GRACE 2003 analysis campaign preliminary ephemeris comparisons

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IDS-GRACE analysis campaign

Analyse three months Oct-Nov-Dec 2002, from all six satellites using up to five gravity field models:

EGM96 GRIM5 GGM01C GGM01S GFZ01S

Standard products:
sets of [weekly station coordinates + daily polar motion] solutions

Products analysed here:

Time series of relative translations and scales of 90 daily orbits computed in ITRF2000 with four different gravity field models with those referred to GGM01C.

24 plots (6 satellites, 4 pairs of gravity fields):
ftp lareg.ensg.ign.fr/pub/martine/IDS_2004

Orbit computation strategy

Satellites

DORIS only: Spot 2, 4, 5,
DORIS+SLR: Topex/Poseidon, Jason 1, Envisat

Fixed references

TRF: ITRF2000 EOP: IERS C04

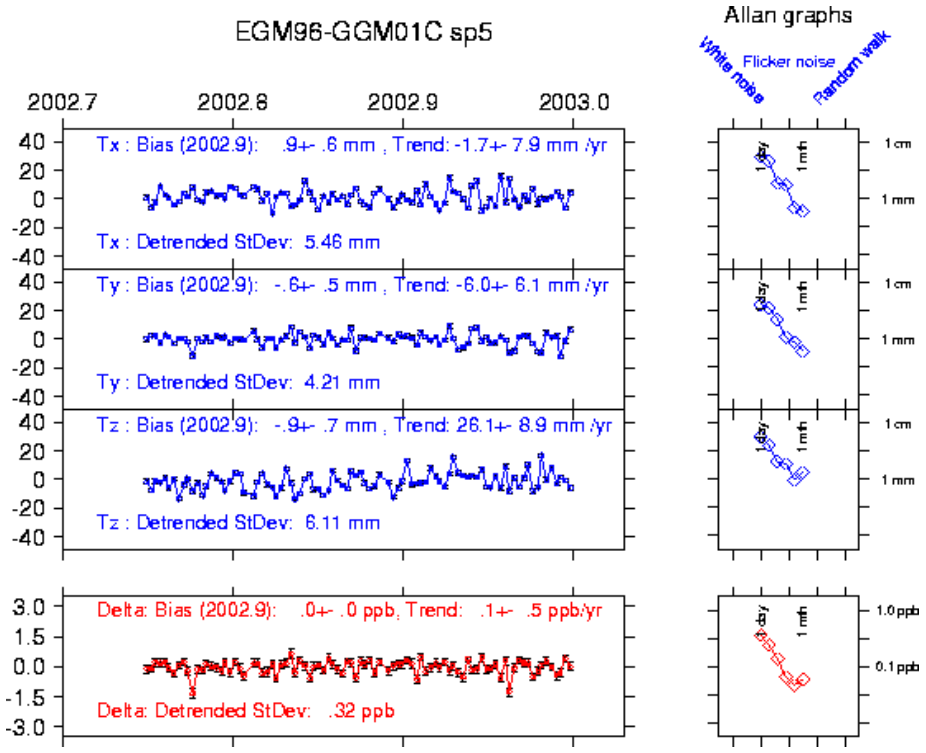
Gravity fields - Degree and order: 95, 95

EGM96 GFZ01S (EIGEN-GRACE)
GRIM5 GGM01C GGM01S

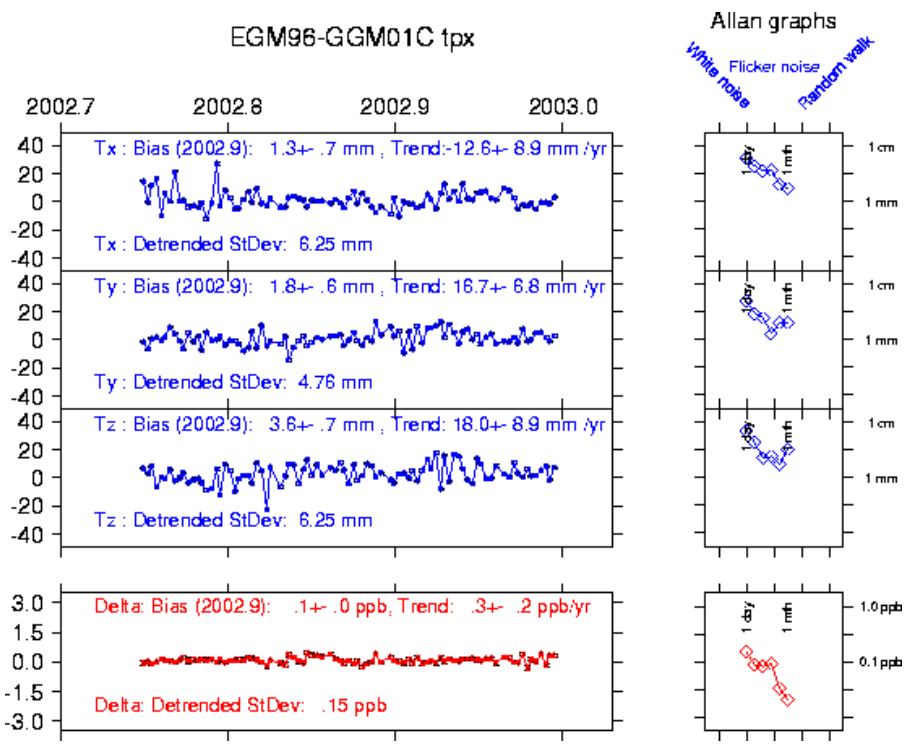
Elevation cutoff: 12 °
Orbit length: 24 hours
Other estimated parameters:
- atmospheric drag
- solar pressure
- Hill empirical parameters
- Tropospheric zenith delay and frequency offset /pass/station

Example 1: EGM96-GGM01C

Spot 5

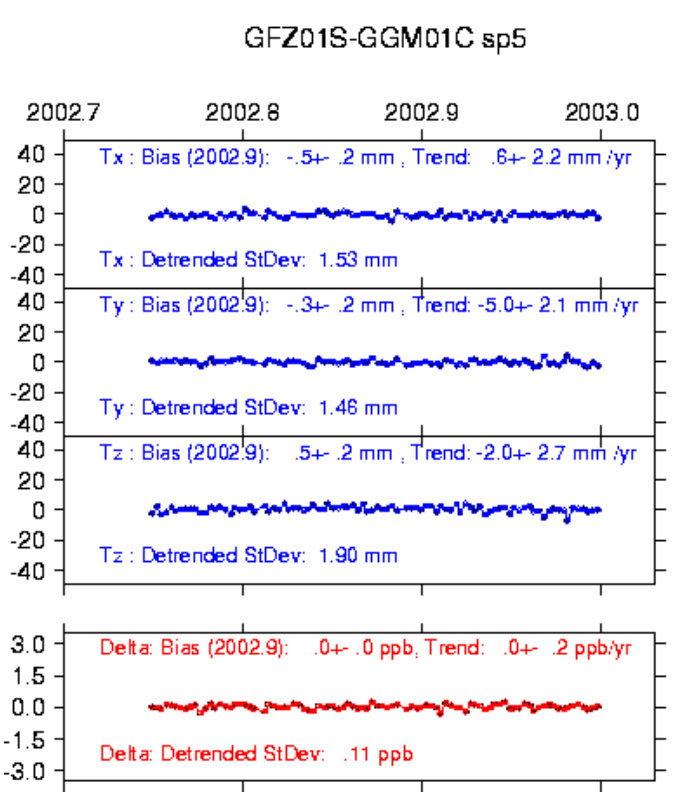


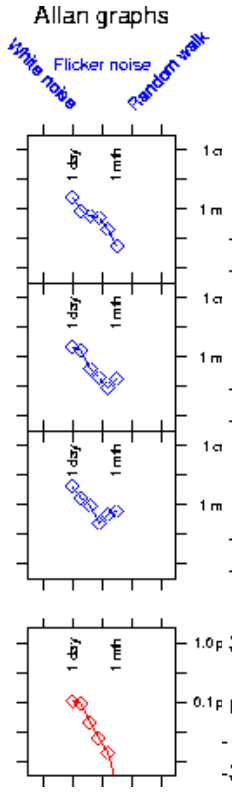
Topex/Poseidon



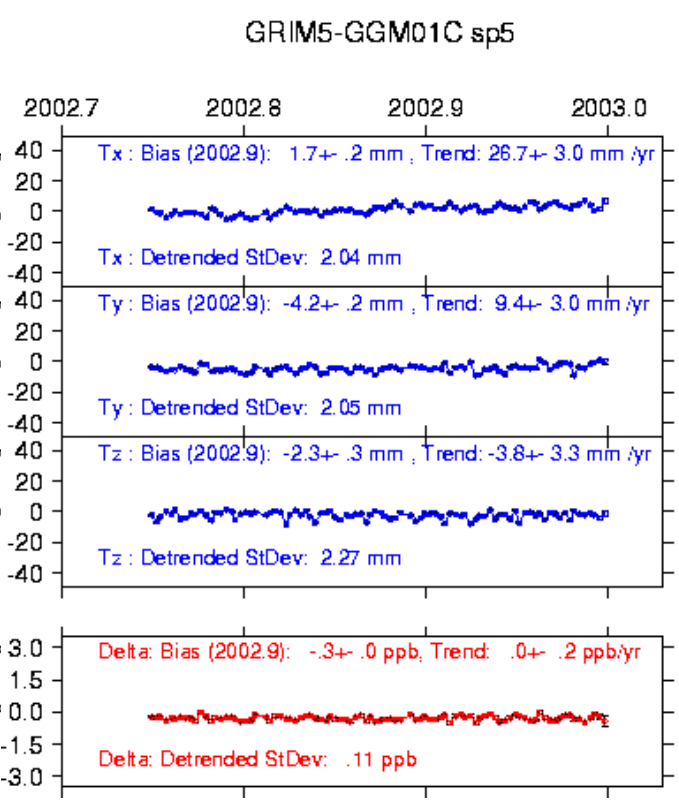
Example 2: Spot5

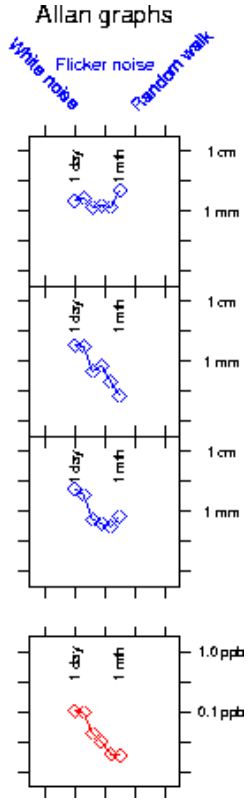
GFZ01S-GGM01C





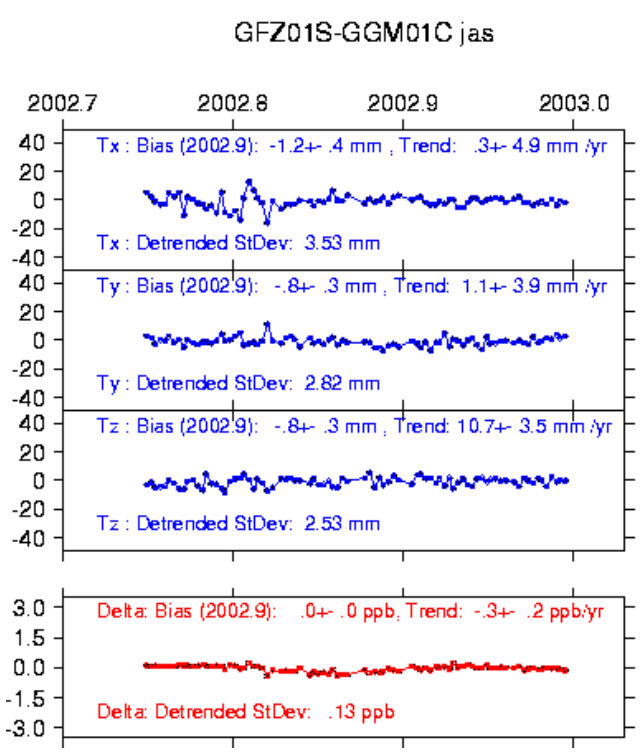
GRIM5-GGM01C

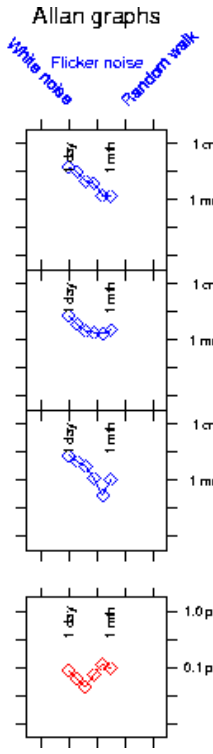




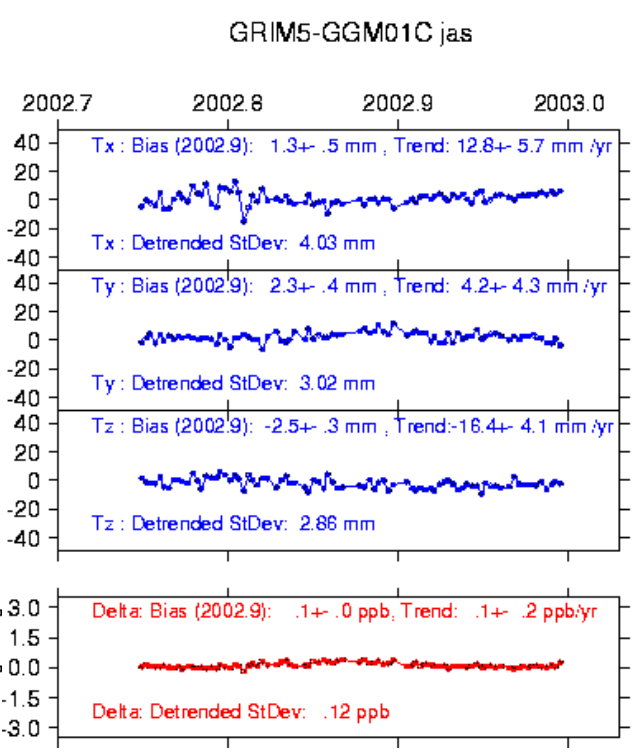
Example 3: Jason 1

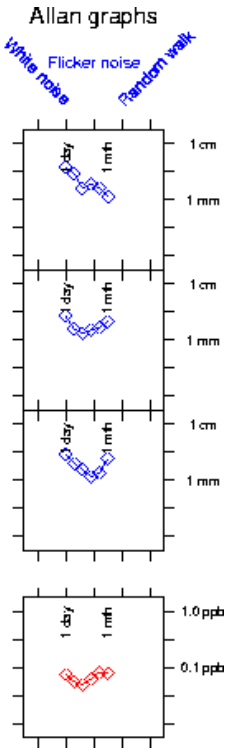
GFZ01S-GGM01C





GRIM5-GGM01C





Deterministic and statistical analyses of differences in origin and scale

Systematic differences

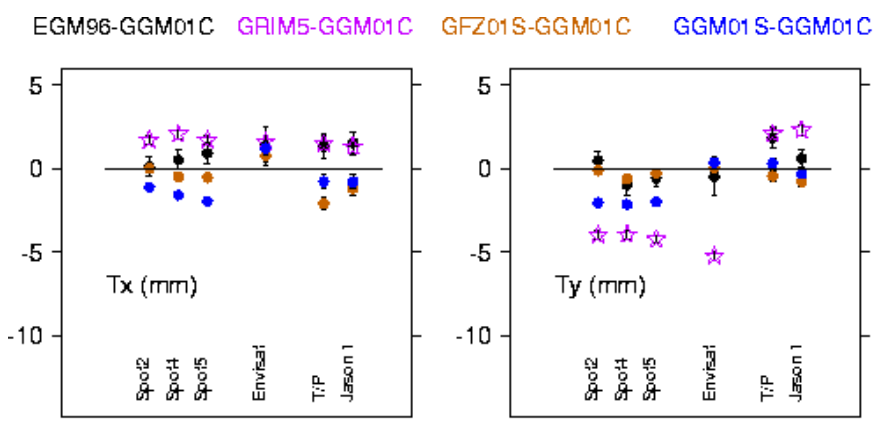
Bias
Drift
Detrended standard deviation

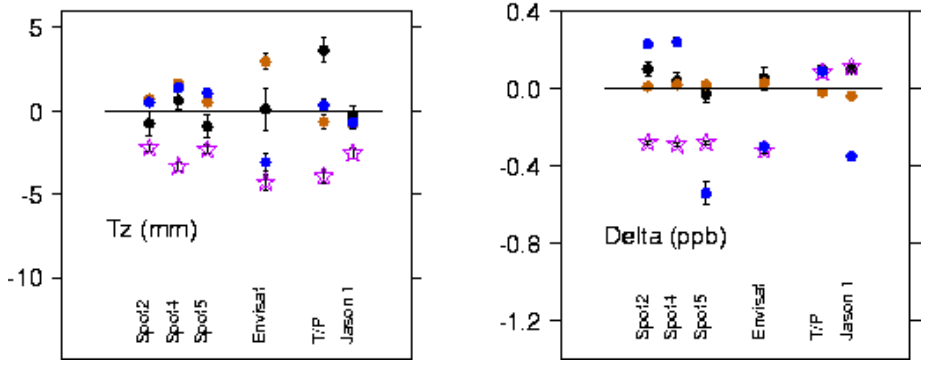
Stability analysis using the Allan variance

The Allan variance is defined as the variance of the first difference of a time series.

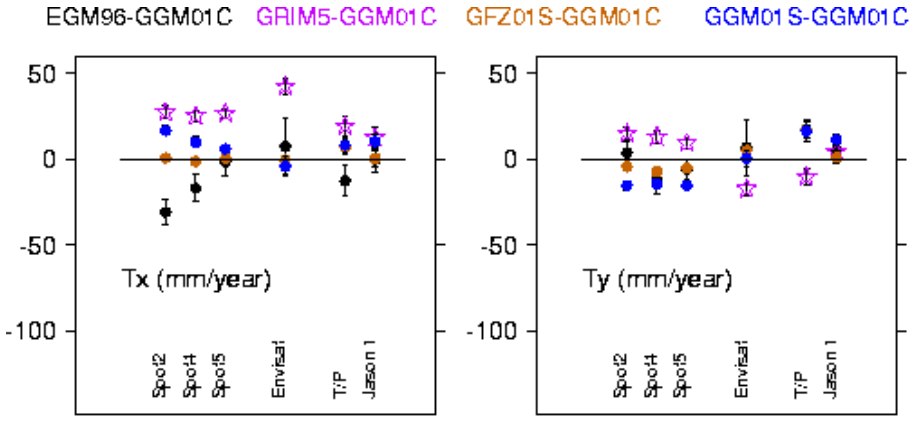
Its variation as a function a the sampling time offers diagnoses for spectral density laws such as
- *white noise* (spectral density independent of frequency)
- *flicker noise* (spectral density ~1/frequency) and
- *random walk* (spectral density ~1/squared frequency).

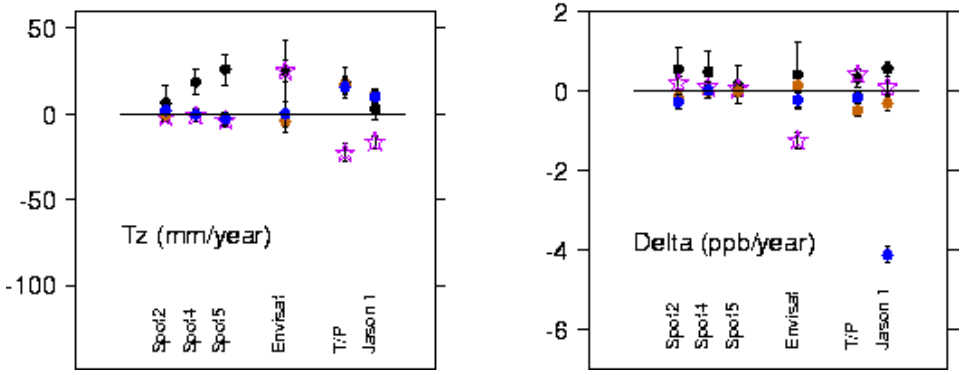
Bias at 2002.9





Linear drift





Origin: effects of changing the gravity field

Bias

- Differences satellite-to-satellite up to 7-8 mm
- $|T_x| < 3$ mm Most satellite-dependent for GFZ and GGM01S
- $|T_y| < 6$ mm Most satellite-dependent for GRIM5 and GGM01S
- $|T_z| < 5$ mm Most satellite-dependent for EGM96 and GGM01S
  Envisat most scattered

Local drift (over 90 days)

- Differences satellite-to-satellite up to 70-80 mm/yr
- $|T_x| < 3$ mm/yr Most satellite-dependent for EGM96 and GRIM5
  Spot2 most scattered
- $|T_y| < 6$ mm /yr Most satellite-dependent for GRIM5 and GGM01S
- $|T_z| < 5$ mm /yr Most satellite-dependent for GRIM5

Scale: effects of changing the gravity field

Bias

- Differences satellite-to-satellite up to 0.8 ppb
- Most satellite-dependent for GRIM5 and GGM01S
- Outlier

  GGM01S/Spot5: - 0.54 ppb

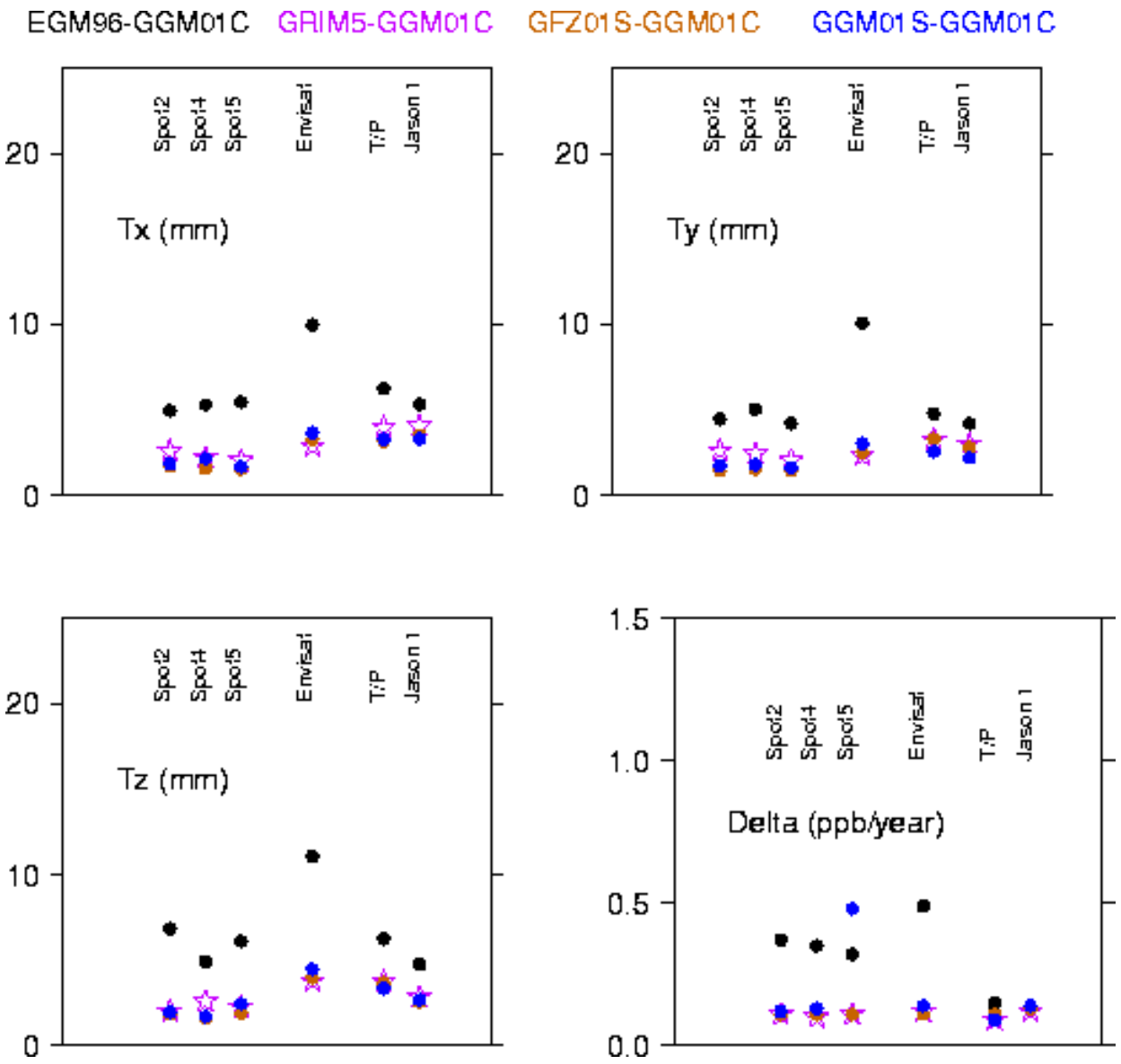
Local drift (over 90 days)

- Differences satellite-to-satellite up to 70-80 ppb/yr
- Most satellite-dependent for GRIM5 and GGM01S
- Outliers

  GGM01S/Spot5: - 4.1 ppb/yr

  GGM01S/Jason: - 8.9 ppb/yr

Detrended standard deviation



Scattering: effects of changing the gravity field

Origin

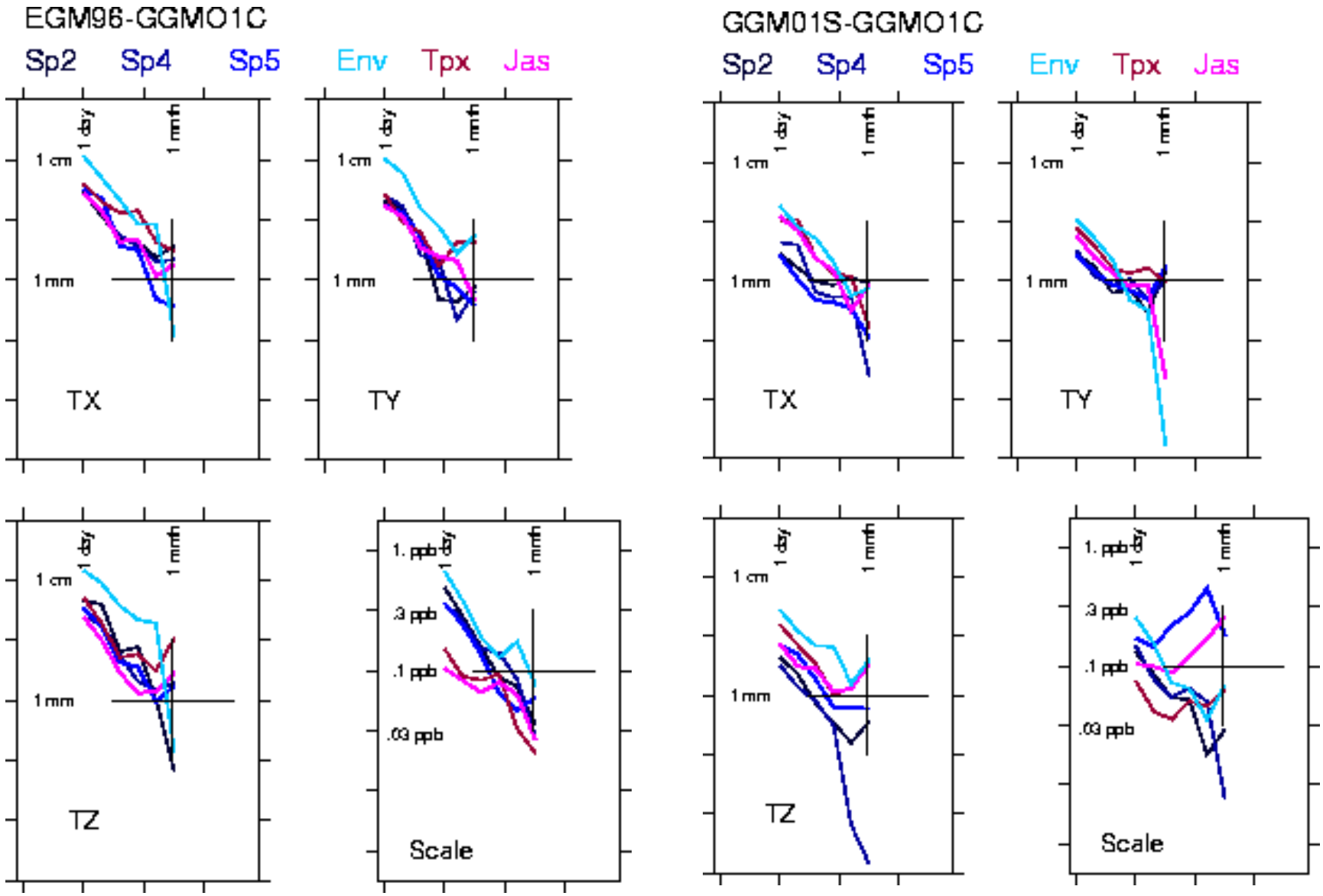
- EGM96: detrended standard deviation 5-10 mm (Envisat)
- All others: detrended standard deviation < 4 mm
- Differences satellite-to-satellite small

Scale

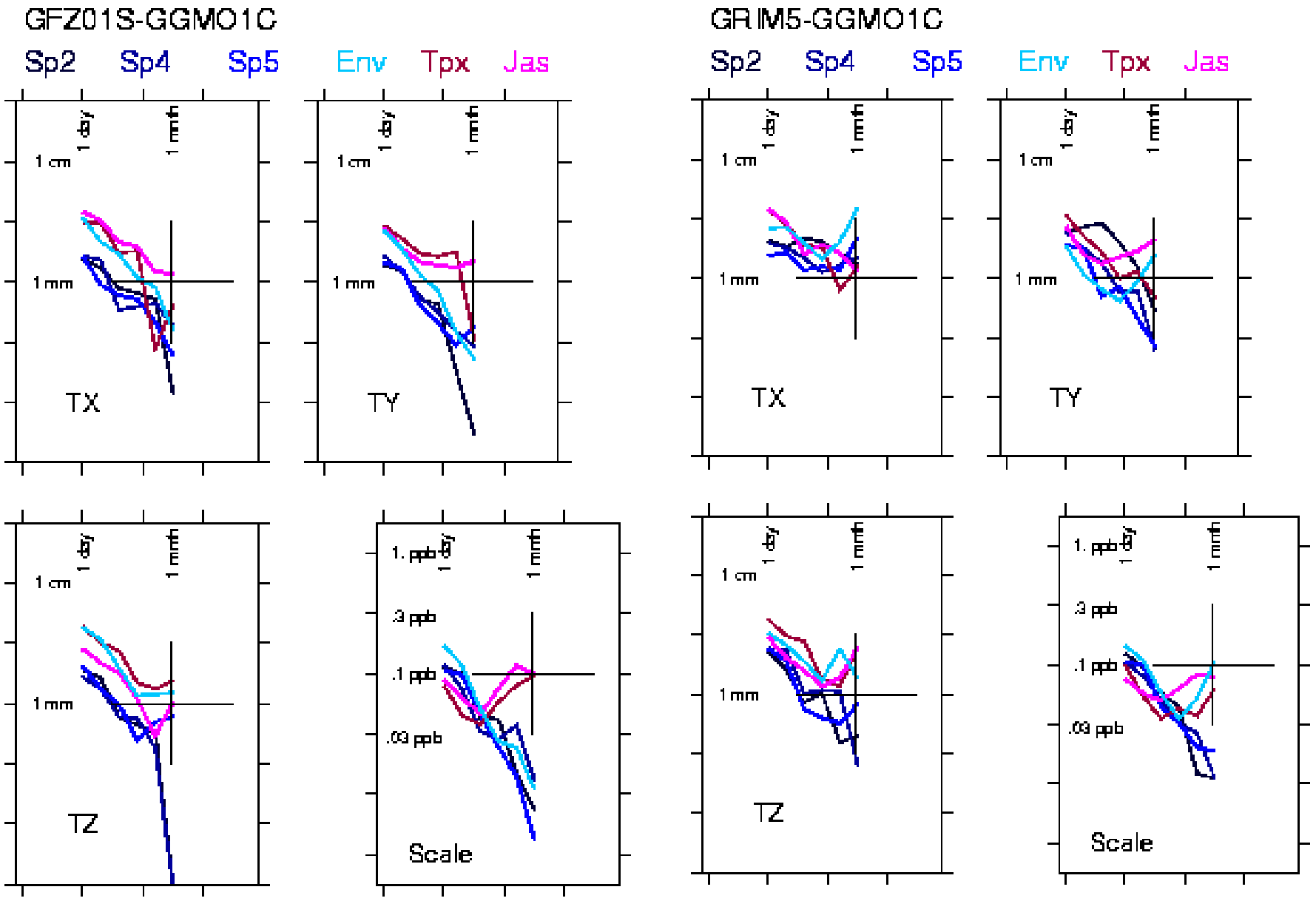
- EGM96: detrended standard deviation 0.1-0.5 ppb
- All others: detrended standard deviation < 0.2 ppb
- Differences satellite-to-satellite small, except for EGM96
- Outlier

  GGM01S/Spot5: 0.48 ppb (anomalous behaviour)

Stability graphs (1/2)



Stability graphs (2/2)



Stability (1d-1mth):
effects of changing the gravity field

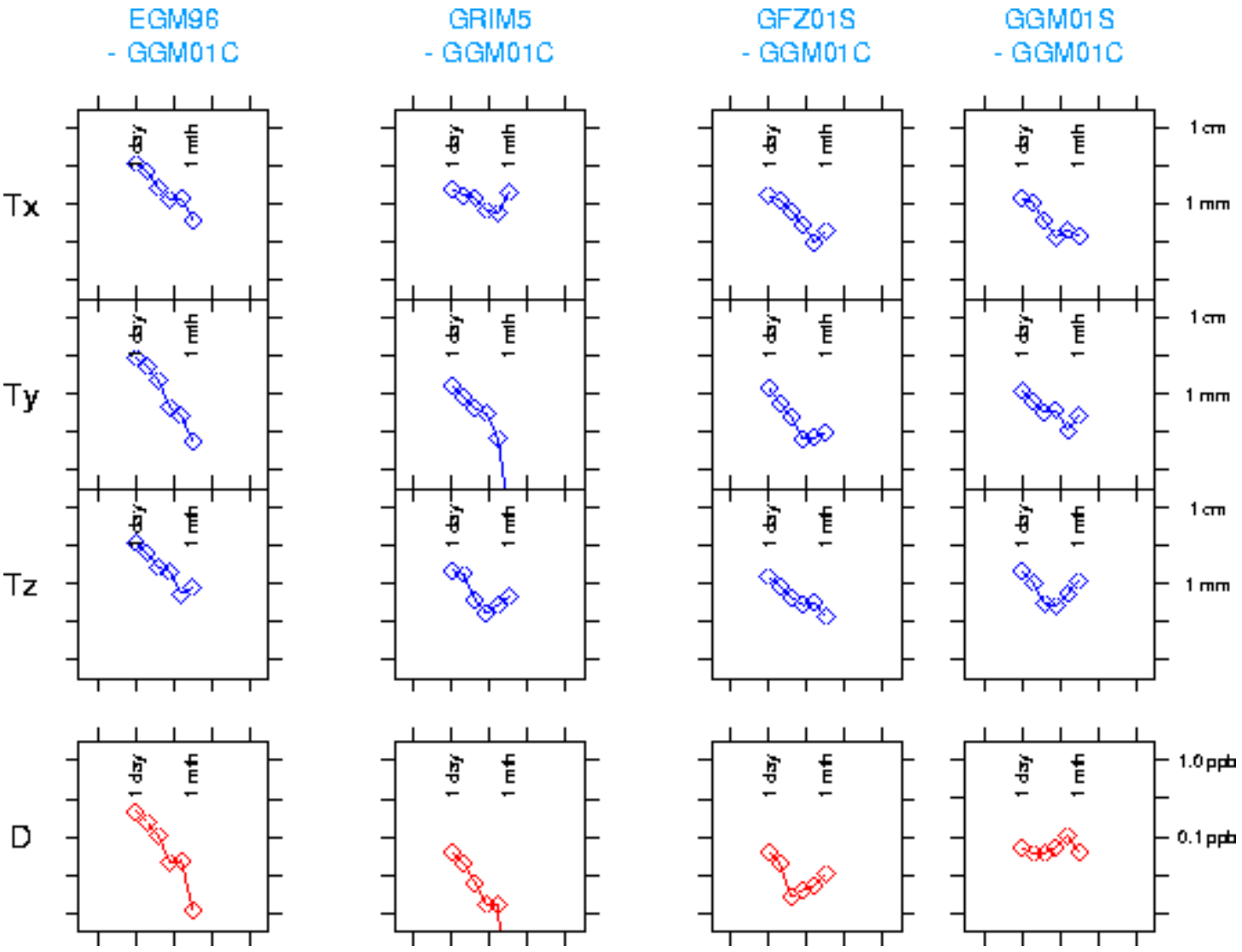
Origin

- Mostly **white noise** => **< 1mm @ 1 mth**
- EGM96 differences least stable (> 1 mm @ 1 mth)
- Anomalous behaviours

Scale

- Mostly **white noise** => **< 0.05 ppb @ 1 mth**
- EGM96 differences least stable (> 0.05 ppb @ 1 mth)
- Anomalous behaviours with GRIM5 for T/P and Jason

Average stability (six satellites)



Average effect (six satellites)
Reference gravity field model: GGM01C

Origin (mm)

	Std Deviation			Bias (2002.9)		
	Tx	Ty	Tz	Tx	Ty	Tz
EGM96	3.6	2.9	3.6	1.2 +- .4	.2 +- .3	.6 +- .4
GRIM5	2.7	2.7	3.5	1.5 +- .2	-2.3 +- .2	-3.2 +- .2
GFZ01S	1.5	1.2	1.6	-.5 +- .2	-.4 +- .1	.9 +- .2
GGM01S	1.8	1.5	1.6	-.9 +- .1	-.9 +- .1	.1 +- .2

Scale (ppb)

	Std Dev	Bias (2002.9)
EGM96	.20	.05 +- .02
GRIM5	.18	-.17 +- .01
GFZ01S	.06	.00 +- .01
GGM01S	.21	-.10 +- .01