



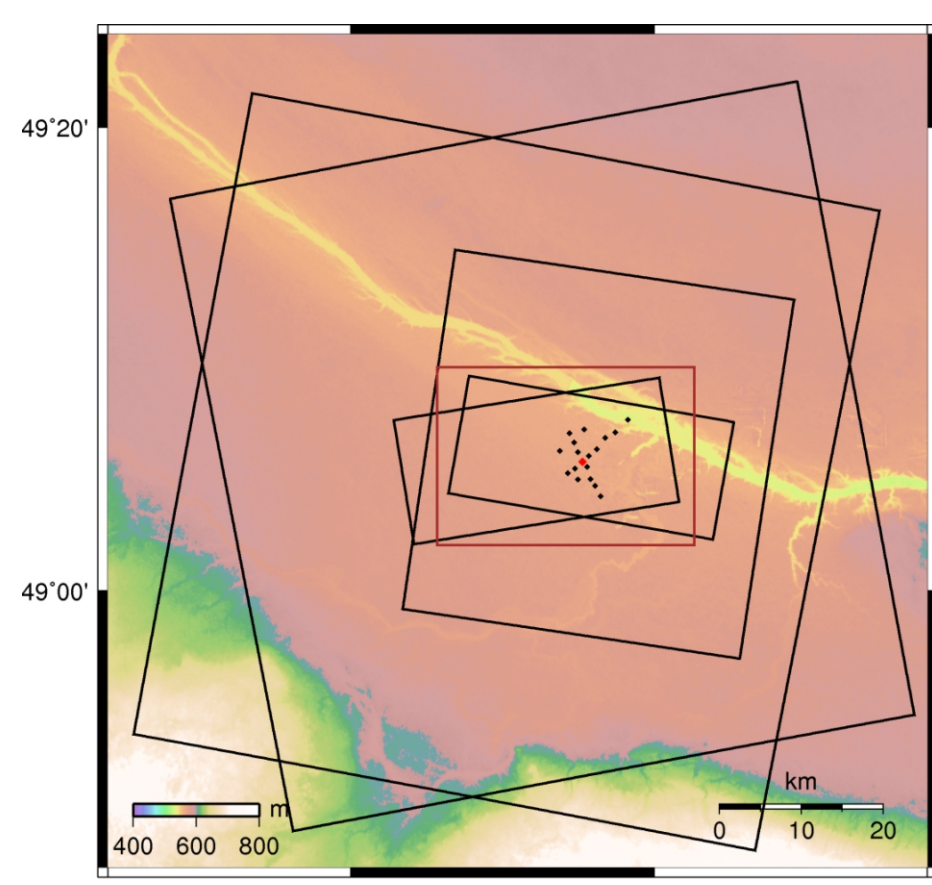
ABSTRACT

The objectives of the Aquistore CO₂ storage project are to design, adapt, and test non-seismic monitoring methods that have not been systematically utilized to date for monitoring CO₂ storage, and to integrate the data from these various monitoring tools to obtain quantitative estimates of the change in subsurface fluid distributions, pressure changes and associated surface deformation. Since spring of 2012 RADARSAT-2 data from five beams (ascending and descending Spotlight, Wide UltraFine and Fine Quad-Pol) were regularly (with the individual frequency of 24 days) collected and used for calculation of ground deformation time series over the Aquistore CO₂ storage site located in SE Saskatchewan. The initial InSAR analysis (Samsonov et al., 2012) revealed slow ground deformation not related to CO₂ injection but caused by various natural and anthropogenic processes - snow melt, surface moisture variation, ground and surface water level changes and post-mining activities. In this work we provide updated results based on over one hundred RADARSAT-2 images acquired during May 2012–May 2013.

Location Map, SE Saskatchewan



DEM of the region and outline of RADARSAT-2 frames



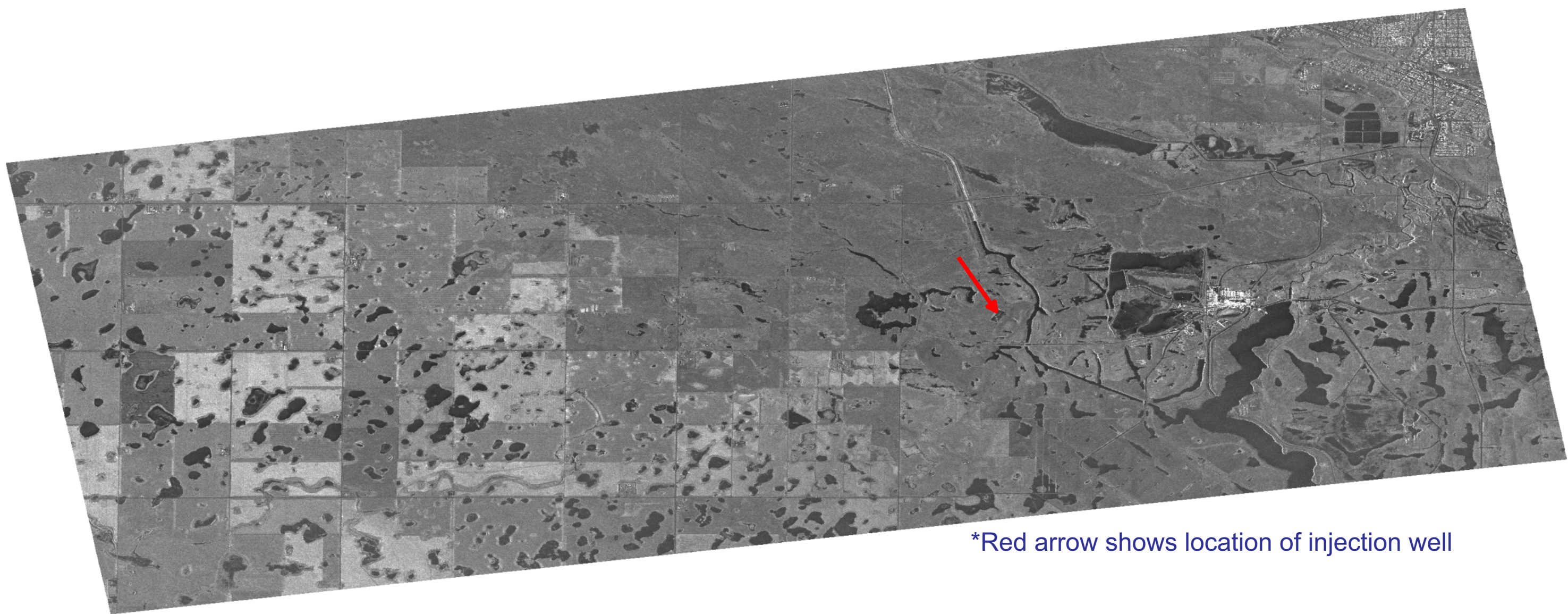
Injection-well 4B5-06-02-08W2M extending to the Winnipeg and Deadwood Formations at ~3350 m depth



TABLE 1. SAR DATA SETS USED IN THIS STUDY: TIME SPAN (IN YYYYMMDD FORMAT), RANGE-AZIMUTH RESOLUTION, RANGE-AZIMUTH COVERAGE, AZIMUTH θ AND INCIDENCE ϕ ANGLES, AND NUMBER OF AVAILABLE SAR IMAGES N FOR EACH DATA SET.

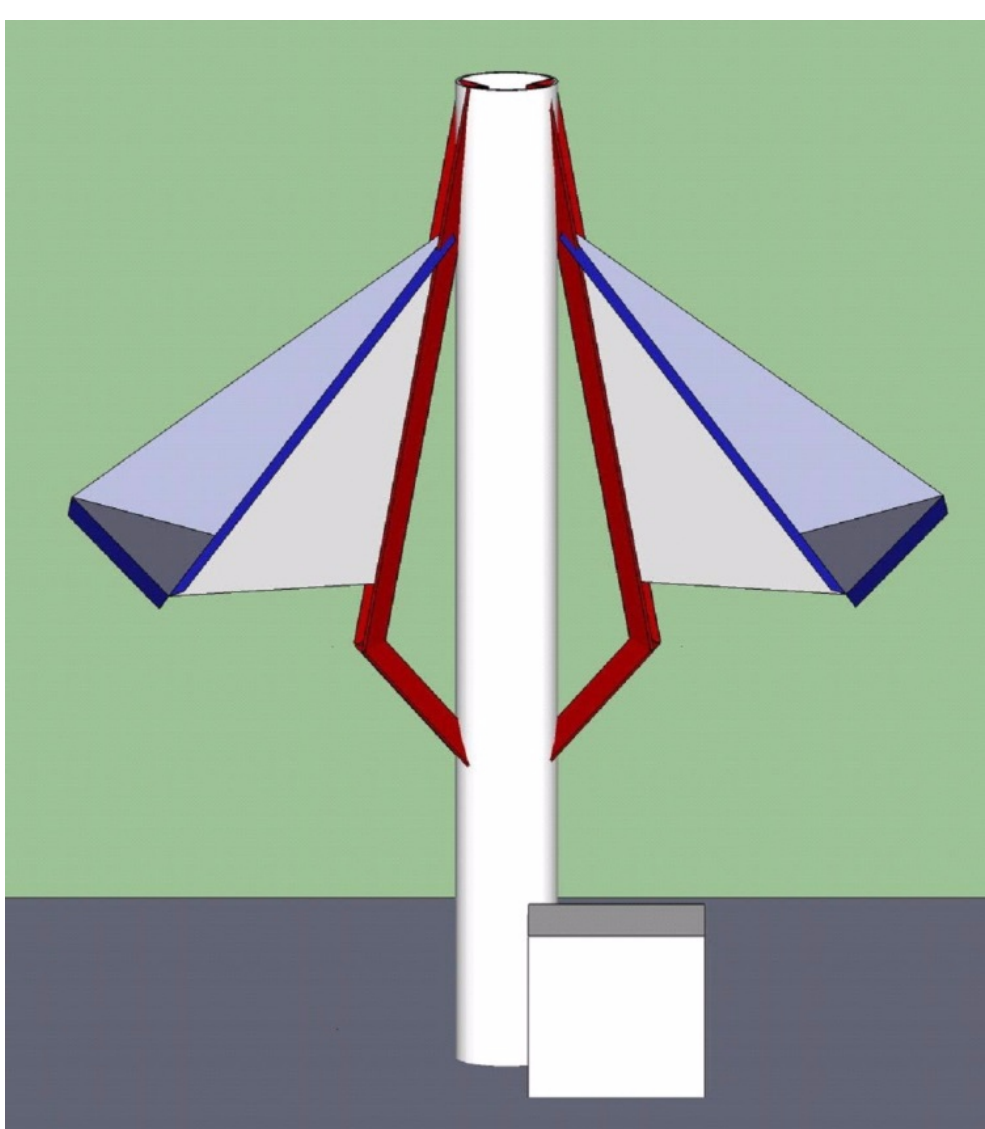
InSAR set	Time span	Res., m	Cov., km	θ°	ϕ°	N
U7W2 asc	20120619-20130521	1.6-2.8	50-50	349	35	11
U7W2 dsc	20120615-20130423	1.6-2.8	50-50	-170	35	11
SLA18 asc	20120605-20130531	1.6-0.8	18-8	351	43	14
SLA11 dsc	20120622-20130524	1.6-0.8	18-8	-170	39	14
FQ28 dsc	20120612-20130514	5.2-7.6	25-25	-172	47	14

Radarsat-2 descending Spotlight 18 image acquired on 31 May 2013
Coverage: 18x8 km, Resolution: 1.6x0.8 m



*Red arrow shows location of injection well

Sketch and photo of corner reflector installed at five sites: SITE, NW1, NE1, SW1, SE1.



Corner reflector was designed by Kevin Murnaghan, CCMEO/NRCAN



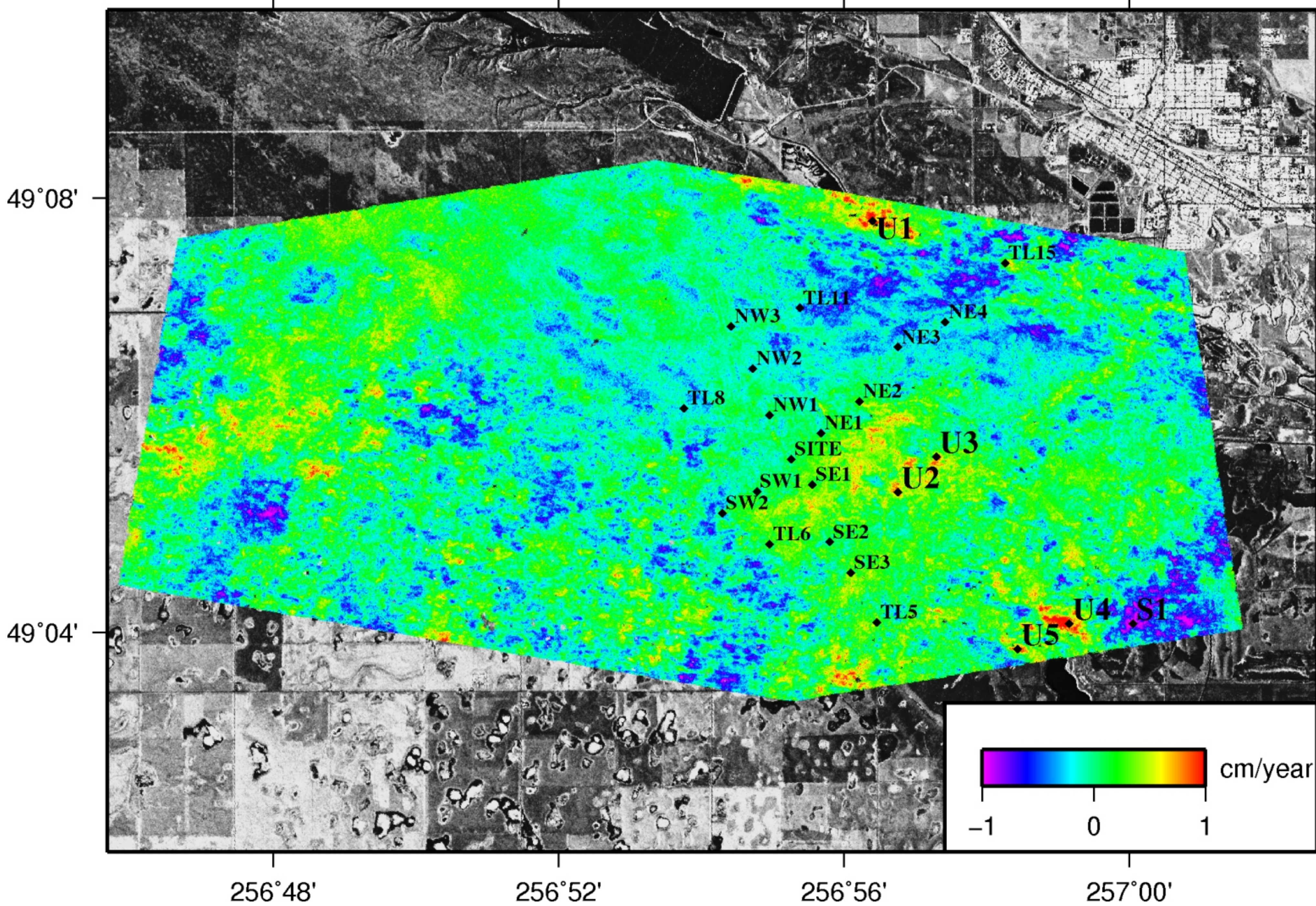
SUMMARY

- By 2014 injection rates at the Aquistore CO₂ injection site should reach ~0.5 M tonnes per annum.
- CO₂ injection will cause redistribution of stress at the injection depth ~3350 m that may manifest as a measurable uplift at the surface.
- For monitoring temporal and spatial distribution of ground deformation, a variety of instruments will be installed, including 13 continuously operating GPS receivers and 15 tiltmeters.
- SAR data from Radarsat-2 satellite acquired approximately once a week is used for InSAR analysis. Five corner reflectors were installed to provide high-precision measurements.
- Vertical deformation rate map with corresponding time series presented here demonstrate background processes. These signals need to be properly understood and, if possible, corrected to increase the measuring precision necessary to detect the slow deformation that may be produced by CO₂ injection.

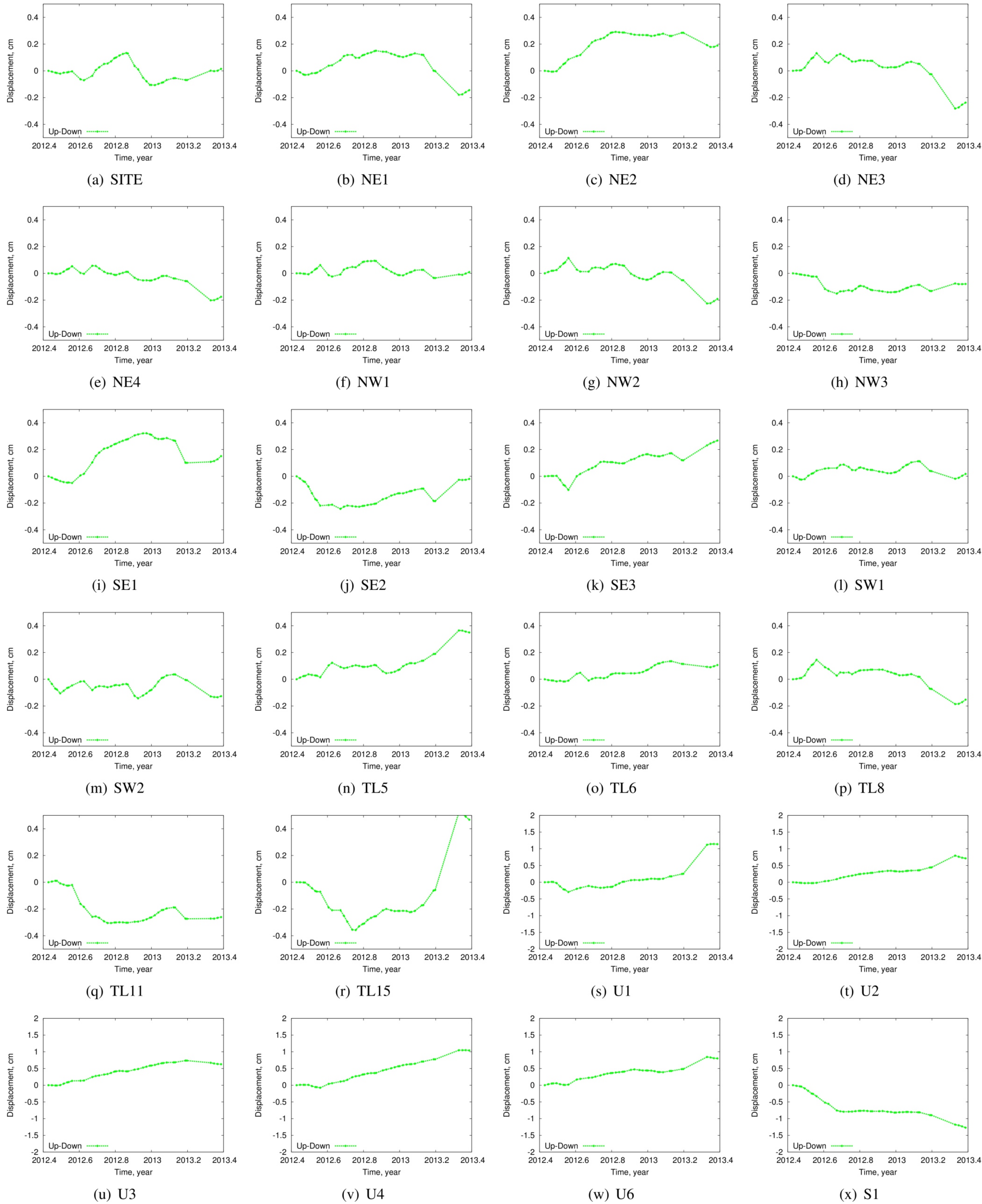
REFERENCES

- Samsonov, S. and d'Oreye, N., 2012. Multidimensional time series analysis of ground deformation from multiple InSAR data sets applied to Virunga Volcanic Province; *Geophysical Journal International*, 191 (3), 1095-1108. doi:10.1111/j.1365-246X.2012.05669.x
- Samsonov, S., White, D., Craymer, M., Murnaghan, K., and Chalaturnyk, R., 2012. Monitoring Ground Deformation at the Aquistore CO₂ Storage Site in SE Saskatchewan, Canada, AGU Fall Meeting, San Francisco, California, U.S.A.

Vertical linear deformation rate map calculated from InSAR data using the MSBAS methodology (Samsonov and d'Oreye, 2012) during May 2012–May 2013



Time series of ground deformation at selected sites. Measurement noise is ~0.5 cm/year. Uplift at UP1-UP5 and subsidence at S1 are clearly above the noise level.



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