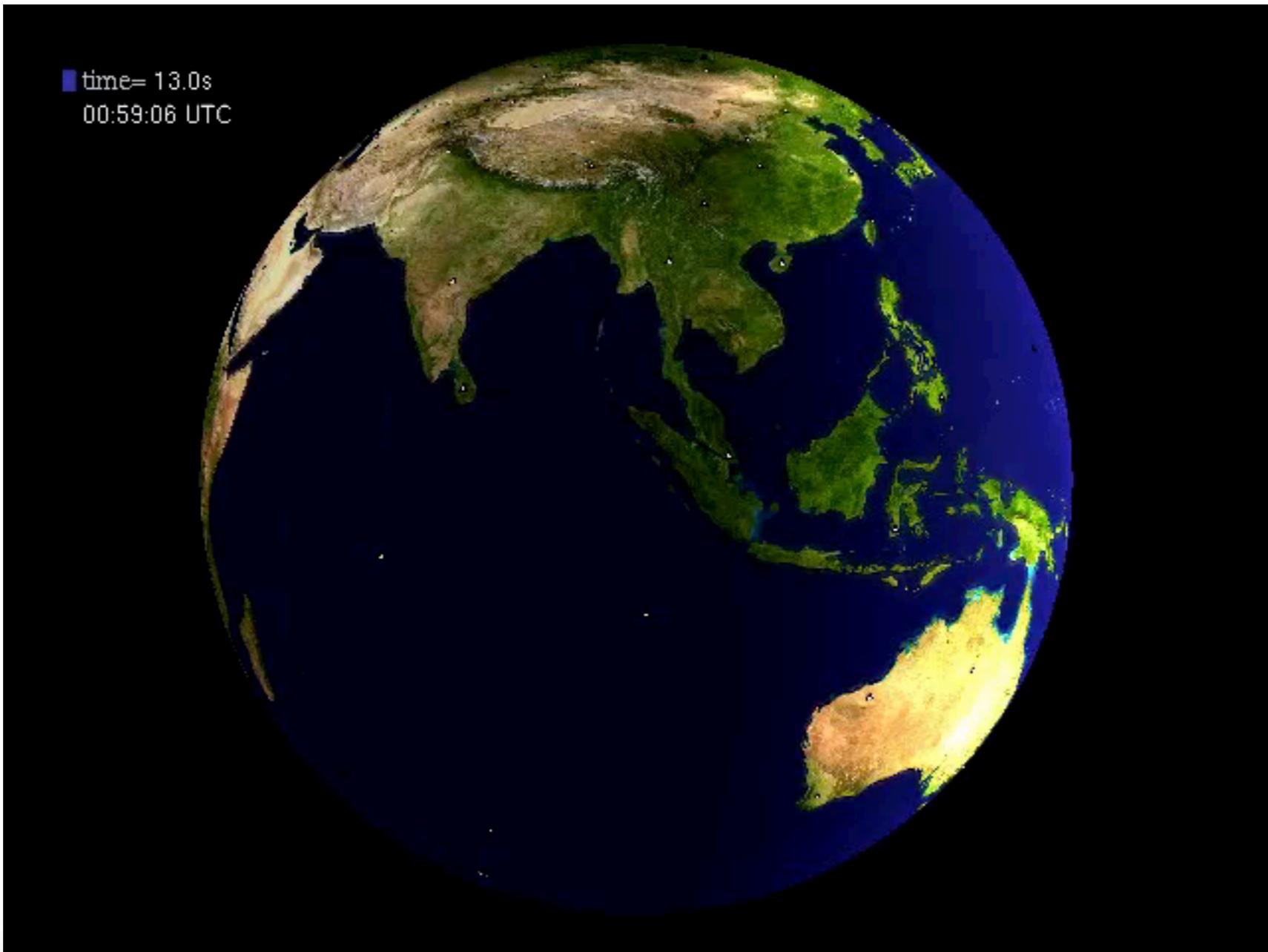


# Computational Geophysics

## ErSE 390C



Computational Geophysics



## Introduction:

- Top500

## Geophysics:

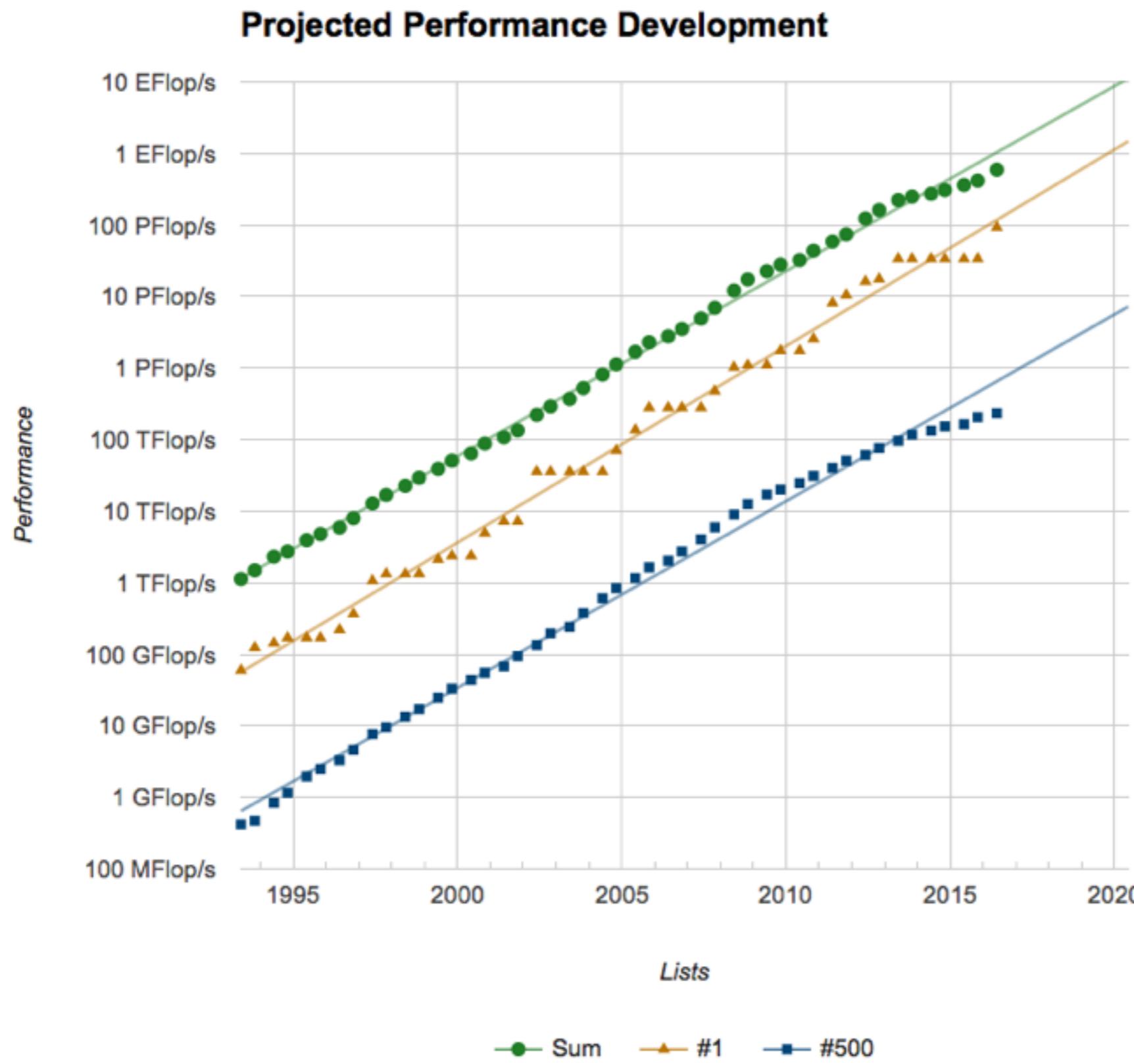
- Heat Flow
- Wave propagation

## Numerical methods:

- finite-differences (FD)
- pseudo-spectral (PS)
- finite-element method (FEM)
- spectral-element method (SEM)



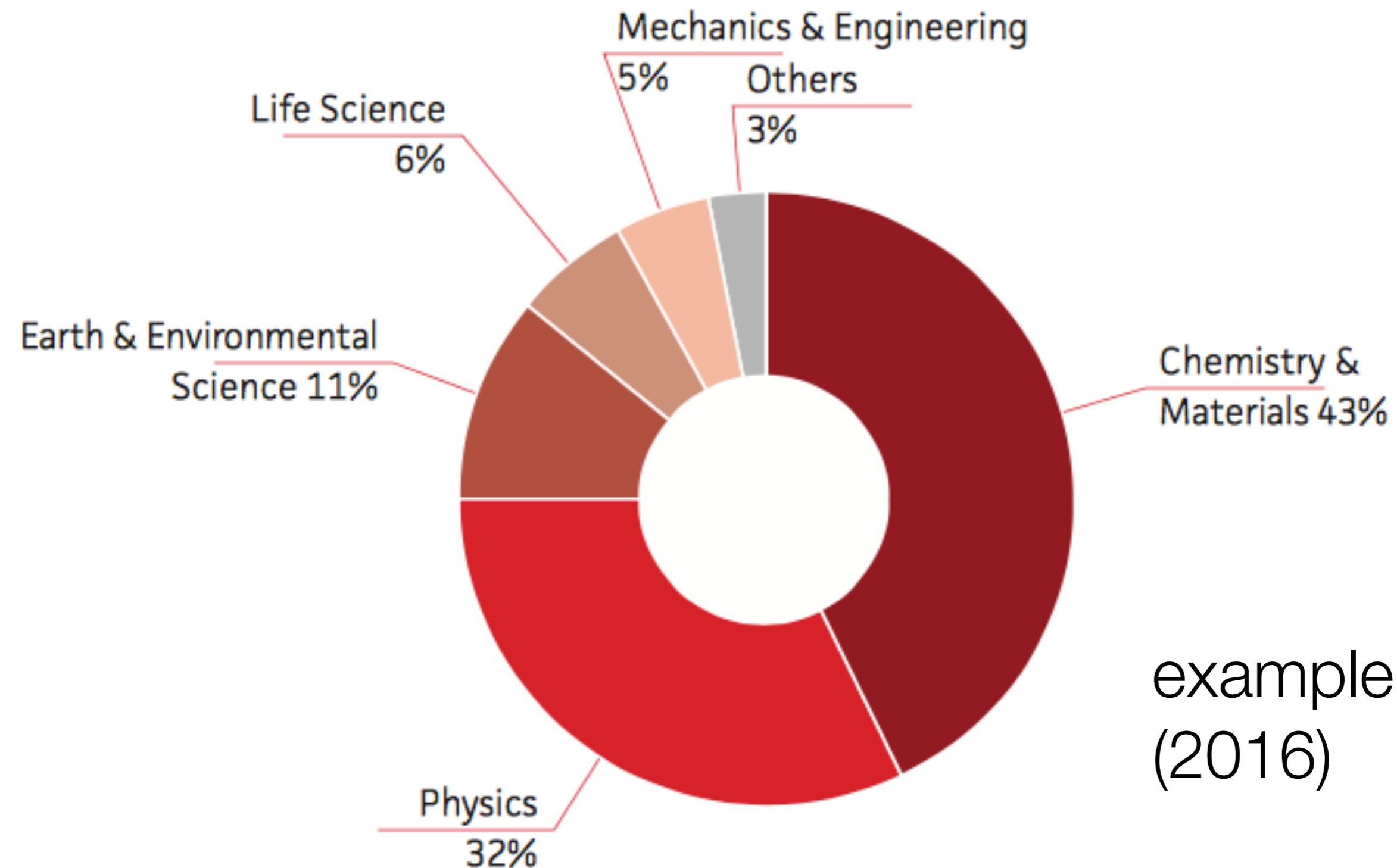
# Trends - fastest supercomputers



exa-scale system  
year ~2020



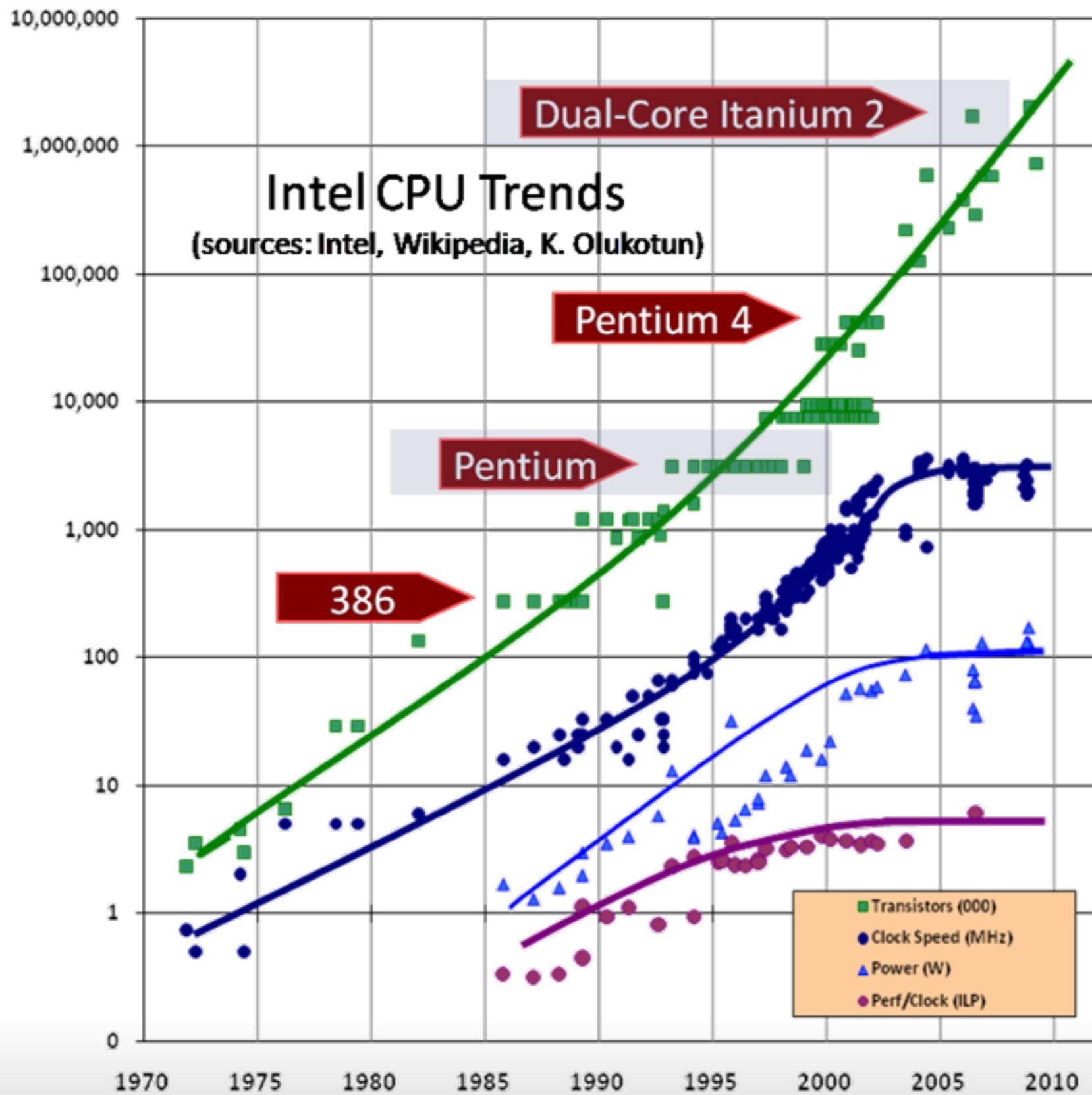
# Trends - Usage by Research Field



example CSCS  
(2016)



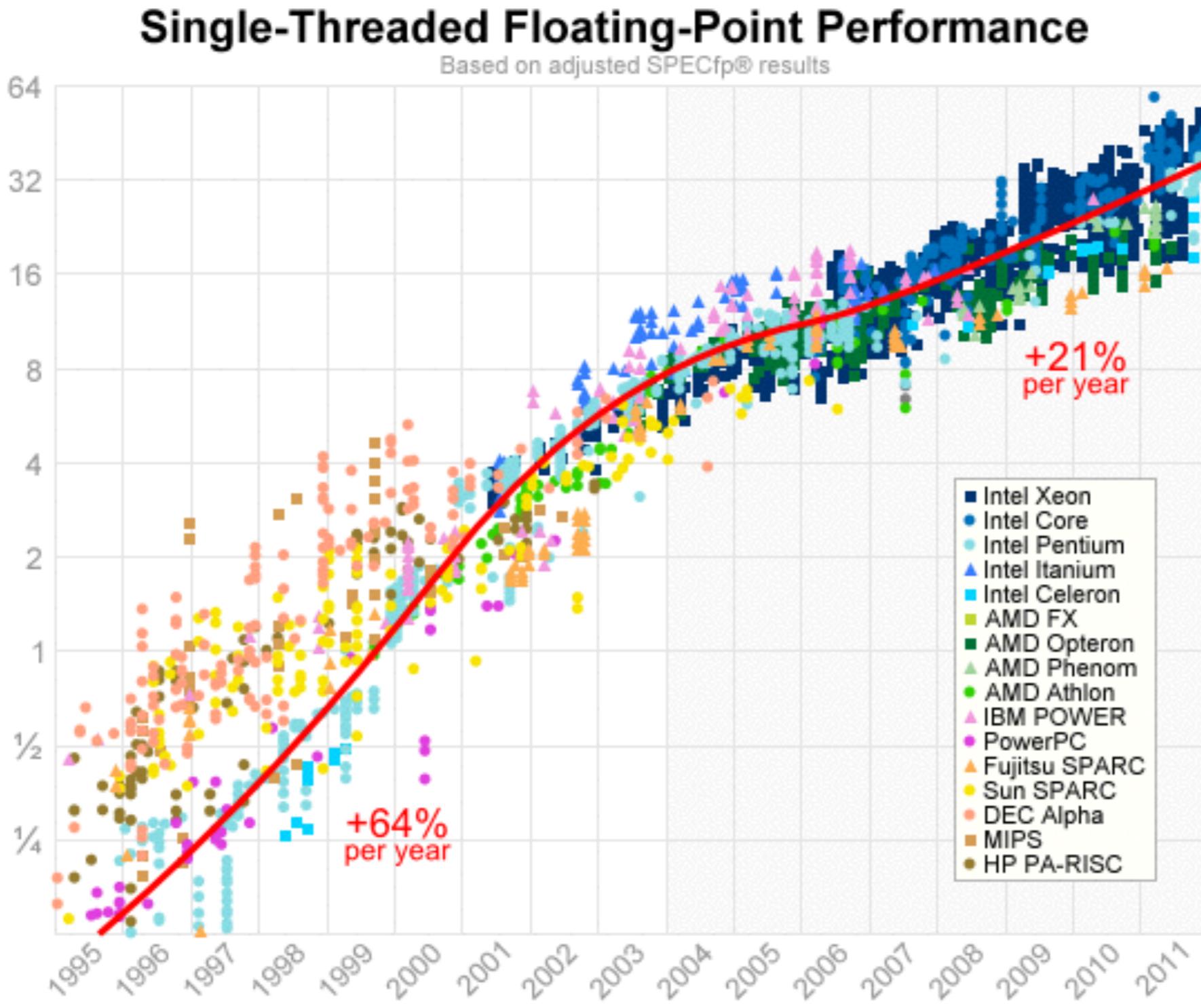
# Trends - CPU



multi-core CPUs  
since ~2006



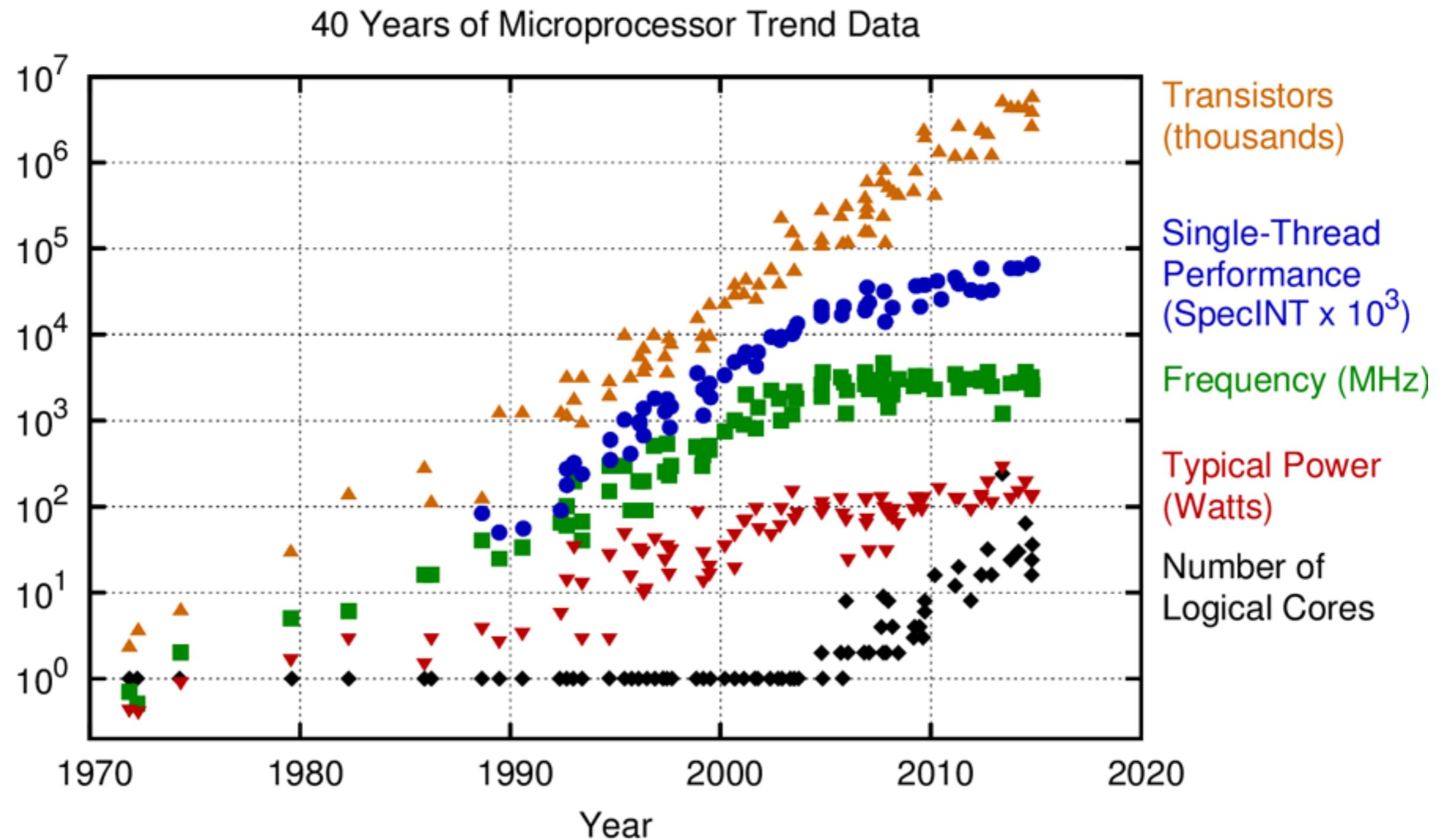
# Trends - CPU



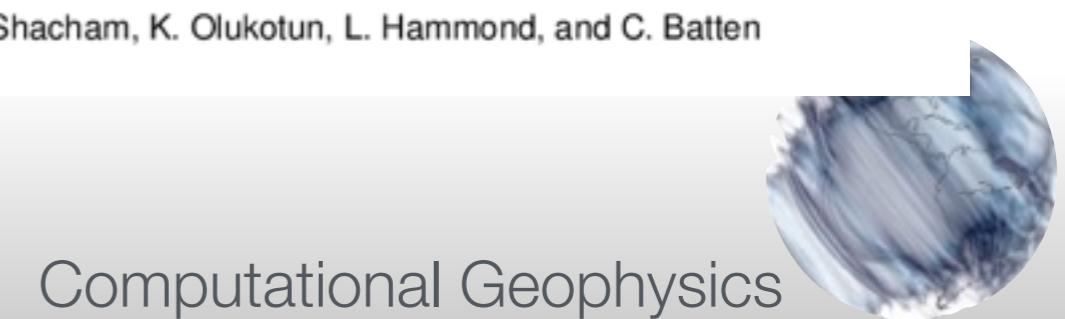
slow-down  
since ~2003



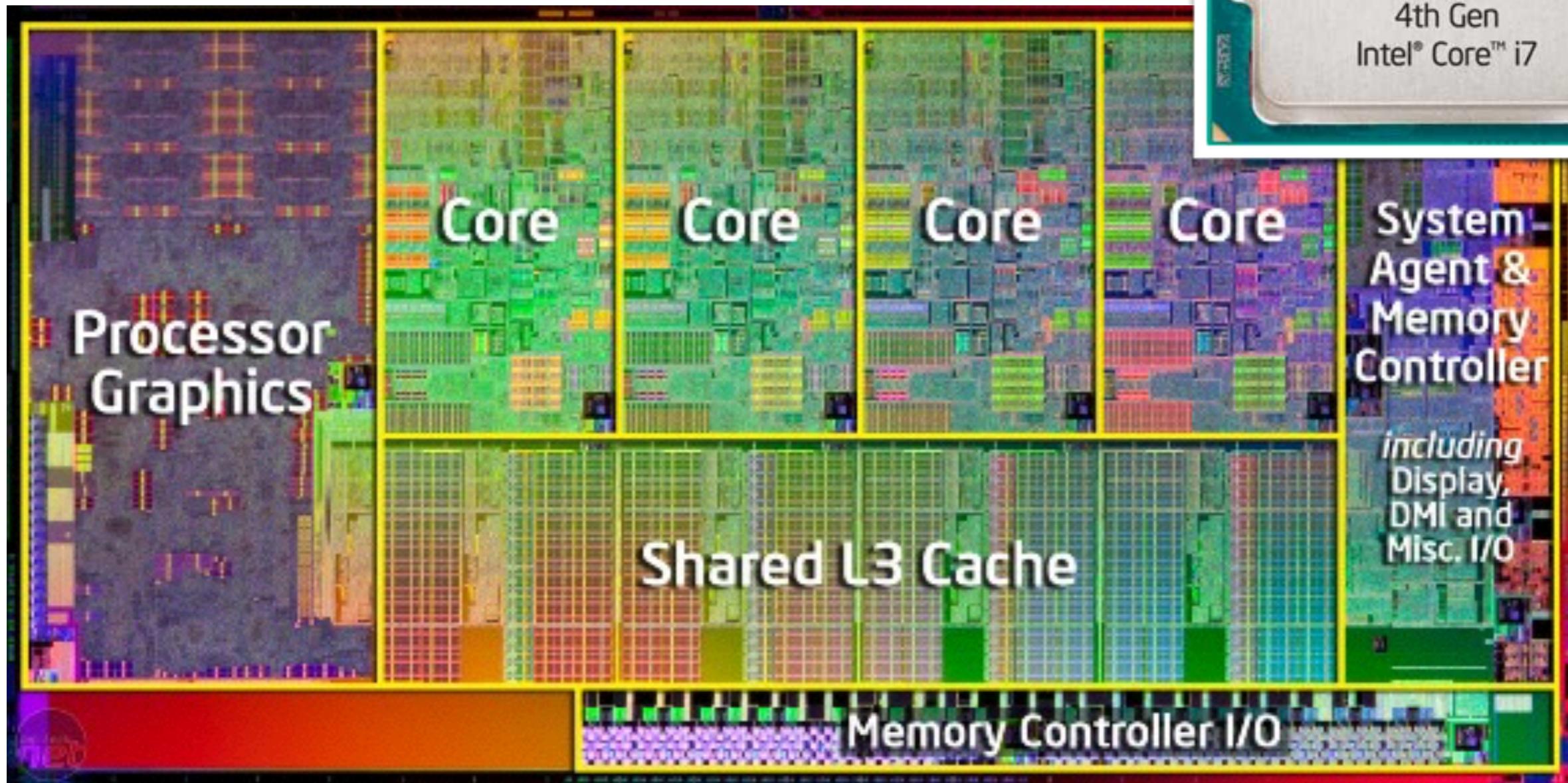
# Trends - CPU



Original data up to the year 2010 collected and plotted by M. Horowitz, F. Labonte, O. Shacham, K. Olukotun, L. Hammond, and C. Batten  
New plot and data collected for 2010-2015 by K. Rupp

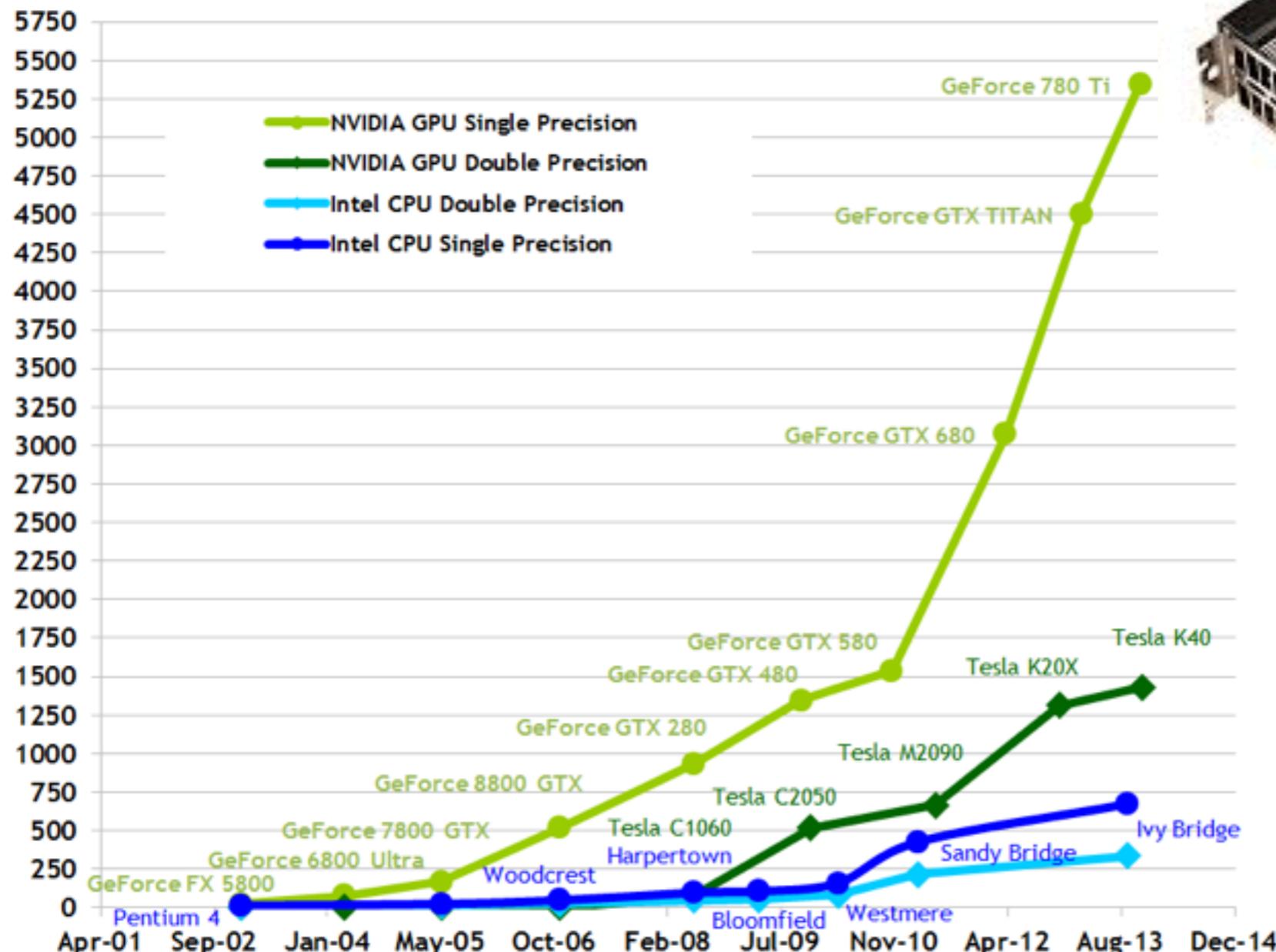


# Trends - CPU



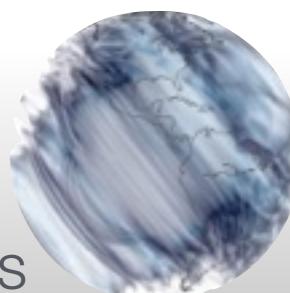
# Trends - GPU

Theoretical GFLOP/s

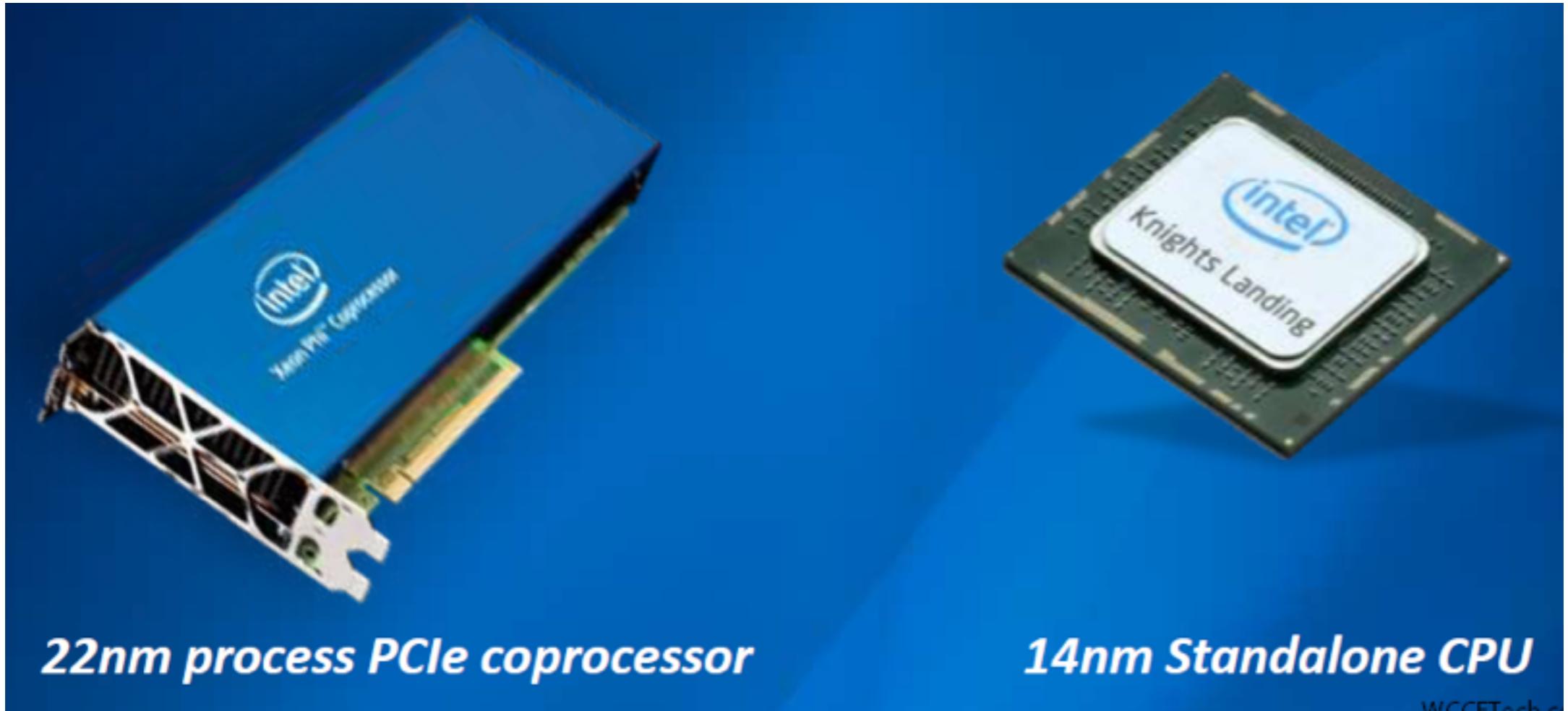


hardware  
accelerators

Floating-Point Operations per Second - Nvidia CUDA C Programming Guide  
Version 6.5 - 24/9/2014 - copyright Nvidia Corporation 2014



# Trends - Intel Phi

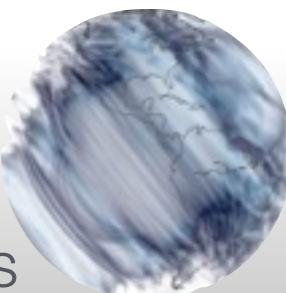


***22nm process PCIe coprocessor***

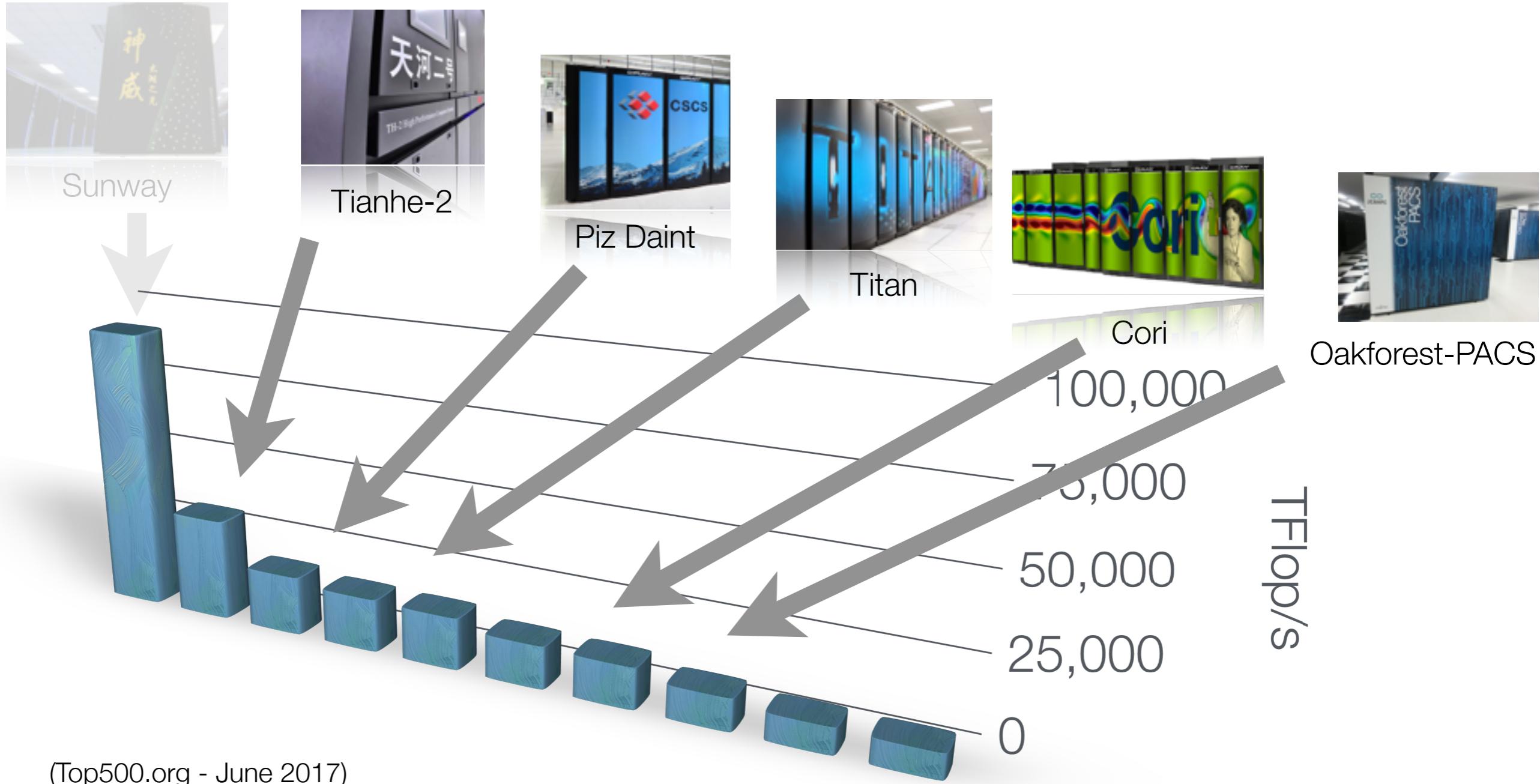
***14nm Standalone CPU***

WCCETech.com

hardware accelerators



# Trends - Supercomputers w/ hardware accelerators



(Top500.org - June 2017)



## Introduction:

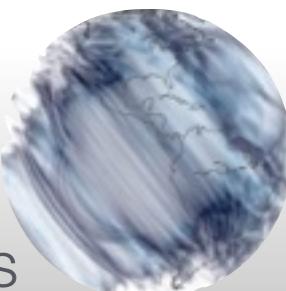
- Top500

## Geophysics:

- Heat Flow
- Wave propagation

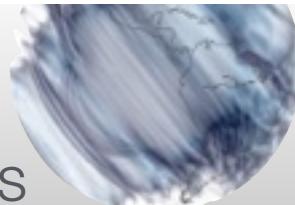
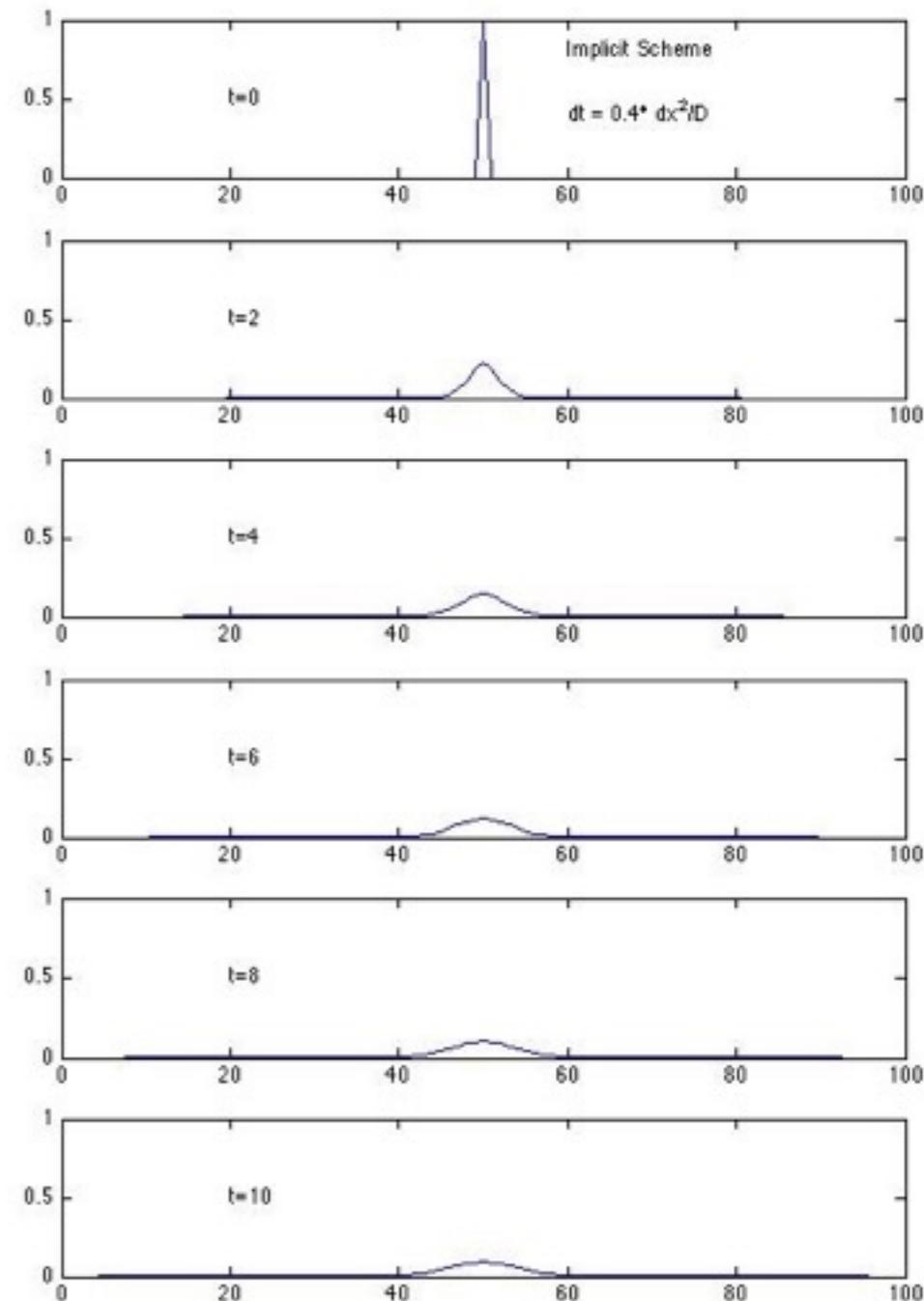
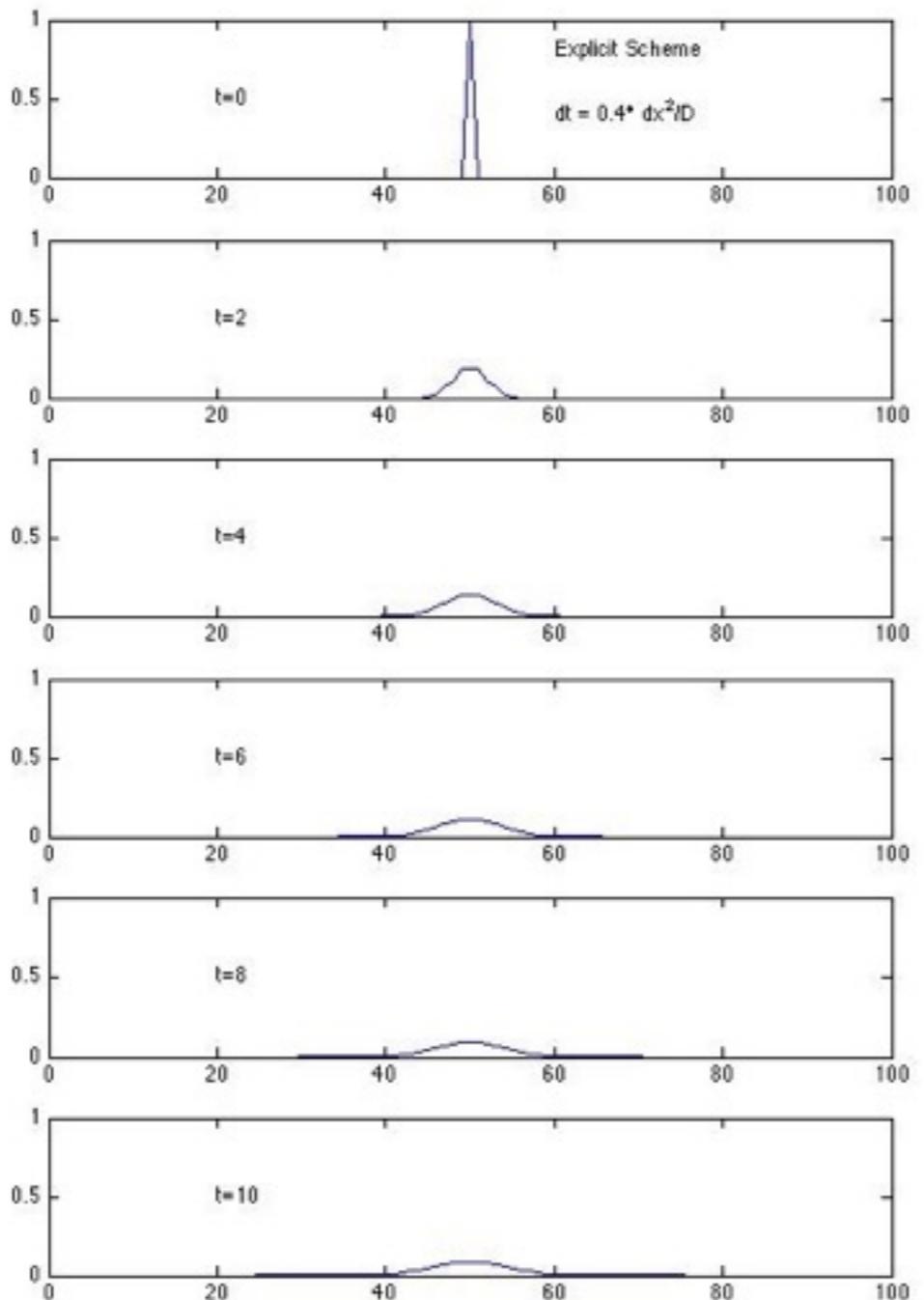
## Numerical methods:

- finite-differences (FD)
- pseudo-spectral (PS)
- finite-element method (FEM)
- spectral-element method (SEM)



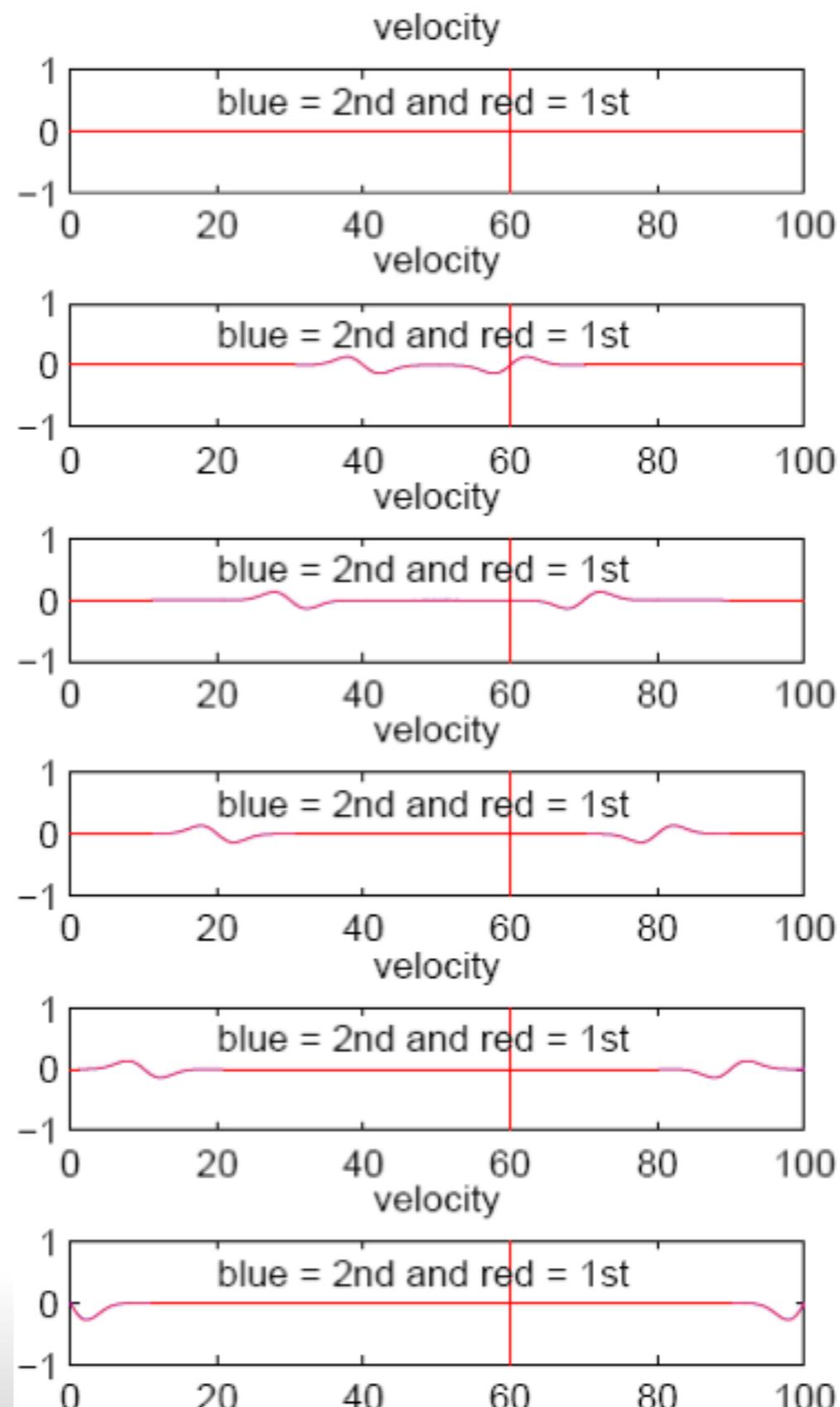
# Numerical methods - Finite-Differences

heat flow



# Numerical methods - Finite-Differences

wave propagation



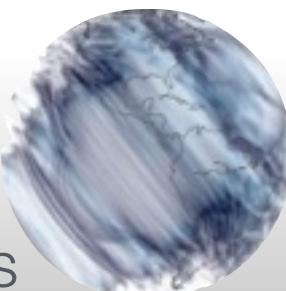
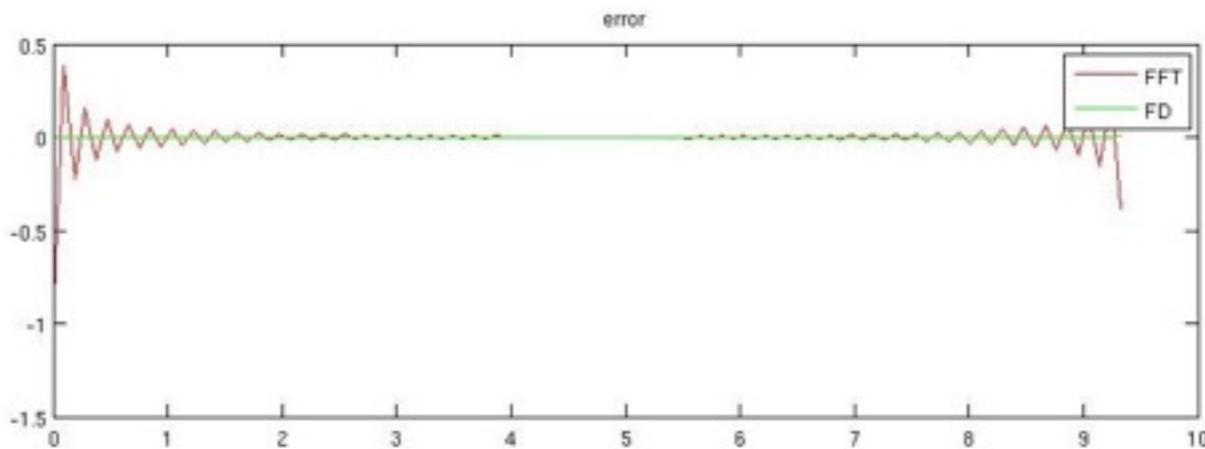
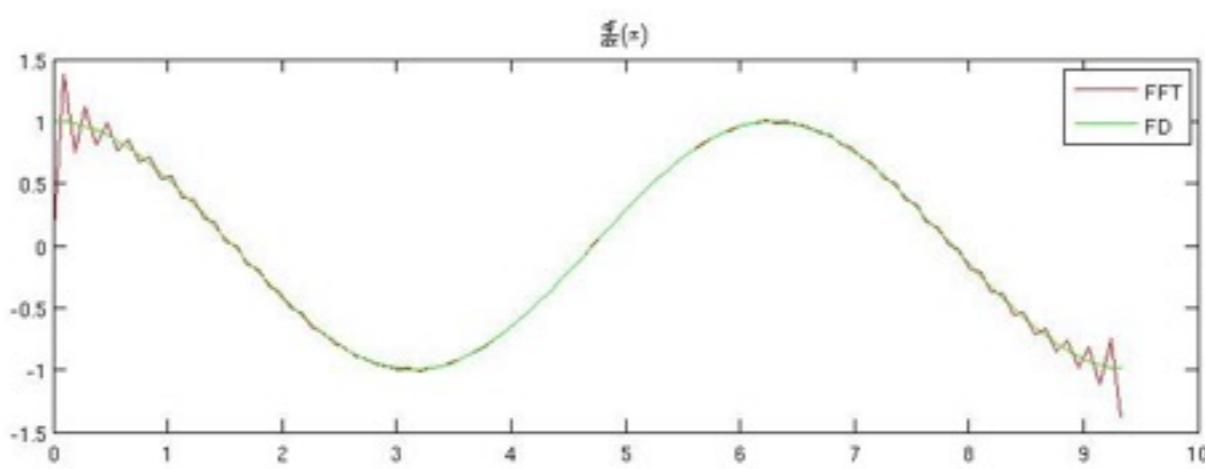
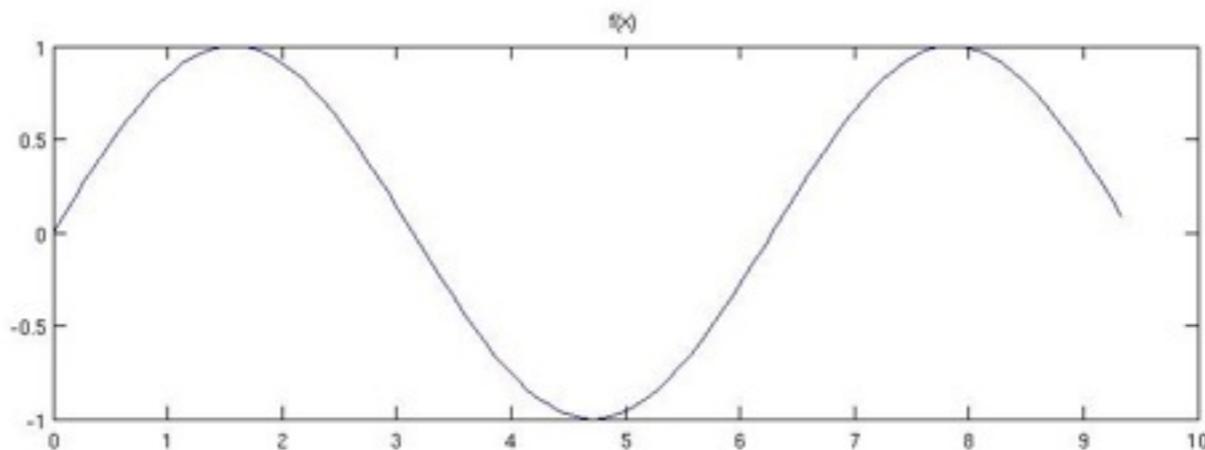
# Numerical methods - Finite-Differences

tsunami waves



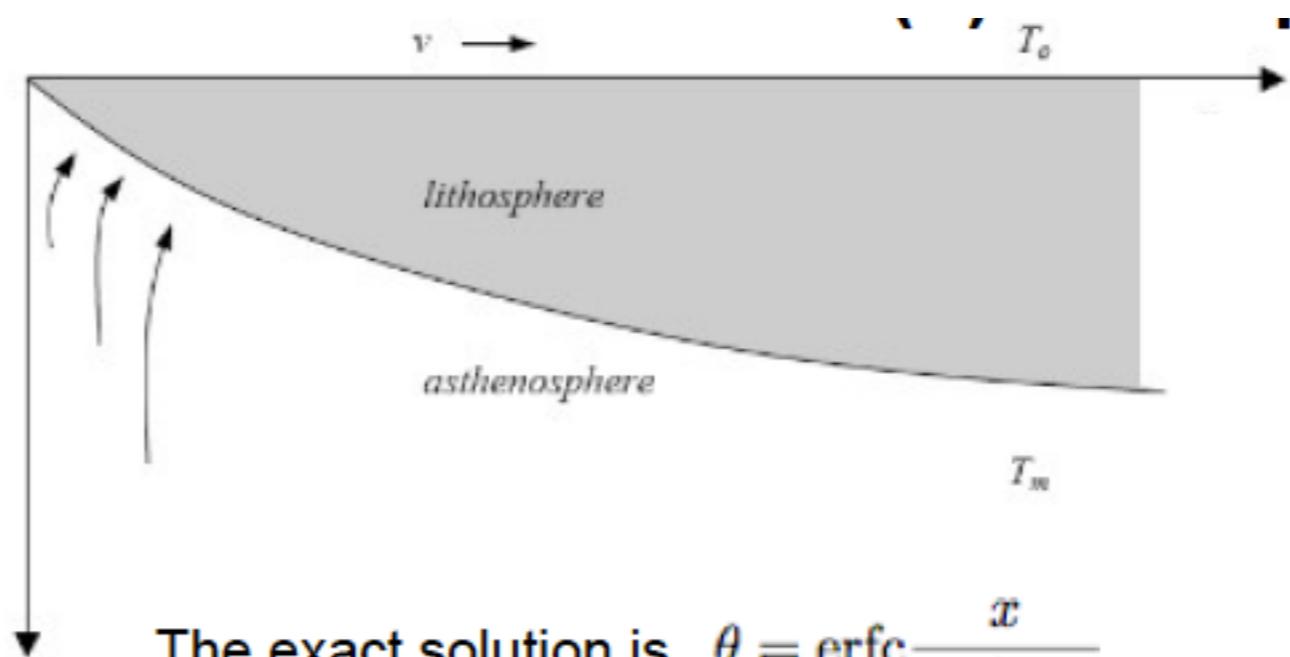
# Numerical methods - Pseudo-Spectral

wave propagation

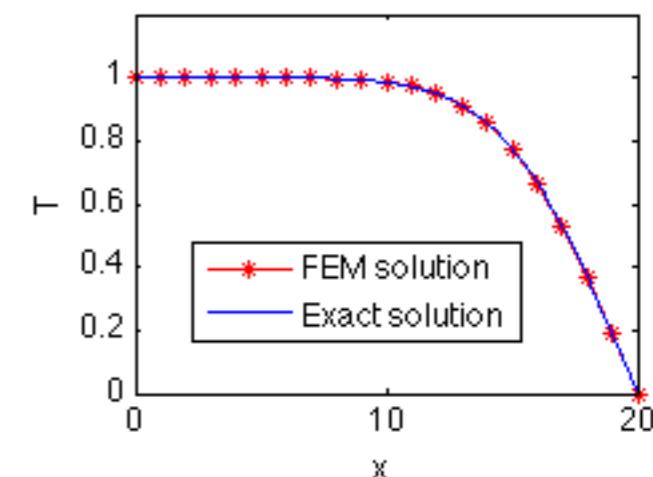
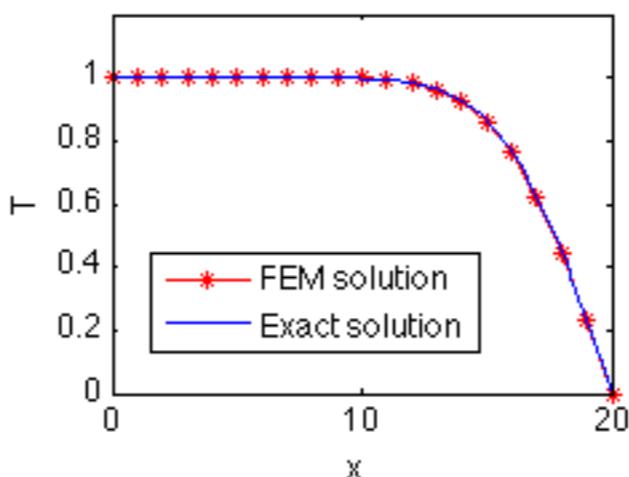
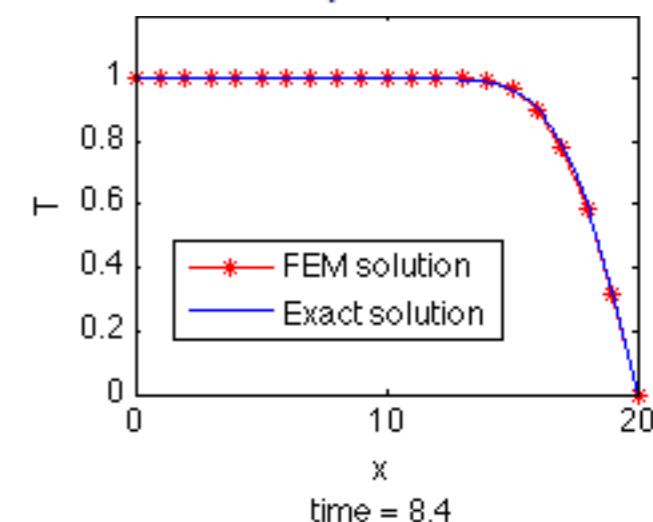
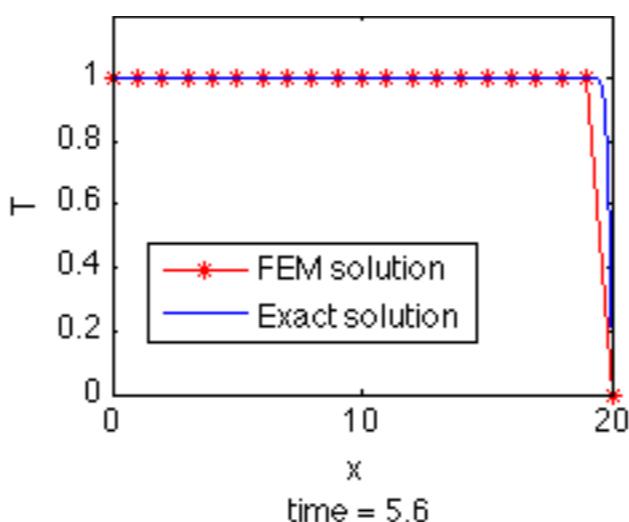


# Numerical methods - Finite-element method

half-space cooling

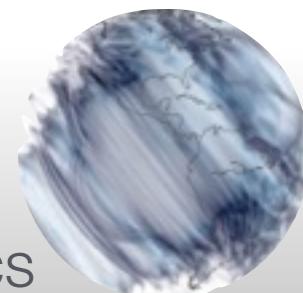


The exact solution is  $\theta = \text{erfc} \frac{x}{2\sqrt{\frac{\kappa}{\rho c_p} t}}$

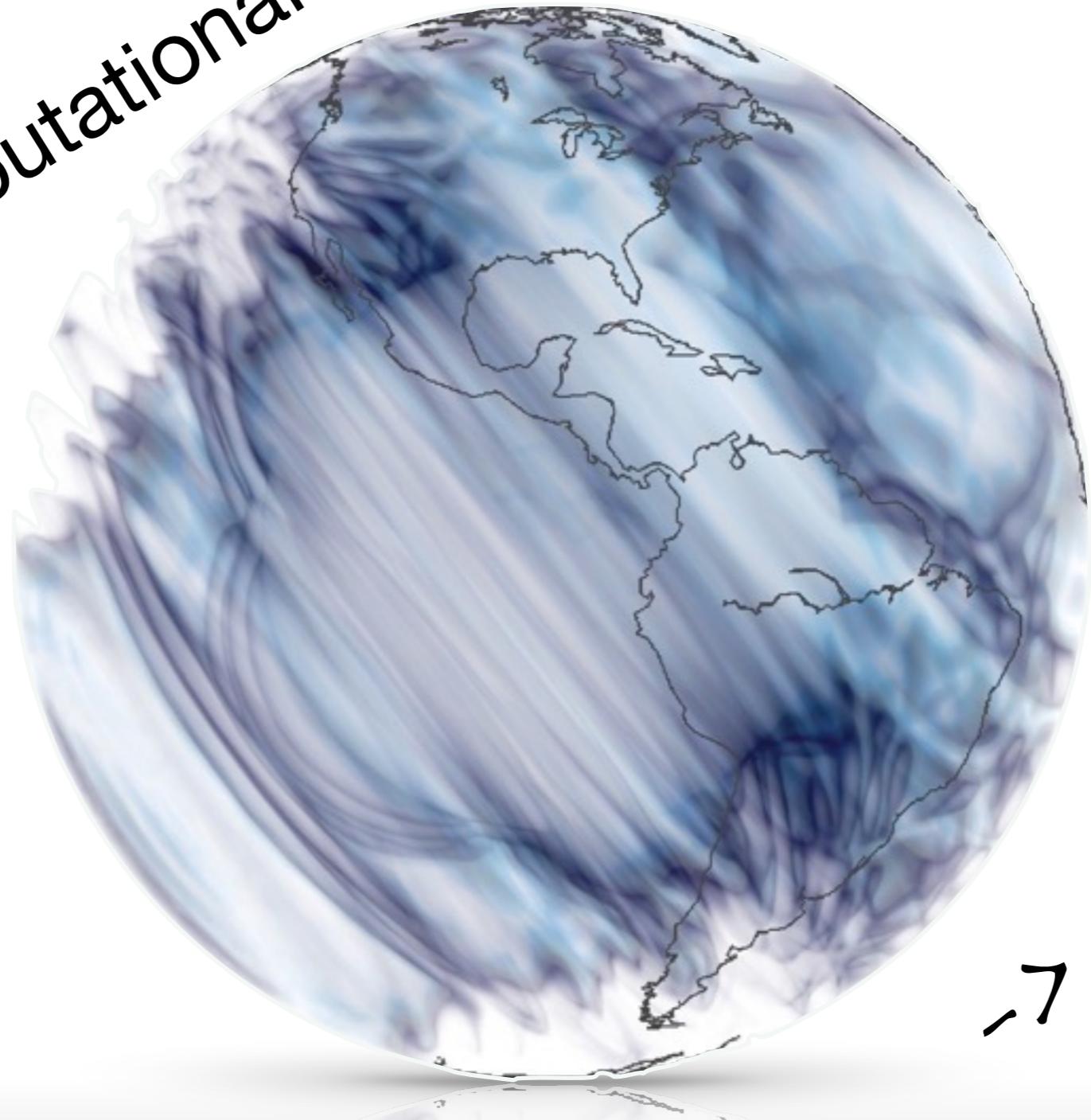


# Numerical methods - Spectral-element method

wave propagation



390C - Computational Geophysics



-7 in a nutshell

Computational Geophysics

