Remote Sensing Research Group

Climatology/Geography

UNIVERSITÄT
BERN

Master thesis subject

Spatiotemporal Fusion of Land Surface Temperature (LST) in the Pan-Arctic Region

Context

Due to Arctic Amplification, the Arctic region is warming four times faster than anywhere else. The warming affects the sensible ecosystem, vegetation dynamics and the cryosphere (sea ice, snow and permafrost). Permafrost, a crucial component of arctic ecosystems, is particularly sensitive to increasing air temperatures and changes in the snow regime. Thawing permafrost affects the stability of the bedrock, damages infrastructures, and releases massive quantities of methane and organic carbon. Permafrost cannot directly be observed from space, but permafrost models can link physical surface variables such as land surface temperature (LST) to the thermal ground regime. On a global scale, observation of LST can be obtained from thermal satellite missions. However, a fine spatiotemporal resolution is desired for permafrost monitoring over time. Until today no single satellite sensor can provide fine spatial resolution land surface temperature (LST) products with frequent coverage for a sufficiently long period.

Project

To compute LST on a hemispheric scale, we use the Advanced Very High Resolution Radiometer (AVHRR) Global Area Coverage (GAC) data set starting in 1981. The AVHRR on board the NOAA and MetOp satellite series now covers over four decades. The resolution of the AVHRR GAC dataset is 4km, which is insufficient to represent fine-grained landscape patterns. Spatial downscaling of remote sensing imagery can be tackled by different methods such as spatiotemporal fusion of different sensors, e.g. MODIS and Landsat [1,2], spatiospectral fusion (pan-sharpening) or super-resolution frameworks. In recent literature, different algorithms for spatiotemporal algorithms are presented. Below are some examples:

- ESATRFM (Fusion based on regression) [3]
- GAN-STFM (conditional GAN) [4]
- STTFN (convolutional neuronal network) [5]
- DCSTFN/EDSTFN (convolutional neuronal network) [6]

The goals of the project are 1) selection of suitable algorithms, 2) adaptation of the algorithms to the AVHRR use case (or creation of a custom algorithm), 3) comparison of the performance of different algorithms for downscaling AVHRR data from 4km to 1km (target) over typical permafrost landscape 4) LST time series analysis over an area of interest.

Requirements

- Interest in computer vision and satellite imagery
- Python programming or willingness to learn
- Knowledge of machine learning and libraries such as PyTorch or TensorFlow is a plus

Literature

[1] Wu et al., "Spatially Continuous and High-Resolution Land Surface Temperature Product Generation: A review of reconstruction and spatiotemporal fusion techniques", IEEE GEOSCIENCE AND REMOTE SENSING MAGAZINE, 2021

[2] Sdraka et al., "Deep Learning for Downscaling Remote Sensing Images", IEEE GEOSCIENCE AND REMOTE SENSING MAGAZINE, 2022

[3] X. Zhu, J. Chen, F. Gao, X. Chen, and J. G. Masek, "An enhanced spatial and temporal adaptive reflectance fusion model for complex heterogeneous regions," Remote Sens. Environ., vol. 114, no. 11, pp. 2610–2623, Nov. 2010

[4] Z. Tan, M. Gao, X. Li, and L. Jiang, "A flexible reference-insensitive spatiotemporal fusion model for remote sensing images using conditional generative adversarial network," IEEE Trans. Geosci. Remote Sens., vol. 60, pp. 1–13, Jan. 2021, doi: 10.1109/TGRS.2021.3050551.

[5] Z. Yin et al., "Spatiotemporal fusion of land surface temperature based on a convolutional neural network," IEEE Trans. Geosci. Remote Sens., early access. doi: 10.1109/TGRS.2020.2999943.

[6] Z. Tan, L. Di, M. Zhang, L. Guo, and M. Gao, "An enhanced deep convolutional model for spatiotemporal image fusion," Remote Sens., vol. 11, no. 24, p. 2898, Dec. 2019, doi: 10.3390/rs11242898.

Contact

Sonia Dupuis: sonia.dupuis@unibe.ch

Stefan Wunderle: stefan.wunderle@unibe.ch

Remote Sensing Research Group

Climatology/Geography

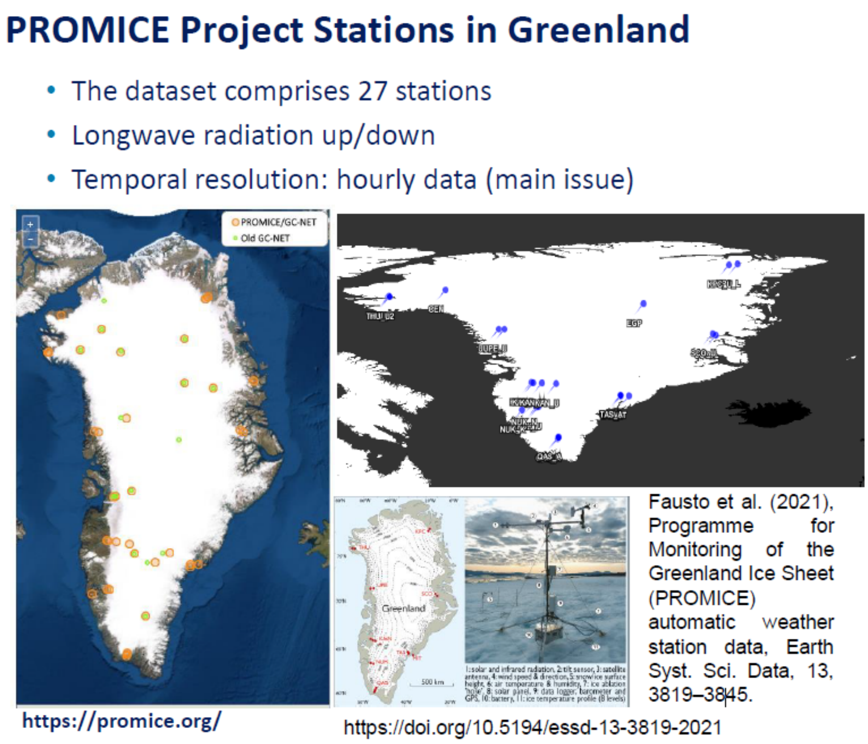
UNIVERSITÄT BERN

Master/Bachelor thesis subject

Analysis of weather station data in Greenland / Snow surface temperature time series / Emissivity of Snow

Context

Land surface temperature (LST) observation retrieved from AVHHR data must be validated. The satellite-derived LST can be validated with other satellite imagery or using in-situ data. LST can be recorded directly by dedicated radiometers mounted on a mast or by computing LST from radiation data recorded at automatic weather stations (AWS). Most of the LST validation stations are located in the mid-latitudes. Therefore, the PROMICE network (https://promice.org/weather-stations/ [1]) located in Greenland is particularly interesting.



Project

The data from the PROMICE network can be directly accessed from the online web portal. The goals of the project are 1) perform exploratory data analysis on the data from the AWS, 2) Derive LST from radiation components [2], 3) Comparison with LST from AVHRR data.

Upon interest: 4) Time series analysis and analysis of thermal properties of snow.

Requirements

- GIS software
- Python programming or willingness to learn
-

Literature

[1] Fausto, R. S., van As, D., Mankoff, K. D., Vandecrux, B., Citterio, M., Ahlstrøm, A. P., Andersen, S. B., Colgan, W., Karlsson, N. B., Kjeldsen, K. K., Korsgaard, N. J., Larsen, S. H., Nielsen, S., Pedersen, A. Ø., Shields, C. L., Solgaard, A. M., and Box, J. E.: "Programme for Monitoring of the Greenland Ice Sheet (PROMICE) automatic weather station data", Earth Syst. Sci. Data, 13, 3819–3845, https://doi.org/10.5194/essd-13-3819-2021, 2021.

[2] Martin M, Ghent D, Pires A et al., "Comprehensive in situ validation of five satellite land surface temperature data sets over multiple stations and years", Remote Sensing, 2019

Contact

Sonia Dupuis: sonia.dupuis@unibe.ch

Stefan Wunderle: stefan.wunderle@unibe.ch