Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Schweizerischer Erdbebendienst
Swiss Seismological Service

Combining controlled-source seismology and local earthquake data to derive a consistent three-dimensional model of the crust: Application to the Alpine region

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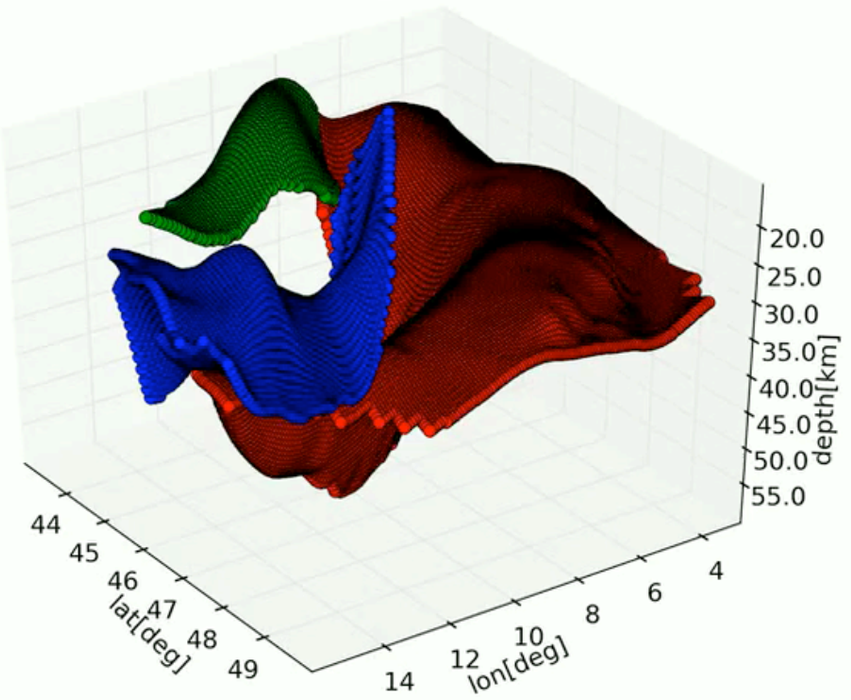
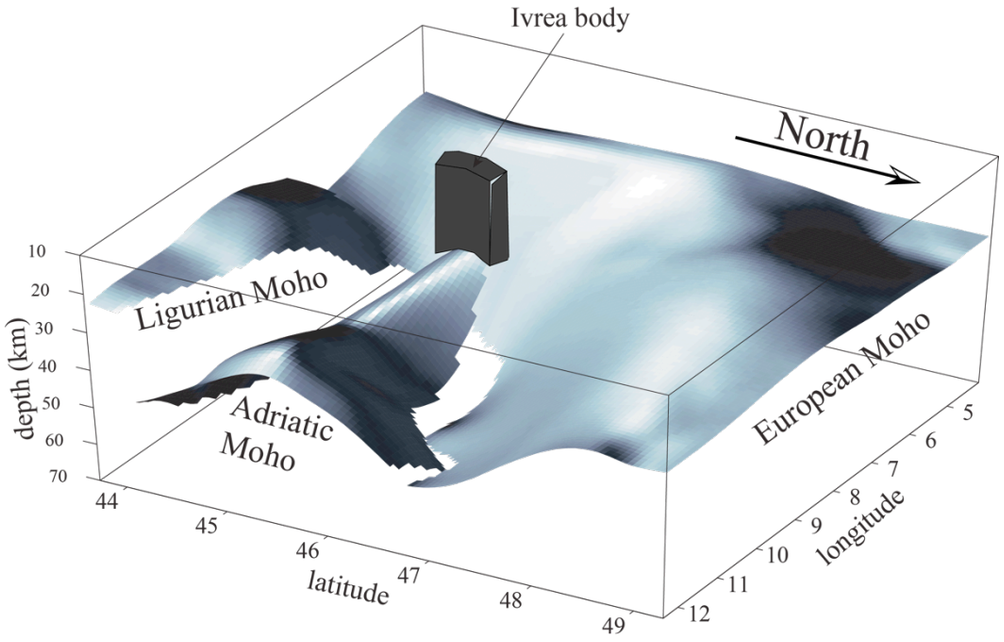


Motivation

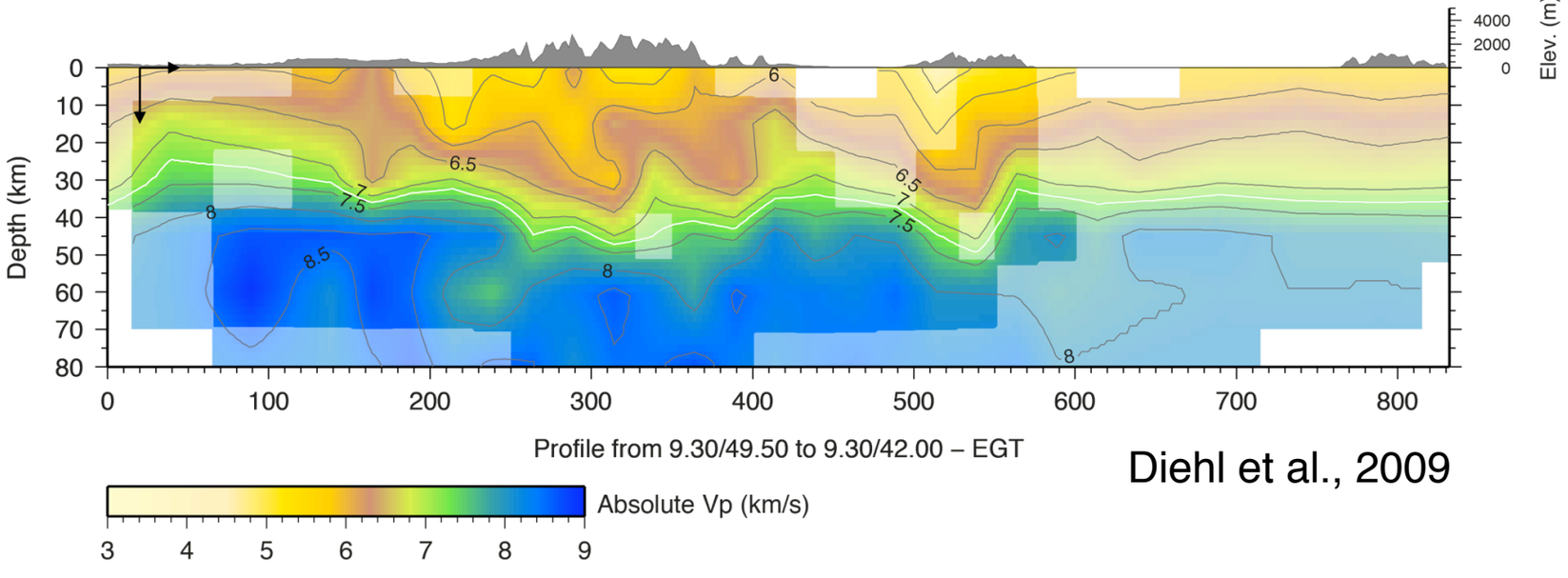
Development of a 3D crustal P-wave velocity model of the Alpine region for seismic applications, e.g. regional earthquake hypocenter location, including:

→ A realistic representation of the geology and (first order) **discontinuities**, e.g. Moho discontinuity.

→ A realistic representation of **crustal velocities**, i.e. 3D variations in seismic velocities.



after Waldhauser et al., 2002

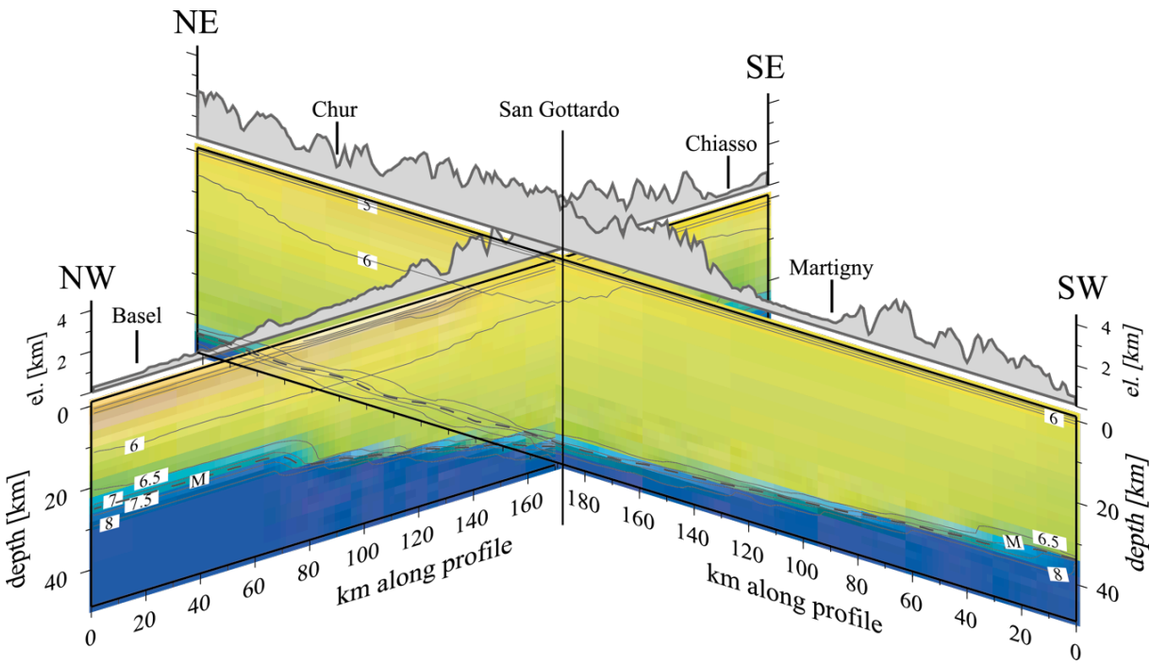


Diehl et al., 2009

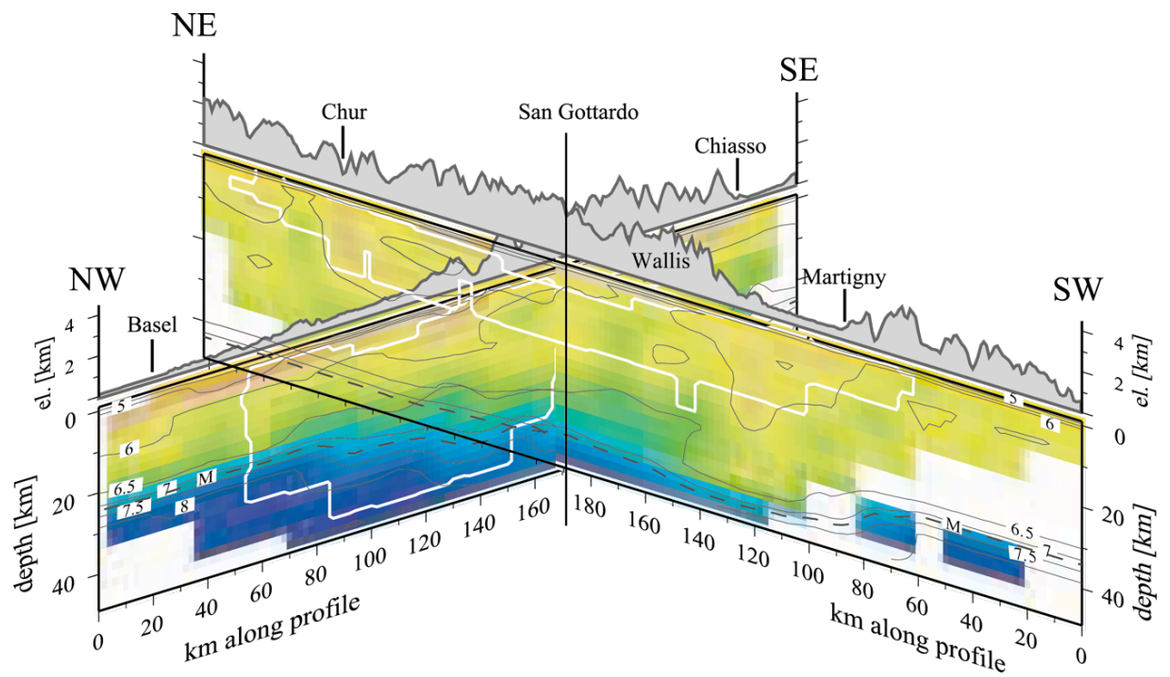
Motivation (cont.)

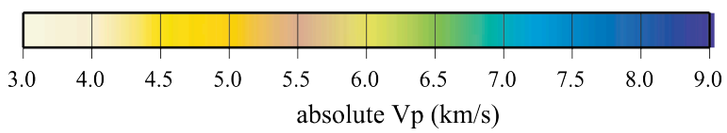
Controlled-source seismology (CSS)
vs. local earthquake tomography (LET)

3D CSS model (Waldhauser et al., 2002)



3D LET model (Husen et al., 2003)



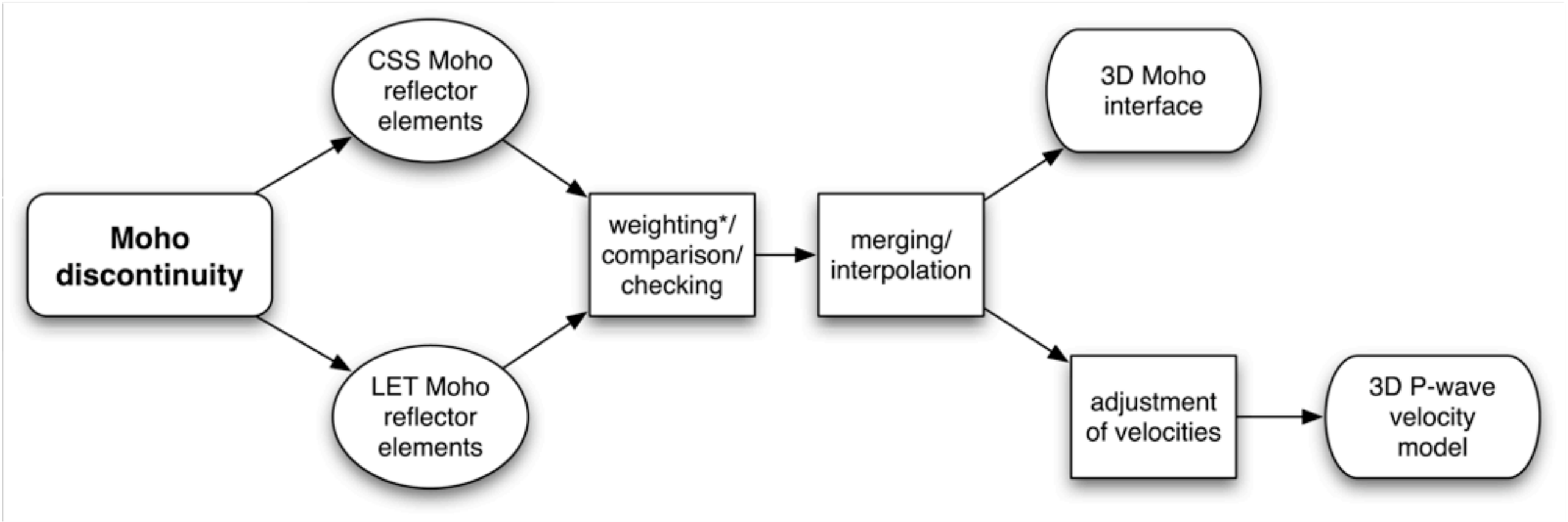


Husen et al., 2003

First order discontinuity,
but only simplified velocities.

No first order discontinuity,
but 3D seismic velocities.

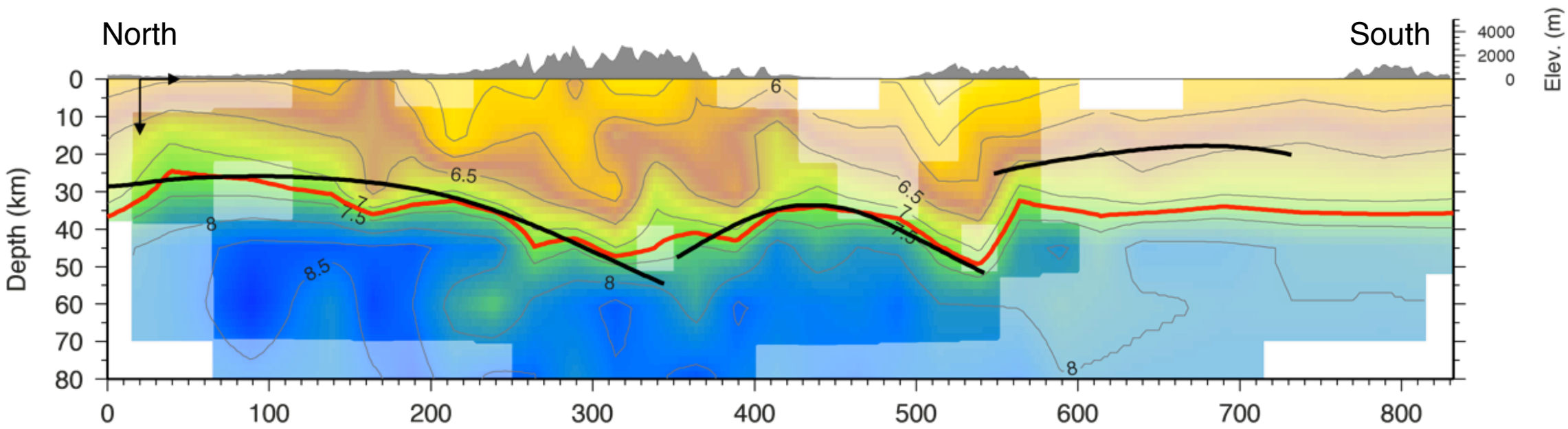
Approach

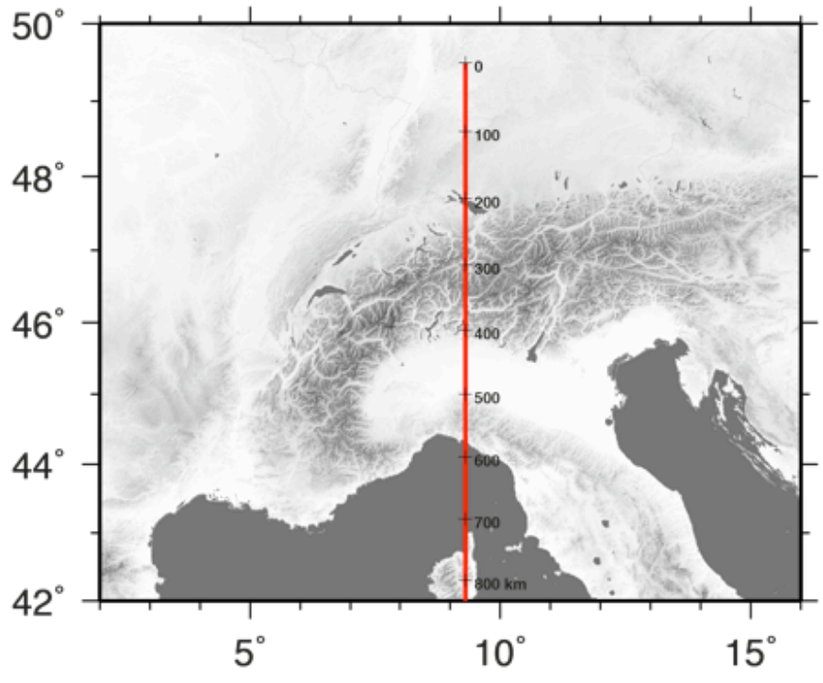


*CSS: after Waldhauser et al., 1998 (best: ± 3 km)
LET: class 0 (± 5 km), class 1 (± 7 km)

CSS vs. LET

Agreement in CSS and LET Moho depth

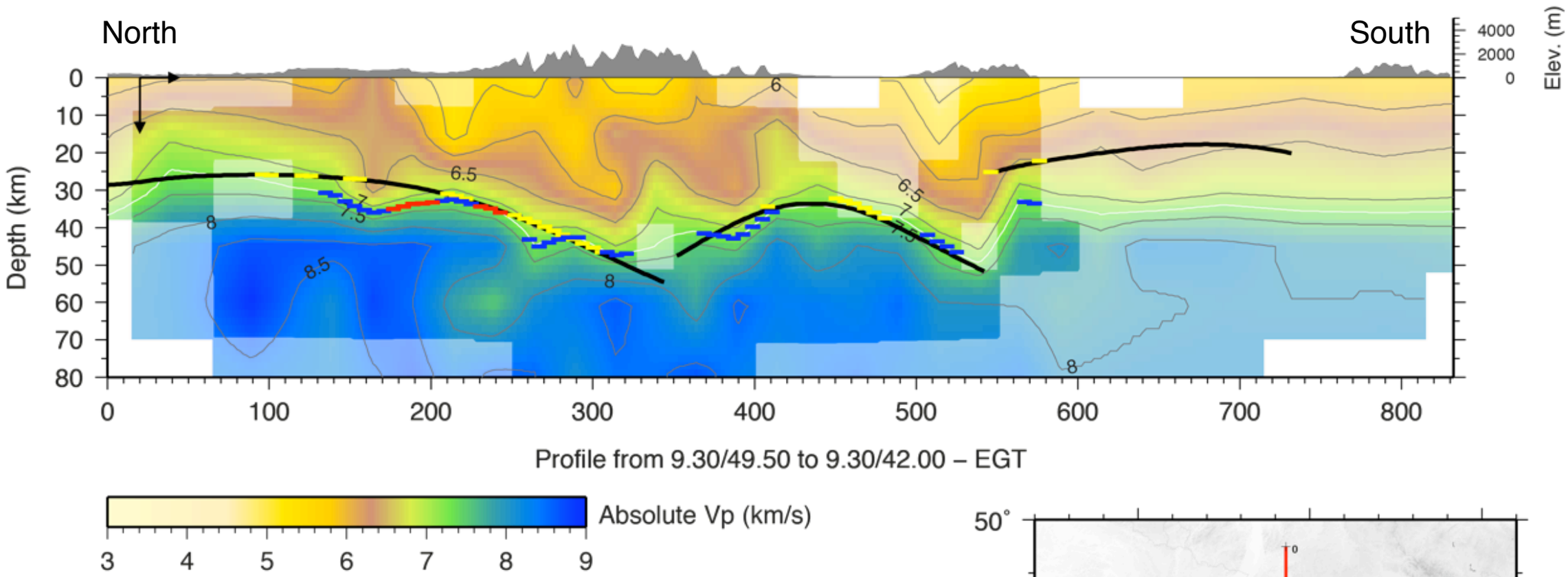




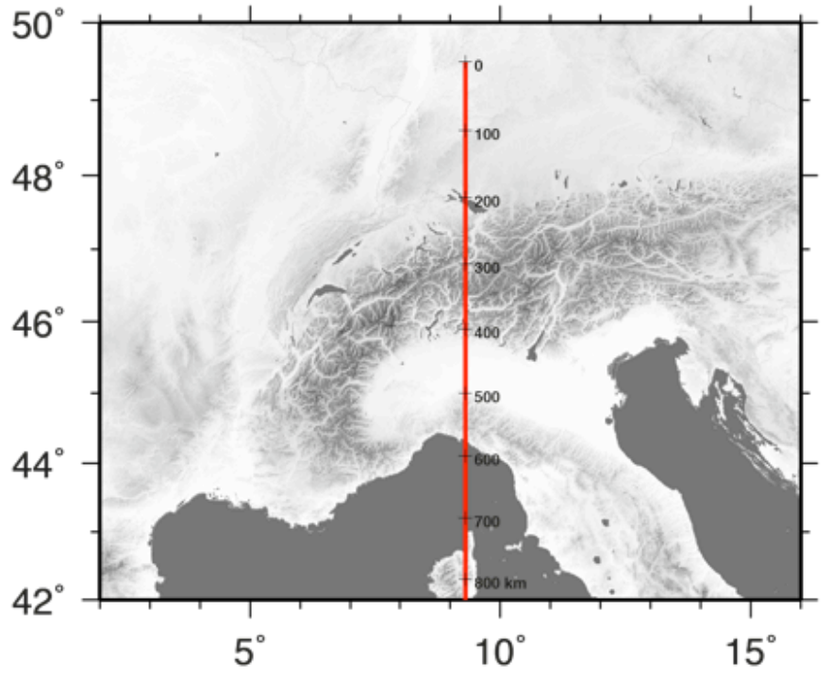
Red line: 7.25 km/s isoline
(LET Moho after Diehl et al., 2009)
Black line: interpolated CSS Moho depth

CSS vs. LET (cont.)

Discretization of LET Moho



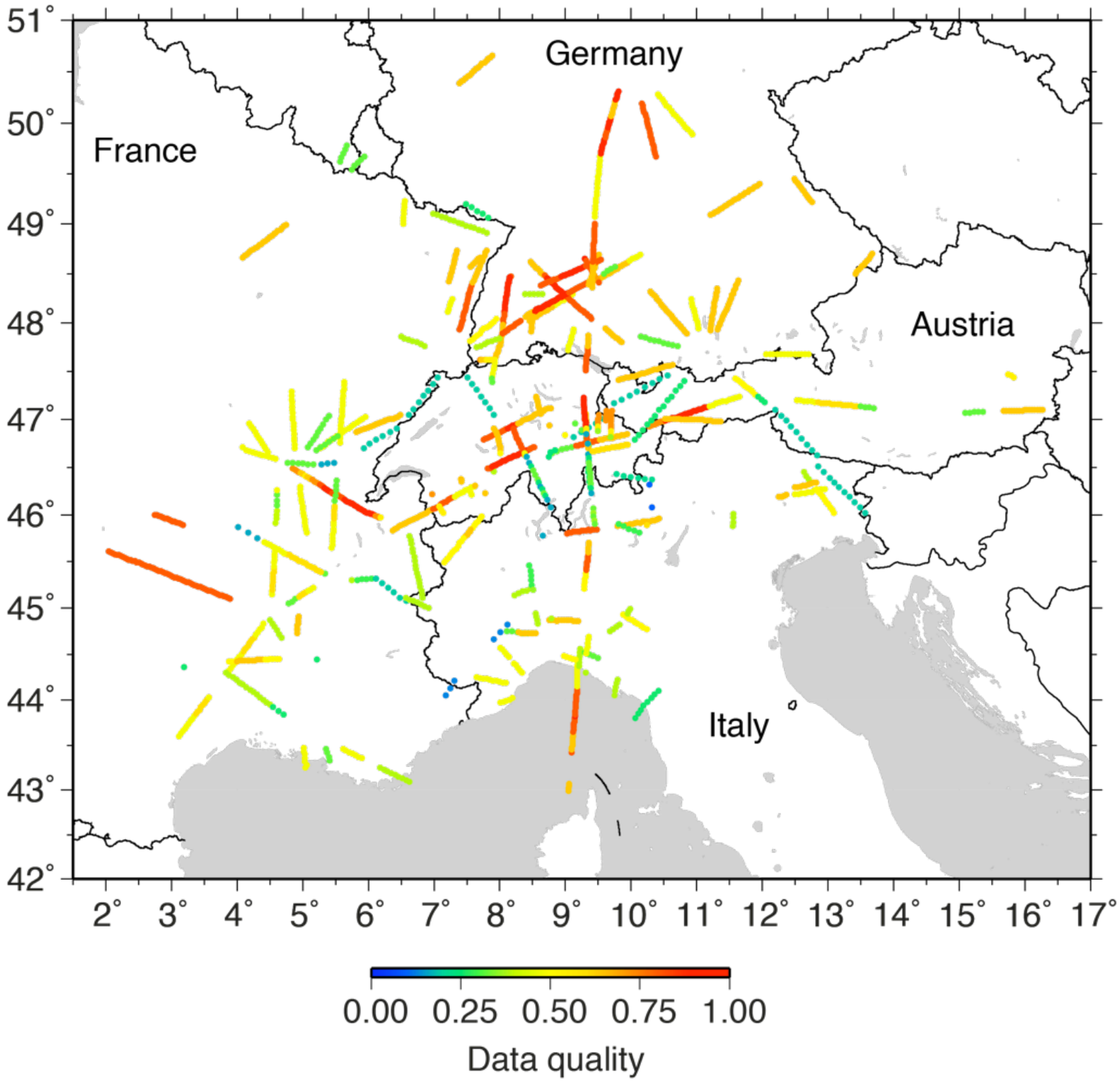
- CSS Moho reflector elements
- LET Moho reflector elements (class 0)
- LET Moho reflector elements (class 1)



Combined Moho modeling

CSS data

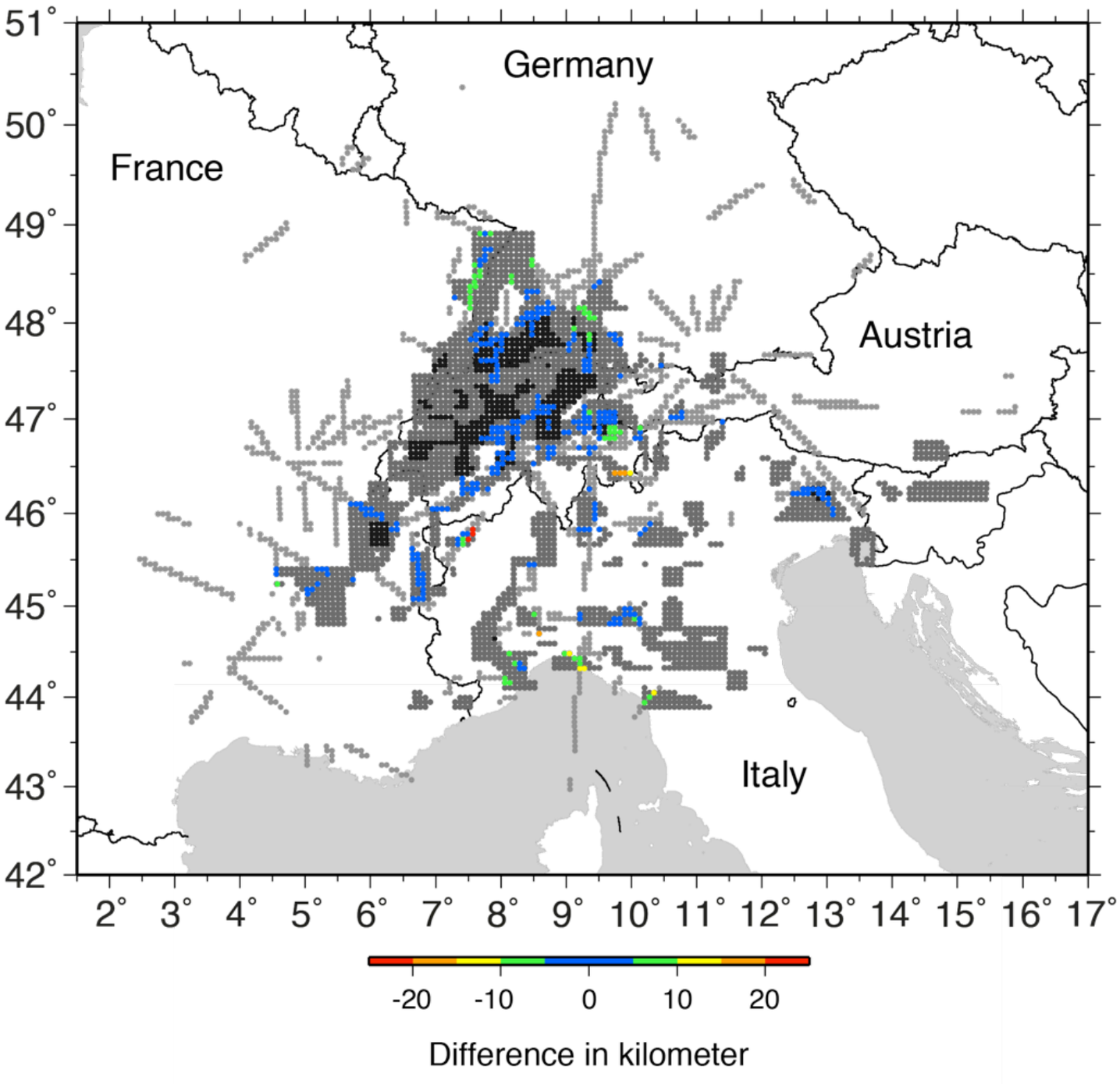
- Alpine region is a very well-known study area.
- Existence of many profiles from the last decades.
- But there are gaps in between!



after Waldhauser et al., 1998

Combined Moho modeling (cont.)

Comparison of CSS/LET Moho reflector elements



- LET data complement existing CSS information.
- Very good agreement in depth of CSS and LET Moho reflector elements!

criterion	class 0	class 1	total
all	420	2332	2752
$\Delta z \leq err_{LET} + err_{CSS}$	71	278	349
$\Delta z > err_{LET} + err_{CSS}$	0	4	4

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Combined Moho topography

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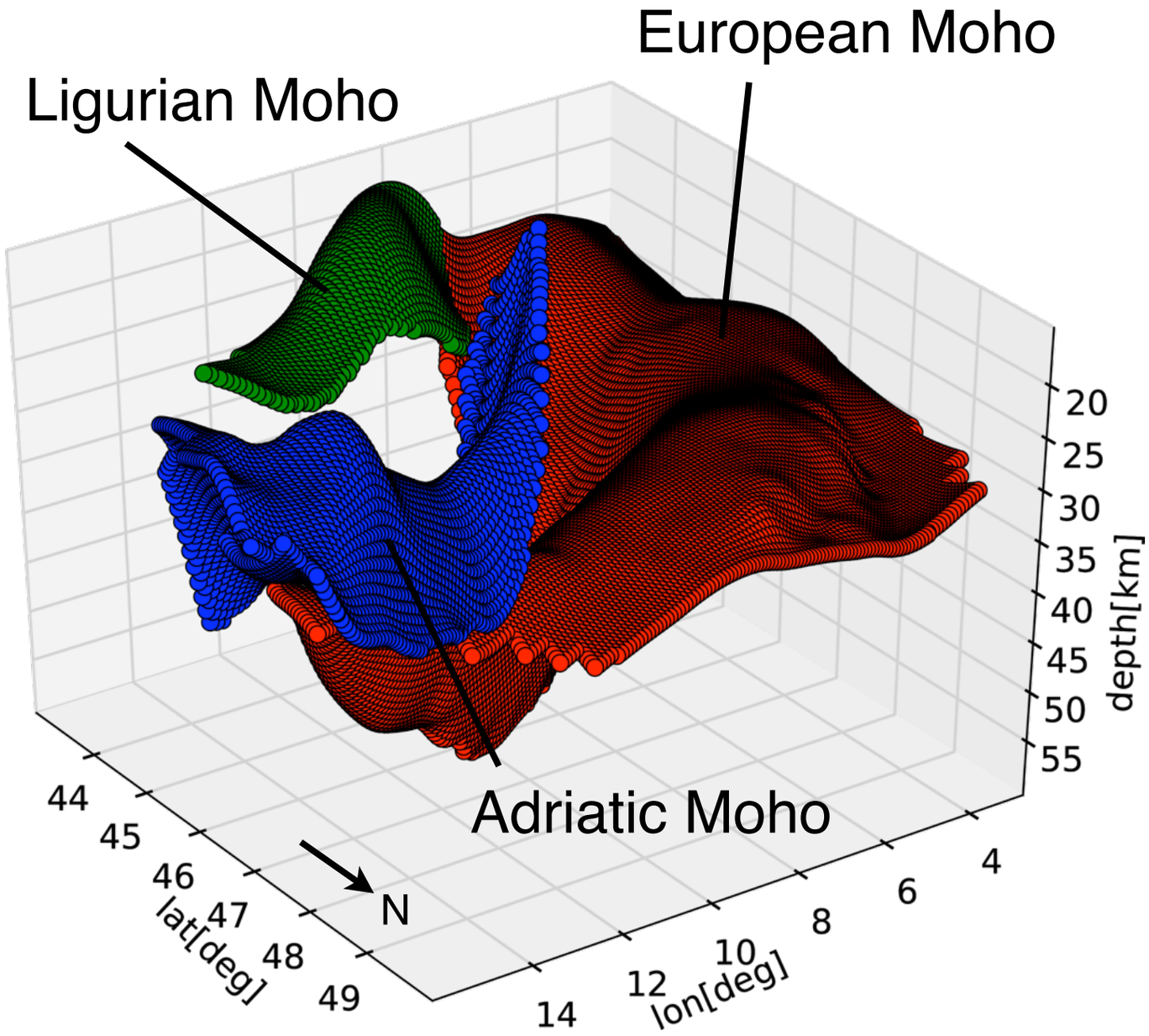
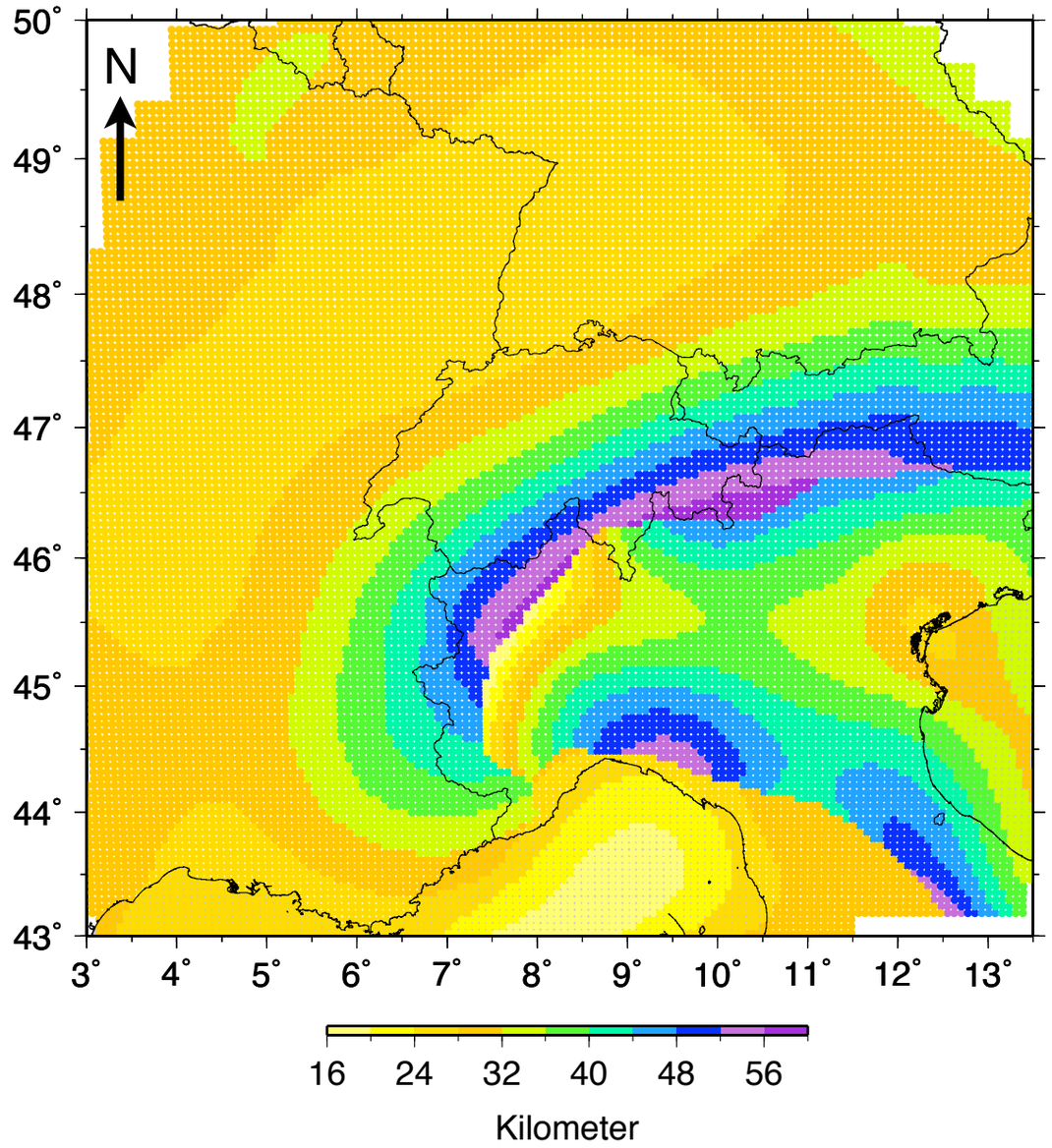
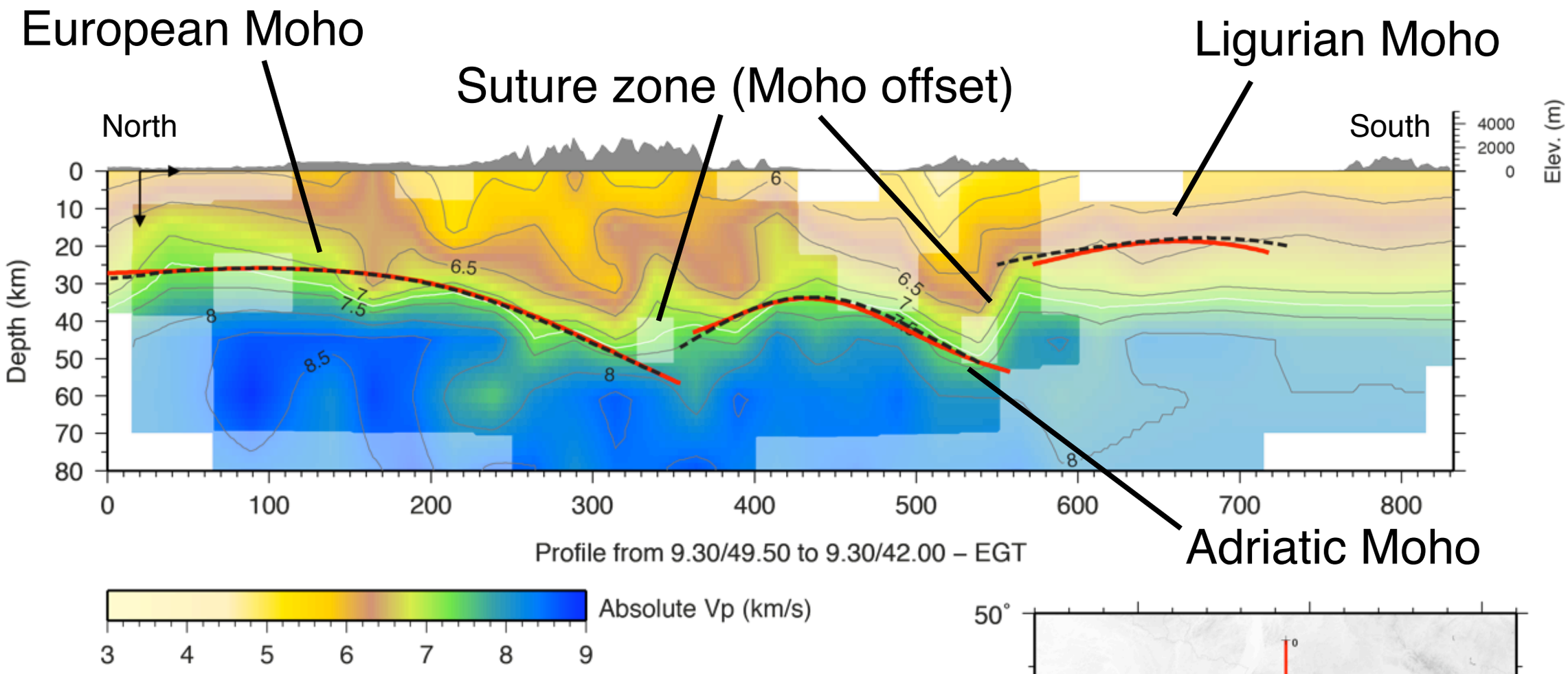
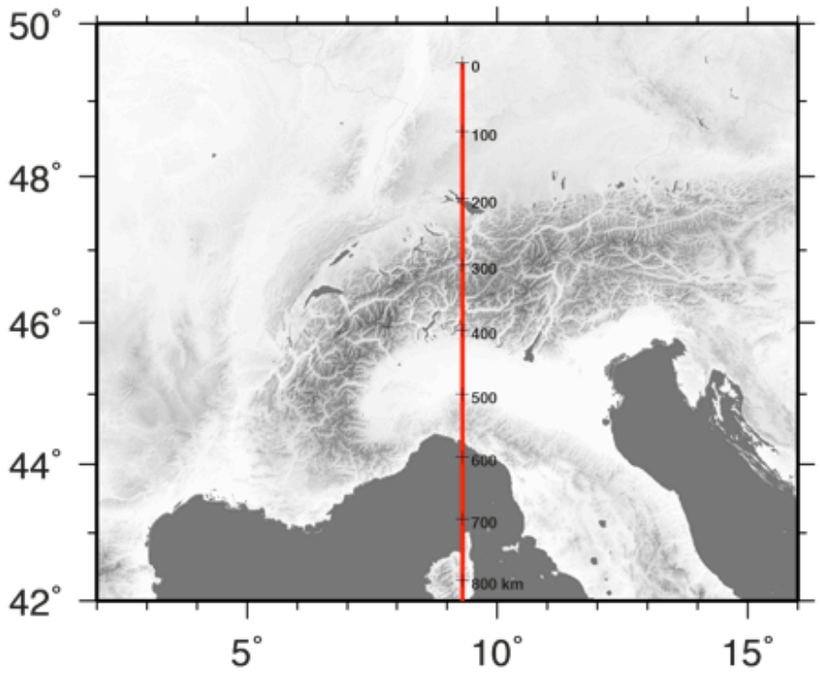
Interpolated CSS/LET Moho





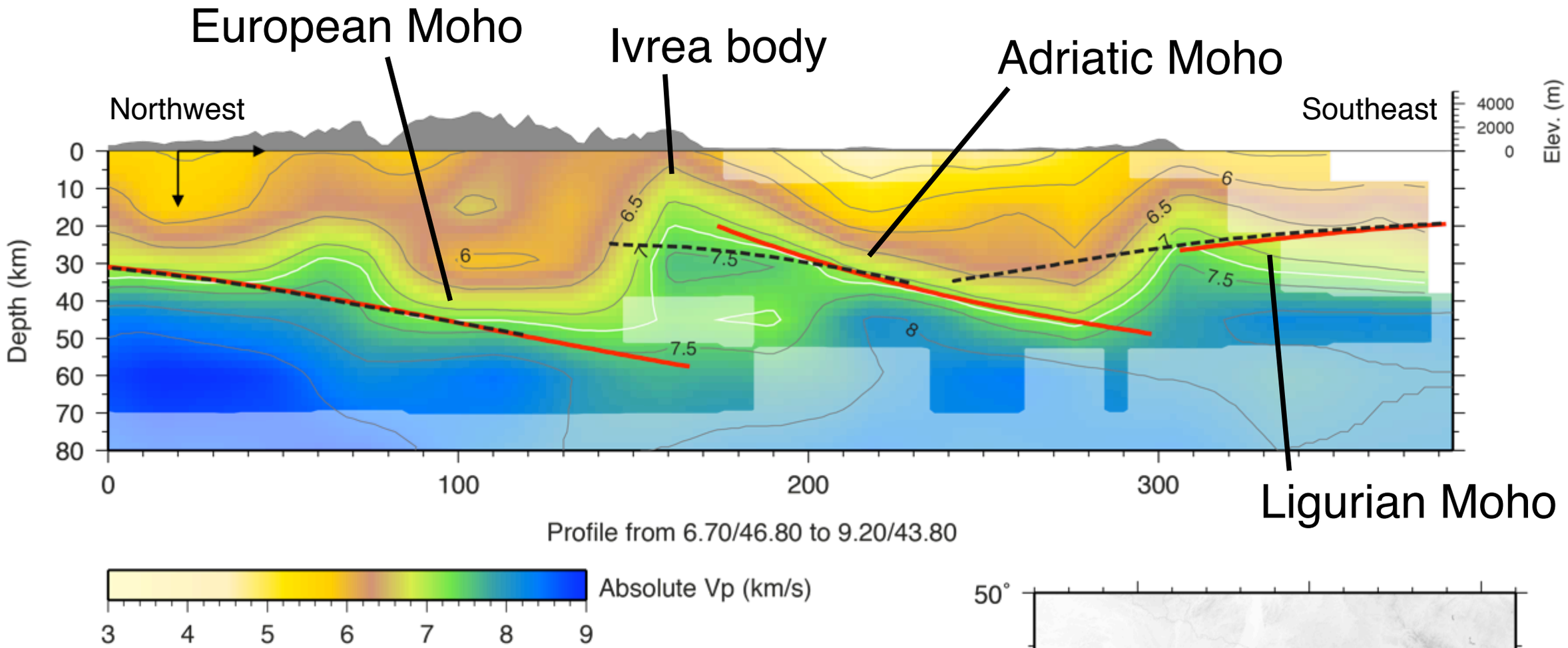
Combined Moho topography (cont.)



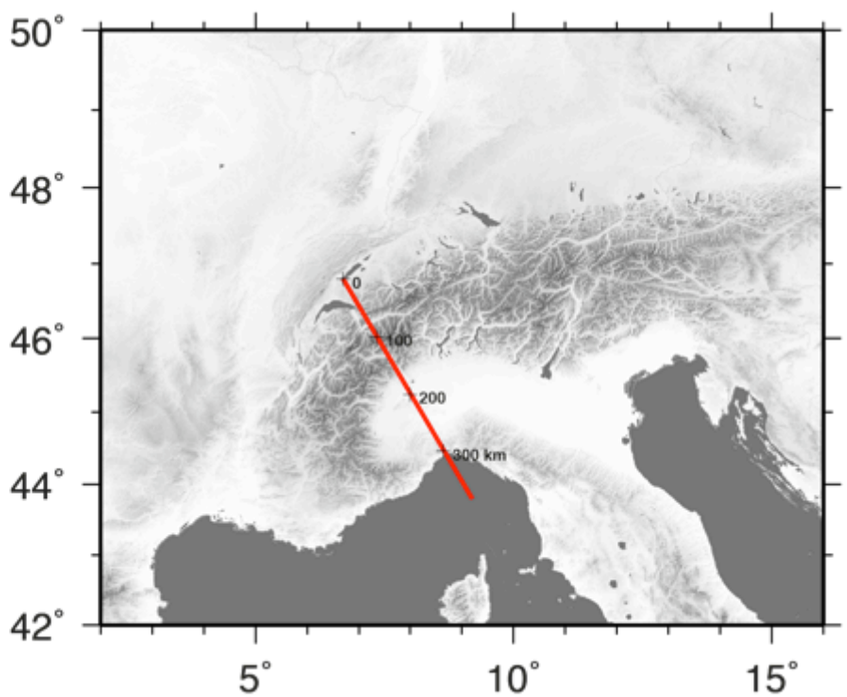


Black (dashed) line: CSS only Moho
Red line: combined CSS/LET Moho

Combined Moho topography (cont.)



Black (dashed) line: CSS only Moho
Red line: combined CSS/LET Moho



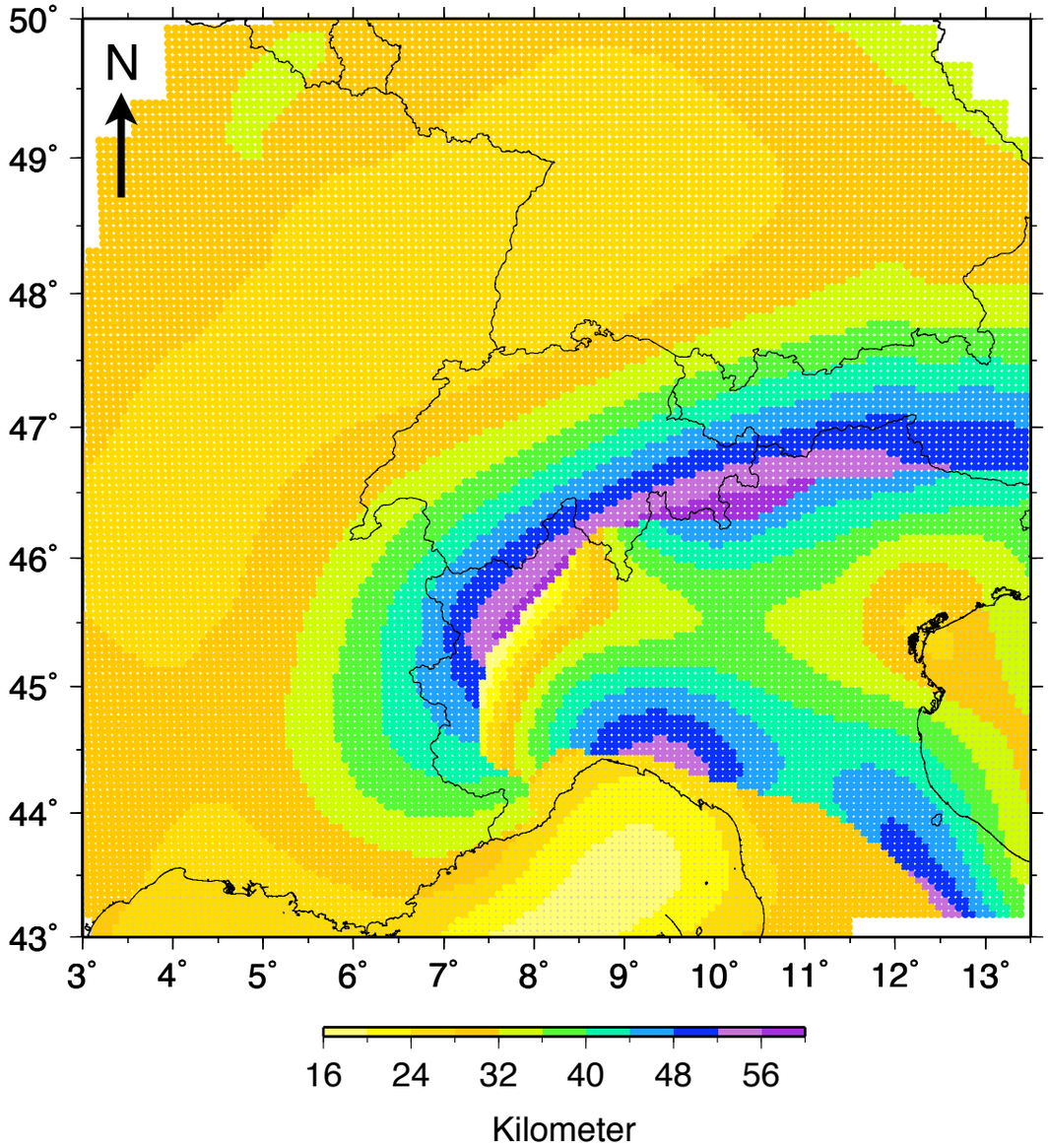
Conclusions

- Merging of CSS and LET data is possible based on their individual ability to identify the Moho discontinuity.

- Well-resolved CSS and LET Moho reflector elements are in good agreement.

- LET data will update and complement the previous existing CSS information to get a spatially more complete model of the Alpine crust.

- The larger number of Moho reflector elements allows for a more accurate definition of plate boundaries.



Outlook: 3D seismic velocity modeling

Conclusions

Thank you!