**EAS 4803/8803 Lab: Thermal Infrared Remote Sensing of Snow**

**NAME:**

*If you are working in a group, please indicate the names of the students you are working with.*

**Instructions**

**Due date: Friday 28th of March 2025 11:59 pm**

Upload your answers to this lab report via Canvas Assignment.

**Question 1. Airborne IR imagery (10 points)**

1. Examine the airborne snow temperature map produced in Part 1. Describe the spatial patterns of snow surface temperature, identifying major trends and gradients. Use the visible images to examine the correlation.

**Question 2. Ground-based radiometer time series (15 points)**

Using Fig. 2b from Part 2, which illustrates snow surface temperature time series measured at snow pit #2S10 on Feb 8th, 2020:

1. Describe the temporal (24 hours) variation of snow surface temperature. (5 points)
2. Calculate the mean, minimum, and maximum temperature. (3 points)
3. Identify the time of day when the snow surface temperature is highest and lowest. Compare this temporal resolution to that of the airborne observations. How might these differences affect our understanding of diurnal temperature cycles in snowpacks? (7 points)

**Question 3. Comparison with Airborne Temperatures (20 points)**

Using Fig. 4 from Part 2:

1. Examine the zonal mean airborne temperature (pink line) vs. the value from a single pixel (cyan line). How do these airborne temperatures compare? (5 points)
2. How do the airborne temperatures values compare with the ground observations you have discussed earlier in Question 2(b)? (5 points)
3. Discuss potential sources of these differences, considering factors such as measurement physics, atmospheric effects, and spatial/temporal mismatches. (10 points)

**Question 4. ASTER Thermal-Infrared (TIR) imagery (15 points)**

1. Using Fig. 5 from Part 3, describe the spatial variation in surface temperatures recorded by ASTER TIR camera, focusing on the region where it overlaps with the ground-based (red cross) and the airborne observations (yellow box).

**Question 5. Cross-Platform Comparison (40 points)**

Fig. 7 in Part 4 shows the snow surface temperatures at a time where the three datasets roughly overlap:

1. Extract the snow surface temperature from each dataset. Calculate and describe the differences between each pair of measurements. To aid your answer, examine the mean, standard deviation, and the range (represented by the error bar) of these three datasets more closely. (10 points)
2. Identify reasons behind these temperature discrepancies. HINT: Review the instrument specification shown in Table 1. (10 points)
3. Using the provided sensor specifications in Table 1, propagate the stated accuracy of each sensor through the radiative transfer equation shown in Equation 1 as follows: , where T is temperature, L is measured radiance, ε is emissivity, and σ is the Stefan-Boltzmann constant. Compare resulting temperature uncertainties across platforms. How do these uncertainties impact our ability to detect small temperature variations in snow? (12 points)
4. Based on your evaluation in (c), in no more than two paragraphs, design hypothetical cryospheric or planetary science research question that leverages the strengths of one or several of TIR observation methods. Explain which thermal sensor(s) and dataset(s) you would use and why. (8 points)