Supplement of

The vertical distribution of biomass burning pollution over tropical South America from aircraft in situ measurements during SAMBBA

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S1. Data

In-situ Coverage

Owing to difficult operating conditions instrument coverage was variable across and within all flights. Of twenty flights undertaken during SAMBBA (b731 – b750) all but two (b733 and b747) were full science flights. Hence, ratios derived from different instruments are not always comparing the same sample points in time and space. Optimum bin sizes for the calculation of the median profiles were chosen based on containing approximately the same number of data points in each bin.

![Figure S1. Schematic of percentage data coverage for key parameters, per 30 minute segment flight time](image)

In-situ Acquisition

A comprehensive set of all variables were measured during SAMBBA on a 1 Hz base. Profile time series were averaged into 50-m altitude bins for the automated analysis presented here. Both datasets are available upon request.

Ancillary Products

The MODIS instrument, operating on-board the Aqua and Terra satellites, provided retrievals of daily Aerosol Optical Depth (AOD) at 550 nm on a 1° x 1° grid (specific products: MYD08_D3.061, MOD08_D3.061). Instruments on-board the Tropical Rainfall Measuring Missions (TRMM) satellite mission provided a measure of precipitation rate (in mm/hr) at a 3-hr interval on a 0.25° x 0.25° grid (specific product: 3B42.007) these products were obtained from the Giovanni online data system, developed and maintained by the NASA GES DISC (http://disc.sci.gsfc.nasa.gov/giovanni).

The fire data were produced by the University of Maryland and acquired from the online Fire Information for Resource Management System (FIRMS; https://earthdata.nasa.gov/data/near-real-time-data/firms/abouts; specific product: MCD14ML).

Model wind fields and soil moisture values were obtained from the ERA-Interim global atmospheric reanalysis product (Dee et al., 2011; http://www.ecmwf.int/en/research/climate-reanalysis/era-interim). All soil moistures reported in the manuscript are for soil water layer 1. When soil moistures are linked to profiles, the value used is the nearest grid box at the closest 6-hour time step.

Land cover data was provided at a 300 m resolution from the European Space Agency Land Cover Maps (v2.07), which are based on observations from the MEdium Resolution Imaging Spectrometer (MERIS), Advanced Very High Resolution Radiometer (AVHRR), SPOT-VGT, PROBA-V and PROBA-B satellites. The land cover data was re-gridded on to a 5’ x 5’ grid for presentation purposes in this manuscript. This product is based on the UN Land Cover Classification System (LCCS), which was simplified based on the approach of Chen et al., (2013) for MODIS IGBP (International Geosphere–Biosphere Programme) data and is displayed below:
<table>
<thead>
<tr>
<th>LCSS Scheme</th>
<th>New Scheme</th>
<th>LCSS Scheme</th>
<th>New Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>Class Name</td>
<td>Class</td>
<td>Class Name</td>
</tr>
<tr>
<td>0</td>
<td>no_data</td>
<td>100</td>
<td>mosaic_tree_and_shrub SAVN</td>
</tr>
<tr>
<td>10</td>
<td>cropland_rainfed</td>
<td>AGRI</td>
<td>110 mosaic_herbaceous SAVN</td>
</tr>
<tr>
<td>11</td>
<td>cropland_rainfed_herbaceous_cover</td>
<td>AGRI</td>
<td>120 shrubland SAVN</td>
</tr>
<tr>
<td>12</td>
<td>cropland_rainfed_tree_or_shrub_cover</td>
<td>AGRI</td>
<td>121 shrubland evergreen SAVN</td>
</tr>
<tr>
<td>20</td>
<td>cropland_irrigated</td>
<td>AGRI</td>
<td>122 shrubland deciduous SAVN</td>
</tr>
<tr>
<td>30</td>
<td>mosaic_cropland</td>
<td>AGRI</td>
<td>126 grassland SAVN</td>
</tr>
<tr>
<td>40</td>
<td>mosaic_natural_vegetation</td>
<td>AGRI</td>
<td>-116 lichens_and_mosses</td>
</tr>
<tr>
<td>50</td>
<td>tree_broadleaved evergreen closed_to_open</td>
<td>EVGN</td>
<td>-106 sparse_vegetation</td>
</tr>
<tr>
<td>60</td>
<td>tree_broadleaved deciduous closed_to_open</td>
<td>DECF</td>
<td>-104 sparse_shrub</td>
</tr>
<tr>
<td>61</td>
<td>tree_broadleaved deciduous closed</td>
<td>DECF</td>
<td>-103 sparse_herbaceous</td>
</tr>
<tr>
<td>62</td>
<td>tree_broadleaved deciduous open</td>
<td>DECF</td>
<td>-96 tree_cover flooded_fresh_or_brakish_water</td>
</tr>
<tr>
<td>70</td>
<td>tree_needleleaved evergreen closed_to_open</td>
<td>EVGN</td>
<td>-86 tree_cover flooded_saline_water</td>
</tr>
<tr>
<td>71</td>
<td>tree_needleleaved evergreen closed</td>
<td>EVGN</td>
<td>-76 shrub or herbaceous cover flooded</td>
</tr>
<tr>
<td>72</td>
<td>tree_needleleaved evergreen open</td>
<td>EVGN</td>
<td>-66 urban</td>
</tr>
<tr>
<td>80</td>
<td>tree_needleleaved deciduous closed_to_open</td>
<td>DECF</td>
<td>-56 bare_areas</td>
</tr>
<tr>
<td>81</td>
<td>tree_needleleaved deciduous closed</td>
<td>DECF</td>
<td>-55 bare_areas consolidated</td>
</tr>
<tr>
<td>82</td>
<td>tree_needleleaved deciduous open</td>
<td>DECF</td>
<td>-54 bare_areas unconsolidated</td>
</tr>
<tr>
<td>90</td>
<td>tree_mixed</td>
<td>DECF</td>
<td>-46 water</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-36 snow_and_ice</td>
</tr>
</tbody>
</table>

**S2. Data Processing**

**Individual Profile Operations**

Individual profiles were analysed to determine common features to elucidate the drivers of the pollutant vertical distribution. As a precursor step, to ensure pollutant and thermodynamic parameters were comparable, profile data was resampled into 50 metre altitude bins - the value in any given bin being the median of all points in that range.

**Convective Mixing Layer (CML):** This was estimated from a manual inspection of each profile and the spread of these automated methods: i) location of the point \(\frac{d\theta}{dz} \geq 2 \text{ K km}^{-1}\) (Fisch et al., 2004), following Seidel et al., (2010) the location of the minimal vertical gradient of ii) specific humidity, iii) relative humidity, iv) potential temperature and v) refractivity, plus vi) the Wang and Wang, (2014) approach of combining methods 2-5. The spread amongst these was often large for each profile, given the complex atmospheric structure encountered (e.g. multiple residual mixing layers), hence the necessity for a manual approach. For example, in Fig. 3, techniques 1-6 were in close agreement (100-150 m) given the sharp gradient in all parameters.
**Thermodynamic Layers**: The lifted condensation level (LCL), level of free convection (LFC) and limit of convection (LOC) were automatically calculated from the tephigrams in Fig. 3. These parameters were only calculated if data was present below 500 m. In profiles where the CML, LCL, LFC and LOC could not be calculated, e.g. a profile between 3-8 km with no near surface data, values from temporally and geographic neighbouring profiles were applied, if appropriate.

**Pollutants well mixed in the convective boundary layer**: Determined via comparison of the pollutant vertical gradient and pollutant variability within the CML. For the same definition thresholds to be used across all pollutants they were standardised via z-score normalisation. The gradient was calculated from fitting a straight line throughout the normalised data points within the CML region. The variability was represented via the standard deviation of this data. If the gradient was between +/- 0.0005 and the standard deviation less than 1.5 that pollutant was considered well mixed.

**Plumes**: Identified via first considering pollutants separately (steps 1-3) and then combined (step 4), via the following methodology:

1. A baseline was calculated as the moving 25th percentile over a 1500 m window to represent the underlying profile shape.
2. A value was then added to this baseline to create an upper threshold, any points above which are considered in excess of the background haze and represent a significant enhancement. The values chosen were the campaign 90th percentiles (above background) within the convective boundary layer (< 4 km), based on aircraft straight and level runs: 331 ppb for CO, 18.6 ppm for CO2, 1.32 µg sm^{-3} for rBC and 125 Mm^{-1} for σ_{sp}.
3. Any given exceedance of this threshold was defined as a potential plume. The footprint of this was then identified by locating the above/below altitudes at which pollutant values returned to ‘near baseline’. This was defined as the baseline plus the above background campaign 10th percentile of each pollutant within the lowest 4 km, calculated from the flight straight and level runs.
4. The plumes identified from each pollutant profile were then collated. If any plume footprints overlapped, these were deemed co-incident and the plume footprint was redefined to encompass the region of these plumes.

To our knowledge this is the first attempt at identifying plumes from vertical profiles within an already polluted boundary layer. Reported pollutant values/ratios are calculated as the plume integrated value across the total plume footprint.

**Horizontal wind speed maximum**: Starting at the lowermost altitude, the horizontal wind speed was interrogated to determine if it was greater than the wind speed at the next two altitudes. At points above 100 m, the wind speed was also required to be greater than the two altitudes below. A horizontal wind speed maxima was defined if these conditions were satisfied and the wind speed was also greater than some threshold. The threshold was defined in a similar manner to that used for plume identification: the moving 25th percentile over a 1500 m window (the baseline) plus a value of 1 m s^{-1}. Once a maxima is defined, the identification procedure begins again at the following altitude plus 100 m.

**Horizontal positive wind shear region**: ‘Positive’ wind shear refers to an increase in horizontal wind speed with altitude. Based on the assumption this will be associated with a local wind speed maxima the above approach is utilised, albeit with a greater threshold (+ 2m s^{-1}) given the coarser scale of wind shear regions. When the differential of the wind speed profile was less than zero at three successive altitudes below the wind speed maximum altitude, the base of the wind shear region was identified.

**Horizontal wind speed maximum coincident with pollutant maximum**: Pollutant maximum in each profile were identified in a similar manner to steps 1-3 in identifying plumes, only the upper threshold was lower – calculated as the campaign 25th percentile of each pollutant within the lowest 4 km, calculated from the flight straight and level runs. Data points +50, 0, and -50 m above each of the horizontal wind speed maximum were interrogated to determine if they also contained a pollutant maximum.

**Horizontal wind shear region coincident with pollutant reduction**: If the pollutant profile in the wind shear regions identified (see above) satisfied with the following three conditions, it was considered the shear was acting to reduce the pollutant concentrations: i) the differential of the pollutants was majoritively negative, ii) the pollutant median of the upper half of the shear range was lesser than that of the lower half, and iii) The range covered in this reduction was greater than some threshold, defined here as the campaign 25th minus 5th percentile from straight and level runs. Capturing this feature programmatically is difficult, yielding occasional
spurious results (Sect. S5). The results provide a broad and approximate insight into the prevalence of interactions between the horizontal wind speed and pollutant distribution rather than strict quantitative results.

**Residual Layer:** A pollutant residual layer was identified if burdens between the top of the mixing layer (or if absent, the surface) and 4 km exceeded those of unpolluted background conditions, defined as 0.1 ng cm\(^{-3}\) for rBC (Artaxo et al., 2013), 15 Mm\(^{-1}\) for \(\sigma_{sp}\) (Rizzo et al., 2013) and 140 ppb for CO (Andreae et al., 2012). CO\(_2\) not included in this analysis given the difficulty of determining unpolluted background concentrations.

**Pollutant transport via deep convection:** CO profiles with a sufficient vertical extent, of at least 5 km, were identified. The altitude of the CO minimum was identified and was used to determine a representative background concentration for the altitudes above and the altitude below. The altitude of the CO maximum above the minimum was identified and a representative CO maximum calculated from the concentration at that altitude, the altitude above and the altitude below. If the representative maximum CO concentration was greater than the representative minimum CO concentration plus a threshold of 40 ppb, transport via deep convection was identified. The rBC and \(\sigma_{sp}\) values were interrogated at the CO minimum and the altitudes of the maxima. If these were greater at the maximum altitude by 0.2 µg m\(^{-3}\) (rBC) or 25 Mm\(^{-1}\) (\(\sigma_{sp}\)) than transport via deep convection for these aerosol properties was also identified.

**Miscellaneous**

The scattering only aerosol optical depth (AOD) was calculated for each profile and plume therein as the integral of \(\sigma_{sp, amb}\) at ambient temperature and pressure.

The dropsonde altitude in metres was derived by applying the relationship between pressure and altitude from the aircraft to the dropsonde measured pressure.

Local time was defined as UTC minus 4 hours.

The relationships in Fig. 9 and trends in Fig. 5 are modelled by robust multilinear regressions using iteratively reweighted least squares with a bisquare weighting function.

The bulk of the analysis in this manuscript was undertaken with MATLAB 2012a. In the above instances, where the moving median is calculated, the function ‘moving’ was utilised – available at the MATLAB file exchange:

**S3. Tables**

<table>
<thead>
<tr>
<th>Feature</th>
<th>All</th>
<th>CO</th>
<th>CO$_2$</th>
<th>rBC</th>
<th>$\sigma_{sp, dry}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Profile frequency (# instances/ # profiles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well mixed thermodynamic and pollutant mixing layer - AM</td>
<td>6/2/34</td>
<td>23/7/31</td>
<td>25/6/24</td>
<td>50/15/50</td>
<td>45/15/33</td>
</tr>
<tr>
<td>Well mixed thermodynamic and pollutant mixing layer - PM</td>
<td>22/5/23</td>
<td>43/9/21</td>
<td>50/11/22</td>
<td>41/7/17</td>
<td>50/11/22</td>
</tr>
<tr>
<td>Pollutant residual layer present above mixing layer</td>
<td>73/52/71</td>
<td>88/60/88</td>
<td>89/55/62</td>
<td>97/67/69</td>
<td></td>
</tr>
<tr>
<td>Pollutant residual layer in absence of mixing layer</td>
<td>62/16/26</td>
<td>76/19/25</td>
<td>88/21/24</td>
<td>100/24/24</td>
<td></td>
</tr>
<tr>
<td>Coincident positive horizontal wind shear and pollutant reduction</td>
<td>16/14/90</td>
<td>59/51/84</td>
<td>48/40/84</td>
<td>41/33/81</td>
<td>41/35/85</td>
</tr>
<tr>
<td>Plume</td>
<td>18/12/65</td>
<td>45/28/62</td>
<td>57/55/61</td>
<td>70/40/57</td>
<td>55/36/55</td>
</tr>
<tr>
<td>Plume</td>
<td>10/12/122</td>
<td>35/41/118</td>
<td>34/39/114</td>
<td>71/75/105</td>
<td>42/50/119</td>
</tr>
</tbody>
</table>

Table S1. Prevalence of interactions between atmospheric structure and biomass burning pollutants

<table>
<thead>
<tr>
<th>% Plume occurrence in layer (# layer instances)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface $\rightarrow$ CML top</td>
</tr>
<tr>
<td>AM</td>
</tr>
<tr>
<td>CO</td>
</tr>
<tr>
<td>CO2</td>
</tr>
<tr>
<td>rBC</td>
</tr>
<tr>
<td>$\sigma_{sp, dry}$</td>
</tr>
</tbody>
</table>

Table S2. Prevalence of pollutant plumes in different thermodynamic layers, segregated by morning and afternoon. Bracketed values represent sample frequency of layers.

<table>
<thead>
<tr>
<th>All</th>
<th>E0</th>
<th>W1</th>
<th>W2</th>
<th>N1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO Deep convection</td>
<td>81.1 (53)</td>
<td>100 (2)</td>
<td>77.8 (18)</td>
<td>79.3 (29)</td>
</tr>
<tr>
<td>Co-incident rBC increase</td>
<td>8.1 (37)</td>
<td>0 (2)</td>
<td>10.0 (10)</td>
<td>9.5 (21)</td>
</tr>
<tr>
<td>Co-incident $\sigma_{sp}$ increase</td>
<td>2.7 (37)</td>
<td>0 (2)</td>
<td>0.0 (11)</td>
<td>4.8 (21)</td>
</tr>
</tbody>
</table>

Table S3. Percentage of sufficiently deep profiles showing evidence of CO transport via deep convection and co-incident increase in rBC and $\sigma_{sp}$. Bracketed values represent the number of sufficiently deep profiles.
S4. Figures

Figure S2. 2000-2014 climatology and 2012 anomaly of meteorological parameters. Skin temperature and cloud fraction are from the AIRS satellite instrument. Rainfall rates are from the TRMM satellite mission. Soil moisture and winds are from ECMWF reanalysis.

Figure S3. Pollutant profiles averaged over each regime with (dashed line) and without (solid line) plumes removed.

Figure S4. Additional median profiles of rBC properties by regime.
Fig S5. Median profiles of the scattering Angstrom exponent between 550 and 700 nm for each regime. Angstrom exponent calculated from nephelometer scattering coefficient measurements at these wavelengths. To reduce the noise the Angstrom exponent is only displayed here when the scattering coefficient at 550 nm was greater than 10 Mm$^{-1}$. Lighter shading represents the median absolute deviation.

Figure S6. History of air masses sampled during SAMBBA flights in each regime. Trajectories were released at 60 second intervals along each straight and level run and profile and calculated 120 hours backward. The occurrence in each 1° grid was calculated and normalised.
across the whole domain to produce % contributions. Trajectories were calculated using the HYSPLIT model (Stein et al., 2015) using GDAS (Global Data Assimilation System) meteorological fields.

Figure S7.a. Lidar curtain (main panel) for flight b733. Side panel shows a comparison of in-situ $\sigma_{p,\text{dry}}$ to local Lidar extinction coefficients (at 532). $\sigma_{p,\text{dry}}$ is reported at ambient temperature and pressure, with the profile# corresponding to the library of profiles (Sect S5). Colour of lidar profiles corresponds to the coloured markers at the base of the main panel. Lidar curtain reproduced with permission from (Marenco et al., 2016).

Figure S7.b. As (a) but flight b734

Figure S7.c. As (a) but flight b741
Figure S7.d. As (a) but flight b742

Figure S7.e. As (a) but flight b743

Figure S7.f. As (a) but flight b746
Figure S8. Geographic profile frequency plot on 1-degree grid during phase 1 (left) and phase 2 (right) for nephelometer (top) and lidar (bottom). East (orange), west (turquoise) and north (grey) domains displayed, the former two of which represent the regions averaged over for the profiles presented in Fig. 10.

Figure S9. CO emissions on 20th September 2012 from biomass burning (left) and anthropogenic sources (right). Fire CO emissions are derived from the Brazilian Biomass Burning Emission Model (3BEM). Anthropogenic CO emissions are derived from the Emissions Database for Global Atmosphere Research (EDGAR) version 4.0 2005. Both emissions maps were generated using PREP-CHEM-SRC v1.4 as described in Archer-Nicholls et al., (2015). The dashed grey box represents the flight area and near-surface air mass history. The sum of the emissions flux within this area is 1.11 Mmol hr\(^{-1}\) for fire CO and 0.29 Mmol hr\(^{-1}\) for anthropogenic CO.
Figure S10. Emissions factors for aerosol:CO plotted against the MCE. Derived from past literature studies in tropical South America (Ferek et al., 1998; Yokelson et al., 2007).

Figure S11. Enhancement factors calculated from straight and level plume intercepts during SAMBBA for a) rBC and b) $\sigma_{sp,dry}$ ratioed to CO against the modified combustion efficiency (MCE). Enhancement ratios and MCE calculated following the approach of (Hodgson et al., 2018). Relationships are modelled by robust multilinear regressions using iteratively reweighted least squares with a bisquare weighting function. These relationships are categorised by regime, although W1 is split into the contributions from flight b737 and other flights – this is because the single large deforestation wildfire sampled in b737 is likely unique for the region (Hodgson et al., 2018).
Figure. S12. Histograms of plume frequency by altitude, weighted by sample points.

Figure. S13. (Overleaf). Library of CALIPSO attenuated backscatter and aerosol subtype curtains from overpasses for the air mass footprint of flights b741, b742 and b743. This includes any overpass off the coast of TSA between 15°N, 15°S, 50°W and 10°E and the dates 21st – 27th September. This is approximately the air mass footprint for E0 but does not include flight b748 (2nd October) which contributed 1 profile to the average profile in Fig. 8. The figures presented are compiled from the ‘Lidar Browse Images’ section of the CALIPSO webpage (https://www-calipso.larc.nasa.gov/products/lidar/browse_images/production/) and represent version 4.0 level 1 CALIPSO data.

References


Marenco, F., Johnson, B., Langridge, J. M., Mulcahy, J., Benedetti, A., Remy, S., Jones, L., Szpek, K., Haywood, J., Longo, K. and


S5. Individual Profile Library

Each profile is displayed in a similar format to Fig. 3, in order of time of day sampled.
Profile ID #24
b744, 28/09
09:11 Local
WEST P2
Profile ID #43
09:46 Local
WEST P2

Wind speed max.
Horizontal wind shear zone
Convective mixing layer (CML)
Level of free convection (LFC)
Lifted condensation level (LCL)

Wind Speed (m s\(^{-1}\))
RH (%)
Temperature (°C)
rBC Mass (ug sm\(^{-3}\))
σ\(_{sp,550 \text{ nm}}\) (m\(^{-1}\))
CO (ppb)
CO\(_2\) (ppm)
rBC Coating (nm)

Baseline
Upper threshold
Lower threshold
Smoke plume
Urban plume
Spurious plume

Pollutants well mixed (Yes/No)
Pollutant residual layer (Yes/No)
Horizontal wind shear capping
Coincident wind & pollutant maximum

Profile ID #43 09:46 Local
b744, 28/09 WEST P2
Profile ID #89

b744, 28/09

10:58 Local

WEST P2

Wind speed max.

Convective mixing layer (CML)

Limit of convection (LOC)

Level of free convection (LFC)

Lifted condensation level (LCL)

Pollutants well mixed (Yes/No)

Pollutant residual layer (Yes/No)

Horizontal wind shear capping

Coincident wind & pollutant maximum

Baseline

Upper threshold

Lower threshold

Smoke plume

Urban plume

Spurious plume

Pollutants well mixed (Yes/No)

Pollutant residual layer (Yes/No)

Horizontal wind shear capping

Coincident wind & pollutant maximum

Wind Speed (m s\(^{-1}\))

Temperature (°C)

RH (%)

q (g kg\(^{-1}\))

\(\theta\) (K)

\(\theta_e\) (K)

Temperature

rBC Mass (ug sm\(^{-3}\))

\(\sigma_{sp,550\text{ nm}}\) (m\(^{-1}\))

CO (ppb)

CO2 (ppm)

rBC Coating (nm)

Profile ID #89 10:58 Local

b744, 28/09 WEST P2
Profile ID #95
b741, 26/09
11:12 Local

Horizontal wind shear zone
Convective mixing layer (CML)
Limit of convection (LOC)
Level of free convection (LFC)
Lifted condensation level (LCL)

Wind speed max.

Pollutants well mixed (Yes/No)
Pollutant residual layer (Yes/No)

Baseline
Upper threshold
Lower threshold
Smoke plume
Urban plume
Spurious plume

Horizontal wind shear capping
Coincident wind & pollutant maximum

Pollutants well mixed?
Pollutant residual layer?

Wind direction
Wind speed
RH
Temperature
Concentration

0 5 10 15
0 5 10
0 100
0 50
0 10

0 50 100 150
0 5 10 15
0 300 310 320 330
0 320 325 330 335

CO
CO2
rBC coating

Profile ID #95 11:12 Local
b741, 26/09 WEST P2
Profile ID #131
b746, 29/09
12:03 Local
WEST P2

Wind speed max.
Horizontal wind shear zone

Convective mixing layer (CML)
Level of free convection (LFC)
Lifted condensation level (LCL)

Baseline
Upper threshold
Lower threshold
Smoke plume
Urban plume
Spurious plume

Pollutants well mixed (Yes/No)
Pollutant residual layer (Yes/No)

Horizontal wind shear capping
Coincident wind & pollutant maximum

Pressure (kPa)

Wind Speed (m s\(^{-1}\))

RH (%)

q (g kg\(^{-1}\))

\(\theta\) (K)

\(\theta_e\) (K)

\(\sigma_{sp,550\ nm}\) (m\(^{-1}\))

CO (ppb)

CO\(_2\) (ppm)
rBC Mass (ug sm\(^{-3}\))
rBC Coating (nm)

Temperature (°C)

A
B
C

Legend:

0
5
10
15
20
30
40
50
60
70
80
90
100

0
5
10
15
20
30

0
10
20
30

0
10
20
30

0
10
20
30

0
10
20
30

0
10
20
30

0
10
20
30

Profile ID #131 12:03 Local
b746, 29/09 WEST P2
Profile ID #152
b749, 03/10
12:49 Local
WEST P2

- Wind speed max.
- Horizontal wind shear zone
- Convective mixing layer (CML)
- Limit of convection (LOC)
- Level of free convection (LFC)
- Lifted condensation level (LCL)
- Pollutants well mixed (Yes/No)
- Pollutant residual layer (Yes/No)
- Horizontal wind shear capping
- Coincident wind & pollutant maximum

- Pressure (kPa)
- Horizontal wind shear zone

- Wind speed (m s$^{-1}$)
- RH (%)
- Temperature ($^\circ$C)
- rBC Mass (ug sm$^{-3}$)
- σ$_{sp,550}$ nm (m$^{-1}$)
- CO (ppb)
- CO2 (ppm)
- rBC Coating (nm)

- Wind Direction ($^\circ$)
- q (g kg$^{-1}$)
- θ (K)
- θ$_e$ (K)

A B C D.i .ii E.i .ii F.i .ii G.i .ii H

Profile ID #152 12:49 Local
b749, 03/10 WEST P2
Wind speed max.

Convective mixing layer (CML)

Limit of convection (LOC)
Level of free convection (LFC)
Lifted condensation level (LCL)

Pollutants well mixed (Yes/No)

Baseline
Upper threshold
Lower threshold
Smoke plume
Urban plume
Spurious plume

Pollutant residual layer (Yes/No)
Horizontal wind shear capping
Coincident wind & pollutant maximum

Baseline
Upper threshold
Lower threshold

Wind speed (m s\(^{-1}\))
RH (%)
Temperature (°C)
rBC Mass (ug sm\(^{-3}\))

σ\(_{sp,550\ \text{nm}}\) (m\(^{-1}\))
CO (ppb)
CO\(_2\) (ppm)
rBC Coating (nm)

Profile ID #157 13:32 Local

b731, 14/09 WEST P1
- Wind speed max.
- Horizontal wind shear zone
- Convective mixing layer (CML)
- Limit of convection (LOC)
- Level of free convection (LFC)
- Lifted condensation level (LCL)
- Pollutants well mixed (Yes/No)
- Pollutant residual layer (Yes/No)
- Horizontal wind shear capping
- Coincident wind & pollutant maximum
- Smoke plume
- Urban plume
- Spurious plume

Wind Speed (m s$^{-1}$)
RH (%)
Temperature (°C)
rBC Mass (μg sm$^{-3}$)
σ$_{sp,550 \text{ nm}}$ (m$^{-1}$)
CO (ppb)
CO$_2$ (ppm)
rBC Coating (nm)

Profile ID #180  15:52 Local
b736, 19/09  WEST P1
Profile ID #187

b745, 28/09

16:18 Local

WEST P2

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0 0.5 1

30 40 50 60 70 80 90 100

Pressure (kPa)

Horizontal wind shear zone

Convective mixing layer (CML)

Limit of convection (LOC)

Level of free convection (LFC)

Lifted condensation level (LCL)

Wind speed max.

Pollutants well mixed (Yes/No)

Pollutant residual layer (Yes/No)

Horizontal wind shear capping

Coincident wind & pollutant maximum

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A

B

C

D.i

E.i

F.i

G.i

H

---

0 2 4 6 8

0 5 10 20 30

300 350 400

Wind Speed (m s$^{-1}$)

RH (%)

Temperature (°C)

rBC Mass (ug sm$^{-3}$)

σ$_{sp,550}$ nm (m$^{-1}$)

CO (ppb)

CO$_2$ (ppm)

rBC Coating (nm)

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Profile ID #187 16:18 Local

b745, 28/09 WEST P2
Profile ID #188
b745, 28/09
16:18 Local
WEST P2

Wind speed max.
Horizontal wind shear zone
Convective mixing layer (CML)
Level of free convection (LFC)
Lifted condensation level (LCL)
Limit of convection (LOC)
Baseline
Upper threshold
Lower threshold
Smoke plume
Urban plume
Spurious plume
Horizontal wind shear capping
Coincident wind & pollutant maximum

Pollutants well mixed (Yes/No)
Pollutant residual layer (Yes/No)

Wind Speed (m s\(^{-1}\))
Wind Direction (°)
RH (%)
q (g kg\(^{-1}\))
\(\theta\) (K)
\(\theta_e\) (K)
Temperature (°C)
rBC Mass (ug sm\(^{-3}\))
\(\sigma_{sp,550 \text{ nm}}\) (m\(^{-1}\))
CO (ppb)
CO2 (ppm)
rBC Coating (nm)

Profile ID #188 16:18 Local
b745, 28/09 WEST P2
A. Wind speed max.
B. Horizontal wind shear zone
C. Convective mixing layer (CML)
D. Limit of convection (LOC)
E. Level of free convection (LFC)
F. Lifted condensation level (LCL)
G. Pollutants well mixed (Yes/No)
H. Pollutant residual layer (Yes/No)

Pressure (kPa)

Pressure

Wind Speed (m s$^{-1}$)

RH (%)

Temperature ($^\circ$C)

rBC Mass (ug sm$^{-3}$)

σ$_{sp,550}$ nm (m$^{-1}$)

CO (ppb)

CO$_2$ (ppm)

rBC Coating (nm)

Profile ID #195  17:16 Local

b750, 03/10  WEST P2