HPC Techniques, Technologies and Strategies

Presented by
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Geophysical Fluid Dynamics Laboratory Review

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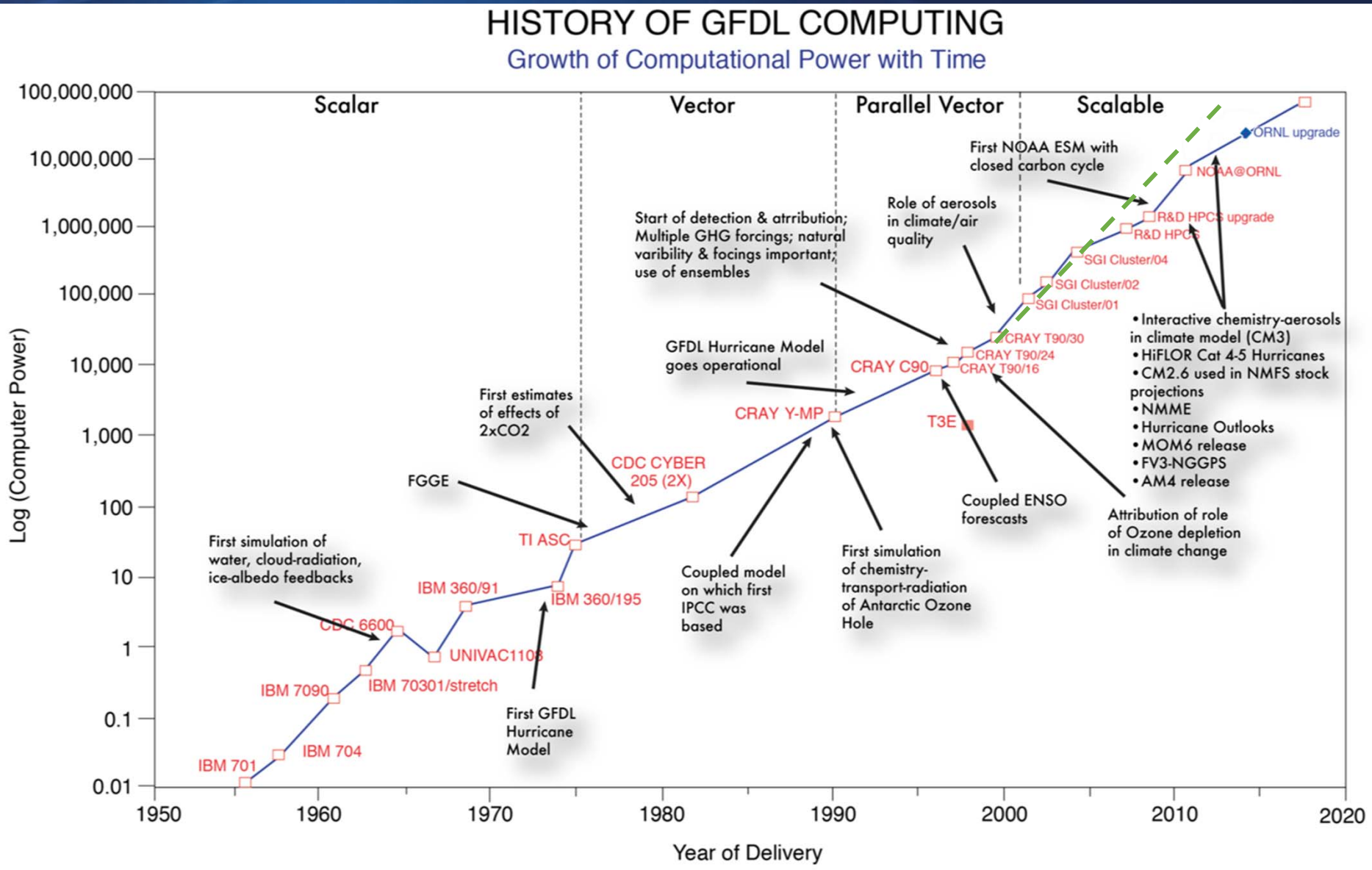
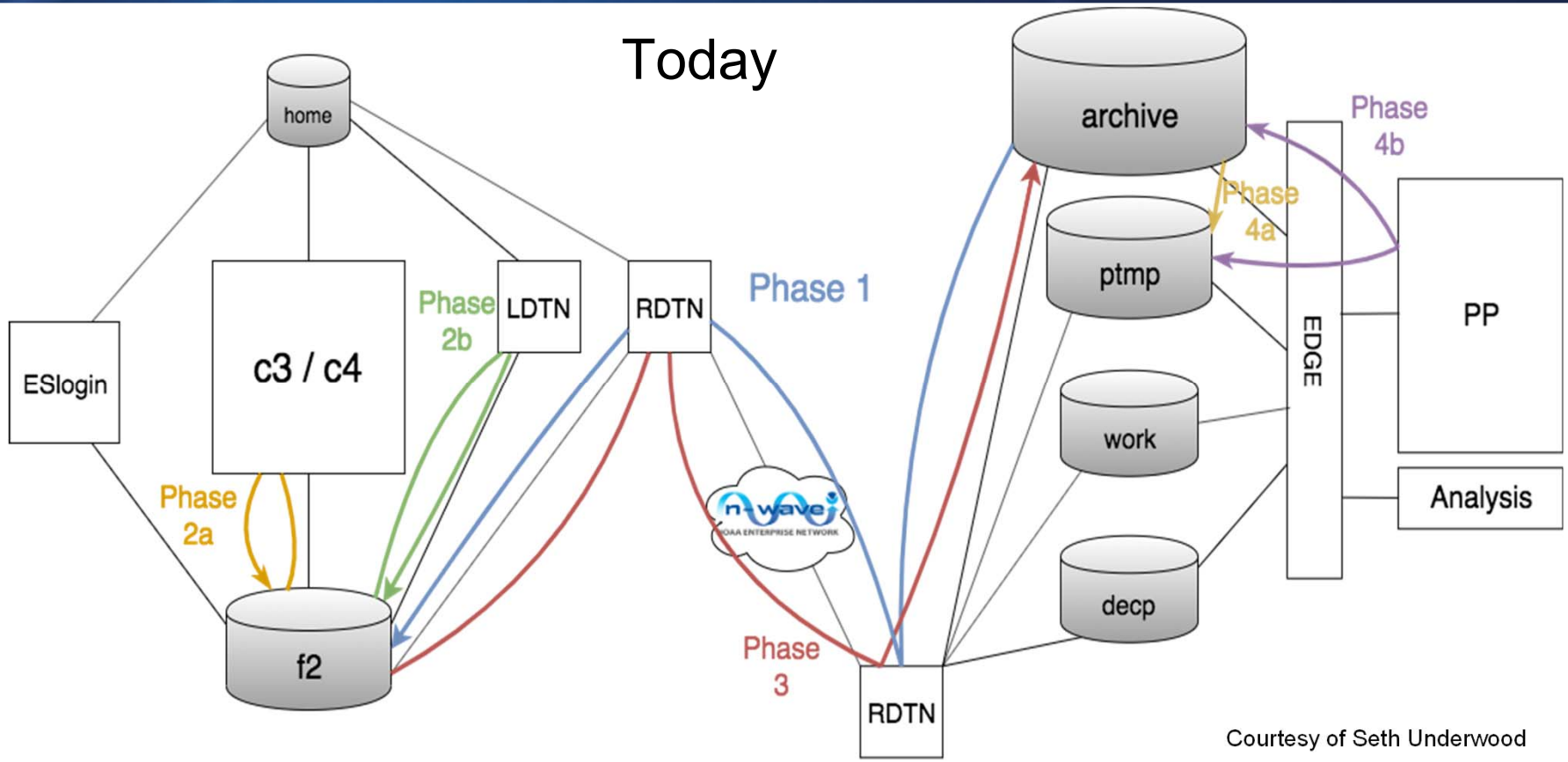
HPC Permeates Earth System Modeling

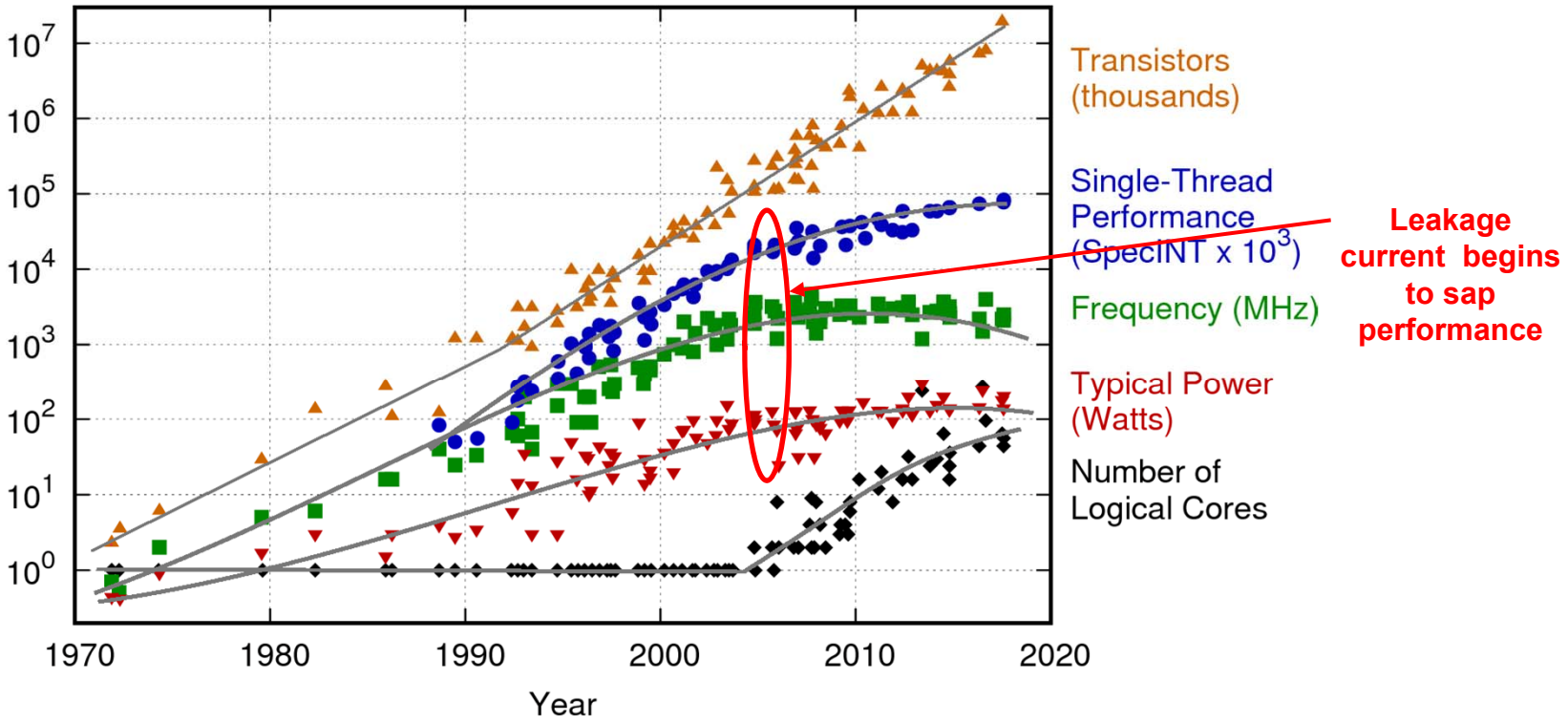


Explosive Growth = Spiraling Complexity



- Increased model resolutions will drive huge increase in data volumes
- As complex as storage hierarchies are today, the future promises even more levels
  - For example: On system non-volatile memory and Flash-based file systems
- Workflows must adapt to deploy processing at the appropriate level of storage

30 Years of Microprocessor Performance Scaling Ends



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 2010-2017 by K. Rupp

- Power and heat problems inhibit further improvements in processor core speed
- But we can continue to etch more cores onto the chip => core counts proliferate
- Theoretical instructions per cycle and memory hierarchy capabilities to deliver data diverge
  - Earth System modeling computations remain extended stencils with many variables
  - Peak flops become increasingly mythical

Courtesy of Seth Underwood

What role might GPUs play in GFDL's Future?

Analysis of HPC trends has motivated DOE to invest well over $1B in GPU based technologies

Pre-Exascale
2020

Perlmutter – NERSC @LBL ($146M)
Cray / AMD CPU / NVIDIA GPU
Nodes: CPU-only & CPU+GPU

Exascale
2021

2022

Aurora – ALCF @ANL ($500M)
Cray / Intel CPU+ Intel GPUs
Nodes: Uniform CPU+GPU

Intel Xeon + Xᵉ

?

Frontier – NCRC @ORNL ($600M+)
Cray / AMD CPU+ AMD GPUs
Nodes: Uniform CPU+GPU

AMD EPYC + Radeon