International Journal of Offshore and Polar Engineering
Vol. 14, No. 3, September 2004 (ISSN 1053-5381)

An Energy-conserving Oceanographic Profiler for Use Under Mobile Ice Cover: ICYCLER

George A. Fowler, Greg R. Siddall and Simon J. Prinsenberg*
Bedford Institute of Oceanography, Department of Fisheries & Oceans, Dartmouth, Nova Scotia, Canada

ABSTRACT

ICYCLER is a moored oceanographic profiler designed to measure surface-layer water properties under mobile ice cover. The profiler can provide daily 50-m salinity-temperature-chlorophyll profiles for a full year. Data are collected during each profiling ascent with an instrumented float that avoids ice impact by using an onboard echo sounder. Once measurements are acquired, the sensors are hauled back down to an ice-free depth. An efficient energy-conserving mechanical design minimizes power requirements to allow for autonomous operation using a logistically manageable and hydrodynamically efficient package. An ICYCLER prototype was successfully used in the Canadian Arctic Archipelago for a year-long deployment, and a second redesigned ICYCLER is being tested for Arctic deployment in the summer of 2004.

INTRODUCTION

Scientists suspect that our polar ice caps are melting, and that the additional freshwater being introduced could affect ocean processes and possibly change global ocean circulation. To address this, oceanographers need to measure the seasonal variability of freshwater flux from the Arctic Ocean through the Canadian Arctic Archipelago. The only way to do this, using current sensor technology, is to sample the water in situ near the surface, as this is where the freshwater is concentrated. The problem for oceanographers is that the surface of the Arctic Ocean is frequently covered with ice.

Suspending an instrument through the ice is often not practical because the ice is unstable for long periods of the year. To approach surface water from below has the advantage of making measurements at a fixed location, but Arctic ice is not of even thickness and is often mobile. Ice thickness can vary drastically where ice sheets have jammed together from the effects of strong currents or high winds. As these ice ridges sweep down-channel, instruments at a depth of 30 m or more are at risk. To address this problem, the Bedford Institute of Oceanography (BIO) has developed a new instrument called ICYCLER.

MOORING DESCRIPTION

Two-float System

ICYCLER is a mooring that profiles a suite of sensors through the ice-hazard zone from an ice-free depth. It uses a 2-float system (Fig. 1) to create a midwater platform from which profiling is initiated. This reduces energy consumption by enabling a small float to lift only the sensors towards the surface.

Ice Avoidance Strategy

Oceanographic measurements are made during each profiling ascent, and the data are relayed to electronics located on the midwater float via electromechanical cable. The electronics provide system control and data storage. Once an echo sounder detects a preset distance to the ice or open-water surface, the sensor float is immediately pulled down into deeper water.

Sensor Float

ICYCLER's sensor float (Fig. 2) uses a streamlined OpenSeas SUB fairing (Hamilton, Fowler and Belliveau, 1997) to enclose a Seabird 19+ CTD with pump and a Wetlabs fluorometer to collect data, while a Datasonics echo sounder monitors the distance to the underside of the ice during each profile. The echo sounder is angled to look slightly forward of the float to anticipate moving ice, and to compensate for float pitch caused by hydrodynamic drag on the tail during ascent. The CTD pump draws water from outside the enclosure through an anti-foulant device located at the entry point.

Energy-conserving Mechanical Design

ICYCLER uses an energy-conserving mechanical design to reduce battery weight, thus gaining buoyancy without increasing platform size. This approach is proving to be an efficient method of maintaining performance in higher water-flow conditions, and it improves the ability to deploy the instrument from ships of opportunity.

To achieve this, ICYCLER mechanically stores the energy gained from the ascent portion of a profile and uses this stored energy to power the descent phase. The only energy consumed during the profiling cycle is what's lost to mechanical inefficiencies and imbalanced float drag.

The midwater float contains a winch assembly with 2 drums. The winch operates both drums simultaneously and is configured to pull the midwater float down through the water column as the sensor float rises towards the surface. On the next phase of the cycle, the sensor float is winched down while the midwater float is allowed to float back up to its original depth. By varying the ratios of float buoyancies and depths traversed, most of the profiling energy can be conserved.

---

*ISOPE Member.

Received March 8, 2004; revised manuscript received by the editors July 22, 2004. The original version (prior to the final revised manuscript) was presented at the 14th International Offshore and Polar Engineering Conference (ISOPE-2004), Toulon, France, May 23–28, 2004.

KEY WORDS: ICYCLER, SeaMotor, profiler, energy-conserving, mooring, ice.