PecubeGUI: a new graphical user interface for Pecube

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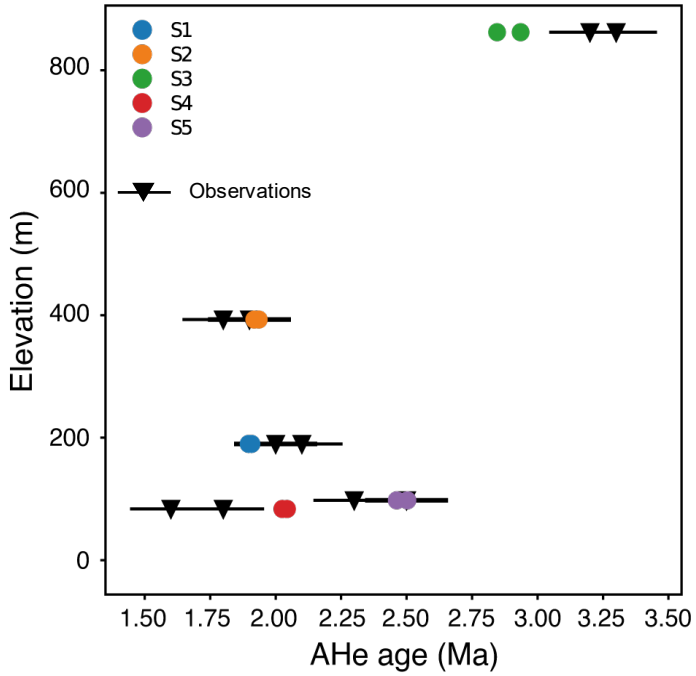

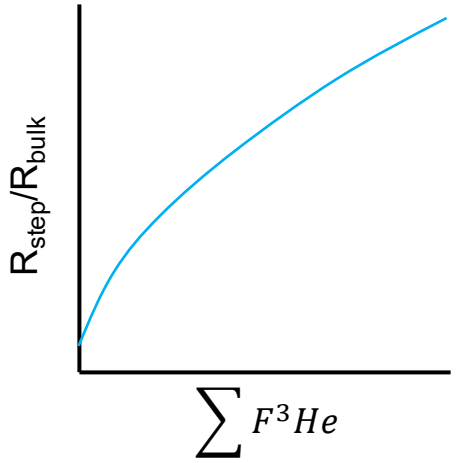

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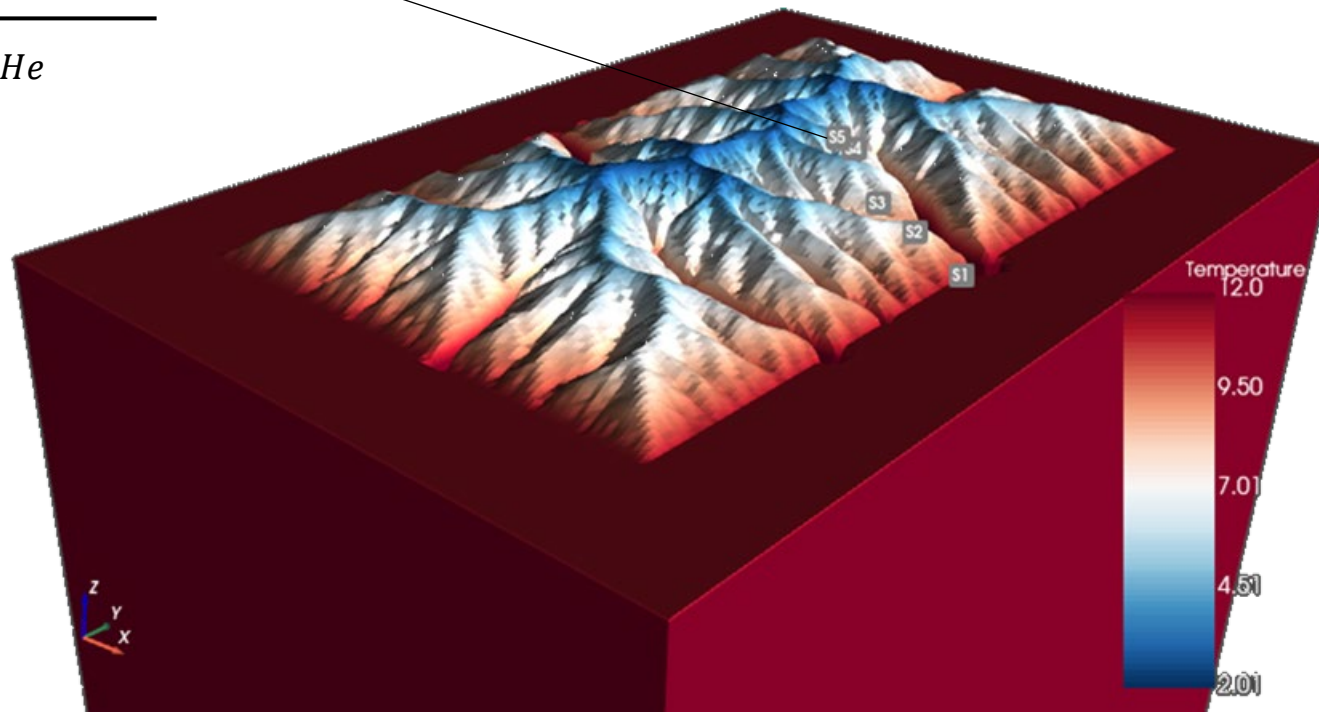

Universität Potsdam

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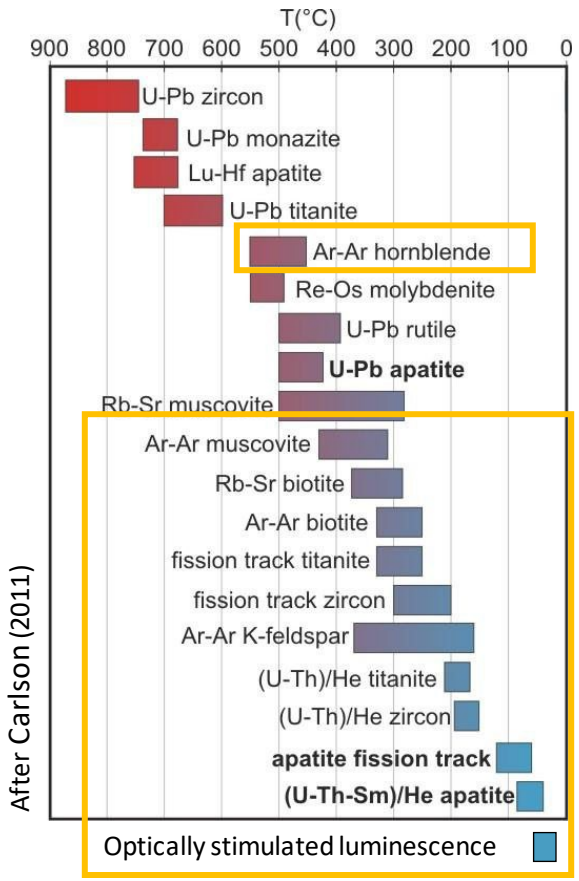
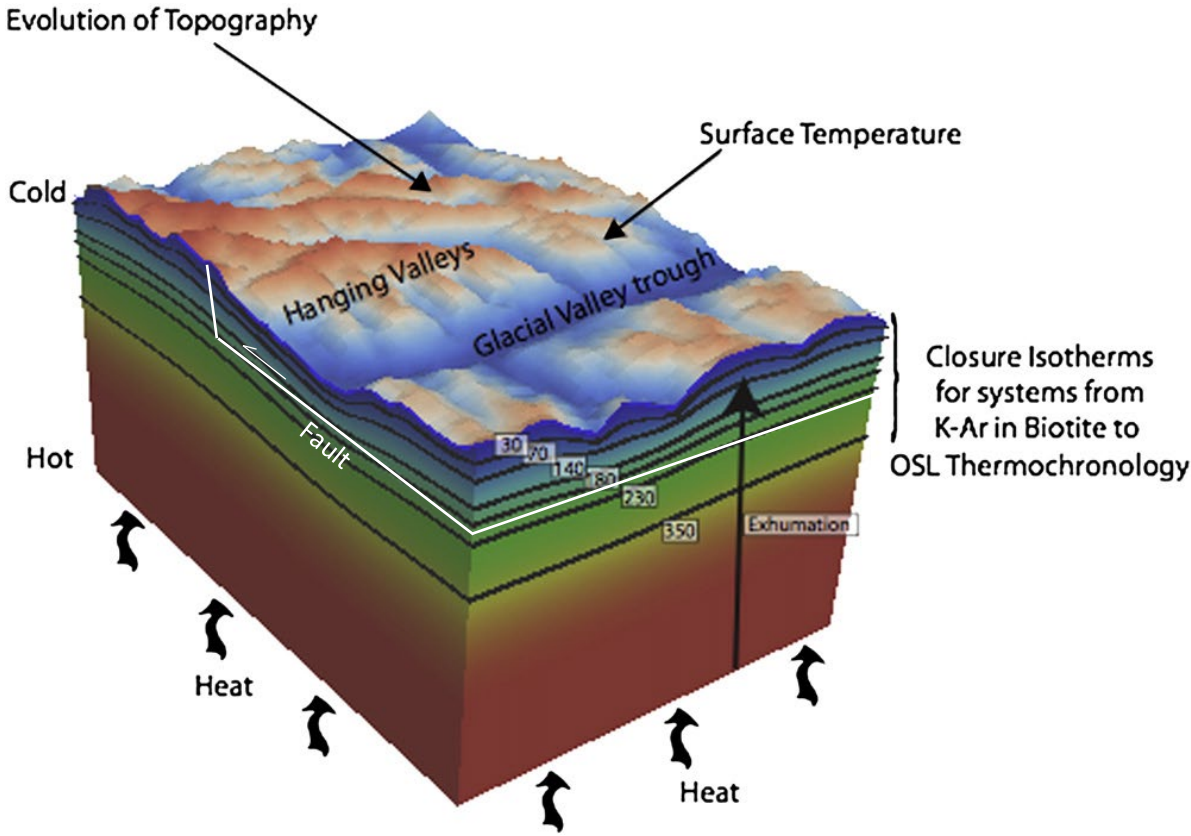
Pecube: a 3D thermo-kinematic model

- Designed to solve the 3D heat-transfer equation and to predict thermochronological data (Braun, 2003)
- Surface topographic evolution as boundary condition





From Braun et al. (2012)

Pecube: a 3D thermo-kinematic model

- Widely used by the community (596 references – google scholar)
- Enabled better understanding of topographic evolution and interpretation of thermochronological data

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 114, F04021, doi:10.1029/2008JF001195, 2009

Effects of exhumation kinematics and topographic evolution on detrital thermochronometer data

D. M. Whipp Jr.,[1,2,3] T. A. Ehlers,[1,4] J. Braun,[2,5] and C. D. Spath[1]

Received 11 November 2008; revised 11 June 2009; accepted 10 August 2009; published 8 December 2009.

Earth and Planetary Science Letters 295 (2010) 511–522

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journal homepage: www.elsevier.com/locate/epsl

Inversion of thermochronological age-elevation profiles to extract independent estimates of denudation and relief history – I: Theory and conceptual model

Pierre G. Valla [a,*], Frédéric Herman [b], Peter A. van der Beek [a], Jean Braun [a]

[a] Laboratoire de Géodynamique des Chaînes Alpines, Université Joseph Fourier, BP 53, 38041 Grenoble, France
[b] Geologisches Institut, ETH Zürich, 8092 Zürich, Switzerland

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 109, F04009, doi:10.1029/2004JF000147, 2004

Evolution of passive margin escarpments: What can we learn from low-temperature thermochronology?

Jean Braun[1]
Research School of Earth Sciences, The Australian National University, Canberra, ACT, Australia

Peter van der Beek
Laboratoire de Géodynamique des Chaînes Alpines, Université Joseph Fourier, Grenoble, France

Received 9 March 2004; revised 10 August 2004; accepted 28 September 2004; published 21 December 2004.

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 117, F01024, doi:10.1029/2011JF001985, 2012

Limits to reconstructing paleotopography from thermochronometer data

Stephanie M. Olen,[1,2] Todd A. Ehlers,[3] and Mathew S. Densmore[1]

Received 9 February 2011; revised 18 December 2011; accepted 14 January 2012; published 16 March 2012.

Pecube: a 3D thermo-kinematic model

Some limitations:

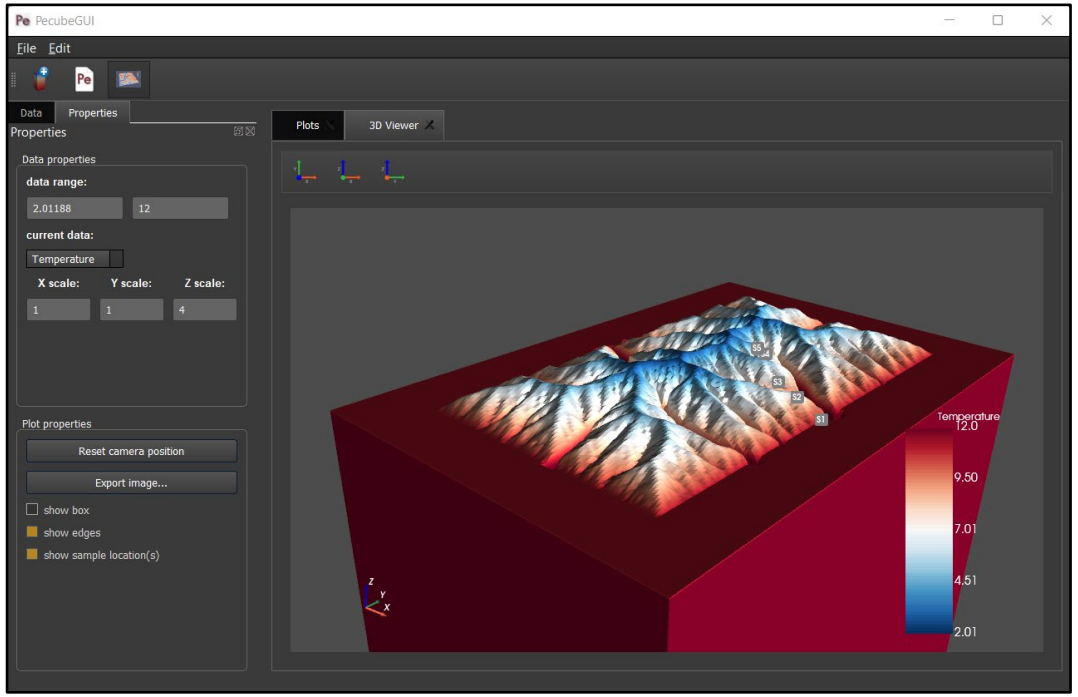
- Use in command line and input files
- Still have relatively simple kinetic models for helium diffusion and fission track annealing
- Side developments by the community

Goals:

- Provide a user-friendly interface for Pecube to the community
- Implement more recent kinetic models for thermochronometers data predictions
- Host an official version in open access

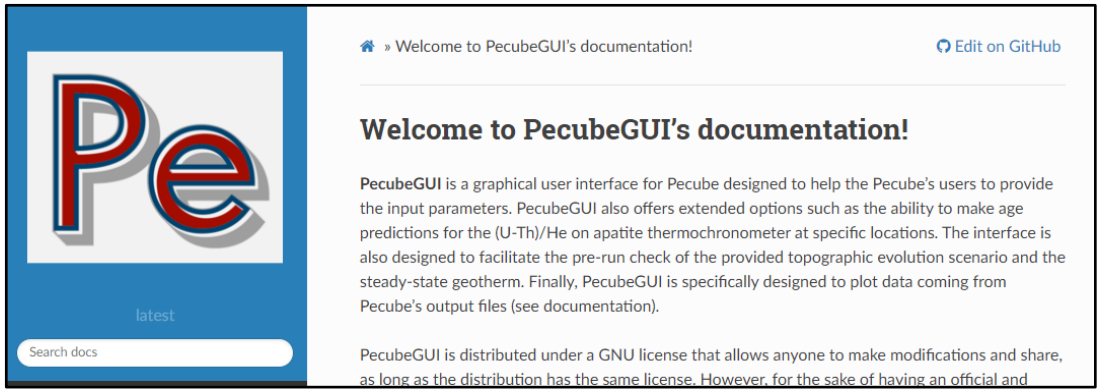
PecubeGUI: a user interface for Pecube

	Pecube v4	PecubeGUI
User interface	X	V
Sample-specific predictions	X	V
Grain characteristics	X	V
Various diffusion kinetics models	X	V
Open-access	V	V



PecubeGUI:

- Python-based interface (PyQT5)
- Open-access
- Soon publicly released on Github
- Online documentation (readthedoc)
- For Windows and MacOS (> 10.13)

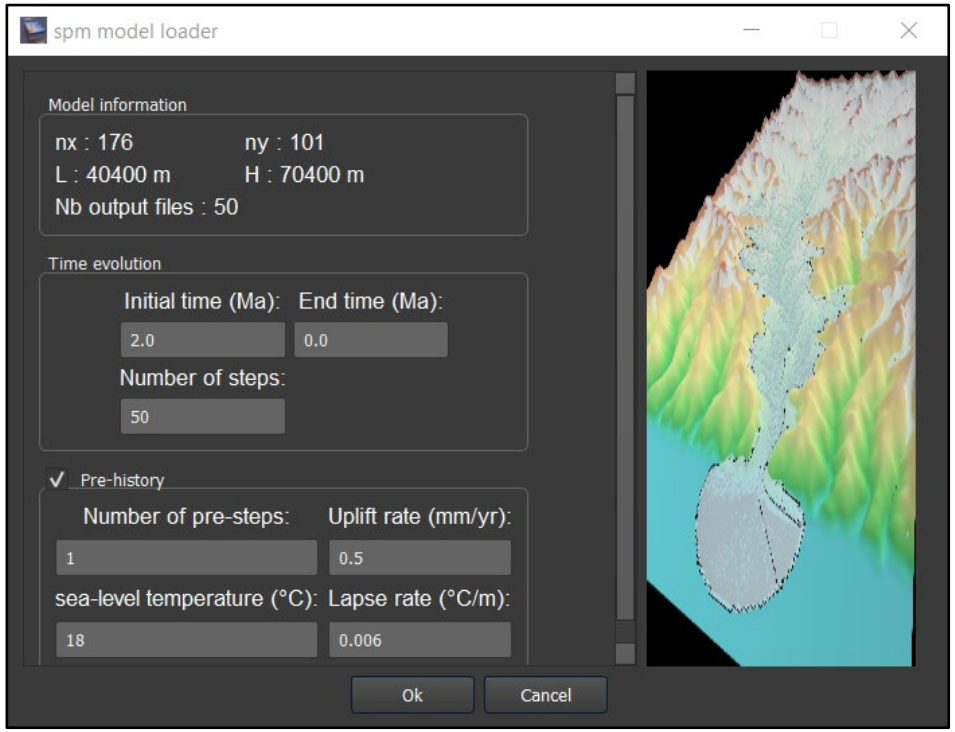


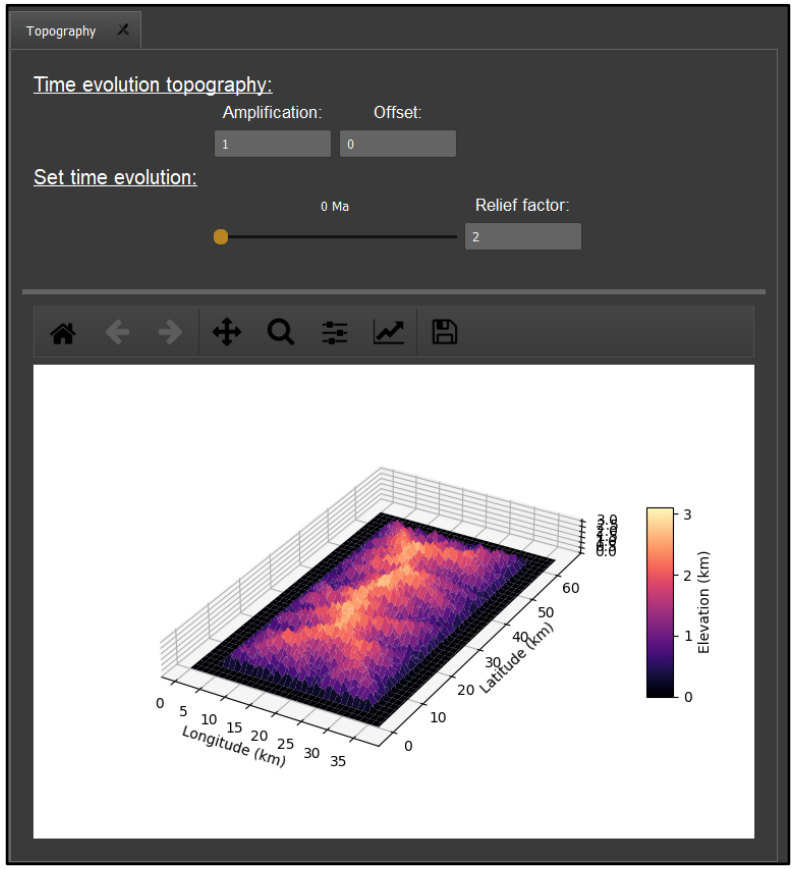
Welcome to PecubeGUI's documentation! — PecubeGUI 0.1 documentation (pecubegui-doc.readthedocs.io)

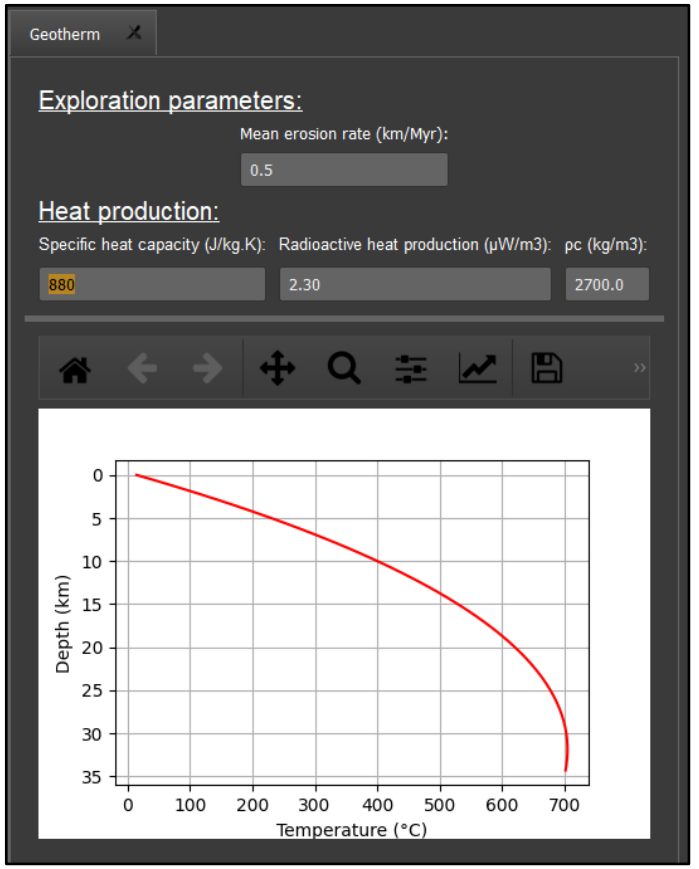
PecubeGUI: a user interface for Pecube

Inputs:

- Pecube input parameters
- Load from surface process model or DEM
- Visualize input topography, 1D steady-state geotherm



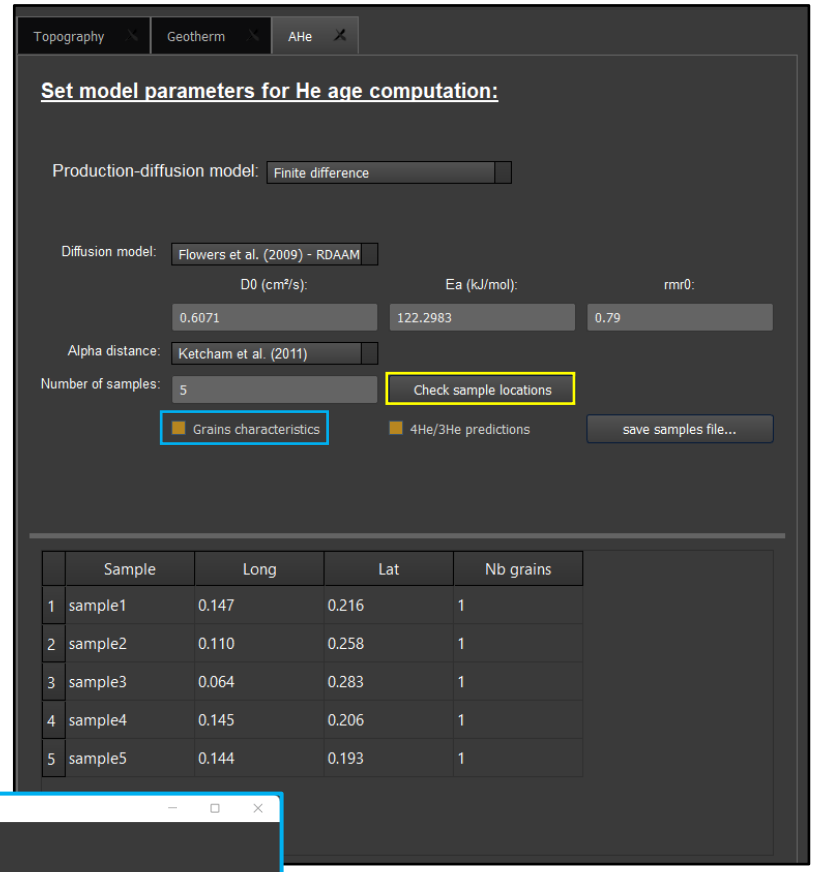




PecubeGUI: sample-specific predictions

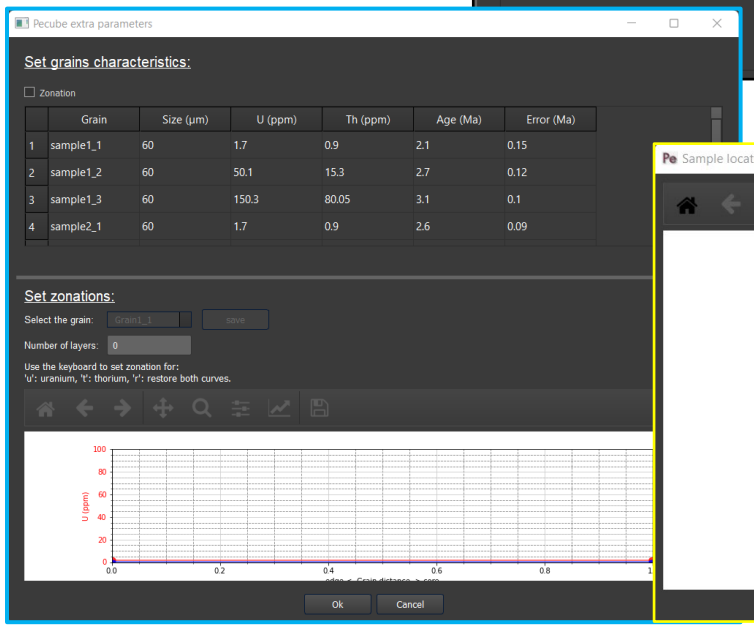
NEW !

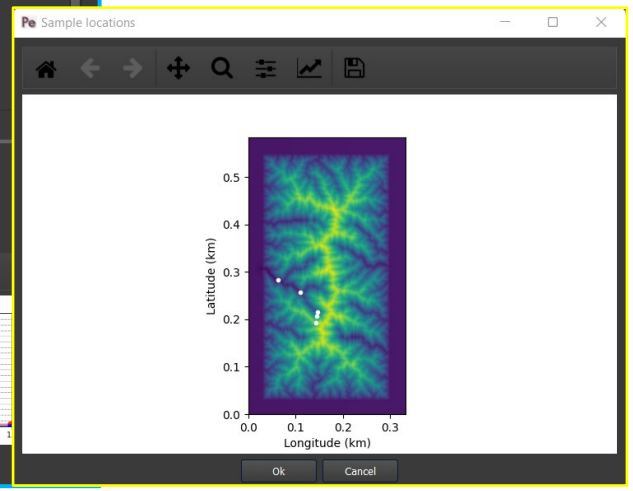
- Diffusion kinetics models for (U-Th)/He on apatite
  - Grain-specific characteristics (size, eU, zonation)
  - Comparison with observed data (Age and error)
  - Radiation damage models (Flowers et al., 2009; Gautheron et al., 2009; Willett et al., 2017)
- $^{4}He/^{3}He$ release spectra



Purposes:

- To integrate last developments while keeping computational efficiency
- To help interpreting the observed data
- To guide sampling strategies on the field
- To constrain numerical models with observed data and inversely

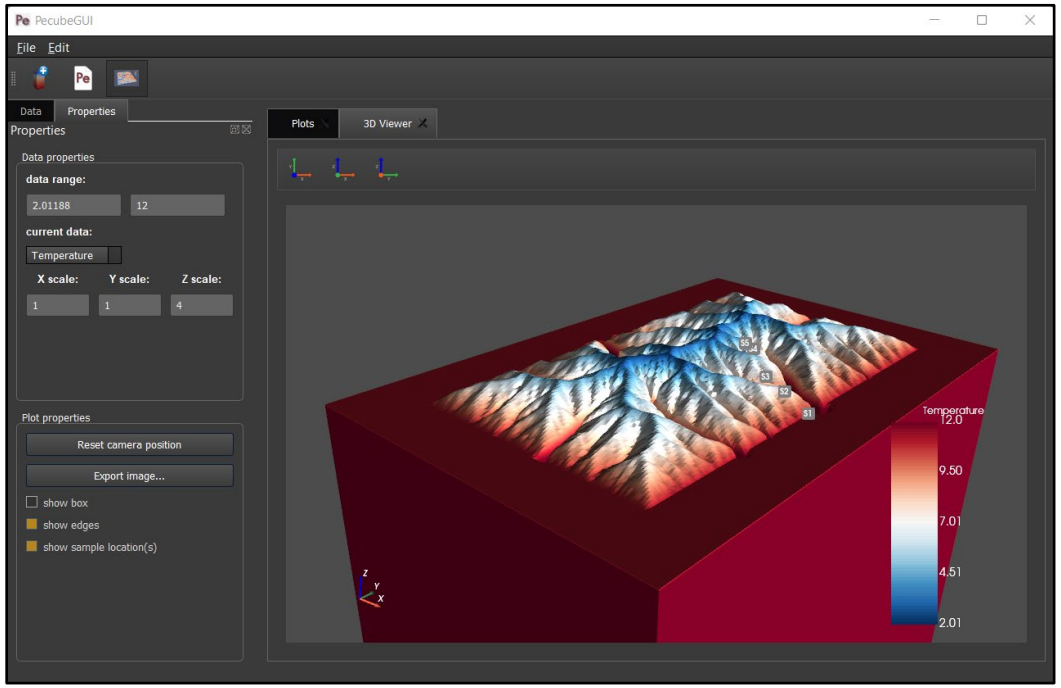


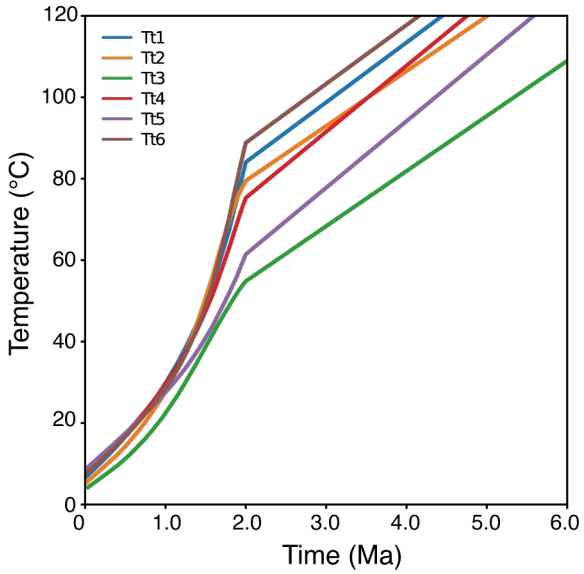


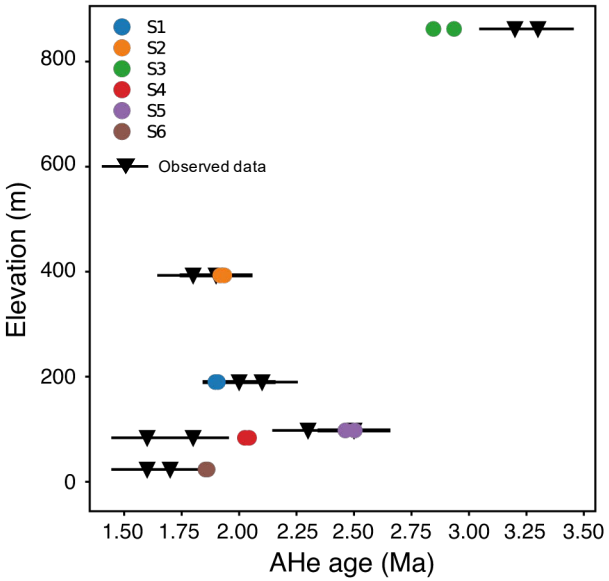
PecubeGUI: a user interface for Pecube

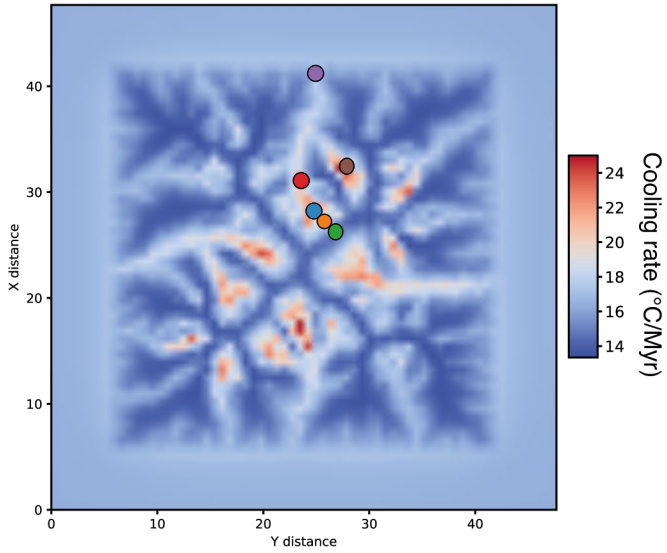
Outputs:

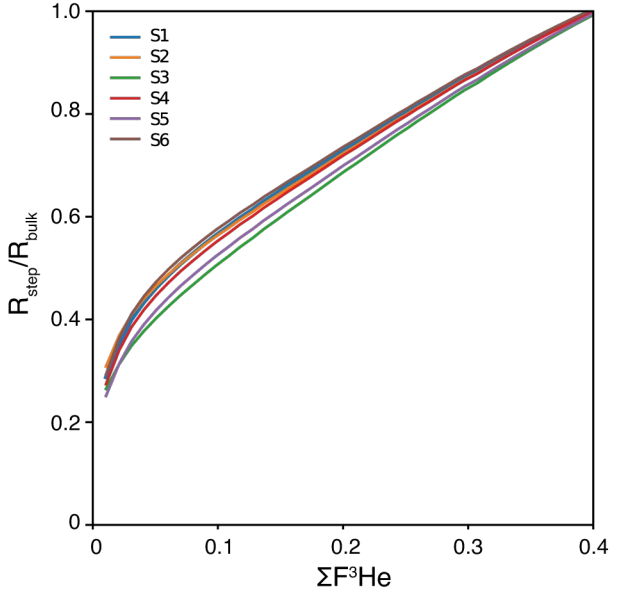
- Age-elevations, Tt paths, time-age evolution, $^4He/^3He$ spectra, Date vs eU…
- 2D maps of cooling rates, isotherm, ages…
- 3D visualization with pyvista (Sullivan et al., 2019)





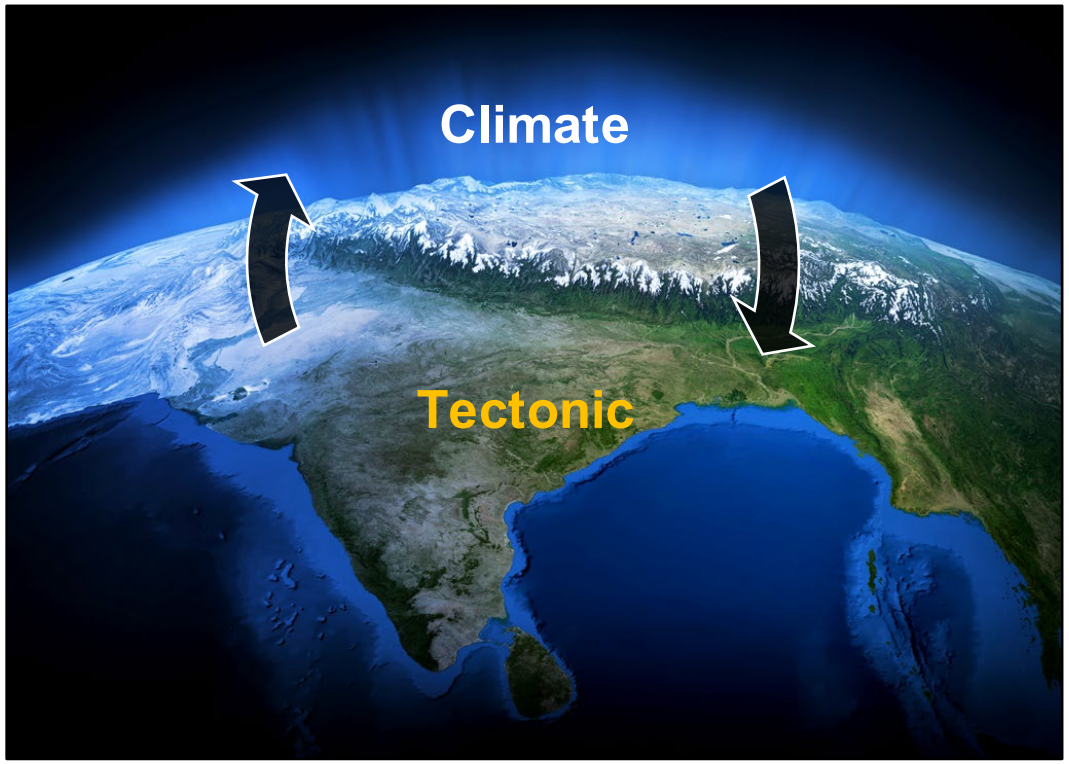






The COOLER Project (Potsdam)

- European Research Council project (ERC) – Pr. Peter Van der Beek



Main objective: Quantify the feedbacks between tectonic and climate processes through glacial erosion

- Development $^{4}He/^{3}He$ laboratory and new protocol for proton irradiation (Julien Amalberti, Cody Colleps)

GMPV1.1, Thursday 18h room K1

GM2.4., Thursday 9h30 room -2.31

- Developments in Pecube and sample-specific age predictions with recent developments of helium diffusion kinetics (PecubeGUI) + coupling with spm (iSOSIA)

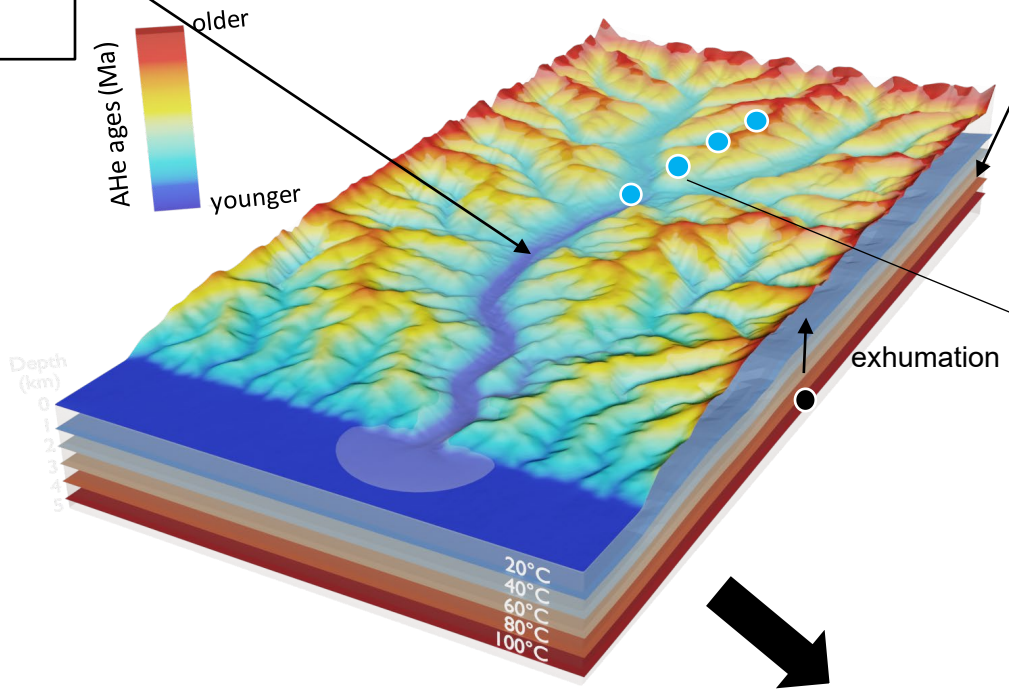
Our approach: combining a surface process model with PecubeGUI

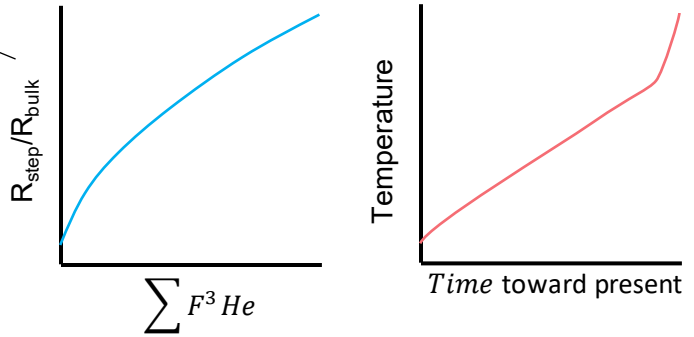
1. Surface processes model (iSOSIA):

- Glacial erosion scenario
- Tectonic uplift

2. Thermal and thermochronological model (**PecubeGUI**):

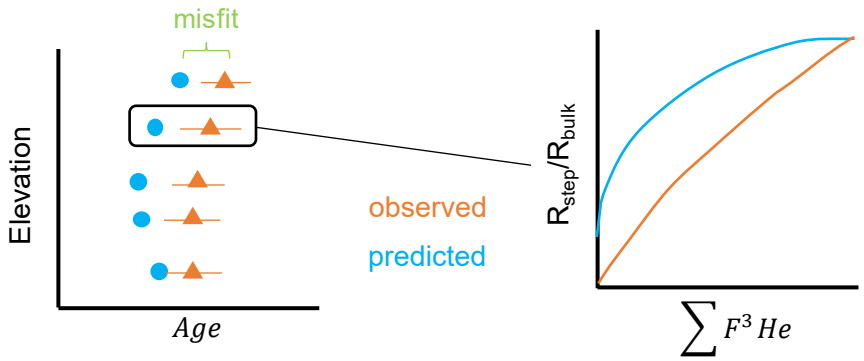
- Thermal diffusivity, heat production…
- RD model, zonation, grain size, eU…





e.g. What's the most probable glacial erosion scenario? The resulting erosion?

3b. Predicted vs observed data:



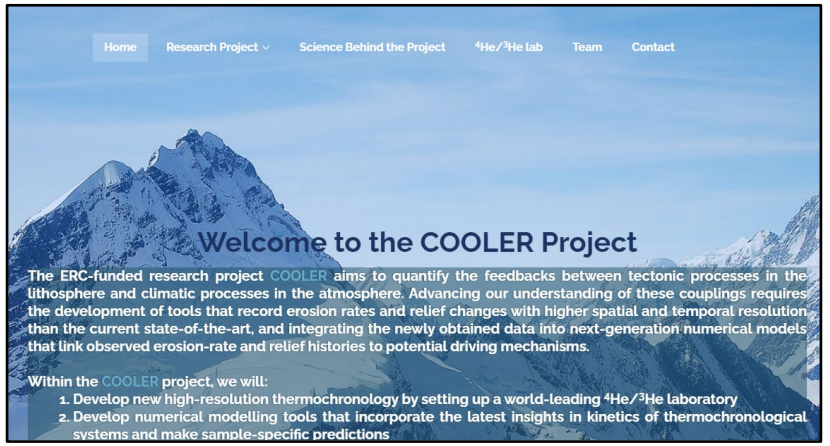
3a. Synthetic data for sensitivity tests:

How much information on glacial erosion can we extract from thermochronological data?

How this varies according to tectonic settings?

PecubeGUI: perspectives

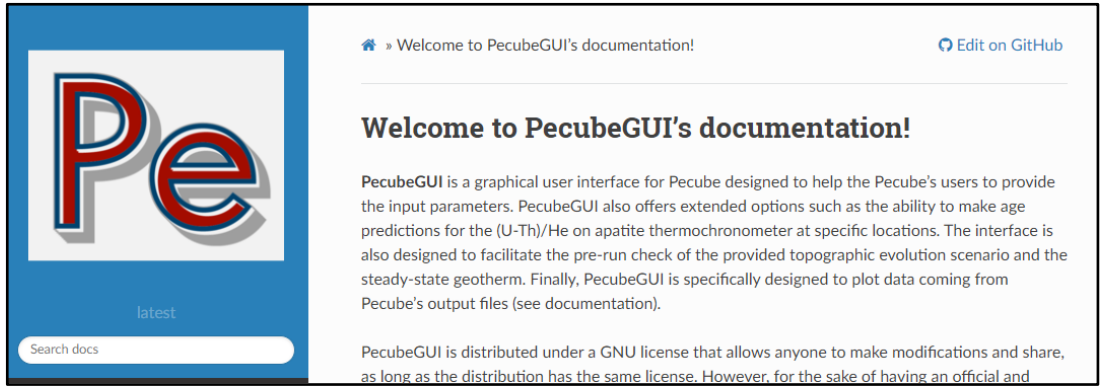
- Sample-specific predictions for apatite and zircon fission tracks
- Different crystals geometry (Gautheron et al., 2010)
- Interactively set fault geometry and visualization
- Pre-spm topographic evolution scenarios…



The COOLER project: www.erc-cooler.eu

Anyone could contribute to PecubeGUI! (but update the official version)

To know more about PecubeGUI, contact me:
maxime.bernard@uni-potsdam.de



Welcome to PecubeGUI's documentation! — PecubeGUI 0.1 documentation (pecubegui-doc.readthedocs.io)

Appendix 1: iSOSIA (Egholm et al. 2011)

- A 3D surface process model for glacial erosion
- depth-integrated second-order shallow ice approximation
- Efficient and accurate for application in mountain areas

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 116, F02012, doi:10.1029/2010JF001900, 2011

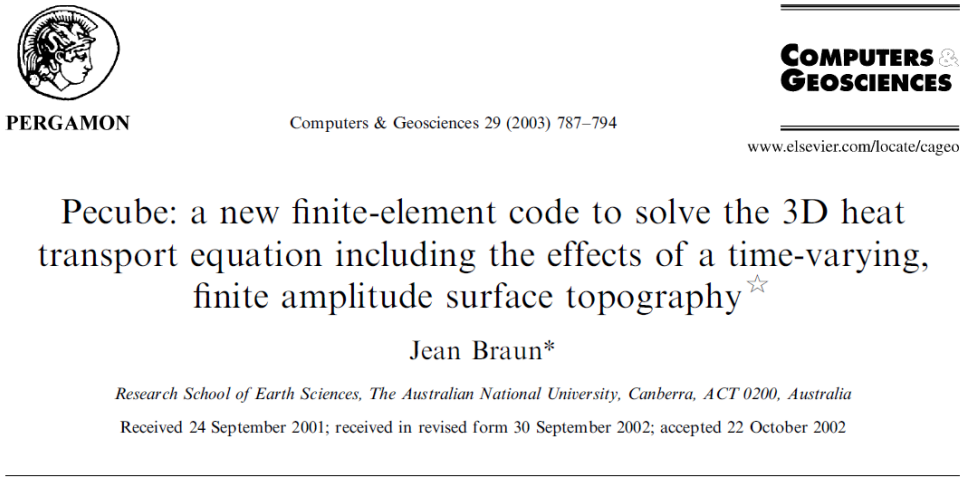
Modeling the flow of glaciers in steep terrains: The integrated second-order shallow ice approximation (iSOSIA)

David L. Egholm,[1] Mads F. Knudsen,[1] Chris D. Clark,[2] and Jerome E. Lesemann[1]

Received 5 October 2010; revised 23 February 2011; accepted 4 March 2011; published 18 May 2011.

Appendix 2: Pecube (Braun et al. 2003)

- A 3D thermo-mechanical model that computes the evolution of a thermal field submitted to an evolving surface topography
- Predicts thermochronological data (e.g., fission track, (U-Th/He) on apatites and zircon)
- Widely used in the community



PERGAMON

Computers & Geosciences 29 (2003) 787–794

COMPUTERS & GEOSCIENCES

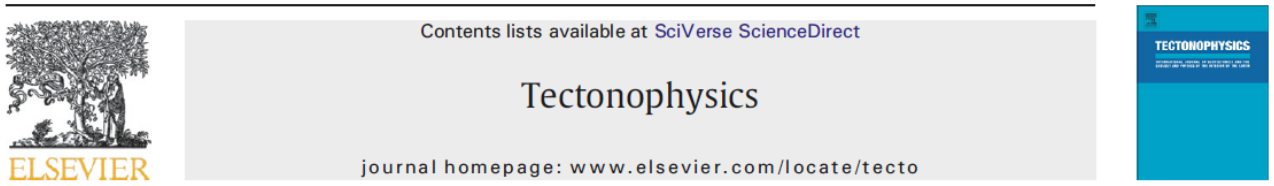
www.elsevier.com/locate/cageo

Pecube: a new finite-element code to solve the 3D heat transport equation including the effects of a time-varying, finite amplitude surface topography ☆

Jean Braun*

Research School of Earth Sciences, The Australian National University, Canberra, ACT 0200, Australia

Received 24 September 2001; received in revised form 30 September 2002; accepted 22 October 2002



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Review Article

Quantifying rates of landscape evolution and tectonic processes by thermochronology and numerical modeling of crustal heat transport using PECUBE

Jean Braun [a,*], Peter van der Beek [a], Pierre Valla [a,c], Xavier Robert [a], Frédéric Herman [c], Christoph Glotzbach [d], Vivi Pedersen [e], Claire Perry [b], Thibaud Simon-Labric [a,f], Cécile Prigent [g]