Digital Twins

To Safeguard the Planet

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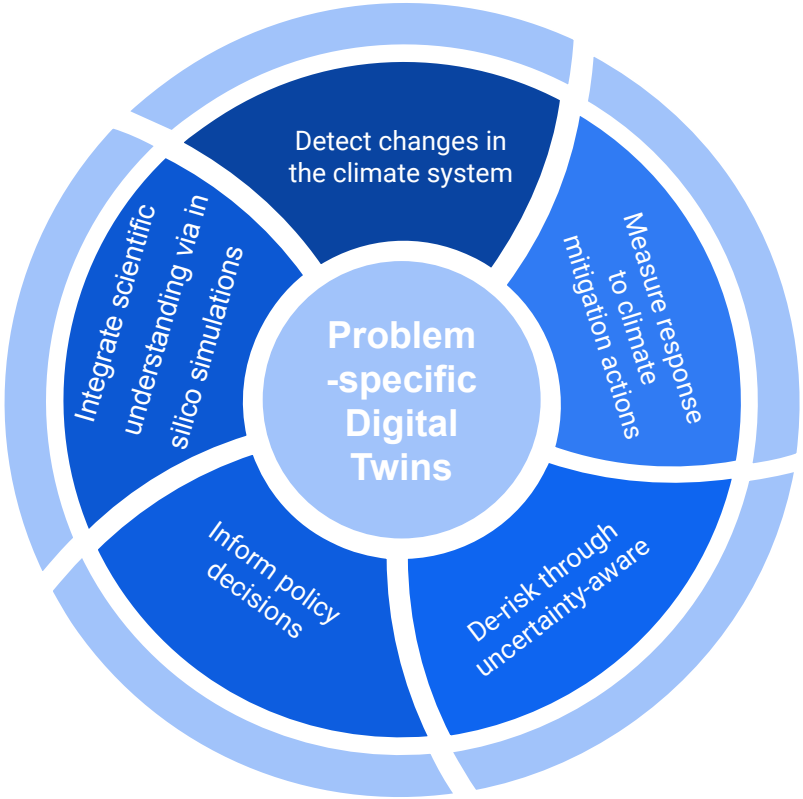
Society for Industrial and Applied Mathematics

The Big Idea

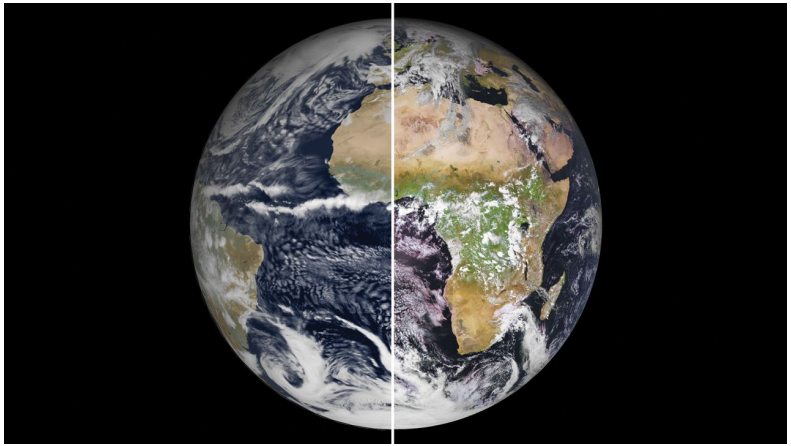
To develop a multi-fidelity, scalable, long-lived open-source platform to build problem-specific Digital Twins

"A digital twin is a virtual representation of an object or system that spans its lifecycle, is updated from real-time data, and uses simulation, machine learning and reasoning to help decision-making." – IBM



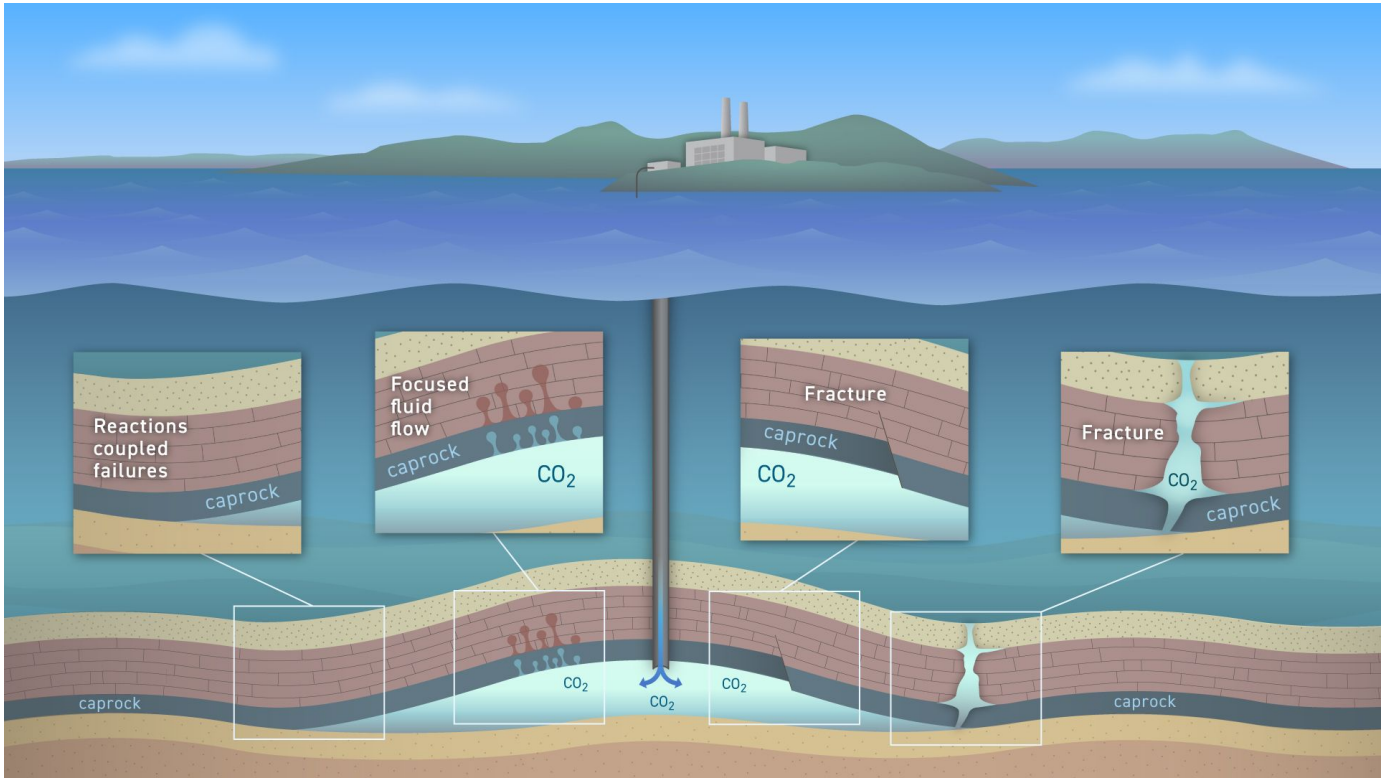
What is the reasoning, justification, and/or supporting evidence behind the idea?

- The Earth is a very complex system
- We need 'what if' scenarios
- Singapore completed work on the world’s first Digital Twin; Europe has launched Destination Earth



The US cannot fall behind, we only know how to lead!

Example for Digital Twins for Carbon Capture Storage (CCS)



https://slim.gatech.edu/research/geological-carbon-storage

What Goal Area(s) does this address?

- Advance Scientific Knowledge
- Anticipate Future Conditions
- Increase Climate Change Resilience
- Accelerate Clean Energy Infrastructure transitions
- Increase Outreach and Broader Impacts
- Promote Sustainable Practices

Development a community of practice around the **Digital Twin** paradigm, which consists of **protocols** that enable **systematic analysis** of **Earth system processes**, including quantification/analysis of dynamic **uncertainty.**

What is required to pursue this?

An interdisciplinary collaboration between:

- **Mathematical modelers**, physicists & chemists to inform *in silico* simulations
- **Statisticians** to assess uncertainty & inform policy decisions w/ confidence
- **Scientific domain experts** for developing problem-specific digital twins
- **Software engineers** to develop & maintain open, long-lived reproducible code
- **Social scientists** to incorporate understanding of human behavior and impact

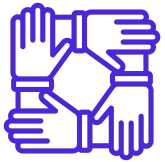
Additional resources:

- Access to truly ***massive*** computations (exabytes & months on Summit for CCS)
- ***Long-term*** (~100 y for CCS), sustained investment & software maintenance

What are the broader impacts and expected value of this idea?

Interdisciplinary teams spanning math, stats, engineering, and the social sciences

Creation of **huge amounts of data** for education & experimentation purposes



Prototype models for **global cooperation** between the US & other countries

Training of the next generation workforce

Access to massive computational power

Expected Value

Create the infrastructure to safeguard the planet