

Interactive comment on “Transport and outflow to the North Atlantic in the lower marine troposphere during ICARTT 2004” by S. R. Davis et al.

Anonymous Referee #1

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This paper contains many very interesting and unique measurements. The analysis has three main aims: To investigate the composition and dynamics of regional plumes in a quasi-Lagrangian framework; to determine the influence of the local marine boundary layer on plume transport and to determine the contribution of low-level plumes to North Atlantic continental outflow. The first aim is achieved via detailed analysis of the chemical and meteorological aircraft profile measurements. The second aim makes use of chemical and meteorological aircraft transect measurements. The third aim is only briefly addressed by analysing surface air quality measurements and performing forward trajectories. This paper contains a lot of information, data and analysis making it difficult to read and obscuring the major findings. One option would be to leave out the work related to the third aim, i.e. section 4.2 and figures 11 and 12.

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Major points:

1. Figures: All of the figures are too small making it difficult to read axis labels, contour labels and location names. In addition, much of the data plotted in the figures, and even individual figures themselves, are not referred to in the text. The failure to select relevant data means that much unnecessary time is spent working out which line and figure is being discussed in the text. Better selection of data is essential to make this paper suitable for publication.

2. As the authors state, internal boundary layers (IBL) usually form due to discontinuities in the ‘surface’ properties. In this paper a plume of polluted air is advected across the coast above a marine IBL. This polluted residual layer then adjusts to the new lower boundary properties – now the top of the marine IBL and not the surface – thus forming a second IBL above the marine IBL. It is not obvious from the paper that this is the structure the authors are describing. Also, it is not clear how the authors relate the meteorological characteristics of this layer to the chemical measurements.

Minor points:

1. Abstract: There is no explanation for why this study was performed or motivation for the work. This needs to be included in the abstract.

2. P2397, Line 12: ‘Upper level forms of outflow (i.e. that facilitated by warm conveyor belts)’ should probably read ‘e.g. that facilitated by warm conveyor belts’ since there are other processes that can lead to pollution transport such as convection.

3. P4000, equation 2: The equation contains variables g , U , V and z that are not defined in the text. Since the gradient Richardson number is commonly used the equation could either be left out entirely, or if included, it needs to be explained in full.

4. P2401, equation 3: The equation contains variables u' , v' , w' , m and e that are not defined in the text. Since the turbulent kinetic energy is commonly used, the equation could either be left out entirely, or if included, it needs to be explained in full.

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5. P2401, line 21: What process is responsible for the ventilation into the shallow tropospheric layer? Weak synoptic forcing isn't a ventilation mechanism.
6. P2402, line 1: Use of the word 'off' is ambiguous here. Do you mean that the southwesterly flow is in an offshore direction, or that the southwesterly flow is observed occurring over the ocean?
7. P2404, line 7: Use of the word 'ventilation' here and at other points in the paper needs to be defined as ventilation is a rather generic word with different meanings to different people.
8. Figure 1: This figure is too small; it is very difficult to read the contour values.
 - a. Shade the land to make the figure easier to interpret.
 - b. Remove the state lines as they complicate the figure and are not referred to in the text.
 - c. The figure caption states that figures a, b and c show mean sea level pressure. However, the contours do not look like mslp. Is this correct? Perhaps they are wind speed?
 - d. The figure caption states that a, b and c show surface wind vectors. Are the wind vectors scaled? If so, include a reference vector.
 - e. Figures d, e and f are not referred to in the text. Do they need to be included?
 - f. Include the units of the plotted variables in the figure caption.
9. Figure 2: This figure is too small. It is difficult to read the labels.
 - a. It would be useful to show the location of the horizontal transects referred to in the text.
 - b. It would also be useful to show the location of the profiles taken on the flights.
10. Figure 3: This figure is too small. It is difficult to read the axis labels or values.

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- a. Do the SO₂ concentrations for 19:20 UTC go off the scale below 500m? If so, extend the axis to include all values.
- b. It is impossible to interpret figures g and h as the data overlaps so much. Would a logarithmic scale highlight the features of interest better?
11. P2403, line 4: Shipping is also likely to be another large source of SO₂ in this region.
12. P2403, line 19 and figure 4: Why did the authors choose to perform the Lagrangian back trajectories from 1900m, 1200m and 500m? Are these related to the layers of pollutants seen in figure 3? Similarly, what is the justification for the heights of the forward trajectories? Why are the heights chosen for the forward and back trajectories different?
13. P2403, line 26: The correlation coefficient '0.83' does not appear in figure 5a. What does this value refer to?
14. Figure 5: This figure is too small. It is difficult to read the correlation coefficients.
 - a. The figure caption says that (a) and (b) show O₃/NO_y but the text and axis labels refer to O₃/CO.
 - b. Include units of measurements on either the figure axis or in the figure caption.
 - c. Each panel includes 3 equations and correlation coefficients. These values should be described in the figure caption.
 - d. The ordering of the key changes from figures a,b to c,d,e and f. This is confusing.
15. P2404, line 15: The relationship between O₃ and NO_y is described as being 'weaker'. Weaker than what? Also the correlation coefficient is 0.63 in the text but 0.56 in the figure.
16. P2405, line 3: 'Juyy' should be 'July'.

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17. P2405, lines 2-15: This section justifies the fact that the plume was anthropogenic in origin and close to the source region. Is it necessary to include such a lengthy justification for this fairly uncontroversial statement?
18. P2406, line 1: Where has this detachment of the plume from adjacent vertical layers been shown?
19. P2406, line 5: 'Entrainment' implies mixing of two air masses. The process referred to however, could be explained by advection of the plume into the coastal residual layer.
20. P2406, line 26: 'The wind has shifted by 30o'. Over what time period and from which direction?
21. P2407, line 12: It is very difficult to see that increase in TKE at the upper and lower bounds of the plume in figure 3g due to the overlapping data. Could another scale be used, or could the data from 19:20 UTC and 20:00 UTC be removed if it is not referred to in the text?
22. P2407, line 28: It is impossible to see drops in Ri between 500m and 1500m due to the x-axis scale used in figure 3g.
23. P2408, lines 1-15. Why are the authors convinced that the peaks seen at 18:30, 19:20 and 20:00 are emitted from the same source, and are subsiding from 1500m to 250m?
24. P2410, line 25: What heights were the aircraft transects performed at?
25. Figure 6: This figure is too small. Is data from the 20/21st and 22nd July referred to in the text?
26. Figure 7: This figure is too small. I don't think figures 7a, b, c, d, e, g, h or i are referred to in the text. If this is correct, is it necessary to include them?
27. Figures 8/9/10: These figures are too small. As for figure 7, are all these figures referred to in the text, if not remove them. Also define MEK in figure 9.

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28. Figure 11: This figure is too small. I cannot read the axis labels.
- a. In the figure caption you refer to the statistics in figure (d). However, the statistics figure is labelled (e).
- b. Is it necessary to include the green lines to indicate the peak values in (e)? Surely, this is obvious from the maximum bar in the histogram?
29. Figure 12: Figure c is too small to read the values.
- a. What is the x-axis in figure b? Is it time in hours? Include an axis title and units.
30. P2415, line 2: 'Metven' should be 'Methven'.
31. P2416, line 2: Define SIBL. Stable/stratified/surface internal boundary I

Please also note the supplement to this comment:
<http://www.atmos-chem-phys-discuss.net/12/C224/2012/acpd-12-C224-2012-supplement.pdf>

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 2395, 2012.