Series of meetings of EAC enthusiasts

Sydney, November 2014

Sydney, March 2016

Sydney, November 2015

Raglan, NZ, April 2017
What do we all think we know about the EAC system?
... published schematics between 1853 and 2018
Key messages

Traditional view

- EAC is a continuous boundary current off eastern Australia – flowing between ~18-32S – that leaves the coast and flows either towards New Zealand or around Tasmania.
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Revised view

• EAC is a meandering stream off eastern Australia that starts at about 18S and “feeds” a field of eddies. EAC eddies propagate either nowhere, towards NZ, or around Tasmania.
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Do you see the front?
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Myths about the EAC

• The eastward extension of the EAC is the Tasman Fronts - evident as a zonal jet.

• The southward extension of the EAC is the EAC extension – evident as a southward jet.
Where's the:
EAC jet? Tasman Front? EAC Extension?

The EAC from IMOS OceanCurrent
… showing the 1st of each month
during 2016.

SST (colour) and surface
geostrophic currents (from
altimetry)
Where’s the:
EAC jet? Tasman Front? EAC Extension?
Where’s the:
EAC jet? Tasman Front? EAC Extension?
The Tasman Front ... the what?

THE TASMAN FRONT
R. N. DENHAM and F. G. CROOK
Defence Scientific Establishment, Ministry of Defence, HMNZ Dockyard, Auckland 9, New Zealand


The Tasman Front
B. R. STANTON
N.Z. Oceanographic Institute, Department of Scientific and Industrial Research, P.O. Box 12-346, Wellington, New Zealand

Observations of the Tasman Front
JOHN C. ANDREWS
Australian Institute of Marine Science, Cape Ferguson, Townsville, Queensland, Australia

MARTIN W. LAWRENCE and CARL S. NILSSON
R.A.N. Research Laboratory, Edgecliff, N.S.W., Australia
(Manuscript received 3 January 1980, in final form 15 July 1980)

Bruce A. Warren
WOODS HOLE OCEANOGRAPHIC INSTITUTION, WOODS HOLE, MASSACHUSETTS

GENERAL CIRCULATION OF THE SOUTH PACIFIC
Why do we believe?

- Wyrtki (1962) drew maps that led him to speculate about a broad zonal flow between Australia and New Zealand.
- Warren (1970) drew on Sverdrup dynamics to conclude that there must be a zonal jet between Australia and New Zealand.
- Denham and Crook (1976), Stanton (1979), and Andrews (1980) then looked for the Tasman Front ...

... and found it

... sort of
The Tasman Front ... the what?

THE TASMAN FRONT

R. N. Denham and F. G. Crook

Defence Scientific Establishment, Ministry of Defence, HMNZ Dockyard, Auckland 9, New Zealand
The Tasman Front ... the what?

Could be a meandering front, like Denham and Crook describe ...
What do we all think we know about the EAC system?

… published schematics between 1853 and 2018
The Tasman Front … the what?

… or it could be the EAC recirculating and a couple of big warm-core eddies
Each section shows a thermal front, although this feature is not as well defined in the April 1973 section. In addition, Fig. 6 shows that at 240 m there is a change in temperature of some 1.5–2°C associated with this front, and that the steepest horizontal temperature gradients lie close to the 15°C isotherm; thus again this front can probably be associated with a locally intense flow of the East Australian Current. Figure 5 shows that in each section the front lies close to the northern end of a part of the Norfolk Ridge, where the depth is less than 1000 m and rises to a recorded minimum of 82 m on the Wanganella Bank (Eade 1972).
Tasman Front “observations”

... but linear interpolation implies something much less interesting
Along the middle section (Fig. 3) the vertical temperature section showed no simple crossing of the frontal zone comparable with that found on the previous section. The middle section appears to have crossed part of a meander in the front and then recrossed it again, returning to the warm water side of the front. Doming in the subsurface isotherms, along with the surface temperatures and salinities, suggests that the front was only just crossed completely south of Stn I 104 on the outward passage, (Fig. 3a) and not completely crossed on the return passage (Fig. 3b). Because of the finite width of the frontal zone it is possible for a straight section to cross only part of a frontal meander and then return to the same side of the front. The position of the meander appears to have changed in the 2-week interval between these two sections. As a result, the whole pattern is found some 50 km further north in the later observations. However, the line of this section was not exactly reproduced on the second occasion (see Fig. 1) and hence some of this apparent movement may be attributable to experimental error. This type of error can be large where the front is highly convoluted and a section intersects the front at a small angle.
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Do you see the front?
Surface drifting buoys

(a) n=48

(b) n=41

(c) n=45

(d) n=42

days since reaching source/sink area

0 60 120 180 240 300 360 420 480 540
Argo float trajectories
EKE/MKE (IMOS OceanCurrent)
... and from (a) EAC Deep water moorings; and (b) HF radar at Coffs Harbour
Time-averaged picture

... showing speed and surface geostrophic currents from altimetry (from IMOS OceanCurrent)
... only showing vectors that exceed 0.05 m/s
Suggested schematic

Historic view
- Wyrtski suggested a broad eastward flow.
- Warren suggested a narrow zonal jet.
- Denham, Crook, Stanton, Andrews et al. observed eddies (that they reported as the Tasman Front).

Revised view
- EAC jet feeds the eddy field.
- Eddies either drift eastward towards the top of New Zealand, or around Tasmania.
Volume transport based on XBT and altimetry
Tasman Front “observations”

Described by Denham and Crook (1976) merely as sub-surface thermal front at 167E and 165E

... but again, could be merely the EAC eddy field
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The Tasman Front

B. R. Stanton

N.Z. Oceanographic Institute, Department of Scientific and Industrial Research, P.O. Box 12-346, Wellington, New Zealand
Tasman Front "observations"

Fig. 1. Survey area northwest of New Zealand showing stations occupied in August 1975 and bathymetry (contours in metres; depths less than 1000 m stippled).

DATA

Data were collected from r.v. Tangaroa in the region between New Zealand and Norfolk Island from 29 August to 15 September 1975. Between latitudes 31° and 35°S where the Tasman Front was expected three sections, running approximately north-south and parallel to the bathymetry of the Norfolk Ridge, were worked (Fig. 1). These sections were placed made every 50 km, but on the return passage this spacing was reduced to 30 km. Standard temperature/salinity casts were made at 24 stations (Fig. 1) and the data obtained were analysed using standard methods. Hourly surface salinity sampling and a recording surface thermograph were operated between stations. Station data are listed in Greig (1978).
Along the eastern section (Fig. 2), the steep slope of the subsurface isotherms near 32°S showed that the Tasman Front had been crossed. The isotherms slope downwards under the warm water side of the front.

... or ... we measured a pair of warm core eddies and artificially added a bunch of features in our hand-drawn charts that weren’t really in the data!
Tasman Front “observations”

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Fig. 3. Vertical cross sections of temperature (°C) along the Norfolk Ridge. Arrows on horizontal axis mark positions of observed surface temperature fronts, dashed lines mark station positions or bathythermograph (BT) casts.
The Tasman Front

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Tasman Front “observations”

Fig. 3. Vertical cross sections of temperature (°C) along the Norfolk Ridge. Arrows on horizontal axis mark positions of observed surface temperature fronts, dashed lines mark station positions or bathy-thermograph (BT) casts.
Along the middle section (Fig. 3) the vertical temperature section showed no simple crossing of the frontal zone comparable with that found on the previous section. The middle section appears to have crossed part of a meander in the front and then recrossed it again, returning to the warm water side of the front. Doming in the subsurface isotherms, along with the surface temperatures and salinities, suggests that the front was only just crossed completely south of Stn I 104 on the outward passage, (Fig. 3a) and not completely crossed on the return passage (Fig. 3b). Because of the finite width of the frontal zone it is possible for a straight section to cross only part of a frontal meander and then return to the same side of the front. The position of the meander appears to have changed in the 2-week interval between these two sections. As a result, the whole pattern is found some 50 km further north in the later observations. However, the line of this section was not exactly reproduced on the second occasion (see Fig. 1) and hence some of this apparent movement may be attributable to experimental error. This type of error can be large where the front is highly convoluted and a section intersects the front at a small angle.
They thought about eddies – but dismissed the idea …

The data used in the construction of Fig. 5, when taken with the data collected in the East Australian Current system, suggest that the Lord Howe Rise may divide the flow in the north Tasman Sea into two regimes. To the west of the Lord Howe Rise, the flow frequently consists of a series of eddies which shows clearly on temperature sections (Hamon 1970, Boland 1973, Andrews & Scully-Power 1976). In contrast, sections and station data to the east of the Lord Howe Rise show a meandering zonal jet. Although, on occasions, meanders in this jet can be highly convoluted, the data do not show meanders cut off to form eddies. The presence of the Lord Howe Rise, as an obstruction to the water from the East Australian Current flowing freely towards the east, appears to induce subtle changes in the circulation pattern found on either side of the rise.
Along the western section the vertical temperature section (Fig. 4) showed the Tasman Front very clearly with the subsurface isotherms between 17.5 and 16.5°C rising steeply to the surface near 33.5°S.

Fig. 4. Vertical cross sections of temperature (°C) to the west of the Norfolk Ridge. Arrows on horizontal axis mark positions of observed surface temperature fronts, dashed lines mark station positions or bathythermograph (BT) casts.