



## DefVolc: interface and web service for fast computation of volcano displacement

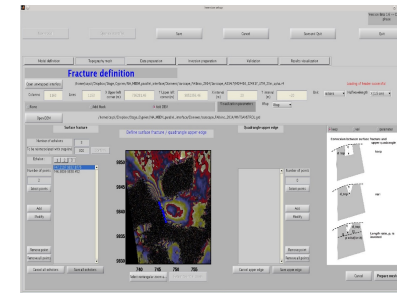
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Marine Tridon, Delphine Smittarello,  
Olivier Bodart, Jean-Luc Froger



## DefVolv pre- and post- processor

(Linux or windows compiled matlab program on user's local computers)

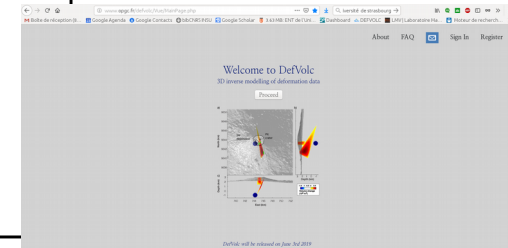
Generate topography file, input file, data and covariance files  
Estimate computation duration



## Dedicated web interface for launching inversions using UCA mesocenter facility (<https://www.opgc.fr/defvolc/>)

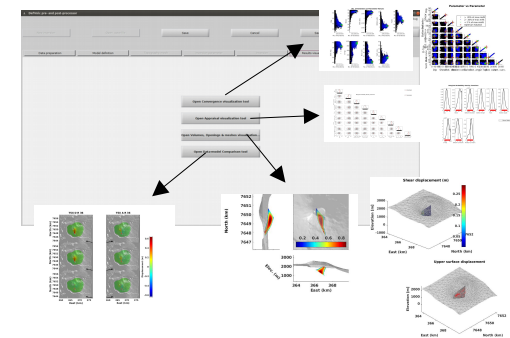
Users :

- Must register (password on request)
- Can run up to 3 inversions using 50 simultaneous processors
- Are informed by email once an inversion is completed
- Can download the results on their local computer



## DefVolv pre- and post- processor

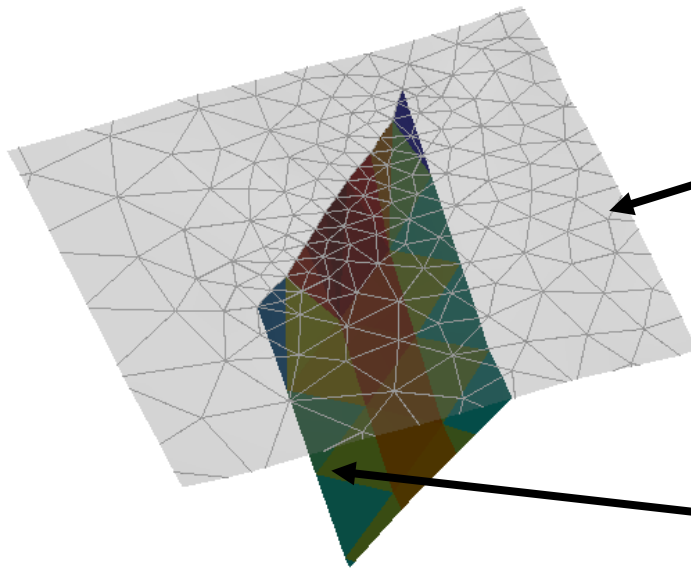
Convergence visualization  
Best fit model visualization  
Confidence intervals, mean model visualization



## Modelling with a 3D Mixed Boundary Element Method

(Cayol and Cornet, 1997; 1998)

- **3D Numerical method:**
  - Realistic topographies
  - Any number and geometry of pressure sources
  - treats the interactions between sources
- **Assumptions:**
  - the volcano is elastic, homogeneous and isotropic
  - constant stress changes
- **Method:** combination of two types of boundary element methods



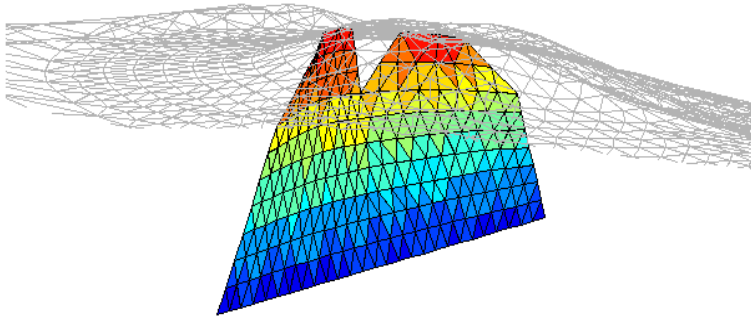
Direct method (Cruse,  
Computers and struct., 1974)  
efficient and precise

Displacement discontinuity method  
(Crouch Starfield, 1983)  
Most precise for fractures

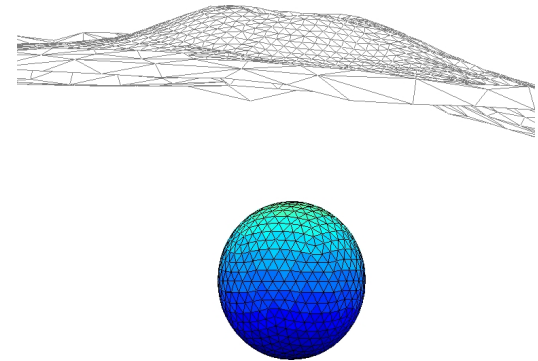
# Principle

## Available sources

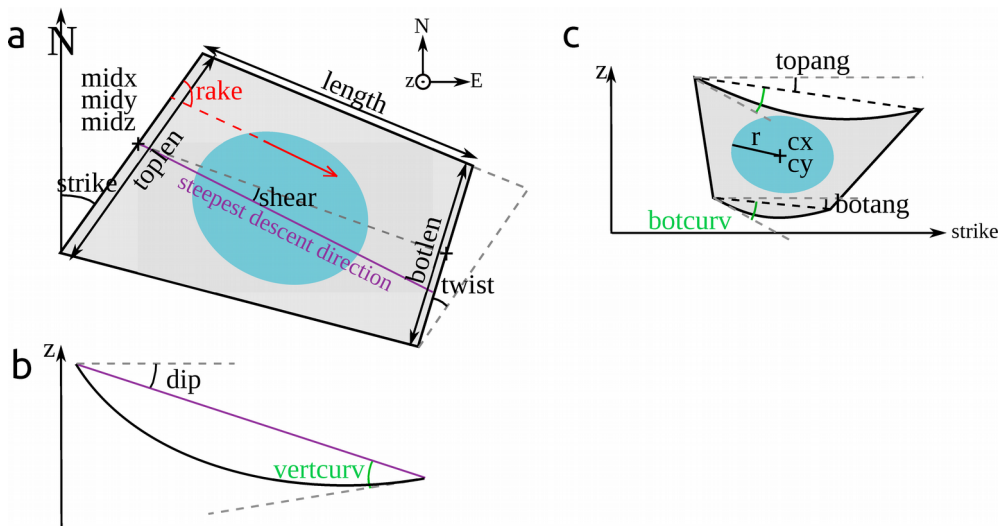
### Dikes or faults



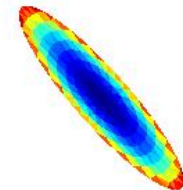
### Massive Reservoirs:



### Curved stressed quadrangular sources



### Planar ellipsoids

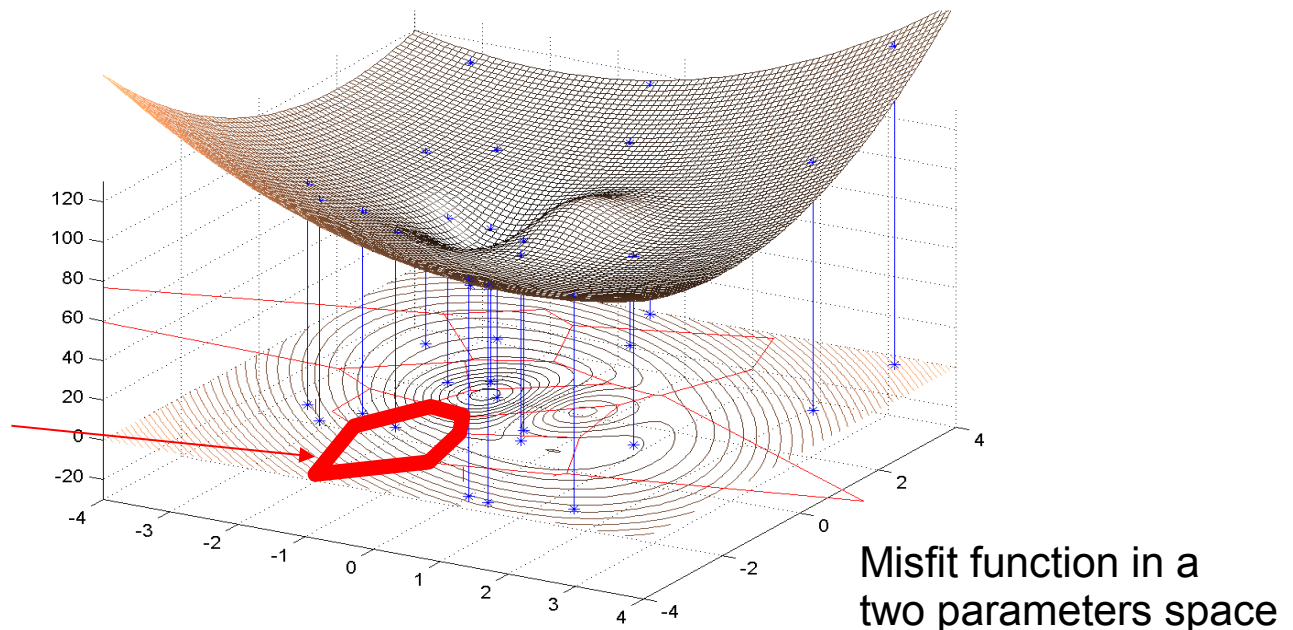


## Inversions with a near neighborhood algorithm

- **non linear inversion to invert for geometrical parameters**

(Sambridge, GJI,  
1999a, Fukushima et al.,  
JGR, 2005)

Voronoi cell  
(neighborhood): region  
closest to a point than any  
other point

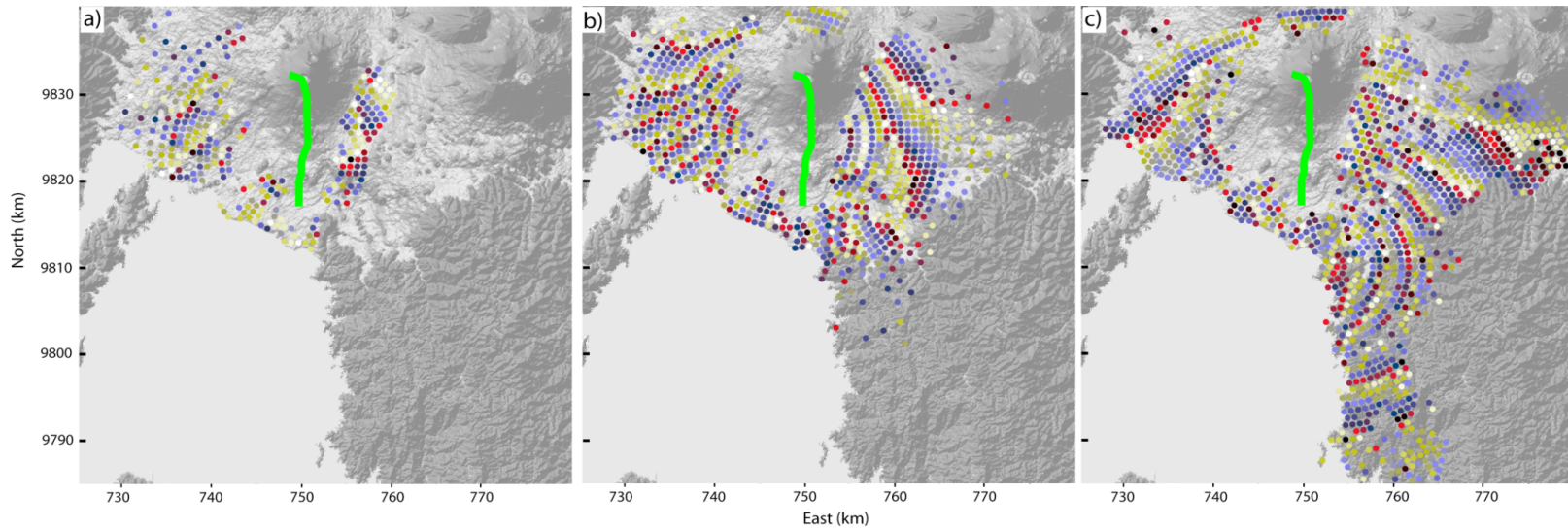
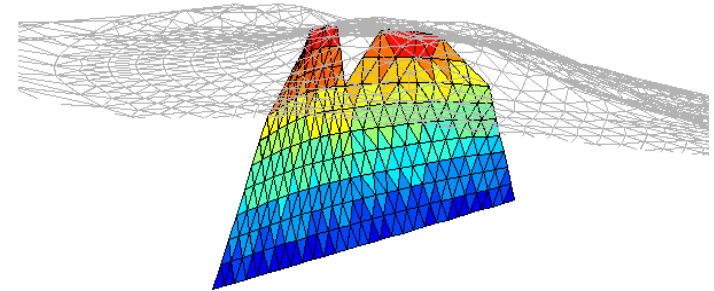


- **Linear inversions of pressure and data shift**
- **Appraisal of model using Bayesian inference → confidence intervals and**
- **trade-offs between parameters (Sambridge, JGI, 1999b)**
- **Synthetic test → parameters are well resolved within confidence intervals**



## The user is guided through the different steps

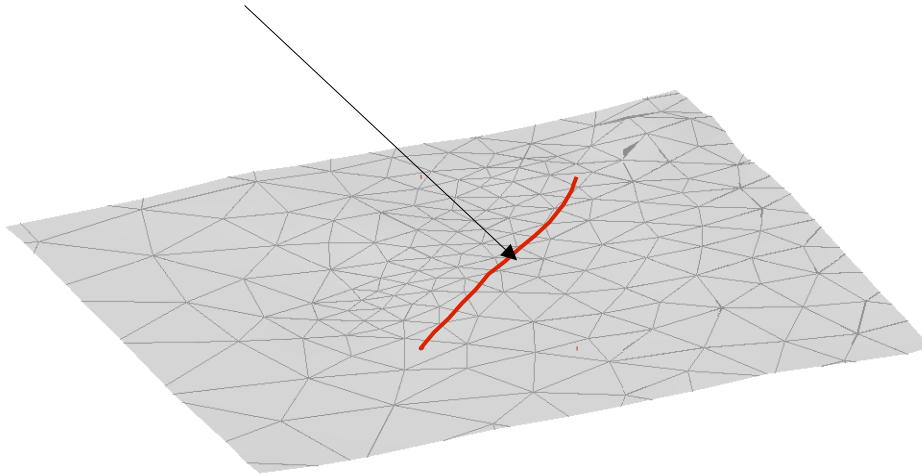
- data undersampling
- model (dike, spherical source, etc) and parameter ranges
- fissures coordinates
- topography file
- covariance matrix  $C_d$  computation



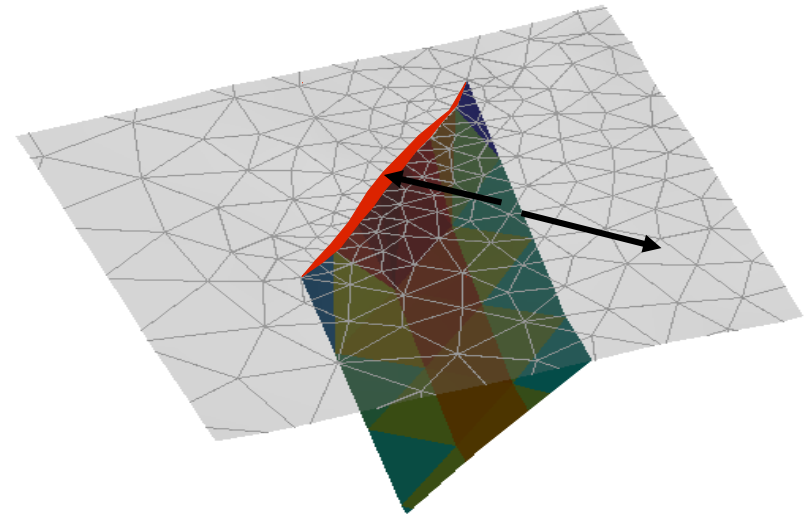


Steps can be imbricated: Eruptive fissures required for topography mesh

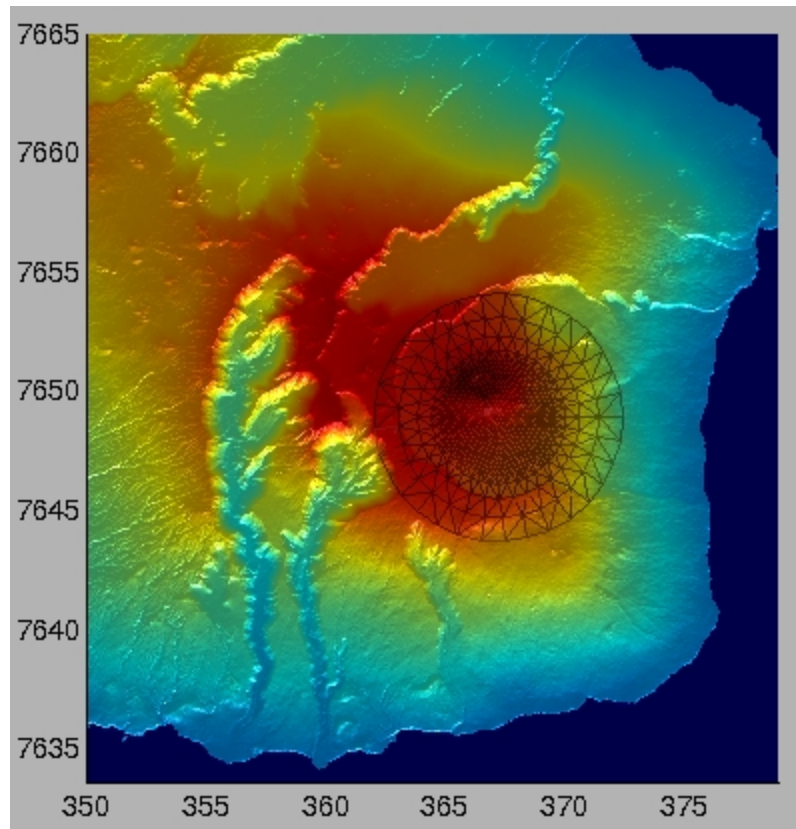
Eruptive fissure



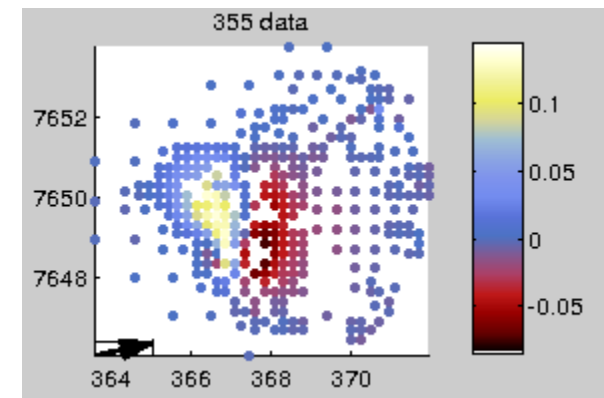
Discontinuity at fissure  $\mathbf{D} = \mathbf{u}^+ - \mathbf{u}^-$



**Permits a graphical control**



Mesh  
construction

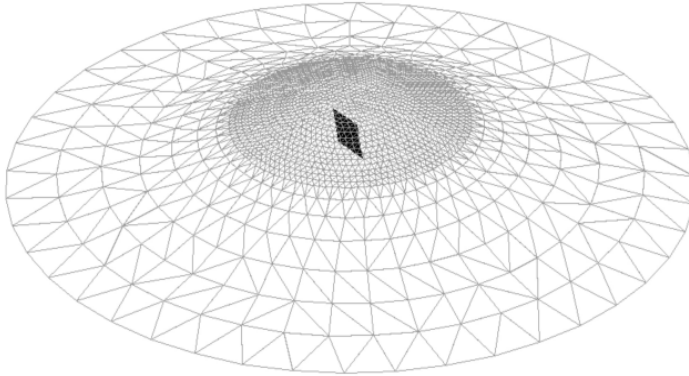


For undersampling parameters

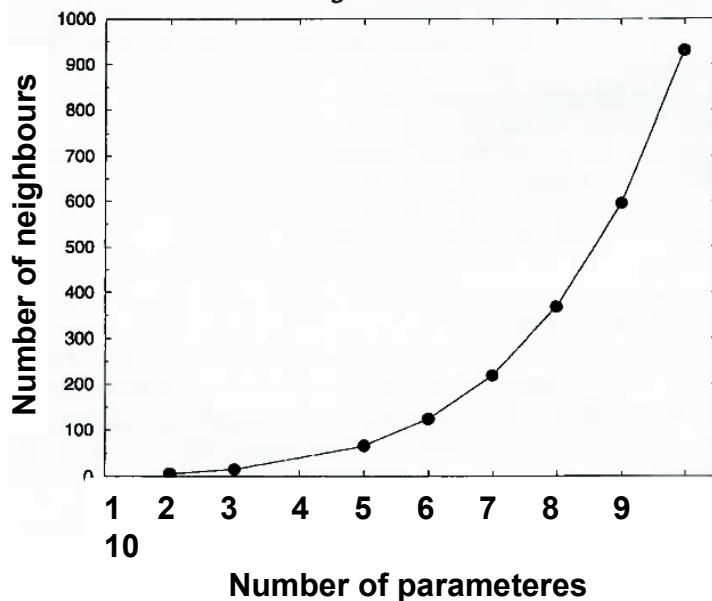




### Rules of thumbs are implicitly proposed

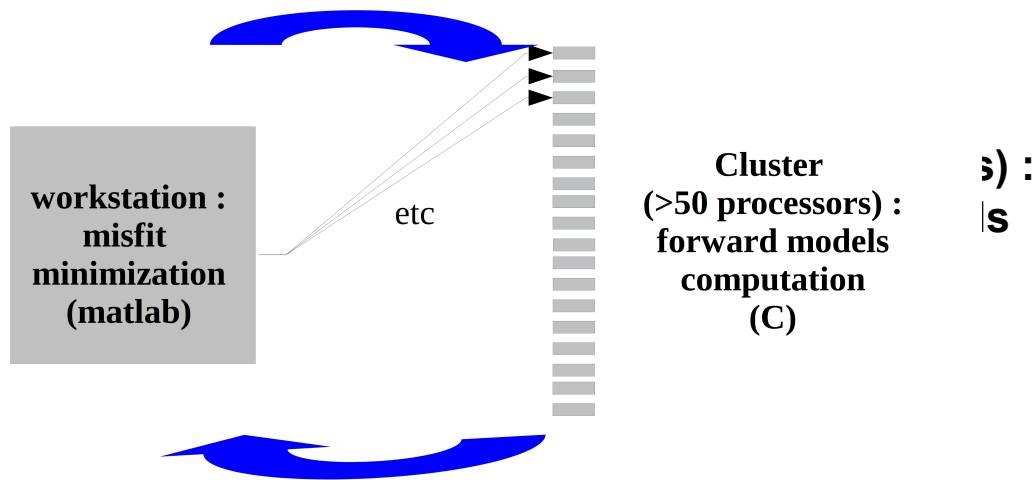
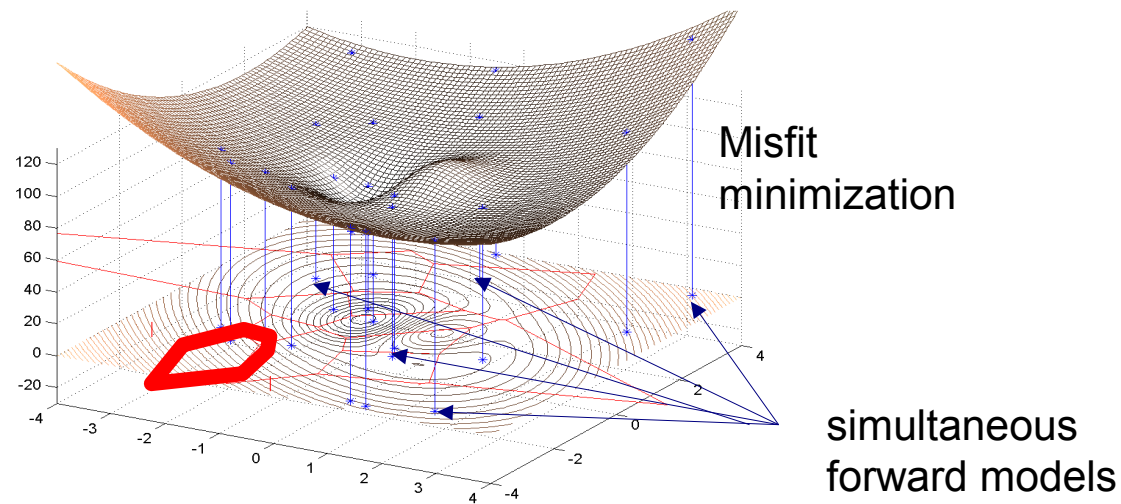


Extension of topography mesh with respect to the source depth and dimension



Number of forward models at first iteration as a function of the number of parameters

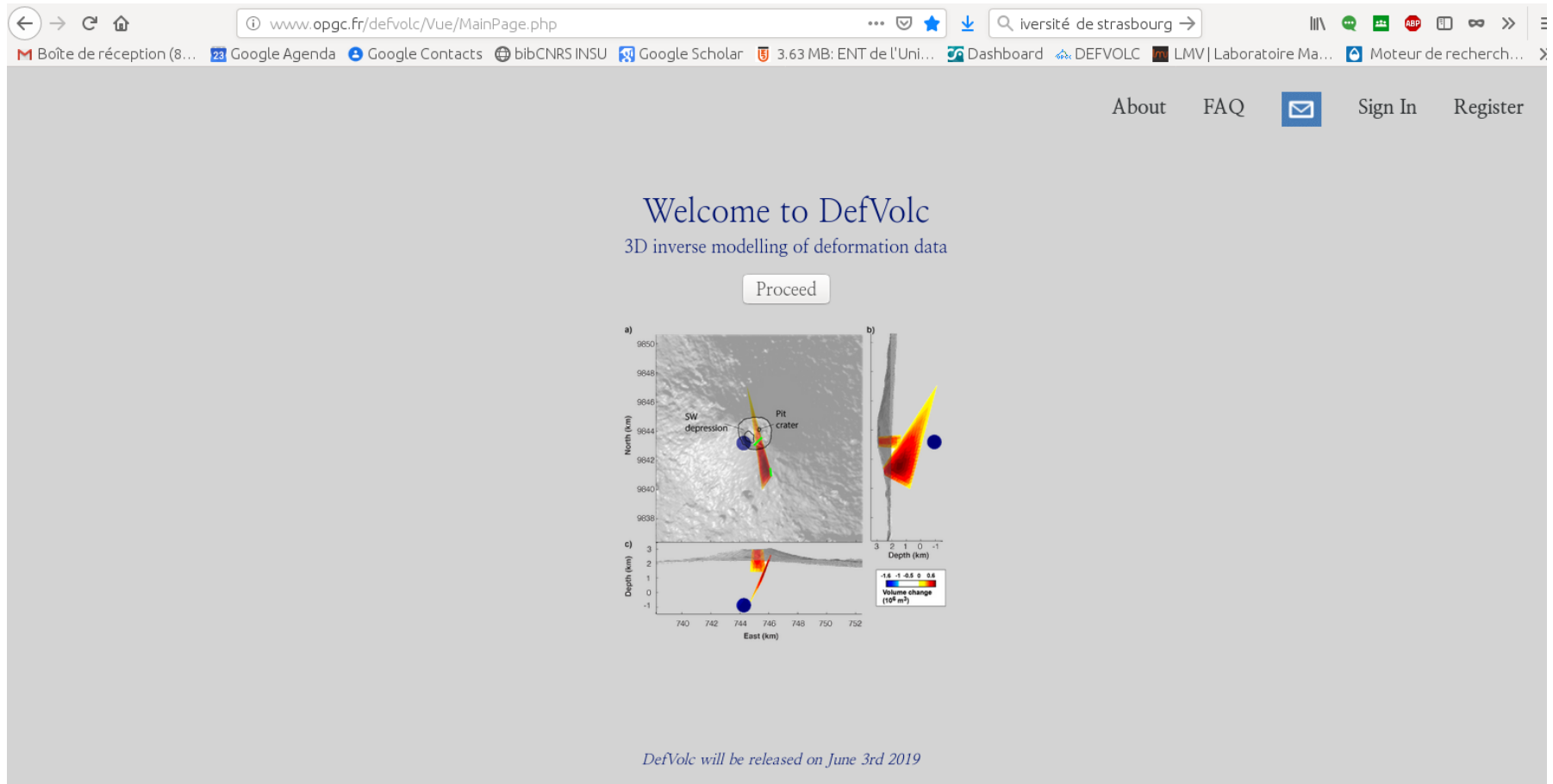
(Sambridge, 1998)



➡ 50 times faster (6 hours against two weeks)

## Running inversions and appraisal on the UCA clusters

Register on defvolc at <http://www.opgc.fr/defvolc/> ask for project code to [valerie.cayol@uca.fr](mailto:valerie.cayol@uca.fr)



## Running inversions on the UCA clusters

The screenshot shows a web browser window with the URL `www.opgc.fr/defvolc/Vue/UtilityChoice.php`. The page has a header with "Admin Edit" on the left and "About", "FAQ", an email icon, and a power icon on the right. The main content area is titled "Download the manual" and contains the following text:

1 - To prepare and visualize inversions, you will need to pre-process the calculation on your computer with the DefVolc pre- and post-processor. If you do not already have it, download it below :

Below this text are two buttons: "Download user's manual" and "Click here to Download pre-post-processor". An arrow points from the text "download it below" to the "Download user's manual" button.

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2 - If you choose our on-demand service, you can next run inversion on your own cluster or on the clusters of UCA computation center. On these clusters, you can run up to 3 simultaneous inversions, each using a maximum of 50 cores. Inversions should not last more than 72 hours.

Below this text are three buttons: "Launch inversion and appraisal", "Check inversions in progress", and "Download results of completed inversions".

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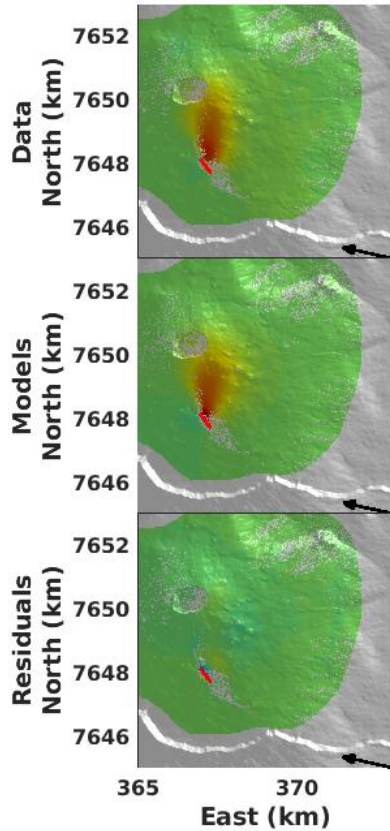
3 - After downloading your results and placing them in your inversion directory, you can visualize them with the DefVolc pre- and post-processor



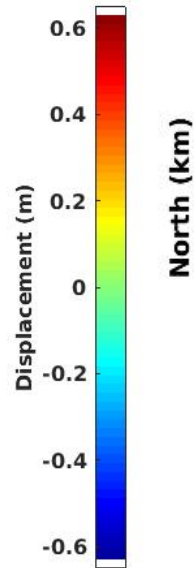
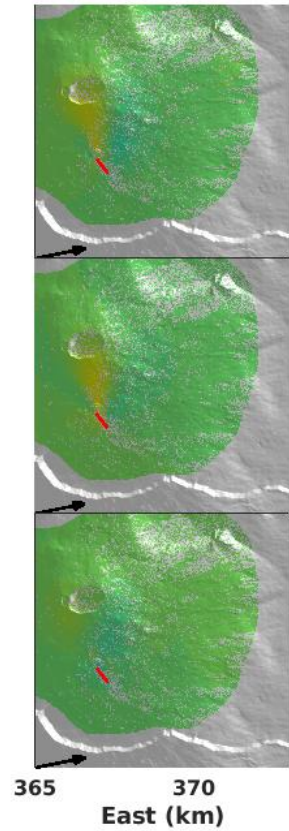
# Example

## Piton de la Fournaise Oct. 2010 eruption

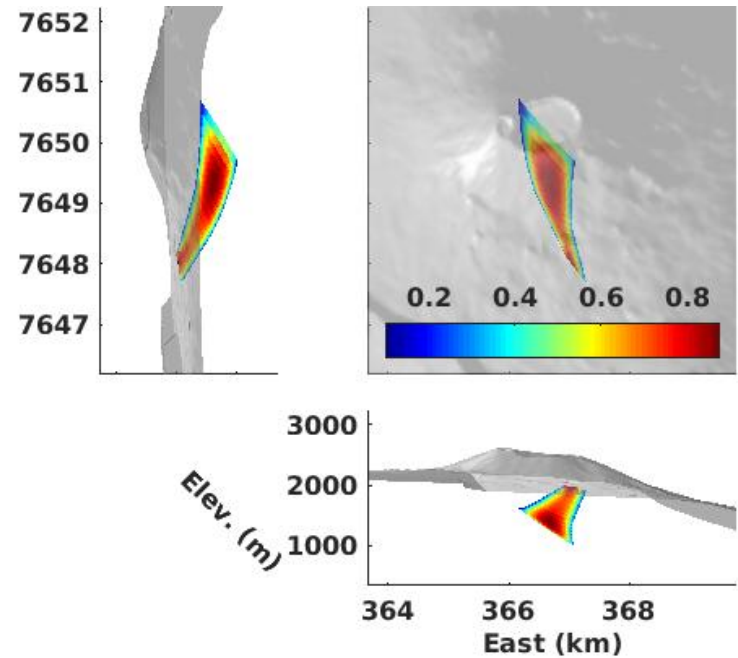
TSX D R 36



TSX A R 36



A sill that turns into a dyke ?



50 processors of a cluster : Takes typically a day for 9 parameters



THE END