



> OSTST meeting

> SARAL/Altika workshop

> IDS workshop

[www.ostst-altimetry-2014.com](http://www.ostst-altimetry-2014.com)

# New frontiers of altimetry

Lake Constance - Germany,  
27-31 October 2014

## **INA DORIS AC processing for ITRF2013**

*Sergey Kuzin, Souria Tatevian*  
*Institute of Astronomy RAS, Russia*

- DORIS data for 1993.0 - 2014.0 (21 years) period have been reprocessed and submitted to IDS for validation as free-network SINEX inawd08 weekly solutions containing station coordinates and EOP
- GIPSY-OASIS II software used for computation
- The data of majority of DORIS satellites were processed except HY2A, SARAL and JASON1

# Standards and models used by INASAN for ITRF2013 IDS contribution

- **Software** GIPSY/OASIS II (v. 6.2)
- Products for IDS Weekly solutions (in SINEX format)  
coordinates of global DORIS station  
network with daily EOPs (X,Y-pole,  
pole rates, LOD)
- SINEX method Variance-covariance format
- Data weight 0.51 mm/s for SPOT2, SPOT3, SPOT4  
TOPEX, ENVISAT, CRYOSAT2  
0.4 mm/s for SPOT5, JASON2
- Station constraint 10 m
- EOP constraint 5 m

## Satellite used

(included in weekly  
SINEX)

SPOT3 (01/02/1994 - 13/11/1996)

SPOT4 (01/05/1998 — 23/06/2013)

SPOT5 (11/06/2002 — 31/12/2013)

TOPEX (03/01/1993 — 01/11/2004)

ENVISAT (02/06/2002 - 08/04/201)

JASON1 - not used

JASON2 (12/07/2008 - 31/12/2013)

CRYOSAT2 (30/05/2010 — 31/12/2013)

HY2A — not used

SARAL – not used

## Arc cut

- arc length 1-day arc
- Handle of Manoeuvres Break arc and start or end at 12:00
- Handle of Data gaps Daily arcs with large data gaps not processed
- Additional margins 3hrs before and 3 hrs after for POD but not in SINEX

## Reference System

- Earth reference system DPOD2008 v1.13
- Celestial reference system Inertial J2000
- Polar motion and UT1 IERS Bulletin A
- Background C21, S21 IERS 2003
- Pole model IERS 2010
- Precession/Nutation IERS 2010
- Station coordinates DPOD2008 v1.13

## Displacement of reference points

- Solid Earth tidal displacement IERS 2010 Conventions
- Ocean loading FES2004
- Tidal atmospheric loading Not applied
- Non tidal atmospheric loading Not applied
- Solid pole tide displacement IERS 2010 Conventions
- Ocean pole tide displacement IERS 2010 Conventions
- Tidal Geocenter Not applied

## Satellite reference

- Mass and center of gravity Initial values and time history from IDS files
- Attitude Model Nominal laws

## Gravity

- Gravity field (static) GOCO02S
- Gravity field (time varying) (1) to 4x4 - fit to SLR, DORIS time series;  
(2) > 4x4. Annual terms from GSFC-derived solution
- Atmospheric gravity Not applied
- Solid Earth tides IERS2010
- Ocean tides FES2004
- Non tidal oceanic gravity Not applied
- Atmospheric tides Not applied
- Earth pole tide IERS 2010 Conventions
- Ocean pole tide IERS 2010 Conventions
- Third bodies Sun, Moon, Planets: DE421 (JPL)

## Surface forces and empiricals

- Radiation Pressure model      CNES model for all satellites except for JASON2 (tuned) and CRYOSAT2 (modified CNES 7-plate macromodel)
- Radiation pressure scale coefficient      Fixed: TOPEX 1.03; SPOT2/3 1.08; SPOT4 1.13; SPOT5 1.03; JASON2 0.92; ENVISAT 1.02; CRYOSAT2 1.05
- Earth radiation      Albedo correction applied
- Atmospheric density model      DTM2000
- Drag coefficients      Cd/8hrs (TOPEX, JASON2); Cd/1hr for SPOT2,3,4,5, ENVISAT, CRYOSAT2
- 1/rev empiricals      Opr/day along + cross-track



## Doris measurements

- Troposphere Model
- Weather (meteorological data)
- Troposphere mapping function
- Troposphere correction

- 2nd order ionosphere
- Frequency

- Relativity

None

Not used

GMF

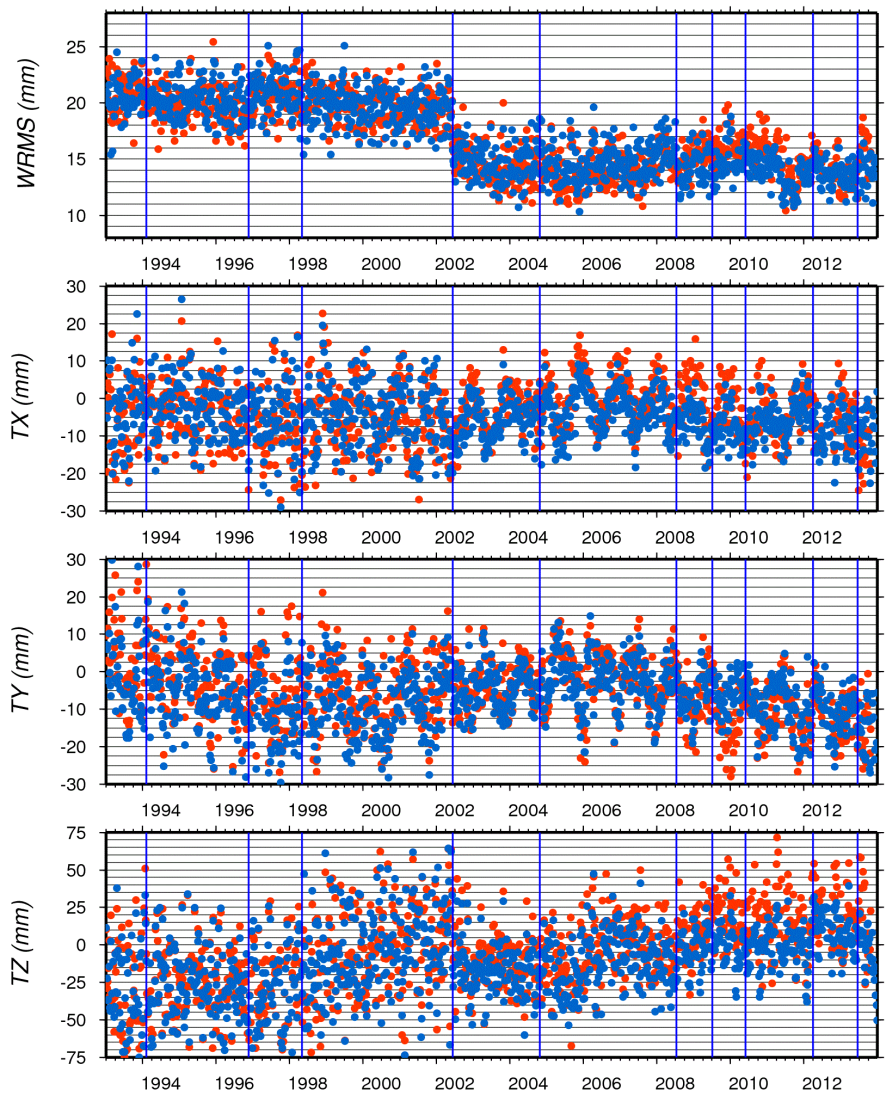
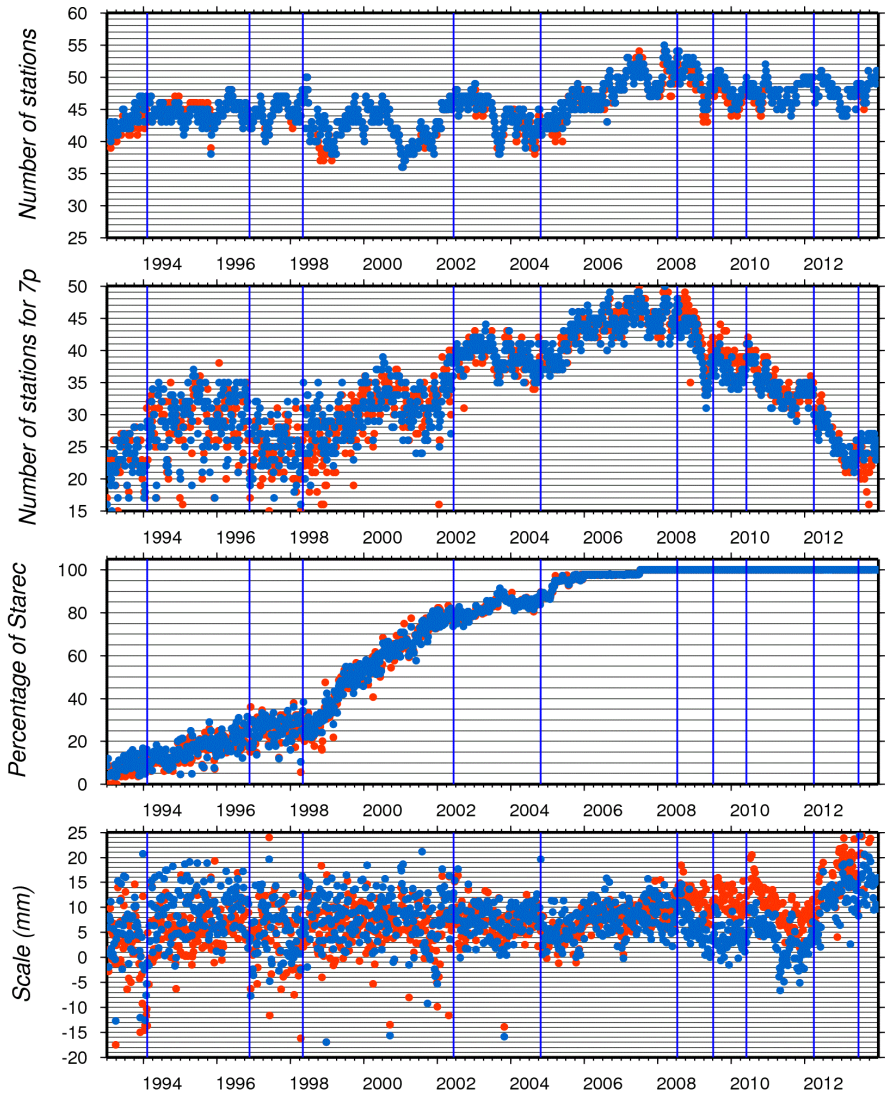
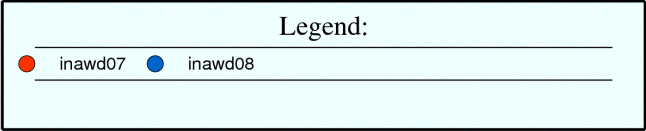
Wet tropospheric delay estimated per station with reset for some passes only if separated more than 20 minutes

Not applied

1 frequency bias adjusted per station clock if separated by more than 20 minutes + 1 frequency bias per satellite  
Schwarzschild model + Lense-Thirring + geodesic precession

- Weight 0.51 mm/s for SPOT2, SPOT3, SPOT4, TOPEX, ENVISAT, CRYOSAT2;  
0.4 mm/s for SPOT5, JASON2
- Elevation angle cutoff 12 degrees
- Downweighting law Data weight =  $1/\sin(\text{elevation})$
- Satellite system Center of mass - antenna phase center computed from macro model + attitude law; no phase law applied
- Ground system Phase centre / reference point vector from manufacturer values; phase law not applied (Alcatel, Srarec)
- DORIS System Time Bias No bias correction applied to satellite clock
- South Atlantic Anomaly Jason-1 data not used at all; corrective model applied for SPOT5 (2006.0 - onward)

# Per week comparison to ITRF2008

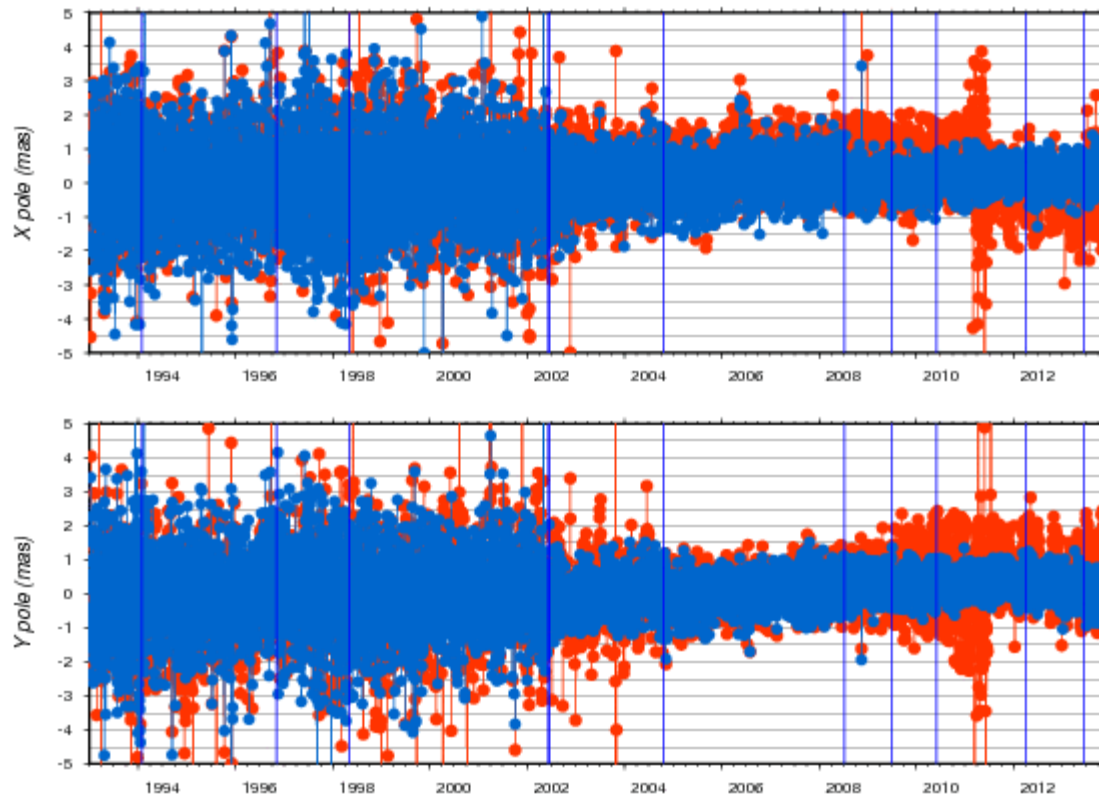


# Comparative statistical characteristics of the INA analysis center contribution to ITRF2008 and ITRF2013

AC series	N stations in SINEX (mean)	N stations for 7-par. estimat- tion (mean)	WRMS (mm)	Scale (mm)	Tx (mm)	Ty (mm)	Tz (mm)
<b>ITRF2013 (1993.0 — 2014.0)</b>							
idswd04	41.56	34.78	13.72±2.04	12.58±4.03	-4.26±5.00	-2.44±5.27	-12.71±18.00
inawd08	45.54	33.47	16.95±1.93	7.44±5.41	-4.92±6.99	-6.58±8.39	-12.24±23.23
<b>ITRF2008 ( 1993.0 — 2009.0)</b>							
idswd03	39.87	37.62	13.82±1.99	3.29±4.18	-2.49±5.92	-1.42±6.83	-16.81±25.17
inawd07	45.20	33.61	17.09±2.14	7.71±5.55	-3.80±7.81	-5.07±8.83	-6.06±24.82

Earth Orientation Parameters wrt IERS C04

● inawd07 ● inawd08

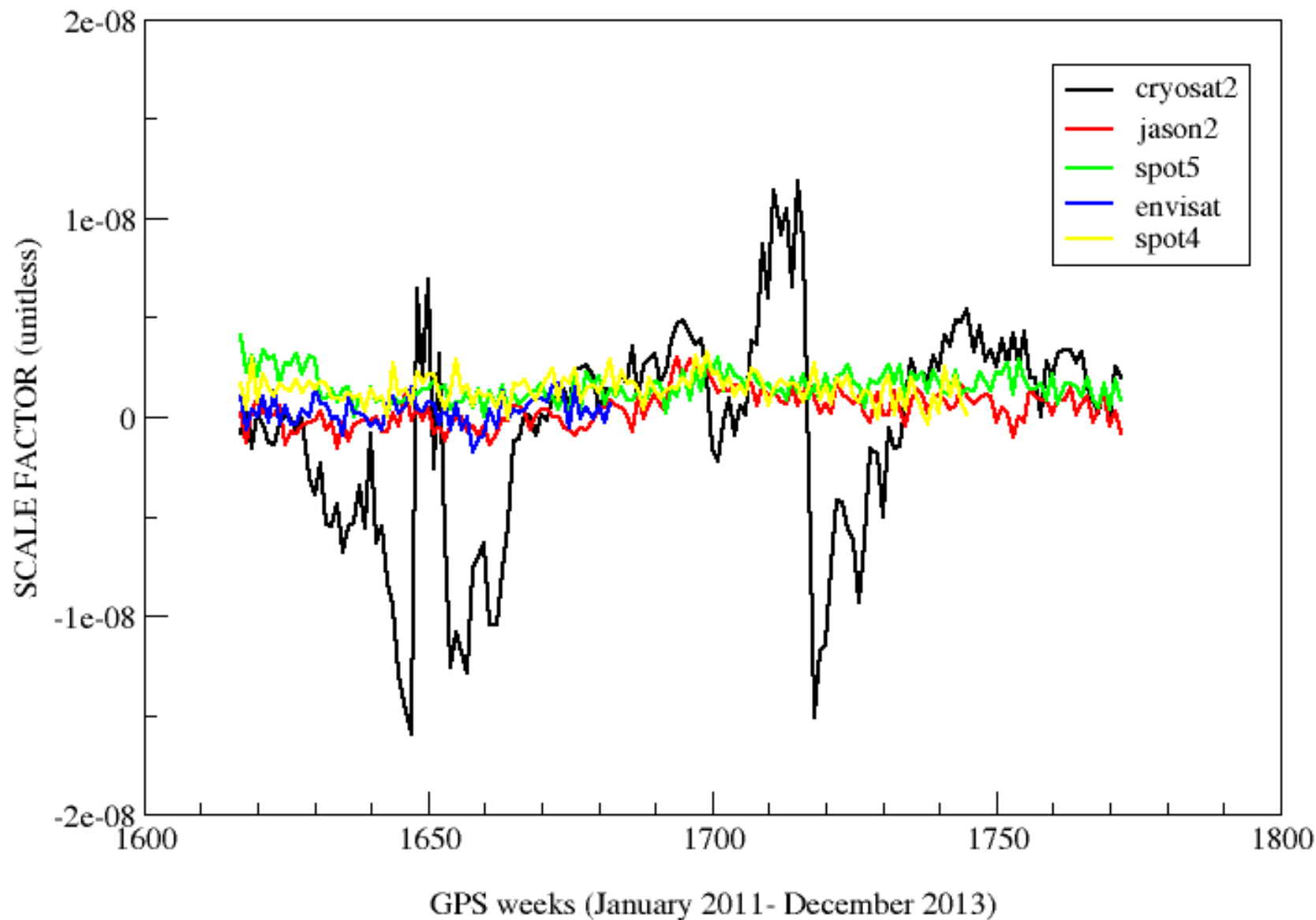


# INA AC Earth Orientation Parameters wrt IERS C04

Analysis Center	Series	# days	X pole (mas)		Y pole (mas)	
			mean	std	mean	std
ina	07	7519	0.198	1.186	0.034	1.226
ina	08	7637	0.062	0.941	0.065	0.852

# TRF scale compare to DPOD2008 (v.1.13)

inawd08: single satellite solutions





# Plans for the future

- including into routine processing the new HY2A and SARAL satellites and may be JASON1 satellite with the SAA corrected data;
- applying the phase center corrective models for ground and satellite antennas;
- improvement of the CRYOSAT2 macromodel for excluding spurious scale factor variations;
- investigation discrepancies (larger than 1 cm) of the stations positions residuals with respect to the combined IDS solutions
- investigation of the applying higher order ionospheric correction on DORIS frequencies;
- use the RINEX DORIS raw phase measurements;
- to produce the new INASAN products delivered to IDS on regular basis (INASAN cumulative solution, orbits, zenith path delay);
- fully automatic delivery INASAN products to IDS