



Supplement of

Persistent deformation in a post-collisional stable continental region: insights from 20 years of cGPS in Romania

Alexandra Muntean et al.

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S1. Introduction

This Supplementary Material provides the technical datasets and sensitivity analyses supporting the results presented in the main manuscript. It includes primary geodetic results such as horizontal and vertical velocity solutions, spatially averaged velocity fields, and derived strain-rate parameters for the study region. To evaluate the robustness of these data, the following sections examine how various local reference frame transformations, including Euler pole rotation, network mean removal, and stable station mean removal, affect the GNSS velocity field relative to the original EU14 velocities.

Additionally, this document provides a comparison of horizontal and vertical solutions against independent datasets, such as those from Piña-Valdés et al. (2022). This comparison accounts for differences in observation periods, network density, and processing strategies, specifically regarding the use of manual versus automated quality control. Detailed descriptions of the methodology, statistical residuals, and specific data processing for the associated tables and figures are provided in the respective subsections below.

S2. Horizontal and vertical GPS velocities

Tables S1 and S2 present the horizontal velocity solutions derived from GPS stations using GipsyX software and the spatially averaged velocity field obtained through the gridding and outlier-rejection process described in the main manuscript. The quality and resolution of these horizontal estimates are further detailed in Figure S1, which illustrates the distribution of velocity magnitudes relative to their associated uncertainties and confirms a high signal-to-noise ratio across the network.

Table S3 contains the vertical velocity solutions for all analyzed stations. Finally, Table S4 summarizes the strain-rate parameters calculated from the interpolated horizontal velocity field using the STRAINTOOL software.

Table S1: Horizontal velocities in the Eurasia reference frame

STAT	LAT	LON	Vlat	Vlon	Siglat	Siglon	Tstart	Tspan	NETWORK
-	deg	deg	mm/yr	mm/yr	mm/yr	mm/yr	date	yrs	-
ABIU	46.0777	23.5663	0.27	-0.14	0.09	0.08	13FEB21	12.26	NACL
ADCS	44.0882	27.9657	0.90	-0.38	0.20	0.16	19MAY16	6.29	NIEP
ADJU	46.0954	27.1893	0.14	-0.39	0.08	0.07	13JAN03	12.40	NACL
AEGY	45.1864	28.8151	0.22	-0.10	0.09	0.08	13NOV29	11.75	Geopontica
AGIG	44.0866	28.6419	0.16	-0.01	0.09	0.08	13JUN13	12.22	Geopontica
ALXR	43.9699	25.3266	-0.79	0.44	0.09	0.09	13JAN04	12.39	NACL
ARAD	46.1732	21.3446	0.41	-0.16	0.08	0.07	13JAN02	12.40	NACL
ARYB	47.6180	25.2110	0.38	-0.40	0.17	0.17	16JUN24	9.18	NIEP
BABA	44.8841	28.7351	0.10	0.02	0.08	0.08	13JUN13	12.21	Geopontica
BACA	46.5621	26.9122	0.10	-0.48	0.05	0.05	06JAN20	19.29	NACL
BAES	44.0292	23.3111	-0.87	-0.39	0.12	0.12	17APR20	8.36	NIEP
BAIA	47.6518	23.5577	-0.12	-0.02	0.05	0.05	06JAN20	19.35	NACL
BAIS	44.0223	23.3405	-0.79	0.03	0.09	0.09	13JAN03	12.40	NACL
BANL	45.3828	21.1367	-0.09	0.64	0.19	0.16	17APR28	7.85	NIEP
BEU	46.6694	22.3514	-0.23	-0.38	0.12	0.13	13AUG07	10.48	NACL
BICA	46.8242	25.8514	0.03	-0.08	0.12	0.11	16JAN01	9.66	NIEP
BIST	47.1289	24.4940	-0.24	-0.07	0.11	0.07	13JAN05	12.39	NACL
BORS	47.0903	21.7858	0.42	0.42	0.16	0.17	15NOV19	9.78	NIEP
BRLD	46.2330	27.6443	-1.06	-1.34	0.18	0.17	19MAR14	6.47	NIEP
BUCE	45.4132	25.4703	-0.00	0.31	0.08	0.08	02MAY15	22.38	NIEP
BUKU	44.4639	26.1257	-1.08	-0.18	0.04	0.04	00AUG18	24.77	NACL
BUZE	45.6191	21.6394	-0.14	0.28	0.07	0.07	07JUL18	18.12	NIEP
CALR	44.2051	27.3134	-0.25	0.11	0.09	0.08	13APR11	12.13	NACL
CHIE	45.4245	29.2890	-0.01	-0.05	0.09	0.08	13JUN14	12.21	Geopontica
CHIT	44.4941	28.8385	0.08	-0.21	0.09	0.08	13MAY23	12.27	Geopontica
CIUC	46.3610	25.8015	-0.22	-0.17	0.09	0.08	13JAN03	12.39	NACL
CLU2	46.7725	23.6248	0.93	0.54	0.22	0.18	19OCT03	5.65	NACL
CONB	44.2138	28.6453	0.18	0.09	0.12	0.13	16JUN24	9.18	NIEP
CORA	43.7748	24.5022	-0.30	-0.12	0.10	0.08	13AUG07	11.80	NACL
COST	44.1615	28.6575	-0.09	-0.05	0.06	0.05	06JAN04	19.39	NACL
CRAI	44.3380	23.7645	-1.01	-0.02	0.09	0.08	13JAN25	12.33	NACL
CRCL	45.1781	28.1363	0.54	0.19	0.10	0.09	14JAN04	11.65	NIEP
CRNV	44.3421	28.0312	0.20	-0.17	0.09	0.10	13AUG06	11.80	NACL
DEVA	45.8784	22.9135	-0.93	0.09	0.08	0.06	09JAN02	16.40	NACL
DRMN	46.3685	26.4905	-0.08	-0.15	0.10	0.08	14JAN09	11.38	NACL
DRTS	44.6272	22.6345	-0.17	0.30	0.09	0.10	13AUG07	10.46	NACL
DUNA	45.0184	29.2738	0.08	-0.14	0.11	0.07	13JUN14	11.16	Geopontica
FAGA	45.8462	24.9687	-1.26	-0.67	0.10	0.09	13AUG07	11.80	NACL
FAGE	45.8546	22.1772	-0.01	-0.48	0.09	0.07	13AUG03	11.82	NACL
FOCS	45.7083	27.1946	0.29	0.04	0.10	0.08	13JAN03	12.39	NACL
GHE1	46.7248	25.5984	0.15	-0.33	0.08	0.08	13AUG07	11.80	NACL
GIUR	43.8863	25.9617	-1.44	1.34	0.08	0.08	13JAN25	12.33	NACL
GPOR	44.6754	28.9872	0.22	0.30	0.09	0.10	13MAY16	12.29	Geopontica
GURA	46.2665	22.3378	0.28	0.60	0.12	0.09	13AUG07	11.80	NACL
HIST	44.5471	28.7702	-0.04	-0.13	0.04	0.04	03SEP08	21.98	NIEP
HORE	45.1456	23.9891	0.41	-0.50	0.11	0.09	14NOV27	10.50	NACL
HUED	46.8653	23.0322	0.33	0.05	0.08	0.07	13FEB01	12.32	NACL
INSU	44.9112	27.6032	0.13	-0.10	0.11	0.08	13JAN03	12.40	NACL
ISTR	44.5724	28.7113	0.43	-0.35	0.10	0.08	13AUG07	11.80	NACL
LACP	45.8233	26.3753	1.46	-0.14	0.20	0.13	04AUG11	21.05	NIEP
LEHL	44.4422	26.8511	-0.38	0.88	0.17	0.18	13AUG07	11.80	NACL
MAJA	47.0545	27.2530	0.67	-0.17	0.18	0.23	13SEP06	11.98	NIEP
MEDS	46.1627	24.3469	0.21	-0.46	0.13	0.09	13JAN26	12.33	NACL
MIDI	44.3462	28.6829	-0.04	0.08	0.09	0.08	13MAY23	12.27	Geopontica
MNG2	43.8011	28.5953	-0.42	-0.25	0.08	0.07	13OCT24	11.85	NIEP
MNGA	43.8106	28.5586	-0.08	-0.00	0.08	0.10	13MAY22	11.93	Geopontica
MNGL	43.8093	28.5801	0.07	0.00	0.09	0.07	13FEB23	12.26	NACL
NEHU	45.4172	26.3023	-1.18	0.64	0.13	0.10	13JAN26	12.33	NACL
ODO1	46.3070	25.2942	-0.16	-0.07	0.08	0.07	13AUG07	11.80	NACL
ORAD	47.0592	21.9416	-1.25	-0.30	0.12	0.09	13AUG07	11.80	NACL
PASC	47.2491	26.7387	0.39	-0.59	0.09	0.09	13AUG07	11.80	NACL
PERI	44.8010	29.2745	0.30	-0.45	0.09	0.09	13MAY17	12.29	Geopontica
PET2	45.4164	23.3702	0.16	-0.26	0.15	0.14	19AUG02	5.49	NACL
PGNL	44.9196	26.9768	-1.31	-0.10	0.19	0.18	20JAN17	5.62	NIEP
PIRE	44.8541	24.8787	-0.42	-0.59	0.16	0.14	18JAN03	7.39	NACL

PLOI	44.9338	25.9899	-0.45	-0.31	0.12	0.08	13JUL17	11.86	NACLR
PTNT	46.9264	26.3664	0.14	-0.27	0.09	0.09	13AUG01	11.82	NACLR
ROSP	46.3169	23.1385	0.12	-0.18	0.06	0.06	09JUL03	16.16	NIEP
ROSU	45.4905	25.9439	-0.21	0.67	0.09	0.09	12JUN28	13.17	NIEP
SATU	47.7904	22.8693	0.08	-0.12	0.09	0.07	13AUG07	11.80	NACLR
SFGH	45.8664	25.7883	0.24	0.55	0.08	0.09	13JAN03	12.40	NACLR
SGHE	44.8986	29.6007	0.19	-0.89	0.18	0.20	13OCT18	11.87	GeoPontica
SIB1	45.7817	24.1461	-0.02	-0.12	0.08	0.07	13AUG07	11.80	NACLR
SLOB	44.5637	27.3657	-0.38	0.14	0.13	0.12	14JAN17	11.36	NACLR
SLTN	44.4227	24.3669	-0.82	-0.22	0.08	0.08	13AUG07	11.80	NACLR
SUCE	47.6359	26.2370	0.83	0.09	0.09	0.07	13AUG07	11.80	NACLR
SULI	45.1563	29.6546	-0.39	-0.17	0.16	0.14	18JAN19	7.35	NACLR
SULN	45.1480	29.7588	0.25	-0.13	0.08	0.08	13SEP05	11.98	GeoPontica
TAJO	44.3755	25.1740	-0.05	-0.29	0.11	0.10	14JAN02	11.40	NACLR
TBUJ	45.8709	27.9127	0.41	-0.40	0.09	0.08	13AUG07	11.80	NACLR
TECC	45.8416	27.4089	0.22	-0.30	0.18	0.15	19MAR14	6.46	NIEP
TGMS	46.5283	24.5224	0.22	1.60	0.16	0.12	15NOV12	9.80	NIEP
TGTS	46.4748	26.4897	-0.91	-0.42	0.08	0.07	09DEC16	15.00	TopGeocart
TIM1	45.7799	21.2310	0.23	0.17	0.09	0.10	13AUG07	11.80	NACLR
TIMA	45.1206	23.1278	-0.34	0.02	0.10	0.09	13NOV22	11.77	NIEP
TIRG	44.4573	28.4123	0.68	-0.38	0.12	0.10	16JAN01	9.66	NIEP
TJIU	45.0469	23.2739	-0.86	-0.84	0.09	0.06	13JAN05	12.39	NACLR
TPLT	46.9263	25.3598	0.25	-0.54	0.20	0.21	20OCT13	4.88	NIEP
TRGV	44.9183	25.4657	-0.60	-0.85	0.09	0.10	13JAN03	12.39	NACLR
TUZL	43.9902	28.6661	0.24	0.15	0.08	0.08	13MAY24	12.27	GeoPontica
VAD2	45.3035	25.7222	0.14	0.56	0.23	0.21	19NOV07	5.55	NACLR
VAMO	47.6516	25.5752	0.42	-0.33	0.09	0.10	13FEB20	12.26	NACLR
VASL	46.6416	27.7246	0.95	0.15	0.11	0.11	13AUG07	11.80	NACLR
VATR	47.3177	25.3388	-0.07	0.06	0.10	0.09	13AUG07	11.80	NACLR
VISE	47.7082	24.4317	0.32	-0.62	0.12	0.13	13AUG07	11.80	NACLR
VLC2	45.1074	24.3664	0.77	-0.84	0.19	0.21	19AUG02	5.82	NACLR
VRAP	45.8513	26.6498	-0.12	-0.26	0.05	0.05	04APR00	21.42	NIEP
ZALU	47.1777	23.0618	0.17	-0.34	0.08	0.08	13AUG07	11.80	NACLR
ZERI	46.6252	21.5174	-0.19	0.01	0.11	0.07	14SEP26	10.34	NACLR

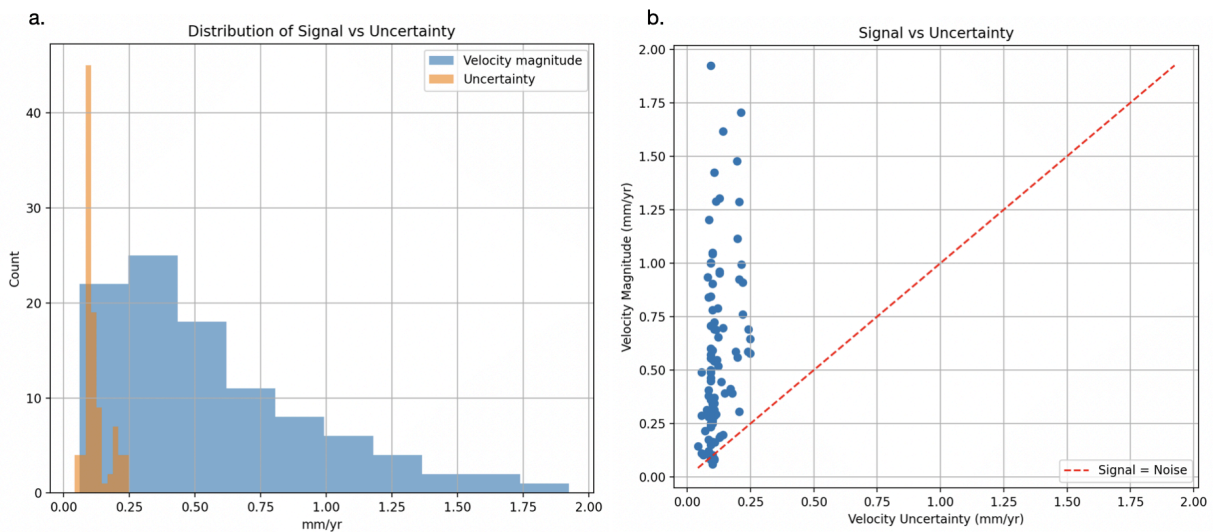


Figure S1: (a) Distribution of horizontal velocity magnitudes and their associated uncertainties. Velocity magnitudes are systematically larger than the corresponding uncertainties. (b) Comparison between horizontal velocity magnitudes and uncertainties. The red dashed line indicates a unit signal-to-noise ratio ($V = \sigma$); most observations plot above this line, indicating that the velocities are well resolved relative to their uncertainties.

Table S2: Gridded horizontal velocity field

LAT deg	LON deg	Vlat mm/yr	Vlon mm/yr	Node -
43.34	23.30	-0.79	0.03	Node002000
43.34	24.70	-0.55	0.16	Node003000
43.34	26.10	-0.79	0.44	Node004000
43.34	28.90	0.08	0.05	Node006000
44.03	21.90	-0.17	0.30	Node001001
44.03	23.30	-0.71	-0.02	Node002001
44.03	24.70	-0.59	-0.04	Node003001
44.03	26.10	-0.57	0.21	Node004001
44.03	27.50	-0.20	0.24	Node005001
44.03	28.90	0.08	0.00	Node006001
44.72	21.90	-0.17	0.30	Node001002
44.72	23.30	-0.39	-0.21	Node002002
44.72	24.70	-0.25	-0.47	Node003002
44.72	26.10	-0.40	-0.03	Node004002
44.72	27.50	-0.14	0.17	Node005002
44.72	28.90	0.09	-0.08	Node006002
44.72	30.30	-0.07	-0.15	Node007002
45.41	20.50	0.23	0.17	Node000003
45.41	21.90	0.03	-0.01	Node001003
45.41	23.30	-0.11	-0.32	Node002003
45.41	24.70	0.02	-0.43	Node003003
45.41	26.10	-0.14	0.10	Node004003
45.41	27.50	0.18	-0.23	Node005003
45.41	28.90	0.08	-0.15	Node006003
45.41	30.30	-0.07	-0.15	Node007003
46.09	20.50	0.32	0.01	Node000004
46.09	21.90	0.09	0.01	Node001004
46.09	23.30	0.08	-0.04	Node002004
46.09	24.70	-0.10	-0.15	Node003004
46.09	26.10	-0.03	0.01	Node004004
46.09	27.50	0.28	-0.23	Node005004
46.09	28.90	0.20	-0.23	Node006004
46.78	20.50	0.41	-0.16	Node000005
46.78	21.90	0.22	0.12	Node001005
46.78	23.30	0.13	-0.05	Node002005
46.78	24.70	-0.09	-0.23	Node003005
46.78	26.10	0.02	-0.23	Node004005
46.78	27.50	0.47	-0.22	Node005005
47.47	21.90	0.25	0.15	Node001006
47.47	23.30	0.12	-0.11	Node002006
47.47	24.70	0.18	-0.32	Node003006
47.47	26.10	0.33	-0.28	Node004006
47.47	27.50	0.67	-0.17	Node005006
48.16	21.90	0.08	-0.12	Node001007
48.16	23.30	-0.02	-0.07	Node002007
48.16	24.70	0.37	-0.45	Node003007
48.16	26.10	0.56	-0.35	Node004007

Table S3: Vertical velocities

STAT -	LAT deg	LON deg	Vrad mm/yr	Sigrad mm/yr	Tstart date	Tspan yrs	NETWORK -
ABIU	46.0777	23.5663	-0.09	0.30	13FEB21	12.26	NACLR
ADCS	44.0882	27.9657	0.22	0.57	19MAY16	6.29	NIEP
ADJU	46.0954	27.1893	0.66	0.30	13JAN03	12.40	NACLR
AEGY	45.1864	28.8151	0.45	0.34	13NOV29	11.75	GeoPontica
AGIG	44.0866	28.6419	0.56	0.37	13JUN13	12.22	GeoPontica
ALXR	43.9699	25.3266	-1.12	0.37	13JAN04	12.39	NACLR
ARAD	46.1732	21.3446	-0.42	0.31	13JAN02	12.40	NACLR
ARYB	47.6180	25.2110	0.33	0.44	16JUN24	9.18	NIEP

BABA	44.8841	28.7351	0.56	0.33	13JUN13	12.21	GeoPontica
BACA	46.5621	26.9122	-0.34	0.20	06JAN20	19.29	NACLRL
BAES	44.0292	23.3311	-0.34	0.40	17APR20	8.36	NIEP
BAIA	47.6518	23.5577	-0.33	0.19	06JAN20	19.35	NACLRL
BAIS	44.0223	23.3405	-0.14	0.32	13JAN03	12.40	NACLRL
BANL	45.3828	21.1367	0.03	0.40	17APR28	8.34	NIEP
BEIU	46.6694	22.3514	-0.00	0.38	13AUG07	10.48	NACLRL
BICA	46.8242	25.8514	1.90	0.54	16JAN01	9.66	NIEP
BIST	47.1289	24.4940	0.21	0.28	13JAN05	12.39	NACLRL
BORS	47.0903	21.7858	-0.15	0.51	15NOV19	9.78	NIEP
BRAI	45.2677	27.9733	-1.15	0.33	13AUG07	11.80	NACLRL
BRLD	46.2330	27.6443	-0.31	0.57	19MAR14	6.47	NIEP
BUCE	45.4132	25.4703	-0.05	0.26	02MAY15	22.38	NIEP
BUCU	44.4639	26.1257	0.48	0.35	14JAN02	11.40	NACLRL
BUZE	45.6191	21.6394	0.01	0.30	07JUL18	18.12	NIEP
CALR	44.2051	27.3134	0.16	0.30	13APR11	12.13	NACLRL
CAM1	46.3634	23.0497	-0.44	0.32	13AUG07	11.80	NACLRL
CHIT	44.4941	28.8385	-0.16	0.32	13MAY23	12.27	GeoPontica
CIUC	46.3610	25.8015	-0.19	0.34	13JAN03	12.39	NACLRL
CLU2	46.7725	23.6248	-0.29	0.84	19OCT03	5.65	NACLRL
CONB	44.2138	28.6453	-0.03	0.38	16JUN24	9.18	NIEP
CORA	43.7748	24.5022	-0.09	0.40	13AUG07	11.80	NACLRL
COST	44.1615	28.6575	0.32	0.18	06JAN04	19.39	NACLRL
CRAI	44.3380	23.7645	0.21	0.34	13JAN25	12.33	NACLRL
CRCL	45.1781	28.1363	-0.51	0.36	14JAN04	11.65	NIEP
CRNV	44.3421	28.0312	0.90	0.36	13AUG06	11.80	NACLRL
DEVA	45.8784	22.9135	0.41	0.27	09JAN02	16.40	NACLRL
DRTS	44.6272	22.6345	0.71	0.39	13AUG07	10.46	NACLRL
FAGA	45.8462	24.9687	0.53	0.34	13AUG07	11.80	NACLRL
FOCS	45.7083	27.1946	-0.60	0.31	13JAN03	12.39	NACLRL
GHEL	46.7248	25.5984	-0.22	0.29	13AUG07	11.80	NACLRL
GIUR	43.8863	25.9617	0.42	0.41	13JAN25	12.33	NACLRL
GPOR	44.6754	28.9872	0.41	0.36	13MAY16	12.29	GeoPontica
GURA	46.2665	22.3378	0.27	0.39	13AUG07	11.80	NACLRL
HARI	44.6884	27.9574	1.49	0.59	13AUG07	11.80	NACLRL
HIST	44.5471	28.7702	0.40	0.18	03SEP08	21.98	NIEP
HUED	46.8653	23.0322	0.49	0.32	13FEB01	12.32	NACLRL
INSU	44.9112	27.6032	0.67	0.35	13JAN03	12.40	NACLRL
ISTR	44.5724	28.7113	-0.11	0.31	13AUG07	11.80	NACLRL
LACP	45.8233	26.3753	0.29	0.38	04AUG11	21.05	NIEP
MAJA	47.0545	27.2530	0.52	0.35	13SEP06	11.98	NIEP
MEDS	46.1627	24.3469	-1.47	0.33	13JAN26	12.33	NACLRL
MIDI	44.3462	28.6829	0.61	0.32	13MAY23	12.27	GeoPontica
MNG2	43.8011	28.5953	-0.21	0.29	13OCT24	11.85	NIEP
MNGA	43.8106	28.5586	0.40	0.32	13MAY22	11.93	GeoPontica
MNGL	43.8093	28.5801	0.46	0.36	13FEB23	12.26	NACLRL
NEGR	46.8382	27.4420	0.19	0.81	20DEC10	4.72	NIEP
NEHU	45.4172	26.3023	0.23	0.30	13JAN26	12.33	NACLRL
ODO1	46.3070	25.2942	0.02	0.31	13AUG07	11.80	NACLRL
ORAD	47.0592	21.9416	-1.49	0.35	13AUG07	11.80	NACLRL
PASC	47.2491	26.7387	-0.34	0.33	13AUG07	11.80	NACLRL
PET2	45.4164	23.3702	1.45	0.82	19AUG02	5.82	NACLRL
PI TE	44.8541	24.8787	1.37	0.36	14FEB27	11.24	NACLRL
PLOI	44.9338	25.9899	-0.29	0.35	13JUL17	11.86	NACLRL
PTNT	46.9264	26.3664	0.81	0.33	13AUG01	11.82	NACLRL
RMSR	45.3906	27.0384	0.68	0.64	19FEB13	5.66	NIEP
ROSP	46.3169	23.1385	0.01	0.24	09JUL03	16.16	NIEP
ROSU	45.4905	25.9439	-0.31	0.36	12JUN28	13.17	NIEP
SATU	47.7904	22.8693	-0.43	0.33	13AUG07	11.80	NACLRL
SFGH	45.8664	25.7883	-0.13	0.29	13JAN03	12.40	NACLRL
SIB1	45.7817	24.1461	0.60	0.33	13AUG07	11.80	NACLRL
SLOB	44.5637	27.3657	-0.11	0.38	14JAN17	11.36	NACLRL
SLTN	44.4227	24.3669	0.05	0.36	13AUG07	11.80	NACLRL
STOL	44.5627	24.7897	-0.46	0.62	17APR13	8.38	NIEP
SUCE	47.6359	26.2370	0.36	0.35	13AUG07	11.80	NACLRL
SULI	45.1563	29.6546	-0.49	0.64	18JAN19	7.35	NACLRL
TAJU	44.3755	25.1740	0.16	0.34	14JAN02	11.40	NACLRL
TBUJ	45.8709	27.9127	0.44	0.31	13AUG07	11.80	NACLRL
TECC	45.8416	27.4089	0.55	0.62	19MAR14	6.46	NIEP
TGMS	46.5283	24.5224	-0.85	0.41	15NOV12	9.80	NIEP
TGTS	46.4748	26.4897	-0.66	0.26	09DEC16	15.00	TopGeocart

TIM1	45.7799	21.2310	-1.40	0.40	13AUG07	11.80	NACLR
TIMA	45.1206	23.1278	0.20	0.35	13NOV22	11.77	NIEP
TIRG	44.4573	28.4123	0.62	0.36	16JAN01	9.66	NIEP
TJIU	45.0469	23.2739	-0.91	0.31	13JAN05	12.39	NACLR
TOPG	44.4477	26.1249	0.04	0.34	09MAY06	15.61	TopGeocart
TPLT	46.9263	25.3598	1.47	0.89	20OCT13	4.88	NIEP
TRGV	44.9183	25.4657	-0.42	0.33	13JAN03	12.39	NACLR
TUZL	43.9902	28.6661	0.13	0.30	13MAY24	12.27	GeoPontica
VAD2	45.3035	25.7222	1.58	0.74	19NOV07	5.55	NACLR
VAMO	47.6516	25.5752	0.72	0.35	13FEB20	12.26	NACLR
VASL	46.6416	27.7246	-0.79	0.39	13AUG07	11.80	NACLR
VATR	47.3177	25.3388	0.28	0.34	13AUG07	11.80	NACLR
VLC2	45.1074	24.3664	0.86	0.61	19AUG02	5.82	NACLR
VLDS	45.8443	28.0808	-1.30	0.46	15JAN22	9.65	NIEP
VRAP	45.8513	26.6498	0.28	0.20	04APR00	21.42	NIEP
ZALU	47.1777	23.0618	-0.02	0.32	13AUG07	11.80	NACLR

Table S4: Horizontal velocity inversion results and derived strain-rate parameters at selected locations. Each row lists geographic coordinates (latitude and longitude), inverted horizontal velocity components (v_x , v_y) and their uncertainties (dv_x , dv_y) in mm/yr; rotation rate (w) in degrees per Myr; and principal strain-rate components (e_{xx} , e_{xy} , e_{yy}) with uncertainties in nanostrain/year. Also included are the maximum and minimum principal strain rates (e_{max} , e_{min}), maximum shear strain rate (shr), azimuth of maximum extension (azi), dilatation rate ($dilat$), and second invariant of the strain-rate tensor, all with associated uncertainties.

Lat(°N)	Lon(°E)	v_x mm/yr	dv_x mm/yr	v_y mm/yr	dv_y mm/yr	w deg/Myr	dw deg/Myr	e_{xx} nstrain/yr	e_{dxx} nstrain/yr	e_{xy} nstrain/yr	e_{dexy} nstrain/yr	e_{yy} nstrain/yr	e_{deyy} nstrain/yr	e_{max} nstrain/yr	e_{demax} nstrain/yr	e_{min} nstrain/yr	e_{deminn} nstrain/yr	shr nstrain/yr	$dshr$ nstrain/yr	azi (deg)	$dazi$ (deg)	$dilat$ nstrain/yr	$ddilat$ nstrain/yr	sec. invariant nstrain/yr	dsec inv nstrain/yr
44.000	20.650	1.0	0.0	-0.5	0.0	0.0	0.0	-3.7	0.4	-2.9	0.3	5.3	0.4	6.2	0.4	-4.6	0.4	5.4	0.3	163.7	0.0	1.6	0.6	7.7	0.4
44.000	21.150	0.9	0.0	-0.6	0.0	0.0	0.0	-3.7	0.3	-3.0	0.3	5.1	0.5	6.1	0.4	-4.6	0.4	5.3	0.3	162.8	0.0	1.4	0.6	7.6	0.4
44.000	21.650	0.7	0.0	-0.8	0.0	-0.0	0.0	-4.5	0.5	-2.9	0.4	5.0	0.7	5.8	0.7	-5.3	0.5	5.6	0.4	164.5	0.0	0.5	0.8	7.9	0.6
44.000	22.150	0.5	0.0	-0.9	0.0	-0.0	0.0	-6.1	0.6	-2.0	0.5	4.9	0.9	5.3	0.9	-6.5	0.6	5.9	0.5	169.9	0.0	-1.2	1.1	8.3	0.7
44.000	22.650	0.2	0.0	-0.9	0.0	-0.0	0.0	-6.9	0.6	-0.9	0.6	4.5	0.9	4.5	0.9	-7.0	0.6	5.8	0.6	175.6	0.0	-2.5	1.1	8.4	0.7
44.000	23.150	0.0	0.1	-0.9	0.1	-0.0	0.0	-4.9	0.8	0.4	0.8	4.2	1.3	4.2	1.3	-4.9	0.8	4.6	0.8	2.2	0.0	-0.7	1.5	6.5	1.0
44.000	23.650	-0.1	0.0	-0.9	0.0	-0.0	0.0	-2.0	0.7	1.3	0.7	3.7	1.1	3.9	1.1	-2.3	0.7	3.1	0.7	12.3	0.1	1.6	1.3	4.6	1.0
44.000	24.150	-0.2	0.0	-0.8	0.0	-0.1	0.0	-0.5	0.5	1.5	0.4	3.0	0.7	3.6	0.7	-1.0	0.5	2.3	0.4	20.0	0.1	2.6	0.8	3.7	0.7
44.000	24.650	-0.2	0.0	-0.7	0.0	-0.0	0.0	0.2	0.5	1.2	0.4	1.9	0.6	2.5	0.6	-0.4	0.5	1.5	0.4	26.4	0.1	2.1	0.8	2.6	0.6
44.000	25.150	-0.2	0.0	-0.6	0.0	-0.0	0.0	0.7	0.3	1.2	0.3	2.0	0.5	2.7	0.4	-0.0	0.4	1.4	0.3	30.7	0.1	2.7	0.6	2.7	0.4
44.000	25.650	-0.1	0.0	-0.6	0.0	-0.0	0.0	0.7	0.2	1.2	0.2	1.6	0.4	2.5	0.4	-0.1	0.3	1.3	0.2	35.1	0.1	2.4	0.5	2.5	0.4
44.000	26.150	-0.1	0.0	-0.5	0.0	-0.0	0.0	0.7	0.2	1.0	0.2	1.3	0.4	2.1	0.4	-0.1	0.3	1.1	0.2	36.7	0.1	1.9	0.5	2.1	0.4
44.000	26.650	-0.1	0.0	-0.4	0.0	-0.0	0.0	0.6	0.2	1.3	0.2	1.0	0.4	2.1	0.4	-0.5	0.3	1.3	0.2	39.9	0.1	1.6	0.5	2.2	0.4
44.000	27.150	-0.1	0.0	-0.3	0.0	-0.0	0.0	0.2	0.3	1.4	0.3	0.8	0.4	2.0	0.4	-1.0	0.3	1.5	0.3	38.3	0.1	1.0	0.5	2.2	0.4
44.000	27.650	-0.1	0.0	-0.2	0.0	-0.1	0.0	-0.1	0.3	1.4	0.2	0.6	0.4	1.7	0.4	-1.2	0.3	1.4	0.2	38.3	0.1	0.6	0.5	2.1	0.3
44.000	28.150	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.3	1.3	0.2	0.5	0.3	1.5	0.3	-1.2	0.3	1.3	0.2	38.3	0.1	0.3	0.4	1.9	0.3

44.000	28.650	-0.1	0.0	-0.0	0.0	-0.1	0.0	-0.2	0.3	1.0	0.2	0.2	0.4	1.0	0.3	-1.0	0.4	1.0	0.2	39.6	0.1	-0.1	0.5	1.4	0.3
44.500	20.650	0.9	0.0	-0.2	0.0	0.0	0.0	-4.2	0.5	-3.1	0.3	4.6	0.4	5.6	0.4	-5.2	0.5	5.4	0.3	162.3	0.0	0.4	0.7	7.6	0.5
44.500	21.150	0.7	0.0	-0.4	0.0	0.0	0.0	-4.2	0.4	-3.0	0.3	4.7	0.4	5.6	0.4	-5.1	0.4	5.4	0.3	162.8	0.0	0.5	0.6	7.6	0.4
44.500	21.650	0.5	0.0	-0.5	0.0	-0.0	0.0	-4.5	0.4	-2.7	0.3	4.7	0.5	5.5	0.5	-5.2	0.4	5.3	0.3	164.6	0.0	0.2	0.6	7.6	0.5
44.500	22.150	0.4	0.0	-0.6	0.0	-0.0	0.0	-4.9	0.5	-2.0	0.4	4.8	0.5	5.1	0.5	-5.3	0.5	5.2	0.4	168.9	0.0	-0.2	0.7	7.4	0.5
44.500	22.650	0.2	0.0	-0.6	0.0	-0.0	0.0	-5.0	0.6	-0.9	0.4	4.7	0.6	4.8	0.6	-5.1	0.6	4.9	0.4	174.6	0.0	-0.3	0.8	7.0	0.6
44.500	23.150	-0.0	0.0	-0.7	0.0	-0.0	0.0	-3.8	0.6	0.1	0.5	4.6	0.7	4.6	0.7	-3.8	0.6	4.2	0.5	0.7	0.0	0.8	0.9	6.0	0.6
44.500	23.650	-0.1	0.0	-0.6	0.0	-0.0	0.0	-2.1	0.6	0.8	0.4	4.1	0.6	4.2	0.6	-2.2	0.6	3.2	0.4	7.3	0.0	2.0	0.9	4.8	0.6
44.500	24.150	-0.2	0.0	-0.6	0.0	-0.0	0.0	-0.7	0.5	1.1	0.4	3.4	0.5	3.7	0.5	-1.0	0.5	2.3	0.4	13.8	0.0	2.7	0.7	3.8	0.5
44.500	24.650	-0.2	0.0	-0.6	0.0	-0.0	0.0	0.6	0.5	0.9	0.4	3.1	0.6	3.4	0.6	0.3	0.6	1.6	0.4	18.2	0.1	3.7	0.8	3.4	0.6
44.500	25.150	-0.1	0.0	-0.5	0.0	-0.0	0.0	0.9	0.4	1.0	0.3	2.4	0.4	2.9	0.4	0.4	0.4	1.2	0.3	26.4	0.1	3.3	0.6	2.9	0.4
44.500	25.650	-0.1	0.0	-0.5	0.0	-0.0	0.0	0.8	0.3	1.0	0.3	2.0	0.4	2.6	0.4	0.3	0.4	1.2	0.3	29.6	0.1	2.8	0.5	2.6	0.4
44.500	26.150	-0.1	0.0	-0.5	0.0	-0.0	0.0	0.9	0.5	1.2	0.4	1.9	0.7	2.7	0.6	0.1	0.5	1.3	0.4	34.5	0.2	2.8	0.8	2.7	0.6
44.500	26.650	-0.1	0.0	-0.3	0.0	0.0	0.0	0.3	0.4	1.0	0.3	1.4	0.5	2.0	0.5	-0.3	0.4	1.1	0.3	31.5	0.1	1.7	0.6	2.0	0.5
44.500	27.150	0.0	0.0	-0.3	0.0	0.0	0.0	-0.2	0.4	1.1	0.3	1.1	0.4	1.7	0.4	-0.9	0.4	1.3	0.3	30.0	0.1	0.8	0.6	2.0	0.4
44.500	27.650	0.0	0.0	-0.2	0.0	-0.1	0.0	-0.6	0.4	1.3	0.3	0.8	0.4	1.6	0.4	-1.4	0.4	1.5	0.3	30.9	0.1	0.2	0.6	2.2	0.4
44.500	28.150	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.5	0.4	1.1	0.3	0.6	0.4	1.3	0.4	-1.3	0.4	1.3	0.3	32.1	0.1	0.1	0.5	1.8	0.4
44.500	28.650	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.5	0.4	0.8	0.3	0.3	0.4	0.8	0.4	-1.0	0.4	0.9	0.3	32.9	0.2	-0.2	0.6	1.3	0.4
44.500	29.150	-0.1	0.0	0.0	0.0	0.0	0.0	-0.4	0.3	0.3	0.2	0.0	0.3	0.1	0.2	-0.6	0.4	0.4	0.2	28.5	0.3	-0.5	0.4	0.6	0.4
45.000	20.650	0.7	0.0	0.0	0.0	0.0	0.0	-4.2	0.9	-3.3	0.5	3.6	0.6	4.8	0.7	-5.4	0.8	5.1	0.5	159.7	0.0	-0.6	1.1	7.3	0.8
45.000	21.150	0.5	0.0	-0.1	0.0	0.0	0.0	-3.8	0.7	-3.1	0.4	3.8	0.6	4.9	0.6	-5.0	0.6	4.9	0.4	160.2	0.0	-0.1	0.9	7.0	0.6

45.000	21.650	0.4	0.0	-0.2	0.0	0.0	0.0	-3.8	0.5	-2.6	0.4	4.1	0.5	4.9	0.5	-4.6	0.5	4.7	0.4	163.4	0.0	0.3	0.8	6.7	0.5
45.000	22.150	0.2	0.0	-0.3	0.0	0.0	0.0	-3.8	0.5	-1.8	0.3	4.6	0.5	4.9	0.5	-4.2	0.5	4.6	0.3	168.2	0.0	0.8	0.7	6.5	0.5
45.000	22.650	0.1	0.0	-0.4	0.0	0.0	0.0	-3.4	0.5	-1.0	0.3	4.4	0.5	4.6	0.5	-3.5	0.5	4.0	0.3	172.6	0.0	1.1	0.7	5.8	0.5
45.000	23.150	0.0	0.0	-0.4	0.0	0.0	0.0	-2.7	0.5	-0.4	0.4	4.3	0.5	4.4	0.5	-2.7	0.5	3.5	0.4	177.2	0.0	1.6	0.7	5.1	0.5
45.000	23.650	-0.1	0.0	-0.4	0.0	0.0	0.0	-1.6	0.5	0.3	0.3	3.9	0.5	3.9	0.5	-1.6	0.5	2.8	0.3	3.5	0.0	2.3	0.7	4.2	0.5
45.000	24.150	-0.1	0.0	-0.4	0.0	0.0	0.0	-0.4	0.5	0.7	0.3	3.4	0.5	3.5	0.5	-0.5	0.5	2.0	0.3	10.1	0.0	3.0	0.6	3.5	0.5
45.000	24.650	-0.1	0.0	-0.4	0.0	0.0	0.0	0.9	0.5	0.8	0.3	3.1	0.5	3.4	0.5	0.6	0.5	1.4	0.3	17.2	0.1	4.0	0.7	3.4	0.5
45.000	25.150	-0.1	0.0	-0.4	0.0	0.0	0.0	1.1	0.4	0.6	0.3	2.7	0.4	2.9	0.4	0.9	0.4	1.0	0.3	19.6	0.1	3.8	0.6	3.0	0.4
45.000	25.650	0.0	0.0	-0.4	0.0	0.0	0.0	1.0	0.5	0.8	0.3	2.5	0.5	2.8	0.5	0.6	0.5	1.1	0.3	23.8	0.1	3.5	0.7	2.9	0.5
45.000	26.150	0.0	0.0	-0.3	0.0	0.0	0.0	0.4	0.6	0.9	0.4	2.3	0.6	2.7	0.6	0.1	0.6	1.3	0.4	21.5	0.1	2.8	0.9	2.7	0.6
45.000	26.650	0.0	0.0	-0.3	0.0	0.0	0.0	-0.4	0.5	0.8	0.4	2.0	0.6	2.3	0.6	-0.7	0.5	1.5	0.4	17.3	0.1	1.6	0.8	2.4	0.5
45.000	27.150	-0.1	0.0	-0.2	0.0	-0.1	0.0	-0.8	0.5	0.7	0.4	1.8	0.5	1.9	0.5	-1.0	0.5	1.5	0.4	15.1	0.1	1.0	0.7	2.2	0.5
45.000	27.650	-0.1	0.0	-0.2	0.0	-0.1	0.0	-0.5	0.5	0.6	0.3	1.3	0.5	1.5	0.5	-0.7	0.5	1.1	0.3	17.8	0.1	0.7	0.7	1.7	0.5
45.000	28.150	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.5	0.5	0.6	0.3	0.7	0.4	0.9	0.4	-0.7	0.5	0.8	0.3	22.7	0.2	0.2	0.6	1.2	0.4
45.000	28.650	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.2	0.5	0.3	0.3	0.2	0.5	0.4	0.5	-0.4	0.5	0.4	0.3	27.8	0.4	0.0	0.7	0.5	0.5
45.000	29.150	-0.1	0.0	0.0	0.0	0.0	0.0	-0.3	0.3	0.1	0.2	0.0	0.4	0.1	0.3	-0.3	0.3	0.2	0.2	16.5	0.4	-0.3	0.5	0.4	0.3
45.000	29.650	-0.1	0.0	0.0	0.0	0.0	0.0	-0.4	0.3	0.1	0.2	-0.1	0.3	0.0	0.3	-0.5	0.3	0.2	0.2	13.4	0.3	-0.5	0.5	0.5	0.3
45.500	20.650	0.3	0.0	0.1	0.0	-0.1	0.0	-2.4	1.3	-3.7	0.8	2.1	0.9	4.2	1.1	-4.5	1.2	4.4	0.8	150.6	0.1	-0.3	1.6	6.2	1.1
45.500	21.150	0.3	0.0	0.0	0.0	-0.1	0.0	-2.3	0.8	-2.9	0.5	2.3	0.7	3.8	0.7	-3.7	0.8	3.7	0.5	154.1	0.1	0.0	1.1	5.3	0.8
45.500	21.650	0.2	0.0	-0.1	0.0	0.0	0.0	-2.4	0.5	-2.2	0.4	2.9	0.6	3.7	0.6	-3.2	0.5	3.5	0.4	160.0	0.0	0.5	0.8	4.9	0.6
45.500	22.150	0.1	0.0	-0.1	0.0	0.0	0.0	-2.2	0.5	-1.6	0.4	3.6	0.6	4.0	0.6	-2.6	0.5	3.3	0.4	165.9	0.0	1.3	0.8	4.7	0.5

45.500	22.650	0.0	0.0	-0.2	0.0	0.0	0.0	-2.0	0.5	-0.9	0.3	3.5	0.5	3.7	0.5	-2.2	0.5	2.9	0.3	171.0	0.0	1.5	0.7	4.3	0.5
45.500	23.150	0.0	0.0	-0.2	0.0	0.0	0.0	-1.4	0.4	-0.3	0.3	3.1	0.5	3.1	0.5	-1.4	0.4	2.2	0.3	176.6	0.0	1.7	0.6	3.4	0.5
45.500	23.650	-0.1	0.0	-0.2	0.0	0.0	0.0	-0.7	0.4	0.1	0.3	3.0	0.4	3.0	0.4	-0.7	0.4	1.9	0.3	1.7	0.0	2.3	0.6	3.1	0.4
45.500	24.150	-0.1	0.0	-0.2	0.0	0.0	0.0	0.2	0.4	0.5	0.3	2.8	0.4	2.8	0.4	0.1	0.4	1.4	0.3	9.8	0.1	2.9	0.6	2.8	0.4
45.500	24.650	-0.1	0.0	-0.2	0.0	0.0	0.0	0.6	0.4	0.4	0.3	2.5	0.4	2.6	0.4	0.5	0.4	1.1	0.3	11.7	0.1	3.1	0.6	2.7	0.4
45.500	25.150	-0.1	0.0	-0.3	0.0	0.0	0.0	0.8	0.4	0.4	0.3	2.3	0.4	2.4	0.4	0.7	0.4	0.8	0.3	15.4	0.1	3.1	0.6	2.5	0.4
45.500	25.650	0.0	0.0	-0.2	0.0	0.0	0.0	0.4	0.5	0.4	0.3	2.2	0.5	2.3	0.5	0.3	0.5	1.0	0.3	12.8	0.1	2.6	0.7	2.4	0.5
45.500	26.150	0.0	0.0	-0.2	0.0	0.0	0.0	-0.6	0.6	0.4	0.4	2.3	0.6	2.3	0.6	-0.6	0.6	1.5	0.4	6.9	0.1	1.7	0.8	2.4	0.6
45.500	26.650	-0.1	0.0	-0.2	0.0	-0.1	0.0	-1.3	0.6	0.2	0.4	2.3	0.6	2.3	0.6	-1.3	0.6	1.8	0.4	2.9	0.1	1.0	0.8	2.7	0.6
45.500	27.150	-0.2	0.0	-0.1	0.0	-0.1	0.0	-1.2	0.5	0.0	0.4	2.1	0.5	2.1	0.5	-1.2	0.5	1.7	0.4	0.4	0.1	0.9	0.8	2.4	0.5
45.500	27.650	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.7	0.5	-0.1	0.4	1.6	0.6	1.6	0.5	-0.7	0.5	1.2	0.4	176.8	0.1	0.9	0.7	1.8	0.5
45.500	28.150	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.4	0.5	-0.1	0.4	1.1	0.5	1.1	0.5	-0.4	0.5	0.7	0.4	176.8	0.1	0.7	0.7	1.2	0.5
45.500	28.650	-0.1	0.0	0.0	0.0	0.0	0.0	-0.2	0.5	-0.1	0.4	0.7	0.6	0.7	0.5	-0.2	0.5	0.5	0.4	175.2	0.2	0.6	0.7	0.8	0.5
45.500	29.150	-0.2	0.0	0.0	0.0	0.0	0.0	-0.4	0.3	0.0	0.2	0.8	0.4	0.8	0.4	-0.4	0.3	0.6	0.2	177.8	0.1	0.4	0.4	0.9	0.3
45.500	29.650	-0.2	0.0	0.1	0.0	0.0	0.0	-0.3	0.3	-0.2	0.2	0.6	0.3	0.7	0.3	-0.3	0.3	0.5	0.2	170.8	0.1	0.3	0.4	0.7	0.3
46.000	20.650	0.1	0.0	0.2	0.0	0.0	0.0	-1.1	0.9	-1.3	0.6	1.2	0.8	1.8	0.9	-1.7	0.9	1.8	0.6	156.1	0.1	0.1	1.3	2.5	0.9
46.000	21.150	0.1	0.0	0.1	0.0	0.0	0.0	-1.1	0.8	-1.9	0.5	1.1	0.7	2.2	0.7	-2.2	0.7	2.2	0.5	150.1	0.1	0.0	1.0	3.1	0.7
46.000	21.650	0.1	0.0	0.1	0.0	0.0	0.0	-1.2	0.6	-1.4	0.5	1.1	0.7	1.8	0.7	-1.9	0.6	1.8	0.5	154.1	0.1	-0.1	0.9	2.6	0.6
46.000	22.150	0.0	0.0	0.0	0.0	0.0	0.0	-1.1	0.5	-1.2	0.4	1.5	0.6	2.0	0.6	-1.5	0.5	1.7	0.4	159.3	0.1	0.4	0.8	2.5	0.6
46.000	22.650	0.0	0.0	-0.1	0.0	0.0	0.0	-0.7	0.6	-0.7	0.4	1.6	0.6	1.8	0.6	-0.9	0.6	1.4	0.4	165.6	0.1	0.9	0.8	2.0	0.6
46.000	23.150	0.0	0.0	-0.1	0.0	0.0	0.0	-0.4	0.5	-0.2	0.3	1.8	0.5	1.8	0.5	-0.4	0.5	1.1	0.3	175.7	0.1	1.4	0.7	1.9	0.5

46.000	23.650	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	0.4	0.0	0.3	2.0	0.4	2.0	0.4	-0.1	0.4	1.1	0.3	0.7	0.1	1.9	0.6	2.0	0.4
46.000	24.150	0.0	0.0	-0.1	0.0	0.0	0.0	+0.3	0.4	0.1	0.3	2.1	0.4	2.1	0.4	0.3	0.4	0.9	0.3	2.2	0.1	2.4	0.5	2.1	0.4
46.000	24.650	0.0	0.0	-0.1	0.0	0.0	0.0	+0.2	0.4	0.0	0.3	2.2	0.4	2.2	0.4	0.2	0.4	1.0	0.3	0.7	0.1	2.4	0.5	2.2	0.4
46.000	25.150	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.4	0.0	0.3	2.0	0.5	2.0	0.5	0.0	0.4	1.0	0.3	0.5	0.1	2.0	0.6	2.0	0.5
46.000	25.650	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.6	0.4	0.2	0.3	2.0	0.5	2.0	0.5	-0.6	0.4	1.3	0.3	3.6	0.1	1.4	0.6	2.1	0.5
46.000	26.150	-0.1	0.0	-0.1	0.0	-0.1	0.0	-1.0	0.5	0.1	0.4	2.1	0.5	2.1	0.5	-1.0	0.5	1.6	0.4	1.4	0.1	1.1	0.7	2.4	0.5
46.000	26.650	-0.1	0.0	0.0	0.0	-0.1	0.0	-1.5	0.5	0.0	0.3	2.3	0.5	2.3	0.5	-1.5	0.5	1.9	0.3	179.8	0.0	0.8	0.7	2.7	0.5
46.000	27.150	-0.2	0.0	0.0	0.0	-0.1	0.0	-1.5	0.5	-0.3	0.4	2.3	0.5	2.3	0.5	-1.6	0.6	1.9	0.4	175.6	0.1	0.7	0.8	2.8	0.5
46.000	27.650	-0.2	0.0	0.0	0.0	-0.1	0.0	-0.8	0.5	-0.2	0.3	1.8	0.5	1.8	0.5	-0.8	0.5	1.3	0.3	176.5	0.1	1.0	0.7	1.9	0.5
46.000	28.150	-0.2	0.0	0.1	0.0	0.0	0.0	-0.5	0.3	0.1	0.2	1.5	0.3	1.5	0.3	-0.5	0.3	1.0	0.2	3.2	0.1	1.1	0.5	1.6	0.3
46.000	28.650	-0.2	0.0	0.1	0.0	0.0	0.0	-0.4	0.3	0.1	0.2	1.5	0.3	1.5	0.3	-0.4	0.3	0.9	0.2	1.7	0.1	1.1	0.5	1.5	0.3
46.000	29.150	-0.2	0.0	0.1	0.0	0.0	0.0	-0.4	0.3	0.0	0.2	1.3	0.3	1.3	0.3	-0.4	0.3	0.8	0.2	1.2	0.1	0.9	0.4	1.3	0.3
46.500	21.150	0.0	0.0	0.1	0.0	0.0	0.0	-0.9	0.6	-1.3	0.4	-0.9	0.6	0.4	0.7	-2.2	0.5	1.3	0.4	135.1	0.2	-1.9	0.9	2.3	0.5
46.500	21.650	0.0	0.0	0.0	0.0	0.0	0.0	-0.9	0.6	-1.0	0.4	-1.2	0.6	-0.1	0.7	-2.0	0.5	1.0	0.4	129.8	0.2	-2.1	0.8	2.0	0.5
46.500	22.150	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	0.6	-0.6	0.4	-1.4	0.6	-0.3	0.6	-1.7	0.6	0.7	0.4	118.7	0.3	-2.1	0.9	1.8	0.6
46.500	22.650	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.6	-0.1	0.4	-0.5	0.6	-0.1	0.6	-0.6	0.6	0.2	0.4	99.6	0.5	-0.6	0.8	0.6	0.6
46.500	23.150	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.0	0.4	0.2	0.5	0.2	0.5	+0.1	0.5	0.1	0.4	163.0	2.0	0.3	0.7	0.2	0.5
46.500	23.650	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	-0.1	0.3	1.0	0.5	1.1	0.5	0.0	0.5	0.6	0.3	173.1	0.2	1.0	0.7	1.1	0.5
46.500	24.150	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.4	-0.3	0.3	1.4	0.4	1.5	0.4	-0.1	0.4	0.8	0.3	168.5	0.1	1.3	0.6	1.5	0.4
46.500	24.650	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.4	-0.3	0.3	1.8	0.5	1.8	0.5	-0.1	0.4	1.0	0.3	170.9	0.1	1.7	0.6	1.8	0.5
46.500	25.150	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	0.4	-0.3	0.3	2.0	0.5	2.0	0.5	-0.7	0.4	1.4	0.3	174.3	0.1	1.3	0.6	2.1	0.5

46.500	25.650	-0.1	0.0	0.0	0.0	-0.1	0.0	-1.0	0.4	-0.2	0.3	2.1	0.4	2.1	0.4	-1.0	0.4	1.6	0.3	176.0	0.0	1.1	0.6	2.3	0.4
46.500	26.150	-0.1	0.0	0.0	0.0	-0.1	0.0	-1.3	0.4	0.3	0.3	1.9	0.4	2.0	0.4	-1.3	0.4	1.6	0.3	5.5	0.0	0.7	0.6	2.4	0.4
46.500	26.650	-0.2	0.0	0.1	0.0	-0.1	0.0	-1.7	0.5	0.4	0.4	2.1	0.5	2.2	0.5	-1.7	0.5	1.9	0.4	5.3	0.1	0.5	0.8	2.8	0.5
46.500	27.150	-0.2	0.0	0.1	0.0	-0.1	0.0	-1.0	0.6	0.3	0.4	2.3	0.5	2.3	0.5	-1.1	0.5	1.7	0.4	4.8	0.1	1.3	0.7	2.6	0.5
46.500	27.650	-0.2	0.0	0.1	0.0	0.0	0.0	-0.3	0.5	0.0	0.3	1.6	0.4	1.6	0.4	-0.3	0.5	0.9	0.3	0.4	0.1	1.3	0.7	1.6	0.4
46.500	28.150	-0.2	0.0	0.1	0.0	0.0	0.0	-0.5	0.4	0.1	0.2	1.5	0.3	1.5	0.3	-0.5	0.4	1.0	0.2	2.9	0.1	1.0	0.5	1.6	0.3
46.500	28.650	-0.2	0.0	0.2	0.0	0.0	0.0	-0.3	0.4	0.1	0.2	1.4	0.3	1.4	0.3	-0.3	0.3	0.9	0.2	2.8	0.1	1.1	0.5	1.5	0.3
47.000	21.650	-0.0	0.0	-0.1	0.0	0.0	0.0	-0.9	0.6	-0.5	0.4	-2.2	0.5	-0.7	0.7	-2.4	0.5	0.8	0.4	109.8	0.2	-3.1	0.8	2.5	0.5
47.000	22.150	-0.1	0.0	-0.2	0.0	-0.1	0.0	-0.3	0.7	0.7	0.5	-1.6	0.6	0.0	0.7	-1.9	0.6	1.0	0.5	65.1	0.2	-1.9	0.9	1.9	0.6
47.000	22.650	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.6	0.6	0.4	-1.2	0.6	0.0	0.6	-1.4	0.6	0.7	0.4	65.1	0.2	-1.4	0.8	1.4	0.6
47.000	23.150	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.1	0.5	0.1	0.4	-0.7	0.6	-0.1	0.5	-0.8	0.6	0.3	0.4	79.5	0.4	-0.9	0.8	0.8	0.6
47.000	23.650	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.1	0.5	-0.4	0.4	0.4	0.5	0.6	0.5	-0.3	0.5	0.4	0.4	151.0	0.4	0.2	0.7	0.6	0.5
47.000	24.150	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.2	0.5	-0.6	0.4	1.2	0.5	1.4	0.5	-0.5	0.5	1.0	0.4	159.2	0.1	1.0	0.7	1.5	0.5
47.000	24.650	-0.1	0.0	0.1	0.0	-0.1	0.0	-0.4	0.5	-0.7	0.3	1.7	0.5	1.9	0.5	-0.7	0.5	1.3	0.3	162.8	0.1	1.3	0.7	2.0	0.5
47.000	25.150	-0.1	0.0	0.1	0.0	-0.1	0.0	-0.9	0.4	-0.6	0.3	2.1	0.5	2.2	0.5	-1.0	0.4	1.6	0.3	169.8	0.1	1.2	0.6	2.4	0.5
47.000	25.650	-0.2	0.0	0.1	0.0	-0.1	0.0	-1.0	0.4	-0.3	0.3	2.3	0.4	2.3	0.4	-1.0	0.4	1.6	0.3	175.4	0.0	1.3	0.6	2.5	0.4
47.000	26.150	-0.2	0.0	0.2	0.0	-0.1	0.0	-0.7	0.4	0.0	0.3	2.1	0.4	2.1	0.4	-0.7	0.4	1.4	0.3	0.9	0.1	1.5	0.6	2.2	0.4
47.000	26.650	-0.2	0.0	0.2	0.0	-0.0	0.0	-0.3	0.5	0.1	0.3	1.8	0.5	1.8	0.5	-0.3	0.5	1.1	0.3	2.2	0.1	1.5	0.7	1.9	0.5
47.000	27.150	-0.2	0.0	0.2	0.0	-0.0	0.0	-0.1	0.7	0.2	0.5	1.3	0.6	1.4	0.6	-0.1	0.7	0.7	0.5	8.5	0.2	1.3	0.9	1.4	0.6
47.000	27.650	-0.2	0.0	0.2	0.0	-0.0	0.0	0.0	0.5	0.1	0.3	1.4	0.4	1.4	0.4	+0.0	0.5	0.7	0.3	176.0	0.1	1.4	0.6	1.4	0.4
47.500	22.150	-0.1	0.0	-0.2	0.0	-0.1	0.0	-0.8	0.5	0.5	0.4	-1.8	0.6	-0.6	0.5	-2.0	0.6	0.7	0.4	67.4	0.2	-2.6	0.8	2.1	0.6

47.500	22.650	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.8	0.4	0.4	0.4	-0.7	0.6	-0.4	0.5	-1.2	0.6	0.4	0.4	41.2	0.5	-1.6	0.8	1.2	0.6
47.500	23.150	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.8	0.4	0.1	0.4	0.1	0.6	0.1	0.6	-0.8	0.4	0.5	0.4	8.7	0.2	-0.7	0.7	0.8	0.4
47.500	23.650	-0.2	0.0	0.1	0.0	-0.1	0.0	-0.3	0.6	-0.6	0.4	0.9	0.7	1.1	0.7	-0.5	0.5	0.8	0.4	156.9	0.2	0.6	0.9	1.3	0.7
47.500	24.150	-0.2	0.0	0.1	0.0	-0.1	0.0	-0.4	0.5	-0.8	0.4	1.8	0.6	2.1	0.6	-0.7	0.5	1.4	0.4	161.2	0.1	1.4	0.8	2.2	0.6
47.500	24.650	-0.2	0.0	0.2	0.0	-0.1	0.0	-0.6	0.5	-1.0	0.4	2.1	0.5	2.4	0.6	-0.9	0.5	1.7	0.4	162.0	0.1	1.6	0.7	2.6	0.6
47.500	25.150	-0.2	0.0	0.2	0.0	-0.1	0.0	-0.6	0.5	-0.7	0.3	2.6	0.5	2.7	0.5	-0.7	0.5	1.7	0.3	168.5	0.1	2.0	0.7	2.8	0.5
47.500	25.650	-0.2	0.0	0.3	0.0	-0.1	0.0	-0.6	0.5	-0.4	0.3	2.7	0.5	2.7	0.5	-0.7	0.5	1.7	0.3	173.6	0.1	2.1	0.7	2.8	0.5
47.500	26.150	-0.3	0.0	0.3	0.0	-0.1	0.0	-0.2	0.5	-0.4	0.4	2.5	0.5	2.6	0.5	-0.3	0.5	1.4	0.4	171.4	0.1	2.3	0.7	2.6	0.5
47.500	26.650	-0.2	0.0	0.3	0.0	-0.0	0.0	0.3	0.5	-0.5	0.4	2.1	0.5	2.2	0.5	0.1	0.5	1.0	0.4	165.5	0.1	2.3	0.7	2.2	0.5
47.500	27.150	-0.2	0.0	0.3	0.0	-0.0	0.0	0.7	0.6	-0.6	0.4	1.2	0.6	1.6	0.5	0.3	0.6	0.6	0.4	147.4	0.3	1.9	0.8	1.6	0.5
48.000	24.150	-0.4	0.0	0.3	0.0	-0.1	0.0	-0.7	0.4	-0.7	0.3	2.0	0.5	2.2	0.5	-0.9	0.3	1.5	0.3	166.4	0.1	1.3	0.6	2.3	0.5
48.000	24.650	-0.4	0.0	0.3	0.0	-0.1	0.0	0.2	0.4	-0.8	0.3	2.5	0.5	2.7	0.5	-0.4	0.4	1.6	0.3	165.0	0.1	2.3	0.6	2.7	0.5
48.000	25.150	-0.4	0.0	0.4	0.0	-0.1	0.0	0.3	0.4	-0.7	0.3	3.0	0.5	3.1	0.5	0.1	0.4	1.5	0.3	166.3	0.1	3.3	0.6	3.1	0.5
48.000	25.650	-0.4	0.0	0.4	0.0	-0.1	0.0	0.4	0.4	-0.5	0.3	2.9	0.5	3.0	0.5	0.3	0.4	1.3	0.3	169.9	0.1	3.3	0.6	3.0	0.5
48.000	26.150	-0.3	0.0	0.4	0.0	-0.1	0.0	0.3	0.4	-0.6	0.3	3.1	0.6	3.2	0.5	0.2	0.4	1.5	0.3	168.7	0.1	3.4	0.7	3.2	0.5

S3. Local Reference Frame Transformations

To assess the sensitivity of our GNSS velocity field to the choice of reference frame, we applied three different approaches to transform the original ITRF2014 velocities into local reference frames: (1) Euler pole rotation, (2) network mean removal, and (3) stable station mean removal. Each method removes different components of the velocity field, allowing us to evaluate whether additional local corrections are necessary for our study area.

The Euler pole rotation method treats the study area as a rigid block rotating about an Euler pole. We first removed the mean velocity from all stations to center the velocity field and then identified “stable” stations as those with residual velocity magnitudes below 5 mm/yr. Using this subset, we estimated the Euler rotation parameters (ω_x , ω_y , ω_z) by solving the linearized relationship between plate rotation and surface velocities. The resulting Euler vector represents the optimal rigid rotation for the stable region and was used to predict velocities at all stations. Residuals were then calculated as the difference between observed and predicted velocities. This approach is physically meaningful in regions that can reasonably be approximated as rigid blocks, as it removes both translational and rotational components. Notably, although conducted as an exercise, the Euler rotation nearly replicates the original EU14 velocities, confirming that it does not materially alter our interpretations.

The network mean removal method is simpler, subtracting the average velocity of all stations from each station’s observed velocity. While this centers the velocity field, it does not account for rotational effects or spatial variations in background motion. This approach is commonly used due to its simplicity, but it may be suboptimal in regions with significant rotation or uneven station distribution.

The stable station mean method aims to capture the regional background motion by averaging velocities from a subset of stations presumed to be on the stable plate interior. Stations with ITRF velocity magnitudes below 25 mm/yr were selected, and their mean north and east velocities were subtracted from all stations to obtain residuals. This approach provides an alternative way to account for local deformation while anchoring the field to presumably stable locations.

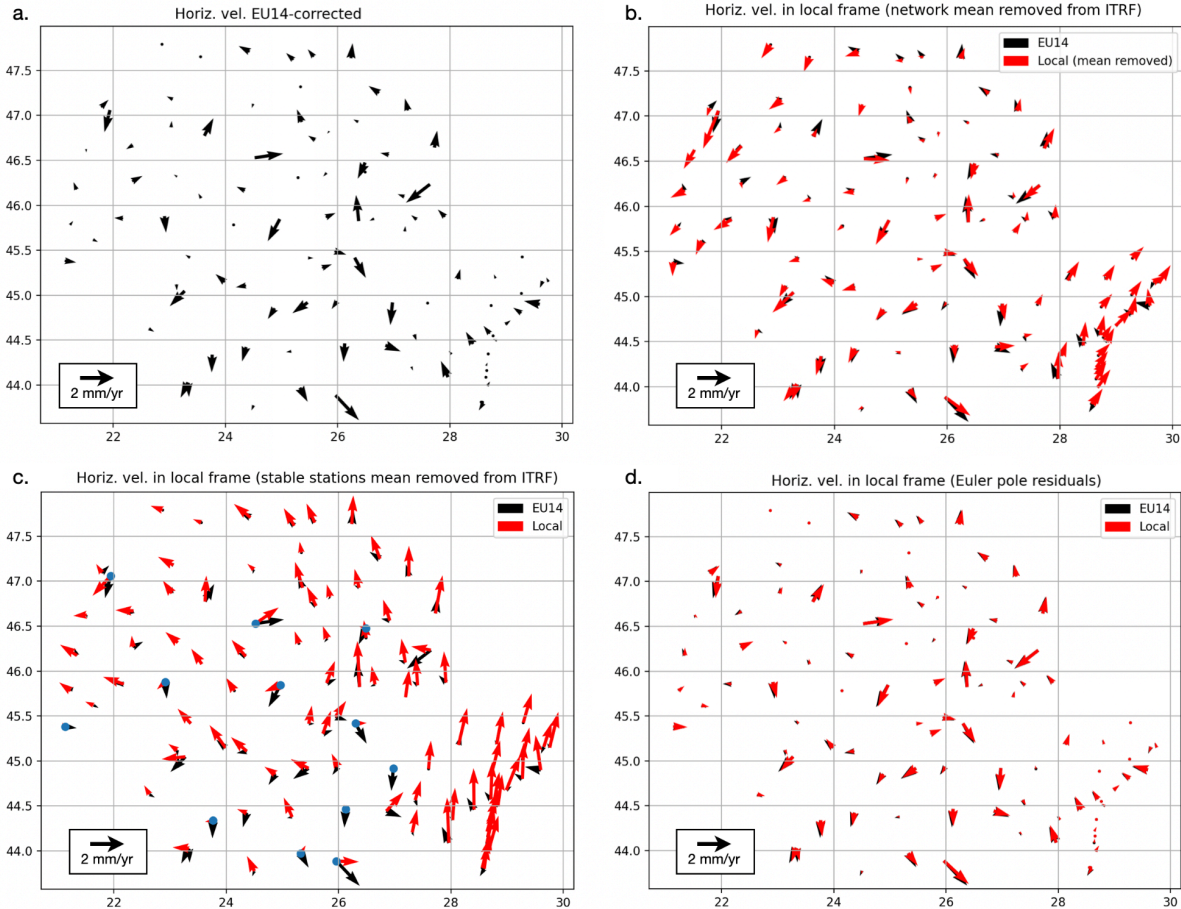


Figure S2. Comparison of horizontal velocity residuals across Romania using different local reference frame transformations. (a) Original velocities in the preferred EU14 reference frame (black vectors). (b) Residual velocities after network mean removal, representing the field with the average translation of all stations subtracted. (c) Residual velocities after stable station mean removal, where the average translation is calculated only from a subset of stable stations (blue circles). (d) Residual velocities after Euler pole rotation, representing the field after removing the rigid-body rotation inverted from the ITRF2014 velocities.

Figure S2 presents the original EU14 velocities alongside the residuals from each transformation method. Original EU14 velocities (Figure S2a) show small magnitudes (mean = 0.34 mm/yr) with a coherent pattern, reflecting the low deformation rates in the region. Euler rotation residuals (Figure S2b) exhibit the smallest magnitudes with no apparent spatial correlation, confirming successful removal of rigid rotation. Network mean residuals (Figure S2c) show intermediate magnitudes and, like the Euler method, appear spatially uncorrelated. Stable stations mean residuals (Figure S2d) display the largest magnitudes with some spatial organization, suggesting that the choice of stable stations may have included stations with small but real local deformation signals, or that the threshold selected does not adequately isolate the true stable plate interior.

S3.1 Statistical comparisons between reference frames

To evaluate the performance of each method, we computed residual velocities and associated statistics, including the mean residual magnitude, standard deviation, RMS, and mean residual components (see Tables S5, S6, and Figures S2, S3). These analyses reveal that while different approaches yield slightly different residuals, the overall effect on the velocity field is minimal, further justifying the use of EU14 velocities directly in the main manuscript rather than applying local reference frame corrections.

Table S5: Residual statistics for each local reference frame method.

Method	Mean mag (mm/yr)	Std Mag (mm/yr)	RMS (mm/yr)	Mean Vn (mm/yr)	Mean Ve (mm/yr)
EU14	0.34	0.28	0.44	-0.086	0.087
Euler Rotation	0.55	0.4	0.68	-0.001	0.008
Network Mean	0.82	0.40	0.92	0.005	-0.011
Selected Stations Mean	1.25	0.55	1.37	0.003	-0.007

The Euler rotation method yields the smallest residuals (RMS = 0.68 mm/yr), indicating that it best captures the regional background motion. This is followed by the network mean method (RMS = 0.92 mm/yr), while the stable station mean method produces the largest residuals (RMS = 1.37 mm/yr). The superior performance of the Euler method suggests that the region exhibits significant rotational motion that must be accounted for when isolating local deformation signals.

All three methods produce mean residual components near zero (<0.01 mm/yr), confirming that each approach effectively centers the residual field. However, the substantially lower RMS and standard deviation of the Euler method demonstrate its superior ability to remove coherent motion compared to translation-only approaches.

The magnitude of change from the original EU14 velocities varies systematically between methods (Table S6, Figure S3). Notably, the original EU14 velocities are already small in magnitude (mean = 0.34 mm/yr, RMS = 0.44 mm/yr), indicating that the study area is characterized by relatively low tectonic activity or that the ITRF2014 frame already accounts for much of the plate motion.

Table S6: Changes applied to EU14 velocities by each reference frame method

Method	Mean ΔV (mm/yr)	Std ΔV (mm/yr)	Max ΔV (mm/yr)	RMS ΔV (mm/yr)
Euler Rotation	0.55	0.40	1.98	0.68
Network Mean	0.82	0.40	2.30	0.92
Selected Stations Mean	1.25	0.55	2.58	1.37

The Euler rotation method applies the smallest modifications to the original velocities (mean $\Delta V = 0.55$ mm/yr), which is consistent with its role in removing only the rotational component while preserving most of the existing velocity field. In contrast, the stable station mean method introduces the largest changes (mean $\Delta V = 1.25$ mm/yr), suggesting that the stable station subset may include stations with small but significant local motions, or that the threshold of 10 mm/yr is too permissive, allowing stations with residual deformation to influence the reference frame.

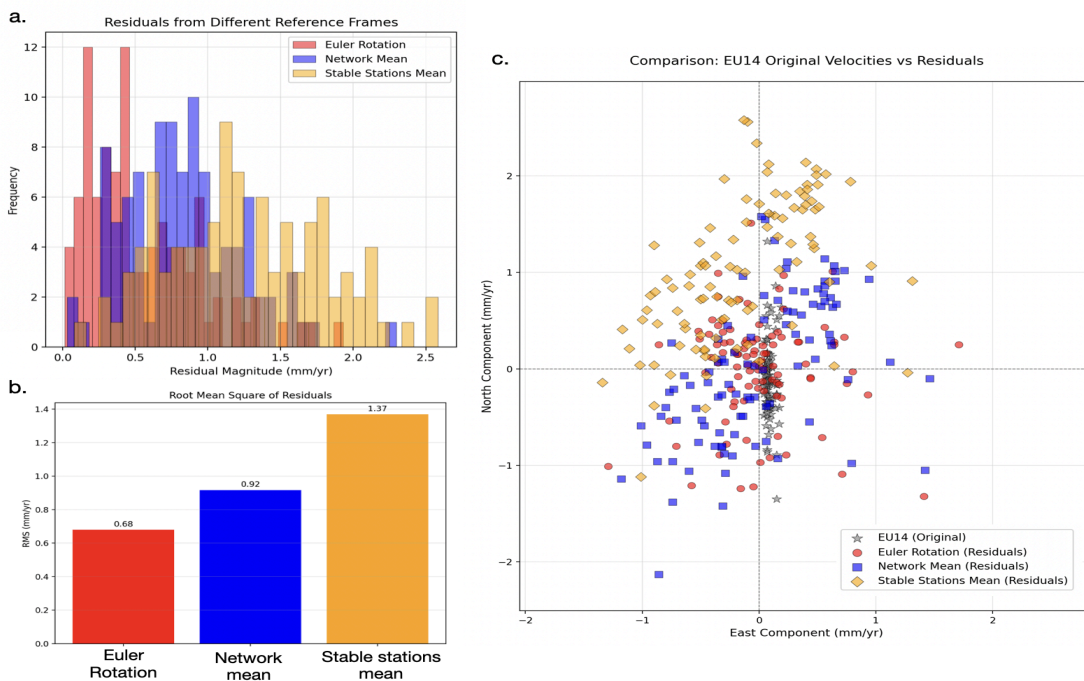


Figure S3: Statistical comparison of local reference frame corrections relative to EU14 velocities. Three panels summarize the effects of three local reference frame approaches (Euler rotation, network mean, and stable station mean) on the GNSS velocity field: (a) Histogram of residual magnitudes for each method, illustrating the distribution and spread of corrections applied to the original EU14 velocities. (b) Bar chart comparing the root mean square (RMS) of residuals for each method, highlighting that Euler rotation produces the lowest RMS. (c) Scatter of residual vectors in north vs. east components, showing EU14 original velocities (gray stars) alongside residuals from each local frame, emphasizing the relative magnitude and direction of corrections.

The differences in performance among the three local reference frame approaches can be understood in terms of what each method is designed to remove. The Euler rotation method accounts for both translational and rotational components by modeling the study area as a rigid block, which is most appropriate when stations sample a region that moves coherently. The low residuals observed for this method (0.68 mm/yr RMS) suggest that this assumption is reasonable for our study area. The network mean method, in contrast, removes only the average translation of all stations, leaving rotational effects uncorrected; the intermediate residuals it produces (0.92 mm/yr RMS) indicate that rotational signals remain and contribute to the variability across the network. The stable station mean method subtracts the average translation of a subset of presumed stable stations, but the larger residuals observed (1.37 mm/yr RMS) likely reflect that the 10 mm/yr threshold may be too lenient, allowing stations affected by local

deformation into the subset, or that the chosen stations do not fully represent the true plate interior. This method may also over-correct by including stations with systematic biases.

Although the Euler rotation yields the smallest residuals among the local transformations, the original EU14 velocities (RMS = 0.44 mm/yr) remain more appropriate for our analysis. The EU14 velocities are already small, indicating that the ITRF2014 reference frame effectively captures the regional plate motion. Local transformations introduce method-dependent uncertainties, require subjective parameter choices, and provide no independent geological constraints. We therefore justify the use of EU14-corrected velocities in the main manuscript as the most robust representation of the GNSS velocity field. The analyses presented here are included in the Supplementary Material to illustrate that alternative reference frame approaches produce comparable results without altering our interpretations or adding additional geological insight.

S4. Comparisons with previous studies

To further assess the consistency of our results, we compared our velocity estimates with those of Piña-Valdés at common stations (Figures S4, S5). For the horizontal components (Figure S4), both the north and east velocity components show good agreement, with no significant systematic bias. The majority of stations cluster tightly around the 1:1 line, and deviations are generally small.

For the vertical component (Figure S5), the two solutions show a clear linear relationship, with most stations clustering near the 1:1 line. A slight systematic offset is observed, with our estimates tending to be marginally lower. Differences indicate that most discrepancies are within the expected uncertainty range for vertical GNSS velocities. Importantly, the spatial pattern of uplift and subsidence is coherent between the two datasets, indicating that both solutions capture the same underlying geophysical signal.

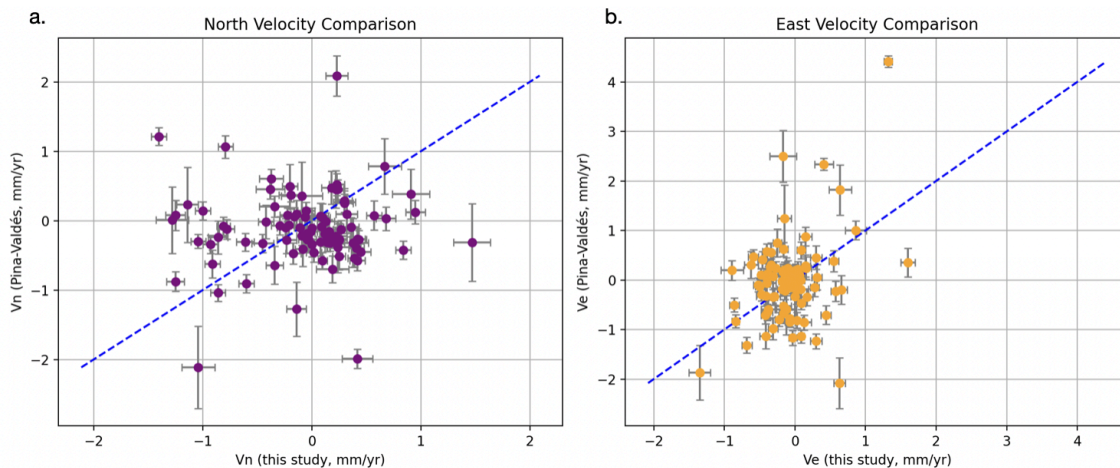


Figure S4. Comparison of horizontal velocities at common stations between this study and Pina-Valdés et al. (a) Scatter plot of northward components (V_n) with 1:1 line, showing overall agreement. (b) Scatter plot of eastward components (V_e).

Small differences between the two datasets can be attributed to differences in processing strategies, including time series length, network density, and treatment of discontinuities. In particular, the present study benefits from longer observation periods and a detailed, station-by-station evaluation of offsets and equipment changes, which likely contributes to a reduction of residual scatter and improved internal consistency.

Overall, the comparison demonstrates that our results are consistent with an independent solution while providing a refined characterization of the velocity field.

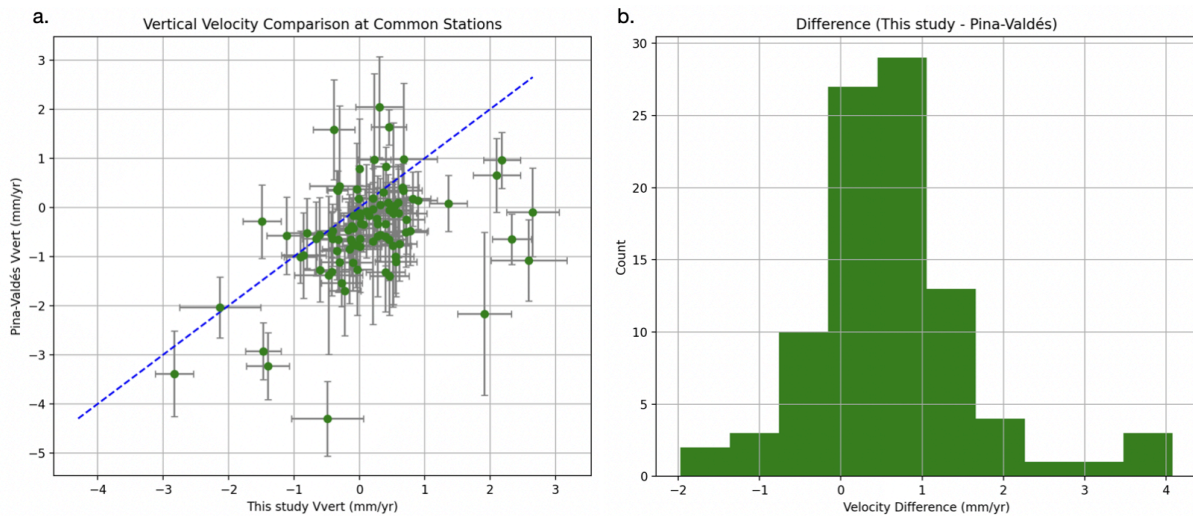


Figure S5. Comparison of vertical velocities at stations common to this study and Pina-Valdés et al. (a) Scatter plot showing velocities from this study versus Pina-Valdés, with the blue dashed line indicating the 1:1 relationship. Most points lie slightly below the 1:1 line, reflecting a small systematic offset, but overall show consistent spatial patterns. (b) Histogram of differences (this study - Pina-Valdés), showing that discrepancies are generally small and within expected uncertainties.