

Interactive comment on “Volatile organic compounds at a rural site in Beijing: Influence of temporary emission control and wintertime heating” by W. Yang et al.

Anonymous Referee #3

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Household air pollution from burning biomass and coal for cooking foods and heating rooms has long been a major environmental problem. Previous studies suggested that the uncontrolled and inefficient combustion of solid fuels for heating in winter also contributed substantially to outdoor PM_{2.5}, BC, OC, SO₂ and NO_x in many regions, such as in the North China Plain (Liu et al., 2016, PNAS). The field observations at the rural site of Beijing in this study further demonstrated that the combustion of solid fuels for heating in winter made remarkable contribution to ambient volatile organic compounds (VOCs). The authors also took advantage of the temporary intervention measures for emission control during the APEC to evaluate the actual effect of the control measures on the ambient VOCs levels through reduction of the source contributions. The com-

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parison between the heating and non-heating periods offered robust results indicating the influential emission from winter heating. Overall, the data quality of this manuscript is quite good, and the interpretation of the results is appropriate and convincing. Therefore, I strongly recommend publication of this manuscript. Majors: As stated above, an important finding of this study is that residential coal burning, especially during winter heating period, could be a major contributor to the ambient VOCs. Apart from the emission factors available for residential coal burning, is it possible for the authors to have the amounts of coals consumed in the residential sector especially during winter and give an in-depth explanation why this source could contribute substantially? The study suggests clean energy use in residential sector is vital for reducing VOCs in the heavily polluted winter. This aspect should be incorporated into the discussion or the conclusion part of the manuscript.

Minors: Although I am not a native English speaker, I would say that there is still room for improving English writing of the manuscript. The authors better find a native English speaker to check the English. Below is a list of changes that, I think, should be made: Line 33-34: Change “during wintertime severe haze events” to “during severe wintertime haze events”; Line 35: Change “comparatively much less” to “not well”; Line 37: Change “inside” to “on” Line 37: add “the” before “University”; Line 38: Change “northeast” to “northeastern”; Line 39: Remove “that”; Line 39: Change “during” to “on”; Line 40: Add “the” before “air quality”; Line 41: Change “in” to “on”; Line 41: Remove “that”; Line 41: Change “since” to “on”; Line 42: Change “it is” to “this sample collection period provided”; Line 43: Remove “the” before “temporary” and before “wintertime”; Line 44, 45: Add “the” before “temporary”; Line 46: Change “about” to “approximately”; Line 47: Change “that” to “the values”; Line 46-48: Change “that of 23.41 ppb before the APEC (25 October-2 November; Period I) or 21.71 ppb after the APEC (13 November-31 December; Period III)” to “the values of 23.41 ppb in Period I (25 October-2 November) before the APEC and 21.71 ppb in period III (13 November-31 December) after the APEC”; Line 48: Change “Their” to “The”; Line 49: Change “drop” to “decrease”; Line 50: Change “of” to “over”; Line 51: Remove “the” before “southerly”; Line 52: Change

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“that in the northerly ones during period I, II and III” to “those in northerly air masses during periods I, II and III”; Line 53: Remove “and”; Line 54: Change “south” to “southern”; Line 56: Change “changed” to “the altered”; Line 57, 58: Remove “the” before “Period”; Line 58: Change “emission” to “emissions”; Line 59: Add “the” before “ambient”; Line 60: Change “emission” to “emissions”; Line 60: Remove “they”; Line 61-62: Change “VOCs during the period I, II and III” to “the VOCs during periods I, II and III”; Line 62-63: Change “became the dominant source which accounted for 45.1% of the VOCs” to “became the largest source, accounting for 45.1% of the VOCs”; Line 64-65: Change “with a remarkably lower average contribution percentage (38.2%) in the southerly air masses than that of 48.8% in the northerly air masses” to “with a specifically lower average contribution percentage in southerly air masses (38.2%) than in northerly air masses (48.8%)”; Line 72: Change “emission” to “emissions”; Line 73: Change “benefit improving” to “improve the”; Line 74: Change “an extensive concern” to “a widespread concern”; Line 75, 79: Change “summertime” to “summer”; Line 75: Change “wintertime” to “winter”; Line 80: Remove “as well”; Line 82: Change “comparatively the role of VOCs in the wintertime with PM2.5” to “comparatively, the effect of VOCs on wintertime PM2.5”; Line 88: Change “in the control of air pollution by PM2.5 in wintertime” to “in the control of PM2.5 air pollution in winter”; Line 90: Change “under” to “on”; Line 92: Change “vehicle exhausts are” to “vehicle exhaust is an”; Line 96: Change “particularly in north China in wintertime” to “particularly in northern China in winter”; Line 99: Add “the” before “VOCs”; Line 100: Change “is widely occurring in the rural areas” to “widely occur in rural areas”; Line 101-102: Change “how the enhanced emission” to “how enhanced emissions”; Line 109: Change “north” to “northern”; Line 110: Add “the” before “air quality”; Line 111: Remove “so”; Line 111: Remove “when”; Line 112: Change “especially in wintertime with” to “especially in winter, with”; Line 116: Change “kind” to “type”; Line 118: Change “As for” to “For”; Line 121: Change “drops of” to “decreases in”; Line 123: Change “inside” to “on”; Line 124: Add “the” before “total”; Line 124: Add “were” before “reduced”; Line 125: Add “those in” before “the period”; Line 126: Change “about” to “of”; Line 127, 134: Remove “the” before

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“urban”; Line 127: Remove “entirely”; Line 128: Add “on” before “a regional scale”; Line 132-133: Change “The objectives of present study are” to “The objectives of the present study are as follows”; Line 135, 136: change “crucial” to “the major”; Line 136: Change “wintertime” to “winter”; Line 137: Add “the” before “APEC”; Line 141: Change “o” to “o”; Line 142: Change “inside the campus of” to “on the campus of the”; Line 142: Add “the” before “Huairou”; Line 143-144: Change “The UCAS is located about 60 km northeast of central Beijing and about 150 km northwest of the Tianjin city” to “UCAS is located approximately 60 km northeast of the center of Beijing and approximately 150 km northwest of the city of Tianjin”; Line 145-147: Change “16 meters above ground on the top of a four-story building, about 100 m west of a national road and only 1.5 km far away from the APEC main conference hall” to “16 meters above the ground on the top of a four-story building, approximately 100 m west of a national road and only 1.5 km away from the main APEC conference hall”; Line 152: Remove “of”; Line 153: Add “and” before “one”; Line 154: Add “was” before “less than”; Line 154: Add “a” before “relative”; Line 154: Add “of” before “less”; Line 158: Remove “the time span”; Line 163-164: Change “and average temperature was 11.4, 7.0, and 0.6°C during periods I, II and III” to “and the average temperature was 11.4, 7.0 and 0.6°C during periods I, II and III”; Line 224: Remove “the” before “period”; Line 226: Change “Total” to “The total”; Line 226: Change “inside” to “at”; Line 227: Change “in” to “on”; Line 229: Change “halves of 57.45, 36.17, and 56.56 ppb” to “half the values (57.45, 36.17, and 56.56 ppb)”; Line 231: Remove “both”; Line 234: Add “a” before “more than”; Line 234: Remove “the”; Line 234: Change “about” to “an approximately”; Line 237: Change “or” to “and the”; Line 238: Change “densities” to “density”; Line 240: Change “shared by” to “of”; Line 240: Remove “quite”; Line 243-244: Change “percentages shared by aromatics became lower during period II (12%) when compared to that in period I (21%) or period III (15%)” to “the percentage of aromatics was lower during period II (12%) than during period I (21%) and period III (15%)”; Line 246-247: Change “decreased by 49.0, 32.5, 72.8, and 48.1%, respectively, when compared to those during period I” to “were 49.0, 32.5, 72.8 and 48.1% lower than those during period

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I, respectively”; Line 247-248: Change “Aromatics evidently had a more substantial drop” to “Aromatics evidently underwent a larger decrease”; Line 249: Remove “as”; Line 252: Change “ozone formation potentials (OFPs)” to “ozone formation potential (OFP)”; Line 253: Change “in average during periods I, II and III were” to “on average during periods I, II and III was”; Line 255: Change “Their” to “The”; Line 255: Change “potentials (SOAFPs)” to “potential (SOAFP)”; Line 257, 259: Add “the” to “total”; Line 261: Change “VOCs” to “VOC”; Line 262: Change “drop” to “decreases”; Line 264: Change “changed contribution by aromatic” to “the altered contribution of aromatics”; Line 266: Change “condition” to “conditions and from”; Line 267: Change “condition” to “conditions”; Line 270: Change “showed” to “shown”; Line 271: Change “with the increase in” to “with an increase in the”; Line 272: Change “like that” to “as those”; Line 276: Add “the” before “wind”; Line 280: Change “showed” to “shows”; Line 281: Change “the” to “a”; Lines 282-285: “It clearly demonstrated that the mixing ratios of VOCs increased rapidly, and the back trajectories indicated that air masses changed from northerly to southerly and then declined sharply while the air masses changed back from southerly to northerly”, rewrite the sentences. Lines 285-286: Change “The southern areas of UCAS are the central Beijing with stronger emissions” to “The southern areas of UCAS are in central Beijing where emissions are stronger”; Line 286: Add “that”; Line 287: Change “increase of” to “increase in the”; Line 288: Change “of source regions” to “in the source region”; Line 289: Change “showed” to “shown”; Line 291: Change “changed” to “altered”. Line 295: Add “and” before “2”); Line 296: should be “. . . Mongolia and quickly. . .”; Line 297: Change “emission” to “emissions”; Line 302: Change “period” to “periods”; Line 303: Change “that” to “those”; Line 304: Change “OFPs in the southerly air masses were” to “the OFP in southerly air masses was”; Line 305: Change “and SOAFPs in the” to “and the SOAFP in”; Line 305: Change “were” to “was”; Line 308: Change “This indicates that the north and south” to “These results indicate that the northern and southern”; Line 313-314: Change “OFPs and SOAFPs” to “OFP and SOAFP”; Line 314: Add “that” before “the changes”; Line 315: Remove “to”; Line 316: Change “when compared to that during period I average” to “compared to

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that during period I, the average”; Line 319: Change “OFPs decreased by 48.1% and SOAFPs” to “the OFP decreased by 48.1% and the SOAFP”; Line 320: Change “when compared to that” to “compared to those”; Line 321: Add “the” before “average”; Line 323: Remove “when”; 144. Line 323-324: Change “OFPs decreased by 48.9% and SOAFPs decreased by over 70% during period II relative to period I” to “the OFP decreased by 48.9%, and the SOAFP decreased by over 70% during period II relative to those in period I”; Line 325: Add “a” before “more”; Line 326: Change “emission control in” to “control over emissions from”; Line 327: Change “less changes in mixing ratios” to “decreased changes in the mixing ratios”; Line 328: Change “of” to “over”; Line 331: Change “that” to “those”; Line 331: Change “This difference in the increase rates” to “These different increases”; Line 332: Change “are” to “were”; Line 333: Change “heating supply was only available since” to “heat sources were only available after”; Line 334: Change “already” to “have”; Line 336: Change “apportioning” to “apportionment”; Line 338: Add “the” before “campaign”; Lines 338-339: Change “might be resulted from changed contribution by emission sources, such like” to “might have resulted from the altered contributions from emission sources, such as”; Line 341: add “the” before “characteristic” Line 344: Change “in average during period” to “on average during periods”; Line 345: Change “were approaching” to “approached”; Line 347, 351: Remove “the” before “period”; Line 348: Remove “, which is characteristic of vehicular exhaust”; Line 349: Add “the” before “incomplete”. Line 354: Change “in” to “on”; Line 355: Change “that coal burning contributed more” to “an increased contribution of coal burning”; Line 357: Change “emission” to “emissions”; Line 359: Change “are mainly from” to “mainly originate from”; Line 361: Change “were” to “are”; Line 364: Change “when compared to that of” to “than the values of”; Line 365: Change “or” to “and of”; Line 366: Change “This drop in aromatics/CO ratios” to “This decrease in the ratios of aromatics to CO”; Line 367: Change “of” to “over”; Line 370, 371: Add “those in” before “period I”; Line 371-372: Change “Apparently larger decrease in TEX/CO ratios in the northerly air masses reflected” to “A larger decrease in the TEX/CO ratios in northerly air masses reflects the fact that”; Line 374: Change “3.3.2 Source Apportioning by PMF” to “3.3.2

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Source Apportionment by PMF”; Line 375: Change “Thirty-five” to “The 35”; Line 375: Add “and” before “ethyne”; Line 376: Change “sources” to “source”; Line 377: Add “use with” before “the PMF”; Line 385: Change “the gasoline vehicle emission” to “gasoline vehicle emissions”; Line 386: should be “trichloroethylene and tetrachloroethylene”; Line 387: Change “of” to “by”; Line 388: Change “manufacturing industrials” to “industrial manufacturing”; Line 389-390: Change “by industries for make” to “in industry to prepare”; Line 390: Add “during the” before “production”; Line 392: Change “emission” to “emissions”; Line 393: Change “a larger percentage of the” to “larger percentages of”; Line 394: Change “It is known that TEX are” to “TEX is known to be”; Line 396: Change “They are also” to “These compounds are also the”; Line 396-397: Change “auto factory painting and building coating” to “automobile factories, paint and building coatings”; Line 398: Change “as” to “to be”; Line 403-404: Change “top 3 species of” to “the top 3 species emitted during”; Line 405: Change “were” to “are”; Line 405-406: Change “and aromatics like benzene” to “as well as aromatics such as benzene”; Line 406-407: Change “So factor 5 is related to the coal/biomass burning” to “Thus, factor 5 is related to coal/biomass burning”; Line 408: Change “period” to “periods”; Line 409: Add “the” before “VOCs”; Line 411: add the “the” before “temporary” and remove “the” before “period”; Line 412: Change “by” to “of”; Line 413: Change “drop” to “decrease”; Line 414: Change “by” to “from”; Line 415: Change “Quite similar” to “Similar”; Line 417: Remove “the”; Line 418: Change “from” to “on”; Line 419: Change “emission” to “emissions”; Line 420: Add “the” before “VOCs”; Line 421: Change “were showed” to “are shown”; Line 422: Change “by” to “of”; Line 422: Change “with the” to “with the increase in”; Line 423: Remove “instead”; Line 427: Change “consumptions” to “consumption”; Line 429: Change “The residential coal combustion is prevailing” to “Residential coal combustion is primarily carried out”; Line 429: Change “by using” to “with”; Line 430: Add “the” before “rural”; Line 431: Change “wintertime” to “winter”; Line 431: Remove “the”; Line 431: Change “accounts” to “accounted”; Line 433: Change “contribute predominately to” to “have been the predominant contributor to the”; Line 437, 438, 444, 446, 449: Remove “the” before “period”; Line 437, 440, 441: Change “by”

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to “from”; Line 441: Change “reduced” to “decreased”; Line 443: Change “showed” to “made”; Line 443: Change “period” to “periods”; Line 447: Change “account” to “accounted”; Line 451: Change “period” to “periods”; Line 451: Remove “respectively”; Line 452: Change “emission (gasoline and diesel vehicles) was” to “emissions (gasoline + diesel) were”; Line 453: Change “VOCs during the period” to “the VOCs during periods”; Line 454: Remove “instead”; Line 456: Change “period” to “periods”; Line 459: Change “Contributions” to “The contributions”; Line 460: Change “were” to “are”; Line 460-461: Change “was mainly coming” to “mainly originated”; Line 467, 468, 470: Change “of” to “in”; Line 472: Change “emission” to “emissions”; Line 474: Change “3.3.3 Source contributions to SOAFPs” to “3.3.3 Source contributions to the SOAFP”; Line 475: Change “apportioning” to “apportionment”; Line 475: Change “SOAFPs by” to “the SOAFP of”; Line 476: Change “showed” to “shown”; Line 477: Change “condition” to “conditions”; Line 477: Change “SOAFPs by solvent use were much higher than that by” to “SOAFP of solvent use was much higher than that of”; Line 478: Change “were” to “was”; Line 479, 481: Change “period” to “periods”; Line 482: Change “of SOAFPs” to “in SOAFP”; Line 483: Change “by” to “from”; Line 485: Change “condition,” to “conditions, the”; Line 485: Change “of” to “in”; Line 486: Change “by” to “from”; Line 490: Change “or” to “and”; Line 490: Change “from” to “during”; Line 494: Change “SOAFPs” to “the SOAFP”; Line 494: Remove “only”; Line 496: Change “is a large of” to “are large”; Line 500-501: Change “SOA often shared higher fractions in” to “SOAs often composed higher fractions of”; Line 502: Change “are much less” to “not well”; Line 504: Change “inside” to “on”; Line 505: Change “during” to “on”; Line 505, 506: Remove “and, in fact”; Line 507: Change “could take” to “took”; Line 509: Change “with” to “from”; Line 510: Change “could also compare” to “also compared”; Line 511: Add “use”; Line 512: Change “investigate” to “investigated”; Line 513: Change “the” to “a”; Line 514-515: Change “period II (3-12 November)” to “period (period II; 3-12 November), the”; Line 515: Change “when compared to that” to “compared to those”; Line 516: Change “And their” to “In addition, the”; Line 516: Change “potentials” to “potential”; Line 518: Change “drop” to “decrease”; Line 519: Change “of” to “over”; Line

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520: Change “apportioning” to “apportionment”; Line 523: Change “about” to “of”; Line 524: Change “With” to “Through”; Line 525: Change “of wind directions” to “in wind direction”; Line 526: Change “Total” to “The total”; Line 527: Change “that” to “those”; Line 531: Change “were” to “was”; Line 533: Change “by” to “of”; Line 534: Change “in average due to drops in the percentages by” to “on average due to decreases in the percentages of”; Line 535-536: Change “that accounted” to “accounting”; Line 537: Change “south” to “southern”; Line 538: Change “north” to “northern”.

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