GEOG 272 Lab 2 Long- Wave Radiation

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Theory:

1.) Air Temperature
- Warmer objects emit more long wave radiation (LW)
- Long wave emission is proportional to the 4th power of temperature
- Therefore, a higher sky temperature gives more incoming long wave radiation from a warmer sky

2.) Atmospheric Water Vapour
- Water vapour is a good emitter of long wave, so it has a high emissivity.
  i. Can be said that water vapour is a good absorber and re-emitter of long wave.
- Therefore, more water vapour in the atmosphere means more incoming long wave radiation
- Water vapour does not reflect long wave; they absorb and re-emit.

3.) Clouds
- Clouds affect both emissivity and radiant temperature
- Clouds are good emitters (have high emissivity)
  i. Can be said that clouds are good absorbers and re-emitter of long wave radiation
  ii. Clouds do not reflect long wave, reflect short wave
- Although most long wave radiation comes from the lower atmosphere, the entire air temperature profile contributes when the atmosphere is clear. This includes the warm lower air and the very cold upper air.
- Because clouds are such efficient emitters, they act like a solid object for long wave. They cut off the cold upper atmosphere, increase the weighted average temperature of the radiating atmosphere, thus contributing to the incoming long wave radiation and increasing the radiant temperature.

Data:

Orange highlighted= omitted for the calculation

Radiant Sky Temperature for Quad

Radiant Sky Temperature	North	South	East	West
50°	-42℃	-36℃	-42℃	-43℃
30°	-21℃	-16℃	-33℃	-31℃
15°	-1℃	11℃ (tree)	-20℃	-1℃
Zenith	-50℃			

Radiant Sky Temperature for Parking Lot

Radiant Sky Temperature	North	South	East	West
50°	-10℃	14℃	-10℃	-17℃
30°	-4℃	12℃ (shade)	12℃ (shade)	12℃ (shade)
15°	2℃	13℃ (tree)	13℃ (tree)	13℃ (tree)
Zenith	-50℃			

Assman Psychrometer for Quad

Air Temperature at Waist Height	Wet Bulb	14.2℃
	Dry Bulb	18.2℃
Air Temperature at Ground Height	Wet Bulb	16.3℃
	Dry Bulb	17.9℃

Assman Psychrometer for Parking Lot

Air Temperature at Waist Height	Wet Bulb	13.1℃
	Dry Bulb	16.2℃
Air Temperature at Ground Height	Wet Bulb	12.1℃
	Dry Bulb	17.2℃

General Weather Condition for Quad: Slightly cloudy to North and has direct sunlight. Cloudy towards the West

General Weather Condition for Parking Lot: Scattered thin clouds mostly clear sky.

Case Study:

1) **a.** The results of using the incoming long wave radiation that is computed using mean sky temperature as a whole for the two sites show that the Quad is cooler than the Parking lot.

   甲.i. Air temperature- The average sky temperature for the Quad is -28℃ and the long wave radiation emitted is 194W/m^2. The average sky temperature for the Parking lot is -10.57℃ and the long wave radiation emitted is 253W/m^2. The Quad has a lower average sky temperature than the Parking lot. Therefore, the Quad is receiving less incoming long wave radiation than the Parking lot. Based on the theory, my expectation is the same as the result because higher temperature means more long wave radiation.

   甲.ii. Atmospheric Water Vapour- The atmospheric vapour pressure for the Quad is 9.3 mmHg and the vapour pressure for Parking lot is 12.24mmHg. Based on the vapour pressure calculation results, it shows that the Parking lot has a higher vapour pressure than the Quad site and therefore, the Parking lot site is receiving more incoming long wave.

   甲.iii. Clouds- At the Quad site, the sky was cloudy at most spots. With that being said, it would reflect more incoming shortwave and act as a cooling device during the day. From our observation, this statement is true because the Quad site is generally cooler than the Parking lot. At the Parking lot site, there were much less clouds in the sky and are thin and scattered. Therefore, less shortwave being reflected and more radiation travel through atmosphere causing a higher mean sky temperature.

1) **b.** The sky as a whole for Parking lot is receiving more long wave than the sky as a whole for the Quad. The mean sky temperature observed shows that the Quad is much cooler than the parking lot. With that being said, it means that less solar long wave radiation is being re-emitted to the Quad. This is affected by several factors. At the Quad, much of the incoming shortwave radiation are being reflected by the clouds and act as a cooling agent during the day. Another interesting factor that might play a role is the wet ground and the albedo. The latent heat process takes place as it changes the phase of water to vapour. This process is taking energy away from the surrounding environment and therefore, it is cooling the surrounding. Grass also has a high albedo of reflecting incoming solar radiation, making the environment cooler. At the Parking lot site, less short wave radiation are being reflected due to the scattered thin clouds. However, the Parking lot site has a higher vapour pressure than the Quad site. Therefore, more long wave radiation is being emitted back to the surface by the atmospheric vapour pressure. The pavement also acts as a low albedo, storing the incoming long wave radiation. However, the

pavement prevents the solar radiation to go further down the ground.

2) **a.** Using the data result from the Quad, it shows that the Zenith angle (-50℃) temperature is much colder than the 30° angle (-25.25℃). This means that the Zenith angle has a low emissivity that re-emits less long wave radiation. Cooler temperature of Zenith angle also means it gives less long wave radiation. At 30° angle it is much warmer, therefore, there is higher emissivity to re-emitting long wave radiation. Higher temperature at 30° angle means that are more incoming long wave radiation.

b. Cooler sky temperature means that are less incoming long wave radiation. The air temperature is much colder at the Zenith angle than the 30° angle, this means that less long wave radiation is being received by the Zenith angle. At higher atmospheric layer, the particles are more scattered and has very few units. This means that at Zenith angle, there is less particles or substances to act as a black body to re-emit radiation. Therefore, the Zenith angle has a lower emissivity than the 30° angle. At 30° angle the beam is passing through different levels of atmospheric levels, this means more particles are acting as a black body to re-emit the long wave radiation.