Assignment 1
GEOG 321 - Climatic Environments / Knox
2024 Winter

Radiation

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Preamble: In this assignment you will use radiation data collected on the University of British Columbia campus, located in Vancouver, BC (49.2°N, 123.2°W)

Using the link below you will be provided with data from a single day (the actual day is selected based on your student number, as shown on the webpage). Data are available for download in various formats:

https://geog321.github.io/assignment1/

In the files you will find measurements of the following variables: incoming and reflected short-wave radiation ($K_{\downarrow}$, $K_{\uparrow}$), incoming and outgoing long-wave radiation ($L_{\downarrow}$, $L_{\uparrow}$), air temperature (T_a) and relative humidity (RH). All measurements are from the set-up on Totem Field. Using these data to answer all the questions.

Instructions: Please upload your answers including calculations, discussions and graphs in a single, well-structured report (either Word, PDF or HTML file). Instructions on how to download an html or PDF file and submit it to myCourses can be found on the course website under the section 'R Resources' - 'RStudio Server' - 'Downloading the output to upload your file to myCourses'. Label the report document with your name, your student number, the course and year. Upload your answers to myCourses by Thursday, Feb 1, 2024, 11:59 pm. Do not attach a spreadsheet.
Marks are indicated in square brackets. In total, there are 50 marks. This assignment is worth 10% of the final course grade.

1. Using your dataset, at which time of the day do you observe (a) the maximum of Q^*, (b) the minimum of Q^*, (c) the maximum of K^*, (d) the maximum of L^* and (e) the minimum of L^*? Briefly comment on the situations that cause the extremes. [5]

2. Calculate the average net short-wave K^*, net long-wave L^*, and net all-wave Q^* radiative flux densities in $\mathrm{W\,m^{-2}}$ over the 24 hour cycle. Then determine the daily energy gain (+) or loss (-) by converting the average $\mathrm{W\,m^{-2}}$ into daily totals (energy per square metre and day, expressed in $\mathrm{MJ\,day^{-1}\,m^{-2}}$) †. [6]

3. Calculate solar declination δ for your day [3].

4. Calculate the incoming solar irradiance at the top of the atmosphere ('extraterrestrial irradiance' K_{Ex}) above the site, for the given day at noon. Note, time in your data (and here) is given in Pacific Standard Time (PST, i.e. no daylight saving offset). Note that PST is UTC-8. [7].

5. What is the approximate bulk transmissivity (Ψ_a) of the total atmospheric column at this time? Comment upon the reasons for the magnitude of Ψ_a you find. [5]

6. Estimate the approximate surface albedo of the grass surface for that day. Justify your calculation of the albedo. Do you observe any diurnal variation of the albedo? † [5]

7. Use the values presented in Topic 7 Slide 5 to get an estimate of the surface emissivity ε_0 of a grass surface. Using this values, calculate the true surface temperature T_0 (i.e. considering that the surface is a grey body and reflects) at noon for the given day. [5]

8. Using measured $L_\downarrow$ and measured air temperature T_a, calculate the actual bulk emissivity of the atmosphere ε_a at noon? [4]

9. Based on the traces of measured radiative flux densities over the course of the day, and your calculations up to this point, speculate on the weather and surface conditions during your particular day. Is there any evidence for clear skies, haze, high clouds or fog? Support your argumentation using your measurements. [4]

10. Graph a scatter plot of the measured incoming solar radiation ($K_\downarrow$) versus the net all-wave radiation (Q^*). If you only had values of $K_\downarrow$

available in the future does this relation provide a possible means of obtaining Q^*? When might it be least useful? Discuss. † [6]

† To answer questions marked by a † it is highly recommended to use a computer / graph software or R (or other programming language). See the course web-page for help documents on how to use the most common graph software or R. However, if you decide to not use a computer, it is appropriate to consider only the values at each full hour (i.e. 00:00, 01:00, 02:00 etc.) and manually calculate results / draw the graphs using this reduced data-set of 24 values.