Insurance Rate Filings and Hurricane Loss Estimation Models

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Abstract
Insurance rate filings involving hurricane perils are generally based on complex, numerical models. Evaluation of such rate filings are further complicated if the model is proprietary so that state regulators are shielded from the inner workings of the models. To circumvent this difficulty while adhering to proprietary restrictions, Watson and Johnson (2003) developed an ensemble of 324 public domain models that bracket the published results of proprietary models while having the advantage of full disclosure of methodology. Moreover, the collection of models can provide regulators an appreciation of the state of the art of hurricane risk modeling to assist them in evaluating future rate filings. This methodology was applied for the North Carolina Department of Insurance but similar studies can be rapidly completed for other states as well. The results provide regulators with an independent, public domain spectrum of values to assess specific rate filings.

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Introduction
Computer simulations of losses from severe weather events such as hurricanes have become important tools for the insurance industry. Complex numerical models have been developed to compute expected losses from extreme events, which are then used in establishing insurance rates. These models draw from expertise in the fields of meteorology, statistics, finance, computer science, and engineering. The use of these models is not without controversy. Traditional actuarial methods to determine rates are based on the past history of losses for a given exposure, and while this may involve proprietary data, the techniques themselves are well-known and familiar to insurance regulators. On the other hand, the low frequency and high potential severity of hurricane insurance claims significantly reduces the credibility of those traditional actuarial methods. In addition, the current generation of numerical loss models is considered proprietary by the companies that develop and market them. The closed nature of these models presents many problems for regulators who must determine that the filed rates based on model outputs are not excessive, inadequate or unfairly discriminatory.

The availability of open techniques and analytical tools for numerical models of hurricane loss would greatly facilitate the regulatory process, as well as facilitate research to improve the models. Here we report the results of computing expected loss costs from hurricanes using methods drawn from the public domain literature. We illustrate their value in the context of experiences of the State of Florida in reviewing proprietary models. The Florida Commission on Hurricane Loss Projection Methodology was established in 1995 to address actuarial methods for producing loss costs from hurricane wind perils. This experience provided substantial motivation in pursuing a public domain approach to hurricane risk modeling. Following the Florida discussion, we describe recent work with the North Carolina Department of Insurance in developing baselines for assessing rate filings (Watson and Johnson, 2003a, 2003b). Finally, we describe how this methodology can be used in future rate filings. Various pitfalls are identified in the modeling process itself, especially as they pertain to aggregation issues—a critical feature for actuarial analyses. A primary feature of this paper is an indication of how the comprehensive modeling study performed for North Carolina can be adapted for other states in anticipation of future rate filings as well as opportunities in other insurance arenas.

This paper proposes a three phase approach to assessing rate filings. The first phase is described in the subsequent Preliminaries section and consists of a list of basic material that should be either in the rate filing or produced on demand to assure that the review process is ready to proceed. The second phase involves a comprehensive set of
calculations on public domain models to place the specific rate filing in context with what could be deemed as plausible rates. Note that Phase Two can (and perhaps should) be conducted prior to the receipt of any specific filing in order to establish a baseline, as it is independent of any specific filing and can take upwards of 90 days to complete. This was the approach taken by North Carolina. However, as the normal process by state insurance departments is to proceed on the basis of the receipt of a specific filing, we describe phase one first. The third and final phase handles a final assessment of the state of the art of computer modeling and the implications of model uncertainty on the rates as perceived by the consumer, insurer and re-insurer. In particular, the state of the art yielding rates having 3 to 1 or greater ratios for diverse but “acceptable” models ought to give pause to the regulators in the assignment of particular numbers. Determining the fundamental sources for model to model variation provides research mandates for improving the methodology.

Preliminaries

Before embarking on an in-depth review of a rate filing, the regulator needs to determine that the rate filing is sufficiently complete. This entails determining answers to the following issues on a rating territory level, either as found in the rate filing itself or in subsequent interrogatories:

1) Definition of an event.
2) List of historical hurricanes included in the model that have produced hurricane force winds in the state.
3) Description of the treatment of bypassing storms.
4) Data and analyses to support the landfall frequencies and intensities as used in the model (i.e., the stochastic storm set).
5) Treatment of topography in the model and sources and dates of topography data bases.
6) Description of the decay of the storm as it passes over land.
7) Data comparing modeled storms with observed events (wind speeds, damage and loss costs).
8) Description of building stock used in the model with the state’s building stock.
9) Data supporting the treatment of building codes and building code enforcement for the rating territories in the state.
10) Information on previous external reviews such as the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) including dates of acceptance and description of differences between the model used in the current rate filing and the model which was subject to FCHLPM review.
11) Description of model treatment, if any, of demand surge.
12) Description of model output that details any modifications, adjustments, assumptions, defaults and treatment of missing values.
13) Description of tests performed to validate the meteorological, vulnerability and actuarial components of the model specifically for the state.

The above list serves as a set of minimal prerequisites needed prior to launching an effective rate filing review. With these issues addressed (and deficiencies overcome), the regulator can then proceed to the second phase by reviewing the detailed results produced by the methods described in this paper.

Methodology

The Department of Insurance of the state of North Carolina commissioned a study by two of the authors (CCW and MEJ) to investigate the realm of possible loss costs for an ensemble of public domain components of models. Watson and Johnson (2003) considered nine wind field models, four friction functions and nine damage functions yielding a collection of 324 distinct combinations of models. These combinations are summarized in Table 1.

Table 1 Components of the 324 Public Domain Models

Wind Field

- Rankin Vortex
- Holton (1992)
- Miller (1967)
- SLOSH (Jenesnianski, et al., 1992)
- Standard Project Hurricane (Schwerdt, et al., 1979)
- Bretschneider (1972)
- AFGWC (Brand, et al., 1977)
- Holland (1980)
- Georgiou (1985)

Friction (Boundary Layer Model)

- None (Schwerdt, et al., 1979)
- Cell- based (Cook, 1985)
- ASCE (2000)
- Trajectory (Watson, 1995)

Damage Functions

- Australian (Leicester, et al., 1978)
- Foremost (1996)
- Friedman (1984)
- Clemson 1 (Sill, et al., 1997)
- Clemson 2 (Rosowsky, et al., 1999)
- Professional Team (FCHLPM, 2002)
- X-cubed (Howard, et al., 1972)
Each of the components listed in Table 1 has a published source that provided the basis for the implementation. No tweaking or adjustments to the published functions were made to enhance comparisons to historical loss cost data for particular storms.

Additional implementation details can be found in the aforementioned paper. The simulation of storms requires a number of input data bases. We used what we deemed the latest viable data bases (considered the most current data base available). In particular, this study used:

- **Topography:** US 90 meter DEM from USGS
- **Land Cover:** NASA/UMD 250m Global Land Cover data set (Spring 2003)
- **Track:** 1851-2002 revised HURDAT data from NHC
- **Exposure:** Census 2000 Block Group data (the STF3 data set).

These data sets (with the exception of the HURDAT tracks, which were used as-is) were re-sampled to a common 180 meter grid. Thus, each of the 324 model combinations relied on the same underlying data bases.

Finally, occurrence rates of events are necessary. The actual historical storm set as given in HURDAT was employed, which precluded “smoothing” of strike probabilities along coastal segments. An additional set of results was produced which relied on empirical fits to annual maxima of winds at each site, which in a sense offers the equivalent of smoothing.

**The Florida Experience and Public Domain Results**

After hurricane Andrew in 1992, the state of Florida faced an insurance crisis. Companies were raising rates and in some cases completely withdrawing hurricane coverage from the state. The drastic increase in rates coupled with reductions in coverage availability focused attention on the methods used by insurance companies to set rates, especially the use of proprietary computer models that could not be fully evaluated by the state Department of Insurance. A major dilemma was that the state’s open records laws (so-called Sunshine laws) created the situation where any information submitted to the Department was available for immediate public access, thus presenting an inherent conflict with the proprietary nature of the models. In 1995 the state of Florida established the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) under
Florida Statutes Section 627.0628. The purpose of the Commission is summarized in its mission statement:

*The mission of the Florida Commission on Hurricane Loss Projection Methodology is to assess the efficacy of various methodologies which have the potential for improving the accuracy of projecting insured Florida losses resulting from hurricanes and to adopt findings regarding the accuracy or reliability of these methodologies for use in residential rate filings.*

The FCHLPM evaluates models through the adoption of standards that must be met by the models. These standards are reviewed and modified on an annual basis. A team of experts in the fields of meteorology, statistics, structural engineering, computer science, and an actuary, who are not subject to the open records laws (having signed a non-disclosure agreement with the modeling companies), conduct field reviews of the modeling companies and report general compliance with the standards to the Commission. In addition to the field reviews, the standards include a number of tests scenarios to be run by the modelers.

The Florida review process is perhaps the most rigorous evaluation of hurricane loss models in operation. Hawaii and other states initiate their rate filing reviews with a determination that a model has been accepted in Florida. However, the Florida review does not provide details as to the applicability of the model in a jurisdiction other than Florida, and in fact only determine that a given model meets the standards, which do not include any tests of the ultimate reasonableness on the loss costs computed by the model. Regulatory officials require methods to expand the Florida reviews for their applicability in their own jurisdictions. Four proprietary models were submitted for evaluation under the 2002 standards, and approved by the Florida Commission during meetings in the spring of 2003. The models approved by the Commission, and abbreviations used in this paper, are:

<table>
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<th>Modeling Company</th>
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<td>Applied Insurance Research, Inc.</td>
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<td>Applied Research Associates</td>
<td>ARA</td>
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<td>EQECAT, Inc.</td>
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<td>Risk Management Solutions, Inc.</td>
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Figure 1 gives the county average loss costs for each of four modeling companies for wood frame structures from the 2002 submissions, with the loss cost for Franklin County (includes the city of Apalachicola) indicated. As is readily apparent, detailed scientific scrutiny does not imply a
convergence of loss cost estimates across approved modelers – the proprietary models in Franklin range from a low of 2.28 to a high of 6.55 per $1000, a ratio of 2.27 to 1, with other counties having higher ratios.

Figure 1: Loss Costs for Florida model submissions (Franklin County highlighted)

Aside from the obvious observation that such a wide range in results indicates substantial uncertainty in the underlying modeling process, an unscrupulous insurer could select a model or a version of a model to enable it to set rates as high as possible to maximize profits at the expense of consumers; likewise, selecting a model that produces lower losses may allow an insurer to justify reduced rates and undercut competitors, but at the risk of insolvency if a major storm strikes. How can the regulator approve such disparate models? The approval process involves consideration of individual technical standards to be met by each modeling company, and it is possible that very different scientific approaches can be “approved” as valid scientifically yet produce distinct results. There is no guarantee that the totality of the parts is valid, as the “correct” answers to the test runs in the submissions process are not known, and as will be seen below the limited observed data permits widely varying approaches to produce “valid” results. The wide range of losses
generated by these models indicates an opportunity for advancing the field of hurricane damage modeling by reducing uncertainty and sensitivity in these models. Of course, due to the proprietary nature of the models, more detailed testing and analysis of the models is difficult or impossible. Thus, there appears to be a need for models based on public domain sources that can be used by the regulatory and research communities to assess methods of both improving hurricane loss modeling and the methods used to evaluate these models.

Once the public domain models are run we can place proprietary model results in a firmer context, as well as assess the ability of the public domain models to reflect the range of proprietary model results. Figure 2 shows on a county basis the range of the public domain results superimposed with the proprietary results. It appears that the public domain results effectively bracket the proprietary results. Hence, the range of variation in the public domain values are not dissimilar to those observed by the approved proprietary models.

![Figure 2: Loss Costs in Florida](image)

A few counties show results different from the proprietary models, and were examined more closely. Since HURDAT is readily available on the web site [http://www.nhc.noaa.gov](http://www.nhc.noaa.gov), which includes the extended data set back in time to 1851, we used the full 152 year time frame. The published submissions of the proprietary models use 1901-2002, in concert with the official storm set declared by the Florida Commission. The main impact is that south west Florida (Monroe county on the mainland up towards Sarasota) had a higher number of additional extreme events in the middle and late 1800’s. The land use/land cover database we use may be
somewhat more current than those used by the proprietary modelers (again, inferring this from the official submissions). Finally, we do not use brute force Monte Carlo methods or other stochastically generated schemes as mentioned previously. In spite of these basic modeling differences, it appears that that our approach provides useful guidelines in interpreting the results obtained from proprietary models.

**North Carolina Study Review**

The Florida study of the previous section was restricted to county level aggregated loss costs, as this is the highest level of resolution of published results from the proprietary models. Figure 3 shows results for the 324 models in North Carolina, with the 25th and 75th percentiles indicated. In rate filings, we are interested in the effect of various levels of aggregation. In particular, with our public domain models, we can examine loss costs at a much finer level of detail. In particular, for North Carolina we have examined the impacts of aggregation at county, ZIP Code and census block group level. Figure 4 shows Dare County, in the Outer Banks, along with a representative census block and Zip Code contained therein. Table 2 shows the range of loss costs generate at each level of aggregation. Note that unlike the proprietary models, which aggregate by population, we aggregated by number of structures to avoid geospatial biasing from apartments, condominiums, and so forth.

![Figure 3](image_url)

Figure 3: Loss costs per $1000 in North Carolina, with 25th and 75th percentiles.
Care must be exercised in performing these calculations, as census block groups can reside in a ZIP Code for one county while actually residing itself in a different count, thus distorting results. From Table 2, it is apparent aggregation has an impact on loss cost calculations, and that there is significant spatial variability even within a relatively small geographic area. This result is not surprising to anyone who has conducted post-storm surveys, with damage varying tremendously even over a mile or so radius.

**Methodology for other states**

The methodology described here could be readily applied in conjunction with rate filings in other states. Some preliminary work would
be required to establish the databases (namely, topography (DEM), land cover, and census block groups) and, of course, to run the public domain models. This is a one-time effort that produces data that should be valid for a number of years barring an improvement in modeling technology or a change in climatology. Based on our experience with the North Carolina Insurance Department, we recommend the following four step scheme for assessing proprietary models used in support of insurance rate filings for hurricane perils:

1) Check for internal model consistency via maps and analyses.
2) Assess consistency of results with historical record and public domain models of the historical record.
3) Compare modeled results with respect to smoothed public domain methods.
4) Evaluate anomalies, if any, and seek explanations from modeler.

To illustrate these steps, we evaluate a randomly chosen public domain model using this four-step process as an example for how this process could be conducted with an actual rate filing. In order to conduct a more realistic evaluation, we had the computer randomly select a model and report the results as “Model X” – thus, we did not know in advance which of the 324 models we were evaluating until step four. The authors evaluated the results and compiled a list of questions to be answered when the model was revealed.

**Step one:** Map results of submission and assess consistency with climatology.

The first step is to load the model results into a geographic information system (GIS) and create basic thematic maps. This allows a rapid assessment of the logical relation to risk, as well the observation of any spatial anomalies. Figure 9 shows the raw loss costs generated by Model X, with historical tracks as an overlay.
Model "X" Loss Costs

Model X appears to be reasonably consistent with the historical tracks, although in the middle part of the state the loss costs appear to drop precipitously. Transitions appear to be smooth from the coast to the interior, and no significant spatial anomalies are noted with the possible exception of Chowan county. It may seem a bit odd that a more inland county has greater loss costs (0.5-1 versus more coastal counties with 0.25-0.5 rates). Questions that would be raised at this stage are what is the definition of an event, and how bypassing storms are handled. Validation data should be requested and reviewed at this point.

Step two: Relation to historical loss costs.

The next step in the evaluation of a model in conjunction with a rate filing is to compare the specific model’s results against the set of results produced from the 324 combinations of models running the full historical storm set. A convenient approach is to identify the specific modeled values amongst the percentiles of the combinations of models. Unusual spatial variations warrant modeler explanations. For example, if hypothetically modeled results are at the very low percentiles in high risk areas and alternatively, at the very high percentiles at low risk areas, then again explanations are necessitated and may call in to question the modeled results. Figure 6 shows the ranking of Model X in comparison to the entire set of model combinations, with percentile rankings for specific counties noted.
Figure 6 indicates numerous areas that require explanation. Given the low values along the coast, landfall probabilities are an immediate question. Over the coastal and middle part of the state, Model X generates loss costs well below the 25th percentile of results, while rising to over the 50th percentile in the mountains. This could indicate a model that is producing unduly low winds on the coast but does not include topography with the rougher terrain in the Blue Ridge Mountains. Absence of topography considerations would not impact the winds and hence allow it to rise above the 25% of the PD models that do include topography.

**Step three:** Map relation to statistically smoothed loss costs.

The statistically smoothed results represent a refinement to the historical loss costs, reducing the impact of anomalous or rare events. This map is particularly appropriate for loss estimates covering areas that are low risk (devoid of events), such as the western part of the state. Figure 7 shows Model X ranking among the 324 statistically smoothed loss cost combinations, along with specific values for selected counties.
This map reinforces the impression that topographic effects should be examined in this model. Another possibility is that landfall intensities are too low and that decay rates are too weak – thus producing low values on the coast and high values in the mountains and uplands.

**Step four**: Evaluate anomalies, if any, and seek explanations from modeler.

Overall, Model “X” seems to produce results at the low end of the expected range of results, and demonstrates some peculiar behavior across the state, as noted previously. In summary, we have the following general questions with respect to “Model X”:

1) What is the definition of an event?
2) Provide data to support landfall intensities and frequencies used.
3) How are bypassing storms handled?
4) How is topography included in the model? What are the sources for topography and land cover?
5) What decay method is used?
6) Provide validation data for observed events.
These questions overlap with those given in the Preliminaries section (phase one of the review process). They are re-visited here based on consideration of the values produced by Model “X”, possibly calling into question various materials provided in the original rate filing.

In an actual review these questions would be presented to the modeler and explanations sought. For our example, at this point we determined which model was randomly generated, and attempted to answer the posed questions. In other words, we switch from our reviewer/auditor role to a modeler role, and represent the results produced by the model.

The actual model that was randomly selected used the Miller wind field, the ASCE-7/98 friction model and the Stubbs (Texas A&M) damage function. We consider each of the above questions in turn.

1) What is the definition of an event?

The events considered by the X model is the same as that used by all the other 323 combinations of models, namely, all tropical cyclone events in HURDAT.

2) Provide data to support landfall intensities and frequencies used.

Here again, the basic data set HURDAT is used to establish intensities and frequencies of the storms considered for the X model. Hence, any discrepancies observed for the X model cannot be attributed to any issues related to intensity or frequency.

3) How are bypassing storms handled?

Bypassing storms are not an issue whatsoever with the X model. All storms in HURDAT are simulated. Hence, issues in practice with the naming of storms and disaster declarations by federal or industry groups is moot in our modeling efforts.

4) How is topography included in the model? What are the sources for topography and land cover?

The model is using the NASA/UMD 2003 land cover data sets, and Census 2000 exposures. The ASCE-7-98 friction modifications include local topography near the site –but do not include regional topography. In other words, elevation of a site relative to its nearby surroundings is considered. However, more distant topographic structures (e.g., hills several miles away) are not considered.

5) What decay method is used?
The observed decay is inherent in the pressure change in HURDAT. Hence, there is no need to presume a functional form for hurricane weakening.

6) Provide validation data for observed events in as much detail as is available commensurate with the rating territories in the rate filing.

The following aggregate Validation Data vs. Reported Claims of “company A” is provided:

Andrew:
- Rank: 56th of 324
- Model result: $2.902 Billion
- Observed Losses: $2.640 Billion
- 9.93% high

Hugo:
- Rank: 16th of 324
- Model Result: $253.9 Million
- Observed Losses: $247.4 Million
- 2.65% high

Overall Rank using RMS error: 8th (0.1027)

Evaluation:
Model X does a credible job of reproducing historical claims for Andrew and Hugo, as well as storm total losses in other events. As further explanatory notes, in the range from 70 to 90 knots the Stubbs function is the lowest among the damage functions. The relatively lower loss costs are probably a result of this fact, as the bulk of damage producing storms in North Carolina are in this wind regime. The county with the higher loss cost than adjacent counties was found to have a higher proportion of mobile homes (nearly 25% vs. 12-15%) than the adjacent counties, resulting in a higher aggregate loss cost as these structures are more vulnerable than other classes of construction. Given the performance of the model against observations, and its use of an industry standard method for including friction (ASCE7), the model appears reasonable despite the relatively low loss costs produced by this model.

This exercise demonstrates the effectiveness of the use of the results of the study for evaluating an individual model. In summary, had Model X been used in a filing, we would have found issues that the modeler would need to address, but acceptable explanations for the questions raised existed and could have been readily made.

**Actuarial Implications**
Statutory regulations require that the rate of return to be earned by the filing insurer following approval of the rates is comparable to that of other industries with risk similar to that which is associated with writing the line of insurance in the state (rates can not be excessive or inadequate). An additional requirement is that differences among rates are statistically supported (rates can not be unfairly discriminatory). The process requires an analysis of the expected income and outflow of funds to the insurer. Therefore, the regulator must determine that the pure premium or loss cost portion of the rates appropriately estimates the loss costs that will be generated in the future for each rating territory.

Actuaries agree that the use of computer modeling provides the most accurate and reliable means of producing expected pure premiums for catastrophic insurance such as hurricane or earthquake coverages. While the reviews performed by the Florida Commission on Hurricane Loss Projection Methodology provide regulators in other states with a solid framework from which to make the necessary determinations, there are portions of the Florida review that are specific to the State of Florida, and as noted earlier the standards say nothing regarding the accuracy or uncertainty of the loss costs computed by the model. Additional analysis is necessary to determine that the model provides statistically reasonable results for the specific rating territories for which the model is producing loss costs.

It is imperative that a hurricane model being approved for use in a specific jurisdiction takes into consideration the local meteorological, construction, and actuarial characteristics for the intended use. Hurricane frequencies and hurricane characteristics must be found to properly estimate those that are expected to occur in the future. To meet the statutory requirements, the modeled effects of building codes must be found to be appropriately considered throughout the state being reviewed. In addition, actuarial considerations such as policy limits, deductibles, coinsurance and the claim practices of the insurer must match those in the jurisdiction as much as is practical given the current state-of-the-art and the currently available historical data.

A comparison of the loss costs produced by the historical storm set (those storms that have produced hurricane force winds in the rating territories) with the stochastic storm set (those hurricanes produced by the model for the same territories) provides information relative to how well the model reproduces historical results. While it is expected that the model results will differ for these two data sets, the reviewer can obtain valuable information from the modeler pertaining to the reasons for those differences within the model.
An analysis of how the model incorporates differences in building codes in the state or in different regions within the state provides information relative to the way in which the model addresses this issue which can have a significant effect on the resulting loss costs.

Models in use today incorporate a variety of construction types and characteristics that is far more sophisticated than the construction classifications currently used in property insurance rate making. It is necessary to ensure that the methods used within the model or by the filing insurer to adjust the model outputs for these construction classification differences should be determined to be scientifically and statistically reasonable.

The inclusion or exclusion of “optional” items such as demand surge must be found to be reasonable. Hurricane damage that is not included as a covered peril (e.g., storm surge flooding) must be excluded in the production of the filed loss costs. In addition, it is necessary for the regulator to be informed of any adjustments, edits or modifications that the filing insurer may have performed on the model output loss costs. The proper review will seek information relative to any such adjustments as well as the filer’s justification for making them.

These issues provide a sample of the types of information that must be analyzed to determine that the resulting loss costs represent the expected loss costs in an accurate and reliable way.

Due to the relatively short historical hurricane record, models are not expected to produce the same results. Therefore, the determination of loss costs that are not excessive, inadequate or unfairly discriminatory requires that the techniques used in the creation of the loss costs be based on methods that are determined to be scientifically reasonable. The purpose of the review is to determine that the science and the underlying data used in the modeling process are appropriate for the territories being rated.

While an effective review of hurricane models used to produce loss costs will not be limited to a specific list of items, the study produced for the North Carolina Department of Insurance provides the state with an analytical tool to allow regulators to concentrate their reviews in those areas where the model produces results that are in the extreme ranges or outside of the range of results produced by the available public models.

A potentially disturbing aspect of the results from the public domain models is the wide range of possible loss costs for scientifically defensible models. Unfortunately, the state of the art of hurricane loss modeling can be seen to lead to ratios of loss costs as high as 3 to 1 or even higher in
some locales. A typical consumer would likely be rather baffled by the
disparity of results, would presumably realize that shopping for better
rates could prove effective. Insurance companies could have a wide
latitude in setting premiums, although they may need temper their options
in order to deal with re-insurance to protect their risk portfolios.

Figure 7 provides plausible loss costs at the 25\textsuperscript{th}, median, and 75\textsuperscript{th}
percentiles based on the 324 combinations considered. They each reveal a
logical relation to risk yet offer considerably different rates. We consider
this to be the most reasonable range for loss costs, although it should be
noted that in the Florida comparison the proprietary models fell within the
10\textsuperscript{th} to 90\textsuperscript{th} percentiles. Also indicated is the ratio of the 75\textsuperscript{th} percentile to
the 25\textsuperscript{th} percentile. Of course, the distribution of exposures makes the
picture more complex than the maps might indicate, since the inland areas
with larger differences tend to be more sparsely populated. Using the total
insured values for each county as reported by the NC Rate Bureau in 2002
(NCRB, 2002), table 3 shows the expected annual losses using the 10\textsuperscript{th},
25\textsuperscript{th}, median, 75\textsuperscript{th}, and 90\textsuperscript{th} percentile loss costs. Exact numbers are
difficult to determine for a variety of reasons (such as changing exposures,
policy provisions, and so forth), but it appears that the annual loss rate for
NCRB over the last 20 years is approximately $118 to $120 million per
year, adjusted to 2002 dollars and exposures.
Figure 7: Loss Cost Scenarios for North Carolina.

Table 3: Expected annual losses for hurricanes only.
Based on NCRB reported exposure of $363 Billion.

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<th>10th</th>
<th>25th</th>
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Note that our “reasonable” range of expected annual losses for North Carolina is 2.59 to one, which encompasses the reported losses by NCRB over the last 20 years. Based on the Florida results, we would expect the proprietary models to encompass a range of 3.02 to one (the 10th to 90th percentiles). This wide range of estimates of annual losses, using scientifically defensible, “state of the art”, techniques, presents severe challenges to users of this data and those who are charged with regulating an industry dependent on these estimates.

Summary of the Paper

This paper describes a set of techniques, based on public domain methodologies, of computing expected annual losses and loss costs from
hurricanes. Through the use of these techniques, the regulator is better equipped able to perform the statutorily required determination as to whether the filed loss costs and resulting rates are not excessive, inadequate or unfairly discriminatory.

A three phase scheme was developed to assist with a regulator’s review of a rate filing. We recommend that Phase Two be conducted prior to the receipt of any specific filing in order to establish an independent baseline. However, as the normal approach by state insurance departments is to proceed on the basis of the receipt of a specific filing, we describe phase one first. Phase one consists of addressing the basic characteristics of the model used in the filing, data sources and validation. The main part of this paper consists of Phase two which involves generation of results for an ensemble of public domain models (324 combinations). These results guide the further in-depth review of the rate filing and could possibly detect fatal flaws in a rate filing. Additionally, the results give regulators and other users of computer loss models an appreciation for the precision of the rates, which may not be as high as some involved in the process would expect or demand. The third phase is an assessment of the filing in the light of the range of public domain results, the limitations of the accuracy of any specific modeled value, and the determination of fair rates given this uncertainty.

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