Natural hazards as a system

Typhoon as a example

Overview

- System
- Typhoon events as a example of a system
- represent a system in a model
- Improve a model with empirical data
  - By conditioning
  - By updating

System

System is natural or manmade construct of elements which interact together in a way that a entity emerges which achieves a task or has a logical relation

System

- System is a part of the reality which has to be investigated
- How a system should be defined is depending on which problem has to be solved

Defining a system

- Top down vs. bottom up
- Different approaches:
  - Integrate as much components as possible
  - Integrate as less components as necessary
- But it has to be possible to model the system

Model a system

- Represent some parts of the reality which was defined as a system in a model
- A model is a virtual representative of a system
- A model can be used to investigate a system

Analysis of a system

- Define the system
- Build a model of the system
- Compare the model to the reality
- Improving model
- Analyze the model

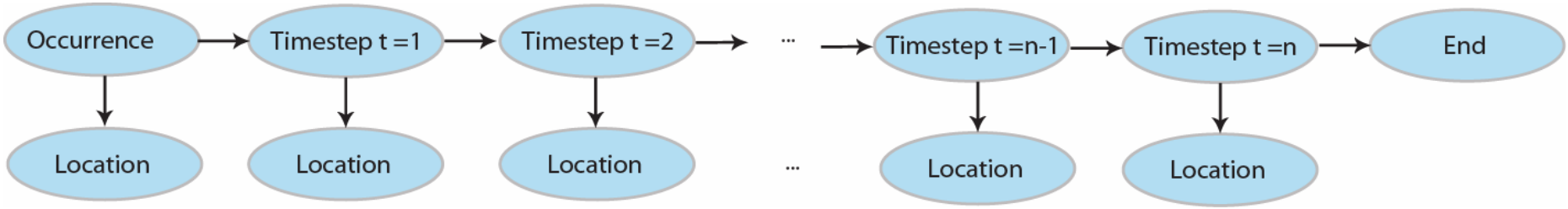
Typhoon

- Global weather and wind system as system
- metrological environment of the area of interest as a system Equilibrium disturbed → typhoon
- Single Typhoon as system

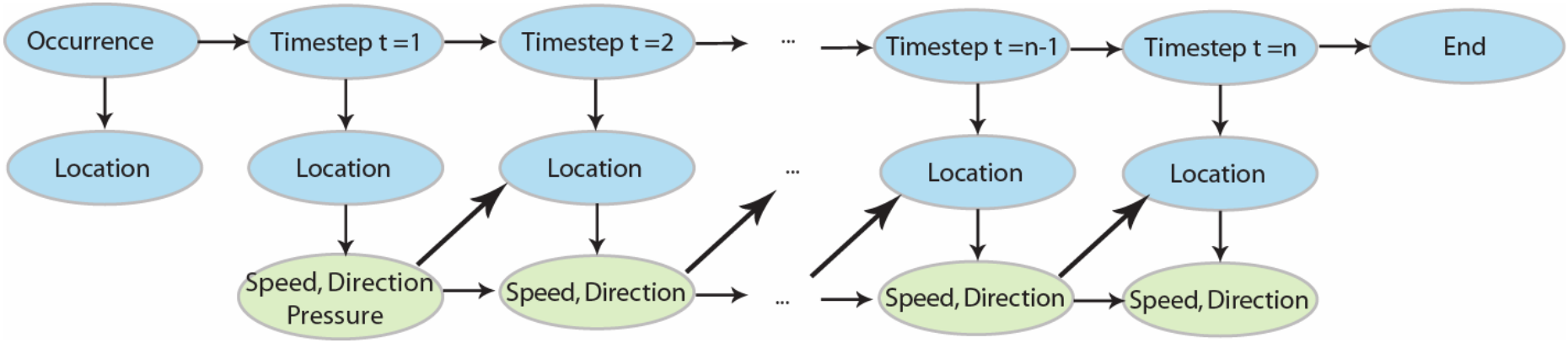
Typhoon

- Typhoon as a system
- Components are the clouds, water in the air or even air particle itself. The meteorological surroundings like high and low pressure zone are the boundaries of the system
- Attribute of typhoon are location, speed, transition angle and central pressure…

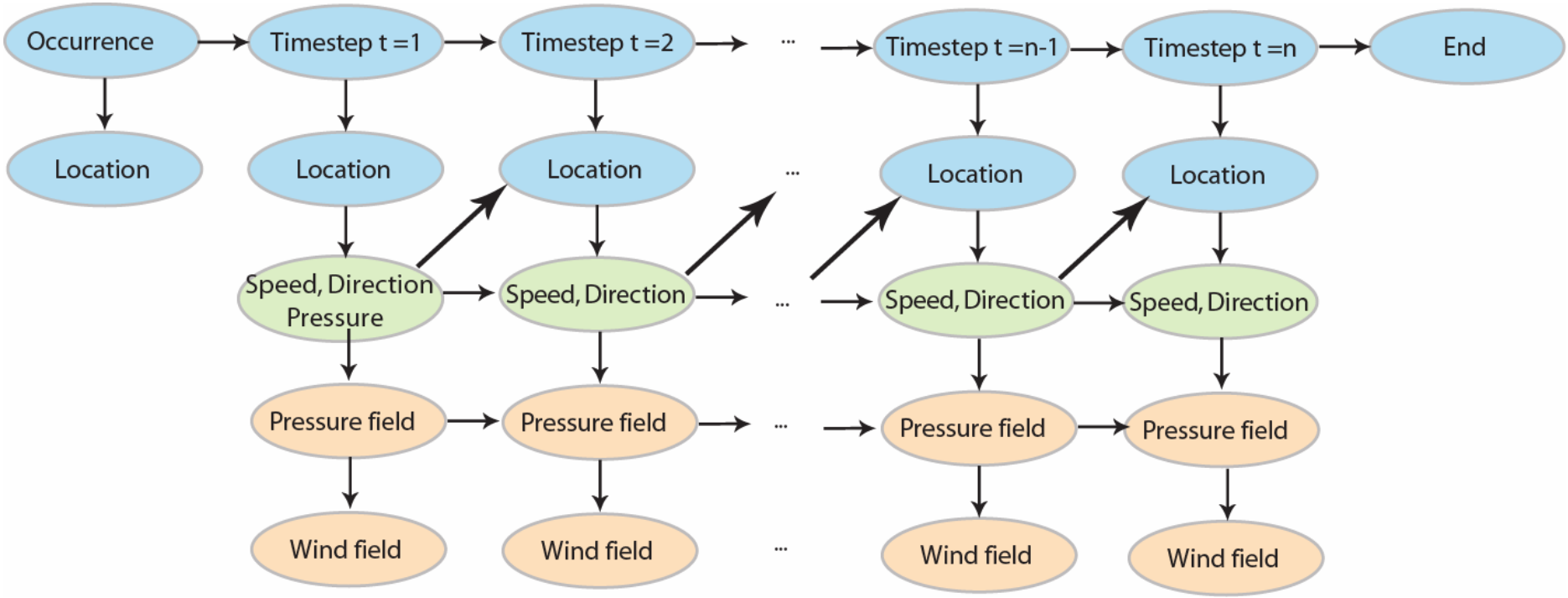
Typhoon as a system



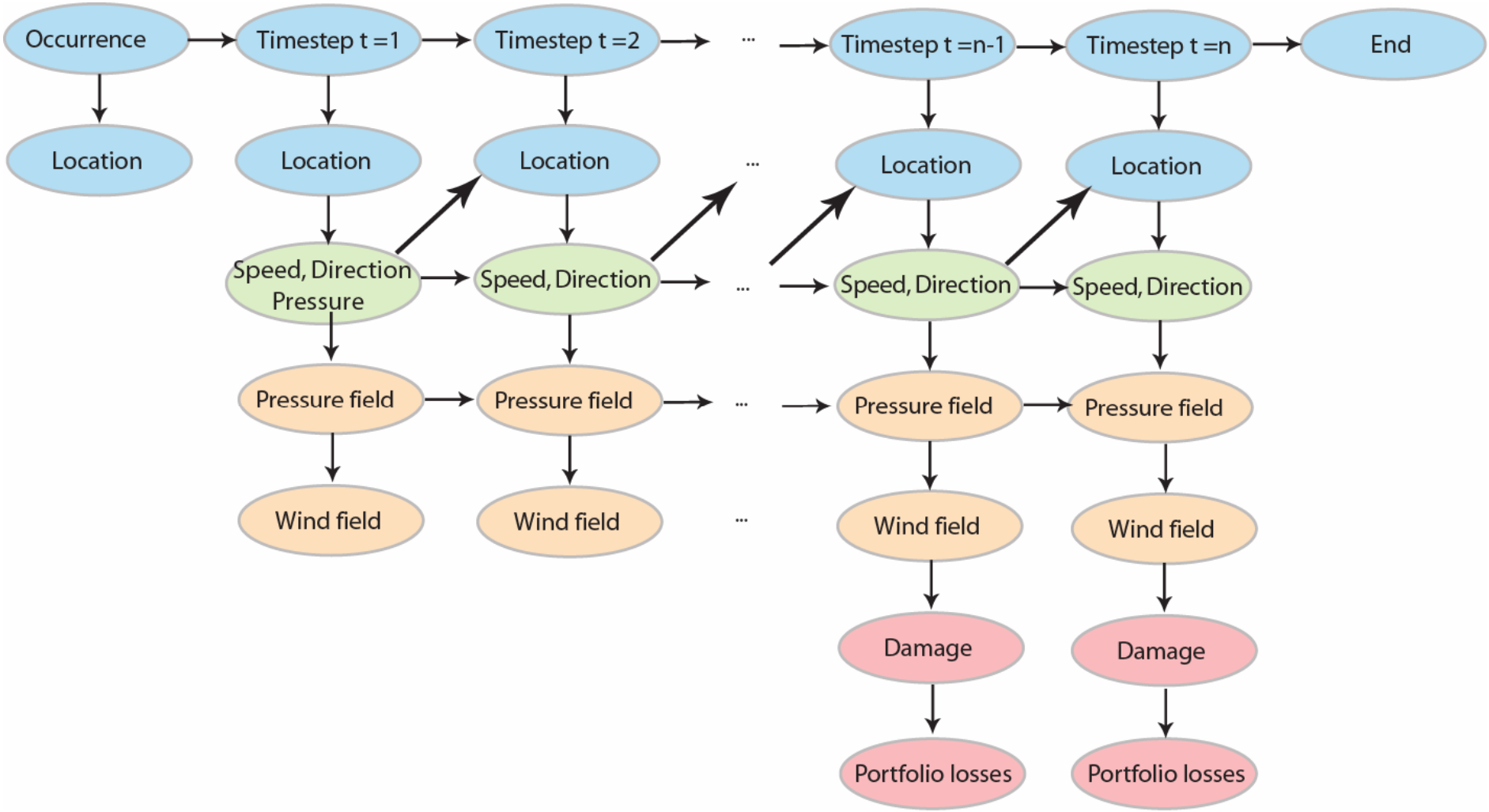
Typhoon as a system



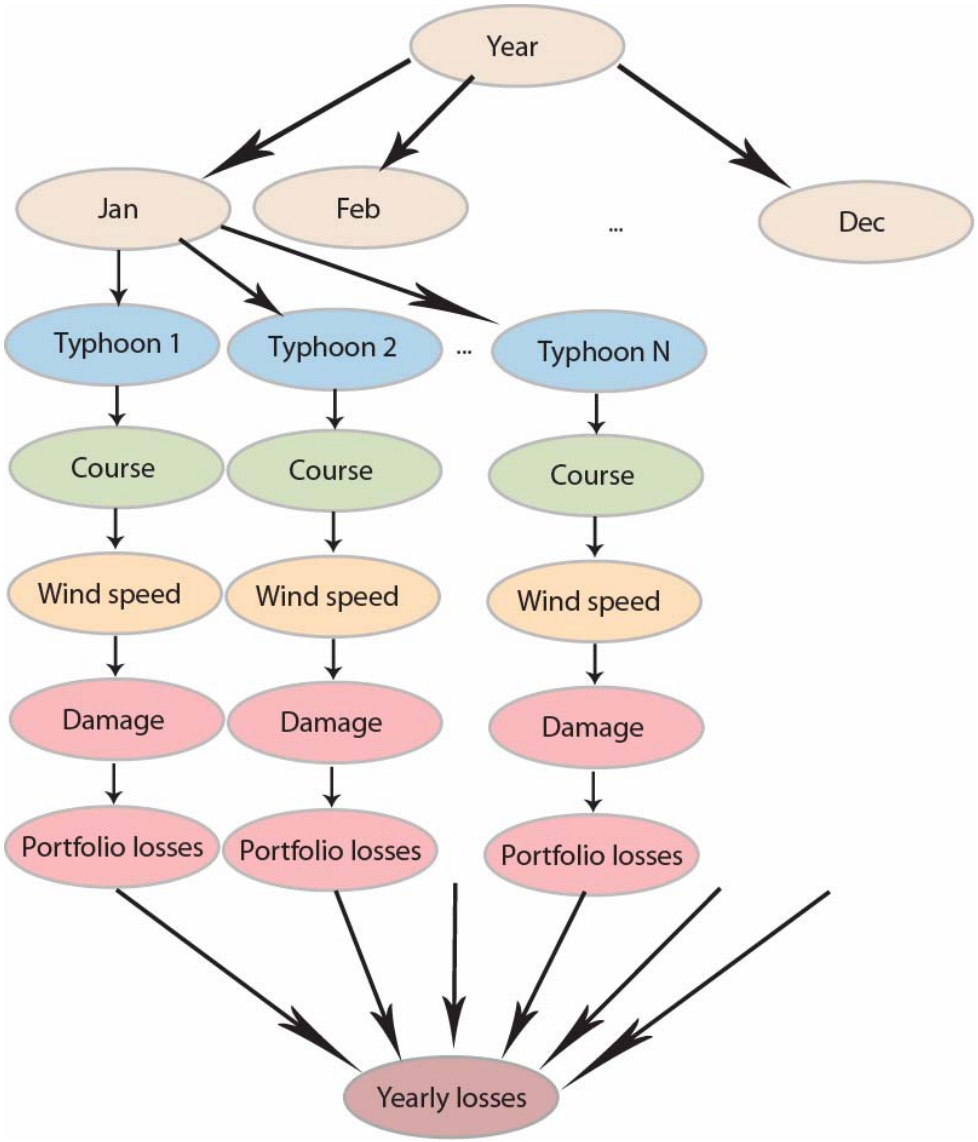
Typhoon as a system



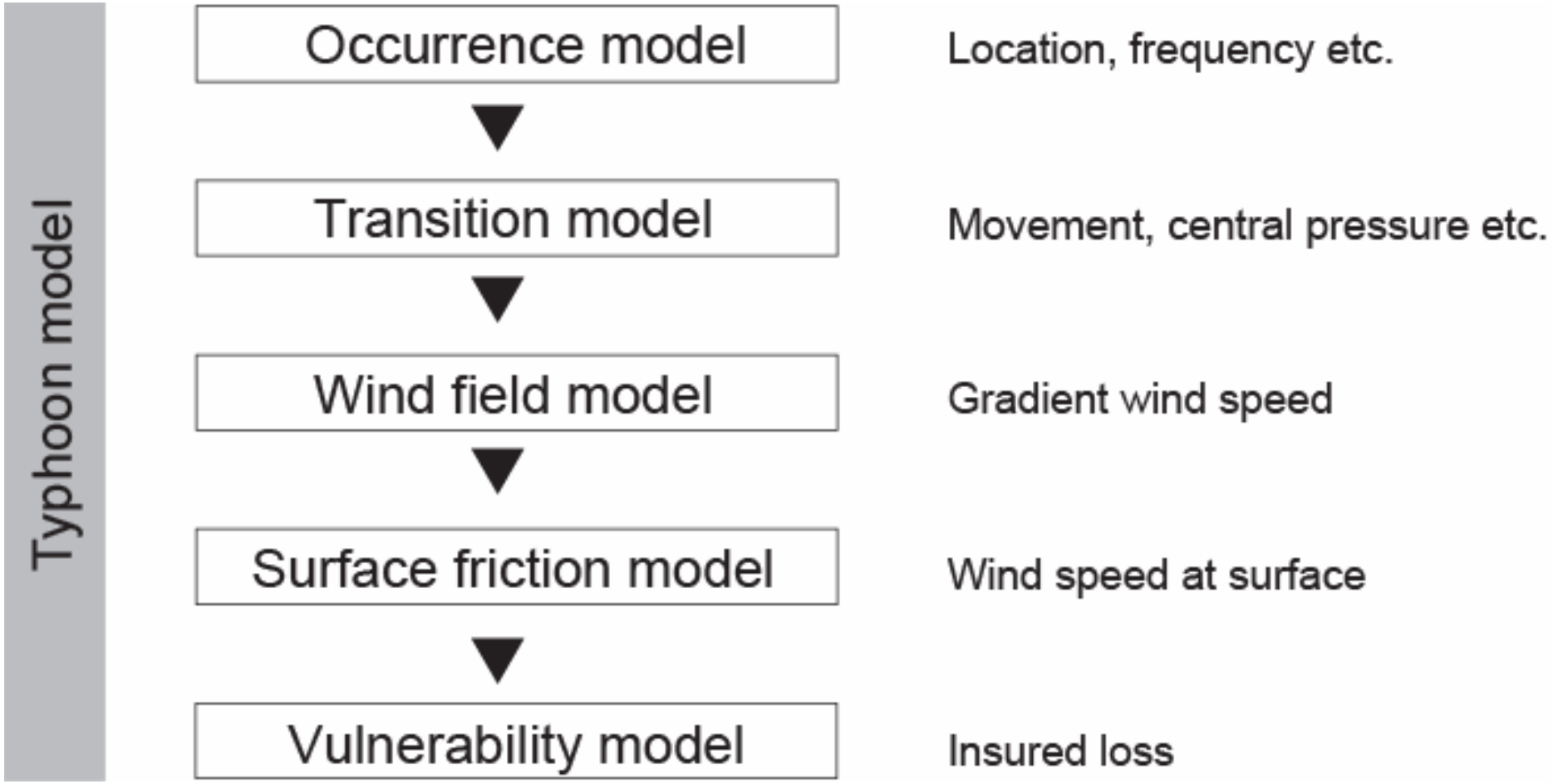
Typhoon as a system



Yearly losses estimation

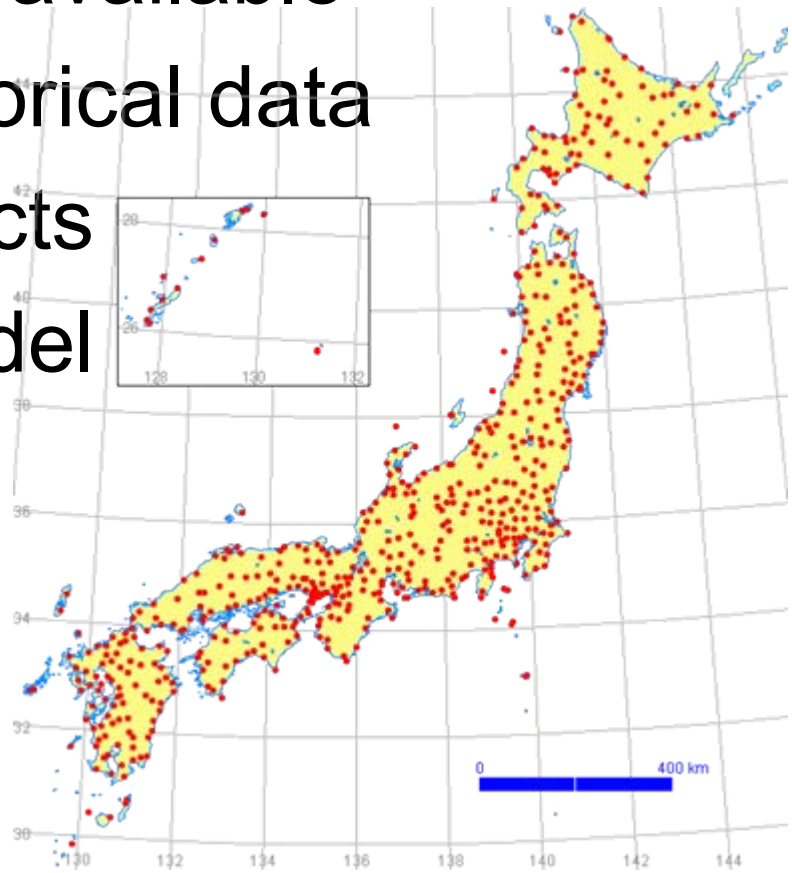


Parts of a typhoon risk model



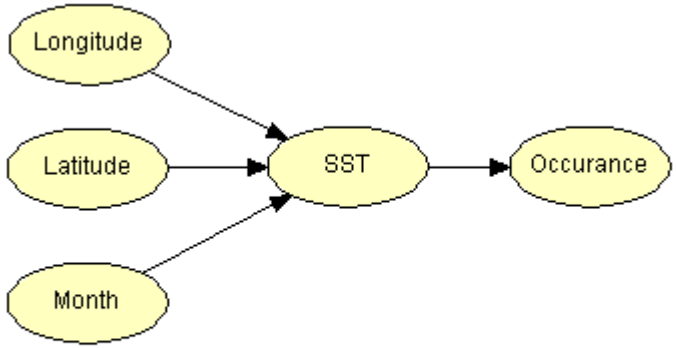
How to build a model

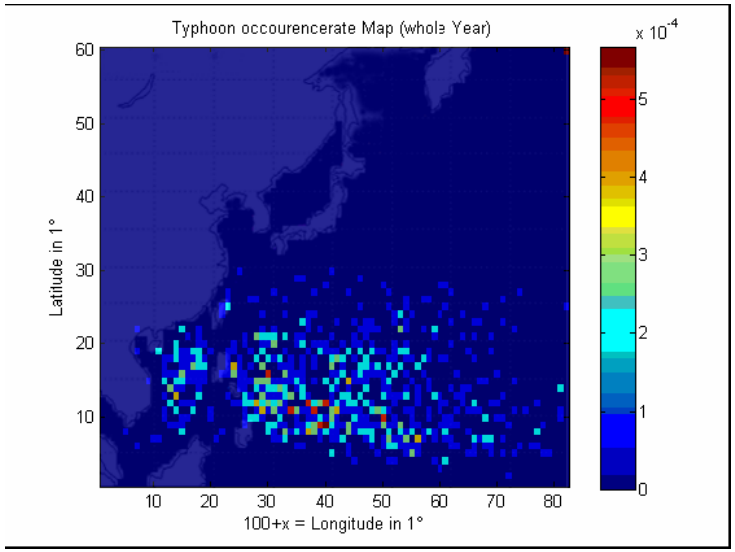
- What Information/data is available
- Empirical analyze of historical data
- Incorporating physical facts
- Example occurrence model

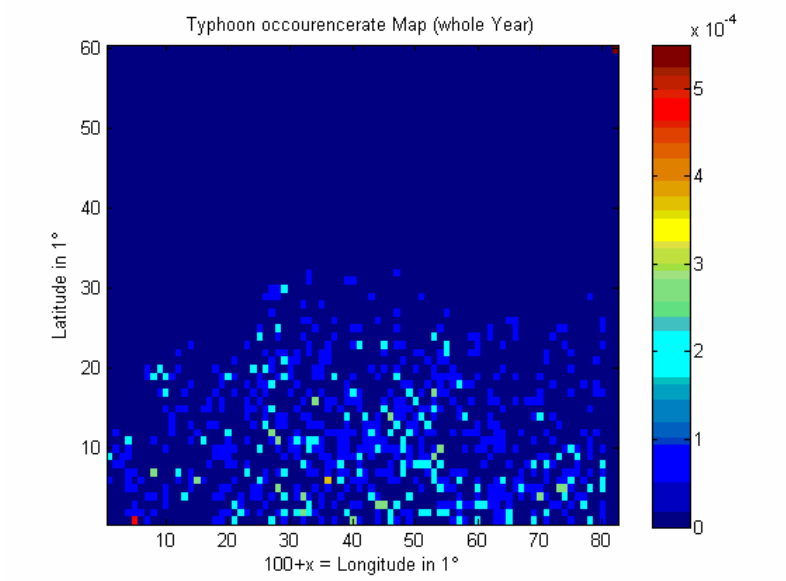


Establishing occurrence model

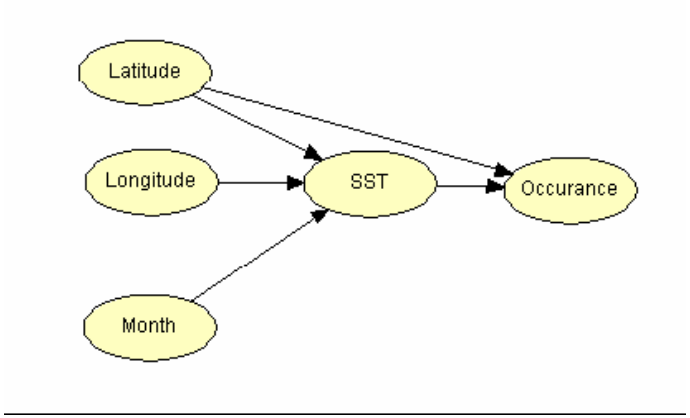
Typhoon normally occurs only on a location which has minimum sea surface temperature of 26.5º C

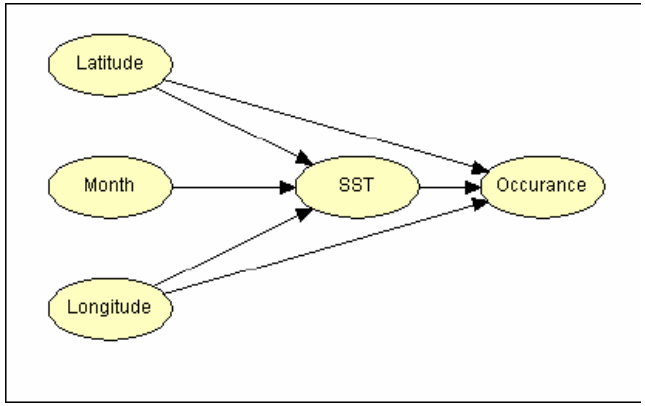


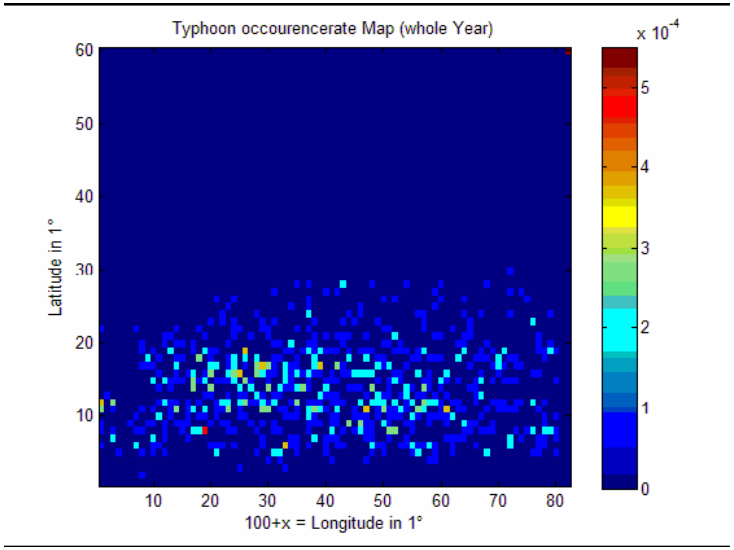


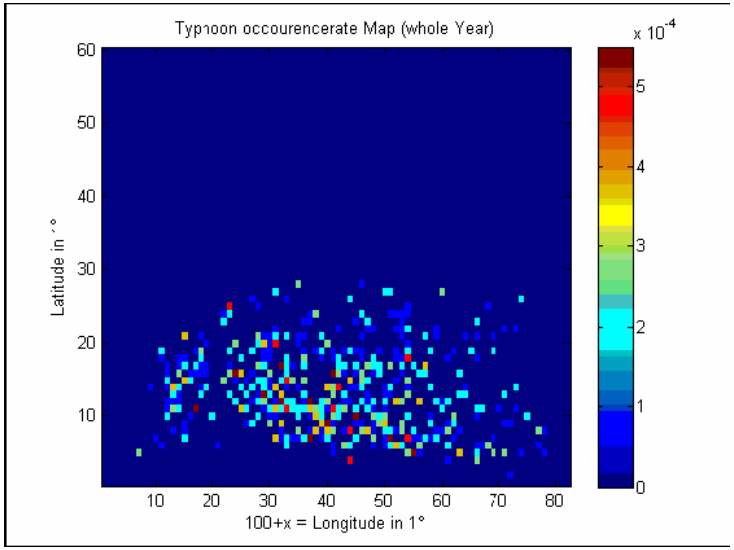


Establishing occurrence model



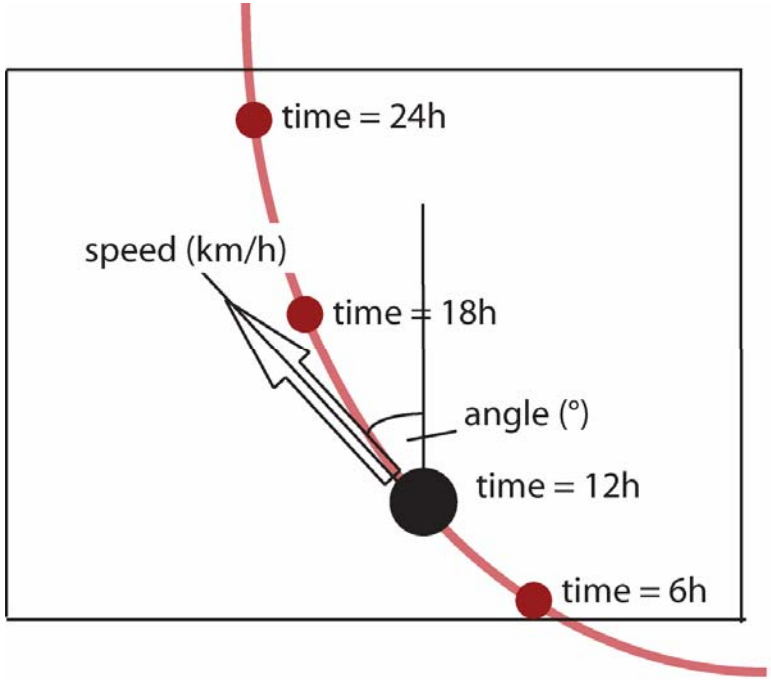


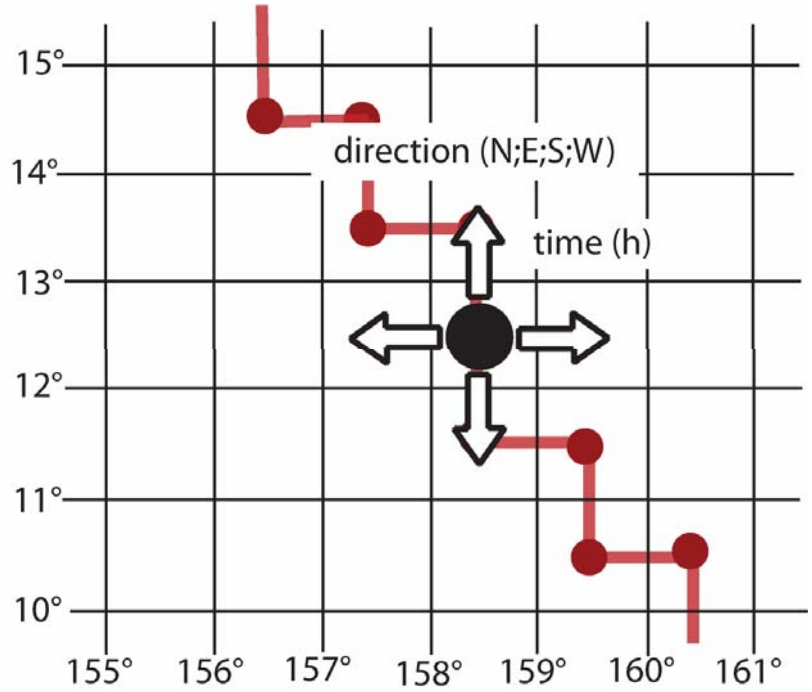




Establishing transition model

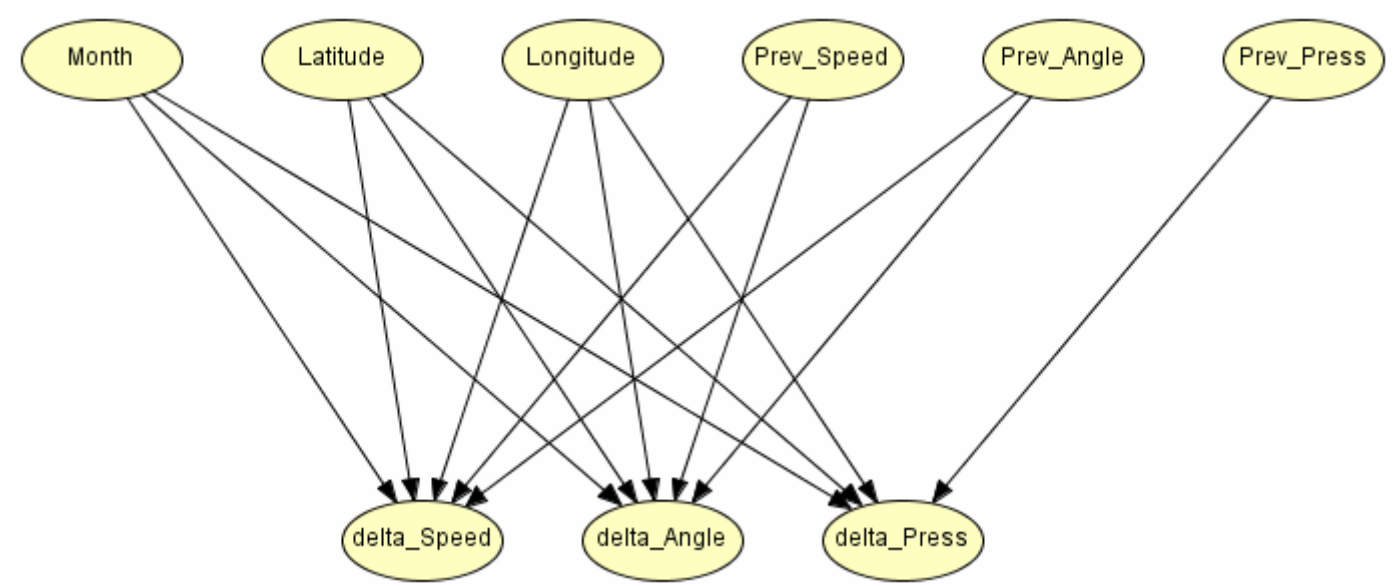
- Movement of typhoon





Establishing transition model

- Structure of transition model



Limitations of establishing a model

- Conditional probability table (CPT) size
  - Accuracy vs. program limitations
- Calculation time
  - Interaction with Hugin and other programs is slow (because of the Hugin ActiveX server)
- Can only reach predetermined states
  - Everything has to be preprogrammed

Improve a model with empirical data

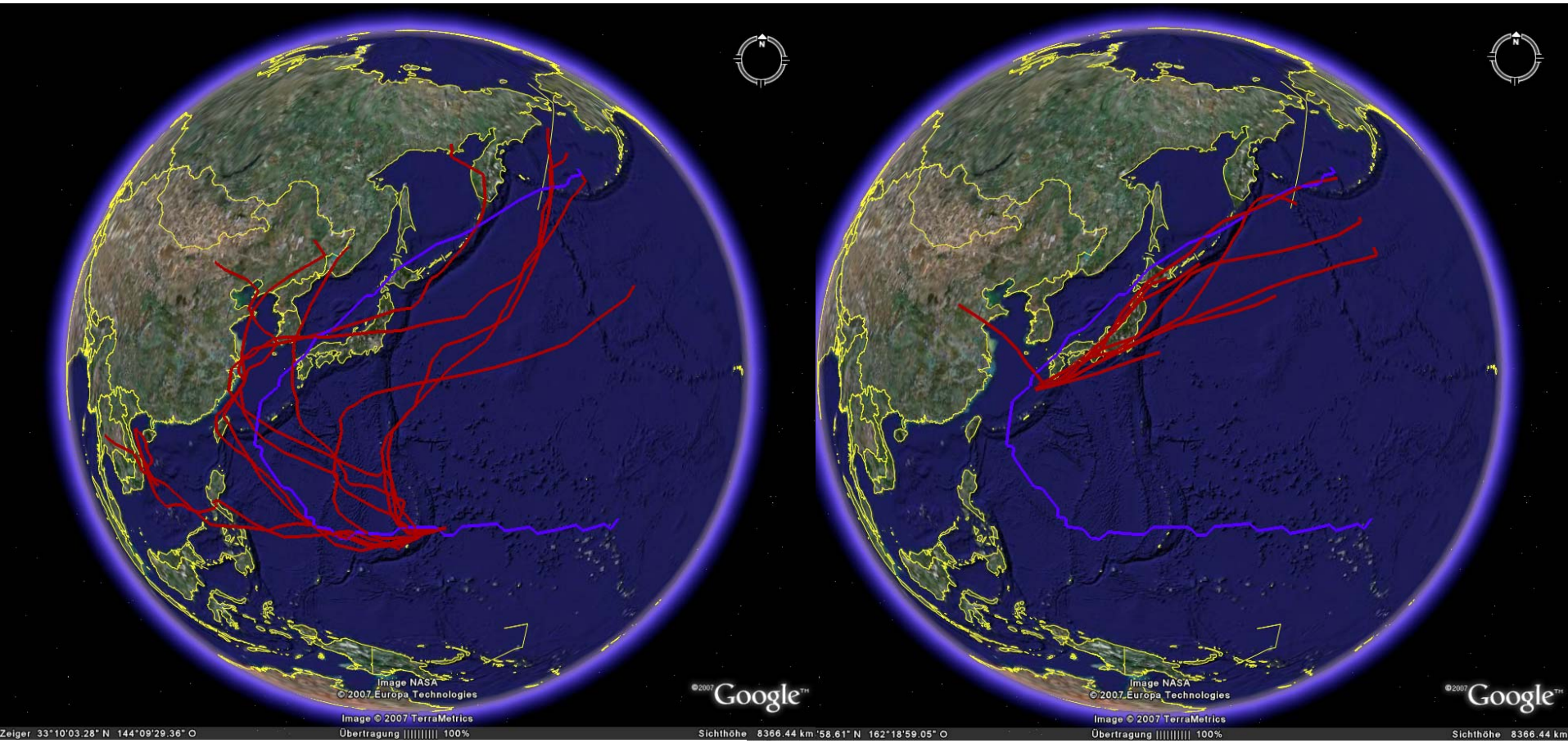
- Utilize data in the same rate as they are available
- Conditioning the model with actual information
- Represent the actual state of the real system

Conitioning

- If a typhoon occurs
  - Location,
  - Speed
  - transition angle
  - pressure

  Can be conditioned

Conditioning



Improve a model with empirical data

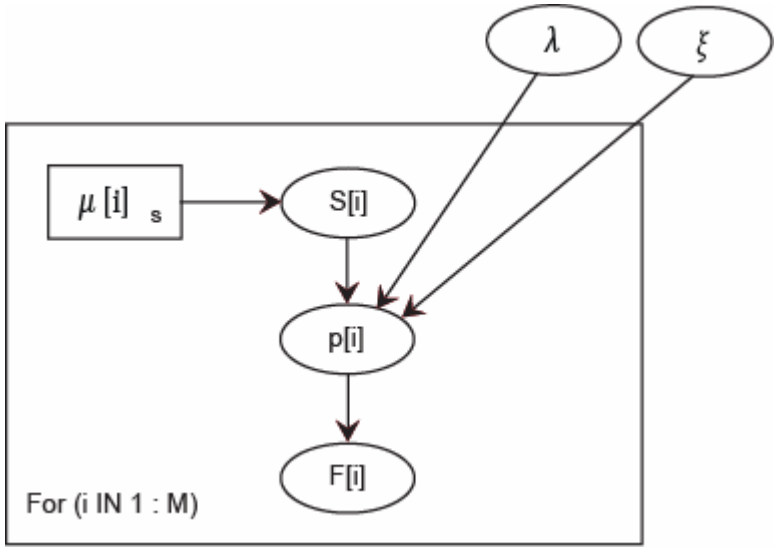
Integrating more data which are measured in the real world helps to represent the system more accurate with the model.

Updating: Example vulnerability model

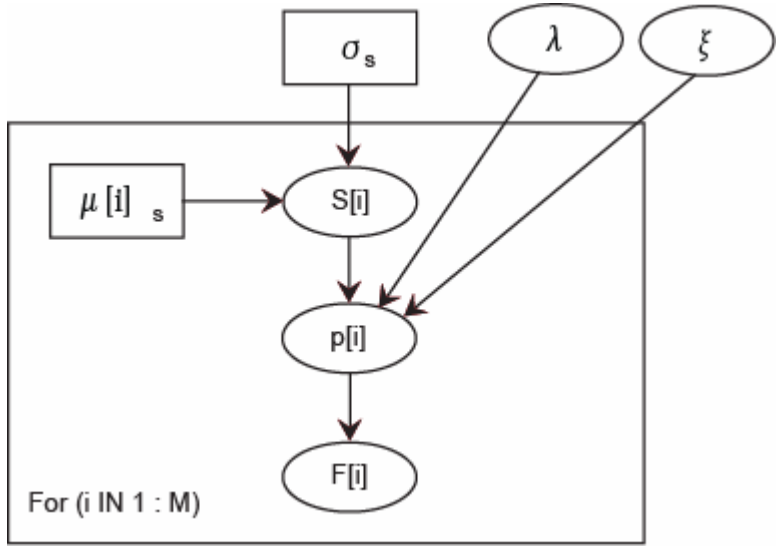
- Standard approach:
- Only joint observations of hazard index and damage utilized
- Hazard index = point estimation based on joint observations

Updating: Example vulnerability model

Standard approach

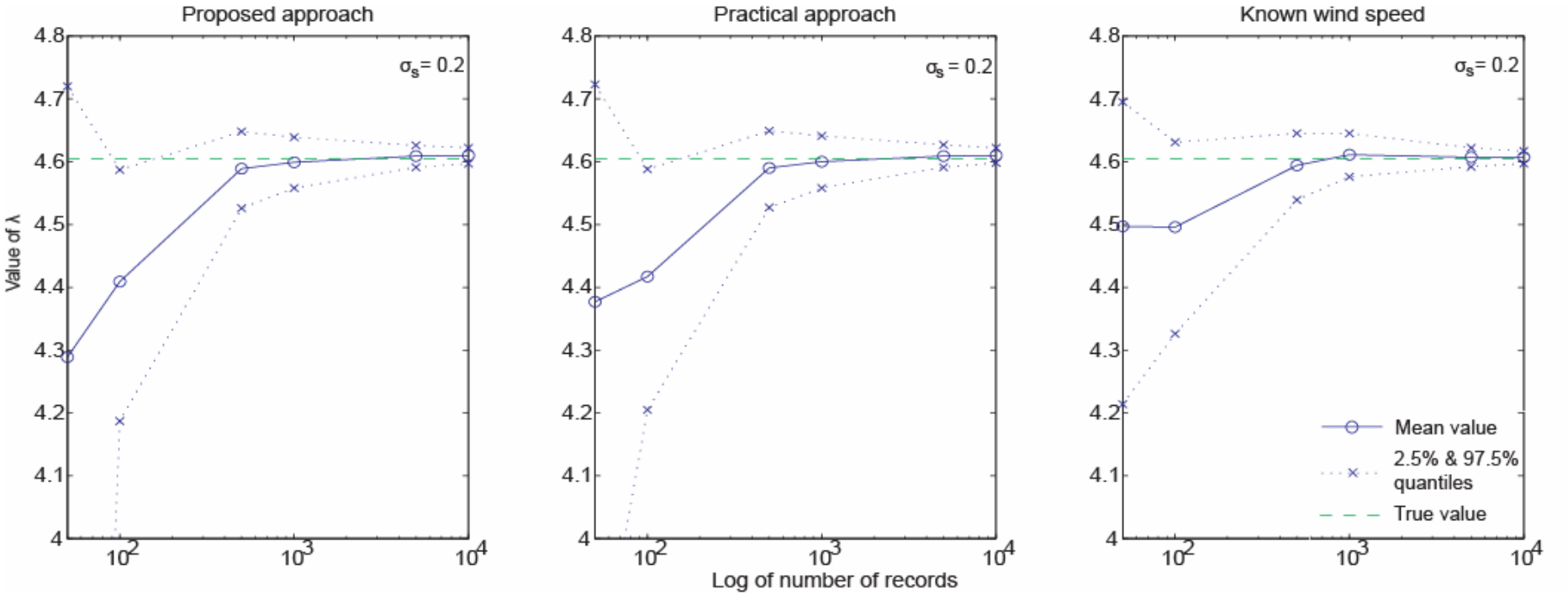


extended by uncertainty of wind estimation



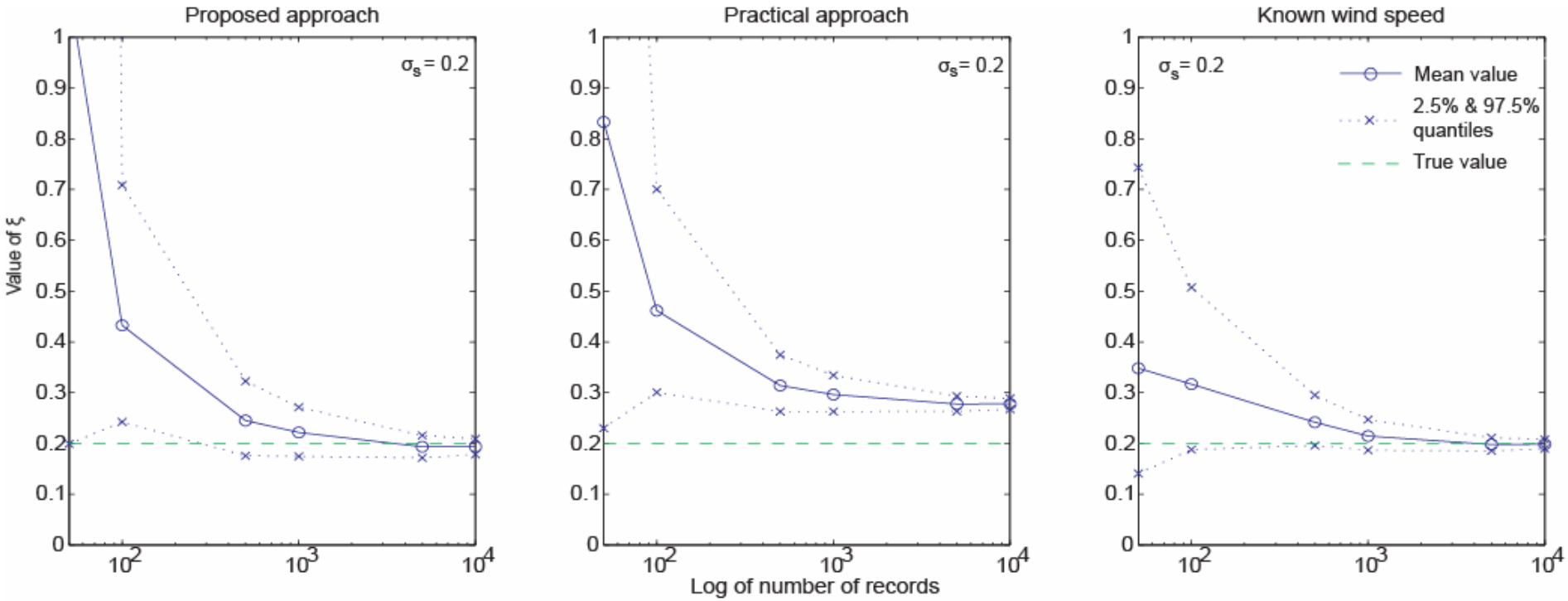
Updating: Example vulnerability model

- Converging of parameter λ



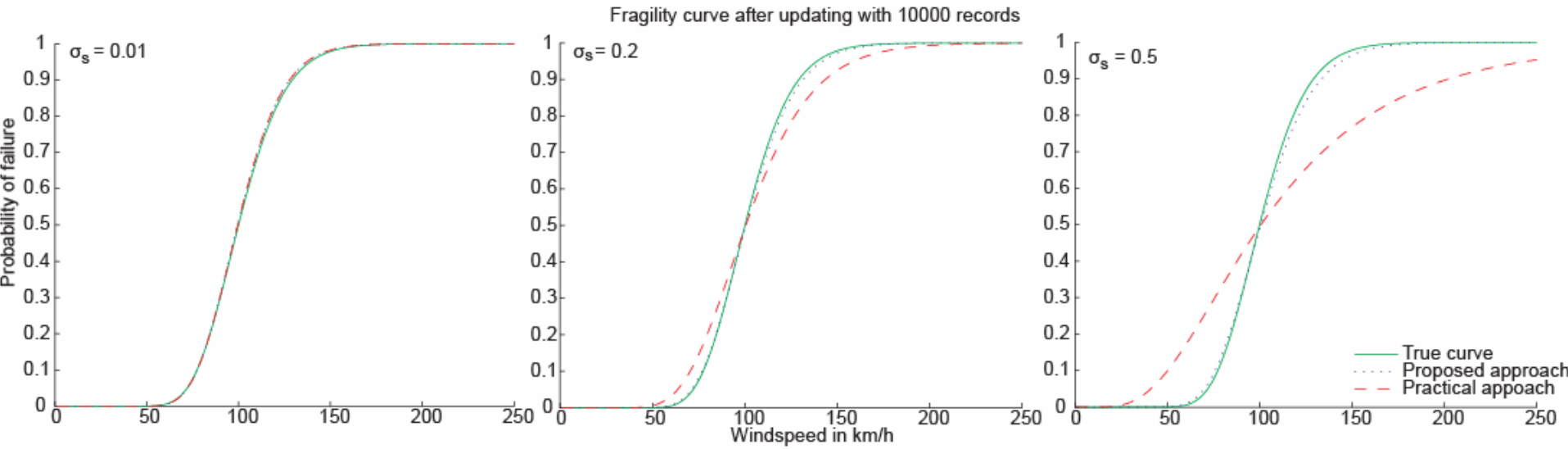
Updating: Example vulnerability model

- Converging of parameter ξ



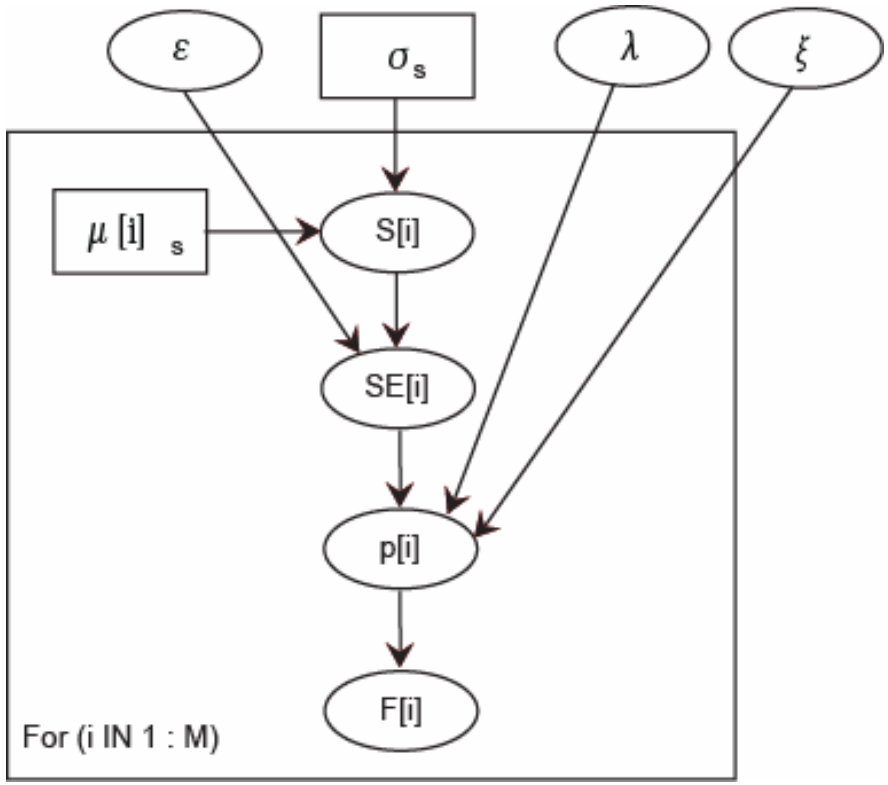
Updating: Example vulnerability model

- Influence of different hazard index uncertainties on the vulnerability curve



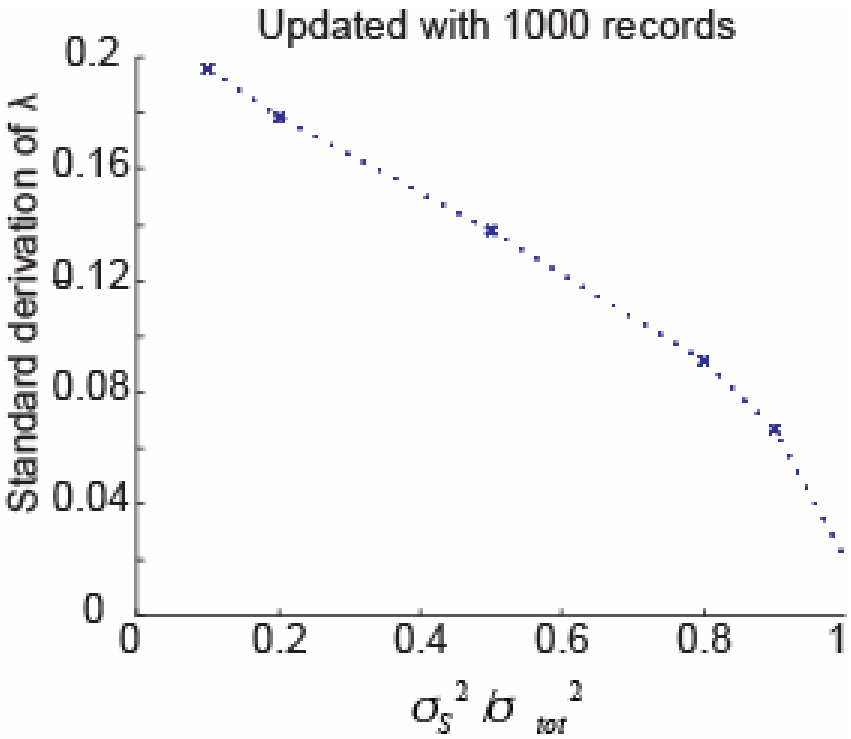
Updating: Example vulnerability model

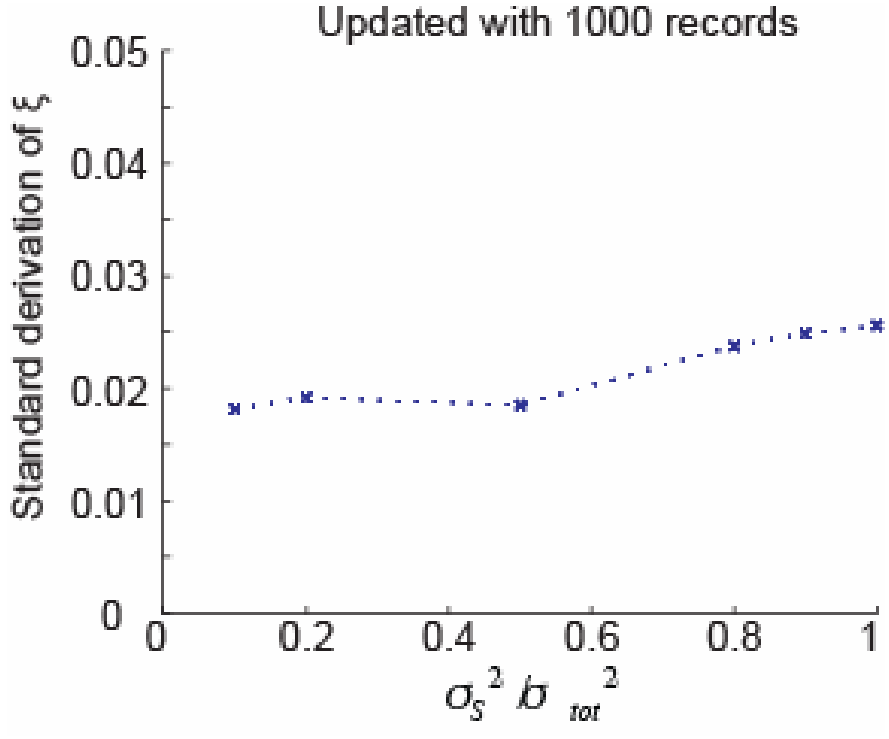
extended by model uncertainty ε



Updating: Example vulnerability model

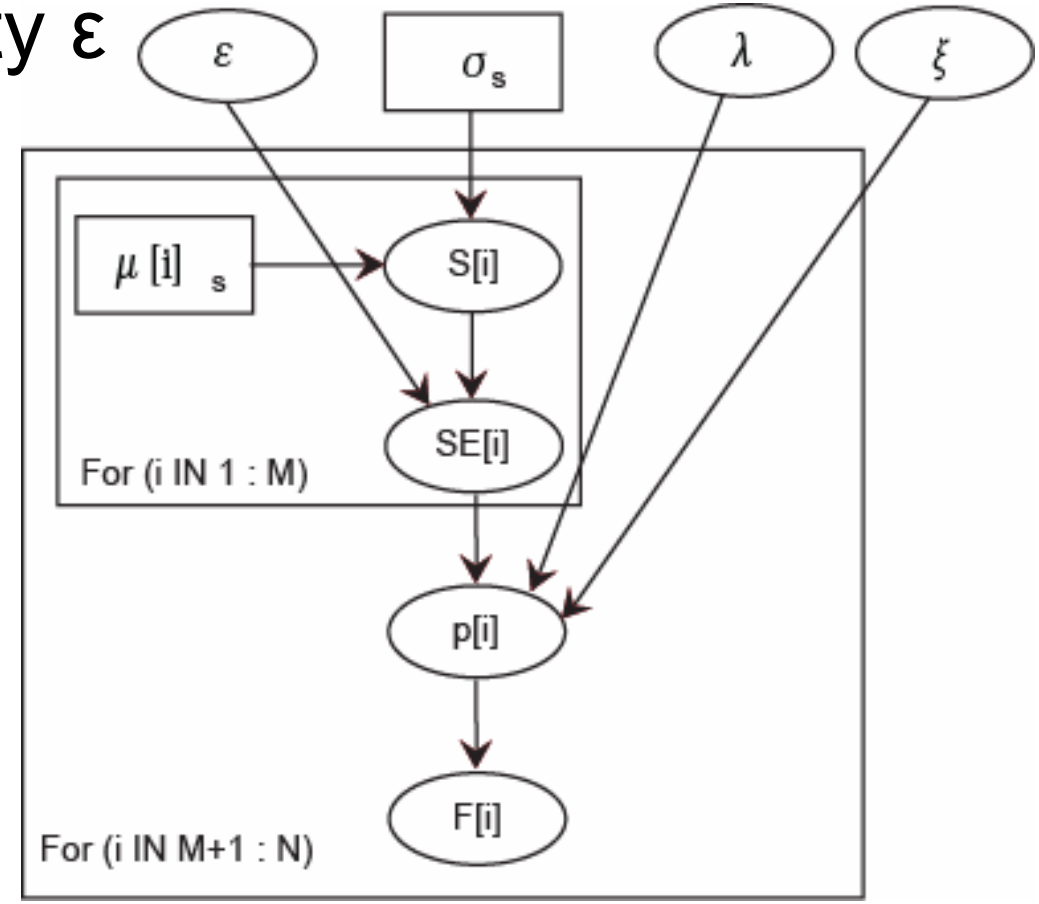
- Influence of different ratios between model and hazard index estimation





Updating: Example vulnerability model

- Using measured data to reduce model uncertainty ε



Limitation of updating

Calculation time increases exponential with number of records in the dataset which is used to update.