

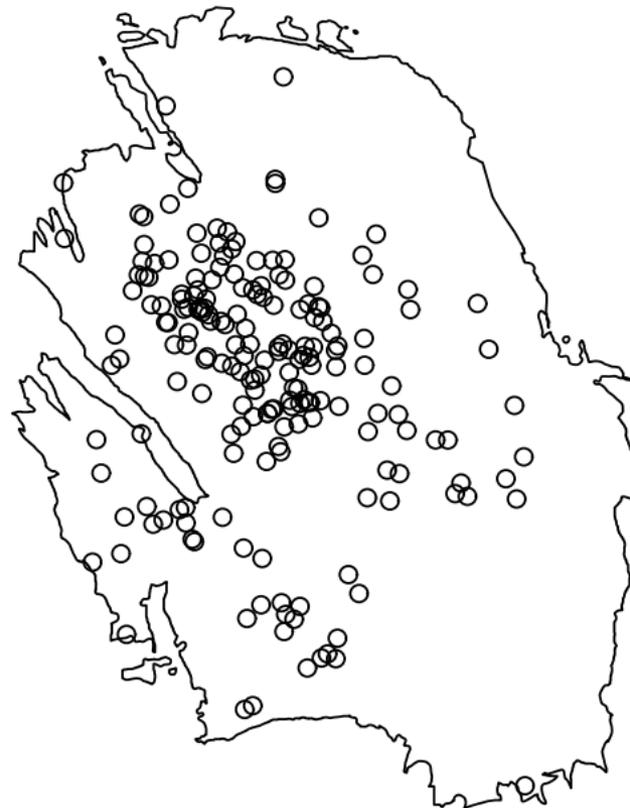
# › A FRAMEWORK FOR TRAINING AND TESTING INDUCED SEISMICITY FORECASTING MODELS

*The Groningen Case Study*

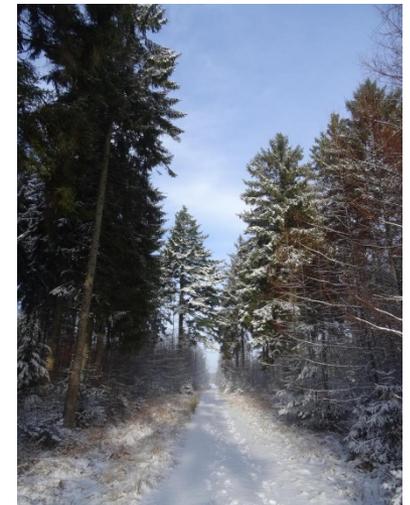
Sander Osinga, Thibault Candela, Dirk Kraaijpoel, Maarten Pluymaekers, Jan-Diederik van Wees

**TNO** innovation  
for life

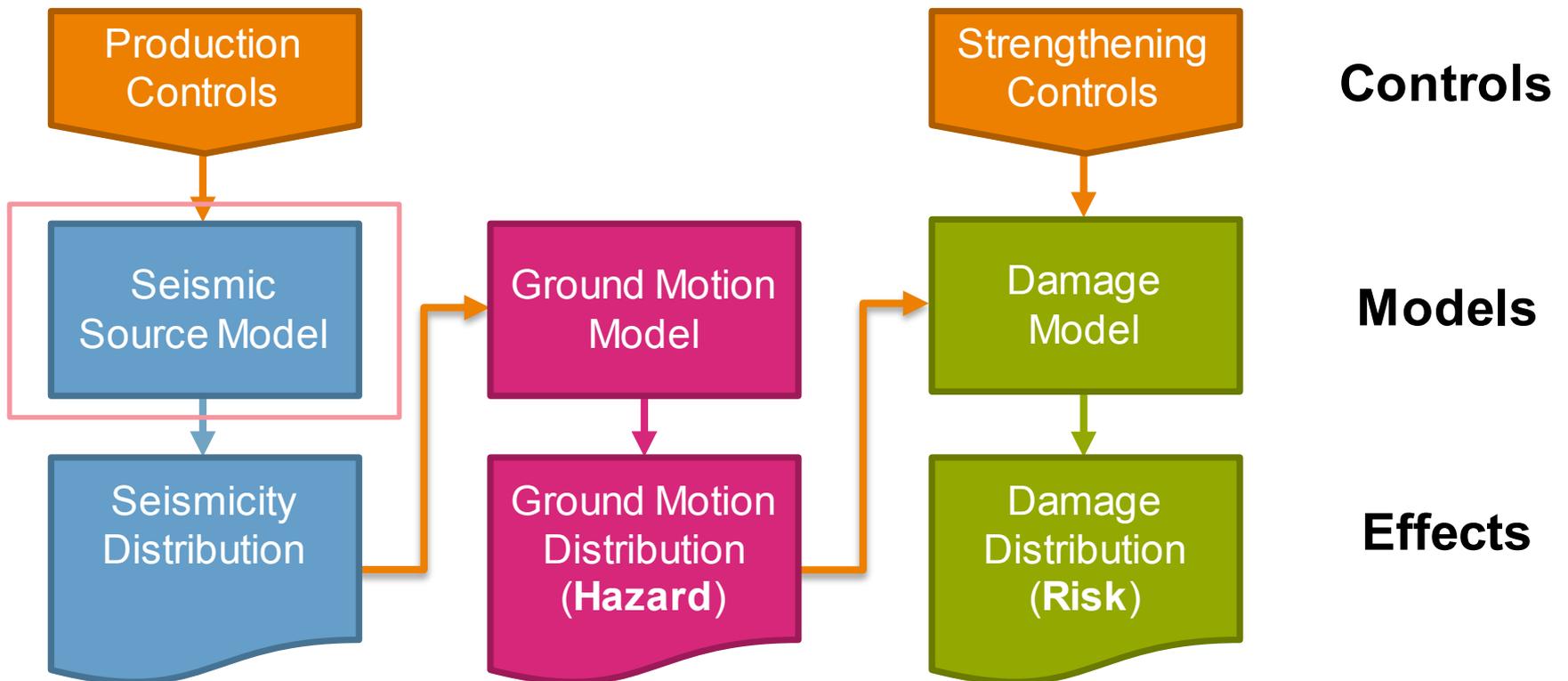
# GRONINGEN



# GRONINGEN



# ROLE WITHIN MODELCHAIN



# FUNCTIONALITY AND PROPERTIES

**PROBABILISTIC**

**MODEL  
TRAINING**

**FORECAST  
PERFORMANCE  
TESTING**

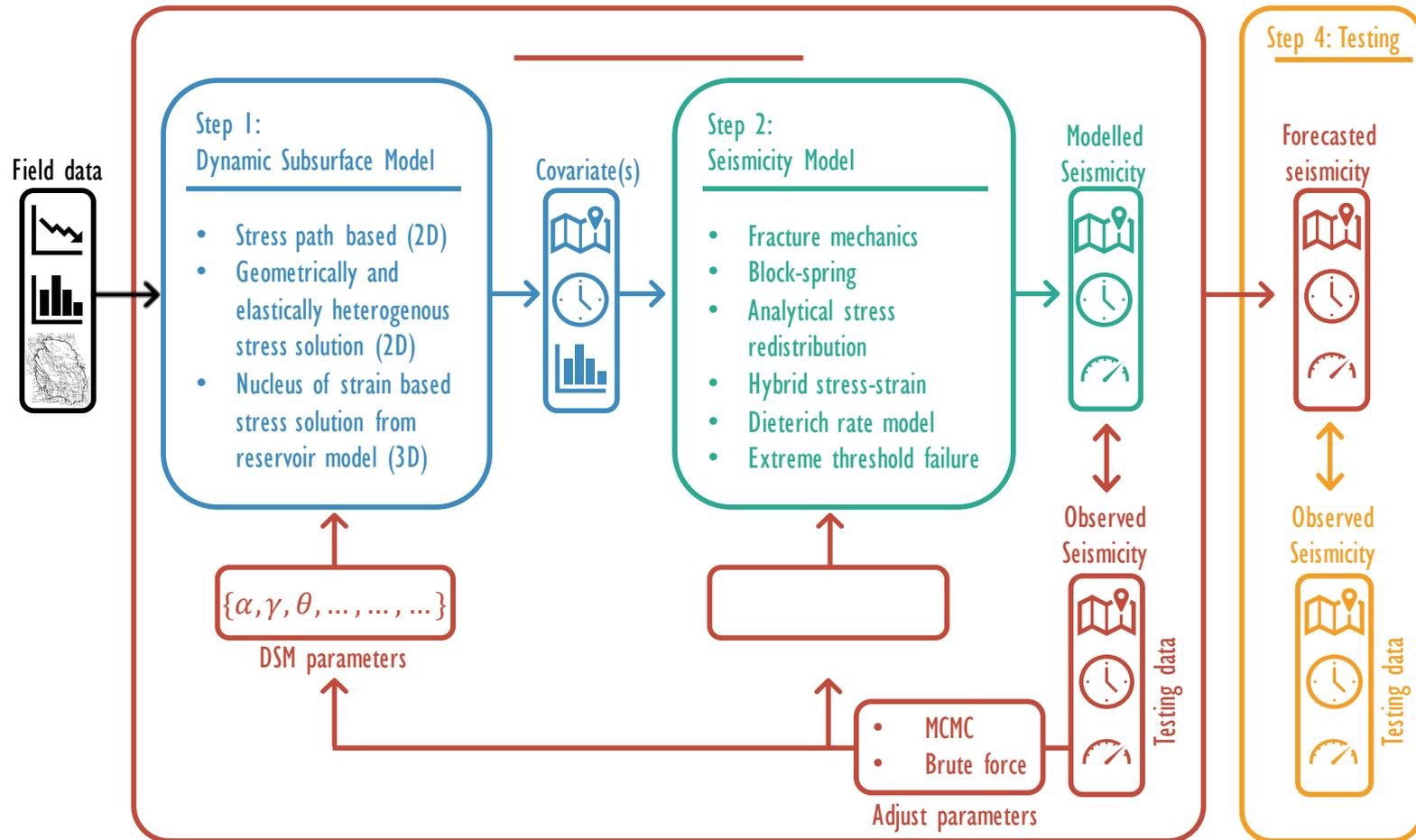
**SEISMICITY FORECAST  
SPACE, TIME, MAGNITUDE**

**FAST**

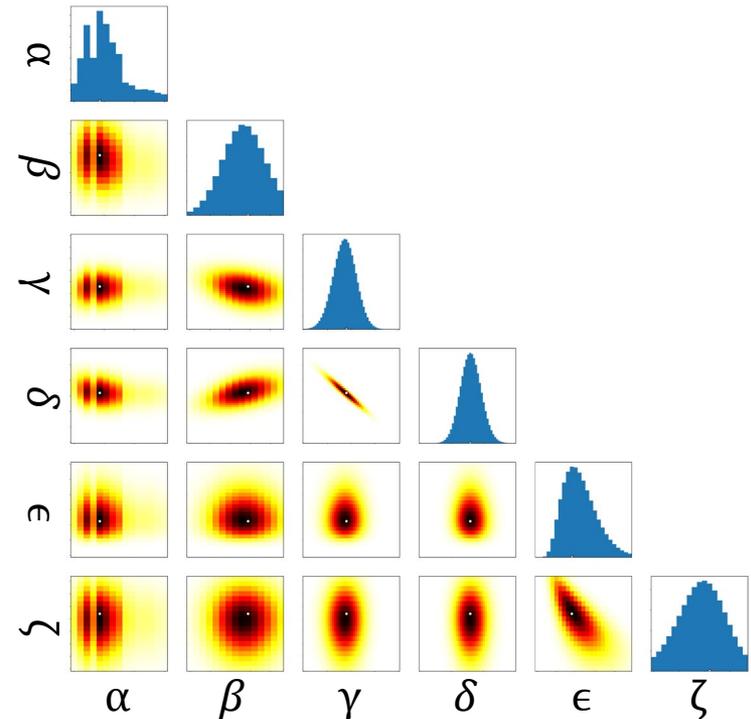
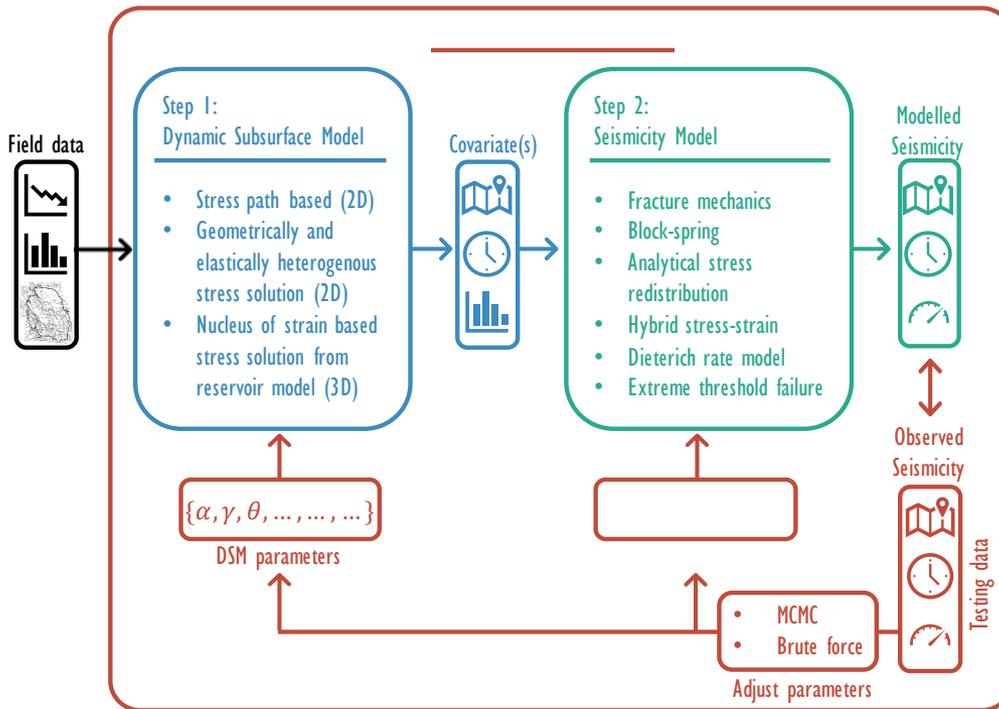
**MODULAR**

**MODEL  
COMPARISON**

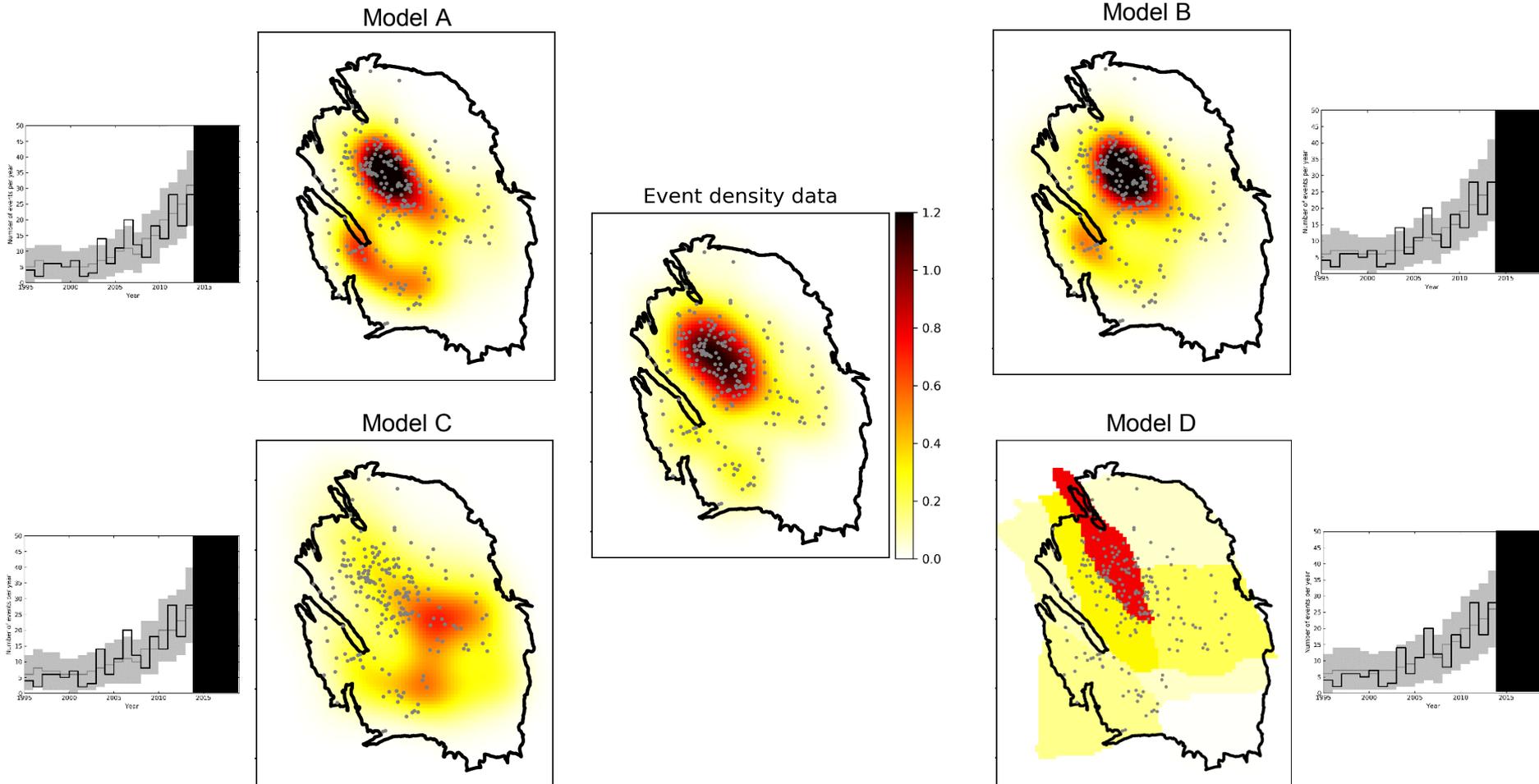
# FUNCTIONALITY AND PROPERTIES



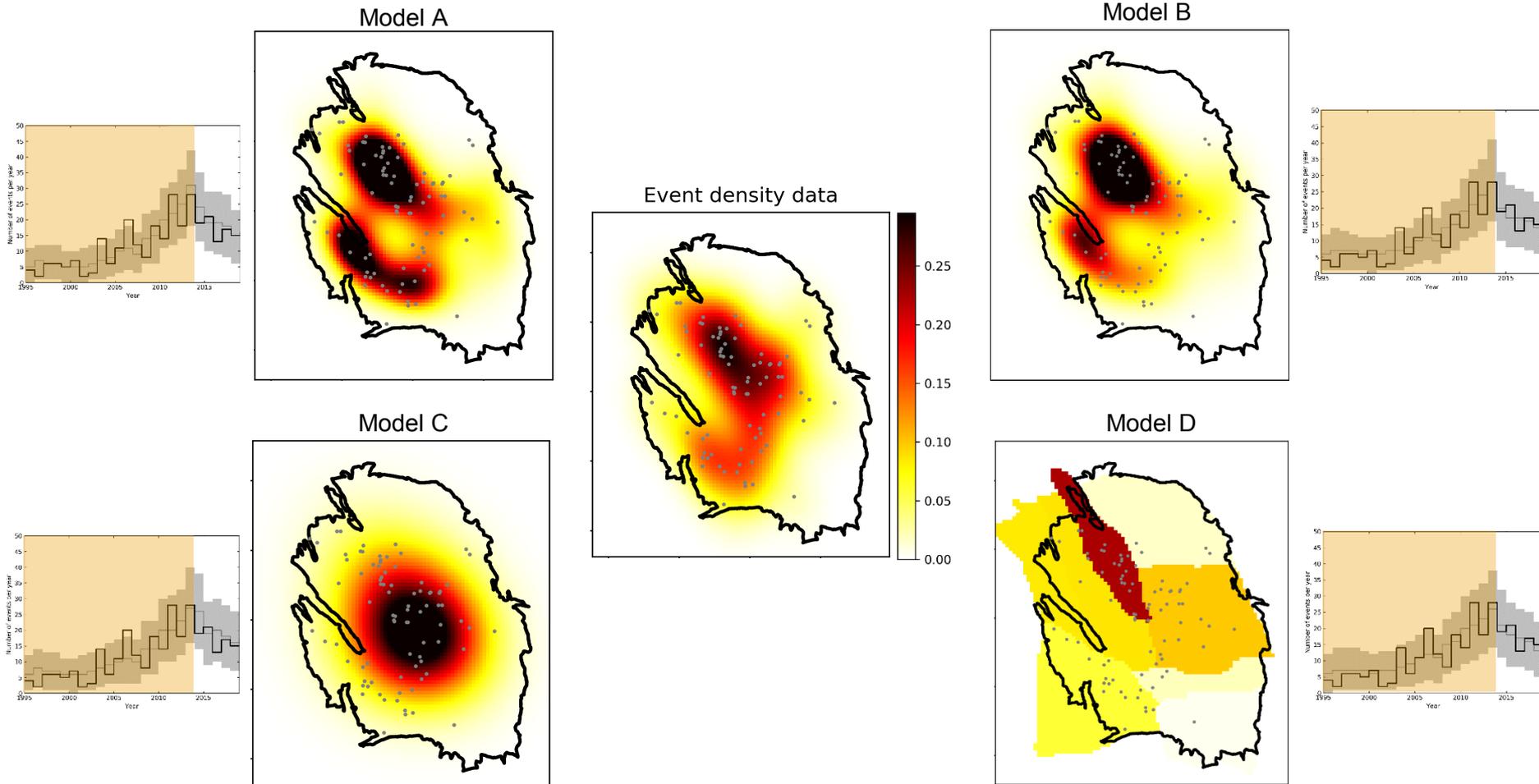
# EXAMPLE: TRAINING



# EXAMPLE: TRAINING

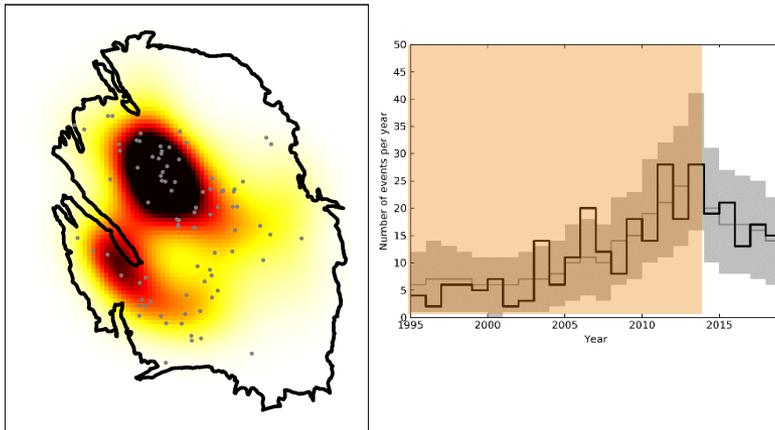


# EXAMPLE: FORECASTING

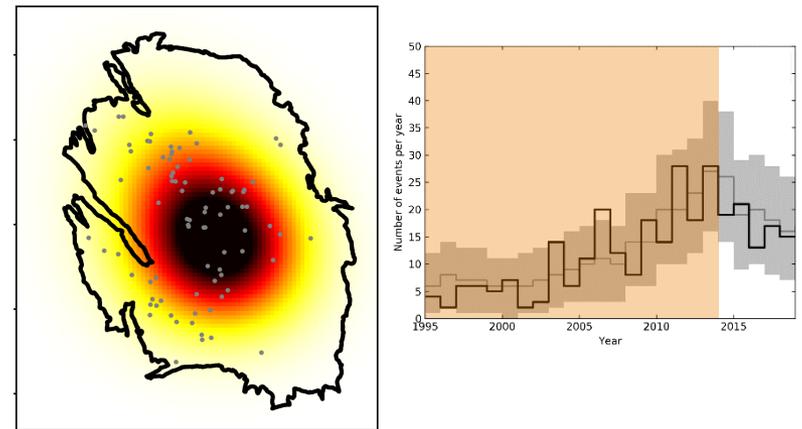


# EXAMPLE: TESTING

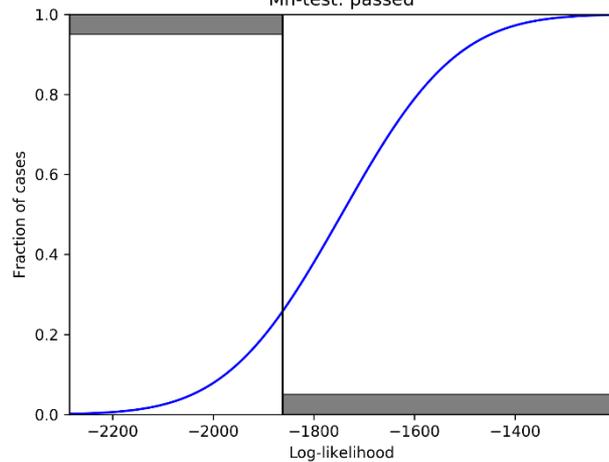
Model B



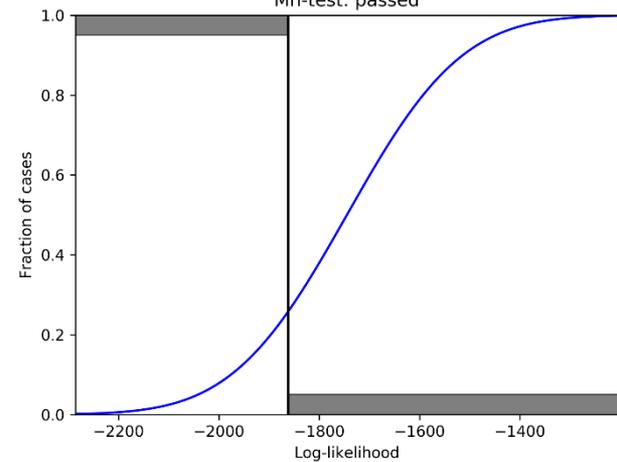
Model C



Mn-test: passed

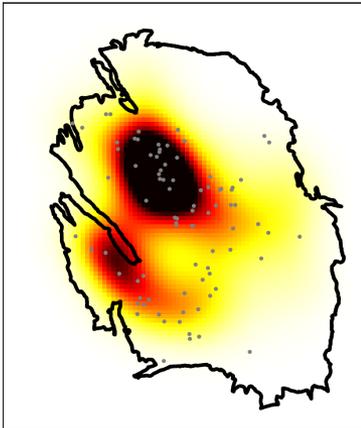


Mn-test: passed

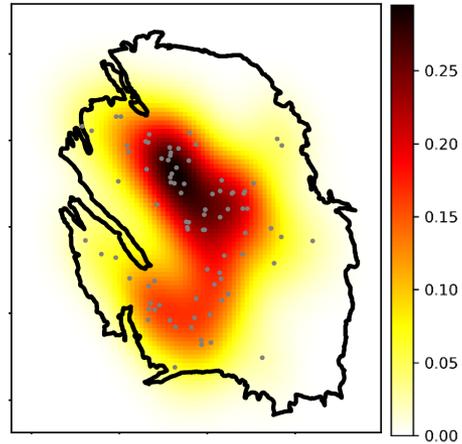


# EXAMPLE: TESTING

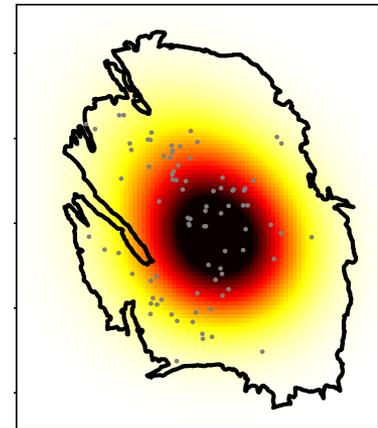
Model B



Event density data

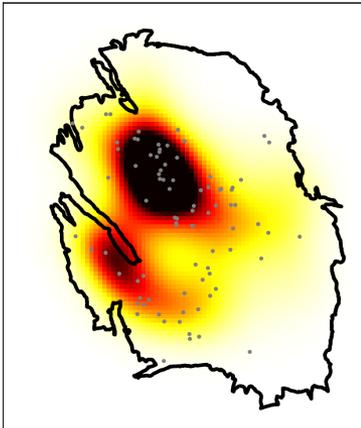


Model C

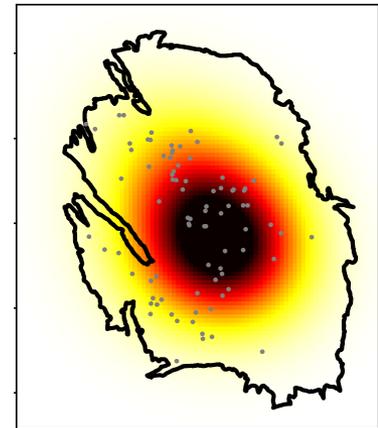


# EXAMPLE: TESTING

Model B



Model C



# FRAMEWORK PERFORMANCE

**FROM UNTRAINED  
MODEL TO  
FORECAST IN MINUTES**

**EVEN FASTER TO  
RUN A NEW FORECAST  
ON A TRAINED MODEL**

**RUNS ON MY LAPTOP**

**DIRECT INTEGRATION  
GIVES  
MEAN POSTERIOR MODEL**

**NO EXHAUSTIVE  
SAMPLING REQUIRED  
TO GENERATE CATALOGUES**

# OUTLOOK

**PUBLICLY ACCESSIBLE  
GRONINGEN (WEB)TOOL**



**MULTI-MODEL FORECASTING  
(COMBINING DIFFERENT MODELS)**



**APPLICATION TO  
OTHER CASES**





› **THANK YOU FOR YOUR ATTENTION**

Take a look:  
**[TNO.NL/TNO-INSIGHTS](https://www.tno.nl/tno-insights)**

**TNO** innovation  
for life