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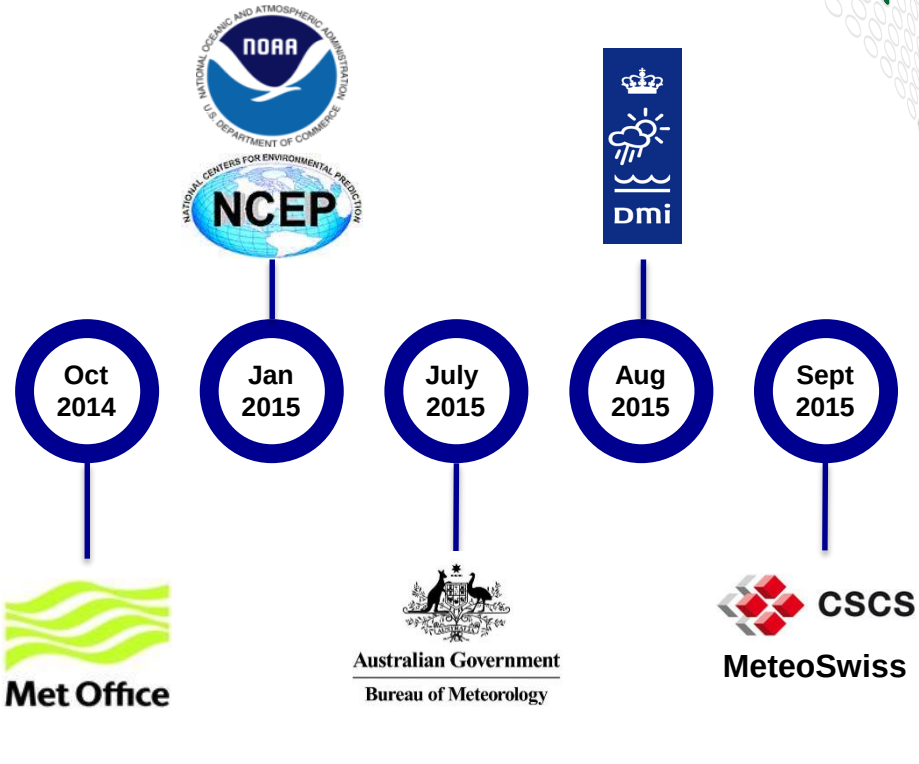
Challenges & Trends in Weather & Climate Modelling

Phil Brown
philipb@cray.com
Earth Sciences Segment Leader

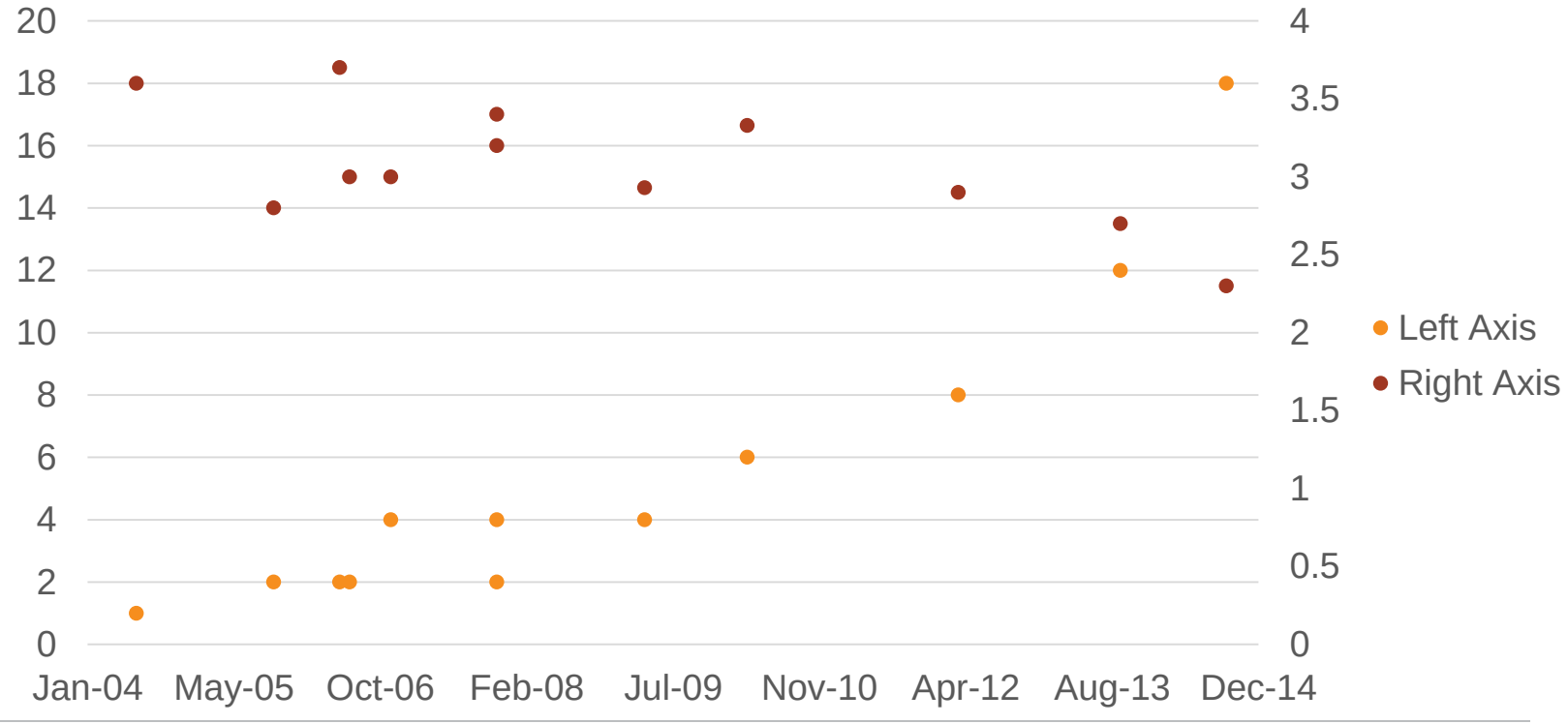
Topics

- **Introduction**
- **Challenges:**
  - Parallelism
  - Heterogeneous Memory/Storage Hierarchy
- **Emerging trends in weather & climate data analysis**

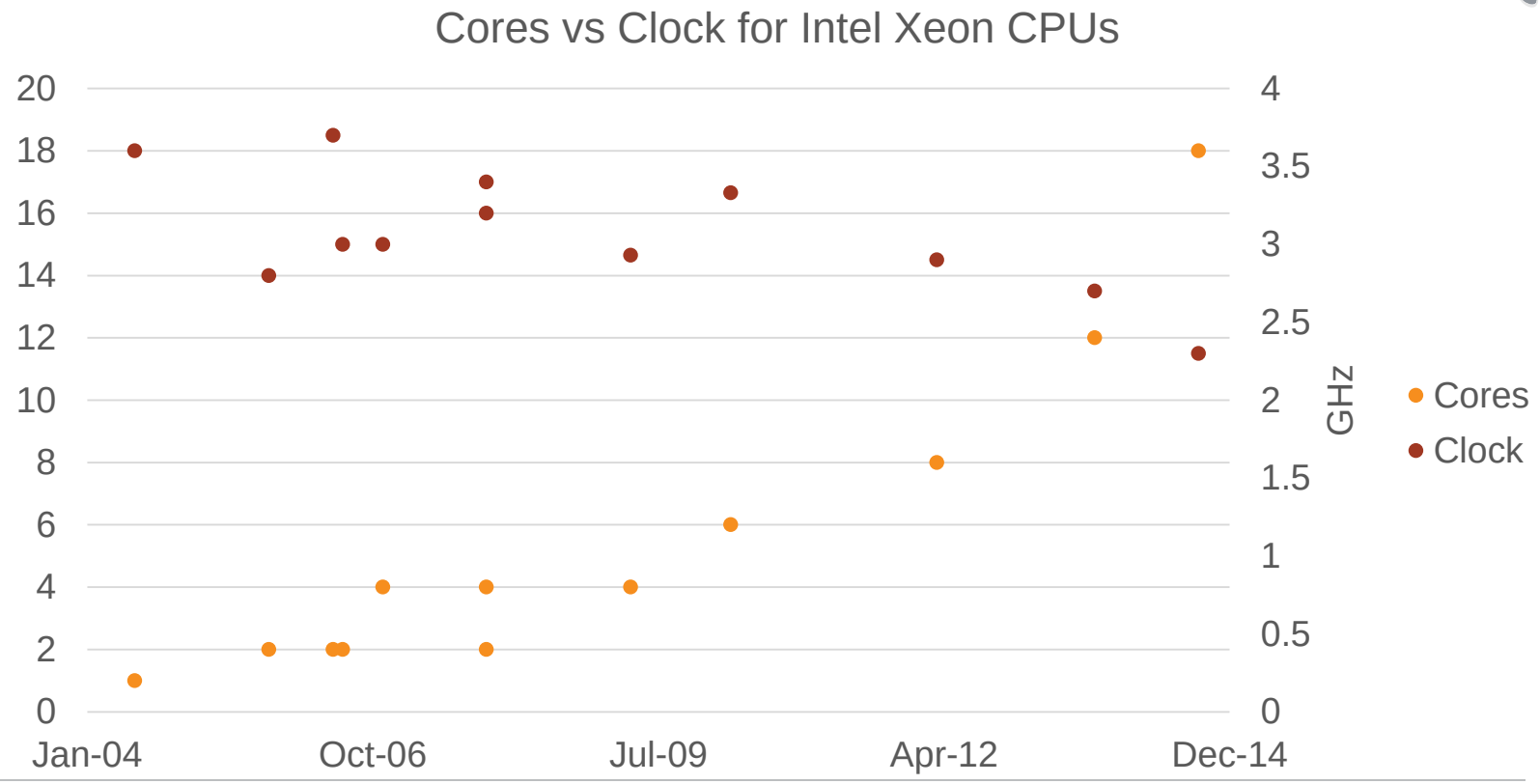
Cray in Weather, Climate and Oceanography



Guess the Data!



Parallelism is here to stay



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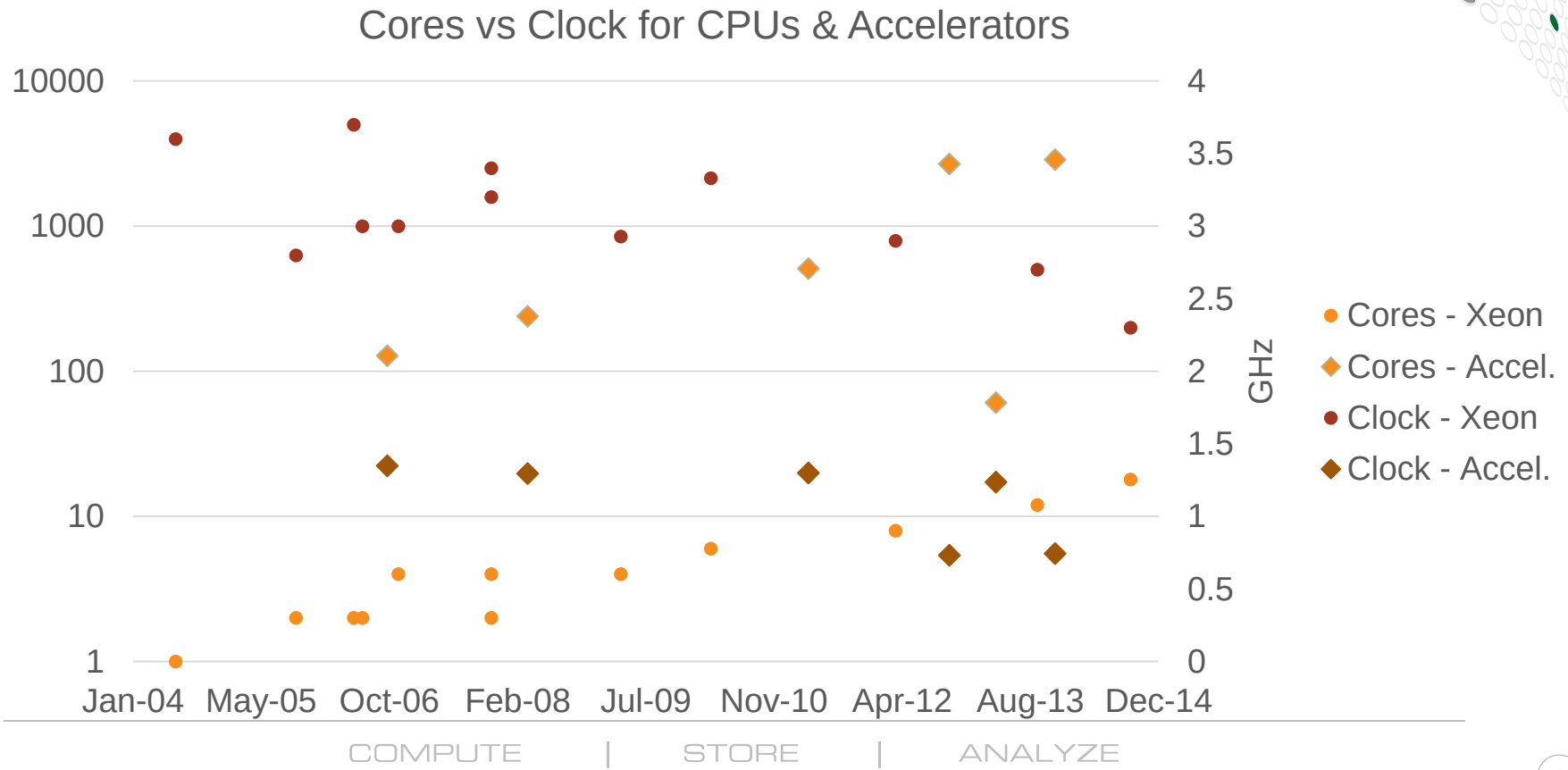


CSCS/MeteoSwiss

- CSCS & MeteoSwiss recently announced the installation of the world's first GPU-based supercomputer for operational numerical weather prediction.
- The Cray CS-Storm systems will enable MeteoSwiss to run more detailed simulations with a 1.1km grid spacing, and is 40x more powerful than the Cray XE6 systems it is replacing

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

CSCS

System Overview

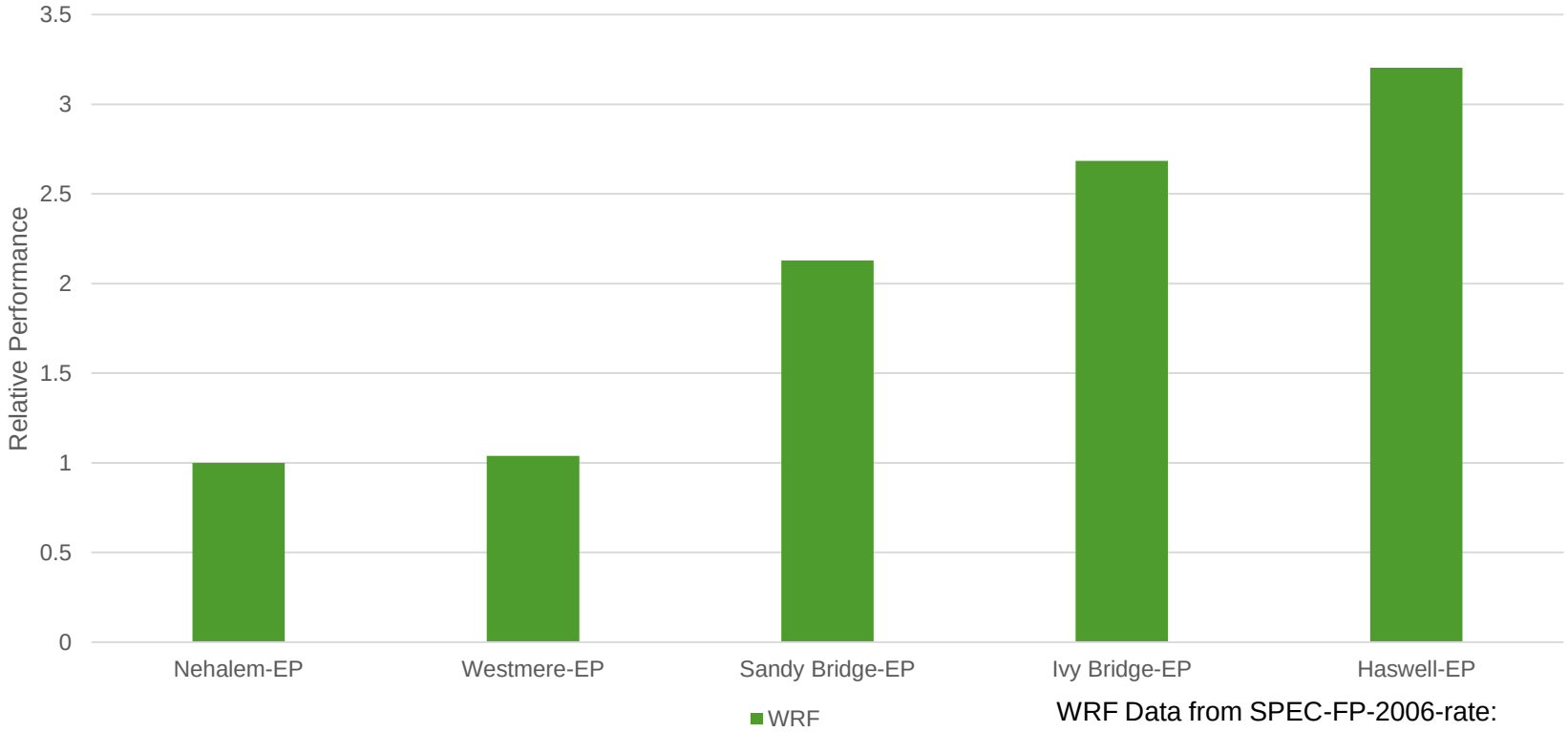
- Dual Cray CS-Storm systems for operations and research/backup
- Intel Xeon Haswell nodes each with eight NVIDIA K80 GPUs
- Allow simulations which are 3x more energy efficient and 2x faster than solely using conventional CPU technology

Testimonial

This grid spacing makes it possible to predict with more detail the precipitation distribution, the risk of storms or valley wind systems in the Swiss mountains. It is an additional step to increase the utility of the weather forecasts

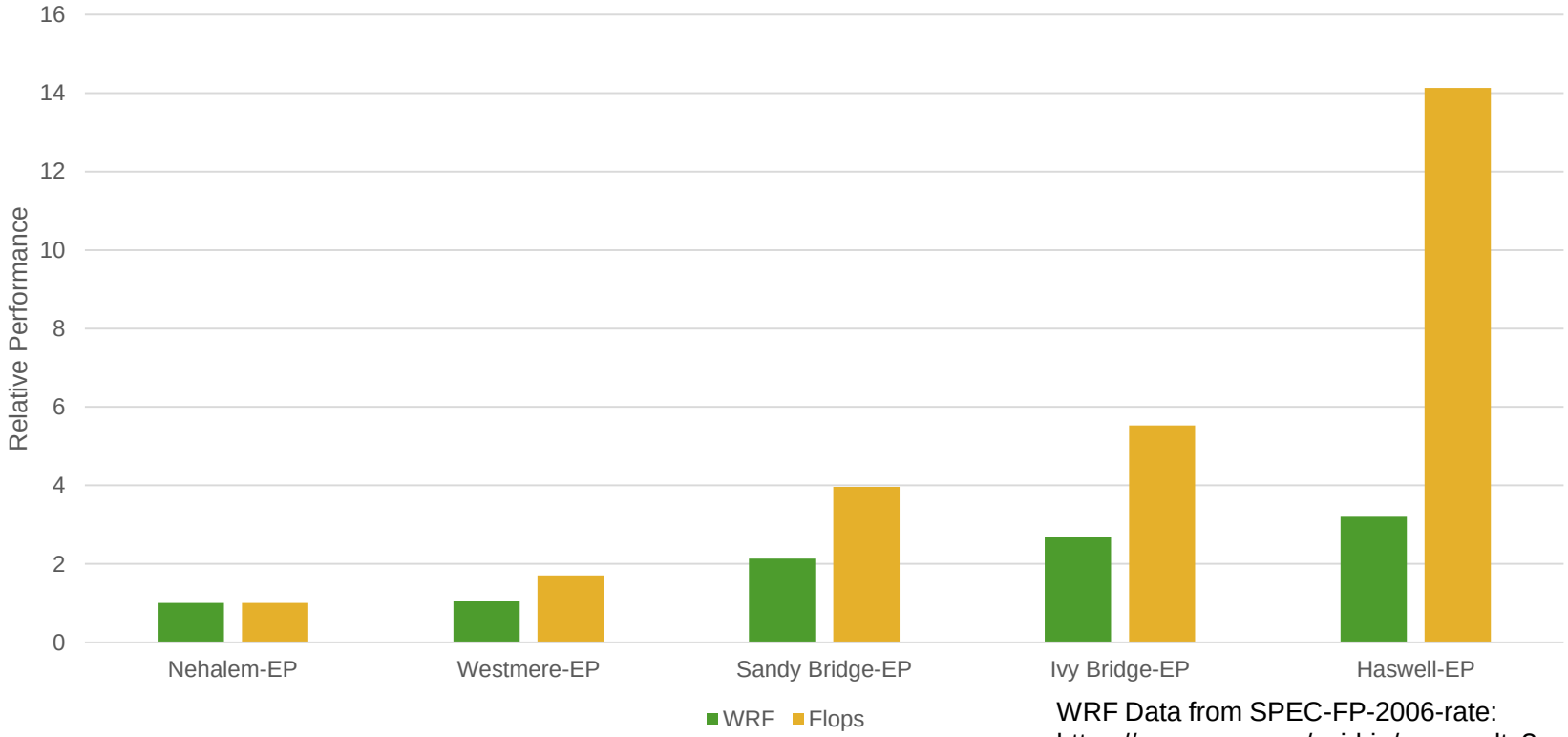
Peter Binder, Director General of MeteoSwiss.

Historical Performance Trends



WRF Data from SPEC-FP-2006-rate:
https://www.spec.org/cgi-bin/osgresults?conf=rfp2006

FLOPs aren't the bottleneck!



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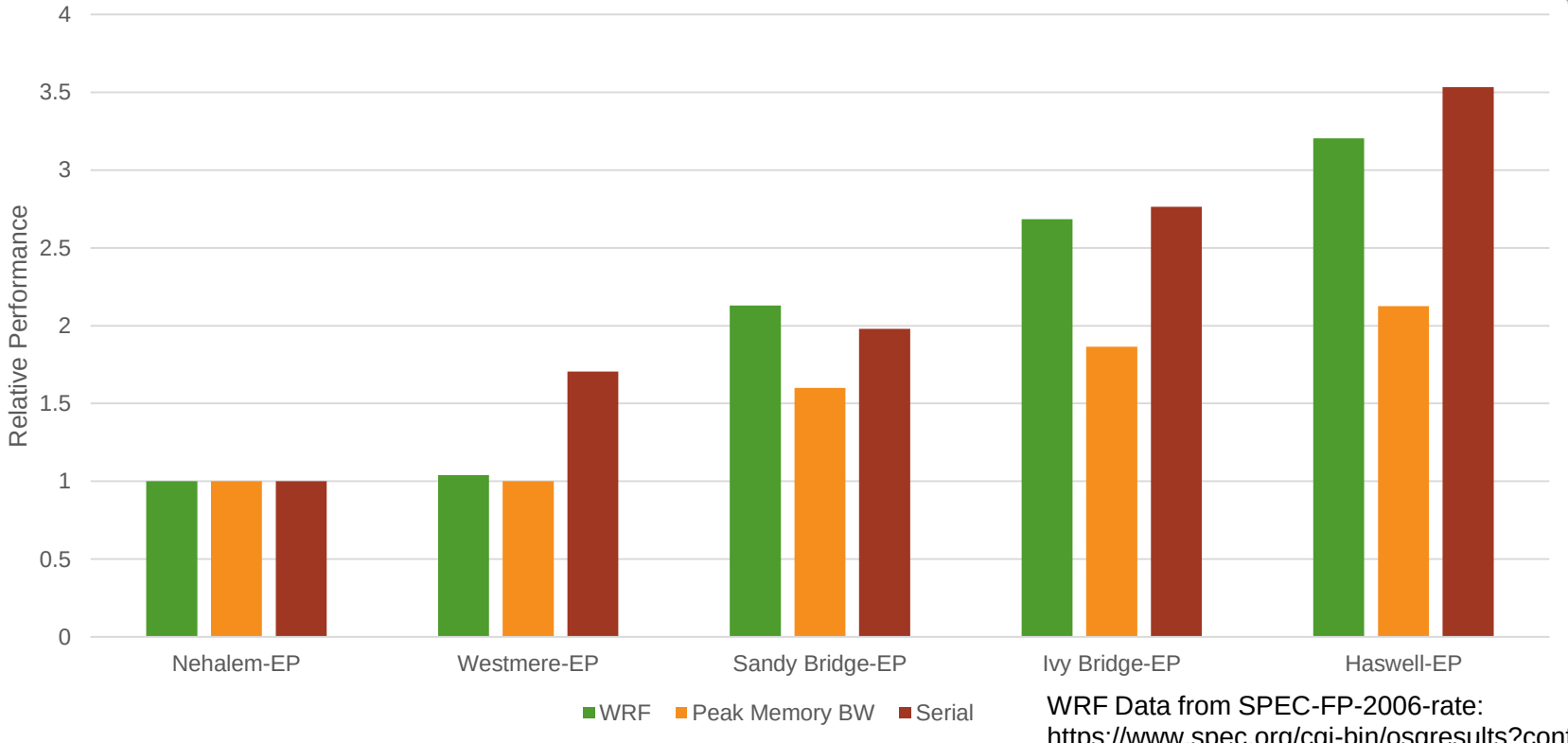

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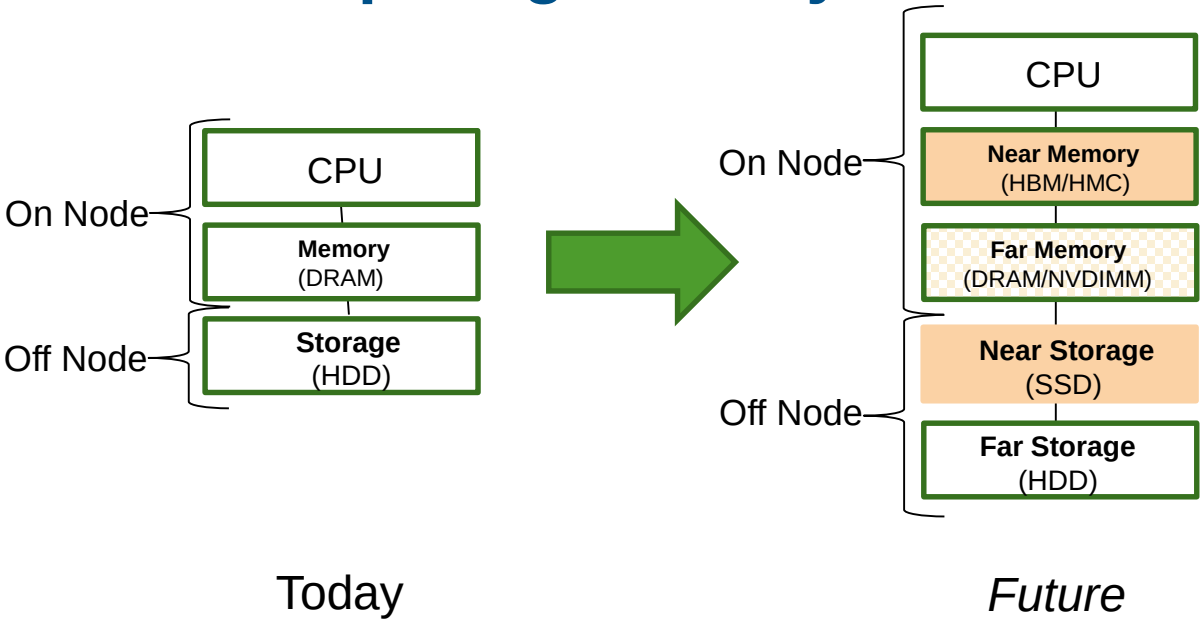
Exascale Computing Memory Trends



- **Good: Helps reduce/mitigate cost of moving data**
- **Bad: Even more complexity in programming models**

Weather/Climate Informatics

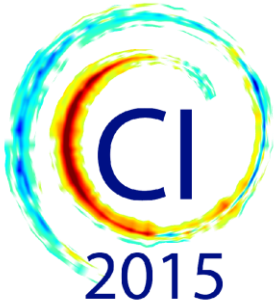
- **Emerging analysis approaches adopted from data analytics & machine learning space**

- **Examples includes:**
  - Complex network & graph based approaches
  - Scalable optimization methods
  - Supervised/unsupervised learning
  - Streaming data processing techniques

- **Some use-cases:**
  - Detecting links between elements in climate system
  - Automated forecaster guidance/decision support
  - Optimizing integration of multi-model climate ensembles

- **Ingest/Analysis will also become more tightly coupled within overall workflow**

Weather/Climate Informatics



5th In
Septe

Hosted

ICCS 2015: "Computational Science at the Gates of Nature"

Sixth Workshop on
Data Mining in Earth System Science (DMESS 2015)

Co-conveners: Forrest M. Hoffman, Jitendra Kumar, and J. Walter Larson

Reykjavík, Iceland | June 1–3, 2015

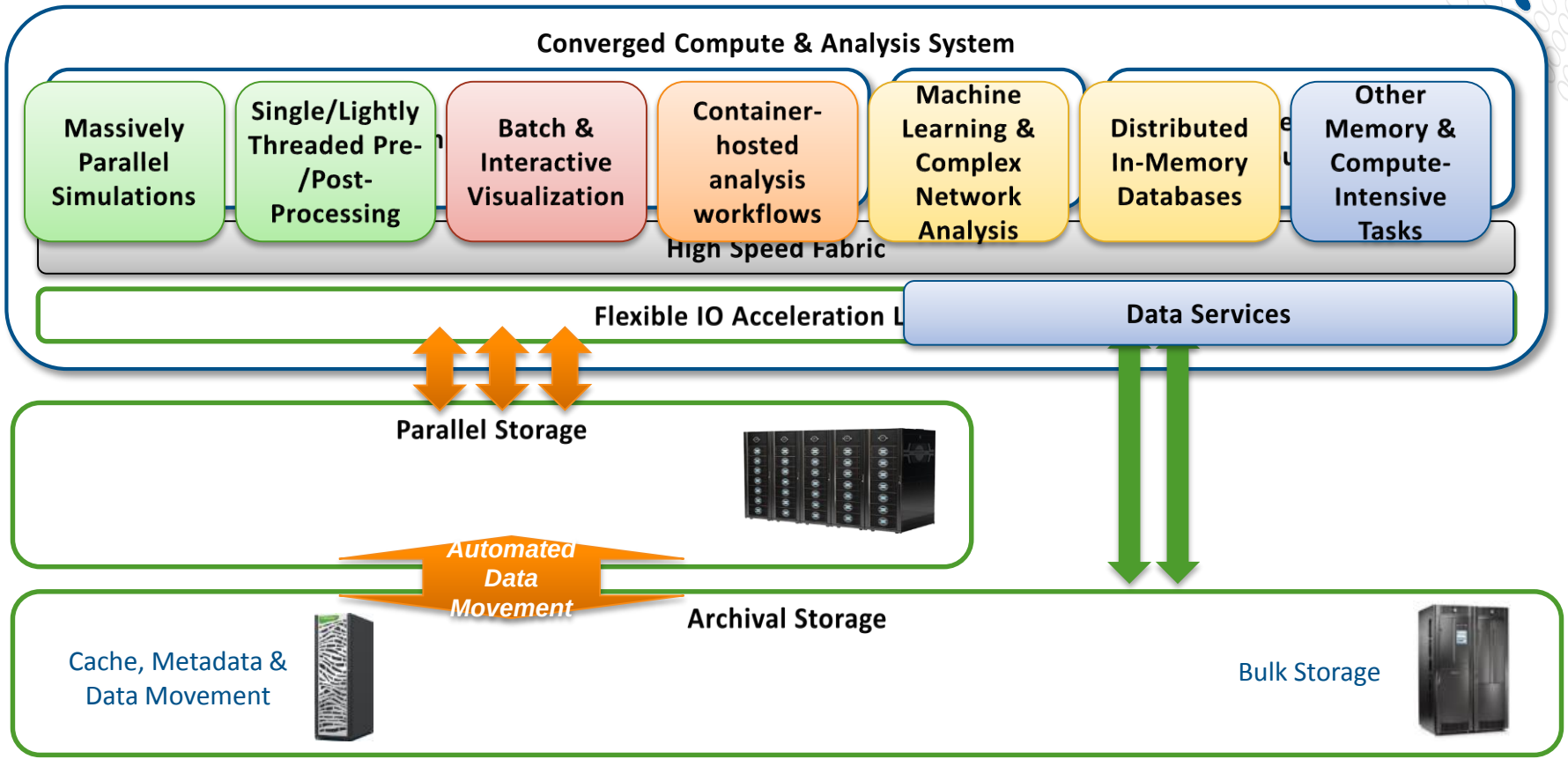
- **Some use-cases:**

UNIVERSITY OF MINNESOTA
Driven to Discover℠

NSF

Fifth Annual Workshop on
Understanding Climate Change from Data
August 4-5, 2015 | University of Minnesota Minneapolis, MN

Future Converged Architecture



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Integrated HPC Environments are the capability that will turn data in to insight and discovery


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Thank you!