VIS2024

FunM^{2}C: A Filter for Uncertainty Visualization of Multivariate Data on Multi-Core Devices

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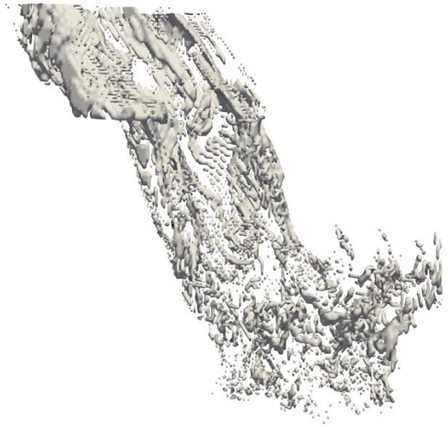
Introduction

1987 — 2015 — 2018

Isosurface (Lorensen and Cline)	Fiber surface (Carr et al.)	Multi-variate surface (Jankowai and Hotz)
Variable = 1	Variable = 2	Variable >= 3



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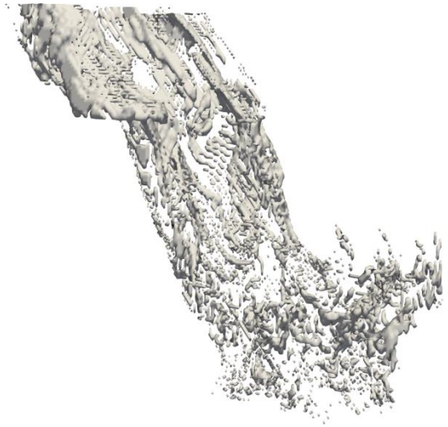
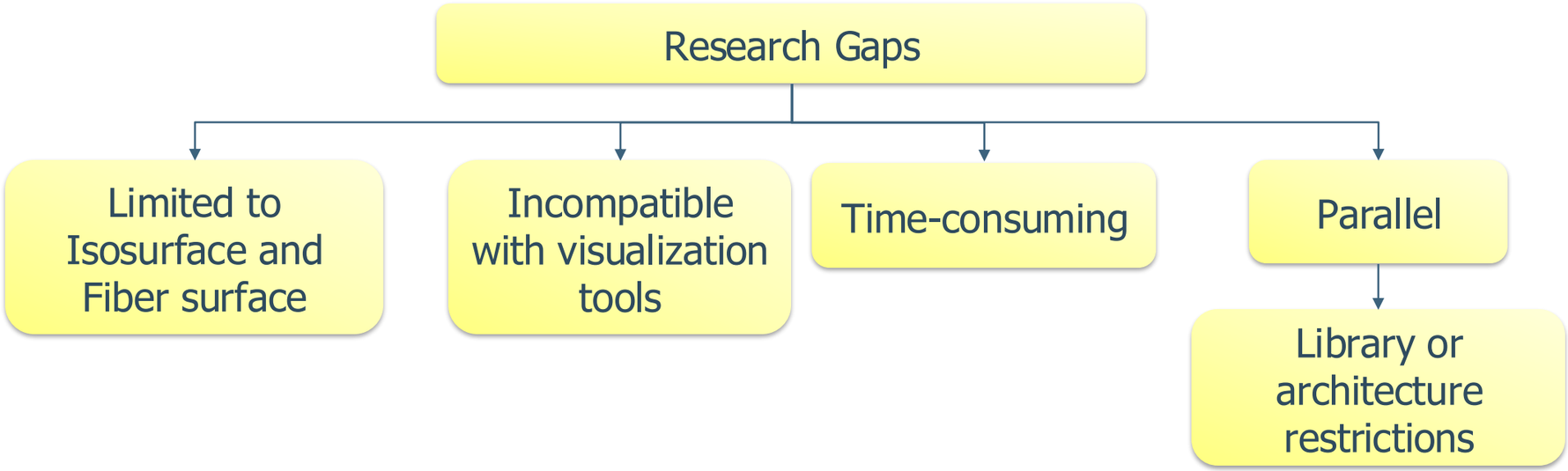


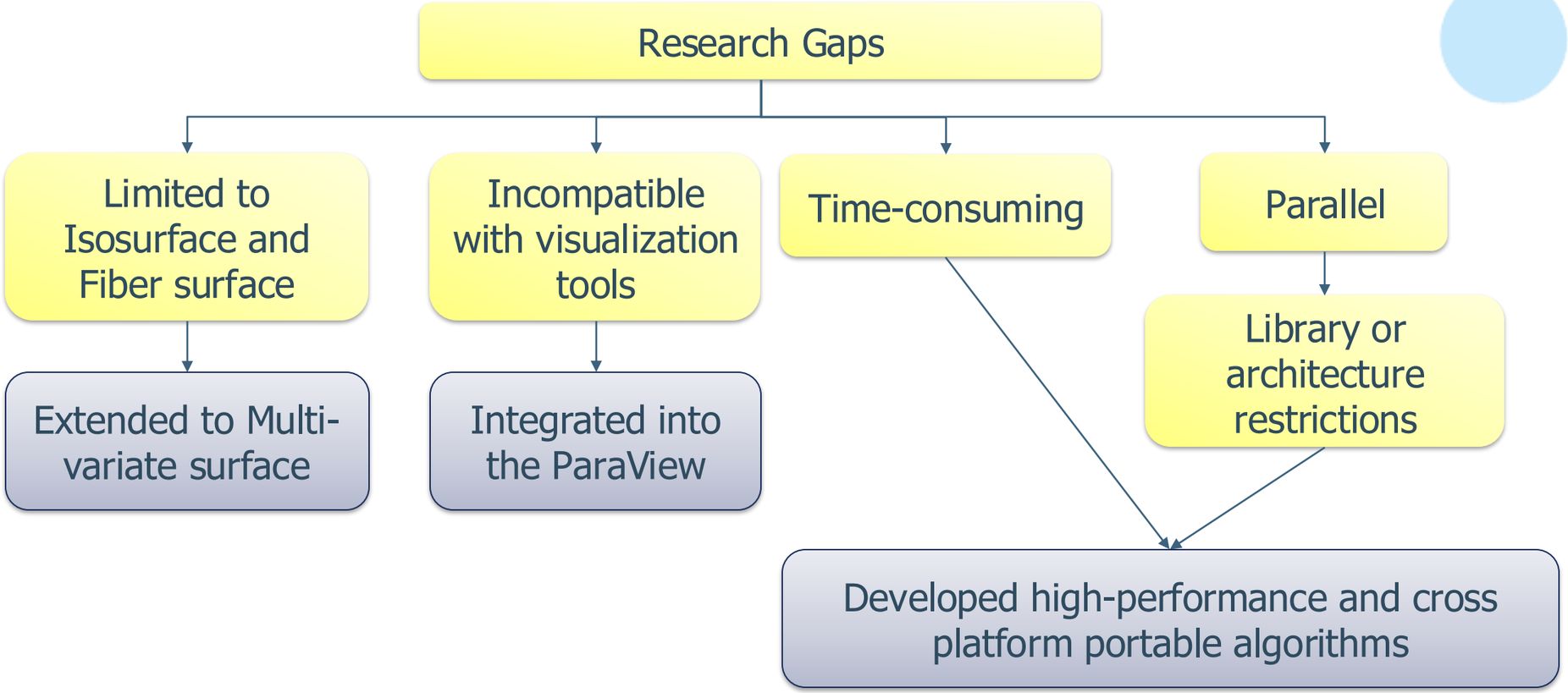
Limitation: All three surfaces neglect inherent data uncertainty

State of the art & Research Gaps

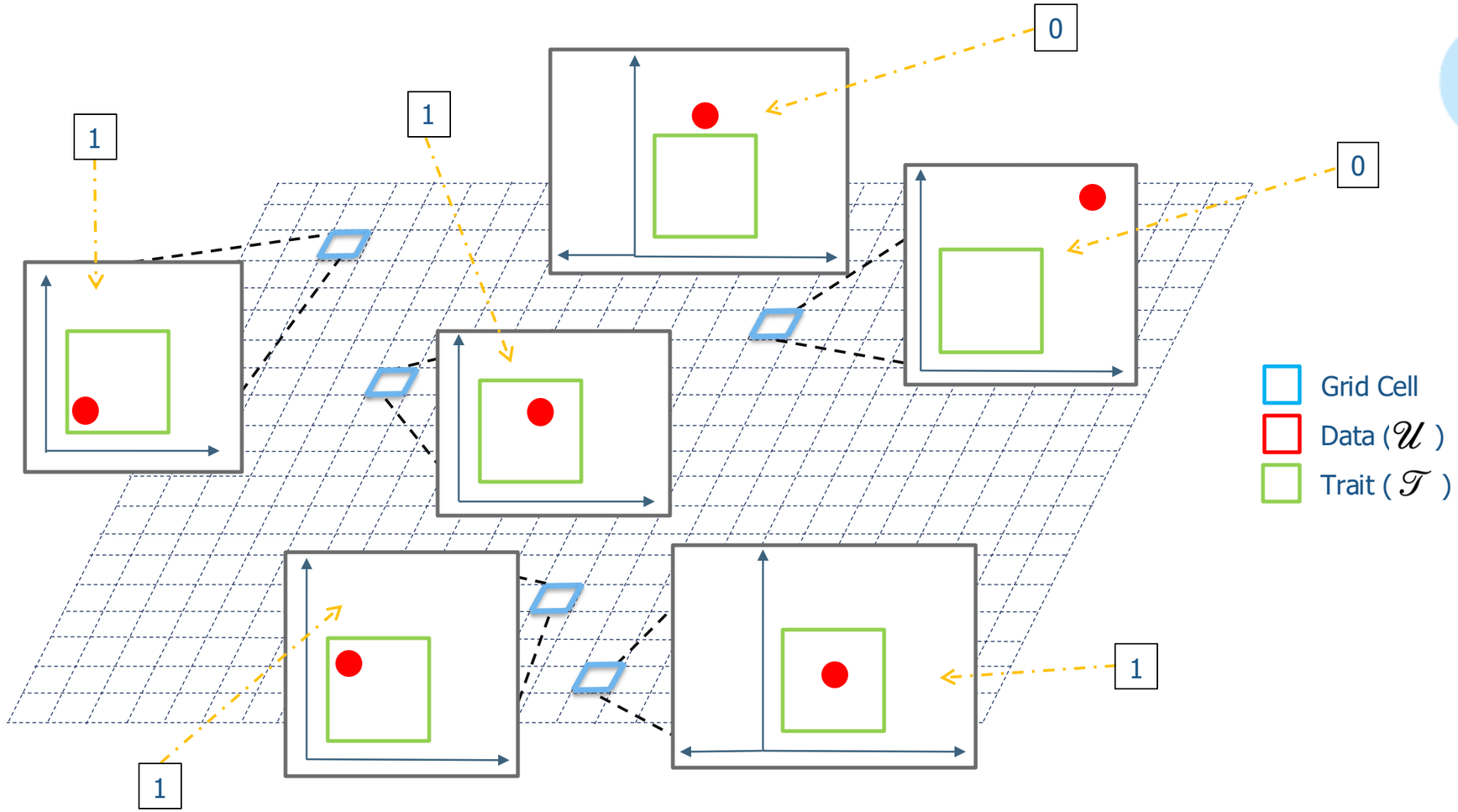
- Isosurface uncertainty visualization [Pothkow and Hege, Athawale et al.]
- Fiber surface uncertainty visualization [Zhang and Sadlo, Athawale et al.]



Contributions



Methodology



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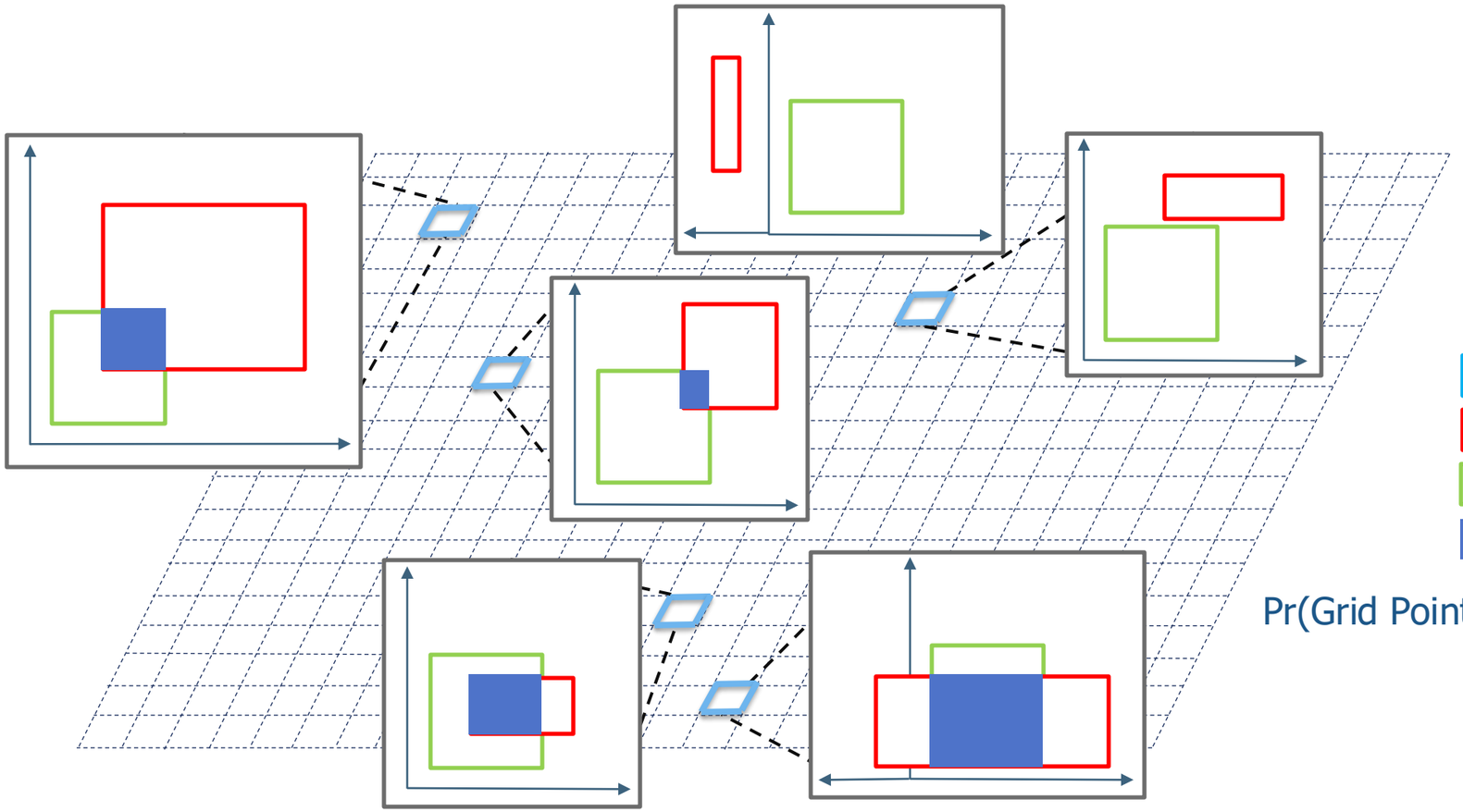
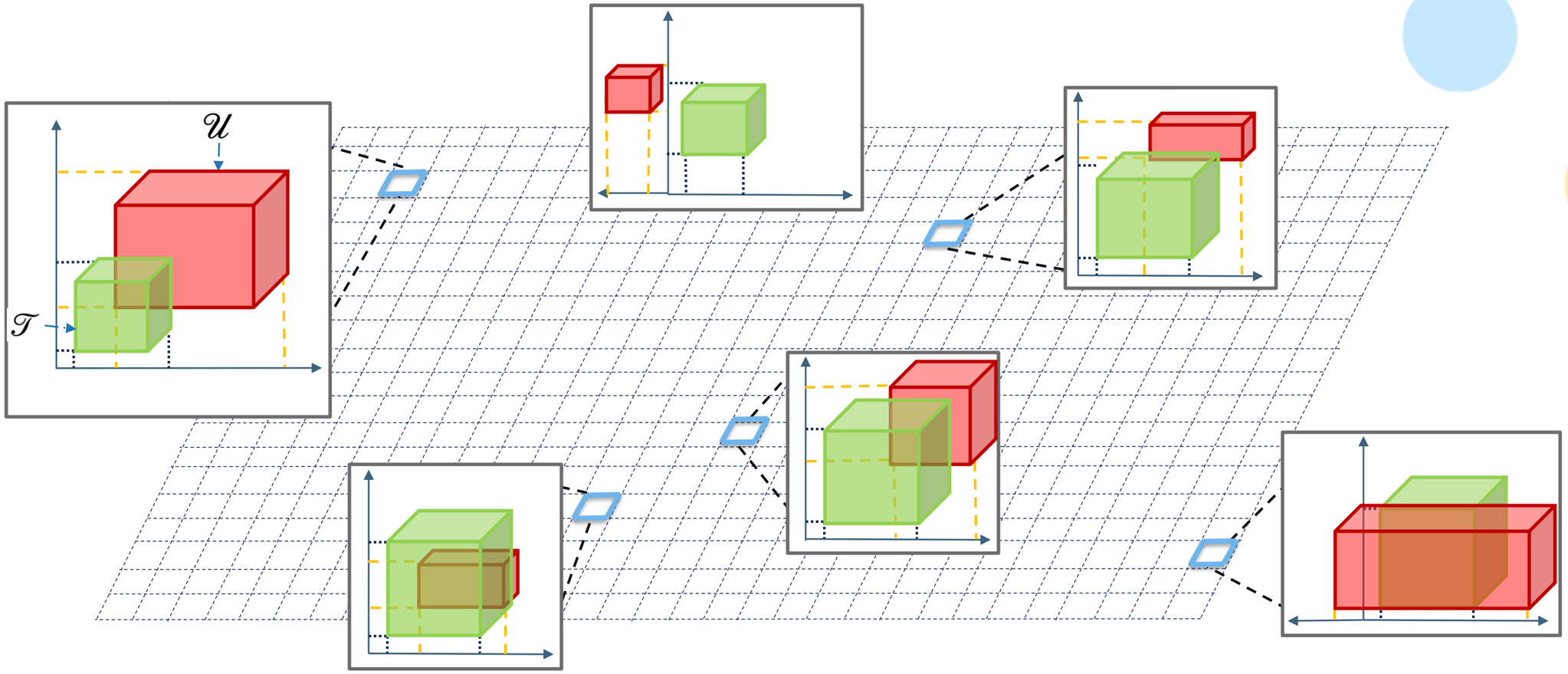


Grid Cell
Data ($\mathcal{U}$)
Trait ($\mathcal{T}$)
Intersection of Trait and User Data

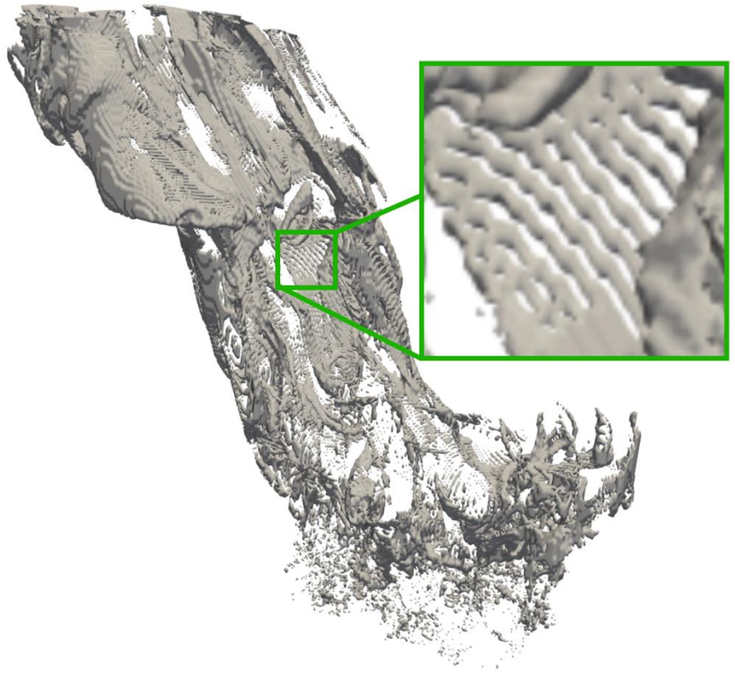
$$\Pr(\text{Grid Point} \in \mathcal{T}) = \text{Area}(\text{Intersection}) \div \text{Area}(\mathcal{U})$$

Methodology (Our contribution)

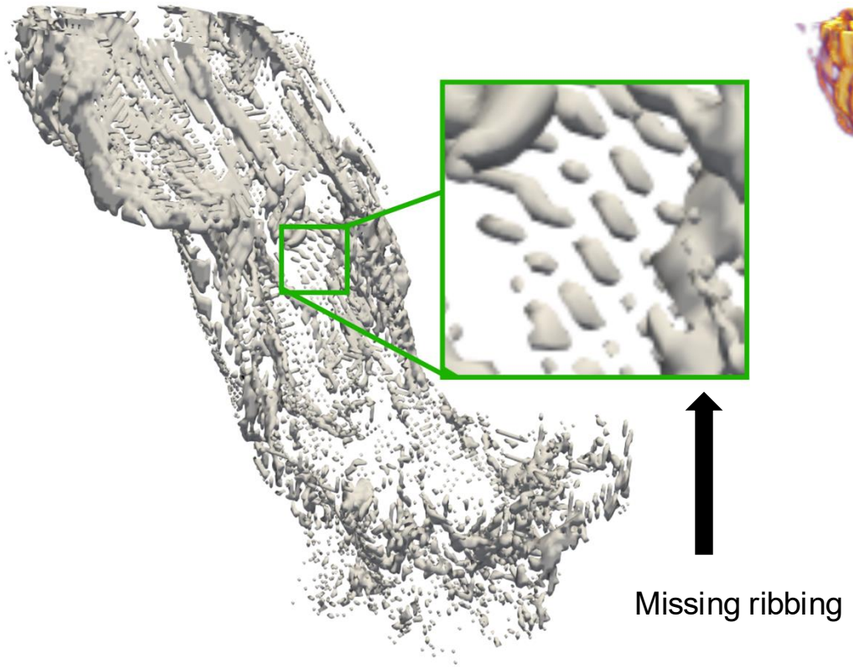


Visualization Uncertainty Filter With Deep Sea Impact

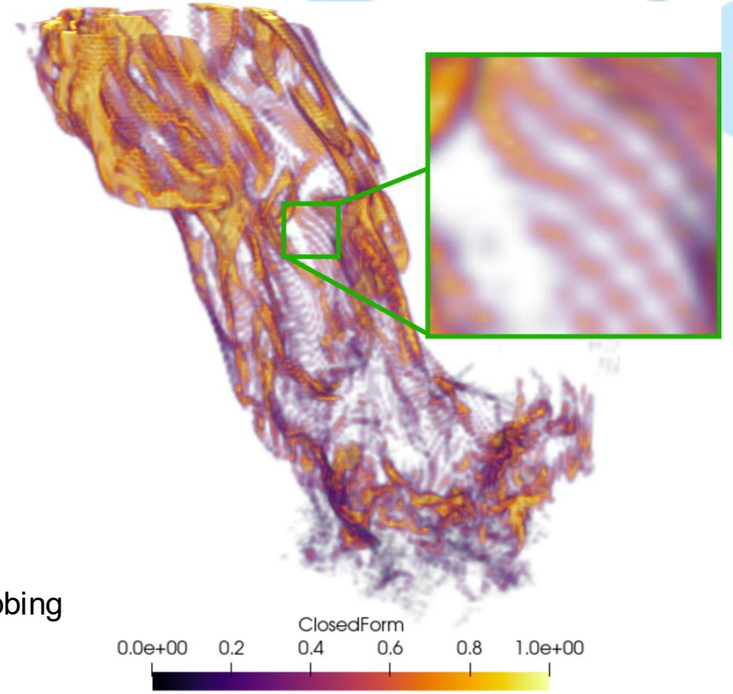
Chosen Traits: v2:(0.1, 0.5), tev:(0.2, 0.25), and prs:(30000, 400000)



490x280x240 Image



2x Compressed Image **without uncertainty**



Add data size 2x Compressed Image **with uncertainty filter**

[J. Patchett et al.]

Visualization Uncertainty With Red Sea

Chosen Traits: curlZ:(−15.0, −0.1), Vorticity:(0.0, 15.0), Velocity:(0.0, 0.4), and Temperature:(10.0, 29.0)

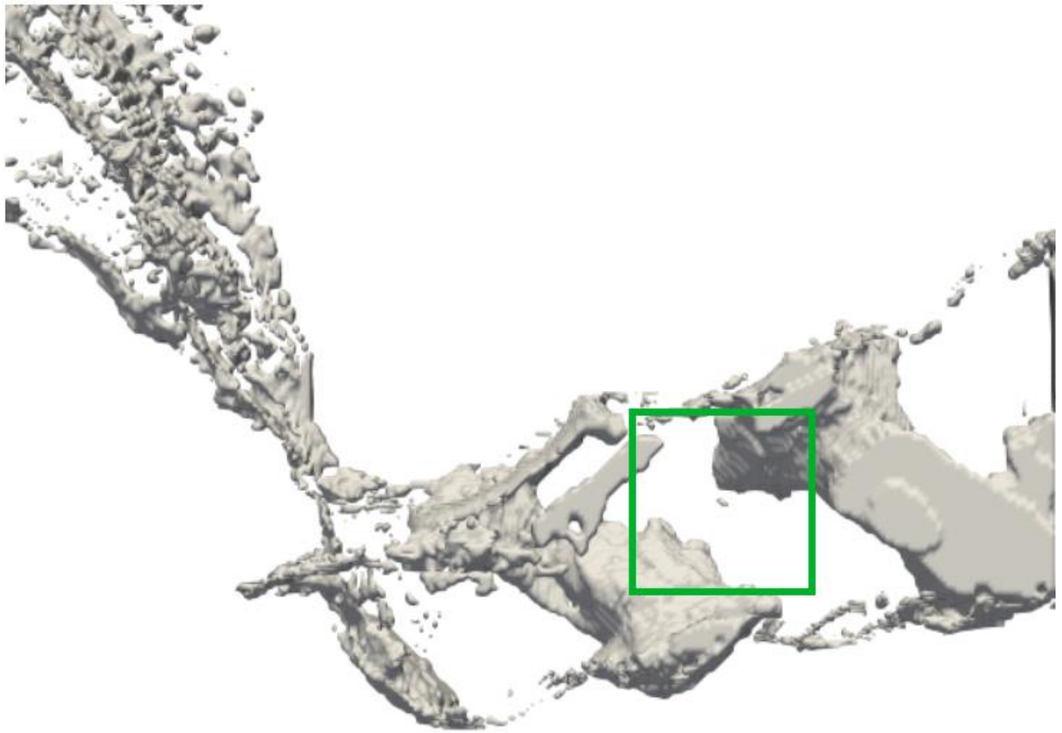


Image with **Without Uncertainty Filter**

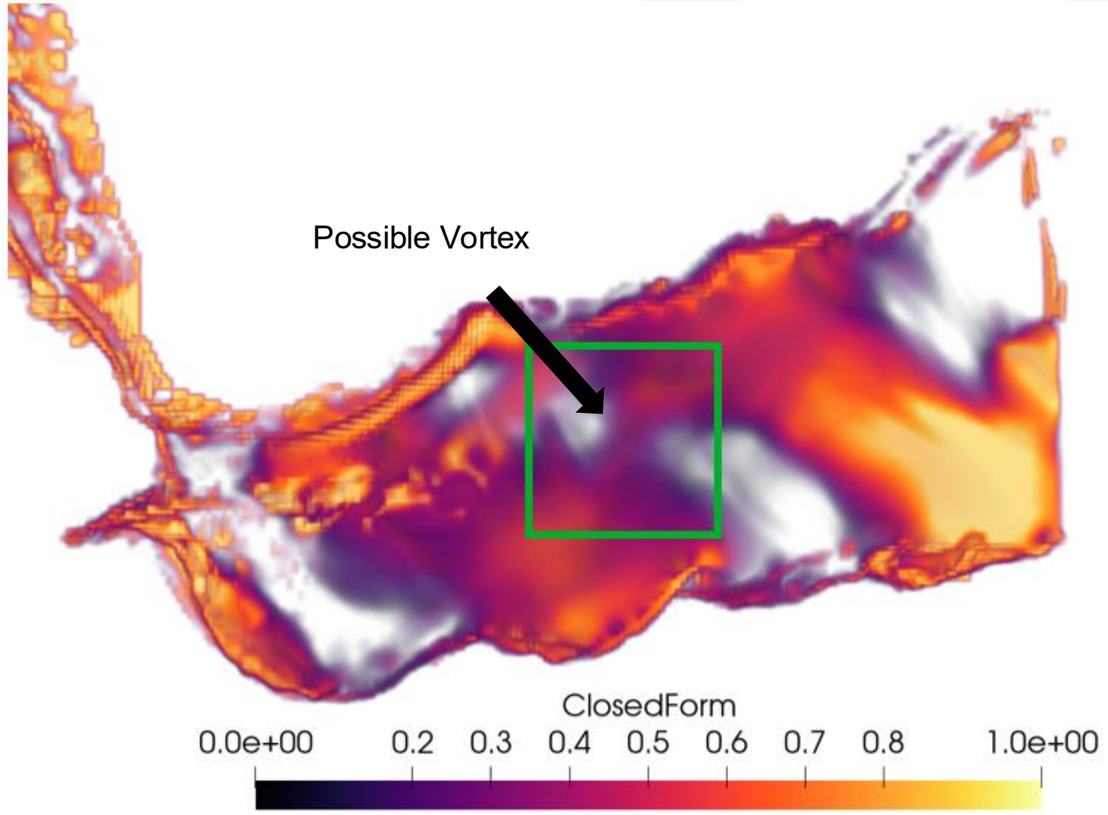
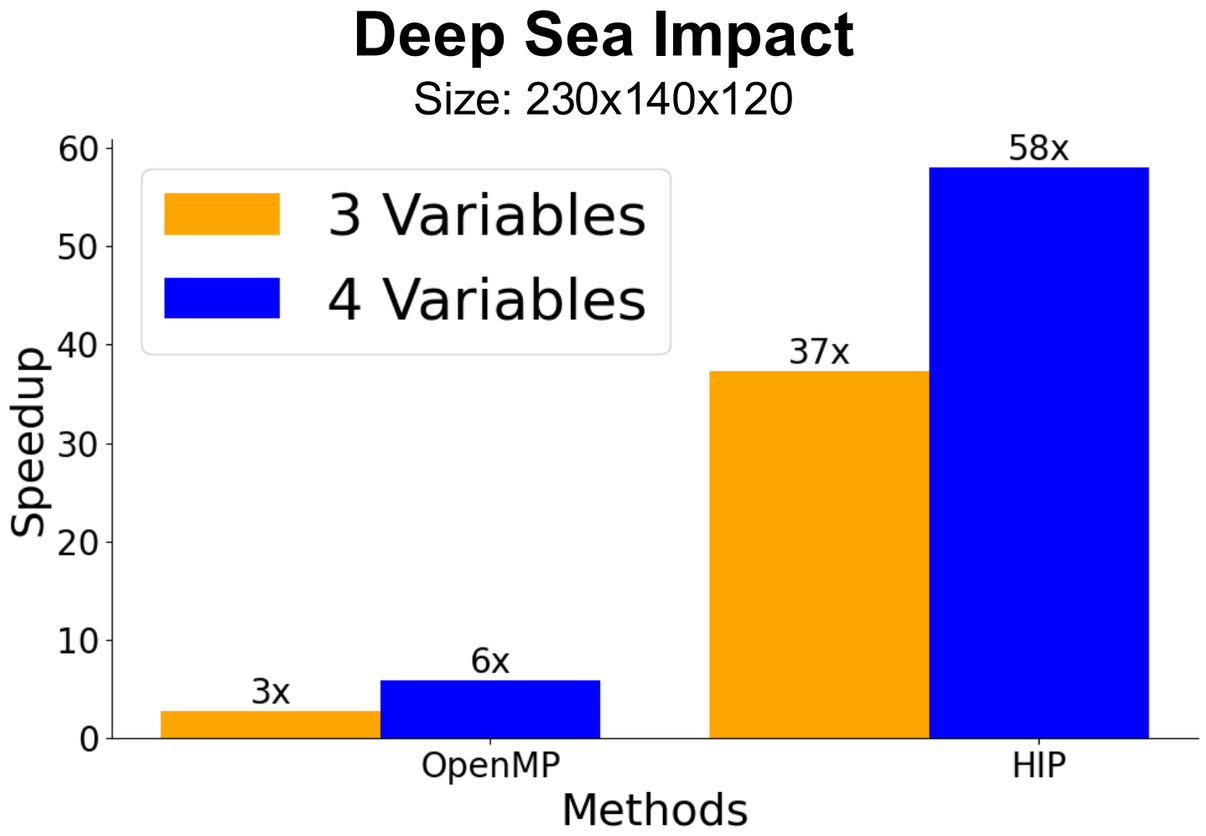
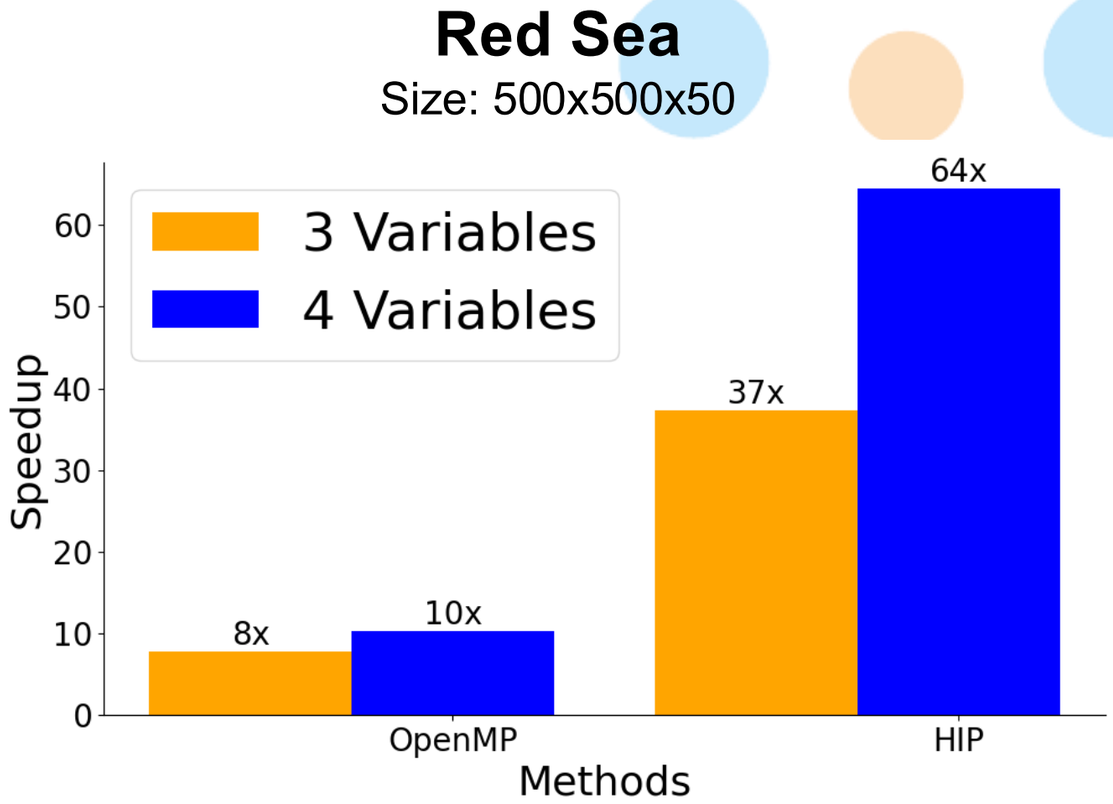


Image with **Uncertainty Filter**

[P Zhan et al.]

Speedups





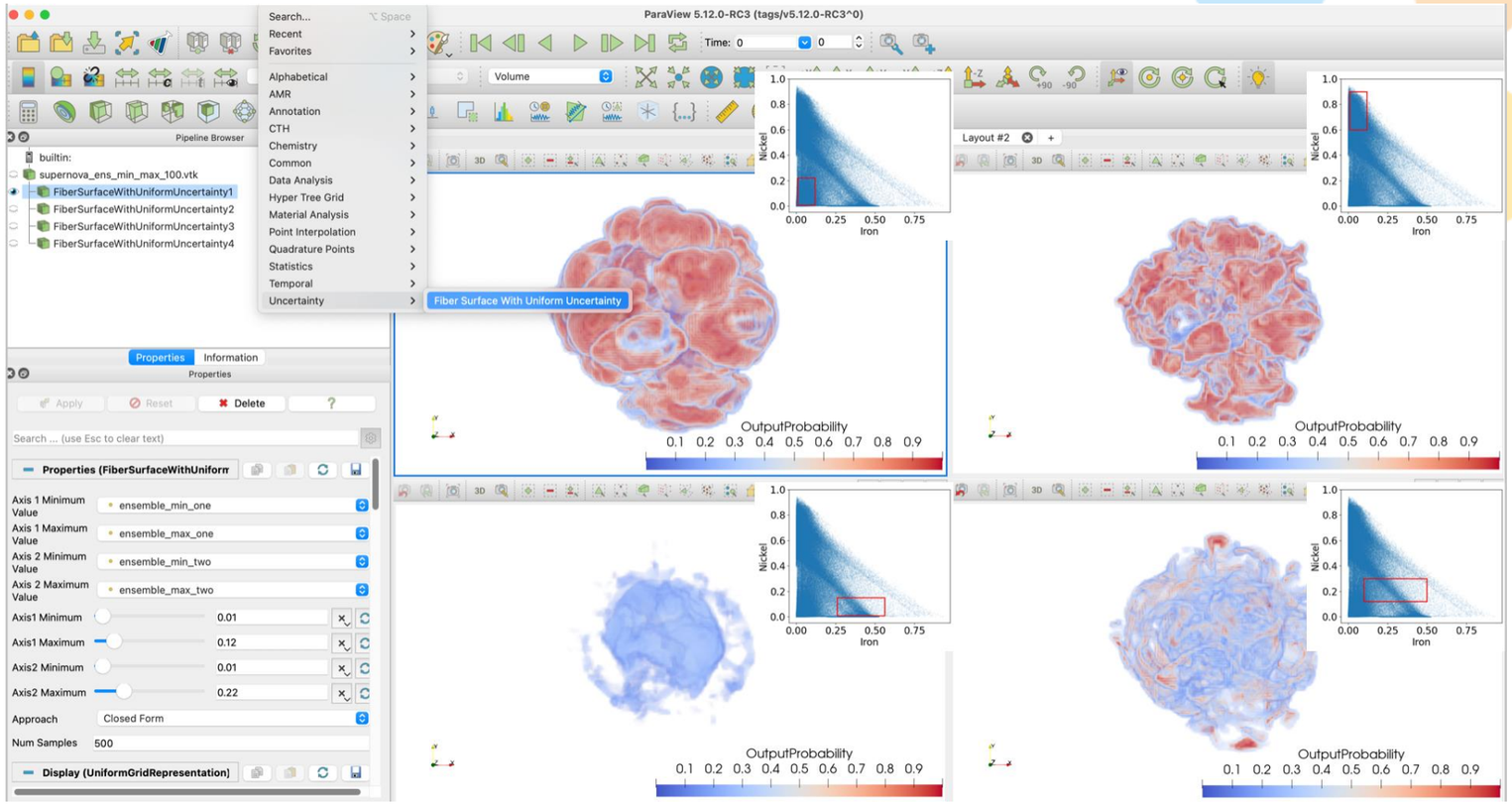
Thanks to Oak Ridge Leadership Computing Facility (OLCF) for the use of Frontier

Integration Into ParaView

- Production tool
- Real time data manipulation

ParaView

[Ahrens et al.]



Conclusion and Future Work

- Showed multivariate data (with 3 and 4 variables)
- Showed up to a 64x speedup, performance scalability for larger
- Integrated into ParaView using VTK-m library

- Current work assumes uniform distributions
  - Extension to Gaussian and histogram distributions
- Current work is limited to rectangular traits
  - Extension to polygonal traits

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