# TRISHNA T-SEC Project – thermal infrared remote sensing of complex ecosystems

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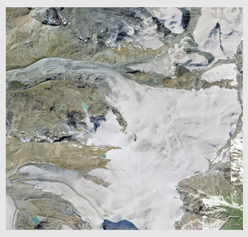
## Swiss TRISHNA – Science and Electronics (T-SEC) project

The TRISHNA (Thermal infraRed Imaging Satellite for High-resolution Natural resource Assessment) mission is a high-resolution space-time thermal infrared (TIR) mission aimed to enhance our understanding of the water cycle and improve our management of the planet's water resources (Lagouarde et al 2018). TRISHNA is planned for launch in 2025, and will provide global high resolution (~60 m), high revisit (3 acquisitions over 8 days) thermal remote sensing measurements. The scientific objectives of the TRISHNA mission include monitoring of terrestrial ecosystems, of the urban environment, coastal and inland waters, the cryosphere, the atmosphere, and applications to the solid Earth.

**Swiss TRISHNA – Science and Electronics Contribution (T-SEC) project :** funded by ESA Prodex, T-SEC is comprised of a commercial part led by Syderal Swiss SA, and a scientific part led by the University of Zurich and Eawag. The scientific part of T-SEC aims to contribute towards the key TRISHNA scientific objectives, and focuses on using TIR remote sensing to understand and measure the water status and stress of continental ecosystems over mountainous and tundra regions.

## T-SEC sub projects

3D modelling of directionality and energy balance over Swiss forests for ecosystem stress monitoring.



Remote sensing of the surface energy budget of the alpine cryosphere.

Effect of ecosystem disturbances on land surface energy fluxes in the Siberian tundra.

High resolution Lake Surface Water Temperature monitoring in Swiss perialpine and alpine lakes.

## T-SEC aims

Energy budget modelling in mountainous and boreal/tundra environments using TRISHNA measurements.

Gain understanding and characterise the key challenges faced by thermal remote sensing observations (e.g. directionality effects, scaling).

TIR Cal/Val activities over reference sites in Switzerland (forests, cryosphere and hydrosphere) and tundra regions.

Field campaigns and thermal in-situ data to help quantify uncertainties of TIR measurements and products.

State-of-the-art reconstructions to model and better understand thermal measurements and products.

Multi-sensor approaches and synergies with thermal remote sensing data.

## Measurement Sites and Instrumentation

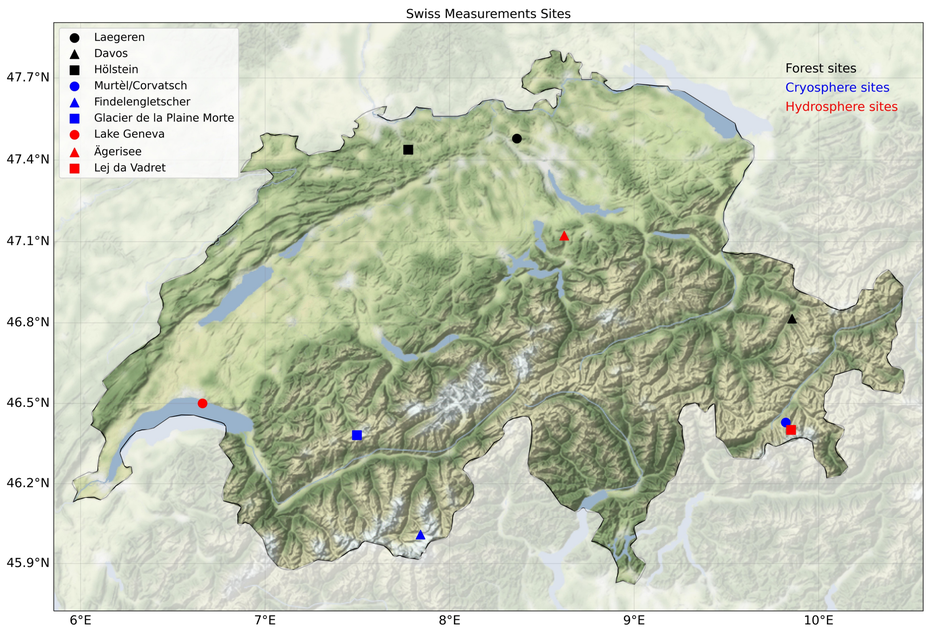


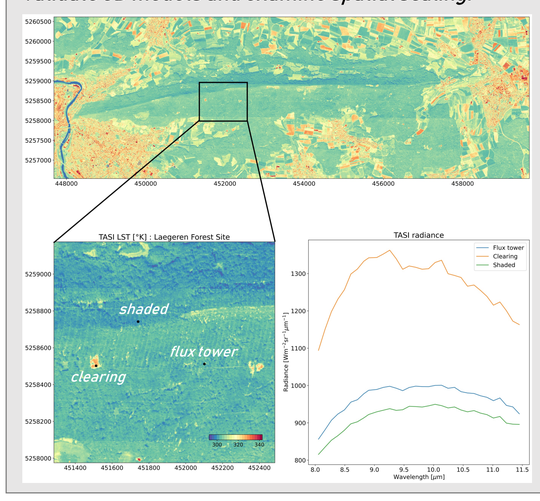

*Figure. 1 (left). Overview of Swiss measurement sites covering forest, cryosphere and hydrosphere domains. Current and planned instrumentation and data acquisition outlined in Table 1.*


*Figure. 2 (below). Overview and location of of Kytalyk field station, Siberian tundra.*

## Preliminary results

### Forest TIR airborne acquisitions

*Figure 3. TASI TIR airborne acquisitions over Laegeren forest site used to extract component temperatures, validate 3D models and examine spatial scaling.*




### Corvatsch Murtèl UAV and TIR radiometer

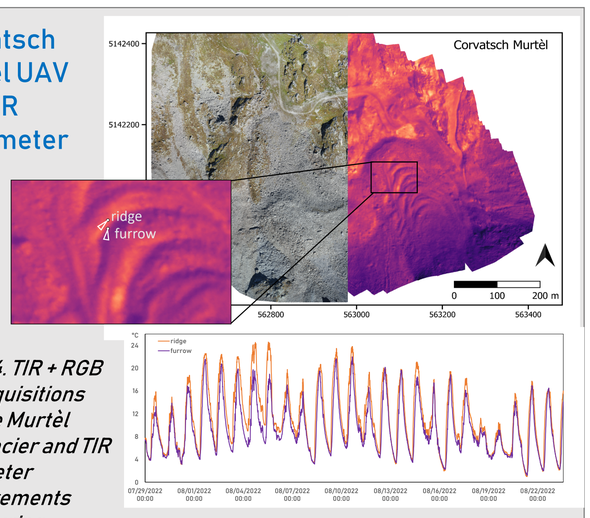



*Figure 4. TIR + RGB UAV acquisitions over the Murtèl rock glacier and TIR radiometer measurements taken during summer 2022.*

Data will be combined with other TIR instruments (Table 1) to investigate spatial scaling and surface energy budget.

### Thermoregulation in Siberian tundra vegetation

*Figure 5. Preliminary analyses of TOMST micrologger measurements at the Kytalyk site to investigate responses of Siberian tundra vegetation thermoregulation to ecosystem variables.*

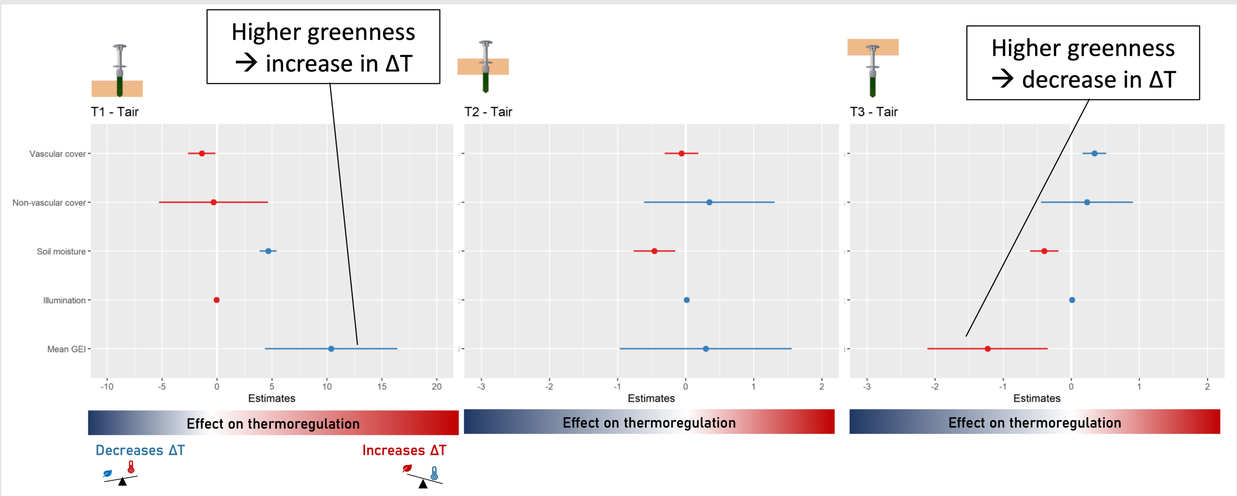



*Table 1. T-SEC sites in-situ instruments and airborne/UAV acquisitions (planned additions in red) and retrieved products.*

| Site | In-situ instruments | TIR UAV / airborne instruments | Collaborations | Retrieved variables & products |
|---|---|---|---|---|
| Laegeren | EC flux tower, FloxBox, Phenocam, TLS/ALS, Heitronics CT15.10, Thermal infrared camera, Sun photometer | TASI (2021, 2022), UAV (2022) | | LST, vertical temperature profile, meteorological data, 3D model |
| Davos | ICOS EC flux tower, FloxBox, TLS, Heitronics CT15.10, Thermal infrared camera | TASI (2021, 2022) | | LST, vertical temperature profile, meteorological data, 3D model |
| Holstein | Swiss Canopy Crane experiment, TLS | TASI (2021, 2022) | | LST, 3D model |
| Murtel/Corvatsch | Thermal infrared & RGB camera, energy balance station, Apogee SI-121 | TASI (2022), UAV (winter/summer 2022), HyTES and ARES | PERMOS (GST, boreholes, energy balance station), UNIFR | LST, meteorological data, spatially distributed energy fluxes |
| Findelengletscher | Seasonal mass balance, RGB camera, meteoswiss station, thermal infrared camera, radiometers, on-glacier meteo station | UAV, HyTES and ARES | GLAMOS (seasonal mass balance), UNIFR | LST, meteorological data, spatially distributed energy fluxes |
| Lake Geneva | Meteo station, thermistor chain, Heitronics KT15.85 for upwelling radiance, Dual-view Heitronics KT15.85 & CT09.85 | Balloon-Launched thermal imagery campaigns (2016-2019) | LéXPLORE floating laboratory (EPFL, UNIL, UNIGE, INRAe) | Sky-radiance corrected Lake Surface Water Temperature (LSWT), vertical temperature profiles, meteorological data |
| Ägerisee | Thermistor chain, meteo station, Heitronics KT15.85 for upwelling radiance | - | Swiss lake temperature montoring network (FOEN) | LSWT, vertical temperature profiles, meteorological data |
| Lej da Vadret | Pressure sensor, Heitronics CT15 for upwelling radiance, meteo station, thermistor chain | TASI (2022) | | LSWT, vertical temperature profiles, meteorological data |
| Kytalyk, Siberia | TOMST, meteo station | UAV (2020, 2021) | | LST, soil/vegetation temperature, air temperature |

## References

J.-P. Lagouarde et al. (2018) "The Indian-French Trishna Mission: Earth Observation in the Thermal Infrared with High Spatio-Temporal Resolution *", IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium*

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