Travel Time Uncertainty Reduction by Multiobjective Optimization of Isotopic Transport Models

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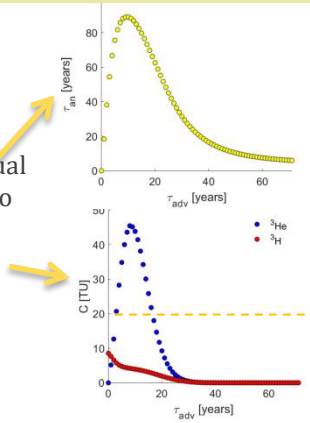
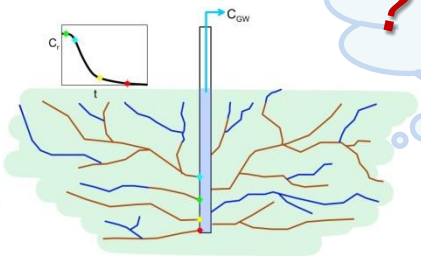
Problem

- Fractured limestone aquifer
- Single fracture model
- Modelled $^3H/^3He$ travel times are not equal to the simplified analytical solution due to multicomponent diffusion
- Non-uniquiness of the model outcome
- Relatively ‚heavy' model (runtime~1h)



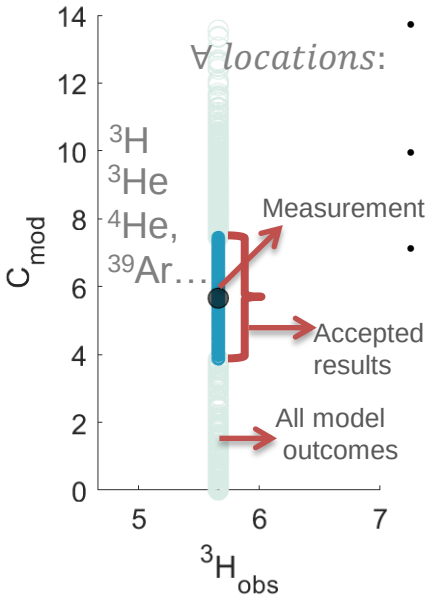


How to estimate groundwater age and transport parameters in the fractured aquifer?

$$C(t,\tau) = \int_0^\infty C_r(t, \tau_{adv}, a, \varepsilon) f(\tau_{adv}, b, \bar{\tau}) d\tau$$

Model output depends on the fracture aperture a, matrix porosity ε, mean travel time $\bar{\tau}$, shape parameter of the travel time distribution b

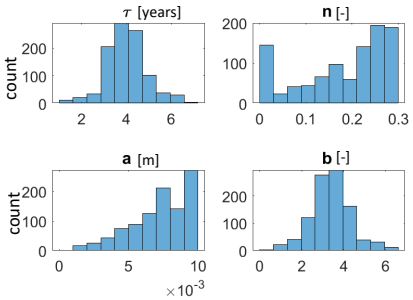
Idea



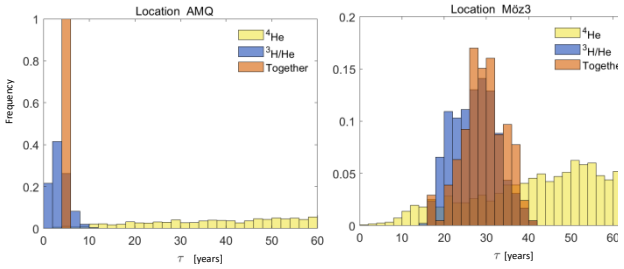
- Apply the Gaussian Proccesses Emulation (GPE) (Erdal et al.,2020) in 4D parametric space to obtain ensemble of plausible parameters.
- Error:

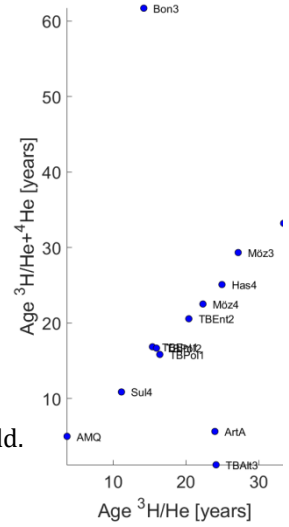
$$E_i = \left(\frac{|C_{obs} - C_{mod}|}{3\sigma_i}\right) < 1$$

- Reduce the parametric uncertainty by considering multiple tracers



Results





- GPE approach efficiently solves the stochastic
- optimization of the ^{3}H/He MIN3P model .
- ^{4}He and ^{39}Ar measurements catalyze uncertainty reduction by 2-5 times + discard multimodality.
- Ammer catchment groundwater is 1 to 62 years old.
- Groundwater is mainly captured in the micritic limestone with porosity < 5 %.

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