Research activities at the IDS Combination Center

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Content

- What's new ?
- Impact of Jason-2, Cryosat-2, HY2-A and Envisat in terms of Helmert parameters and EOPs
- EOPs evaluation of the single satellite campaign
- What's next ?

What's new ?

- Introduction of EOPs evaluation (differences wrt IERS C04 series in ITRF2008 ; formal errors) and combination.

- Processing of SINEX weekly solutions:
  1. Inversion of free singular normal equations for ESA and GSC
     (*new: introduction of inversion error messages in the evaluation report*)
  2. Verification of DORIS station identification (domes # vs acronym, update of acronyms – ex: PATB by PAUB, observation periods)
  3. Rejection of selected stations over the whole time period (never used)
  4. Rejection of selected stations over specific periods (partially used)
  5. Verification/update of position discontinuities
  6. Projection using minimal constraints and rejection of perturbating stations
     ➔ **Combination**
  7. Estimation of Helmert parameters wrt ITRF2008 and projection in ITRF2008
     ➔ **Evaluation** : Helmert parameters and *EOPs analysis*

What's new ?

- Weekly combination process main rules:
  1. Rejection of weeks with less than 3 ACs solutions
  2. For each week, reject stations observed by less than 3 ACs
  3. Reject stations which perturb the combination
  4. Internal constraints are applied on origin and scale and minimal constraints are applied on rotations
  5. EOPs : Computes only XPO and YPO from all the ACs solutions

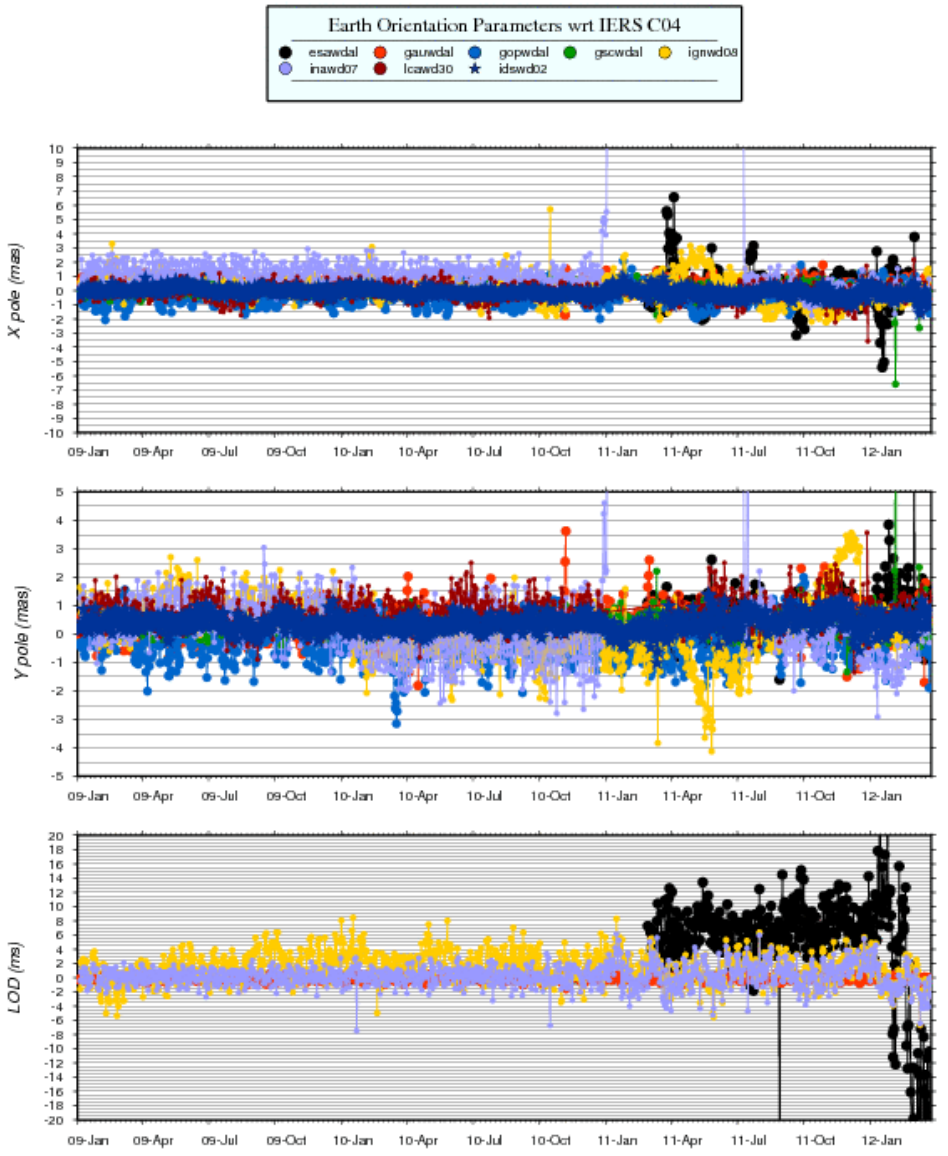
EOPs products per AC (from 2012-001)

	Pole	Pole rates	UT	LOD	LODR
ESA	***Yes***	***Yes***	No	***Yes***	No
GAU	***Yes***	No	No	***Yes***	No
GOP	***Yes***	***Yes***	No	No	No
GSC	***Yes***	No	No	No	No
IGN	***Yes***	***Yes***	***Yes***	No	***Yes***
INA	***Yes***	***Yes***	***Yes***	No	***Yes***
LCA	***Yes***	No	No	No	No

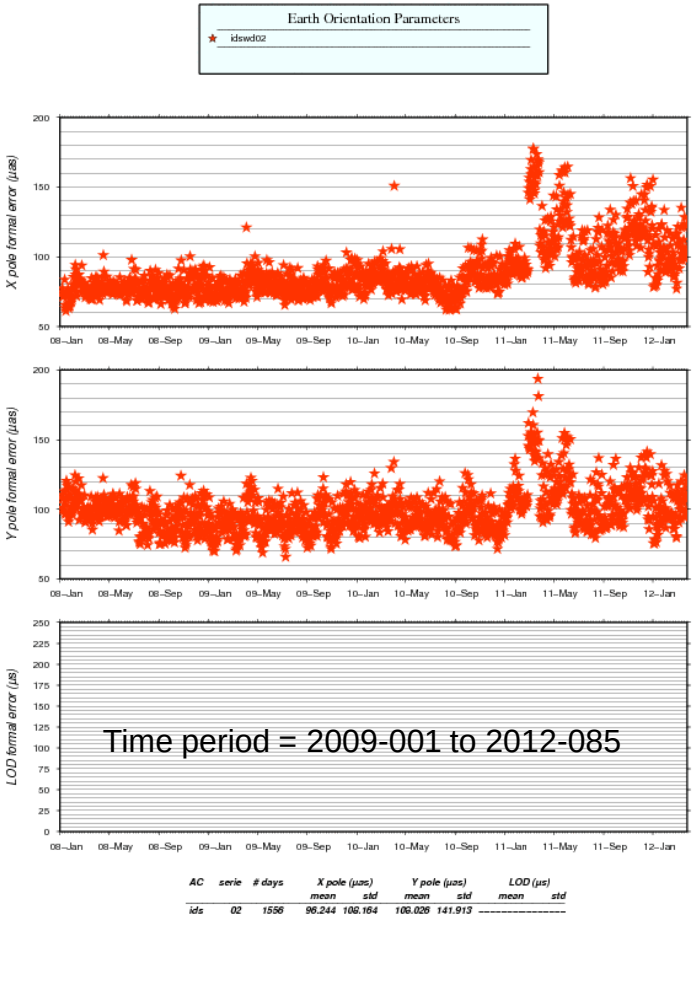
Example of EOPs evaluation & combination (differences wrt C04)

- Time period = 2009-001 to 2012-085

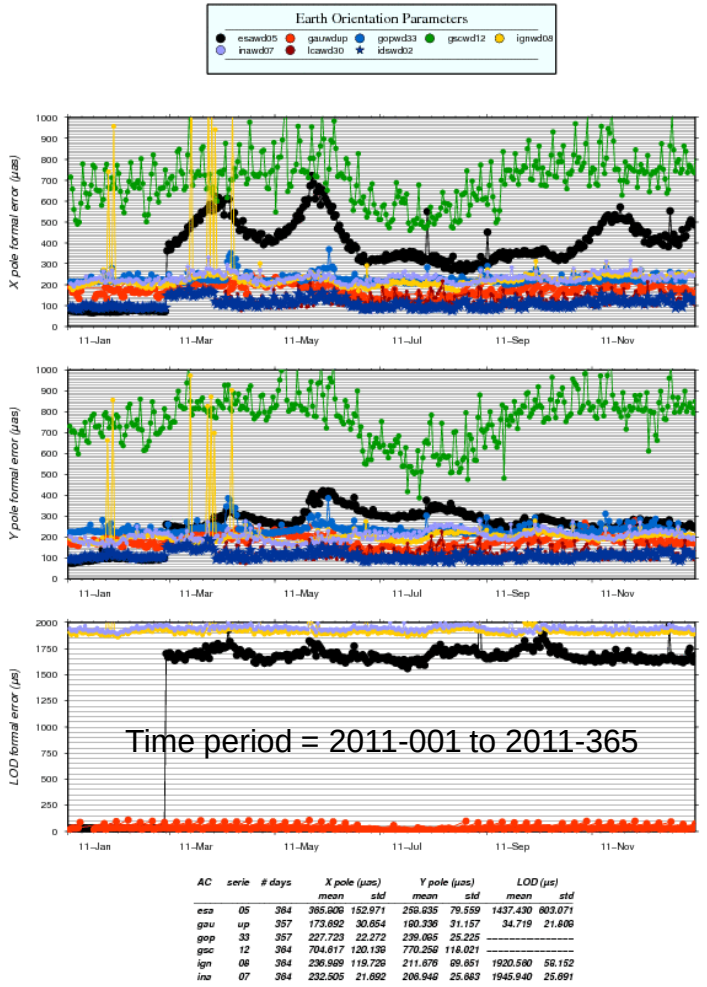
- Differences wrt CO4 series:
  - std of both XPO and YPO from the multi-ACs combined solution are less than 0.5mas



Example of EOPs evaluation & combination (formal errors)



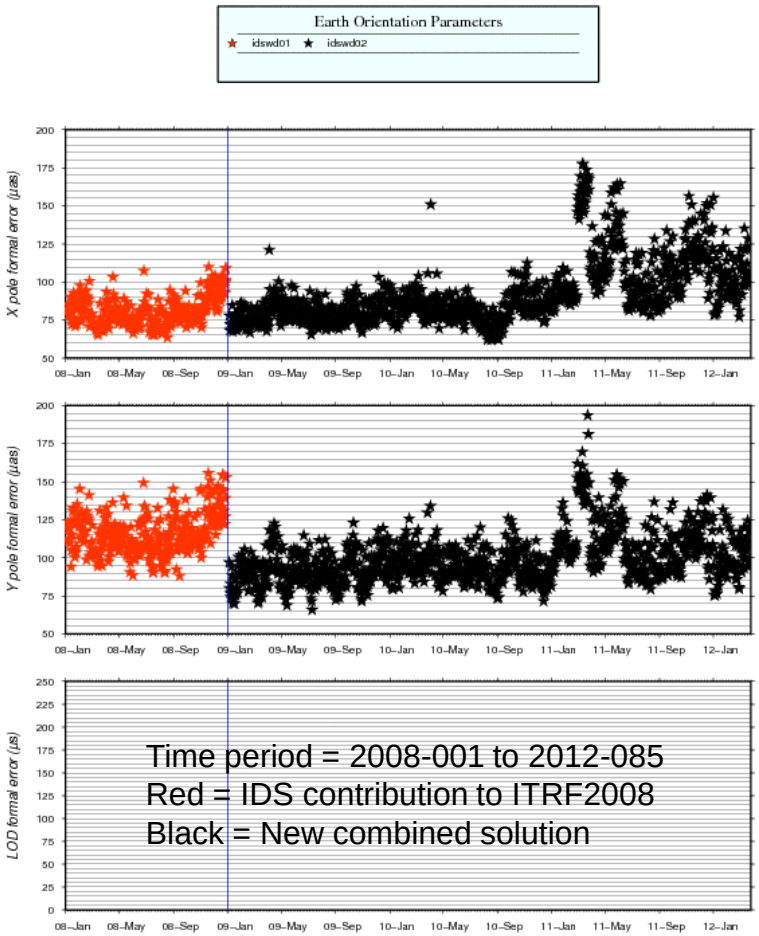
AC	serie	# days	X pole (µas) mean	X pole (µas) std	Y pole (µas) mean	Y pole (µas) std	LOD (µs) mean	LOD (µs) std
ids	02	1556	96.244	108.164	108.026	141.913	----------	----------



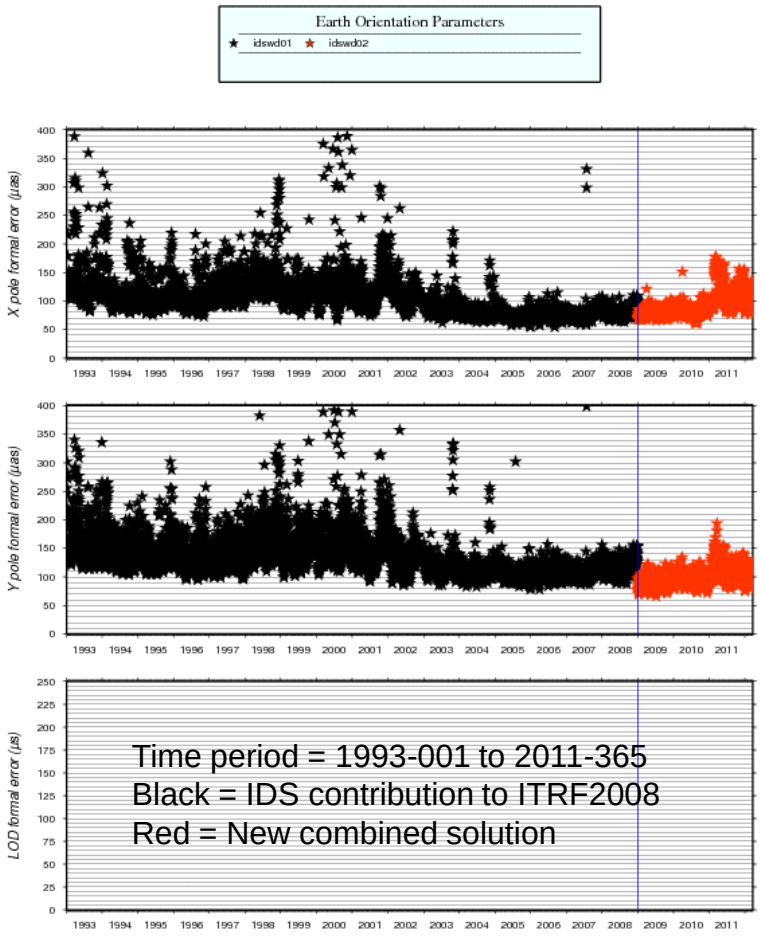
AC	serie	# days	X pole (µas) mean	X pole (µas) std	Y pole (µas) mean	Y pole (µas) std	LOD (µs) mean	LOD (µs) std
esa	05	364	365.906	152.971	259.835	79.559	1437.430	603.071
gau	up	357	173.692	30.654	190.336	31.157	34.719	21.809
gop	33	357	227.723	22.272	239.065	25.225	----------	----------
gsc	12	364	704.617	120.139	770.259	118.021	----------	----------
ign	08	364	236.989	119.729	211.876	99.851	1920.580	59.152
ina	07	364	232.505	21.692	208.948	25.883	1945.940	25.691

- Differences wrt CO4 series:
  - std of both XPO and YPO from the multi-ACs combined solution are less than 0.5mas
- Formal errors:
  - Ranges and signals differ from one AC to another – may reflect some internal constraints
  - Range of combined IDS solution is less than 100 micro arcseconds

Example of EOPs evaluation & combination



AC	serie	# days	X pole (µas) mean	X pole (µas) std	Y pole (µas) mean	Y pole (µas) std	LOD (µs) mean	LOD (µs) std
ids	01	986	109.362	195.499	151.619	255.727	----------	----------
ids	02	1183	92.269	20.503	99.157	16.239	----------	----------



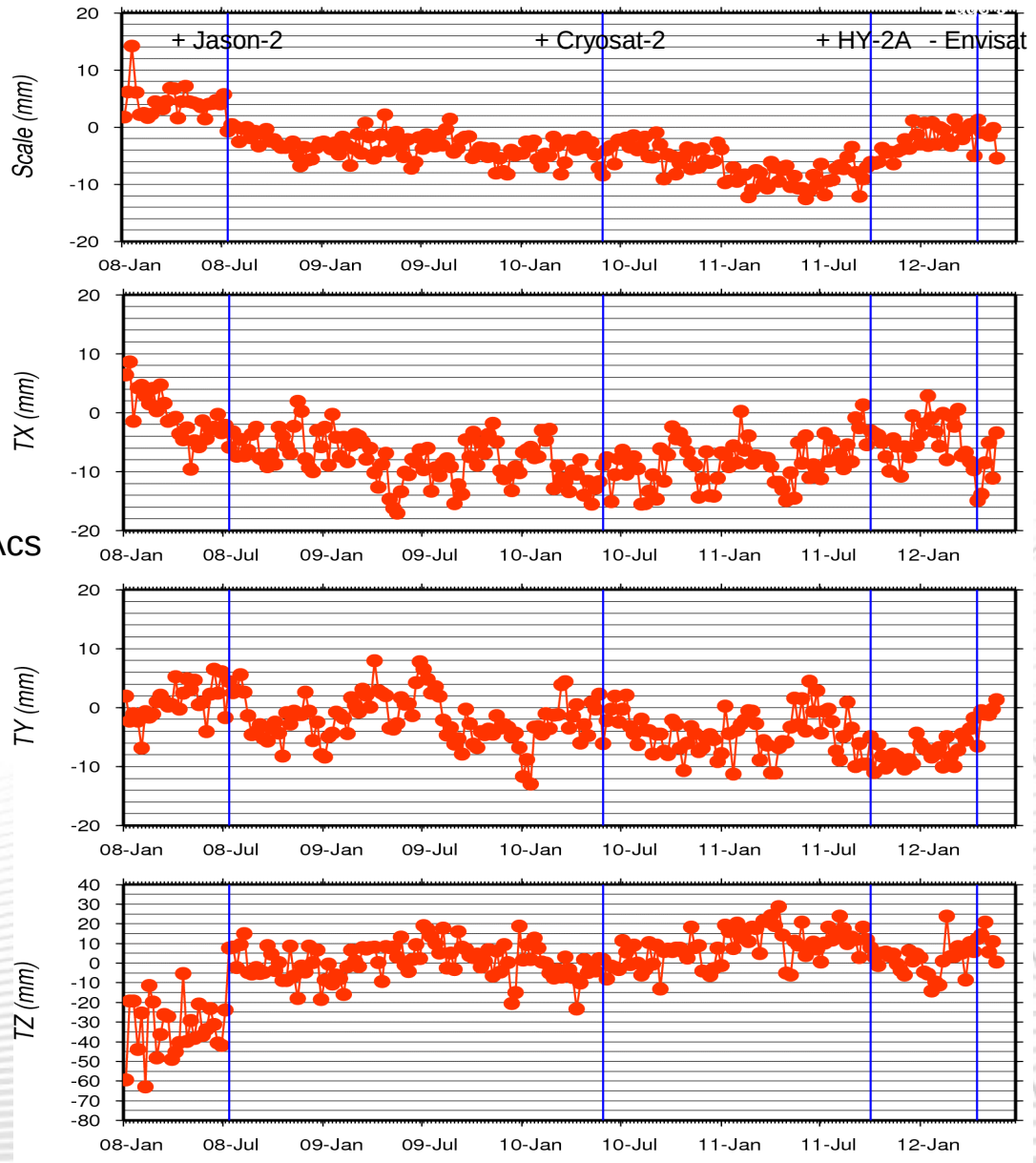
AC	serie	# days	X pole (µas) mean	X pole (µas) std	Y pole (µas) mean	Y pole (µas) std	LOD (µs) mean	LOD (µs) std
ids	01	5748	110.253	77.746	143.903	98.243	----------	----------
ids	02	1183	92.269	20.503	99.157	16.239	----------	----------

Impact of missions in terms of Helmert parameters wrt ITRF2008

- Jason-2 Impact:
  - Tz centered (already known)
- Cryosat-2, HY-2A, Envisat Impact:
  - none

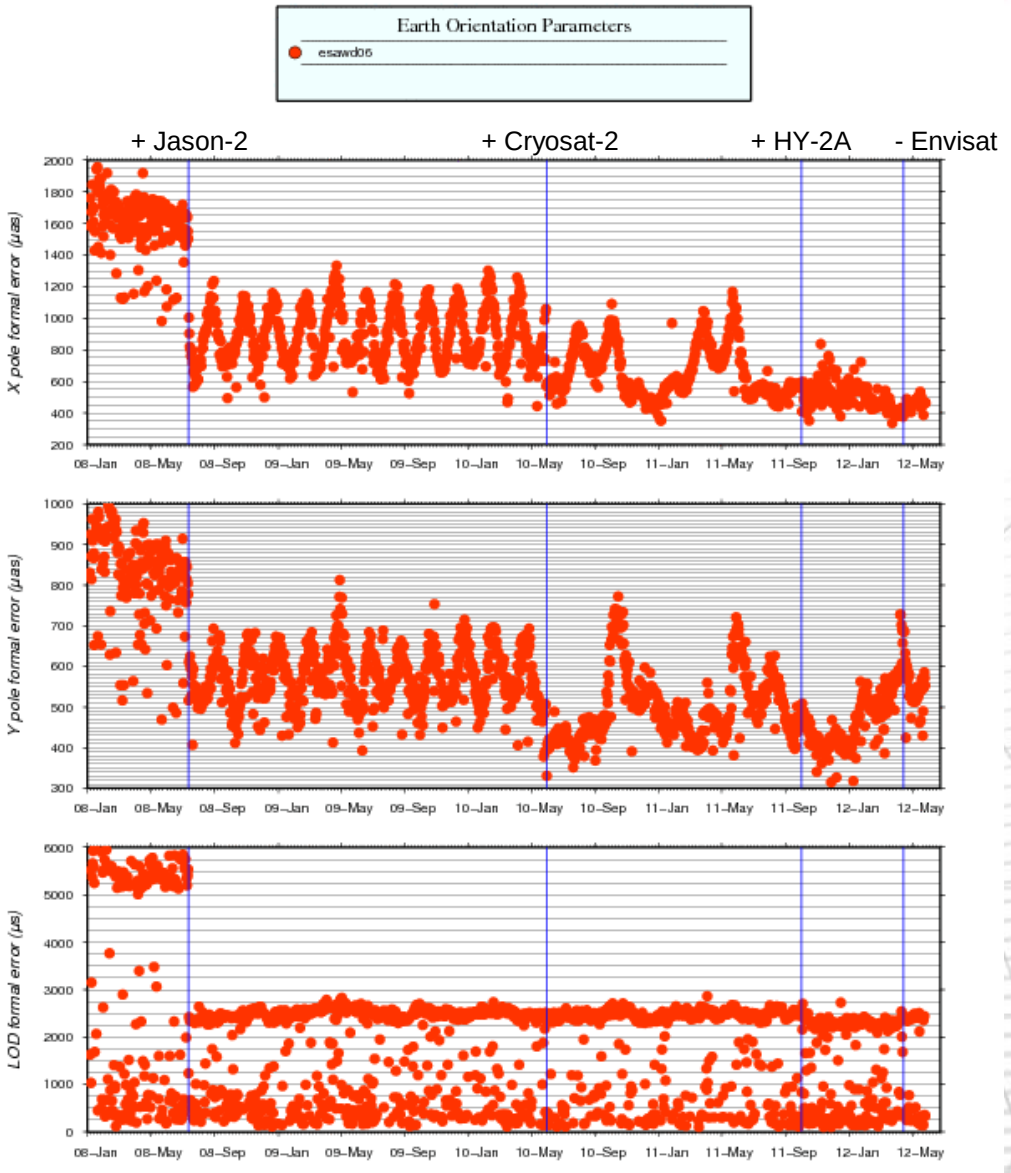
Graph from ESA 06 – Similar results for all the Acs

Time period = 2009-001 to 2012-085/176



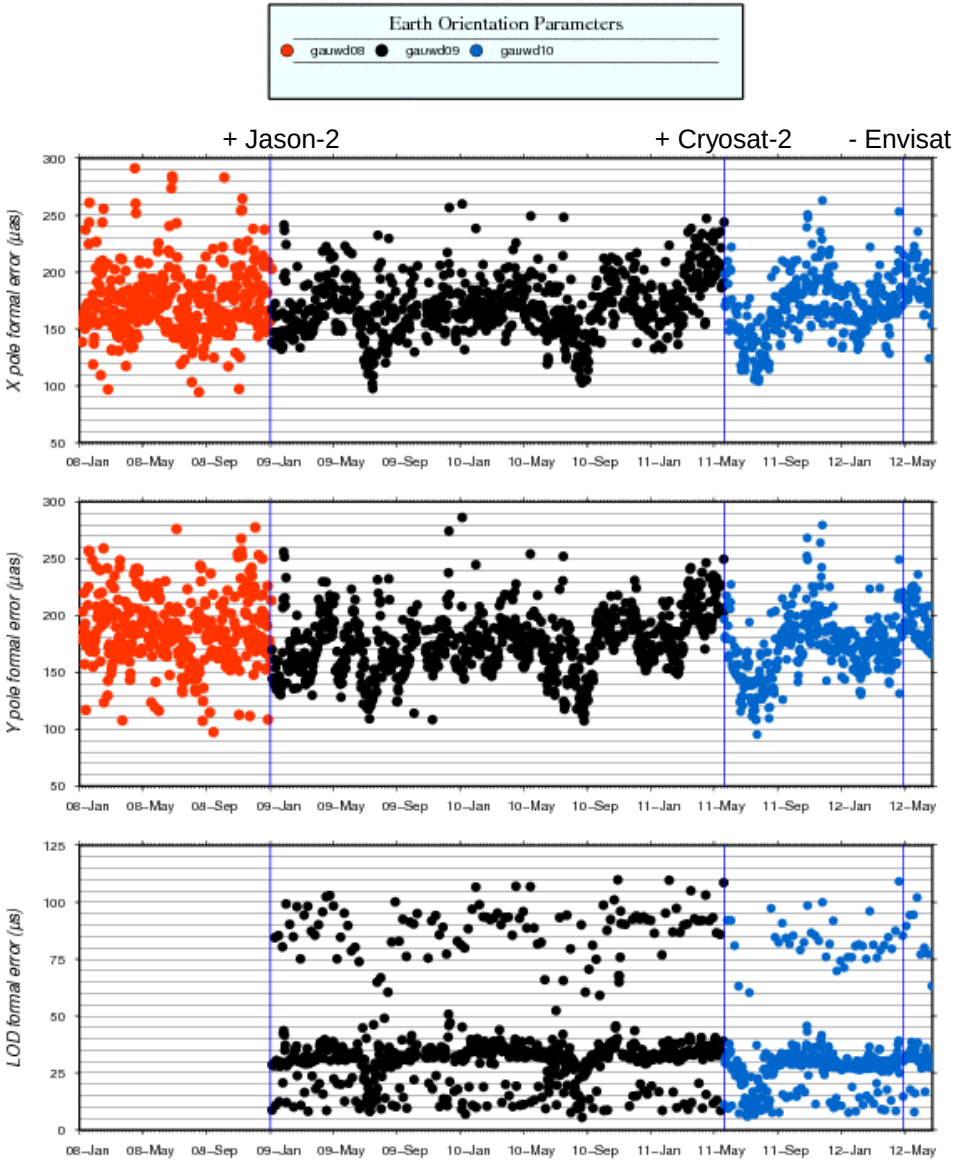
Impact of missions in terms of EOPs formal errors (ESA)

- Jason-2 Impact:
  - Reduces formal errors means by nearly 50%
  - Introduces signal of period of 60 days on X and Y pole
- Cryosat-2 Impact:
  - Slightly reduces formal errors means
- HY-2A impact:
  - Slightly reduces formal errors means
- Envisat Impact: none



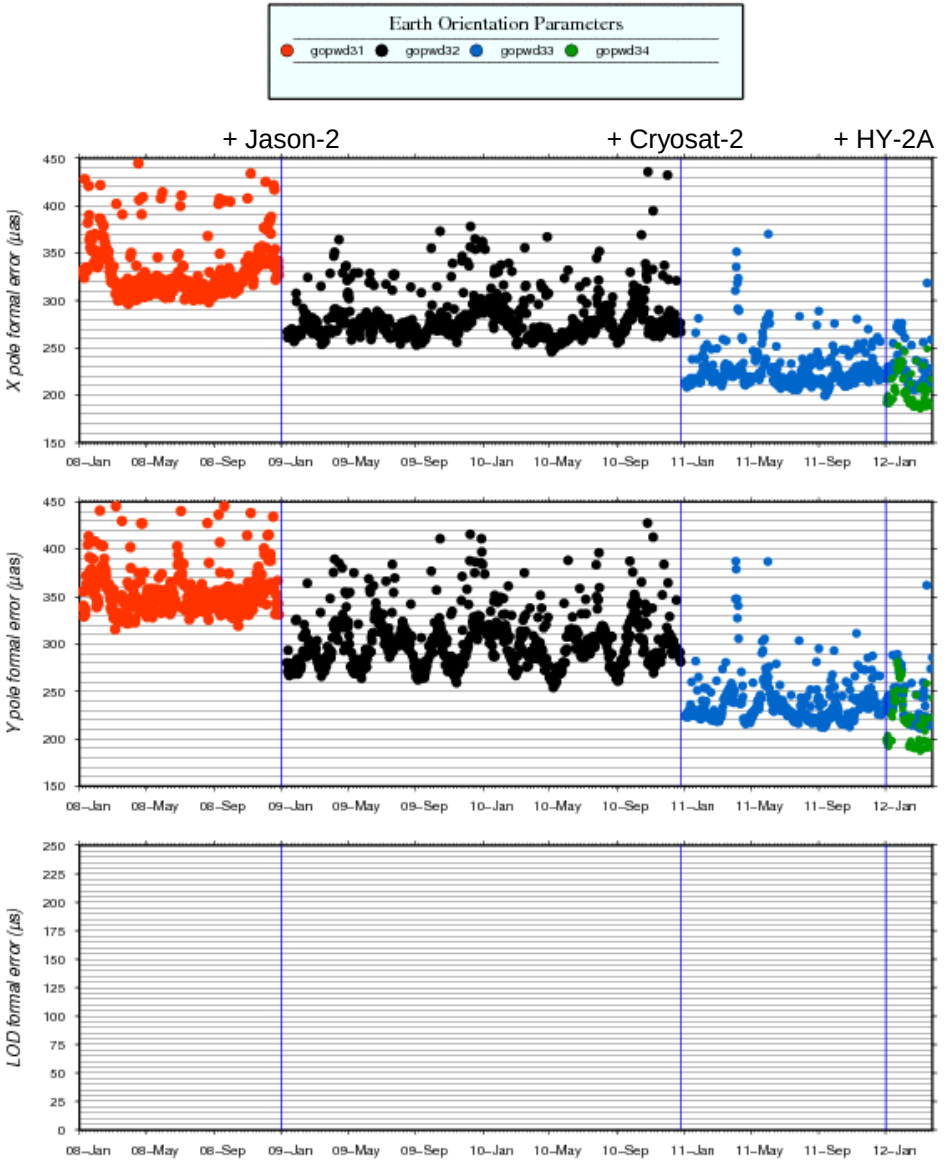
Impact of missions in terms of EOPs formal errors (GAU)

- Jason-2 Impact: none
- Cryosat-2 Impact:none
- Envisat Impact: none
- Overall: signals of period 173 days



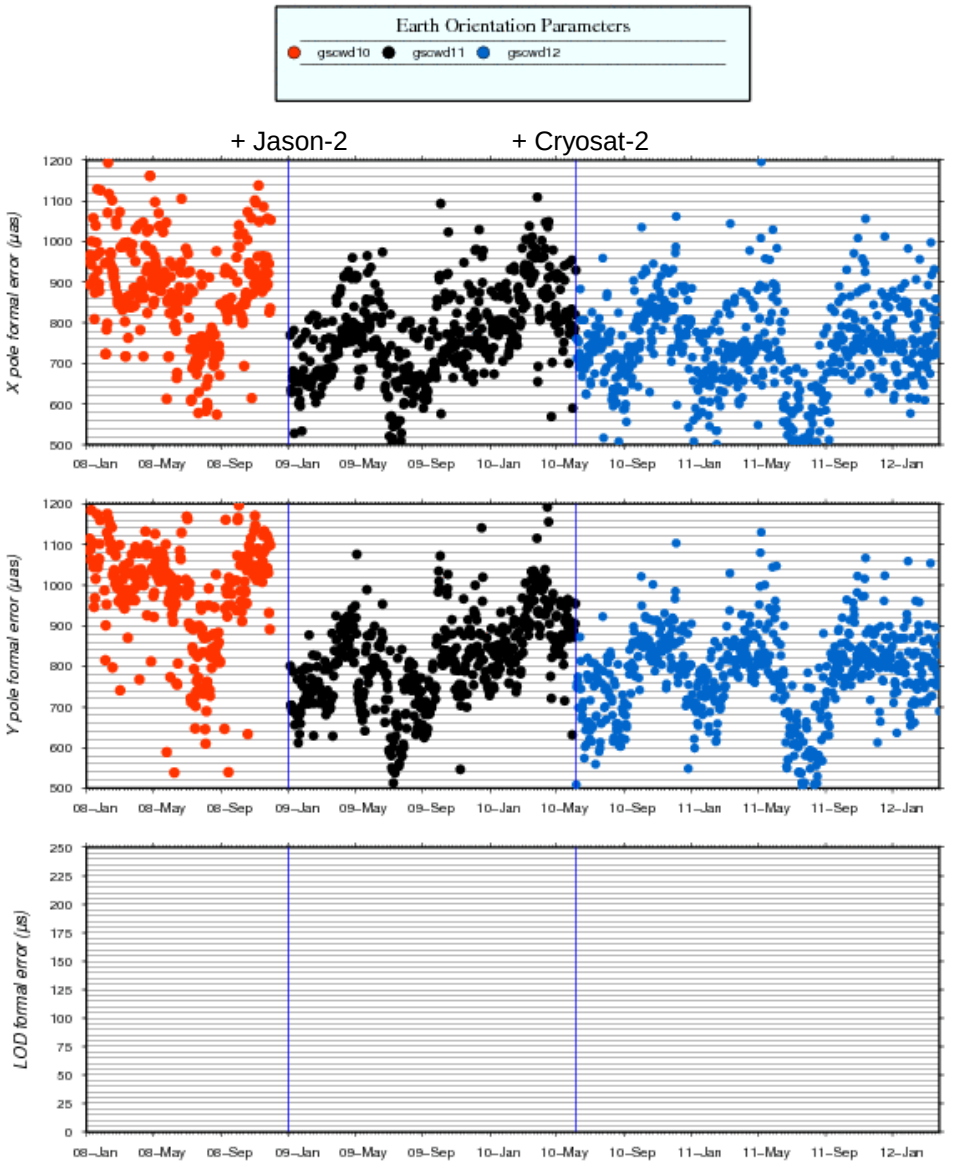
Impact of missions in terms of EOPs formal errors (GOP)

- Jason-2 Impact:
  - Reduces formal errors means by 20%
  - Introduces signal of period 60 days
- Cryosat-2 Impact:
  - Reduces formal errors means by 20%
- HY-2A Impact:
  - Reduces formal errors means by 10%



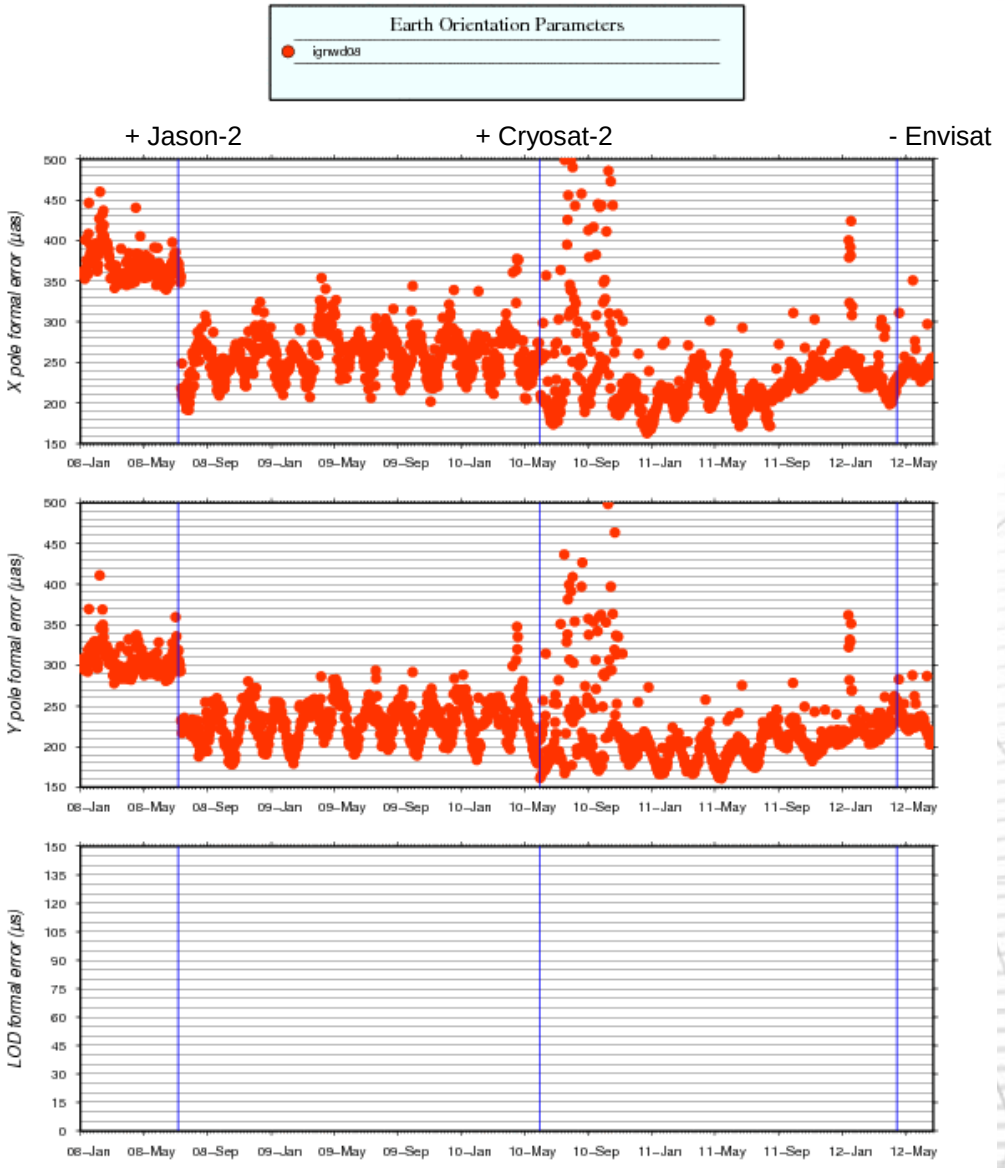
Impact of missions in terms of EOPs formal errors (GSC)

- Jason-2 Impact:
  - Reduces formal errors means by 20%
- Cryosat-2 Impact:
  - Slightly reduces formal errors means
- Overall: signals of period 173 and 166 days on series 11 and 12 respectively



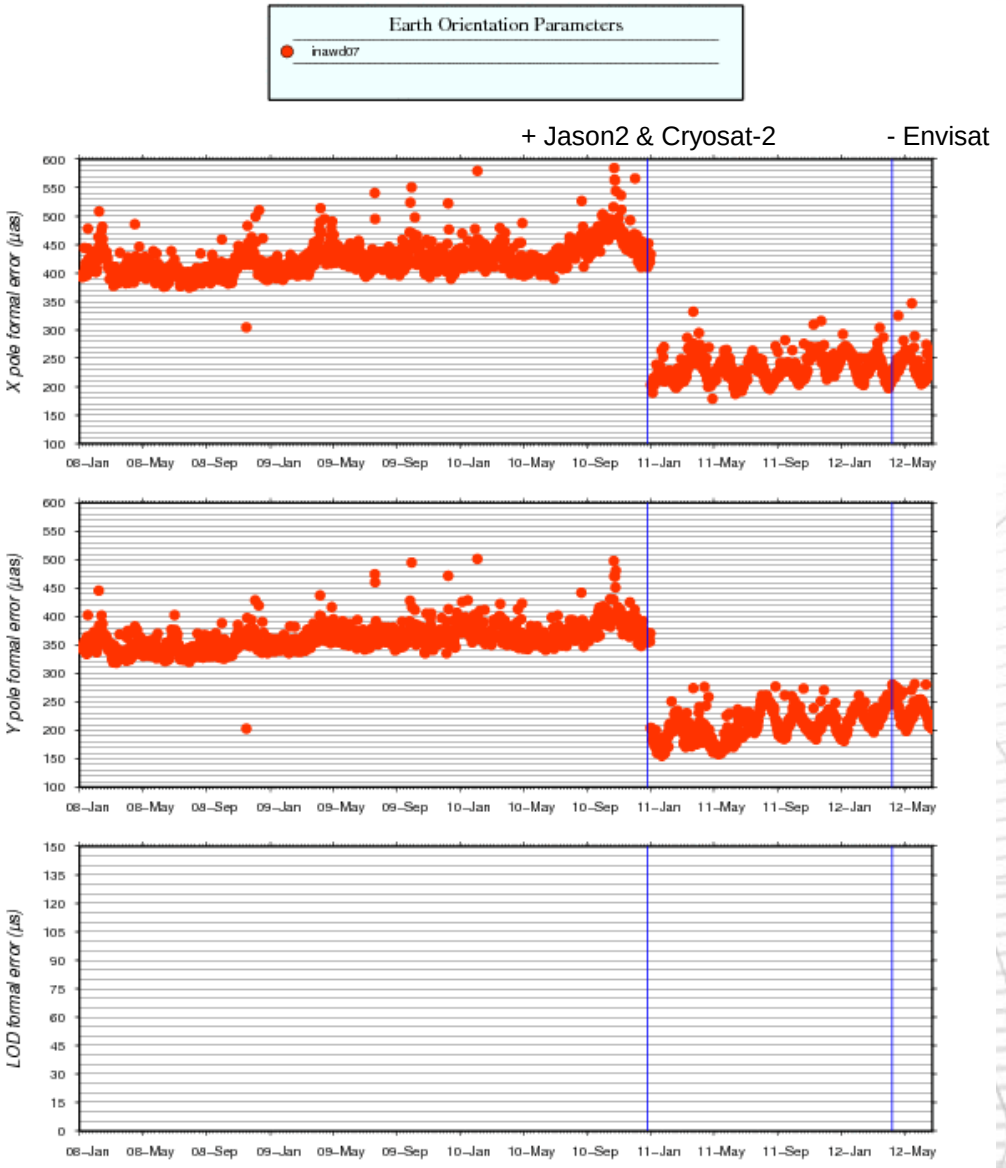
Impact of missions in terms of EOPs formal errors (IGN)

- Jason-2 Impact:
  - Reduces formal errors means by 25%
  - Introduces signal of period of 60 days
- Cryosat-2 Impact:
  - Slightly reduces formal errors means
- Envisat Impact: none



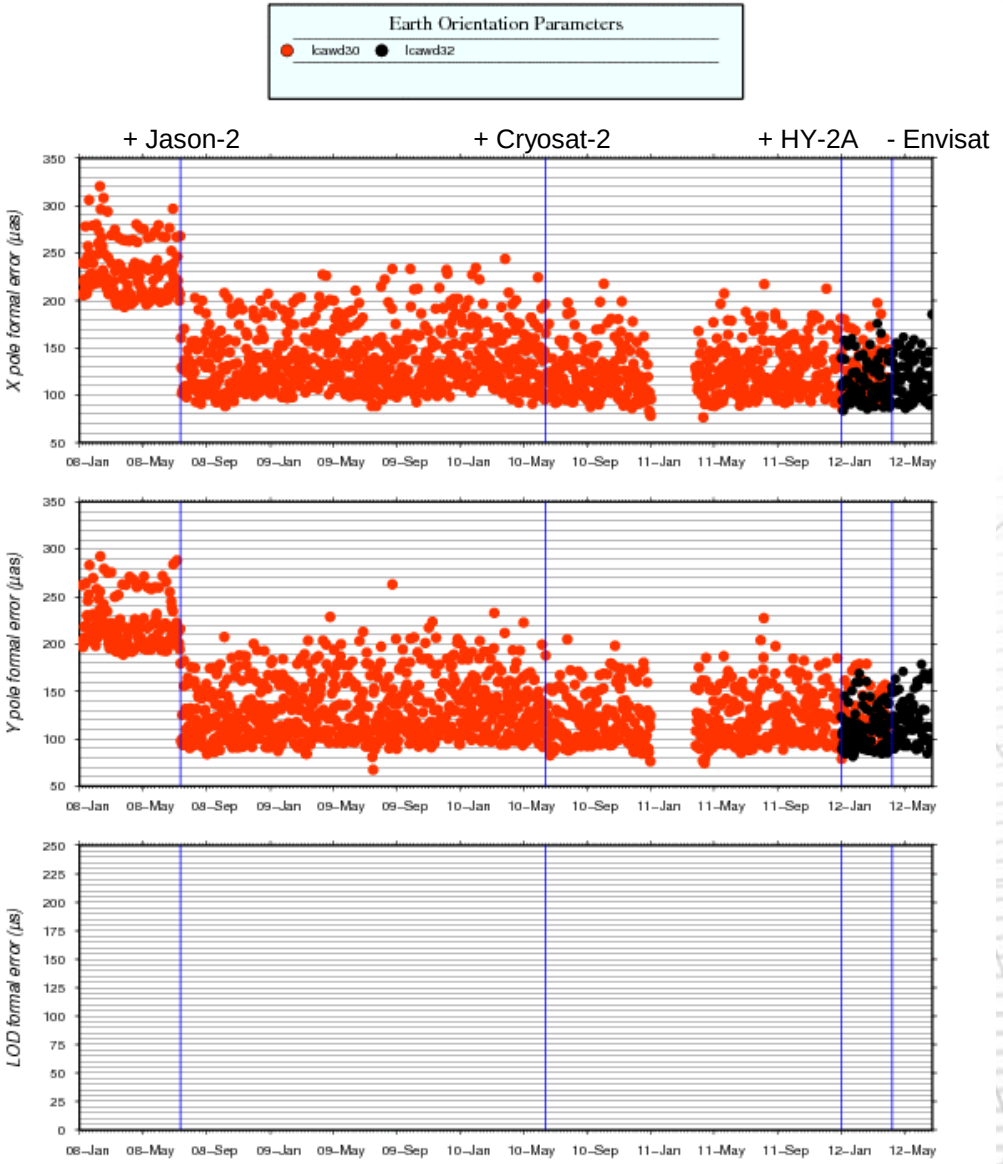
Impact of missions in terms of EOPs formal errors (INA)

- Jason-2 & Cryosat-2 Impact:
  - Reduces formal errors means by nearly 40%
  - Introduces signal of period of 60 days
- Envisat Impact: none

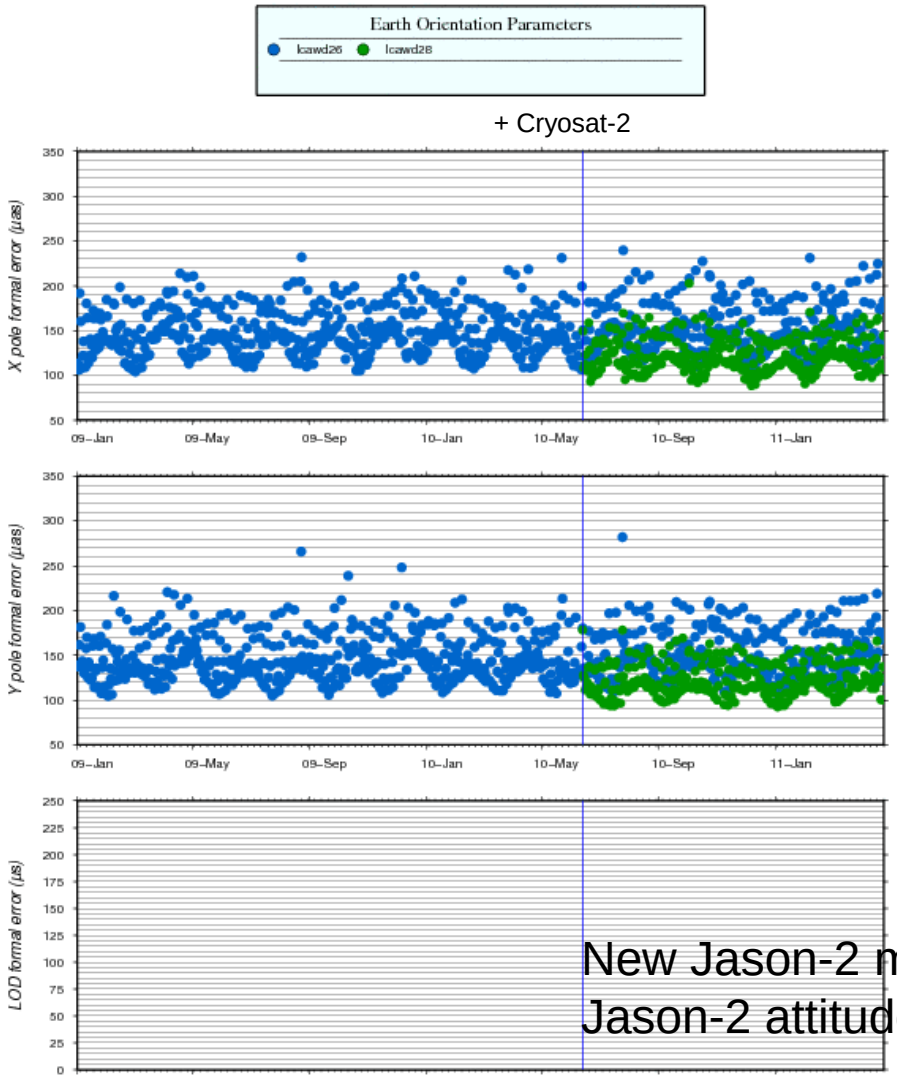


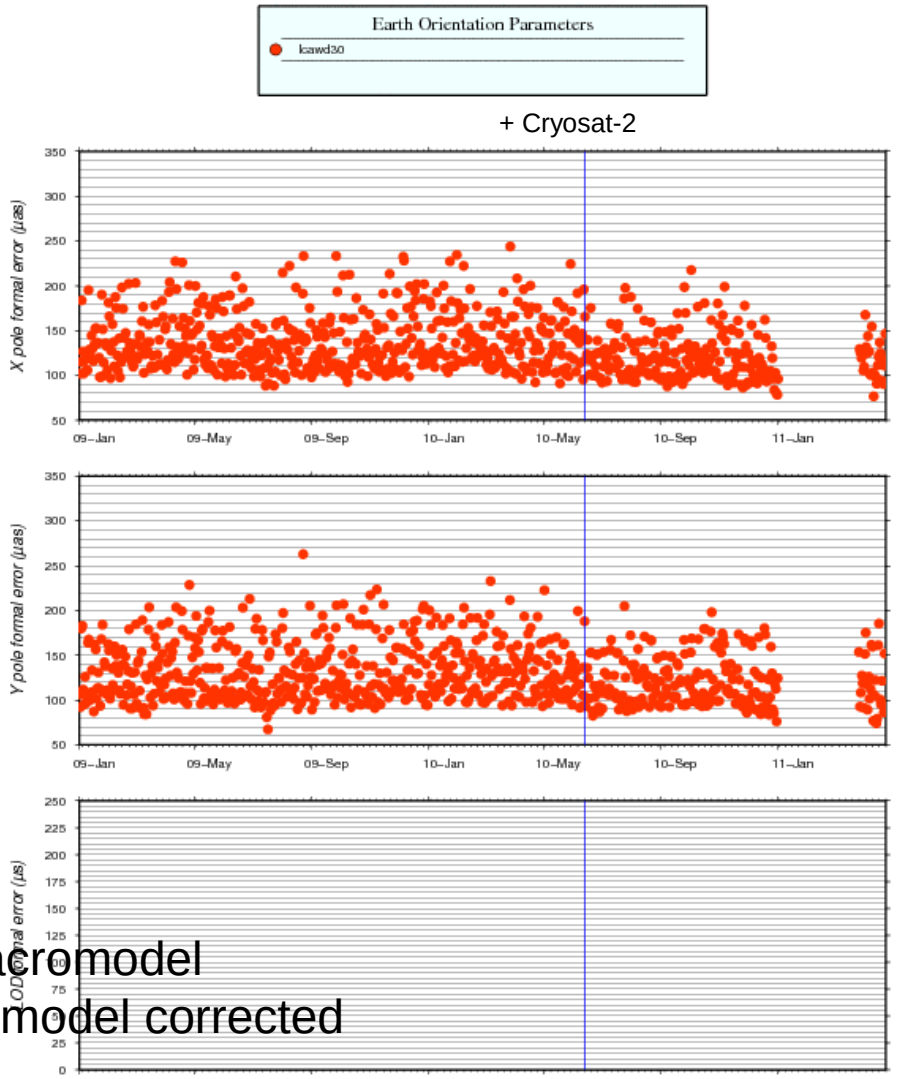
Impact of missions in terms of EOPs formal errors (LCA)

- Jason-2 Impact:
  - Reduces formal errors means by 40%
- Cryosat-2 Impact:
  - Reduces formal errors means by 10%
- HY-2A impact :
  - Reduces formal errors means by 8%
- Envisat Impact: none
- Overall: no clear periodic signal



EOPs formal errors (LCA26-28 vs 30)





New Jason-2 macromodel
Jason-2 attitude model corrected

LCA 26/28: 60 days signal

LCA 30: no periodic signal

Impact of missions in terms of EOPs - Conclusions

- In terms of differences wrt C04 series: no significant impact

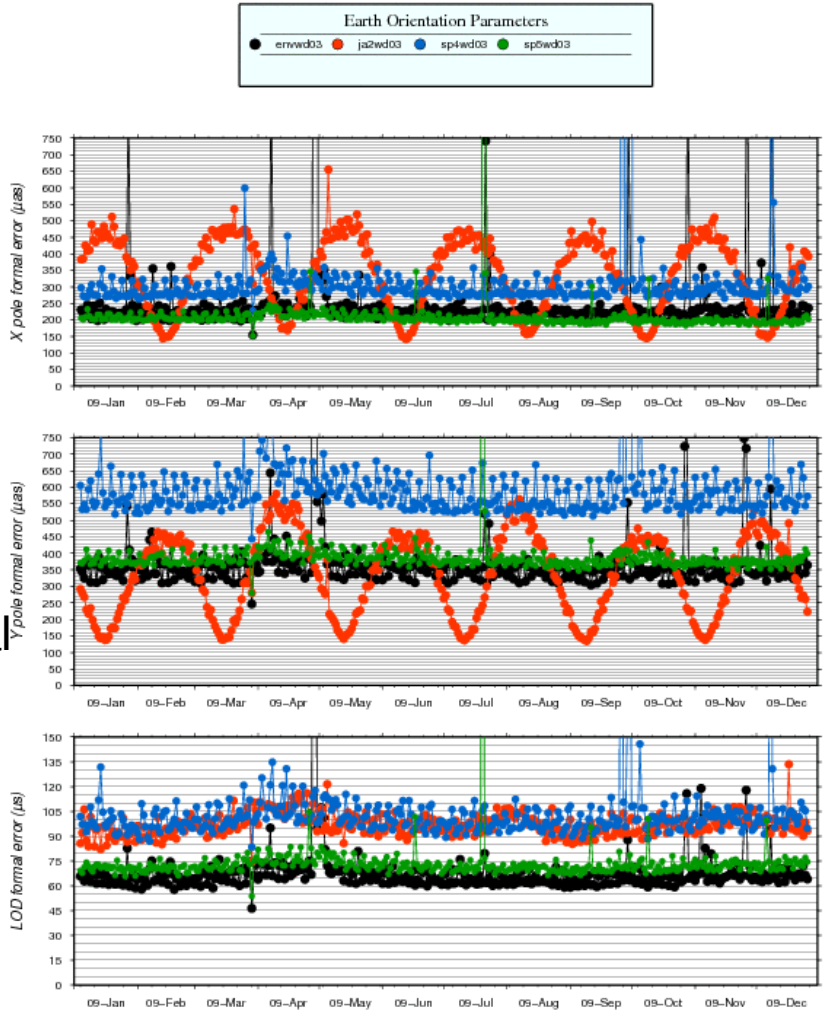
- In terms of formal errors:
  - Positive impact of Jason-2 on the mean
  - Jason-2 induces a signal of period 60 days excepted for LCA
  - Silght impact of Cryosat-2. Less effect than Jason-2 maybe because it was launched after Jason-2
  - No real impact of including HY-2A and loosing Envisat

- No clear impact on the combined solution since mission adding dates differ from one AC to another AC

  ➔ IDS CC propose that all ACs agree for common dates for ITRF2013 reprocessing

IDS Campaign 2010 - EOPs formal errors (ESA)

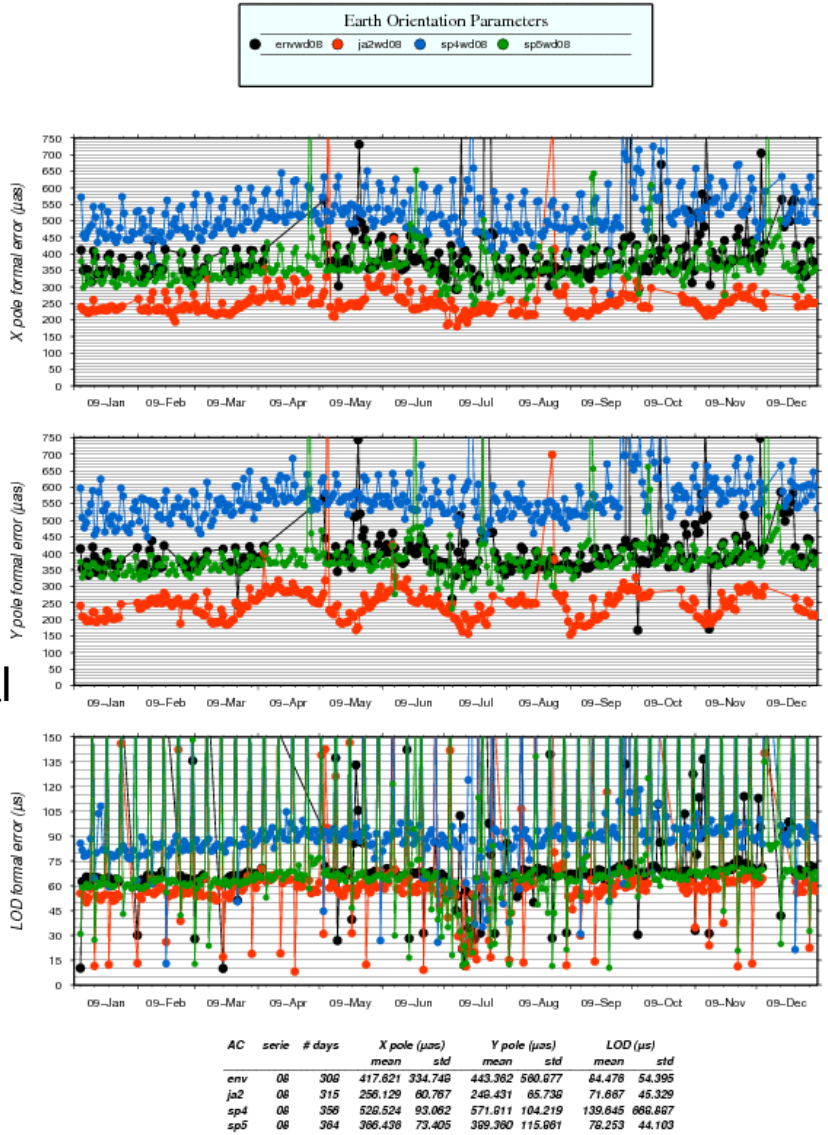
- Envisat : no clear periodic signal
- Jason-2 : 60 days on X and Y
- Spot-4 : no clear periodic signal
- Spot-5 : no clear periodic signal
- LOD : no significant periodic signal



AC	serie	# days	X pole (µas)		Y pole (µas)		LOD (µs)	
			mean	std	mean	std	mean	std
env	03	356	284.557	729.456	382.516	266.625	66.801	32.723
ja2	03	356	338.969	110.590	338.147	122.281	97.122	6.636
sp4	03	355	319.569	257.074	600.202	262.189	102.906	23.193
sp5	03	356	229.219	436.469	401.961	337.204	74.026	27.329

IDS Campaign 2010 - EOPs formal errors (GAU 08)

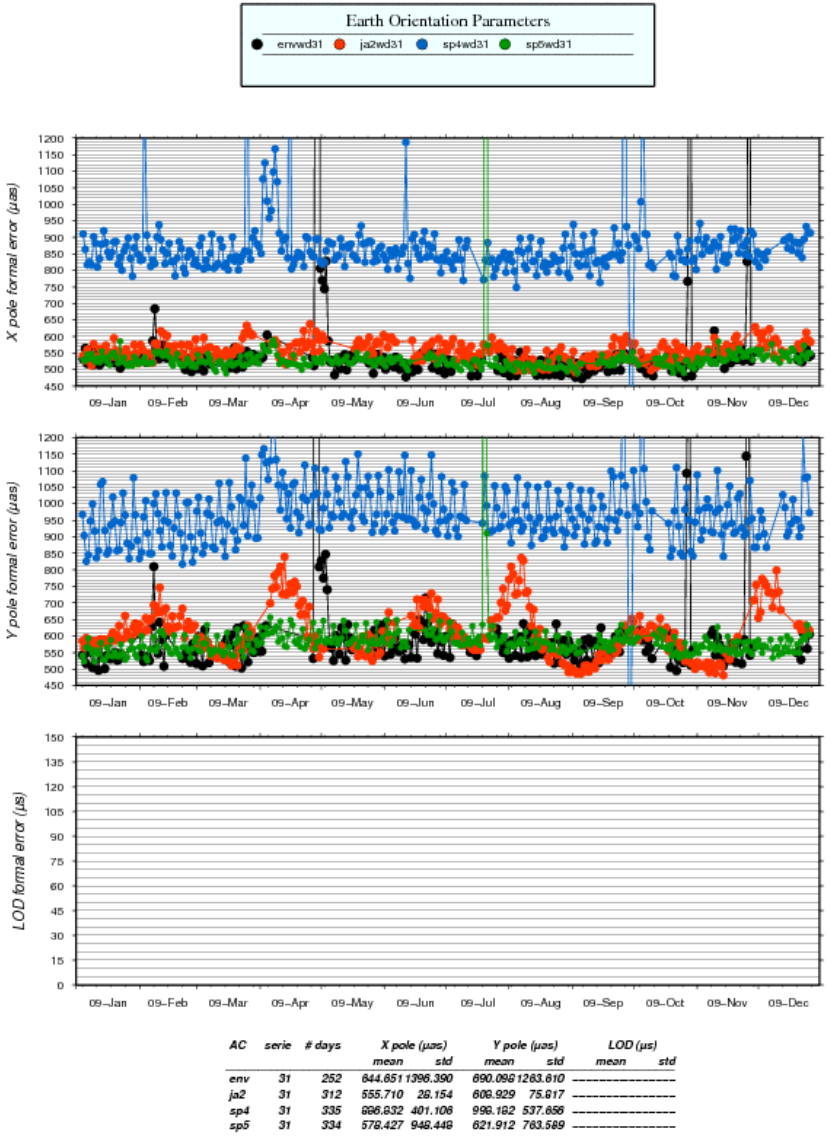
- Envisat : 183 days on X and Y
- Jason-2 : 183 days on X
  61 days on Y
- Spot-4 :183 days on X and Y
- Spot-5 : 183 days on X and Y
- LOD : no significant periodic signal



AC	serie	# days	X pole (µas) mean	X pole (µas) std	Y pole (µas) mean	Y pole (µas) std	LOD (µs) mean	LOD (µs) std
env	08	309	417.621	334.749	443.362	560.677	84.478	54.395
ja2	08	315	256.129	60.767	248.431	85.736	71.667	45.329
sp4	08	356	528.524	93.062	571.911	104.219	139.645	668.667
sp5	08	364	366.436	73.405	369.360	115.661	78.253	44.103

IDS Campaign 2010 - EOPs formal errors (GOP 31)

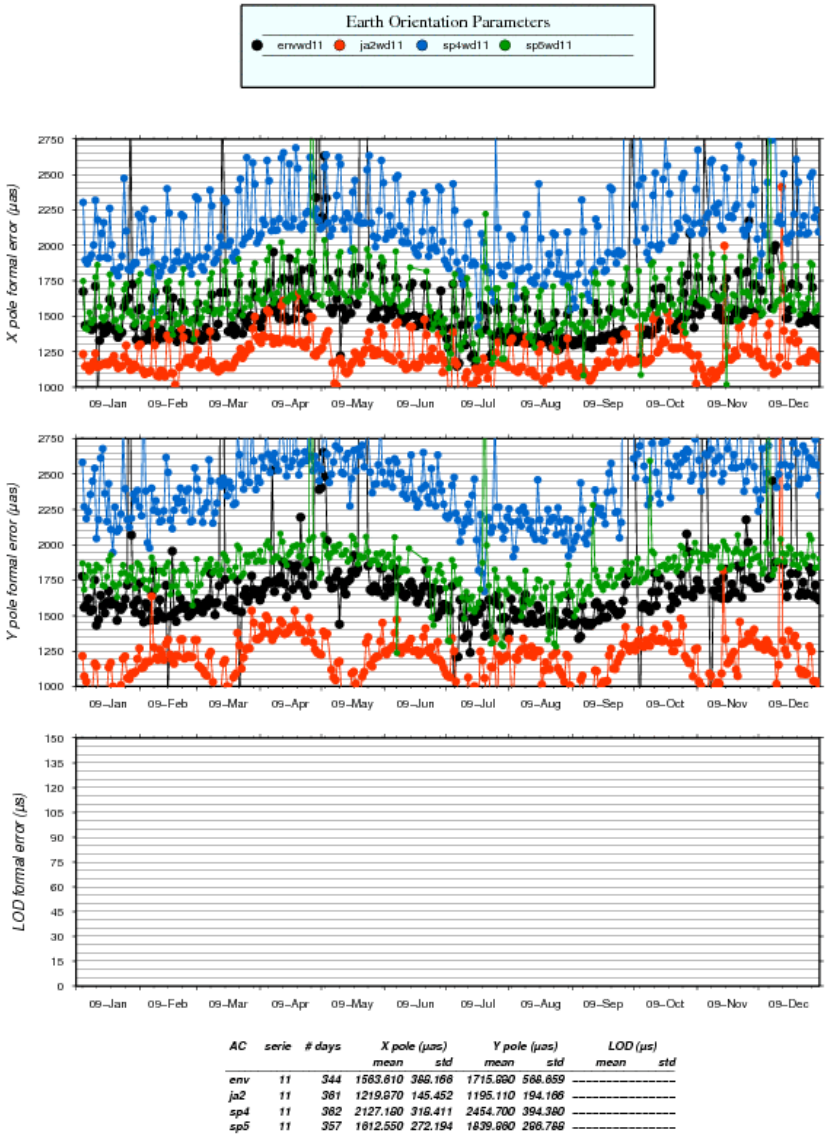
- Envisat : no clear periodic signal Y
- Jason-2 : 60 days on Y
- Spot-4 : no clear periodic signal
- Spot-5 : no clear periodic signal



AC	serie	# days	X pole (µas) mean	X pole (µas) std	Y pole (µas) mean	Y pole (µas) std	LOD (µs) mean	LOD (µs) std
env	31	252	844.651	1396.390	690.099	1263.610	----------	----------
ja2	31	312	555.710	26.154	608.929	75.617	----------	----------
sp4	31	335	996.832	401.106	998.182	537.656	----------	----------
sp5	31	334	578.427	946.448	621.912	763.589	----------	----------

IDS Campaign 2010 - EOPs formal errors (GSC 11)

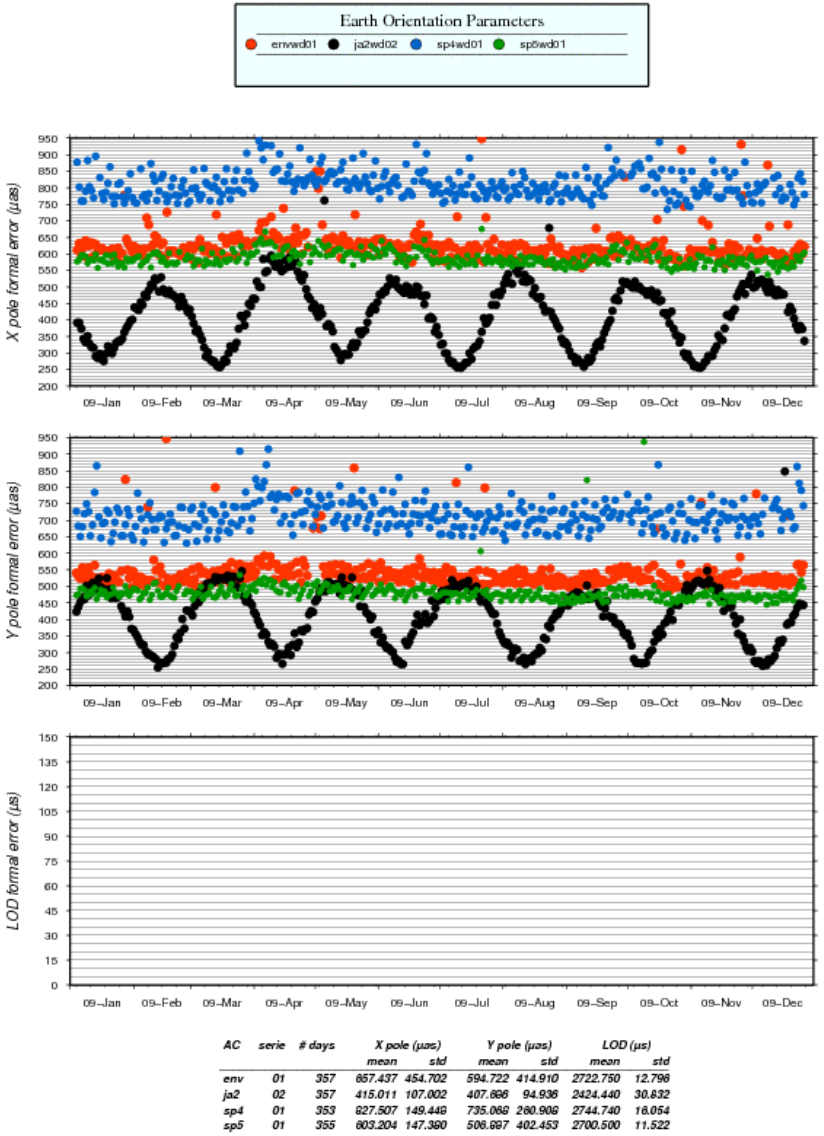
- Envisat : 183 days on X and Y
- Jason-2 : 183 days on X
  61 days on Y
- Spot-4 : 183 days on X and Y
- Spot-5 : 183 days on X and Y



AC	serie	# days	X pole (µas)		Y pole (µas)		LOD (µs)	
			mean	std	mean	std	mean	std
env	11	344	1563.610	386.166	1715.690	568.659	----------	----------
ja2	11	361	1219.870	145.452	1195.110	194.166	----------	----------
sp4	11	362	2127.160	316.411	2454.700	394.380	----------	----------
sp5	11	357	1612.550	272.194	1839.960	298.789	----------	----------

IDS Campaign 2010 - EOPs formal errors (IGN 08)

- Envisat : no clear periodic signal
- Jason-2 : 60 days on X and Y
- Spot-4 : no clear periodic signal
- Spot-5 : no clear periodic signal



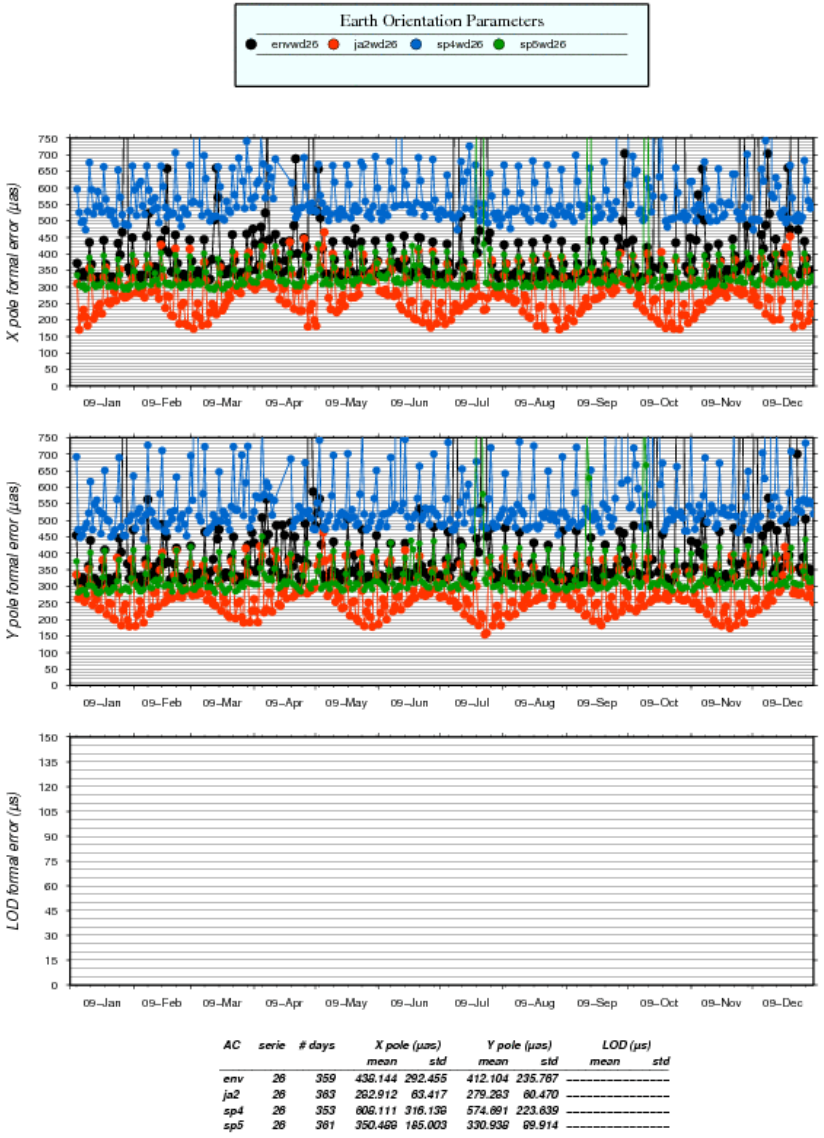
AC	serie	# days	X pole (µas)		Y pole (µas)		LOD (µs)	
			mean	std	mean	std	mean	std
env	01	357	857.437	454.702	594.722	414.910	2722.750	12.798
ja2	02	357	415.011	107.002	407.686	94.936	2424.440	30.832
sp4	01	353	827.507	149.448	795.068	260.909	2744.740	16.054
sp5	01	355	603.204	147.380	508.697	402.453	2700.500	11.522

IDS Campaign 2010 - EOPs formal errors (LCA 26)

- Envisat : 120 days on X and Y
- Jason-2 : 60 days on X and Y

No more present in the latest series 30/32

- Spot-4 : 90 days on X and Y
- Spot-5 : 90 days on X and Y



AC	serie	# days	X pole (µas) mean	X pole (µas) std	Y pole (µas) mean	Y pole (µas) std	LOD (µs) mean	LOD (µs) std
env	26	359	438.144	292.455	412.104	235.767	----------	----------
ja2	26	363	282.912	63.417	279.283	60.470	----------	----------
sp4	26	353	608.111	316.139	574.691	223.639	----------	----------
sp5	26	361	350.469	185.003	330.936	99.914	----------	----------

IDS campaign 2010 – EOPs - Conclusions

- Jason-2: clear 60 days signal for all the ACs
- GAU and GSC: 180 days signal on Envisat, Spot-4 and Spot-5

- List of satellites by decreasing order of mean magnitude:
  - Spot-4
  - Spot-5 & Envisat
  - Jason-2

  closely related to the number of DORIS receiver channels

What's next ?

- Tests on combined pole rates and LOD
- Tests on selection citeria for ACs contribution to combined EOPs

- Computation of a new combined series (with EOPs) since 2009-001
- Online STCDs from IDS combined solution

- Computation of a positions/velocities combined solution over time period 2009-001 to 2012-176 for comparisons with IDS-3 and GPS solution at co-located sites (oral presention at the next AGU fall meeting)

- Online access on IDS web page of a dedicated plottool version to Helmert parameters visualisation