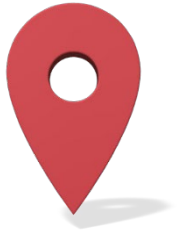


Validation of the ortho product of European Ground Motion Service (EGMS) with the previous InSAR-based studies: a case study in Gävle city, Sweden

Nureldin Gido, Faramarz Nilfouroushan and Chrishan Puwakpitiya Gedara

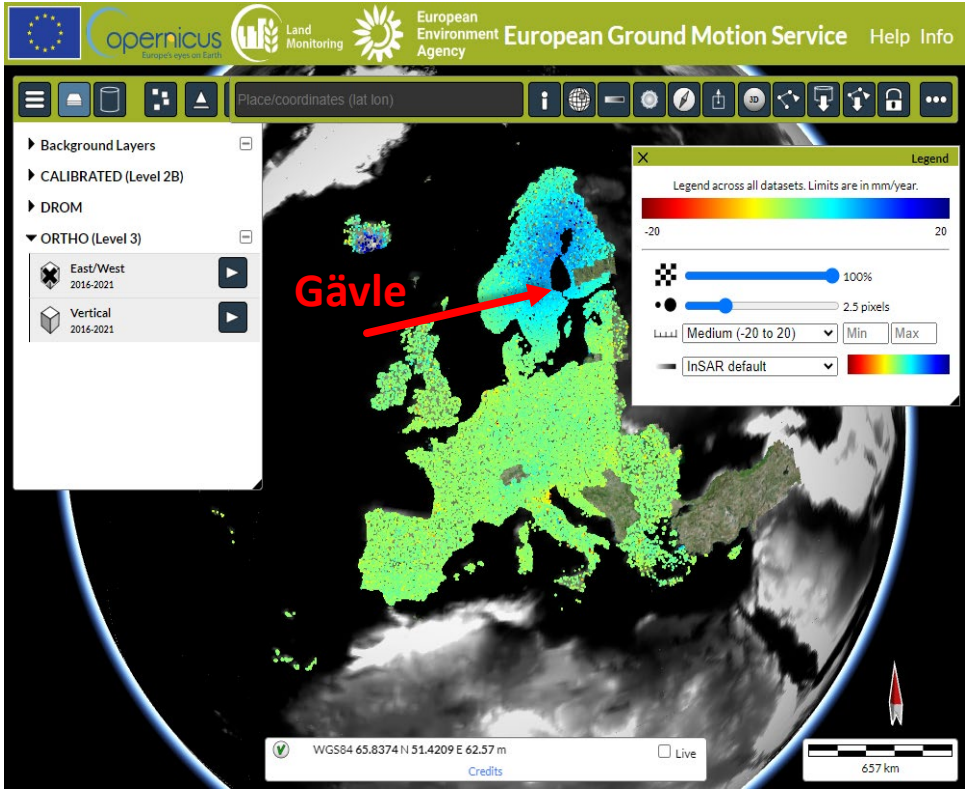
12-09-2023

Fringe 2023, University of Leeds, UK

LANTMÄTERIET

The European ground motion services (EGMS)

- Based on multi-interferogram techniques (**PSI, DS)** using both **ascending and descending Sentinel 1** data (**Feb 2015-Dec 2020**)
- Three annual updates till 2023
- EGMS products:
  - **The Basic product** (LOS displacement)
  - **The Calibrated product** (absolute based on GNSS data)
  - **The Ortho product** (vertical and E-W components_resampled 100x100m)

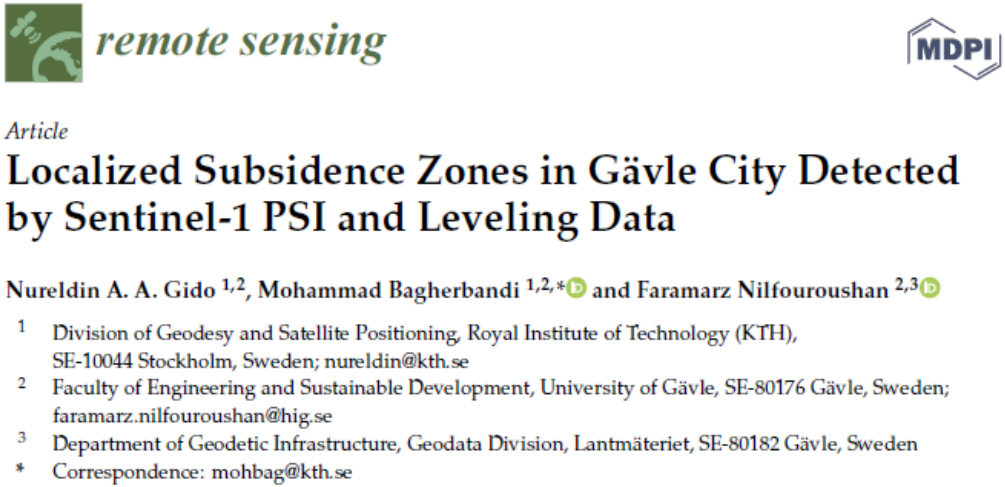


https://egms.land.copernicus.eu/

A case study in Gävle city, Sweden

Using SARproz software

- Based on **PSI**
- 41_Asc_102 (Jan 2015-May 2020))
- 40_Dec_95 (June 2015-May 2020)
- **45** years levelling data



remote sensing

MDPI

Article

Localized Subsidence Zones in Gävle City Detected by Sentinel-1 PSI and Leveling Data

Nureldin A. A. Gido [1,2], Mohammad Bagherbandi [1,2,*] and Faramarz Nilfouroushan [2,3]

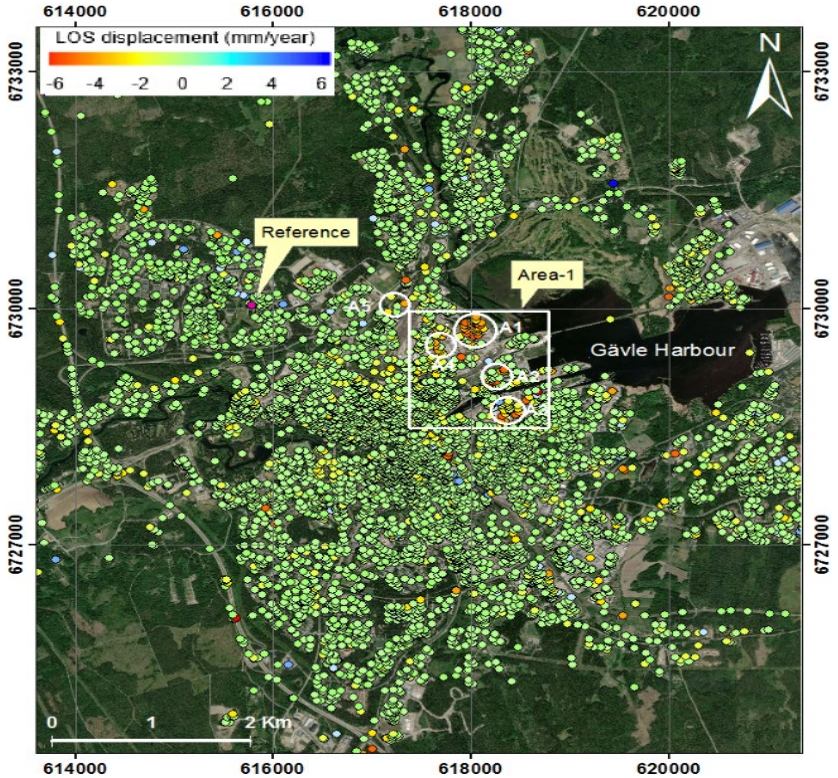
1 Division of Geodesy and Satellite Positioning, Royal Institute of Technology (KTH), SE-10044 Stockholm, Sweden; nureldin@kth.se
2 Faculty of Engineering and Sustainable Development, University of Gävle, SE-80176 Gävle, Sweden; faramarz.nilfouroushan@hig.se
3 Department of Geodetic Infrastructure, Geodata Division, Lantmäteriet, SE-80182 Gävle, Sweden
* Correspondence: mohbag@kth.se

New results using GECORIS toolbox [1]

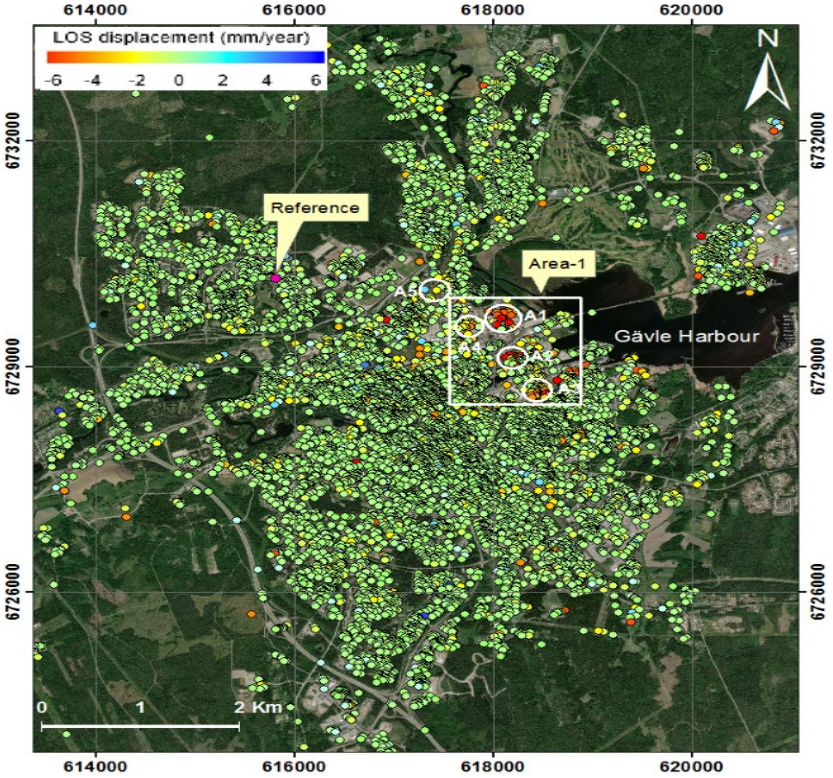
- 141_Asc_102 (Mar 2015-Oct 2021)
- 122_Dec_95 (June 2015-Oct 2021)
- Based on **PSI**

[1] Czikhardt R, van der Marel H, Papco J. GECORIS: An Open-Source Toolbox for Analyzing Time Series of Corner Reflectors in InSAR Geodesy. Remote Sensing. 2021; 13(5):926. https://doi.org/10.3390/rs13050926

GM_SARproz results in LOS direction

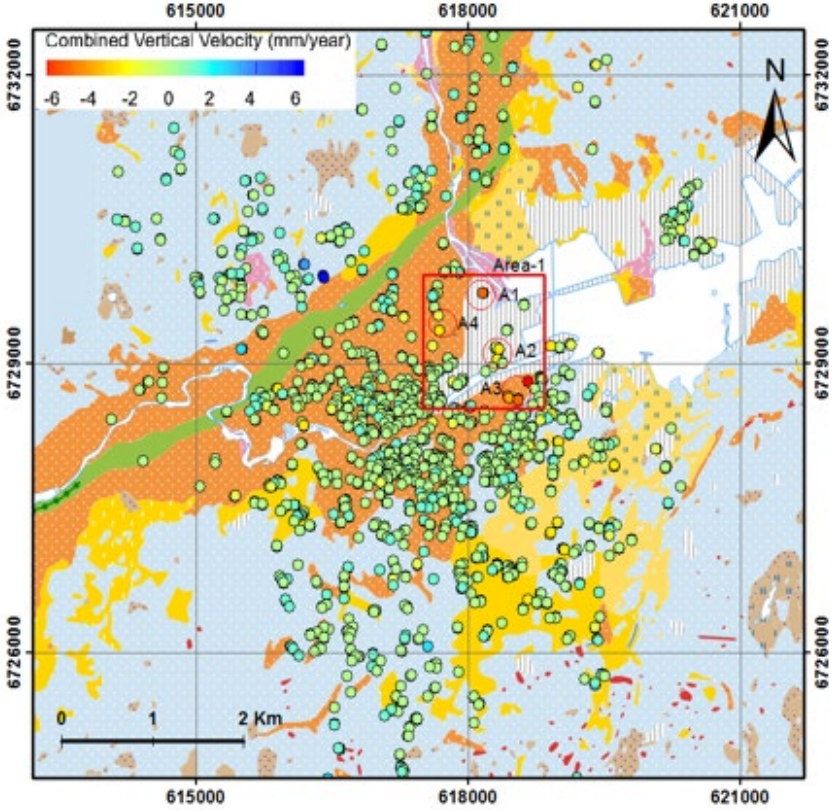


The Ascending geometry

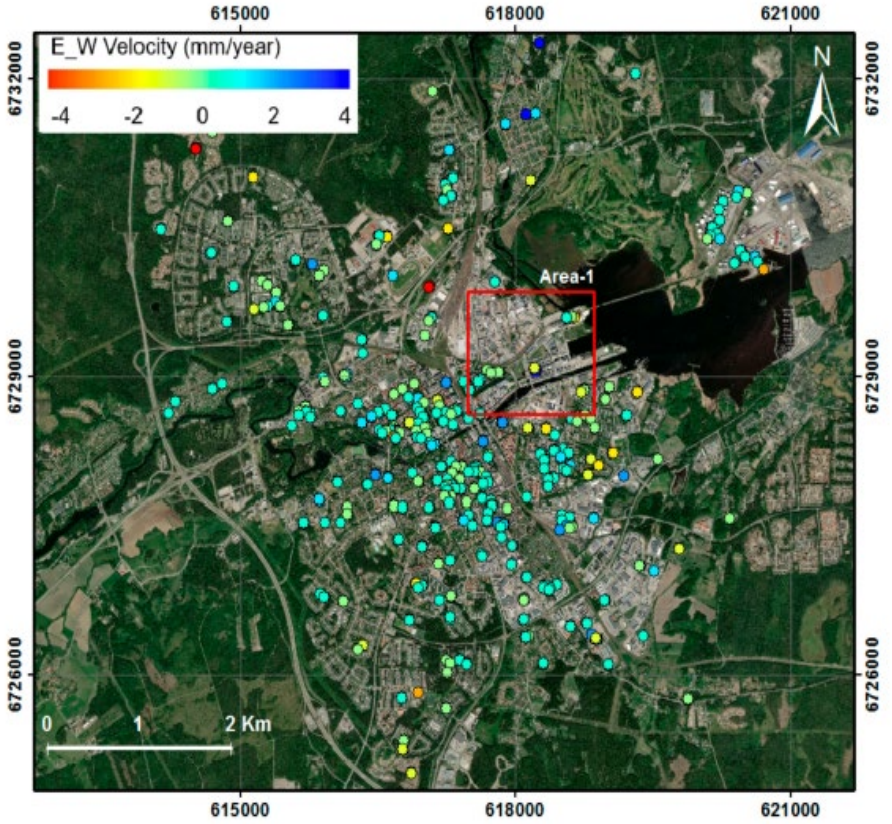


The Descending geometry

GM_SARproz results in Vertical and E-W direction

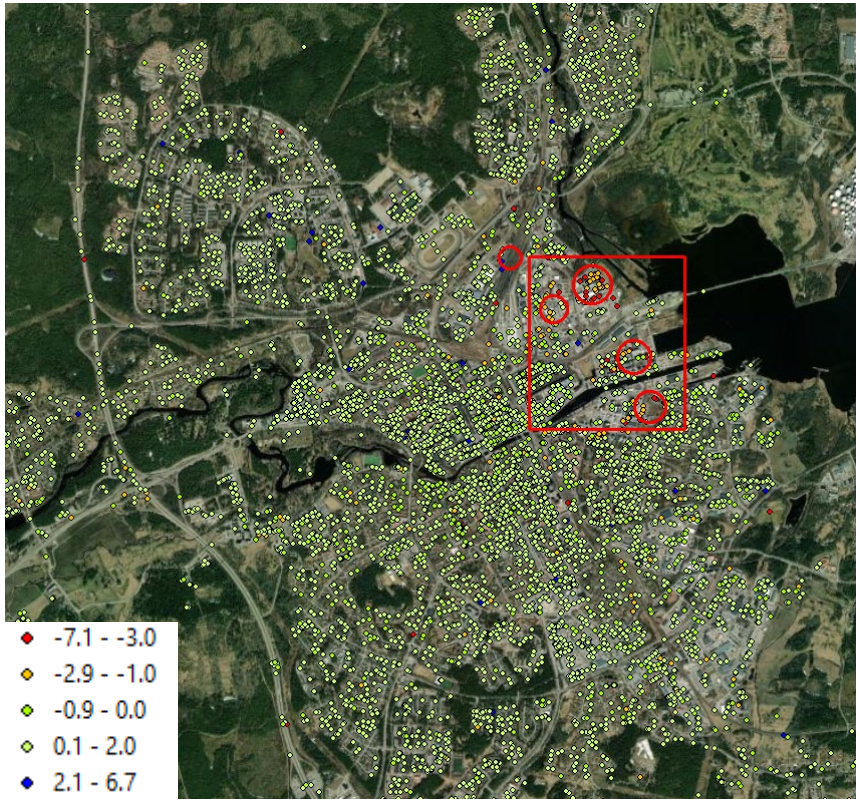


Vertical displacement rate overlaid on the quaternary deposit map of the city

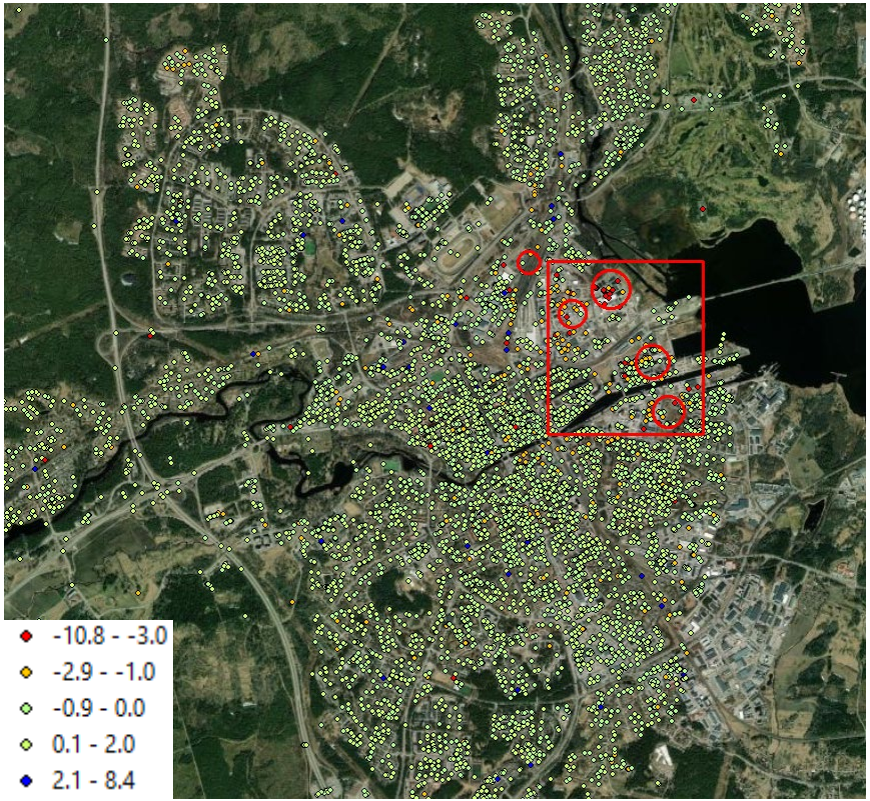


E.W displacement rate

New results: GM_GECORIS results in LOS direction



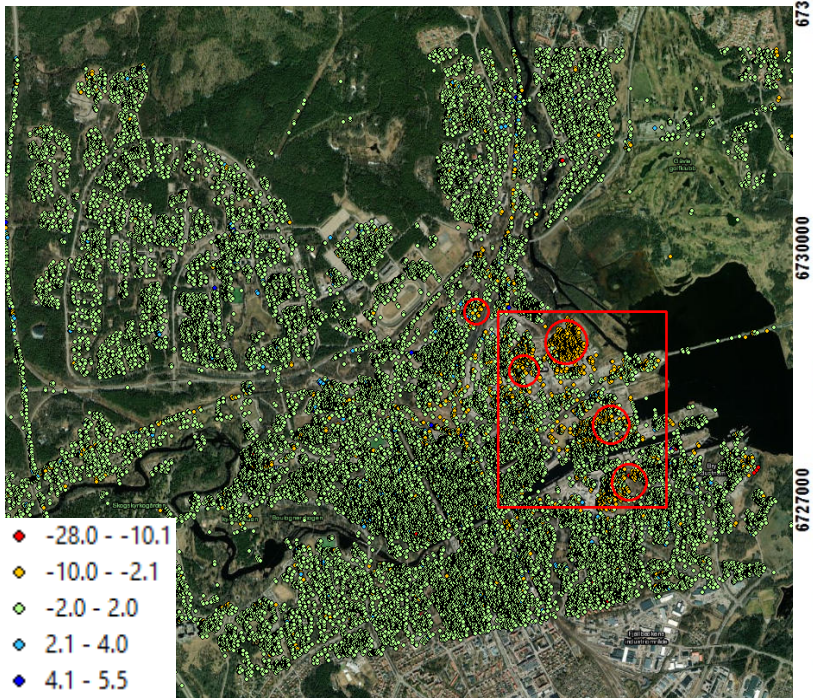
The Ascending geometry

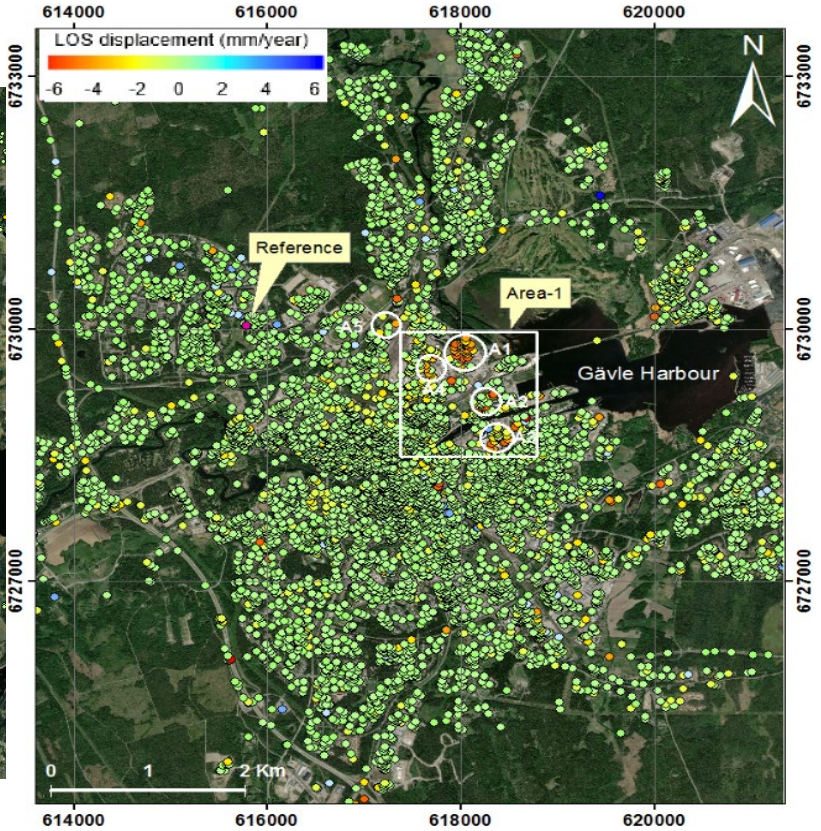


The Descending geometry

EGMS Basic product Vs GM_SARproz (Asc.)

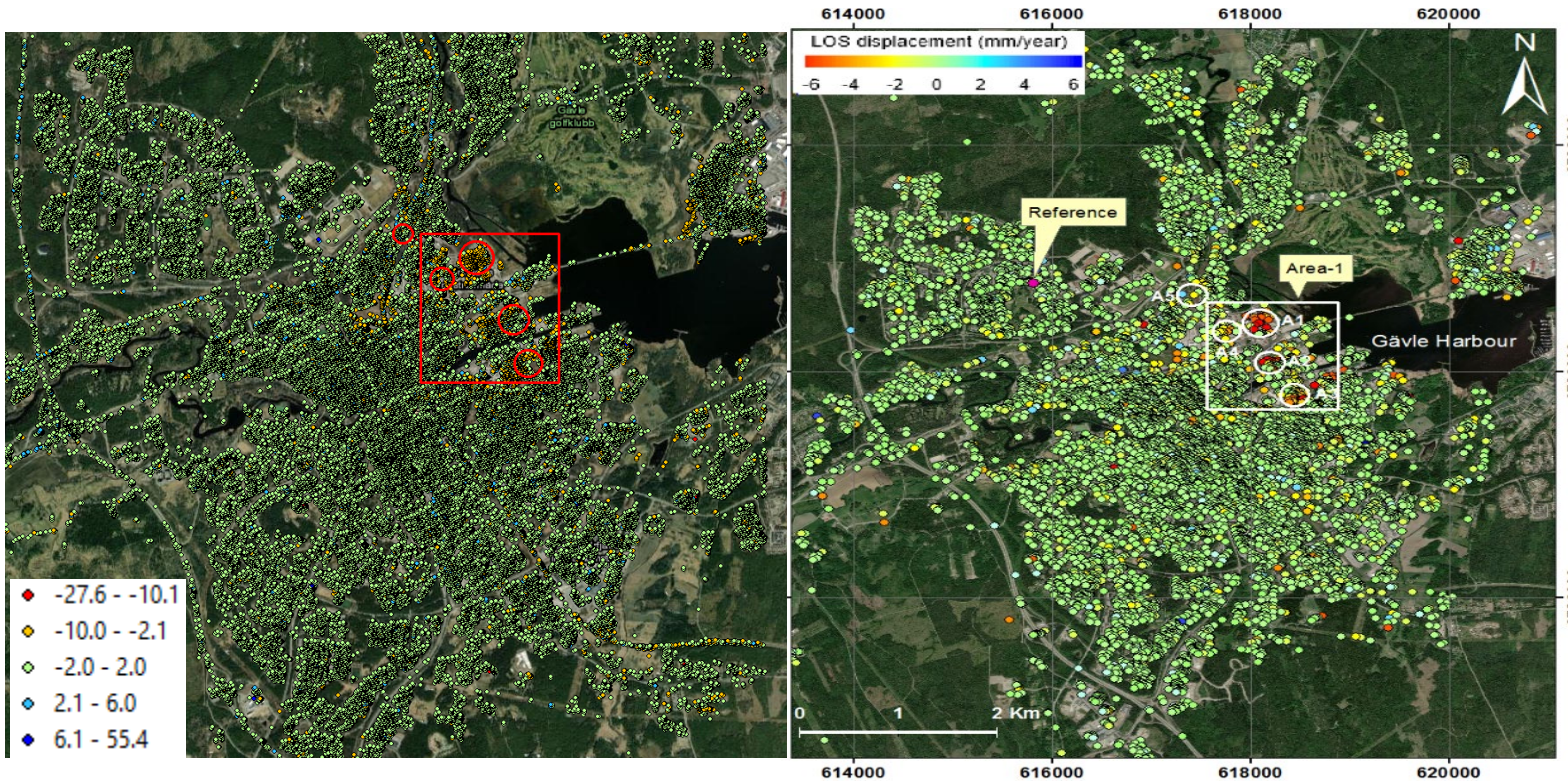
- Basic data download from EGMS Website
- **PS Points** and **Areas** comparison
- Similar tracks Asc_102
- Density diff.
- Scale
- Number of images





GM_SARproz vs the EGMS Basic product (Dsc.)

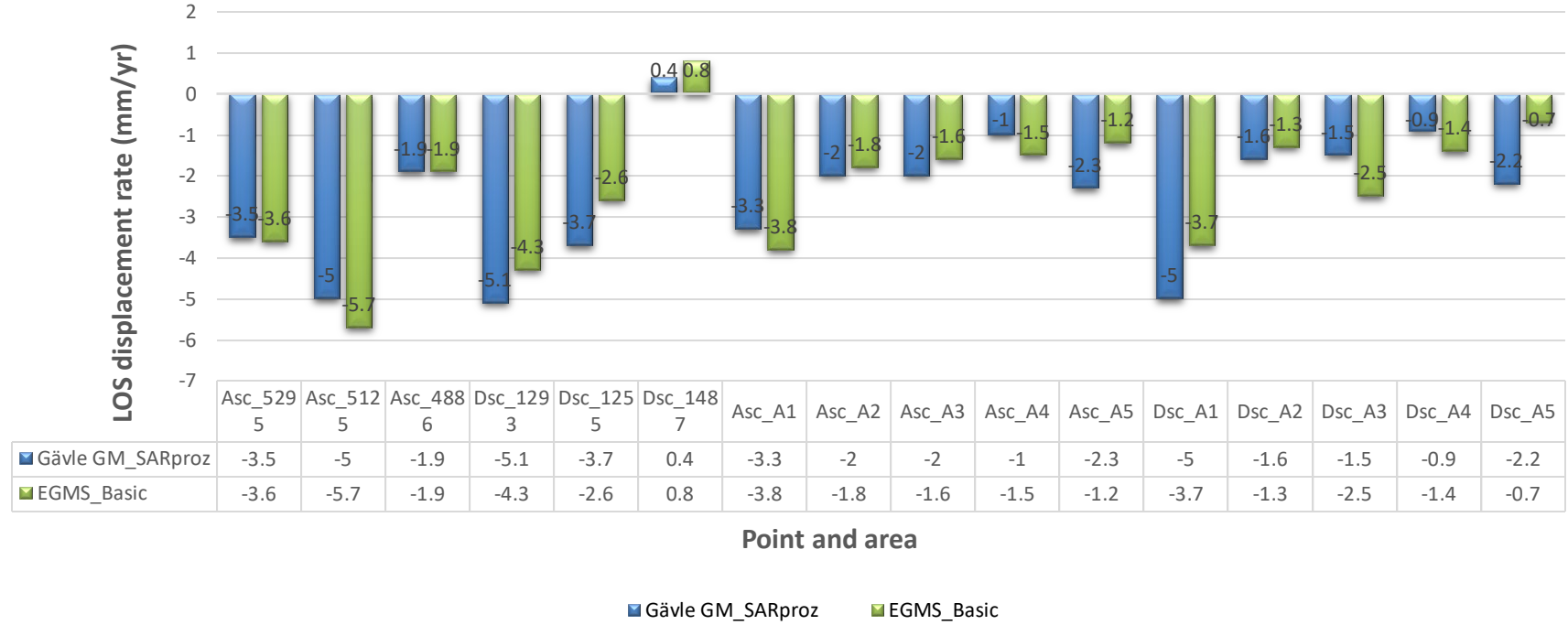
- Data download
- **PS Points** and **Areas** comparison
- Similar tracks Dsc_95
- Density
- Scale
- Number of images



Point and Area velocity comparisons (GM_SARproz vs EGMS_Basic)

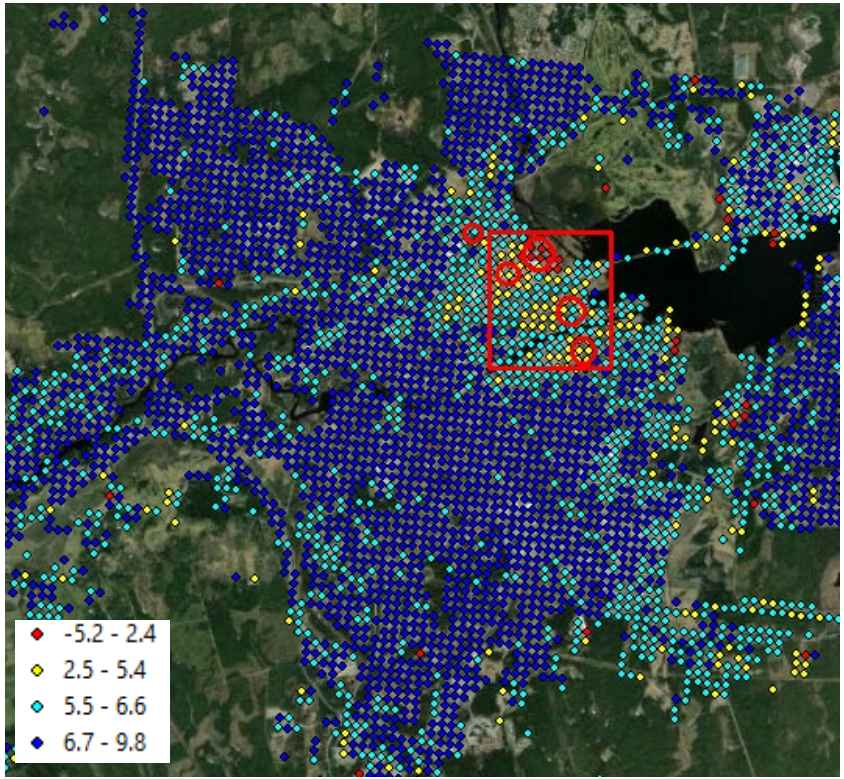
	Gävle GM_SARproz (20150116- 20200519)				EGMS_Basic (20150305- 20211029)			
Track	PS-Point id	LOS rate(mm/yr)	Coher.	Sigma velocity (mm)	PS-Point id	LOS rate(mm/yr)	Coher.	Mean. Vel. Std.
Asc_102	5295	-3.5	0.79	0.44	3S4Ud0eSi9	-3.6	0.88	0.1
Asc_102	5125	-5.0	0.80	0.41	3S4Ud0bRAZ	-5.7	0.66	0.1
Asc_102	4886	-1.9	0.93	0.41	3S4Ud0X2M3	-1.9	0.64	0.2
Dsc_95	1293	-5.1	0.90	0.48	3QAbz3O7cK	-4.3	0.80	0.1
Dsc_95	1255	-3.7	0.93	0.48	3QAbz3MkMk	-2.6	0.80	0.1
Dsc_95	1487	0.4	0.87	0.48	3QAbz3SFPt	0.8	0.74	0.2
	Area id				PS-Points			
Asc_102	A1_23PS	- 3.3	0.81	1.2	279 PS	-3.8	0.72	1.3
Asc_102	A2_16PS	- 2.0	0.75	1.2	230 PS	-1.8	0.71	1.9
Asc_102	A3_10PS	- 2.0	0.75	1.5	230 PS	-1.6	0.72	1.4
Asc_102	A4_1PS	-1.0	0.84	0	87 PS	-1.5	0.71	1.3
Asc_102	A5_2PS	-2.3	0.77	1.2	68 PS	-1.2	0.63	1.7
Dsc_95	A1_7PS	-5.0	0.84	0.7	202 PS	-3.7	0.68	1.6
Dsc_95	A2_22PS	-1.6	0.91	2.1	261 PS	-1.3	0.72	1.9
Dsc_95	A3_18PS	-1.5	0.94	0.9	268 PS	-2.5	0.72	1.5
Dsc_95	A4_5PS	-0.9	0.94	1.0	93 PS	-1.4	0.67	1.2
Dsc_95	A5_1PS	-2.2	0.81	2.0	125 PS	-0.7	0.63	1.6

Differences between GM_SARproz and EGMS_Basic

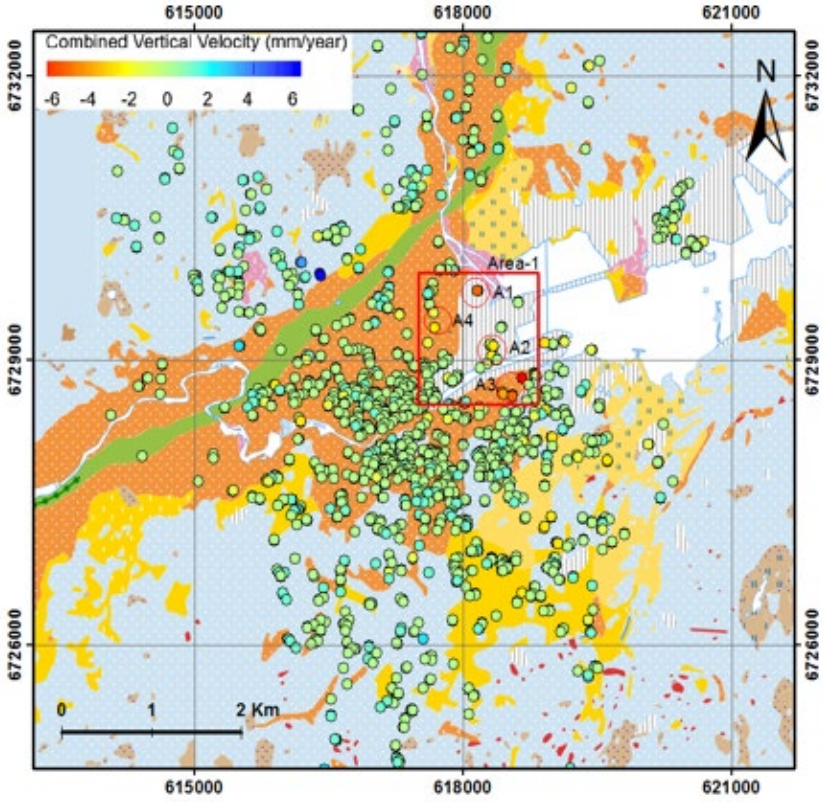


	Asc_5295	Asc_5125	Asc_4886	Dsc_1293	Dsc_1255	Dsc_1487	Asc_A1	Asc_A2	Asc_A3	Asc_A4	Asc_A5	Dsc_A1	Dsc_A2	Dsc_A3	Dsc_A4	Dsc_A5
Gävle GM_SARproz	-3.5	-5	-1.9	-5.1	-3.7	0.4	-3.3	-2	-2	-1	-2.3	-5	-1.6	-1.5	-0.9	-2.2
EGMS_Basic	-3.6	-5.7	-1.9	-4.3	-2.6	0.8	-3.8	-1.8	-1.6	-1.5	-1.2	-3.7	-1.3	-2.5	-1.4	-0.7

Vertical velocity comparisons (GM_SARproz vs the EGMS_Ortho)

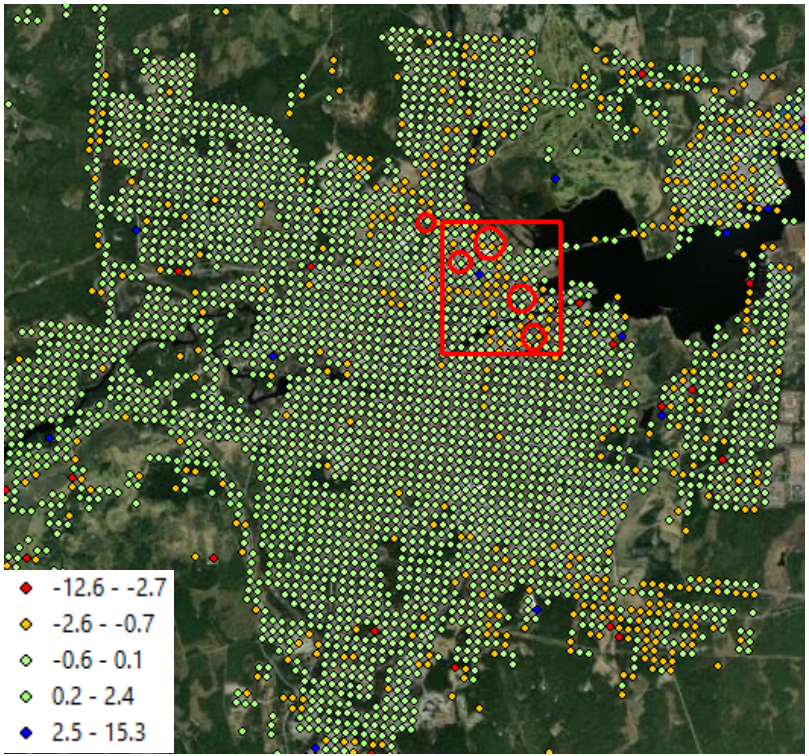


EGMS vertical product, including GIA signal

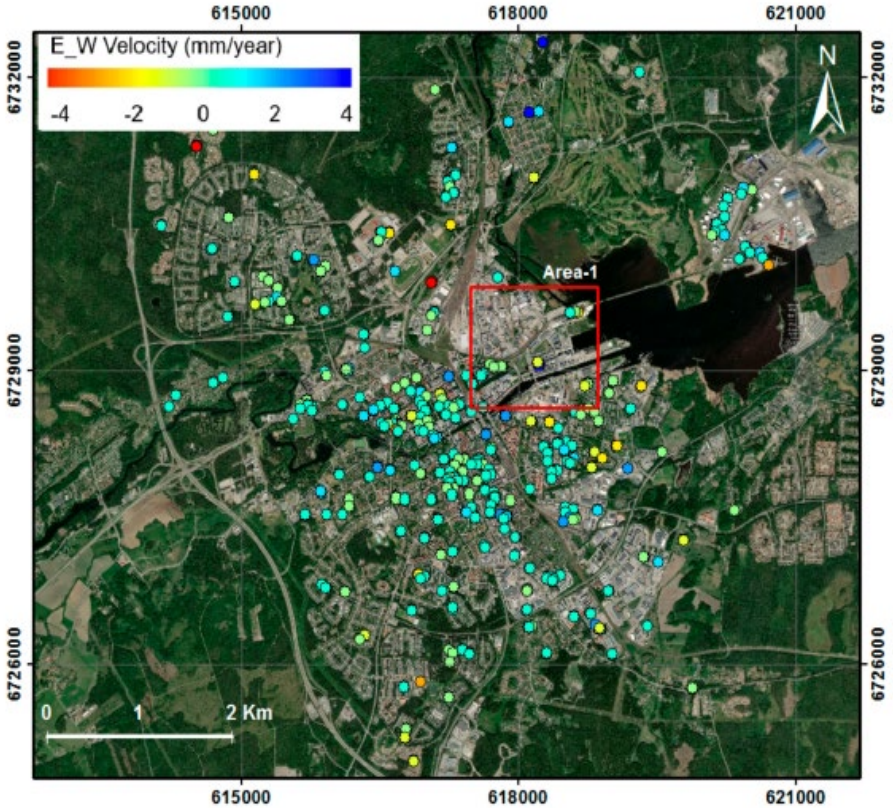


Gävle GM_SARproz vertical product

E-W velocity comparisons (GM_SARproz vs the EGMS_Ortho)



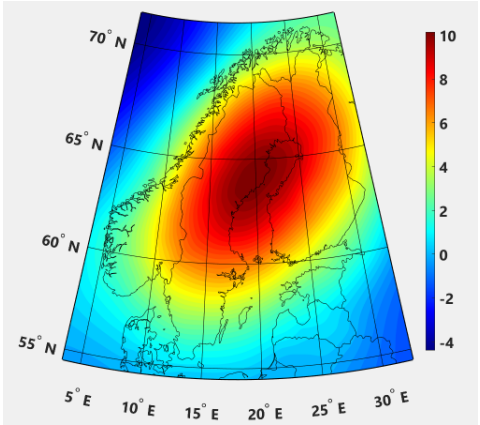
EGMS E-W product, including GIA signal



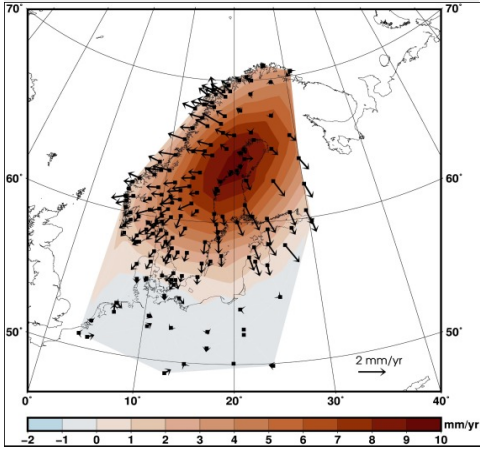
Gävle E-W GM_SARproz

Vertical and E-W velocity comparison results

NKG2016LU



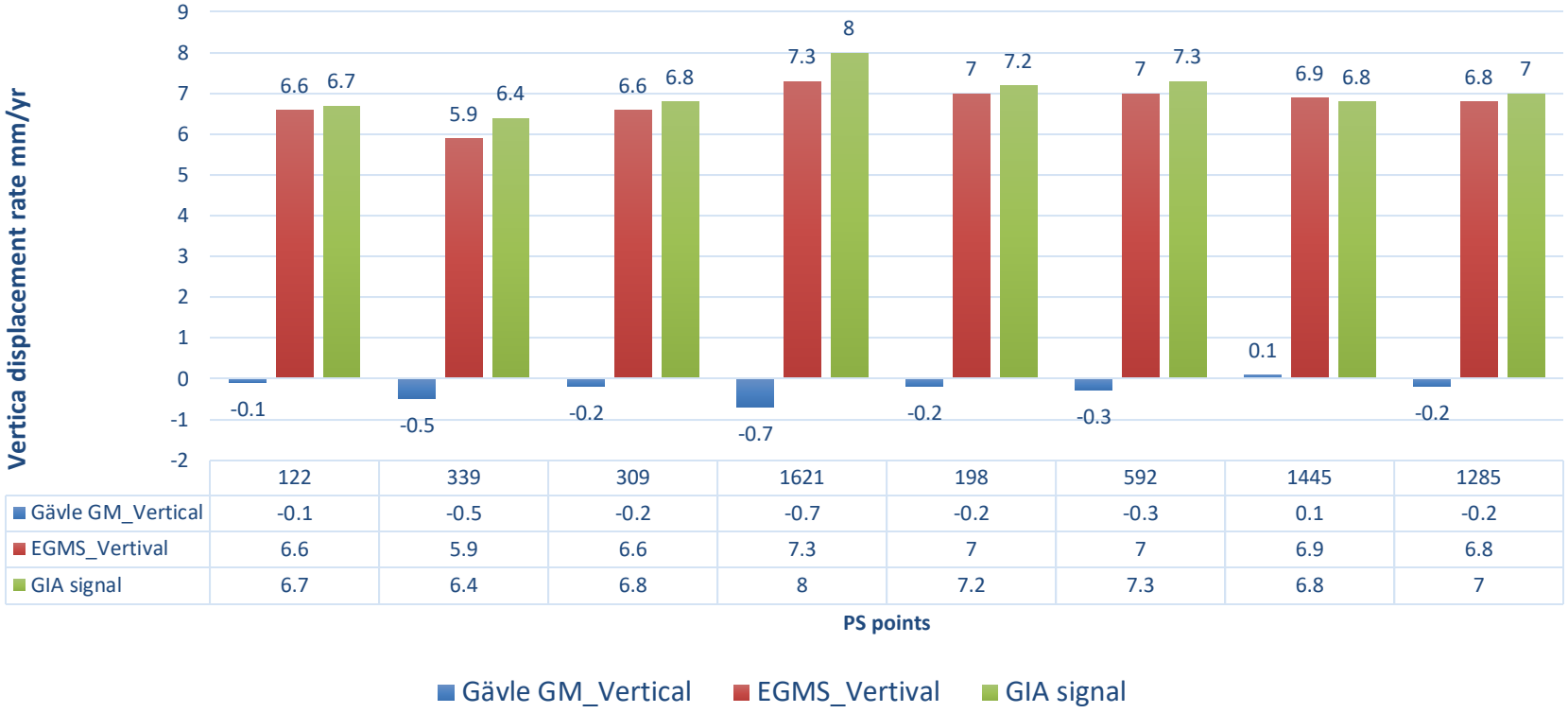
NKG_RF17vel



- **GIA uplift rate** in Gävle (lat: 60.673 ,long: 17.147) derived from NKG2016 LU = **7.7 mm/yr**

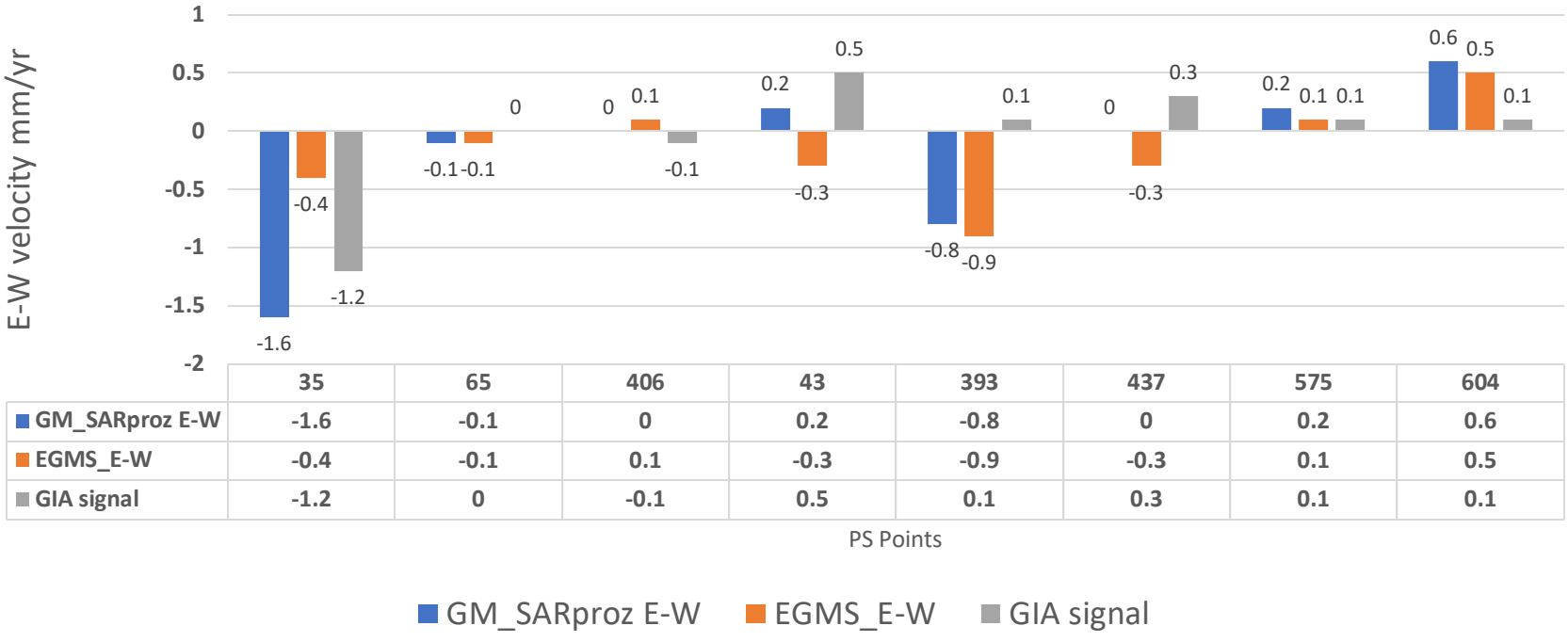
Gävle GM_SARproz (Vertical and E-W)			EGMS ortho products (Vertical and E-W)		
ID	Vel. Direction	Vel. (mm/yr)	ID	Vel. (mm/yr)	Vel. Diff. mm/yr
122	vertical	-0.1	30pAtQGkPE	6.6	6.7
339	vertical	-0.5	30p9pmxJgM	5.9	6.4
309	vertical	-0.2	30p9uTcYsO	6.6	6.8
1621	vertical	-0.7	30p94uIrjW	7.3	8
198	vertical	-0.2	30pAVywWQa	7.0	7.2
592	vertical	-0.3	30p9IyIbJt	7.0	7.3
1445	vertical	0.1	30p9SLd5i5	6.9	6.8
1285	vertical	-0.2	30p9pmxJgE	6.8	7
35	E-W	-1.6	30pBZcFx9M	-0.4	-1.2
65	E-W	-0.1	30pAafblcZ	-0.1	0
406	E-W	0.0	30pA8XcISK	0.1	-0.1
43	E-W	0.2	30pAtQGkPE	-0.3	0.5
393	E-W	-0.8	30pA8XcISk	-0.9	0.1
437	E-W	0	30p9gPcpIV	-0.3	0.3
575	E-W	0.2	30p90DdcXL	0.1	0.1

Vertical velocity differences (GM_SARproz vs EGMS_Ortho)



	122	339	309	1621	198	592	1445	1285
Gävle GM_Vertical	-0.1	-0.5	-0.2	-0.7	-0.2	-0.3	0.1	-0.2
EGMS_Vertival	6.6	5.9	6.6	7.3	7	7	6.9	6.8
GIA signal	6.7	6.4	6.8	8	7.2	7.3	6.8	7

E-W velocity differences (GM_SARproz vs EGMS_Ortho)

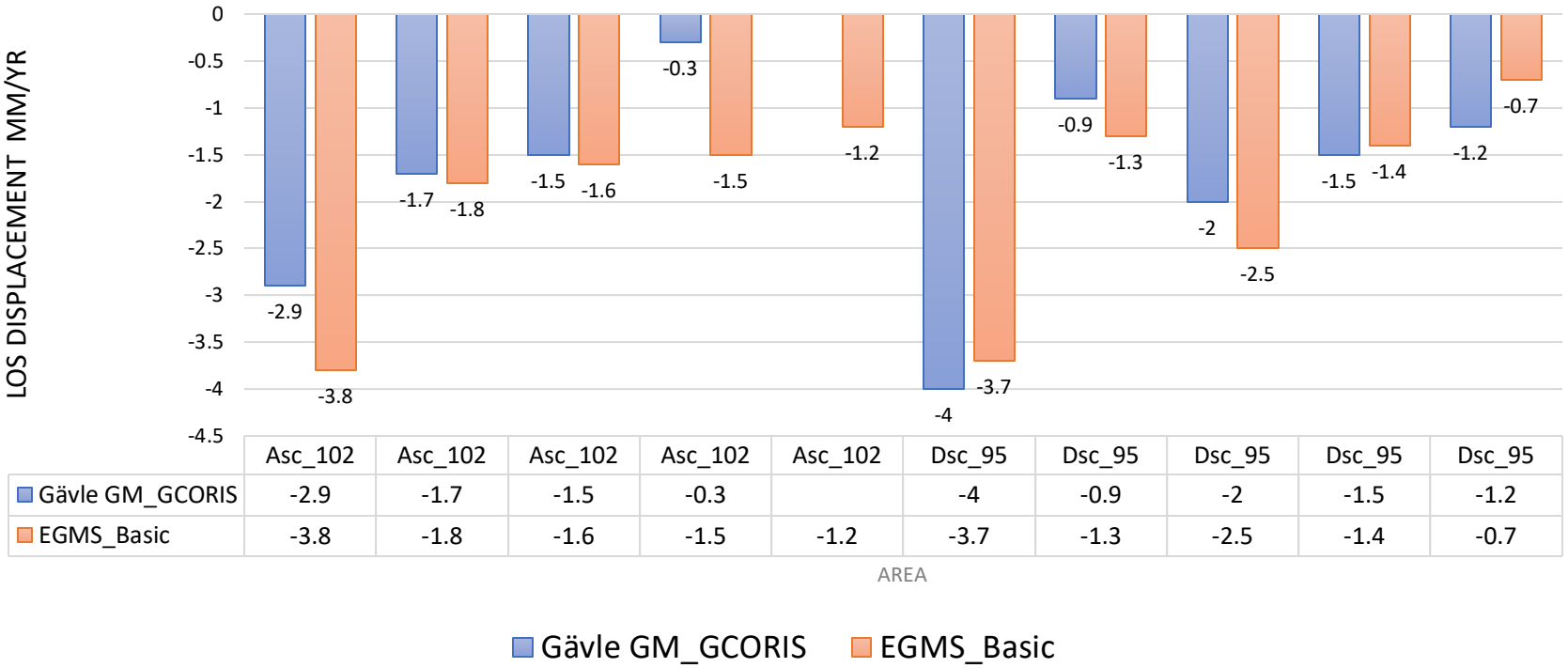


	35	65	406	43	393	437	575	604
GM_SARproz E-W	-1.6	-0.1	0	0.2	-0.8	0	0.2	0.6
EGMS_E-W	-0.4	-0.1	0.1	-0.3	-0.9	-0.3	0.1	0.5
GIA signal	-1.2	0	-0.1	0.5	0.1	0.3	0.1	0.1

Area velocity comparisons (GM_GECORIS vs EGMS_Basic)

	Gävle GM_GECORIS (20150609- 20211029)					EGMS_Basic (20150609- 20211029)			
Track	ID	PS-Points	LOS rate(mm/yr)	Av. Coher.	Sigma velocity (mm)	PS-Points	LOS rate(mm/yr)	Av. Coher.	Mean. Vel. Std.
Asc_102	A1	26	-2.9	0.78	0.9	279	-3.8	0.72	1.3
Asc_102	A2	15	-1.7	0.71	2.0	230	-1.8	0.71	1.9
Asc_102	A3	18	-1.5	0.64	1.4	230	-1.6	0.72	1.4
Asc_102	A4	7	-0.3	0.83	0.6	87	-1.5	0.71	1.3
Asc_102	A5	0				68	-1.2	0.63	1.7
Dsc_95	A1	11	-4.0	0.71	1.0	202	-3.7	0.68	1.6
Dsc_95	A2	29	-0.9	0.77	1.5	261	-1.3	0.72	1.9
Dsc_95	A3	9	-2.0	0.66	1.2	268	-2.5	0.72	1.5
Dsc_95	A4	4	-1.5	0.75	0.8	93	-1.4	0.67	1.2
Dsc_95	A5	6	-1.2	0.70	0.8	125	-0.7	0.63	1.6

LOS Velocity differences between GM_GECORIS and EGMS-basic



	Asc_102	Asc_102	Asc_102	Asc_102	Asc_102	Dsc_95	Dsc_95	Dsc_95	Dsc_95	Dsc_95
Gävle GM_GCORIS	-2.9	-1.7	-1.5	-0.3		-4	-0.9	-2	-1.5	-1.2
EGMS_Basic	-3.8	-1.8	-1.6	-1.5	-1.2	-3.7	-1.3	-2.5	-1.4	-0.7

Conclusions:

- We did cross-validation of EGMS(Basic and Ortho) vs two sets of results: a previous one (using SARproz and Leveling) and a new one (GECORIS)

- The two InSAR studies **generally** agreed well with each other and with EGMS and shows similar deformation localization and the rate of displacements (at ~1 mm/yr agreement) in the selected sample points/areas. Good to mention there are differences in the processing criteria (type of software, processing method, number of images, GIA signal error, etc.).

- As expected, when comparing the EGMS ortho products with our studies, there is an additional signal because of ongoing GIA horizontal and vertical motion.


Thank you for your attention!
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