On the atmospheric noise observed by ARCHEOPS

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Following the concerns (raised by Francesco Melchiorri) that the residual atmosphere at the Archeops balloon altitude may create problems for the scientific output of the experiment, we have computed with the latest atmospheric models (ATM version 1998 Pardo & Cernicharo) the expected transmission and opacity of the sky at 40 km altitude and 45 degree elevation. Figure 1 shows the result with 0.05 GHz resolution. Most of the lines come from Ozone. The water vapour does not contribute to the curves at these high altitudes. Oxygen makes the 2.5 and 5 mm broad lines. While the transmission of the sky is most of the time better than 90 % over the wavelength bands envisaged for Archeops, the opacity is made of lines that have to be properly integrated in order to get the sky emission in the Archeops filtering system. The atmospheric load on the detector that we deduced is lower but close to the results obtained with the assumption of 0.005 for the atmospheric emissivity (cf. Document Archeops_B). So there is no unforeseen additional atmospheric background.

However, variations of the ozone content between different lines of sight can create a parasitic signal. For example, Table 1 gives the additional signal that will be produced if the gondola goes from the nominal 45 degree elevation to 44 (quite an extreme case). This was calculated with the ATM model and a photometric model of the experiment, using square bandpass channels. The change of airmass is by 1.75%. The effect is more important with increasing frequencies. But even in channel 1, the induced dipole could be as far as a tenth of the cosmological dipole. This pendulation (which will be monitored anyway) will produce an effect which will have to be taken into account for the calibration. More important is the case of potential ozone clouds which will be seen by the travelling and rotating gondola (a phenomenon that many CMB balloon astronomers suspect in their data e.g. early balloons or PRONAOS-SPM). The signal may appear at various angular scales and probably without much reproducible structure (unless one spots a distant large cloud). Say that a cloud is an overdensity of 10^{-3} of the total ozone layer. Then it will produce a signal equivalent to $\Delta T/T \simeq 10^{-5}$ in channel 1 and much more in channel 2 and 3, quite a worrying level. The redundancy of a 24 hour flight and decorrelation techniques (as for ground–based instruments e.g. Diabolo) will be needed to remove this atmospheric noise if present. The channel 3 may become the noise remover and may not bring any scientific output. Channel 2 is intermediate. Note that it is fortunate that this noise has not the same colour as the galactic dust foreground, so that with 3 channels, it is, in principle, possible to remove both effects.

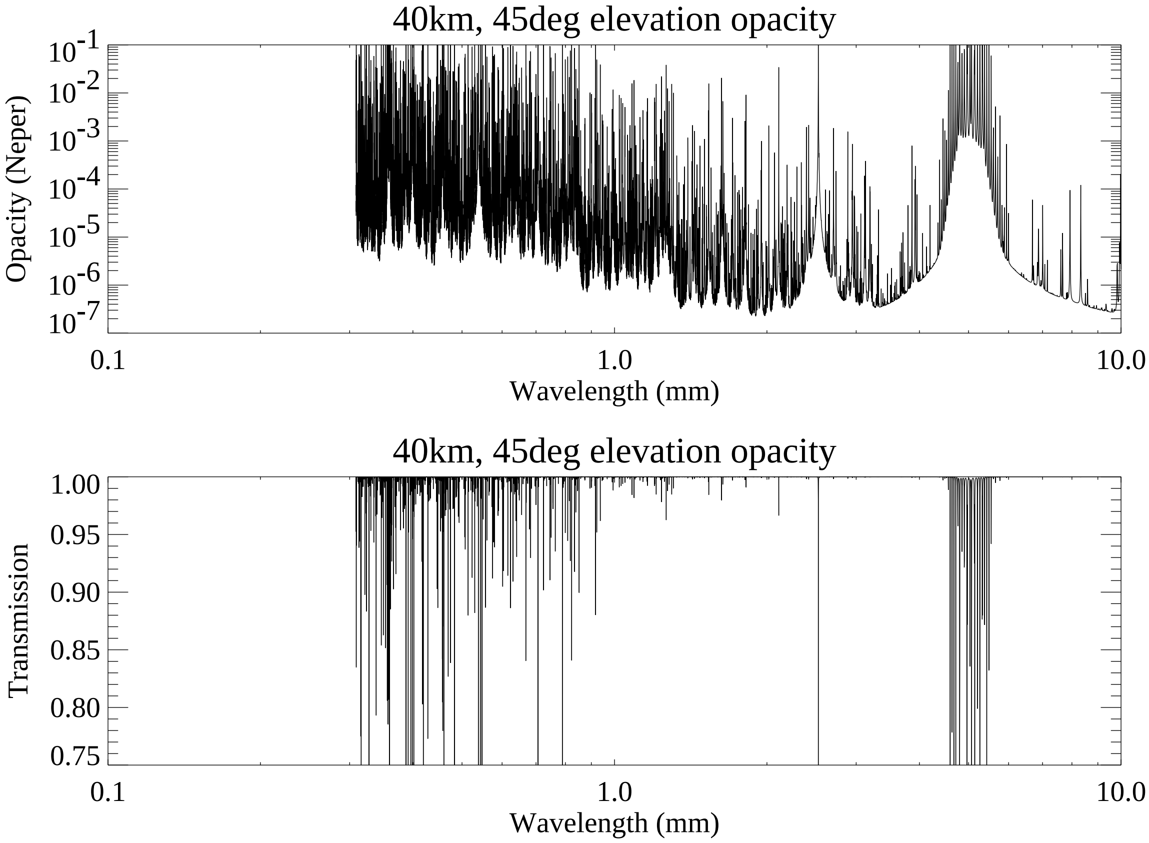

Figure 1: Opacity and transmission of the (sub)mm atmosphere as will be observed by Archeops calculated with ATM model of Pardo & Cernicharo. Resolution is 0.05 GHz.

Table 1: Additional contribution of the atmosphere to Archeops signal in the 3 channels if the elevation changes from 45 to 44 degrees.

P_{atm}/P_{signal}	$\boxed{1}$ 2.1 mm	$\boxed{2}$ 1.4 mm	$\boxed{3}$ 0.8 mm
$\Delta T/T = 10^{-4}$	1.5	6.2	100
$N_H = 10^{20}\,\mathrm{Hcm}^{-2}$	120	130	230
$T_{RJ} = 1\,\mathrm{mK}$	0.25	0.56	2.2
Background	93×10^{-6}	310×10^{-6}	1.2×10^{-3}