We have greatly appreciated the reviewer for his/her re-evaluation. His/her reevaluation comments are apparently helpful to finalization of our manuscript for publication. We carefully discussed the comments among our coauthors. Accordingly, the manuscript was revised again in response to the comments below (RC: reviewer's comments; AR: author's response).

General comments

This is my second evaluation of this paper. I believe the authors have done a good work for the revision. There are several interesting novelties in the study. There are, nevertheless, some unclear/wrong points, here and there, that in my view, must be revised before publication. Probably, the authors forgot the revision of the abstract left in place the questionable quantification of the storage impact on the overall NEE. Both NEE and Fs were not treated quantitatively as sums in the text, but in the abstract, there is still the mention of "1.9%~4.3% underestimation of the NEE"; which is not supported by presented data. I recommend to simply remove that statement. If I am correct, the annual variation in CO_2 concentration in the air column (the global average is around 2-3 ppm) below the eddy covariance system (36 m) should lead to a positive variation in the overall net sink around 0.1 g C m^{-2} y^{-1}.

Response: Reviewer's understanding matches our thinking. The statement of "1.9%~4.3% underestimation of the NEE" in abstract was removed.

Specific comments:

RC1: Line 53: "mixing ratio". I prefer the use of the terms "dry molar fraction", and wet molar fraction if water is included.

AR: We feel "mixing ratio" is more conventionally used in books (e.g. (Aubinet et al., 2012) and programs (e.g. EasyFlux, Campbell Scientific Inc. UT, US). We have been aware of more uses of "dry molar fraction" in recent literature. At this time, we prefer to keep the mixing ratio unchanged to "dry molar fraction".

RC2: Lines 131-133: I cannot understand this sentence.

AR: It is a common practice to use a single profile instrumentation for F_s because of cost effective. A single profile system is equipped with one infrared CO_2/H_2O analyzer to avoid the systematic instrument error among the levels that cannot be cancelled if more analyzers are used. Regarding to spatial averaging, AP200 Atmospheric Profile System uses mixing volume technology. The data from this technology actually is temporal average to represent the spatial average.

Proposed revision:

Furthermore, time-averaged [CO_2] profiling is employed to represent the [CO_2] average within control volume due to resource constraints. This leads to the gap that the systematic bias and random error in F_s estimate are irreconcilable. (Lines 131-134)

RC3: Line 138: "EC site", better EC experimental setup.

AR: Revised as suggested.

RC4: L154: To avoid confusion, please mention that the EC system is at 36 m above ground. In the description of the experiment would be useful to have an indication of its length (months), and the percentage of gaps due to calibration, filter changes and so on.

AR: Thanks for the comments. We have created a table that outlines the instrumentation setups for each flux tower, detailing the configurations for the EC System and the AP200 installation (Table 1). The CPEC310 and AP200 are subject to maintenance and manual calibration on a biannual basis, in the spring and autumn, respectively. The total time required for this process is 16 hours for the CPEC310 and 12 hours for the AP200. Due to calibration, filter changes, and instrument failures, the data from CPEC310 is estimated to be missing approximately 10% per year, while the data from AP200 is estimated to be missing approximately 3% per year.

Proposed revision:

Due to calibration, filter changes, and rugged weather, 10% CPEC data and 3% AP200 data were missed in our study period. (Lines 170-172)

RC5: L206: Could you add some detail/reference about "empirical modal decomposition"? What are the units of the values reported in Table 2? The same lack of units is repeated at line 362.

AR: Thanks for the comments. The empirical mode decomposition (EMD) was employed for the analysis of [CO_2] fluctuations in this study. This analysis comprises of two steps. Initially, the high-frequency [CO_2] time series (10 Hz) is decomposed by EMD, designed to decompose non-linear and non-stationary signals into a set of spectrally independent oscillatory components (Huang and Wu, 2008), the intrinsic mode functions (IMFs). Subsequently, the IMFs proceed through the Fourier spectrum analysis, resulting in a spectrum that preserves local properties in the time domain and provides information in amplitude and frequency domains. This facilitates the identification of hidden local characteristics in the original signal.

We have added a reference about EMD. The unit for A_m is parts per million (ppm), and the unit for P_m is seconds (s). Both Table 2 and the L362 have been revised.

RC6: L309: Please check the writing: I would write something like “Significant diurnal variations occurred… as shown in Fig 4.”

AR: Thanks for the suggestion, we have revised these sentences. The unit for both $\sigma(\varepsilon_s)$ the $|F_s|$ is µmol m^{-2} s^{-1}. This study characterizes the relationship between these two variables as a linear model. Consequently, the unit of the intercept of the linear model is µmol m^{-2} s^{-1}, while the slope of these two variables is dimensionless.

Proposed revision:

Significant diurnal variations and seasonal differences in F_s were observed across the three forest stands, as shown in Fig. 4. (Lines 312-313)

The relationship between $\sigma(\varepsilon_s)$ the $|F_s|$ was characterized by intercepts of 1.99 to 2.82 µmol m^{-2} s^{-1} and slopes of 0.24 to 0.28 (results presented in the Supplementary Tables 5–6). (Lines 365-368)

RC7: L554: Deciduous forests exhibit significant variation in LAI, not evergreen forests.

AR: Thanks for the comment. The dominant tree species at our study site are deciduous trees. Among them, the Larch plantation forests are mainly composed of two deciduous species: *Larix kaempferi* (Lamb.) Carr. and *Larix olgensis* Henry. Our previous study showed that the leaf area index of the forest stands for all three towers showed significant seasonal variation (Li et al., 2023). We have revised this sentence to make it clearer.

Proposed revision:

During the growing season, forests in our study site exhibit higher leaf area index and greater canopy densities than during the dormant season (Li et al., 2023), resulting in longer P_m of short-term [CO_2] fluctuations above the canopy (Fig. 3). (Lines 558-561)

RC8: L563: Why the energy balance should be determined on by “the valley soil surface”? I believe it is dependent by the difference between incoming and outgoing LW radiation. A source of LW radiation is also at canopy level.

AR: We agree with the comment. During night, the loss of heat from the valley soil surface and vegetation canopy through longwave radiation is a primary driver of katabatic flows. To clarify, this sentence has been revised.

Proposed revision:

During night, the difference between incoming and outgoing longwave radiation over the valley soil surface and vegetation canopy gives rise to radiative cooling. Subsequently, the air near the soil surface experiences a gravity-induced downslope acceleration, potentially causing katabatic flow. (Lines 567-570)

RC9: L567: "diversity", in forest composition/structure or what?

AR: Thanks for the comment. We have revised this sentence to make it clearer.

Proposed revision:

The terrain unevenness and the complexity of canopy structure significantly affect the airflow divergence in the atmospheric boundary layer. (Lines 584-585)

RC10: L610: Where is really the indication of AP200 accuracy?

AR: The measurement accuracy of AP200 depends on LI850A infrared CO_2-H_2O analyzer (LI-COR Biosciences, NE, USA). Unfortunately, the accuracy in CO_2 and H_2O of infrared analyzers from two major manufactures, LI-COR Biosciences and Campbell Scientific, for atmospheric applications has not been specified although the precision, cross-sensitivity, and CO_2 and H_2O zero and span drifts are specified (Zhou et al., 2021; Zhou et al., 2022). Zhou et al. (2021; 2022) extensively discussed the accuracies in CO_2 and H_2O that are measured using infrared analyzers and defined these accuracies for applications of open-path eddy-covariance systems and closed-path eddy covariance systems to ecosystems. To the best of our knowledge, the accuracies in CO_2 and H_2O from LI850 have not been defined for its applications to atmospheric profile measurements. This topic goes beyond the scope of this study.

To better indicate the AP200 accuracy, although unavailable, we added the precision and cross-sensitivity of LI850 while describing the auto zero and span functionality of AP200. The LI-850 exhibits a sensitivity to water vapor of less than 0.1 μmol CO_2 per mmol mol^{-1} H_2O, and a sensitivity to CO_2 of less than 0.0001 mmol mol^{-1} H_2O per μmol CO_2.

Proposed revision:

The LI-850 analyzer integrated within in AP200 exhibits a sensitivity to water vapor of less than 0.1 μmol CO_2 per mmol mol^{-1} H_2O, and a sensitivity to CO_2 of less than 0.0001 mmol mol^{-1} H_2O per μmol CO_2. (Lines 616-619)

Reference

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