Analyzing the Relationship between Soil Moisture and Soil Temperature and Snow Freeze/Thaw/Melt in High Mountain Asia

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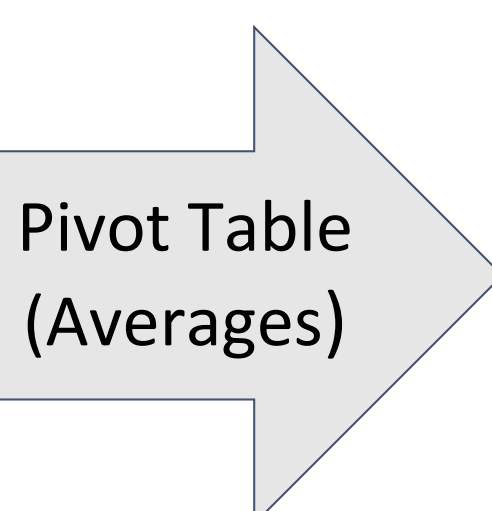AND REMOTE SENSING TECHNOLOGIES

Abstract

The glaciers of High Mountain Asia store huge amounts of freshwater that are critical to the survival and livelihoods of the surrounding regions. With increasing global temperatures, it has become essential to accurately monitor the increasing glacier melt rate. This project focused on analyzing the relationship between soil conditions and snow freeze/thaw/melt (F/T/M) data. In-situ data about soil conditions was acquired from the Third Pole Environment Database, which provides data from a network of Chinese stations on the Tibetan Plateau. Snow F/T/M data was acquired from NASA's Advanced Scatterometer (ASCAT) on the EUMETSAT Metop-A and Metop-B satellites. These satellites utilize vertically polarized (V-pol) C-band (5.255 GHz) backscatter measurements. We plotted the soil data temporally and compared it to spatial representations of the F/T/M data. After visually comparing the two sets of images, correlation between soil moisture/temperature and snow F/T/M was observed with a few exceptions. This research suggests that soil moisture and soil temperature can be not only be used to validate and refine F/T/M data, but it can also be used to observe the effect of global warming on glacier melt rate.
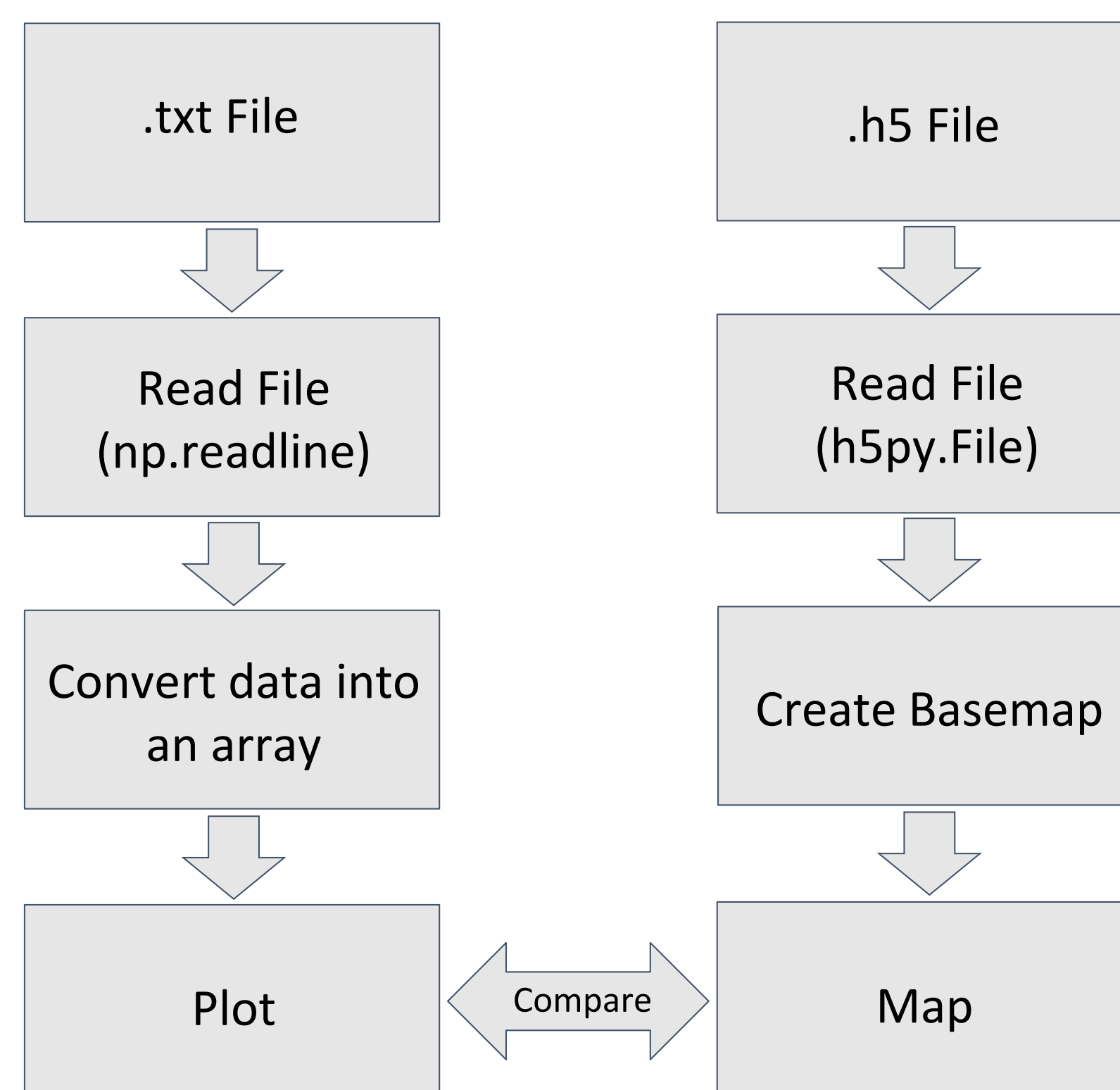
Objectives

- Obtain correlations between soil conditions and snow F/T/M to determine if soil moisture and soil temperature can be used to validate glacier melt rate.
- Determining the accuracy of satellite F/T/M data by comparing it to in-situ data to build on the study.

Methods

Excel

Data → Pivot Table (Averages) → .txt File

Python

.txt File → Read File (np.readline) → Convert data into an array → Plot

.h5 File → Read File (h5py.File) → Create Basemap → Map
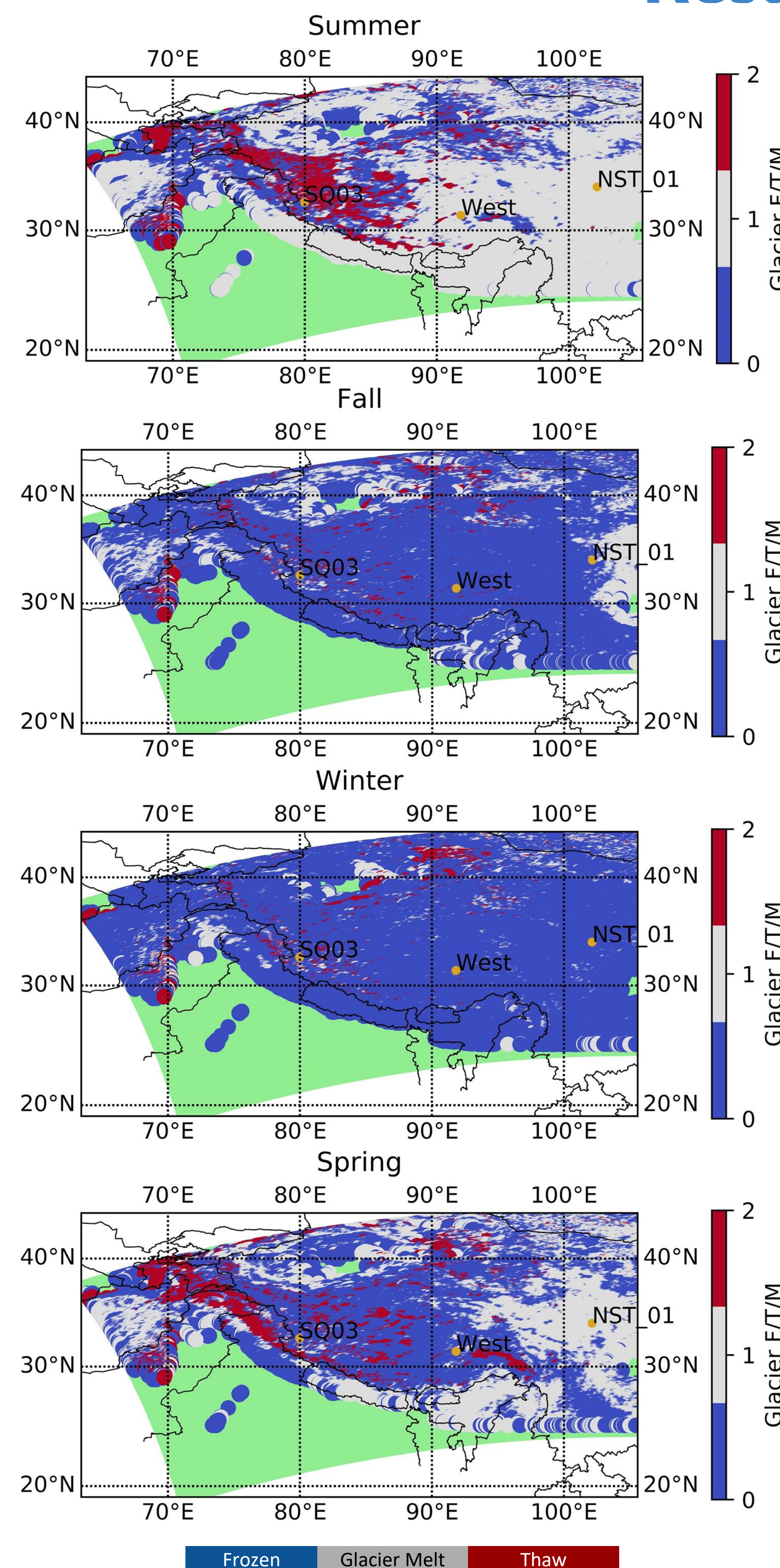
Plot ← Compare → Map

Results

Figure 1: F/T/M satellite data (of 4 days spaced between 08/16/2015-05/16/2016) overlaid on a longitude-latitude map. The three labeled points are stations whose in-situ data are depicted in Figure 2.
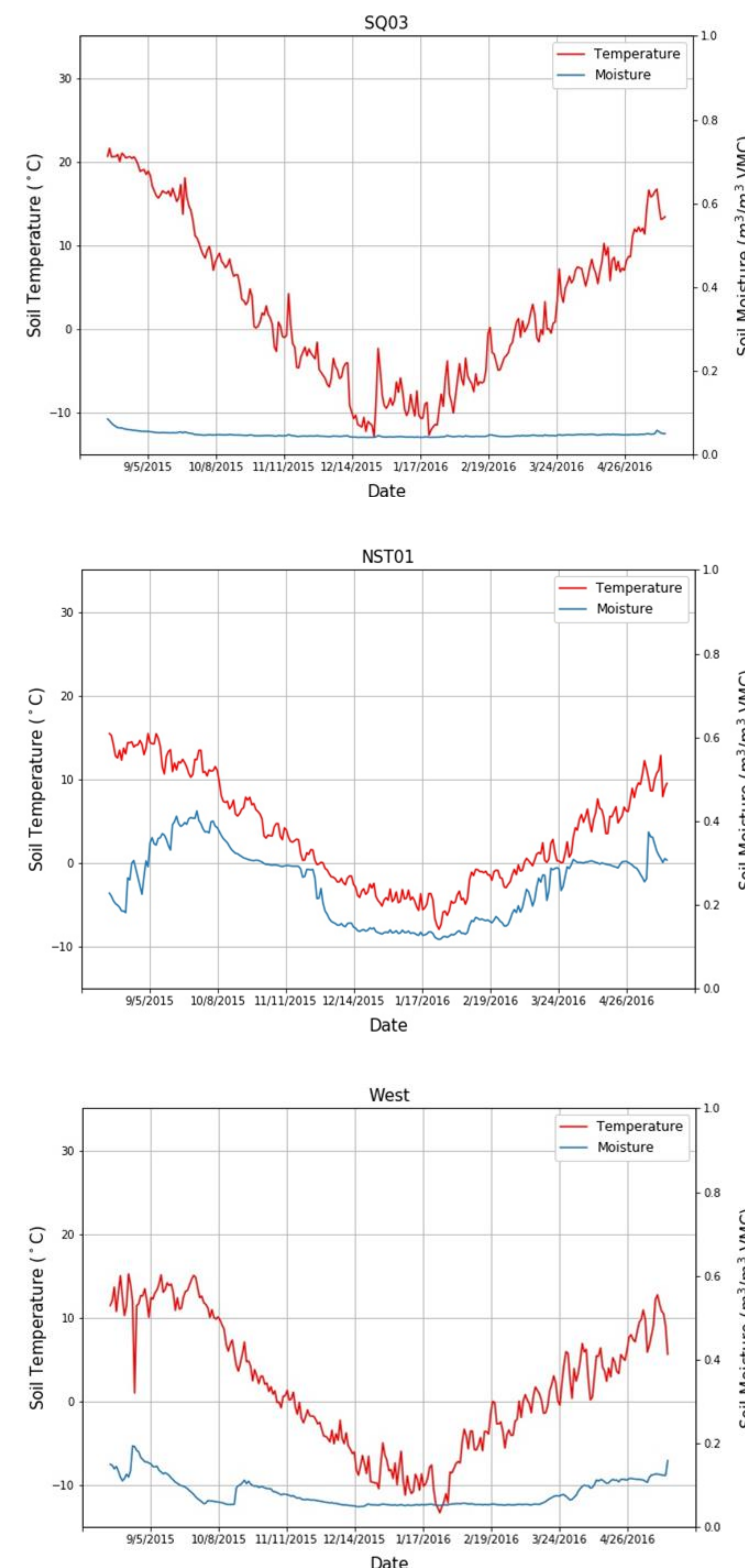

Figure 2: Soil temperature and soil moisture plotted against time for three different stations. (Temporal range: 08/16/2015-05/16/2016)

Conclusions

- Soil temperature/moisture has positive correlation with snow F/T/M.
- Soil conditions should be monitored when analyzing glacier health, and certainly should be considered in future studies involving glacier melt rates.

Future Studies

- Researching how to compile .h5 files would allow for more comprehensive analyses as maps could represent periods of time greater than a day.
- Analyzing the effect of elevation on soil conditions and snow F/T/M could reveal another factor that corresponds with glacier melt rates and further nuance the list of physical conditions that affect F/T/M data.

References

- Su, Z., Wen, J., Dente, L., van der Velde, R., Wang, L., Ma, Y., Yang, K., & Hu, Z. (2011). The Tibetan Plateau observatory of plateau scale soil moisture and soil temperature (Tibet-Obs) for quantifying uncertainties in coarse resolution satellite and model products. Hydrology and Earth System Sciences, 15, 2303-2316.
- Steiner, N. and K. C. McDonald. 2018. *High Mountain Asia ASCAT Freeze/Thaw/Melt Status, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/L319IEPK63VC. [07/31/2018].

Acknowledgements

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