Optimum and adaptive mission planning of gliders

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Outline

- Introduction
- Glider Mission Planner
- Performance in REP10
- Conclusions

Introduction

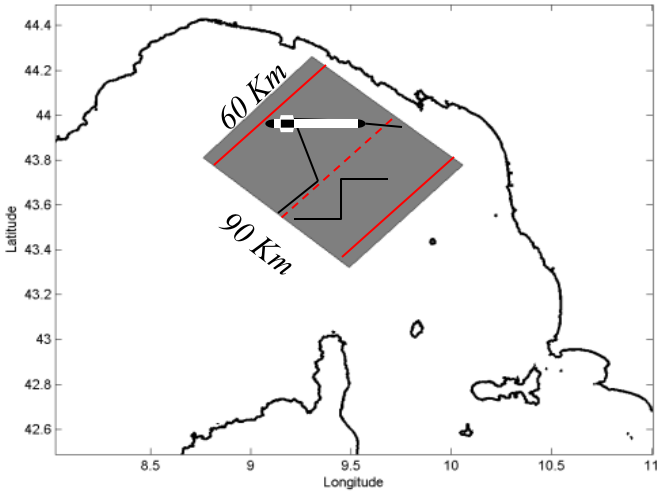
The advent of ocean observatories creates a demand for allocating and complementing observational resources, to maximize the information content of the collected data. Compatibility between the observing capabilities of the different nodes must be found designing optimum sampling strategies. These sampling strategies could adapt to the evolution of the environment, considering the motion capabilities of some of the sensor nodes of the network. Adaptivity of the network topology requires a continuous feedback of information between the nodes and a data processing unit.

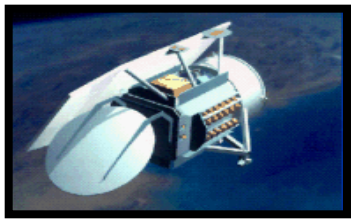
REP10, Aug 20-Sep03 2010

Ligurian Sea

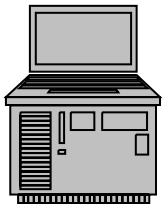
Network of 5 gliders (2 adaptive, 3 validation)

Evaluation adaptive sampling





A data fusion engine that produces a physically sounded analysis of the environment, based on the information received from the *in situ* network and remote sensors. (NCOM and Super-Ensemble)



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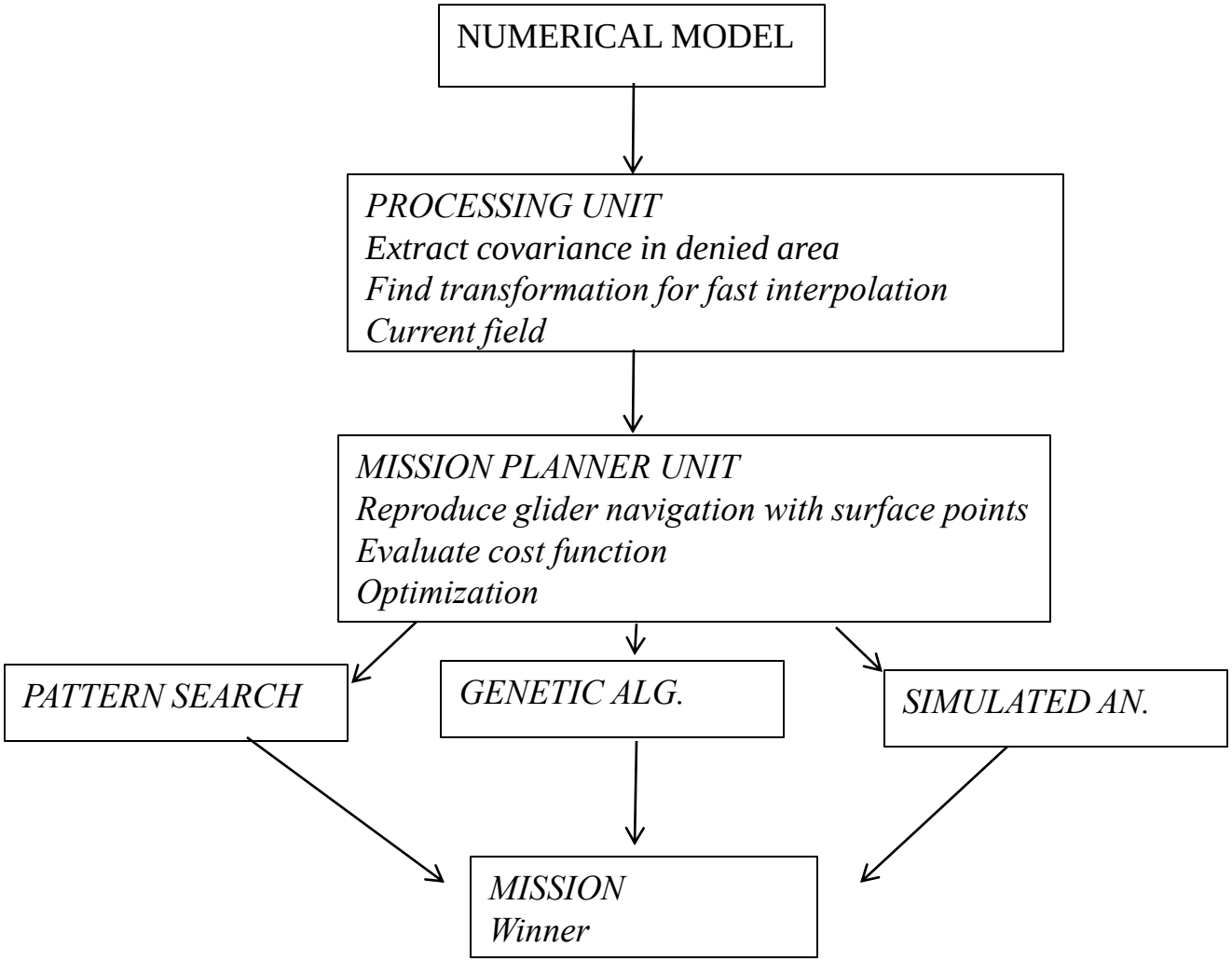
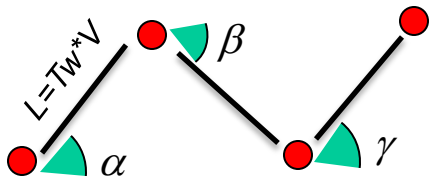
Glider Mission Planning



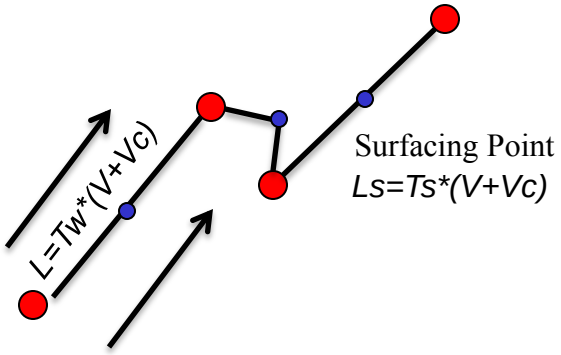
Glider Mission Planning

Trajectories

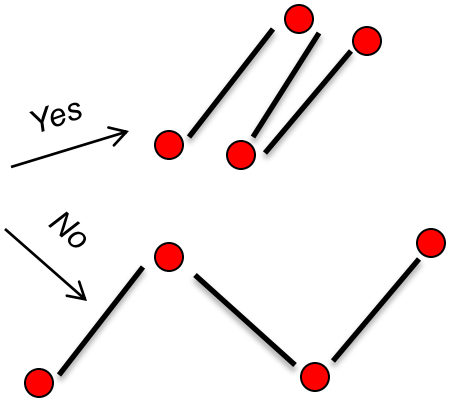
Number of gliders
Initial Position
Speed
Total mission time
Time between waypoints
Surface time



Currents



Outside ops area?
Sensor clusterization?



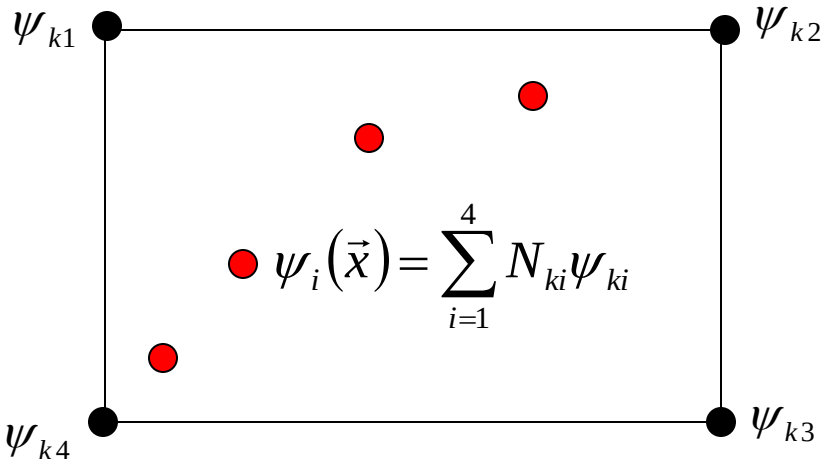
Cost Function 1e20

Cost Function Computation

Glider Mission Planning

Cost Function

$$P(\psi_k) \propto e^{-(\psi_{obs}-H\psi_k)^T \Sigma_{obs}^{-1}(\psi_{obs}-H\psi_k)-(\psi_k-\overline{\psi})^T C_M^{-1}(\psi_k-\overline{\psi})}$$



ψ_k Field values at the grid nodes,

$H = [N]$ Observation matrix,

Σ_{obs} Observation error matrix

$\psi_{obs} = [\psi_i]$ Vector of observations

A- Optimal Design

$$Arg\min(Trace(C_M - C_M H^T [HC_M H^T + \Sigma_{obs}]^{-1} HC_M))$$

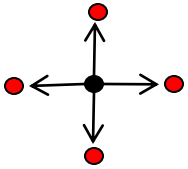
Pre-conditioning could be needed

Glider Mission Planning

Optimization

Pattern Search

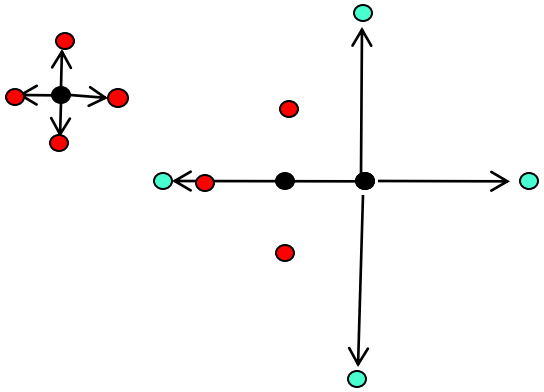
Generate Mesh



Poll Better?

No

Yes



Genetic Algorithm

Generate Population

Evaluation and Selection

Reproduction

Mutation

Simulated Annealing

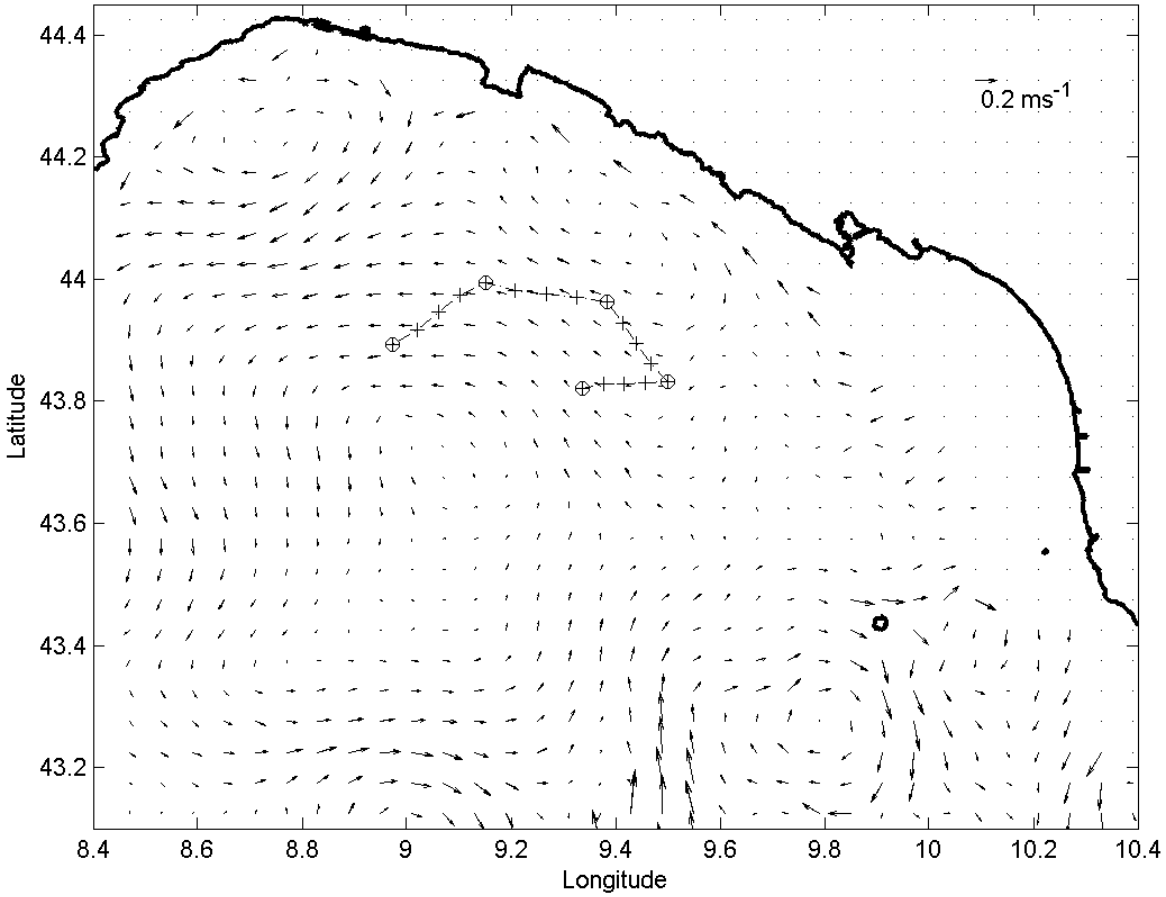
Random Perturbation

Compute change in cost function

Compute probability of acceptance

Glider Mission Planning

Mission plan for August 22nd -24th



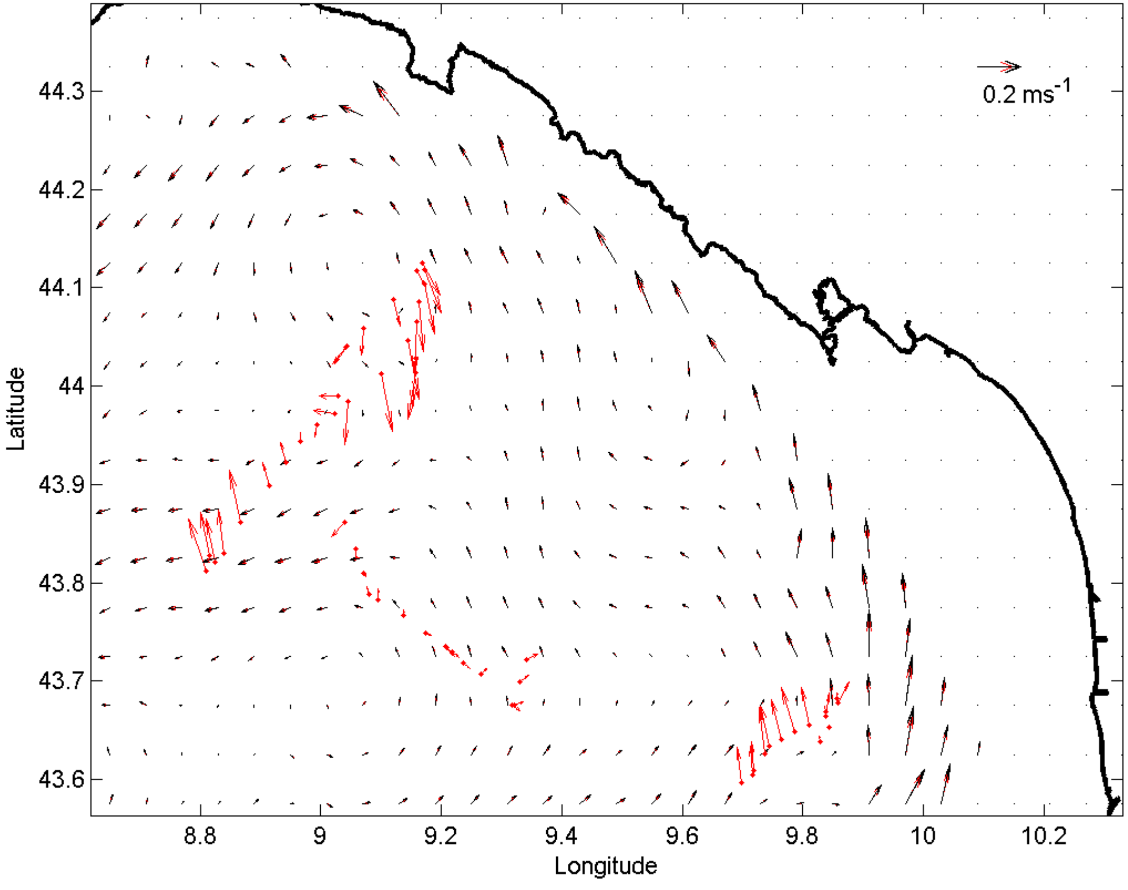
Gliders: 1
Speed:0.38 m/s
Total mission time=48 h
Time between waypoints=12 h
Surfacing Time=3 h
Sensor clusterization parameter=6 Km
Sampling Resolution= 500 m

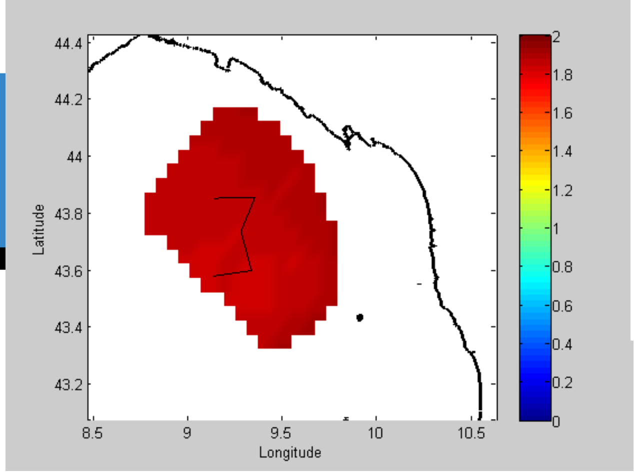
Performance in REP10

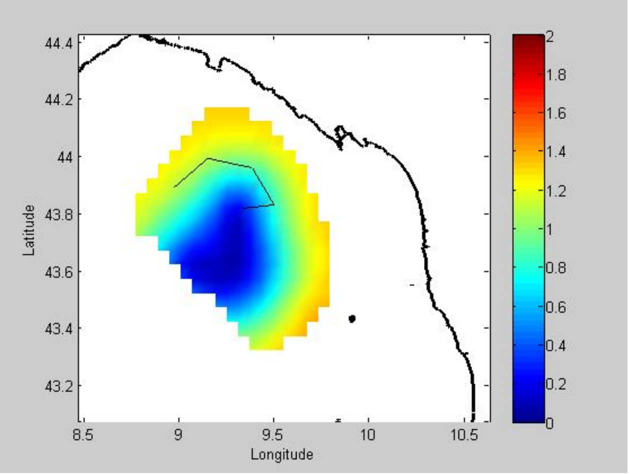
Model Forecast for August 20th -22nd

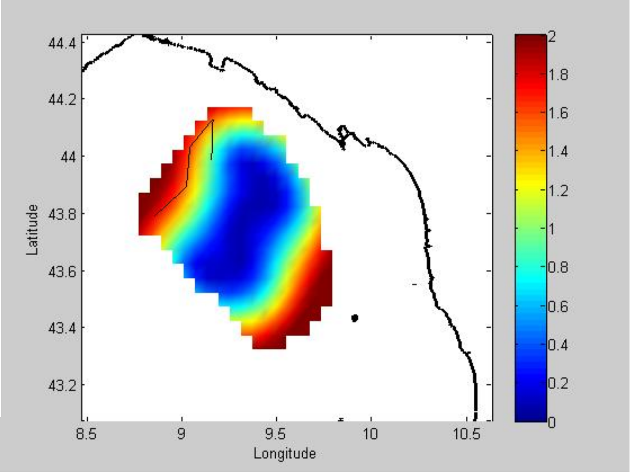
- *Vertically integrated current field*
- *Covariance of the ensemble*

Mission planner



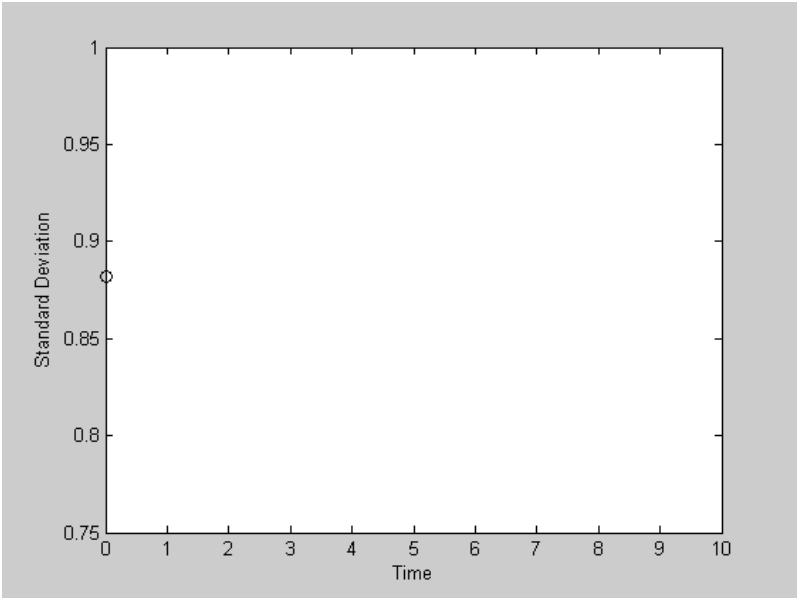




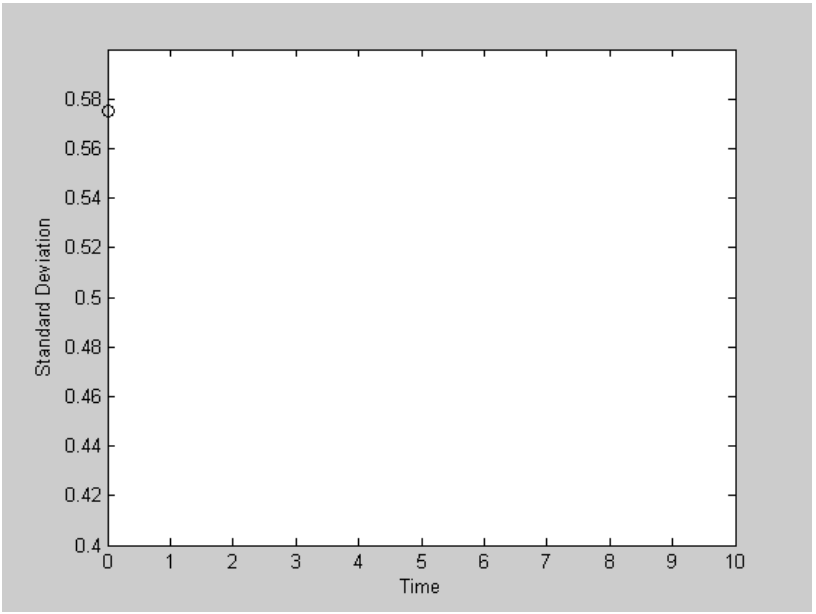


Performance in REP10

Optimization Mission Aug 20th -22nd



Optimization Mission Aug 22nd -24th



Pattern search — Genetic Algorithm — Simulated Annealing —

Conclusion

- *Adaptive sampling is required when observational resources are limited*
- *An optimization engine is required to search for an optimal experimental design*
- *Results show that the performance of pattern search is superior to genetic algorithms and simulated annealing*
- *Adaptive sampling requires an appropriate assimilation scheme that allows corrections in the current field*