Towards Whole Program Generation for Ocean Modeling

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Shallow Water Equations (SWE)

\[
\begin{align*}
\frac{\partial h}{\partial t} + \frac{\partial (hu)}{\partial x} + \frac{\partial (hv)}{\partial y} &= 0 \\
\frac{\partial (hu)}{\partial x} + \frac{\partial (hv)}{\partial y} &= \frac{\partial (huv)}{\partial x} + \frac{\partial (huv)}{\partial y} - gh \frac{\partial h}{\partial x} \\
\end{align*}
\]

Discretization and Solver

Discretization on regular grids using:
- Finite volumes and
- Explicit time integration

\[
\begin{align*}
\Delta x \Delta y (q_{i+1,j} - q_{i,j}) + \Delta x \Delta y (q_{i+1/2,j} - q_{i-1/2,j}) + \Delta x (q_{i,j+1} - q_{i,j-1}) + \Delta y (q_{i,j+1} - q_{i,j}) &= 0 \\
\end{align*}
\]

Results

Weak scaling on PizDaint:
- Up to 2048 nodes, each with
  - 12 core Intel Xeon E5-2690 V3 at 2.60 GHz
  - NVIDIA Tesla P100 with 16 GB RAM

Using the ExaStencils technology allows
- Fully generating SWE solvers with
- Automatically set up CUDA kernels
- Distributed memory parallelization [4] using GPU/Direct

Outlook: Grids

- Collaboration with Daniel Zint and Roberto Grosse
- Unstructured grid of structured quadrilateral patches [6]