1. Occultations as seen by LYRA

We focus this short report to the study of the eclipses monitored by the unit 3 (using silicon detectors). We have studied 12 eclipses spanning from the 19th November to the 8th December. The figure 1 represents the mean values for the four channels of the unit 3 only during the descending phase of the satellite. Those curves are meant to be compared to the model of extinction.

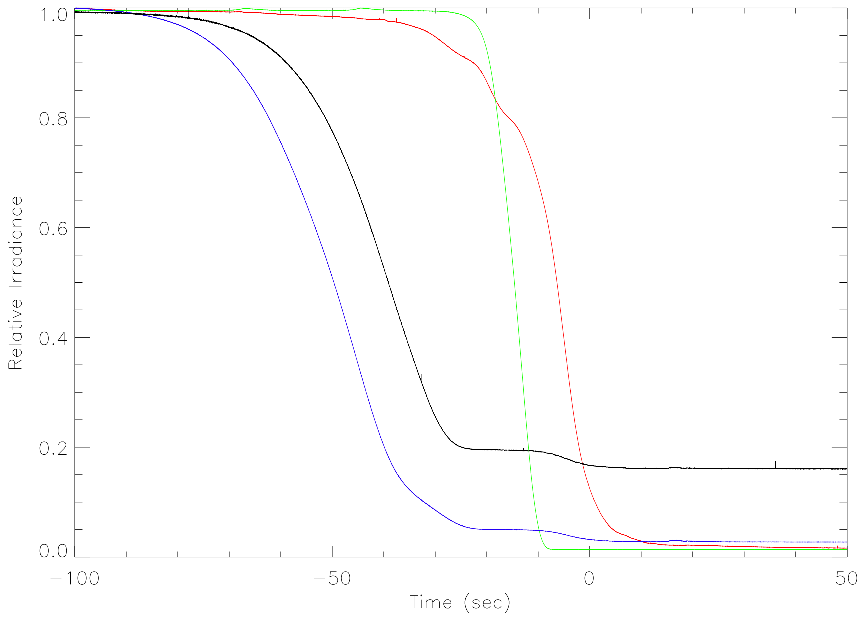

Figure 1. Mean values over 12 eclipses for the unit 3. T = 0 represents the tangential altitude of zero km, i.e. a geometrical occultation.

We can notice that the response of the lyman α channel starts to decrease after the one from the Herzberg channel. One should expect the opposite if we consider the nominal spectral bands of the channel. Silicon detectors are however very sensitive to visible light while diamond detectors (used for the channel 3-2) are not. Contribution for longer wavelengths such as infrared might be also very important for the channel 3-1. This could explain why the channel 3-1 might still have an important signal even after the geometrical occultation.

Let see now the individual behavior for each eclipse.

Lyman α Channel

The measured signals are very close if we consider both descending and ascending phases of the satellite. This general behavior is indeed summarized in

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Figure 2 which shows the descending phase (in blue) and the ascending phase (in red). Both seem to be very similar for one eclipse occurring the last 19th november. Some differences occur however when the tangential altitude of the satellite reaches zero.

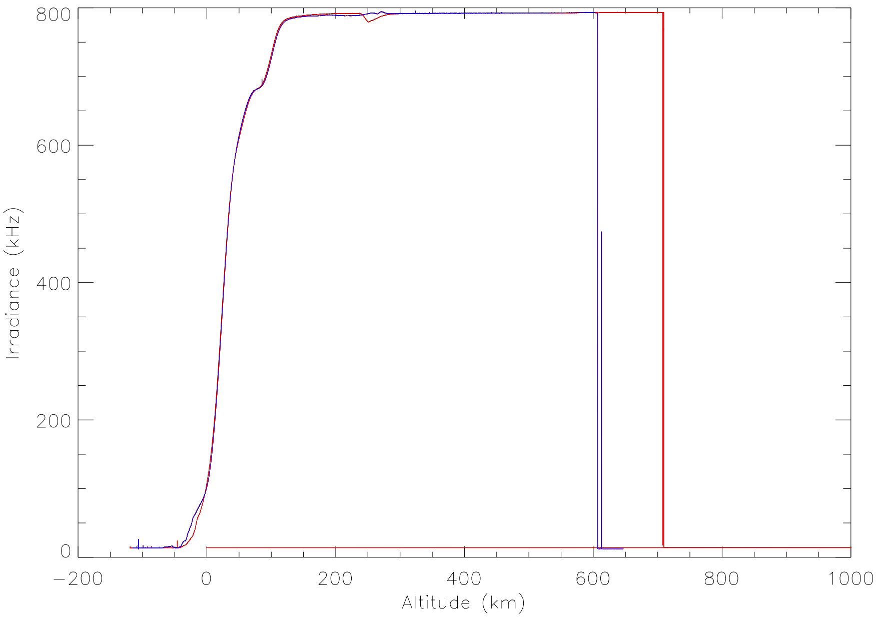

Figure 2. Descending and ascending phase for the channel 3-1.

Figure 3 represents the superposed signal for all the eclipses just for the descending phase we have considered so far (12 eclipses). The response of the lyman α channel appears to be very similar, except one more time for altitudes below zero km (except for one day, where the unit 2 was used). There is indeed here a strange signal, which is not reproducible from an eclipse to an other one (see the figure 4). As the signal for positive altitudes seems very similar for all eclipses, the origin for such discrepancies for negative tangential altitudes might not be du to the Sun. Otherwise, this variability should have appeared sooner. It is however very difficult to determine what causes those strange signals.

Actually several explanations are proposed:

- we are currently in the phase of the Gemenides: meteorites might have been sublimated in the earth atmosphere, and emission from the source or scattered emissions might be particularly important. However, the phase of the Gemenides has began for the 7th December. It could not explain these features prior this date.
- We know that the contribution of the infrared for the unit 3 is quite important (around 800-850 nm). The strange behavior occurs below zero km for the channel 3-1, where infrared emissions are supposed to be more predominant. It could therefore be due to some infrared emissions coming

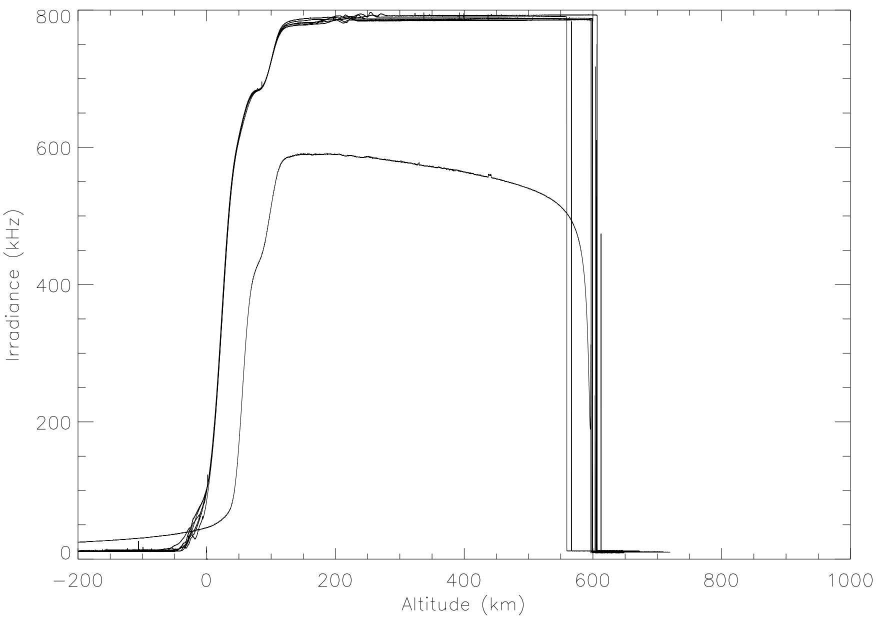

Figure 3. Superposed Signal for the channel 3-1. The signal which is different from the others was monitored by the Unit 2.

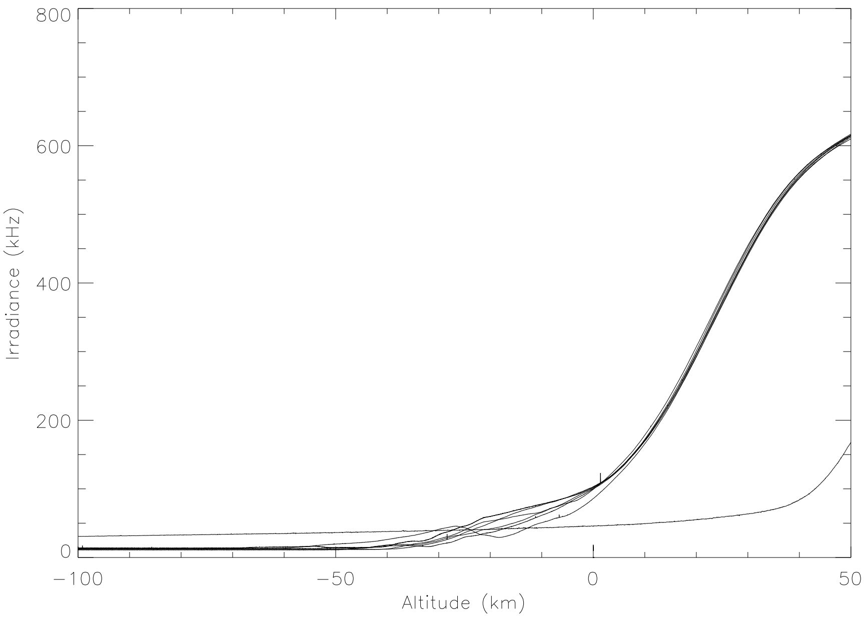

Figure 4. Zoom of the figure 3 for negative tangential altitudes.

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from the earth atmosphere which could explain why we do not have the same signal for each eclipses.

- It could also be due to the contribution of the emission @ lyman α scattered by the earth atmosphere.
- Another explanation may involve a bending of rays due to variations of the index of refraction as a function of altitude.
- Finally, the channel might be sensitive to the airglow of non-homogeneous distributed clouds in the earth atmosphere (Photo-excitation of water leads to the pre-dissociation of the molecule in different states of hydroxyl and oxygen, bands of emission of such species are indeed in Visible and Infra-red).
- These small differences can also be due to the changing perspective of each eclipse as the eclipse season progresses. This could be related to the previous point.

Further investigations are clearly needed to explain what is really happening for negative tangential altitudes, no evident solution has been identified yet.

The figure 3 presents also an eclipse monitored by the unit 2. The variability of this curve is very similar to the curves from the unit 3. It clearly begin to decrease at the same altitude than the curves from the unit 3 so by extension after the Herzberg channel. The first eclipses monitored at the beginning of the year by unit 2 do present another behavior (see the last report from Marie). It clearly means that the response of the channel 2-1 has changed since the beginning of the mission, being more sensitive to longer wavelengths. It is however very difficult to characterize any changes of the spectral response. This is quite an important fact because it may impact the interpretation of the variability from the Sun for this channel. However we need to be cautious in interpreting this response because of the important time response of the diamond detector.

Aluminum and Zirconium Channels

Here the signals from both channel 3-3 and 3-4 do not exhibit the same behavior during the descending and ascending phase. It is summarized by the figure 5 where the normalized irradiance for both channels are represented.

We can see the signal measured by the channel 3-3 during the descending phase of the satellite (in green) then the ascending phase (in black); same thing for the Zirconium channel respectively in red then in blue.

This difference might be explained by the difference in the dynamics of the earth atmosphere, and especially the difference in the ionospheric density during nights and days. Further investigations are needed to understand those curves. A comparison between the extinction model during the sunset and the sunrise is clearly needed. We have moreover checked that satellite's temperature variations do not affect

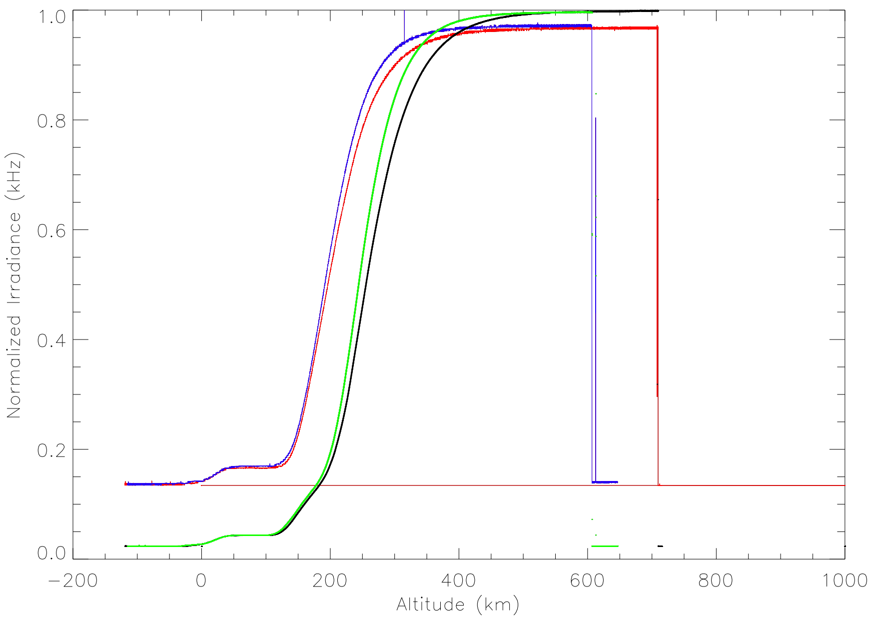

Figure 5. Descending and ascending phase for both channel 3-3 and 3-4 for one eclipse the 19th November.

Finally we could superpose the eclipse as we did for the lyman α channel (Fig. 3). The result is displayed in figure 6. We can noticed here that the superposition is not strong as for the lyman α. This could indeed be explained by the spectral band which the two channels are supposed to be devoted. The variability of the Far Ultraviolet (Channel 3-1) range is less important than the one from the Extreme Ultraviolet range (Channel 3-3). So the earth atmosphere will therefore have a certain dynamic related to this level of variability regarding the spectral range. It might explain why the dispersion over 12 eclipses is more important for the aluminum channel.

We do not see however any strange features for altitude below zero as for the channel 3-1, where infrared emissions might be relatively important. we have no better solution than the scattered lyman α emission to explain these strange signals occurring for latitude less than zero km for the channel 3-1.

Herzberg Channel

This particular channel might constitute in the future a reference curve in order to analyse the degradation of the others channels since the signal is clearly identical from an eclipse to an other as presented in figure 7. Prior the beginning of the eclipse, we may see the degradation. It is basically the altitude/time where the signal begin to decrease rapidly which might constitute a reference.

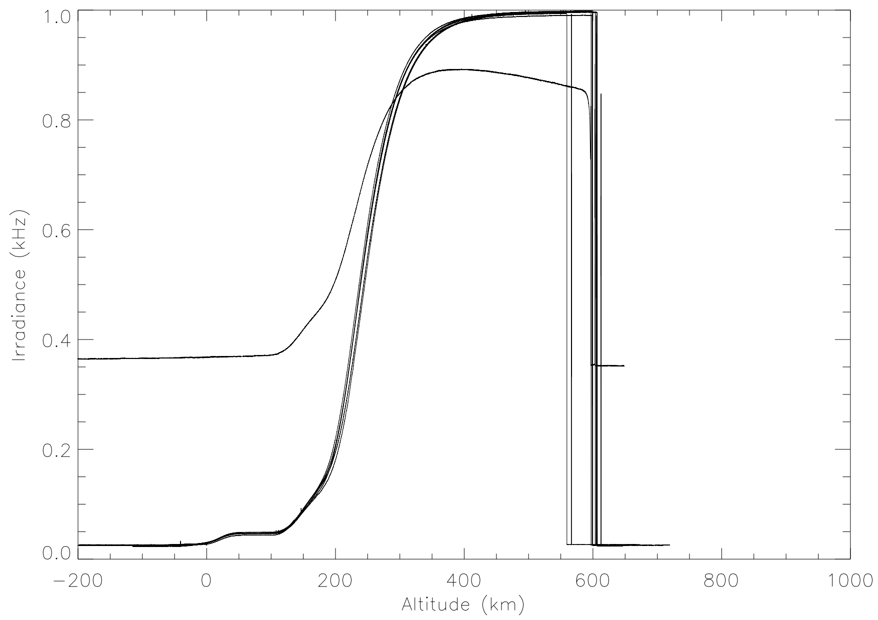

Figure 6. Superposed Signal for the channel 3-3.

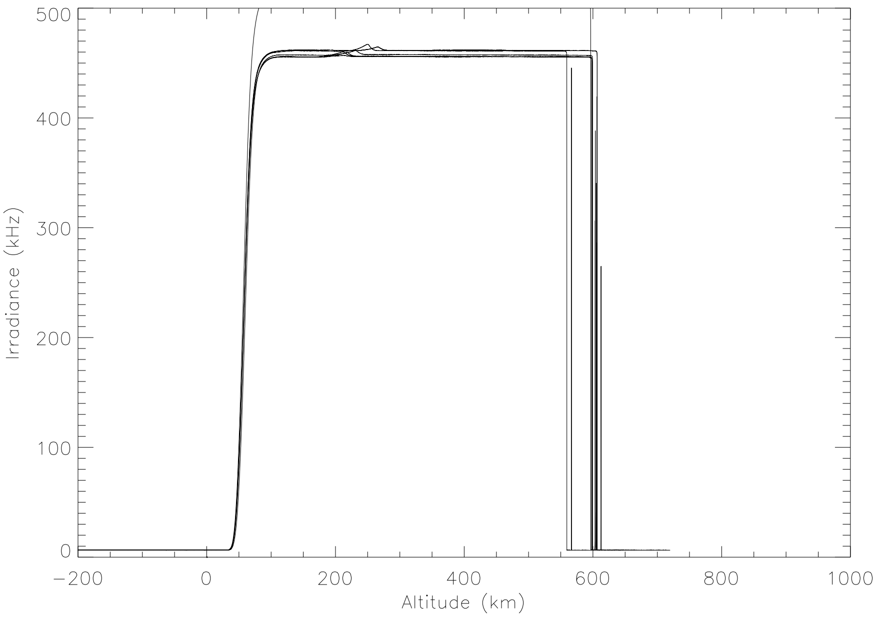

Figure 7. Superposed Signal for the channel 3-2.

The next step is to compare these curves to the model of extinction. This will certainly help to better understand the dynamics of the earth atmosphere.

2. Connection with instrument degradation

We investigate in this section the possibility to study an eventual instrument degradation by comparing the first light as seen by the Unit 3 during an eclipse in January 2010 with those studied in the last section. As we probe different layers (and especially different depth) of the earth atmosphere during an eclipse, spectral bands such as EUV, UV, Visible and Infra-Red are not fully absorbed at the same time/altitude. We first assume that the degradation is only due to filters, if any. Two properties of the signal are here under investigation: first we compare the absolute signal between both signals which may represent the level of sensibility of the instrument, then the shape of the extinction curves which may contains some information about the sensibility of each channel according to the spectral range.

Herzberg Channel

The figure 8 displays the comparison between the extinction curves of the Herbzerg channel for the eclipse of the first light in January 2010 (in black) and the signals measured for three eclipses during November and December 2010 (in colors).

First we may estimate the absolute degradation of the signal since the first light, $\approx 16\%$ of the signal is lost. Between January and December 2010, Unit 3 has been under solar exposure approximatively 50 hours. This could be easily related to the absolute degradation of the signal as measured by the Unit 2.

While a change of absolute sensibility is obvious on the figure 8, we do not see any change about the shape of the extinction curve, meaning that the spectral response of the filter has not changed. So we propose again that this channel might constitute a reference for forthcoming studies as long as this result stands the test of time.

Lyman α Channel

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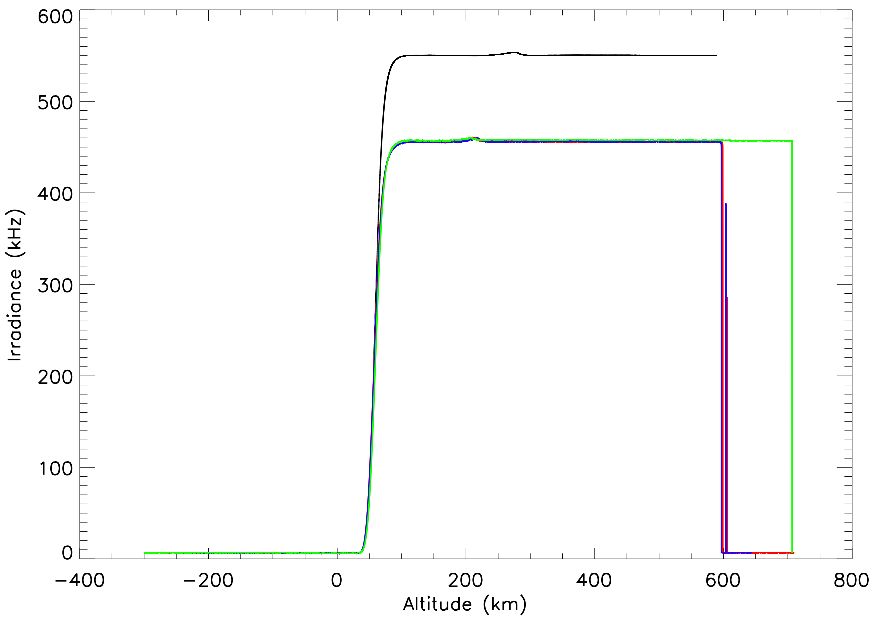

Figure 8. Comparions between the signal measured by the channel 3-1 during an eclipse occurring in January 2010 (in black) and those occurring in November-December 2010 (in colors).

The figure 9 presents also the comparison between the signal as measured by the channel 3-2 during an eclipse occurring in January 2010 (in black) to some occurring in November-December 2010 (in colors). Once again, one could estimate the absolute degradation by comparing the pre-eclipse signal: $\approx$ 19% of the signal is lost.

Here we can also see a change of the shape of the curve at the moment of extinction. It appears for these particular eclipses that signals at early stages of operations do not superpose over those measured in last November-December 2010.

Since we assumed that degradation is only due to filters, we could interpret this difference by a change of the spectral response of the filter: it seems that the channel 3-1 is more sensitive to UV and visible light after 50 hours under solar exposure. We need to study more than one event to conclude about a spectral change of the transmittance: further investigations are clearly needed. This study should be also extended to Unit 2, which was exposed more longer that Unit 3: if a spectral change is indeed confirmed for Unit 3, it could be really problematic to the interpretation of the signal as measured by all the lyman α channels.

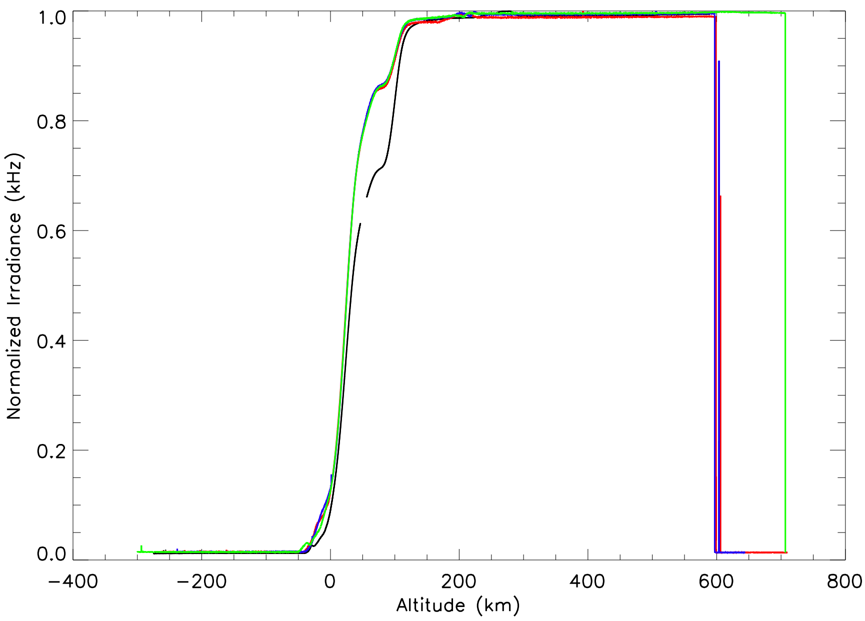

Figure 9. Comparison between the signal measured by the channel 3-1 during an eclipse occurring in January 2010 (in black) and those occurring in November-December 2010 (in colors).

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