RESEARCH SUMMARY

Tracking Tornado Forecasting and Warning Performance

The National Weather Service issues tornado watches and warnings to the public and to local emergency managers who make critical safety decisions. Researchers at IDA recently reviewed how well the National Weather Service has been performing in its tornado forecasts and warnings.

Many Americans are affected by tornadoes. In March 2025, more than 115 tornadoes, with damaging winds and large hail, claimed 23 lives and affected many communities across the Central and Southern United States. Timely and effective forecasts and warnings can increase the survivability of people and perhaps their homes, and identifying opportunities for enhancing these measures is a step towards preventing future loss.

An IDA team, led by researchers Jen Bewley, Ayeisha Brinson and Abe Holland, found that since 2011, the National Weather Service (NWS) had achieved its goal of reducing false alarms in nine of the last 12 years. However, it has consistently fallen short on two fronts: probability of detection for tornadoes and providing people with enough advance warning, or lead time.

The IDA team also found that NWS' parent agency, the National Oceanic and Atmospheric Administration (NOAA), lacks outcome-focused measures to track progress for the Tornado Warning Improvement and Extension Program (TWIEP). The TWIEP is a key component of the Weather Research and Forecasting Innovation Act of 2017 (Weather Act). The program's goal is to reduce fatalities and economic losses from tornadoes. Without improvements, TWIEP's goals will remain unmet. Specifically, the researchers found that:

— NOAA needs a clearer plan for achieving the TWIEP goal defined in the Weather Act.

— The agency does not adequately assess

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improvements to tornado forecast operations. Specifically, it does not measure how well investments in its tornado forecast research enterprise translate into real-world performance gains. It also does not assess how well NWS communicates risk through tornado watches and warnings to the public.

— Public communications on NWS tornado warning lead-time performance are confusing, making it difficult to understand the agency's effectiveness. The current lead-time measure is also affected by multiple factors, including tornado duration. This can make performance appear better or worse for reasons that have little to do with NWS forecasting performance. For example, if a tornado lasts longer, the reported average lead time automatically increases — even when the amount of time between the initial warning and the tornado touching down remains unchanged. As a result, the current metric can mask opportunities for real progress, especially across tornadoes of different strengths.

To address these gaps, the researchers recommend NOAA:

— Develop a detailed implementation plan for carrying out TWIEP activities to improve performance.

— Consider adopting outcome metrics tied to fatalities and economic damages in order to more directly assess programs.

— Revise policies to ensure research investments are evaluated for operational impact.

— Assess how NWS's impact-based decision support services (IDSS) lead to public protective actions.

— Review and improve how performance metrics are communicated to the public.

— Re-examine the lead-time metrics and identify which approach — or mix of approaches — best supports accurate performance assessment and external oversight.

The review also brought forward an additional issue deserving more attention. Despite NWS efforts to improve the consistency of tornado warning performance, significant variation exists across local weather forecast offices. Even among offices that experience similar levels of tornado activity, warning performance remains highly variable. Since these offices are ultimately responsible for issuing warnings in their respective regions, further analysis is needed to understand what drives their differing performance levels.

This summary is based on IDA Product 3002824.

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