Question 4

Despite the increasing awareness of environmental issues, some remain skeptical about climate change being a problem (see https://www.bbc.com/news/science- environment-62225696). Using the data provided in this project and the individual assignment (as well as any other publicly available data, if your team shall desire), build a convincing data narrative to illustrate climate change problems associated with emissions.

Datasets used:

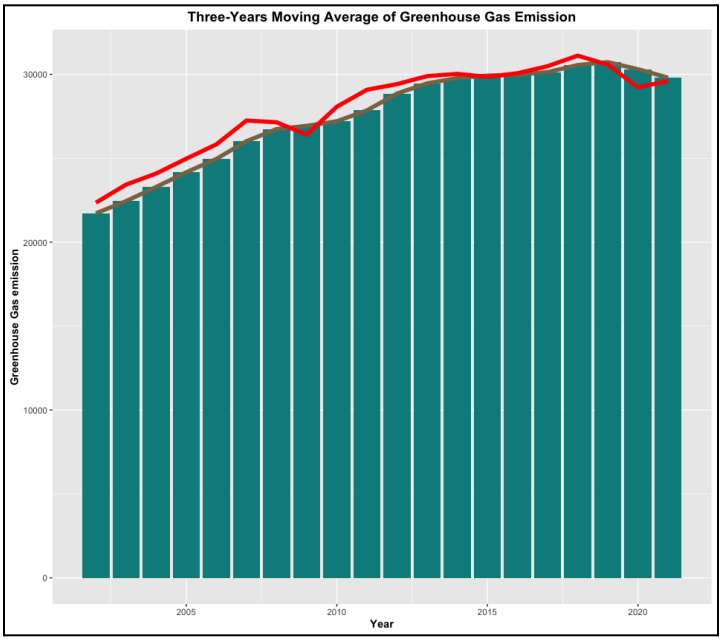
1. Owid_Energy_Data
2. seaice
3. globaltemperatures

Firstly, a query was written using [Owid_Energy_Data] to draw out a table to depict an overview of the global greenhouse gas emission. In the table, the fields include:

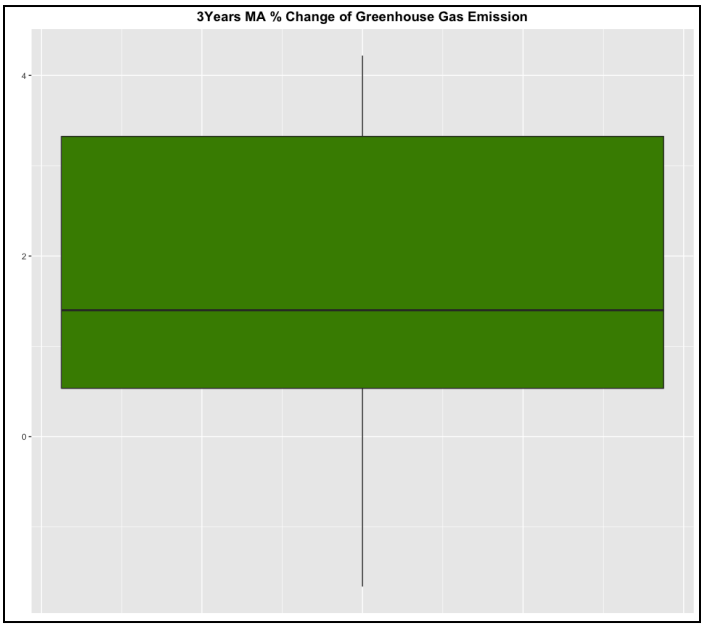
a. Year
b. Yearly greenhouse gas emission
c. Yearly percentage change of greenhouse gas emission
d. Three years moving average of greenhouse gas emission
e. Percentage change of Three years moving average between pairs

year	gh_emission	change_pct	threey_ma	diff_ma_...
2000	21250.64	NULL	NULL	NULL
2001	21551.94	1.42	NULL	NULL
2002	22349.95	3.7	21717.51	NULL
2003	23426.91	4.82	22442.93	3.34
2004	24087.58	2.82	23288.15	3.77
2005	24972.24	3.67	24162.24	3.75
2006	25824.04	3.41	24961.29	3.31
2007	27245.41	5.5	26013.9	4.22
2008	27141.81	-0.38	26737.09	2.78
2009	26398.24	-2.74	26928.49	0.72
2010	28067.47	6.32	27202.51	1.02
2011	29079.26	3.6	27848.32	2.37
2012	29415.2	1.16	28853.98	3.61
2013	29890.22	1.61	29461.56	2.11
2014	30026.16	0.45	29777.19	1.07
2015	29845.13	-0.6	29920.5	0.48
2016	30061.48	0.72	29977.59	0.19
2017	30484.3	1.41	30130.3	0.51
2018	31110.44	2.05	30552.07	1.4
2019	30575.92	-1.72	30723.55	0.56
2020	29226	-4.41	30304.12	-1.37
2021	29597.12	1.27	29799.68	-1.66

Following, insights were garnered from this dataset as follows:



a. Through the years from early 2000s to 2021, the world sees an increase in the three year moving average of greenhouse gases emissions. This is driven by a frequent observation of a year-on-year increase in greenhouse gases emissions as shown with the red line.



b. Although there are instances of negative percentage change, the average of the three year moving average percentage change of greenhouse gases emissions is 1.69%.

Moreover, it has a value of 0.535% in the first quartile, indicating that the occurrence of a positive growth in greenhouse gases emissions is more likely than a negative growth.

With the increase in greenhouse gases emission, it is said to have a drastic impact on climate change. Climate change is defined by the United Nations (n.d.) as a shift in global temperature and weather.

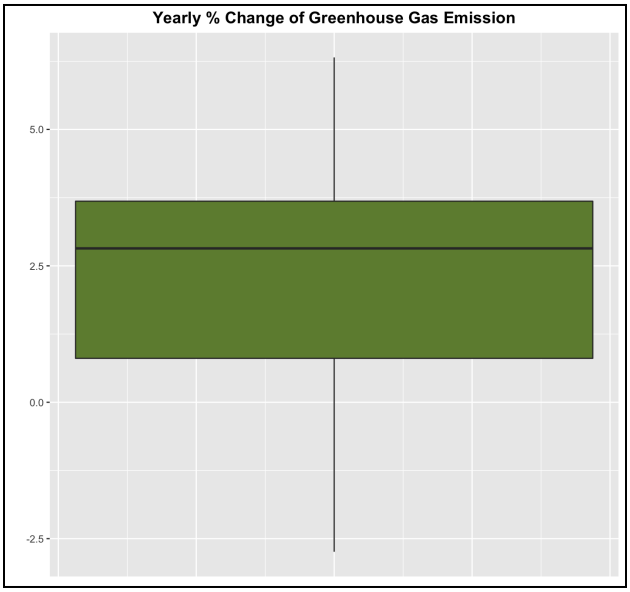
Hence, using the three datasets, a query was written to gather insights on the impact of greenhouse gases emission by generate the following table with fields:

1. Year
2. Yearly greenhouse gas emission
3. Yearly percentage change in greenhouse gas emission
4. Yearly average extent of sea ice
5. Yearly percentage change in extent of sea ice
6. Yearly average of land temperature
7. Yearly percentage change in land temperature

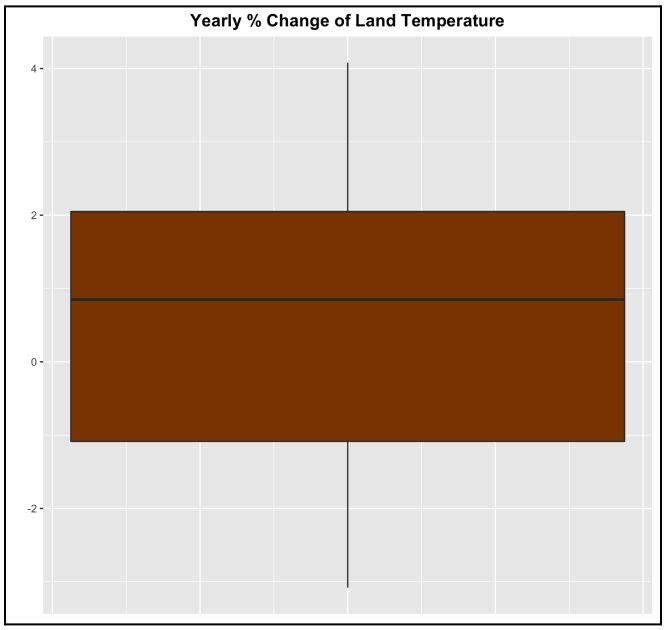
year	gh_emission	change_emission_pct	avg_extent	change_ice_pct	avgLandTemperature	change_temp_pct
2000	21250.64	NULL	11.63	NULL	9.2	NULL
2001	21551.94	1.42	11.64	0.09	9.41	2.28
2002	22349.95	3.7	11.29	-3.01	9.57	1.7
2003	23426.91	4.82	11.68	3.45	9.53	-0.42
2004	24087.58	2.82	11.6	-0.68	9.32	-2.2
2005	24972.24	3.67	11.3	-2.59	9.7	4.08
2006	25824.04	3.41	11.12	-1.59	9.53	-1.75
2007	27245.41	5.5	11.08	-0.36	9.73	2.1
2008	27141.81	-0.38	11.61	4.78	9.43	-3.08
2009	26398.24	-2.74	11.49	-1.03	9.51	0.85
2010	28067.47	6.32	11.41	-0.7	9.7	2
2011	29079.26	3.6	10.99	-3.68	9.52	-1.86
2012	29415.2	1.16	11.21	2	9.51	-0.11
2013	29890.22	1.61	11.71	4.46	9.61	1.05
2014	30026.16	0.45	11.78	0.6	9.57	-0.42
2015	29845.13	-0.6	11.49	-2.46	9.83	2.72

*Only from years 2000-2015 due to missing data in some years across all 3 datasets

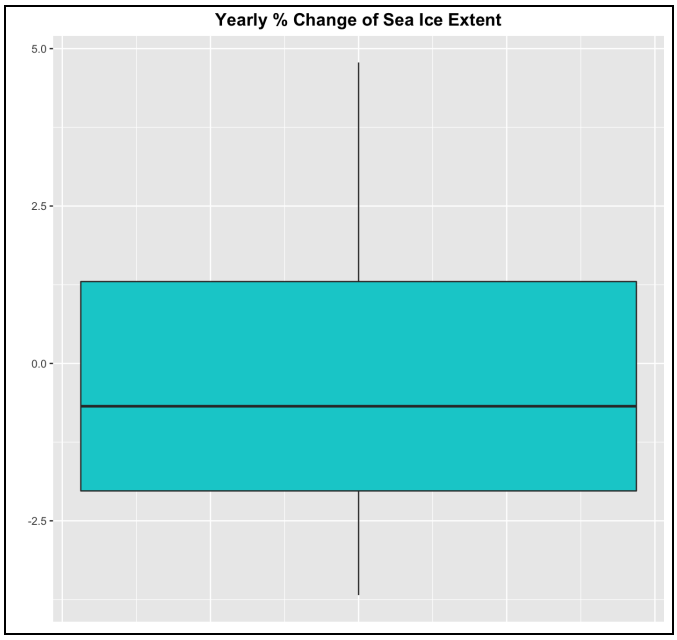
With the table, insights were derived:



a. On average, the amount of greenhouse gases emissions from 2000-2015 is increasing at a percentage growth of 2.32%, while its median stands at 2.82%.



b. On average, Earth's land temperatures from 2000-2015 is increasing at a percentage growth of 0.5%. Although it has a median of 0.85%, its first quartile stands at -1.08%.



c. On average, Earth's yearly percentage change in extent of sea ice is at -0.5%. Its median is -0.68%, while its third quantile stands at 1.3%.

The overview of the yearly percentage change of greenhouse gases emissions, land temperature and sea ice is not telling of the relationship between these variables. Moreover, as these are based on a per-year basis, factors such as the different seasons in a year, which may also be a determinant of these variables, have not been looked at.

Hence, the next step will be to look into the temperature and extent of sea ice change in it each season in a year, namely Spring, Summer, Autumn and Winter, from 2000 to 2015.

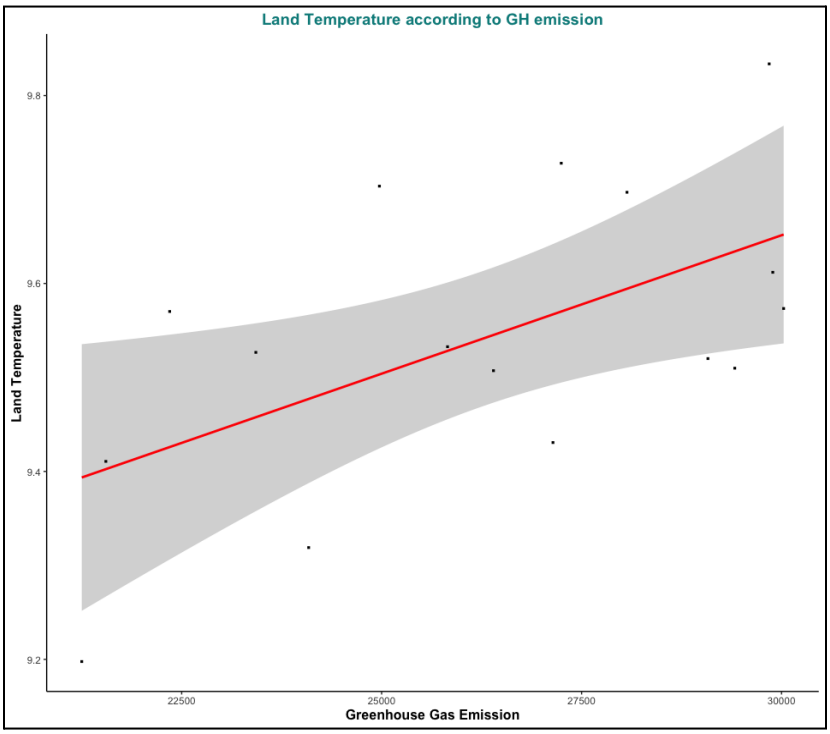
	quarter	temp_pct_change	ice_pct_change
▶	Autumn	0.68	-0.25
	Summer	0.15	-0.2
	Spring	0.23	0.17
	Winter	2.09	0.26

It was observed that there is a positive temperature growth across all seasons. This indicates that even during colder seasons, the land temperature is still rising as compared to previous years which is not normal.

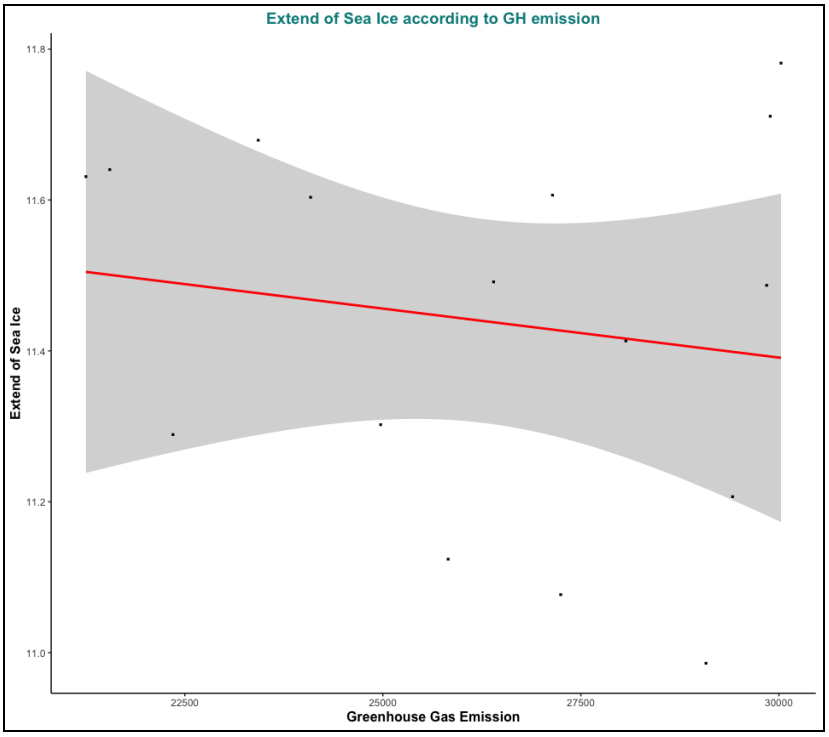
Although there is a positive growth in temperature change across all seasons, there are only two occurrences of negative change in extent of sea ice across all seasons.

To summarise the section in relation to the overview of greenhouse gas emission, it can be noted that an increase in greenhouse gases emissions is positively correlated to the change in temperature. However, evidence for correlation between the extent of sea ice and greenhouse gas emission/ land temperature remains inconclusive due to lack of coherence among seasons.

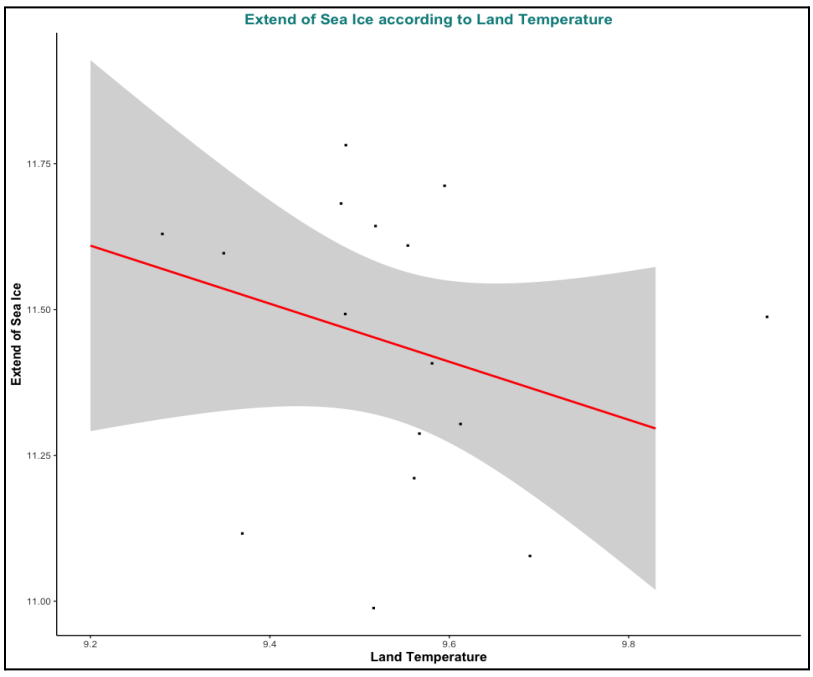
Additionally, correlation does not equal causation. Hence, a statistical method - linear regression model was employed to discern if there exists any relationship between greenhouse gas emission, extent of sea ice and land temperature. It was found that:



a. A positive relation exists between greenhouse gases emissions and land temperature. An increase in the amount of greenhouse gases emissions, will result in an increase in land temperature.



b. It was also found that there is a negative relation between greenhouse gases emissions and the extent of sea ice. As the amount of greenhouse gases emissions increases, the extent of sea ice decreases.



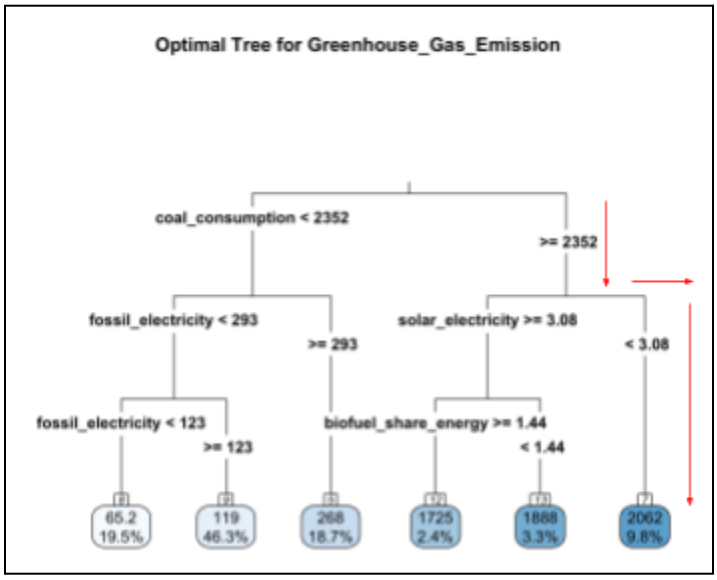
c. A negative relation exists between land temperature and extent of sea ice. As land temperature increases, the extent of sea ice decreases.

To conclude, there are causation effects between greenhouse gas emission, land temperature and extent of sea ice. If there is an increased amount of greenhouse gases emissions, the land temperature will increase, which in turn leads to a decrease in extent of sea ice and vice-versa. This cascading effect is also commonly raised by environmentalists around the world as reports such as the arctic's rapid development into a less frozen region due to greenhouse gases emissions, soaring temperatures and loss of ice is not uncommon (Milman, 2020).

The continual melting of sea ice is bound to have an impact on Earth's ecosystem as it fuels the rising of sea levels and endangers coastal cities with more floods (Hancock, 2022). As it also helps to reflect heat back into space, less sea ice means less reflected heat and more intense heat waves worldwide, a common sight among countries in recent years (Rocks, 2022).

The rising temperature also begins a vicious cycle within the ecosystem as it also contributes to the melting permafrost - a ground that is permanently frozen and stores large amounts of methane, a greenhouse gas. This will then cause even more melting of ice and permafrost, turning into a cycle of chicken-and-egg (Hancock, 2022).

Thus, it is important for the population to take measures in curbing the output of greenhouse gases. Using the [owid_energy_data] dataset and classification and regression trees (CART - a statistical technique to form a decision tree that predict the value of an outcome based on significant variables), it was derived that:



A large amount of coal consumption and less use of solar electricity are the most significant contributors to high emission of greenhouse gases. Hence, various stakeholders such as government authorities should be mindful of this when planning fiscal policies in determining the sources of energy, and as much as possible, limit coal consumption and promote the use of solar energy.