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FRACTAL BASED TECHNIQUE FOR IDENTIFYING MULTIPLE LAYERS IN SODAR ECHOGRAMS DEPICTING FOGGY CONDITIONS

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ABSTRACT

Sodar echogram records the strength of echo returns for upwardly transmitted acoustic pulse. From sodar data, the mixing height can be estimated by employing suitable computer based signal processing techniques [1]. Mixing height is an important meteorological parameter used in aerosol dispersion models [2], [3].

Fog formation has been explained from multilayered sodar data recorded at Maitree station of Antarctica [4]. Essentially, a capping layer forms above the lower inversion layer during fog formation. Multiple layers have been detected [5], [6] using extraction methodology involving Kalman filters to eliminate the measurement noise associated with sodar. Limitation of using such Kalman filter based technique is that some natural fluctuations get suppressed.

To overcome such limitations, fractal based techniques have been proposed for analyzing sodar echograms [7]. The natural phenomenon occurring in the zone of planetary boundary layer exhibits self similarity. Fractal dimension (FD) gives a measure of space-filling [8], which can be mapped to the thermal inhomogeneity captured by sodar in the concerned space-time. FD computation techniques [9] are employed to obtain FD of the time series of intensity data at each height zone. There is a perceptible contrast of FD in the mixing height zone with respect to other height zones.

Multiple backscatter regions form during foggy atmospheric condition. Sodar echograms belonging to fog formed state (Figure 1) have been studied. It is observed that FD stays around 1.2 in the stable region below the mixing height zone. FD value in the region of capping inversion moves up to around 1.6 and then again goes down (Figure 2). The other rise of FD is much above capping and hence not of practical importance.

Advantage of working with Antarctic sodar data is low ambient noise level. The study can be useful for taking environment related decisions from the fractal attribute of monitored data.

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[3] Tampieri, F., and A. Maurizi. 2003. "Investigations on Convective Boundary Layer Turbulence using Sodar Data." Annals of Geophysics 46: 451–457

[4] K. Gajananda, H. N. Dutta, V. E. Lagun, An episode of coastal advection fog over East Antarctica, Current Science 93 (5) (2007) 654–659

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[6] Sreemoyee Roy and Abhik Mukherjee, Exploring the dynamics of capped inversion of sodar data, Fluctuation and Noise Letters, Vol 11, Issue 4, December 2012.

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[8] Falconer, K. 2003. Fractal Geometry-Mathematical Foundations and Applications. Chichester, UK: John Wiley & Sons.

[9] Li, J., Q. Du, and C. Sun. 2009. "An Improved Box-Counting Method for Image Fractal Dimension Estimation." Elsevier: Pattern Recognition 42: 2460–2469.

Attached figure

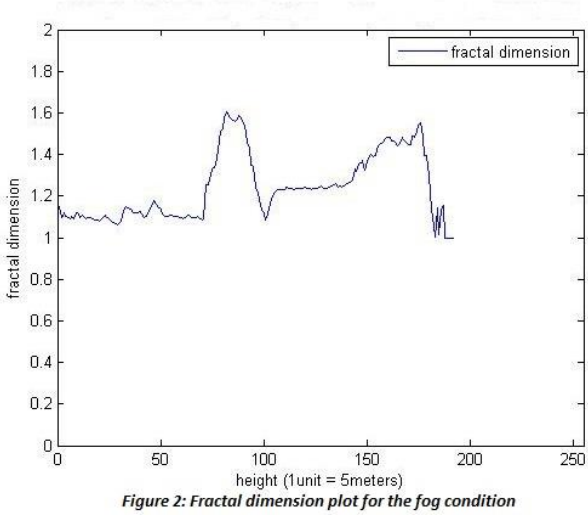

Figure 2: Fractal dimension plot for the fog condition

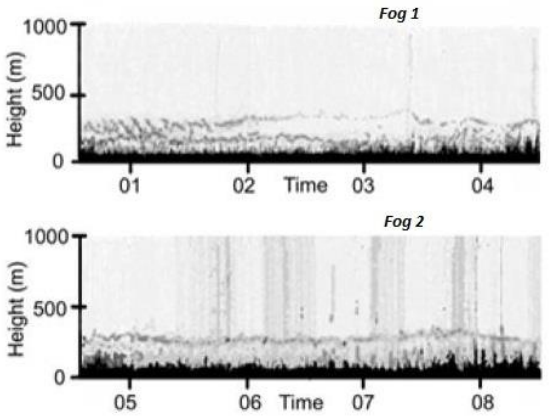

Figure 1: Maitree Sodar echogram of fog condition taken from [4]