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# Dome C site testing: long term statistics of integrated optical turbulence parameters at ground level

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## Abstract

We present long term site testing statistics based on DIMM and GSM data obtained at Dome C, Antarctica. These data have been collected on the bright star Canopus since the end of 2003. We give values of the integrated turbulence parameters in the visible (wavelength 500 nm). The median value we obtained for the seeing are 1.2 arcsec, 2.0 arcsec and 0.8 arcsec at respective elevations of 8m, 3m and 20m above the ground. The isoplanatic angle median value is 4.0 arcsec and the median outer scale is 7.5m. We found that both the seeing and the isoplanatic angle exhibit a strong dependence with the season (the seeing is larger in winter while the isoplanatic angle is smaller).

**keywords:** site testing, atmospheric effects, optical turbulence

## 1 Introduction

The AstroConcordia program has been up to now, dedicated to the qualification of the site of Dome C, Antarctica, for astronomical purposes. After almost 10 years of operation since the first results [1] we could measure long terms characteristics of the turbulent atmosphere. In this contribution we present the results of a decade of turbulence monitoring. We give statistics of the seeing, the isoplanatic angle, and the outer scale during the polar winter and summer. This paper is indeed an update of previously published work: [3] and [4]

## 2 Results

All results presented here come from telescope-based instruments which observe a bright star in the visible and perform continuous measurements of the seeing, the isoplanatic angle and the outer scale. These instruments named DIMM, Thetameter and GSM are described in previous papers ([2], [3], [4]). Several DIMM were placed at different elevations to sample the seeing inside the turbulent surface layer. One was at ground level (elevation  $h \simeq 3\text{m}$ ) as a part of GSM, one at  $h \simeq 8\text{m}$  (this DIMM is taken as the standard one), and a DIMM was placed over the top of the calm building of Concordia at  $h \simeq 20\text{m}$  in 2005 and 2012.

Statistics for the three parameters are given in Table 1. A big difference is observed between the summer and the winter for the seeing and the isoplanatic angle. The latter is sensitive to high altitude turbulent layers and decrease in winter as the polar vortex drives strong winds in the upper atmosphere.

The seeing is dominated by a strongly turbulent surface layer (SL) whose height is around 30 m. This layer is partly caused by a huge thermal gradient near the ground in winter, and disappears partly in summer ([3]). The winter seeing is then highly dependent of the height of the telescope pupil. Fig. 1 presents the winter seeing histograms at  $h=8\text{m}$  and  $20\text{m}$ . The two-bumps structure corresponds to situations where the DIMM is either inside or outside the SL, and the area under each bump gives the fraction of time spent in each situation. At  $h=20\text{m}$ , the telescope is half of the time in the free atmosphere (FA) and this percentage will increase with  $h$ .

Regarding the outer scale, we here confirm the preliminary value of 7.5m published in [4]). The measurements were made at ground level at  $h=3\text{m}$ . No particular variability was observed between the summer and the winter.

## 3 Conclusion

In this paper we gave an update of the statistics of optical turbulence parameters and confirm the general trends published before: poor conditions at ground level in winter, but superb situation at an elevation of a few tens of meters above the snow where the FA can be attained during a significant amount of time. In the FA the median seeing is around  $0.4''$  ([3]).

	Winter (Apr – Sept)	Summer (Dec – Jan)	Total
Seeing $h=3m$ [arcsec]	2.4 [1.8 – 3.2]	1.0 [0.7 – 1.3]	2.0 [1.4 – 2.8]
Seeing $h=8m$ [arcsec]	1.7 [1.0 – 2.4]	0.7 [0.4 – 0.8]	1.2 [0.6 – 1.9]
Seeing $h=20m$ [arcsec]	0.8 [0.4 – 1.5]	-	0.8 [0.4 – 1.5]
Isop. angle [arcsec]	3.2 [2.3 – 4.4]	6.4 [4.5 – 8.5]	4.0 [2.7 – 5.8]
Outer scale [m]	-	-	7.5 [5.1 – 11.3]

Table 1: Statistics of the seeing at 3 elevations, the isoplanatic angle and the outer scale (Von-Kàrman model). Median value is given as well as the 1st and 3rd quartiles (between []).

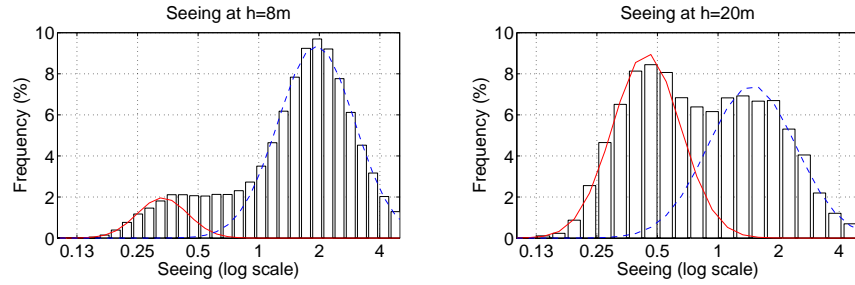


Figure 1: Left: Seeing histogram at an elevation of  $h = 8m$  for the period April to September. Right: Idem for  $h = 20m$  from available data in 2005 and 2012. Red (solid) and blue (dashed) lines are Gaussian fit of the two bumps. The area under them give the fraction of time spent by the DIMM inside (dashed line) or outside (solid line) the SL. At  $h = 20m$  the DIMM is in the free atmosphere 50% of the time (12% at  $h = 8m$ ).

## References

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- [3] Aristidi, E., Fossat, E., Agabi, A., *et al.* 2009, *A&A*, 499, 955
- [4] Ziad, A., Aristidi, E., Agabi, *et al.* 2008, *A&A*, 491, 917