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SCIENCE DIRECT
Estuarine, Coastal and Shelf Science 65 (2005) 405–420
ESTUARINE COASTAL AND SHELF SCIENCE
www.elsevier.com/locate/ECSS

Coastal oceanographic regimes of the Northern Argentine Continental Shelf (34–43 °S)☆

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Received 20 September 2004; accepted 15 June 2005
Available online 19 September 2005

Abstract

The oceanographic regimes of the Northern Argentine Continental Shelf (NACS, 34°–43 °S) are derived from advected waters of subantarctic origin, local sources of continental run-off, and a locally generated salinity maximum. Based on 3690 CTD profiles, monthly mean wind fields at coastal stations, and river discharge data, we define the oceanographic regimes over the shelf by analyzing salinity characteristics and spatial distribution: (1) a maximum in salinity (33.7–34.2) originating from the Gulf of San Matías; (2) a relative salinity minimum (30.0–33.3) of the El Rincón estuarine system; (3) a salinity minimum (0–33.0) originating in the Río de la Plata; and (4) waters of the continental shelf (33.5 and 33.7). Temperature over the shelf is controlled by sea–air heat exchange coupled with bathymetry. An analysis of the Simpson parameter of stability (ϕ) provided an objective definition of a vertically homogenous coastal zone separated from seasonally stratified shelf waters south of 37 °S. Bottom temperature gradients and synoptic sections in the winter and spring indicate the presence of a shallow sea front at the 40–50-m isobaths south of 37 °S, persistent throughout the year. We define two seasonal periods, autumn–winter and spring–summer, based on seasonality in monthly mean winds fields, continental run-off, fresh water balance and the spatial distribution of salinity signals. Maximum seasonal variation in the extent and location of the oceanographic regimes occurs within the coastal zone. In the autumn–winter period, we observe a northward extension of the Río de la Plata and Gulf of San Matías waters, as well as a reduction of the El Rincón and Continental Shelf waters near the coast. The spring–summer period is characterized by Río de la Plata waters flowing to the south and east, a reduction of Gulf of San Matías waters and an invasion of El Rincón and Continental Shelf waters into the coastal areas. In a general sense, waters across the NACS undergo a seasonal oscillation in distribution and extension that implies a spring–summer reversal of the characteristic shelf-wide north–northeastward direction of flow within the coastal zone.

Keywords: coastal oceanography; estuaries; fronts; stratification; Gulf of San Matías; El Rincón; Río de la Plata; Northern Argentine Continental Shelf; 34–43 °S; 53–65 °W

1. Introduction

The Argentine Continental Shelf (34–55 °S) is a broad, shallow platform covered by waters of subantarctic origin, which are modified by local coastal inputs, the temperate thermal cycle, and prevailing winds. Between 34 and 43 °S (Northern Argentine Continental Shelf;

☆ Contribution INIDEP No: 1366.

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doi:10.1016/j.ecss.2005.06.015

NACS), the shallow depths and extreme breadth of the shelf make its waters particularly responsive to atmospheric conditions. Bathymetry, changes in coastline bearing, large inputs of continental run-off, and locally generated cells of high salinity make the region a highly complex oceanographic and ecological system.

A number of studies have addressed basic descriptive oceanography of the continental shelf in the Argentine Sea (e.g. Balech, 1949, 1971, 1986; Thompsen, 1962; Lusquiños and Valdéz, 1971; Martos and Piccolo, 1988; Guerrero and Piola, 1997; Piola and Rivas, 1997). However, all of these studies have lacked sufficient spatial or temporal resolution to elucidate the subtle influences of coastal inputs and seasonality on the extent and distribution of observed water masses. In recent years, significant interest has arisen in the role of the NACS coastal system as a nutrient and biota source for the continental shelf of eastern South America. A useful first step towards a regional ecological understanding is a detailed seasonal description of the regional scale oceanography (for an ecological review see Seeliger et al., 1997; Mianzán et al., 2001; Seeliger and Kjerfve, 2001; Acha et al., 2004).

The goals of this work are to: (1) define the oceanographic regimes on the NACS in terms of their physical characteristics; (2) determine the influence of high/low salinity local sources and infer mean circulation from their property distributions; (3) elucidate any seasonality in the extent and distribution of each regime; and (4) characterize a coastal zone based on water property distribution and water column stability.

1.1. Study area

The coastline of the NACS extends over 1200 km between 34°and 43°S (Fig. 1). Three major basins dominate the NACS coastline: (1) the Gulf of San Matías, (2) the El Rincón basin and (3) the Río de la Plata basin. The Gulf of San Matías is a semi-enclosed coastal embayment with depths (60–200 m) greater than the adjacent shelf. The El Rincón and Río de la Plata basins are shallow, funnel shaped areas oriented roughly northwest/southeast.

The NACS is extremely broad, averaging between 170 and 300 km from the shoreline to the shelf break (defined as the 200 m isobath, Fig. 1). The shelf is uniform except between 38°30′S and 38°S (Necochea to Mar del Plata), where a marked bathymetric gradient known as the Cabo Corrientes step (40 m and 70 m) separates a 20-km-wide shallow coastal area from a broad plateau (>80 m) (see Urien and Ewing, 1974; Parker et al., 1997).

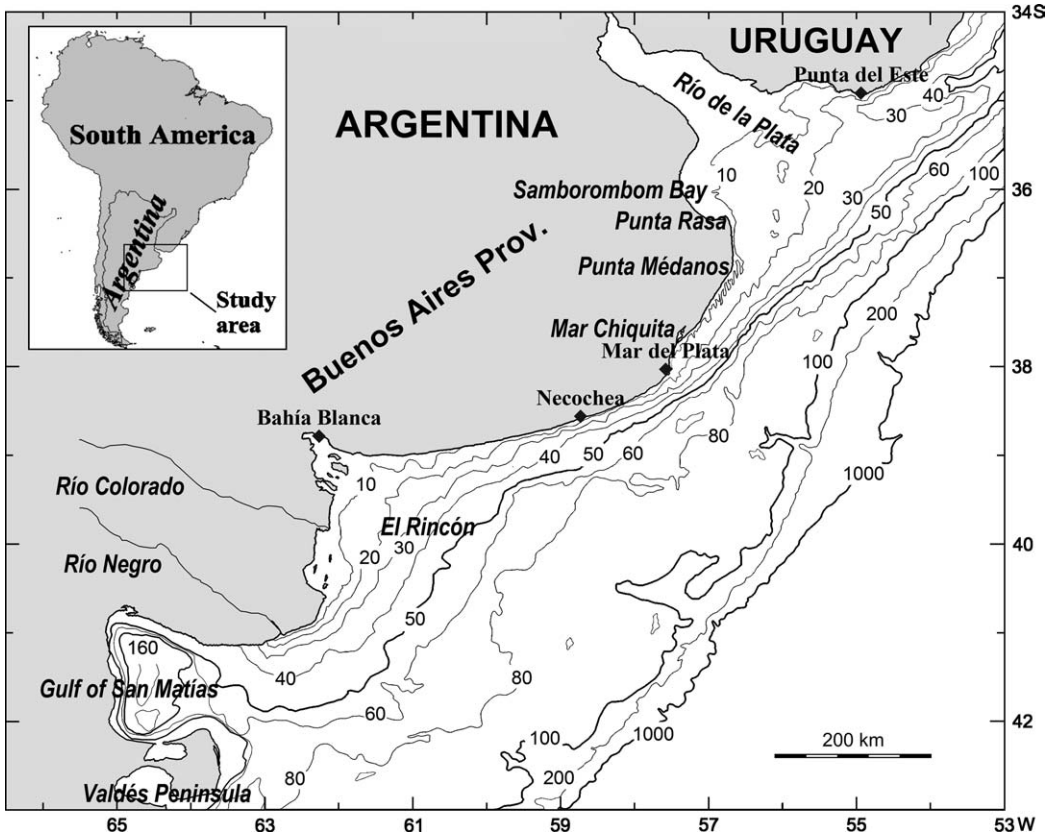

Fig. 1. Northern Argentine Continental Shelf (NACS). High-resolution bathymetry drawn from INIDEP hydroacoustic data. Solid diamonds represent cities referred to in the text. Geographical areas (e.g. Gulf of San Matías) are used as orientation in the text.