Supplement of Atmos. Chem. Phys., 20, 7941–7954, 2020
https://doi.org/10.5194/acp-20-7941-2020-supplement
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Supplement of

An investigation on hygroscopic properties of 15 black carbon (BC)-containing particles from different carbon sources: roles of organic and inorganic components

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Table S1. Bulk elemental compositions determined by elemental analysis and surface elemental compositions determined by X-ray photoelectron spectroscopy (XPS) of different BCPs.

| BCPs     | Bulk elemental compositions<sup>a</sup> | Surface elemental compositions<sup>b</sup> |
|----------|--------------------------------------|------------------------------------------|
|          | C (wt%) | O (wt%) | H (wt%) | N (wt%) | S (wt%) | Ash (wt%) | C (wt%) | O (wt%) | N (wt%) | Si (wt%) | S (wt%) |
| Amaranth | 32.08   | 21.92   | 2.56    | 0.781   | 40.03   | 75.21     | 18.98   | 4.28    | 1.05    | 0.47     |
| Grass    | 58.8    | 23.18   | 3.92    | 0.156   | 11.66   | 76.02     | 19.53   | 2.67    | 1.42    | 0.37     |
| Peanuts  | 49.31   | 18.35   | 3.81    | 0.874   | 26.17   | 71.44     | 22.52   | 3.4     | 2.25    | 0.4      |
| Pea      | 64.065  | 22.19   | 4.13    | 0.454   | 7.809   | 74.75     | 20.56   | 2.62    | 1.75    | 0.32     |
| Rice     | 54.87   | 17.4    | 3.35    | 0.315   | 23.31   | 73.39     | 20.37   | 1.57    | 4.67    | ND<sup>c</sup> |
| Wheat    | 50.895  | 18.85   | 3.22    | 0.405   | 25.66   | 69.69     | 22.86   | 2.82    | 4.63    | ND<sup>c</sup> |
| Millet   | 41.66   | 20.23   | 3.09    | 0.468   | 32.64   | 61.1      | 29.02   | 3.84    | 5.52    | 0.51     |
| Corn     | 53.02   | 16      | 2.7     | 1.305   | 0.39    | 26.59     | 76.72   | 17.88   | 1.97    | 3.42     | ND<sup>c</sup> |
| Sorghum  | 64.35   | 20.04   | 4.03    | 0.334   | 10.41   | 73.28     | 22.85   | 1.58    | 1.96    | 0.32     |
| Bamboo   | 68.535  | 19.86   | 3.54    | 0.168   | 7.456   | 76.28     | 19.39   | 1.11    | 2.88    | 0.34     |
| Red pine | 69.985  | 25.52   | 3.8     | 0.077   | 0.395   | 82.9      | 16.43   | ND<sup>c</sup> | 0.66 | ND<sup>c</sup> |
| Poplar   | 71.795  | 23.63   | 3.78    | 0.129   | 0.245   | 86.57     | 12.59   | ND<sup>c</sup> | 0.84 | ND<sup>c</sup> |
| Diesel engine soot | 36.94 | 20.05   | 2.64    | 1.652   | 35.41   | 78.95     | 18.72   | 1.07    | 1.26    | ND<sup>c</sup> |
| Weifu diesel soot | 76.455 | 18.51   | 2.19    | 0.385   | 0.979   | 1.482     | 78.07   | 21.15   | ND<sup>c</sup> | 0.78 | ND<sup>c</sup> |
| Household soot | 37.075 | 22.07   | 2.89    | 3.655   | 1.734   | 32.58     | 76.09   | 19.3    | 2.97    | 0.6      |

<sup>a</sup>Determined by EA. <sup>b</sup>Determined by XPS. <sup>c</sup>Not detected.
Table S2. Elemental composition, ash content, atomic ratio, and polarity index of alkali-extracted organic carbon (OC$_{AE}$) from three representative BCPs by elemental analysis.

| Samples              | Compositions (wt%) | Ash  |
|----------------------|--------------------|------|
|                      | C      | O      | H      | N      | S      | H/C   | (O+N)/C |       |
| Grass OC$_{AE}$       | 28.16  | 27.14  | 3.02   | 1.41   | 0.49   | 0.11  | 1.01    | 39.78 |
| Wheat OC$_{AE}$       | 18.61  | 21.98  | 2.71   | 0.46   | 0.91   | 0.15  | 1.21    | 55.33 |
| Household soot OC$_{AE}$ | 56.56 | 31.31  | 5.03   | 6.14   | 0.96   | 0.09  | 0.66    | ND$^a$ |

$^a$Not detected.
Table S3. Ratio of the peak intensities of D band (1350 cm\(^{-1}\)) to G band (1582 cm\(^{-1}\)) of Raman spectra for different BCPs.

| BCPs          | I\(_D\)/I\(_G\) \(^\text{a}\) |
|---------------|---------------------------------|
| Amaranth      | 1.01                            |
| Grass         | 0.88                            |
| Peanuts       | 0.89                            |
| Pea           | 0.85                            |
| Rice          | 1.09                            |
| Wheat         | 0.98                            |
| Millet        | 0.86                            |
| Corn          | 0.94                            |
| Sorghum       | 0.9                             |
| Bamboo        | 1.09                            |
| Red pine      | 0.59                            |
| Poplar        | 0.57                            |
| Diesel engine soot | 1.04                      |
| Weifu diesel soot | 1.12                       |
| Household soot | 0.77                           |
Table S4. Porosity properties of different BCPs.

| BCPs          | $V_{\text{mic}}^a$ | $V_{\text{mes}}^b$ |
|---------------|--------------------|--------------------|
| Amaranth      | 0.001              | 0.003              |
| Grass         | 0.003              | 0.005              |
| Peanuts       | 0.001              | 0.001              |
| Pea           | 0.003              | 0.002              |
| Rice          | 0.013              | 0.01               |
| Wheat         | 0.005              | 0.005              |
| Millet        | 0.004              | 0.019              |
| Corn          | 0.015              | 0.013              |
| Sorghum       | 0.001              | 0             |
| Bamboo        | 0.025              | 0.004              |
| Red pine      | 0.03               | 0.002              |
| Poplar        | 0.048              | 0.023              |
| Diesel engine soot | 0.008          | 0.013              |
| Weifu diesel soot | 0.068          | 0.416              |
| Household soot | 0.003            | 0.009              |

$^a$Micropore volume, calculated using the Horvath-Kawazoe method.

$^b$Mesopore volume, determined by subtraction of micropore volume from total pore volume which is shown in Table 1.
Table S5. Salinities of water extracts of different BCPs (BCPs to water ratio: 1/10, w/w).

| BCPs              | Salinity (‰) |
|-------------------|--------------|
| Amaranth          | 0.180        |
| Grass             | 0.080        |
| Peanuts           | 0.070        |
| Pea               | 0.060        |
| Rice              | 0.010        |
| Wheat             | 0.097        |
| Millet            | 0.133        |
| Corn              | 0.030        |
| Sorghum           | 0.080        |
| Bamboo            | 0.010        |
| Red pine          | 0.000        |
| Poplar            | 0.010        |
| Diesel engine soot| 0.060        |
| Weifu diesel soot | 0.057        |
| Household soot    | 0.217        |
Table S6. Mineral compositions of different BCPs measured by X-ray fluorescence spectroscopy (XRF).

| BCPs          | Mineral compositions (%) |
|---------------|--------------------------|
|               | SO₃  | CaO  | P₂O₅ | Al₂O₃ | ZnO  | SiO₂ | Fe₂O₃ | Cl   | K₂O  | MgO  | Na₂O | MnO  | CuO  | PbO  | NiO  | TiO₂ | Cr₂O₃ | BaO  | Sr   |
| Amaranth      | 0.500| 1.070| 0.240| 0.480| 0.002| 1.730| 0.210| 0.170| 2.140| 1.060| 0.130| 0.006| 0.001| ND³ | ND³ | 0.022| ND³ | 0.007| 0.002|   |
| Grass         | 0.092| 0.290| 0.360| 0.037| 0.001| 1.500| 0.014| 0.140| 2.380| ND³  | ND³  | 0.004| ND³  | ND³  | ND³ | ND³  | 0.001| ND³  | ND³  | ND³  |   |
| Peanuts       | 0.120| 0.510| 0.320| 0.310| 0.002| 1.920| 0.073| 0.038| 1.260| 0.360| 0.058| 0.015| ND³  | ND³  | ND³  | 0.011| ND³  | ND³  | ND³  |   |
| Pea           | 0.120| 0.480| 0.120| 0.016| N.D. | 0.120| 0.007| 0.008| 0.770| 0.340| 0.021| N.D. | ND³  | ND³  | ND³  | ND³  | ND³  | ND³  | ND³  |   |
| Rice          | 0.024| 0.050| 0.030| 0.016| 0.001| 2.630| 0.005| 0.006| 0.220| 0.023| ND³  | 0.006| ND³  | ND³  | ND³  | ND³  | ND³  | ND³  |   |
| Wheat         | 0.160| 0.230| 0.110| 0.085| ND³  | 4.020| 0.039| 0.490| 1.720| 0.100| 0.036| 0.009| ND³  | ND³  | ND³  | 0.005| ND³  | ND³  | ND³  |   |
| Millet        | 0.210| 0.360| 0.340| 0.040| 0.007| 5.750| 0.028| 0.160| 2.290| 0.790| ND³  | 0.007| ND³  | ND³  | 0.002| ND³  | ND³  | ND³  | 0.011|   |
| Corn          | 0.160| 0.360| 0.150| 0.110| N.D. | 3.740| 0.038| 0.260| 1.200| 0.190| 0.027| 0.022| ND³  | 0.004| ND³  | 0.007| ND³  | ND³  | ND³  |   |
| Sorghum       | 0.190| 0.710| 0.059| 0.047| 0.002| 0.500| 0.025| 0.300| 1.820| 0.320| 0.037| 0.002| ND³  | ND³  | ND³  | ND³  | ND³  | ND³  | ND³  |   |
| Bamboo        | 0.120| 0.110| 0.180| 0.260| 0.003| 1.280| 0.029| 0.130| 1.630| 0.110| ND³  | 0.016| ND³  | ND³  | 0.003| ND³  | ND³  | ND³  | ND³  |   |
| Red pine      | 0.010| 0.110| 0.008| 0.006| N.D. | 0.026| 0.002| 0.002| 0.072| 0.230| ND³  | 0.005| ND³  | ND³  | ND³  | ND³  | ND³  | ND³  | ND³  |   |
| Poplar        | 0.150| 0.980| 0.280| 0.019| 0.003| 0.220| 0.010| 0.046| 1.040| 0.025| ND³  | 0.004| ND³  | ND³  | ND³  | ND³  | ND³  | ND³  | ND³  |   |
| Diesel engine soot | 2.890| 1.090| 0.200| 0.180| N.D. | 0.900| 3.090| 0.100| 0.067| 0.100| 0.054| 0.013| ND³  | ND³  | 0.013| 0.019| 0.010| 0.013| ND³  |   |
| Weifu soot    | 0.250| 0.230| 0.094| 0.036| 0.019| 0.016| 0.014| 0.006| 0.002| 0.170| ND³  | 0.001| 0.002| 0.003| 0.001| ND³  | 0.002| ND³  | ND³  |   |
| Household soot| 1.530| 1.730| 0.130| 0.740| 0.005| 2.550| 0.230| 2.070| 0.960| 0.240| 0.055| 0.037| ND³  | ND³  | 0.051| ND³  | 0.012| 0.002|   |

*Not detected.
Table S7. Ionic constituents of different BCPs measured by ion chromatography.

| BCPs       | Na⁺ | NH₄⁺ | K⁺  | Mg²⁺ | Ca²⁺ | Cl⁻  | COO⁻  | C₂O₄²⁻ | SO₄²⁻ | NO₃⁻ | PO₄³⁻ | F⁻  |
|------------|-----|------|-----|------|------|------|-------|-------|-------|------|-------|-----|
| Amaranth   | 1.6 | 0.77 | 9.52| 7.64 | 0.86 | 13.46| ND    | ND    | 14.9  | 0.17 | 1.94  | 0.09|
| Grass      | 1.71| 2.37 | 6.4 | 0.72 | 2.57 | 8.43 | 0.79  | 0.54  | 2.27  | 0.22 | 2.7   | 0.1 |
| Peanuts    | 0.4 | 0.36 | 5.79| 0.41 | 0.43 | 0.69 | 0.04  | 2.07  | 3.72  | 0.05 | 0.67  | 0.34|
| Pea        | 2.03| 2.26 | 4.74| 0.78 | 1.43 | 0.28 | 0.06  | 2.69  | 5.56  | 0.1  | 0.45  | 0.15|
| Rice       | 0.57| 2.69 | 0.13| 0.11 | 0.26 | 0.06 | 0.01  | 1.06  | 0.63  | 0.01 | 0.16  | 0.01|
| Wheat      | 0.79| 1.58 | 7.5 | 0.19 | 0.47 | 3.92 | 0.03  | ND    | 6.95  | 0.16 | 0.73  | ND  |
| Millet     | 2.42| 2.62 | 10.55| 1.77 | 1.61 | 1.22 | 0.18  | 15.37 | 7.98  | 0.07 | 1.63  | 0.14|
| Corn       | 0.19| 1.93 | 2.13| 0.28 | 0.51 | 4.42 | 0.05  | 0.87  | 3.38  | 0.02 | 0.91  | 0.03|
| Sorghum    | 0.74| 0.57 | 5.94| 0.63 | 1    | 1.72 | 0.06  | 0.76  | 4.63  | 0.11 | 0.22  | 0.29|
| Bamboo     | 0.25| 2.67 | 0.11| 0.11 | 0.24 | 0.04 | 0.03  | 0.85  | 0.87  | 0.02 | 0.25  | 0.01|
| Red pine   | 0.15| 1.28 | 0.15| 0.05 | 0.13 | 0.05 | 0.02  | N.D.  | 0.14  | 0.06 | 0.08  | 0.003|
| Poplar     | 0.1 | 0.55 | 0.42| 0.17 | 0.38 | 0.28 | 0.01  | 0.07  | 0.38  | 0.01 | 0.24  | 0.5 |
| Diesel engine soot | 1.72| 4.88 | 0.35| 0.97 | 3.74 | 0.31 | 0.13  | 1.76  | 30.06 | 0.15 | 0.39  | 0.6 |
| Weifū soot | 1.15| 0.13 | 0.07| 0.29 | 3.65 | 0.19 | ND    | ND    | 23.51 | 0.2  | 5.41  | 0.42|
| Household soot | 1.2 | 19.71| 2.69| 1.7  | 4.85 | 47.51| ND    | ND    | 26.63 | 0.96 | ND    | 0.36|

aN: Not detected.
Table S8. Accuracy ($R^2$ and $P$) values for regression on equilibrium water uptake against compositional and pore property parameters at different relative humidity (RH) levels.

| Composition          | 23% RH | 33% RH | 43% RH | 47% RH | 75% RH | 84% RH | 94% RH |
|----------------------|--------|--------|--------|--------|--------|--------|--------|
| OC$_{TGA}$           | 0.32   | 0.028  | 0.36   | 0.0187 | 0.4    | 0.0113 | 0.47   | 0.0048 | 0.7    | 0.0001 | 0.82   | <0.0001 | 0.52   | 0.0002 |
| OC$_{AE}$            | 0.12   | 0.207  | 0.14   | 0.1652 | 0.17   | 0.1311 | 0.22   | 0.08   | 0.41   | 0.0097 | 0.64   | 0.0004 | 0.8    | 0.0001 |
| EC                   | 0.21   | 0.083  | 0.21   | 0.087  | 0.22   | 0.0798 | 0.25   | 0.06   | 0.39   | 0.0122 | 0.51   | 0.003  | 0.54   | 0.0019 |
| Dissolved minerals   | 0.1    | 0.2471 | 0.11   | 0.23   | 0.12   | 0.2111 | 0.39   | 0.15   | 0.27   | 0.0468 | 0.45   | 0.0064 | 0.86   | 0.0001 |
| NH$_4^+$             | 0.1    | 0.2548 | 0.13   | 0.19   | 0.16   | 0.1444 | 0.21   | 0.09   | 0.42   | 0.0092 | 0.6    | 0.0007 | 0.54   | 0.0034 |
| Cl$^-$               | 0.04   | 0.4635 | 0.06   | 0.39   | 0.07   | 0.3305 | 0.11   | 0.23   | 0.24   | 0.0619 | 0.43   | 0.0076 | 0.7    | 0.0001 |
| C$_2$O$_4^{2-}$      | 0.06   | 0.1938 | 0.05   | 0.2088 | 0.05   | 0.2120 | 0.05   | 0.2057 | 0.03   | 0.2415 | 0.02   | 0.2752 | 0.002  | 0.8893 |
| SO$_4^{2-}$          | 0.02   | 0.6518 | 0.01   | 0.7    | 0.006  | 0.7933 | 0.0003 | 0.95   | 0.06   | 0.395  | 0.15   | 0.1588 | 0.24   | 0.06   |
| Total porosity       | 0.42   | 0.0095 | 0.4    | 0.01   | 0.39   | 0.0129 | 0.37   | 0.02   | 0.29   | 0.0368 | 0.22   | 0.0761 | 0.08   | 0.3    |
| K$^+$                | 0.19   | 0.1088 | 0.16   | 0.139  | 0.14   | 0.1647 | 0.14   | 0.1764 | 0.09   | 0.2664 | 0.1    | 0.245  | 0.27   | 0.045  |
Table S9. Fitting parameters for water uptake kinetics of BCPs by pseudo-first-order model at different relative humidity (RH) levels.

| BCPs      | 33% RH | 47% RH | 94% RH |
|-----------|--------|--------|--------|
|           | $k_1$ | $Q_e$ (cal) | $Q_e$ (exp) | $R^2$ | $k_1$ | $Q_e$ (cal) | $Q_e$ (exp) | $R^2$ | $k_1$ | $Q_e$ (cal) | $Q_e$ (exp) | $R^2$ |
|           | (10^{-5} s^{-1}) | (mg g^{-1}) | (mg g^{-1}) |      | (10^{-5} s^{-1}) | (mg g^{-1}) | (mg g^{-1}) |      | (10^{-5} s^{-1}) | (mg g^{-1}) | (mg g^{-1}) |      |
| Amaranth  | 2±2   | 9±1     | 18±1    | 0.9879 | 2.01±0.03 | 22±2 | 30±1    | 0.9885 | 10±0   | 290±40 | 270±3   | 0.9993 |
| Grass     | 3±2   | 10±2    | 16±3    | 0.9792 | 2±2     | 21±1 | 38±4    | 0.9359 | 0.9±0.1 | 120±10 | 180±6   | 0.9723 |
| Peanuts   | 2±2   | 6±1     | 27±1    | 0.983  | 2±1     | 13±0 | 41±2    | 0.9154 | 10±0   | 100±10 | 140±4   | 0.9558 |
| Pea       | 1±1   | 9±3     | 27±1    | 0.9979 | 2±3     | 15±2 | 45±6    | 0.9571 | 0.9±0.2 | 55±3   | 120±6   | 0.9258 |
| Rice      | 0.4±0.1 | 5±2    | 21±4    | 0.9759 | 0.8±0.1 | 6±0 | 29±2    | 0.8805 | 1.4±0.1 | 25±0   | 55±3    | 0.8778 |
| Wheat     | 1±1   | 9±2     | 21±5    | 0.948  | 3±1     | 15±4 | 40±4    | 0.9998 | 1.5±1.3 | 230±60 | 240±2   | 0.8017 |
| Millet    | 2±1   | 13±0    | 38±5    | 0.9831 | 3±2     | 12±3 | 54±2    | 0.9804 | 1.3±0.6 | 96±7   | 190±7   | 0.8805 |
| Corn      | 0.7±0.1 | 7±1    | 19±6    | 0.9042 | 3±1     | 15±2 | 28±0    | 0.9643 | 1.3±0.6 | 62±6   | 96±3    | 0.9663 |
| Sorghum   | 1±1   | 12±1    | 30±13   | 0.9491 | 0.9±0.1 | 11±3 | 44±2    | 0.9709 | 1.3±0.6 | 130±12 | 190±10  | 0.9564 |
| Bamboo    | 1±0   | 7±6     | 33±3    | 0.9159 | 0.6±0.4 | 10±2 | 50±8    | 0.9138 | 2±1    | 19±1   | 72±9    | 0.8948 |
| Redpine   | 0.7±0.1 | 4.2±0.2 | 22±2    | 0.8172 | 5±3     | 20±6 | 39±1    | 0.8068 | 1±1    | 20±5   | 68±2    | 0.8252 |
| Poplar    | 0.7±0.1 | 6.0±1.21 | 26±2    | 0.8745 | 2±1     | 8±2  | 33±2    | 0.8218 | 0.9±0.2 | 18±2   | 63±2    | 0.8771 |
| Diesel engine soot | 0.8±0.3 | 2.2±0.3 | 13±1    | 0.9932 | 0.8±0.4 | 8±3  | 30±7    | 0.9462 | 2±1    | 90±21  | 140±4   | 0.9686 |
| Weifu diesel soot | 0.4±0.1 | 14±5   | 21±14   | 0.8009 | 3±1     | 12±1 | 32±7    | 0.8926 | 6±1    | 31±7   | 69±6    | 0.9858 |
| Household soot | 1±0   | 2.12±0.01 | 9±1    | 0.8569 | 3±1     | 17±4 | 29±2    | 0.9524 | 1±1    | 410±40 | 420±20  | 0.9889 |

aPseudo-first-order rate constant. bModel calculated maximum sorbed concentration at equilibrium. cMeasured maximum sorbed concentration at equilibrium.
### Table S10. Fitting parameters for water uptake kinetics of BCPs by pseudo-second-order model at different relative humidity (RH) levels.

| BCPs      | 33% RH |          |          |          | 47% RH |          |          |          | 94% RH |          |          |          |
|-----------|--------|----------|----------|----------|--------|----------|----------|----------|--------|----------|----------|----------|
|           | $k_2$  | $Q_e$ (cal)$^b$ | $Q_e$ (exp)$^c$ | $R^2$    | $k_2$  | $Q_e$ (cal)$^b$ | $Q_e$ (exp)$^c$ | $R^2$    | $k_2$  | $Q_e$ (cal)$^b$ | $Q_e$ (exp)$^c$ | $R^2$    |
|           | (10$^{-5}$ g mg$^{-1}$ s$^{-1}$) | (mg g$^{-1}$) | (mg g$^{-1}$) |          | (10$^{-5}$ g mg$^{-1}$ s$^{-1}$) | (mg g$^{-1}$) | (mg g$^{-1}$) |          | (10$^{-7}$ g mg$^{-1}$ s$^{-1}$) | (mg g$^{-1}$) | (mg g$^{-1}$) |          |
| Amaranth  | 0.5±0.1 | 18±1     | 18±1     | 0.9954   | 0.14±0.01 | 34±1     | 30±1     | 0.963   | 0.31±0.02 | 330±11    | 260±4    | 0.9943   |
| Grass     | 0.52±0.04 | 17±2     | 16±3     | 0.966    | 0.20±0.03 | 40±3     | 38±4     | 0.984   | 1.7±0.1   | 190±5     | 170±6    | 0.9975   |
| Peanuts   | 2±1    | 28±0     | 27±1     | 0.995    | 0.6±0.2  | 41±2     | 41±2     | 0.983   | 2.6±0.2   | 150±3     | 140±4    | 0.9974   |
| Pea       | 0.8±0.2 | 28±1     | 27±1     | 0.9967   | 0.5±0.1  | 46±7     | 45±6     | 0.987   | 5.3±0.4   | 120±5     | 120±6    | 0.9984   |
| Rice      | 1.7±0.3 | 21±4     | 21±4     | 0.9955   | 5±2      | 28±2     | 29±2     | 0.9917  | 28±2      | 55±4      | 55±3     | 0.9985   |
| Wheat     | 0.7±0.1 | 21±5     | 21±5     | 0.9945   | 1.2±0.1  | 37±9     | 40±4     | 0.9959  | 0.5±0.1   | 290±0     | 240±3    | 0.9889   |
| Millet    | 0.6±0.2 | 39±5     | 38±5     | 0.9995   | 0.8±0.2  | 54±2     | 54±2     | 0.9997  | 3.1±0.2   | 190±7     | 180±7    | 0.9993   |
| Corn      | 2±2    | 19±5     | 19±6     | 0.9886   | 0.36±0.01 | 29±1     | 28±0     | 0.984   | 4.2±0.5   | 100±3     | 96±3     | 0.9959   |
| Sorghum   | 0.34±0.03 | 29±6     | 30±13    | 0.9912   | 1.01±0.44 | 45±2     | 44±2     | 0.986   | 1.7±0.1   | 210±11    | 190±10   | 0.9958   |
| Bamboo    | 1.5±0.4 | 34±3     | 33±3     | 0.978    | 4±2      | 50±8     | 50±8     | 0.9992  | 33±3      | 71±10     | 73±9     | 0.9961   |
| Redpine   | 1.6±0.1 | 22±2     | 22±2     | 0.9338   | 0.43±0.01 | 40±1     | 39±1     | 0.983   | 21±4      | 70±2      | 69±2     | 0.9991   |
| Poplar    | 2±1    | 24±3     | 24±3     | 0.9996   | 0.55±0.04 | 33±2     | 32±2     | 0.9991  | 23±4      | 63±2      | 63±2     | 0.9885   |
| Diesel engine soot | 1.6±0.4 | 13±1     | 13±1     | 0.9931   | 0.6±0.1  | 30±4     | 30±4     | 0.947   | 3.2±0.1   | 150±5     | 140±5    | 0.9987   |
| Weifu soot | 0.5±0.1 | 21±14    | 21±14    | 0.9706   | 0.9±0.3  | 31±7     | 32±7     | 0.908   | 86±95     | 72±16     | 70±6     | 0.9954   |
| Household soot | 5±2    | 9±0      | 5±6      | 0.9948   | 0.20±0.03 | 32±2     | 28±2     | 0.949   | 0.21±0.02 | 530±0     | 420±20   | 0.991    |

$^a$Pseudo-second-order rate constant. $^b$Model calculated maximum sorbed concentration at equilibrium. $^c$Measured maximum sorbed concentration at equilibrium.
Table S11. Accuracy ($R^2$ and $P$) values for regression on pseudo-second-order rate constant against compositional and pore property parameters at different relative humidity (RH) levels.

| Composition      | 33% RH |          | 47% RH |          | 94% RH |          |
|------------------|--------|----------|--------|----------|--------|----------|
|                  | $R^2$  | $P$      | $R^2$  | $P$      | $R^2$  | $P$      |
| OC$_{\text{TGA}}$ | 0.47   | 0.0046   | 0.06   | 0.3845   | 0.28   | 0.0423   |
| OC$_{\text{AE}}$ | 0.44   | 0.0070   | 0.10   | 0.2574   | 0.14   | 0.1672   |
| EC               | 0.14   | 0.1700   | 0.05   | 0.4194   | 0.45   | 0.0061   |
| Dissolved minerals | 0.08  | 0.3100   | 0.19   | 0.1086   | 0.17   | 0.1302   |
| NH$_4^+$         | 0.77   | <0.0001  | 0.01   | 0.7118   | 0.06   | 0.3946   |
| Cl$^-$           | 0.60   | 0.0007   | 0.08   | 0.3181   | 0.08   | 0.3118   |
| C$_2$O$_4^{2-}$  | 0.05   | 0.4400   | 0.002  | 0.8848   | 0.004  | 0.5000   |
| SO$_4^{2-}$      | 0.11   | 0.2286   | 0.10   | 0.2529   | 0.02   | 0.6618   |
| Total porosity   | 0.03   | 0.5300   | 0.0001 | 0.9696   | 0.82   | <0.0001  |
| K$^+$            | 0.15   | 0.1509   | 0.13   | 0.1789   | 0.32   | 0.0266   |
II. Figures.

Figure S1. Fourier-transform infrared (FTIR) spectra of different BCPs. (a) Subgroup 1 of herbal BCPs. (b) Subgroup 2 of herbal BCPs. (c) Woody BCPs. (d) Soot BCPs.
Figure S2. Raman spectra of different BCPs.
Figure S3. X-ray diffraction (XRD) profiles of different BCPs.
Figure S4. Compositional percentages of ionic constituents of different BCPs.
Figure S5. Sorption isotherms of water vapor plotted as equilibrium water uptake (mg g\(^{-1}\)) vs. relative humidity (RH, %) obtained by saturated aqueous salt solutions for different BCPs.
Figure S6. Comparison of equilibrium water uptake by BCPs at 94% relative humidity measured by two different gravimetric methods.
Figure S7. Relationships between equilibrium water uptake (mg g⁻¹) vs. compositional and pore property parameters for the group of BCPs at 23% relative humidity.
Figure S8. Relationship between measured values of equilibrium water uptake at 94% relative humidity vs. predicted values obtained by binary factor regression based on contents of OC$_{\text{TGA}}$ and dissolved minerals for the group of BCPs. Regression equation:

\[ \text{Uptake} = 9.886 \cdot \text{OC}_{\text{TGA}} + 17.459 \cdot \text{DM} - 16.839, \]

where OC$_{\text{TGA}}$ and DM are percentage contents of OC$_{\text{TGA}}$ and dissolved minerals.
Figure S9. Comparison of equilibrium water uptake measured by gravimetric method and DRIFTS method for selected BCPs at high relative humidity.
Figure S10. Sorption kinetics of water vapor plotted as water uptake (mg g$^{-1}$) vs. time (h) at 33% relative humidity.
Figure S11. Relationships between pseudo-second water uptake rate constant \( (k_2) \) (g mg\(^{-1}\)s\(^{-1}\)) vs. compositional and pore property parameters for the group of BCPs at 33% relative humidity.