Performance Portability of Shallow Water Model with DPC++

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Motivation
- Portability is a desired capability which enables us to run our code on ever-changing hardware and software platforms.
- It can be difficult and time-consuming to port or develop multiple versions of code that only run on specific architectures.
- DPC++ is a new framework that advertises the ability to execute the same code on CPU or accelerators with limited or no modifications.

Goal
- Port the Shallow Water Model mini-app to DPC++ with limited modifications
- Optimize the performance of the ported code on different hardware architectures

Introduction to DPC++

Memory Models:
- Unified Shared Memory (USM) - Pointer-based approach
- Buffer - Encapsulate data in a SYCL application

Introduction to the Shallow Water Model (SWM) mini-app

SWM is a venerable 2D shallow water model benchmark on staggered finite difference equations on a torus.

Performance & Accuracy - CPU

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Unified Shared Memory:
- The porting is completed
- Device memory allocation doesn’t seem to be feasible
- Up to 20x faster than C++ on CPU for large problem sizes
- Up to 150x slower than OpenACC on GPU

Buffer:
- Memory management issues with large problem sizes
- The porting process had some challenges and was time consuming
- No performance study has been done yet

Future Work
- Run the ported code on Nvidia and AMD GPUs
- Compile and run the SWM code on FPGAs
- Add support for OpenMP
- More investigation on the buffer model
- More optimization on the USM model
- Change the data structure to be more compatible with DPC++ compiler which might serve both models

References

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