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

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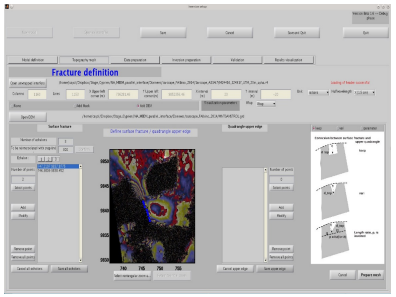
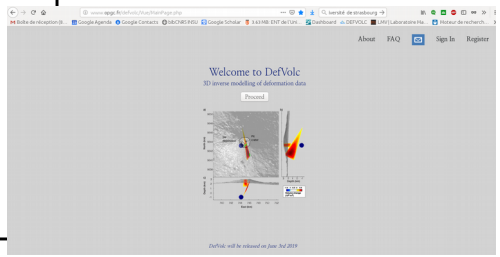
Principle

DefVolc pre- and post- processor
(Linux or windows compiled matlab program on usrer's local computers)
Generate topography file, input file, data and covariance files
Estimate computation duration

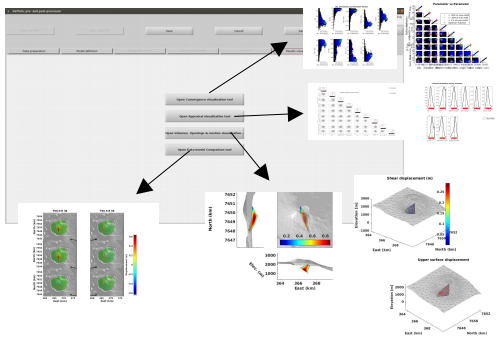


Dedicated web interface for launching inversions using UCA mesocenter facility
(https://www.opgc.fr/defvolc/)
Users :

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



DefVolc pre- and post- processor
Convergence visualization
Best fit model visualization
Confidence intervals, mean model visualization



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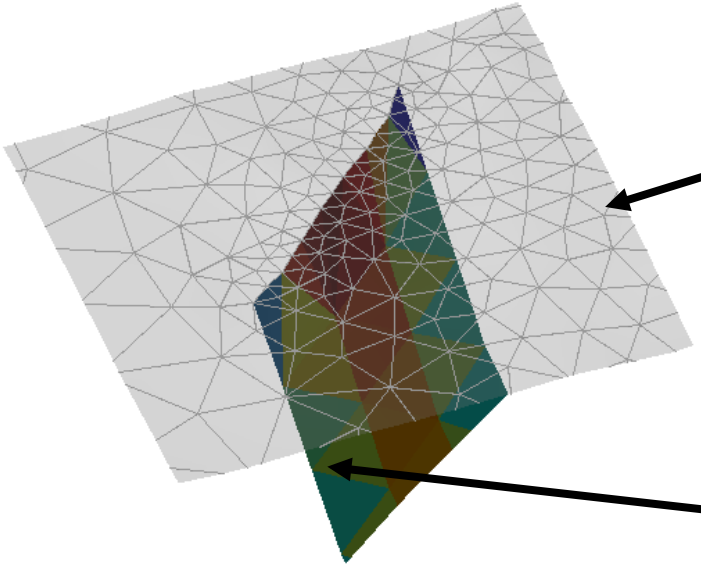
Principle

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**



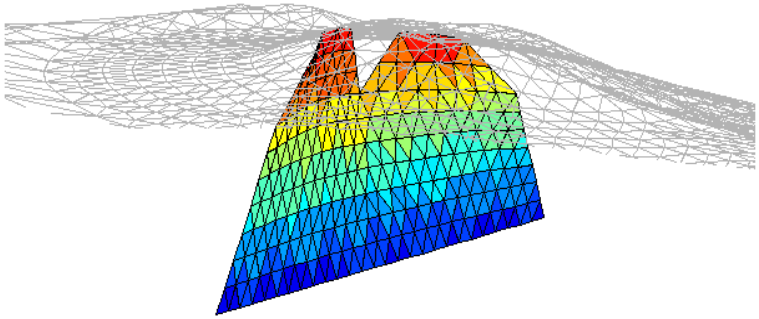
Direct method (Cruse, Computers and struct., 1974)
efficient and precise

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

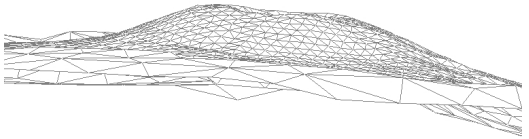
Principle

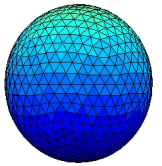
Available sources

Dikes or faults

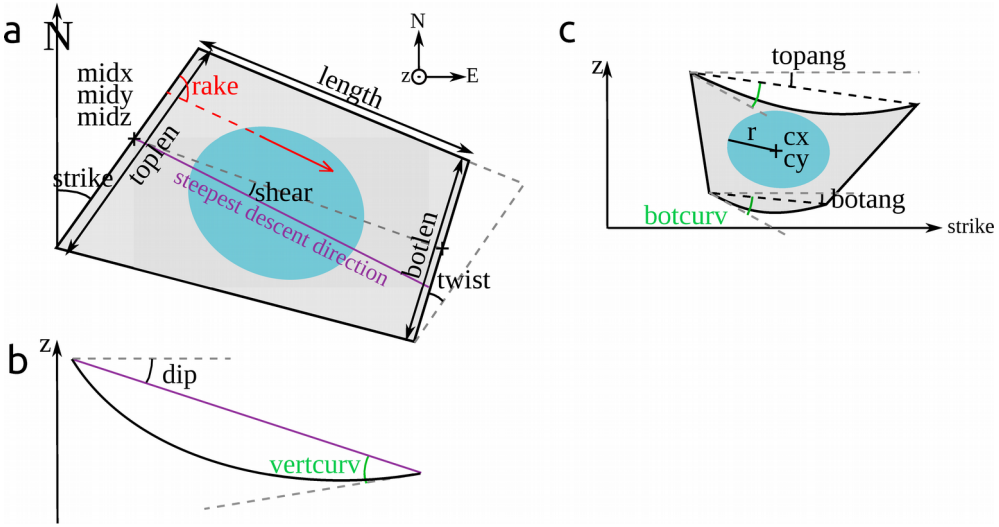


Massive Reservoirs:

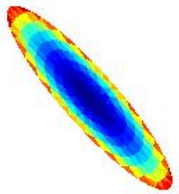




Curved stressed quadrangular sources



Planar ellipsoids



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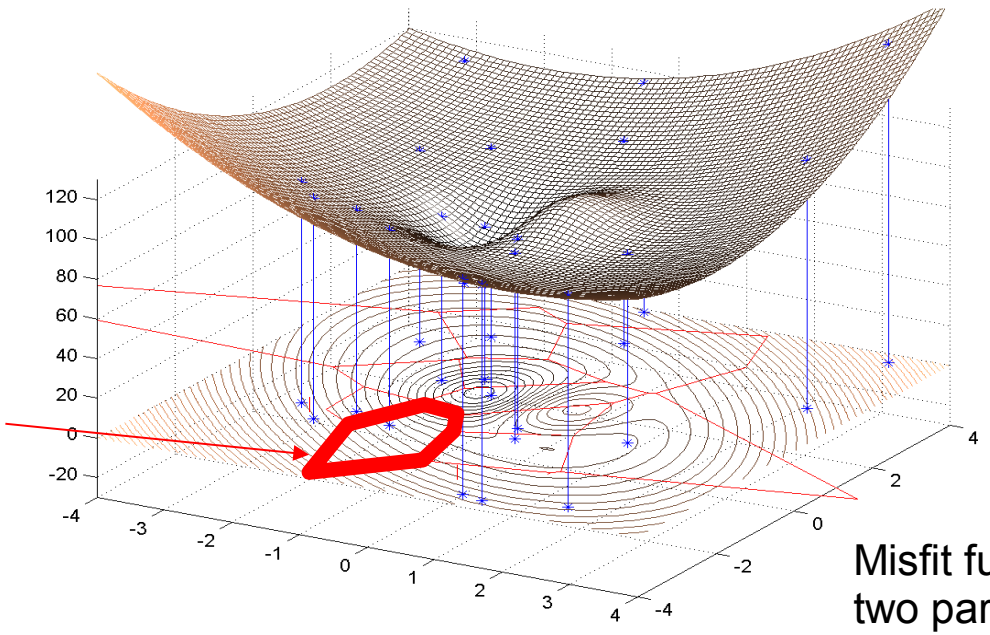
Principle

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



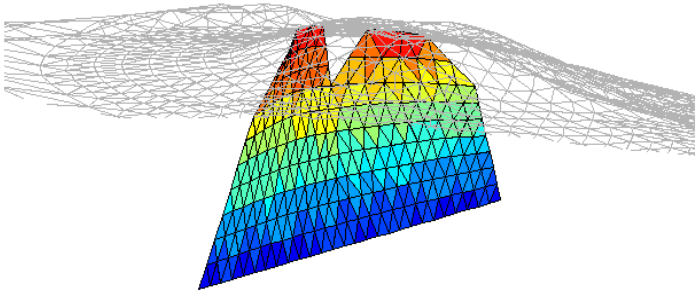
Misfit function in a two parameters space

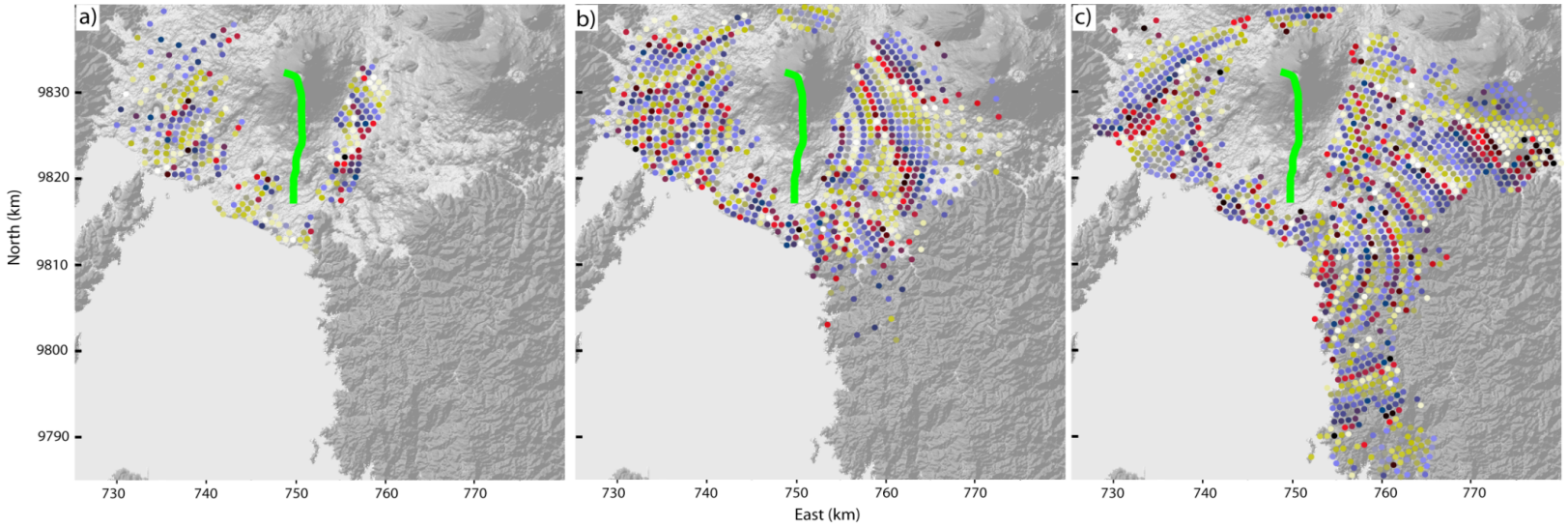
- **Linear inversions of pressure and data shift**
- **Appraisal of model using Bayesian inference → confidence intervals and**
- **trade-offs between parameters** (Sambridge, JGI, 1999b)
- **Synthetic test → parameters are well resolved within confidence intervals**

DefVolc pre- and post-processor

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

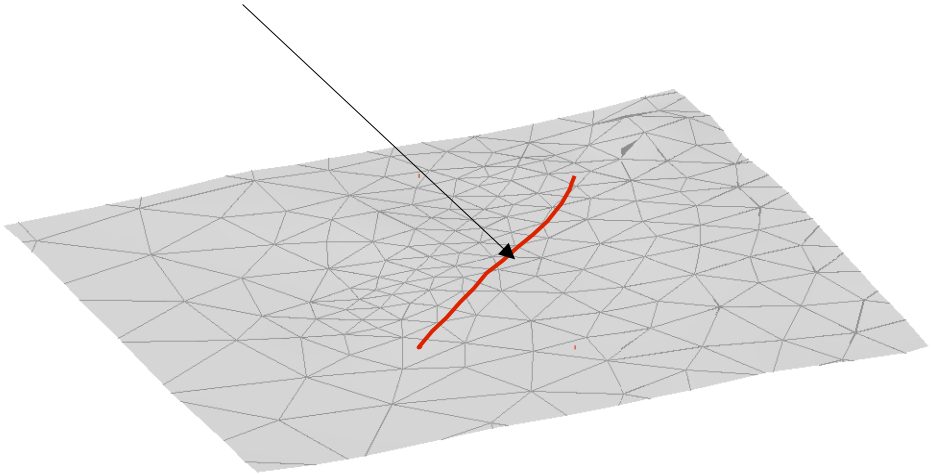




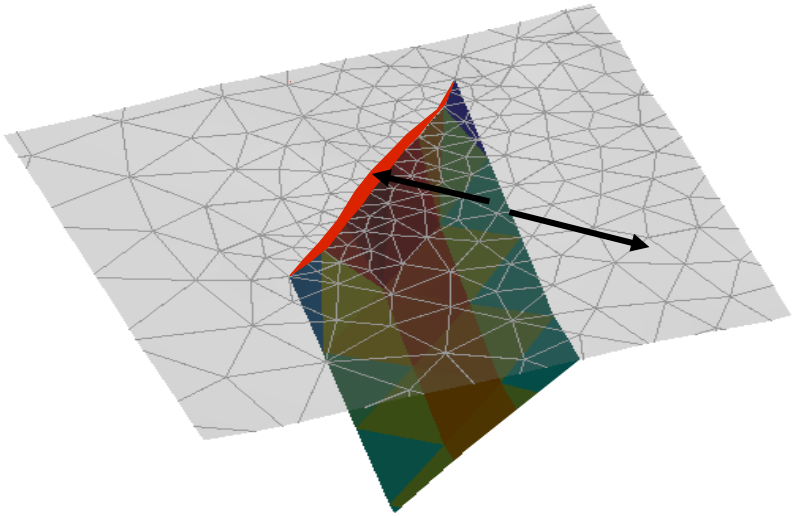
DefVolc pre- and post-processor

Steps can be imbricated: Eruptive fissures required for topography mesh

Eruptive fissure

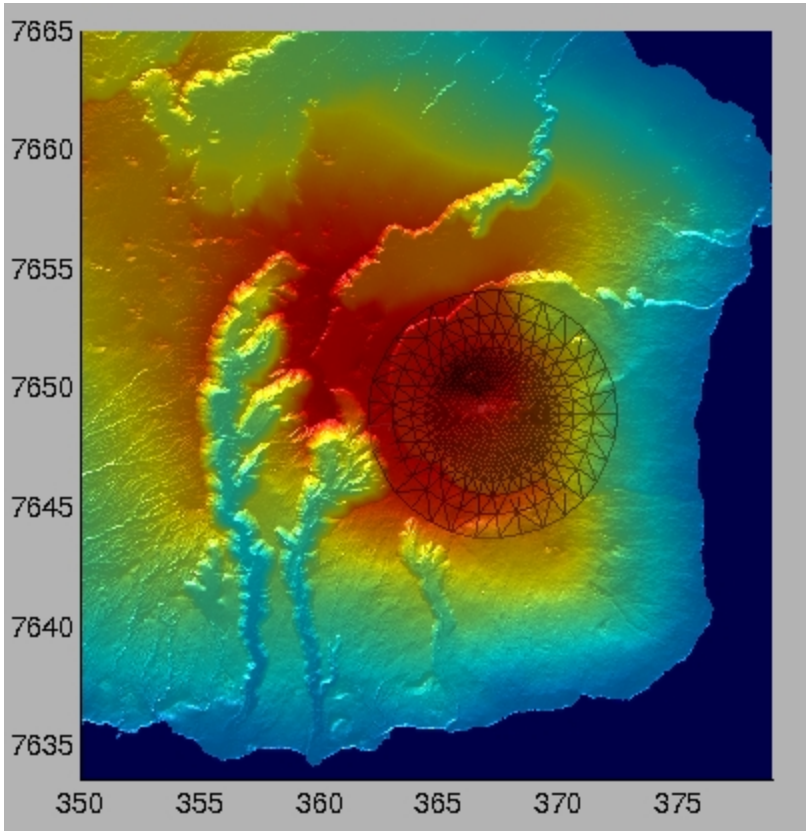


Discontinuity at fissure $\mathbf{D = u^{+} - u^{-}}$

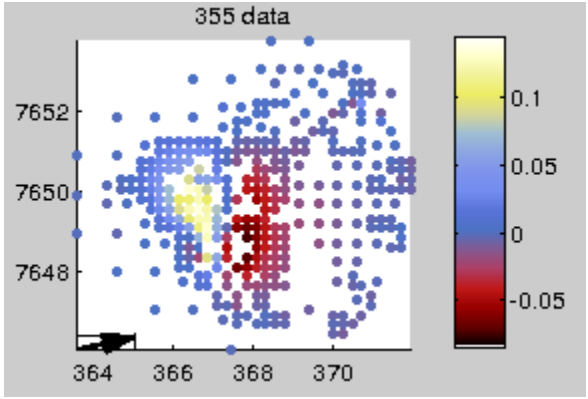


DefVolc pre- and post-processor

Permits a graphical control



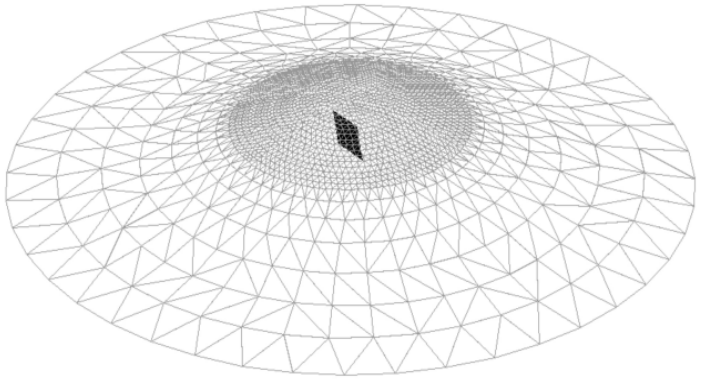
Mesh construction



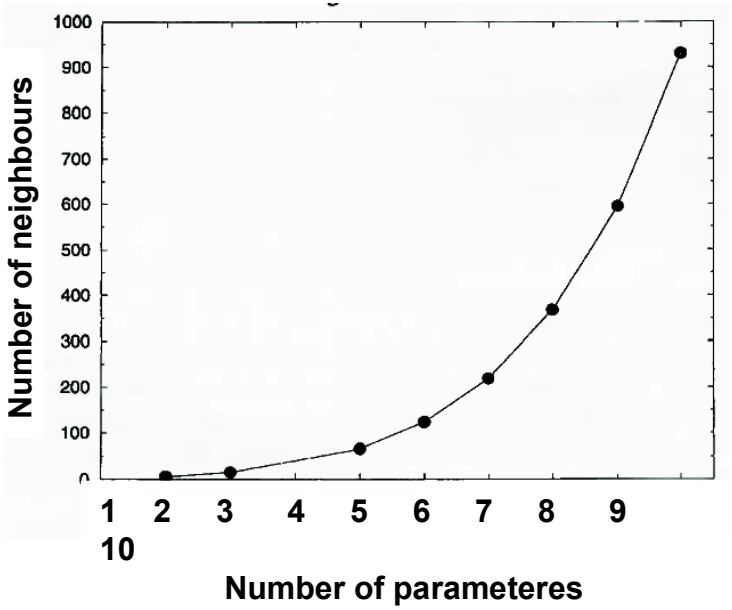
For undersampling parameters

DefVolc pre- and post-processor

Rules of thumbs are implictely 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)

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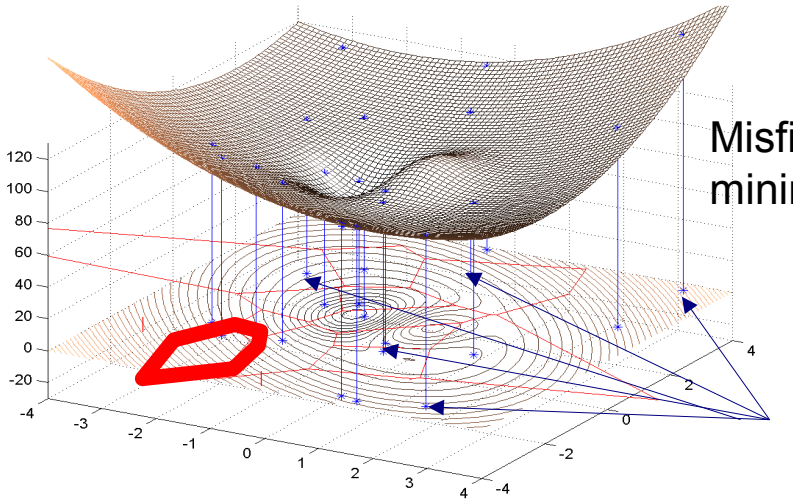
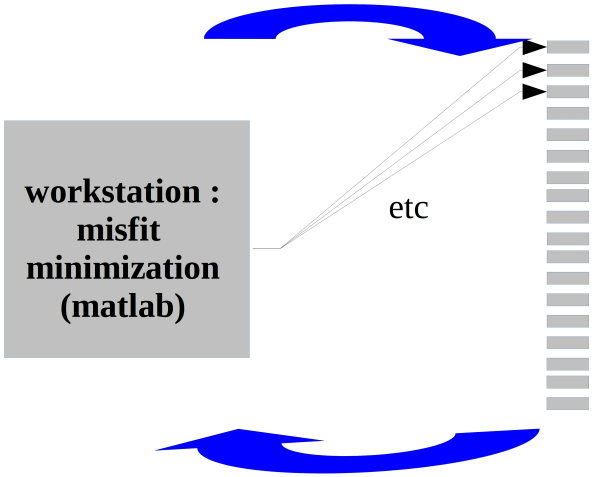
Web service



Misfit minimization

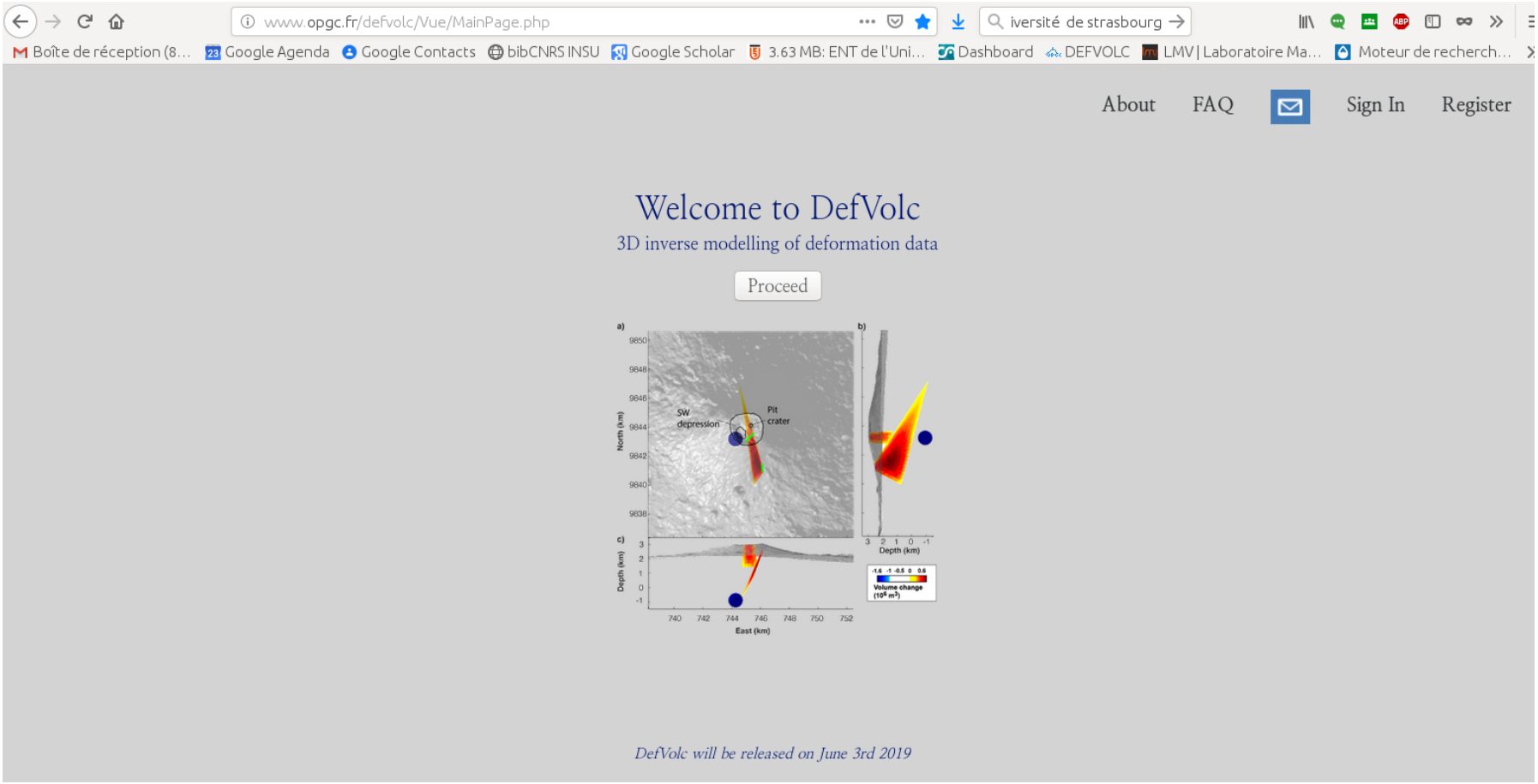
simultaneous forward models



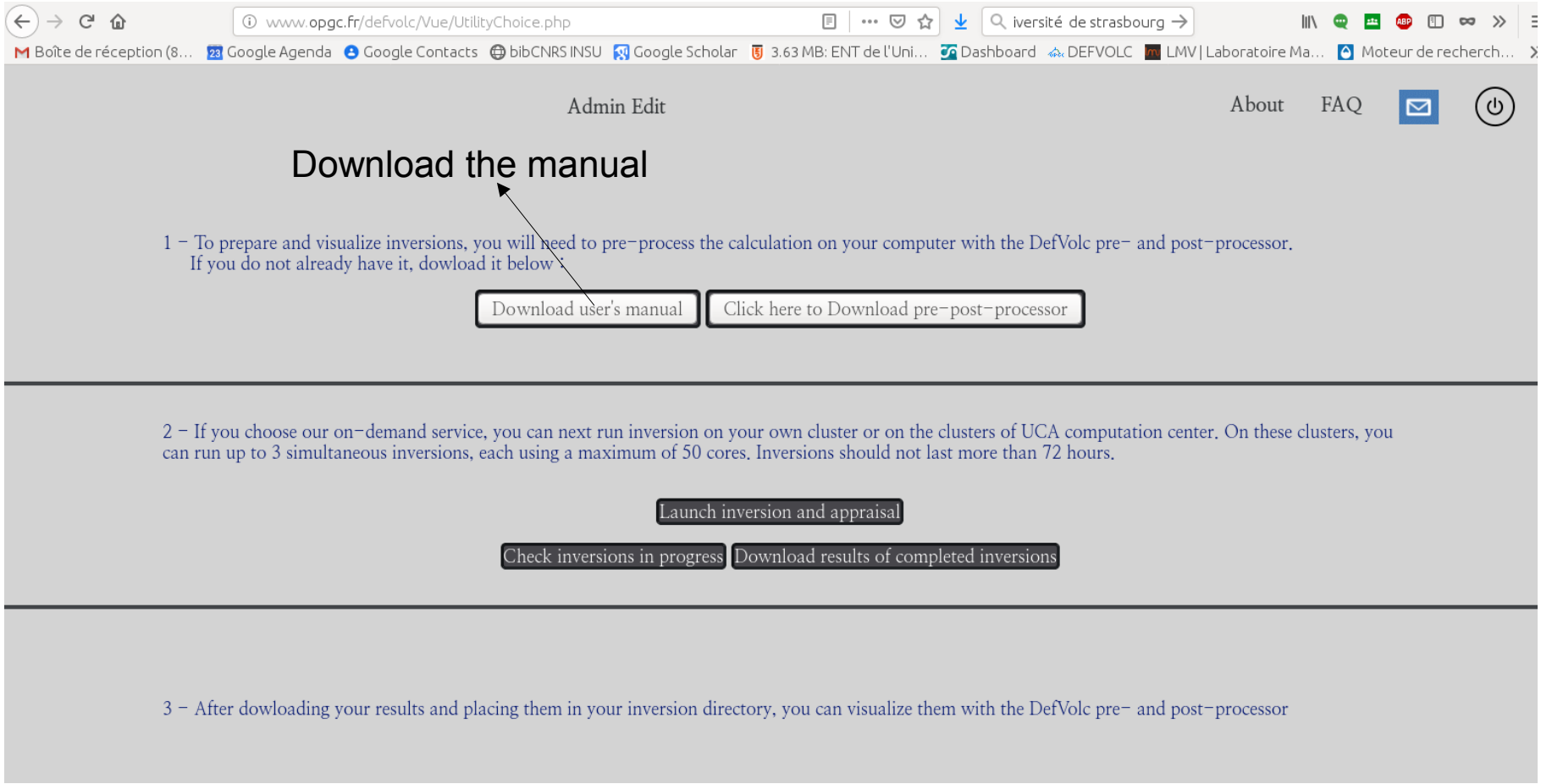
50 times faster (6 hours against two weeks)

Running inversions and appraisal on the UCA clusters

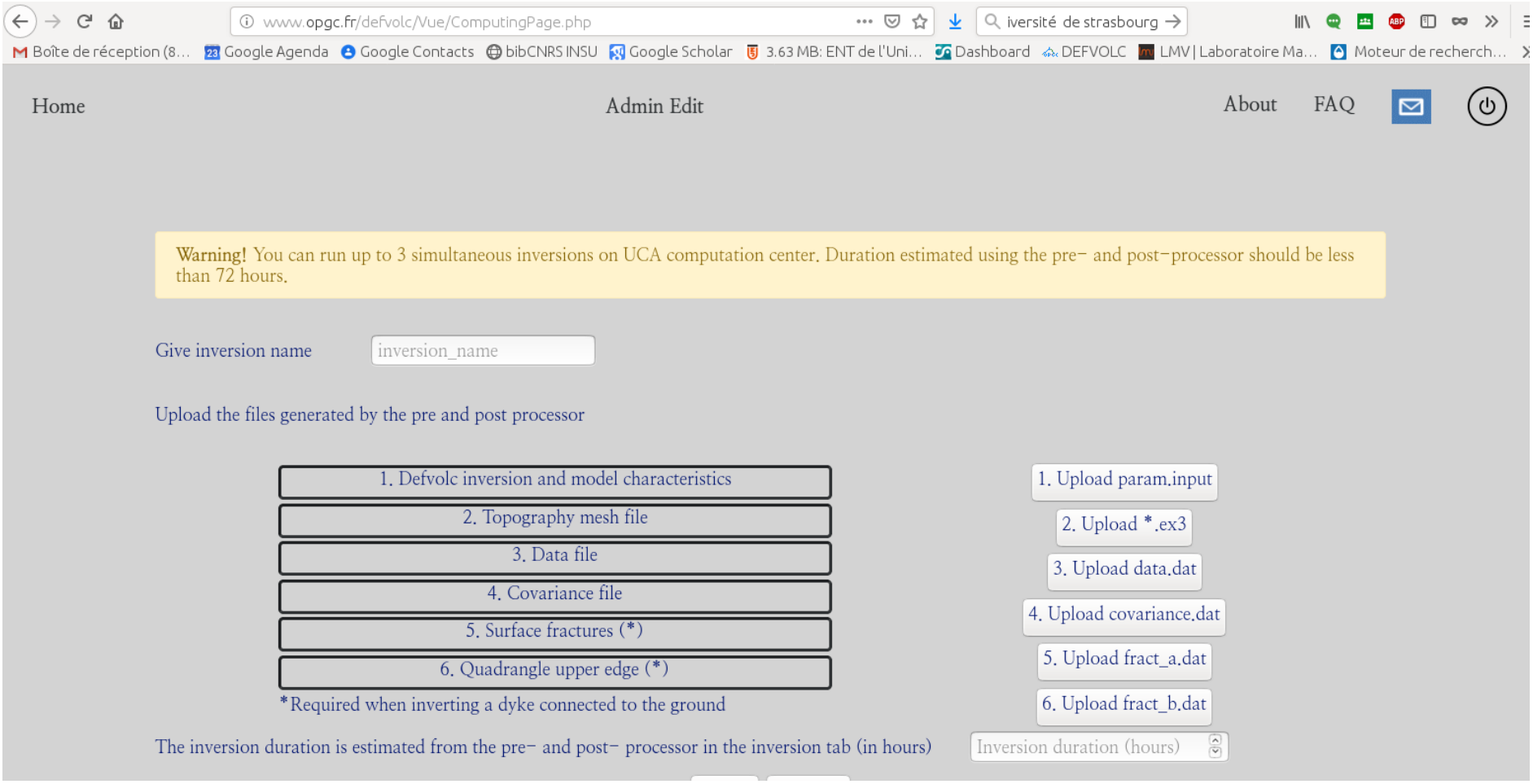
Register on defvolc at http://www.opgc.fr/defvolc/ ask for project code to valerie.cayol@uca.fr



Running inversions on the UCA clusters



Launch inversion and appraisal



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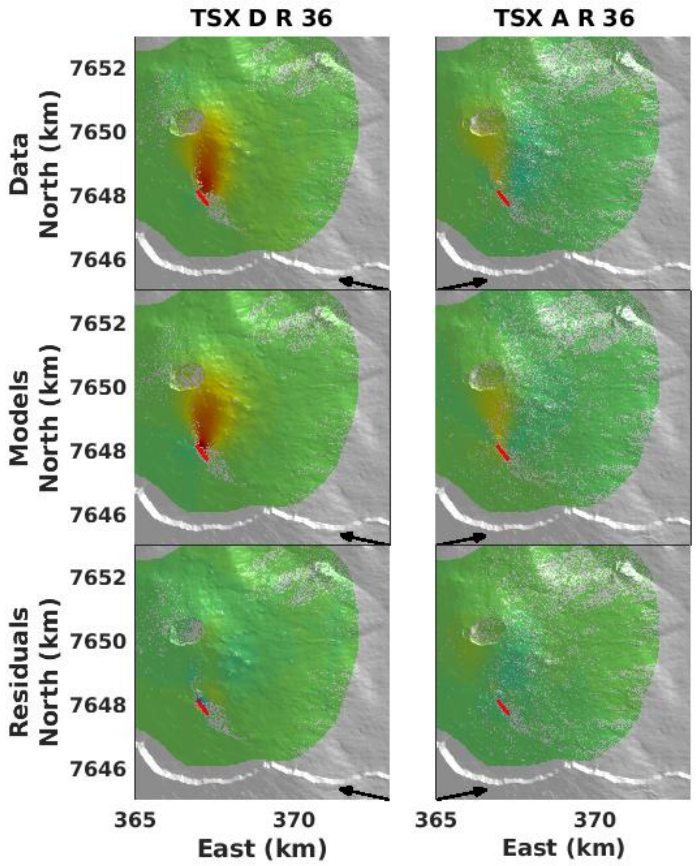
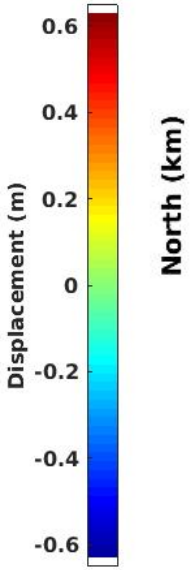
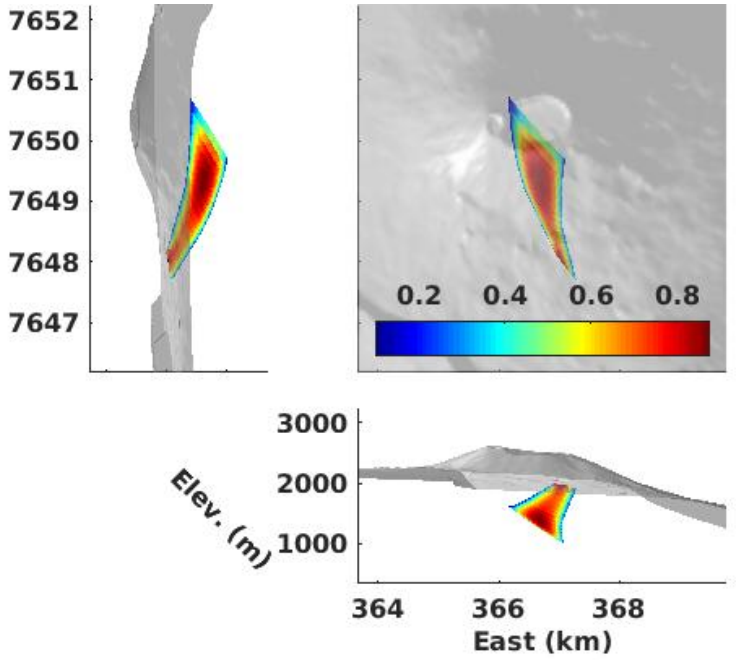
Example

Piton de la Fournaise Oct. 2010 eruption





A sill that turns into a dyke ?



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

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THE END