NSERC CREATE QCS Summer School 2025 Abstracts

July 21–25, 2025 | University of Waterloo

The inaugural summer school of the NSERC CREATE program *"Training for novel directions in quantitative climate science"* (QCS) was hosted at the University of Waterloo during the week of July 21–25, 2025. Herein is the collection of abstracts of talks delivered by invited guest lecturers and QCS co-PIs, and of posters and presentations from the student participants.

NSERC CRSNG We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

Last modified: July 29, 2025

---

1 INVITED SPEAKERS

1.1 Envisioning Future Technologies for Numerical Weather Prediction

Dr. Carlos Pereira Frontado
Environment and Climate Change Canada (Dorval, QC)

Weather forecasting is undergoing a revolutionary transformation. At Environment and Climate Change Canada (ECCC), the Global Environmental Multiscale Model (GEM) has powered operational forecasts for the past few decades, but today's advances in artificial intelligence are fundamentally reshaping how we predict the atmosphere. As we begin this revolution, a natural path forward is to blend new data-driven insights with more established numerical methods for solving partial differential equations. At ECCC, breakthrough innovations like spectral nudging marry AI with classical numerics to boost accuracy, while we are simultaneously developing novel numerical schemes and a physics-informed AI framework, PARADIS, to push low-cost predictive skill even further. In this talk, we will present our hybrid forecasting vision, showcasing our work on high-order accurate numerical techniques and AI to deliver faster, more reliable weather forecasts that could help to save lives and protect our economy.

1.2 Microscale Urban Climate Modeling – pairing numerical modeling with the real world to promote healthy urban environments

Prof. Peter Crank
Department of Geography and Environmental Management, University of Waterloo

Under climate change and growing urban populations, urban climatology is a growing field with many touchpoints with individuals, society, and the environment. Microscale numerical modeling provides researchers with unique tools to explore various urban design scenarios and their impact on the microclimate as well as on human health. Dr. Crank will explore how these models are used, evaluated, and validated through examples in hot climates like Phoenix and Singapore. He will also touch on how these models can be leveraged to support decision-making for healthy urban environments in hot climates but also in the Canadian context.

1.3 High-resolution models of the nearshore ocean and their applications

Dr. Laura Bianucci
Fisheries and Oceans Canada (Victoria, BC)

The coastal ocean is a dynamic, complex region where multi-scale processes interact and create conditions suitable for rich ecosystems. For instance, the combination of processes such as land and

We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

river runoff, local and remotely-forced upwelling, and wind and tidal mixing can bring nutrients to the surface waters, triggering high primary productivity rates. These coastal waters are also subjected to the direct impact of human activities like fishing, aquaculture farming, wastewater runoff, etc. These anthropogenic perturbations along with other pressures exerted by climate change can lead to negative effects in the coastal ocean (e.g., pollution, hypoxia, ocean acidification, sea level rise, etc.), which in turn can negatively affect ocean-dependent human activities. Since global and regional ocean models usually lack the necessary spatial resolution to fully represent many nearshore processes, there is a need for high-resolution coastal models to address some of these issues near shore. These coastal models can be used to understand the physical and biogeochemical drivers in different regions, how these processes can change in the future, and what the implications of these changes are. Furthermore, they can be useful tools to help inform the decision-making process of managers, regulators and the private sector alike. In this presentation, I will share some examples of high-resolution nearshore models developed at Fisheries and Oceans Canada (DFO) and their applications. Furthermore, I will take the opportunity to share my experience working as a scientist for the government of Canada.

2 CO-PI SPEAKERS

2.1 Quantitative Climate Science: Adding Substance to a Phrase

Prof. Marek Stastna
Department of Applied Mathematics, University of Waterloo

Climate science has undergone rapid and transformative development in recent decades. Much of this progress has been driven by advances in computation, accompanied by an expanding range of applications and increasingly sophisticated ways of communicating climate concepts. Despite the deep historical ties between climate science and applied mathematics, those connections have frayed over the very period in which the field has grown most dramatically.

This disconnect is reflected in several ways: in the shifting content of graduate curricula, in the hiring challenges faced by our partners in the civil service, and in the current ambiguity surrounding the role of AI within the broader climate enterprise.

In this talk, I will present three examples of mathematical concepts that surface across different subfields of climate science. These will serve as entry points to explore both the opportunities and the obstacles—conceptual, notational, and practical—that arise when trying to bridge the gap between mathematical and climate science communities. I will make the case for a broader understanding of what constitutes "climate-related" research and argue for a thoughtful reassessment of the training we offer today's students, especially in light of what previous generations (my own included) were taught.

2.2 Fusing data for improved sea ice concentration estimates

Prof. Andrea Scott
Department of Mechanical and Mechatronics Engineering, University of Waterloo

Passive microwave sensors are a valuable tool for monitoring sea ice concentration in the Arctic. However, data from these sensors are known to have biases for thin ice, can be inaccurate when there is significant atmospheric moisture and have a high uncertainty in the marginal ice zone. Fusing passive microwave data with other sources of data can lead to improved results. In this talk we will discuss different data types and data fusion strategies as well as ways to quantify the uncertainty in

We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

the fused results. The focus will be on demonstrating the effectiveness of these tools for monitoring the marginal ice zone.

2.3 Marine Carbon Dioxide Removal (mCDR): The good, the bad, and the ugly

Prof. Katja Fennel
Department of Oceanography, Dalhousie University

Approaches for a deliberate removal of CO_2 from the atmosphere by manipulating the ocean's chemistry or ecosystems (also referred to as "marine Carbon Dioxide Removal" or mCDR) are rapidly gaining attention. None of the proposed approaches are currently technologically mature enough for deployment and significant research efforts are required. In this presentation, I will share general background and some personal thoughts about this rapidly developing field before diving into currently ongoing work on ocean alkalinity enhancement (OAE) in Halifax Harbour. OAE, the deliberate increase of ocean alkalinity, is an emerging technology that is considered comparatively scalable and promises to deliver durable carbon removal. A major challenge to the successful implementation of OAE (and any other mCDR technology) is the difficulty in reliably quantifying how much CO_2 is being removed from the atmosphere and for how long. Observations are inherently sparse and therefore they alone cannot provide a comprehensive quantification of the effects of OAE. Numerical models are important complementary tools that can help guide fieldwork design, provide forecasts of the ocean state, and simulate the effects of alkalinity additions on the seawater carbonate system. I will describe a coupled circulation-biogeochemical model in a nested grid configuration that reaches a very high spatial resolution in Bedford Basin and model applications in support of OAE field work.

3 STUDENT POSTERS

3.1 Enhancing Models to their Fullest Potential: Constraining Error in a Regional Ocean Model of Halifax Harbour

Jacob MacDonald, Bin Wang, Arnaud Laurent, Prof. Katja Fennel
Department of Oceanography, Dalhousie University

Halifax Harbour is a small, mid-latitude fjord in Atlantic Canada. Sporadic intrusion events replace the bottom water of Bedford Basin, the 70-m deep basin at the head of the Harbour, with waters from the adjacent Scotian Shelf. Current modelling efforts with a 3-level nested Regional Ocean Modelling System (ROMS) produce hindcast and forecast simulations of the Harbour to support ongoing climate change and marine carbon dioxide removal (mCDR) related research. This project aims to further improve the model by providing a better understanding of intrusion events and using observations to constrain model errors (which can often relate to intrusions). Four distinct stages of intrusion events are proposed, and wind-driven transport of shelf waters is explored as the driving mechanism behind simulated intrusions. Empirical Orthogonal Function (EOF) analysis reveals the relative importance of intrusion events to the salinity of the Basin/Harbour and is presented as a method to create model reconstructions constrained by observations. The EOF and observation-based model reconstructions could be used to re-initialize model simulations with higher accuracy. Further, the intrusion work and EOF reconstruction help guide the optimal placement of observing assets to better constrain model error and improve the predictive capabilities of Halifax Harbour.

NSERC CRSNG We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

3.2 14 years on the Halifax Line: Assessing trends and variability using ship-based observations and autonomous vehicles

Hana Hourston[1], Prof. Ruth Musgrave[1], Clark Richards[1,2]
[1]*Dalhousie University,* [2]*Fisheries and Oceans Canada*

The Atlantic Zone Monitoring Program (AZMP) is a ship-based ocean monitoring program that was implemented by Fisheries and Oceans Canada (DFO) in 1998. The AZMP comprises over 20 lines on the Scotian Shelf, in the Gulf of St. Lawrence, and around Newfoundland and Labrador. The Halifax Line (HL) is one such line, which is comprised of 13 stations across the Scotian Shelf where biogeochemical and physical water properties are sampled biannually (spring and fall). In June 2011, the Dalhousie-based Ocean Tracking Network (OTN) began additional monitoring of the HL using underwater gliders. Underwater gliders are autonomous profiling instruments to which sensors such as conductivity, temperature, depth (CTD), oxygen, and optical sensors can be affixed. Previous studies have led to a seasonal climatology of glider-based temperature, salinity, and potential density for the period of June 2011 to September 2014 (Dever et al., 2016). Here, we present preliminary seasonal climatologies for ship- and glider-based observations updated to 2011-2024. Both versions show similar vertical structures: in spring, Cabot Strait subsurface water from the Nova Scotia Current overlays warm slope water, and in fall, a solar-heated surface layer sits atop the Cold Intermediate Layer and warm slope water. By analyzing the AZMP and glider time series, we will be able to quantify inter-annual variability and examine how conditions on the Scotian Shelf have changed over the duration of this record.

3.3 A fresh look at wind stress parametrizations

Meixin Zhou, Prof. David Straub
Department of Department of Atmospheric and Oceanic Sciences, McGill University

It is now widely appreciated that the wind stress driving ocean circulation is influenced by surface currents, and that this dependence can significantly reduce the wind power input by about 30% by removing energy from mesoscale eddies. In realistic models, the wind stress is typically parametrized as a quadratic function of $\mathbf{U}_{10} - \mathbf{u}_o$, where $\mathbf{U}_{10}$ and $\mathbf{u}_o$ are the 10-m wind and ocean surface velocity, respectively. Recent work, however, has pointed out that in uncoupled ocean-only models, this approach leads to too much “eddy killing”, i.e., an excessive sink of energy from mesoscale eddies to the atmosphere. This is partially due to an ocean current signature in the reanalysis 10-m wind field and has been termed the Current FeedBack effect (CFB). An empirically derived modification using a current-stress coupling coefficient has been proposed and shown to be successful in ocean-only simulations using realistic 10-m winds. Here, boundary layer turbulence theory is revisited, suggesting a alternative formulation for the wind stress. The CFB problem is mitigated by considering the unaffected geostrophic winds and then linking it back to the 10-m winds for practical purposes. The new formation also reduces “eddy killing” by about 20% by accounting for an Ekman turning angle and a ratio based on different drag coefficients (a major reduction). Moreover, the new parameterization provides a theoretical foundation, allowing other effects—such as sea surface temperature dependence, thermal wind shear, and more—to be incorporated later.

NSERC CRSNG
We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

Last modified: July 29, 2025

3.4 Changing wind extremes in the Great Lakes Region in VR-CESM

Lucas Prates, Prof. Paul Kushner, Michael Morris
Department of Physics, University of Toronto

Changes to the magnitude and frequency of midlatitude extreme winds under climate change are difficult to predict due to an inability to resolve the relevant submesoscale-to-mesoscale dynamics with traditional Earth system models. Recent work with the variable-resolution version of the NCAR Community Earth System Model (VR-CESM) has shown that, with 7 km refinement, it is capable of resolving local sensible heat flux and static stability signatures that contribute to the evolution of extreme winds under climate change, thereby producing more reliable projections than its 100 km uniform-resolution counterpart. Refined resolution simulations produce a robust increase in midlatitude extreme wind speeds. This study builds on the previous work by determining the role of the diurnal cycle in extreme wind events and investigating the seasonality of extreme wind events in the Great Lakes region in VR-CESM under RCP8.5 end-of-century forcing. The timing of the fastest winds during extreme events in this region are strongly controlled by the diurnal cycle as they occur effectively simultaneous with conditions of low static stability and high sensible heat fluxes. Seasonal composite analysis suggests that the climate-change forced increase in the frequency and magnitude of cold-season extreme wind events is dominated by a springtime signal in the Great Lakes Region and is tied to a shift from statically stable to unstable mid-afternoon conditions. This work highlights the importance of considering seasonal and diurnal effects in studies of midlatitude wind extremes.

3.5 Subglacial hydrology modelling of three neighboring outlet glaciers in southwest Greenland

Robert Bahensky, Prof. Christine Dow
Department of Geography and Environmental Management, University of Waterloo

Increasing rates of mass loss from the Greenland ice sheet can be attributed in part to observed increases in the ice flow velocities of its outlet glaciers. The dynamics of these glaciers are modulated by the influx of surface meltwater into the subglacial drainage system and the corresponding changes in the hydraulic efficiency of this system. In particular, transitions between inefficient (distributed) and efficient (channelized) drainage drive changes in basal water pressure which affect the velocity of overlying ice. In this work, we apply the Glacier Drainage System (GlaDS) subglacial hydrology model to three neighboring tidewater glaciers in southwest Greenland over the period from 2014 to 2020. These glaciers have been observed to exhibit differing seasonal velocity variations despite being located within a similar climatic envelope. Here, we present current results from the GlaDS model focusing on differences in the organization of the subglacial drainage system which may explain the glaciers' contrasting velocity responses. Namely, we discuss the formation of subglacial channel networks and the spatial distribution of basal water pressure as key controls on the ice dynamics of the three glaciers.

3.6 Training Module: Using AI To Reduce Uncertainty In Climate Modelling

Tyler C. Herrington, Prof. Christopher G. Fletcher
Department of Geography and Environmental Management, University of Waterloo

Here we outline an overview of six training modules whose aim is to provide students with an understanding of how earth system models (ESMs) are used to simulate Earth's climate, sources of uncertainty in the climate system, and how we can make use of machine learning (ML), and

NSERC CRSNG We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

artificial intelligence (AI) to reduce those uncertainties. Each module will allow students to develop an understanding of the theory, and then apply this knowledge in laboratory exercises, using data from ESMs. The first module introduces students to earth system models and their configuration, as well as why an ensemble of models is necessary. The next three modules invite students to explore the performance of ESMs over the recent past, and quantify uncertainties in future climate scenarios. Finally, in the last two modules, students will investigate the role of ML and AI in climate modelling, focusing around stastical emulation of climate models and the use of AI-based cloud parameterizations.

3.7 Instabilities of Sheared Flow in an Idealized Arctic-Ocean Gyre Model

Rosalie Cormier[1], Prof. Francis Poulin[1], Prof. Andrea K. Scott[2]
[1]*Department of Applied Mathematics, University of Waterloo,* [2]*Department of Mechanical and Mechatronics Engineering, University of Waterloo*

The Beaufort Gyre is a major region of circulation in the Arctic Ocean. Atmospheric winds and a fluctuating sea-ice cover exert stress on the gyre's surface, driving a vertically sheared flow. The gyre's shear is balanced by slumped isopycnals, which signify available potential energy. In this configuration, the gyre is baroclinically unstable: susceptible to the development of baroclinic eddies, which grow by converting potential energy into kinetic energy. Baroclinic eddies constitute an important mechanism for weakening the gyre's stratification, thus permitting more vertical overturning. Thus, they provide a pathway for the redistribution of salt and heat throughout the gyre's depth.

In my poster, I present the nonlinear equations that govern the dynamics of the Beaufort Gyre and discuss the linearization of these equations about a geostrophically balanced background state. I show that, if this background state is subjected to an initially small perturbation, the radial and vertical shears of the background state allow the perturbation field to gain momentum via first-order energy transfers. I present preliminary results from our linear stability analysis of an idealized model of the Beaufort Gyre. I compare our linear stability computations with the output of numerical simulations, developed using the Oceananigans.jl library, in which we evolve the model via the nonlinear equations.

3.8 Integrating Nudging and Neural Operators in a Data-Driven Assimilation Framework

Maksym Veremchuk, Zhao Pan, Prof. Andrea K. Scott
Department of Mechanical and Mechatronics Engineering, University of Waterloo

Global warming is rapidly reducing Arctic summer sea-ice extent, leading to increasing possibilities for Arctic shipping. Safe navigation under harsh Arctic conditions requires accurate short-term forecasts of sea-ice motion, which in part depend on reliable ocean current predictions. We present a hybrid data-assimilation framework that integrates a Fourier Neural Operator (FNO) with a nudging correction step: at each time step, the FNO forecasts the flow field, then a small nudging term pulls the forecast toward the latest observations, maintaining physical consistency. We tested our method on data from a quasi-geostrophic model, a simplified representation of large-scale ocean circulation. In benchmark experiments, our FNO-nudging system shows only a 4 % loss in accuracy compared to classical solvers but runs orders of magnitude faster, making real-time sea-ice trajectory forecasting and thus safer Arctic navigation, practically achievable.

NSERC CRSNG We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

3.9 Modelling Temperature Evolution Under Partial Ice Cover

Erika Kember, Prof. Marek Stastna
Department of Applied Mathematics, University of Waterloo

We propose a coupled ordinary differential equation two-box model of water temperature under partial ice cover that includes mixing between zones of ice cover. The goal is to determine if a basic box model can achieve reasonable temperature results. Simulations were run under constant insolation and with a day-night cycle. Constant insolation results showed that to promote strong mixing between boxes, a nonlinear transport term is required. Day-night cycle results showed that the model will continue to get colder past freezing level unless an emissivity change is applied to the open water box when its temperature drops below 0 K.

3.10 Investigating the effects of wind on floating particles

Khush Bhavsar, Prof. Marek Stastna
Department of Applied Mathematics, University of Waterloo

Drifters are used to track near-surface ocean currents. Recently, focus has been shifted to making drifters smaller and with different designs to increase efficiency and reduce cost. However, a floating object does not necessarily follow the path of the water. This 'slip'/'leeway' arises primarily due to wind effects and inertia (since drifters have mass). Effects of the wind on such drifters are not well documented. There have been studies in the past aimed at analyzing observational datasets and modelling boundary layer effects (due to wind, drag and Stokes drift) on some drifters launched during the TReX experiment (Pawlowicz et al., 2024). We report on the development of modelled drifters in a shallow-water numerical model which involves wind effects. We investigate the effects of wind shear on floating particles using the developed model. We also argue that surface waves are important in modelling drift, and report on a ray-optics based wave propagation model.

3.11 Empirical Orthogonal Function Analysis of the Internal Wave Equation in Basins

Jacob Lessard, Dr. Alain Gervais, Prof. Marek Stastna
Department of Applied Mathematics, University of Waterloo

Basin-scale internal waves are an important driver of transport within lakes, thereby significantly influencing processes such as lake biogeochemistry. We aimed to solve for these internal waves in a model lake and to compare the analytical solutions with results obtained from data-driven methods. Our approach consisted of solving the forced, linear, inviscid internal wave equation with the Boussinesq approximation. We imposed radial symmetry on our solutions and then applied separation of variables in cylindrical coordinates to obtain the analytical solutions. The analytical solutions were then compared with the solutions given by Empirical Orthogonal Function (EOF) Analysis. Initially, we determined that arbitrary pairs of vertical eigenfunctions (which depend on both the radial and vertical mode number) were not necessarily orthogonal. Consequently, forcing one spatial mode resonantly excites a broad spectrum of modes in the solution. Additionally, we learned that the eigenfunctions differ significantly from the EOFs. Moreover, we found that relatively few EOFs captured most of the variance in the data, and that they could produce approximations of the original data with small error. Altogether, EOFs provided an efficient means to approximate and capture the predominant dynamics within our model for internal waves, thereby allowing us to represent the phenomena with fewer basis functions that are orthogonal by construction.

NSERC CRSNG
We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

3.12 Exploratory Data Analysis of Winter Stratification in Lake Superior

Leonard Korreshi, Prof. Marek Stastna
Department of Applied Mathematics, University of Waterloo

During winter, Lake Superior stratifies from an autumn well-mixed period, with colder, less-dense 0°C water on top, and warmer, denser 4°C water near the lakebed. Characterizing this stratification is the subject of study, using exploratory data methods to establish relationships between the onset, development, and extent of winter stratification. Empirical orthogonal functions (EOFs) provide a view into the complexity of the data, revealing that most of the data can be explained by just a few modes. The continuous wavelet transform (CWT) gives insight on what timescales stratification develops. Wavelet coherence can additionally be used to compare CWT outputs and show how air temperatures might affect surface temperatures or how shallow layers might drive the evolution of thermocline layers, and how this relationship shifts as the winter progresses.

4 STUDENT GROUP PRESENTATIONS

The summer school student participants were assigned to small groups to look at an example in QCS, which they worked on throughout the week. The purpose was for the students to gain experience in collaborative group work (project scoping, division of labour, presenting results) with peers with various backgrounds. The shallow-water equations on an f-plane, and their extensions, were used as a guide. Students were provided reading materials and code as a starting point. Each group set a goal to actively explore from among of a range of proposed topics. The students learned background knowledge, wrote and ran numerical codes, and finally presented the results of their explorations in a session on July 25th, 2025. As a part of this group exercise, the students composed abstracts for their short projects, which are included below.

4.1 Effects of the Rossby Number on a geostrophic squiggly jet

Khush Bhavsar[1], Hana Hourston[2], Madelynn Mast[3], Marty Hewitt[4]
[1]*Department of Applied Mathematics, University of Waterloo,* [2]*Department of Oceanography, Dalhousie University,* [3]*Department of Geography and Environmental Management, University of Waterloo,* [4]*Department of Physics, University of Toronto*

Rossby number is a quantifier of the importance of rotation in a flow. We seek to investigate the effects of varying Ro on a wavy jet. The provided Python code was used to simulate development of the flow in a non-hydrostatic, two-dimensional domain. Varying the Coriolis parameter revealed equal free surfaces and opposing velocities at equal and opposing latitudes. Reducing the length scale of the domain caused wave formation and energy being radiated outwards. The larger domain showed the flow to remain in geostrophic balance with slight perturbations.

4.2 Can the Shallow Water Model Handle Ontario Heatwaves? A Comparison of the Hydrostatic and Shallow Water Models

Rosalie Cormier[1], Tyler Herrington[2], Aidan Joers[1], Jacob MacDonald[3]
[1]*Department of Applied Mathematics, University of Waterloo,* [2]*Department of Geology and Environmental Management, University of Waterloo,* [3]*Department of Oceanography, Dalhousie University*

The shallow water model simplifies the Navier–Stokes equations by assuming that fluid depth is much smaller than the horizontal length of the system and that the vertical velocity is much

NSERC CRSNG
We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

smaller than the horizontal velocity. The result is a suite of equations describing how the fluid's free surface and horizontal velocity change over time. These equations can be applied to model various oceanographic phenomena, such as tsunami wave propagation and coastal flood monitoring. However, we realize that in reality these systems are also subject to other forcing, such as thermal forcing, which is not accounted for in the shallow water model equations. We therefore assess the shortcomings of the shallow water model by comparing it to a hydrostatic free surface model that accounts for thermal forcing. A horizontal jet in a 100 m long, 100 m wide, and 5 m deep box is simulated using both the shallow water model and the hydrostatic model to reference and facilitate comparisons between conditions that both models are capable of handling. The same conditions are replicated in a third simulation for the hydrostatic model, but also with balanced horizontal heating and cooling at the surface to show the dynamics that the shallow water model misses by not accounting for thermal forcing. These results demonstrate the limitations of the shallow water model and help provide intuition for oceanographic conditions where the shallow water model is inadequate.

4.3 Seiche Happens – So We Emulate It!

Erika Kember[1], Lucas Prates[2], Maksym Veremchuk[3], Mehdi Haned[1]
[1]*Department of Applied Mathematics, University of Waterloo,* [2]*Department of Physics, University of Toronto,* [3]*Department of Mechanical and Mechatronics Engineering, University of Waterloo*

A seiche is a type of wind driven flow that is common on the Great Lakes, particularly Lake Erie. We trained a convolutional neural network on seiche simulation data. 100 different simulation datasets with varied initial conditions were used, with 70 datasets being used for training, 20 used for validation and 10 for testing. The CNN was tasked with predicting the final 100 time steps of the simulation. Performance was poor and could be improved by using more training data.

4.4 The effects of the scale on the non-hydrostatic adjustment in the Shallow Water Equations

Jacob Lessard[1], Nico Castro-Folker[1], Leonard Korreshi[1], Meixin Zhou[2]
[1]*Department of Applied Mathematics, University of Waterloo,* [2]*Department of Department of Atmospheric and Oceanic Sciences, McGill University*

If we assume the domain of a fluid is much wider than it is tall, then we can model it using the Shallow Water Equations (SWE). By adjusting boundary conditions, and adding terms to account for forces such as surface tension or rotation, the SWE can be used to model phenomena from wine candling to tidal bores. One such addition is the non-hydrostatic adjustment. This modification is a twice spatial derivative of the horizontal acceleration. Mathematically, this introduces a dispersive term that mitigates shocks. Physically, it accounts for the inertial response of the fluid to the horizontal acceleration induced by the displacement of the free surface. To better understand the non-hydrostatic adjustment, we perform numerical simulations using the SWE initialized with free-surface displacements of disparate scales. We find that narrow displacements require the non-hydrostatic adjustment to be adequately modelled.

NSERC CRSNG
We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).