DORIS DIODE : instantaneous Earth Pole coordinates computed in space

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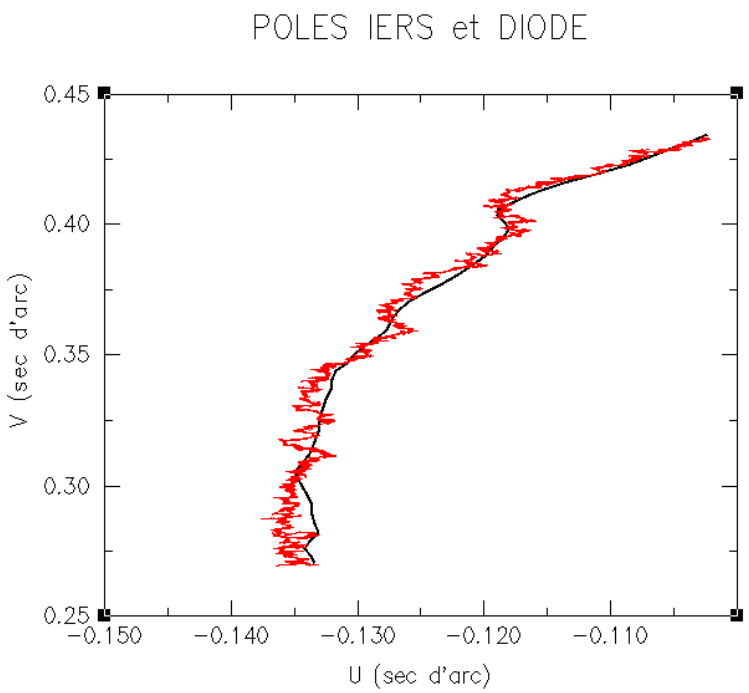
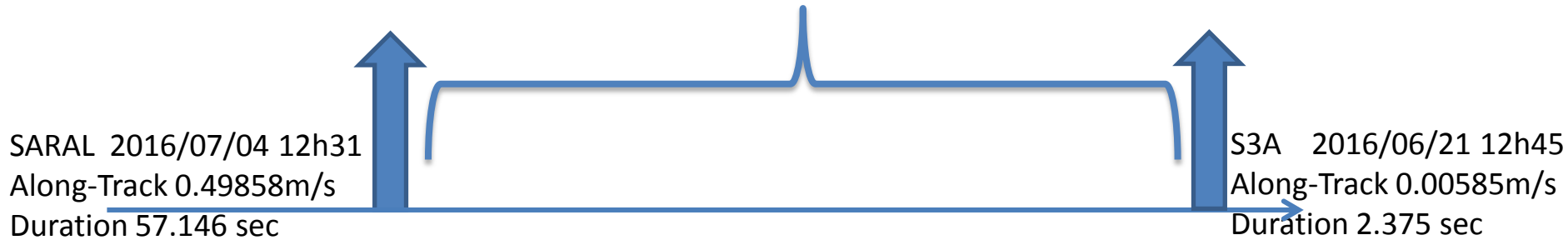
with insights by Christian Bizouard (OBSPM)



Introduction

- Compare Earth Pole Coordinates estimates computed by different DIODE software versions
- Measurements from six different satellites Jason-2, Cryosat-2, Saral, HY-2A, … and also Jason-3, Sentinel-3A.
- First, define a Reference period without any manœuvre :

17 days	from	2016 July, 4th (24291) 12h31 (SARAL)
	to	2016 July, 21st (24308) 12h45 (S3A)



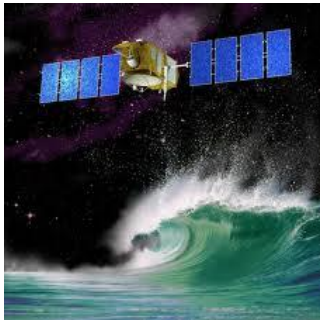
Ground activation with the latest DIODE version (v05_00)

- (Jason-3 Sentinel-3A ground reprocessing not integrated yet)

Cryosat2

HY2

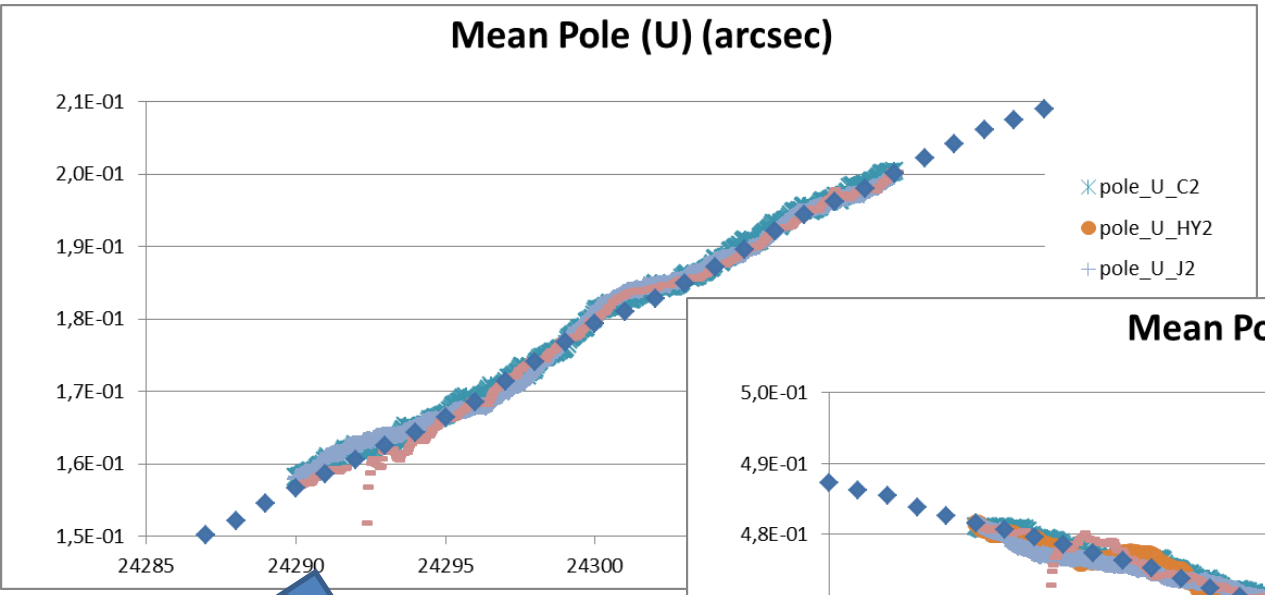
Jason2



Saral

Ground activation with the latest DIODE version (v05_00)

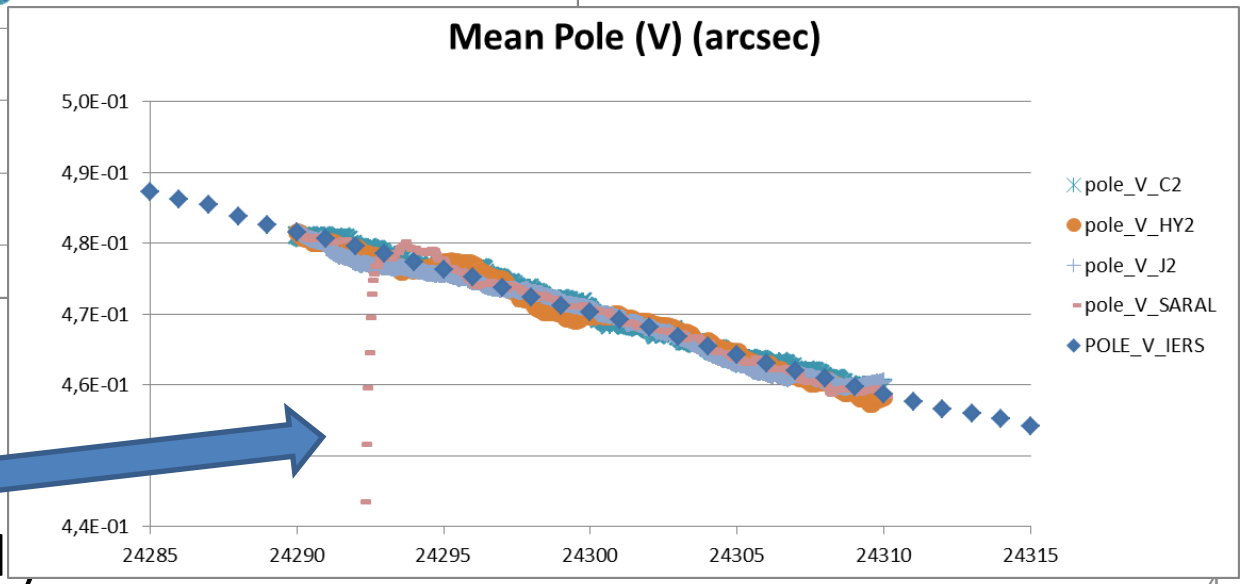
- General shape looks identical as seen by each satellite



1 mas = 3 cm

Daily variations 2-9 cm

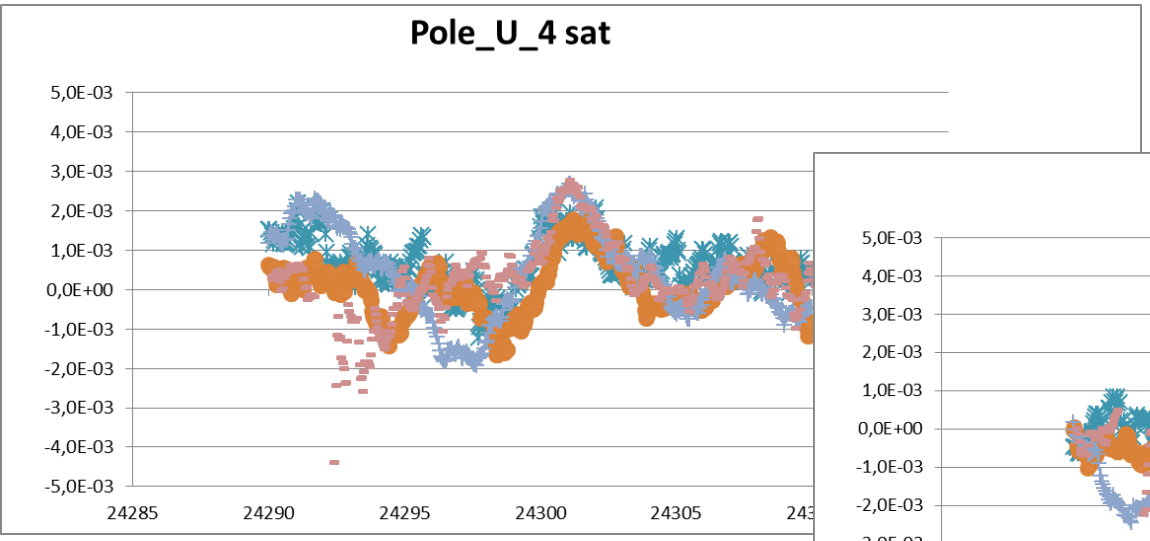
Diurnal 1.5 cm

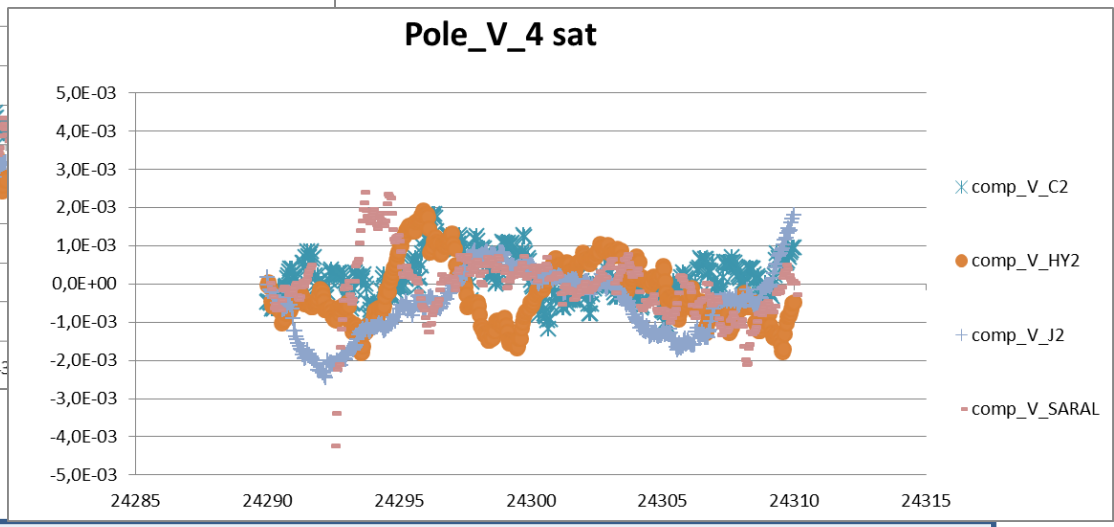


- (SARAL manoeuver unproperly processed)

Pole: inter-satellite comparison

- Mean pole comparison : DIODE – IERS C04 series
- Variability from one satellite to the other : improvements can be expected with future issues of the DIODE software



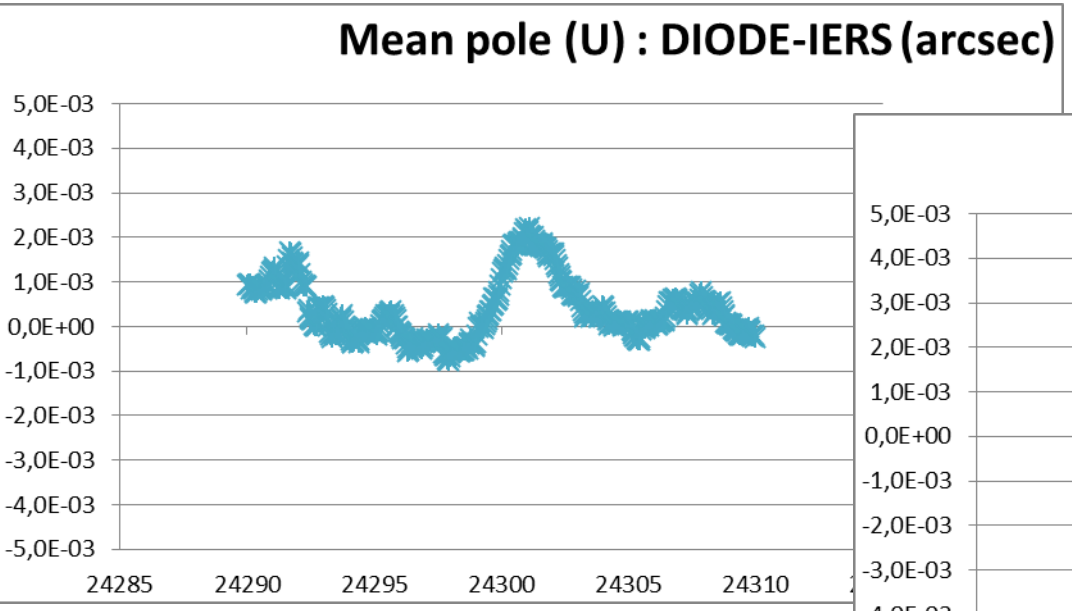


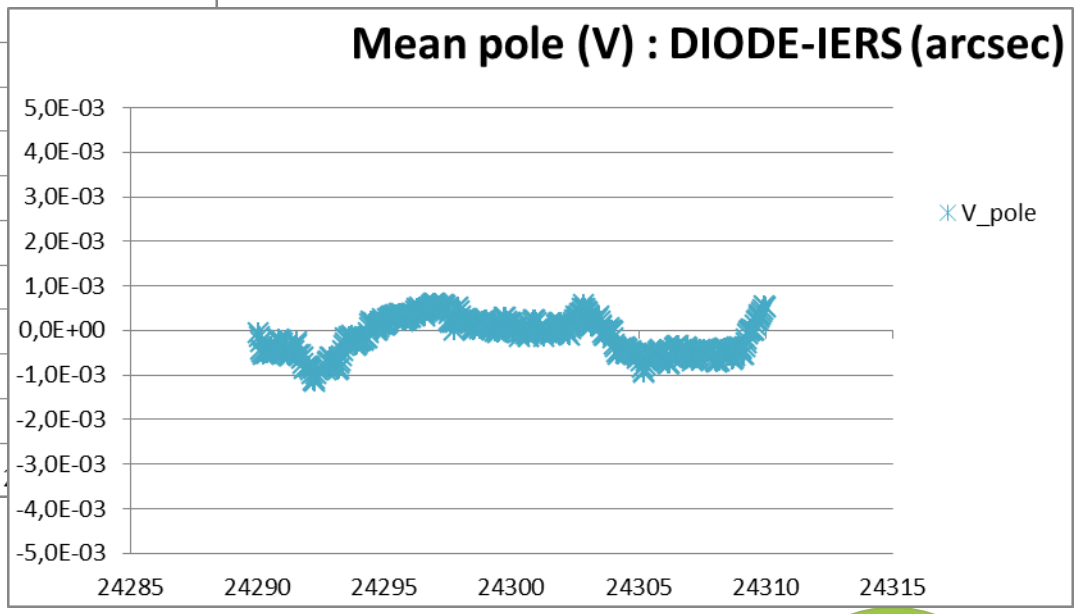
	Cryosat2	HY2	Jason2	Saral
POLE_U	8.864E-04	7.254E-04	1.230E-03	9.876E-04
POLE_V	5.773E-04	8.653E-04	1.002E-03	7.623E-04

RMS (arcsec) on the converged period

4-satellites mixed : J2 CR2 SRL HY2

- Comparison to IERS restituted values : mixing allows reduction of individual solutions noise





Statistics (arcsec)

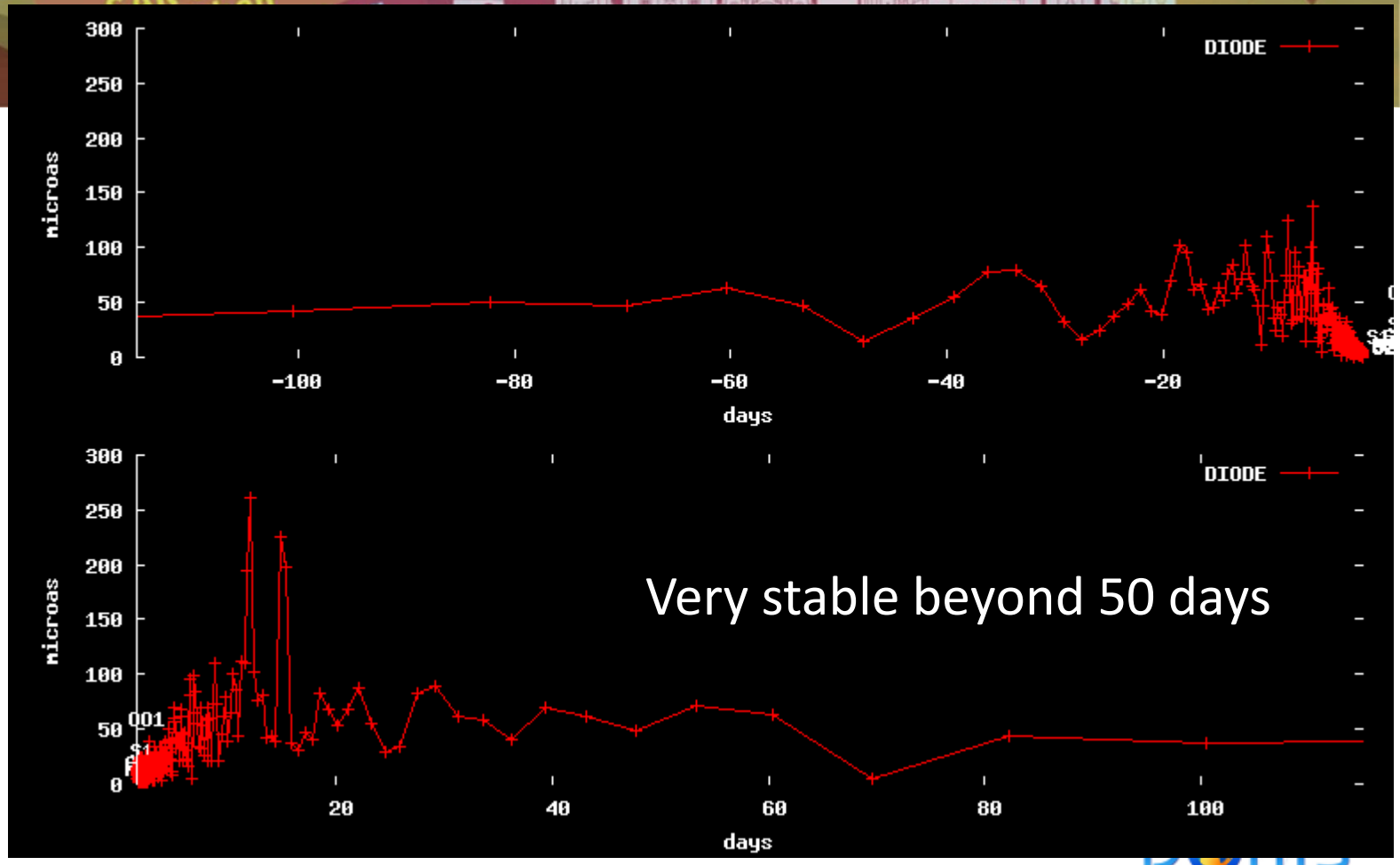
	MINIMUM	MAXIMUM	MEAN	ST DEV	RMS
	**********	*********	**********	*********	*********
POLE_U	-7.763E-04	2.210E-03	3.751E-04	6.771E-04	7.740E-04
POLE_V	-2.993E-03	5.982E-04	-1.707E-04	4.448E-04	4.764E-04

High-frequency spectrum reveals residual tidal peaks with respect to the IERS model of the ocean tidal effects on polar motion. Some of them present amplitude well above the expected corrections on the tidal model: +0.923 day (OO1) - 60 µas amplitude (the corresponding tidal effect is about 2 µas)
+1 day (S1) - 20 µas amplitude (the corresponding tidal effect is about 1 µas)
These peaks can mix different causes: atmospheric tide, defect in Doris treatment, defect in the ocean tidal model.

http://hpiers.obspm.fr/eop-pc/products/operational/doris/

It is worth to note a ter-diurnal peak, at -0.33 day (S3) (about 10 µas), probably revealing the third harmonics of the S1 atmospheric thermal tide

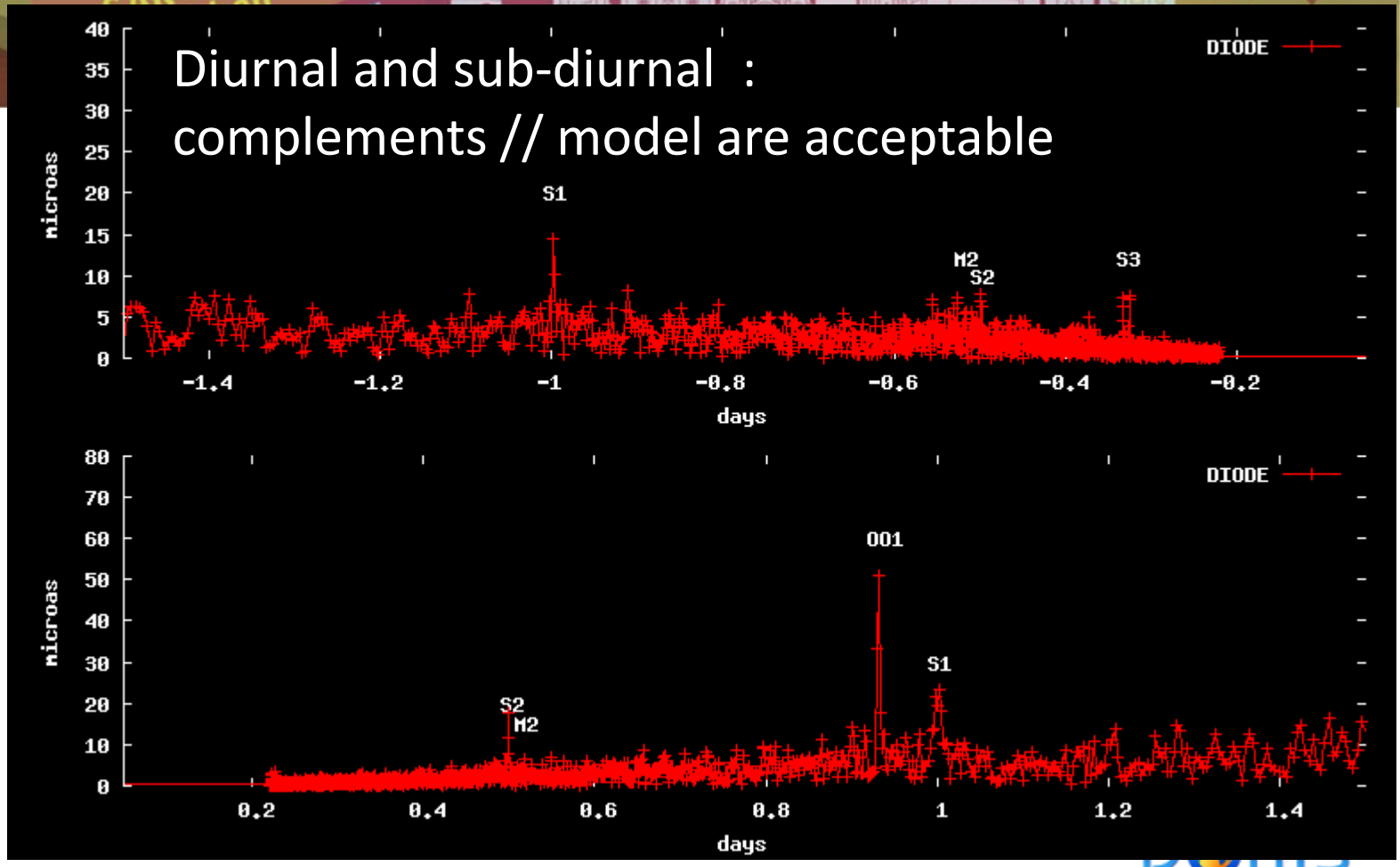
Complex spectrum of Δx-i Δy: periods > 1.5 day



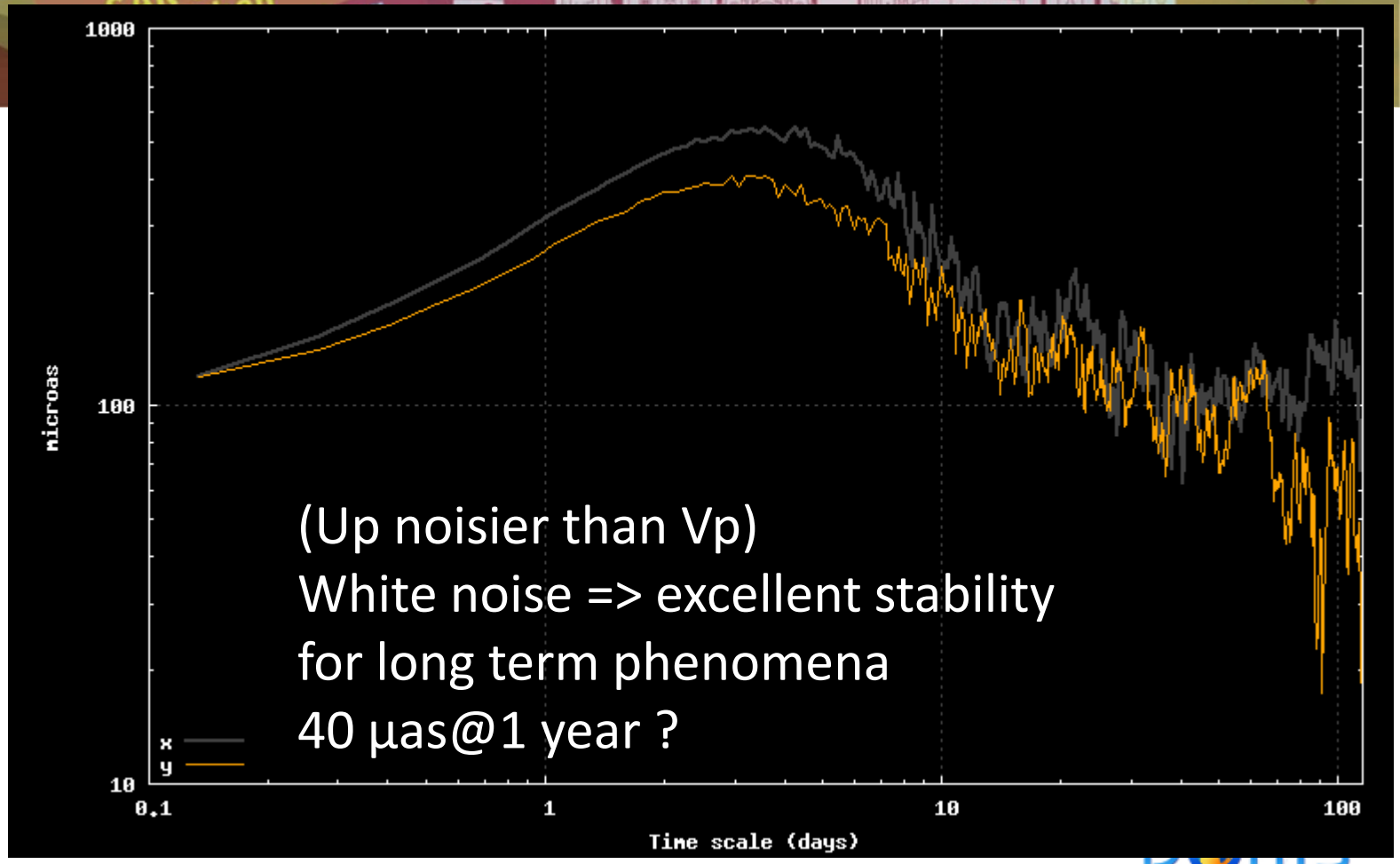
Very stable beyond 50 days

Complex spectrum of Δx-i Δy: diurnal and sub-diurnal periods

Diurnal and sub-diurnal : complements // model are acceptable

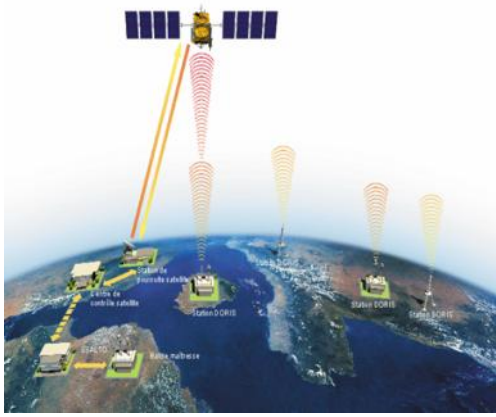


Allan deviation analysis of the Doris - C04 differences (at the date of Doris series)



On-board Earth Pole : auxiliary Data

- New TeleMetry format containing on-board estimates
  - Earth Pole coordinates and drifts

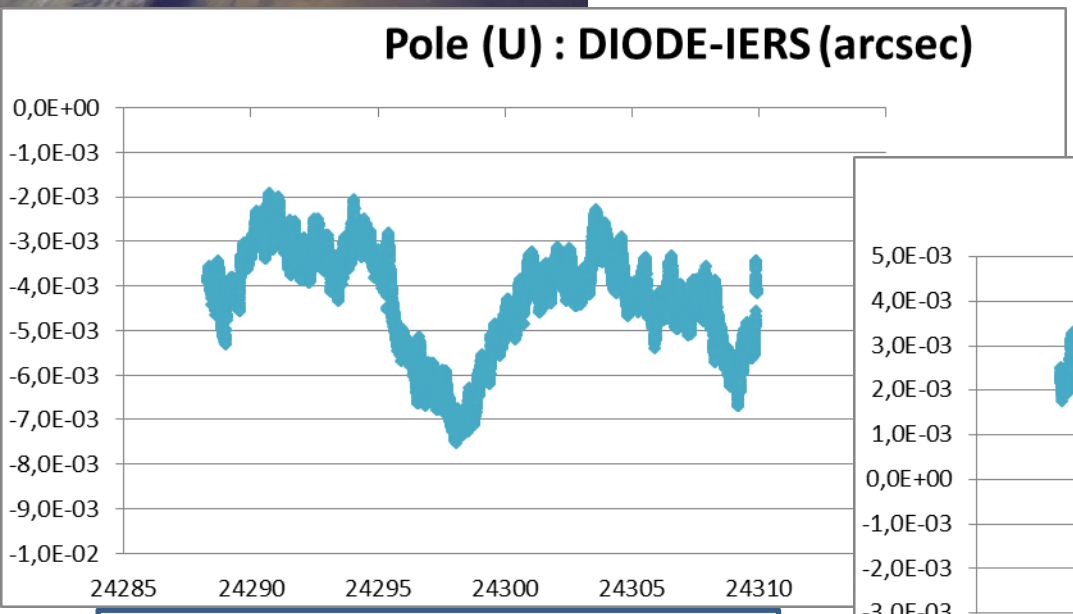


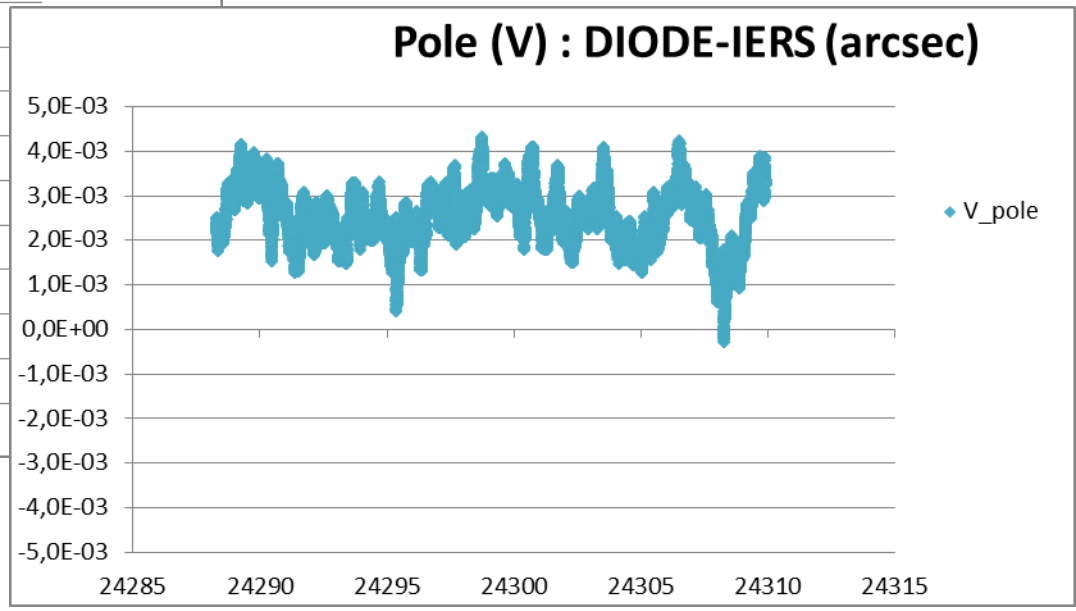
- Available for Jason-3 and Sentinel-3
  - in Near Real Time (typically 3h = TM delivery)

- Real-time Earth pole estimates
  - with the best accuracy possible

Jason-3 on-board results

- Comparison to IERS (every 10 secs)
- DIODE on-board version = v04_00

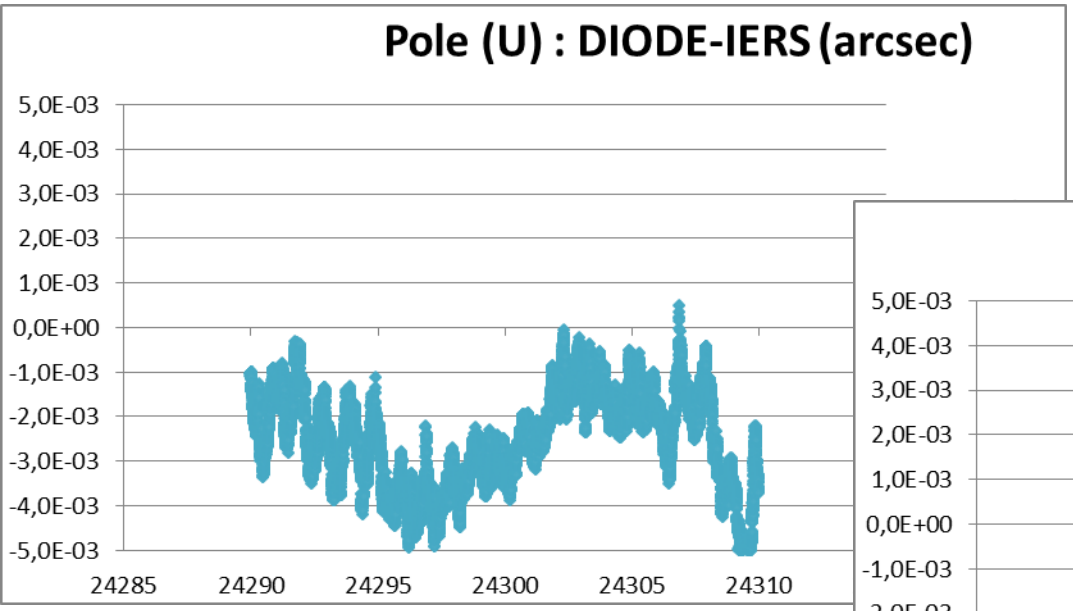


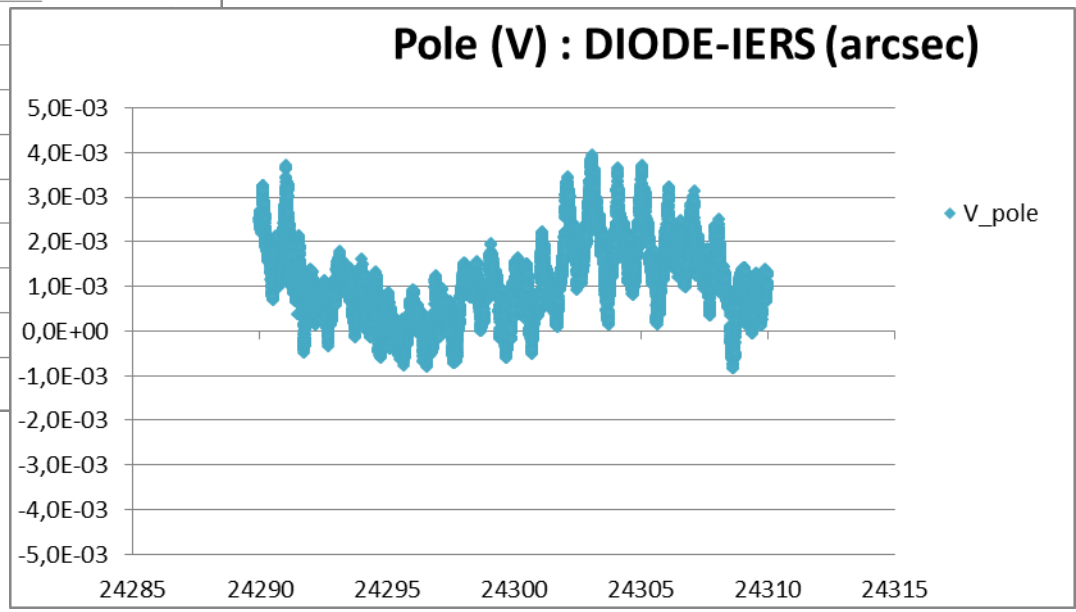


RMS (arcsec) Jason3	
POLE_U	4.501E-03
POLE_V	2.577E-03

Sentinel-3A on-board results

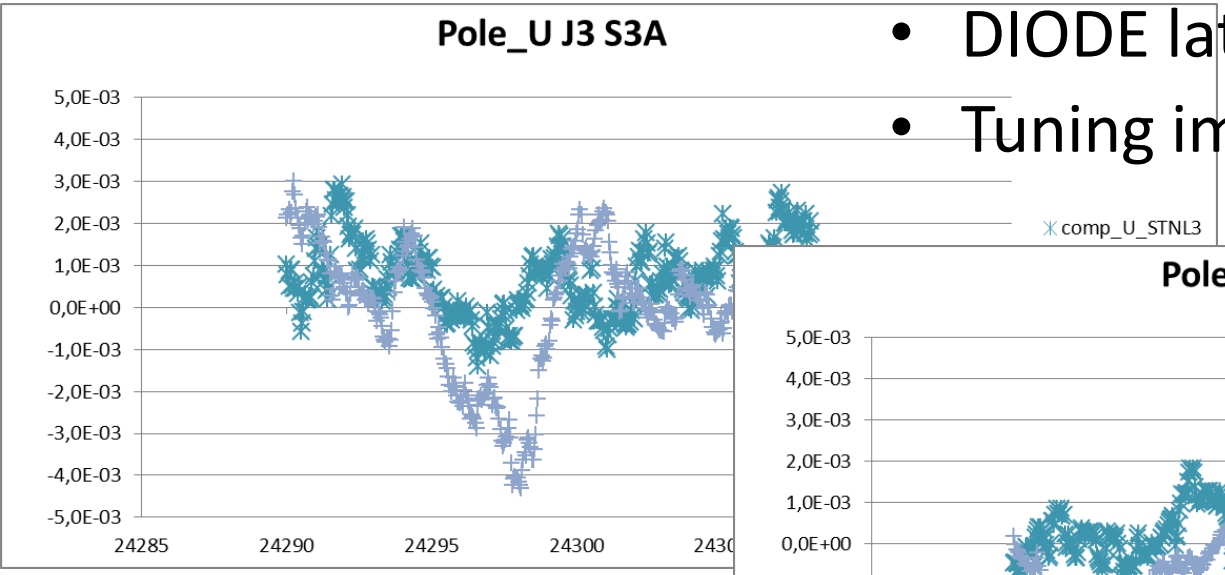
- Comparison to IERS (every 10 secs)
- DIODE on-board version = v04_00



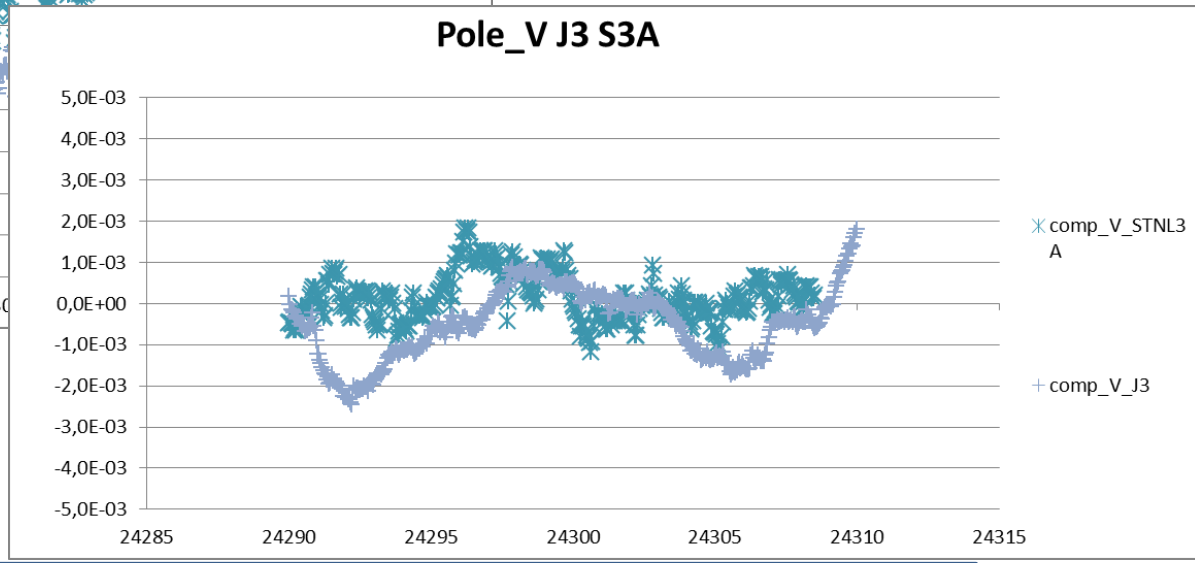


RMS (arcsec) Sentinel3	
POLE_U	2.755E-03
POLE_V	1.407E-03

On-ground Jason-3 Sentinel-3A reprocessing



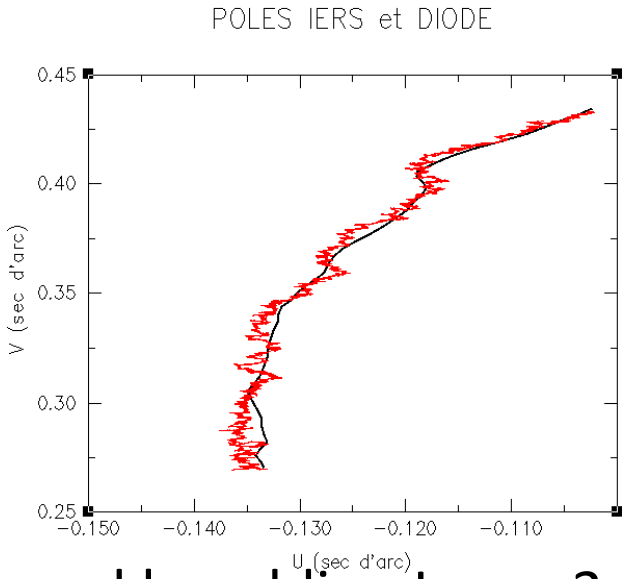
- DIODE latest version = v05_00
- Tuning improved



	Sentinel-3A	Jason3
POLE_U	1.102E-03	1.528E-03
POLE_V	1.088E-03	1.186E-03

RMS (arcsec) on the converged period

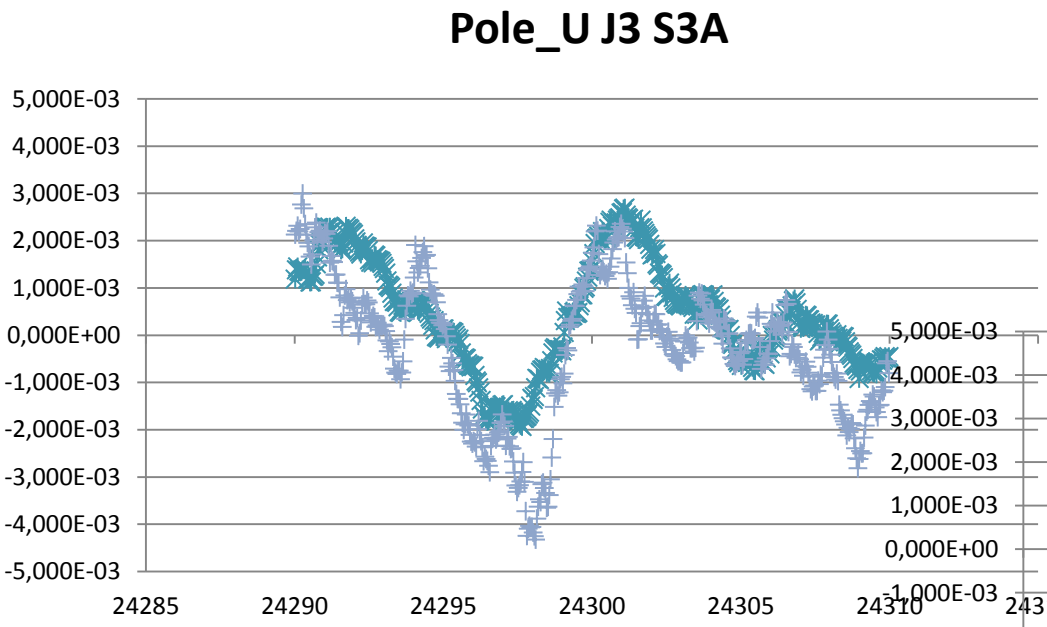
Conclusions

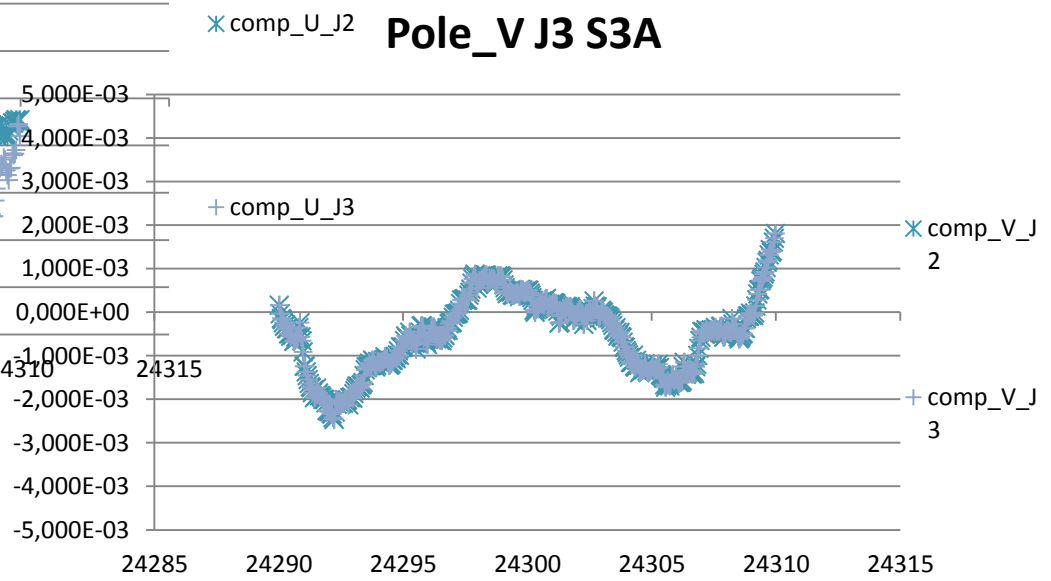


- Accuracy of 4-satellites mixed solution is between 0.4 and 0.8 mas RMS, i.e. between 1.2 and 2.4 cm
- Further improvements :
  - Accuracy and robustness could be improved by adding Jason-3 and Sentinel-3A => 6-sat solutions
  - Parameters optimization (Kalman filtering) may improve
- Upgrade Jason-3 / Sentinel-3A (and B) on-board versions to v5_00
  - (IDS analogy) 2 Analysis Centers in space, 4 on-ground, mixing done on ground
- These DORIS-DIODE EOP estimations contain interesting spectrum and could help for a IERS Rapid Service, or to stabilize current short-term predictions

Back-up slides

Jason2-Jason3 comparison





- conclusion ?

- Retour de C. Bizouard de l'OBSPM : e-mail du 02/10/2015

J'ai mis en place le rapatriement automatisé journalier des fichiers POLE_DIODE_XXXX que vous déposez sur notre site FTP, la mise en forme et le dépôt sur sur notre base de données.

J'ai procédé à une première analyse des coordonnées du pôle.

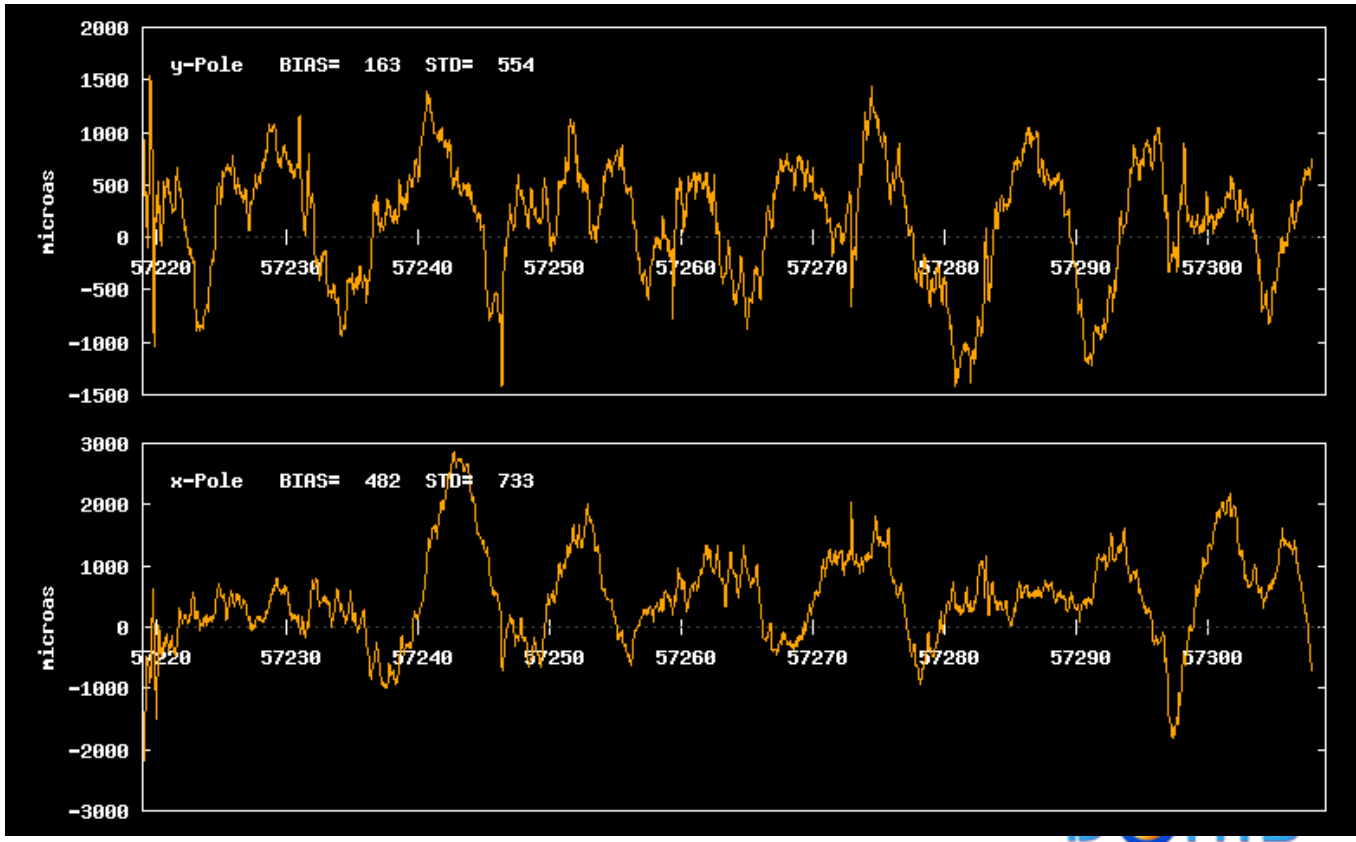
L'écart à la C04 se manifeste surtout par un terme de 10-11 jours de l'ordre de 0.5 mas.

Le domaine diurne et sub-diurne est tout à fait intéressant.

En particulier on trouve un terme circulaire prograde à 0.923 jour (marée lunaire 001) à la hauteur de 80 microseconde de degré, ce qui est beaucoup plus fort que

Differences Doris-C04 (at the date of Doris series) Δx and Δy

It is mainly composed of a 10 day term, confirmed by the following complex Fourier spectrum



Chers collègues

Lors de la réunion du directoire de l'IERS, j'ai présenté les travaux de notre équipe Rotation de la terre. J'ai parlé de vos travaux sur la restitution des coordonnées du pole à haute fréquence.

Les résultats que vous obtenez ont intéressé les membres, particulièrement la nouvelle responsable du Rapid Service à l'USNO , Christine Hackman.

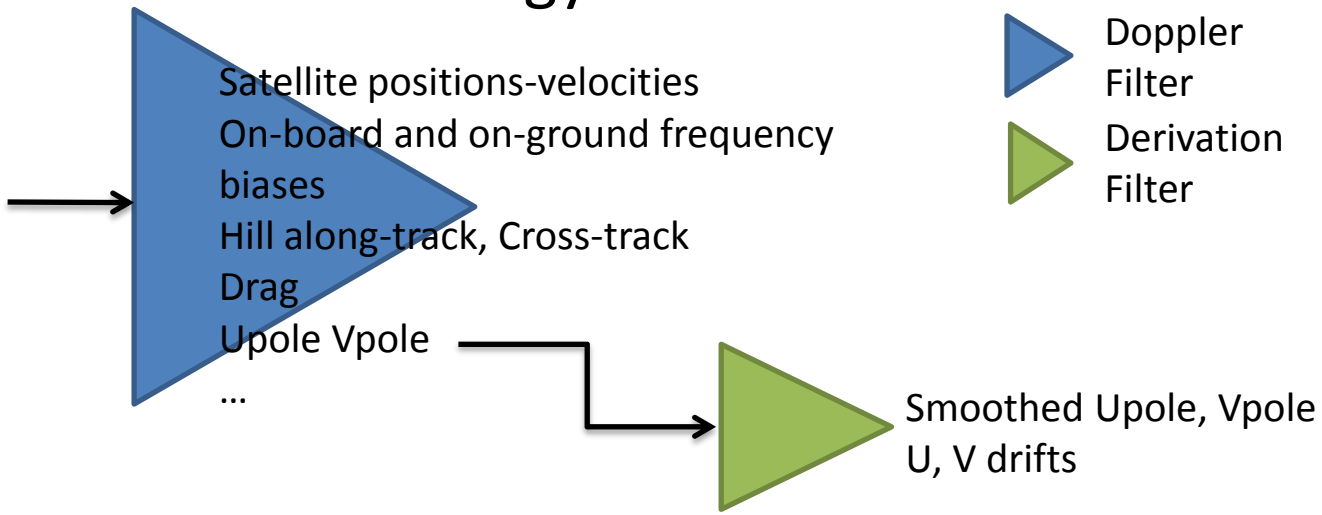
livraison des séries « Pole Rapide DORIS !

> Et nous serions enchantés que cette série apporte de l'information dans le domaine diurne et subdiurne.
> Si on filtrait les basses fréquences (T> 8 jours par exemple), tant que nous n'avons pas trouvé ce phénomène dans nos algorithmes ?
> Pourriez-vous alors bénéficier de l'apport d'information sans le phénomène parasite ?
Je peux faire ce filtrage de mon côté à partir des données actuelles.
C'est un jeu d'enfant.

> Penses-tu que Christine Hackman de l'USNO sera intéressée par ces données ?
Certainement.

Pole coordinates and drifts

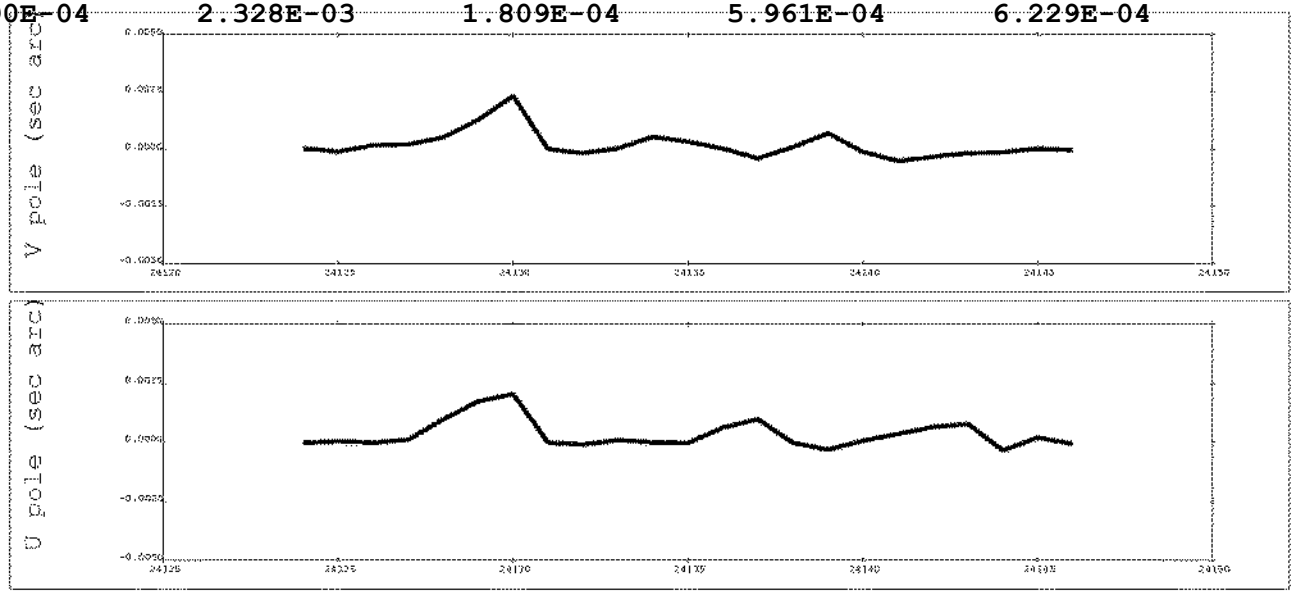
- DIODE estimation strategy



- Variation model for period < 1 day
  - Described in IERS conventions
- Outputs
  - Smoothed mean pole coordinates
  - Mean pole drift

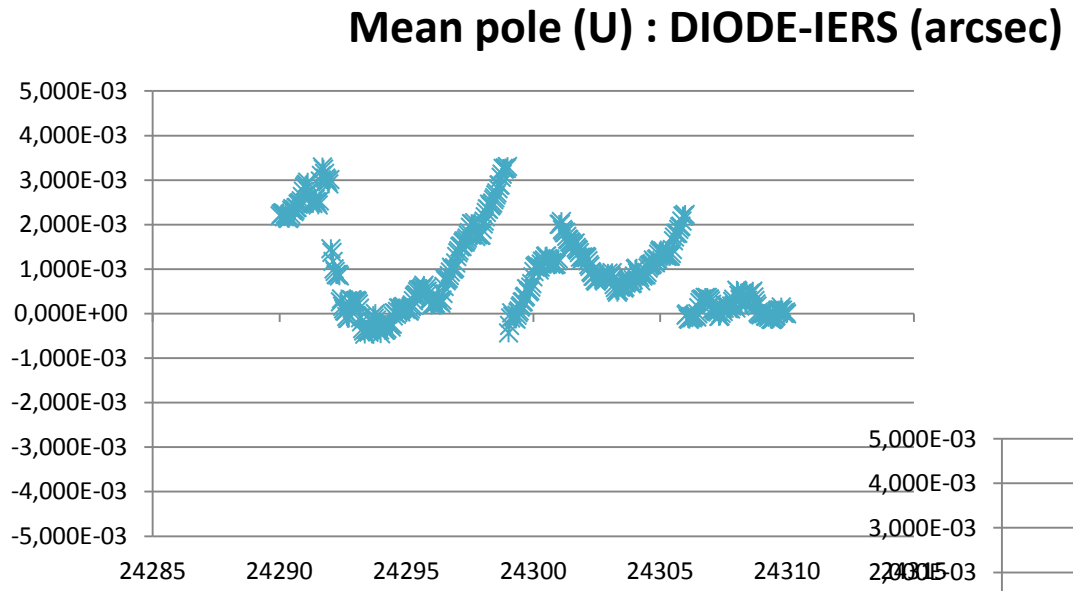
Comparaison entre : iers_prédit et ../iers_restitué

	NB POINTS	MINIMUM	MAXIMUM	MOYENNE	ECART TYPE	RMS
	**********	**********	**********	**********	**********	**********
POLE_U	23	-3.530E-04	2.036E-03	3.262E-04	6.020E-04	6.846E-04
POLE_V	23	-5.190E-04	2.328E-03	1.809E-04	5.961E-04	6.229E-04



- Capacité des données DIODE à stabiliser la prédiction ?
- La précision a postériori de la solution DIODE mixée 4 satellites est de l'ordre de 0.4 à 0.8 mas RMS

IERS predictions



- Multi satellite mixing (same as sl9) compared to each-day IERS predictions