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Reply on RC2

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Author comment on "The soil heat flux sensor functioning checks, imbalances' origins, and forgotten energies" by Bartosz M. Zawilski, Geosci. Instrum. Method. Data Syst. Discuss., https://doi.org/10.5194/gi-2021-34-AC4, 2022

I am particularly grateful to the second referee designated as “RC2”, for his comments, criticism, and enriching suggestions that helped me to improve this paper.

I would like to answer, point by point, the second referee's RC2 comments.

RC2: “In section 3.2.3 Evapotranspiration, positive imbalances sources, I would recommend the author to include some tought on hydraulic redistribution (i.e., hydraulic lift). This might be a good source of discussion, and some comments might be worthed https://doi.org/10.1016/S0169-5347(98)01328-7”

The hydraulic lift is effectively an interesting mechanism of groundwater transfer between the deep wet soil layers and shallow dry soil layers. The suggested reference is added to the revised manuscript. Indeed, depending on how shallow is the soil layer benefiting from the hydraulic lift, namely if the root lifted water is released below or above the SHFP, the corresponding convective heat flux should be added or not to the sensed heat flux.

RC: ”In section 3.2.4 Rainfall or irrigation a negative and positive imbalance source, it will be good to include a perspective of non-rainfall/irrigation inputs (i.e., mist, fog, marine brezee). It is a common feature of some mediterranean ecosystems (i.e., across the shoreline of the Californias), and might enhance the audience. The mist/fog/marine brezee is an important input of water that is not traditionally measured as an input, but is measured as an output of energy by eddy covariance measurements, however, might have influence in the soil heat flux too.”

Anty convective flow means any fluid movement into the soil carrying some energy, “escapes” from SHFPs’ measurement. In this paper, I would highlight the measurement leaks resulting from that fluxes citing the most obvious and present on FR-Lam. It is beyond the scope of this paper to make an exhaustive list of the possible convective flux. However, I agree with the RC2 that it may initiate a larger discussion signaling some possible convective fluxes even if they are not studied in this paper. A corresponding sentence and references are added to the conclusion in the revised version of the manuscript. As I have already signaled in my answer to RC1, snowfall and hail fall should

be considered too, I agree that mist/fog and marine breeze should be considered for concerned climates. As I am saying in the text, all these considerations may deserve more attention.

RC2: "L185-190. I do not completely agree on the criteria for removing G42 and G51. From my point of view, this is natural variability until it is demonstrated that the sensors are incorrect. Is there another criteria for removing these measurements? i.e., do not fall

between three standard deviations from the mean of the remaining sensors?"

This point is similar to the reticence expressed by the first referee. I am not dealing with any malfunctioning SHFP here. The main reason for the proposed exclusion is the non-representability of the plates G42 and G51 which display a very positive imbalance when the close placed plates (the plates are always placed by pair and spaced by 60cm on Fr-Lam) display a common imbalance. Furthermore, in my mind, G42 and G51 are not resulting from a correct measurement of a non-representative emplacement, but a not correct measurement of a non-representative emplacement. Indeed, the SHFP are measuring only the vertical (one-dimensional) conductive heat flow. In the case of one-dimensional conductive heat flow, after geothermal heat flow subtraction, the annual integration should be almost nil. This is never the case and the main two causes are:

- Presence of horizontal heat fluxes resulting mainly from a narrow soil or energy apport inhomogeneity such as a partially shadowed surface.
- Convective, not sensed, heat fluxes such as root pumped water, rainfall water infiltration, and so on.

Individually integrating all the SHFPs' measurements and comparing the results provide a rapid indication of the inhomogeneities presence in the case of obvious divergence of several SHFPs' measurements compared with most other plates' measurements (G42 and G51 in this case). These inhomogeneities can be real and natural, it is not the point, however, the measurement of these inhomogeneities maybe not correct with the SHFPs because the non-vertical heat fluxes are not sensed. Resulting SHFPs' measurements are partial. Moreover, any inhomogeneity causes on one side of the boundary a positive unbalance and a negative unbalance on the other side. When an SHFP is located on one side without another SHFP on the other side, the overall measurement does not represent the overall soil heat flux but only the very local heat flux. The only way for correct inhomogeneity measurement would be to place at least two SHFPs on both sides of the boundary providing a correct *overall* measurement. But this has to be checked with annual integration.

In the case when SHFP were placed only on one side I am proposing to reject the corresponding measurements to assess the other measurement imbalance source: the convective heat fluxes. This assessment is, in my mind, possible when most of the plates present a similar yearly imbalance as in the studied FR-Lam example.