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SUCA: An engine for repetitive autonomous profiling near the ocean surface

Craig L. Stevens, Peter Hill, Murray J. Smith, and Stéphane Popinet*
National Institute for Water and Atmospheric Research, Greta Point, PO Box 14-901, Kilbirnie, New Zealand

Abstract

The SUCA (SUbmerging Controller Addition) is a robust engine for repeated profiling (yo-yoing) in near-surface waters. It connects to a number of existing oceanic sampling packages and enables many hundreds of profiles to be made over the upper 10 m or so of the ocean or lake in a relatively short period. The workings of the unit are described along with an estimate of power requirements and the wind-limited maximum depth. An advantage of the SUCA is that it enables the entire sampling package to be positively buoyant. The engine has proven to be a simple and robust device that is flexible enough to work with a range of sampling packages in a variety of locations including long-swell Southern Ocean conditions and choppy coastal waters.

Quantifying variability in the upper few meters of the ocean is of primary importance for understanding momentum and mass transfer between the ocean and atmosphere (Agrawal et al. 1992; Gemmrich and Farmer 2004; Stevens and Smith 2004). Near-surface variability is not confined to dissipative scales. Horizontal transects of near-surface temperature show substantial variability at wavelengths of 10 to 1000 m (e.g., Wijesekera et al. 2001; Bowman et al. 1973). It is likely that other biogeochemically important properties will vary on similar scales. Accurate determination of these properties has a substantial influence on estimation of biogeochemical processes such as gas-exchange and vertical mixing of phytoplankton (e.g., Ward et al. 2004*a*; MacIntyre et al. 2001; Law et al. 2003).

The usual approach to providing near-surface vertical profiles of microscale properties is through the use of some form of timed-release ballast from an otherwise positively buoyant profiler with the sensor-end facing upwards (Carter and Imberger 1986; Soloviev et al. 1988; Anis and Moum 1995). This is labor intensive and not particularly suited to recording many tens of profiles in as short a time as possible. Additionally, the approach necessitates profiling near to the support vessel, which is typically generating substantial flow distortion and a turbulent wake. Near-surface biogeochemical properties are typically sampled from a ship paying only moderate attention to flow distortion by the vessel and no attention to variability.

Multi-parameter profilers are becoming more readily available (e.g., Wolk et al. 2002; Ward et al. 2004*b*) that can measure many of the properties relevant to turbulence estimation (shear, thermal, and salinity variance) and biogeochemical processes (chlorophyll, light, transmissivity). What is required is a way of remotely and repeatedly profiling a sensor package upwards with as little time between profiles as possible. One approach is for a remote profiler to automatically modify its own buoyancy repeatedly. An example of this is the SOLO float (Davis et al. 2001) used in the ARGO drifter program (Turton 2003). These autonomous floats cycle up and down through several thousand meters of water. However, by their very nature, they have a slow dynamic response and are very finely tuned in terms of buoyancy. The repeat-profiler SkinDeEP also uses the SOLO vehicle and is normally negatively buoyant but employs the SOLO gas-filled collar to give a periodic switch to positive buoyancy (Ward et al. 2004*b*).

There are benefits to working with a package that is always positively buoyant, not the least of which is some potential of recovery in the event of a surface tether or power failure. This article describes an engine for driving the repeated profiling of

*E-mail: c.stevens@niwa.cri.nz

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