



TEXAS A&M  
UNIVERSITY

King Abdullah University of  
Science and Technology



KAUST

# A Comprehensive Vision for the Applied Mathematical, Statistical and Computational Sciences

Presented by: Dr. James A. Calvin

Texas A&M University



## Three intrinsically linked major research themes

- **Multiscale modeling and simulation**
  - Aquatic Ecosystems
  - Material characterization
- **Deterministic and statistical methods in inverse problems**
  - Solar energy input for ocean model
  - Local signal speed in seismic imaging
- **Data-driven computational science and visualization**
  - 3-D visualization (e.g., oil field, vascular system)



- Many “grand challenge” scientific and engineering problems require modeling physical phenomena over vast ranges of spatial and temporal scales
  - Global climate models
  - Advanced materials design from the nano to the macro scale
- Research area addresses how such models are constructed, theoretically analyzed and numerically solved
  - Computational Earth Sciences (Aquatic Ecosystems)
  - Computational Material Sciences (High temperature material failure)

# Deterministic and statistical methods in inverse problems



- Complex models contain many components that must be determined from first principles or estimated from data (e.g., climate modeling)
- There is often uncertainty associated with the data from which model parameters are to be estimated (e.g., aquatic ecosystems)
- Determining model components from experimental or observational data constitutes a challenging mathematical inverse problem which requires deterministic and statistical methods to resolve



- Mathematical models to simulate complex physical systems and empirical data to estimate model parameters both involve vast amounts of data
- Concerned with how to make sense of and develop mathematical models from vast amounts of data, especially in the presence of data uncertainty
- A key tool is the ability to visualize such data using state-of-the-art technologies and mathematical algorithms. (e.g., 3-D visualization of a physical structure)



## Annual themes tied to areas of significance

Year 1: Computational Earth Sciences

Year 2: Computational Material Science and Engineering

- Promotion of theme specific visiting scholars to link theoretical results to thematically driven problems
- Development of visualization tools for broad application
- Establishing a new paradigm for applied mathematical education

# Relevance to global problems



Utilization of externally driven advisory boards to help establish annual themes and annually review Center focus

Internal Advisory Board

External Advisory Board (International)

Use of ***Innovation Grant Program*** to promote evolution of Center focus and initiation of new partnerships

Promotion of industrial partnerships

# Importance to Saudi Arabia and KAUST



Annual themes to reflect issues of significance to Saudi Arabia (Earth Sciences and Material Sciences)

KAUST participation on External Advisory Board

Focus on *partnership* building

New Faculty Exchanges

Global Seminar Series

Innovation Seed Grants

# Importance to Saudi Arabia and KAUST



## Integrated graduate education capability

- Joint recruiting of students

- Co-advising of students

## Workshops and Symposia

- Semiannual symposia (rotating locations)

- Theme year workshops

# Importance to Saudi Arabia and KAUST



Promotion of peer reviewed dissemination of research

Leveraging of collaborations

Integrated IT plan to promote intra-institutional and inter-institutional capabilities

- Computing infrastructure

- Global communication and archiving