BaySys Newsletter

Issue 5 - Spring 2019

Project Update

The BaySys Project enters into the second half of the year with dataset processing and analysis nearly completed. Teams are working hard to write up their results, and publish in the now open BaySys Special Issue in the peer-reviewed journal *Elementa: Science of the Anthropocene.* As results come out, Team Leads will prepare their final Phase 2 deliverables in the form of a comprehensive analysis report, and synthesis report expected to be drafted by the end of the year. This report will contribute to the overall project aim and help address the individual team, and overall project objectives.

Upcoming Meetings

SSC/RAC Meeting - May 24th, 2019, Manitoba Hydro
IGS 2019 Sea Ice Symposium - August 19 - 23, 2019, Winnipeg, MB
BaySys All-Hands Meeting - November 14-15, 2019, Winnipeg, MB
BaySys Wrap-up Meeting - February/March 2020

Recent Graduate Student Completions

Team 6 - Jafarikhasragh, S. Numerical modeling of Hudson Bay Complex, sea ice regime and sea surface temperature, 2019. https://mspace.lib.umanitoba.ca/xmlui/handle/1993/33851

Team 5 - Stainton, T. An initial investigation into the sources and transport of particulate organic matter in the Nelson River system, Manitoba, 2019. https://mspace.lib.umanitoba.ca/xmlui/handle/1993/33788

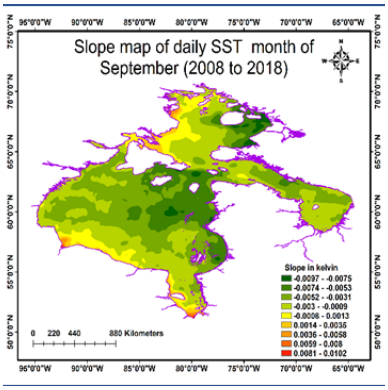
Team 4 - Kazmiruk, Z. Potential for microbial degradation of terrestrial dissolved organic carbon in coastal Hudson Bay, 2018. https://mspace.lib.umanitoba.ca/xmlui/handle/1993/33646

Team 3 - Dalman, L. Physical gradient influences on sea ice algae in the Canadian Arctic, 2018. https://mspace.lib

Team 1

Daily Sea-surface temperature data (Level 4 gridded product, GHRSST) have been analyzed for the Canadian sub-arctic region (Hudson Bay, Hudson Strait, James Bay, and Foxe Basin). The daily data for the open water seasons (August, September, and October) for the last decade (2008 to 2018) have been analyzed. Preliminary analysis indicates some interesting facts. The mean SST for the study period over the total study area shows a steady decreasing pattern, while the trend of SST maximum is increasing in August and September with a slightly decreasing trend in October.

The general trend over the last decade, shows a rise in SST throughout the whole western and south-western coast of Hudson Bay, contrastingly a steady decline in SST throughout the eastern margin and parts of the central Hudson Bay. Similar patterns can be observed in James Bay as well. SST trends, particularly over Foxe Basin, has been quite intriguing; there has been a steady rise in the eastern coastal margin and northern coast of Southampton Island and a relatively decreasing trend in the north-eastern region.

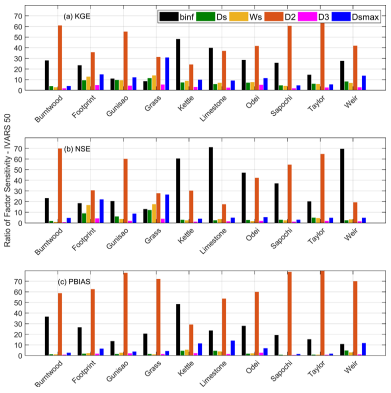


Slope map of daily SST month of September (2008-2018)

Team 2

Building a high-fidelity hydrological model remains a challenging task due to the availability of different input forcing data sets, model complexities, behavior, uncertainties in model structure, and parameterization. In this study we evaluate uncertainties propagated through different climate data sets in seasonal and annual hydrological simulations over the LNRB, using the VIC model. Further, we perform a comprehensive sensitivity and uncertainty analysis of the VIC model using a recently developed robust technique called Variogram Analysis of Response Surfaces (VARS). This requires large number of model simulations to advocate sensitivity as an integral part of VIC by discussing its capabilities as a tool for identifying influential parameters and streamflow sensitivity to parameter uncertainty at seasonal and annual time scales.

As a specific outcome of this work, reliable input forcing, the most influential model parameters, and the uncertainty envelope in stream flow prediction, are presented for the VIC model. These results, along with some specific recommendations, are expected to assist the broader VIC modeling community, and other users of VARS, and land surface schemes, to enhance their modeling applications.

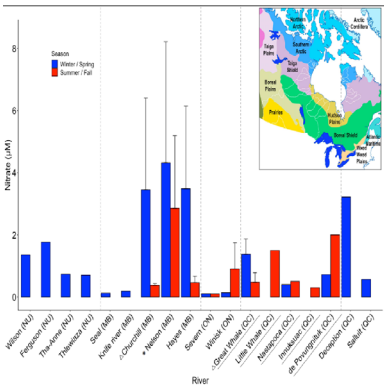


Ratio of factor sensitivity (%) of IVARS 50 for each parameter at annual scale over all sub-watersheds of the LNRB for the three model performance metrics (1981-2010) (a) KGE, (b) NSE, and (c) PBIAS. Ratio of factor sensitivity is estimated by normalizing IVARS 50 values in each case, so they add up to 100% for all parameters.

Team 3

Results from nutrient analyses showed that nitrate concentrations varied across the different watersheds, presumably due to contrasted vegetation zones and rock formations. Southwestern rivers and the Great Whale show high nitrate concentrations in winter/spring relative to summer/fall. This pattern is either reversed or absent in the southern and eastern rivers sampled.

The Nelson River exhibits highly variable and generally high nitrate concentrations relative to other southwestern rivers and the difference is particularly pronounced during summer/fall. This pattern is consistent with an input of fertilizer and organic manure and the fact that cultivated crops dominate land use within the Nelson watershed (CAMP report 2017, Manitoba Hydro).

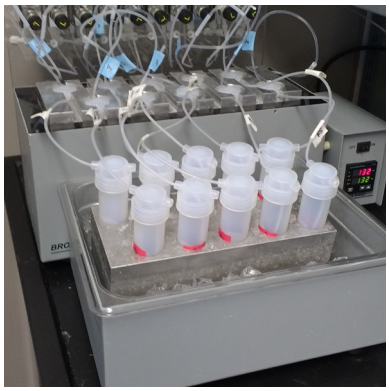


Concentrations of nitrate in different rivers during the summer-fall (July – October) and/or winter-spring (November –June) periods using historical data and BaySyS measurements.

Team 4

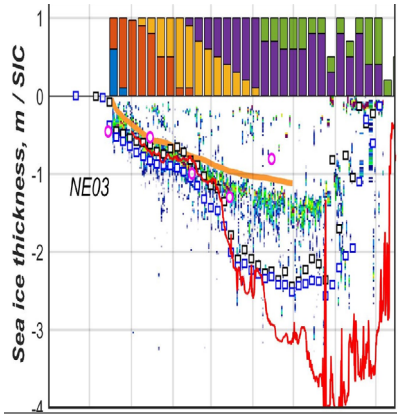
One of Team 4's objectives is to determine the mineralization processes of dissolved organic matter in Hudson Bay. Surface water samples were collected in the Churchill River and aboard the CCGS Des Groseilliers in 2016, and laboratory experiments were conducted to simulate the photochemical degradation characteristic of dissolved organic matter (DOM). Sohidul Islam (PhD student) found a photochemical loss ranging from 59% in Bay waters to >99% in river waters. The DOM photomineralization rates (0.03-0.18 h-1) will be used by Inge Deschepper (Team 3) in the BaySys biogeochemical model. Sohidul's first manuscript will be submitted for peer-review publication this spring.

Team 5



Twelve sediment cores were collected during the 2018 bay-wide cruise. Members of teams 4 and 5 are processing the cores to examine the historical cycling of organic matter and mercury in Hudson Bay. The cores have been sectioned and each section has been dated. We will spend our summer analyzing each section for different chemical components, such as marine and terrestrial organic matter components or methylmercury content. For methylmercury, this analysis is labour-intensive. Each sediment sample must be freeze-dried, ground, and distilled before the resulting aqueous sample can be quantified in the laboratory. However, our summer spent in the laboratory will provide historical context for our measurements of organic matter and mercury in water samples collected during spring 2018.

Team 6



Team 6 continues to develop the structure for an integrated observational/modeling assessment and framework for BaySys through research and publications, diagnostic development, and coordination amongst teams. Research contributions include the publication of manuscripts, "Revisiting summer circulation in Hudson Bay" led by HQP Natasha Ridenour, and "Modelling SST in HBC using bulk heat flux parameterization" led by HQP Shabnam Jafarikhasragh. A manuscript providing an evaluation of he ANHA configuration of the NEMO model (Ridenour et al.) is in press, and thermodynamic and dynamic contributions to sea ice conditions in the HBC (Jafarikhasragh et al.) in review. ANHA comparisons with Environment and Climate Change Canada's RIOPS forecasting model are well underway, as is the baseline evaluation in collaboration with Manitoba Hydro for the 2016-2018 BaySys timeframe. Diagnostic development to quantify relative climate change and regulation impacts using output from BaySys simulations to be launched this spring is also in progress in collaboration with BaySys teams.

Stories from BaySys - Team 4 - Mohamed Ahmed

You may wonder why a person from Egypt is interested in doing his Ph.D. research in the Arctic. My answer is simple: experience and adventure. Since I was a young child, the sheer intricacy of our planet is something that has always left me in utter amazement and motivated me to explore and ask many questions. My current research is primarily within team 4 and centered on studying the air-sea CO2 exchange in Hudson Bay and how it will be affected by climate change and river runoff regulation. As the hydroelectric development in the Hudson Bay watershed has produced significant changes in the timing and distribution of freshwater discharge, therefore it is important to understand the impacts of those changes on the carbon cycle. Unfortunately, there is high uncertainty about carbon system processes in Hudson Bay due to relatively few observations and fast climate change. My project seeks to overcome these issues by upscaling the ship observations collected last year to the entire Hudson Bay region by using remote sensing products from numerous platforms in order to provide monthly CO2 flux maps and describe the key factors of air-sea CO2 exchange. If you wish to talk more about my research, you can email me on (mohamed.ahmed3@ucalgary.ca) or follow me on twitter (@MohamdMMAhmed).

Stories from BaySys - Team 6 - Shabnam Jafarikhasragh

I began working on NEMO model simulations in 2015 as part of the BAYSYS project (Team 6) and as a primary aim of my thesis research. I like the concept of numerical models, such as NEMO, as a tool to provide meaningful climatological information in a variety of spatial and temporal resolutions. Although errors are always a part of the simulated results, they are some of the only tools which can provide us with large-scale future (projections) and historical information.
Through the use of NEMO modeling as part of the BaySys project, we aim to understand the effects of climate change and water regulation on the Hudson Bay Complex climate and eco-system. To meet these goals, different simulations have been run, or are in process of being evaluated and analyzed by our team.

I recently graduated and will continue my studies as a research associate with the BAYSYS project with Dr. David Barber, Dr. Paul Myers and Dr. Jennifer Lukovich. I recently published a manuscript titled "Modelling Sea Surface Temperature (SST) in the Hudson Bay Complex Using Bulk Heat Flux Parameterization: Sensitivity to Atmospheric Forcing and Model Resolution" in the journal of Atmosphere-Ocean, and I'm also submitting a second manuscript exploring dynamical and thermodynamical sea ice thickness tendency over the HBC, which is of great interest to both my supervisor and me :).

Partners