Field Testing of the Nereus Network

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Measuring chemical and physical properties of natural water bodies with sufficient spatiotemporal resolution is a difficult problem when studying or monitoring processes that are transient, or produce steep spatial gradients or plumes. To address this problem, the Nereus underwater mass spectrometer has been deployed aboard an autonomous underwater vehicle (AUV). In addition to providing much-increased spatiotemporal coverage, the mass spectrometer/AUV combination obviates the need for sample preservation and is able to identify and quantify a wide variety of dissolved volatile chemicals. The analytical capabilities of a mass spectrometer, combined with those of a standard water quality multiprobe, provide measurement of a wide and useful range of parameters including pH, temperature, salinity, turbidity, and Pt electrode potential as well as multiple dissolved gas species such as methane, oxygen, nitrogen, and carbon dioxide.

The Nereus mass spectrometer/AUV is part of a hybrid data network that uses both radio (for overwater) and acoustic (for underwater) communication for the collection of chemical and physical data in real time. The network also includes fixed sensors located on buoys, providing continuous time records of such baseline parameters as thermal structure of the water column. In addition to providing real time data from instruments and sensors, the network provides AUV tracking information, and potentially can control the AUV and its instruments, whether surfaced or underwater, as part of an adaptive sampling system. To be accessible to a wide variety of potential users, the network is based on open-source software and low-cost off-the-shelf components.

We describe recent field results of the system at our test site in Upper Mystic Lake near Boston, MA, particularly as they relate to key practical issues such as i) creating electrical and mechanical interfaces between the mass spectrometer and an AUV, ii) providing autonomous, but remotely modifiable, operation of the mass spectrometer, iii) providing adequate localization of the AUV when submerged, and iv) obtaining real-time acoustic transmission of mass spectrometric data during submerged missions in an acoustically challenging environment. In addition to providing greatly expanded chemical data sets, we suggest that streams of spatiotemporally-diverse, real-time chemical data such as in-situ mass spectrometry can provide will also facilitate advances in research methods heretofore not traditionally applicable to studies of natural water geochemistry, such as real-time adaptive sampling and data fusion methodologies.