Remote Sensing of Canada's New Arctic Frontier

Summary

Project Leader

Babin, Marcel

Rapid climate change and industrialization are unlocking the natural resources of the vast Canadian Arctic and increasingly impacting its ecosystems. The stewardship of these ecosystems, the environmentally sustainable development of arctic resources, and the adaptation of northern communities to their rapidly changing world require a massive intensification of scientific observations. Furthermore, these observations must be organized into geo-referenced data banks and models that will provide stakeholders in government, industry and communities with the knowledge needed to inform their decisions. The objectives of this project are aligned with the targeted achievements of the Canada Excellence Research Chair on “Remote Sensing of Canada's New Arctic Frontier” to: (1) Augment in time and space the observation of arctic marine ecosystems by implementing new algorithms for the remote-sensing of phytoplankton, particulate matter, dissolved organic carbon and seawater optical properties in the surface layer of the Canadian Arctic Ocean, from which primary production, bacterial growth, and organic matter photo-oxidation will be derived; (2) Develop, validate, and implement the urgently-needed ecosystem models that will help anticipate the impacts of climate change and industrialization on the resources and services (fisheries, navigation, minerals, energy, tourism) provided now and in the near future by the ecosystems of the Canadian Arctic Ocean; (3) Adapt existing and future new observing technologies to the extreme conditions of the Arctic Ocean, with emphasis on the field deployment of Profiling Floats, Autonomous Underwater Vehicles, and Ocean Gliders, and on the use of optical sensors; (4) In collaboration with the Canadian Cryospheric Information Network (CCIN), Centre d’études nordiques (CEN) and other national and international partners, mesh the respective expertise of ArcticNet and GEOIDE, two pan-Canadian NCE, into the development of state-of-the-art geo-referenced data archiving systems that can be accessed online by scientific, industrial and government stakeholders to produce maps and analyses of the transforming Canadian Arctic. The scientific broad objectives of this ambitious program are: (1) To understand the functioning of the arctic marine ecosystems. What is the composition of the microbial communities (biocenoses)? Who are the main players among phytoplankters and bacteria in terms of energy and biomass transfer to higher trophic levels? What are the main ecologically distinct environments (biotopes)? Where do critical biological processes really happen in this environment? What are the interactions between the biocenoses and biotopes? How does the ecosystem work? (2) To determine the carbon fluxes (rivers ? coastal environment ? ocean), with special emphasis on those affected by light. What is the impact of bacterial activity and photo-oxidation on mineralizing organic carbon? What is the extent of new organic carbon production by primary production? What are the chemical and physical factors controlling those three carbon fluxes affected by light: primary production, bacterial activity and photo-oxidation? What is the spatial and temporal variability of those three processes? What large-scale physical phenomena control that variability? (3) To determine the impact of current and near-future changes in the Arctic environment on marine ecosystems and biogeochemical fluxes. How will CO2 production from the mineralization of old organic carbon be compensated by the new sequestration of carbon? Will the Arctic Ocean experience a major shift biotopes and biocenoses? What will be the impact on higher trophic levels? Briefly, the milestones are, for 2011-2014: (i) Develop the CERC technical team and implement the necessary land-base research facilities; (ii) adapt autonomous platforms and in situ sensors for operation in the Arctic Ocean; (iii) identify and isolate the key Arctic phytoplankton species during oceanographic cruises; (iv) characterize in the laboratory their optical and physiological properties, and derive relevant model parameters, (v) archive and process all available ocean color data and other relevant remote sensing data for the Arctic Ocean; (vi) conduct intensive sampling in key region of the Arctic Ocean with regard to biological production, using various platforms (ship, AUV, gliders and profiling floats) ; and (vii) analyze time series derived from remote sensing data and diagnostic models to identify the main drivers of biological production.

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Publications

Articles Published in Refereed Publications

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Tremblay, J.É., Raimbault, P., Garcia, N., Lansard, B., Babin, M. and Gagnon, J, 2013, Impact of river discharge, upwelling and vertical mixing on the nutrient loading and productivity of the Canadian Beaufort Shelf, Biogeosciences Discussions 10, 16675-16712, Published

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Non-Refereed Contributions

Bracher, A., Hardman-Mountford, N., Hirata, T., Bernard, S., Boss, E., Brewin, R., Bricaud, A., Brotas, V., Chase, A., Ciotti, A., Choi, J.-K., Clementson, L., Devred, E., DiGiacomo, P., Dupouy, C., Hirawake, T., Kim, W., Kostadinov, T., Kwiatkowska, E., Lavender, S., Moisan, T., Mouw, C., Son, S., Sosik, H., Uitz, J. Werdell, J., and Zheng, G., 2014, Phytoplankton Composition from Space: Towards a validation strategy for satellite algorithms, The International Ocean-Colour Coordinating Group (IOCCG), NASA/TM–2015-217528, Published

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Roy, G., Mathieu, P., Cao, X., Cinq-Mars, A., Roy, S., Fournier, G., Marec, C. and Bécu, G., 2013, Development of an underwater fiber-optic lidar for the characterization of sea water and ice properties, LIDAR REMOTE SENSING FOR ENVIRONMENTAL MONITORING XIV Book Series: Proceedings of SPIE Volume: 8872, Article Number: 88720I, Published