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BUILDING FOREST MODELS WITH LASER SCAN TREE HEIGHT DATA – METHODOLOGY AND RESULTS

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22.06.2017

AGENDA

- About Meventus
- General Approach
- Data Preparation
- Windsim Settings
- Assessment

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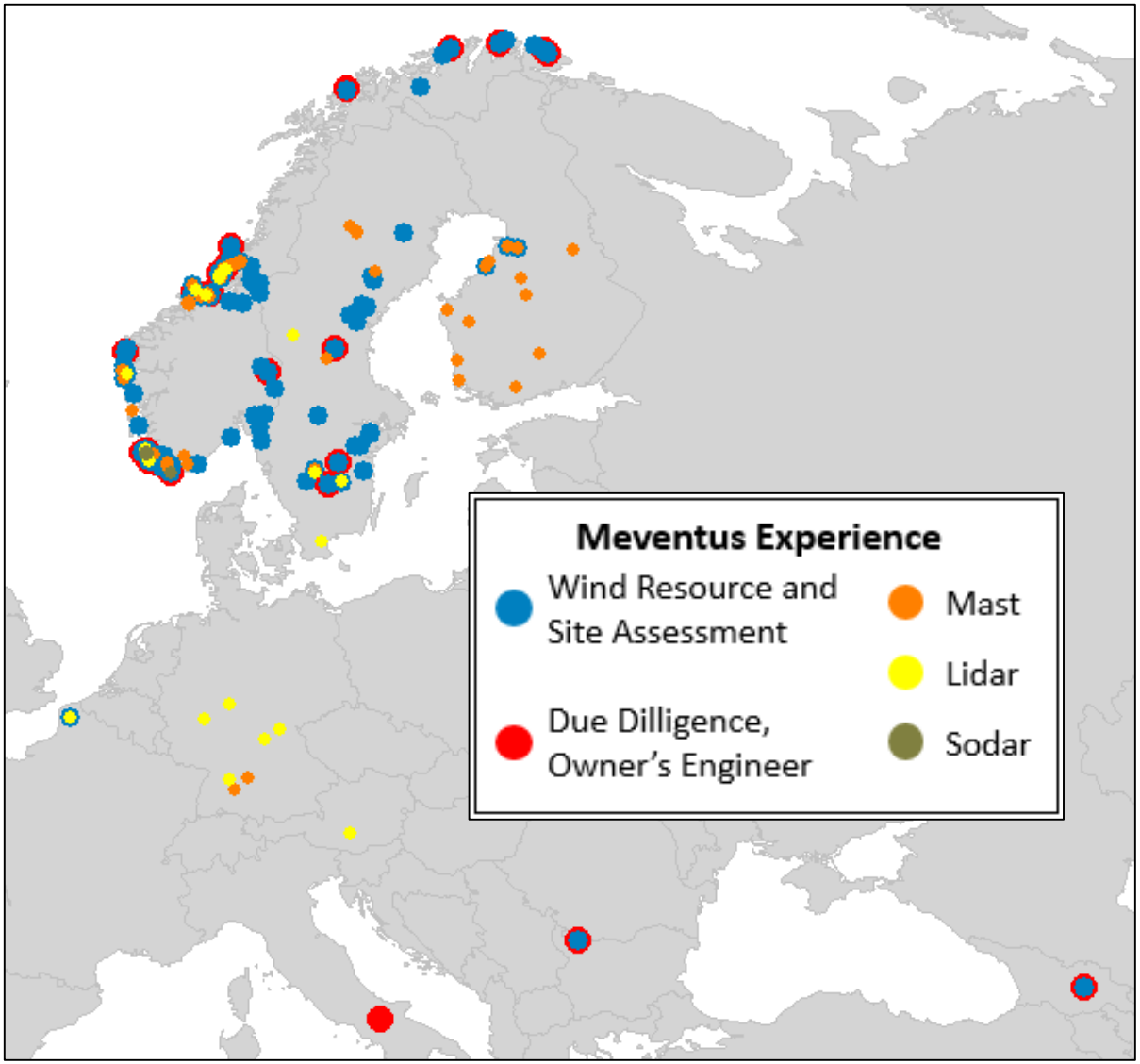
ABOUT MEVENTUS



- **Offices in Norway, Sweden, Denmark**
- **Windsim users since 2007**
- **Built over 70 Windsim flow models, assessed more than 6,000 GW of park capacity**

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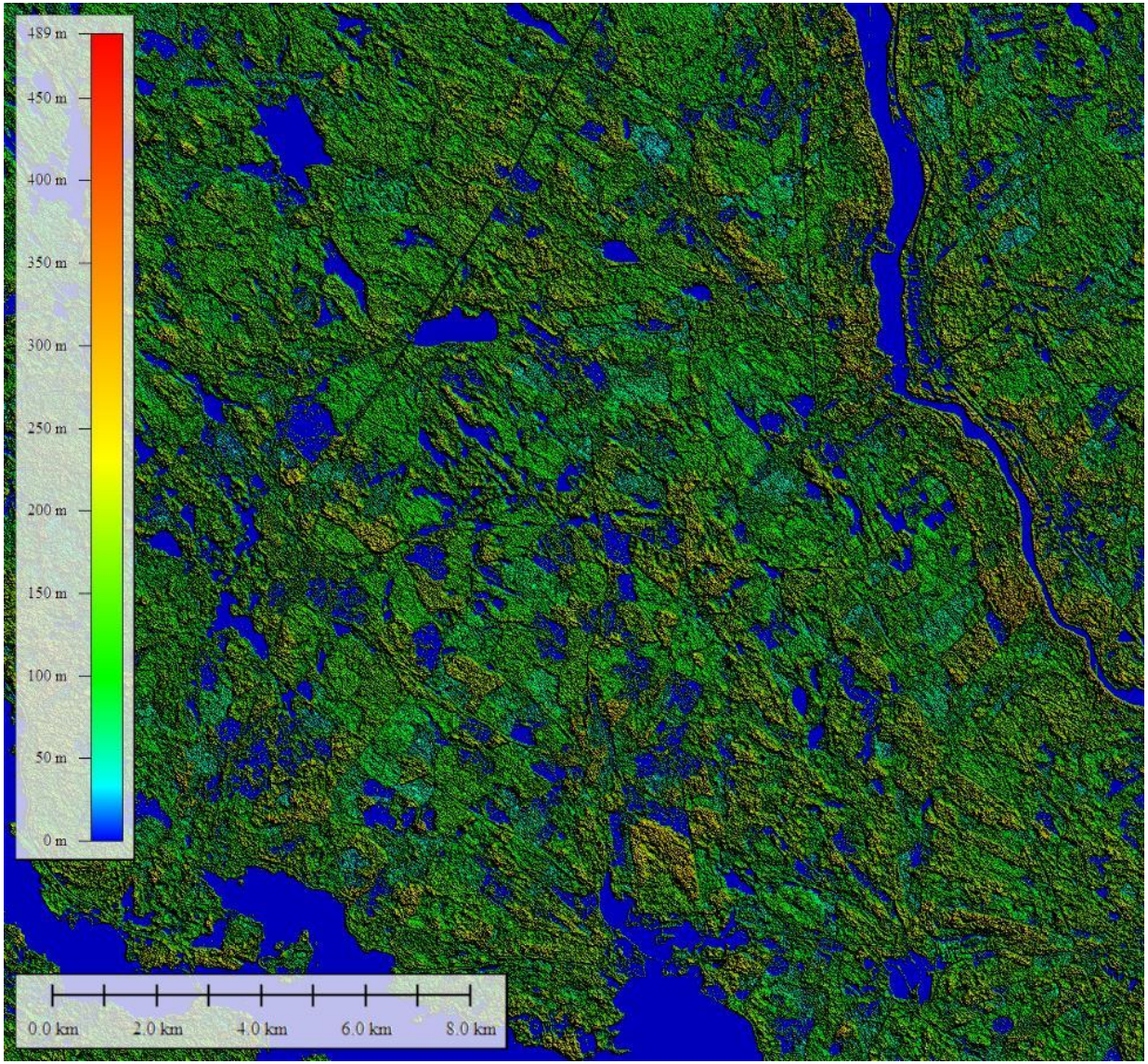
HOW MUCH FOREST DATA IS TOO MUCH?



- Laser scanned forest data can give tree heights with thousands of different unique values
- How much data is too much to be useful?
- How do you simplify the data enough to model, without losing the benefits of high resolution data?

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GENERAL APPROACH

- Assess the forest heights in your area of interest to determine what range you should model

- Using a combination of GIS software (such as Global Mapper) and other analysis software (such as Matlab, Excel, SPSS), simplify the forest data by
  - grouping areas with «bunches» of similar forest height
  - reducing the resolution for areas with a large mixture of different height

- Assign roughness values to the different forest height groups you want to model

- Combine the background roughness for the area (particularly non-forested or forested areas with very low tree heights) with the assigned tree height roughness values

- Explicity model tree heights > 10m as forest, use roughness values for low tree heights

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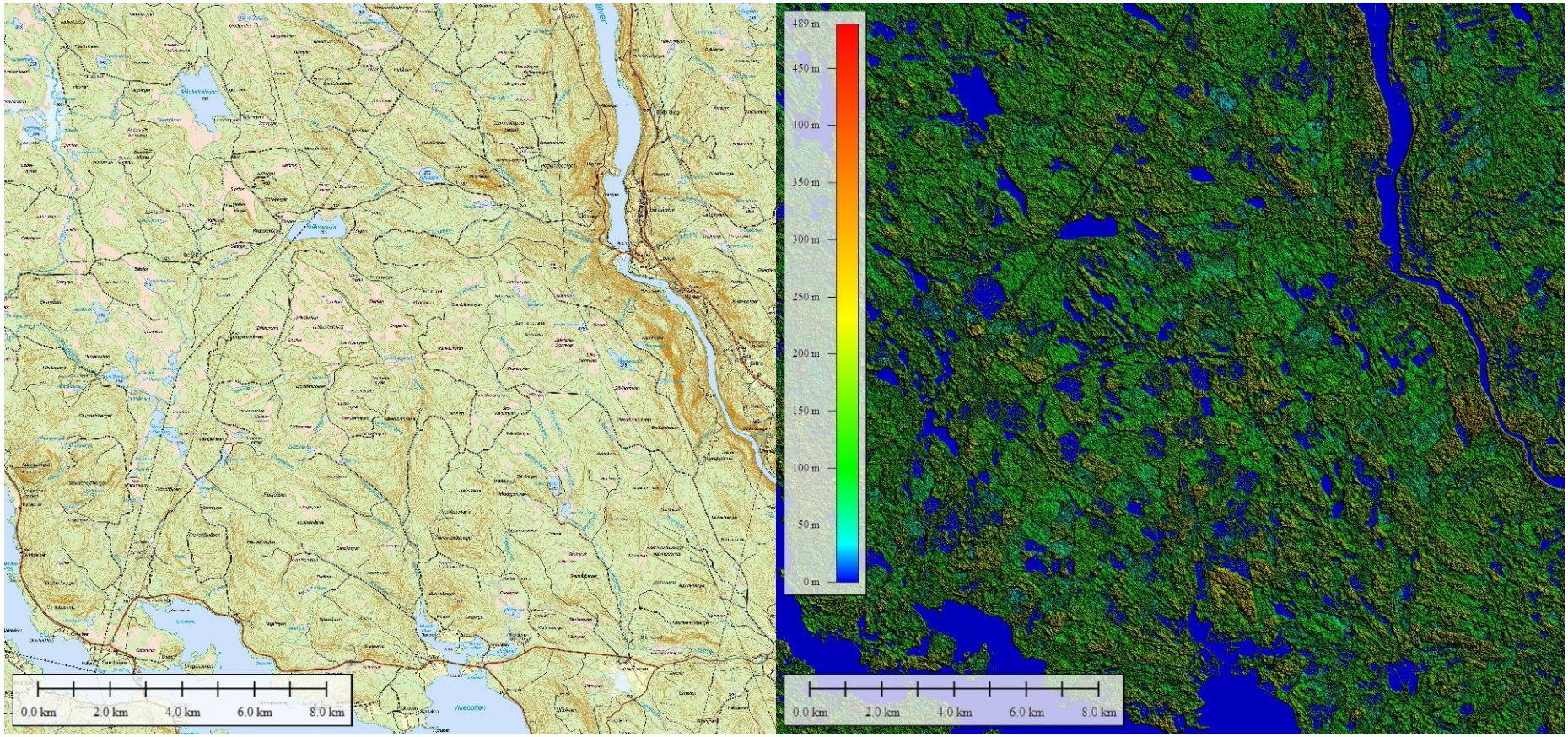
PREPARING FOREST DATA



- Example of typical laser scanned forest data available in Sweden

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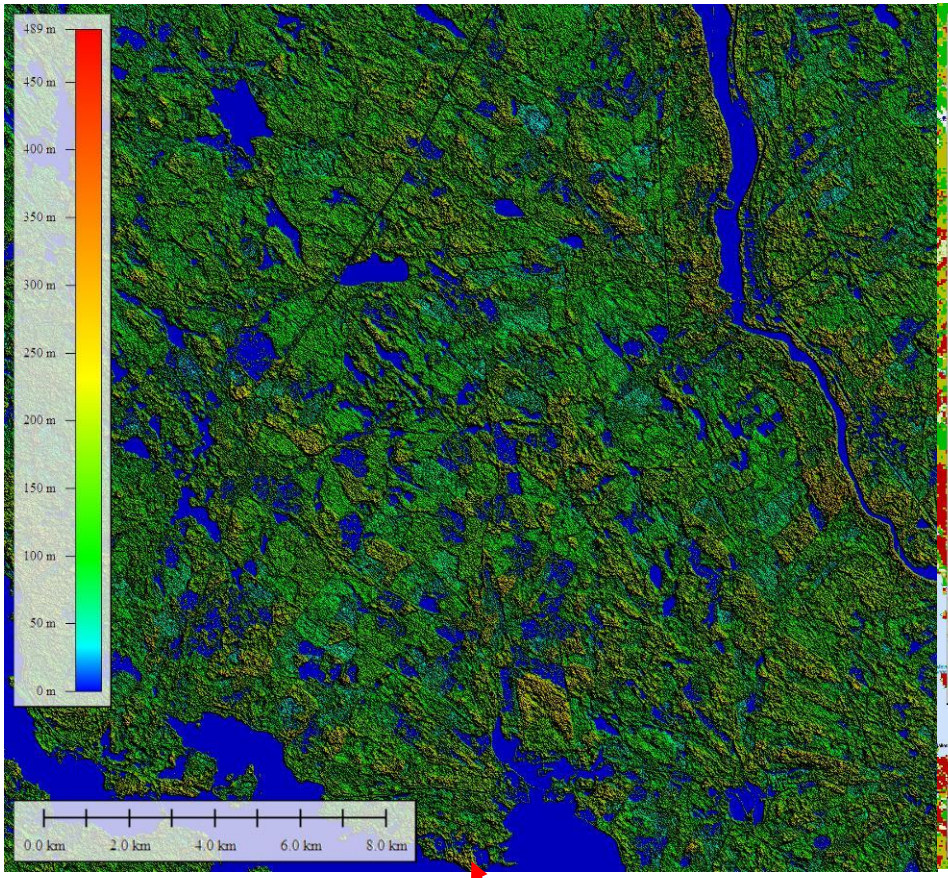
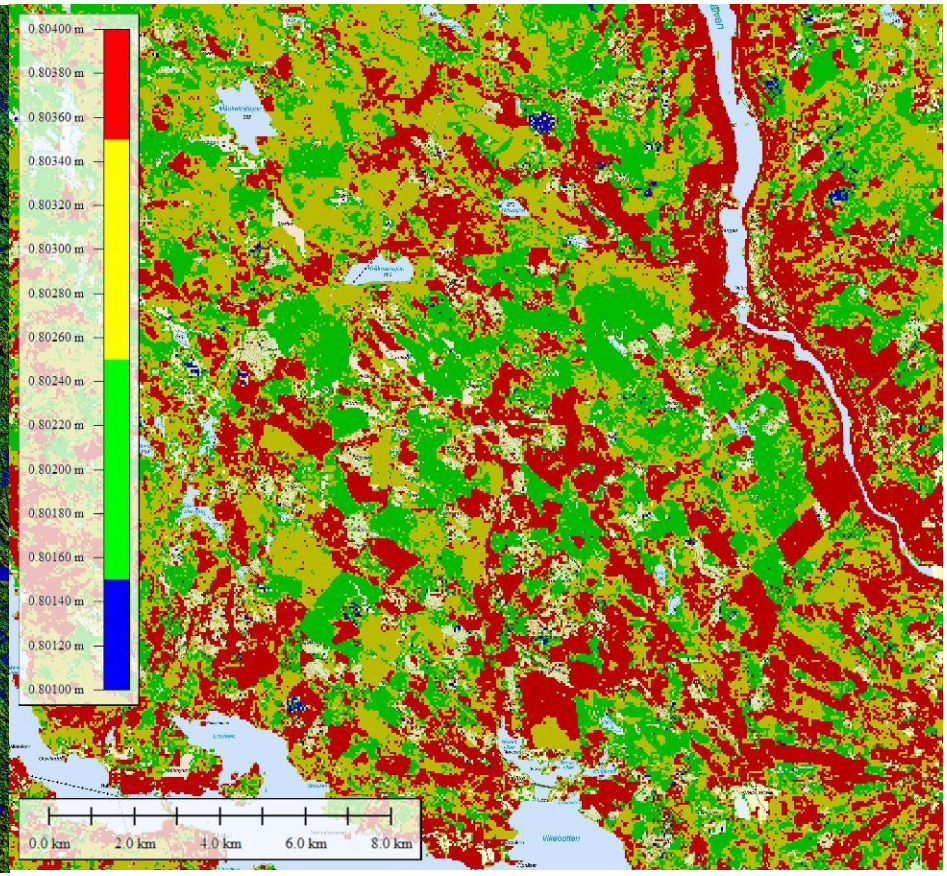
PREPARING FOREST DATA





Simplify this

To Something like this

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GENERALIZING THE DATA (1 OF 2)

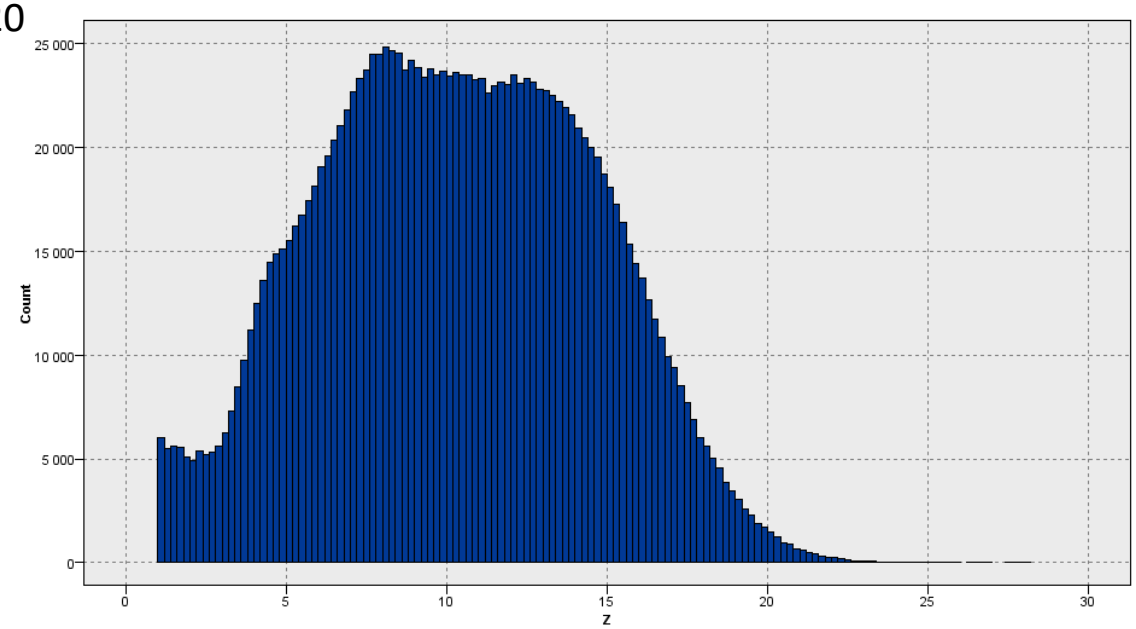
- Import data into GIS software (such as Global Mapper)

- Export data in high resolution (10m) to xyz file (do not interpolate gaps)

- Import resulting xyz file into your data software (Matlab, SPSS Modeler, Excel, etc.)
  - Convert tree height to meters, if necessary
  - Plot a histogram of the tree heights to determine general forest characteristics

- Group the tree heights based on the desired buckets, for example
  - Z > 2.50 and Z <= 5, then 5
  - Z > 5 and Z < 12.5, then 10
  - Z >= 12.5 and Z < 17.5, then 15
  - Z >= 17.5, then 20

- Export grouped data to xyz file



GENERALIZING THE DATA (2 OF 2)

- Import bucketed xyz file back into GIS software at lower resolution
  - Settings should be
    - Tight grid. This reduces «spreading» of tree height data to areas where there is none
    - No interpolation
    - Low resolution (minimum 50 m). This helps reduce the areas with a large mixture of different tree heights that may be hard to model
      - Should perform a sensitivity check on what level of resolution works best for your site. Too low resolution may group too much data, too high may not group enough

- Export XYZ grid again at desired resolution (We generally use 50 m resolution)

- Import into your data software, group one more time to ensure there was no interpolation in the GIS software, then assign a roughness value for each respective height group
  - Example: 0.801 for heights in the 5 m bucket, 0.802 for heights in the 10 m bucket, etc.

- Import resulting XYZ file with assigned roughness values back into GIS software, and combine it with your general background roughness file by placing it «on top».
  - This defines roughness lengths for non-forested areas, or for gaps in the forest data due to low tree height areas

- Export resulting file into GWS format

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WINDSIM SUGGESTED SETTINGS

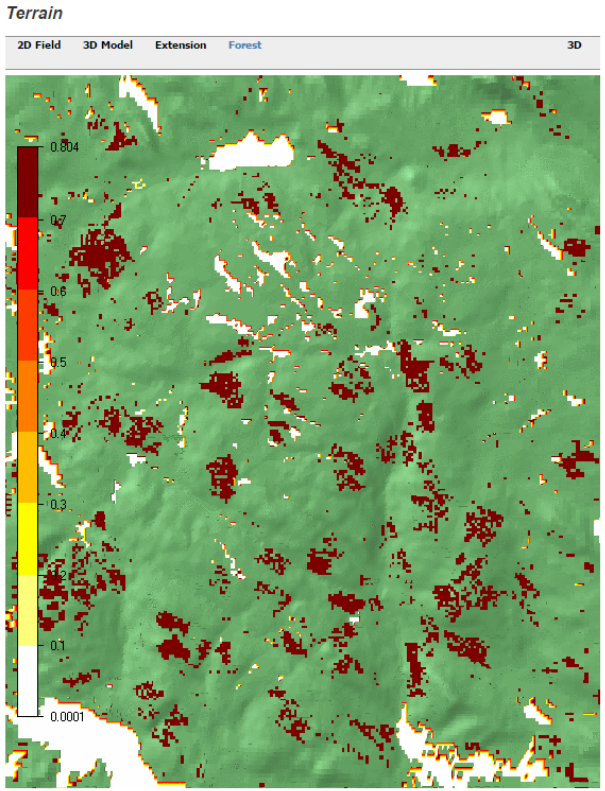


Fig 1. Digital terrain model - Forest

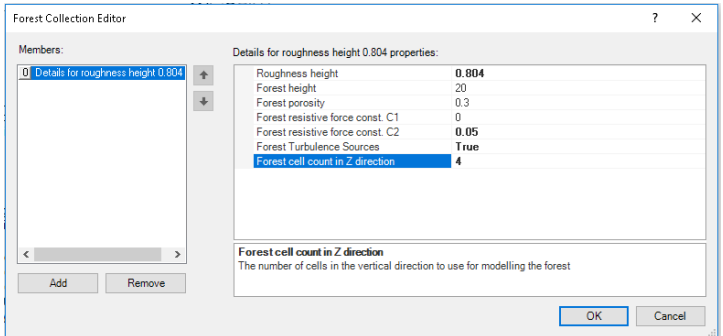
A forest is generated at all locations with a given roughness height.

Roughness height (m)	Forest height (m)	Porosity	C1 (1/s)	C2 (-)	TS	# Cells
0.8020	10.00	0.30	0.000000	0.050000	T	2
0.8030	15.00	0.30	0.000000	0.050000	T	3
0.8040	20.00	0.30	0.000000	0.050000	T	4

Table 1. Forest data.

- Nesting model
  - 26 x 26 km area centered on planning area
  - 100 m horizontal resolution
  - 30 cells vertical
  - Forest settings
    - Recommend modeling all forest with at least 20 m height, with 2 cells
      - Higher heights can be used depending on the site histogram

- Fine model
  - Refinement area, 20 m resolution
  - Outer refinement area between 2.5 to 3 km distance
  - 30 cells vertical
  - Forest settings
    - Recommend using roughness values for tree heights less than 10 m, not forest model
    - Use 1 cell for every 5 m tree height



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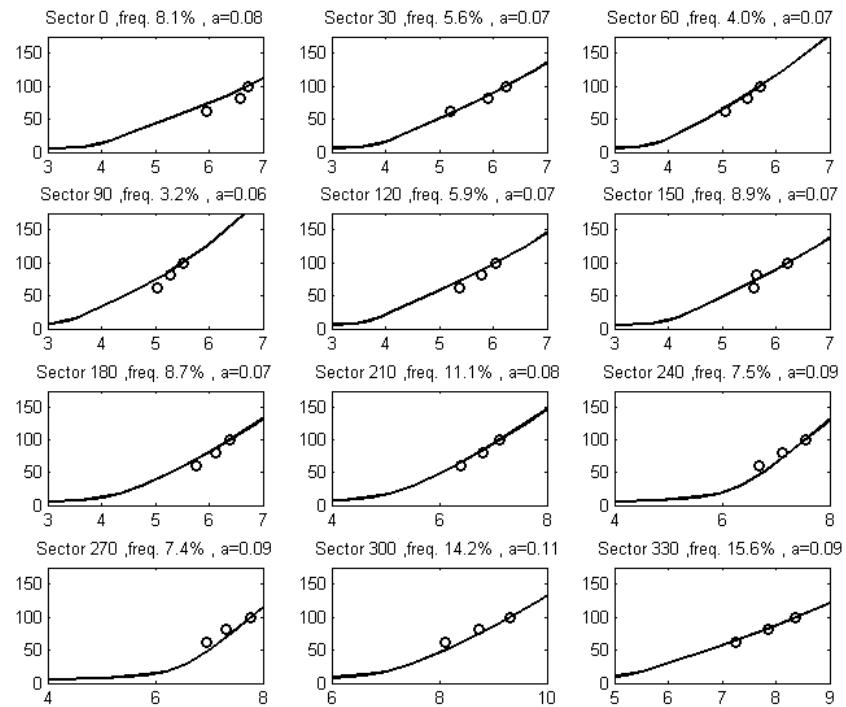
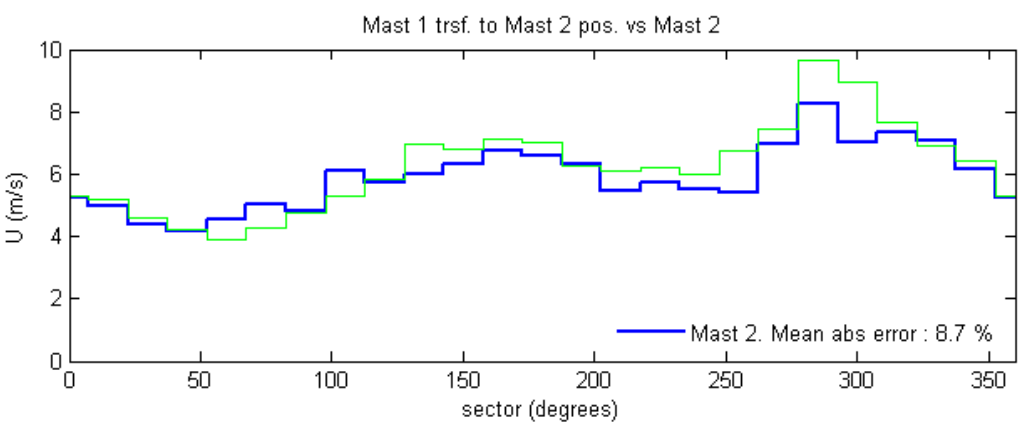
FLOW MODEL ASSESSMENT METHOD

- Compare measured to modeled shear at the measurement positions
- Use transferred climatology to cross-predict measurements between positions when there is concurrent data

Measured versus modeled shear



Sector-wise Cross Prediction Errors



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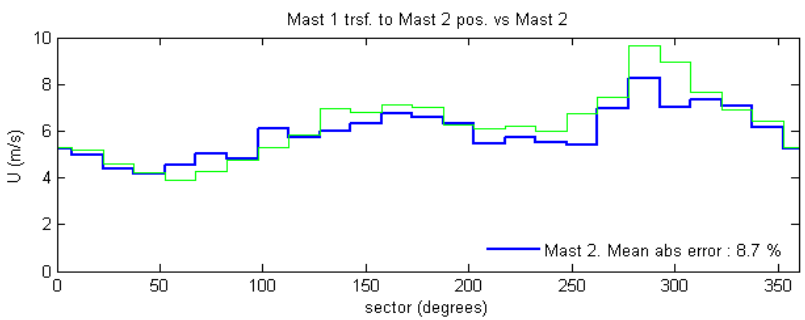
PARK 1

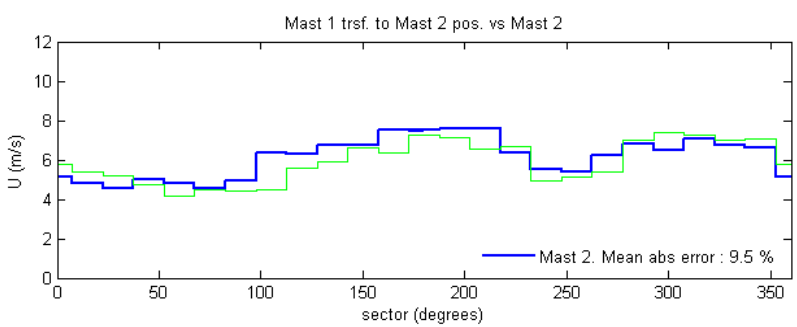
- One mast, 3 sodar campaigns

Mean Cross Prediction Errors

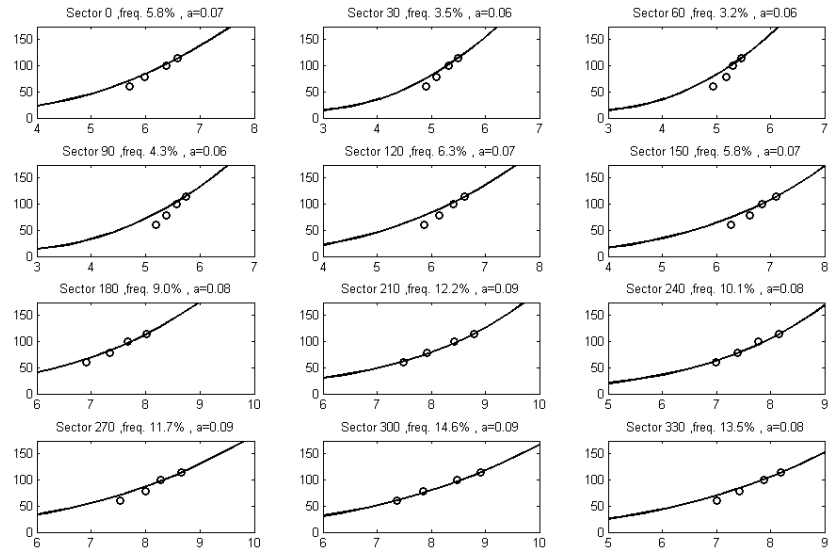
From\To	Mast	Sodar	Sodar	Sodar
Mast		4.85	2.96	-3.22
Sodar	-1.90			
Sodar	-1.57			
Sodar	5.14			

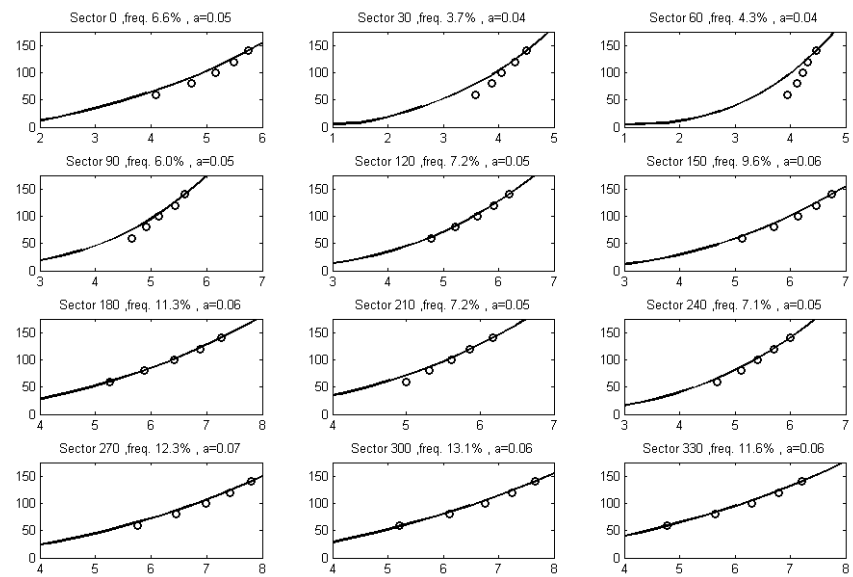
Sector-wise Cross Prediction Errors





Measured versus modeled shear





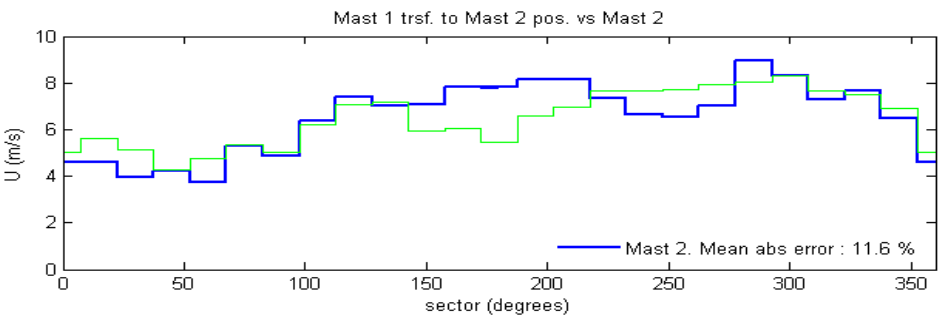
PARK 2

- One mast, 3 sodar campaigns

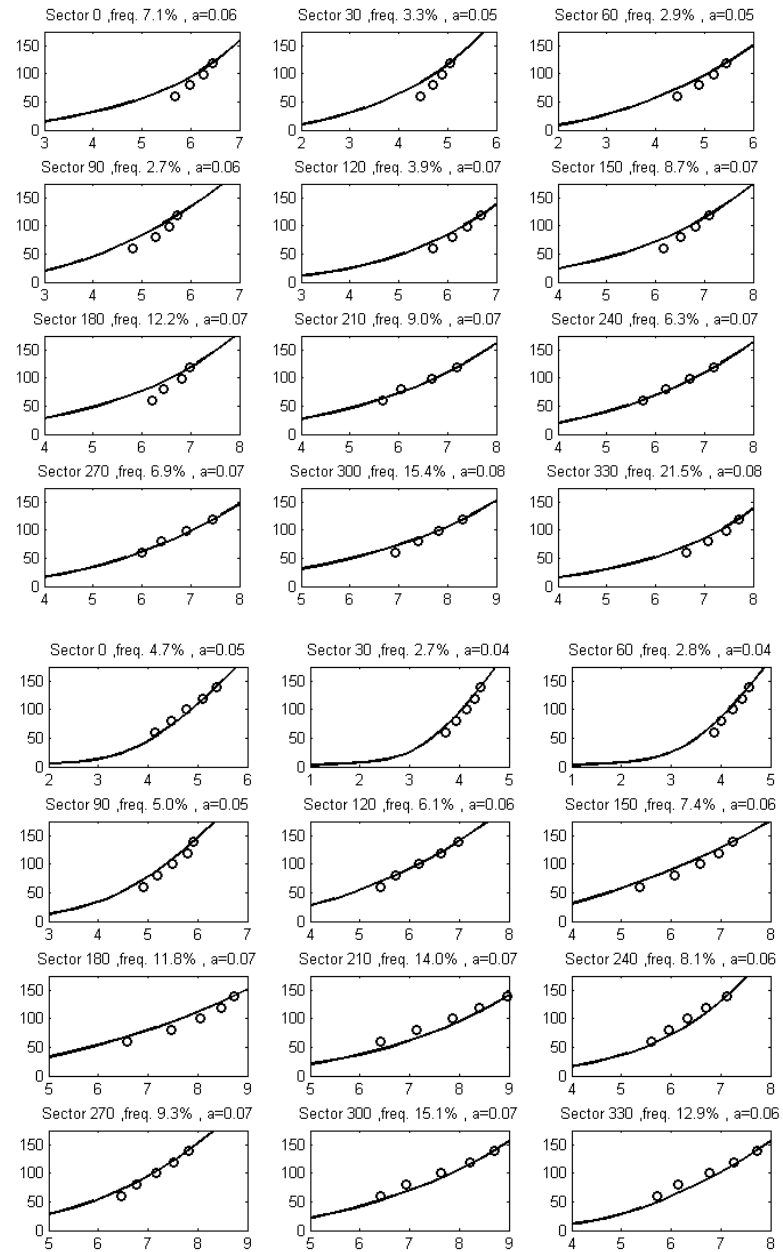
Mean Cross Prediction Errors

From\To	Mast	Sodar	Sodar
Mast		1.5	-2.5
Sodar	5.7		
Sodar	3.4		

Sector-wise Cross Prediction Errors



Measured versus modeled shear



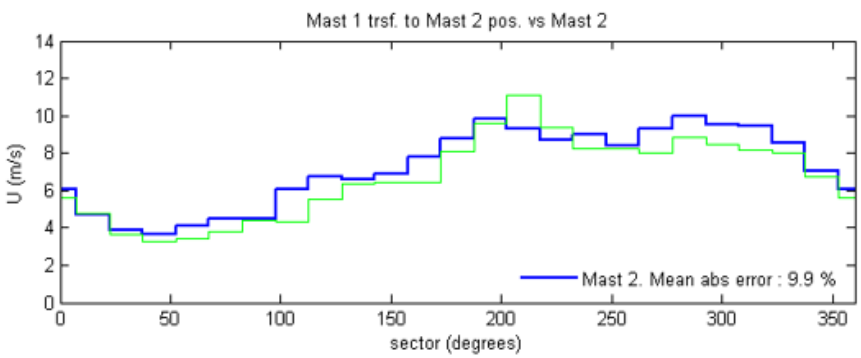
PARK 3

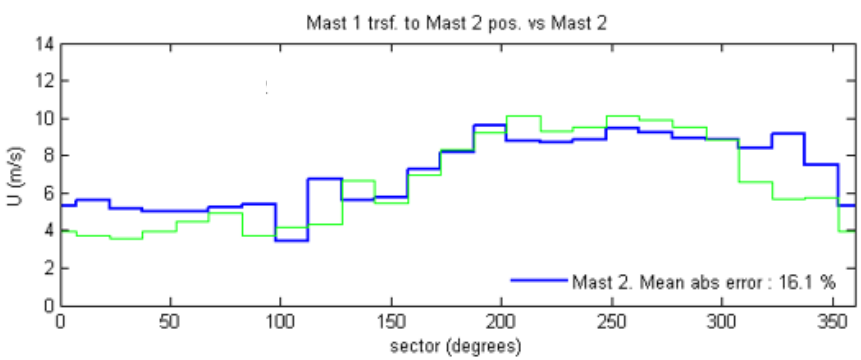
- One mast, 3 sodar campaigns

Mean Cross Prediction Errors

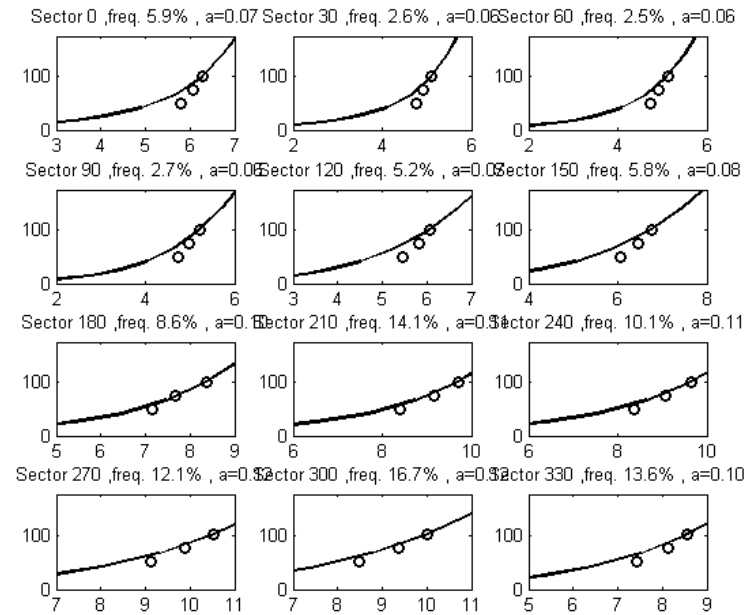
From\To	Mas	Sodar	Soda	Sodar
Mast		-7.5	-8.3	0.1
Sodar	9.7			
Sodar	13.7			
Sodar	0.6			

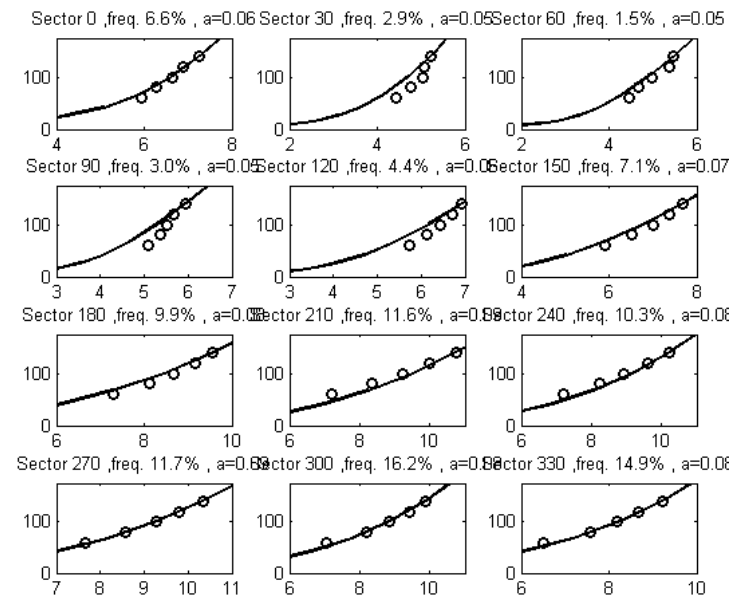
Sector-wise Cross Prediction Errors





Measured versus modeled shear





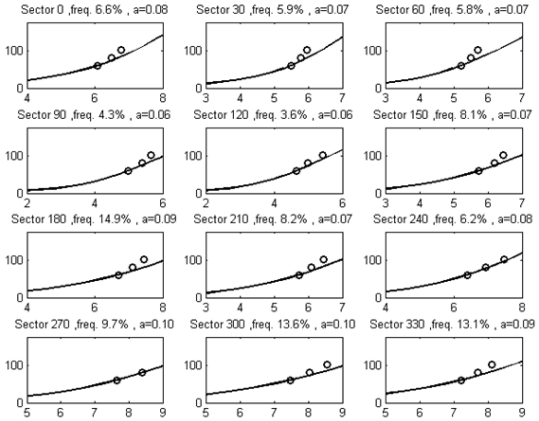
PARKS 4 AND 5 (NEIGHBOR PROJECTS)

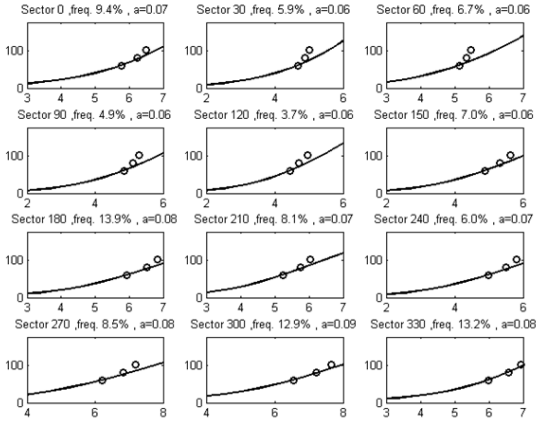
- Park 6: Two masts
- Park 7: One mast

Mean Cross Prediction Errors

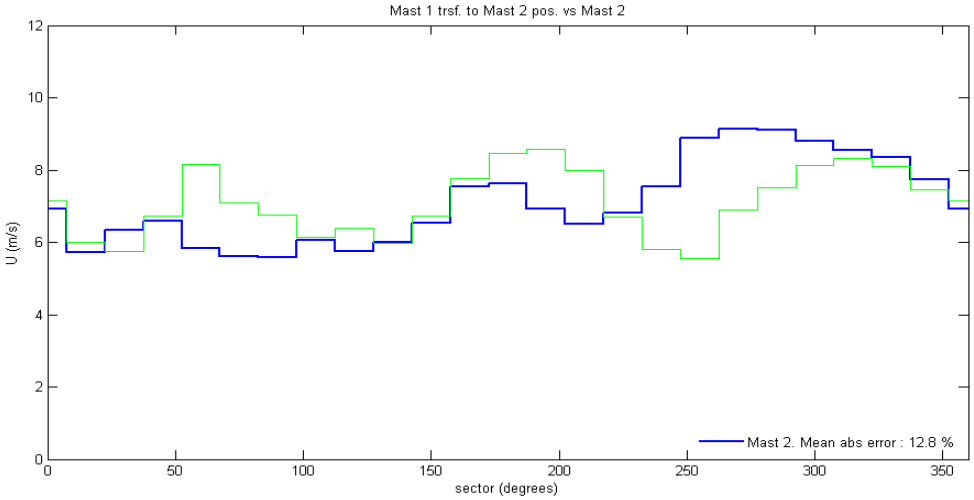
From\To	Mast	Mast
Mast	-	1.84
Mast	3.42	-

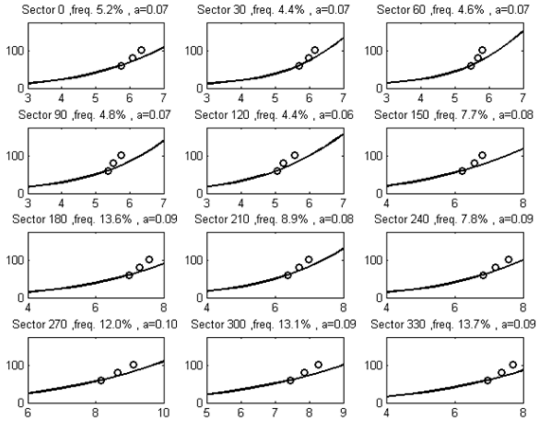
Measured versus modeled shear





Sector-wise Cross Prediction Errors





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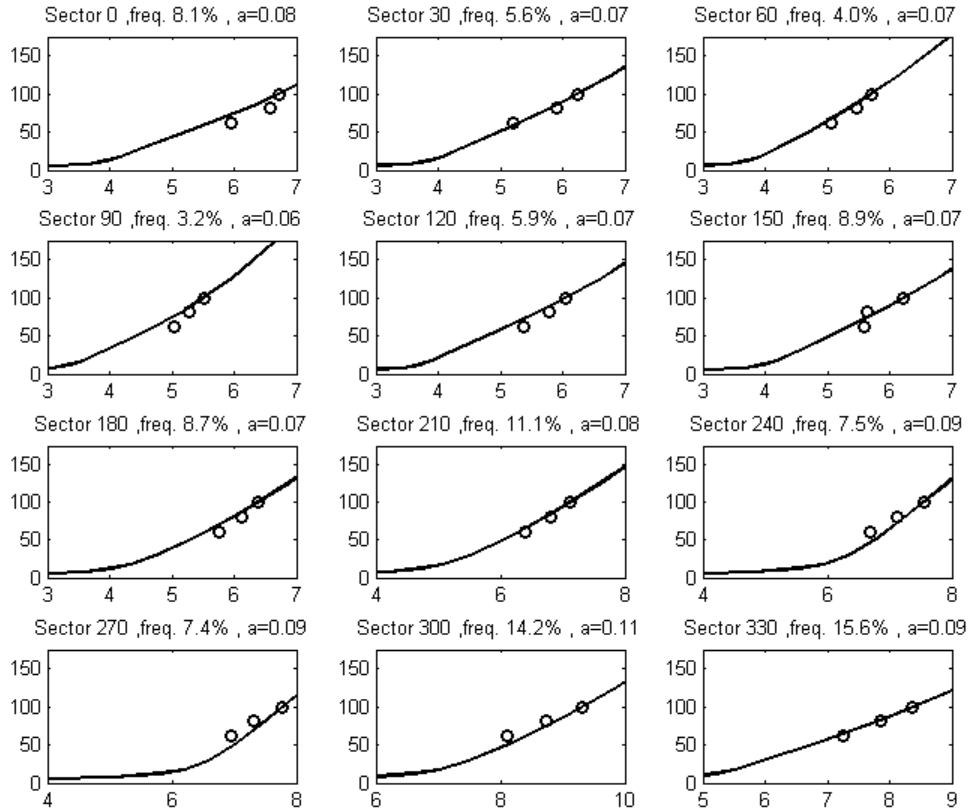
PARK 6

- One 100 m mast
  - 5 years of measurement

Measured versus modeled shear



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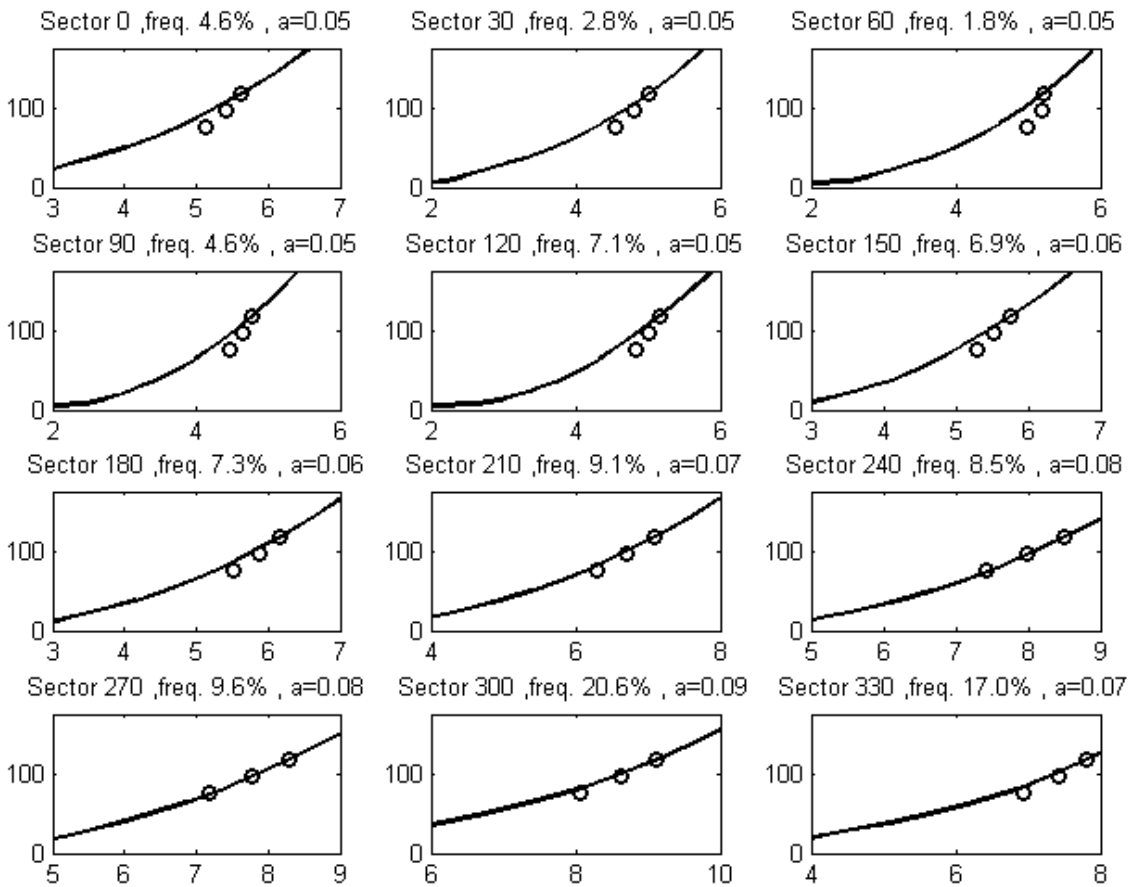
PARK 7

- One 140 m mast
  - 1 year of measurement

Measured versus modeled shear



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QUESTIONS?

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