

Scientific Paper:

Environ. Sci. Technol. (2011) 45, 700 - 705

Determination of Dissolved Oxygen in the Cryosphere: A Comprehensive Laboratory and Field Evaluation of Fiber Optic Sensors

E. A. Bagshaw¹, J. L. Wadham¹, M. Mowlem², M. Tranter¹, J. Eveness^{1,3}, A. G. Fountain⁴, and J. Telling¹

¹Bristol Glacial Centre, University of Bristol, UK

²National Oceanography Centre, University of Southampton, UK

³Current address: ABB Sensors, Gloucestershire, UK

⁴Departments of Geology and Geography, Portland State University, US

Abstract:

Recent advances in the Cryospheric Sciences have shown that icy environments are host to consortia of microbial communities, whose function and dynamics are often controlled by the concentrations of dissolved oxygen (DO) in solution. To date, only limited spot determinations of DO have been possible in these environments. They reveal the potential for rates of change that exceed realistic manual sampling rates, highlighting the need to explore methods for the continuous measurement of DO concentrations. We report the first comprehensive field and laboratory performance tests of fiber-optic sensors (PreSens, Regensburg, Germany) for measuring DO in icy ecosystems. A series of laboratory tests performed at low and standard temperature (-5 to 20 °C) demonstrates high precision (0.3 % at 50 µmol/kg and 1.3 % at 300 µmol/kg), rapid response times (< 20 s) and minimal drift (< 0.4 %). Survival of freeze thaw was problematic, unless the sensor film was mechanically fixed to the fiber and protected by a stainless steel sheath. Results of two field deployments of the sensors to the Swiss Alps and Antarctica largely demonstrate a performance consistent with laboratory tests and superior to traditional methods.

Keywords: glacial aquatic environments, microbial communities, dissolved oxygen measurement, biogeochemical cycles, meltwater, sensor test