Overview of Stanford University Smart Fields Consortium (SFC)

Computational optimization, history matching (data assimilation), uncertainty quantification, and data interpretation are important technologies for modern reservoir management and carbon storage operations. The Stanford Smart Fields Consortium is a multidisciplinary program that performs state-of-the-art research in these important areas. We investigate a wide variety of approaches, algorithms and enabling technologies for optimization and history matching. A key SFC focus is the extension and application of computational methodologies developed for oil/gas production to carbon storage (and eventually hydrogen storage) operations. Several of our projects involve the development of deep neural-network surrogate models to greatly reduce the computation required for Smart Fields applications. Many of our optimization and constraint-handling treatments are incorporated into a modular code base called the Unified Optimization Framework, which is linked to a variety of simulators (GEOS, Eclipse, tNavigator, ADGPRS). SFC mainly includes faculty, students, postdocs and research scientists from the Department of Energy Science and Engineering, though researchers from other departments and visitors are also involved in our research. The program benefits from the computational resources provided by the SDSS Center for Computation and from interactions with other Stanford research groups.

Smart Fields current and recent research areas include:

- Wide variety of optimization techniques for well placement, well control, history matching, and closed-loop modeling of subsurface operations
- Development of deep learning-based surrogate models for flow simulation, with application to history matching and optimization
- Deep learning-based surrogate models for coupled flow and geomechanical simulation, with application to CO_2 storage
- Treatment of model error in history matching
- Multifidelity approaches for optimization and uncertainty quantification
- Optimization of monitoring well location and type for CO_2 storage
- Basin-scale CO_2 storage optimization and history matching
- Optimization under geological uncertainty
- Data-space inversion for history matching and uncertainty quantification
- History matching with DAS data to predict fault-slip tendency during CO_2 storage
- Deep learning for geological parameterization for efficient/realistic history matching
- Application of Smart Fields methodologies to field experiments and practical operations

We review our research for member companies in workshops held at Stanford University and/or via Zoom meetings. Members have fast access to the results of our work, and assistance with code developed within SFC can be requested. You can see many of our recent publications at https://scholar.google.com/citations?hl=en&user=lb7BrecAAAAJ&view_op=list_works&sortby=pubdate and https://scholar.google.com/citations?hl=en&user=cXOAfbcAAAAJ&view_op=list_works&sortby=pubdate .
The Smart Fields Consortium interacts with the Reservoir Simulation Research Consortium (SUETRI-B) and the Stanford Center for Carbon Storage (SCCS). SFC is directed by Professors Louis Durlofsky and Hamdi Tchelepi. The Smart Fields membership fee is $50,000 per year (there is only one membership level). For more information on SFC, please contact Louis Durlofsky (lou@stanford.edu) or Diane Wade (dlarsonc@stanford.edu).