

3-D ERT Monitoring of Salt Tracer Tomography

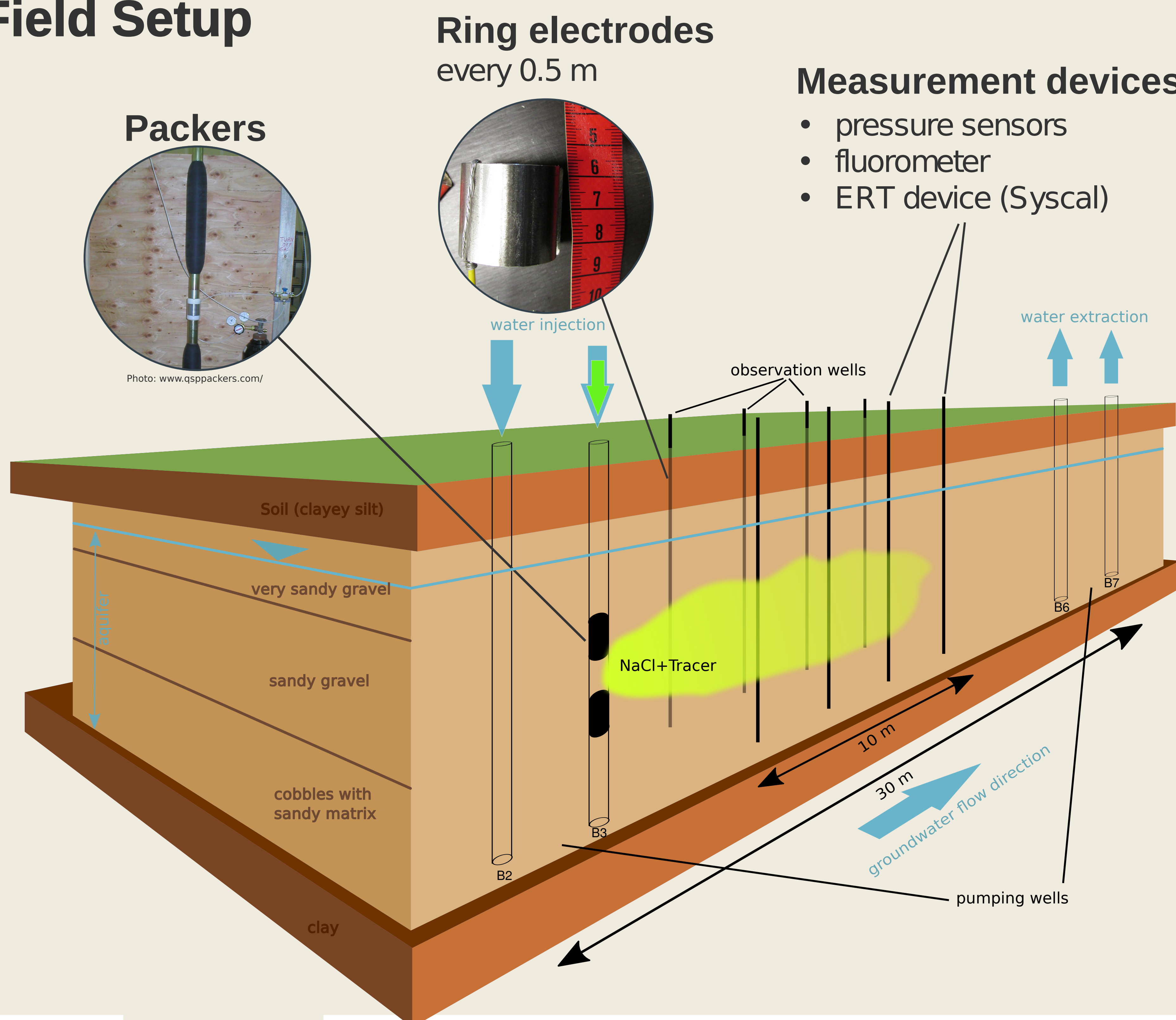
Field Experiments and Inversion using Ensemble-Kalman Filtering

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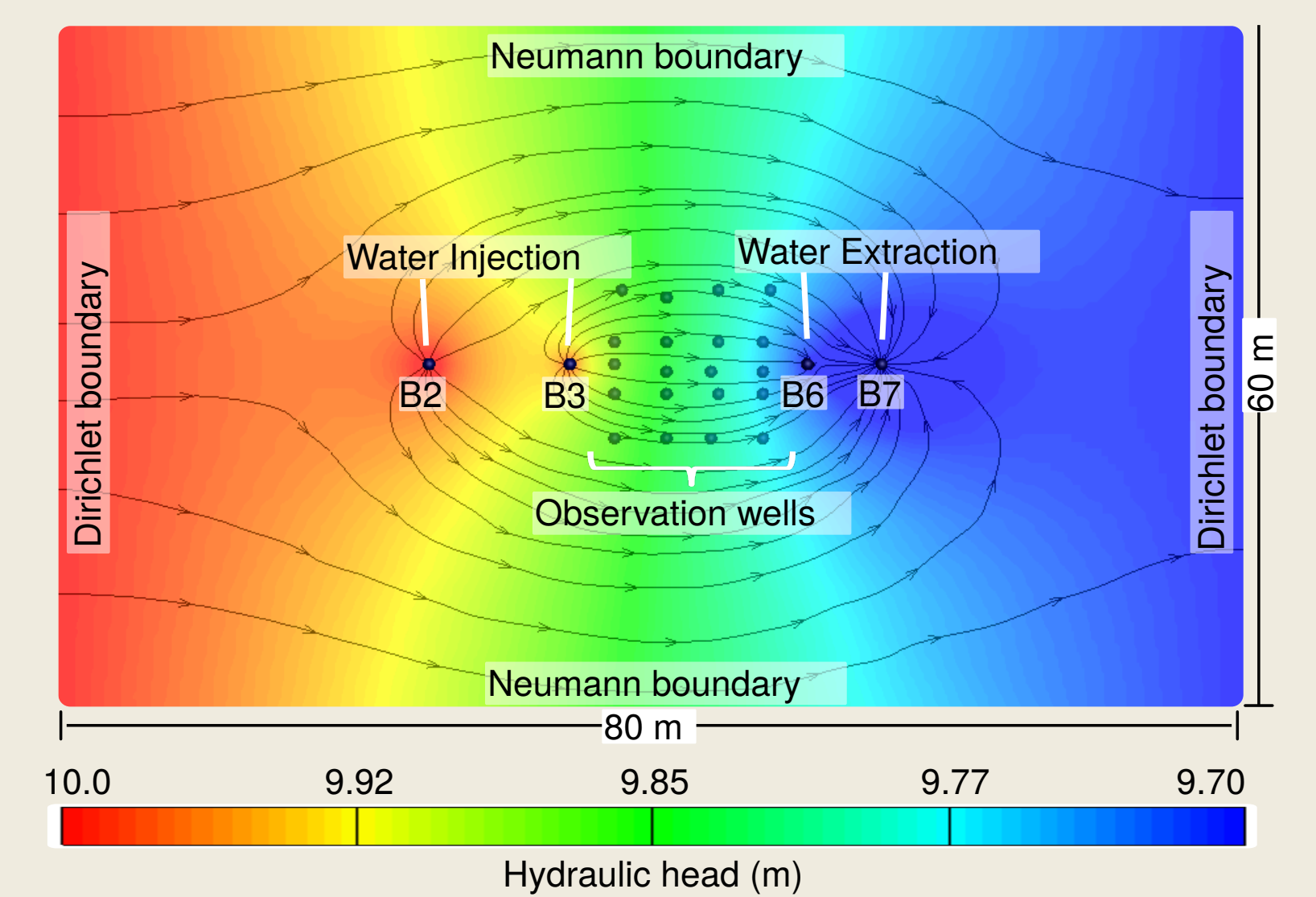
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Will additional ERT Data improve parameter estimation of model parameters of a tracer tomography experiment?

Field Setup



Steady-state conditions



Tracer tomography

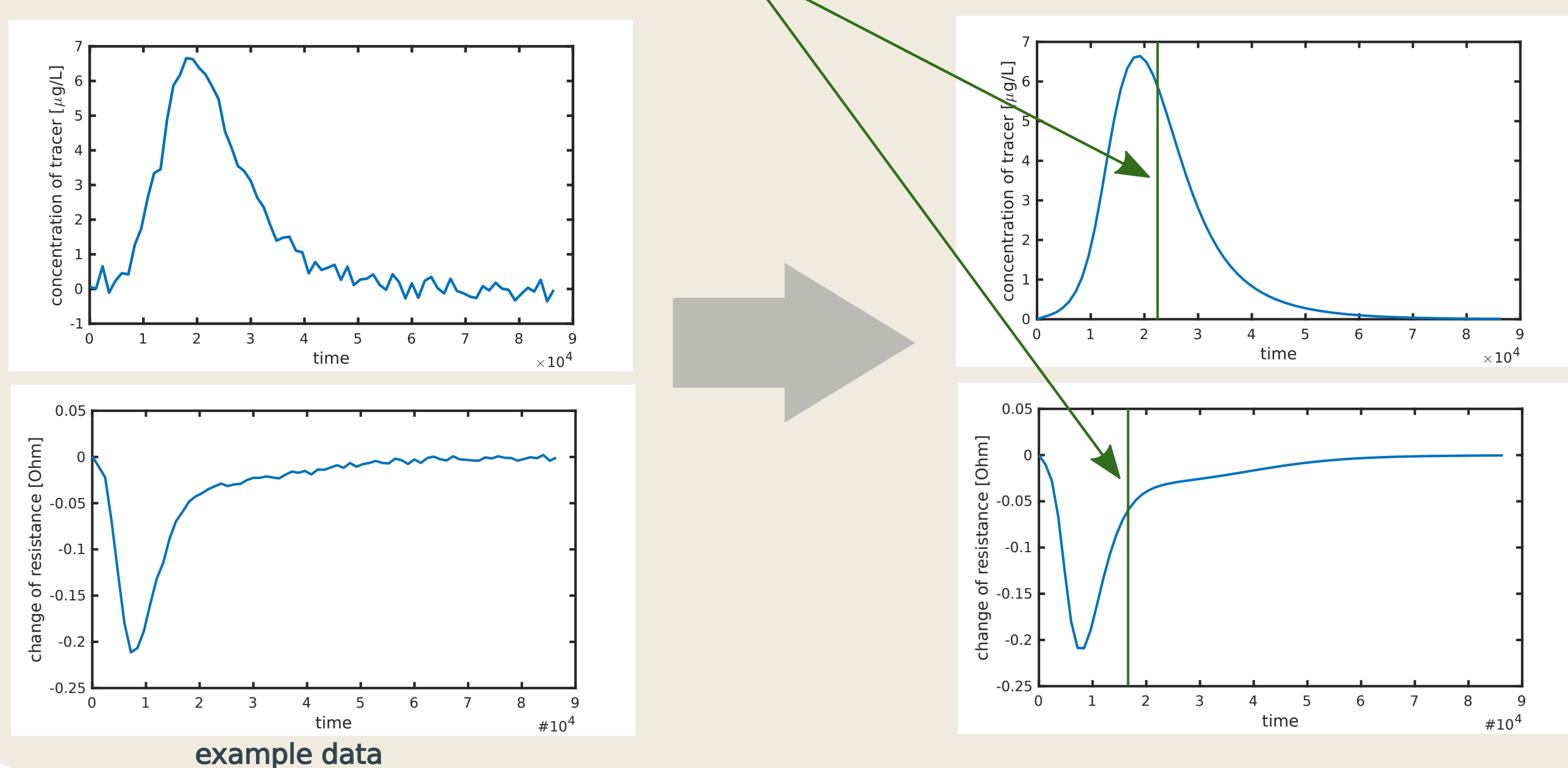
- performed under steady-state conditions
- tracer is injected in several depths
- ERT measurement every 30 min

Data Processing

1. Data filtering, noise removal
2. Temporal moments given by $m_k(\mathbf{x}) = \int_{t=0}^{\infty} t^k c(\mathbf{x}, t) dt$

$$m_0 \quad \text{total mass/discharge}$$

$$t_c = \frac{m_1}{m_0} \quad \text{mean time of breakthrough}$$



Ensemble Kalman Filter

Forecast step

$$\mathbf{y}_t^{sim} = g(\bar{\mathbf{p}}_{t-1}, \bar{\mathbf{x}}_{t-1})$$

\mathbf{y}^{sim} simulated observations
 $g(\dots)$ non-linear model
 t time index

Update step

$$\mathbf{P}_t = \mathbf{P}_{t-1} + \beta \mathbf{Q}_{PY} (\mathbf{Q}_{YY} + \mathbf{R})^{-1} (\mathbf{Y}_t^{real} - (\mathbf{Y}_t^{sim} - \epsilon_t))$$

\mathbf{Y}^{real} real observations
 \mathbf{P} model parameters
 \mathbf{R} covariance matrix of measurement errors
 $\mathbf{Q}_{YY}, \mathbf{Q}_{PY}$ auto-/cross-covariance matrices of model observations and parameters

ϵ measurement noise
 β damping factor