Experimental assessment and prediction of short-term ATES for DSM applications

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FP102

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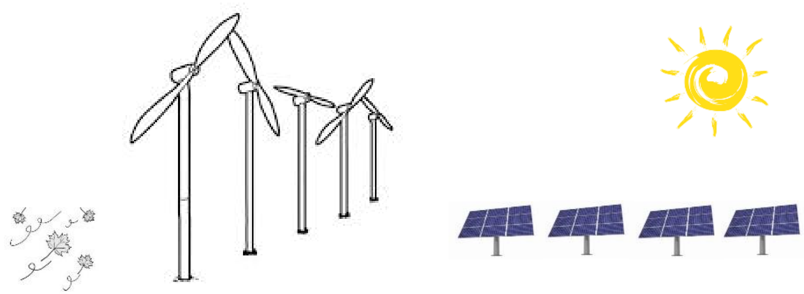
Experimental assessment and prediction of short-term ATES for DSM applications

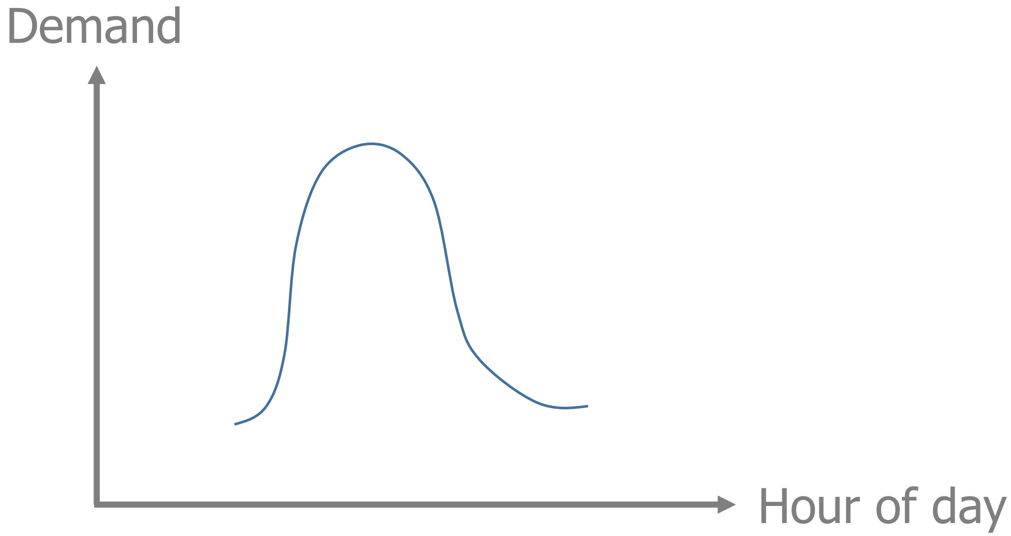


Energy production

must be in balance with

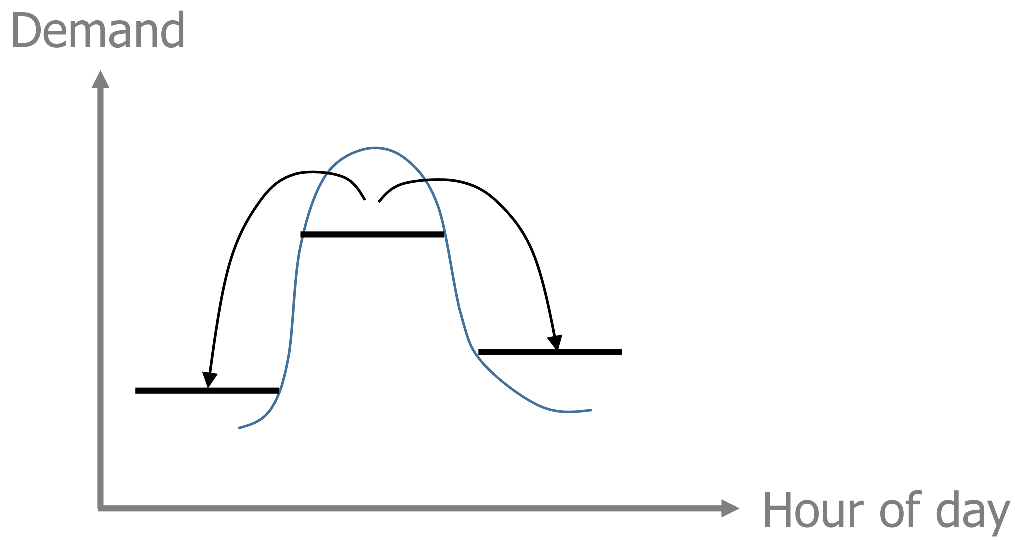
energy consumption

Experimental assessment and prediction of short-term ATES for DSM applications



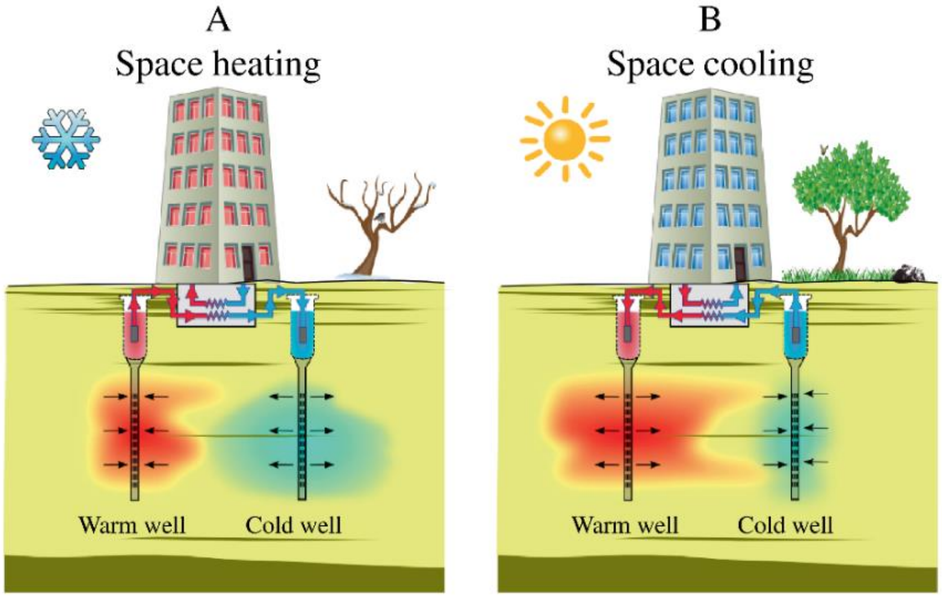
DSM is Demand Side Management

Experimental assessment and prediction of short-term ATES for DSM applications



an example of load-shifting

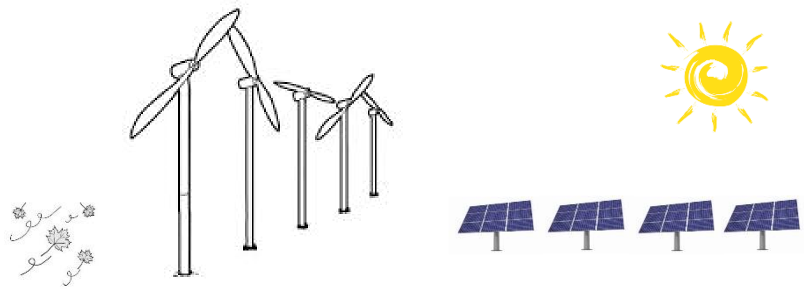
Experimental assessment and prediction of short-term ATES for DSM applications



Modified after Bonte (2013)

ATES is Aquifer Thermal Energy Storage
It is mainly seasonal so far

Why using ATES for DSM applications?



energy production

GWHP produces heat but consumes electricity

energy consumption

Experimental assessment and prediction of short-term ATES for DSM applications

DSM frequencies comprises
real-time, intraday, and interday too

&

The longer we wait, the less we recover!

&

Exergy

Experimental assessment

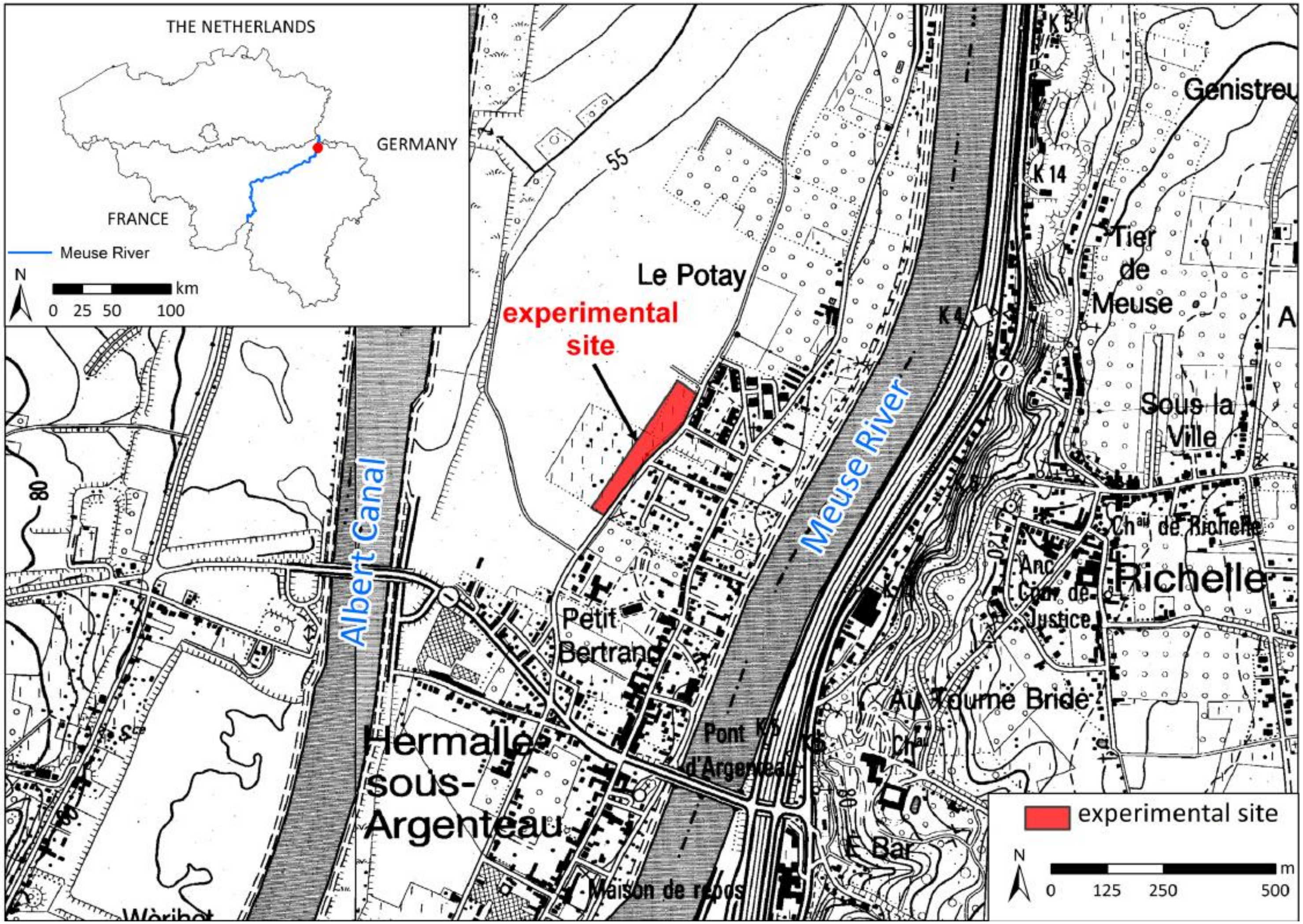
Experimental prediction

only alluvial aquifers are considered

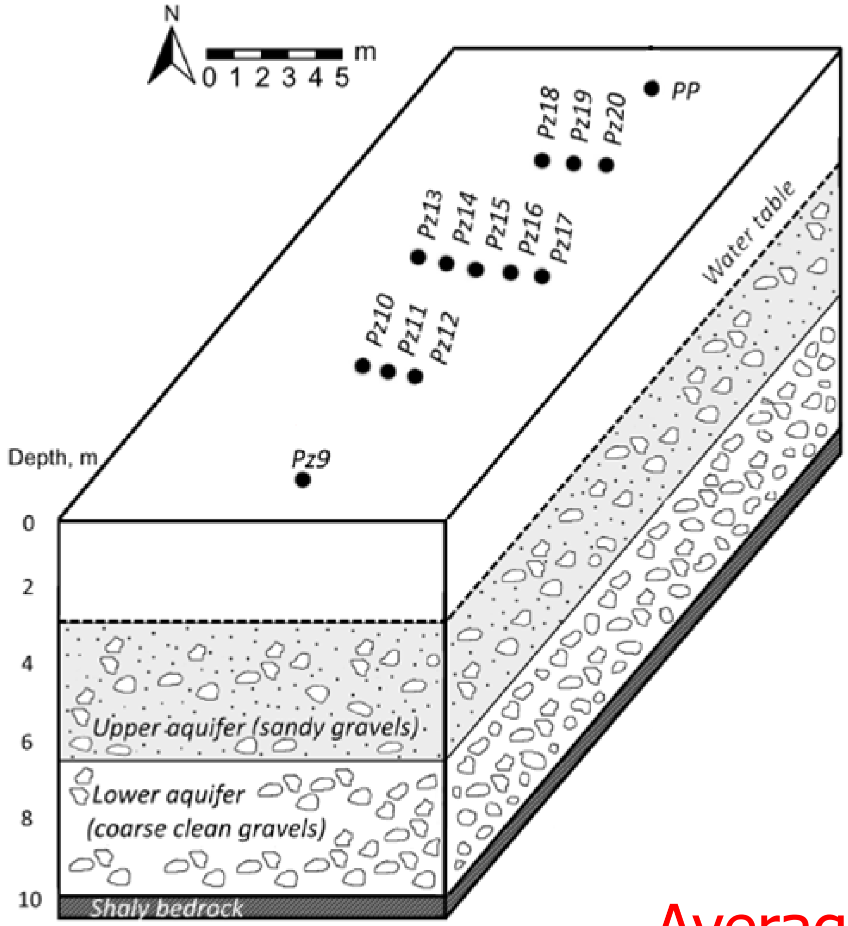
Experimental assessment

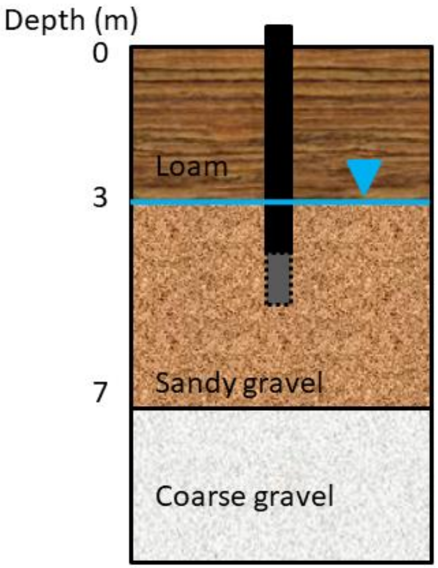
Experimental prediction

Case study one: HssA



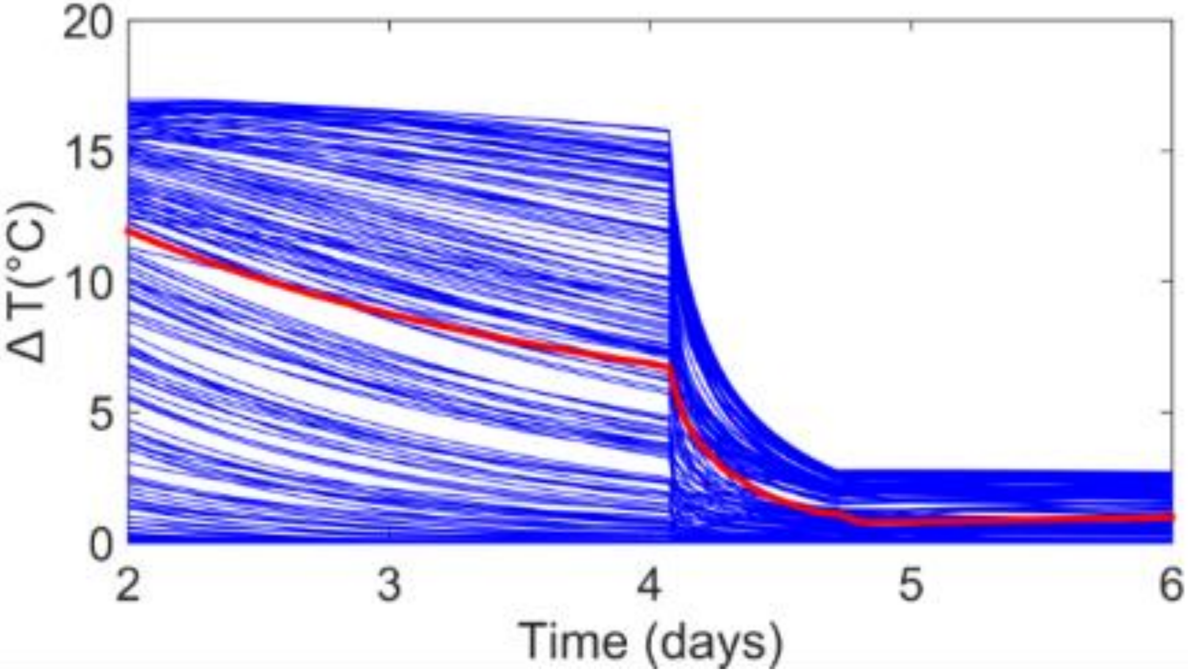
HssA: push/pull tests in Pz15 upper layer



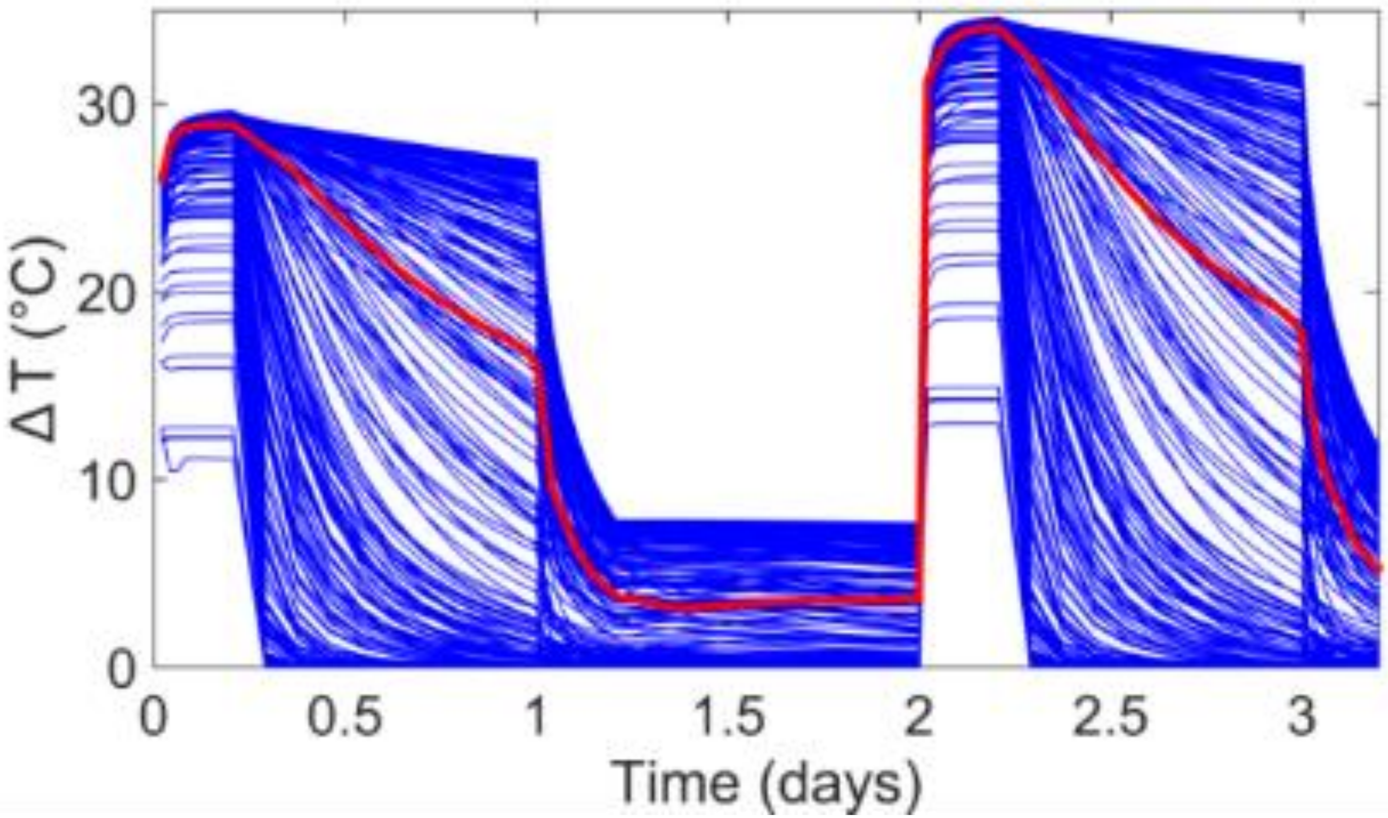


Average fluxes ~ 20m/day

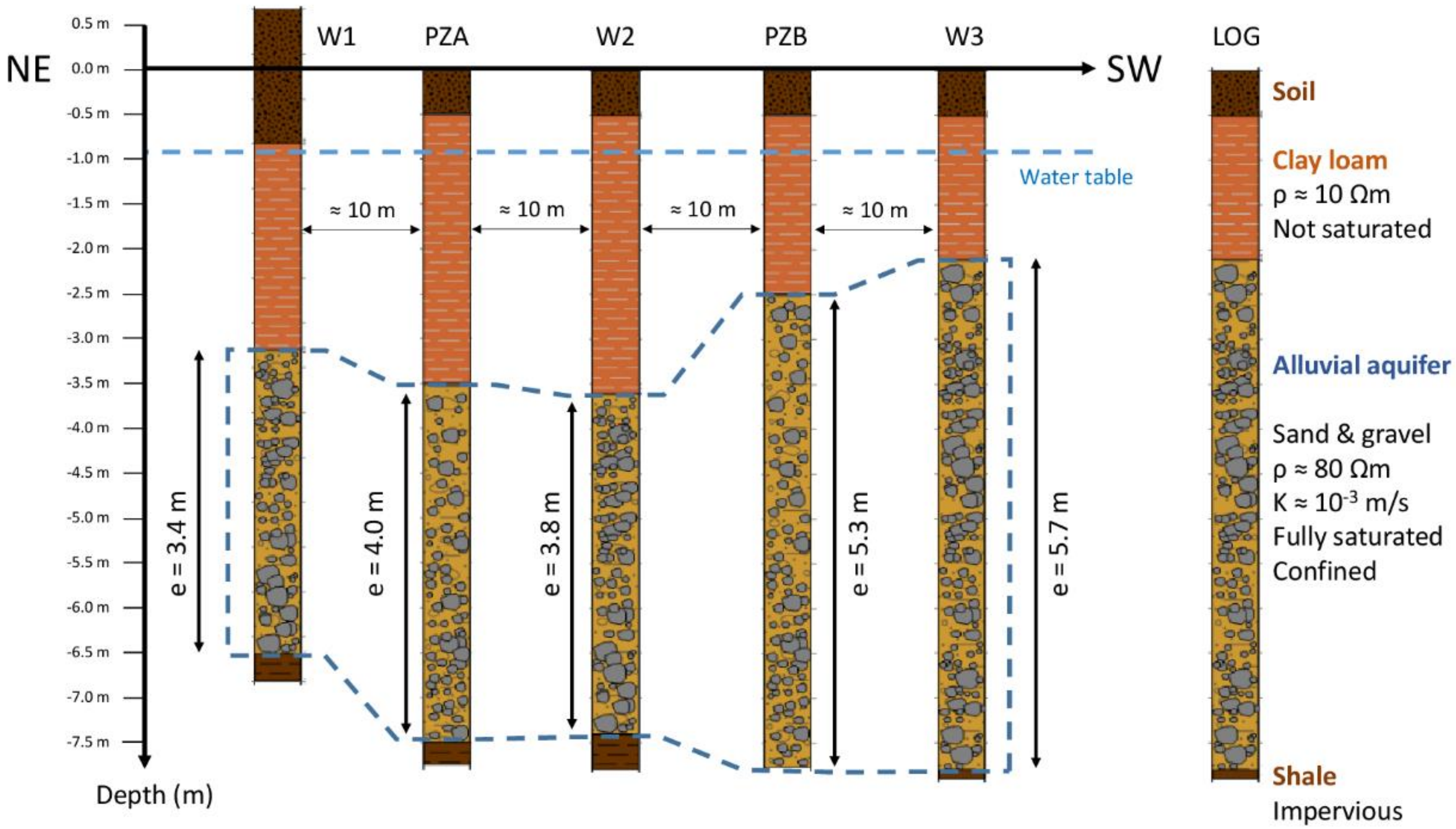
HssA: test 1 = storage phase lasted 4d



HssA: test 2 = storage phase lasted 19h

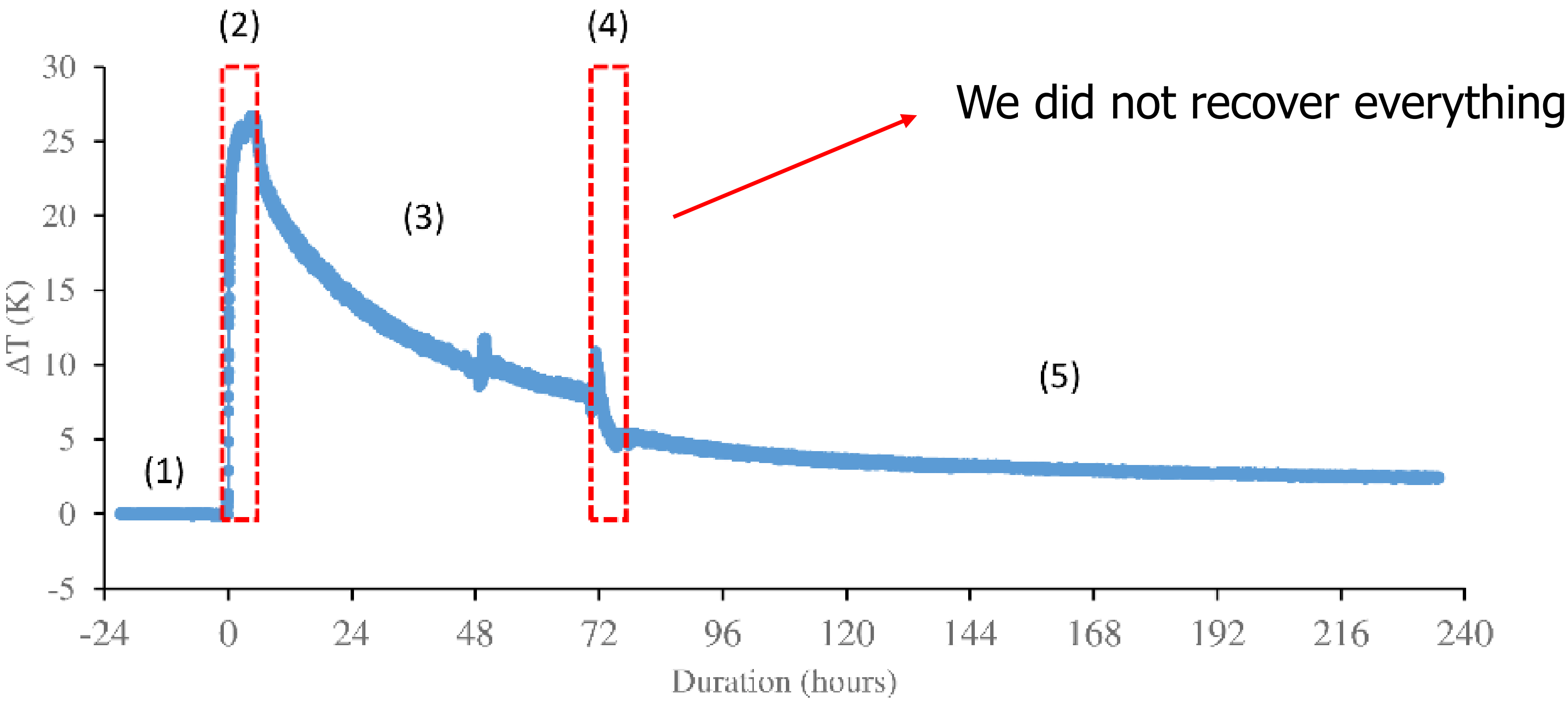


Case study two: JSS



Average fluxes < 1m/day

JSS: 1 test with a storage phase of 3d



Energy recovery summary

Storage duration → Site	19 hours	72 hours	91 hours
JSS	-	75 % (16 m³ injected, 37 m³ pumped) Up to 90 % with higher pumped volume	-
HSSA, upper layer			25 % (18 m³ injected, 37 m³ pumped)

GW fluxes difference:
< 1m/d JSS and ~20 m/d HSSA top

Energy recovery summary

Storage duration → Site	19 hours	72 hours	91 hours
JSS	-	75 % (16 m^3 injected, 37 m^3 pumped) Up to 90 % with higher pumped volume	-
HSSA, upper layer	35 % for cycle 1 (15 m^3 injected, 25 m^3 pumped) 43 % for cycle 2 (15 m^3 injected, 25 m^3 pumped)	-	25 % (18 m^3 injected, 37 m^3 pumped) 37 % (18 m^3 injected, 78 m^3 pumped)

Energy recovery summary

Storage duration → Site	19 hours	72 hours	91 hours
JSS	-	75 % (16 m³ injected, 37 m³ pumped) Up to 90 % with higher pumped volume	-
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Exergy summary

Storage duration → **Site**	**19 hours**	**72 hours**	**91 hours**
JSS	-	ΔT from 12 to 5 K	-
HSSA, upper layer	ΔT from 18 to 7 K	-	ΔT from 7 to 2 K

The longer we wait, the less we recover!

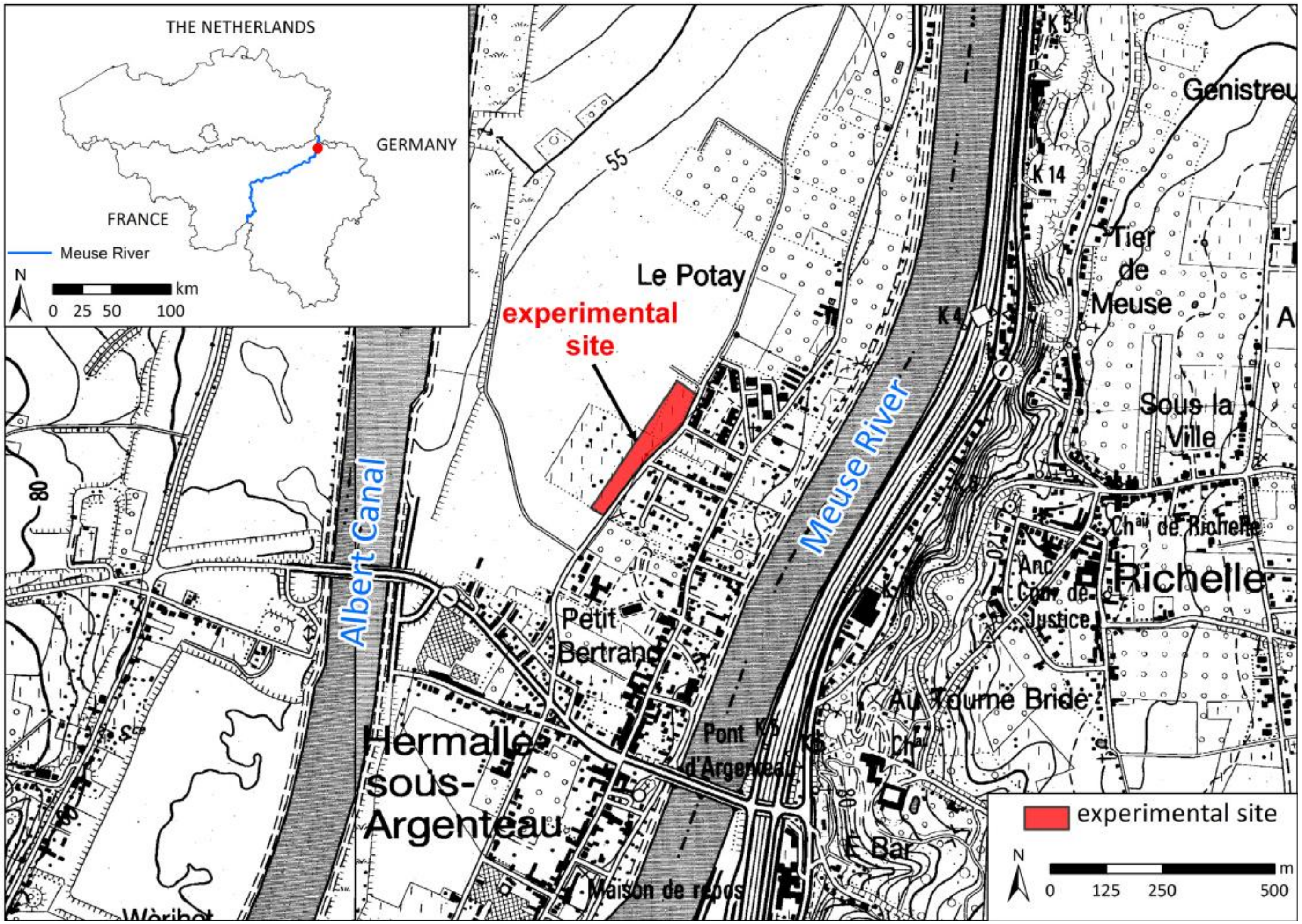
&

The longer we pump, the lower is the exergy

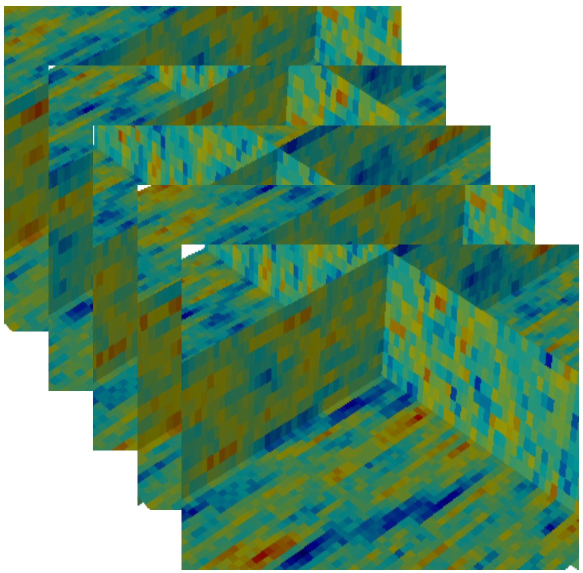
Experimental assessment

Experimental prediction

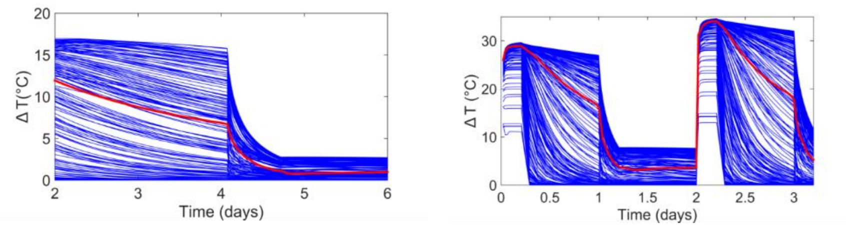
The HssA site is used again



We used BEL to simulate ATES with 500 surrogate models



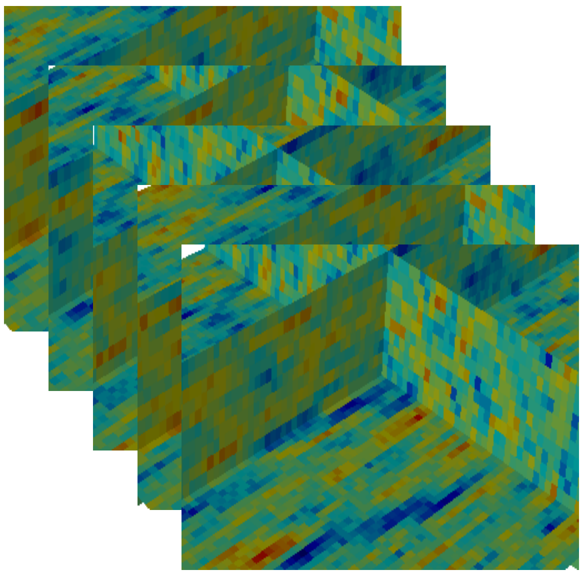
heat push/pull tests

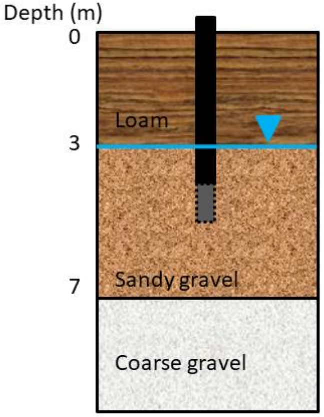


Evaluation of energy recovery and exergy

Exp. prediction?

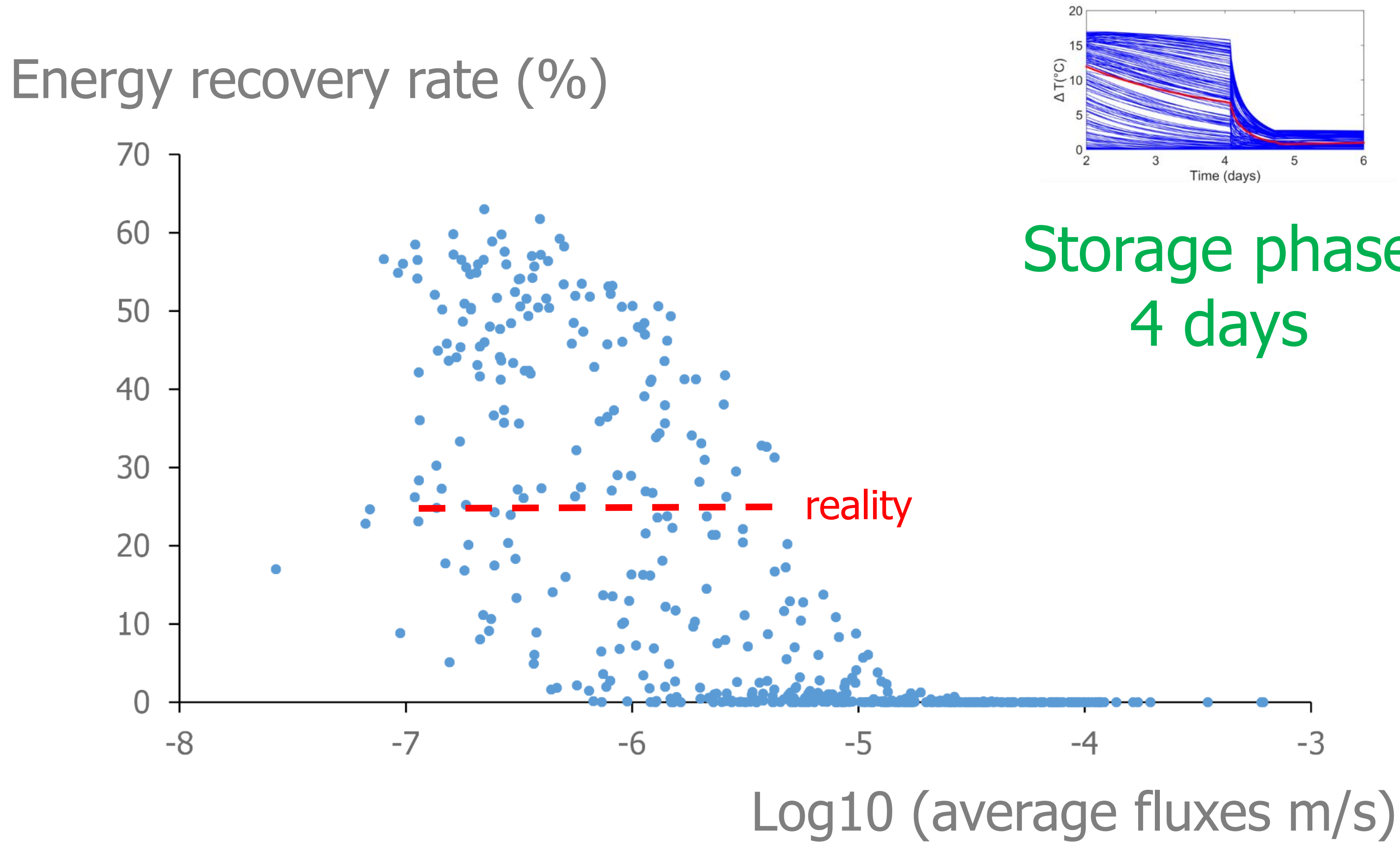
We used the same prior information as for the last talk





Mean of log_{10} K (m/s)	U[-4 -1]
Variance log_{10} K (m/s)	U[0.05 2]
Range (m)	U[1 10]
Anisotropy ratio	U[0.1 0.5]
Orientation	U[0 π]
Porosity	U[0.05 0.30]
Gradient (%)	U[0.083 0.167]

A trend exists between average GW fluxes and energy recovery rates



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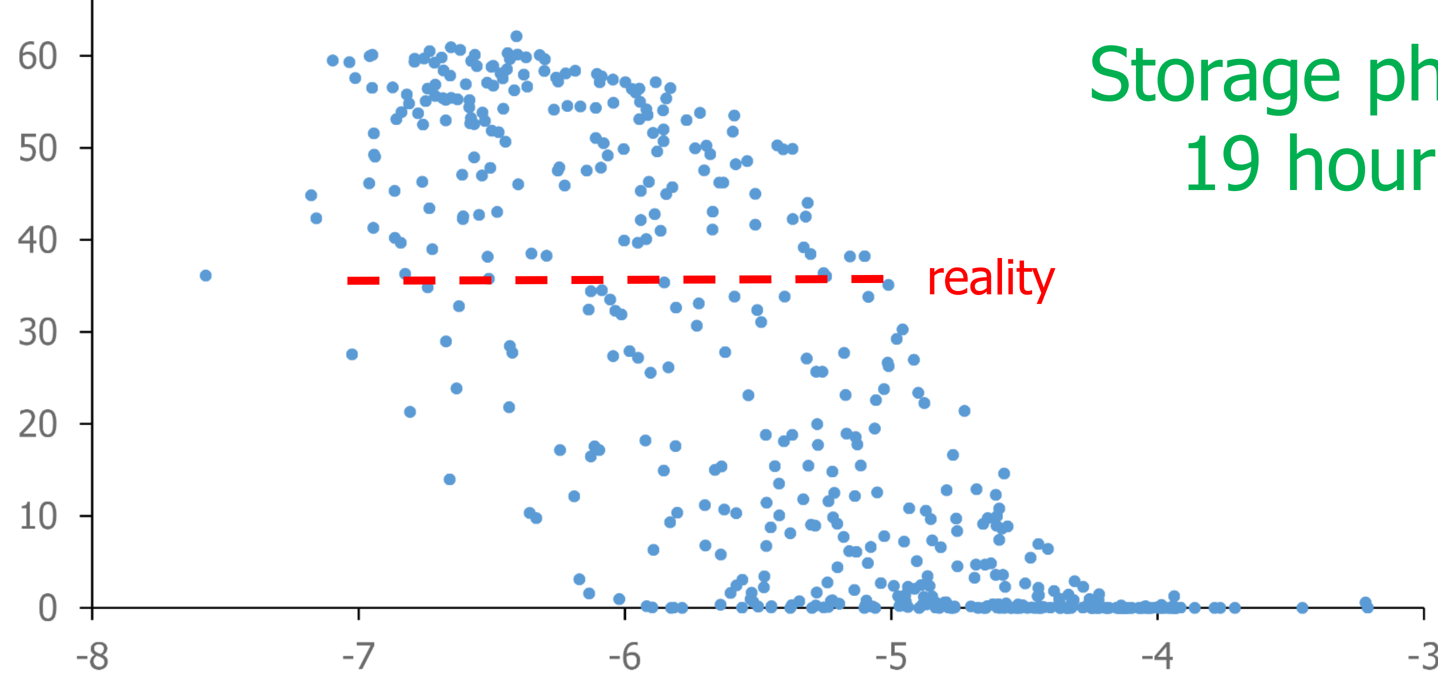
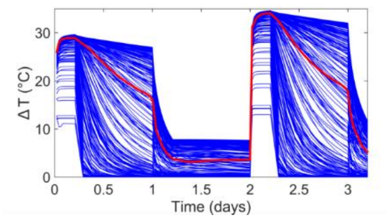
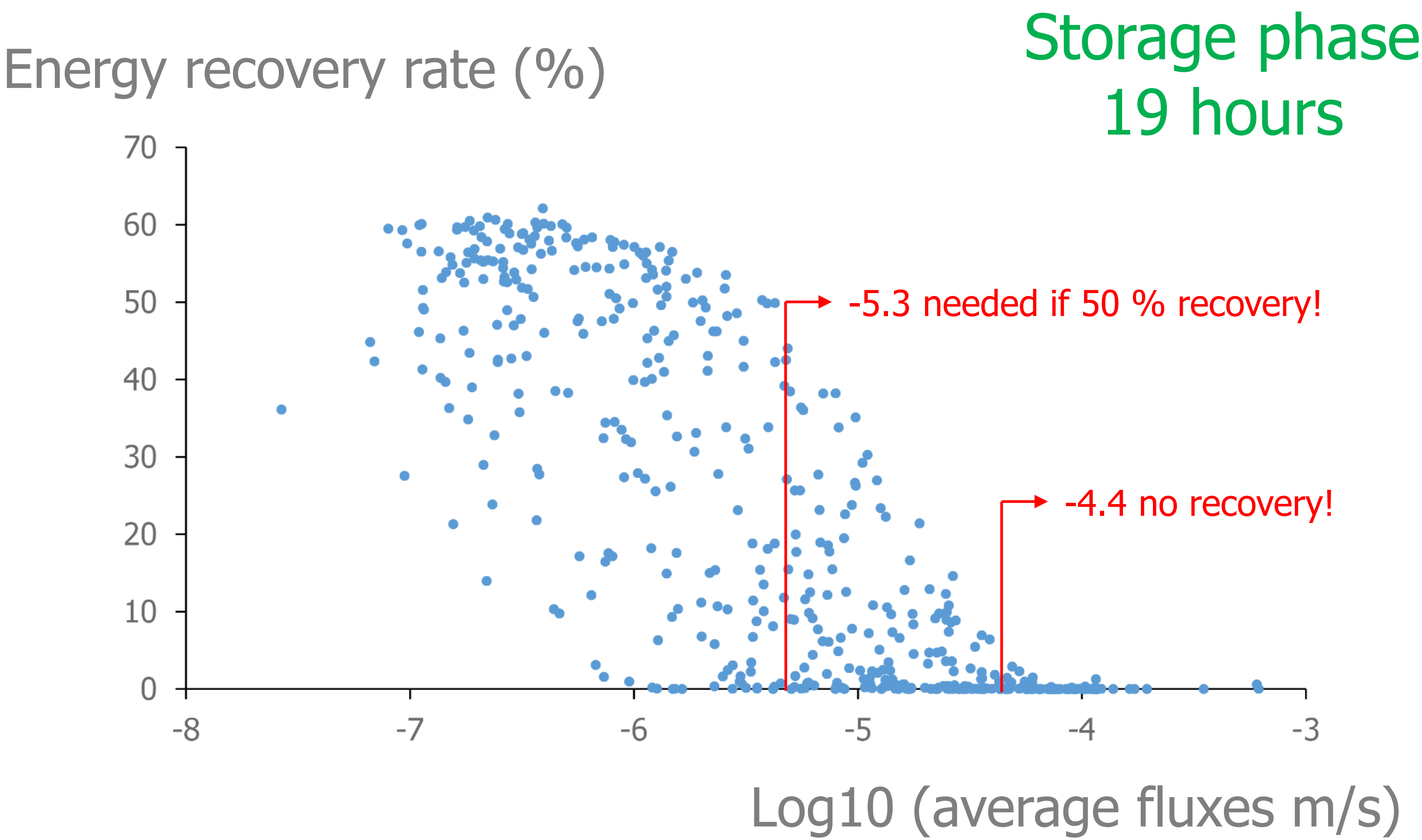




Storage phase
19 hours

This trend could be used to predict
a range of energy recovery rates
for every DSM frequencies
if you have an idea about average GW fluxes

To specify cut-off on fluxes for which ATES is not suitable



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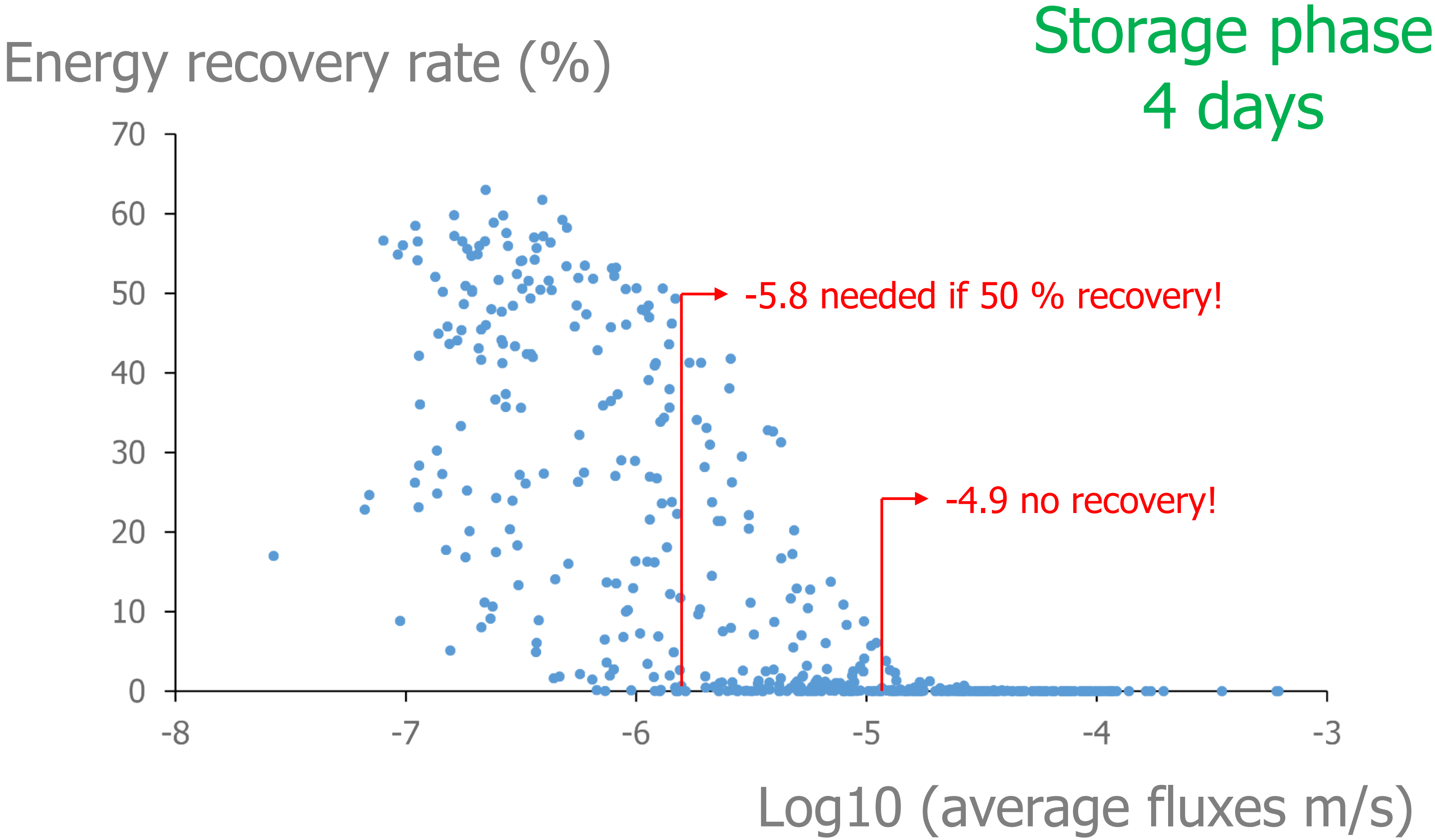

Experimental assessment and prediction of short-term ATES for DSM applications?

The longer we wait,
the less we recover!

The slower groundwater flows,
the most we recover!

Exergy is higher with short-term ATES

DSM is potentially feasible for all ATES
but not for all frequencies

Any questions?

Groundwater Quality 2019
The next IAHS conference on Groundwater Quality (**GQ 2019**) will be held in Liège (Belgium) on 9-12 September 2019 !
With the support of IAH, NICOLE, UK CL:AIRE and EU H2020 ITN iNSPIRATION

More information : **aimontefiore.org/GQ2019**
Contact: c.dizier@aim-association.org – serge.brouyere@uliege.be

Can short-term hydrogeological experiments predict the long-term behavior of subsurface reservoirs?

An example from shallow geothermy

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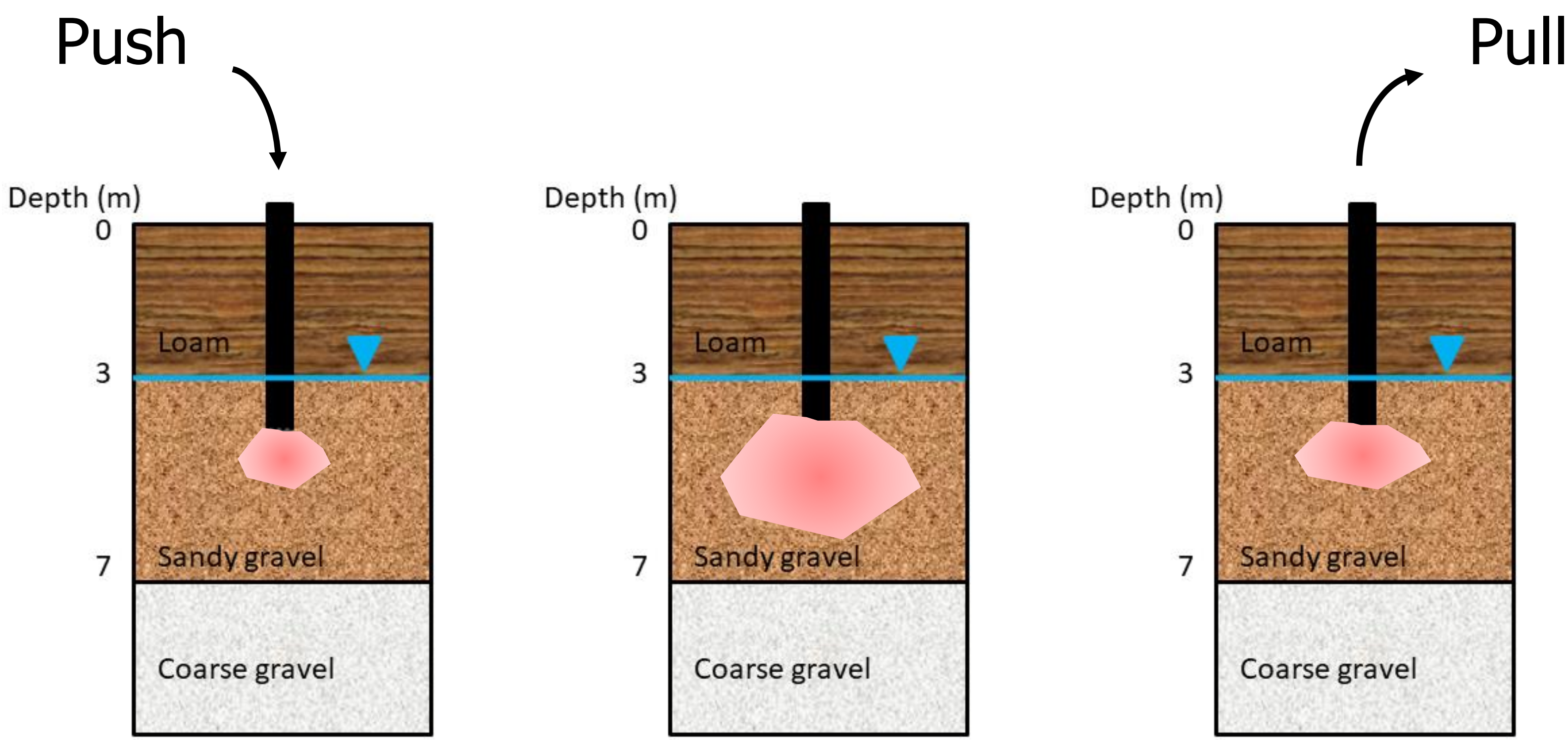
Additional slides

An interday frequency

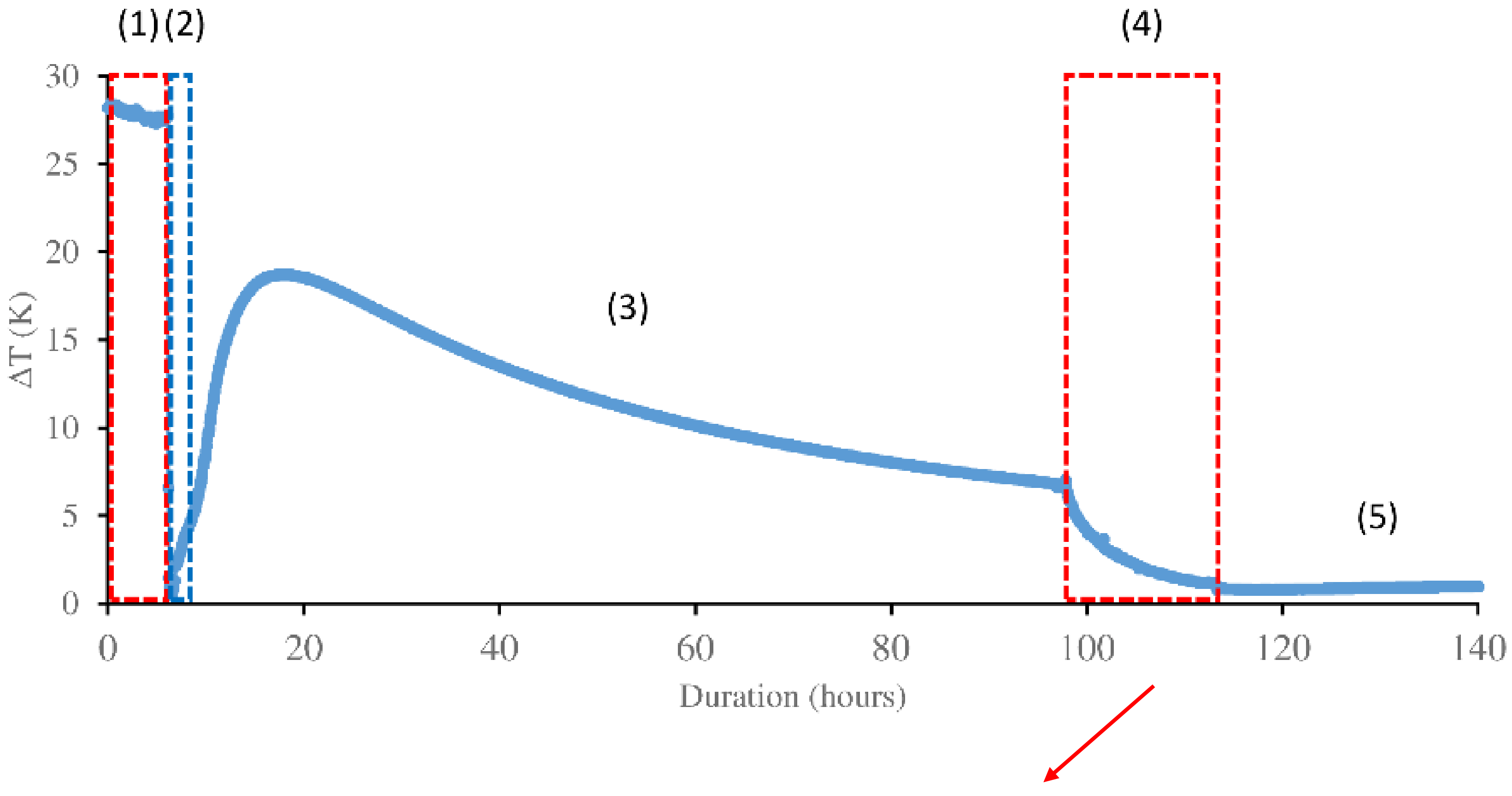


$+3m^3/h$ for 6h
$\Delta T=30K$

Storage phase
4 days

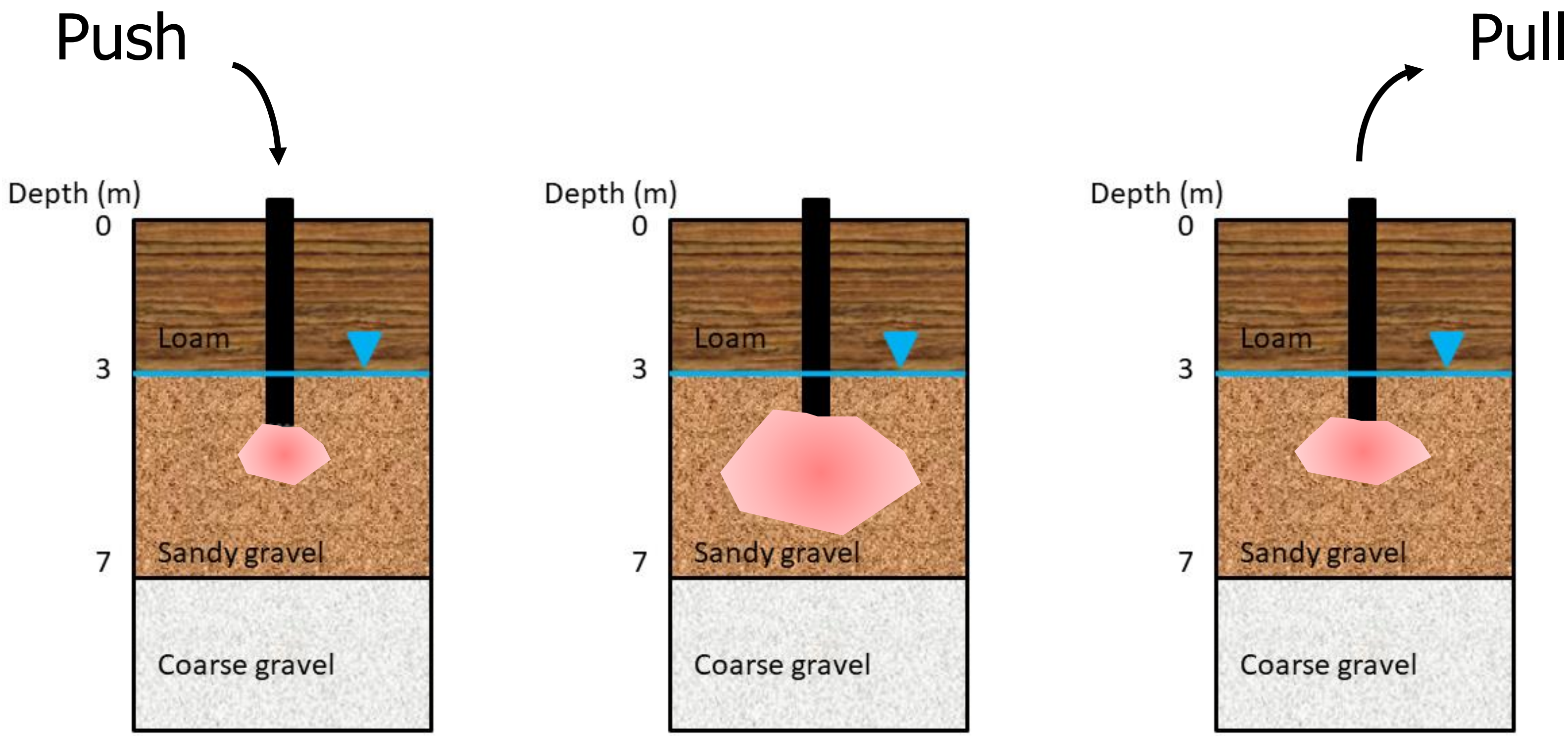
$-5m^3/h$ for 16h
T = data

HssA: test 1 = storage phase lasted 4d



We tried to recover everything

An intraday frequency

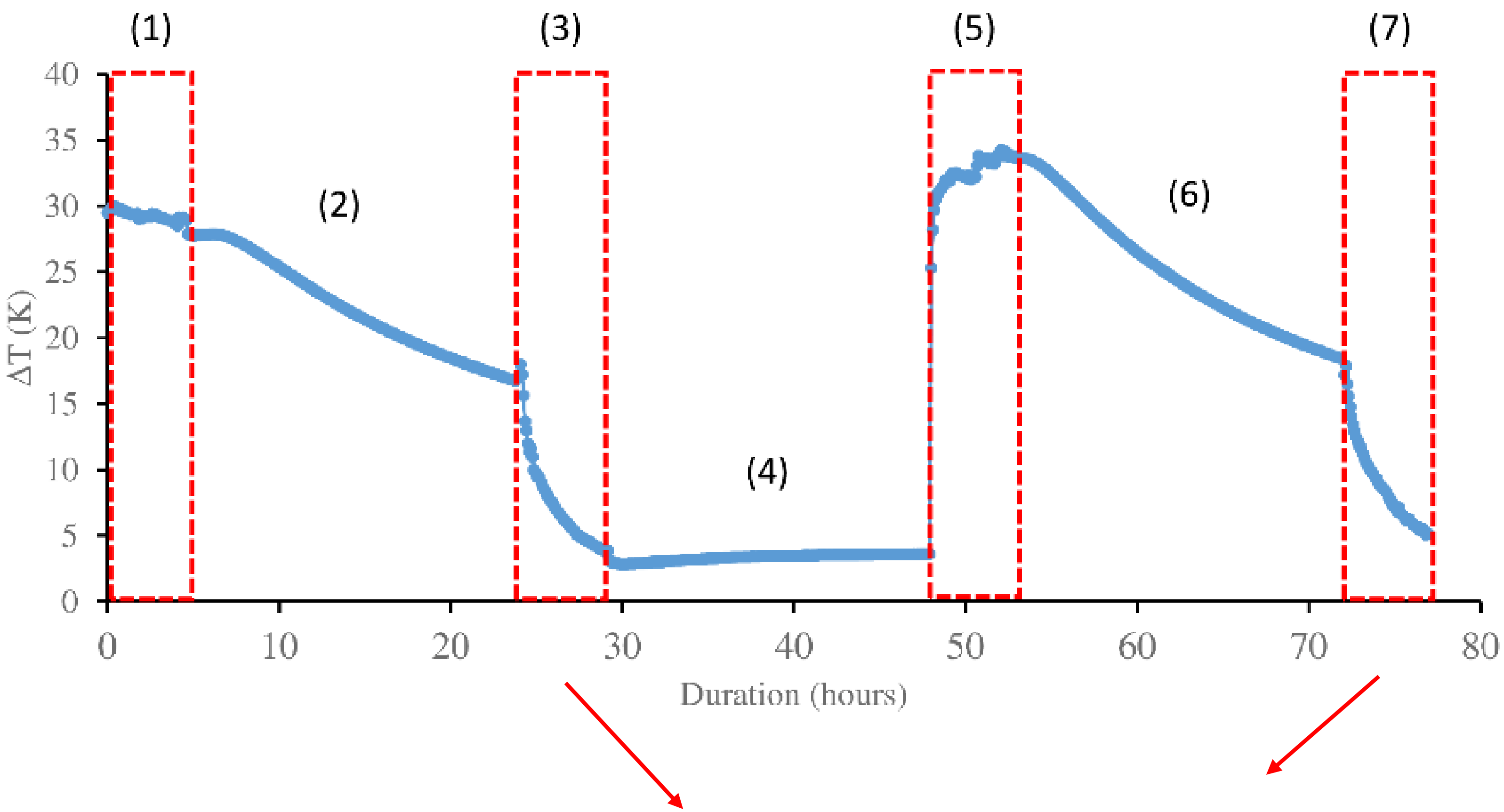


+3m³/h for 5h
ΔT=30K

Storage phase
19 hours

-5m³/h for 5h
T = data

HssA: test 2 = storage phase lasted 19h



We did not try to recover everything