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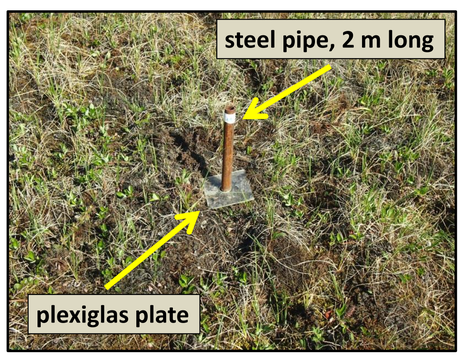
Permafrost thaw subsidence of Siberian yedoma: field measurements and TerraSAR-X interferometry

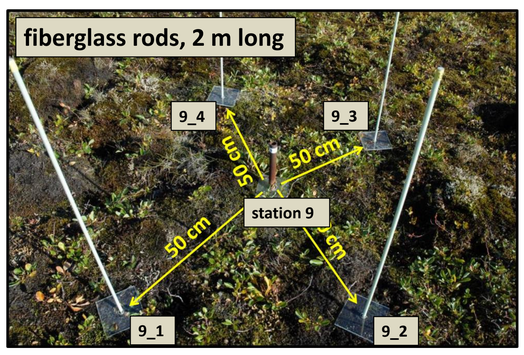
Introduction

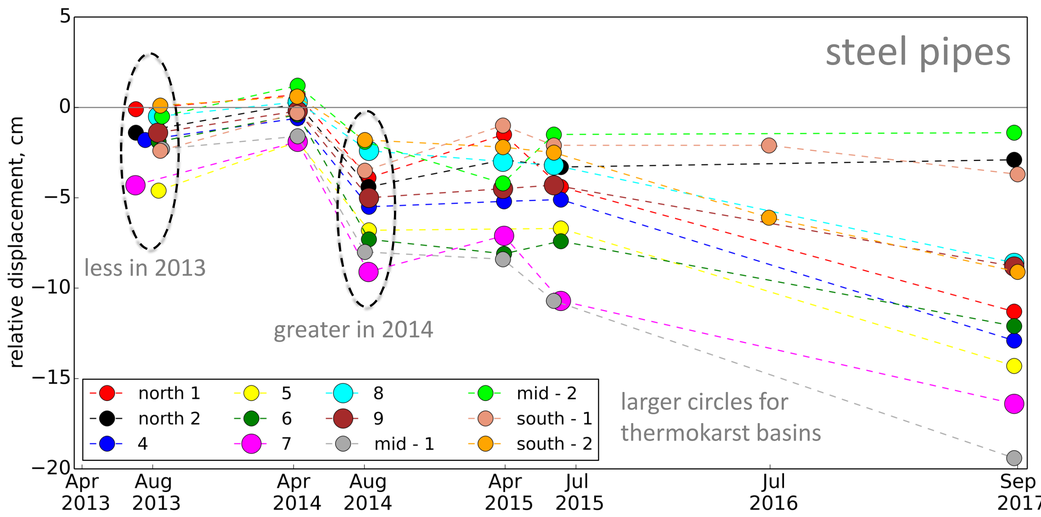
The seasonal freezing and thawing of the active layer forms excess ice during the winter, which melts during the summer, resulting in seasonal vertical movements of the ground. Additionally, relatively uniform thawing of the ice-rich layer at the permafrost table contributes to irreversible lowering of the surface, which has been reported for a number of Arctic locations (Günther et al., 2015; Streletskiy et al., 2016).

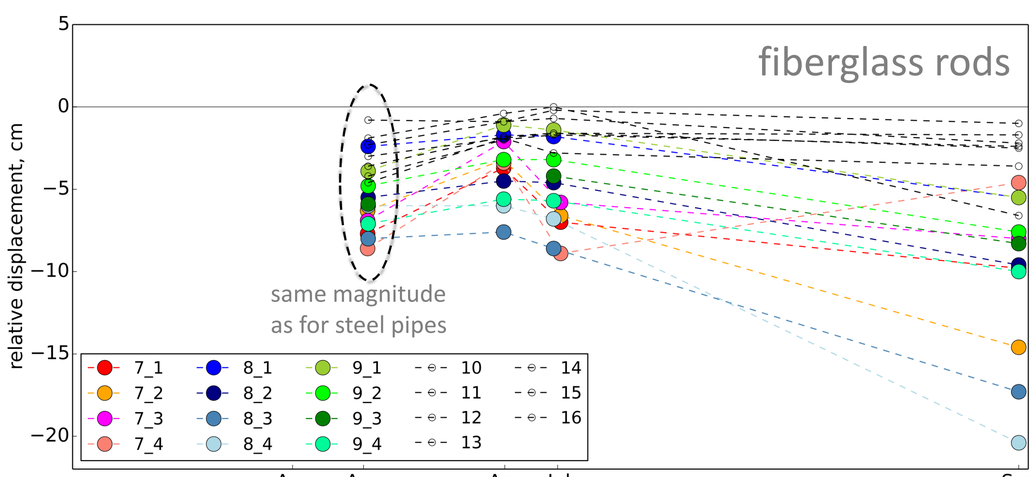
We report here the field measurements from a yedoma site in the Siberian Lena River Delta made in the period from 2013 to 2017. We also show the results of differential interferometry (DInSAR), performed on the TerraSAR-X (TSX) data for the summer season in 2013.

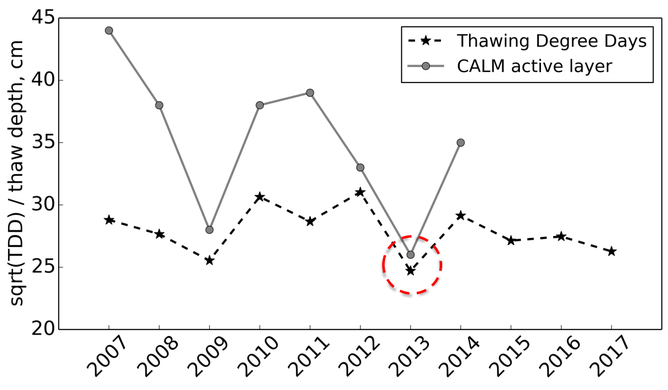
Field measurements











summer 2013 was considerably colder compared to summer 2014, which can explain lower subsidence in 2013 compared to 2014

DInSAR

TSX:

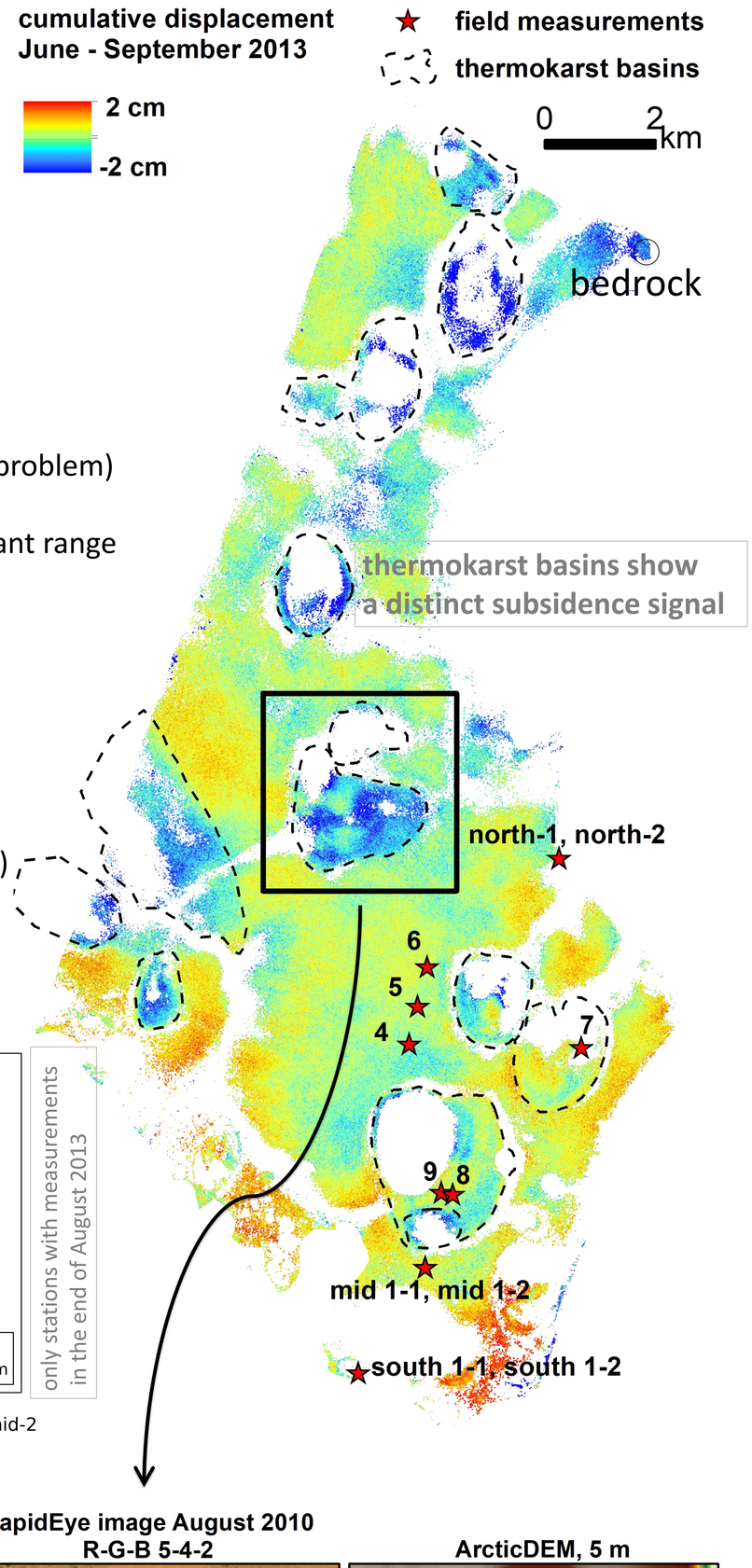
- wavelength 3 cm

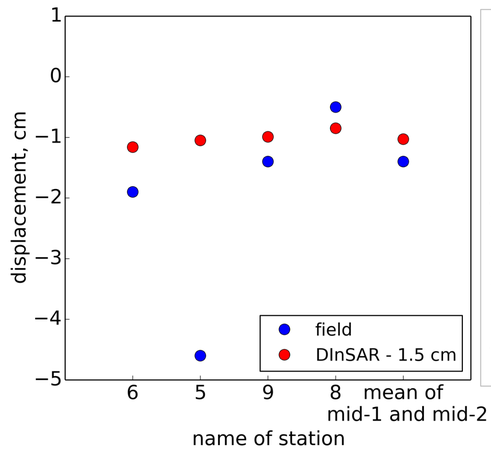
(loss of coherence is the main problem)

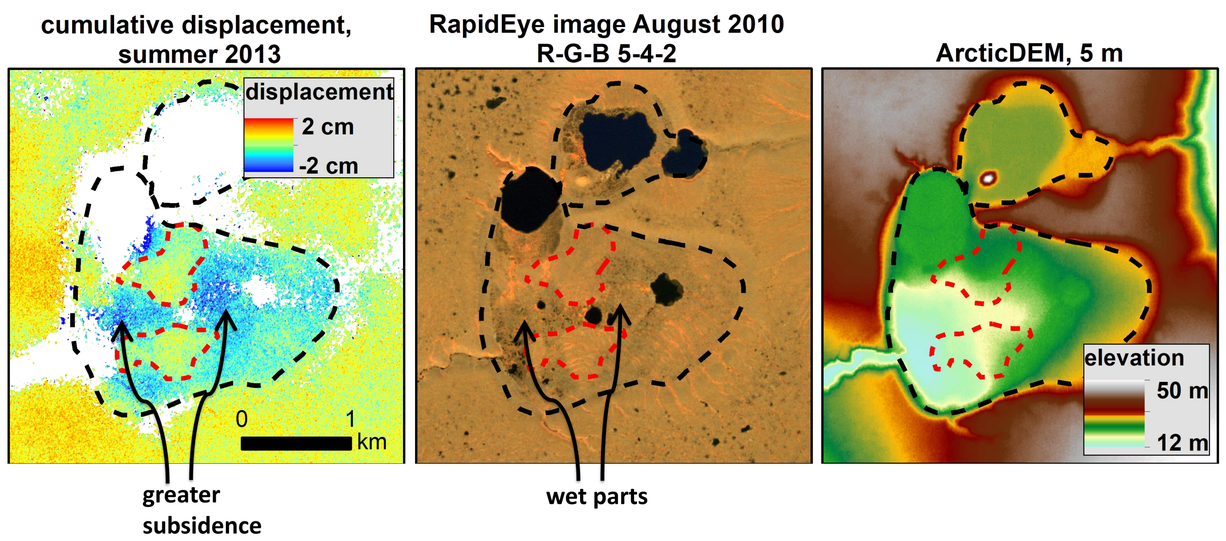
- repeat cycle 11 days
- pixel size 0.9 m x 2.4 m in slant range

DInSAR steps:

- only 11-day interferograms
- multilooking 4x3
- topographic phase removal with ArcticDEM (res. 5x5 m)
- adaptive filtering
- phase unwrapping (reference point on bedrock)
- stacking to reduce atmospheric effects
- removing linear phase ramp







Conclusions

- pronounced seasonal and multi-year net subsidence from the field data, seasonal uplift is also detected;
- high spatial variability on sub-meter scale;
- multi-year variability is related to the climatic differences;
- DInSAR subsidence map generally showed a slight uplift, which might be related to the choice of reference point, i.e. can probably be corrected with a constant;
- distinct subsidence signal in the thermokarst basins;
- subsidence is greater in the wet parts of the basins.

References
Günther, F., Overduin, P. P., Yakshina, I. A., Opel, T., Baranskaya, A. V., & Grigoriev, M. N. (2015). Observing Muostakh disappear: permafrost thaw subsidence and erosion of a ground-ice-rich island in response to arctic summer warming and sea ice reduction. *The Cryosphere, 9*(1), 151-178, doi:10.5194/tc-9-151-2015
Streletskiy, D.A., Shiklomanov, N.I., Little, J.D., Nelson, F.E., Brown, J., Nyland, K.E. & Klene, A.E. (2016). Thaw subsidence in undisturbed tundra landscapes, Barrow, Alaska, 1962–2015. *Permafrost and Periglacial Processes*, doi: 10.1002/ppp.1918.

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