Atmos. Chem. Phys., 6, 907-923, 2006
www.atmos-chem-phys.net/6/907/2006/

The structure of the haze plume over the Indian Ocean during INDOEX: tracer simulations and LIDAR observations

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Abstract. Three-dimensional, nested tracer simulations of a pollution plume originating from the Indian sub-continent over the Indian Ocean, in the framework of the Indian Ocean Experiment (INDOEX), between 5 and 9 March 1999, were performed with the Regional Atmospheric Modeling System (RAMS), to provide insight into the transport patterns of the pollutants, as well as to investigate the dynamical mechanisms controlling the vertical structure of the plume and its evolution in the vicinity of the Maldives Islands. Airborne and ground-based LIDAR observations of the structure of the haze plume made on 7 March 1999 were used to assess the quality of the simulations, as well as the impact of grid resolution on the vertical structure of the simulated plume. It is shown that, over the Arabian Sea, in the vicinity of the Maldives Islands, the pollutants composing the plume observed by the airborne LIDAR essentially originated from the city of Madras and that the vertical structure of the plume was controlled by the diurnal cycle of the continental boundary layer depth. A combination of tracer simulations and remote sensing observations (airborne LIDAR, ship-borne photometer, ground-based LIDAR in Goa) was used to analyse the diurnal evolution of the haze plume over the sea. We find evidence that the sea breeze circulation and orographic lifting taking place in the southern part of the Indian sub-continent during the daytime play a crucial role in the modulation of the continental boundary layer depth, and in turn, the haze plume depth. The eastward shift of the subtropical high from central India to the Bay of Bengal after 6 March lead to an increase in the tracer concentrations simulated over the Arabian Sea, in the region of intensive observations north of the Maldives, as transport pathways form Hyderabad and Madras were modified significantly. The nesting of a high horizontal resolution domain (5 km, with 39 vertical levels below 4000 m above mean seal level) allows for a better representation of local dynamics, the circulation of sea and mountains breezes, and therefore a noticeable improvement in the representation of the pollutants' plume in the simulation.

Final Revised Paper (PDF, 8215 KB) Discussion Paper (ACPD)

Citation: Forêt, G., Flamant, C., Cautenet, S., Pelon, J., Minvielle, F.,

Taghavi, M., and Chazette, P.: The structure of the haze plume over the Indian Ocean during INDOEX: tracer simulations and LIDAR observations, Atmos. Chem. Phys., 6, 907-923, 2006. Bibtex EndNote Reference Manager