The University of British Columbia
Knox / GEOB 300 / February 8, 2019

Midterm Examination

Name	Student #	
Signature	*for marking only* Marks	Grade

Write answers directly into the space provided. Additional pages are not allowed and will not be marked. There are 8 pages. Make sure you have all. Marks are indicated in square brackets. Total possible marks are 100 (Part A: 32, Part B: 28, Part C: 40). Time allowed - 50 min.

Part A: Multiple choice questions

Solve all multiple choice questions. Check only one box per question. If you check none or multiple boxes, your answer will be invalid and you receive zero points.

1. Which of the following atmospheric phenomena is micro-scale? [4]

   ◯ Thunderstorm ◯ Dust devil ◯ Land/sea-breeze circulation ◯ Hurricane

2. How is net short-wave radiation defined? [4]

   ◯ $(1-\alpha)K_\downarrow$ ◯ $K_\uparrow/K_\downarrow$ ◯ $K_\downarrow - K_\uparrow + L_\downarrow - L_\uparrow$ ◯ σT^4

3. In which of the following times is the Sun always at its highest point at noon (12:00) in Vancouver? [4]

   ◯ PST ◯ LAT ◯ UTC ◯ LMST

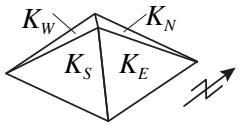
4. How are specific heat c and heat capacity C linked? [4]

   ◯ $C = \rho c$ ◯ $C = \frac{1}{c}$ ◯ $c = \frac{1}{C}$ ◯ $c = \rho C$

5. What do we call the radiant flux density in $\mathrm{W\,m^{-2}}$ emitted from a surface? [4]

   ◯ Emissivity ◯ Emittance ◯ Emission intensity ◯ Emitter

6. The following figure shows a pyramid, where K_N, K_E, K_S, and K_W are the slope-normal daily total short-wave irradiances on the North, East, South and West side, respectively. In absence of any atmospheric effects, which of the following equations is always correct for any day of the year and for any location on Earth? [4]

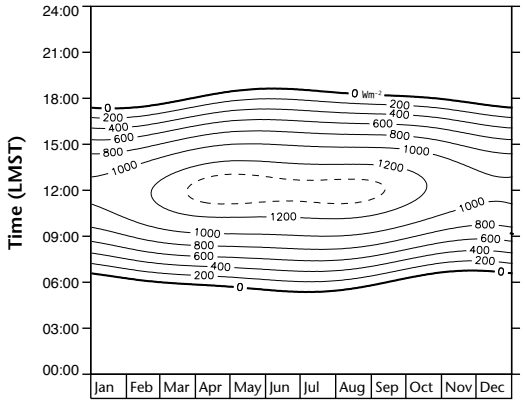


   ◯ $K_S > K_N$ ◯ $K_N = K_S$ ◯ $K_E < K_S$ ◯ $K_W = K_E$

7. What is a realistic value for the extraterrestrial irradiance K_{Ex} today, February 8, 2019, at noon? [4]

◯ $1366\,\mathrm{W\,m^{-2}}$ ◯ $1366\,\mathrm{W\,m^{-2}\,sr^{-1}}$ ◯ $720\,\mathrm{W\,m^{-2}}$ ◯ $720\,\mathrm{W\,m^{-2}\,sr^{-1}}$

8. The following graph shows the distribution of extraterrestrial irradiance K_{Ex} (in $\mathrm{W\,m^{-2}}$) for a given latitude over the course of the year (x-axis) and the course of a day (y-axis). Determine the latitude this graph is valid for? [4]



◯ Buenos Aires, Argentina (34°S)

◯ Mumbai, India (19°N)

◯ Yellowknife, Canada (62°N)

◯ Manaus, Brazil (3°S)

Part B: Short answer questions.

Answer only four out of these five short answer questions. Note: the first four questions with any answer written into the space provided will be marked, hence solving more than four questions is not to your advantage.

1. Briefly explain the difference between *shortwave* and *longwave* radiation. [7]

2. Briefly explain the difference between *Fourier's law* and *Beer's law* in a homogeneous medium [7]

3. Briefly explain the difference between the *atmospheric boundary layer depth* and the *damping depth* in a soil. [7]

4. Briefly explain the difference between *albedo* and *reflectance* of a surface. [7]

5. A soil heat flux plate (SHFP) is made up of a material similar to soil with a well-known thermal conductivity that is put in-between two metal plates that are spaced 1 cm apart. A SHFP with a $k = 0.5\,\mathrm{W\,m^{-1}\,K^{-1}}$ is inserted into a soil. The upper metal plate of the SHFP measures 20.0°C while the lower plate measures 18.0°C. Determine the ground heat flux Q_G conducting heat through the plate. [7]

Part C: Problem questions

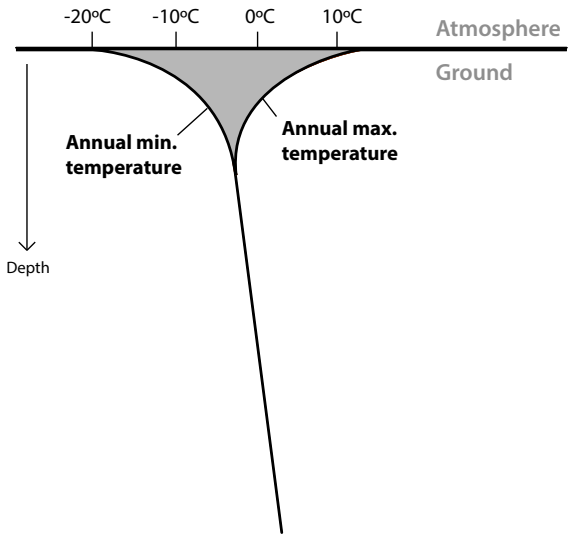
Answer only four out of the following six questions. Again: the first four questions with any answer written into the space provided will be marked, hence solving more than four questions is not to your advantage.

1. Every year, about 6 million hectares of humid tropical forest are deforested and many logged regions are permanently transformed into rangeland for cattle (e.g. Brazil). This will change the regional climate and the surface radiation processes in addition to causing emissions of greenhouse gases.

   In the table below, compare all four components and Q^* of the radiative budget over a landscape with humid tropical forest and a landscape of rangeland. Fill-in the boxes below with (=,<, or >). Briefly explain each postulated change (or explain why no change is expected). [10]

tropical forest landscape		rangeland landscape	brief explanation
$K\downarrow$	$\square$	$K\downarrow$	
$K\uparrow$	$\square$	$K\uparrow$	
$L\downarrow$	$\square$	$L\downarrow$	
$L\uparrow$	$\square$	$L\uparrow$	
Q^*	$\square$	Q^*	

2. The curves below show the range of observed subsurface temperatures in the Canadian Arctic from the surface to a depth of approximately 500 m [10]

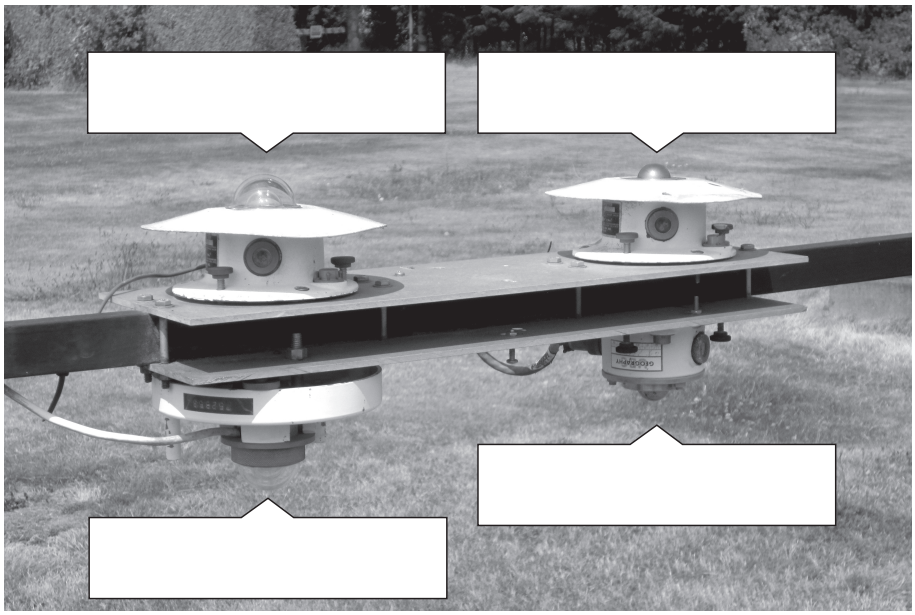


(a) Label the depths where you expect permafrost to occur? Where is the active layer? [4]

(b) If the thermal diffusivity of the subsurface would be significantly higher, how would that impact the occurrence of permafrost? [3]

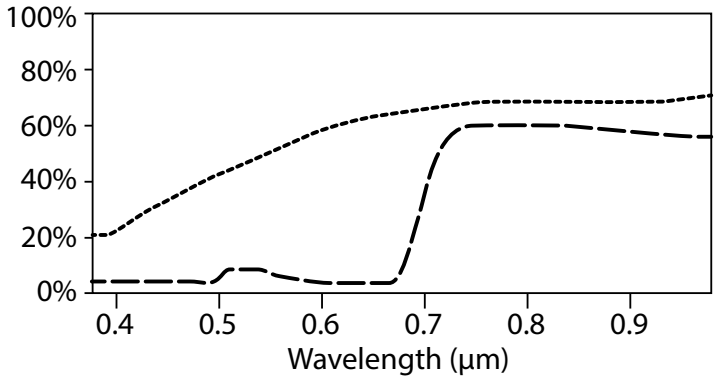
(c) Why is the temperature not constant as we move to deeper parts of the subsurface. [3]

3. You saw this instrumentation during your field visit to UBC's Totem Field. In each of the white boxes on the photo place the name of the meteorological instrument [4]. Also state which variable each instrument is recording [4]. Finally, explain which flux density can be measured by the combination of all four instruments? [2]



4. In mid-latitude climates, farmers are often keen to retain a deep snow cover over their land during the winter and early spring. List two reasons why this could be an advantage from an agricultural perspective. [10]

5. In class, we discussed the spectral reflectivity of leaves and how we can use this information in remote sensing applications. Below are two spectra, one is from a green leaf and one is from an autumn leaf.



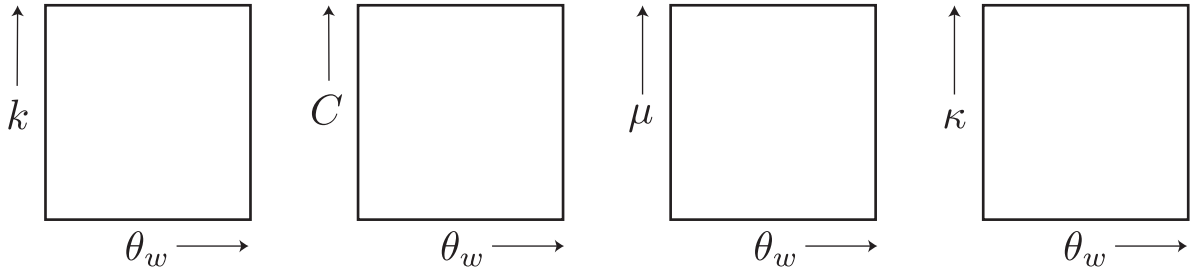
(a) Label the y-axis of the graph [2]

(b) Along the x-axis determine the relevant regions of the electromagnetic spectrum [2]

(c) Attribute the green and autumn leaf to the corresponding curves, and briefly justify your choice [4].

(d) Briefly say how the difference in the curves may benefit the remote sensing of land surfaces [2].

6. To each of the blank graphs below, add a sketched line to show roughly the way each thermal property of soils varies with increasing soil water content θ_w (k - thermal conductivity, C - heat capacity, μ - thermal admittance, κ - thermal diffusivity). Briefly discuss the shape of each of the curves. [10]



END OF EXAM