



EGUsphere, author comment AC3
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Comment on egusphere-2022-761

Mathieu Le Breton et al.

Author comment on "Monitoring snow water equivalent using the phase of RFID signals"
by Mathieu Le Breton et al., EGU sphere,
<https://doi.org/10.5194/egusphere-2022-761-AC3>, 2023

Dear Christian Matzer,

First, thank you for your comments. We have just received the second referee's comment so I am answering both. We have processed your (see the answer in the attached document), they will help to improve the manuscript.

Regarding the multipathing, however, we propose an alternative approach.

We agree that there is a need to better understand the multipathing effect on RFID systems in snow contexts. However, this is far beyond the scope of the present study: multipathing is a general issue in RFID (very present for localization indoors for example). All the reflective elements should be a source of multipathing: The environment (snow surface, layers of snow, soil), and the installation itself (tags, light plastic supporting structure that holds the tag, large metallic structure that holds the reader). Any modification of geometry (snow depth) or dielectric constant (i.e., snow density, moisture content of the snow and soil) should modify the influence of multipathing on phase measurements. In practice, multipathing in RFID is more often mitigated than predicted.

It is mitigated in the study by using multiple antennas and tags (=spatial diversity). To further mitigate it in a future installation, we suggest (as you did) to use an array of tags placed very close to the ground (also necessary to reduce the thermal influence of the system). It should help average the spread due to spatial diversity, and reduce the reflection on the tags and on the supporting material.

We have a work in progress that explores more in depth the role of multipathing when using an RFID system in snow context, for which we will dedicate a communication in itself. The document attached presents (still unpublished) results of two experiments and one model: the amplitude of the phase variation induced by multipathing (from 1.4 to 3 rad) is coherent with the spread in our study (1.2 rad).

I also suggest to improve the link of our study, to existing studies related to multipathing in the snow or with RFID systems:

—The model used and preliminary results are also in:

Le Breton, M., 2019. Suivi temporel d'un glissement de terrain à l'aide d'étiquettes RFID passives, couplé à l'observation de pluviométrie et de bruit sismique ambiant (PhD Thesis). Université Grenoble Alpes, ISTERre, Grenoble, France.
<https://www.theses.fr/2019GREAU013> (page 144 to 156).

—Some methods exploit multipathing for snow, such as

Espín-López, P. F., Pasian, M., 2021. Determination of Snow Water Equivalent for Dry Snowpacks Using the Multipath Propagation of Ground-Based Radars. *IEEE Geoscience and Remote Sensing Letters* 18, 276–280. <https://doi.org/10.1109/LGRS.2020.2974546>;

Kulsoom, F., Dell'Acqua, F., Pasian, M., Espín-López, P. F., 2021. Snow Layer Detection by Pattern Matching in a Multipath Radar Interference Scenario. *International Journal of Remote Sensing* 42, 3193–3218. <https://doi.org/10.1080/01431161.2020.1854890>.

—Mitigating multipathing in RFID is a topic in itself. Some studies are dedicated to propose mitigation methods, such as

DiGiampaolo, E., Martinelli, F., 2020. A Multiple Baseline Approach to Face Multipath. *IEEE Journal of Radio Frequency Identification* 4, 314–321.
<https://doi.org/10.1109/JRFID.2020.3022576>

In short, we encountered the multipathing issue and demonstrated a simple way to mitigate it. However, describing in detail the multipathing issue and how to further mitigate it, is a topic in itself which, in our opinion, should not be in the present paper. Instead we suggest to (a) propose a future installation that further reduce the multipathing issue, (b) to detail more about the causes of multipathing in the text, and (c) to link our observations with other studies that deal specifically about multipathing with snow or rfid.

Is this approach suitable to you ?

Best regards,

Please also note the supplement to this comment:

<https://egusphere.copernicus.org/preprints/2022/egusphere-2022-761/egusphere-2022-761-AC3-supplement.pdf>