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RSL measurements | products | policy

TRISHNA

Thermal infrared remote sensing across scales to monitor surface energy fluxes over rockglacier Murtèl, Switzerland

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Introduction

The surface energy budget of the alpine cryospheric components is out of balance. An improved monitoring in particular at the spatial lengths scale is urgently needed for rugged terrain. It is crucial to be able to capture the individual heat fluxes and undertand their spatial variability and interactions at the complex surface-atmosphere interface.

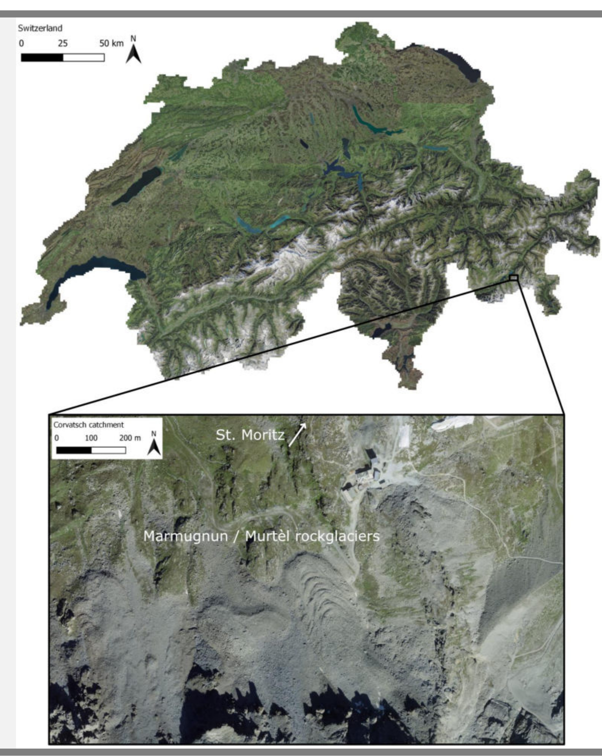
The surface temperature (T_s) crucially governs the net longwave radiation (L_o) and the turbulent sensible heat flux (Q_H):

ε – emissivity
σ – Stefan-Bolzman constant
ρ_a – air density
c_p – specific heat capacity
C – bulk transfer coefficient
u – wind speed
T – air temperature
z – measurement height

$$L_o = \varepsilon \sigma T_s^4 \qquad Q_H = \rho_a c_p C u (T_z - T_s)$$

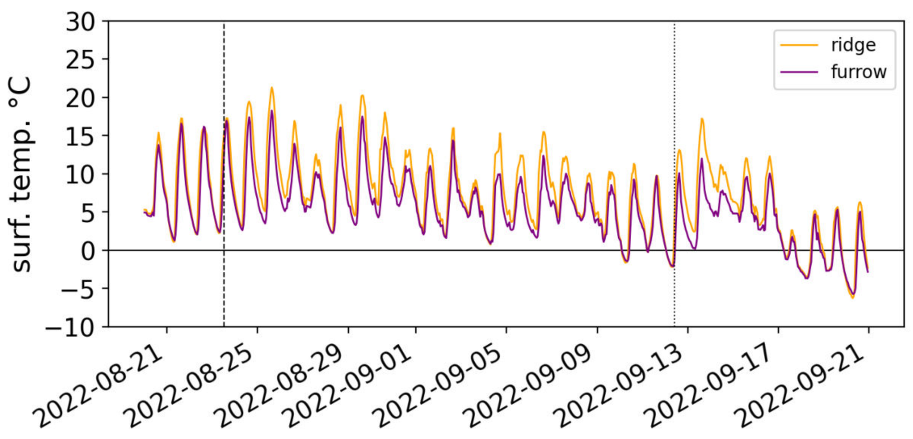
Study Site & Data

- terrestrial TIR & RGB camera
- TIR radiometers
- UAV TIR
- hyperspectral TIR & optical airborne
- full SEB station
- ground surface temperature loggers
- geophysical monitoring
- permafrost borehole temperatures



Spatio-temporal data acquisition

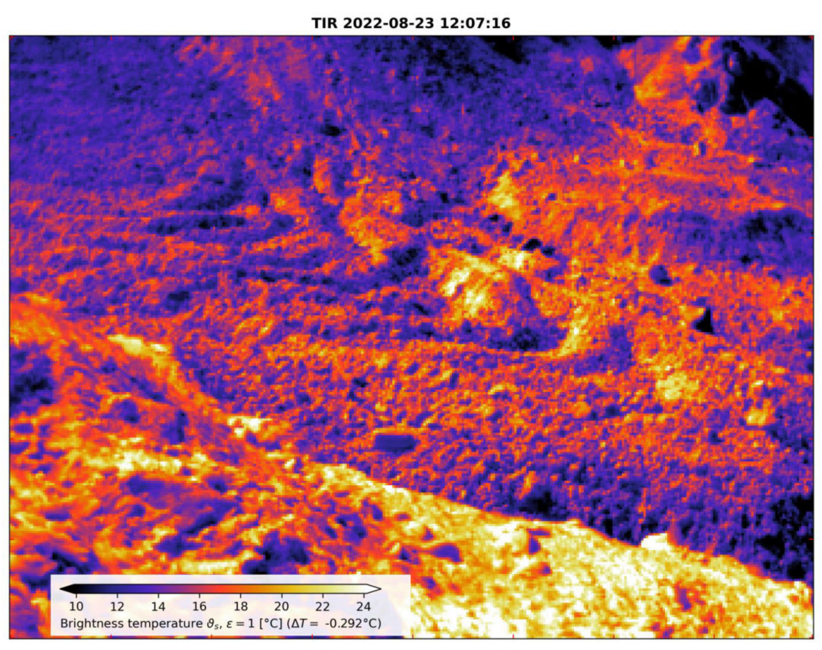
in-situ observations



Apogee thermal infrared radiometer

- 8 to 14 µm atmospheric window
- 18° half-angle FOV
- 0.2-0.5 °C Calibration Uncertainty

> representative location?

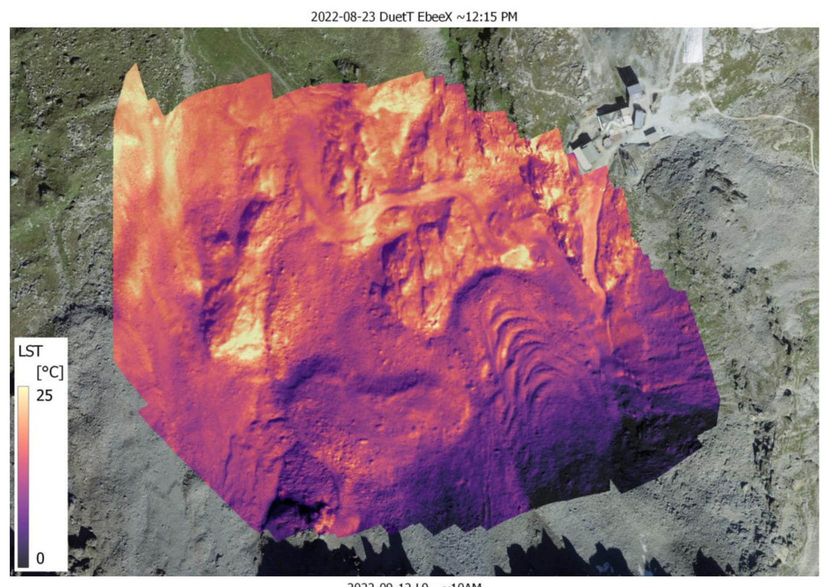


Mobotix M16 Thermal TR (TIR/RGB)

- 7.5 to 13.5 µm atmospheric window
- 45° horiz./vert. image angle
- 50 mK sens. NeTD (thermal resolution)
- 336 x 252 pixels

> orthorectification?
> atmospheric correction?
> topographic correction?

close-range RS

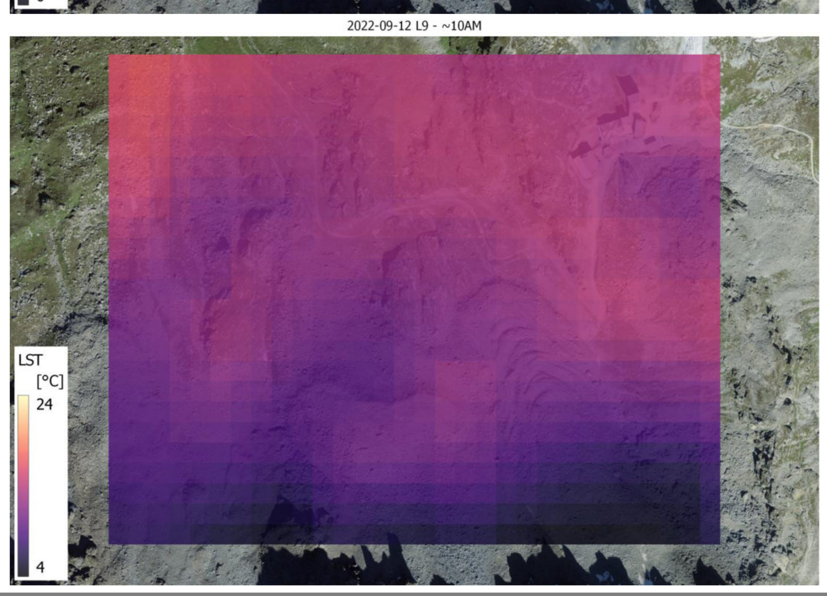


ebee X Duet T

- 7.5 to 13.5 µm atmospheric window
- 16 cm GSD at 120 m
- 50 mK sens. NeTD (thermal resolution)
- 640 x 512 pixels

> time of overflight?
> thermal ground control targets?

satellite RS



Landsat suite

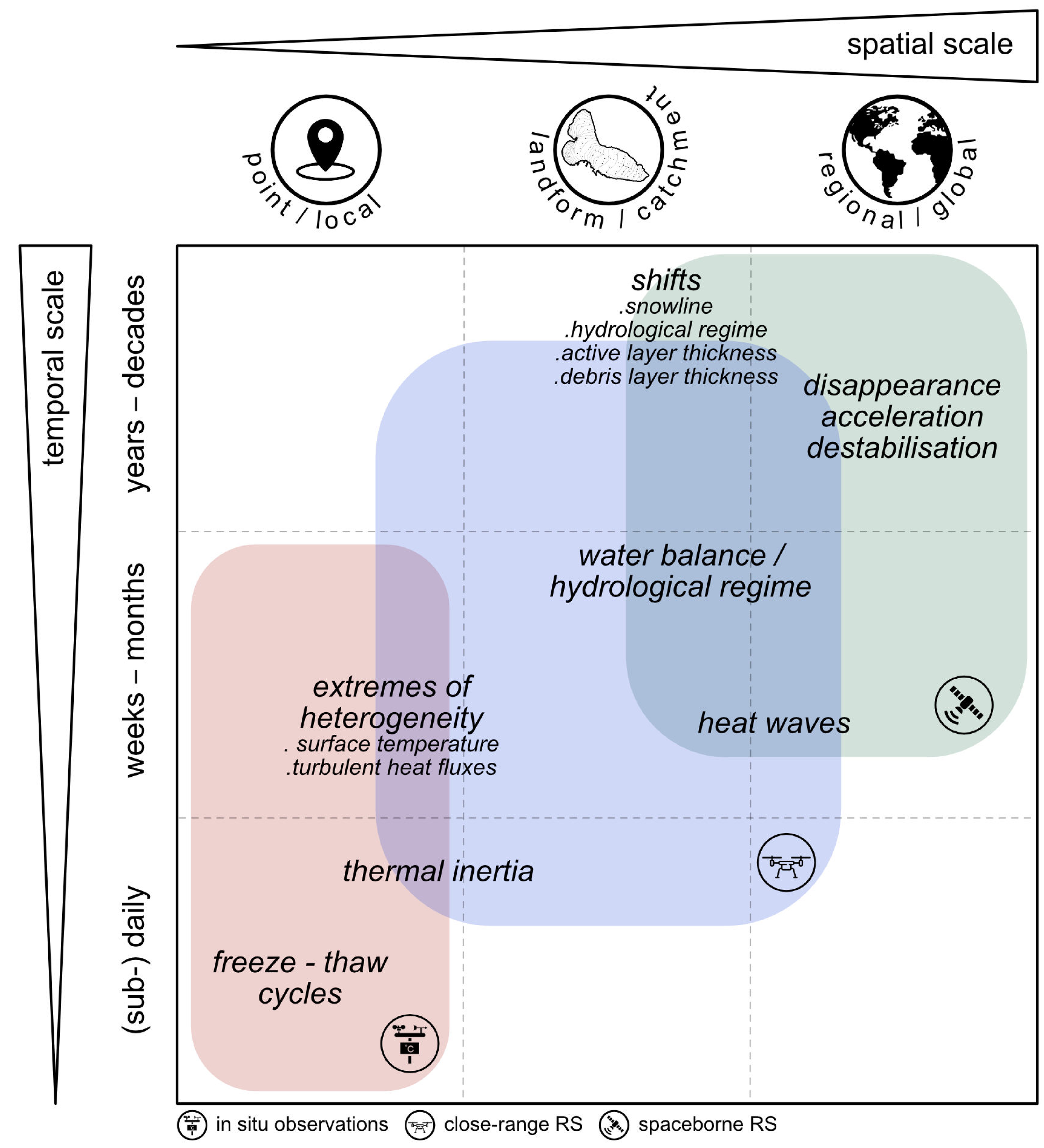
- surface temperature coll. 2, lev. 2 product
- Landsat Single-Channel Surface Temperature v1.3.0 (based on Band 10 located at 10.6 – 11.19 µm)
- 30 x 30 m pixel

> calibration?
> validation?

Motivation and Potential

Why study surface temperatures over cryospheric components?

- crucial for surface energy budget
- little knowledge about spatio-temporal variability
- challenging to accurately retrieve in complex terrain
- lack of spatially distributed and temporally highly resolved data (upcoming missions: TRISHNA, LSTM, SBG)



TRISHNA (CNES/ISRO cooperation)

(Thermal infraRed Imaging Satellite for High-resolution Natural resource Assessment)

- Launch: 2025
- Coverage: global
- Revisit: 3 acquisitions at equator over 8 days
- Bands: 4 TIR, 5 VNIR, 2 SWIR
- Scan angle: 34° (1030km swath)
- Spatial resolution: 57 m (1 km over open ocean)
- Overpass: 1 pm and 1 am
- NeDT: 0.2 K
- Data policy: Free and open for scientific community
- Synergies/pathway: ECOSTRESS, SBG and LSTM

T-SEC (UZH/eawag funded by ESA PRODEX)

- Energy budget modelling in complex ecosystems
- TIR cal/val activities over reference sites in Switzerland and tundra regions
- Virtual reconstructions of sites to model and understand thermal measurements
- Characterisation of key challenges faced by TIR remote sensing observations
- Quantification of uncertainties based on field campaigns and TIR *in situ* data
- Multi-sensor approaches and synergies with TIR remote sensing data

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