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OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Topics for Master- and Bachelor thesis in Remote Sensing

You are welcome to contact one of the group members for more details!

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Overview of our activities: combining satellite remote sensing and climatology

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- Our research activities are focused on
  - Long time series (40 years)
  - Advanced Very High Resolution Radiometer (AVHRR)
    - UniBe archive covers Europe in sub-daily resolution (250.000 data sets); 1km
    - EUMETSAT Fundamental Data Record (FDR) covers the globe in daily resolution (4km)
  - Cloud retrieval (ground based) using AI
- Running projects
  - ESA Climate Change Initiative CCI+ - snow project
  - Land Surface Temperature (NH) Project in cooperation with KIT and University of Oslo
  - Interaction of Albedo and Vegetation (NH)
  - Cloud project (autonomous devices in Payerne and Thun)

Potential topics for MA or BA

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> **Spatiotemporal Fusion of Land Surface Temperature (LST) in the Pan-Arctic Region**
  - Aim: to increase the spatial resolution (4km → 1km) applying different fusion techniques.
  - 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

> **Analysis of weather station data in Greenland / Snow surface temperature time series / Emissivity of Snow**
  - Aim: derive LST from radiation components and compare it with AVHRR LST

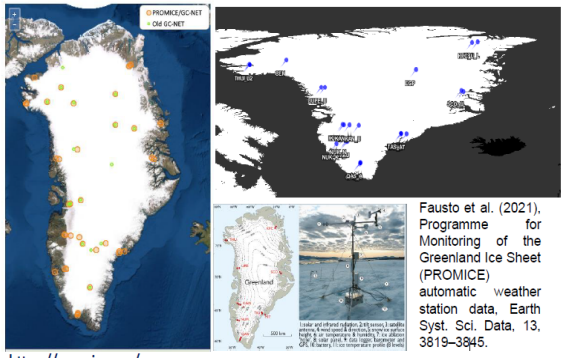
> **Snow time series (1981 – 2020)**
  - Generation and analysis of fractional snow information of the last 40 years based on our ESA CCI+ snow product. Regions: HKH, European Alps (1km), Scandinavia (gap filling with PMW in cooperation with FMI), …

> **Influence of vegetation activity on albedo (Pan-Arctic region) from 1981 – 2020**

- NDVI (SOS, EOS) in relation to albedo changes

PROMICE Project Stations in Greenland

- The dataset comprises 27 stations
- Longwave radiation up/down
- Temporal resolution: hourly data (main issue)



https://promice.org/

Fausto et al. (2021), 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

Cloud retrieval based in Webcams and FLIR camera

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DASHBOARD | THERMAL CAMERA | HEMISPHERICAL WEBCAM | ATMOSPHERIC MEASUREMENTS | ABOUT THE PROJECT | CONTACT

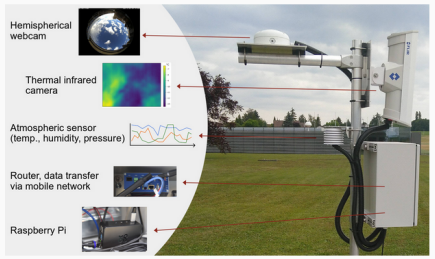
Location 1: Payerne, MeteoSwiss

CH coordinates	2'562'158.1, 1'184'746.1
WGS84 lat / lon	46.81279, 6.94281
Measurements since	01.06.2022

Location 2: Thun, armasuisse

CH coordinates	2'612'322.7, 1'179'020.2
WGS84 lat/lon	46.76225, 7.59994
Measurements since	03.08.2023

About the devices



The camera system includes a thermal camera, a hemispherical webcam, and an atmospheric sensor measuring air temperature, relative humidity, and atmospheric pressure.

About the project

Observing atmospheric conditions such as the height of a cloud ceiling is extremely important for air traffic management. Instruments to accurately measure the cloud's base height from the ground, so-called ceilometers, are extremely expensive and limited to point measurements vertically oriented to the atmosphere. An alternative solution are upward facing thermal cameras. The temperatures measured by such cameras decrease significantly if a cloud is present; the higher the cloud, the lower the measured temperature. However, the thermal camera does not correct for the atmospheric water vapour between the ground and the measured cloud. Thus, the relation between the measured temperature and the cloud base height is complex, but can be learned by a deep neural network (DNN).

In this project, we propose to use parallel measurements of a ceilometer, a thermal camera, and measurements of meteorological variables (surface pressure, relative humidity, and air temperature) as an input for a DNN to predict the cloud base height from temperatures measured by the thermal camera. Different approaches are tested using deep classification, deep regression, and a convolutional neural network.

This website illustrates how the trained networks are able to predict the cloud base height. The hemispherical webcam is used to analyze different cloud types in relation to the predicted cloud base height information.

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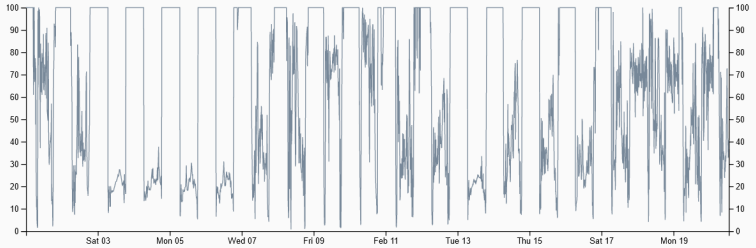
Cloud Cover [%] at Payerne - February 2024 — Go to Thun



Hemispherical Webcam at Payerne - 2024-02-20 12:55 CET — Go to Thun

Cloud Cover
- 40.3% (3 oktas)
- scattered clouds

ML-derived Cloud Type
- Cumulus
- confidence: 70%

Ground level measurements

Air Temperature	9.3°C
Relative Humidity	70.4%
Atm. Pressure QFE	971 hPa

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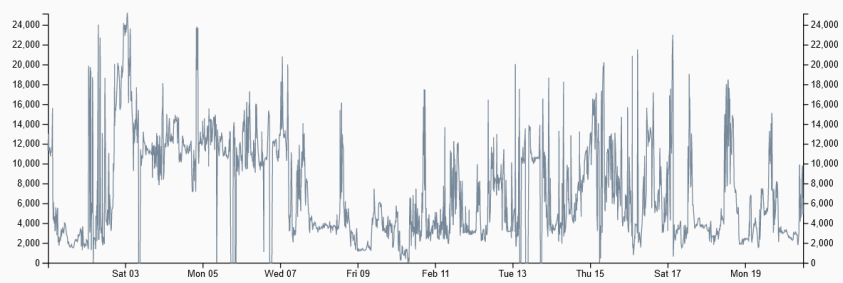
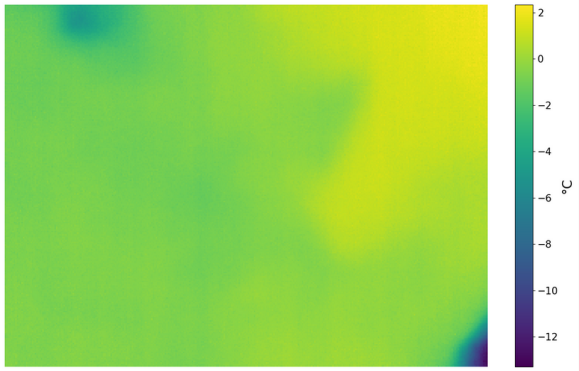
Cloud Base Height [m] at Payerne - February 2024 — Go to Thun



Thermal Camera at Payerne - 2024-02-20 11:55 UTC — Go to Thun



Cloud Base Height at
- 4905 m
- 16093 ft

Cloud Category
- middle clouds
- probability: 99.9%

Mean Sky Temperature
- -0.34°C

Temperature Span
- 15.63°C

Next steps:

- Webcam based cloud retrieval to be included in CNN of FLIR
- Integrate COSMO-1 atmospheric profiles and train CNN-FLIR
- Self-learning approach: integrate the retrieval from Payerne into Thun procedure