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Improving forecasts of extreme precipitation with MAD-WRF mesoscale model

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The Multi-sensor Advection Diffusion Weather Research and Forecast (MAD-WRF) model is a state-of-the-art addition to the WRF model that includes a fast cloud-initialization procedure, making it more suitable for hydrometeors analysis and clouds forecasts. The MAD-WRF cloud initialization combines a cloud parameterization that infers the presence of clouds based on relative humidity with observations of the cloud mask and cloud top/base height to provide a three-dimensional cloud analysis. During the forecasts, the hydrometeors can be advected and diffused with no microphysics, in what we refer to as the MAD-WRF passive mode. Alternatively, these passive hydrometeors can be integrated into the explicitly resolved hydrometeors during a nudging phase, designated the MAD-WRF active mode (Jiménez et al., 10.1016/j.solener.2022.04.055). As such, MAD-WRF has been extensively used for solar energy predictions.

Here we have investigated the feasibility of using MAD-WRF to improve the accuracy of intense precipitation forecasts. An extreme precipitation event over Israel that led to urban floods and two casualties in Tel-Aviv during January 4th, 2020, has been chosen as a case study. The extreme accumulated precipitation responsible for noon and early afternoon floods was triggered by a persistent cloud train that developed over the area several hours before. MAD-WRF model has been configured with 3-nested domains with 9, 3 and 1 km grid-sizes. We have run MAD-WRF in active mode incorporating satellite-retrieved cloud-top heights provided by the European Space Agency EUMETSAT in all three domains. EUMETSAT data are available in near real-time making it suitable for operational forecasts.

Independent precipitation data measured by the Israel Meteorological Service radar at Bet-Dagan (about 10 km south-east of Tel-Aviv) has been used for forecasts verification. Comparison between radar data and MAD-WRF forecasts with and without incorporation of EUMETSAT cloud-tops retrievals reveal the advantage MAD-WRF cloud initialization. The significant improvement in the forecast of the location and rate of the precipitation is observed up to 12 hours ahead in time.

On-going work focuses on the evaluation of the precipitation distributions and improvement of the forecast of dry areas.