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WRF sensitivity analysis of the diurnal cycle of Saharan planetary boundary layer

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The Saharan planetary boundary layer (SPBL) is a subject of intense interest due to its complex and unique structure. During summer, the region experiences the deepest PBL on earth up to around 6km height. A pronounced diurnal cycle of heating/cooling and mixing is observed resulting in and near-neutral residual layers aloft. Mineral dust aerosol loadings are often intense and dust is rapidly uplifted and mixed vertically by predominantly dry convection throughout the depth of the PBL. This dust has a strong feedback on radiation and therefore dynamics. Model representation of these PBL processes is important for accurate weather/climate and aerosol prediction and is still a matter of intensive study. Insufficiency of observational data in this region has obstructed a comprehensive model evaluation. In June 2011, the Fennec campaign provided extensive observational data in order to improve our understanding in the dynamics of the Saharan atmosphere. In this work, we study the ability of the Weather Research and Forecasting (WRF) model with a Chemistry module (WRF-Chem) to represent key multi-scale processes and diurnal cycle of the Saharan PBL. A comprehensive sensitivity analysis was conducted comprising model experimentation with several horizontal and vertical resolutions, several physical parameterization schemes including cumulus convective, microphysics, planetary boundary layer schemes and radiation. Model simulations are confronted with a suite of airborne and surface observations resulted from the intense observation period (IOP) of the Fennec campaign in June 2011.