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Atmospheric Measurement Techniques Discussions

Interactive comment on "Can statistics of turbulent tracer dispersion be inferred from camera observations of SO_2 in the ultraviolet?" *by* Arve Kylling et al.

Anonymous Referee #2

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Brief summary of the paper...

The aim of the paper is to present a novel method to simulate UV camera images of a dispersing SO2 plume with a 3D Monte Carlo radiative transfer model, and then to examine how various factors (solar angles, aerosol content, and surface albedo) affect the statistical parameters characterizing plume dispersion. Instead of a real atmospheric flow, results from a large eddy simulation (LES) of a plume are used to validate the simulation method. The success of the simulated UV camera images is assessed by calculating plume statistics (first three moments of the concentration field in the absolute and relative coordinate systems) and comparing results for the LES data with

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those for the simulated images. Tracer dispersion was further analyzed by calculating the fractal dimension using a mass box counting method.

Several reference cases were considered and analysed in detail, yielding good results. Based on these results, the authors conclude that UV camera images of SO2 plumes in real atmospheric turbulence may be used to make quantitative investigations of plume dispersion in the real atmosphere.

1. General comments (overall quality)

The approach taken by the authors strikes me as innovative and valuable. It is clear to me that the good results for the plume statistics comparisons gives needed confidence that satellite UV camera images can potentially provide accurate fluid dynamical information.

Having said that, I have some criticisms of the data analysis.

2. Specific comments (scientific questions / issues)

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.

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.

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 interpre-

tation of images from real atmospheric flows.

3. Technical corrections.

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

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?

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. 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.

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.

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