Satellight

Commission of the European Communities

Notes on Heliosat v2a,v2b and v3: Comparison with Geneva's data

Working paper, Pierre Ineichen

Satellight meeting

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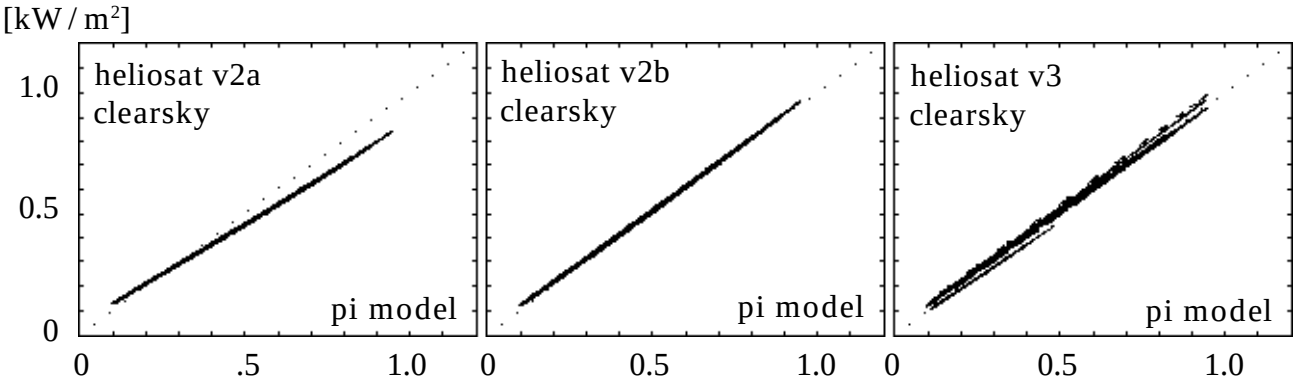
Forewords

As I presented it during the last satellight meeting, I try to develop a model that performs the evaluation of the sky luminance distribution on the basis of the pixel information. My first attempt was to derive the zenith luminance from the pixel and then the luminance distribution. My path was to go through the Perez epsilon and delta, so my work was not far from the heliosat model. As I just received my pixel data from PRE, I began to test the PRE data and would like to present some ascertainment I pointed out.

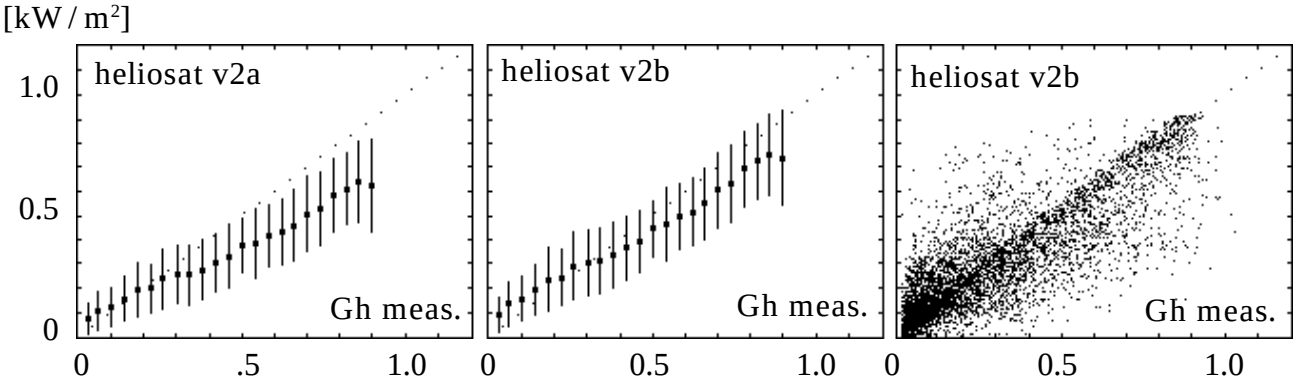
Version 2a, 2b and 3 of the heliosat model.

I tested the three versions of the clear sky model against the model I developed in Geneva in 1983 (Ineichen, 1983). For the Geneva's data, v2b is clearly better than v2a. The difference between v2b and v3 is not very significant. The pi model is not turbidity dependent, and this causes the split in the last graph of the following figure.

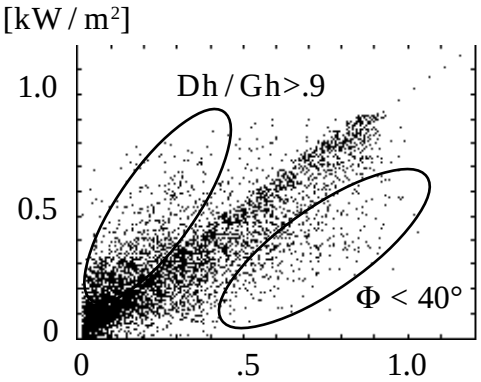


Heliosat global versus measured global

All the following results and tests were made on the three versions of the heliosat model. The v2a model gives different results than the two others, but, following the clear sky models evaluation, I concluded that the v2b and v3 are better then the v2a, and didn't investigate deeper the v2a version. On the following figures, the modeled horizontal global is plotted



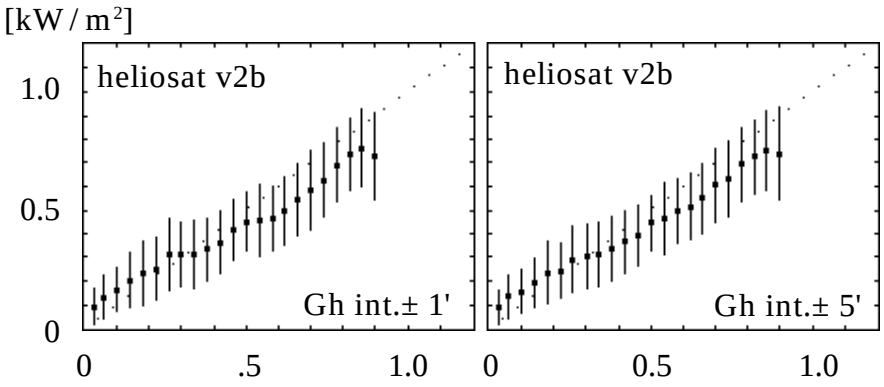
versus the measurements. On the two left graphs, the abscissa scale is divided in bins. For each bin, the mean value is given (point) and is surrounded by ± one standard deviation (line). It is noteworthy on the last graph, that there is a *darker* diagonal region where the model slightly overestimates, whereas the mean bins values have a negative bias (second graph)



The v2b and v3 versions of the model give slightly the same results. It is often not possible to point out the differences. I then decided to investigate only the v2b version. On the right side figure, the scatter plot is represented. The lower right points are representative of situations where the angular distance (Φ) between the sun direction and the satellite is lower than 40°. In counterpart, the upper left side points are cloudy conditions where the Dh / Gh ratio is higher the 0.9. Results of a parameter dependence are given in a following paragraph.

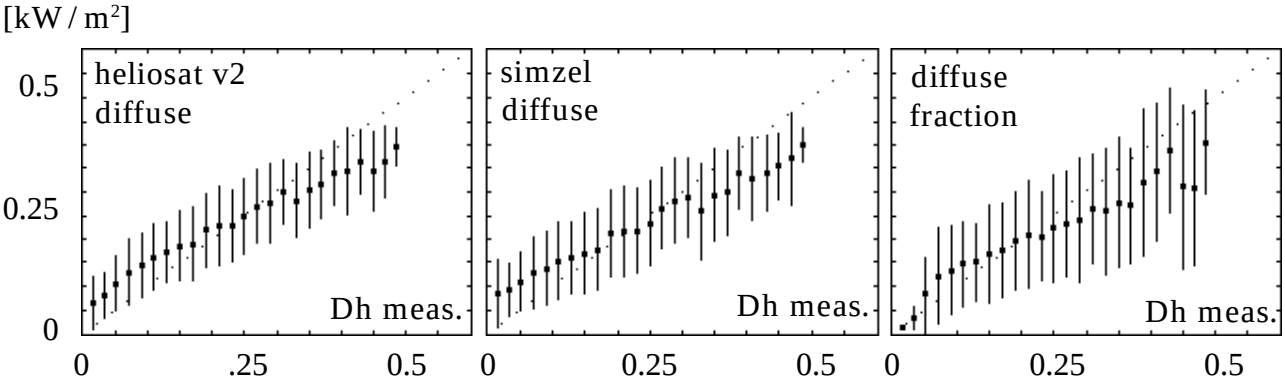
Heliosat versus ±1 minute and ±5 minutes integrated measurements

I compared the heliosat modeled global and the measured global for two conditions: heliosat v2b versus instantaneous measurements (integrated within ±1 minute of the meteosat measurement time), and versus integrated measurements (within ±5 minutes). The result of the comparison with integrated measurements gives slightly better results, the modeled versus measured global radiation is smoother with integrated values than with instantaneous values. Considering the surface covered by one pixel, the use of integrated values is better.



Heliosat diffuse versus measured diffuse

As for the global irradiance, the heliosat v2b and v3 give slightly the same results for the diffuse irradiance. The v2a is worse. I compared the modeled and the measured diffuse irradiances, for the heliosat model and two other splitting models: the simzel model (Perez, 1992) and a diffuse fraction model (Ineichen 1984). To be coherent with the aim of the heliosat model, I used the heliosat modeled global as input for the simzel and the diffuse fraction



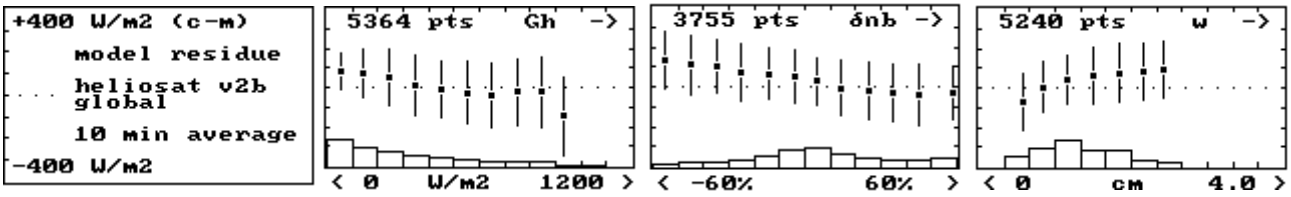
models and this enlarges the dispersion. The above figures show clearly that the heliosat is

the best way to estimate the diffuse irradiance in this context. A dependence study is given in the next paragraph.

Heliosat parameter dependence study for the global irradiance.

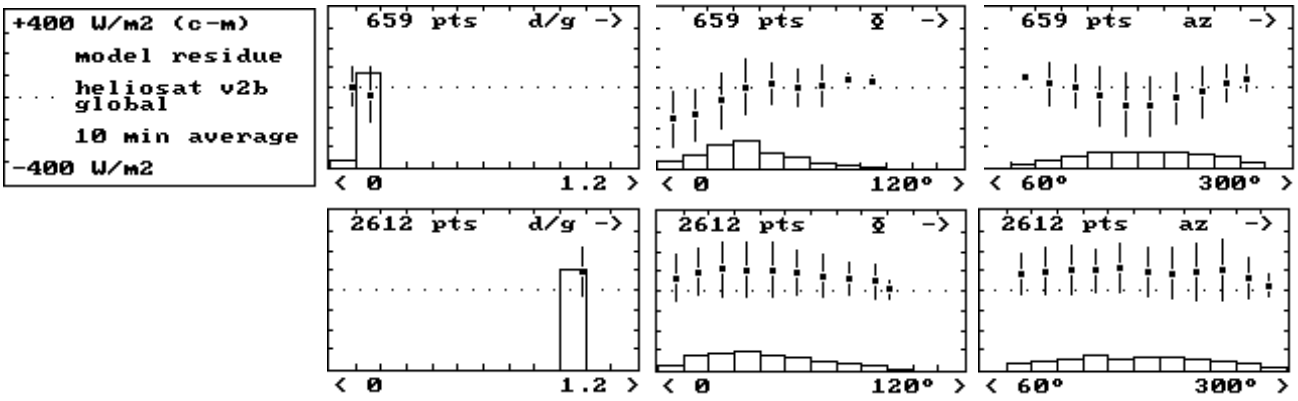
On the basis of the Geneva's data and the heliosat modeled irradiances, I made a parameter dependence of the model residue. It is not a study of the model, but as I am working on the luminance model and I need to know these dependencies, I just want to highlight some significant points.

As a general comment, one can point out that low global irradiances are overestimated and high irradiances underestimated. The following figure shows that the model can eventually be improved by the use of the water vapour content (this will be done with version v4 of



heliosat). It's noteworthy that the δnb (which is the relative difference between the nebulosity index issued from 1 pixel and from 3x5 pixels) could be a good parameter to improve the model. Again considering the surface covered by 1 pixel, this is a logical conclusion. (The complete figure is given in appendix).

A second possibility to improve the model is to differentiate clear conditions and overcast conditions. As I mentioned it in a previous paragraph, on the scatter plot, the high model-measurement's differences can be classified in two categories: overcast conditions and low angular distance between the sun direction and the satellite (Φ). On the following figure, one can see that the model bias is clearly and significantly Φ dependent, and in a different



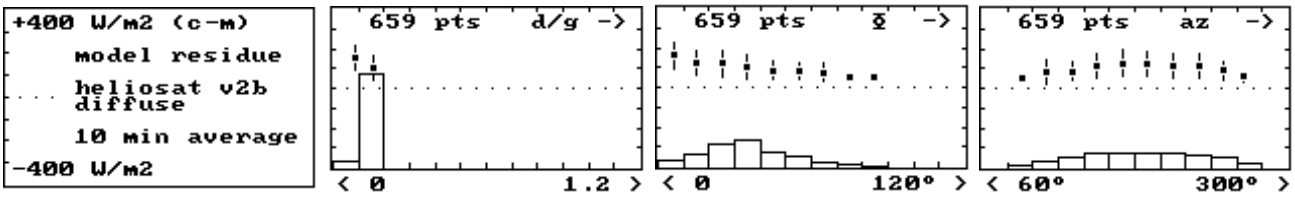
way for clear and overcast conditions. One can notice (cf. appendix) that as the satellite azimuth is near from the South, the bias is also visible on the sun azimuth dependence (considering the physical properties of the diffusion, it seems that the parameter must be the Φ instead of the sun's azimuth).

The aim of this notice is not to improve the model, but to point out some significant

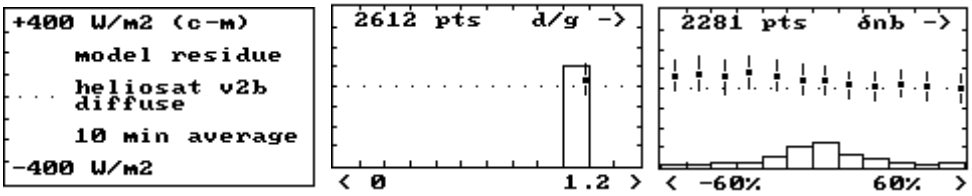
dependencies, for the Geneva data. They have to be confirmed with other sites' data.

Heliosat parameter dependence study for the diffuse irradiance.

On the basis of the graphs given in the appendix, one can point out a similar dependence with the angular distance sun / satellite (Φ) or with the azimuth of the sun. The following figures are extracted from the appendix and give this bias for clear sky conditions.



As for the global, a general comment is that for clear sky conditions, the diffuse is overestimated, and that there is a slight significant bias with the δnb (δnb is described in the global section)



Conclusion

For a first try to derive the diffuse irradiation from the heliosat method, the results are very good for Geneva. The fact that the results are better with the heliosat method than with a splitting of the global is very encouraging.

Concerning the global and the diffuse heliosat model, I noted some significant biases with the Geneva's data and I think, if this trend is corroborated with other data sets, that the model could be improved with these simple and available parameters.

References

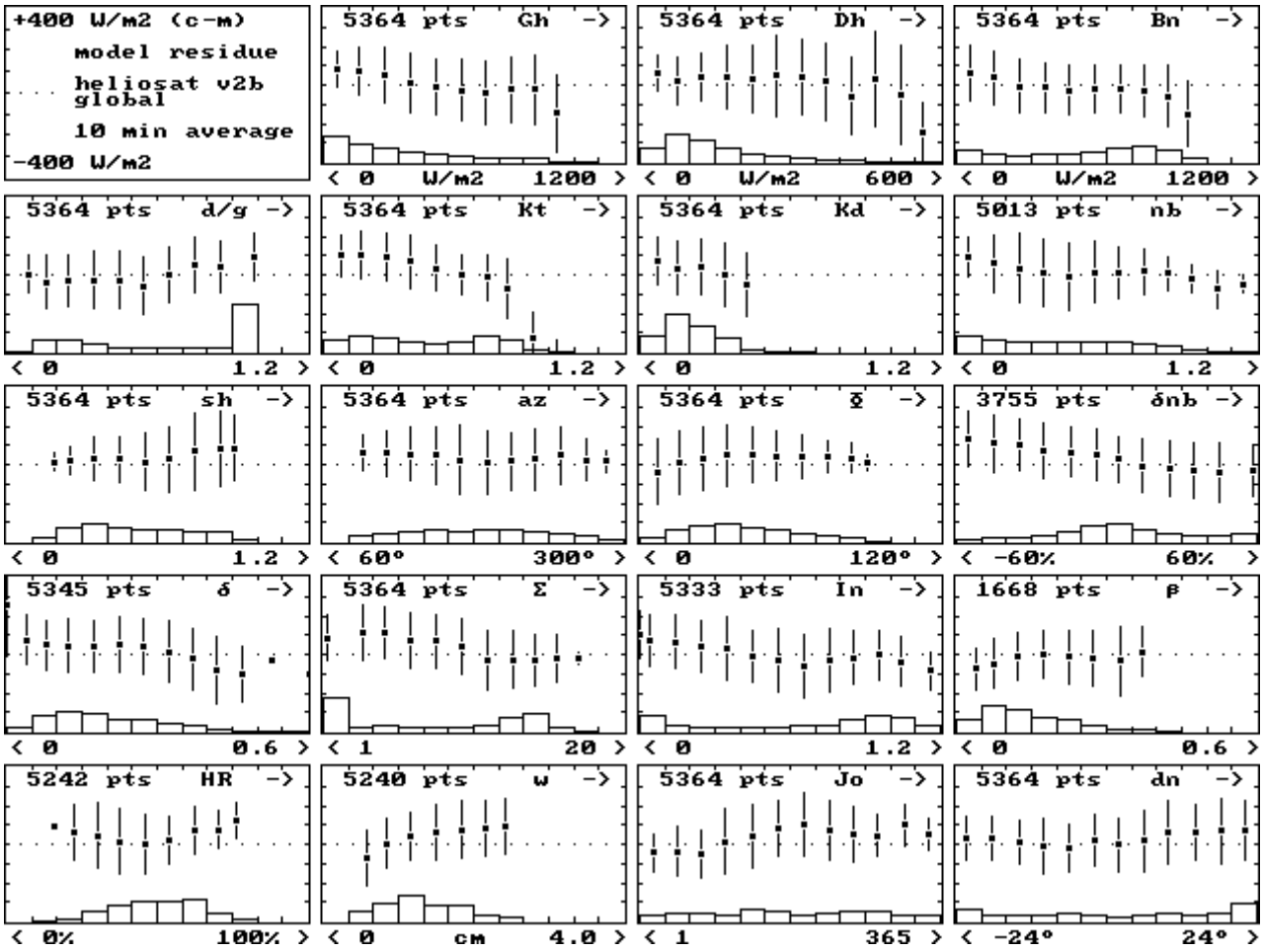
P. Ineichen. *Quatre années de mesure d'ensoleillement à Genève.* Rapport de Thèse. Université de Genève. 1983.

P. Ineichen, O. Guisan, A. Razafindraibe. *Indice de clarté.* Université de Genève. Série de Publication du CUEPE N° 20. 1984.

R. Perez, P. Ineichen,E. Maxwell, R. Seals, A. Zelenka. *Dynamic Global-to-Direct Irradiance Conversion Models.* Ashrae Transactions, V. 92, pp 3578-3593, 1992

Appendix: Parameter dependence of the v2b heliosat model.

Residue of the heliosat v2b model, for the global radiation, station of Geneva and all weather conditions and for different parameters.



The abcissa scale is divided in bins. For each bin, the mean value is given (point) and is surrounded by ± one standard deviation (line). The bar chart at the bottom of each dependence represents the occurence frequency for each bin in percent of the total number of occurences. The scale is 20% per graduation.

Gh	horizontal global	Kt	clearness index	nb	nebulosity index
Dh	horizontal diffuse	Kd	diffuse cl. index	δnb	nb variation (1 pix / 15pix)
Bn	normal beam	In	Perreaudau index	HR	relative humidity
d / g	Dh normalized by Gh	Σ	Perez epsilon	w	water vapor
		δ	Perez delta	β	Ångström turbidity
Jo	day of the year	dn	declination		
sh	sun height sine	az	sun azimuth	Φ	sun / satellite angle

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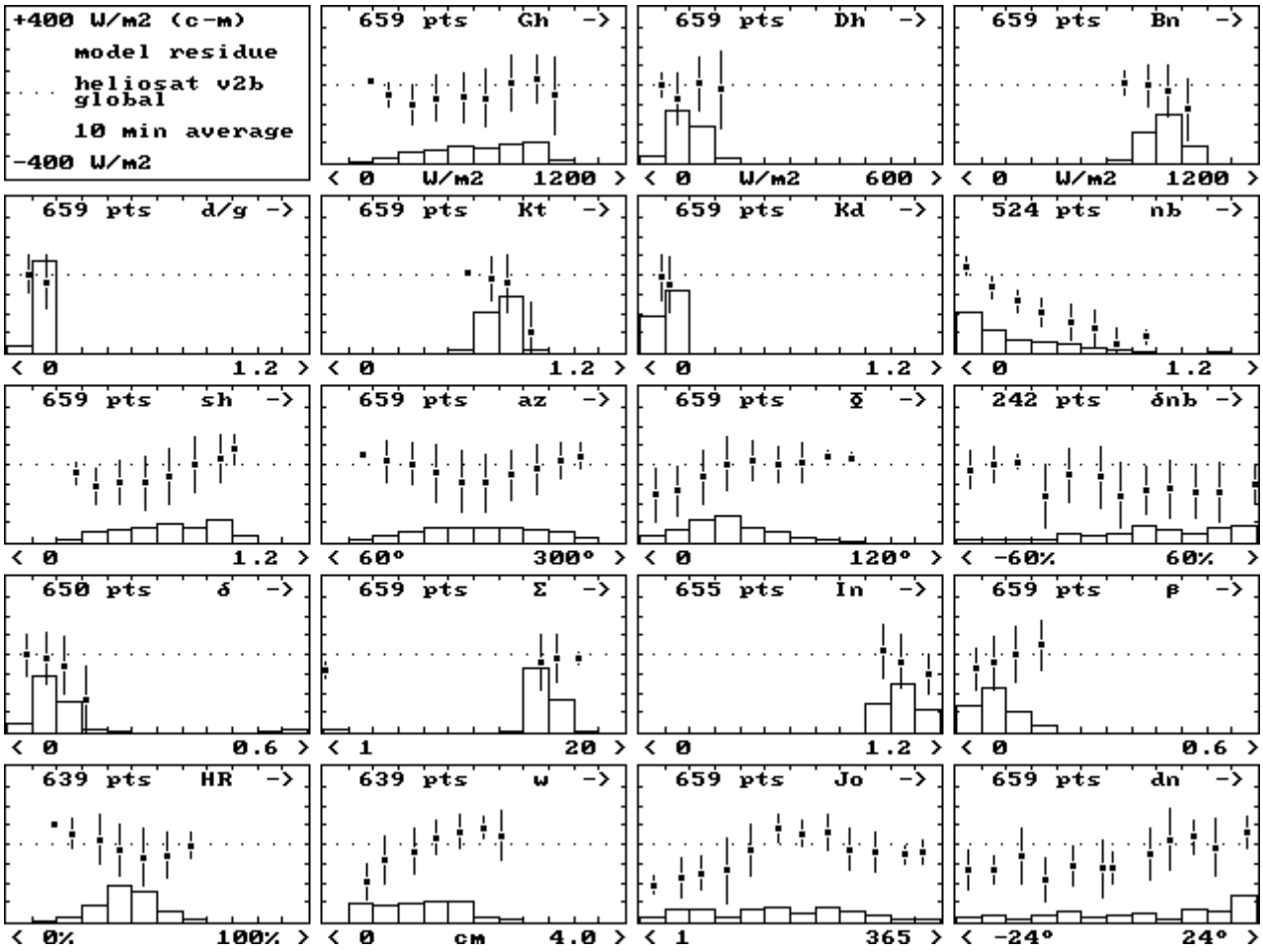

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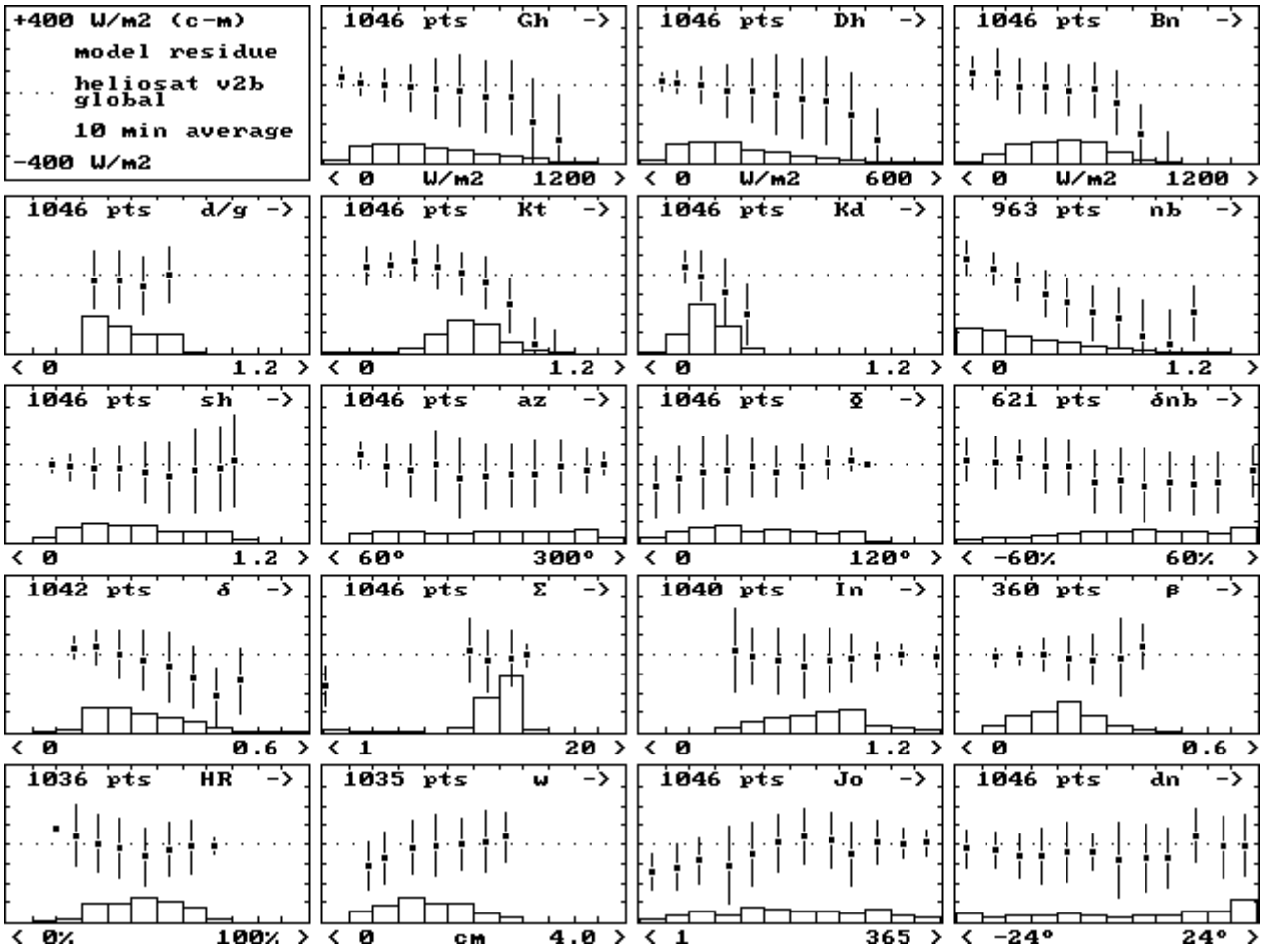

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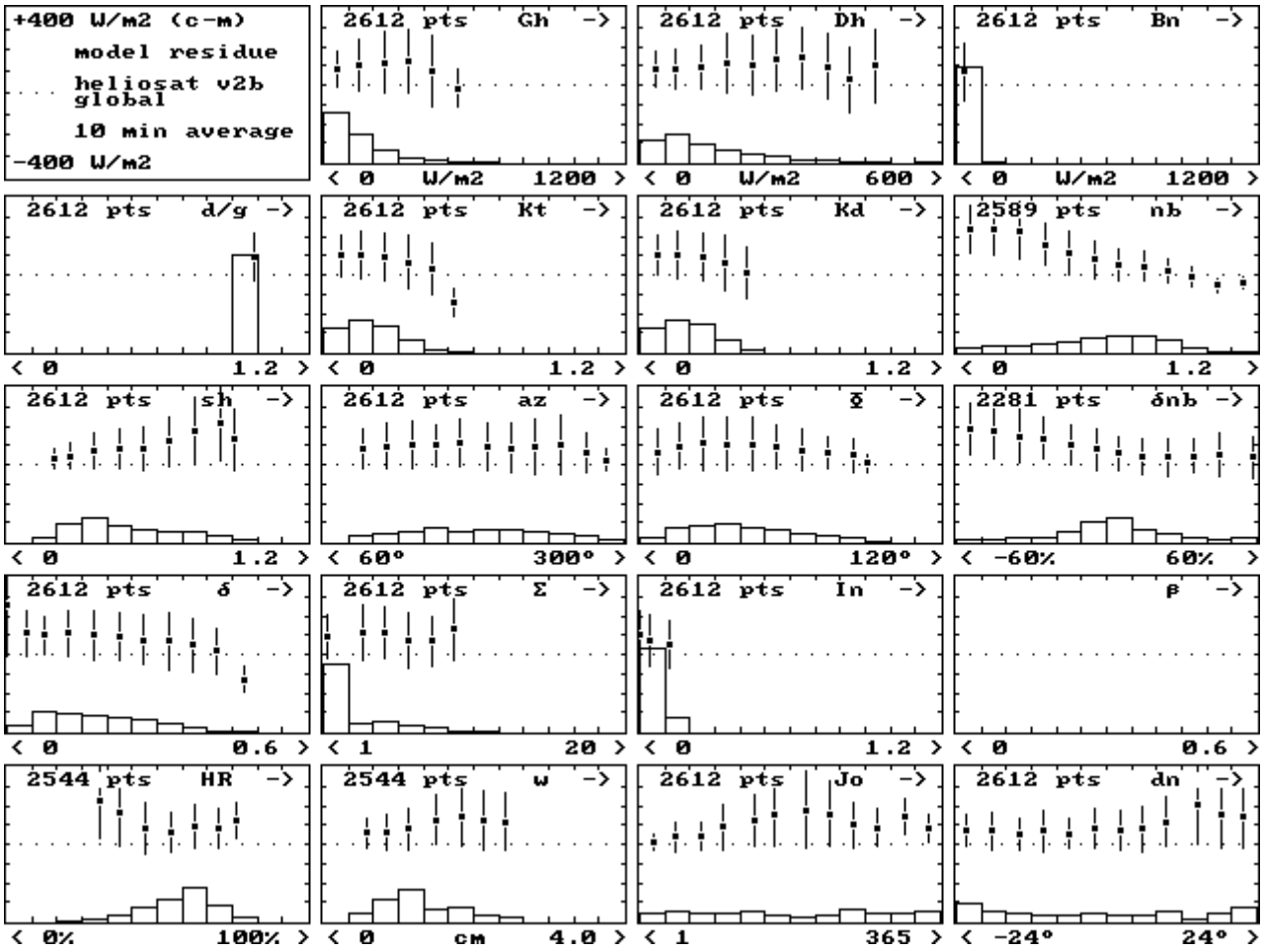

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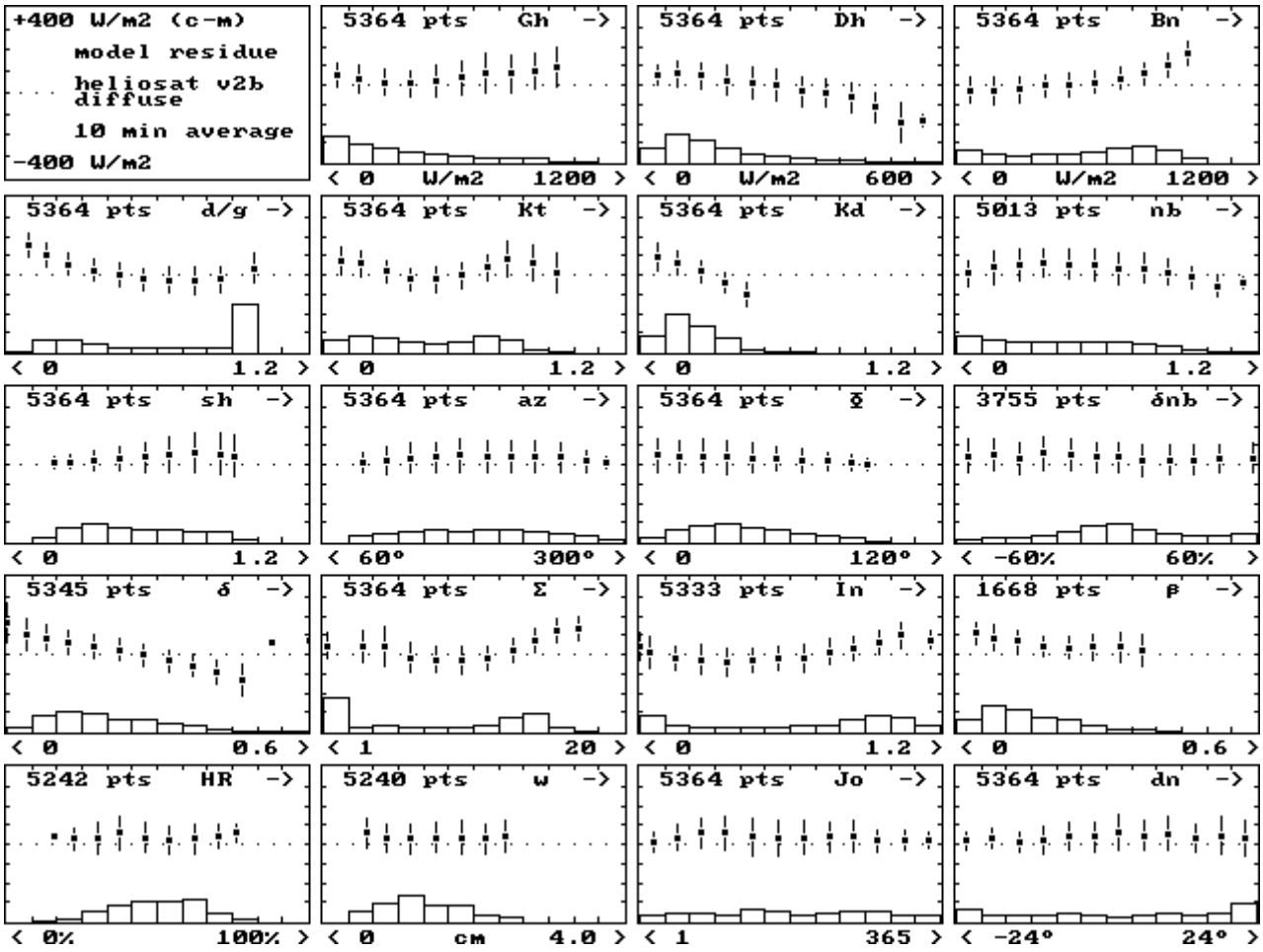

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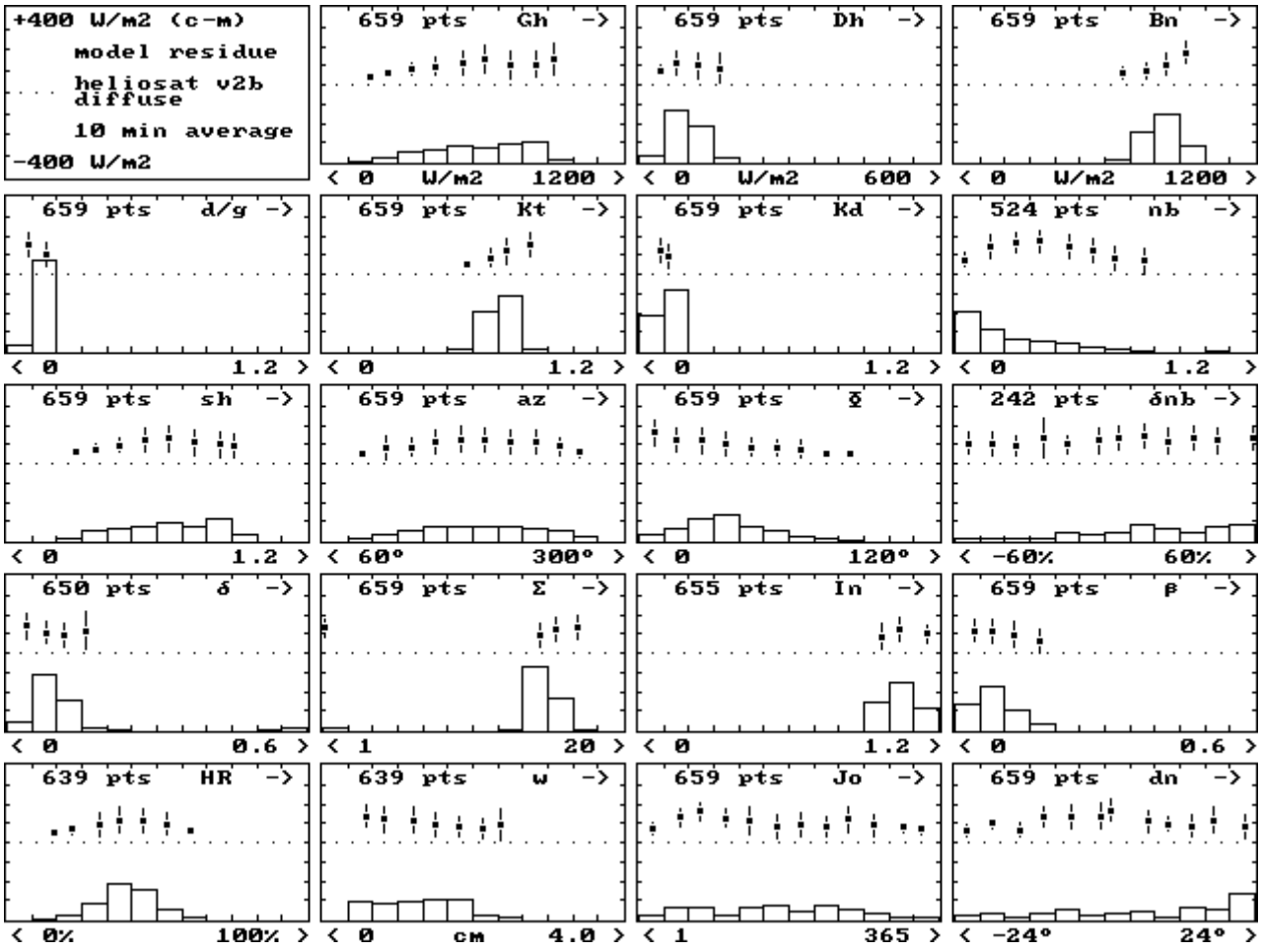

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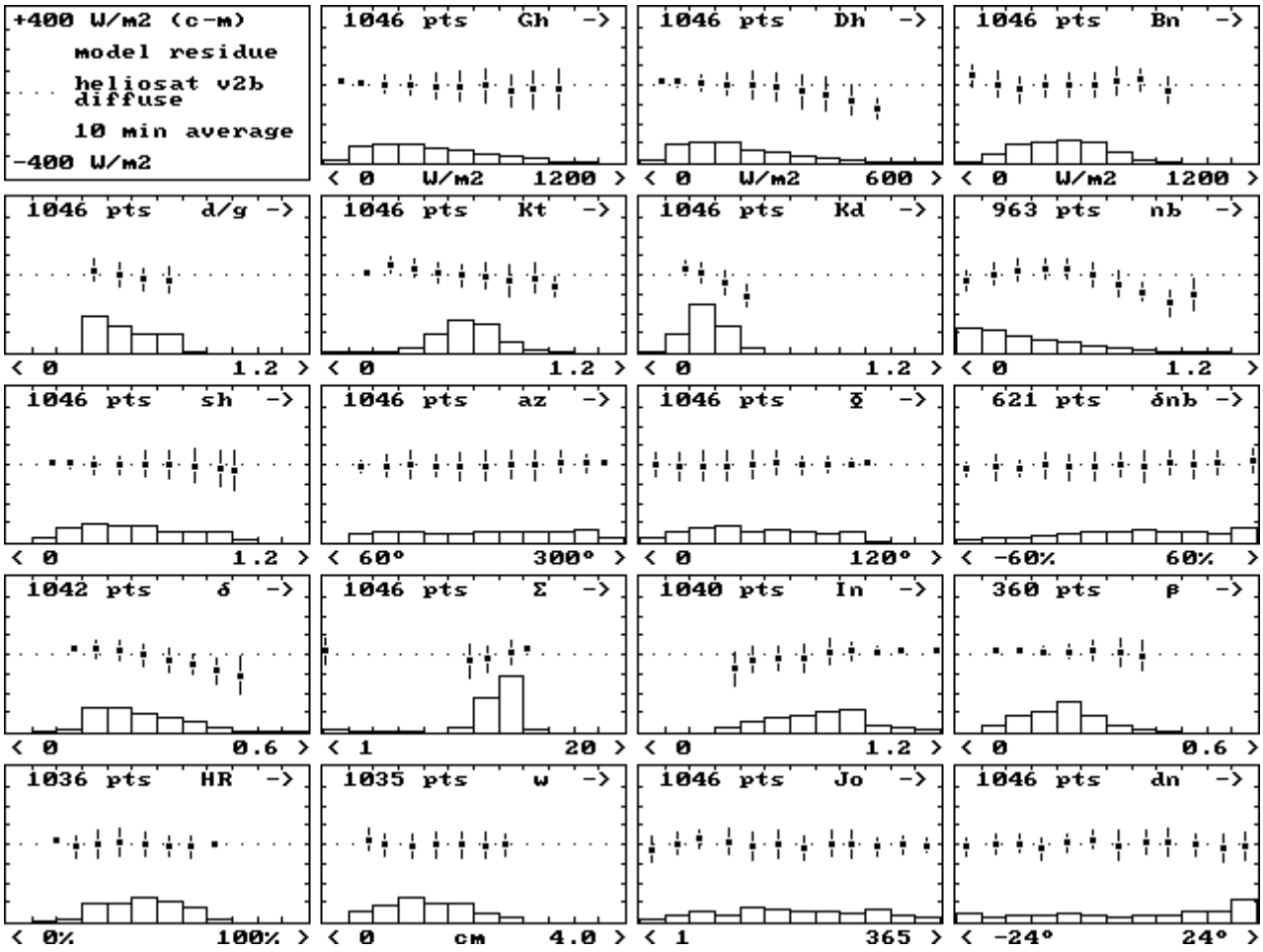

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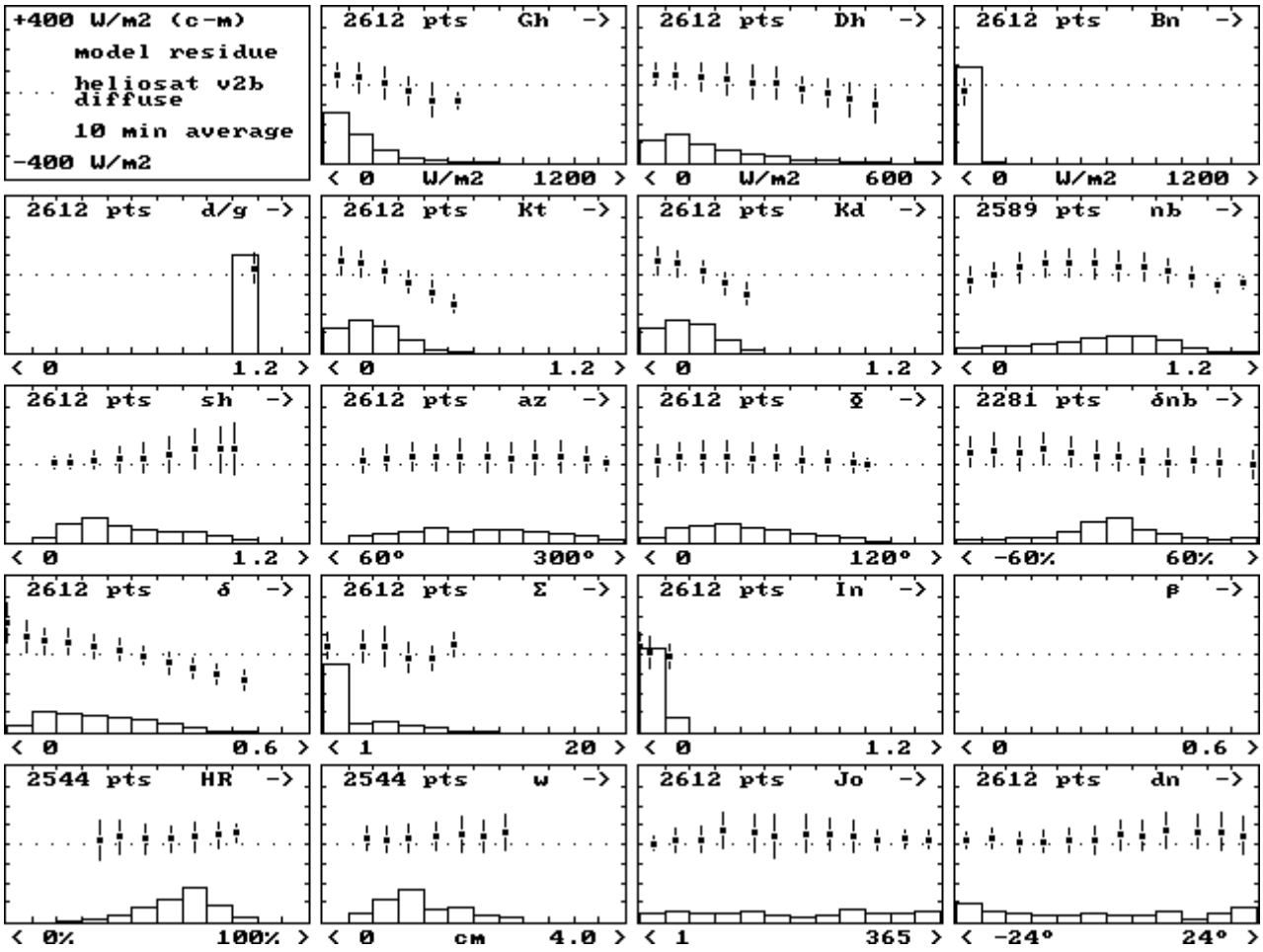

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