Attempts to separate apparent observational range bias from true geodetic signals

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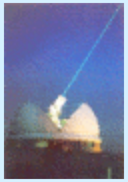
Background

- Using laser, GPS and absolute gravity data for long-term monitoring of Herstmonceux site;
- Analysis of global laser range data to LAGEOS, ETALON
- Use of and analysis of GPS networks that include HERS and HERT
- Operation and analysis of absolute gravity data
  - to include collaborations to look into local geology and hydrological loading effects on gravity.



Motivation

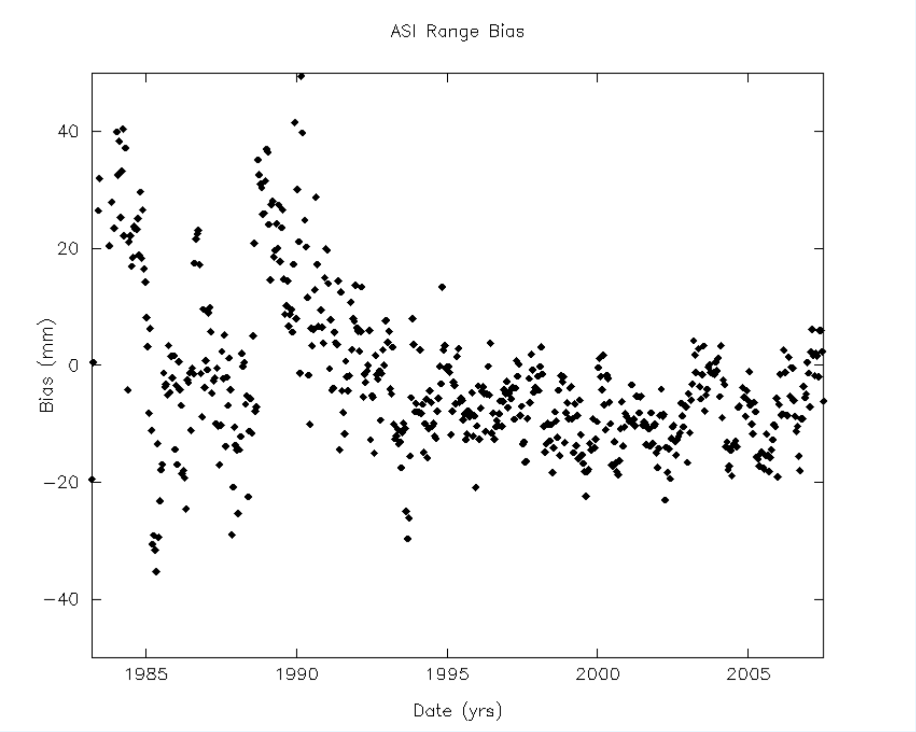
- Long time span of accurate laser range observations is key to definition of ITRF
- Within ILRS Analysis Working Group, ongoing programme of re-analysis of LAGEOS data from 1983-date
- To include generation of range-bias time series
  - Can reveal possible engineering problems

Motivation

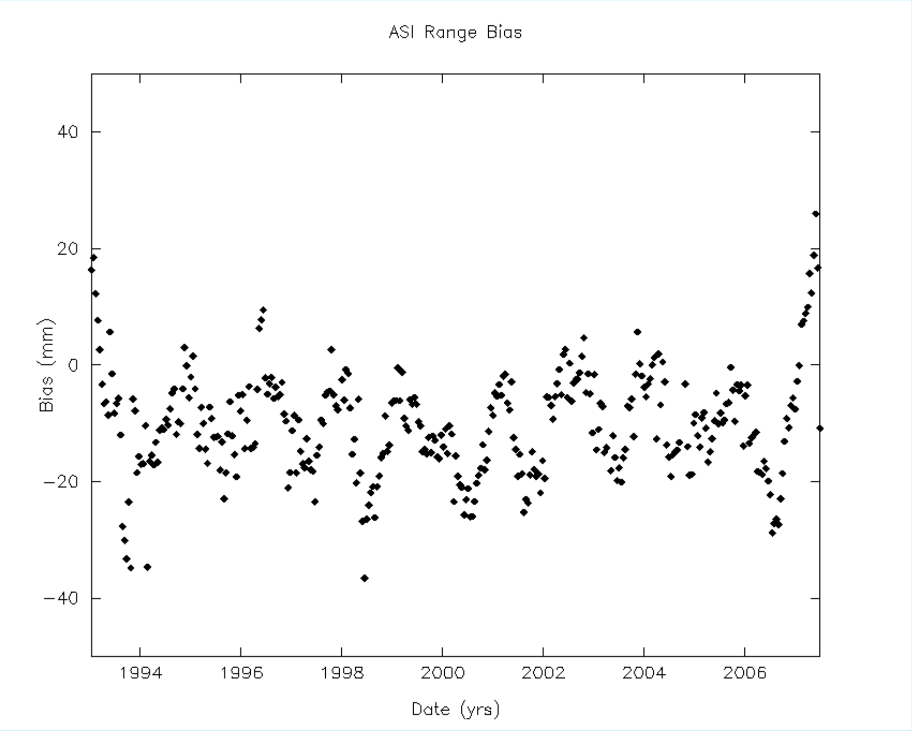
- High correlation of course between station height and range bias
  - Depends upon minimum ranging elevation

- Thus potential danger of attributing real height change to system problems
- Ideal is to have good on-site QC and not allow system changes to affect range accuracy
  - plus orbital QC – see e.g.new **http://sgf.rgo.ac.uk**
- However, recent email exchanges suggest some Herstmonceux range accuracy issues are emerging.

Range bias solutions (CGS) for Herstmonceux

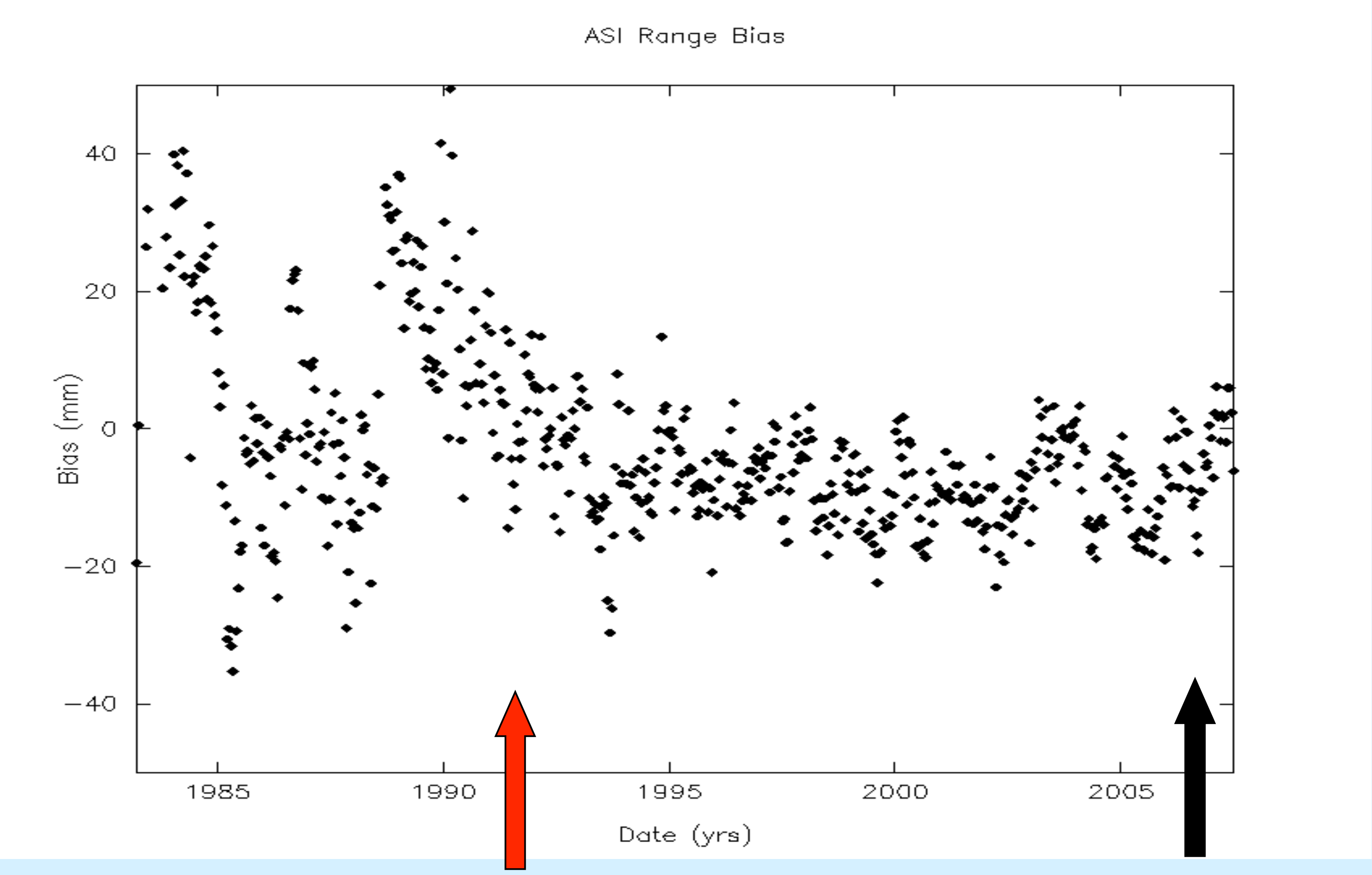


LAGEOS



LAGEOS-2

LAGEOS



End Maryland event timer era

End Stanford counter era

RB time series

- Maryland counter era (1983-1990):
  - mostly un-removable 0->~20mm variable bias;
    - Appleby et al, 1990
  - RB values estimated recently in consistent way during POD by Luceri, 2007
    - As time series of corrections: on ILRS website
- Stanford counters era (1992-2007)
  - Clear ‘real’ seasonal signal, real height changes
    - But engineering tests at Herstmonceux also reveal ~8mm potential bias depending on targets’ ranges;
      - Gibbs et al, 2006, 2007

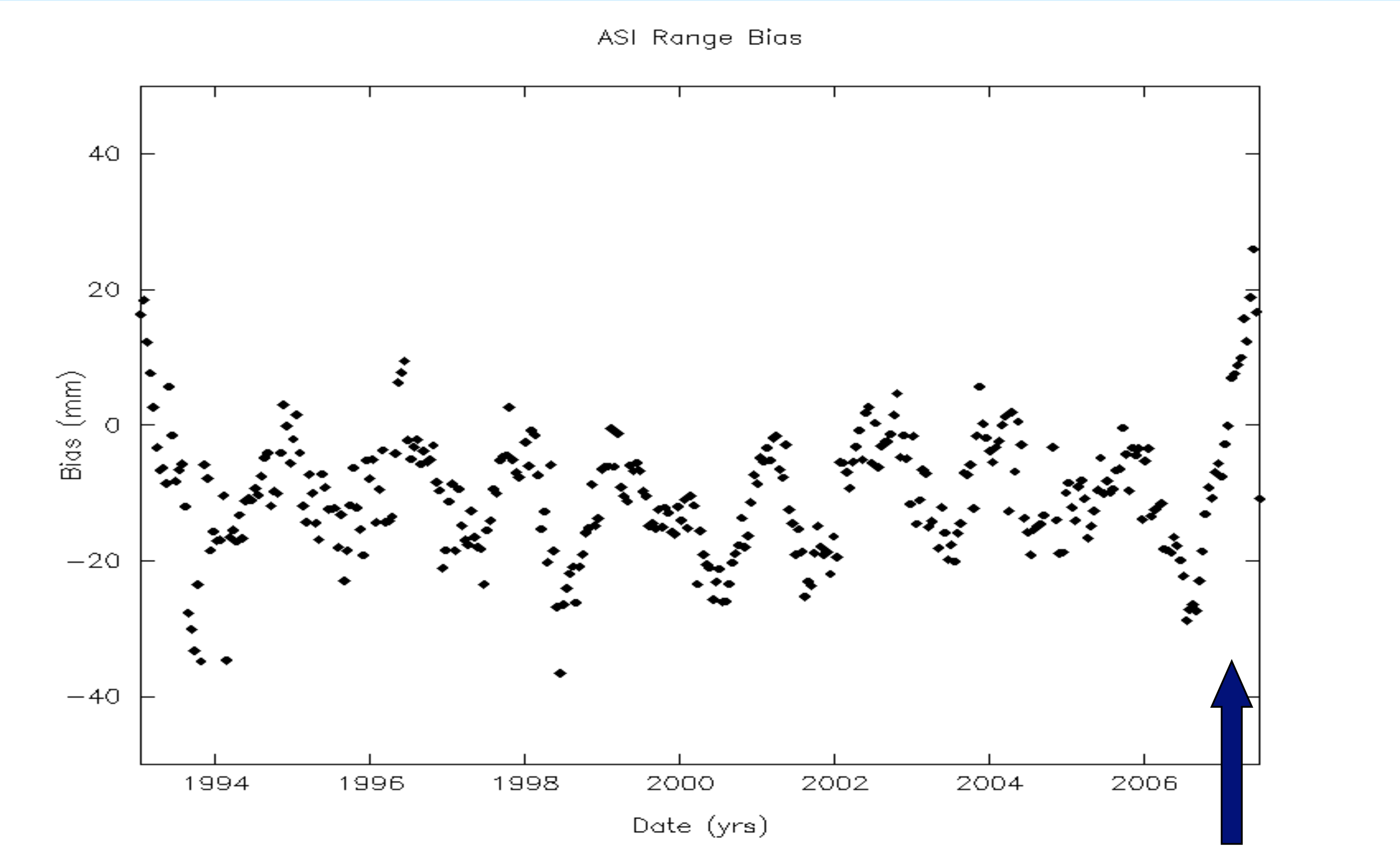
Tests and estimates on Stanford counters

- From tests or estimates, following table constructed via comparison with high-spec event timer.
- Computed for LEO-MEO
- Test results in **bold**
- Re-iterate the uncertainty in this approach
  - High-frequency, several mm, variations present
  - Not possible to do an exact ‘calibration’
  - Uncertainty may be as much as 3mm
  - **But invitation remains for stations to send us their counters for rapid (<1 day) checks**

STATION NAME		PAD ID	Calib error	LEO error	LAGEOS error	GPS error
BEIL	Beijing	7249	-12	- 2	- 2	- 3
BORL	**Borowiec**	**7811**	**- 9**	**- 9**	**- 9**	**0**
BREF	Brest	7604	-10	0	0	- 1
GLSV	Kiev	1824	- 6	+ 4	+ 4	+ 3
HELW	Helwan	7831	0	+10	+10	+ 9
HERL	**Herstmon.**	**7840**	**- 7**	**- 7**	**- 7**	**- 7**
KTZL	Katzively, Ukraine	1893	0	+10	+10	+ 9
KUNL	Kunming, China	7820	- 9	+ 1	+ 1	0
POT3	**Potsdam**	**7841**	**0**	**+ 5**	**+ 5**	**+ 5**
POTL	Potsdam	7836	0	+ 3	+ 3	+ 3
SFEL	**San Fernando**	**7824**	**0**	**+ 8**	**+ 8**	**+ 8**
SISL	Simosato, Japan	7838	+ 1	+11	+11	+10
SJUL	San Juan	7406	0	+10	+10	+ 9
WUHL	Wuhan	7231	0	+10	+10	+ 9
ZIML	**Zimmerwald**	**7810**	**- 3**	**- 3**	**- 3**	**- 3**
GRSL	Grasse	7835	- 1	+ 9	+ 9	+ 8

Range correction (mm) table for stations using Stanford counters;
Stations in **bold** have had counters measured at SGF; others are estimates
NB: all values subject to error of 3mm.

LAGEOS-2

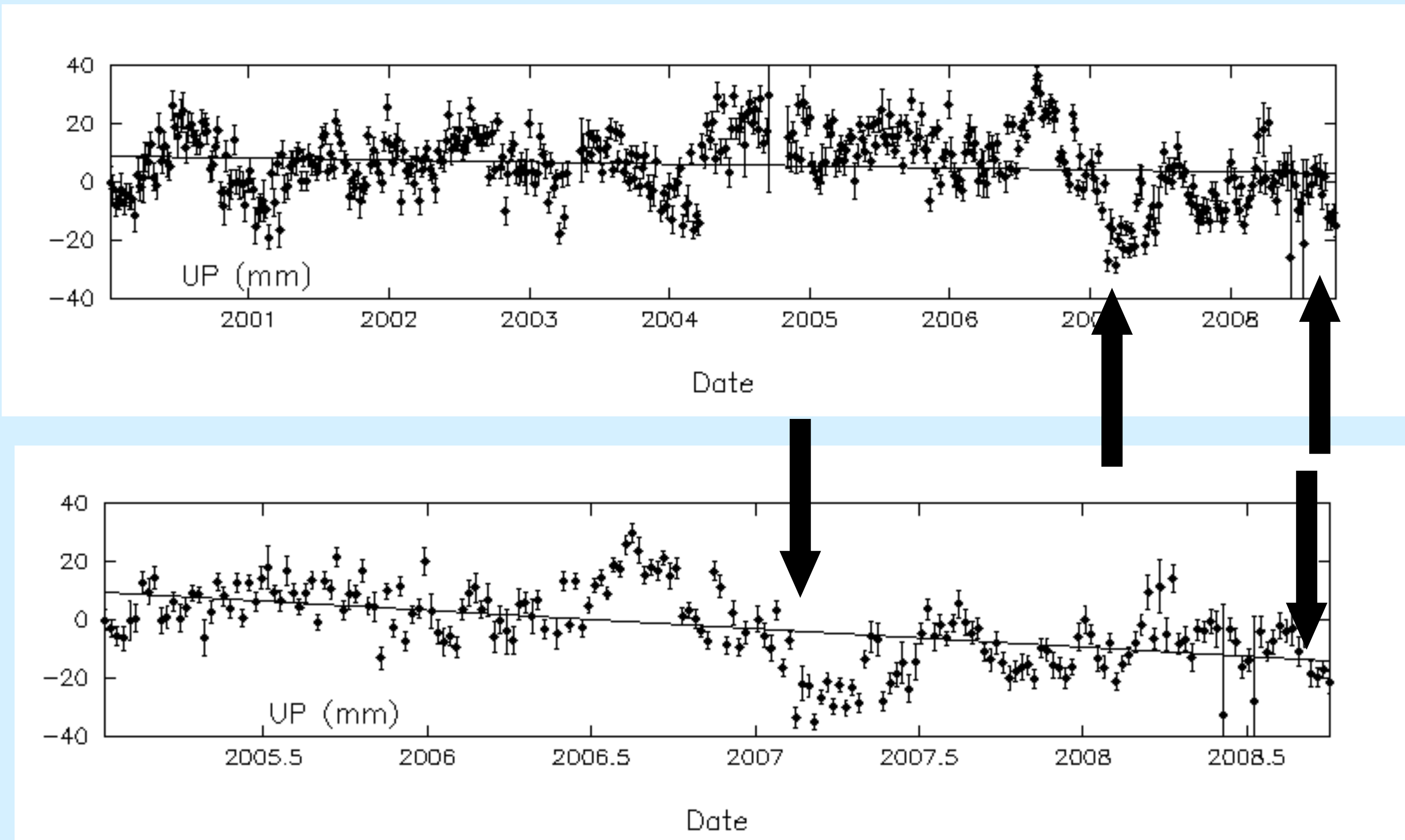


Stanford counter era **Start Thales event timer era**

High-quality event timer

- Based on high-spec Thales units, ps-level linearity
- Introduced 2007 Feb 11 (doy 41)
- From that date, system should be bias-free at mm-level
- However, ‘jump’ in LAGEOS-2 RB series starts 2007 ~ doy 21 and again 2008 ~ doy 245 ?

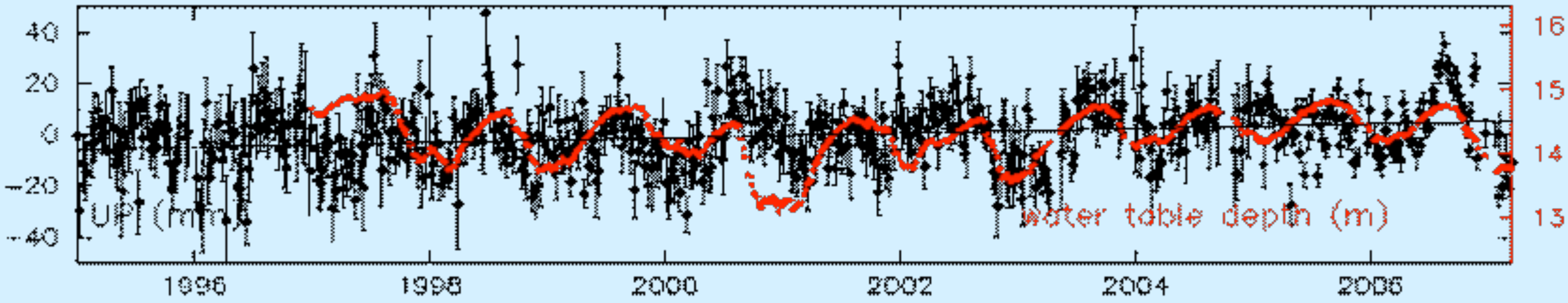
Height time series for Herstmonceux from LAGEOS and ETALON (SGF and ASI solutions)



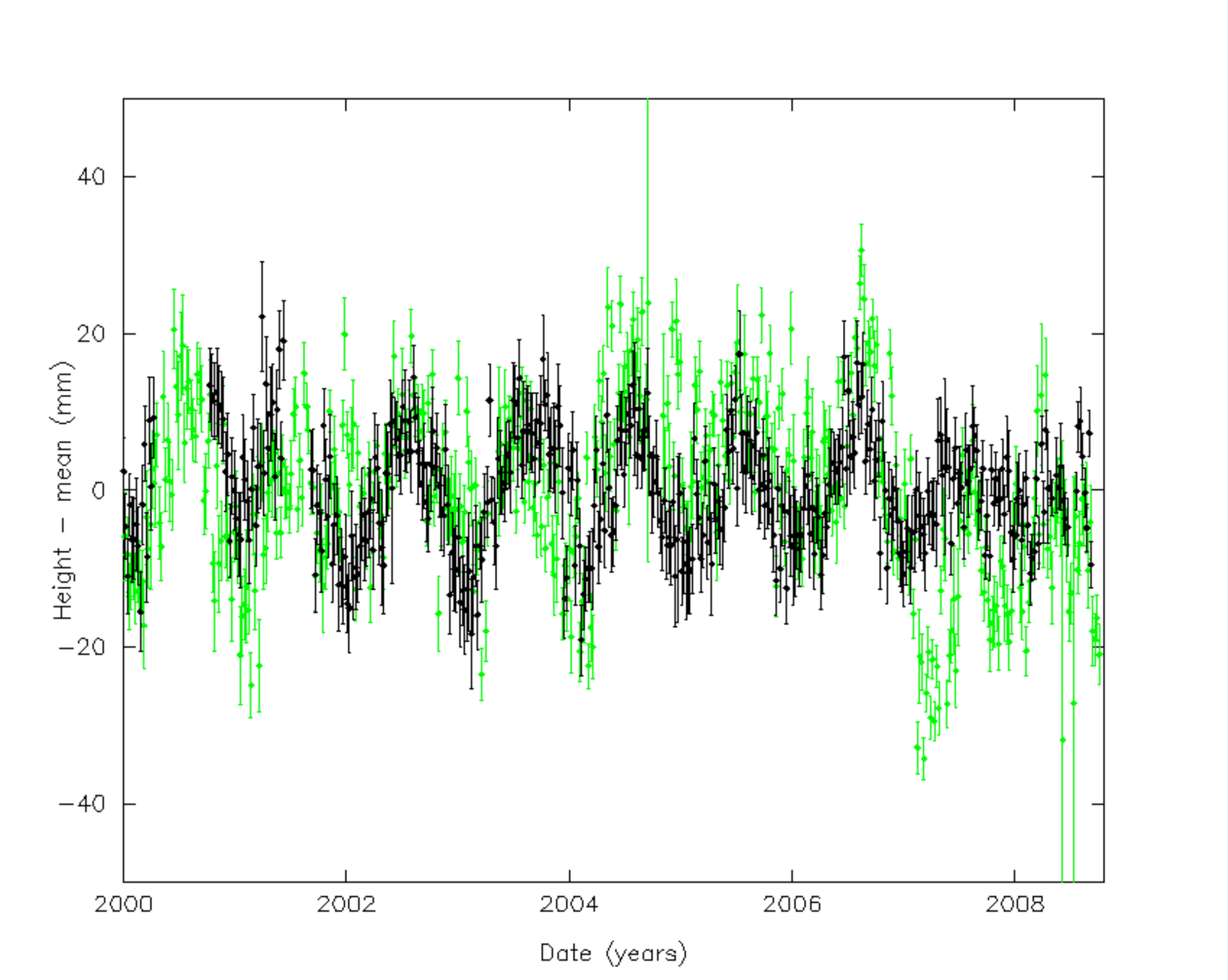
arrows mark RB 'jumps' dates

RB or local deformation?

- From this height series, it was not immediately apparent that there is a 2007 ‘jump’, RB problem.
- Previously-observed correlation between seasonal water-table level and height – loading or soil moisture driven:

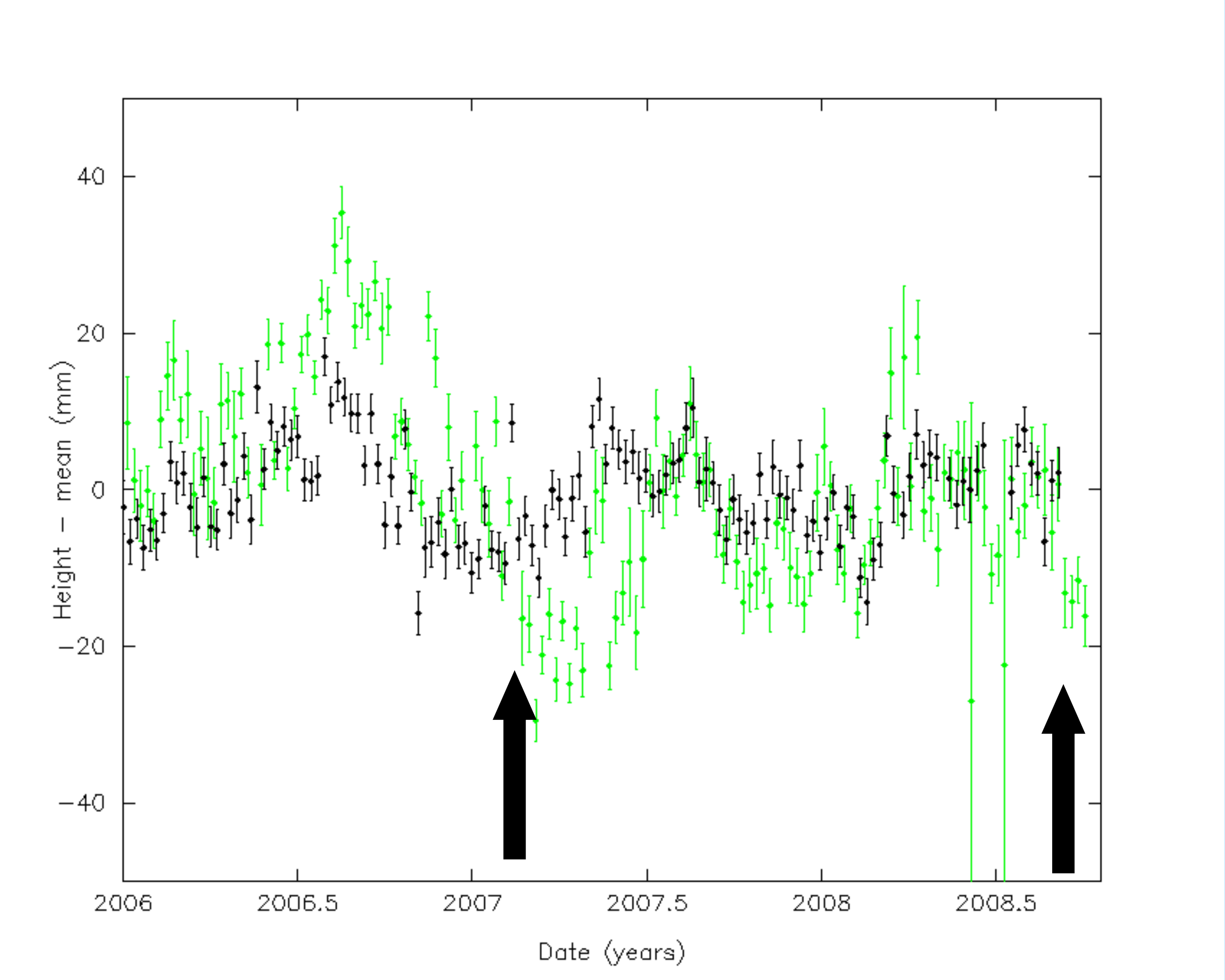


Comparison with HERS GPS system, close to laser ranger



Laser series (green), GPS (SOPAC, black)

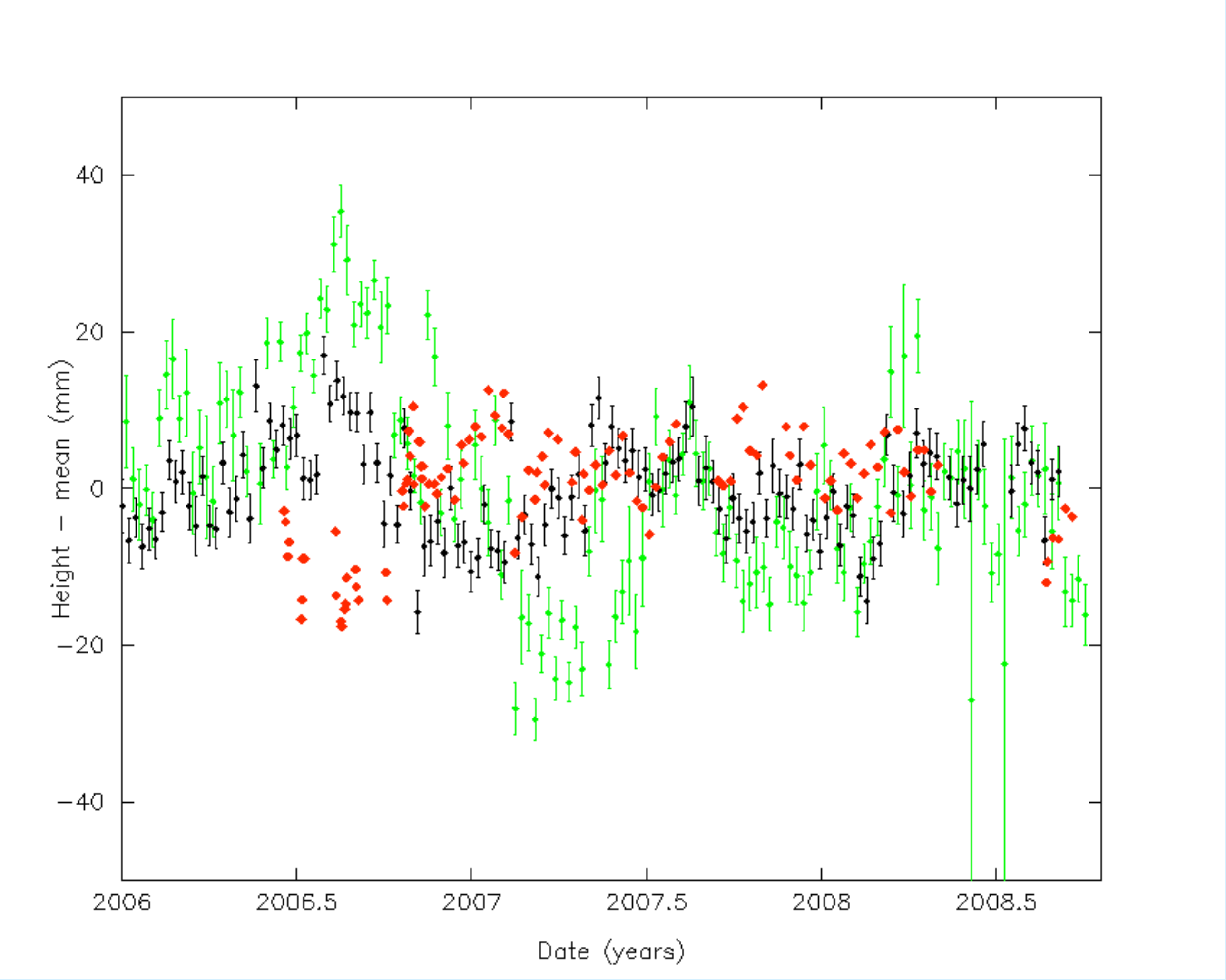
In close-up, from 2006 to date



Addition of absolute gravity measurements

- From early 2006, an FG5 absolute gravimeter has been operated on site
- From late 2006, weekly, 24-hour observing sessions
- Average gravity variations converted to equivalent height changes using estimated 1μGal = - 4.5mm (following Zerbini *et al*, 2007)
  - conversion to be refined in future, to consider loading mechanisms
- Precision of average values ~4mm

Laser (green), GPS (SOPAC, black) and height-from-gravity (red)



Conclusion

- This work suggests that there is a problem with Herstmonceux laser data
  - 2007.1 -> 2007.4 and 2008.7->
  - Confirmed by several laser analysts of LEO and LAGEOS missions
- Shows value of multi-techniques closely co-located
- Urgent review underway at SGF