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INTRODUCTION TO PHYSICAL OCEANOGRAPHY

UNIVERSITY OF VICTORIA

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First printing, September 2026

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Foreword

These are the course notes for Descriptive Physical Oceanography, taught at the University of Victoria, School of Earth and Ocean Sciences, a 13-week undergraduate course.

Unlike many physical oceanography courses, students taking this course are not expected to have studied vector calculus or differential equations, nor are they expected to have learned classical mechanics beyond what is typically offered in a first-year physics course. Many of the students have a deep interest in understanding the ocean and often approach the course with considerable intuition. The challenge of a course like this is to offer more than just a list of facts, but rather to try to give a feeling for the forces that drive the ocean, without becoming too bogged down in mathematical formalism. As such, this course tries to strike a balance between knowing about the various physical phenomena in the ocean and understanding the dynamics that give rise to them, while still giving students some practice in practical calculations.

The course is divided into three unequal parts: overturning circulations driven by lateral buoyancy differences and mixing; waves and tides; and wind-driven circulations. We start with estuaries as a nice introduction to overturning circulations, but also because the students do work in Saanich Inlet, and understanding estuaries early is very helpful.

Part I

Overturning circulations

Part II

Waves and Tides

Part III

Wind-driven circulations

10

Wind-driven circulation overview

As discussed the overturning circulation is rather weak in the global ocean, but is very important for the climate as that is how deep water stores heat and carbon. However, the major ocean currents (other than tides) are typically driven by the winds.

This chapter provides some data with minimal discussion that shows two example flows that we are interested in for the following chapters. The first is wind blowing along a coast. Such a wind drives coastal upwelling and downwelling and is very important for the ecosystem of the coast. The second is the large-scale circulation of the North Pacific basin.

10.1 Coastal upwelling

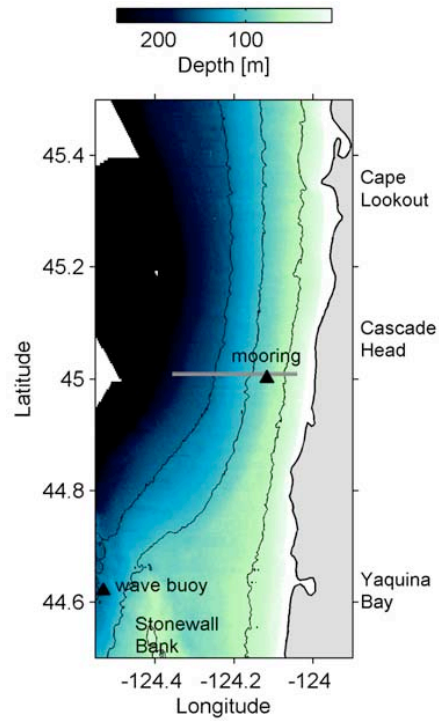


Figure 10.1: Location of coastal observations. A ship transited the line at 45°N repeatedly over an 8-day period.

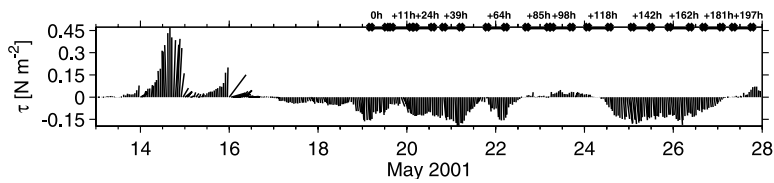


Figure 10.2: Wind stress arrows, where the wind direction is indicated by the arrow direction, and is mostly north (positive) and south (negative). During the cruise (dots along top axes), winds were mostly towards the south, except for a brief reversal 23-24 May.

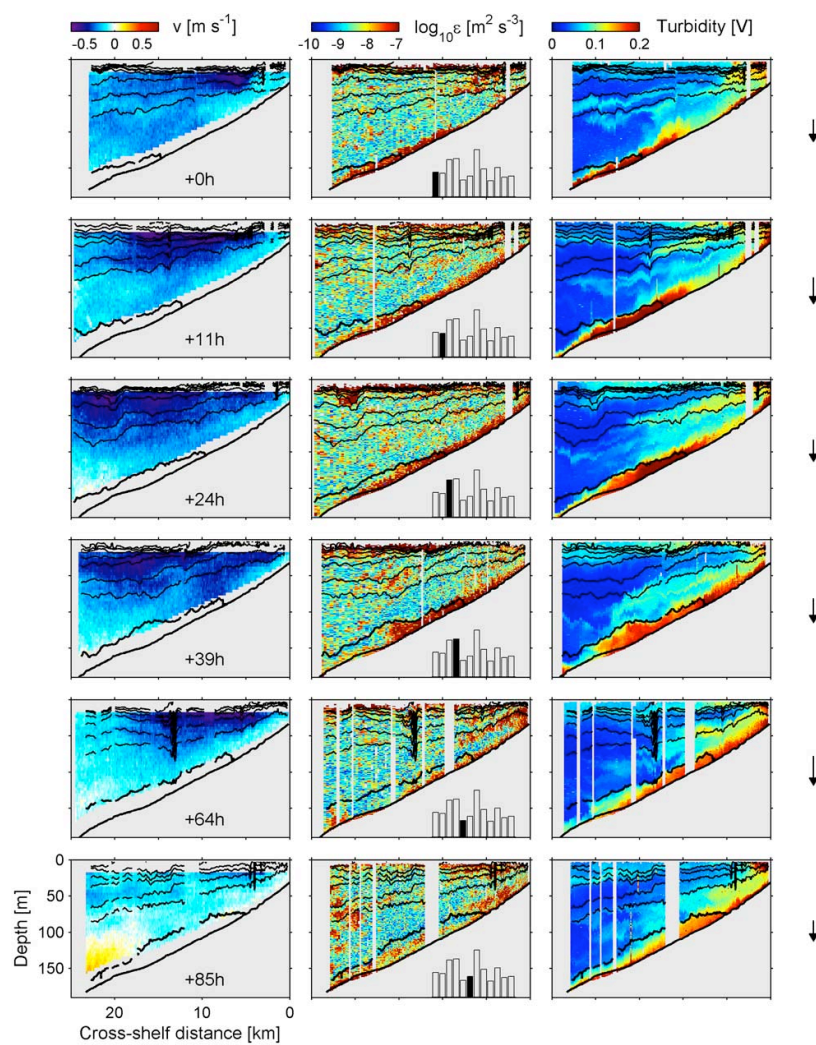


Figure 10.3: Observations from the ship. Black contours are potential density. The left column shows along-shelf current speed, blue meaning towards the south. The middle column shows the strength of turbulence in the water column, yellow/red being more turbulent. The right column shows turbidity, a measure of particles suspended in the water column. the arrows on the far right are the wind stress vectors.

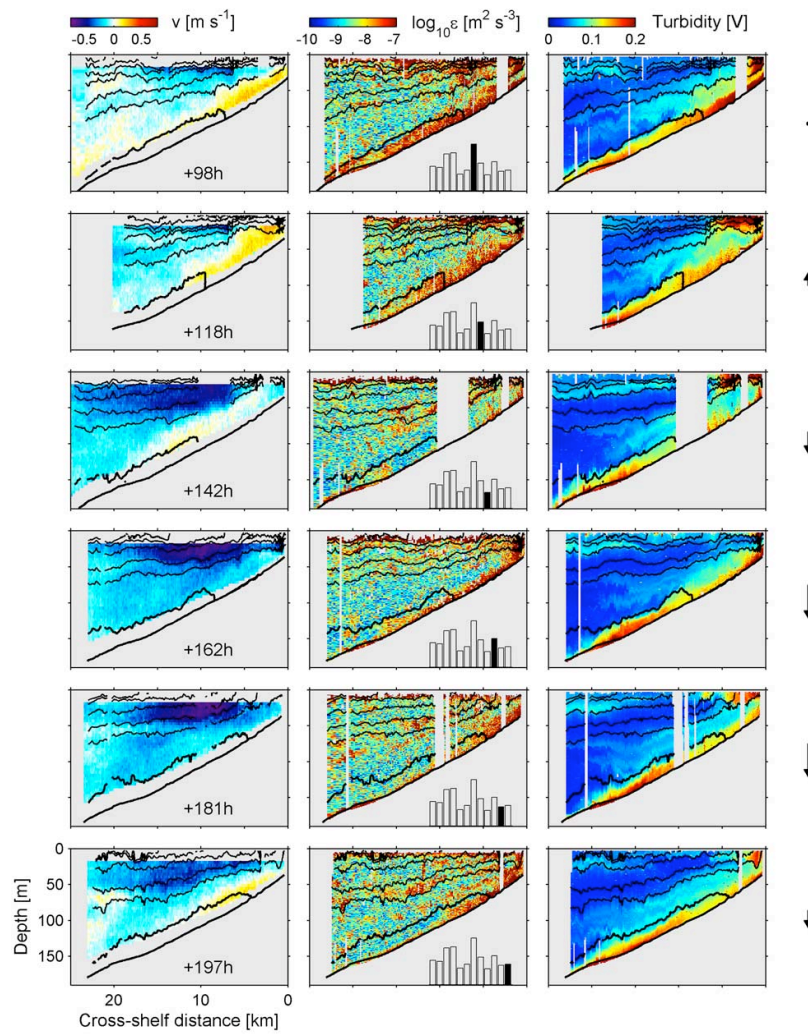


Figure 10.4: As in figure 10.3. Note the wind reversal and then resumption of wind blowing to the south.

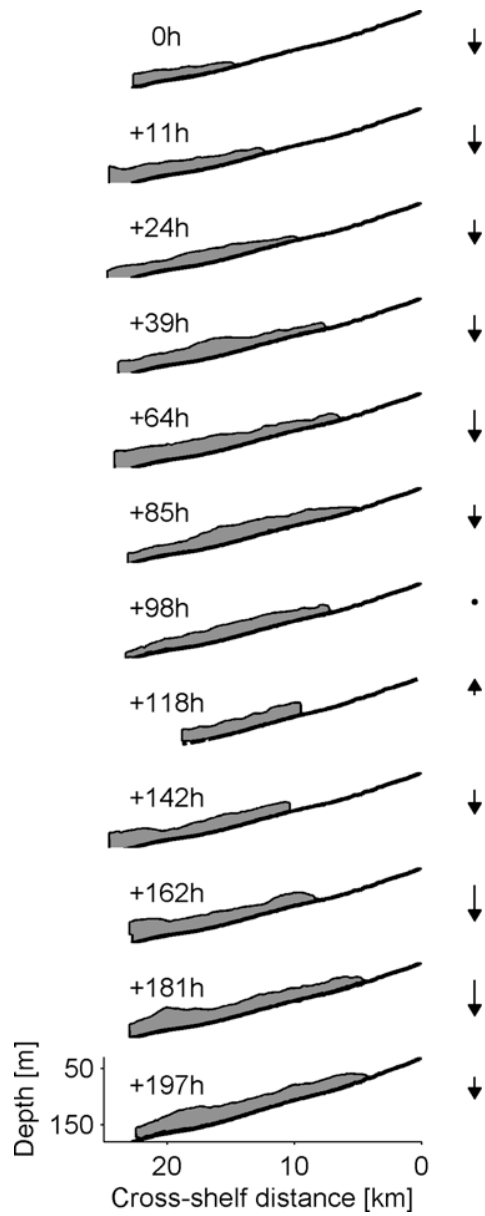


Figure 10.5: Same density data as figure 10.3 and figure 10.4, highlighting the motion of the bottom boundary layer up and down the shelf. During peak upwelling the speed is about 6 km/d.

10.2 North Pacific observations

