

Accuracy assessment of the ILRS network and potential impact on ITRF scale

Graham Appleby

Jose Rodriguez

SGF Herstmonceux ILRS Analysis Centre

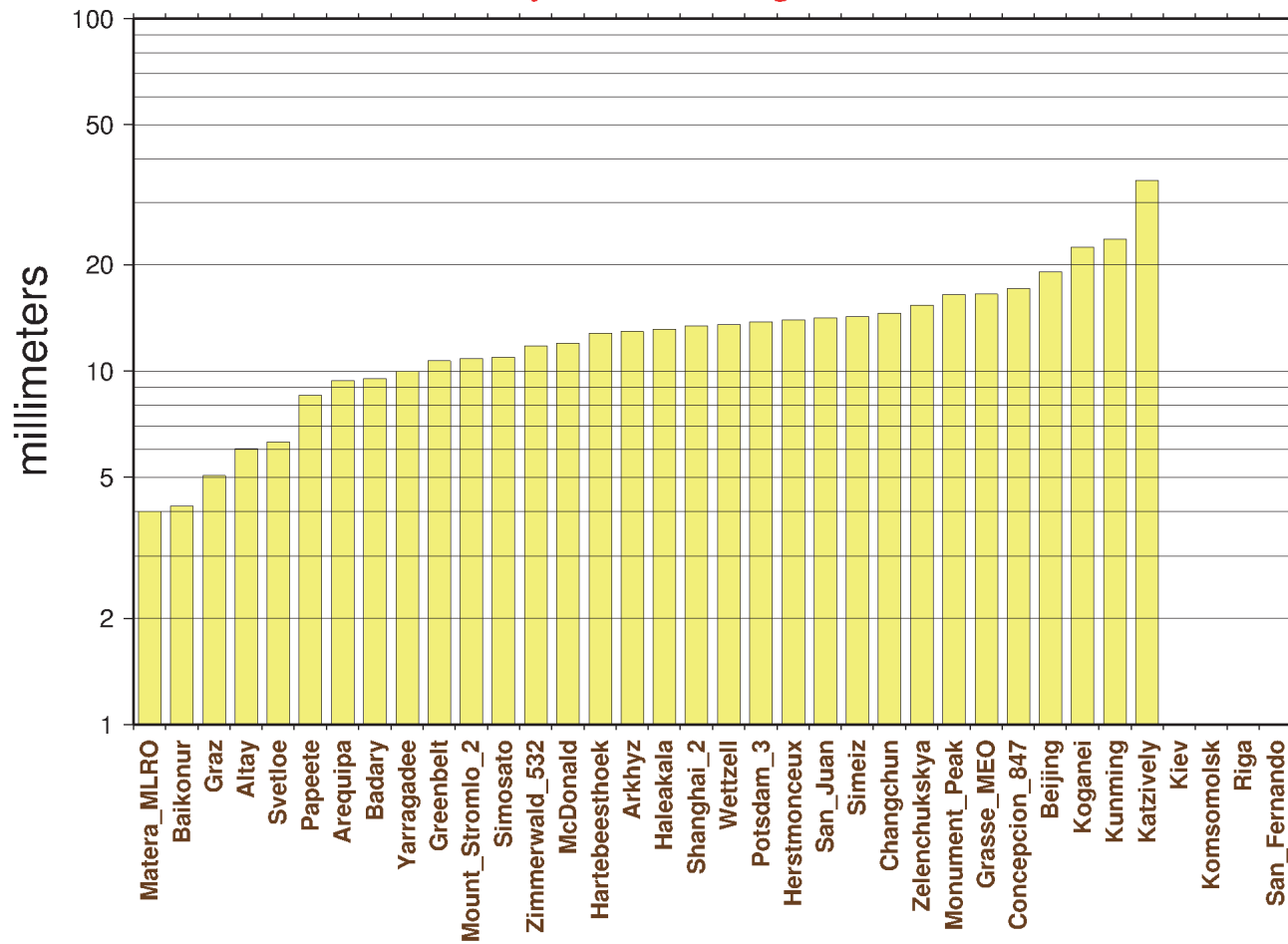


motivation

- It is relatively straightforward to assess the precision of laser range measurements from the global ILRS stations;
 - Single-shot precision of calibration board ranges;
 - Single-shot precision of LAGEOS ranging;
 - Leads to mm-precision normal point data via $\sqrt{n}$
- Daily/weekly QC also monitors change in potential bias relative to location in current ITRF

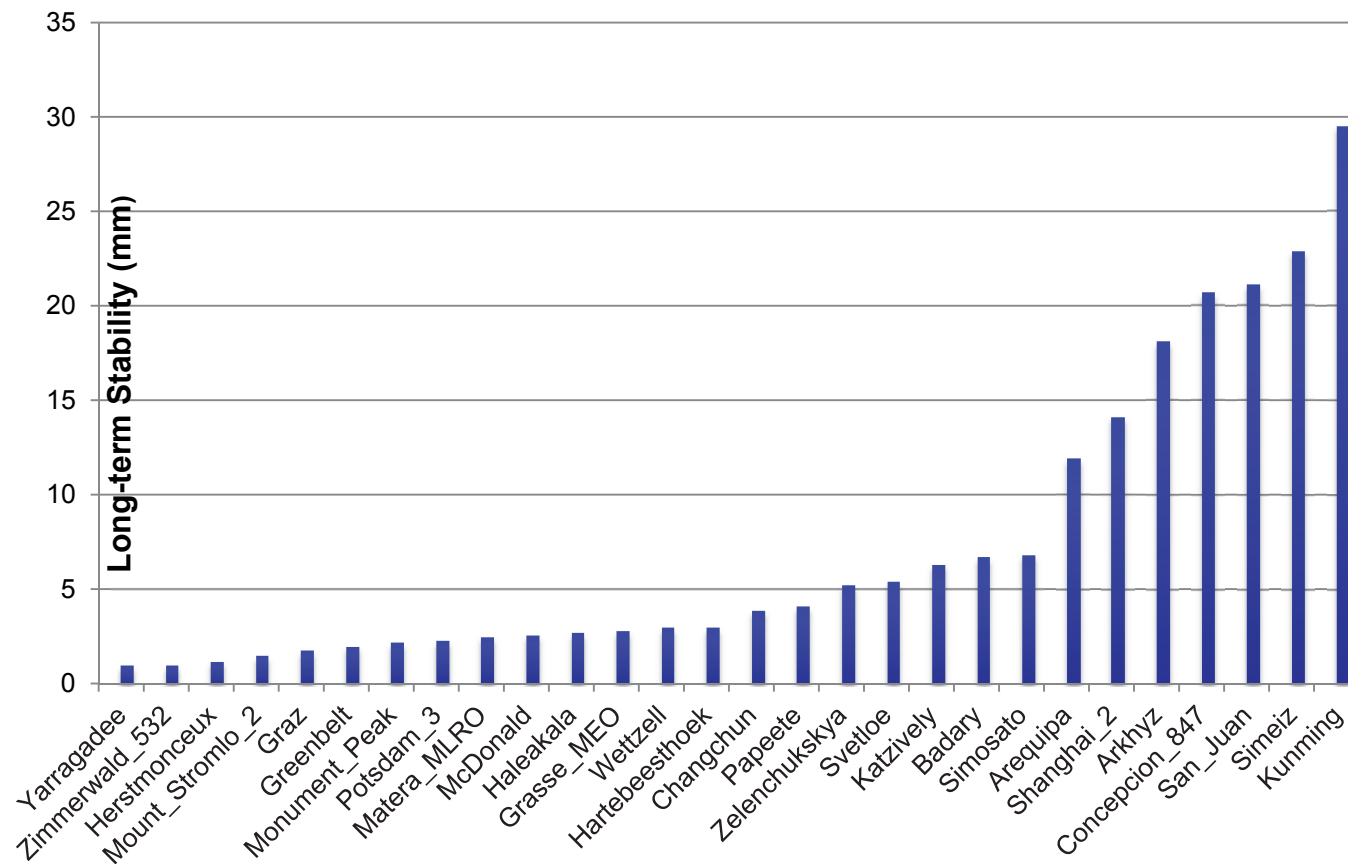
Single-shot precision on LAGEOS (ILRS)

LAGEOS RMS
from January 1, 2014 through March 31, 2014



20140402

Long Term geodetic ranging stability (mm) from ILRS AC QC orbital analysis 2013



Towards an accuracy assessment

- Following bias issues with station Herstmonceux prior to 2007;
 - Effect of non-linearity in time-of-flight counters
 - Revealed by introduction of ps-level event timer
- Considered the possibility that other prolific stations may have small bias
 - Perhaps induced by hardware (counters, signal-strength bias, calib. target distance error, etc.)
 - Perhaps induced by post-processing, such as non-perfect CoM correction for LAGEOS, Etalon

outline

- Such small bias, if not explicitly solved-for:
- Will be absorbed into station coordinates, primarily height
 - In the Zenith, height and RB partials are identical
- So later attempts to monitor RB will be *relative* only to that already absorbed in ITRF
- Can we solve for RB for all stations simultaneously with orbits and TRF?
- Will the TRF scale be changed?

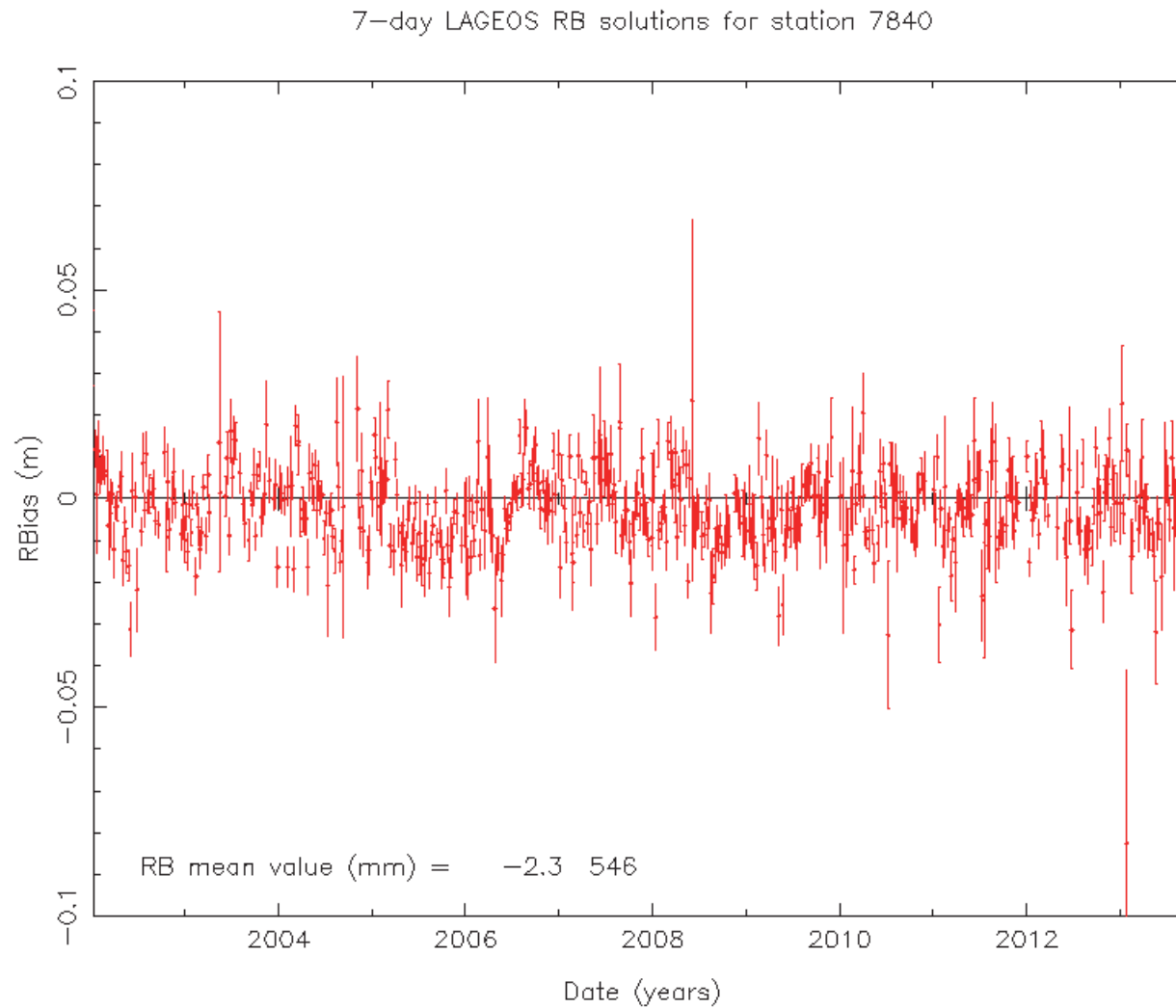
Bias Issues

- Work carried out for AGU 2012 presentation and IERS ‘systematics workshop’, 2013:
- Solved for weekly RB for many of the major sites simultaneously with the TRF solutions:
- Some large biases for the ‘known bias’ stations
- But also few-mm bias for the stations whose RB are not usually solved
 - E.g. YARR (7090), Graz (7839), HERL (7840)
- **Based on this preliminary work, decided:**

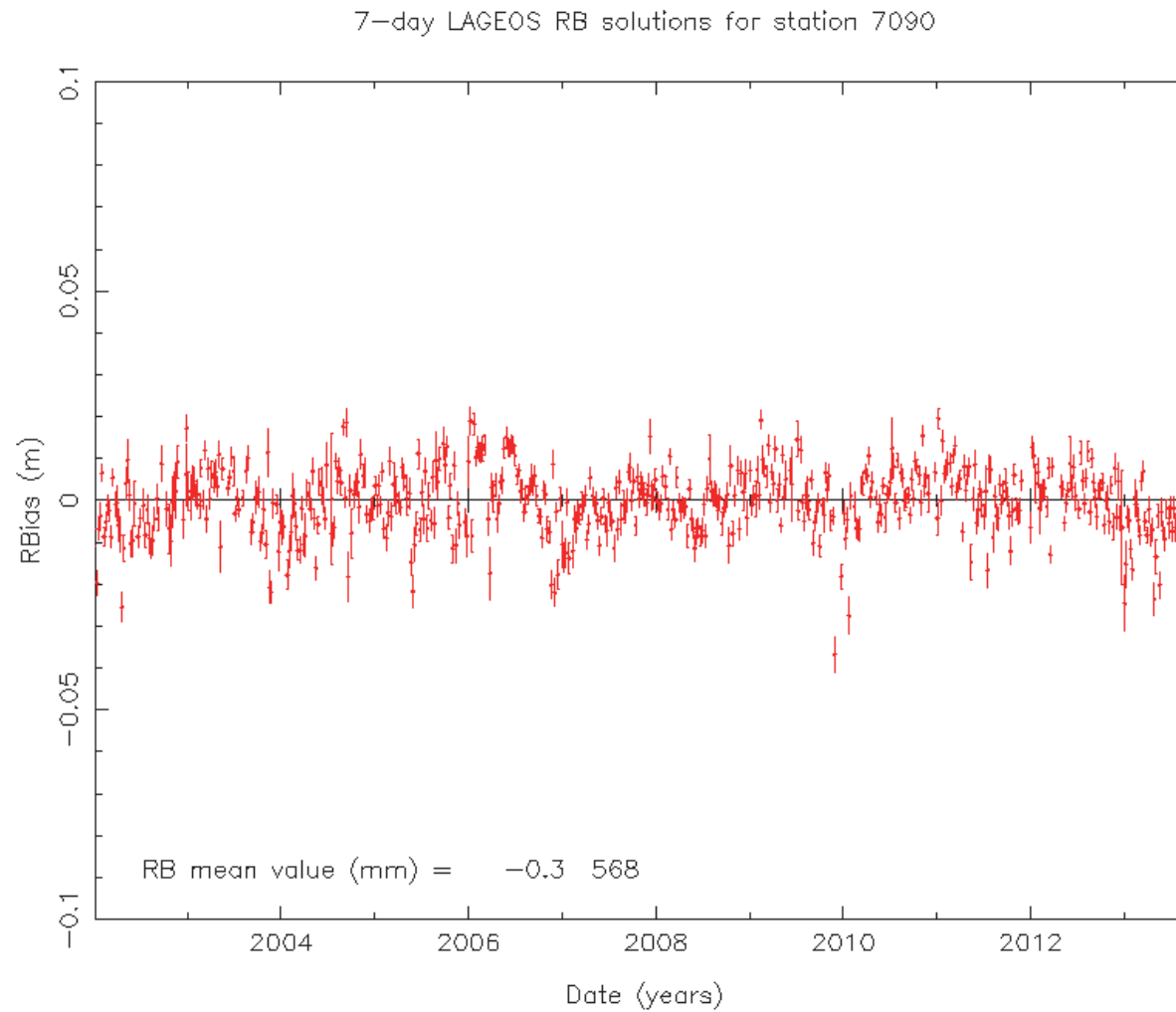
Bias Issues

- Carry out full reference frame solutions using weekly LAGEOS and LAGEOS-2 arcs
- Solved for station coordinates, orbits, EOPs and L1+L2 **combined** range bias for ALL stations (v50 SINEXs)
- For comparison, as above but RB only for the AWG-approved stations (v55 SINEX)
- Weekly solutions for 2002-2013.9
 - Applied CoM from tables plus data corrections from ILRS handling file

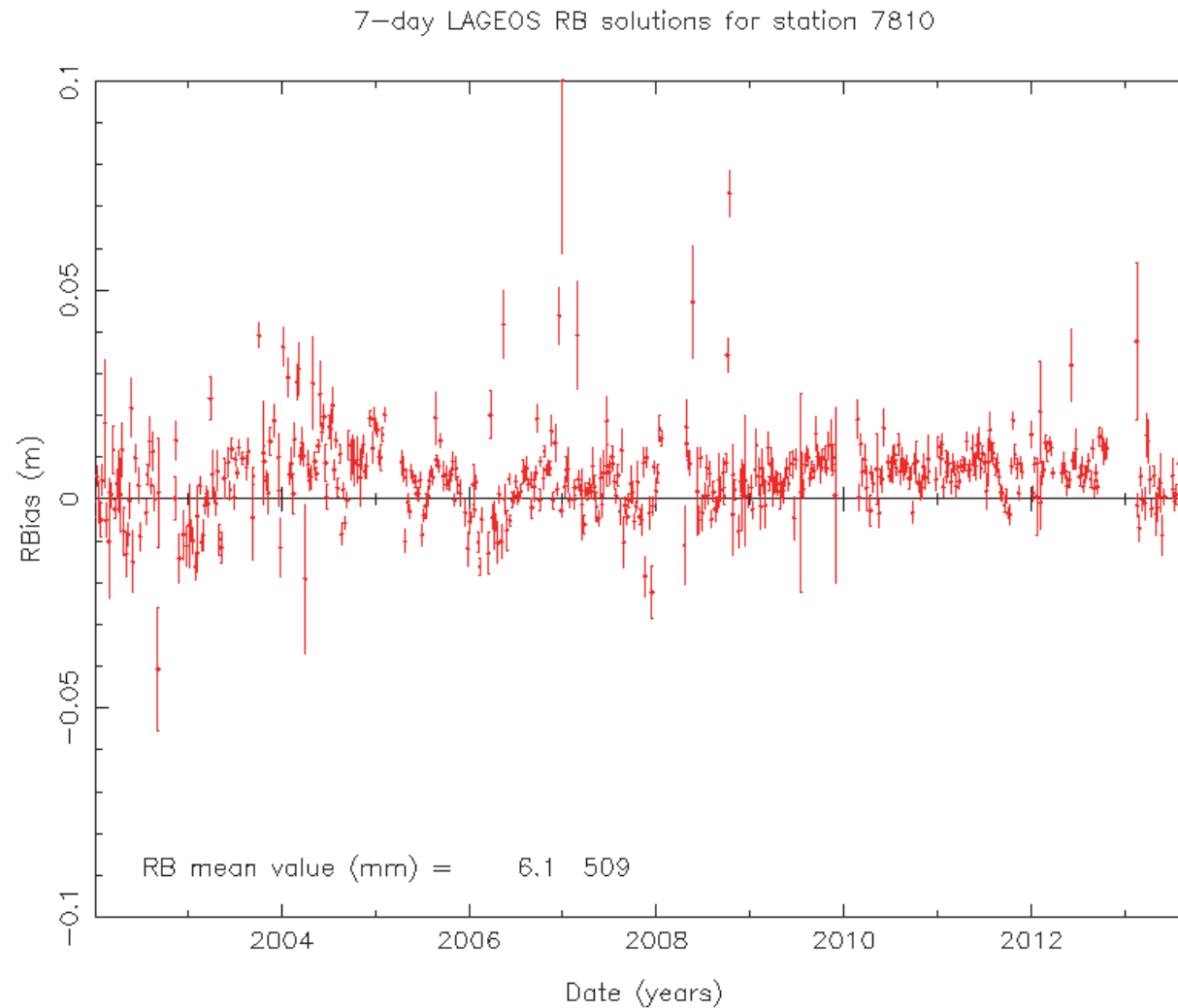
Some RB time series



Some RB time series



Some RB time series

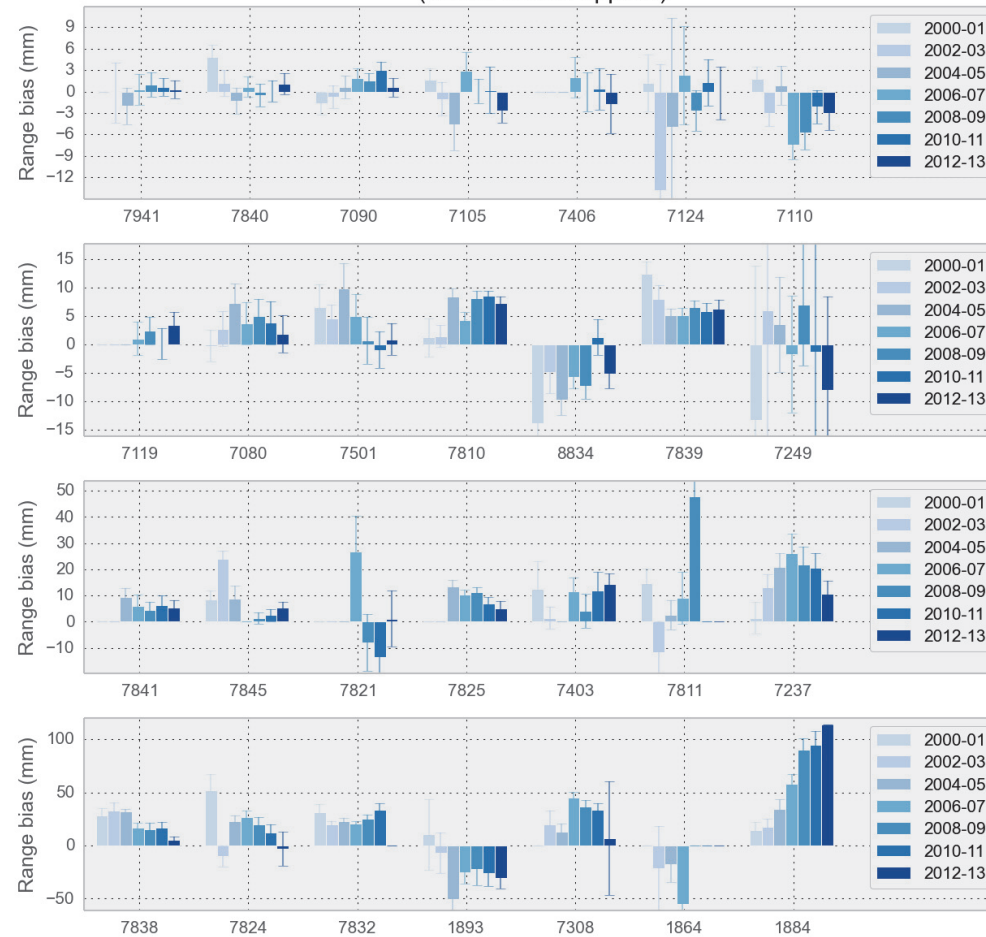


Results: Statistics 2002-2013.9

Note: RB from the ILRS 'data handling' file have been applied a-priori

Two-year RB averages of most productive ILRS stations 2000-2013

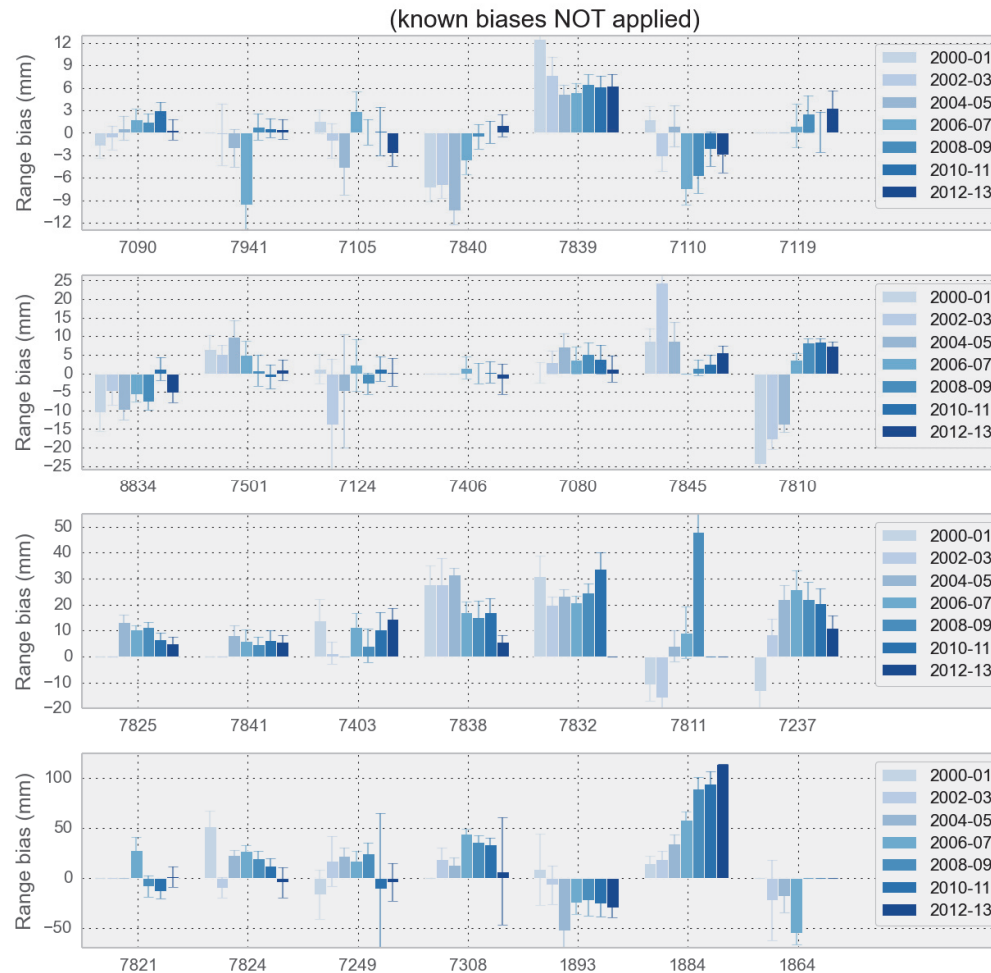
(known biases applied)



Results: Statistics 2002-2013.9

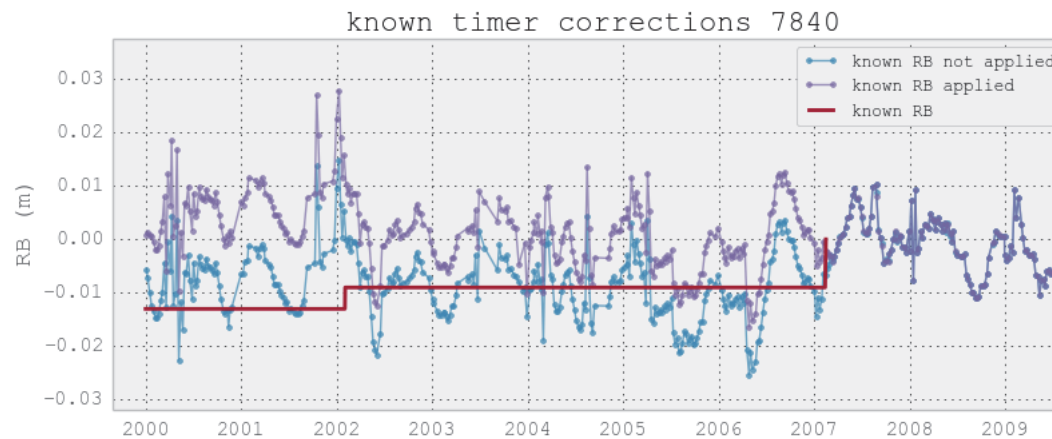
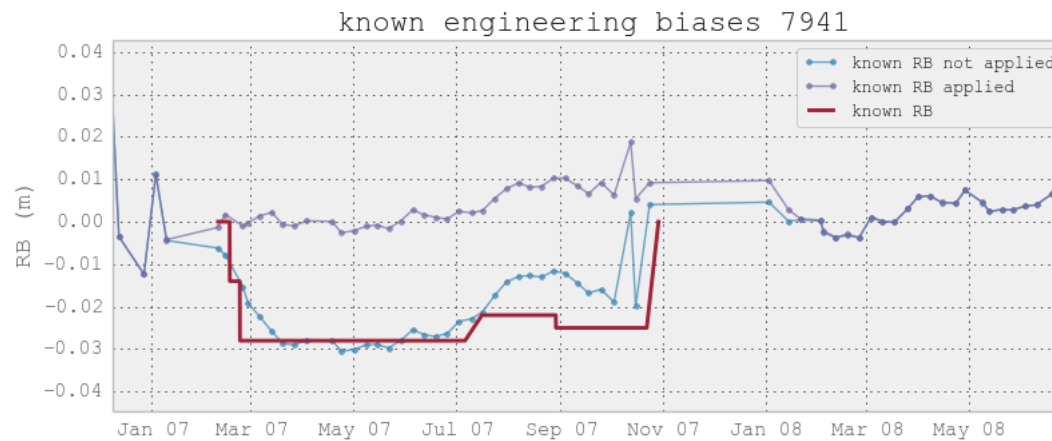
Note: RB from the ILRS 'data handling' file **have NOT** been applied a-priori

Two-year RB averages of most productive ILRS stations 2000-2013



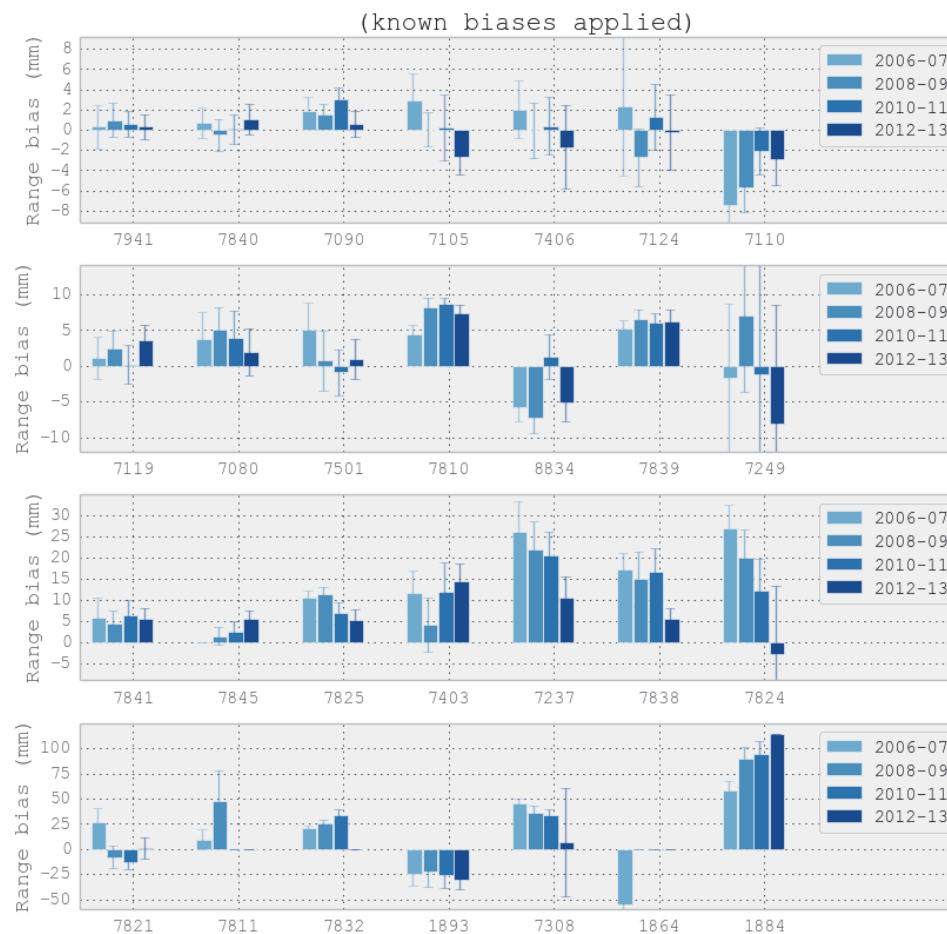
Comparison of solved-for RB with that in data handling file ('known') – two examples

RB estimation correctly identifying known biases



Recent years full RB and frame solutions - impressive accuracy for top two tiers

Two-year RB averages of most productive ILRS stations 2006-2013

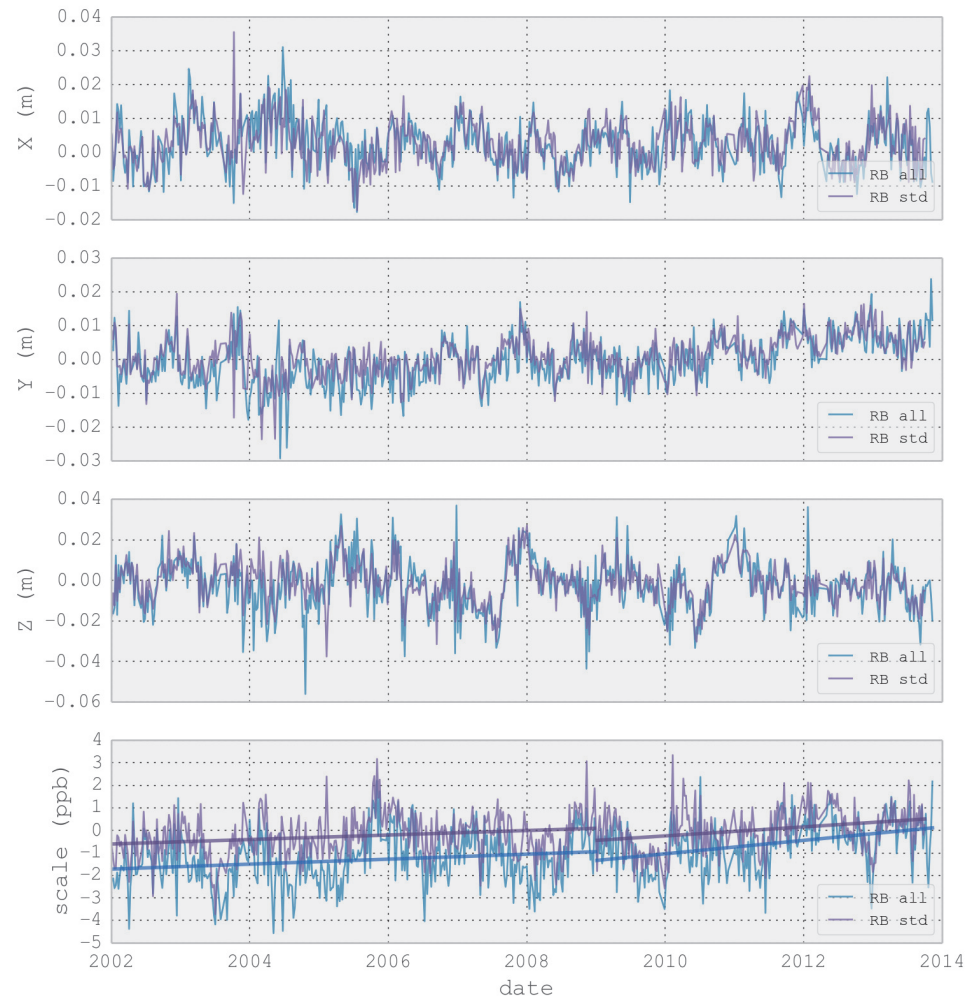


Comparison of weekly solutions with SLRF2008

- Both the 'standard' (limited RB, v55) and 'experimental' (all-RB, v50) solutions have been compared to SLRF2008
- Helmert 7-parameter solutions for translation, scale (and rotations)
- O-C is (SLRF2008 – SGF v50/55 solutions)
- Time series of translation and scale are plotted:

Helmert solutions w.r.t. ITRF2008

Helmert parameters ITRF2008 - SLR



**TRF scale change
implied by
solving for all RB is ~
1ppb**

Preliminary outcome/suggestions

- Scale: Changing the processing to include RB estimation **for all** stations:
 - Scale change by -0.90 ppb for 2002-2009.0
 - Implies ITRF2008 scale **too small** by 0.90ppb
 - **Sense and magnitude** of this correction independently confirmed from SGF SINEXs (Altamimi, personal communication, 2014)
 - ITRF2008 (Altamimi): SLR scale 0.6ppb **smaller** than VLBI

Preliminary outcome/suggestions

- Scale slope same for both solutions -
 - Different scale and slopes for 2009-2013, **beyond the data period** that contributed to ITRF2008
- Translations (geocentre): not a major increase in noise for the all-bias solutions
- Next steps – increase stations for which RB should be solved operationally?
 - As suggested as an ILRS pilot project
- Rationalise the issues at station level
- Solve for a ‘consistent’ GM – need multi-sat, with sat-specific RB