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DETERMINATION AND MODELLING OF EMISSIONS FROM AIRCRAFT AT KAHRAMANMARAS AIRPORT, TURKEY

UÇAKLARDAN KAYNAKLANAN EMİSYONLARIN BELİRLENMESİ VE MODELLENMESİ: KAHRAMANMARAŞ HAVALİMANI ÖRNEĞİ

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ÖZET

Havaalanları önemli hava kirletici kaynaklarından biridir. Sera gazları (CO_2, CH_4, N_2O, H_2O, O_3) ve partikül maddeler (PM) en çok bilinen havalimanı kaynaklı hava kirleticileridir. Sera gazı karakterli antropojenik kaynaklı diğer kirleticiler ve insan aktiviteleri de bu hava kirleticilerinin bir bölümünü oluşturur. Sera gazlarının (Karbondioksit, metan ve azot oksit) konsantrasyonları insan aktiviteleriyle artış göstermektedir.

Bu çalışmada Tier 1 ve 2 yaklaşımları aracılığıyla IPCC (Hükümetlerarası İklim Değişikliği Paneli) metodolojilerini kullanarak hava kirletici emisyon emisyonlarının (CO, NO_x, SO_2, NMVOC) ve özellikle beş doğal sera gazından başlıca üç tanesinin (CO_2, CH_4, N_2O) konsantrasyonlarının, LTO (iniş / kalkış) sırasındaki uçaklardan ve Kahramanmaraş Havaalanındaki diğer kaynaklardan oluşum miktarları 2015 ve 2016 yılları için tahmin edildi. Buna göre LTO sayısı 2015 yılı için 2330; 2016 yılı için 2693 olarak belirlendi. Buna ek olarak, LTO fazları sırasında ortaya çıkan SO_2 emisyonları, Kahramanmaraş Havalimanı'nın hava kalitesi üzerine etkisi MATLAB SIMULINK kullanılarak modellenmiştir. Elde edilen sonuçlar, SO_2 emisyonunun konsantrasyon değişikliklerine katkısının Kahramanmaraş şehir modelinde nispeten daha düşük ve daha yavaş değiştiği gösterirken, konsantrasyon değişikliklerine SO_2 emisyon katkısının Kahramanmaraş Havaalanı modeline göre daha hızlı ve daha fazla gözlendiğini göstermiştir.

Anahtar Kelimeler: İniş ve kalkış, uçak emisyonları, kutu modeli, SO_2

ABSTRACT

Airports are one of the significant sources of air pollutants. Greenhouse gases (CO_2, CH_4, N_2O, H_2O, O_3) and particulate matter are most known airport originated air pollutant. Human activity has provided additional sources for these and other gases that have greenhouse-gas characteristics. Carbon dioxide, methane, and nitrous oxide concentration have increased line due to the human activity.

Values of air pollutants emissions (CO, NO_x, SO_2, NMVOC) and specifically three of five natural greenhouse gases (CO_2, CH_4, N_2O) were estimated from aircraft during the LTO (landing / take off) and other sources at Kahramanmaras Airport for 2015 and 2016 using methodologies of IPCC (Intergovernmental Panel on Climate Change) by means of Tier 1 and 2 approaches in this study. According to these data number of LTO were determined 2330 for 2015 year and 2693 for 2016 year respectively. In addition to this SO_2 emissions which occurred during LTO phases were modeled using by MATLAB SIMULINK on air quality of Kahramanmaras Airport. The results indicated that the SO_2 emission contribution to changes of concentration was been observed relatively lower and more slowly on Kahramanmaras city model, while SO_2 emission contribution to changes of concentration was been observed more quickly and more based on Kahramanmaras Airport model.

Keywords: Landing and take-off, aircraft emissions, box model, SO_2

GİRİŞ

Civil aviation is a sector that has grown strongly in the last decade through economic development. The growth of civil aviation depends on the safety and speed of air transport. Although road, rail and maritime transport is an important source of greenhouse gas and air pollutant emissions in the atmosphere, air traffic is also an important source of emissions and has a significant impact on atmosphere and climate change (Song and Shon, 2012). Accordingly (Lee et al., 2009), the calculated annual average passenger traffic growth rate was 5.3% between 2000-2007, while passenger traffic increased by 38% (Song & all., 2015) Similar situation has been reported in our country. the situation has been determined from 34 million to 166 million in the last 9 years at 317% (Yılmaz, 2017). Air traffic activities are therefore an important issue in the environmental impact assessment of civil aviation. Air transportation generated emissions are different from other emission sources. Emissions from aircraft are caused by fuel burned in aircraft engines and have significant air pollutant rates in traffic. Up to now, studies on this issue have tried to determine the damage levels of air transport emissions. Most studies emphasize that air emissions have negative effects on the atmosphere and may cause deterioration of air quality at airports (Pecorari et al., 2016; Song et al., 2015). It also has direct or indirect harmful effects on human health, ecosystems and cultural heritage (Yılmaz, 2017).
The values of these emissions varying depend on the airport intensity and size. Namely, the amount of emissions is much higher in very intense and large airports which located at the crossroads of national and international airway. Moreover, aircraft type, frequency of aircraft flights are other factors on this situation. Civil IFR (Instrumental Flight Rules) flights; Civil VFR (Visual Flight Rules) flights, also called general aviation; Civil Helicopters, and Operational Military flights are main component of air traffic (EEA, 2000). In assessing the potential of aircraft emissions to affect the lower atmosphere, Civil IFR (Instrumental Flight Rules) flights stands out as a unique category since the it covers largest fraction of scheduled flights of aircrafts. (Fig. 1)

In general, the exhaust emissions of aircraft are CO_2 (Carbon Dioxide), H_2O (water vapor), NO_x (nitrogen oxides), SO_x (sulfur oxides), CO (carbon monoxide), HC (hydrocarbons), VOC (volatile organic carbons) other gases and particulates during flight (Kesgin, 2006).In the 1970s, the effects of NOx (NO + NO_2) emissions from Concorde civilian supersonic aircrafts on stratospheric ozone depletion were investigated. At the end of the 1980s, studies on the effects of subsonic aircraft emissions on tropospheric ozone and climate change and contrail have been carried out.

Moreover, these emissions contribute to positive radiative forcing (RF) of climate, the early of 1990s and in the 2000s, effects of aviation emissions (CO_2, NO_x, particulates, etc.) on climatic RF (radioactive force) were investigated. According to these studies, total RF from aviation occur 3.5% of anthropogenic RF with 55 Wm^{-2} (Song&all., 2012).

Generally these exhaust are the products of the combustion of kerosene which a fossil-based fuel (Unger & all., 2012).While Carbon monoxide, hydrocarbons and particulate matter (PM) are composed from the incomplete combustion of hydrocarbon fuels; carbon dioxide and water vapor, which they occur combining carbon and hydrogen in fuel with oxygen in the air, are composed from the complete combustion of hydrocarbon fuels like kerosene, gasoline, and diesel. Nitrogen oxides emissions are composed when fossil-based fuel is burned at high temperatures, as in the combustion process. One of the exhaust emissions of aircraft is sulphur oxides that produced from gasoline, coal etc. Sulphur contained fuels. (Yılmaz, 2017) In this point, it is important consideration in the environmental impact of aircraft emissions with regard to fuel type.

Service buses, support equipment, auxiliary power units (APUs), fixed airport power supplies (FAA, 2015) tyre, brake and asphalt wear are other emission sources at the airports. Additional sources may also be present at airports, including maintenance work, heating facilities, fugitive vapors from refueling operations, kitchens and restaurants for passengers and operators, etc. Especially large fractions of total particulate matter mass originate from the turbulence which occur during aircraft movements (e.g., British Airports Authority, 2006). Aircraft emissions at airport have been investigated in only a few studies.

In the recent years because of the strong aviation passenger transport volume increases in these emissions has continued and contributed to air pollution at the local scale. The emissions from aircraft have been evaluated according to their potential environmental impacts and they investigated also two different way as LTO, which includes all activities near the airport that take place below the altitude of 3000 feet (1000 m). (take-off and landing phases of aviation) and non-LTO cycle (above 1000 m and at cruise level). The aim of this study to determine the characteristics of pollutant emission from aircraft, the impacts upon micro and macro scale air quality by using LTO cycle and MATLAB SIMULINK Model Structure

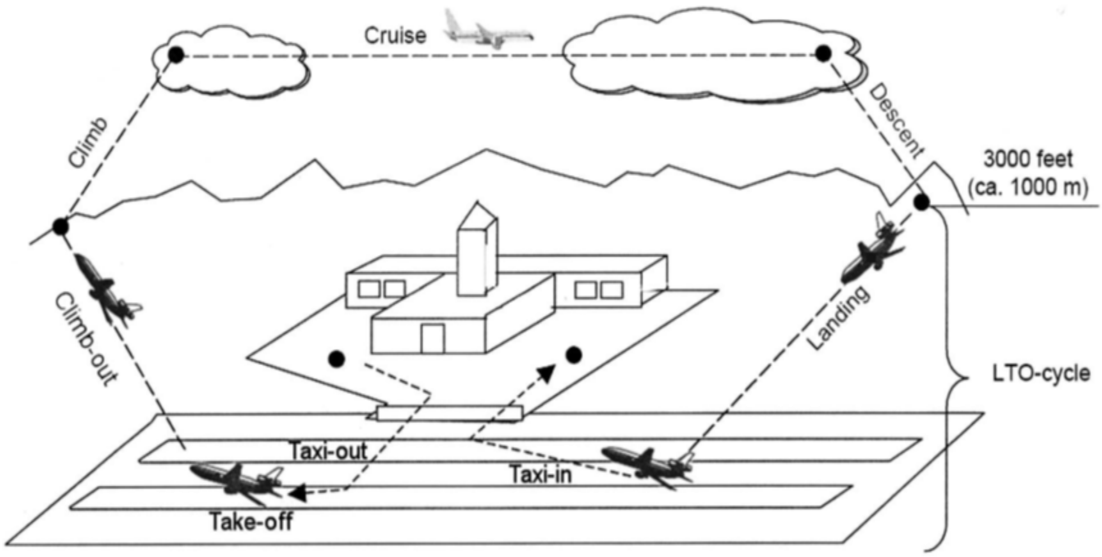

Fig. 1. LTO Cycle (Adapted From IPCC, 1997)

It is possible to see examples of this situation in the world and in our country related to studies conducted. At Turkish airports, aircraft emissions estimations were investigated by limited number studies, there is not comprehensively research article until now. The estimating of aircraft emissions during the LTO cycle around a local airport in Turkey was studied by (Kesgin, 2006) using flight data recorded by the State Airports Authority.

Similarly, emission estimation was carried out at Adnan Menderes Airport, Turkey (Elbir, 2008). In that study, emissions of aircrafts with gas turbine engines investigated during LTO cycle. Estimation of aircraft LTO pollutant gas emissions during LTO cycle at Kayseri Airport was carried out using flight data recorded by the State Airports Authority. According to the ICAO - Engine emission data bank calculations were determined. Author estimated the effect of taxiing time on the aircraft emissions. (Yılmaz,2017) Aircraft emissions during LTO cycle and their chemical and physical characteristics, their modeling have been investigated in different studies all over the world.

(Unal & all., 2005) assessed the impact of airport-based $PM_{2.5}$ and ozone on local air quality by using the EDMS (Emission Dispersion Model System) at Hartsfield-Jackson International Atlanta Airport.

(Carslaw & all., 2006) measured the NO_x concentration by using two variable polar graphic and data filtration techniques at seven geographical sites around the airport to determine the emission effects from airplane activities at London Heathrow Airport.

(Schürmann & all., 2007) compared to emission indices of the aircraft at idle with the emission indices published by the ICAO (International Civil Aviation Organization) by measuring the emission indices of the aircraft at the Zurich Airport by using the open path device to determine NO, NO_2, CO and CO_2 emissions. It has been determined that the concentration of CO near the terminal is largely dependent on the movement of the aircraft while the concentration of NO is derived from the ground support vehicles and the emission indices measured for the aircraft are largely dependent on the engine type.

(Westerdahl & all., 2008) In order to measure UFP (Ultra Fine Particle), size distribution, particle length, Black Carbon, NOx and polycyclic aromatic hydrocarbons (PM-PAH) in the vicinity of Los Angeles International Airport (LAX) moving air monitor is used. Emission measurements were made in two directions, upwind and downwind. As a result of, it was observed that the particle size distributions for two cases were quite different from each other.

(Lee & all., 2009) calculated radioactive forces based on IPCC SRES A1 and B2 estimation scenarios and provided technological strategies to reduce emissions in order to assess the impacts of aviation emissions on global climate change between 2005 and 2050.

(Arunanachalam & all., 2011), Hartsfield-Jackson, Chicago's O Hare and Providences T.F. Green located in the US at three airports has been analyzed by using the Community Multiscale Air Quality Model (CMAQ) to determine the effect of $PM_{2,5}$ pollutants occurred during the LTO (landing / takeoff) of aircrafts.

(Ellermann & all., 2011) Long-term air quality measurements of $PM_{2,5}$ and NO_x were made at UFP's screening measurements and Apron and background measurement sites to determine air quality at Copenhagen Airport.
(Zhu&all., 2011) In Los Angeles Airport, five different sampling regions were selected in the departure position of the aircraft and measurements were made in the downwind. Size distribution and concentration of UFP (Ultrafine particle) with a diameter of less than 100 nm; $PM_{2.5}$ mass and chemical species.

(Hauglustaine & Koffi, 2012) investigated the effects of NO_x emissions from aircraft exhaust in Europe and the United States on the ozone layer and have shown that, based on various projections, NO_x emissions from aircrafts in 2050 could cause an increase in ozone concentrations of 30-40%.

(Hsu & all., 2012) Worwick T.F. At Green Airport, measurements were made by using high resolution monitor and aircraft activity data around 4 sites to determine the effect of UFP (Ultrafine particle) concentrations resulting from aircraft landing and takeoff (LTO) activities. (Barret & all., 2013) empirically explained the relationship between aircraft engine type and NO_x concentration by using the aircraft smoke dispersion method at London Heathrow Airport.

(Gettelman & Chen, 2013) estimated climatic effects of Black Carbon and Sulphate (SO_4) aerosols from the aviation sector by using the Global Cycle Model (GCM / General Circulation Model). They observed that when black carbon was nucleating enough, it had no significant effect on the radioactive force and that sulfate emissions changed the water vapor (H_2O) in the clouds at low altitudes (~200 hPa) and that the aerosol forces from aviation should be considered together to assess the global effects on the climate has been achieved.

(Song & all., 2015) investigated the effect of air pollutants radiated in the boundary layer (BL) on Ozone concentration in summer with the help of the CMAQ model at three international airports in South Korea (Incheon, RKSI, Gimpo, RKSS, Jeju, RKPC).

(Pecorari & all., 2016) analyzed the spatial and temporal aircraft exhaust distribution for the LTO (landing / takeoff) cycles, which evaluated the distribution and deposition of the main aircraft exhaust emissions (NO_x, HC and CO) by using the Lagrangian particle model.

In our country, the number of studies about pollutant emissions at the airport is limited, mainly these are;
(Unal & all., 2014) calculated the greenhouse gas emissions from Nevsehir Cappadocia Airport according to the Tier 1 and Tier 2 approaches determined by the IPCC methodology and compared them with the limit values in the legislation.

(Ekici & all., 2013) in 2012. Ataturk Airport (Istanbul), Antalya Airport (Antalya), the Esenboga Airport (Ankara) in Turkey (HC, CO, NOx) emissions during landing/takeoff from aircraft were examined.

(Elbir, 2008) calculated HC, CO and NO_x emissions for aircraft LTO (landing, take off, climb and approach) phases with the help of a Flight Data Recorder (FDR) at Adnan Menderes Airport.

The latest study (Yılmaz, 2017) examine destination of pollutant gas emissions including nitrogen oxides (NO_x), hydro- carbons (HC), and carbon monoxide (CO), from aircraft during landing and take-off (LTO) cycles for the year 2010 at Kayseri Airport in Turkey.

In this study, air pollutants (CO, NO_x, SO_2, NMVOC) estimated according to Tier approaches proposed by the Intergovernmental Panel on Climate Change (IPCC) in the Kahramanmaras Airport during the LTO (landing/ take off). In addition to, this study attempted to model the SO_2 emissions occurred by aircraft during LTO by means of box modeling. Modeling Flight data and meteorological data were simulated by using MATLAB SIMULINK.

MATERIAL AND METHOD

Study Area

Kahramanmaras city is the 18th largest city of Turkey with a population of 1.2 million and It is the 11th largest city of Turkey with an area of 14,346 km². It is located between 37-38 northern parallels and 36-37 eastern meridians. Kahramanmaras city is located to the east of the Mediterranean Region and is located in an important position connecting the roads from the south and the Mediterranean to the east and north in both road and rail transportation. Kahramanmaras Airport, which provides air transportation of Kahramanmaras, was opened to service by State Airports Authority Directorate General (SAADG) in 1996. According to the main status of State Airports Authority Directorate Genaral (SAADG) which it is affiliated with, it operates as a State- owned Enterprise and operates as a Civil Airport.

Kahramanmaras Airport is 5 km away from the city center on the Gaziantep-Pazarcik beltway in south-east of Kahramanmaras. It is located in the distance 19 km to Turkoglu district and 31 km to Pazarcik district (Fig. 2). The residential area where the airport is located is 1,100,000 m^2. 07 * 25 runway has composite coating of 2300 * 45 size. The open areas of the passenger are 540 m2 and the parking capacity of the car is 40 '. Geographical Coordinates 37 ° 32 '18 "N, 36 ° 57' 7"E (SAADG, 2017).

Fig. 2. Location of Kahramanmaras Airport and Map oKahramanmaras

Determination of Emissions

Emissions calculations have been assessed according to the Tier 1 and Tier 2 approaches identified by IPCC methodologies.

Tier 1 method is calculated by multiplying the amount of fuel consumed in LTO (landing / take-off) and cruise operations by average emission factors, as shown in eq. (1).

$$Emission = Emission\ Factor\ \times Fuel\ Consumption \qquad (1)$$

Less than 1% of the fuel used in aviation originates from aircraft gasoline. Therefore, calculations generally are made according to aircrafts using jet fuel.

Tier 2 method is used only for jet engine aircraft using jet fuel. In the Tier 2 method, aircraft operations are divided into two phases as LTO and cruise phases. In order to apply the Tier 2 method, it is necessary to know the number of LTOs and the types of aircraft. The number of LTOs belonging to aircraft types and aircraft type for the 2016 year was taken from Kahramanmaras Airport and the emission amounts according to eq. (2) were calculated by multiplying with the emission factors and amount of fuel consumption as shown (Table 1) in Intergovernmental Panel on Climate Change, 2006 (IPCC, 2006)

$$LTO\ Emissions = LTO\ Number \times LTO\ Emission\ Factor \quad (2)$$

Table 1. IPCC Emission Factors for Some Aircraft Types for LTO Cycle

Aircraft Type	CO_2 (kg/LTO)	CH_4 (kg/LTO)	N_2O (kg/LTO)	NO_x (kg/LTO)	CO (kg/LTO)	NMVOC (kg/LTO)	SO_2 (kg/LTO)	Fuel Cons. (kg/LTO)
A319	2310	0.06	0.1	8.73	6.35	0.54	0.73	730
A320	2440	0.06	0.1	9.01	6.19	0.51	0.77	770
A321	3020	0.14	0.1	16.72	7.55	1.27	0.96	960
B738	2780	0.07	0.1	12.30	7.07	0.65	0.88	880
GLF4	2160	0.14	0.1	5.63	8.88	1.23	0.68	680

The Box Model

The simple method to model air pollutants is box model. Air flow assumed defined volume of air (box). The box model based on conservation of mass. It can calculate dispersions, chemical and physical reactions of air pollutants in the box, when atmosphere thought of as a box. In addition, meteorological events and effects of their distribution on pollutants can be easily calculated with box modeling. Gases and uncertain pollutants in the box are uniformly distributed and homogeneously mixed. Advantages of box model are that the particle and gas pollutants in the box give better results than the model made entirely in the atmosphere and simplification of atmospheric events. Formation of pollutants can be simulated regardless their local movements. According to this result box model provide an idea movement of pollutants irrespective of the meteorological conditions that may vary depending on the region. Box model; simple, diffuse and multi-cell model. The simple box model is based on the conservation of contaminant mass in an Eularian box representing the urban area (Zeydan, 2017). In this model, the city is assumed to be rectangular and a side of the city should be parallel to the wind direction (Fig.3).

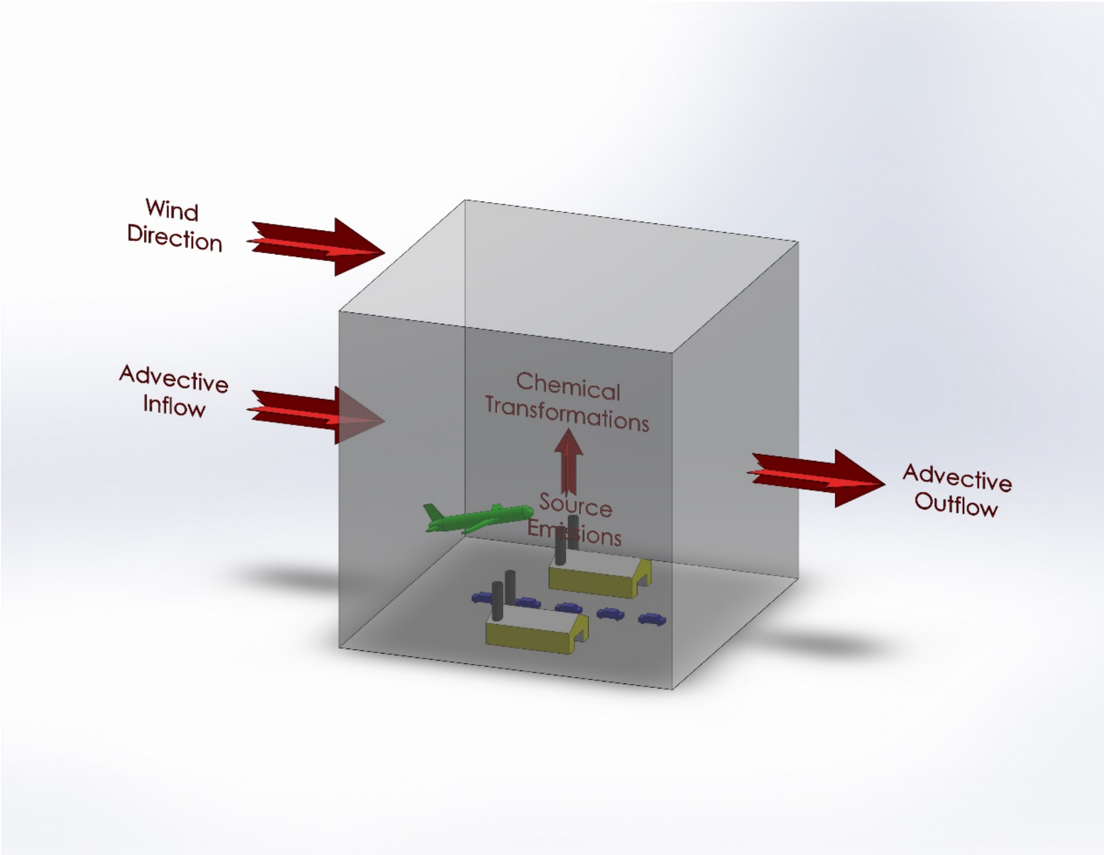

Fig.3. Processing the Box Model (Adapted by Finlayson-Pitts B.&J., Pitts J. N.,2000)

The simple box model aims to calculate the concentrations of air pollutants in the city based on the general substance balance equation (equation 3).

$$Pollutants\ Entering\ The\ Box - Pollutants\ Released\ From\ The\ Box = 0 \qquad (3)$$

$$uWHb + qWL = uWHc$$

$\boldsymbol{uWHb}$: Flow rates in
$\boldsymbol{Q = qWL}$: Emissions are emitted to the atmosphere by a variety of sources.
$\boldsymbol{uWHc}$: All flow rates out
$\boldsymbol{c = \frac{qL}{uH}}$
$\boldsymbol{c}$: c is the concentration in the entire box it is uniform in the whole volume of air over the city $(\frac{\mu g}{m^3})$
$\boldsymbol{b}$: background concentration (upwind), the concentration of pollutant in the air entering the city is constant and is equal $(\frac{\mu g}{m^3})$; without flowrate in b=0
$\boldsymbol{Q}$: The air pollutant emission rate of the city $(\frac{g}{s})$
$\boldsymbol{q}$: The emission rate per unit area is $q = \frac{Q}{A} \quad g/s.m^2$
$\boldsymbol{A}$: Area (m^2)=WL
$\boldsymbol{W, L}$: Dimensions, with one side parallel to the wind direction
$\boldsymbol{u}$: Wind velocity in the x direction
$\boldsymbol{Q = qA}$

RESULT AND DISCUSSION

(SAADG) Kahramanmaras Airport reports that aircraft LTO number at Kahramanmaras Airport strengthened to 2393 in 2016, up from 2330 in 2015. There is a 2.7% increase in the number of LTOs between 2015 and 2016 according to these data. While Boeing 737-800 (738) series were the aircraft that made the most landing /take off to Kahramanmaras Airport with 684 LTO number in 2015 (Fig. 4), Airbus 320 type aircraft became the most landing/take off aircraft to Kahramanmaras Airport with 951 LTO number (Fig. 5) in 2016 when LTO number investigated up to aircraft types.

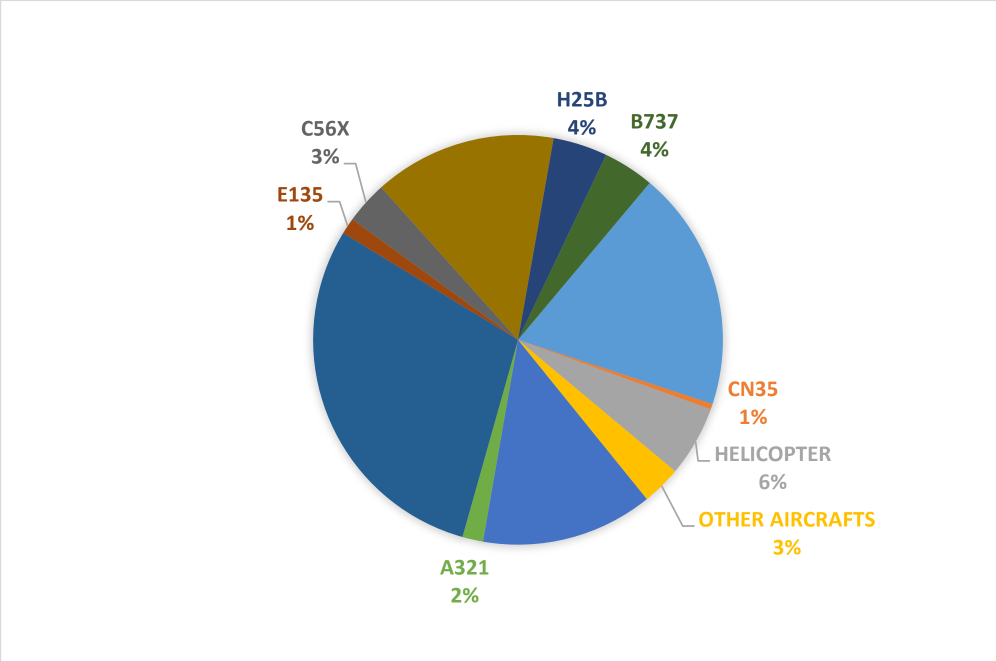

Fig.4. Distribution of Aircraft Types According to LTO Numbers at Kahramanmaras Airport In 2015

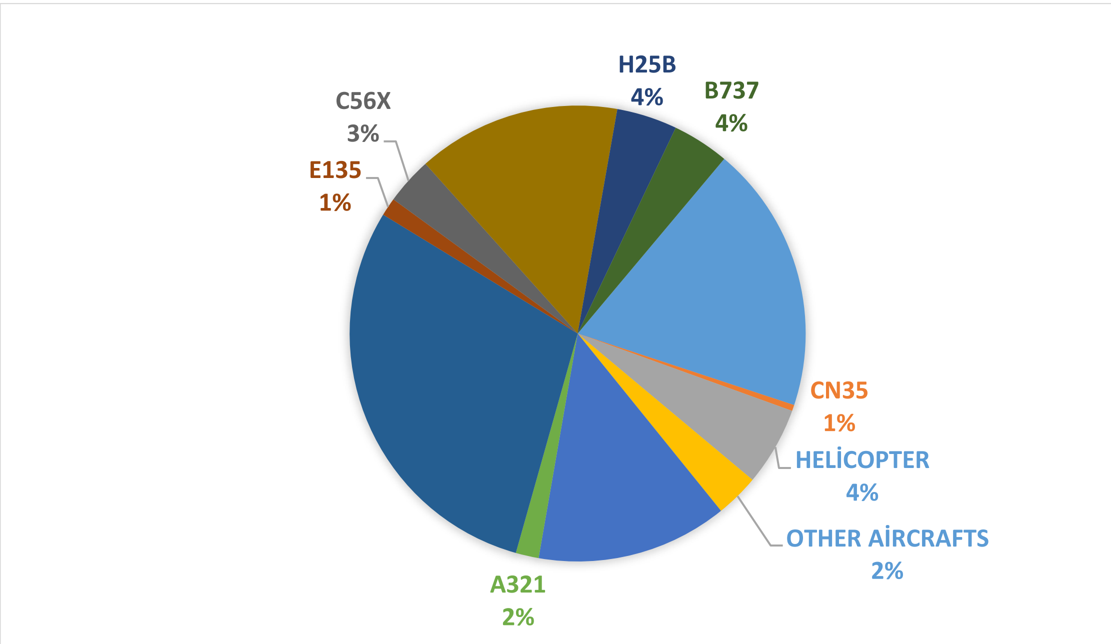

Fig.5. Distribution of Aircraft Types According to LTO Numbers at Kahramanmaras Airport In 2016

As seen in Figure 6, there is a decrease in LTO numbers of aircraft wintertime compared to other months for the period of 2015-2016. It can be said that this decrease in LTO counts in winter is dependent on meteorological conditions. Especially in 2015, the number of LTOs showed more tendency to decrease due to the more severe meteorological conditions of winter months of this year.

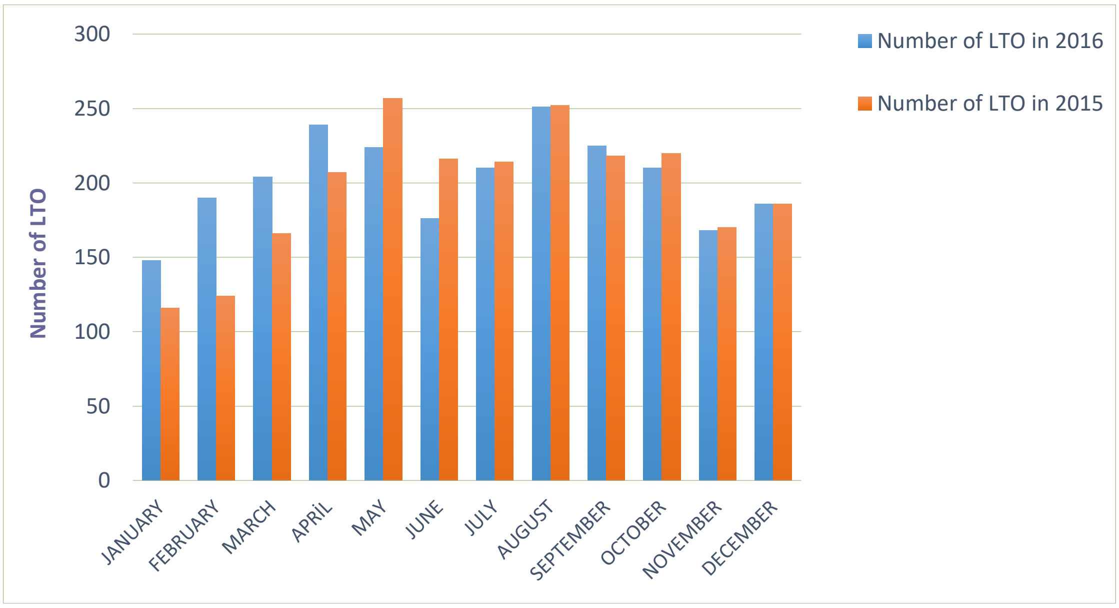

Fig.6. Comparison of LTO Numbers by Months In 2015 and 2016

In this study, the greenhouse gas emissions (CO_2, CH_4, N_2O) and air pollutants (CO, NO_x, SO_2, NMVOC) for LTO modes (including take-off, climb-out, taxi, and approach)of aircraft in Kahramanmaras Airport in 2016 were estimated according to Tier 2 approach determined by the methodologies of IPCC Intergovernmental Panel on Climate Change (IPCC). In 2016, a very small percentage (4%) of the aircraft landing / take off to Kahramanmaras Airport constitutes helicopters using gasoline as fuel. Therefore, calculations are made of according to aircraft using jet fuel. The emission factors and fuel consumption used in the calculations are taken from the IPCC 2006 guidelines (Table 1). Amount of emission were calculated according to equation number 2 by using the data of LTO numbers taken from Kahramanmaras Airport. As a result of the calculations, the emission amounts shown in Table 2 were obtained.

As a result of the calculations made, it is concluded that aircraft type generating most emission was Airbus 320 (A320). Even though the Boeing 737-800 (738) and Airbus 321 (A321) aircraft types are lower than the A320 type aircraft emission factor (Table 1), the LTO number is higher than the other aircrafts. Therefore, A320 aircraft type has maximum emission.

Amount of emission differ according to aircraft types, but emissions of CO_2, NO_x, CO and SO_2 always are higher than those of N_2O, CH_4 and NMVOC emissions (Fig. 7).

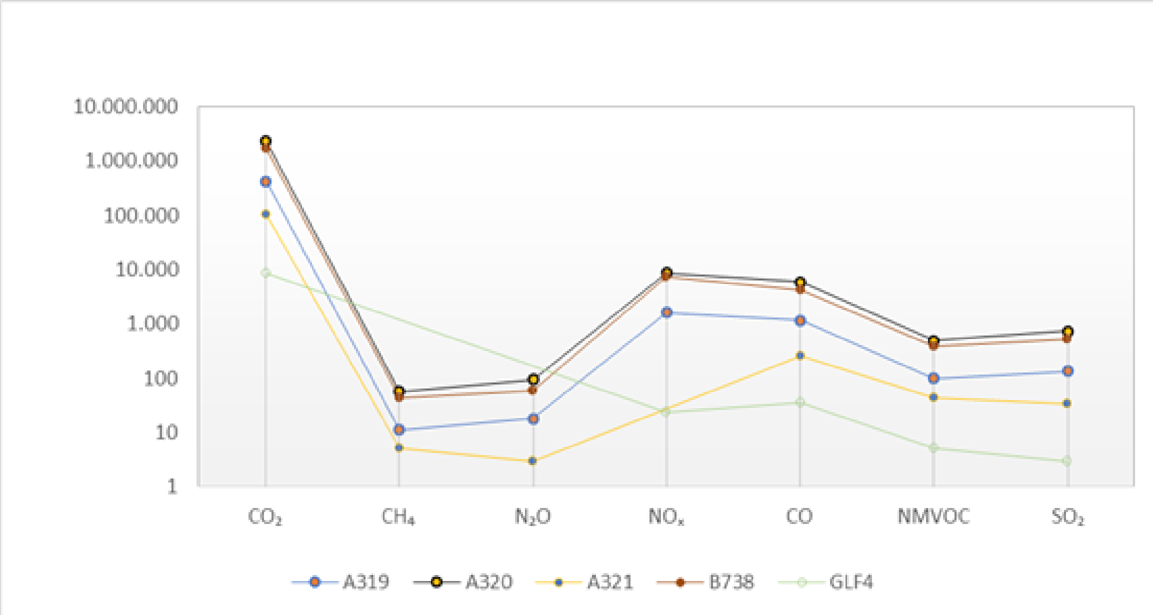

Fig.7. Emission Amounts According to Aircraft Type

Table 2. LTO Number, Emission Values and Fuel Consumption During LTO For Year 2016

Aircraft type	LTO Number	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	Fuel Consumption (kg)
A319	184	425.040	11	18	1.606	1.168	99	134	134.320
A320	951	2.320.440	57	95	8.568	5.886	485	732	732.270
A321	34	102.680	5	3	568.48	257	43	33	32.640
B738	604	1.679.120	43	60	7.429	4.270	393	532	531.520
GLF4	4	8.640	0	0	23	36	5	3	2720

Determining of SO_2 Emissions from aircrafts with Simple Box Model

In this study, we were applied box model in order to determine the effect of concentrations of SO_2. This was done using two large (W=14000 m, L= 20000 m) (Fig.8) and small (W=2000 m, L=600 m) (Fig.9) imaginary boxes over the Kahramanmaras city and Kahramanmaras Airport respectively. Eq.3. was used to calculations. W and L lengths are calculated on the map assuming that Kahramanmaras city and Kahramanmaras airport are rectangular. The average value (16 µg/m^3) shown in the national air quality monitoring network was used for the background concentration calculation of SO_2 emissions. The height of the aircraft during the LTO cycle for (H=1000m), the total SO_2 concentration / total LTO number that calculated by Tier 2 method for the Q account; ICAO data (Takeoff = 0.7 min Climb = 2.2 min Approach = 4 min Idle = 26 min) for the total time spent during LTO, was utilized Table 2. The dominant wind direction and average speed were northwest and 3 m / s.

Fig.8. Imaginary Big Box Over the Kahramanmaras City

Fig.9. Imaginary Small Box Over the Kahramanmaras Airport (Comparison Volume)

These all data were simulated using MATLAB SIMULINK. First, variables are defined, and calculations are made with these variables and integrator. This simulation determined separately for imaginary big box (Fig.8) and small box (Fig.9) defined on Kahramanmaras and Kahramanmaras Airport. These imaginary boxes were created based on the direction of the dominant wind in Kahramanmaras city. L dimensions of each boxes choosed in the north-westerly direction which is the direction of the dominant wind in this region. In addition, the initial conditions of the integrator were entered by calculating the background concentration for each case. The calculation is started by multiplying the volume (WxHxL) and b value. Matlab Simulink diagram of imaginary big and small box over the Kahramanmaras City is shown (Fig. 10) and (Fig. 11) respectively.

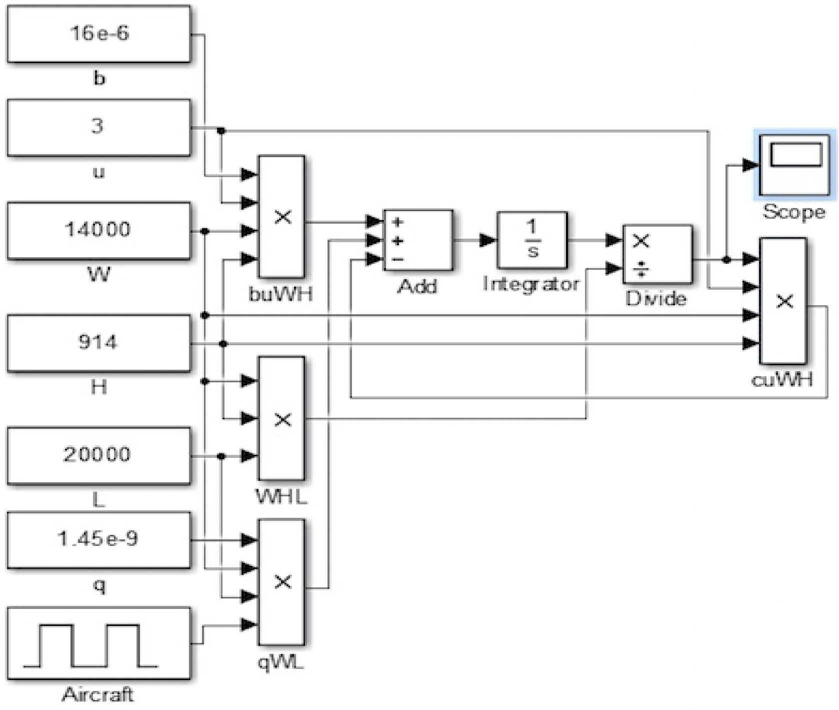

Fig.10. Matlab Simulink Diagram of Imaginary Big Box Over the Kahramanmaras City

The graphical outputs of the results in this study are obtained and given in (Fig.12), (Fig.13). Two different boxes model were performed according to these results; i) big box simulation ii) small box simulation. In the big box simulation, SO_2 concentrations less varied and decreased, the effects of emissions from airplanes have remained constant. Whereas, in the small box simulation, SO_2 concentrations more varied and decreased, the effects of emissions from airplanes have lost their effects up to speed and direction of wind. However, despite this short and rapid change, instant SO_2 concentration values in small box were observed higher than big box. These findings suggest that Box Model is performed and shaped normally, when consider logical structure of Box Model.

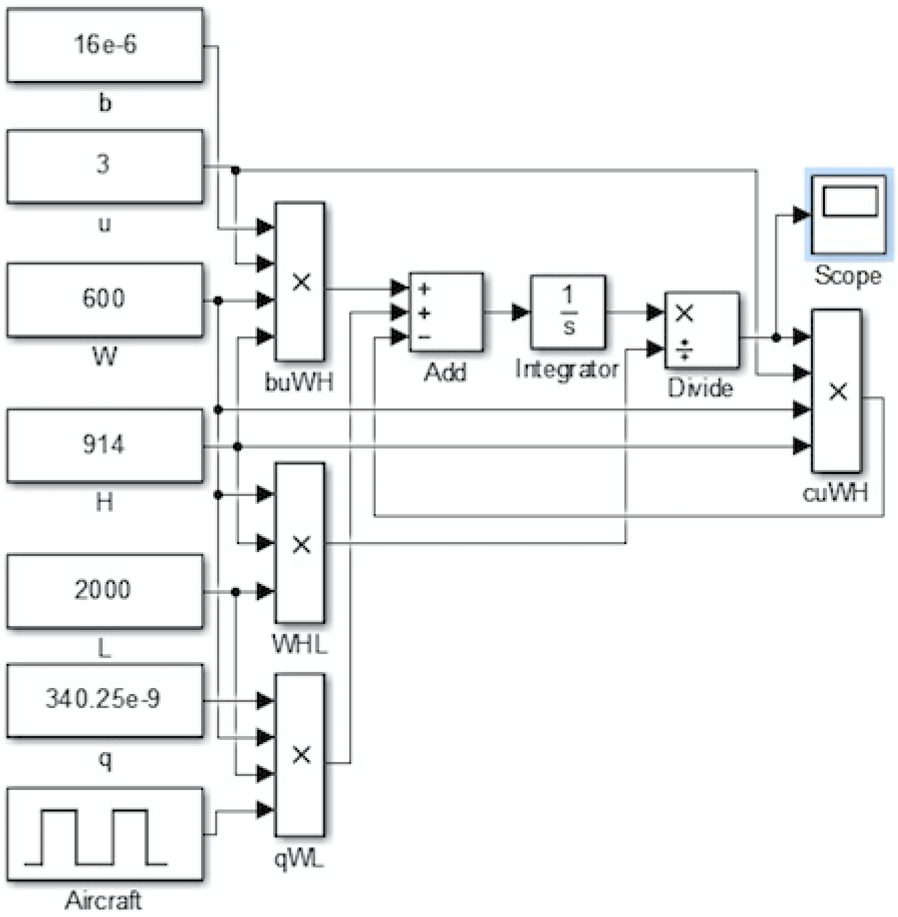

Fig.11. Matlab Simulink Diagram of Imaginary Small Box Over the Kahramanmaras Airport

Max and min concentration of SO_2 in the big box were observed 16.003 ug/m^3 and 16.001 ug/m^3. When based the small box, max and min values of SO_2 were observed 16.23 ug/m^3 and 16.000 ug/m^3 respectively. When consider big and small box model, the contribution and effect of the emissions comes from Kahramanmaras airport to the city atmosphere and near the Kahramanmaras Airport atmosphere were 0.018% and %1,43 approximately. The results show that the contribution of airport emissions to Kahramanmaras city atmosphere emissions values (big box) was less effective than to small box. They have created partial impact near the Kahramanmaras Airport.

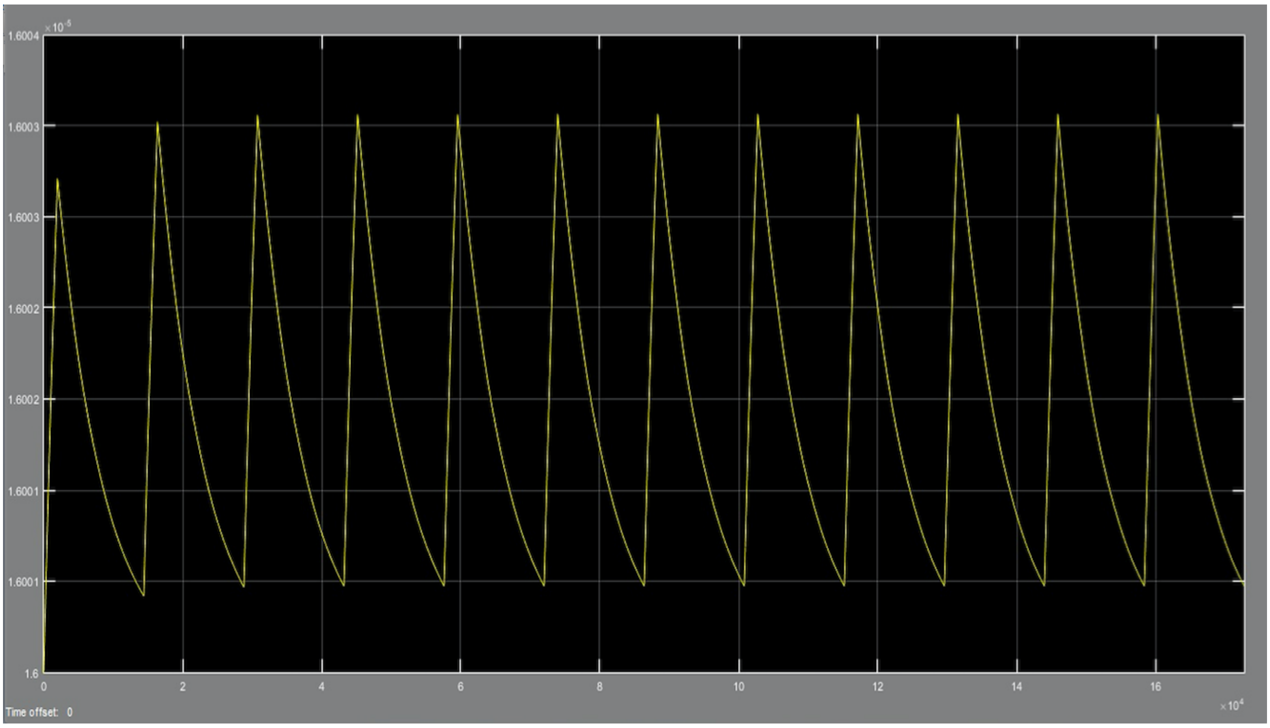

Fig.12. Graphic of SO_2 Concentration Variation in The Imaginary Big Box Over the Kahramanmaras City Atmosphere

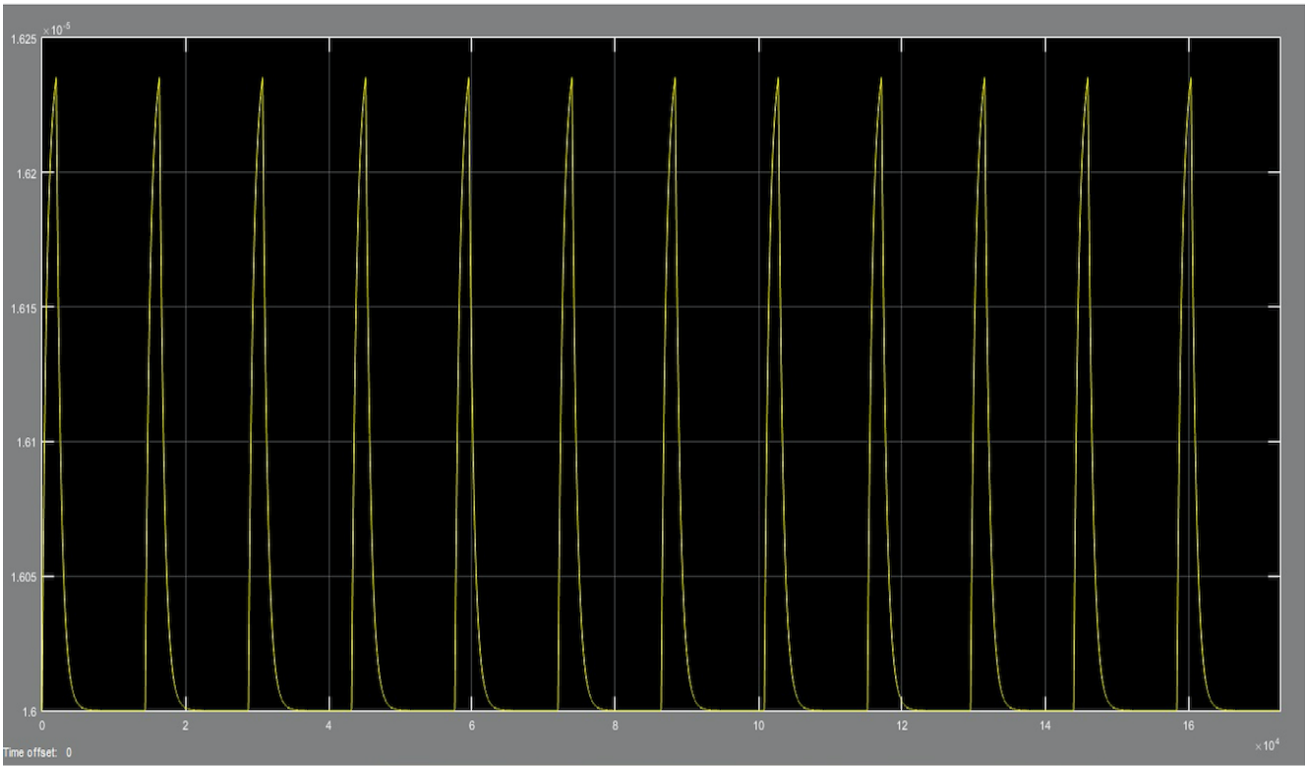

Fig.13. Graphic of SO_2 Concentration Variation in The Imaginary Small Box Over the Kahramanmaras Airport Atmosphere

CONCLUSION

Emissions from aircraft are generally classified as carbondioxide (CO_2), methane (CH_4), water vapor (H_2O), nitrogen oxides (NO_x), various sulfur oxides (SO_x), carbon monoxide (CO), various nonmethane hydrocarbons gasses and particles. Emissions from aircraft motors are effective on stratosphere and troposphere layers of atmosphere. It is critical to think air quality and climate change in relation to adverse effects of aircraft emissions. The negative effects of aircraft emissions exist not only at environment but health also. For that reason, it has recently become important to know the amount of emissions besides the emissions.

It is aimed to calculate amount of emissions from aircraft according to Tier approaches of IPCC Methodologies for the year 2016 at Kahramanmaras Airport. These calculations were carried out using flight datas, which are contain monthly and yearly LTO number of aircraft into Kahramanmaras Airport in 2016 and 2015, recorded by the State Airports Authority and International Civil Aviation Organization (ICAO). Engine Emission Data Bank (EEDB) used for calculations.

When we see that aircraft, movements are higher in the summertime than in the wintertime. It is determined for the most intense month of the flights is August, the least frequent month is January. As seen in the results, there was a continuous increase in the aircraft traffic for period 2015-2016 at Kahramanmaras Airport. It is expected, emissions from aircraft have increase with the development of aircraft traffic. Examination of aircraft types, Airbus 320 determined that was the most frequent aircraft type at Kahramanmaras Airport in 2016. It is reported IPCC Guidelines that the Airbus 320 type has a low fuel emission factor for LTO cycles when compare with Boeing 700-800 series, thus they are giving less emissions to the atmosphere. For this reason, it can be said that the 320 aircraft type is more environmentally friendly than the other aircraft types. The biggest emission type was found to be CO_2. The annual total most important greenhouse gases CO_2 emissions for Airbus 320 during the LTO cycle were estimated to be 2,320,440 kg/y at Kahramanmaras Airport, Turkey. Box model shows that the SO_2 emissions comes from the aircraft during the LTO at Kahramanmaras Airport have an effect of 0,018% on the air quality of Kahramanmaras city atmosphere and 1,43% on the effect of Kahramanmaras Airport atmosphere respectively. According to this result, the SO_2 emissions originate from aircrafts for Kahramanmaras city partially affected around the airport, although they do not have much effect over the city. This situation is also related to the fact that Kahramanmaras Airport is not a very active and busy airport. It is obvious that the results will be different if we consider that a similar study is made for large-capitated airports in metropolises that have more parameters such as number of airplanes, number of landings-departures, number of passengers. For this reason, it can be estimated that urban atmosphere contributions will be higher than aircraft emissions contributions.

Emissions from aircrafts are increasing every year due to the increase in demand for air transportation. In the next years, the development of technological strategies to reduce the adverse effects of emissions on air quality depends on the accurate detection of emission quantities and up-to-date inventory data. The lack of emission factors and the aircraft types contained in the IPCC guidelines make it difficult to reach a definitive result in calculations. For this reason, conducting empirical studies will allow a more accurate calculation of emission quantities.

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