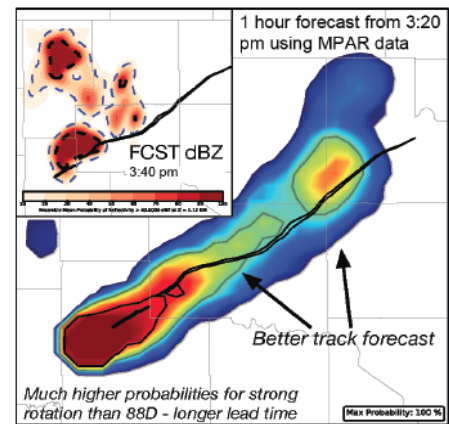
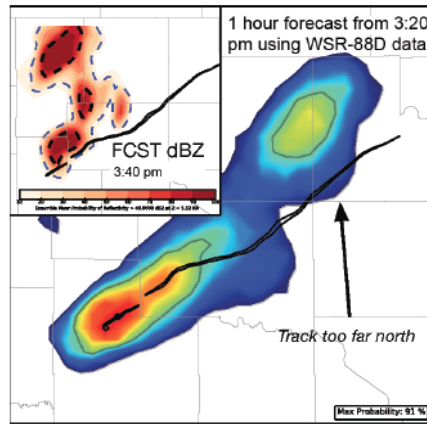




NOAA's Warn-on-Forecast research project aims to create computer-model projections that accurately predict storm-scale phenomena such as tornadoes, large hail, and extreme localized rainfall. If Warn-on-Forecast is successful, forecasters will be provided with reliable guidance for issuing tornado, severe thunderstorm, and flash flood warnings up to an hour before they strike.

El Reno, OK EF-5 tornado

- Duration: 3:50-5:35 pm (1 hr 45 min)
- Distance traveled: 101 km
- Fatalities: 9



Left: One hour chances for strong low-level rotation (tornado threat) in a thunderstorm using WSR-88D 5-minute data in a combination ("ensemble") of forecast models. Right: One hour chances for strong low-level rotation using MPAR 1-minute data in an ensemble of forecast models. The inset plots show moderate rain predicted by the ensemble. Image credit: NOAA NSSL.

Warn on detection (The present)

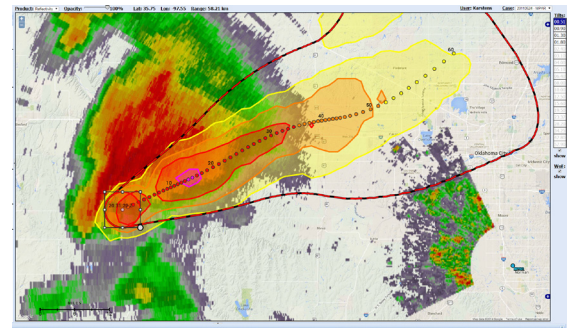
Currently, the NOAA National Weather Service (NWS) does not issue warnings for local severe weather until they see an early signal on radar, or the weather hazard is spotted. This approach provides the public with an average of 13 minutes advance notice before a tornado strikes. For some needs, this is not enough lead-time to move people to safety.

Warn-on-Forecast (The Future)

Warn-on-Forecast researchers work to combine high-resolution surface, satellite, and radar data into an optimal set of analyses to initialize ultra-high-resolution surface, satellite, and radar data into an optimal set of analyses to initialize ultra-high resolution computer models that will predict specific weather hazards 30-60 minutes before they form. This advanced modeling system will predict probabilities of a hazard occurring, the confidence in the path, and adjust to trends in the threat level based on new weather observations, and rapid and adaptive radar scanning capabilities.

Warn-on-Forecast and FACETs

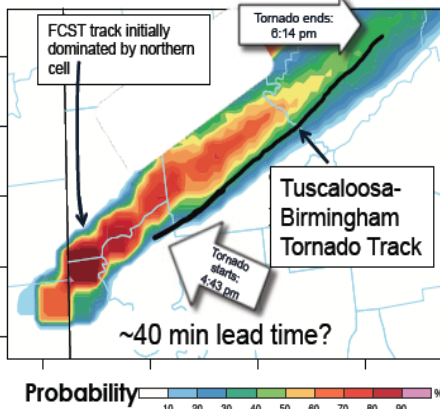
Warn on Forecast is the foundation of the new Forecasting a Continuum of Environmental Threats (FACETs), a proposed next-generation severe weather forecasting concept. FACETs aims to build a modern, flexible system that forecasters can use to communicate user-specific, understandable weather threat information. FACETs will serve as a "delivery mechanism" for WoF predictions of storm-specific hazards such as tor-



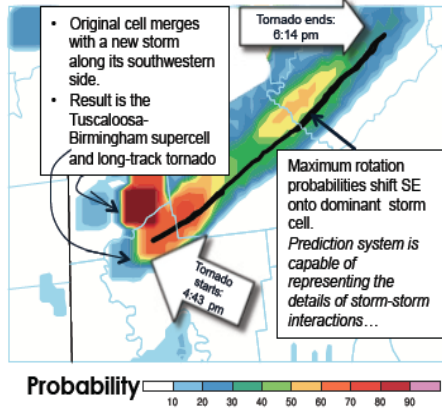
An example of how FACETs could use a suite of computer models to predict the path of a potentially tornadic supercell over the next hour. The confidence level that the tornado will affect a given location is highlighted.



Rotation track prediction for Tuscaloosa-Birmingham storm
Valid: 4:00-6:15 pm (135 min forecast)
Two storms are near MS border.....



30 Minutes Later: Rotation Track Prediction
Valid: 4:30-6:15 pm (105 min forecast)
Southwestern cell becomes dominant.....



Tuscaloosa to Birmingham EF-4 tornado

- Duration: 4:43-6:14 (1 hr 30 min)
- Distance traveled: 130 km
- Fatalities: 65

Left: One hour prediction of the chances of strong low-level rotation from a Warn-on-Forecast prototype system that uses WSR-88D radar data in a combination of forecasts (“ensembles”). Red or pink show near 90-100% chances of strong low-level rotation. Right: Another prediction of strong low-level rotation made 30 minutes later shows how the WoF prediction system can represent details of storm interactions.

nadoes, large hail, and extreme local rainfall. This work will enable the current NWS warnings paradigm to move beyond a binary yes/no warning process (from being in our outside the warning polygon) toward one which provides a more detailed threat assessment allowing various classes of users to base decisions on their specific situations and vulnerabilities. Decision-makers could set their own hazardous weather threat thresholds based on their specific needs.

Testing the Warn-on-Forecast concept

As new Warn-on-Forecast technologies emerge, they are tested in simulated forecasting and warning exercises in the NOAA Hazardous Weather Testbed (HWT), ensuring an efficient transition into forecasting operations. In the HWT, Warn-on-Forecast scientists and NWS forecasters have already evaluated multiple building blocks of a future Warn-on-Forecast system, including:

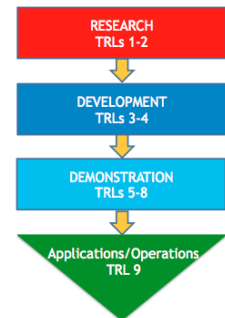
- Phased Array Radar and its ability to provide more frequent updates than current NWS radars,
- Different techniques to feed radar data into forecast models accurately and quickly
- Different suites of forecast models that can be combined into a single system representing all possible outcomes for a given weather event, and
- Development of strategies that allow forecasters to rapidly interpret computer-model guidance and add value in generating prototype forecast products.

Supporting a Weather Ready Nation

The Warn-on-Forecast activity supports requirements and activities documented in the NWS Weather Ready Nation road map, the NOAA 5-year Research and Development Plan, and recommenda-

Warn on Forecast
Research to Operations “Schedule”
NWS/OST/MDL Technology Readiness Level (TRL)
Framework

- NOAA projects move through four life-cycle phases on their way to (and including) application/operations
- Warn-on-Forecast began as a Research project (TRL=1) in mid-2010
- Now transitioning to the Development level (TRL=3) in FY15-16 (via HWT)
- Warn on Forecast could be at a Demonstration level (TRL=5) by FY19, depending on funding.
- Current EMC plans have Warn-on-Forecast operational around FY23.
- Due to computational constraints, WoF’s initial implementation will likely be an on-demand prediction system similar to the HWRF system today.



tions in the National Academy of Science 2012 report, “The National Weather Service Modernization and Associated Restructuring.” Warn-on-Forecast is led by NSSL and represents a collaborative effort across several NOAA groups including the Earth System Research Laboratory, the Storm Prediction Center, and the Norman NWS Forecast Office. Academic collaborators are the Center for Analysis and Prediction of Storms, and the Cooperative Institute for Mesoscale Meteorological Studies at the University of Oklahoma.