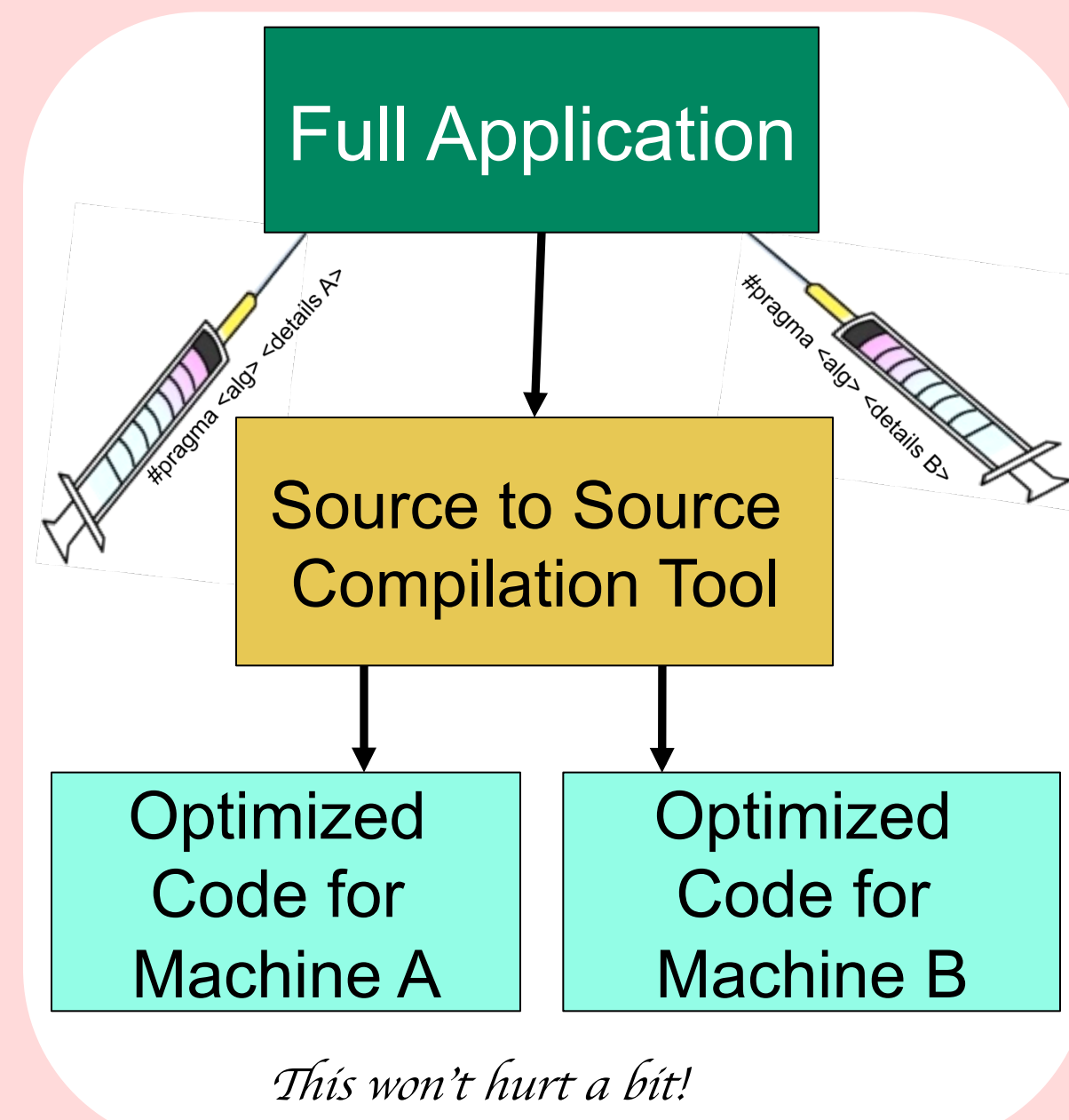


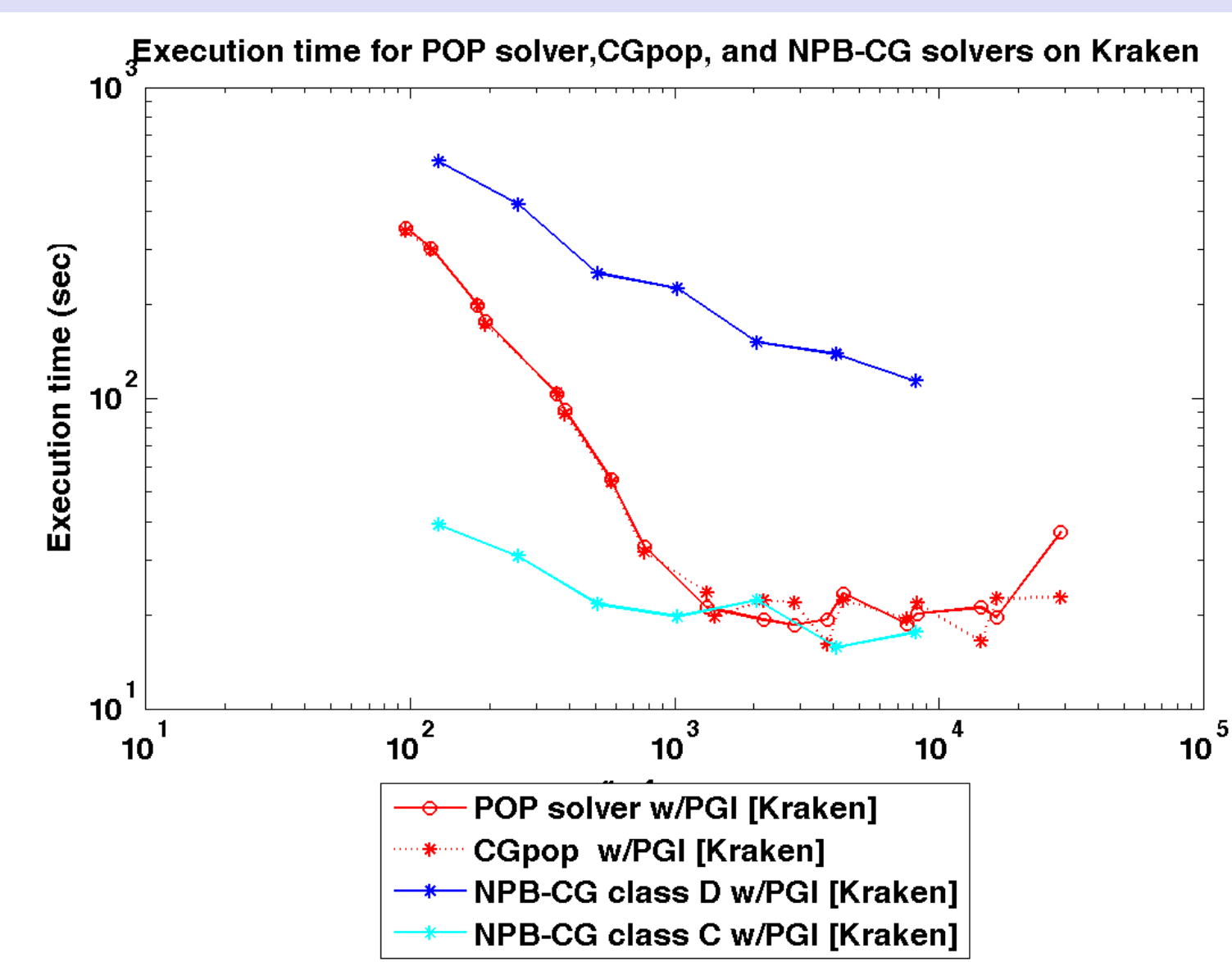
Separating Algorithm and Implementation via Model Injection (SAIMI, DOE #DE-SC3956)



- Express performance critical subcomputations in restricted programming models.
- Express implementation details as transformations of sub-computations.
- Evaluate injectable programming models with DOE miniapps.

About Miniapps

- For large simulation applications researchers are investigating new **programming models**, **data-structures**, and **algorithms**
- Benchmarks are traditionally used to evaluate new techniques.
- Performance on medium-sized benchmarks do not always translate to performance on large simulation codes.



NAS CG is a popular conjugate gradient benchmark. However, it does not accurately model the performance of the POP application.

Solution

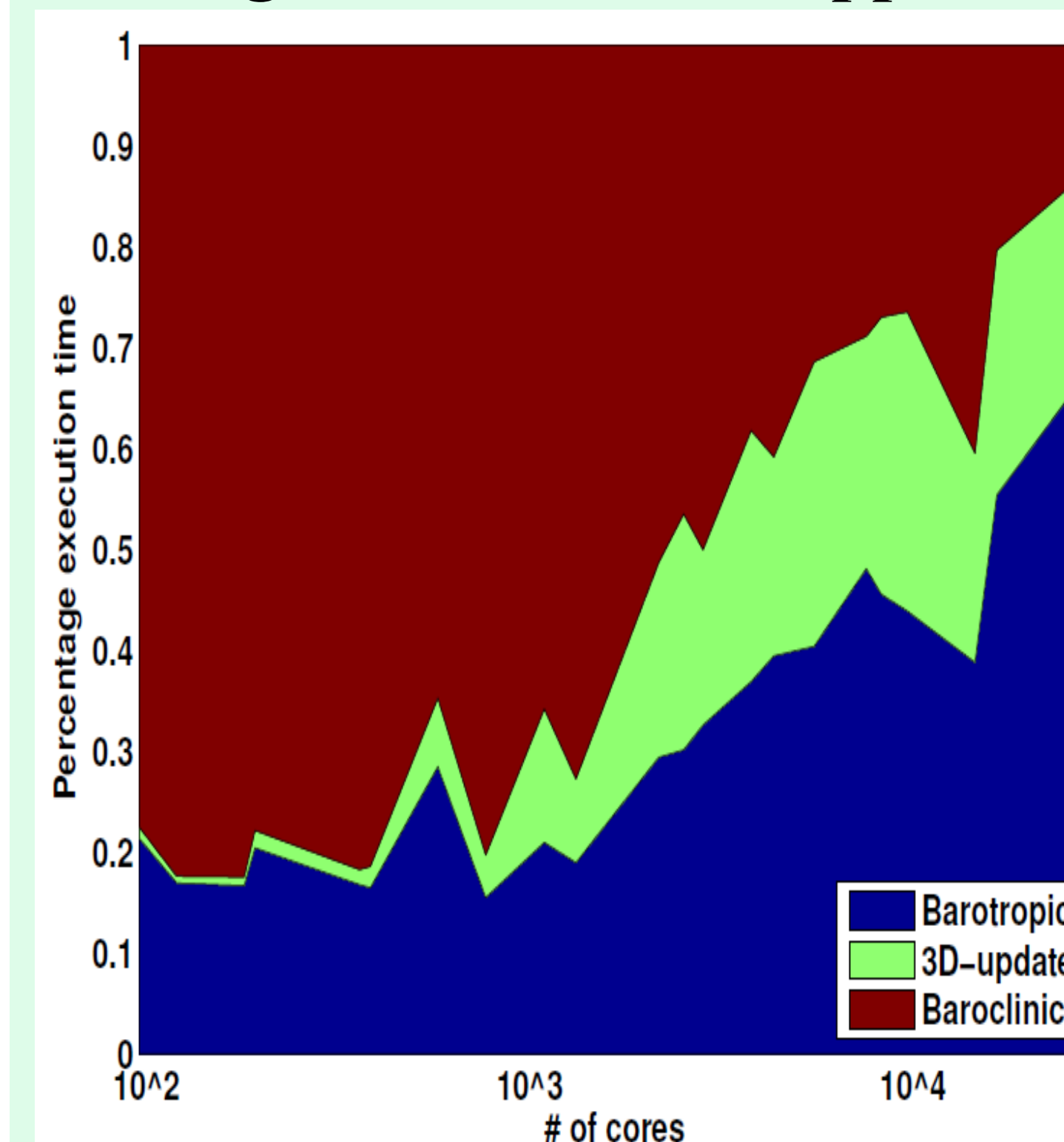
- Take a real world application and create a smaller proxy app that models its performance
- Make changes on the smaller app to infer how the changes would impact the larger one.

POP and CGPOP

The Parallel Ocean Program (POP):

- An important multi-agency code
- Simulates Surface Pressure of Earth's Oceans over time
- More than 70 KLOC

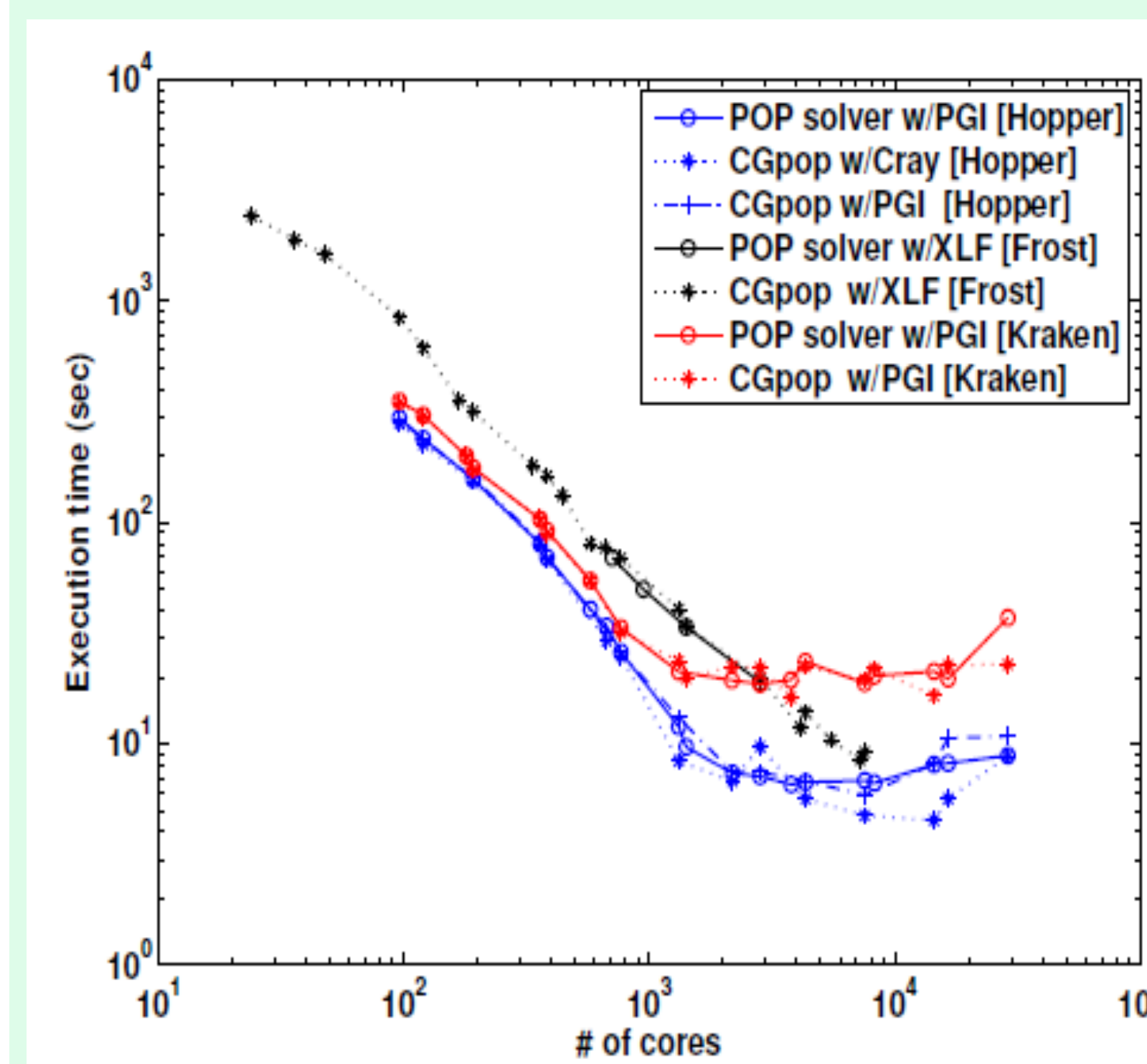
Turning POP into a miniapp:



- Relative cost of the baroclinic component dominates at fewer than 1000 cores
- Barotropic and 3D-update dominate at greater than 1000 cores
- We extracted CGPOP from the barotropic component, and the conjugate gradient algorithm within it specifically.

CGPOP:

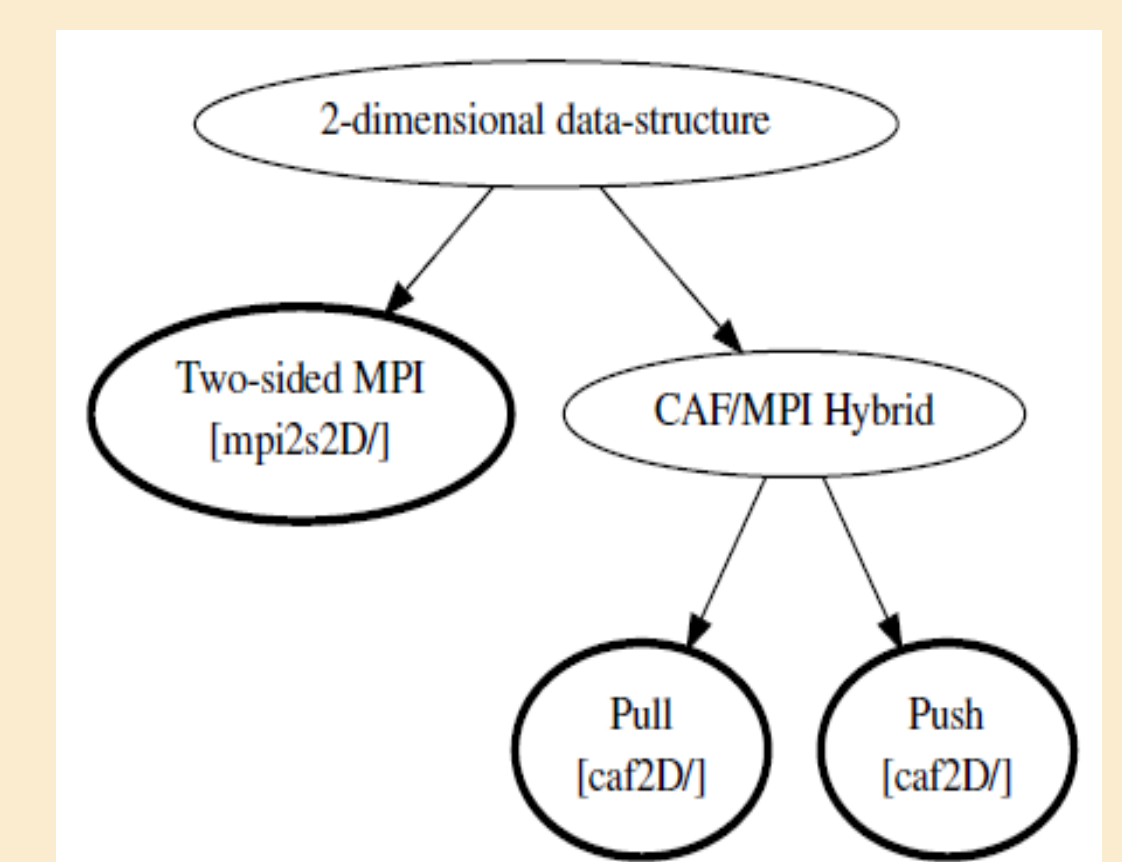
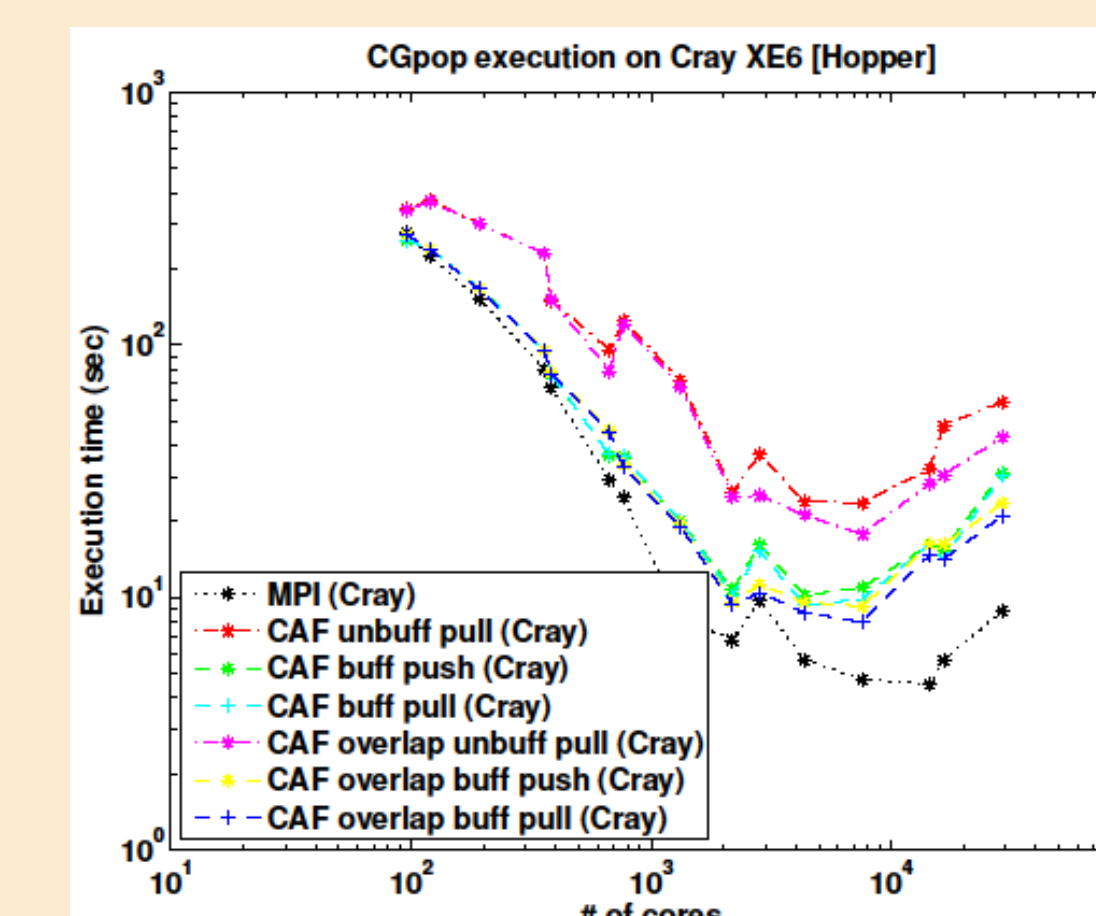
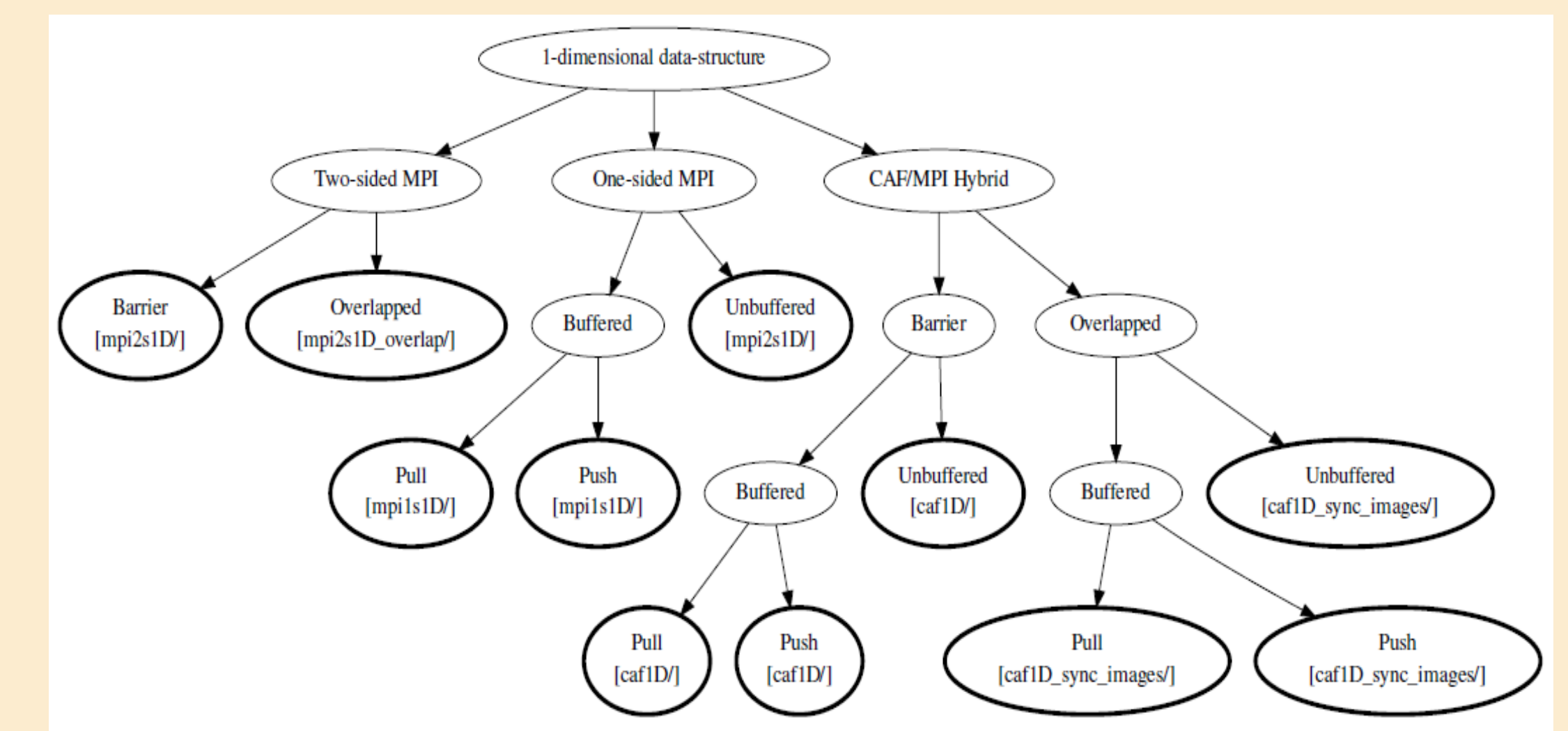
- Conjugate gradient solver in POP (Parallel Ocean Program)
- About 3 KLOC



- CGPOP is a performance proxy for POP on three different systems using two different compilers.

Variants

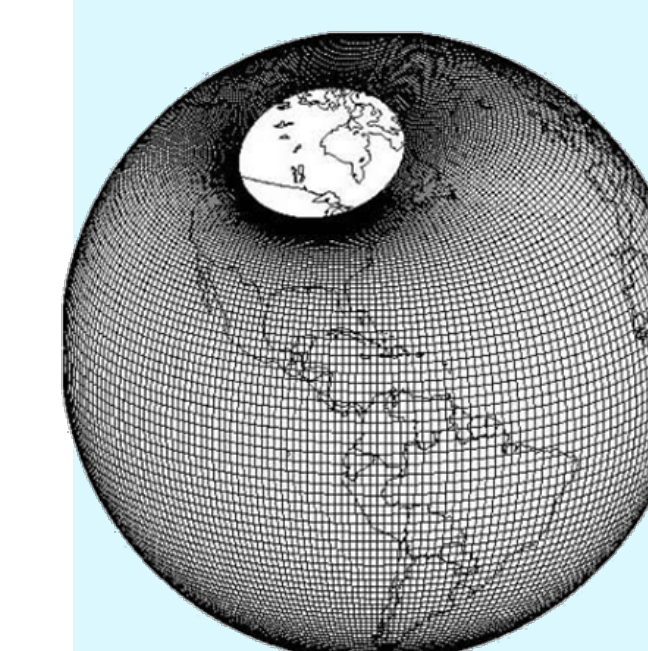
- We implemented several different variants of CGPOP:
 - **subdomain data structure** (sparse one-dimensional array or dense two-dimensional array),
 - **communication mechanism** (e.g., two-sided MPI, one-sided MPI, or Co-Array Fortran),
 - **optimizations** such as buffering of data, communication overlap, and whether data is pushed or pulled in for the one-sided versions.



Comparing the performance of the two-sided two-dimensional MPI variant against several CAF variants

Future Work

- Future work in SAIMI includes separating grid details from algorithm.
- CGPOP currently uses dipole grid (pictured on left)
- Use SAIMI approach to generate a version of CGPOP that uses a tripole grid (pictured on right)



Download CGPOP package at:
<http://www.cs.colostate.edu/hpc/cgpop>