



Overview on my scientific research in probability and volcanology

Andrea Bevilacqua

Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Pisa.

Postdoctoral Researcher in:

“Development and application of physical-mathematical and statistical models in quantifying volcanic hazard”

27 March, INGV, Postdoc and Fellowship Day.

LIFE-STORY

2018
5 months

Postdoctoral Associate

INGV, Sezione di Pisa; Project FISR 2017 - SOIR

Development and application of physical-mathematical and statistical models for the quantification of volcanic hazard.



2016
29 months

Postdoctoral Associate (R.V. Fisher Postdoctoral Fellowship)

Center for Geohazard Studies, Department of Earth Sciences, University at Buffalo, NY, USA
Hazard SEES project NSF, and CDSE Program, UB.

Multidisciplinary Volcano Hazards Research – probabilistic volcanic hazard analyses and uncertainty quantification related to case studies at Kilauea and Long Valley volcanic systems.



2014
18 months

Research Fellow

INGV, Sezione di Pisa; Progects DPC-V1 e EU-FP7 Supersite MED-SUV

Volcanic hazard assessment related to pyroclastic flows and ash dispersion through mathematical models, probabilistic analysis and uncertainty quantification techniques.



2011
36 months

PhD Scholar in Applied Mathematics

Scuola Normale Superiore di Pisa, and INGV, Sezione di Pisa.

DEGREES

2015 Phd in Mathematics for Industrial Technologies

Supervisors: Prof. Franco Flandoli, Dr. Augusto Neri
Scuola Normale Superiore di Pisa, in collaboration with INGV

2011 MS in Mathematics (Laurea Magistrale)

Thesis Advisor: Prof. Franco Flandoli, Università di Pisa

2009 BS in Mathematics (Laurea Triennale)

Thesis Advisor: Prof. Franco Flandoli, Università di Pisa

2006 High School Degree

Liceo scientifico Ulisse Dini, Pisa




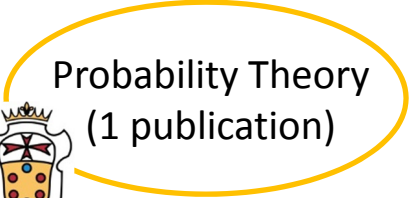

Birthplace: Pietrasanta (LU), 3 July 1987.

RESEARCH LINES

PVHA: Probabilistic Volcanic Hazard Assessment

2011- 2014

Probability Theory
(1 publication)




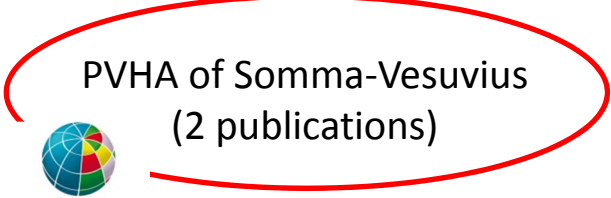

2012- 2017

DPC-V1 (all. C)
PVHA of Campi Flegrei caldera
(5 publications)



MED-SUV (EU-FP7)


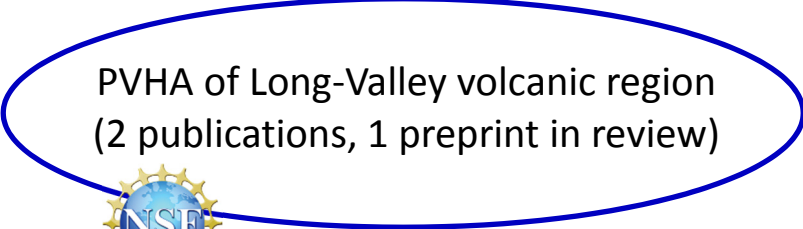

PVHA of Somma-Vesuvius
(2 publications)



2016 - ...


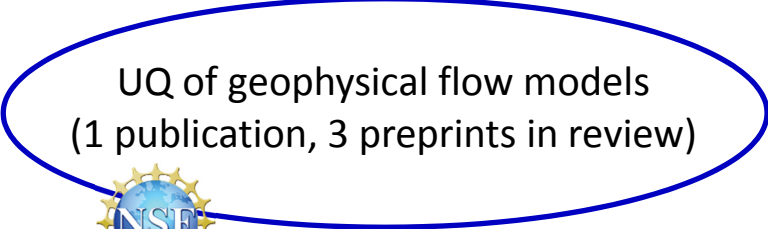

HSEES (NSF #1521855)

PVHA of Long-Valley volcanic region
(2 publications, 1 preprint in review)



NSF #1339765, NSF #1621853

UQ of geophysical flow models
(1 publication, 3 preprints in review)



2018 - ...


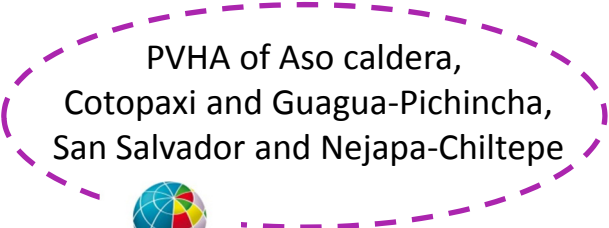

FISR2017

NSF #1821311

PVHA using Precursory Data
(2 preprints in review)



PVHA of Aso caldera,
Cotopaxi and Guagua-Pichincha,
San Salvador and Nejapa-Chiltepe



UQ: Uncertainty quantification

2012 - 2015

PVHA at Campi Flegrei caldera (5 publications)



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Figure 1. Probability maps of **vent opening** (PVO), % per km², **conditional on a new eruption.** (a) and (c) refer to the 5th and 95th %iles, Figure (b) to the mean values.

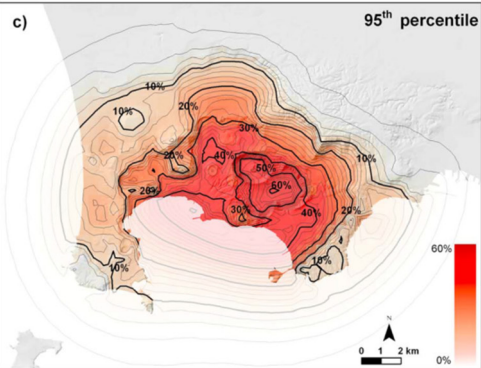
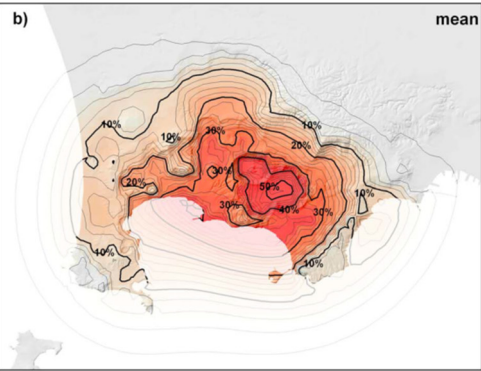
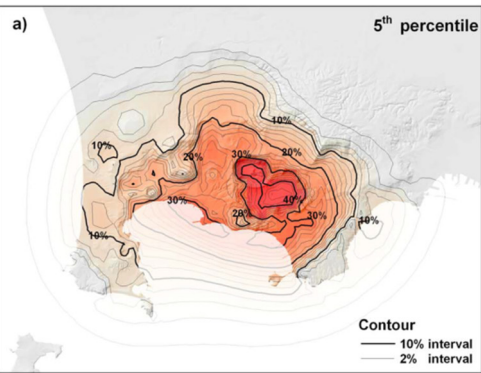
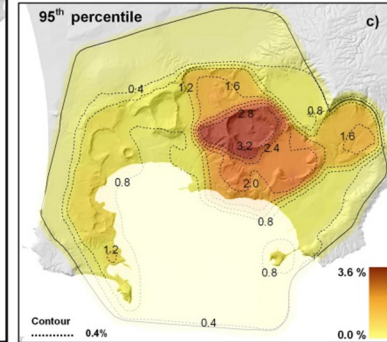
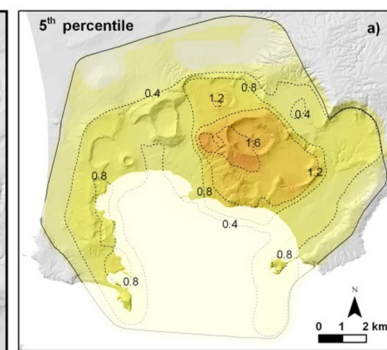
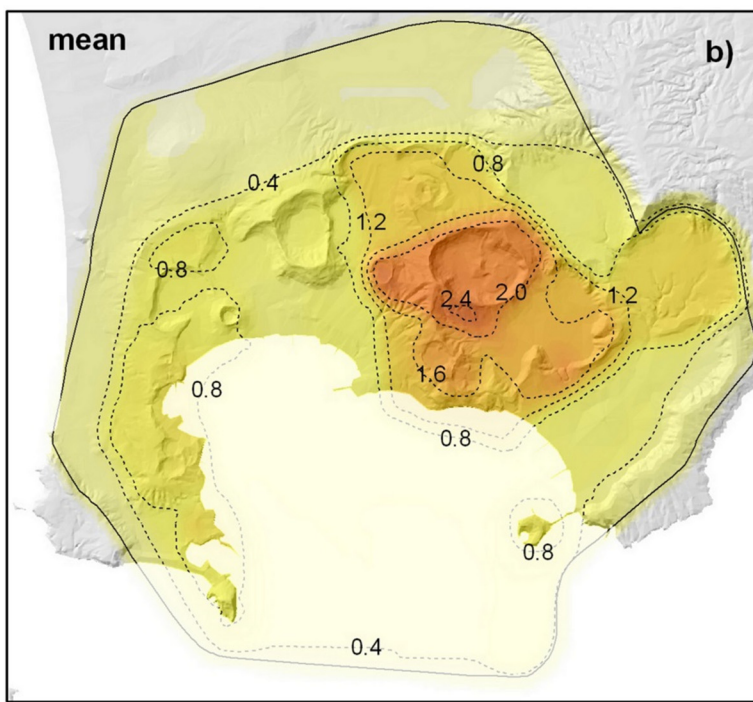


Figure 2. PDC invasion hazard maps with the PVO in Fig. 1 and the areal sizes in the last 5 ka. Maps **conditional on a new explosive eruption**, with a vent located inland. (a) and (c) are the 5th %ile and 95th %ile, (b) the mean values.

AGU PUBLICATIONS

Journal of Geophysical Research: Solid Earth

RESEARCH ARTICLE
10.1002/2014JB011775

This article is a companion to Neri et al. [2015] doi:10.1002/2014JB011776.

Key Points:
• Probability of vent opening is higher in the central eastern part of

Quantifying volcanic hazard at Campi Flegrei caldera (Italy) with uncertainty assessment: 1. Vent opening maps

Andrea Bevilacqua^{1,2}, Roberto Isaia³, Augusto Neri¹, Stefano Vitale⁴, Willy P. Aspinall^{5,6}, Marina Bisson¹, Franco Flandoli⁷, Peter J. Baxter⁸, Antonella Bertagnini¹, Tomaso Esposti Ongaro¹, Enrico Iannuzzi³, Marco Pistolesi^{9,10}, and Mauro Rosi^{10,11}

AGU PUBLICATIONS

Journal of Geophysical Research: Solid Earth

RESEARCH ARTICLE
10.1002/2014JB011776

This article is a companion to Bevilacqua et al. [2015] doi:10.1002/2014JB011775.

Key Points:
• Probabilistic invasion maps for PDC were produced

Quantifying volcanic hazard at Campi Flegrei caldera (Italy) with uncertainty assessment: 2. Pyroclastic density current invasion maps

Augusto Neri¹, Andrea Bevilacqua^{1,2}, Tomaso Esposti Ongaro¹, Roberto Isaia³, Willy P. Aspinall^{4,5}, Marina Bisson¹, Franco Flandoli⁶, Peter J. Baxter⁷, Antonella Bertagnini¹, Enrico Iannuzzi³, Simone Orsucci^{1,8}, Marco Pistolesi^{9,10}, Mauro Rosi^{10,11}, and Stefano Vitale¹²

2014 - 2017

PVHA at Campi Flegrei caldera (5 publications)



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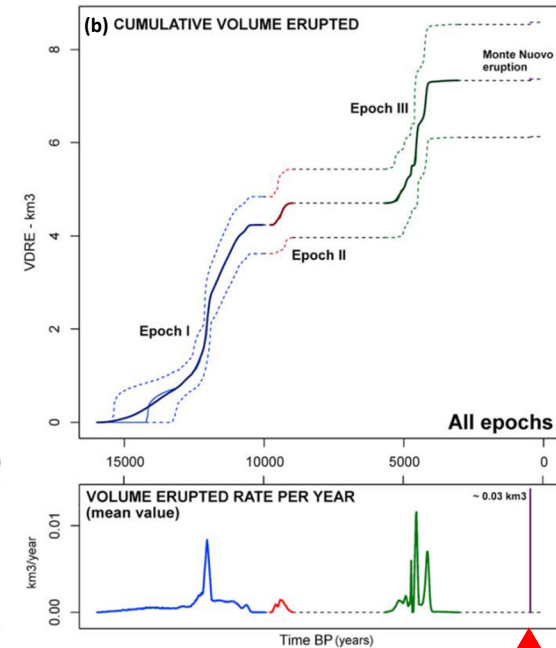
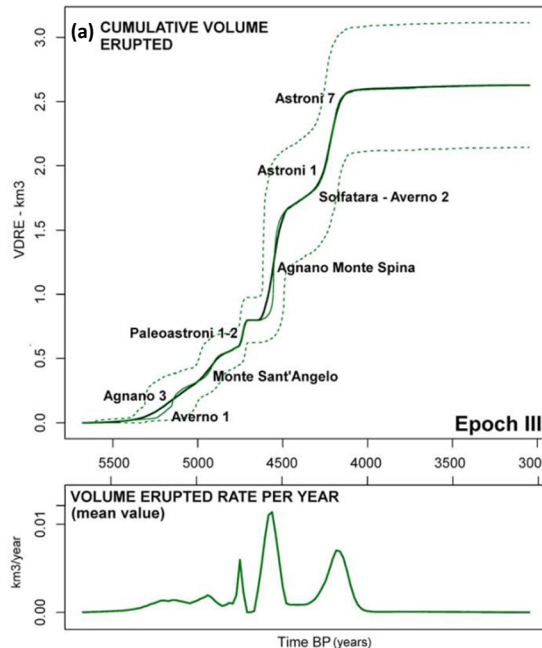
Andrea Bevilacqua

Doubly Stochastic Models for Volcanic Hazard Assessment at Campi Flegrei Caldera



EDIZIONI DELLA NORMALE

Figure 1. Cumulative volume erupted in (a) Epoch III and (b) in the last 15ka. Mean value and 5th and 95th %iles.



PDC HAZARD ESTIMATES FOR THE NEXT 50 YEARS

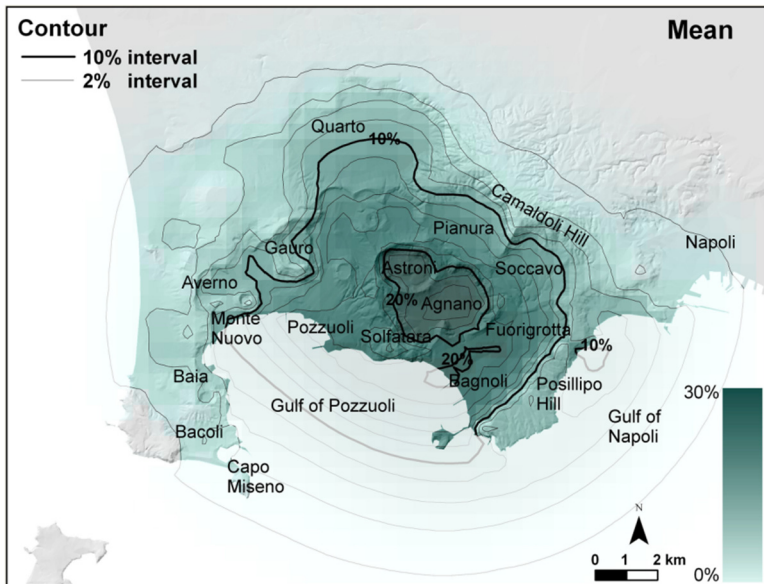


Figure 2. Temporal PDC invasion hazard map assuming to be in a new eruptive epoch. Mean % hazard in the next 50 years with the possibility of a sequence of multiple events.

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Solid Earth

RESEARCH ARTICLE 10.1002/2016JB013171

Temporal models for the episodic volcanism of Campi Flegrei caldera (Italy) with uncertainty quantification

Andrea Bevilacqua^{1,2,3}, Franco Flandoli⁴, Augusto Neri¹, Roberto Isaia⁵, and Stefano Vitale⁶

Key Points:

- Uncertainty model to describe the eruptive record of Campi Flegrei caldera
- Probability model to describe episodic and clustering nature of Campi Flegrei volcanism

¹Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Pisa, Pisa, Italy, ²Scuola Normale Superiore di Pisa, Pisa, Italy, ³Now at Department of Geology, State University of New York at Buffalo, Buffalo, New York, USA, ⁴Dipartimento di Matematica, Università di Pisa, Pisa, Italy, ⁵Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Vesuviano, Napoli, Italy, ⁶Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, Università di Napoli "Federico II", Napoli, Italy

frontiers
in Earth Science

ORIGINAL RESEARCH
published: 12 September 2017
doi: 10.3389/feart.2017.00072

The Effects of Vent Location, Event Scale, and Time Forecasts on Pyroclastic Density Current Hazard Maps at Campi Flegrei Caldera (Italy)

Andrea Bevilacqua^{1,2}, Augusto Neri^{1*}, Marina Bisson¹, Tomaso Esposti Ongaro¹, Franco Flandoli³, Roberto Isaia⁴, Mauro Rosi⁵ and Stefano Vitale^{4,6}

2014 - 2017

PVHA of Somma-Vesuvius (2 publications)



ISTITUTO NAZIONALE
DI GEOFISICA E VULCANOLOGIA

Dataset Weights Probability Density Functions - Cooke Method

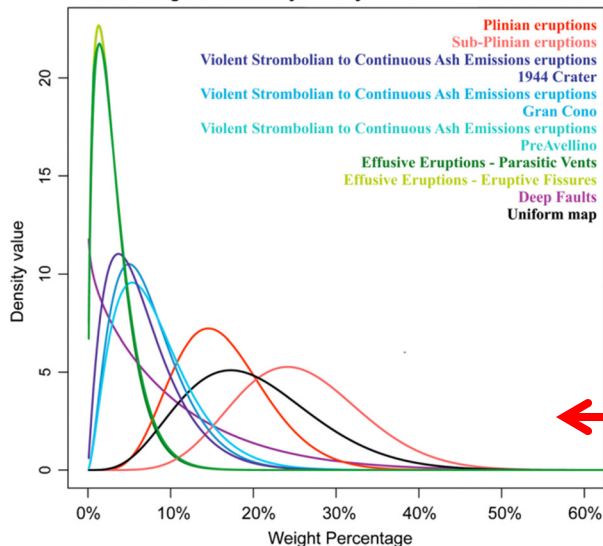


Figure 1. Pdf of expert judgement weights of various information from nine different data sets.

AGU PUBLICATIONS

Journal of Geophysical Research: Solid Earth

RESEARCH ARTICLE

10.1002/2016JB013858

This article is a companion to Tadini et al. [2017] doi:10.1002/2016JB013858.

Assessing future vent opening locations at the Somma-Vesuvio volcanic complex: 1. A new information geodatabase with uncertainty characterizations

A. Tadini^{1,2}, M. Bisson², A. Neri², R. Cioni¹, A. Bevilacqua^{2,3,4}, and W. P. Aspinall^{5,6}

AGU PUBLICATIONS

Journal of Geophysical Research: Solid Earth

RESEARCH ARTICLE

10.1002/2016JB013860

This article is a companion to Tadini et al. [2017] doi:10.1002/2016JB013860.

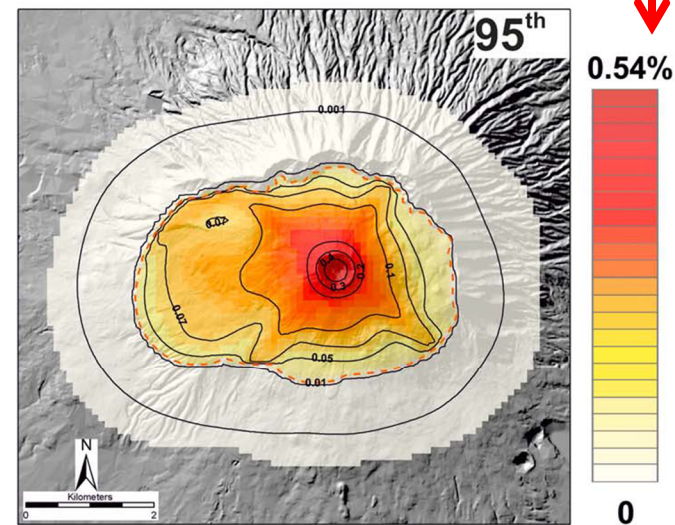
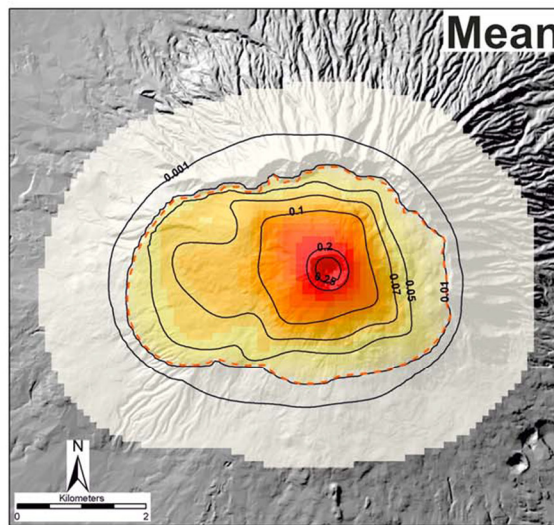
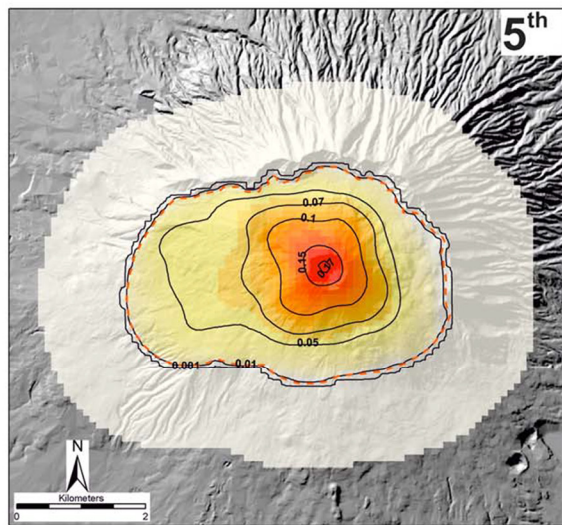
Assessing future vent opening locations at the Somma-Vesuvio volcanic complex: 2. Probability maps of the caldera for a future Plinian/sub-Plinian event with uncertainty quantification

A. Tadini^{1,2}, A. Bevilacqua^{2,3,4}, A. Neri², R. Cioni¹, W. P. Aspinall^{5,6}, M. Bisson², R. Isaia⁷, F. Mazzarini², G. A. Valentine⁸, S. Vitale^{7,9}, P. J. Baxter¹⁰, A. Bertagnini², M. Cerminara², M. de Michieli Vitturi², A. Di Roberto², S. Engwell^{2,11}, T. Esposti Ongaro², F. Flandoli¹², and M. Pistolesi¹

Key Points:

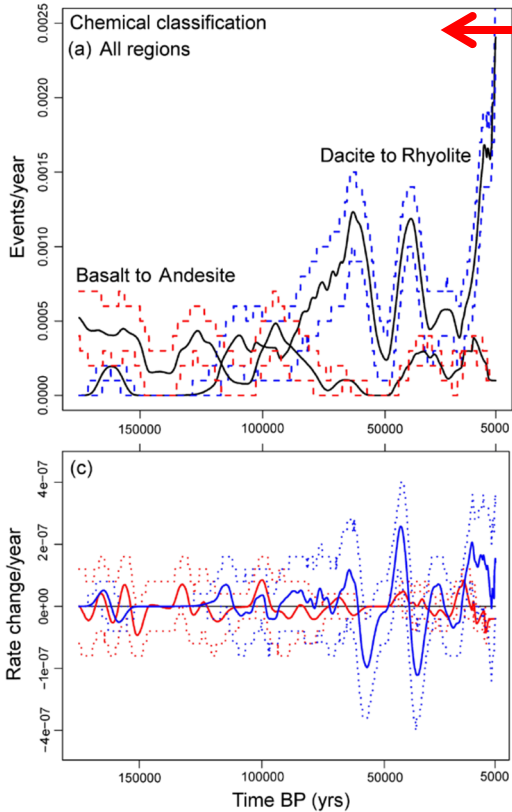
- New vent opening probability maps for a future Plinian/sub-Plinian eruption of Somma-Vesuvio volcano developed
- The maps incorporate uncertainty

Figure 2. PVO maps with possible caldera enlargement effects included. 5th, mean, and 95th %ile values in case of a sub-Plinian or Plinian eruption.



2016 - ...

PVHA in Long-Valley volcanic region
(2 publications, 1 preprint in review)



RESEARCH ARTICLE

10.1029/2018JB015644

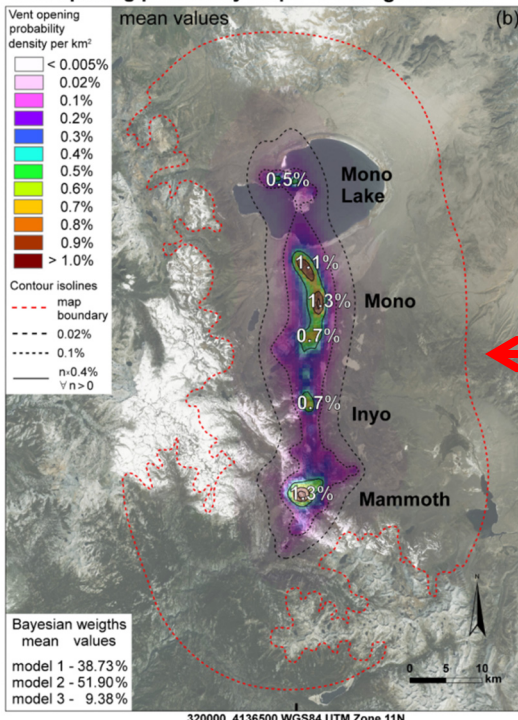
Late Quaternary Eruption Record and Probability of Future Volcanic Eruptions in the Long Valley Volcanic Region (CA, USA)

Andrea Bevilacqua¹, Marcus Bursik¹, Abani Patra², E. Bruce Pitman³, Qingyuan Yang¹, Radhika Sangani¹, and Shannon Kobs-Nawotniak⁴

Key Points:

- There is approximately 22.5% chance of a new volcanic eruption in the Long Valley volcanic region sometime during the next 100 years

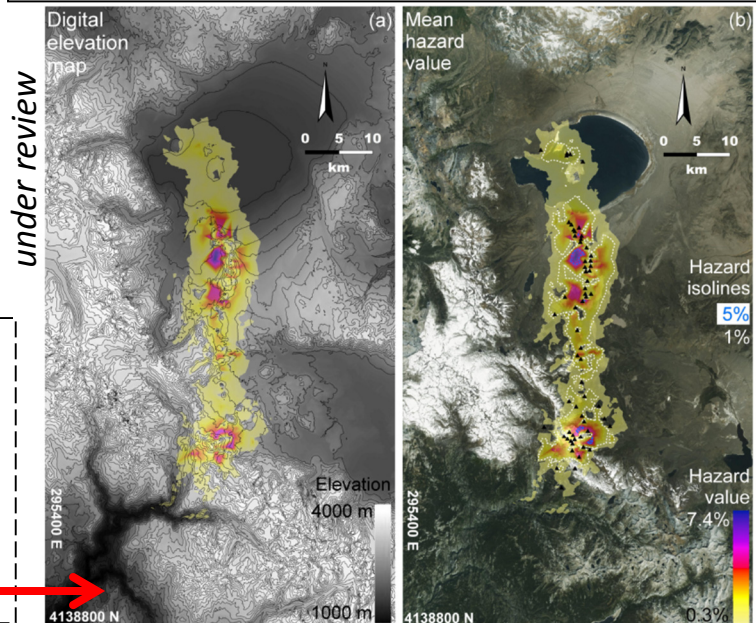
Vent opening probability maps - Averaged model



STATISTICS IN VOLCANOLOGY
Volume 3
August 18, 2017

Bayesian construction of a long-term vent opening map in the Long Valley volcanic region (CA, USA)

ANDREA BEVILACQUA¹
MARCUS BURSİK¹
ABANI PATRA²
E. BRUCE PITMAN³
RYAN TILL⁴

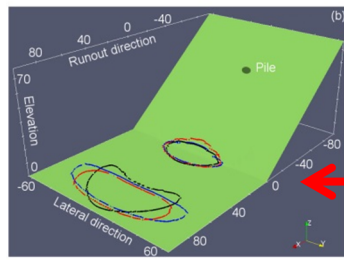
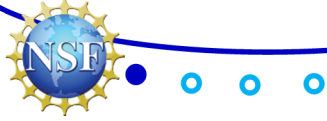


Probabilistic hazard mapping in the Long Valley Volcanic Region CA: integrating vent opening maps and statistical surrogates of physical models of pyroclastic density currents

Regis Rutarindwa¹, Elaine T. Spiller¹, Andrea Bevilacqua^{2,4,5}, Marcus I. Bursik², and Abani K. Patra^{3,4}

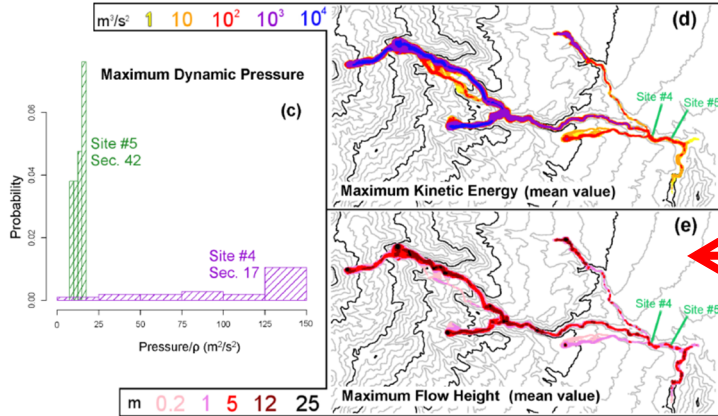
2017 - ...

UQ of geophysical flows models
(1 publication, 3 preprints in review)



Analyzing Complex Models Using Data and Statistics

Abani K. Patra^{1,3}(✉), Andrea Bevilacqua², and Ali Akhavan Safei³



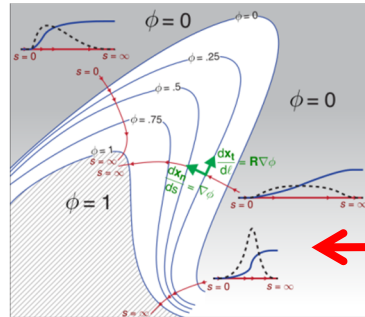
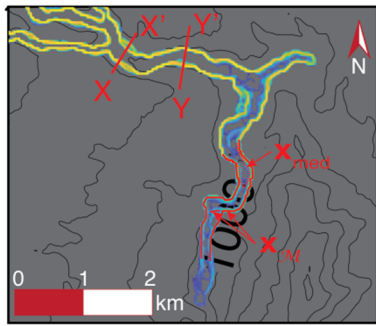
under review

Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2018-294>
Manuscript under review for journal Nat. Hazards Earth Syst. Sci.
Discussion started: 12 November 2018
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Probabilistic forecasting of plausible debris flows from Nevado de Colima (México) using data from the Atenquique debris flow, 1955

Andrea Bevilacqua^{1,2}, Abani K. Patra^{3,2}, Marcus I. Bursik¹, E. Bruce Pitman⁴, José Luis Macías⁵, Ricardo Saucedo⁶, and David Hyman¹



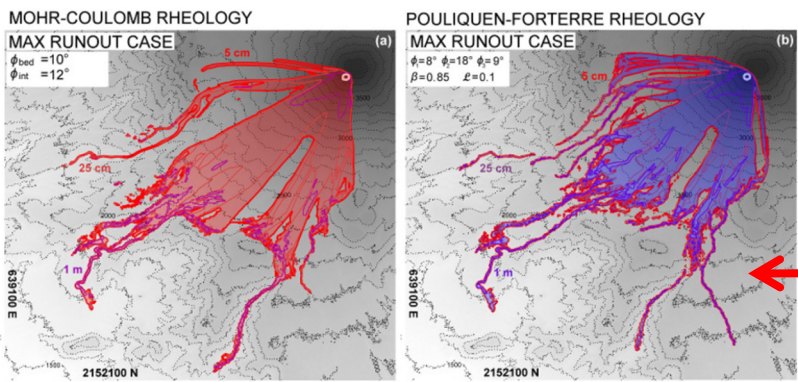
under review

Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2018-344>
Manuscript under review for journal Nat. Hazards Earth Syst. Sci.
Discussion started: 16 November 2018
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Statistical theory of probabilistic hazard maps: a probability distribution for the hazard boundary location

David M. Hyman^{1,2}, Andrea Bevilacqua^{2,3,4}, and Marcus I. Bursik²



under review

Comparative analysis of the structures and outcomes of geophysical flow models and modeling assumptions using uncertainty quantification

Abani Patra^{1,2}, Andrea Bevilacqua^{3,2}, Ali Akhavan-Safei¹, E. Bruce Pitman⁴, Marcus Bursik³, and David Hyman³

2018 - ...

PVHA using Precursory Data (2 preprints in review)



under review

Probabilistic enhancement of the Failure Forecast Method using a stochastic differential equation and application to volcanic eruption forecasts

Andrea Bevilacqua^{1,4,5}, E. Bruce Pitman², Abani Patra^{3,4}, Augusto Neri⁵, Marcus Bursik¹, and Barry Voight⁶

under review

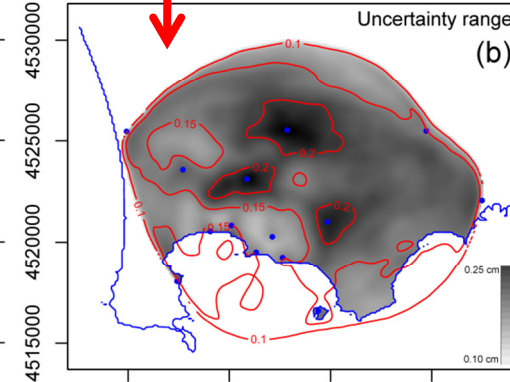
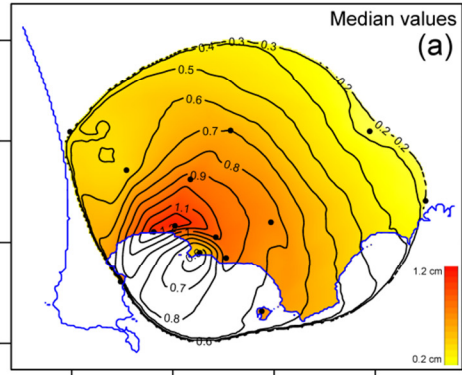
Radial interpolation of GPS and leveling data of ground deformation in a resurgent caldera: application to Campi Flegrei (Italy).

Andrea Bevilacqua^{1,†}, Stefano Vitale^{2,3}, Roberto Isaia³, Augusto Neri¹, Alessandro Novellino⁴

Figure 1. (a, c) **interpolated maps of horizontal (a) and vertical (c) displacement**, based on UP7 GPS data. (b, d) are uncertainty ranges.

UP5, 7/2011 - 5/2012

Horizontal displacement



UP7, 12/2012 - 4/2013

Horizontal displacement

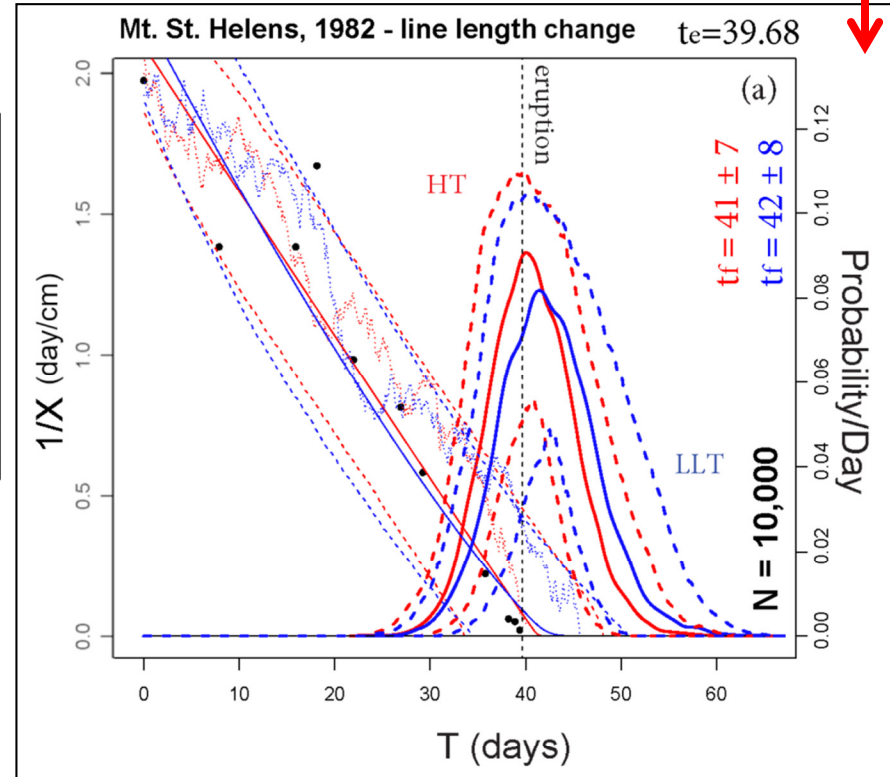
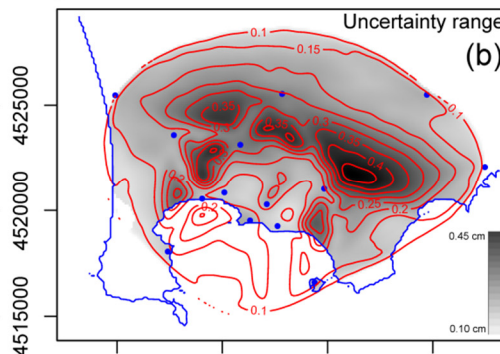
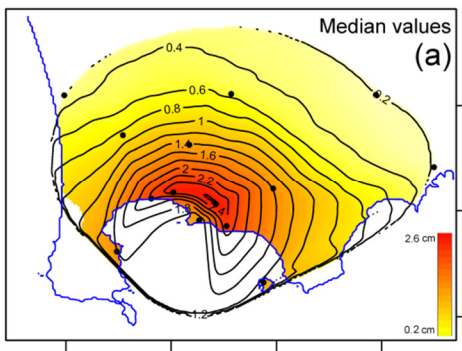


Figure 2. Estimators of failure time t_f . Bold line the pdf of t_f , with its 5th and 95th %ile values. **SDE paths** of $1/X$ are shown. Points are inverse rate data.