

***Interactive comment on “Eddies in motion:
visualizing boundary-layer turbulence above an
open boreal peatland using UAS thermal videos”
by Pavel Alekseychik et al.***

Anonymous Referee #1

Received and published: 16 November 2020

General Comments:

The article uses a thermal imager on a UAS flown at 500 m over boreal peatland to extract surface temperature fluctuation using methodology from Christen et al 2012. Several corrections are applied to the dataset to allow accurate assessment of turbulent statistics. From the temperature fluctuations TIV is performed to extract 2D velocity fields and a spectral analysis is performed to identify eddy size and shape for eddies of the order of 10-100 m. Further analysis looking at the size and aspect ratio of the eddies is compared to relevant turbulent statistics. I applaud the authors on their methodology and problem-solving skills to treat this dataset to bring it to the

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point where turbulence analysis can be performed. I too have dealt with many of the issues described here without any publication to speak of. I see the science within this document as a reflection as step forward for UAS-TIR measurements in atmospheric boundary layer research. While the results and methodology of the document are worthwhile of publication, I have provided a series of major and minor comments below. I find the merit and methodology of the work very high, but the presentation and text to only be fair, thus the comments accumulate to a minor revision. Primarily, I find that the manuscript is lacking a strong review of the literature. I recommend the authors spend more time in the introduction and text to provide citations on turbulent structures. Specifically, the LES community has been studying this topic for some time and should be included. Additionally, the text is very informal, often using inconsistent abbreviations and acronyms. The authors should re-read and work the text to improve its quality and consistency.

Major Comment: Line 53: Be careful, throughout the document you interchangeably use IR and TIR. I understand the overlap, but IR is reserved for short-wave while TIR is reserved for mid-to-long wave infrared radiation. I am only going to comment here on this but will need to change throughout the document.

Major Comment: How did you handle the transmissivity? At such an altitude (500 m) there is likely some degree of error introduced from the transmissivity of the air on the accuracy of the measurement. I believe the FLIR software has a default correction based on the air temperature and humidity, did you use this to correct for the transmissivity?

Major Comment: Many informal sentences. Please use input from co-authors or a reputable grammar editor like Grammarly to help improve make the text more formal. Please rewrite any sentence with the word “so” or beginning with the word “Because.” Such phrasing leads to informal sentences.

Minor comment: What is the anticipated error from the noise introduced leaves? Are

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there leaves? How does the surface look? A high quality (larger than Figure 4) visual image or satellite view would be very helpful.

Minor comment: Can you add a photo of the flux tower setup?

Minor comment: Please provide more details on how the imregister function (as well as other functions) work. Please remember that Matlab is a paid programming language such that the methodology should be explained as to someone is reprogramming this methodology with another language like C++.

Minor Comments:

Line 15: comma after (UAS)

Line 19: Please change “whilst” to “while”

Line 23: The UAS thermal imagery is collocated with a ground-based eddy-covariance system.

Line 45: Remove “made”

Line 50: Replace regretted with reported

Line 58: Remove “Evidently”

Line 67: Replace 2-day to two-day

Line 70: Rewrite for clarity: “..and the available eddy-covariance (EC) tower. . .”

Line 75: Please include the spectral response of your camera

Line 82: Remove “quite well”

Line 82-83: Rewrite

Line 91: Replace “.,.” with a period “.”

Line 91: Can you comment on the time synchronization more? For long averaging

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periods (>5 minutes) it may not be a concern, but for detection of large eddies this is rather important. Was this method with the aluminum sheet synchronized with a watch? Was there an onboard GPS available? Was the EC tower GPS synchronized.

Line 93: Remove “easily”

Line 98: Please provide a literature source for the emissivity value used.

Line 108 and 109: Remove “The” in phrase “The Steps,” also “Steps” is not capitalized

Figure 2: Please add a more informative caption.

Line 129: Rewrite 129 to not begin with “Because”

Line 141: Remove “To do that”

Line 161: What is a deviation from a space-time average? This doesn’t make sense to me.

Line 162: Replace “so” with “such”

Line 165: No need for “e.g.”

Line 169: This is confusing to me. A forward finite difference already implies it was divided the time. Was dT/dt multiplied by the sampling frequency after this?

Line 173: Remove “now”

Line 181: Rewrite to “A 2D wavelet. . .”

Line 181: Remove “then”

Line 186: Incomplete sentence “The positive. . .”

Line 194: Please spell out wind direction or define WD

Lines 205-210: Here you are calling the methodology PIV. While it is true you are borrowing methodology from PIV, the community has adopted the terminology Thermal

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Image Velocimetry (TIV) when using “thermal” particles.

Line 215: Replace “that is” with “as”

Line 216: (WS)

Line 218: u star, z_0 and L should all be in parentheses.

Line 220: I think partitioned should be replaced with temporally averaged.

Line 224: Informal sentence, please rewrite

Line 225: Here you abbreviate August. Please spell it out like you did earlier in the document.

Line 227: “3-m”

Table 2: Is z L_0 suppose to be z/L_0 ?

Caption Figure 4: Here you use a percentage for the emissivity. Earlier in the document you use a fractional number. Please be consistent.

Line 258: Remove “probably” and please hedge this sentence more formally.

Line 271: Super interesting about the heat capacity of the needles!

Line 279: Spell out north and south

Line 281: Please define sigma. I assume you are talking about the standard deviation.

Line 286: When was this spectrum taken? Using which data? Can you comment here on the difference between the signals at the larger frequencies. I think this is a interesting result.

Line 305: Please spell out temperature

Line 342: Please change “power” to “spectral power density”

Line 349: Remove “However”

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Line 350: Change the colon to a comma

Line 358: Please change “additionally explored by inquiry” to “studied by dividing the signal”

Line 369: Remove “,too,”

Figure 10: Please add a legend for the red lines

Line 371: Please correct for informalities.

Figure 10: It is interesting to see the larger variability in the ratio of the 128-cross and along wind structures peak for flight 3. I understand this to be the flight with the fanning pattern observed.

Line 395: Can you rewrite, I don’t understand what you mean “flights 1-2 group close together...” and so forth

Figure 11: What’s the major and minor axis?

Line 423: What do you mean by “associated”?

Line 424: Please use consistent nomenclature for “R2”

Figure 13: It would be easier to interpret this one to one if the limits of the axes were the same.

Figure 13: Which footprint methodology did you use? Please cite.

Line 434: Change from “Such,..” to “The”

Line 436: Please use a comma instead of the colon

Line 440: These are indeed “large” structures but are not the “largest structures.” I would be more specific here and say structures ranging from 1-420 m structures.

Line 443: Again, be careful here about how you talk about turbulent length scales. The smallest scales of turbulence are order 1 mm.

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Lines 440-452: While I agree this method is very advantageous and progressive, some of the previous works mentioned were looking at smaller scale turbulence. For the goal of looking at TOS I agree a larger field of view from a UAV is perfect, but the tradeoffs were looking resolution for smaller scale processes and sensitivity from using a thermal imager with a microbolometer.

Line 464: Plethora is informal

Line 470: Add citations here about wind speed and TOS. Such papers as “Surface Thermal Heterogeneities and the Atmospheric Boundary Layer: The Relevance of Dispersive Fluxes” by Margairaz et al and “Buoyancy effects on the integral length scales and mean velocity profile in atmospheric surface layer flows” by Salesky et al.

Lines 434-500: I do not feel like this discussion is anything more than a conclusion of the presented work.

Lines 490-495: Several methods exist to exact SHF from thermal imaging products. Morrison et al 2012 as well as other remote sensing papers should be discussed here.

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