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Modeling the impact of tropical mesoscale convective systems on Sahelian mineral dust budget: a case study during AMMA SOPs 1-2

C. BOUET (1), G. CAUTENET (2), B. MARTICORENA (1), G. BERGAMETTI (1), B. CHATENET (1), J.-L. RAJOT (3), and L. DESCROIX (4)

(1) CNRS/Universités Paris 7 et Paris 12, Laboratoire Interuniversitaire des Systèmes Atmosphériques, CRETEIL, France (bouet@lisa.univ-paris12.fr), (2) CNRS/Université Blaise Pascal, Laboratoire de Météorologie Physique, AUBIERE, France, (3) Institut de Recherche pour le Développement, NIAMEY, Niger, (4) Institut de Recherche pour le Développement, Laboratoire d'études des Transferts en Hydrologie et Environnement, GRENOBLE, France

Tropical mesoscale convective systems (MCSs) are a prominent feature of the African meteorology. A continuous monitoring of the aeolian activity in an experimental site located in Niger showed that such events are responsible for the major part of the annual local wind erosion, i.e. for most of the Sahelian dust emission [Rajot, 2001]. However, the net effect of these MCSs on mineral dust budget has to be estimated: on the one hand, these systems produce extremely high surface wind velocities leading to intense dust uptake, but on the other hand, rainfalls associated with these systems can efficiently remove the emitted dust from the atmosphere.
High resolution modeling of MCSs appears as the most relevant approach to assess the budget between dust emission and deposition in such local meteorological systems. As a first step, in order to properly estimate dust emissions, it is necessary to accurately describe the surface wind fields at the local scale. Indeed, dust emission is a threshold phenomenon that depends on the third power of surface wind velocity.
This study focuses on a case study of dust emission associated with the passage of a MCS observed during one of the intensive observation period of the international African Monsoon Multidisciplinary Analysis (AMMA – SOPs 1-2) program. The simulations were made using the Regional Atmospheric Modeling System (RAMS) coupled online with the dust production model (DPM) developed by Marticorena and Bergametti [1995] and recently improved by Laurent et al. [2008] for Africa. Two horizontal resolutions were tested (5 km and 2.5 km) as well as two microphysical schemes (a 1-moment scheme [Walko et al., 1995] and a 2-moment scheme [Meyers et al., 1997]). The use of the two convective parameterizations now available in the version 6 of RAMS (Kuo [1995] modified by Molinari [1985] and Molinari and Corsetti [1985], and Kain and Fritsch [1992; 1993]) to simulate cloud convection was also tested. Sensitivity tests have been performed in order to:
(i) identify the physical processes that must be taken into account in the mesoscale model to correctly simulate the observed MCS,
(ii) determine how these processes have to be accounted for (horizontal resolution, convective parameterization) in the mesoscale model.
Finally, the impact on the simulated dust emissions of the bias on the simulation of the MCSs will be discussed.