Improving path-planning for glider operations: A current-forecast based approach applied in the Gulf of St. Lawrence

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Abstract

Ocean gliders are a key platform that can fill the gaps between coastal and open ocean observing systems, between Argo floats, and moorings and ship-based strategies (Testor et al., 2019). One challenge for these slow-moving, primarily underwater systems, is to improve waypoint-based navigation to minimize the effects of wind and current driven dynamics. This is important in time-critical applications where there are advantages in reaching a site as quickly as possible, for example when monitoring storm systems or tracking eddies. Optimal path planning will also be important in long duration missions where battery consumption is a limiting factor of the deployment. In August 2019, a Slocum glider was deployed in the Gulf of St. Lawrence for preliminary system studies. During the deployment, a waypoint planning system was used to generate the glider waypoints list files. In this presentation, we will present the design of the path-planning system and show in-situ scientific measurements collected by the glider. The key optimized value assigned to enable path planning are minimizing current speeds and the key metric for validating the performance is the distance covered per hour. This approach has tremendous value for improving the autonomy of gliders in operational ocean monitoring applications, removing pressure from pilots managing the glider mission and improving the state-of-the-art of ocean data products.

Improving Ocean Glider Navigation

Results from Testing a New Glider Navigation Tool (GNT)

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SCAN ME

Challenge: Gliders are slow and sometimes become trapped in water features like eddies or frontal currents leading to mission failures.

Opportunity: Developing a new glider navigation tool (GNT) to efficiently go from A to B, improve battery use and reduce risks and pilot workload.

Objectives

[smart] Take advantage of ocean currents while making best possible headway towards destination

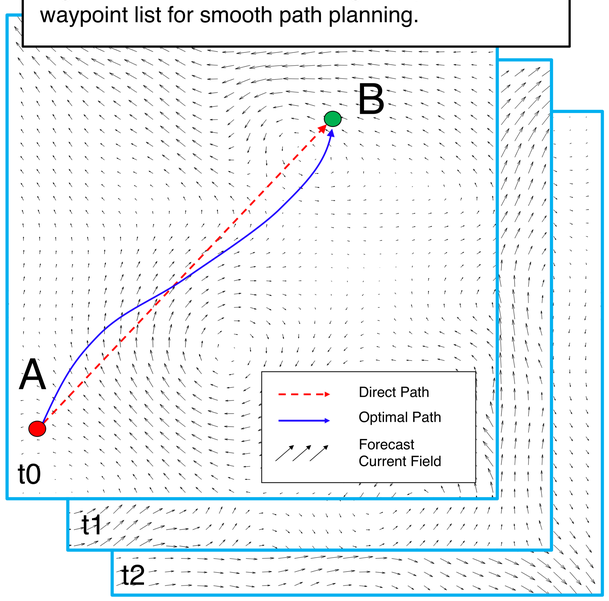
[reliable] Planned route reflects actual ocean conditions, reliable current forecast models

[helpful] Easy to use and implement, needs to be relevant to a mission, better and easier piloting

Concept

GNT combines forecast and hindcast model output

Algorithm produces optimized glider path, reduces waypoint list for smooth path planning.



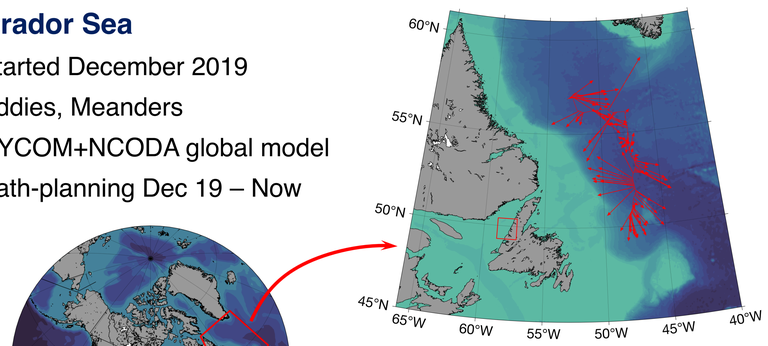
How It Works

Initiate Request (User) | GNT Processing (Automated) | Upload Result

Glider Deployments

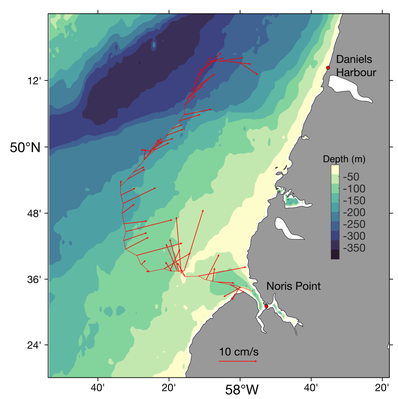
Labrador Sea

- Started December 2019
- Eddies, Meanders
- HYCOM+NCODA global model
- Path-planning Dec 19 – Now



Gulf of St. Lawrence (GOSL)

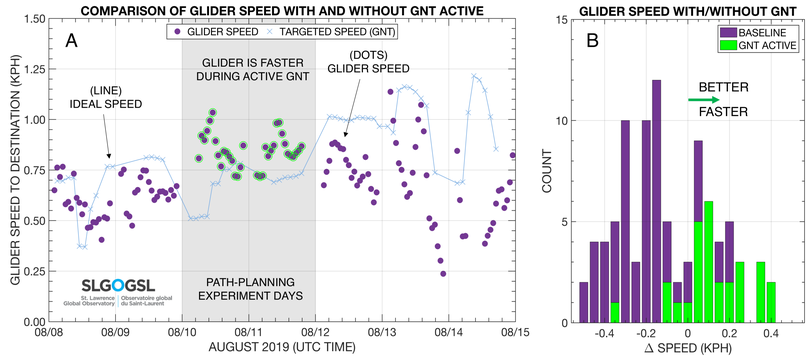
- August 2019
- 4x daily reversing currents
- GOSL local 24hr forecast
- Total mission 10 days
- Path Planning August 10-12



Conclusions

- The GNT improves the speed of the glider towards its destination by around 15%
- The target speeds from the GNT have so far matched up well with the actual glider speeds
- The GNT has been easy to use and runs fast enough for on-demand navigation planning

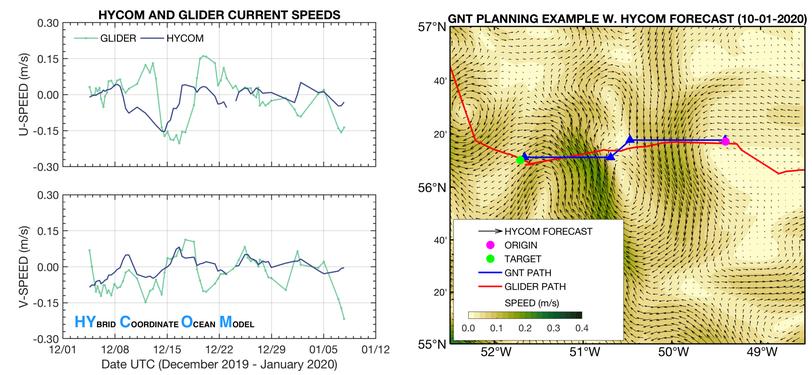
Gulf of St. Lawrence Results



Panel A: Glider and GNT planned speed towards direction of destination; greyed out area highlights the path planning experiment days August 10 – 12, 2019 during which the results of the GNT were actively sent to the glider. **Panel B:** Difference in glider and GNT speeds showing clear improvement during active path-planning days.

- Improved glider speed towards destination on average by 10-20% when using path-planning
- Close match between glider depth averaged and forecast model current speeds (scan QR code for more info)

Labrador Sea Results (Ongoing)



- The GNT improved the speed of the glider towards the destination in the Labrador Sea by 15% on average
- During the initial active GNT planning period from 19-30 December the glider travelled over 340 km (30+ km/day)
- The GNT is easy to use and works well providing on demand glider path planning
- HYCOM 24-hr forecast conditions and the depth averaged currents from the glider reveal good match

Acknowledgements

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