Solute transport experiments and modelling in terminal conduit of karst hydrosystems, Southern France

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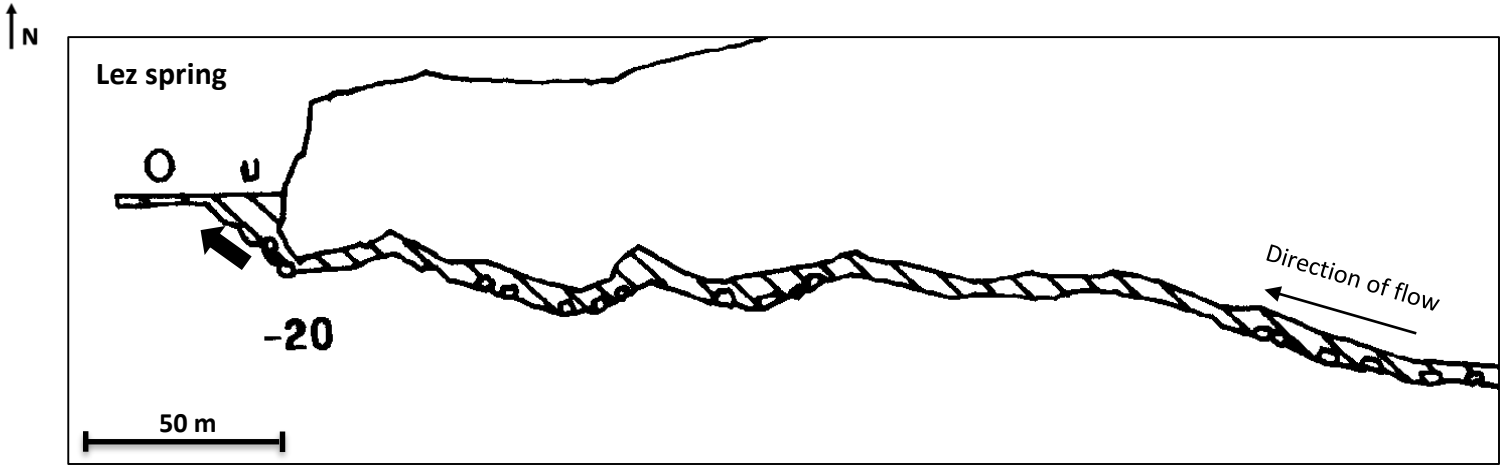
INTRODUCTION AND OBJECTIVE

- Understanding solute and **contaminant transport** within karst hydrosystems can be performed with the help of different approaches such as laboratory experiments, **field experiments**, and **groundwater flow** and **transport numerical simulations**.

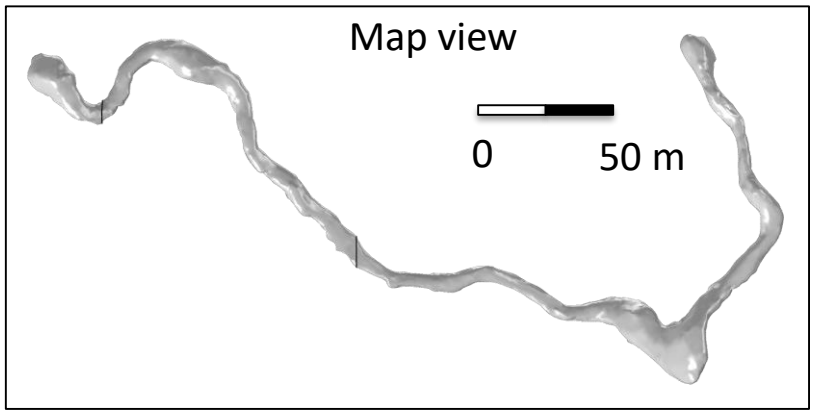
- In this study, we performed a **solute transport experiment** in the **terminal conduit** of a **karst spring**, the Lez spring, with the objective to better assess the effect of **karst conduit morphology** and **geometry** on **transport processes**.

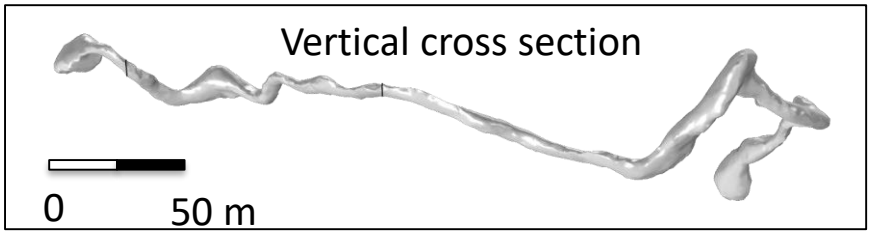
LEZ SPRING AND TERMINAL KARST CONDUIT



3D MAPPING OF THE TERMINAL KARST CONDUIT

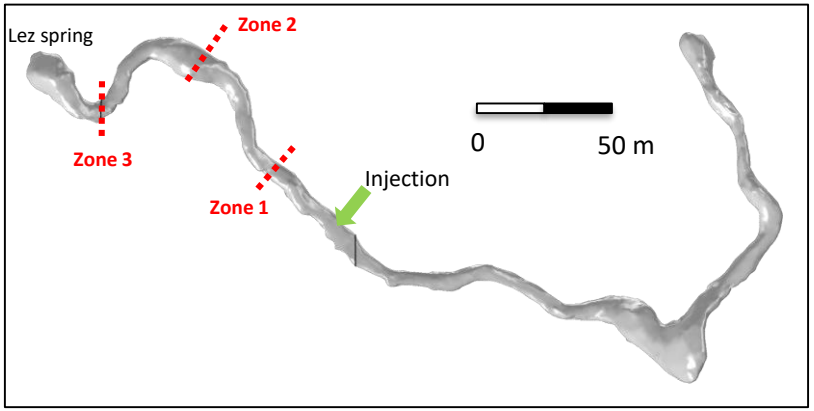
3D MAPPING TOOL - REEDS



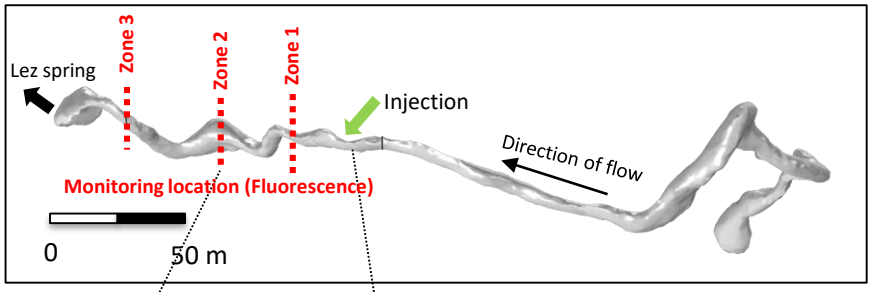


EXPERIMENTAL SET UP

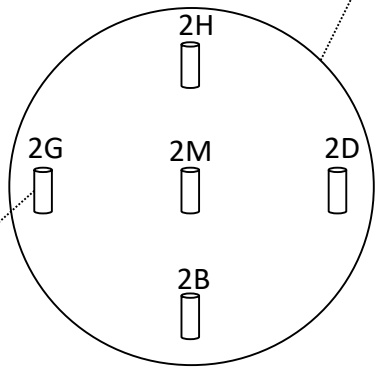
Map view



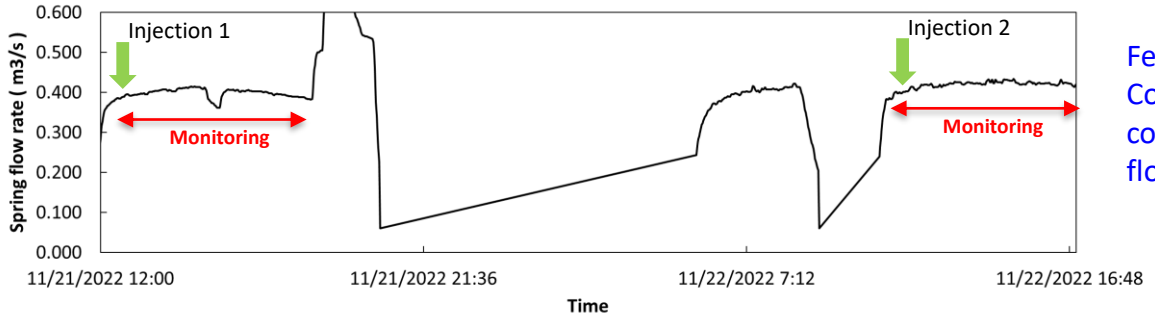
Vertical cross section



Delayed dye injection

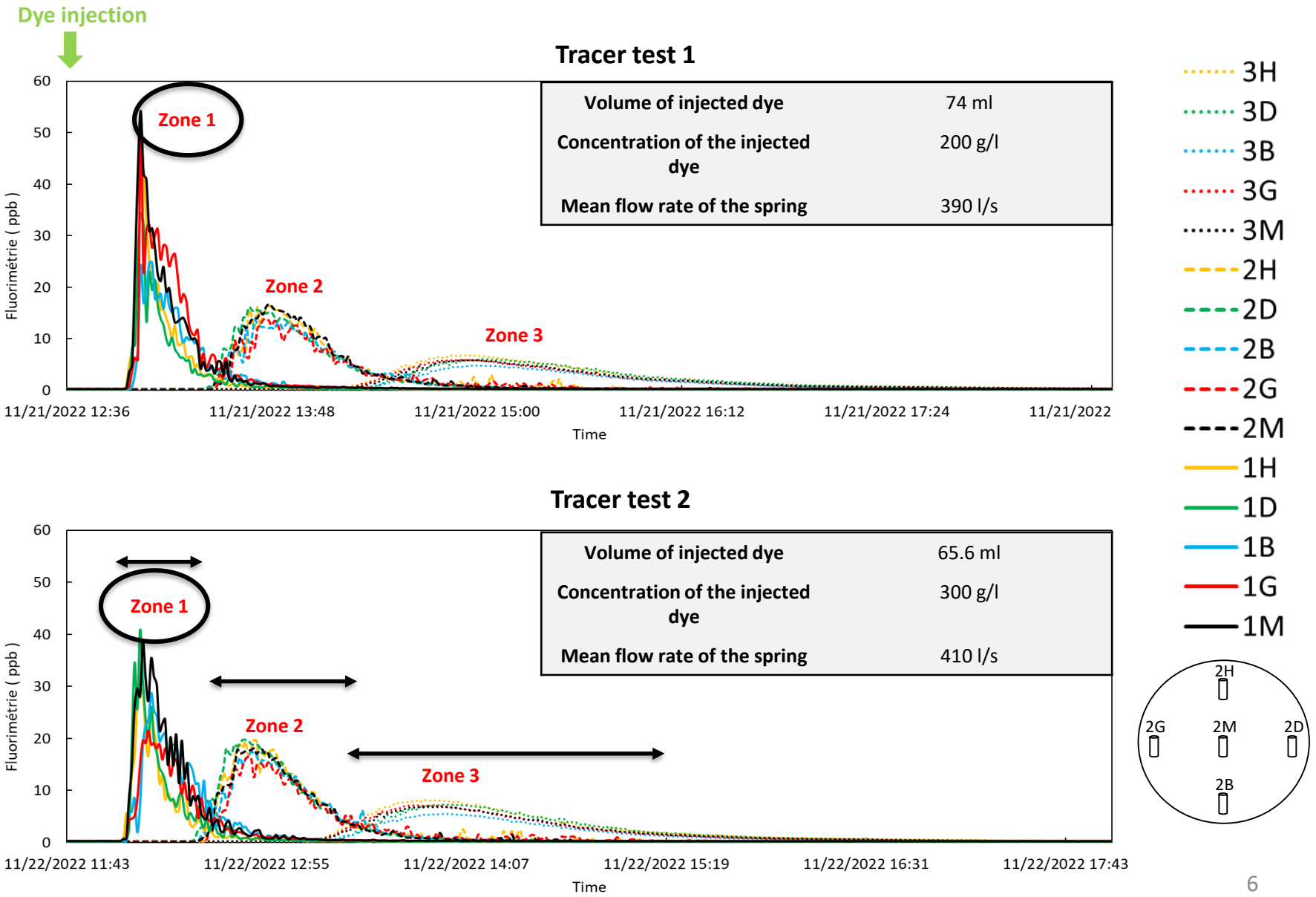


STREAM® - TRAQUA

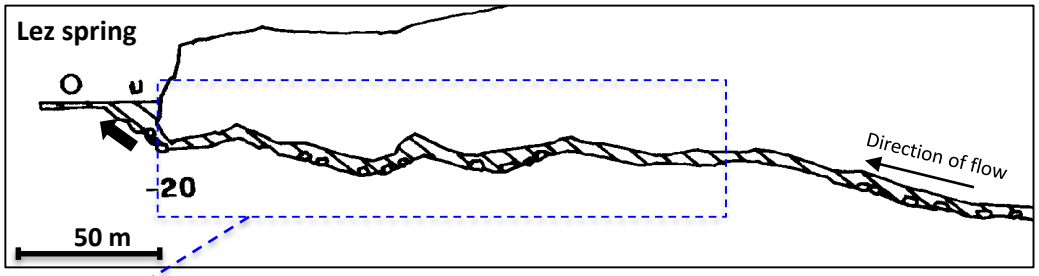


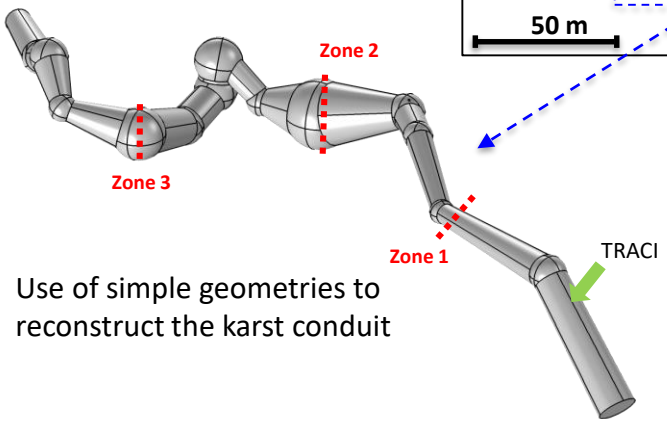
Few variation→ Constant flow rate considered for 3D flow modelling

COMPILATION OF TRACER TESTS RESULTS



NUMERICAL SIMULATION – SIMPLE CONDUIT GEOMETRY

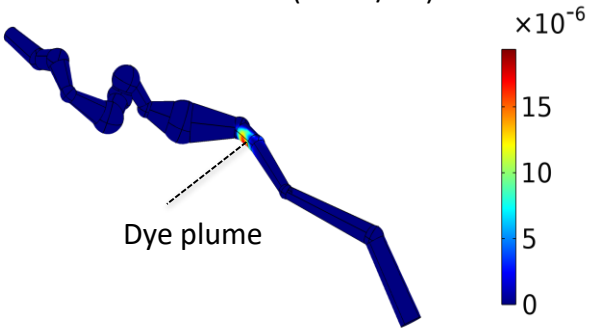


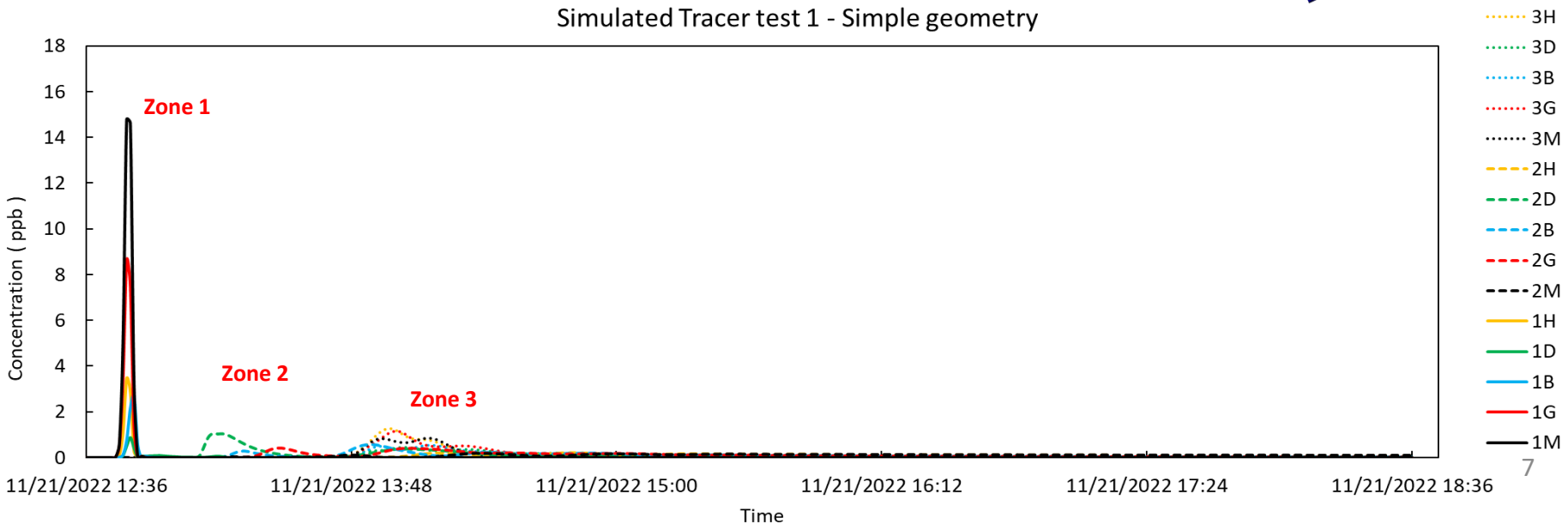


Use of simple geometries to reconstruct the karst conduit

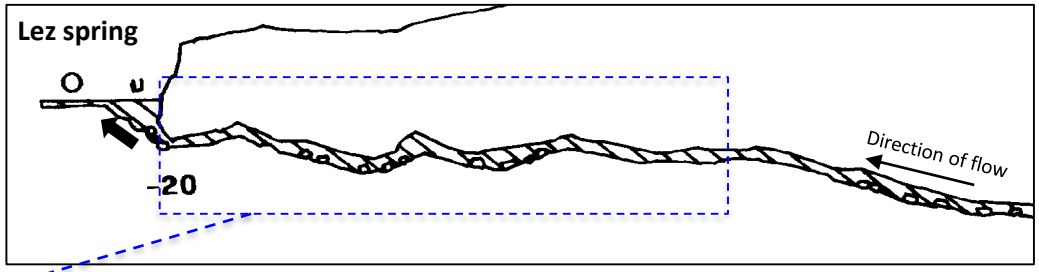
Simulate flow and transport

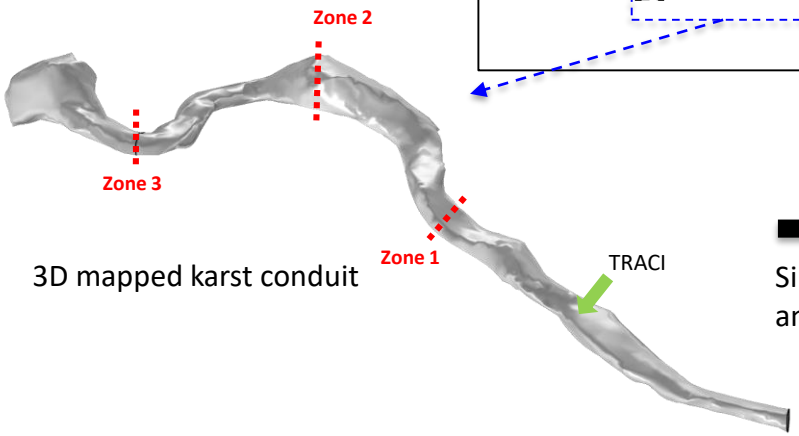
Concentration (mmol/m^3)





NUMERICAL SIMULATION – 3D MAPPED CONDUIT

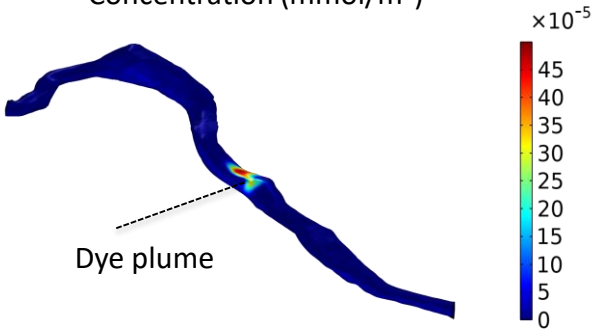




3D mapped karst conduit

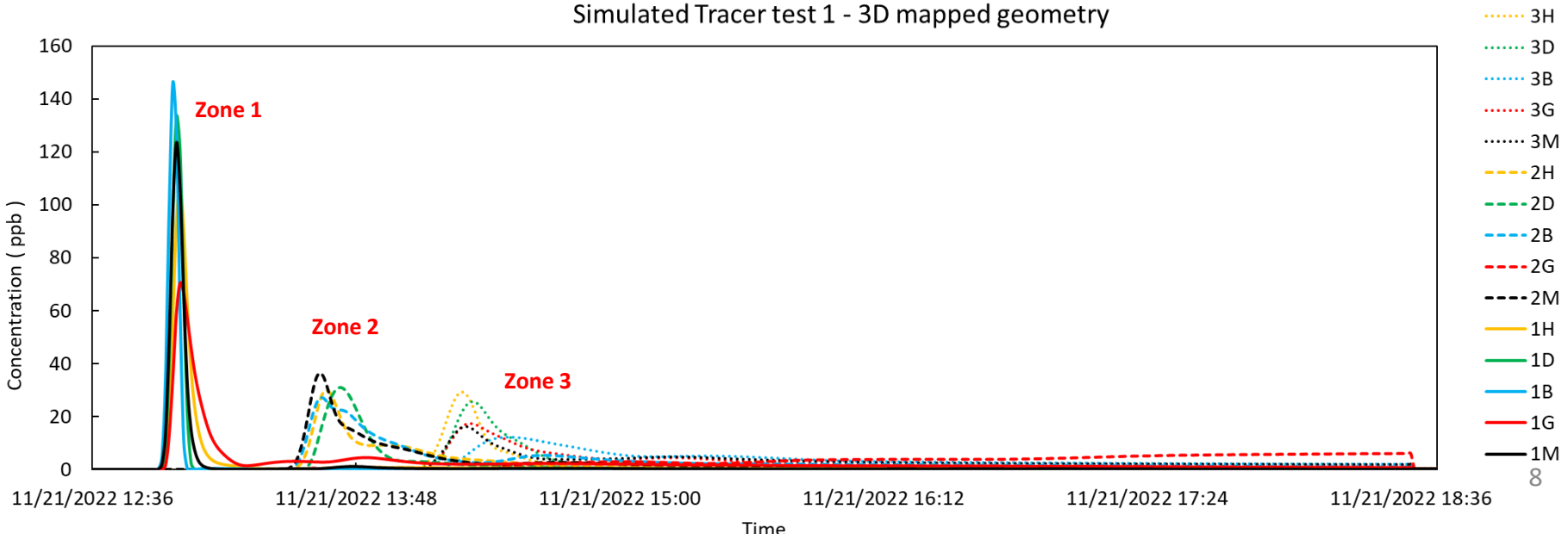
Simulate flow and transport

Concentration (mmol/m³)

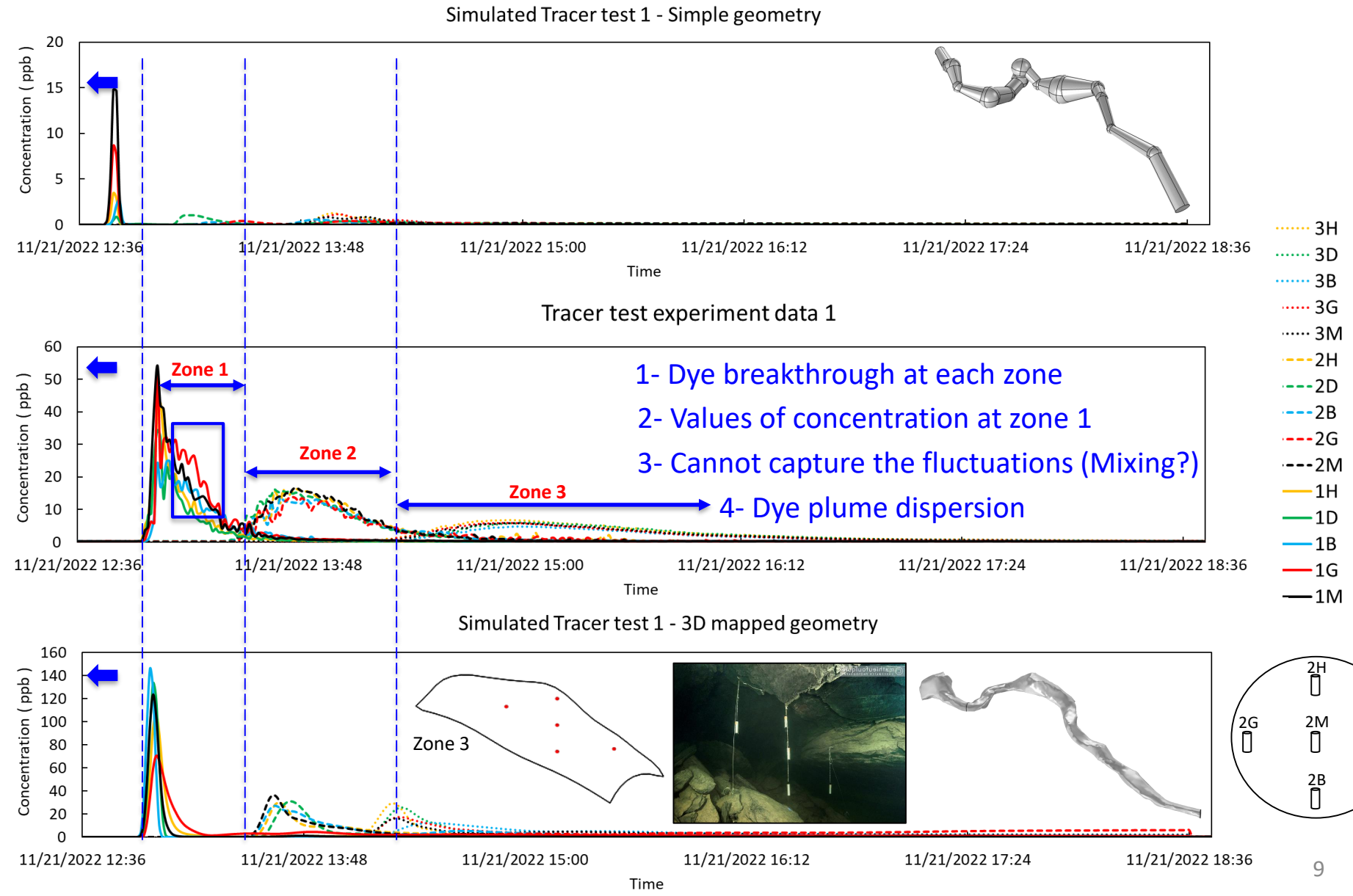


Dye plume

Simulated Tracer test 1 - 3D mapped geometry



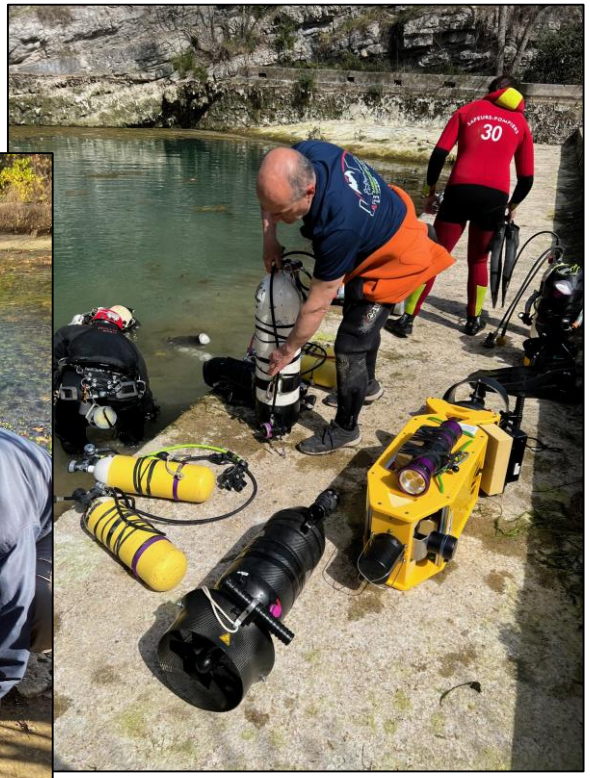
COMPARISON OF DIFFERENT RESULTS



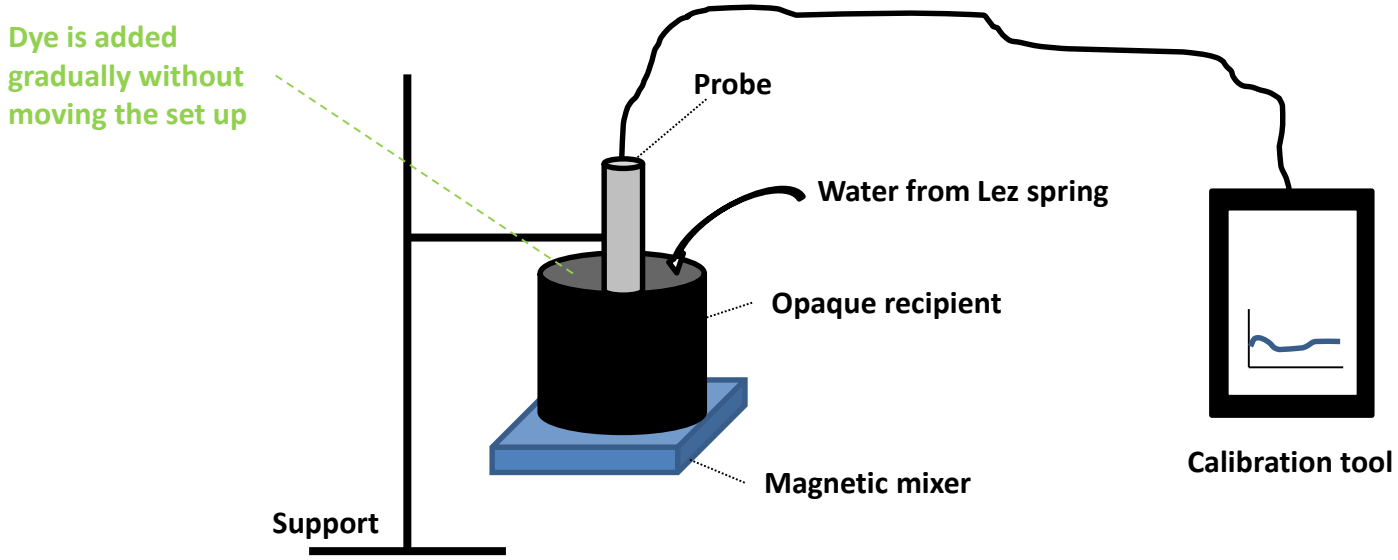
SUMMARY

- We mapped the terminal karst conduit of Lez spring in three dimensions where we performed a solute transport experiment.
- The spatial distribution of 15 probes allowed to reconstruct the evolution of the concentration plume during the tracer test.
- Comparison between observed tracer test data and numerical simulations showed the importance of conduit morphology and geometry on controlling flow and solute transport.
- Knowing the morphology of the karst conduit as well as the exact location of the monitoring points is relevant to reproduce transport processes at the kilometric scale. Thus, further investigation (i.e. Tracer test 2 data, conduit wall asperity, …) is required.

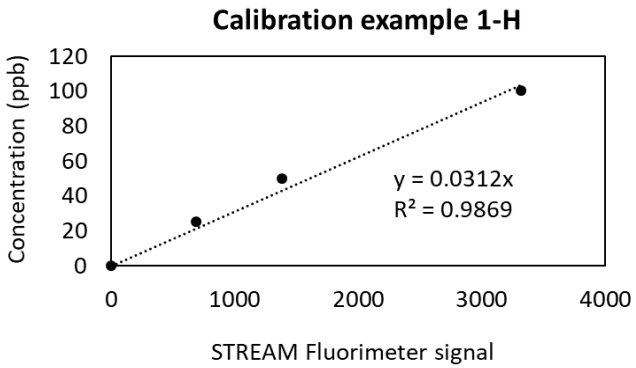
Thank you!



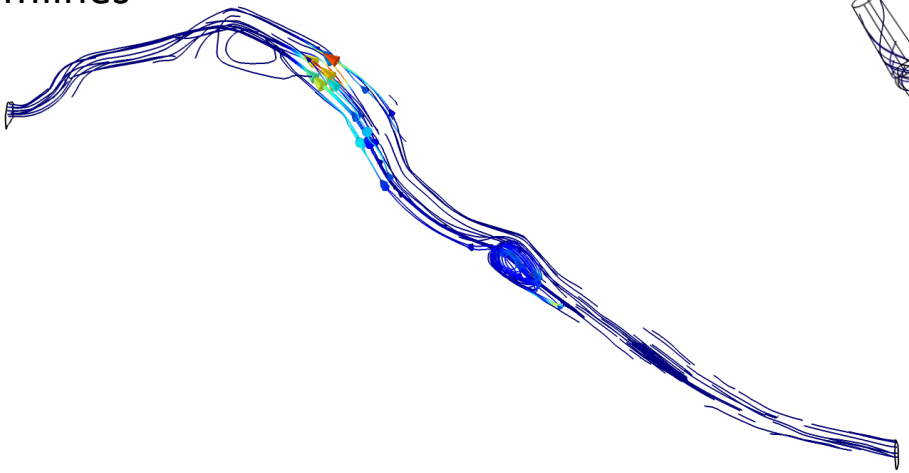
PROBES CALIBRATION



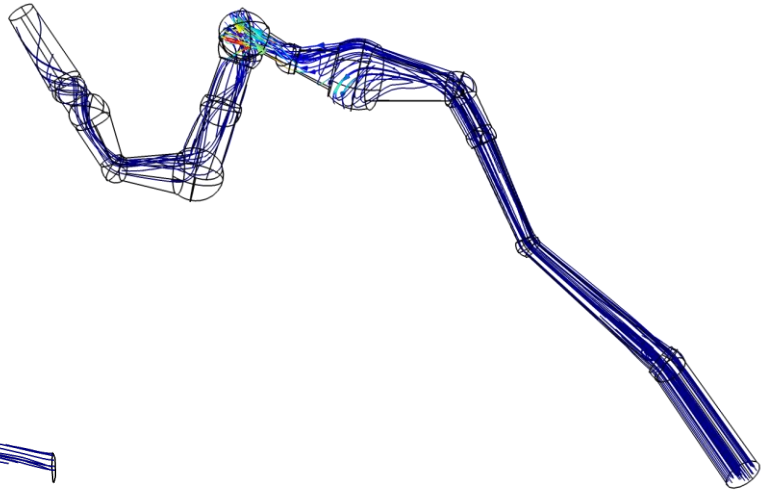
Parameter	Concentration (ppb)
For offset	0
Measurement 1	25
Measurement 2	50
Measurement 3	100



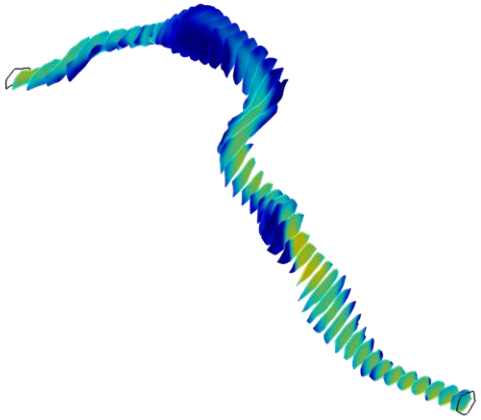
3D mapped conduit – Concentration streamlines



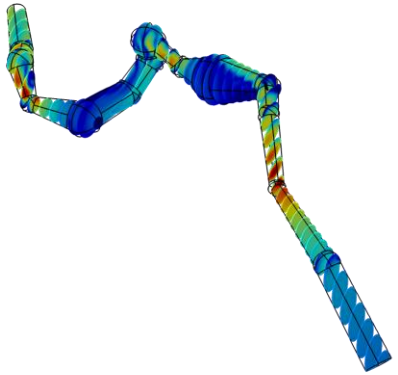
Simple geometry – Concentration streamlines



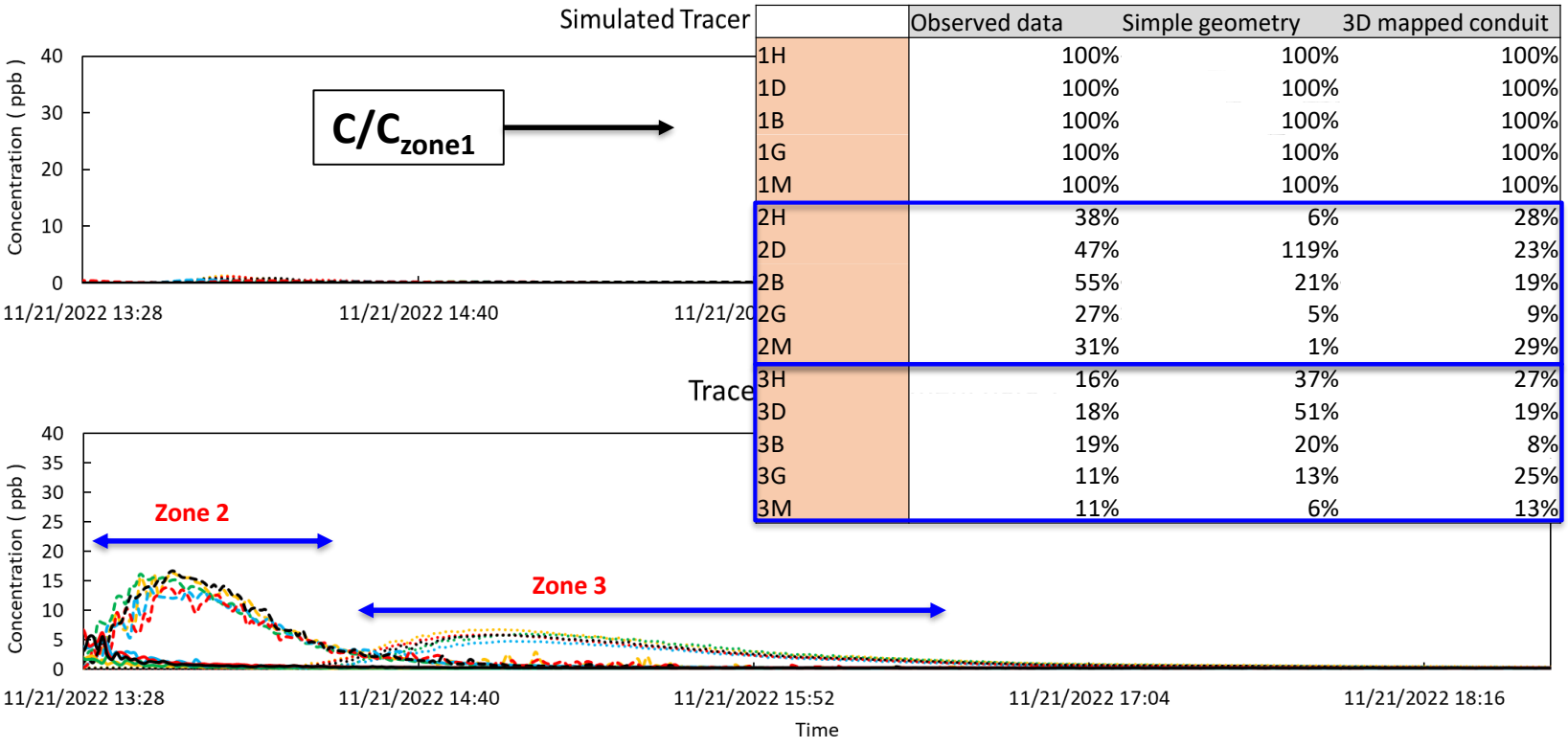
Time=21600 s Slice: Velocity magnitude (m/s)



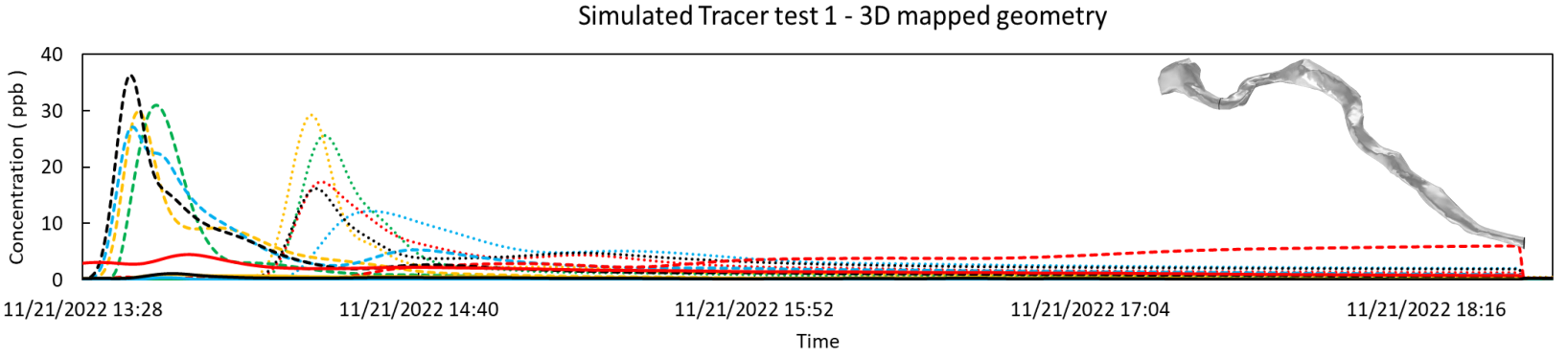
Time=21600 s Slice: Velocity magnitude (m/s)

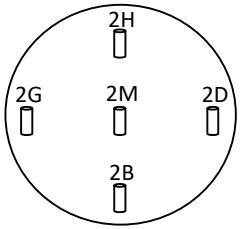


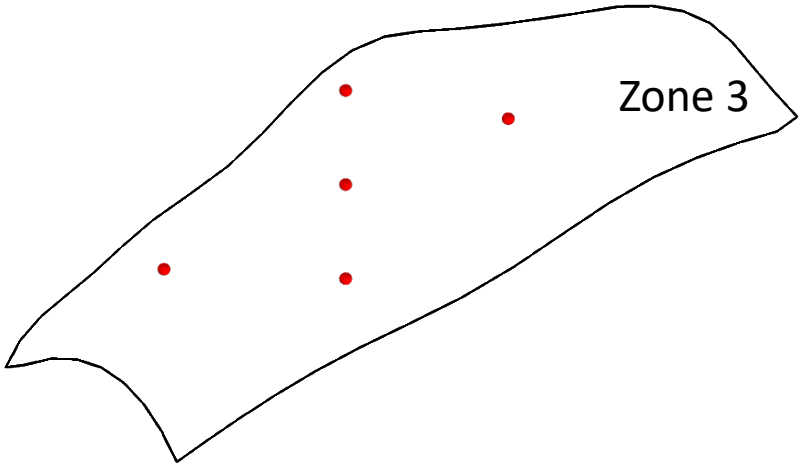
COMPARISON OF DIFFERENT RESULTS

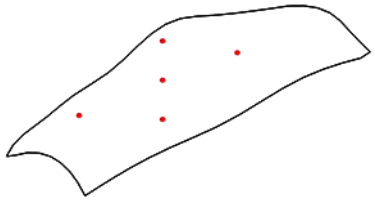


	Observed data	Simple geometry	3D mapped conduit
1H	100%	100%	100%
1D	100%	100%	100%
1B	100%	100%	100%
1G	100%	100%	100%
1M	100%	100%	100%
2H	38%	6%	28%
2D	47%	119%	23%
2B	55%	21%	19%
2G	27%	5%	9%
2M	31%	1%	29%
3H	16%	37%	27%
3D	18%	51%	19%
3B	19%	20%	8%
3G	11%	13%	25%
3M	11%	6%	13%






Zone 3



Zone 3

	Observed data	Simple geometry	3D mapped conduit
1H	100%	100%	100%
1D	100%	100%	100%
1B	100%	100%	100%
1G	100%	100%	100%
1M	100%	100%	100%
2H	38%	6%	28%
2D	47%	119%	23%
2B	55%	21%	19%
2G	27%	5%	9%
2M	31%	1%	29%
3H	16%	37%	27%
3D	18%	51%	19%
3B	19%	20%	8%
3G	11%	13%	25%
3M	11%	6%	13%

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