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APPLICATIONS OF SATELLITE OCEAN COLOR IMAGERY FOR DETECTING AND MONITORING HARMFUL ALGAL BLOOMS IN THE OLYMPIC PENINSULA REGION

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ABSTRACT

Harmful algal blooms (HABs) attributed to *Pseudo-nitzschia* species, a diatom that produces Domoic acid, are a common occurrence and serious threat along the coast of the US Northwest. Monitoring these events or providing advanced warning of their occurrence at the coast would provide an important aid to fisheries managers. Remote sensing, which is being used in the Gulf of Mexico for HAB detection and forecasting (of a different algae), could provide a tool for monitoring and warnings. Chlorophyll and SST imagery are being used to support a research and monitoring program for the region, and HAB monitoring techniques used in the Gulf of Mexico are being examined for their potential utility along the Washington coast. The focus of this study is to determine the efficacy of using satellite ocean color imagery for HAB monitoring off of Washington's Olympic Peninsula region, and to provide support in the form of ocean color imagery products for management and mitigation efforts.

BACKGROUND

Harmful Algal Blooms (HABs) are a common occurrence in the coastal waters of the North Pacific. Of particular concern are HABs that are attributed to *Pseudo-nitzschia* species, a group of diatoms that produce the neurotoxin Domoic acid (Trainer et al., 2002). Domoic acid (DA) causes permanent short-term memory loss in victims and is associated with the syndrome commonly referred to as amnesic shellfish poisoning (ASP). Domoic acid has also been documented to cause marine mammal deaths off of the coast of California (Scholin et al., 2000). In addition to health implications for humans and animals, HAB events along the Washington coast have an economic impact and are of particular concern to U.S. state agencies, coastal Native tribes and businesses that rely on shellfish harvests.

Currently, the ORHAB (Olympic Region Harmful Algal Bloom) project is working to mitigate the negative health, ecological, and economic impacts of harmful algal blooms by improving methods for HAB detection and monitoring. This study focuses on the development and support of remote sensing methods, specifically SeaWiFs ocean color imagery, to aid the ORHAB project in its goal of mitigating the effects of HABs along the coast of Washington.

METHODS

Processing of 9-km SeaWiFs data: Monthly climatologies were created using SeaWiFs 9-km data. The monthly means were used to identify regional chlorophyll patterns that may correlate with *Pseudo-nitzschia* spp. bloom events.

Processing of 1-km SeaWiFs data: Daily SeaWiFs imagery was processed using the standard SeaWiFS global chlorophyll algorithm (O'Reilly et al., 2000). Daily chlorophyll imagery was created and made available to the ORHAB partners. In addition to providing the necessary data for an anomaly-detection method, this imagery can be used to analyze temporal and spatial distributions of *Pseudo-nitzschia* spp.

Assessment of anomaly technique for detecting HABs: The HAB detection technique for *Karenia brevis* in the Gulf of Mexico involves locating new blooms (Stumpf et al., 2003). Using SeaWiFs 1-km resolution ocean color imagery, climatological two-month running chlorophyll means are created (Tomlinson et al., in press). These two-month running means end two weeks before the current day. The current-day SeaWiFS image is then subtracted from this two-month running mean. Areas within the resultant image that exhibit a chlorophyll increase are marked to determine the temporal and spatial distributions of chlorophyll features. These features are being used to compare with distributions of *Pseudo-nitzschia* spp. in the Olympic Peninsula region.

Assessment of data improvement methods: For the anomaly technique and related detection methods, accurate baseline chlorophyll is needed to differentiate between natural variability and toxic-induced events. However, cloud ubiquity in the northwest makes SeaWiFS 1-km data unusually gappy. Methods of data interpolation, including data-filling techniques which utilize observed decorrelation scales of chlorophyll (Abbott and Letelier, 1998), were investigated for mitigating the effects of cloud-contamination in the SeaWiFs imagery to obtain a cloud-free baseline.

MANAGEMENT IMPLICATIONS

A major goal of the ORHAB program is the development and implementation of rapid detection technologies to complement current monitoring strategies, thus offering the best protection from human exposure to toxins. Chlorophyll and SST ocean color imagery can be used to track occurrences of high chlorophyll and associated algal blooms. This data can then be used by the ORHAB partners to track the transport of *Pseudo-nitzschia* spp. cells to the Washington coast.

FIGURES

Figure 1 a-c
Pseudo-nitzschia contours from the NH8 cruise, August 11-13, 1998, superimposed on images of anomaly, SST, and chlorophyll. Imagery and cell-count data is provided courtesy of the Marine Biotoxins Program, Northwest Fisheries Science Center.

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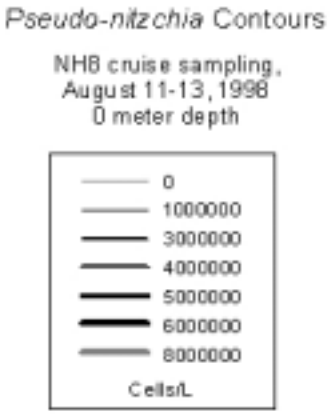

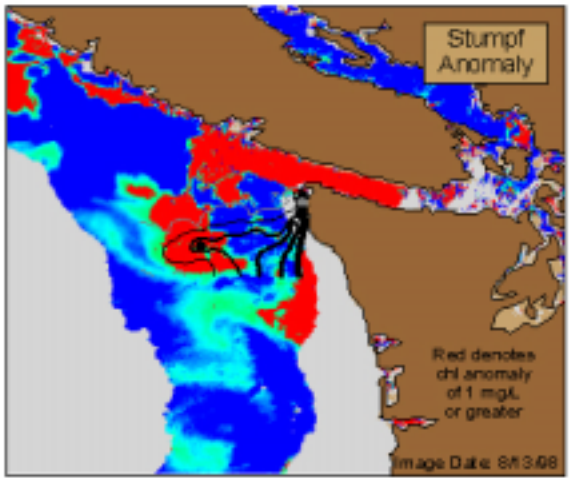

Figure 1a

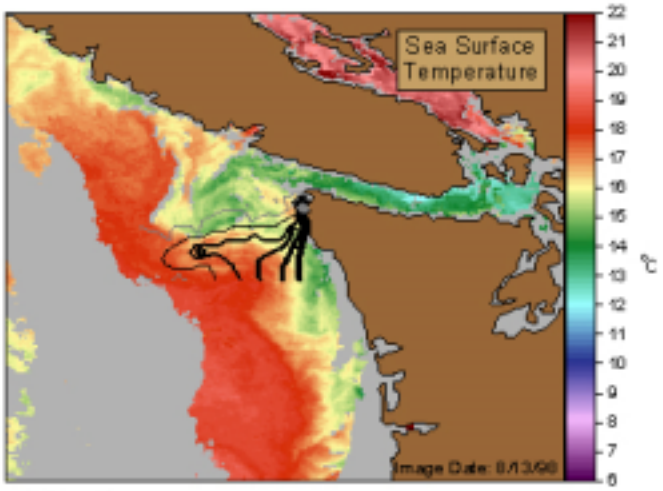

Figure 1b

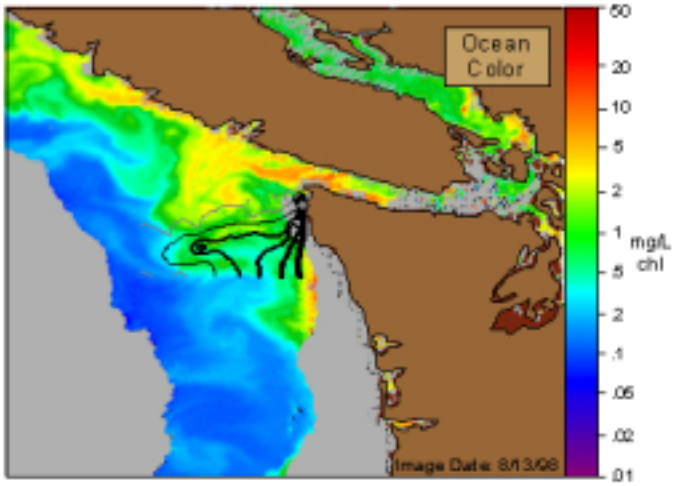

Figure 1c