3-D ERT Monitoring of Salt Tracer Tomography
Field Experiments and Inversion using Ensemble-Kalman Filtering

Veronika Rieckh\textsuperscript{1}, Carsten Leven\textsuperscript{1}, Olaf A. Cirpka\textsuperscript{1}
\textsuperscript{1} Center of Applied Geoscience, University of Tübingen, Hölderlinstr. 12, D-72074 Tübingen, Germany
veronika.rieckh@uni-tuebingen.de, carsten.leven@uni-tuebingen.de, olaf.cirpka@uni-tuebingen.de

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

**Field Setup**
- Ring electrodes every 0.5 m
- Packers
- Measurement devices:
  - pressure sensors
  - fluorometer
  - ERT device (Syscal)

**Data Processing**
1. Data filtering, noise removal
2. Temporal moments given by \( m_{k}(x) = \int_{0}^{m_{k}} c(x, t) \, dt \)

**Ensemble Kalman Filter**
- Forecast step:
  \[
  y_{t}^{\text{sim}} = g(\tilde{p}_{t-1}, \tilde{x}_{t-1})
  \]
- Update step:
  \[
  P_{t} = P_{t-1} + \beta Q_{YY}(Q_{YY} + R)^{-1}(Y_{t}^{\text{real}} - (Y_{t}^{\text{sim}} - \epsilon_{t}))
  \]

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

**Tracer tomography**
- 

\( m_{0} \) total mass/discharge
\( t_{c} = \frac{m_{1}}{m_{0}} \) mean time of breakthrough

\( \epsilon \) measurement noise
\( \beta \) damping factor
\( R \) covariance matrix of measurement errors
\( Q_{YY}, Q_{PY} \) auto-/cross-covariance matrices of model observations and parameters