A study on marine boundary layer processes in the ITCZ and non-ITCZ regimes over Indian Ocean with INDOEX IFP-99 data

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A one-dimensional numerical planetary boundary layer (PBL) model was applied to simulate the dynamical and thermodynamical characteristics of the tropical Indian Ocean under varying convective regimes. Using sounding as well as surface meteorological data obtained during the INDOEX field phase, the PBL was validated for three different regions within the INDOEX domain. The three regions identified were, a coastal location representing suppressed convection, an open ocean region with medium convection, and a region of intense convection in the vicinity of the Inter-Tropical Convergence Zone (ITCZ). The model was integrated using observed sounding as initial as well as lateral boundary conditions, for a period up to 48 h. The model simulated surface fields as well as vertical profiles were compared with observations for the three cases. In general the model performance was good. The one-dimensional model could not simulate the dynamical features associated with advection and winds satisfactorily. However, the convective regimes are well simulated. As such, the PBL processes near the ITCZ were better simulated compared to the coastal regions. Results suggest that such a model can be used as a tool to develop high resolution, time-varying profiles over data-sparse regions to enhance mesoscale analysis.

ONE of the significant objectives of INDOEX was to understand the transport of the continental air masses into the Inter-Tropical Convergence Zone (ITCZ). The ITCZ is a region of wind discontinuity in the lower troposphere where the trade winds from the two hemispheres converge. This convergence zone is located in the Southern Hemisphere. For the INDOEX study period (January to March), the ITCZ is located mostly in the Southern Hemisphere around 5°S and is migratory. The ITCZ can also be regarded as a zone of horizontal velocity convergence associated with ascending motion, and persistent organized convective activities. Thus, this region can be identified as a cloud belt with east–west elongated shear zone with westward moving cloud clusters embedded in this structure. ITCZ thus acts as a sink of continental materials. One of the central hypotheses tested during INDOEX related to the understanding of this continental transport is the lower troposphere.

The aim of this study is to understand the marine boundary layer (MBL) characteristics with respect to the varying convection associated with coastal effects and the ITCZ regimes. Variation of the MBL characteristics under three different convective regimes, viz. coastal ocean representing suppressed convection, open ocean with medium convection, and in the vicinity of the ITCZ, an active convective zone, is investigated in this paper. This is achieved by using a numerical MBL model[1] along with shipboard observations during the 1999 INDOEX intensive field phase (IFP) from RV *Ronald Brown*. One of the secondary objectives of this study is to validate the MBL model for the tropical ocean environment using INDOEX observations.

Model initial conditions and numerical experiments

During the INDOEX intensive field phase (IFP), upper air sounding and surface observations were obtained onboard R/V *Ronald Brown* between 21 February 1999 and 29 March 1999. The sounding data comprised high-resolution (average 50 m vertical resolution) profiles using a GPS sonde system[2]. This contained winds and thermodynamic variables from surface (~ 10 m) to about 15 km. Since our aim is to study the MBL characteristics, we focus on the first 2 km in the vertical. Additional data comprised surface meteorological variables and the sea surface temperature (SST). Surface data corresponding to the radiosonde launches are used in the model as described subsequently. The ship track for RV *Ronald Brown* during IFP is shown in Figure 1. The ship resumed its course from Mauritius to Maldives and crossed the ITCZ during this leg. From Maldives it went to the Arabian Sea and

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