**Cruise Data Analysis**

**NOx zeroes**

After talking to James and Lucy, we decided that for NOx instead of interpolating to apply the zeroes we could simply get an average value for each “zero session” and then average these values. This singular, final value would be used to apply the zeroes to NO and NO2. First of all, zeroes that were problematic (taken when sampling ship stack or when instrument temperature was outside bounds) were removed. The mean and median were each calculated for each zero session and then compared. The stdev for the mean process was lower than that for the median process and was therefore selected.

The value subtracted from all NO measurements is -0.0363139655120056.

The same process was repeated for NO2, with the mean rather than median values also being selected. The value subtracted from all NO2 measurements is -0.134759009068831.

**Removing ship stack measurements**

The position data was imported and converted from degrees and minutes to one decimal value by dividing the minutes values by 60 and adding the result to the degrees.

Surfmet data (relative wind speed and direction) was also imported. For both these datasets, as well as the concentration dataset, a rounding function was applied to the dates to ensure that each date column was rounded to the correct second, allowing for the datasets to be merged (using left\_join).

Before joining, the concentrations and met data sets were averaged to one minute (not the CO because the calibrated CO data was provided averaged to one second). For the relative wind speed and wind direction, the timeAverage function from openair was used, to ensure that the average was calculated using vectors.

Once this was done, all the datasets were joined together, and a flag was created to mark when the ship stack was being sampled – when the relative wind direction is between 157.7 ° and 202.5 °. When the wind is coming from the stern of the ship, the ship stack will be blown towards the inlet and in this situation the relative wind direction is 180 °. Analysis has then been done on a one-on-one level with individual spikes that happen around ship stack flagging, but not directly during this flagging. Since there are not many (4), they were also flagged in order to be on the safe side.

David wrote some code in R for me, to calculate the true wind speed and direction from the relative values, ship speed and heading. Whilst doing this, I noticed that relative wind speed values were suspiciously high (40 ms-1) on the morning of 10th June – some of the values had been flagged (value of 999.99), but there were clearly still issues with other values. All wind data between 06:00 and 12:00 on 10th June has therefore been removed.

With true wind speed data, filtering according to the wind speed is possible. Any measurements taken when the wind speed was less than 2 ms-1 were flagged as potentially being due to sampling the ship stack. After this, the data was manually checked and any spikes which were “half-flagged”, were fully flagged.

**Data analysis**

**O3/CO correlation**

Going to check data station by station to see how the relationship between O3 and CO changes. Will also look at these datapoint coloured by doy and by NOy.

* East of Greenland: the highest average concentrations of both O3 and CO were measured at this station, with quite a large spread for both gases. The correlation between O3 and CO appears to have been negative most of the time, all of the time really on the first two days at this station. The third day shows a bit of a shift in the amount of CO measured (100ppb-ish and 108ppb-ish), with the portion of datapoints between these two sections of negative correlation showing a slightly positive correlation. Looking at the timeseries for O3 and CO during the East Greenland station, a jump in both O3 and CO concentrations on the third day can indeed be seen. Slight increase in NOy (2- 3 ppb!!) in a more isolated section of datapoints (different airmass?)

From the backtrajectories, I think that at around the time the O3 and CO concentrations responded together, the air reaching the ship was coming from over inland Greenland?

* Nuuk: much lower O3 concentrations (second lowest from whole cruise), with the most outliers for O3, CO also showing a significant number of outliers. The correlation between the two is negative for the whole time basically, with O3 concentrations increasing as we entered the fjord, whereas CO concentrations decreased when this happened. When outside of Nuuk had very low O3 concentrations, in the teens and early twenties. At the end of the station, drastic increase in O3, with corresponding decrease in CO. When plotted against each other, you can see spikes in CO, likely due to anthropogenic emissions (not ships, as most of the CO spikes in Nuuk don’t show a corresponding spike in NOx). No insight to be gained from NOy really, other than some higher values with both low O3 and CO. NB: scale in NOy much higher than in East of Greenland. From backtrajectories, airmass seems to be coming more from over the land during the last day (31/05) of our stay at Nuuk (over the coastal sea on first day, 30/05)
* Maniitsoq 1: Due to low windspeeds, a lot of this data has been filtered out. Massive CO peak (roughly 300 ppb), not see in NOx or NOy. Much higher ozone levels on the third day in Maniitsoq (saw that from timeseries too). Slight negative correlation here as well. First and second day are roughly the same, with the large spike in CO on the first day. May have removed too much data from this station? Not much added from looking at NOy concentration, max reached is around 3ppb, which was seen for four datapoints when O3levels were higher.
* Sisimiut: weird stuff happening with CO, O3 and VOCs (toluene and isoprene) when we arrived – might have been filtered (may need to look at filtering again). Something weird going on with NOy?

Very slightly positive correlation between the two, more so at low O3, seems to be unrelated when O3 is higher (CO doesn’t really vary). Quite a few CO spikes, most occur at low O3. Highest O3 has lowest NOy

* Disko bay: no spikes in CO at all really, O3 shows quite a large increase, with its peak corresponding to a drop below zero in NOy. Hard to determine if there is really any sort of relationship between O3 and CO and O3 at this station. Not much else to add following NOy colouring.
* Sea ice: There are quite a few spikes, at the same time, in both NOy and CO, which are not from the Discovery based on ws and wd, but I think they may be due to other ships at the sea ice. Negative correlation basically every day. Less O3 and CO as the days go by. Hard to get any information from colouring based on NOy because high NOy (around 100ppb) seen with high CO (spikes from other ships most likely). All other NOy values are v low in comparison, so much so that it is hard to distinguish them