Numerical Modelling of Saharian dust impact on the atmospheric dynamics in the Bodele depression.

D. Boukaram(1), C. Flamant(1), P. Tulet(2), J.-P. Chaboureau(3) , R. Washington(4), M. Todd(5)

(1)Service d'Aéronomie / IPSL, Paris, France
(2)Météo-France, CNRM/GMEI, Toulouse, France
(3)Laboratoire d'Aérologie, UPS and CNRS, Toulouse, France
(4)Oxford University Centre for the Environment, University of Oxford, UK
(5)Department of Geography, University College London, UK

The historical record suggests that the Bodélé depression is a remarkably strong dust source on a global scale and it has been active for several hundred years. This region is undoubtedly the most intense dust source in the world [Prospero et al., 2002]. It is a unique dust source due to its location at a bottle neck of two large magmatic formations that serves as a 'wind lens', guiding and focusing the surface winds to the Bodélé depression. In the winter, the low level jet resulting from the constriction between the Tibesti and Ennedi massifs is responsible for the large dust loads observed by satellite, averaging more than 0.5Tg per day on 40% of the winter days [Koren et al, 2006 and Washington et al, 2006]. During the Bodélé Dust Experiment (BodEX) which took place in March 2005, mass flux of dust emission was estimated to be approximately 1.2Tg per day [Todd et al., in press].

In this presentation, the dynamics associated with the dust emission in this region, are analysed by means of observations and numerical modelling. Our goal is to evaluate the direct radiative effect of the aerosols lofted in this source area and the effects of this on the planetary boundary layer thermodynamics in the region using a combination of mesoscale simulations (model Meso-NH) and ground-based measurements acquired in the framework of BodEX.

MesoNH is a regional model initialized by and nudged with ECMWF analyses, including a prognostic dust scheme allowing feedback studies between dynamics and radiation [Grini et al., 2006], and a dust emission box model, the Dust Entrainment And Deposition (DEAD) model [Zender et al., 2003] which is implemented as a component of the MesoNH. DEAD describes dust sources and sinks while dust advection and diffusion are quantified by the transport processes and methods used in the host model.

A series of simulations covering the whole BodEX period was carried out, on a 2000 km2 domain (20-km horizontal resolution). A nested domain (5-km resolution) was also implemented and has been activated on days when large dust events were observed (March 4 and 9 to 12). The 20-km resolution domain is centered at 16°53' N, 18°33' E which is the position of the site of observation, 72 levels were used on the vertical resolution starting at 10 m above the ground. The nested domain was centered at 17°40'N and 19°70'E, and also used 72 levels.

With the aim of better understanding the connection between the various processes concerned, and to evaluate the role of each one, we carried out 3 types of simulations: a simulation without dust aerosols, a simulation with prognostics dust aerosols, and a simulation with the characteristcs properities of the dust aerosols as measured during BoDEx. The 3 simulations were evaluated against the BoDEx data. For that purpose, surface measurements of meteorological parameters at 2m height (including temperature, wind speed, humidity, solar UV radiation and air pressure), and measurements of aerosols optical properities like aerosol optical depth and dust size distribution, were used.

Maximum wind speeds are underestimated by the model with a 2m/s difference approximatively, while the spatio-temporal evolution of dust cloud and daytime temperature at 2m are reasonably well reproduced.