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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Local air pollution from oil rig emissions observed during the airborne DACCIWA campaign" *by* Vanessa Brocchi et al.

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This paper presents aircraft measurements of pollutant emissions from an FPSO off the coast of Guinea. The case study described featured two flights within a week, with transects of the flare plume conducted at various distances downwind of the source. The Lagrangian dispersion model FLEXPART has been used in conjunction with a recent satellite-derived emissions inventory to calculate simulated plume enhancements corresponding to the aircraft sampling, which are then compared to the measurements. Sensitivity tests are performed by perturbing the magnitude of the emissions and the injection height of the plume, and it is concluded that emissions may be larger than those given by the inventory. The chemical composition of the plume, and the difference in its composition between the two flights, is also discussed.



The air quality impact of oil platforms in this region is a very important and active area of research, yet there is a lack of in situ measurements (such as those presented here) to validate satellite-based emissions estimates. Furthermore, the use of dispersion models to simulate plume enhancements for near-source aircraft sampling, as required to estimate emissions from individual facilities, has a general application for similar studies throughout the world. This study provides useful insight into both of these research areas, and I recommend its publication in ACP after the following issues are addressed.

1) The main issue I have with the study as it stands regards the way the model-measurement comparison is performed. It is not clear that comparing the peak mole fraction enhancement is the best way to do this, and at the very least this needs more discussion. For one thing, for narrow plumes the peak measured enhancement is often dependent on the e-fold time of the cell. Looking at Fig. 2 this might not be an issue here (if the actual plume width is much larger than the measurement e-fold time multiplied by the flight speed) but it is hard to be certain. Providing these details in the text might help to clear this up.

A bigger issue comes when looking at the impact of doubling the emissions inventory values. The FLEXPART simulations for this are not shown, but from the CTRL run simulation in Fig. 2 it appears that the simulated plumes are much wider than the measurements. In some cases two narrow measured plumes are combined into a single simulated plume. This feature clearly represents an error in the dispersion modelling, not the inventory. So it is possible that the inventory value is entirely correct (although obviously it's unlikely to be spot on!) but FLEXPART simply overestimates the lateral dispersion of the plume. For both flights it is concluded that one of the simulations with doubled emissions is the most representative of the measurements, but this may be a case of "right for the wrong reason" – i.e. in order to compensate for the overestimated lateral dispersion of the plume you have to bump up the emissions to get the same peak enhancements.

An alternative approach would be to compare the integrated area under each of the plume transects. This would then give a better idea of the total amount of each species within the plume (in the same way as is usually employed for calculating species-species enhancement ratios). Both approaches could be employed alongside each other as long as a suitable discussion of the issues above is included. I also think it would really help interpret what is going on here if Fig. 2 included the results from the other simulations. If you really think it's getting too cluttered then these could be moved to the supplement, but I think it's important to include them somewhere.

2) The lack of CO in the plumes measured on flight 1, and the subsequent detection of CO in the flight 2 plumes, is a really interesting result. However the discussion in Sect. 4.3 is fairly brief – it would be great to see this expanded. I'm not really clear as to what is meant by "more disturbed weather conditions" – does this mean the boundary layer was more turbulent? If so why does this mean that the combustion is less efficient? I'm not disputing that is the case, it's just not obvious to me without further explanation. I can see that probing the fluid dynamics within the flare is beyond the scope here, but are there other studies that this finding could be linked to? Were there any measurements of CO2 (and ideally CH4) on board? Then something quantitative could be said about the flare efficiency?

Specific points:

P2 L2 – In Nigeria all associated gas may well be flared, but in other places (at least in the UK) this associated gas is exported for use. So I think it would be more accurate to say that gas flaring is used to dispose of this natural gas in cases where the infrastructure to export it does not exist.

P3 L25 – "The concept...deeper water" – sentence reads awkwardly and needs rephrasing

P3 L28 – I suggest "dispose of" rather than "eliminate"



P3 L30 – "mixture of gas" is ambiguous – presumably this means a mixture of emitted gases?

P4 L7 – "released along time" needs rewording

P4 L11 – If I understand correctly these are just tracer particles, so their assigned mass is just a nominal quantity used in the subsequent calculations (i.e. it does not correspond to a physical mass which impacts on the particle dispersion). If so I think it would be best to clarify this, as particle mass has quite a strong association for people who work with aerosols.

P4 L20 – "for the DACCIWA project"

P5 L2 – I think it would be useful to add a sentence in here explaining both the buoyancy and momentum effects. This would make it easier to understand the subsequent assertion that the momentum effect can be ignored.

P5 L31 – P6 L3 – The description of the terms in Eq. 4 is not easy to read. It might make it clearer to define the units of the constituent terms rather than the coefficient 74.4? Also the phrase "f as the fraction of radiated heat equals to 0.27" confuses me.

P6 L30 – How is the background calculated – presumably by averaging the measured data outside the plumes? If so then it's worth stating this.

P7 L27 – "only a few quantities of pollutants" needs rewording

P8 L7 – "The turbulence increases the mixing and affects..." might be better

Fig. 1 – I trust your word that there was no SO2 measured, but you might as well add an SO2 trace to the CO plots just to demonstrate this point.

Fig. 2 – Could you make the circles around the measured data in panels b) and e) more distinct please? At least on my screen it is really hard to make these out, especially in b). See also my main point 1)

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