



University  
of Glasgow | School of  
Computing Science



# Accelerating Lagrangian Particle Dispersion Modelling with OpenCL

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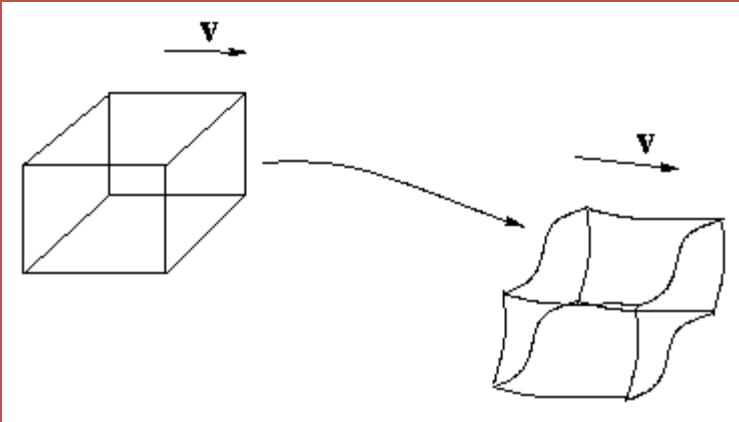
University of Glasgow, University of Aizu

# What is Lagrangian Particle Dispersion Modelling?

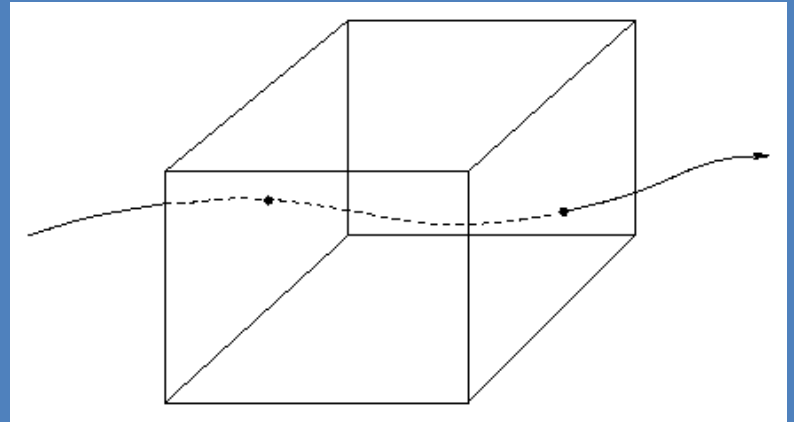
# Particle Dispersion



# Lagrangian vs Eulerian Particle Dispersion

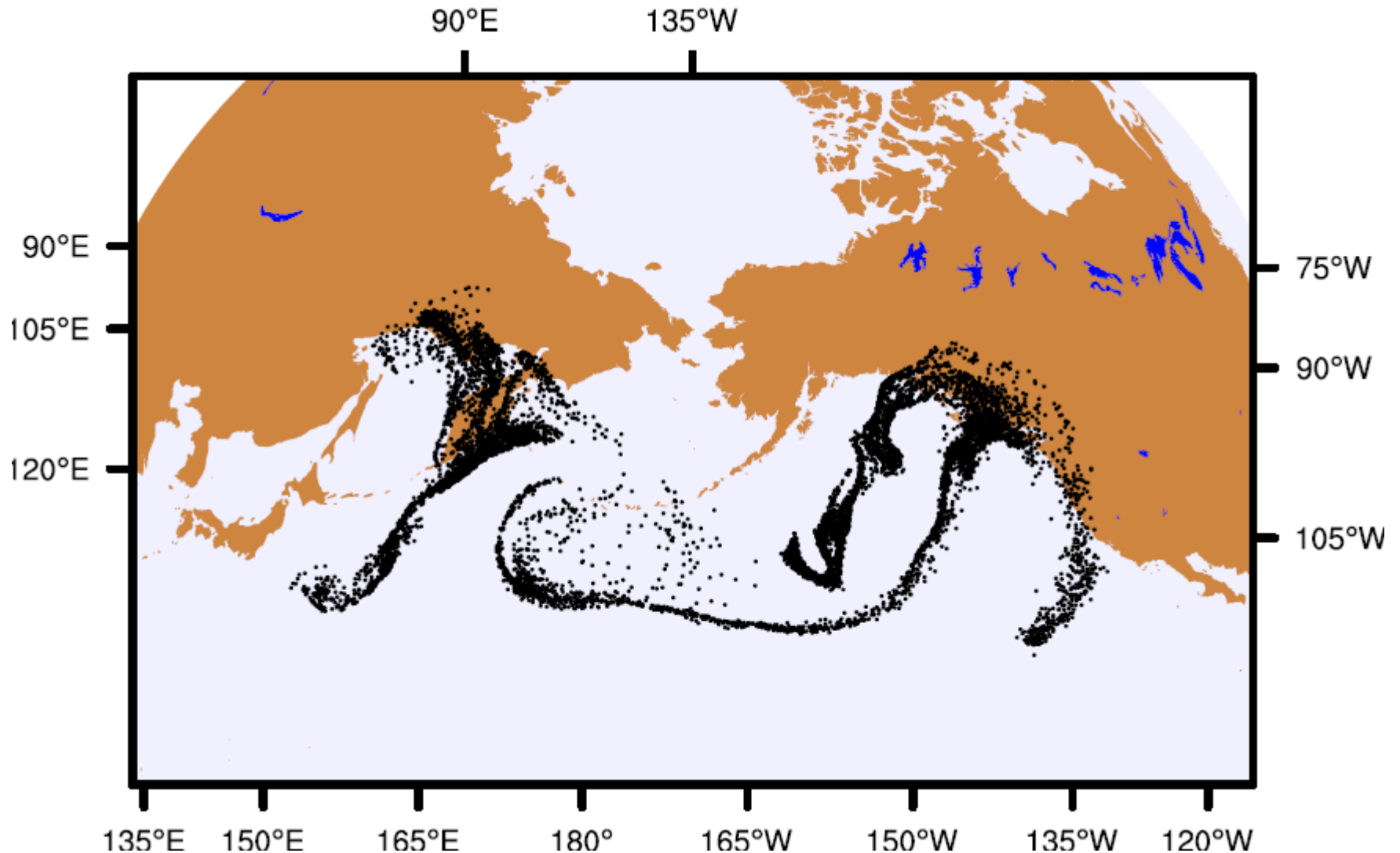


Lagrangian



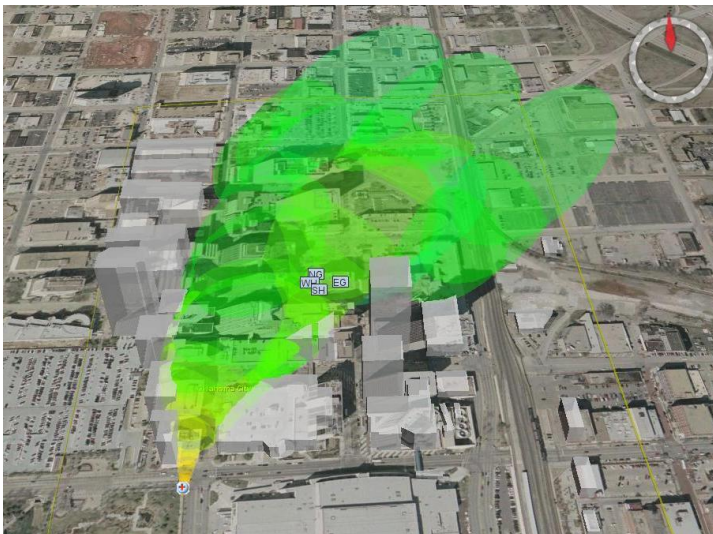
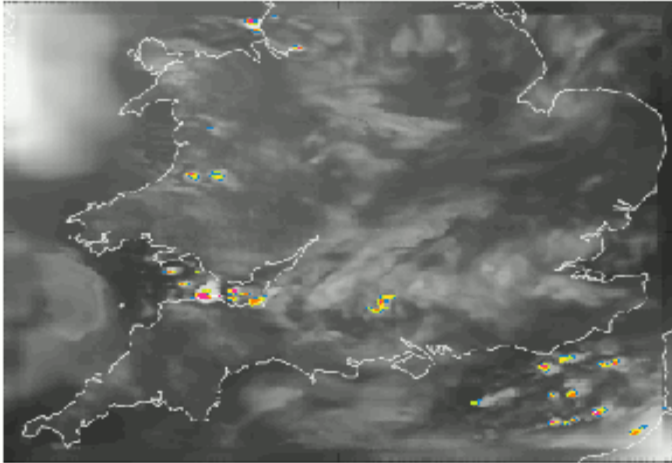
Eulerian

# Lagrangian Particle Dispersion Modelling

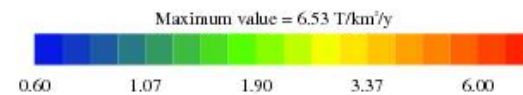
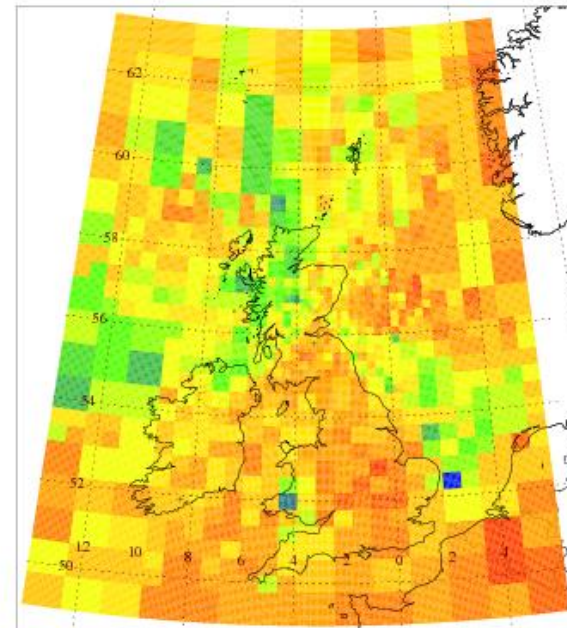


# Who Cares?

Q1 R and Surface Rain Rate (mm/hr)  
0700

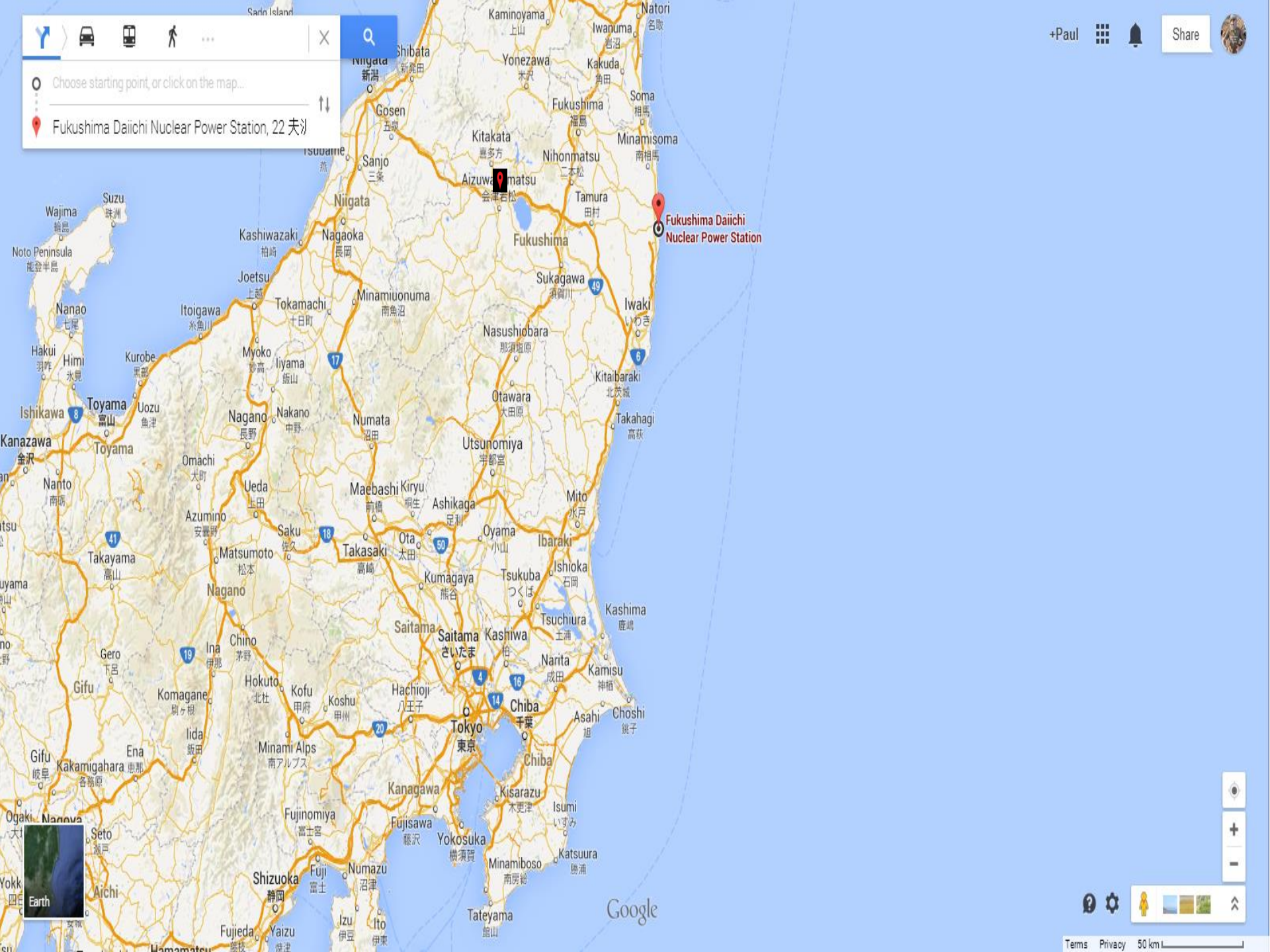


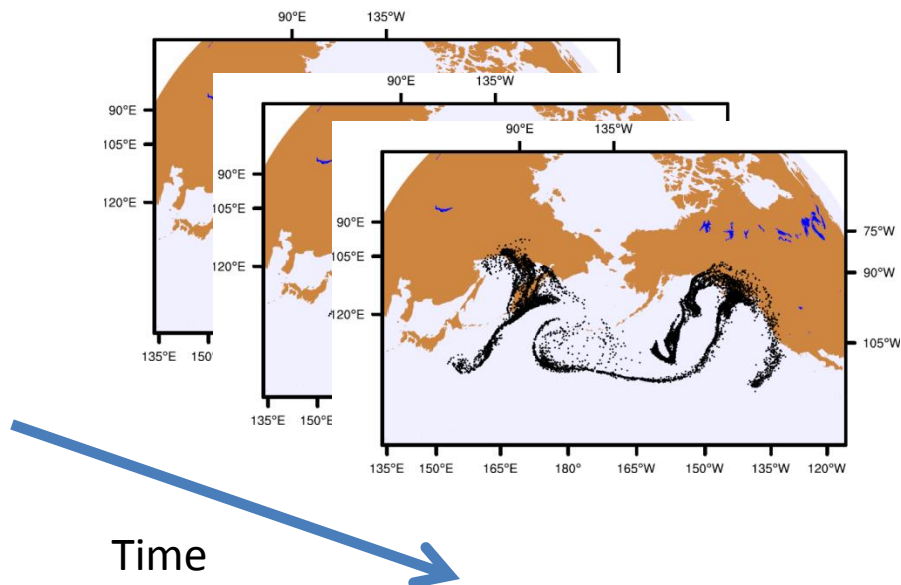
MapT= 6.8 Mt/y MEAN Methane



Choose starting point, or click on the map...

Fukushima Daiichi Nuclear Power Station, 22 夫







- Fortran (1998)
- Typical particle release 10,000 – 100,000
- Bottlenecks
  - Interpolation of particle position
  - Dispersion / trajectory calculations
  - Multiple particle releases per simulation



While more hours to simulate

Time for another release?

For each particle Release

Read In Weather Data

Interpolate

Disperse || Track

Convect?

Save Data

# Maths

$$x_i(t + \Delta t) = x_i(t) + u_i(t)\Delta t$$

$$y_i(t + \Delta t) = y_i(t) + v_i(t)\Delta t$$

$$z_i(t + \Delta t) = z_i(t) + w_i(t)\Delta t$$

$$u_i = \bar{u}_i + u'_i$$

$$v_i = \bar{v}_i + v'_i$$

$$w_i = \bar{w}_i + w'_i$$

$$dw =$$

$$-w \frac{dt}{\tau_{L_w}} + \frac{\partial \sigma_w^2}{\partial z} dt + \frac{\sigma_w^2}{\rho} \frac{\partial \rho}{\partial z} dt + \left( \frac{2}{\tau_{L_w}} \right)^{1/2} \sigma_w dW \; ,$$

FLEXCPP

While more hours to simulate

Time for another release?

For each particle Release

Read In Weather Data

Interpolate

Disperse || Track

Convect?

Save Data

While more hours to simulate

Time for another release?

For each particle Release

Read In Weather Data

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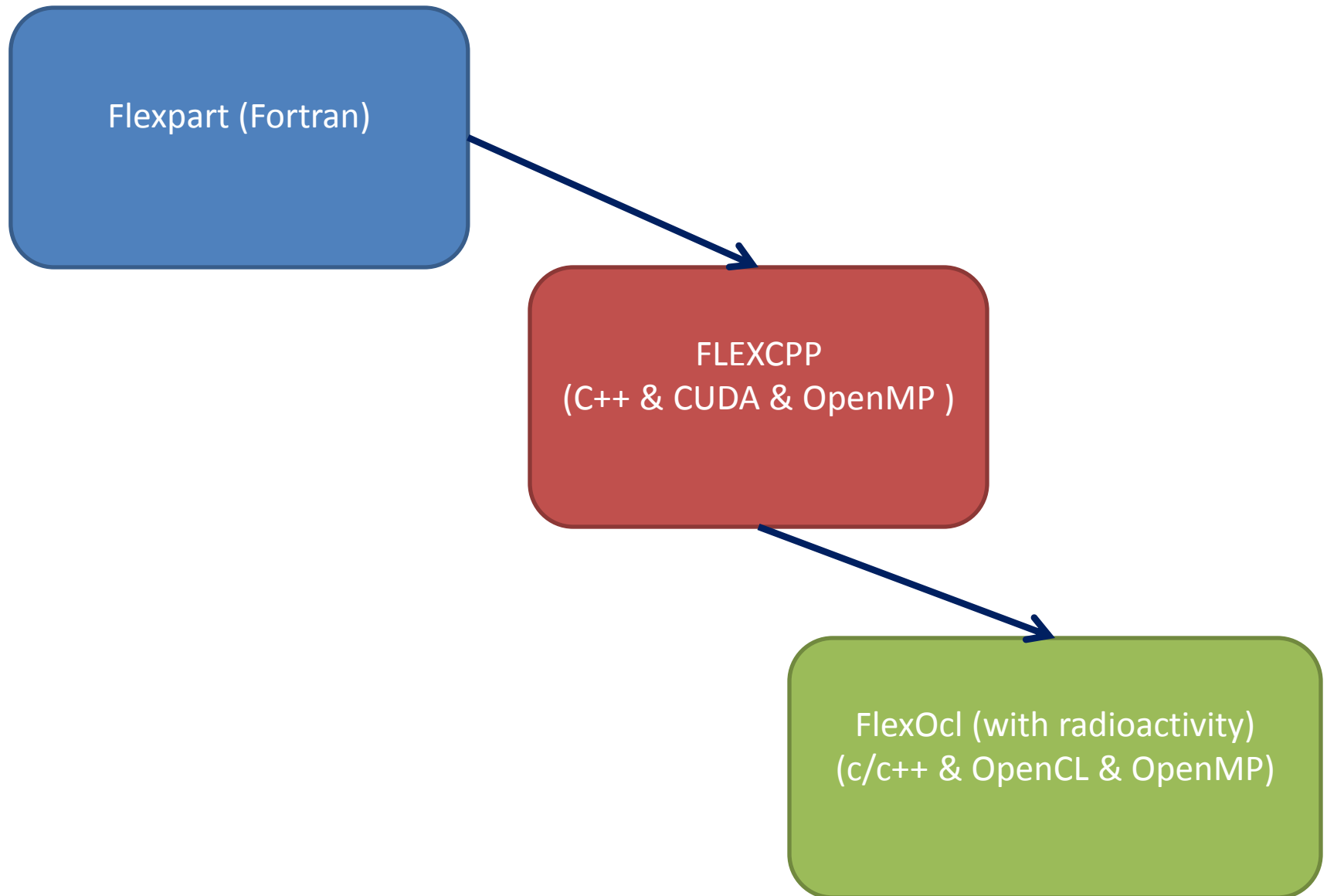
Disperse || Track

Convect?

Radioactive

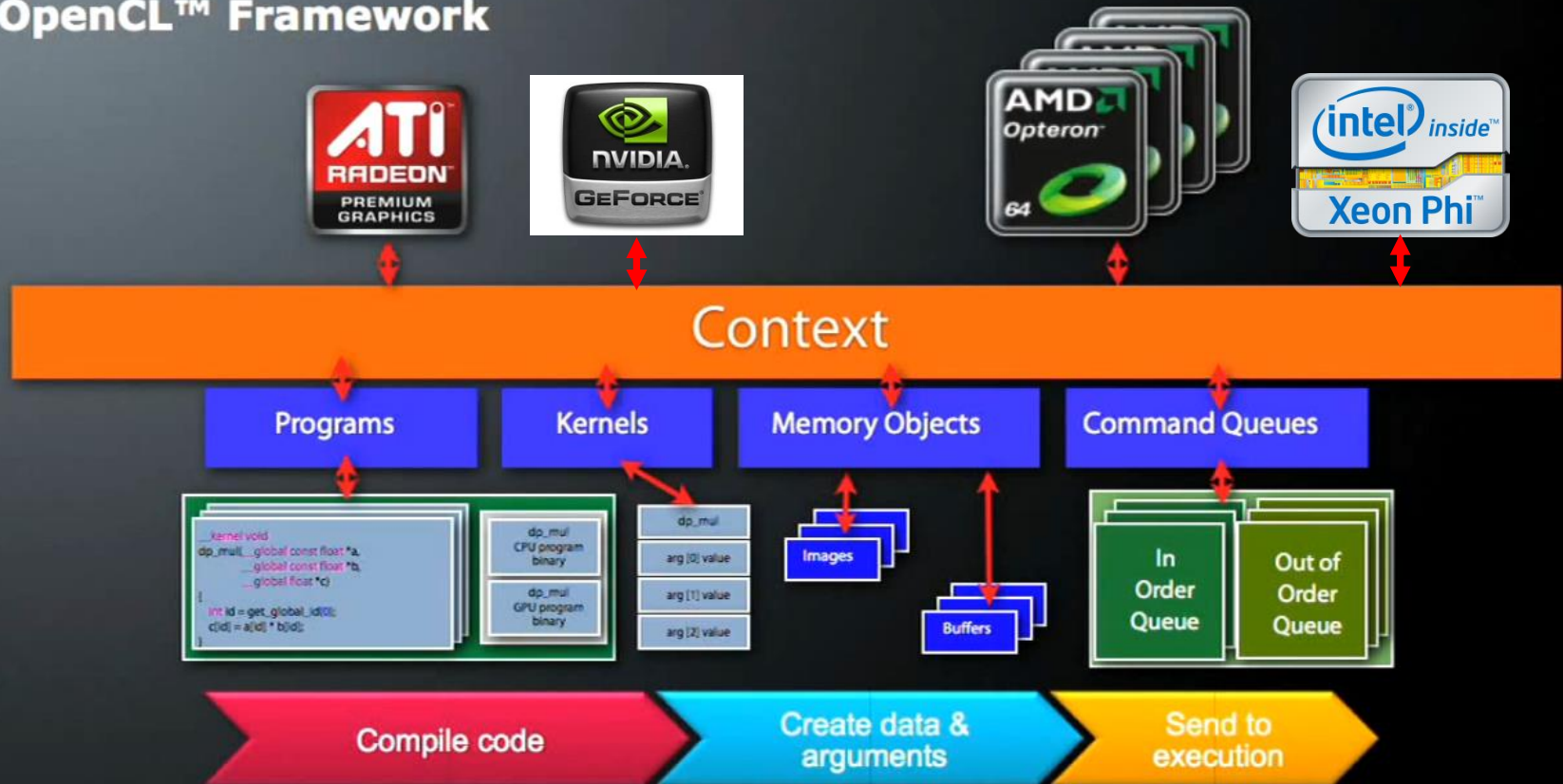
Save Data

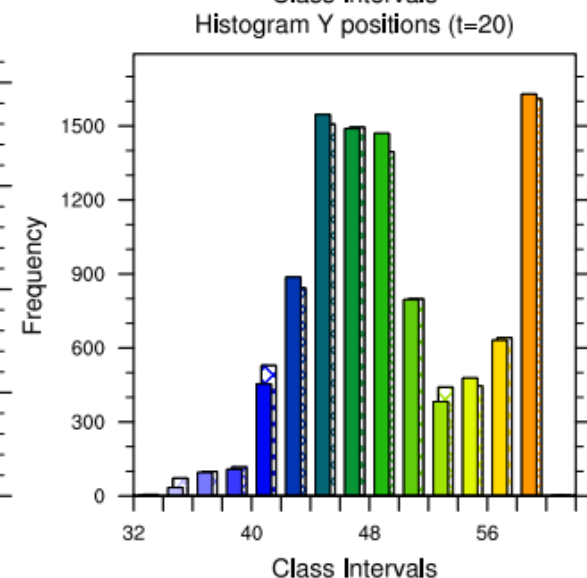
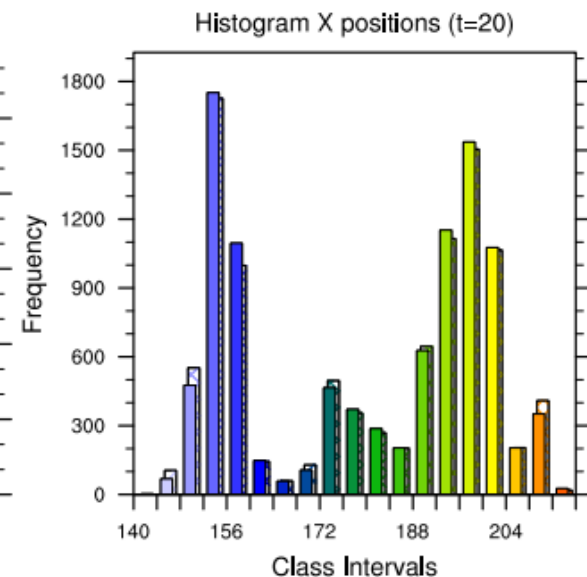
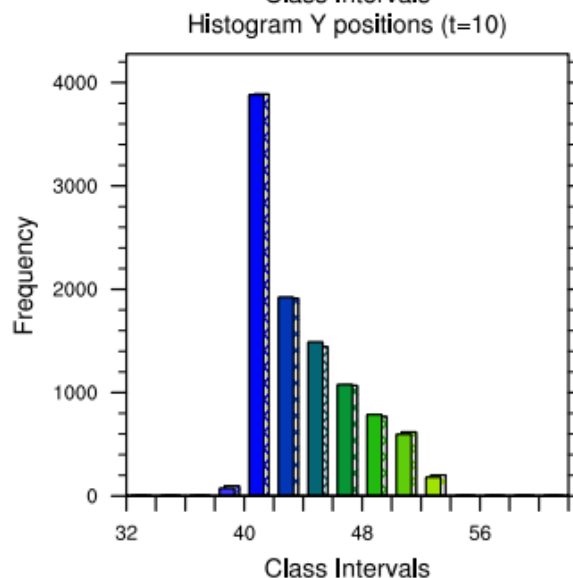
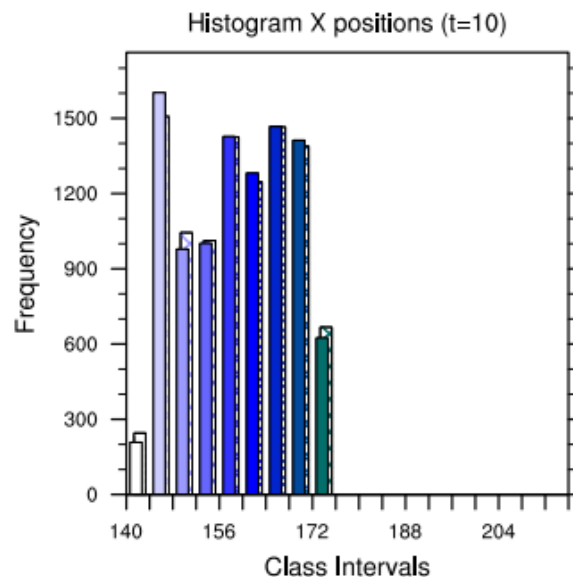
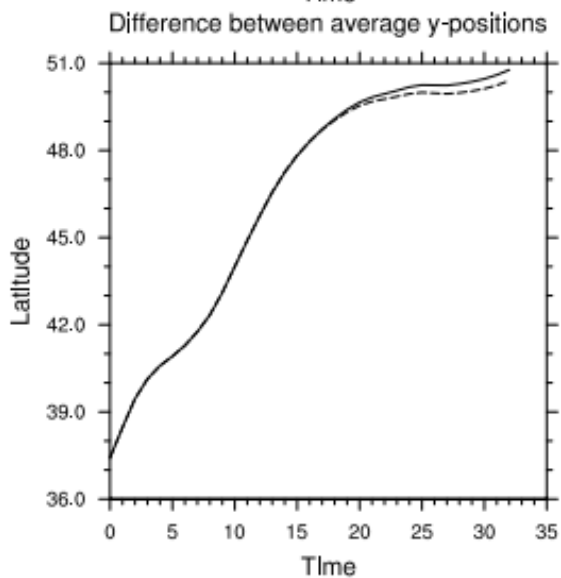
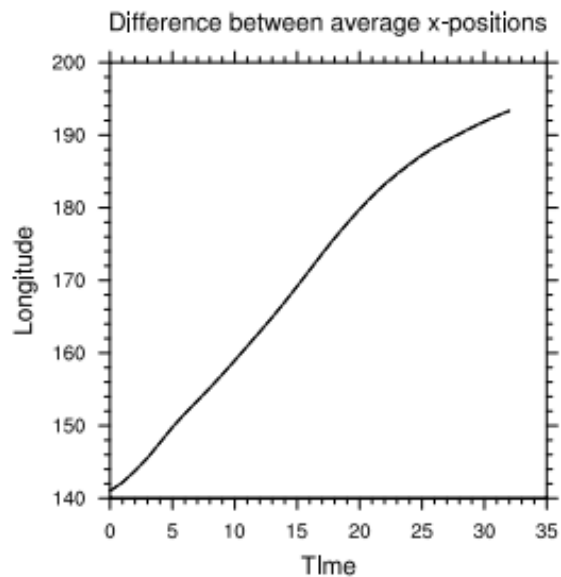
# Simulation



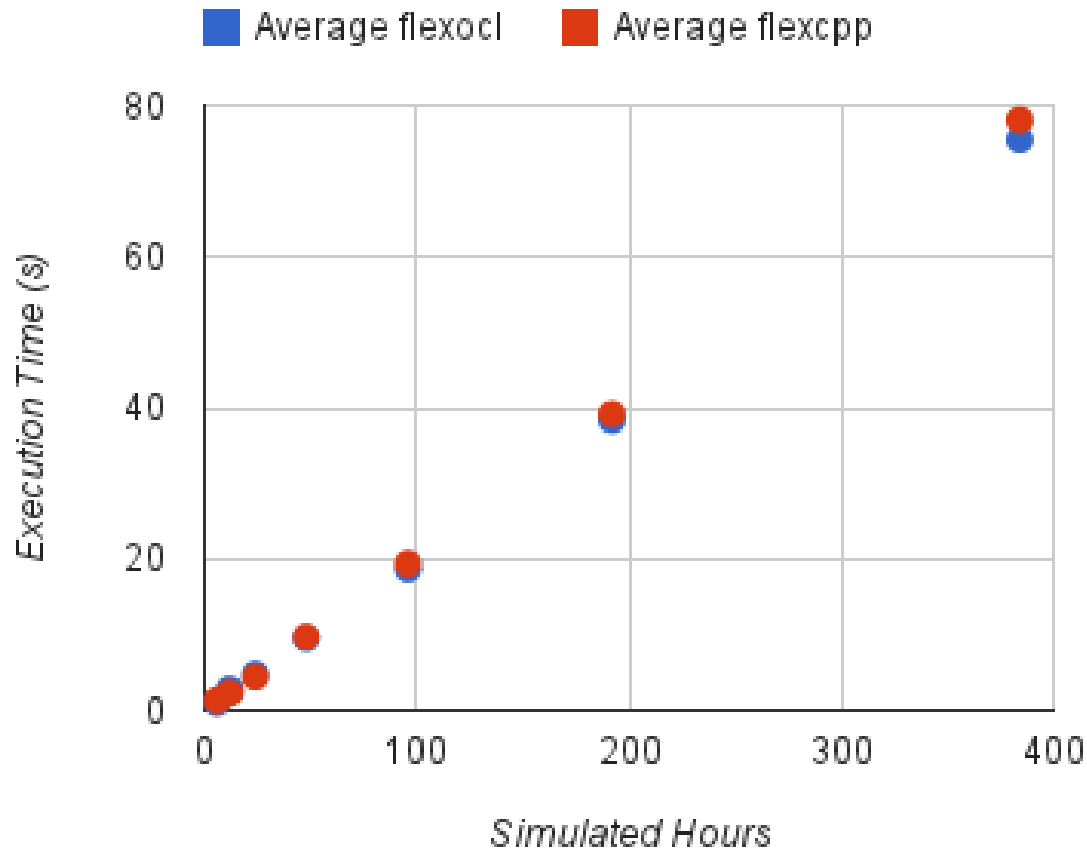
# Opencl

## OpenCL™ Framework

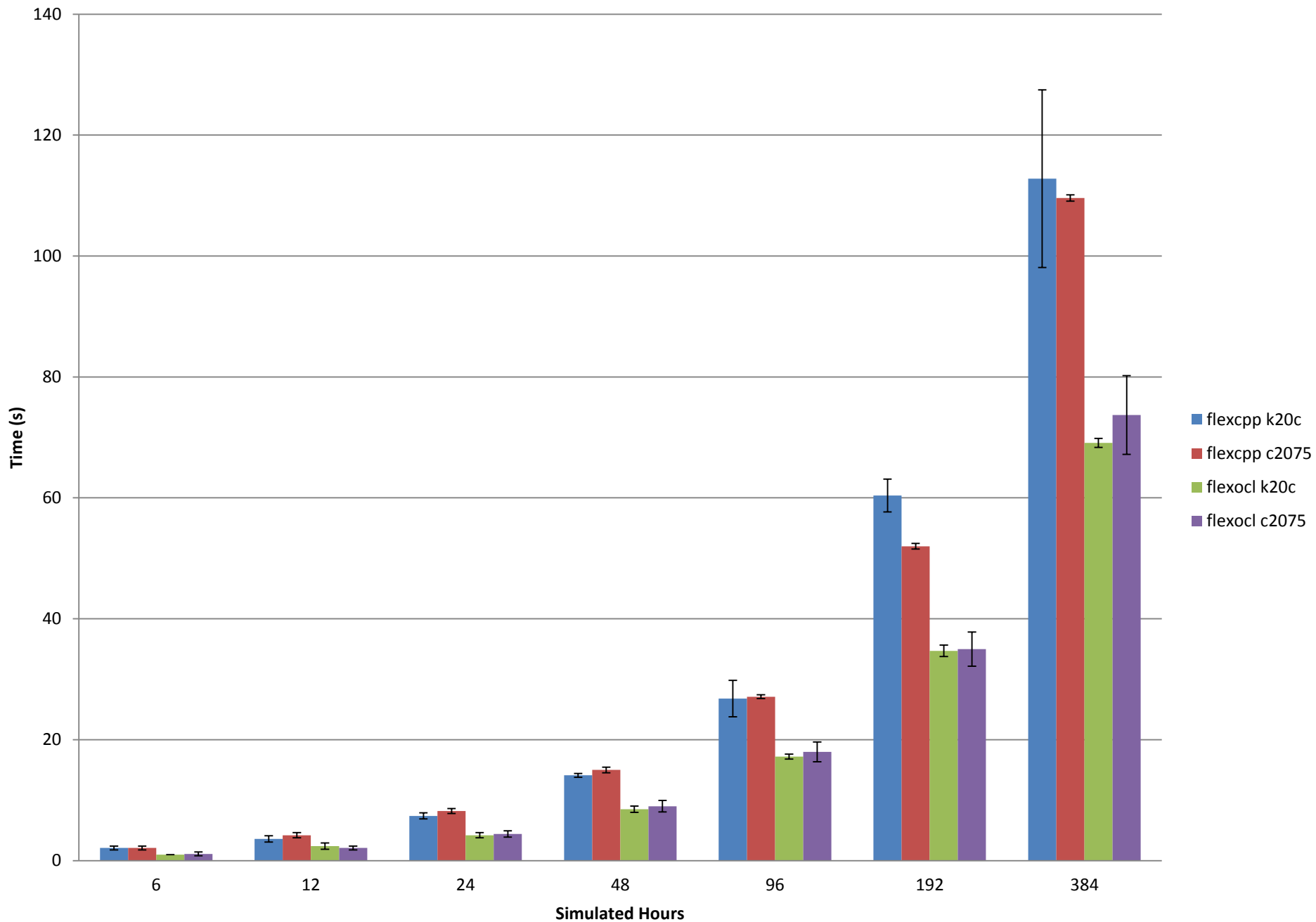




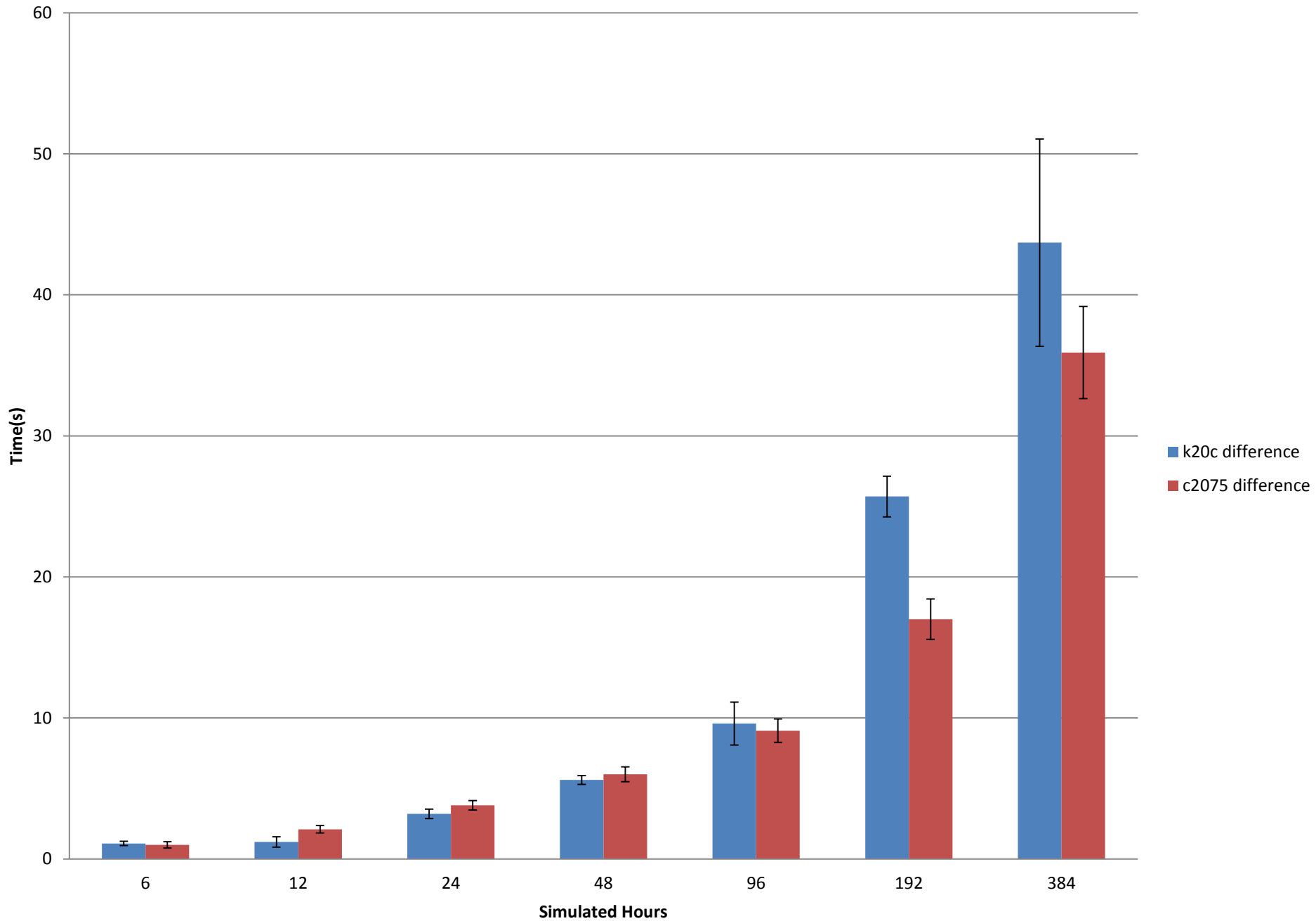
# Single Threaded – Nothing Fancy



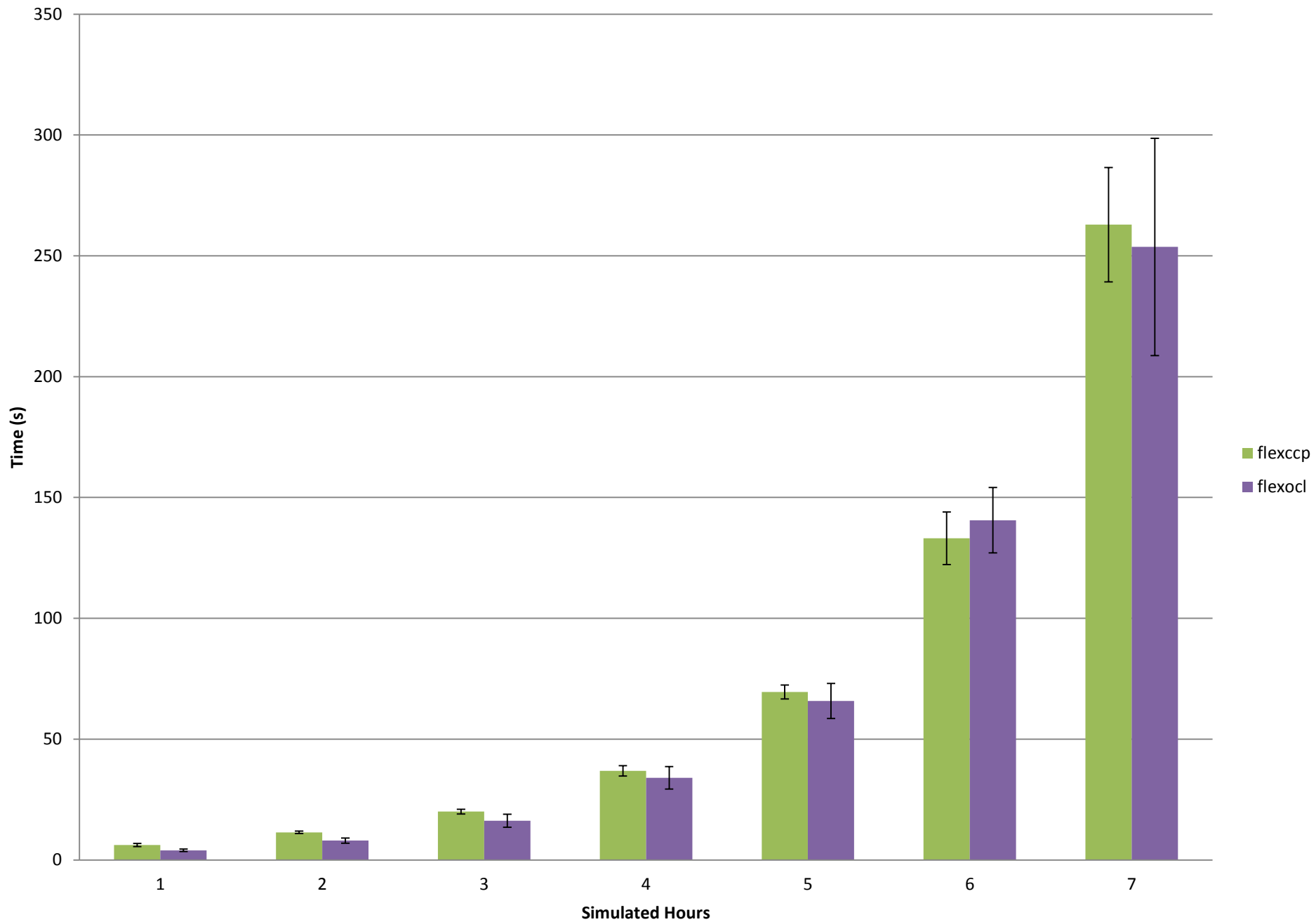
# OpenCL Vs Cuda on Nvidia Gpus



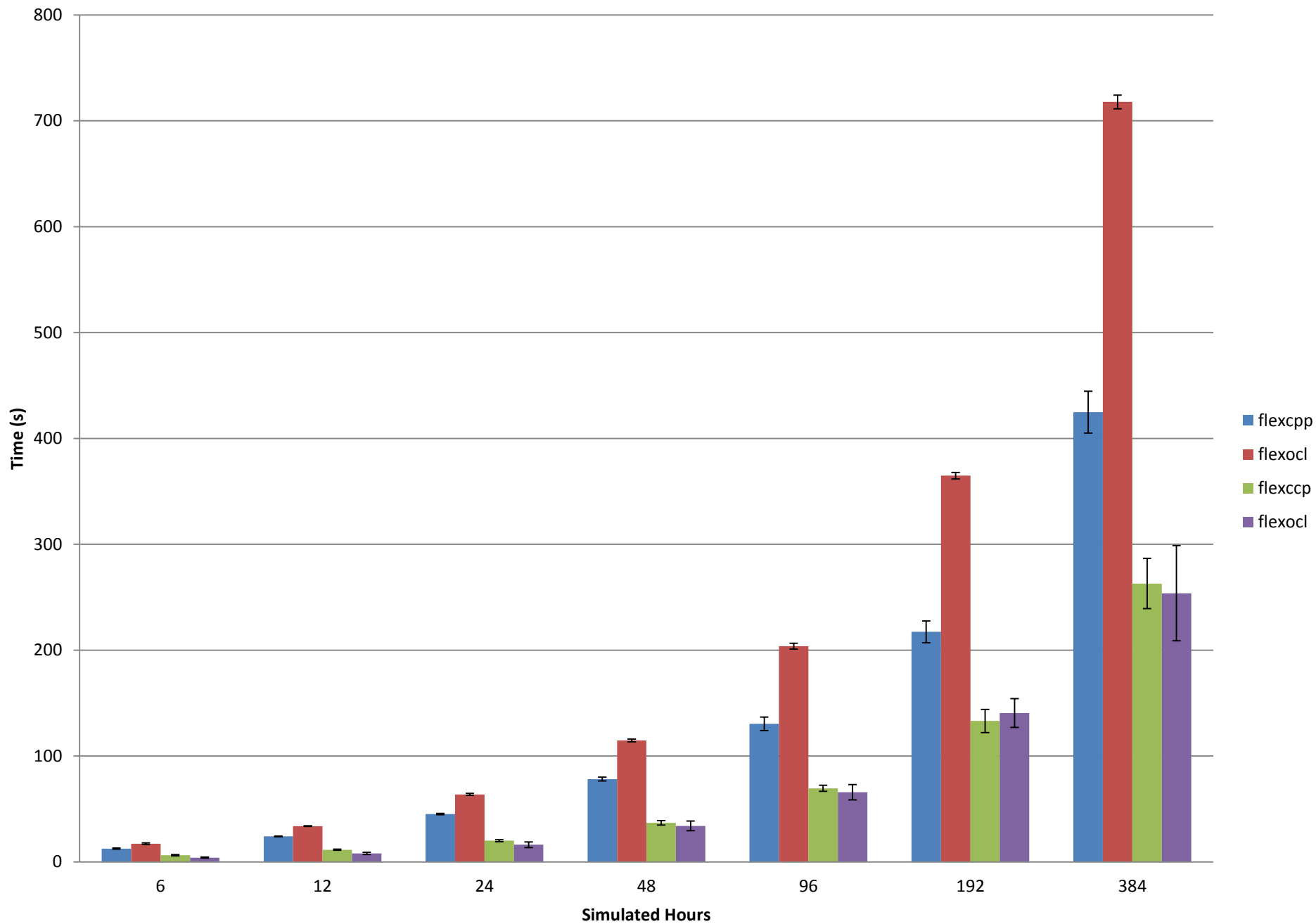
# OpenCL Performance Improvement



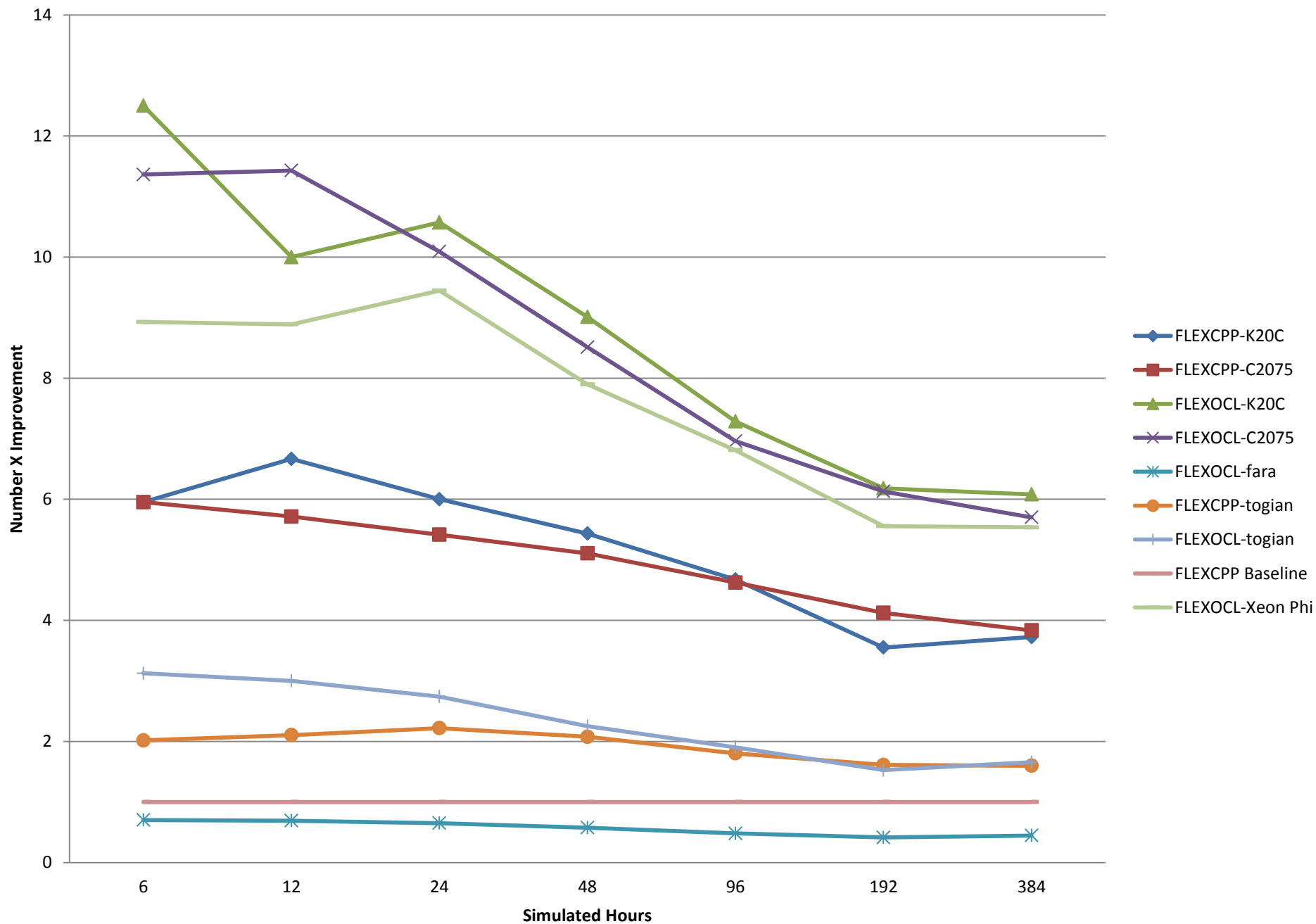
# 64 Core AMD



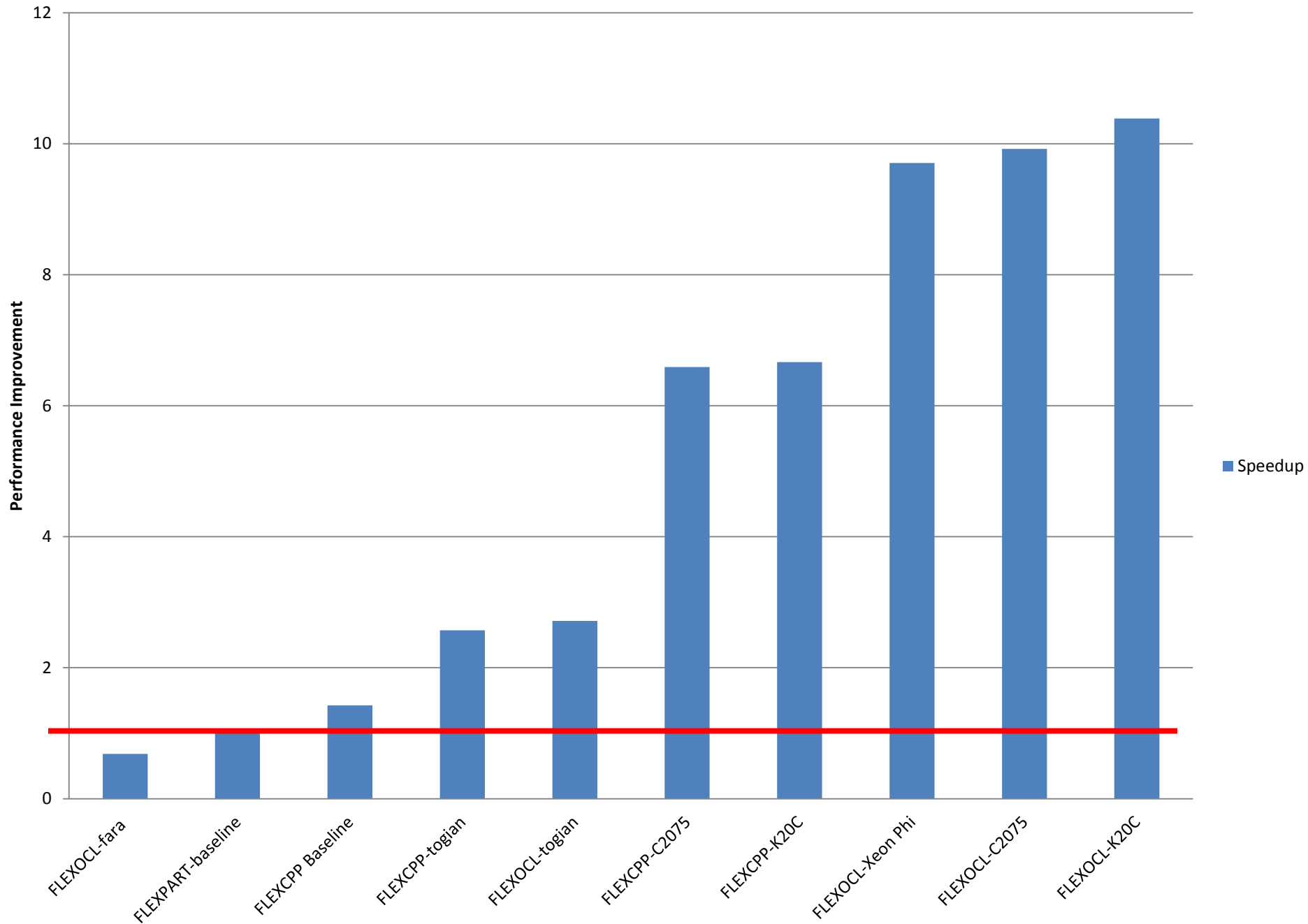
# The Power of O2



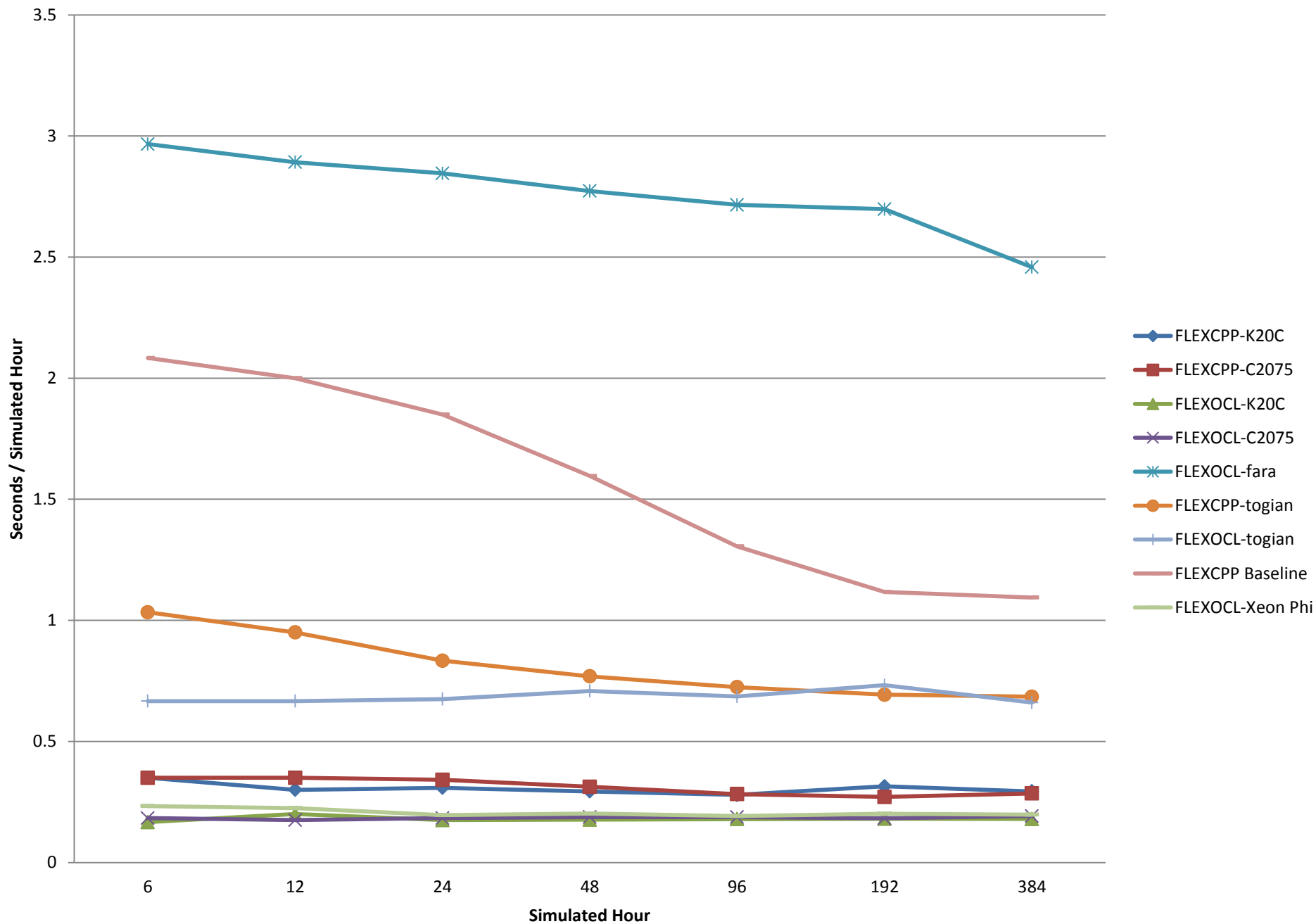
# Speed up Normalised to Baseline



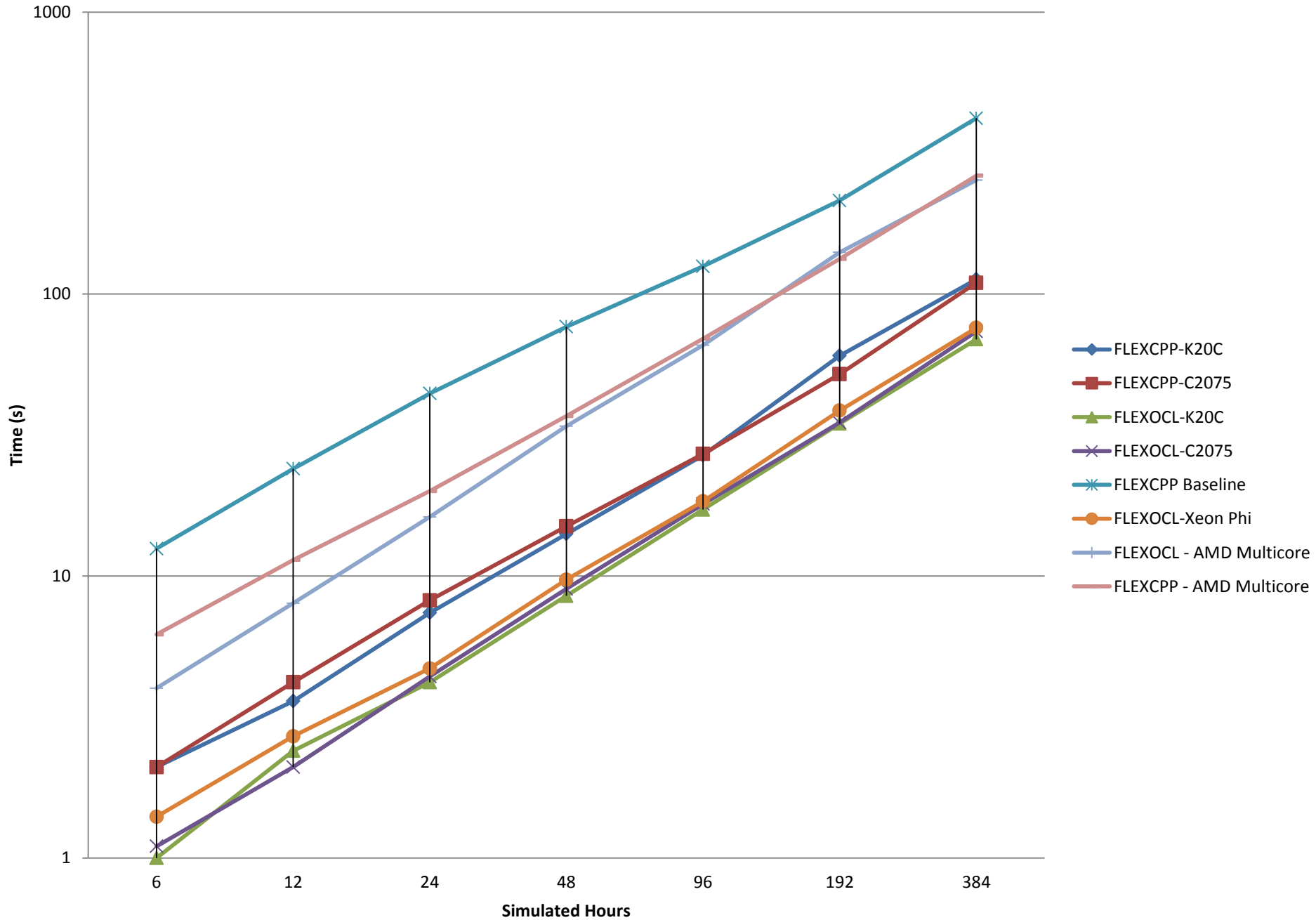
# Speedup Vs Fortran - 96 Hours



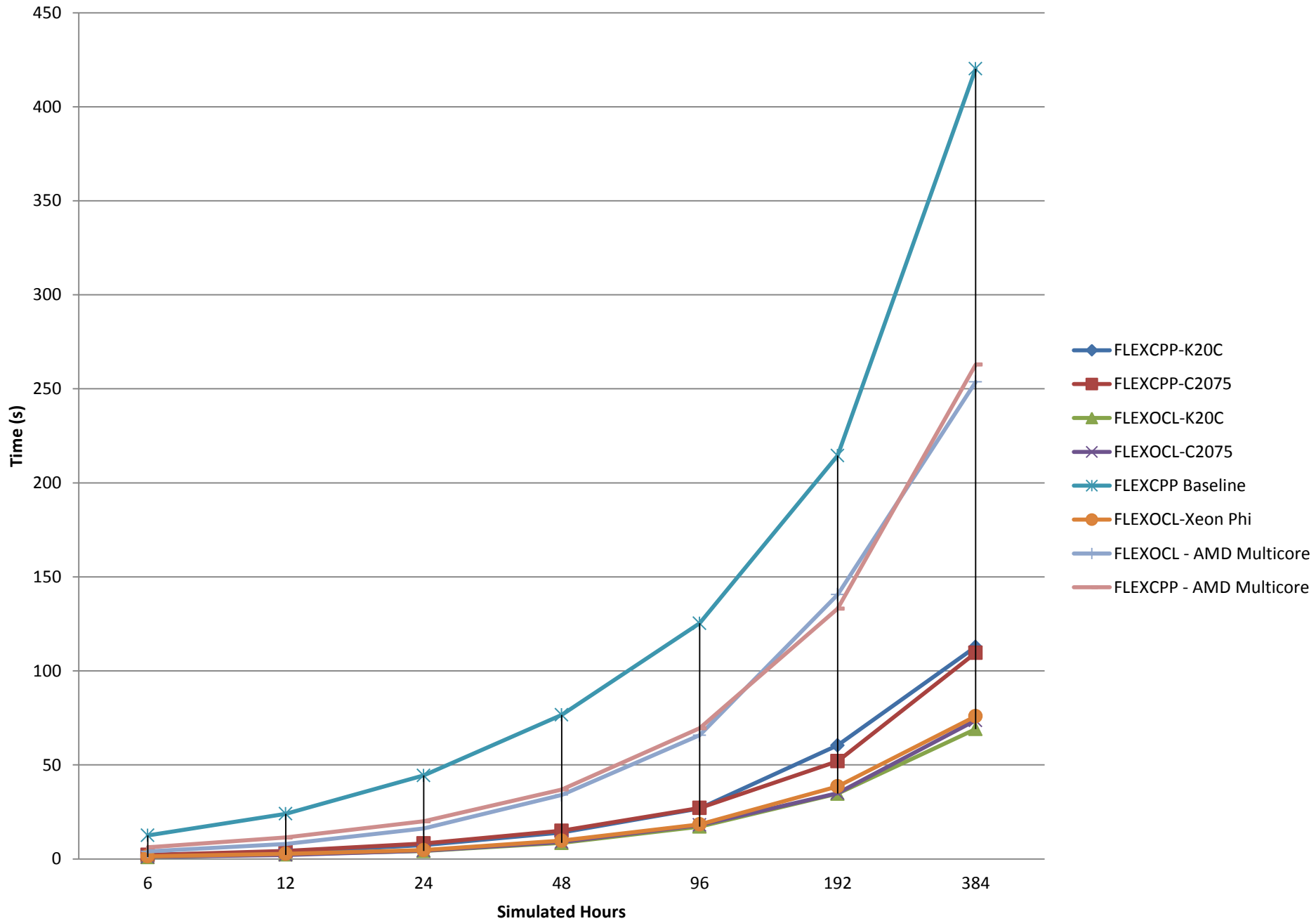
# Simulator Performance

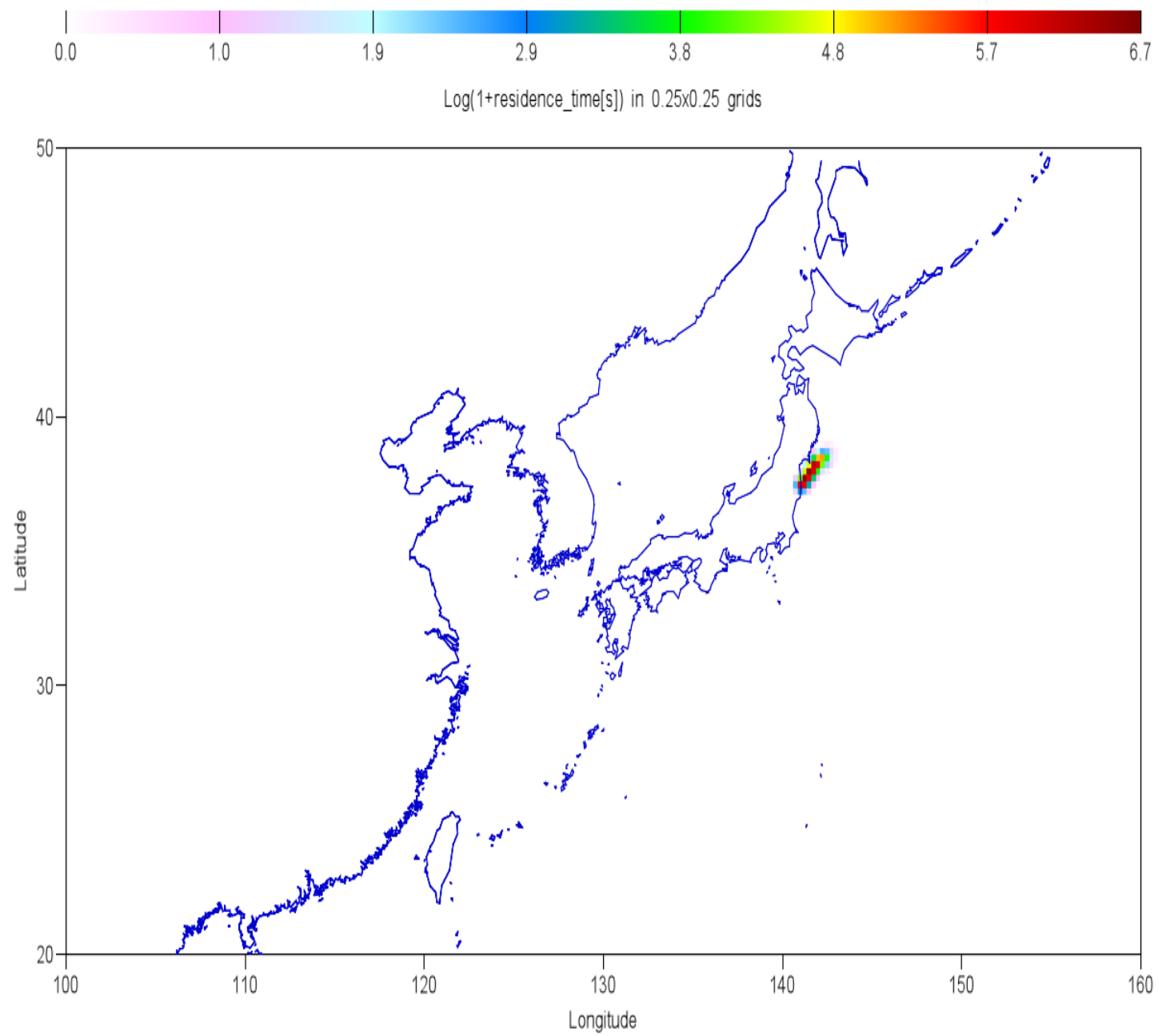


# Multi-Platform Comparison



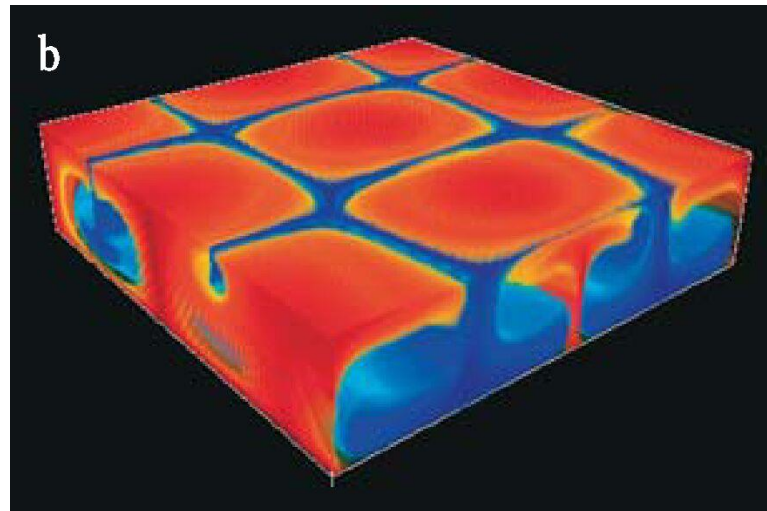
# Multi-Platform Comparison





# More Sophisticated Model

- Deposition:
  - Wet
  - Dry
- Convection



どうもありがとうございました



質問