SENTINEL-3

Upgrade from POE-E to POE-F orbit standard for Sentinel-3 mission

Date and Signature

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For Application to	SALP	Jason-1	EnviSat	CFOSAT	Jason-CS	SWOT
	SMM	Hy-2A	Jason-2	Jason-3	SARAL	Sentinel-3
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CHANGES

Parts that have been modified since the previous version of the document are identified by a vertical line in the left margin.

Version	Date	Purpose
1.0	26/09/2018	Document creation

APPLICABLE DOCUMENTS

Reference	Document title
SALP-GP-MA-GO-16797-CN ESA-EOPG-CSCOP-PL-0005	DA1 : *Sentinel-3 ESA-CNES Phase E2 Support Management Plan*

REFERENCE DOCUMENTS

Reference	Document title
SMM-LI-M-EA-24130-CN	DR1: *S3 CNES-ESA Ground Segment Applicable and Reference Documents List*
SMM-IF-M6-EA-20174-CN	DR*2 : Specification d'interfaces internes SALP: Orbitographie mission*
S3A-ID-M-00012-CN	DR3 : Sentinel-3 – PDGS-SALP ICD

LIST OF THINGS TO BE CONFIRMED/DETERMINED

TBC/TBD	Section	Short title

ABBREVIATIONS

CONTENTS

1. SUBJECT OF THE DOCUMENT

Currently the S3 STC/NTC operational orbits from CNES are computed with the “E” standard. As discussed during the S3 Copernicus POD QWG held on January 18, 2018, and as part of continuous improvement of the POD quality, it is proposed to upgrade this standard towards “F” version with new parametrization, measurement and dynamic models for Sentinel-3 mission.

This new standard will be applied for both S3-A and S3-B satellites, and on STC and NTC orbits, provided by CNES.

The purpose of this document is to present the new orbital standard POE-F and the improvements it will bring to the Sentinel-3 Topography mission.

It also proposes a tentative schedule for the transfer in routine operations of the new standard.

The document is structured as follow:

- Introduction: this section;
- Evolutions contained within POE-F standard: section 2;
- Improvements as demonstrated with Laser measurements: section 3;
- Improvements as demonstrated with SSH analysis: section 4;
- Impacts on STC and NTC operational orbit files formats: section 5;
- Schedule proposition: section 6.

2. EVOLUTIONS CONTAINED WITHIN POE-F STANDARD

The table below details the evolution of the models from POE-E to POE-F orbit standard:

	POE-E	POE-F
Gravity model	EIGEN-GRGS.RL03-v2.MEAN-FIELD	**EIGEN-GRGS.RL04-v1.MEAN-FIELD**
	Non-tidal TVG: one annual, one semi-annual, one bias and one drift terms for each year up to deg/ord 80; C21/S21 modeled according to IERS2010 conventions	Non-tidal TVG: one annual, one semi-annual, one bias and one drift terms for each year **up to deg/ord 90; C21/S21 non modified**
	Solid Earth tides: from IERS2003 conventions	Unchanged
	Ocean tides: FES2012	Ocean tides: **FES2014**
	Oceanic/atmospheric gravity: 6hr NCEP pressure fields (70x70) + tides from Biancale-Bode model	Oceanic/atmospheric gravity: **3hr dealiasing products from GFZ AOD1B RL06**
	Pole tide: solid Earth and ocean from IERS2010 conventions	Unchanged
	Third bodies: Sun, Moon, Venus, Mars and Jupiter	Unchanged
Surface forces	Radiation pressure model: calibrated semi-empirical solar radiation pressure model	Unchanged
	Earth radiation: Knocke-Ries albedo and IR satellite model	Unchanged
	Atmospheric density model: DTM-13 for Jason satellites, HY-2A, and MSIS-86 for other satellites	Atmospheric density model: DTM-13 for Jason satellites, HY-2A, and **MSIS-00 for other satellites**
Estimated dynamical parameters	Stochastic solutions	Unchanged
Satellite reference	Mass and center of gravity: post-launch values + variations generated by Control Center	Unchanged
	Attitude model:	**Refined nominal attitude laws**

	For Jason satellites: quaternions and solar panel orientation from control center, completed by nominal yaw steering law when necessary Other satellites: nominal attitude law	
Displacement of reference points	Earth tides: IERS2003 conventions Ocean loading: FES2012 Pole tide: solid earth pole tides and ocean pole tides (Desai, 2002), cubic+linear mean pole model from IERS2010 S1-S2 atmospheric pressure loading, implementation of Ray & Ponte (2003) by van Dam Reference GPS constellation: JPL solution - fully consistent with IGS08	Unchanged Ocean loading: **FES2014** Pole tide: solid earth pole tides and ocean pole tides (Desai, 2002), **new linear mean pole model** Unchanged Reference GPS constellation: **GRG solution – fully consistent with IGS14**
Geocenter variations	Tidal: ocean loading and S1-S2 atmospheric pressure loading Non-tidal: seasonal model from J. Ries, applied to DORIS/SLR stations	Unchanged Non-tidal: **full non-tidal model (semi-annual, annual, inter-annual) derived from DORIS data and the OSTM/Jason-2 satellite, applied to DORIS/SLR stations and GPS satellites**
Terrestrial Reference Frame	Extended ITRF2008 (SLRF/ITRF2008, DPOD2008, IGS08)	**Extended ITRF2014 (SLRF/ITRF2014, DPOD2014, IGS14)**
Earth orientation	Consistent with IERS2010 conventions and ITRF2008	Consistent with IERS2010 conventions and **ITRF2014**
Propagations delays	SLR troposphere correction: Mendes-Pavlis SLR range correction: constant 5.0 cm range correction for Envisat, elevation dependent range correction for Jason DORIS troposphere correction: GPT/GMF model DORIS beacons phase center correction	Unchanged SLR range correction: **geometrical models for all satellites** DORIS troposphere correction: **GPT2/VMF1 model** Unchanged

	GPS PCO/PCV (emitter and receiver) consistent with constellation orbits and clocks (IGS08 ANTEX), pre-launch GPS receiver phase map GPS: phase wind-up correction	GPS PCO/PCV (emitter and receiver) consistent with constellation orbits and clocks **(IGS14 ANTEX), in-flight adjusted GPS receiver phase map** Unchanged
Estimated measurement parameters	DORIS: one frequency bias per pass, one troposphere zenith bias per pass SLR: Reference used to evaluate orbit precision and stability GPS: floating ambiguity per pass, receiver clock adjusted per epoch	DORIS: one frequency bias **and drift (for "SAA stations")** per pass, one troposphere zenith bias per pass, **horizontal tropospheric gradients per arc** Unchanged GPS: **fixed ambiguity only for NTC orbits and when possible** per pass, receiver clock adjusted per epoch
Tracking Data corrections	Jason-1 Doris data: updated South Atlantic Anomaly model (J.-M. Lemoine et al.) applied before and after DORIS instrument change DORIS time-tagging bias for Envisat and Jason aligned with SLR before and after instrument change	Unchanged Unchanged
Doris Weight	1.5 mm/s (1.5 cm over 10 sec) For Jason-1, SAA DORIS beacons weight is divided by 10 before DORIS instrument change	**Process data down to as low elevation angles as possible (from 10° to 5° elevation cut-off angle) with a consistent down-weighting law** Unchanged
SLR Weight	15 cm Reference used to evaluate orbit precision and stability	Unchanged
GPS Weight	2 cm (phase) / 2 m (code)	Unchanged

Concerning the GPS fixed ambiguity per pass:

- This is applicable only to NTC obit computation

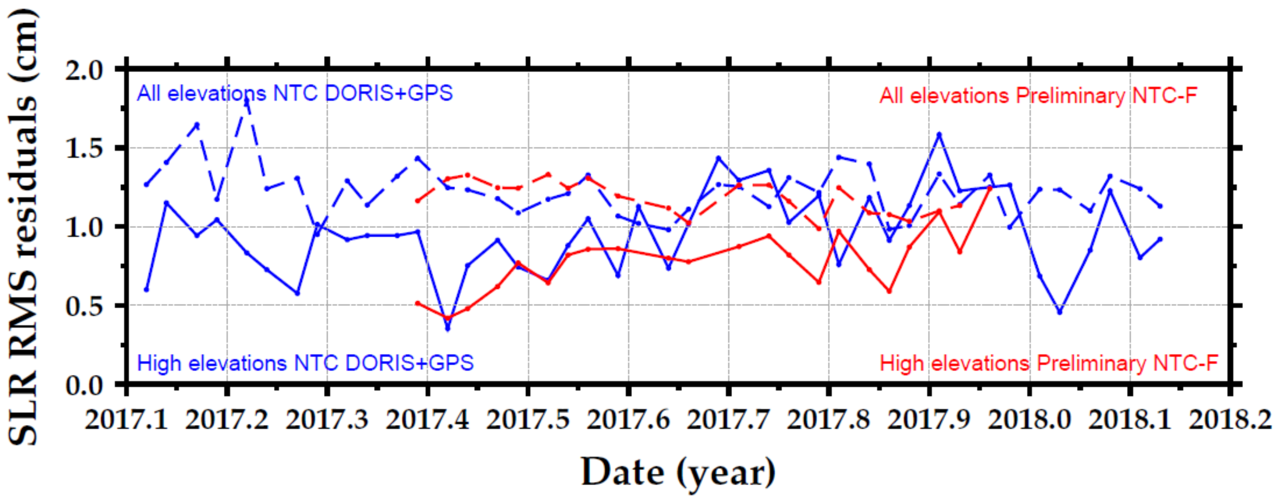
- The orbit / clock products of the CNES-CLS analysis center, issued by IGS, will be used for the NTC orbit, in place of the one from JPL used for "E" standard. This to be able to block GPS ambiguities.

  Unfortunately, in a very few cases (less than 5%), these data may not be available on time to meet the NTC delivery date requirements (within 25 days after data acquisition). In that case, the current JPL orbit / clock products will then be used instead, to keep fulfilling the NTC delivery requirements.

3. IMPROVEMENTS AS DEMONSTRATED WITH LASER MEASUREMENTS

The first preliminary results of the comparison of the SLR RMS between POE-E and POE-F standards for the NTC S3A orbits, indicate a systematic improvement of the high elevation SLR residual using the POE-F standard.

Orbit standard	All elevations	High elevations
POE-E (current)	1.1 cms	0.9 cms
POE-F	**0.85 cms**	**0.7 cms**



4. IMPROVEMENTS AS DEMONSTRATED WITH SSH ANALYSIS

This chapter will be completed at the end of the S3A and S3B POE-F orbits reprocessing.

5. IMPACTS ON STC AND NTC OPERATIONAL ORBIT FILES FORMATS

This evolution has **no impact on the products interfaces, on orbit file formats, or on the files header.**

Likewise, there is no **change on the dissemination processes** (generation frequency for example) nor on the operations.

The PDGS-SALP ICD (See DR3) continues thus to be fully applicable without any modification.

6. DEPLOYMENT SCHEDULE

It was decided to transfer to POE-F in routine operations as follow, **dates have been defined by mutual agreement with ESA/ESRIN:**

- S3A and S3B STC preliminary orbits:
  - Switch STC to POE-F orbit during the drift phase
    On the 12 of November, 2018 (MOE processed and disseminated the 13th of November), which correspond to the beginning of the S3A cycle number 38;
  -
- S3A and S3B NTC precise orbits:
  - S3A & S3B at the same arc than the STC orbits

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