WAsP Validation Study of Forestry Effects

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Modelling Forestry Effects

- Wind shear profiles well understood for flat open terrain
- Transition at forest edge **not** well understood
- Can WAsP model this effect?

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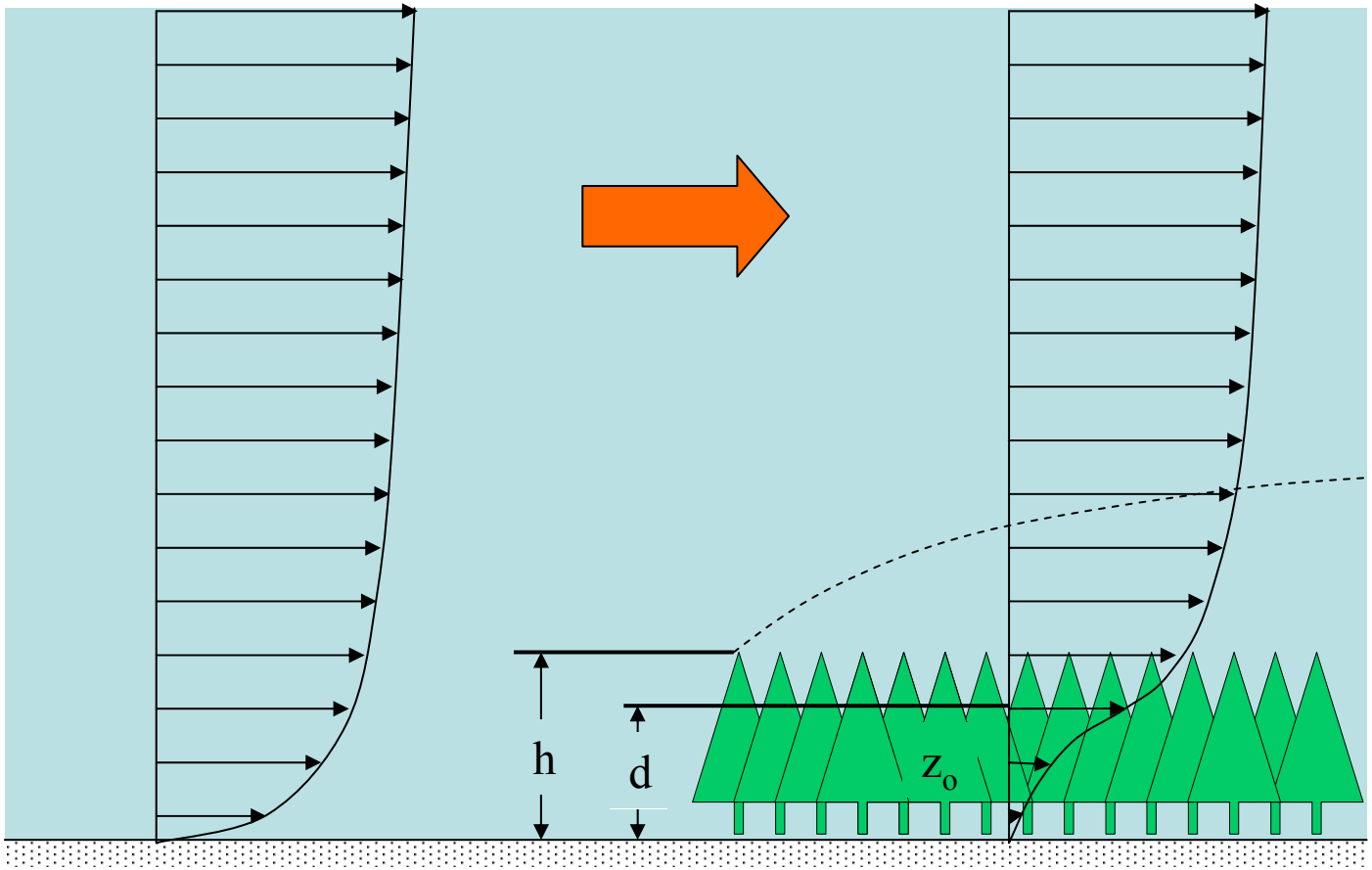
Wind Shear in Forestry



WAsP Forestry Model - Method 1

- No displacement height, d = 0
- Roughness length, z_o = 1/30 of tree height, h
- Source: Reference in L. L. Freris

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WAsP Forestry Model - Method 2

- Displacement height calculated as

$$d = h - 4.3 \times z_o \times (1 - P)$$

- Roughness length, z_o = 1/30 of tree height, h
- Plan area density, P = 0.8 (assumed average)
- Source: ESDU Item No. 82026

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WAsP Forestry Model - Method 3

- Displacement height calculated as

$$d = h - 4.3 \times z_o \times (1 - P)$$

- Roughness length, z_o = fixed at 0.3 m
- Plan area density, P = 0.8 (assumed average)
- Source: EDSU and N. J. Cook 1985

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WAsP Forestry Model - Method 4

- Purely empirical method
- Displacement height, d = 0.076 x tree height, h
- Roughness length, z_o = 0.78 x tree height, h
- Source: Reference in J. R. Garrat, 1994

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WAsP Forestry Model - Method 5

- Displacement height, d = 2/3 x tree height, h
- Roughness length, z_o = 1/3 x 1/30 x tree height, h
- Source: Reference in J. R. Garrat, 1994

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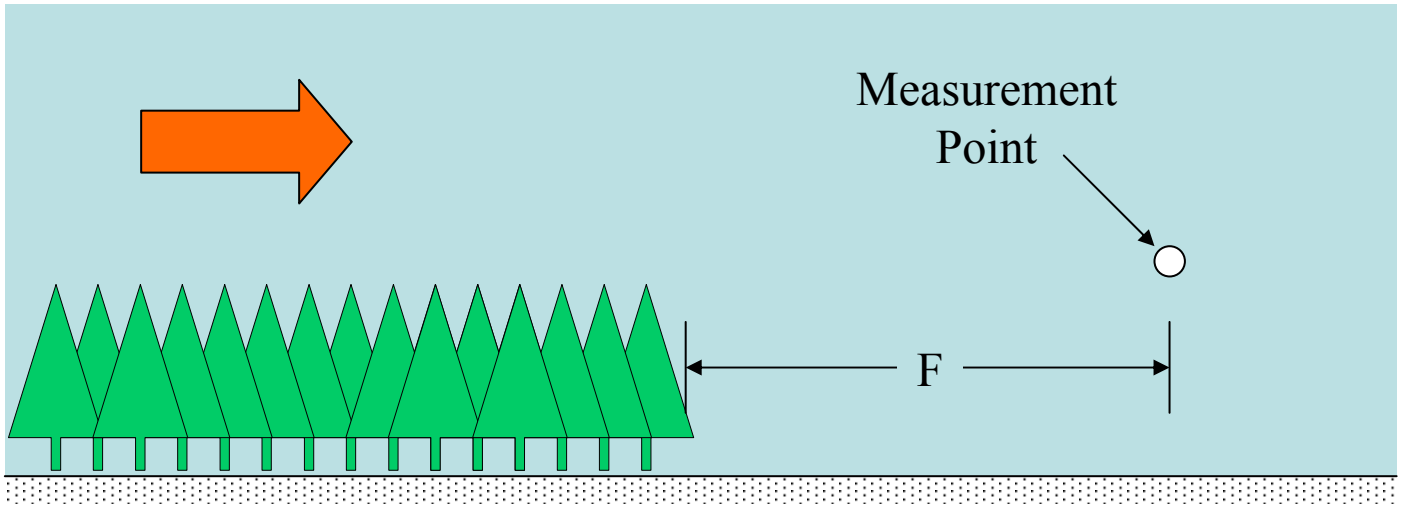
Application of Forestry Models near Edges

- Effective displacement height, $d_{eff} = d - F / 50$
- Linear degradation based on WAsP manual



Validation Study

- 3 cases are considered using all 5 methods
- Validation between two masts
- One mast affected by forestry, one not
- Chosen to isolate forestry effects from terrain

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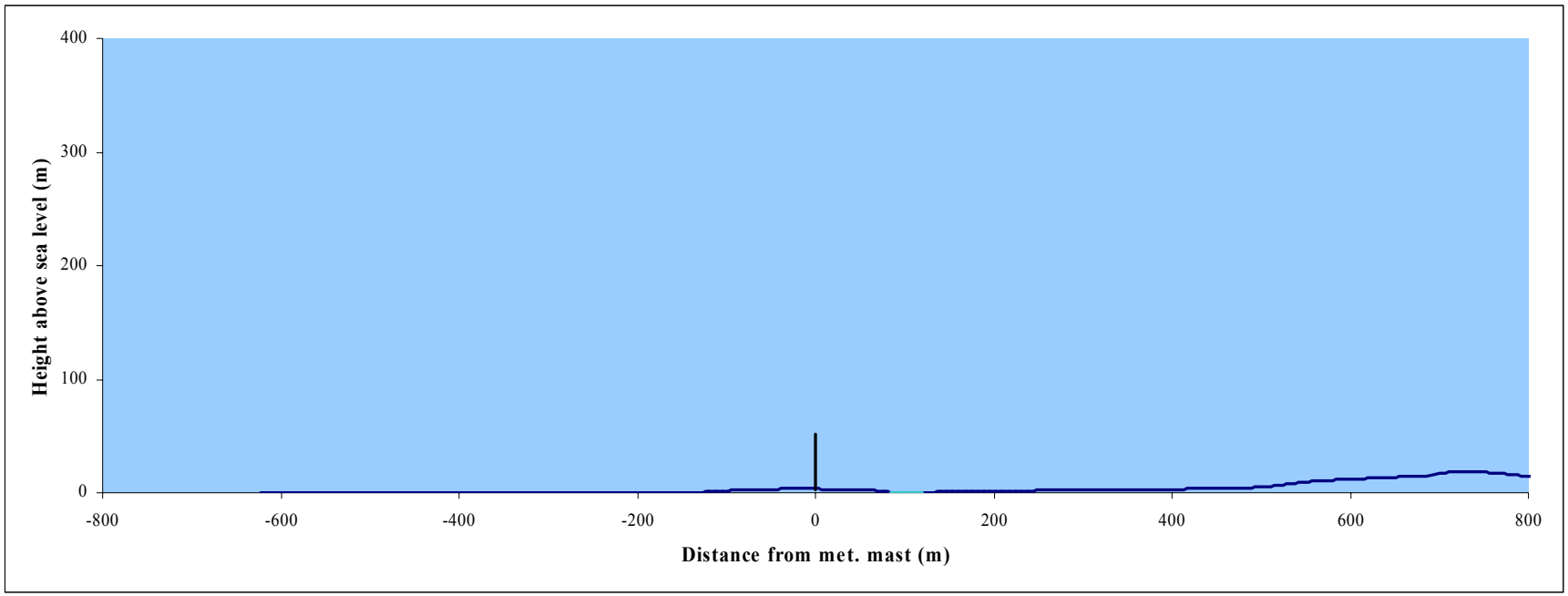
Validation Study – Case 1

- Mast 1, unaffected by trees, data at 30 m and 40 m



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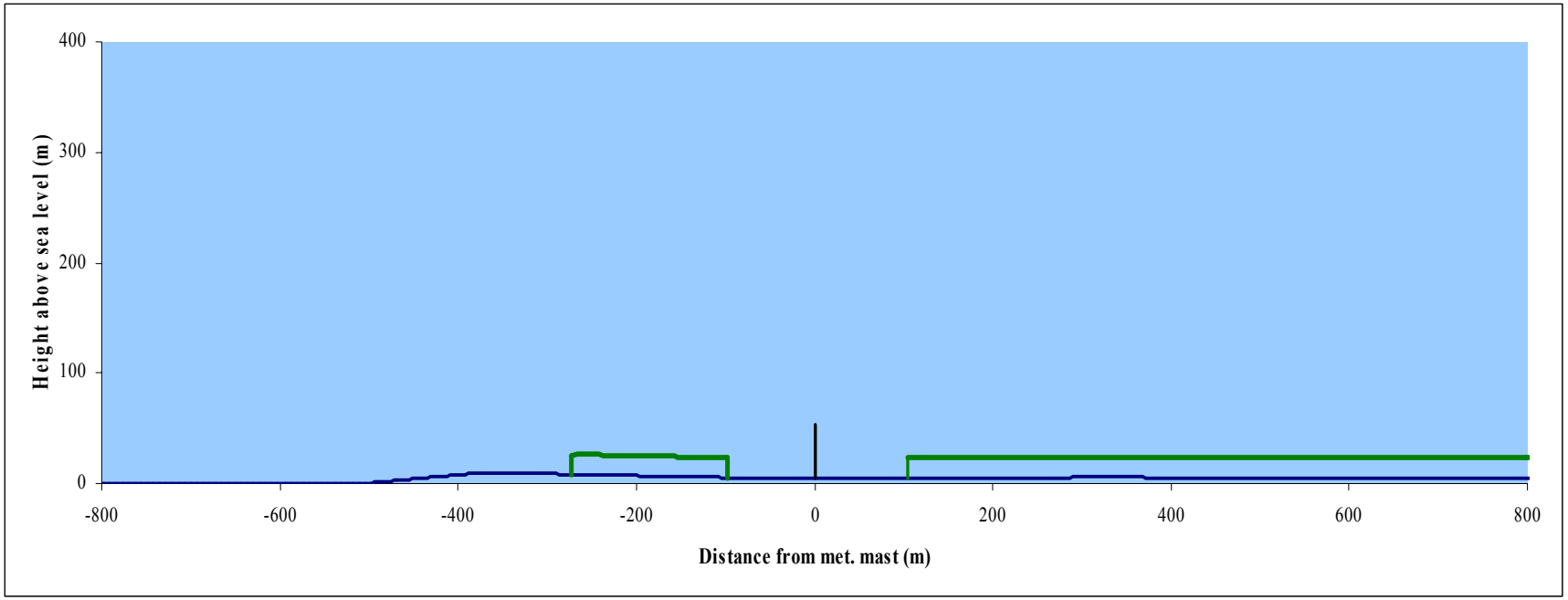
Validation Study – Case 1

- Mast 2, affected by trees, data at 30 m, 40 m and 49 m
- 1200 m from Mast 1



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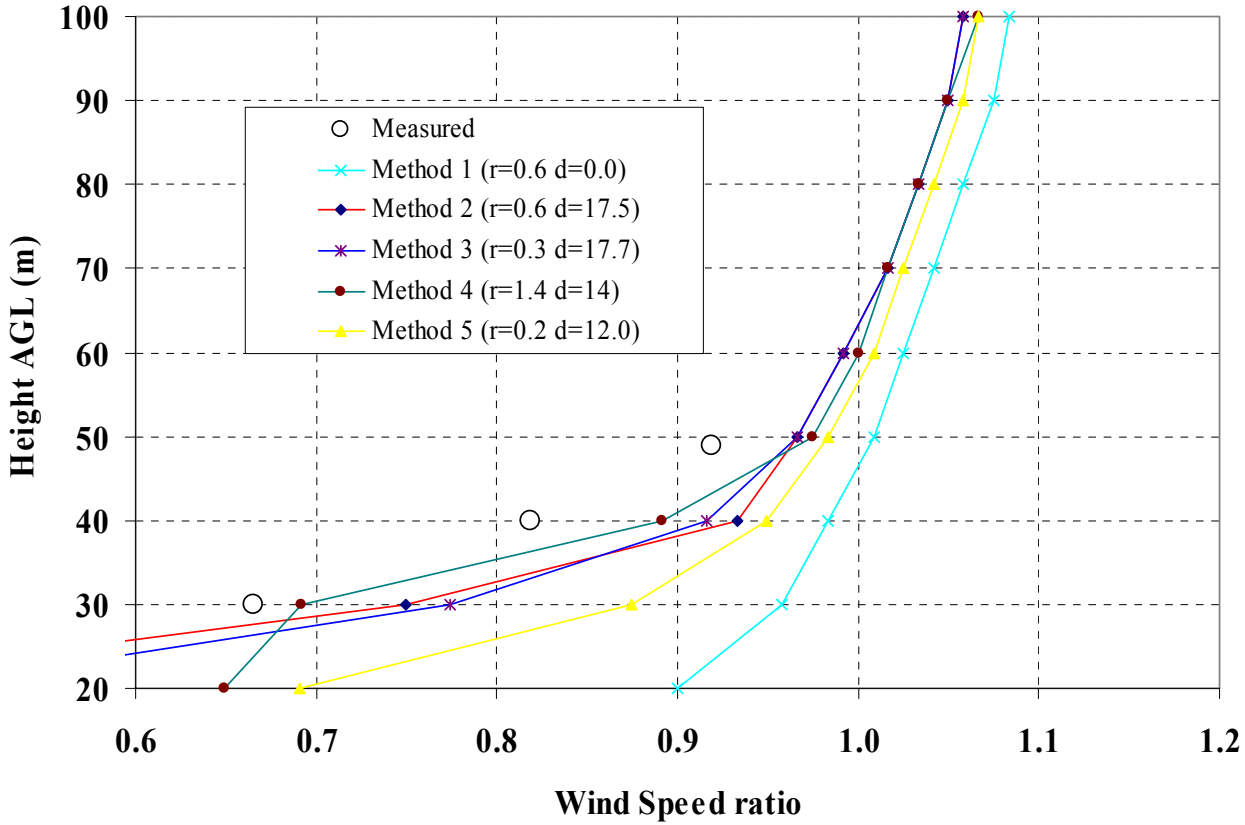
Validation Study – Case 1

- Mast 1 at 40 m predicting to Mast 2



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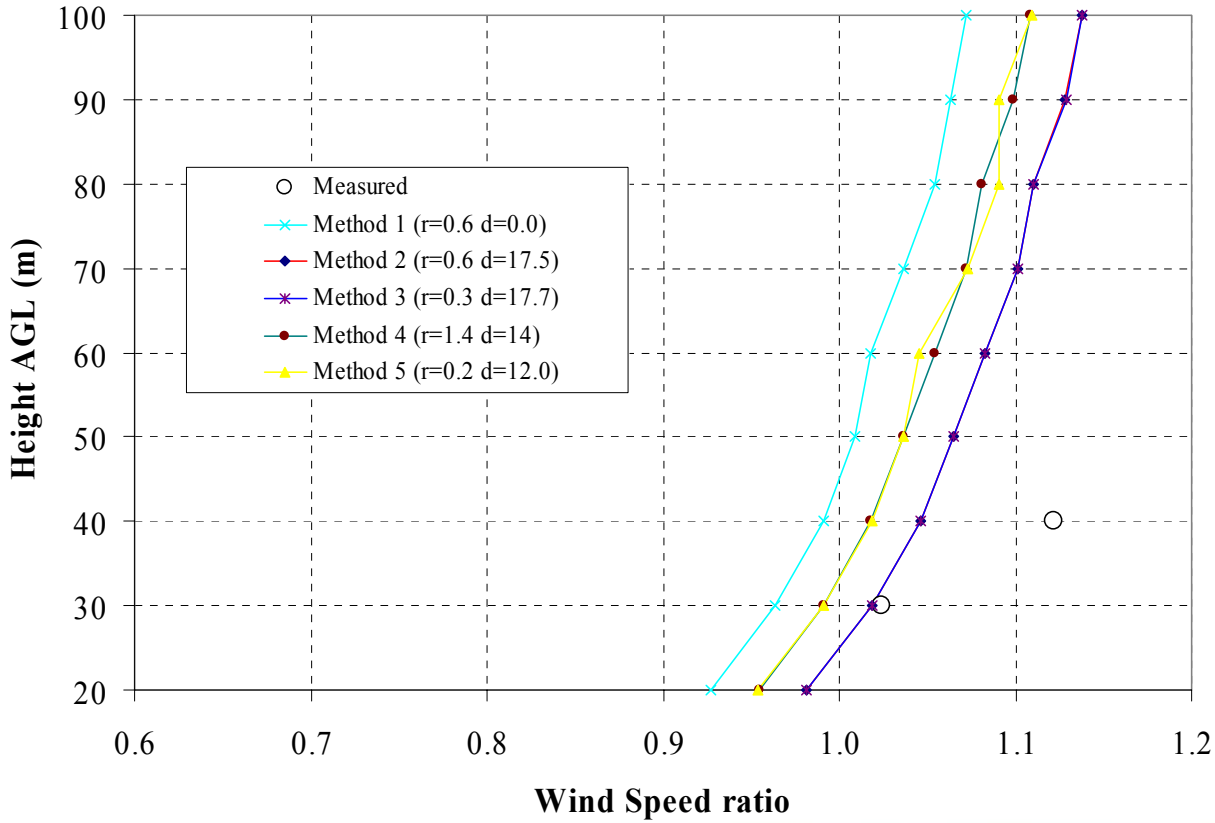
Validation Study – Case 1

- Mast 2 at 49 m predicting to Mast 1



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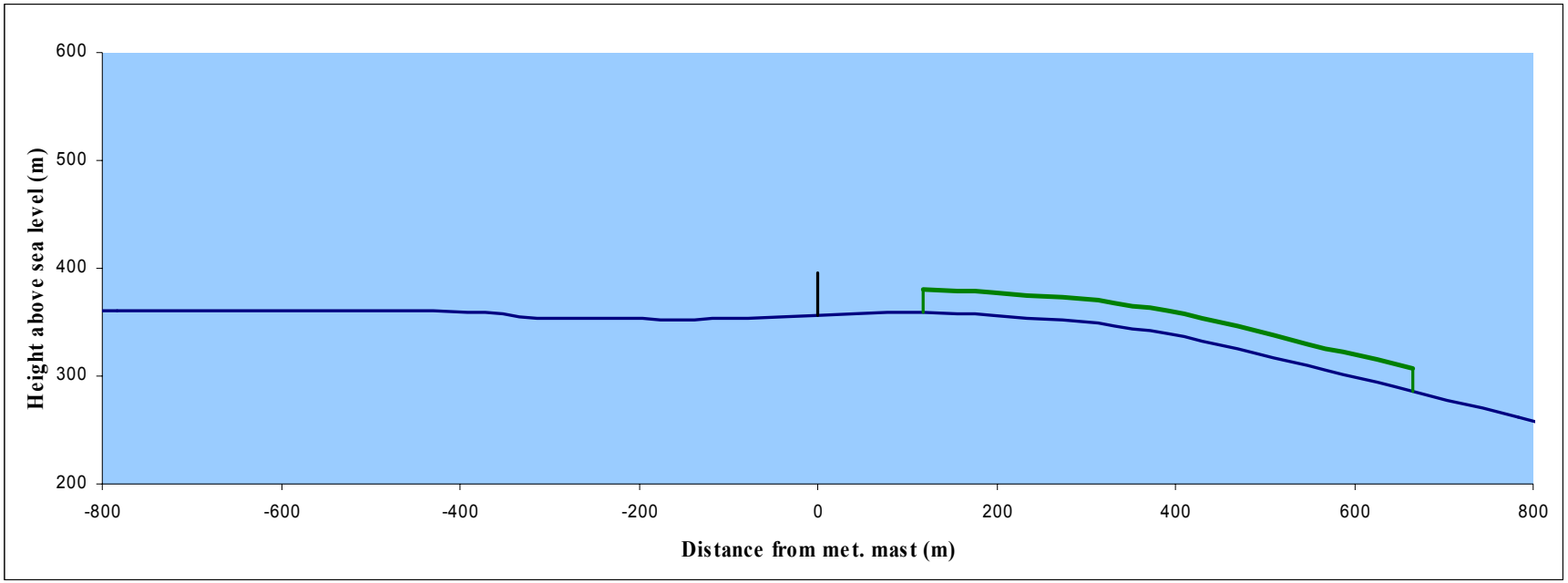
Validation Study – Case 2

- Mast 1, unaffected by trees, data at 40 m



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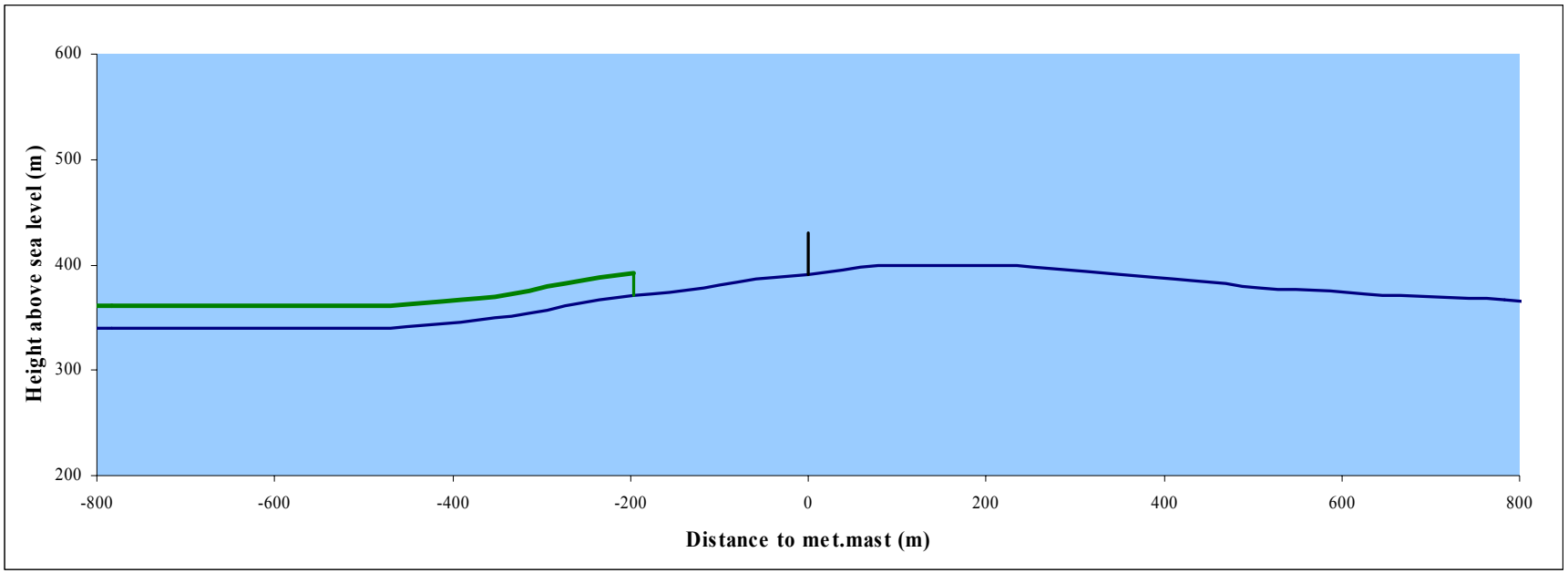
Validation Study – Case 2

- Mast 2, affected by trees, data at 40 m
- 4800 m from Mast 1



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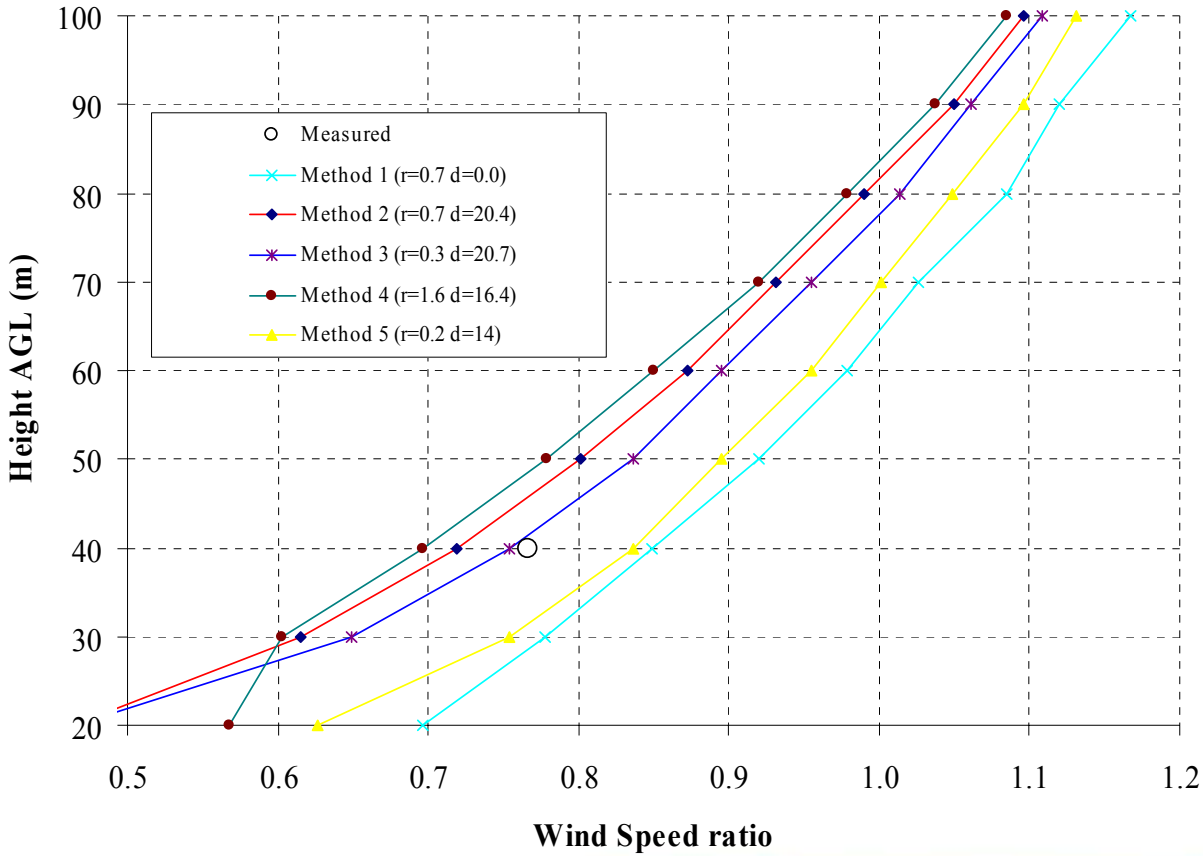
Validation Study – Case 2

- Mast 1 at 40 m predicting to Mast 2



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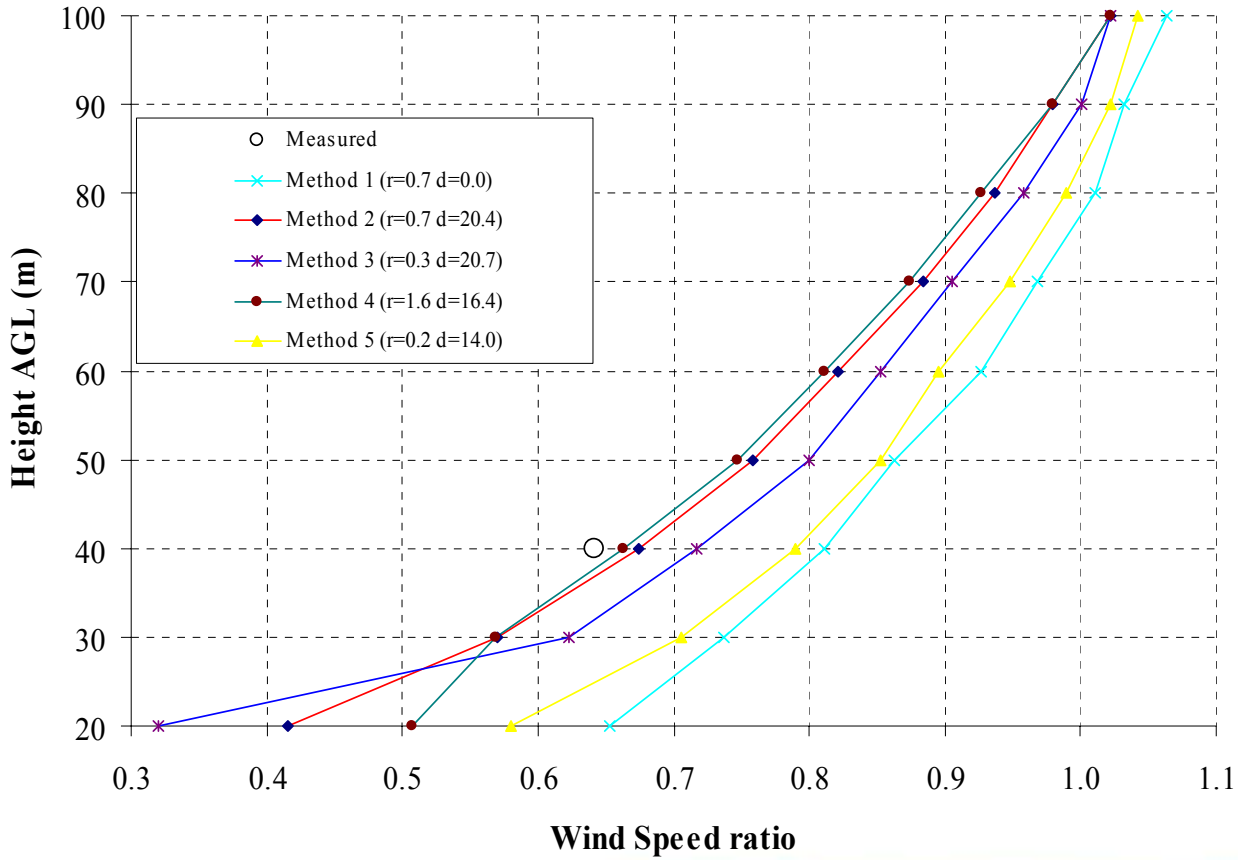
Validation Study – Case 2

- Mast 1 at 40 m to Mast 2 – other direction sector



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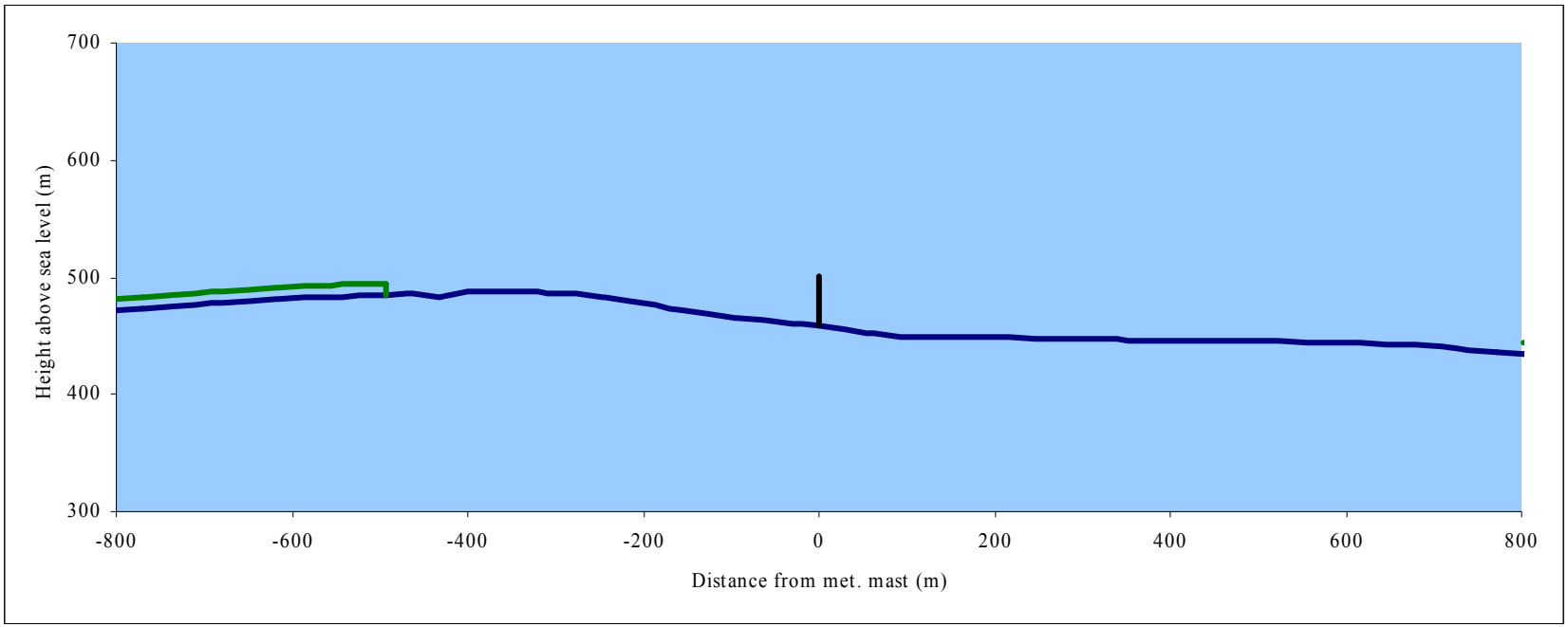
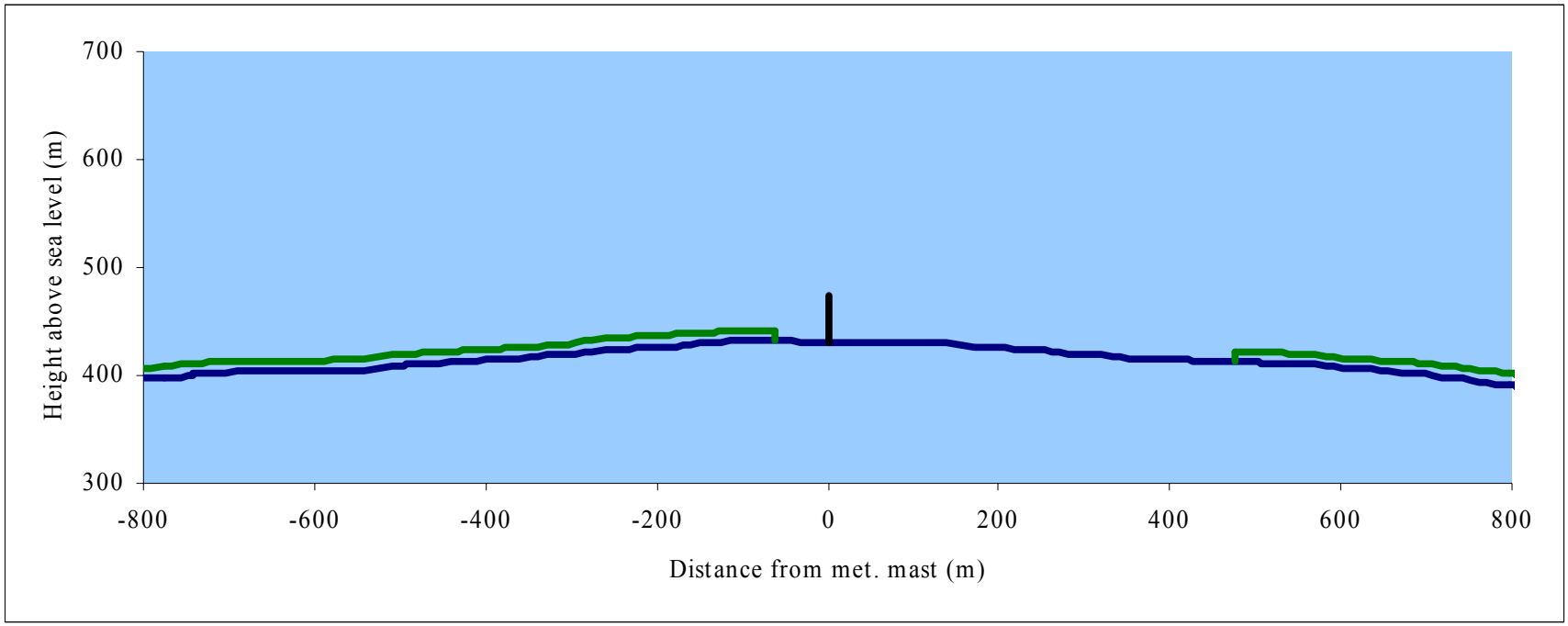
Validation Study – Case 3

- Mast 1, unaffected by trees, data at 31 m



Validation Study – Case 3

- Mast 2, affected by trees, data at 21, 26, 31, 36 and 41 m
- 550 m from Mast 1



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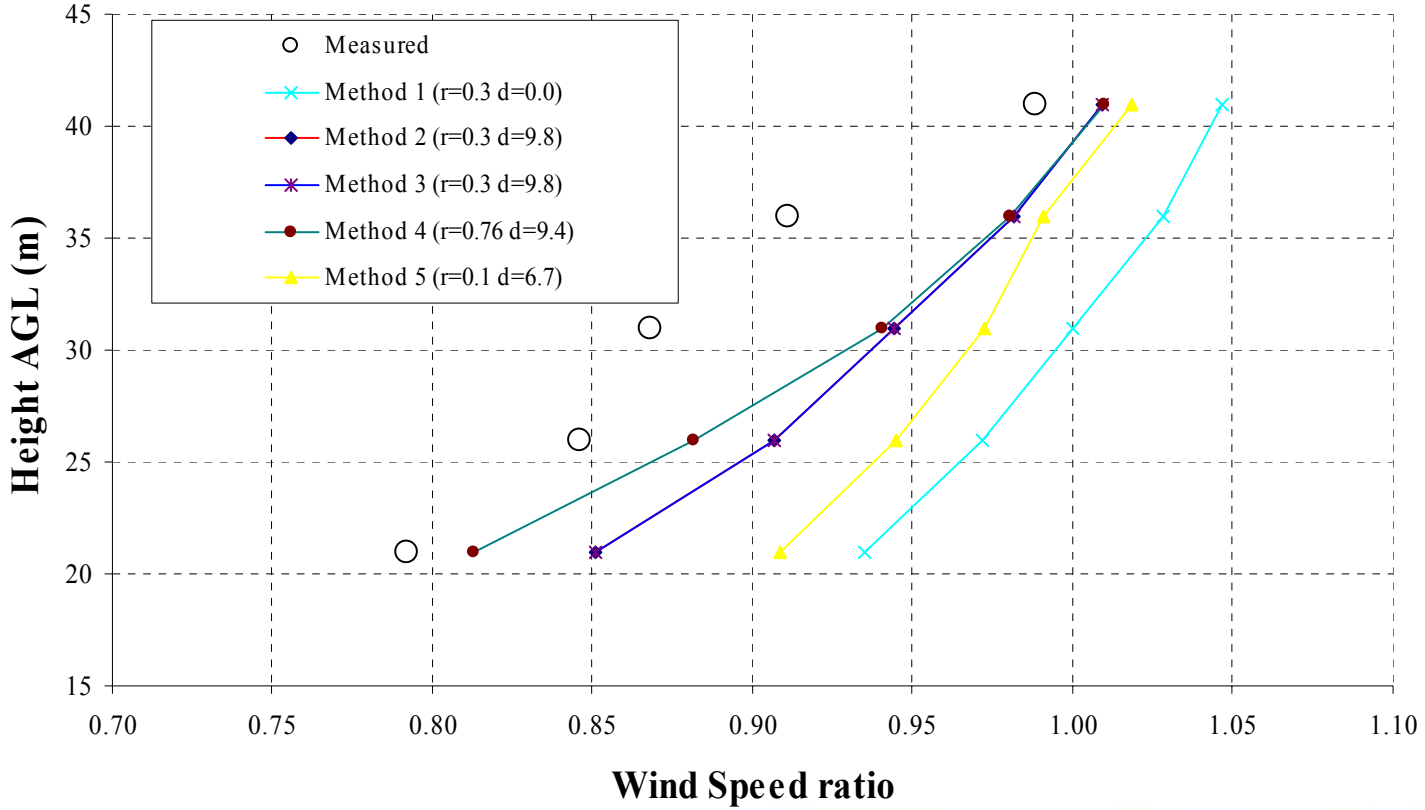
Validation Study – Case 3

- Mast 1 at 31 m predicting to Mast 2



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Conclusions

- Despite various uncertainties in validations

- General picture:
  - Low accuracy using WAsP to predict heavy forestry
  - Tendency for WAsP to underpredict forest effects

- Critical to have masts in representative locations

  Turbine in forest = Mast in forest

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