New Zealand Journal of Marine and Freshwater Research

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tnzm20

The physics of New Zealand's shelf seas: introduction to the special issue

Craig L. Stevens, Joe O'Callaghan, Stephen M. Chiswell & Moninya Roughan

To cite this article: Craig L. Stevens, Joe O'Callaghan, Stephen M. Chiswell & Moninya Roughan (2021) The physics of New Zealand's shelf seas: introduction to the special issue, New Zealand Journal of Marine and Freshwater Research, 55:1, 1-5, DOI: 10.1080/00288330.2021.1877160

To link to this article: https://doi.org/10.1080/00288330.2021.1877160

Published online: 31 Jan 2021.

NEW ZEALAND JOURNAL OF MARINE AND FRESHWATER RESEARCH
2021, VOL. 55, NO. 1, 1–5
https://doi.org/10.1080/00288330.2021.1877160

EDITORIAL

The physics of New Zealand's shelf seas: introduction to the special issue

Craig L. Stevens [a,b], Joe O'Callaghan [a], Stephen M. Chiswell [a] and Moninya Roughan [c]

[a]National Institute of Water and Atmospheric Research, Wellington, New Zealand; [b]Department of Physics, University of Auckland, Auckland, New Zealand; [c]School of Mathematics and Statistics, University of New South Wales, Sydney, Australia

KEYWORDS Oceanography; shelf seas; climate change; open data; continental shelf

Aotearoa New Zealand is a marine nation. The islands are 1700 km from the nearest continental land mass, its northern coasts are bathed by warm waters arriving from the tropics, and its southern coasts sit just north of the cold Southern Ocean whipped by an unbroken band of westerly winds that circles the globe. A consequence of this is the ocean environment influences nearly all aspects of life in New Zealand. It controls the weather and climate extremes, impacts on transport, energy supply, food production, and export earnings. Daily lives at work and play are affected by how the ocean changes seasonally, interannually and inexorably with climate.

The motivation for this special issue on New Zealand's Shelf Seas emerged from the 2017 Physical Oceanography Workshop held in Wellington organised by Dr. Natalie Robinson of NIWA. At the meeting it was clear that there was a critical mass of mature regionally-specific research to form the basis of a special issue on physical oceanography of New Zealand's shelf seas. This special issue subsequently coalesced around a Shelf Seas review article (Stevens et al. 2021, this issue) which complemented an earlier well-cited review of deep water processes by Chiswell et al. (2021).

New Zealand's Shelf Seas are dominated by a complex range of processes operating at a variety of scales. Coupled with this complexity is the present trajectory of the planet's changing climate, where some of the fastest rates of ocean warming are occurring in the New Zealand region (Sutton and Bowen 2019). However, it is not always clear that we sample sufficiently to detect the impacts of such changes sufficiently early (PCE 2019). This makes work like that described in Broekhuizen (2021, this issue) valuable as long-term temperature records are explored in the context of thermal tolerances for sessile organisms and aquaculture. These authors focus on the Pelorus Sounds region adjacent to Cook Strait and show it is warming (0.2–0.4°C per decade) which is comparable to that observed in the wider regional oceans (Sutton and Bowen 2019). In the same region, Hadfield and Stevens (2021, this issue) examine the question 'what is the net flow through Cook Strait?' The work demonstrates the interplay between observation and modelling and has resulted in a more reliable estimate of a key quantity in central New Zealand oceanography.

CONTACT Craig L. Stevens craig.stevens@niwa.co.nz

Oceanography has always been interdisciplinary, this is evident here with a number of the papers having significant contributions across disciplinary divides. Sharples and Zeldis (2021, this issue) extend pioneering work on shelf seas biophysical interactions (Sharples 1997) by examining the interaction between turbulent fluxes and background nutrient conditions along the Northeast shelf of the North Island to consider how this might evolve with a climate-induced changes to the surface ocean.

Changes to sediment transport in the coastal margins is a downstream outcome from modified land use and the linkage of the fate of suspended material to processes such as waves and currents is vital in order to understand long-term implications. The study by Nokes et al. (2021, this issue) examines sediment data in the context of hydrodynamic variability in the North Canterbury shelf region, where the Southland Current sweeps past Banks Peninsular northward to the Kaikoura Canyon. It demonstrates that the dominant physical processes influencing sediment transport vary along the coast which has implications for what tools are used when considering future scenarios.

At the larger scale, and again with the theme of finding the best tool for the task, de Souza et al. (2021, this issue) compare a suite of near-global eddy resolving models in a New Zealand context to improve understanding of strengths and weaknesses of how each might be used as boundary conditions for locally-focused studies. They show that downscaling is required as these large-scale models fail to adequately represent a range of shelf-seas processes. The analysis is able to identify a product that performs best in the New Zealand region as a reanalysis and as boundary conditions for model downscaling efforts.

Even now, in the early 21st century, some of the basic descriptions of the major currents around New Zealand are uncertain, and Chandler et al. (2021, this issue) present analysis of altimeter data to propose a new name – the Fiordland Current – for the current flowing southward along the West Coast of the South Island, showing that it is separate from the Southland Current. They partition the Fiordland Current into inner and outer flows and link the strength of the flows to wind forcing at both interannual and decadal timescales. In the same general region, Chiswell and O'Callaghan (2021, this issue) examine the connection between sea surface thermal extreme events (both warm and cool), wind-forcing and oceanic primary production. They found no increase in extrema but did identify that the events were becoming warmer. They utilise remotely sensed data to quantify the connection between wind and stratification as a driver for production.

A unique feature of the shelf seas around Aotearoa New Zealand is the presence of large submerged plateaus, so much so that the wider system is described as the submerged continent of Zealandia (Bostock et al. 2019). Forcen-Vazquez et al. (2021, this issue) synthesise all available vessel-based hydrographic transects to provide a picture of the transport and water mass transformation on the Campbell Plateau, to the south of the South Island. Their analysis identifies how the water masses on the plateau differ from the wider Southern Ocean, strengthening the decision to include the region in a shelf seas category.

Sustainable utilisation of the marine domain is increasingly a focus for a range of stakeholders – sufficiently so that one of the 2014 National Science Challenges was focused on 'Sustainable Seas' (Davies et al. 2018). This Challenge supported the first comprehensive suite of oceanographic observations from the Tasman/Golden Bay region (Chiswell et al. 2021, this issue). Direct measurements of Lagrangian pathways (i.e. physical connectivity) in the context of forcing and stratification provide a valuable assessment of the mechanics of the Tasman Bay-Golden Bay region of the South Island, and also examples of exchange with the Western Greater Cook Strait.

Some of the challenges facing the New Zealand physical oceanographic community are unique. A small pool of researchers and resources are charged with understanding a very large region of the planet's oceans. Consequently, directly observed data have modest spatiotemporal coverage and coordination (O'Callaghan et al. 2019; PCE 2019). In addition, there is an expectation to meet the obligations set out in the Treaty of Waitangi (Clapcott et al. 2018) so that Māori perspectives on ocean research are valued and incorporated. More generally, the field of ocean science is changing rapidly as dramatic improvements in open data and publishing, analysis tools and global initiatives such as the Argo Programme, have increased access to resources for researchers. Furthermore, and relevant to a geographically isolated small research community, the Covid-19 pandemic has changed the mechanics of collaboration and dissemination of science. And critically, the pandemic is influencing how the public views science more generally (McGuire et al. 2020).

The New Zealand Government continues to drive for increased diversity in the science system including dimensions such as gender and cultural identity (MBIE 2019). The closest the special issue comes is the analysis of institutional demographics in Stevens et al. (2021). Physical oceanography as a field has a history of poor gender representation (Mouw et al. 2018) and the authorship of the special issue articles reflect this. With different but overlapping drivers, Māori representation is also poor in marine science broadly. While this is apparent across academia in general (McAllister et al. 2019), Stevens et al. (2021, this issue) explore pathways for change in the physical oceanography sector. Another limitation on the breadth of diversity of researchers in the field is the limited profile within the academic sector (Stevens and O'Callaghan 2015). Recent New Zealand Government investment in the Moana Project (Kaiser et al. 2019), including a number of graduate student projects, has the potential to re-shape the physical oceanography research community at a national level over the coming decade.

Climate, technology, interdisciplinarity and connection between the science and stakeholders and policy-makers will be critical to how the field will progress over the coming decades. This special issue captures the field on the cusp of change, with the topic evolving rapidly both internationally and nationally, so that the expectation is that the work captured here is just the leading-edge of a time of growth in understanding, capacity and application for the science of the physics of New Zealand's shelf seas.

Acknowledgements

We thank all the authors and reviewers who contributed to producing this special issue. In addition, we thank Dr. Natalie Robinson for leading the initial forum that started the initiative, as well as Dr. Joanne Clapcott who contributed as an Editor for one of the submissions. We also thank the Royal Society NZ for their support.

ORCID

Craig L. Stevens http://orcid.org/0000-0002-4730-6985
Joe O'Callaghan http://orcid.org/0000-0002-7638-136X
Stephen M. Chiswell http://orcid.org/0000-0002-5957-3706

References

Bostock H, Jenkins C, Mackay K, Carter L, Nodder S, Orpin A, Pallentin A, Wysoczanski R. 2019. Distribution of surficial sediments in the ocean around New Zealand/Aotearoa. Part A: continental slope and deep ocean. New Zealand Journal of Geology and Geophysics. 62(1):1–23. doi:10.1080/00288306.2018.1523198.

Broekhuizen N. 2021. Sea temperature rise over the period 2002 in Pelorus Sound, New Zealand – with possible implications for the aquaculture industry. 55(1):46–64. doi:10.1080/00288330.2020.1868539.

Chandler M, Bowen M, Smith RO. 2021. The Fiordland Current, southwest New Zealand: mean, variability, and trends. New Zealand Journal of Marine and Freshwater Research. 55(1):156–176. doi:10.1080/00288330.2019.1629467.

Chiswell SM, Bostock HC, Sutton PJ, Williams MJ 2021. Physical oceanography of the deep seas around New Zealand: a review. New Zealand Journal of Marine and Freshwater Research. 49:286–317.

Chiswell SM, O'Callaghan JM. 2021. Long-term trends in the frequency and magnitude of upwelling along the West Coast of the South Island, New Zealand, and the impact on primary production. New Zealand Journal of Marine and Freshwater Research. 55(1):177–198. doi:10.1080/00288330.2020.1865416.

Clapcott J, Ataria J, Hepburn C, Hikuroa D, Jackson A-M, Kirikiri R, Williams E. 2018. Mātauranga Māori: shaping marine and freshwater futures. New Zealand Journal of Marine and Freshwater Research. 52(4):457–466. doi:10.1080/00288330.2018.1539404.

Davies K, Fisher K, Foley M, Greenaway A, Hewitt J, Le Heron R, Mikaere H, Ratana K, Spiers R, Lundquist C. 2018. Navigating collaborative networks and cumulative effects for sustainable seas. Environmental Science & Policy. 83:22–32. doi:10.1016/j.envsci.2018.01.013.

de Souza JMAC, Couto P, Soutelino R, Roughan M. 2021. Evaluation of four global ocean reanalysis products for New Zealand waters – a guide for regional ocean modelling. New Zealand Journal of Marine and Freshwater Research. 55(1):132–155. doi:10.1080/00288330.2020.1713179.

Forcen-Vazquez A, Williams MJM, Bowen M, Carter L, Bostock H. 2021. Frontal dynamics and water mass variability on the Campbell Plateau. New Zealand Journal of Marine and Freshwater Research. 55(1):199–222. doi:10.1080/00288330.2021.1875490.

Hadfield MG, Stevens CL. 2021. A modelling synthesis of the volume flux through Cook Strait. New Zealand Journal of Marine and Freshwater Research. 55(1):65–93. doi:10.1080/00288330.2020.1784963.

Kaiser BA, Hoeberechts M, Maxwell K, Eerkes-Medrano L, Hilmi N, Safa A, Horbel C, Juniper SK, Roughan M, Lowen NT, Short K. 2019. The importance of connected ocean monitoring knowledge systems and communities. Frontiers in Marine Science. 6:309. doi:10.3389/fmars.2019.00309.

MBIE. 2019. Draft research, science and innovation strategy, ministry for business, innovation and employment. https://www.mbie.govt.nz/dmsdocument/6935-new-zealands-research-science-and-innovation-strategy-draft-for-consultation.

McAllister TG, Kidman J, Rowley O, Theordore RF. 2019. Why isn't my professor Māori? A snapshot of the academic workforce in New Zealand universities. MAI Journal: A New Zealand Journal of Indigenous Scholarship. 8:2. doi:10.20507/MAIJournal.2019.8.2.10.

McGuire D, Cunningham JE, Reynolds K, Matthews-Smith G. 2020, Aug 7. Beating the virus: an examination of the crisis communication approach taken by New Zealand Prime Minister Jacinda Ardern during the Covid-19 pandemic. Human Resource Development International. 23(4):361–79. doi:10.1080/13678868.2020.1779543.

Mouw CB, Clem S, Legg S, Stockard J. 2018. Meeting mentoring needs in physical oceanography: an evaluation of the impact of MPOWIR. Oceanography. 31(4):171–179. doi:10.5670/oceanog.2018.405.

Nokes CR, Bostock HC, Strachan LJ, Hadfield MG. 2021. Hydrodynamics and sediment transport on the North Canterbury Shelf, New Zealand. New Zealand Journal of Marine and Freshwater Research. 55(1):112–131. doi:10.1080/00288330.2019.1699584.

O'Callaghan J, Stevens C, Roughan M, Sutton P, Garrett S, Giorli G, Smith RO, Currie KI, Suanda SH, Williams M, Bowen M. 2019. Developing an integrated ocean observing system for New Zealand. Frontiers in Marine Science. 6:143. doi:10.3389/fmars.2019.00143.

PCE. 2019. Focusing Aotearoa New Zealand's environmental reporting system, NZ Parliamentary Commissioner for the Environment. ISBN 978-0-947517-17-5.

Sharples J. 1997. Cross-shelf intrusion of subtropical water into the coastal zone of northeast New Zealand. Continental Shelf Research. 17(7):835–857. doi:10.1016/S0278-4343(96)00060-X.

Sharples J, Zeldis JR. 2021. Variability of internal tide energy, mixing and nitrate fluxes in response to changes in stratification on the northeast New Zealand continental shelf. New Zealand Journal of Marine and Freshwater Research. 55(1):94–111. doi:10.1080/00288330.2019.1705357.

Stevens C, O'Callaghan J. 2015. When the holiday is over: being clever in New Zealand's marine domain. Journal of the Royal Society of New Zealand. 45(2):89–94. doi:10.1080/03036758.2015.1014377.

Stevens CL, O'Callaghan JM, Chiswell SM, Hadfield MG. 2021. Physical oceanography of New Zealand/Aotearoa shelf seas – a review. New Zealand Journal of Marine and Freshwater Research. 55(1):6–45. doi:10.1080/00288330.2019.1588746.

Stevens CL, Paul-Burke K, Russell P. 2021. Pūtahitanga: the intersection of western science and mātauranga Māori in the context of Aotearoa New Zealand's physical oceanography. New Zealand Journal of Marine and Freshwater Research. 55(1):249–263. doi:10.1080/00288330.2019.1698621.

Sutton PJ, Bowen M. 2019. Ocean temperature change around New Zealand over the last 36 years. New Zealand Journal of Marine and Freshwater Research. 53(3):305–326.