Towards a European Dense Velocities Field as a basis for Maintaining the European Reference Frame

EUREF 2019 Symposium

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Motivation: Example Spain

- ETRF2005 as intermediate reference frame chosen (Memo published before ETRF2005 was set as “not recommendable”)
- no official coordinates for the Iberian Peninsula (various organisations); Differences are calculated, but no coordinate values published on EPN web
- New solution in July 2018:
  - SGC Spain (Superior Geographical Commission of Spain) published a new realisation in ETRF2000
  - 4 different ACs in Spain: IGN, Catalanian Institute, ITACYL and IECA. Reference frame ITRF2008 (Apr 2011 to Jan 2017), establishing outliers, discontinuities and velocities of about 240 stations in Spain (presented at LAC WS 2017)
  - CRD results used for “Official National CRD compare”
  - VEL results used in WG “EU Dense Velocities”
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Differences to EPN solution (C1995): Horizontally

Before:

After:

national coordinates can be reproduced on (sub-) millimeter level compared to EPN scientific coordinates (at given epoch)
Differences to EPN solution (C1995): Vertically

Before:

After:

national coordinates can be **reproduced** on (sub-) millimeter level compared to EPN scientific coordinates (at given epoch)
Fast-Forward +10 slides → combined velocity field for Spain

East velocities
~4 mm/yr
w.r.t. ETRF + North Spain

Static reference frame
1.1.2017 : < 1 mm
May 2019 : < 10 mm
1.1.2022 : < 20 mm
**Status “EU Dense Velocities”**

- **Started 2017**
- Presentation + Splinter Meeting in Amsterdam (May 2018)
- Questionnaire + Web page as feedback to contributors started (June 2018):

Feedback web page: Example gut14 (Gdansk University, Poland)

Input field (gridded background)

Residuals to combination

Neighbour stations

Residuals to combination (sortable table)

<table>
<thead>
<tr>
<th>STATION</th>
<th>Maps LAT/LON</th>
<th>VN</th>
<th>VE</th>
<th>VU</th>
<th>VHV</th>
<th>VV</th>
<th>NUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRO1</td>
<td>[+59.663/+018.948]</td>
<td>-0.61</td>
<td>-0.20</td>
<td>-0.48</td>
<td>0.65</td>
<td>0.48</td>
<td>11</td>
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<td>-0.46</td>
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<td>0.46</td>
<td>4</td>
</tr>
</tbody>
</table>
Key parameter: Status May 2019

- 28 contributions, Weighted average combination
- 3-D GNSS fields (permanent + campaigns), INSAR/Levelling velocities, levelling velocities, global gsrmt set (2D), grids...
- Station identification by site name and approximate position (10 km)
- Stations in solutions: ZIMM: 18, GRAS: 16, GRAZ 15, POTS: 14, ...
### Combination statistics

**x0 - x000 sites common to combination**

**Standard deviation**
- ~0.2-0.3 mm/yr hor.
- ~0.4-0.7 mm/yr up

**Regions with tectonic signals**

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</table>

**Reference frame alignment**

*http://pnac.swisstopo.admin.ch/divers/dens_veil/000.html#STATISTICS*
Global velocities (w.r.t ETRF)

http://pnac.swisstopo.admin.ch/divers/dens_vel/combvel_global_all_cmb_basic_dh.jpg
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Velocity field: Europe

http://pnac.swisstopo.admin.ch/divers/dens_vel/combvel_eu_all_cmb_basic_dh.jpg

NKG velocity grid

3-4 cm/yr movements
Turkey, Greece
Velocity field: Zoom Alps

«gurnd08» – combined INSAR

3-4 mm/yr movements
Italy, Slovenia, Croatia, …

outlier…

http://pnac.swisstopo.admin.ch/divers/dens_vel/combvel_eu_ch_cmb_dh.jpg
Velocity models

1-D fits by component (not yet suited as final velocity model but well for data screening)

http://pnac.swisstopo.admin.ch/divers/dens_vel/000.html#VELOCITIES
Graphical support

Stations (>2 ACs)

Map view links:
- Map view of the network (Google Maps api:3.0, no IE browser)
- Map view of validation stations (Mercator TEST-only web viewer)
- Map view of all stations (Mercator TEST-only web viewer, more than 2 minutes loading)
- Map view of validation stations with ellipses (Mercator TEST-only web viewer, 2 minutes loading)
- Map view of validation stations with ellipses (CH, Geo Aviation Viewer)
- Static plots: Plot Global, hor.
- Static plots: Plot EU, hor. | Plot EU, up
- Static plots: Plot EU, north model | Plot EU, east model | Plot EU, up model
- Static plots: Plot Central, hor. | Plot Central, up
- Static plots: Plot Central, north model | Plot Central, east model | Plot Central, up model
- Download kml: kml validation sites | kml all sites

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swisstopo
Mercator Viewer

- Swiss data + Openstreetmap data
- Global coverage
- Maps are vector based – you can design your map yourself

Stations (>2 ACs)
Mercator Viewer

Stations (>2 ACs)
Mercator View – Example Slovenia
Sandi Berk, Klemen Medved

https://test.map.geo.admin.ch/?layers=KML||your_kml_on_web

https://test.map.geo.admin.ch/?layers=KML%7C%7Chttp:%2F%2Fpnac.swisstopo.admin.ch%2Fdivers%2Fkml%2FSVN_ETRF00_Hz_vel.kml&lon=14.3&lat=46.05&lang=en

WG mail
8.2.2019
Summary

- Thanks to the various individual inputs (> 20) and their good quality a preliminary velocity field for Europe can be generated. Providers have the know-how and partly have velocity generation automated.
- A web system is up and running giving feedback to the provider (sortable tables with outliers, plots, grids, etc.). First successfull viewing possibilities developed.
- Especially in regions of slow motions, some iterations are necessary to remove outliers, instable stations, differences between provider (mainly task of the provider): “Validation first” Some provider should start this refinement activities using our web…
- On a longer view “Model next”:
  - acceptance of “cleaned” velocity fields or velocity grids (e.g. if model is already applied in a country)
  - a velocity model extends the lifetime of the European (and national) reference frames

Thanks to the active WG members! Practical examples: Splinter meeting