# Community Surface Dynamics Modeling System
# CSDMS

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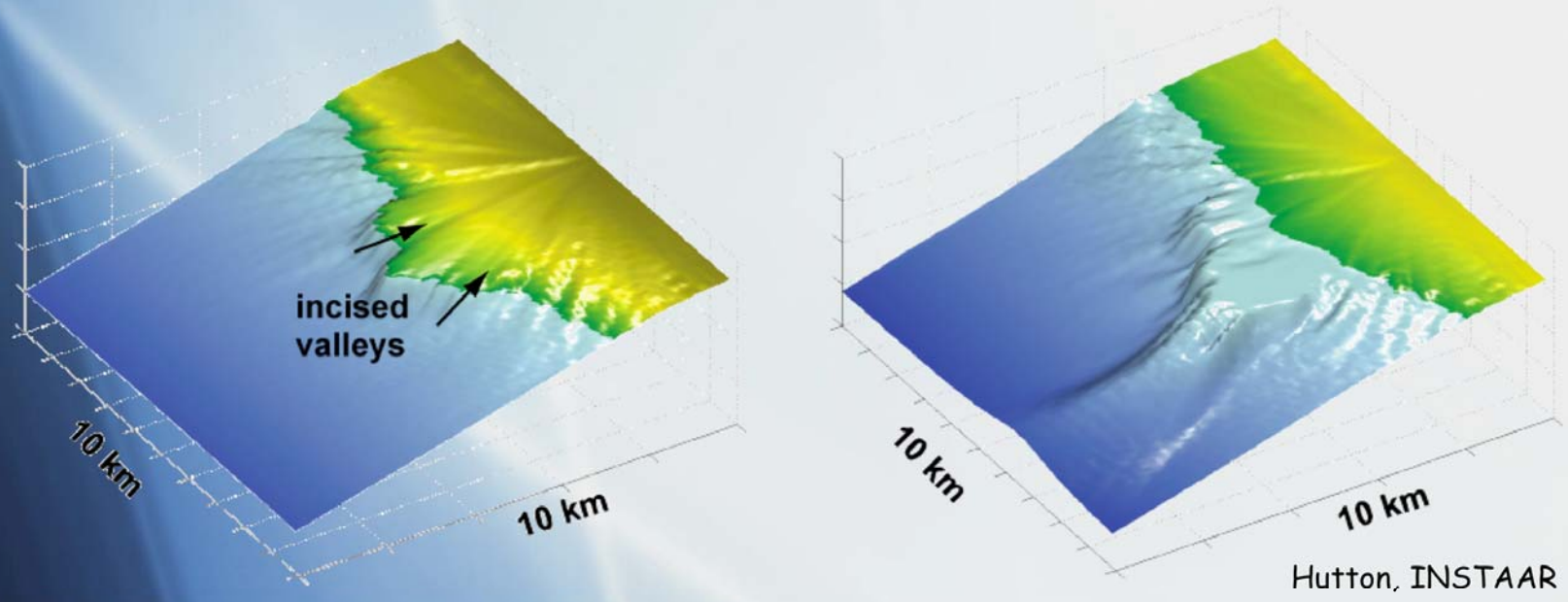
*U.Colorado—Boulder*



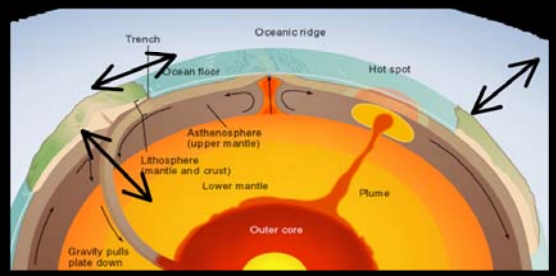


CSDMS
Community Surface Dynamics Modeling System

# What is CSDMS?

- An integrated community of scientific & engineering experts to promote the quantitative modeling of earth-surface processes.
- Protocols for community-generated, continuously evolving, open software.
- Cyber-infrastructure to distribute software tools & models able to address the properties of surface-dynamic systems: self-organization, localization, thresholds, system linkages, scale invariance,interwoven biology & geochemistry.
- Linked dynamical models tailored to specific landscape-basin evolution problems, at specific temporal and spatial scales.
- Partnerships with related computational and scientific programs, providing strong linkage between predictions and observations in nature or experiments.

**Modeling Planet Earth (CIG, CSDMS, CCSM)**







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# CSDMS Goal

Develop, support, and disseminate integrated software modules that predict the erosion, transport, and deposition of sediment & solutes in landscapes and their sedimentary basins.


CSDMS involves the Earth surface — the dynamic interface between lithosphere, atmosphere, cryosphere, and hydrosphere.

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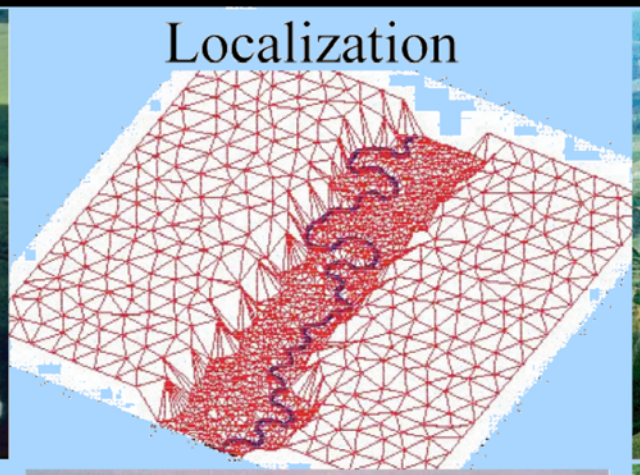
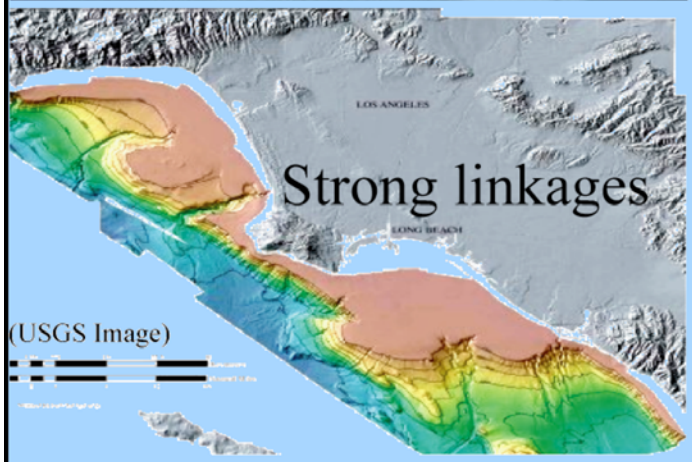
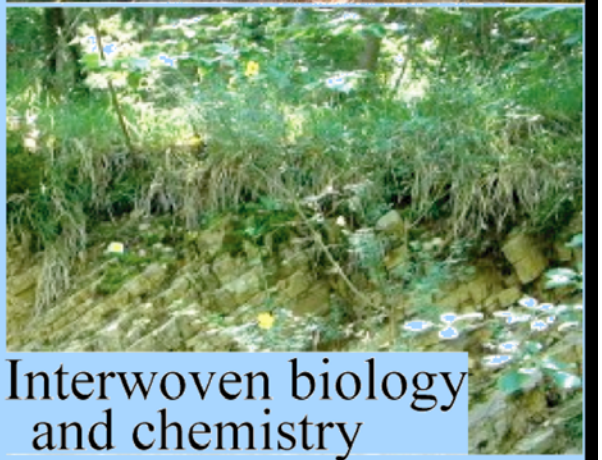
# Key properties of surface systems







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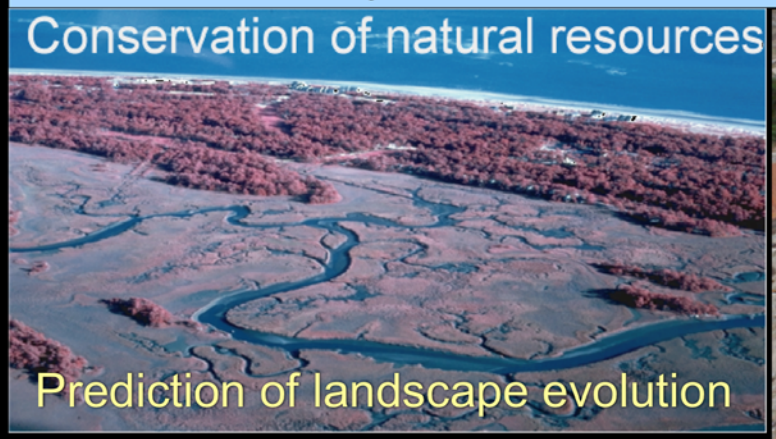
# NRC National Imperatives will be addressed by the CSDMS Effort





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## CU CSDMS Integration Facility

Executive Assistant → Executive Director

- Software Architects
- Research Scientists
- Post Doctoral Fellows
- Graduate Students
- Education & Knowledge Transfer Specialist
- Web Communication & IT
- System Administration
- Accounting Technician

## CU CSDMS Facility

Executive Committee ↔ Steering Committee (non-CU)

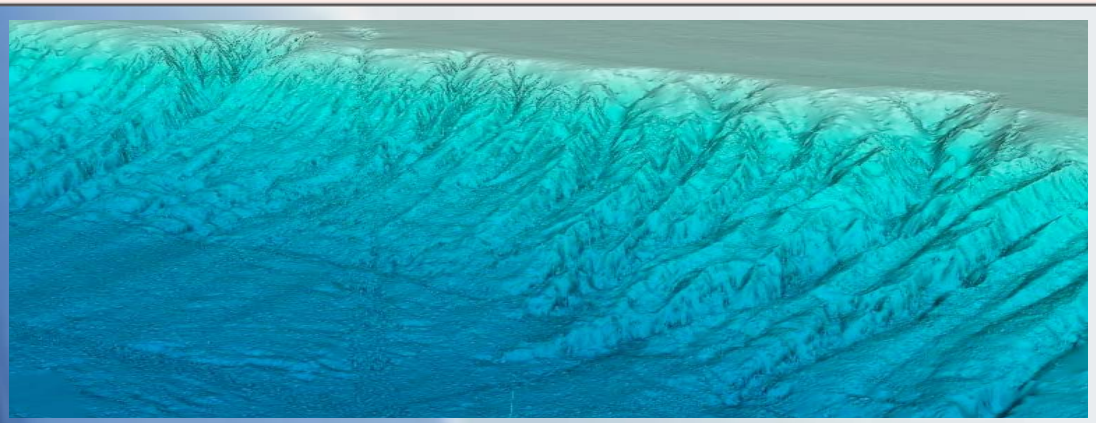
Working Groups
- Terrestrial Systems
- Coastal Systems
- Marine Systems
- Education & Knowledge Transfer
- Cyberinfrastructure & Numerics

CSDMS Directorate (Member Institutions)

Partner Committees (non-CU)
- International
- Industrial
- Agencies
- Affiliates (Cyber, Data, Field)

Individually-funded Scientists

Funders
NSF
ONR
NASA
USGS
NOAA
ACE
ARO
Industry
others



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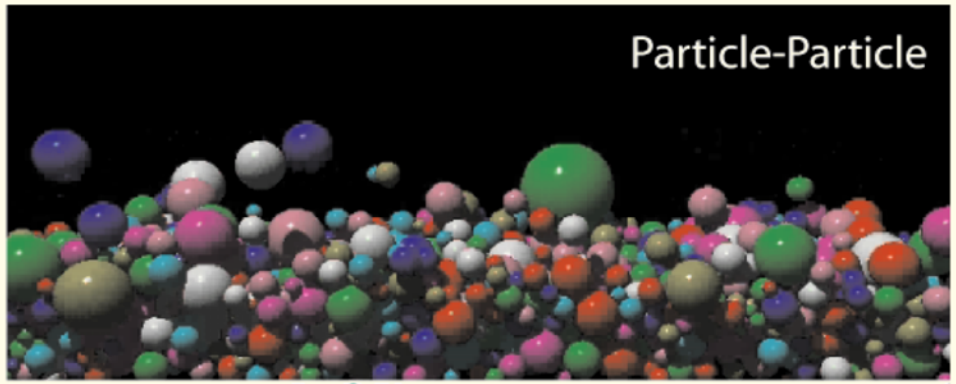
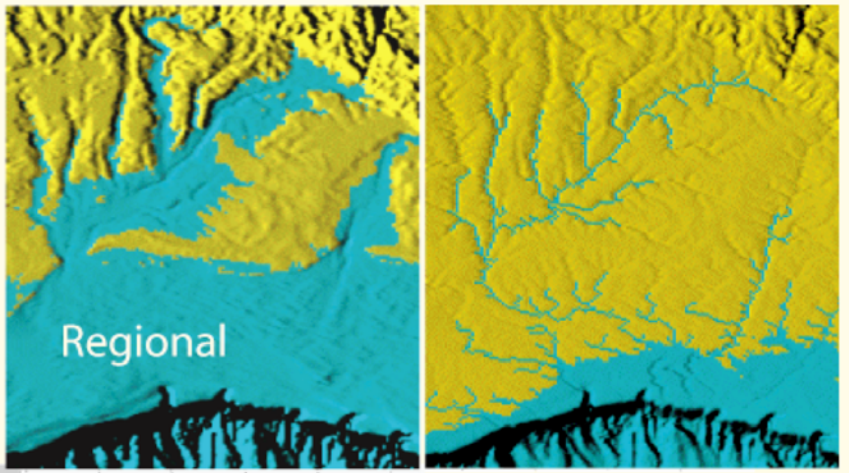
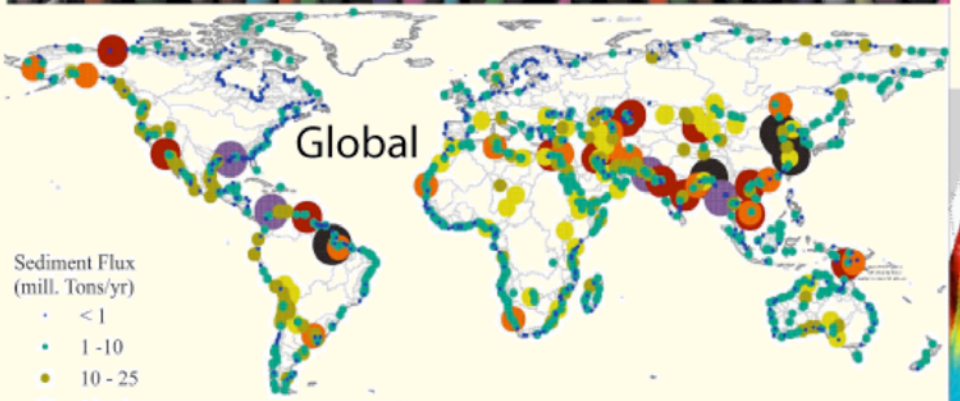
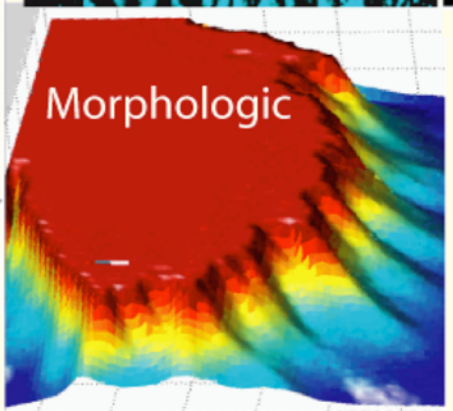
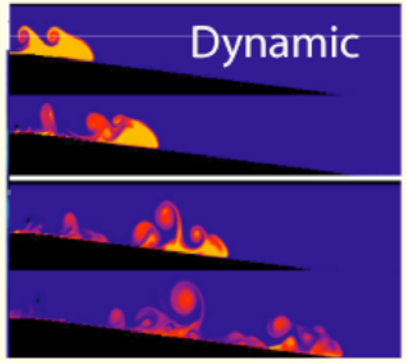
Key system requirements: novel computational strategies, moving boundaries, distributed source terms, nested modules for time & space, etc




$$\sigma + \frac{\partial \eta}{\partial t} = \frac{\partial}{\partial x}\left[\nu_f \frac{\partial \eta}{\partial x}\right]$$

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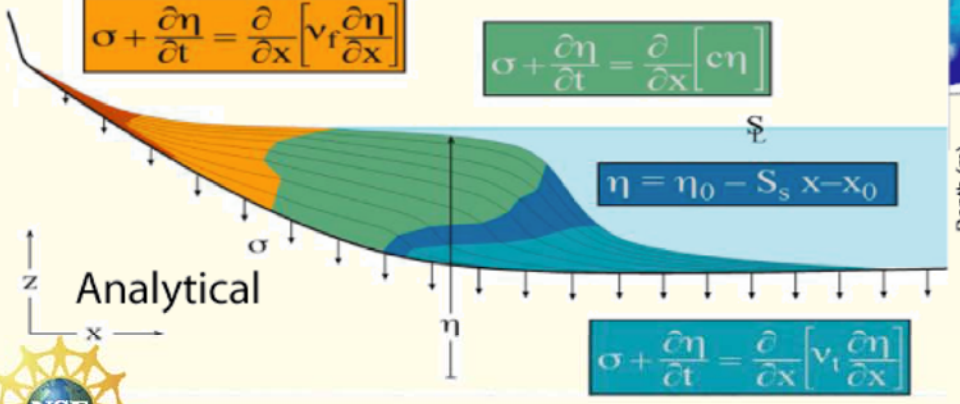
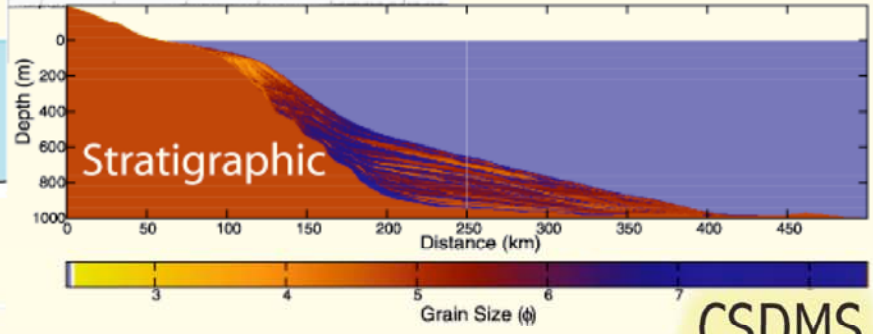



$$\sigma + \frac{\partial \eta}{\partial t} = \frac{\partial}{\partial x}\left[\nu_t \frac{\partial \eta}{\partial x}\right]$$

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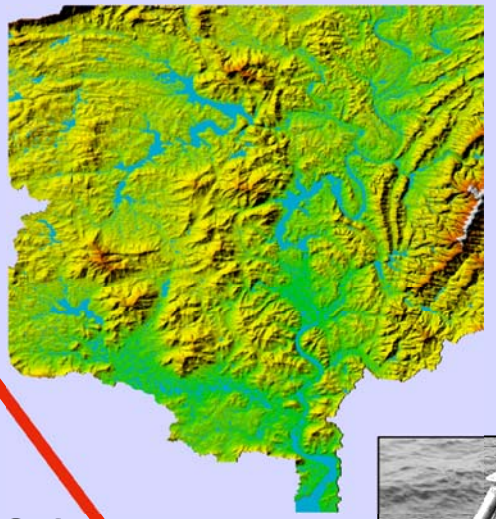
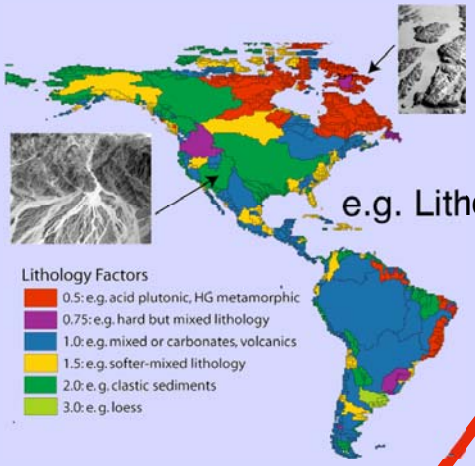
ELM

Climatology: T°C, PPT, Wind, Waves


Topography/Bathymetry/Sea Level



## Gridded Boundary Conditions

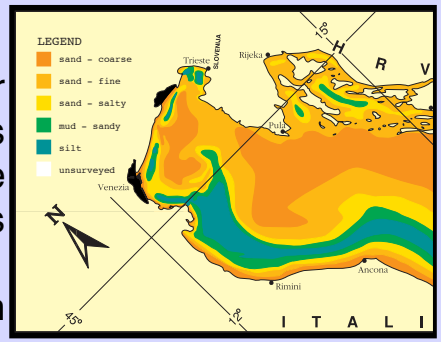


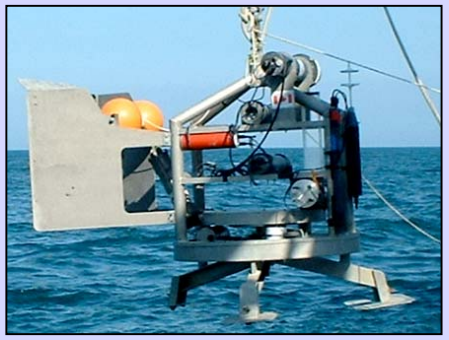

# Data Integration in Modeling

$$Q_{s,s}^{x} = \int_{z=\delta wbl}^{h} c_s U dz$$

## Gridded Initializations

Ice Sheet Cover
Soil Type/Thickness
Grain Size
Lakes/Reservoirs
Human Factors: GNP, Pop.
Vegetation
Lithology



## Domain Parameterization

Flocculation
Critical Shear Stress
Bioturbation
Weathering grade
Productivity
Authigenesis

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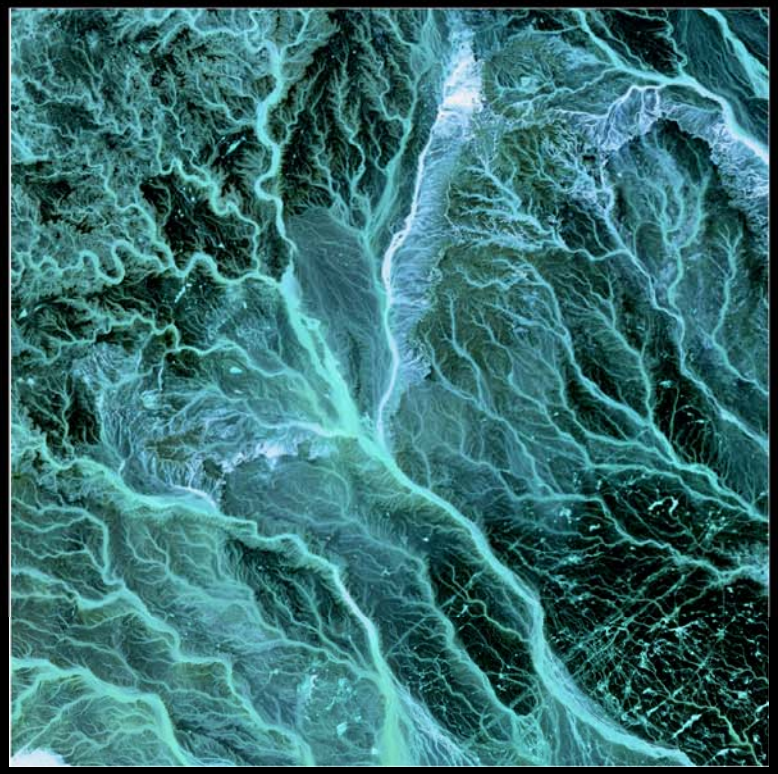
# CSDMS Demonstration
# Proof-of-Concept Challenges

1. Predicting the Transport and Fate of Fine Sediments & Carbon from Source to Sink

2. Sediment Dynamics in the Anthropocene - *the Human Dimension*

3. Tracking Surface Dynamics through Pleistocene Glacial Cycles

4. Models & Modules in Aid of Natural Disasters Mitigation



ASTER image, Jordan

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# The Promise of CSDMS

Better predict the evolution of Earth's varied surface environments, while understanding the uncertainties related to these predictions. Provide tools in support of surface-dynamic research. Address the complexities of feedbacks and linkages known in surface science, employing the expertise of scientists of widely varied backgrounds. Develop useful products for the benefit of broader society.

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