ROB

# EPN Reference Frame Alignment: Consistency of the Station Positions

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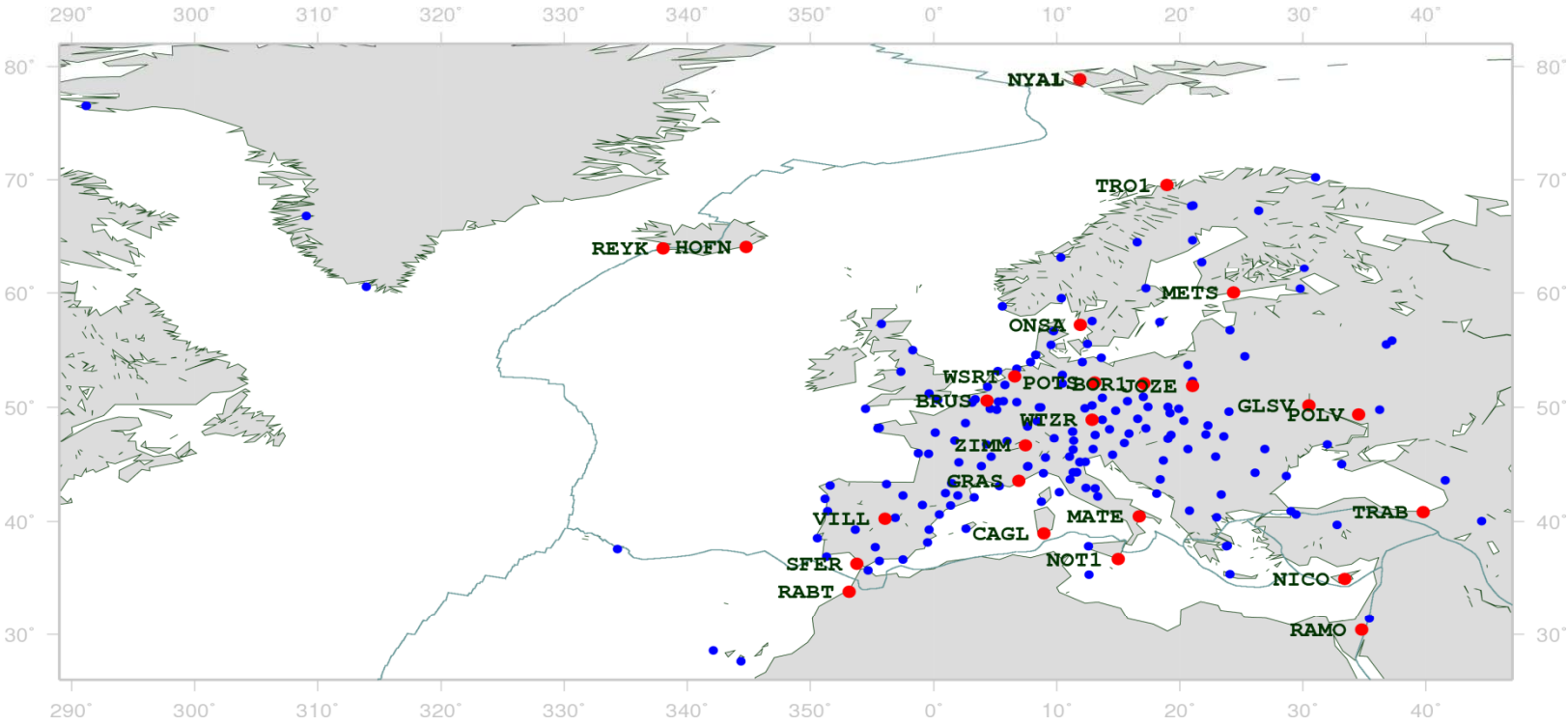
## Combined EPN solution

- based on the subnetwork solutions submitted by 16 ACs
- since week 1400, expressed in IGS05 under minimal constraints
- Fiducial stations: Only regional stations



# IGS05 and ITRF2005

**ITRF2005 based on RPCV** + **Corrections for station-dependent coordinate differences between the APCV and RPCV models**

New frame corrected for site effects

aligned to ITRF2005 with 7-parameter transformation (~130 stations)

**IGS05 APCV compatible**

The 2 frames are equivalent at the global level

BUT

Is it still true at regional level ?

# Questions ?

- What is the impact on the coordinates when:
  - using global instead of regional stations
  - using IGS05 instead of ITRF2005

- Is it sufficient to use regional stations in order to reliably express a GPS solution in a given reference frame ?

# Networks

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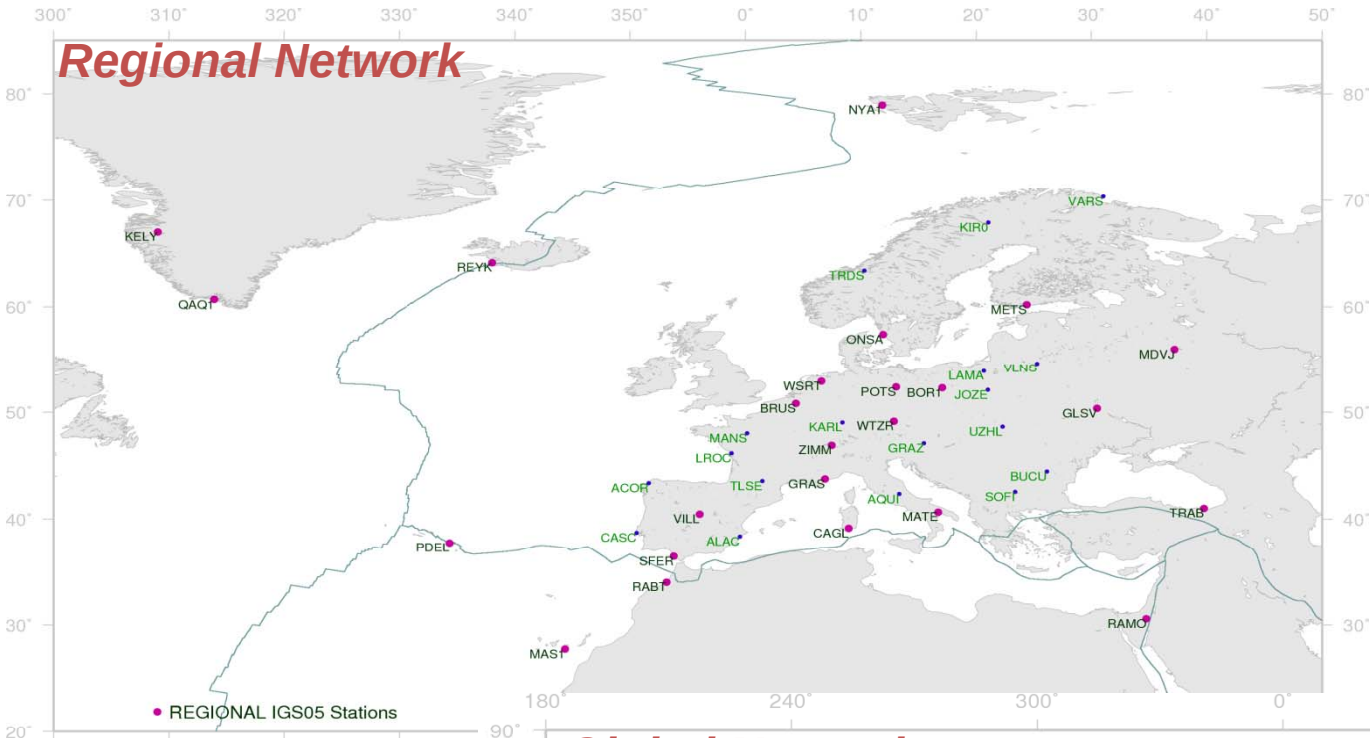
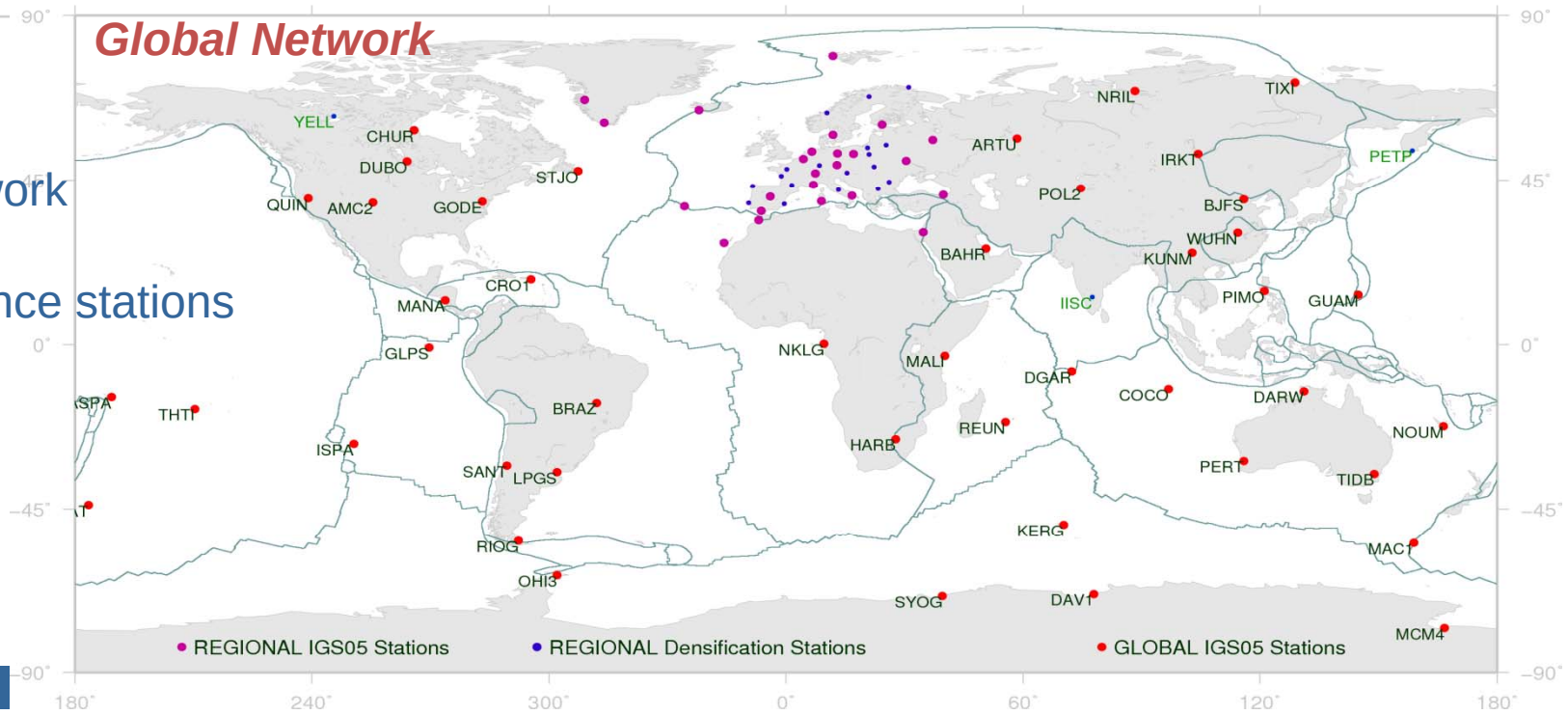
42 EPN stations
(24 also IGS reference stations)




regional network
+
47 global IGS reference stations

# Data Processing

~ 1 year of data

(wk 1400 (Nov. 2006) to wk 1445 (Sep. 2007)

- BERNESE software version 5.0
- ionosphere-free double differences in a network approach
- absolute antenna phase center corrections
- IGS final orbits and ERPs
- Troposphere: wet-Niell mapping function, 1h ZTD corrections, daily horizontal gradient parameter

- Regional/Global cumulative solutions (CATREF, Altamimi)

# IGS05 vs ITRF2005

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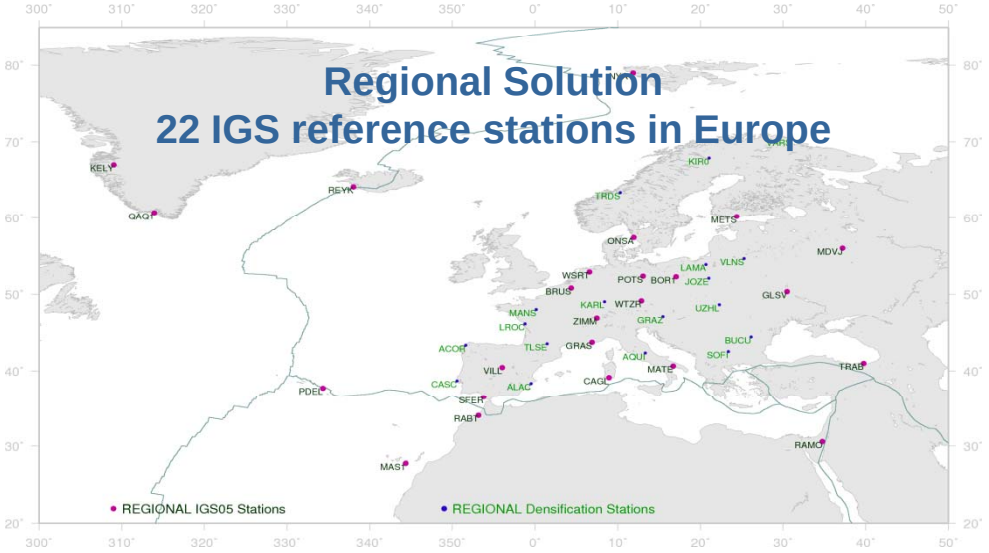
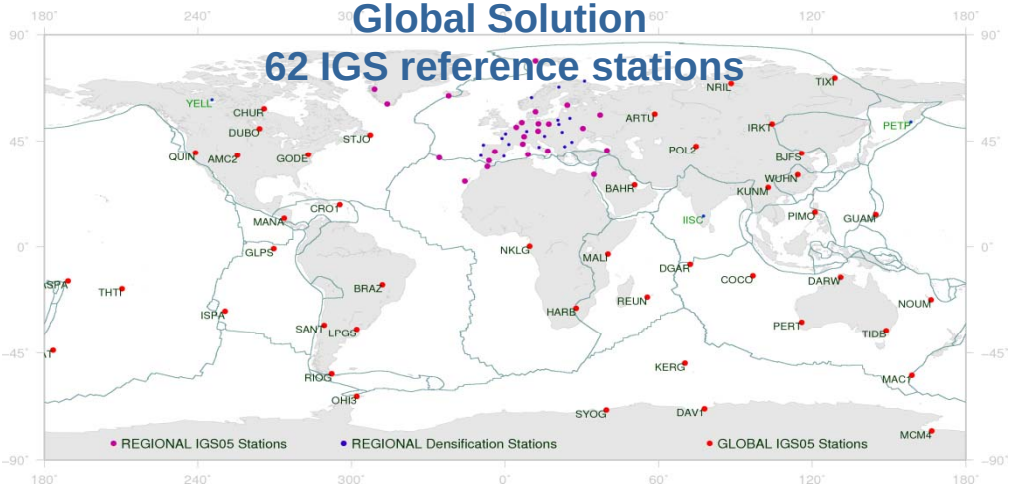


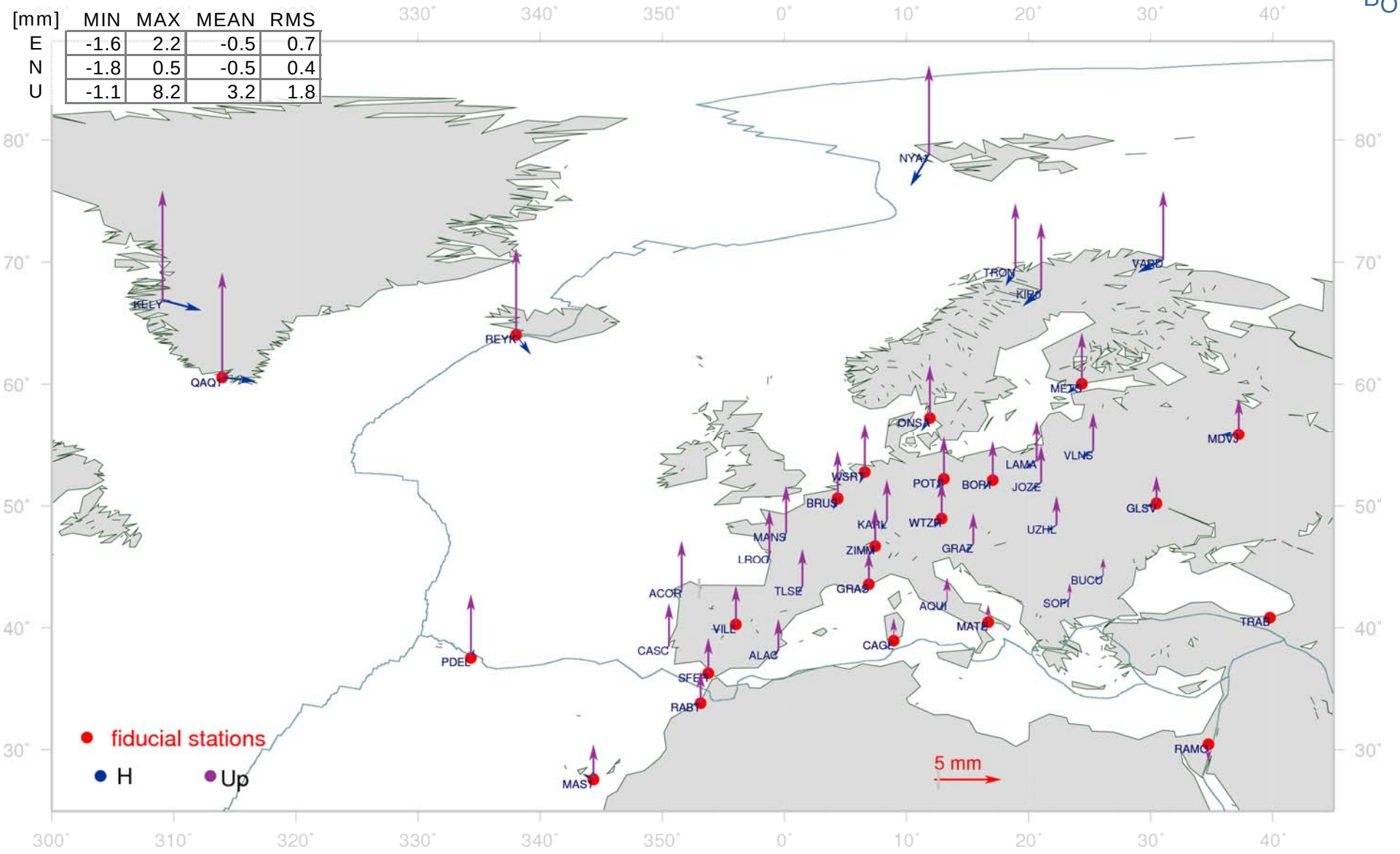

Minimal constraints on Translations, Rotations and Scale

| Type of solution | Regional | | Global | |
|---|---|---|---|---|
| Reference Frame | IGS05 | ITRF2005 | IGS05 | ITRF2005 |

< 1 mm

# IGS05 vs ITRF2005 (Regional solutions)

| [mm] | MIN | MAX | MEAN | RMS |
|---|---|---|---|---|
| E | -1.6 | 2.2 | -0.5 | 0.7 |
| N | -1.8 | 0.5 | -0.5 | 0.4 |
| U | -1.1 | 8.2 | 3.2 | 1.8 |




*Position differences between the regional cumulative solution in IGS05 and the regional cumulative solution in ITRF2005*

# IGS05 vs ITRF2005 (Regional solutions)

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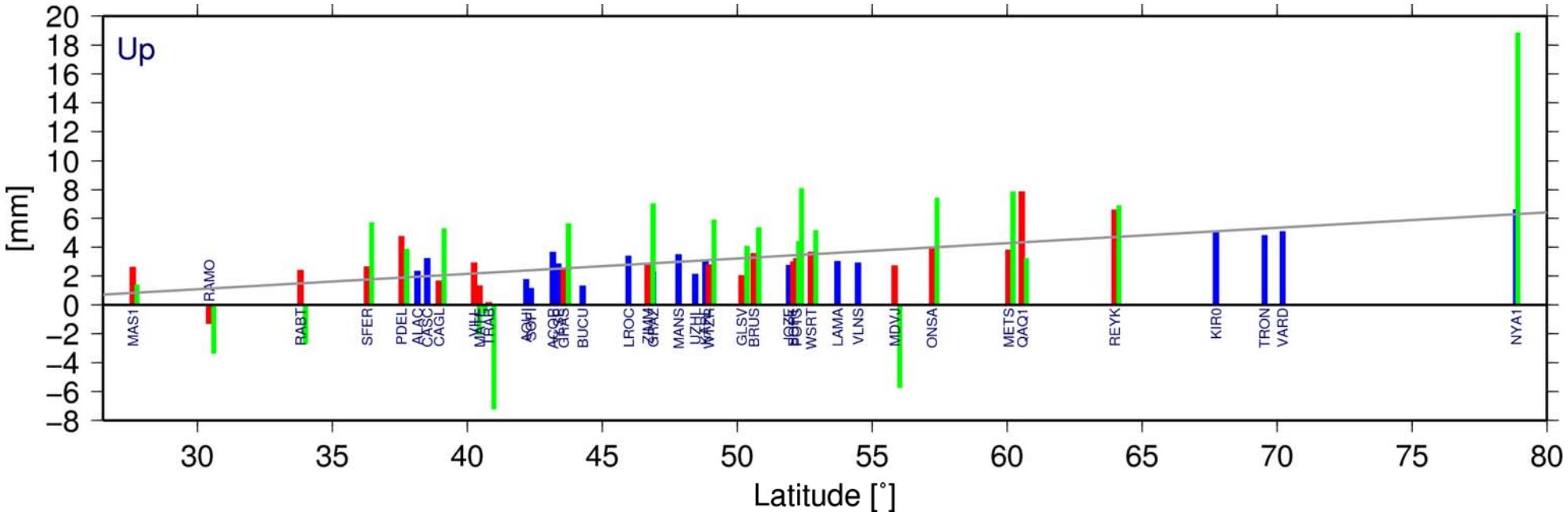
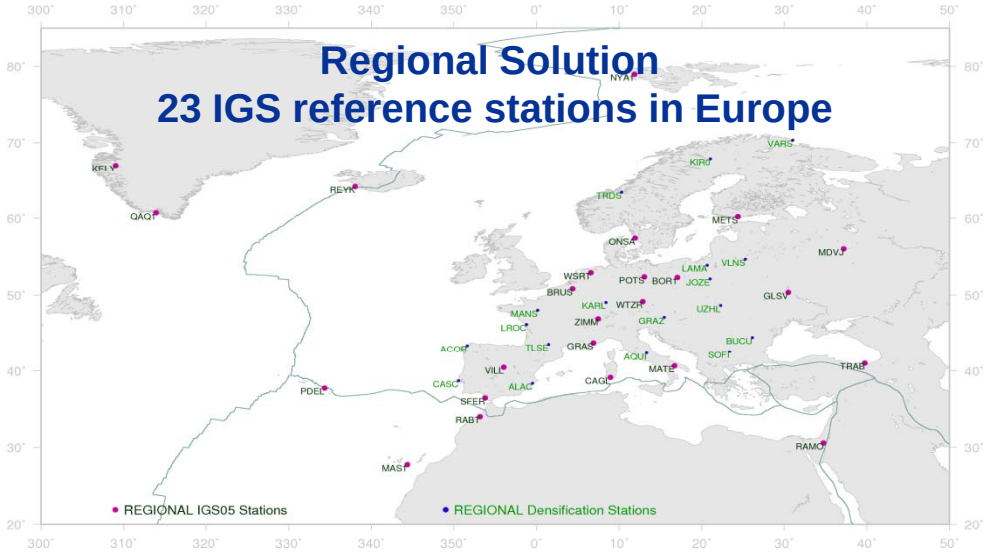
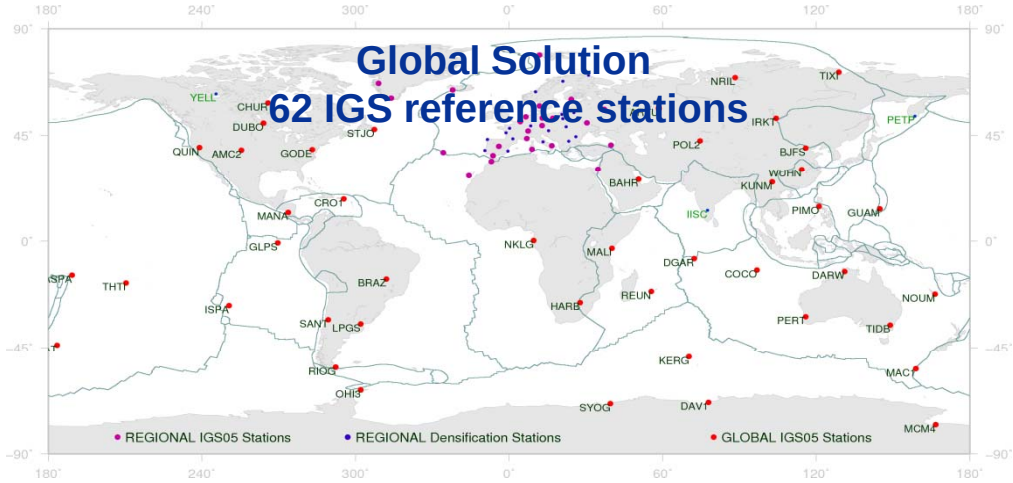
## Stations sorted by increasing latitude



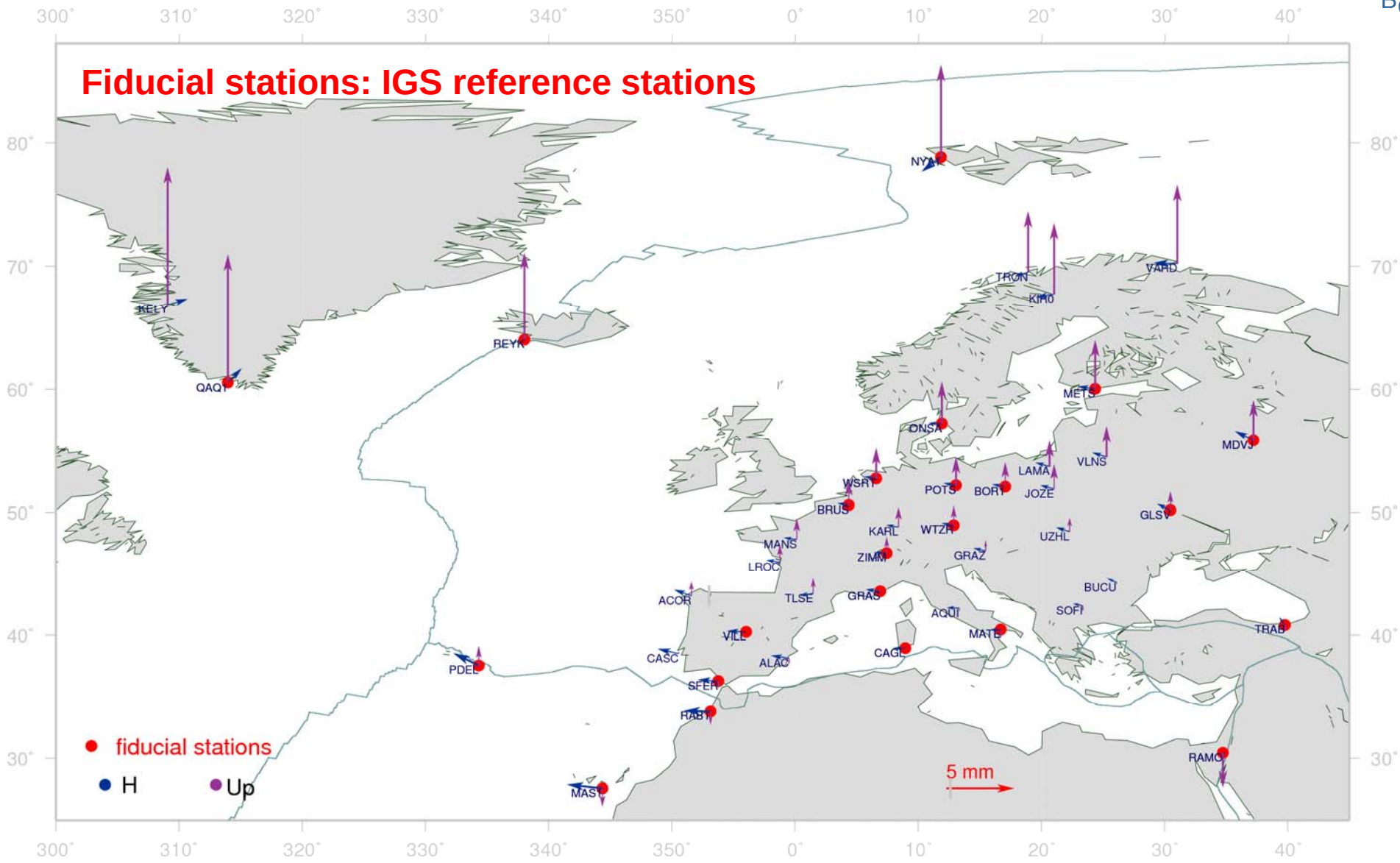
# Regional vs Global




| Type of solution | Regional | | Global | |
|---|---|---|---|---|
| Reference Frame | IGS05 | ITRF2005 | IGS05 | ITRF2005 |

# Regional vs Global



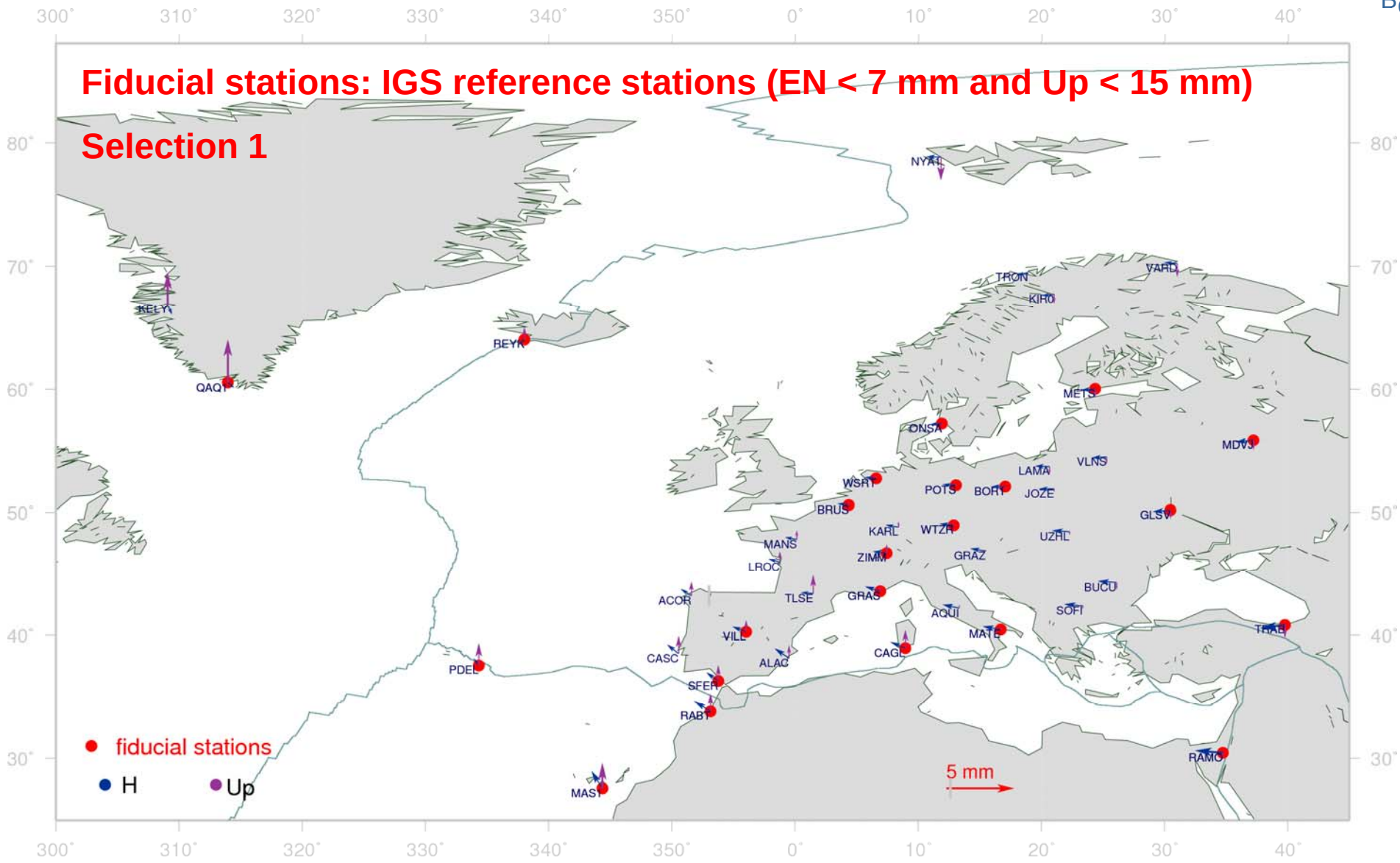

*Difference in positions between the global cumulative solution in ITRF2005 and the regional cumulative solution in ITRF2005*

# Agreement with ITRF2005

## Position residuals between the regional solution expressed in ITRF2005 and ITRF2005

| | IGS RF stations without criteria | | |
|---|---|---|---|
| | East | North | Up |
| | [mm] | | |
| BOR1 | 0.7 | -0.1 | 1.2 |
| BRUS | -0.9 | -0.1 | 1.0 |
| CAGL | -1.7 | -0.1 | -2.2 |
| GLSV | -2.0 | -3.0 | -3.9 |
| GRAS | 1.2 | -0.1 | -2.0 |
| MAS1 | 3.0 | 3.3 | 11.1 |
| MATE | -1.6 | 1.6 | -3.6 |
| MDVJ | 2.9 | -3.4 | -5.5 |
| METS | 1.7 | -0.4 | 1.6 |
| NYA1 | 0.4 | 2.1 | 21.8 |
| ONSA | 0.4 | -0.4 | 1.4 |
| PDEL | 2.2 | -7.2 | 2.0 |
| POTS | 0.2 | -0.4 | -3.7 |
| QAQ1 | -0.6 | 0.4 | -12.0 |
| RABT | 2.6 | 2.5 | -11.2 |
| RAMO | -2.6 | 4.0 | 4.7 |
| REYK | -1.2 | 1.8 | -8.6 |
| SFER | -2.8 | -0.4 | 4.0 |
| TRAB | 0.5 | 0.7 | -8.2 |
| VILL | -2.1 | -0.3 | 2.0 |
| WSRT | 0.8 | -0.7 | 6.9 |
| WTZR | 1.3 | 0.7 | 1.6 |
| ZIMM | -1.7 | -1.9 | 1.4 |
| rms | 1.8 | 2.3 | 7.4 |
| max | 7.5 | | 21.8 |

# Regional vs Global




*Difference in positions between the global cumulative solution in ITRF2005 and the regional cumulative solution in ITRF2005*

# Agreement with ITRF2005

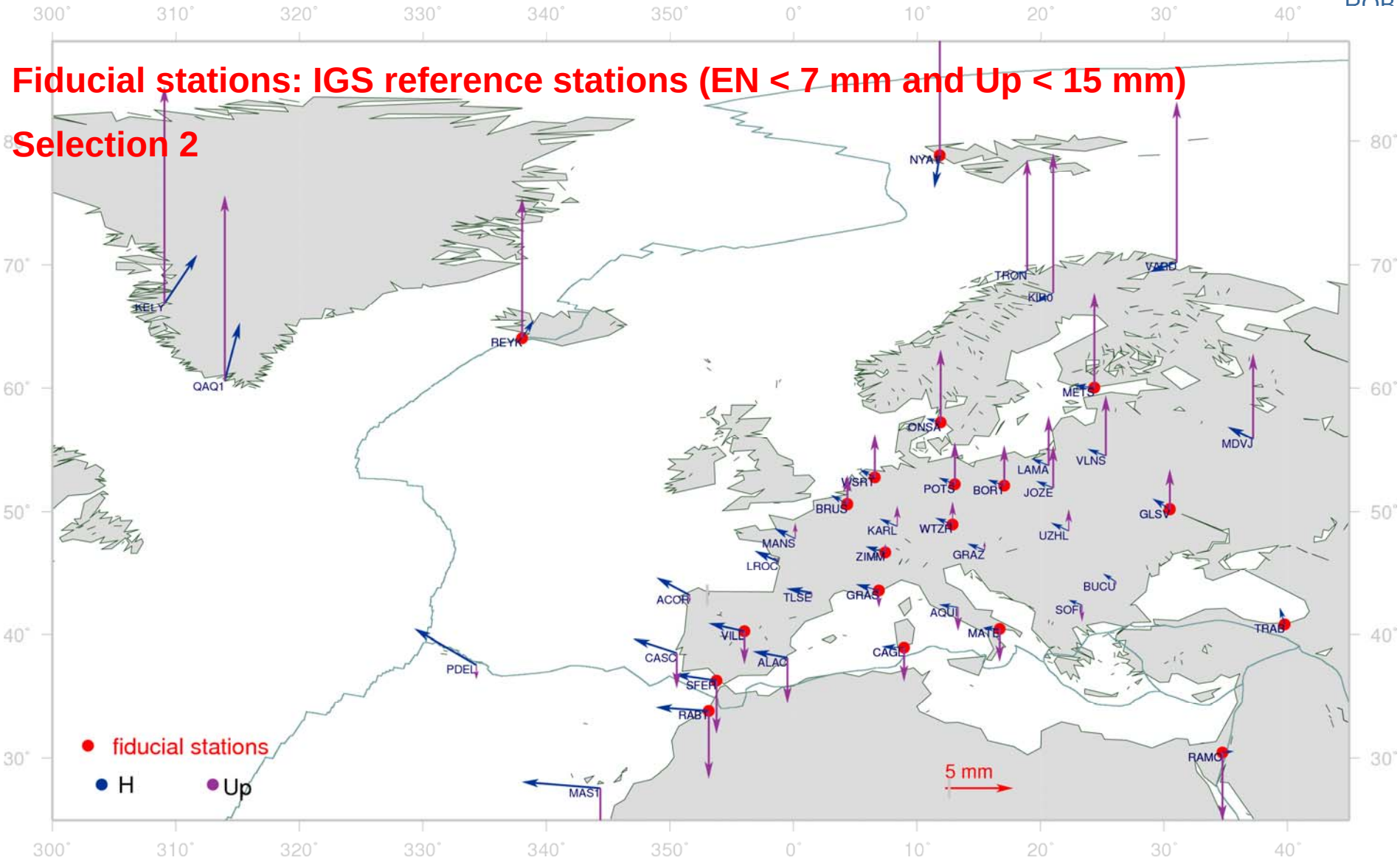
## Position residuals between the regional solution expressed in ITRF2005 and ITRF2005

| | IGS RF stations without criteria | | | IGS RF stations with EN<7mm U<1.5cm | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | selection 1 | | | selection 2 | | |
| | East | North | Up | East | North | Up | East | North | Up |
| | [mm] | | | [mm] | | | [mm] | | |
| BOR1 | 0.7 | -0.1 | 1.2 | 0.8 | 0.1 | 3.2 | 0.9 | -0.3 | 0.0 |
| BRUS | -0.9 | -0.1 | 1.0 | -1.0 | -0.1 | 2.6 | -0.6 | -0.7 | 0.7 |
| CAGL | -1.7 | -0.1 | -2.2 | -1.5 | -0.6 | -3.5 | -0.9 | -0.2 | 0.3 |
| GLSV | -2.0 | -3.0 | -3.9 | -1.6 | -2.4 | -1.8 | -1.7 | -3.3 | -5.4 |
| GRAS | 1.2 | -0.1 | -2.0 | 1.2 | -0.3 | -2.3 | 1.8 | -0.4 | -0.7 |
| MAS1 | 3.0 | 3.3 | 11.1 | 1.1 | 2.4 | 7.9 | | | |
| MATE | -1.6 | 1.6 | -3.6 | -1.1 | 1.3 | -4.5 | -1.2 | 1.5 | -1.9 |
| MDVJ | 2.9 | -3.4 | -5.5 | 2.9 | -2.5 | -1.8 | | | |
| METS | 1.7 | -0.4 | 1.6 | 1.4 | -0.1 | 5.8 | 1.9 | -0.4 | -1.9 |
| NYA1 | 0.4 | 2.1 | 21.8 | | | | -0.6 | 3.5 | 14.4 |
| ONSA | 0.4 | -0.4 | 1.4 | 0.4 | -0.3 | 4.7 | 0.5 | -0.7 | -0.8 |
| PDEL | 2.2 | -7.2 | 2.0 | 0.6 | -6.8 | 1.8 | | | |
| POTS | 0.2 | -0.4 | -3.7 | 0.3 | -0.3 | -1.8 | 0.4 | -0.7 | -4.7 |
| QAQ1 | -0.6 | 0.4 | -12.0 | 0.0 | 1.8 | -5.6 | | | |
| RABT | 2.6 | 2.5 | -11.2 | 1.8 | 1.8 | -13.5 | 4.5 | 2.3 | -7.2 |
| RAMO | -2.6 | 4.0 | 4.7 | -0.3 | 3.8 | 2.4 | -3.2 | 3.9 | 7.1 |
| REYK | -1.2 | 1.8 | -8.6 | -0.8 | 2.0 | -3.0 | -2.0 | 0.4 | -12.5 |
| SFER | -2.8 | -0.4 | 4.0 | -3.4 | -1.0 | 2.2 | -1.1 | -0.8 | 7.4 |
| TRAB | 0.5 | 0.7 | -8.2 | 1.9 | 1.5 | -7.7 | 0.4 | 0.1 | -8.6 |
| VILL | -2.1 | -0.3 | 2.0 | -2.5 | -0.6 | 1.2 | -0.8 | -0.8 | 4.4 |
| WSRT | 0.8 | -0.7 | 6.9 | 0.8 | -0.6 | 9.0 | 1.0 | -1.1 | 6.0 |
| WTZR | 1.3 | 0.7 | 1.6 | 1.4 | 0.7 | 2.8 | 1.6 | 0.3 | 1.4 |
| ZIMM | -1.7 | -1.9 | 1.4 | -1.6 | -2.0 | 1.9 | -1.2 | -2.3 | 1.9 |
| rms | 1.8 | 2.3 | 7.4 | 1.6 | 2.2 | 5.2 | 1.8 | 1.8 | 6.3 |
| max | 7.5 | | 21.8 | 6.8 | | 13.5 | 5.0 | | 14.4 |

# Regional vs Global

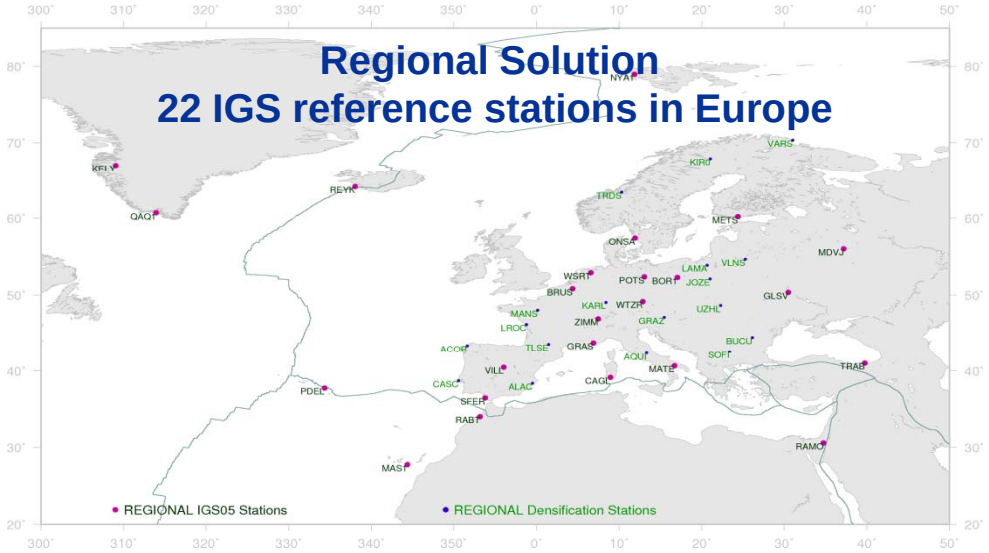
**Fiducial stations: IGS reference stations (EN < 7 mm and Up < 15 mm)**

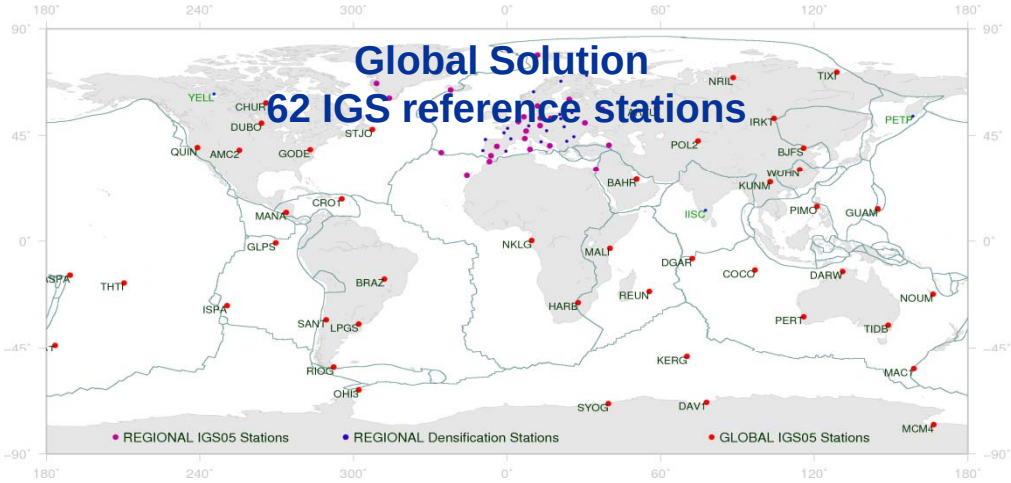
**Selection 2**




*Difference in positions between the global cumulative solution in ITRF2005 and the regional cumulative solution in ITRF2005*

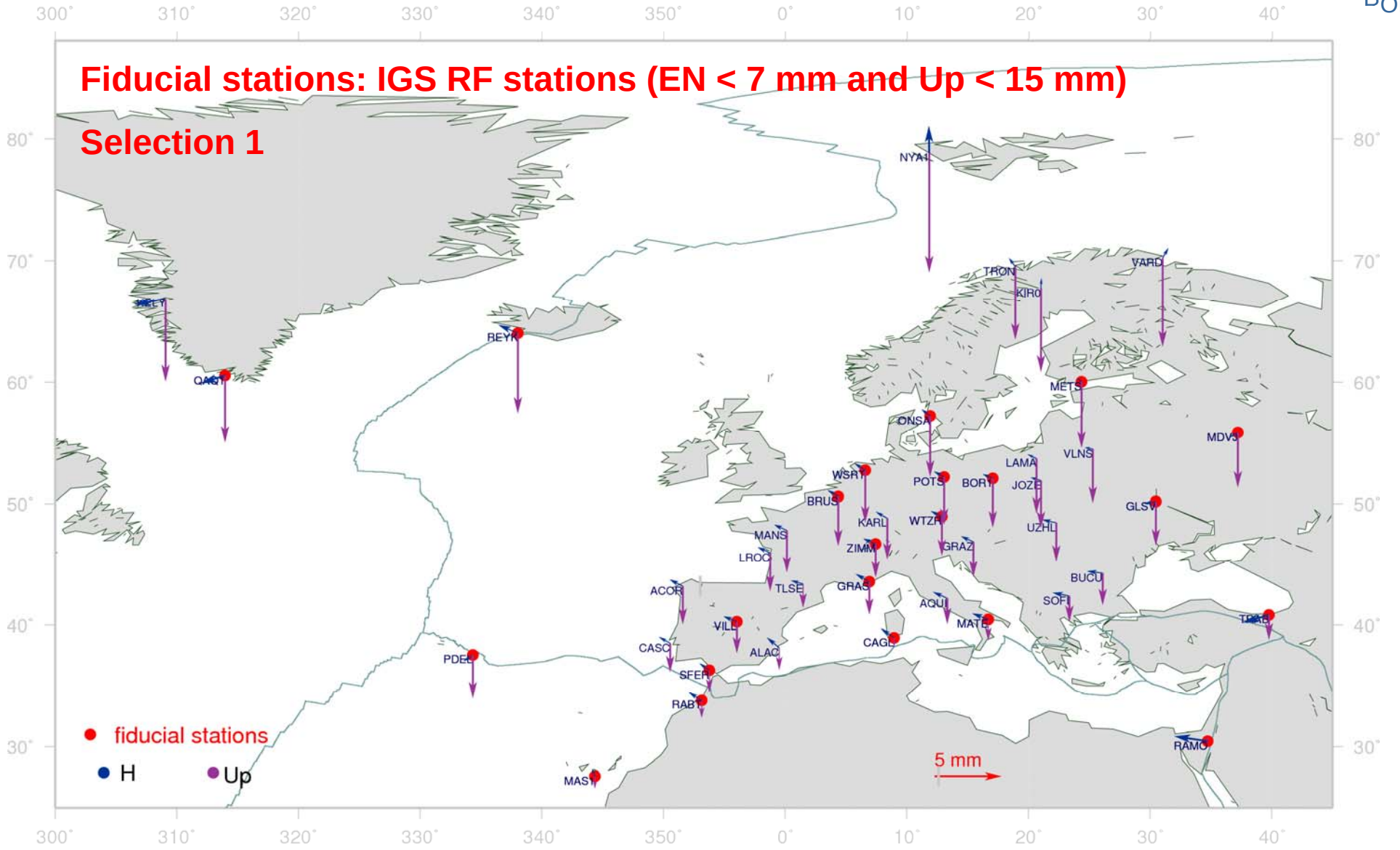
# Regional vs Global




| Type of solution | Regional | | Global | |
|---|---|---|---|---|
| Reference Frame | IGS05 | ITRF2005 | IGS05 | ITRF2005 |

# Regional vs Global




*Difference in positions between the global cumulative solution in IGS05 and the regional cumulative solution in IGS05*

# Regional vs Global

Position differences between regional and global solutions :

- fully explained by a 7-parameter transformation (network effect)

- Possible to have a good agreement but regional solutions very sensitive to :
  - The reference frame used: IGS05/ITRF2005
  - The set of fiducial stations used

- Tilt/Bias: cm level in up / 0.5 cm even in horizontal

# Overview of the tests

| | Regional | Global |
|---|---|---|
| IGS05<br>ITRF2005 | Bias/tilt<br>8 mm in up | < 1 mm |
| Outliers<br>in the fiducial stations | 1 outlier<br>(Up 2.2 cm)<br>Bias/tilt<br>9 mm in up | 6 outliers<br>(Up 2.5 cm / EN 1.5 cm)<br>< 2 mm<br>< 0.8 mm in Europe |
| Different sets of fiducial stations | # stations : s1:22 / s2:19<br>Bias/tilt<br>Up: cm level<br>horizontal: 0.5 cm | # stations : s1:62 / s2:45<br>< 1.5 mm<br>< 0.5 mm in Europe |

# Conclusions

- **Regional:**
  different regional solutions can show biases (up to the cm-level) with respect to each other
  - Outliers in fiducial stations
  - Set of fiducial stations
  - Reference frame: IGS05 / ITRF2005

- **Global:**
  stable sub-mm level

- EPN reprocessing: What about a global network ?