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Sub-seasonal forecast capability for Arabian Peninsula convective extremes using convective-permitting regional climate modeling

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Severe weather associated with convective thunderstorms is becoming more intense globally and is also observed in the Arabian Peninsula (AP). AP convective extremes are often observed during winter season (October to March). Improvements in extreme weather forecast for sub-seasonal to seasonal forecast increase the preparedness of convective extremes and related hazards. We designed a series of ensemble forecast downscaling using the Weather Research and Forecasting model (WRF) at convective-permitting spatial scale. The driving global sub-seasonal to seasonal reforecast is provided by the European Centre for Medium-Range Weather Forecasts (ECMWF).

Sub-seasonal WRF simulations are performed on the AP's top 20 extreme precipitation events reported in the last 20 years, downscaling from the 11 ECMWF hindcast ensemble members. Each of the events recorded at least 20 mm/day rainfall in the Jeddah station. Several aspects of the simulated events are evaluated: (1) Precipitation forecast capability: determine forecast window of opportunity in the regional climate model at 1-week, 2-week and 3-week lead time, identify the value added using convective-permitting type modeling; (2) Teleconnection pattern forecast capability: determine forecast skill for the dominant large scale pattern related to the convective extremes in the driving ECMWF reforecasts and ERA-Interim reanalysis data; (3) Dominant synoptic patterns associated with the AP's top 20 extreme events: identify forecast capability for different synoptic-driven extreme events. Historic data analysis identified 3 general synoptic patterns that lead to precipitation extreme. The top 20 extreme events are parsed into the 3 synoptic groups. Sub-seasonal forecast evaluations are then performed with statistical analysis tools commonly used in operational forecast evaluation, such as Probability of Detection (POD), False Alarm Rate (FAR) and Relative Operating Characteristics (ROC); (4) Mesoscale convective system (MCS) tracking: objectively tracking the MCS clouds in satellite observation and WRF downscaled reforecasts using cloud top temperature and precipitation. Through the designed analyses, we can collectively show the ensemble forecast skills for the largest convective events in the AP and advancement in forecast capability at sub-seasonal time scale.