17. (2 points)

A catastrophe modeler would like to incorporate a new construction technique into a catastrophe model. This new technique would theoretically reduce the amount of building damage sustained during hurricane force winds. However, experts have not reached a consensus on the effectiveness of the new construction technique because it has not been exposed to an actual hurricane.

a. (0.5 point)

Briefly describe which module(s) of the catastrophe model would need to be modified to account for the new information.

b. (0.5 point)

Classify the uncertainty created with the new construction technique as either aleatory or epistemic and briefly justify the selection.

c. (1 point)

Briefly describe and contrast two methods the modeler could use to incorporate uncertainty in this catastrophe model.

QUESTION 17	
TOTAL POINT VALUE: 2	**LEARNING OBJECTIVE(S): C2**
SAMPLE ANSWERS	

Part a: 0.5 point

Sample 1
Vulnerability module quantifies the physical damage on properties at risk
Inventory module describes properties at risk

Sample 2
It will impact both inventory module and vulnerability module:
Because the insurer needs to update properties' information regarding this new construction technique in the inventory module and incorporate its susceptibility to loss damage in the vulnerability module.

Sample 3
This change would primarily affect the vulnerability module which relates to how susceptible different building types are to damage from a catastrophe. The change would require the use of engineering judgment, building response analysts, or class-based building response analysis to create revised assumptions. The change would also require an update to the inventory module to make sure that buildings of the new type in the insurer's portfolio are appropriately identified as such.

Part b: 0.5 point

Sample 1
Epistemic, because it's due to lack of data.

Sample 2
It will be epistemic. We may not know enough about this technique, and there's no historical data for us to model it, causing uncertainty.

Sample 3
This is epistemic uncertainty since it is parameter risk rather than process risk inherent to the nature of the catastrophe. The epistemic uncertainty could be mitigated with greater scientific knowledge.

Sample 4
Aleatory is inherent randomness from natural hazard events (CAT version of process risk); epistemic risk stems from lack of knowledge about a hazard. This new construction technique creates epistemic uncertainty since we have no historical data on its performance and little scientific data to base our estimates on.

Part c: 1 point

Sample 1

- Logic Tree assigns weight to parameter alternatives based on expert opinion. A weighted linear combination is calculated. This relies on simplified opinions but is easy to communicate.
- Simulation creates randomly sampled alternatives from a probability distribution of the parameter. It can handle complex situations but is difficult to compute.

Sample 2

- Incorporate uncertainty by assigning different weights (probabilities) to parameters using a logic tree. This addresses epistemic uncertainty. This method maybe somewhat difficult to update and requires reliance on expert opinion. However, it is potentially easier to understand.
- Use simulation techniques to attempt to recreate the inherent randomness of the catastrophe. This addresses aleatory uncertainty. Simulation techniques can incorporate more robust assumptions and data and can be updated more easily. However, these models require more calculation and can be difficult to understand.

Sample 3

- Logic Trees can be used to incorporate uncertainty. Probability can be assigned to various parameters (magnitude, soil type, location, wind speed, etc.) and probabilities and parameter values are multiplied together to get expected loss. This method is easy to trace and understand, but simple and not easy to scale to a large number of scenarios.
- Simulation can also be used to account for uncertainty in modeling. These are complex scenarios that are run thousands of times based on probabilities of various parameters to estimate expected loss. These methods are computationally complex and may be a "black box" to those who don't understand the mechanics.

Sample 4

- Add a risk load to the expected loss when calculating the premium. Risk load could be some percentage of standard deviation of expected annual aggregate losses. This may be easier to communicate and calculate, but it is judgmentally selected and more difficult to justify.
- Credibility weight with and without effects of the new science to get credibility weighted damage function, with the compliment of credibility being no inclusion of non-consensus science. This may be more stable, as it will have less major change year over year until new science becomes more mainstream and generally accepted.

Sample 5

- Run multiple models with different vulnerability assumptions for the new technique. Compare the models to gauge impact. This is "sensitivity testing" to get an idea of how much the change impacts the overall model.
- Add a probability distribution around the vulnerability assumptions with the model. This will incorporate uncertainty directly into the model.
- The first method may be more reliant on expert opinion, which are judgmental and could be biased.
- The second method gives a better overall view of the uncertainty in future results but is more computationally intensive.

EXAMINER'S REPORT

Candidates were expected to describe the components and structure of catastrophe models, understand the sources of uncertainty in modeling, and illustrate the basic mechanics of uncertainty in models.

SAMPLE ANSWERS AND EXAMINER'S REPORT

Part a
Candidates were expected to identify the inventory and vulnerability modules and provide a brief description of each. A common mistake was to only describe one module.
Part b
Candidates were expected to identify the uncertainty as epistemic and briefly justify why. Common mistakes included: • Conflating epistemic risk with aleatory risk • Providing an explanation without selecting the type of uncertainty
Part c
Candidates were expected to name and describe two distinct methods of incorporating uncertainty and list two ways in which the given methods materially differ. Candidates most commonly used logic trees and simulation as methods to incorporate uncertainty. Alternative answers earned credit if they described a way to quantify and integrate *multiple* parameter estimates, *multiple* model outputs, *or* a specific way to add a risk load to the expected losses. Common mistakes included: • Providing no description or only a vague description (e.g. "add a risk load", "increase the variance") • Neglecting to include contrasting qualities of the two methods • Simply describing a component of the vulnerability module