Adaptive sampling and optimal path planning for underwater gliders

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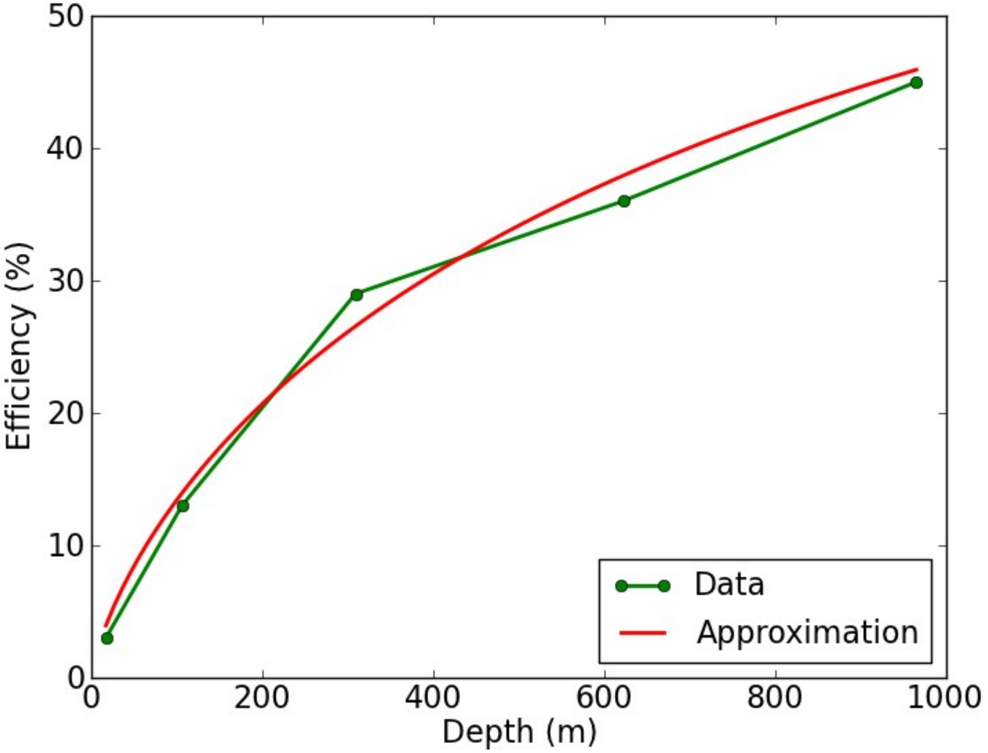
Motivation

- We want to be able to perform adaptive sampling with gliders.
- We need to minimise energy consumption.
- The method used here is similar to that employed in Garau *et al.* 2005.

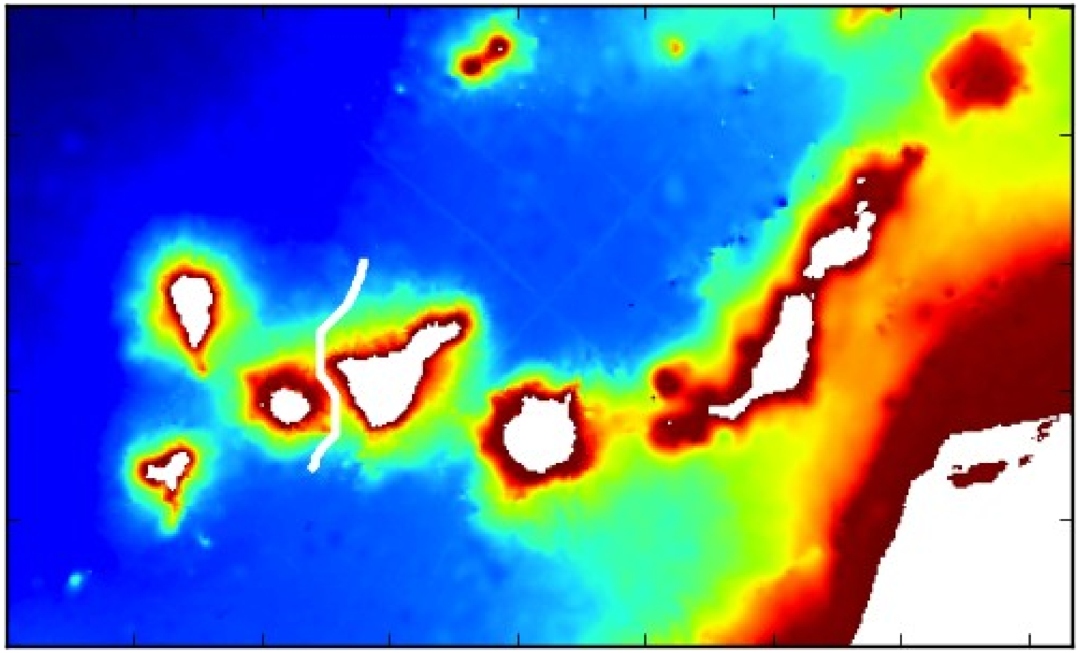
Depth

- The main power draw is the buoyancy pump.
- The pump efficiency increases with depth.



Distance

- An increase in travel distance means an increase in energy consumption.
- *(All other things being equal)*



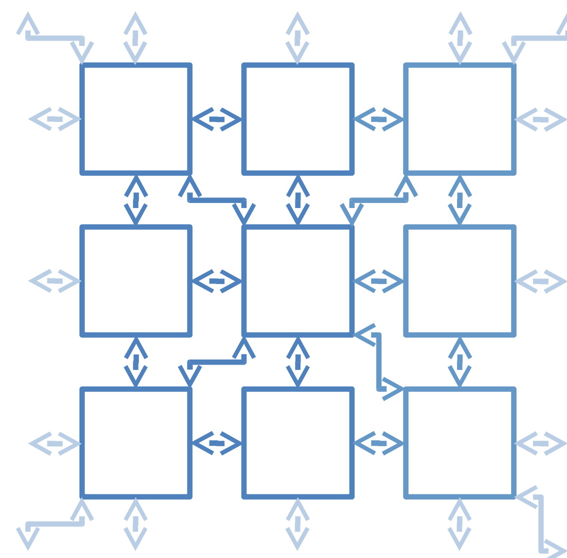
Balancing depth and distance

- The problem:

Find the path between the start and end points that minimises pump usage.

A*

- Our solution is to use an algorithm called A*.
- A* is a search algorithm; it searches graphs.
- To fit this model, we turn our domain into an 8-connected grid.



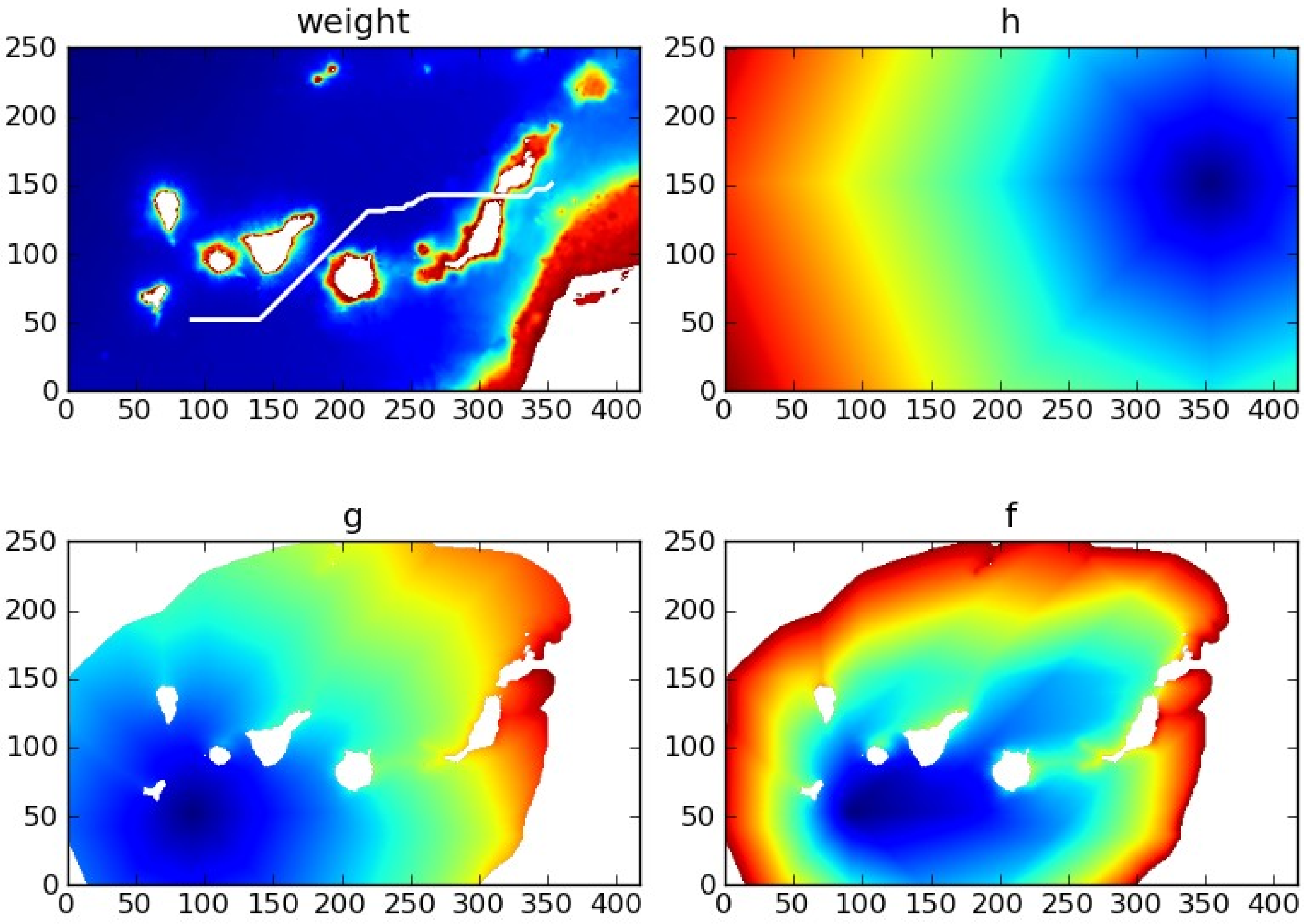
Individual weight per edge

h = estimated cost to the goal

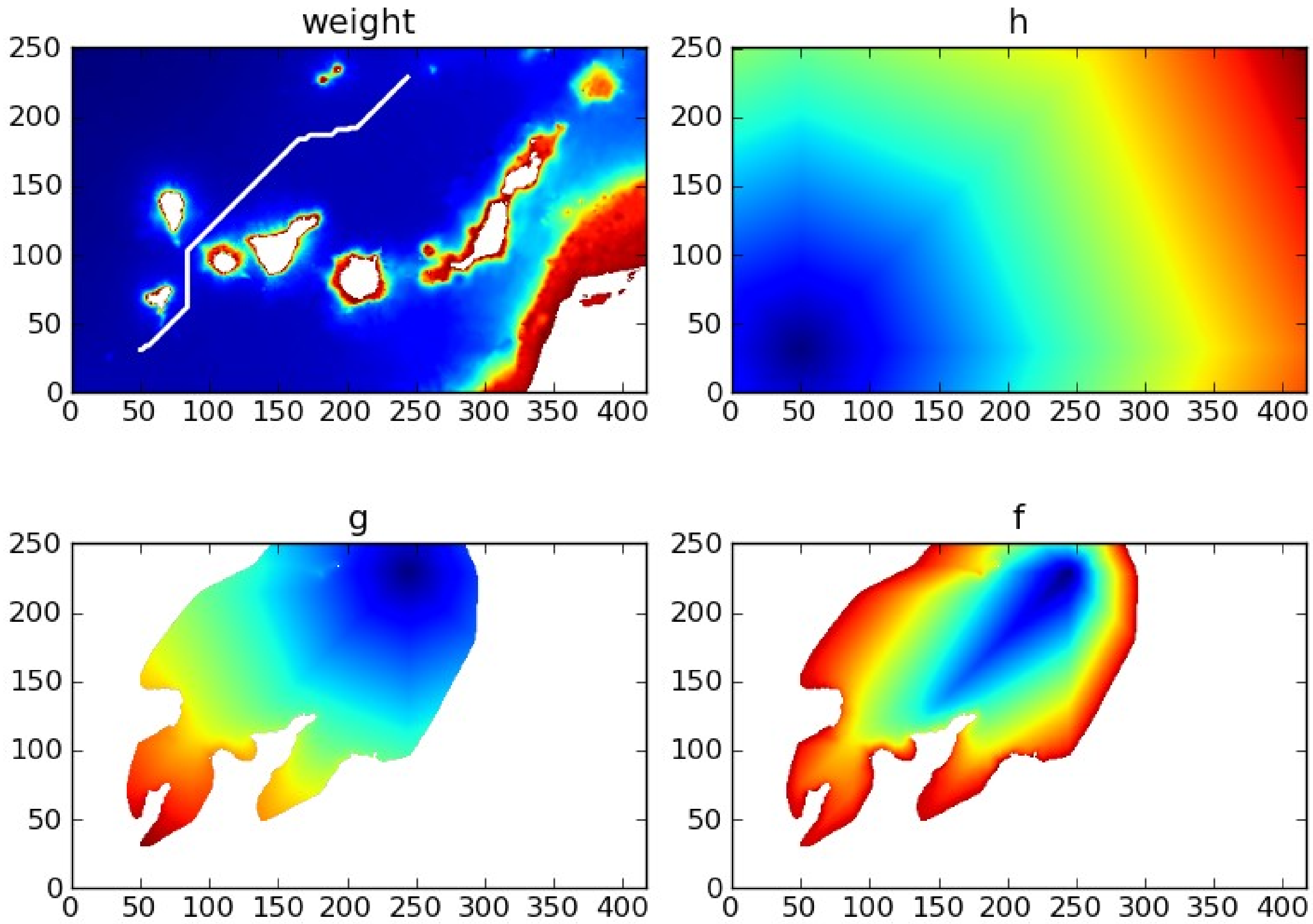
g = sum of weights from the start

$f = h + g$

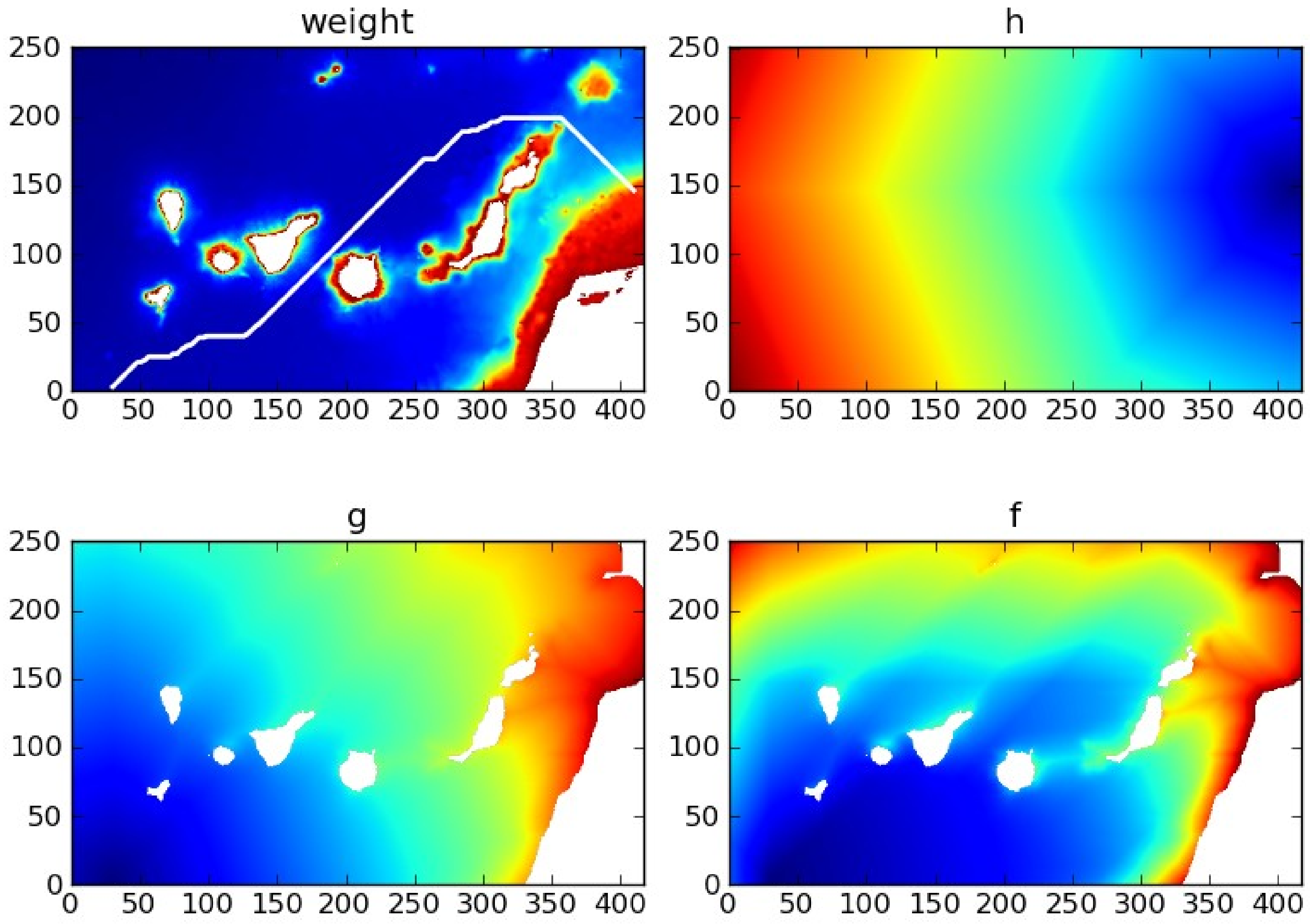
Some results (1/3)



Some results (2/3)

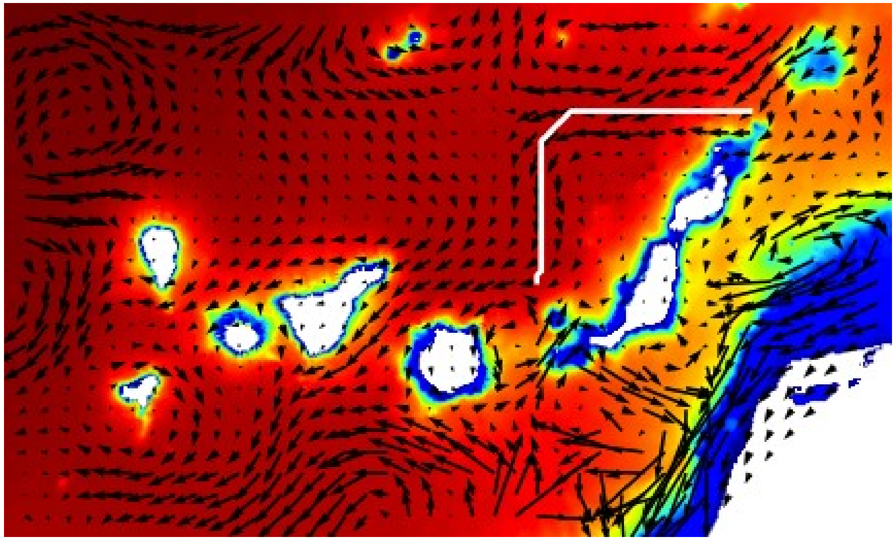


Some results (3/3)



Currents

- The method as presented so far assumes that distance travelled is proportional to energy expenditure wherever the glider is.
- Unfortunately the ocean is not so forgiving.



Conclusion

- We are trying to investigate methods for adaptive sampling.
- The method presented here is limited to finding paths between two points.
- We need to be able to handle interactions between two (or more) gliders.
- Adaptive sampling is a multi-objective optimisation problem.

Outline of future work

- Twin-model experiments in NEMO.
- Initially using idealised models.
- Assimilate from one model into another, allowing us to assess assimilation value.
- Ultimately implement adaptive sampling within the context of the Met Office's FOAM Mediterranean model.

Any Questions?

Garau et al. Path Planning of Autonomous Underwater Vehicles in Current Fields with Complex Spatial Variability: an A* Approach. Robotics and Automation, 2005. ICRA 2005. Proceedings of the 2005 IEEE International Conference on (2005) pp. 194 - 198