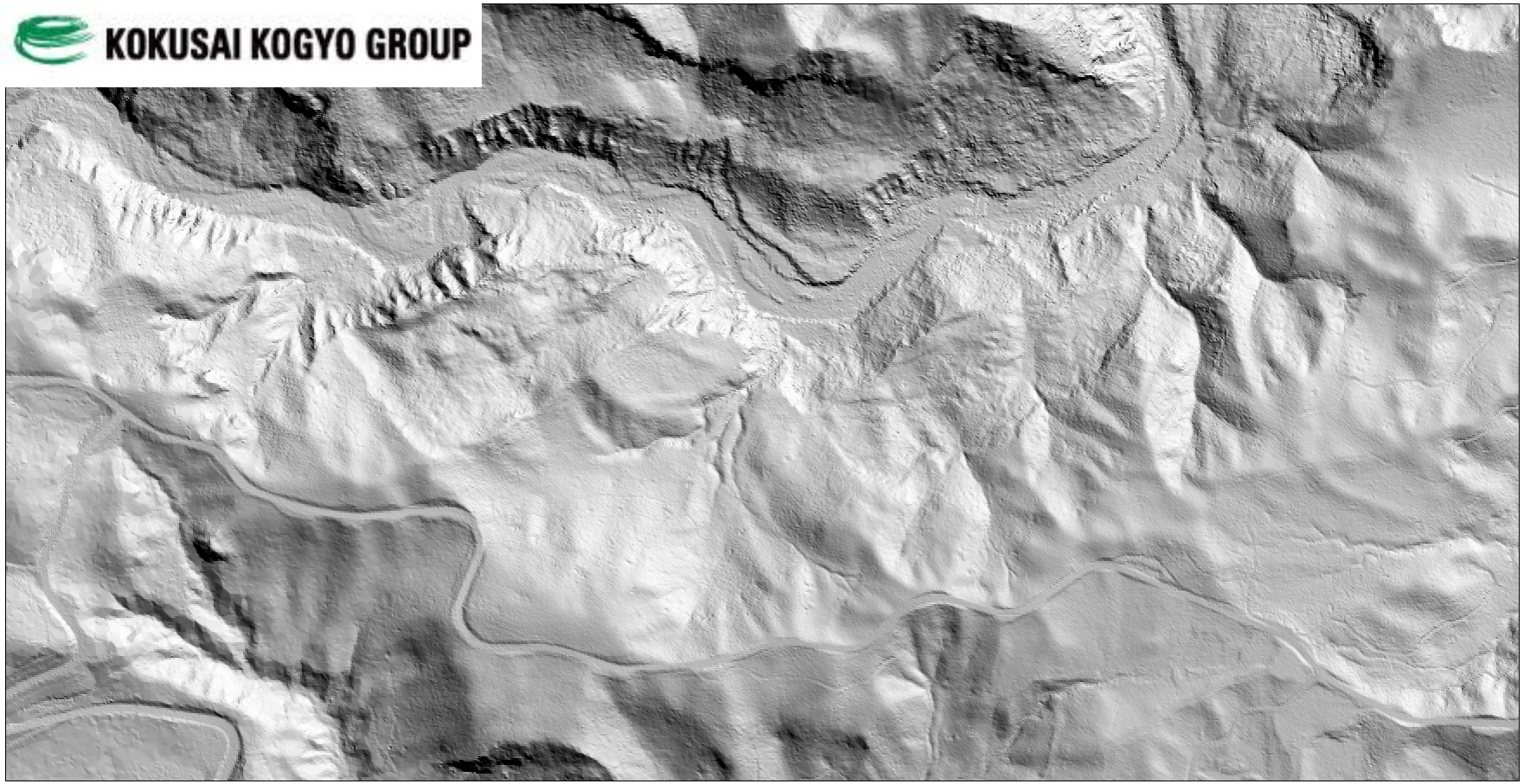
Differential topography

How does topography change with time?

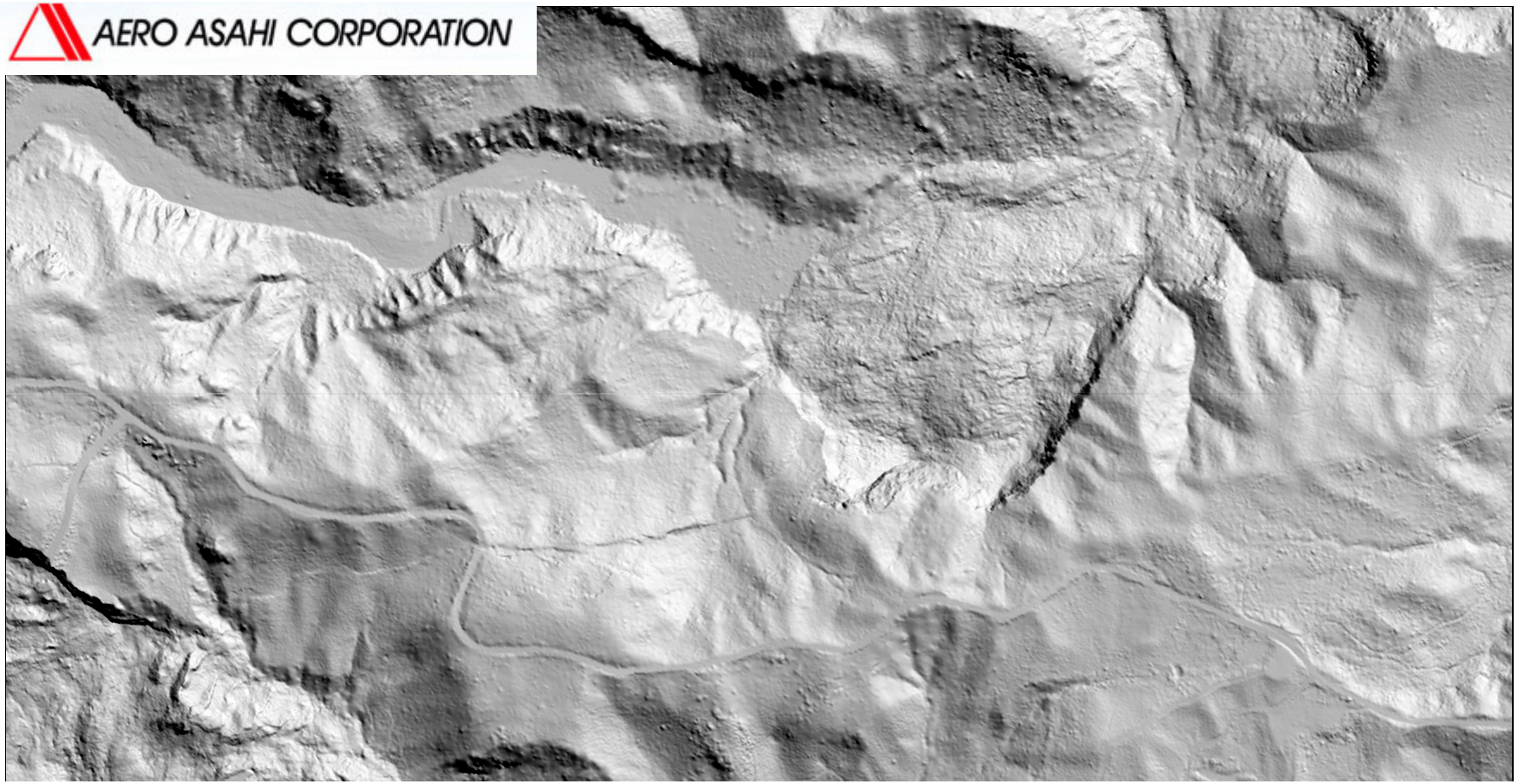
The 2008 Iwate-Miyagi earthquake (Mw 6.9), Japan



Pre-earthquake DTM (2m)

Nissen, E., Maruyama, T., Arrowsmith, J R., Elliot, J. R., Krishnan, A. K., Oskin, M. E., Saripalli, S., Coseismic fault zone deformation revealed with differential LiDAR: examples from Japanese Mw 7 intraplate earthquakes, Earth and Planetary Science Letters, 2014

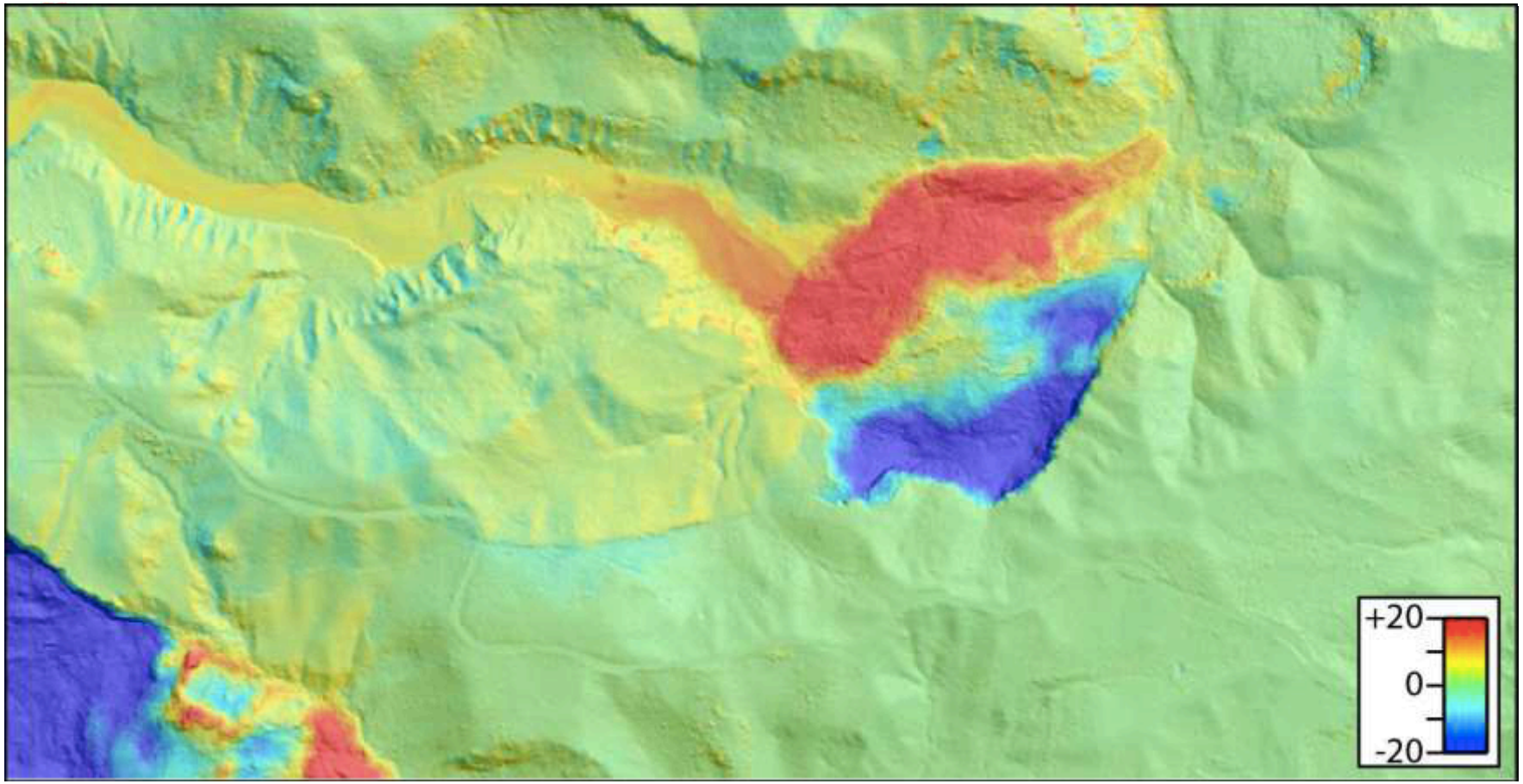
The 2008 Iwate-Miyagi earthquake (Mw 6.9), Japan



Post-earthquake DTM (1m)

Nissen, E., Maruyama, T., Arrowsmith, J R., Elliot, J. R., Krishnan, A. K., Oskin, M. E., Saripalli, S., Coseismic fault zone deformation revealed with differential LiDAR: examples from Japanese Mw 7 intraplate earthquakes, Earth and Planetary Science Letters, 2014

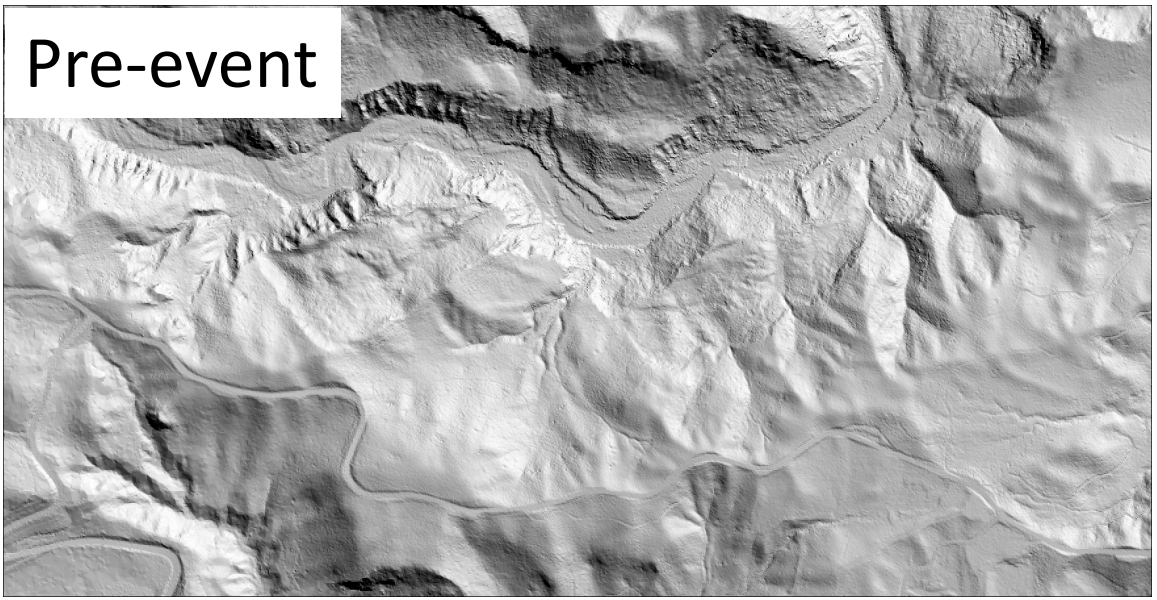
The 2008 Iwate-Miyagi earthquake (Mw 6.9), Japan

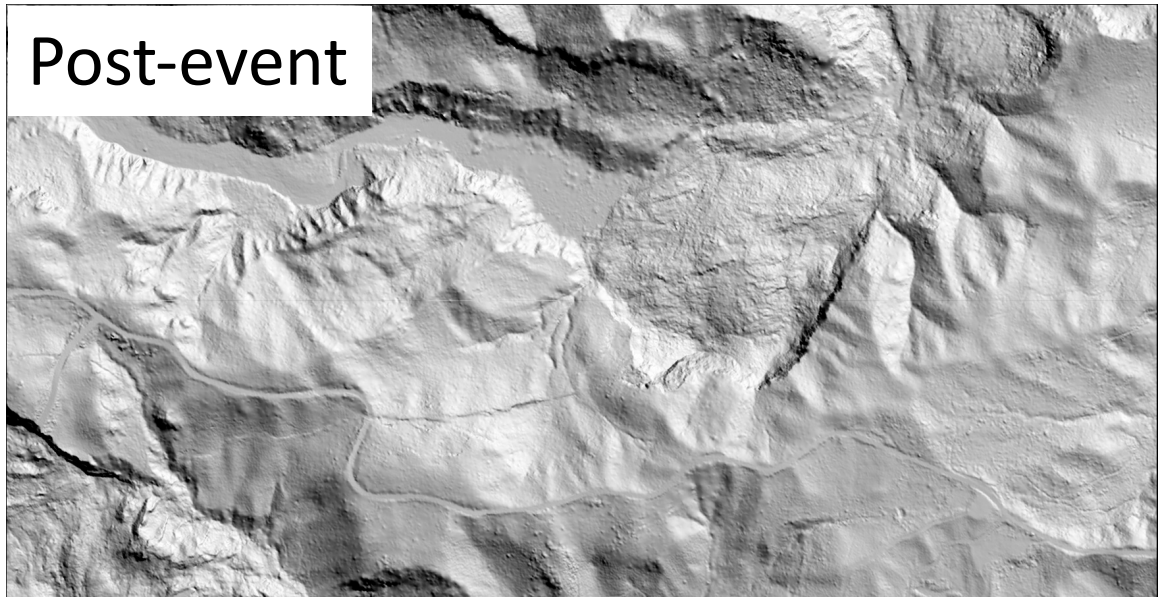


2006-2008 Height Change (m)

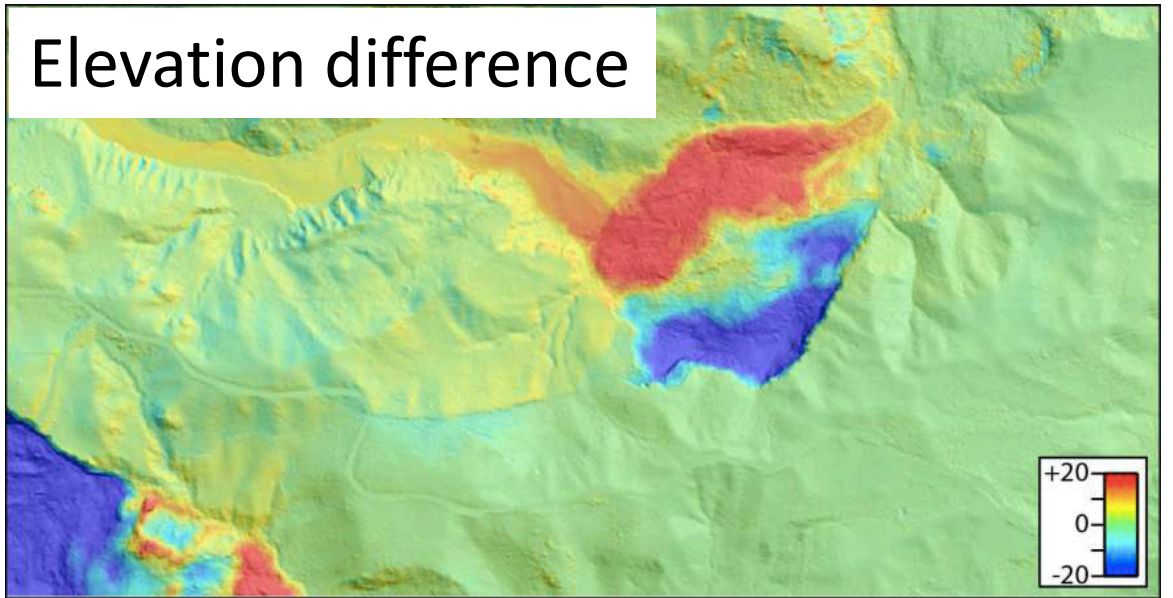
Nissen, E., Maruyama, T., Arrowsmith, J R., Elliot, J. R., Krishnan, A. K., Oskin, M. E., Saripalli, S., Coseismic fault zone deformation revealed with differential LiDAR: examples from Japanese Mw 7 intraplate earthquakes, Earth and Planetary Science Letters, 2014

Vertical differencing



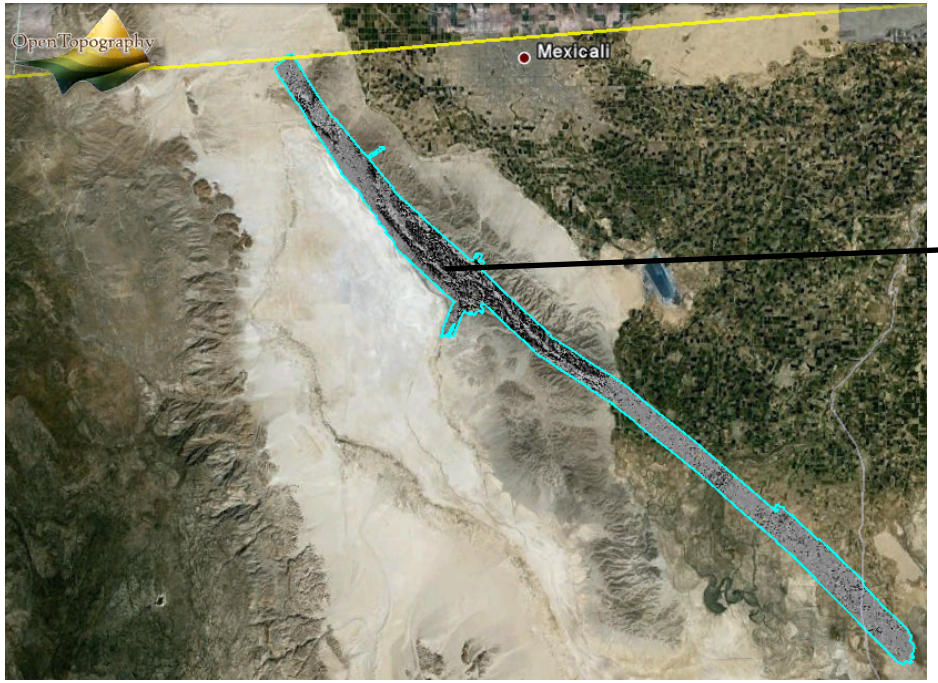


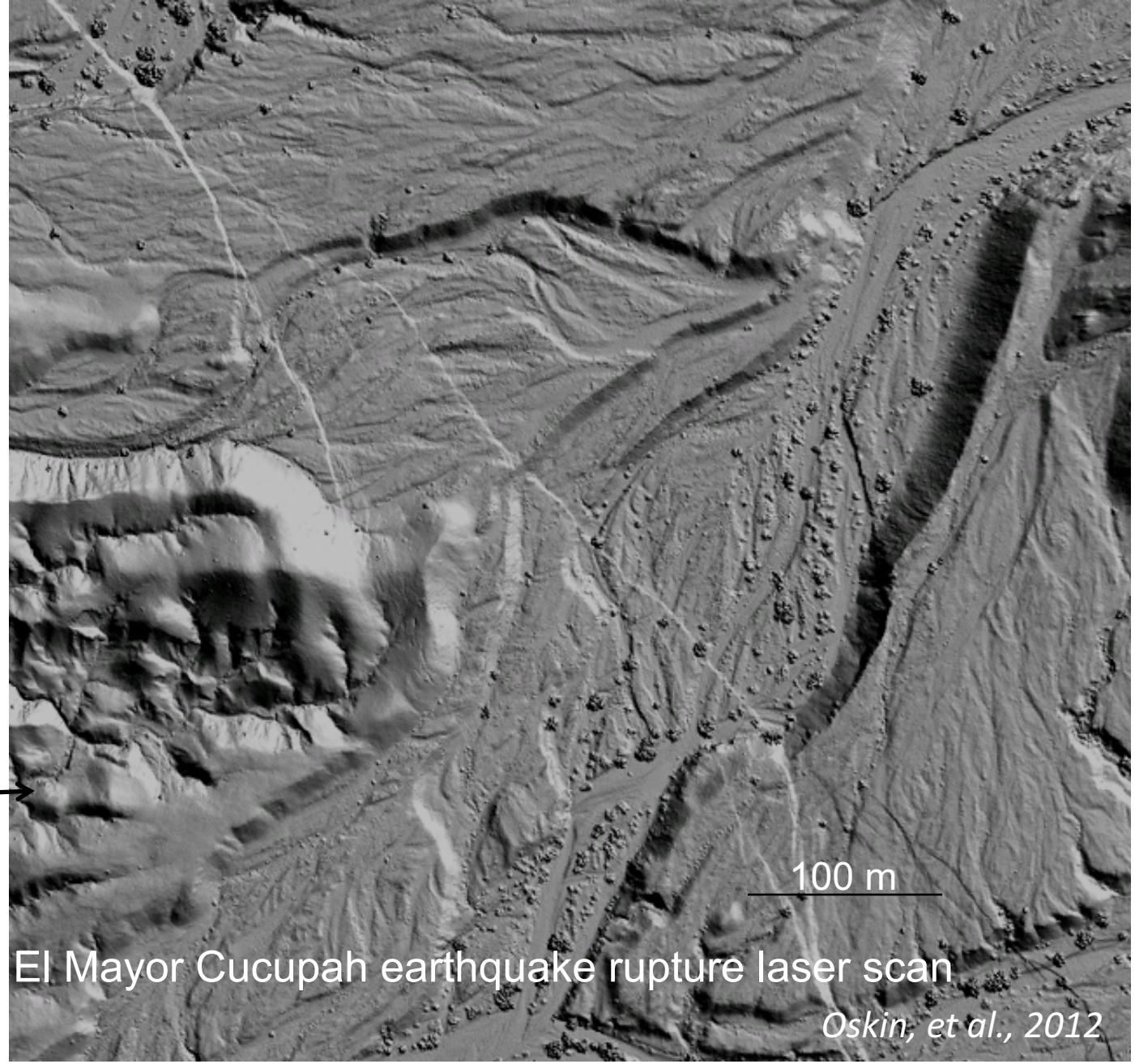
Elevation difference
= post-event elevation-pre-event elevation



Imagery from Nissen et al (2014)

2010 M_w 7.2 El Mayor Cucupah, Mexico, Earthquake





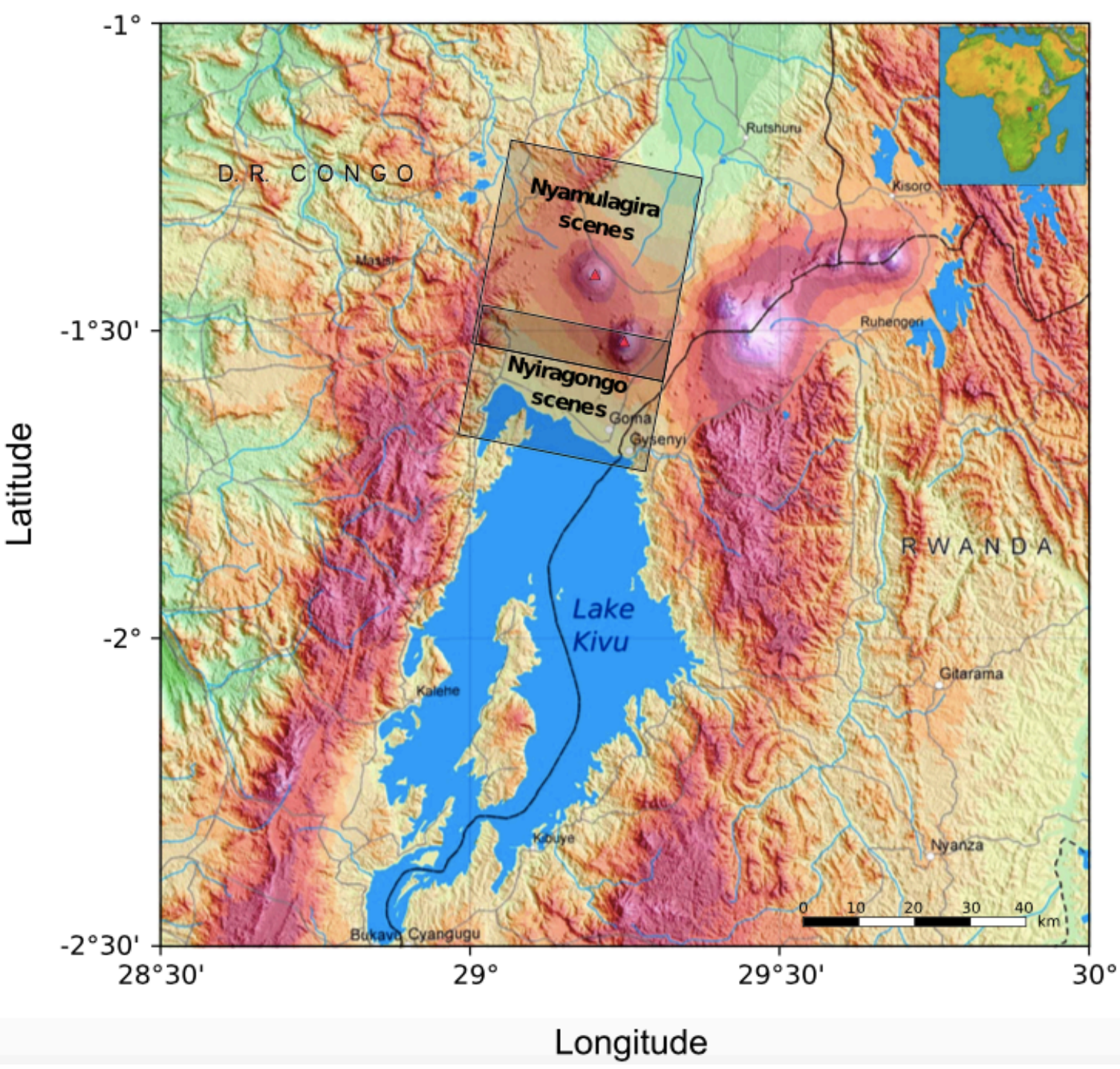
El Mayor Cucupah earthquake rupture laser scan

Oskin, et al., 2012

UCDAVIS DEPARTMENT OF GEOLOGY CICESE ASU SCHOOL OF EARTH & SPACE EXPLORATION ARIZONA STATE UNIVERSITY NSF NCALM

Photo by Tom Rockwell

https://www.youtube.com/watch?v=BpoE-mwpPT0

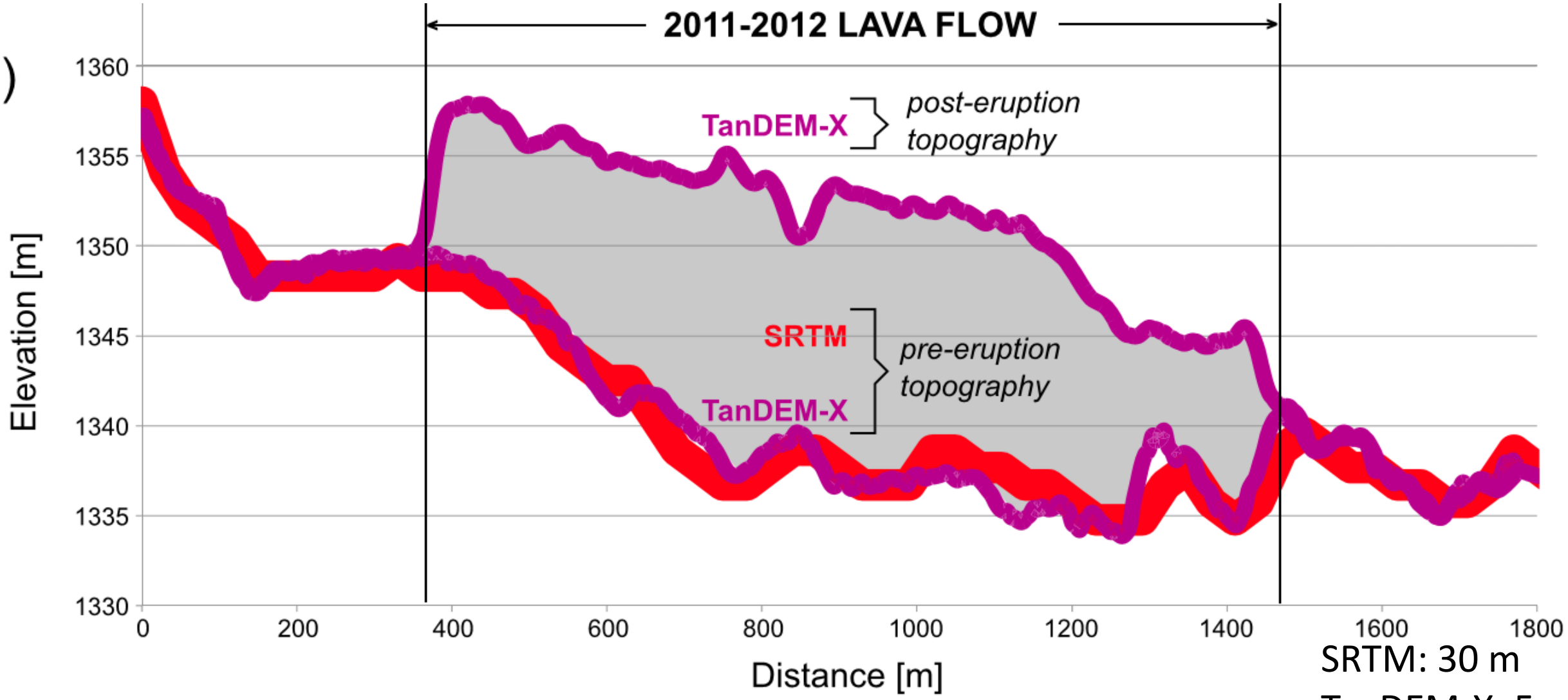


Volcanoes

- What is timing and location of the volcanic eruptions?
- What is the volume of the volcanic eruption?
- What is the eruption rate?

High-resolution TanDEM-X DEM: An accurate method to estimate lava flow volumes at Nyamulagira Volcano (D. R. Congo): Albino et al. (2015)

Volcanic eruption



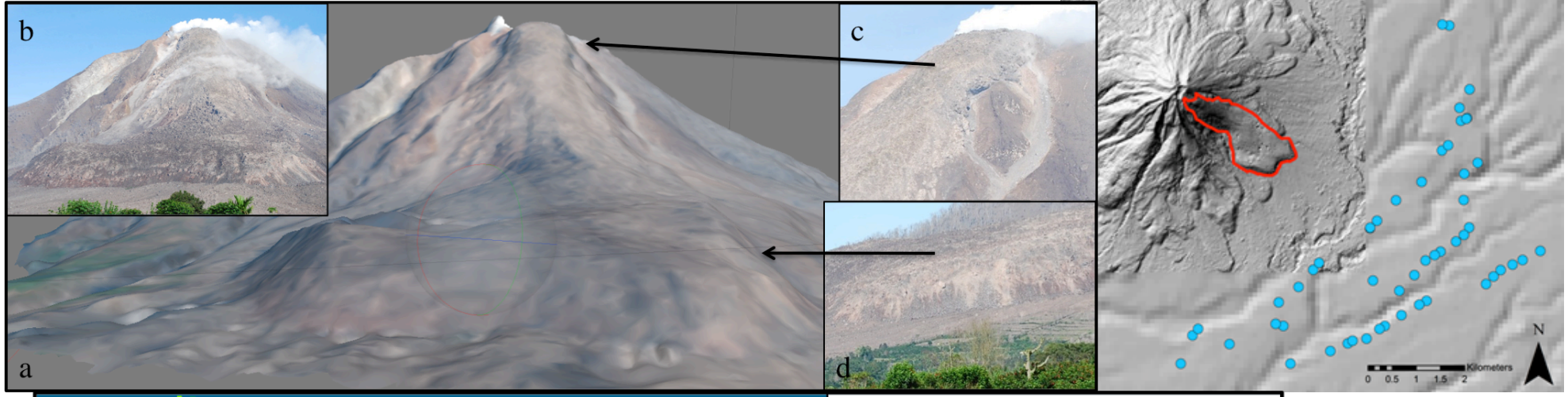
SRTM: 30 m

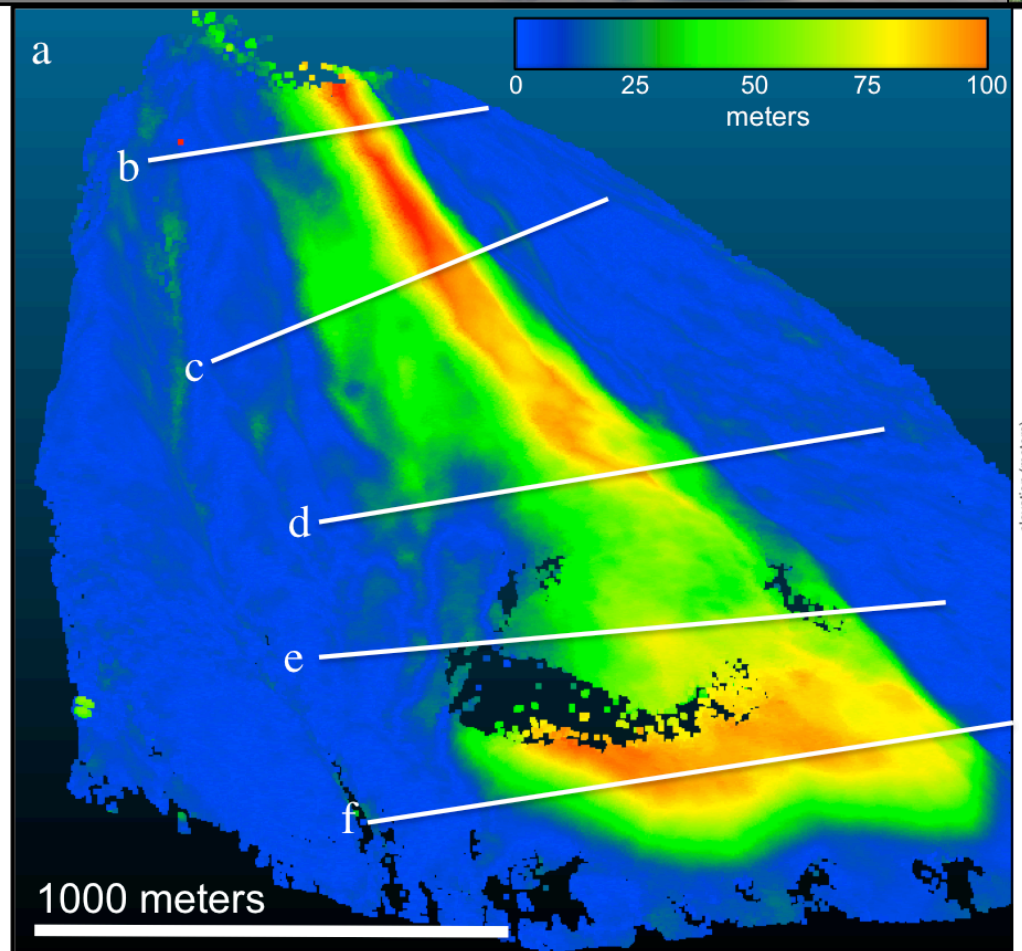
TanDEM-X: 5 m

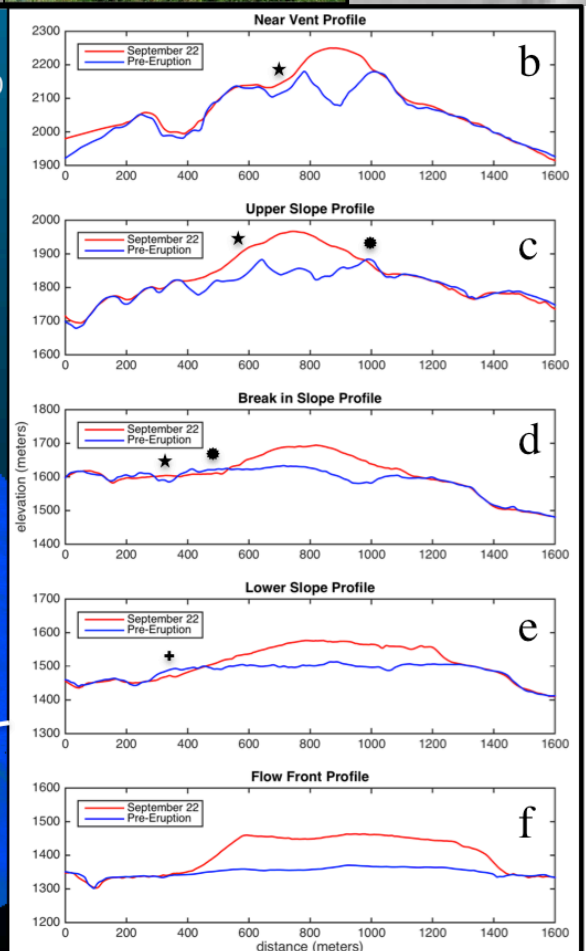
Mean thickness: 12.7 m

Eruptive volume: 305.2+/- 36.0x10^6 m^3

Albino et al. (2015)







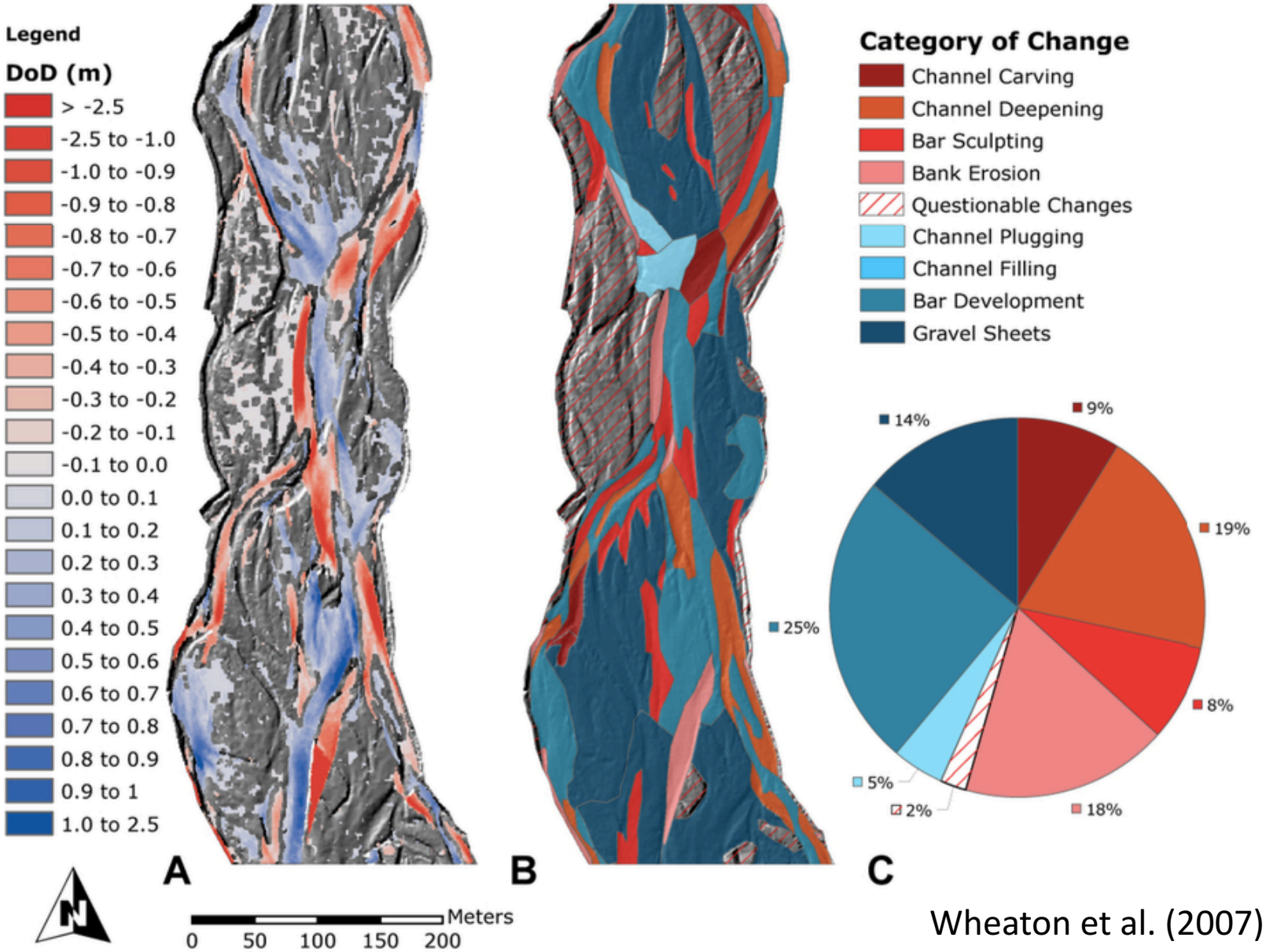
The emplacement of the active lava flow at Sinabung Volcano, Sumatra, Indonesia, documented by structure-from-motion photogrammetry -Carr, et al., in prep.

Fluvial geomorphology

- What processes control the sediment budget?

DEM of difference

Category of change from field, DEM, and aerial photography

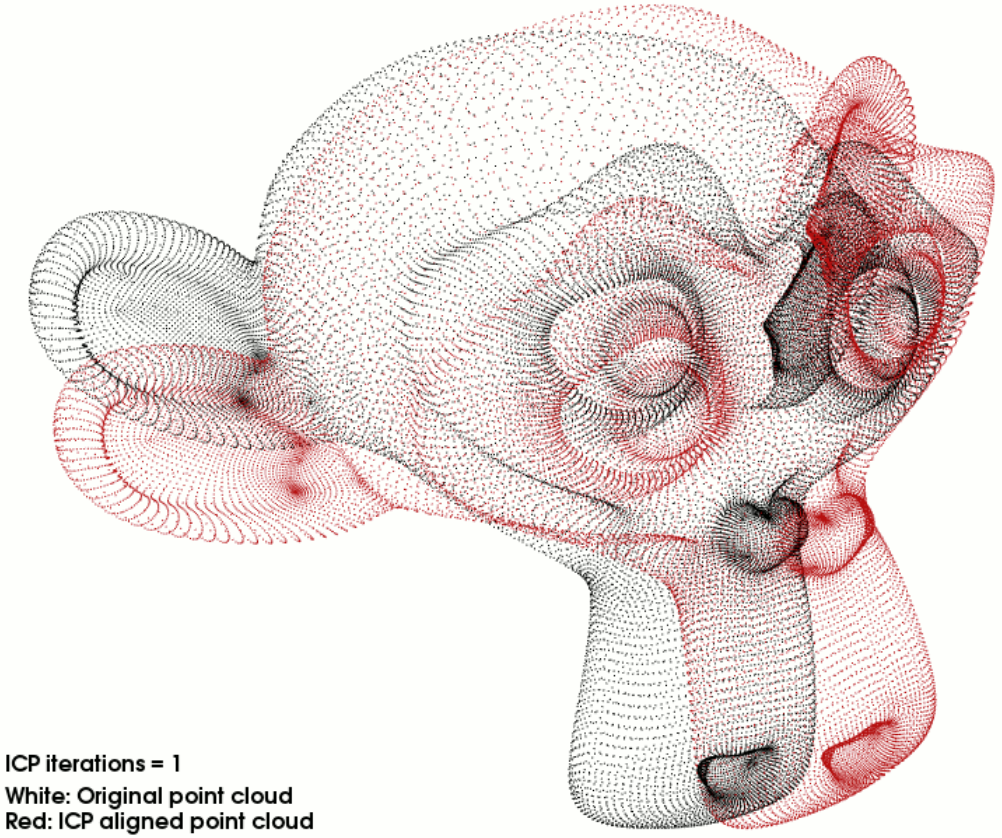


Wheaton et al. (2007)

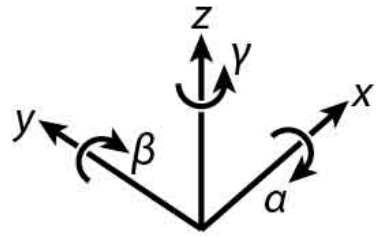
3-D earthquake deformation from repeat LiDAR point clouds

• The **iterative closest point** algorithm (ICP) is a method for registering (aligning) irregular point clouds, well known in computer vision and medical imaging

• ICP minimizes closest point pair distances using iterative **rigid-body transformations,** each one comprising a **translation** [t_x t_y t_z] and a **rotation** [**α β γ**]

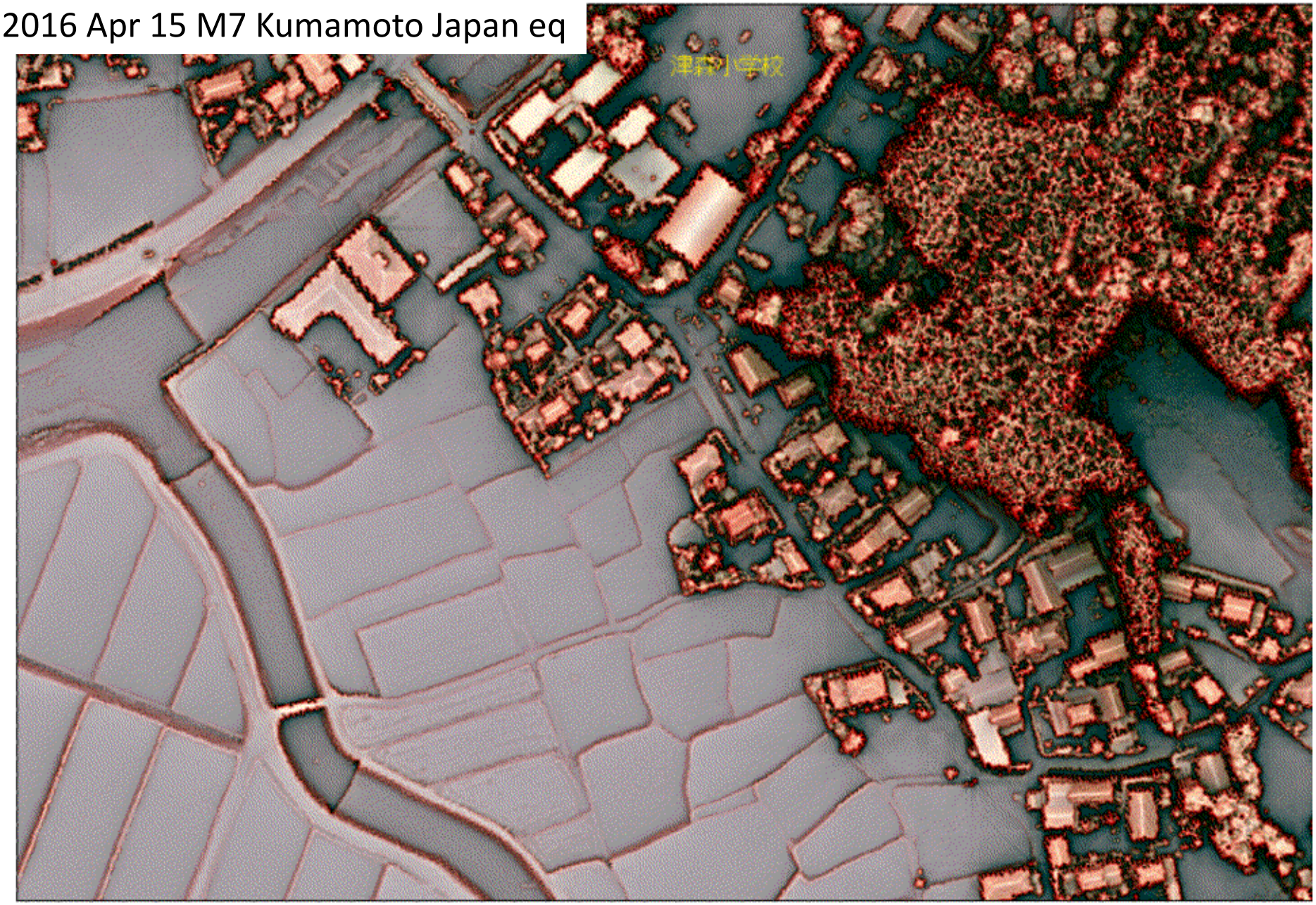


$$\Phi = \begin{pmatrix} 1 & -\gamma & \beta & t_x \\ \gamma & 1 & -\alpha & t_y \\ -\beta & \alpha & 1 & t_z \\ 0 & 0 & 0 & 1 \end{pmatrix}$$



pointclouds.org/documentation/tutorials/interactive_icp.php

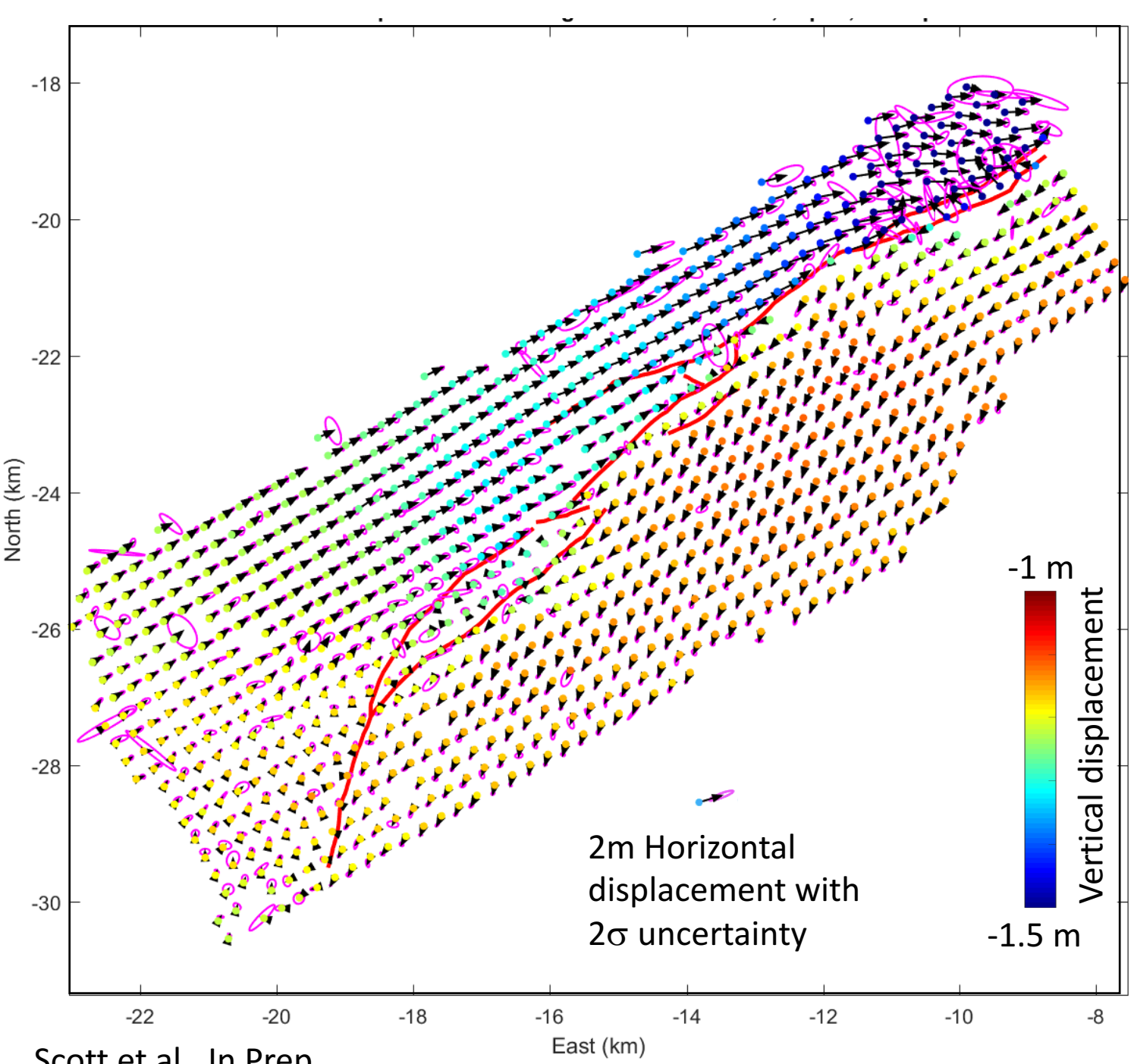
2016 Apr 15 M7 Kumamoto Japan eq



4/15計測　DSMデータによる赤色立体地図
益城町　津森小学校周辺

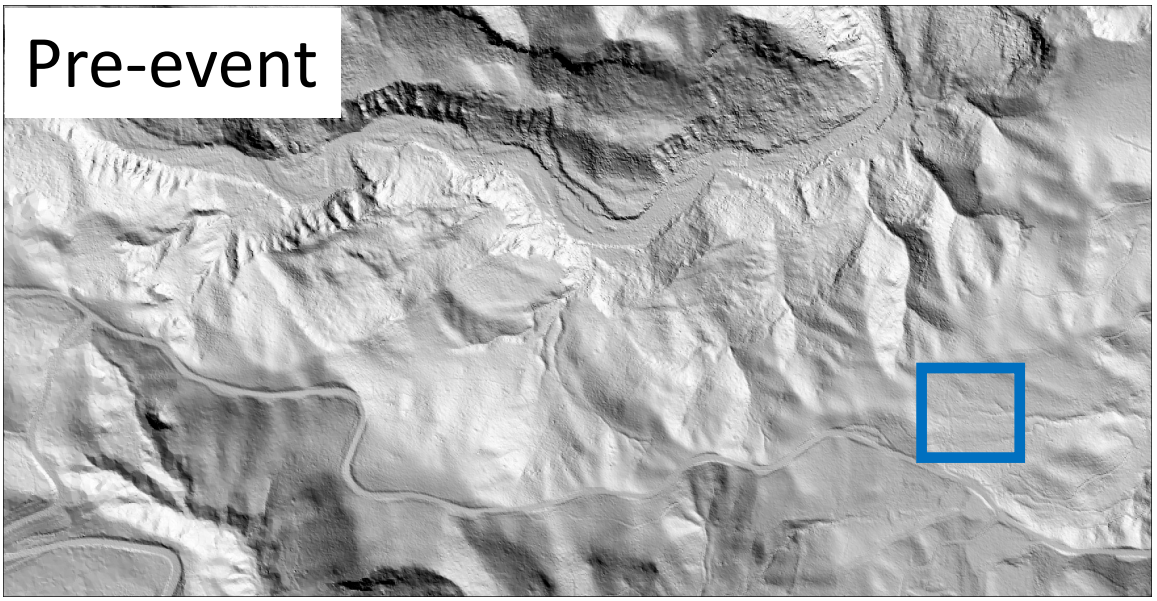
http://www.ajiko.co.jp/saigai/kumamoto_2016_04_2/gif_a.gif

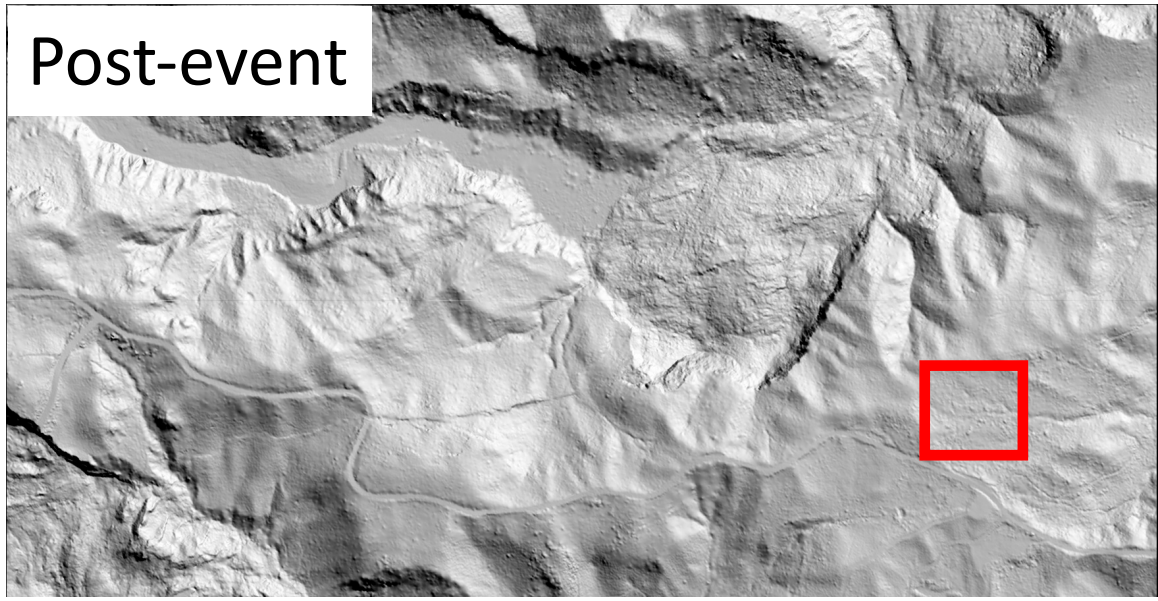
Coseismic displacements during the Kumamoto earthquake

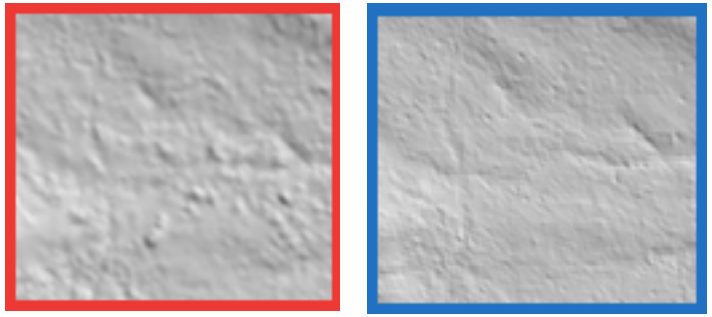


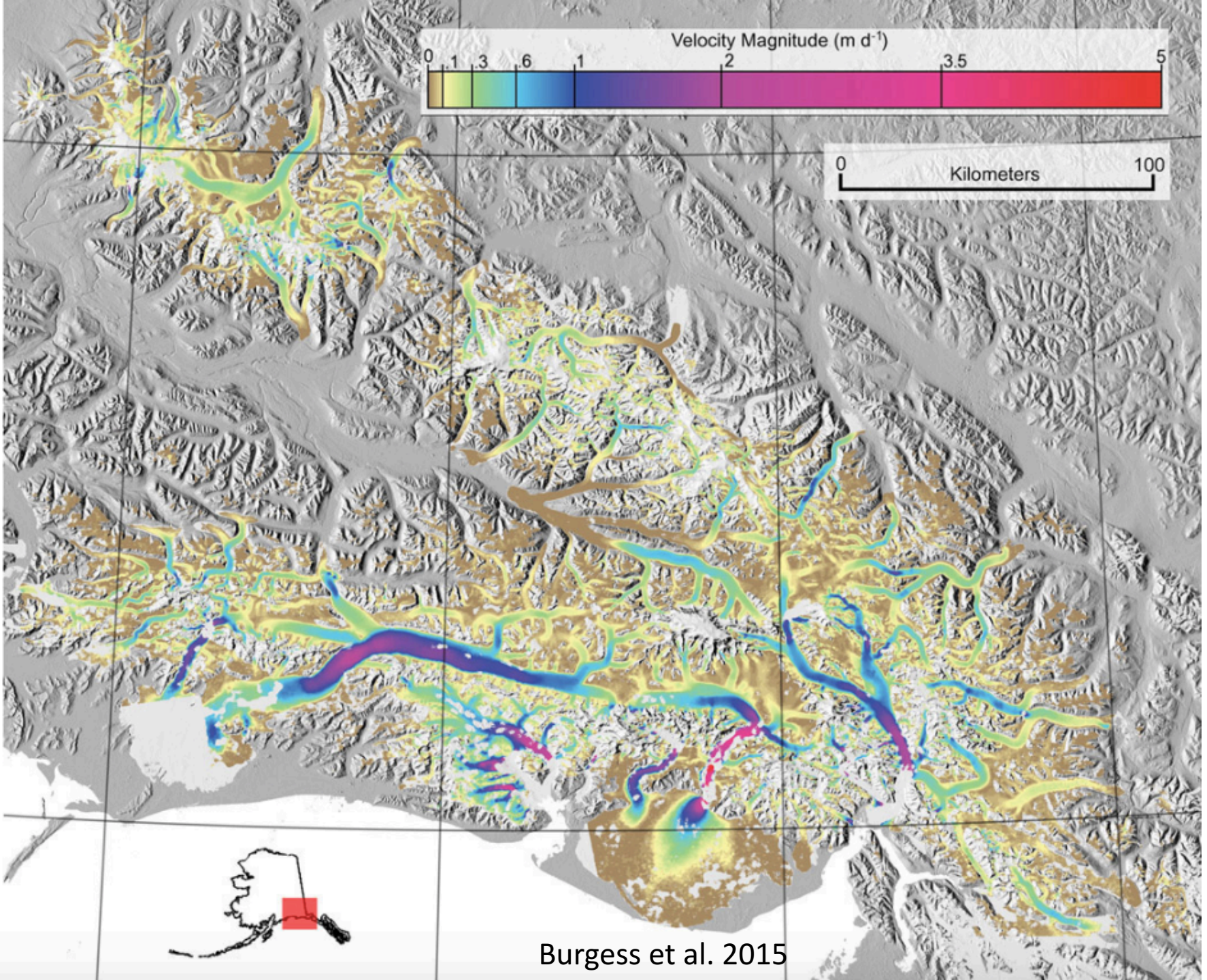
Scott et al., In Prep

Horizontal displacements from cross-correlation









Burgess et al. 2015

What are the velocities of the glacier?