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Transport of surface waters from the Juan de Fuca eddy region to the Washington coast

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Abstract

A seasonal cold eddy located off the mouth of the Strait of Juan de Fuca has been implicated as an initiation site for toxic HABs affecting the Washington coast. To investigate the fate of eddy waters, a diagnostic finite element circulation model was developed for this region and the northern Washington shelf. The model was based on hydrographic data from several cruises in the summer of 1998, a year in which record levels of toxin were measured in razor clams at Washington beaches. Additional model forcing included tides and surface wind stress typical of fair weather/upwelling conditions or fall storms.

The model showed strong retention in the eddy and a preferred southeastward trajectory for model drifters leaving the eddy. ARGOS-tracked drifters released in the vicinity of the eddy in the summers of 2001 through 2003 were consistent with model results generated with 1998 data demonstrating the robust nature of the large-scale currents in this region. Model and true drifter results show that the Juan de Fuca eddy is an important source region for PNW shelf waters. Furthermore, both model and true drifters moved onshore during storms suggesting that surface waters of the Juan de Fuca eddy can impact the Washington coast.

Keywords: Juan de Fuca eddy; Harmful algal blooms; Circulation; Washington; Vancouver Island

1. Introduction

The Juan de Fuca eddy, an important component of the summer circulation off the northern Washington coast and southwestern Vancouver Island, has recently been implicated as a potential source region of toxic *Pseudo-nitzschia* blooms which impact the Washington coast (Trainer et al., 2002). Several species of diatoms in this genus are known to produce the neurotoxin domoic acid, which enters the food chain through planktivorous fish and shellfish. Surveys conducted during the

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summer of several years indicate that *Pseudo-nitzschia* in the vicinity of the Juan de Fuca eddy are more likely to produce the toxin than blooms in nearshore upwelling regions (Trainer et al., 2002).

The eddy is a cyclonic cold feature located off the mouth of the Strait of Juan de Fuca on the southern British Columbia shelf. This region is one of extremely complex bathymetry (Fig. 1). The shelf width varies from 40 to 100 km, with maximum width off the mouth of Juan de Fuca Strait. Shallow banks are separated by numerous deep canyons including the 400 m deep, ~10 km wide Juan de Fuca canyon which bisects the shelf. The canyon makes several sharp bends before entering the strait. Deep upwelled water passes through the canyon and enters the strait as a compensating flow to the surface estuarine outflow (Mackas et al., 1980).

First identified by Tully (1942), the eddy was the subject of several studies in the 1980s (Freeland and Denman, 1982; Denman and Freeland, 1985; Freeland and McIntosh, 1989). These studies showed the eddy to be a seasonal feature, developing around the time of the spring transition and declining in the fall. During this period, typical alongshore winds are from the northwest and force a seasonal mean southeastward shelf break current over the slope and outer shelf. These shelf currents are oppositely directed to the buoyancy driven Vancouver Island coastal current (VICC), which flows northwestward from the mouth of Juan de Fuca Strait adjacent to the west coast of Vancouver Island (Thomson et al., 1989;

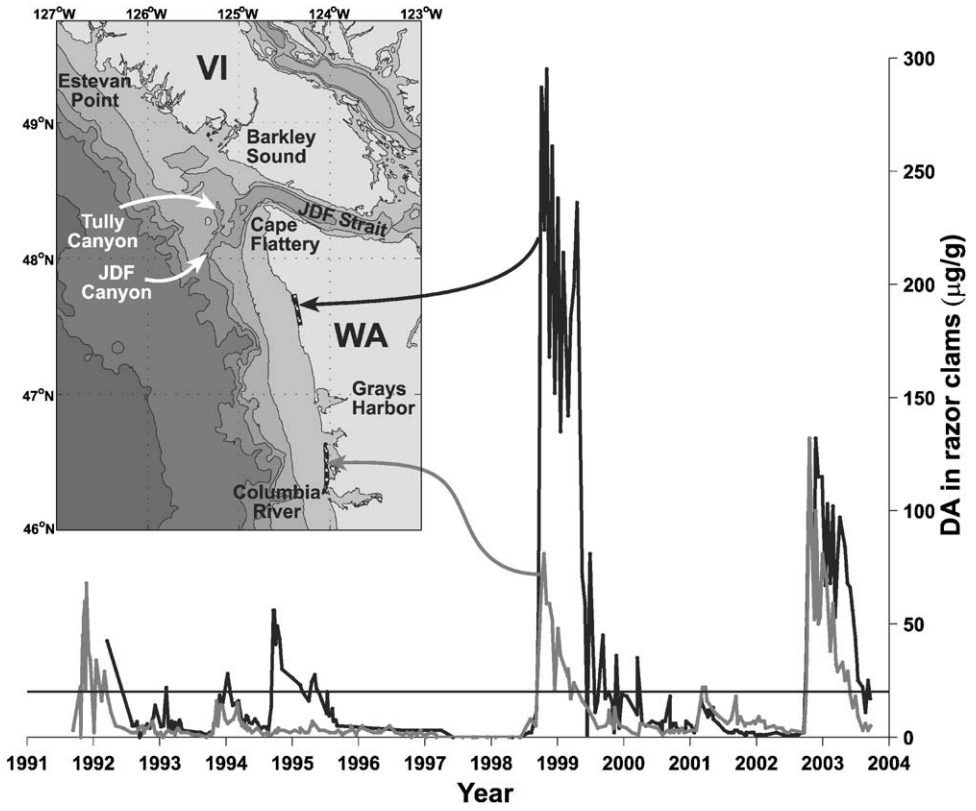

Fig. 1. Time series of domic acid measured in razor clam tissue by the WA state Department of Health at northern and southern clamming beaches. Inset shows WA and southern VI shelf bathymetry and location of places mentioned in the text. Bathymetry contours depicted here and in subsequent figures are 2500 m, 1000 m, 500 m, 180 m and 100 m.