# Application of three-dimensional triple nested mesoscale model for assessing the transport and boundary layer variability over the Indian Ocean during INDOEX

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**A three-dimensional triple nested domain version of MM5 was applied for INDOEX region (40.12°N–32.04°S; 32.10°E–117.90°E) to study the regional flow patterns and associated transport using backward and forward trajectories. The model was integrated for 48-h period starting 00 UTC 5 March 1999. From the simulations a mapping of the temporal and spatial variations in the marine boundary layer (MBL) heights were obtained. The boundary layer heights were verified using actual ship-based sounding from RV *Ronald H. Brown* and a good agreement was found. The model simulated significant variability in the MBL heights both spatially and temporally. During the daytime, the continental boundary layer was ~ 1500 m deep while over the ocean, the MBL was shallow (~ 300 m) near the coast, and it increased steadily towards the ITCZ where MBL heights of ~ 1000 m were encountered. During night there was a reversal with the continental boundary layer heights averaging less than 500 m while over the ocean, particularly over the ITCZ, the MBL heights were ~ 1000 to 1500 m. This variability in the MBL heights significantly affected the transport pattern over the INDOEX region. Both the backward and forward trajectories showed distinct characteristics depending on the source region (eastern or western coastal landmass, equator, or near ITCZ). Near the coast, there was an evidence for localized circulation in which the air parcels were trapped along the coast. For the open oceans (both near the ITCZ as well as equator) the air parcel trajectories continued over a significant distance. Results suggest that MM5 can be successfully applied for diagnostic studies related to INDOEX, and that the boundary layer heights and the variations in the air parcel transport need to be considered for interpreting the surface measurements.**

THE Indian Ocean Experiment (INDOEX) was designed to understand the impact of transport of continental aerosols to the ITCZ on cloud radiative properties and surface energy balance over equatorial Indian Ocean. The central hypothesis was that the aerosol-rich continental air parcels would eventually reach ITCZ, and entrain into the convective clouds making their response more uncertain in terms of regional warming or cooling. Thus pertinent to INDOEX objective is the need to develop an understanding of the transport and aerosol entrainment from the continental landmasses. These transport and entrainment processes are governed by the regional circulation (airflow trajectories) and convection (buoyancy). For INDOEX, these processes have been studied mainly using point observation over ship-based platforms[1]. Observations have suggested that the INDOEX study region is fairly inhomogeneous and there are several mesoscale processes interacting with the large-scale dynamics. Thus, a regional analysis for a domain with such a spatial and temporal variability cannot be addressed by point observations alone. Further, large scale analysis generated from coarse resolution global circulation models (GCMs) is inadequate as it cannot capture the mesoscale features such as land–sea breeze circulation, orographic convection, and modification of the lower tropospheric circulation due to surface inhomogeneities. In addition to the circulation, another important aspect is the distribution of the transported material aloft to the lower troposphere, which depends on the entrainment potential. This further depends on the boundary layer depth and the surface turbulent heat fluxes. To address these issues, a mesoscale numerical modeling study was attempted for the INDOEX region. A triple nested, nonhydrostatic version of the Fifth generation PSU–NCAR Mesoscale Model (MM5) was used.

## Experimental design

A three-dimensional, triple nested MM5 domain was set up over the INODEX region. The Coarse Grid Mesh (CGM), Medium Grid Mesh (MGM), and Fine Grid Mesh

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