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Comité national canadien pour SCOR

Scientific Committee on Oceanic Research

CANADIAN OCEAN SCIENCE NEWSLETTER

LE BULLETIN CANADIEN DES SCIENCES DE L'OCÉAN

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The Development of a Numerical Water Circulation Model of Shelburne, Nova Scotia for Aquaculture Support

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Abstract

Shelburne, Nova Scotia is an area with an active aquaculture industry. With the presence of fish farms comes the need to map the transport and deposition of organic waste and the transport and dispersal of pesticides and drugs, all of which require knowledge of the water circulation in the area. To this end, the Finite Volume Community Model (FVCOM) was implemented for Shelburne, Nova Scotia. The model was run in barotropic mode, forced with tidal variations of sea level at the open boundaries, and forced with temporally and spatially varying 2013 seasonal winds at the surface. The model is validated against measured sea surface height and current data. The model is capable of adequately reproducing the sea surface heights for which the tidal components accounts for at least 88% of the variation. The observed currents in the area were determined to have tidal and non-tidal variances of similar amplitudes. The amplitude of the M2 current along the major axis is reasonably well predicted by the model but the model does not capture the vertical variation of the minor amplitude, inclination or phase. A barotropic model forced with tides and wind was found to be insufficient to predict the non-tidal component of the current. These results indicate that the model can be used for transport and dispersion in the near field but should not be used to predict far field effects.

Introduction

The coast of Shelburne County, Nova Scotia is an active aquaculture area (Figure 1) with fish farms in Shelburne Harbour, near McNutts Island and in Jordan Bay. With the presence of fish farms comes the need to map the transport and deposition of organic waste and the transport and dispersal of pesticides and drugs, all of which require knowledge of the water circulation in the area. To meet this requirement, implementation of the Finite Volume Community Ocean Model (FVCOM; Chen et al., 2006) was initiated

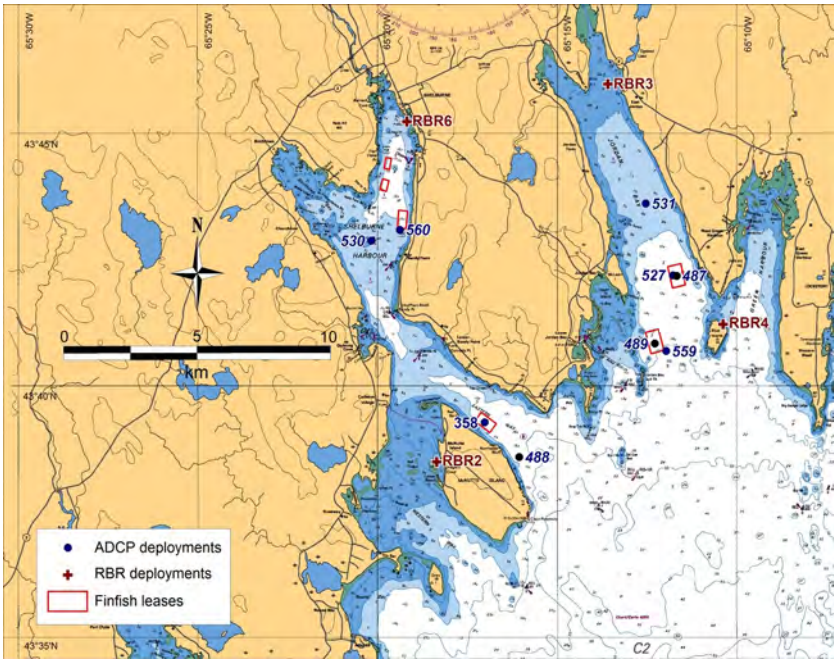

Figure 1. Map of the Shelburne area. The background map is part of Canadian Hydrographic Service chart 4241 (Lockeport to Cape Sable, November 2002 edition); depths are in metres below lowest normal tide.

for the study area. As a first step, a barotropic model forced with seasonal winds for 2013 was developed.

Methods

FVCOM uses an unstructured mesh which allows for accurate representation of the coastline and bathymetry and capturing of small scale features in areas of interest without requiring higher horizontal grid resolution throughout the model domain. FVCOM version 3.2.1 was used. The grid used for this project (Figure 2) encompasses the Bay of Fundy, Gulf of Maine and Scotian Shelf.

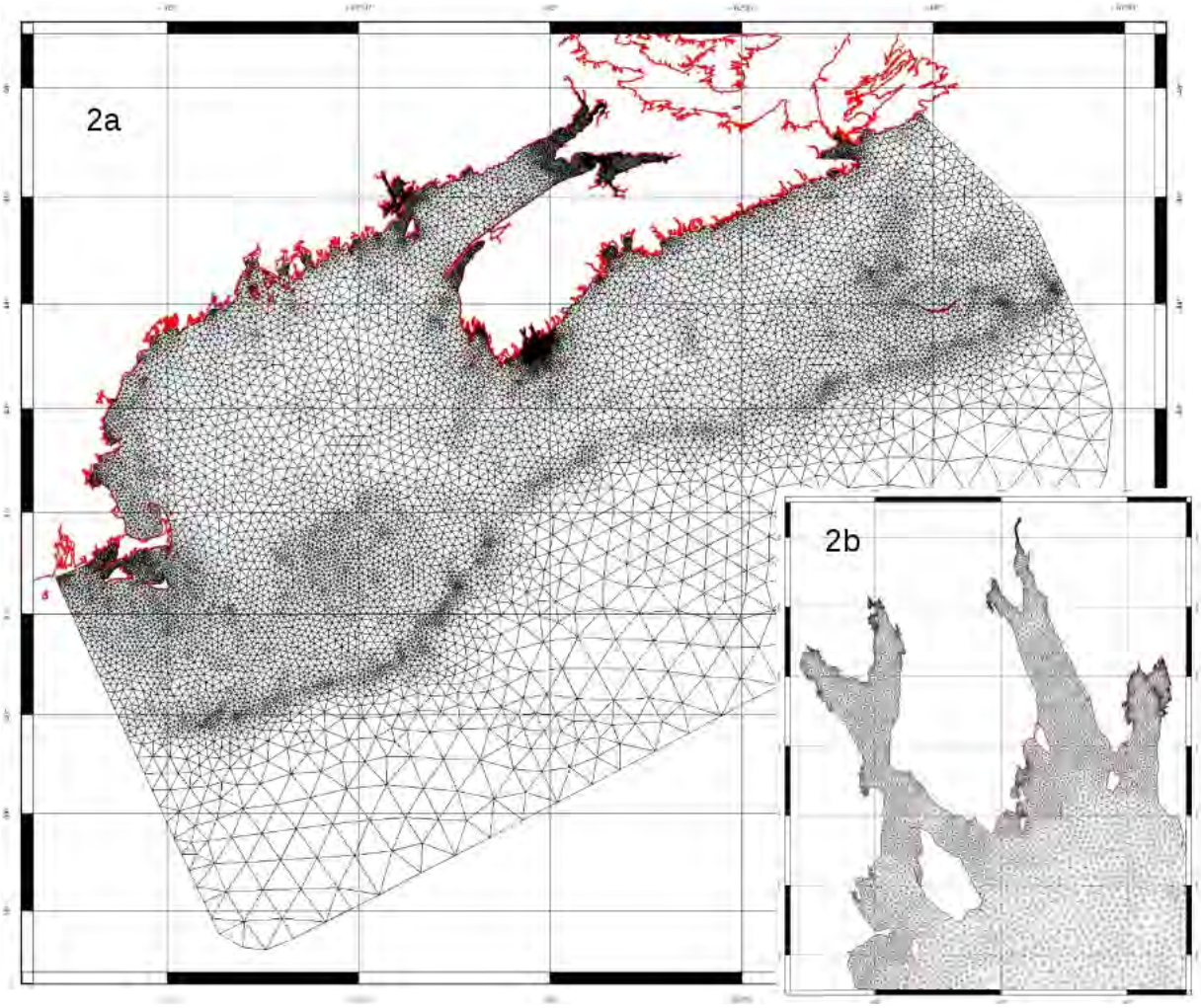

Figure 2. FVCOM mesh for Shelburne area: 24,151 nodes; 44,526 cells, horizontal resolution of 15 m to 53 km. a) entire model domain; b) enlargement of grid for Shelburne Harbour and Jordan Bay.

The grid has 24,151 nodes (vertices of triangles) and 44,526 cells (triangles) with horizontal length scales ranging from 53 kilometers off the Scotian Shelf to 15 meters with the highest resolution in the area of interest, the Shelburne area. In the vertical, FVCOM uses terrain following coordinates. The model used 21 vertical levels with higher resolutions near the surface and the bottom. The model was run in barotropic mode with wetting and drying, allowing for representation of inter-tidal areas. The model was forced with tidal variation in sea level at the lateral open boundaries and with spatially and temporally variable seasonal winds for 2013 at the surface. For all runs, the model was started from rest and spun-up for 6 days, including a 12 hour ramp-up time.

Observations on current speeds and sea level were used to calibrate and validate the FVCOM model. The current data were obtained using acoustic Doppler current profilers (ADCP) equipped with a pressure sensor and coastal sea level was obtained from pressure data loggers (RBR). The locations of the equipment deployments are shown in Figure 1 and the data are described in Chang et al. (2017). Analysis of the sea surface height records in the Shelburne region revealed that the tide accounts for 88% to 97% of the total sea surface height variation (Chang et al., 2017) indicating the importance of ensuring that the model correctly predicted the tidal sea surface height. The open boundary of the FVCOM model consists of all nodes along the outer edge of the model domain which are not coastline. For the Shelburne implementation, the open boundary was forced with five tidal constituents: M2, N2, S2, K1 and O1. The tidal amplitudes and phases of these constituents along the open boundary were initially interpolated from WebTide's (WebTide Tidal Prediction Model, 2015) Scotian Shelf data set, but were then adjusted so that the model gave good agreement with the Shelburne field data. Results of the model calibration for the M2 tidal constituent, the dominant constituent, are given in Table 1 and indicate that, in the Shelburne region, the model, on average predicted the M2 tidal amplitudes and phases of the sea surface height very well. Calibration results of the other four constituents used to force the model were similar.

Table 1. The M2 amplitudes and phases at the locations used to calibrate the open boundary forcing. The M2 amplitudes from the analysis of the observed and modeled sea surface heights are given as well as the ratio of the modeled amplitude over the observed amplitude. The phase from the tidal analysis of the observed and modeled sea surface heights are given as well as the difference between the modeled phase and the observed phase. The distance is the length of the error vector between the modelled and observed amplitudes and phases plotted in polar coordinates.

M2	Amplitudes			Phases			Distance
Deploy	OBS	FVCOM	Ratio	OBS	FVCOM	Δ	
RBR2	0.728	0.727	0.999	3.9	2.0	-1.9	0.023
RBR3	0.722	0.720	0.997	3.0	1.0	-2.0	0.025
RBR4	0.713	0.712	0.999	2.7	0.6	-2.1	0.026
RBR6	0.739	0.739	1.001	3.9	2.2	-1.7	0.021
358	0.743	0.719	0.968	-0.6	1.3	1.9	0.034
488	0.697	0.715	1.025	-2.6	1.2	3.8	0.049
489	0.680	0.713	1.048	0.3	0.8	0.5	0.033
527	0.717	0.714	0.996	-2.6	0.8	3.4	0.042
530	0.750	0.738	0.984	2.9	2.3	-0.6	0.015
531	0.728	0.717	0.986	2.1	0.8	-1.3	0.020
Mean			1.000			0.0	0.029
S.D.			0.022			2.3	0.011

In addition to the calibrated tidal forcing at the open boundary, the model was forced with spatially and temporally variable seasonal winds from 2013. The wind data are from the Canadian Meteorological Centre's Global Deterministic Prediction System (0.6° x 0.6°, approximately 48 km x 67 km). The weather model provided twice daily forecasts at 0:00 and 12:00 with output predictions at 0, 3, 6 and 9 hours from the forecast time. The wind data was spatially interpolated to the FVCOM grid. Each season was modeled by a representative 30 day simulation (Table 2). There are seasonal variations in the winds, but there is little spatial variation in the wind fields in the Shelburne area. This is a result of the coarse horizontal grid resolution

(0.6°) used by the global weather model. As a first approximation of the wind fields, this is acceptable since the Shelburne area has little topographic structure and hence there is likely

Table 2. Simulation dates for FVCOM seasonal runs.

Season	Run Start Date	Run End Date
Winter	1 February 2013	3 March 2013
Spring	1 May 2013	31 May 2013
Summer	1 August 2013	31 August 2013
Fall	1 November 2013	1 December 2013

little topographic steering of the winds. Comparison of modeled winds with observed wind data collected by Environment Canada at Baccaro Point, Nova Scotia show that the modelled wind fields capture the low frequency variation of the observed wind, but as the wind fields are only provided at three hour intervals, the high frequency variation is not represented.

Results

The model forcing was calibrated against the tidal sea surface heights, but for aquaculture regulatory purposes it is the predicted current fields which are of primary interest. The results of the tidal analysis of the currents for six ADCP deployments (358, 527, 530, 531, 559 and 560) and the tidal analysis of the FVCOM model currents at the same locations were compared. Results show that the model's ability to correctly predict the tidal currents varies from location to location but there are features that are evident at most locations. The M2 tidal parameters for deployment 531, which is located in Jordan Bay, (Figure 1) are shown in Figure 3. M2 is the dominant constituent with amplitudes that are 4-5 times the next most important constituent, N2. Deployment 531 is one of two ADCP records, deployment 530 being the other, whose deployments dates have an overlap with the model run dates.In general the model provided a reasonable

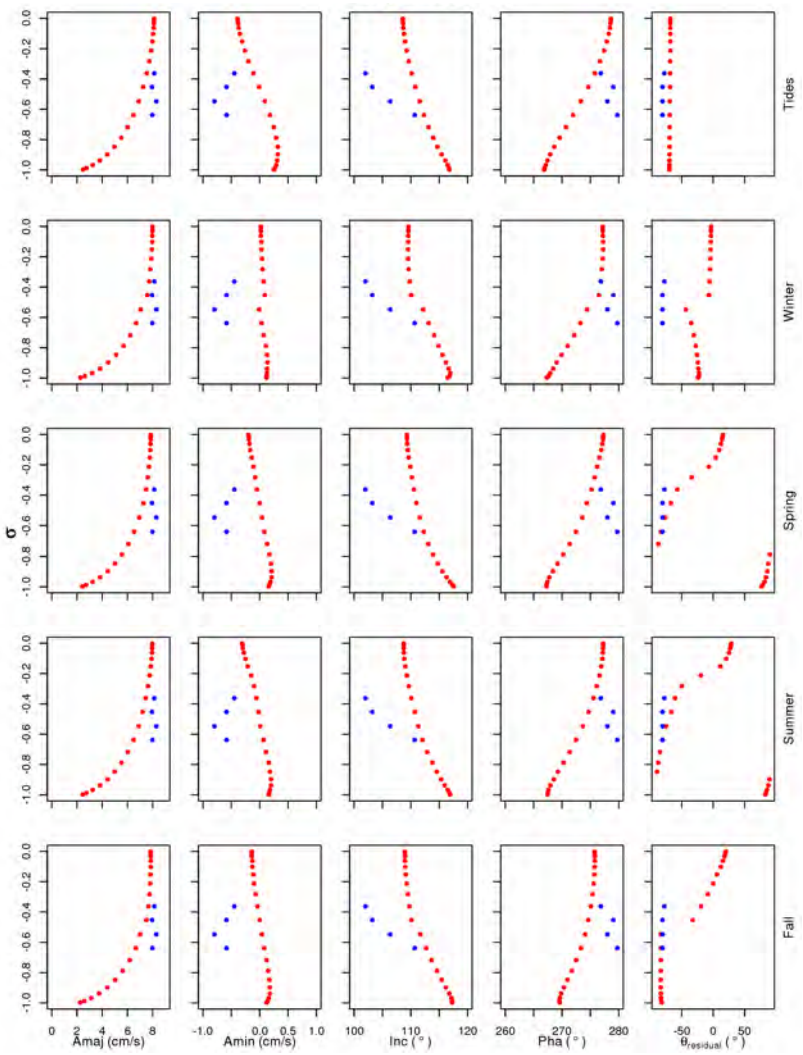

Figure 3. Comparison between the M2 constituent results from the tidal analysis of currents from ADCP deployment 531 (blue) and the FVCOM model (red). Shown are the amplitudes of the M2 tide along the major and minor axis of the current, the inclination (Inc) of the major axis, the phase (Pha) and the direction from the principal component analysis of the residual currents (θresidual). The vertical coordinate, σ, varies from 0 at the surface to -1 at the seabed.

prediction of the major amplitude though there was some indication that the current decays too quickly in the bottom boundary layer. Minor amplitudes were generally over-predicted by the model and the vertical structure was not captured but it should be noted that the differences between observed and modeled values are in the range of uncertainty in both data measurement and analysis. The model's inability to capture the vertical variation is evident in most of the parameters. There are two rivers which discharge into the area of interest: the Roseway River into Shelburne Harbour and the Jordan River into Jordan Bay. From CTD measurements (Chang et al., 2017), there is evidence that these rivers do affect the vertical temperature and salinity structure at certain times of year and so it is possible that baroclinic effects caused the observed vertical variation in the currents. As the FVCOM model was run in barotropic mode, these effects were not taken into account. Additionally, the modeled vertical structure is dependent on the vertical turbulence closure scheme used. The FVCOM implementation of the Mellor and Yamada (1982) level 2.5 turbulent closure model (Chen et al., 2006) was used for this study. Although other turbulence closure schemes are available, their effects have not been investigated.

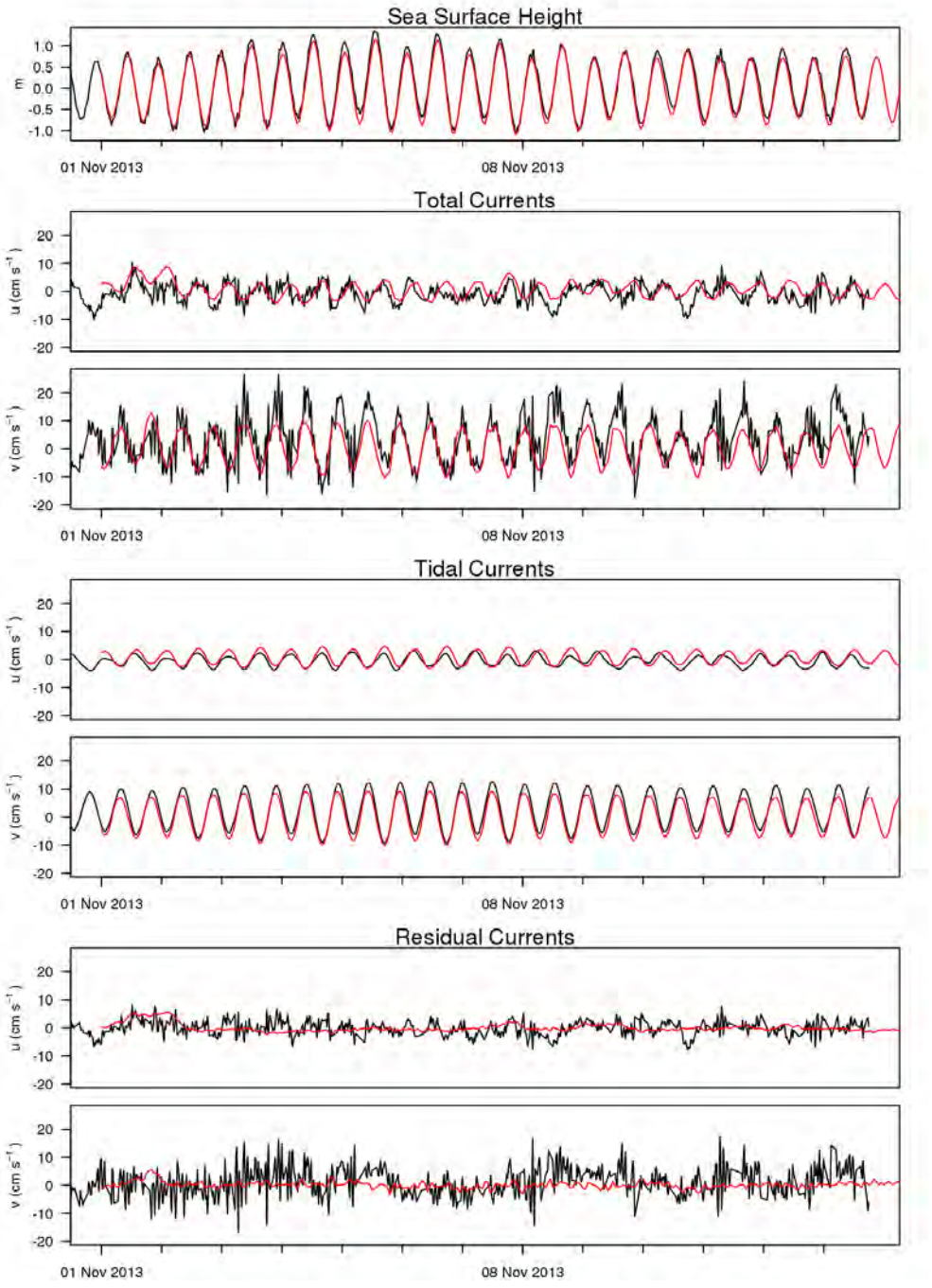

Figure 4. Time series comparison between current data for ADCP deployment 531 (black) and modelled currents from FVCOM fall 2013 simulation (red) at vertical level σ = -0.4525 where σ = 0 is the surface and σ = -1 is the seabed. Total currents have been decomposed into tidal and residual components where the residual current is the difference between the total current and the tidal current. Tidal currents include contributions from all constituents included in the tidal analysis.

For the phase and inclination, the differences between modeled and observed phases and inclinations are as great as 20°, where 20° represents a 41 minute difference in the timing of

observed and predicted currents. Typically, the values agree quite well at one vertical level but diverge moving away from that level. It should be noted that adding wind had little effect on the tidal parameters.

Unlike sea surface height for which the five tidal constituents used to force the model account for 88% to 97% of the variation, the same five constituents account for a smaller amount of the currents variation, between 30% and 80% (Chang et al, 2017). For this reason, non-tidal contribution to the currents must be examined. Time series decompositions for ADCP deployment 531 are shown in Figure 4. Forcing the barotropic FVCOM model with tides and wind alone was insufficient to capture the range of the observed currents. The measured non-tidal residual currents are of the same order of magnitude as the measured tidal currents but the model did not capture this important feature. Ongoing work concerning implementation of a baroclinic model will hopefully address this shortcoming.

Discussion

A FVCOM model for the Shelburne, Nova Scotia region was developed to examine the effects of seasonal winds on the circulation and to assess its usefulness for aquaculture regulatory purposes. The model was run in barotropic mode and included wetting and drying of inter-tidal areas. The open boundaries were forced by the tidal constituents M2, N2, S2, K1 and O1. Surface winds were also included in four 30-day runs, one during each season of 2013.

It was demonstrated that the model was capable of reproducing sea surface heights. For the currents, the model was able to predict the tidal amplitude in the major direction reasonably well. This is encouraging as the major amplitude has the biggest impact on the tidally driven distance travelled by agents which are advected by the currents. There was some indication that current amplitudes decayed too quickly towards the seabed. The model did not capture the observed vertical variation in the minor amplitude, inclination or phase. Additionally, winds alone were insufficient to capture the non-tidal variation of the currents.

One of the limitations of this study was the lack of overlapping time series for model and observations. Additionally, the ADCP were bottom mounted facing upward resulting in a lack of current observations near the sea bed. Work is continuing on improving the Shelburne model. Including baroclinicity and waves are under investigation.

Acknowledgements

This study would not have been possible without the involvement of many people in the collection of the field data including Sarah Scouten and Kenneth MacKeigan of Fisheries and Oceans Canada (DFO) and crew members Captain Perry Smith, Danny Loveless and Michael Dow of Canadian Coast Guard (CCG) vessel Viola M. Davidson, and Captain Richard Starr and Charles Hamilton of CCG vessel Sigma T. We would like to thank Brendan DeTracey (DFO) for kindly providing the wind data and Sheila Gidney (DFO) for administrative support This project was funded by the Program for Aquaculture Regulatory Research (PARR), DFO.

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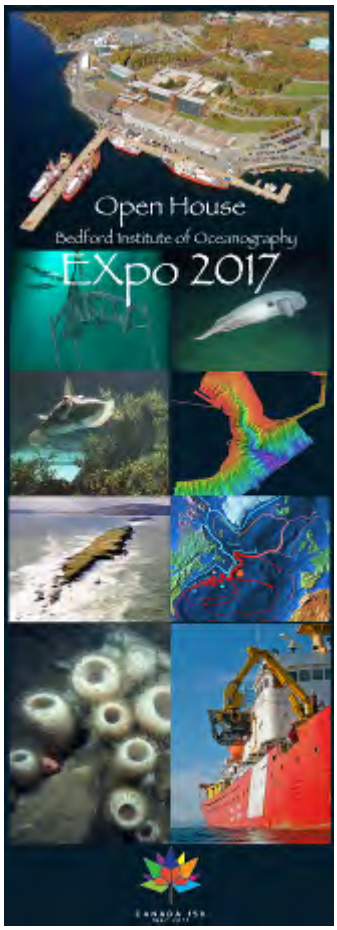
BIO Expo 2017 - September 20-24

Canada is 150 years old. The Geological Survey of Canada is 175 year old. The Bedford Institute of Oceanography is 55 years old. There will be a celebration. You are invited to learn about the Institute's various oceanographic research initiatives with an Ocean Science EXPO. For the past 55 years, the Bedford Institute of Oceanography has been opening its doors to thousands of intrigued visitors twice a decade - and 2017 will be no exception! The Open House will showcase some of the Institute's cutting-edge research with many interpretive and interactive exhibits!



The official opening for invited guests is scheduled for September 20. "School Days" span the two days September 21 and 22 from 9 am to 3 pm both days . They are open to all public and private schools. The first

School Day is dedicated for groups that include Elementary aged children. The second School Day is dedicated for Junior High, and High School aged groups. The visitors can talk with experts at interactive displays in a self-directed and self-paced setting. Information at BIO EXPO 2017 will be in both official languages. School Group arrival times will be booked on a first come, first served basis (the number of available school group start times are limited). Students can also attend with their families during Public Days. Public Days are January 23rd and 24th, also 9 am to 3 pm.

This expo is expected to be at least as busy as past open houses and could attract 10-20,000 visitors.

Les ondes internes font l'actualité

Comme on l'a vu dans Québec-Océan:

La découverte d'un mécanisme de formation de vagues sous-marines géantes avait été publiée en décembre 2016 dans la prestigieuse revue Nature Communications. Le quotidien de la Capitale l'a retenue comme l'une des percées scientifiques de l'année 2016. Le journaliste Jean-François Cliche s'est entretenu à ce sujet avec Daniel Bourgault de l'UQAR-ISMER. Les co-auteurs de l'étude sont Peter Galbraith, de l'Institut Maurice-Lamontagne (Pêches et Océans Canada) ainsi que Cédric Chavanne de l'UQAR-ISMER.

Québec OCÉAN Le groupe interinstitutionnel de recherches océanographiques du Québec

Du journal le Soleil:

(Québec) LES PERCÉES SCIENTIFIQUES EN 2016 / Une vague de 8 mètres de hauteur? Pas en pleine mer, mais dans le fjord du Saguenay? Vraiment? Daniel Bourgault a dû passer un drôle de temps des Fêtes, rempli de sourcils circonspects et de sourires figés, s'il a parlé de ses recherches en océanographie lors de ses soupers de famille. Car c'est bien cette découverte en apparence difficile à croire qui lui a valu une publication dans la prestigieuse revue savante *Nature Communications* en 2016. ...

leSoleil

Le résumé de Nature Communications:

Internal solitary waves are hump-shaped, large-amplitude waves that are physically analogous to surface waves except that they propagate within the fluid, along density steps that typically characterize the layered vertical structure of lakes, oceans and the atmosphere. As do surface waves, internal solitary waves may overturn and break, and the process is thought to provide a globally significant source of turbulent mixing and energy dissipation. Although commonly observed in geophysical fluids, the origins of internal solitary waves remain unclear. Here we report a rarely observed natural case of the birth of internal solitary waves from a frontally forced interfacial gravity current intruding into a two-layer and vertically sheared background environment. The results of the analysis carried out suggest that fronts may represent additional and unexpected sources of internal solitary waves in regions of lakes, oceans and atmospheres that are dynamically similar to the situation examined here in the Saguenay Fjord, Canada.

nature COMMUNICATIONS

This section of your newsletter provides an opportunity to highlight your research programs to the Ocean Science Community. *Your are invited to send contributions to David Greenberg,* *david.greenberg@dfo-mpo.gc.ca*	*Mettez en valeur vos programmes de recherche en publiant un article dans cette première section de votre bulletin.* *Faites parvenir vos contributions à David Greenberg,* *david.greenberg@dfo-mpo.gc.ca*

MEETINGS

CMOS Congress - update

June 4 – 8, 2017, Toronto

February 15 is an important date for all things Congress. That is final date for abstract submissions. The abstract submission process can be started here. Student CMOS members are encouraged to participate and to apply for a Student Travel Bursary when submitting an abstract (up to $500 per student). To apply for a Student Travel Bursary, complete an application form (click here) and email it to SPC@cmos.ca. February 15 is also the closing date for nominations for many of the prizes and awards presented at the congress. Some of these awards are open only to CMOS members and some are open to all. Details of the nomination process can be found on the web page linked above. CMOS has a rich history recognizing deserving persons (members and non - members) through its awards programs. But regrettably, there are many deserving candidates who go unrewarded each year because we were too busy to work up a nomination. Don't wait - do it now!

Regional Sea Level Changes and Coastal Impacts

10-14 July 2017, Columbia University, New-York (NY) - USA

The World Climate Research Program (WCRP), jointly with the Intergovernmental Oceanographic Commission of UNESCO (**IOC**), is organizing an international conference on sea level research that will address the existing challenges in describing and predicting regional sea level changes, and in quantifying the intrinsic uncertainties. It follows 11 years after the first WCRP sea level conference (Paris, 2006), and three years after the last Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). It will provide a comprehensive summary of the state of worldwide climate-related large scale sea level research. Abstract submission closes February 15. Conference website.

The 49th International Liege colloquium on Ocean Dynamics - The 8th Warnemünde Turbulence Days

Marine Turbulence Re^3-visited 22th - 26th May 2017,Liège, Belgium

Almost four decades after the « Marine Turbulence », 11th Liège Colloquium in 1980. Three decades after the « Turbulence in the ocean. From the millimeter to the megameter », 19th Liège Colloquium in 1987. Two decades after the « Marine Turbulence Revisited », 29th Liège Colloquium in 1997. One decade after the "Turbulence Re-revisited", 39th Liège Colloquium on in 2007. The exciting topic of Marine Turbulence will be revisited for the 3rd time during "Marine Turbulence Re^3-visited" as the 49th Liège Colloquium in 2017. Abstract submission closes January 30. Conference website.

GEOTRACES-related sessions at Goldschmidt 2017

13-18 August 2017, Paris, France

Goldschmidt is the foremost annual, international conference on geochemistry and related subjects, organized by the European Association of Geochemistry and the Geochemical Society. Please sign up to the mailing list to receive email updates.

The following sessions could be of interest to the GEOTRACES community:

10i: Cycles of Trace Elements and Isotopes in the Ocean: GEOTRACES and Beyond Convenors: Tim Conway, Geraldine Sarthou, Tianyu Chen, Gregory de Souza, Aridane G. González, Kristen Buck, Tina van de Flierdt, Walter Geibert, Zhimian Cao, Catherine Jeandel

10o: The Role of Scavenging in the Ocean: Chemical Processes, Environmental Controls and Modeling Convenors: Yves Plancherel, Phoebe Lam

10h: Non-Conventional Stable Isotopes in the Ocean: Novel Applications, Technological Advances and Future Applications Convenors: Horner Tristan, Pearce Christopher, Philip Pogge von Strandmann, Kathleen Scheiderich, Juan Carlos Silva-Tamayo

10k: Atmosphere-Ocean Interactions and Impacts on Ocean Chemistry and Biology Convenors: Adi Torfstein, Sophie Bonnet, Eyal Rahav, William Landing

10m: Insights into Ocean Processes Through the Application of Radioactive Tracers Convenors: Paul Morris, Guizhi Wang, Virginie Sanial

Abstract submission deadline April 1, 2017.

2017 ESSAS Open Science Meeting on Subarctic and Arctic Science

11-15 June 2017, Tromsø, Norway

The Ecosystem Studies of Subarctic and Arctic Seas (ESSAS) is a regional program of the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project. Its objectives are to understand how climate variability and climate change affect the marine ecosystems of Subarctic and Arctic seas and their sustainability, and in turn, how changes in these marine ecosystems affect humans. The Subarctic seas support large stocks of commercial fish that generate a major portion of the fish landings of the nations bordering them. Both the Subarctic and Arctic marine ecosystems support subsistence fishers along their coasts, and vast numbers of marine birds and mammals. Climate-forced changes in these systems have major economic and societal impacts. ESSAS conducts research to compare, quantify, and predict the impact of climate variability and global change on the productivity and sustainability of Subarctic and Arctic marine ecosystems.

This 3rd Open Science Meeting (OSM) is intended to attract an interdisciplinary group of scholars who will be prepared to discuss their research in the Subarctic, in both the North Atlantic and the North Pacific, and the Arctic Ocean. The title of the OSM is Moving in, out and across the Subarctic and Arctic marine ecosystems: shifting boundaries of water, ice, flora, fauna, people and institutions. Theme sessions include Advection and mixing and their ecosystem impacts that may be of interest to Canadian scientists; Ocean Acidification and many more.
Deadline for early fee payment: 15 Mar 2017.

Please send meeting announcements to David Greenberg, david.greenberg@dfo-mpo.gc.ca	*SVP faites parvenir vos annonces de réunion à David Greenberg, david.greenberg@dfo-mpo.gc.ca*

CANADIAN JOBS and TRAINING

Research Chairs in oil spills at the University of Manitoba

The University of Manitoba is looking to fill two research chair positions – A Canada Research Chair (Tier 1) in Marine Oil Spill Science (Associate or Full Professor) and an NSERC Industrial Research Chair (IRC, Associate Level) in Northern oil spill research -a full-time tenure-track position at the rank of Assistant or Associate Professor. The deadline for applications for both competitions is February 28, 2017.

Postdoctoral position to study application of stable isotopes and biomarkers as proxies for palaeoenvironmental reconstruction:

The Trace Metal Experimental and Biogeochemistry Group within the Department of Earth Sciences, Stellenbosch University, Western Cape, South Africa, invites applications for a postdoctoral position. The broader research project examines the application of stable isotopes and biomarkers to better understand the biogeochemical cycling of carbon in marine and terrestrial environments. The position is for 24 months, commencing any time from 1st of March 2017. Renewal of the position for the second year is subject to performance. For further information about the project and to apply please contact Prof A Roychoudhury (roy@sun.ac.za) and Dr Susanne Fietz (sfietz@sun.ac.za). Applications should be received by **February 15, 2017** and should include, as a single pdf document, a cover/motivation letter, a comprehensive Résumé/CV and a research statement. Please also provide the names and contact information for three professional references. Full notice and other positions at Geotraces.

Looking for work? Try the CMOS site (click).	*Vous recherchez un emploi? Visitez le site SCMO (click).*

GENERAL

CNC-SCOR Early Career Ocean Scientist Award

The Early Career Ocean Scientist Award is presented to an early career oceanographer/marine scientist for an outstanding contribution to marine sciences (in the broadest sense) within Canada. The award can be based on a single work/paper that provides a seminal contribution to the field, or ongoing work at a sufficiently high level of excellence that provides an outstanding overall contribution.

The Award: The award winner will receive a plaque with the award, as well as funds, from CNC-SCOR, to travel to the upcoming CMOS congress to receive the award and present a paper. Additionally, the award winner will invited to sit on the CNC-SCOR committee for 1 year beginning with the CMOS Congress associated with their award

Obligations of winner: The winner will acknowledge CNC-SCOR on their presentation at the CMOS-Congress, and will be asked to provide a 1 to 2 page article on their research for the Canadian Ocean Sciences Newsletter.

History of the Award: The award was presented for the first time in 2016. It is open to candidates (Canadians, working in Canada or overseas, or permanent residents) who are within 10 years of completion of their Ph.D. (note that periods of leave (e.g., parental, health) during this period do not count against the 10 year duration, provided appropriate documentation is provided). The candidate can work in any area of marine sciences, including academia, government, industry, NGO's, etc.

Award Nomination Instructions: Nominations are to be received no later than **15 February 2017**, by email to the CNC–SCOR secretary: David.Greenberg@dfo-mpo.gc.ca to be considered by the selection Committee. Receipt of submissions will be provided if requested.

Nominations will be adjudicated by the CNC-SCOR committee and will require a nomination letter highlighting the nominee's merits (maximum 2 pages), plus 2-4 supporting letters as well as an up to date CV of nominee. Nominations not selected for the award in previous years will be maintained active for three subsequent years (although they can be updated) or until the 10-year deadline has passed.

Teacher Professional Development - The Maury Project

Do you know a dynamic precollege teacher who could lead the way in oceanographic education? The Maury Project is a two-week teacher professional development workshop designed for precollege teachers and supervisors of science who teach, or supervise the teaching of, units with significant oceanography content. The workshop is fully paid for by the American Meteorological Society (AMS) and the US Naval Academy of the United States. Travel expenses are covered by CNC-SCOR and CMOS. Presentations at the workshop are made by some of the most respected American scientists in the field of oceanographic sciences. Participants have returned with material, resources and teaching modules readily adaptable to classroom presentations. It is to be noted that the successful candidate must agree to give two presentations to in-service teachers or other community groups in the following school year and to also provide CMOS with a short report on his/her experience at the workshop and a short report on the two presentations carried out during the school year. The application form must arrive by mail or email no later than March 15 2017 at:

CMOS Project Maury Workshop
P. O. Box 3211 Station D Ottawa ON
K1P 6H7

or:
awards-coord@cmos.ca .

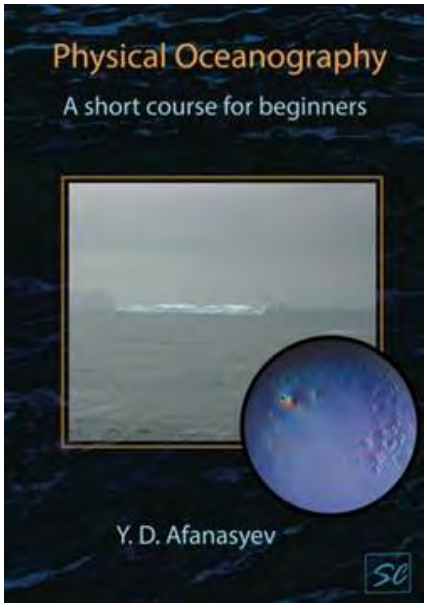
Training with NF-POGO Centre of Excellence at the Alfred Wegener Institute

Applications are now being accepted for Year 5 of the Nippon Foundation-POGO Centre of Excellence (NF-POGO CofE) at the Alfred Wegener Institute (AWI) Helmholtz Centre for Polar and Marine Research (AWI). The training will run from October 2017 to August 2018. Located in the North Sea, the NF-POGO Centre of Excellence at AWI will be conducted on the offshore island of Helgoland and the UNESCO reserve Waddensea island of Sylt. Helgoland provides opportunities for the study of open-ocean sciences; shelf/basin interactions are topics of study at Sylt. Your application should be submitted by 6th March 2017.

OERA Student Research Travel Program

The objective of the OERA Student Research Travel Program is to cultivate collaborations between Nova Scotia student researchers and international research facilities or laboratories that will contribute to advancing the offshore energy sector here in Nova Scotia and in building research capacity for the province. The program is open to full-time senior honours and graduate students* attending a Nova Scotia university or the Nova Scotia Community College (NSCC), who are conducting research in marine renewables, marine geosciences or seismic & marine sound. *Funding for post-doctoral fellows may be considered on a case by case basis. Interested applicants must complete a 'Student Research Travel Program Application Form'. OERA will consider applications to a maximum amount of CAD $5,000 (inclusive of applicable taxes) per student per fiscal year. Deadline for Applications: February 28, 2017.

New Oceanography Text



Yakov Afanassiev of Memorial University of Newfoundland tells us that the 2nd edition of his textbook *Physical Oceanography: A short course for beginners* is now available. From the description: "Oceanography is a vast science, and beginners often feel overwhelmed by the number and variety of different topics. This book presents a distilled version of physical oceanography by providing physical insight into the circulation of the Earth's oceans. A consistent view of the circulation is presented using only simple mathematics and an intuitive approach; however, hints to various phenomena are given for those who are willing to explore beyond this book. The book also contains an elementary introduction to fluid mechanics. This book is written at a mathematical level appropriate for undergraduate students in oceanic and climate science."

CANADIAN OCEAN SCIENCE NEWSLETTER

LE BULLETIN CANADIEN DES SCIENCES DE L'OCÉAN

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