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# Analysis of local ties from multi-year solutions of different techniques

M. Krügel, D. Angermann

Deutsches Geodätisches Forschungsinstitut (DGFI)  
Marstallplatz 8, D-80539 München

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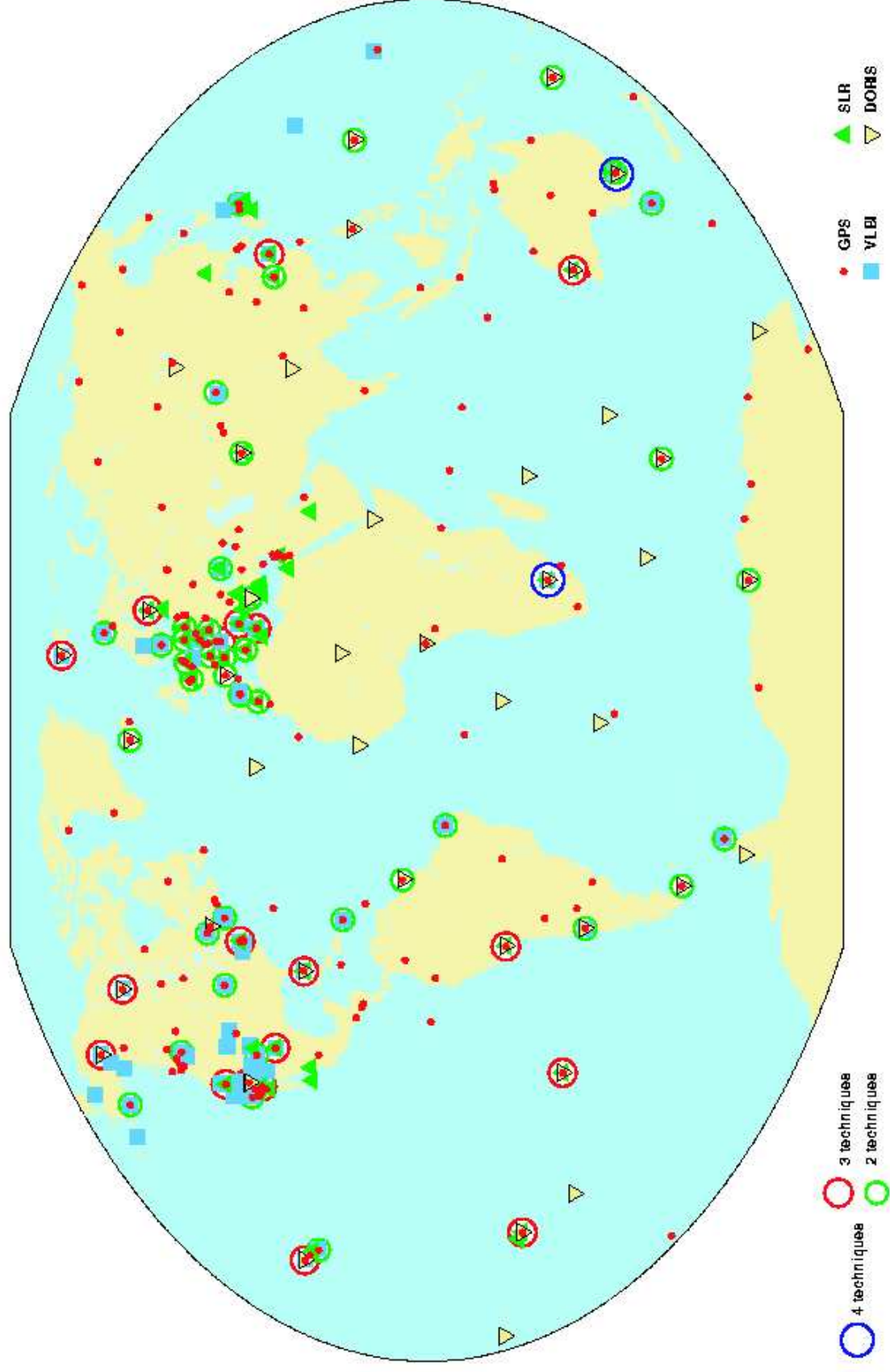
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# Overview

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1. **Input:** combined multi-year solutions from GPS, SLR, VLBI and DORIS
2. **Strategy** for the selection of local ties:  
criteria for local ties and velocities
3. **Results** of the investigations
4. **Conclusions**

# Co-location Sites



# Selection of local ties for combining multi-year solutions (I)

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## Selection in two steps:

1.- **Generate** multi-year solutions of each technique  
datum definition: NNR, NNT w.r.t. ITRF2000 (0.1[mm],[mm/yr])

- **Comparison** of space geodetic derived:
  - coordinate differences and local ties\*
  - velocities at co-location sites

(\*<ftp://lareg.ensg.ign.fr/pub/itrf/itrf2000/tiesnx/... .SNX>)

**Criteria:** abs. local tie differences:  $< 5\text{mm}$   
abs. velocity differences:  $< 2.5\text{ mm/yr}$

# Local tie statistics (I)

Local ties, selected in step 1: differences between derived  
and official values (  ITRF2000):

| Co-location<br>Sites | Techniques | Eccentricities [mm]<br>“derived – local meas.” |                 |            | Velocity differences<br>Between techniques[mm/yr] |                 |            |
|----------------------|------------|------------------------------------------------|-----------------|------------|---------------------------------------------------|-----------------|------------|
|                      |            | $\Delta\phi$                                   | $\Delta\lambda$ | $\Delta h$ | $\Delta\phi$                                      | $\Delta\lambda$ | $\Delta h$ |
| Wettzell             | GPS-VLBI   | -0,01                                          | -0,76           | 3,71       | 0,17                                              | 0,03            | 0,77       |
|                      |            | -0,07                                          | -0,32           | -0,48      |                                                   |                 |            |
| Mauna Kea            | GPS-VLBI   | -1,46                                          | -4,75           | 1,32       | -0,07                                             | -0,74           | 1,89       |
|                      |            | -1,21                                          | -2,46           | -2,23      |                                                   |                 |            |
| North Liberty        | GPS-VLBI   | -1,68                                          | -2,89           | -2,01      | -0,79                                             | -0,53           | 2,23       |
|                      |            | -1,04                                          | -1,77           | -4,23      |                                                   |                 |            |
| Potsdam              | GPS-SLR    | 2,85                                           | 1,75            | -2,81      | 0,15                                              | -0,03           | 0,29       |
|                      |            | 0,81                                           | 0,92            | -0,97      |                                                   |                 |            |
| Graz                 | GPS-SLR    | 3,61                                           | -0,19           | 1,84       | -0,02                                             | -0,37           | 0,85       |
|                      |            | 1,29                                           | -0,32           | 0,79       |                                                   |                 |            |
| Yarragadee           | GPS-SLR    | -1,18                                          | 0,61            | -3,14      | 0,84                                              | -0,92           | 0,46       |
|                      |            | -0,43                                          | 0,29            | -0,31      |                                                   |                 |            |

## Local tie statistics (II)

|                                                          |               | GPS-<br>VLBI | GPS-<br>SLR | SLR-<br>VLBI | GPS-<br>DORIS |
|----------------------------------------------------------|---------------|--------------|-------------|--------------|---------------|
| <b>Co-locations</b>                                      |               | 35           | 24          | 12           | 21            |
| <b>Terrestrial measurements</b>                          |               | 30           | 20          | 10           | 19            |
| <b><math>\Delta</math> Exz.<br/>Absolute differences</b> | < 5 mm        | 3            | 3           | -            | -             |
|                                                          | < 10 mm       | 6            | 5           | 2            | -             |
|                                                          | 10 – 20 mm    | 10           | 6           | 3            | 3             |
|                                                          | > 20 mm       | 11           | 6           | 5            | 17            |
| <b><math>\Delta</math> Vel.<br/>Absolute differences</b> | < 1 mm/yr     | 5            | 2           | 1            | -             |
|                                                          | 1 – 2.5 mm/yr | 12           | 9           | 5            | 3             |
|                                                          | 2.5 – 5 mm/yr | 9            | 8           | 3            | 9             |
|                                                          | > 5 mm/yr     | 8            | 5           | 3            | 9             |

### Possible problems:

- Uncertainties of space geodetic solutions and systematic biases (datum definition)
- Local site dependent effects
- Errors in local tie measurements

# Selection of local ties for combining multi-year solutions (II)

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2. **Combination** of technique solutions using the local ties, selected in step 1 ( $\sigma = 0,1\text{mm}$ )

datum definition: translations and their rates by SLR

rotations and their rates by NNR conditions

**Comparison** of : - derived coordinate differences and local ties  
- velocities

**Criteria:** abs. local tie differences:  $< 1\text{cm}$   
abs. velocity differences:  $< 4.5\text{mm/yr}$

3. **Iteration** of step 2 (using local ties selected in step 2 ( $\sigma = 1\text{mm}$ ) )

➡ selected local ties: 41 (inclusive DORIS: 54)

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# Analysis

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## 7 parameter Helmert transformation between GPS and SLR\* / VLBI\*

|                           |        | <i>VLBI</i>    | <i>SLR</i>     |
|---------------------------|--------|----------------|----------------|
| # transformation stations |        | 16             | 15             |
| Translation               | X [mm] | $0,6 \pm 2,4$  | $-2,3 \pm 1,9$ |
|                           | Y [mm] | $3,1 \pm 2,4$  | $2,1 \pm 1,9$  |
|                           | Z [mm] | $-1,2 \pm 2,4$ | $2,6 \pm 1,9$  |
| Rotation                  | X [mm] | $4,8 \pm 2,9$  | $4,6 \pm 2,4$  |
|                           | Y [mm] | $-3,0 \pm 2,6$ | $1,3 \pm 2,2$  |
|                           | Z [mm] | $-1,5 \pm 2,7$ | $0,2 \pm 2,3$  |
| Scale                     | [mm]   | $2,8 \pm 2,3$  | $-2,6 \pm 1,8$ |

(\*co-location stations „transformed“ to GPS stations using local ties)



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# Conclusions

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- Analysis of space geodetic solutions provides important external information to validate local tie measurements (e.g. reference point)
- Interpretation of „observed“ discrepancies between space geodetic results and local tie measurements is difficult due to various possible effects
- Only a few „excellent“ co-locations do exist
- Combined space geodetic solutions are sensitive w.r.t. selection of local ties (poor network geometry) and processing (e.g. weighting)
- Improvements:
  - detect and remove systematic differences between techniques (time series of parameters)
  - co-locations and local tie measurements



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