+ ...

DPOD2008 :
a DORIS terrestrial reference frame
for precise orbit determination

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(by alphabetical order)
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SUMMARY

- What is DPOD2008?

- Why 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 of positions/velocities)
- Previous work done :
  - DPOD2000 (Willis and Ries, J. Geod., 2005)
  - DPOD2005 (Willis et al., ASR, 2009)
- Latest version is version 1.4 (complete data 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
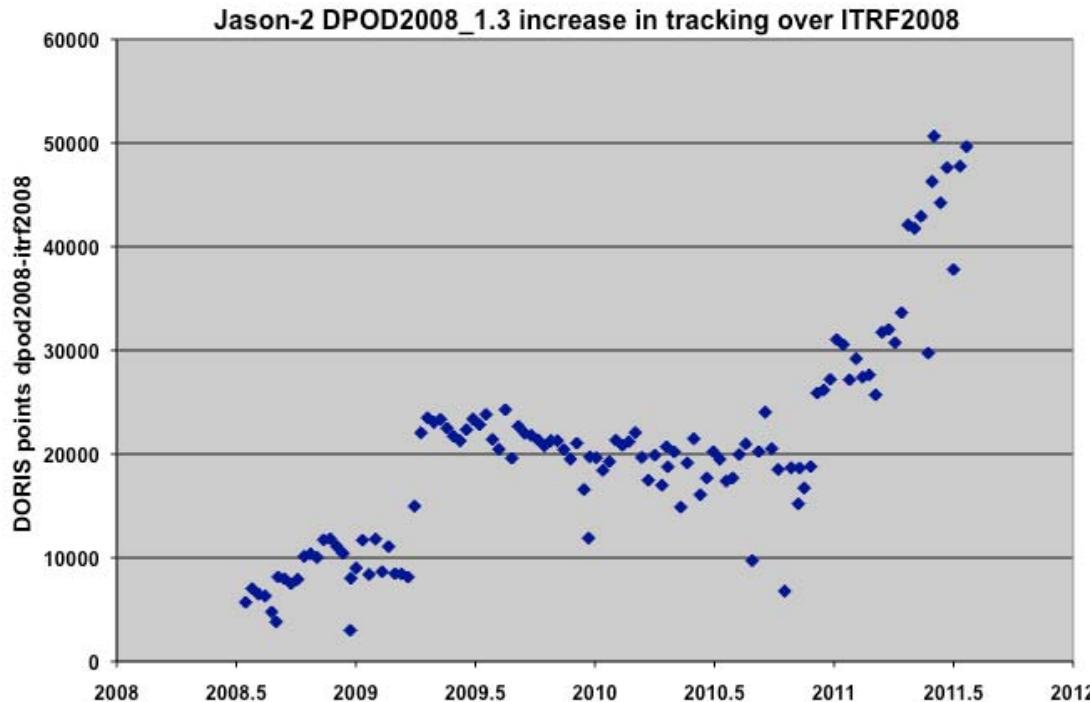
Why are we doing it?
(and not just use ITRF2008, IDS-3, IGN09D02, …)

- Required for operational POD computations
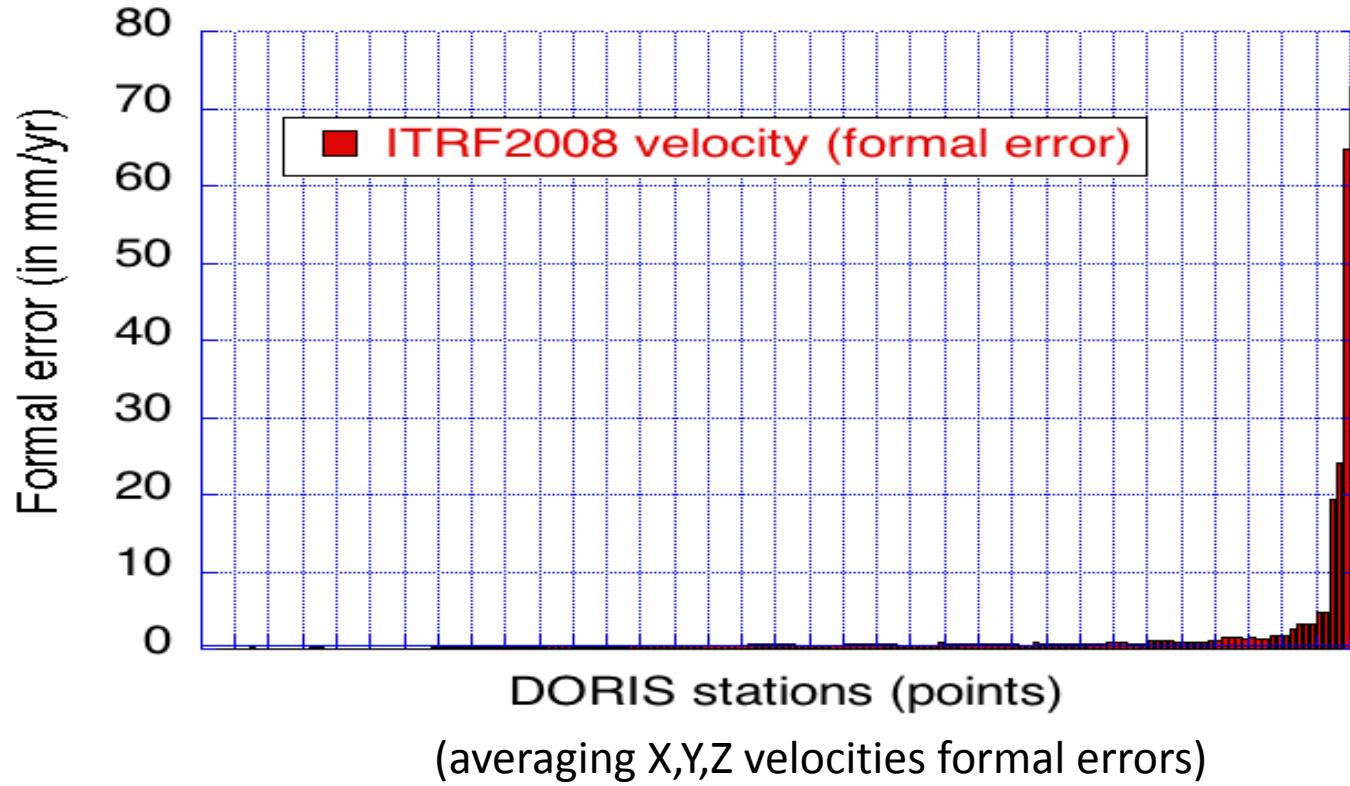
Consequently ➜

- 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)

Jason-2 increase in tracking (DPOD2008 vs ITRF2008)

Jason-2 DPOD2008_1.3 increase in tracking over ITRF2008

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)
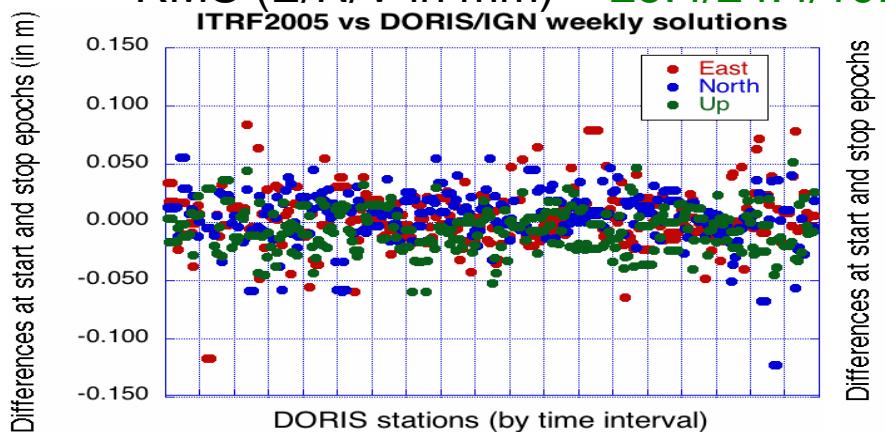
ITRF2005
114 stations in file
Pb with AREA, AREB, SANB*, SODA
RMS (E/N/V in mm) = 25.4/24.4/19.7
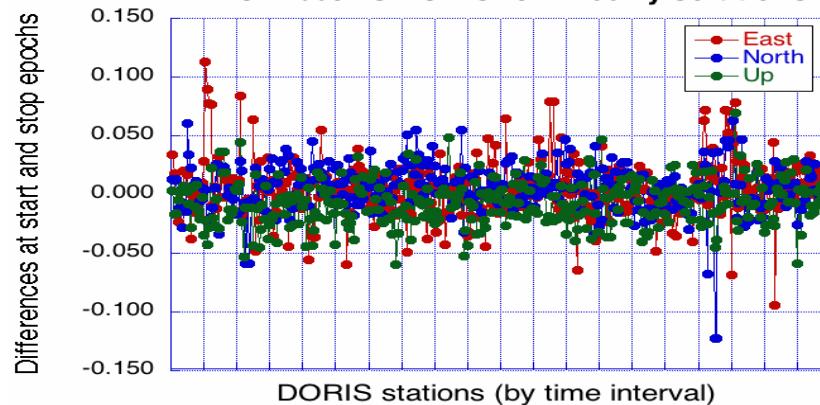
DPOD2005
158 stations in file
Pb with KOKA**, SANB*, SODA
RMS (E/N/V in mm) = 25.3/21.5/19.2
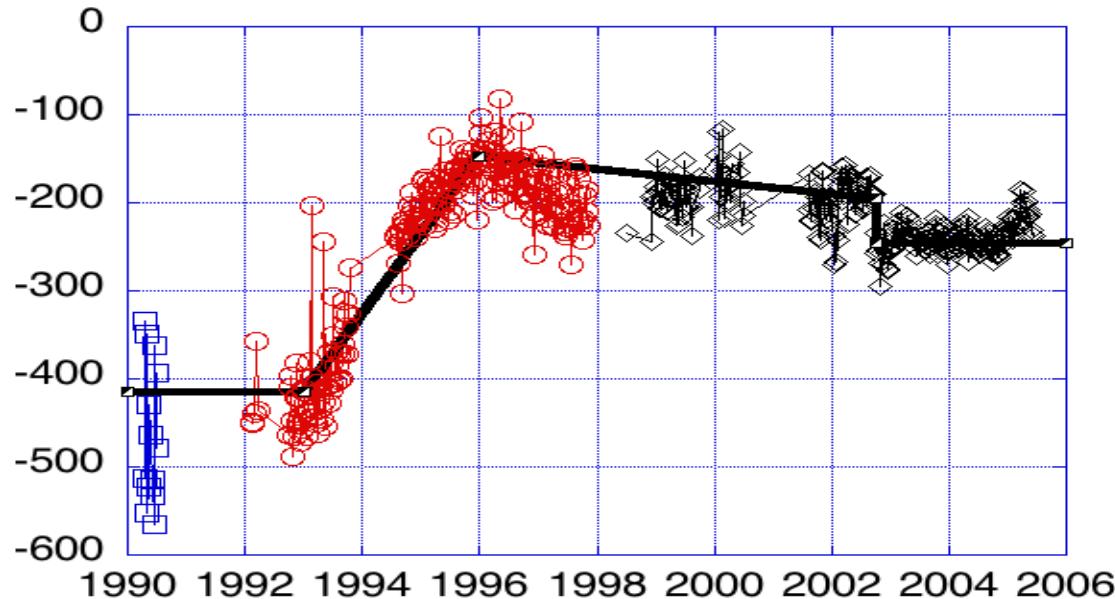
* = 2010 Chile/Maule Earthquake   ** = Typo in KOKA Z-velocity (sign error)

How did we derive it?
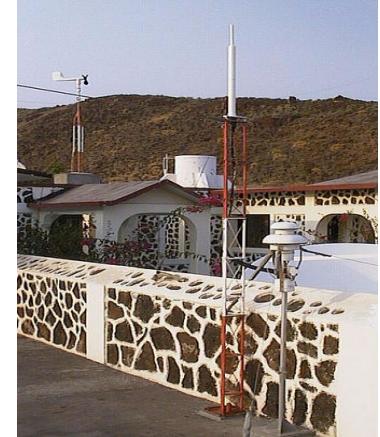
- Sources of information
  - Original ITRF2008 data set
  - Recent DORIS/IGN cumulative position/velocity solution (tf_110422a)
  - Time series of station positions expressed in ITRF2008
    - Weekly DORIS (from 1993.0 – 2011.25 for estimation) – IGN (for tests)
    - Weekly DORIS (from 1990.0 to 1993.0 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 VM2, Peltier, 2007)
  - DPOD2005
- Basic rules :
  - Check and use original ITRF2008 positions/velocities as much as possible
  - Otherwise use velocity from GPS, geophysical model, or DORIS and <u>estimate only position at epoch 2000.0</u> 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
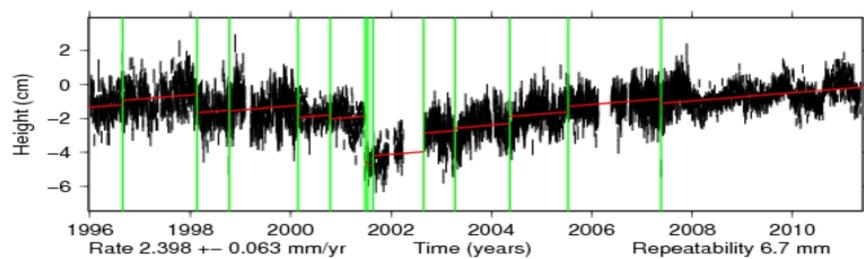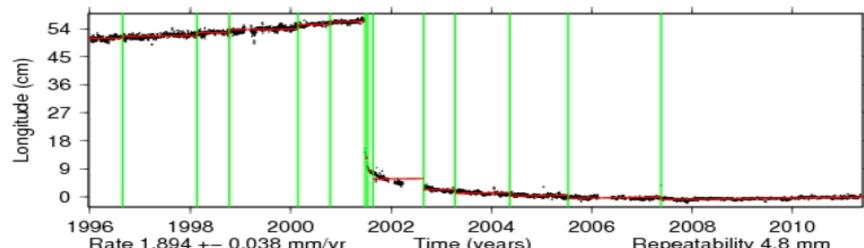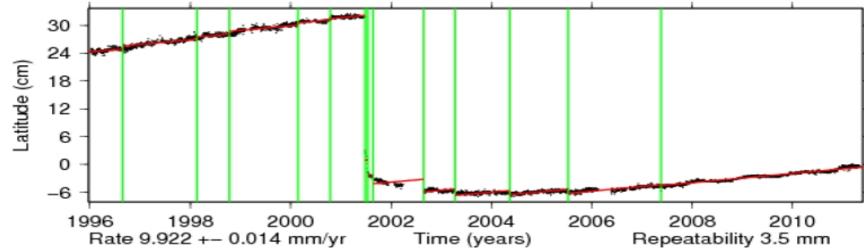
Using local tie (around epoch of observations, even when Velocities are different)

A few examples (2) Arequipa

Time series for AREQ.

DORIS =   AREA*
          AREB
          ARFB

GPS daily time series available at

http://sideshow.jpl.nasa.gov/mbh/all/plots/AREQ.jpg
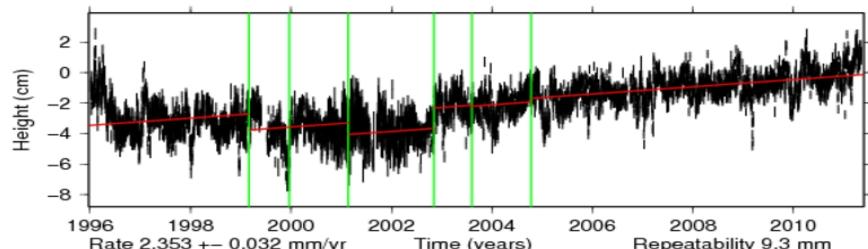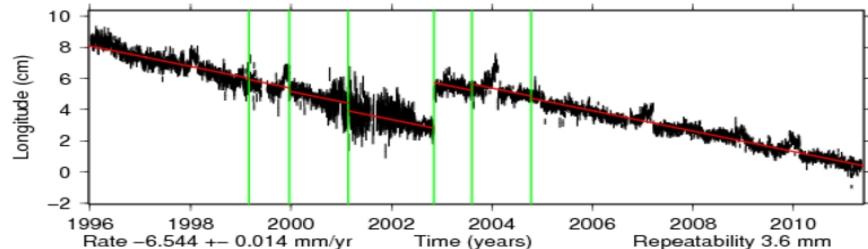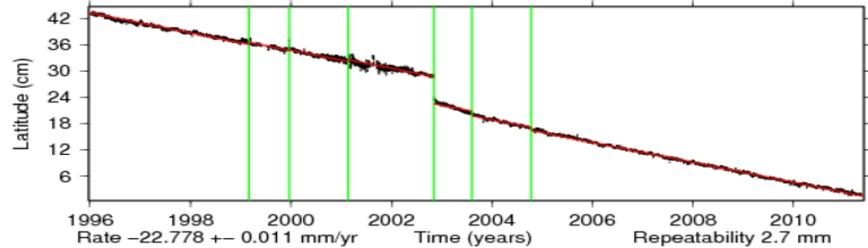
NB: SLR could also be used

-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 (3) Fairbanks

Time series for FAIR.

DORIS is : FAIA
FAIB*

GPS daily time series available at

http://sideshow.jpl.nasa.gov/mbh/all/plots/FAIR.jpg
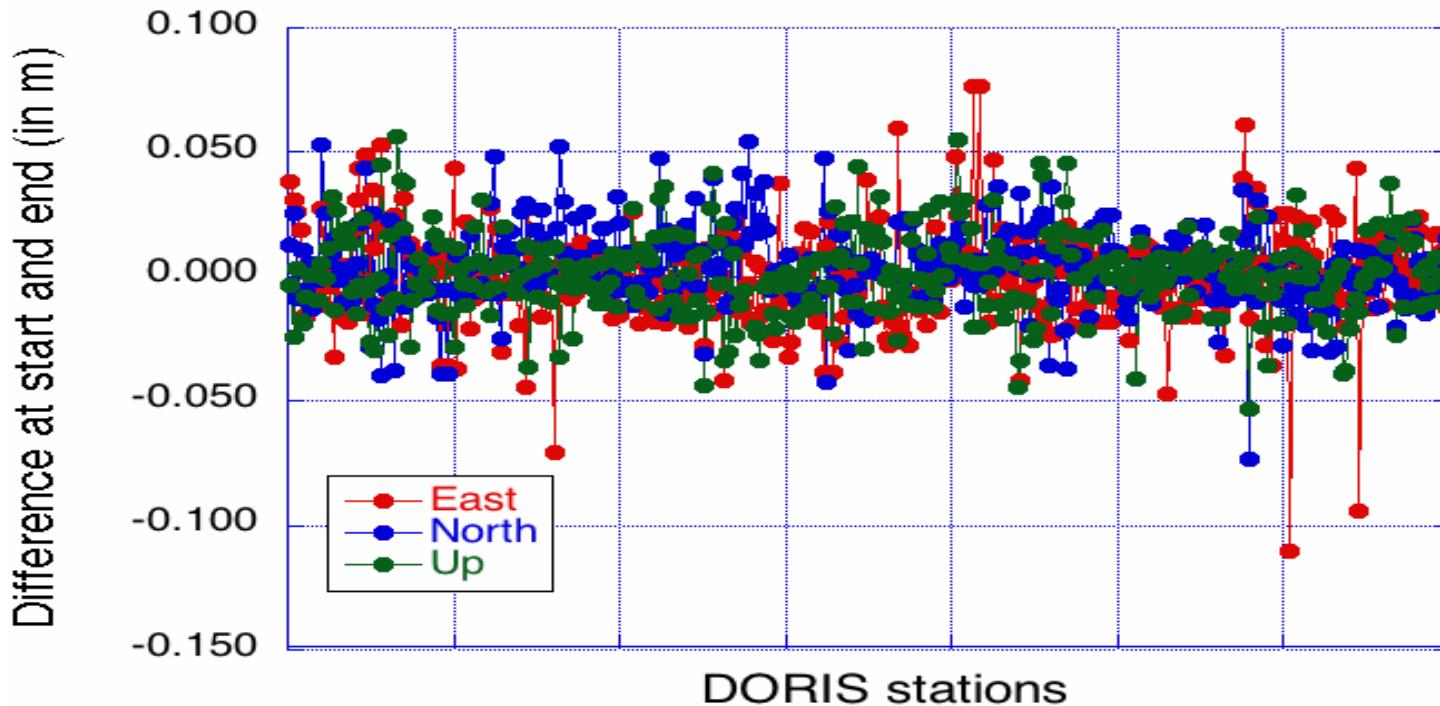
-Earthquake on November 2, 2002*

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

Internal check (2) – At epoch of data
Verifying DPOD2008 with a DORIS time series
at start and end epoch of each time interval
(recent 1993.0 -2011.25 data)
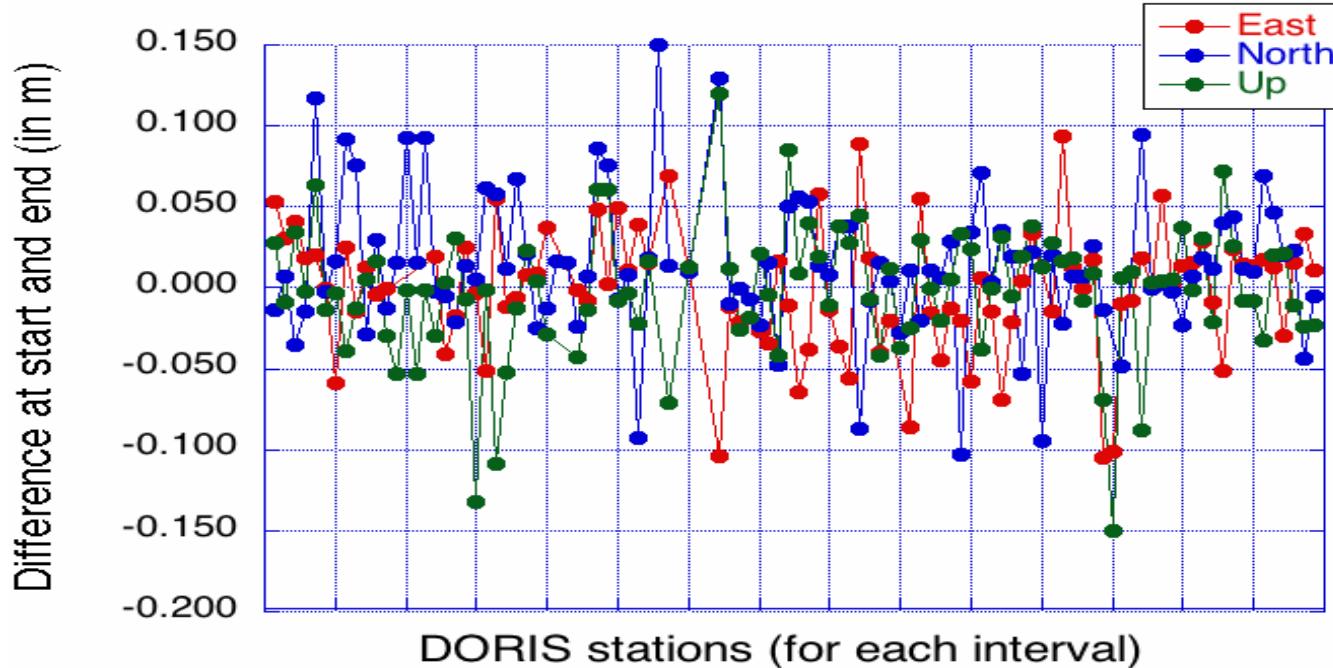
NB: using 3-week smoothing and after removing KERB (20 cm up) and SODA DORIS data exist

External check (1) – Outside data observation

Verifying with another DORIS time series (old 1990 data)
at start and end epoch of each time interval

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

Jason-2 DORIS-only residuals summary cycles 1-112

Test	doris		average residuals		
	sites	average points	doris (mm/s)	slr* (cm)	xover* (cm)
itrf2008	53	146319	0.3572	2.16	5.531
itrf2008 merge dpod2005	57	152859	0.3639	2.27	5.535
dpod2008_1.3	68	166700	0.3519	2.18	5.529
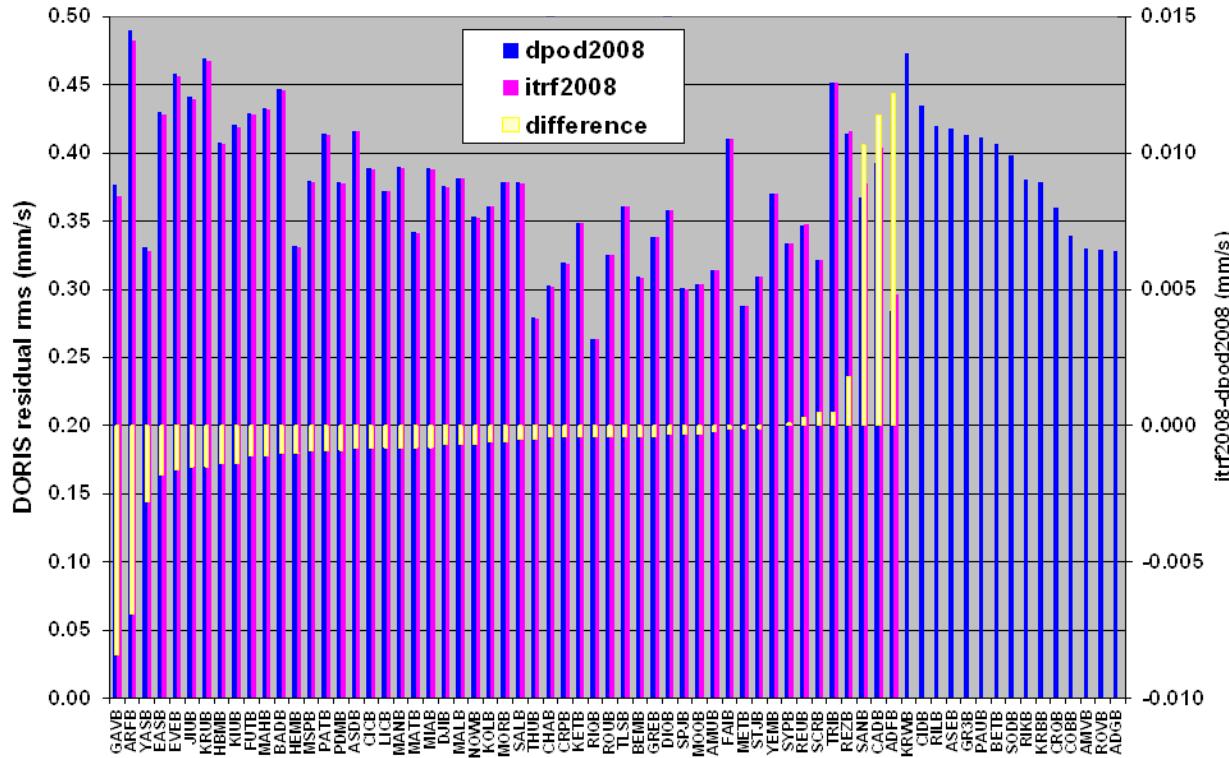
Jason-2 DORIS-only residuals summary cycles 1-112 (new)

Test	doris		average residuals/cycle		
	sites	average points/cy	doris (mm/s)	slr* (cm)	xover* (cm)
itrf2008	53	146319	0.3661	2.16	5.531
itrf2008 merge dpod2005	57	152859	0.3724	2.27	5.535
dpod2008_1.3	68	166700	0.3661	2.18	5.529
dpod2008_1.3	53		0.3663		

* independent data

# Jason-2 DORIS-only residuals by station (cycles 1-112)

positive => improvement for dpod2008
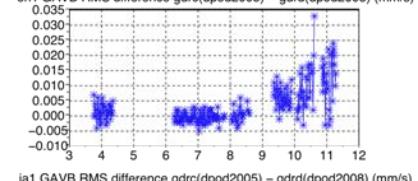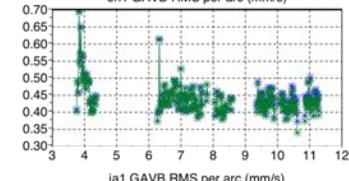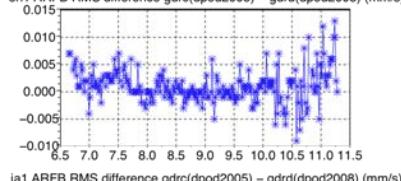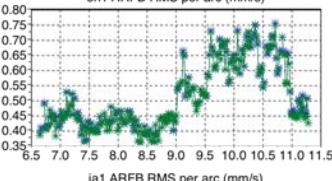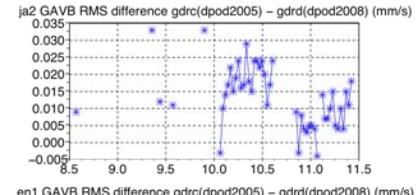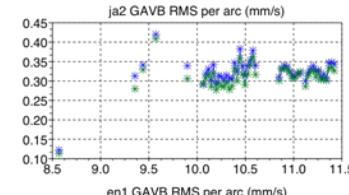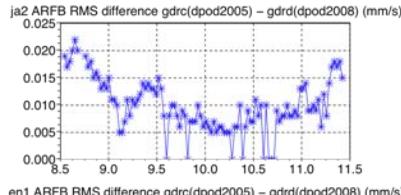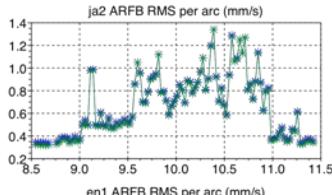
Geodyn results

Possible problems:
GAVB
ARFB

Other POD results (CNES)
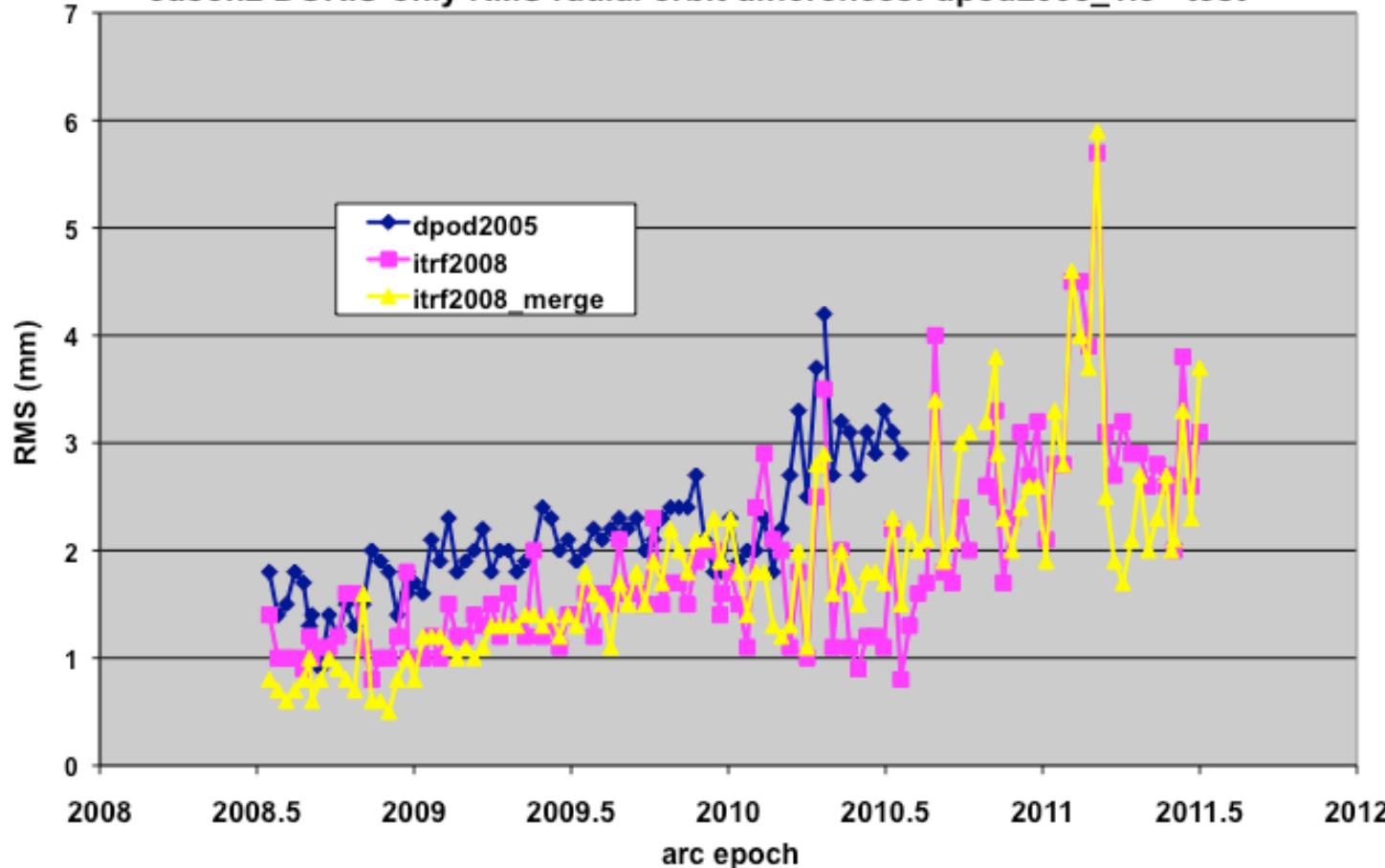
Problems seem to be satellite-dependent

ARFB

GAVB

Jason2 DORIS-only RMS radial orbit differences: dpod2008_1.3 - test

Future plans

- Solve DORIS problems detected while preparing these viewgraphs for:
  - AREB, HUAA, KERB, MORA, SODA, GAVB, ARFB

  NB: However, some problems may not be linked to coordinates/velocities
- 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.
- 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 1.4 (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