Response to interactive comments from Referee #2

Besides adressing the comments, we have also made the following changes to the manuscript:

- In the previous version of the manuscript all results were reported in the units of camera pixels. We now report in physical units (meters) where appropriate.

- To obtain statistics for locations further downwind from the release point, we have included results for three more camera positions. One, camera B, at the same location as the original camera A, but with a smaller horizontal field of view, and similar cameras at about 300 m (camera B), and 500 m (camera C) downwind from the release point. For cameras B, C and D the release point of the plume is at a higher altitude to allow the cameras to see the full vertical extent of the plume. Furthermore, these cameras have more pixels in the vertical direction than camera A.

- To be able to compare the LES with the simulated images for these new camera viewing directions (viewing the plume at an elevation angle of 30.7° compared to 5.7°) new software had to be developed to calculate slant column densities along the camera lines of sight through the LES 3D concentration.

Below the comments from Referee #2 are given in italic font. Our responses to the comments are shown in roman font.

Specific comments

- *One criticism is that the usefulness of the fractal dimension calculation is unclear. Indeed, the authors description of the mass box counting method lacks detail, giving the impression that they do not know how best to make use of this parameter.*

  In response to the comment we have decided to leave this section out.

- *Another is that a more complete comparison could be made by comparing concentration PDFs. PDFs may or may not yield interesting information for the LES and simulated images used in this study, but in real turbulence one often finds intermittency, and its signature can be seen in the tails of the PDFs.*

  The images provides column densities (typically units of $1/m^2$) along the line of sight of the camera. This is a quantity different from the concentration (units of $1/m^3$) usually used to calculate PDFs. We have, however, calculated the probability density function (pdf) of the column densities from the LES and simulated images as shown in Fig. A1. These pdfs and their contribution to the explanation of the differences between the statitistical quantities from the LES and simulated images, are discussed in the revised manuscript.

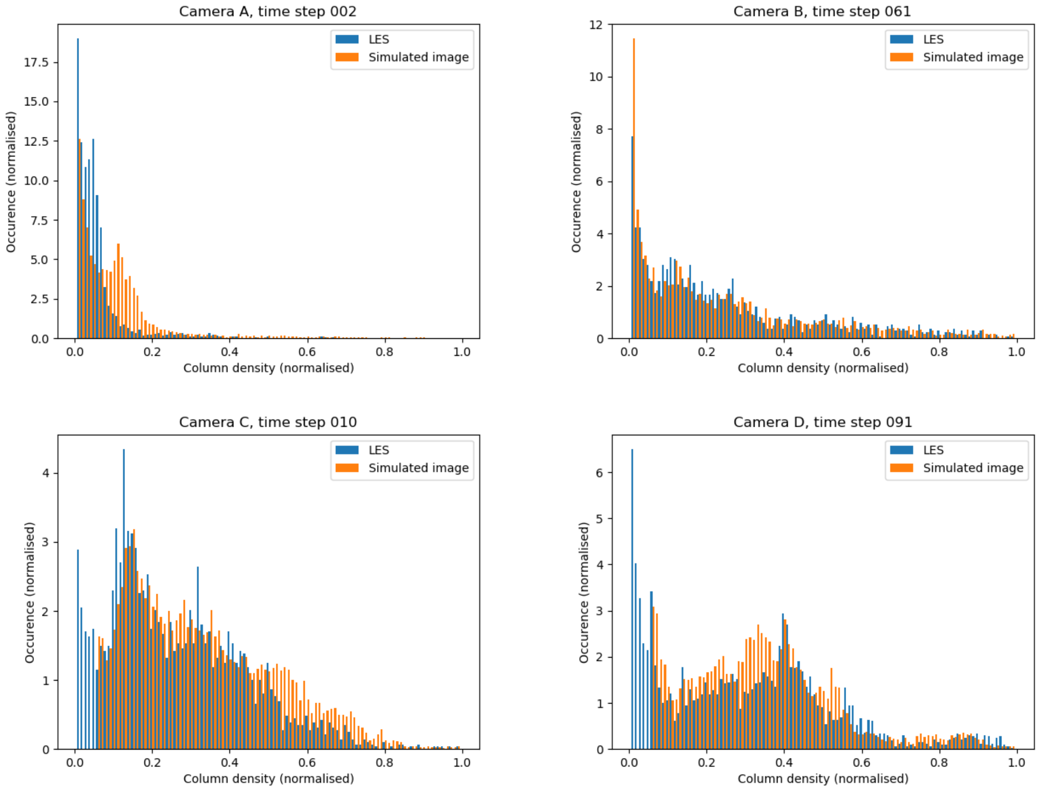

Figure A1: The probability density function (pdf) of the column densities from the LES and simulated images in Figs. 4-7 in the revised manuscript.

- *Finally, an analysis of the LES velocity field, projected onto the planes of the camera images (2D slices of the field), was not done. Calculations of divergence, vorticity and rate of strain in these 2D slices will help to identify vortex cores, saddle points and, where large 2D divergence will show up regions where out-of plane motion is significant. Such information will help interpret the structure of the concentration field and tracer dispersion, and the experience should generate intuition useful to the interpretation of images from real atmospheric flows.*

  A velocity field can be extracted from the camera images using for example the techniques described by Gliß et al. (2017). However, this velocity field is integrated by the concentration along the view path. As such it is very different from 2D slices and a comparison between the two is not trivial nor straightforward. The LES velocity and concentration fields are thoroughly discussed in the paper by Ardeshiri et al. (2020) which is cited in the manuscript.

Technical corrections

- *In the Introduction, please explain to the reader the motivation to investigate SO2 instead of some other tracer(s).*

To motivate the use of SO_2 we have added the following text to the Introduction:

> Over short transport distances, sulfur dioxide (SO_2) may be considered to be a passive tracer. Furthermore, SO_2 strongly absorbs radiation in part of the UV spectrum and may thus be detected by for example UV sensitive cameras (see for example Kern et al., 2010, and references therein).

- *Is this the first time a simulation of camera images or UV camera images have been attempted? If so, please say. If there have been previous efforts, were they successful or not?*

  To the authors knowledge UV camera images have not been simulated before. This statement has been added to the Introduction.

- *Page 2, line 17: The phrase "based on a large eddy simulation (LES)" does not convey the correct impression. I think you mean to say that you use LES in lieu of a real atmospheric flow.*

  We have rephrased this part so it now reads:

  > We present a novel method to simulate UV camera images of a dispersing SO_2 plume using a 3D radiative transfer model. The 3D descripton of the SO_2 plume is provided by large eddy simulation (LES) and are used in lieu of real atmospheric flow. The simulated images are used to examine how various factors (solar angles, aerosol content, and surface albedo) affect the statistical parameters characterizing the SO_2 plume dispersion.

- *The following sentence appears twice, once in the abstract and once in the conclusions. "Turbulence is one of the unsolved problems of physics." In both cases the sentence is unnecessary and distracting. It should be deleted.*

  This sentence has been removed both places as suggested.

- *A similar sentence appears in the Introduction (line 8): "The complete description of turbulence remains one of the unsolved problems of physics." This sentence also seems out of place and unnecessary and should be deleted.*

  The sentence has been removed as suggested.

Bibliography

Ardeshiri, H., Cassiani, M., Park, S., Stohl, A., I.Pisso, and Dinger, A.: On the convergence and capability of large eddy simulation for passive plumes concentration fluctuations in an infinite-Re neutral boundary layer, Boundary-Layer Meteorol., accepted for publication, 2020.

Gliß, J., Stebel, K., Kylling, A., Dinger, A. S., Sihler, H., and Aasmund, S.: Pyplis - A Python Software Toolbox for the Analysis of SO2 Camera Images for Emission Rate Retrievals from Point Sources, Geosciences, 7, https://doi.org/10.3390/geosciences7040134, URL `http://www.mdpi.com/2076-3263/7/4/134`, 2017.

Kern, C., Kick, F., Lübcke, P., Vogel, L., Wöhrbach, M., and Platt, U.: Theoretical description of functionality, applications, and limitations of SO_2 cameras for the remote sensing of volcanic plumes, Atmospheric Measurement Techniques, 3, 733–749, https://doi.org/10.5194/amt-3-733-2010, URL `http://www.atmos-meas-tech.net/3/733/2010/`, 2010.