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Comment on acp-2021-1073

Anonymous Referee #1

Referee comment on "Energy and mass exchange at an urban site in mountainous terrain – the Alpine city of Innsbruck" by Helen Claire Ward et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-1073-RC1, 2022

Understanding singularities of the urban climate is becoming increasingly important in the light of contemporary climate change. Cities are the main point sources of the greenhouse gases and, on the other hand, areas that are vulnerable to climate change. Modifications of the elements of local climate by urbanization (e.g. urban heat island) have been intensively studied and are well recognized for the "ideal" case, i.e. a city surrounded by flat homogenous rural areas, especially in mid-latitudes. Similar modifications in the case of mountain or coastal cities will remain an open issue due to the possible interactions of various local factors. The presented manuscript fits perfectly into this research needs.

Moreover, the study is not limited to the classical meteorological elements, but also includes analysis of turbulent exchange mass, energy and momentum between the city's surface and atmosphere. Measurements of turbulent fluxes are extremely difficult in urban areas, which makes such studies unique.

For these reasons, I am absolutely convinced that the manuscript should be published in the ACP. It is very well prepared, following the standards of scientific articles. The flow of argumentation is clear, and I have found nothing that needs to be corrected, expanded or shortened. Thus, I suggest to publish manuscript as it is, with one technical correction: unit of parameter a2 in Table C1 should be [h] not [1/h].

The following are issues that may be considered, but do not necessarily need to be corrected in the manuscript.

In ln. 251-252 authors state that "the reason for this 20-30° difference between the valley axis and the main wind directions is not clear" – I agree, but one can speculate, that it is related to the friction effect at anemometer height. The upper (in boundary layer) wind might probably be parallel to the valley axis, but at the height of the anemometer the friction reduces its speed and causes a left turn, like in an Ekman spiral. Of course, the valley wind is not geostrophic, but like any moving object, it is subject to Coriolis force, counterbalanced by other forces. When the speed is reduced by friction, the Coriolis force weakens and surface wind turns to the left.

In ln. 427-428 it is written: "on mostly clear-sky days cumulus clouds often form above the mountain peaks during the afternoons, making sunset appear even earlier since the sun is blocked by clouds before it is blocked by terrain" – the phenomenon is correctly described, but is it really an earlier "sunset"? In this way, any obscuring of the sun's disc by clouds could be called a "sunset". Fortunately, a more accurate wording was used in the summary (ln. 826): "cloud formation over the crests can further reduce solar radiation".

I like analysis of CO_2 flux in relation to source area (ln. 692-716). But, in the light of these results, it may be considered what could be the best method to calculate the annual exchange of CO_2 in the vicinity of the measuring point. Here it is calculated as an average of the gap-filled CO_2 flux dataset – standard approach. But perhaps it would be more realistic to divide the data into two data sets, fill the gaps and the next average both values. It is almost done in ln. 725-726 and result is pretty the same as in ln. 718.

In conclusions (ln. 848-850) the reduced Q_H and enhanced Q_E during the afternoons at IAO is attributed to the valley-wind circulation with mechanism similar as at rural site, but is it not possible that this is a similar effect of changes in the source area as in the case of the diurnal asymmetry of the CO_2 flux in the summer?