



## **C-DOGS 2013**

*Conference of Dalhousie Oceanography Graduate Students*

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Friday March 22, 2013

8:30 *am* - 5:00 *pm*, University Hall

Dalhousie University, Halifax, Nova Scotia

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## Physical Oceanography Local Area Network - Unique IT services in Oceanography

Daniel Morrison<sup>1</sup>

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For over twenty years, the computing needs of many Physical Oceanographers at Dalhousie have been met by a dedicated staff person who maintains the Physical Oceanography Local Area Network (POLAN). Oceanographers in other disciplines have joined, and today POLAN provides IT services to almost half of the researchers in the Department of Oceanography. Services offered range from Internet connectivity, generous email capacity, web publishing, file storage, file sharing, and printing, to more specialized support of Unix/Linux free software and computational tools such as Matlab, R, and Python. Additionally assistance is offered for the technical aspects of special events such as conferences and seminars, and for the selection and purchase of new computer hardware and upgrade parts. POLAN provides a friendly liaison to the Dalhousie ITS staff who provide core networking on campus. New services are being developed, recently for the automated backup of user desktop and laptop systems, as well as new open standard collaborative tools for effectively working in our modern mobile environment. Feedback and inquiries are always welcome by email at <systems@phys.ocean.dal.ca>.

## Geometry and composition of ice banks in a macrotidal channel

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Large ice blocks containing enough sediment to be denser than sea water form in the Minas Basin of the Bay of Fundy. Timing of block formation and block composition were monitored to improve understanding of the potential threat to tidal power generators posed by collision with blocks. Large blocks are produced from ice cliffs that form when anchored ice obstructs tidal channels and decreases flow speed. Decreased flow causes channel cross-sectional area to decrease. In 2012 cross-sectional area of the Kennetcook River decreased by 28% due to formation of ice cliffs. Large ice blocks separated from the cliffs during the two spring tides following the maximum change in cumulative negative degree hours in the atmosphere. Ten percent of sampled ice blocks were denser than fresh water. Seven of twelve ice cores collected from the ice cliffs along the Kennetcook contained enough sediment to become denser than seawater.

## Effects of Temperature and Salinity on Species Succession in Invasive Tunicate Communities

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Four species of non-native tunicates have spread across the provinces of Nova Scotia and Prince Edward Island over the last ten years. As most of these coastal waters are considered suitable habitat based on the species physiological tolerances, we aimed to determine if their current distribution is forced by regional or local environmental conditions. We focused on temperature and salinity as potential environmental drivers as recent warmer temperature trends have been implicated in the northward shifts of both native and non-native species. We studied fouling communities in three Maritime regions representing three climate regimes: cold and marine, warm and marine and warm and brackish. From June to October, twenty PVC collector plates were deployed at six locations in each regime. The plates were photographed bi-monthly, at which time half were manipulated by counting and removing invasive tunicate settlers to promote native community development. Preliminary results reveal high variability in the succession and development of native and tunicate-invaded communities both within and between climate regimes. This suggests that local conditions are crucial in determining potential invasion success of new species.

## Monitoring coastal circulation and ocean properties along the Halifax Line using autonomous underwater gliders

Mathieu Dever<sup>1</sup>, Dave Hebert<sup>2</sup>, Blair Greenan<sup>2</sup>, Jinyu Sheng<sup>1</sup>, Peter Smith<sup>2</sup>

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Glider surveys over the Scotian shelf are used to demonstrate the potential of underwater autonomous gliders in a coastal region with complex flow and small-scale features. Two Slocum gliders repeatedly surveyed the Halifax Line from Halifax Harbour to about 250 km offshore collecting profiles of temperature and salinity as well as vertically averaged currents. After exploring the strengths and weaknesses of glider-based observations, the circulation over the inner shelf is described using the thermal wind equation combined with vertically averaged currents. A special focus will be put on the Nova Scotia Current, where observations from ADCPs are also available. Time series of currents from the ADCPs are used to validate glider-based currents as well as to compare transport estimates of the Nova Scotia Current. It is found that current estimations based on the thermal wind equation yield results that agree reasonably with the ADCP measurements and could therefore be a reliable way to determine transport across a buoyancy-driven flow such as the Nova Scotia Current.

## Diversity of Invertebrate Colonists Associated with Deep-water Gorgonian Corals on Simple and Complex Substrates, off Nova-Scotia

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Deep-sea corals ecosystems are known to host high diversities and abundances of invertebrates compared to the relatively homogenous seafloor. The aim of this study was to quantify the diversity of colonizing assemblages in a deep-water coral conservation area, on the continental slope off Nova Scotia (Northeast channel) and also to determine the role of complex physical substrate structure on colonization. A four-year field experimentation was conducted at depths > 650m using two kind of substrates: basalt rocks and complex substrates with interstitial spaces (scotch-Britt sponge pads). For both substrates, faunal assemblages were dominated by suspension-feeders. While octocorals were the most abundant taxa on rocks, sponges were dominated by crustaceans. Polychaetes were the most diversified taxa for both substrates yet gastropods were much more diversified on the sponges than on the basalts. Overall, the fauna associated with sponges was more diverse and abundant than the fauna found on the basalt rocks. However, the rarefaction curves showed that more samples would be necessary; many more associated species are still to be found. Those results suggest that more complex substrates facilitate the colonization of a diverse faunal assemblage in the northeast channel. Indeed, complexity increases the surface available for settlement and provides shelter from both physical and biological disturbances.

### The "Unpredictable" Tide in South West Nova Scotia

Justine McMillan<sup>1</sup>, Alex Hay<sup>1</sup>, Doug Schillinger<sup>1</sup>, Greg Trowse<sup>1</sup>, Richard Karsten<sup>2</sup>

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Most people who live near, or visit, the coast are familiar with the tides. Everyday, usually twice per day, the water level rises and falls due to the combined effects of the earth's rotation and the gravitational forces exerted by the moon and the sun. Over 300 years has passed since Isaac Newton first explained tidal phenomena and it is now common practice to predict tidal amplitudes using historical records and computer programs. This predictability is seen as one of the driving forces of tidal power development.

In this talk, I will summarize measurements that were made as part of a tidal energy resource assessment that was conducted in three passages in the Digby Neck region of Nova Scotia. In total, 15 acoustic Doppler current profiles (ADCPs) were deployed for approximately one month. Overall, the measurement campaign was successful, however several interesting challenges arose due to the high-speed flow. In addition to discussing these challenges, I will highlight some surprising results which suggest that certain aspects of this tidal flow are unpredictable.

## Carbon and nitrogen recycling efficiency in coastal sedimentary environments: the role of habitat heterogeneity

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Shallow coastal systems typically have a complex mosaic of benthic habitats coupled to pelagic ones. This habitat diversity maintains, regulates and defines the net ecosystem metabolism, as well as the capacity of the system to provide ecosystem services and ecological functions that benefit both, human and natural populations. The incorporation of habitat heterogeneity, and therefore spatial variability, to ecosystem and biogeochemical models, has been considered a critical aspect to reach more realistic whole-area estimations of supporting services widely extended through sedimentary environments. This aspect equally applies to the distinction between natural and human-induced variability.

This presentation show current progresses in the development of a mechanistic diagenetic model to predict, compare and understand the dynamic relationships and contribution of littoral sediments and photic benthic habitats to carbon and nitrogen removal from coastal areas (as CO<sub>2</sub> and N<sub>2</sub> respectively). Major attention will be devoted to bare sediments as spatially dominant habitat type, and seagrass beds, highly valued in habitat restoration.

## Using a computer-based aural classifier for inter-species discrimination of cetacean vocalizations

Carolyn Binder<sup>1,2</sup>, Paul Hines<sup>2</sup>

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Passive acoustic methods are in widespread use to detect, classify and localize marine mammals; however, these passive sonar systems are often triggered by other transient sources, producing large numbers of false detections. In order to isolate the true detections and to positively identify marine mammals, large volumes of data are collected that need to be processed by a trained analyst. To reduce acoustic analyst workload, an automatic detector can be implemented with a high false positive rate. Detections from this may then be passed to an automatic classifier to both significantly reduce the number of false detections and classify the marine mammal species. This process requires the development of a classifier capable of performing inter-species classification and discriminating cetacean vocalizations from noise sources. A prototype aural classifier has been developed at Defence R&D Canada that uses perceptual signal features which model the features employed by the human auditory system. The aural classifier has successfully been used to reduce false detections rates and discriminate vocalizations from four cetacean species: bowhead, humpback, North Atlantic right, and sperm whales. This talk will present an overview of the aural classifier architecture and then vocalizations from the previously mentioned cetacean species will be used to quantify the aural classifiers performance in discriminating cetacean vocalizations.

## Quantifying population dynamics of the invasive bryozoan *Membranipora membranacea* in the northwest Atlantic

Danielle Denley<sup>1</sup>

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Biological invasions can often catalyze significant changes in community composition and ecosystem function, making the introduction non-indigenous species one of the major anthropogenic threats to local biodiversity. While its native range in the northern hemisphere includes the Pacific coast of North America and the Atlantic coast of Europe, the colonial, encrusting bryozoan *Membranipora membranacea* is thought to have been introduced to the eastern Atlantic via ballast water from European populations. The capacity of this non-native species to alter coastal habitats has generated significant concern for the welfare of Nova Scotia's marine ecosystems, in particular, the welfare of ecologically and economically important species such as lobsters and urchins. A thorough understanding of *M. membranacea*'s population dynamics is necessary in order to predict future population outbreaks and range expansions, a critical step in mitigating the potentially dramatic effect this bryozoan may have on Nova Scotia's marine biodiversity. In this talk I will discuss the difficulties associated with quantifying population dynamics in colonial organisms, as well as, highlight some preliminary results depicting seasonal variation in the reproductive capacity of *M. membranacea* colonies, an important predictor of the timing and extent of *M. membranacea* outbreaks.

## Physical Processes Affecting Circulation and Hydrography in the Sable Gully

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The Sable Gully is the largest submarine canyon along the shelfbreak off the east coast of North America. The circulation and hydrography in the Gully have significant temporal and spatial variability. This study presents a numerical study of the three-dimensional (3D) circulation and hydrography in the Gully using a multi-nested model. The model is forced by tides, wind stress and surface heat/freshwater fluxes. Model results are in fair agreement with the current and hydrographic observations made in the Gully in 2006 and 2007. A process study is conducted to examine the main physical processes affecting the circulation and hydrography, including tide-topography interaction, wind forcing, and the shelf-scale circulation over the eastern Canadian Shelf. The model results demonstrate significant tide-topography interaction inside the Gully. The circulation and hydrography above the canyon rim are also influenced significantly by wind, particularly during storm events, while the subsurface flow over the shelf slope is affected by the shelf-scale circulation. Based on the simulated 3D flow fields, a particle tracking model is used to identify localized retention zones, downstream and upstream areas of the Gully.



## Acoustic Reflections from Ice in the Bay of Fundy

Nicholas Dourado<sup>1</sup>

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If neutrally-buoyant ice collides with a tidal turbine and no one is there to see it, does it make a sound?

This proverbial question is the subject of a research program that extends from the Bay of Fundy's tidal rivers to Dalhousie's Aquatron Tower Tank. The risk posed to tidal turbines by migratory ice is still unknown and many preliminary questions remain unanswered. Can sound penetrate an ice block and provide information that will enable better infrastructure management in this hostile environment?

This talk will seek to address this 'chilling' mystery using broadband acoustic backscatter data collected in vitro from submerged ice. It is my goal to use this information to model acoustic returns from sediment-laden ice that occurs in Minas Passage.

## Bubble enhancement of optical estimates of calcite in the Southern Ocean

Michael Brown<sup>1</sup>, Susanne Craig<sup>1</sup>, William Balch<sup>2</sup>, Bruce Bowler<sup>2</sup>, David Drapeau<sup>2</sup>,  
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Global satellite ocean colour imagery has revealed a circumpolar region of elevated reflectances that consistently forms during austral summers in the Southern Ocean. Remote sensing algorithms for the mineral calcite indicate that these reflectances are at least partially due to the presence of coccolithophores, a type of phytoplankton that produce external calcite plates that are very efficient at backscattering light. Thus this feature has been named the Great Calcite Belt. Given its immense size, as well as the cellular calcification rates of coccolithophores, the Belt could potentially have important implications for global biogeochemical cycles. However, the Southern Ocean is characterized by strong wind speeds. Therefore it has been suggested that wind generated submerged bubble layers are contributing in combination with coccolithophores to the observed reflectances, and resulting in overestimates of optically derived calcite. It would be important to determine if this is occurring, as it could impact global estimates of calcification. For this talk I will discuss recent work that aims to identify bubble enhancement of optical estimates of calcite in the Belt. I utilize a unique dataset collected during an oceanographic research cruise that observed a coccolithophore bloom off the Patagonian Shelf in 2008. Measurements included optical estimates of calcite-dependent backscattering derived from above-water radiometry, along with more direct acid-labile measurements. An attempt is made to relate the differences between these to the shipboard wind speed.

## Tracing Stable Isotopes in and around Halifax Harbour

Elizabeth Kerrigan<sup>1</sup>, Markus Kienast<sup>1</sup>, Doug Wallace<sup>1</sup>

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Technological advancements have allowed for an increase in stable isotope measurements in the Ocean in recent years. In particular, measurements of oxygen and hydrogen isotopes,  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  respectively, have become increasingly popular due to their role as a water tracer and the increased ease associated with sampling. These isotopes are preferentially used as water tracers over salinity, which cannot distinguish between freshwater inputs into a water source;  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  are intimately connected to the water, creating a link between the atmosphere, continents and precipitation. Water samples are taken from 9 sites in and around the Harbour, as well as rain and snow samples that represent the input of precipitation. These samples are run through a salinometer to determine salinity and a CRDS (Cavity ring-down spectroscopy) Isotope Analyzer to determine  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  for all water samples. By looking at the isotopic composition and salinity of these water masses it is possible to determine the relative input of different water sources into the Harbour as well as its general circulation pattern. The collection of  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  measurements from in and around the Harbour helps not only to quantify the proportion of inputs into the Harbour and to trace water flow, but it also provides us with baseline measurements that were previously unknown for this area. This talk will present some of my preliminary data, illustrating the major inputs of water into the Harbour, the general proportions of these water masses as well as the overall movement of water through Halifax Harbour.

## Modelling the spring bloom initiation in the North Atlantic

Angela Kuhn<sup>1</sup>, Paul Mattern<sup>1</sup>, Katja Fennel<sup>1</sup>

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The precise mechanisms of the spring bloom initiation are still an open paradigm of the ocean sciences. A one-dimensional NPZD model with optimized parameters has been used to test whether the initiation of the bloom is affected by light and nutrient limitations (as in the critical depth hypothesis) or top-down control of the system by zooplankton (as in the dilution-recoupling hypothesis). The model is able to replicate accurately the annual cycle of chlorophyll in the North Atlantic Ocean, as a proxy of phytoplankton concentrations. Taking advantage of the low computational cost and flexibility of the model, a series of simple experiments explore the isolated effects of changes in the mixed layer depth, phytoplankton growth parameter and zooplankton grazing.

## Seasonal effects of biofilms on fine sediment resuspension in the Minas Basin, NS

Jessica Carrière-Garwood<sup>1</sup>, Paul S. Hill<sup>1</sup>

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A seasonal cycle in total suspended sediment mass has previously been observed in the Minas Basin of the Bay of Fundy. This study investigated the effects of sediment biofilms on this seasonal cycle, as biofilms are known to limit erosion. From April through November 2012, sediment cores were collected biweekly from an intertidal flat near Kingsport, NS. A Gust microcosm was used to simulate natural erosion at the sediment surface of the cores. For every collection day, half of the eroded cores remained untreated, while the other half was treated with bleach prior to erosion to destroy the biofilm. Properties of the sediment resuspended from both cores, such as grain size, were then compared, and linked to properties of the biofilms, such as chlorophyll *a* levels. Preliminary results will be presented, including interesting evidence for *Corophium*-induced sediment resuspension.

## Getting better estimates of chlorophyll-a: a fluorometer-based bio-optical approach

Matthew Beck<sup>1</sup>, John Cullen<sup>1</sup>

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Chlorophyll *a* (*Chla*) is a pigment found in phytoplankton that has traditionally been used as a proxy for estimating phytoplankton biomass. Since phytoplankton are at the base of the marine food chain, any errors made in estimating their abundance will be carried forward in projections of primary productivity, biogeochemical cycling, and indices significant for marine assessment and management. It is therefore important that measurements made in the field be as accurate as possible. Since the 1960s, a common way to estimate *Chla* in the field has been through *in situ* fluorometry, the accuracy of which is usually validated with simultaneously obtained water samples. Today, autonomous platforms such as buoys, floats, and gliders are routinely equipped with fluorometers, providing spatial and temporal resolution that would be prohibitively expensive to obtain through traditional ship-based methods. However this lack of a coincident, ship-based sampling regime makes it difficult to validate the accuracy of these measurements, so it is increasingly important to develop robust procedures for calibrating autonomous instruments without relying on direct validation from water samples. This work focuses on a multi-parameter, optics-based approach to increasing the accuracy of autonomous, *in situ* *Chla* estimates. By complementing fluorometer measurements with information from particulate backscattering, downwelling irradiance, and the diffuse downwelling attenuation coefficient, we can determine localized calibrations that correct for regional and temporal changes in the relationship between fluorescence and *Chla* in natural phytoplankton populations.

## Predation of planktonic invertebrate larvae

Kevin Sorochan<sup>1</sup>

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The consumption of planktonic larvae by predators is often considered a significant source of benthic invertebrate mortality; however, information supporting this notion is limited. Even baseline information on the diversity of predators and their relative importance to larval predation under natural conditions is surprisingly scarce. My research is focused on evaluating fundamental questions that will help to facilitate the estimation, and ultimately the prediction, of the impact of pelagic predators on planktonic larval populations in St. Margarets Bay, NS. In this presentation, I will discuss field and laboratory approaches that I will use to address two of the most basic (yet problematic) questions: who are the predators? and what do they eat? In addition, I will discuss how studying predator-prey interactions can be used to evaluate the more important question: how much do they eat?

## Radium isotopes on the Scotian Shelf: Unique distributions and tracers of cross-shelf transport

William Burt<sup>1</sup>, Helmuth Thomas<sup>1</sup>, Jean-Pierre Auclair<sup>1</sup>

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Radium (Ra) isotopes have become a common tool for investigating mixing rates on continental shelves, and more recently have been used to quantify the release of dissolved compounds enriched in pore-waters into the water column. Our sampling on the Scotian Shelf will represent the first published dataset of Ra isotopes from this region. Observed features include relatively small coastal signals, considerable activities far offshore, and activities consistently above detection limit throughout the entire shelf, and in open ocean waters. Our study investigates the strengths and limitations of the commonly used 1-D diffusion model to calculate mixing coefficients on the Scotian Shelf, and compares results from the 1-D model to those obtained using 2-D numerical simulations, which includes the effect of bathymetry on Radium distributions across the shelf.

## Observations of the Space-time Structure of Flow, Vorticity and Stress over Orbital-scale Ripples

Jenna Hare<sup>1</sup>, Alex Hay<sup>1</sup>, Richard Cheel<sup>1</sup>, Len Zedel<sup>2</sup>

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Results are presented from a laboratory investigation of the spatial and temporal structure at turbulence-resolving scales of the flow, vorticity and stress over equilibrium orbital-scale sand ripples. The ripples were created in 153  $\mu\text{m}$  median diameter sand using the oscillating tray apparatus described in Hay et al. (2012) at a period of 10 s and an excursion of 0.5 m. Vertical profiles of velocity above the bed were obtained at 3 mm vertical resolution and 40 Hz using a wide-band coherent Doppler profiler (MFDop). Through runs at different positions of the MFDop relative to a particular ripple crest, phase-averaged measures of the flow over a full ripple wavelength were obtained as a function of phase during the forcing cycle. These measurements are used to determine the formation of the lee vortex. The evolution of turbulent kinetic energy, Reynolds stress and turbulence production are also presented.

### Accelerometry: the key to monitoring fish growth in the wild.

Franziska Broell<sup>1</sup>, C.T. Taggart<sup>1</sup>, Andre Bezanson<sup>2</sup>

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The ability to monitor *in situ* time varying estimates of growth rate of fish in the wild has yet to be achieved. Growth rate is typically derived a posteriori based on some estimate of size-at-time ( $L_t$ ). We propose that onboard micro-scale accelerometry may provide *in situ* estimates of  $L_t$ , and thus time varying growth rate if acceleration, within a species, is a function of size ( $L$ ). To test this hypothesis, we design and develop a high-frequency (up to 550 Hz) micro-accelerometer tag. Statistical properties and parameters (e.g. spectral) in the acceleration signal are examined in relation to fish size. This is being achieved first in the lab by using various species of fish that include Atlantic pollock (*Pollachius pollachius*), Atlantic cod (*Gadus morhua*) and in the field with Shortnose sturgeon (*Acipenser brevirostrum*). This talk will offer details on the concepts, on our advances in micro-accelerometry, and on some preliminary results from a variety of acceleration trails.