



Review

A review of the shelf-slope circulation along Australia's southern shelves: Cape Leeuwin to Portland

John F. Middleton ^{a,b,*}, John A.T. Bye ^c

^a South Australian Research and Development Institute, Aquatic Sciences, West Beach, S.A. 5022, Australia

^b School of Mathematics and Statistics, University of New South Wales, Sydney 2052, NSW, Australia

^c School of Earth Sciences, University of Melbourne, Parkville, Victoria, Australia

Received 28 April 2006; received in revised form 4 May 2007

Available online 20 July 2007

Abstract

A review is presented of the ocean circulation along Australia's southern shelves and slope. Uniquely, the long, zonal shelf is subject to an equatorward Sverdrup transport that gives rise to the Flinders Current – a small sister to the world's major Western Boundary Currents. The Flinders Current is strongest near the 600 m isobath where the current speeds can reach 20 cm/s and the bottom boundary layer is upwelling favourable. It is larger in the west but likely intermittent in both space and time due to possibly opposing winds, thermohaline circulation and mesoscale eddies. The Flinders Current may be important to deep upwelling within the ubiquitous canyons of the region.

During winter, the Leeuwin Current and local winds act to drive eastward currents that average up to 20–30 cm/s. The currents associated with the intense coastal-trapped wave-field (6–12 day band) are of order 25–30 cm/s and can peak at 80–90 cm/s. Wintertime winds and cooling also lead to downwelling to depths of 200 m or more and the formation of dense coastal water within the Great Australian Bight and the South Australian Sea. Within the Great Australian Bight, the thermohaline circulation associated with this dense water is unknown, but may enhance the eastward shelf-edge, South Australian Current. The dense salty water formed within Spencer Gulf is known to cascade as a gravity current to depths of 200 m off Kangaroo Island. This dense water outflow and meanders in the shelf circulation also fix the locations of a sequence of quasi-permanent mesoscale eddies between the Eyre Peninsula and Portland.

During summer, the average coastal winds reverse and surface heating leads to the formation of warm water in the western Great Australian Bight and the South Australian Sea. No significant exchange of shelf water and gulf water appears to occur due to the presence of a dense, nutrient-rich (sub-surface) pool that is upwelled off Kangaroo Island. The winds lead to weak average coastal currents (<10 cm/s) that flow to the north-west. In the Great Australian Bight, the wind stress curl can lead to an anticyclonic circulation gyre that can result in shelf-break downwelling in the western Great Australian Bight and the formation of the eastward, South Australian Current. In the east, upwelling favourable winds and coastal-trapped waves can lead to deep upwelling events off Kangaroo Island and the Bonney Coast that occur over 3–10 days and some 2–4 times a season. The alongshore currents here can be large (~40 cm/s) and the vertical scales of upwelling are of order 150 m (off Kangaroo Island) and 250 m (off the Bonney Coast).

* Corresponding author. Address: Aquatic Sciences Centre, PO Box 120 Henley Beach, South Australia, Australia 5022. Tel.: +61 8 8207 5449; fax: +61 8 8207 5481.

E-mail address: Middleton.John@saugov.sa.gov.au (J.F. Middleton).

Increasing evidence suggests that El Nino events (4–7 year period) can have a major impact on the winter and summer circulation. These events propagate from the Pacific Ocean and around the shelf-slope wave-guide of West Australia and into the Great Australian Bight. During winter El Nino events, the average shelf currents may be largely shut-down. During summer, the thermocline may be raised by up to 150 m. The nature and role of tides and surface waves is also discussed along with uncertainties in the general circulation and future research.

© 2007 Elsevier Ltd. All rights reserved.

Keywords: Shelf currents; Shelf-edge; Upwelling; Downwelling; Oceanic eddies; Boundary currents

Contents

1.	Introduction	3
2.	The Flinders Current and mesoscale eddies: the mean and seasonal picture.	5
2.1.	Summary	5
2.2.	The Flinders Current: dynamics and observations	6
2.3.	Seasonal variability: forcing and model results	7
2.3.1.	Winter circulation.	8
2.3.2.	Summer circulation	9
2.4.	Eddy variability.	10
2.5.	Transport and ecological implications	16
3.	The mean winter shelf circulation and downwelling	16
3.1.	Summary	16
3.2.	Discussion.	16
3.2.1.	An overview of shelf currents: observations and numerical model results.	16
3.2.2.	The hydrography and thermohaline forcing	18
3.3.	Transport and ecological implications	20
4.	Winter weather-band circulation and coastal-trapped waves	22
4.1.	Summary	22
4.2.	Discussion.	23
5.	The mean summer shelf circulation and upwelling	24
5.1.	Summary	24
5.2.	Discussion: large-scale circulation	24
5.2.1.	An overview of shelf currents within the GAB: observations and numerical models	24
5.2.2.	Circulation in the South Australian Sea	25
6.	Summer upwelling, weather-band circulation, coastal-trapped waves and recirculation features.	29
6.1.	Summary	29
6.2.	Discussion.	29
6.3.	Coastal trapped wave scattering and Bonney Coast upwelling.	31
6.4.	Upwelling, recirculation and ecological implications.	31
7.	El Nino events.	33
7.1.	Summary	33
7.2.	Discussion.	33
8.	Surface waves, tides and inertial waves	34
8.1.	Summary	34
8.2.	Surface waves	35
8.3.	Tides	35
8.4.	Inertial waves	37
9.	Summary, uncertainties and future research	37
	Acknowledgements.	38
	References.	38

Download English Version:

<https://daneshyari.com/en/article/4553774>

Download Persian Version:

<https://daneshyari.com/article/4553774>

[Daneshyari.com](https://daneshyari.com)