Photo by Kenny Louie

COMPUTE CANADA RESEARCH PROFILE:

DR. KATJA FENNEL

Today, advanced research computing is central to all research fields. Compute Canada's national platform, experts and services play a significant role in attracting, retaining and enabling the best research teams. Together, they are producing results and breakthroughs in many different sectors, from aerospace design and climate modeling to medical imaging and nanotechnology.

Dr. Katja Fennel

Tier II Canada Research Chair in Marine Prediction

Associate Professor, Department of Oceanography, Dalhousie University (adjunct appointments at Rutgers University and the University of Maine)

Research area: Dr. Fennel develops and applies realistic numerical models of the physical, chemical and biological changes occurring in coastal marine ecosystems due to natural variability and human pressures. Oceanography depends on advanced mathematics – and powerful computing capabilities – to simulate and predict changes in ocean conditions such as salinity, temperature, ocean currents, acidity, oxygen and abundances of marine species from microscopic organisms to mammals.

Research relevance: To provide policy and decision makers with information that will help them develop sound and beneficial strategies with respect to coastal areas.

Q&A WITH DR. KATJA FENNEL

Where did you work before Dalhousie?
I left Rutgers University in the U.S. and came to Canada in 2006 because I was offered a Canada Research Chair in Marine Prediction. Also, the Canada Foundation for Innovation grant that accompanied my Chair award enabled me to buy my own little super computer – a Linux cluster that has served my group well but is outdated now. Instead of spending limited research dollars to buy a new computer, we now rely daily on high performance computing facilities from Compute Canada, via the regional consortium in Quebec (Calcul Quebec).

What is your research exploring?
I develop and use biogeochemical ocean models that describe the dynamics of ocean properties, such as currents, temperature, salinity, oxygen levels, carbon dioxide levels (which can make the ocean more acidic) and nutrient concentrations (which can cause algae blooms). For example, drawing on data from global ocean models used by the Intergovernmental Panel on Climate Change, we construct regionally focused models that describe the present situation on Canada's east coast and how that could change over the next 50 to 100 years.

Where are you sourcing these data from?
It depends on the region we're working on. For example, we're developing a model that encompasses the east cost of Canada, the Gulf of St. Lawrence, Grand Banks, Gulf of Maine, and the adjacent deep oceans. We rely on data from the Bedford Institute of Oceanography's (Dartmouth, NS) Atlantic Zone monitoring program, the Ocean Tracking Network, satellite observations and the Argo Programme, which collects temperature and salinity observations from 3,000 underwater floats. Canada is a partner in this international project.

Why is this research important to Canada?
Biogeochemical models are essential tools in assessing, understanding and projecting the environmental changes affecting coastal and open ocean ecosystems. This is particularly relevant to Canada given its long coastline, its dependence on coastal resources, and its commitment to implementing an ecosystem approach to ocean resource management. It's about providing policymakers with the practical tools they need to understand the effects on marine food webs, the ocean's capacity for carbon uptake, and species of commercial importance, such as fish, bivalves and crustaceans – and to develop strategies for managing these valuable resources in the future.

Why do you need access to Compute Canada resources?
We're talking about computationally-intensive numerical models that accurately simulate the physical, chemical and biological processes in the oceans. These models are highly complex and can only be solved using massive-parallel high-performance computers.

How has advanced research computing evolved or changed how you work?
Take a model we're running for the northern Gulf of Mexico. Running it on our local computer would take years to produce the multi-year simulations we need. Obviously this isn't feasible. Using Compute Canada resources allows us to obtain results in just days making this work possible.

Does having access to Compute Canada resources make your students more job-ready when they graduate?
Using this cutting-edge infrastructure provides them with both quantitative and technical skills which is increasingly important in today's job market. For example, one of my former students transferred his training in ocean science and ocean modelling into computer animation. Several others have joined the private sector working on ocean-related consulting and engineering, and some are continuing on a more academic carrier track.

How do you see your computing needs evolving over the next few years?
The ocean modeling community continues to be limited by computing capabilities. In other words, if we had access to a computer ten times more powerful then we do today we could start using it tomorrow. For example, we could increase the spatial resolution of our models, which would make them more realistic. Our models produce terabytes of data and to run them we need hundreds of processors running simultaneously for days to weeks. We increasingly need to run model ensembles, where dozens of model simulations run simultaneously to provide more accurate predictions and better estimates of model uncertainties. Advanced computing capabilities will help to maintain Canada's global leadership in this important research field.

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