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AMS Statement on Hurricane Forecasting: Hurricane Track Forecasts Improved Tremendously in Past 5 Years; Intensity Forecasts, Other Challenges Remain

Hurricane track forecasts, the forecasts that pinpoint the path of a storm, have improved steadily in recent decades with track forecast errors now roughly half of what they were in 1990, but predicting the intensity of the storms is still a challenge for forecasters, according to a new information statement on hurricane forecasting issued by the American Meteorological Society.

The AMS statement outlines the state of science of hurricane forecasting in the United States including hurricane related hazards, observations, forecasting skills, and challenges for the coming decade. The statement is available online at http://www.ametsoc.org/POLICY/2007hurricaneforecasting.html

The tropical cyclone track forecast is the foundation of the forecast and warning process. Between 2001 and 2005, the National Weather Service's National Hurricane Center (NHC) track forecast errors averaged 65 nautical miles (120 km) for the 24 hour forecast and 118 nautical miles (269 km) for the 48 hour forecast. NHC track forecast errors are now roughly half of what they were in 1990.

The statement notes that in spite of improvements in track forecast accuracy, forecast uncertainty still necessitates the issuance of hurricane warnings for relatively large coastal areas. From 2000–2005, the average length of coastline under a hurricane warning in the United States was 275 nautical miles (510 km). This represents a substantial decrease from the preceding decade, during which the average warning length was 395 nautical miles (730 km). However, only about one-quarter of an average hurricane warning area experiences hurricane conditions. Continued improvements in track forecast accuracy could decrease the amount of "over warning," but this must be carefully balanced with the priority to safeguard lives and property.

In contrast to the improvements for track forecasts, mean intensity errors have not changed significantly during the past 30 years. Furthermore, there are large intensity forecast errors that typically occur when storms strengthen (or weaken) rapidly. Unexpected rapid increases in strength close to landfall can result in communities being under prepared. Changes in the distribution of damaging winds are often extremely difficult to anticipate. These changes in storm structure can significantly affect storm impacts. The inability to anticipate these changes is of great concern to the meteorological community.

What about heavy rain and storm surge predictions? Accurate prediction of rainfall from landfalling hurricanes remains elusive because of complicating factors such as terrain effects, the low predictability of rainfall, and uncertainties in the hurricane track and structure forecasts.

According to the statement, the largest losses of life in hurricanes result from storm surges -- the rapid rises of sea water and associated flooding that occur when hurricanes make landfall. Storm surge height can exceed 20 ft (6 m) when strong hurricanes strike a coastline with shallow water offshore. In recent decades, large losses of life due to storm surge had become less frequent; however, the rapid growth of U. S. coastal populations and related infrastructure, and the increasing complexity of evacuation have led to increased vulnerability of coastal communities. This vulnerability was illustrated by 2005's Hurricane Katrina, which by some estimates killed more than 1700 people in Louisiana and Mississippi.

Given a sufficiently accurate forecast of the hurricane's track and surface wind structure, as well as accurate topographic and bathymetric data, numerical models can accurately predict storm surge inundation. However, because of uncertainty in tropical cyclone forecasts, evacuation decisions cannot be made based on individual runs of a storm surge model.

The statement also notes that predictions of seasonal hurricane activity in the Atlantic basin have demonstrated forecast skill since the mid-1980s; however the 2006 season reminds us that challenges remain in even basin-scale seasonal forecasting. Further, it is not yet possible to confidently predict seasonal activity for smaller regions or landfalls.

What challenges remain? According to the AMS, improvements in intensity forecasts would benefit from continuing improvements to observational systems (such as Doppler radars and satellites) that can effectively observe the details of the storm core, improved data assimilation techniques, improved modeling capabilities on both the global and regional scale, as well as improved prediction of ocean–atmosphere interactions. More effective remote sensing of ocean surface winds also is essential to improve the analysis, forecasting, and initial detection of tropical cyclones. In addition, better quantification of forecast uncertainty would enable users to make more informed decisions. Potential cut-backs in future satellite systems supporting operational forecasting are of grave concern.

The ultimate goal of hurricane monitoring and forecasting is to prevent loss of life and to reduce vulnerability to hurricane-related hazards. The 2005 Atlantic season was a powerful reminder of that vulnerability. Evacuation times for some communities exceed expectations for present and projected forecast accuracy, and some of the potentially most difficult evacuation problems have not been tested for generations. Thus, while the primary focus of the meteorological community must always be on a concerted scientific effort to improve forecasts, greater resilience to hurricanes requires effective engagement of other disciplines including engineering, ecology, biology, the social, behavioral, and economic sciences, and public policy. Further development of community awareness and preparedness programs through a comprehensive framework is also essential for ensuring public understanding of hurricane threat and the ability to take appropriate action to mitigate the loss of life and property that links the entire process — from data collection to forecast to communication of the societal impact.

The informational statements issued by the AMS are designed to provide a trustworthy, objective and scientifically up-to-date explanation of scientific issues of concern to the public at large. This summary of the current state of scientific understanding is based on the peer-reviewed scientific literature.

The American Meteorological Society (www.ametsoc.org) is the nation's leading professional organization for those involved in the atmospheric and related sciences. Founded in 1919, the AMS has more 11,000 international members, organizes nearly a dozen scientific conferences annually, and publishes nine peer-reviewed journals.

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