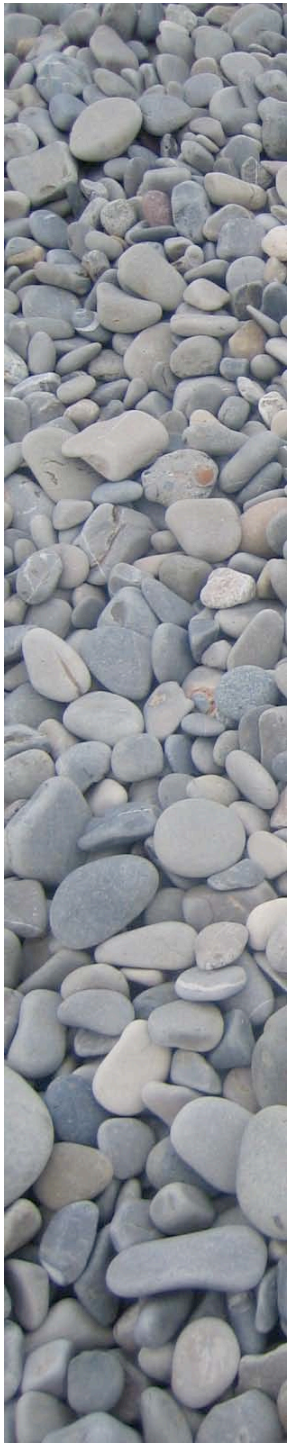
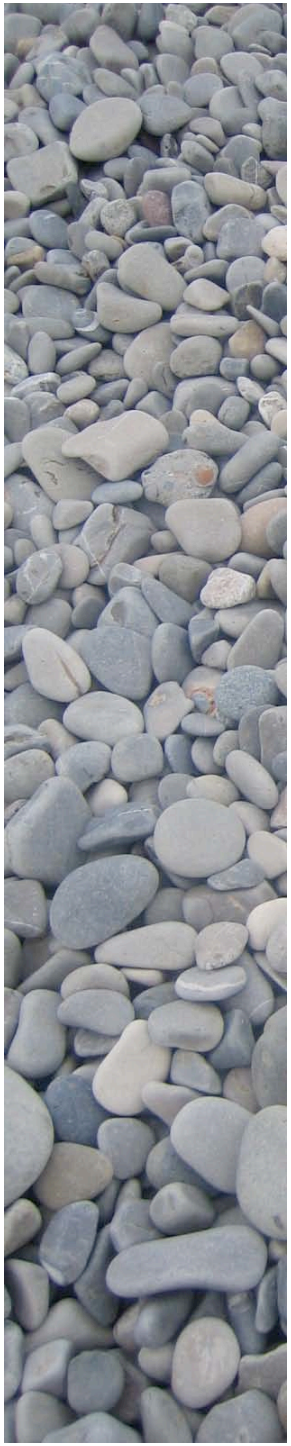


GSFC/NASA DORIS Contribution to ITRF2008

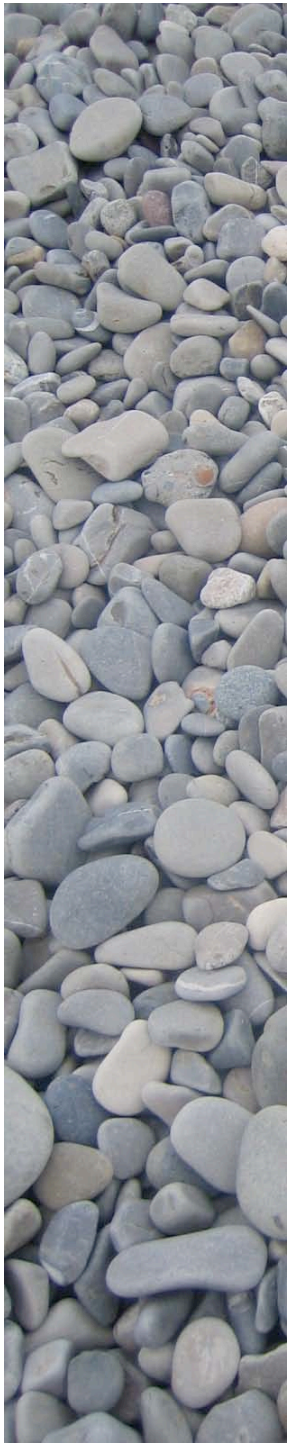
Karine Le Bail, GEST/UMBC/NASA and GRGS
Frank G. Lemoine, GSFC/NASA
Douglas S. Chinn, SGT/NASA

IDS workshop 12-14 Nov 2008
Nice, France



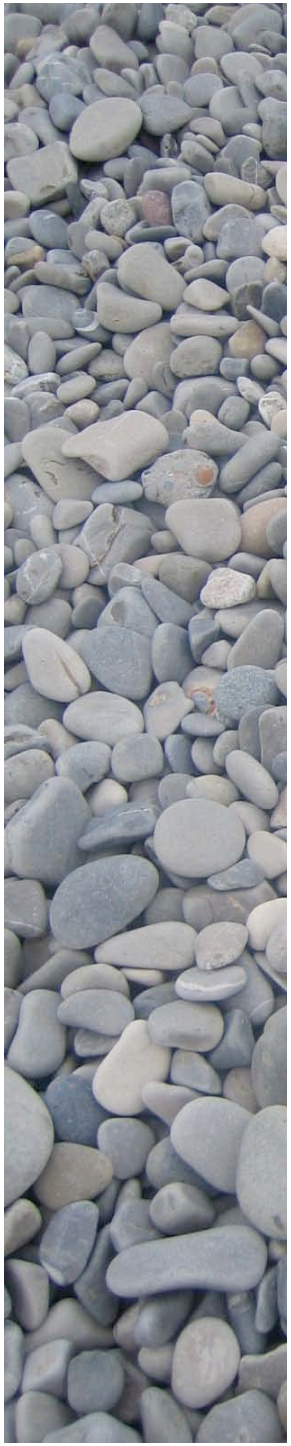
Contents

- Processing of the DORIS data at GSFC/NASA;
- Tests on
  - the elevation cutoff degree;
  - the gravity model (SPOT5);
  - the satellite surface model for Envisat and Jason1.



Processing for ITRF2008 Contribution

- Inputs from the Technique Center or the Analysis Centers in the form of time series, full history of the technique:
  - Station positions;
  - Polar motion/rates.
- DATELINE: Feb 10, 2009 => deadline for submissions by TC/AC;
- Processed so far at GSFC:
  - 2003-2007 (5 years);
  - Envisat, spot2, spot4, spot5, Jason1.

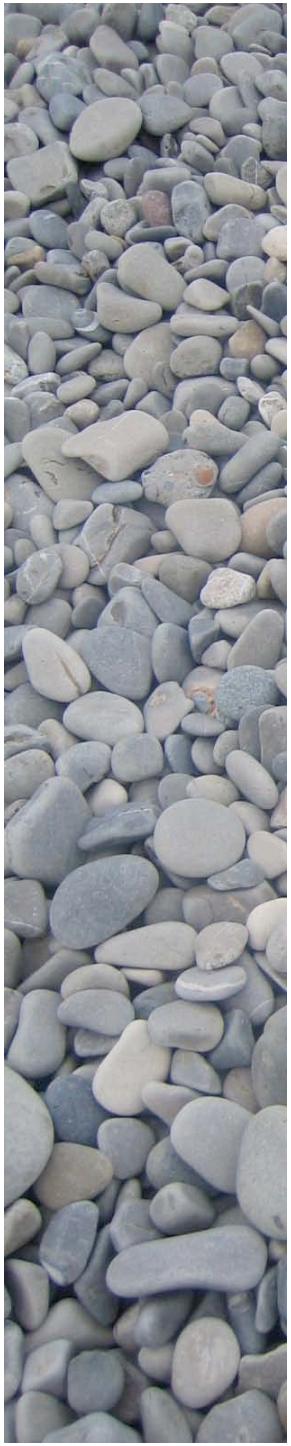


Summary of Force Models

- NASA software GEODYN version 0810;

- Gravity field : ggm02c (120x120);
- Time variable gravity to 20x20 annual terms;
- Atmospheric gravity to 50x50 6 hours (NCEP Petrov);

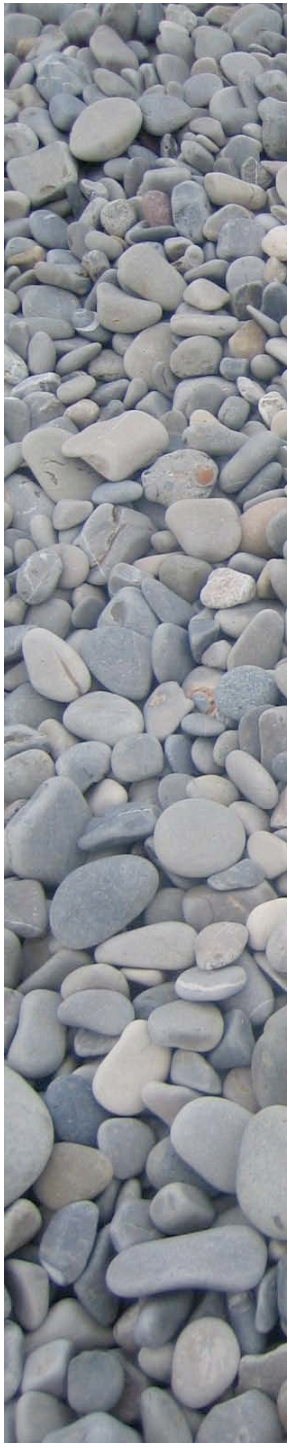
- Macromodels (CNES); GSFC for spot2;
  - Cross sectional areas apply to Drag, Radiation Pre., Planetary Rad Pre;
  - Specular/diffuse reflectivity apply to SRP.
- UCL model used for Envisat and Jason1;
- Albedo/thermal emission (Knocke et Ries, 1988);
- Ocean Loading : GOT00; Ocean Tides : GOT00;
- IERS2003 - Solid Tides.



Measurements Models, Data and Parameterization

- SAA model Jason1;
- 10 deg elevation cutoff;
- Arc length :
  - 7 days +/- 6 hours (no maneuvers);
  - Shorter (with maneuvers).
- A priori station positions : ITRF2005 + ign07d02 for other stations;
- Empirical accelerations : one per day along-track and cross-track.

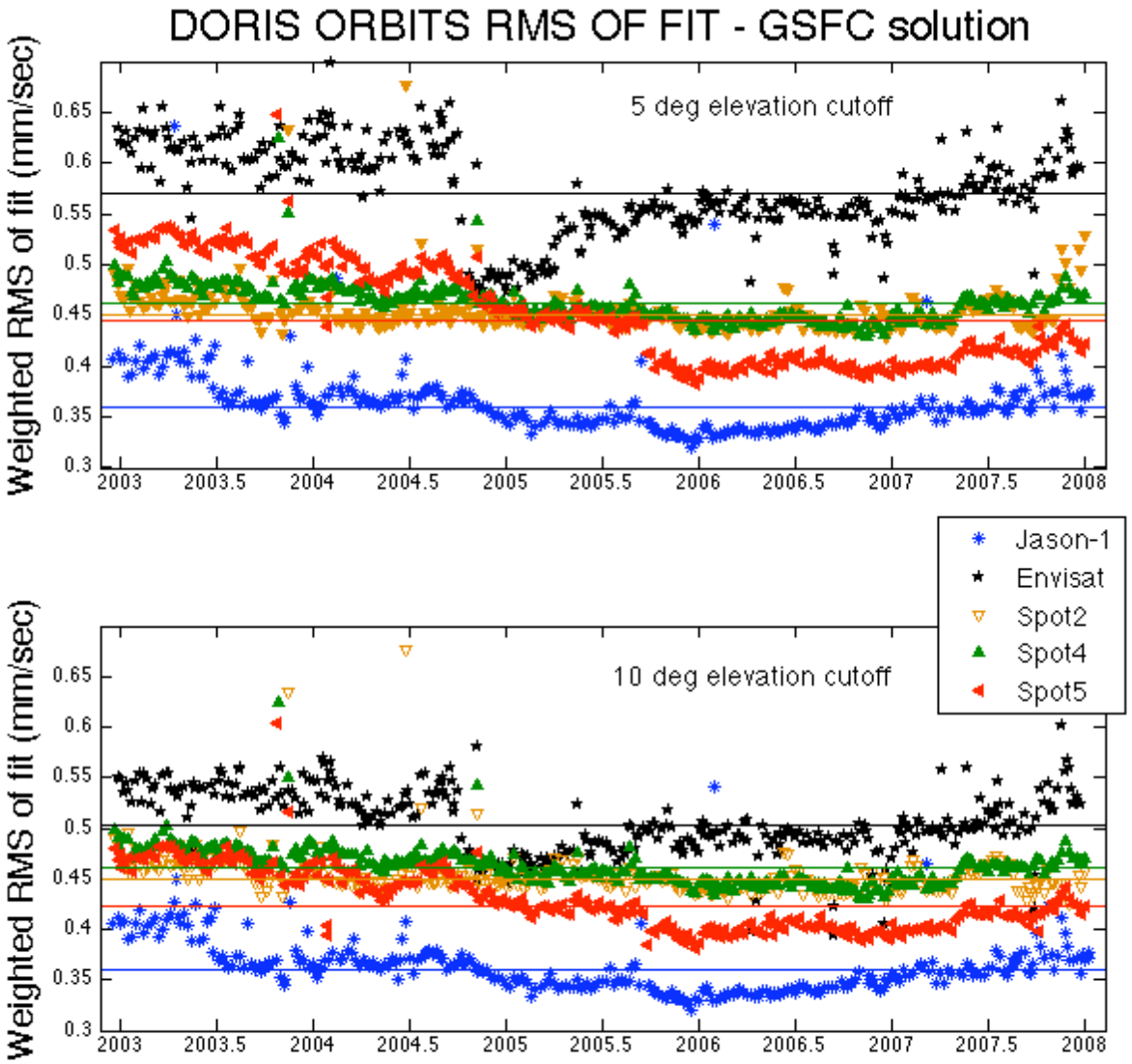
	SPOT2	SPOT4	SPOT5	JASON1	ENVISAT
DRAG	3/day (8hrs)	4/day (6hrs)	4/day (6hrs)	3/day (8hrs)	4/day (6hrs)



Tests towards an optimal analysis strategy

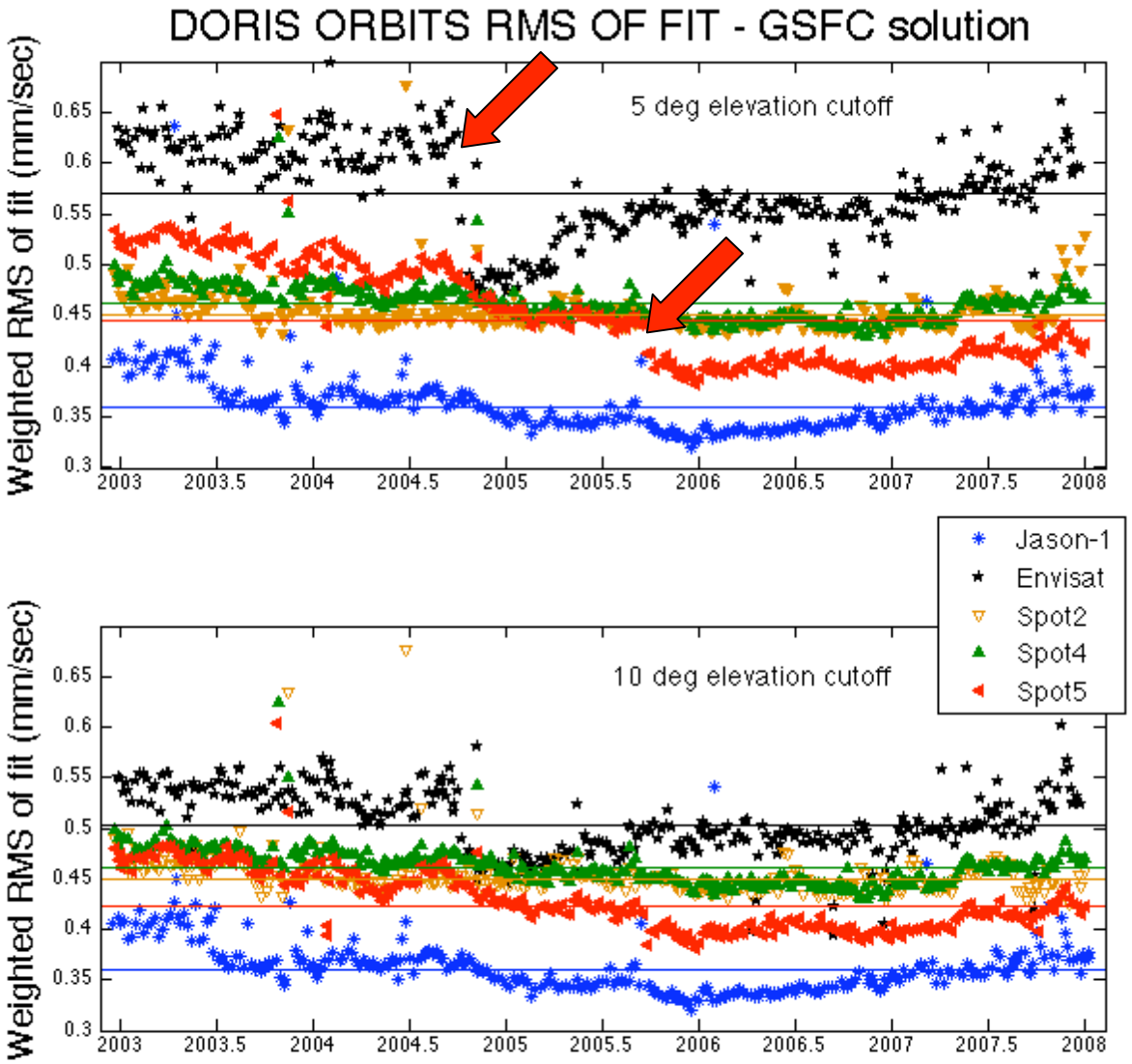
- Comparison with the other AC's orbits (Lemoine talk);
- 10 deg elevation cutoff versus 5 deg;
- Use of different gravity analysis strategies (GGM02C with or without atmospheric gravity, EIGEN-GL04S1, EGM2008, ITG);
- Modeling of the satellite surface: macromodel versus UCL model.

Elevation cutoff : 10 vs 5 deg (1)



mm/sec	5deg	10deg
SP2	0.45	0.45
Nobs	35694	35689
SP4	0.46	0.46
Nobs	38710	38712
SP5	0.45	0.42
Nobs	60937	58114
JA1	0.36	0.36
Nobs	84472	84402
ENV	0.57	0.50
Nobs	38218	35916

Elevation cutoff : 10 vs 5 deg (1)



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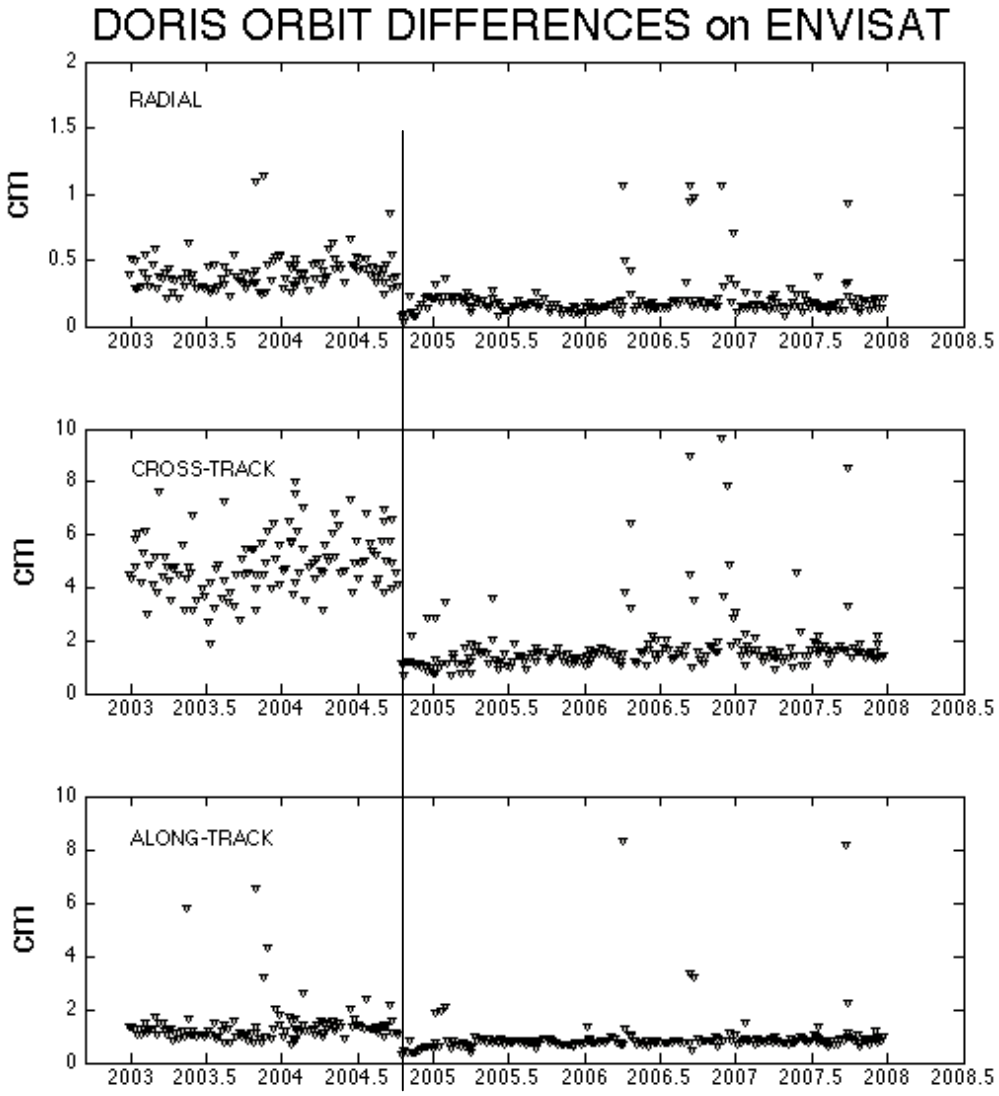
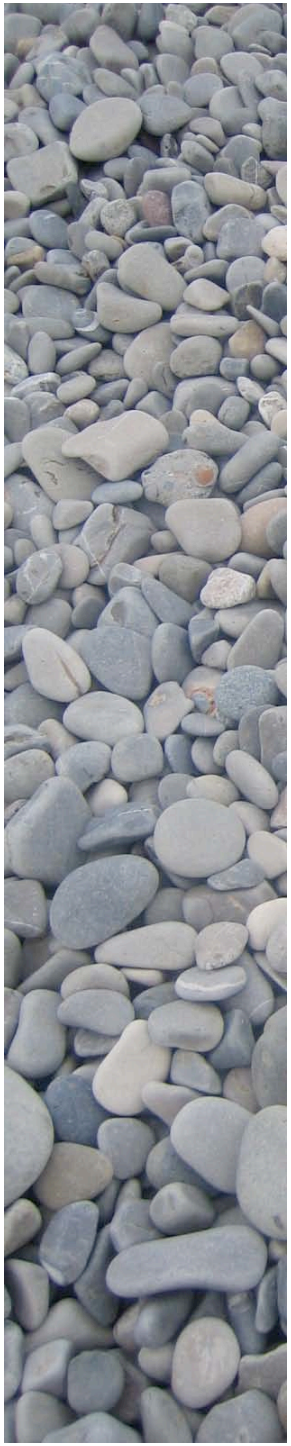
Nobs	60937	58114
JA1	0.36	0.36
Nobs	84472	84402
ENV	0.57	0.50
Nobs	38218	35916

Elevation cutoff : 10 vs 5 deg (2)



cm	Rad	CrT	AIT
SP2	0.01	0.26	0.03
SP4	0.25	2.29	1.01
SP5	0.13	1.22	0.50
JA1	0.04	0.30	0.13
ENV	0.22	1.86	0.89



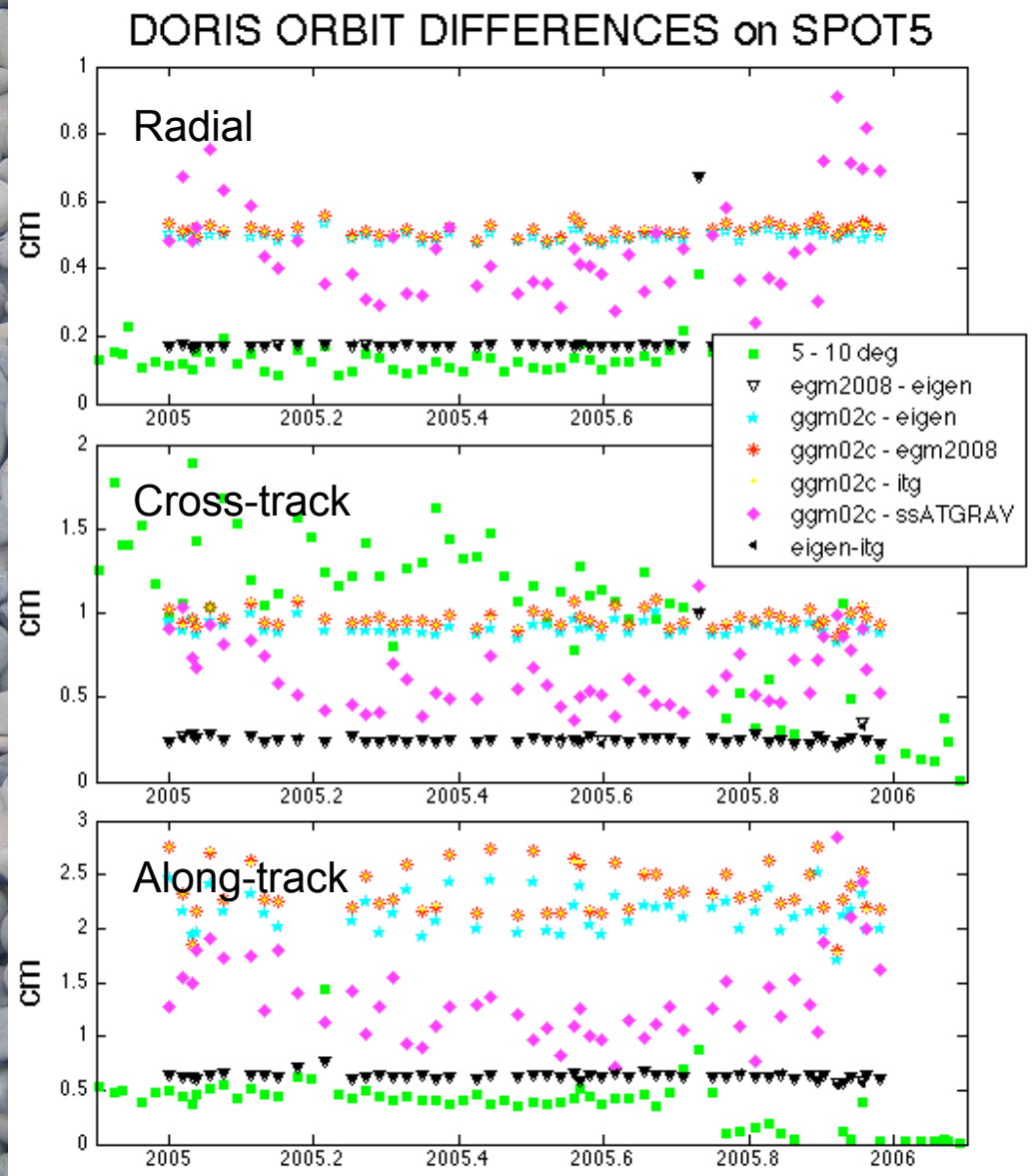
Gravity models (1)

- SPOT5;
- 1 year of test : 2005;
- Models tested :
  - GGMO2C (5 and 10 elevation cutoff degrees);
  - ITG;
  - EGM2008;
  - EIGEN-GL04S1;
  - GGM02C without atmospheric gravity.
- RMS of fit, overlaps, orbits differences, empirical accelerations.

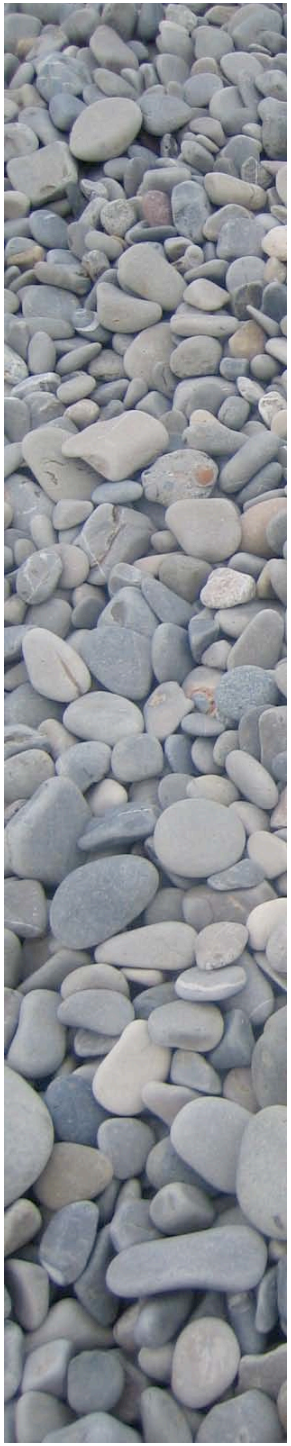
Gravity models (2)

Median	RMS of fit (mm/sec)	Overlaps Radial (cm)	Overlaps CrossTr (cm)	Overlaps AlongTr (cm)
GGM02C 5deg	0.444	0.829	9.600	5.064
ITG	0.446	0.573	3.251	2.013
EIGEN-GL04S1	0.446	0.606	3.278	2.017
EGM2008	0.446	0.548	3.252	1.923
w/o atm. gravity	*0.423*	0.808	*3.188*	*2.919*
GGM02C 10deg	*0.422*	0.837	9.587	5.115

Gravity models (3)

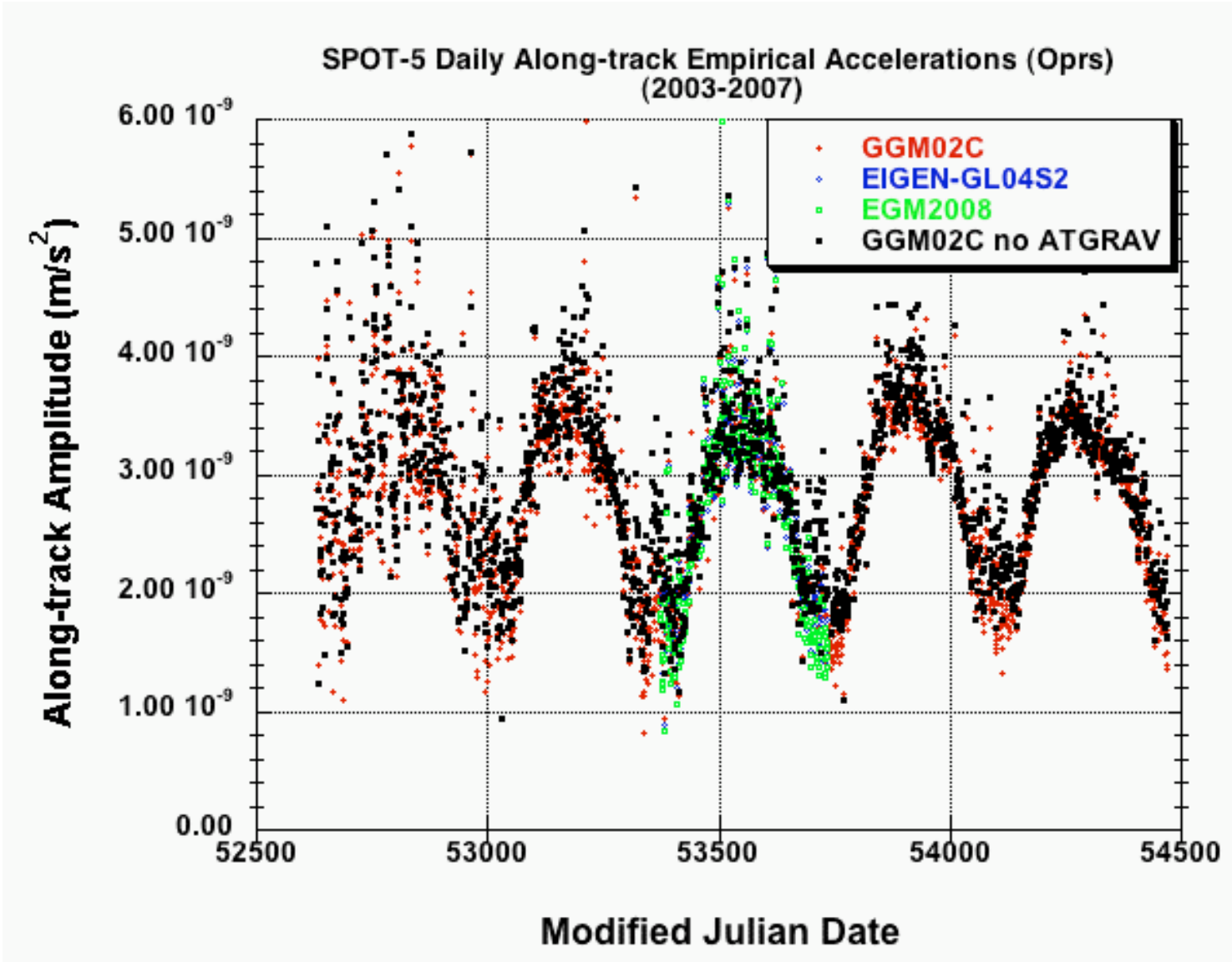


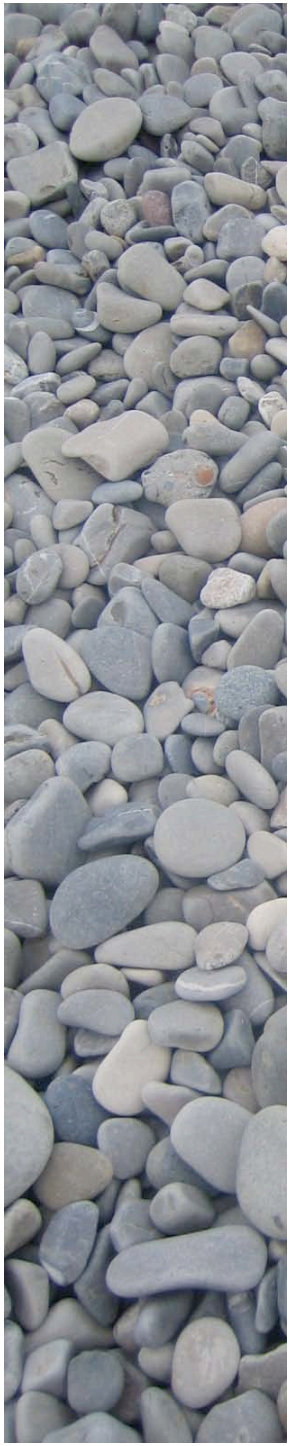
=> Biases between the different gravity models.



Gravity models (3)

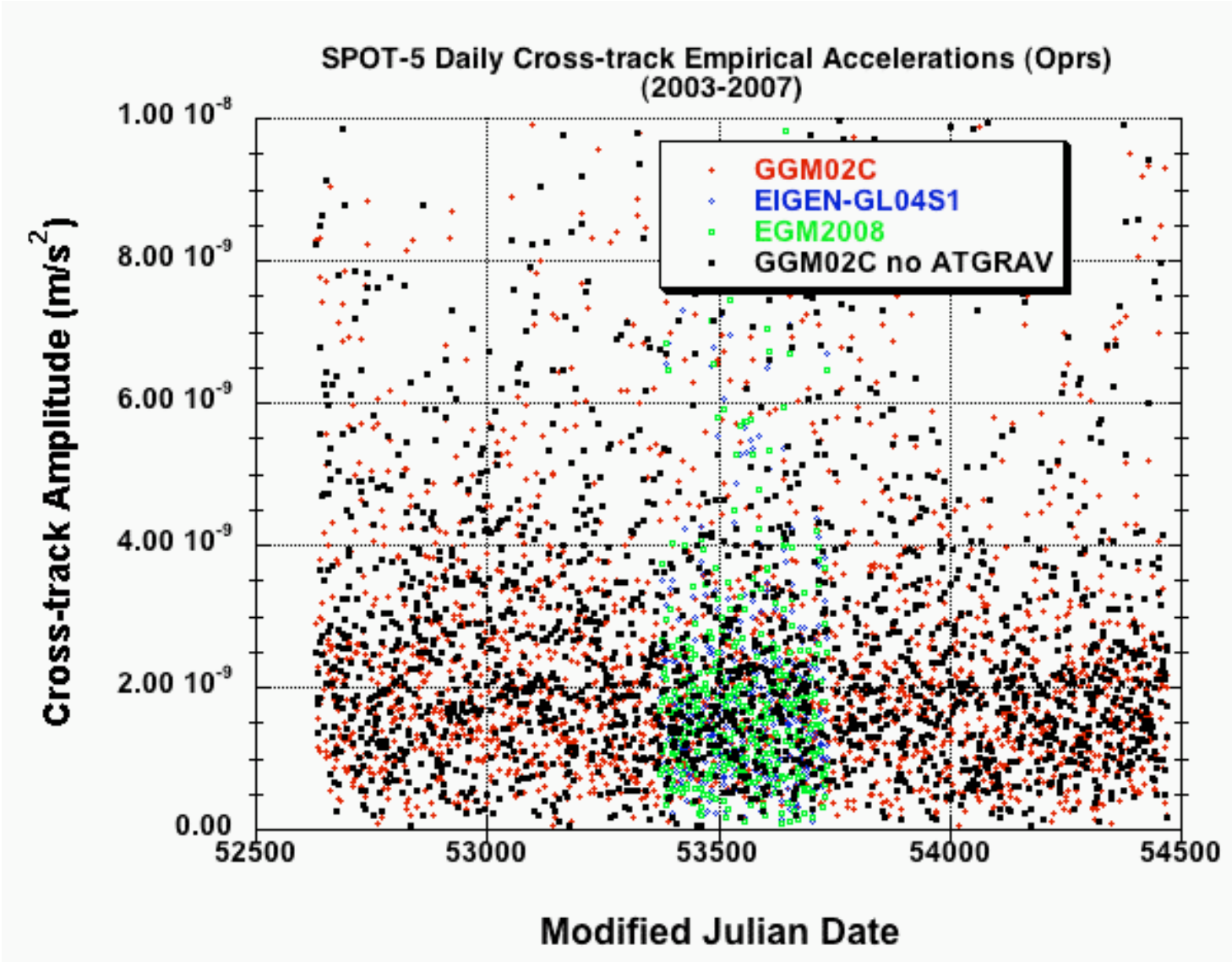
Empirical accelerations (a)

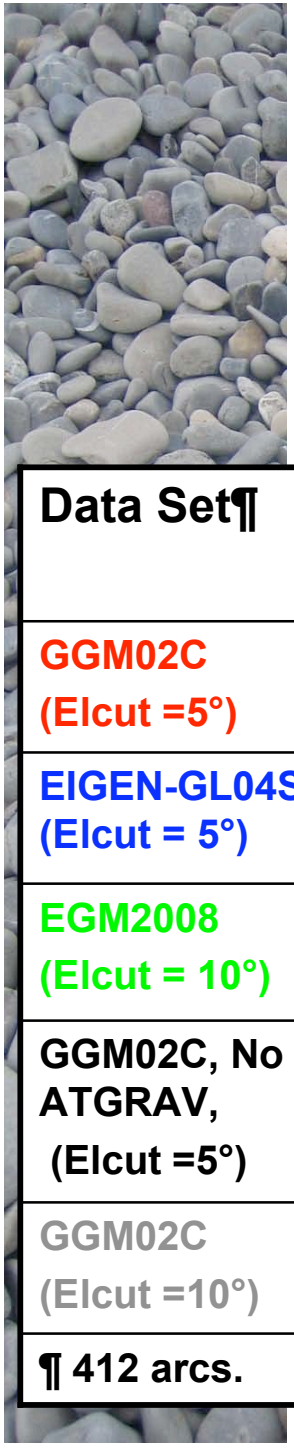




Gravity models (3)

Empirical accelerations (b)





Gravity models (3)

Empirical accelerations (c)

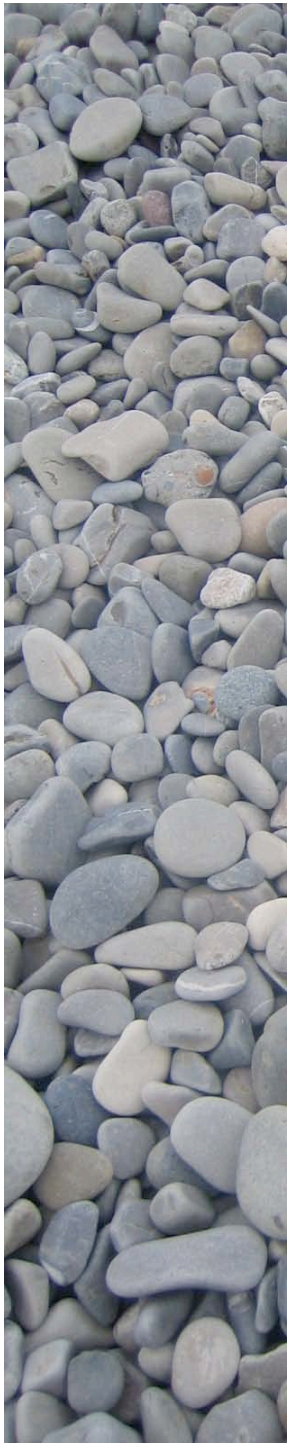
Average Daily Empirical Acceleration Amplitudes (oprs) for SPOT-5 orbits (2005 only), m/s^2

Data Set¶	Along-track mean & *(med)*	Cross-track mean & *(med)*
GGM02C (Elcut =5°)	3.22×10^{-9} *(2.79×10^{-9})*	2.77×10^{-9} *(1.99×10^{-9})*
EIGEN-GL04S1 (Elcut = 5°)	3.18×10^{-9} *(2.74×10^{-9})*	1.97×10^{-9} *(1.56×10^{-9})*
EGM2008 (Elcut = 10°)	3.17×10^{-9} *(2.81×10^{-9})*	2.00×10^{-9} *(1.64×10^{-9})*
GGM02C, No ATGRAV, (Elcut =5°)	3.36×10^{-9} *(2.87×10^{-9})*	2.88×10^{-9} *(2.19×10^{-9})*
GGM02C (Elcut =10°)	3.19×10^{-9} *(2.75×10^{-9})*	2.48×10^{-9} *(1.88×10^{-9})*

¶ 412 arcs.

EIGEN-GL04S1 gravity model - produces lowest empirical OPR's - especially cross-track.

IDS



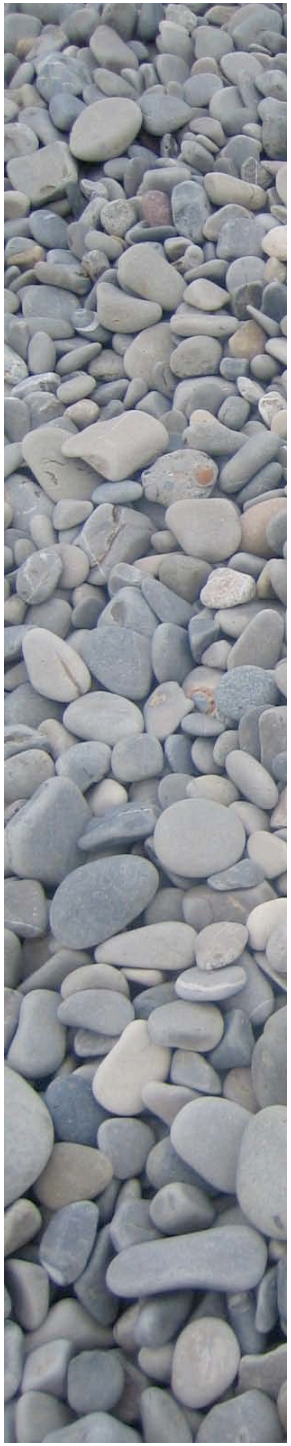
Macromodel vs UCL model (1)

- Envisat et Jason1;
- 5 years : 2003 - 2007;
- UCL satellite modeling, not the “box and wings” model.

Macromodel vs UCL model for Envisat (1)

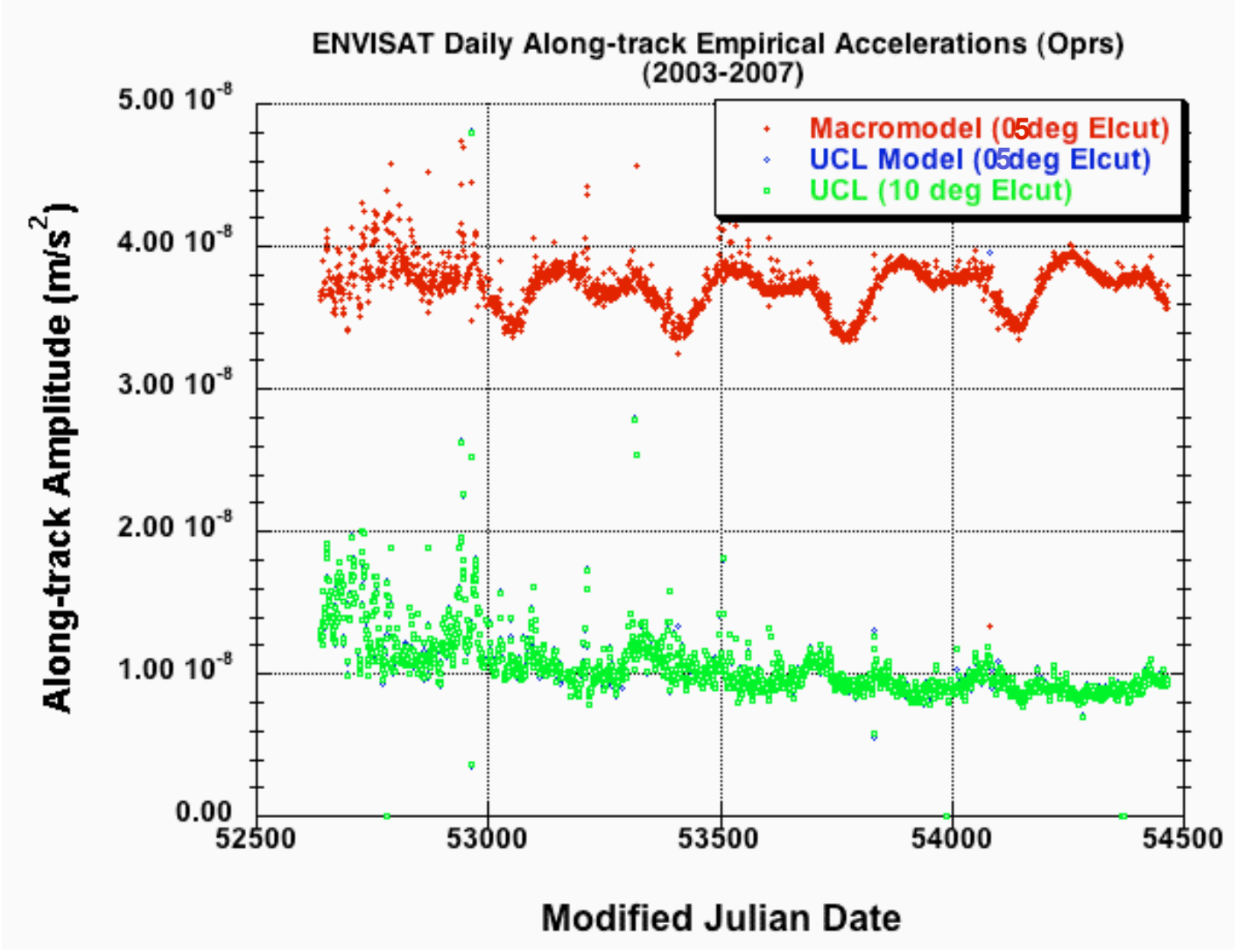
Median	Macromodel	UCL model
RMS of fit (mm/sec)	0.5714	0.5706

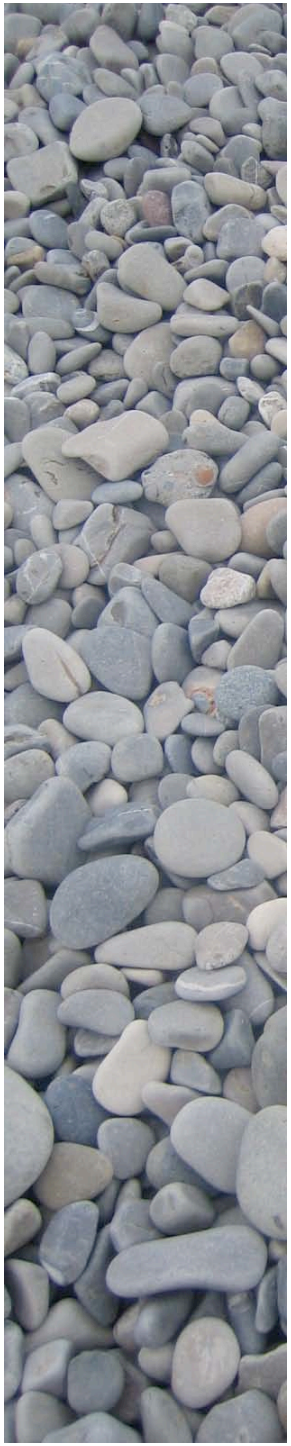
Median (cm)	Radial	Cross-track	Along-track
Orbit diff.	0.59	2.36	1.23
Overlaps macro.	0.99	9.82	5.81
Overlaps UCL	1.00	9.87	5.83



Macromodel vs UCL model for Envisat (2)

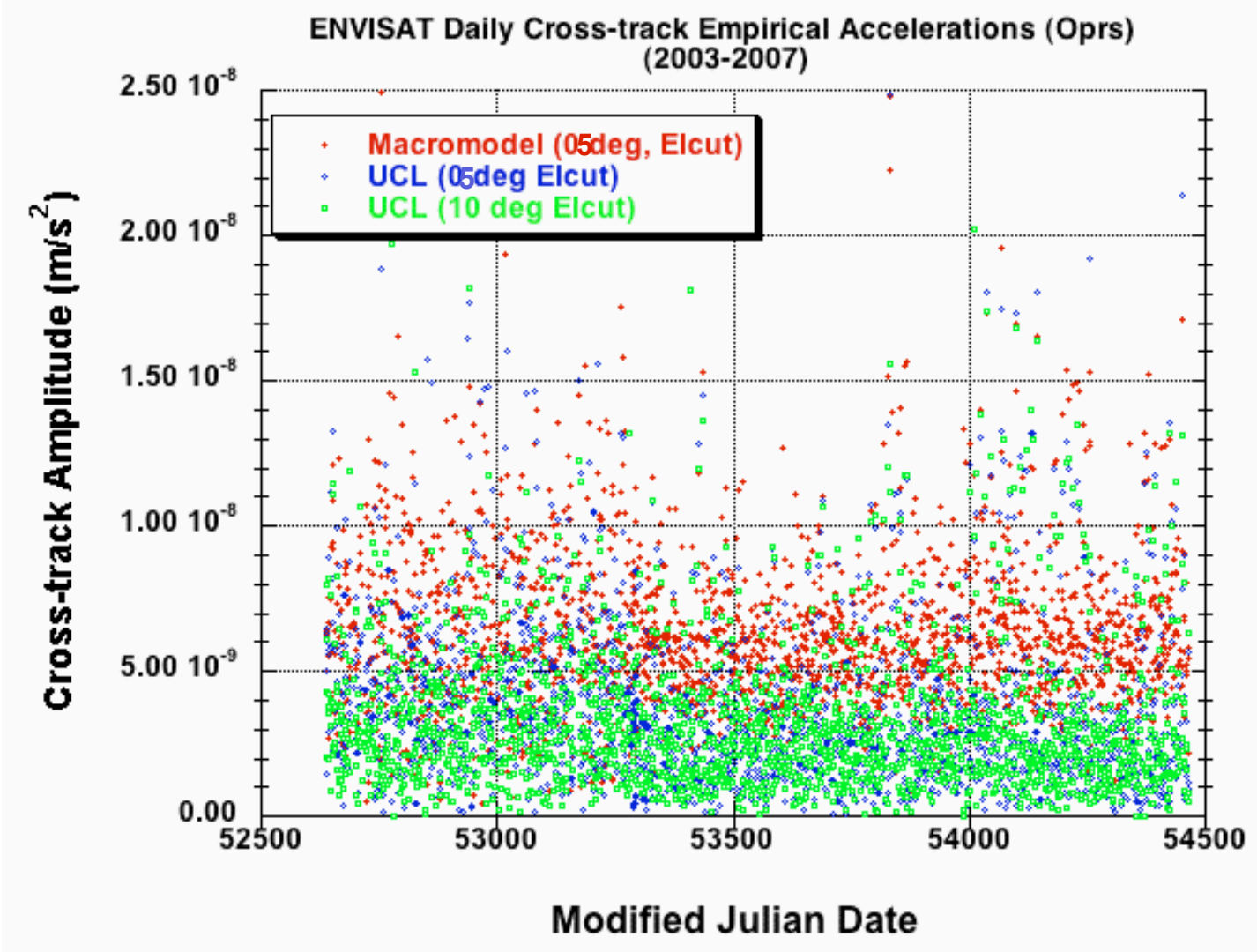
Empirical accelerations (a)

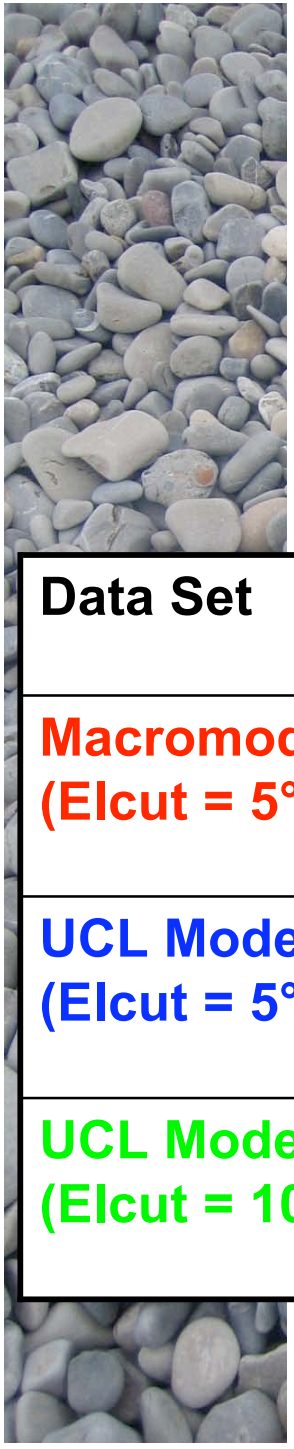




Macromodel vs UCL model for Envisat (2)

Empirical accelerations (b)





Macromodel vs UCL model for Envisat (2)

Empirical accelerations (c)

Average Daily Empirical Acceleration Amplitudes (oprs) for ENVISAT orbits (2003-2007), m/s^2

Data Set	Along-track mean & *(median)*	Cross-track mean & *(median)*
Macromodel (Elcut = 5°)	3.74×10^{-8} *(3.75×10^{-8})*	6.44×10^{-9} *(5.93×10^{-9})*
UCL Model (Elcut = 5°)	1.06×10^{-8} *(0.99×10^{-9})*	3.87×10^{-9} *(3.06×10^{-9})*
UCL Model (Elcut = 10°)	1.05×10^{-8} *(0.98×10^{-9})*	3.32×10^{-9} *(2.60×10^{-9})*

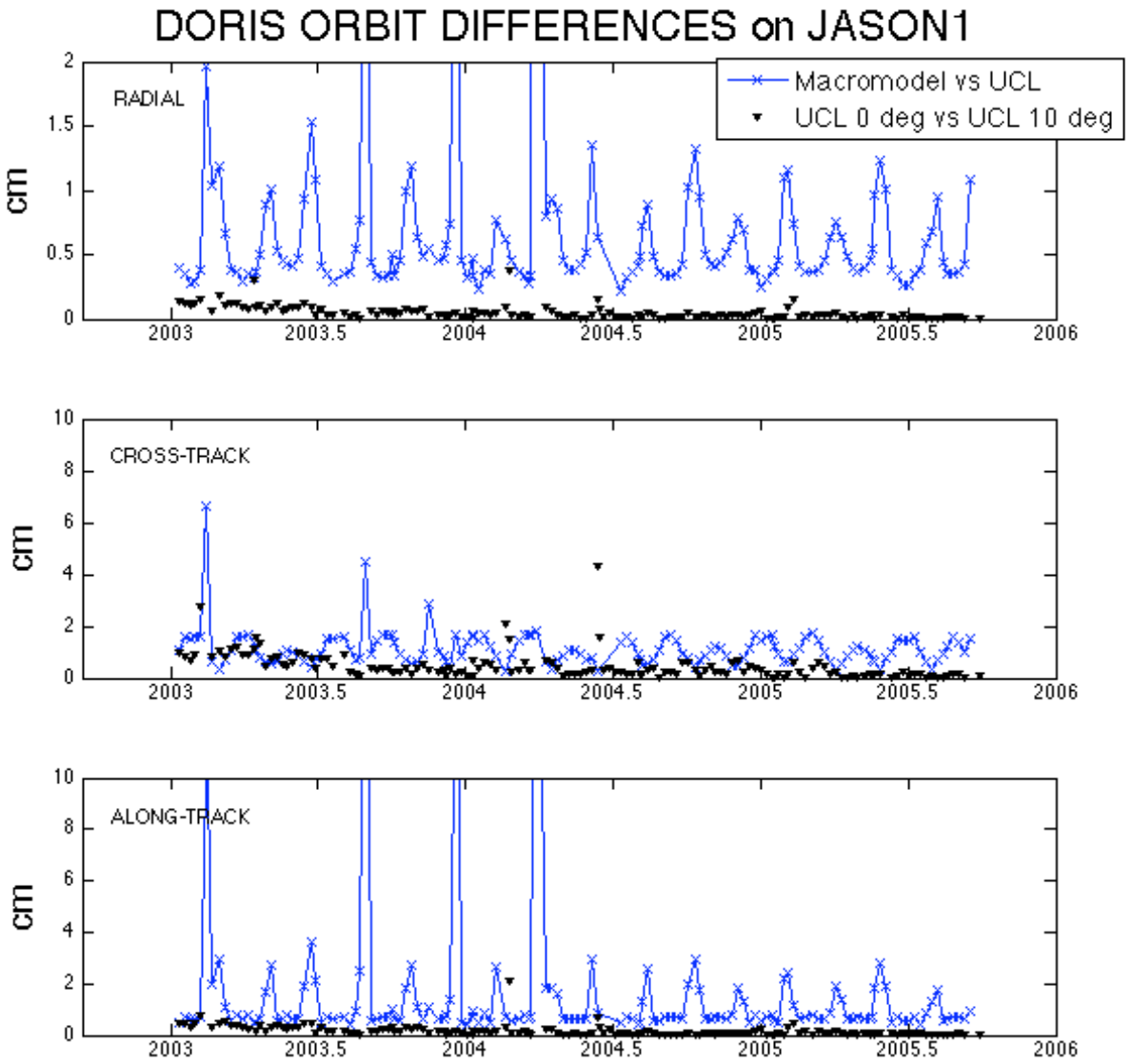
1. **UCL model produces lower residual OPR signature (both along & cross-track).**
2. **Low-elevation data (<10°) Troposphere modelling errors alias with empirical accelerations cross-track (opr).**

Macromodel vs UCL model for Jason1 (1)

Median	Macromodel	UCL model
RMS of fit (mm/sec)	0.3556	0.3596

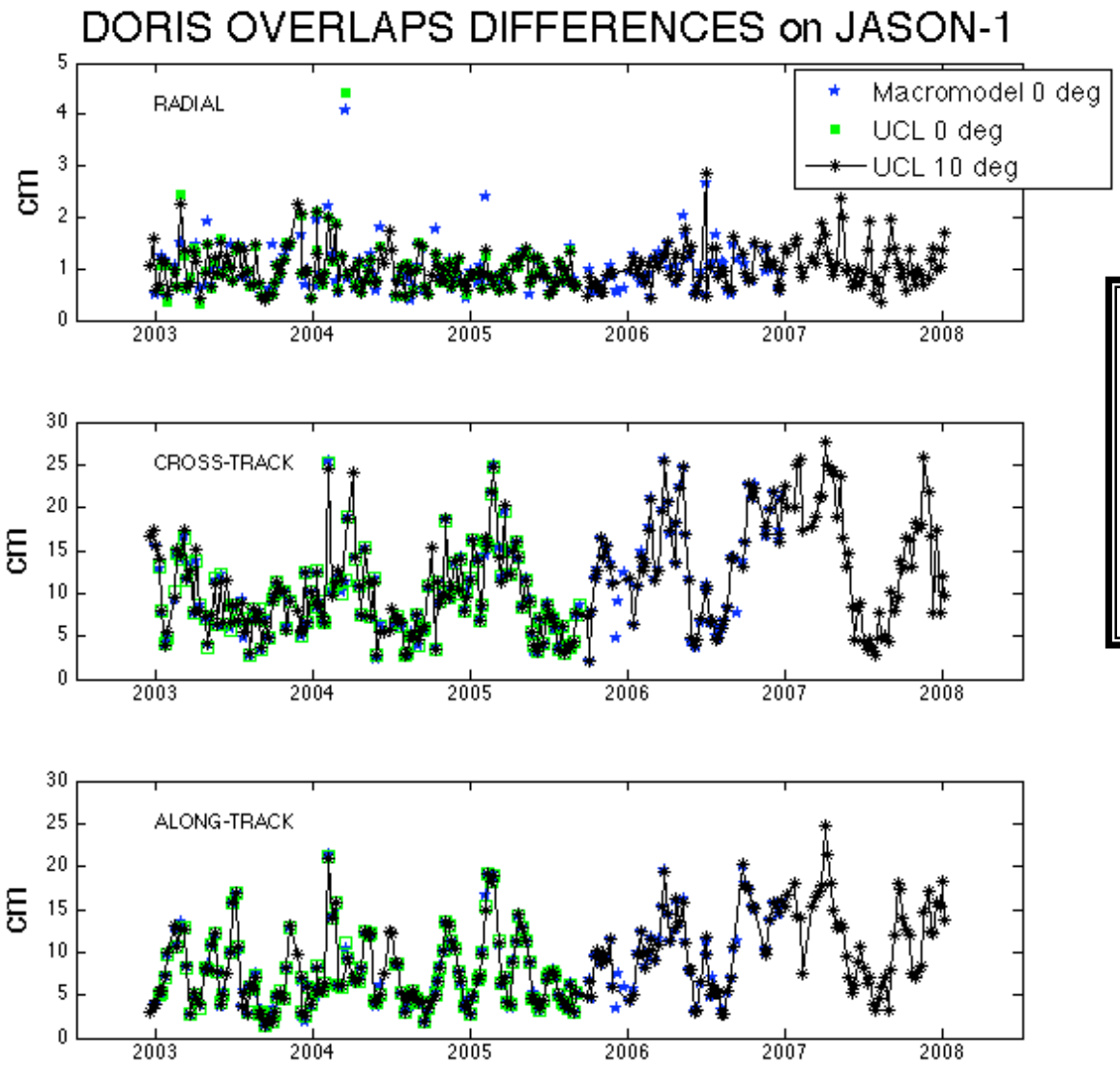
Median (cm)	Radial	Cross-track	Along-track
Orbit diff.	0.45	1.01	0.71
Overlaps macro.	0.88	10.05	7.31
Overlaps UCL	0.91	8.67	6.37

Macromodel vs UCL model for Jason1 (2)



A 60-day term appears in the three components.

Macromodel vs UCL model for Jason1 (3)

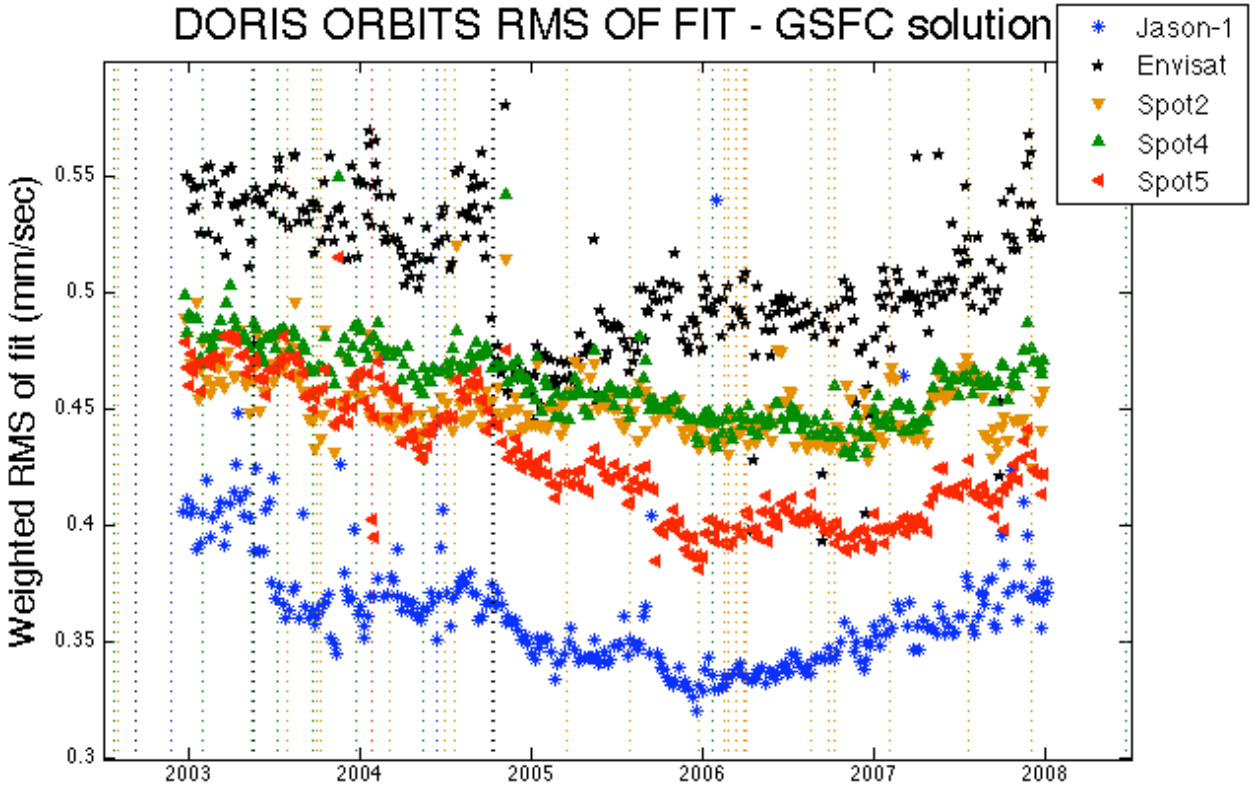


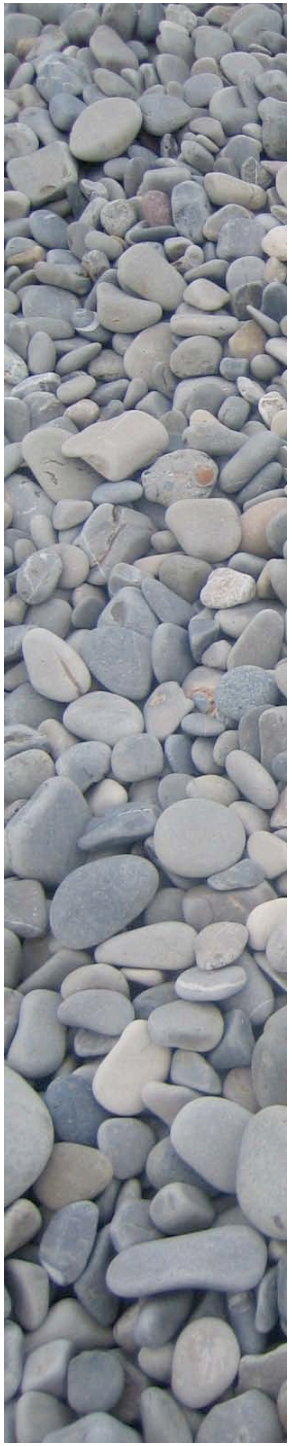
A annual term with an increasing amplitude is seen on the cross-track and the along-track components.

?

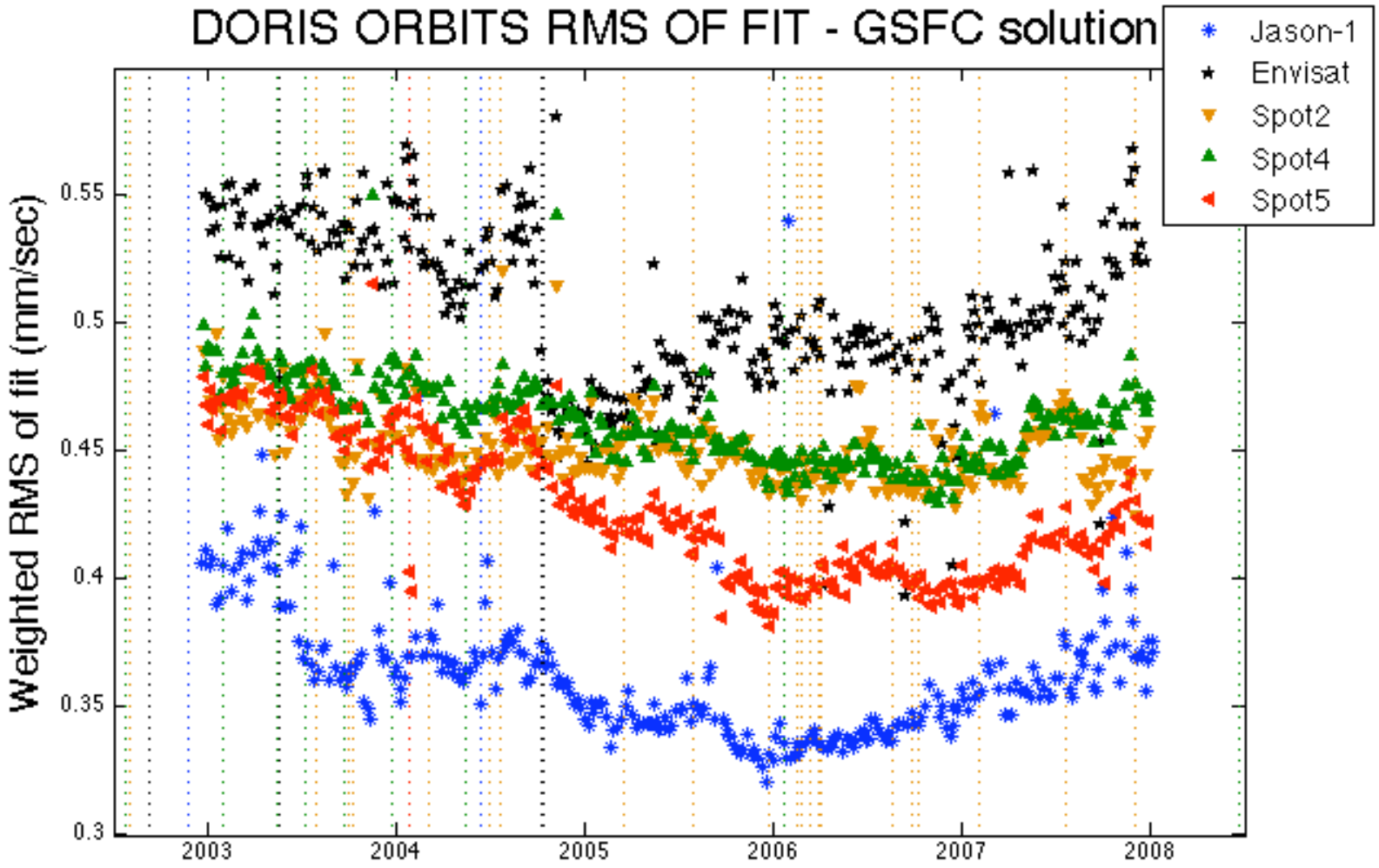
Conclusions and perspectives (1)

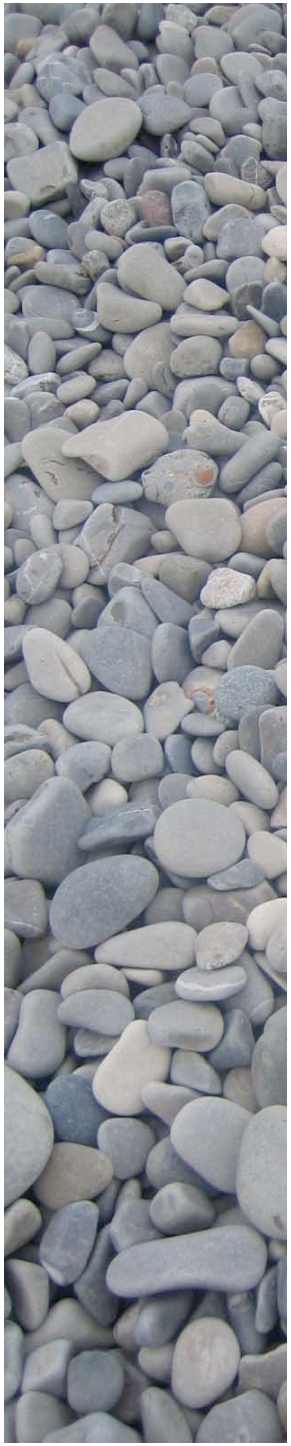
- 5 years of SINEX files (Envisat, spot2, spot4 and spot5) in the normal equations format.





- DORIS events:
  http://ids.cls.fr/html/doris/events.php3

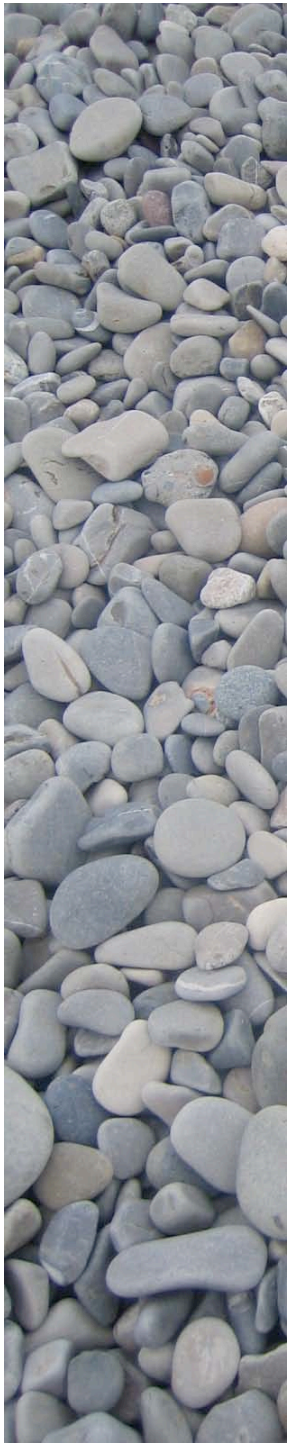




Conclusions and perspectives (2)

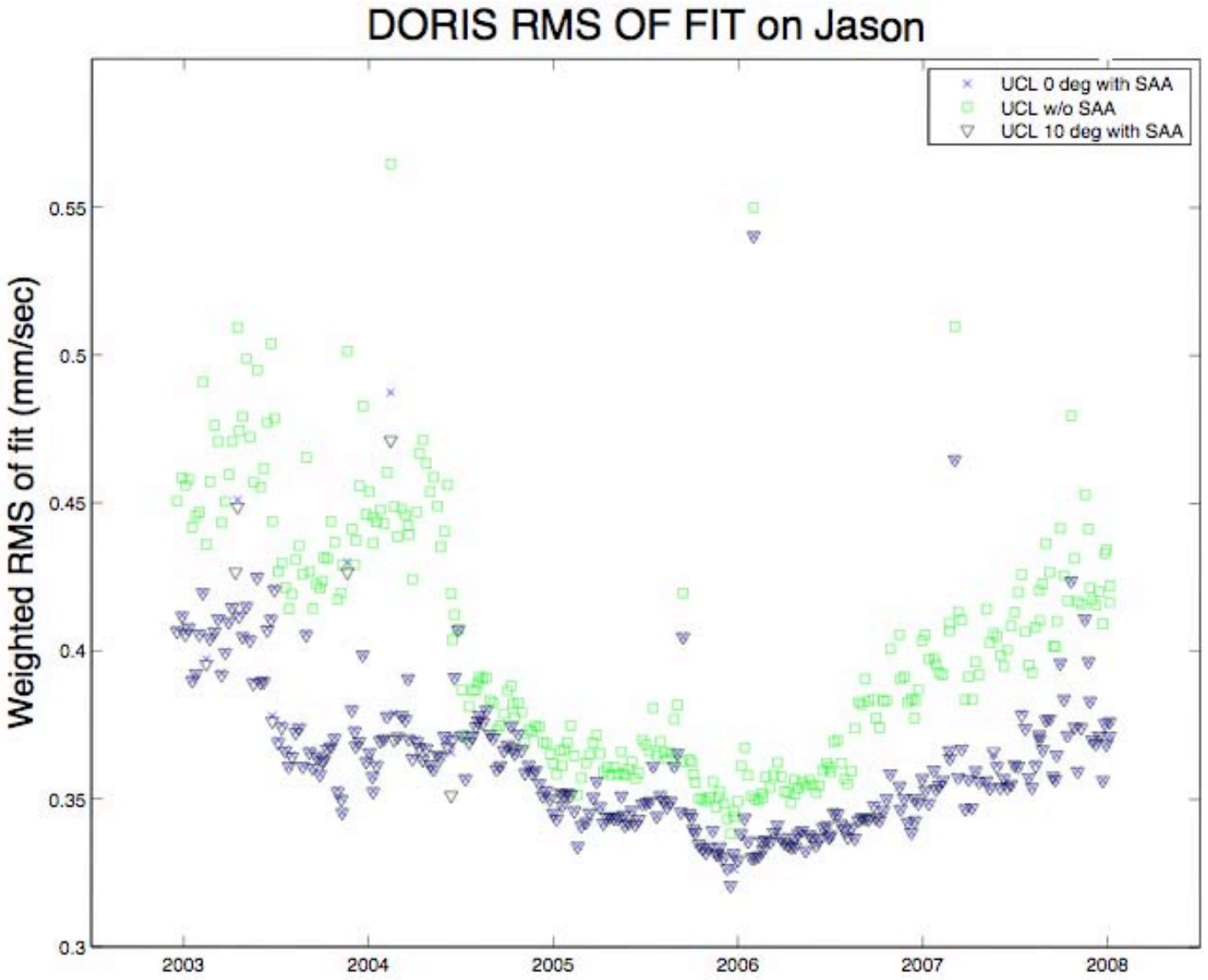
- For ITRF2008 :
  - Test with GOT4.7;
  - Add EIGEN-GL04S1;
  - Spot3, TOPEX/POSEIDON;
  - Updated set of a priori station positions (DPOD2005);
  - Extension to 1994-2008.
- Solution analysis (AGU) :
  - DORIS geocenter;
  - DORIS time-variable gravity coefficients compared to GRACE.

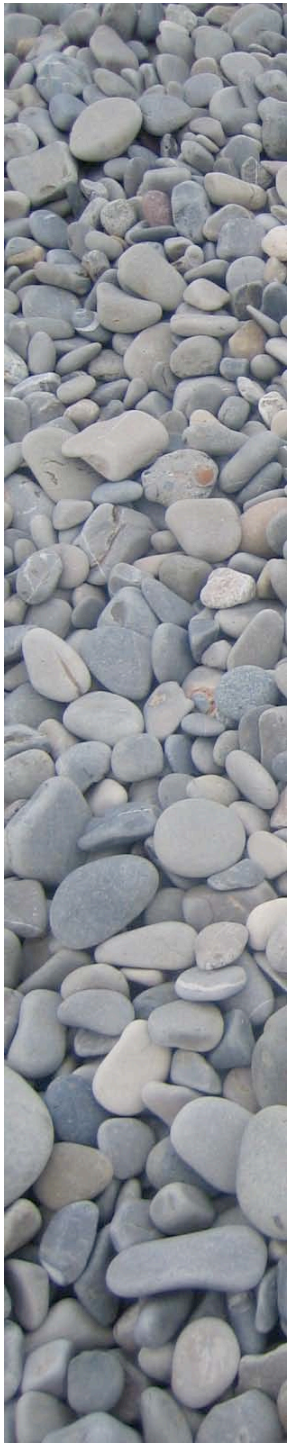

Thank you for your attention!



Jason test (1)

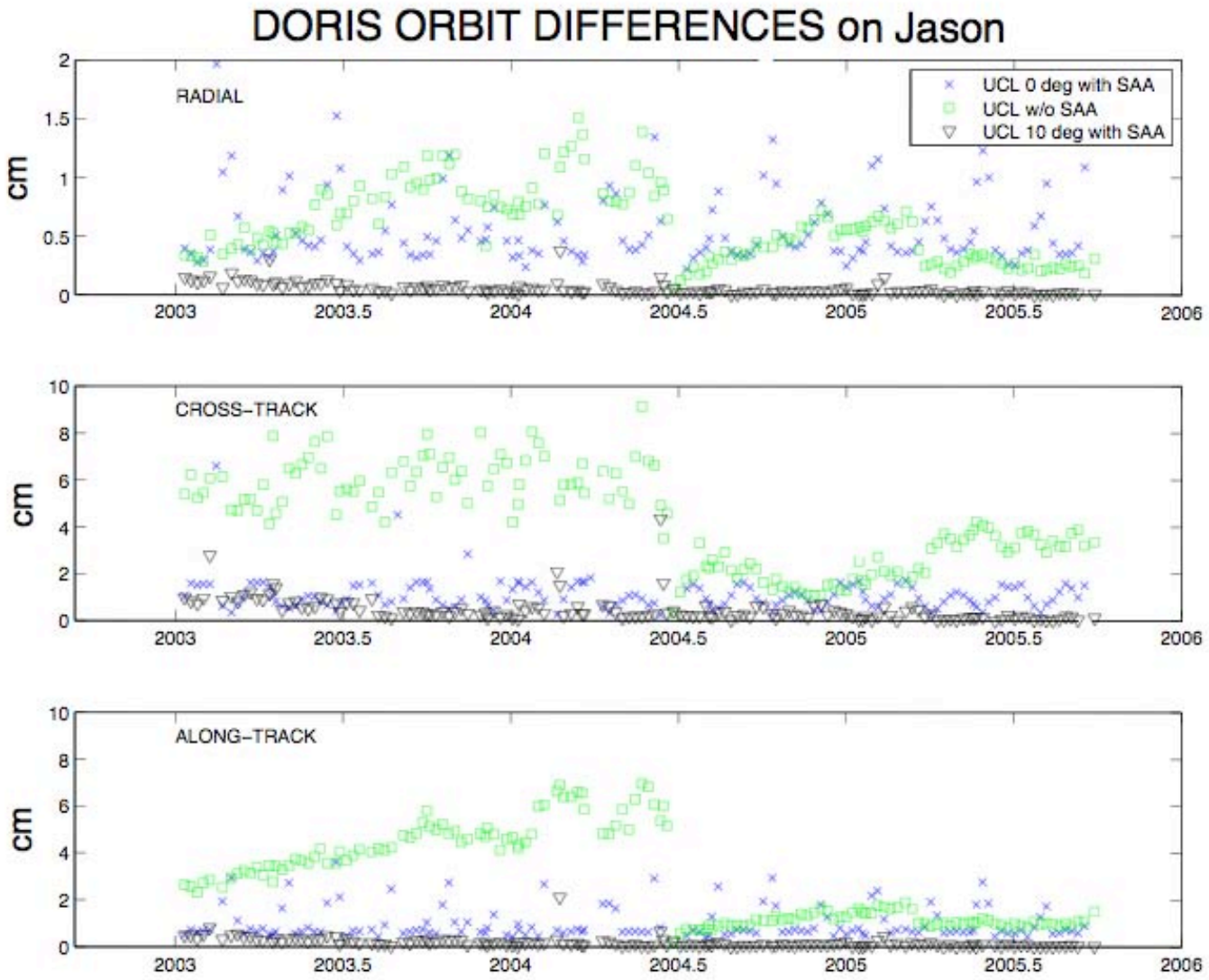
Use of SAA model

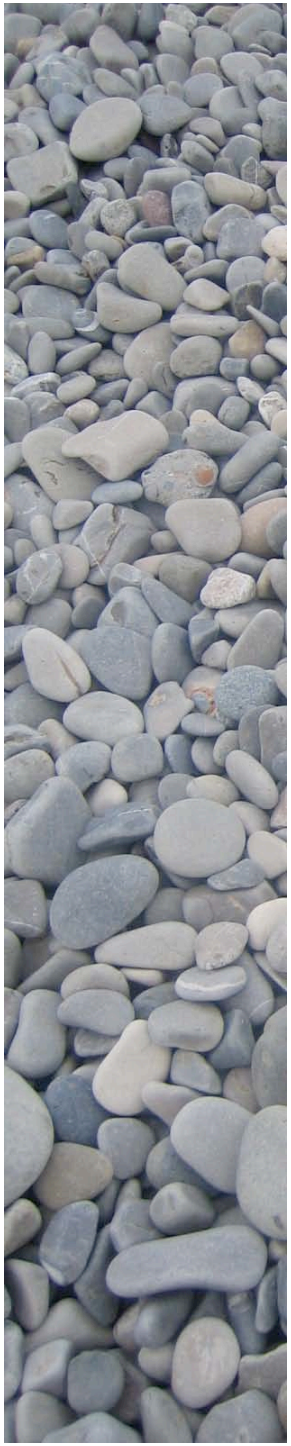




Jason test (2)

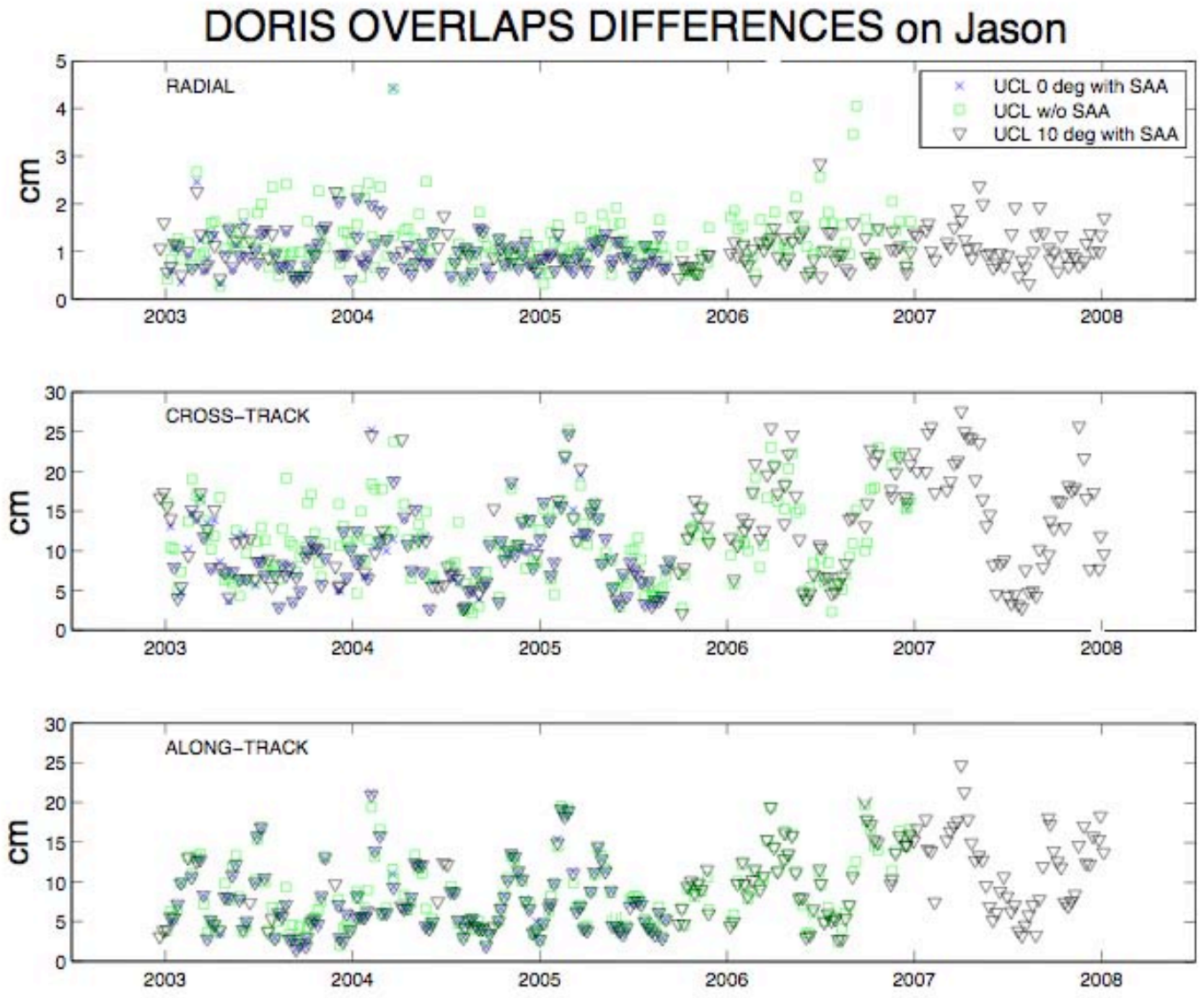
Use of SAA model

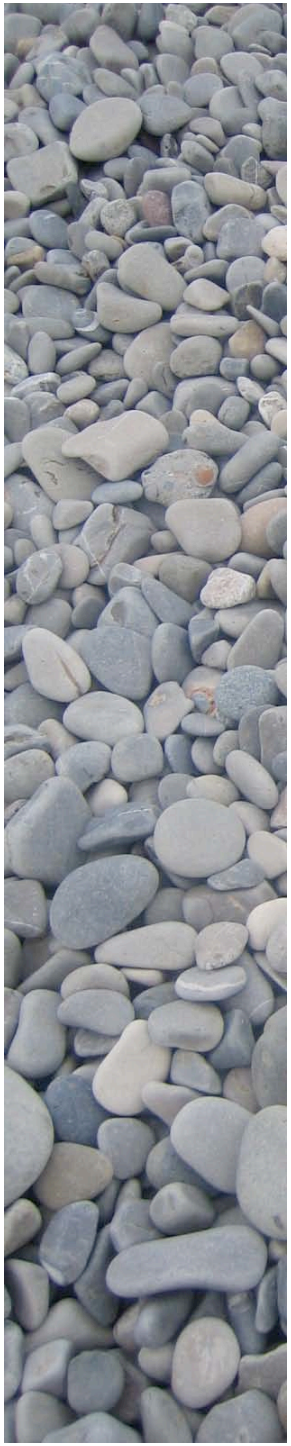




Jason test (2)

Use of SAA model (c)

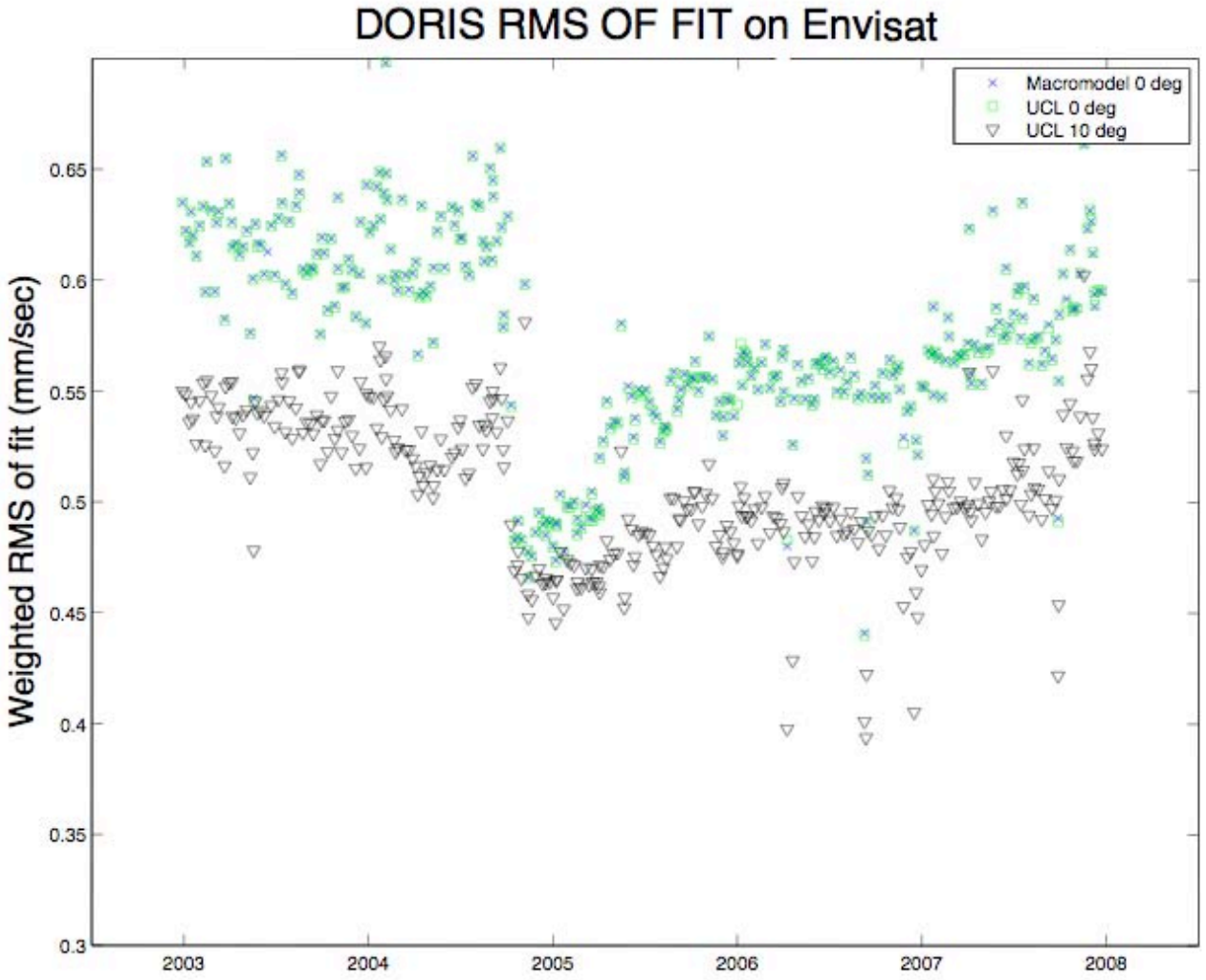




UCL vs macromodel for Envisat (1)

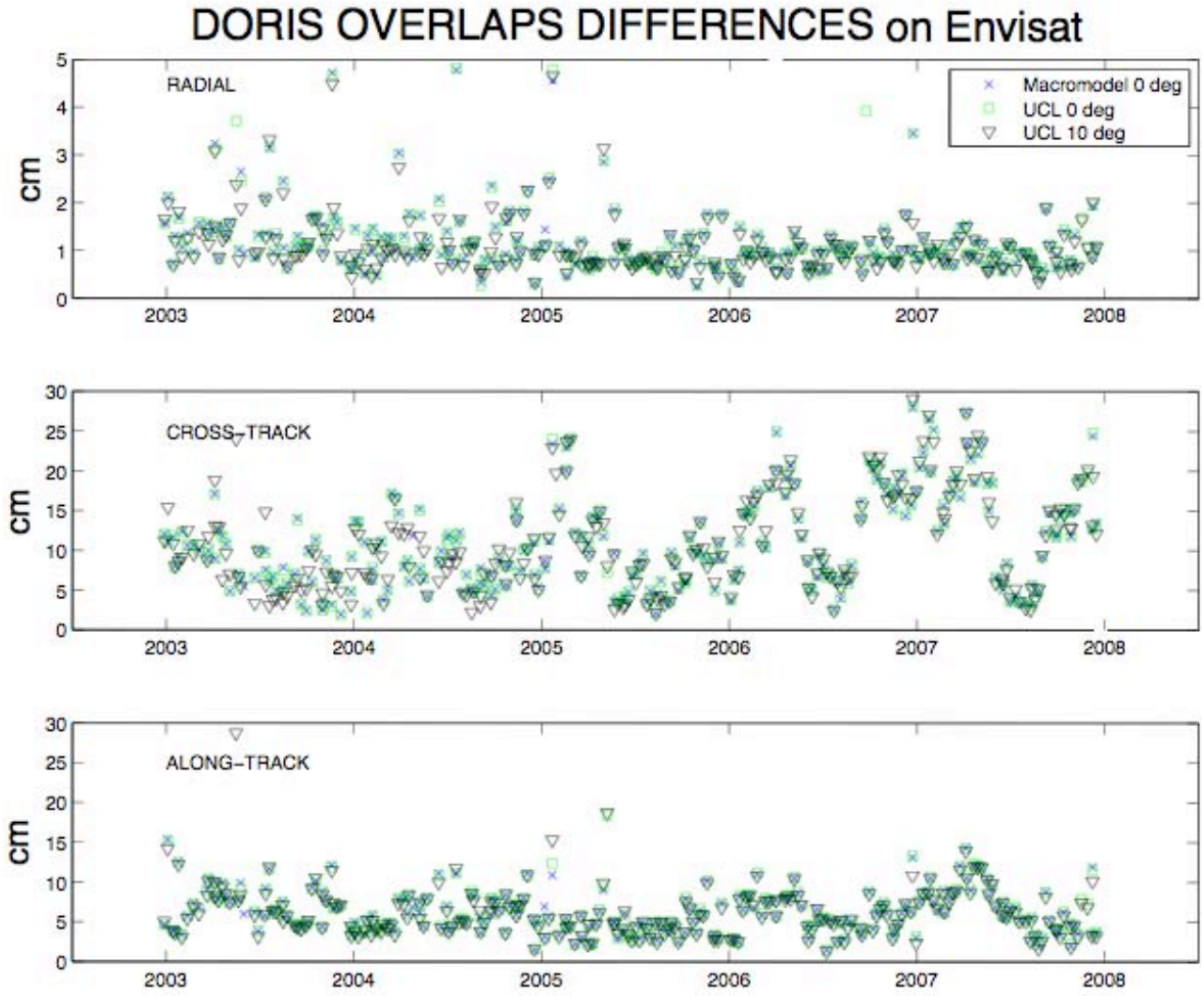
RMS of fit : no significative improvement

Median : 0.5714 (macro) / 0.5706 (UCL)



UCL vs macromodel for Envisat (4)

Differences in overlaps



Macromodel vs UCL for Envisat (2)

Orbit differences