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EXTINCTION AND SKY BRIGHTNESS AT DOME C

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Abstract. We have installed a small telescope to monitor the sky brightness around the sun at the French-Italian station Concordia at Dome C in Antarctica. Previous campaigns have been performed with the same instrument at Haleakala in Hawai and Sunspot in New Mexico. We compare here the results of the first year of the campaign at Dome C (2008) to the purest sky observed at Haleakala. We show that Dome C is an outstanding site for coronal observations. Compared to Haleaka, it appears to be more transparent, and to contain less aerosols. Its water vapour content is also significantly smaller. These results still have to be confirmed by the analysis of the 2009 and 2010 data.

1 Introduction

The Sky Brightness Monitor (SBM) is an instrument which was specifically developed for the ATST site survey. It is a modified externally occulted coronagraph capable of imaging the solar disk and sky simultaneously. It is described in details in Lin & Penn (2004). The ability to image the Sun and the sky simultaneously greatly simplifies the calibration of the sky-brightness measurements. The SBM is sensitive to sky brightness below 10^{-6} disk center intensity, with a field of view extending from 4 to 8 $R_\odot$. It measures the solar disk and sky brightness at three continuum bandpasses located at 450, 530, and 890 nm. A fourth bandpass is centered at the 940 nm water vapor absorption band. With measurements of disk and sky brightness at these four wavelengths, site characteristics such as extinctions, aerosol content, and precipitable water vapor content can be derived. This instrument was installed at the Concordia Station at Dome C in December 2007. In the following we analyze data obtained in January 2008 and we compare the results to the ones obtained with the same instrument at Haleakala, by Penn *et al.* (2004).

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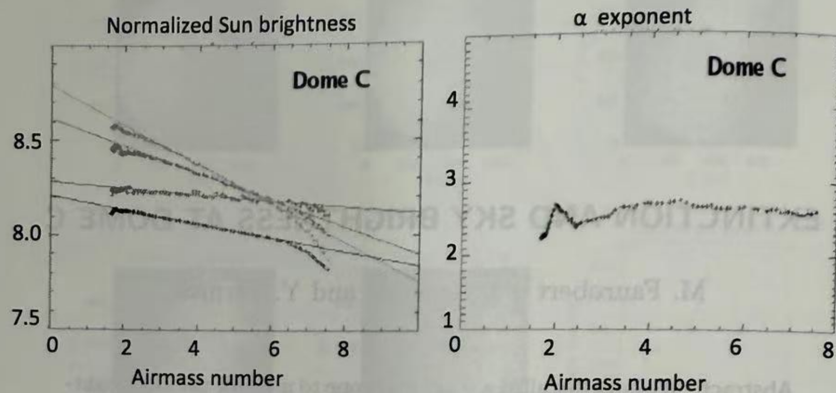

Fig. 1. *Left panel*: normalized brightness of the Sun image on a logarithmic scale as a function of airmass number. Red symbols: at $\lambda = 890$ nm, Green symbols: $\lambda = 530$ nm, blue symbols: $\lambda = 450$ nm, black symbols: water vapor band at $\lambda = 940$ nm. *Right panel*: α exponent of the Angstrom law as a function of airmass number.

2 Extinction and aerosols

Figure 1 shows the Sun image brightness, on a logarithmic scale, as a function of airmass number for the four wavelengths. The linear behaviour of the curves shows that Dome C has a good photometric quality. The extinction coefficient is quite stable during the day. The extinction for one airmass is given in Table 1, where we also show the values at Haleakala. We find that the extinction is smaller at Dome C.

Table 1. Extinction (in %) at one airmass in the four wavelength bandpasses.

wavelength	Dome C	Haleakala
Blue	10%	18 %
Green	7.5%	12 %
Red	1.3%	5%
Water vapor	5%	20%

In the visible domain the extinction is mainly due to scattering by dust particules and by molecules in the atmosphere. The wavelength dependence of the extinction coefficient may be represented by a power law, according to the Angstrom formula,

$$k(\lambda) = C_0 \lambda^{-\alpha}. \tag{2.1}$$

We may derive the value of the exponent α by fitting the extinction obtained in the three wavelength bands between 450 nm and 890 nm. This gives information

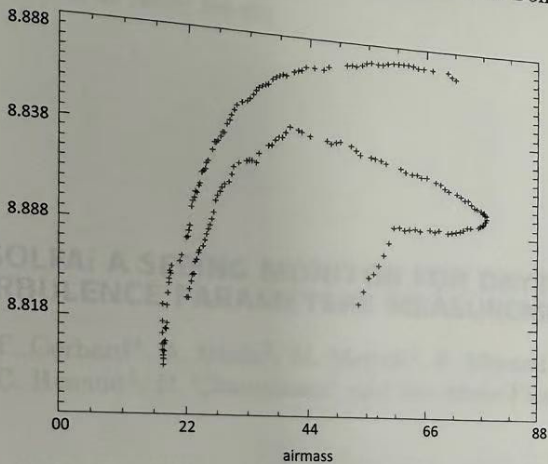

Fig. 2. k_{water} as a function of aimass at Dome C.

on the nature of the dominant scattering mechanism in the atmosphere. If $\alpha = 0$, the extinction does not depend on wavelength, it is due to dust particules, whereas if $\alpha = 4$, the scattering mechanism is Rayleigh scattering by molecules. In realistic cases both types of scatterings occur and α takes values between 0 and 4, depending on the dust content. The smaller the dust content, the closest is α to 4. Figure 1 shows the behaviour of the α exponent as a function of the airmass number. We notice that it is quite stable during day time and that it is between 2.5 and 3. We recall that the α value at Haleakala is close to 2 (Lin & Penn 2004).

3 Water vapor

We can estimate the extinction due to the absorption by water vapor in the water band by writing

$$k(940) = k_s(940) + k_{water}(940), \tag{3.1}$$

where k_s denotes the extinction due to scattering mechanisms, and k_{water} the extinction due to absorption by water vapour. The scattering term is obtained by using the Angstrom law with the value of α derived above. Figure 2 shows the behaviour of k_{water} as a function of airmass number at Dome C for 3 different days. The water content at Dome C is three time smaller than at Haleakala (Lin & Penn 2004).

References

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