Resilient Forests Research Programme

SCION FORESTS▪PRODUCTS▪INNOVATION

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Technical Note

Scanning other species with Discbot.

Summary:

Discs from Cypress, Totara and Eucalyptus nitens were scanned and processed on discbot to test the existing measurement methods used routinely for radiata pine on these three species and look for any problems that might arise. The results obtained indicate that the methods used on Discbot can be applied to look at variation between-trees and within-tree property patterns for wood density and sound speed. With species specific calibration the Discbot methods have good potential to give accurate estimates of wood density, sound speed, and wood chemistry composition. NIR (near-infrared reflectance) models for wood chemistry need to be calibrated with wet-chemistry calibration data on other species. For all three species thinner samples are required for masked light transmission to measure grain-angle.

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Introduction

The DiscBot disc scanning system was designed and developed primarily to answer the inherent question 'how variable are wood properties within individual trees?'. We need to understand tree-to-tree variation in intra-tree wood property patterns. Confirming and understanding this will influence the direction of research into wood processing, as what will become important is how (cheaply) it's possible to find the best bits of the tree; and it will open up research into how to manipulate the variants within the trees. To date, research has been focussed on improving the mean (of forest stands) – the DiscBot will confirm the necessity of research into these new areas, with changes in industry outcomes being realised. While this has been optimised for Radiata Pine, it would be of interest to investigate the utility of the DiscBot to assess wood quality in other species.

Method

Half discs collected from previous mill studies on Cypress (*Cupressus x ovensii*), Totara and *Eucalyptus nitens* were scanned using the current *P.radiata* Discbot method settings and data processing models. A total of 10 randomly selected half discs were scanned for each species. Disc sizes were from 300mm to 400mm diameter.

Density was calculated by X-ray attenuation. The x-ray mass attenuation coefficient used was 0.3135 cm^2/g which had been previously calculated for *P.radiata*. Ideally a gravimetric calibration for each species to determine the mass attenuation coefficient would be a preferable approach, but was outside the scope of this pilot study.
The x-ray calculated density is unextracted air-dried density in g/cm^3. The X-ray attenuation coefficient does vary with moisture content because of different element mass compositions of dry-wood and water.

Ultrasound speed was determined using wheeled probe transducers with a transducer frequency of 1.25 MHz. The pulse arrival time picks were based on the removal of high frequency modes by empirical mode decomposition and determination of pulse peak arrival time of the highest energy mode.

Wood lignin content was predicted by a NIR model calibrated on 54 juvenile radiata pine samples, including a mix or compression wood and normal wood. For Klason lignin content a 2 component PLS model was fitted to the absorbance spectra (900nm to 1700 nm range) using 7-fold cross-validation after standard normal variate spectra normalisation pre-processing. For the calibration data set Klason lignin which was measured on extracted wood for following Tappi method T222. The wood anatomy variation of the three different species can be expected to result in variation in light scattering and light reflection. Also,

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chromophores in heartwood can be expected to influence wood light absorption properties. The calibration data set did not include any heartwood Therefore, using a NIR calibration based on juvenile *P.radiata* is not ideally applicable to all three species. The calibration for *P.radiata* is probably most suitable for the Cypress samples which are young softwood trees.

Masked light transmission (MLT) is the Discbot method for grain angle and spiral grain measurement. This method developed for dry *P.radiata* was applied without modification to the three species.

Results

The half-disc average x-ray calculated density values for each wood species are very similar to the half-disc gravimetric density values (Table 1).

Table 1. Comparison of gravimetric and x-ray density values for two discs of each species

Species	Thickness (mm)	Gravimetric density (g/cm³)	X-ray density³(g/cm
Cypress	27.9	0.368	0.375
	27.3	0.369	0.375
E.nitens	27.1	0.553	0.556
	27.3	0.544	0.547
Totara	24.7	0.453	0.457
	27.2	0.556	0.566

An interesting feature of the Cypress (*Cupressus x ovensii*) discs is the uniformity of the density with minimal evidence of higher density latewood banding. An area of higher density wood below the pith for totara disc dkd2 is related to a resinous zone. The ring density pattern is not always clear because the ring edge is not perfectly aligned with the x-ray path through the disc. This blurring of rings is more evident when the rings are close together as with the Totara discs.

The disc average sound speed values for the *E.nitens* are higher than Cypress and Totara sound speeds . The E. nitens discs contained 22 rings and the higher sound speed along with the high density is consistent with other studies showing high MOE for *E.nitens* (3). The low values for Cypress are attributed to the very young age of these discs with only 12 growth rings. The innermost rings have a lower sound speed than the outer rings for Cypress which is similar to the radial pattern in *P.radiata*. The totara discs show zones of lower sound speed wood. Totara disc ozqa has a sector of lower speed. Totara disc dkd2 has several rings of lower speed wood at different ages, and an area of lower speed wood associated with branching. This lower speed wood is a result of the grain angle deviation around the occluded branch.

Lignin patterns in the Cypress disc are similar to patterns in *P.radiata* with higher lignin associated with innermost rings and also some compression wood rings with higher lignin content and also lower density and lower sound speed. The *E.nitens* discs have a steady radial decease in lignin content from pith to bark. The Totara discs have much higher inner lignin content – especially Totara disc ozqa which has 66 rings. This pattern could be the result of extractives content of heartwood in the disc and not lignin content. It could also be from compression wood zones in the disc since in this disc ozqa the high lignin wood is also associated with lower sound speed and slightly higher density in the inner rings and in the lower sector of the disc.

MLT grain angle measurement was not successful for *E. nitens* and Totara with almost no detected light transmission. For Cypress a weak level of light was transmitted which is too dim for accurate measurement purposes. The discs were thicker than ideal at approximately 27 mm. For *P.radiata* a useful measurement is possible at 27 mm disc thickness, but a much better transmission is achieved on dry discs at 20 mm disc thickness.

Conclusions

- Existing Discbot methods can be used to look at variation between-trees and within-tree property patterns for wood density and sound speed for these 3 species tested.
- With species specific calibration the Discbot methods have good potential to give accurate estimates of wood density, sound speed, and wood chemistry composition.
- NIR (near-infrared reflectance) models for wood chemistry need to be calibrated with wet-chemistry calibration data on other species.
- For all three species thinner samples are required for masked light transmission to measure grain-angle.

References

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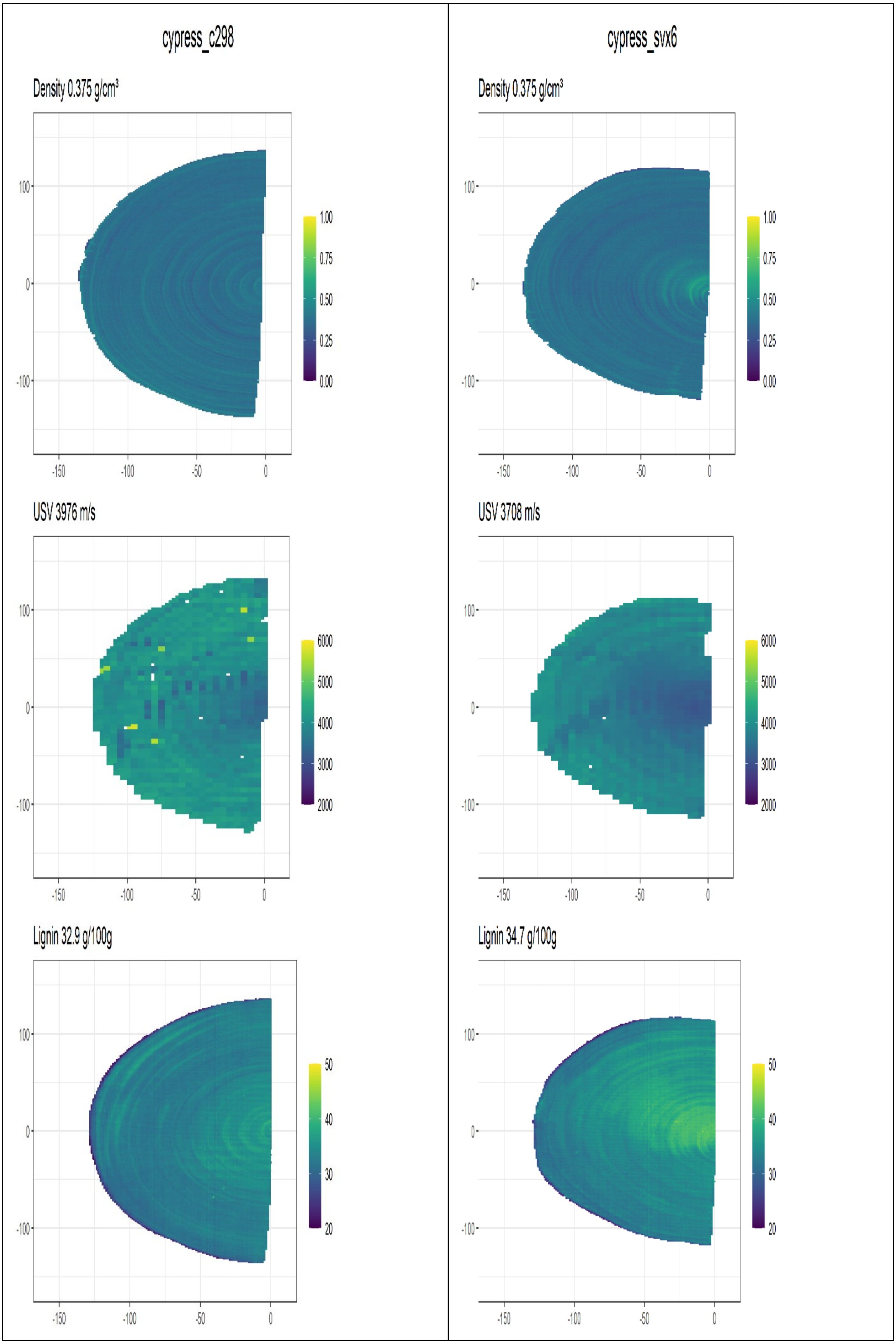
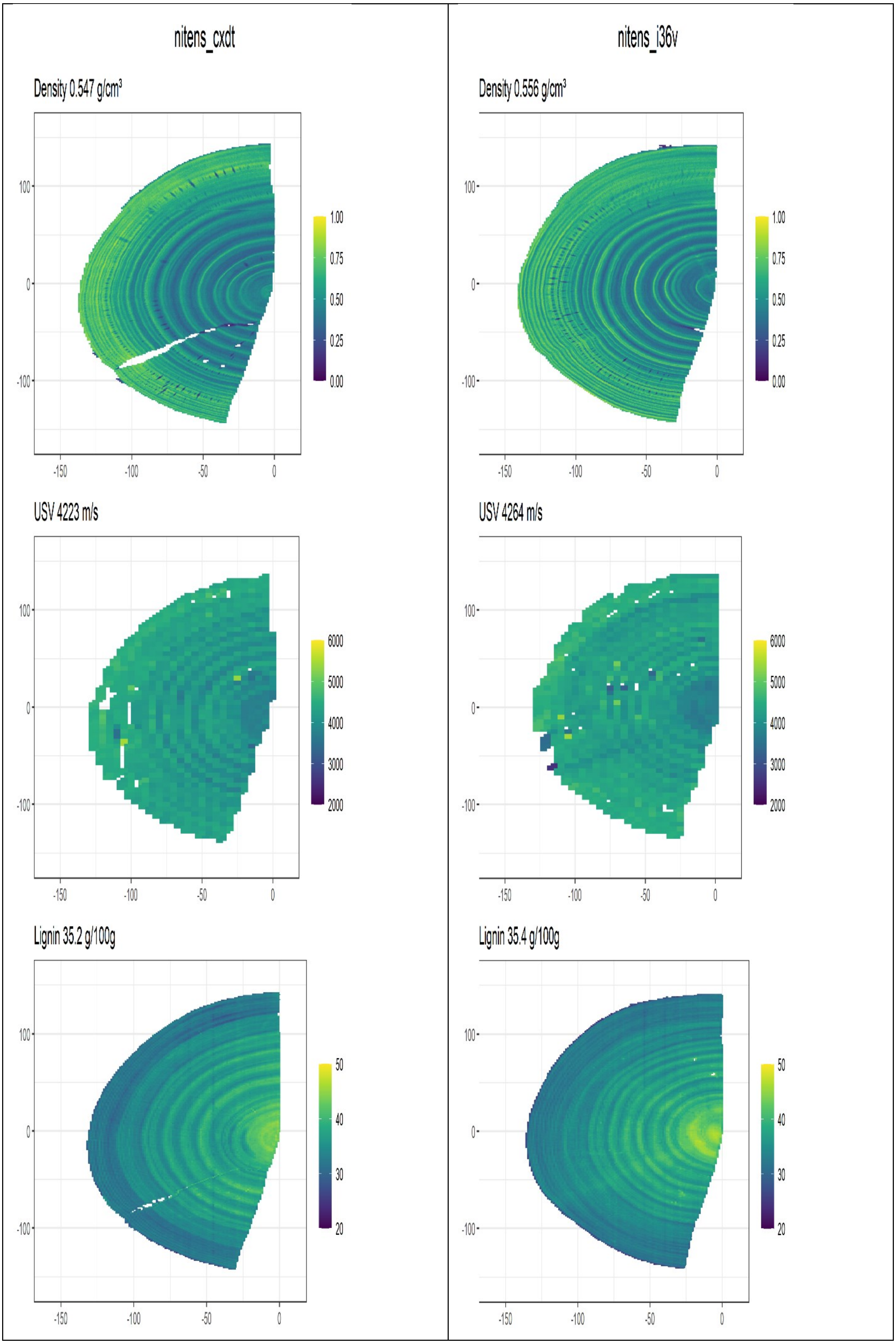
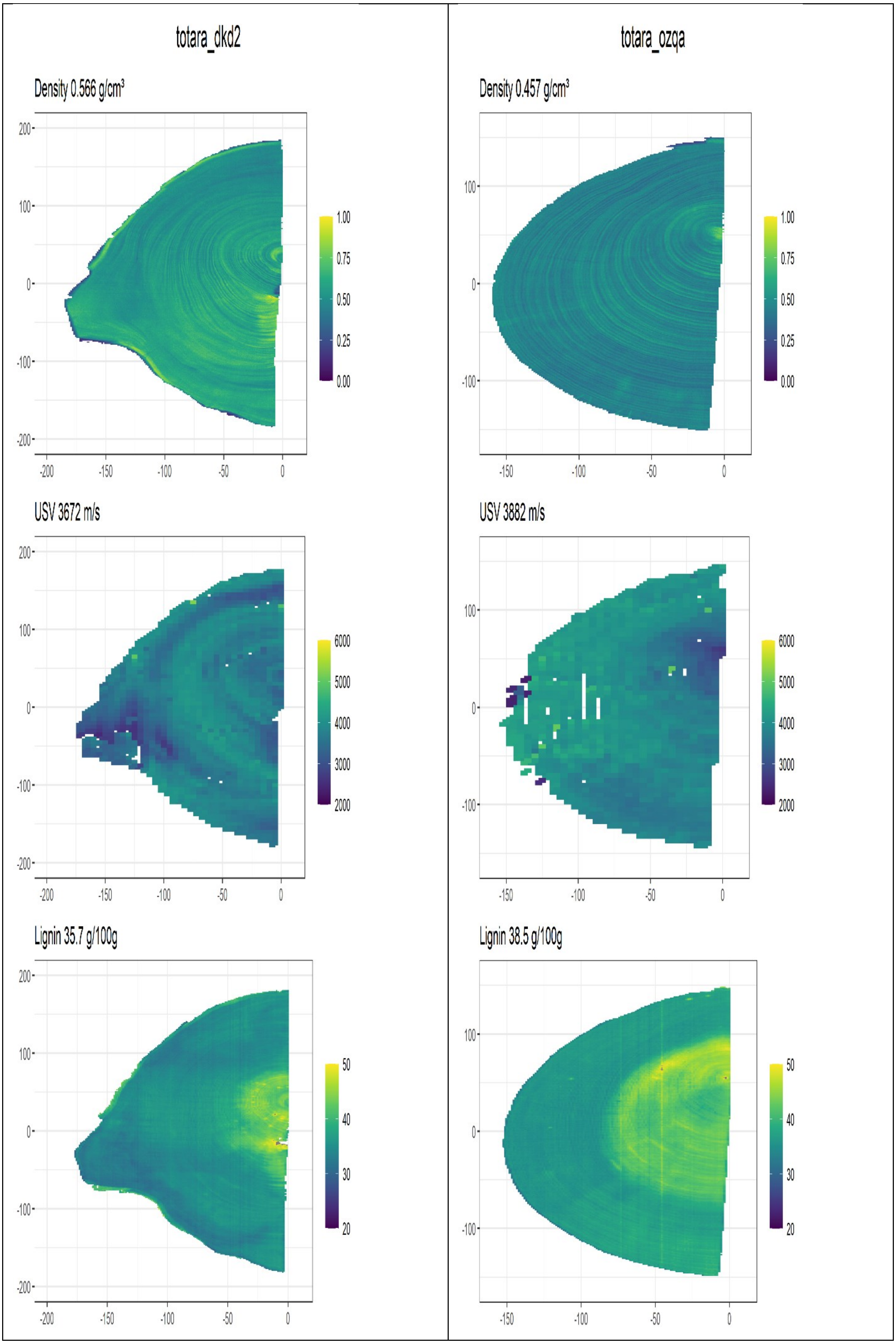

cypress_c298
Density 0.375 g/cm³
USV 3976 m/s
Lignin 32.9 g/100g
cypress_svx6
Density 0.375 g/cm³
USV 3708 m/s
Lignin 34.7 g/100g


nitens_cxdt
Density 0.547 g/cm³
USV 4223 m/s
Lignin 35.2 g/100g
nitens_i36v
Density 0.556 g/cm³
USV 4264 m/s
Lignin 35.4 g/100g
-150
-100
-50
0
100
1.00
0.75
0.50
0.25
0.00
6000
5000
4000
3000
2000
50
40
30
20


totara_dkd2
Density 0.566 g/cm³
1.00
0.75
0.50
0.25
0.00
USV 3672 m/s
6000
5000
4000
3000
2000
Lignin 35.7 g/100g
50
40
30
20
totara_ozqa
Density 0.457 g/cm³
1.00
0.75
0.50
0.25
0.00
USV 3882 m/s
6000
5000
4000
3000
2000
Lignin 38.5 g/100g
50
40
30
20