CLASSIFICATION OF GTE-ABLE-2B TURBULENT DATA ABOVE AND BELOW THE CANOPY OF THE AMAZONIAN RAIN FOREST USING WAVELET TRANSFORMS

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Abstract

In this work we study the turbulent signal measured above and below the Amazon Rain Forest (GTE-ABLE-2B Experiment) during daytime, in a dry day, in stable conditions, using wavelet transforms. Here there has been a systematic preocupation with the scale optimization of the analysis. Such methodology results in better analysis results and can indicate important physical aspects of the turbulent exchange processes. In this we compare the data from above and below the canopy, with the objective of better understanding the role of the Rain Forest's canopy as physical barrier to the exchange processes of heat and momentum.

1. INTRODUCTION

For a long time the turbulent processes were studied as if they were stationary (Lumley et Panofsky, 1964). However, the technological innovations introduced in measuring and processing the turbulent signal have lead to the conclusion that this signal is essentially non-stationary and intermittent (Mahrt, 1989), even in flow above and below forests (Collineau and Brunet, 1993; Lu and Fitzjarrald, 1994). That requires the use of more powerful methods to analyze it. One of them, the Wavelet Transform (Farge, 1992), was used here to investigate the characteristics of the turbulence above and below the canopy of the "terra firme" amazon rain forest. Intermittency detection and the possibility of statistical estimation of turbulent parameters were also examined.

2. EXPERIMENTAL DATA

The data were obtained on a micometoro-logical tower in Ducke Forest Reserve (2^0 57' S; 59^0 57' W), 26 km from Manaus, AM, during Experiment GTE-ABLE/2B in April-May 1987. More information about the place, topography and climatologic characteristics of the region can be found in Sá et al. (1988) and in Fitzjarrald et al. (1990).

The turbulent quantities studied, the vertical wind velocity (w) and the temperature (T), were measured at 10 Hz with Campbell fast response instruments. w was measured with sonic anemometer and T with thermocouple thermometer. The data were collected in May 5 1987 during the day, from 11 a.m. to nearly 2 p.m., at 45 m above the ground (above canopy) and 23 m above the ground (below canopy). The average height of the forest was 35 m.

The data collected had gaps. Therefore an interpolation was made on those series. The resulting time series had sampling time-interval of 0.4 s. These interpolated series were the actual inputs to the wavelet transformers.

3. METHODOLOGY

The method used to characterize the two data series involved two steps. The first was to calculate Discrete Wavelet Transforms of each time-series. The second was to select at each scale the transform which best represented the physics of the scale according to the Matched Filter Principle (Skolnik, 1962). This principle is widely used in radar enginnering to detect pulses of known form.

4. CONCLUSIONS

The authors have shown that, although every orthonormal wavelet transform is mathematically equally suited to execute a multiresolution analysis of this data series, the analysis can be optimized to each scale.

Sharp structures were detected in the inertial subrange of turbulence, the high-frequency part of the spectrum, while smooth ones are detected in the low-frequency part of the spectrum of the data, where energy is produced.

We showed that the canopy appears to insulate the bottom of the forest from the atmosphere above. This agrees with the conlusions of Shuttleworth et al. (1985).

The smallest scale studied showed clearly a strongly non-stationary behaviour.

Finally, we were reluctant to make straightforward statistical analyses of the signals measured because of the impossibility of insuring ergodicity.

Acknowledgments

This research was partially supported by FAPESP under contract 93/2715-1 and CNPq under contract 300995/92-0 (NV). The authors thank also Dr. David Fitzjarrald, from SUNY at Albany, who kindly provided the data.

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