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SYNTHETIC TURBULENCE PROFILE GENERATION

A. P. Orfanoz[1]

Using an autoregressive model, synthetics turbulence time series are created from originals profiles, measured with MASS and DIMM on Mauna Kea, Hawaii, for TMT Site Testing team.

Our goal in this work is to test an autoregressive model used to produce synthetic time series of seeing of manageable length, which retains the statistical and temporal characteristics of the turbulence profiles, and to determine whether the method can be used when the turbulence layers are treated as independent (Herriot et al. 2009).

There are seven turbulence layers, six layers centered around 0.5, 1, 2, 4, 8 and 16 km elevation plus the ground layer under 0.5 km height.

Using the model requires lognormal distributions of the parameter, therefore we work with the base 10 logarithm of $C_n^2 dh$.

The distribution of $\log_{10}(C_n^2 dh)$ is not a lognormal with the exception of the bottom and the top layers. The remaining layers have noise in their distributions (Figure 1) when the turbulence is very low.

To solve this problem and to apply the model, we cut the data at the point above the noise. This cut must be applied to all layers in order to keep them synchronized. This effect biases the distribution, but for the purpose of testing the auto-regression method, this is acceptable.

Using the cleaned up profiles, the autocorrelation function for each layer is calculated, the news profiles are built and their statistics are compared with the original data.

In this case each layer is treated as independent, but to verify this assumption the cross-correlation is calculated between all the layers (all 21 of them). In Figure 2, the crosscorrelations between first three adjacent layers are shown.

The results register a large discrepancy between the statistics of the generated profiles and their input counterparts (see Table 1). This is particularly true for the middle layers, where the cross-correlation is strong. We attribute this discrepancy to the fact that the layers cannot be treated as independent.

[1]Departamento de Física, Universidad Católica del Norte, Av. Angamos 0610, Antofagasta, Chile (aorfanoz@ucn.cl).

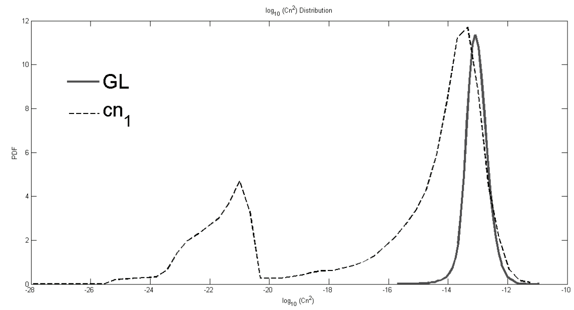

Fig. 1. Distributions of $\log_{10}(C_n^2)$ of the ground layer (GL) and the next layer (cn_1).

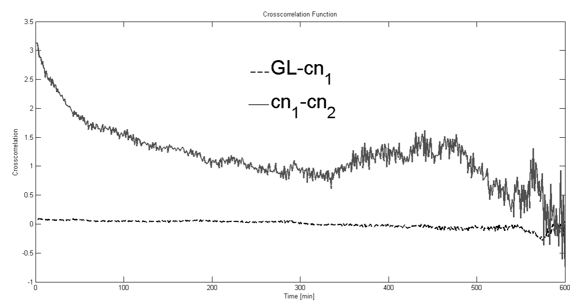

Fig. 2. Crosscorrelation function of first three layers.

TABLE 1

cn_0^2dh N. pts.	Input ($m^{1/3}$) 74054	Output ($m^{1/3}$) 231410	% diff
Mean	$1,3800 \times 10^{-13}$	$1,2393 \times 10^{-13}$	10,1957
Median	$9,2590 \times 10^{-14}$	$9,0993 \times 10^{-14}$	1,7248
STD	$1,5730 \times 10^{-13}$	$1,1578 \times 10^{-13}$	26,3954
cn_2^2dh	Input ($m^{1/3}$)	Output ($m^{1/3}$)	% diff
Mean	$3,6900 \times 10^{-14}$	$5,1755 \times 10^{-15}$	85,9743
Median	$3,9200 \times 10^{-15}$	$3,0675 \times 10^{-15}$	21,7474
STD	$1,6660 \times 10^{-13}$	$7,3012 \times 10^{-15}$	95,6175

Highest and lowest percentage of difference from comparison between real and synthetic data correspond to the ground layer (cn_0^2) and the third layer (cn_2^2) respectively.

REFERENCES

Herriot, G., et al. 2009, OSA Technical Digest (CD) (Washington, DC: OSA), paper AOThB1

`http://sitedata.tmt.org/`