Wind and turbulence at a forest edge

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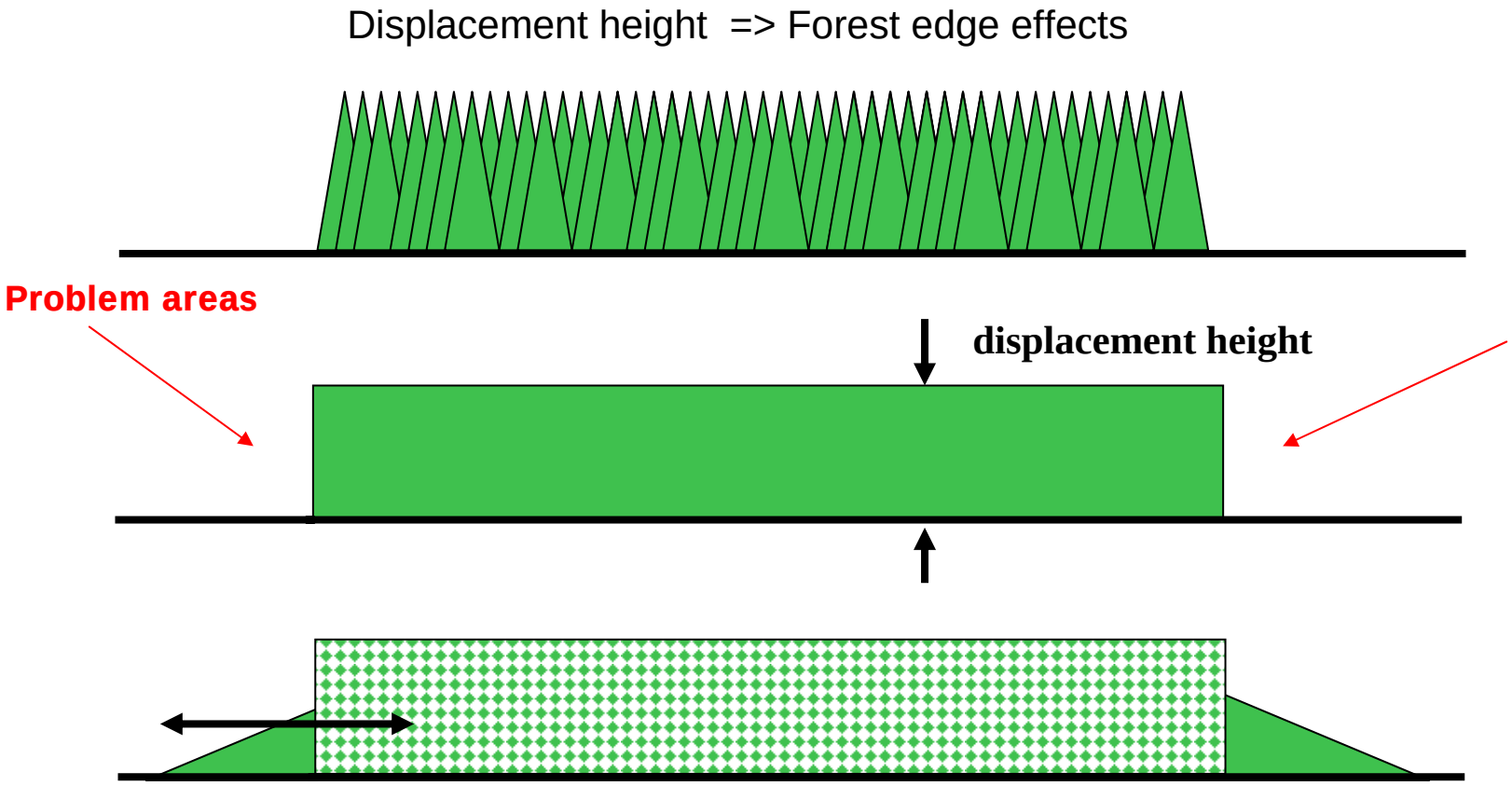
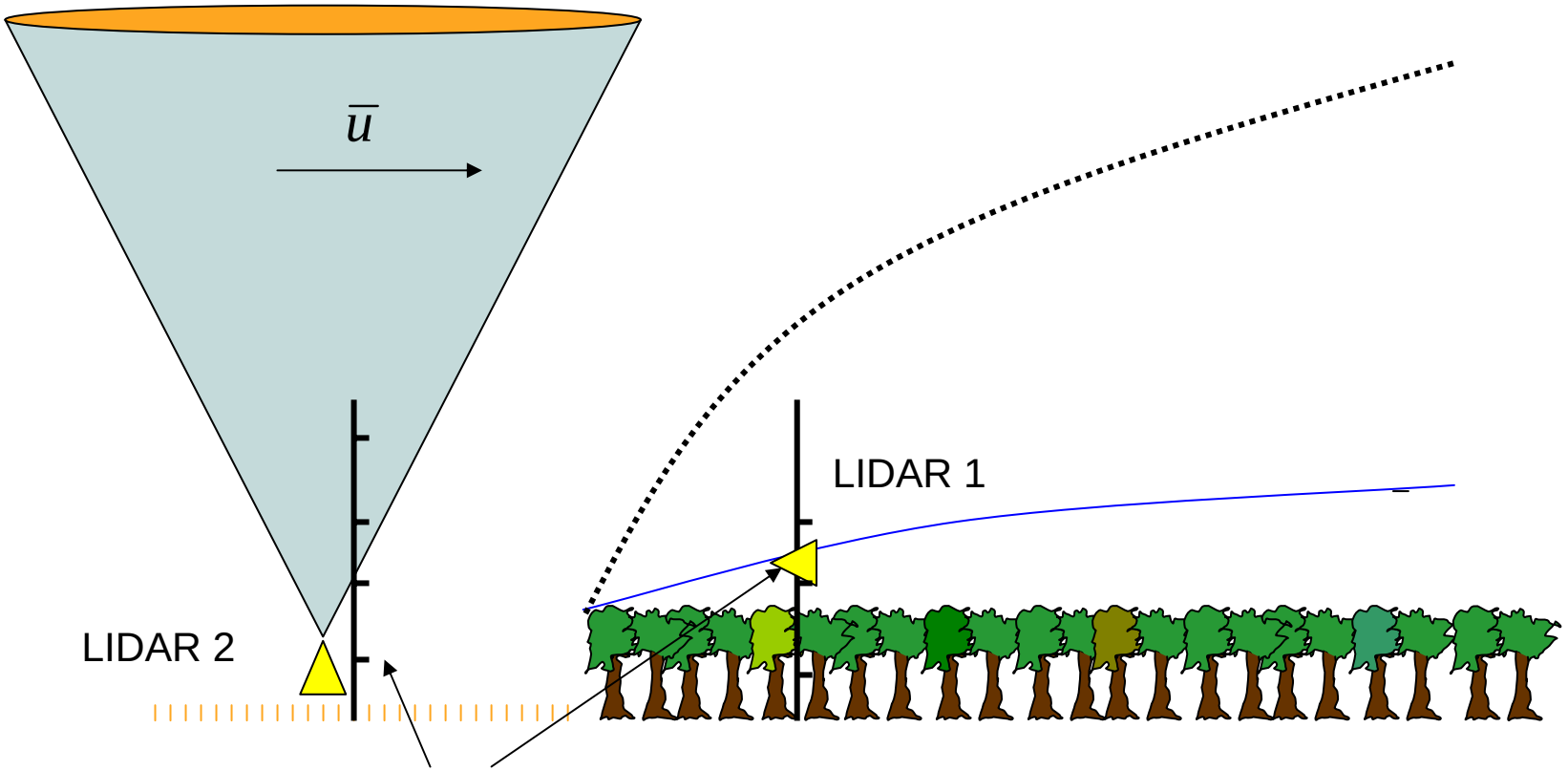
Outline

- Introduction to scientific goals and experiment.
- Mast and lidar data analysis at different atmospheric stability conditions.
- Modelling / model introduction.
- Preliminary WAsP Engineering solution.

How can the forest be parameterised in simple models?



Experiment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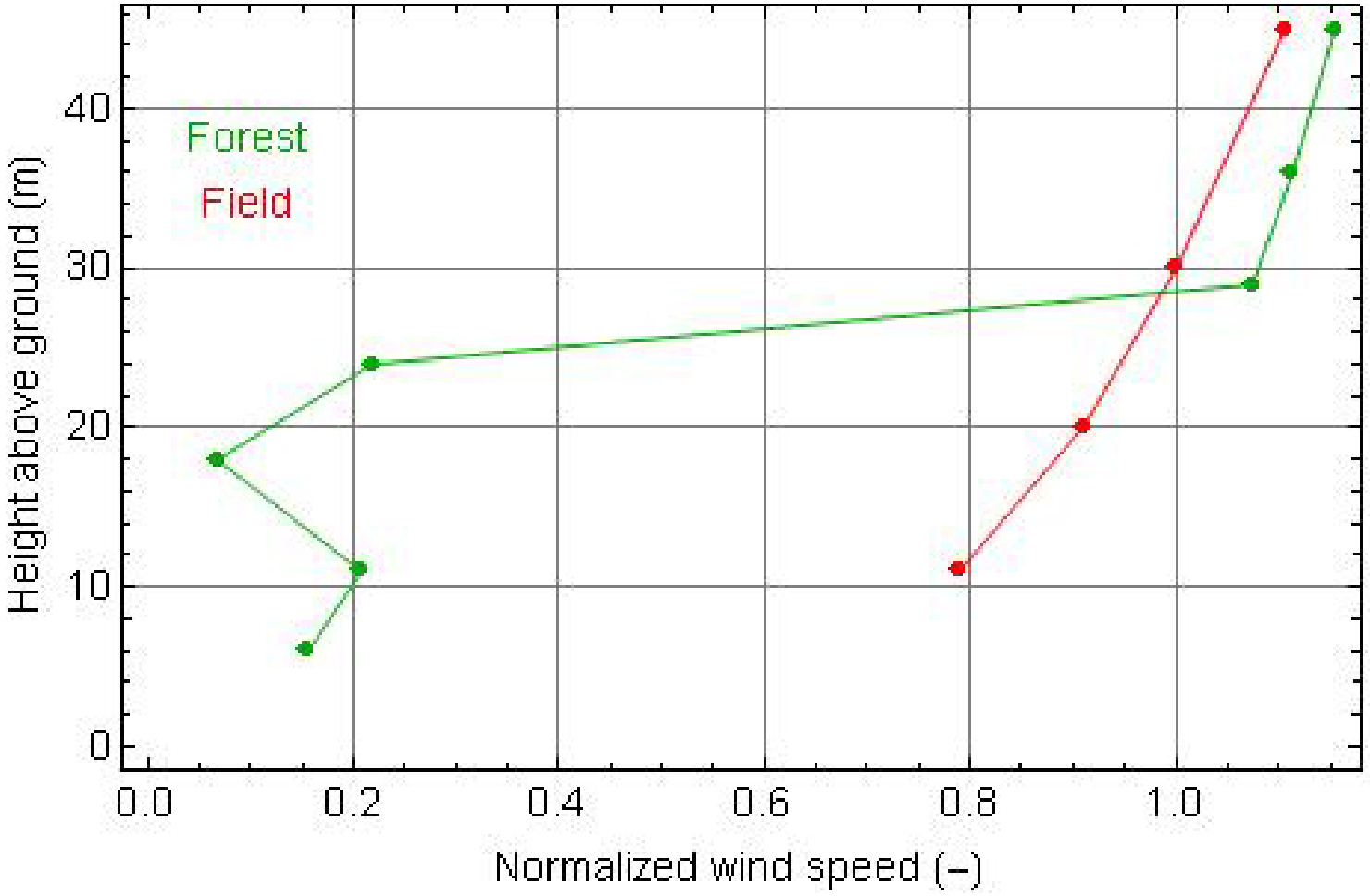
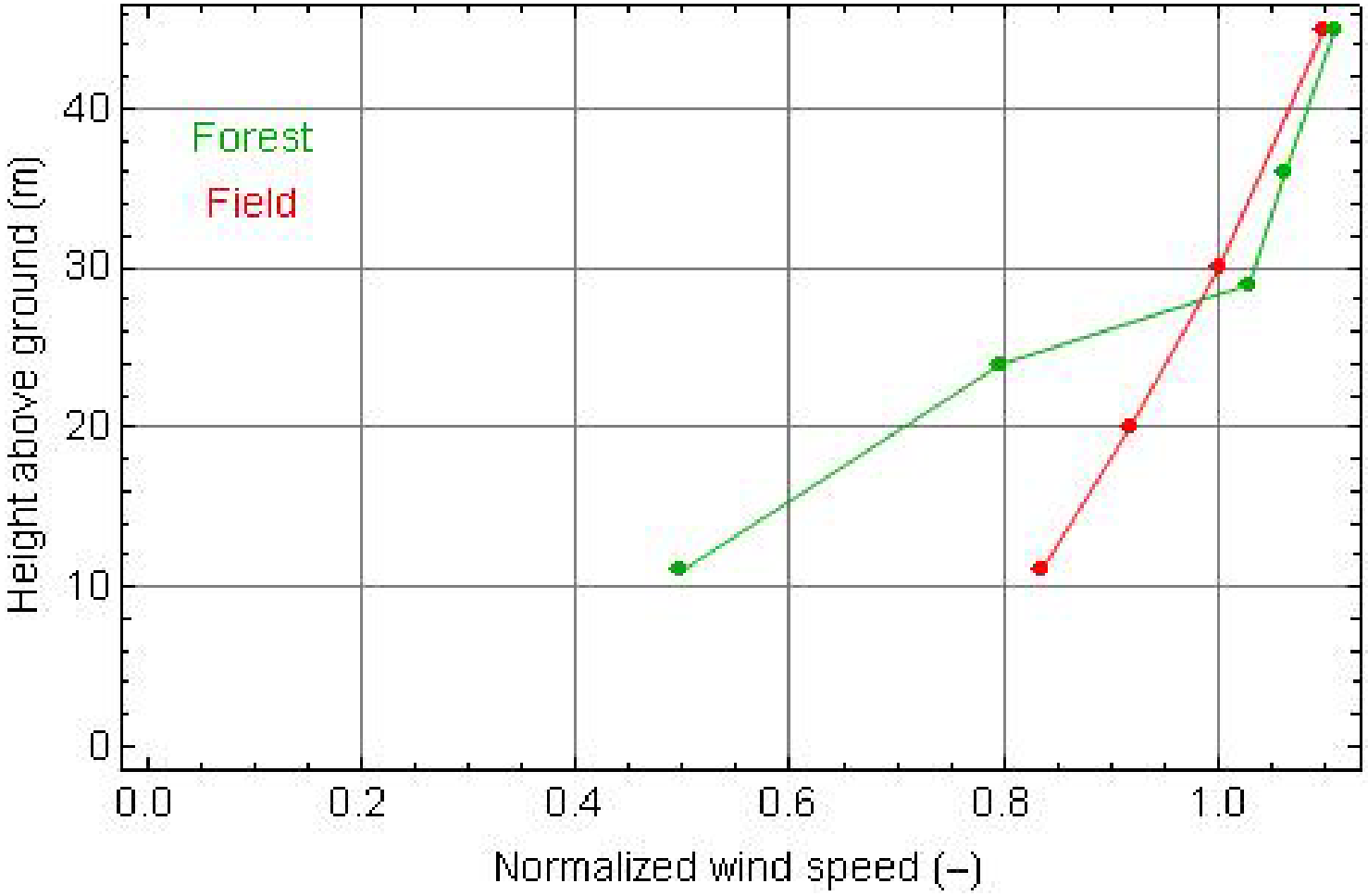
LIDAR 1
LIDAR 2
Masts for turbulence
and mean wind speed
measurements

Site: Tromnæs forest

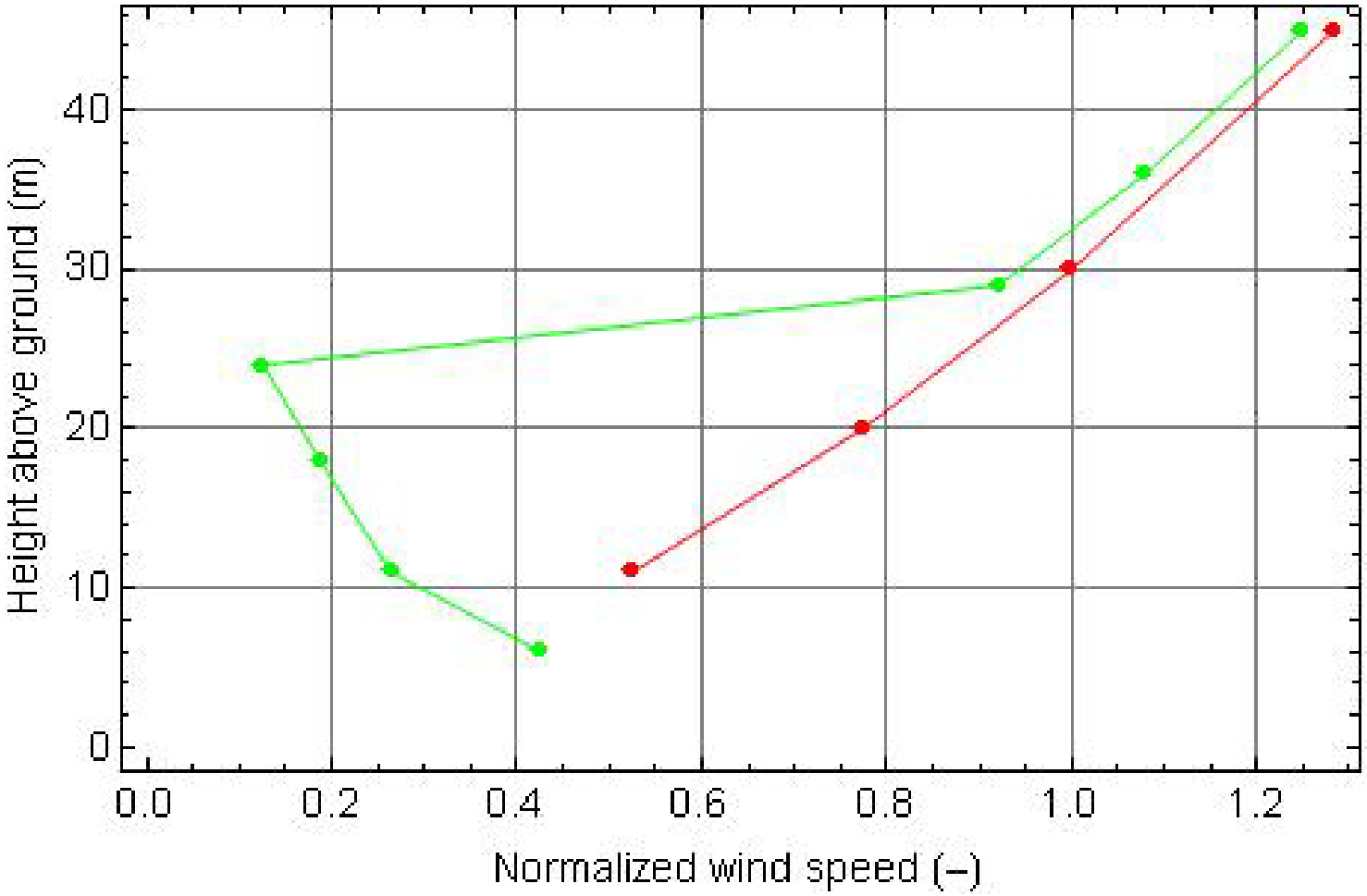
Mean wind speed – neutral stratification, summer



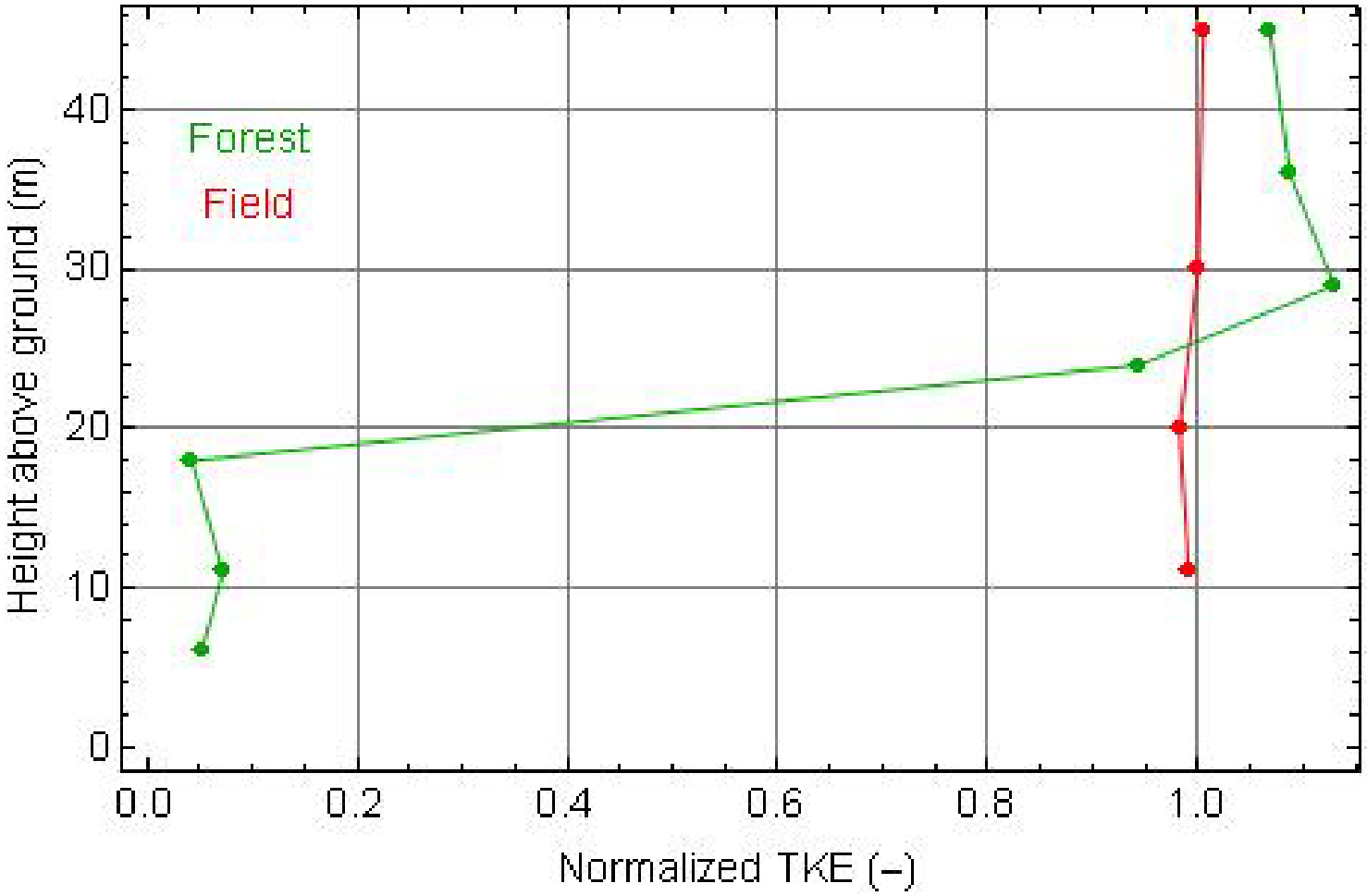
Mean wind speed – neutral stratification, winter



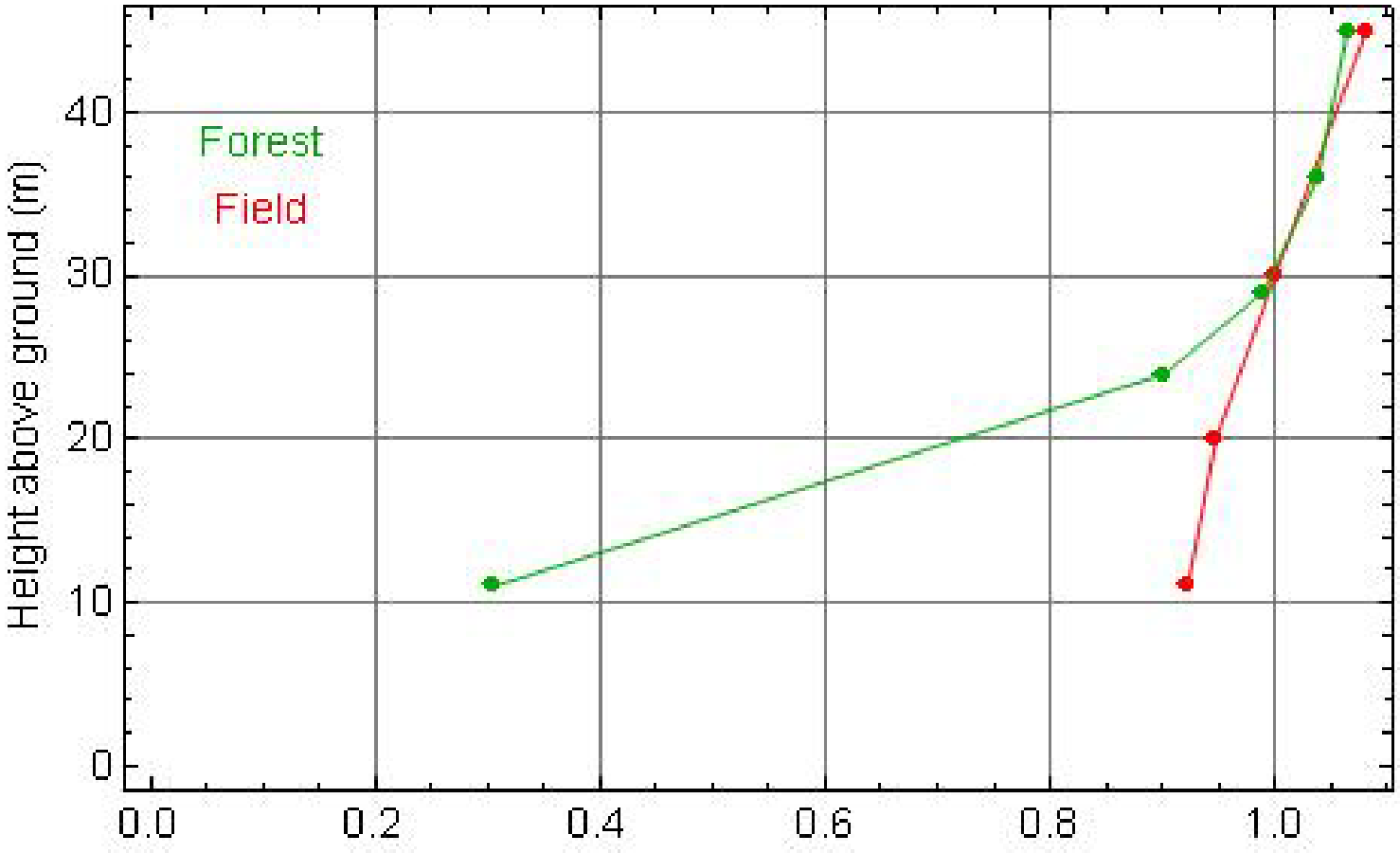
Mast data – stable stratification, summer



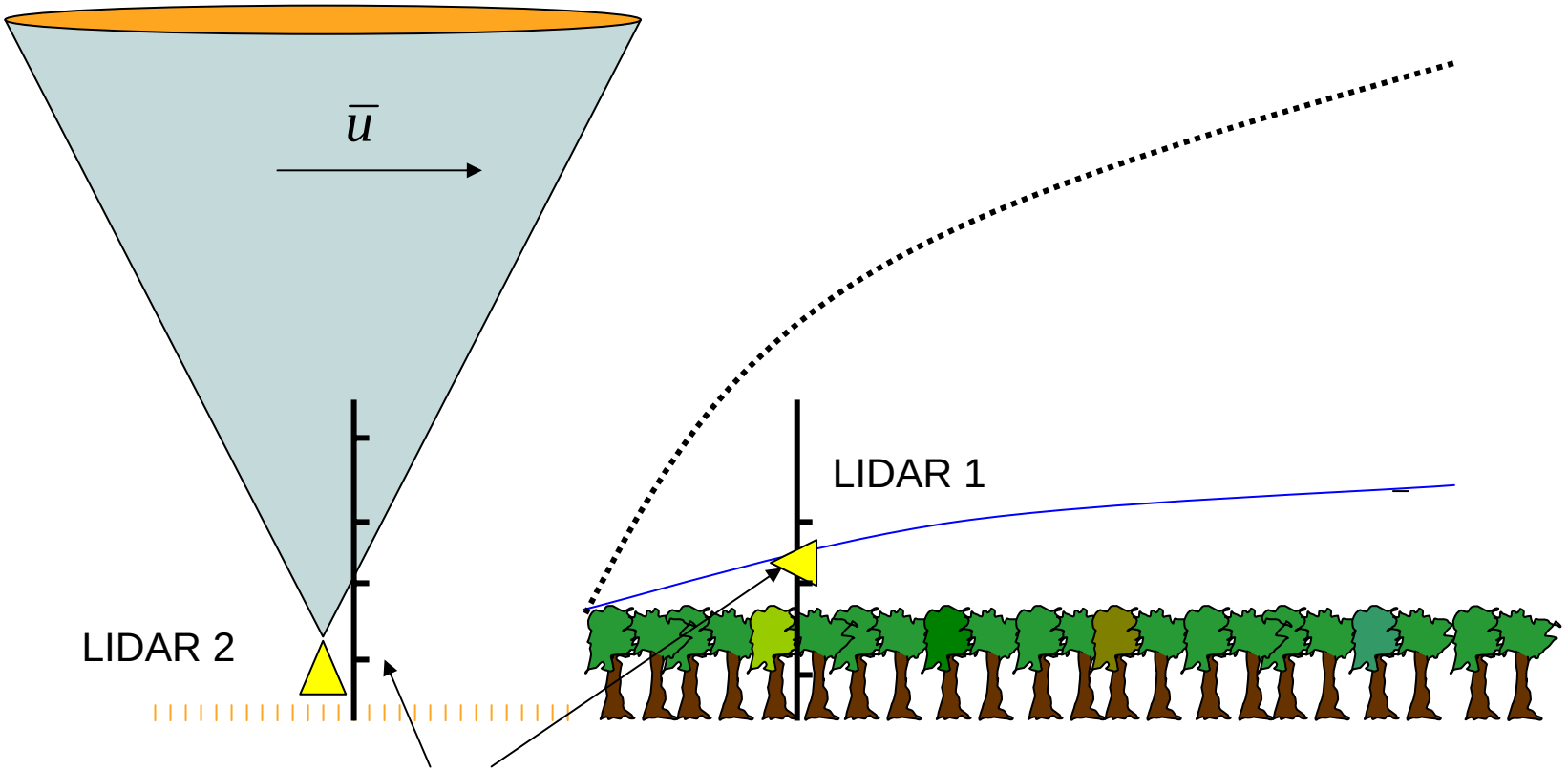
Turbulent kinetic energy – neutral, summer



Turbulent kinetic energy – neutral, winter



Experiment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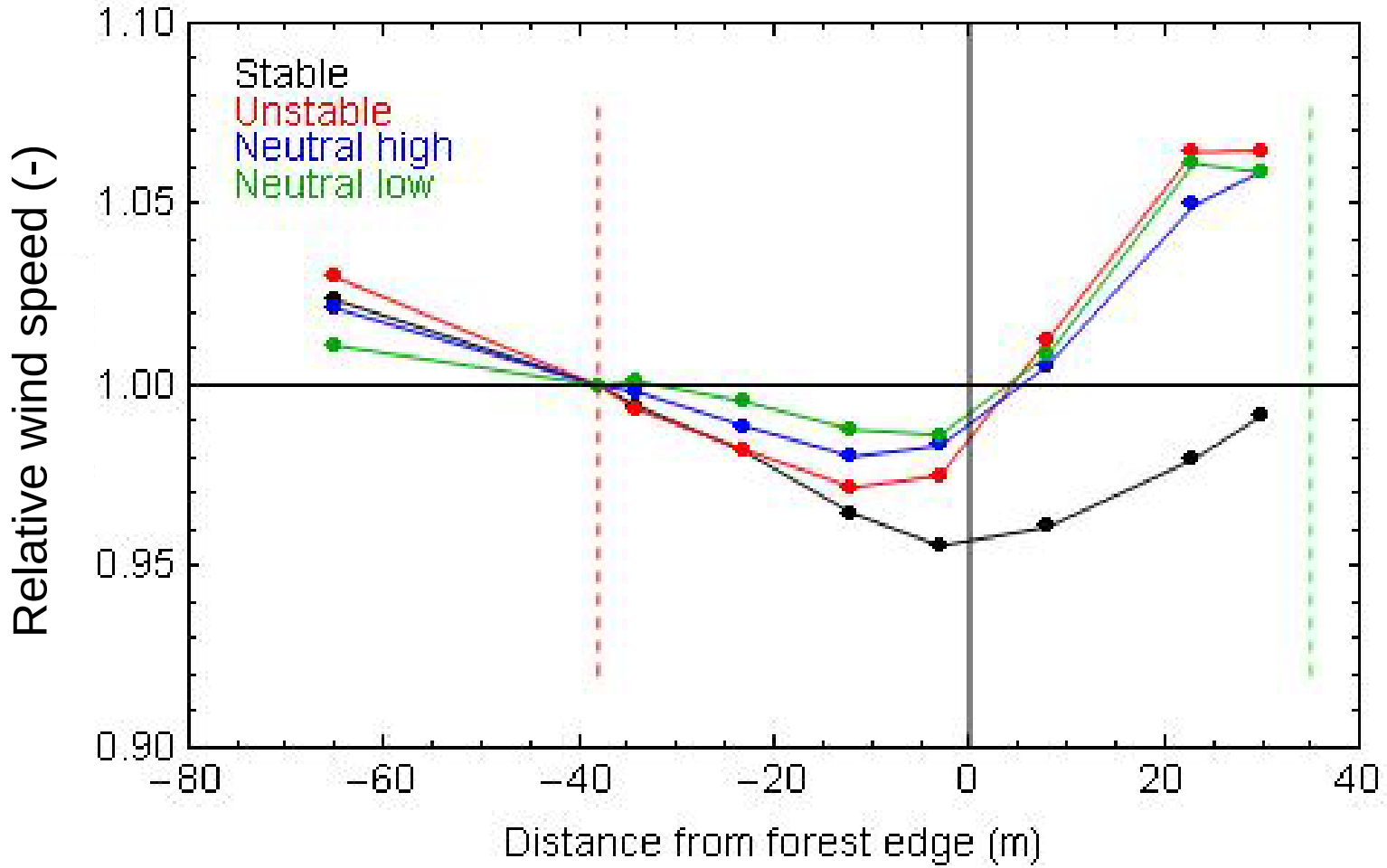
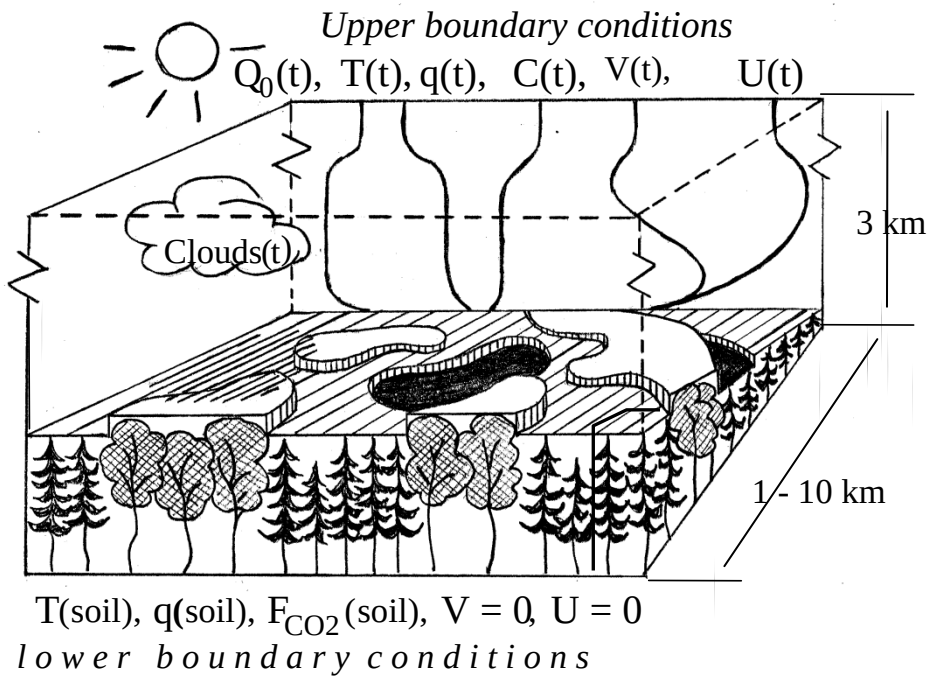
LIDAR horisontal scan @ 30m

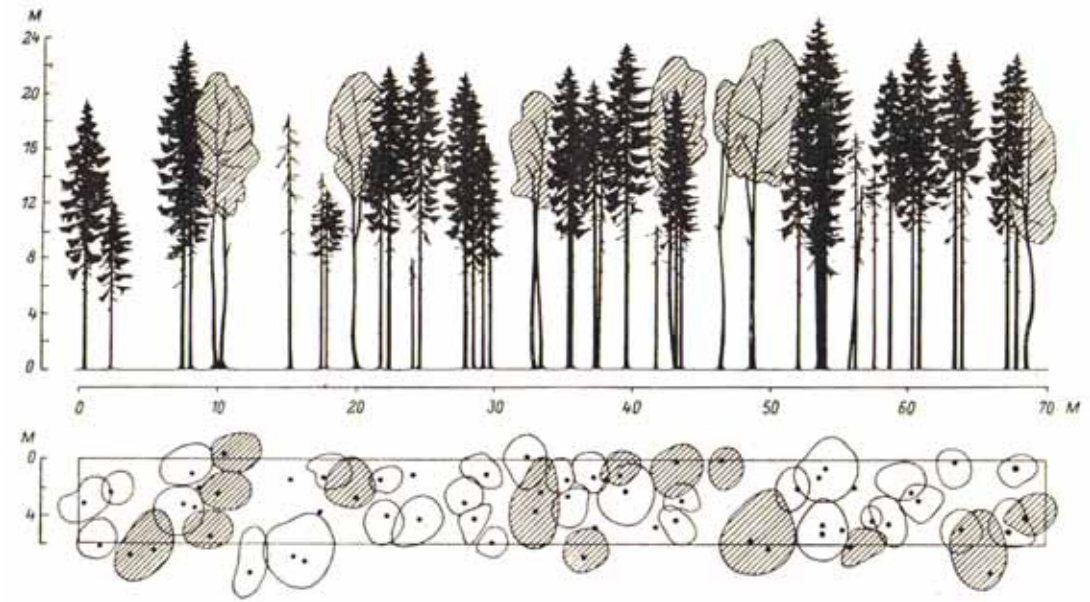


SCADIS



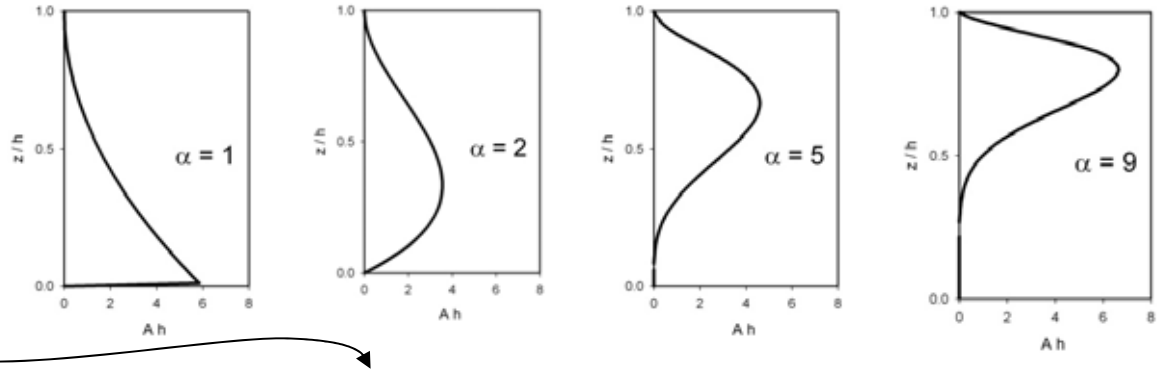
- Solves the RANS equations
- k-eps closure
- Enables detailed forest parameterisation
- Originally developped for environmental applications

Forest parameterisation



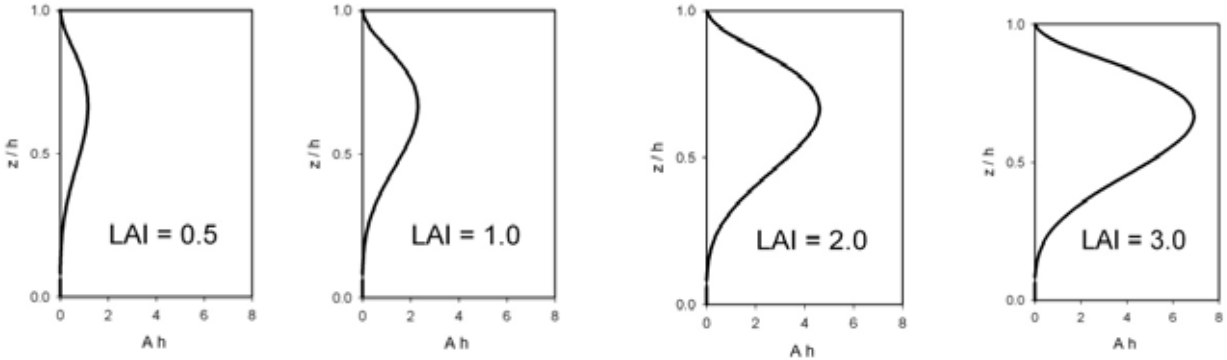
SCADIS forest parameterisation

Forest type

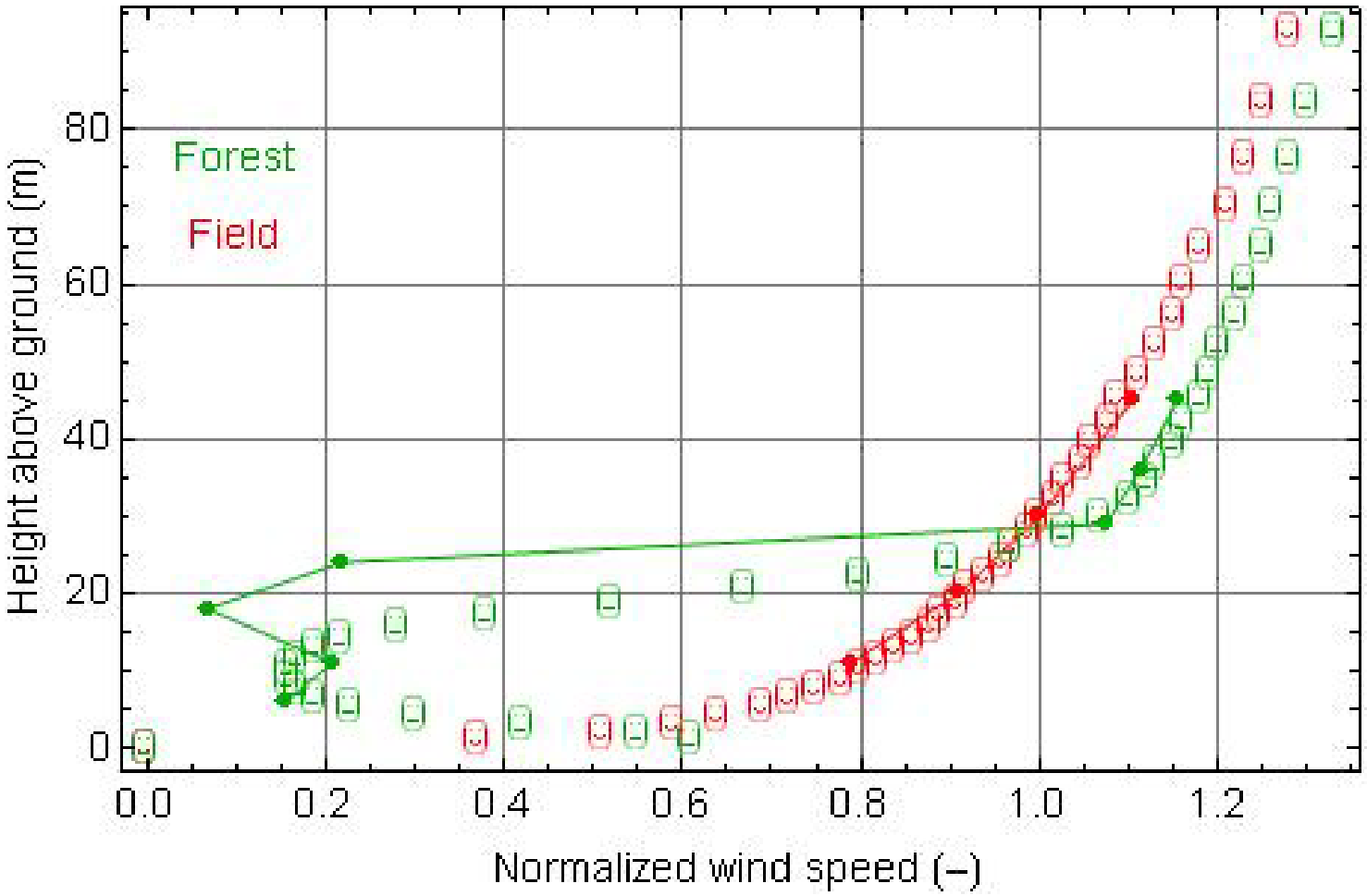


Drag force *S*: $S_i = -c_d \, \rho_{air} A(z) \overline{U}_i |U|$

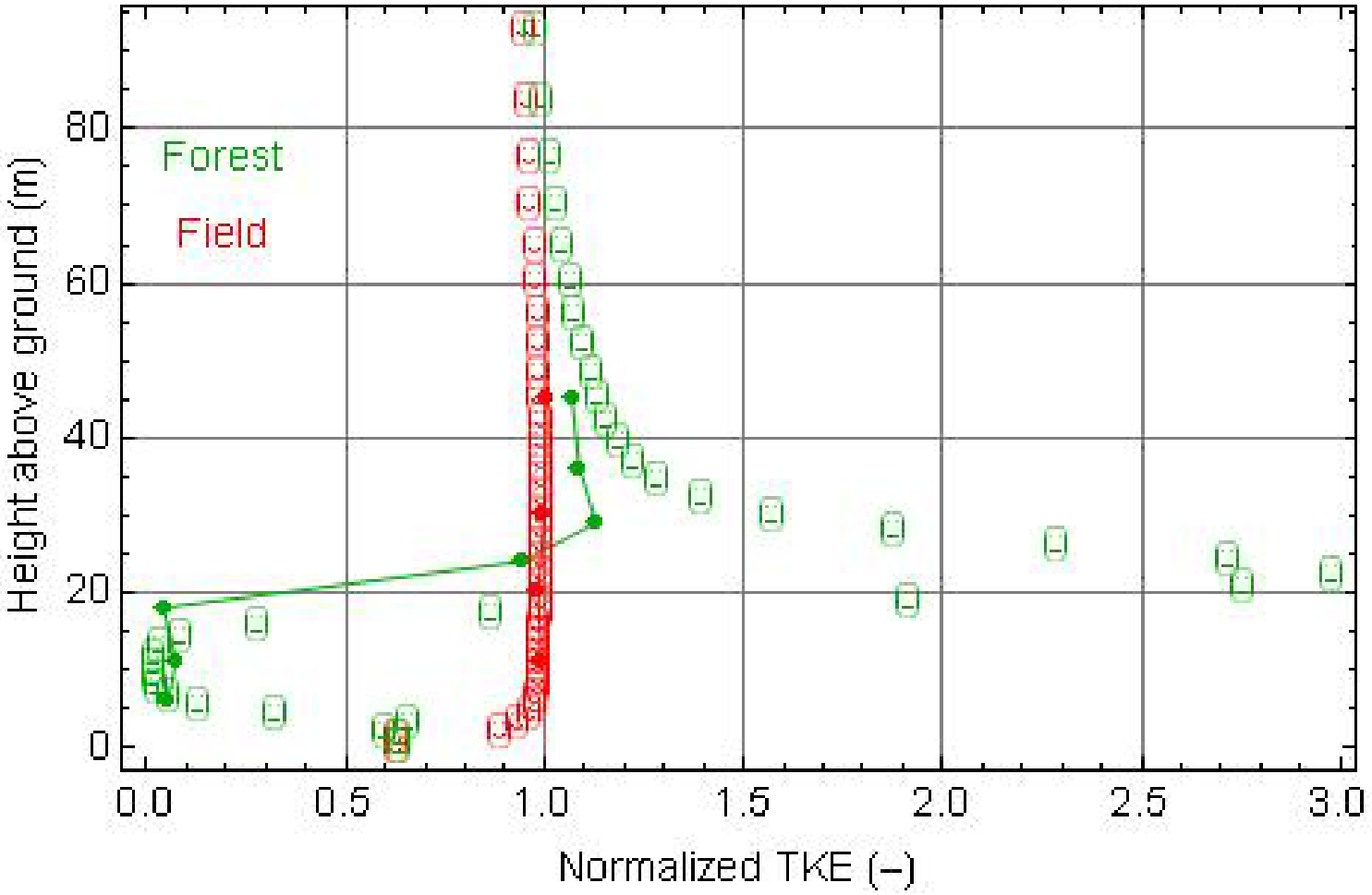
Forest density



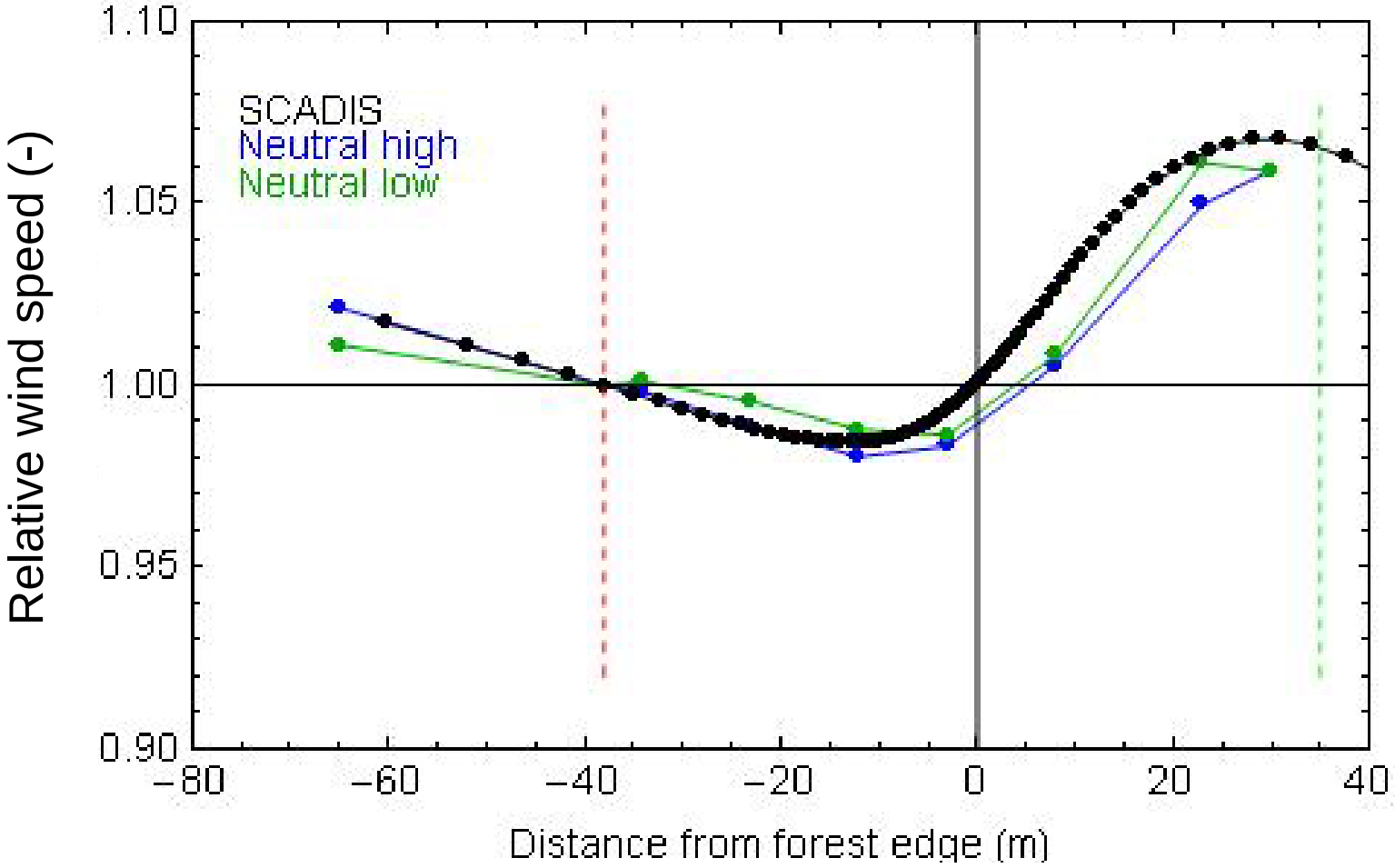
Mean wind speed – neutral, summer



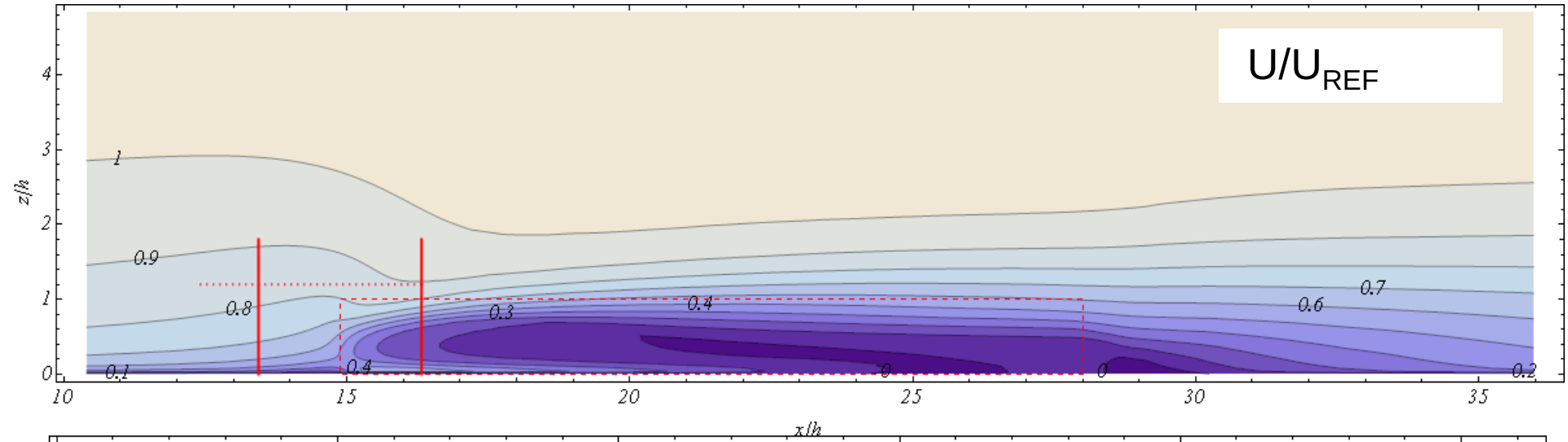
Turbulent Kinetic Energy – neutral, summer

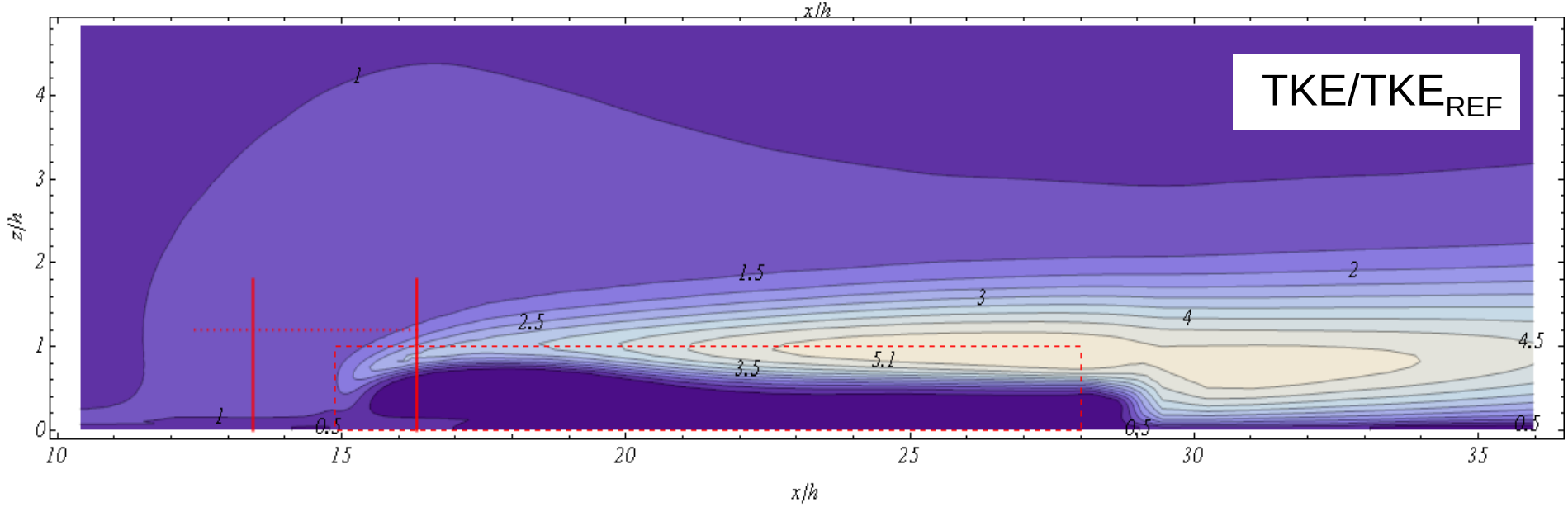


Model-LIDAR comparison



2D modelling results





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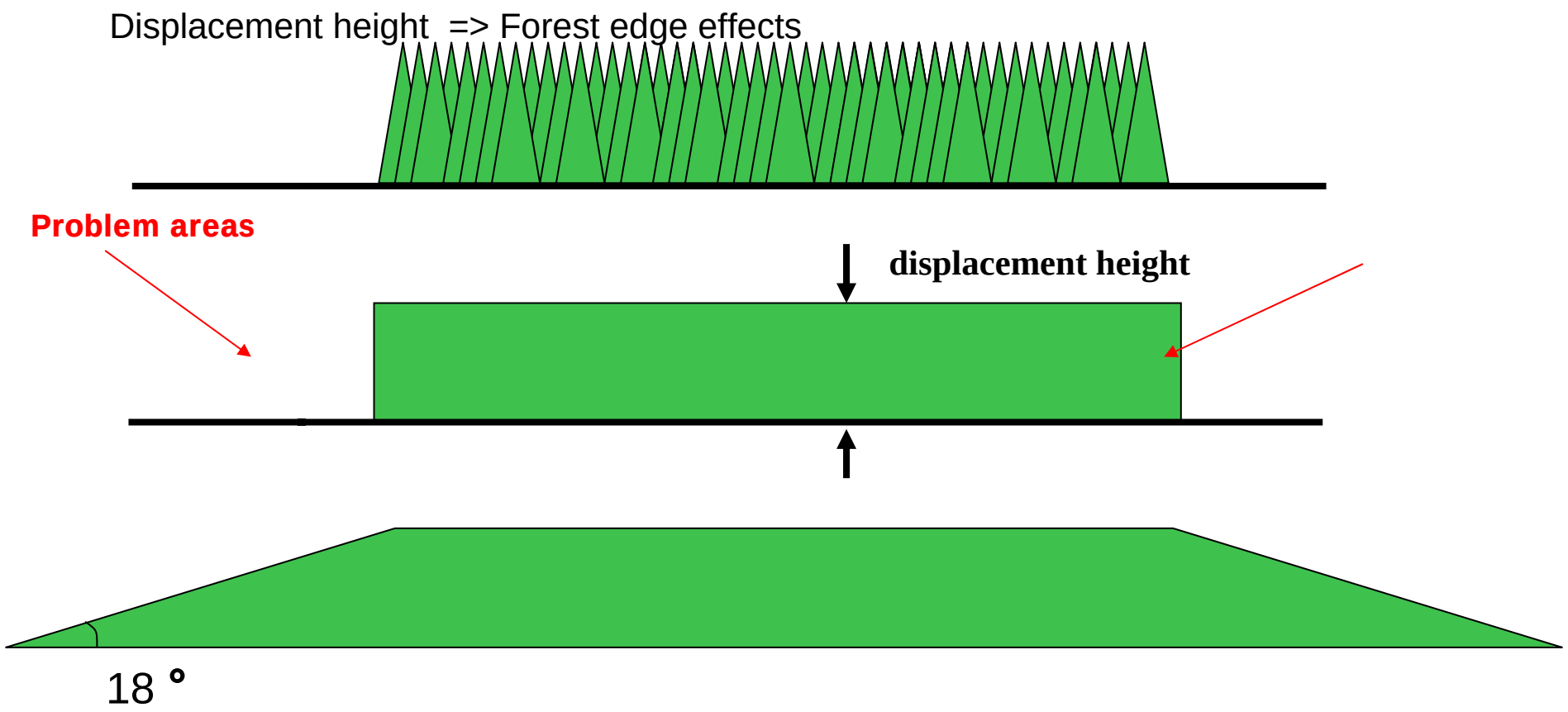
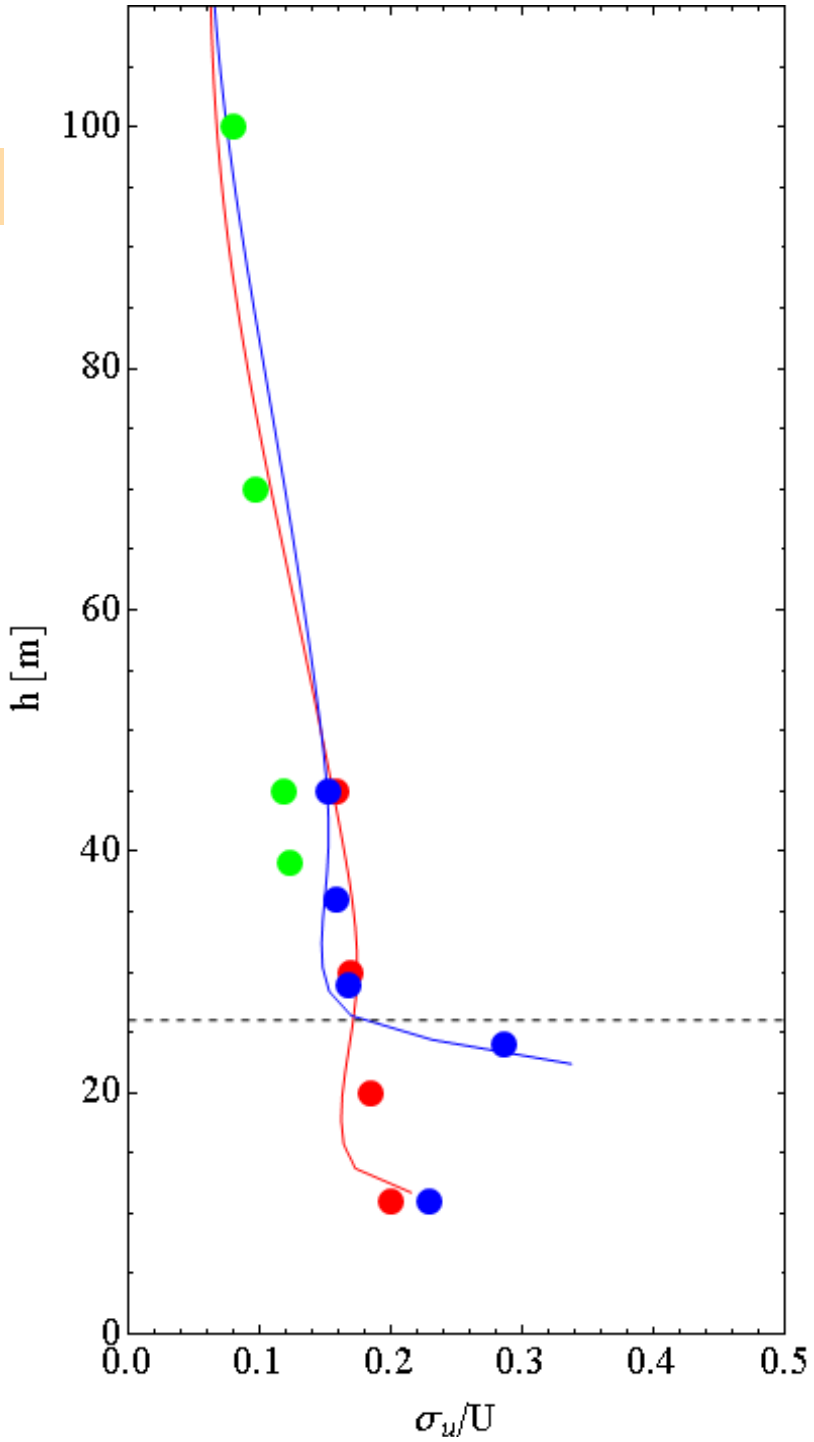


WAsP Engineering 18 ° slope

- **Forest**
- **Field**
- **Conical scanning LIDAR**



Conclusions

- The relative speed-up over the forest edge is dependent on the atmospheric stratification as well as the canopy density.
- At both mast positions, the wind field is affected by the forest edge.
- The SCADIS model can predict the flow speed-up over the edge.
- WAsP Engineering comparison shows that substituting the edge with a slope of 18 degrees is a good first approximtion.
- Further analysis necessary to finalize recommendations for WAsP and WAsP Engineering.