Modeling surface velocities in the Southern and Eastern Alps by finite dislocations at crustal depths

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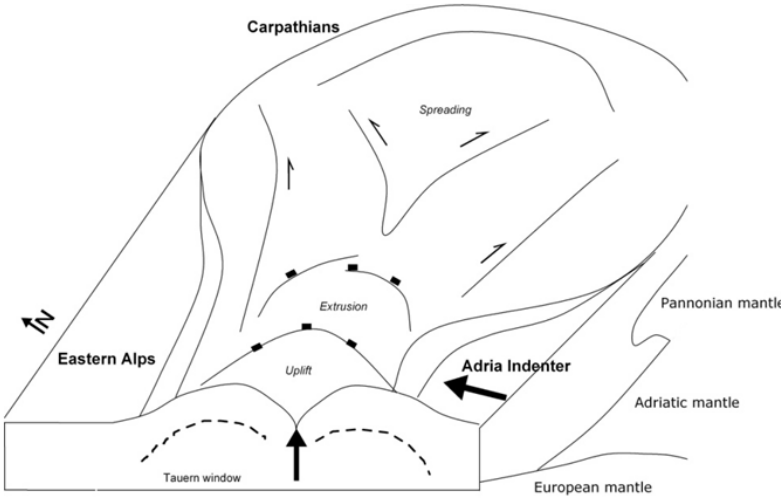
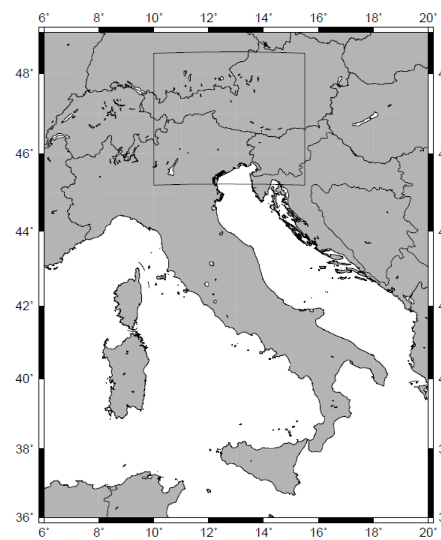
Highlights

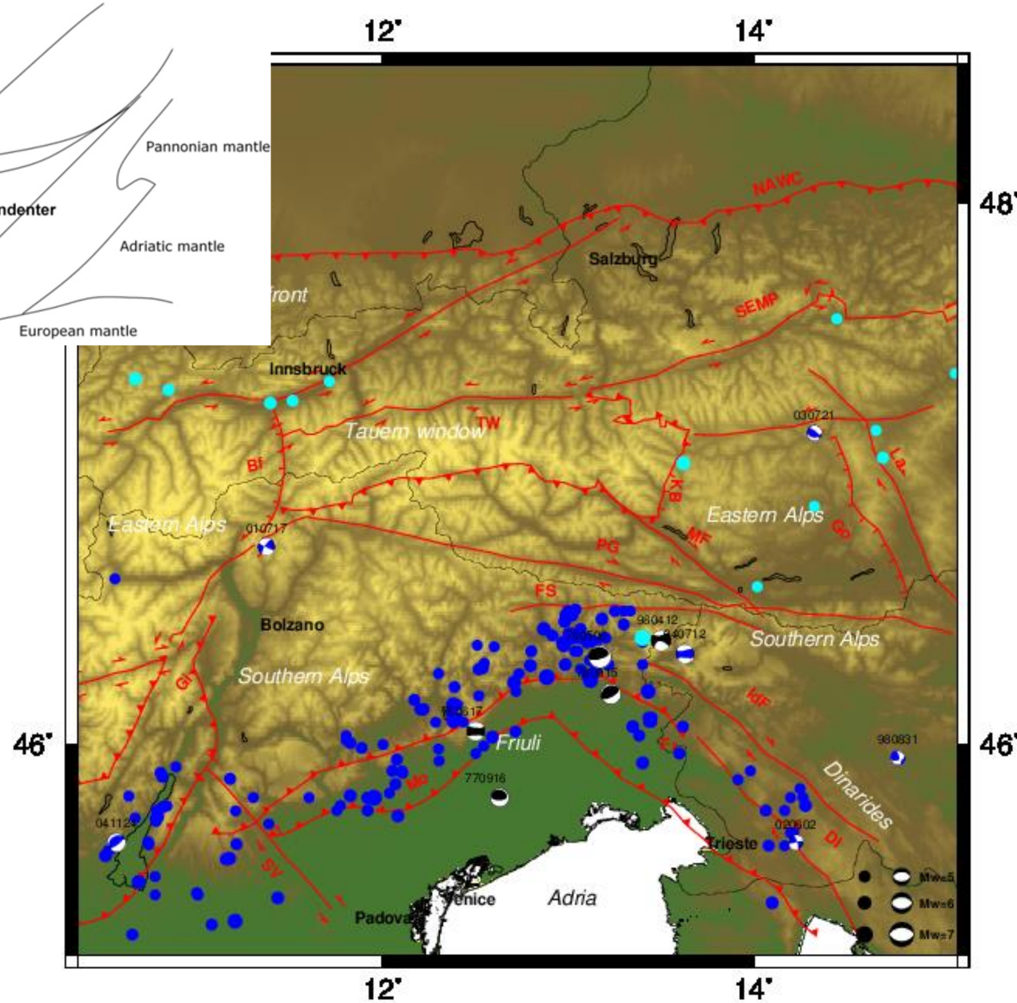
- **Indentation of the Adria modeled by GPS data and an elastic dislocation model.**
- **Geometry and slip rates of six rectangular faults are constrained by least squares.**
- **Reverse, transpressional and normal slips from 10 to 30 mm/yr within the crust.**
- **Regional stress pattern from CMTs agrees with the implied strain rate eigenvectors.**
- **Shear heating on a half space suggests slip onset is Pliocene or more recent.**

Structural setting, historical seismicity

- Indentation of Adria, uplift of Tauern and lateral escape towards the Pannonian basin
- Diffuse seismicity along the edge of the wedge





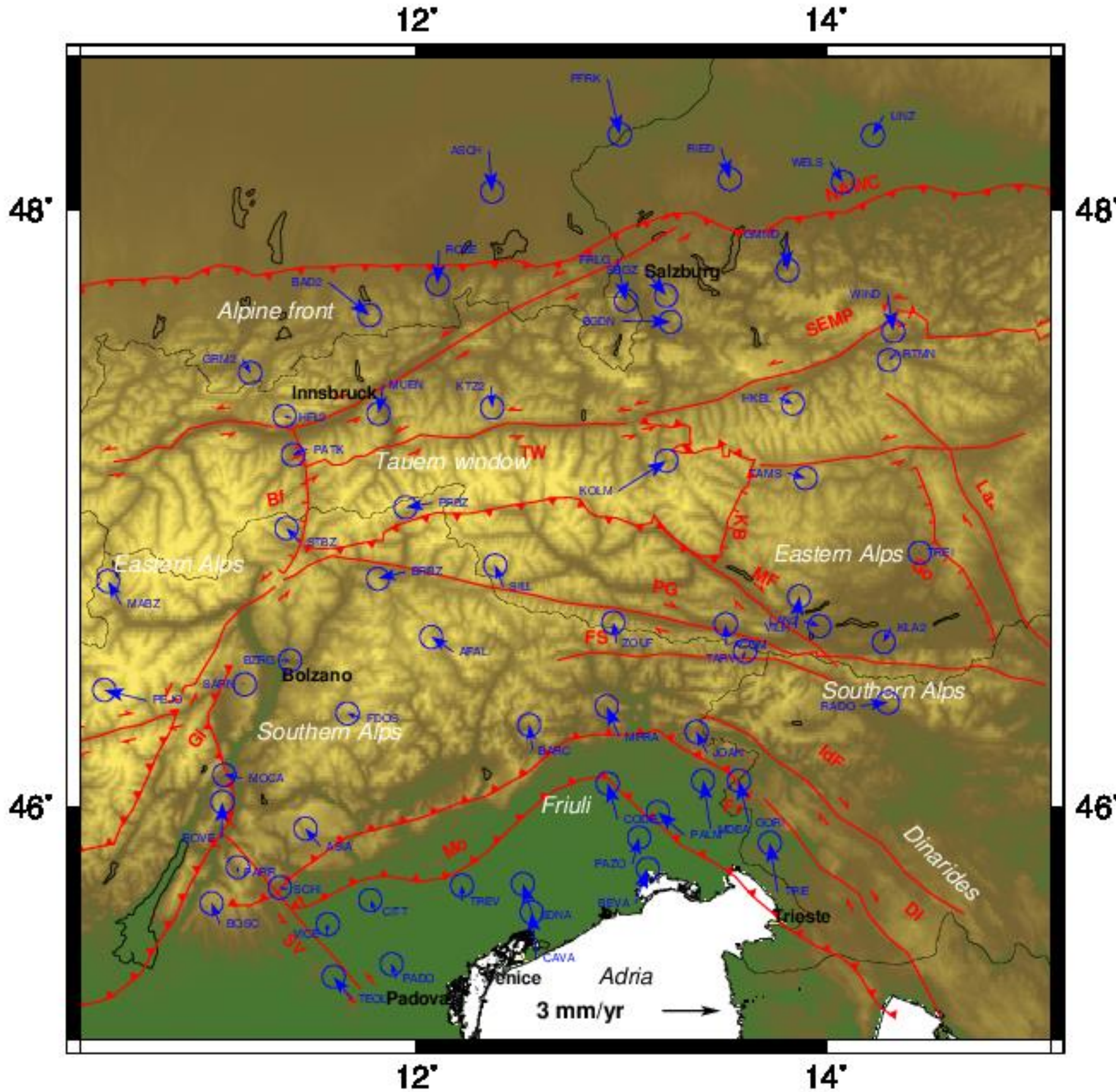


Available GPS velocities

Horizontal velocities of 75 permanent GPS stations resulting from the multiyear combination of the Austrian and Italian weekly solutions

BSW50 software, IGS/EPN processing standards

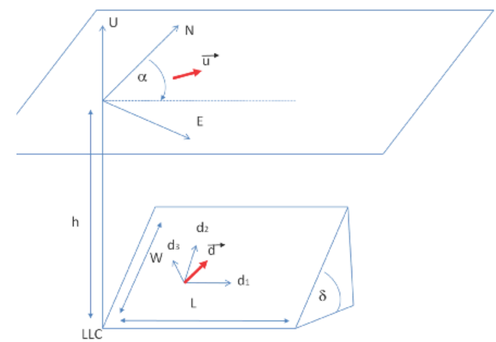
Reduction of the velocities to a common Eurasian frame by subtraction of rigid rotation about a common pole

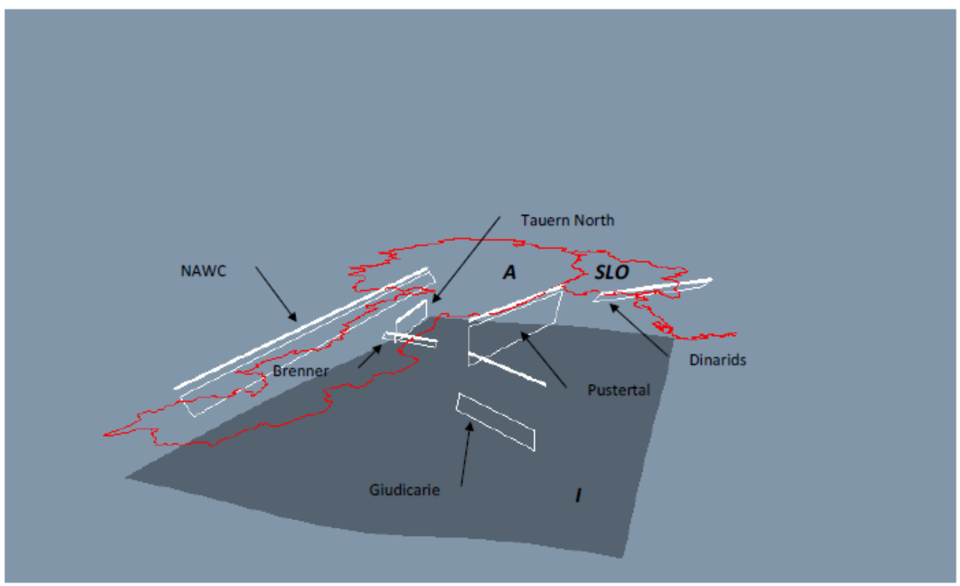


Elastic dislocation model

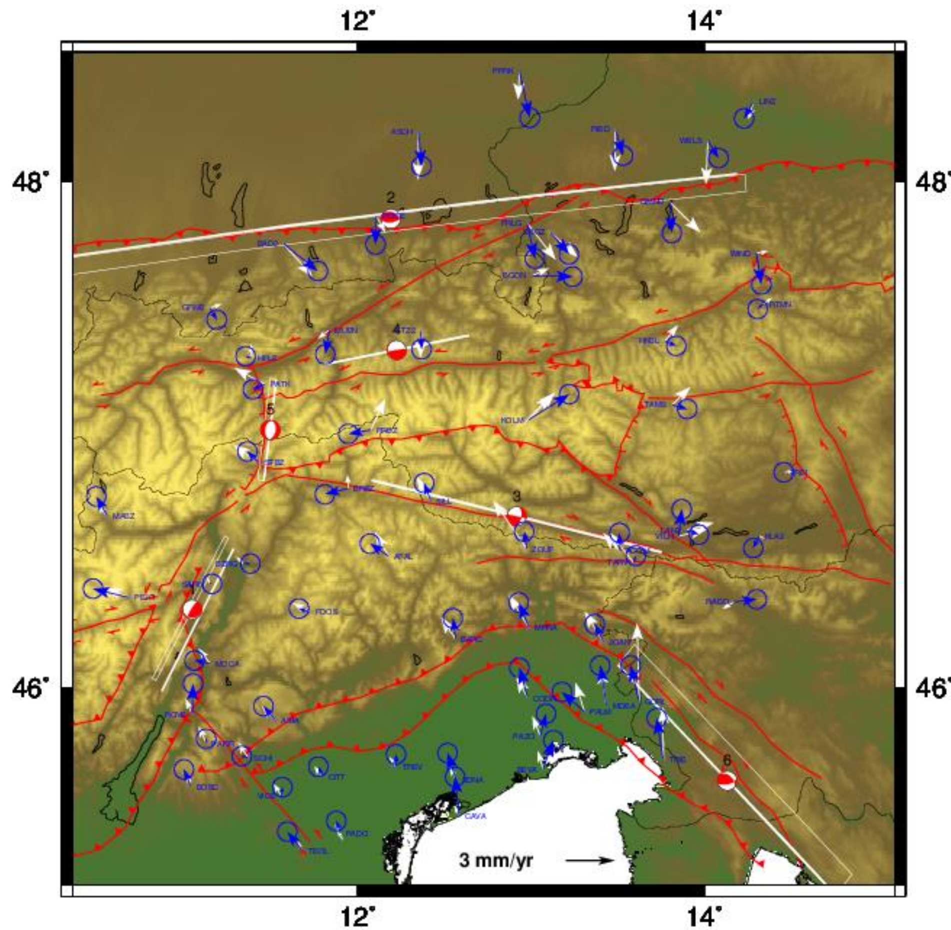
- Measured velocities are the effect of slip at depth along 6 suitable planes
- Use geology to set up the planes
- Change the plane parameters until the rss of the observed velocities minus modelec velocities is minimal

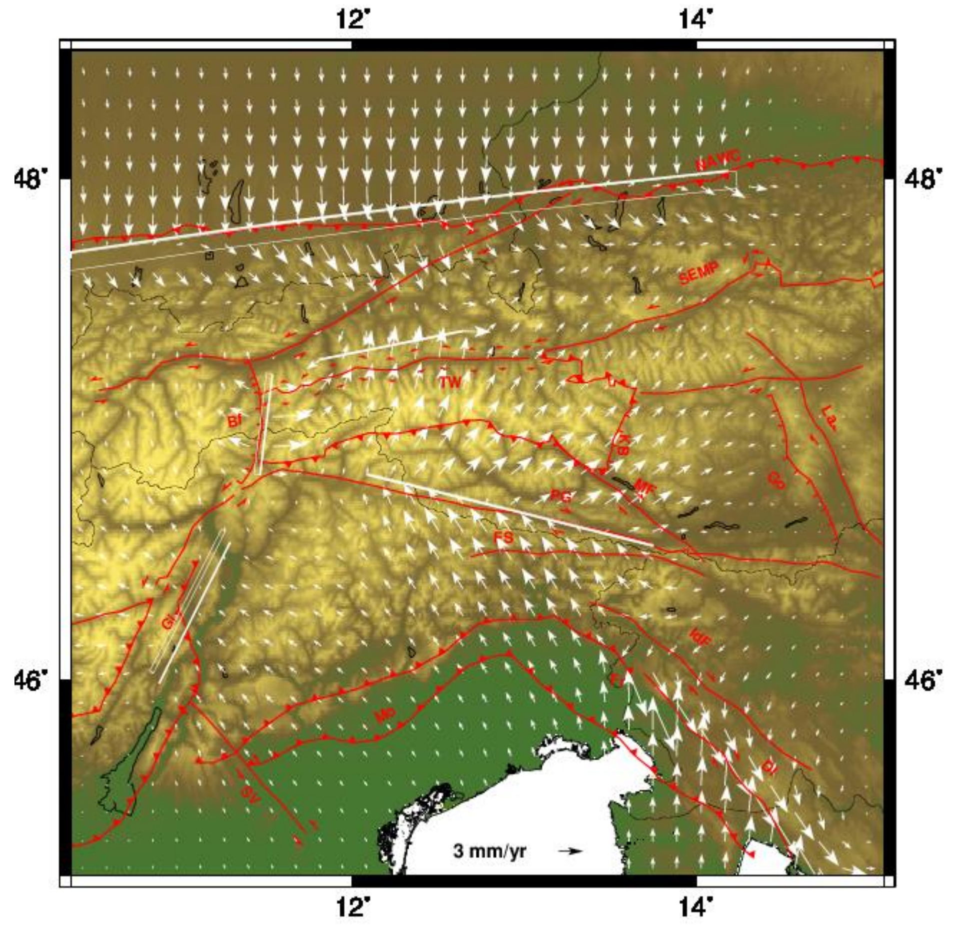
Fault id.	Name	Long. (deg)	Lat. (deg)	depth (km)	strike (deg)	dip (deg)	right lat. (m/yr)	reverse (m/yr)	Length (km)	Width (km)	Moment rate 10^{18} J/yr
1	Giudicarie	11.04	46.31	30	211	80	-0.01	0.03	58	10	0.56
2	NAWC	12.18	47.85	10	84	60	-0.01	0.02	297	12	2.02
3	Pustertal	12.91	46.68	20	282	89	0.01	0.01	123	30	1.41
4	TW north	12.22	47.34	8	261	89	0.00	0.02	61	20	0.55
5	Brenner fault	11.49	47.02	2	188	45	0.00	-0.02	35	4	0.08
6	Dinarids	14.13	45.62	5	312	45	0.01	0.01	122	14	0.73





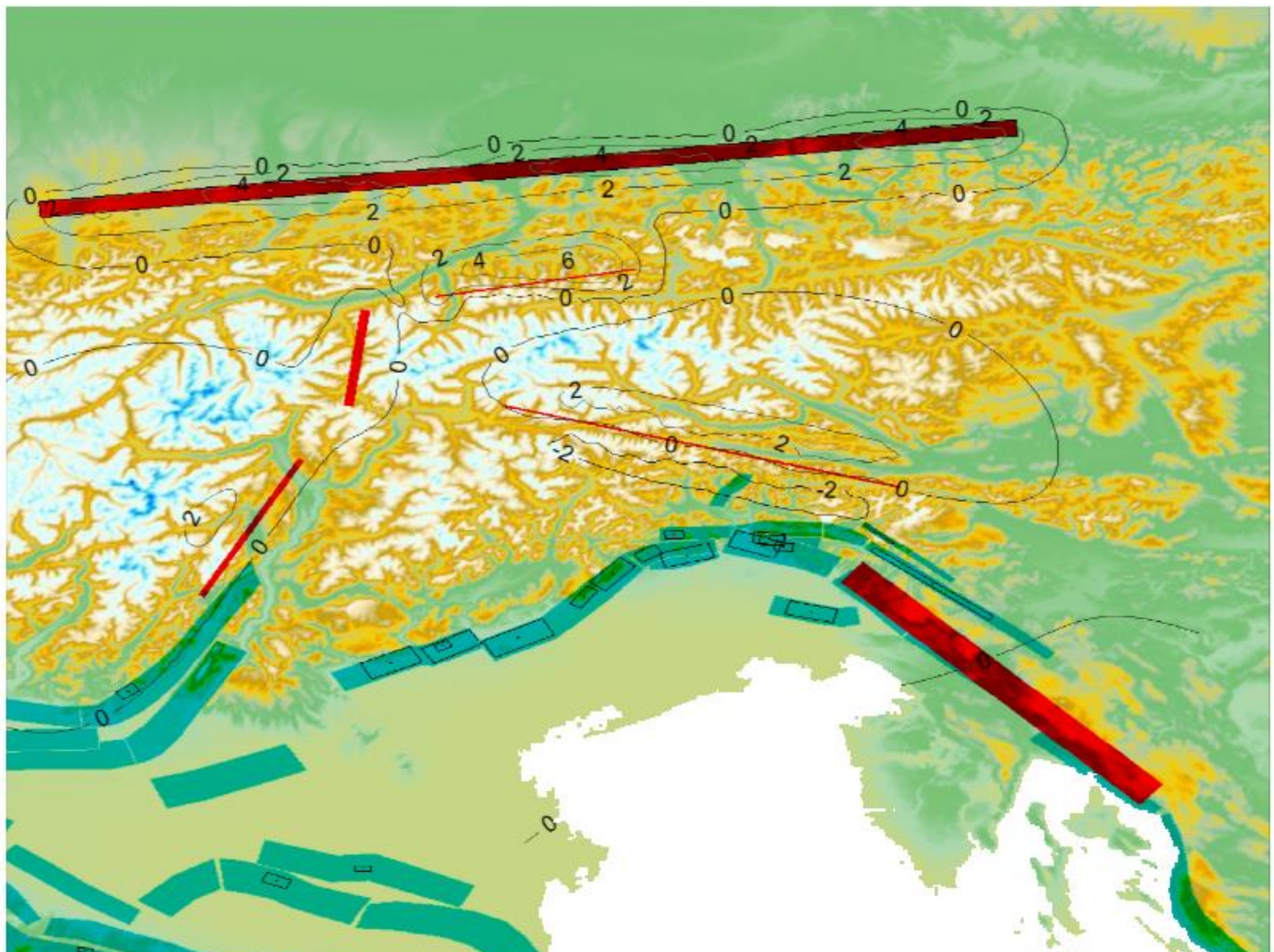
The surface kinematics predicted (white arrows) by the best fitting model

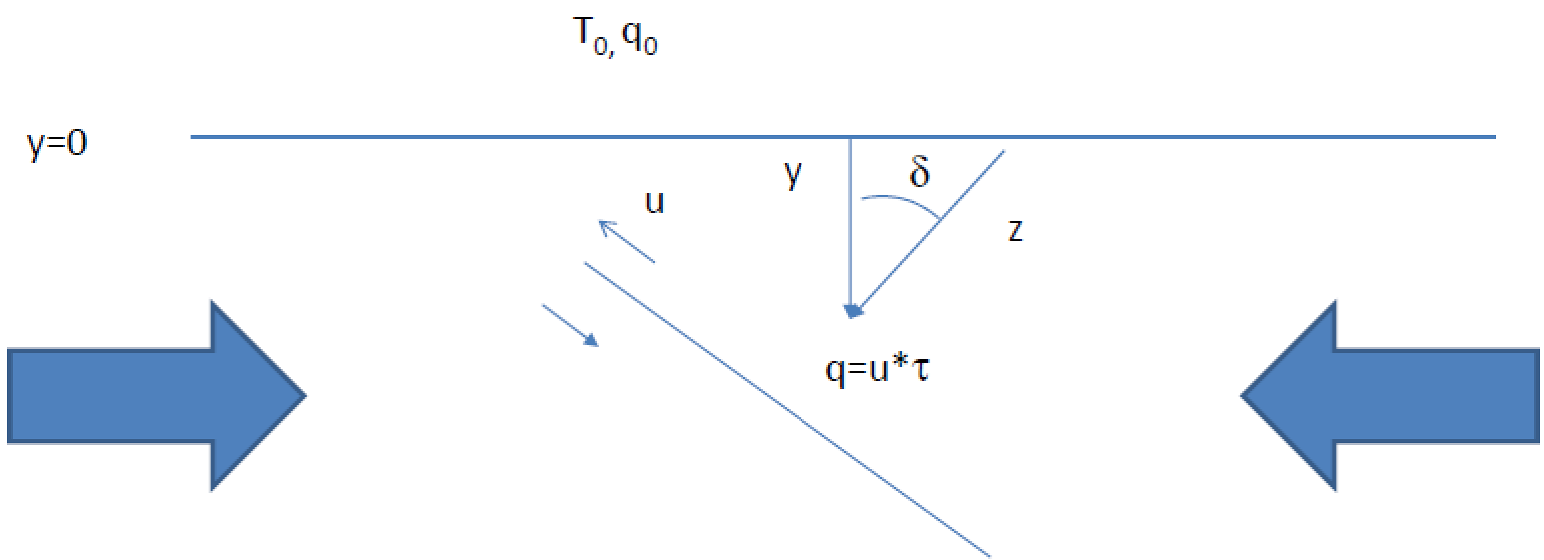




Predicted vertical motion (mm/yr)

- We show the vertical motion predicted by the elastic model
- The actual vertical motion includes also effects of GIA and erosion, which are not modeled in this work
- Hence comparison with vertical uplift data should be made with care.
- Blue polygons represent Individual seismic sources from DISS





Frictional heating at the fault plane generates considerable heat flow,
A model for the surface temperature and heat flow can be set up, depending on a number of parameters
The surface temperature and heat flow can be measured and used to constrain the heating process at depth

Conclusion: for shear stress in the range 100 – 300 Mpa, assuming no lateral fluid advection and nominal diffusion coefficients of the rocks, the absence of high heat flow at the surface implies that the slip process must be relatively recent (Plio-Pleistocene) relative to the time of collision of Adria with the Southern Alps (Oligocene-Miocene)

Conclusion

- GPS velocities can be modeled in deformation areas to constrain geophysical processes at depth
- With the geophysical model we can predict the velocities at any point at the surface of the deformed area
- The Eastern/Southern Alps could then be an example in support to the WG on Geokinematics (chair: M. Lidberg)