EPOS GNSS - Description of the Products

1 Details of processing options for time series solutions

1.1 SGO-EPND solution

EUROPEAN PLATE OBSERVING SYSTEM – GNSS products SGO-EPND Analysis Center Strategy Summary (combined product based on EPND+EPOS solutions)	
Analysis center	SGO-EPND LTK Satellite Geodetic Observatory H-1111 Budapest, Budafoki ut 59, Hungary
Contact person(s)	Ambrus Kenyeres e-mail: info@sgo-penc.hu
Software used	Bernese GNSS Software 5.2&4 – 25 EPND ACs, GAMIT/GLOBK 10.71 – 3 EPND + 1 EPOS AC, GIPSY-OASIS II – 1 EPOS AC. The details of the processing strategy correspond to options and models requested by the EPN and EPOS processing guidelines. The combination of the individual solutions is being done with the CATREF software.
Preparation date	31-01-2023
Version number	1
DOI	In progress
Modification dates	
Date last complete data analysis	
Automatic updates of the time series	No, it is done manually following the annual extension of the combination series
MEASUREMENT MODELS	
Observable	Double differences, ionosphere free linear combination of L1 and L2 phase pseudoranges. Code observations used for receiver clock synchronization and for ambiguity resolution using Melbourne-Wubbena linear combination. The data sampling rate is 30 seconds for preprocessing and 180 seconds for final solution.
Data weighting	Elevation weighting
Data Editing	Phase preprocessing using triple differences. Cycle slips are detected and fixed.
RHC phase rotation corr.	Phase polarization effects applied
Ground antenna phase center cal.	Elevation- and azimuth-dependent phase center corrections are applied according to the IGS model (igs20.atx). In addition individual calibrations are used for some EPN stations according to EUREF model (epnc_20.atx).
Troposphere	Atmospheric mapping functions and hydrostatic zenith delays from VMF1/VMF3 numerical model (Boehm et al., 2006; Landskron and Böhm 2018).
Ionosphere	First order term is eliminated using ionosphere-free linear combination of L1 and L2. Higher order corrections (second, third and bending effect) are modeled (using CODE ionosphere global model and International Geomagnetic Reference Field

	model). CODE global model is also used to improve ambiguity resolution strategies.
Plate motions	IGS20 velocities
Tidal	Solid earth tidal displacement: IERS2010 (Petit and Luzum, 2010) Earth pole tide and ocean pole tide: IERS2010 (Petit and Luzum, 2010) Ocean loading: FES2014b (Lyard et al., 2021)
Non-tidal loading	Atmospheric Pressure: Not applied Ocean Bottom Pressure: Not applied Surface Hydrology: Not applied Other Effects: None applied
Earth Orientation Parameter (EOP) Model	IGS products
Satellite phase center calibration	IGS antenna model (igs20.atx)
Relativity corrections	Shapiro effect
GPS attitude model	Nominal attitude
ORBIT MODELS	
Geopotential	EGM2008 (up to degree 12)
Third-body	Positions of Moon, Sun, and planets according to DE421 JPL model.
Solar radiation pressure	Parameters of the new Empirical CODE model estimated (Arnold, 2015).
Tidal forces	Solid Earth: IERS2000, Ocean tides: FES2014b (up to degree 8)
Relativity	Schwarzschild effect
Numerical Integration	Collocation method of 10th order.
ESTIMATED PARAMETERS (APRIORI VALUES & SIGMAS)	
Adjustment	Weighted least squares
Stations coordinates	Minimum constraints (no net translation) applied on EPN reference stations.
Satellite clocks bias	Not estimated
Receiver clock bias	Estimated using code pseudo-ranges
Orbital parameters	Not estimated
Troposphere	Troposphere zenith delays estimated as piece-wise linear functions in 1-hour intervals. Tropospheric horizontal gradients in north and east directions estimated in 24-hour intervals as piece wise linear function.
Ionosphere	Not estimated
Ambiguity	Ambiguities resolved in a baseline by baseline mode using different strategies according to baseline length (Dach et al., 2015)
Earth Orientation Parameters (EOP)	Not estimated
GPS attitude model	Not estimated
REFERENCE FRAMES	
Inertial	J2000 geocentric
Terrestrial	IGS20
Interconnection	Transformation between celestial and terrestrial systems according to IERS2010 convention (Petit and Luzum, 2010)
REFERENCES	

Altamimi, Z., Sillard, P., and Boucher, C., 2007, CATREF software: Combination and analysis of terrestrial reference frames: LAREG Technical, Institut Géographique National, Paris, France, p. 47.

Bos, M., Fernandes, R., Williams, S., and Bastos, L., 2013, Fast error analysis of continuous GNSS observations with missing data: Journal of Geodesy, v. 87, no. 4, p. 351-360.
Magyar, B., Kenyeres, A., Tóth, S., Hajdu, I., and Horváth, R., 2022, Spatial outlier detection on discrete GNSS velocity fields using robust Mahalanobis-distance-based unsupervised classification: GPS Solutions, v. 26, no. 4, p. 1-11.

2 Details of processing options for velocity solutions

2.1 Default velocity product: combined densified solution using CATREF at LTK SGO

Multi-year combination using CATREF
Input: Daily/weekly SINEXs from 28 EPND Analysis Centres + 2 EPOS AC
Estimated parameters: Positions, Velocities, Transformation parameters between each individual solution and the combined solution
Reference Frame: Position and Velocity solution aligned to IGb14 with minimal constraints on 14 parameters
Outliers removed
Position and Velocity changes accounted for
Constraints: Velocities of collocated sites are constrained except in case of disagreement
Piece-wise velocities constrained except in case of disagreement