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Earth Surface Dynamics Discussions

Interactive comment on "Vertical movements of frost mounds in sub-Arctic permafrost regions analyzed using geodetic survey and satellite interferometry" *by* I. Beck et al.

Anonymous Referee #1

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The authors study the vertical heave and subsidence of three lithalsas in Quebec during a period of two years using two geodetic techniques (dGPS, DInSAR). The spatial and temporal patterns of these movements are analysed, as is the suitability of the two observational techniques. The magnitude and temporal dynamics of the vertical movements were found to be related to the state of degradation and the surface cover. I find the presented work (observations & analyses) highly relevant and interesting. I thus think that the manuscript is certainly suitable for publication in EDS, provided several points are clarified.

1. Gist of the manuscript

The manuscript is generally very pleasant to read but it could benefit from a structural revision. In particular the introduction does not make sufficiently clear

- why this work is interesting/relevant

- how it relates to previous studies

- what the open questions, aims and hypotheses are; which ones the authors want to to address

2. Description of dGPS measurements, processing methods and uncertainties

These descriptions are not clear and the reproducibility thus questionable. The impact on the results/interpretation should be discussed more transparently.

If I understand the measurement and processing strategy correctly, the authors used kinematic stop-and-go differential GPS with one fixed base station (Berber et al.). As the coordinates of the location of the latter were not well known, they estimated them by PPP (Bisnath & Gao), and these estimates were then used in the dGPS processing. However, no detailed technical description is given and neither are references to the scientific literature.

Was the position of the base station always the same (if so, how was that point marked)? Which initialization was used to fix the ambiguities? What is the uncertainty (Hofmann-Wellenhof et al.) of the observed elevations at the lithalsas i) in absolute terms, ii) relative to the base station, iii) relative to each other? Which numbers are reported by the software? How do errors in the coordinates of the base station affect these three uncertainties?

M. Berber, A. Ustun & M. Yetkin. Comparison of accuracy of GPS techniques. Measurement 45 (2012) 1742–1746. dx.doi.org/10.1016/j.measurement.2012.04.010

B. Hofmann-Wellenhof, H. Lichtenegger & E. Wasle. GNSS – Global Navigation Satellite Systems. Springer (2008).

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S. Bisnath & Y. Gao. Current State of Precise Point Positioning and Future Prospects and Limitations. International Association of Geodesy Symposia Volume 133, 2009, pp 615-623

3. DInSAR analyses

Also here several aspects of the processing and the observations could be made clearer:

Was the phase unwrapping successful? If so, were there obvious errors? Fig. 6 only shows the wrapped phase.

How were the coherences and phases estimated (window size, number of looks; spectral filtering)? A figure displaying these coherences would be useful.

The window size (and also the height of ambiguity, not given in Tab. 1, only the basline) might be important for interpreting the coherences: It is claimed (p 265, lines 9-16) that the size of the movement compared to the wavelength leads to decorrelation, whereas I would expect the variation of movements within the window to be the determining factor [cf. glaciology: ice movements can be hundreds of metres but strain*window size is smaller than the wavelength, potentially keeping the coherence high]. Similarly, I do not quite follow the inference that the vegetation (owing to its sparseness) does not play a major role here. Relevant non-dimensional quantities are (Zebker & Villasenor): the height compared to the height of ambiguity; the size of the movements (of leaves, say) compared to the wavelength. Changes in the dielectric properties (soil and vegetation moisture) might also influence both the coherence and the phase:

Barrett, B., Whelan, P., and Dwyer, E. (2012) 'The use of C- and L-band repeat-pass interferometric SAR coherence for soil moisture change detection in vegetated areas'. The Open Remote Sensing Journal, 5 (1):37-53

Zebker, H.A., and J. Villasenor, Decorrelation in interferometric radar echoes, IEEE Trans. Geo. Rem. Sensing, Vol 30, no. 5, pp 950-959, September, 1992.

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Interactive Comment

S. Zwieback, S. Hensley, I. Hajnsek. Assessment of soil moisture effects on L-band radar interferometry. Remote Sens. Environ., 164, 77-89, 2015.

Minor points:

p 253 l15-16: The morpohology of lithalsas and palsas are ...

p 254 l9, l10 and several additional points in the manuscript: use of dGPS with definite or indefinite articles seems a bit odd

p 257 l1: The first sentence refers to phase observations, the second one to ones using only the codes. Please clarify

p 259, l12: (see details below) where?

p 267, l4: though: usually put at the end of a phrase

Interactive comment on Earth Surf. Dynam. Discuss., 3, 251, 2015.