1) Motivation
- Different inverse solvers give different results
- Only a few solvers are freely available for academic institutions
- New codes should harness modern HPC to work with complex models and large datasets.

2) Inverse problem
- Mathematical formulation
  \( \mathbf{H}(\mathbf{M}) = \frac{1}{2} \left( \mathbf{f} - \mathbf{G} \mathbf{A} \mathbf{A}^\top \mathbf{G}^\top \mathbf{M} \right) \)
- Target function form \( \mathbf{r} = \left( \sigma \right)^\top \mathbf{M} \left( \mathbf{M} \left( \sigma \right) \right) \)
- Main challenges:
  - Choosing stabilizer \( \Omega \)
  - Solving of the nonlinear optimization problem
  - Choice of parameters:
    - Model parameters
    - Choice of the parameter of \( \mathbf{f} \)

3) Inverse solver ExtrEMeJoyMT
- Fast solving of the nonlinear optimization problem:
  - Choosing parametrization
  - Choosing stabilizer \( \Omega \)

4) True model
- Due to IE-approach only anomaly domain is discretized
- Integration error is removed with like step
- 2D integration of anomaly grid with like step

5) Inversion results
- Both anomalies and bigger ones were inverted together
- 2D integral was added to the response
- Modified domain is \( 16 \times 16 \times 3 \times 3 \)
- Different domain discretizations
- For forward modelling \( M = 500, N = 100, d = d_x = d_y = 0.06, d_z = 0.1 \), for inverse modelling \( 0.02 \times 0.02 \times 0.06 \) as geometric sequences

6) Mask parameterization
- One element of the inverse domain i.e. \( m_k \) is the union of cells from forward modelling domain
- The rule how to merge cells is defined by researcher

7) Scalability
- Two levels of parallelism are implemented:
  - Parallel domain in different \( \mathbf{R}_k \) responses or \( k \) responses in \( \mathbf{R}_k \)
  - Hierarchical MPI+OpenMP approach
  - Minimum number of used nodes is \( 2 \times 2 \times \ldots \times \ldots \times N \)

8) Conclusion
- New 3D inverse solver ExtrEMeJoyMT is presented
- Flexible inversion domain parameterization
  - Whole class of parameterizations
  - Two-modern IEs solvers for forward problems
  - Automatic approach for gradient calculations
- Perfect scalability on HPC

9) Contacts
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10) References