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The Importance of Integrating Observation Data as Input to Weather Models in Europe and Indonesia During-Early the Covid-19 Pandemic

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ABSTRACT

The Covid-19 pandemic that occurred throughout the world caused tremendous losses and reduced the intensity of human activities, especially in cities that had the potential to reduce the number of pollutants in the atmosphere. The purpose of this article is to see the relationship between pollutant fluctuations with weather factors and the reliability of weather models. Elaboration of pollutant data, weather models, and government policies is used to see the extent to which a decrease in pollutant concentration is detected by a weather model. The results obtained show that a decrease in pollutant intensity is very visible in almost all European cities, but for Indonesia, a significant decrease is only in Jakarta and Tangerang, while in Semarang City an increase has been detected. Sophisticated weather modeling can be used to monitor pollutant fluctuations, but this model still requires field observation data. The same condition certainly applies to other parameters, especially maritime observations for which data have not been obtained.

Keyword: Covid-19, pandemic, pollutants, weather models, maritime.

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1. Introduction

The Covid-19 pandemic is an ongoing coronavirus pandemic caused by a severe acute respiratory syndrome called SARS-CoV-2. The outbreak was first identified in Wuhan, China, in December 2019 by the World Health Organization (2020) on January 30, 2020, and was recognized as a pandemic on March 11, 2020 (WHO, 2022). Until February 27, 2021, more than 113,514,984 cases of COVID-19 have been reported in 192 countries and regions in the world. It was also reported that Covid-19 has caused more than 2,519,257 deaths and 64,062,636 people have managed to recover (Gisandata, 2022) although there may be a possibility of relapse or re-infection (Roser et al., 2020).

The virus is spread between people in close contact when a person coughs, sneezes, or talks (Pfefferbaum & North, 2020). Moreover, the virus easily spread and can survive on surfaces of stuff for up to 72 hours (Daniel, 2020) so that it caused the spreading is very rapid and massive. The pandemic has caused severe global socio-economic disruption (Susskind & Vines, 2020) and will be the largest global recession in history. Many countries are predicted will have the long-term effects of the Covid-19 pandemic. Based on the experience, the pandemic can increase massive unemployment like the world's recession in the 1930s, which is known as the great depression (Surico & Galeotti, 2020). As a result, the pandemic has cut off growth in countries that previously enjoyed fantastic growth such as China. Moreover, the COVID-19 pandemic will wipe out 6.7% of global labor hours by the second quarter of 2020 which is the equivalent of 195 million full-time workers more than the crisis in 2008/2009 (ILO, 2020). The global costs of the COVID-19 pandemic are estimated to range from $2 trillion to $4.1 trillion, an increase of 2.3% to 4.8% of global gross domestic product (GDP).

The Covid-19 pandemic has hit all major cities in the world, including Indonesia. A city that is a gathering place for human activities causes high pollutants compared to small cities. Research in Europe and China reports that urban areas are places with high concentrations of pollution which can increase the risk of the Covid-19 outbreak (Bowler; 2022; The Guardian, 2020). However, after the outbreak's emergence human activities have become limited, and can cause the air to be clean, as has happened in several cities in the world including those in China (Nasional Gegraphic, 2020).

Since announced an outbreak at the end of March 2020, the Indonesian government has not directly adopted a national restriction policy, although several places have started to take steps to stop public activities. Several big cities in Indonesia are located on the coast which is supported by their development by the existence of seaports. The large economic turnover in the city causes a strong attraction for the surrounding population, making the population very large (Didiharyono & Giarno, 2021). As a result, the anthropogenic influence causes changes in climatological conditions. However, the ongoing Covid-19 pandemic appears to be affecting the rhythm of these cities because some of them have started to limit their activities. The decrease in human activity may have an impact on changes in the concentration of pollutant particles in the city atmosphere, especially organic pollutants due to burning fossil fuels.

Decreasing pollutant concentration is very important because the low concentration of pollutants in the air can make the air fresher and healthier (BPDL, 2021). The purpose of this study is to show the response of weather models to changes in pollutants in several cities in Europe and big cities in Indonesia which are located on the coast. Analysis of this model is associated with observational data and pollutant index. Particularly related to the response of the weather model, in this case, the European Center for Medium-Range Weather Forecasts (ECMWF) and also its relationship with the policy of limiting public activity taken by the government in each of these cities.

2. Method

Based on the theory that temperature fluctuations are calculated based on the population of cities that are more than 1 million people. Concerning data from the Indonesian Central Statistics Agency (BPS), there are 11 cities in Indonesia with a population of more than 1 million inhabitants. The cities of Depok and Bandung are not adjacent to the beach. Meanwhile, South Tangerang will be considered one with Tangerang City, and Bekasi City will be considered one with Jakarta so that the sample cities taken will be 8 as shown in Table 1.

Table 1. Cities in Indonesia with a population of more than 1 million (BPS, 2010)

Number	Cities	Province	Total Population
1.	Jakarta	DKI Jakarta	9.586.705
2.	Surabaya	East Java	2.940.925
3.	Medan	North Sumatra	2.497.183
4.	Tangerang	Banten	1.798.601
5.	Semarang	Central Java	1.520.481
6.	Palembang	South Sumatra	1.440.678
7.	Makassar	South Sulawesi	1.331.391

The pollutant data used is organic particulate data spatially using reanalysis data from the European Center for Medium-Range Weather Forecasts (ECMWF), which can be accessed freely at https://www.ecmwf.int/. These polluting particulates can cause several health problems related to illness and death related to heart or lung disease. These contaminants can also cause corrosive losses. This data reanalysis is a global grid data with a resolution of 0.40. The area of ECMWF data is more than 44 km, so it is necessary to compare the surface observation data so that real variations can be known. Atmospheric conditions are included to determine the effect of weather on pollutants, which in this study uses data collected and accessed freely at http://ogimet.com/.

This study also uses air quality data or air quality index (AQI) in several cities in Europe (EEA Member Countries, 2020) and Indonesia (AQICN, 2021). This study also uses graph and table visualization to facilitate analysis. Comparisons between these charts are used as material for analysis and will be added with policies taken by the Indonesian government regarding the Covid-19 pandemic.

3. Result and Discussion

Air quality, pandemic and weather effects

The ECMWF model shows a very striking change in the number of organic particulates in Europe which is very striking before and after the Covid-19 outbreak as can be seen in Figure 1 and Figure 2. On April 1, 2019, most places in Europe had concentrations of more than 0.9 ppm. Cities in Italy, Spain, and France appear to have a greater concentration of organic particulates than any other country in Europe. Meanwhile, on April 1, 2020, where this outbreak had spread in Europe, and many people were infected with Covid-19, even the number who died was very large, at that time there was also a decrease in the intensity of organic particulates (PO).

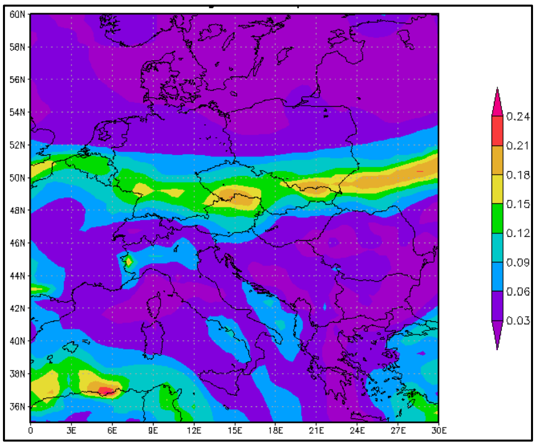

Figure 1. PO April 1, 2019, in Europe

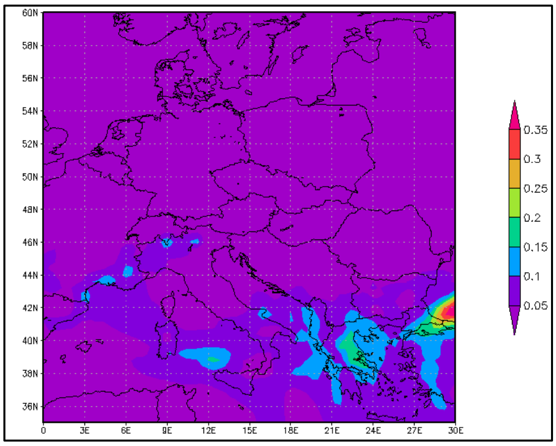

Figure 2. PO April 1, 2020, in Europe.

This condition is different from what happened in Indonesia, where on April 1, 2020, the intensity of organic particulates was even more than the same day in the previous year as can be seen in Figure 3 and Figure 4. Even on the coasts of East Sumatra, Bagia, Central Java, and Sulawesi To the south this increase was very large and reached more than 0.5 ppm.

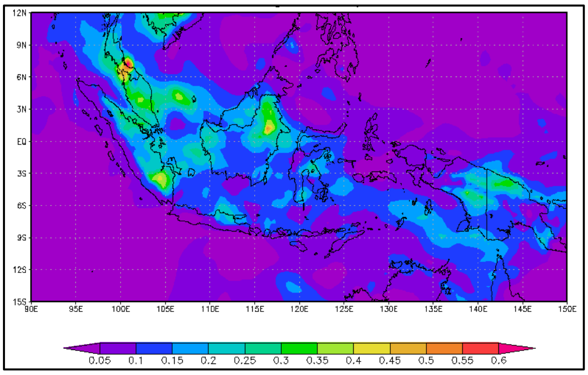

Figure 3. PO April 1, 2019, in Indonesia

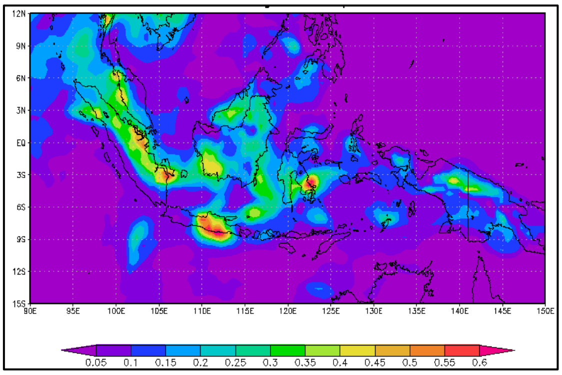

Figure 4. PO April 1, 2020, in Indonesia

The sample on April 1, turned out to be representative of the particulate distribution conditions in April as a whole. This can be seen from the comparisons in Table 2 and Table 3 which calculate the average particulate (PO) from April 1 to April 24, 2020.

Table 2. PO in European cities

Capital	PO2019	PO2020	Reduction
Wina	0,141	0,019	-87%
Amsterdam	0,132	0,024	-82%
Brussels	0,185	0,024	-87%
Paris	0,125	0,027	-78%
Roma	0,085	0,034	-60%
Madrid	0,171	0,029	-83%

Table 3. PO in Indonesian cities

Capital	PO2019	PO2020	Reduction
Jakarta	0,178	0,139	-22%
Makassar	0,105	0,110	4%
Medan	0,216	0,198	-9%
Surabaya	0,147	0,140	-5%
Semarang	0,136	0,180	32%
Tangerag	0,180	0,134	-25%

The concentration of organic particulates in major cities in Europe, namely Vienna (Austria), Amsterdam (Netherlands), Brussels (Belgium), Paris (France), Rome (Italy), and Madrid (Spain) dropped dramatically. Rome was the city with the smallest decline at 60%, while Brussels and Vienna had the lowest concentration of 87%. The Covid-19 outbreak that hit Europe seems to have made citizen activity decrease dramatically, especially in these countries that have imposed a lockdown since March 15, 2020, due to the Covid-19 attack. Even though this effort is considered too late, in April 2020 the results have shown with the number of Covid-19 victims not as many as March 2020.

The results of the ECMWF model are in line with observations, where air quality in several major cities in Europe shows a decrease in the AQI value, which means that air quality in Europe has improved with the Covid-19 outbreak as can be seen in Table 4. Countries with the number of Covid-19 sufferers most in Europe, namely Italy, Spain, England, and France experienced improved air quality.

Table 4. Air Quality Index Scores in several European cities

AQI	2019	2020	Reduction %
Austria	22,460	17,525	-22%
Netherlands	20,571	19,294	-6%
Belgium	27,487	20,425	-26%
France	19,538	11,965	-39%
UK	24,740	16,714	-32%
Spain	17,550	8,668	-51%
Italia	23,089	13,484	-42%

This European condition, in contrast to Indonesia, where the concentration of organic particulates only decreased quite significantly in Jakarta and Tangerang, namely 22% and 25% as can be seen in Table 2.While in other big cities, the decrease was insignificant in Surabaya, Medan, and Makassar. In Semarang, there was an increase in the concentration of organic particulates, reaching 32%. This ECMWF calculation is the same as the historical data of fluctuations in the air quality index in Jakarta.

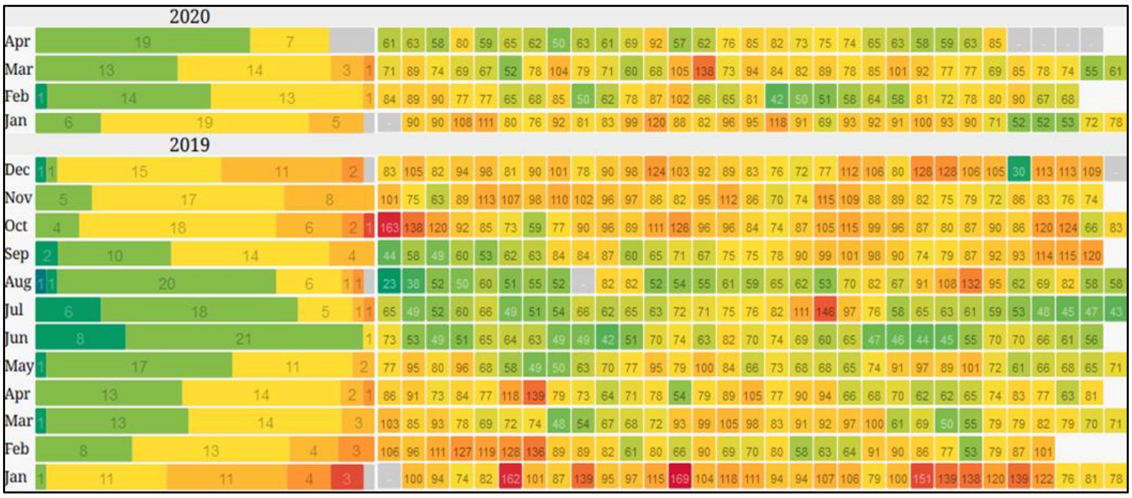

Figure 5. History of air quality in Jakarta.

Increasing air quality in Jakarta and Indonesia is not necessarily the result of government restrictions on citizens' activities, but weather conditions in Indonesia play a bigger role. This is because, until April 26, 2020, cloud growth in Indonesia is still quite massive, as seen in the satellite image in Figure 6.

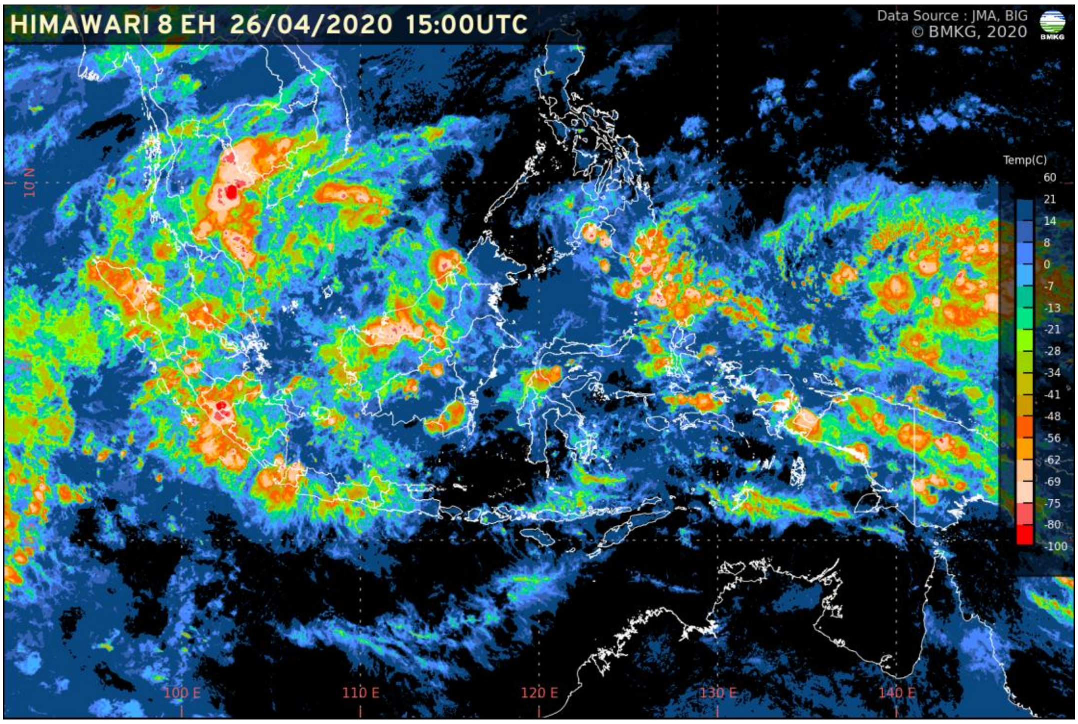

Figure 6. IR image April 26, 2020, 15:00 UTC

Rain still falls in almost all parts of Indonesia, and a large amount of rainfall can reduce pollutants in the air. Water droplets falling from rain clouds collide with pollutant particles. Because these water droplets are larger and can dissolve, pollutants will also fall to the surface of the earth. Areas of Indonesia where rain often occurs as shown in Table 5, thus causing the atmosphere to tend to be cleaner.

Table 5. Accumulated Rainfall until April 20, 2020

Cities	Rainfall (mm)
Jakarta	161,0
Makassar	116,0
Medan	1,3
Surabaya	240,0
Semarang	176,0
Tangerang	37,0

Based on weather observation data, it is obtained that the rainfall for April 2020 is still quite a lot of rainfall in Indonesia. Cities such as Jakarta, Makassar, Surabaya, and Semarang still receive rainfall of more than 100 mm until April 20, 2020. This condition has the potential to reduce pollutant levels not only due to activity restrictions due to Covid-19 but also due to rain. However, the result of this limitation can be seen from the drop of organic particulates in Tangerang where the rainfall in this area is only 37 mm. As we know, the conditions of industrial cities that emit a lot of pollutants will quickly get dirty again if the rain does not occur, as can be seen in Figure 5, which shows how quickly the air quality index deteriorates on an adjacent day.

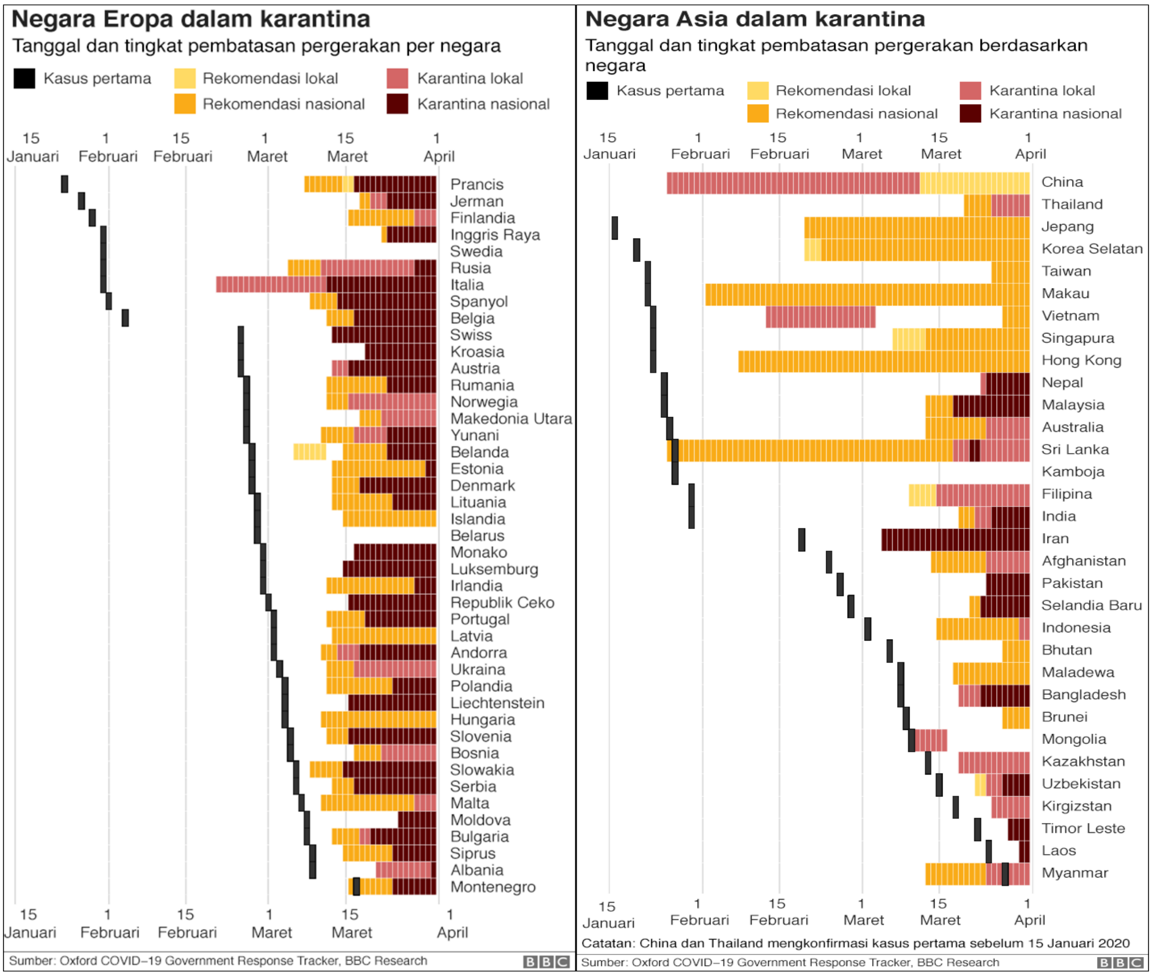

Figure 6. IR image April 26, 2020, 15:00 UTC (Source: bbc.com)

The rapid policies taken by the state resulted in a decrease in the intensity of public activities. In European countries, almost all of them limit their activities nationally, starting at the beginning of March 2020. In contrast to countries in Asia which are more varied as can be seen in Figure 7. China and Vietnam are two countries that are quick to impose restrictions. Large-scale quarantines were carried out in Wuhan and Hebei province as the origin of the outbreak and followed by national-scale restrictions. Meanwhile, Vietnam took preventive action earlier so that it could reduce the spread of Covid-19. It is different from Indonesia, which until now has limited activities only in a few places, which are relatively small in number compared to their total area. Jabotabek is the area with the earliest restrictions so it is natural to reduce pollutants in this area even though at the same time it still rains sometimes.

The effect of observations on weather models

Based on its air quality index, Jakarta occupies the 13th position in world capitals (IQAir, 2020) with a score of 95. This index is far from being compared to the City of Vienna 42, Amsterdam 52, Brussels 41, Paris 47, Rome 35, and Madrid 55. This index, if Compared with the model results in Tables 1 and 2, will appear that the PO values between Jakarta are 0.178 and the PO values for these cities are 0.141, 0.132, 0.185, 0.125, 0.085, and 0.171. The PO Jakarta concentration is better than Paris and almost the same as the organic particulate concentration in the City of Madrid, even though the air quality index in these two cities is much better than Jakarta.

Cities in Europe are known for their good air quality because of the very high concern and awareness of environmental sustainability. It is a question of the ECMWF model results in the same value in a city with good and bad air quality. Weather modeling is indeed a different matter from the actual conditions that occur in the field because in modeling there must be many factors that are considered static but dynamic or the neglect of certain factors as a simplification. However, by integrating the results of the observations into the model, the results of the model will be able to describe the real conditions on a global scale. Sometimes the model response is also late with a break to enter field observation data. Therefore, in the use of a weather model, there is usually statistical guidance as a reference for the implementation of the model in forecasts.

Dynamic weather conditions in Indonesia cause weather changes, especially rainfall which is complex and varies from place to place (Marzuki et al, 2023). Naturally, if a model finds errors when compared to real conditions because remote sensing observations which are also included in the observation category also have errors. What is observed from a considerable distance still has differences with the results of observations on the earth's surface, such as variations in rainfall accuracy in South Sulawesi and around the Makassar Strait (Sanusi, 2017; Rosly et al., 2022). The results of observations on the earth's surface are still very important because they become a reference for determining accuracy which can then be used as an improvement in model input.

If the number of data on land which is relatively easier and cheaper to measure is still limited, of course, there will be less data that is more difficult to obtain, such as at sea and in the air. For maritime people, it is very important to pay attention to weather forecasts in the sea, where many fishermen and sailors depend for their livelihoods (Giarno et al., 2020). In situ observation data at sea has a high level of difficulty, both how to obtain it and the available resources, not to mention the loss of equipment installed in the Buoy. Thus, synergy is needed between users of marine weather forecasts such as fishermen and sailing vessels to voluntarily maintain marine weather parameter measuring equipment. If coupled with the awareness of observing the weather during the trip and reporting it to the nearest weather station, this observation data gap can still be corrected. Of course, there must be reciprocal training and assistance for equipment calibration on ships that carry out observations so that quality and quantity are maintained, in addition to that there needs to be an evaluation of every forecast issued If this synergy goes well, optimism will increase the accuracy of marine weather forecasts and improve shipping safety achievable.

4. Conclusion

The Covid-19 outbreak that hit the world has seen a decrease in the intensity of human activities, especially in cities around the world. The decrease in the intensity of this activity can be monitored by sophisticated weather modeling that includes pollutant parameters in it. However, this model still requires field observation data as a comparison, because errors will appear when there is no correction. This of course also applies to other parameters, especially observations in the sea where data is almost nonexistent. Thus, the synergy between Meteorology Climatology and Geophysics Agency (BMKG) and shipping actors is needed to improve maritime data acquisition.

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