

## 2 years of prominence-observations with a PST

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### Introduction

Since June 2005, I observe the Sun in H-alpha with a PST, following the methodology of the Belgian Solar Section<sup>1</sup>. The prominence number  $R_p$  and the number of hearths  $H$  (prominence groups) are determined per hemisphere. Since August 2005, drawings are being made systematically and also the positions of the prominences are determined. The drawings provide some typical features of the prominences, like e.g. their height. The position of the prominences is calculated from time measurements<sup>2</sup>. As a consequence, each hemisphere can be divided in a main zone (from  $0^\circ$  to  $50^\circ$  latitude) and a polar zone (from  $50^\circ$  to  $90^\circ$  latitude). The results presented here only apply to prominences, and cover the period from August 2005 to October 2007 during which 143 observations were made (Figure 1). There were no observations in April-May 2006, due to repairs of the PST. This was taken into account when smoothing the results. The seeing exhibits a seasonal variation around  $Q=3$ , whereas the background brightness (Wedel) remains stable at  $W=2,3$ .

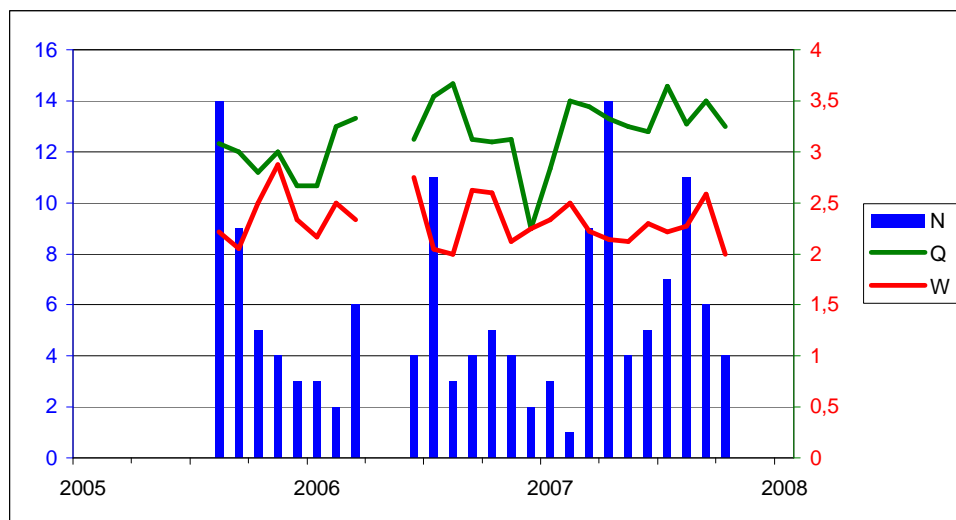


Figure 1. Evolution of the monthly number of observations  $N$ , the seeing  $Q$  and the transparency  $W$ .

### Comparison with BAA

Both the Belgian Solar Section (BSO) as the British Solar Section (BAA) publish their results in a monthly Newsletter<sup>3</sup>. They contain an entire section on H-alpha observations, mentioning also the MDPF (Mean Daily Prominence Frequency). The definition of “MDPF” (BAA) equals that for “H” (BSO), but already after a few months it became clear that the BSO-results were significantly higher than BAA’s. In a study<sup>4</sup> late last year, the principal reasons for this deviation were that BSO also counted detached prominences, and that –in concert with the German solar section Sonne- a prominence was already counted if it’s height was 1% of the solar radius. BAA also does not count active prominences, but these were over the conceived

<sup>1</sup> <http://users.telenet.be/j.janssens/Halpha/Halfaeng.html>

<sup>2</sup> <http://users.telenet.be/j.janssens/Halpha/Halfaeng.html#Kruisdraad>

<sup>3</sup> <http://britastro.org/solar/> (BAA), <http://www.bso.vvs.be/> (BSO)

<sup>4</sup> <http://users.telenet.be/j.janssens/Halpha/Halfaeng.html#BAA>

time period of no influence. If all my initial results are “adjusted” for this (JJ adj), then the new values become much closer to those of BAA (Figure 2). The small –but persistent– difference is probably a consequence of light-poor prominences not seen by BAA-members. A bigger problem are the month-to-month variations. The correlation  $r^2$  between JJ adj and BAA is excellent for the smoothed values (0,98), but for the unsmoothed monthly values it’s only 0,42. Possibly, my low and strongly varying number of observation days per month is the cause.

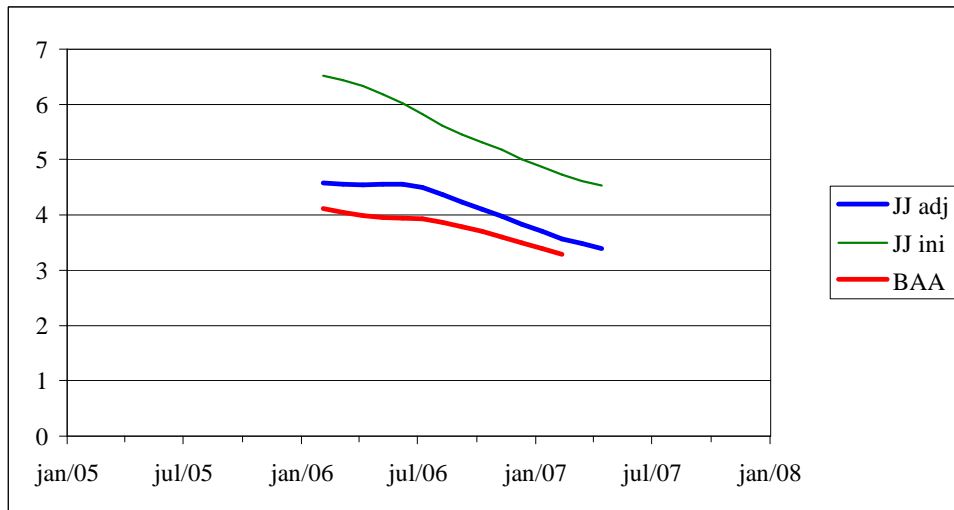


Figure 2. The smoothed number of prominences ( $H$ ) – JJ ini are my initial results, JJ adj are my adjusted results, and BAA are the values of the British solar section.

### Evolution of the prominence number

The prominence number  $R_p$  can be split up per solar hemisphere, and these areas in turn can be divided into a main zone (region up to  $50^\circ$  latitude) and a polar zone (region outside the main zone). The evolution of all these parameters is represented by Figure 3.

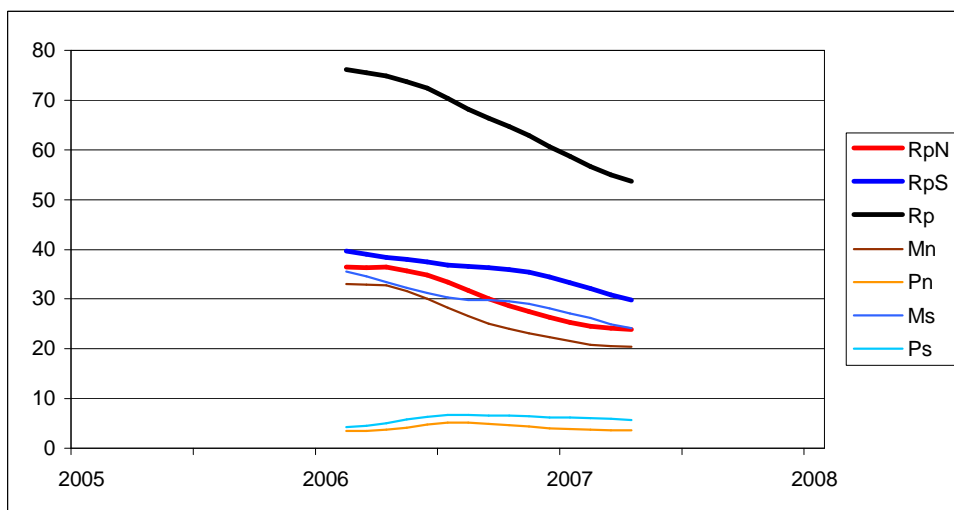


Figure 3. Evolution of the prominence number

It is immediately clear that the prominence activity on the southern hemisphere is higher than that of the northern, and this in both the main and polar zone. The global decrease is manifesting itself especially in the main zones, in contrast to the polar zones, where the prominence number is quite stable. In the northern main zone, there seems to be a

(temporarily?) pause in this decrease. Because the northern hemisphere seems to be about a year ahead both in visual (sunspots) as in H-alpha, it may be worthwhile to follow the evolution on especially this hemisphere. According to Roth et al.<sup>5</sup>, polar prominences appear about 2 years prior to the sunspot minimum, and the number of prominences of the main zone is smallest about a year prior to the sunspot minimum. A sunspot minimum in 2008 is certainly very possible, but 2009 can not be excluded at this time.

### **Prominence hearths and prominence number**

During the last meeting of the solar section (October 2007), it was noted that there exists a very good correlation between the number of hearths  $H$  and the prominence number  $R_p$ . Analysis of my own observations confirms this relationship (Figure 4). The correlation  $r^2$  of 0,99 hints that one of the 2 parameters is no longer necessary. It's quite significant that  $R_p$  is only used by the German "Sonne":  $R_p$  was introduced by Sonne as a less work-intensive alternative for the "Prominence Profile Area"<sup>6</sup>. This is a parameter used by professional astronomers to determine chromospheric activity. To me, it looks like a good idea to continue determining  $R_p$  over an entire solar cycle. If the correlation between  $H$  and  $R_p$  remains as good and/or does not show a significant change, one can still decide to drop  $R_p$ .

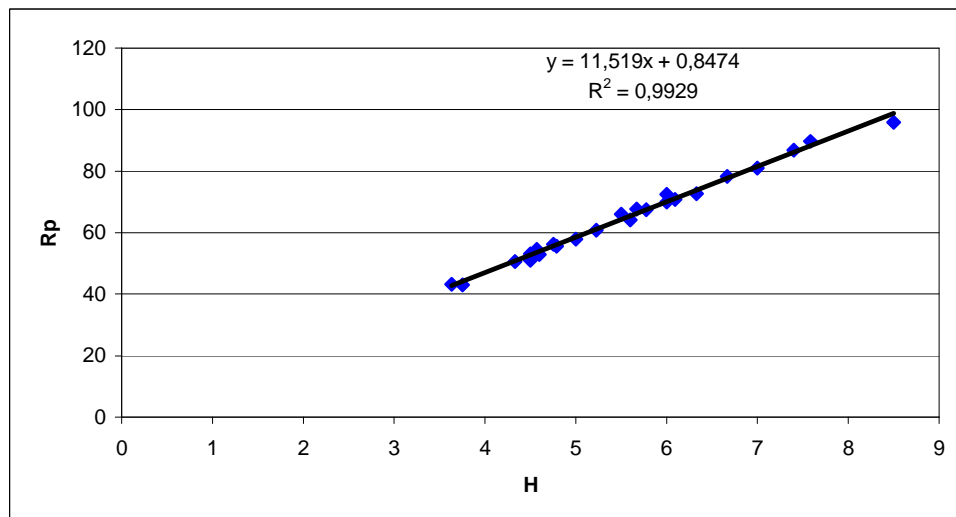


Figure 4. There exists a near perfect correlation between the monthly number of prominences  $H$  and the prominence number  $R_p$ .

### **Height of the prominence hearths**

From the drawings, the size of the prominences can be determined based on its height above the solar limb. In this analysis a hearth was considered small if its height was smaller than 5% of the solar radius, big if its height was more than 15% of the solar radius, and medium for values in between<sup>6</sup>. Detached prominences were also included in the results.

<sup>5</sup> G.D. Roth, *Compendium of Practical Astronomy*, Vol. 2, pp. 39, Springer-Verlag, 1994

<sup>6</sup> <http://users.telenet.be/j.janssens/Halpha/Halfaeng.html#Grootte>



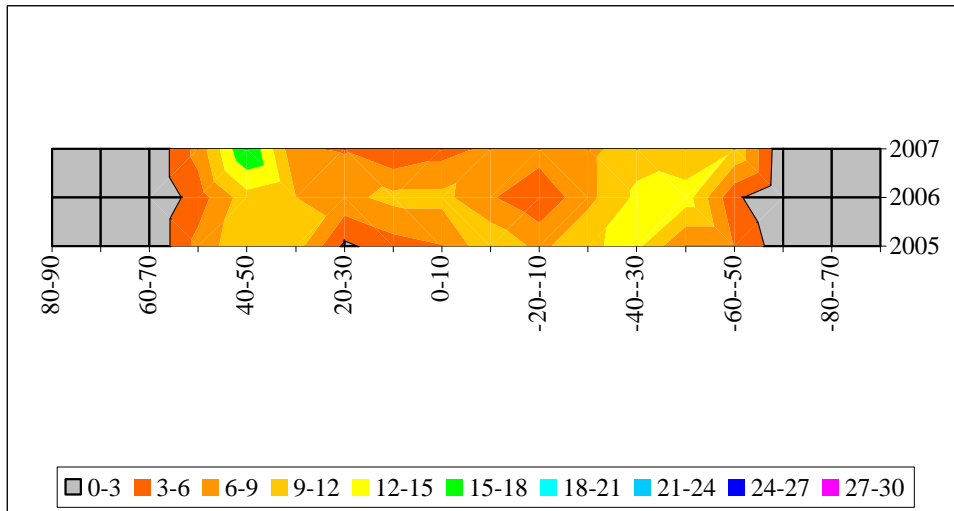


Figure 6a and 6b. Evolution of the yearly percentage of prominences according to their latitude. The top figure shows this in a bar diagram, the figure at the bottom presents a surface diagram. A gradual movement to and increased intensity at higher latitudes is noticeable.

### The thickness of the Chromosphere

For the determination of the latitude of the prominences, one records the time the sun needs to transit over its diameter. This time varies throughout the year, and depends on the distance sun-earth and the solar declination. These timings can be found on my website<sup>7</sup>.

Using my recorded timings in a 1 year graph, this yearly variation clearly exists. There is however one difference: the recorded values are about 2,5 seconds bigger than the calculated ones (Figure 7). Because the calculated values are actually for the photosphere (solar radius = 696.000 km), one could conclude that the thickness of the chromosphere is about 13.000 km. However, there are a few influences in the observations that warrant some caution.

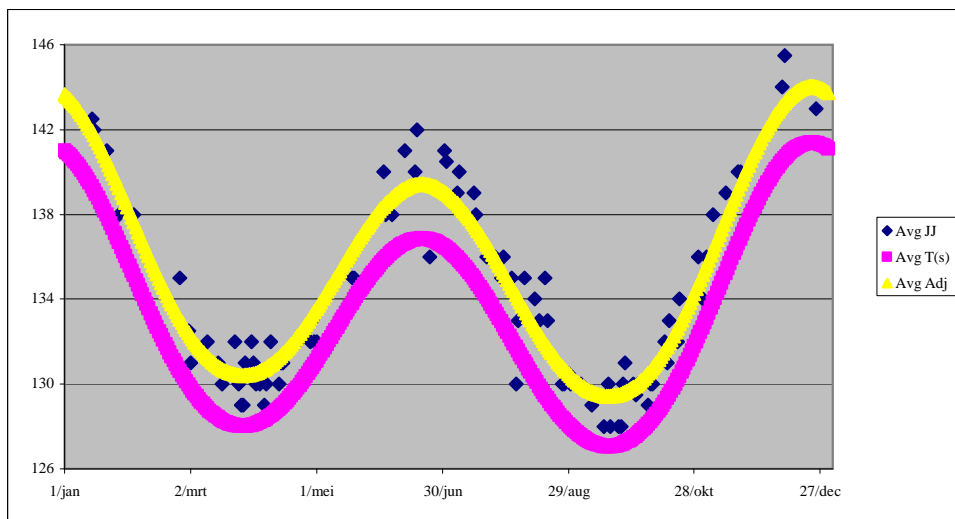


Figure 7. Evolution of the transit time of the sun in H-alpha and comparison with the calculated values for the photosphere. The best fitting curve is about 2,5 seconds higher, corresponding with a thickness for the chromosphere of 13.000 km.

One of the possible influences is without a doubt that the transit times are measured with an accuracy of only one second, using a non-digital watch. That is OK to determine the latitude

<sup>7</sup> <http://users.telenet.be/j.janssens/Engobserveren.html#Solcoord>

of prominences, but most likely causes systematic errors when determining the thickness of the chromosphere. Another influence might be that the sun, when using the time method, should run parallel with the crosswire. A small deviation can quickly lead to major differences in the transit times. To explain the difference of 2,5 seconds, the crosswire should deviate  $11^\circ$  from the true movement of the sun's disk. Such a large deviation should have its influence on the position of prominences. However, a comparison of positions with Rik Blondeel<sup>8</sup> and Solar Monitor<sup>9</sup> revealed this is certainly not the case: the deviation is at most 2 degrees. The thickness of the chromosphere is about 2.000 km. However, this value is an astrophysical quantity indicating the height at which the temperature in the solar atmosphere suddenly increases from about  $10.000^\circ\text{C}$  to 1 million  $^\circ\text{C}$ <sup>10</sup>. Visually, the chromospheric thickness is determined by the spicules that can reach an average height of about  $9.000\text{ km}$ <sup>11</sup>. Because the PST has a resolution of only 4 arc seconds, it's no wonder that the chromosphere looks a bit thicker. A more accurate time measurement may yield a better value for the thickness of the chromosphere.

### **Conclusions**

Although only 2 years with H-alpha observations are available, already some interesting results can be presented. The evolution of all the parameters will become clearer as the solar cycle is progressing.

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<sup>8</sup> <http://www.bso.vvs.be/blondeel.php>

<sup>9</sup> <http://www.solarmonitor.org/index.php>

<sup>10</sup> K.J.H. Phillips, *Guide to the Sun*, pp. 109, Cambridge University Press, 1992

<sup>11</sup> K.J.H. Phillips, *Guide to the Sun*, pp. 107, Cambridge University Press, 1992