25PA6 **LIDAR OBSERVATION OF TURBULENT STRUCTURE IN MARINE BOUNDARY LAYER**

Susumu Yamagishi, Hiroshi Yamanouchi, and Masayuki Tsuchiya

Ship Equipment and Marine Environment Division
Ship Research Institute, Ministry of Transport
6-38-1, Shinkawa, Mitaka, Tokyo, 181 JAPAN
Phone: 81-422-41-3123 Facsimile: 81-422-41-3115

## 1. INTRODUCTION

Marine atmospheric boundary layer (ABL) plays an important role in the transportation of pollution. When air pollution is confined to the atmospheric boundary layer, entrainment of non-polluted air will decrease the mean concentration. Thus the calculation of the height of the ABL and of its mean properties as functions of time is of great practical importance.

In order to understand the way ABL develops it is necessary to have insight in the way turbulence behaves, how it is maintained and what its structure is in vertical direction. But, because of difficulties of measurements, the parametrization in higher part of ABL has not been sufficiently confirmed by field measurements. [1,2]

This report describes observations of the marine boundary layer by shipboard lidar in north west part of Pacific Ocean.

## 2. OBSERVATION

On-board lidar[3] observation was carried out Nov. 25- Dec.5 in 1993 from Tokyo wan to off-shore of Minami-torishima. The measurements were performed with the spacial resolution of 7.5m using YAG SHG laser with a 10 Hz repetition rate. The rolling and pitching motions of the ship were corrected according to the trans-vector which uses GPS data. Simultaneously with lidar observation meteorological data were obtained the radiosonde. During the cruise the vertical observations was conducted every half hour. The weather was cloudy, and the wind blew from the west. The maximum rolling angle was 3 degrees.

## 3. RESULTS and DISCUSSION

Fig.1 shows the vertical profile of the higher up in ABL, where data were arranged in time series. The top of cloud was about 1.5km, the base 1km.

Mean velocity : Fig.2 shows the contour of aerosol distribution in higher up in ABL, calculated the data of Fig. 1.

In this figure, the similar pattern persist for longer time compared with the sampling time(0.3sec). From an inclination of the pattern, one can deduce the mean velocity in the ABL, e.g. around 60sec, the up-flow pattern is observed, its velocity of 0.8m/sec is obtained. In this figure, the ABL zone of 525-900m, there was not apparent down-flow component. Even if there was down-flow component, that would be limited higher than 900m.

Turbulent structure: Often it may be assumed that the turbulence is in local equilibrium with the external conditions, that is the turbulent time scale of large eddies is much smaller than the time scale of the change e.g. in the surface heat flux. In this case, aerosol fluctuations seems stationary, the aerosol fluctuations including the maximum scale of time can be analyzed by FFT. Fig. 3 shows the distribution of power spectrum in vertical direction. The quit similar distribution is observed 525-670m, higher frequency is observed above this. The structure of turbulence higher up in the ABL and in the vicinity of capping inversion may be affected by entrainment.

Fig. 4 shows power spectrum of passed fluctuations of aerosol. The spectral distribution of aerosol fluctuations is well agree with the " -7/5 power law " of the pressure fluctuations .[4]

## 4. SUMMARY

As a result of these observations a summery can be made, that the tops of the marine atmospheric boundary layer of 1-1.5km was observed by lidar and radiosonde. Up-flow of the mean velocity was detected by graphical analysis of the lidar scattering. The distributions in vertical direction of spectra of aerosol fluctuations shows that there are zones of the homogenous distribution. The spectral distribution of aerosol fluctuations is well agree with the " -7/3 power law " of the pressure fluctuations.

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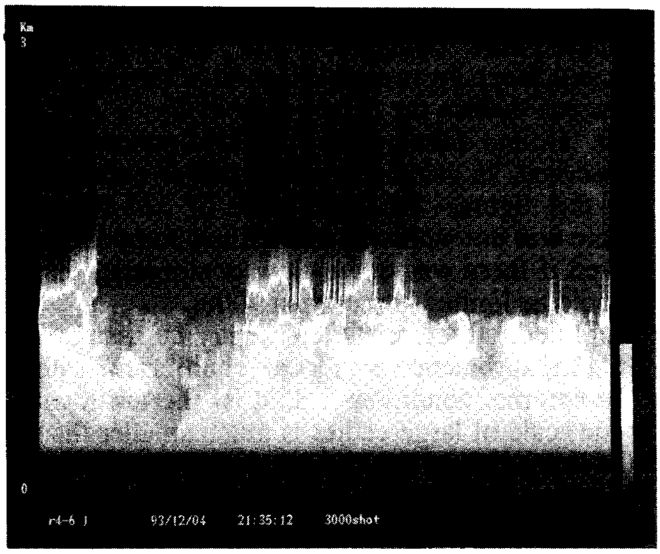


Fig. 1 Evolution in time of aerosol profile in vertical direction of the marine boundary layer observed by the shipboard lidar. 21: 35, 04/12/93

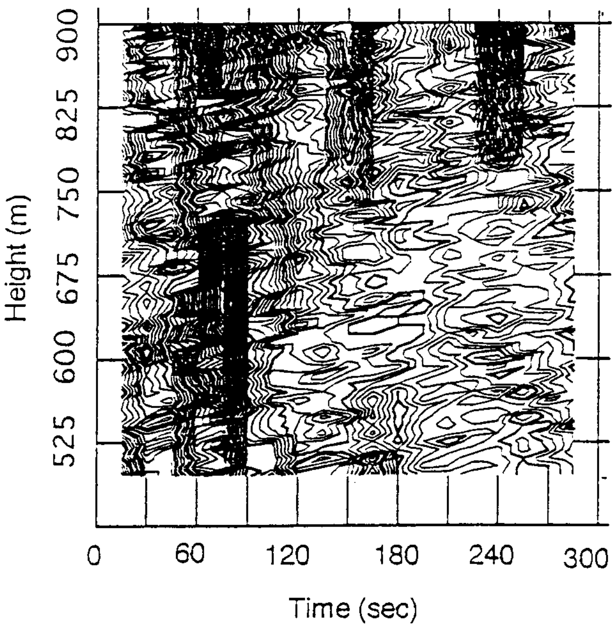


Fig. 2 Contours of aerosol distribution in higher up in the ABL. 21:35, 04/12/93

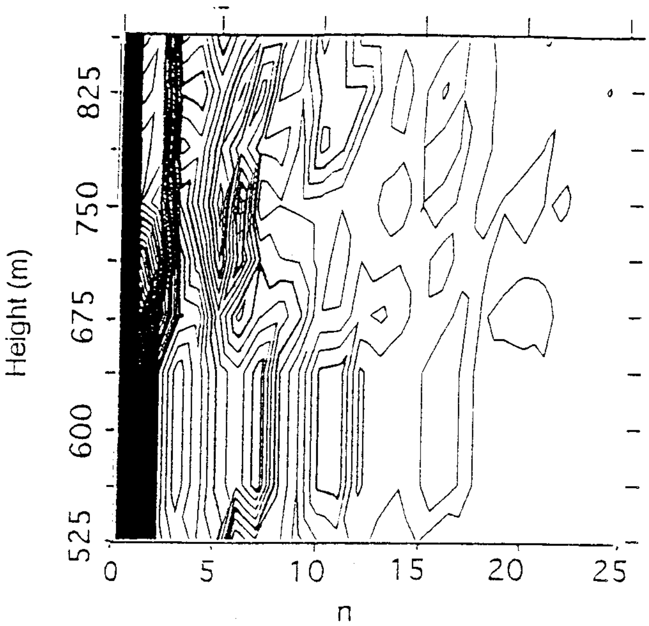


Fig. 3 Spectrum distribution in vertical direction of aerosol fluctuation.

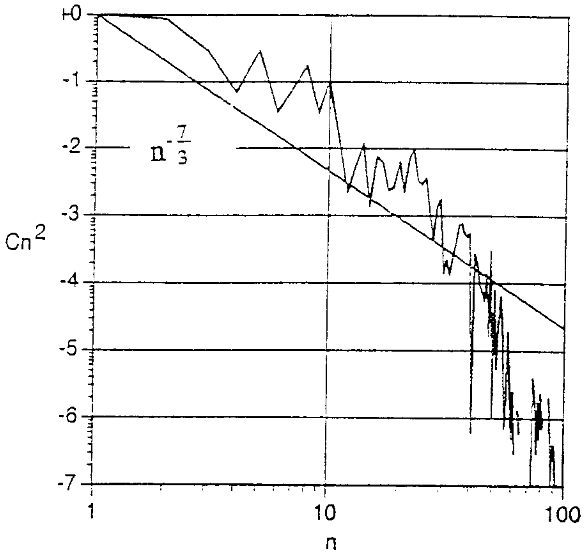


Fig. 4 Power spectrum of aerosol fluctuations, compared with the curve of "-7/3 power law".