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Assessing and improving focal mechanisms in Switzerland: Towards a comprehensive seismotectonic model of the Central Alps and their foreland

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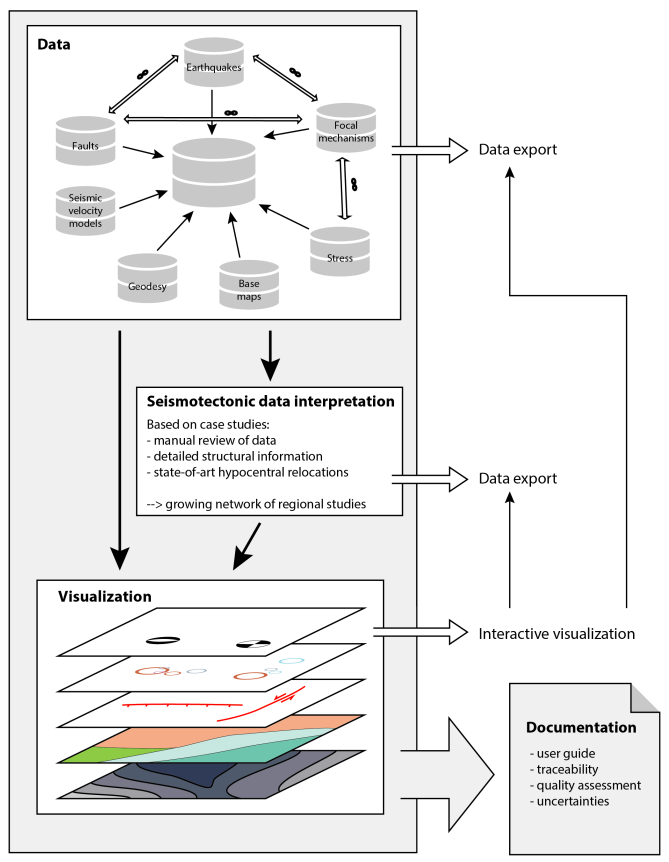
1: Motivation

This study is a contribution to the SeismoTeCH project aimed at producing an integrative seismotectonic model for Switzerland that combine all the relevant seismotectonic data in order to better understand the interplay between stress, faulting and seismicity of Switzerland.

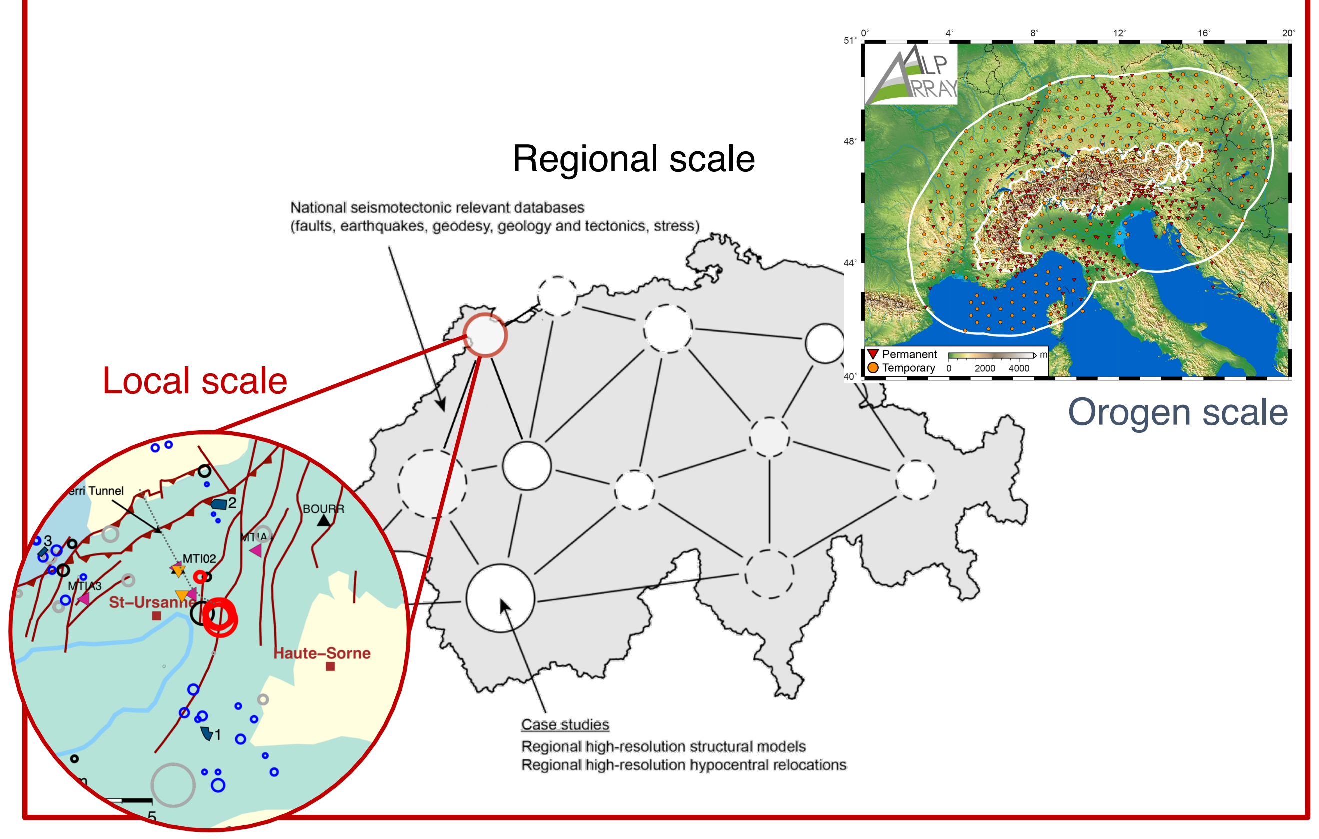
Project goals:

- Provide an up-to-date, high-quality, and consistent catalog of first-motion focal mechanisms since 1976.
- Develop an **updated full crustal 3D velocity model.**
- Incorporate automated and semi-automated techniques for expanding the calculation of first-motion focal mechanisms (and moment tensors) to events of smaller magnitude.

2: SeismoTeCH Project



- Joint project between University of Bern, SED, and Swisstopo, funded by the Swiss Geophysical Commission (SGPK).
- Combine:
  - Hypocenter locations,
  - Velocity models,
  - Focal mechanisms and moment-tensors,
  - Faults,
  - Geodetic data,
  - In-situ/regional stress data
- Interactive database



3: Velocity Model Sensitivity Tests

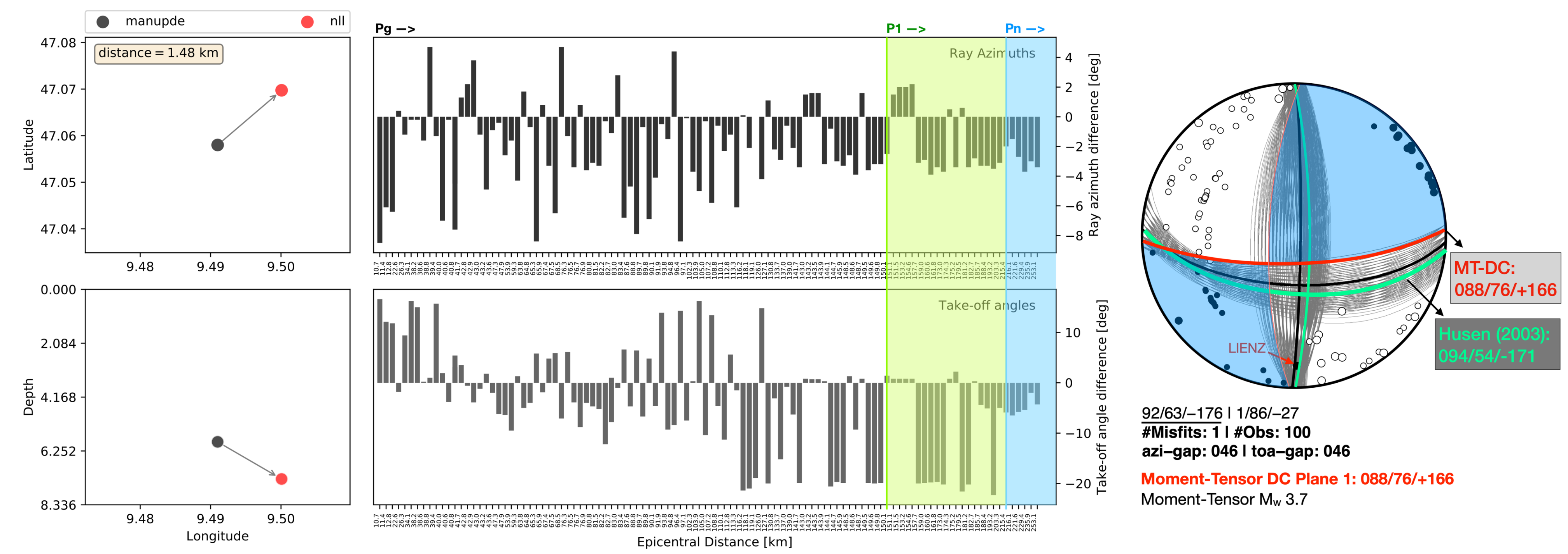
Tests on selected problematic mechanisms are first carried out in order to assess the sensitivity of the focal mechanisms to the velocity models used to calculate location and take-off angles. Here, we compare existing solutions using the standard 3D P-wave model of the SED from Husen et al. 2003 (green planes) with solutions based on a recently derived high-resolution 3D Pg+Sg model (Diehl et al., in prep - black planes).

Observations:

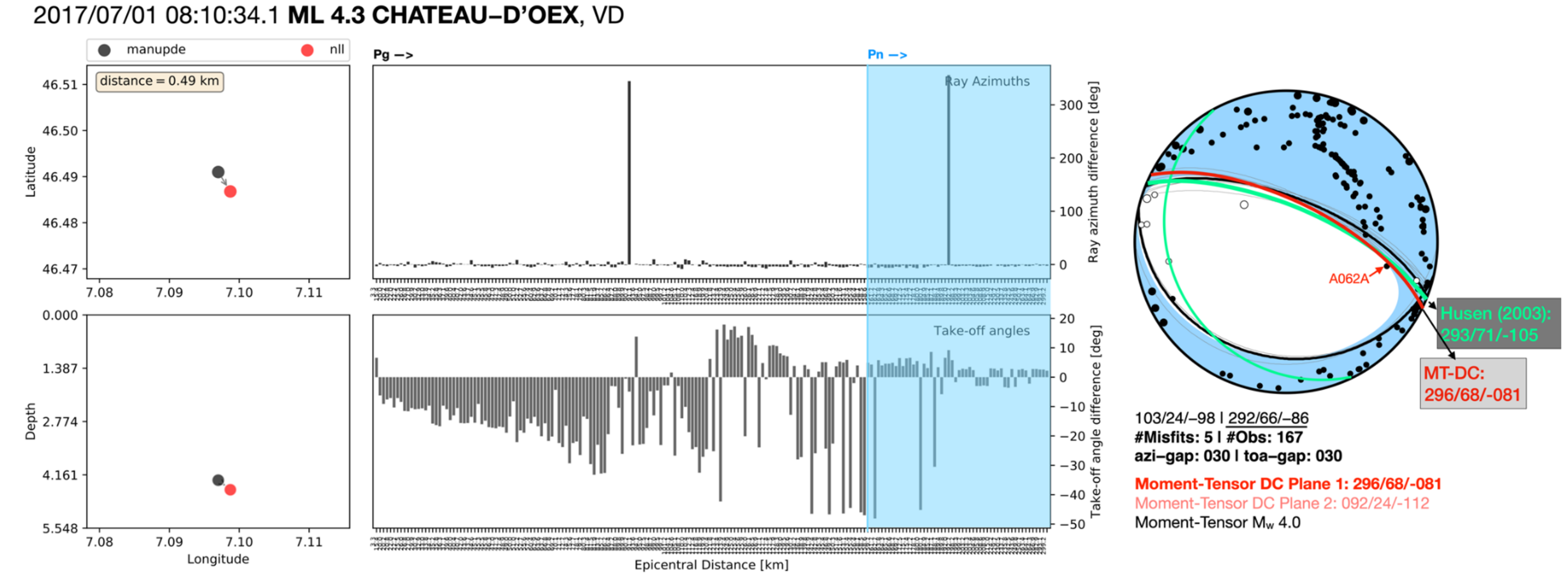
- Not only the different take-off angles but also improved absolute hypocenters (Diehl et al., in prep) have an impact in the solution (*coupled problem*!).
- In case of many observations, changes are negligible.
- Generally, we found a better coherency (and fewer misfits) of the focal solutions with the new 3D Pg+Sg model.

Examples showing comparisons between the existing focal mechanisms solutions and the ones obtained using the new 3D Pg+Sg model of Diehl et al. (in prep). Solutions are calculated from NonLinLoc (Lomax et al., 2000) relocations (red dots). The moment-tensor solution is overlaid in blue with the active plane in red. Right panel shows ray-azimuth and take-off angles differences arranged by epicentral distance.

2013/12/12 00:59:18.8 **ML 4.1 Balzers**, FL



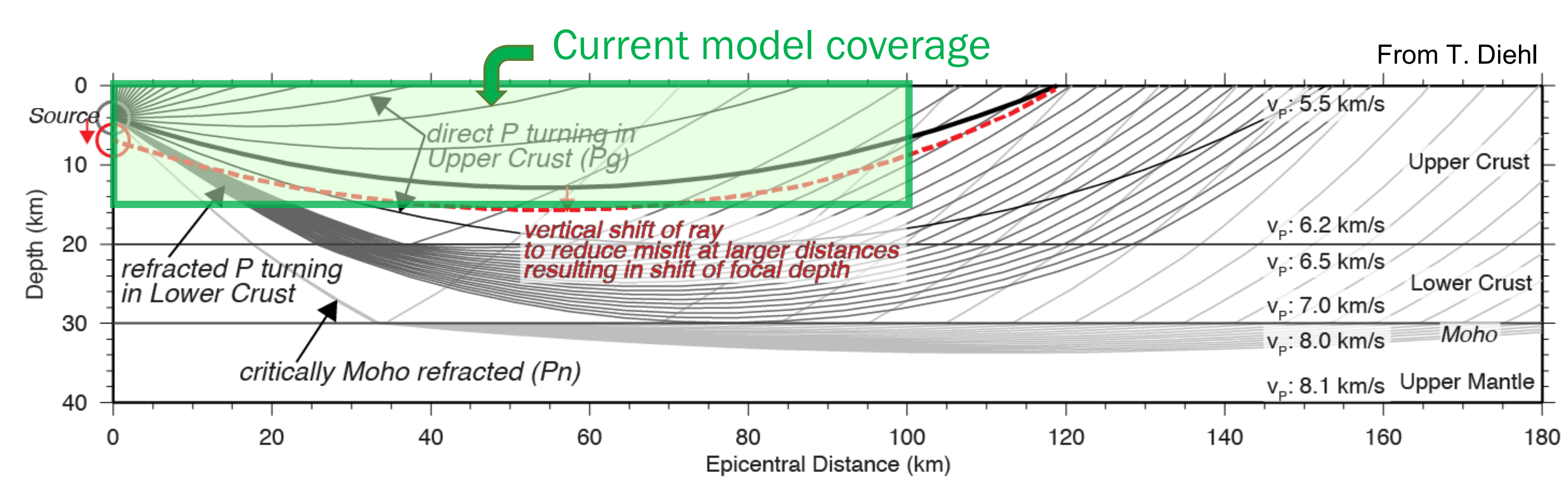
2017/07/01 08:10:34.1 **ML 4.3 CHATEAU–D'OEX**, VD



4: Key Findings and Future Directions

Modern data in combination with modern tools like double-difference relocation can give high-resolution insights in geometries of fault systems, likewise we also need to improve the focal mechanisms (FM) to better understand their kinematics.

Although changes in the FM solutions are of second-order compared to the catalog derived using the previous 3D model of Husen et al. 2003, because our goal is to push the resolution in order to connect it with field-scale observations of faults, the tests show that these second-order differences can/do matter, and it is worth re-computing the take-off angles in a full crustal 3-D model.



Future steps:

- Extend Pg + Sg model with Pn phases without biasing the focal depth estimates for shallow seismicity.
- Use more distance Pg/Sg phases >80 km and complement it with regional data (Diehl et al. 2009, AlpArray) and other methods (CSS) to improve resolution of entire crust.
- Consistently recompute FM solutions with new model