

**Imaging and Analyzing Southern California's Active Faults with High Resolution
Topography:
A Joint SCEC/OpenTopography/UNAVCO Short Course**

2015 Southern California Earthquake Center Research Summary, Project #15188

SCEC PIs

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Abstract:

High resolution topographic data has become an important tool for earthquake scientists to make detailed observations and model surface evolution. Within the last decade, several efforts have been made to collect high resolution topographic (HRT) data for active faults (e.g. The B4 project, EarthScope, and numerous NCALM and USGS projects). These datasets are freely available online through OpenTopography, a NSF funded data distribution portal. The active faulting community has taken great interest in these exciting datasets, using them to generate new and important insights into earthquake processes in Southern California. OpenTopography in partnership with the Southern California Earthquake Center, UNAVCO, and EarthScope hosted a short course at Arizona State University on January 25-26, 2016. This 2-day course highlighted recent research results and provide beginner to intermediate training on airborne and terrestrial lidar, and Structure from Motion technology, point cloud and raster-based data processing, and active fault-oriented analysis. We emphasized fault trace and geomorphic mapping, topographic differencing, integration with other geospatial data, and data visualization and analysis approaches. Participant had the opportunity to discuss their research with other participants and the instructors via short evening presentations. The curriculum included modules on fault trace and geomorphic mapping applications, topographic differencing, integration with other geospatial data, and data visualization and analysis approaches. Consistent with previous SCEC-supported lidar short courses in 2009, 2011, and 2013, interest in the 2016 course exceeded capacity with 90 applications for 35 course slots. Course participants were primarily early career graduate students, and postdocs, with a hand full of faculty participants.

SCEC Science Sections: Geology, Seismology
SCEC Science Priorities: 4c, 4b, 2a

Technical Report

Overview:

The *Imaging and Analyzing Southern California's Active Faults with High Resolution Topography* short course was held January 25-26, 2016 at Arizona State University in Tempe, AZ. The primary course sponsor was SCEC, but OpenTopography, UNAVCO, and EarthScope also contributed funding and staff time to support the course. Course co-organizers and instructors included the PIs as well as Ed Nissen (CSM).

We received 90 applications to the short course, with an intended target of 35 participants. The workshop was a great success and we had lots of great discussion, training, and demonstration with a diverse group of participants. We received numerous compliments on the content, organization, and execution. Course participants were primarily early career graduate students, and postdocs, with a hand full of faculty participants (see list of attendees below).

A website was developed to capture all of the lectures, exercises, and other content prepared for the course (http://www.opentopography.org/community/workshops/16SCEC_course). This repository of information is a valuable resource for users seeking to familiarize themselves with lidar data and applications to active fault studies.

Course Agenda, Lectures, Exercises:

Monday, January 25th 2016

Time	Topic	Instructor, Affiliation (Location)
8:30am	Welcome, group introductions	ISTB4 Rm 240
9:30am	Introductory lectures: <ul style="list-style-type: none">• Sharpening our view of earth processes with high resolution topography• Presentation recordings	Ramón Arrowsmith, Arizona State University (ISTB4 Rm 240)
10:15am	<i>Break</i>	
10:30am	Introductory lectures, cont.: Introduction to ALS , introduction to TLS , Lidar quality, artifacts, issues to keep in mind	Christopher Crosby, UNAVCO/OpenTopography (ISTB4 Rm 240)
12:00pm	<i>Lunch</i>	<i>Provided (Crater Carpet, 3rd Floor ISTB4)</i>

1:00pm	OpenTopography, UNAVCO, NCALM, and other resources	Christopher Crosby, UNAVCO/OpenTopography (ISTB4 Rm 240)
3:00pm	Introduction to point cloud visualization and analysis using CloudCompare and LAStools <ul style="list-style-type: none"> • Tahoe las file • DEM generation from point cloud data 	Ramón Arrowsmith, Arizona State University (PSH Rm 461)
4:00pm	Raster-based HRT analysis in ArcGIS: Data visualization, mapping, simple topographic differencing, hydrologic analysis <ul style="list-style-type: none"> • Video Tutorials • Basic visualization of LiDAR Digital Elevation Models using ArcGIS • Extracting Information from DEMs in ArcMap • Simple landscape morphometry and stream network delineation • Standard DEMs, Dragon's Back sample data 	Ramón Arrowsmith, Arizona State University (PSH Rm 461)
5:30pm	<i>Return to hotel</i>	Dinner on your own
7:30pm	Presentations from participants & social gathering	Hayden Ballroom, 2nd Floor Graduate Hotel

Tuesday, January 26th 2016

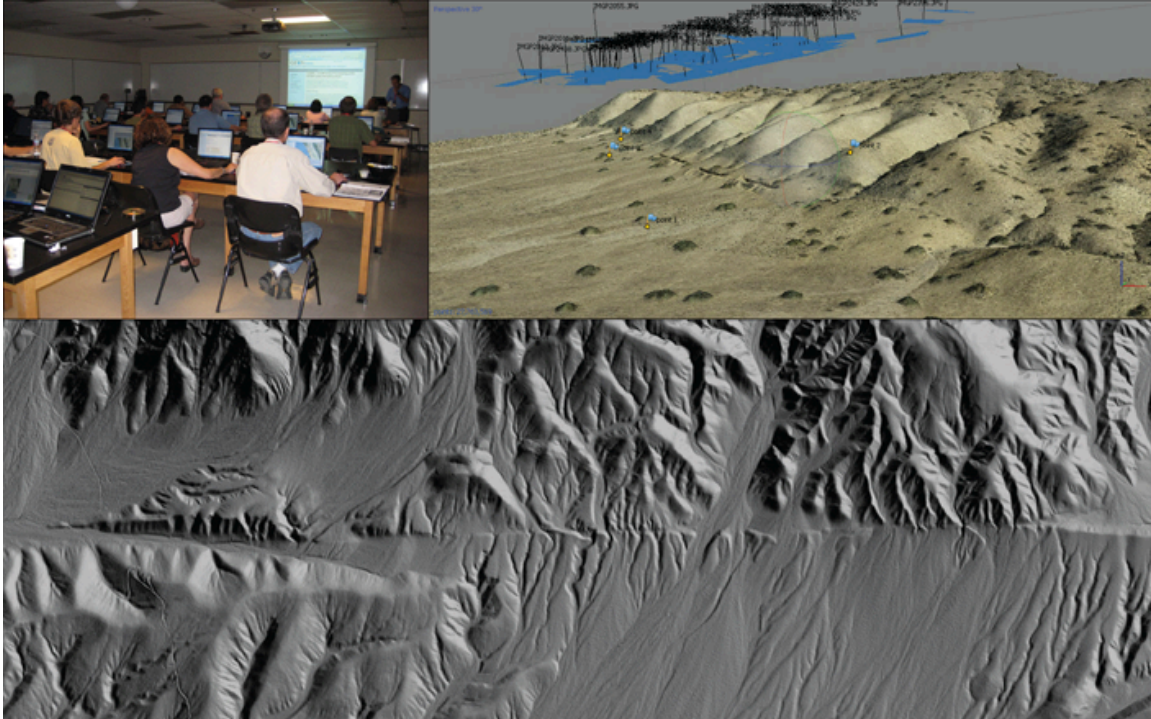
Time	Topic	Instructor, Affiliation (Location)
8:30am	Lecture: Topographic Change Detection, ICP using CloudCompare, registering multiple topographic datasets, and topographic change detection	Ed Nissen, CO School of Mines (ISTB4 Rm 240)
	Lecture: Structure from Motion (SfM)	Ed Nissen, CO School of Mines

		(ISTB4 Rm 240)
10:00am	<i>Break; move to H461; take a few pictures on the way for an SfM model</i>	
10:15am	Considerations for Building SfM Machines for Use With Agisoft PhotoScan Structure from Motion (SfM) demo - EMC EQ SfM images	Barret Salisbury, ASU Ed Nissen, CO School of Mines + Arrowsmith + Crosby
12:00pm	<i>Lunch</i>	<i>Provided</i>
1:00pm	Topographic Change Detection, ICP using CloudCompare, registering multiple topographic datasets, and topographic change detection (Deo) <ul style="list-style-type: none"> • Tutorial: ICP cloud registration and change detection with CloudCompare - White Sands dunes sample data • Nissen et al. code for windowed ICP change detection • Dimitri Lague's tools for point cloud filtering (CANUPO) and change detection (M3C2) 	Ed Nissen, CO School of Mines + Crosby
3:00pm	LaDicaoz: Lidar data handling and lateral displacement measurement - LaDiCaoz data and Scripts for Short Course	Ramón Arrowsmith, Arizona State University (PSH Rm 461)
4:30pm	Final discussion, Q&A	All Instructors (PSH Rm 461)

Short Course Participants:

Name	Organization/Affiliation	Position
Nathan Dickey	California State University, Northridge, Department of Geological Sciences	Graduate student
Eui-jo Marquez	Department of Geological Sciences, San Diego State University	Graduate student
Greg Yin	University of California, Los Angeles	Undergraduate
Alexandra Hatem	University of Southern California, PhD student w/ James Dolan	Graduate student
Elaine Young	University of California, Davis, Department of Earth and Planetary Science	Graduate student
Katherine Lewis	California State University, Northridge	Graduate student
William "Joe" Cochran	Virginia Polytechnic Institute	Graduate student
Jerlyn Swiatlowski	University of California, Riverside	Graduate student
Christodoulos Kyriakopoulos	UC Riverside	Postdoc
Philip Schoettle-Greene	University of Washington department of Earth and Space Sciences	Graduate student
Robert Leeper	University of California, Riverside	Graduate student
Jessica Vermeer	Humboldt State University, Arcata, CA	Graduate student
Alex Eddy	University of Colorado Boulder; Institute of Arctic and Alpine Studies (INSTAAR); Boulder Creek Critical Zone Observatory (PI: Dr. Suzanne Anderson)	Graduate student
Mindi Curran	Humboldt State University Geology Department	Graduate student
Alexander Shmurakov	Masters student at San Jose State University	Graduate student
Cassandra Brigham	I am a recent graduate of Carleton College, currently employed by the National Park Service.	Undergraduate
Patricia Andrade García	Centro de Investigación Científica y de Educación Superior (CICESE)	Graduate student
Stephanie Dudash	US Geological Survey I work with the SAFSOC group-Bob Powell, Chris Menges, Jon Matti	Agency scientist/researcher
Juvenal León (Parham) Mostafa	CICESE, Baja California, México.	Graduate student
Khoshmanesh	Arizona State University	Graduate student
Rebecca VanderLeest	Adjunct professor at Penn State Harrisburg and graduated with my Master's degree December 2015.	Faculty
Matthew Dorsey	San Diego State University - Geological Sciences	Graduate student
Ailin Zhang	UCLA Department of Earth, Planetary, and Space Sciences	Graduate student
Ian Pierce	Center for Neotectonic Studies Nevada Seismological Laboratory University of Nevada, Reno	Graduate student
Nicolas Barth	Assistant Professor of Geology (early career) Department of Earth Sciences University of California, Riverside	Faculty
Shao Yanixu	1. Liu Jing Group member, Institute of Geology, China Earthquake Administration 2. Michael Oskin Group, University of California, Davis	Graduate student
Lisa Jose	University of Maryland, Baltimore County	Undergraduate
Jozi del Angel	University of California, Riverside	Graduate student
Amelia Nachbor	University of South Florida	Graduate student
Austin Hanson	New Mexico State University	Graduate student
Andrea Donnellan	JPL	Agency scientist/researcher
Jinny Lee	JPL & California State University, Los Angeles	Graduate student
Kade Carlson	University of Kentucky	Graduate student

Exemplary Figure



Imaging and Analyzing Southern California's Active Faults with High Resolution Topography short course summary image. Upper left: participants work through a hands-on data processing exercise in computer lab at ASU. Upper right: Structure from Motion model showing camera positions. Bottom: Lidar hillshade for the Garlock fault. (Photo: C. Crosby)

Intellectual Merit

With over 4500 km² of recently acquired fault zone lidar available in southern California, and a pool of TLS equipment accessible to the community through UNAVCO, enthusiasm and interest in these data are high. The SCEC lidar short course is timely and focused venue to present advances in analysis techniques and recent results, and to provide a foundation for new community members who wish to incorporate these data into their research. This course helps to develop a community of SCEC scientists, graduate students, and agency and consulting geoscientists who can fully harness the rich community airborne and terrestrial lidar resources currently available, and SfM technology, to advance SCEC science priorities.

Broader Impacts

The SCEC lidar short course provides hands-on training in new geospatial data processing and analysis techniques that are applicable beyond active tectonics applications of lidar. With an emphasis on undergraduate, graduate, and postdoctoral participants, the short course provides technical training and education to the future geoscience workforce. All materials from the course are also available online where they can be reused by the larger scientific and practitioner communities.

Publications - NA