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Diagnostics of extreme events in the coastal area of the northeastern Black Sea using WRF model

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Northeastern part of the Black Sea is highly exposed to hydrometeorological extremes due to strong interaction of the regional circulation patterns with local orography. These extreme events consist of (but are not limited to) bora - strong seaward wind blowing from the coastal mountains and extreme coastline precipitation associated with the Mediterranean and Black Sea cyclones. Both weather extremes result in natural hazards with bora being associated with damage of port and offshore infrastructure (icing in winter time) and cyclone activity leading to the coastal inundation and flooding even in elevated areas. We built a diagnostic system which allows for the accurate diagnostics and analysis of the mechanisms of these extreme events. The system is based on high resolution non-hydrostatic WRF-ARW-3.5 model whose set-up includes 3 domains with the sub-grids corresponding to 9, 3 and 1 km respectively going from the external outer to inner domains. For all three domains the model has 36 levels in vertical and realizes a set of physical parameterizations whose choice has been justified by sensitivity experiments. We present diagnostics of the two major recent extreme events in the area. Diagnostics of one of the strongest in the record bora (February 2012) allowed for accurate simulation of timing of the peak winds (up to 40 m/sec) and also provided very realistic representation of the structure of seaward wind jets and clouds which were in agreements with the analysis of satellite images from RADARSAT and MODIS. Diagnostics of the major precipitation event in July 2013 (which resulted in hazardous flooding and more than 50 fatalities) clearly demonstrated the mechanism of forming extreme precipitation due to strong moisture uptake inside the cyclone over the Black Sea and further rapid condensation over the coastline due to strong vertical temperature gradients. The model accurately replicated maximum precipitation of 253 mm/day and also the development of the vertical structure of the moisture advection. Some issues of the optimal model setting for the further diagnostics of extreme events and comparison with observations are discussed. In particular, direct comparison of simulated and observed precipitation requires accurate handling of scaling problem associated with grid cell averaging.