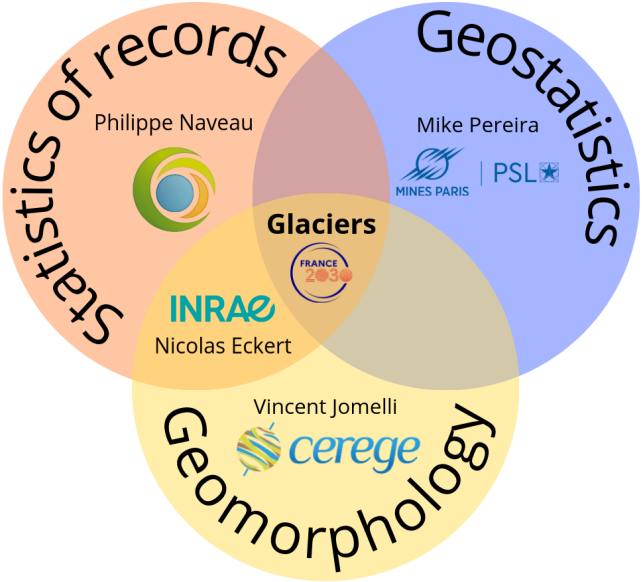
Stochastic generator of glacial trajectories from moraines data

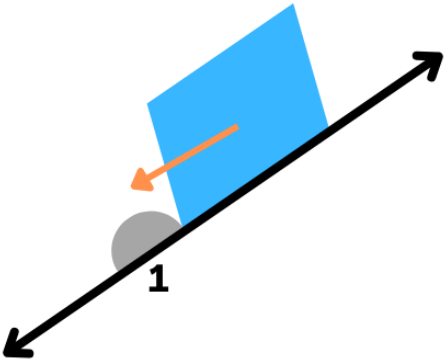
Maud MEGRET (LSCE), Philippe Naveau (LSCE), Nicolas Eckert (IGE),Mike Pereira (Centre de Géosciences, Mines PSL), Vincent Jomelli (CEREGE)


Statistics of records
Philippe Naveau
Geostatistics
Mike Pereira
MINES PARIS
PSL
Glaciers
FRANCE 2030
INRAE
Nicolas Eckert
Vincent Jomelli
cerege
Geomorphology

Why study glaciers ? [1]

[1] Bernard Francou et al. : Les glaciers à l'épreuve du climat [4]
Gerard H Roe : What do glaciers tell us about climate variability and climate change? [9]

How moraines are created ?



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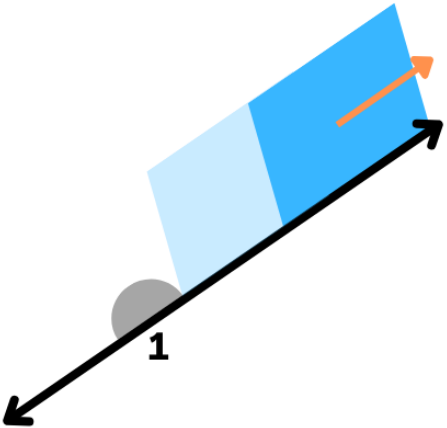

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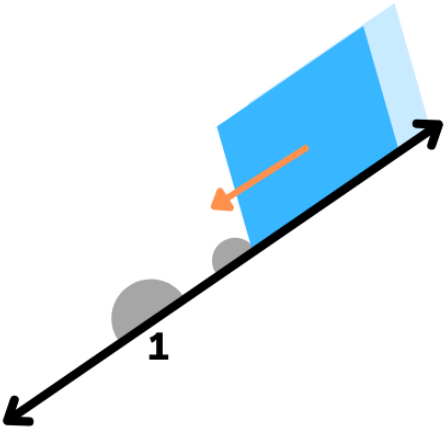

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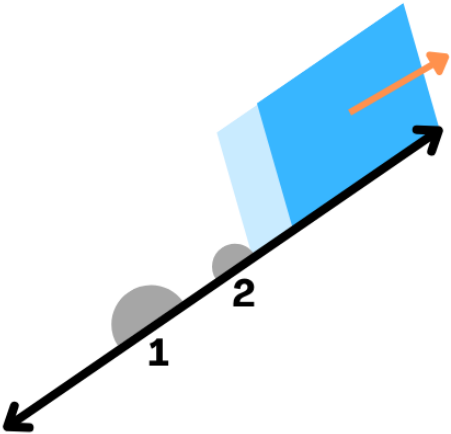

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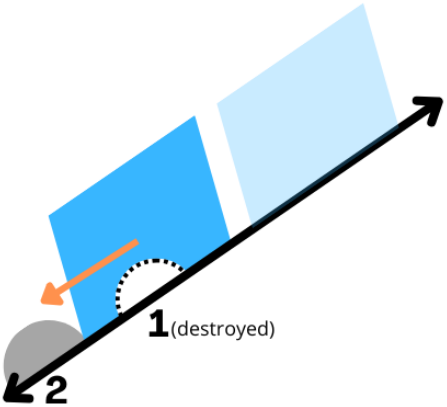

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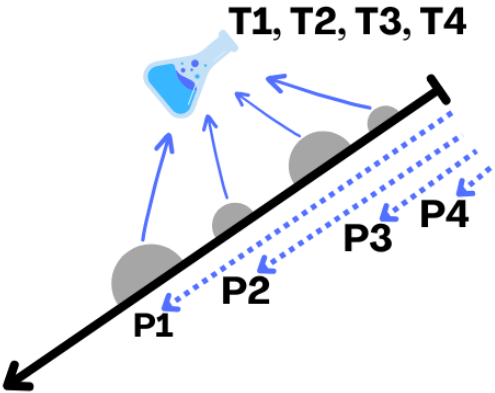
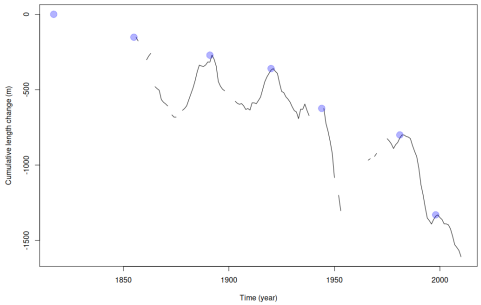


Transformation of the glacier fluctuations[2] representation



[2]Nussbaumer and Zumbühl (2012) [8]
Erich M Fischer et al. : Record-breaking extremes in a warming climate [3]

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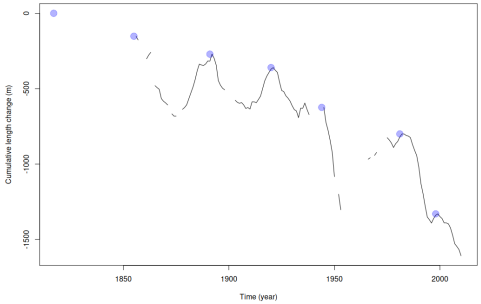

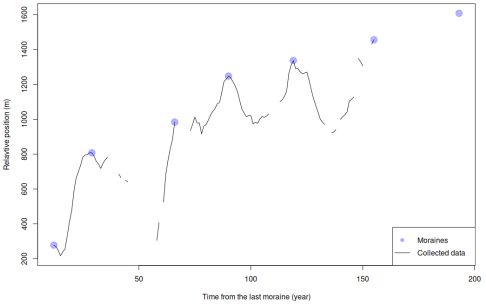

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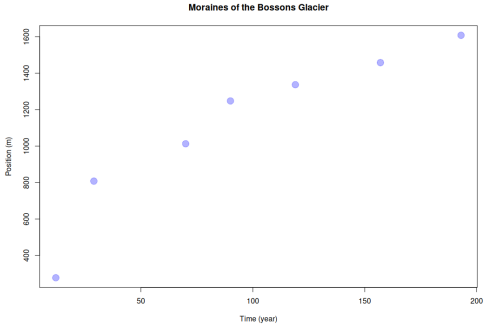
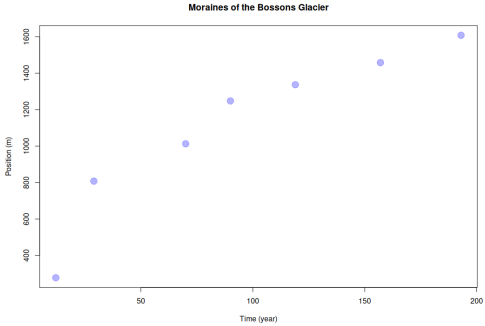
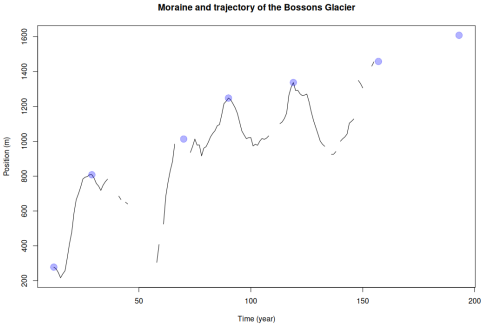
Generating past glacier positions from moraines



Generating past glacier positions from moraines





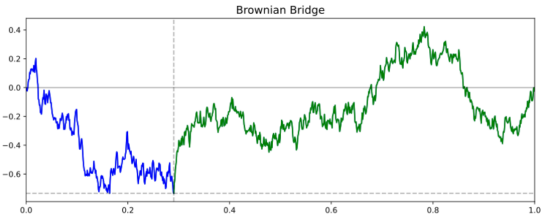
Model construction

One-dimensional Brownian motion

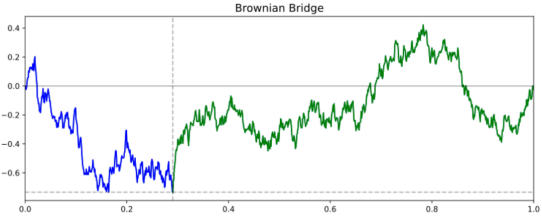
Zero-mean stochastic process starting at 0 with independant and centred gaussian increments

Brownian excursion

Brownian motion conditioned to be positive and to take value 0 at last time

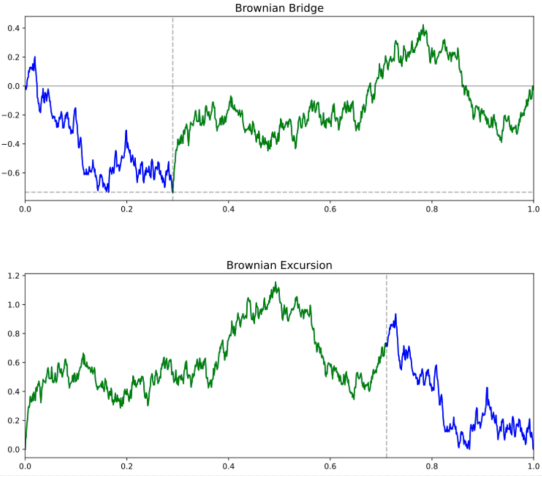


Model construction[3]



[3] Titus Lupu, Jim Pitman et Wenpin Tang : The vervaat transform of brownian bridges and brownian motion [7]

Model construction[3]



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Valid trajectory

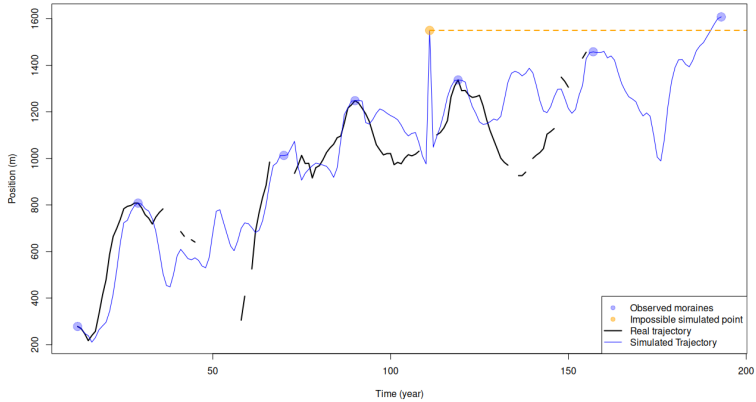
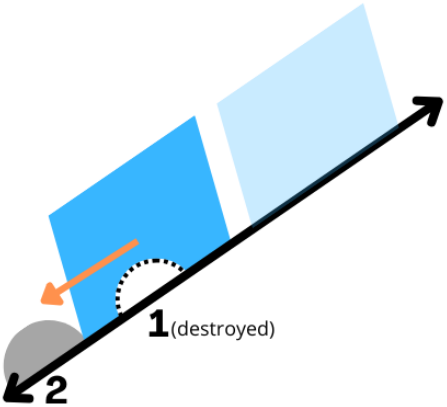


fig 1: Illustration of the condition needed to be a valid trajectory

Valid trajectory



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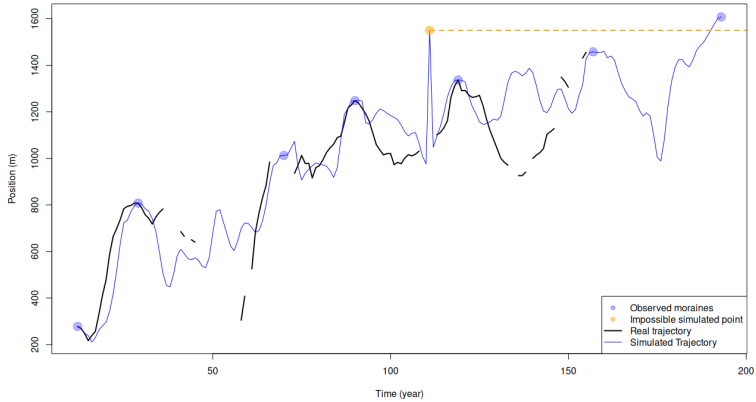


fig 2: Illustration of the condition needed to be a valid trajectory

Influence of the parameters

2 parametres : a smoothing parameter and the variance of the brownian motions

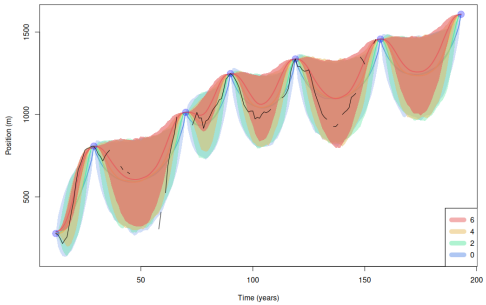


fig 3: Influence of the smoothing parameter

Influence of the parameters

2 parametres : a smoothing parameter and the variance of the brownian motions

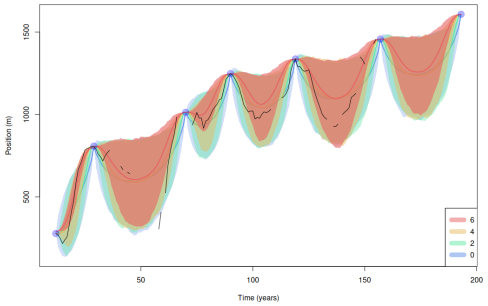


fig 3: Influence of the smoothing parameter

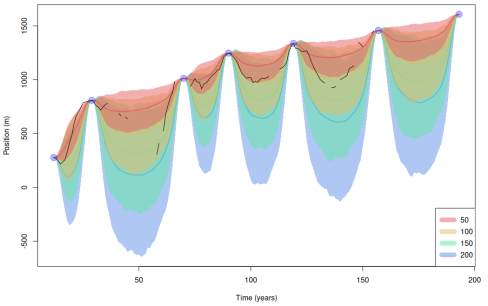


fig 4: Influence of the variance parameter

Objective : Be able to define the model parameter giving the more realistic trajectories

Neural Based Inference for parameters selection

- **Inputs :** Glaciers trajectories simulated with the model
- **Outputs :** Parameters used
- **Architecture :** 2 hidden layers, Width : 64, 32, Activation : Relu

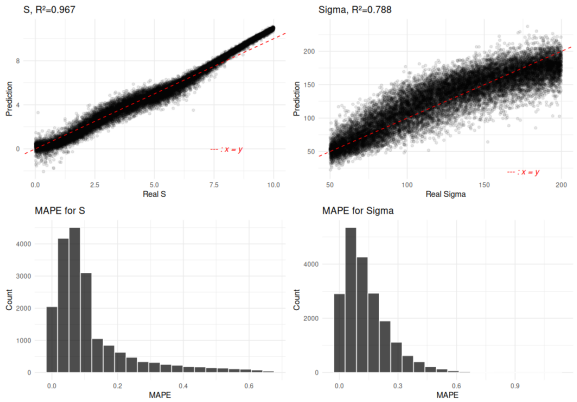


fig 5: NBI predictions results on the testing sample

Results of the parameters selection

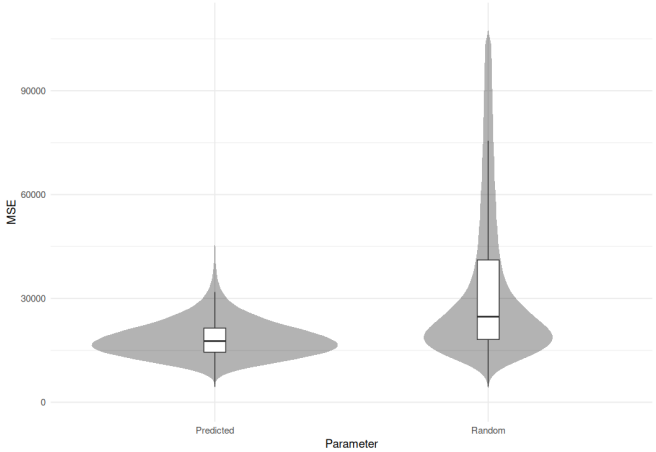
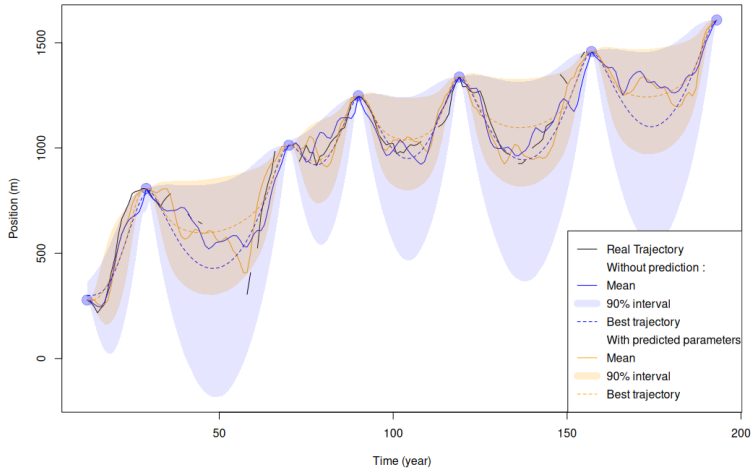


fig 6: MSE between trajectories predictions and the real one with predicted parameters or with random ones

Trajectory beams for the Brownian Motions Method



Conclusion

- We created a stochastic generator based on brownian motions to simulate trajectories
- We learned the link between its parameters and the shapes of the trajectories
- We can study real trajectories to define those parameters and improve the simulations
- Perspective : Use more real trajectories to improve the model

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[2][3][4][5][1][6][7][8][9][10][11]