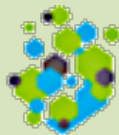


# 2017 CSDMS Annual Meeting: Modeling Coupled Earth & Human Systems - The Dynamic Duo

The **Community Surface Dynamics Modeling System** serves as a  
**Science Gateway**  
to support the  
development, integration, archiving & dissemination of software to  
define Earth's surface dynamics

Jai Syvitski, CSDMS *Outgoing* Director

Greg Tucker, CSDMS *Incoming* Director



CoMSES | OpenABM  
NETWORK



**CSDMS**

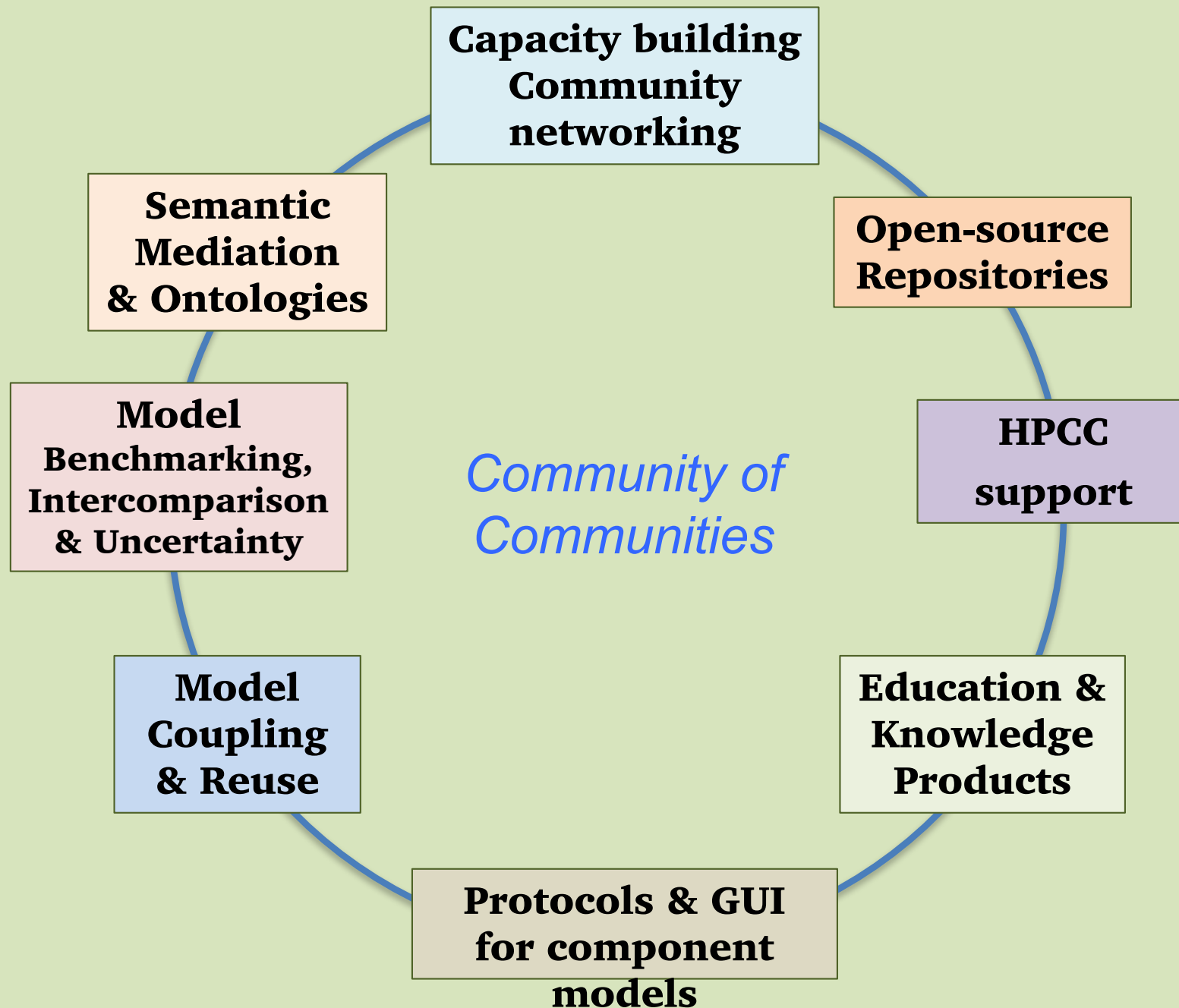
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

# FUNDAMENTAL QUESTIONS MOTIVATING CSDMS SCIENTISTS:

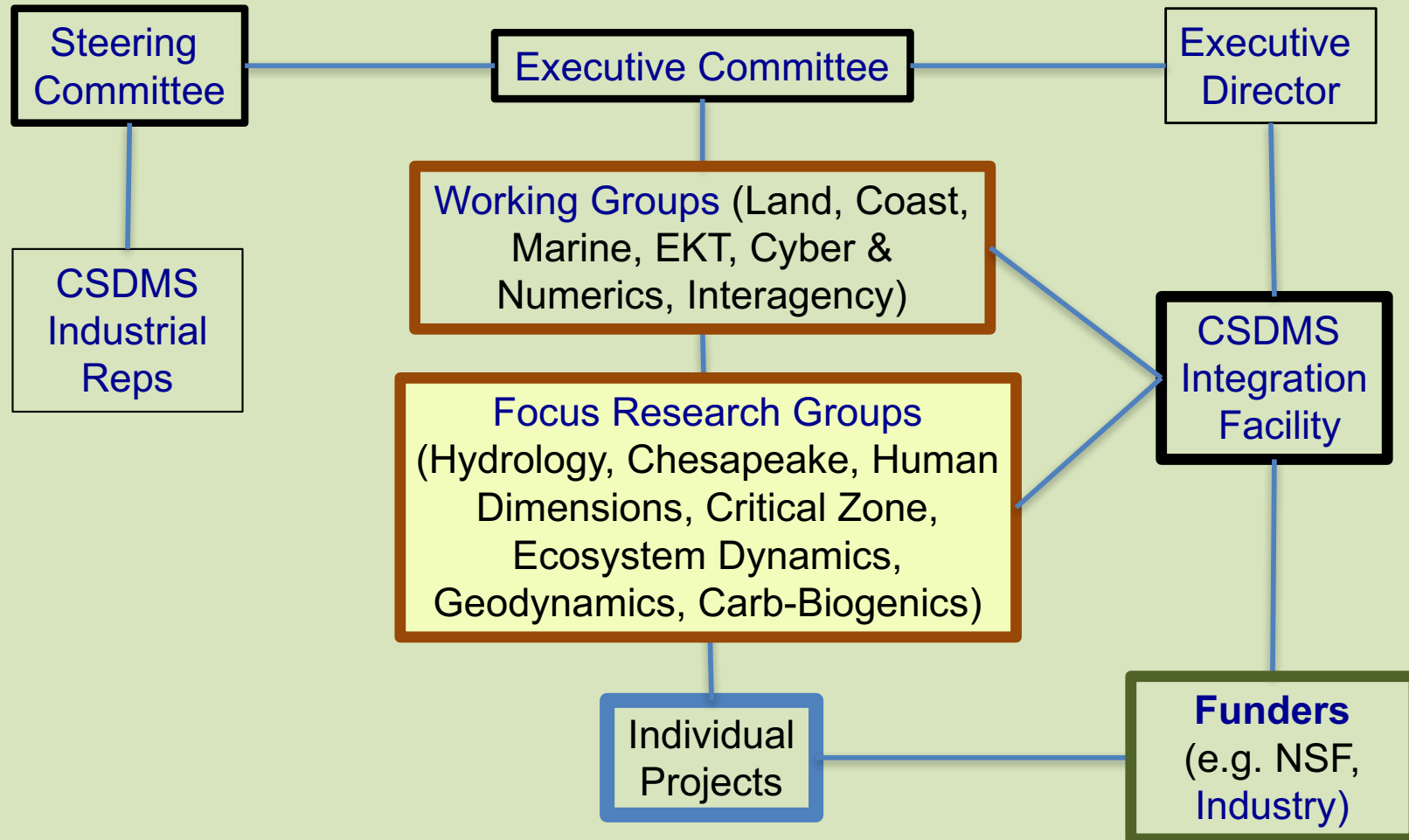
1. How do **TRANSPORT PROCESSES** interact with properties of morphology, geology, ecology, climatology, oceanography and human activities?
2. What processes support self-organization and **PATTERN FORMATION** in surface systems?
3. How do **MATERIAL FLUXES** and **SURFACE EVOLUTION** vary across time and space scales? How are these fluxes recorded in **SEDIMENTARY DEPOSITS**?
4. How are physical, ecological & human processes **COUPLED** within **SURFACE SYSTEMS** and constrained by Earth's interior and Earth's atmospheric dynamics?



# 2.0 Functions



## CSDMS Governance



For every CSDMS IF \$, NSF gives 13\$ to CSDMS-affiliated projects (\$64M/5 yr).  
Other agencies increase this 13:1 force multiplier.





## Capacity building, Community networking

United States	914	Norway	9
China	80	Argentina	8
United Kingdom	77	Poland	8
Canada	44	Portugal	8
India	43	Belgium	7
France	40	Chile	7
Netherlands	38	Denmark	6
Italy	30	Japan	6
Germany	29	New Zealand	6
Spain	17	Nigeria	6
Australia	14	Pakistan	6
Brazil	12	Colombia	5
Indonesia	12	Egypt	5
South Korea	12	Greece	5
Bangladesh	11	Ireland	5

150 members added per year  
from 550+ Institutions (academic, government,  
industry) located in 69 countries

Sweden	5	Ghana	2	Burma	1
Switzerland	5	Mexico	2	Cambodia	1
Vietnam	5	Philippines	2	Ecuador	1
Iran	4	Saudi Arabia	2	Iraq	1
Israel	4	Singapore	2	Jordan	1
Malaysia	4	Thailand	2	Kazakhstan	1
Russia	4	United Arab Em.	2	Kenya	1
Taiwan	4	Uruguay	2	Morocco	1
Hungary	3	Venezuela	2	Nepal	1
Peru	3	Algeria	1	Qatar	1
Romania	3	Armenia	1	South Africa	1
Turkey	3	Austria	1		
Cuba	2	Bolivia	1		
El Salvador	2	Bulgaria	1		

## Working Groups

Terrestrial	740
Coastal	580
Marine	370
EKT	240
Cyber	220

## Focus Research Groups

Hydrology	590
Geodynamics	150
Carbonate & Biogenics	110
Human Dimensions	100
Critical Zone	95
Chesapeake	80
Ecodynamics	80

## Initiatives

Coastal Vulnerability	110
Continental Margins	60



# CSDMS

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

## Functions

**Capacity building  
Community  
networking**

**New Group Co-Chairs:**

**Kim de Mutsert- Ecosystems Dyn. FRG**

**Moira Zellner- Human Dimensions FRG**

**Mary Hill- Hydrology FRG**

**Scott Peckham-**

**Cyber & Numerics WG**



200+ CSDMS workshops,  
symposia



**UNDERWORLD2**

**Kudryavtsev Model**

**FROST MODEL**

**PyDeltaRCM**

**SiStER**

**CLUMONDO**

**LaMEM**

**DynEarthSol3D**

**AnugaSed**

**RivMAP**

**DAKOTATHON**

**MCPM**

**ILAMB**

**Open-source  
Repositories**

**River Network Bed-Material Sed**

**SLAMM**

- Diffusive ➡ ADM ➡ SWEM ➡ RANS ➡ LES ➡ DNS
- Boussinesq ➡ non-hydrostatic ➡ non-Boussinesq
- FDM ➡ FVM ➡ FEM; Explicit ➡ implicit
- 1D ➡ 2D ➡ 3D
- Eulerian ➡ Lagrangian ➡ PIC
- Steady-state ➡ Non-steady state; Abiotic ➡ Biotic
- Newtonian ➡ non-Newtonian
- Depositional ➡ Post-depositional
- Time marching ➡ Compute & drift ➡ Event-based
- Local ➡ regional ➡ global
- Social Science (e.g. ABM, IAM, GEM, LULC)

Domain	Models	Tools	Compliant
Terrestrial	80	75	7
Coastal	61	7	7
Marine	49	7	4
Hydrology	62	45	20
Carbonate & Biogenics	3	4	1
Climate	12	4	2
Geodynamics	13	1	1



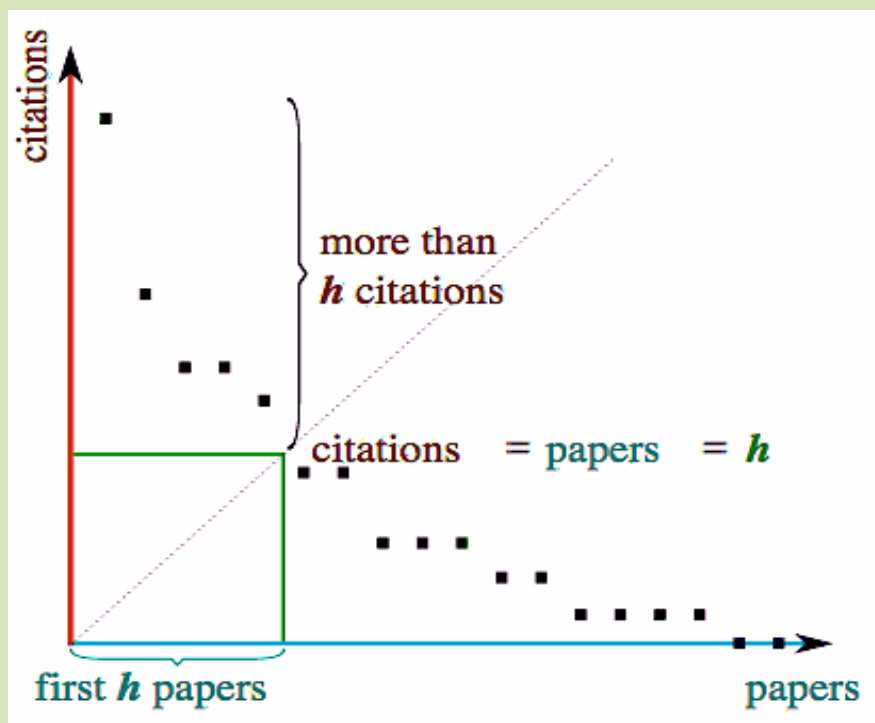
**csdms-contrib**

Models & tools by CSDMS members  
[csdmssupport@colorado.edu](mailto:csdmssupport@colorado.edu)



CSDMS provides:

- 1) **Citation Indices** for both **model overview** and **model application** pubs.
- 2) **Model Metadata** including a DOI (Digital Object Identifier) for each stable model version
- 3) **Model Code**
- 4) **Version Control** through Github.




## Model info

Authors [\[Expand\]](#)  
Source code [\[Collapse\]](#)

- [Go to external source code site](#)

DOI [\[Collapse\]](#)

- Download CHILDR version:  
2010.07.06  
Doi: 10.1594/IEDA/100102

Model citations [\[Collapse\]](#)  
**Citation indices** **CHILDR**  
Citations: 4171  
h-index: 28  
QR-code [\[Collapse\]](#)  
  
[Link to this page](#)

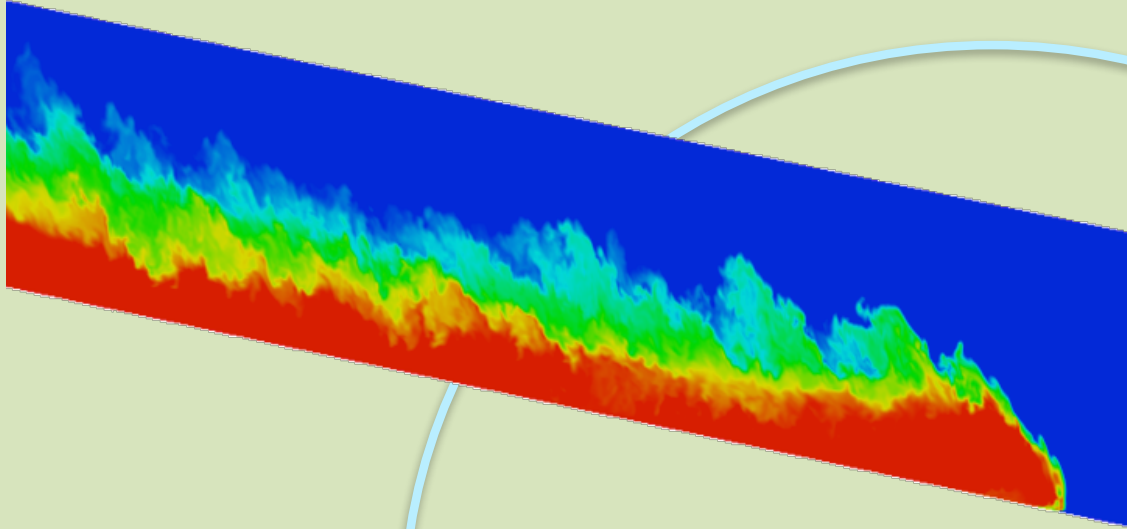
Other models by this author [\[Expand\]](#)

**Open-source  
Repositories**



# CSDMS Functions

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM



**HPCC  
support**

## **Beach:**

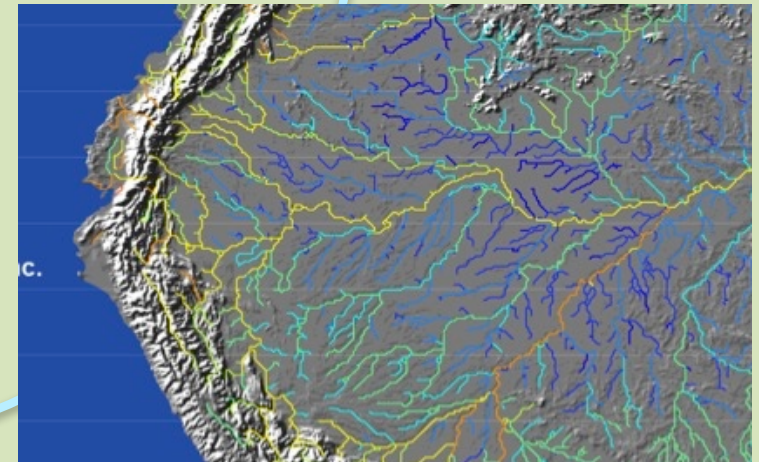
704-3GHz cores, 2-4 GB/c, 21GB/s, 8TFlop/s

## **Janus:**

16,416-3.2GHz cores, 2 GB/c, 40GB/s, 153TFlop/s

## **Summit:**

9,960-3.3GHz cores, 5-42 GB/c, 100GB/s, >400TFlop/s



# CSDMS Functions

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM



## CSDMS Special Issues

- 1 Marine Transport Modeling
- 2 Stratigraphic Modeling
- 3 Modeling Environmental Change
- 4 Model Uncertainty & Sensitivity

## On Line Services

- ✧ Student labs (31)
- ✧ Modeling short courses (9)
- ✧ Lectures (300+);
- ✧ Textbooks (6)
- ✧ Global domain datasets (84)
- ✧ 145 movies on the CSDMS YouTube channel
- ✧ Science on a Sphere (9 datasets and labs)
- ✧ 600+ daily views of the CSDMS web portal on average



**Education & Knowledge Products**



# EKT Repository: Quantitative toolbox

- Tagged by **concepts**: heat flow, diffusion, flow routing, mass continuity, shallow water equations, settling rates, drag force, flocculation, fluid flow, Darcy's flow, stability/torque balance, compaction, waves, uncertainty
- Tagged by **discipline**: hydrology, sedimentology, geomorphology, oceanography, general climate/earth science/global change.
- Tagged by **domain**: terrestrial, coastal, marine
- Tagged by **level**: K6-12, undergraduate, graduate
- Tagged by **model difficulty progression**: examine data or simulation movies → complete a simple calculation → carry out a 3-5 parameter model exercise → model a realistic case study.

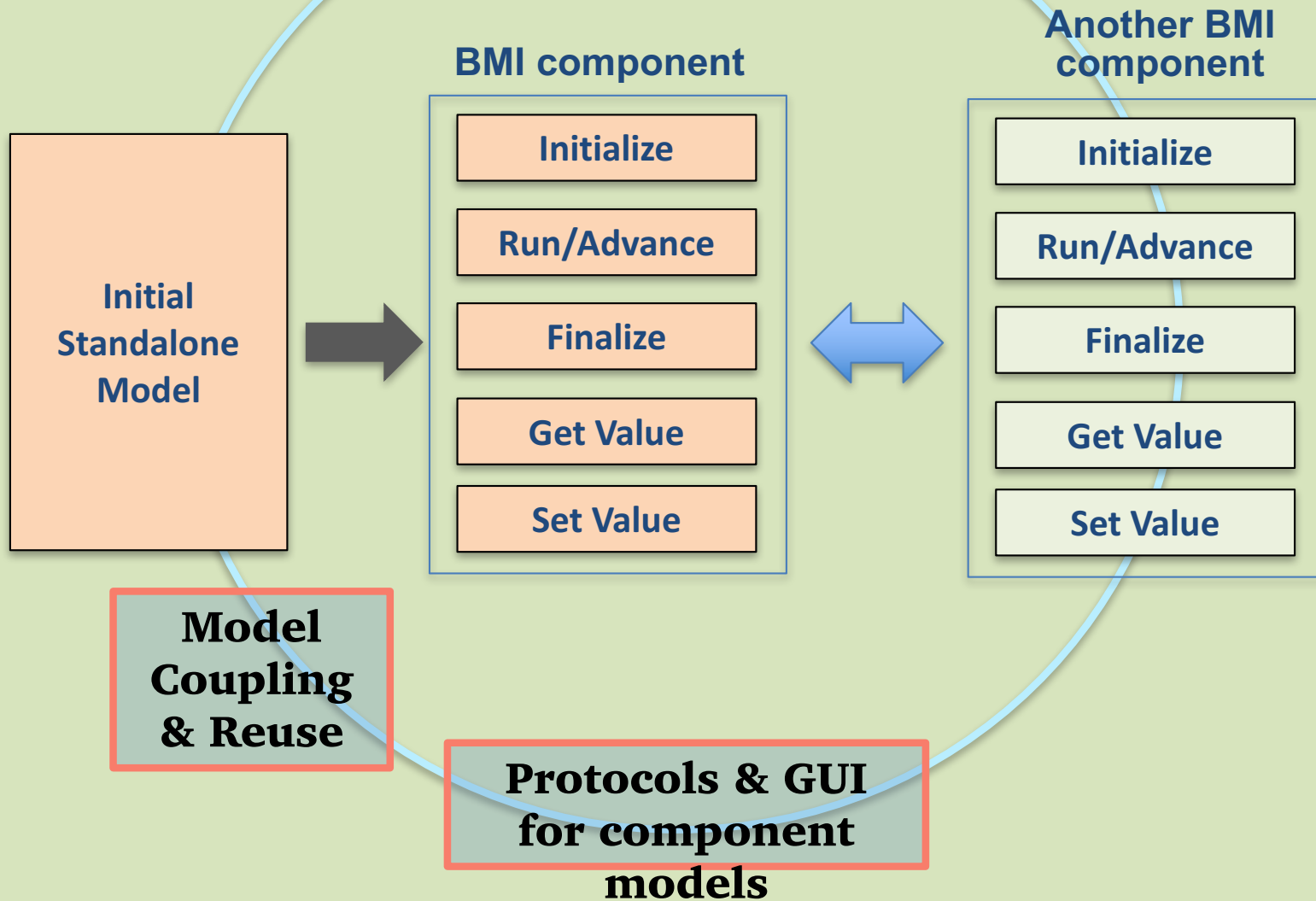
**Education &  
Knowledge  
Products**



# CSDMS Functions

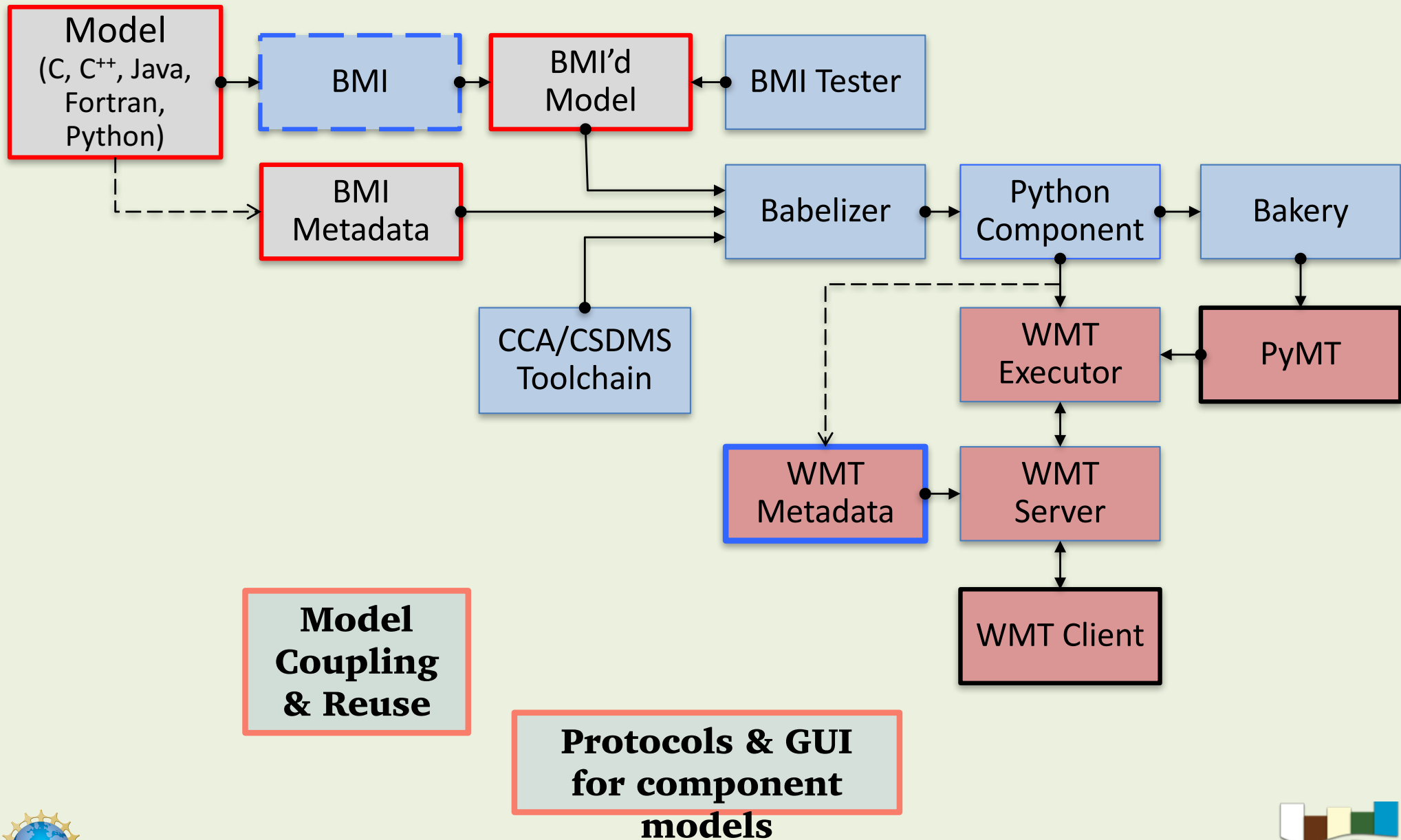
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

**CSDMS Basic Model Interface or BMI** standard is a distillation of key ingredients of major coupling systems.

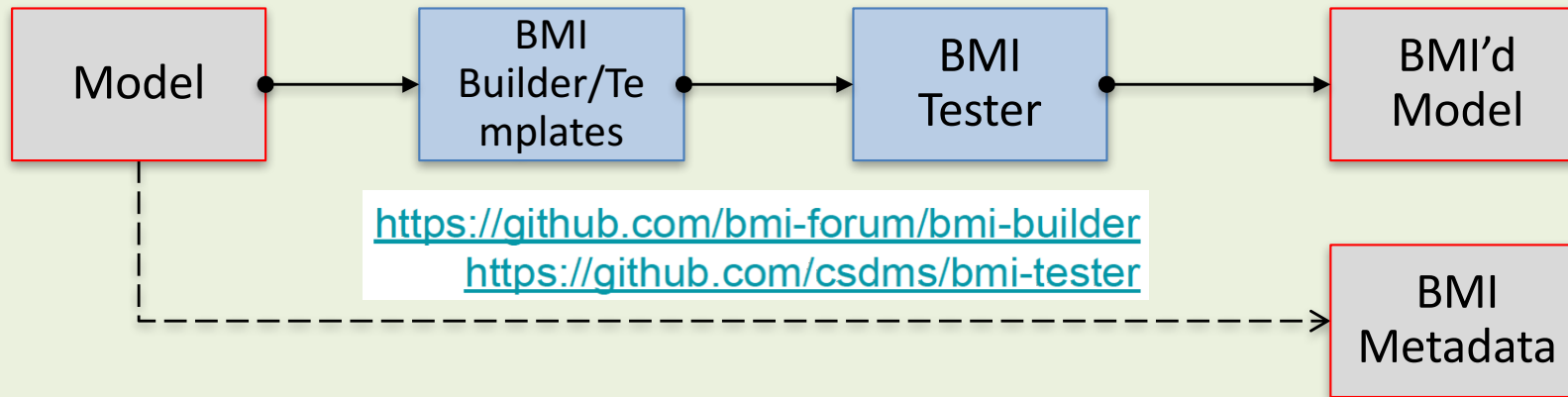




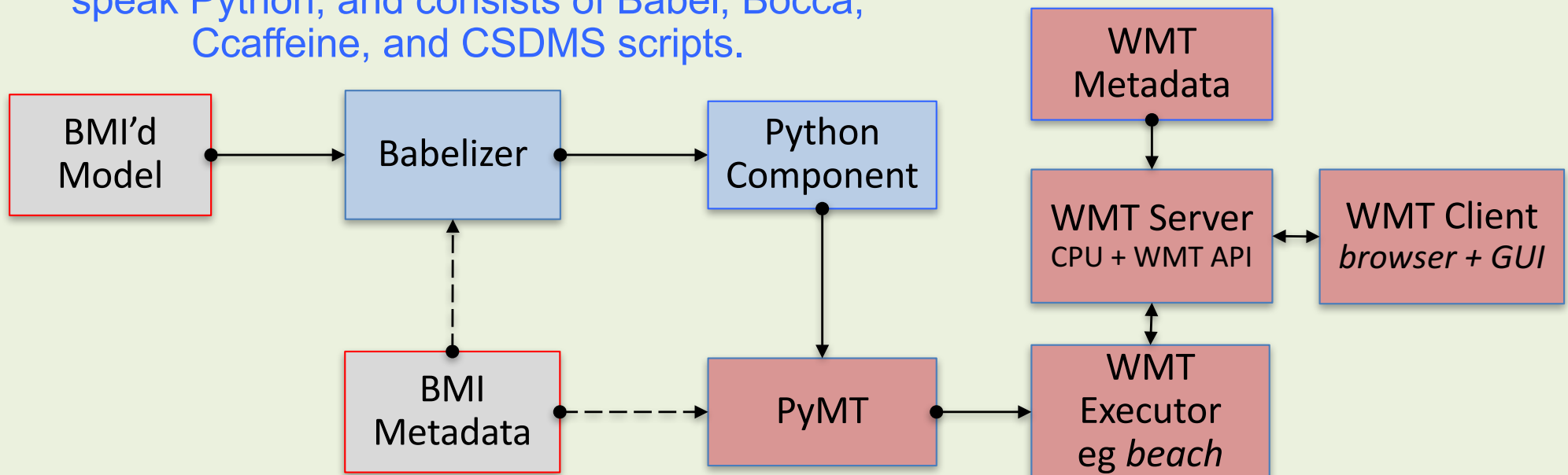
# The CSDMS Process: Model → Component → WMT - PyMT



CSDMS Tools help developers add a BMI to their model.



The CSDMS Babelizer makes a BMI'd model speak Python, and consists of Babel, Bocca, Ccaffeine, and CSDMS scripts.

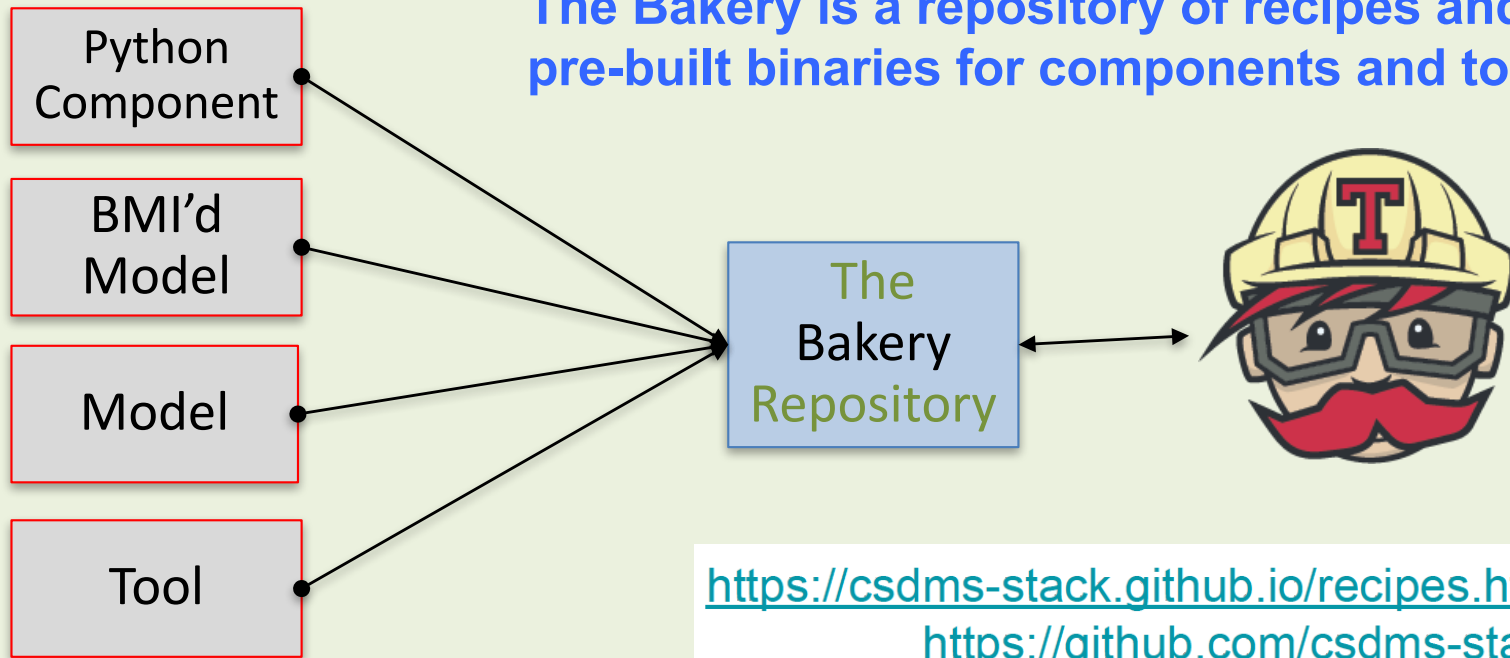


<https://github.com/csdms/pymt>  
<https://github.com/bmi-forum/babelizer>

PyMT forms the basis of the executor portion of the model-coupling triad.



The Bakery is a repository of recipes and pre-built binaries for components and tools



**Model  
Coupling  
& Reuse**

**Protocols & GUI  
for component  
models**

**Semantic  
Mediation  
& Ontologies**

**Model  
Benchmarking,  
Intercomparison  
& Uncertainty**

**Standard Names** uses a variable naming template:

**object name** + [**operation name**] + **quantity name**

Developers provide a *mapping dictionary* of I/O variables using CSDMS Standard Names, and a *Model Metadata File* with units, grid type, etc



**A Multilevel Parallel Object-Oriented Framework for:**

- Design Optimization
- Parameter Estimation
- Uncertainty Quantification
- Sensitivity Analysis

✧ *DAKOTATHON uncertainty tool*

✧ *ILAMB benchmarking tool*



# Initial CSDMS Initiators & heroes

1<sup>st</sup> CSDMS meeting 2002, Boulder



CSDMS DC-Agency meeting 2003



Pat Wiberg



Greg Tucker



Brad Murray



Chris Paola



Rudy Slingerland



Dave Furbish



Jai Syvitski

## Community Surface Dynamics Modeling System (CSDMS)

### Implementation Plan Workshop

#### Minneapolis, Minnesota

2<sup>nd</sup> CSDMS meeting 2004

May 8 - 10, 2004

$x + \Delta x, y) - 2\zeta(x,$



We herald in new CSDMS leadership with the recent and unanimous election of Professor Brad Murray as SC Chair and thank Professor Pat Wiberg for her wisdom, insight and kindness



**Pat Wiberg**  
**SC Chair 2012-2017**



**Brad Murray**  
**SC Chair 2017—**

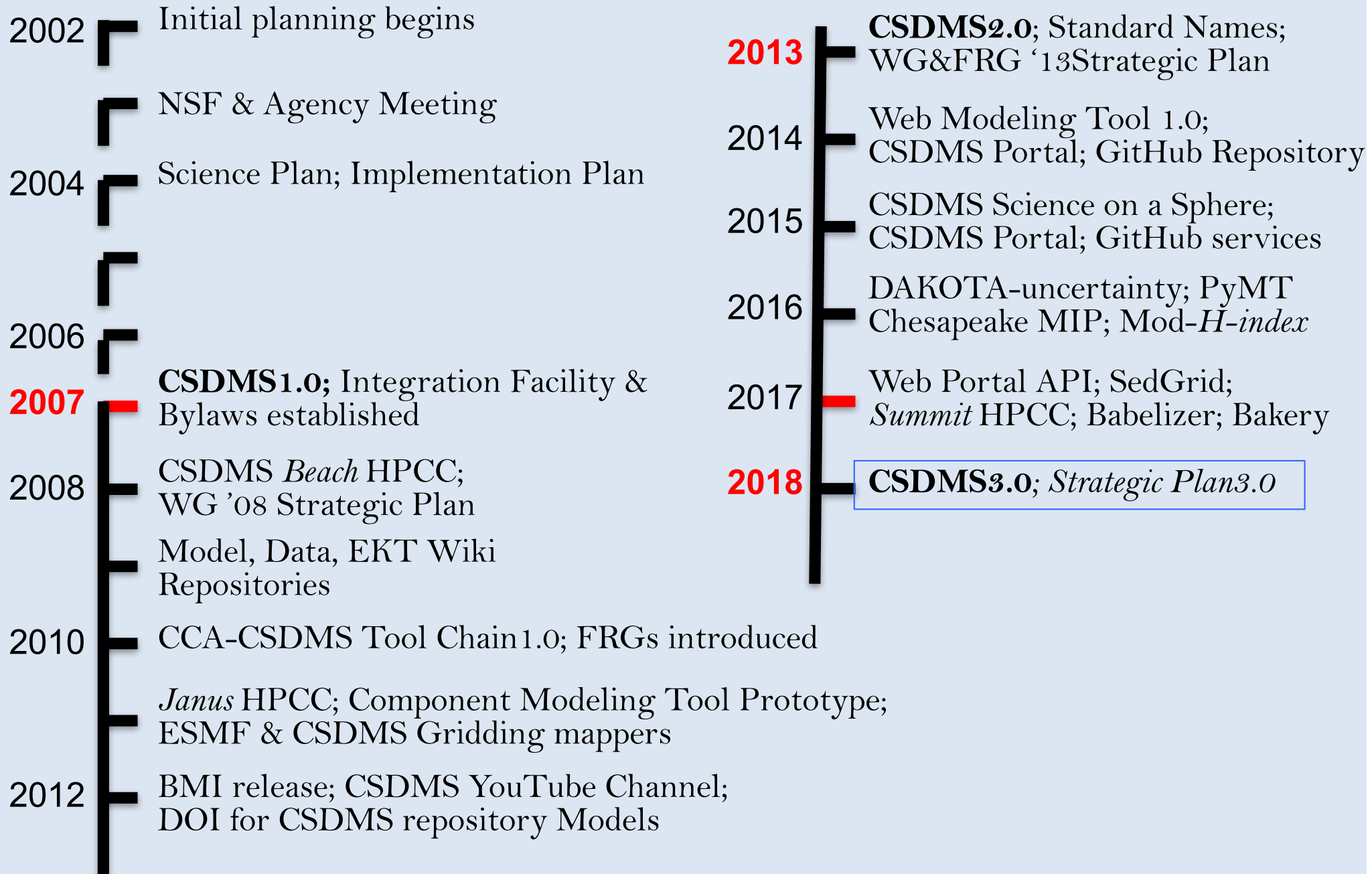


**Rudy Slingerland**  
**SC Chair 2007-2012**





# CSDMS History



# 2017 CSDMS Integration Facility Staff & Associates



**Greg Tucker**  
Incoming Director



**Lynn McCready**  
Executive Assistant



**Eric Hutton**  
Senior Software  
Engineer



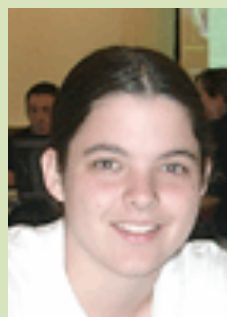
**Irina Overeem**  
Education Officer



**Albert Kettner**  
Cyber Com & Data



**Mark Piper**  
Software Engineer



**Mariela Perignon**  
Software Engineer



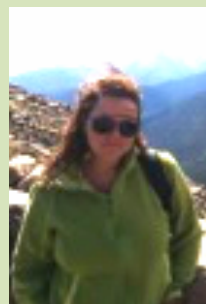
**Chris Jenkins**  
Marine Data



**Kimberly Rogers**  
Human Dimensions



**Bob Brakenridge**  
Dir, Flood Observatory



**Chrystal Pochay**  
Accountant



**Chad Stoffel**  
IT





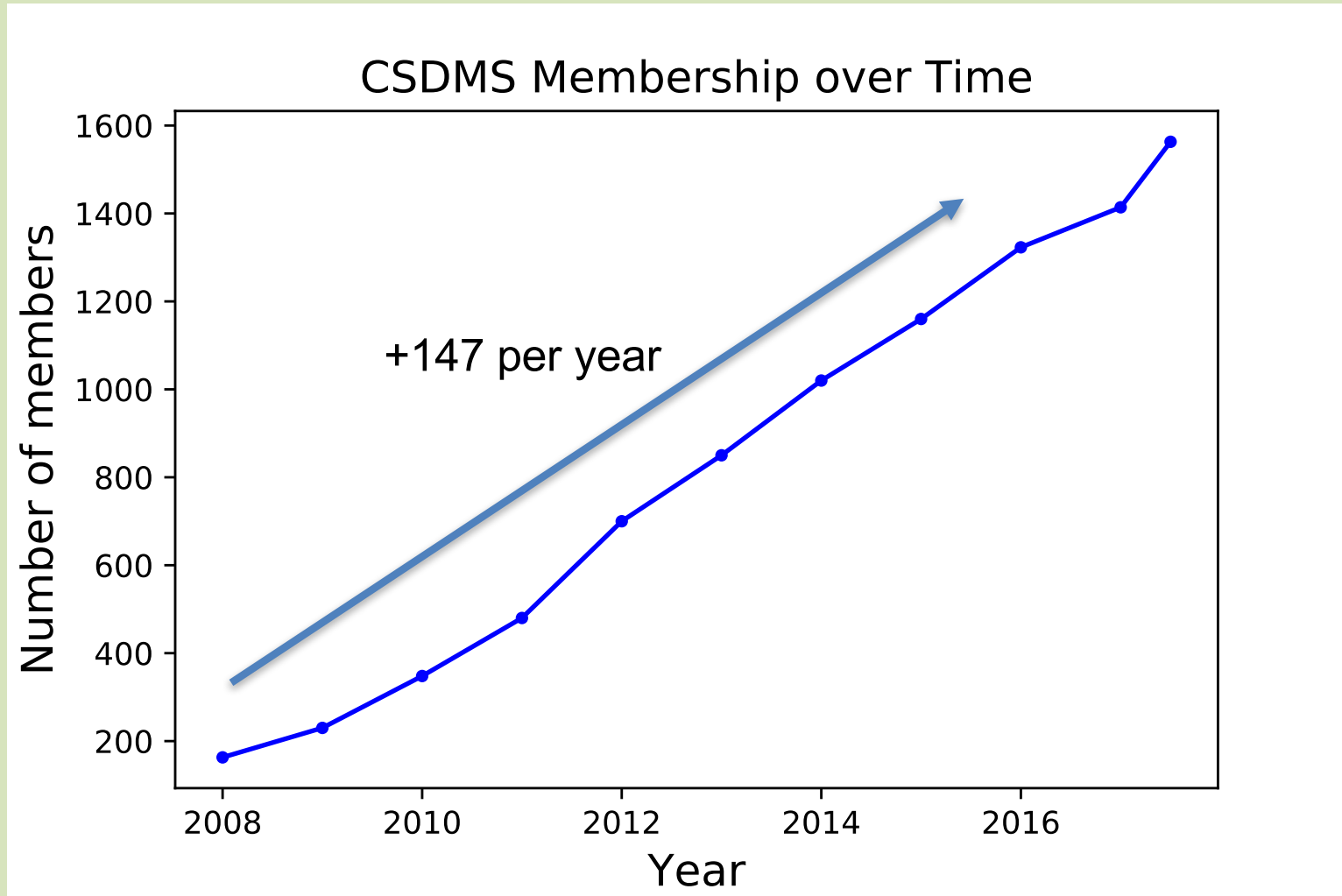
**2017 CSDMS Annual Meeting:**  
**Modeling Coupled Earth & Human Systems**  
**- The Dynamic Duo**

**CSDMS 3.0:**

**Learning from the past,  
Looking forward to the future**

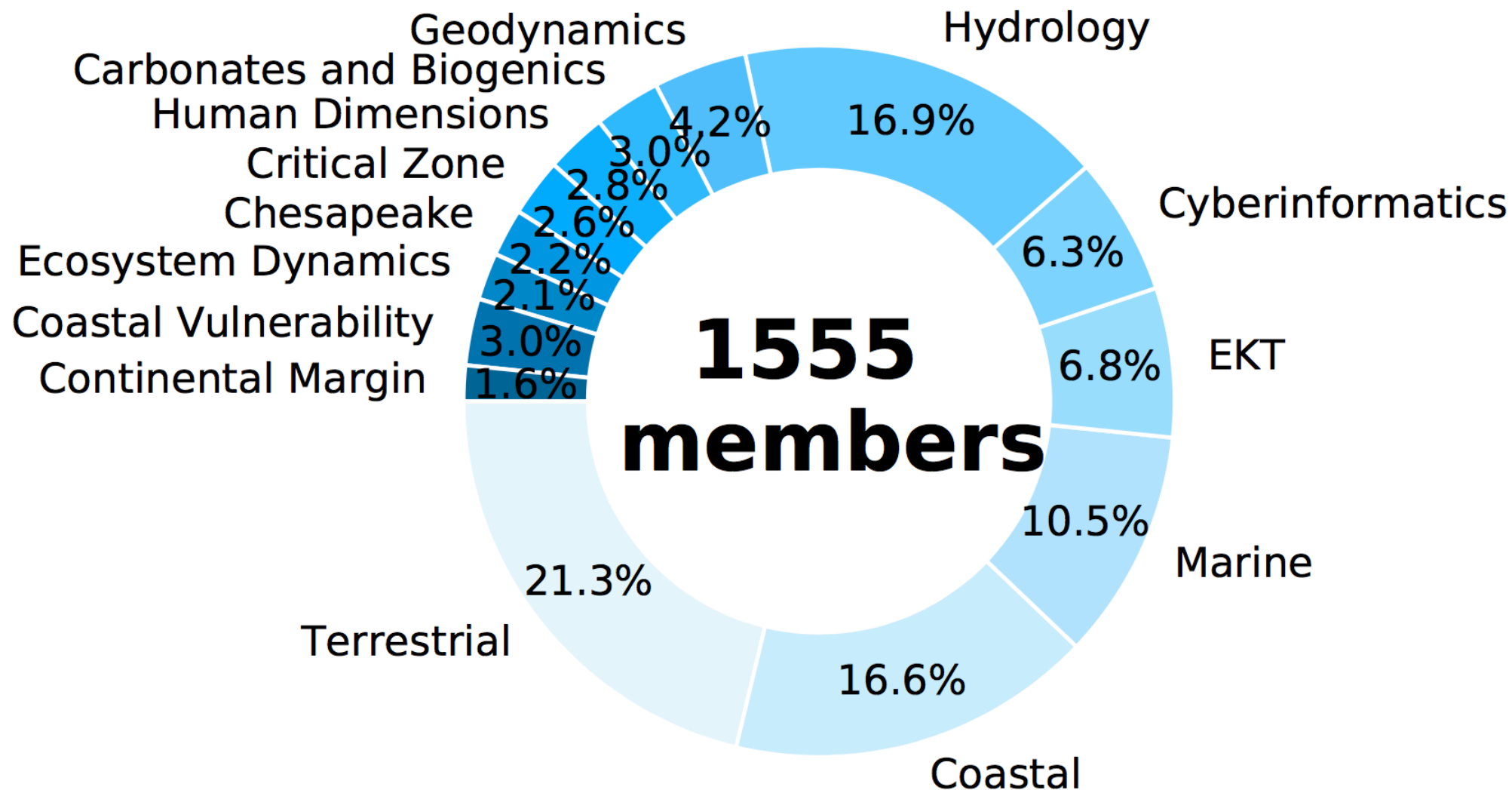


# CSDMS: a growing community



***“In a world of almost infinite data, it is code and software that turn data into information and knowledge.” – Teal (2017)***

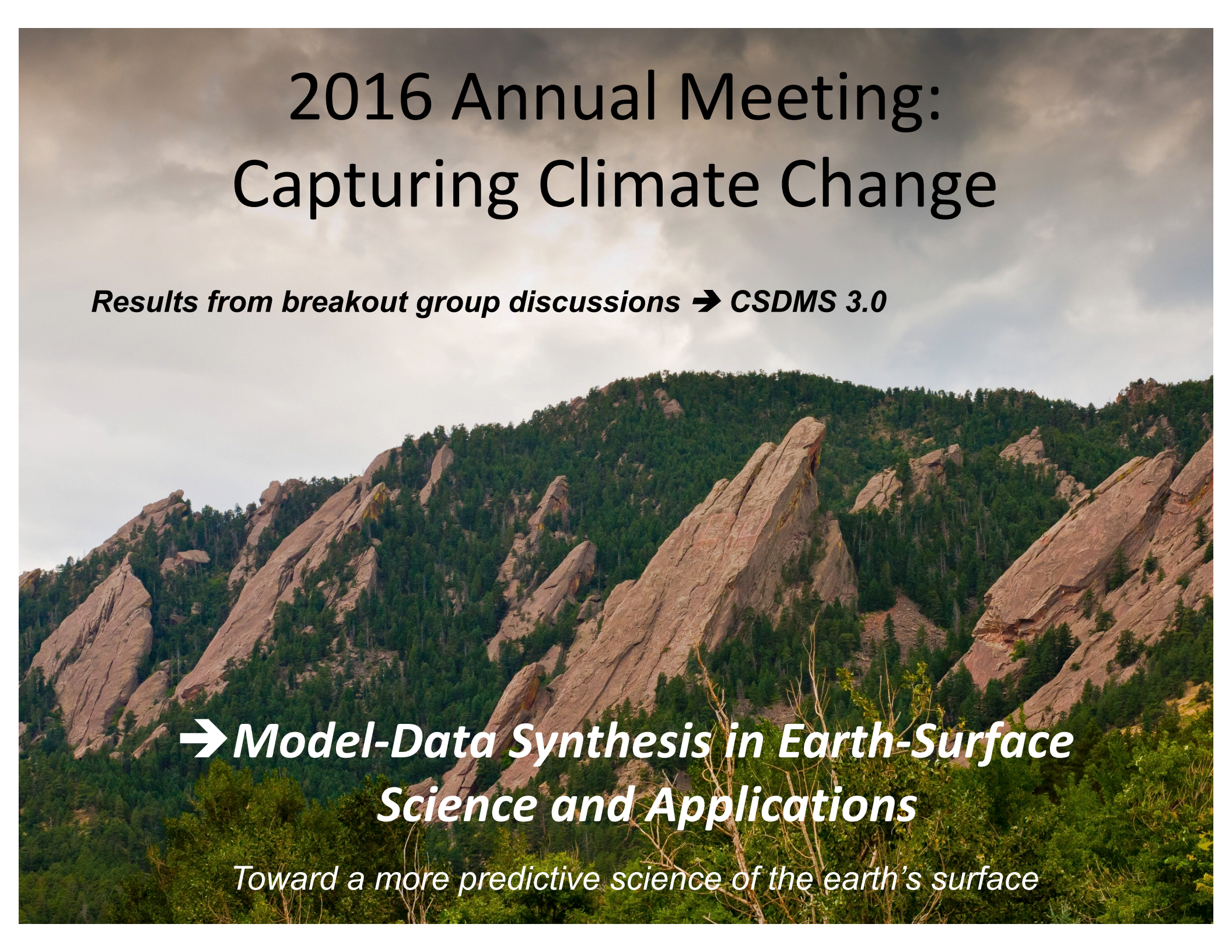




***“The grand challenges of today ... require convergence: the merging of ideas, approaches and technologies from widely diverse fields of knowledge to stimulate innovation and discovery..” – (NSF, 10 Big Ideas)***







# 2016 Annual Meeting: Capturing Climate Change

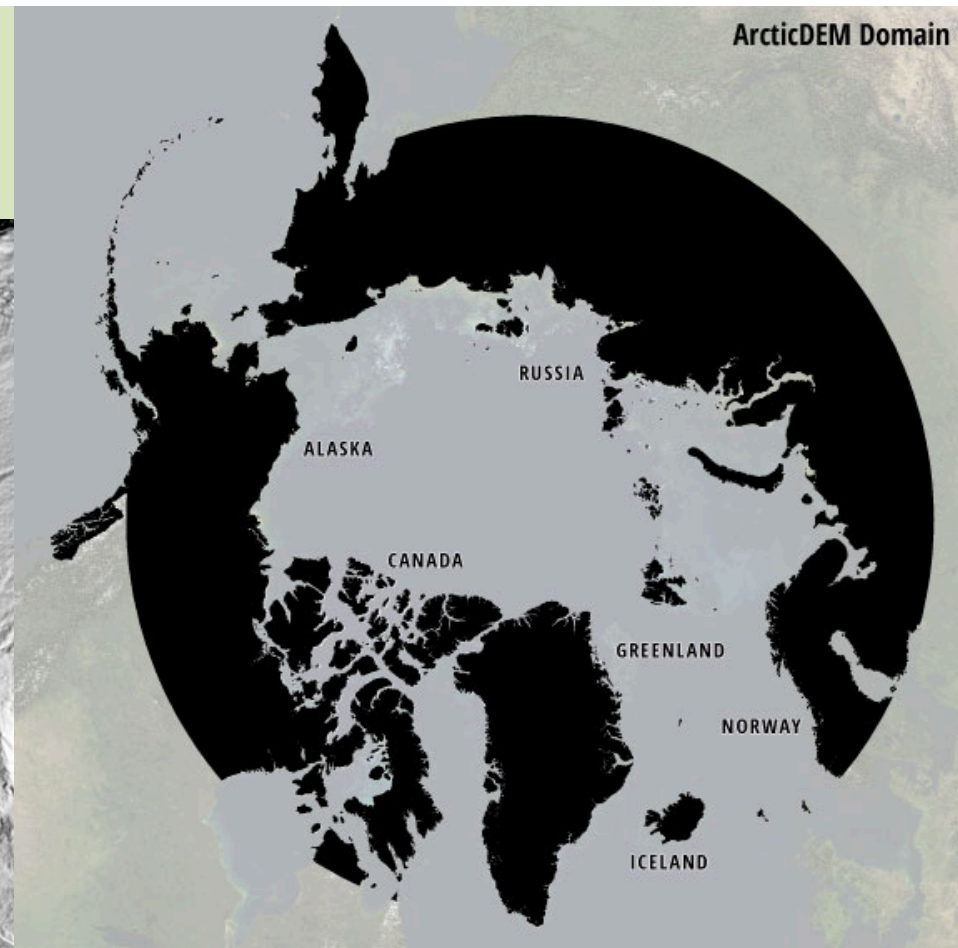
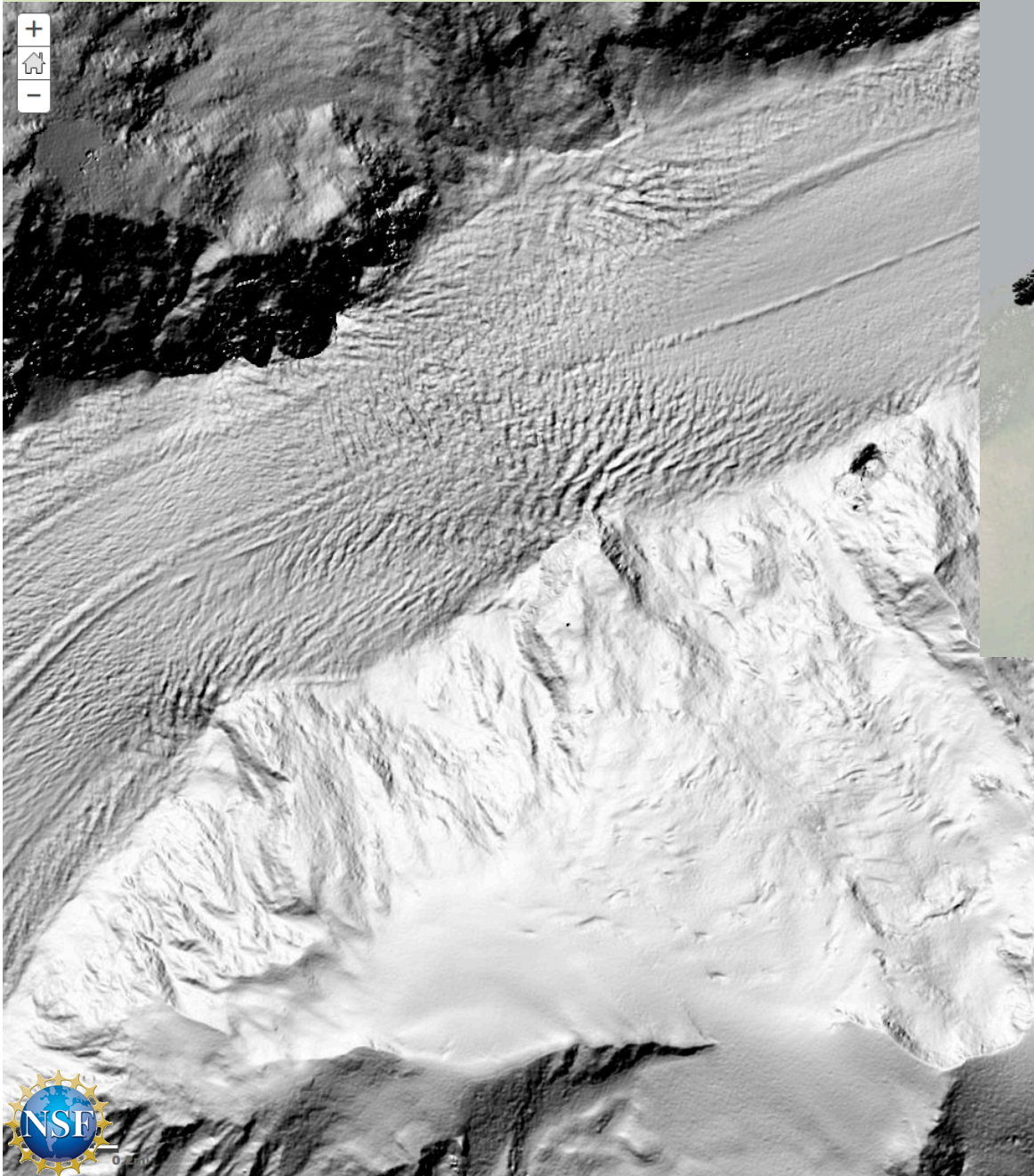
*Results from breakout group discussions → CSDMS 3.0*

**→ Model-Data Synthesis in Earth-Surface  
Science and Applications**

*Toward a more predictive science of the earth's surface*



ArcticDEM: high-resolution (1-5 m), pan-Arctic, repeatable satellite photogrammetry

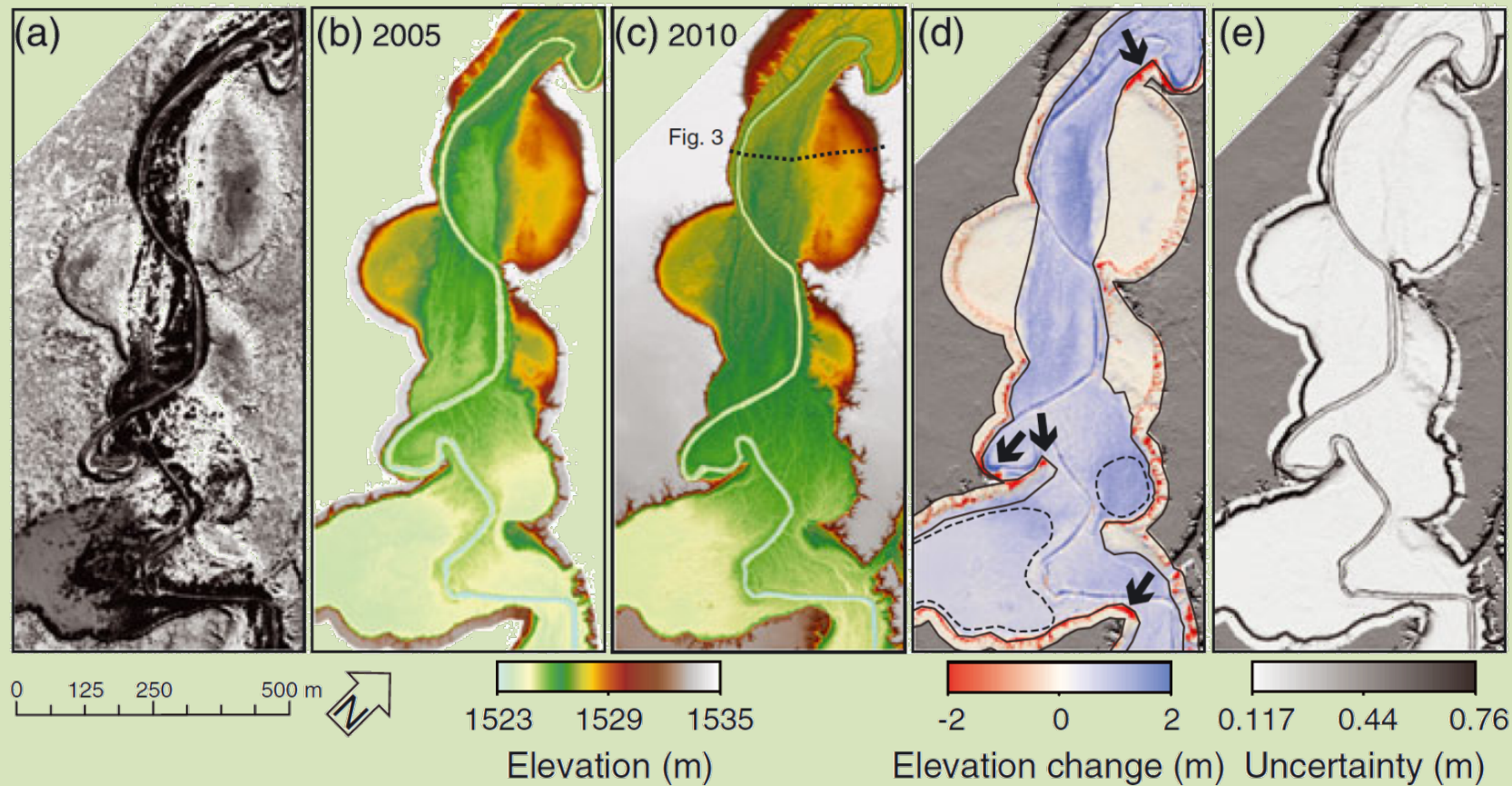


<https://www.pgc.umn.edu/data/arcticdem/>



# Example of LiDAR differencing for change detection

Rio Puerco, NM, LiDAR difference images  
2010 minus 2005



(Perignon et al., 2013)

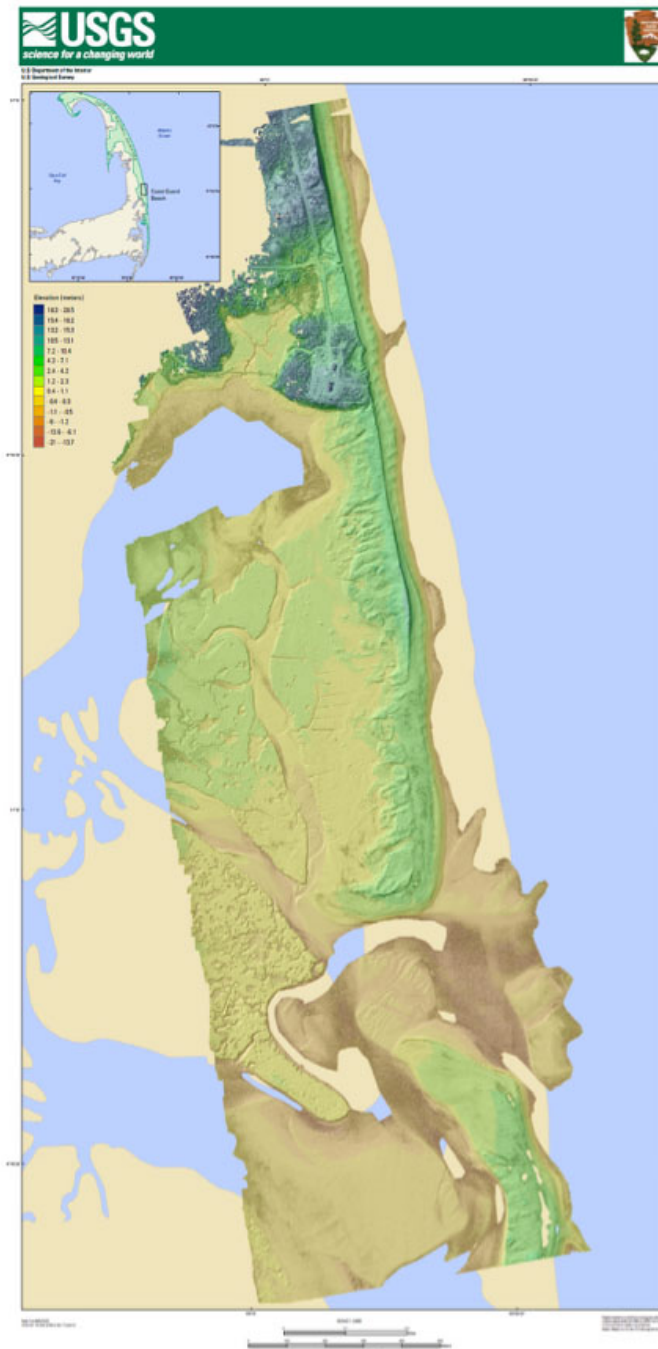




# First USGS Coastal Maps from Unmanned Aerial Systems

By [Chris Sherwood](#)

June / July 2016



Shaded Relief Map of Coast Guard Beach, Cape Cod National Seashore

By  
Christopher R. Sherwood, Brian R. Anderson  
2016



Orthophotomosaic Overlaid on Shaded Relief of Coast Guard Beach, Cape Cod National Seashore

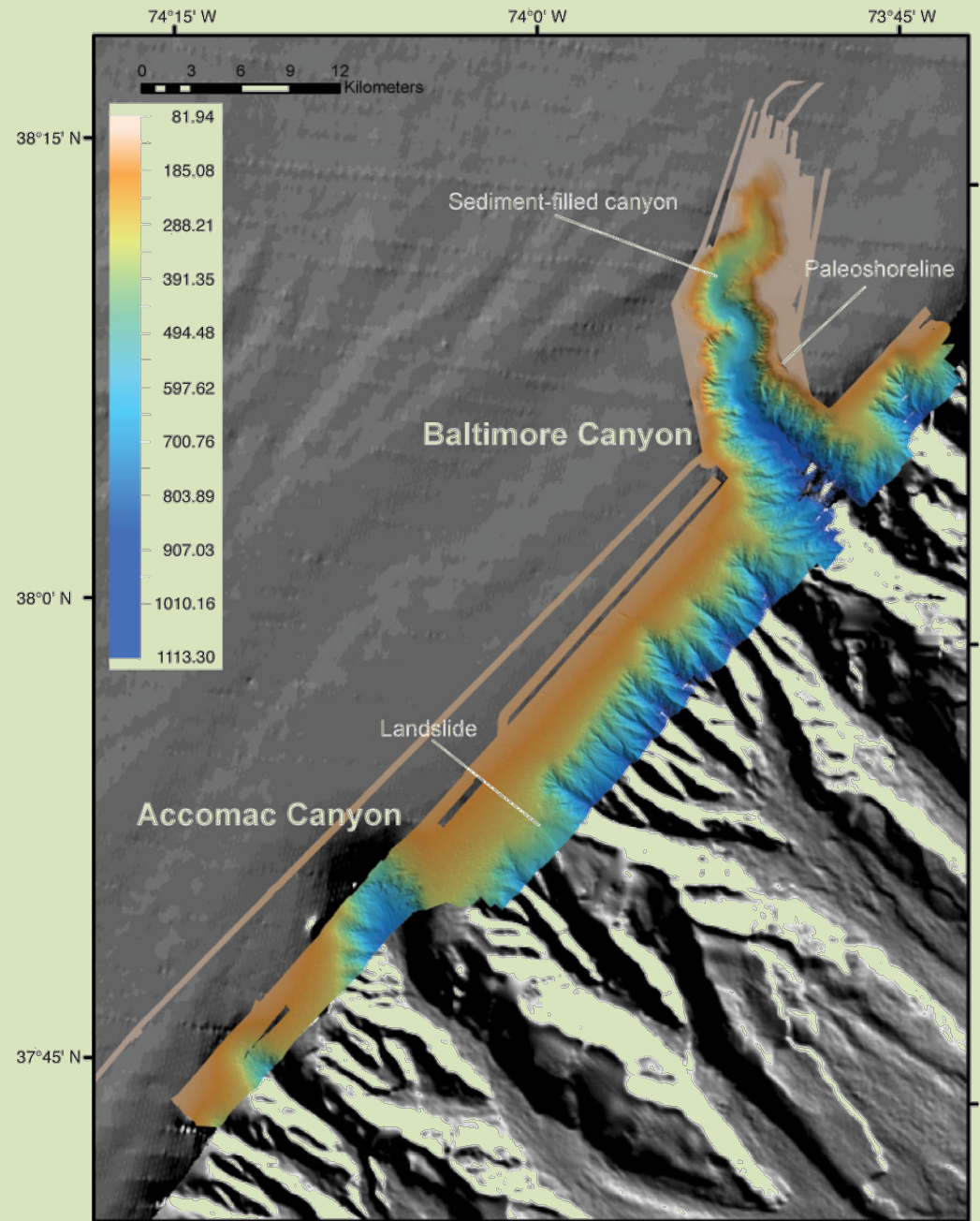
By  
Christopher R. Sherwood, Brian R. Anderson  
2016

# High-Resolution Multibeam Mapping of Mid-Atlantic Canyons to Assess Tsunami Hazards

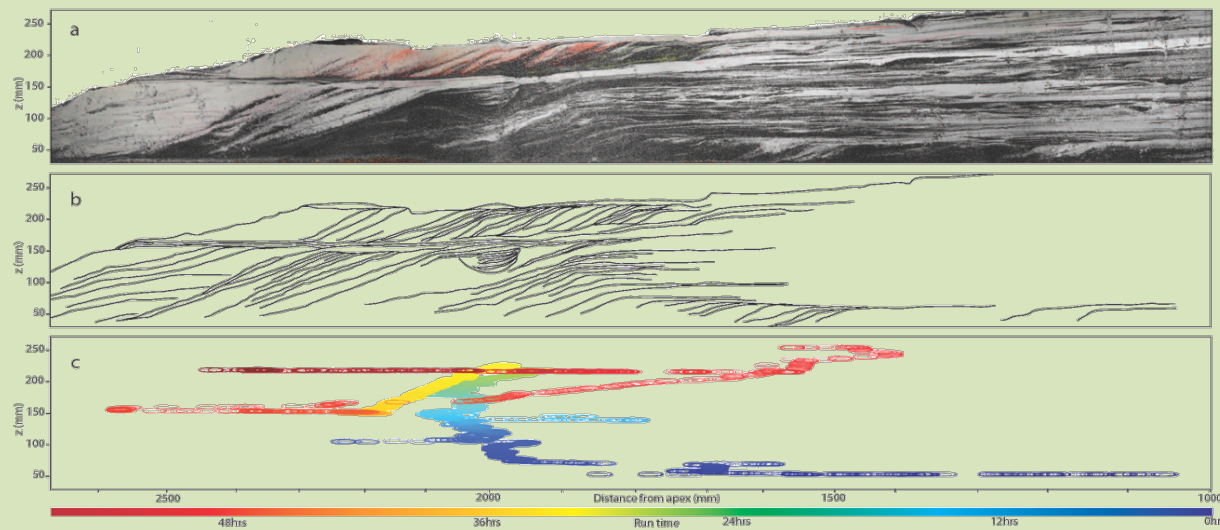
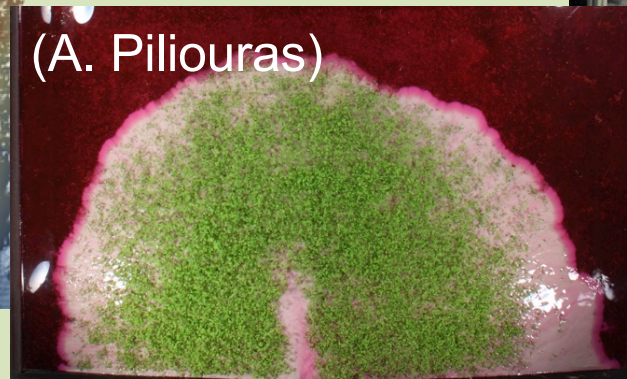
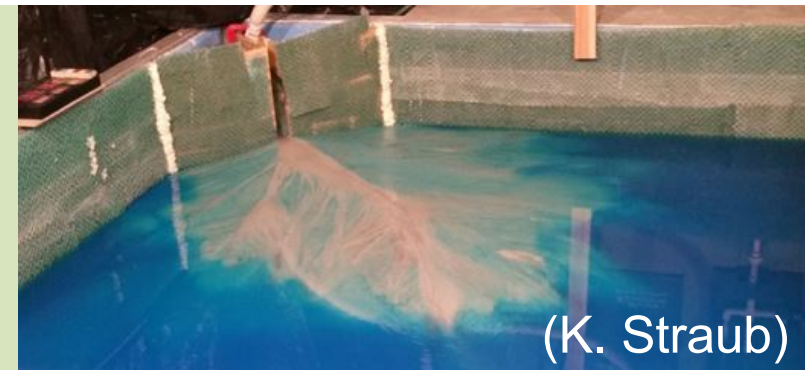
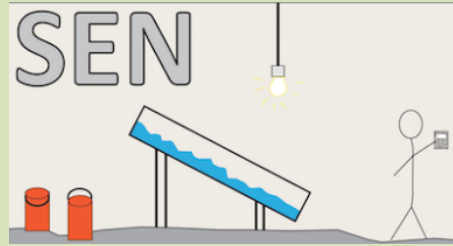
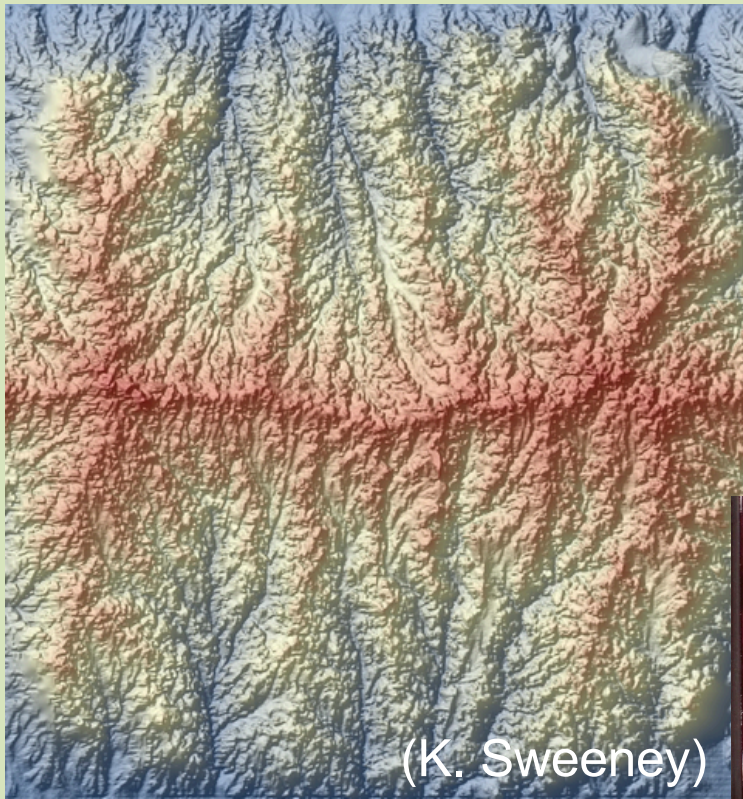
By [Jason Chaytor](#) and [Daniel Brothers](#)

Sept. / Oct. 2011

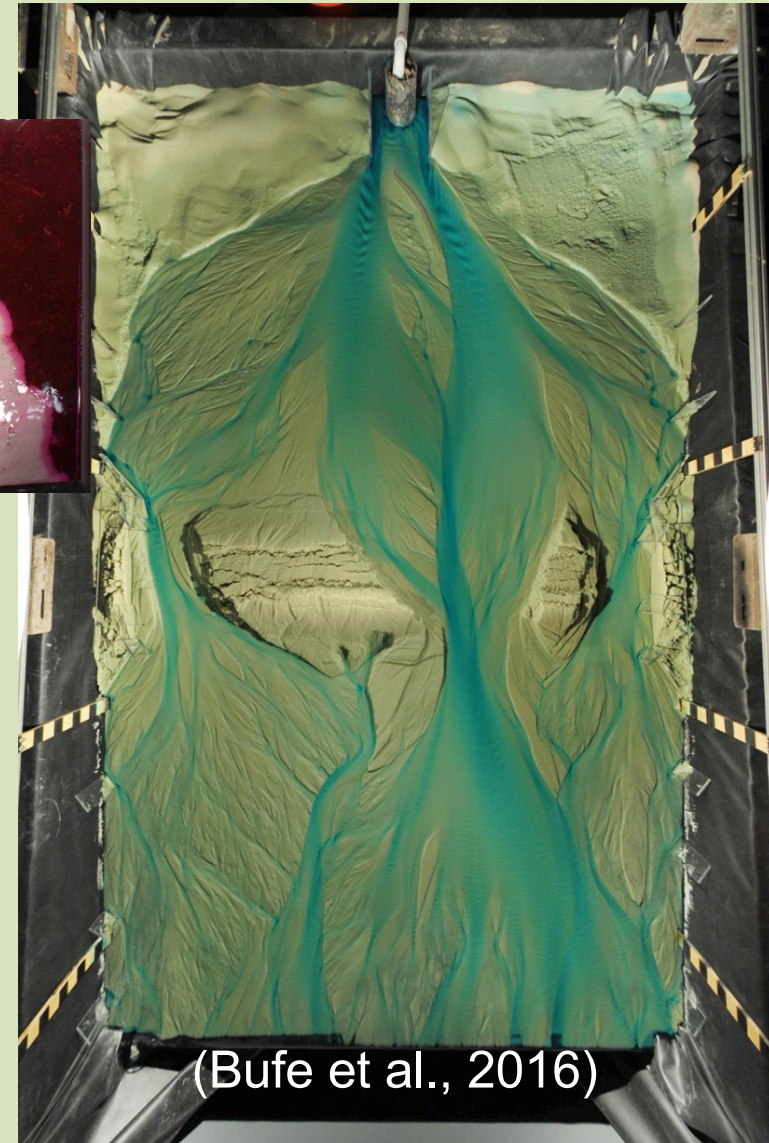
Multibeam bathymetry  
5—10 m horizontal resolution







(Mahon et al., 2015)



# Meeting the challenge ... in three pillars

*share resources,  
collaborate*



**COMMUNITY  
SUPPORT**

*create, run, test, and  
apply models*



**COMPUTING  
RESOURCES**

*learn and teach*



**EDUCATION  
OPPORTUNITIES**

# CSDMS

COMMUNITY SURFACE DYNAMICS MODELING SYSTEM





# CSDMS 3.0: education & training

- EKT Group and Repository
- Clinics
- Pre/post-meeting workshops
- **Webinars**
- **Hackathons**
- ***CSDMS Summer Schools***



**EDUCATION  
OPPORTUNITIES**

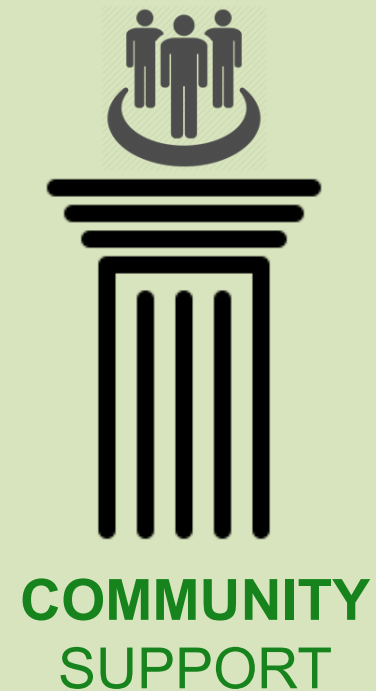
# CSDMS 3.0: computing resources

- Basic Model Interface (BMI)
- Web Modeling Tool → *Python* ...
- *Uncertainty tools*
- **BMI for data & web API**
- **GIS / geospatial capability**
- **Landlab integration**
- **Upgrade to BEACH**
- *Python Modeling Tool (PyMT)*



# CSDMS 3.0: community support

- Annual meetings
- Hosted workshops
- **Enhanced** model repository
- **Cryosphere Focus Group**
- **Project and proposal support**
- ***Science Teams***  
*(a.k.a. Science Steering Committees)*



# CSDMS 3.0

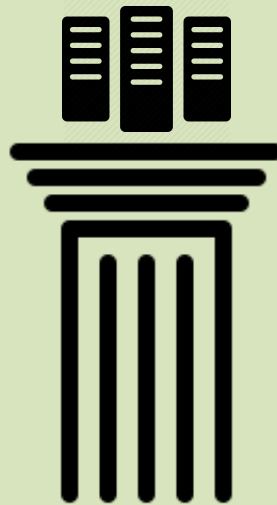
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

*share resources,  
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SUPPORT**

*create, run, test, and  
apply models*



**COMPUTING  
RESOURCES**

*learn and teach*



**EDUCATION  
OPPORTUNITIES**



[csdms@colorado.edu](mailto:csdms@colorado.edu)



# **2017 CSDMS Annual Meeting:**

## **Modeling Coupled Earth & Human Systems**

### **- The Dynamic Duo**



[csdms@colorado.edu](mailto:csdms@colorado.edu)







1) Linking Earth System Dynamics & Social System Modeling,  
May 23-25 2016  
Boulder CO USA



2) Modeling Challenges for Sustainability,  
Sept 27-30 2016,  
Kyoto, Japan




3) Integrated Modeling of Socio-Environmental Systems, Mar 13-15 2017,  
Potsdam, Germany

4) Modeling Coupled Earth & Human Systems - The Dynamic Duo, May 23-25 2017, Boulder CO USA





# 2017 Annual Meeting Theme *The Dynamic Duo*

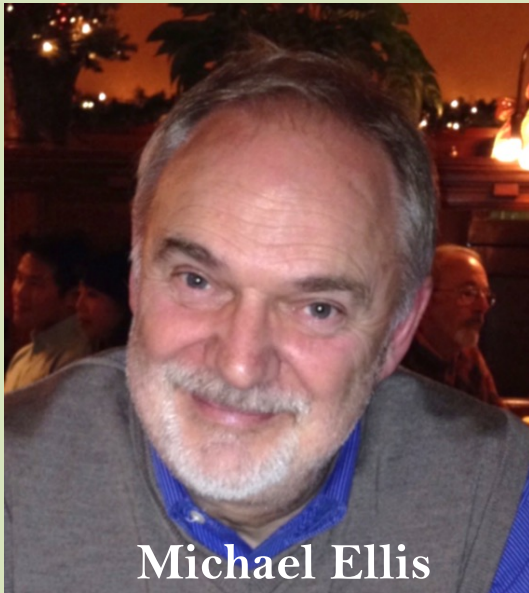
Tuesday	Wednesday	Thursday	Friday
Welcome talks (3)	Plenary Keynotes (2)	Plenary Keynotes (3)	ExCom Meeting
Plenary Keynotes (2)	Plenary PyMT Demo		
Discussion Breakout (6) <i>Nat &amp; Social Modeling</i>	Group Business Meetings (5)	Clinics (4)	Steering Committee Meet
Lunch	Lunch	Lunch	Lunch
Clinics (4)	Clinics (4)	Plenary Keynotes (3)	
Plenary Keynotes (2)	Posters	Group Business Meetings (5)	
Posters	Banquet	Final Remarks Departures	
			2017 Best Poster Award

**Modeling Clinics:** *Landlab & Dakota, ANUGA, SiSteR, ABM, PERMAFrost, BMI: Live!, LANDLAB1.0, CSDMS EKT, Landlab Toolkit, Best Practices, SEN, ParFlow, EcoPath & EcoSim*

**CSDMS Group Business Meetings:** i) Goal updates, ii) CSDMS3.0



## 2017: Program Director's Award



Michael Ellis

*Oversaw CSDMS initiation at NSF.  
First chair of Anthropocene FRG  
(renamed Human Dimensions FRG).*

- BGS Director *Land, Soil & Coast*, and formerly —
- BGS Director, Climate & Landscape Change
- BGS Head, Climate Change Science
- Founder & first AGU Chair, *Earth & Planetary Surface Processes*
- NSF Director, Geomorphology & Land-use Dynamics

## Student Modeler Award

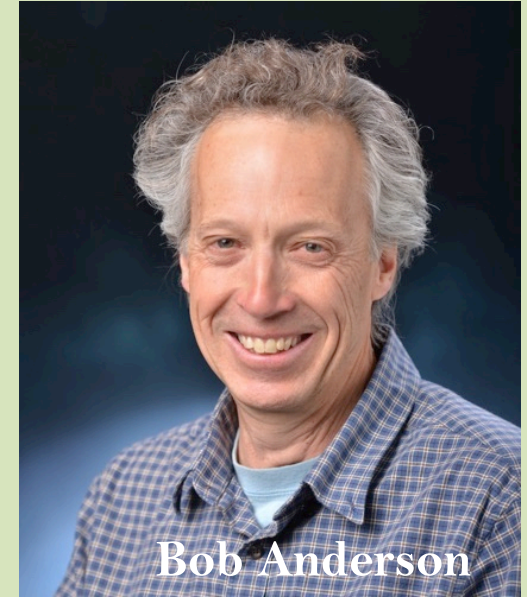


Julia Moriarty

*“Coupling Sediment Transport  
& Biogeochemical Processes:  
Role of Resuspension on O<sub>2</sub> &  
Nutrient Dynamics”*

- Ph.D candidate @ VIMS  
Physical & Geological  
Oceanography
- NSF East Asia & Pacific  
Summer Institute Fellow,  
Academia Sinica, Taiwan
- George R. Healy Fellowship  
Awardee, College of William  
& Mary

## Life-time achievement Award



Bob Anderson

*Outstanding CSDMS model developer  
(aeolian transport, arctic coastal  
erosion, glacier dynamics, fjords, etc.)*

- CU Distinguished Professor
- CU Hazel Barnes Prize
- NSF Presidential Young Investigator
- GSA Gladys Cole Award
- Fellow, AGU
- Fellow, INSTAAR
- AGU's Gilbert award
- 157+ well-cited peer-reviewed papers & books

