BDA Project: Hurricane forecasting in Stan

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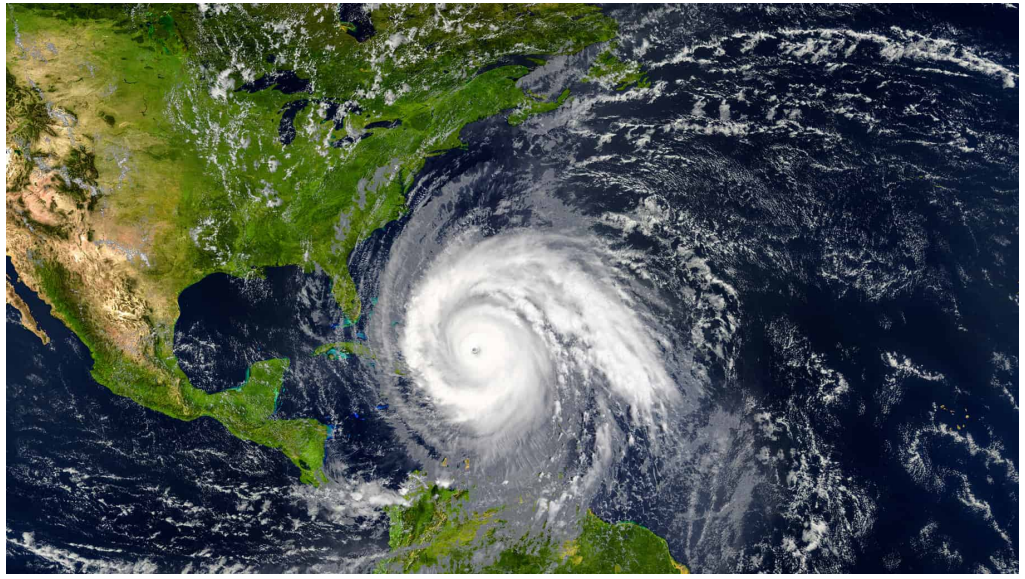
Aalto University

Hurricane introduction

- Destructive storms occuring in the late summer and fall in the northern hemisphere's tropical region.



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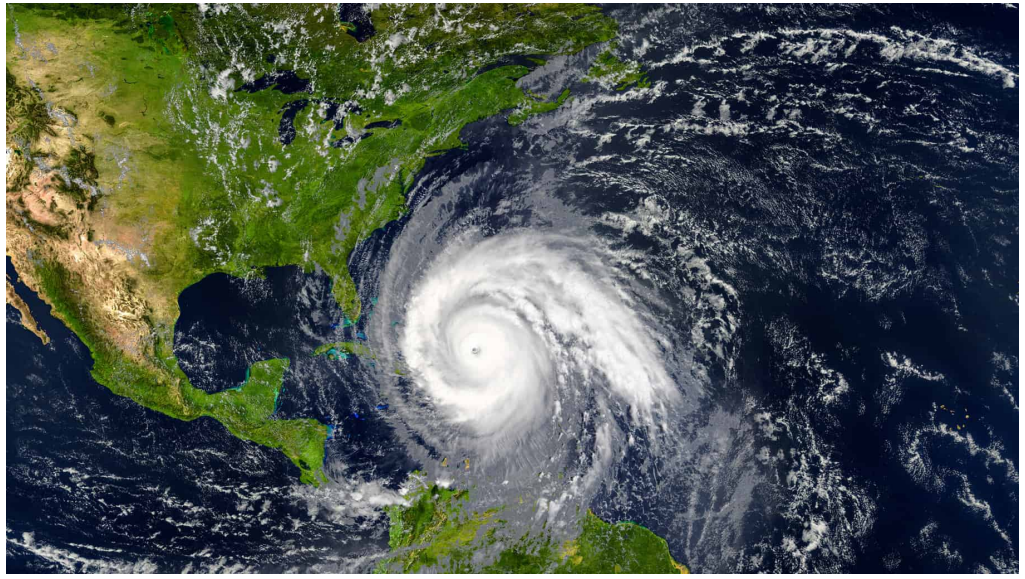

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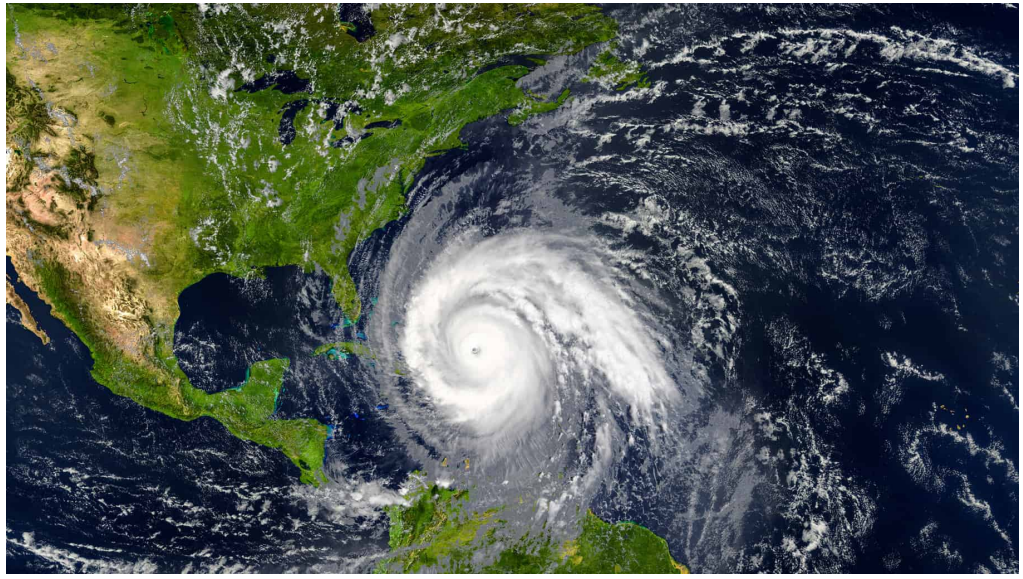

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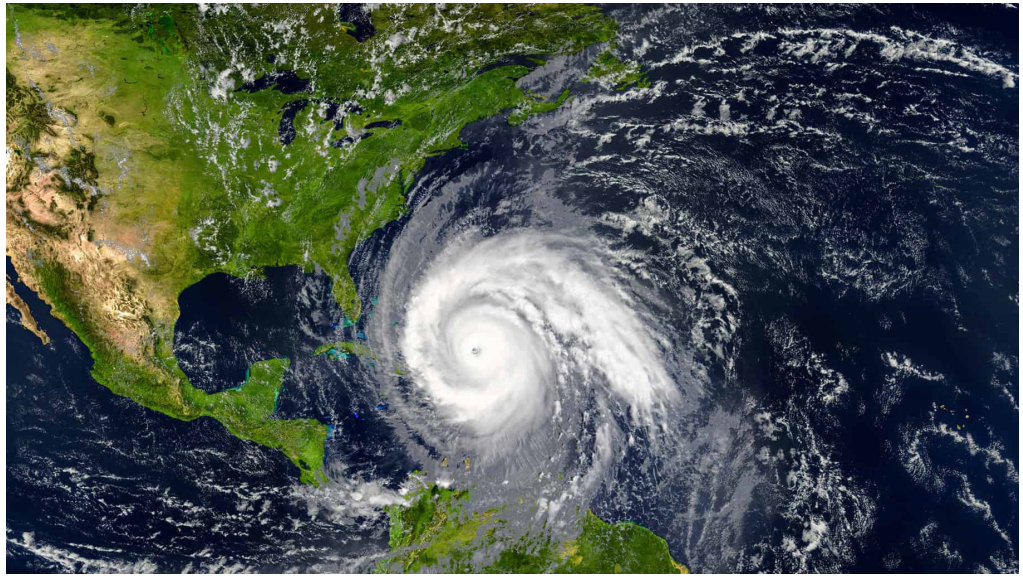
- Monetary damages and loss of lives increase with an almost exponential character as a function of storm intensity.



Hurricane forecasting basics

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- *Rapid intensification*: forecasted better by dynamical models
- This project: a *statistical* model for *intensity*

Hurricane forecasting basics: the SHIPS data

The US government forecasting agency, the National Hurricane Center (NHC), uses a large number of models operationally. The models (together: the *model ensemble*) are used together with experienced meteorologists' judgment to provide the official forecast.

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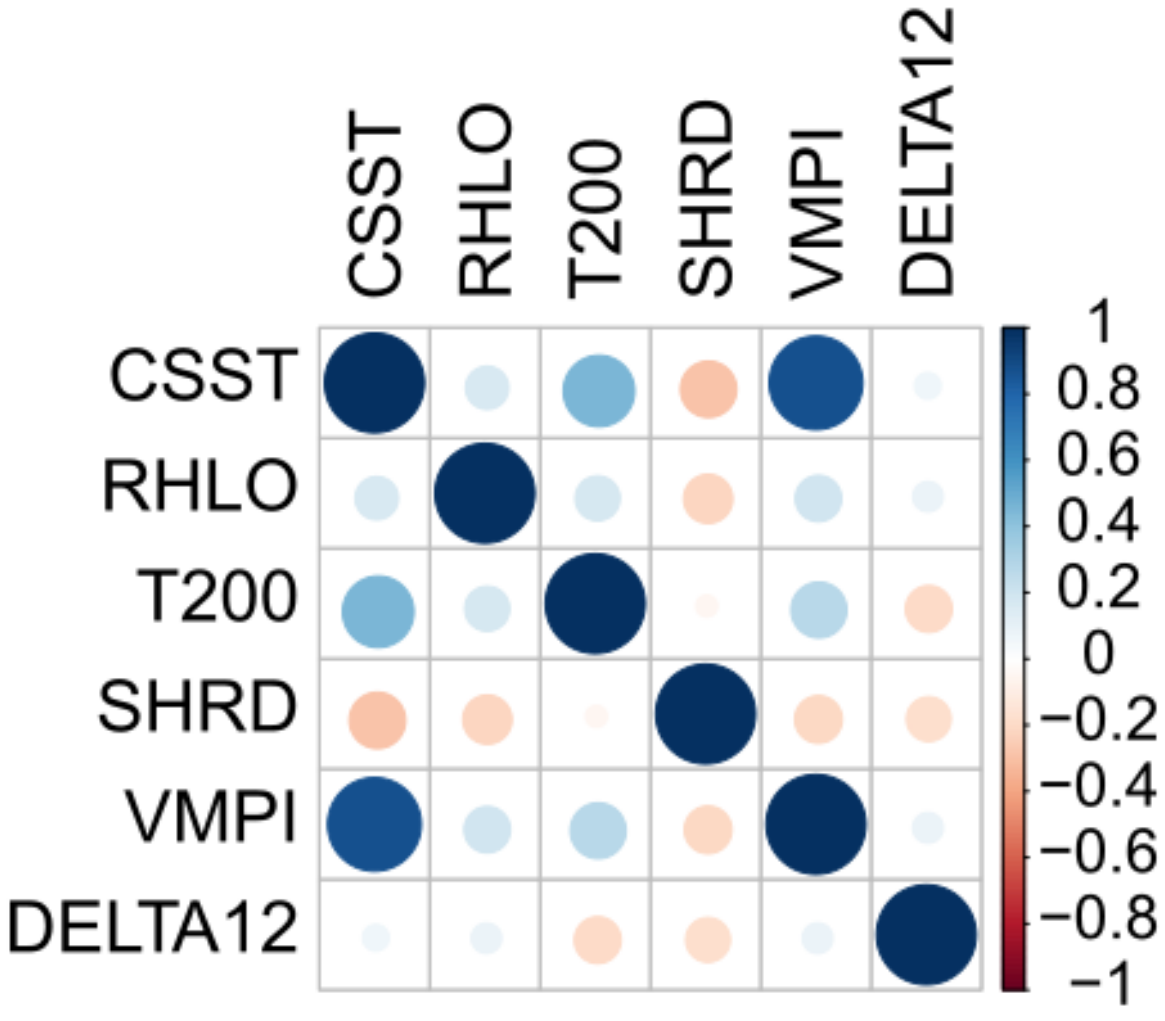
- SHIPS: only a point estimate; our project: a predictive distribution

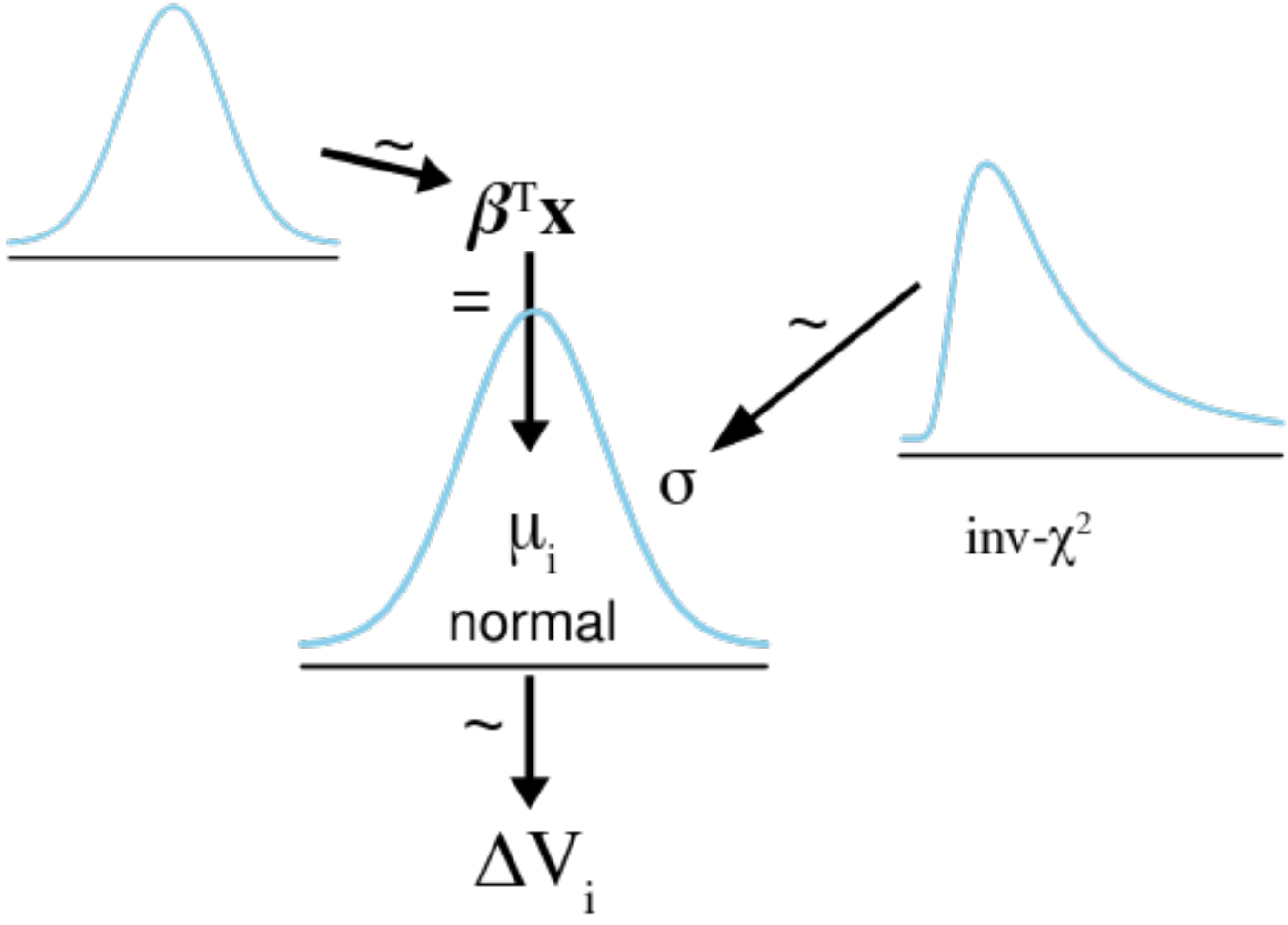
Hurricane forecasting basics: the SHIPS data

Hurricane forecasting basics: our selection



Intensity change predictive model

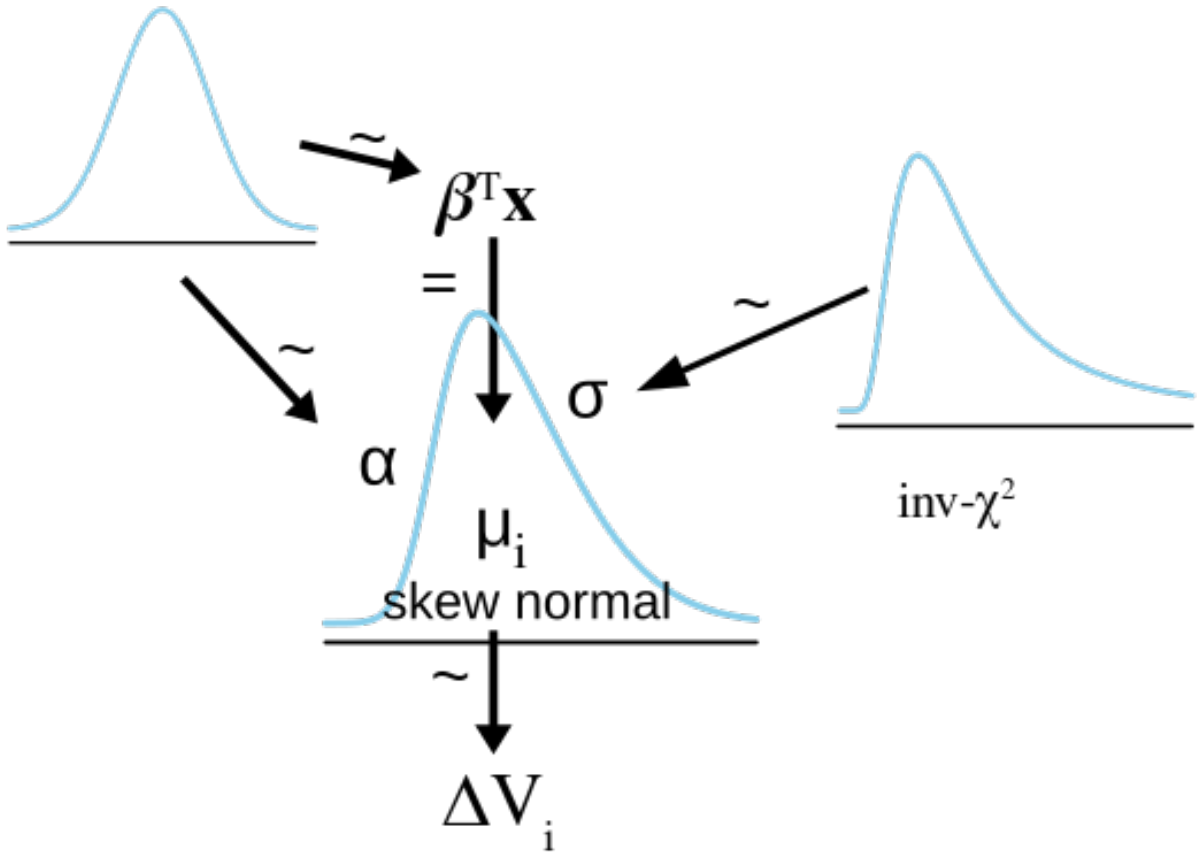
The SHIPS Blunder: a simple linear regression



Intensity change predictive model

Model 2: regression with skewness

- errors not symmetric around the mean prediction!



Intensity change predictive model

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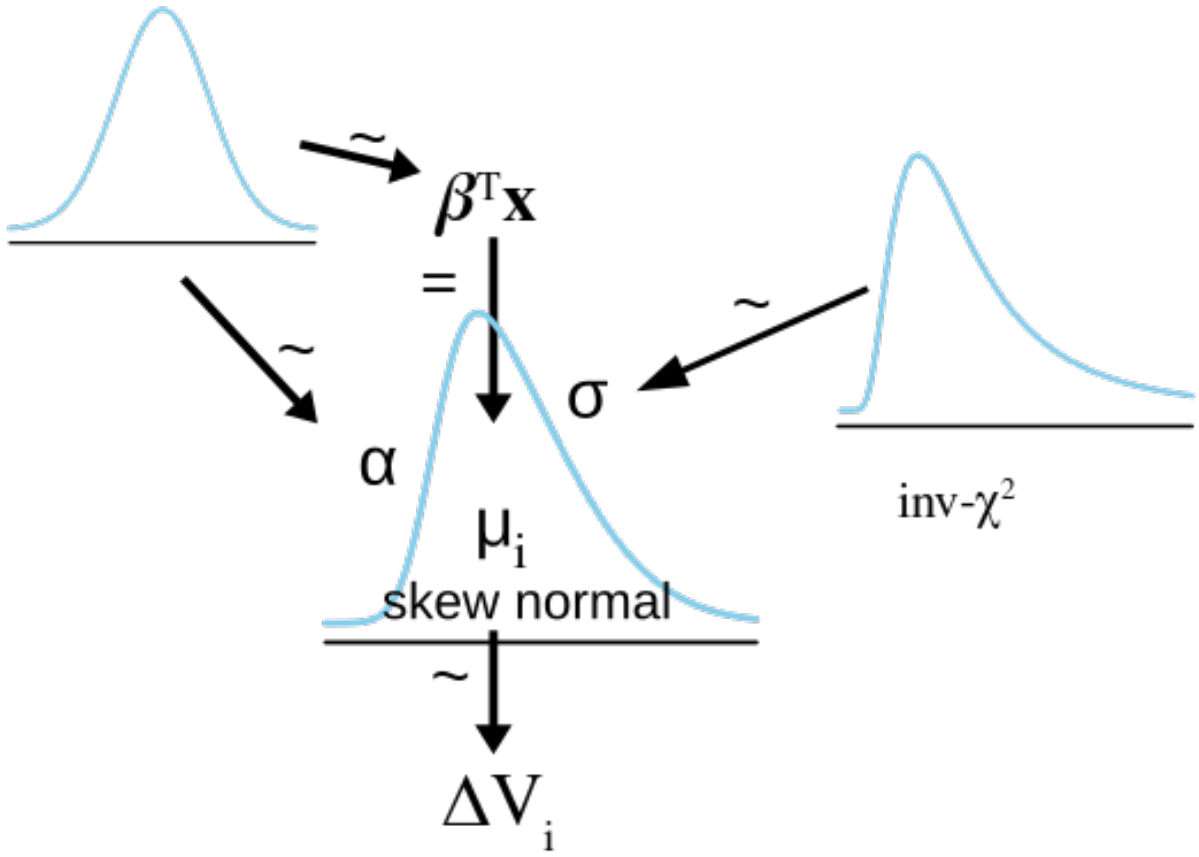
- errors not symmetric around the mean prediction!
- rapid intensification!



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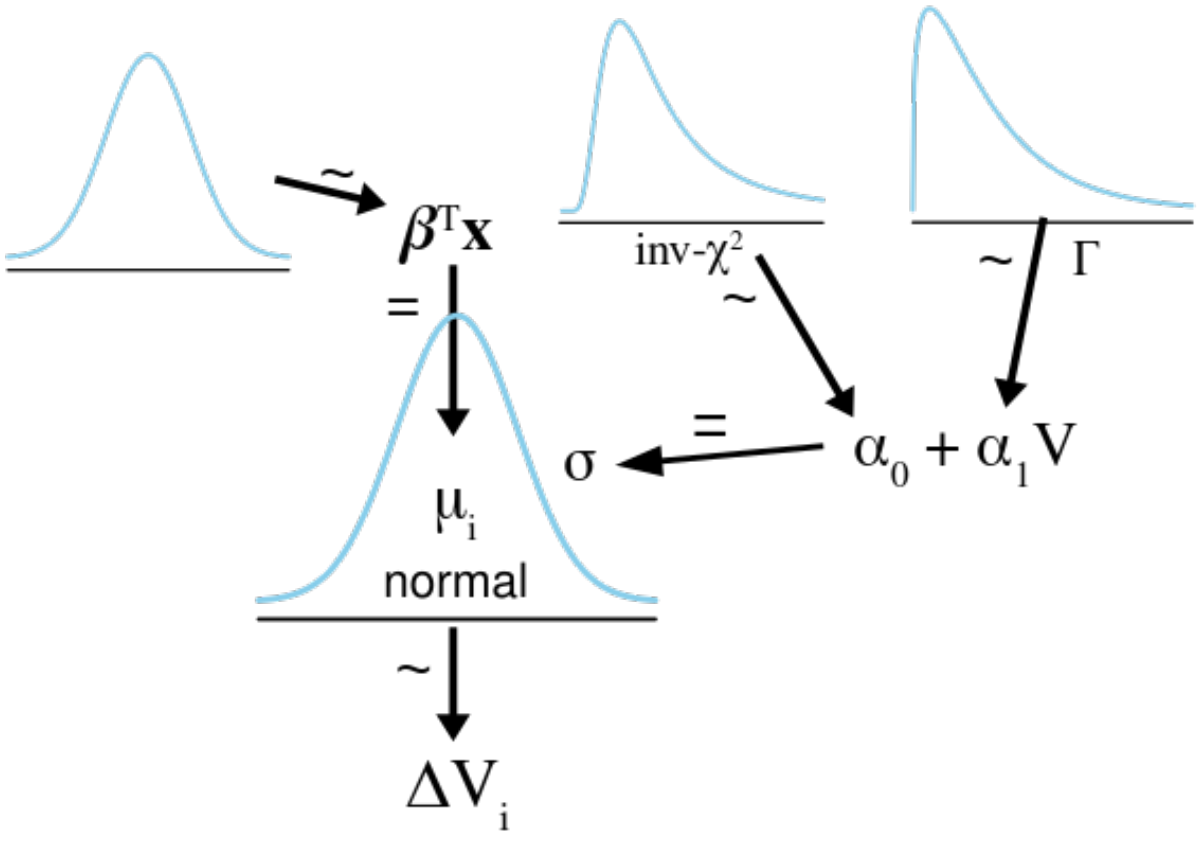
Model 3: regression with a linear model for standard deviation

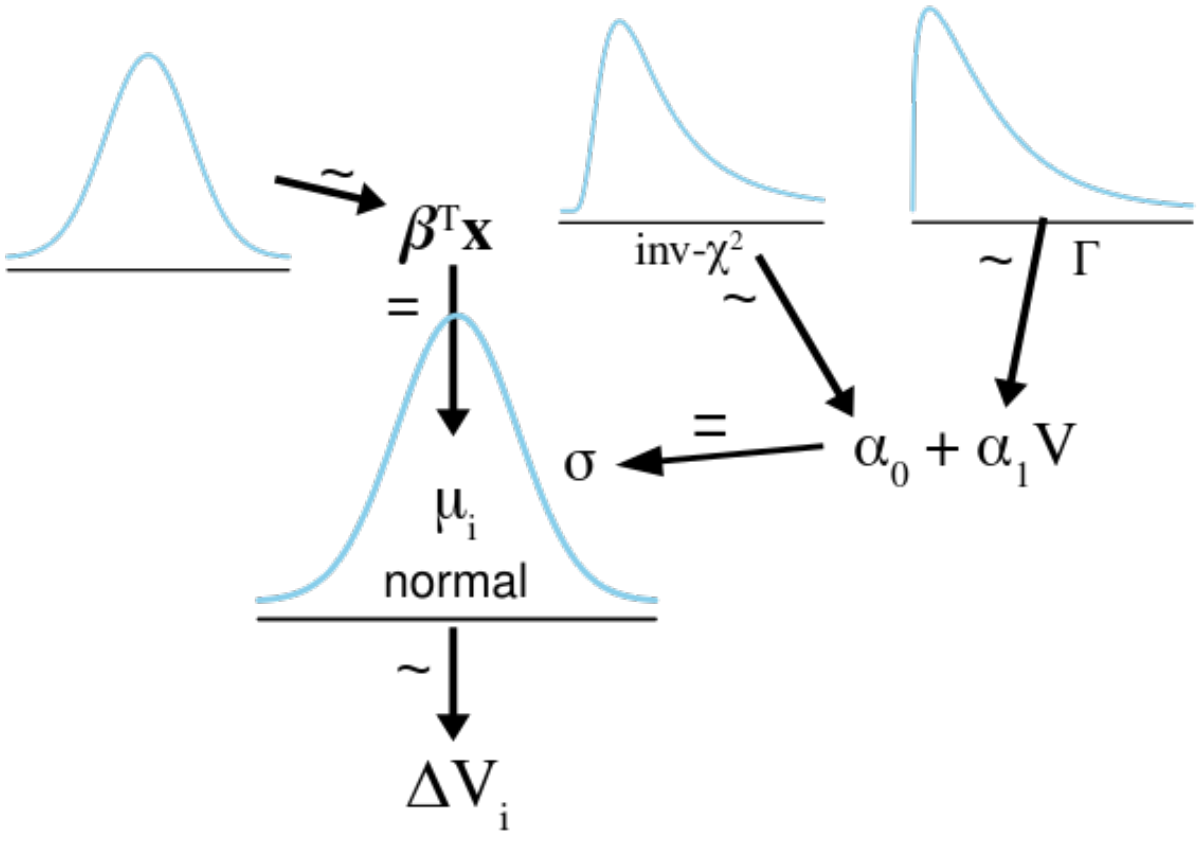
- fewer storms reach higher values of `VMAX`



Intensity change predictive model

Model 3: regression with a linear model for standard deviation

- fewer storms reach higher values of `VMAX`
- allow for higher variance to account for larger historical uncertainty



Model: limitations

Model: posterior predictive checking

Model: variables to use

Model: marginal posteriors of coefficients

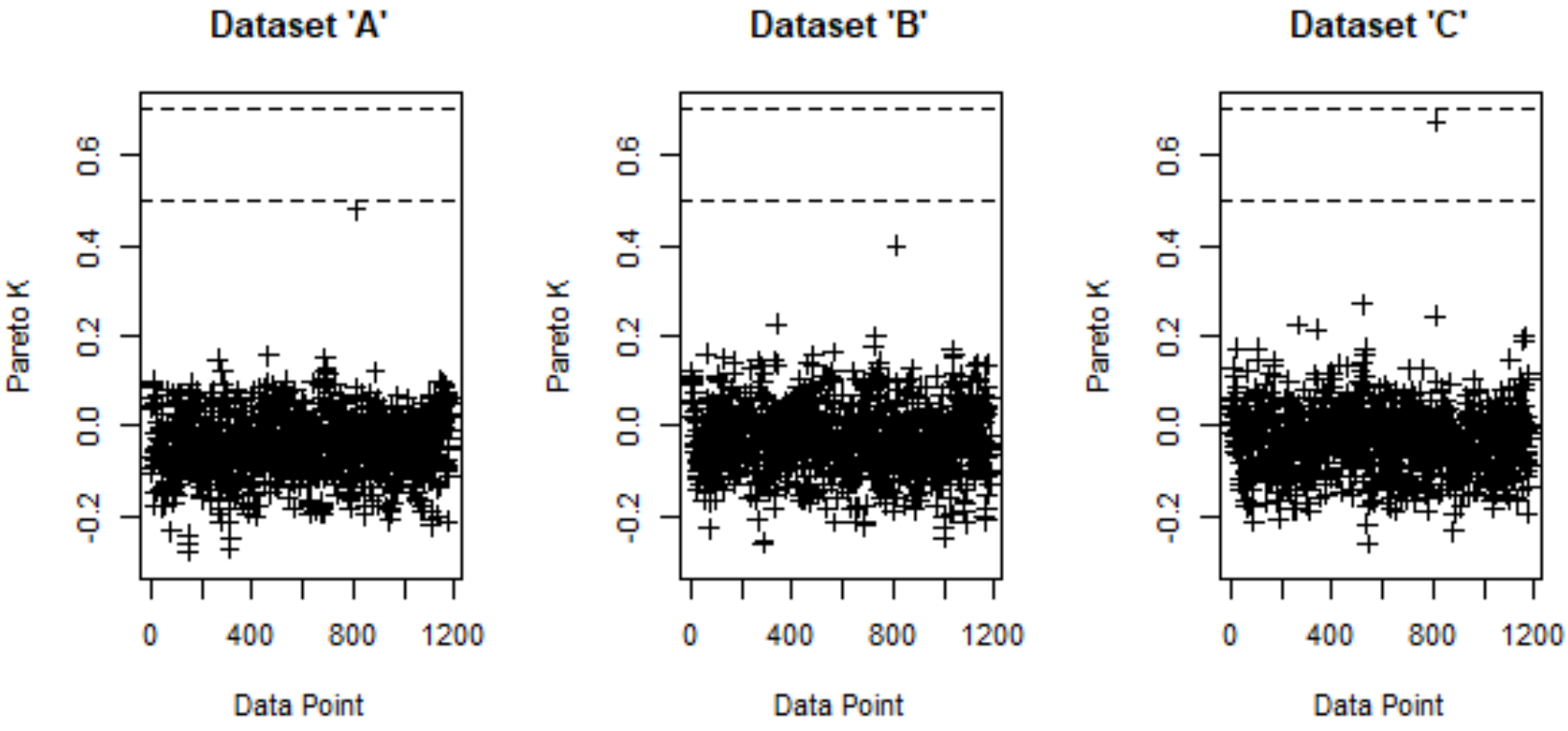
Model: margin of SHRD and CSST

Forecasting

Forecasting: Model Comparison (1)

Dataset comparison for the **linear regression model** (LOOCV)

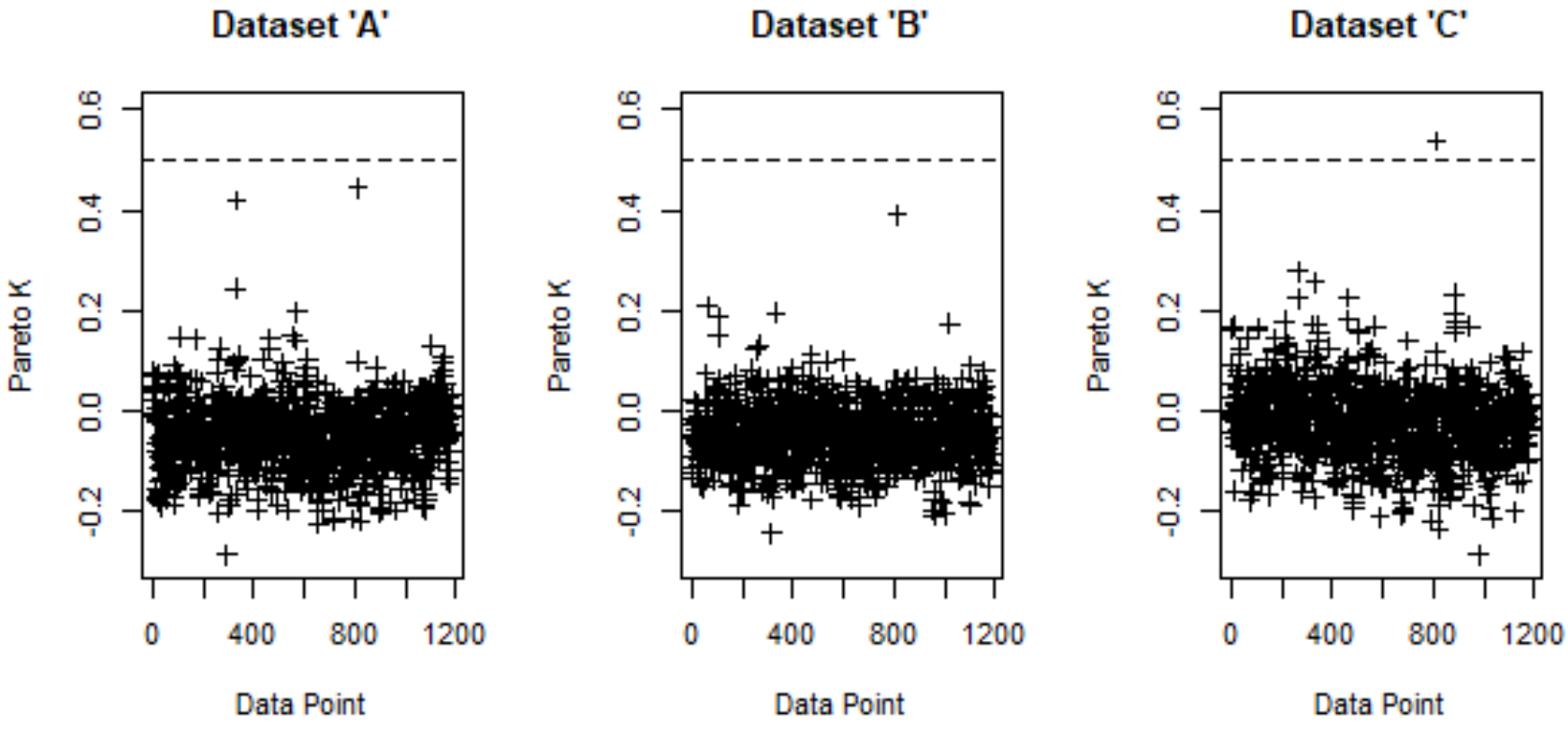
Dataset	**elpd_diff**	**se_diff**
C	0.0	0.0
B	-25.0	6.5
A	-27.4	6.3



Forecasting: Model Comparison (2)

Dataset comparison for the **skewed regression model** (LOOCV)

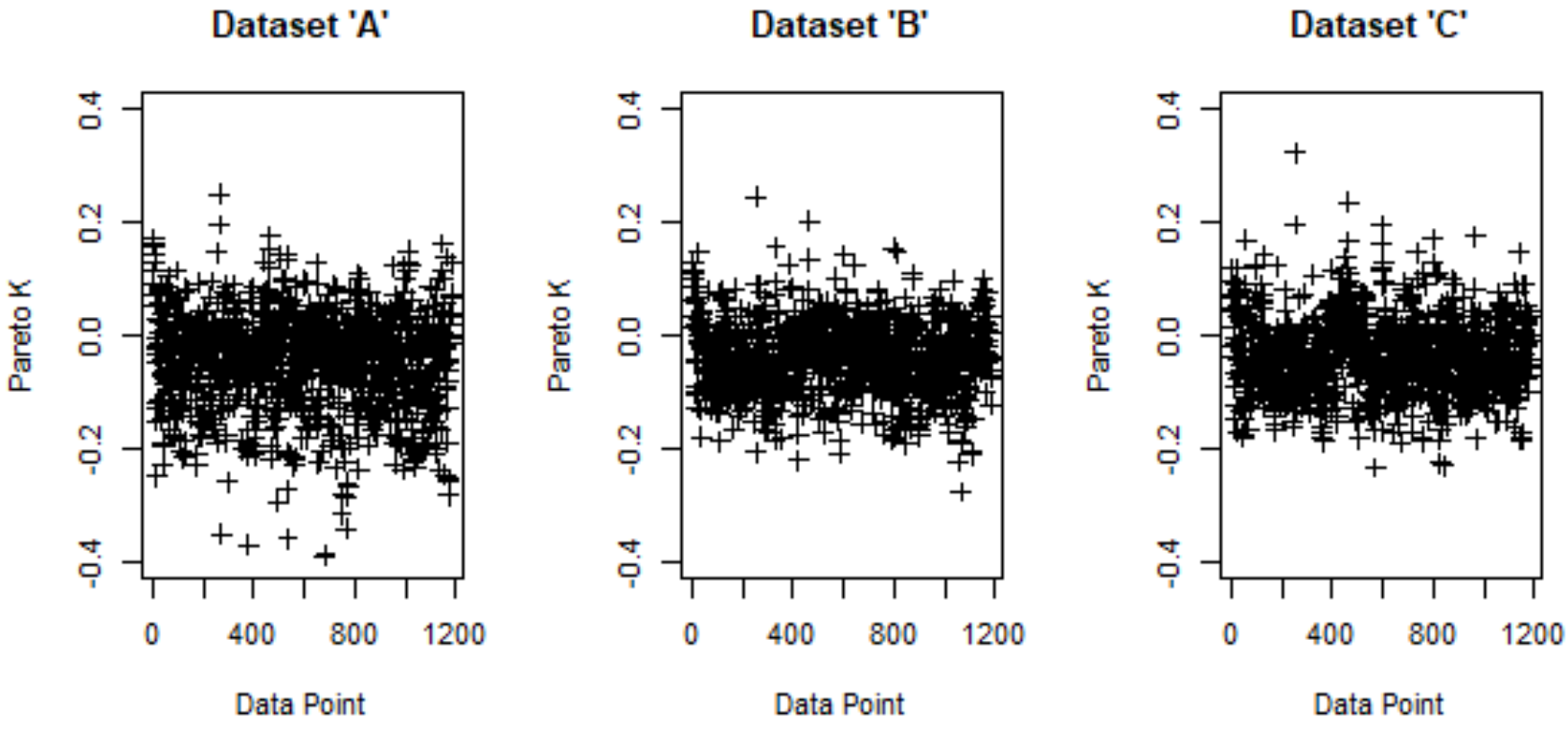
Dataset	**elpd_diff**	**se_diff**
C	0.0	0.0
B	-23.2	6.2
A	-28.7	6.2



Forecasting: Model Comparison (3)

Dataset comparison for the **Changing variance model** (LOOCV)

Dataset	**elpd_diff**	**se_diff**
C	0.0	0.0
B	-32.6	8.2
A	-37.1	8.2



Forecasting: Model Comparison (4)

Model comparison using the Dataset C (LOOCV)

Model	**elpd_diff**	**se_diff**
Variance	0.0	0.0
Skew	-176.3	27.8
Linear	-205.5	34.9

Forecasting: what about the NHC?

Problems to solve & development ideas

- variable selection in full SHIPS dataset

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- variable selection in full SHIPS dataset
- more time series autoregressive components
- use LGEM model (will explain)

Conclusions & contact info

Additional information

R Markdown

This is an R Markdown presentation. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document.

Slide with Bullets

- Bullet 1

Slide with Bullets

- Bullet 1
- Bullet 2

Slide with Bullets

- Bullet 1
- Bullet 2
- Bullet 3

Slide with R Output

```
summary(cars)
```

```
##      speed           dist       
##  Min.   : 4.0   Min.   :  2.00  
##  1st Qu.:12.0   1st Qu.: 26.00  
##  Median :15.0   Median : 36.00  
##  Mean   :15.4   Mean   : 42.98  
##  3rd Qu.:19.0   3rd Qu.: 56.00  
##  Max.   :25.0   Max.   :120.00
```

Slide with Plot