The ALPS-GPSQUAKENET project
–
A permanent GPS network in the Alps

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ALPS GPSQUAKENET

"Alpine Integrated GPS Network: Real-Time Monitoring and Master Model for Continental Deformation and Earthquake Hazard"

Establishment of a geodetic network covering the ALPS (40 CGPS) for the determination:

- **Crustal deformation (GPS),**
- Landslides (GPS und INSAR) and
- Meteorology (GPS)

Partly funded (50%) by INTERREG IIIb Alpine Space!

Partners from the following countries:

France (2), Italy (7), Germany (2) and Slovenia (1)

Missing: Austria and Switzerland

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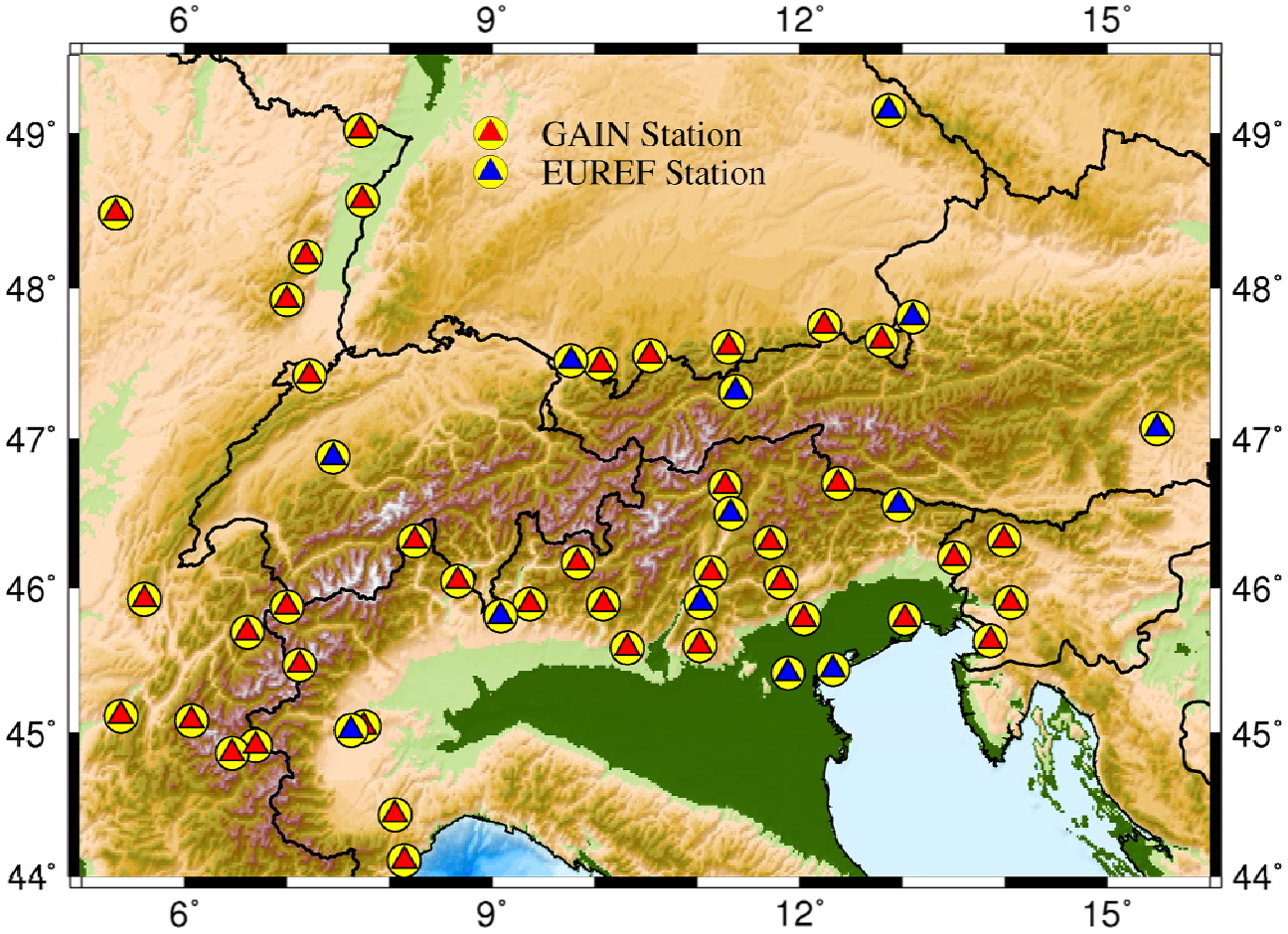
GAIN: Geodetic Alpine Integrated Network

(+EPN sites)



Status: 40 stations established in December 2007

Alpine Deformation

- Collision of the Eurasian and African plates leads to the formation process of the ALPS.
- Western Alps:
  - Low to moderate seismotectonic activity
  - E-W extension in the central part of the mountain belt is observed by GPS studies (1997-2001)
  - Compressional Strain (N-S & NW-SE) is observed in the southern part

    (Calais et al., 2002)
- South-Eastern Alps:
  - Represents one of the seismically active regions in Europe
  - Appearance of active faults
  - Seismic Events: Friuli sequence (M=6.5), Western Slovenia (1998 M=5.7 and 2004 M=5.3)
- Glacier shrinkages lead to vertical uplift (significant signal ?).

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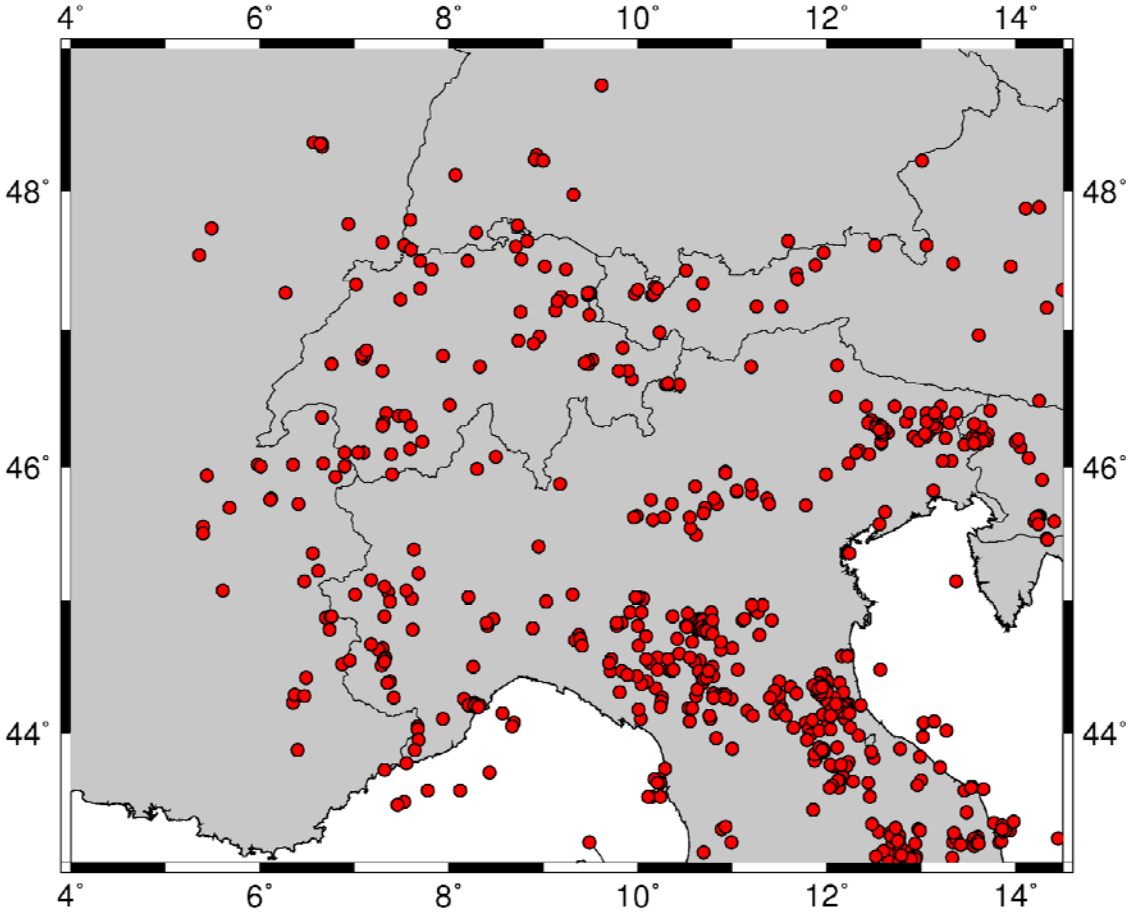
Distribution of Earthquakes



Source:
NEIC: National Earthquake Information Centre.

Showing earthquakes since 1986 with
$M_s > 3.5$

Concentration:

Friuli, Apennine

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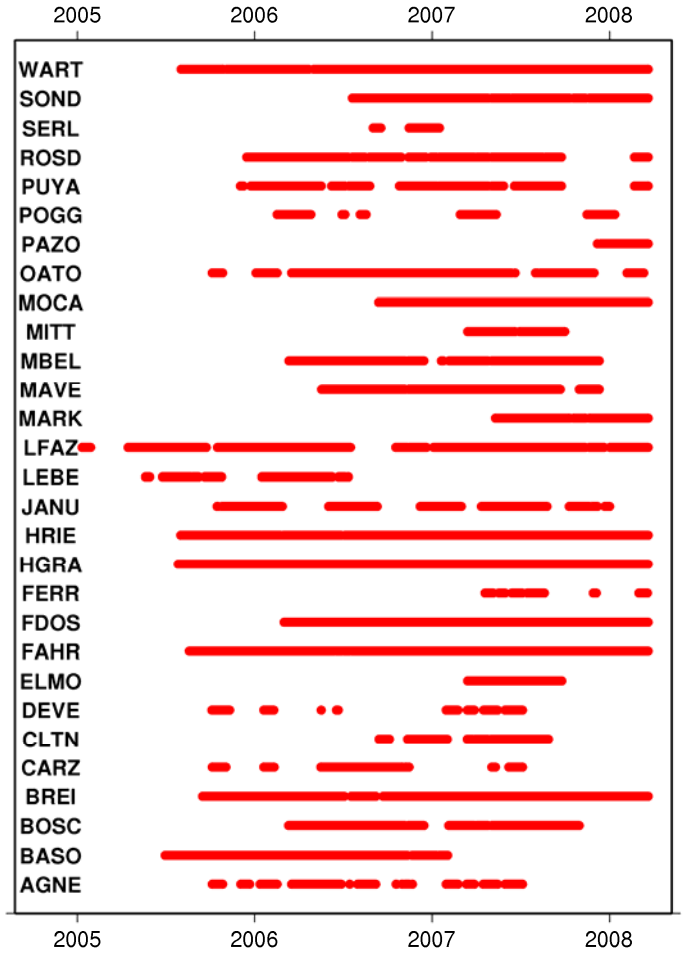
Data Availability

- Frequent data gaps (incomplete).
- Daily access is limited to a few stations.
- Late realisation of the stations leads to rather short time series.
- Of the 40 stations only 29 deliver or delivered data to the Trieste data centre.

=> Collection of additional data:

- Austria (+ **11** sites)
- Italy [**FReDNet**: The Friuli Regional Deformation network] + **13** sites



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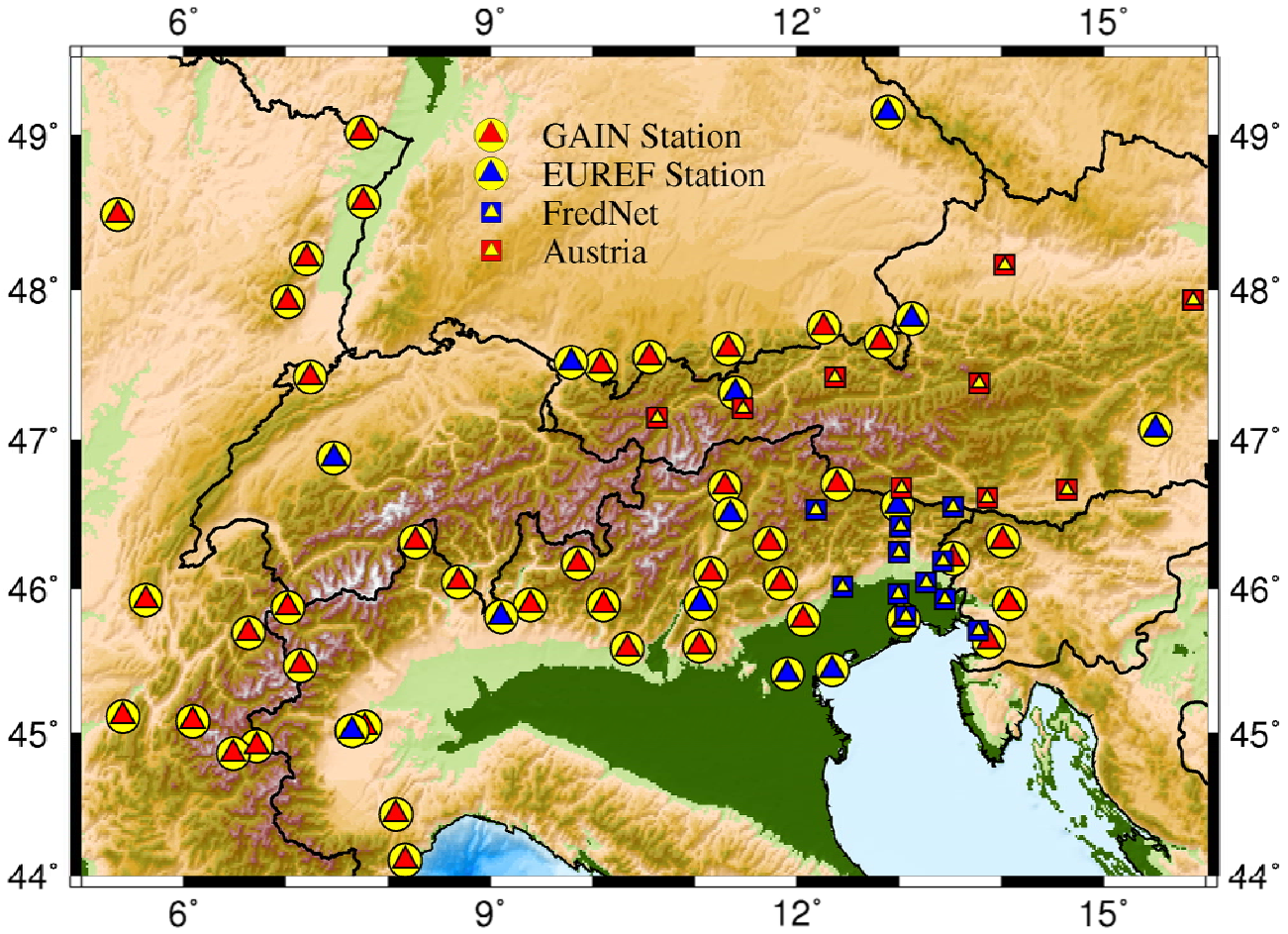
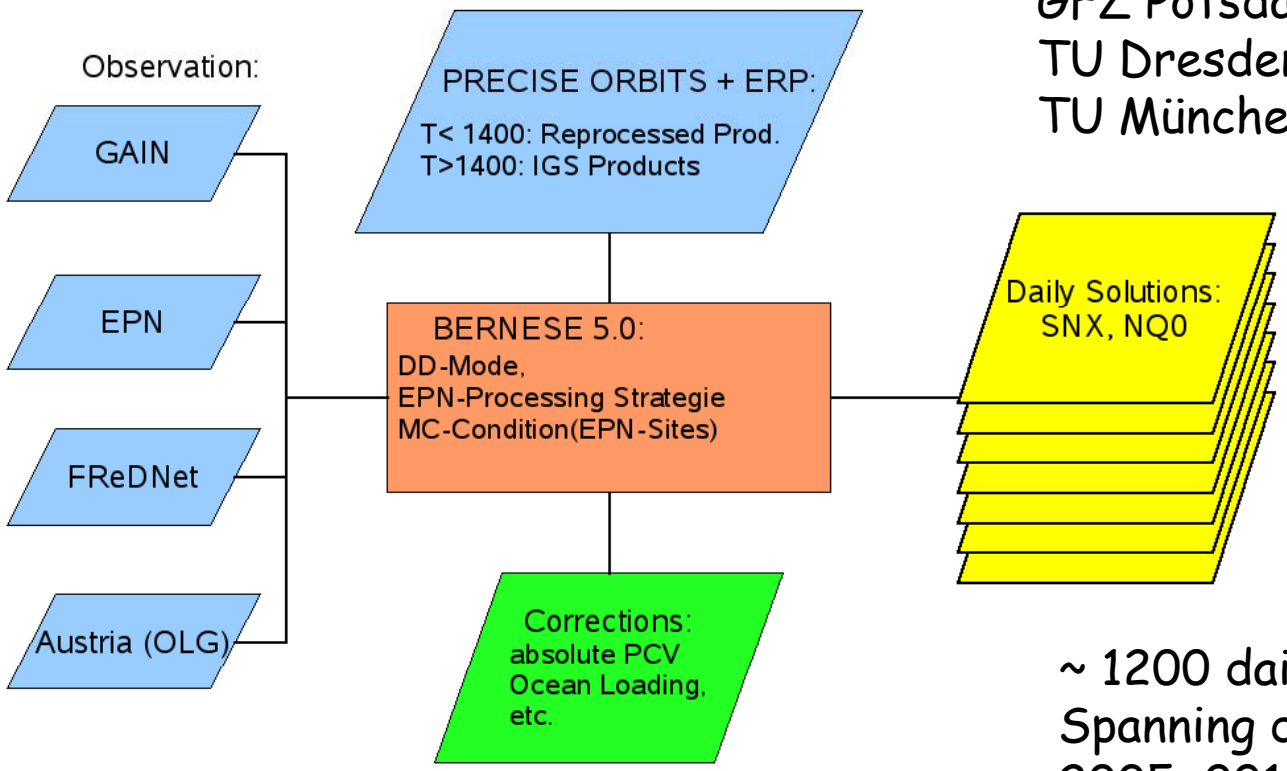
Complete GPS network

(73 sites processed)



No coverage of Switzerland, yet !!

Daily Data Analysis

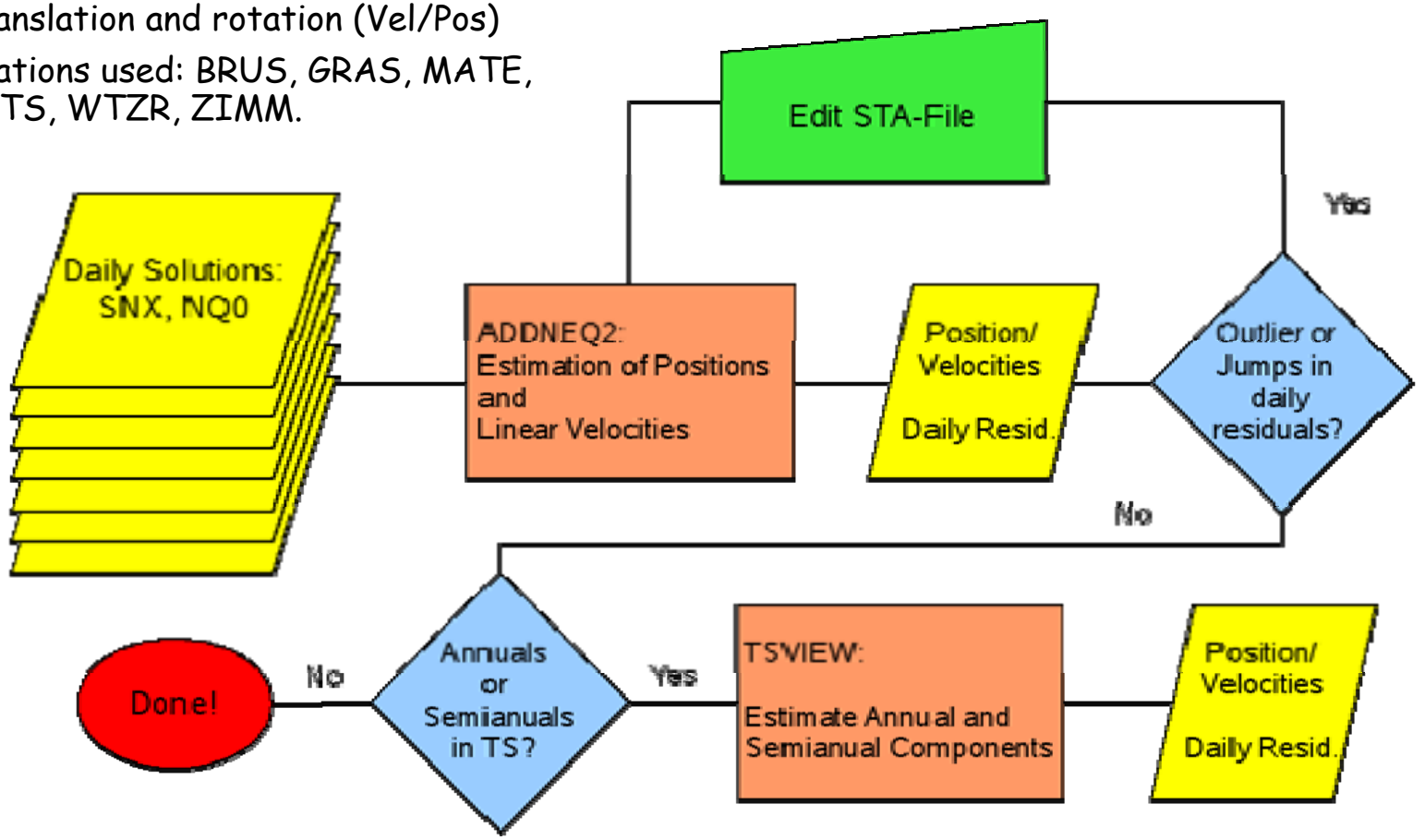


Re-processed Orbits/ERP by:
GFZ Potsdam
TU Dresden
TU München

~ 1200 daily solutions files
Spanning data between
2005, 001 – 2008, 099

Estimation of the velocity field

- MC-Condition:
  - Translation and rotation (Vel/Pos)
  - Stations used: BRUS, GRAS, MATE, POTS, WTZR, ZIMM.



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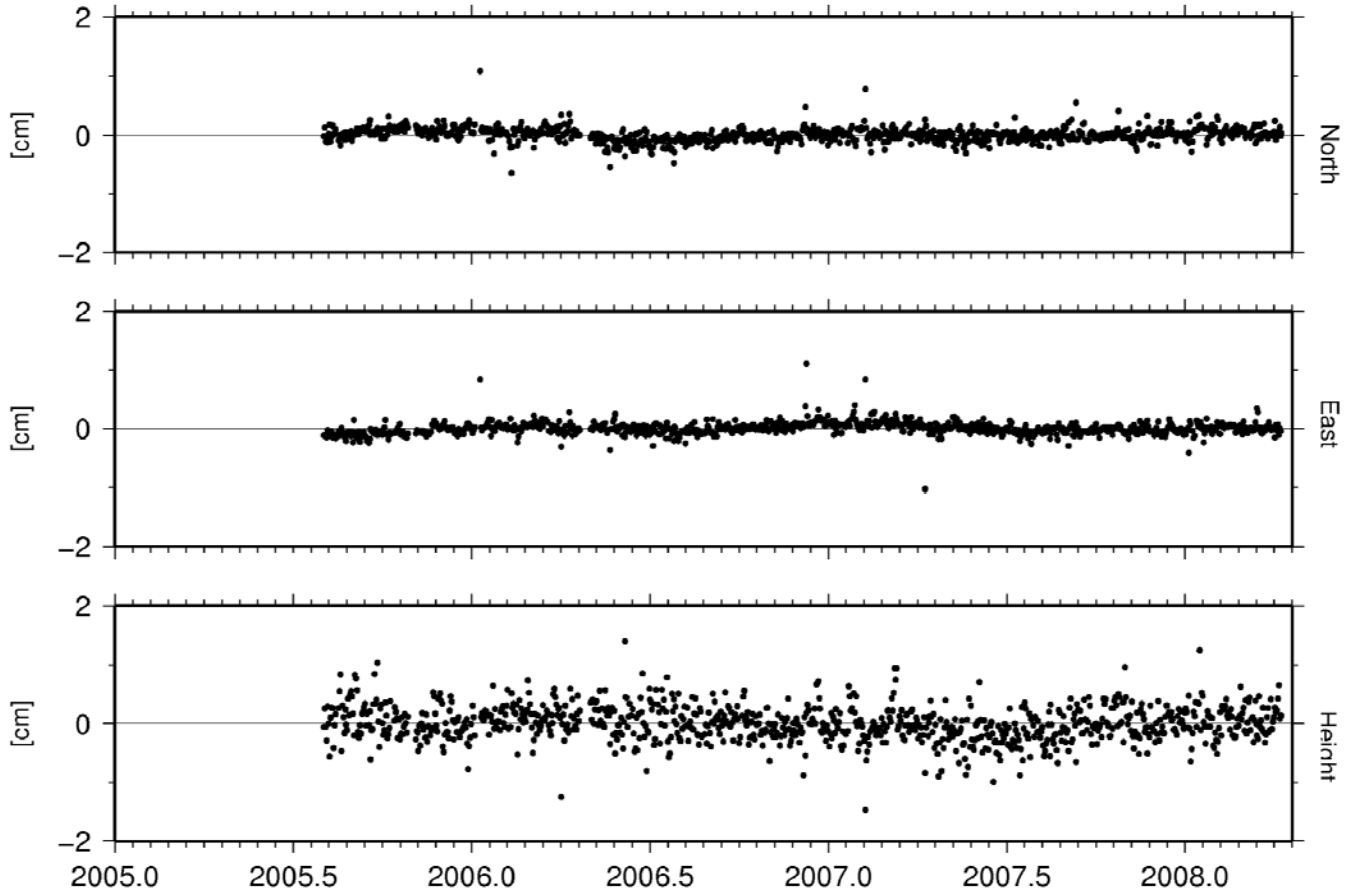
Time Series

(linear Trend removed)

WART



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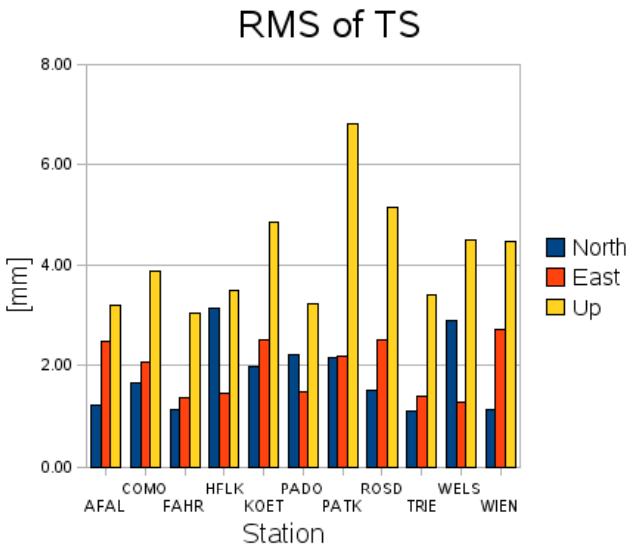
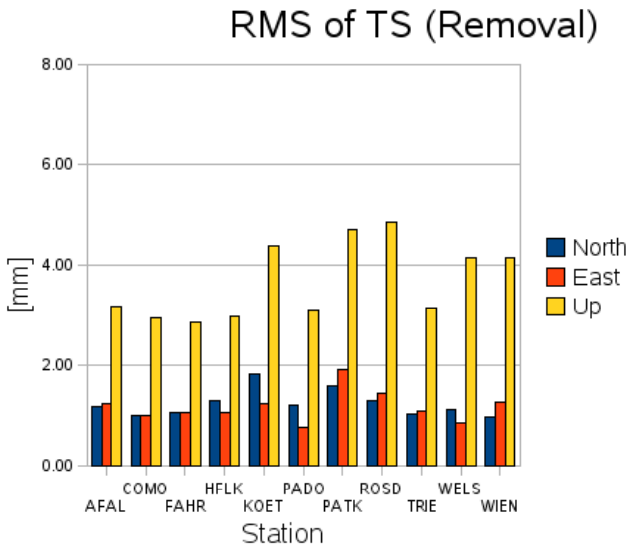
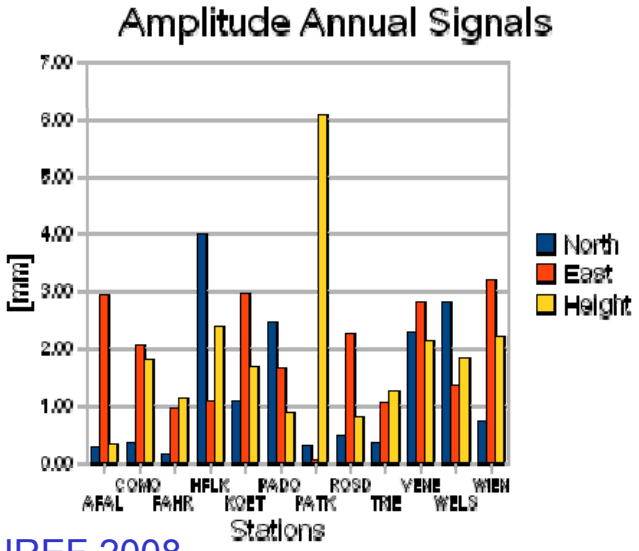
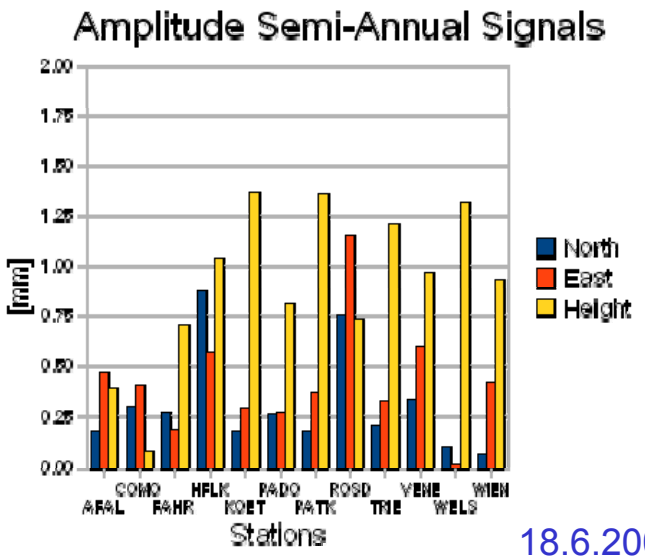
Annual and Semi-Annual Signals



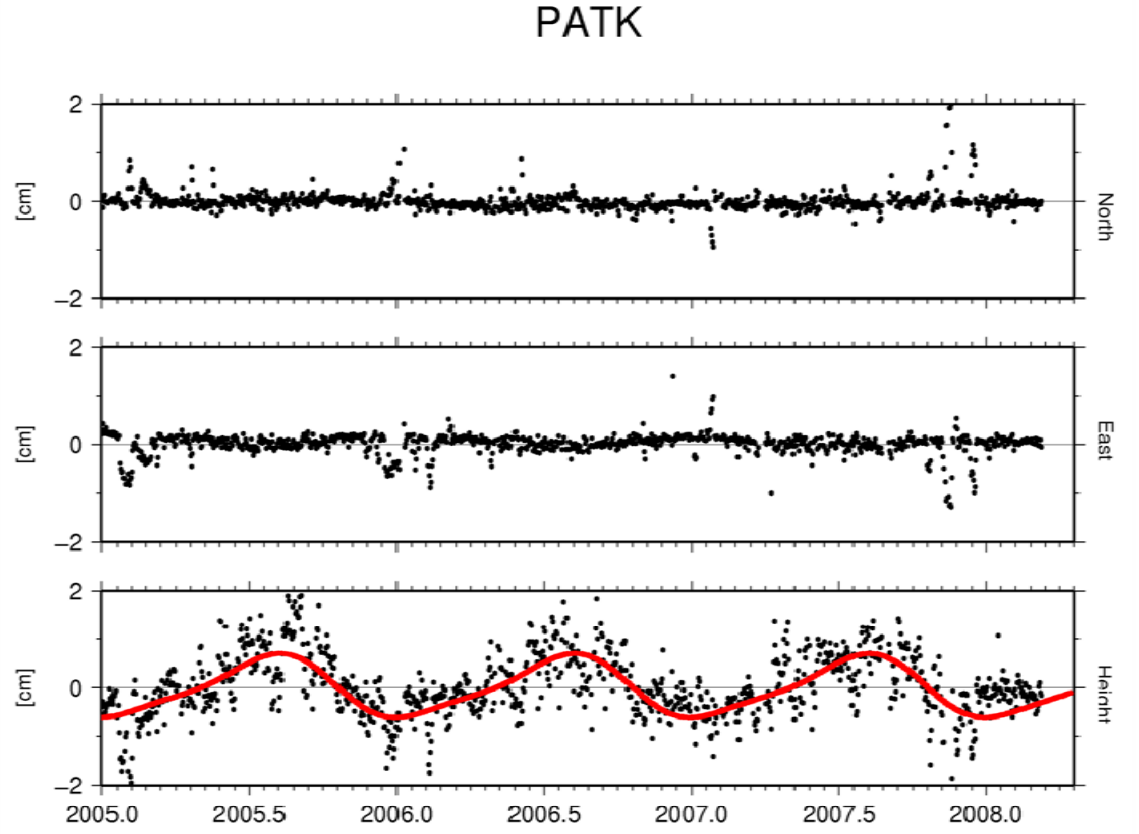






Time Series "Patscherkofel"

(linear Trend removed)



	Ampli. (mm)	Phase (day)
Annual	6.07	208
Semi-An.	1.36	110

After Removal of periodic signals for selected sites:
Coordinate Repeatabilities are
North=1.3, East=1.3 mm, Height=3.8mm

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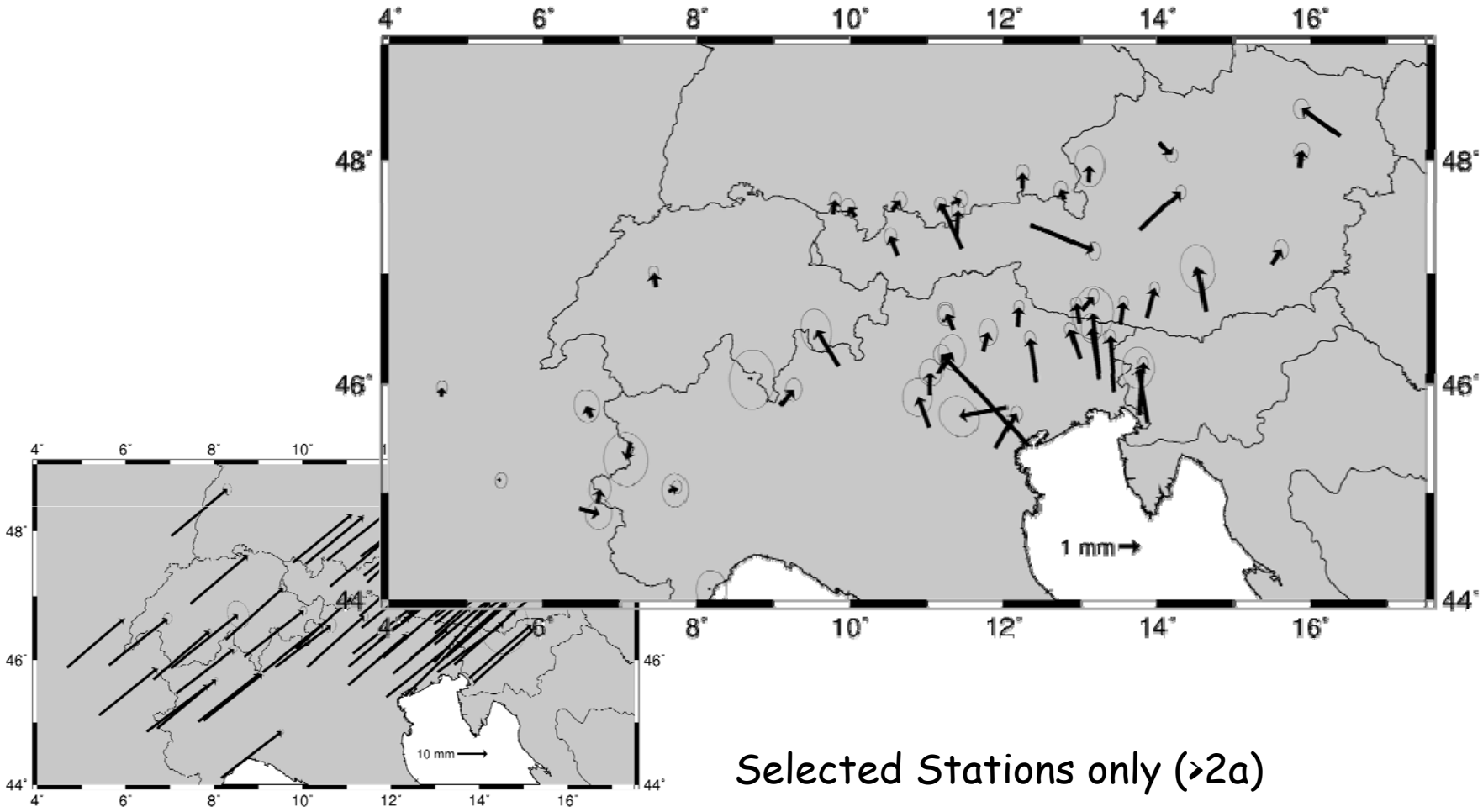
Horizontal Velocities in ETRS

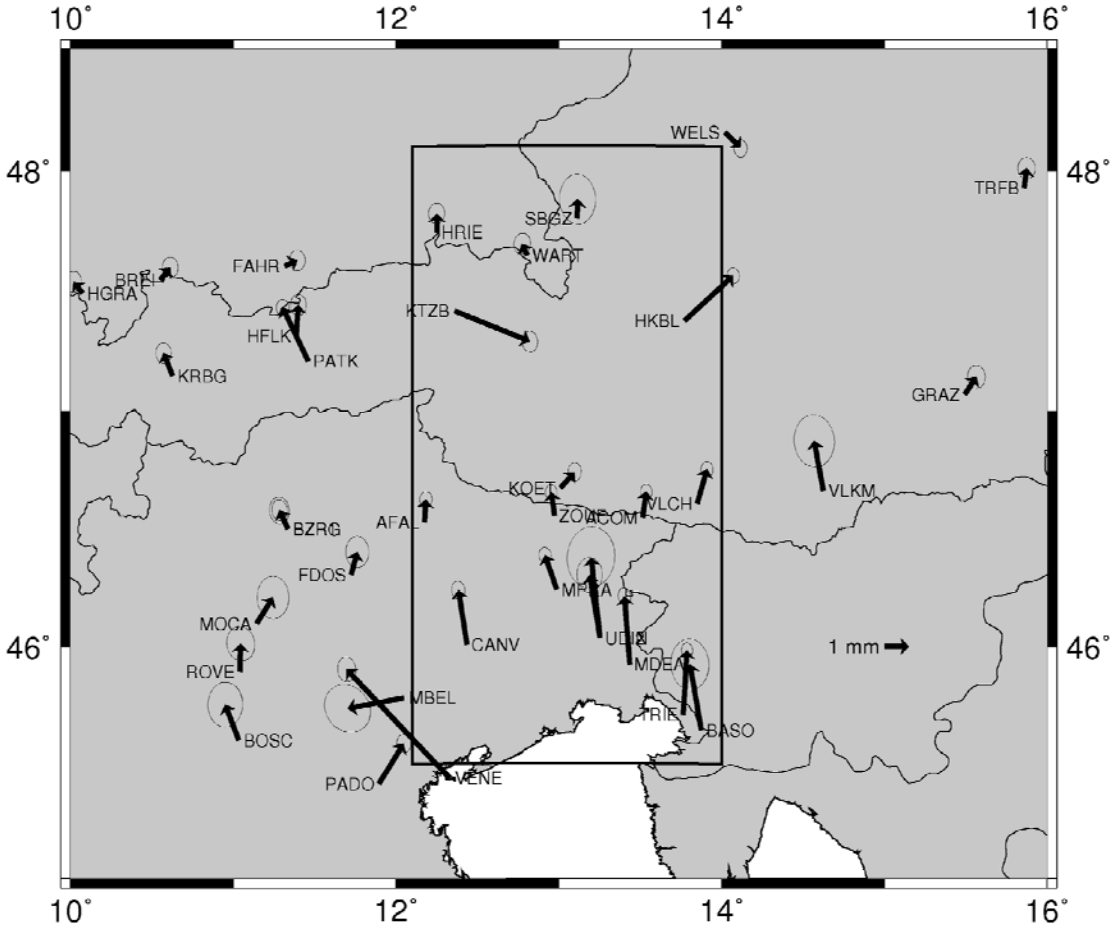


Selected Stations only (>2a)

Deformation across the Eastern Alps

Deformation Zone:

Φ=46.5-48.3° N
Λ=12.0-14.0° E



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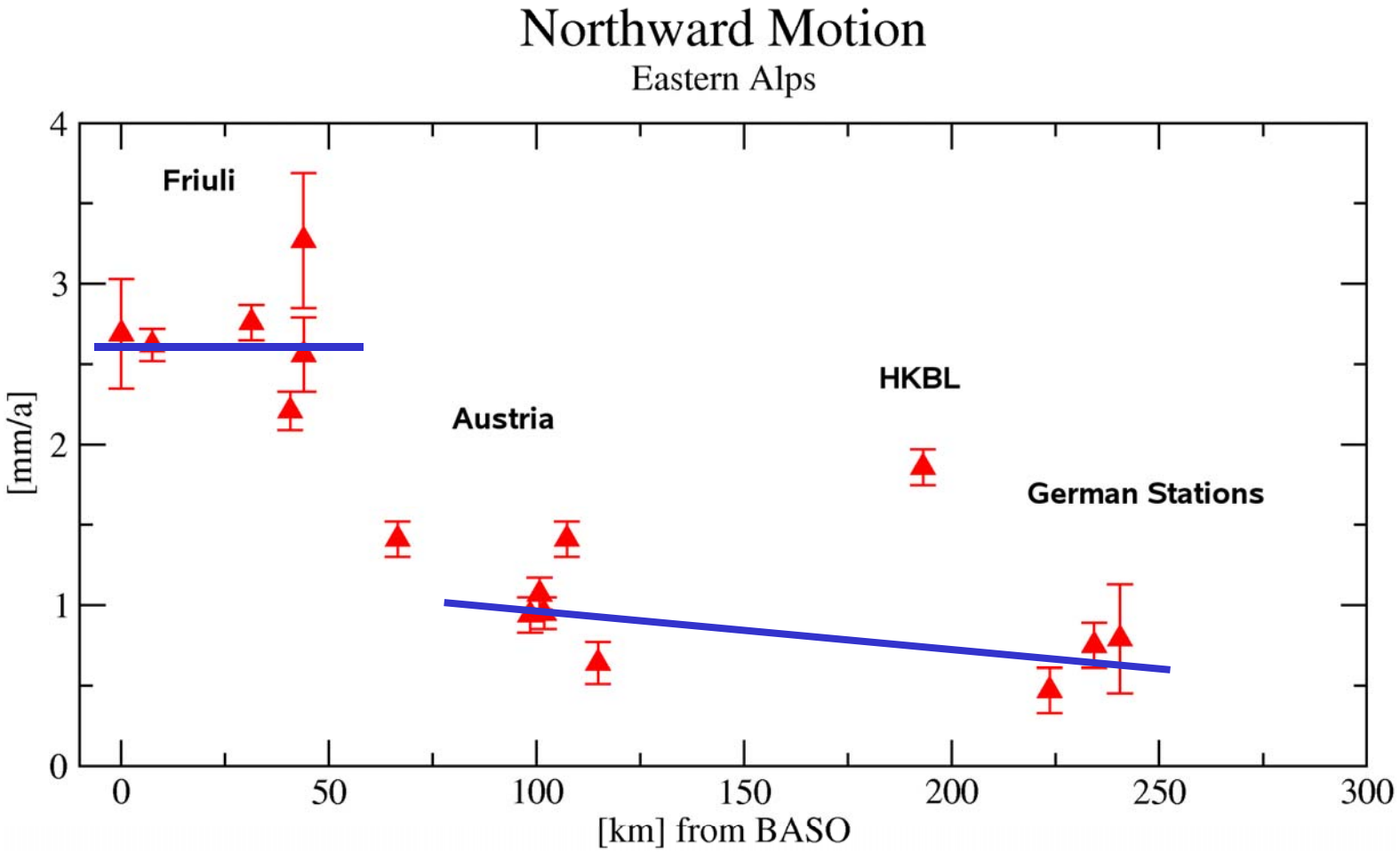
Profile across the Alps



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Conclusions

- Time series of the stations are still very short.
  - Stations with a history of close to 3 years show [(FReDNET), Austria+ EPN] significant horizontal deformations.
  - Access to the data of the GAIN network needs to be improved!
  - Due to the shortness of the time series vertical velocities are still critical (no discussion at the moment).
  - Some sites show clear seasonal dependence, origin is still unknown and needs to be evaluated (Snow and others).
- Western ALPS and Eastern Alps show different behaviour:
  - West: partly extension, but still very noisy!
  - East: shortening across the ALPS is clearly visible
    - Deformation zone in the Eastern Alps shows compression between 2.5 – 1 mm/a.
- Extend analysis over several years.

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Annual and Semiannual Signals

Station	RMS			North				East				Height				RMS (new)		
	North	East	Up	annual		semia.		annual		semia.		annual		semia.		North	East	Up
	mm			cos	sin	cos	sin	cos	sin	cos	sin	cos	sin	cos	sin	mm		
AFAL	1,21	2,47	3,22	0,25	-0,12	0,04	-0,17	0,95	-2,77	0,37	0,28	-0,16	0,28	-0,32	-0,22	1,18	1,25	3,18
COMO	1,67	2,06	3,88	0,27	-0,21	0,24	-0,18	1,90	0,76	-0,21	0,34	1,79	0,04	0,01	-0,07	1,01	1,00	2,94
FAHR	1,12	1,36	3,05	-0,13	-0,01	-0,05	-0,26	0,70	0,63	-0,01	0,18	-1,06	-0,36	-0,41	0,58	1,08	1,08	2,87
HFLK	3,15	1,46	3,51	-1,58	-3,65	0,53	0,70	-0,18	-1,04	0,09	0,56	-1,03	2,15	-1,04	0,05	1,32	1,07	2,97
KOET	1,98	2,51	4,85	0,51	-0,94	0,01	0,17	-2,95	0,05	0,19	-0,22	1,67	-0,06	0,51	1,27	1,84	1,26	4,38
PADO	2,22	1,48	3,25	-2,27	-0,93	0,26	-0,04	1,47	0,74	-0,25	-0,09	-0,21	-0,84	-0,81	-0,06	1,21	0,79	3,10
PATK	2,16	2,19	6,83	0,23	-0,20	0,17	0,01	-0,03	0,04	-0,30	-0,22	-5,61	-2,33	-0,47	1,28	1,61	1,91	4,73
ROSD	1,50	2,51	5,15	0,02	0,46	-0,03	-0,75	0,83	-2,09	0,75	0,87	-0,16	-0,78	0,60	0,42	1,30	1,46	4,87
TRIE	1,09	1,39	3,42	-0,10	-0,32	0,18	0,09	0,13	1,03	-0,17	-0,28	0,53	-1,14	-1,19	-0,20	1,04	1,10	3,17
WELS	2,89	1,29	4,50	2,79	0,15	-0,02	-0,09	-1,33	0,16	0,00	0,01	1,71	-0,63	-1,31	-0,16	1,14	0,86	4,16

After Removal of periodic signals for selected sites:
Coordinate Repeatabilities are
North=1.3, East=1.3 mm, Height=3.8mm

Improved Velocities by Removal of annual and semiannual sigansl