Observations of Arctic-Atlantic Ocean Flux using Autonomous Gliders
C. Eriksen and P.B.Rhines, University of Washington

Project Summary

We propose a program of high latitude observations of ocean physics and biology to be made with autonomous undersea vehicles, which can be queried and commanded in real time. Rapid climate change is occurring at high latitude. Freshwater of Arctic origin is spilling over the northern Atlantic, and it is predicted that its buoyancy will affect the global overturning circulation of the oceans, in addition to local effects on climate, circulation, sea ice and ecosystems. The Arctic-SubArctic Ocean Flux (ASOF) program is designed to provide observations in key areas between the Arctic Basin and the subpolar oceans, emphasizing measurements of currents and repeated hydrographic and tracer profiles. Such fields are particularly good indices of climate change, both in passages connecting Arctic and subpolar regions, and in ‘stable catchment basins’ where water masses record shift in climate.

Computer models of climate cannot accurately resolve key high-latitude processes, in part due to the fine spatial scales of oceanic freshwater, upper-ocean boundary layers and boundary currents, topography and ice fields. There is also rich temporal behavior from strong tides, diurnal, seasonal cycles as well as the sought-after decadal variability. It is these aspects of the ocean that the Seaglider, an autonomous undersea vehicle, is designed to observe.

The proposed 5-year deployments should yield more than 120,000 km of hydrographic and biological sections in support of the ASOF program, in the passages and basins connecting the Arctic Ocean, Nordic Seas, Labrador Sea and Atlantic oceans. Four Seagliders will be on continuous patrol, carrying sensors for temperature, salinity, dissolved oxygen, fluorescence and particle scattering. They will gather high-resolution data through all seasons. The Seaglider also can measure depth-averaged velocity. With geostrophy this gives estimates of the full velocity profile normal to its path. Emphasis will be on the rather fine-scale water-masses of the upper ocean, a region completely resolved by the Seaglider. The proposed program makes a substantial contribution to the hydrographic requirements of ASOF. The measurements will cover the northwestern Labrador Sea, the Davis Strait in summer, boundary currents and standard cross-sections of the Labrador Sea, the Iceland-Faeroe Ridge and Faeroe-Shetland Channel.

The depth of the sections initially will be 1000m, with 3 to 6 km horizontal resolution, yet proportionately higher finer resolution in shallower regions, and with real-time intensification of sampling at fronts. The glider’s effective speed depends upon the regime of currents through which it is passing, but averages 20km day\(^{-1}\) horizontally; the program can provide 24,000 km per year of sections, equivalent to about 8000 hydrographic stations per year. The sections will extend to full ocean depth following development of gliders with strengthened hulls (a development currently underway, funded by Office of Naval Research). The data will be integrated with Baffin Bay and Canadian Archipelago hydrography collected by Canadian and US elements of the ASOF program, by the Greenland-Norwegian Sea hydrographic work in ASOF and CLIVAR, and by CLIVAR-related hydrography in the subpolar Atlantic.

Intellectual merit. The proposed work will provide the first three-dimensional, regularly sampled image of the ocean circulation and water masses associated with Arctic outflows and global climate change. Ocean buoyancy, velocity and potential vorticity fields are key dynamical variables, while dissolved oxygen and multi-channel particle scattering are key biological variables. The observations will serve climate models as well as our conceptual understanding of high-latitude climate and our practical awareness of its consequences. They may explain the long-term upward trend of freshwater in the entire subpolar Atlantic. This is a step toward dynamical understanding and prediction of oceans and climate, and ultimately of the changing biosphere.
**Broader impacts.** The proposed work will contribute to the training and education of project-graduate students, and of a much larger audience of students who will be exposed to the first real-time, remotely commanded, trans-ocean observational research program ever to occur. Appropriate web-site presentation of glider observations will be publicly available. As Seaglider activity increases, in company with other modern remote and *in situ* sensing, we will begin to have a synoptic network recording the state of the oceans.