Report from Ocean Networks Canada Workshop on

Sediment fluxes and carbon burial inshore and offshore Vancouver Island using seafloor observatories

University of Victoria's Ocean-Climate Campus Building at the Queenswood Campus, 2474 Arbutus Road, Victoria, BC V8N 1V9

27-28 November 2018

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Summary

Ocean Networks Canada's fourth Theme Leader Workshop entitled "Sediment fluxes and carbon burial inshore and offshore Vancouver Island using seafloor observatories" was held at Ocean Networks Canada's new headquarters during 27-28 November 2018. "Sediment in Motion" Theme Leader Pere Puig (CSIC, Barcelona, Spain) lead the workshop with Gwyn Lintern (NRCan, Sidney BC, Canada) as co-lead, to bring together a Barkley Canyon sediment and particulate carbon focused research group and the Fraser Delta Dynamics sediment mass transport group. The discussions ranged from the powerful turbidity flows captured off Vancouver on the Fraser River Delta to the controls of the pelagic-benthic coupling in Barkley Canyon ecosystem. The participants were a mixed group of researchers already active with Ocean Networks Canada (ONC) as well as newly engaged scientists from Spain, the U.K., the Netherlands, Germany, the U.S. and Canada. The largest part of the meeting was dedicated to discussions on potential research and publication of the existing data, but also knowledge and data gaps were identified to be potentially closed by new instrumentations or new sites. The outcome was a list of papers to be written, improving sampling and sample analysis standards and protocols, new instrumentation and experiment proposals to be prepared.

Important Outcomes

- Agreement to write at least six peer-reviewed papers in the short-term (1-2 years) with existing data
- Recommendation to rise priority for seafloor crawler Wally
- Request to add turbidity as ONC core parameter
- Recommendation to move Barkley Canyon Upper Slope and Vertical Profiling System platforms into Barkley Canyon axis at 600 m depth
- Recommendation to analyze bottom sediment and sediment trap samples at UVic lab for coherent long-term time series of sample data, and request sample analysis data from previous samples

- Agreement to write expedition and research proposal to compare Hydrate Ridge with Barkley Canyon (to Schmidt Ocean Institute and/or National Science Foundation)
- Suggestion to consider ONC hosting NRCan observatory data from Kitimat Arm
- Established list of future sites of interest

Participant List

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Participants of the Ocean Networks Canada “Sediment in Motion” Theme Leader workshop in Victoria, BC, Canada, November 2019.

Introduction

This workshop was the fourth of Ocean Networks Canada's (ONC's) Theme Leader Workshops and the first workshop dedicated to the theme of "Seafloor and Sediment in Motion." Theme Leader Pere Puig (CSIC) teamed up with Gwyn Lintern (NRCan) to bring together sediment flux and carbon burial researchers with an interest to work on ONC's time series data from the two sediment-focus sites, Barkley Canyon on the NEPTUNE observatory off Vancouver Island and the Fraser River Delta on the VENUS observatory in the Strait of Georgia off Vancouver. The Fraser Delta has a well-developed research focus and time-series and since 2008 whereas the Barkley Canyon sedimentary focused observatory research is considered to be still at the

infancy stage. The workshop took place 27-28 November 2018 at the new ONC headquarters at the Queenswood Ocean and Climate Campus of the University of Victoria.

Workshop Objective and Plan

The objective was to enhance the visibility of ONC infrastructures related to sediment transport and motivate the scientific community to publish papers using ONC data products.

- Focus of Day 1: What can be done with existing ONC data?
- Focus of Day 2: What else could be done to improve ONC data collection/processing?

Workshop Format

On Day 1 (agenda below), introductions into 20 years of planning, building and running Ocean Networks Canada (www.oceannetworks.ca) in general, with VENUS being online since 2006 and NEPTUNE since 2009, and free open data access (data.oceannetworks.ca) in particular were presented, followed by two more focused introductory presentations dedicated to the two sites (Barkley Canyon and Fraser Delta), demonstrating the uniqueness of cabled observatories' data. After that, two research theme talks showed the scientific potential of both sites, and the subsequent discussions in site-specific breakout groups focused on potential research using the existing data in the short-term (1-2 years; outcome captured and summarized below).

Day 2 started with an overview of ONC's role to support scientists in their research by continued data acquisition, potential non-ONC data ingestion, and data distribution in a flexible way based on the scientists needs but without funds for actual research. This was followed by potential expansions of the network, e.g. with additional instrumentation or sites, e.g. the British Columbian Douglas Channel or the Arctic. Breakout group discussions continued with the medium- and long-term future scientific questions and goals (3-5 and 5-10 years, respectively), and the workshop concluded with summarizing the findings and identifying action items (outcome captured and summarized below).

Online participation was facilitated by Google Meet with predefined access codes; one per meeting room to accommodate breaking out into subgroups.

Meeting notes were captured live in Google Docs and therefore accessible in real time by online participants. Meeting notes were split into:
the large group:
(https://docs.google.com/document/d/1PtMcpmENmTY47DqfJV-3Jqixlg35mfj_IpRLCmc7AvU);
the Barkley Canyon breakout group:
(https://docs.google.com/document/d/1Zb9f9sSPZ_5vYpAk5ezy662M8c0VdgvxEl1FV4Jtosw);
and the Fraser Delta breakout group:
(https://docs.google.com/document/d/1nGfSqh_8PZwOTM_tbP2udYymrTe7DPsZuJvyFKN9eU4).

Outcome

The workshop participants had lively discussions on the theme, resulting in the following list of research ideas on new or improved technologies and methods, open and new questions, identified data gaps, current and new proposals, and finally research papers, summarized as follows.

Ideas on New or Improved Technologies and Methods

Inshore
Use NOCS M3 sonar either on ship or observatory for capturing freshet plume and how it turns into gravity flow (4D = 3D time-lapse); M3 system as 30-120 beam width, average data volume 1 Tb per week; needs feasibility assessment and should be deployable by R/Vs Heron/Strickland
Add long pole of pressure sensors to DDL platform to capture vertically varying down-slope flow speeds similar to what is being done on land avalanches; could be used to trigger connected sampler (medium term)
Improve Seismic Liquefaction In-situ Penetrometer (SLIP) for pore pressure, re-equip spare NRCan SLIP (medium term)
Detection of long-term morphology changes from repeat multi beam and LIDAR measurements, combined with modelling, to obtain tidal influence on erosion, separate from turbidity currents
Chlorophyll to backscatter helped to identify turbidity currents but can also qualify kinds of particles
Instrument segments of pipe and cables to measure vibrations, strumming and breakage under turbidity current load
Develop bio-sampling robot with water filters of different sizes
Use docking AUV to extend observatory footprint, useful for oil or plume monitoring or other event responses, and could do regular health-system check-ups
Add nano-dust experiment to track turbulent flows
Monitor bed-load transfer vs water column mass transfer; adding broadband seismometer to Fraser to understand bed-load
Combine CODAR surface currents data with ferry turbidity data
Biofouling interesting topic, testing different materials/metals, studying rates of corrosion in and out of sediments (inside sediments faster corrosion rate), establishing time-series of growths (what where), with scraping of samples, e.g. study title "Microbial biofouling on an observatory cables" (Andrew Thurber)
Dredge disposal measuring on moorings or other satellite platforms; UBC and NRCan developed sampling system (Thurber also knows someone who deployed a sampling system); sampling radius e.g. from ship's ADCP surveys several km past DDL platform, incl. zone of dredge deposits, and potentially also the sponge reefs NW of DDL

Offshore
New experiment for tracking bottom trawling fishing with VMS (Vessel Monitoring System) and AIS (Automatic Identification System) data; AIS data not easy to obtain, not sure if fishing is seasonal; Global Fishing Watch has five years of data but don't differentiate between mid-water and bottom trawling
Plan for ONC to obtain sample analysis data back from labs to back available at data portal - needs internal ONC lead
Push cores taken more regularly now during ONC expeditions, also aiming for 50 cm cores instead of existing 30 cm
Important to establish core sampling protocols, inventory of existing samples and how they are preserved; Sample preservation, sample process protocol shared by F. Mienis; Consistent protocol for sample analysis, basic/core index
Would be good to collaborate with other cruises for sediment core collection
Ideally ONC data would be pre-processed, turbidity spikes removed, maybe 10 s sample interval
Glider fleet and can they carry pH sensors; good experience was made with SeaFET pH-Sensors from Seabird (Thomsen)
Respiration chamber, incubation chamber. (Medium term)
Interest in tracking organic aggregates, what processes are generating and transporting them, using turbidity looking for downwelling episodes, identifying residual flows, tidal pumping, persistent march of organic aggregates down canyon
Could investigate Barkley circulation, where top and mid sections show tide fluctuations and seasonal signals whereas bottom more stable
Crawler fluorescence or turbidity data show hourly spikes, should be removed, combined with active acoustics data showing copepods or small fish
Repeat ship's multibeam bathymetry data available around canyon but not processed separately, by year, yet.
Story from sediment push cores and sediment trap samples. Water column important but data missing but could be added from CTD rosette Niskins, to obtain average nutrient distribution
Potential paper on food quantity and quality in Barkley Canyon; ideally from existing sediment samples (ask Paul Snelgrove if he has samples left), and add ROV sampling transact down to 2000 m; look at multibeam data to find hard substrate for potential coral sites; deep sea coral and sponge mapping would be good
Oxygen changes important for seasonal, long-term or even tidal changes, include temperature as they are related, and association to fauna, see if oxygen is stress factor; zooplankton relied on real data from 50 years of Line-P sampling
INCISE community interested in internal tides from ADCP data; important to understand exchange of water between shelf and canyon, up- or downwelling, water circulation. Susan Allen (has student) interesting in modelling
Thomsen interested in comparing POC and DIC in Barkley Canyon; expand Integrated Carbon Observation System (ICOS) to include cabled observatories.

Verify the winter fluxes and add data on importance of downwelling for DIC from surface waters through the canyon to offer a wider picture on carbon fluxes and attract funds for climate change studies. (Thomsen)
Once Wally is online again, it could work at the Canyon Axes and run transects analyses on sediment oxygen demand and ecosystem functioning. (Thomsen)
Respiratory experiment (Schmidt Ocean Institute Falkor proposal?), measure oxygen uptake, experiment for a whole year to picture seasonal changes (medium term)
Plot/look at the data at canyon head data (plumes around) (short-term)

Open and New Research Questions

Inshore
Plume Dynamics, Deposits, Contaminants
What is the exact dynamic behaviour of a sediment plume, how is it transported, how does it settle and deposit, and what role does it play in contaminant transport? ● DDL instrumentation and research is covering sediment transport and slope stability ● Lintern looking for collaborators for plume settling studies
What is the correlation of plankton and river plume? ● Need to study the Fraser Delta plankton blooms and primary productivity linked to freshet ● Quantify flux of organic carbon at Fraser Delta, studying fate of organics, taking into account material transport, recycling, resuspension, oxidization, flocculation, which part of plume contains organics; biogenic gas already mapped, but nutrient effects from seawater not known; differentiate between plume and turbidity current for material transport; map volume of fan and concentrations of plume front at DDL and calculate efficiency of carbon flux and burial over different time scale, freshet and over decades.
What is the correlation of ADCP and other sonar and optical instrument data with multifrequency backscatter? ● Multifrequency backscatter gives concentrations, and correlation with long-term ADCP; optical backscatter and other sensors could extrapolate the time-series; excellent cross calibration opportunity
By comparing ADCP with hydrophone data, could we detect sound seconds before changes in velocity?
Can CODAR data combined with ADCP data show if plume reaches sponge reefs?
What is the residence time of certain types of materials?
How do fluxes and ecology change with distance along the Fraser Channel
How to landslides form, as instantaneous whole or progressive failures?
Climate Change
What is the extent of climate change on the sediment transport?
Can we actually detect climate change related changes at the DDL site?
How does the Fraser River discharge change?

Animal behaviour
What are the effects of the delta on local biology, sponge reefs, whale/animal response to events like turbidity flows or earthquakes? ● Use animals as sensors, track them, observe abundance, behaviour, responses to perturbation, human behaviour; animals are first to respond and will eventually return; establish baseline of "normal," observe response to quick events like pressure waves, sense early warning capabilities, understand them for geological, paleontological records ● Check if whales become silent during earthquakes
Tidal Energy
How much tidal energy could be harnessed at ONC sites like DDL or Campbell River?
Whole Carbon Story from Source to Sink
How does the entire sediment flow system work, from source to sink? ● Whole carbon story not touched yet
How does the Fraser work, what is the driver for sedimentation, comparison between Kitimat, Fraser, Terrace-Prince Rupert Skeena River, and what drives the deposition that leads to failure?

Offshore
What is the relationship between EDNA(?) and fish?
How are the physical processes in Barkley Canyon interconnected (mesoscale gliders?), and how does a subtle change in condition transform the benthic ecosystem (using test sites?)? (Lo Lacono & De Leo)
Do we have a general vision of processes and habitat distribution in Barkley Canyon, or do we need more ground truthing to predict habitat distribution? (Lo Lacono & De Leo)
What is the multiscale vertical structure among different sites within Barkley Canyon, e.g. nutrient distribution, from a comparison among variety of sites? (Lo Lacono & De Leo)
What is the general role of the canyon in particle transport including carbon organic matter, benthic-pelagic coupling? (Mienis & Seabrook)
For a functional comparison of within canyon/outside canyon, what is the carbon flux, link to benthic ecology, link to fauna (e.g. sponge/coral occurrence), by conducting experiments to see how material is being used? (Mienis & Seabrook)
What is the influence of trawling and its seasonality? (Mienis & Seabrook)
How does the oxygen minimum zone change over time, influencing ecosystem, e.g. corals at seep sites? (Mienis & Seabrook)
Does the movement of particles differ within canyon or outside of canyon system, for example how does the food availability compare within and outside of canyon? (Thurber & Paradis-Vilar)
What are the inputs and drivers of community composition, microbial community structure, impact of seasonality? (Thurber & Paradis-Vilar)
What is the influence of natural forcing from storms on hydrodynamics of the canyon, on turbidity current of the canyon, and can we distinguish the seasonality from fishing/trawling or other shipping effects? (Thurber & Paradis-Vilar)

What is the source of the particles, either from surface water, transported by tides or other water movement, or by the offshore transport? ● Need to characterize the canyon dynamics ● Need analyze the sediment trap samples, and water dynamics monitoring. ● What are the data missing? (Puig)
What is the sediment transport in and out of Canyon?

New or Extended Sites and Site Comparisons

Inshore
Douglas Channel
Kitimat Arm at end of Douglas Channel, about 300 m in depth, recorded two landslide-generated tsunamis (1974 and 1975) with up to 7 m run-up; history of landslides not been considered when planning $40 billion LNG project, mostly new pipeline and expansion of port
ONC community observatory exists at Kitimaat Village across the arm from Kitimat port
Also has glass sponges at southern part, and is rich area for herring and whales
Need current meter in area for modelling
Debate on studying Douglas Channel as a human, community influenced system, or Skeena River as a more natural environment; Kitimaat Village observatory not Kitimat Port which is changing the most.
West Coast Fjords
Howe Sound, Squamish, much more active as Fraser, also interesting for biological perspective, sponge reefs, also has history of landslide generated tsunamis, growing ports, could study anthropogenic processes, local and easily accessible for installing a small network
- Interesting to compare Fraser River Delta with Canadian west coast fjords, e.g. Squamish has hundreds of turbidity flows a year.
Skeena River
Research community interested in Terrace BC community observatory, interest in sponge reefs, study of trawling impacts and recovery; MEOPAR is finding research there (Sally Leys; should involve Maia Hoeberechts)
Arctic
Some Interest in Arctic, e.g. Beaufort Sea; Cambridge Bay has solid ice until end of June, has observatory land (shore) station and shallow platform
Mackenzie River Delta is interesting comparison site for Fraser, also has lots of development, could also study role of ice on physical and biological processes
Fraser Delta Expansion
Debate moving DDL after 10 years, though still collecting interesting data, perhaps closer to south of ferry terminal, or expand Delta observatory to Sand Heads (Transport Canada interested), Fraser Ridge (Tunnicliffe old CFI proposal), Fraser Channel
Critical Infrastructure
Other critical infrastructure locations susceptible to earthquakes, floods, landslides, such as Delta Port, BC Ferries, BC Hydro transmission cables, Richmond dikes
Marine Protected Areas

Comparison from in and around Marine Protected Areas (MPA), sediment accumulation inside caused by fishing activity outside MPA (potentially new sites like Fraser Ridge)
Little Estuaries
Monitor little estuaries' turbidity patterns (potentially new sites), compare with Fraser
Southern Salish Sea
Integrate data from University of Washington moorings in southern Salish Sea

Offshore
Barkley Canyon Head
Consider changing Upper Slope South closer to Canyon Head
Like to monitor other canyon head branches, and potentially conduct simultaneous experiments at various canyon heads to detect which is the main sediment pathway under which oceanographic conditions
Focus on the canyon head branch towards the north end to characterize the settlement of sediments, or the role the canyon itself is playing in the sediment settlement, to explore the canyon behaviour, and expand the limits of oxygen minimum zone.
Barkley Upper Slope
Could expand on autonomous moorings around Barkley Upper Slope
Barkley Upper Axis
Vertical Profiling System inside canyon at 600 m
Extend cable to northeast of Canyon Axis, along the axis, for more water column information recorded to characterize water masses movement/behaviour, related to sediment settlement questions
Coral Locations
Coral Cliff, add ROV dives, sampling on the corals (coral reef)
Coral community in oxygen limitation zone in Pacific Region (2-page proposal) or short term goal? (Medium term)
Barkley Canyon vs Clayoquot Slope
Would be good to compare canyon with non-canyon (Barkley vs Clayoquot) ● Would need to measure particle fluxes at Clayoquot Slope ● Compare deep sites in Canyon (900 m, 600 m) with Clayoquot Slope site (1200 m) with vertical coverage to see oxygen limited zone
Barkley Canyon vs OOI Hydrate Ridge
M. Goni interesting in NSF proposal to compare OOI Hydrate Ridge with ONC Barkley Canyon
More comparison study within ONC network, using Barkley interaction, OOI collaboration for extension of experiment on corals and sponges (sea pens).
Kitimat Canyon
Comparison of Barkley Canyon with other canyons of similar morphology
General/All
Add one more node to west side of canyon axis, a bit north of canyon axis site (towards the canyon head ~ 600 m), for comparing sites at 600 m west, 1000 m inside, and 600 m outside east of canyon. Bringing interest from physical oceanography community including modelling. Autonomous monitoring at head.

All the dataset from all sites for comparison (consistent sensors on the platforms) (long term)
Canyon Node (600 m) & Canyon Head (~ 400 m) comparison
Should occupy additional seep sites, study the influence of sediments on seeps and gas hydrates.

Missing Data

Inshore
Spatial surveys, adaptive to events, repeats at standard locations, using mobile systems, ships of opportunities, entire coastal ferry routes
LIDAR at bow of ships over water for tracking organic particulates in water column
Cameras on low-flying planes
Sector scanning sonar with 100 m range to resolve plume and turbidity flow dynamics
Longer cores of stratigraphy for better site and site history characterization
Grain size, kind or organic carbon analysis
Tracers down river to understand contaminant and organic carbon transport
Kitimat needs current meter, for Douglas Channel winter outflow strength affecting Kitimat LNG tanker traffic
Observations from dredging processes and disposals, pathogens from new sequencing techniques, on moorings
OTN-style observations from hydrophones listening to migrations of lobsters and crabs
Add fluorescence or turbidity measurements to ferries crossing Fraser delta
NRCan data from Kitimat Arm, could be ingested and hosted by ONC

Offshore
General
Should start a sampling data base
Biological Samples
Sponge and coral samples; rare as not much hard substrate exists for growth
Biological samples from Coral Cliff site at Barkley Hydrates, and explore interaction between them; already have some ADCP from Coral Cliff (2012-2013) but not published
Site characterization should include bio-ecological data (fauna), turbidity, water column features to understand linkages
Benthic respiration/incubation chambers
Baited experiments
Baited traps
Larvae samples; sediment traps not useful to track larvae due to formalin preservation
Turbidity and Fluorescence
Important to measure NTU and fluorescence at all sites, to link to sediments, analyze quality, potential food source, whether fresh or decayed; should add FLNTU sensors to sediment traps down canyon; Thomsen has three Seapoint, Puig and Ogston may have, too.
Turbidity data at all sites; cheap sensors, important to have on CTD+O2

Turbidity data on all platforms (cheap sensor, connecting to CTD) but important; e.g. Upper Slope & Barkley Node
Seapoint turbidity and fluorescence sensors at mid canyon and canyon axis, plus Folger Passage plus at the meteorological buoys, to link to MODIS chlorophyll. (Thomsen)
Water Column
More Water column measurement, water column dynamic samples, VPS inside the canyon.
Use or add more oxygen sensors to track downwelling.
Water column CTD casts done from ship at sites of oxygen sensors, and usually on ROV; would be nice to add turbidity sensor to CTD rosette or ROV
Add more water column measurements (VPS/glider/flying Wally)
VPS, water column measurements (information) within the canyon, VPS outside of canyon. Within the Canyon axis, will be more useful to have the water column measurement to resolve water column related questions.
ROV observations, spatial coverage
ROV dives along the Canyon - ground truthing where knowledge is limited
ROV bottom transects missing inside and up Barkley Canyon; should connect all sites; this is an important addition to existing ROV bottom transects that already exist elsewhere.
Sites should be equipped with similar instruments
AUV data to extend spatial footprint
More video
More instrumented comparison sites (canyon vs non-canyon sites, inside/outside of canyon), turbidity, ADCP, fluorescence at Barkley Node and Canyon Axis.
Sediment Samples
Additional sediment traps
More sediment cores (longer cores, both ROV push cores (50 cm), plus ship gravity cores (2 m)), spatial distribution along Canyon axis
We need canyon sediments to calibrate the sensors. (Thomsen)
Canyon axis sediment trap data (short-term)
More CTDs, cores high upon on the list (short-term)
Sediment trap data, sediment traps by clicking at certain depths, for specific analysis. Characterize the particle arrivals.
Sediment coring along the canyon axis, no clear picture of the sediment composition, type of sediment along the axis
Other
Dissolved Inorganic Carbon (DIC), uncertain of data exist, perhaps pCO2; also important to track downwelling
Respirometry

Proposals

Inshore
Lintern (NRCan) developing Niskin bottle sampling device to capture turbidity flow sediment and concentrations, to be deployed at the Delta Dynamics Laboratory platform

Rebuild DDL platform for improved deployment on smaller vessels (Lintern, NRCan)
Cable tension and strumming measurements, as a current strain meter, at the DDL platform, proposed by Lintern (NRCan)
Proposal with Talling (Durham University) and Lintern (NRcan) to use multiple hydrophones on Fraser Delta for areal turbidity current detections (? From meeting notes - or was this the fibre-optic turbidity cable (below)?)
Infrastructure expansion from NRCan-UK collaboration on fibre-optic strain gauge cable (long-term)

Offshore
Acoustic camera to be moved to Barkley Canyon (De Leo)
Seafloor crawler Wally be redeployed; Wally important platform for Barkley Canyon; should consider flying Wally; Recommendation to prioritize Wally as a reliable mobile platform
New proposal for eco-hydrodynamics of cold-water coral habitats (INCISE, De Leo)
Mienis and De Leo to discuss with Kim Juniper potential funding application for Canyon study
Use existing data to prepare a proposal for shiptime (core sample collection, Falkor, 2-page, coral related project) (short-term or medium-term goal?)

Potential Research Papers

Inshore
Committed Research Papers
● Long term changes on Fraser Delta and Roberts Bank (lead: Gwyn Lintern) ● River conditions versus sedimentation rates (lead: Gwyn Lintern) ● Track plume to sponge reefs (maybe add Sally Leys and NOC Belize for corals) - may require CODAR and ADCP comparison (medium-term) and integration of Susan Allen's existing model (lead: Gwyn Lintern) ● Comparison of platform designs - maybe include sedimentation rates from repeat multi beam and platform-mounted sonars - for upcoming ISSMMTC meeting (lead: Michael Clare)
Potential short term (1-2 years), not yet underway
● Turbidity event detection (and recurrence frequency) from ADCP data converted to scalar time-series ● Full data analysis of strong recent turbidity event from fully instrumented DDL platform
Potential medium term (3-5 years), already under way

- Settling Plume, Turbidity maximum and flocculation conditions. Look at settling velocities, bottom fluid mud layers and long-term bed elevations (lead: Gwyn Lintern)
- Turbidity currents – investigating structure, power, and changes to bed throughout flows.
    - Statistics (Louis), runout (Pope), structure (Daniela)?
    - Flow Structure from Aquascat suspended sediment profiler (lead: Gwyn Lintern)
    - What role do hydrophones play in monitoring? (lead: Gwyn Lintern)
    - What are concentrations? (lead: Gwyn Lintern)
- Effect of earthquakes and seasonal groundwater flow in relation to Roberts Bank pore pressures

Potential medium term (3-5 years), not yet under way

- Comparison of CODAR and ADCP for plume tracking (see also committed short-term above)
- Turbidity currents at different seasons. Does cohesion or biofilm change the rheology? Are flows different in different seasons. Is the biofilm the top of the delta involved in concentrating sediment into flows? Potential collaborators: Baas, Hendry
- Flows at southern delta off ports and deep nodes - data not even looked at

Potential longer term, already underway

- Sedimentation in relation to oceanographic conditions at different time scales (seconds to years) (lead: Gwyn Lintern)
- Turbidity currents – investigating structure, power, and changes to bed throughout flows - Why these turbidity currents, at such high velocities, don't scour the bed much (lead: Gwyn Lintern)
- Groundwater plume escape on the Fraser Delta (lead: Gwyn Lintern)

Potential longer term, not yet underway

- Inter-calibration between many acoustic and optical instruments - potential lead: Simmons
- Carbon cycle, effective transport offshore, volumetric transport of sediment in fan versus river plume, eco-regions, sponge reef, fan, gassy sediment, critical whale habitat. Comparison to channelized fjords. Potential collaborator: Miguel
- Dynamic pressure from flow. Hydraulic jump? Pore pressure?
- How does plume affect plankton blooms?
- Fish, zooplankton at the mouth of an important Salmon River
- Turbidity event comparison between Fraser and Monterey Canyon from all data of Fraser Delta Turbidity events (once event database is established)

Offshore

Committed Research Papers

• Site characterization of the canyon axis, and related to the presence of corals (deep sea) and sponges, south of the Canyon Axis. These have not been described yet, and rely on the delivery of particles to that site. There is AUV data to be exploited, covering the coral cliff. Three years of current meter data, focus on that time, and look at the time series of all the platforms over that same time range and use the particle flux measurements over the last year to characterize these environments for the corals and sponges (lead: Claudio Lo Iacono) • Off-shelf (canyon head) sediment transport to the mid-canyon axis site. Hoping the sediment trap at the canyon head will collect nice data, same at the axis, and combine data sets. Incorporate data from the Upper Slope if that is possible (lead: Pere Puig)
Potential longer term
• Changes in the sedimentation rates in the axis associated with fisheries activities; data sediment cores from last cruise, see if sedimentation rates changed post 90's to see if fishing activities have had an impact. ROV transects on fishing grounds, see if the canyon walls are trawled, etc., and build the story

Appendix

Participants Feedback

Feedback regarding Oceans 2.0

- How much data am I requesting?
- Where can I provide/obtain direct or "live" feedback?

Mini Feedback Survey

A post-workshop mini feedback survey was sent to all participant, with the following questions and responses:

Q1: How useful was this workshop for you and your research?

Useless	0
Below expectations	0
As expected	1
Above expectations	3
Above and beyond	1

Q2: What were the good aspects of the workshop, what worked well?

"Cooperation, logistics, potential in strategic and technological aspects"
"Informative presentations regarding data availability and access. Great opportunities to develop connections with other researchers and ONC staff."
"Good ambience and fruitful scientific discussion"
"The group assembled was from a diverse background of scientist with a willingness to collaborate and discuss ideas from very applied to big picture. It also made the resources

clear as to what was available and supportable by ONC and how to augment or build off those. This will likely lead to interesting cross discipline advances in canyon science (and in my own realm - ecology).”
"Not too many presentations, enough time for discussions. Nice venue."

Q3: What did not work well, could be improved for future workshops?

"This has been a first approach for addressing common research interests and improve the transfer of knowledge. So no more can be demanded. Further meetings could help in put into reality what has been foreseen, and foster a real cooperation in writing scientific papers and proposals for sea-going funds."
"The breakdown sessions were useful but in some cases overly focused or constrained to some specific issues."
"Videoconference"
"In some ways the two groups (coastal and Barkley canyon) were a little more separate than they needed to be. There was real effort on the group level to combine ideas but potentially doing a 1-2-5 minute cross team idea sharing could make the overall ideas more connected between the two groups."
"Prior to workshop, get a list of attendees, affiliations, mini-background. Maybe during introduction, give everyone more time to introduce themselves, what they work on, i.e. what they could bring to the group."

Q4: Any further comments?

"This was a highly useful workshop that did an excellent job to facilitate the sharing of ideas in an open and friendly atmosphere while highlighting and invigorating the potential and use of ONC data streams. The organizers should be commended for this as I believe it will lead to significant use of the infrastructure while advancing science."

Agenda

Day 1, Tuesday, 27 Nov 2018
9:00 - Welcoming - Pere Puig (5 min)
- Round Table personal introduction (10 min)
- Introduction to ONC and Four Research Themes - Richard Dewey (15 min)
- Summary of research infrastructures related with sediment transport by regions
- Fraser River Delta - Martin Scherwath (20 min)
- DDL History, mapping, sediment coring, piezometer, etc.
- List of published papers
- Barkley Canyon - Fabio De Leo (20 min)
- Instrumented sites and experiments, sensor reconfiguration, ROV footage, sediment coring, ship and AUV multibeam mapping, etc
- List of published papers
- Data access (Oceans 2.0), sample archive - Dwight Owens (20 min)

10:30 - Coffee Break (15 min)
- Fraser Delta Presentation - Gwyn Lintern (15 min)
- Group Discussion (20 min)
- Barkley Canyon Presentation - Andrea Ogston (15 min)
- Group Discussion (20 min)
12.00 Lunch (60 min)
13:00 - Breakout into regional groups (Delta - Gwyn and Martin; Barkley - Pere and Fabio)
- What papers can be generated with existing data?
- Data issues needed to be solved before publishing
- Site characterization potential
- Don't discuss new/missing data yet!!
15:30 Coffee Break (15 min)
- Travel reimbursement review - Corinne (10 min)
- All-in reporting back to group
- Open discussion on ONC data usage
16:45 END

Day 2, Wednesday, 28 Nov 2018
9:00 - Summary of Day 1 Pere (15 min)
- ONC role Richard (15 min presentation + questions and discussion)
- What ONC can do and provide, sampling priorities (calibration, site characterization, additional requests)
- What ONC cannot do (fund research)
- Presentation of other ONC cabled observatory sites - Martin (20 min presentation + questions and discussion)
- Funded and proposed network expansions, past examples
- Kitimat - Douglas Channel, LNG development plans
- Potential for growth/external proposals
- Brief Introduction to Breakouts format - Martin (5 min)
10:30 - Coffee Break (15 min)
- Breakout into regional groups (Delta - Gwyn and Martin; Barkley - Pere and Fabio)
- New science questions (1-2-5-All)*
- Missing data (1-2-5-All)*
- Good/bad/better/new locations (1-2-5-All)*
- Feasibility discussion of new ideas
12.00 - Lunch (60 min)
- Resume breakouts, else continue
- Identify future goals (together or in regional groups)
- 50% Short-term (1-2 years, with existing data)
- 30% Medium-term (3-5 years, with little add-ons)
- 20% Long-term (5-10 years, with potentially new experiments)
- 15:00 - Coffee Break (15 min)

- All-in reporting back to group
- All-in discussion on other cabled regions (e.g. Kitimat, ?)
- Distribute Action Items (together or in regional groups)
- Identify potential papers with existing data
- Who is leading which paper?
- Convey ideas and turn into medium- or long-term ONC projects
16:45 END
*(1-2-5-All): On this question, think one minute for yourself, discuss for two minutes with your neighbour, spend five minutes with the table, then enter a group discussion on the question. This helps to filter ALL ideas and only the best ones reach the entire group.