Light variations during the predawn solar eclipse of May 31st, 2003 as observed in Belgium

Felix Verbelen

The annular solar eclipse of May 31st, 2003 was seen in Belgium as a large partial eclipse whose maximum phase occurred just before sunrise.

Since we are particularly interested in eclipses and their perception by ancient astronomers, this seemed to be an unusual combination of circumstances, certainly worth to be investigated.
In particular we wanted to measure the effects of the partial eclipse on the predawn twilight, since it was unclear how this would be affected, if at all, by the eclipse on the morning of May 31st, 2003.

The local eclipse circumstances were as follows:

Time UT	**elevation Sun**	
02h37m	-7°	1st contact
03h31m	-1°	maximum eclipse (magnitude = 89%)
03h34m		*sunrise*
04h28m	+6°	last contact

The measurements

The observations were carried out from my home at Kampenhout (Belgium), using the same light detecting equipment as was used in France for the August 11th, 1999 total solar eclipse. For some more information on this home-made automatic light recording device, see also
http://user.online.be/felixverbelen/selight.html

Co-ordinates of the light detector
Longitude = 50°57’04” North
Latitude = 04°35’45” East
Altitude = 18 m above sea level

The LDR-detector was put in place at a high point of the house and permanently directed to the zenith. The detector was connected to an old 80486-desktop via the same interface as in 1999 and operated by the same self-written software.
The software is so designed that 3 successive light measurements are performed, from which an average value is calculated; this value is written to the hard-disk and then the system is stopped for 1 second before handling the next set of measurements. In this way, a value for the ambient light intensity is obtained approximately every 2 seconds, which is felt to be more than sufficient for our aim.

For comparison, a similar backup system was put in place. This second light recording device was made up of an identical LDR-detector and connected to a second 80486-desktop - running the same software -, via an interface that was practically identical to the primary one. The LDR detector was located at some 10 cm from the primary one, while care had been taken to avoid as much as possible reflections or other undesired interference.

As was hoped, the results obtained by means of this backup system were practically identical to those of the primary system. So, they will not be presented hereafter.

I order to get a good basis for comparison, the light measurements were started several days before eclipse day.
In the graphs hereafter, only comparison data obtained on May 29th and May 30th, the two days before eclipse day, are incorporated.

Weather conditions

It was very fortunate that on both May 29th and May 30th the sky remained essentially cloudless, with just some morning haze that quickly disappeared after sunrise, and some minor altostratus on May 30th.

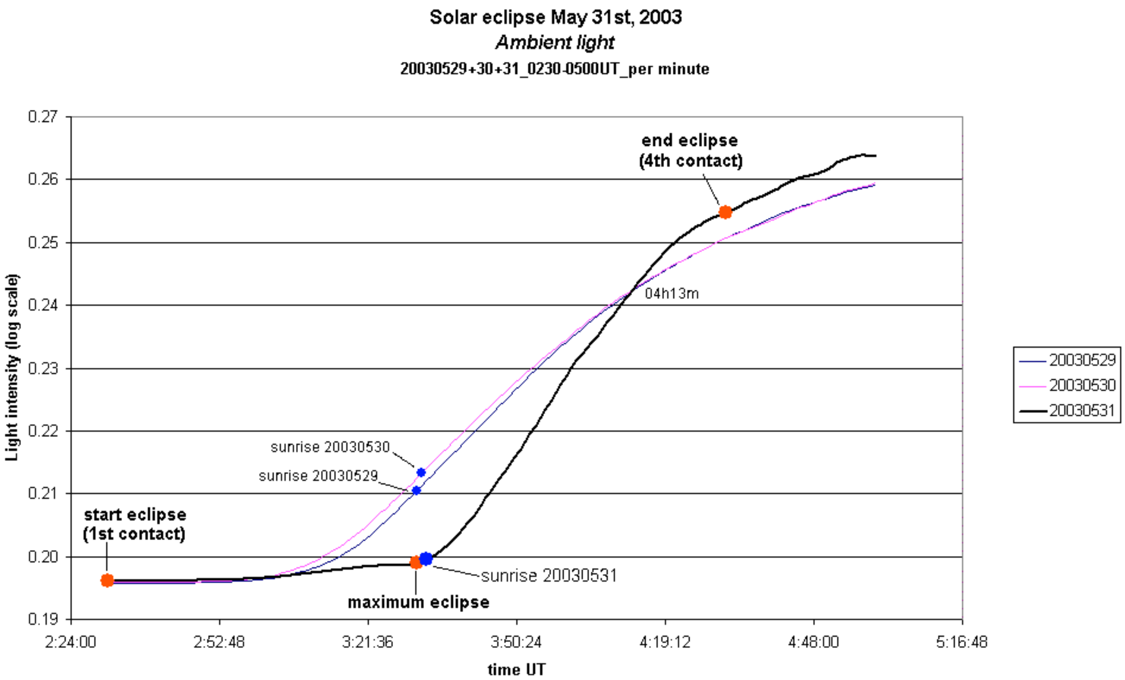
On May 31st, at the time of first contact the sky was heavily clouded, but these clouds fairly rapidly disappeared. By the time of maximum eclipse and thus also at the moment of sunrise, most clouds had gone, except for a layer at the north-eastern and eastern horizon, up to an altitude of some 10°. So, the rising sun remained invisible, while the rest of the sky was fairly clear by that time. Clouds at the horizon slowly moved away while the sun was rising, but by that time a haze layer had developed and prevented direct viewing of the sun.
It was 04h08m UT when, at last, the sun was seen by the unprotected naked eye as a beautiful dark red ball, still partially eclipsed by the moon.
At 4th contact (end eclipse) the sun had moved to the edge of the haze layer, almost into the blue sky. But soon altostratus and perhaps cirrostratus clouds developed, making the sky look fairly white during the following hours as a result of the light dispersion.

Results

The results of the light measurements are shown in the following charts:

Graph 1

This graph shows the evolution of the ambient light on May 29th, 30th and 31st, in each case between 02h37m and 05h00m.



For this graph, the measured values have been averaged out per minute. The instants of 1st contact, maximum eclipse, last contact and also the moments of sunrise for the 3 days are indicated by coloured dots.

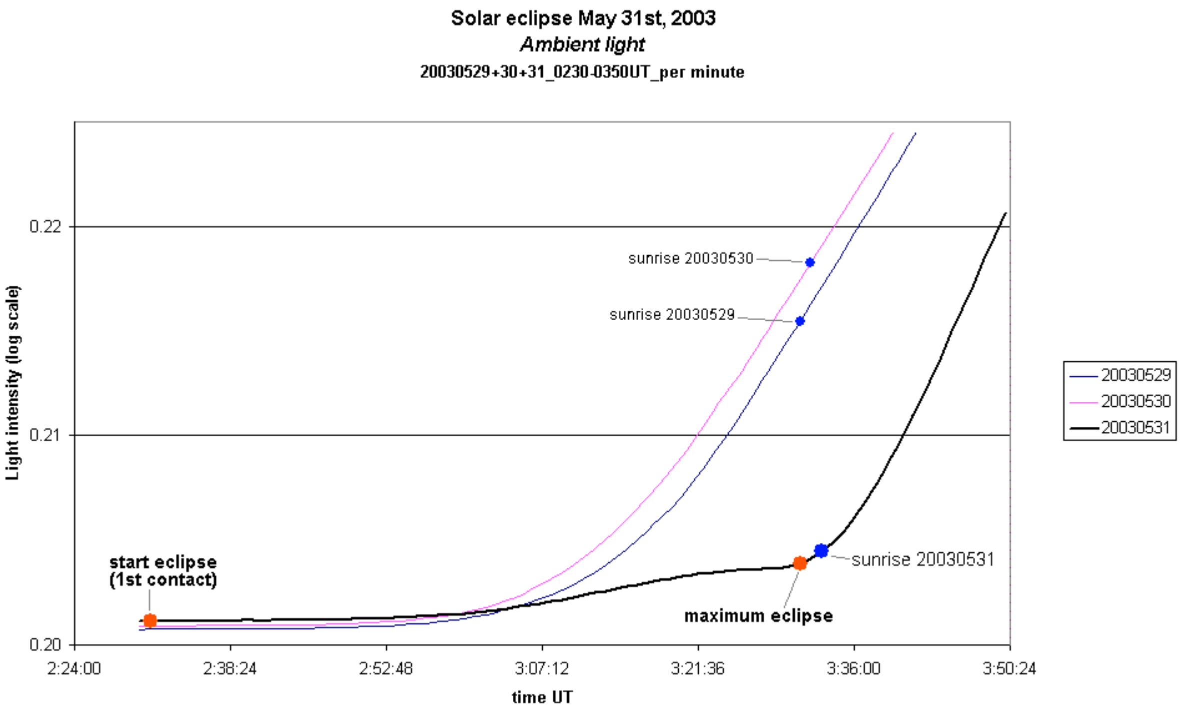
As one can see, the recordings on May 29th an 30th gave very similar results. The ambient light on May 30th was, for some time – say between 03h00m and 04h00m - slightly more intense than on May 30th. This was very probable due to the white cirrostratus on May 30th, causing a greater diffusion and/or better reflection of the solar light.

The results for eclipse day were substantially different.
During the initial phase of the solar eclipse – between 1st contact and 03h00m -, the measured ambient light intensity was slightly higher than on the two previous days. This was certainly due to the cloudy sky which acted as a reflector of the general artificial illumination in the area (moderate light pollution).
This changed dramatically after 03h00m.
Whereas on the previous days the light intensity increased steadily, on eclipse day from 03h00m up to the time of maximum eclipse and indeed sunrise, the ambient light increased only very slightly.
In fact, at the moment of sunrise (03h34m), the intensity of the ambient light was equivalent to the intensity at 03h10m on the previous days.

After sunrise the intensity of the ambient light increased more rapidly than the previous days, but not before 04h13m did the light intensity on eclipse day catch up with that of the previous days.
Subsequently, the recordings showed a greater intensity on May 31st than on May 29th and 30th, undoubtedly because of the white alto- and cirrostratus clouding.

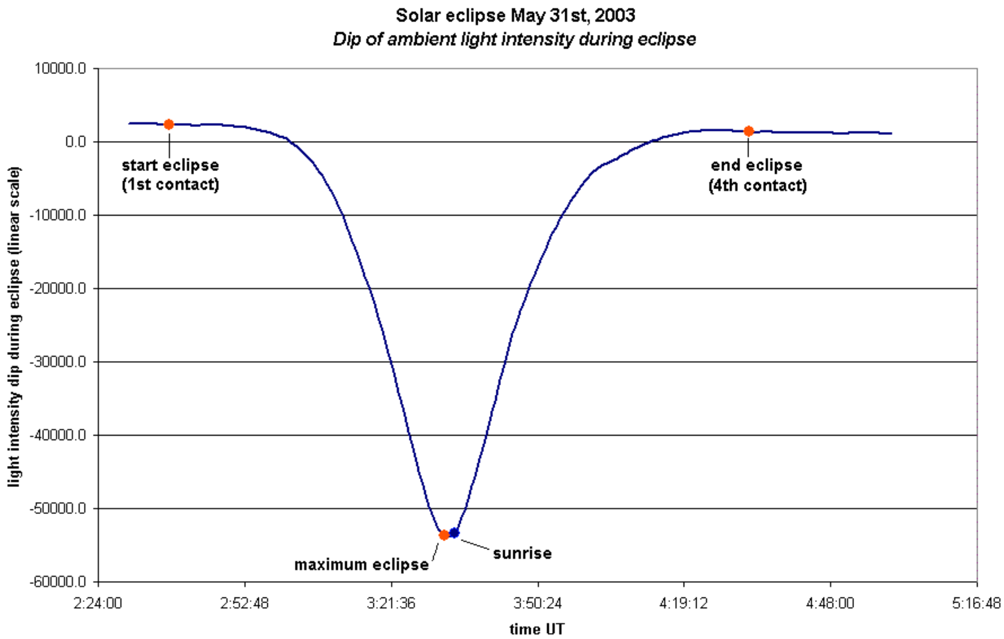
Graph 1a

This is again graph 1, but now zoomed in on the period between the time of first contact and 03h50m UT.
It shows better how the curves separate at about 03h00m UT and how the level of ambient light evolves during the eclipse, before and after sunrise.



Graph 2

For this graph, first an average value was calculated (per minute) from the values obtained on both May 29th and May 30th. This average value was subtracted from the corresponding values obtained on May 31st.



As in graph 1, the instants of 1st contact, maximum eclipse, last contact and sunrise are indicated by dots.
The graph shows a surprisingly smooth dip curve, where the greatest deviation coincides with the instant of maximum eclipse and sunrise.

Also surprising is the fact that the light increase due to the predawn sun approaching the horizon, is more than offset by the increasing magnitude of the partial eclipse.
Moreover, the slope of the light increase after sunrise and decreasing eclipse magnitude is surprisingly similar with the slope of the light decrease before eclipse maximum.

Conclusion

For several reasons the variations of the measured light intensities during both the predawn and the after-dawn phases were unexpected:

- the effect of the partial predawn eclipse (89%) on the ambient light was surprisingly important: the duration of the morning twilight was extended by some 25 minutes, and only by 04h13m - this is almost 40 minutes after sunrise - did the ambient light reach the same level as the previous days;
- the light increase caused by the predawn sun approaching the horizon was almost completely offset by the increasing partial eclipse;
- notwithstanding the fairly complex combination of the light variations caused by the ongoing eclipse, the evolving sunrise and the atmospheric conditions, does the dip curve show a fairly smooth shape and a high degree of symmetricallity.

More detailed data are available on request at felix.verbelen@online.be