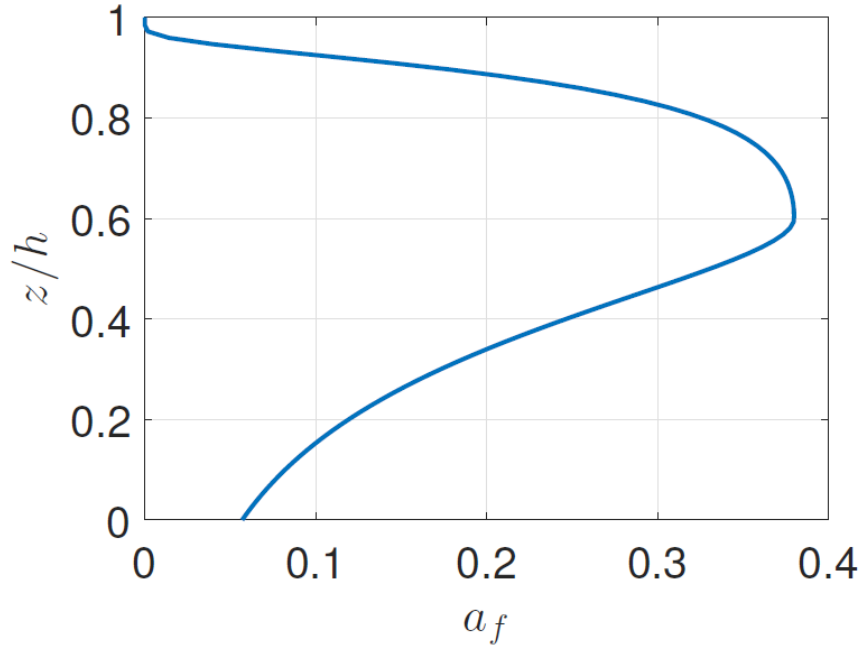
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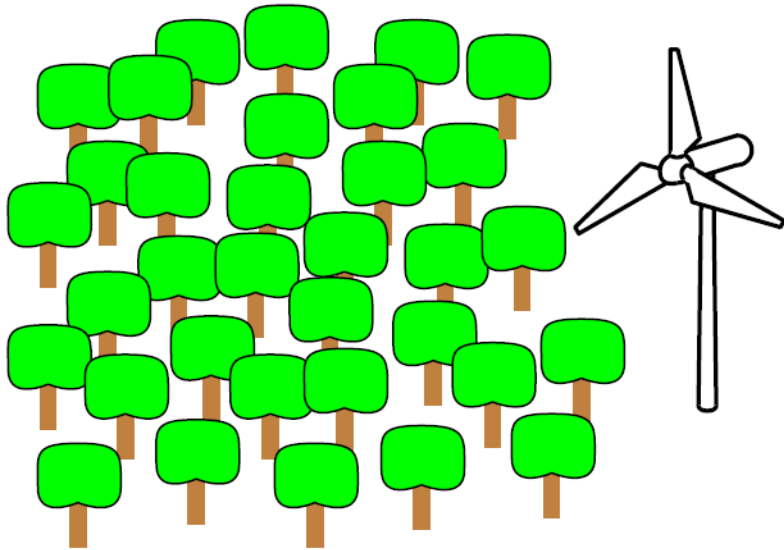
Implementation of the forest



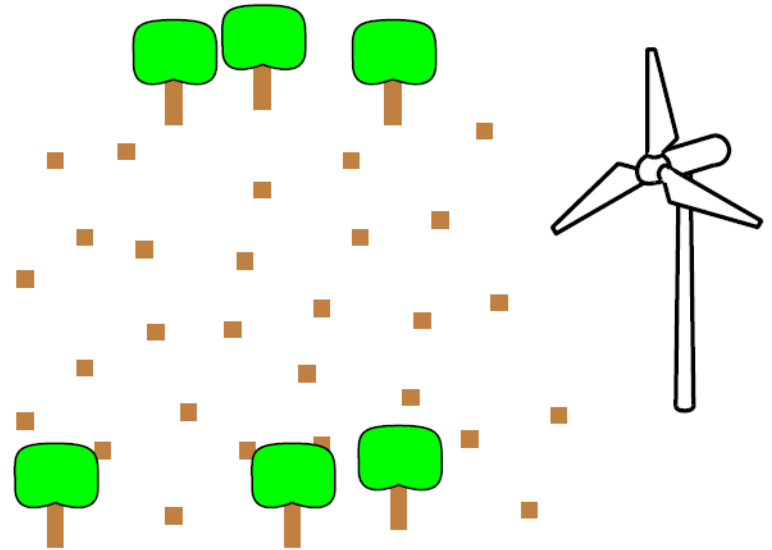
Model by: Lalic and Mihailovic, 2003

Test case

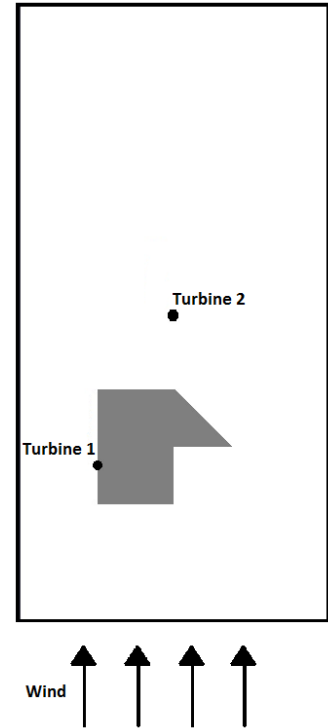
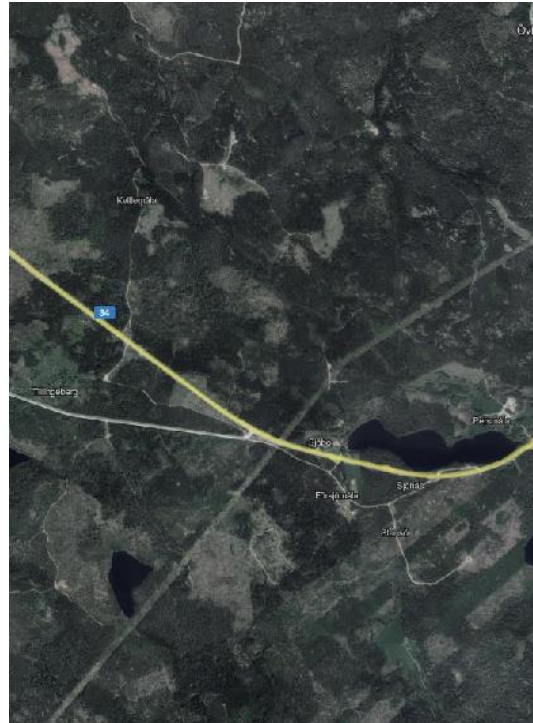
Before



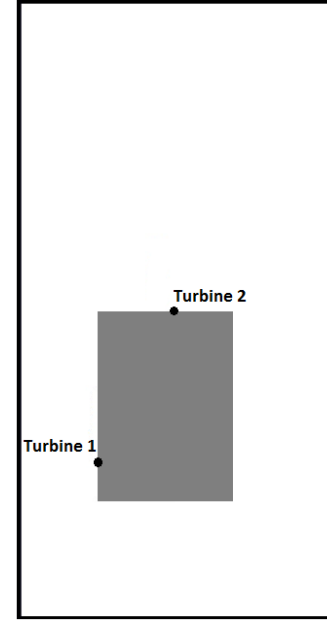
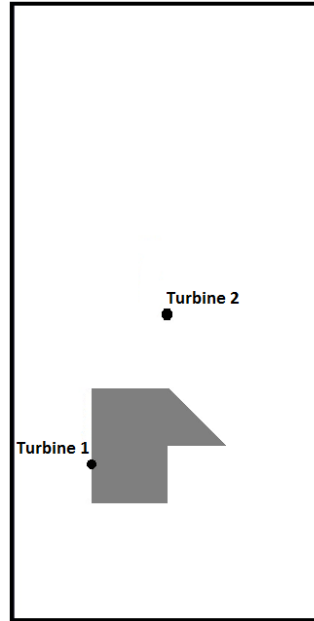
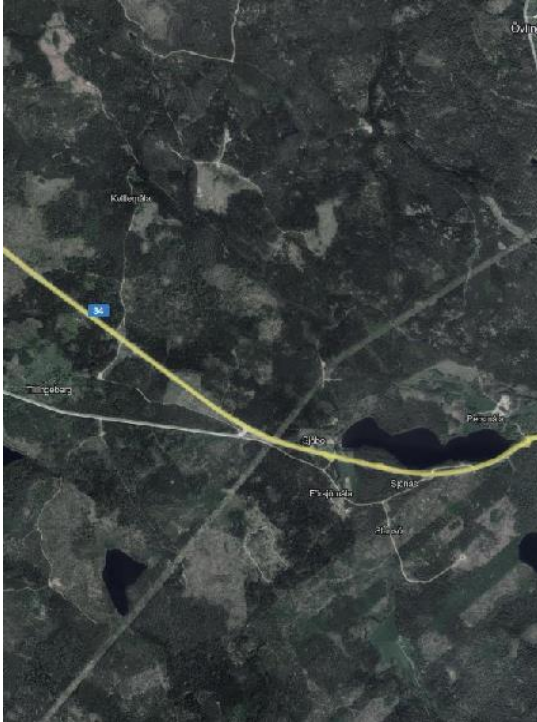
After



Test case



Simulation setup: current and extended clearing



Electrical generator power

	Homogeneous forest		Current clearing		Extended clearing	
	Wind turbine 1	Wind turbine 2	Wind turbine 1	Wind turbine 2	Wind turbine 1	Wind turbine 2
$\langle U \rangle^3$	+6.9%	0.0	+7.0%	+4.3%	+7.2%	+1.2%

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$\langle U \rangle^3$	+6.9%	0.0	+7.0%	+4.3%	+7.2%	+1.2%
Only turbine 2		0.0		+3.8%		-2.6%
Both turbines	+8.6%	0.0	+8.5%	+3.0%	+8.5%	-3.5%

Rotor bending moment around y-axis

	Homogeneous forest		Current clearing		Extended clearing	
	Wind turbine 1	Wind turbine 2	Wind turbine 1	Wind turbine 2	Wind turbine 1	Wind turbine 2
Only turbine 2		0.0		-0.5%		-5.0%
Both turbines	+2.4%	0.0	+1.0%	-0.9%	+1.0%	-5.0%

Conclusions

- **Further work is needed to find the optimal clearing and wind turbine location to increase production and decrease the loads**

Further outlook

- **Increase the width and height of the computational domain**
 - **No numerical effects**
- **Test site B**
 - **Unstable and stable stratification**
 - **LiDAR measurements performed by Meventus**
 - **SCADA data from wind turbines by Stena Renewables**

Thanks for your attention!

