Advances in correcting vertical land motion at tide gauges using GPS estimates

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Contributions from Médéric Gravelle (Université de La Rochelle)

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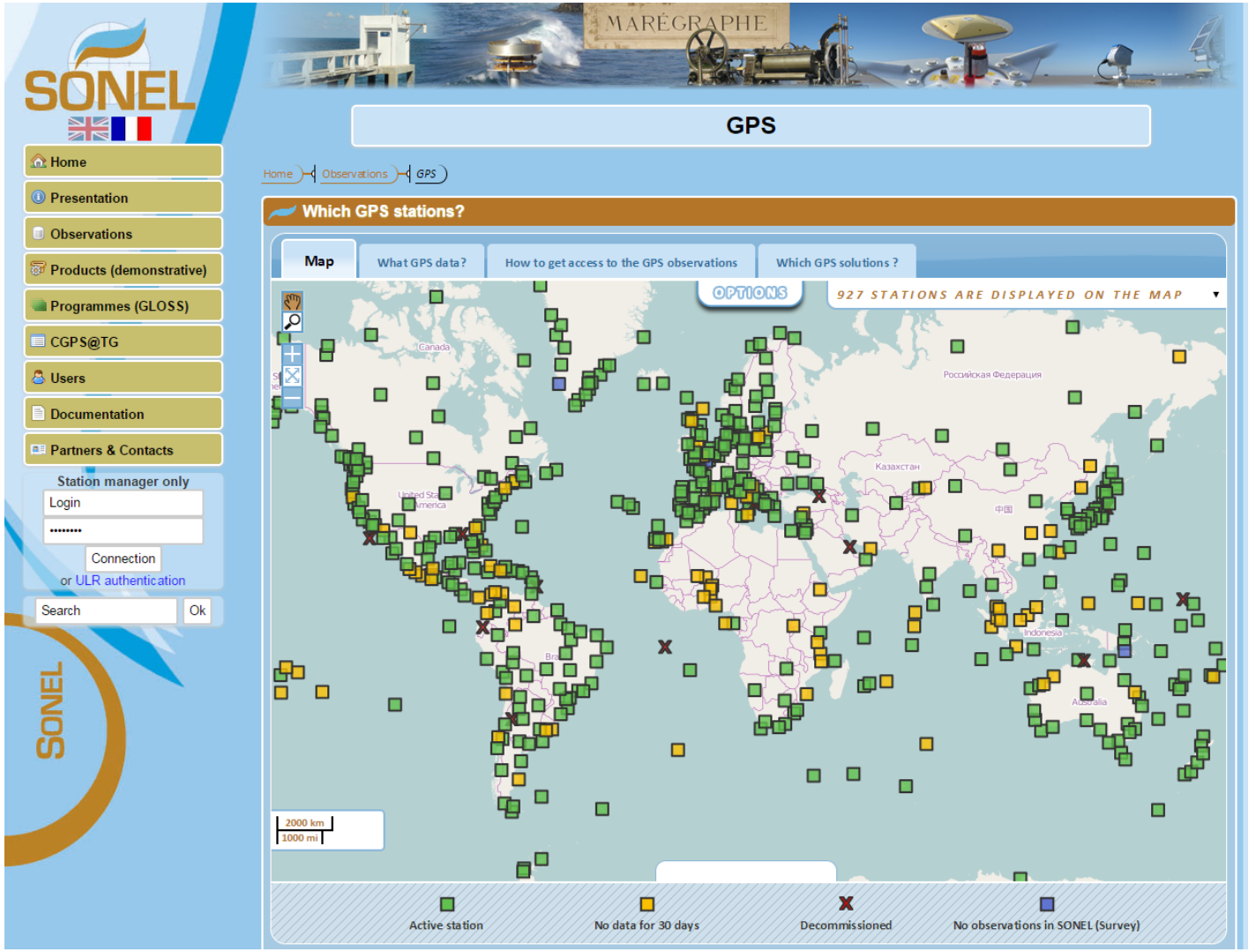
SONEL www.sonel.org



IGS INTERNATIONAL GNSS SERVICE

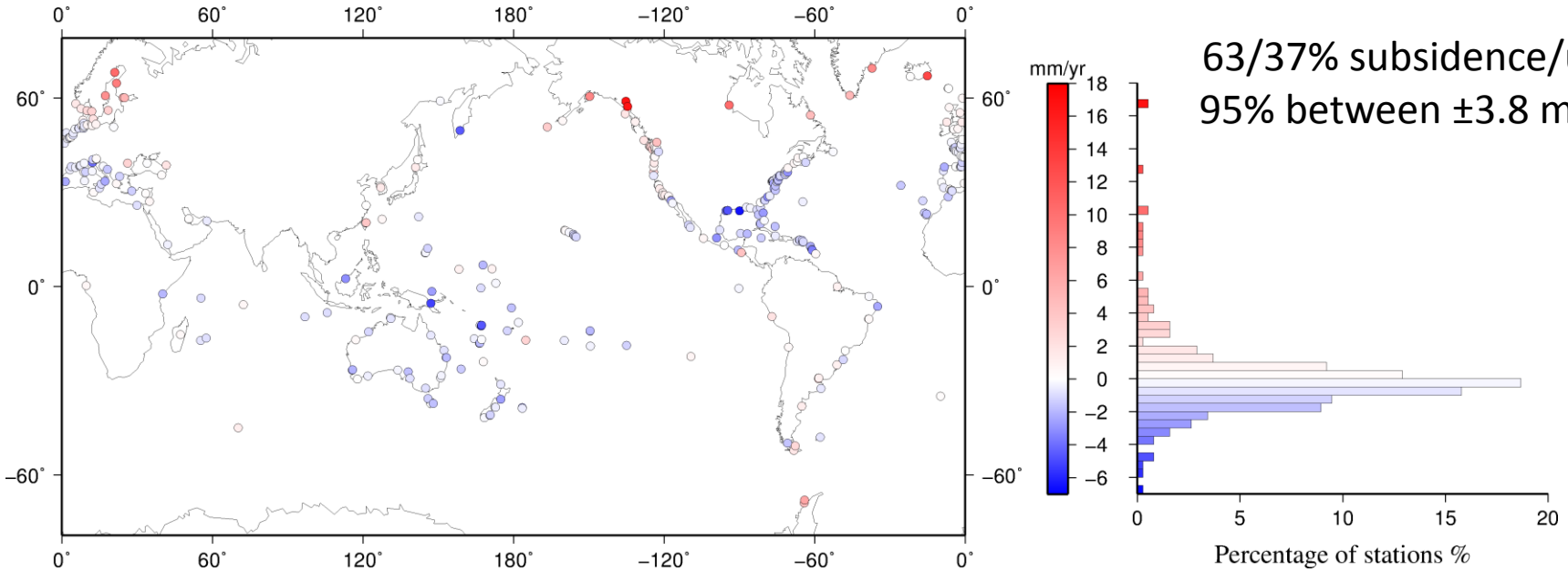
GLOSS GLOBAL SEA LEVEL OBSERVING SYSTEM

New **ULR6** to be available soon.

Largest
Longest
Best

4th ULR repro
2nd IGS repro

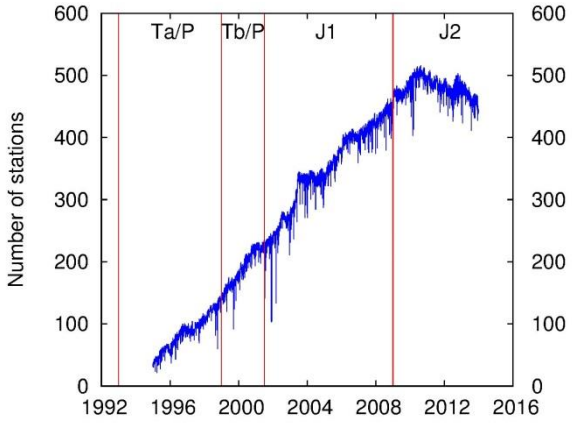
ULR6 vertical velocities in numbers



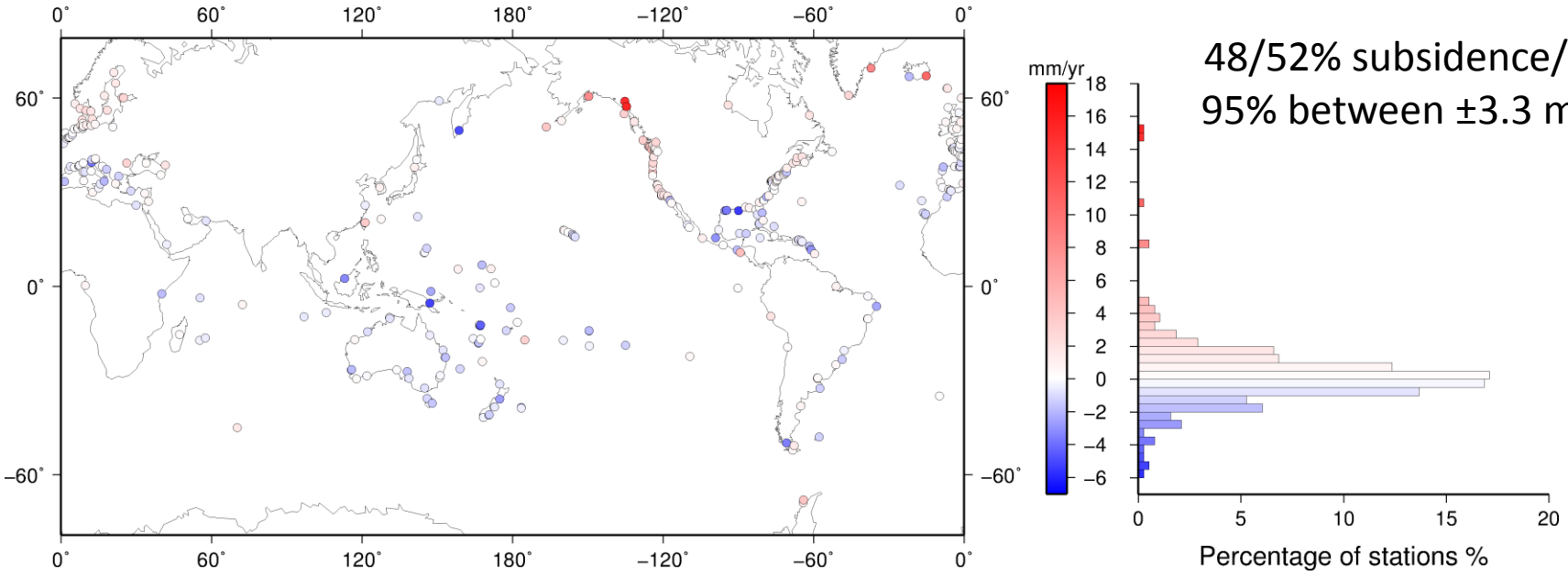
63/37% subsidence/uplift
95% between ±3.8 mm/yr

742 stations ⟨ 3 years between jumps / uncertainty < 1 mm/yr ⟩ 497 velocities

~380 close to a TG between ± 66° lat



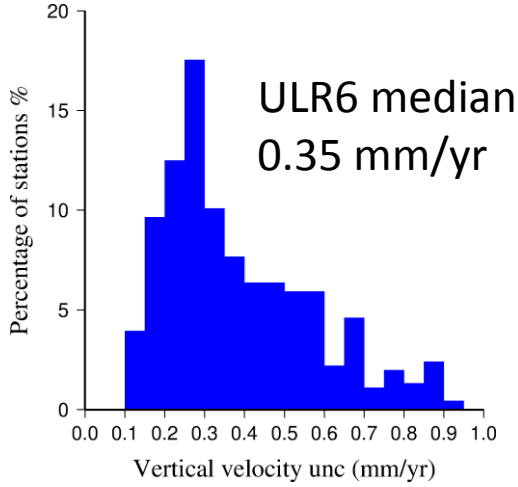
Comparison to GIA predictions



48/52% subsidence/uplift
95% between ±3.3 mm/yr

ULR6 minus ICE-6G VM5a (Peltier et al. 2015)

Median difference 0.05 mm/yr
RMS difference 1.4 mm/yr (removing outliers)
15% differences > 2 mm/yr



ULR6 median unc.
0.35 mm/yr

The «Achilles heel» of GPS vertical velocities to correct VLM at TGs

With increasing concern:

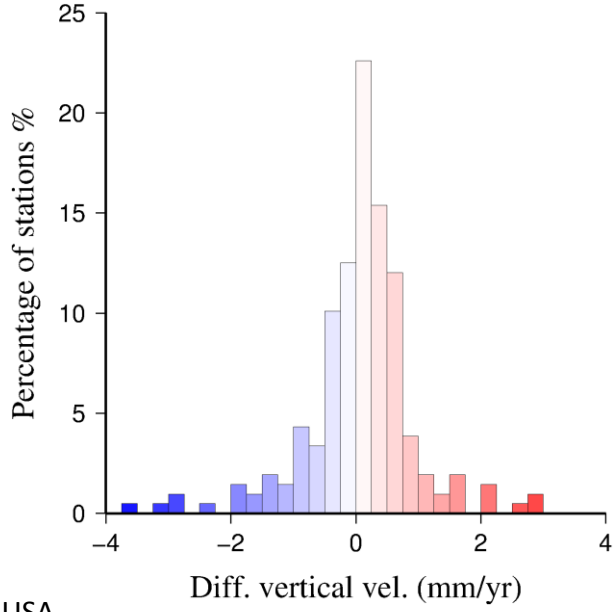
1. Reference frame stability and alignment
2. Long-period non-linear behaviour (autocorrelation)

   Interannual deformation from surface loading in 5 yr time series may bias velocities by 0.5 mm/yr globally (Santamaría-Gómez and Mémin 2015)
3. Position discontinuities (known or unknown)
4. Relative VLM wrt TG

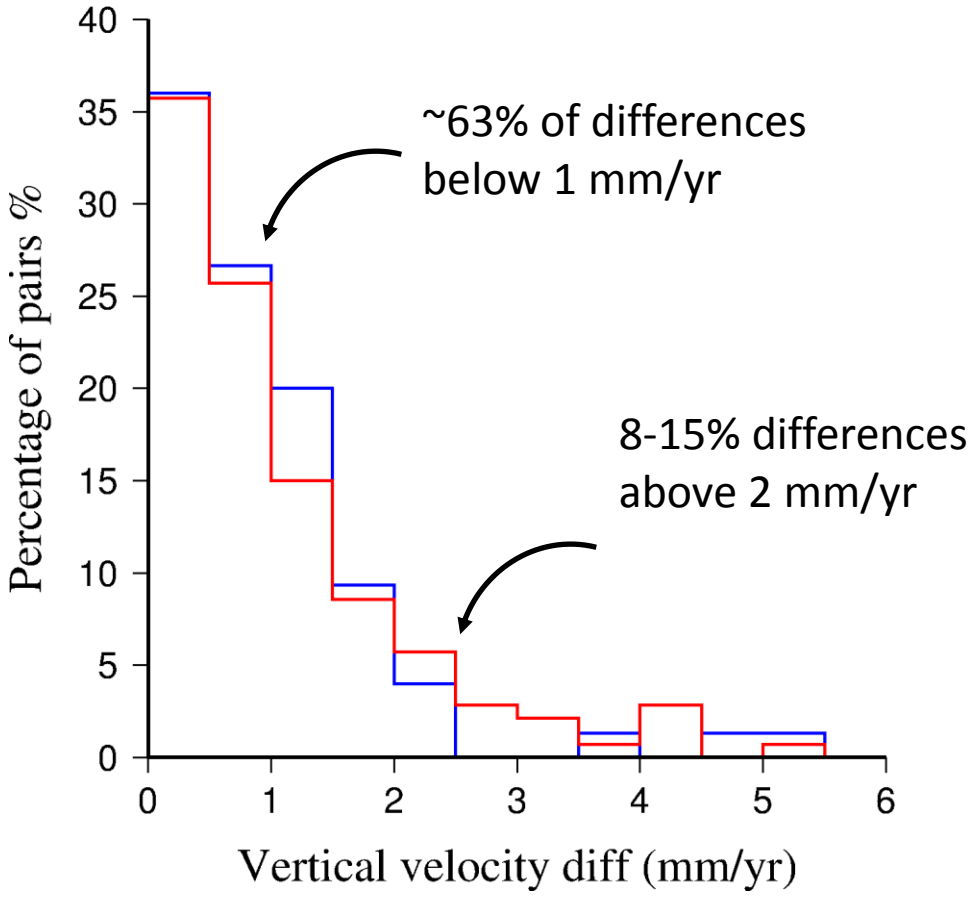
Comparison to ITRF2008

- ULR6 aligned to ITRF2008 => same frame origin, orientation and scale and their evolution
- However, individual station velocities are different (208 stations, RMS 0.8 mm/yr)
- Main reasons:
  1) not the same period (not fair comp)
  2) not the same offset number/epoch
  3) not the same offset amplitude

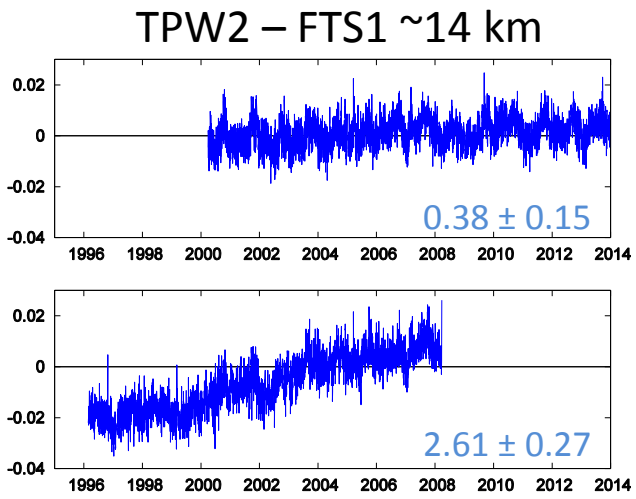
- Velocity differences between stations used in the alignment (30 stations, RMS 0.5 mm/yr)



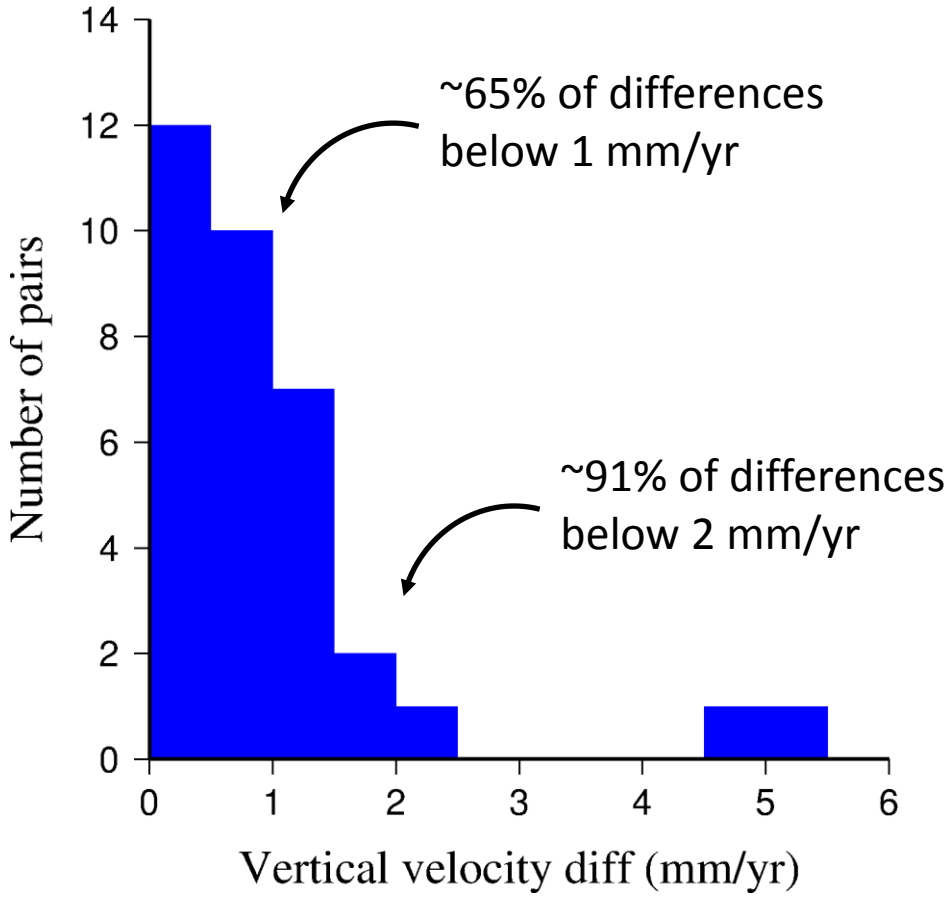
Relative VLM between GPS and TG



Histogram of vertical velocity differences between pairs of GPS stations separated up to 15 km and from 15 to 100 km: **there is almost no difference globally!** (there may be at regions with GIA gradient)



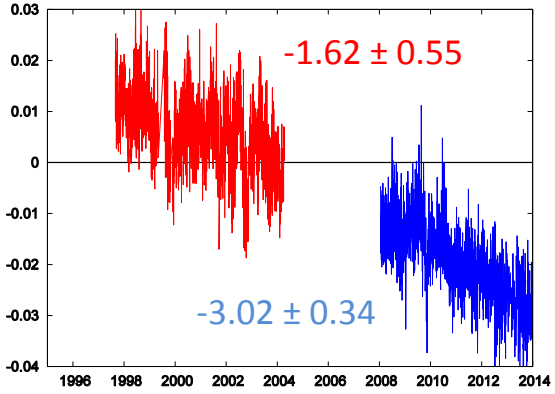
Differences between nearby (< 1 km) VLM



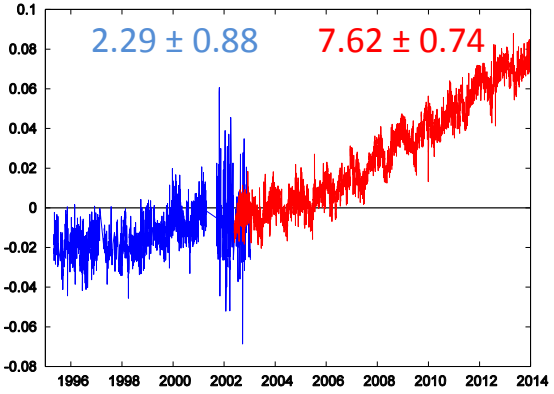
Median difference
0.7 mm/yr

Differences between nearby (< 1 km) VLM

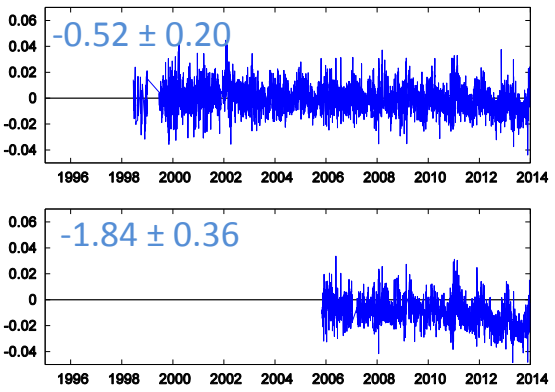
NCDU – DUCK ~54 m



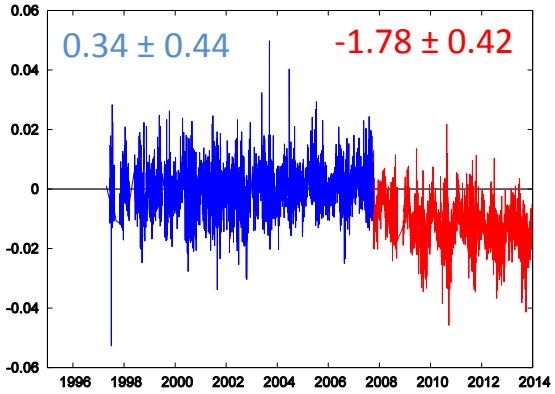
THU1 – THU3 ~1 km



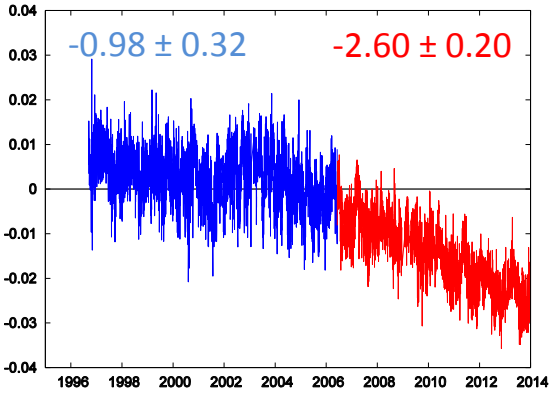
THTI – TAH2 ~282 m



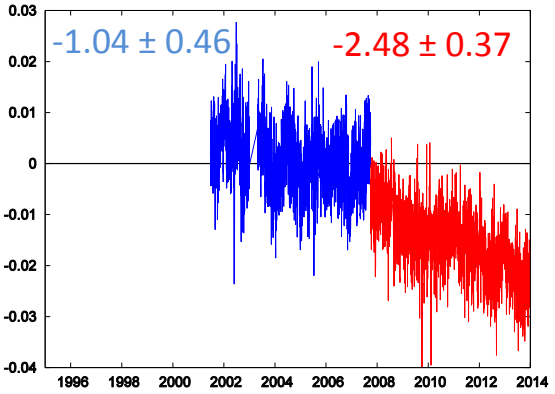
KYW1 – KYW5 ~0.2 m



FTS1 – FTS5 ~0.2 m



ANP1 – ANP5 ~0.2 m



Conclusions

GPS velocities is the best tool we have for correcting VLM at TGs.

GPS is better than GIA and GIA is better than nothing.

New ULR6 GPS velocities to be released soon (www.sonel.org). More stations, better GPS processing and longer GPS time series allow better frame alignment and mitigation of non-linear VLM.

HOWEVER, GPS velocities may be affected by systematic errors (not explained by formal uncertainties) somewhere between 0.5 – 1 mm/yr. Extreme errors > 1 mm/yr exist in a few cases. VLM repeatability (redundancy) is safer than formal unc.

Position discontinuities still a serious problem (no advances here).

IAG Joint Working Group 3.2

Vertical motion of the Earth's crust and sea-level change

Started in August 2015.

Objective: Comparison of VLM estimates at TGs used for altimeter drift calibration and long-term sea level change.

GPS, but also DORIS, gravimetry and GIA.

Steering committee:

- Alvaro Santamaría-Gómez (chair)
- Guy Wöppelmann
- Matt King
- Tonie van Dam
- Tilo Schöne

Looking for contributions!