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NMMB/BSC-DUST: an online mineral dust atmospheric model from meso to global scales

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While mineral dust distribution and effects are important at global scales, they strongly depend on dust emissions that are controlled on small spatial and temporal scales. Most global dust models use prescribed wind fields provided by meteorological centers (e.g., NCEP and ECMWF) and their spatial resolution is currently never better than about $1°\times1°$. Regional dust models offer substantially higher resolution (10-20 km) and are typically coupled with weather forecast models that simulate processes that GCMs either cannot resolve or can resolve only poorly. These include internal circulation features such as the low-level nocturnal jet which is a crucial feature for dust emission in several dust 'hot spot' sources in North Africa.

Based on our modeling experience with the BSC-DREAM regional forecast model (http://www.bsc.es/projects/earthscience/DREAM/) we are currently implementing an improved mineral dust model [Pérez et al., 2008] coupled online with the new global/regional NMMB atmospheric model under development in NOAA/NCEP/EMC [Janjic, 2005]. The NMMB is an evolution of the operational WRF-NMME extending from meso to global scales. The NMMB will become the next-generation NCEP model for operational weather forecast in 2010. The corresponding unified non-hydrostatic dynamical core ranges from meso to global scale allowing regional and global simulations. It has got an add-on non-hydrostatic module and it is based on the Arakawa B-grid and hybrid pressure-sigma vertical coordinates. NMMB is fully embedded into the Earth System Modeling Framework (ESMF), treating dynamics and physics separately and coupling them easily within the ESMF structure. Our main goal is to provide global dust forecasts up to 7 days at mesoscale resolutions.

New features of the model include a physically-based dust emission scheme after White [1979], Iversen and White [1982] and Marticorena and Bergametti [1995] that takes the effects of saltation and sandblasting into account. Viscous sublayer approach [Janjic, 1994] for dust injection in the lower atmosphere is maintained as applied in DREAM [Nickovic et al., 2001]. Soil moisture effects are considered following Fecan et al. [1999]. A new source function for the land surface is calculated using the USGS 1km landuse database, the NESDIS 5-years monthly climatology for the vegetation fraction, and preferential source areas according the topographic approach after Ginoux et al. [2001]. Furthermore, 4 top soil texture classes (coarse sand, fine/medium sand, silt, clay) are introduced, based on the new STASGO-FAO 1km soil database and modified following Tegen et al. [2002]. The dry deposition scheme accounts for the effects of sedimentation and turbulent mixout following the approach of Giorgi [1986]. Finally, in-cloud and below-cloud wet scavenging for grid-scale and convective precipitation is applied following Slinn [1983; 1984] and Loosmore and Cederwall [2004]. Dust radiative feedback on meteorology is not yet considered.

In order to explore the assets and drawbacks of the new model, we perform global simulations of the dust cycle at 0.3ºx0.45º to demonstrate the ability of the model to capture the large scale and seasonal patterns. These fundamental evaluations serve as starting point for further testing as well as future developments of the NMMb-DUST. In a second step, we study the behavior of the model during the SAMUM-I phase [Haustein et al., 2009] and the BODEX campaign [Todd et al., 2008], focusing on how the model reproduces moist convection and low level jet in North Africa at mesoscale resolutions.

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