Three-Dimensional Tide and Surge Modelling and Layered Particle Tracking Techniques Applied to Southern Australian Coastal Seas

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Thesis submitted for the degree of
Doctor of Philosophy
in
Applied Mathematics
at
The University of Adelaide
(Faculty of Engineering, Computer & Mathematical Sciences)

Department of Applied Mathematics

July, 2000

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Abstract

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This thesis reports the development, testing, and application of computer programs for simulating Lagrangian–Stochastic particle dispersion in coastal seas, with particular application to tide and storm induced dispersion in South Australian seas.

The three-dimensional tidal equations are briefly discussed for the two types of surge models used, and finite-difference methods for numerically solving these equations are considered. Different methods of simulating flows at open sea boundaries are investigated. The method of particle tracking and the development of the particle tracking model is also described. Various tests are conducted to investigate both the advective and diffusive aspects of dispersion, and a number of scenarios for the simulation of open (ocean) and closed (coastal) boundaries are considered. Various aspects of the particle tracking routine are given specific characteristics according to the nature of the particle being considered.

Application of the tide and storm surge model to the Great Australian Bight is described. This uses spherical polar co-ordinates to account for the curvature of the earth, and an oblique boundary element to increase accuracy of the coastline representation. The effect of a low pressure system moving from west to east across the Bight and the resulting significant observed surge at Thevenard during the storm of April 1996 is simulated.

This storm resulted in a significant number of deaths in aquaculture farms containing southern bluefin tuna (*Thunnas maccoyii*) within the Boston Bay region to the extreme east of the Bight due to the agitation of almost neutrally buoyant organic sediments at the sea floor. The effects of this storm are further considered using a Cartesian co-ordinate fine-grid local model of Boston Bay, in Spencer Gulf, South Australia, where both tidal and storm (wind and outside surge) induced flows are simulated. The dispersion of suspended neutrally buoyant sediment throughout the region is considered, and compared with the mortalities of tuna at various farms within the region.

Tidal and storm induced currents in the Gulf St. Vincent region, South Australia, have also been modelled using Cartesian co-ordinates. Detailed consideration has been given to the modelling of tides, winds, atmospheric pressures and outside surges from the two open boundaries in Investigator Strait and Backstairs Passage. The information obtained has enabled the modelling of a number of storm surge scenarios. Further to this, various simulations of the dispersion of the larvae of the western king prawn (*Penaeus latisulcatus*) have been driven using the storm surge model developed. These incorporate currents near the surface and the sea floor, as well as the consideration of changes in behaviour during the life history of the larvae.

Signed Statement

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

SIGNED: ..... DATE: .....

Acknowledgements

Firstly, my sincerest gratitude to Associate Professor John Noye, my supervisor. John has maintained his drive and enthusiasm for this PhD, even through more recent times of ill-health. I am most appreciative of the guidance, proof-reading and (most of all) discussion that has lead to the completion of this thesis. I wish you and your family the best of health for the future.

Thankyou to Dr. Peter Gill, the Head of the Applied Mathematics Department at the University of Adelaide, for support and direction when required. Also, I am appreciative of the suggestions given by Dr. Michael Teubner in the early stages of this work, and of the efforts given by the staff of the Applied Mathematics Department.

Many thanks to Dr. Karyn Matthews and Julianne Stevens for their contributions to papers produced during this PhD. Other contributers to discussion and helpers when in need have included; Pete Evans for help with concepts of particle tracking; Dr. John Nixon and David Beard for problems of a computational nature; Greg Lewis for discussion of particle tracking techniques and proof-reading; James Chittleborough for proof-reading; David McInerny and Alice Von Trojan for the trading of relevant hints and tips for PhD candidates; Paul Rasser, for formulating weather simulation fields in the Great Australian Bight; Mervi Kangas, for information regarding prawn biology; Paul Davill (National Tidal Facility), for access to sea level data; Bruce Brooks (Bureau of Meteorology), for meteorological data. I give my thanks to all of these, and any other unnamed contributers to the completion of this thesis.

Many thanks to the staff at the National Tidal Facility, who have made me feel at home during my many visits to Flinders University. Special mention must be made of Dr. Wolfgang Scherer and Bill Mitchell, who encouraged my presence at the facility on a regular basis, as well as James Chittleborough, Anna Nielsen and Esmee Van Wijk for their suggestions and support.

To my family, Joe, Leonie, Jamie and Felicity. It is always much easier to finish a task such as this with the support of family, and I thank you all for that support. Thankyou also to my Grandmother, Olga, who's financial assistance first enabled me to begin my degree in 1992.

Throughout the writing of this document I have been supported by an Australian Postgraduate Award Scholarship. I am most grateful to receive this award, and doubt very much that this thesis would have been completed without the finances provided.

To my friends, there are so many that I would like to mention, and I thank you all for your continued support during this time. Particular mention should go to Melissa Barrett, who has been a great help to me throughout the course of this PhD, by helping to keep me motivated as well as proof-reading. I wish you all the best in your travels to exotic locations around the world, and I won't forget the contribution that you have made to this thesis. Others that have my gratitude for their interest in my work include Heather, Luisa, Damien, Shaun, Frank, Alex, Vicki, Alexis, Jayne, Amanda, Sara, Dean, Beryl, Albert, Michael and Nina.

Finally, and most importantly, I'd like to thank Amanda Boyd. Thankyou so much for being there to help motivate me, for your encouragement and for your support. In particular, at times when work was difficult during this final year, your influence was important in helping to inspire the final writing of this document. It is not an easy task to complete a PhD, and I am grateful to you for helping me to reach this stage, where I can be happy with the successful completion of this significant portion of my life.