Field Study into the Influence of Polluted Urban Environment on Aerosol Number Concentrations in Al-Ramadi City of Iraq

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الخلاصة

مدى عريض لحجوم أعداد تراكيز جسيمات الهباء الجوي من 0.3 µm الى 25µm تم رصده بإستخدام عداد الجسيمات الليزري في موقعين أولهما مأهول بالسكان ذو شوارع ضيقة مزدحمة وأسواق تجارية ومصانع قديمة ضخمة والآخر ماهول بالسكان ذو كثافة مرورية قليلة وليس ذو طبيعة تجارية ولايحوي مصانع للفترة من 4/11 الى 23/12/2010 بمعدل قراءات 17 عينة مقاسة باليوم الواحد و 34 عينة مقاسة في الساعة الواحدة من مجموع أيام القياس. التغير اليومي لتراكيز أعداد جسيمات الهباء الجوي في الموقع الملوث أشر إرتفاعا مهما في تراكيز الجسيمات الصغيرة خلال الليل والصباح وانخفاضا عند الظهيرة بينما تراكيز الجسيمات الكبيرة تنخفض في الليل وتزداد في النهار . معدل تراكيز أعداد جسيمات الهباء الجوي المقاسة لستة مديات حجمية (0.3 و 0.5 و 1.0 و5.0و 10.0 و 25.0 مايكرون) كانت 65378961 و 23316310 و 8242311 و 604482 و 105690 و 4912 جسيم بالمتر المكعب على التوالي. وإن معدل الزيادة في تراكيز أعداد جسيمات الهباء الجوي في البيئة الملوثة للمدن كانت 71 و 44 و 56 و 93 و 66 و 56 % فوق الطبيعي للمديات الحجمية الستة على الترتيب.

ABSTRACT

The size-separated number concentrations of aerosols ranging from 0.3 to 25 µm were observed by laser particle counter in two sites one in a residential and commercial area with narrow Streets and heavy vehicular trafficand with huge old Factories, and the other in a residential area with lower traffic density and without Industries or commercial areas for the period from 4/11 to 23/12/2010 at a rate of 17sample/day and 34 sample/ hour of total measured days. Daily variation of aerosol number concentrations in urban area indicate a high significant for fine particles at night/morning of day and lowerly at afternoon while for coarse particles are decrease at night time and increase at day time.The measured mean of aerosol number concentration for six size channels (0.3, 0.5, 1.0, 5.0, 10.0 and 25.0 µm) was 65378961,

23316310, 8242311, 604482, 105690 and 4912 particle/m3 respectively. The increase's ratio of aerosol number concentrations in urban polluted environment was 71, 44, 56, 93, 66 and 56 % up-normal for the six size channels respectively.

INTRODUCTION

Particles in ambient air have size spanning from few nanometers to 100 μm [1]. These particles of various sizes are generated by different sources in atmosphere and rapid process of recombination; nucleation, etc. take place in atmosphere. There are two types of particles in atmosphere: (i) primary aerosols, which are directly produced in atmosphere by wind-blown dust, soil erosion, bubble bursts, volcano eruptions and human activities; (ii) secondary aerosols, which are produced by nucleation of low volatile gases and are mainly produced by industrial activities, forest fires and vehicular emission, etc. [2-4].

The particles of size > 1 μm called coarse or super micron particles are mostly generated by dust resulting from excavation, blowing wind, etc. [5]. The particles >2.5 μm are generally remove by upper respiratory tract, called respirable suspended particulate matter and are not much harmful to health [6].The suspended particles of size less than 1 μm are called fine or submicron particles [7], they are further classified as accumulation mode (1-0.1 μm) and fine particles of this range are dangerous as they penetrate in to lungs and produce respiratory problems [8].

The Earth’s climate is also influenced greatly by the physical and chemical properties exhibited by atmospheric aerosols, which alter cloud properties and the Earth’s radiative balance [9-11].

Therefore, Particle number concentration in the troposphere is an important parameter controlling the climate and health impacts of atmospheric aerosols not only in the visibly affected mega-cities of the developing world, but also at the relatively low concentrations found in the air of the more developed world too[12, 13].

The objectives of this study are to determine the aerosol number concentration in Al-Ramadi city for six sizes channels by leaser particles counter and to identify the influence of polluted urban environment on aerosol number concentrations in this city.

METHODSANDTECHNIQUES

Two sites were chosen for measuring aerosol number concentrations both of themare located in Al-Anbar, Iraq. The first site was located in Al-Ramadi City Metropolitan Area In a residential and commercial area with narrow Streets and heavy vehicular traffic from 7:00 am to l0:00 pm, so it was expected to have heavy vehicular emissions. The second site was a residential area with lower traffic density and without Industrial or commercial areas called Al-Doar city away 35 km from the first site.

The ground-based measurements are the most accurate and low-cost tools for studying polluted urban environment effects,some attempts to distinguish the properties of urban aerosols were previously done [14].

In this study, Aerosol number concentrations ANC wasaccounted withinsixsize-ranges (0.3, 0.5, 1.0, 5.0, 10.0 and 25.0 μm)by laser particle counter (model: Climet CI-500)tothe rate offlow(28.3 liter/ Minute)andtoHighestconcentrations(1000000 particle/ft^3).Temperatures inthe accuracy(± 0.4°C)and relative humiditywithaccuracy(± 2%) werealso measuredin thesameplaceandtime ofsamplingand byusingthe same device [15].

The sampleswere recordedin48 daysduring the periodfrom4/11 to 23/12/2010in Al-Ramadi city, at a rate of17sample/dayand34sample/ houroftotalmeasured daysalsorecordedsamplesin3 days, twoof theminNovemberand oneinDecember for24 hoursinAl-Doar city.Sampling processwasat an altitude of 1m above ground surface and for 0.01 m^3as a sample sizeinthe both sites.

Thegreat effortshavebeen madetoneutralize theeffectsof somefactorsthat are notinthe objectives of thisstudy, such as wind speedor directionandtheimpacts in small scale, which may effecton thefact of ANC. Also the sampleshave beenneglected in a rainyand dusty days.In additiontoother processes, such as measurement ofANC,temperatureandrelative humidityinsideandoutsidethe fitting roomto make sure thatsimilarinternal andexternalenvironment.

RESULTSANDDISCUSSION

Variation of ANC in Al-Ramadi city

The Daily behaviorof Aerosol number concentrationsare variedwith different size of particles. Fine particles of size less than 1.0 μm have dissimilarity behavior from that of coarse particles of size greater than 2.5 μm

while that for respirable suspended particulate (2.5 μm > p < 1.0 μm)is oscillatinginclinedtowardsthe dominantsize-rangesofone of fineorcoarse particles, as shown in Table 1.

Table -1: Hourly mean variation of aerosol number concentration in Al-Ramadi city

Time (hour)	Aerosol number concentrations (particle/m^3)					
	0.3 μm	0.5 μm	1.0 μm	5.0 μm	10.0 μm	25.0 μm
00	70803690.8	22889551	6326037	279187.9	37284.85	1506.475
01	70913483.7	25799028.1	9780126.3	279550.6	54822.88	1156.412
02	73079267.4	25230226.9	8906412.3	237442.7	55154.03	1016.103
03	72952233.9	21543539	6083130.6	192509.6	40743.7	790.1852
04	70048420	21477491	3417724.7	193862	54881.13	1135.217
05	69726500.6	17411875.6	3492773.5	189163.2	31413.03	1102.034
06	66315943.4	16473970.3	4057809.6	294578.7	46891.13	1733.833
07	64929754.9	18124980.9	5040503.5	321241.5	66416.69	2438.057
08	65776373.7	20907256.6	6970057.8	493281.7	96952.87	4813.308
09	66119693.7	20300151.7	6607492.4	578685.6	127717.2	4701.563
10	65330259.3	18777137.5	6068015.2	507640.4	114297.3	6080.889
11	62871150.2	21095717.9	7875699.7	669617.2	114319.2	7212.421
12	62633401.1	23577053.6	9840045.7	888137.1	149028.5	10470.89
13	58550106.5	19971458.7	8694783	844382.4	155705.4	12686.42
14	56776394.3	18942573.4	8145634.8	692548.4	168565.8	9477.73
15	56202153.1	17039490.3	7083998.2	717683.9	142817.6	7819.167
16	57070989.7	21089057.3	10133153	994911.3	187273.4	10564.39
17	59633109.4	30346654.8	14270594	1415341	207024.9	9058.833
18	63280238.2	33516831.1	14303004	1178958	166398.1	5959.541
19	66110705.5	34479387.8	13824623	1050848	172162.9	6018.919
20	66082944.9	30073620.2	10725955	826496.3	108346.6	3836.806
21	66515398.7	30088724	10489988	746542.6	119433.4	3744.868
22	67634772	26528240.8	8999945.4	574907.8	74221.44	2532.923
23	69738100.4	23907429.4	6677964.4	340061.1	44691.92	2036

Aerosol number concentrations for fine particles are increase at night and morning of day while decreasing at the afternoon and reached in its highest value for the three size channels (0.3, 0.5 and 1.0μm) 73079267, 34479387 and 14303004 particle/m^3respectively while reached in its lowest value 56202153, 16473970 and 3417724 particle/m^3 respectively. Also the daily variation of Aerosol number concentrations for coarse particles of size channels (5.0, 10.0

and 25.0μm) are decrease at night time reached 189163, 31413 and 790 particle/m^3 respectively, and increase at the day time reached 1415341, 207024 and 12686 particle/m^3respectively.therefor the mean ANC for all six channels is 65378961, 23316310, 8242311, 604482, 105690 and 4912 particle/m^3, as shown in Table 2.

Desert nature surrounding Al-Ramadi city and its dusty wind-blown cause the up-normal ANC of coarse particles, as well as a little decrease in ANC of fine particles by compared measured data with other measured data at Baghdad [16].

Table -2: aerosol number concentration (Max., Mean, Min.) for six size channels in Al-Ramadi city and it's increasing and decreasing at day time.

Particles size channels	Day time		Aerosol number concentrations		
	ANC Increasing time	ANC Decreasing time	Max.	Mean	Min.
P > 0.3 μm	19 pm – 11 am	12 am – 18 pm	73079267	65378961	56202153
P > 0.5 μm	17 pm – 4 am 11 am -13 pm	4 am – 10 am 14 pm – 16 pm	34479387	23316310	16473970
P > 1.0 μm	16 pm – 2 am 11 am – 13 pm	3 am – 10 am 14 pm – 15 pm	14303004	8242311	3417724
P > 5.0 μm	10 am – 17 pm	18 pm – 9 am	1415341	604482	189163
P > 10.0 μm	9 am – 21 pm	22 pm – 8 am	207024	105690	31413
P > 25.0 μm	8 am – 21 pm	22 pm – 7 am	12686	4912	790

Polluted urban versus clear desert ANC.

The traffic jams areas [17, 18], large commercial areas, factories and power stations [13] inside cities cause air pollution and an increase in ANC. For assessment that pollution was chosen unpolluted city to compare with polluted city after measured aerosol number concentrations in the same field conditions.

As isevident inFigure(1)Aerosol number concentrations indicate a significant increase for all size-ranges. That increase's ratio shown in table 3 was 71, 44, 56, 93, 66 and 56 % for the six size channels 0.3, 0.5, 1.0, 5.0, 10.0 and 25.0 μm respectively.

Table-3: Increase's ratio of ANC in polluted urban environment for six particle size channels

ANC mean (no./m^3)	Particle size channels (µm)					
	0.3	0.5	1.0	5.0	10.0	25.0
1st site	65378961	23316310	8242311	604482	105690	4912
2nd site	27180653	7193773	2979692	292380	42065	1764
Increase's ANC	38198308	16122537	5262619	312101	63624	3148
Increase's ratio (%)	71	44	56	93	66	56

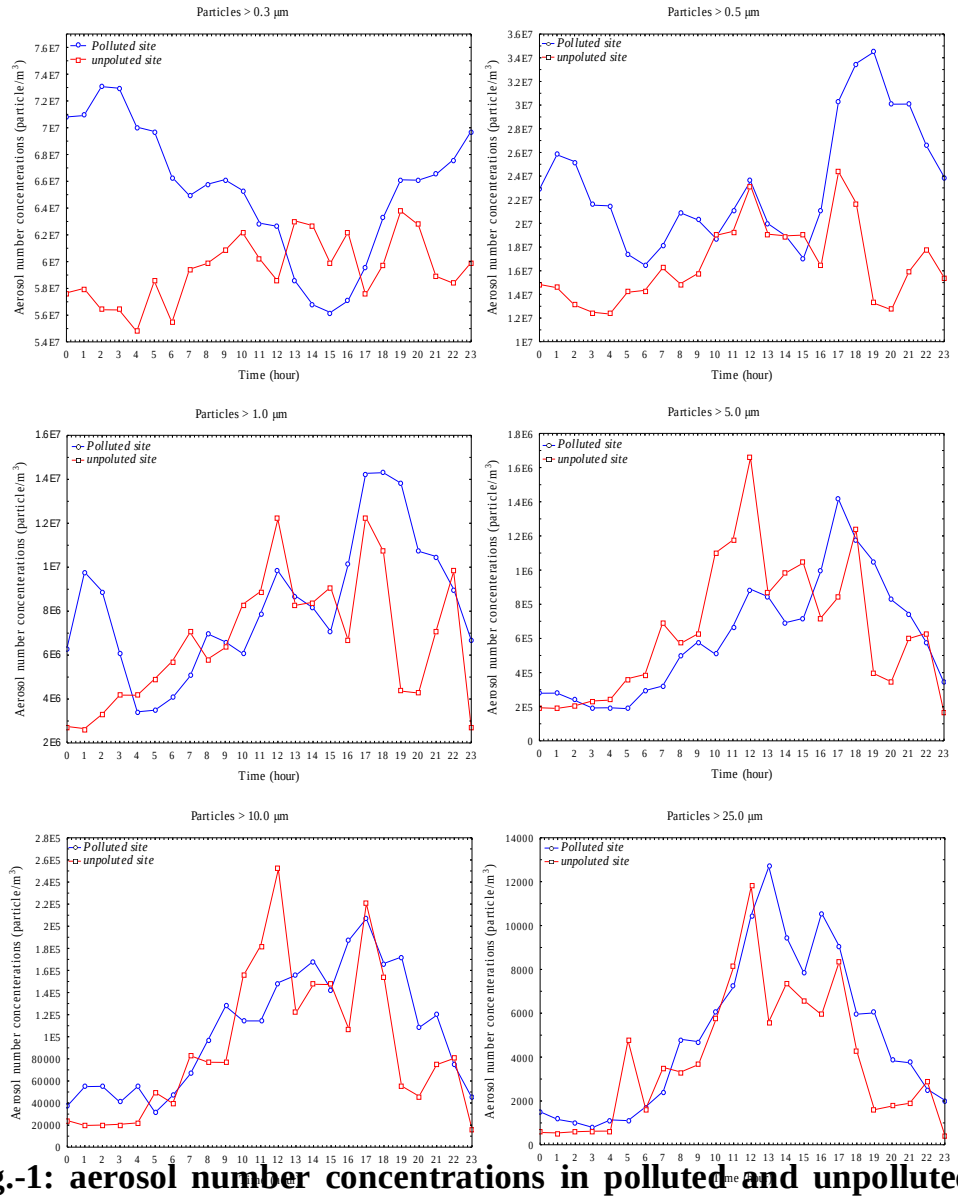

Fig.-1: aerosol number concentrations in polluted and unpolluted site for size-ranges 0.3, 0.5, 1.0, 5.0, 10.0 and 25.0 µm.

The main objective of this study was to determine the aerosol number concentration in Al-Ramadi city and to identify the influence of polluted urban environment on aerosol number concentrations. Aerosol number concentrations was accounted withinsix size-ranges (0.3, 0.5, 1.0, 5.0, 10.0, 25.0 μm)by laser particle counterfor48 daysduring the periodfrom4/11 to 23/12/2010in Al-Ramadi city and 3 daysinAl-Doar city.

This study showed that in Al-Ramadi city:

1) Aerosol number concentrations for fine particles are increase at night and early of day while decreasing at the afternoonwhile for coarse particles are decrease at night time and increase at the day time.
2) The highest value of aerosol number concentration in for the six size channels (0.3, 0.5, 1.0, 5.0, 10.0 and 25.0 μm) was 73079267, 34479387, 14303004, 1415341, 207024 and 12686 particle/m^3 respectively, and the lowest value was 56202153, 16473970, 3417724, 189163, 31413 and 790 particle/m^3 respectively.
3) The mean aerosol number concentration for the six channels was 65378961, 23316310, 8242311, 604482, 105690 and 4912 particle/m^3.
4) The increase's ratio of aerosol number concentrations in urban polluted environment was 71, 44, 56, 93, 66 and 56 % up-normal for the six size channels respectively.

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