Corner Reflector Network Graz

3 Years of Observation

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Motivation

Corner reflectors (CRs) are artificial passive reflectors which serve as calibration and reference targets or are used for deformation monitoring applications especially in areas, that suffer a lack of coherent natural radar reflections. For this reason, JOANNEUM RESEARCH and Geosphere Austria have joined forces and established a CR network around the city of Graz, Austria in order to shed more light on two key research questions:

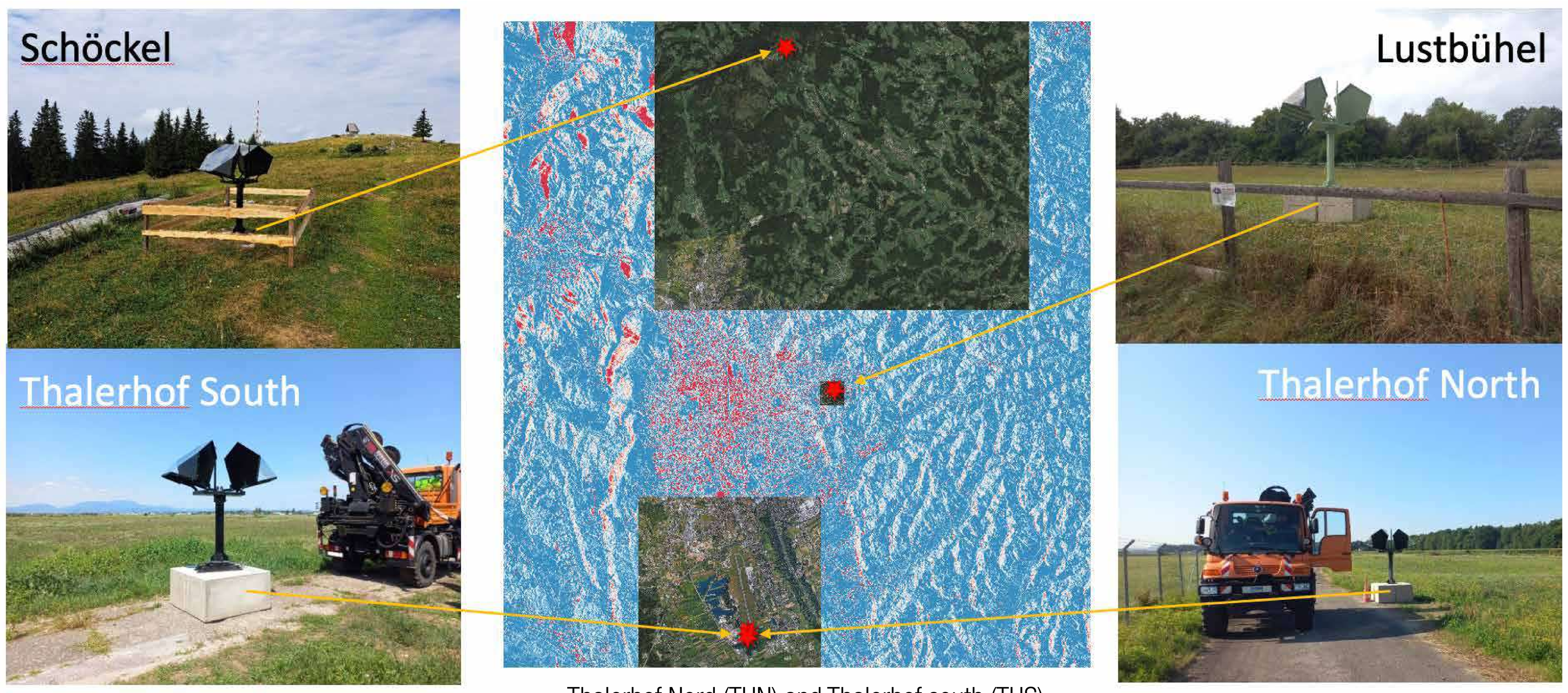
1. What are the effects of atmospheric dynamcis on path delays?
2. And, what are, subsequently, the effects in applications, such as deformation monitoring?

In total, four double headed CRs were installed in the surrounding area of Graz: two CRs at the airport at Graz Thalerhof (THS, THN), one at Graz-Lustbühel (LBL), characterizing the lowermost tropospheric conditions at the flat and hilly areas of Grazer Feld.

The latter CRs are located at the flat and hilly areas of the Grazer Feld, as an additional CR is located at the Graz-Schöckel-plateau (SKL) at 1442 m.a.s.l., more than 1100 m elevated to the Flughafen Graz.

The special features of this network are that (i) LBL is close to the renowned Satellite Laser Ranging Station at the Lustbühel Observatory and (ii) THS was equipped with a fixed shifting device, enabling controlled east/west and up/down movements.

For Sentinel-1 - depending on the imaging geometry - a CR can theoretically be detected in up to three bursts. As the CRs THN, THS and SKL each can be located in one orbit in two consecutive bursts, whereby only the valid range of bursts was counted, there are a total of 15 detections of CRs of the Graz Corner Reflector network. Additionally, all four CRs could be detected and hence monitored in one TerraSAR-X stripmap data stack.



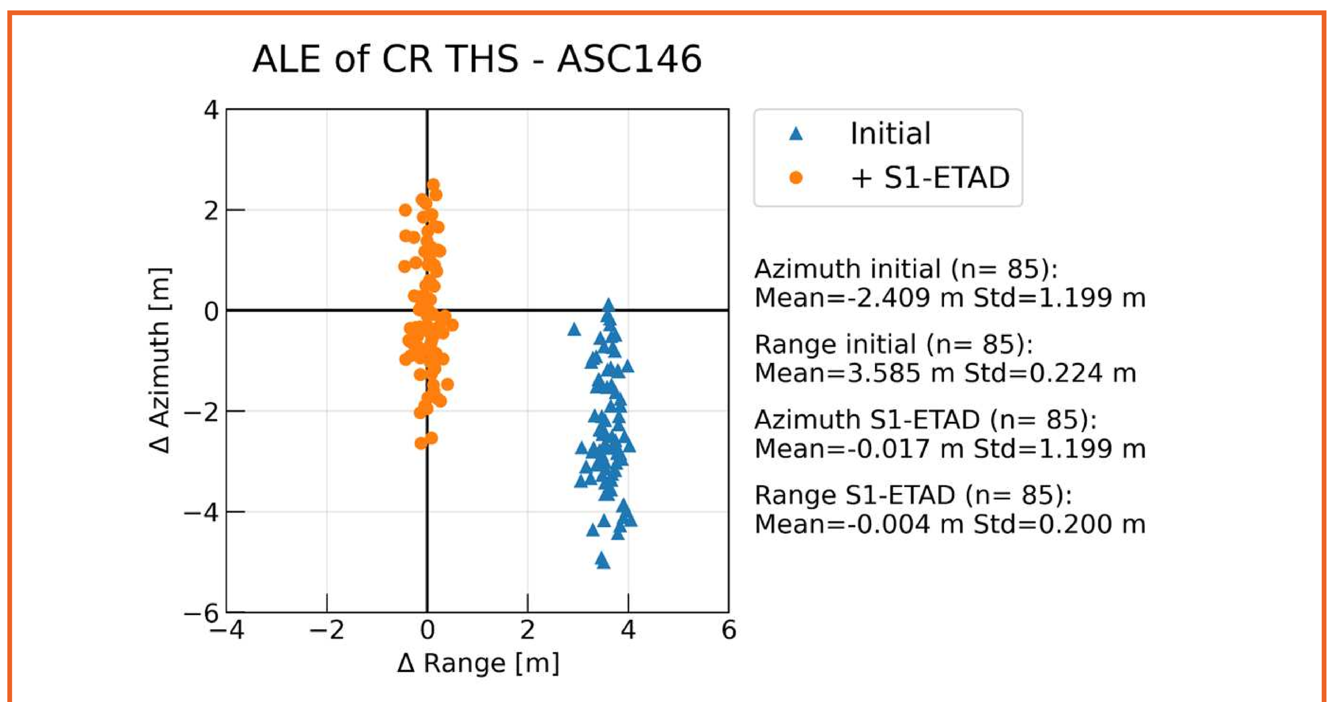
Thalerhof Nord (THN) and Thalerhof south (THS)

Absolute Localisation Error

The absolute localisation errors **(ALE)** for **Sentinel-1** are in a feasible range of **-0.31 to +0.29 m in azimuth and -0.18 to +0.32 m/+0.15 m in range** direction. All these numbers include the corrections as provided by the S1-ETAD product.

However, the measurements of THN in ascending orbit 146 show a higher ALE of about 0.30 m in range direction. To exclude multi-path effects, we conducted a terrestrial laser scanning campaign in measuring the distances to possible other reflectors nearby. Although a paved road and a metallic fence is close to THN, a multipath effect cannot be fully explained, due to their distance to the respective CRs.

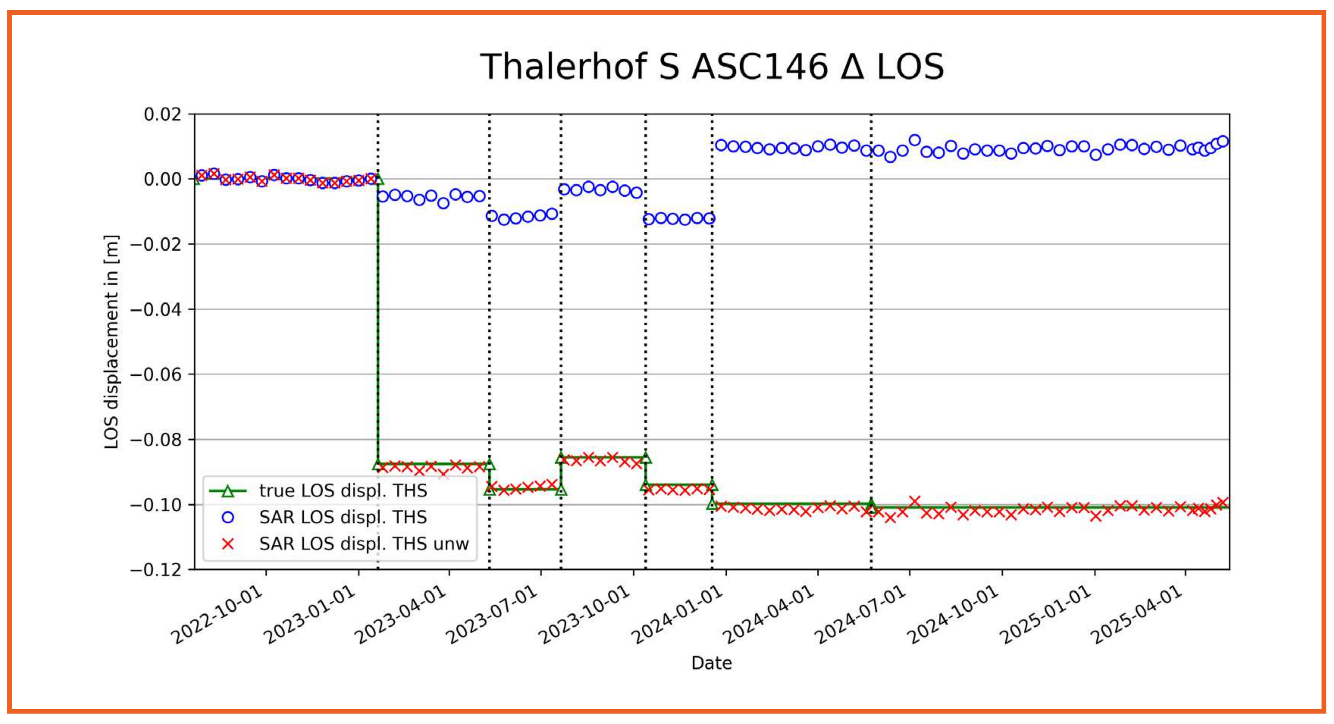
The **ALEs** for the **TerraSAR-X** data stack – although ascending orbit direction too - do not show any deviating behaviour of THN. The ALE **in azimuth direction** is in the range from **-0.01 to 0.02 m** and, after replacing the standard atmospheric range correction with corrections based on ERA-5 or the AROME NWP model, the ALE **in range direction** is in the range from **0.04 to 0.10 m.**



Deformation Monitoring

To the best of our knowledge, the shifting device, as developed for THS, is unique and allows a simple, user defined controlled shift of the whole CR in east/west and up/down direction. We simulated several "movements" of the CR, most of which were independently measured by terrestrial laser scanning.

To evaluate the accuracy of observable surface displacements using differential SAR interferometry (d-InSAR), we calculated the differences in line-of-sight (LOS) displacements between the stable corner reflector THN and the "moving" corner reflector THS. The observed d-InSAR LOS displacement differences (∆LOS THN-THS) were compared with terrestrial measurements of differences in East, North, and Height directions, projected onto the incidence angles of the respective Sentinel-1 orbits. The analysis of around 90 **d-InSAR** measurements revealed a mean **difference** of **0.75 mm ± 1.07 mm for ascending orbit 146, –0.46 mm ± 1.31 mm for descending orbit 22, and 0.06 mm ± 1.96 for descending orbit 124**.



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