ENV-409 NABEL Data Analysis Assignment

Spring 2023

Instructions:

1. Select an approved pair of monitoring stations situated in contrasting locations (degree of influence from urban emissions) to analyze concentrations of pollutants and their meteorology.
2. You can download hourly concentrations from the NABEL website. Additional meteorological data (wind speed, wind direction) for the sites will be provided on Moodle.
3. Perform the analysis and submit a report containing answers to the questions listed below. There are a total of 7 problems worth 80 points. Problems 1-3 are worth 8 points each (total of 24 points). Problems 4-7 are worth 14 points each (total of 56 points).

Assignment parameters:

- Submit on Moodle by 23h55 on the day of deadline (automatic 50% deduction for late submissions - you are probably better off submitting what you have at that point).
- Use standard report formatting – no less than 10pt font, 1.5cm margins.
- Up to two members per group – no exceptions.
- Each group must upload a unique report to Moodle.
- Submit only reports; no code (you are not required to use R, though the tutorial will be given in it).

Additional information:

- The questions pertain to *regulated pollutants* and meteorological variables – additional measurements available at each station can be used to support conclusions but do not have to be reported otherwise. Some stations do not measure all regulated pollutants. You may skip answering questions these pollutants *for that site*, but do not skip for the other site if the measurement is available.
- Recommended limits on number of pages (which should include figures) are listed next to each question to give an indication of the length of answer expected, but do not have to be strictly followed. You may provide additional data/figures in an appendix if you wish.
- In analyzing environmental observations, it is often the case that the measurements do not provide sufficient evidence to "confirm" or "prove" a hypothesis, and such language should be avoided.
- To go beyond simply listing all possible explanations for the cause of variations observed in pollutant concentrations, we encourage using 1) references outside of lecture notes and 2) back-of-the-envelope calculations (often dealing with approximate time scales or length scales) to support interpretation beyond that possible by the NABEL data.

However, you must properly cite figures, references, and sources used in your report. If you cite technical reports or peer-reviewed literature, you should also consider (and remark) whether findings drawn from them are truly relevant for your geographical location and time period.

Some of the instructions are left intentionally vague. E.g., you must choose the level of data aggregation, analysis, and type of chart that makes the most sense in answering the question.

Problem 1 - (1-2 pages of text/tables; more if figures included)

Demonstrate understanding of *reference* instruments in the monitoring network. (Hint: check the NABEL website for relevant technical documents)

a. Describe the physical or chemical principle behind each reference instrument used to measure the regulated air pollutants in Switzerland.
b. Describe the potential biases or errors in each type of measurement.

Problem 2 - (3 pages)

Analyze pollutant concentrations with respect to their limit values.

a. Determine whether regulatory limits are met or exceeded for each pollutant. Summarize the results in a table.
b. Identify periods in which regulatory limits are exceeded. You can either list individual periods, or just the count if the number is high.

Problem 3 - (3 pages)

Describe the seasonal averages of each regulated pollutant and meteorological variables and note differences between the two sites (including wind direction/speed). Describe most likely reasons for the variations.

Problem 4 - (5 pages)

Describe the weekday and weekend concentrations of each regulated pollutant and meteorological variables (including wind direction/speed) and note differences between the two sites and between two seasons (summer and winter).

a. Examine diurnal profiles (hourly values). Describe differences and most likely reasons for the variations, referring to figures and relevant values that have been calculated.
b. Contrast the mean weekday and weekend concentrations of each regulated pollutant and meteorological variable (exclude wind direction/speed) between the two sites. Are they statistically different? Can a weekly periodicity be observed in daily mean or peak ozone concentrations to support your finding?
c. Explain whether or not there is a “weekend effect” in ozone?

Problem 5 - (3 pages)

Select two correlations or lagged correlations among pollutant concentrations with meteorological variables.

a. Begin the statement of hypotheses of what should be correlated according to cause and effect, and support or discredit it with your analysis.

b. Which variables show mild to strong correlations with each other for which sites and time periods?
c. Give (physically) plausible reasons why these correlations might exist. Do they share a causal relationship, or are they dependent on a third confounding variable (e.g., common source of emissions or photochemistry).

Problem 6 - (3 pages)

Analyze statistical distributions of pollutant concentrations. Select the month of July for the following analysis.

a. Using the appropriate statistical test, determine if each pollutant concentration at each site is lognormally distributed for i) hourly-averaged concentrations and ii) daily-averaged concentrations.
b. Explain if these distributions are reasonable to expect for each species (given the processes responsible).

Problem 7 - (3-4 pages)

Select and describe one period that lies out of "usual" patterns.

a. Why do you identify it as unusual?
b. Using multi-pollutant correlations and meteorological analysis, try to determine whether any cause can be attributed to these events to the extent that you can tell from your data set.
c. If appropriate, perform a HYSPLIT back trajectory analysis to determine whether this unusual event can be explained by long-range transport.