



# **IDS Combined Solution for contribution to ITRF2014**

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- **February 27th:**

**Delivery to IERS of IDS 09 series from 2014 doy 005 to 2014 doy 243**

- **May 22th:**

**Delivery to IERS of 17 new SINEXs of series IDS 09**

- 2000 doy 366 (was not delivered before due to an IDS CC internal bug)

- 2014 doy 243 to 2014 doy 355.

**2014 doy 243 was redelivered due to GOP extension.**

**These new SINEXs do not take into account ESA contribution as ESA was not able to extend its series 10 after 2014.5.**

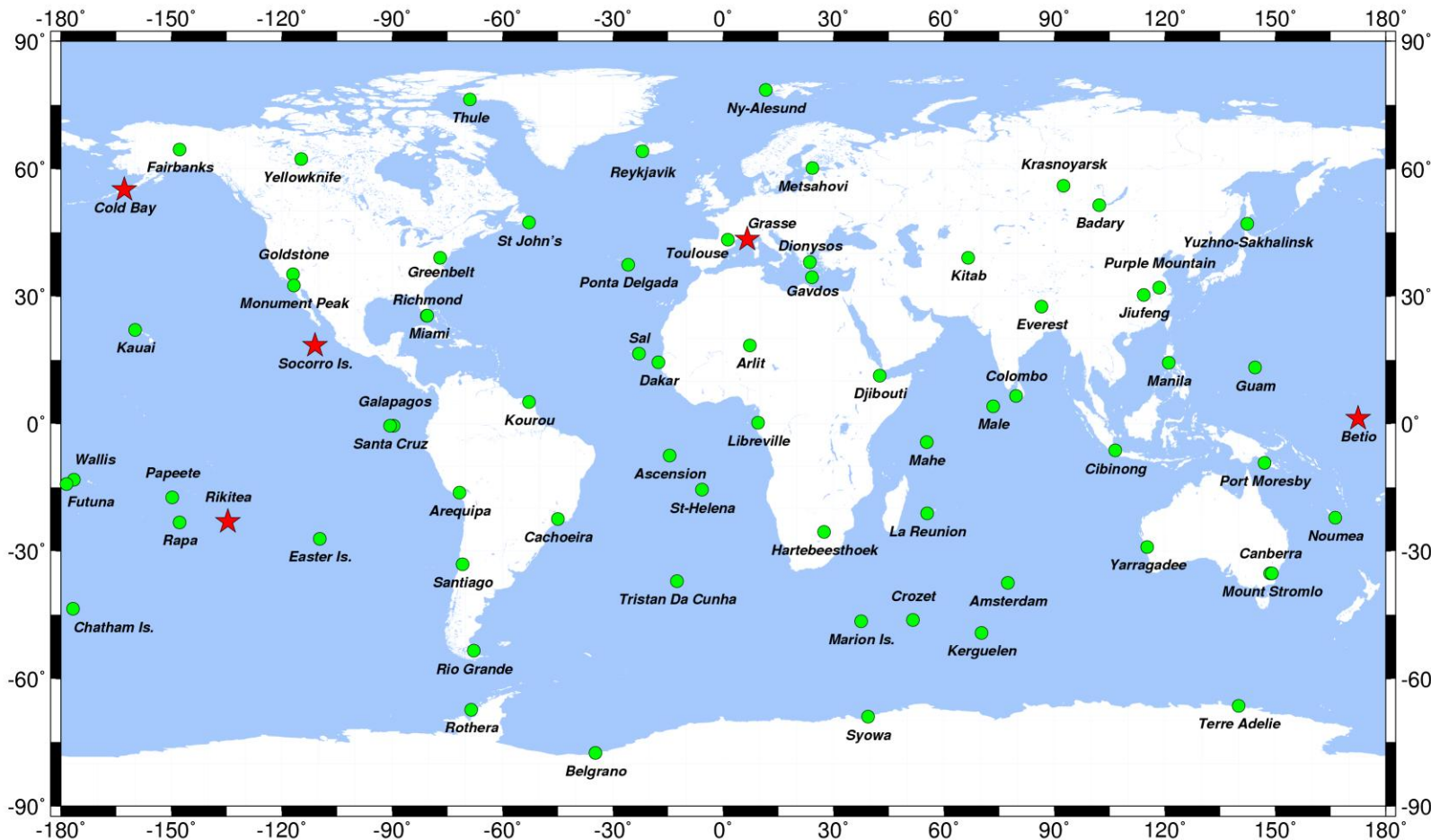
## 6 ACs from 6 different institutions with 5 different software packages

AC	Software	Series number	Solution Type	Phase laws	Time Span	Nb of SINEXs	EOPs
ESA	NAPEOS	10	NEQ	Yes	1993.0-2014.5	1103 (1082)*	Motion+rate+LOD
GOP	BERNESE	43/46	COV	Yes	1993.0-2015.0	1142 (1132)*	Motion+rate
GSC	GEODYN	26	NEQ	Yes	1993.0-2015.0	1148 (1129)*	Motion
IGN	GIPSY-OASIS II	15	COV	Yes	1993.0-2015.0	1147 (1139)*	Motion(+rate+LODR+UT)
INA	GIPSY-OASIS II	08	COV	No	1993.0-2015.0	1148 (1135)*	Motion(+rate+LODR+UT)
GRG (LCA)	GINS-DYNAMO	40	COV	Yes	1993.0-2015.0	1144 (1132)*	Motion
<b>IDS</b>	<b>CATREF</b>	<b>09</b>	<b>COV</b>		<b>1993.0-2015.0</b>	<b>1140</b>	<b>Motion</b>

(xxx) \*= number of weeks included in the IDS combined solution

Does not contribute to the combined scale

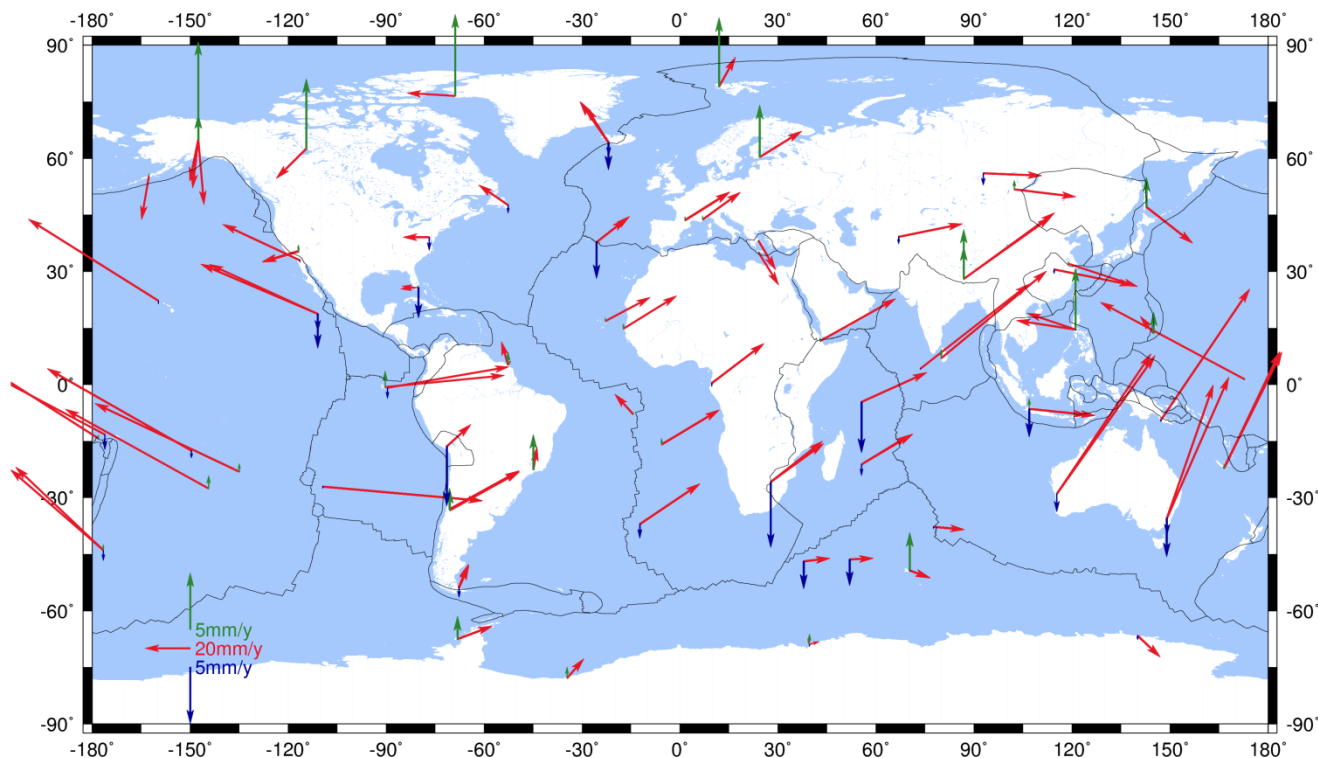
# DORIS ITRF2014 Network



➔ 156 stations over 71 sites (38 in northern hemisphere).

➔ 5 new sites (★) wrt ITRF2008: Betio, Cold-Bay, Grasse, Rikitea and Socorro.

## Velocities from IDS 09 Cumulative Solution



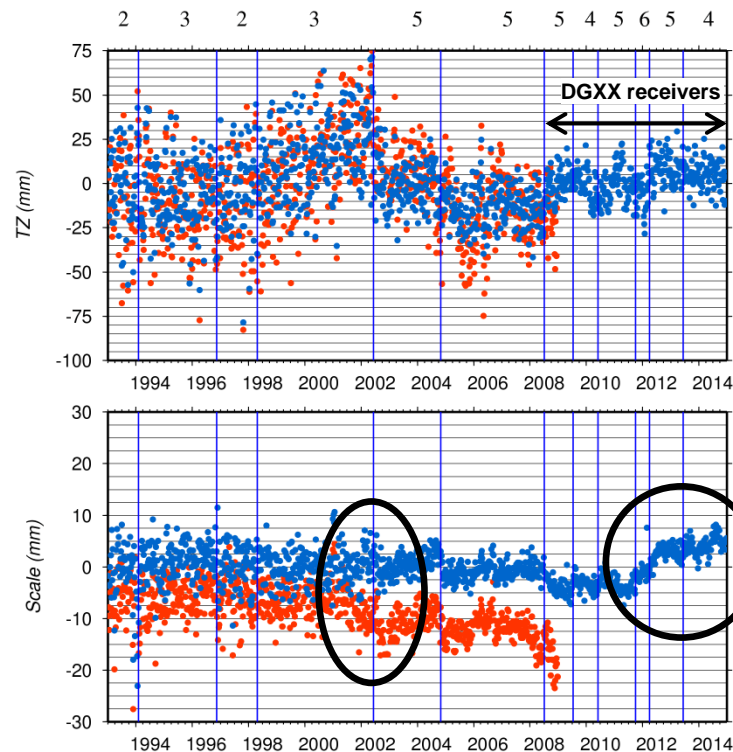
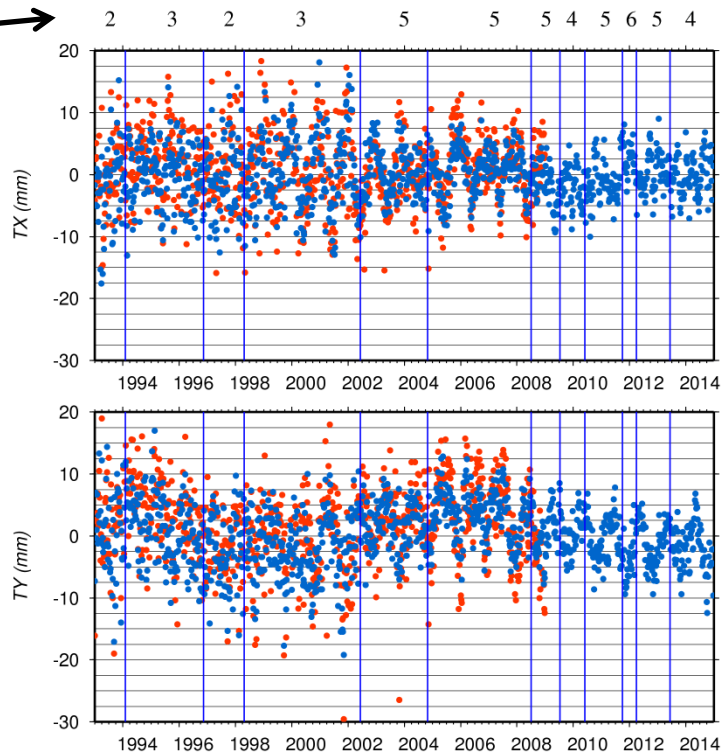
- ❑ From the 1140 IDS 09 weekly SINEX files over time span 1993.0 – 2015.0
- ❑ Makes use of 96 DORIS-DORIS tie vectors (from IGN) and 128 velocity constraints.
- ❑ IDS 09 (resp. IDS 03) counts 65 (resp. 53) position discontinuities over 35 (resp. 31) sites
  - ✓ 24 (resp. 14) with seismic origin.
  - ✓ 12 (resp. 06) with beacon change origin.
  - ✓ 29 (resp. 33) with unknown origin.

**Note that the discontinuities have been shared and agreed by DGFI.**

# IDS 09 (ITRF2014) vs IDS 03 (ITRF2008) Origin and scale wrt IDSTRF2014

## IDS 09 vs IDS 03

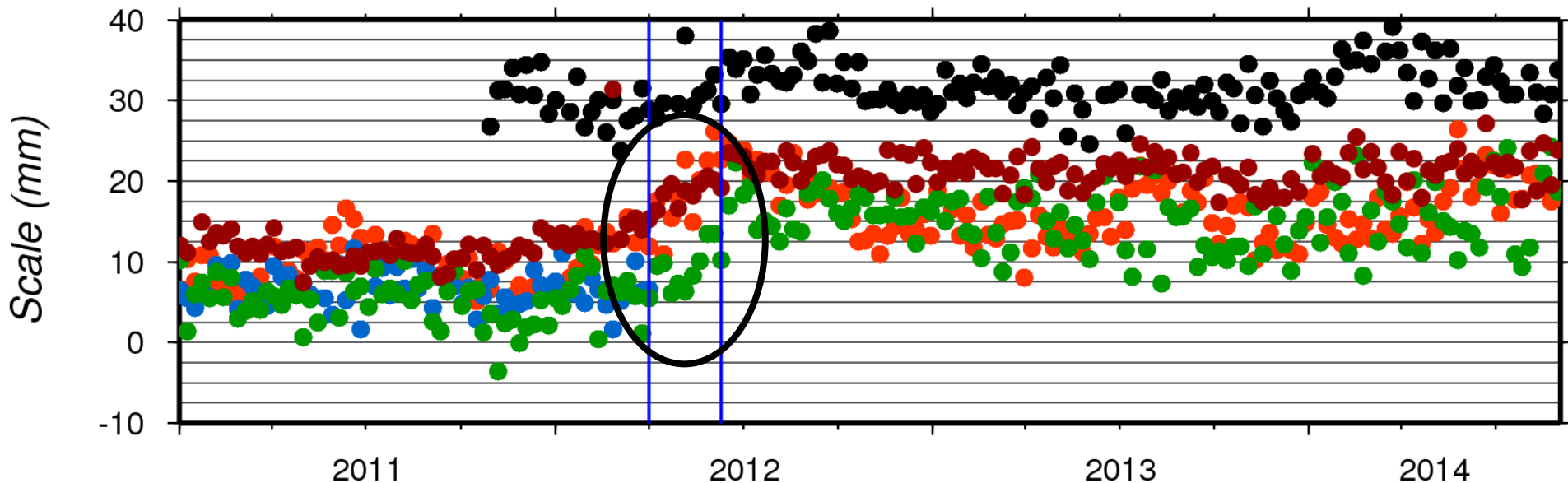
Nb of satellites →



- Results are improved when more satellites available and with new DGXX receivers.
- Origin: Improvements of Tx, Ty and Tz after 2002 (lower STDs, less annual signal).
- IDS 09 Scale:
  - ✓ Shows an offset wrt IDS 03' due to beacons PCVs.
  - ✓ Has no more scale discontinuity in 2002 thanks to beacon frequency offset estimations.
  - ✓ Presents an increase of around 10mm mid 2012 and is more stable before.
  - ✓ End of 2014 is in line with 2012.5-2014.0

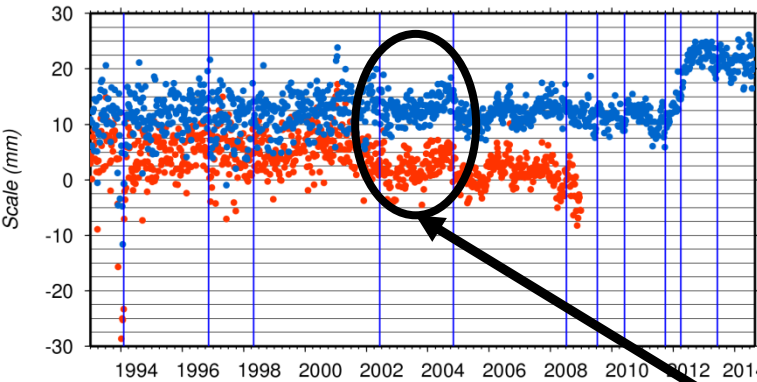
## IDS 09 - Origin of scale increase mid 2012

Scale wrt ITRF2008 of single-satellite solutions from CNES/CLS IDS AC

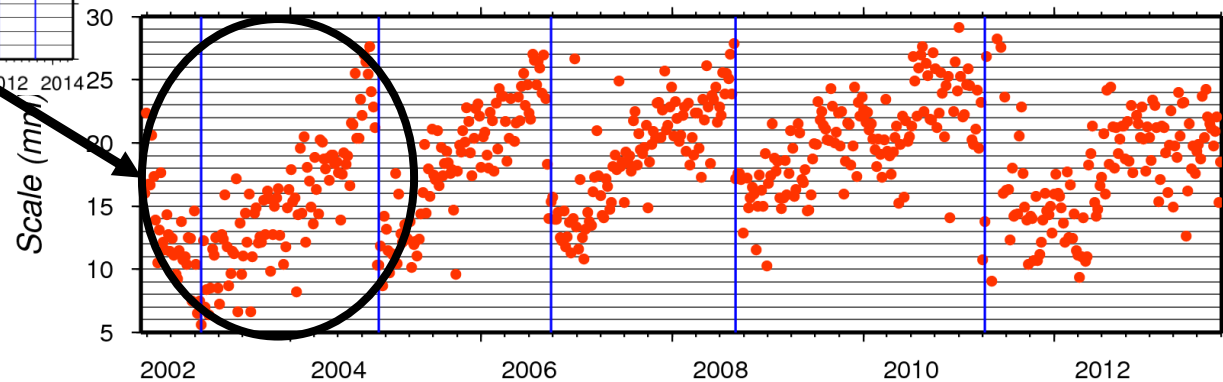


- ❑ Similar scales behavior from GOP, GSC and INA single-satellite solutions.
- ❑ **Cryosat-2** and **Jason-2** present a scale increase mid 2012.
  - ➔ Scale increase of the multi-satellites solution **grg40**.
- ❑ Origin of Cryosat-2 and Jason-2 scale
  - ✓ Does not seem to be the consequence of any network change.
  - ✓ Part of the increase depends on the origin of the CoM-CoP vector.
  - AC using data-supplied corrections have a more prominent increase.
  - ✓ **Is not yet explained but is still under investigations.**

**IDS 03 and IDS 09 scales wrt ITRF2008**



**SPOT5 scale wrt ITRF2008 from GSC single-satellite solution**



- Strong correlation between IDS 09 (03) and SPOT5 scales between 2002.4 and 2005.0.
- Similar scales behavior from ESA, GRG and GSC single-satellite solutions.
- SPOT5 is the only satellite to show such sawtooth pattern.
- Break dates (approximations):  
2003/01/26; 2004/12/05; 2006/09/24; 2008/08/31; 2011/04/10.
- Pattern can not be explained by SAA corrections.
- So far, that SPOT5 scale behavior is not explained.

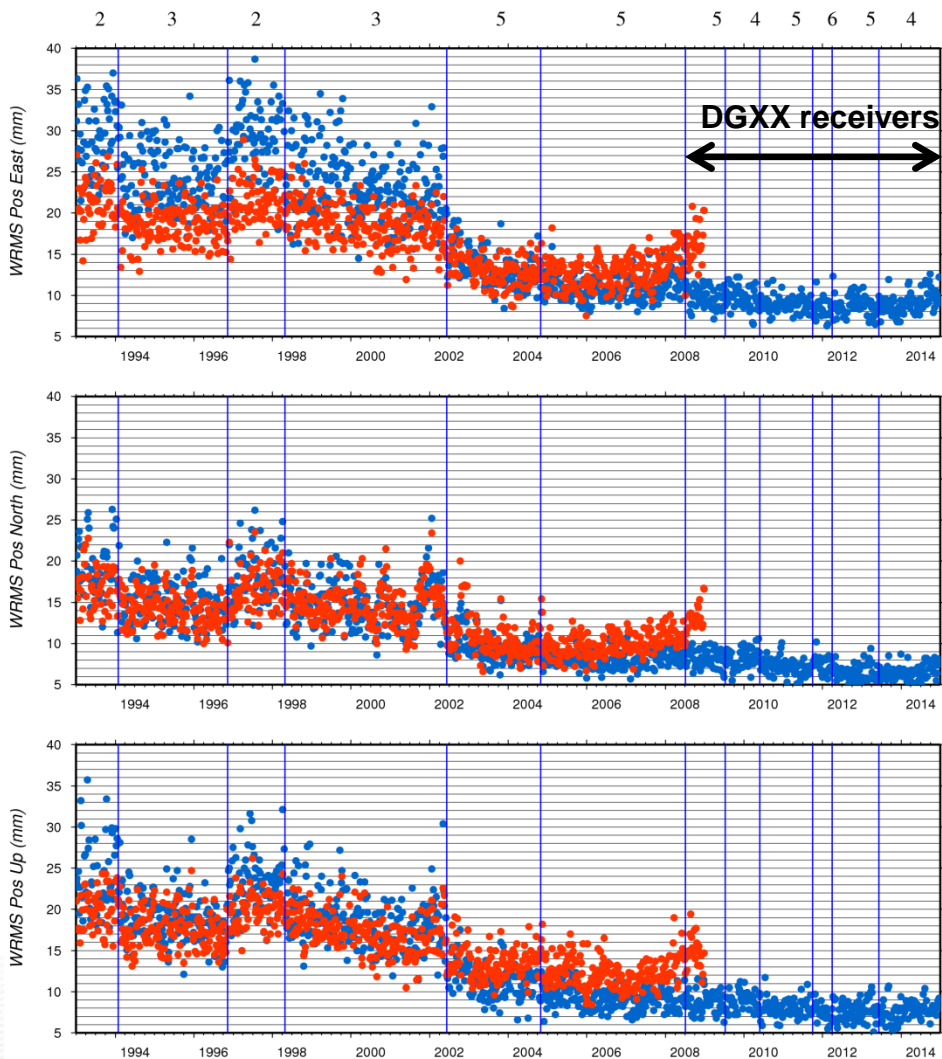




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## IDS 09 vs IDS 03

# IDS 09 (ITRF2014) vs IDS 03 (ITRF2008) Station Position Residuals wrt IDSTRF2014



❑ Substantial degradation from 1993 to mid-2002.

- ✓ Mainly in the East direction (perpendicular to orbit track).
- ✓ Smaller differences if IDS 09 network is set to IDS 03 mean diff. decreases from 4 to 1.7mm).
- ✓ Some sites show higher degradations: Cachoeira, Santiago, Arequipa, Purple Mountain, Easter Island.

❑ Slightly better performances since mid 2002 thanks to beacon frequency offset estimations.

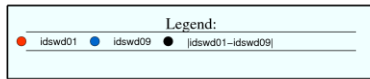
❑ North direction gives best performances (along orbit track).

❑ Results improved when more satellites are available and with new DGXX receivers.

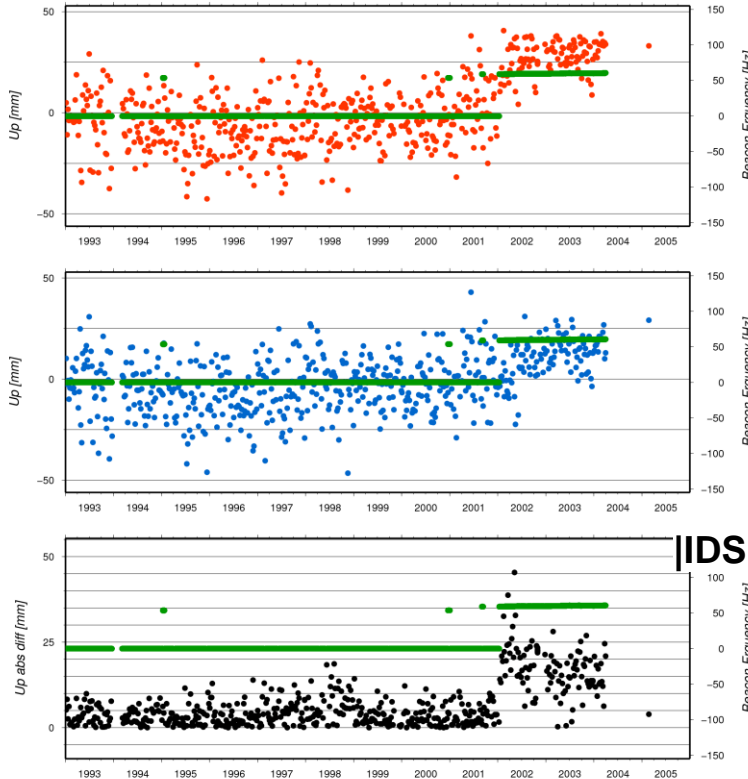
- ➔ Below 10mm after including Jason-1 (late 2004).
- ➔ Around 7-8 mm since late 2011 (HY-2A adding).

# Impact of beacon frequency offset estimations

## Examples of ROTA and YASB



**ROTA (Rothera)**



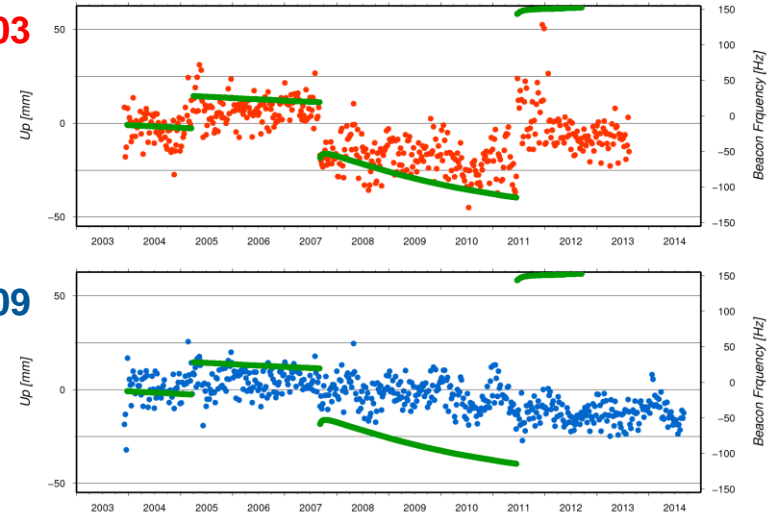
- Smaller position discontinuity in IDS 09 at 02:013
- But discontinuity still candidate for ITRF2014

Beacon frequency offset from GRG



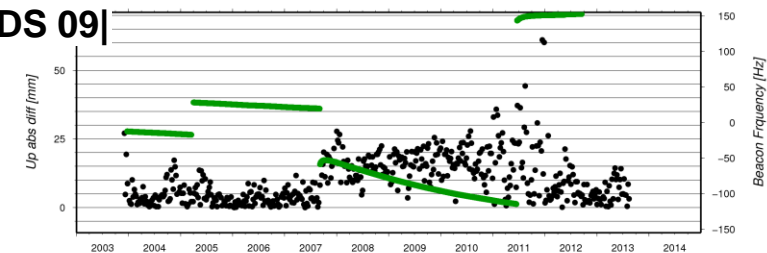
**YASB (Yarragadee)**

**IDS 03**



**IDS 09**

**IDS 03 - IDS 09**

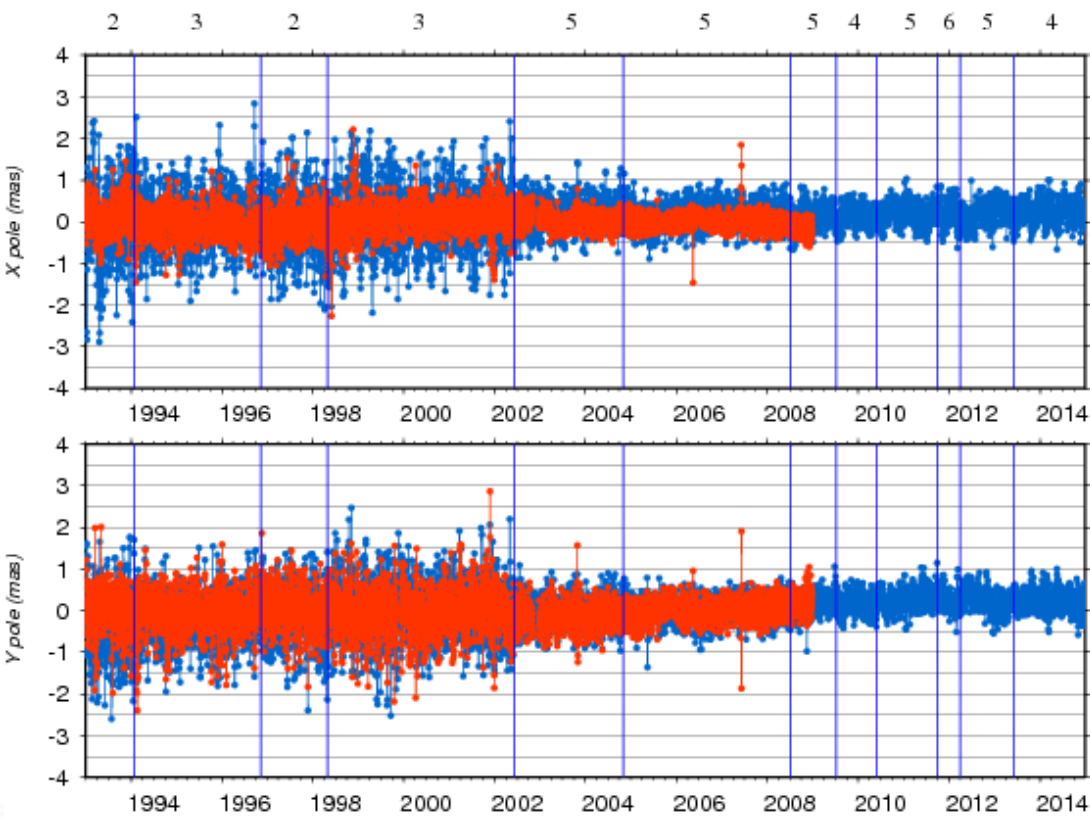


- No more position discontinuity at 05:071 and 07:244
- Still velocity discontinuity at 07:244
- Discontinuity at 05:071 no more candidate for ITRF2014

**→ So far, 8 (resp. 5) ITRF2008 (resp. ITRF2014) of “unknown” discontinuities could be associated to beacon frequency offsets.**

# IDS 09 (ITRF2014) vs IDS 03 (ITRF2008) EOPs differences wrt IERS C04 series

## IDS 09 vs IDS 03



- ❑ Substantial degradation from 1993 to mid-2002 on X pole mainly (2 ACs less compared to ITRF2008).
- ❑ X-pole differences present draconitic periods of 118 days (TOPEX, Jason-1/2).
- ❑ Results are improved when more satellites are available.

Period of time	Std $\Delta X$ [ $\mu\text{as}$ ]	Std $\Delta Y$ [ $\mu\text{as}$ ]
1993.0-2002.4	685	624
2002.40-2008.5	309	293
2008.5-2015.0	245	235

- **For DORIS**

- **6 Analysis Centers.**
- **22 years of data (1993-2015).**
- **Up to 12 DORIS missions.**

- **Results improved**

- **With beacon frequency variations included.**
- **With time variable gravity field: reduces periodic signal on translations.**
- **With Jason-1 SAA corrected data.**
- **With new DGXX satellites.**
- **3D positioning is at 7-8 mm from 2010 onward.**

- **Open questions**
  - **Origin of scale increase mid 2012.**
  - **Origin of piecewise linear behavior of SPOT5 scale.**
  - **Origin of IDS 09 WRMS degradations wrt IDS 03 before 2002.4.**



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## IDS CC Feedbacks from ITRF2014

Page 14

- **ITRF2014 = second ITRF for the IDS CC**
- **ITRF2014 = first ITRF for the present IDS CC**
  
- **ITRF2014 needs represents nearly one full year.**
- **Part of the activity was devoted to development of new tools (ex: residual analysis, cumulative solution).**
  
- **ITRF2014 was a very good experience to increase my knowledge in the tools and geophysics of the DORIS combination.**
- **Still points to better overcome such as computation and validation of cumulative solution, AC individual weighting...**
  
- **Single-satellite solutions are very instructives.**
- **« One model update, one new series » is strongly recommended to better analyze its impact at the AC and CC levels.**