SZ4D ML/AI Virtual Workshop

Session 2
Theme: Making Predictions with ML/AI

August 3, 2023 (9am-11:30am PDT)
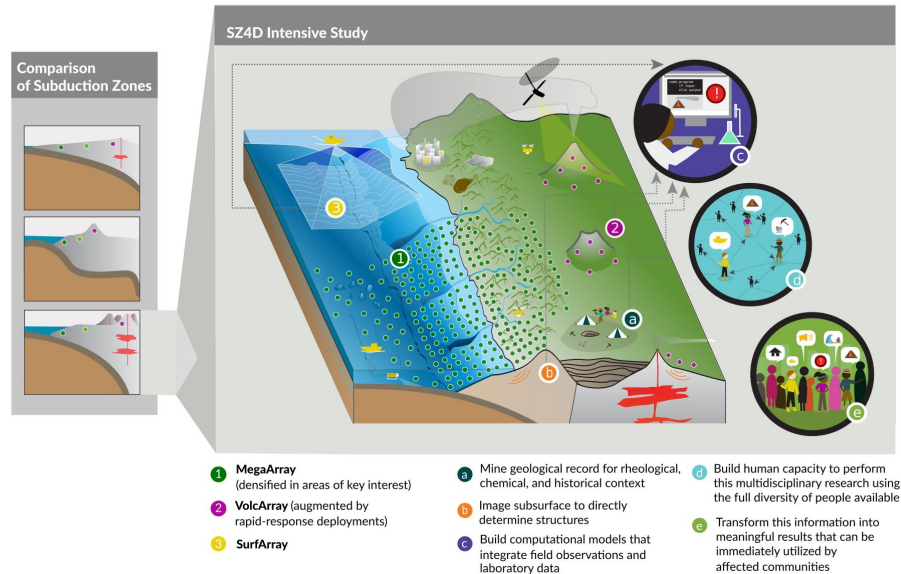
Daniel Trugman (University of Nevada, Reno)
Tushar Mittal (Penn State University)
Xuesong Ding (University of Texas at Austin)

**… with tons of help
from Anaïs Férot!**

What is SZ4D?

SZ4D or Subduction Zones in Four Dimensions, is a community-driven initiative for a long-term, interdisciplinary research program to understand the limits and possibilities of predicting geohazards. The group utilizes subduction zones as the ideal natural laboratories for these efforts and works together to create the infrastructure and resources needed to enable new discoveries. SZ4D brings together a diverse community of scientists from a wide range of disciplines and backgrounds who study earthquakes, volcanic eruptions, and surface processes.

SZ4D Intensive Study

Comparison of Subduction Zones

1 **MegaArray** (densified in areas of key interest)

2 **VolcArray** (augmented by rapid-response deployments)

3 **SurfArray**

a Mine geological record for rheological, chemical, and historical context

b Image subsurface to directly determine structures

c Build computational models that integrate field observations and laboratory data

d Build human capacity to perform this multidisciplinary research using the full diversity of people available

e Transform this information into meaningful results that can be immediately utilized by affected communities

SZ4D Working Groups define science goals and strategies

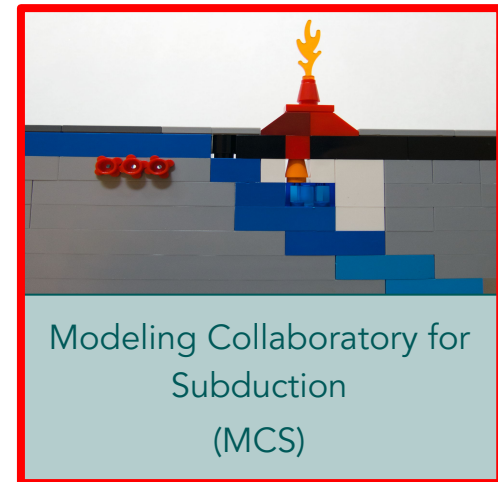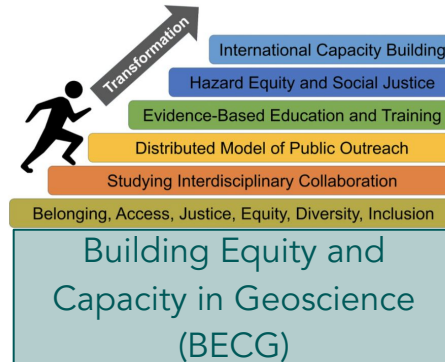Faulting & Earthquake Cycles Working Group (FEC)
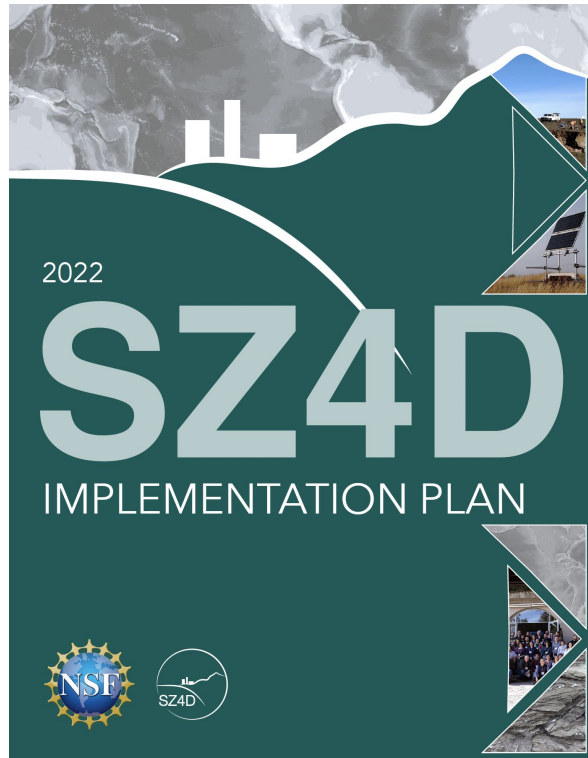

Magmatic Drivers of Eruption Working Group (MDE)

Landscapes & Seascapes Working Group (L&S)

SZ4D Integrative Groups plan infrastructure and related activities that reach across the system

Transformation

International Capacity Building
Hazard Equity and Social Justice
Evidence-Based Education and Training
Distributed Model of Public Outreach
Studying Interdisciplinary Collaboration
Belonging, Access, Justice, Equity, Diversity, Inclusion

Building Equity and Capacity in Geoscience (BECG)

Modeling Collaboratory for Subduction (MCS)

Implementation Report Released November 2022

CONTENTS

Overview and Objectives for the Workshop

<u>Motivation from the SZ4D Implementation Plan:</u> "Given that the initial planning phase of the MCS RCN was focused primarily on physics-based modeling, it will be important to carry out similar efforts for data-driven computational science applications like ML in the next phase of SZ4D. Workshops and other community-building activities are needed to identify community needs, opportunities for open-source software development, and training and educational activities."

<u>Main objectives for this workshop:</u> get community input, buy-in, and feedback regarding what AI/ML approaches are most promising, and what specific steps are needed, to achieve SZ4D goals:
- Connect useful techniques across domains to enable multi-disciplinary science
- Determine and prioritize focus areas for future proposals
- Understand community needs for ML/AI training and community software

Three virtual sessions with different themes

WEDNESDAY - Session 1 | Making Sense of Data with ML/AI (talk slides will be available online on the workshop page)

TODAY - Session 2 | Making Predictions with ML/AI

FRIDAY - Session 3 | Facilitating Process-Based Modeling w/ ML/AI
Confirmed Invited Speakers:
  Zongyi Li (Caltech) - LS/MDE
  Qingkai Kong (LLNL) - FEC
  Hamed O'Ghaffari (MIT) - MDE/FEC

Still time to register!

SESSION 3

Session 2 (August 3rd, 9am-11:30am PDT)
Theme: Making Predictions with ML/AI

Topics and Focus Areas:
- Forecasting / time series datasets
- Data assimilation
- Causality and causal inference
- Transfer learning across domains/regions
- Generative models
- Optimal experimental design

Invited Speakers (span all SZ4D working groups):
- Chaopeng Shen (Penn State University): Landscapes and Seascapes (LS)
- Christelle Wauthier (Penn State University): Magmatic Drivers of Eruption (MDE)
- Diego Melgar (University of Oregon): Faulting and Earthquake Cycles (FEC)

Schedule for Today [all times PDT, UTC-7]

9:00am - 9:10am | Overview and Meeting Objectives

9:10am - 9:25am | Chaopeng Shen: Differentiable modelling to unify machine learning and physical models for hydrology and geosciences

9:25am - 9:40am | Christelle Wauthier: Signal extraction and characterization from geodetic datasets using AI approaches

9:40am - 9:55am | Diego Melgar: Early warning for great earthquakes from characterization of crustal deformation patterns with deep learning

9:55am - 10:10am | Q & A discussion for all the speakers

10:10am - 10:15am | Break

10:15am - 11:00am | Breakout Discussions

11:00am - 11:30am | Report Back and Synthesis

Breakout Session (45 min)

Following the three science talks, participants will be randomly assigned to breakout rooms to discuss key points relevant to current and future ML/AI connections to SZ4D

- Each breakout group will select two discussion leaders to keep the conversation on track and to record key talking points
- Find the breakout documents for your group in the shared Google Drive folder [see links in the chat]
- The document will include instructions, guidelines, and possible discussion topics [the leader or scribe can add more]

Breakout Session (45 min)

Following the three science talks, participants will be randomly assigned to breakout rooms to discuss key points relevant to current and future ML/AI connections to SZ4D

Guidelines and ground rules (following SZ4D's Code of Conduct):

- Listen attentively and be respectful.
- Do not interrupt. Apologize if you do and return the floor to the speaker.
- Be generous in how you interpret what others are saying.
- Limit your speaking time and avoid dominating the conversation.
- Encourage participation from everyone, especially early career scientists!

Report back & Synthesis (30 min)

- Following the breakout session, discussion leader/designated person from each breakout group will select briefly summarize the key points from the group's discussion

- <u>The ideas and discussion points from this workshop will be synthesized</u> into a publicly available report aimed at guiding future SZ4D proposals and activities in the realm at ML/AI associated with SZ4D & MCS

Outcomes and Next Steps

Main workshop objectives: get community input, buy-in, and feedback regarding what AI/ML approaches are most promising, and what specific steps are needed, to achieve SZ4D goals
- Connect useful techniques across domains to enable multi-disciplinary science
- Determine and prioritize focus areas for future proposals
- Understand community needs for ML/AI training and community software

The ideas and discussion points from this workshop will be synthesized into a report aimed at guiding future SZ4D proposals and activities in the realm at ML/AI

- If you are interested in being involved in this process, please let us know!

- SZ4D's ML/AI task force: Daniel Trugman (dtrugman@unr.edu), Tushar Mittal (tmittal@psu.edu), Xuesong Ding (xuesong.ding@beg.utexas.edu)

Thank you for coming, and have a great workshop!

…and don't forget to register for the session on Friday!

Outcomes and Next Steps

The ideas and discussion points from this workshop will be synthesized into a public report aimed at guiding future SZ4D proposals and activities in the realm at ML/AI - report will be published on the website and the SZ4D September e-newsletter.

- If you are interested in being involved in this process, please let us know!

- SZ4D's ML/AI task force: Daniel Trugman (dtrugman@unr.edu), Tushar Mittal (tmittal@psu.edu), Xuesong Ding (xuesong.ding@beg.utexas.edu)

Workshop Feedback Survey - We will send out a survey to all the participants to get feedback on the workshop and future activities that SZ4D/MCS should organize with regards to ML/AI

Thank you for coming

…and don't forget to register for the sessions on Friday! (https://www.sz4d.org/workshop-ml-ai-2023)

SZ4D Code of Conduct

SZ4D

EXPECTED BEHAVIOR
- Treat all participants with respect, valuing a diversity of views and opinions.
- Be considerate, respectful, and collaborative.
- Acknowledge the contributions of others.
- Contribute to an accessible and inclusive environment for all participants.
- Do not make audio/visual recordings of presentations unless permission is specifically approved.

UNACCEPTABLE BEHAVIOR in all environments includes but is not limited to:
- Verbal abuse, including bullying, harassment, intimidation, or discrimination in any form.
- Sexual attention or advances, or inappropriate sexual references.
- Other conduct which could reasonably be considered inappropriate in a professional setting.

CONSEQUENCES
- Anyone requested to stop unacceptable behavior is expected to comply immediately.
- SZ4D meeting organizers may take action deemed necessary and appropriate, including:
  - Immediate removal from the event,
  - Prohibiting attendance at a future event, online gathering, conference, workshop or field project.
  - Sending notification to a Home Institution and funding agencies supporting SZ4D
- Reporting contacts: SZ4D Program Manager: Anaïs Férot (aferot@ucsc.edu), Chair of the Collective Impact Committee: Mike Brudzinski (brudzimr@miamioh.edu)