CO, NO_X, and Particulate Matter at the Rogue Valley International – Medford Airport

Change in paper

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Abstract:

Air pollution created by emissions from civil aircrafts can now be responsible for premature deaths of roughly 16,000 people around the world each year. This would cause a global economic cost of roughly $13.5 billion according to an Environmental Research Journal. Currently, the majority (87%) of the calculated 16,000 deaths per year were attributed to aviation emissions from take-off and landing emissions produced for aircrafts. Currently many airports do not regulate particulate matter that comply with current federal regulations. Using local air quality and calculating carbon monoxide (CO), nitrogen oxides (NO_X), and particulate matter (PM 2.5) produced by aviation emissions at the Rogue Valley International – Medford Airport (MFR); research will show the diminishing air quality and ultimately affect the health of the public living within a 2-3-mile radius of MFR. Using other case studies and examples of other airports that provide air quality data from the planes that take-off, idle, and arrive at those locations. In addition to providing air quality levels created from aircrafts at MFR, research will provide data of health hazards that could be possible to the public in the surround urban area.

I. Introduction

Air travel is one of the most important modes of transportation globally. It connects people to parts of the world that may be impossible in anything but an aircraft. Airplanes have been around ever since 1903 when they were invented, but it wasn't until 1914 when the first commercial flight was scheduled by United Airlines. With over 500,000 people up in an airplane at any given time flying at around 550 mph, one can see why so many people use this mode of transportation frequently. To just save time alone, having air transportation is a huge time saver than driving. In 2016, over 822,000 passengers used air transportation and over 39,000 air planes flew into the airport's main terminal. (Jackson County, 2018)

Climate change today is a concerning issue that not everyone takes seriously. It is important to understand how climate change is affected and how air traffic plays an important role in contributing to that. Taking one round trip from California to New York generates roughly 20% of the total amounts of greenhouse gasses your car would produce in a given year. According to some estimates there are roughly 20,000 planes around the world that are serving three million passengers. By 2040, estimates predict that there will be 50,000 planes in service. The more times a plane takes off the more fuel you use in creating more particulate. Planes emit far less particulate flying at a cruising altitude than they would while taking off. According to NASA roughly 25% of a plane's emission comes from landing, taking off, and moving from gates. Unfortunately, many airports are situated in close proximity to urban areas and with the majority of the emissions being concentrated in these areas, it calls for concern.

The Rogue Valley International-Medford Airport has no data of how much pollution the air crafters are creating when they arrive and depart from MFR. We are interested in finding the amount of particle matter, carbon monoxide, and nitrogen oxides that are in the air near the surrounding urban areas of the airport. MFR is located between Central Point and Medford; both areas highly populated by residents. Many residents of the area do not think about the air quality they are breathing in.

Under the Clean Air Act Section 40 part 6-93 regulates air pollutants emissions from stationary and mobile sources and authorizes the Environmental Protection Agency (EPA) to establish the National Ambient Air Quality Standards (NAAQS) for criteria pollutants and to regulate Hazardous Air Pollutants (HAP). While the Federal Aviation Association (FAA) has regulations on NAAQS they leave enforcement up to the EPA. Currently there haven’t been any studies conducted at MFR on their air quality. With many other surrounding airports, not only local but all over the world taking a conscious look at the emission they are producing, it’s time that the citizens be aware of what they are being exposed to. However, out of a survey that was conducted out of 969 people ages ranging from 18-69, 32% responded that the flight would take place no matter what, so there was no need to worry about the negative environmental impacts of flying (Statista, 2017). This is a concerning and people need to be better educated regarding the negative effects of airports and airplanes on our environment and air quality. To the average traveler it could be more detrimental to them in the long run being adversely affected not only by their health but the economics of the industry as a whole.

Several different studies have been conducted at different airports around the world. One study in particular found conclusive evidence that the concentration levels of both black carbon and particulate matter were two times higher than at any freeway in the city (Shirmohammadi, 2017). Black carbon is a component in the mixture from particulate matter. In this case black carbon is usually the case of unburnt fuel. As of recent studies it has emerged as one of the main contributors of global warming, second to $C0_2$. A separate study conducted at Logan International Airport investigated outdoor and indoor particle levels at residences when the wind was blowing directly from the airport on them. On average these locations ranged from 5-6 km away. The study was conducted in both the Boston as well as the Chelsea area; revealed that outdoor particle number concentrations (PNC) infiltrate into indoor environments and significantly raise the PNC (Hudda, 2018). With several airports getting scrutinized several airports in the world are working to lower their overall emissions. One-way Portland International Airport has worked to combat this issue was to reduce the number of ground handling equipment that ran on petroleum products and switch them over to electric. The airport has also recently replaced 62 diesel air conditioning carts with electric units. This ultimately reduced 62,000 tons of carbon monoxide over the life time of the units. These essential units are what provide heating and cooling for the airplanes while they are parked at gates. Also, notably all of their ground transportation busses run on either compressed natural gas or electricity. As of 2016, the port has achieved 71% reduction in greenhouse gasses from the 1990 baseline readings. As a result of this, Portland International airport is a part of an airport carbon accreditation program that aims at cutting carbon emissions. They have successfully completed 50% of the main targets in that program. Consumers need to be pushing other airports globally to take part in these strategic programs that help the airports take a proactive approach at combating greenhouse gases.

A study was conducted in South Korea evaluating the environmental health factors of Radon and particulate matter in underground parking structures. They correlated the data they collected with data they collected in underground subway stations. While their results showed significant hazardous conditions to those of the ages between 1 and 10. (Sung Ho, 2016) Their data results also showed strong differences depending on the season. Another study analyzed fuel and emissions impacts of different travel modes. They included bus, automobile, and aircraft in their study. They were comparing scenarios for trips ranging in length from 200 to 1600km in length. Many factors were considered in this study including passenger loading factors, manufacture emissions of making vehicles, and contrition of highways to name a few. The study found that aviation was not a fuel-efficient use of transportation for trips that were shorter than 500km due to the large energy impacts associated with take-off and landing. They also noted that ground support vehicles associated with flight travel contributed to the overall negative impact of short haul trips. However, they noted that any trip that was longer than 700km, aviation was more energy efficient and produces less emissions per passenger than low occupancy automobiles (Liu, 2016).

Everyone is aware of the relationship between poor air quality and increased adverse short-term and long-term effects on human health. Since the 1970’s the International Civil Aviation Organization (ICAO) through the Committee on Aircraft Engine Emissions (CAEE) have tightly regulated the standards for aircraft engines. They have mandated that every engine manufacture that manufactures an engine that goes into to an aircraft go through extensive standardized testing. Through the CAEE they have an extensive data base that list all the pollutants that are expelled by every aircraft engine that has been in production. Each engine has been tested by the manufacture under all different kinds of conditions including take off, idle, climb out, and approach conditions. This information can be cross referenced with different airplane models to determine what engines are in what aircraft. However, there are a few uncontrolled variables that are hard to produce in a lab setting that can affect the test emission data. For one, with engine age and fatigue the engine would run less efficient and more particulate would be emitted as the engine starts to wear out and tolerances increase. Another variable that is uncontrollable in a lab is outside environments. For instance, heavy rain or specific weather conditions can have adverse effects on some aircraft's engines.

People who live in close proximity to airports are more susceptible to these pollutants than anyone else. A study found that airport congestion significantly impacted the health of nearly 6 million local residents living within 10-12 of the largest airports in California (Barmania, 2018). The daily pollution levels led to an additional $1 million in hospital costs for respiratory and heart-related hospital admissions. The reported health effects occurred at Carbon monoxide levels that were far below the existing EPA mandates.

Offering financial incentives is one way to help persuade companies to take a non-adversarial approach to reducing the environmental impact of aviation. Aircraft manufactures are constantly being pushed to become more competitive and to produce the most cost-effective aircraft while at the same time upgrade and make each aircraft more reliable than the last. Each commercial flight that lands or buys fuel or communicates with the air traffic control is subject to fees. This is why adjusting fees based on the amount of emissions a plane emits is a proactive approach that works for everyone. Today a few airports in Europe have already adopted this approach, but this would be much more effective if this became standardized internationally. During 2009 the aviation sector came together, and all agreed to cut carbon emissions by 1.5 percent annually and then to half them by 2050. This certification will greatly help encourage the integration of new technologies into aircraft design and development.

Several new technologies have been proposed and developed to help combat the issue of emission control. For one, bio fuel has become ever more popular in recent years. It was first approved for commercial use in 2011 and since then companies have slowly been experimenting with it. Several airports, Alaska Airlines, and the University of Washington have been the main sponsors and contributors to this program on the west coast and are actively attempting to get alternative fuels more widely accepted. NASA has determined that a jet fuel mixture of 50% biofuel can cut air pollution caused by air traffic by 50-70%. Certain airlines including Lufthansa and Virgin Airlines experimented with using an algae blend in their fuel, but no significant evidence was brought forth. This ultimately failed due to production forecast being too widespread. However, the use of bio fuel presents a few downsides that could explain why the use of this fuel isn't more commonly used. For instance, the jet fuel bio blend starts to oxidize if left for too long especially at lower temperatures which then causes it to gel. Lastly some of the rubber seals that are in some of the older aircraft aren't meant to come in contact with non-paraffin fuel products, which in turn could cause the blend to shrink and deteriorate rubber seals and hoses in the plane. The sustainable aviation fuel production pace seems to be insufficient to meet the IATA target in 2050. While many people question solar, electric, and hydrogen powered panes, the technology just isn't there yet. It is also not expected that they feasible in the near future as they will lack not only the power to weight ratio but coming up with a global compatible infrastructure would be difficult.

II. Research question(s)

This focus of this research is to collect and research data, regarding the air quality at the Rogue Valley International-Medford Airport. This project will specifically evaluate the amount of particle matter (PM 2.5), carbon monoxide (CO), and nitrogen oxides (NO_X) created from plane engines arriving, idling, and departing from MFR. Some of the main goals are to see how air quality diminishes over time near the airport, provide the airport and nearby urban residences of the air quality, and to have MFR up to standards with the EPA federal regulations. By creating models and maps of the emissions produced and areas affected near MFR it will provide evidence and data to help further promote action of regulation to take place and local residences to be cautious of the air quality they breathe in.

III. Methodology

The project is designed by collecting data from the Rogue Valley International-Medford Airport (MFR) of their summary flight schedules from the month of October from the past five years and using data from International Civil Aviation Organization (ICAO) using the Committee on Aircraft Engine Emissions (CAEÉ), we will calculate the amount of particle matter, carbon monoxide, and nitrogen oxide that is created by each engine. We will be contacting MFR asking for their four pervious flight summaries from the month of October. This data will tell us the flights that are arriving and departing, and the type of engines used for each plane. Using this data and the data from ICAO and CAEÉ, we can get the amount of carbon monoxide and nitrogen oxides being created. Using other research paper called *Derivation of a First Order Approximation of Particulate Matter from Aircrafts* by Roger L. Wayson and others we will use the equation they have supplied to calculate the particulate matter that is being produced. The paper provides in-depth detail of PM from aviation emissions of aircrafts and equations to finding PM levels produced.

We will than compare each month of October from the five years using data analysis and excel to creating T-test to compare the data. This will help us see the difference in the amount on PM, carbon monoxide, and nitrogen oxides and if the pollution and increased or decreased over the years. Next will be creating models of the data using John Gutrich's environmental modeling class to create an input-output model. Using Stella this will help us get a better visual and understanding of the estimate impact of positive or negative effects. Stella will allow us to show the input-output of emissions using stocks (MFR) and flows (plane arrivals, idling, and take-off aviation emissions) to show the increase or decrease of air quality at and near the surrounding urban area.

Pairing this data collected from MFR and data from Stella; using GIS and remote sensing, we will create a map of the surround urban and industrial area of MFR. Only including data from emissions produced from aviation aircrafts for the GIS/remote sensing maps; the maps will show areas with most concentrated low air quality standards affected by aviation emissions produced from arrival, take-off, and idling. The maps will have a focus of areas within the 2-3-mile radius of the airport. These areas are close to where the planes arrive and take-off flying near/low to the urban houses and stores.

IV. Results & Discussion

This is where we will talk about our results from the data we collected. We will include charts, Stella models, and GIS/remote sensing maps in the appendices below. We will explain here with figure labels of what each figure means and what each figure tells us. We will also discuss initiatives that can be taken place by MFR and educate the urban area of the air quality they are breathing. Lastly, we will explain the research will did (repeat/summary) and what we learned from this research and the possibility of further research.

V. Conclusion

Our end goal is to find the amount of particle matter, carbon monoxide, and nitrogen oxides created at the Rogue Valley International-Medford Airport. Thus, giving the airport staff and surrounding urban areas knowledge of the air there are breathing. Aviation is a key piece in how we get from place to place. I don't foresee it going away, if anything it is only going to get bigger. There just needs to be a better balance between airports and how they affect urban areas around them. We just need to keep pushing the companies to come up with new technology that is more environmentally friendly, so we can continue to experience the love and convince of flying that many of us like.

Appendices

Project Partners

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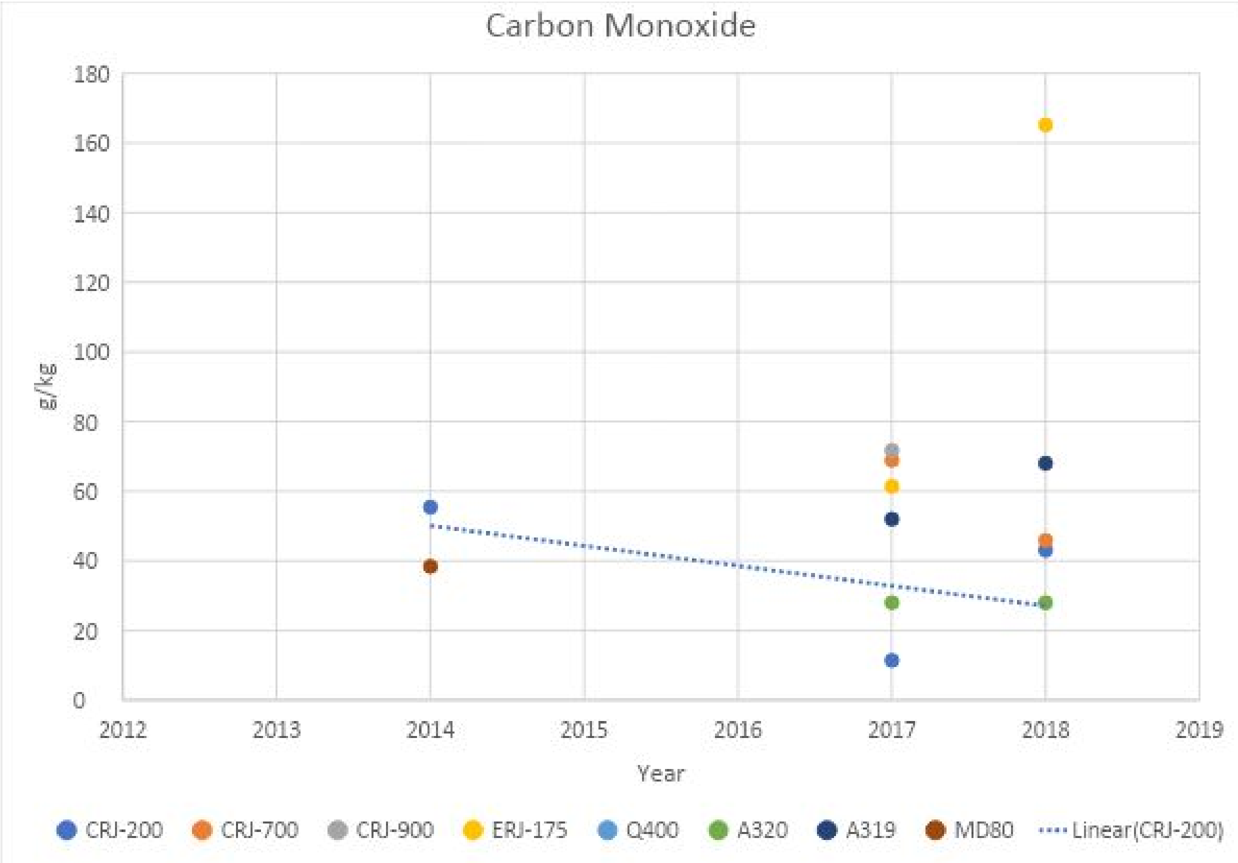
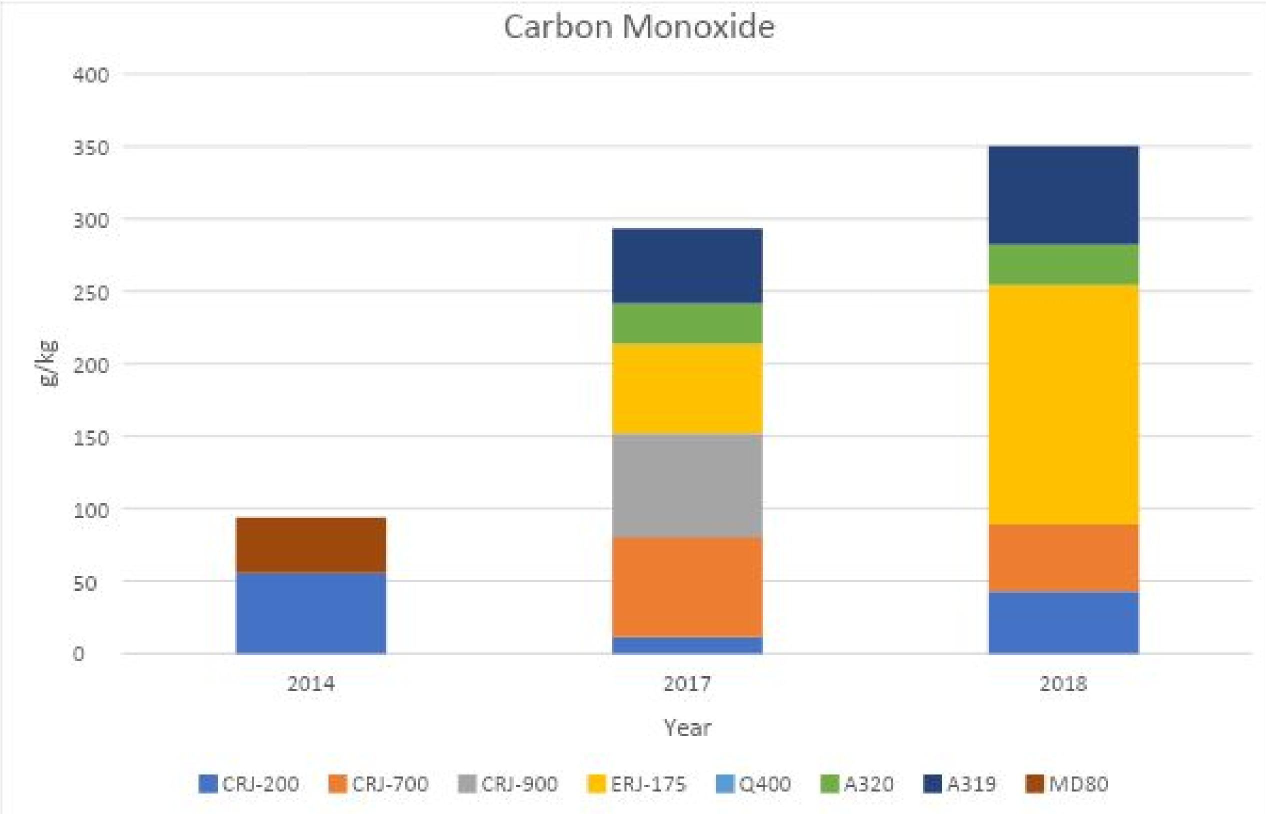
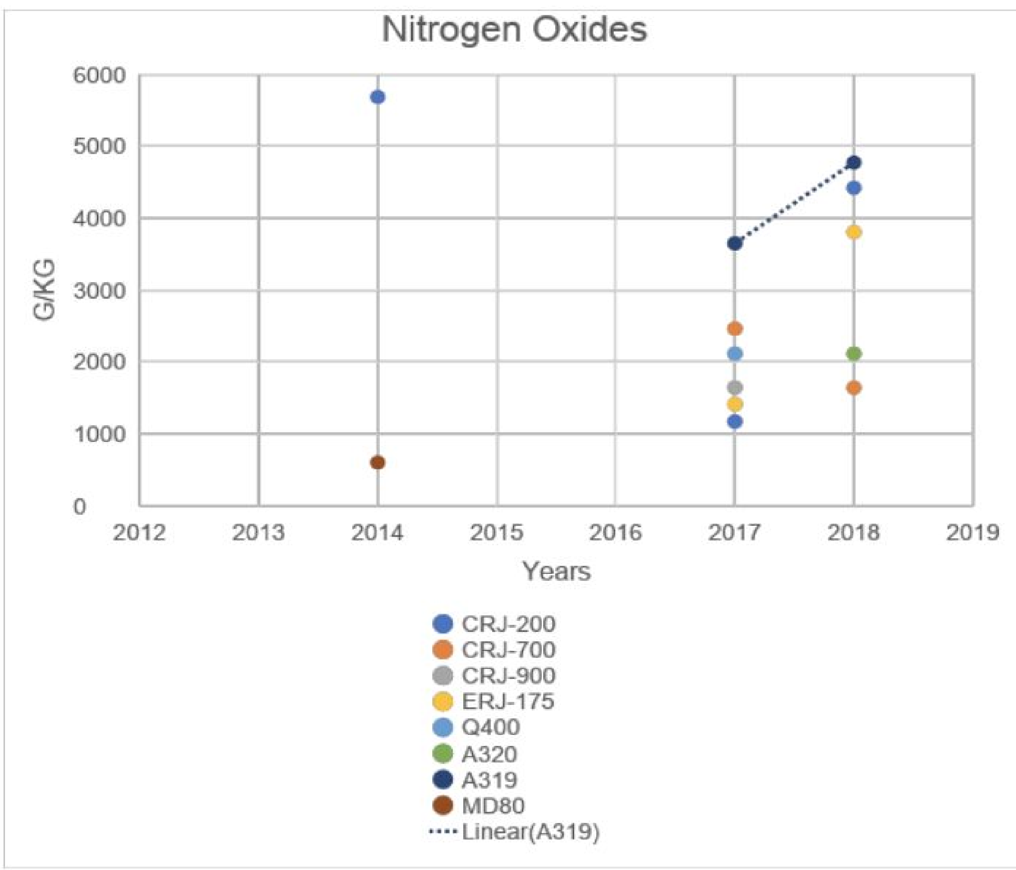
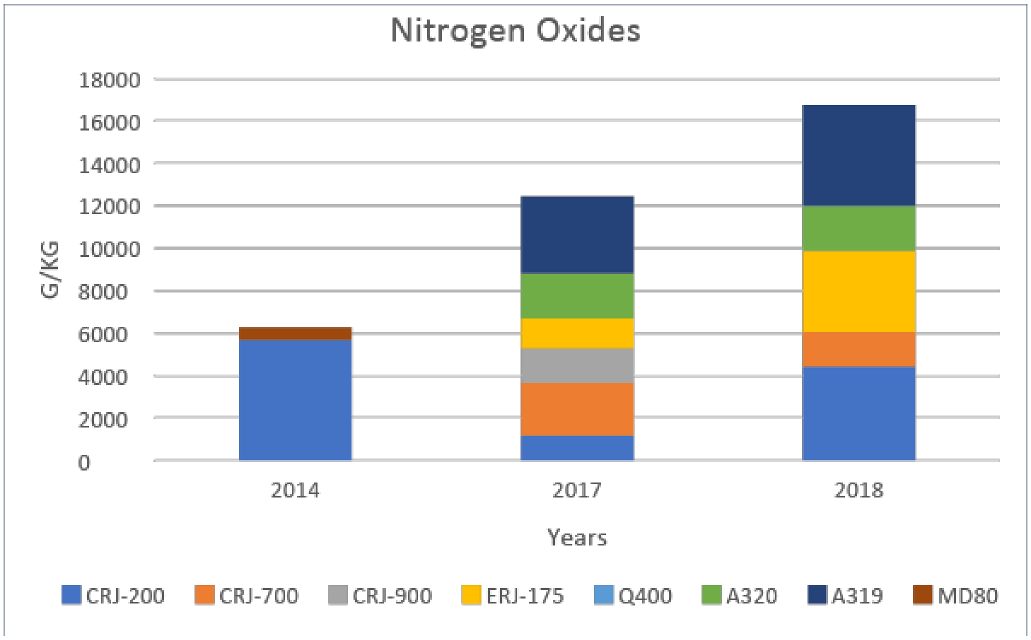
g/kg per cubic meter		Carbon Monoxide			
Aircraft Model	Engine Model	Take off	Climb out	Approach	Idle
CRJ-200	CF34-3B	0.11	0.09	1.88	47.59
CRJ-700	CF34-8C1	0.41	0.50	2.91	24.92
CRJ-900	CF34-8C5	0.64	0.57	4.24	18.25
ERJ-175	CF34-8E2	0.59	0.58	4.52	20.01
Q400					
A320	CFM56-5B2	0.50	0.50	1.40	27.40
A319	CFM56-5B1	0.50	0.50	1.57	28.40
MD80	JT8D-11	1.2	1.9	9.4	35.0


Carbon Monoxide
180
160
140
120
100
80
60
40
20
0
g/kg
2012
2013
2014
2015
2016
2017
2018
2019
Year
CRJ-200
CRJ-700
CRJ-900
ERJ-175
Q400
A320
A319
MD80
Linear(CRJ-200)

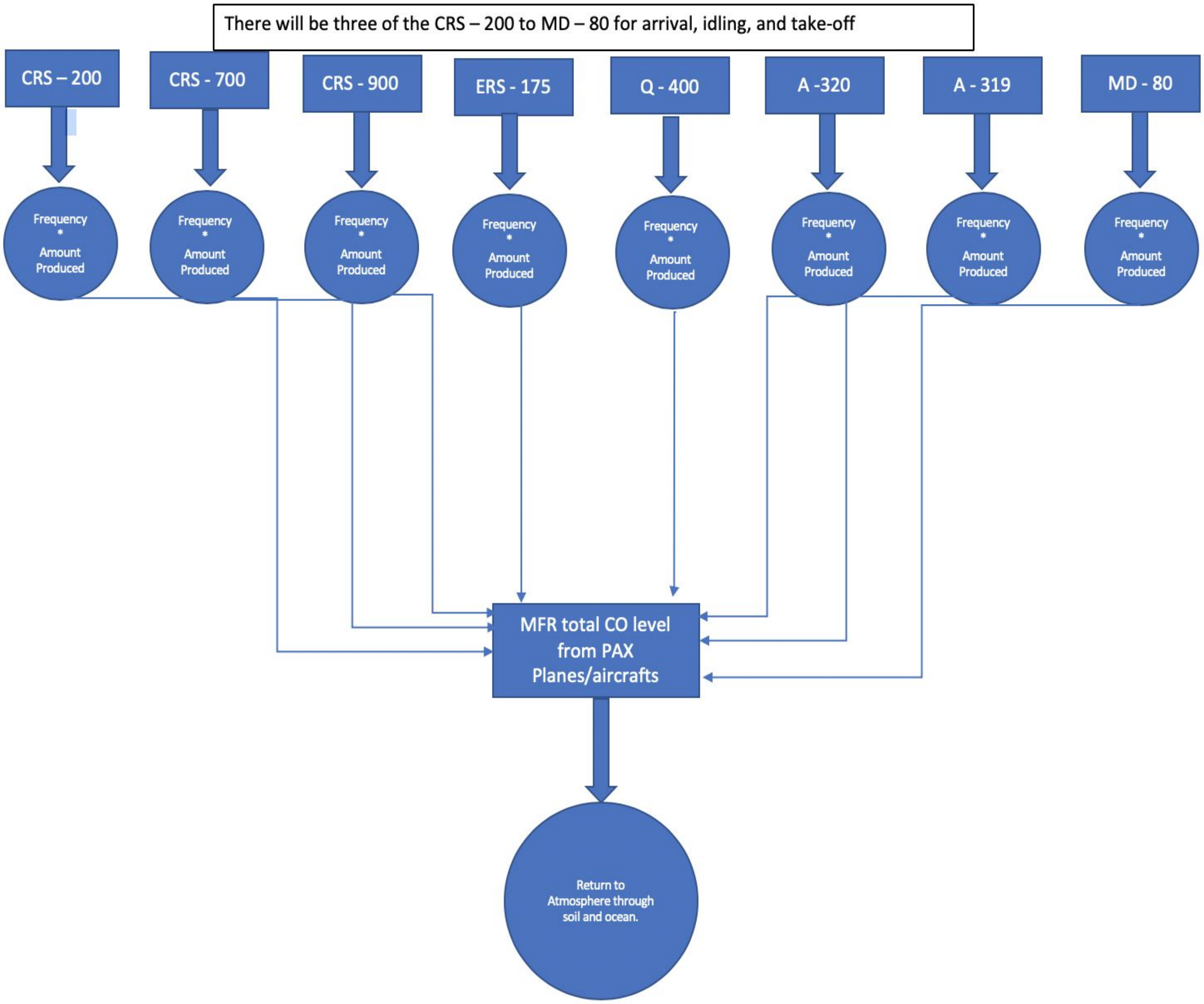

Carbon Monoxide
400
350
300
250
200
150
100
50
0
g/kg
2014
2017
2018
Year
CRJ-200
CRJ-700
CRJ-900
ERJ-175
Q400
A320
A319
MD80

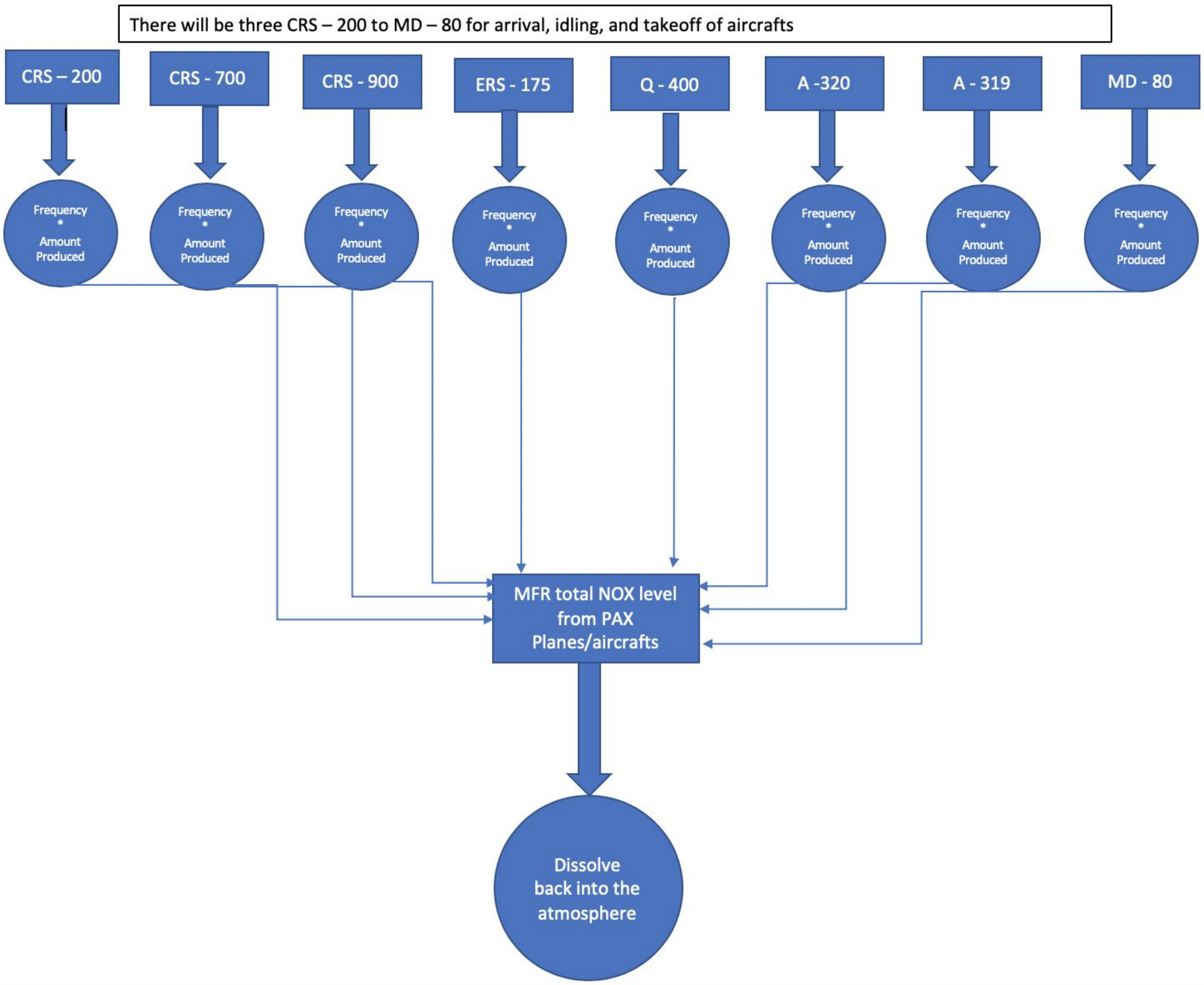
g/kg per cubic meter		Nitrogen Oxides			
Aircraft Model	Engine Model	Take off	Climb out	Approach	Idle
CRJ-200	CF34-3B	11.28	9.68	6.63	3.72
CRJ-700	CF34-8C1	14.67	12.82	11.10	4.31
CRJ-900	CF34-8C5	14.69	12.60	10.75	4.60
ERJ-175	CF34-8E2	13.60	11.82	10.29	4.45
Q400					
A320	CFM56-5B2	37.8	28.5	11.0	4.7
A319	CFM56-5B1	35.1	27.2	10.8	4.6
MD80	JT8D-11	18.9	14.6	5.8	2.75

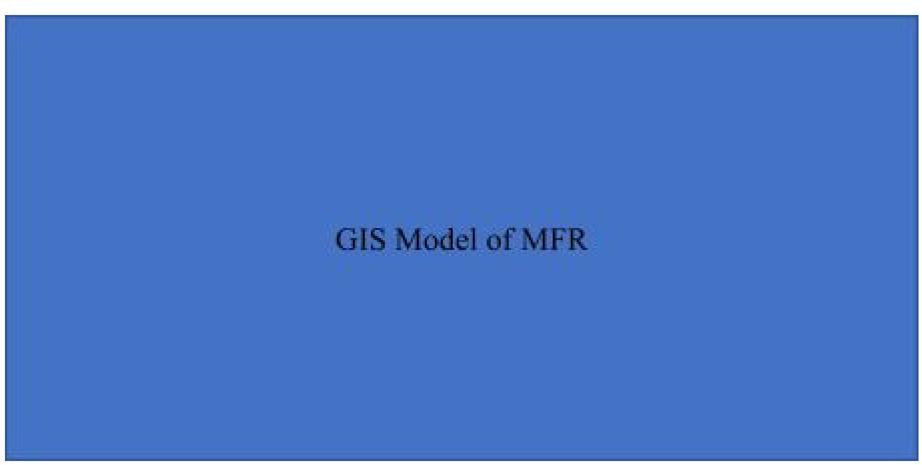




Particulate Matter chart and graphs


There will be three of the CRS – 200 to MD – 80 for arrival, idling, and take-off
CRS – 200
CRS - 700
CRS - 900
ERS - 175
Q - 400
A -320
A - 319
MD - 80
Frequency * Amount Produced
MFR total CO level from PAX Planes/aircrafts
Return to Atmosphere through soil and ocean.


There will be three CRS – 200 to MD – 80 for arrival, idling, and takeoff of aircrafts
CRS – 200
CRS - 700
CRS - 900
ERS - 175
Q - 400
A -320
A - 319
MD - 80
Frequency * Amount Produced
MFR total NOX level from PAX Planes/aircrafts
Dissolve back into the atmosphere


GIS Model of MFR

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