+ …

DPOD2008

Method, status report and future plans

Pascal Willis and the DPOD2008 team

(by alphabetical order)

Don Argus (JPL), Luca Cerri (CNES), Michael Heflin (JPL), Frank Lemoine NASA/GSFC), Guilhem Moreaux (CLS), Michiel Otten (ESA/ESOC), John Ries (UT/CSR), Laurent Soudarin (CLS), Nikita Zelensky (SGT)

SUMMARY

- What is DPOD2008?
- Why do are we doing it?
- How was it derived (a few examples)?
- How did we test it? :
  - internal checks
  - external checks
- Future plans

What is DPOD2008?

- = DORIS Precise Orbit Determination (data set)
- Previous work done :
  - DPOD2000 (Willis and Ries, J. Geod., 2005)
  - DPOD2005 (Willis et al., ASR, 2009)
- Latest version is version 1.1 (complete set)
  - Online at http://www.ipgp.fr/~willis/DPOD2008/
- Piecewise linear model + info on bad data periods (per DORIS beacon)
- Example:
  - ASDB 30602S004 01.02.98 20.01.02 6121161.5410 -1563943.1853 -872613.0491 -3.24 -8.96 11.14
  - ASDB 30602S004 21.01.02 13.04.02 XXX XXX XXX XXX XXX XXX
  - ASDB 30602S004 14.04.02 13.06.10 6121161.5410 -1563943.1853 -872613.0491 -3.24 -8.96 11.14
  - ASEB 30602S005 14.06.10 ... 6121154.0976 -1563976.6779 -872606.0745 -3.24 -8.96 11.14

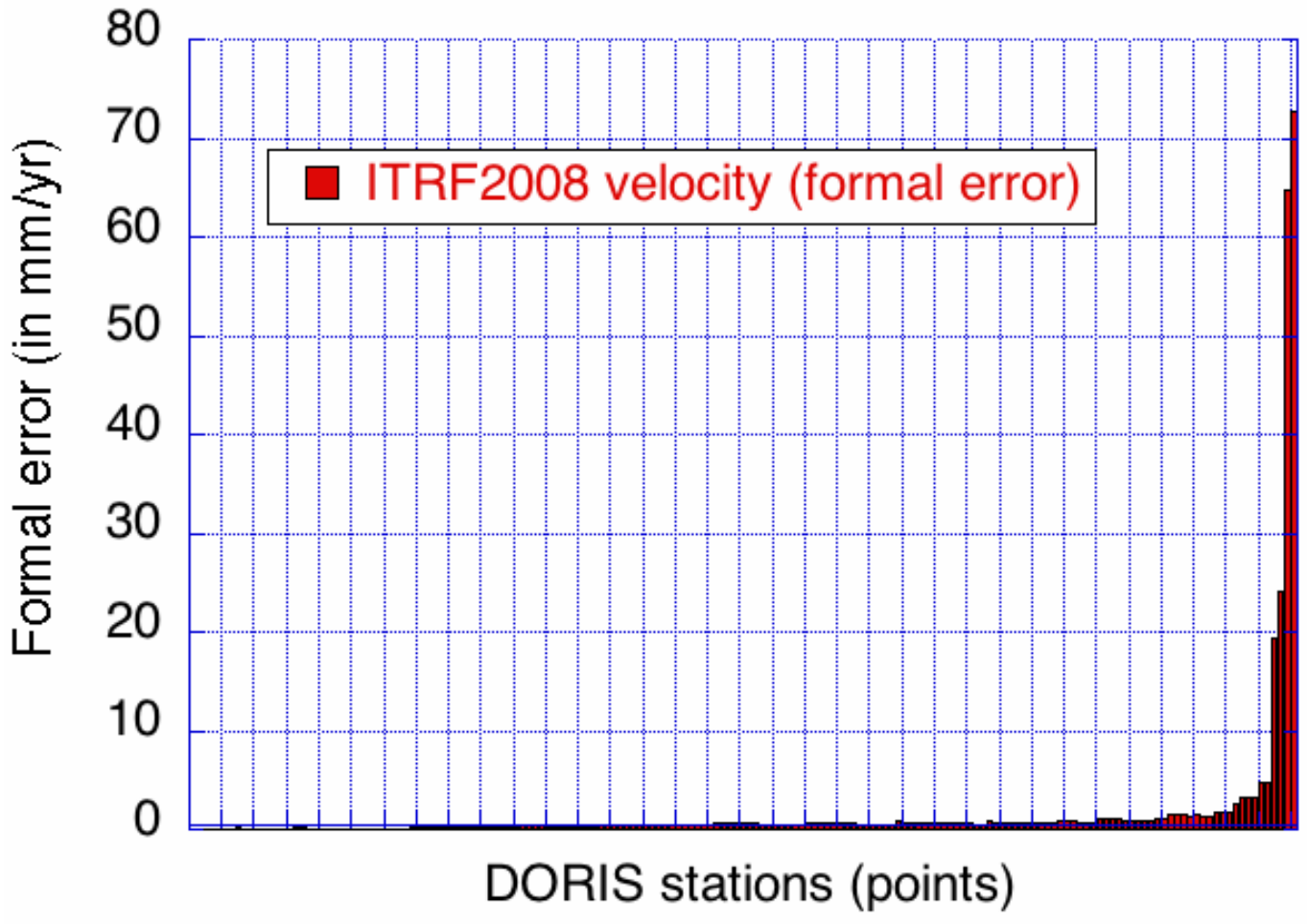
Why are we doing it?
(and not just use ITRF2008, IDS-3, IGN09D02, …)

- Required for operational POD computations

Consequently ➔

- Need to include **all available** DORIS stations
  - ITRF2008 = 130 DORIS beacons
  - DPOD2008 = 166 DORIS beacons
    - (will also be updated for new stations)
- Need to specify **time of bad data** quality for some stations
  - In version 1.0 = 32 such time intervals exist
- Need to be usable for the next few years (**velocity must be reliable**)
  - 2 stations in ITRF2008 with velocity formal error ranging from 20 to 80 mm/yr (Fairbanks = 2 points, Reykjavik = 1 point)
  - For these stations, expected ITRF2008 position error from extrapolation from 2009.0 to 2013.0 is between 8 to 32 cm (see Morel and Willis, ASR, 2002 for consequences on POD results, especially for stations at latitude close to the satellite inclination = 66 deg)

ITRF2008 velocity formal errors

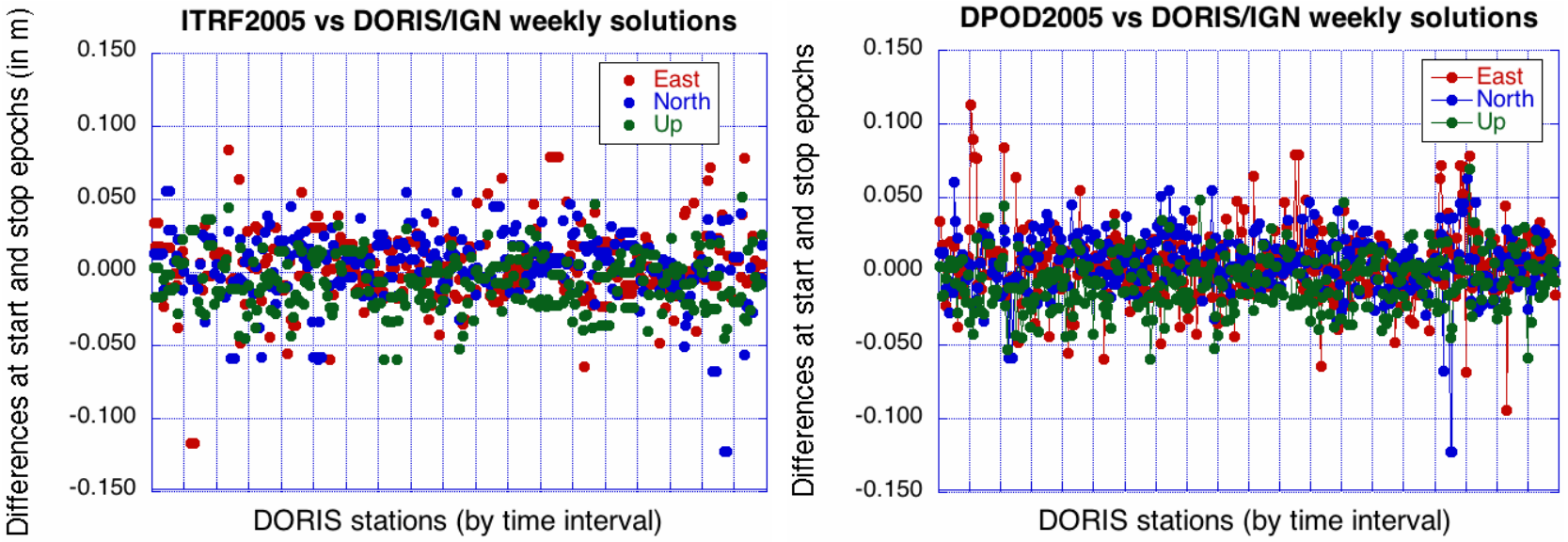


(averaging X,Y,Z velocities formal errors)

Testing prediction of ITRF2005 and DPOD2005 solutions with recent DORIS weekly results (up to 2011.25)

ITRF2005
114 stations in file
Pb with AREA, AREB, SANB*, SODA
RMS (E/N/V in mm) = 25.4/24.4/19.7

DPOD2005
158 stations in file
Pb with KOKA**, SANB*, SODA
RMS (E/N/V in mm) = 25.3/21.5/19.2

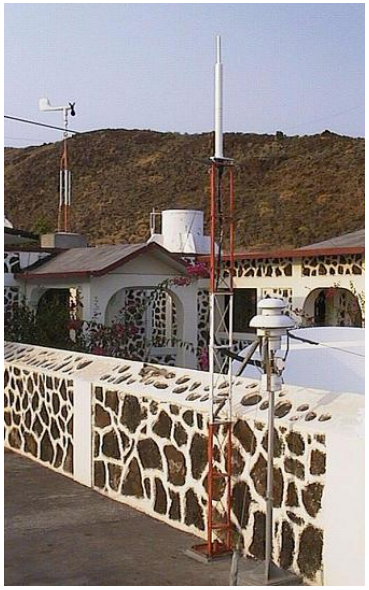


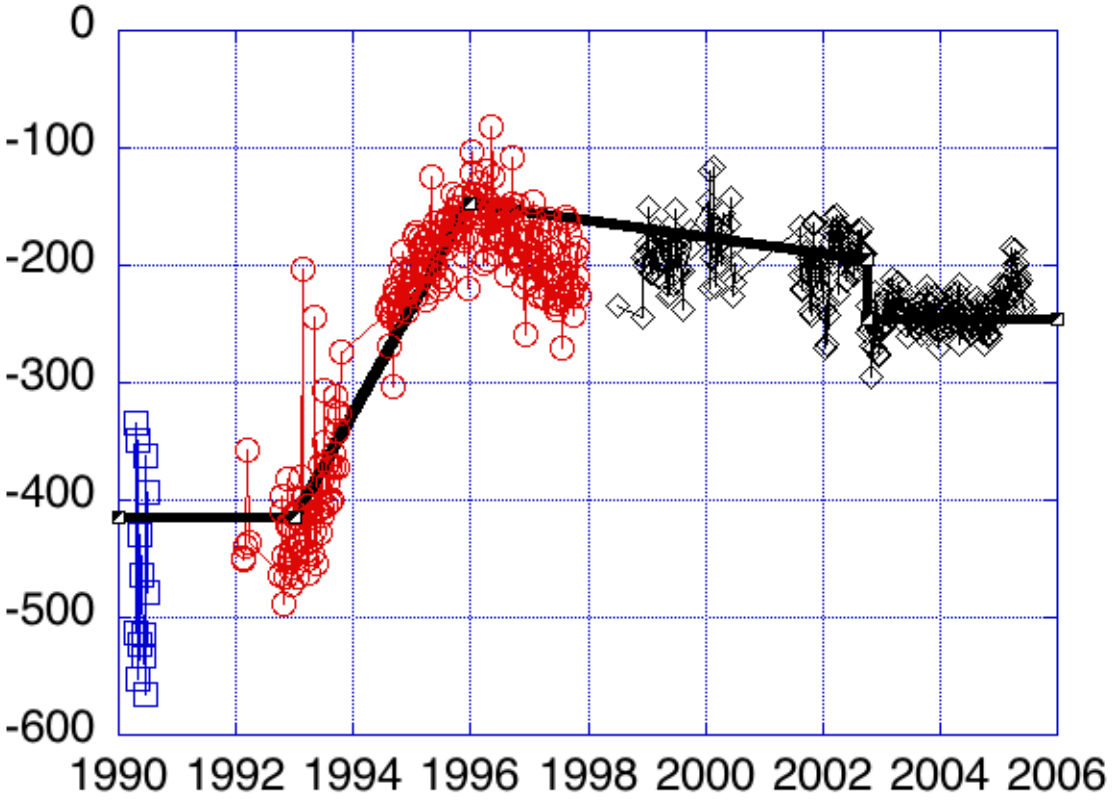
* = Earthquake happening after 2006.0 ** = Typo in KOKA Z-velocity (sign error)

How did we derive it?

- Sources of information
  - Original ITRF2008 data set
  - Recent DORIS/IGN cumulative position/velocity solution (tf_110422a)
  - Time series of station positions expressed in ITRF2008
    - Weekly DORIS (from 1993.0 – 2011.25 for estimation) – IGN (for tests)
    - Weekly DORIS (from 1990.0 to 1993.0 for evaluation) – IGN (for use)
    - Daily GPS (from 1996.0 to 2011.25) - JPL
  - Geodetic local ties – (SIMB version 110510)
  - Plate tectonic models (GEODVEL, Argus et al., GJI, 2010)
  - Post-glacial rebound models (ICE-5G, Peltier et al.,)
  - DPOD2005
- Basic rules :
  - Check and use original ITRF2008 positions/velocities as much as possible
  - Otherwise use velocity from GPS, geophysical model, or DORIS and estimate only position at epoch 2000.0 using DORIS weekly results
  - Test results with all available other source of information (at different epochs)

A few examples (1) (Socorro)





DORIS weekly results (North)

After removing plate motion

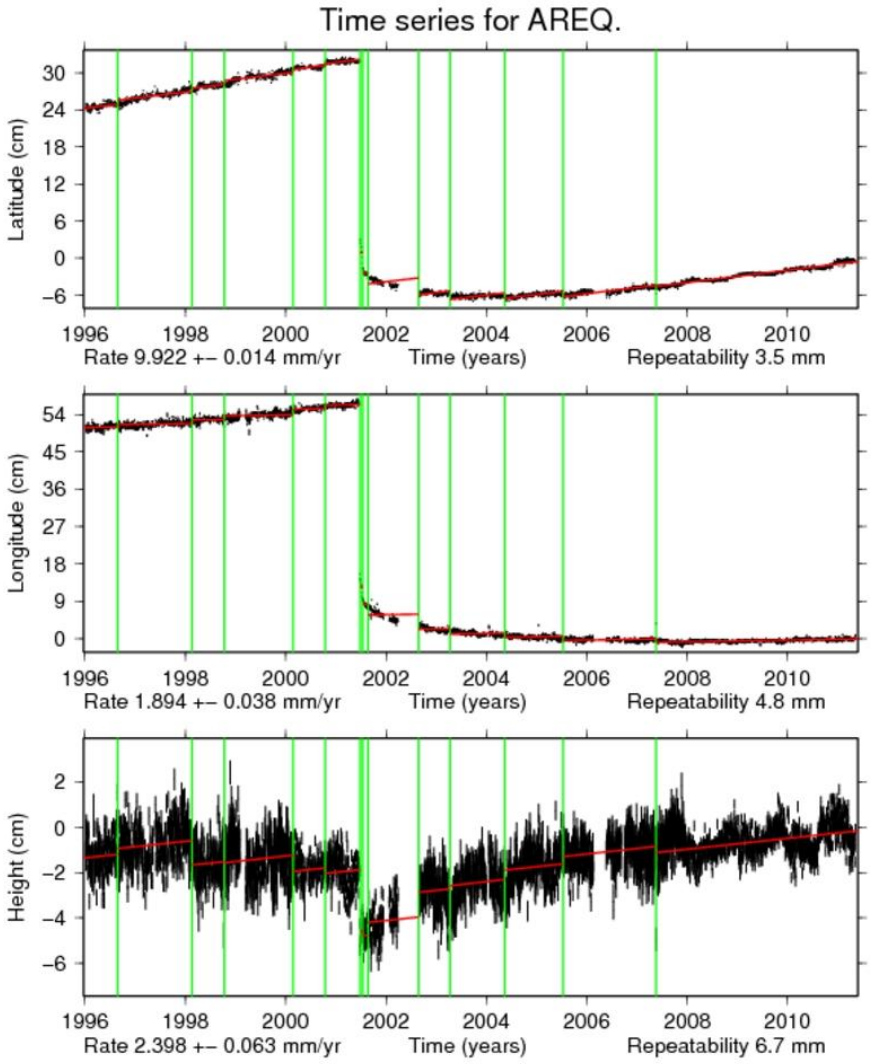
See Briole et al., GJI, 2010

Piecewise linear model

Using continuity conditions

Using local tie (around epoch of observations, even when Velocities are different)

A few examples (2)
Arequipa



DORIS = AREA*
AREB
ARFB

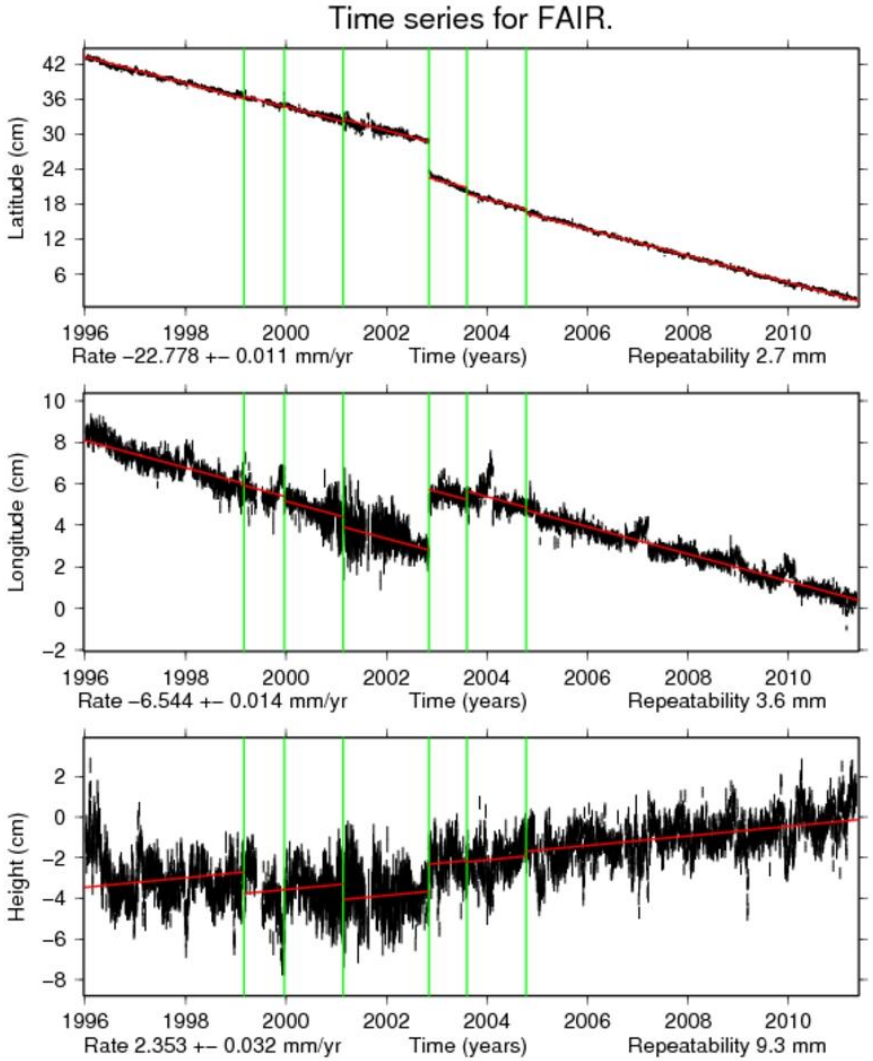
GPS daily time series available at

http://sideshow.jpl.nasa.gov/mbh/all/plots/AREQ.jpg

-Earthquake on June 22, 2001*

-Discontinuity in position
(more in GPS vs DORIS)
-Discontinuity in velocity
-Relaxation process
(several months or years
after the Earthquake)

A few examples (2) Fairbanks



DORIS is : FAIA
FAIB*

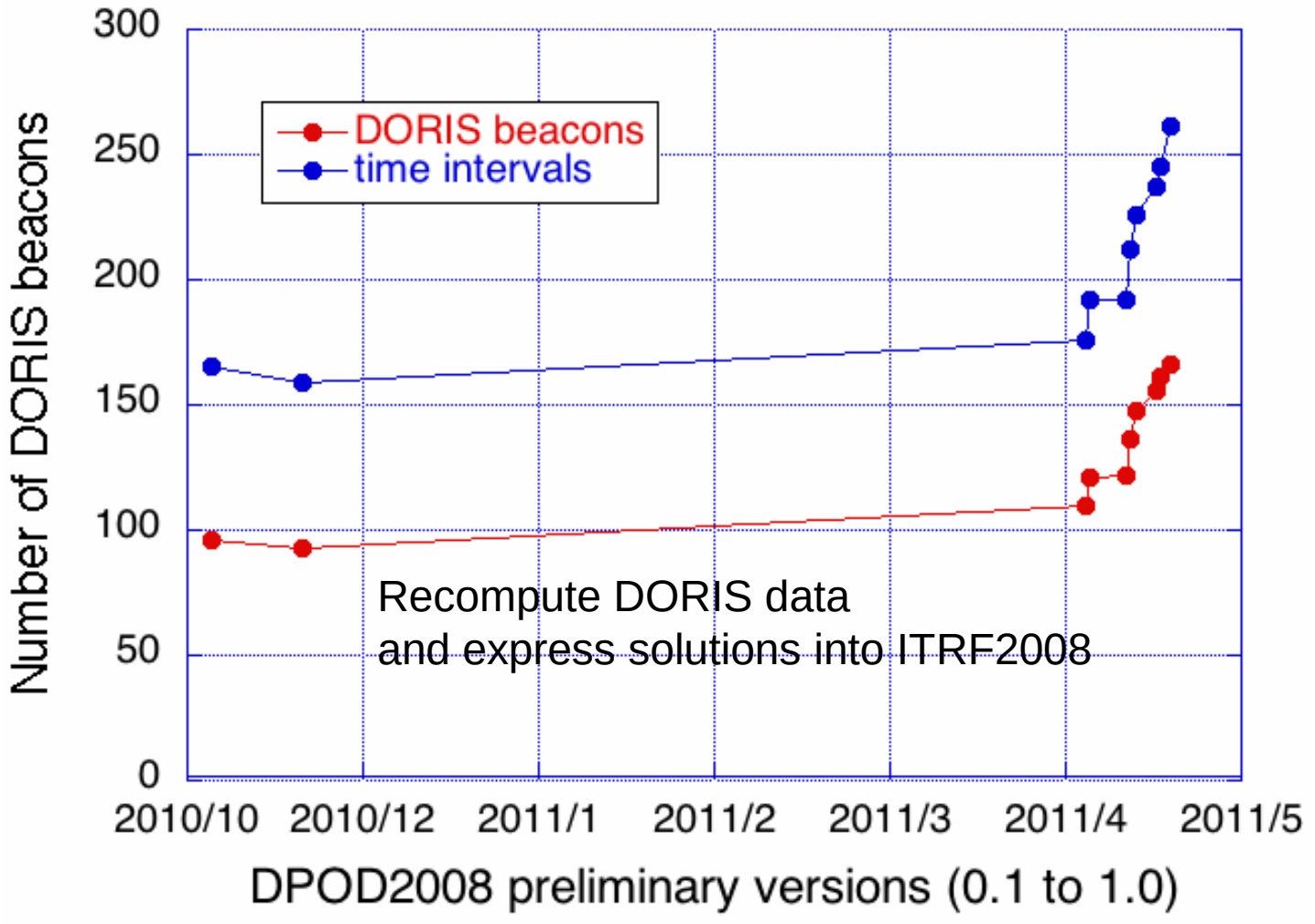
GPS daily time series available at

http://sideshow.jpl.nasa.gov/mbh/all/plots/FAIR.jpg

-Earthquake on November 2, 2002*

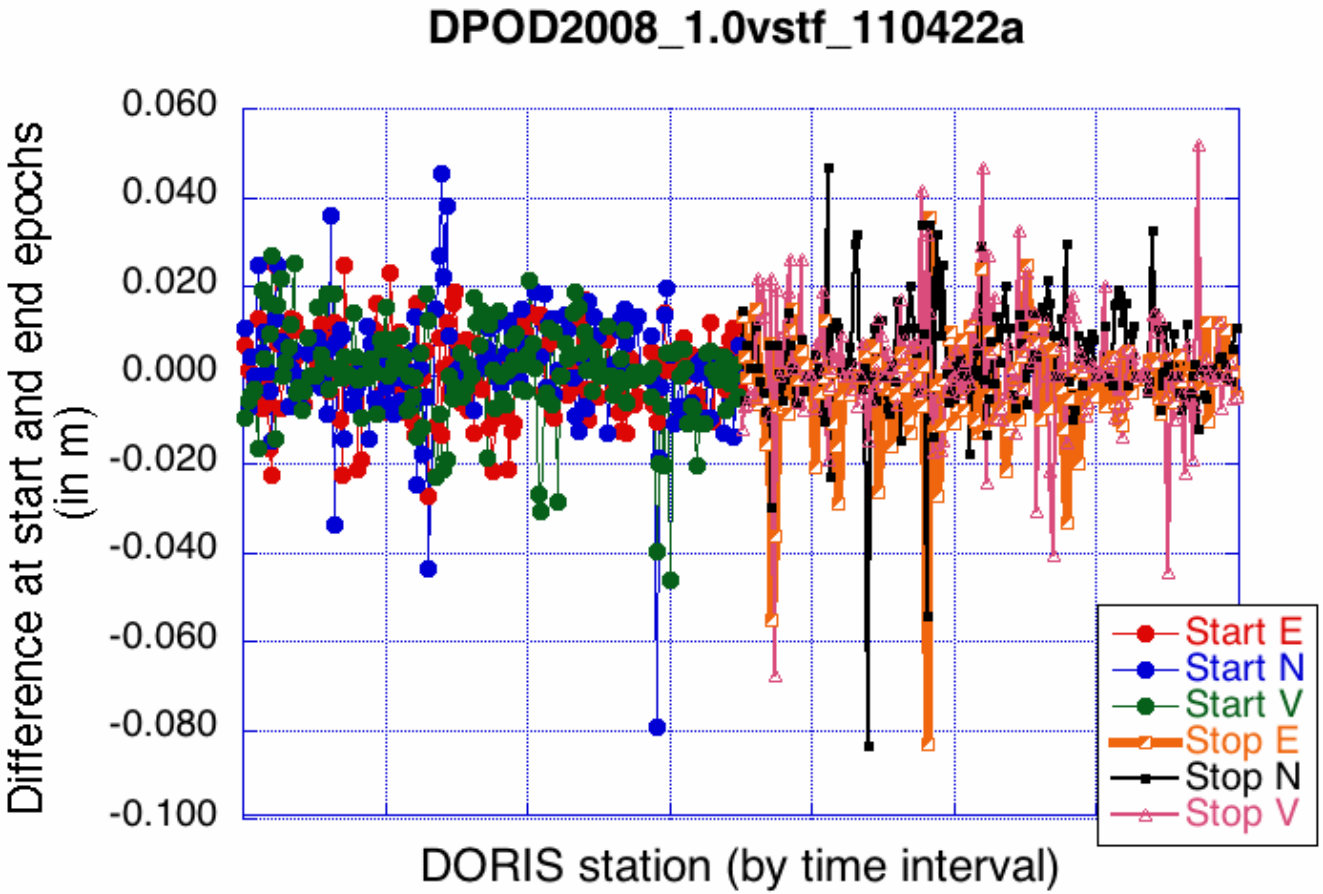
-Discontinuity in position
-(more in GPS vs DORIS)
-Discontinuity in velocity
-Relaxation process

Historical considerations



Internal check (1)

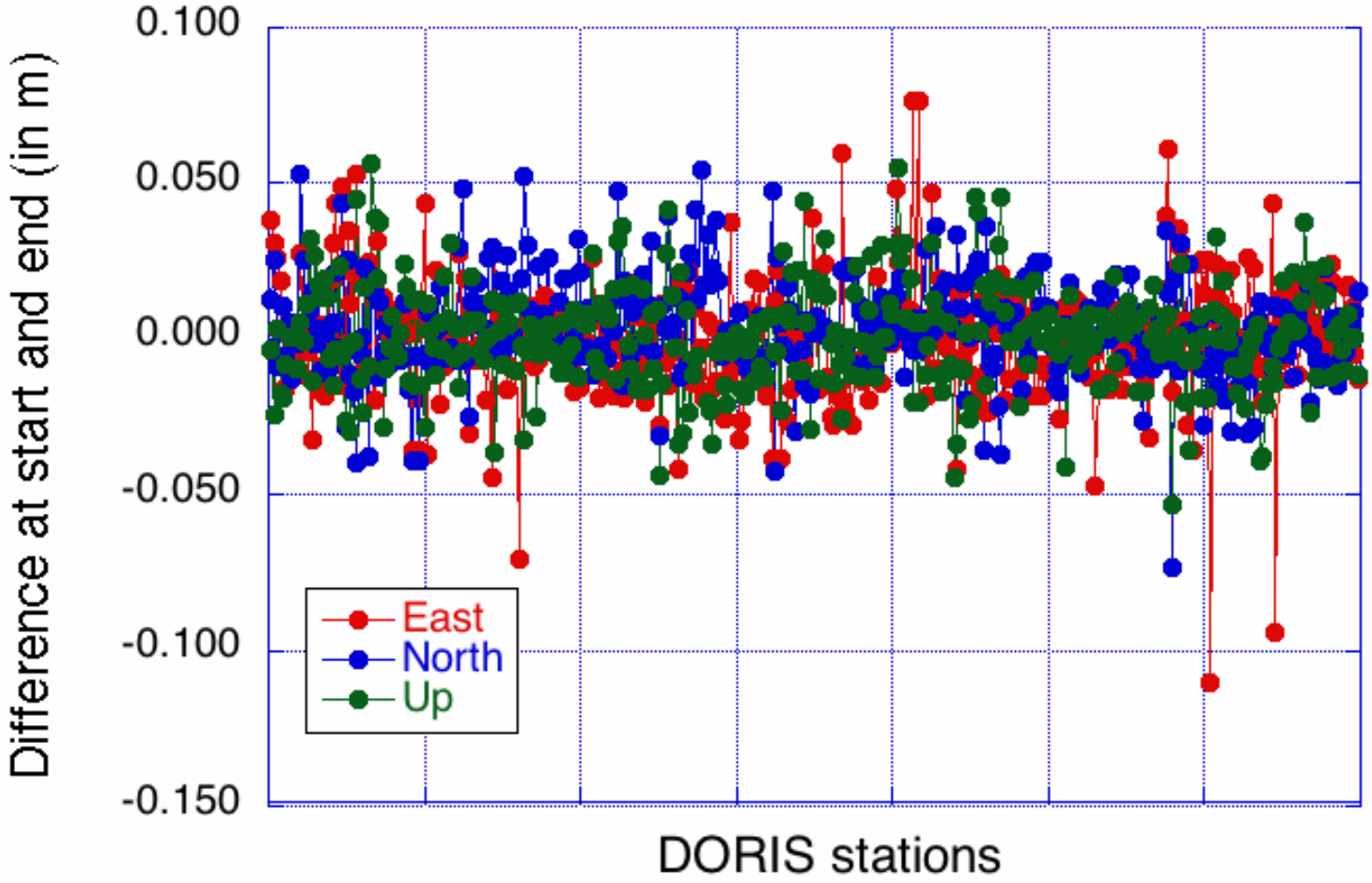
Verifying DPOD2008 with another position/velocity solution (DORIS/IGN tf_110422a) at start and end epoch of each time interval



NB: comparison is done even if no DORIS data exist at start or end

Internal check (2)

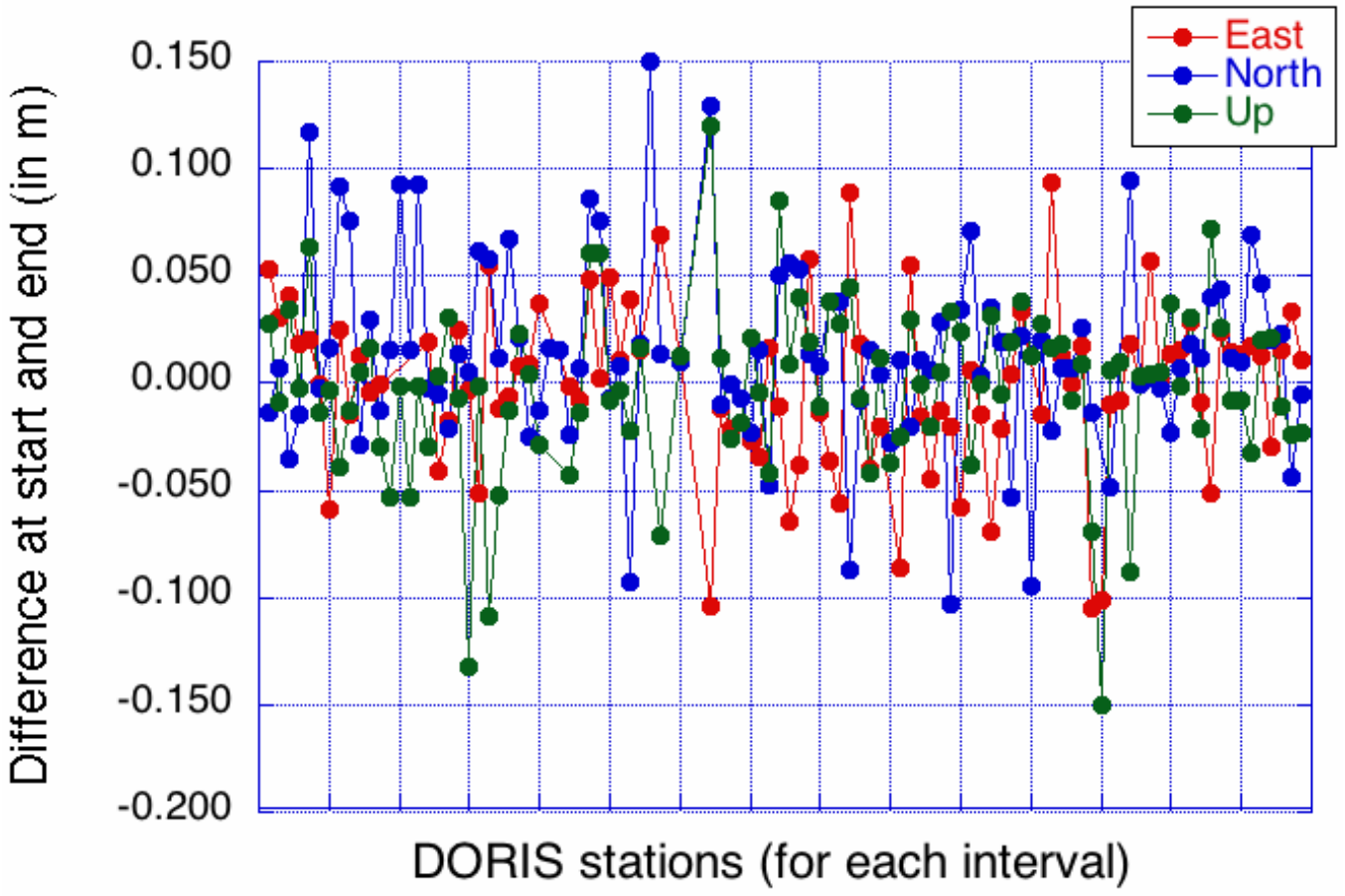
Verifying DPOD2008 with a DORIS time series
at start and end epoch of each time interval
(recent 1993.0 -2011.25 data)



NB: using 3-week smoothing and after removing KERB (20 cm up) and SODA
DORIS data exist

External check (1)

Verifying with a DORIS time series
at start and end epoch of each time interval
(1990.0 -1993.0 data)



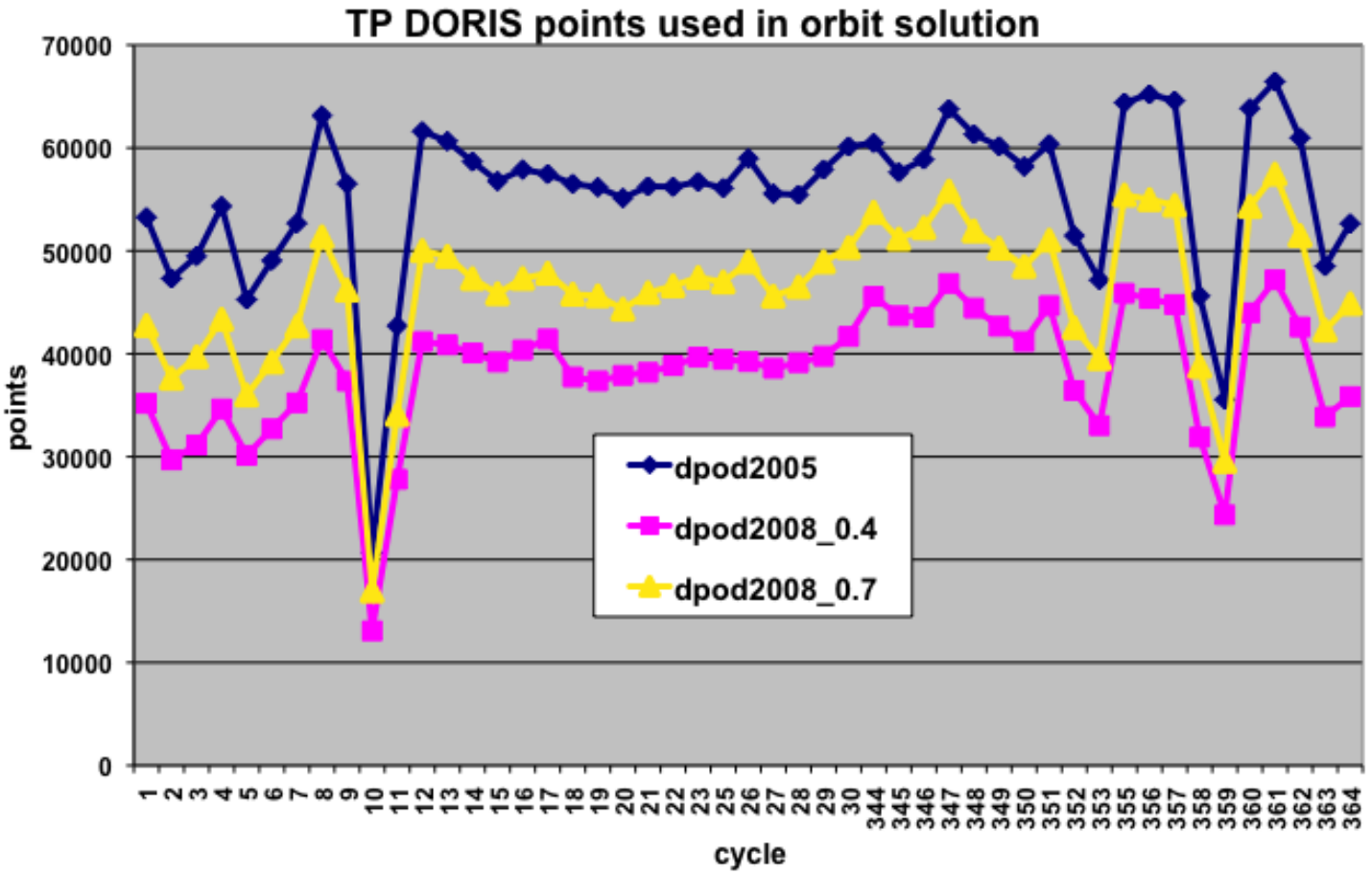
DPOD2008 is used in an extrapolation mode (3 years)

NB:SPOT-2 only results are also noisier

NB: using 3-week smoothing and after removing HUAA and MORA

External check (2) – POD/TOPEX

TOPEX/Poseidon (TP) DORIS tracking (Sep 1992- Jul 1993, Jan 2002 - Aug 2002)

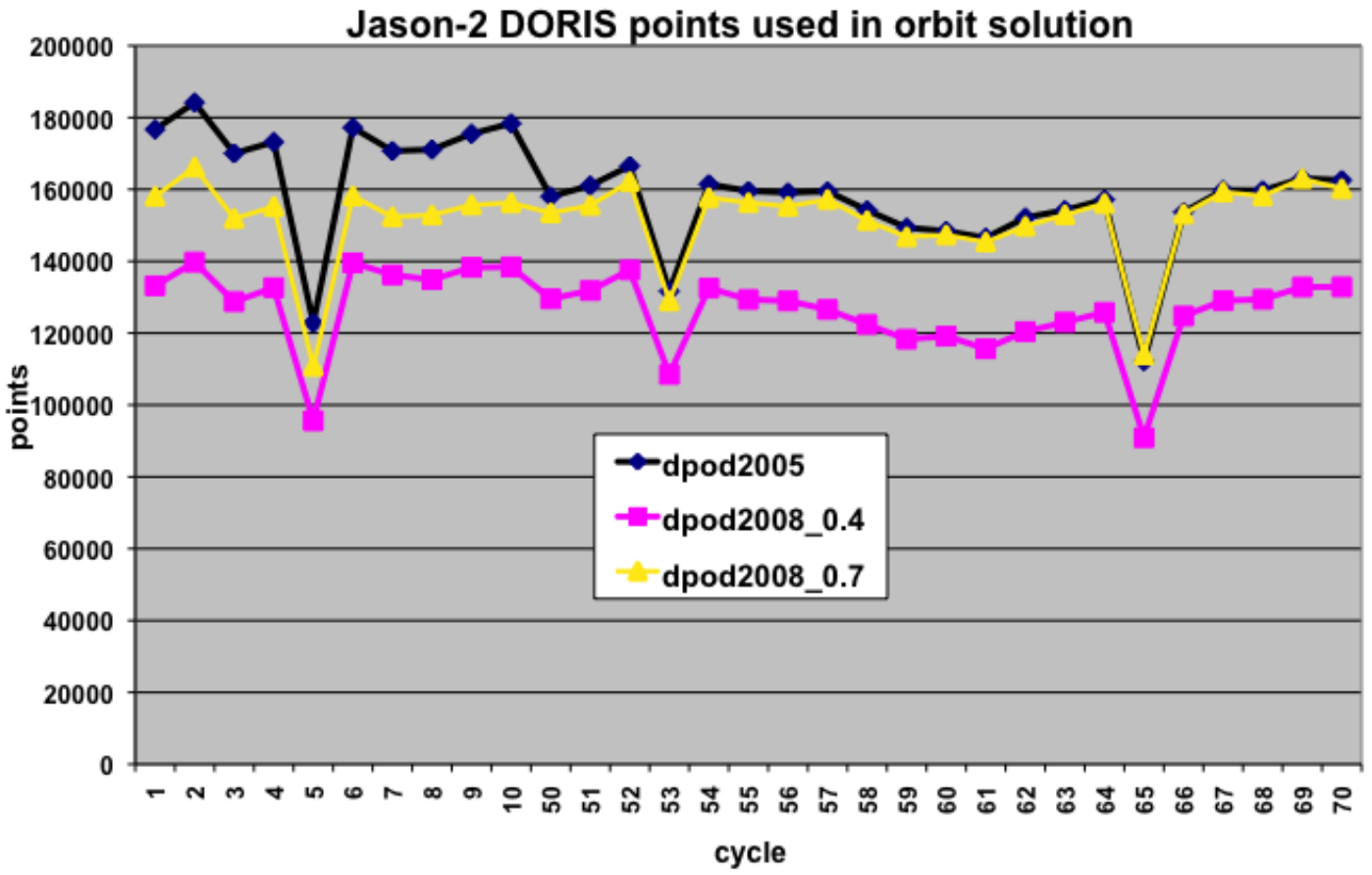


TP DORIS Performance

TP DORIS performance over the march of time						
period	test DORIS-only	number stations	average points / cycle	average residuals / cycle		
				doris (mm/s)	slr* (cm)	xover* (cm)
Apr 19, 1993 - Jul 17, 1993 (TP cycles 22-30)	dpod2005	45	57135	0.5386	4.83	5.936
	dpod2008_0.7	39	47658	0.5406	4.99	5.977
	itrf2008**	39	47658	0.5406	4.99	5.976
Jan 15, 2002 - Aug 11, 2002 (TP cycles 344-364)	dpod2005	53	57365	0.4733	4.16	5.622
	dpod2008_0.7	47	49015	0.4746	4.11	5.652
	itrf2008**	47	49015	0.4746	4.12	5.641
* independent data ** edited to match dpod2008_0.7 tracking						

External check (3) – POD/Jason-2

Jason-2 (J2) DORIS tracking
(Jul 2008- Oct 2008, Nov 2009 - Jun 2010)



Jason-2 DORIS Performance

Jason-2 DORIS performance over the march of time						
period	test DORIS-only	number stations	average points / cycle	average residuals / cycle		
				doris (mm/s)	slr* (cm)	xover* (cm)
Jul 7 2008 - Oct 19 2008 (Cycles 1-10)	dpod2005	56	170969	0.3677	---	5.607
	dpod2008_0.7	50	151736	0.3634	2.20	5.691
	itrf2008**	51	152163	0.3649	2.23	5.691
Nov 9 2009 - Jun 6, 2010 (Cycles 50-70)	dpod2005	50	153809	---	---	---
	dpod2008_0.7	49	151604	0.3664	2.71	---
	itrf2008**	45**	138938	0.3724	2.66	---

* independent data

** edited to match dpod2008_0.4 tracking (AMVB, CIDB, CRQB, RILB not in DPOD2005 or ITRF2008)

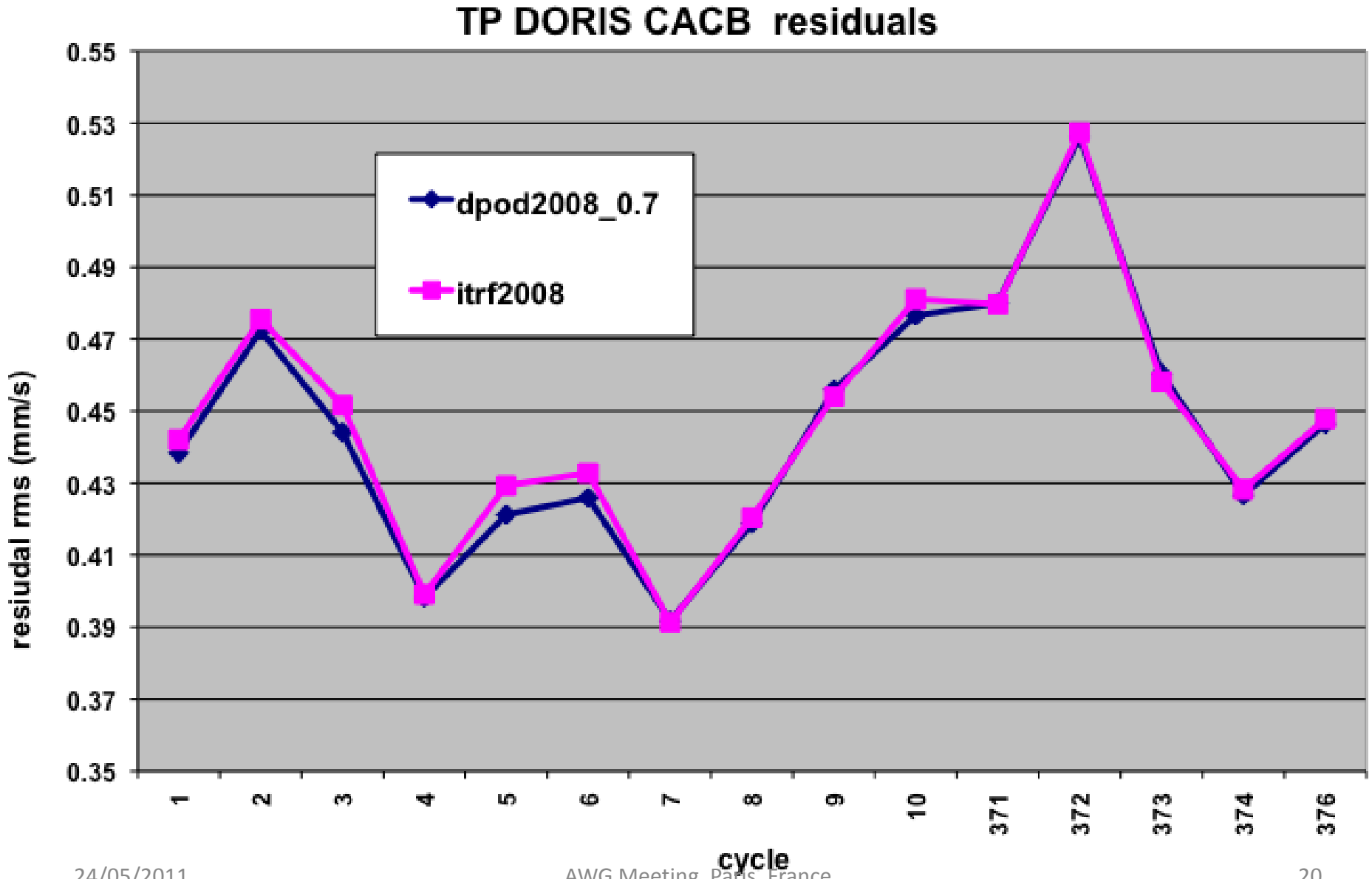
DORIS CACB and CADB realizations

DORIS Station difference ITRF2008-DPOD2008 0.7 (epoch 2005)						
Station	Position (mm)			Velocity (mm/y)		
	x	y	z	x	y	z
CACB	-6.9	54.9	6.0	1.313	10.265	-1.072
CADB	-29.1	5.8	4.0	1.313	10.265	-1.072

DORIS Station Performance: DPOD2008 0.7 and ITRF2008						
satellite	CACB # cycles	TRF	residuals (mm/s)	CADB # cycles	TRF	residuals (mm/s)
TP	15 cycles	dpod2008	0.4455	05 cycles	dpod2008	0.4243
		itrf2008	0.4479		itrf2008	0.4257

Improvement in CACB residuals may reflect that the newest DORIS/IGN solution may be less affected by SAA/SPOT5 problems
(see Stepanek et al., ASR, 2010; Bock et al., ASR, 2010)

DORIS CACB TP residuals



Future plans

- Solve DORIS problems detected while preparing these viewgraphs for:
  - AREB, HUAA, KERB, MORA, SODA
- Do more extensive POD tests :
  - Using recent Jason-2, Cryosat-2 + old TOPEX data
  - If possible complete reprocessing or test with cycles well distributed over the whole satellite lifetime
- Use all available GPS/DORIS co-location to test and/or improve DPOD2008 version 1.0. Some have not been used for ITRF2008 :
  - GODZ, GOD2, RCM6, RIO2, THU2, TID1, TID2, YAR2, …
- Recheck all solution velocities with recent plate motion + post-glacial rebound models
- Reconsider analysis for bad quality data (since 1990)
  - Looking in rejected data in DORIS/IGN analysis (as well as other analysis)
- Refine some models (Recheck stations with larger RMS in POD computations) and iterate

CONCLUSIONS

- DPOD2008 version 1.0 (first complete data set) is available at http://www.ipgp.fr/~willis/DPOD2008/
- More extensive POD tests are required
- New ideas for additional tests are welcome
- Ways for improvements :
  - Verify results at all co-located GPS sites
  - Check POD residuals / station / epoch
  - Recheck periods of bad data quality
- Final version will be available in mid June 2011