Seasonal Variability of Water Mass Properties in Bass Strait:

THREE-DIMENSIONAL OCEANOGRAPHIC MODELLING STUDIES

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Abstract

The climatology of the seasonal cycle of water mass variation and transformation in Bass Strait, south-eastern Australia, is studied using a high resolution three-dimensional sigma-coordinate hydrodynamic model coupled with data from observations and previous studies.

Model forcing consists of the principal tidal constituents from the Australian National Tidal Centre and long-term monthly mean atmospheric forcing fields from NCEP reanalysis. The initial density field is established using temperature and salinity means and annual and semi-annual harmonics from the CARS2000 hydrographic atlas. This is also used to prescribe incoming water mass properties at model open-sea boundaries with seasonal variation. Far-field forcing is included with open-sea boundary parameterisation of residual sea-level representing both the South Australian Current and the East Australian Current. Lagrangian and Eulerian tracer methods are used to derive transport timescales, such as age, residence times and flushing times. These are used to examine and summarise model predictions and as a diagnostic tool in sensitivity studies.

Currents, sea-level and water mass properties in the model compare favourably with previous studies and observations, despite limitations in the model and in the data used for comparison. The seasonal cycle, in model results, is characterised by formation of a shallow (< 20 m) saltier surface-layer in late spring to summer and subsequent downward mixing and erosion of the salinity field in autumn to winter with water mass from the west. This leaves behind water mass with positive age and salinity anomalies in areas of low flushing. In late winter-early spring most parts of this water mass leave the Strait interior. These areas are thought to be related to the source water of the Bass Strait Cascade. The residual circulation in all model experiments is shown to be related to seasonal-mean sea-level anomalies, arising from both barotropic and baroclinic adjustment, both in and surrounding the Strait.

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I dedicate this work to Verity, Nicholas and Barbara.

Declaration of Authenticity

‘I certify that this thesis does not incorporate, without acknowledgment, any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text’.

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List Of Acronyms

AOMIP	Arctic Ocean Model Intercomparison Project
ASMD94	Atlas of Surface Marine Data 1994
BSC	Bass Strait Cascade
CARS	Climatological Atlas of Regional Seas
CC	Coastal Current
CFL	Courant-Friedrichs-Lewy stability condition
CGBAPS	Cape Grim Baseline Air Pollution Monitoring Station
COADS	Comprehensive Ocean Atmosphere Dataset
COHERENS	Coupled Hydrodynamical and Ecological Model for Regional and Shelf Seas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTD	Conductivity-Temperature-Depth Sensor
CTW	Coastal-trapped Wave
EAC	East Australian Current
EACW	East Australian Current Water
FC	Flinders Current
GAB	Great Australian Bight
HR	Hellerman-Rosenstein
NCEP	National Centre for Environmental Prediction
NTC	National Tidal Centre
NOAA	National Oceanographic and Atmospheric Administration
SAC	South Australian Current
SACW	South Australian Current Water
SAPAC	South Australian Partnership for Advanced Computing
SASW	Sub-antarctic Surface Water
STC	Sub-tropical Convergence
TVD	Total Variation Diminishing
ZC	Zeehan Current