

Cold One Day, Warm Another?

Lesson Time : 60 minutes

Grade Level : 9-12

Vocabulary: Coriolis force, coastal front, upwelling, downwelling, wind vectors

Summary

Using water temperature and wind vector data from the U.S. Army Corps of Engineers Field Research Facility explore trends in nearshore upwelling.

Objectives

- Discuss the forces that contribute to upwelling and downwelling.
- Examine the relationship between wind and water temperature.
- Assess changes in water temperature and wind vectors.

Introduction

People often ask staff at the US Army Corps of Engineer’s Field Research Facility (FRF) why water temperatures change so rapidly on the Outer Banks of North Carolina — not an easy question to answer since the ocean currents of this region are very complex. This area is the southernmost extent of cold and relatively low saline Labrador Current water that travels south along the coast, then mixes with the warm higher saline water of the northerly flowing Gulf Stream. As the Gulf Stream passes Cape Hatteras, it moves in a northeast direction, sometimes shedding rings, or eddies, of warm water that mix with the coastal water. Satellite imagery of sea surface temperature is useful in identifying different water masses.

Water flowing out of Chesapeake Bay also has an influence on our coastal waters. As low saline water leaves the bay, it is less dense than the ocean water and tends to float on the surface. This water may flow south down the coast to the Outer Banks, most likely when there is a wind from the north. Coriolis force, which causes currents to bend to the right of their direction of travel in the northern hemisphere, will help keep this water against the coast. These flows are often visible as a coastal front traveling south.

In addition, the wind has a dramatic effect on driving currents. Generally, the coastal water has warmer (less dense) water on the surface and cooler (denser) water below. Wind blowing offshore can push the surface water along with it; colder water from below replaces the surface water, a process called upwelling. Conversely, an onshore wind can transport the warm surface water shoreward pushing the cold water below, a process called downwelling.

Data Activity

Six temperature sensors are used to monitor the water temperature at the end of the FRF pier. The following plots show water temperature for 15 days (horizontal axis) from the surface to 7m depth (vertical axis). Wind vectors are computed in FRF coordinates from an anemometer (gauge 932) located at the end of the pier and are shown below with water temperature profiles for 1-15 and 15-31 of July 2002 and 2003.

Use the appended graphic to answer the discussion questions below.

Discussion

- What trends in water temperature and wind direction do you see for July 2002?
- What correlation do you see between the patterns of water temperature and wind direction for July 2002?
- What trends in water temperature and wind direction do you see for July 2003?
- What correlation do you see between the patterns of water temperature and wind direction for July 2003?
- What were the differences in water temperature and wind direction between July 2002 and July 2003?
- What effect does the change in water temperature have on the surrounding environment? (Hint: How does it affect fish, fishermen, surfers, vacationers?)

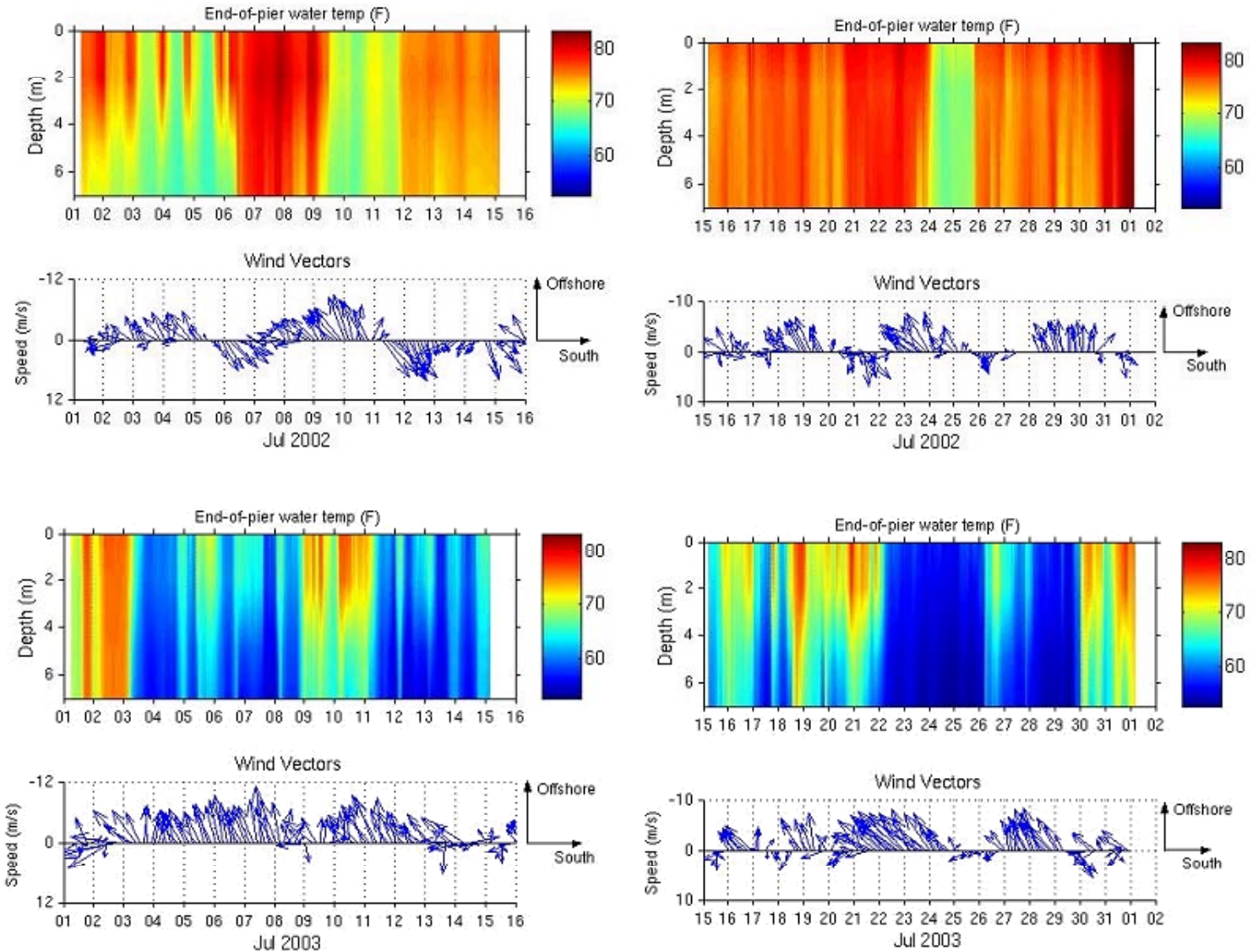
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For more data-based lessons, visit: bridgeoceaneducation.org/data-series.

Upwelling: Cold One Day, Warm Another

Bridge Data Activity

www.marine-ed.org/bridge/



Data from the U.S. Army Corps of Engineers Field Research Facility (<http://frf.usace.army.mil/frf.shtml>)