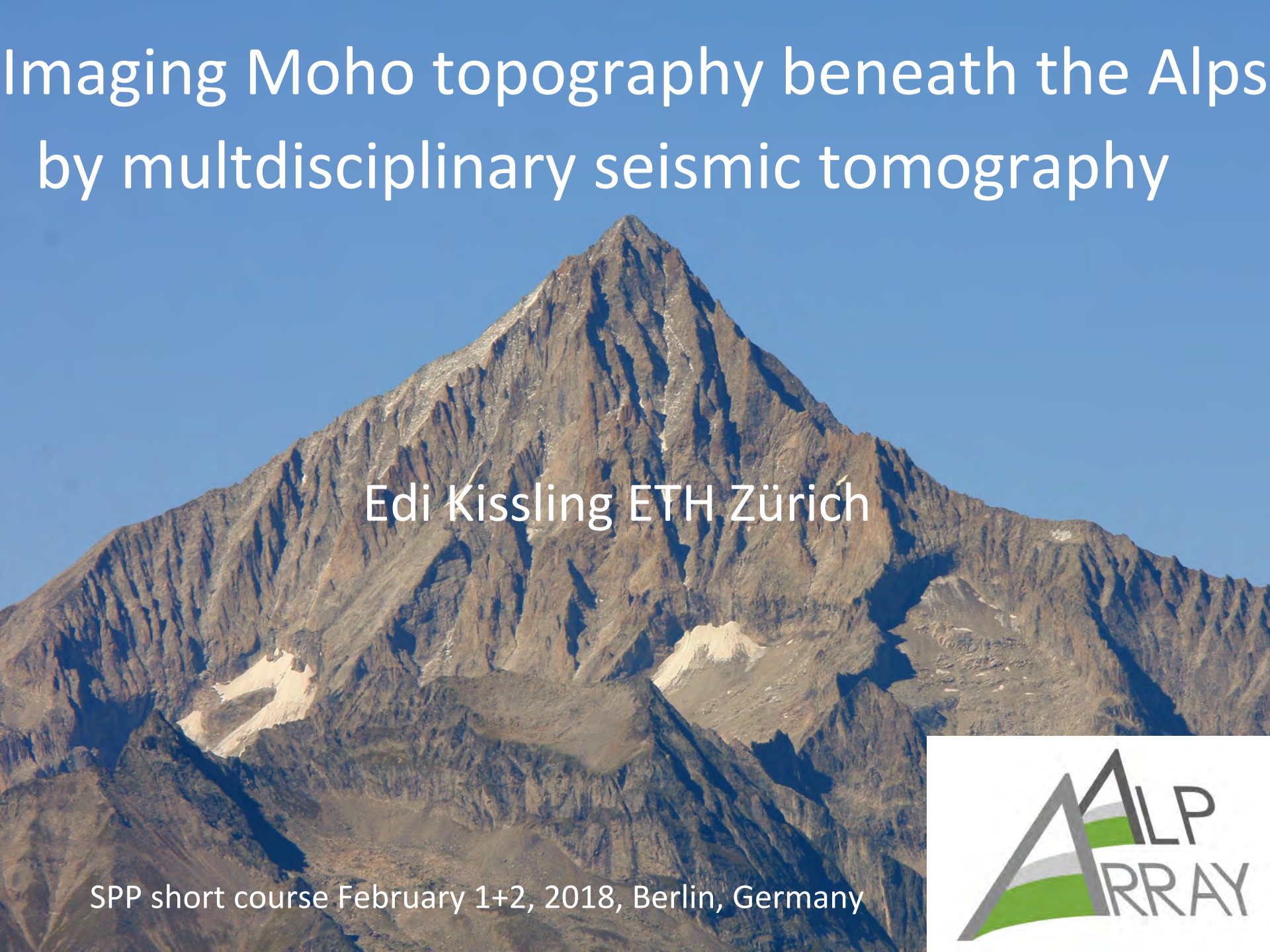
Imaging Moho topography beneath the Alps by multdisciplinary seismic tomography



Edi Kissling ETH Zürich

SPP short course February 1+2, 2018, Berlin, Germany

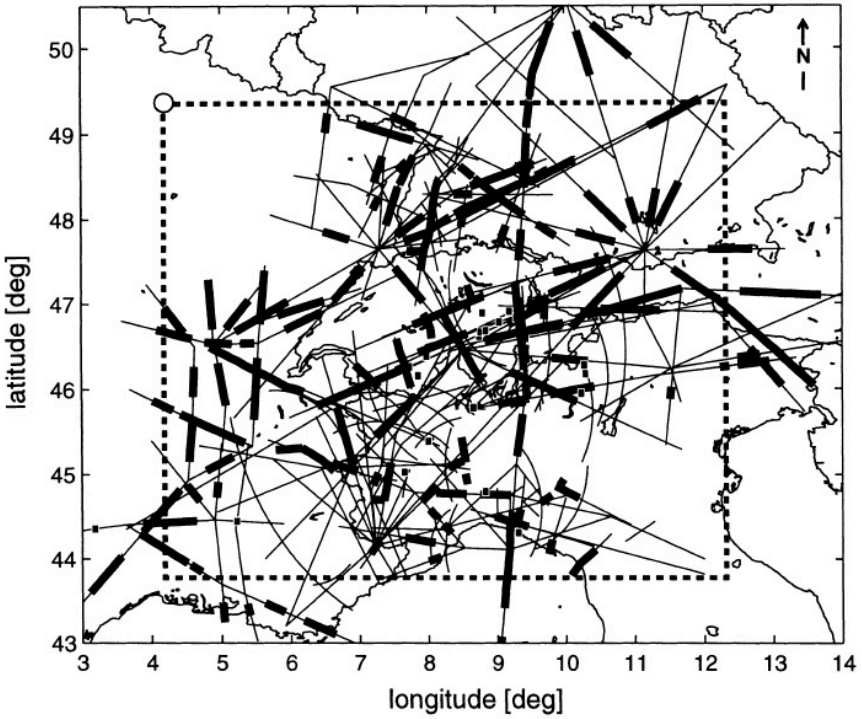
ALP ARRAY

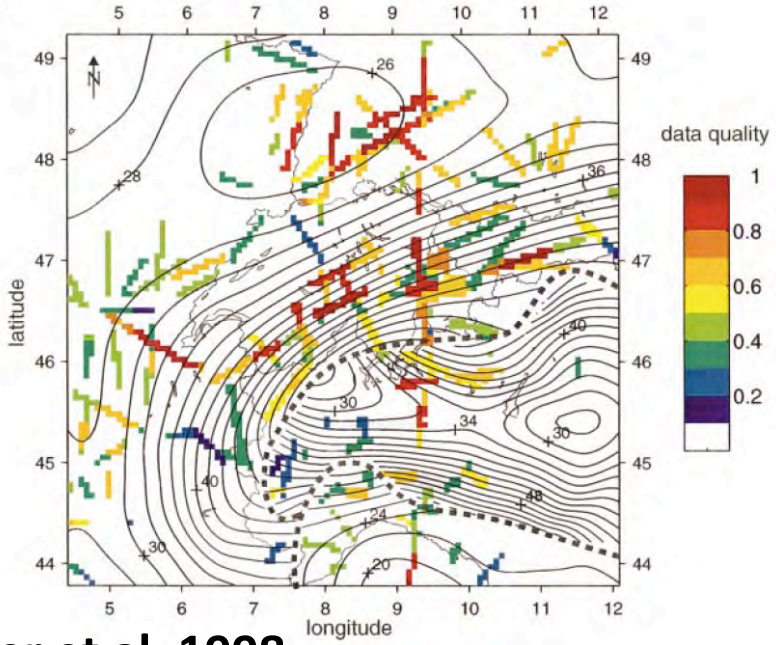
Alpine Moho map from CSS

Observation quality

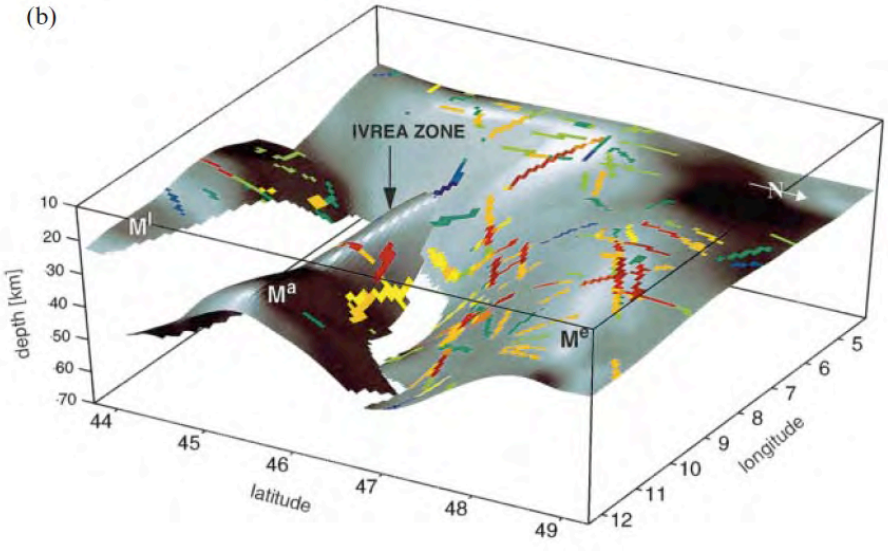
Moho uncertainty derived from CSS data quality

sampled Moho locations





Waldhauser et al. 1998



(combining refraction seismic and near-vertical reflection seismic data with respect to strengths and limitations of methods and to individual data qualities)

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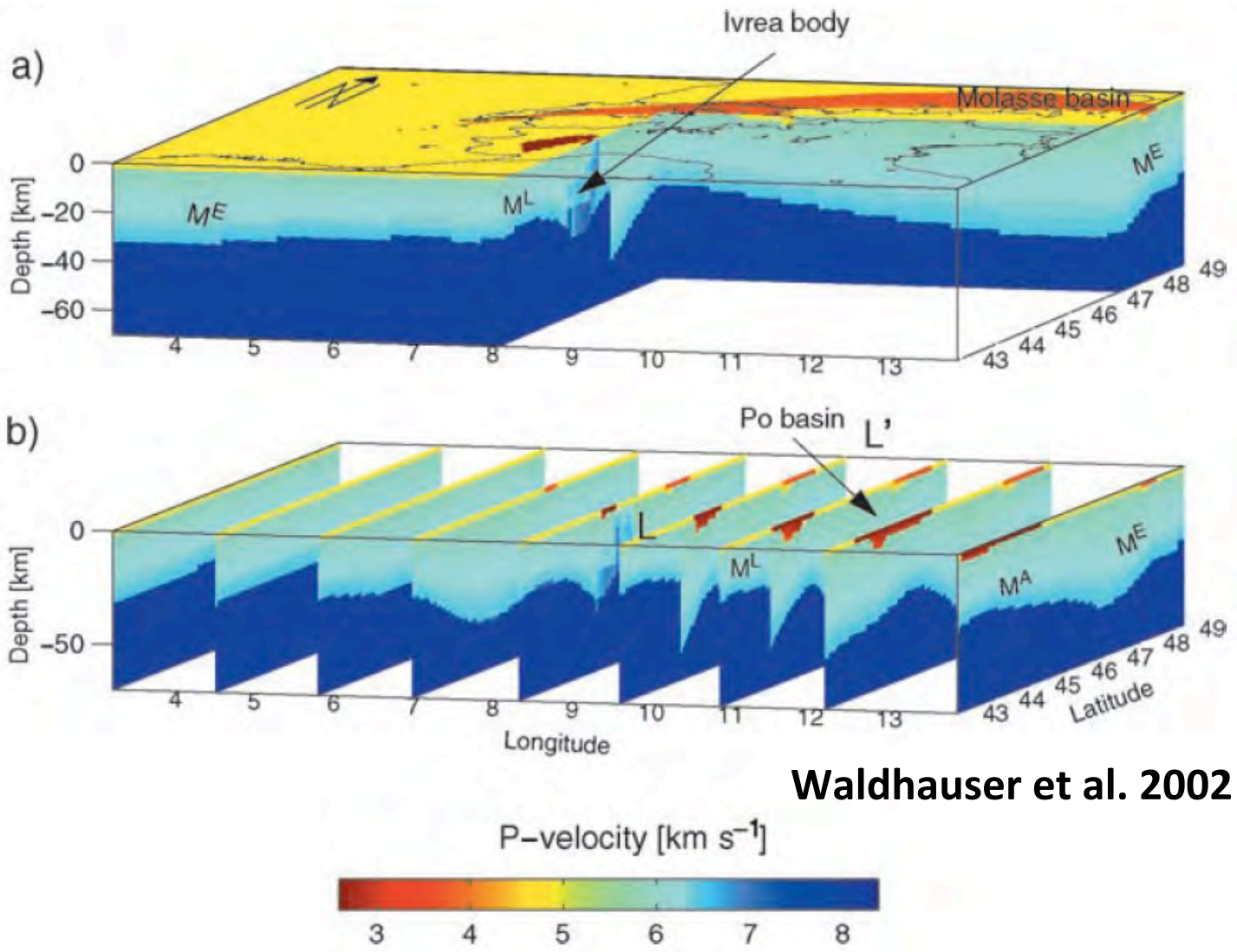
3D Alpine crustal model from CSS



Waldhauser et al. 2002

(3D velocity model based on re-interpretation of 120+ refraction seismic and near-vertical reflection profile and extraction and 3D migration of high-quality data)

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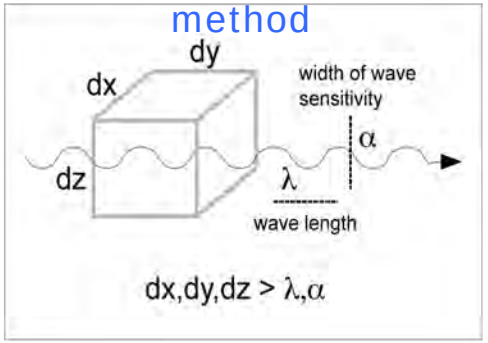
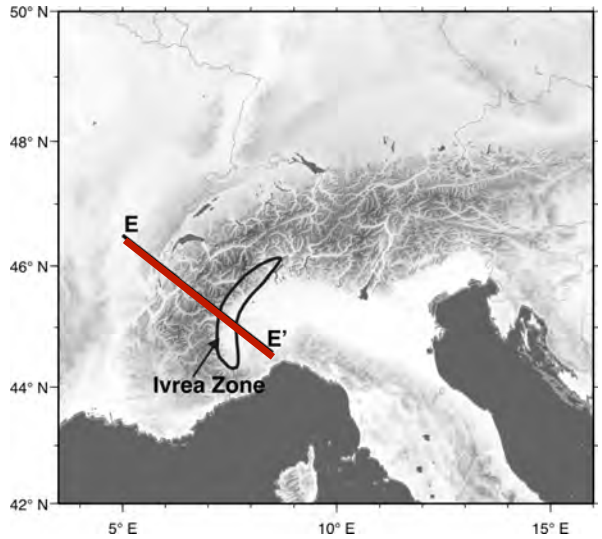
CSS and LET

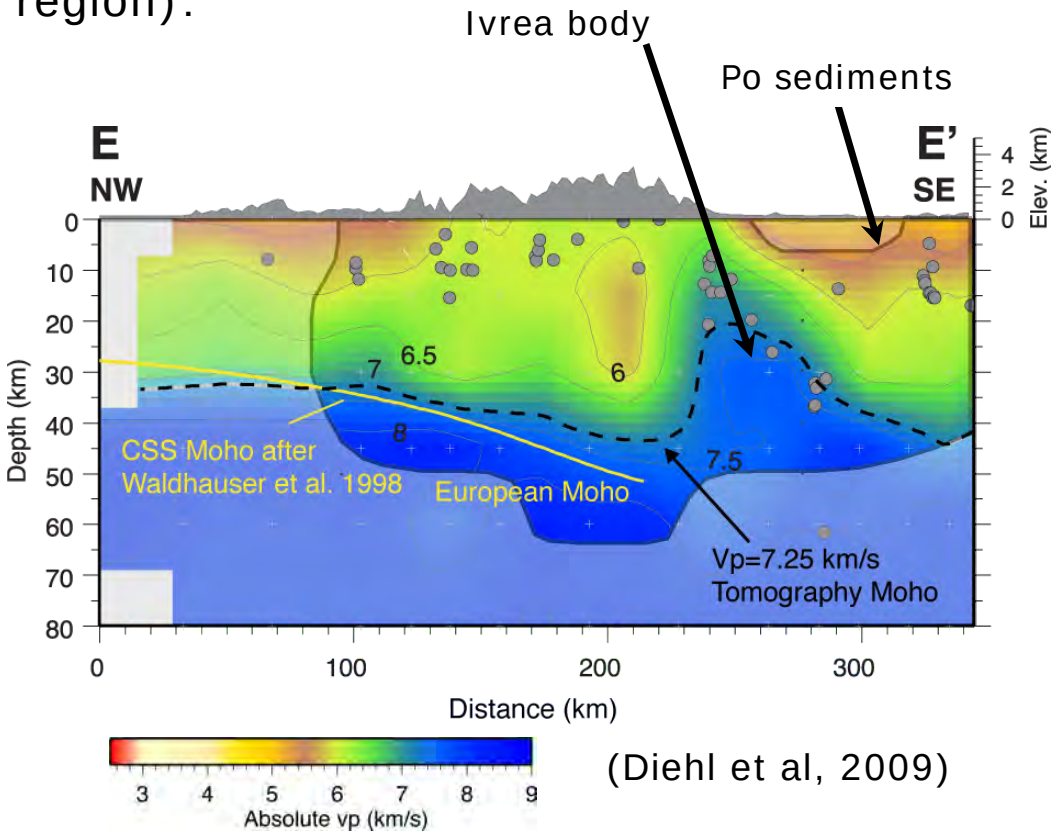
Volumetric velocity method



With local earthquake tomography we can complement CSS imaging the 3-D seismic structure:

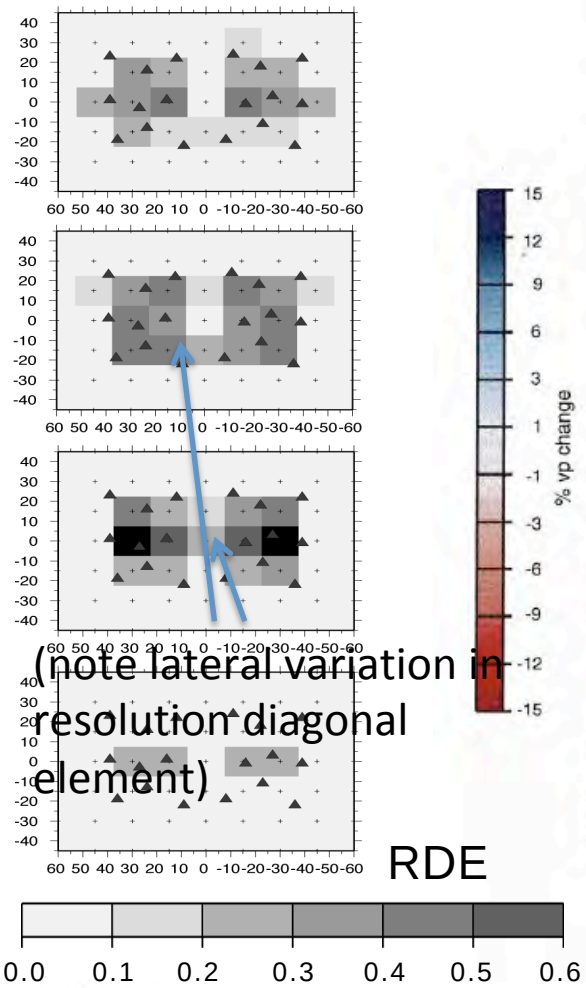
- in collision zones (e.g. Alpine region):



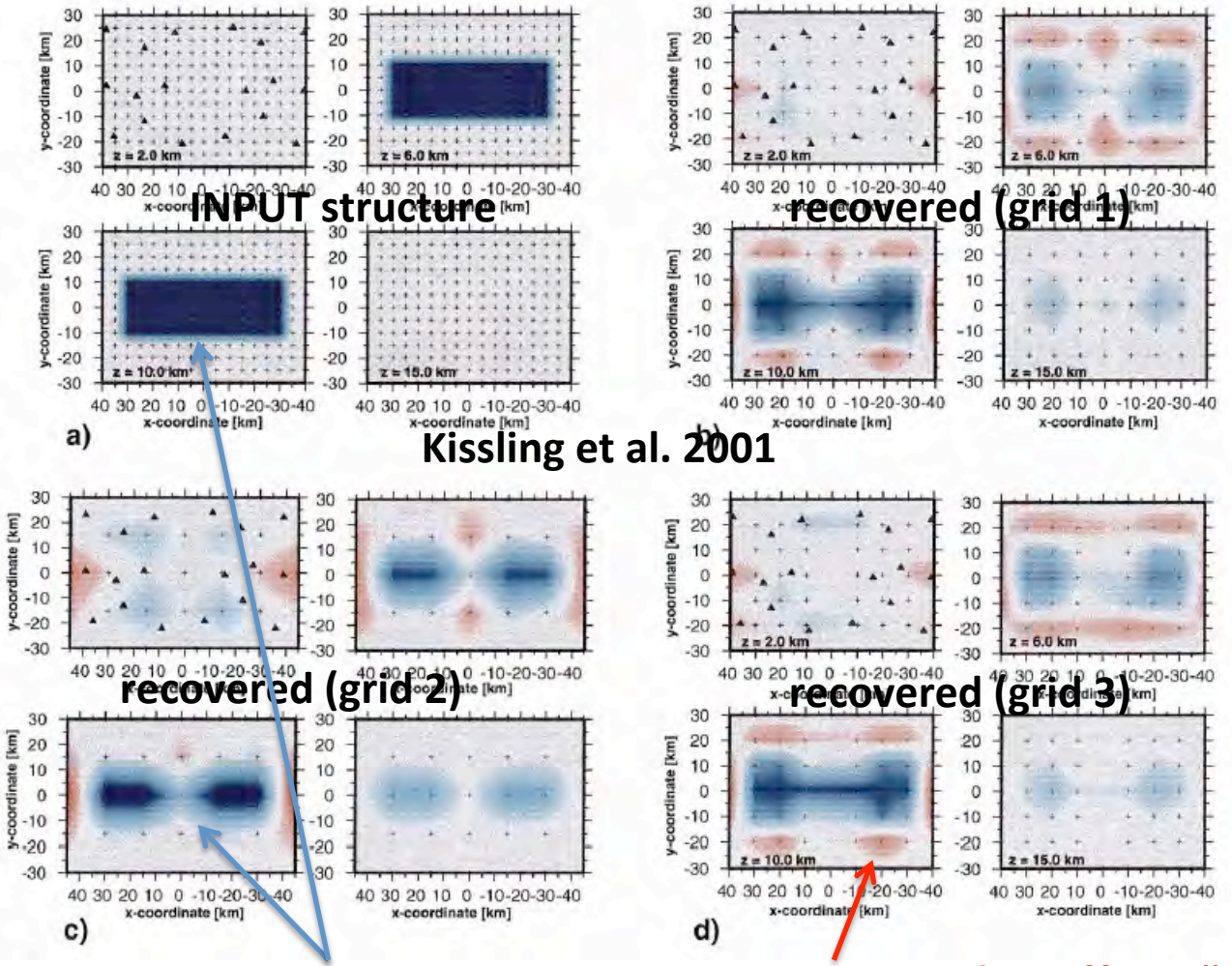


(Diehl et al, 2009)

effects of resolution variation across a tomographic image (due to inhomogeneous data)



(note lateral variation in resolution diagonal element)



the „violine effect“

„overswing edge effects“

(resolution variation causes distortion in imaged structure)

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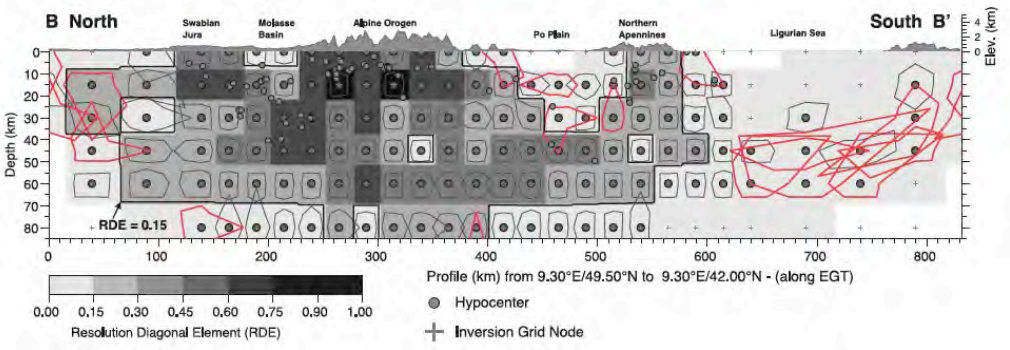
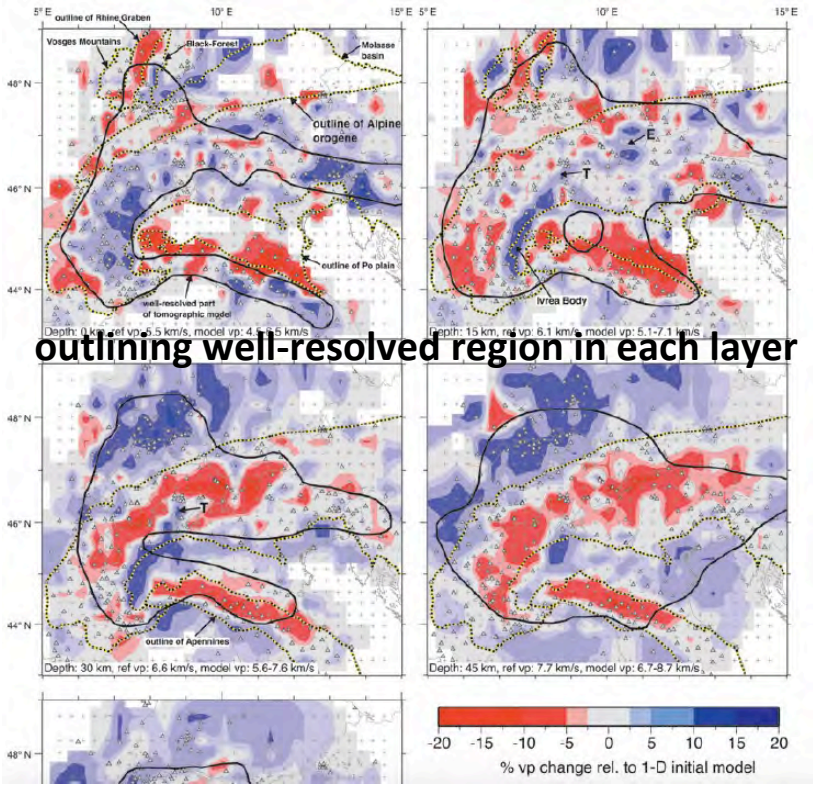
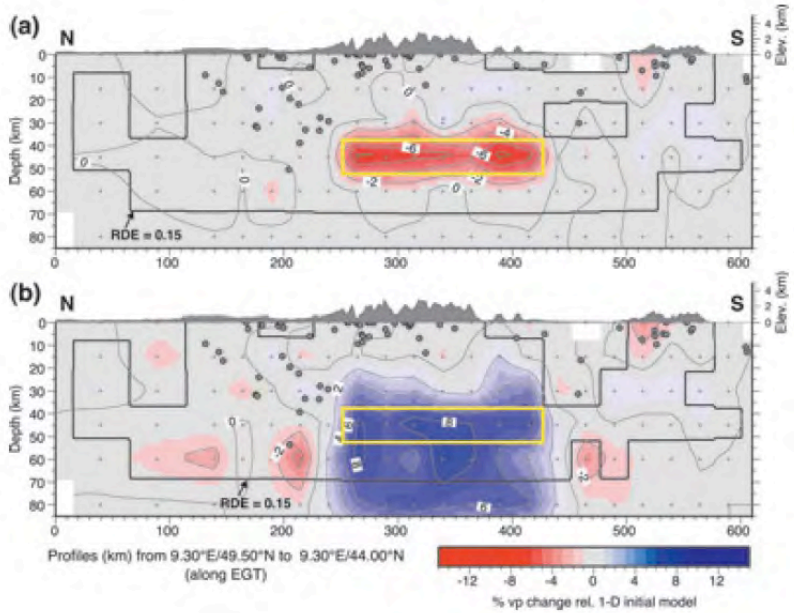
example assessing resolution in LET



RDE and resolution contours (off-diagonal elements)

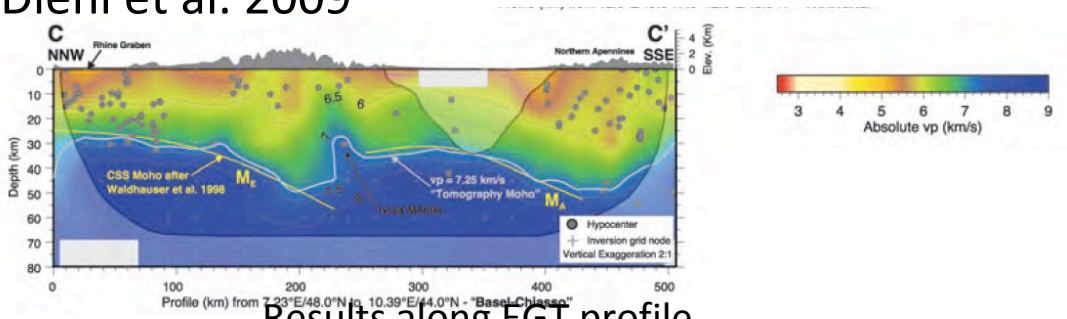


outlining well-resolved region in each layer



synthetic test with lower crustal model structure. Note different results for high- and low velocity anomalies!

Diehl et al. 2009



Results along EGT profile

ALP ARRAY

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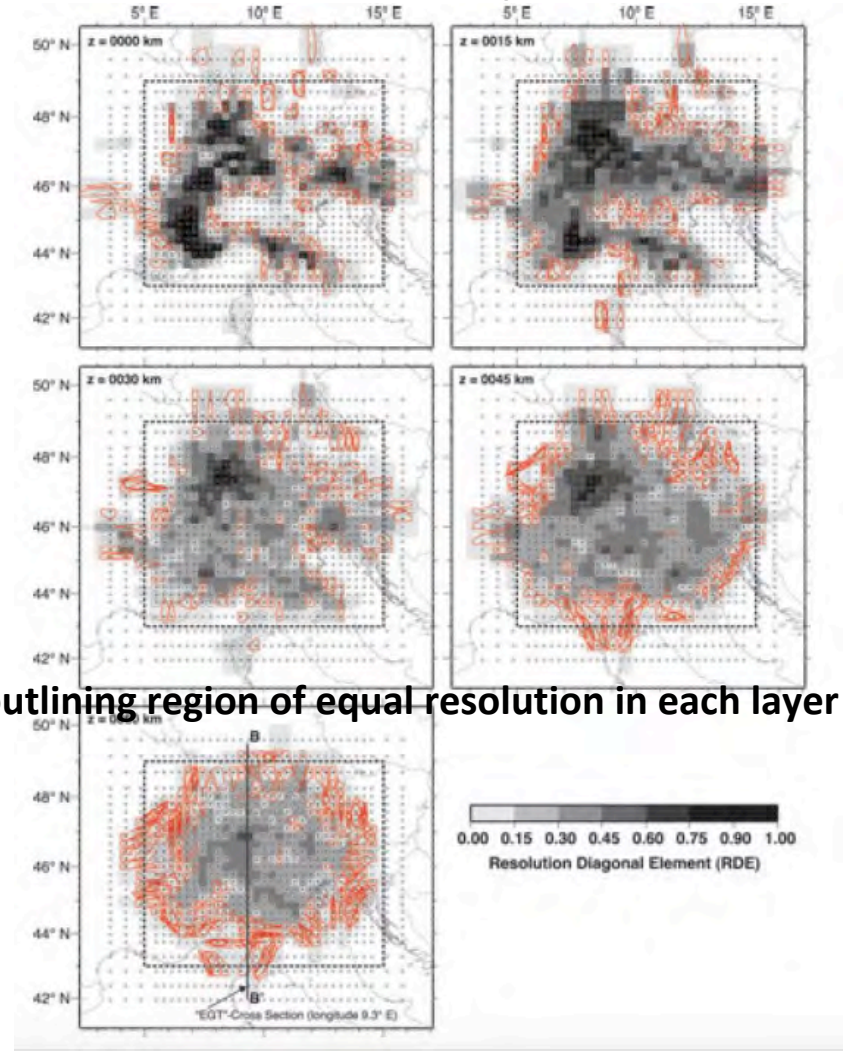
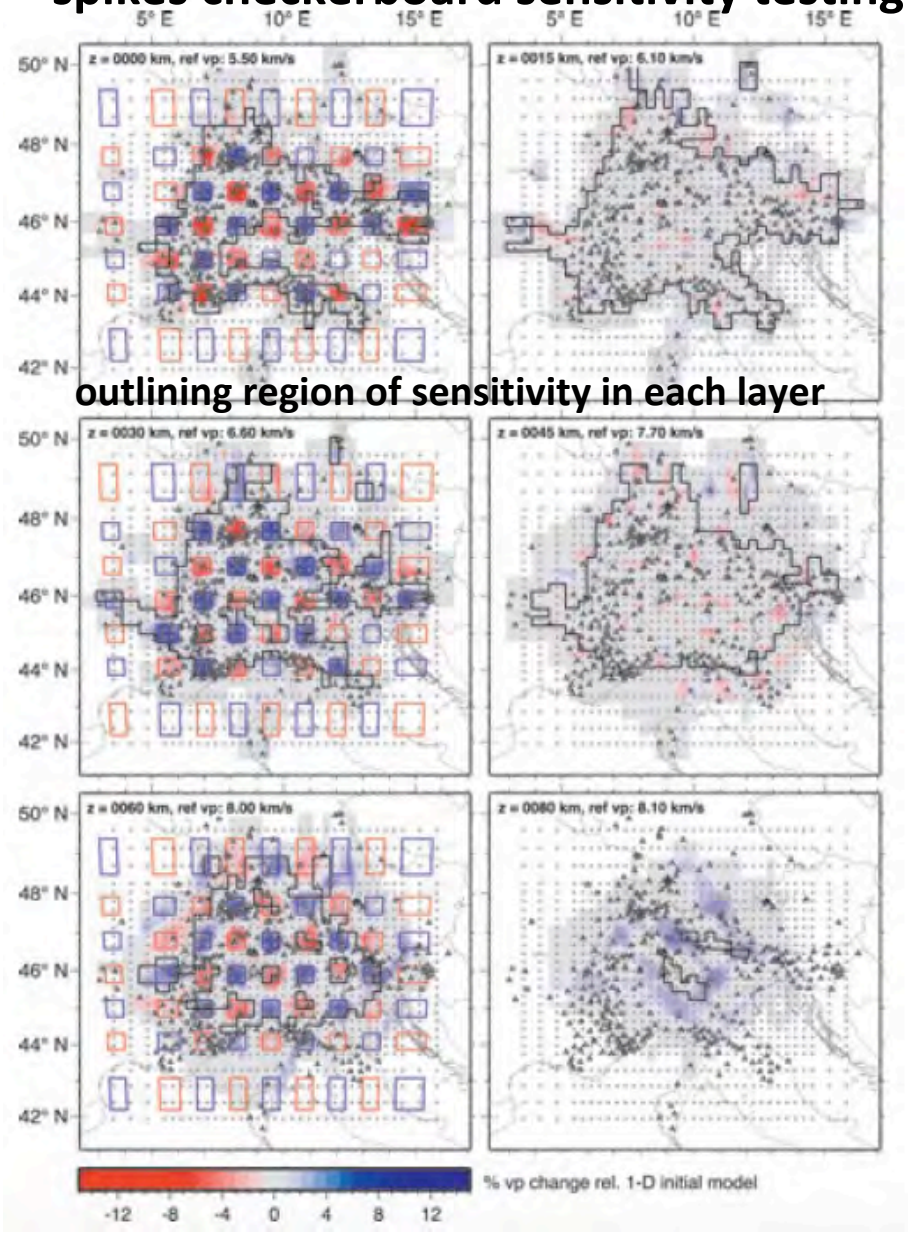
LET Alps

resolution RDE & spread contour



outlining region of equal resolution in each layer

spikes checkerboard sensitivity testing



outlining region of sensitivity in each layer

Diehl et al. 2009

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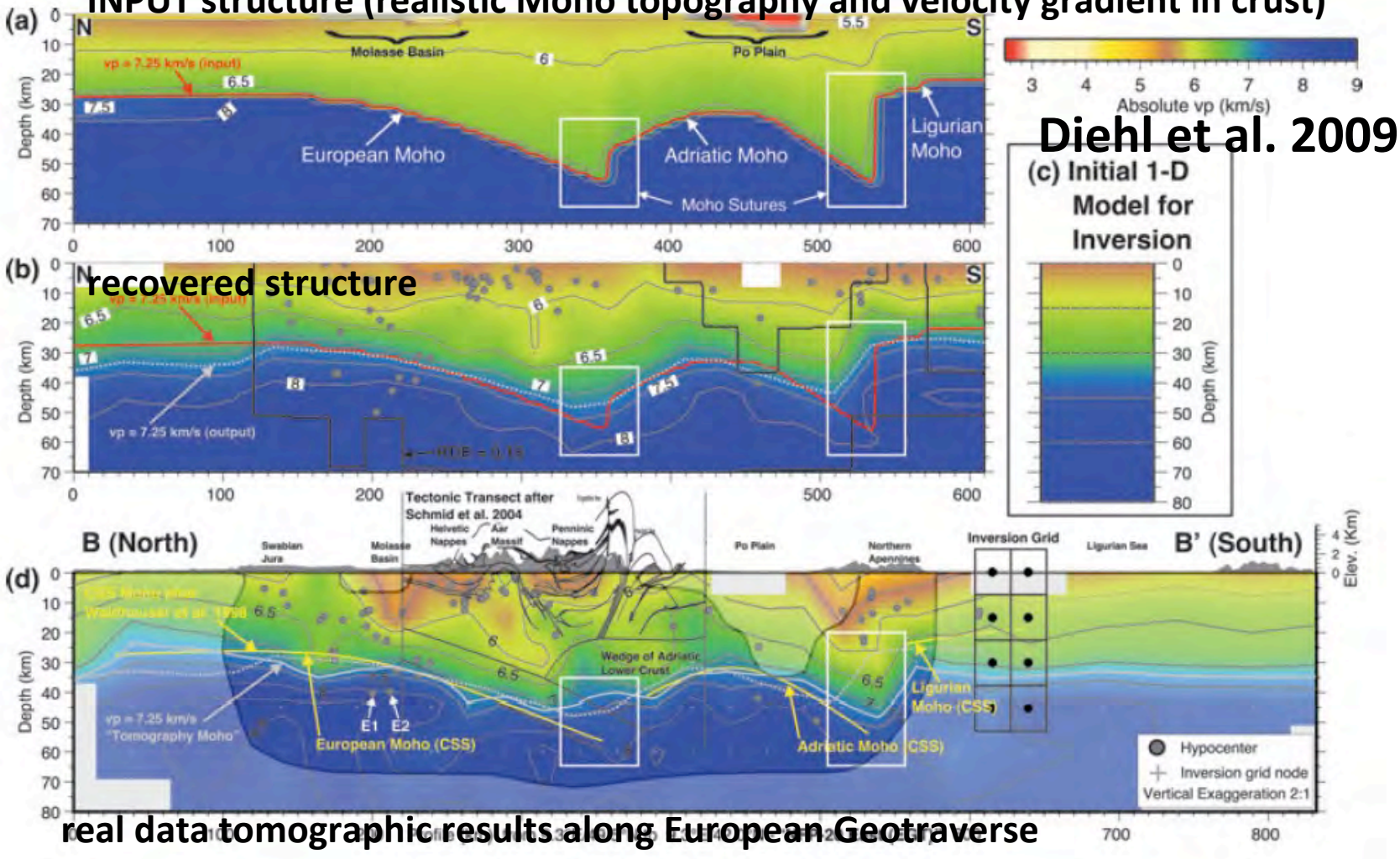
LET Alps testing Moho resolution

INPUT structure (realistic Moho topography and velocity gradient in crust)



Diehl et al. 2009

real data tomographic results along European Geotraverse

=> Moho can be well resolved with high-quality local earthquake data

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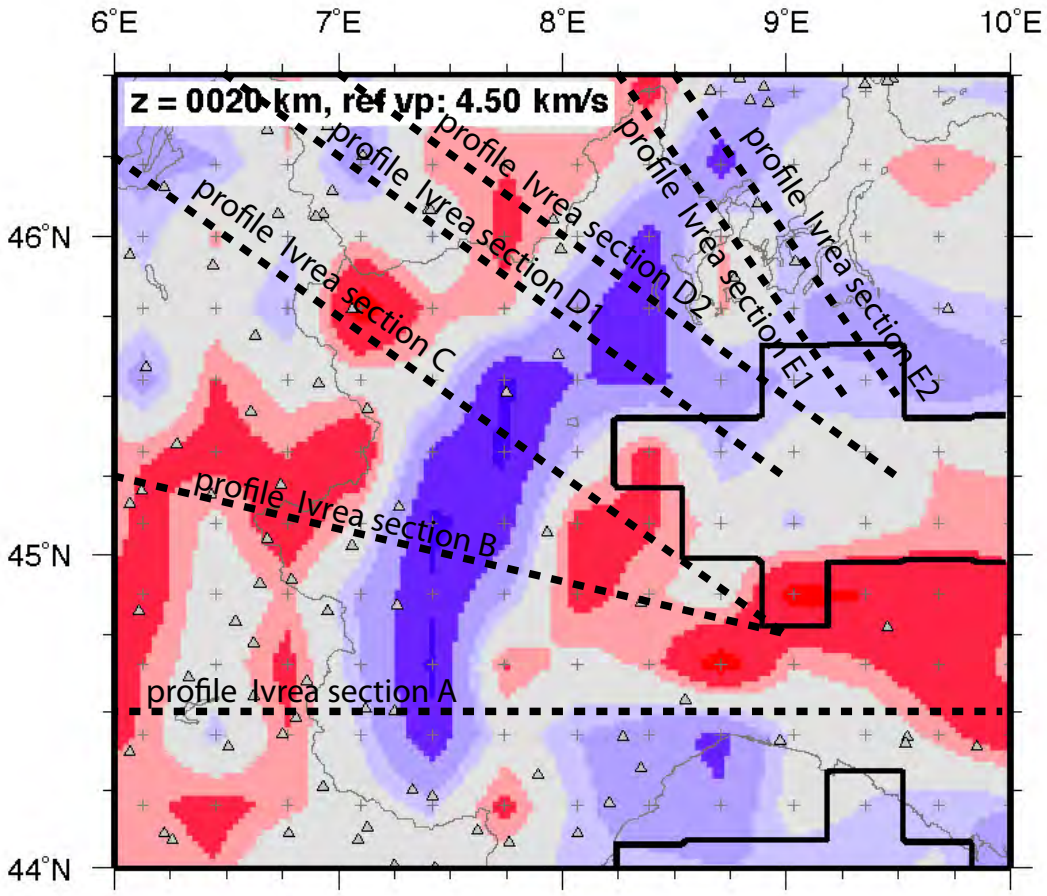
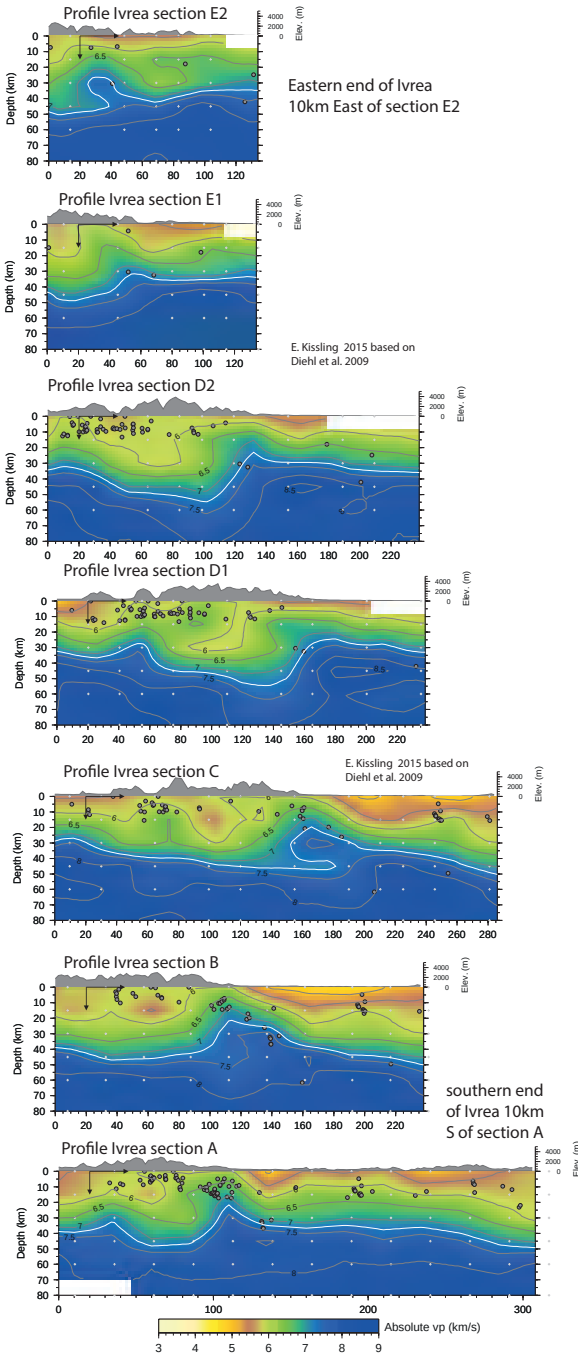
LET Alps Ivrea body





based on P tomography by Diehl et al. 2009

=> Ivrea body exhibits significant geometrical variation from S to N

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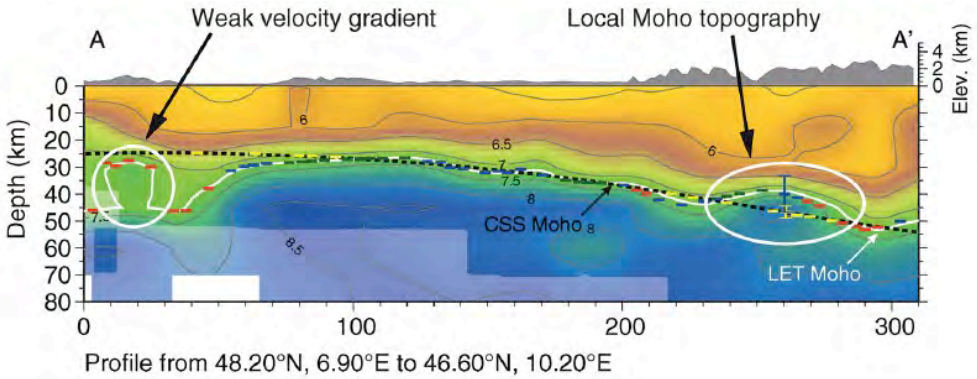
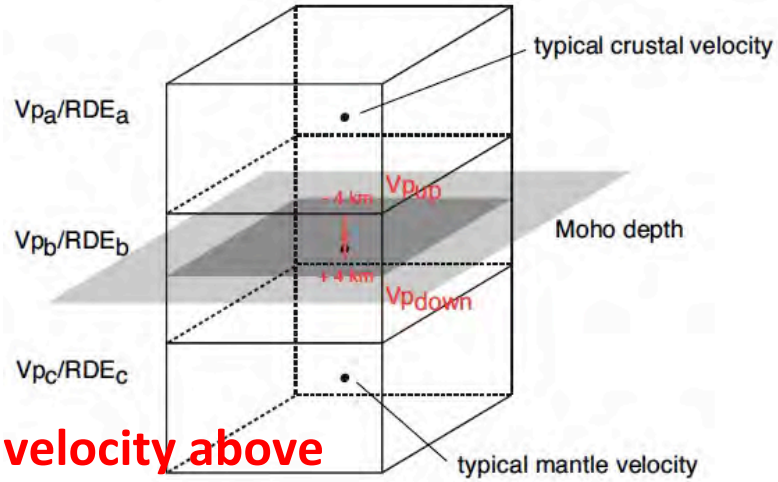
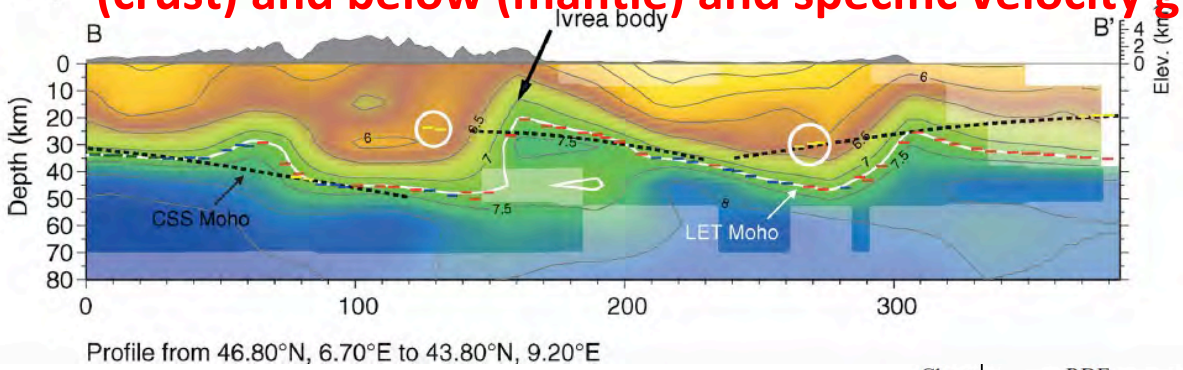
Moho topography from LET





=> Moho depth recognized in LET by typical velocity above (crust) and below (mantle) and specific velocity gradient

c)

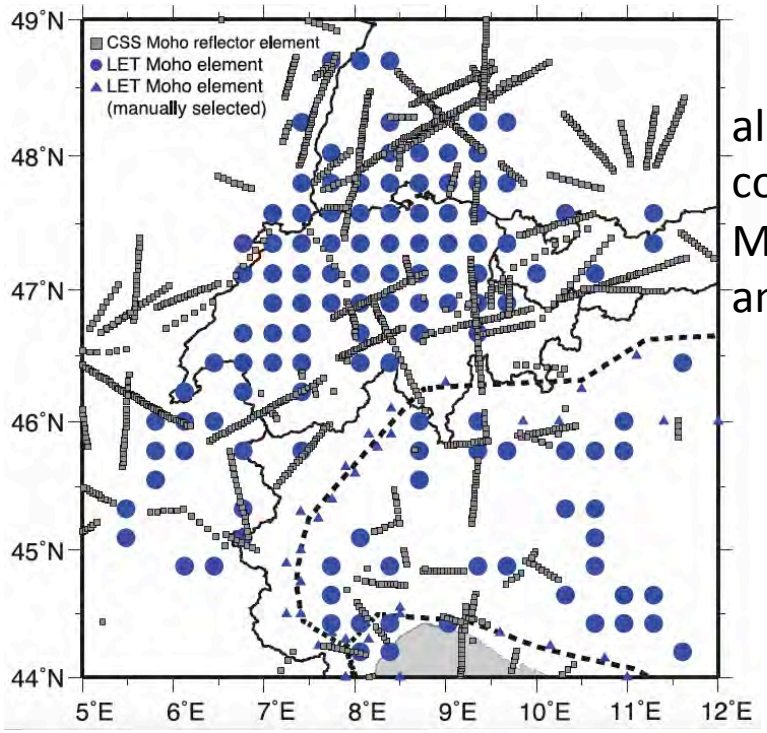


Wagner et al. 2012

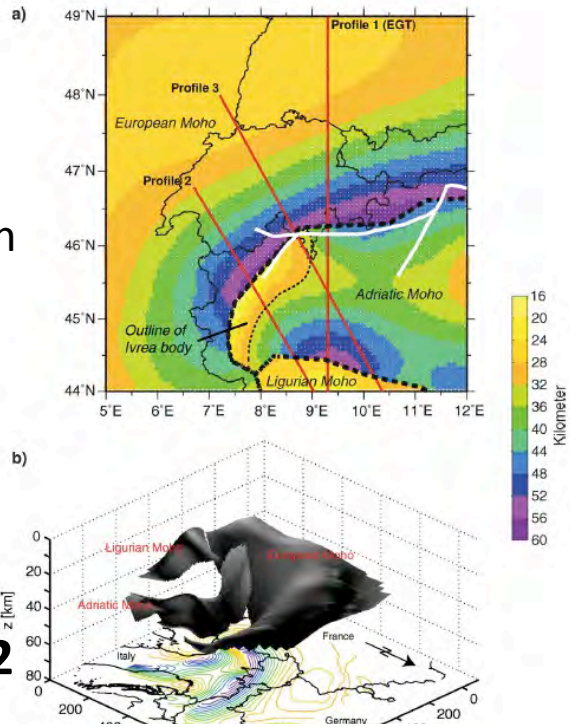
Moho uncertainty derived from LET data quality

Class	RDE	Vp_{abs} (km s^{-1})	Vp_{grad} (km s^{-1})	Resulting uncertainty (km)
		and		
0	$RDE_a \geq 2\ RDE_{min}$ $RDE_b \geq 2\ RDE_{min}$ $RDE_c \geq 2\ RDE_{min}$	$Vp_a > 6.0$ if $z_a > 25$ km $Vp_a < 6.5$ $Vp_c > 7.8$	$Vp_{up} < 6.9$ $Vp_{down} > 7.6$	±5
		either/or		
1	$RDE_a \geq RDE_{min}$ $RDE_b \geq RDE_{min}$ $RDE_c \geq RDE_{min}$	$Vp_a > 6.0$ if $z_a > 25$ km $Vp_a < 6.5$ $Vp_c > 7.8$	$Vp_{up} < 6.9$ $Vp_{down} > 7.6$	±7
2		else		rejected

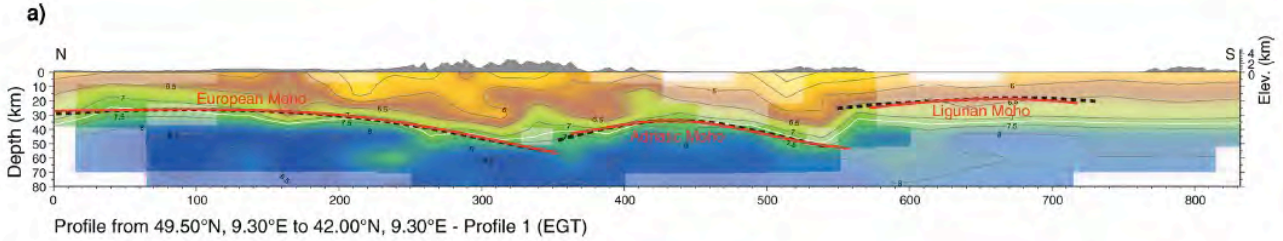
Moho Alps from CSS & LET combined



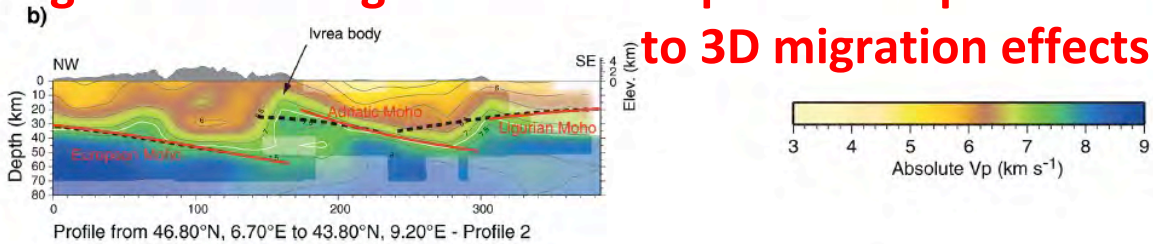
almost continous coverage of European Moho beneath Western and Central Alps



Wagner et al. 2012



Note significant changes in Moho depth across plate boundaries due to 3D migration effects of CSS data



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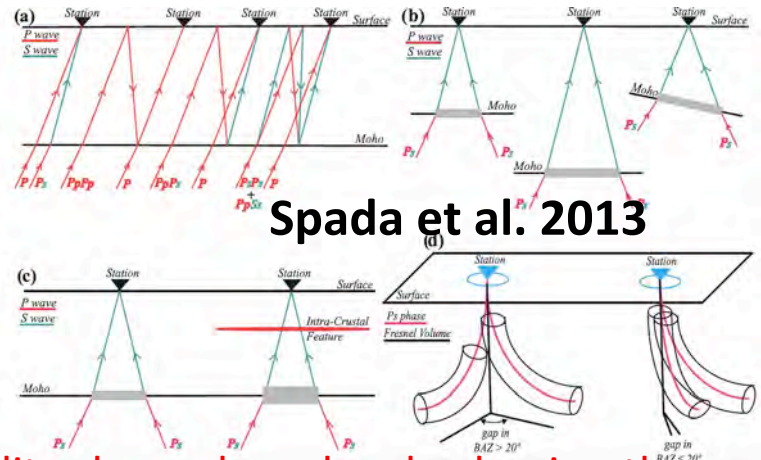
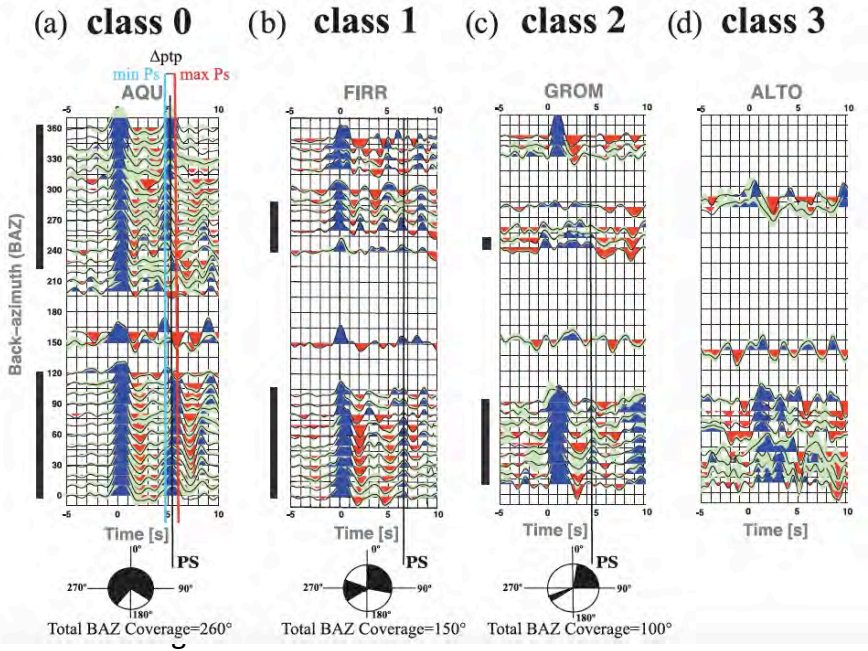
Moho Alps from CSS & LET & RF

Moho uncertainty derived from RF quality

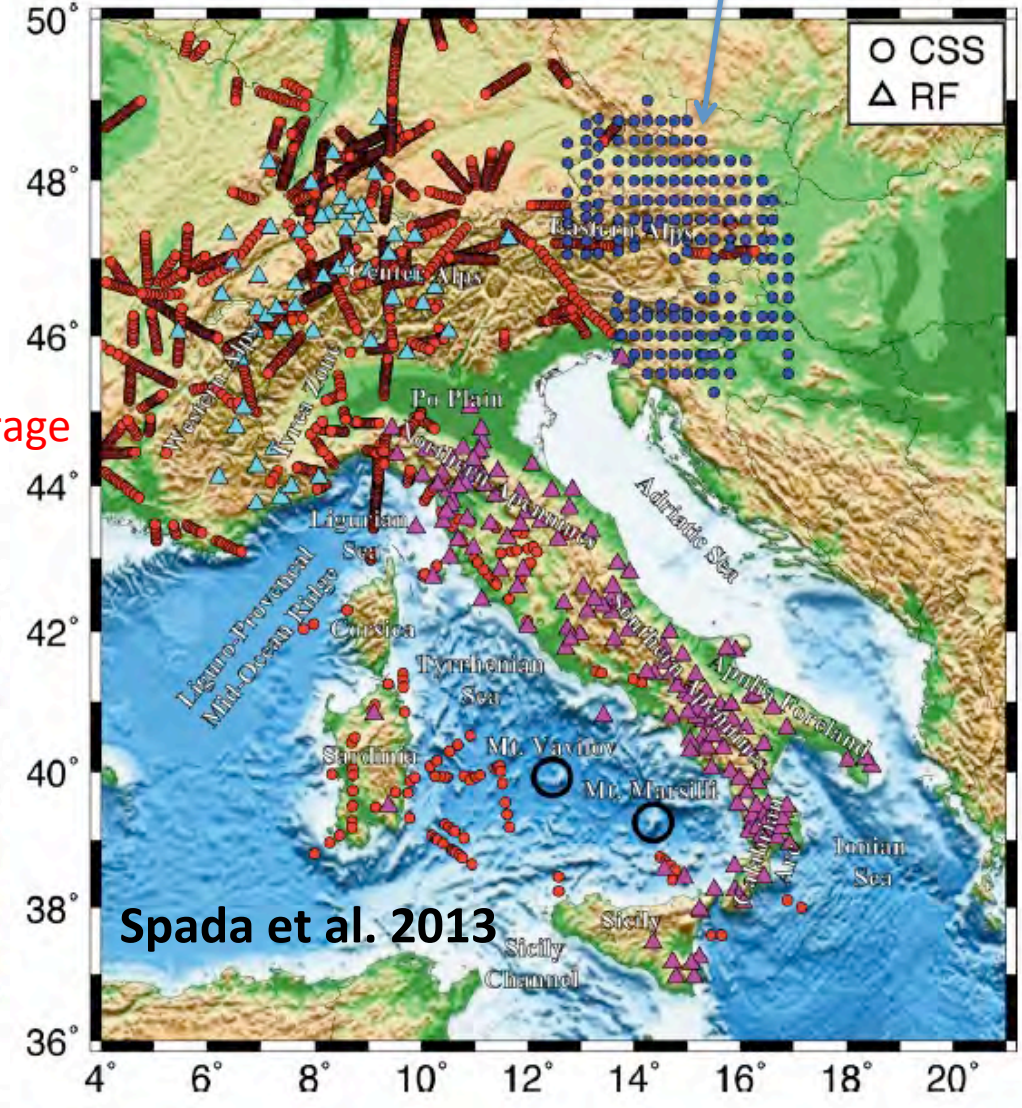


Spada et al. 2013

Quality classes based on back azimuth coverage

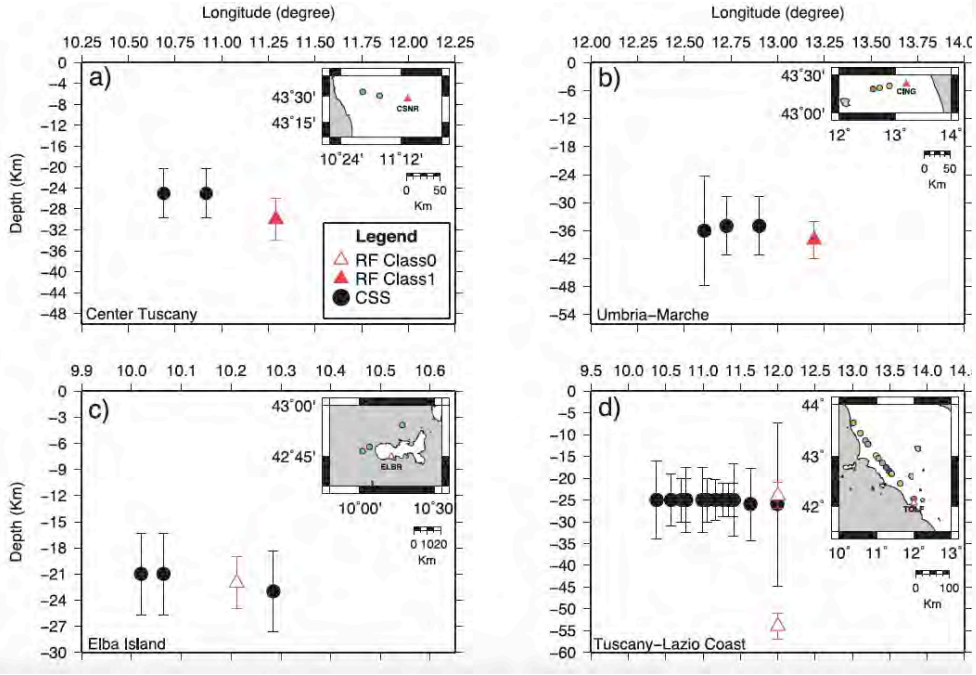


PmP reflection points from Behm et al. 2006



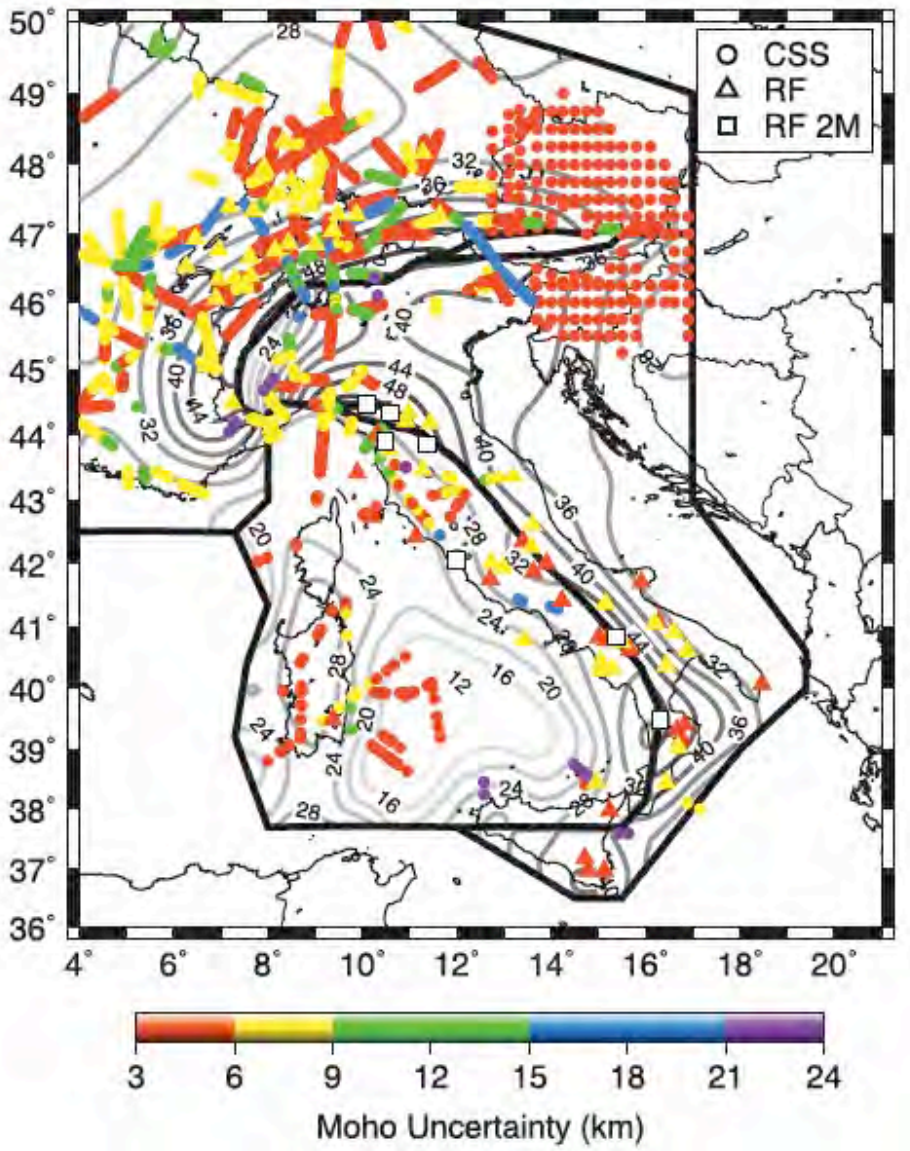
Moho Alps from CSS & LET & RF

Spada et al. 2013



Comparison of CSS and RF Moho information including their individual uncertainties along selected profiles in Apennines

Moho data uncertainties for CSS and RF



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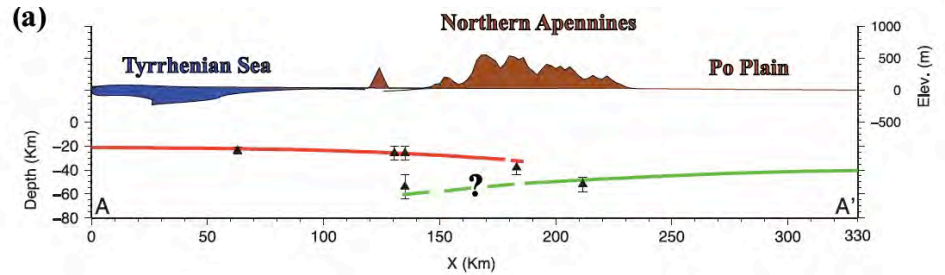
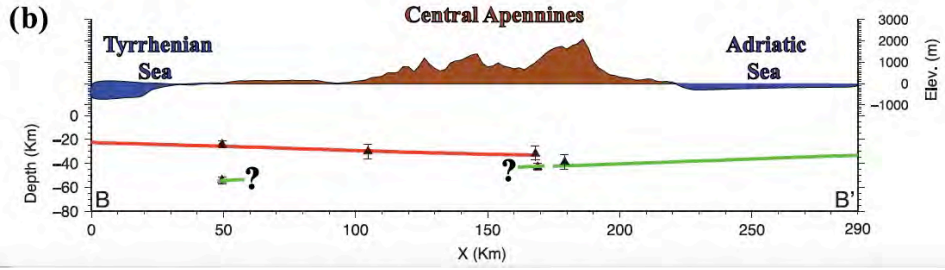
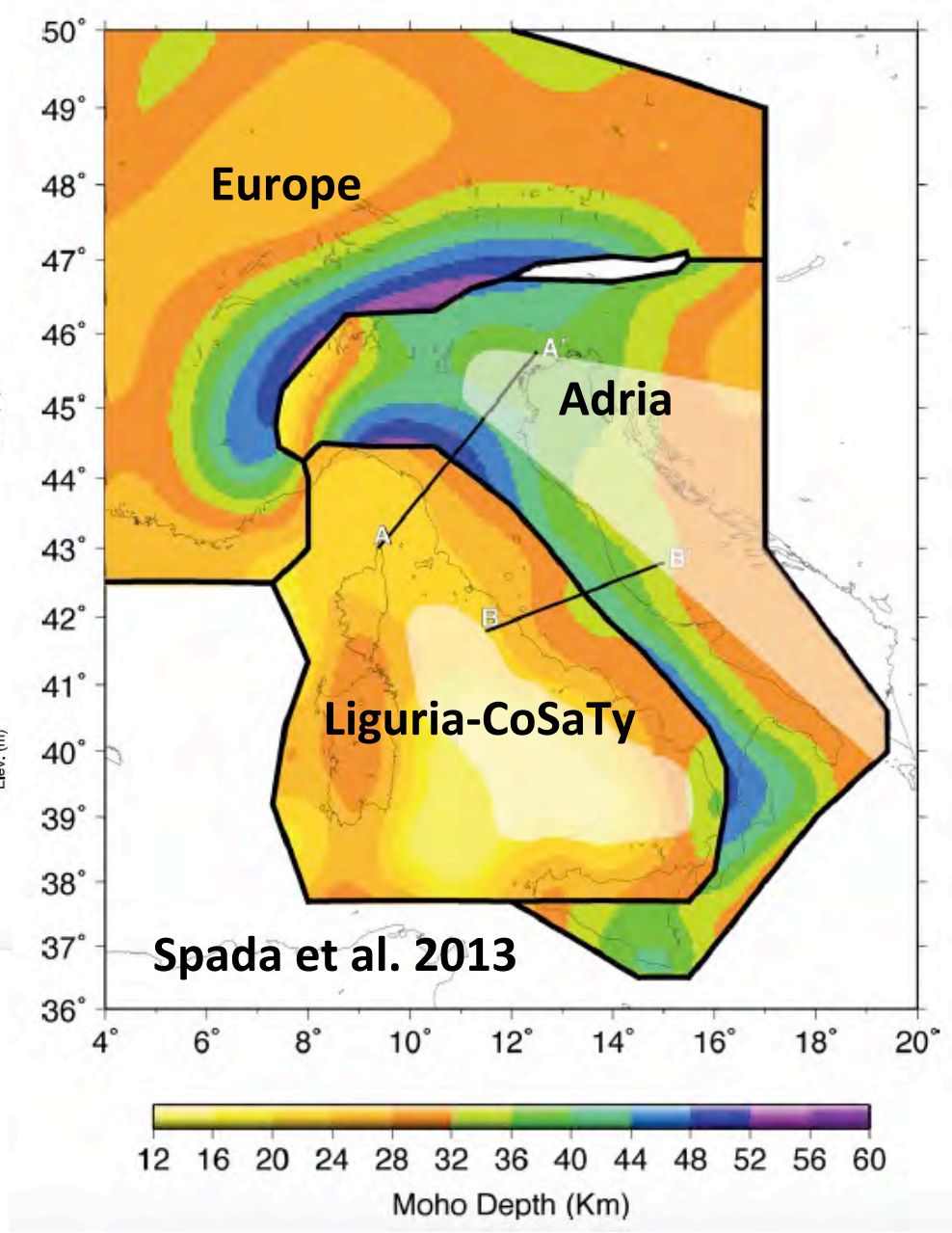
Moho Alps from CSS & LET & RF

Moho segment uncertainties derived from individual CSS, LET and RF data qualities



(profile locations see on right)





Moho map data available via researchgate.net Edi Kissling

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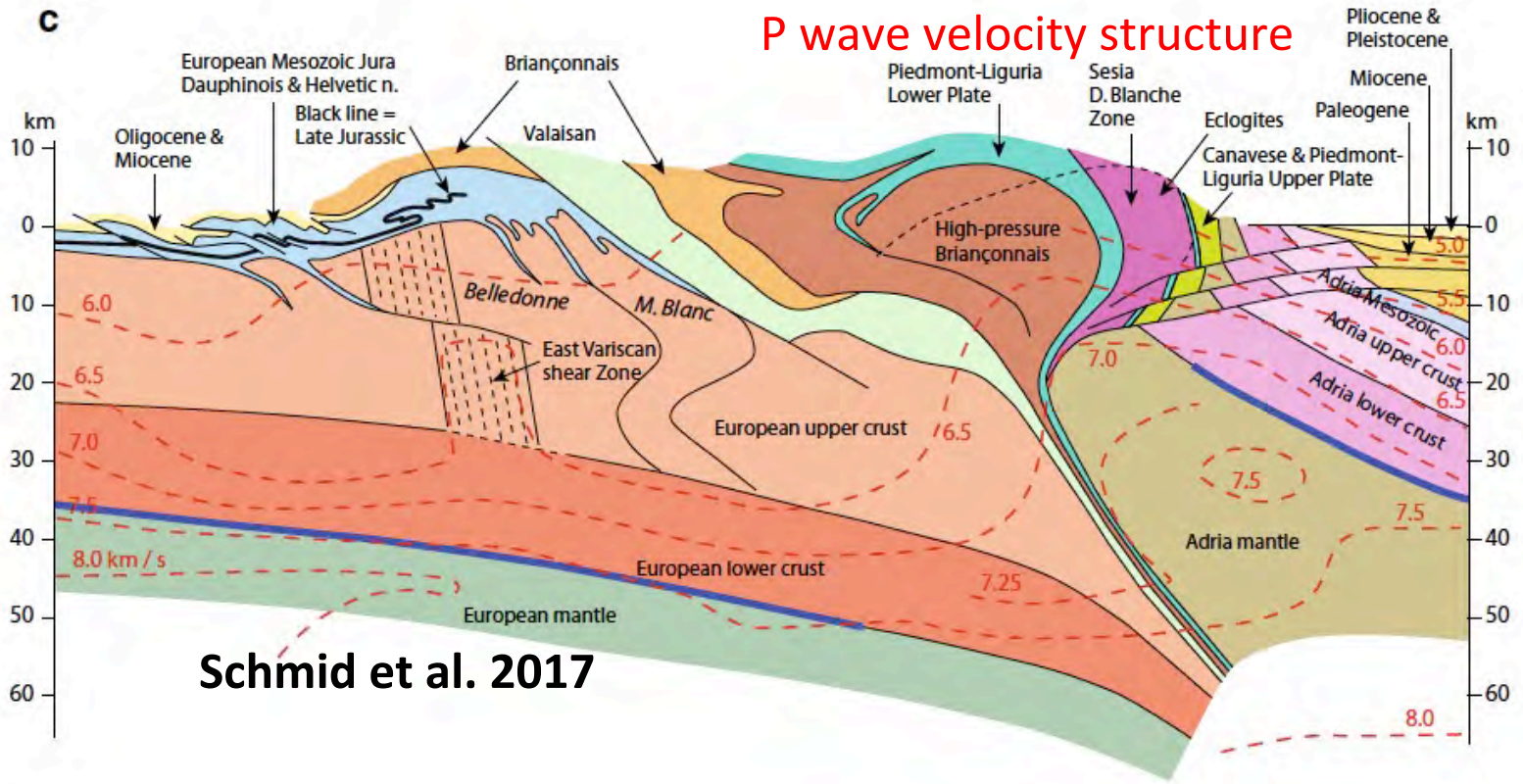
Further steps: Vs-information, 3D crustal corrections and tectonic interpretations

(add results from ambient noise tomography, extend region of coverage)



Thank you for your attention

E. Kissling