Comparison of PhotoMARVL data with TreeBLOSSIM predictions: 1978 Genetic Gain Trials

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NOTE : Confidential to participants of the Stand Growth Modelling Cooperative.
: This is an unpublished report and must not be cited as a literature reference.

EXECUTIVE SUMMARY

Ninety-one PHOTOMARVL images were taken in the 1978 Genetic Gain Trials in order to determine how well TreeBLOSSIM performed for GF7, GF14 and GF22 seedlots in these trials which were planted on 6 sites throughout New Zealand.

These data have been analysed in two ways. One approach (see SGMC Report No. 119) was to examine:

- the relationship between the diameter of the largest branch in a cluster with respect to cluster height, to determine whether the hypotheses built into TreeBLOSSIM appear realistic;
- the variation in the regression coefficients of the above relationships with respect to site and seedlot, for a set of plots managed under a common silviculture regime.

The second approach (the subject of this report) was to compare the PhotoMARVL data for each tree with the TreeBLOSSIM predictions for that tree. The branching characteristics examined were:

- the diameter of the largest branch in a cluster
- the variability in the diameter of the largest branch in a cluster
- the number of branch clusters on the stem

Actual and predicted values for diameter of the largest branch in a cluster were assessed by comparing mean values for given zones within the stem. Each stem was divided into 2 or 3 zones. If the TreeBLOSSIM and PhotoMARVL means were within 2 cm, then the model prediction was considered acceptable. For 11 of the 18 site/seedlot combinations, the predictions were acceptable in 80% or more of the zones. The percentage of acceptable predictions was less than 60% for only 3 site/seedlot combinations. Two of these plots contained several trees that had been damaged.

For 4 of the 6 sites, TreeBLOSSIM predictions of variance in diameter of the largest branch in a cluster were realistic. Aupouri and Golden Downs stood out as sites where the TreeBLOSSIM variance was often significantly larger than the PhotoMARVL variance. These are sites that tend to have small branches.

TreeBLOSSIM predictions of the number of branch clusters were generally good. As noticed previously, TreeBLOSSIM predicted more clusters higher in the tree than was observed with PhotoMARVL. This may be due to the difficulty in observing very small branch clusters high on the tree stem when using PhotoMARVL.

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Introduction

TreeBLOSSIM is a linked individual tree and branch growth model that was developed to project mid-rotation inventory data forward in time. The branching data required to develop the model was obtained through detailed destructive sampling of a few trees. Non-destructive sampling using PhotoMARVL is considered to be an appropriate method to determine how well the model performs for a wider range of sites, silvicultural treatments, and different seedlots.

The objective of this study was to determine how well the current version (2.0x - May 2003) of TreeBLOSSIM predicts branching characteristics of radiata pine in the 1978 Genetic Gain Trials. This version only differs from Versions 1.1 and 1.2 in that minor programming errors have been fixed. The model is described in SGMC Report No. 113 and the model functions in SGMC Report No. 108.

Methods

<u>1978 Genetic Gain Trials</u>

The 1978 Genetic gain trials were established to compare the growth of GF2, GF7, GF14 and GF22 seedlots when planted in large plots. The trials were planted on six sites:
- Aupouri (AK1058)
- Kaingaroa (RO2103/1)
- Mohaka (WN377)
- Golden Downs (NN530/2)
- Waimate (CY421/1)
- Longwood (SD564/1)

The prescribed silviculture regime was:
- Plant at 1111 stems/ha
- Thin to 600 stems/ha at mean crop height of 6.2 m
- Thin to 300 stems/ha at mean crop height of 12 m
- Three pruning lifts: 2.2m, 4.2m and 6m.

<u>Sample plot selection</u>

At each site one plot from each of the GF7, GF14 and GF22 was selected (see Table 1). These plots were selected based on the following criteria:
- there was minimal mortality
- the stocking was similar between the three selected plots
- the stocking remained close to the prescribed treatment

Table 1. Sample plots used in PhotoMARVL study.

Site	GF7	GF14	GF22
Aupouri AK1058/0	7/41	8/41	15/61
Kaingaroa RO2103/1	7/31	10/51	15/11
Mohaka WN377/0	1/61	6/41	14/41
Golden Downs NN530/2	7/41	6/31	14/21
Waimate CY421/1	1/61	9/21	6/41
Longwood SD564/1	7/51	5/61	11/31

Notes:
Longwood: Plot 8/51 was initially selected for GF22 seedlot, but only one of the five selected trees was undamaged. The plot was therefore replaced with Plot 11/31.

<u>Sample tree selection</u>

For each selected plot, the trees present at the last (winter 2002) PSP re-measurement were ranked according to the diameter at breast height (DBH). Undamaged trees whose rank was closest to the 10^{th}, 30^{th}, 50^{th}, 70^{th}, and 90^{th} percentile were selected to be PhotoMARVLed.

Table 2. Sample trees PhotoMARVLed

Site	**Plot**	**GF**	**PSP Tree Key No. for tree PhotoMARVLed at following percentile positions from DBH distribution:**				
			10^{th}	**30^{th}**	**50^{th}**	**70^{th}**	**90^{th}**
Aupouri	7/41	7	11	1	28	14	26
Aupouri	8/41	14	13	1	11	19	22
Aupouri	15/61	22	16	5	10	4	11
Kaingaroa	7/31	7	5*	26*	19	3	20
Kaingaroa	10/51	14	4	9	13	17	20
Kaingaroa	15/11	22	12	6	7	3	5
Mohaka	1/61	7	14	28	9	4	12
Mohaka	6/41	14	18	19	11	20	8
Mohaka	14/41	22	9	6	4*	10	5
Golden Downs	7/41	7	16	19	22	24	5
Golden Downs	6/31	14	22	19	29	23	9
Golden Downs	14/21	22	4	11	9	1	8
Waimate	1/61	7	2*	3*	25	14	20
Waimate	9/21	14	10*	25	17	2*	23
Waimate	6/41	22	1	12	16	2	23
Longwood	7/51	7	6	9	12	1	2
Longwood	5/61	14	6	8	10	12	3
Longwood	11/31**	22	11	2	7	10	6

Notes:
Tree-Key is a unique code used to identify trees in the PSP system.
* Indicates that sample tree chosen initially was replaced in the field with the listed tree. Trees were only replaced if the tree was damaged or very difficult to view.
** Indicates plot originally selected was replaced in field by the one shown.

PhotoMARVL image collection and analysis

These ninety PhotoMARVL images, plus an extra image from the undamaged tree in Plot 8/51, Longwood, were collected between July and December 2002. The extra image was not used for the analysis below.

In the office, the following measurements were extracted from the photograph for each branch cluster using the AP190 analytical stereoplotter (Firth *et al*, 2000):

- stem diameter below the cluster,
- height to base and top of the cluster,
- diameter of the largest branch in the cluster that was visible on the photograph.

TreeBLOSSIM simulations

For each selected sample plot, the 2002 PSP measurements were imported into TreeBLOSSIM (Version 2.0x – 23.5.2003) and the branching pattern estimated taking the previous silviculture history into account. The model was set so that there was no tree mortality and any mortality accounted for by assuming a thinning at that age (Table 3). This approach avoided using the Individual Tree Growth Model to grow improved seedlots forward in time, thus eliminating one possible source of error. The fact that the PhotoMARVL images were collected in spring, rather than winter was neglected. This is a reasonable assumption, as the branches visible in the PhotoMARVL image are unlikely to have grown during this period because they were not in the actively growing section of the crown.

Table 3. Thinning history for 1978 Genetic Gain Plots.

Site	**Plot**	**Age of 1st thinning**	**Stems/ha after 1st thinning**	**Age of 2nd thinning**	**Stems/ha after 2nd thinning**
Aupouri	7/41	5	600	12.05	360
	8/41	5	640	12.05	360
	15/61	5	600	12.05	360
Kaingaroa	7/31	6	560	10.0	300
	10/51	6	540	10.0	300
	15/11	6	600	10.0	300
Mohaka	1/61	5	620	8.4	320
	6/41	5	620	8.4	300
	14/41	5	600	8.4	300
Golden Downs	7/41	8	680	10.15	300
	6/31	8	600	10.15	300
	14/21	8	600	10.15	320
Waimate	1/61	6	500	-	
	9/21	6	580	18 (mortality)	560
	6/41	6	500	16 (mortality) 19 (mortality)	480 460
Longwood	7/51	8	600	10 24 (mortality)	260 240
	5/61	8	600	10	260
	11/31	8	600	10 19 (mortality) 22 (mortality) 24 (mortality)	340 320 280 260

The resulting branch data file was exported from TreeBLOSSIM and imported into a SAS program that extracted the following variables for each PhotoMARVL tree:

- tree diameter at breast height
- cluster height and diameter of largest branch in each cluster.

Comparisons

To compare PhotoMARVL data with TreeBLOSSIM predictions, the stem was divided into two or three zones based on the length of stem visible in the PhotoMARVL image and previously fitted curves (see SGMC Report No. 119).

Table 4. Zones used in TreeBLOSSIM Comparison

Site	Zone 1	Zone 2	Zone 3
Aupouri	≤ 15 m	> 15 m	-
Kaingaroa	≤12 m	12< cluster ht < 15.5	≥15.5 m
Mohaka	≤12 m	12 < cluster ht < 17	≥ 17 m
Golden Downs	≤12 m	12< cluster ht < 15.5	≥15.5 m
Waimate	≤ 10 m	> 10 m	-
Longwood	≤ 9 m	9< cluster ht < 14	≥ 14 m

For each zone, the mean branch diameter (averaged over the largest branch in each cluster) was calculated for both the model predictions and PhotoMARVL estimates. The difference between the two means was calculated. If the difference was less than 2 cm, then the model was deemed acceptable for that zone.

To compare the variability in the diameter of the largest branch in a cluster within a zone, the variance was calculated for both the PhotoMARVL data and TreeBLOSSIM predictions. The ratio was compared using an F test.

For each zone, the number of branch clusters was calculated for both the model prediction and PhotoMARVL assessment, and compared using a t-test.

Results

Graphs showing the PhotoMARVL data and TreeBLOSSIM predictions for each tree are shown in Appendix 1. Examining these graphs, three points stand out:

- The model predictions look realistic for many trees.
- Where the model prediction is not good, the PhotoMARVL measurements of branch diameter tend to be larger than the predicted measurements.
- For some trees, the TreeBLOSSIM prediction of variability in branch diameter is too large.

a. Branch diameter- mean and variance

Summary across sites

The number of zones per site where the model prediction and PhotoMARVL estimate of mean branch diameter in a zone (averaged over the largest branch in a cluster) were within 2 cm of each other are shown in Table 5. The following points should be noted:

- TreeBLOSSIM predictions were generally best for the GF14 seedlot.
- TreeBLOSSIM predictions were generally poorest for the GF7 seedlot.
- TreeBLOSSIM predictions were generally poor for Kaingaroa.
- Three plots stand out as having particularly poor predictions: the GF7 plot at Waimate, the GF 22 plot at Longwood (both plots contained a lot of trees that had been damaged), and the GF7 plot at Kaingaroa.

Table 5. Percentage of zones by site where the model prediction and PhotoMARVL estimate of mean branch diameter in a zone (averaged over the largest branch in a cluster) were within 2 cm of each other.

Site	No. of Zones	GF7	GF14	GF22
Aupouri	10	90%	100%	80%
Kaingaroa	15	53%	60%	67%
Mohaka	15	67%	93%	87%
Golden Downs	15	67%	100%	100%
Waimate	10	40%	90%	80%
Longwood	15	87%	87%	53%

Summary across zones

Table 6 lists the number of trees in each zone where the model prediction and PhotoMARVL estimate of mean branch diameter in a zone (averaged over the largest branch in a cluster) were within 2 cm of each other. The following points should be noted:

- TreeBLOSSIM predictions tended to be poorest for Zone 3, the highest zone.
- No zone 3 at Aupouri and Waimate.

Table 6. Number of trees in each zone where the model prediction and PhotoMARVL estimate of mean branch diameter in a zone (averaged over the largest branch in a cluster) were within 2 cm of each other.

Site	Plot	GF	No. of per zone Comparisons	Zone 1	Zone 2	Zone 3
Aupouri	7/41	7	5	5	4	-
Aupouri	8/41	14	5	5	5	-
Aupouri	15/61	22	5	5	3	-
Kaingaroa	7/31	7	5	3	3	2
Kaingaroa	10/51	14	5	5	4	0
Kaingaroa	15/11	22	5	5	4	1
Mohaka	1/61	7	5	5	4	1
Mohaka	6/41	14	5	5	5	4
Mohaka	14/41	22	5	5	4	4
Golden Downs	7/41	7	5	4	2	4
Golden Downs	6/31	14	5	5	5	5
Golden Downs	14/21	22	5	5	5	5
Waimate	1/61	7	5	3	1	-
Waimate	9/21	14	5	5	4	-
Waimate	6/41	22	5	5	3	-
Longwood	7/51	7	5	5	4	4
Longwood	5/61	14	5	5	5	3
Longwood	11/31	22	5	5	2	1

Variance

The variability in the diameter of the largest branch in a cluster was examined by calculating the variance by zones for both the PhotoMARVL measurements and TreeBLOSSIM predictions. The two variances were compared using an f-test.

Table 7 shows, by site and GF, the percentage of zones where the variances are either significantly different at 5% level or not.

The following points should be noted:

- In more than half the zones, the variances are not significantly different.
- Aupouri and Golden Downs stand out as sites where the TreeBLOSSIM variance is often significantly larger than the PhotoMARVL variance.

Table 7. Comparison of variance of diameter of largest branch in a cluster within a zone.

Site	Plot	GF	No. of zones within plot	TreeBLOSSIM variance significantly greater than PhotoMARVL variance	Variances not significantly different	PhotoMARVL variance significantly greater than TreeBLOSSIM variance
Aupouri	7/41	7	10	20%	80%	0%
Aupouri	8/41	14	10	40%	60%	0%
Aupouri	15/61	22	10	0%	70%	30%
Kaingaroa	7/31	7	15	7%	66%	27%
Kaingaroa	10/51	14	15	7%	60%	33%
Kaingaroa	15/11	22	15	7%	93%	0%
Mohaka	1/61	7	15	0%	80%	20%
Mohaka	6/41	14	15	0%	87%	13%
Mohaka	14/41	22	15	13%	80%	7%
Golden Downs	7/41	7	15	0%	93%	7%
Golden Downs	6/31	14	15	40%	53%	7%
Golden Downs	14/21	22	15	33%	67%	0%
Waimate	1/61	7	10	0%	70%	30%
Waimate	9/21	14	10	20%	60%	20%
Waimate	6/41	22	10	0%	90%	10%
Longwood	7/51	7	15	0%	80%	20%
Longwood	5/61	14	15	0%	80%	20%
Longwood	11/31	22	15	0%	80%	20%

b. Number of branch clusters

For each tree, the difference between the PhotoMARVL measurement and TreeBLOSSIM predictions of number of branch clusters per metre in each zone was calculated. The plot mean difference was then calculated. These values are shown in Table 8. The following points should be noted:

- A negative value in Table 8 means TreeBLOSSIM predicted more clusters than were observed on the PhotoMARVL image.
- The difference was not significantly different from zero in 37 out of the 48 zones (77%).
- In the highest zone, TreeBLOSSIM usually predicts more clusters than were observed in the PhotoMARVL image. This also occurred in the 1975 final crop stocking trials (see SGMC Reports 110, 116 and 117).

Table 8. PhotoMARVL measurement minus TreeBLOSSIM prediction of plot mean values of number of branch clusters per metre

Site	Plot	GF	Zone 1	Zone 2	Zone 3
Aupouri	7/41	7	-0.54*	-1.17*	-
Aupouri	8/41	14	-0.46*	-1.06*	-
Aupouri	15/61	22	0.16	-0.91*	-
Kaingaroa	7/31	7	0.12	-0.11	-0.30
Kaingaroa	10/51	14	0.16	0.00	-0.56*
Kaingaroa	15/11	22	0.37	-0.17	-0.36
Mohaka	1/61	7	-0.01	-0.60*	-0.52
Mohaka	6/41	14	-0.20	-0.44	-0.05
Mohaka	14/41	22	0.00	-0.24	-0.04
Golden Downs	7/41	7	-0.23	-0.17	-0.60
Golden Downs	6/31	14	-0.24	0.40*	0.25
Golden Downs	14/21	22	-0.26	-0.23	-0.35
Waimate	1/61	7	-0.25*	-0.88*	-
Waimate	9/21	14	-0.10	-0.30	-
Waimate	6/41	22	-0.02	-0.38	-
Longwood	7/51	7	0.58*	-0.32	-0.50
Longwood	5/61	14	0.24	-0.28	-0.36
Longwood	11/31	22	0.24	-0.20	-0.22

Note: * indicates mean value is significantly different from zero ($p \leq 0.05$).

Discussion

The objective of the current study was to use PhotoMARVL as a non-destructive tool to determine how well TreeBLOSSIM performed for GF7, GF14 and GF22 seedlots in the 1978 genetic gain trials, which were planted on 6 sites throughout New Zealand.

The branching characteristics examined were:

- the diameter of the largest branch in a cluster
- the variability in the diameter of the largest branch in a cluster
- the number of branch clusters on the stem

TreeBLOSSIM was run assuming all seedlots were GF14. This was a reasonable assumption and allowed us to see how the GF14 functions performed for other seedlots.

In terms of zone mean values for diameter of largest branch in a cluster, TreeBLOSSIM predictions were generally best for the GF14 seedlot, and worst for the GF7 seedlots, indicating that there are differences in branching characteristics between the seedlots. The differences were only small. The next step will be to see whether we can improve the predictions using the subjective data collected at a plot level.

At a site level, TreeBLOSSIM predictions of diameter of the largest branch in a cluster were poorest for Kaingaroa with TreeBLOSSIM predictions being smaller than the PhotoMARVL measurements. This was an interesting result considering that the model performed well for the 1975 final crop stocking trial in Kaingaroa, which covered final crop stockings from 100 to 600 stems/ha (see SGMC Report No. 110). To be able to improve TreeBLOSSIM, we need to understand why this result occurred. We considered whether this result might be due to difference in site quality, but this does not appear to be the reason. The 1975 final crop stocking trial was on a medium quality site whereas the 1978 genetic gain trial was on a high quality site. Tombleson *et al.* (1990) showed that branch index increased with decreasing site quality across three sites in Kaingaroa. On this basis, we would have expected PhotoMARVL measurements to be smaller than the TreeBLOSSIM predictions.

At a plot level, the predictions of diameter of the largest branch in a cluster were particularly poor for the GF7 plot at Waimate and the GF 22 plot at Longwood, with TreeBLOSSIM predictions being smaller than the PhotoMARVL measurements. Both plots contained a lot of trees that had been damaged. This is considered to be the likely reason for the poor prediction.

At an individual tree level, Tree-Key 24 in the GF7 seedlot at Golden Downs stood out as having much larger branches than predicted by TreeBLOSSIM. This result is interesting in that there was one such tree in the 1975 final crop stocking trial at Golden Downs. It would be interesting to determine whether such trees stand out in terms of wood properties.

For 4 of the 6 sites, TreeBLOSSIM predictions of variance in diameter of the largest branch in a cluster were realistic. Aupouri and Golden Downs stood out as sites where the TreeBLOSSIM variance was often significantly larger than the PhotoMARVL variance. These are sites which tend to have small branches. A similar result was observed in the 1975 final crop stocking trial. TreeBLOSSIM needs to be improved so it predicts smaller variances for such sites.

TreeBLOSSIM predictions of number of branch clusters were generally good. As in the 1975 final crop stocking trials, TreeBLOSSIM predicted more clusters higher in the tree than was observed with PhotoMARVL. This may be due to the difficulty in observing very small branch clusters high on the stem using PhotoMARVL. One way to test this would be to run TreeBLOSSIM for PSPs where we have felled sample trees and compare the predicted number of branch clusters with the field measurements.

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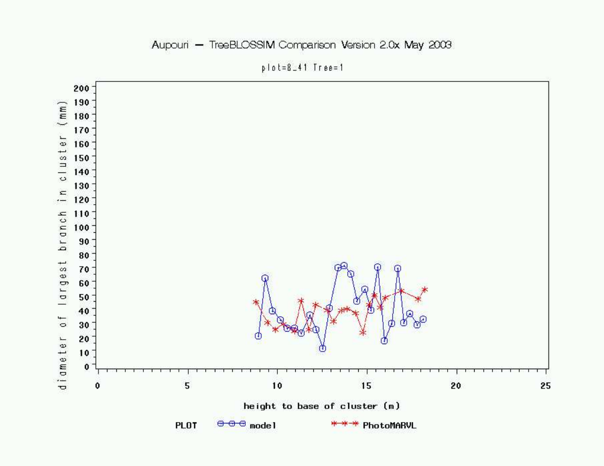
APPENDIX 1. Graphs of PhotoMARVL data and TreeBLOSSIM predictions for individual trees.

The graphs for an individual plot can be found using the following Table

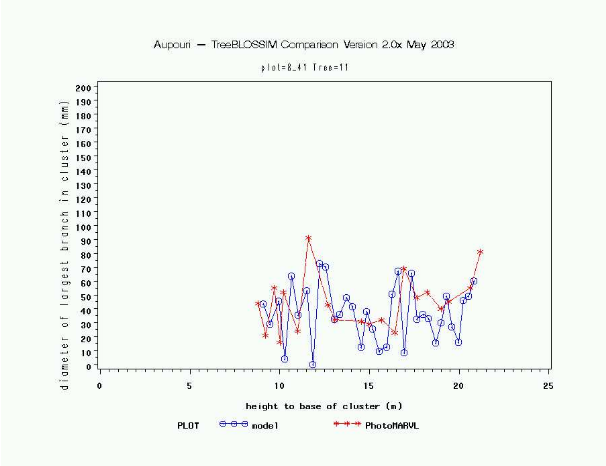
Site	Plot	GF	Page
Aupouri	7/41	7	12
Aupouri	8/41	14	13
Aupouri	15/61	22	14
Kaingaroa	7/31	7	15
Kaingaroa	10/51	14	16
Kaingaroa	15/11	22	17
Mohaka	1/61	7	18
Mohaka	6/41	14	19
Mohaka	14/41	22	20
Golden Downs	7/41	7	21
Golden Downs	6/31	14	22
Golden Downs	14/21	22	23
Waimate	1/61	7	24
Waimate	9/21	14	25
Waimate	6/41	22	26
Longwood	7/51	7	27
Longwood	5/61	14	28
Longwood	11/31	22	29

PhotoMARVL – TreeBLOSSIM comparisons for Aupouri.

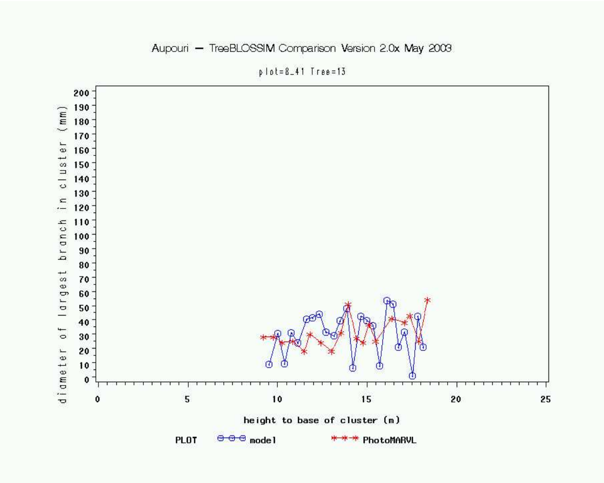
TREE-KEY 1, 30TH PERCENTILE, GF14



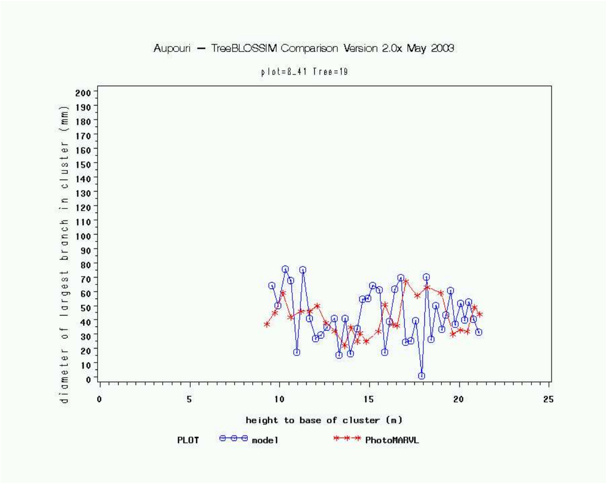
TREE-KEY 11, 50TH PERCENTILE, GF14



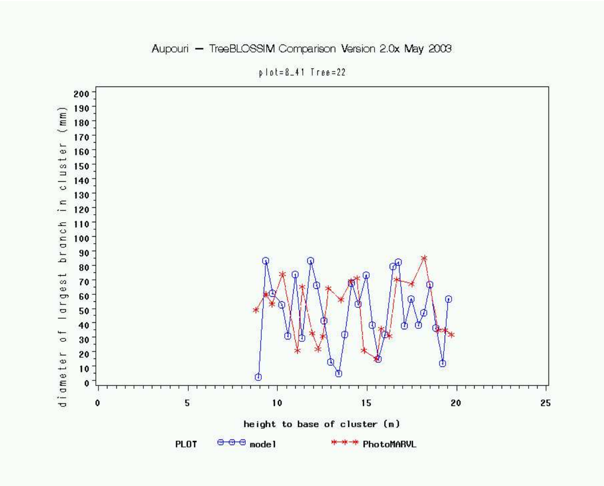
TREE-KEY 13, 10TH PERCENTILE, GF14



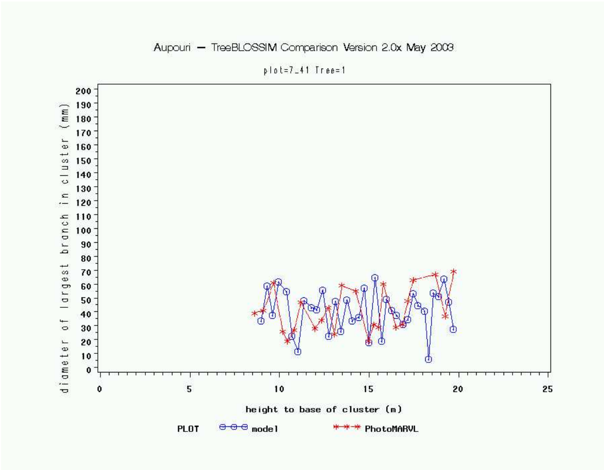
TREE-KEY 19, 70TH PERCENTILE, GF14



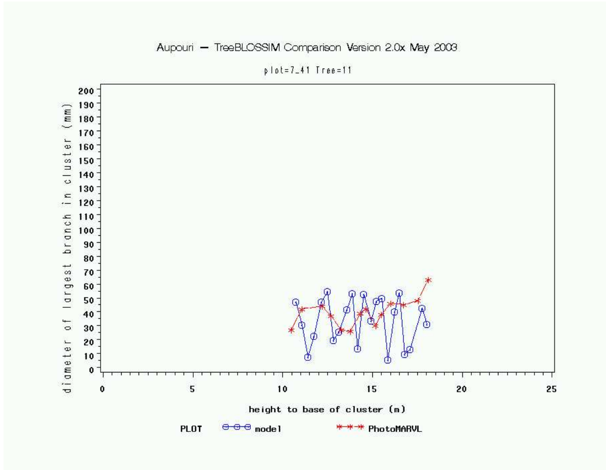
TREE-KEY 22, 90TH PERCENTILE, GF14



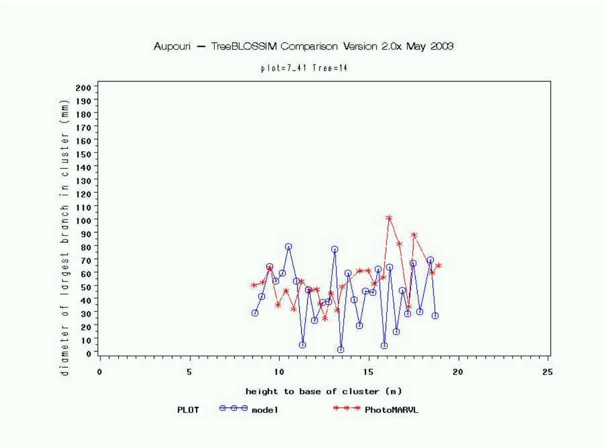
TREE-KEY 1, 30TH PERCENTILE, GF7



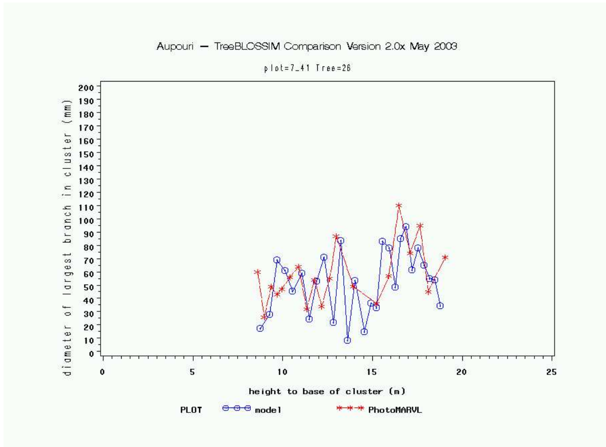
TREE-KEY 11, 10TH PERCENTILE, GF7



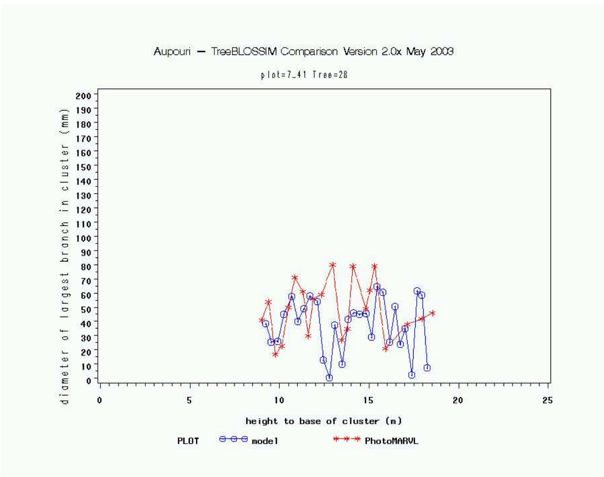
TREE-KEY 14, 70TH PERCENTILE, GF7



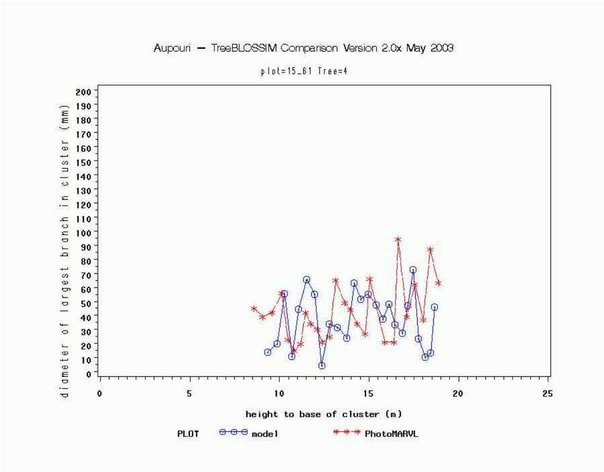
TREE-KEY 26, 90TH PERCENTILE, GF7



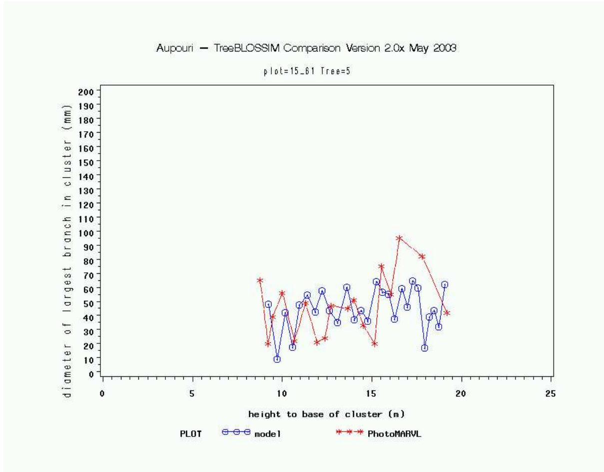
TREE-KEY 28, 50TH PERCENTILE, GF7



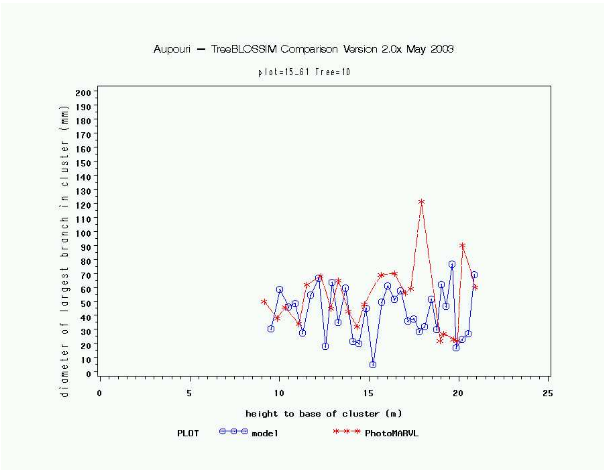
TREE-KEY 4, 70TH PERCENTILE, GF22



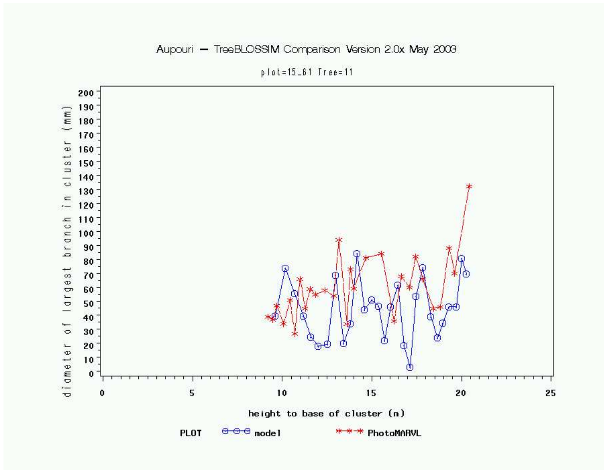
TREE-KEY 5, 30TH PERCENTILE, GF22



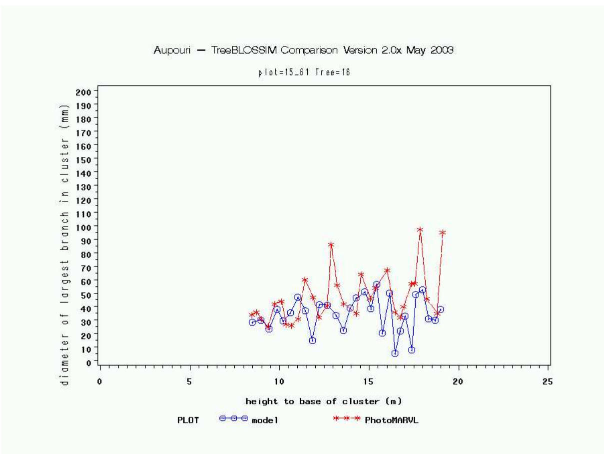
TREE-KEY 10, 50TH PERCENTILE, GF22



TREE-KEY 11, 90TH PERCENTILE, GF22

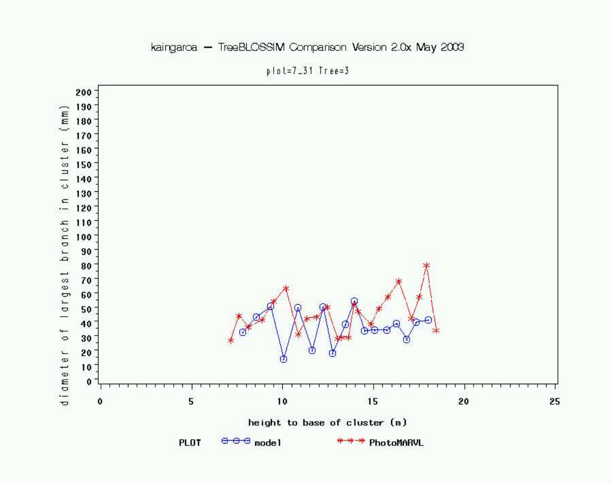


TREE-KEY 16, 10TH PERCENTILE, GF22

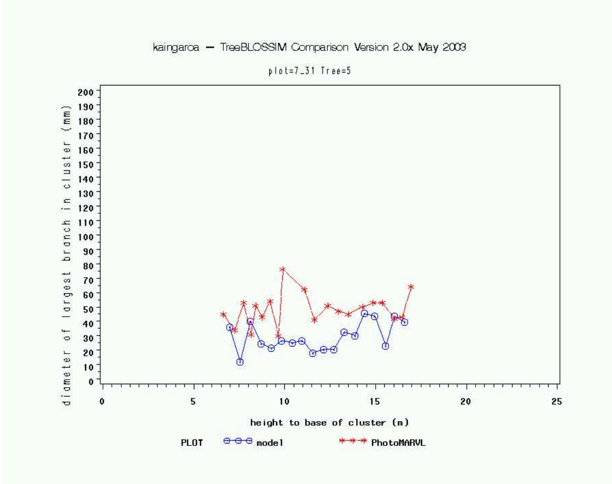


PhotoMARVL – TreeBLOSSIM comparisons for Kaingaroa

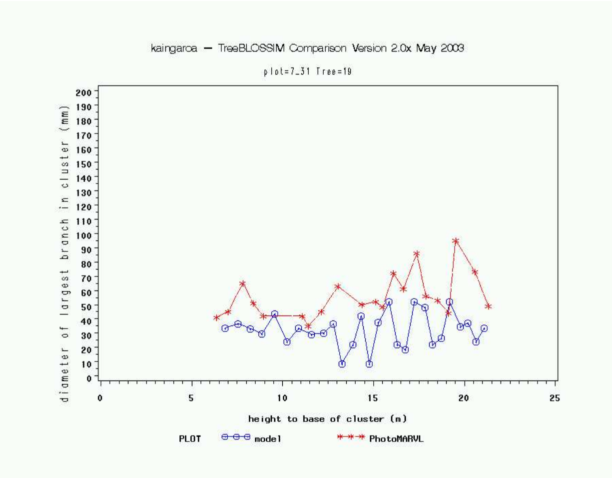
TREE-KEY 3, 70TH PERCENTILE, GF7



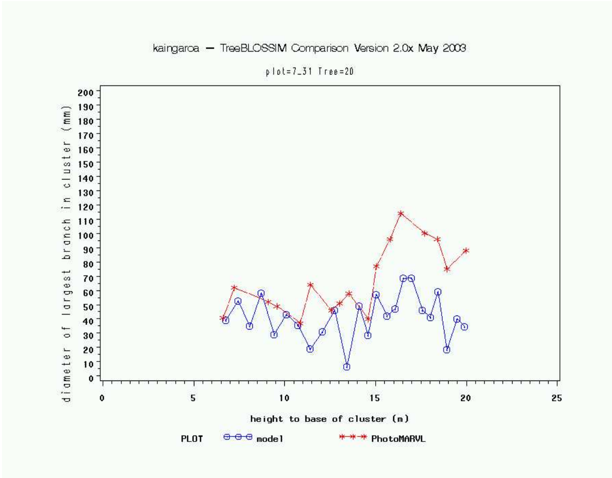
TREE-KEY 5, 10TH PERCENTILE, GF7



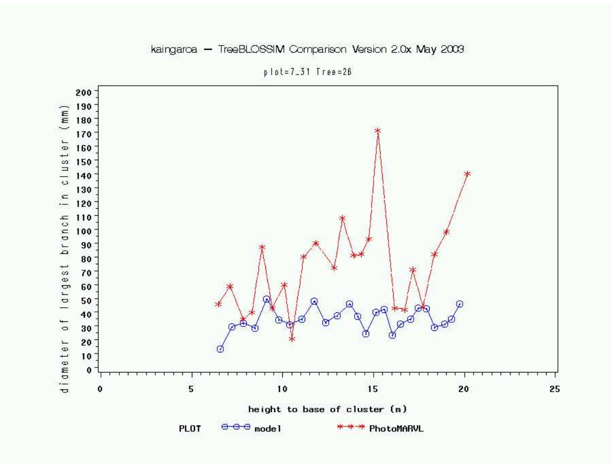
TREE-KEY 19, 50TH PERCENTILE, GF7



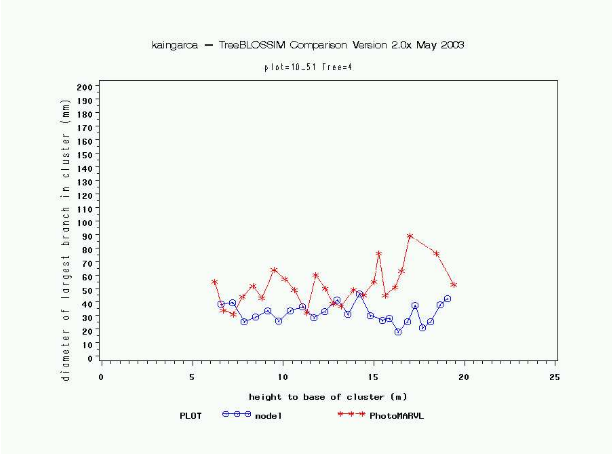
TREE-KEY 20, 90TH PERCENTILE, GF7



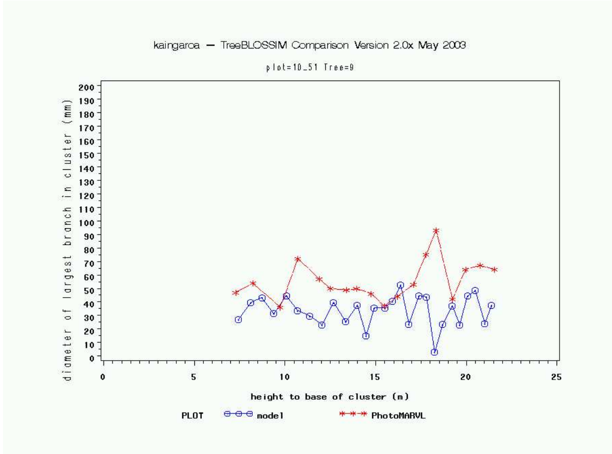
TREE-KEY 26, 30TH PERCENTILE, GF7



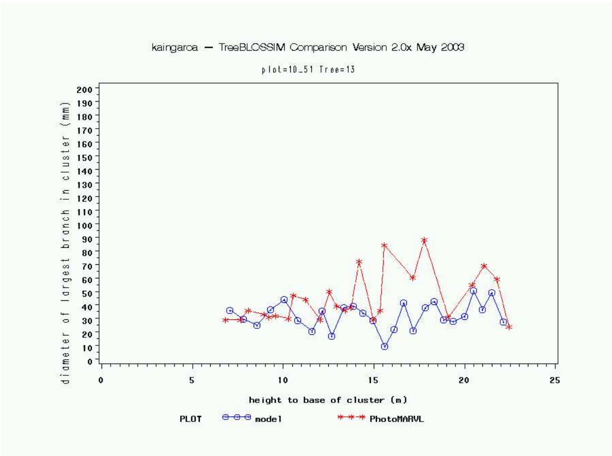
TREE-KEY 4, 10TH PERCENTILE, GF14



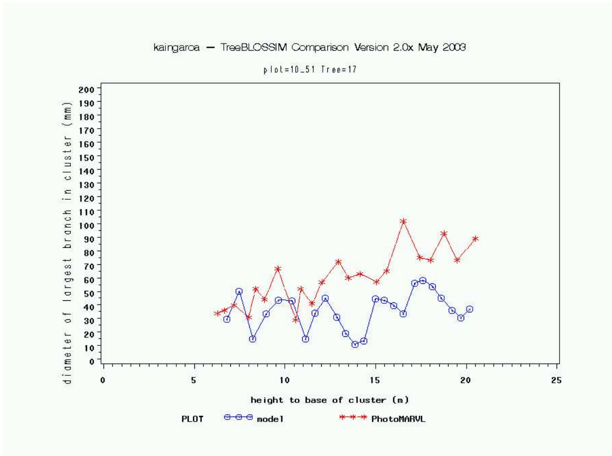
TREE-KEY 9, 30TH PERCENTILE, GF14



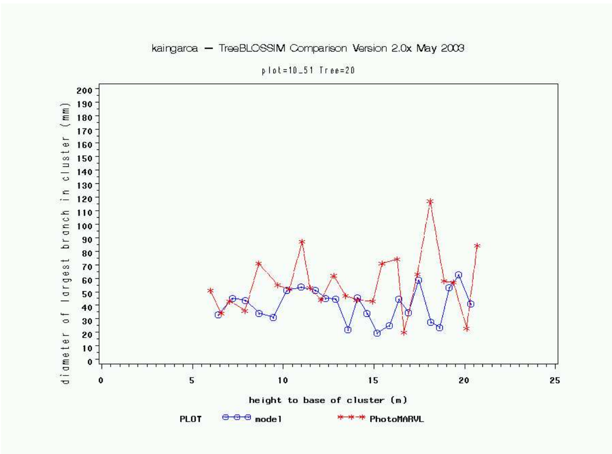
TREE-KEY 13, 50TH PERCENTILE, GF14



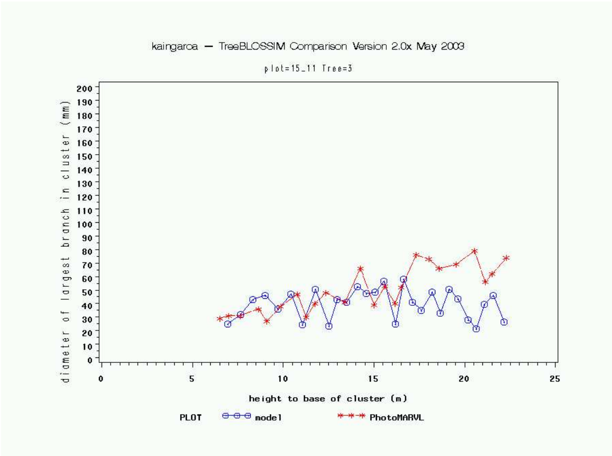
TREE-KEY 17, 70TH PERCENTILE, GF14



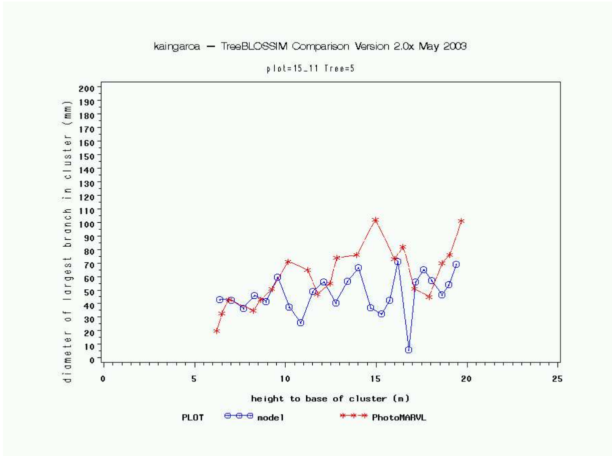
TREE-KEY 20, 90TH PERCENTILE, GF14



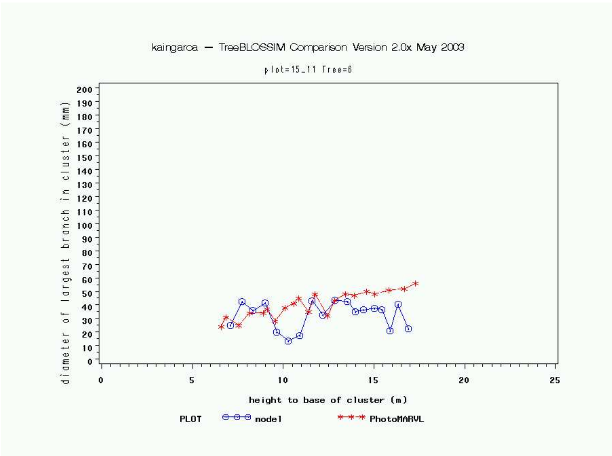
TREE-KEY 3, 70TH PERCENTILE, GF22



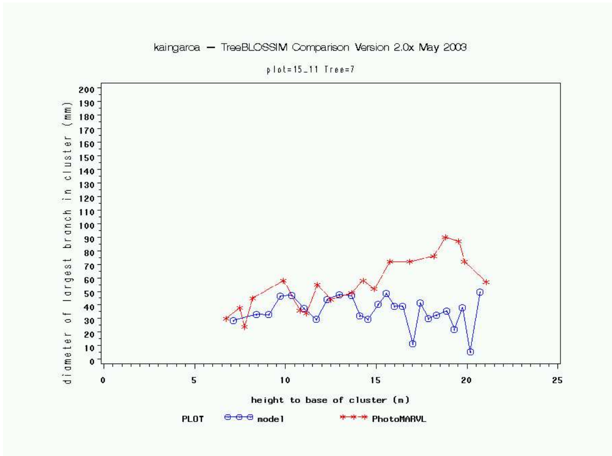
TREE-KEY 5, 90TH PERCENTILE, GF22



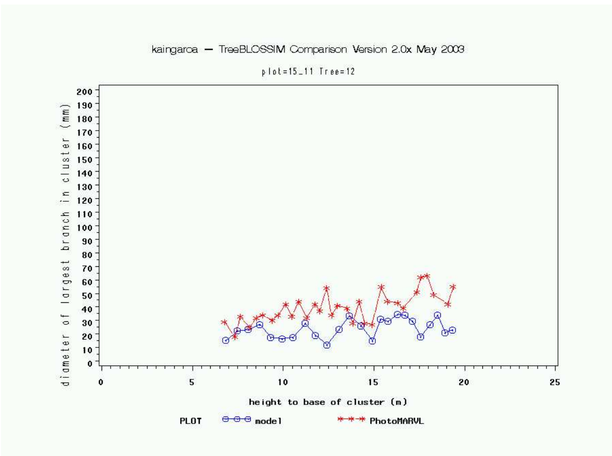
TREE-KEY 6, 30TH PERCENTILE, GF22



TREE-KEY 7, 50TH PERCENTILE, GF22

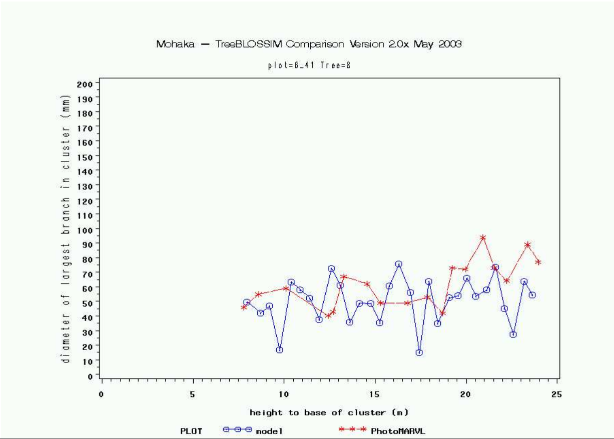


TREE-KEY 12, 10TH PERCENTILE, GF22

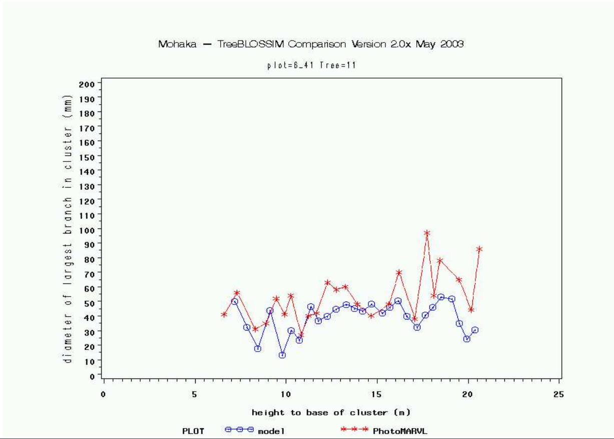


PhotoMARVL – TreeBLOSSIM Comparisons for Mohaka

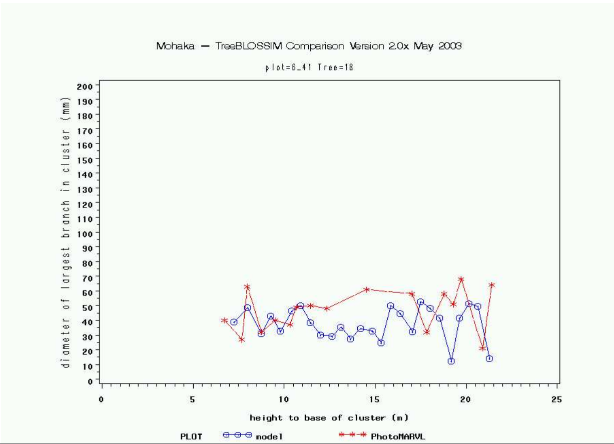
TREE-KEY 8, 90TH PERCENTILE, GF14



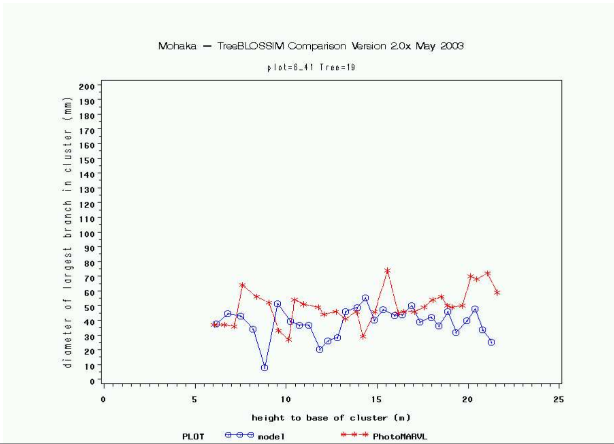
TREE-KEY 11, 50TH PERCENTILE, GF14



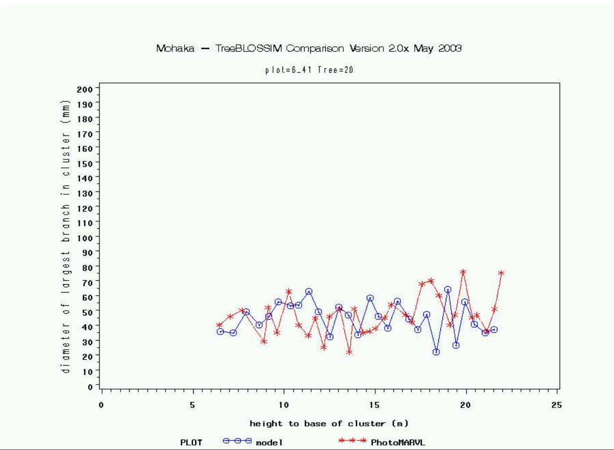
TREE-KEY 18, 10TH PERCENTILE, GF14



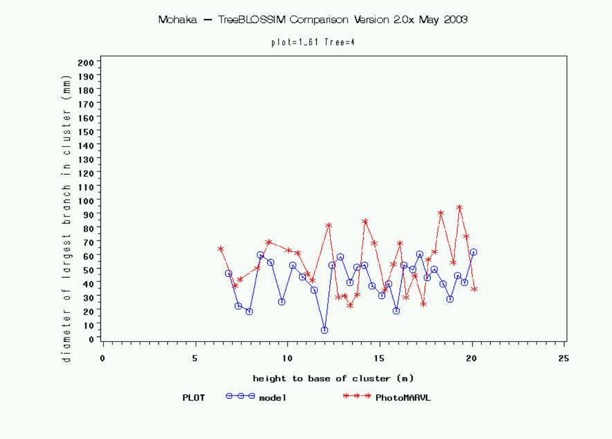
TREE-KEY 19, 30TH PERCENTILE, GF14



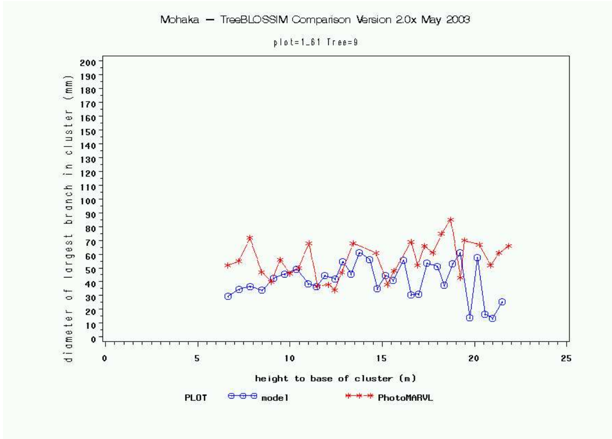
TREE-KEY 20, 70TH PERCENTILE, GF14



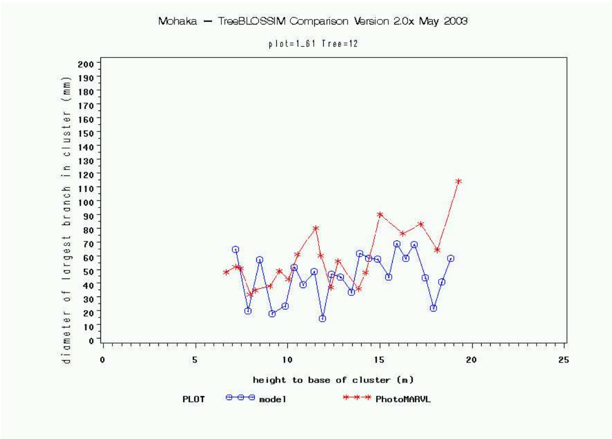
TREE-KEY 4, 70TH PERCENTILE, GF7



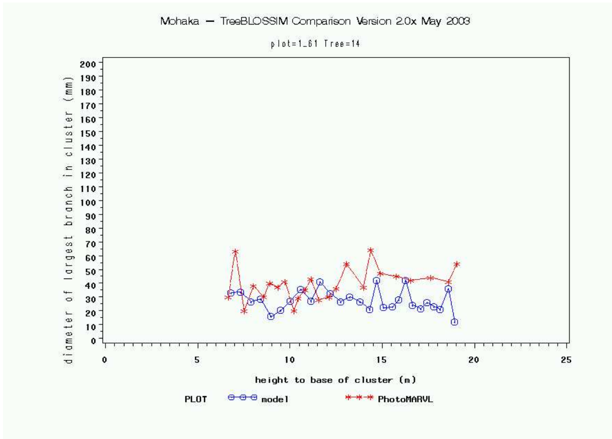
TREE-KEY 9, 50TH PERCENTILE, GF7



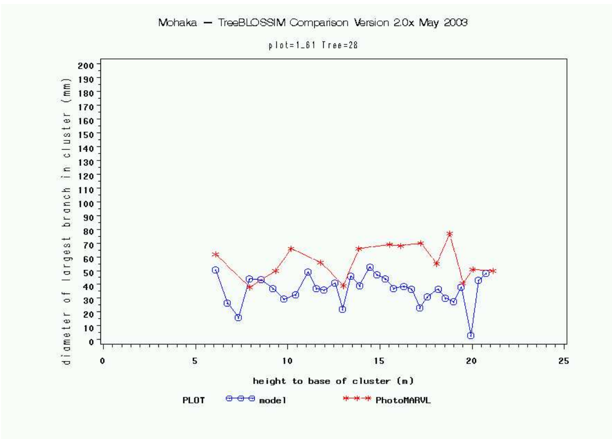
TREE-KEY 12, 90TH PERCENTILE, GF7



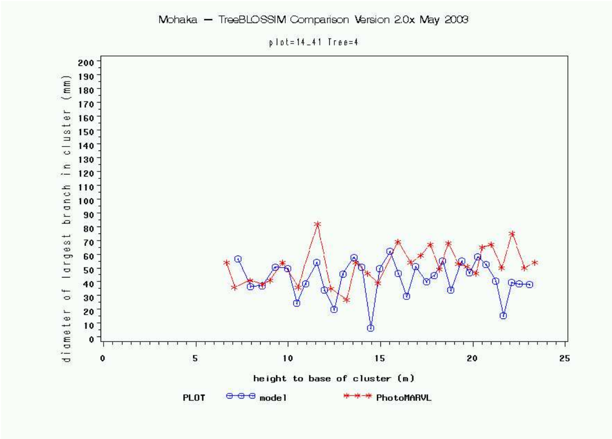
TREE-KEY 14, 10TH PERCENTILE, GF7



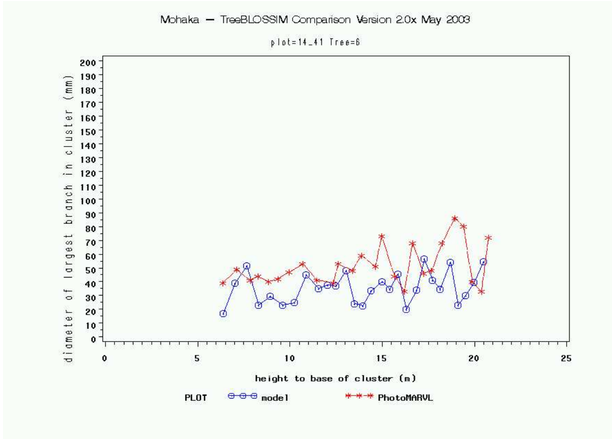
TREE-KEY 28, 30TH PERCENTILE, GF7



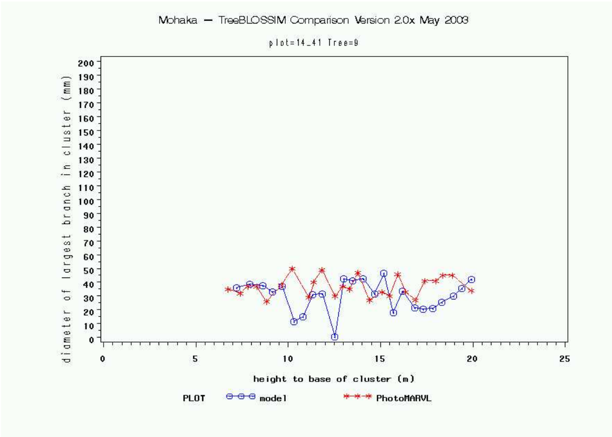
TREE-KEY 4, 50TH PERCENTILE, GF22



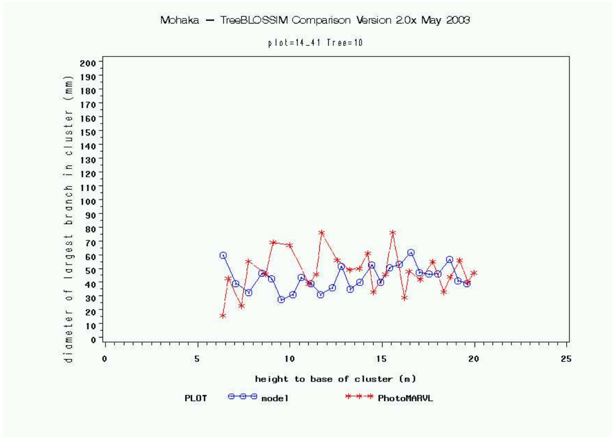
TREE-KEY 6, 30TH PERCENTILE, GF22



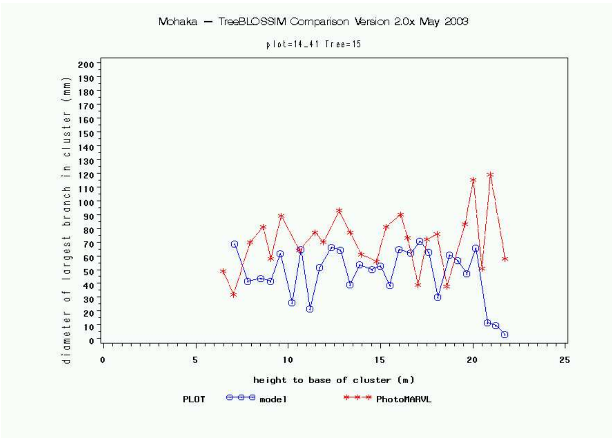
TREE-KEY 9, 10TH PERCENTILE, GF22



TREE-KEY 10, 70TH PERCENTILE, GF22

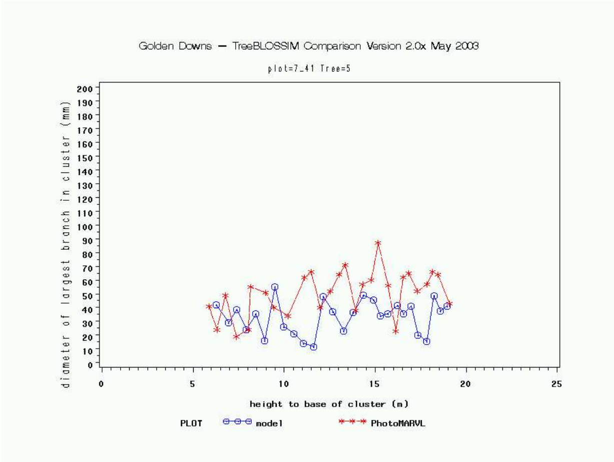


TREE-KEY 15, 90TH PERCENTILE, GF22

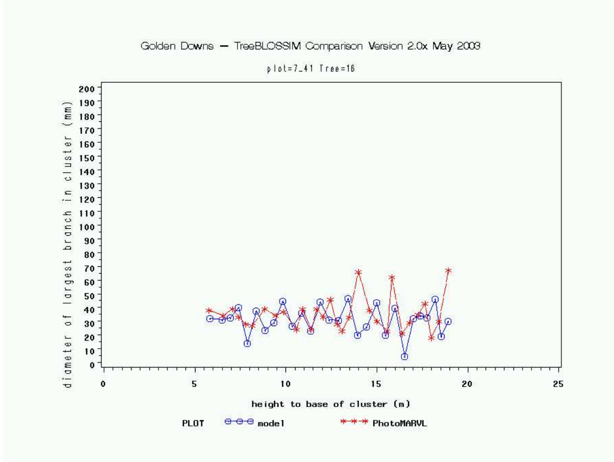


PhotoMARVL-TreeBLOSSIM Comparisons for Golden Downs

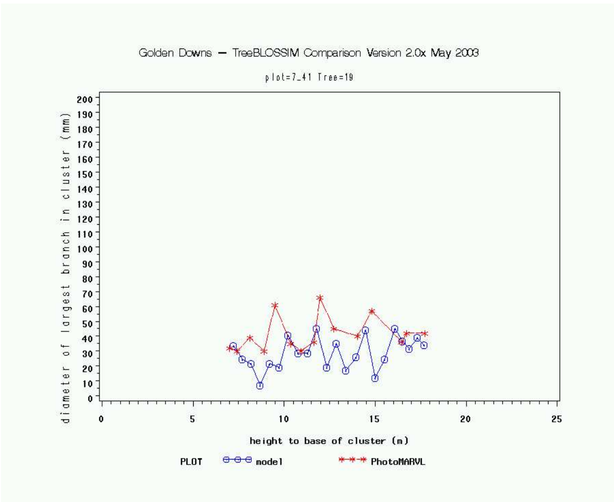
TREE-KEY 5, 90TH PERCENTILE, GF7



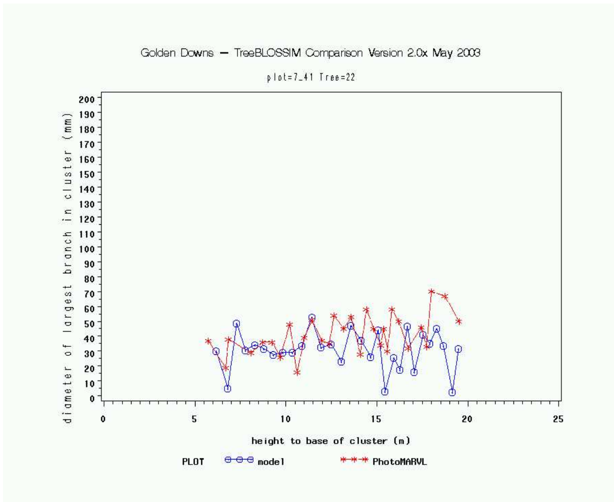
TREE-KEY 16, 10TH PERCENTILE, GF7



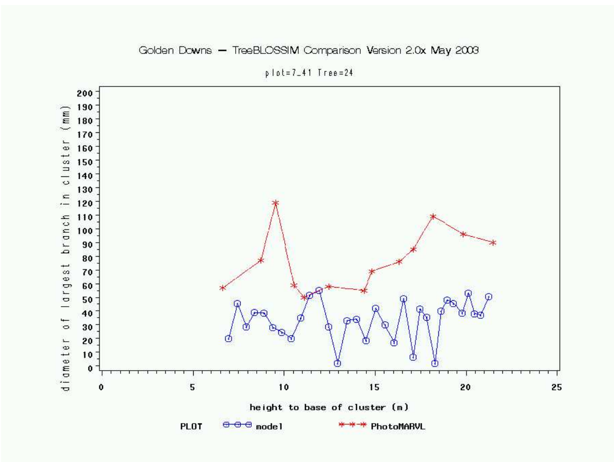
TREE-KEY 19, 30TH PERCENTILE, GF7



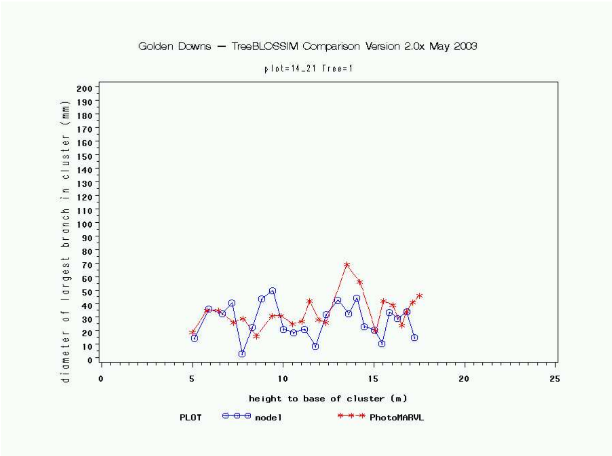
TREE-KEY 22, 50TH PERCENTILE, GF7



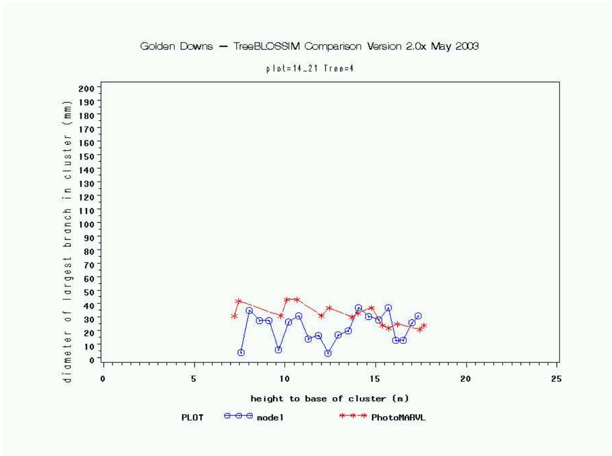
TREE-KEY 24, 70TH PERCENTILE, GF7



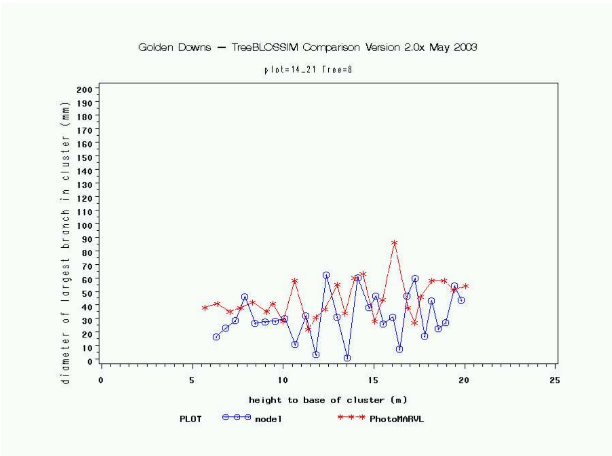
TREE-KEY 1, 70TH PERCENTILE, GF22



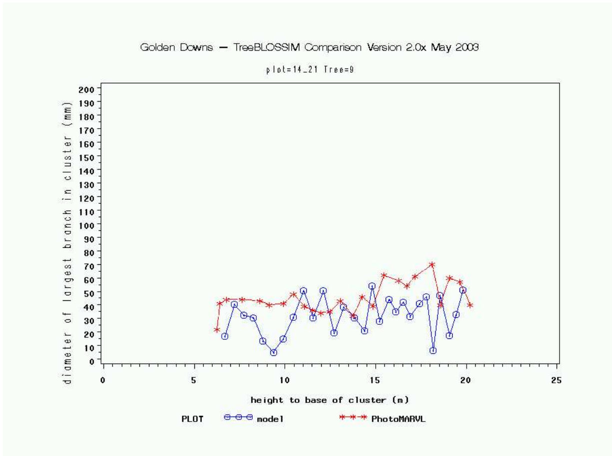
TREE-KEY 4, 10TH PERCENTILE, GF22



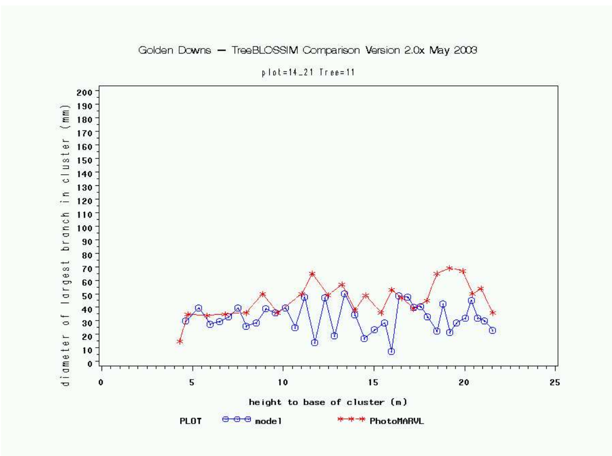
TREE-KEY 8, 90TH PERCENTILE, GF22



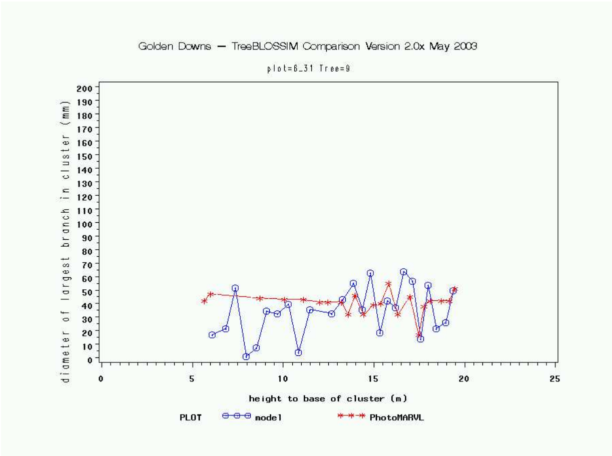
TREE-KEY 9, 50TH PERCENTILE, GF22



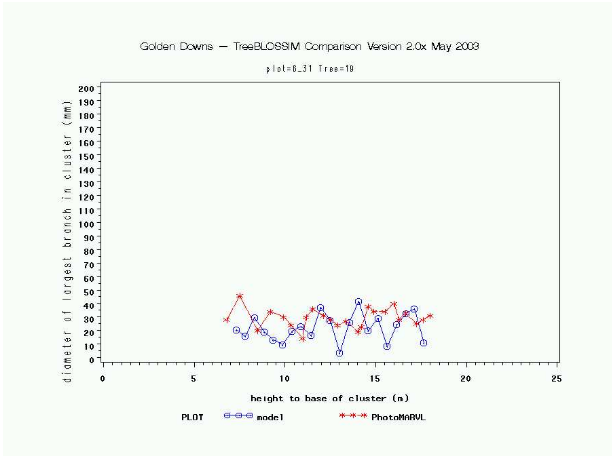
TREE-KEY 11, 30TH PERCENTILE, GF22



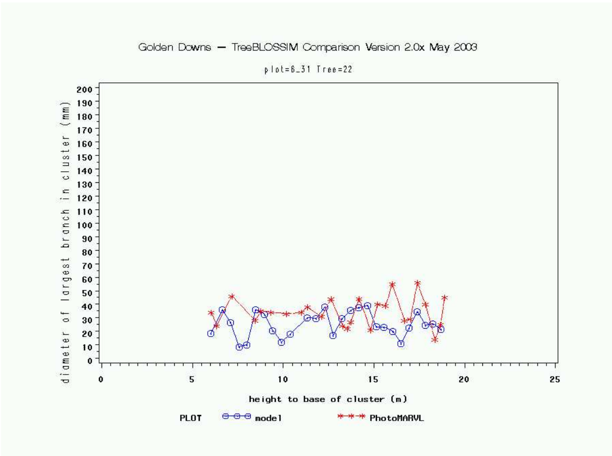
TREE-KEY 9, 90TH PERCENTILE, GF14



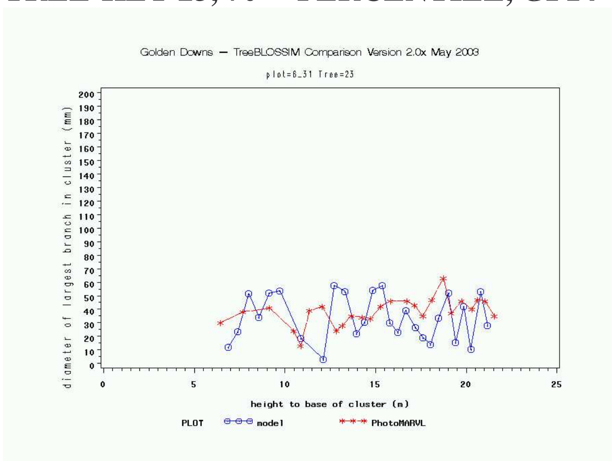
TREE-KEY 19, 30TH PERCENTILE, GF14



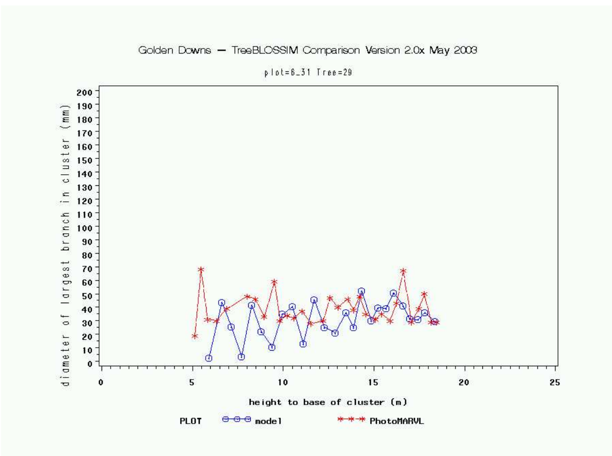
TREE-KEY 22, 10TH PERCENTILE, GF14



TREE-KEY 23, 70TH PERCENTILE, GF14

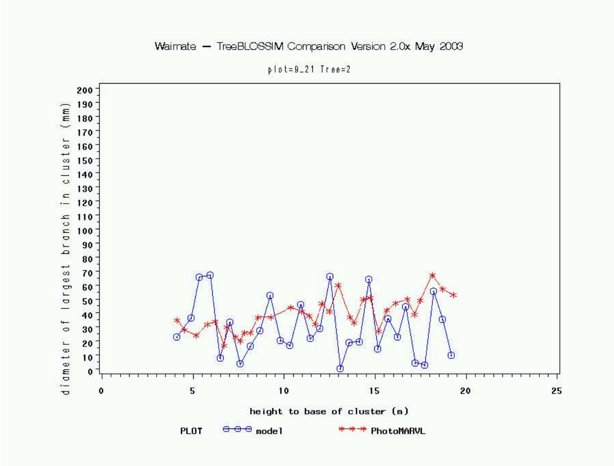


TREE-KEY 29, 50TH PERCENTILE, GF14

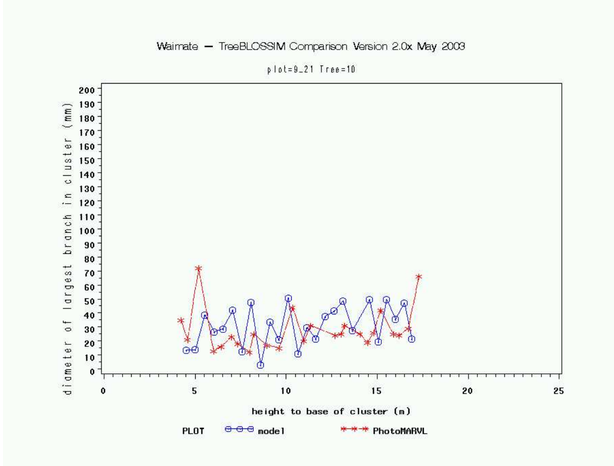


PhotoMARVL – TreeBLOSSIM Comparisons for Waimate

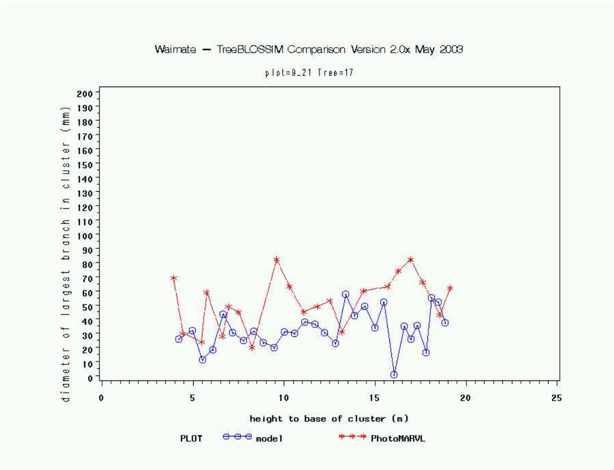
TREE-KEY 2, 70TH PERCENTILE, GF14



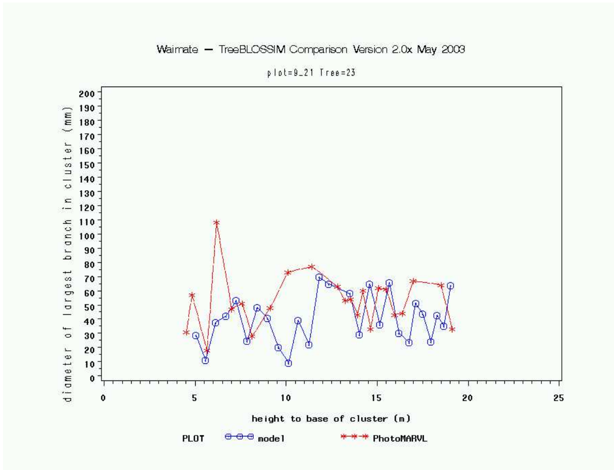
TREE-KEY 10, 10TH PERCENTILE, GF14



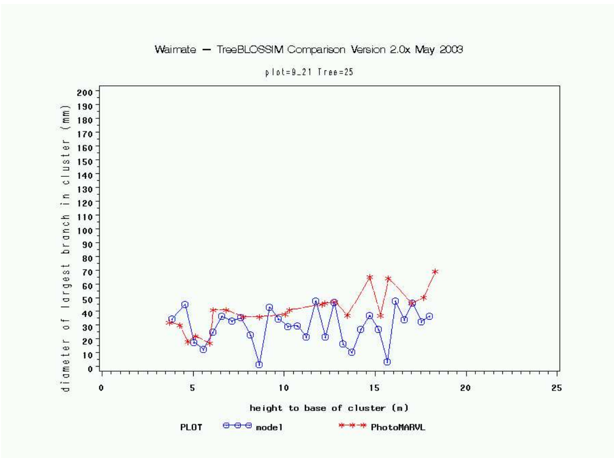
TREE-KEY 17, 50TH PERCENTILE, GF14



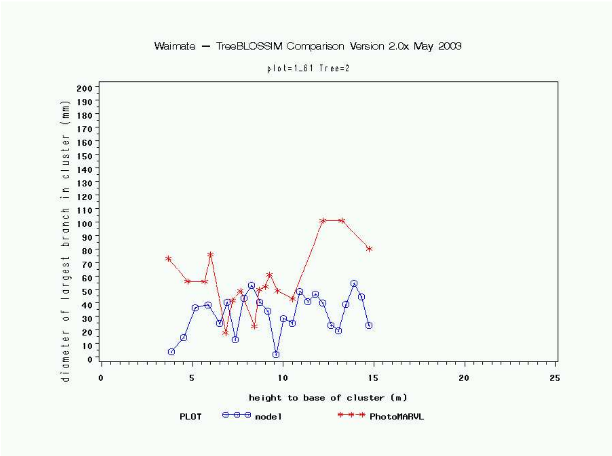
TREE-KEY 23, 90TH PERCENTILE, GF14



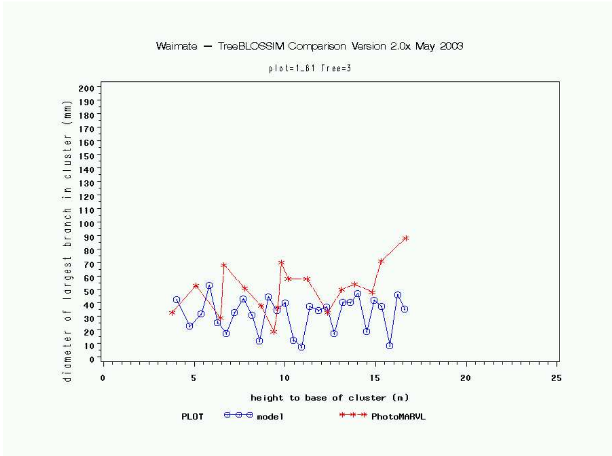
TREE-KEY 25, 30TH PERCENTILE, GF14



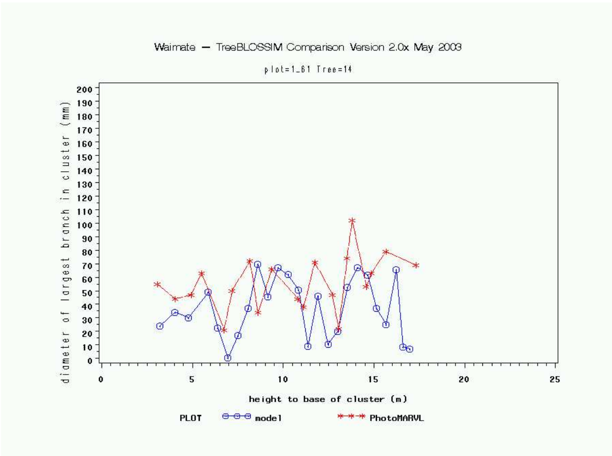
TREE-KEY 2, 10TH PERCENTILE, GF7



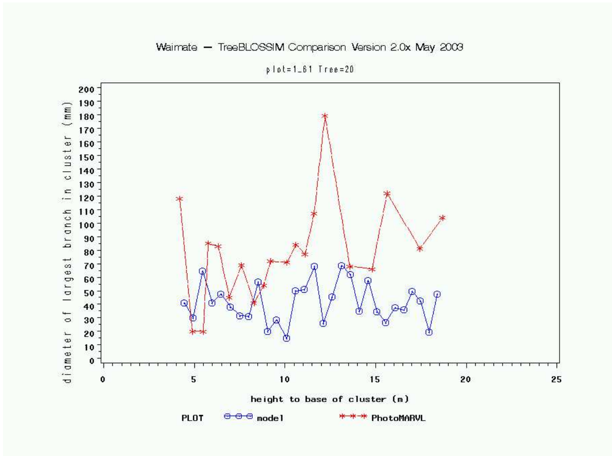
TREE-KEY 3, 30TH PERCENTILE, GF7



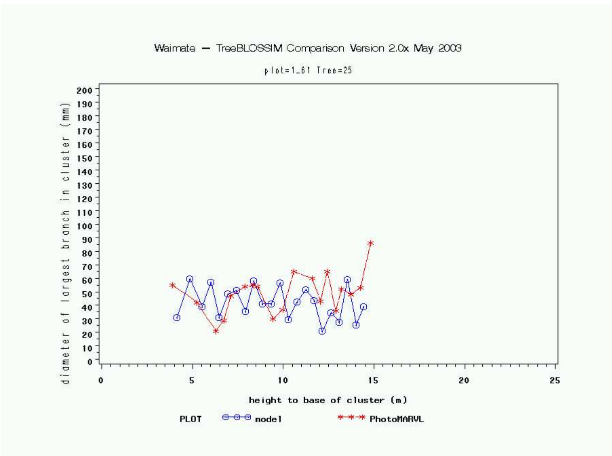
TREE-KEY 14, 70TH PERCENTILE, GF7



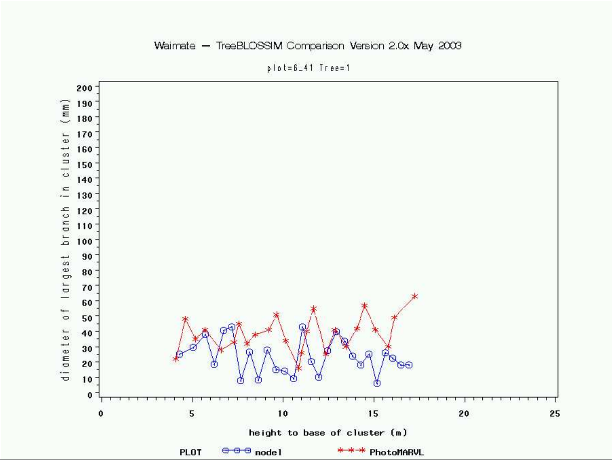
TREE-KEY 20, 90TH PERCENTILE, GF7



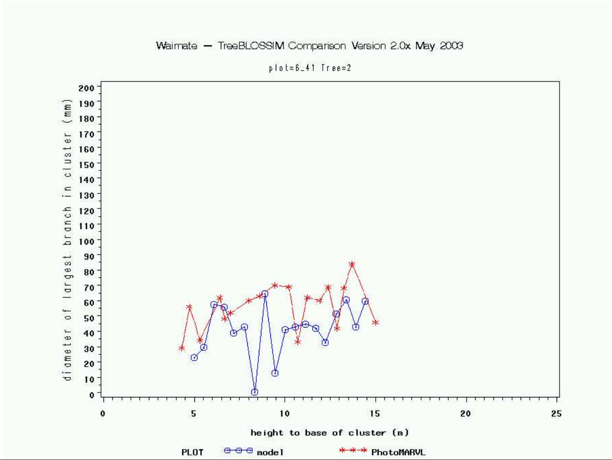
TREE-KEY 25, 50TH PERCENTILE, GF7



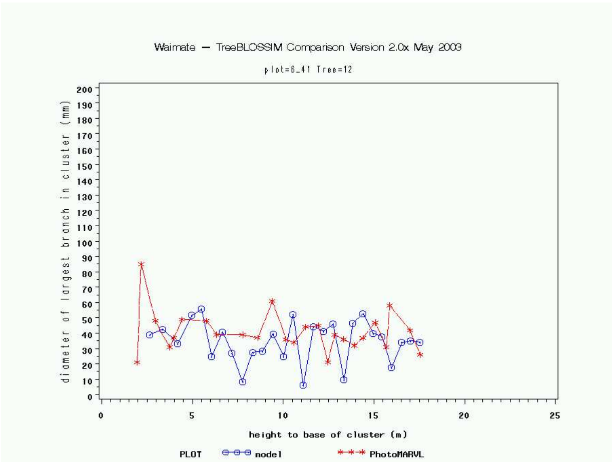
TREE-KEY 1, 10TH PERCENTILE, GF22



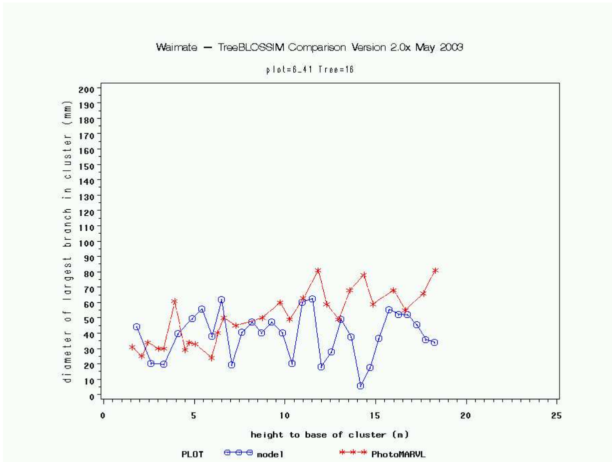
TREE-KEY 2, 70TH PERCENTILE, GF22



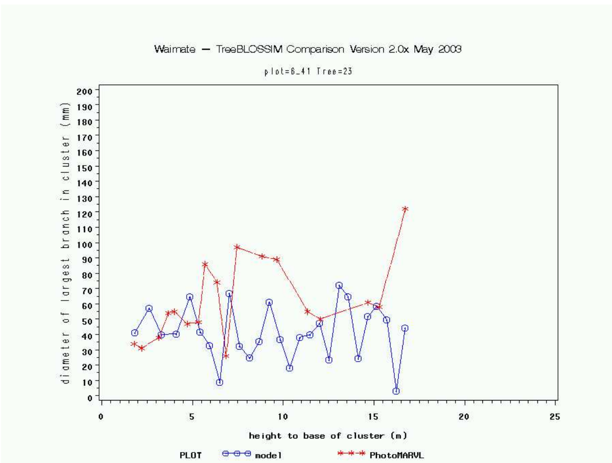
TREE-KEY 12, 30TH PERCENTILE, GF22



TREE-KEY 16, 50TH PERCENTILE, GF22

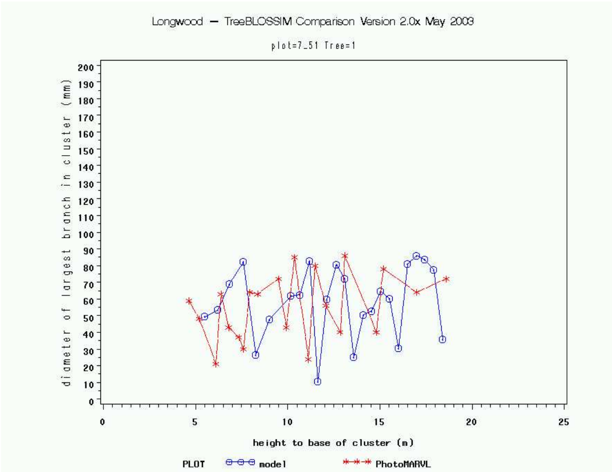


TREE-KEY 23, 90TH PERCENTILE, GF22

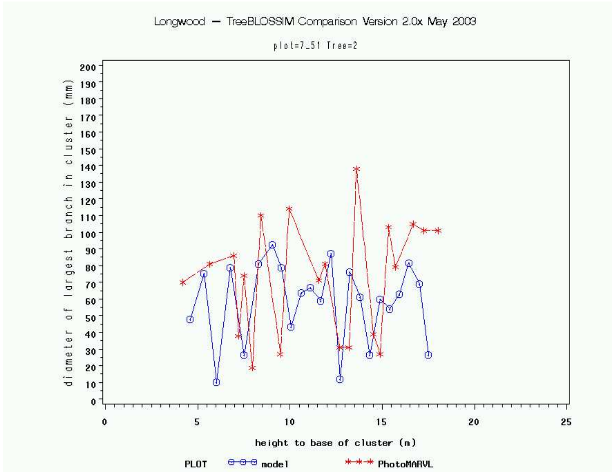


PhotoMARVL-TreeBLOSSIM Comparisons for Longwood

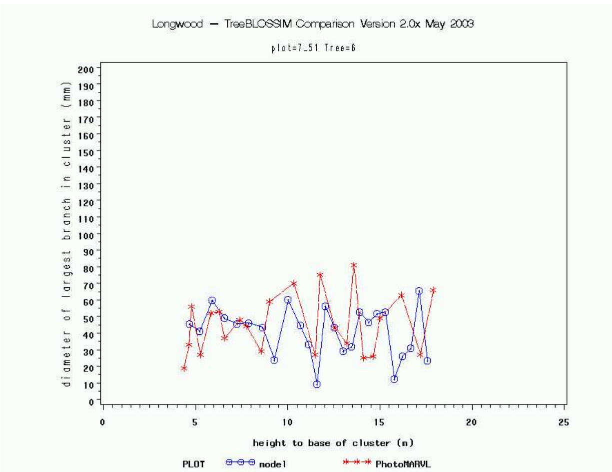
TREE-KEY 1, 70TH PERCENTILE, GF7



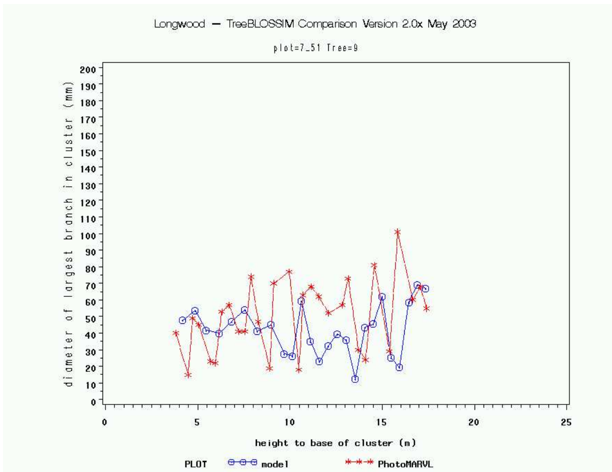
TREE-KEY 2, 90TH PERCENTILE, GF7



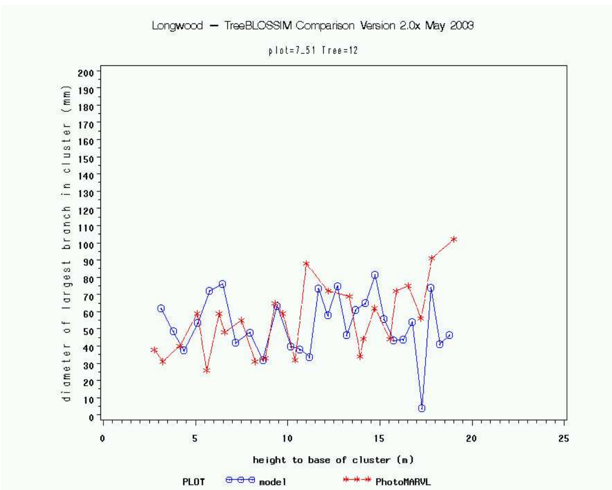
TREE-KEY 6, 10TH PERCENTILE, GF7

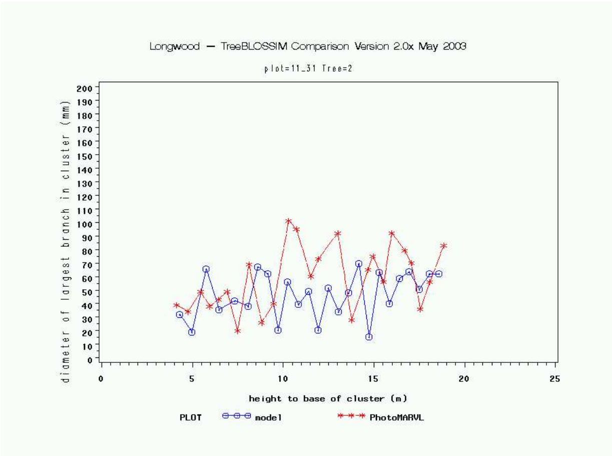
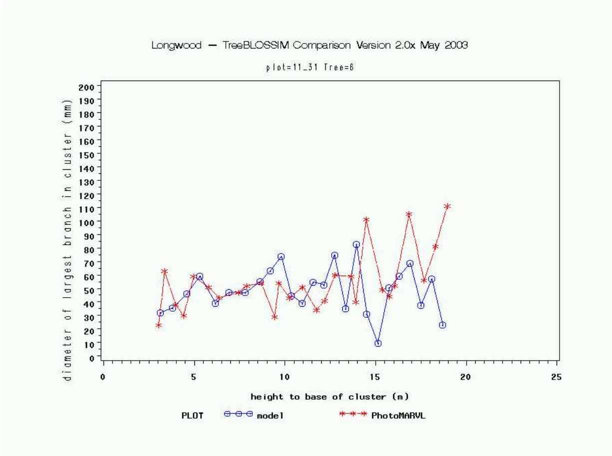
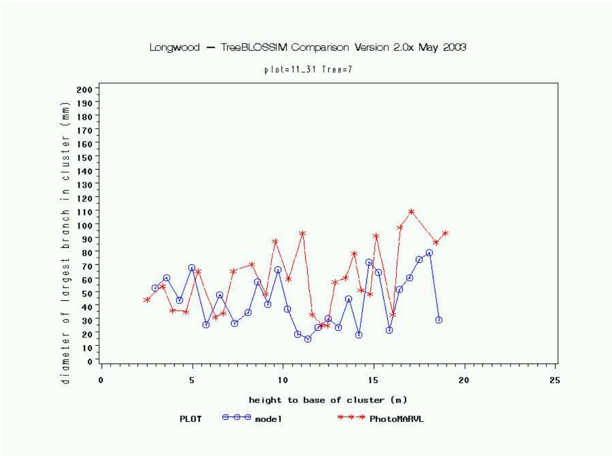
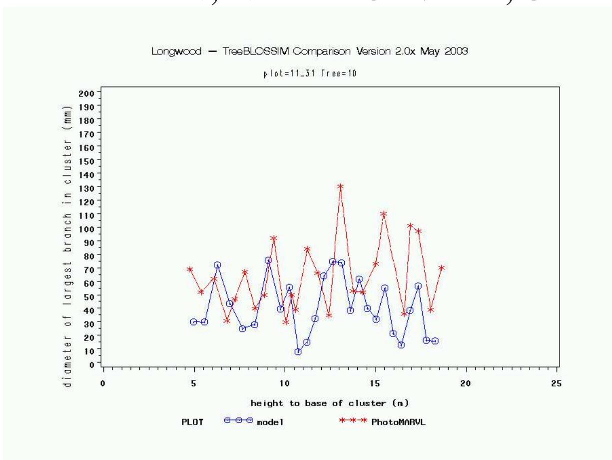
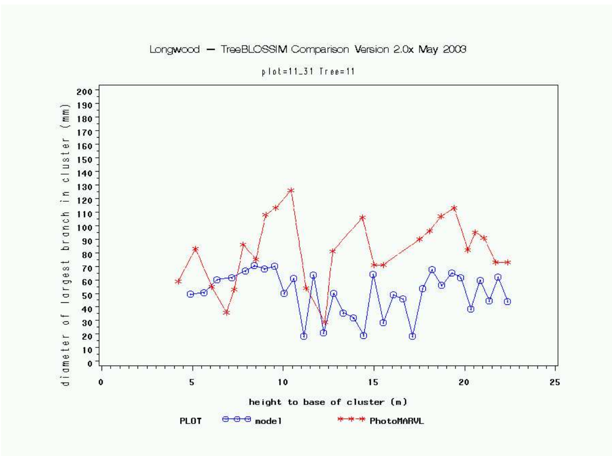


TREE-KEY 9, 30TH PERCENTILE, GF7

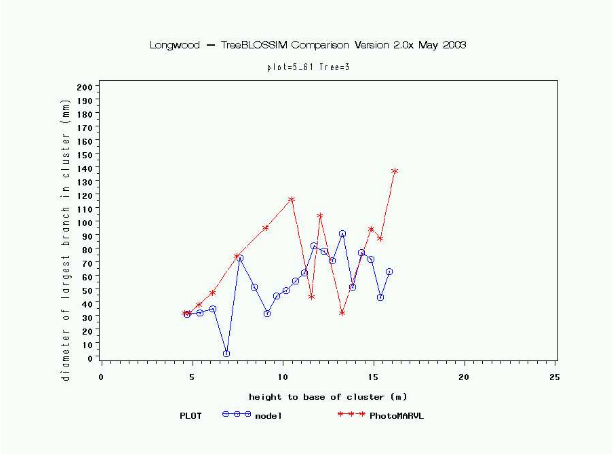


TREE-KEY 12, 50TH PERCENTILE, GF7

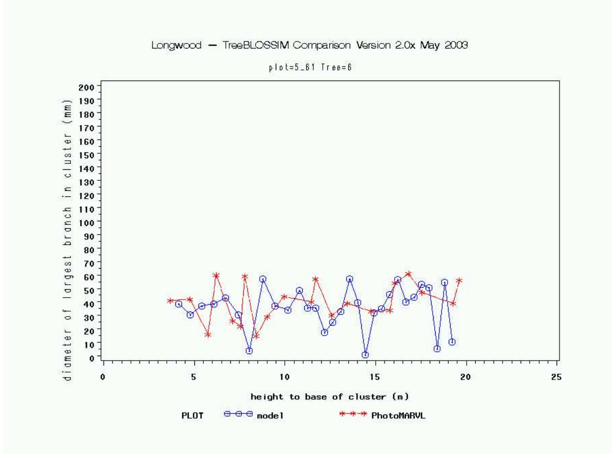


TREE-KEY 2, 30TH PERCENTILE, GF22 	**TREE-KEY 6, 90TH PERCENTILE, GF22** 
TREE-KEY 7, 50TH PERCENTILE, GF22 	**TREE-KEY 10, 70TH PERCENTILE, GF22** 
TREE-KEY 11, 10TH PERCENTILE, GF22 	

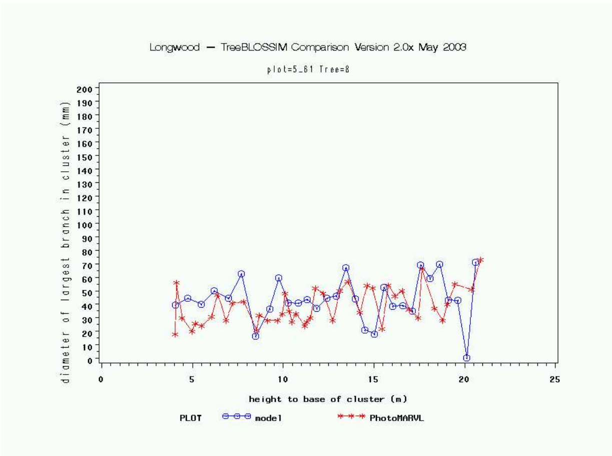
TREE-KEY 3, 90TH PERCENTILE, GF14



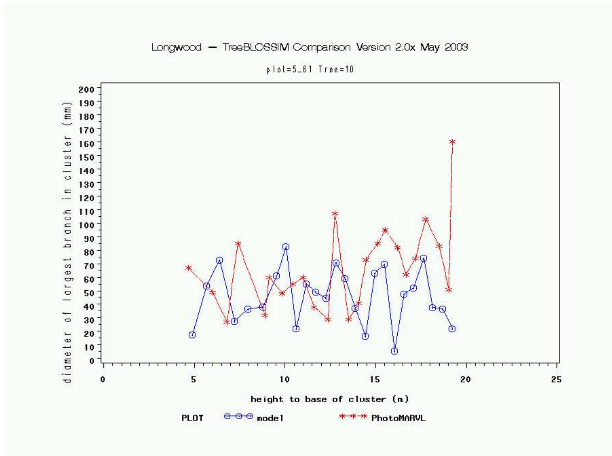
TREE-KEY 6, 10TH PERCENTILE, GF14



TREE-KEY 8, 30TH PERCENTILE, GF14



TREE-KEY 10, 50TH PERCENTILE, GF14



TREE-KEY 12, 70TH PERCENTILE, GF14