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The synergy of the unbalanced mesoscale circulations and the polar-subtropical jetstreams to severe dust transport phenomena over the Mediterranean

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This study investigates the contribution of both polar jet (PJ) and subtropical jet (SPJ) to the large-scale thermal wind imbalance and the mesoscale atmospheric circulations that are responsible for desert dust advection from North Africa source regions to the Mediterranean basin and Europe. The merging of both PJ and SPJ jets causes significantly accelerative jet streak circulations, which are associated with a mesoscale mass adjustment as the main response to a large scale imbalance. Especially, in dust source areas the prevailed small-scale vertical motions cause a low-level instability and ageostrophic winds formation. This mechanism initiates dust mobilization, as turbulent kinetic energy (TKE) forms in response to low-level mass adjustment and cold air advection under the accelerating jet streak. The overall impact of synoptic-to-mesoscale circulations to the dust emission fluxes and particles mobilization are mainly resolved in this study through the fully coupled Weather Research and Forecasting/Chemistry (WRF/Chem) model applied in a case study of large scale desert dust advection over the Mediterranean Sea. Especially, for the dust simulations, the Goddard Global Ozone Chemistry Aerosol Radiation and Transport of the Air Force Weather Agency (GOCART/AFWA) module is applied, as it provides a sectional scheme for dust emissions and advection. This simulation revealed the increasing imbalance mainly through the high Rossby numbers, the ageostrophy, the cold air advection and the fall of the mean sea level pressure during the dust emission stage. The overall performance of the dust simulation is finally evaluated through the comparison of the model's results with ground observations data and mainly with atmospheric optical depth (AOD), concerning the dust sources regions and the areas that are characterized by significant dust advection over the Mediterranean.