Feldspar single grain luminescence of modern fluvial sediments as a new tool to study fluvial transport

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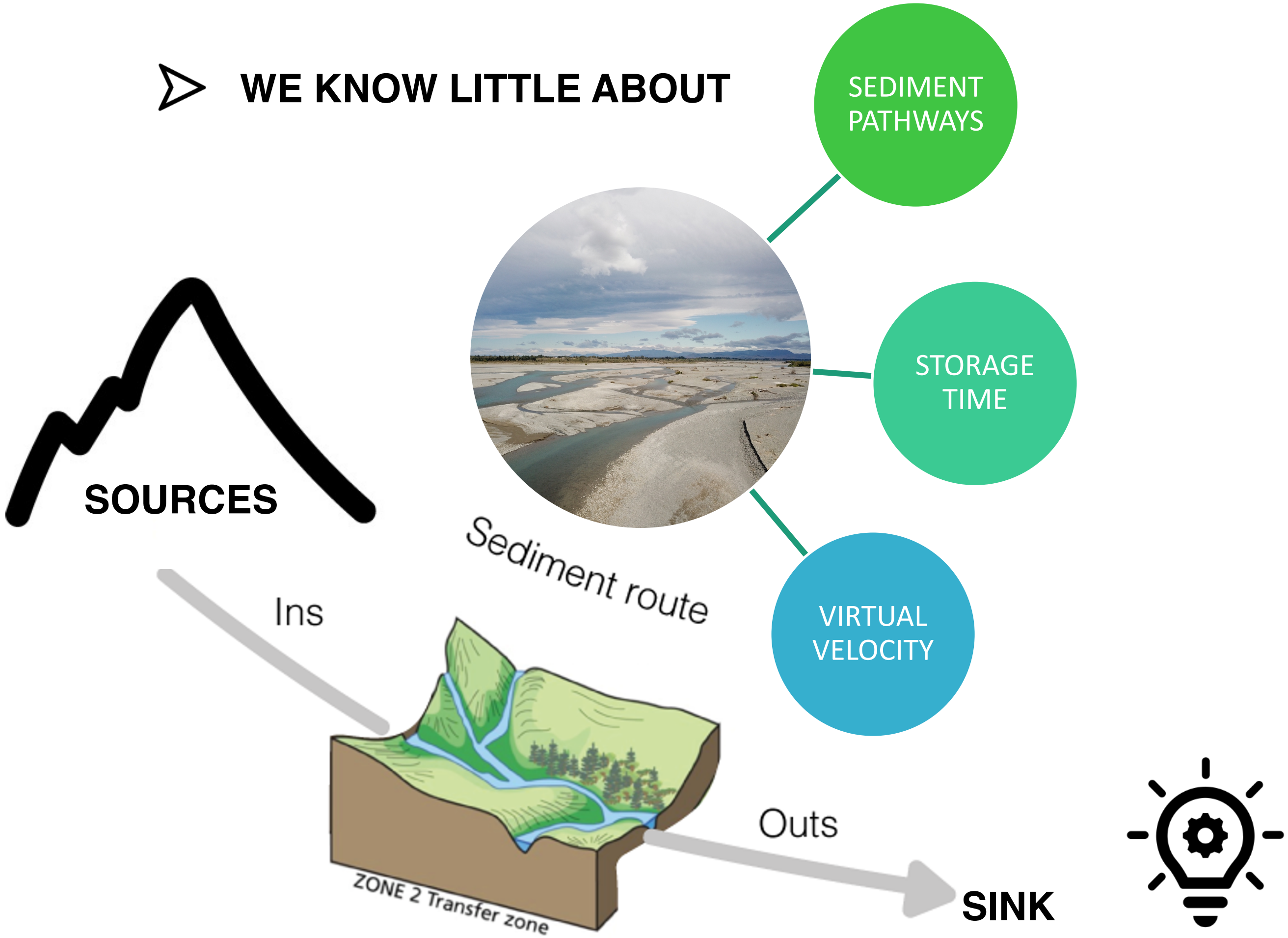
GM10.1 Responding to Change: Climatic, Tectonic, Autogenic, and Anthropogenic Signal Propagation from Source to Sink

WE KNOW LITTLE ABOUT

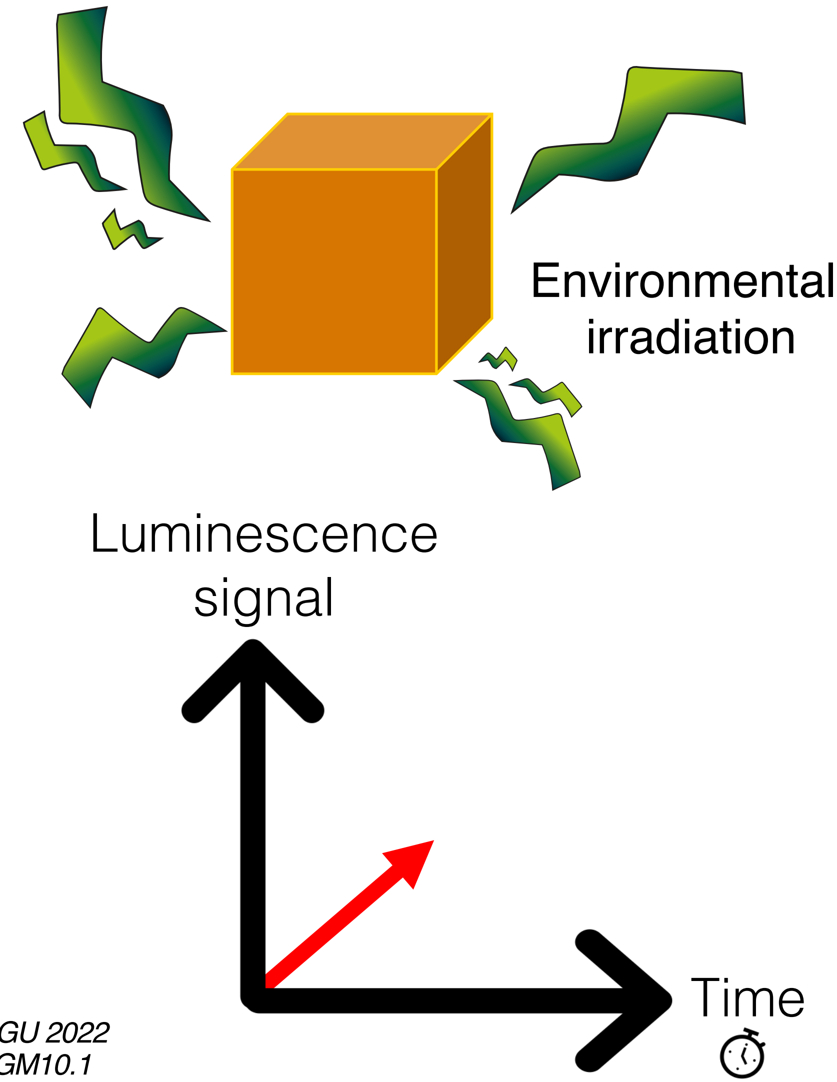


Source: Trista L. Thornberry-Ehrlich, Colorado State University.

LUMINESCENCE IN SINGLE-GRAIN AS A NEW TOOL

HOW DOES IT WORK ?

Grains are **buried (e.g. in floodplains)**



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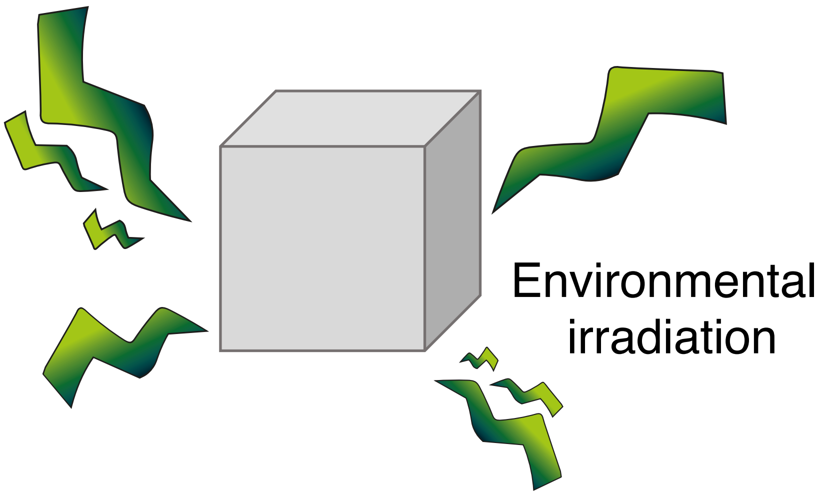

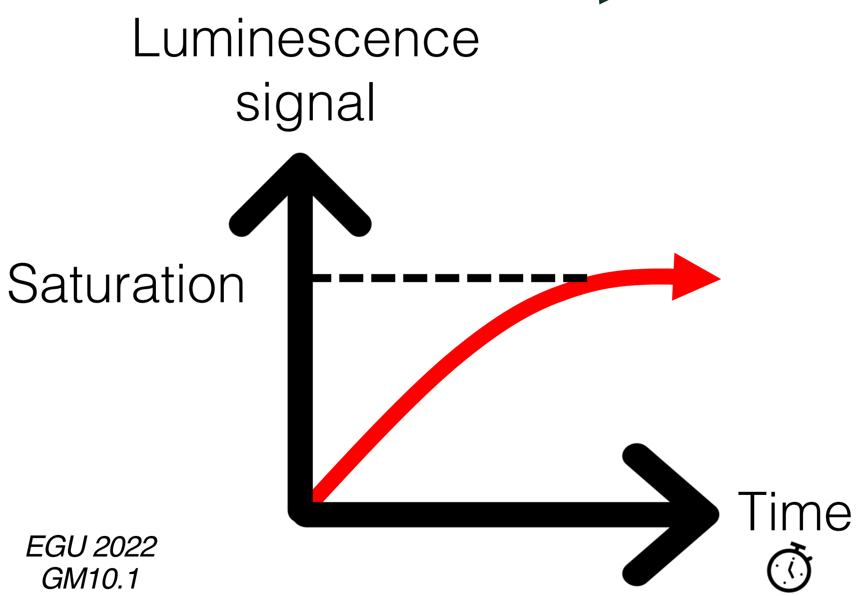

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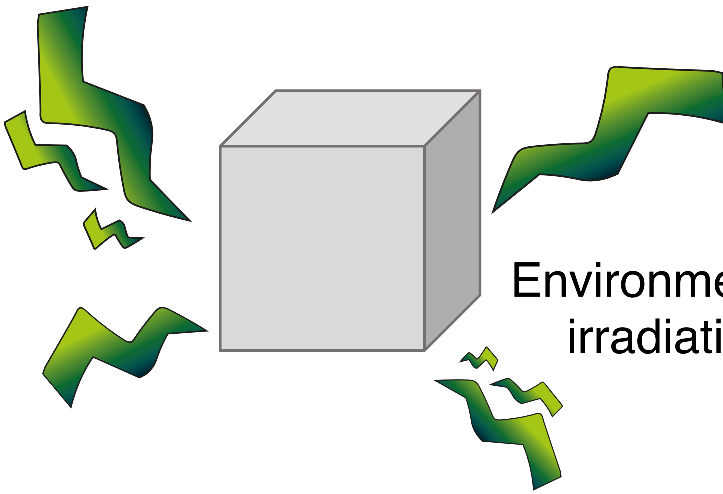
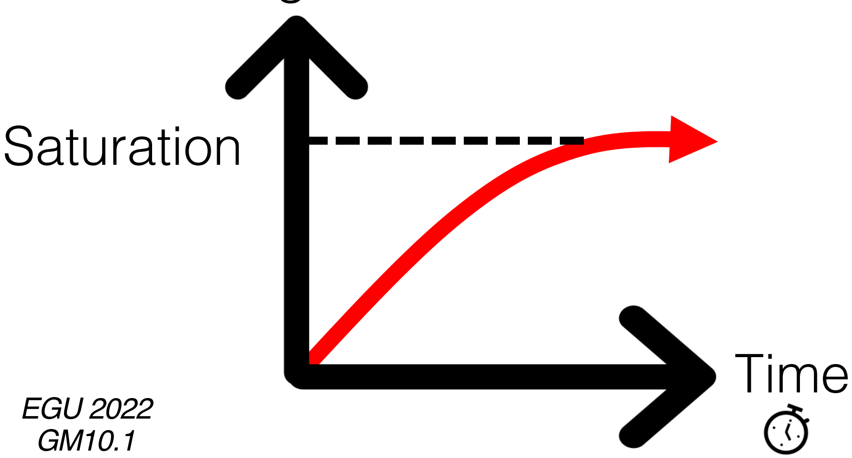
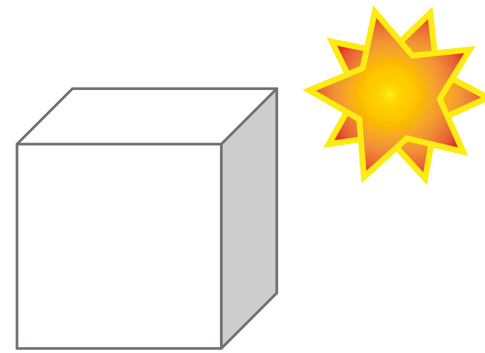


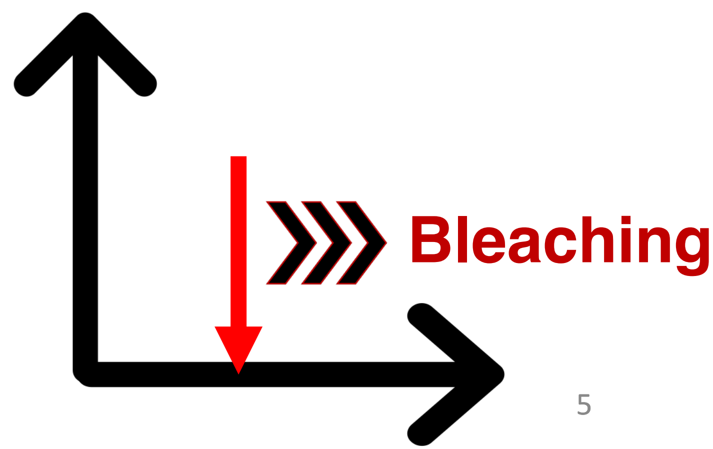
Luminescence signal



Grains are **exposed to sunligth**

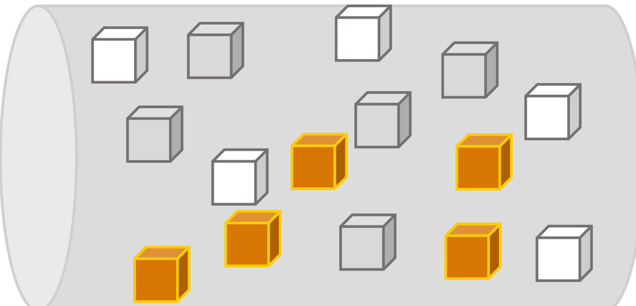


Luminescence signal is reset



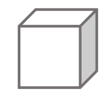
HOW DOES IT WORK ?

Sampling and single grains measurements

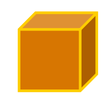


Allows identifying:

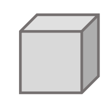
Well-bleached grains

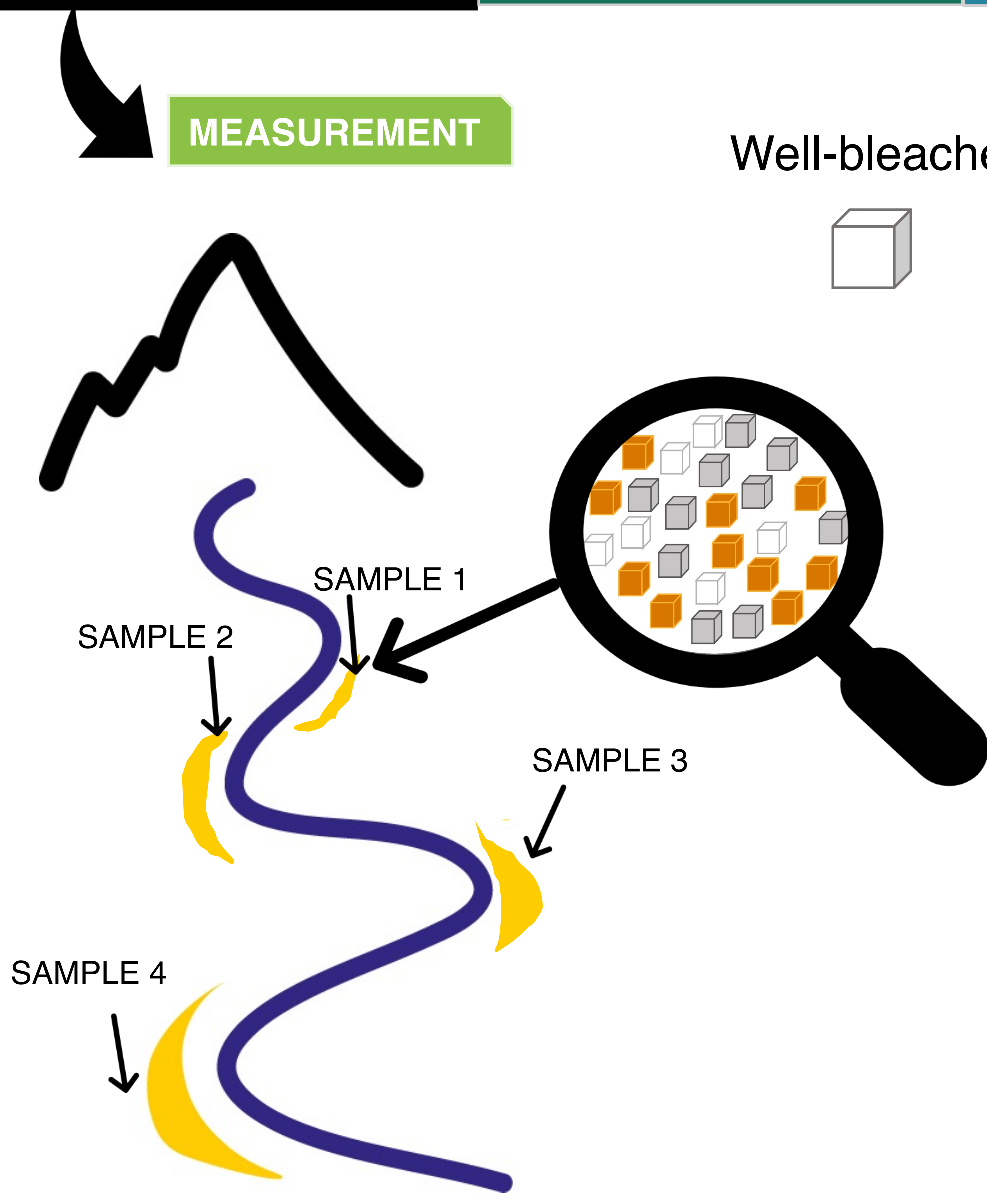


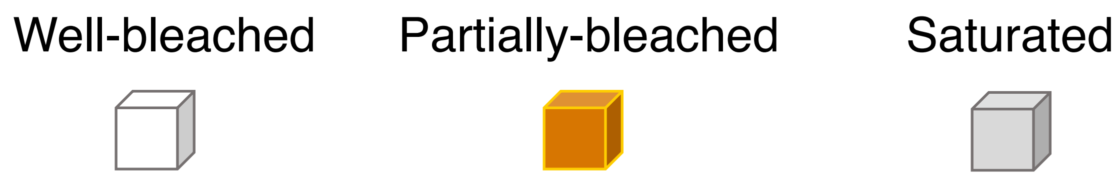
Partially-bleached grains



Saturated



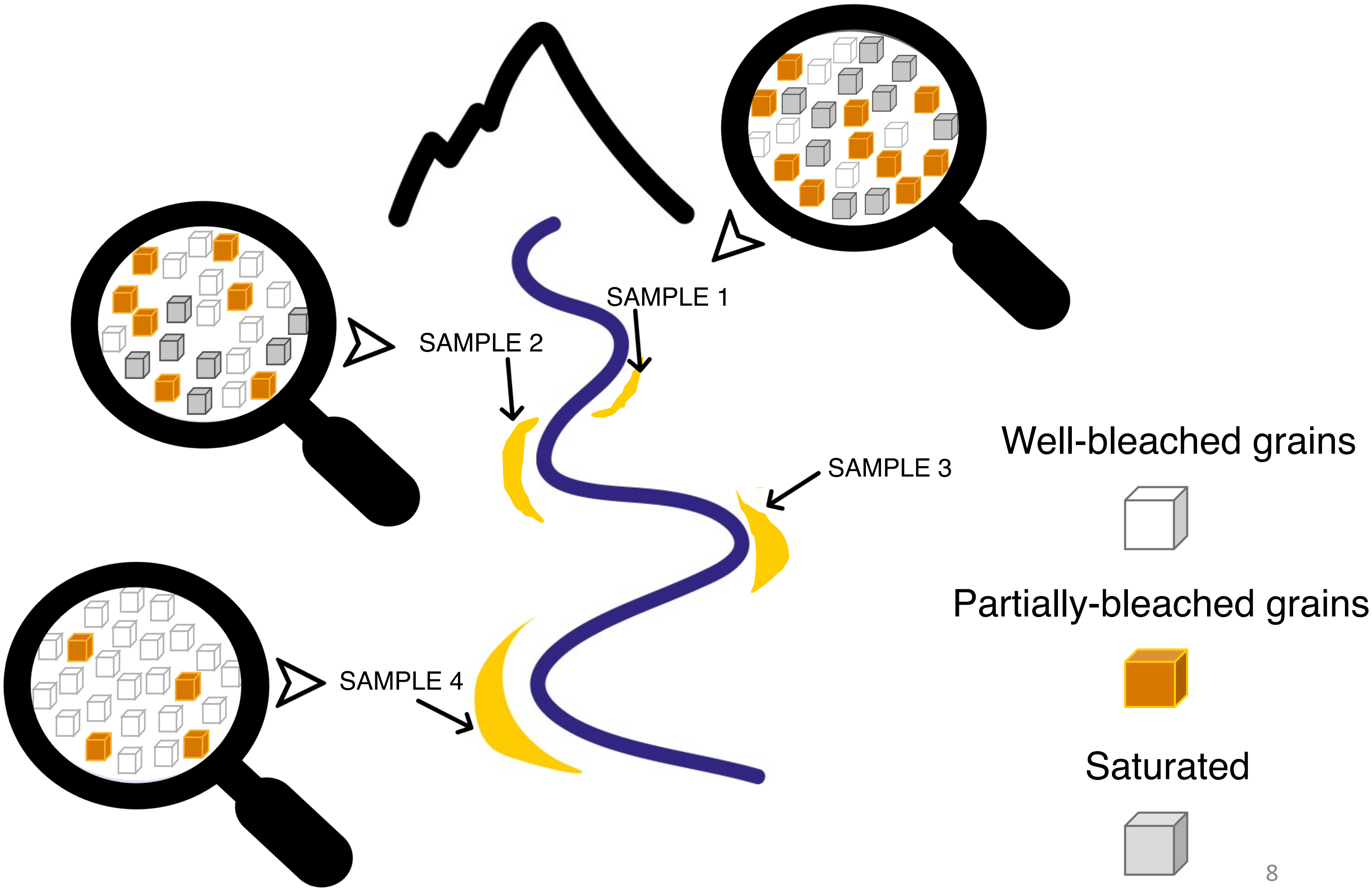


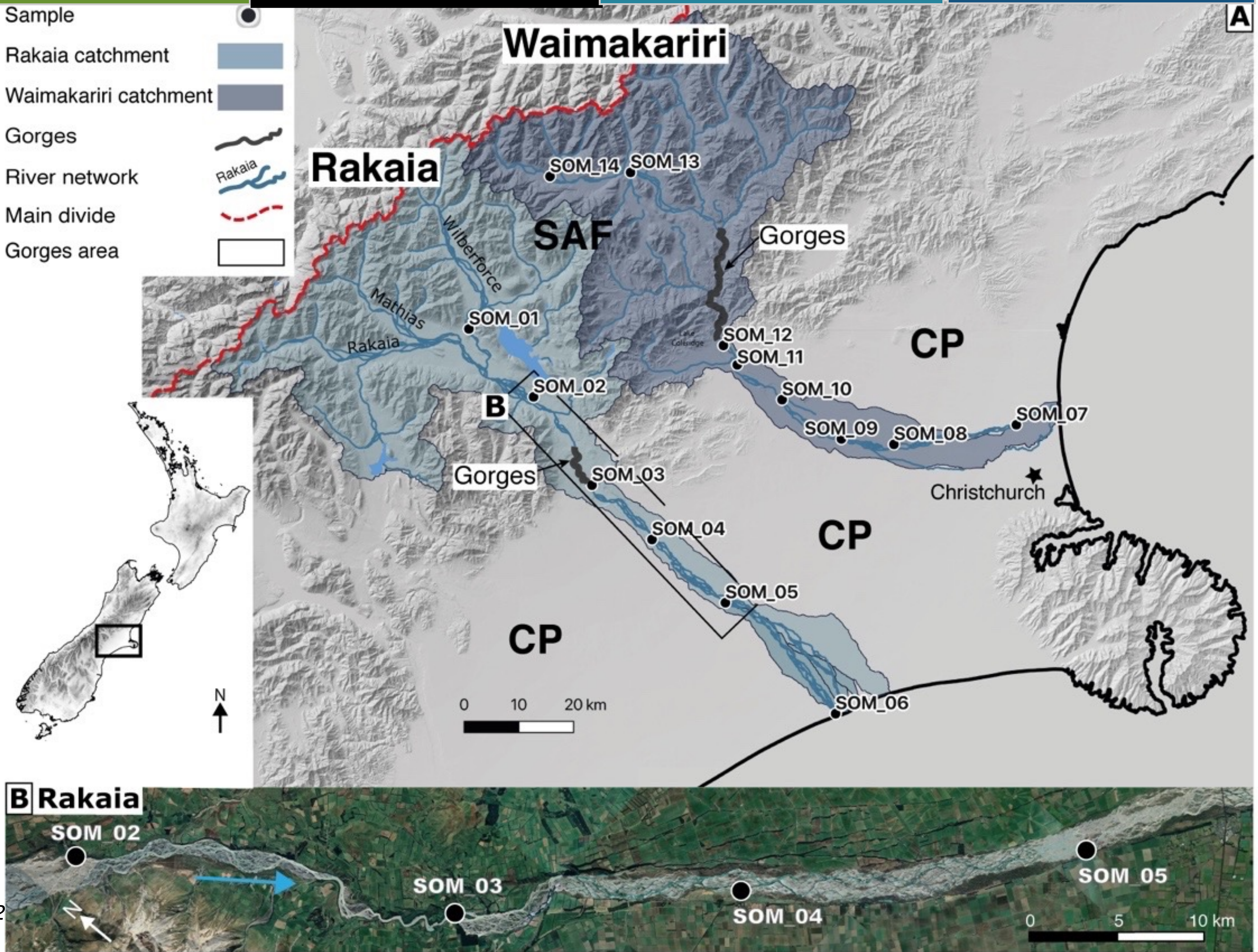


Hypothesis:

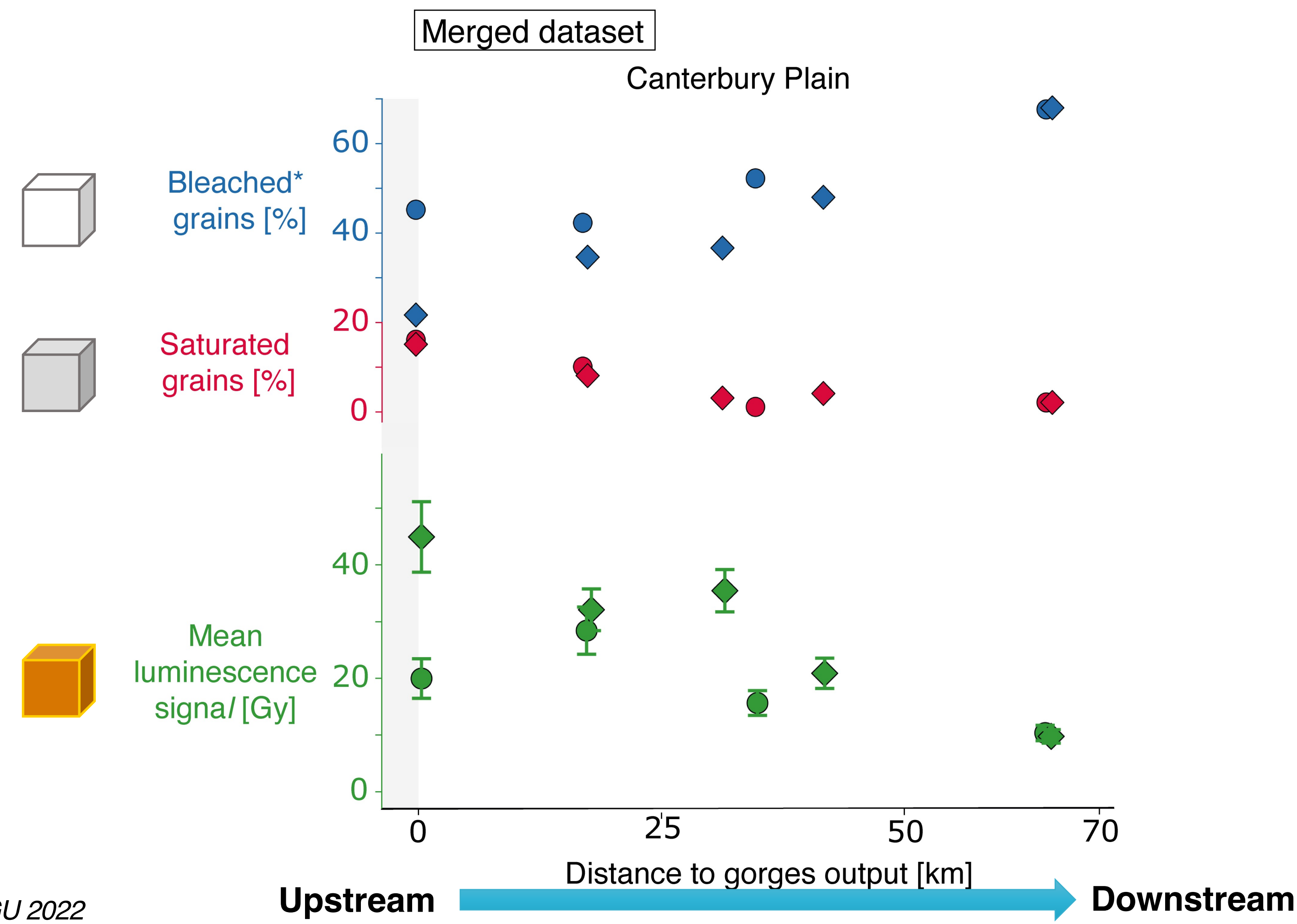
- The % of each grain varies alongstream due to **transport** and **storage**
- Single-grain data can provide quantitative insight into **sediment transfer in river systems**.

Strategy: alongstream sampling of modern deposits



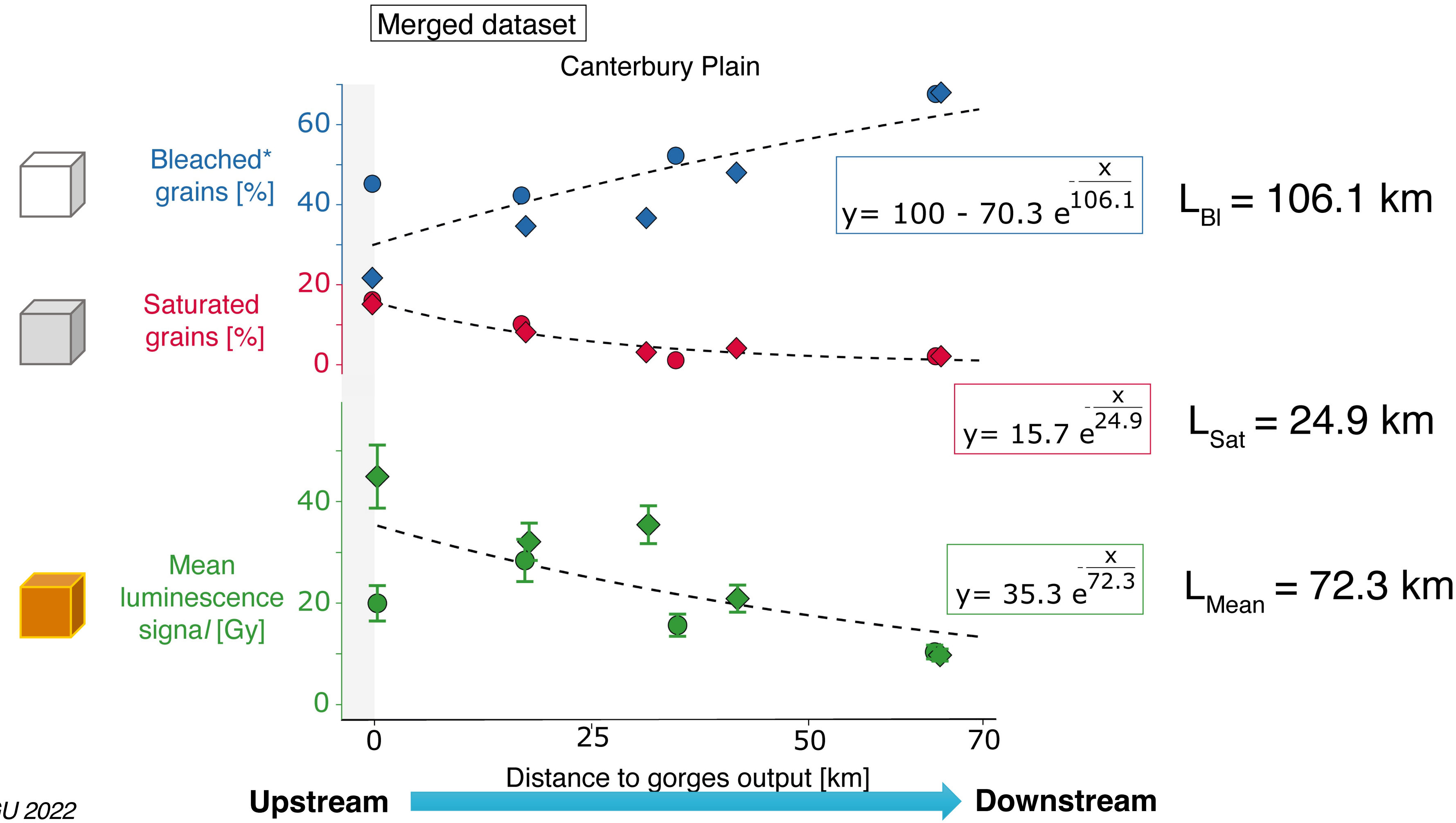

Sample
Rakaia catchment
Waimakariri catchment
Gorges
River network
Rakaia
Main divide
Gorges area
A
Waimakariri
Rakaia
SAF
Wilberforce
Mathias
Rakaia
SOM_14
SOM_13
Gorges
SOM_01
SOM_12
SOM_11
SOM_10
SOM_02
B
SOM_07
SOM_09
SOM_08
Gorges
SOM_03
Christchurch
CP
CP
SOM_04
SOM_05
CP
SOM_06
0 10 20 km
N
B Rakaia
SOM_02
SOM_03
SOM_04
SOM_05
0 5 10 km

River	Bleached* grains (%)	Saturated grains (%)	Mean luminescence signal(Gy)
Waimakariri	◆	◆	◆
Rakaia	●	●	●



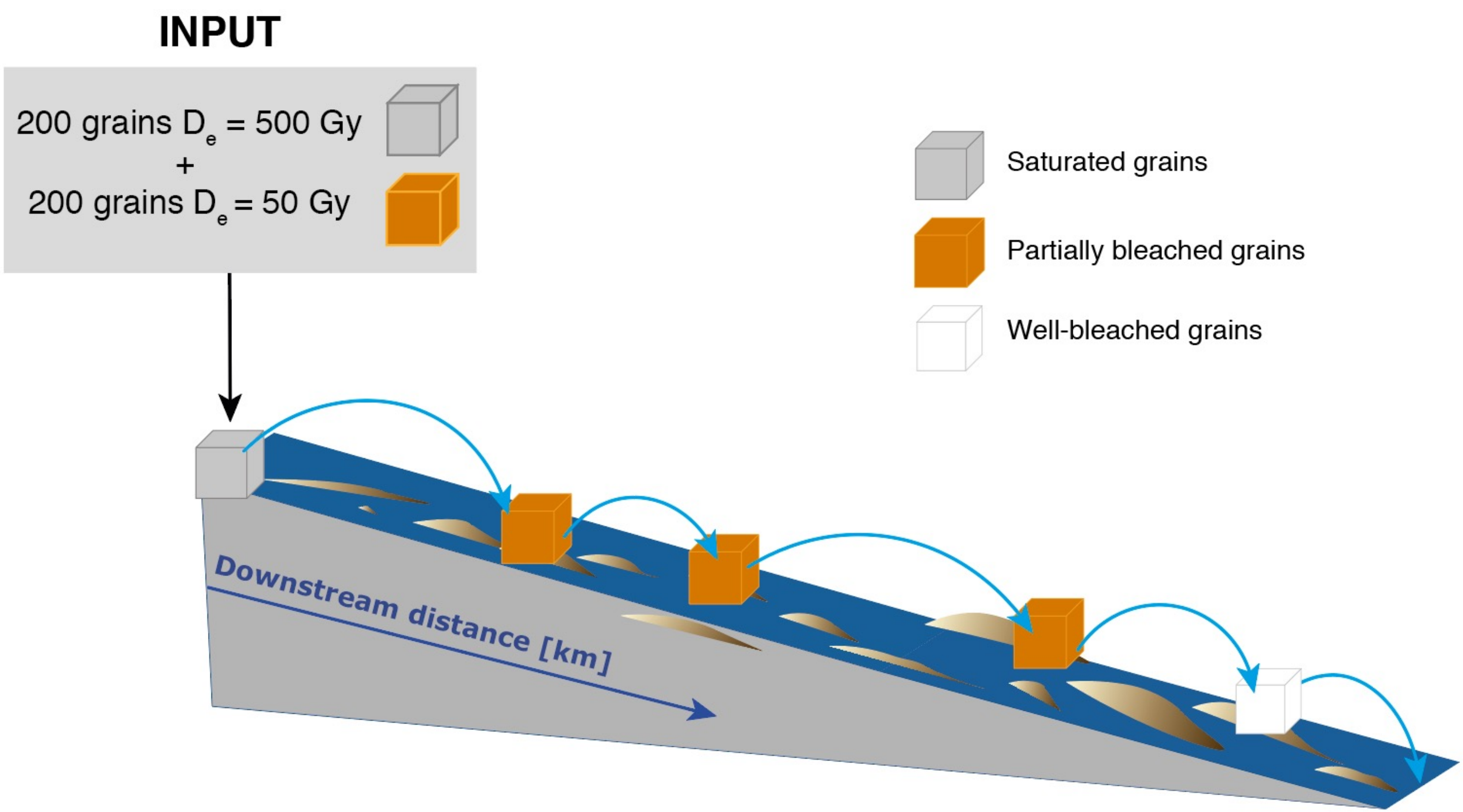
* Bleached grains : grains with De < 10 Gy

River	Bleached* grains (%)	Saturated grains (%)	Mean luminescence signal(Gy)
Waimakariri	◆	◆	◆
Rakaia	●	●	●



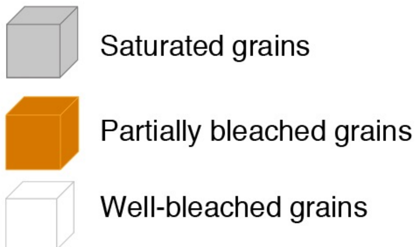
* Bleached grains : grains with De < 10 Gy

Numerical simulation of alongstream change in luminescence



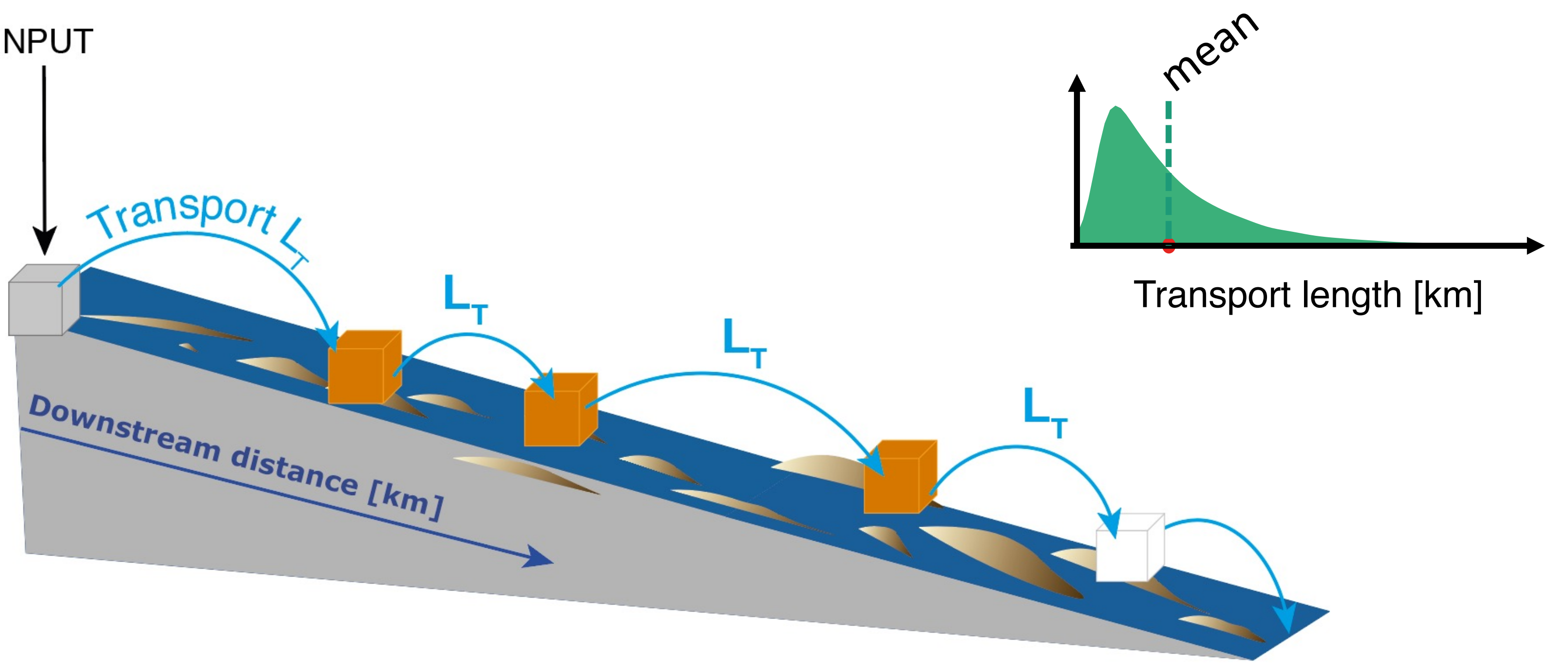
Numerical simulation of alongstream change in luminescence

Input parameters of the model ▷ Transport length



Mean L_T : 0.2 – 20 km

Exponential distribution



Numerical simulation of alongstream change in luminescence

Saturated grains

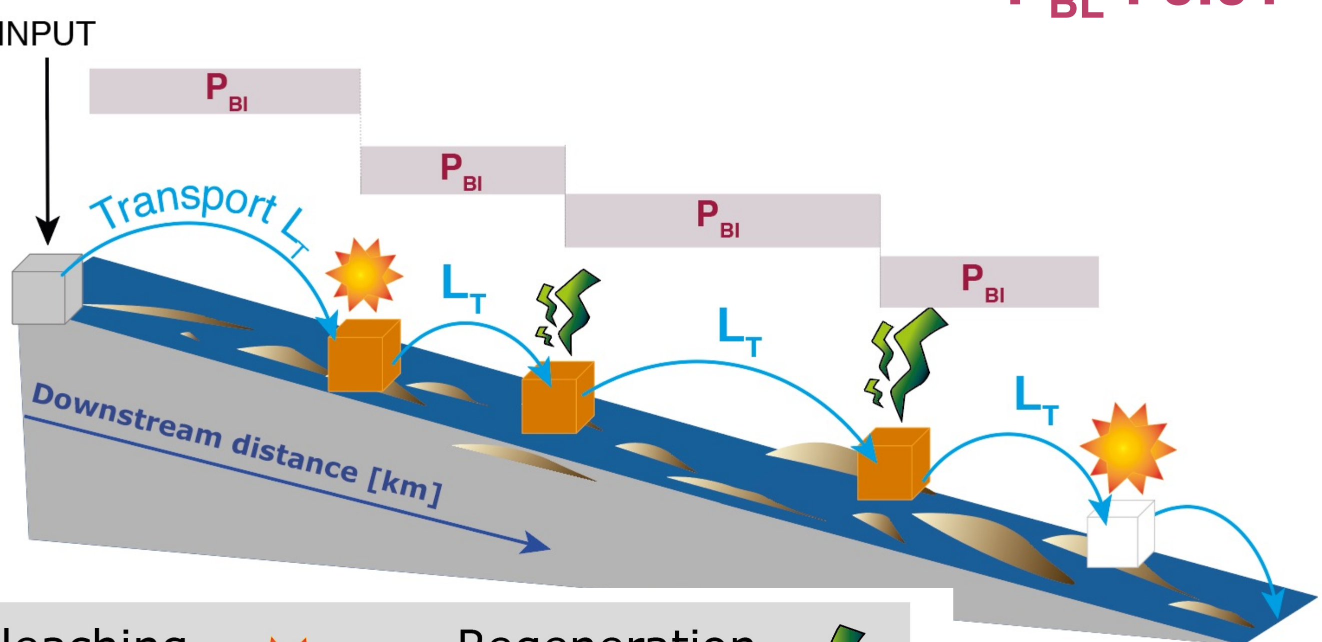
Partially bleached grains

Well-bleached grains

Input parameters of the model

➢ Probability to be bleach

P_{BL} : 0.01 – 0.5



Process	Bleaching	Regeneration
By	*Sunlight exposure*	*Ionising radiation during burial at 3 Gy/ka*

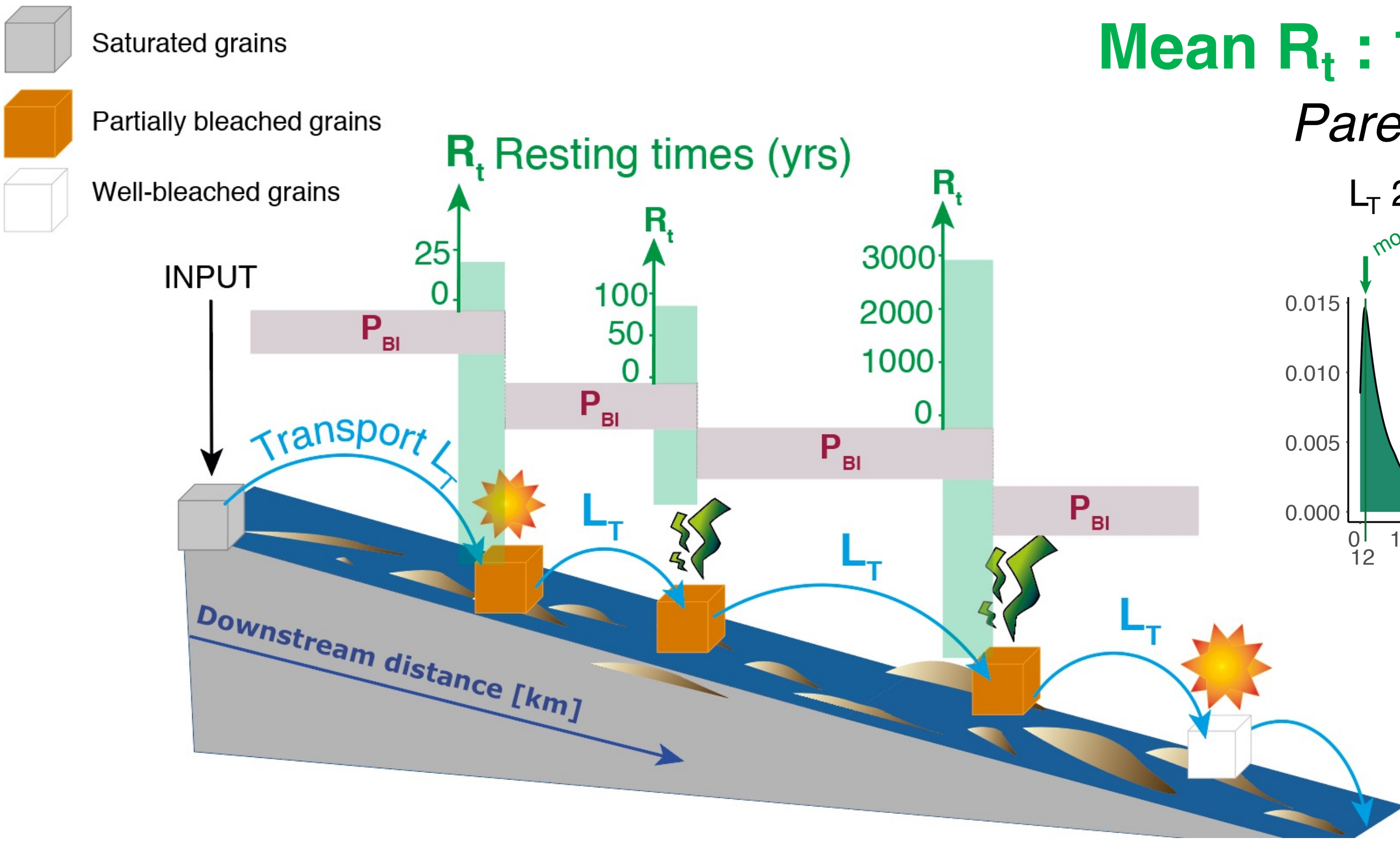
Numerical simulation of alongstream change in luminescence

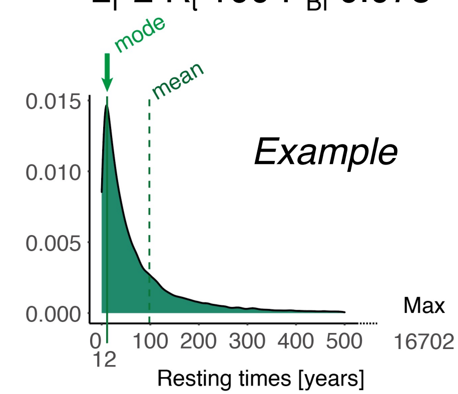
Input parameters of the model

➢ Resting times

Mean R_t : 1 – 800 yrs

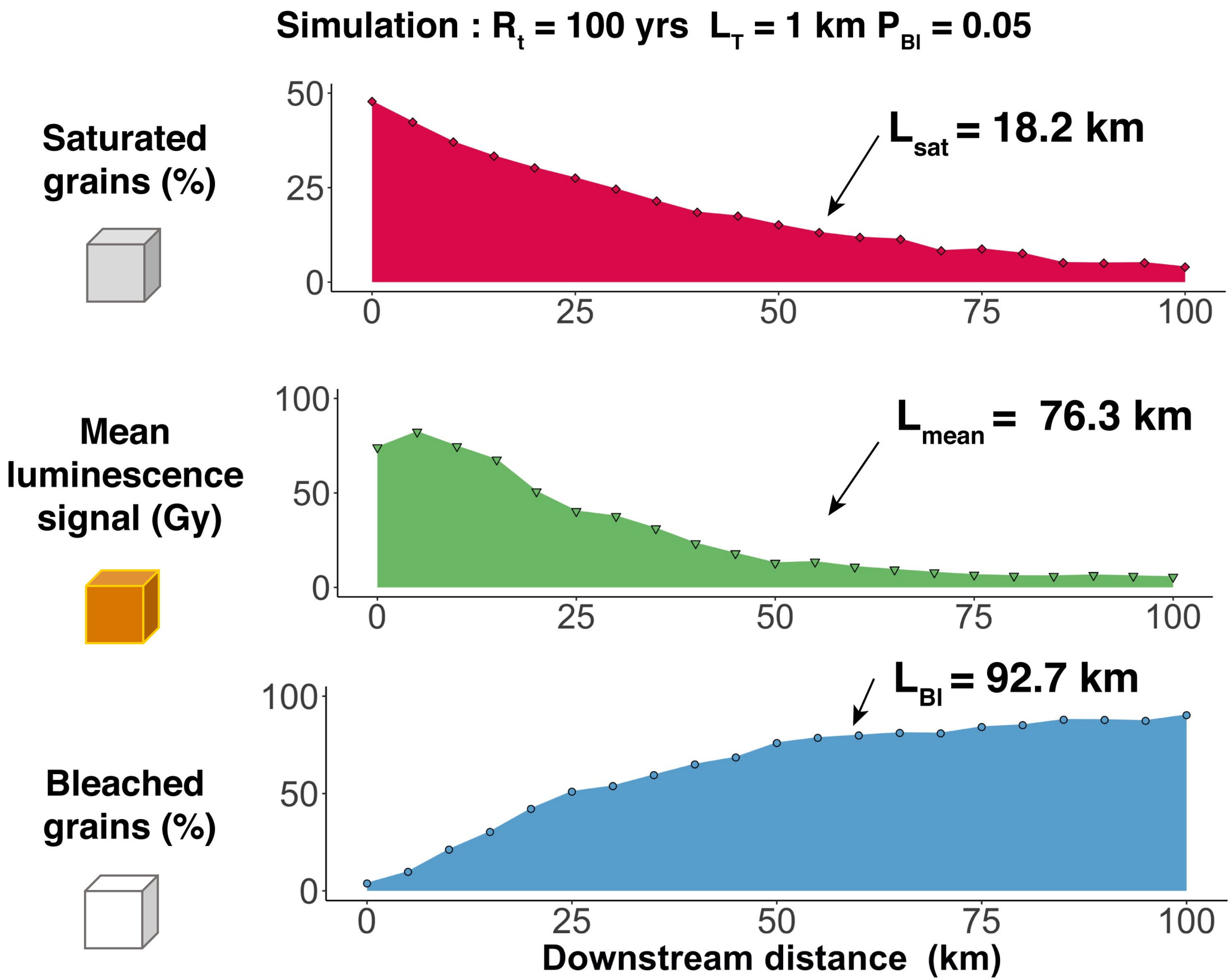
Pareto distribution





Process		
	Bleaching	Regeneration
By	*Sunlight exposure*	*Ionising radiation during burial at 3 Gy/ka*

- 3 metrics
- Same than for natural system
- To analyse the raw data from simulation



Bleached grains : grains with De < 10 Gy

Results from the model

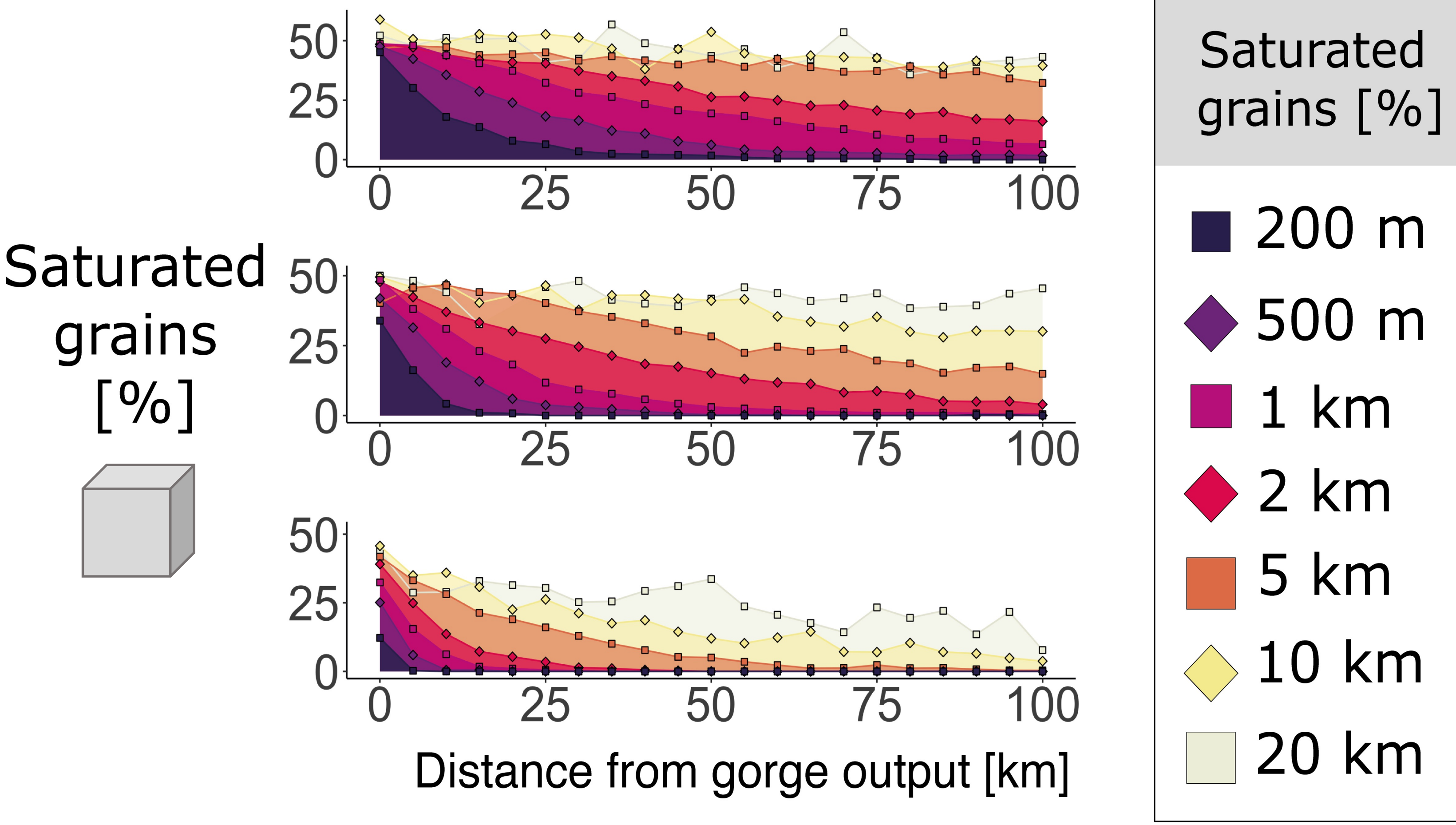
R_t = 200 yrs

P_{BI}

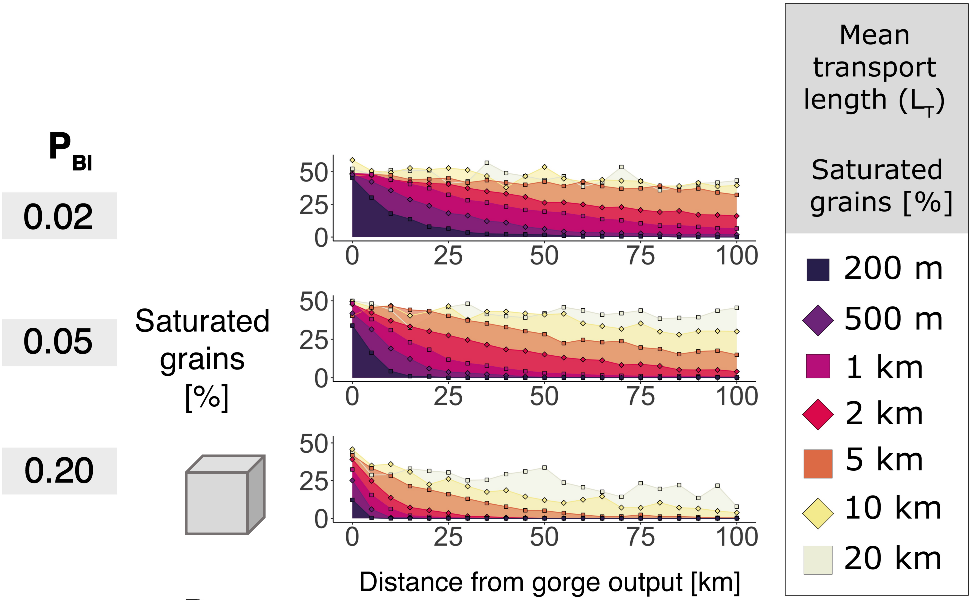
0.02

0.05

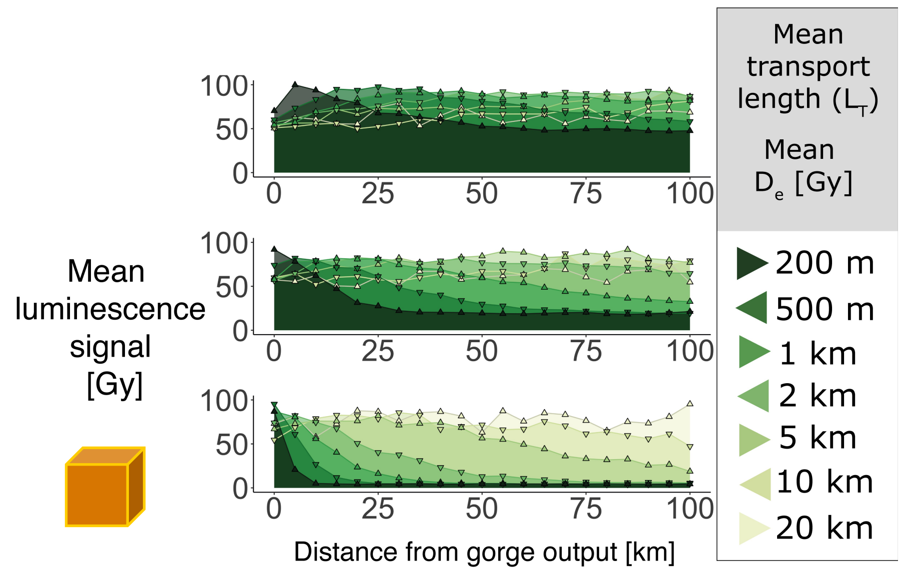
0.20



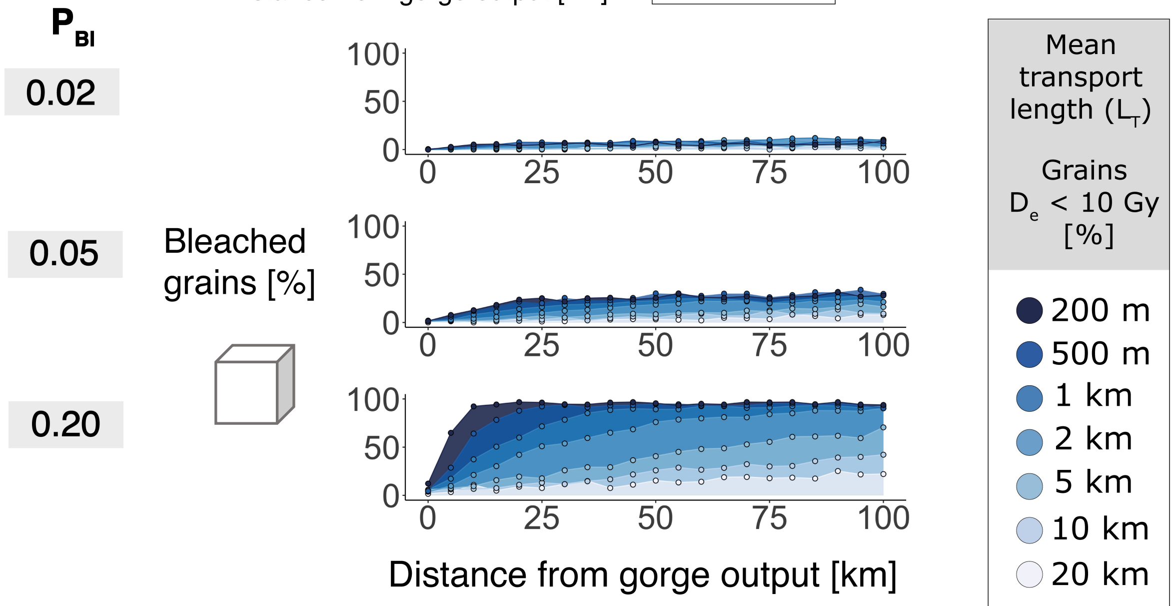
R_t = 200 years



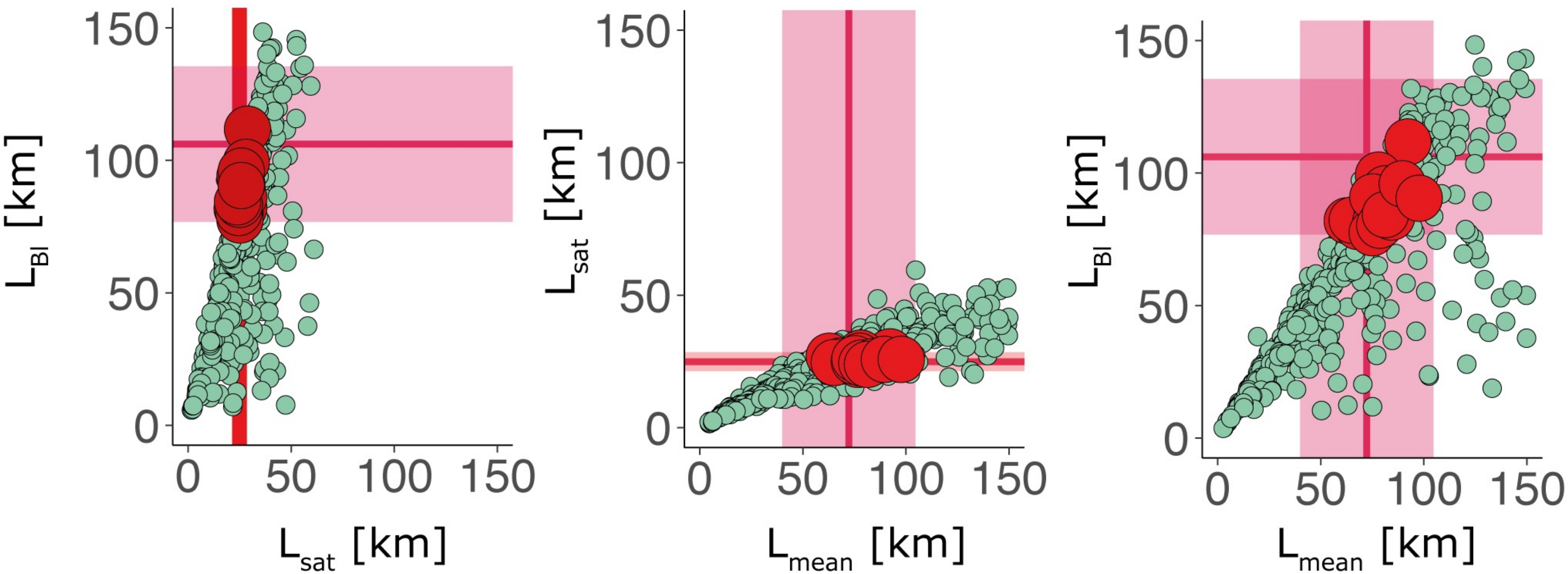
P_{BI}
0.02
0.05
0.20
Saturated grains [%]
Distance from gorge output [km]
Mean transport length (L_T)
Saturated grains [%]
200 m
500 m
1 km
2 km
5 km
10 km
20 km



Mean luminescence signal [Gy]
Distance from gorge output [km]
Mean transport length (L_T)
Mean D_e [Gy]
200 m
500 m
1 km
2 km
5 km
10 km
20 km



P_{BI}
0.02
0.05
0.20
Bleached grains [%]
Distance from gorge output [km]
Mean transport length (L_T)
Grains D_e < 10 Gy [%]
200 m
500 m
1 km
2 km
5 km
10 km
20 km

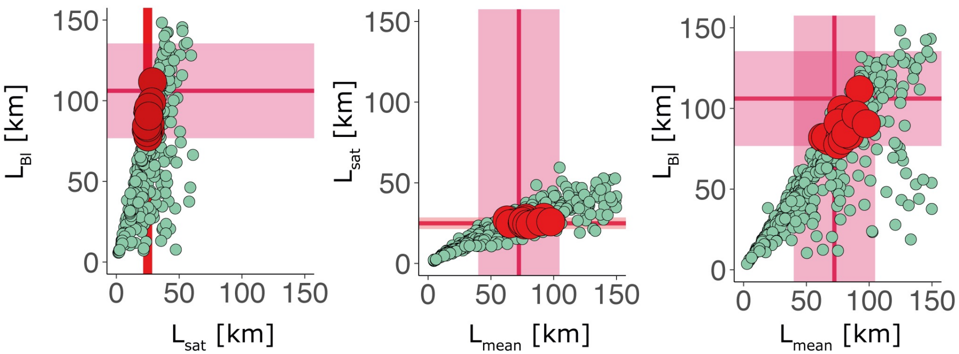


Natural system

- L_{sat} , L_{bl} and L_{mean}
- L_{sat} , L_{bl} and L_{mean} standard error

Simulations

- Raw data
- Best fits (chi-2 test, 1-sigma)



Natural system

L_{sat} , L_{bl} and L_{mean}

L_{sat} , L_{bl} and L_{mean} standard error

Simulations

Raw data

Best fits (chi-2 test, 1-sigma)

15 (among 850 tested) combination of parameters that best perform in simulating observations

L_T between 2 and 10 km

R_t between 20 and 150 years

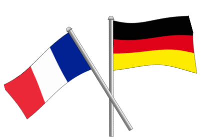
TRANSIT TIMES of 2.1 to 10.3 kyrs
VIRTUAL VELOCITY of 20 to 95 m/yr

Conclusions

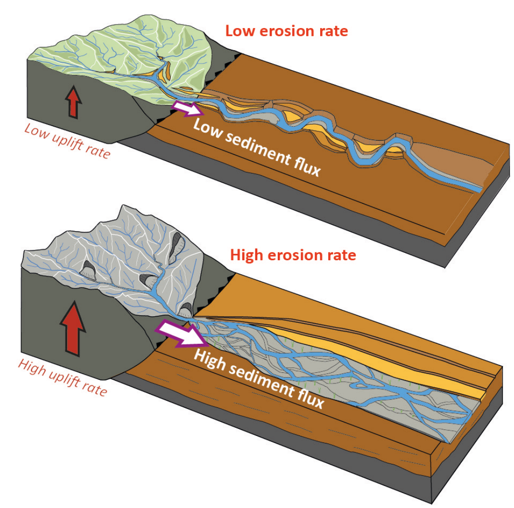
- Single grain luminescence signals vary consistently alongstream
- Better progressive bleaching downwards
- Numerical simulation indicate that it corresponds to a mean virtual velocity of 46±28 $m.yr^{-1}$ and transit times of 6.9±2.9 kyr

Future work needed

- Other rivers and coupling with other methods (meteoric ^{10}Be; Repasch et al. 2020)
- How parameters (virtual velocity, transit times) vary according to fluvial styles, climate or tectonic
- Add other signals : Multiple elevated temperature IRSL
- Better understand partial bleaching



All this will be investigated in the french-german research project **WEARING-DOWN** (2022-2025)



UNIVERSITÉ TOULOUSE III PAUL SABATIER
anr agence nationale de la recherche
Universität zu Köln
DFG Deutsche Forschungsgemeinschaft

A more detailed talk will be given on **June 16** in **landscapes live**

Landscapes Live
EGU-GM Online Seminars in Geomorphology

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