



Reshaping the Hurricane Cone of Uncertainty: A Study on Public Perception

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Abstract

The Cone of Uncertainty, a popular National Hurricane Center (NHC) graphic, communicates the possible deviations from the forecasted track of a tropical system's center. The deviations are determined by using historical forecast errors from the previous five hurricane seasons, resulting in a cone that does not change in width with each NHC advisory. Because this behavior does not reflect the variability of forecasting tropical cyclone tracks, the NHC is considering a redesign that integrates model data with each advisory, creating a cone that can expand and contract in width. To investigate how clear this behavior is to the public, a focus group study involving 124 participants was conducted during the summer of 2022. These participants were split up into four groups with one group using the current cone and three other groups using differing cone widths to analyze a storm simulation. In this five-day simulation, participants described their levels of concern at three locations as a fictional storm approached the U.S. East Coast. After a qualitative analysis of these descriptions, the results suggest that people's levels of concern for the storm were not hindered by the implementation of various cone widths. Additionally, when asked how the cone was constructed, every participant already believed that the cone was built using current weather information and models. These conclusions suggest that, in their next redesign, the NHC could implement a model-dependent cone that properly communicates the variability of the track forecast to the public.

Methodology

This study recruited citizens across the United States, with an emphasis on the Southeastern US coastline, to participate in a study on the cone of uncertainty and how modified cones would impact participant's intuition on a hypothetical tropical cyclone event. An online survey was conducted in late-May to early-June of 2022 to which 895 people responded to. Out of this respondent pool, 124 people were chosen to participate in focus groups in mid-June through mid-July. These groups were broken up into 4 sub-groups with 4 different cone variations (current/control, wide, narrow, and mixed).

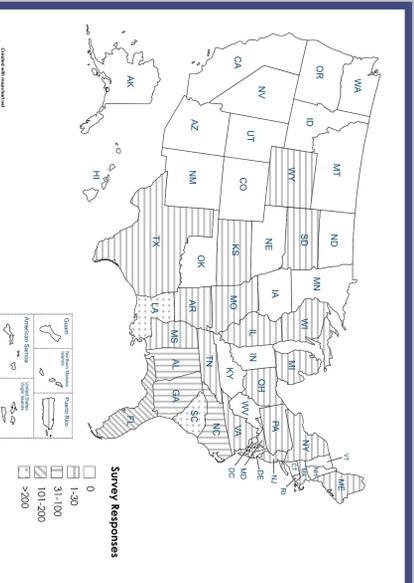
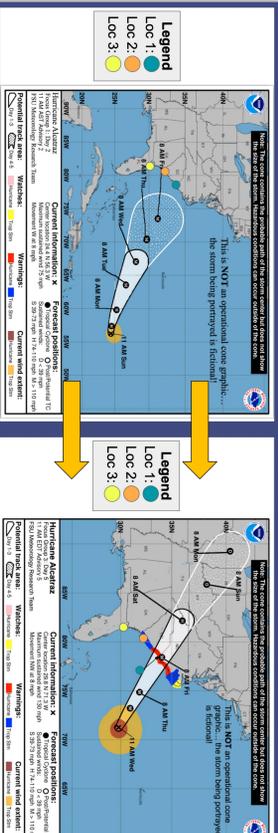
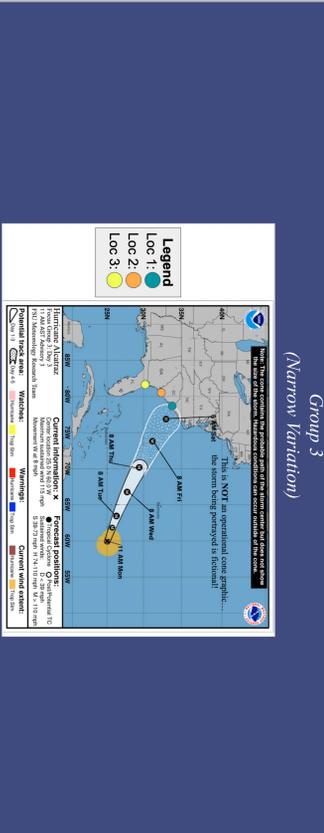
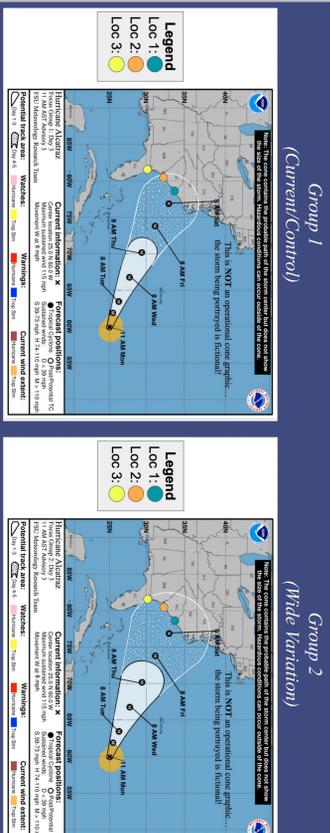


Figure 1. 68 was the calculated minimum respondent threshold to make statewide conclusions where a population is above one million, South Carolina, Florida, and Louisiana achieved this threshold.

The study intended to sample a diverse racial group across different socioeconomic backgrounds. However, the result was a skewed demographic sample, with 89.5% identifying as White or Caucasian; 3.2% identifying as African American or Black; 3.2% identifying as Biracial; 2.4% identifying as Hispanic or Latina; and 1.6% identifying as American Indian, Alaska Native, or Native American. Additionally, 33.1% of participants indicated having a federal income tax rate of 10-12%, 58.9% indicated a tax rate of 22-24%, and 8.9% indicated a tax rate of 32-37%. Lastly, the educational result showed that 3.2% identified as having a high school diploma or equivalent; 16.9% identified as having an associate degree, some college, or trade school; 79.0% identified as having at least a 4-year bachelor degree/equivalent or higher. While stratified sampling was used to attempt to achieve more diverse opinions, the highly skewed demographics are the result of a low commitment rate among minority groups.

Cone Modification Designs

To assess the public's perception of a model-based cone, which would be able to change sizes (Majumdar et. al 2010), three cones of various widths were created. Participants in Group 1 were exposed to the control condition: the NHC cone with 2022 size parameters. Group 2 participants used a wide cone variation which had a width 1.5 times that of the control condition; in contrast, Group 3 participants used a narrow cone variation which had a width 0.5 times that of the current graphic. For all three groups, the size of the cone did not change during the five-day simulation. Group 4 participants began the simulation by using the wide variation on day 1, the control condition for days 2 and 3, and the narrow variation on days 4 and 5.



Focus group participants were placed into four groups where they utilized either the current cone, a wide variation, a narrow variation, or a mixed variation during a five day storm simulation. The cone width, the independent variable, was isolated as one of two graphical element that changed between the groups and each day of the simulation. The other which expanded based on the variance in the track forecast for each group.

Situational Perceptions



Conclusion

This study's findings suggest that implementing a model-based cone that could vary in width would not significantly interfere with participants' concern levels, especially earlier in the storm's life. This pattern may derive from the majority of focus group participants believing that the current graphic was constructed with model data and real-time observations. Although incorrect, this assumption could be beneficial if a model-based cone is introduced since viewers already believe the cone changes sizes and, as demonstrated by nearly all focus group participants, they understand that the cone's width correlates to the uncertainty in the track forecast. This study also found that, while over a majority of people know the cone's purpose is to show the track of the eye of the storm, several participants still used the cone's perimeter as a demarcation line to determine their levels of concern. This behavior is demonstrated by the average concern score given by participants for location 3 using the wide cone variant. The pattern suggests that the cone itself has a correlation with the storm's damage path, resulting in a reactionary-behavior change that does not always correlate to the situation's actual danger (Broad et. al 2007).

This series of barplots show the average level of concern among focus group participants separated by the cone type that was implemented in the simulation. The concern score, which is not on a scale, was calculated using a qualitative analysis that gave a score based on past and future expressions given by each individual. A low score expresses minimal concern while a high score expresses maximal concern.

References

Majumdar, S. J., & Finocchio, P. M. (2010). On the Ability of Global Ensemble Prediction Systems to Predict Tropical Cyclone Track Probabilities. *Weather and Forecasting*, 25(2), 659-680. Retrieved Sep 14, 2022, from https://journals.ametsoc.org/view/journals/wefo/25/2/2009wa1222327_1.xml

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