Assessing Small Scale Variability in Surface Snow and Landscape Temperature using Drone-Based Thermal Observations

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MOTIVATION & BACKGROUND

- Goal to observe the evolution of snow surface temperature (SST) and freeze/thaw (FT) throughout a single day
- Provide information on landscape surface temperature variability for high-resolution (spatial/temporal) process modeling
- Investigate the potential uses of emerging drone technology for applications in SST and FT processes

Drone PROS: affordable, repeatable flights, rapid deployment, high-resolution (cm scale), relatively simple acquisition process, minimal atmospheric effects on imagery, ability to fly below cloud deck

Drone CONS: limited area coverage, limited sensor precision/characterization, flight highly dependent on weather conditions

APPLICATIONS

TAKAWAYS

- No snowmelt was observed over the focus study location even as temperatures approached 4 °C (~40 °F)
- Image calibration improved accuracy to around +/- 2 °C (from +/- 5 °C)
- High-resolution imagery allowed identification of small-scale processes: i.e. warming of SST on sun facing side of trees, shadow cooling, and showed consistency of vegetation temperature throughout the day

RESULTS

STUDY PLOT CONDITIONS

- Study site RGB imagery with calibration target locations indicated
- Elevation from ASTER 30m DEM with full visible RGB image of study region overlaid

DISCUSSION & CONCLUSIONS

- TIR observations appeared to match well with nearby meteorologic station IR measurements of the snow surface
- Standard deviation of SST shown to decrease throughout the day
- Trees maintain consistent temperature throughout daytime (~ 4 °C)
- Patterns observed in SST due to influences of vegetation, shading
- SST did not climb above freezing during flights, even as air temperatures climbed above freezing for an extended period
- Clear thermal drift and vignette effects were observed in the collected imagery requiring non-trivial calibration to correct
- Next Steps
  - Modeling small scale surface temperature processes, including snow melt
  - Comparing drone mapped TIR to satellite-based thermal and microwave observations
  - More flights and equally spread out flights, beginning earlier to capture more complete picture of warm up and cool down
  - Apply knowledge to downscaling of FT processes

RELEVANT PUBLICATIONS & ACKNOWLEDGEMENTS


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