IJO-SCIENCE
(INTERNATIONAL JOURNAL ONLINE OF SCIENCE)
ISSN: 2455-0108 Volume II, Issue VI SEPTEMBER

STUDY ON VERTICAL STRUCTURE OF MARINE BOUNDARY LAYER OVER PALAU

S Venkata Raju
Assistant Professor
Department of Physics
D.N.R Degree college,
BHIMAVARAM, West Godavari Dt. A.P
&
K Madhusudhana
Department of Physics
Mahaveer Institute of Science and Technology
Bandlaguda,
HYDERABAD, Telangana.

Abstract:

Atmospheric Boundary Layer (ABL) over land and ocean surface is quite diriment because of the differing dynamic and thermodynamic characteristics of both the surface. The structure and characteristics of the ABL over the oceanic surface, often known as the Marine Boundary Layer (MBL) plays an important role in regulating the surface energy, moisture fluxes and in controlling the convective transfer of energy moisture of the free atmosphere. It is imperative for coupled ocean-atmosphere modelling and numerical weather prediction. PALAU (Pacific Area Long-term Atmospheric observation for the Understanding of climate change) over Aimeliik state of Babeldaob Island (7.45° N; 134.47° E) of Republic of Palau field study can advances our knowledge of marine stratocumulus by providing information on the boundary layer and cloud structure, as well as their diurnal cycle.

An important parameter of the MBL is the MBL height that is controlled by surface forcing and entrainment at the MBL top as well as by advection areas. The MBL height has been progressively recognized as playing a key role in the surface layer turbulence structure, and the interplay of processes at different spatial and temporal scales. The MBL height and its dynamics, which governs ocean-atmosphere interaction, has been the main subject for coupled ocean-atmosphere modelling and numerical weather prediction. Further, the MBL dynamics influence transport, lifetimes and diurnal cycles of aerosols and particulate matters. The marine aerosol particles affect radiation budget and cloud process in a complicated manner because of their complex vertical variability. Hence, the detailed observations of MBL variable are essential to improve modelling and simulation of transport processes, cloud and precipitation development.

Profiler radar has proven to be a superb tool for finding out convective structures and marine boundary layer depth with smart temporal and vertical resolution. a new algorithmic program for MBL height determination has been developed and evaluated its performances using Radiosonde, ceilometers and WRR observations over Palau islands within the Tropical Western pacific ocean. Empirical results obtained from our algorithm show a good agreement with MBL calculable by normal peak choosing technique. Using new MBL height detection algorithm, the diurnal evolution and its seasonal variability has been investigated. The MBL height shows a diurnal variation with its maximum in the afternoon and decrease slowly reaching it in the night. The seasonal variability of MBL height is maximum in the month of April and minimum in the month of September. The effect of solar radiation and low level cold air advection on BML height is investigated. it is clear that, surface solar radiation is responsible for the maximum MBL height in the easterly monsoon period and cold air advection from the surrounding marine atmosphere is responsible for the shallow MBL heights during the westerly monsoon period.

Introduction:

Atmosphere boundary layer (ABL) over land and ocean surface is kind of completely different because of the differing dynamics and thermodynamic characteristics of each the surfaces. The structure and characteristics of the ABL over the oceanic surface, usually referred to as the Marine boundary layer (MBL) plays a crucial role in control the surface energy, wet fluxes and in controlling the convective transfer of energy wet to the free atmosphere. It is imperative for coupled ocean-atmosphere modelling and numerical weather prediction. Analysis on MBL dynamics, structure and cloud-radiative processes has long been hampered by an absence of appropriate observant systems for the oceans. Moreover, the open ocean measurements of MBL structure are usually difficult because of unavailability of a stable platform over the oceanic surfaces.

Data base and Methodology

In this study, observations from wind profiler radar, Ceilometer, Disdrometer/Micro Rain Radar, Radiosonde and surface meteorological data collected during four years from April 2003 to March 2007 at Aimeliik, Palau are used to explore the variability of the marine boundary layer characteristics over Palau in the Pacific Ocean during Easterly and Westerly monsoon. Due to the focus on describing the vertical structure of MBL in the context of aerosol (Ventilation Coefficient), clouds and precipitation, aforesaid instrumentation are used to deduce the statistics.

Vertical structure of Marine Boundary Layer during dry convective

IJO-SCIENCE
(INTERNATIONAL JOURNAL ONLINE OF SCIENCE)
ISSN: 2455-0108 Volume II, Issue VI SEPTEMBER

days

An important parameter of the MBL is the MBL height that is controlled by surface forcing and entrainment at the MBL top as well as by advection areas (Klein and Hartmann 1993; Stevens et., al., 2003). The MBL height has been progressively recognized as playing a key in the surface layer turbulence structure, and the interplay of processes at different spatial and temporal scales (Klosel and Albrecht 1989; Sempreviva and Gryning, 2000; Larsen and Sempreviva, 2008). The MBL height and its dynamics, which governs ocean-atmosphere interaction, has been the main subject for coupled ocean-atmosphere modelling and numerical weather prediction (Hong and Pan 1996; Belijaars and Viterbo 1998). Further, the MBL dynamics influence transport, lifetimes, and diurnal cycles of aerosols and particulate matters.

In this slide an example time height profile of radar reflectivity during 02nd July 2003. The solid line represents the hourly averaged MBL height derived from radar reflectivity during 0800 to 1800 local time on the same day. When the amount of incoming solar radiation increases in the morning hours, then MBL height also increases and reaches its maximum in the afternoon. When the solar elevation decreases, the available energy is small, so the thermally-driven turbulence decays and vertical mixing decreases and hence the MBL height decreases.

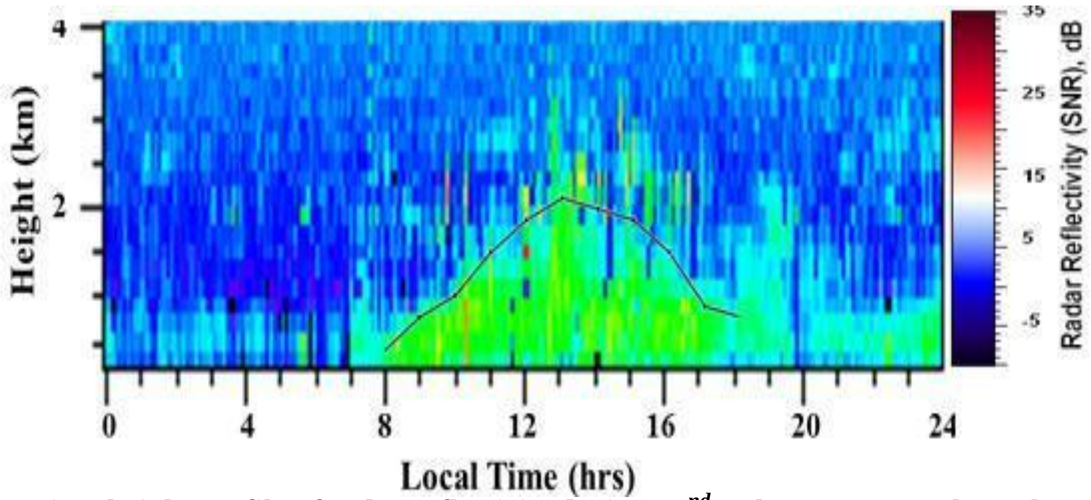

Fig. 1: Time height profile of radar reflectivity during 02nd July 2003over Palau. The solid line represents the hourly averaged MBL height derived from radar reflectivity.

The figure shows monthly averaged diurnal variation of MBL height during the years 2003 to 2007. The months of Feb, March and April show the longest and highest MBL heights during that the average sunshine hours are more and therefore the months August and Sep the lowest

MBL height, corresponding to the lowest average sunshine hours.

Monthly and Annual Variability of Marine Boundary Layer height

The daily time series maximum MBL height, as a function of Julian day of year, is showing both individual daily values and a plot 5-day running mean. The plot MBL height is at or near its maximum in the month of April, before the onset of westerly monsoon period and then decreases with time until July, increases slightly and then decreases again reaching its minimum values during the month of September. The MBL height partially recovers to a second but lower peak at the end of westerly monsoon period then increases again.

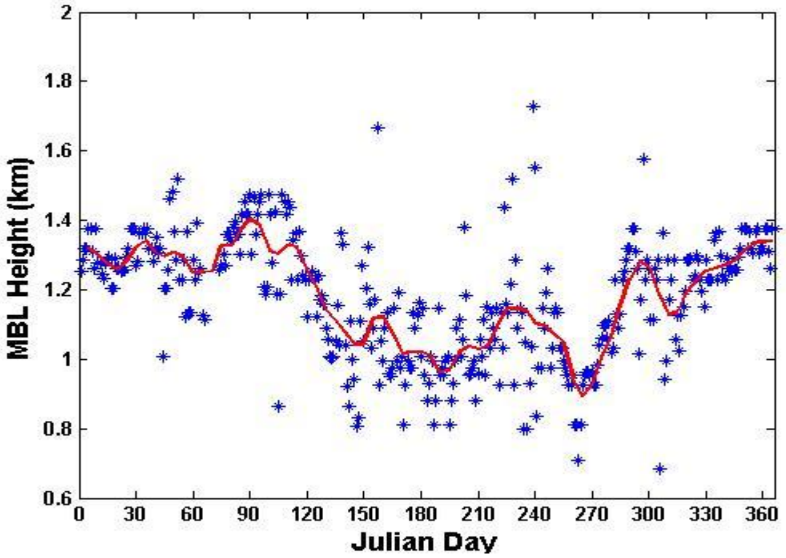

Fig. 2: Time series of maximum daily boundary-layer depths (km) as a function of the Julian day of the year (blue stars). The red line is the smoothed interpolation of the data.

Table 1: Monthly mean solar radiation (top number); and monthly mean hourly maximum solar radiation, SR (bottom number).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean SR	194.9	206.3	212.3	232.2	178	198.3	186.9	213.4	214	210.1	198.9	189.5
Max SR	832.9	814.7	804.3	860.2	684.6	745.7	743	797.2	814.1	845.4	796.6	710.5

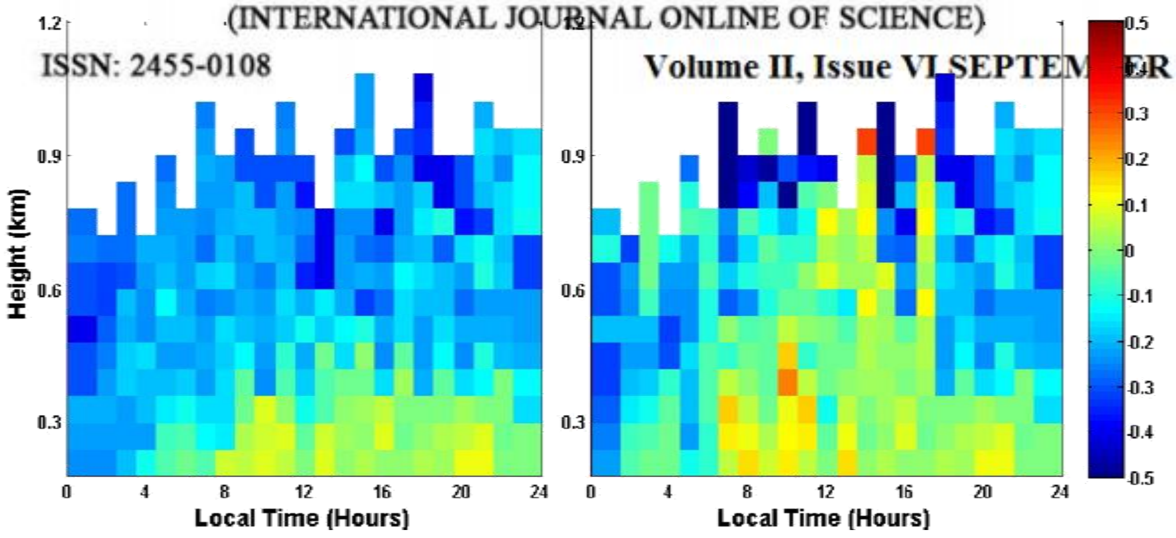

Fig. 3: Diurnal mean time–height cross section of virtual temperature advection for (a) Easterly (b) Westerly monsoon period.

Table. 2: Seasonal variation of MBL height and VC over Palau during April 2003 to March 2007.

Sl. No.	Season/Climate	Months	Mean noon time MBL height (km)	Ventilation Coefficient (m^2s^{-1})
1.	Easterly monsoon	Late December to April	1.28 ± 0.26	5670
2.	Easterly to Westerly monsoon Transition	May and June	1.11 ± 0.17	5120
3.	Westerly monsoon	July to October	1.19 ± 0.21	7020
4.	Westerly to Easterly monsoon Transition	November to Early December	0.97 ± 0.16	6230

Results and conclusion

Wind Profiler Radar has ascertained to be an outstanding tool for studying convective structure and Marine Boundary Layer (MBL) depth with good temporal (~ 10min) and vertical resolution (60 m). A new algorithm for MBL height determination has been established and valued its performances using Radiosonde, Ceilometers and WRR observations over Palau islands in the Tropical Western Pacific Ocean. Observational consequences obtained from our algorithm show good agreement with MBL estimated by normal peak picking technique. Using new MBL height detection algorithm, the diurnal evaluation and its seasonal variability has been studied. The MBL height shows a diurnal variation with its maximum in the afternoon and drops slowly reaching its minimum in the night. The seasonal variability of MBL shows a maximum in the month on April and minimum in the month of September. The effect of surface solar radiation and low level cold air advection on MBL height is investigated. It is clear that, surface solar radiation is responsible for the maximum MBL height in the Easterly monsoon period and cold air advection form the surrounding marine atmosphere is responsible for the shallow MBL heights during the westerly monsoon period.

References

Beljaars, A. C. M., and P. Viterbo, 1998: Role of the boundary layer in a numerical weather prediction model. Clear and Cloudy boundary Layers, A. A. M. Holtslag and P. G. Dunkerke, Eds., Royal Netherlands Academy of Arts and Sciences, 372 pp.

Hong, Song-You, and Hua-Lu Pan, 1996: Nonlocal Boundary Layer Vertical Diffusion in a Medium-Range Forecast Model. Mon. Wea. Rev., 124, 2322–2339.

Klein, S. A., and D. L. Hartmann, 1993: The seasonal cycle of low stratiform clouds. J. Clim., 6, 1587–1606.

Kloesel, K. A., and Albrecht, B. A. 1989: Low - Level inversions over the tropical pacific- thermodynamic structure of the boundary layer and the above-Inversion moisture structure. Mon. Weath. Rev., 117,87-101.

Lars´en, X. G. and Sempreviva, A. M., 2008: Temperature and humidity dissimilarity in the marine surface layer, Solas News, 8, 12–13,

Sempreviva, A.M., and Sven-Erik Gryning, 2000: Mixing height over water and its role on the correlation between temperature and humidity fluctuations in the unstable surface layer**,** Bound. Layer Meteorol.,97, 273-291.

Stevens, B., D. H. Lenschow, G. Vali, H. Gerber, A. Bandy, B. Blomquist, J.-L. Brenguier, C. S. Bretherton, F. Burnet, T. Campos, S. Chai, I. Faloona, D. Friesen, S. Haimov, K. Laursen, D. K. Lilly, S. M. Loehrer, S. P. Malinowski, B. Morley, M. D.Petters, D. C. Rogers, L. Russell, V. Savic-Jovcic, J. R. Snider, D. Straub, M. J. Szumowski, H. Takagi, D. C. Thornton, M. Tschudi, C. Twohy, M. Wetzel, and M. C.van Zanten, 2003: Dynamics and chemistry of marine stratocumulus—DYCOMS-II. Bull. Amer. Meteor. Soc., 84, 579–593, doi:10.1175/BAMS-84-5-579.