The University of British Columbia
Christen / GEOB 300 / October 14, 2011

Midterm Examination

Name	Student #	
Signature	*for marking only* Score	Grade

Write answers directly into space provided. Additional pages are not allowed and will not be marked. There are 7 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.

1. What is the property that describes the energy required to warm up one kilogram of air by one Kelvin? [4]

   ◯ The specific heat of air c
   ◯ The thermal diffusivity of air κ
   ◯ The heat capacity of air C
   ◯ The thermal admittance of air μ

2. What is the correct definition of 'albedo' α? [4]

   ◯ The radiant flux density (in $\mathrm{W\,m^{-2}}$) reflected by a surface.
   ◯ The reflection coefficient (in %) of a surface in the entire shortwave part of the spectrum.
   ◯ The average reflectance (in $\mathrm{W\,m^{-2}}$) of a surface in the entire shortwave part of the spectrum.
   ◯ The average reflectivity (in %) of a surface in the shortwave part of the spectrum.

3. Which statement is always valid for a horizontal land-surface? [4]

   ◯ $Q^* \geq 0$ ◯ $K^* \geq 0$ ◯ $L^* \leq 0$ ◯ $L^* \geq 0$

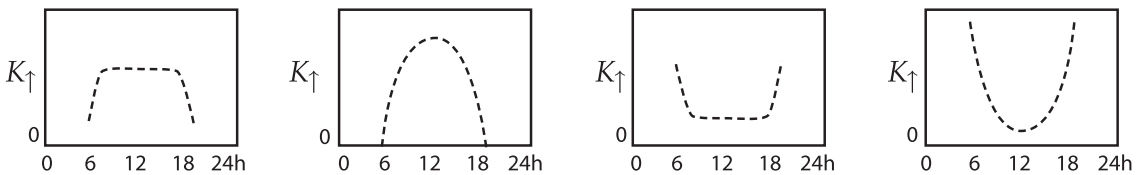
4. Which of the following relationships is incorrect? S is direct beam irradiance, D is diffuse irradiance. [4]

   ◯ $S \leq K_\downarrow$ ◯ $D \leq K_\downarrow$ ◯ $K_\uparrow \leq K_\downarrow - S$ ◯ $K_\uparrow \leq S + D$

5. For Vancouver (123°W, 49°N), in which reference time does solar elevation β always reach it highest point on each day at 12:00 (noon)? [4]

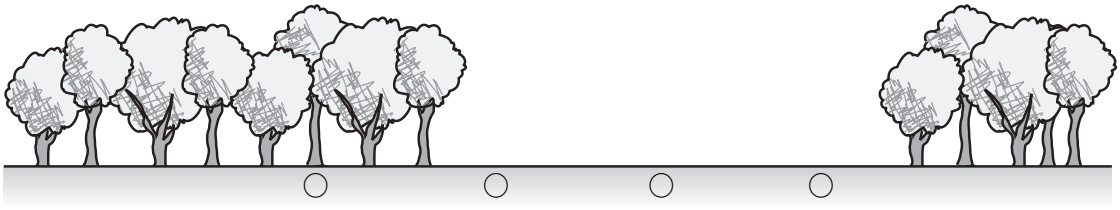
   ◯ LAT ◯ LMST ◯ PDT ◯ None

6. In British Columbia, how do you expect the short-wave reflectance $K_\uparrow$ of a grass surface - such as Totem Field - to change over a clear-sky day? [4]

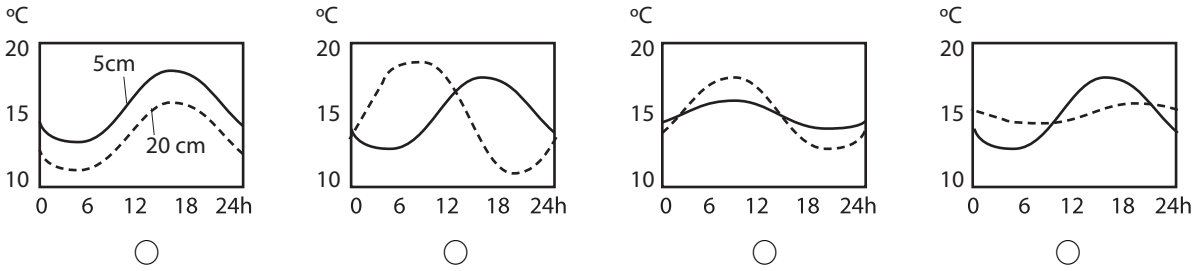


◯ ◯ ◯ ◯

7. This sketch shows a cross-section through a dense forest and a clearing. For a night situation without any clouds, where on the ground would you expect the lowest (most negative) Q^*?. Assume that ground and tree temperature is about 10°C, and air/sky temperature is lower. [4]



8. Which of the following graphs shows realistic soil temperature traces at a depth of 5 cm (full line) and at a depth of 20 cm (dashed line) for a typical soil in mid-summer in British Columbia? [4]



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 the *Solar constant* I_0 and the *Extraterrestrial irradiance* K_{Ex}. [7]

2. Briefly explain the difference between *Reflection* and *Emission*. [7]

3. Briefly explain the difference between *Resolution* and *Domain* of an atmospheric model. [7]

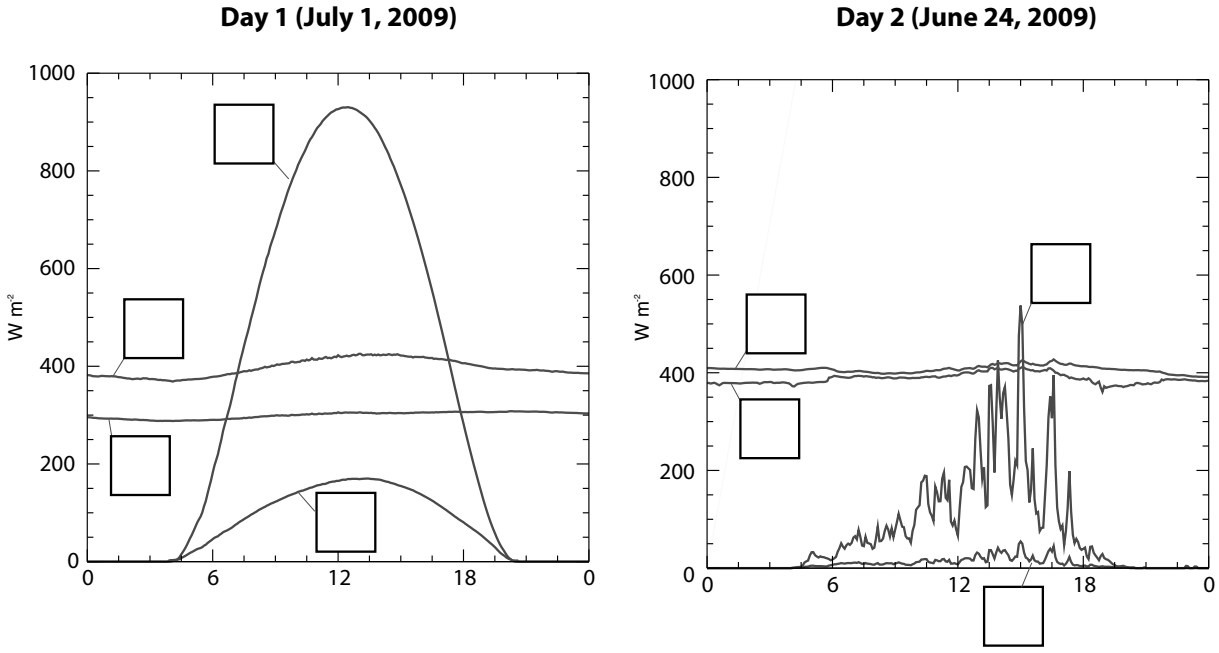
4. Briefly explain the difference between the bulk *Atmospheric transmissivity* and the *Atmospheric window*. [7]

5. Calculate the heat capacity C_{soil} of a dry mineral soil with a porosity of 50%. The heat capacity of the mineral soil matrix is $C_m = 2.0\,\mathrm{MJ\,m^{-3}\,K^{-1}}$. [7]

Part C: Problem questions

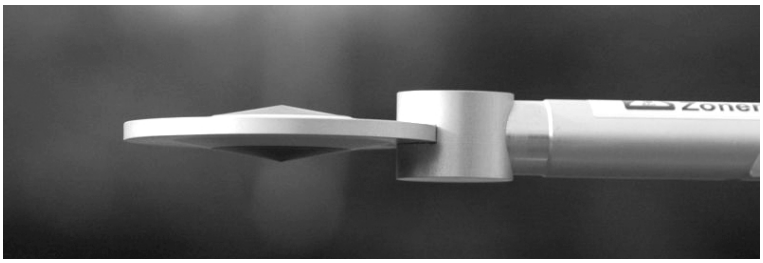
Answer only four out of the following six questions. Again: the first four questions with any answer written into the space provided will be marked, hence solving more than four questions is not to your advantage.

1. The following two graphs show all four components of the radiation balance on Totem Field for two summer days. (a) Label all curves on both days with the correct symbols ($K_\uparrow$,$K_\downarrow$,$L_\uparrow$,$L_\downarrow$) (b) What can you say about the weather on those two days? (c) Which day has the higher daily total Q^*, which has the higher daily total K^* and which has the higher daily total L^*? Briefly justify your choice (a few words each is enough) [10]

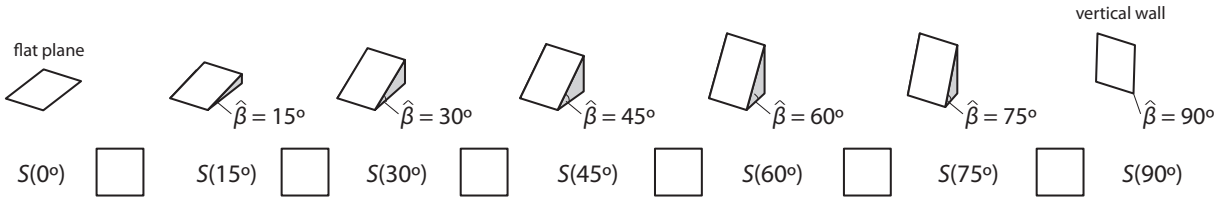


2. Compare the same bare mineral soil in a dry and a saturated state. (a) Which state has a higher thermal conductivity k? Justify your answer. (b) Which state has a higher thermal admittance μ? Justify your answer. (c) Which state has the higher albedo? Justify your answer. [10]

3. You saw the following meteorological instrument on UBC Totem Field during the field visit. (a) What is the name of the instrument? (b) Which meteorological process or variable does it measure? (c) How does it work? [10]

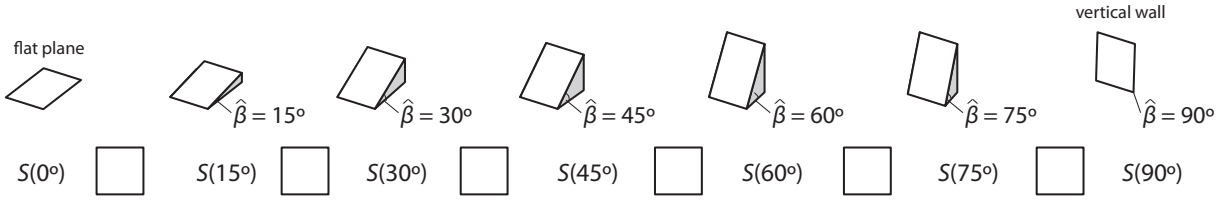


4. All of the following slopes are oriented towards South ($\hat{\Omega} = 180°$), but have different slope angles $\hat{\beta}$.
(a) Assume those slopes are located at the latitude of $\phi = 45°$N, and disregard any effects of the atmosphere (clouds etc). $S(\hat{\beta})$ is the annual total direct-beam irradiance for each of the slopes. Fill in the boxes with either '>', '<', or '=', i.e. compare $S(0°)$ with $S(15°)$ and write in the box between $S(0°)$ and $S(15°)$ if $S(0°) < S(15°)$, $S(0°) > S(15°)$, or $S(15°)$ if $S(0°) = S(15°)$. Repeat the same for all other boxes.



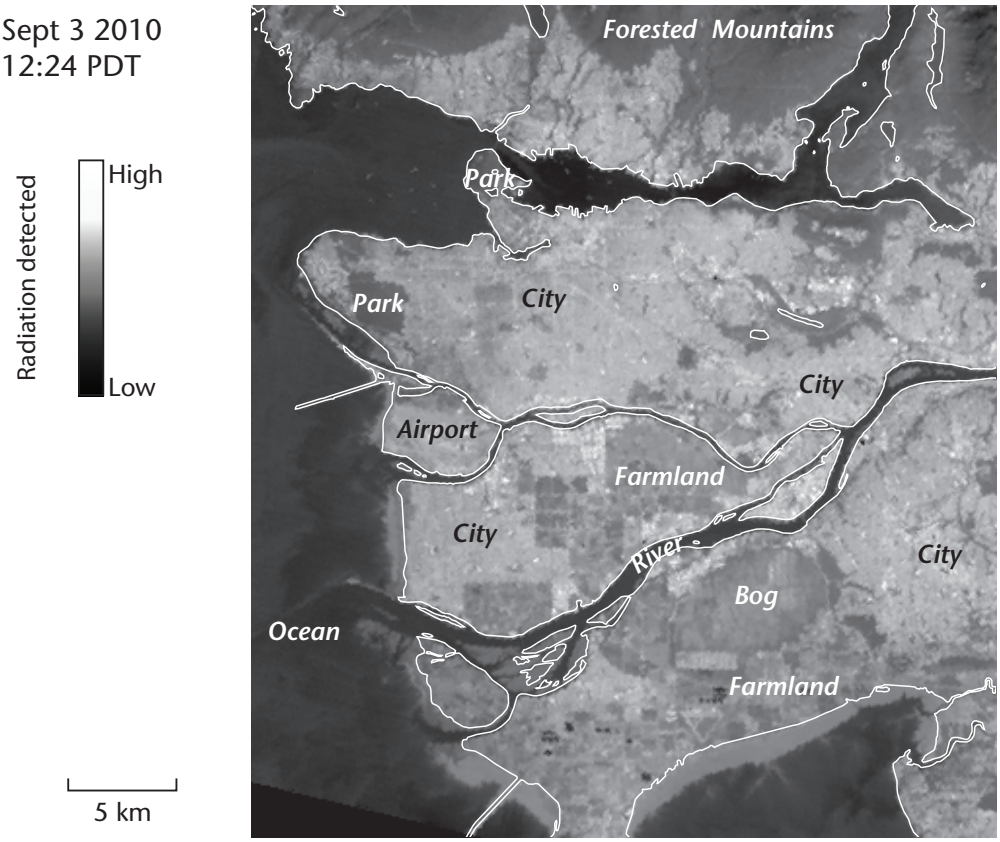
(b) How is $S(15°)$ and $S(75°)$ distributed over the course of a year?

(c) How would your answer to (a) differ if you are not at $\phi = 45°$N but at the Equator (and the slope is still oriented towards South ($\hat{\Omega} = 180°$)? [10]



5. Shortwave radiation can be transmitted through the upper layers of a snow-pack. (a) Sketch the form of the decay of radiation with depth beneath the surface. (b) say how it differs with wavelength (in the short-wave). (c) What is the name of the law used to describe the curve?

6. The following figure shows Vancouver from space. The figure visualizes radiation measured between $\lambda = 8\mu$m and $\lambda = 13\mu$m by a satellite sensor. (a) Describe why the satellite measures exactly in this range of the electromagnetic spectrum. (b) What does the map actually show (i.e. which physical processes are causing the signal)?



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