Assessment of practical 3-D geodetic accuracy for static GPS surveying

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Static GPS

- Most accurate and most traditional GPS measurement mode
- As result: coordinate differences between points
- Mostly used for determining coordinates for higher order control points

What do we know about accuracy?

- Leaflet by vendors
  - Horizontal ±5 mm + 0.5 ppm
  - Vertical ±5 mm + 1 ppm
- Books
  - 20 min + 2 min / km (Hoffmann-Wellenhoff et. Al., 2001)
- Published papers
  - Dong and Bock (1989), Davis et al. (1989) and Larson and Agnew (1991)
  - Eckl et al. (2001), Soler et al. (2006)

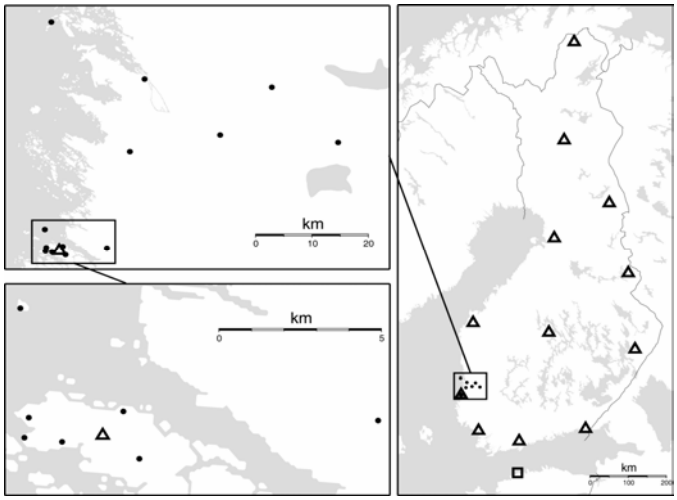
What do we know about accuracy?

- Non-published guidelines, rules of thumb by experienced surveyors
- Users have requested more detailed information
  - Especially the connection between:
    - Accuracy
    - Observing time
    - Baseline length

Our approach

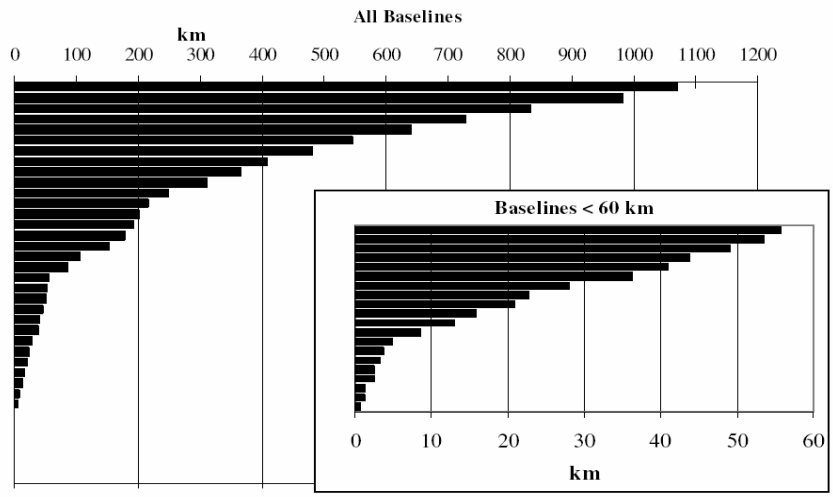
- Collect GPS data covering necessary baseline lengths
  - Use available data if possible
- Define reference coordinates
- Process the data with …
  - … commercial software
  - … broadcast orbits
  - … precise orbits
- Study the results
  - Give easily readable general guidelines

Test Field

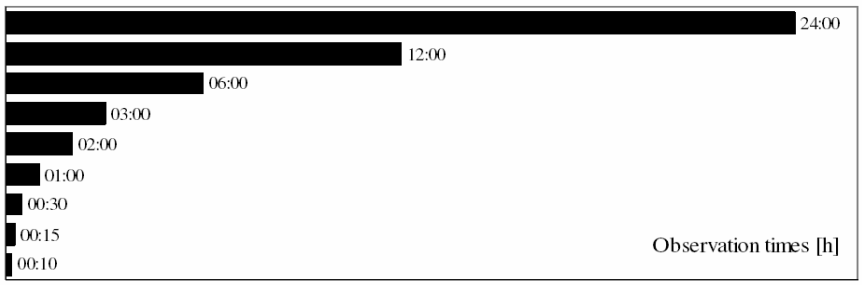


Test Sites

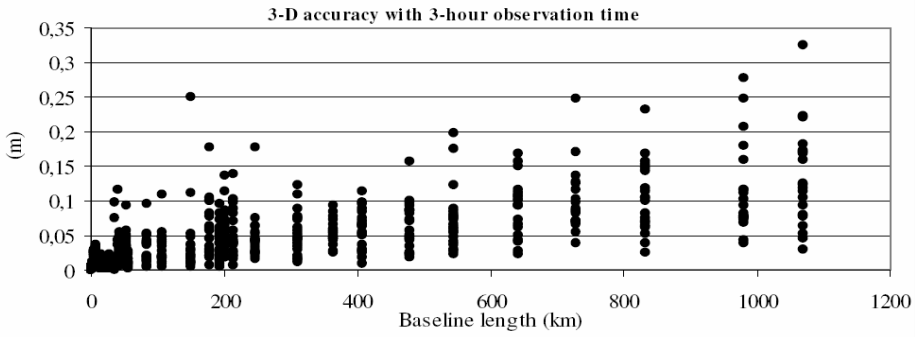
Baseline Lengths



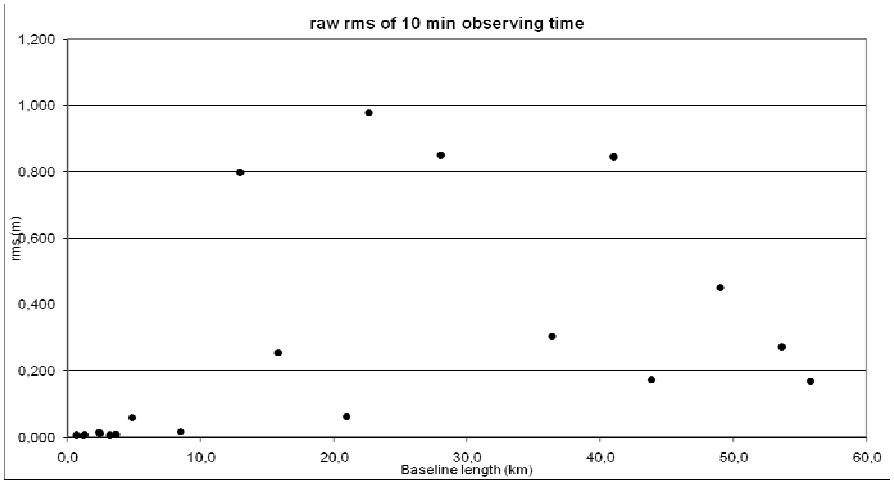
Session lengths



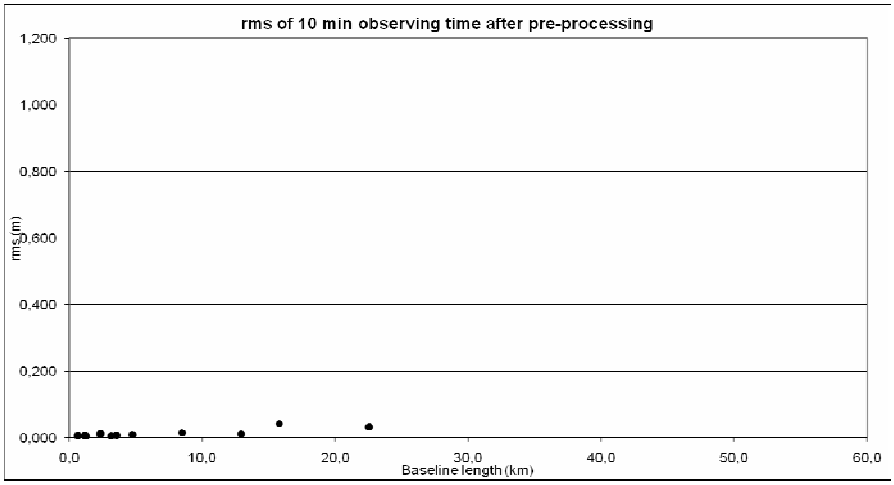
Data processing



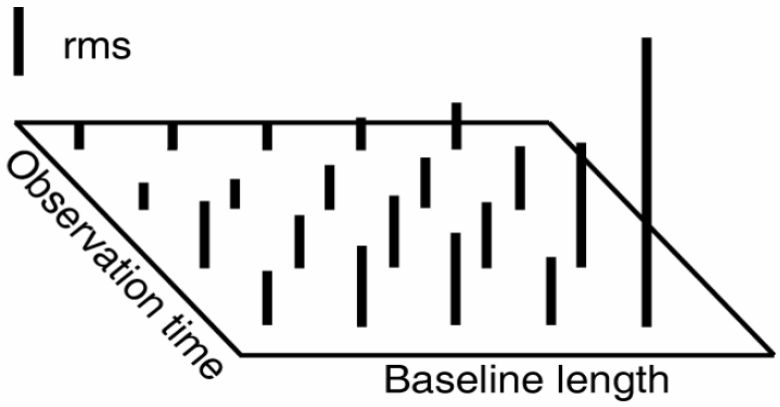
Pre-processing of data series



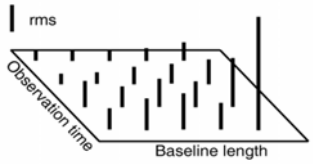
Pre-processing of data series



Tabulating the results



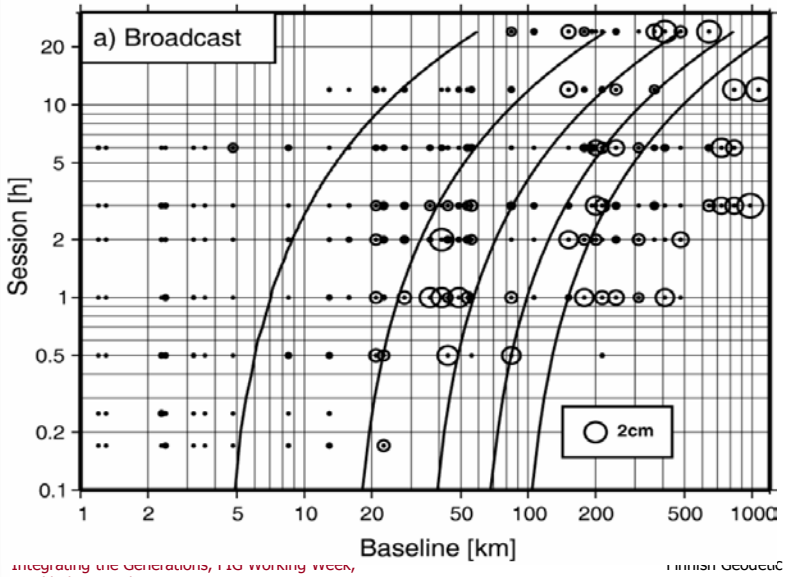
Surface Fit



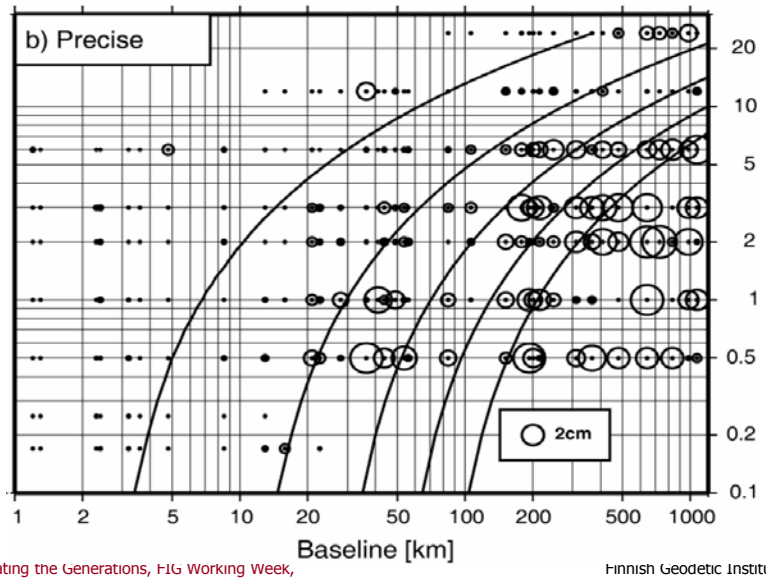
$$\log_{10}(z) = a + b \cdot \log_{10}(x) + c \cdot \sqrt{y}\,, \text{ where}$$

x baseline length [km]
y session duration [h]
z rms of accuracy [m]
a, b, c coefficients of surface fit

Fit error for broadcast orbits



Fit error for precise orbits



Statistics

Value	Broadcast	Precise
R^2 [-]	0.907	0.866
rms [mm]	8.2	10.9
rms, area [mm]	7.3	8.7
Max error [mm]	23.6	32.4
Iterations	7	4
# of grid points in fit	199	239

Results

$$x = \frac{10^{\log_{10}(z) - a - c\cdot\sqrt{y}}}{b}$$

$$y = \left[\frac{\log_{10}(z) - a - b\cdot\log_{10}(x)}{c}\right]^2$$

$$z = 10^{a + b\cdot\log_{10}(x) + c\cdot\sqrt{y}}$$

x baseline length [km]
y session duration [h]
z rms of accuracy [m]
a, b, c coefficients of surface fit

Final quideline for 3D accuracy of static GPS