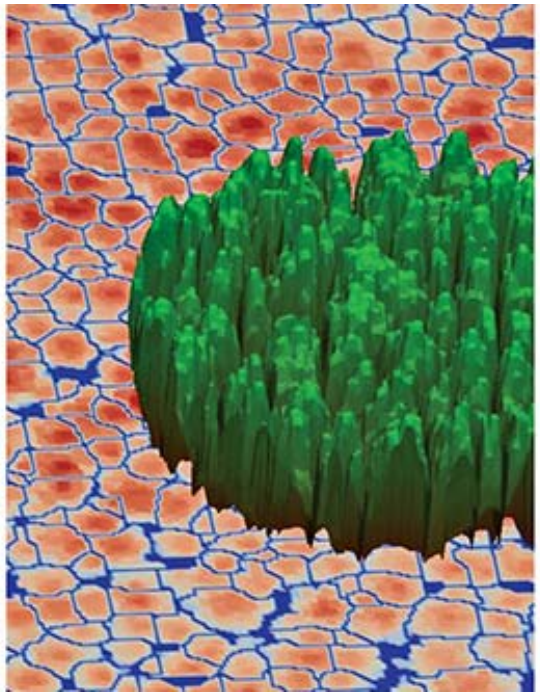
Growing confidence in forestry's future Research Programme

SCION forests · products · innovation

Prediction of productivity indices using remotely sensed data

Michael Watt, Jonathan Dash, Pete Watt, Santosh Bhandari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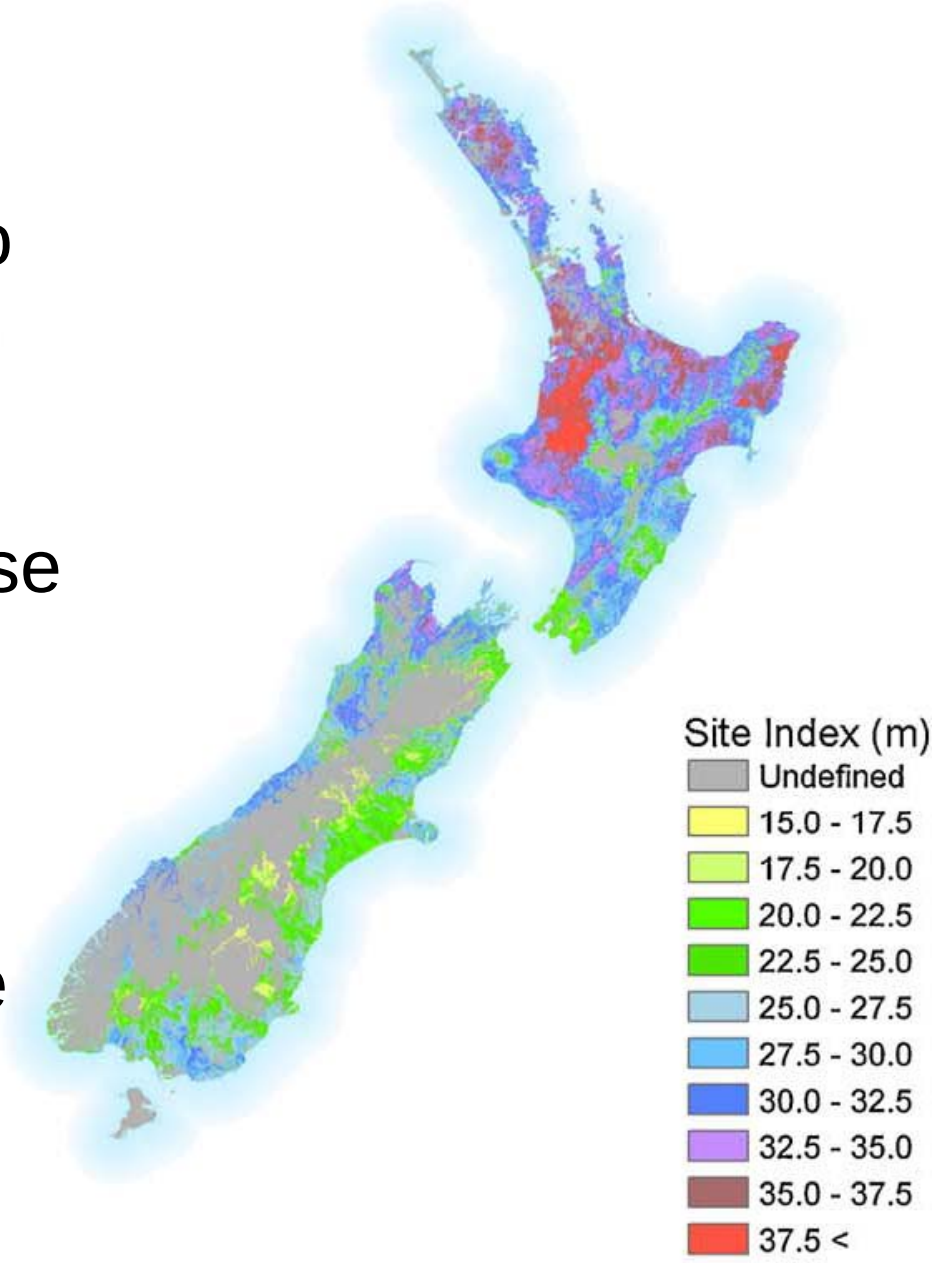
Introduction

- Site Index, 300 Index commonly used metrics to describe plantation productivity
- Typically estimates of these properties made at the stand level by foresters
- Estimates of these productivity surfaces have also been made using environmental variables



Introduction

- Little research has investigated the utility of remotely sensed data sources for predicting productivity metrics

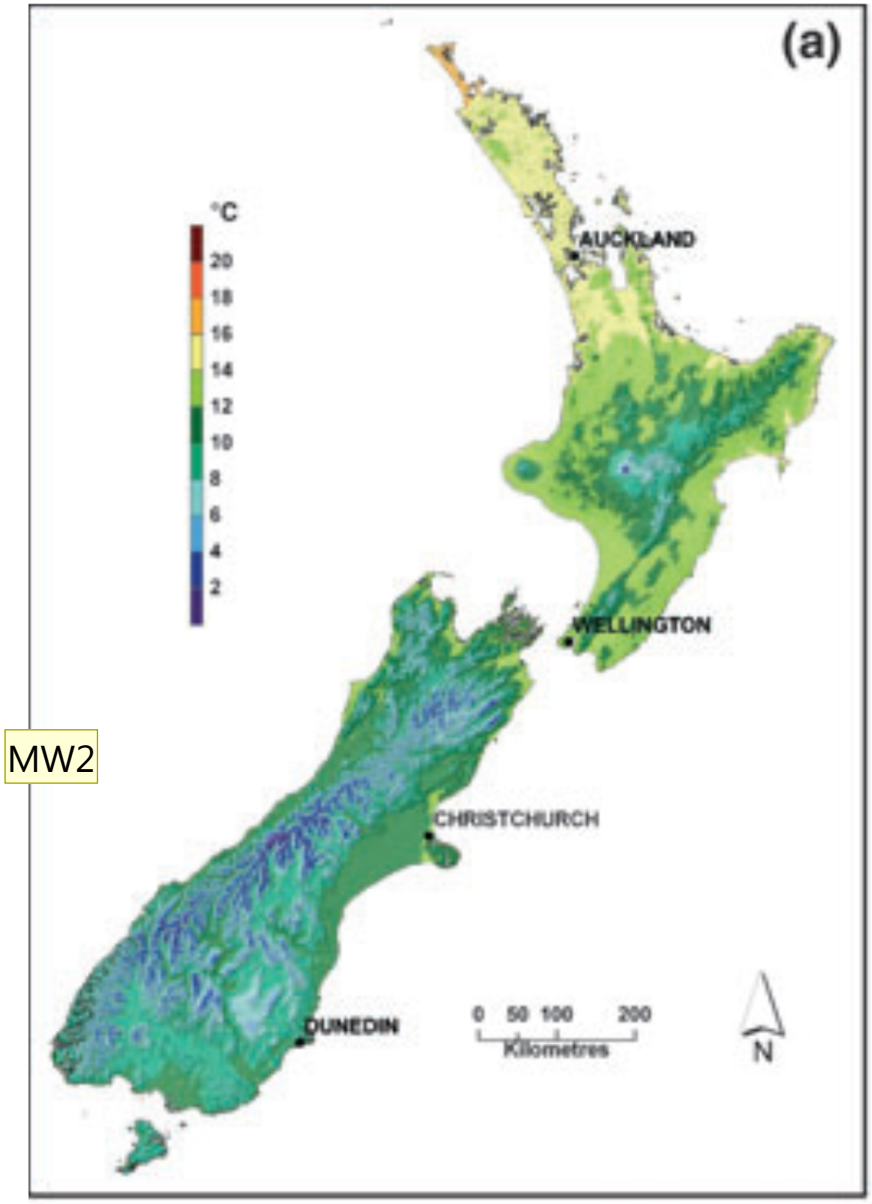
- Use of remotely sensed data could :
  - improve prediction accuracy
  - allow fine scale spatial prediction

- Combinations of the following three data sources could be useful :
  - Environmental Surfaces
  - Satellite Imagery
  - LiDAR

Data sources
- Environmental surfaces

- Data mostly at 100 m^2 resolution

- Air temperature
- Solar radiation
- Rainfall
- Relative humidity
- Slope
- Soil fertility

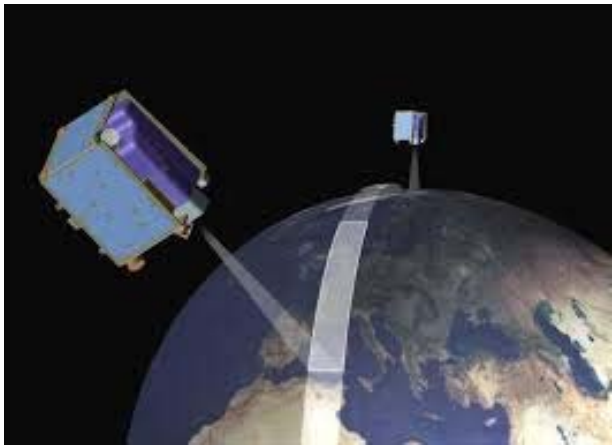


MW2

Slide 4

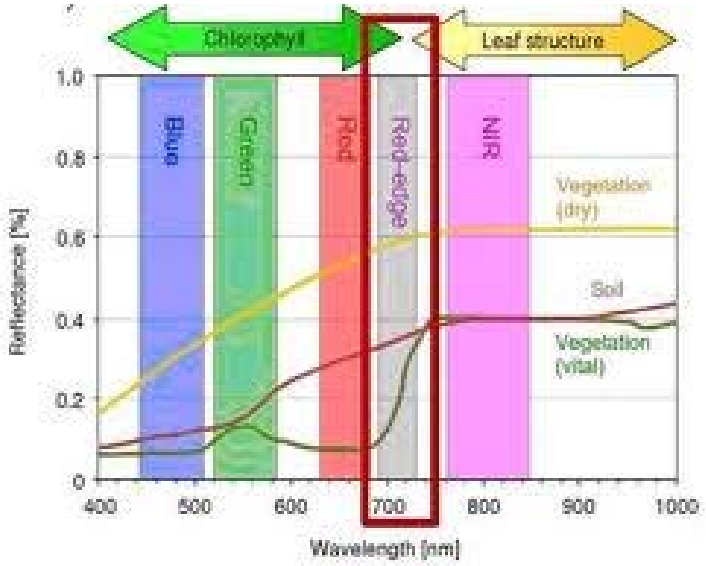
MW2 Pete, Santosh, if you have any additional information or pictures please add these.
Michael Watt, 4/03/2015

Data sources
- satellite imagery



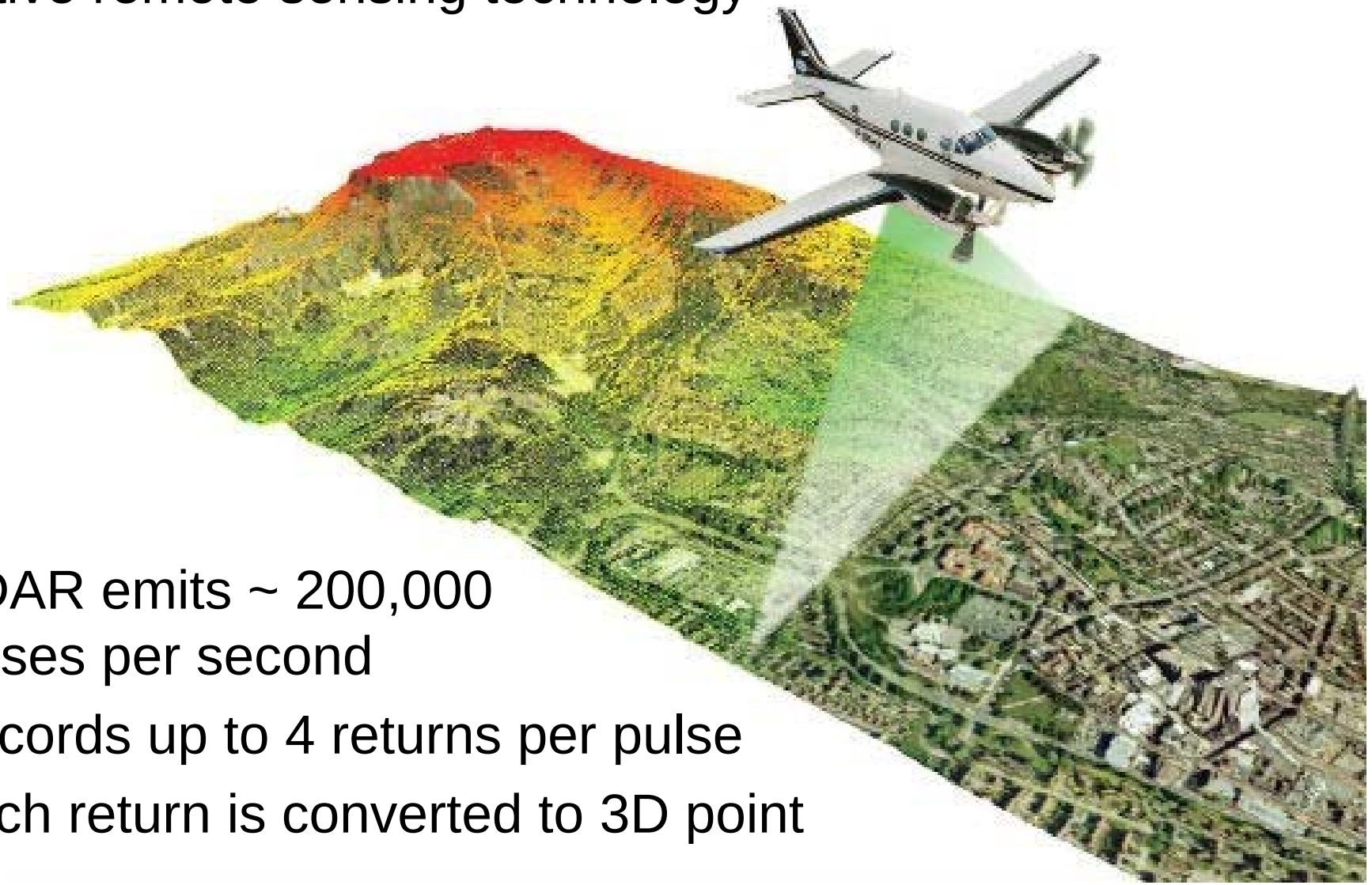
- RapidEye most useful satellite
  - 5 m resolution, 0.01-0.02 $/ha

- 5 spectral bands
- Vegetation ratios that describe photosynthetic activity can be derived.
- Textural measures that describe vegetation surfaces can be derived.
- Easily incorporated into GIS



Data sources
- Light detection and ranging (LiDAR)

Active remote sensing technology



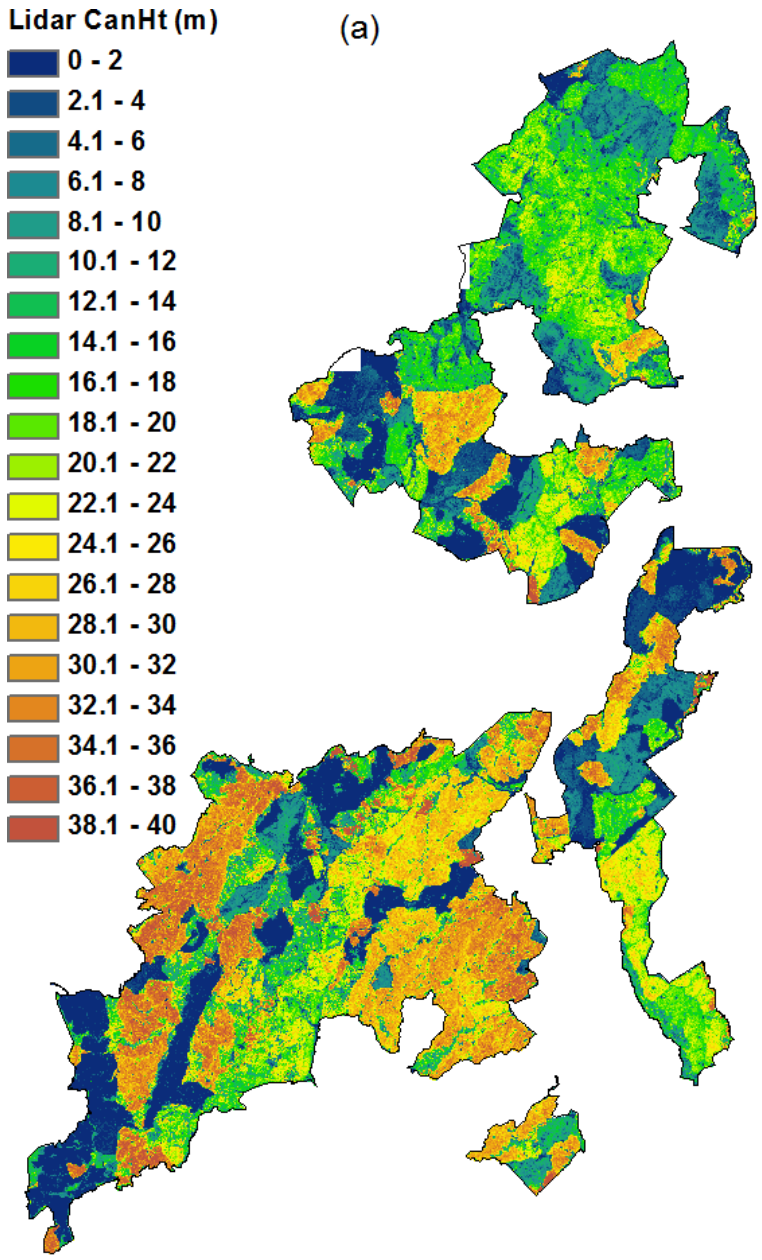
LiDAR emits ~ 200,000 pulses per second

Records up to 4 returns per pulse

Each return is converted to 3D point

Site Index from LiDAR

- LiDAR can be used to accurately predict height
- Using stand age and a age-height equation we can estimate Site Index
- Site Index predicted from LiDAR was used for modelling



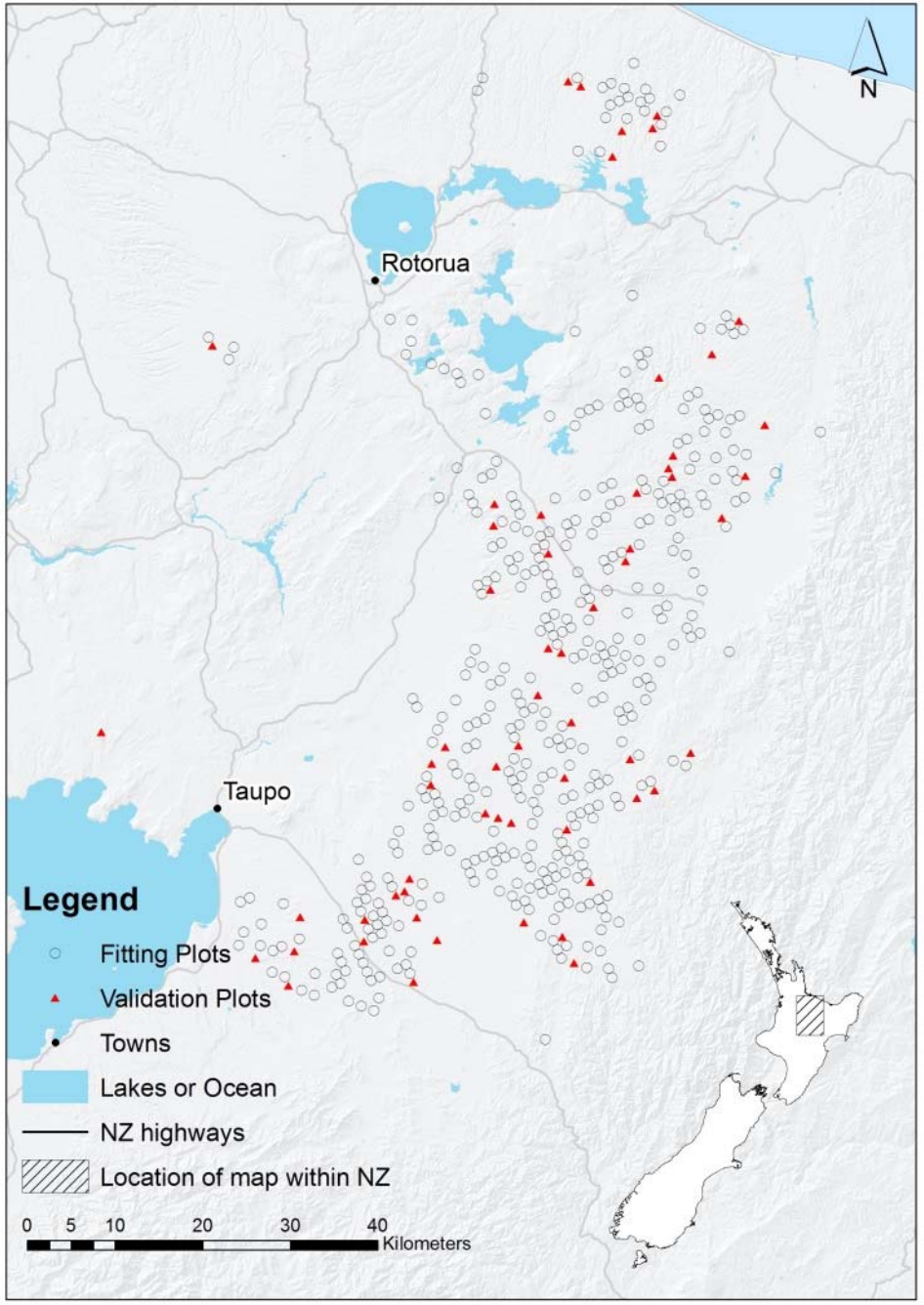
Objective

- Develop models of 300 Index and Site Index using different combinations of LiDAR, satellite imagery and environmental surfaces

- Models developed with and without stand age using both non-parametric and parametric methods

Methods

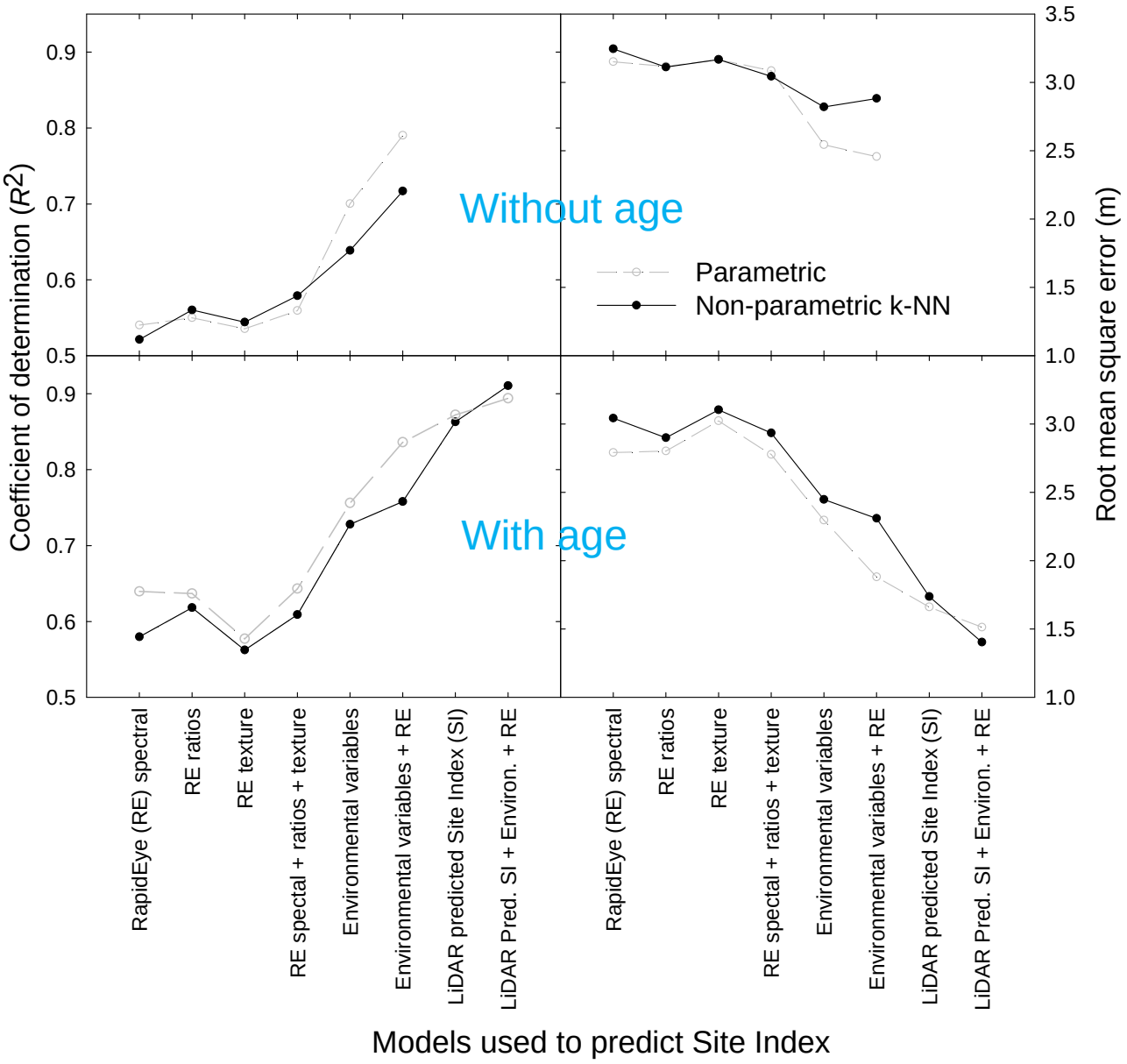
- LiDAR acquired early 2014 ~ 11 points m^2
- RapidEye acquired January 2014
- Total of 493 plots installed early 2014
- 433 plots used for model fitting, 60 plots set aside for model validation



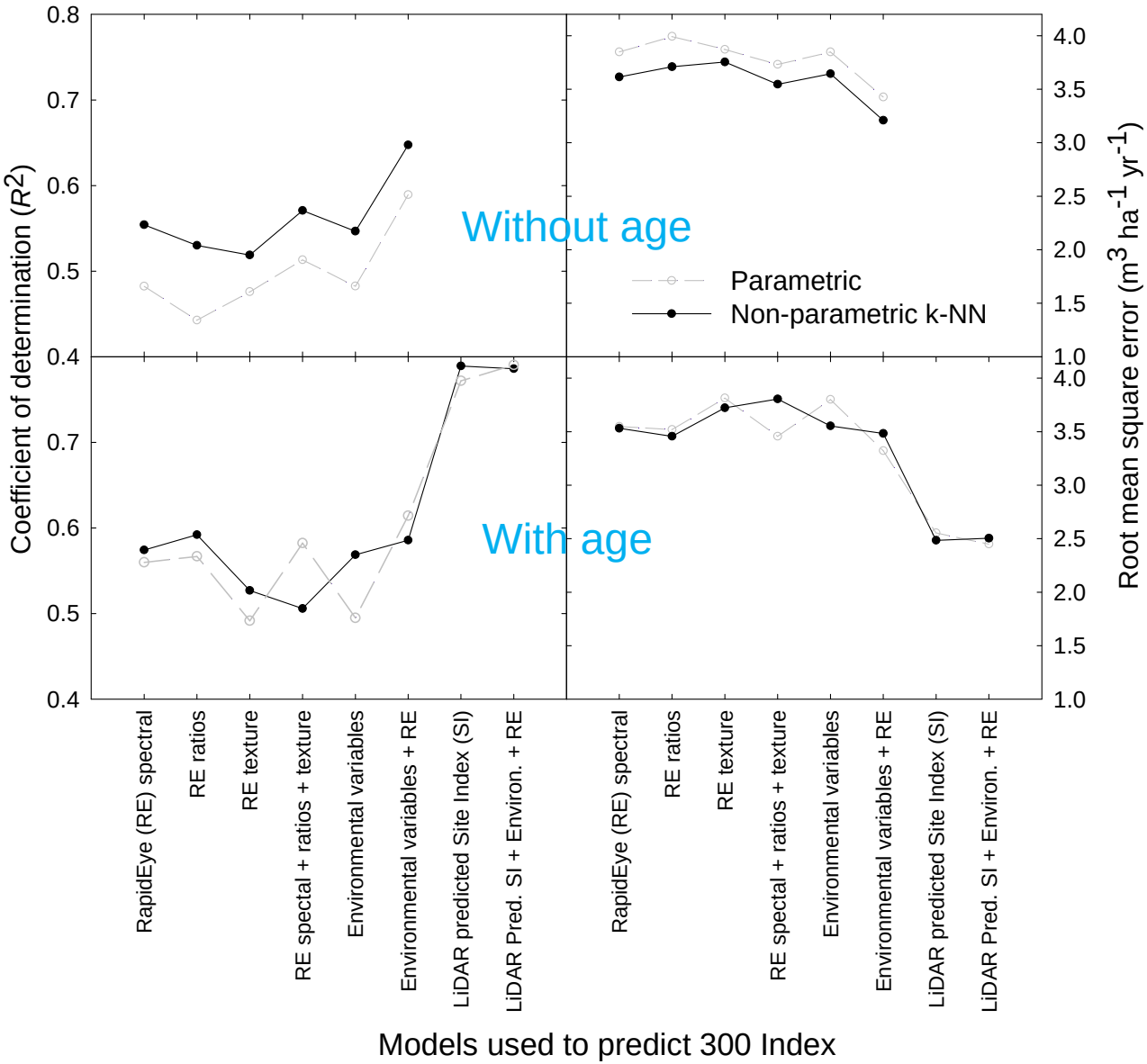
Methods

- Total of 14 models developed using various combinations of the three datasets.
- Parametric method used was multiple regression
- Non-parametric method used was k-nearest neighbour
  - Random forest or k-MSN used to assign neighbours
  - Values of k were optimised to minimise model error

Results - Site Index



Results - 300 Index

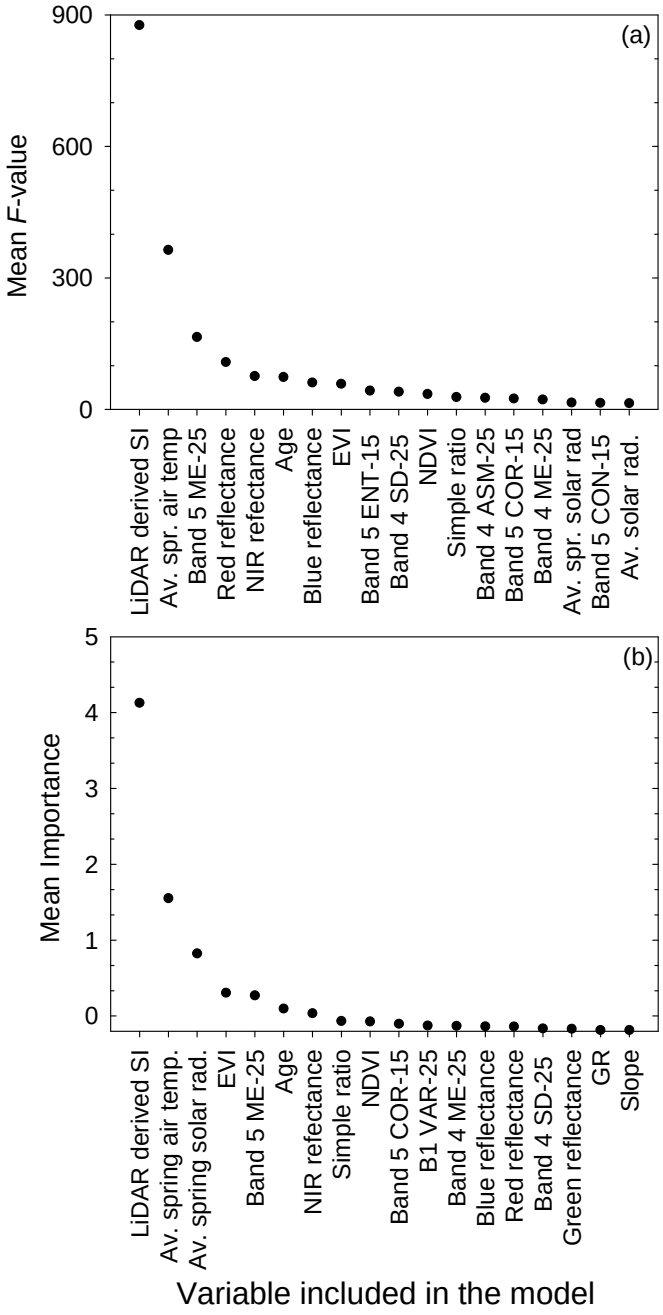


Results – Best Models

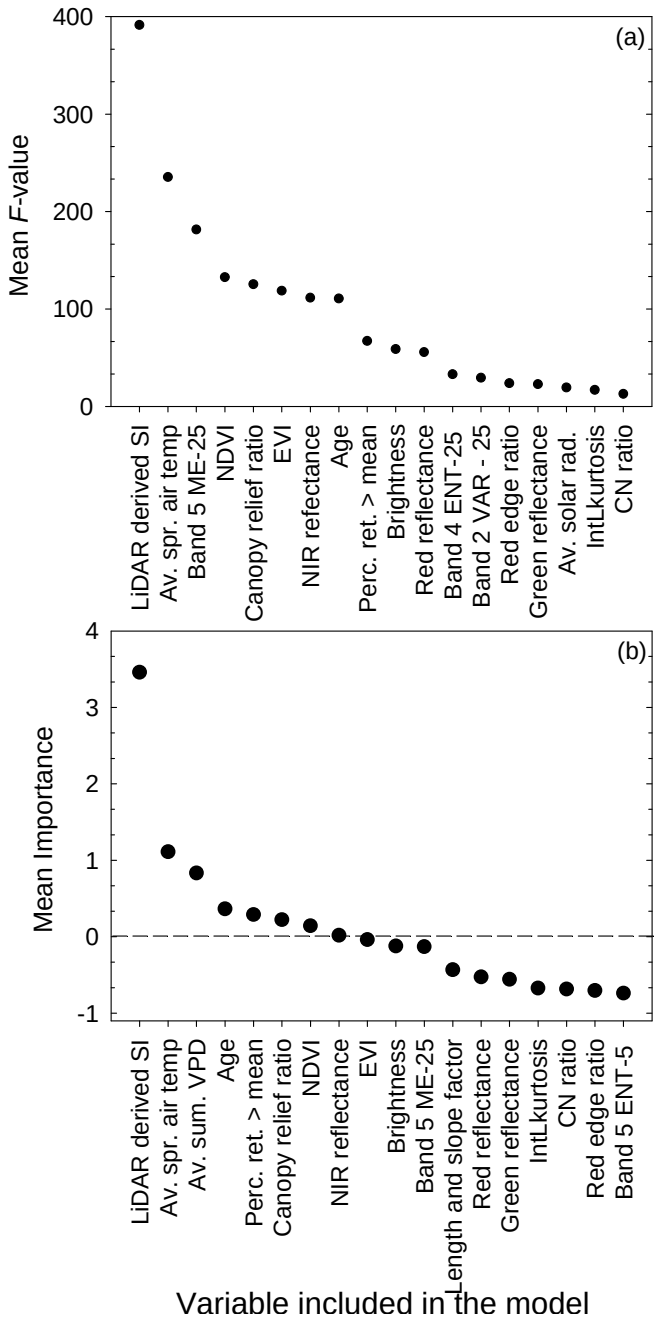
Metric	Age?	Type	Variables	R^2	RMSE
Site Index	Y	NP	LiDAR + Environ. + RapidEye	0.91	1.40 m
	N	P	Environmental + RapidEye	0.79	2.46 m
300 Index	Y	P	LiDAR	0.79	2.45 $m^3\ ha^{-1}\ yr^{-1}$
	N	NP	Environmental + RapidEye	0.65	3.21 $m^3\ ha^{-1}\ yr^{-1}$

Variable importance

Site Index



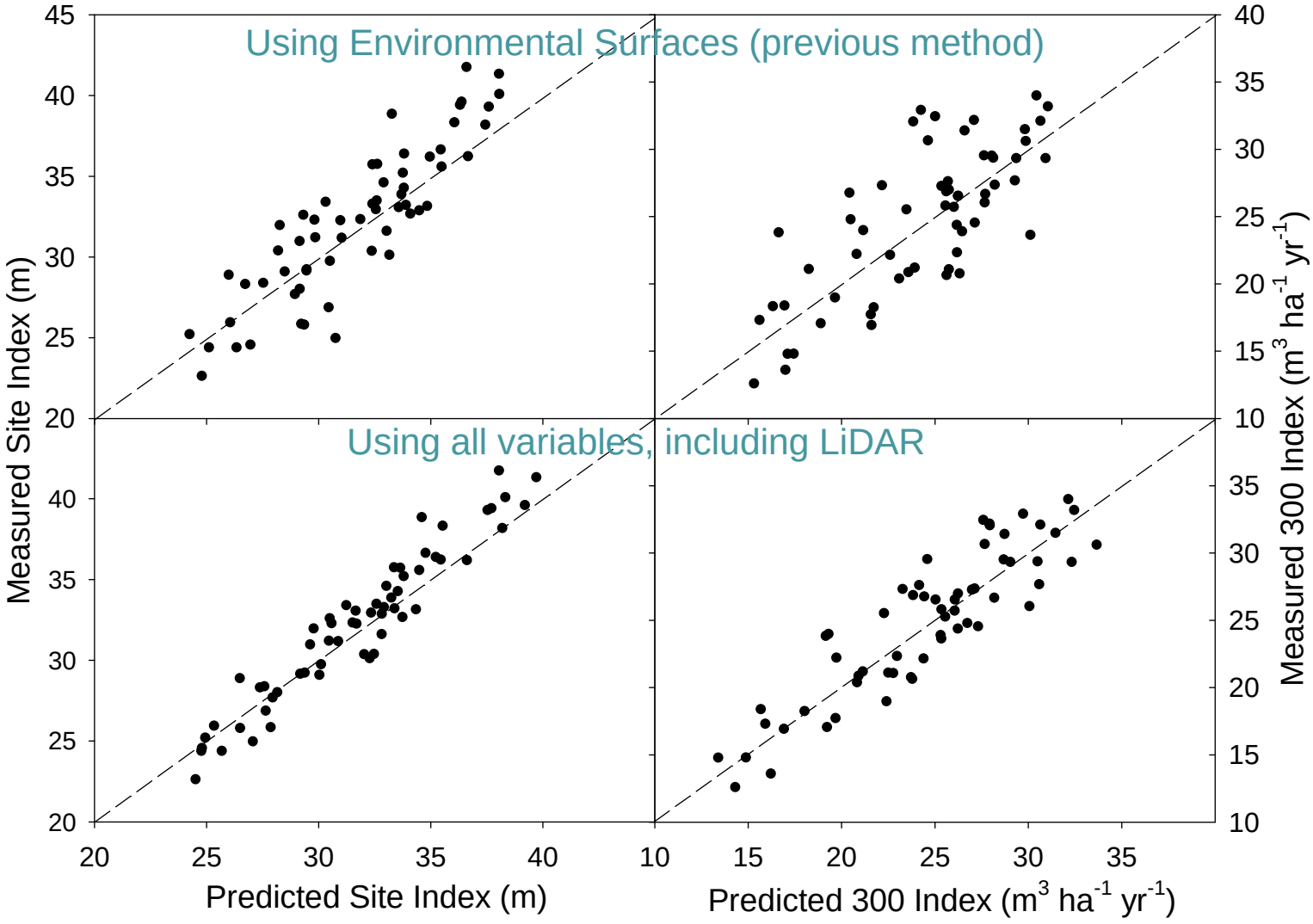
300 Index



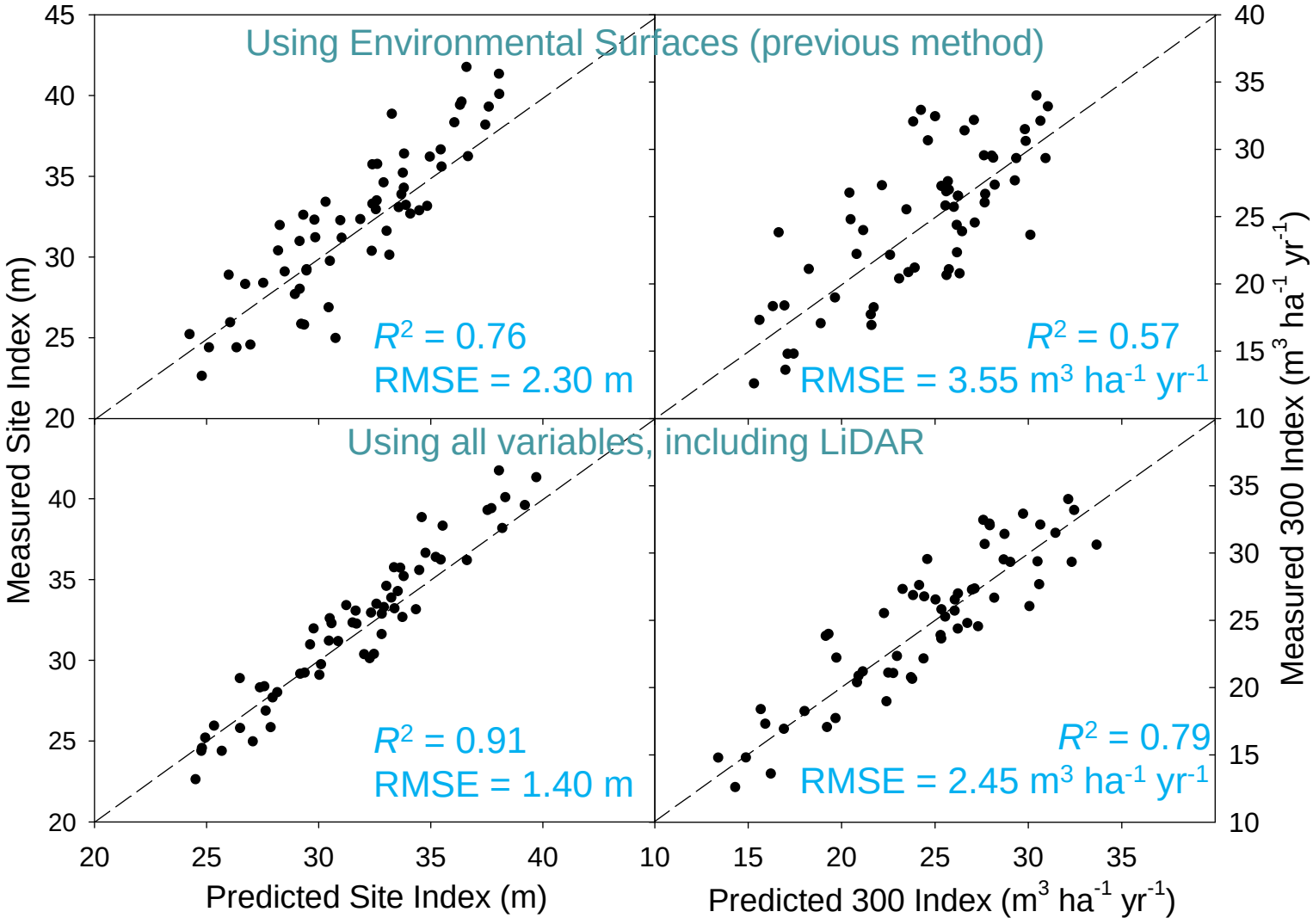
Results – Top three variables

Metric	Type	Variables
Site Index	P	LiDAR derived Site Index; Av. spring air temp; NIR mean texture
	NP	LiDAR derived Site Index; Av. spring air temp; Av. spring solar rad.
300 Index	P	LiDAR derived Site Index; Av. spring air temp; NIR mean texture
	NP	LiDAR derived Site Index; Av. spring air temp; Av. summer VPD

Research gains



Research gains



Summary

- Models of Site Index and 300 Index created
- Significant gains in precision possible using information from LiDAR and RapidEye
- For models without age, best data source were environmental surfaces + RapidEye
- For models with age, best data source was LiDAR
- RapidEye and environmental surfaces useful cost effective alternative to LiDAR

Acknowledgements

- GCFF programme jointly funded by MBIE and NZ Forest Growers Levy Trust
- Timberlands
- Professional contribution of all field teams involved

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Date:24 March 2015

forestgrowers levy trust inc Funding Support Provided by the Forest Growers Levy Trust

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