FRI Project Record

No. 4425

AN EXAMINATION OF THE VALIDITY OF THREE DOUGLAS FIR GROWTH MODELS

R. B. TENNENT

REPORT No 41. JUNE 1995

FRI/INDUSTRY RESEARCH COOPERATIVES

AN EXAMINATION OF THE VALIDITY OF THREE DOUGLAS FIR GROWTH MODELS

EXECUTIVE SUMMARY

In 1993 there were three major models available for the prediction of the growth of Douglas-fir. Members of the Stand Growth Modelling Cooperative had concerns as to the validity of the models and authorised a pilot investigation to examine the accuracy of the models. The three models investigated were the North Island model (Liu Xu, 1989), the South Island model (Law, 1990), and the Temu model (Temu, 1992).

All sample plots established in pure even aged stands of Douglas-fir were extracted from the PSP system, and screened to provide a validation data set consisting of 355 plots. The validation set had a predominance of long run plots, and did not include any plots established prior to 1940. The models were run using the first observation of each plot as a starting point. After each thinning the sample plot values were re-input for prediction of the next growth period.

The validation showed that all three models predict the growth of Douglas-fir to within generally acceptable limits. The models performed best in the regions their data were derived from.

There has been much speculation on the mortality function of the South Island model. The validation demonstrated that the South Island model does have a tendency to overpredict at higher stockings, but the model also has a far lower variation in the prediction. This means that the model may have a greater bias, but also has increased accuracy of prediction.

An examination of the validity of three Douglas fir growth models

R. B. Tennent

Introduction

In 1993 there were three major models available for the prediction of the growth of Pseudotsuga menzezii, Douglas-fir. Members of the NZ Forest Research Institute Stand Growth Modelling Cooperative had concerns as to the validity of the models.

Tasman Forestry had made a comparison between the predictions of the Golden Downs Douglas-fir model (Tennent, pers comm) and the South Island model (Law, 1990) models as compared with actual growth. The comparison included the following figures for a plot thinned to 500 sph at age 19, and grown on with the two models.

	Age 34.5			Age 50		
	SPH	BA	Piece size	SPH	BA	Piece size
Actual	500	56.0				
South Island model	467	47.9	0.79	417	74.9	1.86
Golden Downs model	498	53.0	0.80	489	81.3	1.62

Table 1. Actual and predicted stand variables for Douglas-fir PSPs (Macintosh, pers comm)

The South Island model shows high predicted mortality at age 34.5, and the predictions at age 50 are far higher than that predicted by the Golden Downs Douglas-fir model. The high mortality has a significant effect on predicted piece size at age 50. An investigation of the models' validity was added to the list of cooperative projects.

Procedure

The aim of the investigation was to examine the accuracy of three models available for Douglas-fir, the North Island model (Liu Xu, 1989), the South Island model (Law, 1990), and the Temu model (Temu, 1992), using data extracted from the PSP system.

All sample plots established in pure even aged stands of Douglas-fir were extracted from the PSP system, and screened to provide a validation data set consisting of 355 plots. The validation set had a predominance of long run plots, and did not include any plots established prior to 1940.

The South Island, Central North Island and Temu models were run using the first observation of each plot as a starting point. After each thinning the sample plot values were re-input for prediction of the next growth period. This excluded the thinning functions of the models from the investigation. A separate examination of thinning functions has been carried out (Kimberley and Knowles, 1993), and this investigation concentrated on the growth functions.

The following statistics were prepared, including a series of graphs of model bias, presented as Appendix 1, Figures 1 to 9.

Model	Observations	Stocking (N/ha)	Basal Area (m2/ha)	Height (m)
North Island	1126	8	0.6	0.2
South Island,	1252	18	-0.8	-0.4
Temu	1848	-1	-1.9	-0.1

Table 2. Average prediction residual, overall dataset.

The following table shows the BA input results by model by island.

Model/region	Observations	Stocking (N/ha)	Basal Area (m2/ha)	Height (m)
North Island model, North Island forests	545	8	-0.4	-0.1
North Island model, South Island forests	581	8	1.7	0.4
South Island model, North Island forests	701	21	-1.8	-0.6
South Island model, South Island forests	551	14	0.5	-0.2
Temu model, North Island forests	1061	-4	-2.6	-0.2
Temu model, South Island forests	786	3	-0.8	0.1

Table 3. Average prediction residual, BA input, grouped regionally.

Discussion

Table 1 shows that all models provide estimates of height growth which are generally acceptable, with the average error within .5 metres of the observed value. There is more variation in basal area, and the South Island model has an average stocking residual of 18 stems/hectare, indicating an overprediction of mortality.

Table 2 breaks the residuals down by Island. The North Island model appears to predict equally well for both Islands, although showing a slight tendency to under-predict basal area growth in the South Island, whereas the Temu model shows a tendency to underpredict basal area growth in the North Island. The South Island model has a greater average residual for the North Island, and overpredicts mortality more for the North Island than the South Island.

Figures 1 to 9 allow the residuals to be examined in greater detail. The basal area residuals show little additional detail, apart from a slight tendency for the Temu model to overpredict basal area increment at high basal areas. The stocking residuals are evenly distributed, with the exception of the South Island model, which has a pronounced tendency to overpredict mortality. However, the South Island model residuals have a far lower variance than the other two models.

The North Island model has the tightest height residual pattern, with the South Island model tending to overpredict height at greater heights, and the Temu model showing a slight tendency to overpredict.

Conclusions

The validation showed that all three models predict the growth of Douglas-fir to within generally acceptable limits. As may be expected, the models perform best in the regions their data were derived from.

There has been much speculation on the mortality function of the South Island model. The validation demonstrated that the South Island model does have a tendency to overpredict at higher stockings, but the model also has a far lower variation in the prediction. This means that the model may have a greater bias, but also has increased accuracy of prediction.

References

Law, K. 1990: A growth model for Douglas-fir grown in the South Island. NZ Forest Research Institute Project record 2488

Liu Xu, 1989: Douglas Fir central North Island growth model. NZ Forest Research Institute Project Record 2497.

Temu, J. 1992. Ph.D thesis, University of Canterbury, Christchurch.

Figure 1: Central NI model - BA residuals

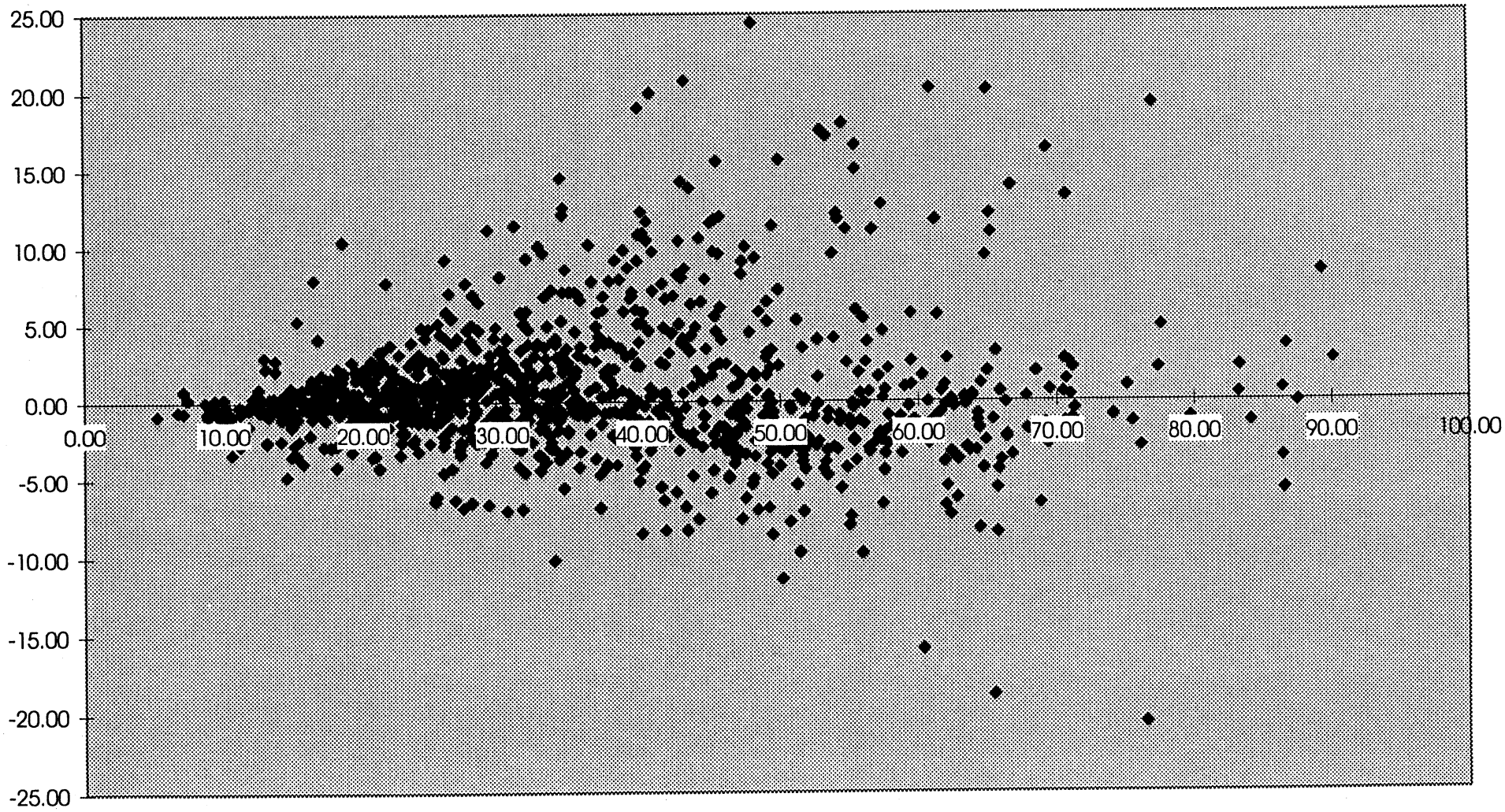

Figure 2: South Island model - BA residuals

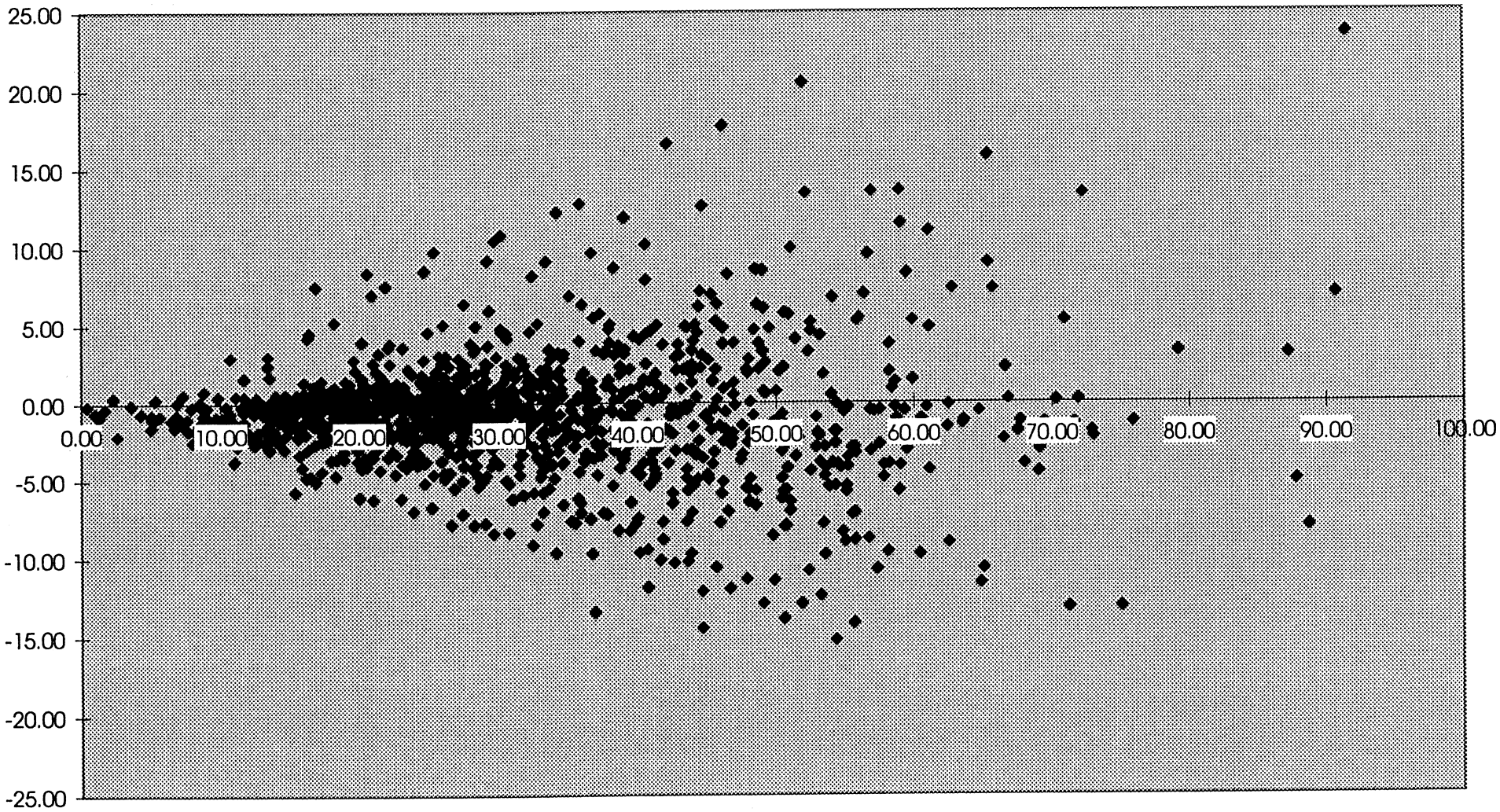

Figure 3: Temu model - BA residuals

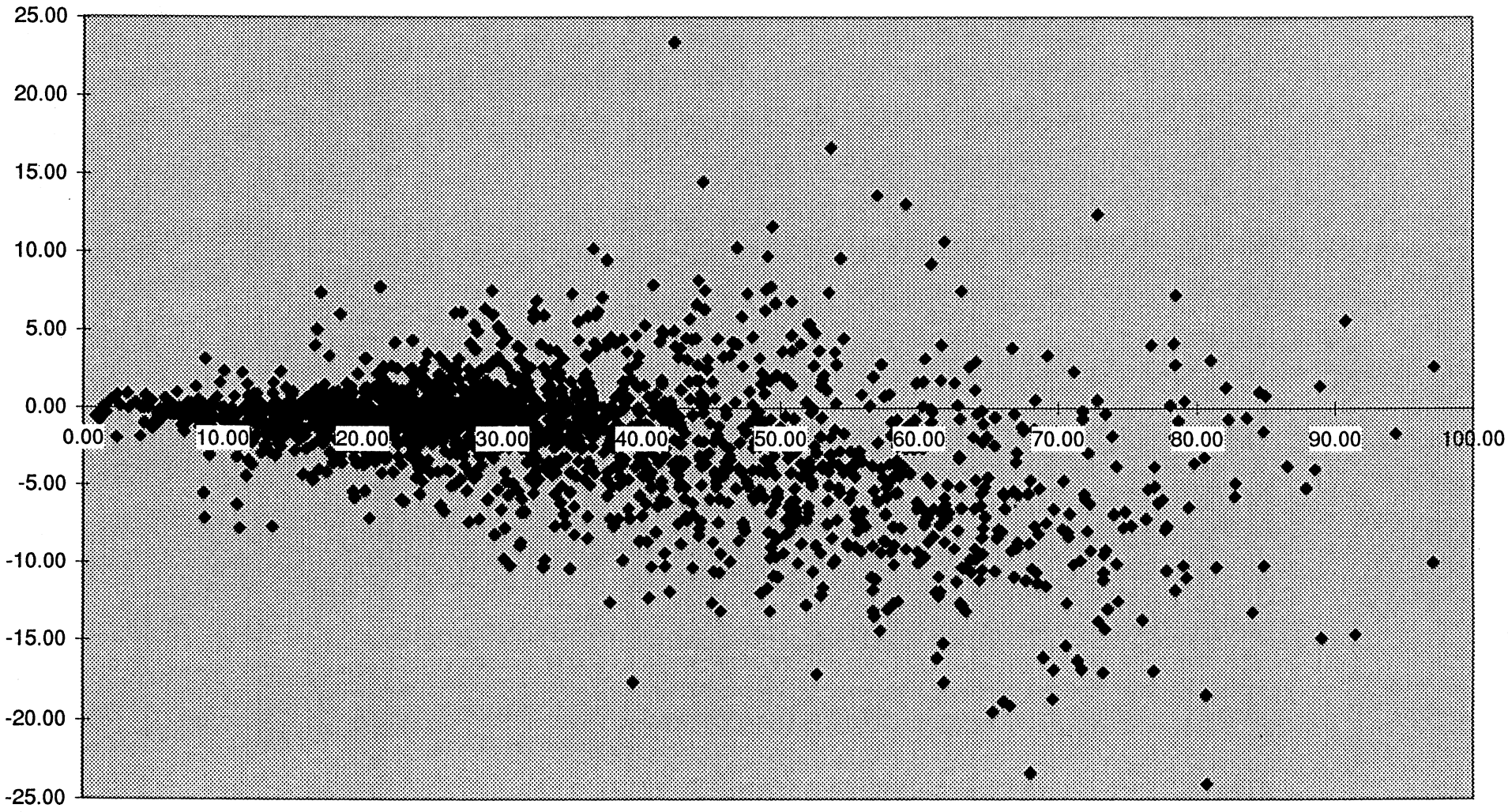

Figure 4: Central NI model - SPH residuals

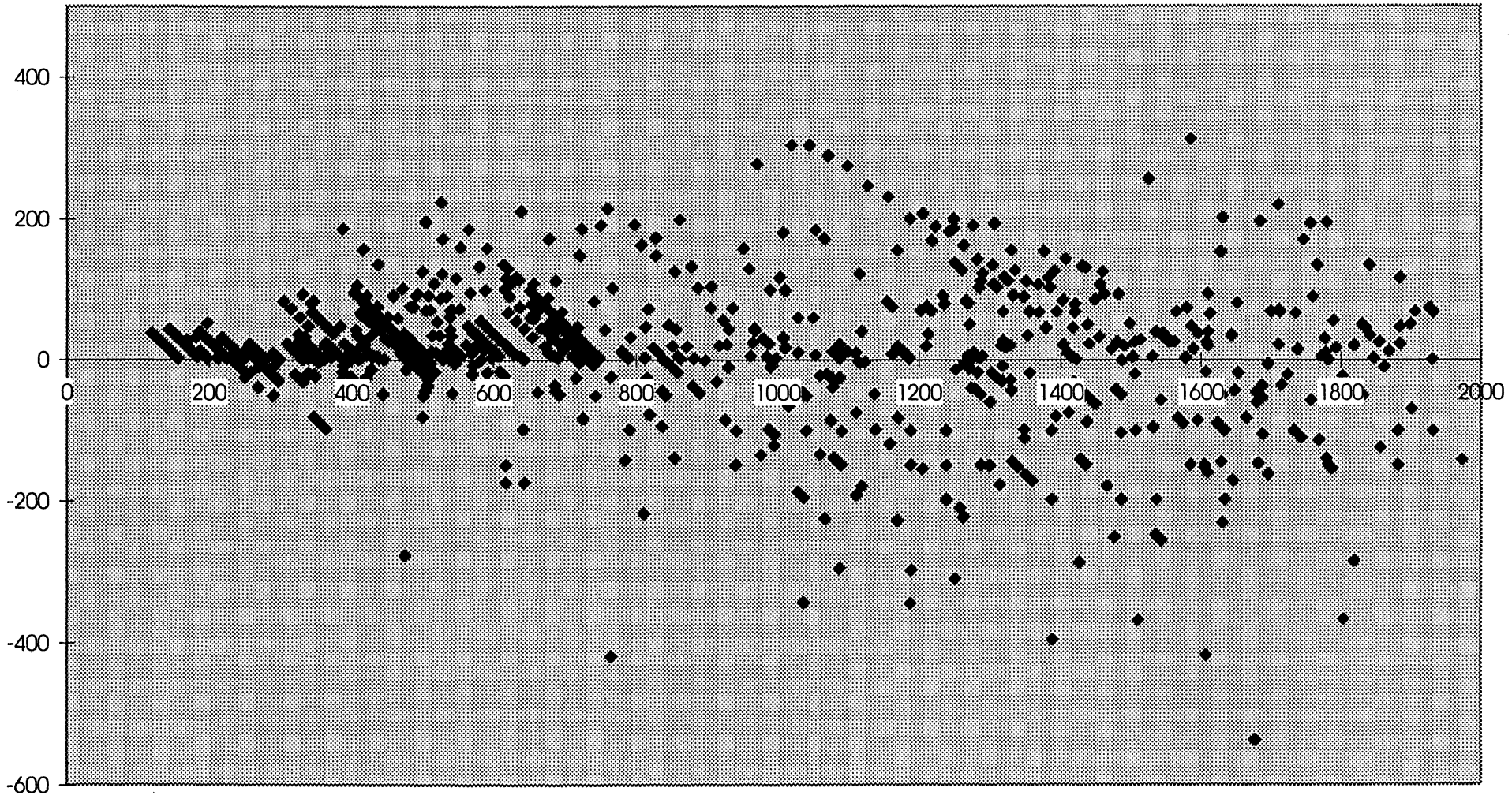

Figure 5: South Island model - SPH residuals

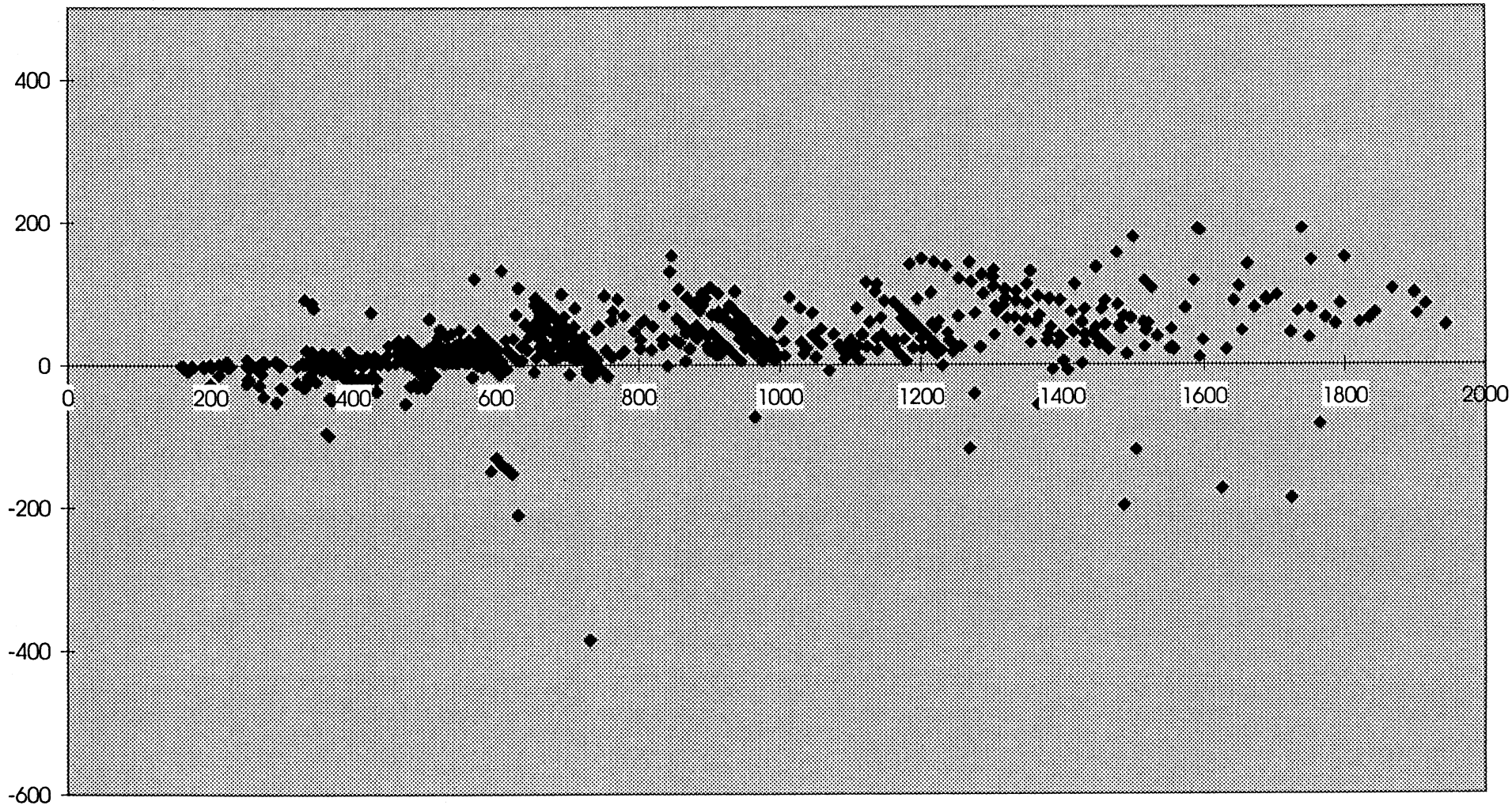

Figure 6: Temu model - SPH residuals

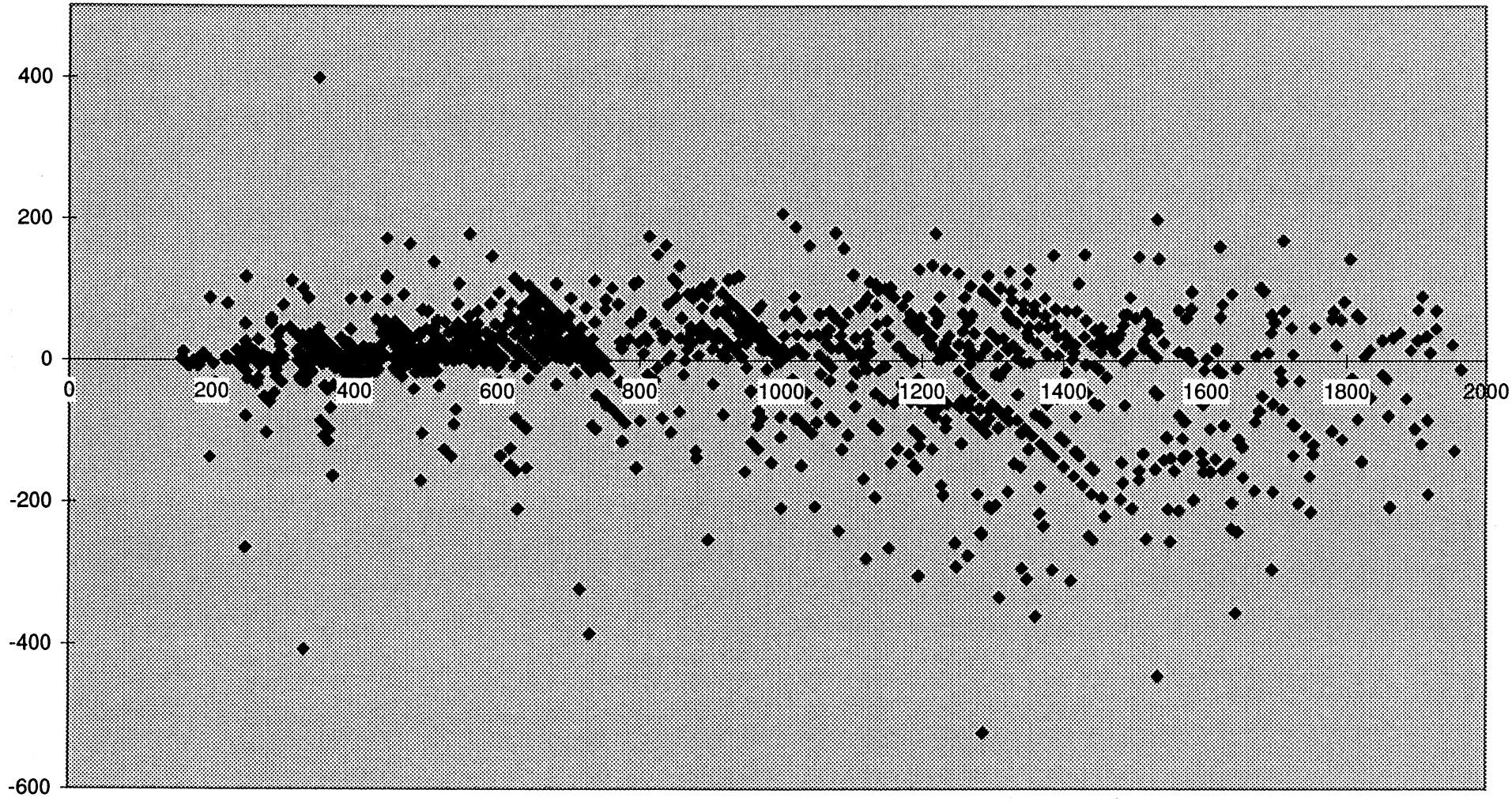

Figure 7: Central NI model - Height residuals

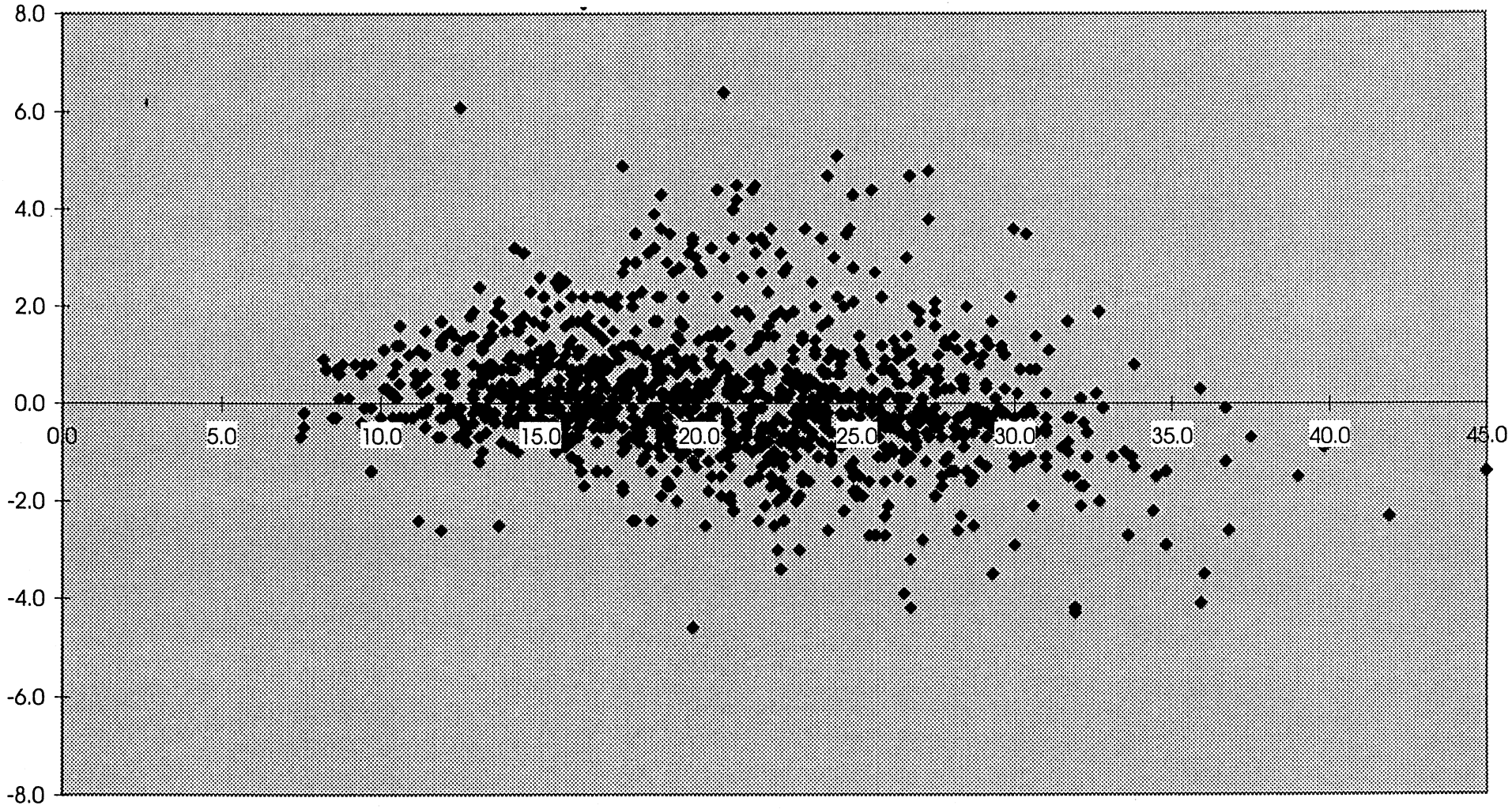

Figure 8: South Island model - Height residuals

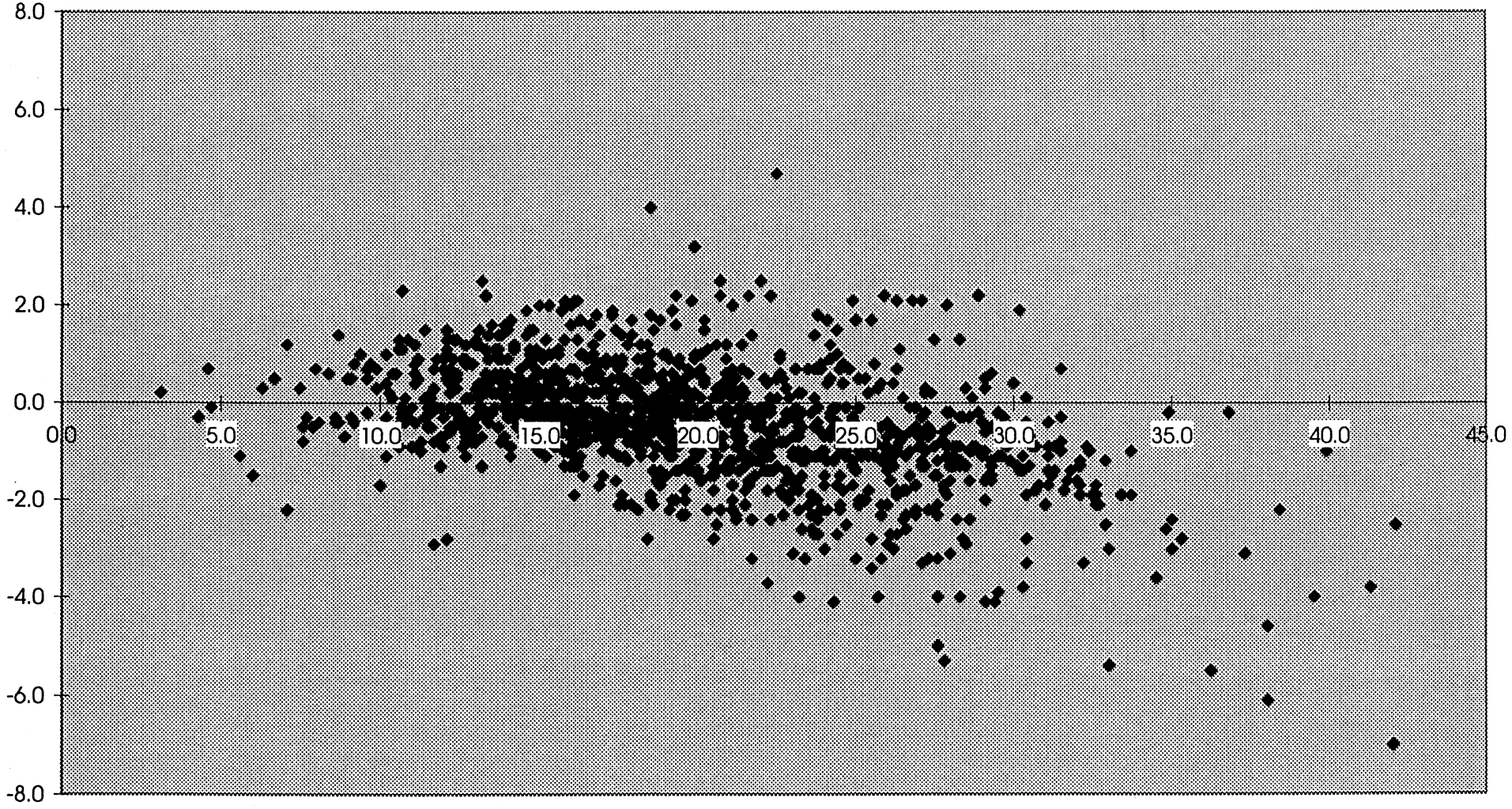

Figure 9: Temu model - Height residuals