McGill University, Montreal
GEOG 321 - Climatic Environments
Knox
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Study Questions - Topic 10

1. The specific heat of water is $c_p = 4.18$ kJ kg^{-1} K^{-1}. Calculate the heat capacity C of water.

2. Calculate the heat capacity C of a dry mineral soil with a porosity of 55%. Use values from the table in Lecture 10, Slide 8.

3. Calculate the heat capacity C for the same soil if it is completely saturated.

4. Calculate the heat capacity C of a partly saturated soil with $P = 50\%$, $\theta_a = 0.30$ and an organic to mineral ratio of 1.5. Again, use the table in Lecture 10, Slide 8.

5. If you increase the soil volumetric water content θ_w of any soil by 0.1, how does the heat capacity C of the soil change?

6. Assume we have a soil with $C = 2\,\mathrm{MJ\,m^{-3}\,K^{-1}}$ and we measure a soil heat flux density Q_G of $+100\,\mathrm{W\,m^{-2}}$ all going to the first 10 cm of the soil, how fast would the layer 0-10 cm heat up?

7. Write Fourier's law and explain it briefly.

8. In a dry and uniform mineral soil with a porosity of 55%, we measure soil temperatures T_1 at 2 cm and T_2 at 6 cm. $T_1 = 20°\mathrm{C}$, $T_2 = 18.5°\mathrm{C}$. Calculate the soil heat flux density Q_G assuming a thermal conductivity of $k = 0.27\,\mathrm{W\,m^{-1}\,K^{-1}}$.

9. At 5 cm depth we measure a soil heat flux density $Q_G = 20\,\mathrm{W\,m^{-2}}$ and simultaneously a temperature gradient of -0.5 $\mathrm{K\,cm^{-1}}$. Calculate the thermal conductivity k.

10. For a soil with a specific heat $c_p = 1.8$ kJ kg^{-1} K^{-1}, a density $\rho = 1.4$ Mg m^{-3}, and a thermal conductivity $k = 0.4\,\mathrm{W\,m^{-1}\,K^{-1}}$, calculate the thermal diffusivity κ.

11. Calculate the thermal admittance μ for the same soil.

12. Assume we know a soil's dry mass fraction of organic material (f_o =25%), and its bulk density ($\rho_s = 1.4\,\mathrm{Mg\,m^{-3}}$). What is the mass of organic (M_o) and mineral material (M_m) contained in one cubic metre of this soil?

13. Using the values of specific heat for organic (c_o) and mineral (c_m) given in the table of Lecture 10, slide 8, calculate the composite heat capacity (C_s) for the dry soil in Question 12.