THE RMS U.S. AND CANADA SEVERE CONVECTIVE STORM MODEL

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I. INTRODUCTION

RMS has developed a U.S. and Canada Severe Convective Storms model which quantifies the financial risk and impact of Convective Storms in the U.S. and Canada. The United States has the most active severe convective storm climatology in the world. Canada ranks as the second most active. In the U.S. the annual losses from SCS represent the second highest from natural catastrophes.

II. PRESENTATION OF RESEARCH

RMS models the risk of SCS by using a stochastic set of events which include hail, tornado, straight-line winds storms. The stochastic event set has over 80,000 simulated events, each of which is defined by the intensity of hail, tornado or wind at the locations impacted by the storm. These events represent a comprehensive set of physically possible variations of the key storm parameters and their associated rates of ocurrance.

In order to properly represent the intensity, frequency and small-scale damage pattern of events as well the geographical extent and correlation between the 3 perils (hail, tornado and straight-line winds), RMS has developed a hybrid modelling approach that combines the strengths of numerical weather prediction and statistical techniques.

RMS derived CAPE (Convective Available Potential Energy) and shear from the North American Regional Reanalysis data in 1975-2005 (Mesinger, 2006) and used them as convective potential indicators. RMS resampled this reanalysis data to create a stochastic set of several thousands simulated years of continent-wide convective conditions. This ensures that spatial and temporal correlations in the data are preserved while simulating a set in which each year is unique and represents a year of convective activity that is physically feasible and that has never been observed before. These continous weather patterns are then discretized to create events. An event is defined as continuous convective storm activity which lasts from a single to several consecutive days. Within these simulated days multiple outbreaks of tornadoes, hail and straight-line winds may occur over a large area.

The Straight-line winds Model

The RMS U.S. and Canada Convective Storm model includes straight-line winds which comprises downbursts, outflow, microbursts, and even larger more organized storms such as *derechos.* For the characterization of these events in terms of intensity and morphology, we use different sources of data such as historical reports (1955-2006) from the Storm Prediction Center, anemometer data (1995-2006) which include Oklahoma's Mesonet stations which are specifically designed to capture meso- and micro-structure of convective wind events.

We have created an algorithm that identifies and delimits derecho's geographical extent based on the historical data mentioned above and a modified definition of Coniglio's which identifies derechos based on wind speeds, the size of the area of the convectively induced wind gusts and the continuity of the temporal and spatial progression of reports (Coniglio and Stensrud, 2004) . This definition was further modified to identify other straight-line winds events which are not considered derechos but have damaging winds. The morphological characteristics of derechos were calibrated based on data from 1968-2006, as the first measured derecho was indentified in 1968.

Wind footprints of the maximum winds were created for the historical events using interpolated anemometer observations at the time and location of the identified historical events. A probabilistic distribution of characteristic winds during a straight-line wind event was estimated at each location using all the wind measurements from the reproduced historical footprints. These characteristic wind distributions were sampled for the simulated wind events in the stochastic set.

The Tornado Model

The U.S. and Canada Severe Convective Storm model uses reports of historical tornadoes to parametrize the morphology of a tornado outbreak. RMS identified over 20,000 tornado clusters between 1950 and 2006 in the historical tornado records. The clusters can be characterized by the strongest tornado in the cluster. The stochastic tornadoes in the RMS model are based on these historical cluster observations and accurately represent the range of sizes of tornado outbreaks observed in the historical record. Intensities are measured using the Fujita scale and are assigned to each tornado streak in a cluster consistent with the range of intensities in the historical data.

For the development of the stochastic tonado parametrization, RMS has focused on tornado reports corresponding to different years of the complete record for each tornado intensity. This has been done as, it is widely known, the annual number of tornado reports has increased with time (McCarthy 2003). In addition, the frequencies of weaker tornadoes have been corrected to compensate for underreporting.

Individual tornado characteristics, such as path length and width, are based on probability distributions specific to each intensity class. The intensity across the path of a tornado is modeled using a meteorological model for vorticinial wind speed. This model has been further calibrated using damage surveys that record intensities across the path of historical tornadoes.

The Hail Model

The development of the RMS model was based on thousands of observations from over 50 years of hail incident reports. In addition industry claims have been used as they can provide a unique high-resolution view of the intensity footprint of a hail storm.

Radar data was also used in the development as this has the advantage of overcoming the large spatial gaps in the observational hail data. RMS worked with Weather Decision Technologies Inc. (WDT) to interpret high resolution WSR-88D radar data from a wide range of events to define the areas of individual hail swaths. This high resolution data, in conjunction with reports and claims data allowed us to characterise the hail swaths and streaks in terms of their morphology and intensity. RMS parametrizes the size and shape of the individual hail swaths and uses two intensity classes which are based on an equivalent of the kinetic energy of the hail swath at a location.

III. RESULTS AND CONCLUSIONS

RMS has developed a comprehensive U.S. and Canada Severe Convective Storms Model. RMS models the risk of SCS by using a stochastic set of events which include hail, tornado and straight-line winds storms. These events are characterized by their intensity, geographical location and rate of occurrence and include outbreaks any combination of the 3 perils.

RMS has used a variety of data (reanalysis data, anemometer readings, radar images, event and damage reports as well as loss data) and modeling techniques (statistical, numerical and meteorological) to develop its SCS model. Using reanalysis data we have created a risk surface which captures the link between convective meteorological conditions and the probability and intensity of an event. The surface drives the occurrence of events and maintains the spatial coherence between the outbreaks and the 3 perils. This approach also avoids biases around populated areas where historical reports are concentrated on.

We have used historical data to characterize the events in terms of their morphology, intensity and the small scale characteristics of the individual footprints.

V. REFERENCES

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Mesinger, F. et al. 2006: North American Regional Reanalysis. *Bulletin of the American Meteorological Society*, 87(3) 343-360.

Coniglio M. C., Stensrud D. J., 2004: Interpreting the Climatology of Derechos. *Weather and Forecasting*, 19(2) 320-337.

McCarthy, D. W., 2003: NWS tornado surveys and the impact on the national tornado database. Preprints, *First Symp. of F-Scale and Severe-Weather Damage Assessment*, Long Beach, CA, Amer. Meteor. Soc., CD-ROM, 3.2.