Continental Shelf Research 114 (2016) 1–15

Contents lists available at ScienceDirect

Continental Shelf Research

journal homepage: www.elsevier.com/locate/csr

Research papers

The Costa Rica Coastal Current, eddies and wind forcing in the Gulf of Tehuantepec, Southern Mexican Pacific

Cristóbal Reyes-Hernández [a,*], Miguel Ángel Ahumada-Sempoal [a], Reginaldo Durazo [b]

[a] Universidad del Mar, Instituto de Recursos. Ciudad Universitaria Campus Puerto Ángel, Pochutla, Oaxaca, C.P: 70902, México
[b] Universidad Autónoma de Baja California, Facultad de Ciencias Marinas, km 107 Carretera Tijuana-Ensenada, Zona Playitas, Ensenada, BC, C.P.: 22860, México

ARTICLE INFO

Article history:
Received 9 September 2014
Received in revised form
17 November 2015
Accepted 23 December 2015
Available online 24 December 2015

Keywords:
Hydrography
Tropical perturbation
Dynamic topography
Tehuantepec

ABSTRACT

The hydrographic structure and circulation of the Southern Mexican Pacific, from August 31 to September 24 2004, when tropical atmospheric activity was at its peak, was analyzed based on AVISO absolute dynamic topography and an array of 106 CTD profiles, within an area of about 500 km × 500 km between Punta Maldonado and Puerto Chiapas. The surveyed area was occupied by mesoscale anticyclonic and cyclonic eddies that determined the path of water with temperature and salinity characteristic of the Costa Rica Coastal Current. The origin of each eddy was investigated with respect to QuikSCAT wind conditions. The sequence of AVISO images and wind data showed that the largest anticyclonic eddies originated outside the Gulf of Tehuantepec through mechanisms distinct from local wind forcing, although two northerly wind events in the Gulf of Tehuantepec possibly had an influence on the smallest anticyclonic and cyclonic eddies. The relative position of each eddy allowed the flow of relatively low temperature and salinity water (the Costa Rica Coastal Current) into and throughout the Gulf of Tehuantepec, converging at about Puerto Angel with relatively high temperature and salinity water moving from the west.

1. Introduction

The Southern Mexican Pacific surrounding the Gulf of Tehuantepec (GT) is located within the Northeastern Tropical Pacific (Fig. 1a) between the southeastern and northeastern boundaries of the large hemispheric anticyclonic eddies that characterize the surface circulation of oceanic scale. Early interpretations of ship drifts by Wyrtki (1965, 1967) led him to propose the Costa Rica Coastal Current (CRCC) as the main current seasonally occupying the south coast of Mexico, directed northwest with a speed exceeding 0.25 ms^{-1}, a width of between 300 and 500 km, and a depth of up to 600 m. Fed by equatorial countercurrents that turn northward at the Costa Rica Dome (CRD), the main water masses potentially related to the CRCC, according to Fiedler and Talley (2006), are: Tropical Surface Water (TSW, $T>25$ °C, $S<34$), Equatorial Surface Water (ESW, $T<25$ °C, $S>34$), Subtropical Surface Water (STSW, $T\sim25$ °C, $S>35$), Subtropical Under Water (STUW, 22 °C $>T>$ 13 °C, $35.5>S>34.3$), and Antarctic Intermediate Water (AAIW, $T\sim5$ °C, $S<34.5$). Quarterly thermocline depth maps produced by Fiedler and Talley (2006), their Fig. 9 and dynamic height maps produced by Kessler (2006), his Fig. 7 are consistent with the general picture of the CRCC, but also show some discrepancies regarding both the northward reach of the current and its seasonality. On the other hand, observations made by Trasviña and Barton (2008) and Barton et al. (2009) have challenged the perception of the CRCC as a persistent clearly defined coastal flow.

According to Wyrtki (1967), the CRCC flows along the Mexican coast up to Cabo Corrientes in June–July, but is absent from the coast of Mexico from January to March as it flows westward after detaching from the coast of Costa Rica. Kessler (2006) set the presence of the CRCC as being between the CRD (9 °N, 90 °W) and the Tehuantepec Bowl (13 °N, 105 °W); therefore, west of Puerto Angel and north of 17 °N, the West Mexican Current is independent of the CRCC. The author related the seasonality of the CRCC to the expansion and contraction of the CRD in response to variations in the wind stress curl in the Tropical Pacific, the displacement of the Intertropical Convergence Zone (ITCZ), and variations in the North Equatorial Counter Current (NECC). He also found the NECC to be strongest in November, months after the ITCZ reaches its most northern position and when wind stress curl and equatorial upwelling intensify, which consequently intensify the CRCC as well (i.e., months after the CRCC intensification time proposed by Wyrtki). From November to January, as the ITCZ

* Corresponding author.
E-mail address: creyes@angel.umar.mx (C. Reyes-Hernández).

http://dx.doi.org/10.1016/j.csr.2015.12.012
0278-4343/

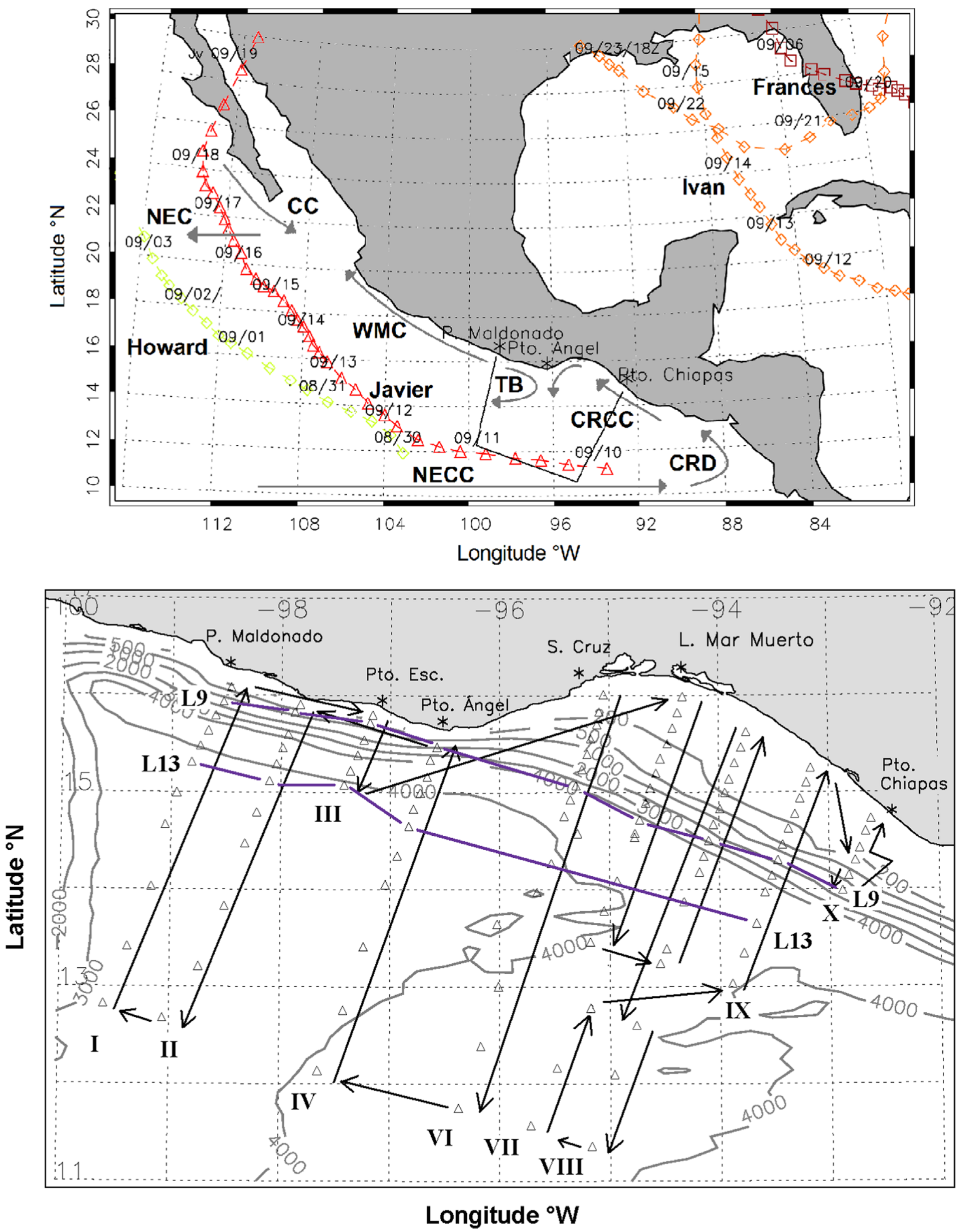

Fig. 1. a) The Southern Mexican Pacific and its main ocean currents, as per Kessler (2006): North Equatorial Counter Current (NECC), North Equatorial Current (NEC), California Current (CC), Western Mexican Current (WMC), Tehuantepec Bowl (TB), Costa Rica Dome (CRD), and Costa Rica Coastal Current (CCCR). The tracks of atmospheric perturbations during the survey—Howard (green diamonds), Javier (red triangles) and Ivan (orange diamonds)—are also shown. b) Transect numbers (in roman), arrows, indicate the progress of the ship. Lines parallel to the coast L13 and L9 correspond to lines 13 and 9, as described in Section 5. Bathymetry contours in meters. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

moves south, the equatorial isotherms are progressively depressed, weakening the NECC and therefore also the CRCC. Because of this the NECC is absent east of 110 °W at the end of the spring (June) and the CRCC is absent from the Gulf of Tehuantepec. Consistent with temperature, salinity and geostrophic flow characteristics typical of the CRCC (cf. Wyrtki (1967)) and in seasonal consistency with Kessler (2006), Brenes et al. (2008) observed a poleward flow between the CRD and Central America during Sep–Oct 1993 and Feb–Mar 1994. Observations within the Gulf of Tehuantepec made in both summer (Jun–Aug 2000; Trasviña and Barton (2008)) and winter (Jan–Feb 1988 and Feb 1996; Barton et al. (2009)) do not totally agree with the concept of the CRCC as a clearly identifiable poleward flow, bound to the coast. Instead of the CRCC, Trasviña and Barton (2008) found an anticyclonic eddy