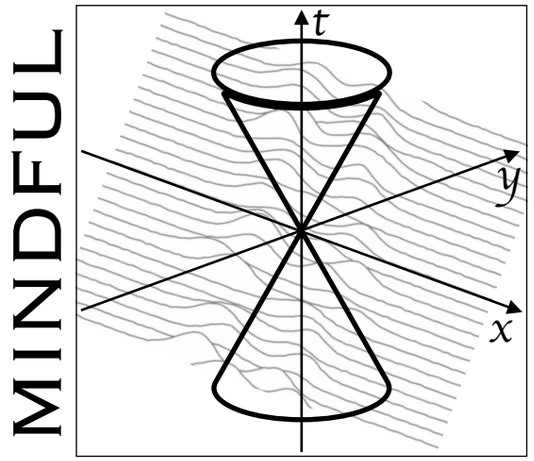
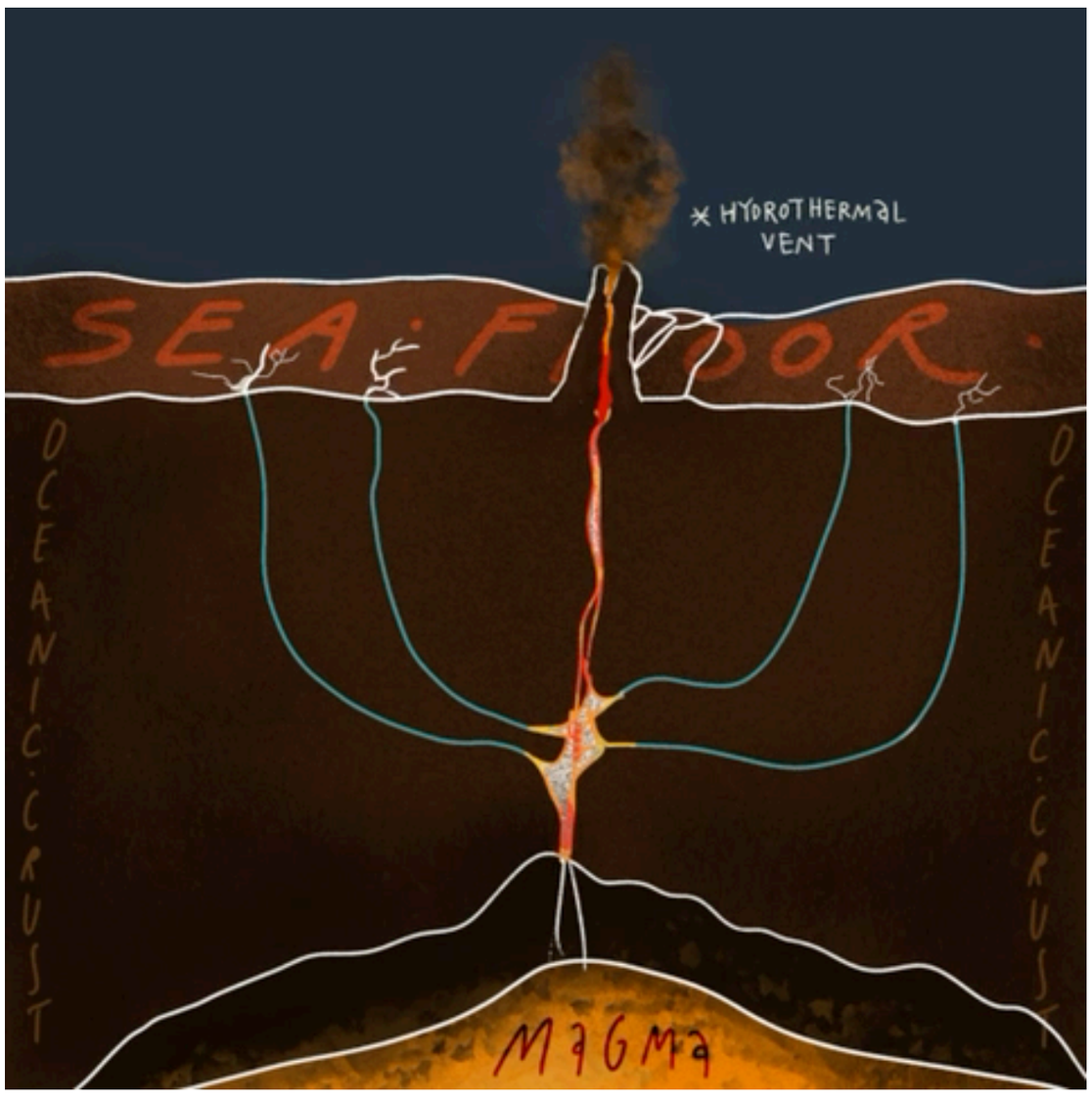
MINDFUL

Multi-scale Investigation of Hydrothermal Fluxes and Associated Life Habitats



T. Barreyre and C. Cathalot (Geo-Ocean), M. Matabos (BEEP), and G. Roullet (LOPS)

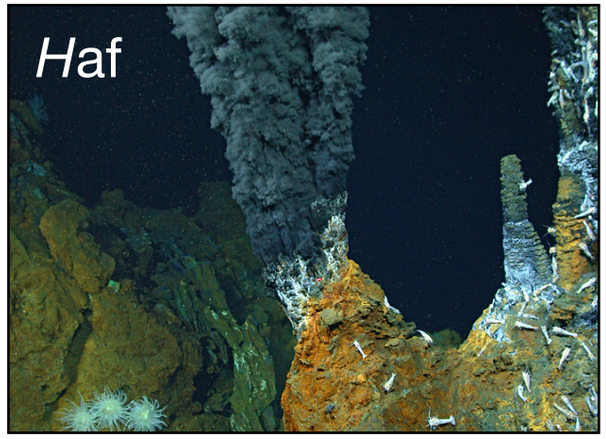


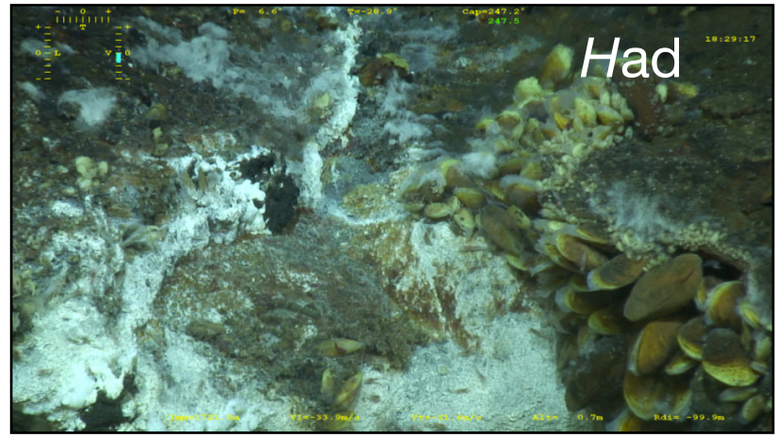
Project's research objectives

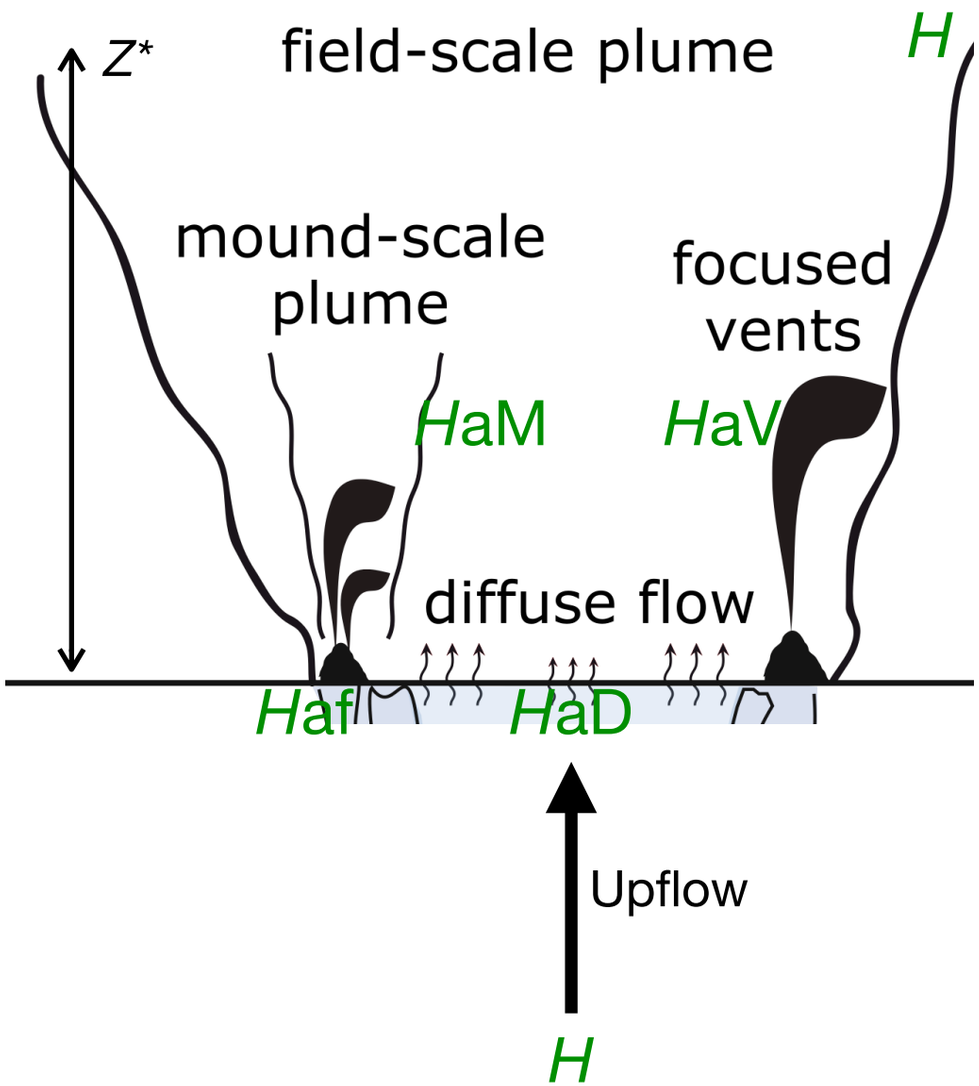
- Quantifying thermo-chemical output across spatial scales
- Assessing the temporal variability of hydrothermal output
- Estimating the correlation between fluxes and habitat functional groups

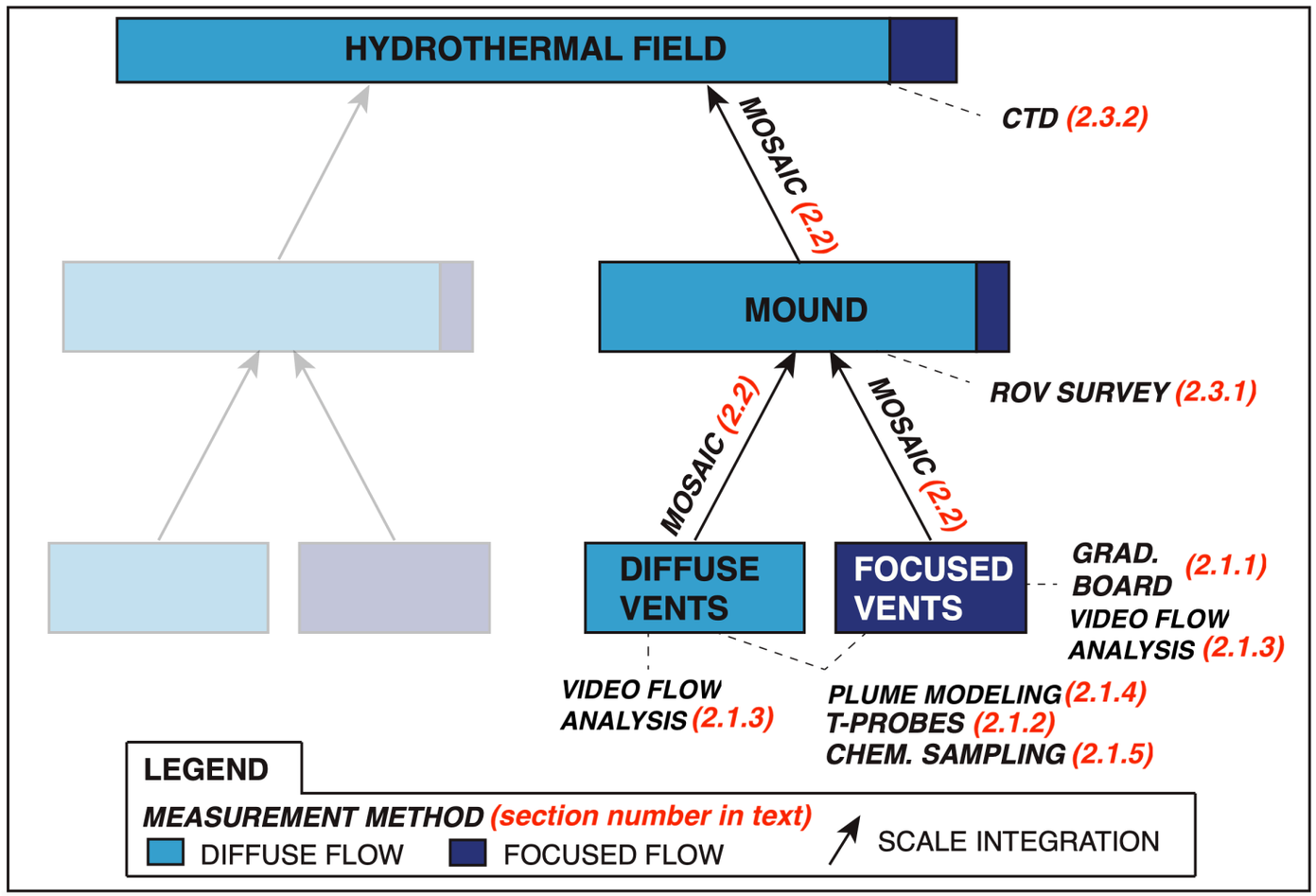
We advocate that combining complementary flux measurement techniques together on a single, targeted field, will allow to evaluate the relative accuracy and "in situ" uncertainty relative to each method.

Quantification of fluxes - scales dependency







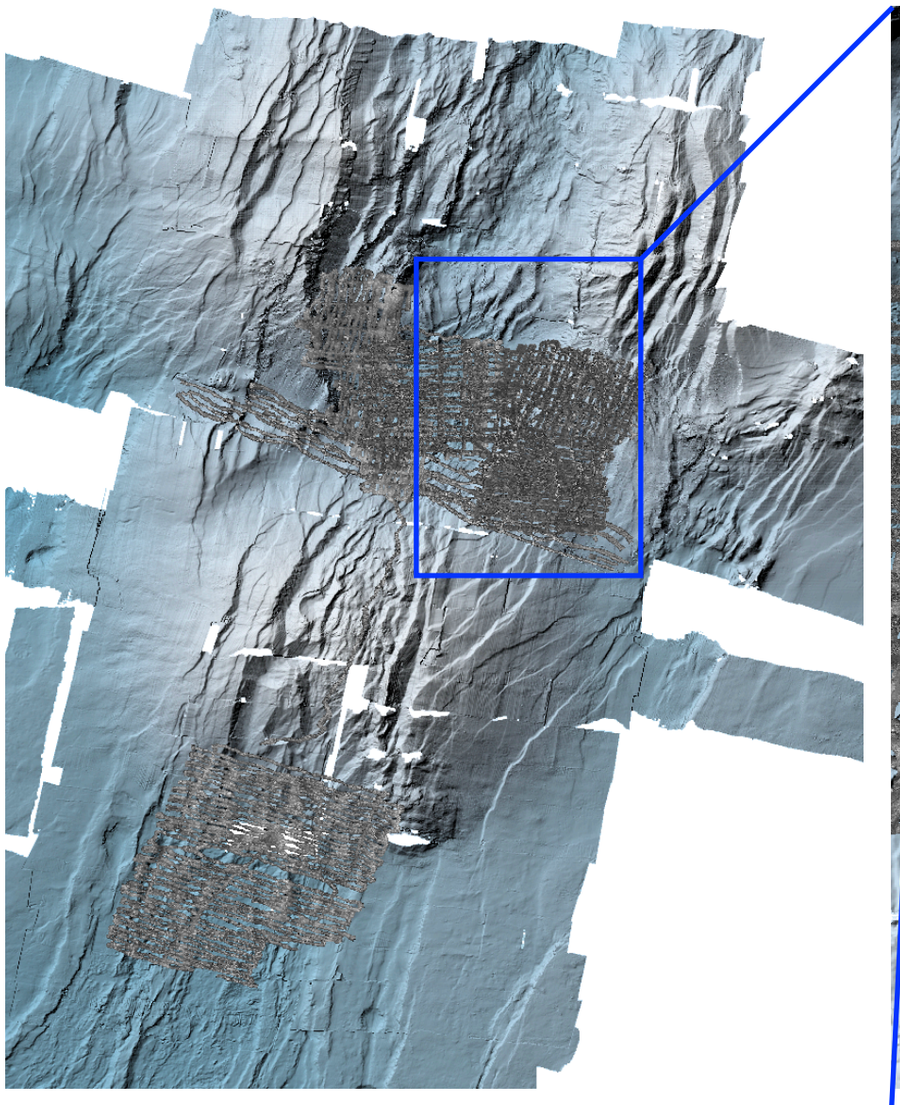


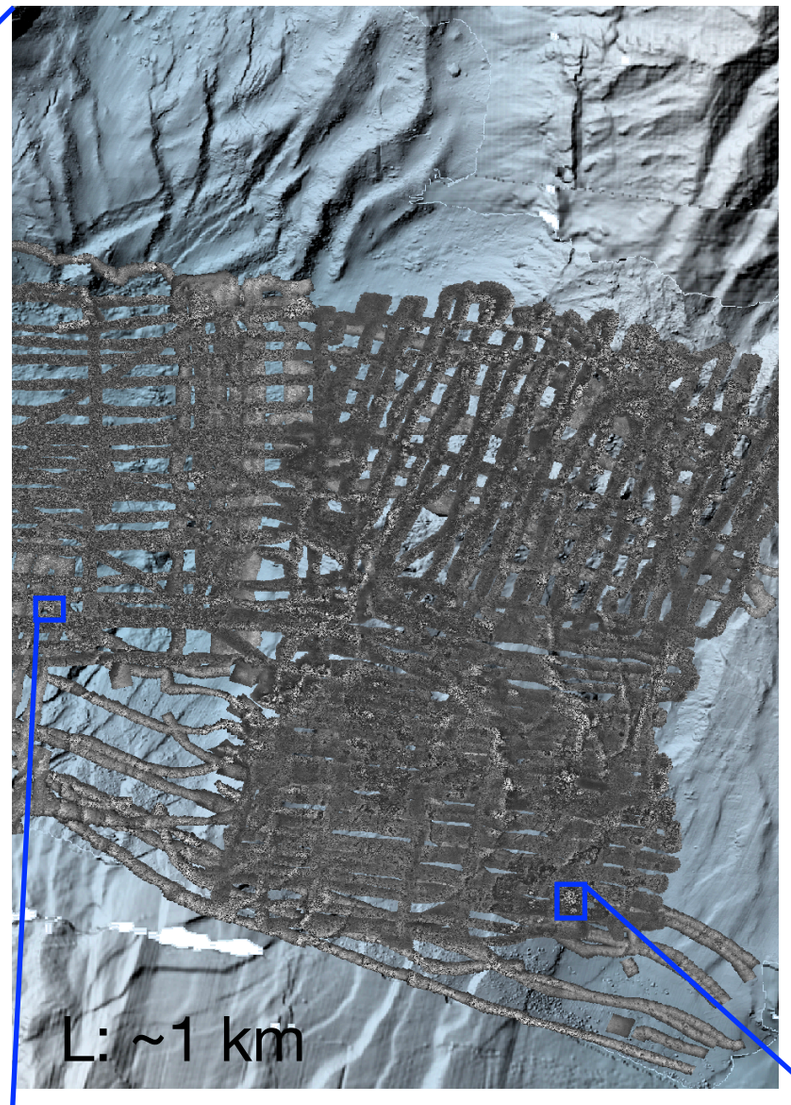
$$HF = \Delta T \,.\, \rho \,.\, v \,.\, C_p \,.\, S$$

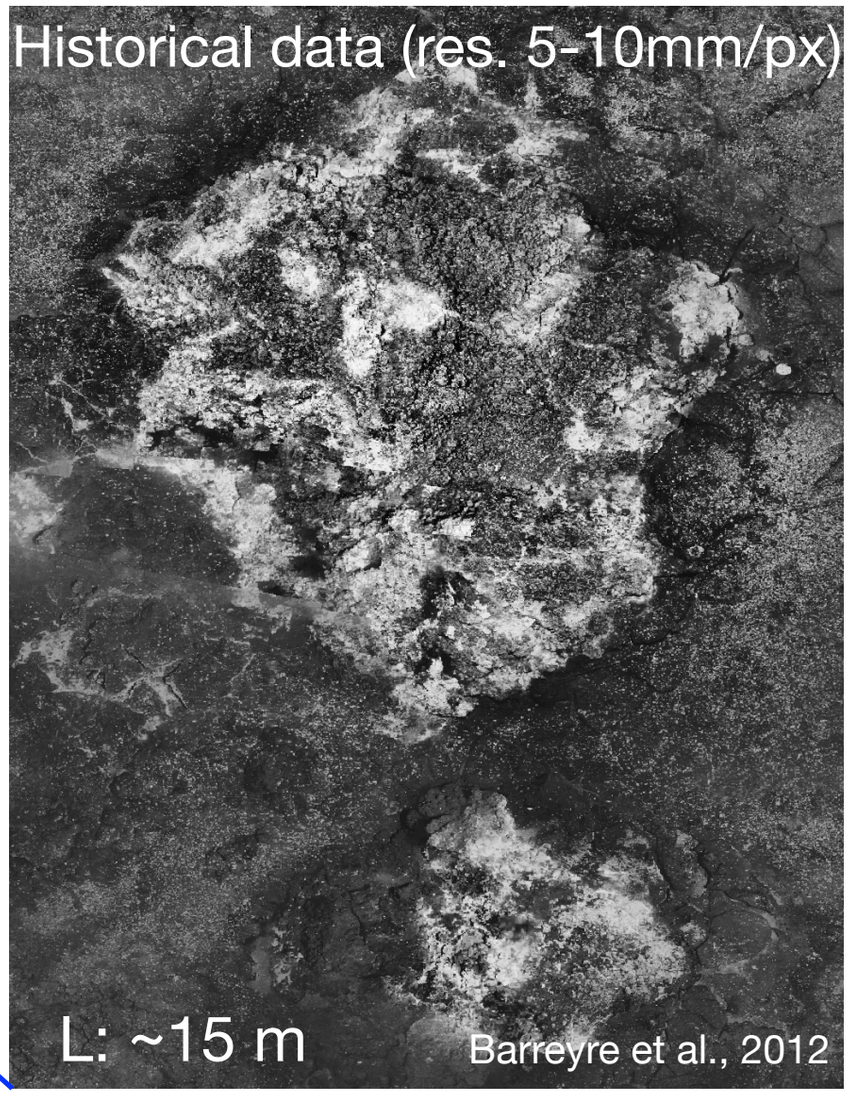
ΔT : e.g. temp. sensors
v : e.g. flowmeter, video
S : e.g. photomosaics

Exit-fluid surface area

$$HF = \Delta T \,.\, v \,.\, \rho \,.\, C_p \,.\, S$$

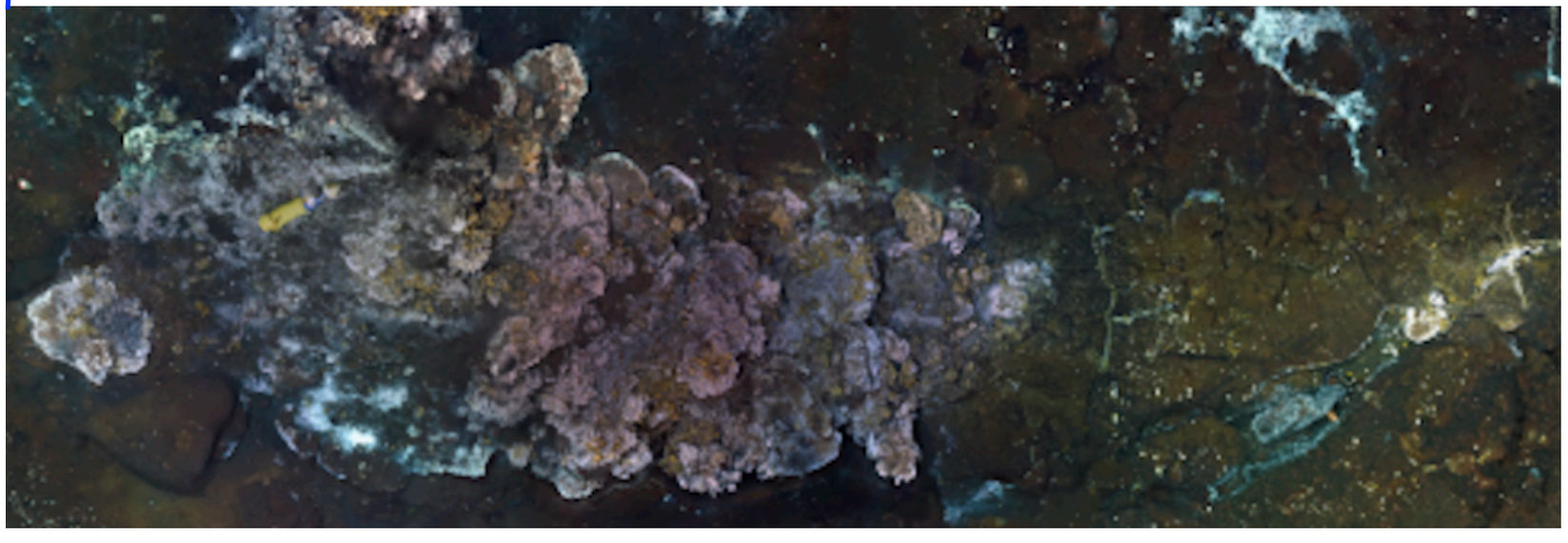






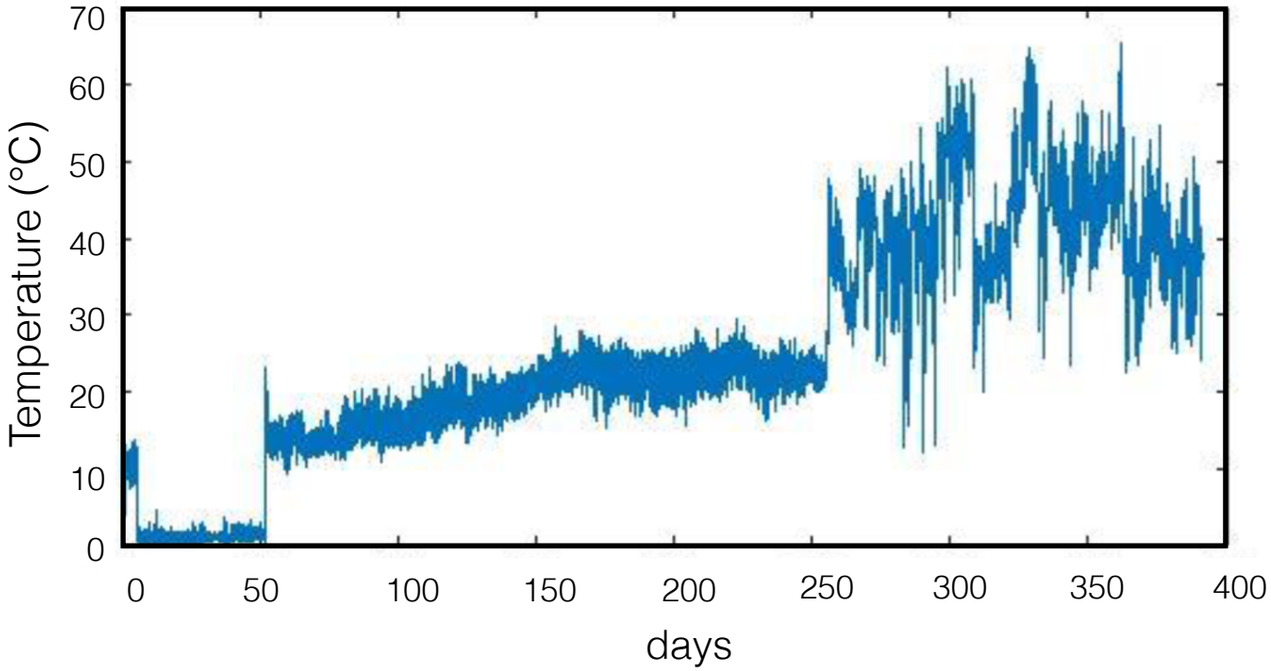
Global Spatial Data Project (QGIS)
—> FAIR & Open Source

Recently acquired data (res. 5 mm/px)



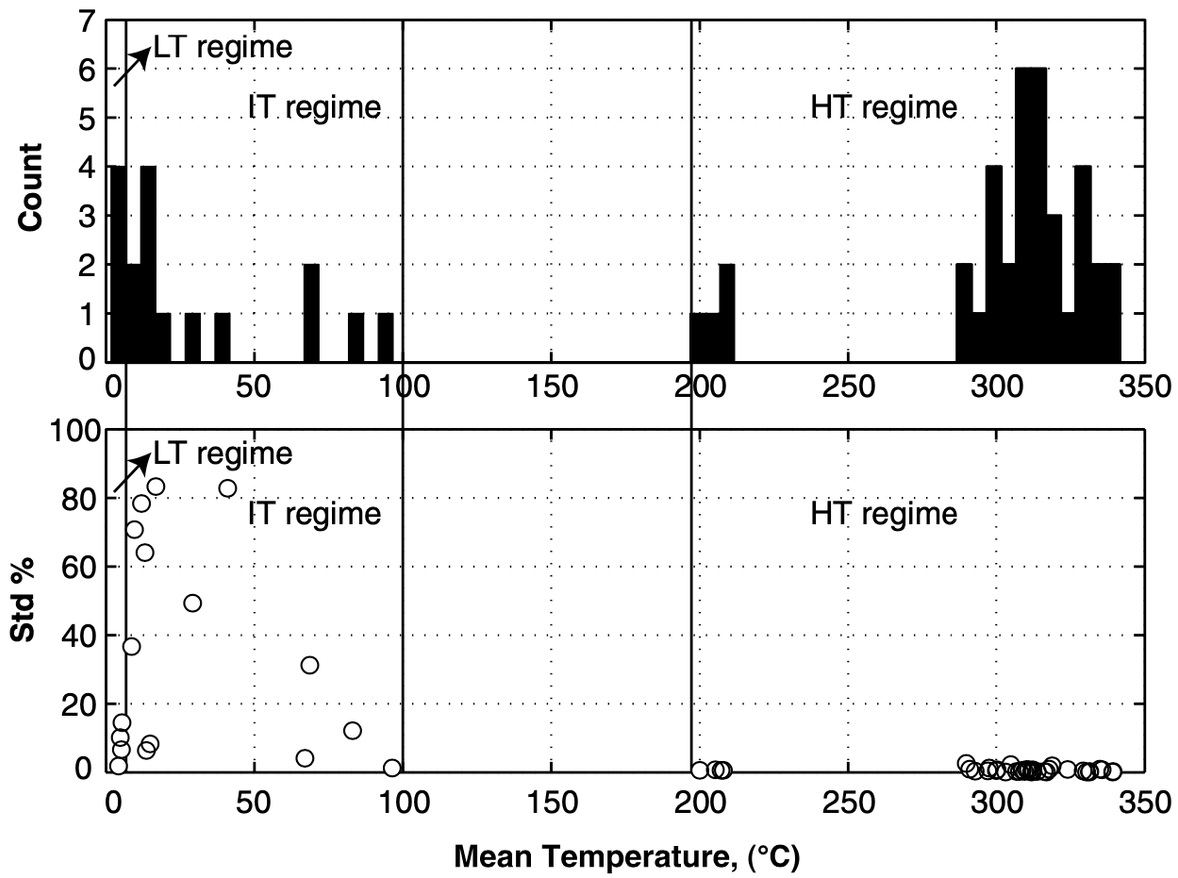
Exit-fluid vent temperature

$$HF = \Delta T \,.\, v \,.\, \rho \,.\, C_p \,.\, S$$



Historical 3-year dataset

Barreyre et al., 2014



Now, ≥15 years dataset

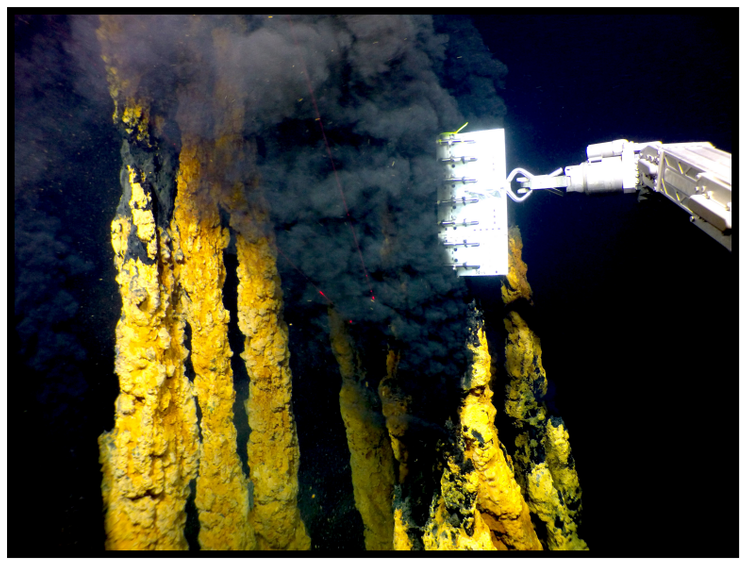
≥ 5,000,000 samples

Exit-fluid vent velocity

$$HF = \Delta T \,.\, v \,.\, \rho \,.\, C_p \,.\, S$$

Focused flow (model based/derived)

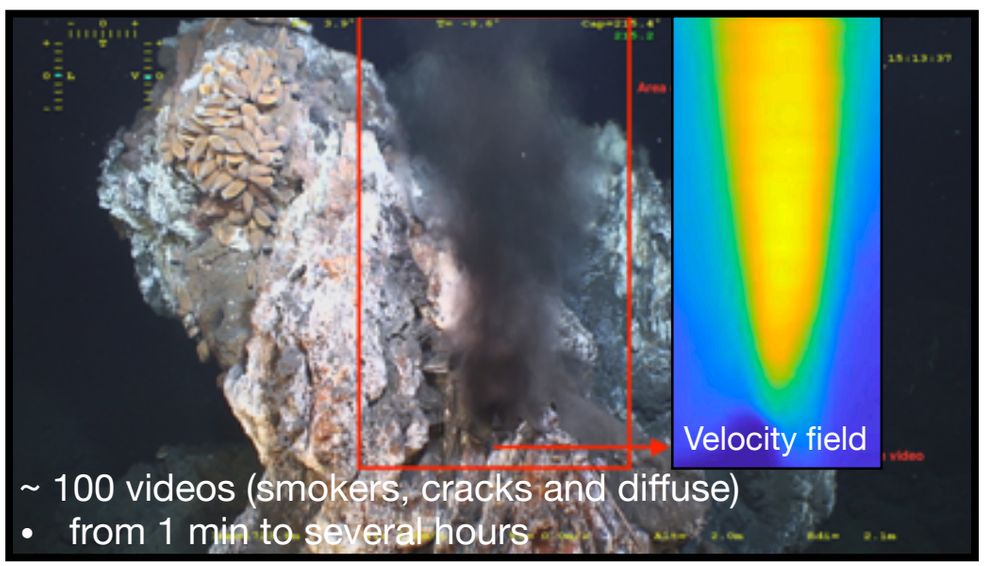
Vent temperature gradient



Derived Velocity and Temperature

Diffuse flow

Vent videos

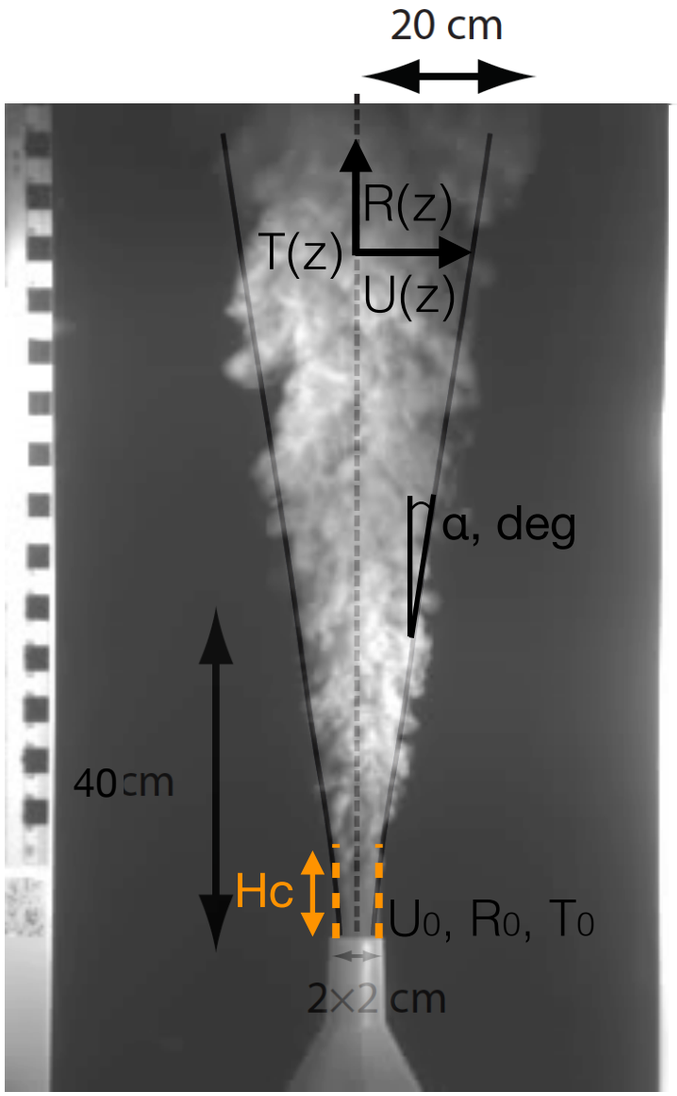


Derived Velocity and Temperature

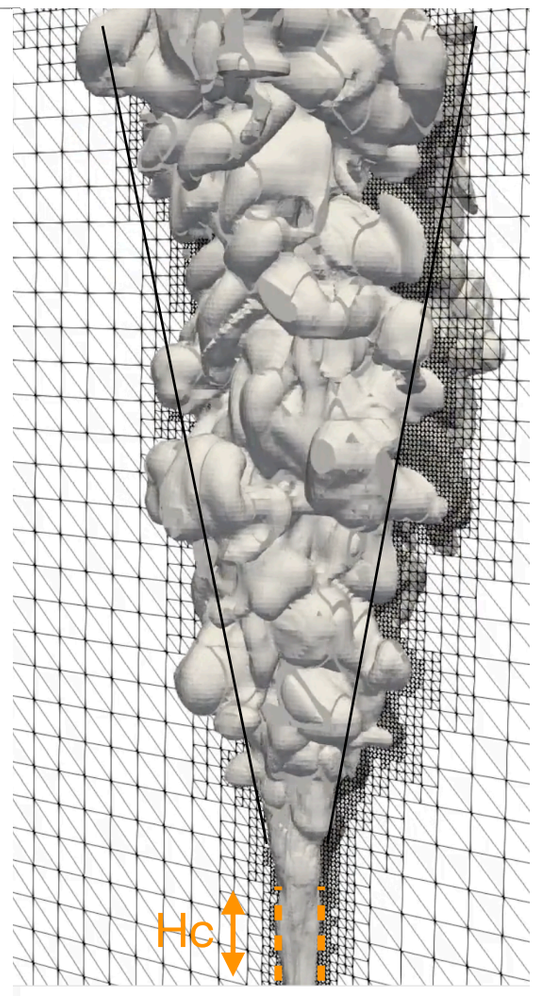
Suite of analytical, analogical and numerical models

Different outflow morphologies, and processes

Plume: point buoyant (+jet) source

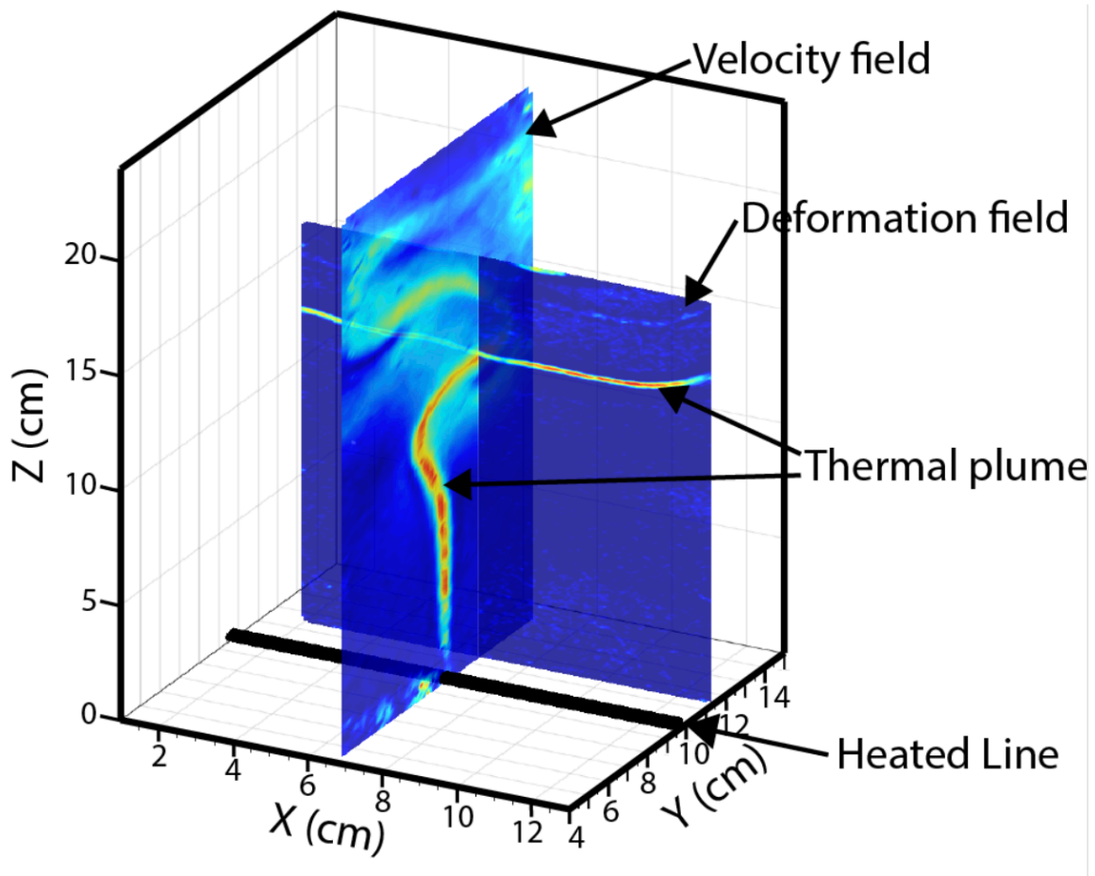


Numerical



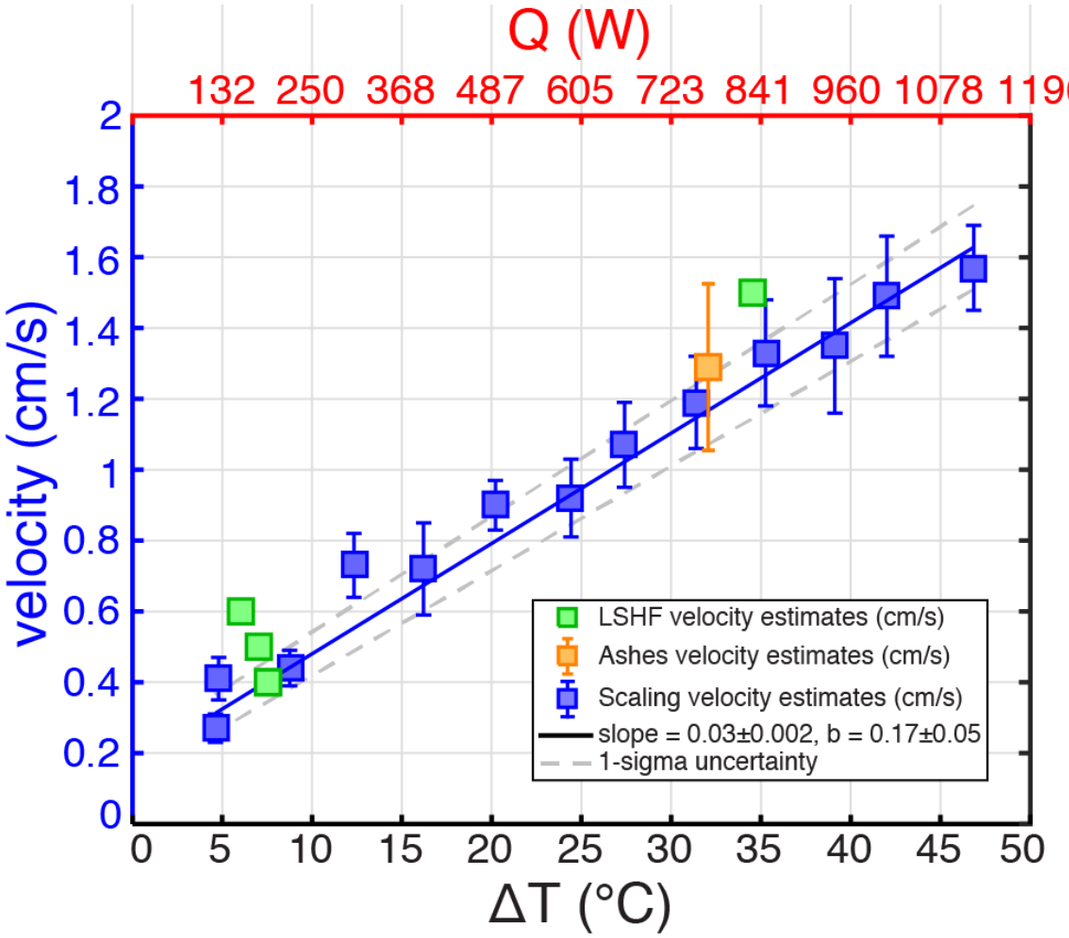
Linear: free/natural convection

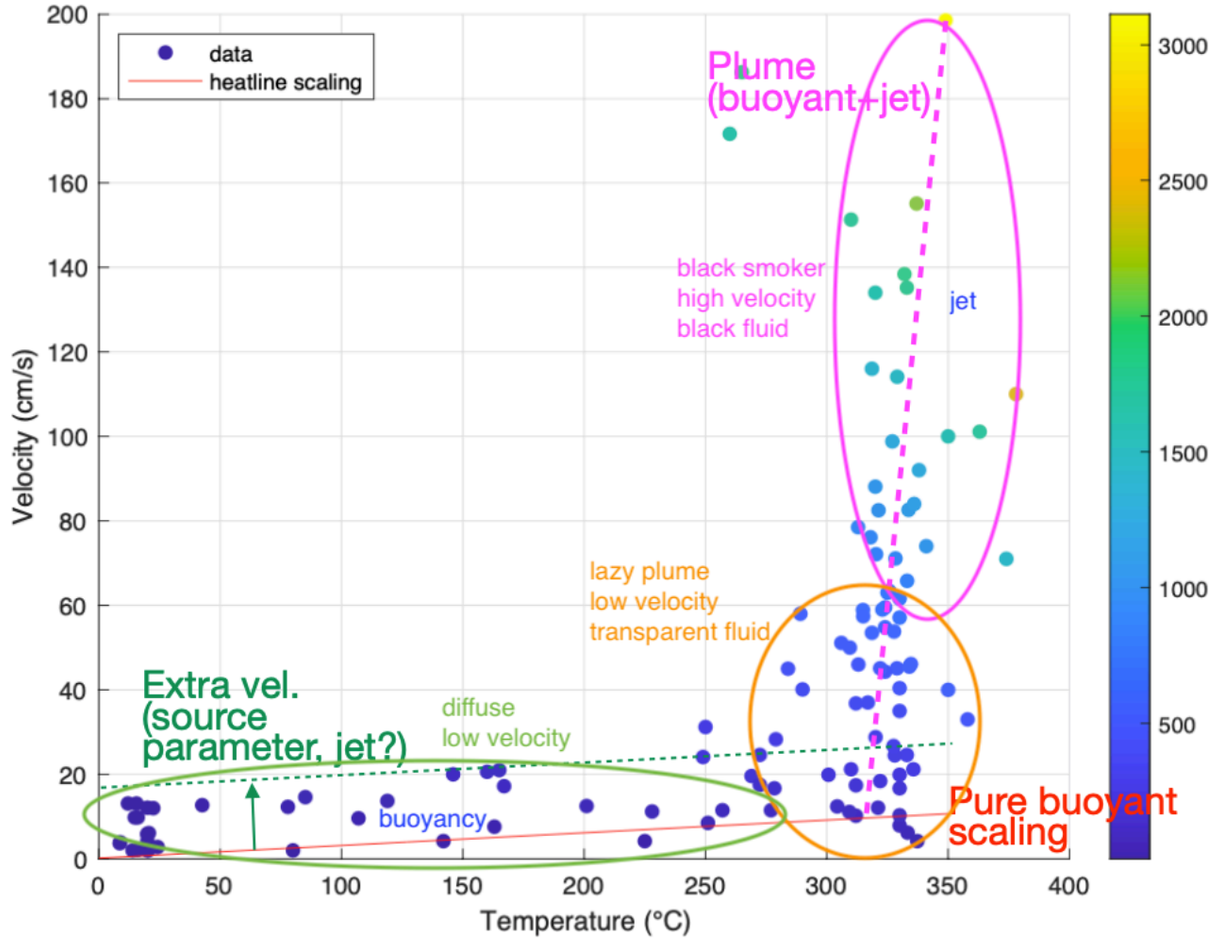
Analogical



Deriving scaling laws

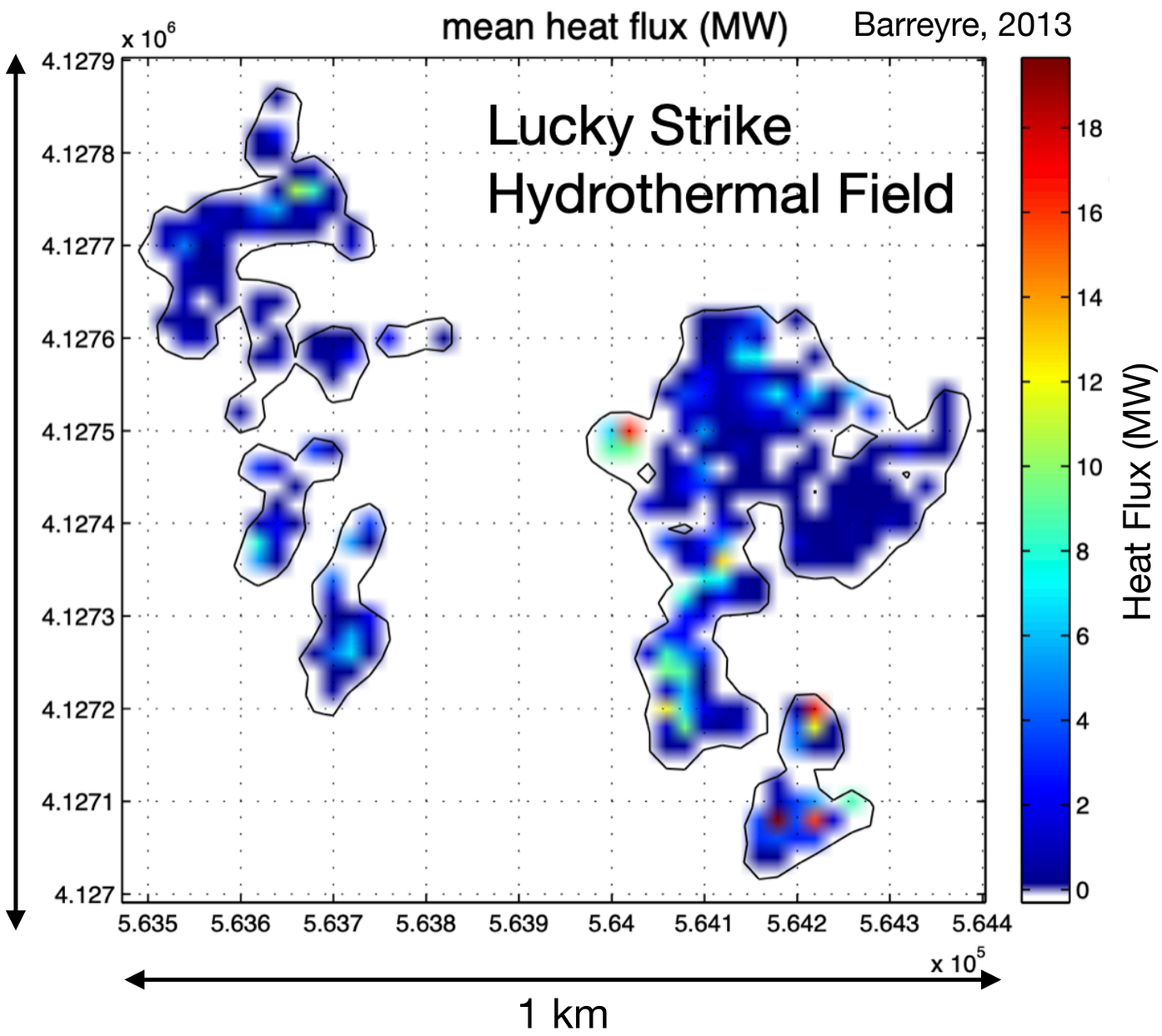
Pure buoyant scaling (natural convection)



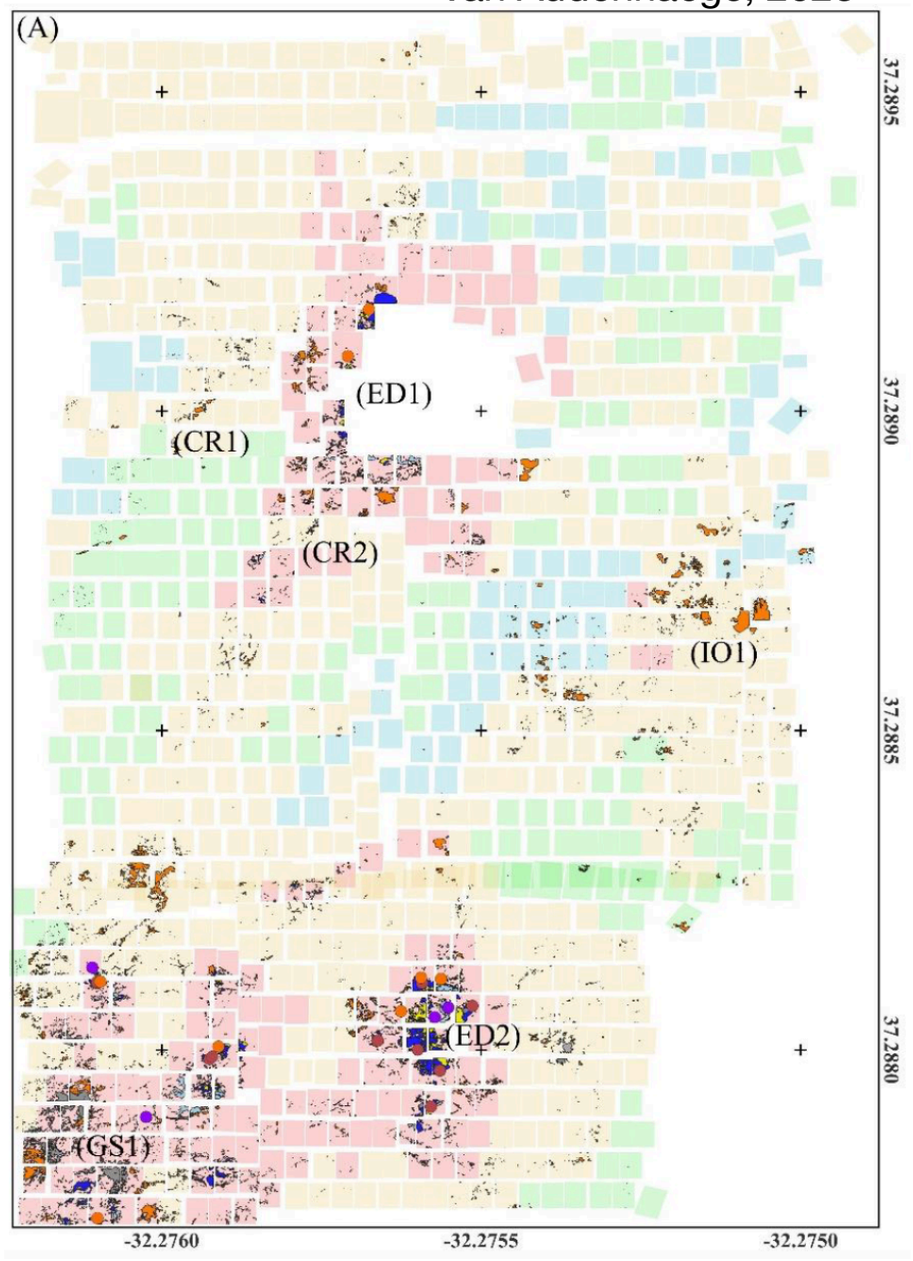


$$v = C_v \cdot \frac{\alpha g}{\nu} \cdot \Delta T$$

Correlation between fluxes and habitat functional groups



Van Audenhaege, 2023



Previous (unconstrained) results

$$HF = \Delta T \,.\, v \,.\, \rho \,.\, C_p \,.\, S$$

Quantification of fluxes - augmented equation and statistical approach

$$HF = \Delta T \,.\, v \,.\, \rho \,.\, C_p \,.\, S$$

ΔT : *e.g. temp. sensors*
v : *e.g. flowmeter, video*
S : *e.g. photomosaics*

shape-dependant

$$\begin{bmatrix} HF_1 \\ . \\ . \\ . \\ HF_{n-1} \\ HF_n \end{bmatrix} = \begin{bmatrix} \Delta \mathrm{T}_1 \\ . \\ . \\ . \\ \Delta \mathrm{T}_{n-1} \\ \Delta \mathrm{T}_n \end{bmatrix} * \begin{bmatrix} v_1 \\ . \\ . \\ . \\ v_{n-1} \\ v_n \end{bmatrix} * \begin{bmatrix} \rho_1 \\ . \\ . \\ . \\ \rho_{n-1} \\ \rho_n \end{bmatrix} * \begin{bmatrix} C_{p1} \\ . \\ . \\ . \\ C_{pn-1} \\ C_{pn} \end{bmatrix} * S$$

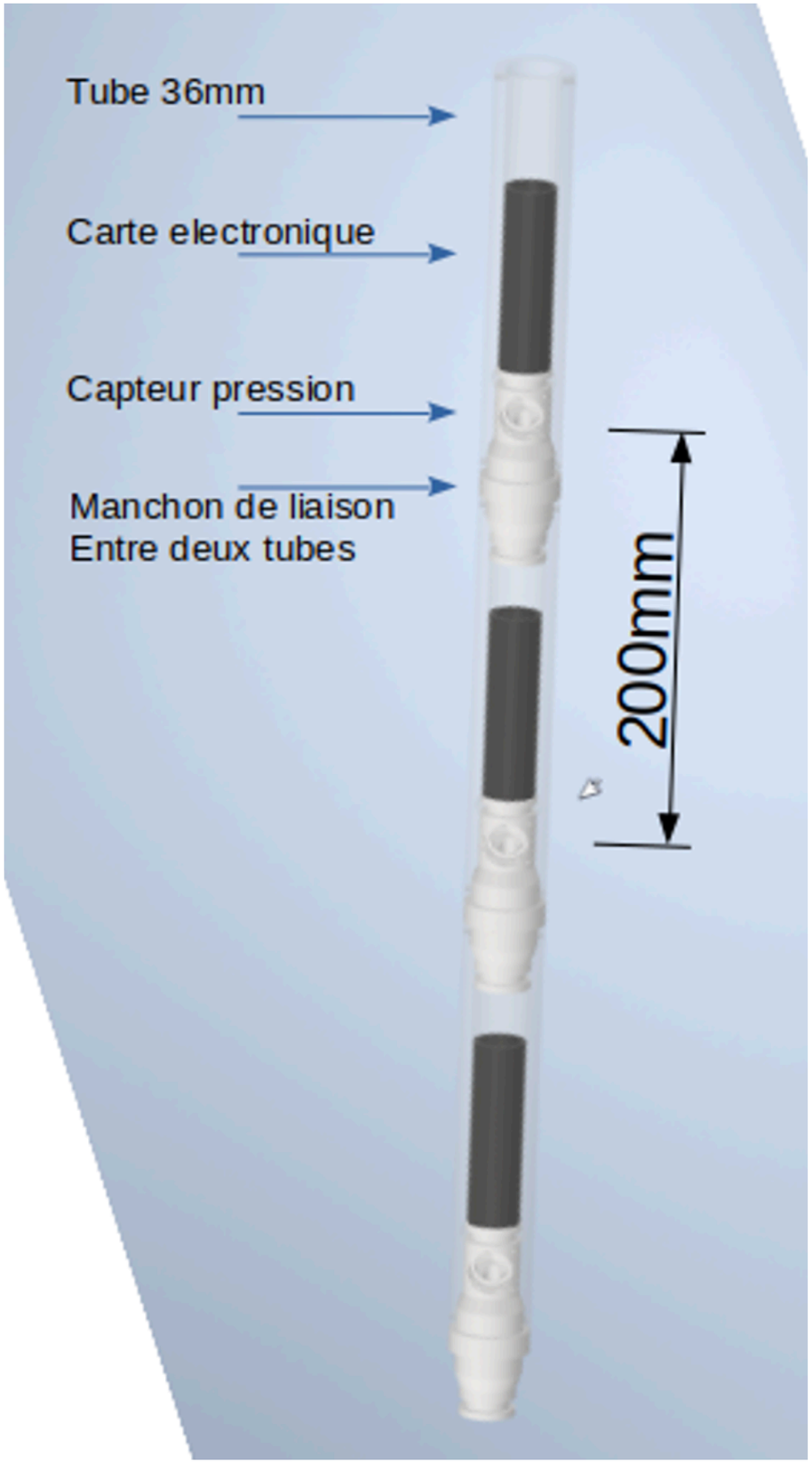
Constrain the states and natural variability —> e.g., Bootstrap

Developing a new pore pressure - temperature vertical profiler

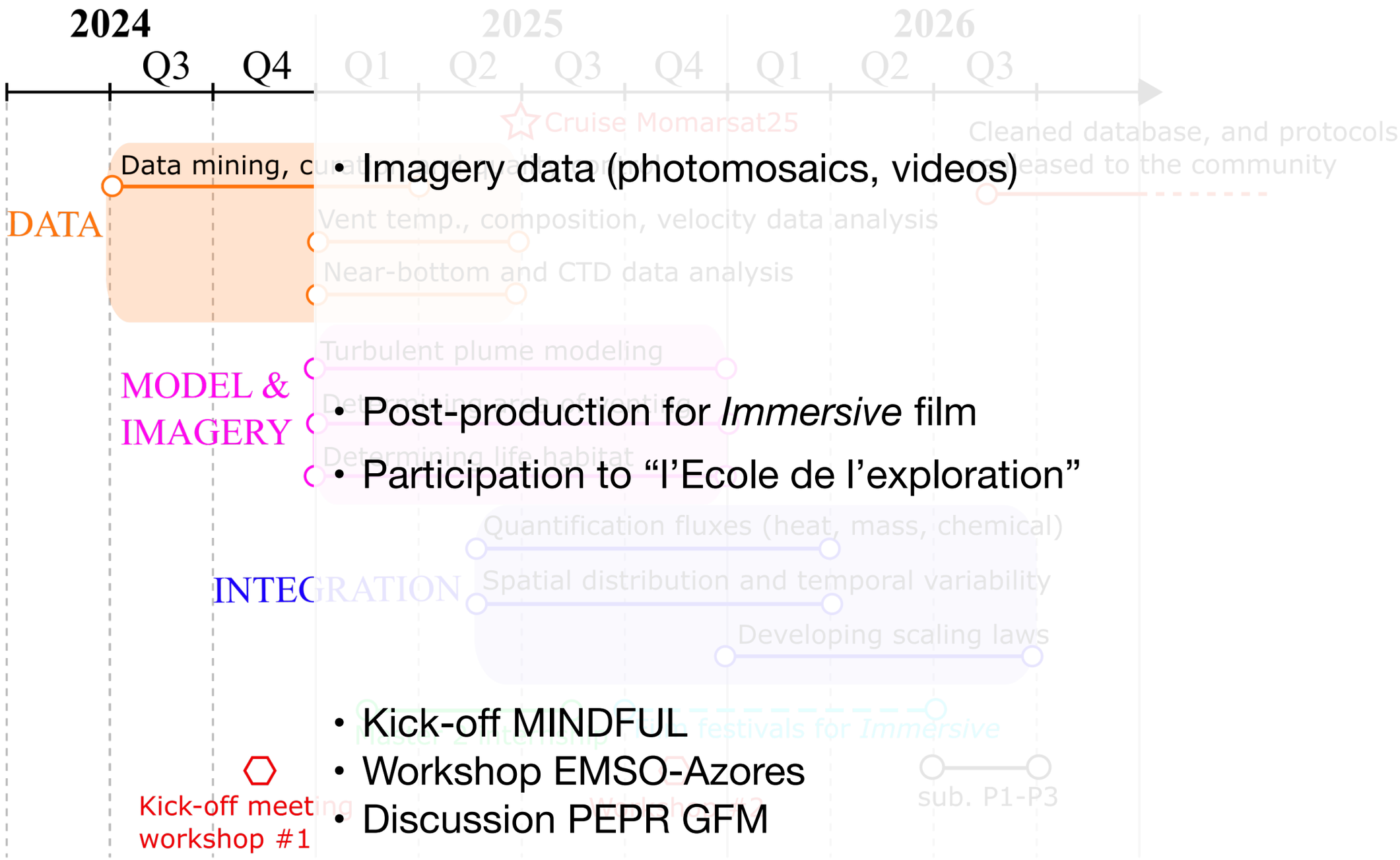
- Collaboration with Pascal Pelleau

- Access to Darcy velocity, volume fluxes

- To be tested in summer 2025 during Momarsat25 cruise



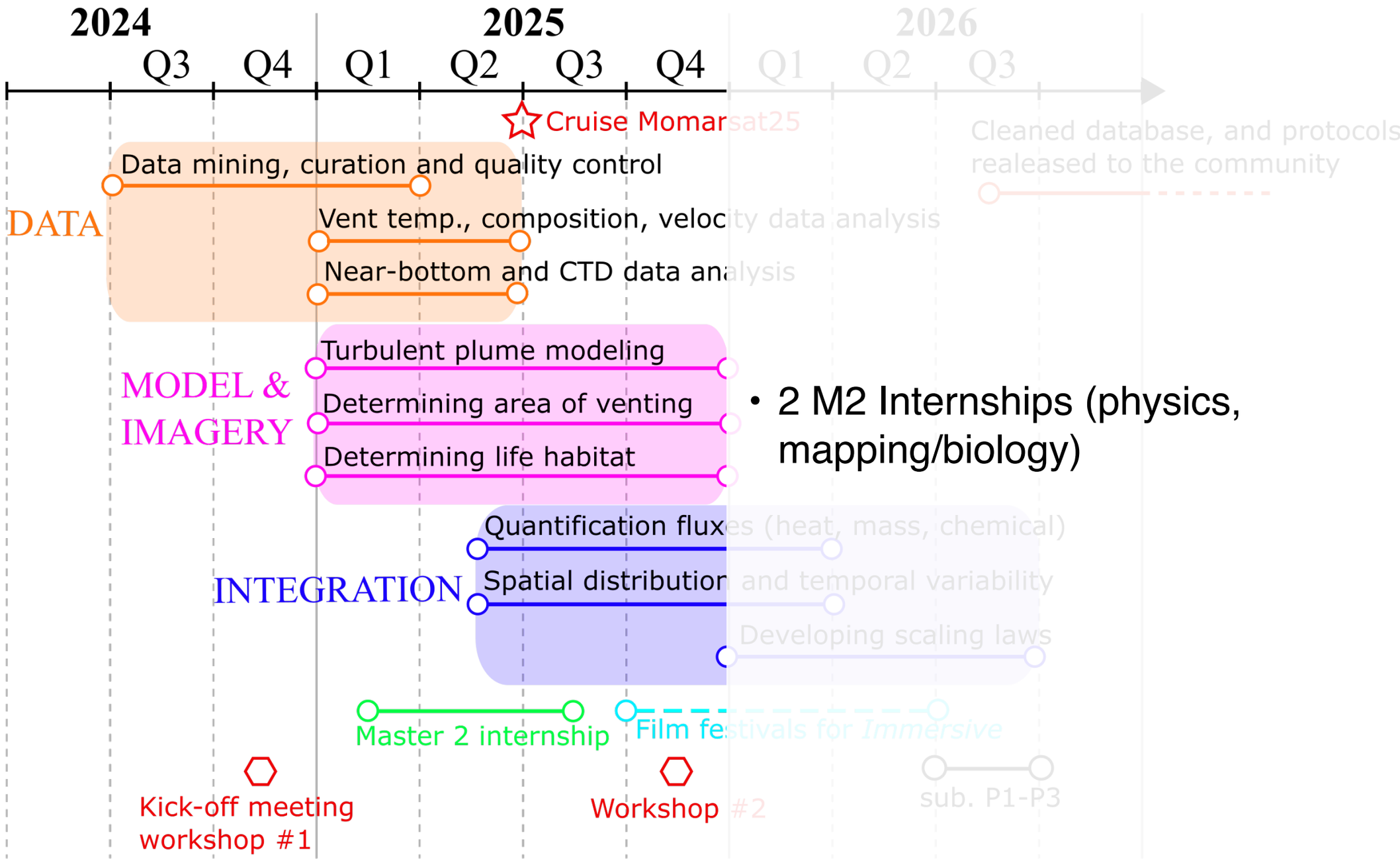
Provisional schedule: what has been done so far



- Imagery data (photomosaics, videos)
- Post-production for *Immersive* film
- Participation to “l’Ecole de l’exploration”
- Kick-off MINDFUL
- Workshop EMSO-Azores
- Discussion PEPR GFM

- MoMARSAT Cruise proposal was successful: secured yearly cruises up to 2029

Provisional schedule: what is planned for the upcoming year



- 2 M2 Internships (physics, mapping/biology)

- MoMARSAT Cruise proposal was successful: secured yearly cruises up to 2029