NOAA Science Advisory Board Report Review and Recommendations to NOAA of the "Report to Congress – Tornado Warning Improvement and Extension Program Plan"

Prepared by the Environmental Information

Services Working Group

July 2019

Environmental Information Services Working Group

A working group of the National Oceanic and Atmospheric Administration Science Advisory Board

3 July 2019

To: Lynn Scarlett, Chair, NOAA Science Advisory Board

CC: Robert Winokur, SAB Liaison to the Environmental Information Services Working Group

Everette Joseph, SAB Liaison to the Environmental Information Services Working Group

Cynthia Decker, NOAA SAB Executive Director

Subject: EISWG Review and Recommendations to NOAA of "Report to Congress – Tornado Warning Improvement and Extension Program Plan"

Dear Ms. Scarlett:

In response to the requirements of Title I, Section 103 of the Weather Research and Forecasting Innovation Act of 2017 (P.L. 115-25, signed 18 April 2017), as amended (P.L. 115-423, 7 January 2019) (hereafter, the Weather Act), the National Oceanic and Atmospheric Administration (NOAA) has prepared and submitted a "Report to Congress – Tornado Warning Improvement and Extension Program Plan" (hereafter, the Report). See Attachment 1. In accordance with Title IV, Section 401(c) of the Weather Act, the Environmental Information Services Working Group (EISWG), a working group of the NOAA Science Advisory Board (SAB), has reviewed the Report and prepared the following comments and recommendations.

To aid the working group in its review, the EISWG requested comments on the Report from Dr. Greg Forbes, formerly a senior faculty member in the Department of Meteorology, Penn State University, and now a semi-retired severe convective weather expert and broadcast meteorologist at The Weather Channel.

In general, the EISWG finds that the Report is comprehensive and responsive to the requirements of the Weather Act. It provides a good assessment of the technological and social/behavioral challenges that are essential to address in parallel to increase both the skill of NOAA's monitoring and forecasting, and the effectiveness of its warnings of tornadoes (and other destructive phenomena, such as microbursts, associated with severe thunderstorms). The Report describes the several efforts that NOAA has either underway or planned to address these technological and social challenges. The EISWG was pleased to see the many mentions of working in

partnership with the entire Weather Enterprise to achieve jointly the shared goals of saving lives, protecting property, and reducing the economic impact from tornadoes.

Given the budget and other resources likely to be available to NOAA over the next five or so years, the EISWG is concerned that NOAA's ambitions may exceed its capabilities to accomplish the goals it has set for itself. This further highlights the importance of working with and leveraging the capabilities of the national Weather Enterprise.

With respect to technological objectives, the EISWG notes that some of the challenges could be accomplished with currently deployed technologies through software or hardware upgrades, or the deployment of readily adaptable commercial-off-the-shelf technologies. In particular, NOAA should recognize the following:

(1) While convection-allowing models have made great progress, they still do not capture every important mesoscale feature. Timing and position of thunderstorms can be off in time by an hour or two and in space by a county or more. Model forecasts seem less accurate when storms are already present when the model is initialized.

Recommendation 1: In its development of Warn on Forecast (WOF) procedures, NOAA should include pattern recognition and artificial intelligence algorithms that take into account and adapt for the various known shortcomings in explicit computer model forecasts.

(2) The greatest successes with tornado warnings come in supercell situations; skillful warnings for non-supercell tornadoes remain a serious challenge.

Recommendation 2: NOAA should focus more strongly on reducing the false alarm rate (FAR) and other metrics of skill in current generation tornado warnings. Polygon-based warnings challenge the way FAR is determined and so demand new methods to quantify true positive, false positive, true negative, and false negative for precision, recall, and accuracy. As warning polygons are now updated as severe storms evolve, FAR measures will need to be assessed over space and time. The ways these metrics are computed should be transparent. National metrics are nearly meaningless by themselves; NOAA should compute and release metrics by Forecast Office. Importantly, while the focus should be on reducing the FAR, such reductions cannot come at the expense of affecting negatively other tornado warning-based metrics, such as the probability of detection (POD). In other words, reducing the FAR while decreasing the POD would not be a positive outcome. These are related metrics, both very important

and clearly improving the quality of tornado warnings will require a balance between these two important metrics to provide people with more accurate warnings to support decision making.

Recommendation 3: As a means for obtaining greater low-level radar coverage of non-supercell tornadic circulations and so significantly aiding in the warning of tornadoes, NOAA should consider …

a) … reducing the lowest allowable elevation angle on ***all*** NEXRAD/WSR-88D radars to the minimum possible value, consistent with ground clutter and local environmental considerations, and

b) … adding one or two tower sections to selected existing NEXRAD to reduce ground clutter, increase the radar horizon, and allow better overall coverage.

Recommendation 4: To aid in the warning of short-lived tornadoes, NOAA should build on the experiences in south-central Oklahoma and across the multi-county Dallas-Fort Worth metropolitan area and include networked X- or C-band as gap-filling radars to obtain greater low-level coverage of non-supercell circulations and strong winds.

Recommendation 5: The NEXRAD processing software used to detect mesocyclone and tornado vortex signatures should be modernized/upgraded to reflect the best science now available. An example is provided by the Mesocyclone Detection Algorithm (MDA), which currently uses only a portion of the available shear information. A modernization of this key algorithm might allow circulations of (weak) intensity levels 1 and 2 to be detected sooner and utilized with some confidence. This could make possible earlier (by several minutes, or equivalently two or three volume scans) detection of the earliest stages of formation of long-lived tornadoes, and allow tracking of at least a portion of the life cycle of short-lived tornadoes.

With respect to the sociological objectives, NOAA should recognize that the protection of life and property from the impact of tornadoes is not only a meteorological challenge, but also a sociological one. For example, to justify the costs and effort involved in developing and deploying WOF systems that may provide people advance skillful warnings of an hour or more, NOAA needs to understand better if people will take appropriate actions upon receipt of such lengthy advance warnings.

Recommendation 6: Given the limited number of federal social science positions within the agency, NOAA should utilize its set of joint and cooperative institutes to access social science expertise in the national university community.

Recommendation 7: NOAA should have social science programs charged with investigating questions such as the following: Will people take action more than a few minutes in advance, even if given warnings an hour in advance? Where is the balance between lead-time and good decision-making? If actions are taken based upon lead times an hour or longer than at present, will this include fleeing and, if so, will road infrastructure and traffic management suffice? Will the public take action based upon probabilistic tornado warnings? How should the public best receive such warnings? Will the public be responsive to repeatedly updated warnings (N.B., The Report (see Attachment 1), p. 7 suggests that such warnings could be updated every 2 minutes), or simply confused by such frequent updates, and so waiting until the last minute to attempt to take action?

Recommendation 8: To reduce impacts in terms of minimizing property losses (as well as improve life safety measures), it will be necessary to implement stronger building codes. NOAA should develop and implement - in partnership with NIST, universities such as Texas Tech, and entities such as the Institute for Business and Home Safety - a weather-ready home certification program as an extension of its StormReady community and Weather-Ready Nation program,. This could encourage in-home shelters, hurricane clips to hold on roofs, etc.

In closing, the EISWG notes the resources portion of the plan seems generic. This leads to questions such as, "Has a detailed action plan been produced?" "If so, what are the detailed timelines?" "Has a detailed cost/benefit analysis been performed?" Such information is needed by the EISWG to know if NOAA is tracking favorably against the intended deliverables when reviewing subsequent reports.

On behalf of the members of the EISWG,

John T. Snow
EISWG Co-Chair, and Dean Emeritus and Regents' Professor Emeritus of Meteorology, The University of Oklahoma, Norman, OK

Brad Colman
EISWG Co-Chair, and Director of Weather Strategy, Bayer Crop Sciences - The Climate Corporation, Seattle, WA

Dated: 3 July 2019
Letter To: Ms. Lynn Scarlett, Chair, NOAA SAB
Subject: EISWG Review of “Report to Congress – Tornado Warning Improvement and Extension Program Plan” and Recommendations to NOAA

Attachment:

1) NOAA, 2019: “Report to Congress – Tornado Warning Improvement and Extension Program Plan.”