Poster 542

Advances in Convective Hazard Predictions for Army Test and Evaluation Command (ATEC) Ranges

Cathy Kessinger, Wiebke Deierling, Dan Megenhardt and Susan Dettling

National Center for Atmospheric Research, Boulder, CO

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Introduction

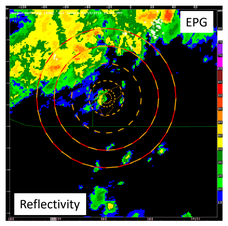
Forecasters at the Army Test and Evaluation Command (ATEC) ranges must address various convective weather challenges such as thunderstorms, lightning and flash flooding. The NCAR Convective Weather group provides decision support systems (DSS) for thunderstorm and lightning detection and nowcasting.

At the ranges, the DSS include the AutoNowcaster (ANC) or the AutoNowcaster-Lite (AN-Lite). The ANC system is deployed at the White Sands Missile Range in New Mexico (Saxen et al., 2008) and the Redstone Test Center in Alabama (Nelson et al., 2012). The AN-Lite system is deployed at the Aberdeen Test Center in Maryland, the Electronic Proving Grounds and Yuma Proving Grounds in Arizona, the Dugway Proving Grounds in Utah and the Cold Regions Test Center in Alaska.

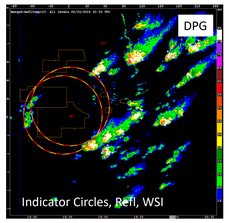
Within the ANC and AN-Lite systems, an application called Trident has been developed to detect and warn of potential flash flooding situations. This application was first deployed at the Yuma Proving Grounds and has proven to be a valuable asset to the forecasters. Trident results will be discussed as will results from stream flow gauges that are present at that range. A new application, called Wash Indicator Circles, has been created to warn forecasters of running wash conditions. Trident was recently deployed at the other western ranges and early results will be presented. Deployment at Redstone Test Center is planned soon.

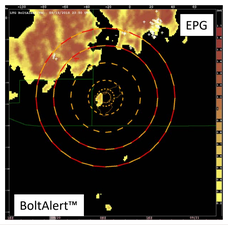
A second set of applications, called BoltAlert™ and Lightning Indicator Circles, were deployed at all ranges some years ago and are used to detect, nowcast and warn of the potential for lightning occurrence in the tactical time frame. Recent enhancements have been made to the applications that include an enhanced anvil lightning detection threshold and the use of the GOES-East Geostationary Lighting Mapper (GLM) total lightning data set. A third application provides strategic forecasts of lighting potential using the Four Dimensional Weather (4DWX) system based on the Weather Research and Forecasting (WRF) model. This application has been deployed in the ANC systems for a number of years and will be deployed within the AN-Lite systems soon.

BoltAlert™ and Lightning Indicator Circles

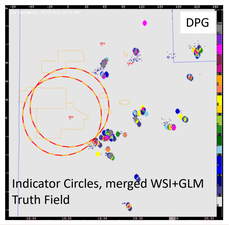


At left, results are shown using BoltAlert™ to alert range forecasters at Electronic Proving Ground of the potential of lightning occurrence. Indicator Circles shaded only orange indicate potential lightning strikes while those shaded red and orange indicate verified lightning strikes.





At right, Indicator Circles are shown to alert Dugway Proving Ground forecasters of the potential of lightning occurrence. A recent update merges ground based lightning data with GOES-16 Geostationary Lightning Mapper data as verification.



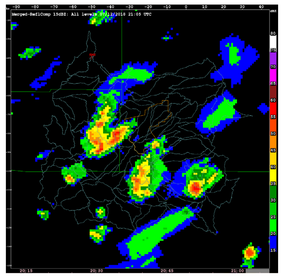
Trident

Flash floods are a safety concern at some ranges, especially those in the western regions. In response to the need for advance warning of potential flash flooding events, the Trident algorithm was first deployed at the Yuma Proving Grounds. In subsequent years, Trident has been deployed at the White Sands Missile Range (WSMR), Dugway Proving Grounds (DPG), and Electronic Proving Grounds (EPG).

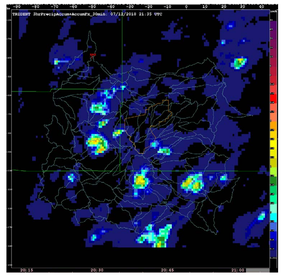
The Trident algorithm makes predictions of radar-derived precipitation accumulation at 10-min intervals out to 1-hr and updates the predictions with each new radar volume. Trident is not a flash-flood prediction *per se* but gives a heads-up to the forecaster where significant rainfall may be occurring. Forecaster knowledge of local terrain, ground cover and other hydrological conditions allows them to make a final assessment of the potential for a flash flood.

The Trident algorithm inputs the radar reflectivity and applies a Z-R relationship to convert the reflectivity to rain rate. A gridded motion field, calculated using the Cartesian Tracking Radar Echoes by Correlation (CTREC; Tuttle and Foote, 1990) method, determines the advection vector to apply for storm extrapolation. Next, the precipitation accumulation is computed for each forecast interval using the current radar volume. Finally, the precipitation accumulation over the past three hours is computed and added to the current amount. Rain gauge data are not used to calibrate the radar-derived estimates, but this could be done.

Example of Trident Results from Electronic Proving Ground Case



The EPG composite radar reflectivity is shown on 12 July 2018 at 2105 UTC. The boundary of EPG is shown in orange. The watershed sub-basins are shown in blue.



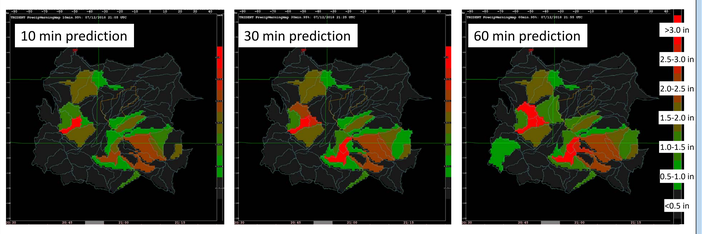
Using the reflectivity field shown at left, Trident results for precipitation accumulation (inches) are shown for a 30 min forecast and summed with the 3 hr accumulated precipitation.

Maps2GridWarning

The Maps2GridWarning application applies Trident results to a drainage sub-basin map to give forecasters a visual clue that precipitation accumulations are predicted to exceed specified thresholds as storms move across the range. As the precipitation accumulation exceeds each threshold, a different color shades the confines of the sub-basin. The application provides high glance value to warn of potential flash flood conditions.

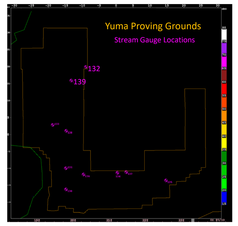
The same Trident case as used above is shown below for a 10 min, 30 min and 60 min prediction as color-coded by Maps2GridWarning.

Example of Maps2GridWarning Results from Electronic Proving Ground Case



Results from Maps2GridWarning on 12 July 2018 at 2105 UTC. Precipitation accumulation that exceeds each threshold are coded by the color scale shown to the right. Predictions are shown for 10 min, 30 min, and 60 min. The boundary of EPG is shown in orange. The watershed sub-basins are shown in blue.

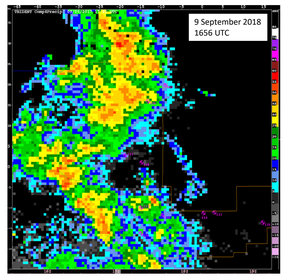
Wash Indicator Circles



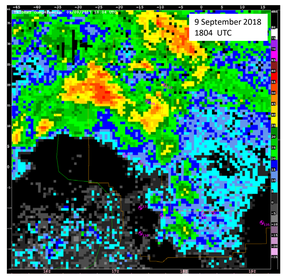
Yuma Proving Grounds (YPG) has a network of 10 stream gauges to measure the depth of water in the dry washes. The figure at left shows their locations across the range.

An application, Wash Indicator Circles, ingests the stream gauge data and provides a visual warning indicator to the forecasters as specified thresholds are exceeded. The Wash Indicator Circles appear as a visual icon, color coded for stream depth at each threshold. The YPG forecasters issues warnings when stream depth is at 8 inches, so the thresholds for the Wash Indicator are set to 1 inches (gold and small dashes) to give a first heads up to the forecaster, then to 4 inches (orange with large dashes) and finally to 8 inches (red with large dashes).

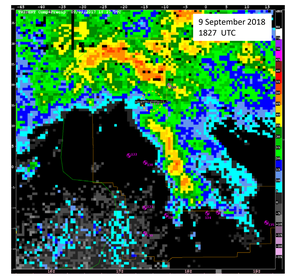
An example case from 9 September 2018, below, is presented to illustrate how the Wash Indicator Circles evolve during storm passage. In this case, the gauges 132 and 139 at the northern end of the range measure significant stream flow after the passage of the storms. The maximum stream depth is plotted at the center of the Wash Indicator Circle in inches.



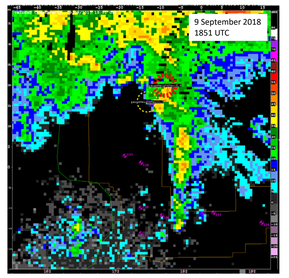
At 1656, the first strong reflectivity reaches gauge 139. Storms move to the northeast.



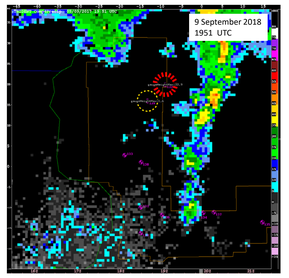
At 1804, a second set of storms reaches the two gauges. Storms move to the north.



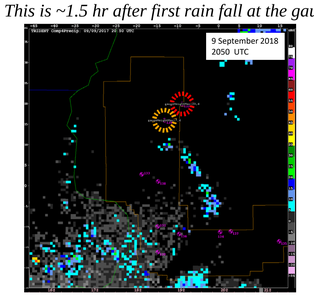
At 1827, the 1 inch threshold is reached for gauge 139 and a gold Wash Indicator Circle is drawn. This is ~1.5 hr after first rain fall at the gauge.



At 1851, gauge 132 has exceeded the 8 inch threshold, showing 8.4 in as the maximum height. Gauge 139 shows 1.7 in.



At 1951, storms have moved away from the gauges. Gauge 132 shows a 22.9 in maximum depth with gauge 139 showing 1.6 in.

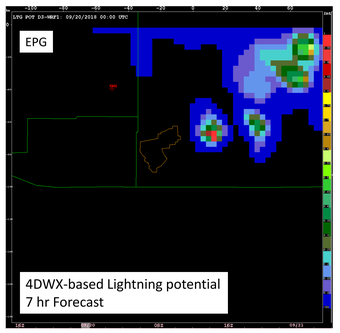


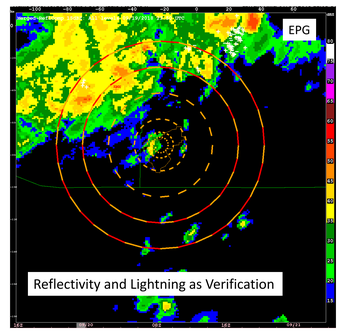
At 2050, gauge 132 shows 20.4 in while gauge 139 shows 7.4 in maximum depth. High stream depth can persist for an extended time, as this case shows.

4DWX-based Lightning Potential

Model-based lightning potential application uses the 4DWX model (based on WRF with the Thompson microphysics) as input. Using the 4DWX microphysical and dynamical output fields, empirical relationships for “lightning - ice water path” and “lightning - updraft volume” are applied. A fuzzy logic algorithm combines these two parameters to compute a lightning potential field.

The lightning potential forecast performance is dependent on how well the model predicts the location and intensity of storms in the region.





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Acknowledgements

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