

# ESOC MGNSS Processing Strategy

This document summarizes the Processing Strategy of the our published ESOC MGNSS products. The prodcuts may be found on our web page.

If you have any additional questions, please contact us.

**Last update:** 18/01/2023  
**Software used:** NAPEOS 4.8  
**Most recent changes:** Transition to ITRF2020

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Category	Topic	Value
Relativistic model	Schwarzschild terms	applied
	Lense-Thirring precession	applied, IERS 2010 conventions
	Geodesic (de Sitter) precession	applied, IERS 2010 conventions
	Relativistic clock effects	2nd order relativistic correction for non-zero orbit ellipticity
	Gravitational time delay	applied, IERS 2010 conventions
Gravity field	Degree and order	12
Gravitational perturbations	Gravity field (static)	EIGEN.GRGS.RL04.Imp.coef, C21 and S21 computed according to IERS 2010 conventions
	Gravity field (time varying)	annual/semi-annual terms of the low coefficients
	Solid Earth tides	IERS 2010 conventions
	Permanent tide (tidal system)	IERS 2010 conventions
	Solid Earth pole tide	IERS 2010 conventions
	Ocean tides	EOT11A
	Ocean pole tide	applied, model by S. Desai for C21 and S21 terms only (IERS Conventions 2010)
	Lunar gravity	applied, only J2 effect considered
	Third bodies	JPL DE405: all planets, Sun and Moon
EOP	Precession-nutation	IAU 2006/2000A
	Celestial pole offsets	IAU 2006/2000A, daily dx and dy corrections from IERS Bulletin-A applied
	Celestial pole rates	interpolating between given offsets
	Subdaily nutation	prograde diurnal and semi-diurnal nutations in polar motion applied using IERS routine PMSDNUT2.F
	UT1-UTC	interpolated from IERS Bulletin A (IERS rapids)
	UT1 libration	semi-diurnal UT1 libration applied using IERS routine UT1LIBR.F
	Subdaily pole/UT1	The sub-daily EOP tide model from Desai & Sibois (2016; <a href="https://doi.org/10.1002/2016JB013125">https://doi.org/10.1002/2016JB013125</a> )
	Secular pole	IERS secular pole model
Terrestrial pole offsets	interpolated from IERS Bulletin A (IERS rapids)	
Terrestrial reference frame	A priori frame	ITRF2020
	Post seismic deformation	ITRF2020
	Solid Earth tides	anelastic Earth model, IERS 2010 Conventions (dehanttideinel.f)
	Permanent tide	zero-frequency contribution left in tide model, NOT in site coordinates (conventional tide-free)
	Solid Earth pole tide	IERS 2010 conventions, mean pole removed by IERS 2010 mean pole model
	Ocean tides	IERS 2010 conventions, site-dependent amps/phases from free ocean tide loading provider (Bos and Scherneck, 2017) for EOT11A tide model including centre of mass correction, NEU site displacements computed using HARDISP.F from D.Agnew
Troposphere	Hydrostatic a priori model	Saastamoinen, pressure and temperature from GPT model
	Hydrostatic mapping function	GMF dry (Boehm et. al, 2006)
	Wet mapping function	GMF wet (Boehm et. al, 2006)
	Gradient mapping functions	$1/(\sin(e) * \tan(e) + 0.0032)$
Ionosphere Observations	First order effect	accounted for by dual-frequency obs. in linear combination
	Sampling	30s
	Elevation cutoff angle	10degrees
	Weighting of observations	elevation-dependent
	Observation type	ionosphere-free linear combination of dual-frequency
	GNSS receiving antenna	igs20.atx (offsets from ARP and elevation- and azimuth dependent PCVs applied)
	Phase wind up	applied according to Wu et al. (1993)
Orbit integration	Integrator details	Adams-Bashforth/Adams-Moulton 8th order prediction-correction (multistep) method initialization: 8th order Runge Kutta (RKF)
	Integrator step size	120 steps per revolution
Parametrisation	Earth orientation	daily X-pole, Y-pole, pole rates, LOD
	Clock sampling	30s
	Transmitter & Receiver clocks	at each epoch
	Satellite orbits	deterministic positions and velocities (300s sampling)
	Arc length	24h
	Troposphere	zenith delay estimated as linear parameters every 1 hrs, North and East gradients as linear parameter per day
	Empirical accelerations	1 set per arc from the enhanced CODE orbit model (Springer, 1999): D0, Y0, B0, Bcos, Bsin
	1/rev empiricals (CPR)	1 set per arc in along-track: A0, Acos, Asin
	Phase cycle ambiguities	adjusted except when double difference ambiguities can be resolved confidently. Integer ambiguity resolution scheme from GFZ

# Constellations

Constellation	Galileo	GPS	GLONASS	BeiDou		QZSS		
Block	IOV FOC			BeiDou-2	BeiDou-3	QZSS	QZSS-2I	QZSS-2G
Signals	L1-L5Q	L1W-L2W	L1-L2	B1-B3 (before 2019 B1-B2)		L1-L2		
Centre of Mass	GSC values	IGS Satellite Metadata	IGS Satellite Metadata	IGS Satellite Metadata		Cabinett Office values		
PCO	GSC values (GSAT_*.atx)	igs20.atx	ESOC estimates	ESOC estimates		igs20.atx		
PCV	GSC values (GSAT_*.atx)	igs20.atx	ESOC estimates	ESOC estimates		igs20.atx		
Attitude model	GSC values (Eclipse model)	Nominal	Eclipse model using GLONASS yaw rates	Orbit normal modes for  Beta  < 4deg with smooth transition	Eclipse model (also for BeiDou 005/C04)	Orbit normal modes for  Beta  < 20deg	Eclipse model	Continuous orbit normal mode
A priori model (SRP, Albedo, IR)	GSC values (Box-Wing)	IGS Satellite Metadata (Box-Wing)	IGS Satellite Metadata (Box-Wing)	ESOC estimates (Box-Wing)		Cabinett Office values (Box-Wing)		
Power Thrust [W]	120 IGS Satellite Metadata	IGS Satellite Metadata	IGS Satellite Metadata	ESOC estimates	240	Cabinett Office values		

## Products

Content	Format	Sampling	Period	Delay	Comment	Filename
Orbits + Clocks	SP3	300 s	24 h	5 days		ESA00FIN_YYYYDDDHHMM_01D_05M_ORB.SP3
Clocks	Clock RINEX	30 s	24 h	5 days		ESA00FIN_YYYYDDDHHMM_01D_05M_CLK.CLK
Troposphere	Tropo SINEX	24 h	24 h	5 days	not published	ESA00FIN_YYYYDDDHHMM_01D_01D_TRO.SNX
Earth Rotation Parameters	IGS ERP	24 h	24 h	5 days	free format	ESA00FIN_YYYYDDDHHMM_01D_01D_ERP.ERP
Inter-System Biases	BIAS SINEX	24 h	24 h	5 days		ESA00FIN_YYYYDDDHHMM_01D_01D_ISB.ERP
Summary file	-	-	168 h	5 days	weekly	ESA00FIN_YYYYDDDHHMM_01D_01D_SUM.SUM