

40 years of European AVHRR-LAC data – compiled, consolidated and now accessible via ESA dissemination service

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Oeschger Centre for Climate Change Research

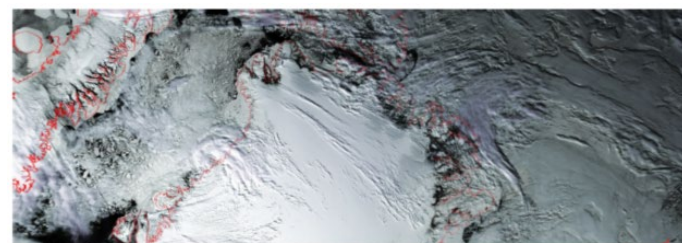
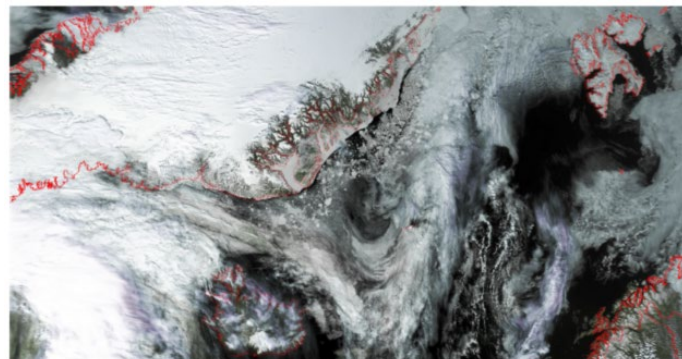
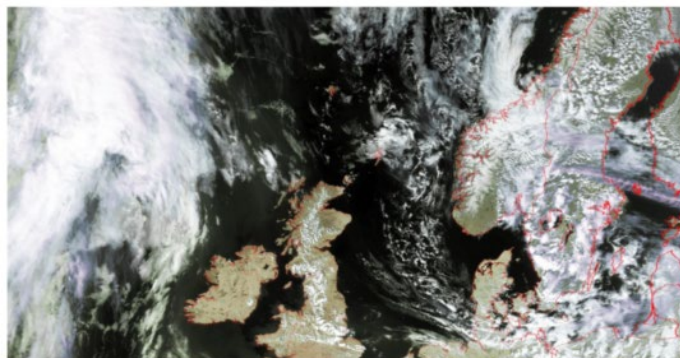
Institute of Geography

University of Bern

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40 years of AVHRR – a success story with some headaches

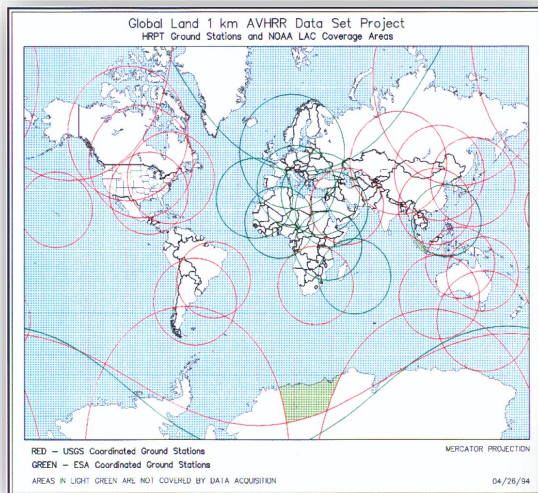
- > Integration of AVHRR data in CEOS Sharp-1 format.



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[INFO] commandline arguments:  
s1b_to_hmf -i TR119005271316/IMAGE -I TR119005271316/LEADER ...  
[INFO] 32681880 bytes read from the SHARP-1 IMAGE file  
[INFO] => number of records: 1441  
[INFO] 9000 bytes read from the SHARP-1 LEADER file  
[INFO] host: little endian  
[INFO] data: big endian  
[INFO] => input data will be swapped  
[INFO] mission identifier: NOAA-11  
[INFO] pass direction: ascending / northbound  
[INFO] => order of Earth data will be rearranged  
[INFO] => order of scanlines will be rearranged  
[INFO] convert every image record to the HMF format  
[INFO] 31939200 bytes written to the HMF file
```

Motivation for the co-operation: ESA Heritage Mission Team and University of Bern

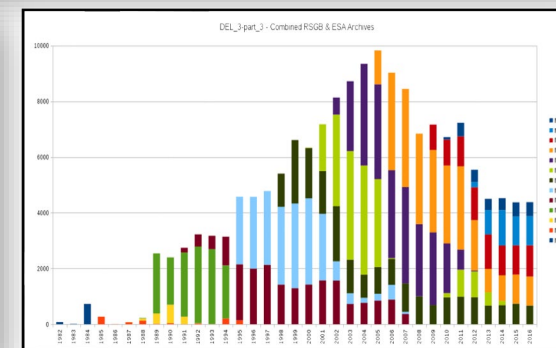
- > Heritage program for third party missions
- > Support climate change initiative and other projects related to climate change studies



AVHRR data archived
on optical disks and
Exabytes in ESRIN



- > UniBern – long tradition of AVHRR reception and processing
- > We see the need to make historical data accessible to the public and keep the data alive for an unlimited time.



COP26 fuels interest in satellite data

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25 Nov 2021

Share your stories



ESA stand in the green zone at COP26

As COP26 stimulates action to reduce global warming, the essential role of satellite data in understanding and monitoring climate change is apparent.

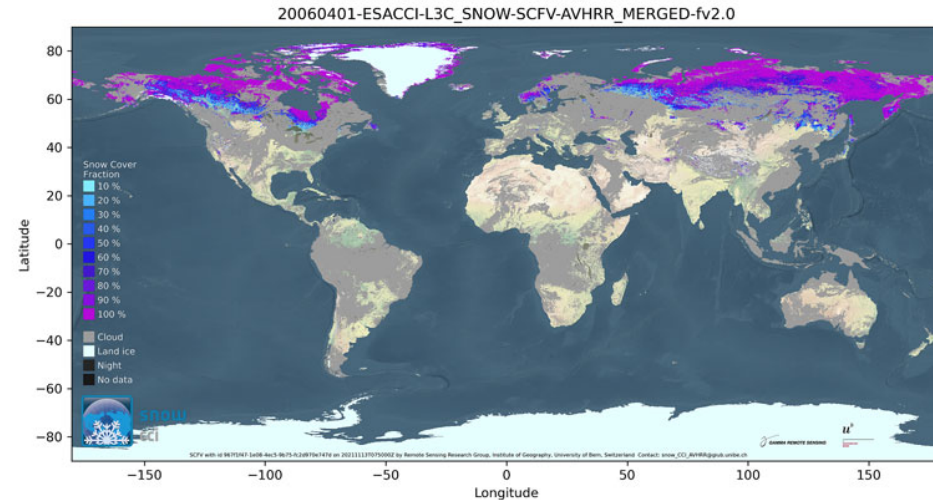
Long term environmental monitoring using satellite data and remote sensing emerges as key contributors to climatological research after two weeks of negotiations at the COP26 climate talks. The Agency showcased several new missions supporting climate action, with high resolution data on [forest biomass](#) and [carbon dioxide emissions](#).

However, satellite data from operational and non-operational ESA missions provide long-term Earth observational records, giving essential context to current climate variability.

The region of High Mountain Asia extending from the Himalayas to the Hindu Kush, held centre stage at the Climate Change Conference since temperatures there are rising three times faster than global averages.

Recent research by the [Remote Sensing Research Group](#) (RSGB) and the Oeschger Centre for Climate Change Research at the University of Bern, used existing Advanced Very High Resolution Radiometer (AVHRR) data to explore this disproportionate regional effect of the climate emergency on seasonal snow cover.

These researchers are specialised in retrieving [Essential Climate Variables](#) (ECVs) from AVHRR data, leveraging the advantage of data acquired over Europe and globally for nearly 40 years, today archived and managed at ESA as part of its [Heritage Space Missions portfolio](#).



Global viewable fractional snow cover

"Crucial to making progress on climate change is to use a climate relevant timescale, which is the real advantage of Heritage Missions," said lead researcher, Dr Kathrin Naegeli. "The AVHRR dataset was of particular interest since in order to produce ECV timeseries that are characterised by high temporal and spatial variability, we needed daily resolution over a long-time scale."

The resulting ECV product, "Daily global snow cover product" is the longest-term snow cover product, covering the period 1982–2020 at a daily temporal and 0.05° spatial resolution, and was used by climate modellers from the University of Grenoble to make future predictions for the region.

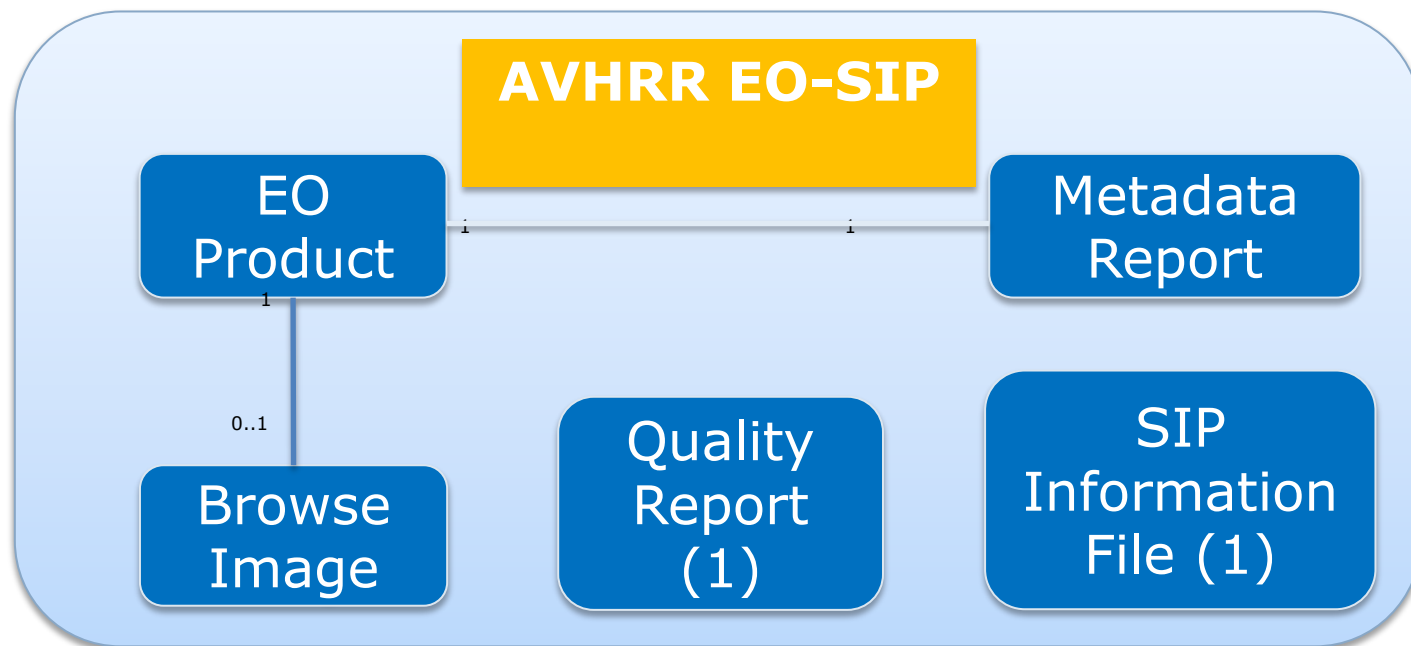
AVHRR provides a medium spatial resolution, which may be coarser than other satellites but still provides higher resolved information than currently used in many climate models.

Procedure to compile an open accessible AVHRR data set via ESA dissemination service

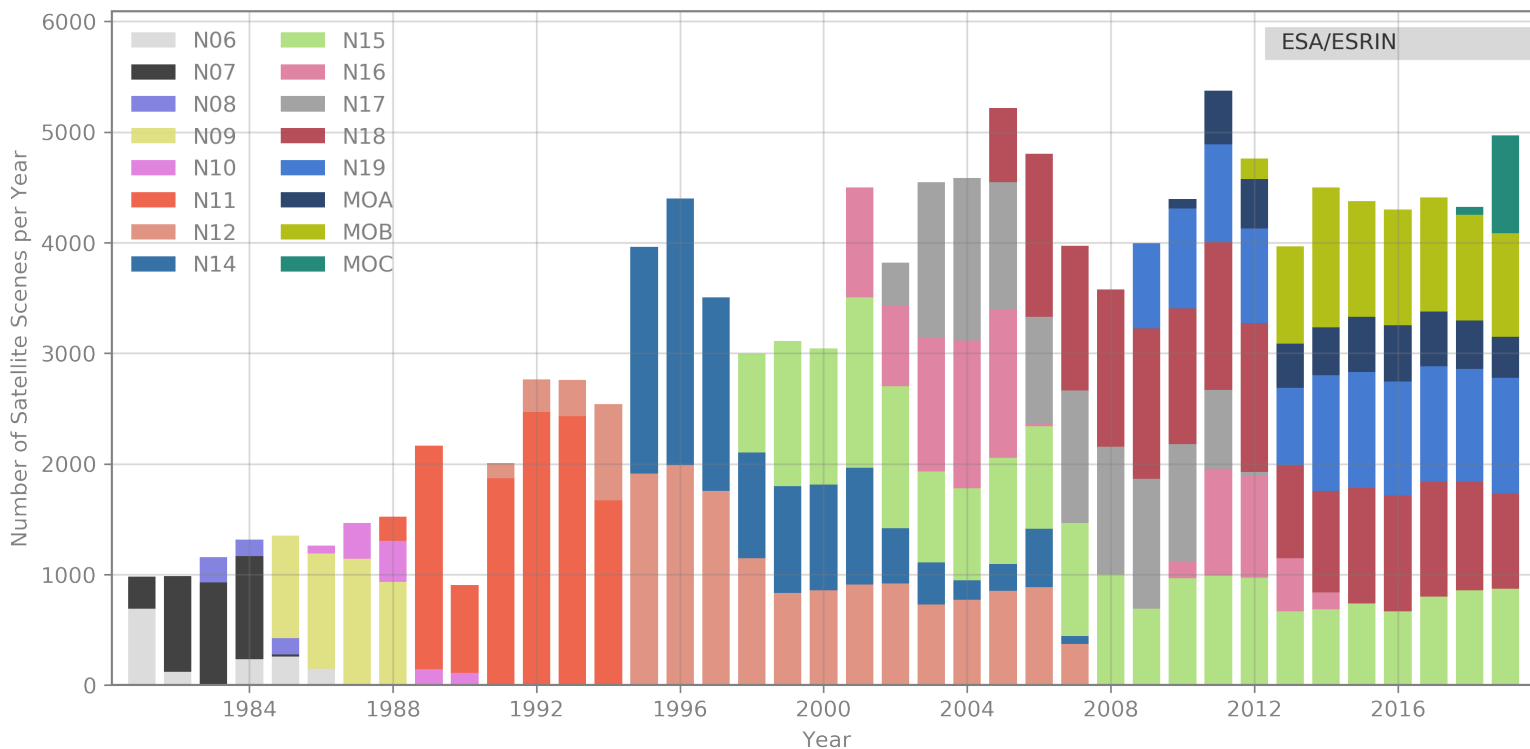
- > WP_1: *Inventory and gaps identification of AVHRR UniBe data incl. ESA data holdings*
- > WP_2: *Consolidation procedure and reprocessing definition; development of software to re-format the different flavors of archived AVHRR data and fill the meta file.*
- > WP_3: *AVHRR Master data set consolidation and reprocessing at UniBe Linux Cluster; transfer of software and scripts to ESA for own re-processing.*
- > WP_4: *AVHRR European Master data set validation (test of readability, check of consistency of all files in EO-SIP)*
- > WP_5: *Consolidation of AVHRR preserved data set composition*
- > WP_6: *Transfer of all re-processed AVHRR data in level 1b (1981 – 2021) to ESA to be included in EARTH ONLINE.*

EO-SIP package (Earth Observation – Submission Information Package)

- > EO-SIP package structure, content and metadata attributes for the AVHRR products in scope, in line with the ESA Next Generation Multi-Mission PDGS Infrastructure, to be used for archiving and dissemination.



European 1-km AVHRR archive hosted at ESA includes data from University of Bern, Dundee Satellite Receiving Station and ESA holdings. Period: 1981 - 2021

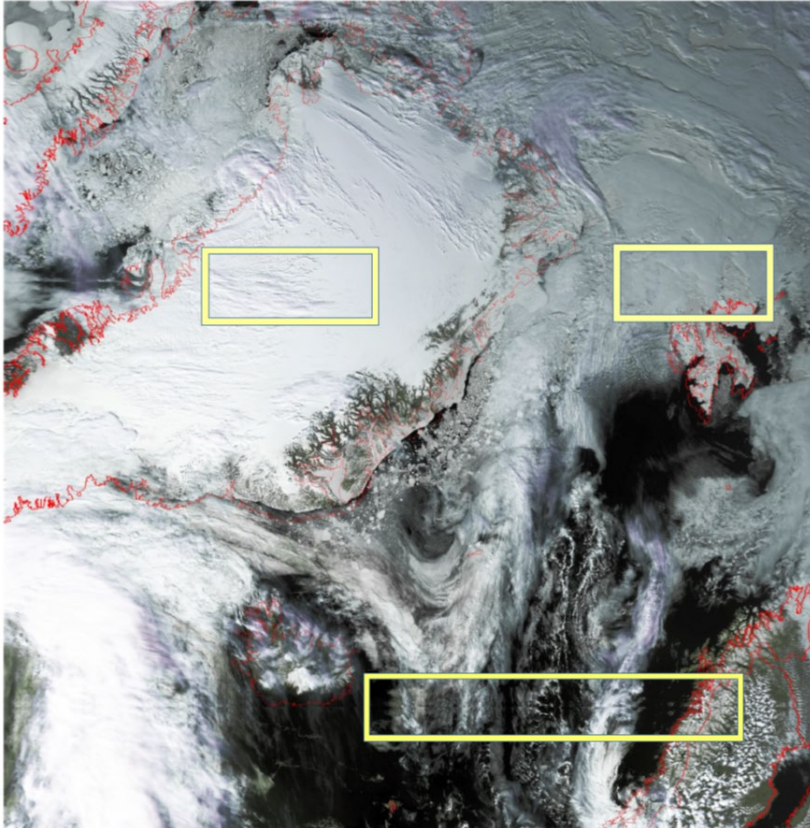


- Two-ten overpasses per day.
- Dataset consists of more than **200.000 data products** harmonized and consolidated through a dedicated ESA project (Heritage Space Programme).
- All accessible **free of charge via ESA dissemination services.**
- **Archived for unlimited time by ESA.**
- Processing to Level-1c planned.

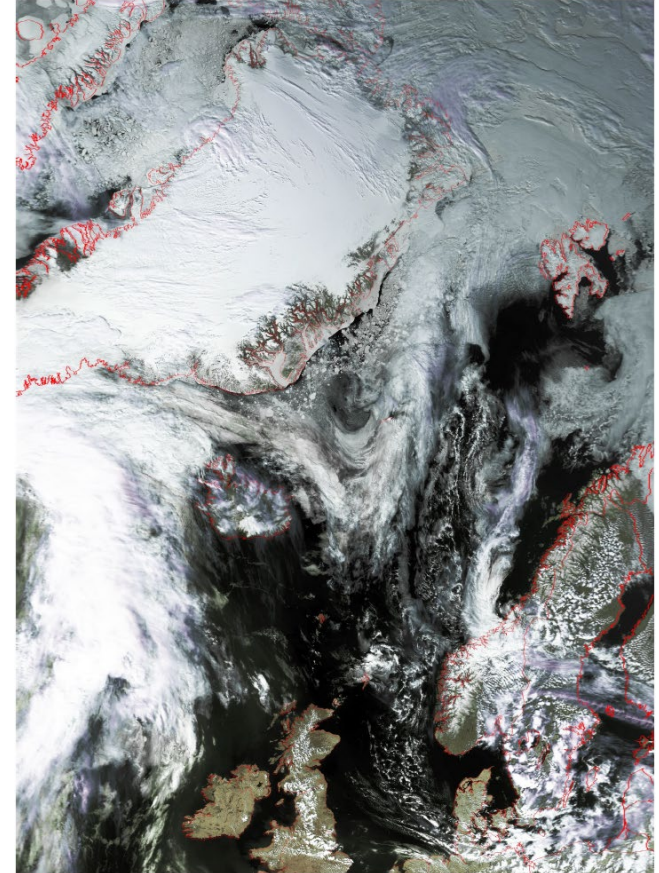
<https://earth.esa.int/eogateway/catalog/avhrr-level-1b-local-area-coverage-imagery>

Merging of CEOS Sharp-1 segments

54.344 data segments are re-processed



- > The SHARP segments have overlapping areas. Merging needs to remove those areas. For this purpose a new tool was developed additionally.
- > The tool identifies the overlapping areas of two HMF files by examining the timestamps and cropping the redundant lines.
- > Now, coastlines of the final product fit perfectly.
- > **Finally, 99.8% (54.245 data segments) of the CEOS data could be re-processed and rescued!**



ESA Online Dissemination – AVHRR L1B data

<https://earth.esa.int/eogateway/catalog/avhrr-level-1b-local-area-coverage-imagery>

- > This collection is composed of AVHRR L1B products (1.1 km) reprocessed from the NOAA POES and Metop AVHRR sensors data acquired at the University of Dundee and University of Bern ground stations and from the ESA and University of Bern data historical archive.
- > The data collection covers Europe and the neighboring regions in the period of 1 January 1981 to 31 December 2020.
- > The product format is the **NOAA AVHRR Level 1B** that combines the AVHRR data from the HRPT stream with ancillary information like Earth location and calibration data which can be applied by the user. Other appended parameters are time codes, quality indicators, solar and satellite angles and telemetry.



[Data](#) / [AVHRR Level-1B Local Area Coverage ...](#)

AVHRR Level-1B Local Area Coverage Imagery

AVHRR L1B LAC

[Missions](#) ▶

How To Access Data

Users can freely access the collection using the below links and will be requested to login (new users shall register) to [ESA EO Sign In](#) to download the products.

ESA internal users can use their ESAAD account.

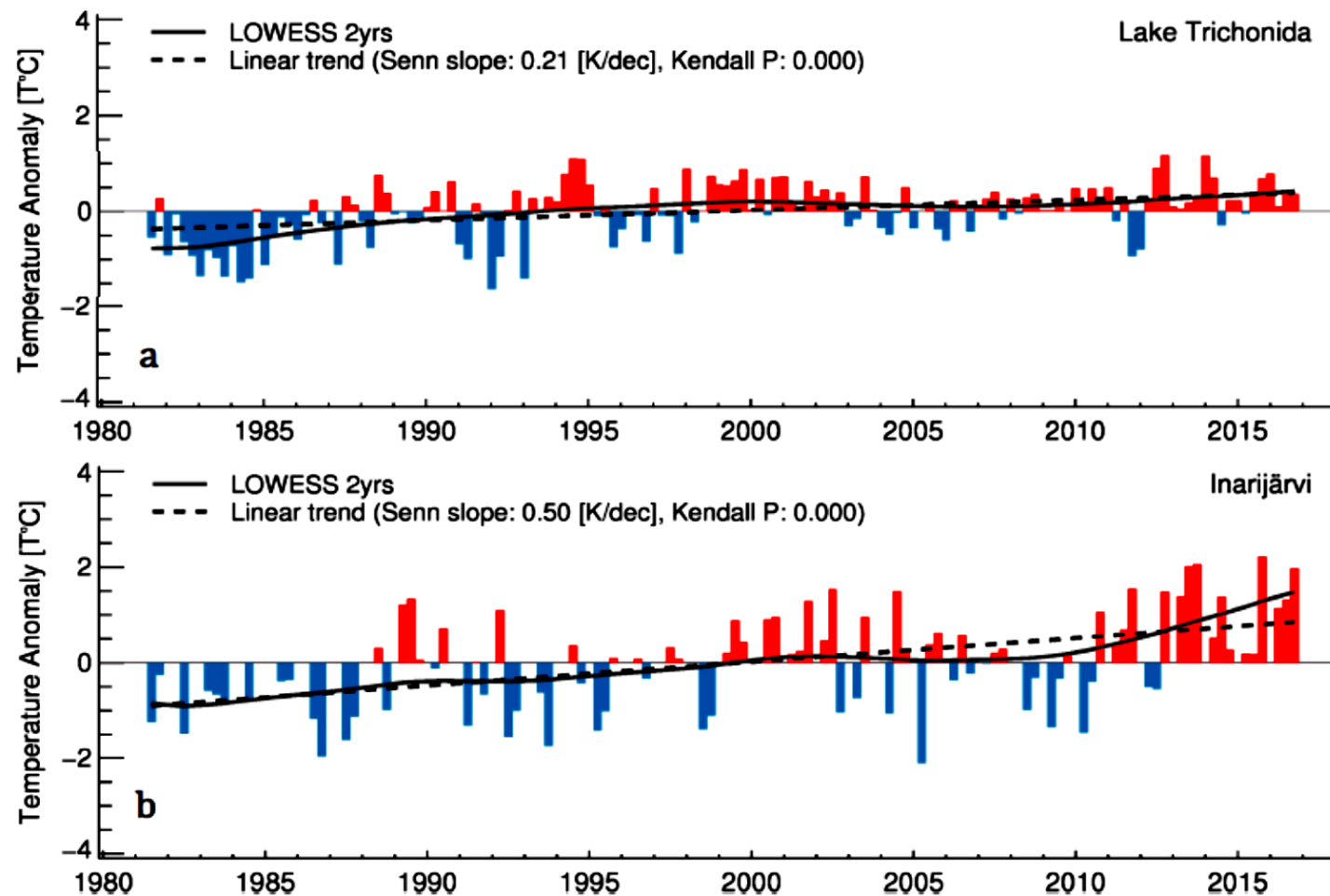
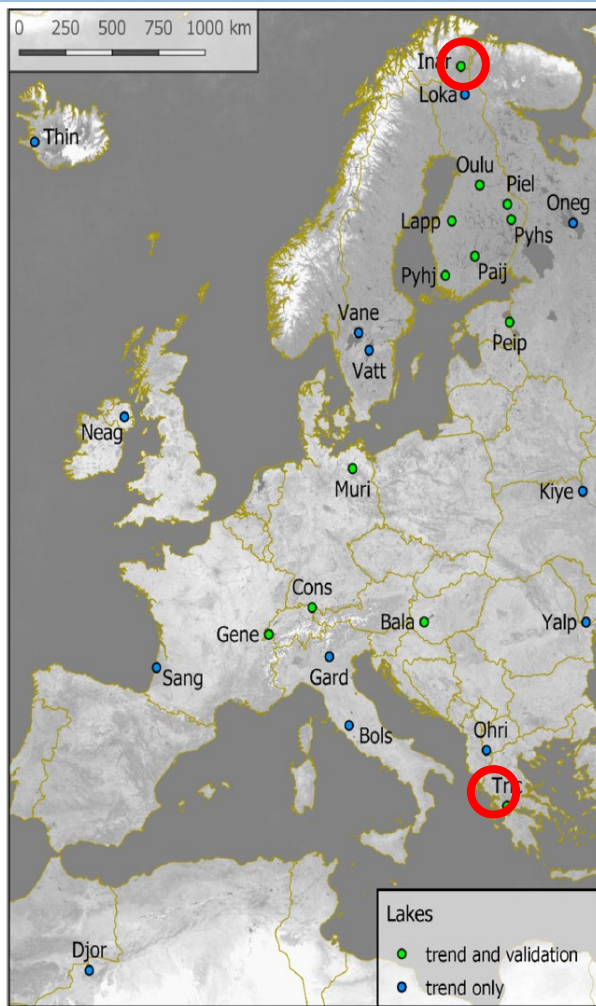
The products are available for download via the following interfaces:

- [ESA EO Multimission Catalogue \(EO CAT\)](#) - Allows users to discover and search products among the available datasets from ESA and Third Party Missions and instruments, using various criteria (spatial, temporal, specific).
- [ESA Third Party Missions \(TPM\) dedicated dissemination service and catalogue](#)

For further information about the EO Sign In Service you can visit [TELIUS](#)

Should you need support please contact [EOHelp](#)

Anomaly of LSWT (1981 – 2016) for North-South transect

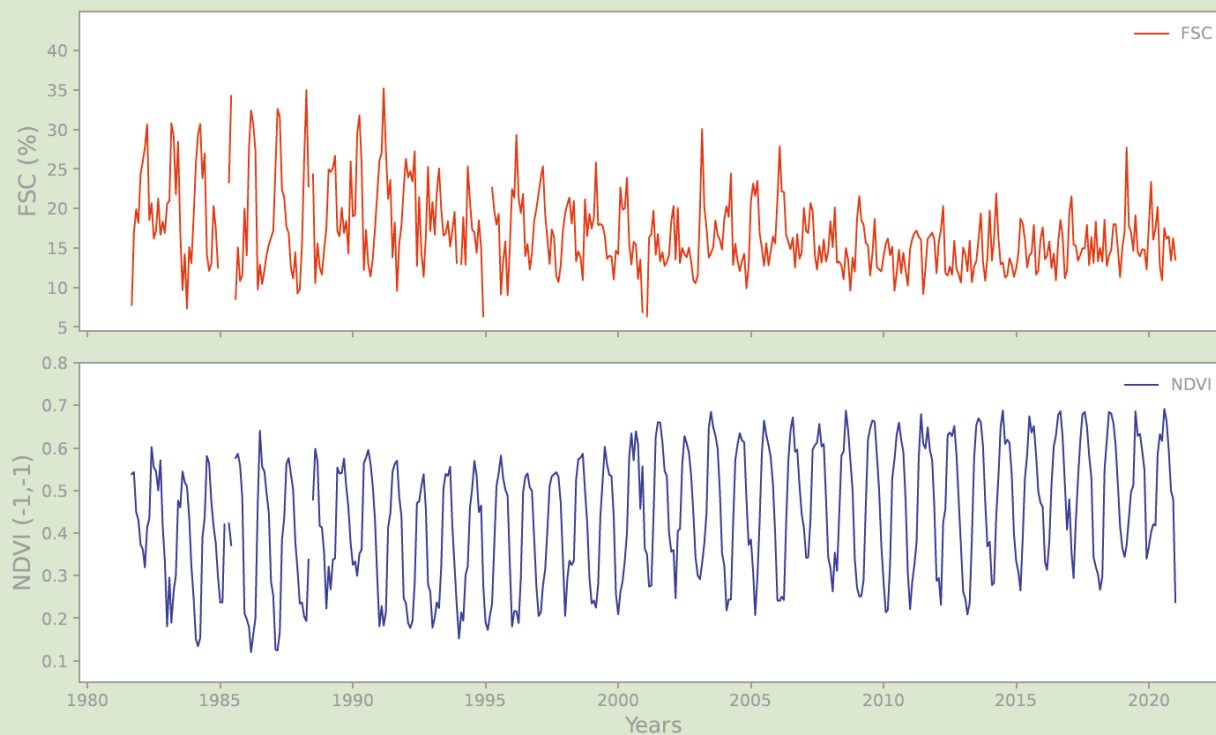


Phenological cross-domain ECV analysis of AVHRR time series by using a semantic EO data cube

Poster presentation by Helga Weber et al.

Data

ECV time series of *area covered by snow* and *vegetation dynamics*, here *NDVI*, were derived from **40+ years** of 1 km AVHRR data (1981 – today), archived by the University of Bern (see Figure 2). Data are curated in the **SemantiX data cube**, a semantic Earth observation (EO) data cube.



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SNOW
CCI

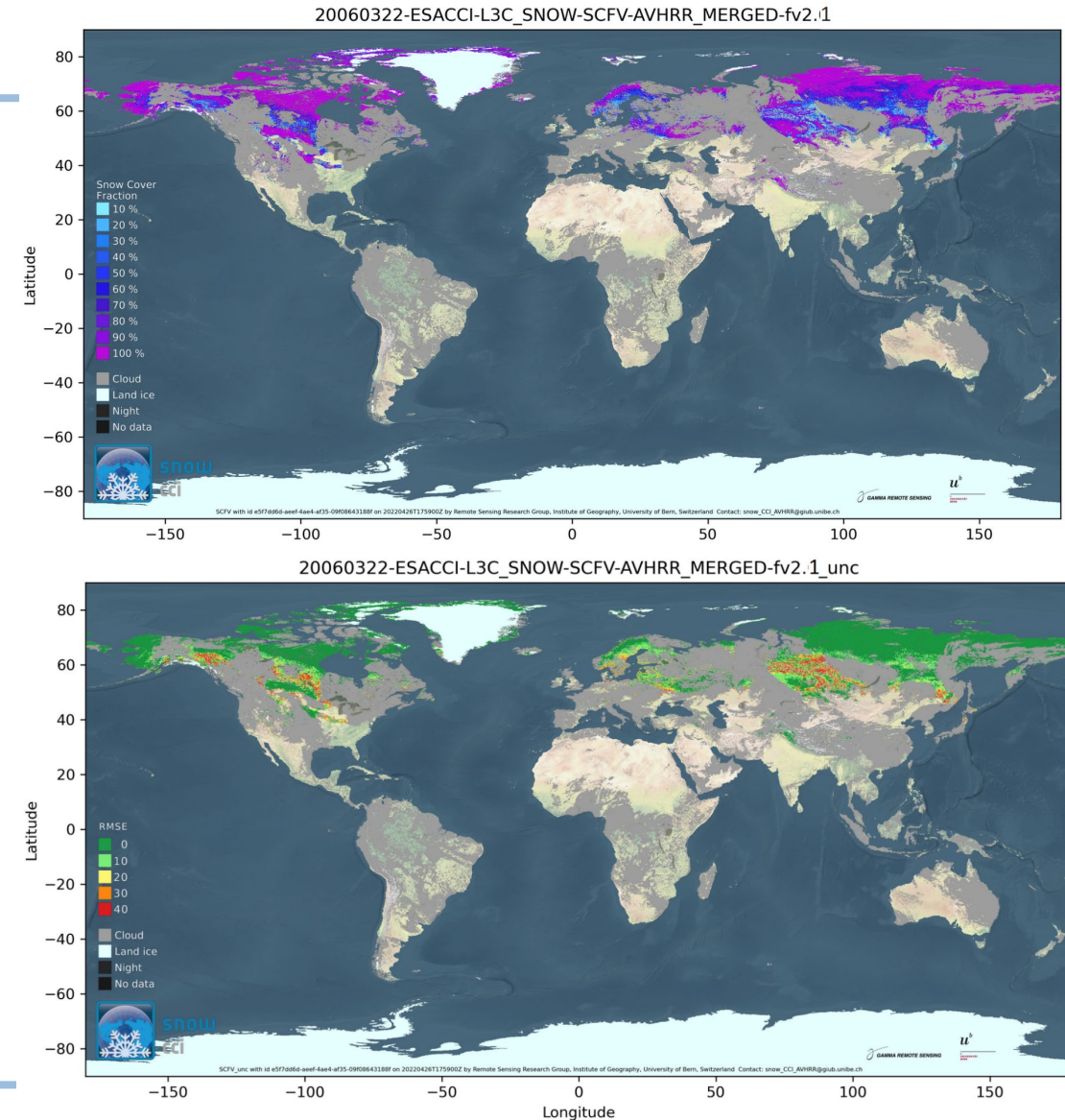
AVHRR Snow Cover Fraction (global) by University of Bern

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UNIVERSITÄT

- > Aim: consistent SCFV/SCFG (1978 – 2023)
- > Data source:
 - AVHRR GAC, reprocessed by EUMETSAT
 - Morning and afternoon passes
 - CLARA-A3 daily composites from CM SAF
- > Retrieval scheme:
 - NDSI, Scamod and tailored thresholds
 - spatial and temporal adapted transmissivity based on NDVI
 - Cloud probability based on CLARA-A3
- > **Postdoc position open at University of Bern**

Right: SCFV and uncertainty (20060322) based on AVHRR GAC



Summary and Outlook

> Summary

- A homogenous and consolidated AVHRR LAC time series (1981 – 2021) is now available via ESA dissemination service.
- More than 200.000 AVHRR data (level 1b) covering Europe are ready to be used
- Approx. 55.000 CEOS Sharp-1 segments were rescued, re-processed in a consistent way (EO-SIP) and are accessible via ESA dissemination service, too.
- Software and processing procedure developed at University of Bern is installed and tested at ESA facilities.
- Next step is the generation of Level 1c data (calibrated and geocoded) for a better service to support communities without the needed expertise in AVHRR processing.

Outlook

- > Filling of AVHRR level1b archive with LAC data until the end of AVHRR sensor (NOAA, MetOp) approx. 2025
- > Integrate global AVHRR LAC data of the pre-MODIS era (e.g. 1992 – 1999; more than 30.000 data sets); start rescue activities for local archives around the world.
- > On the way to a FCDR: include Sentinel-3 and other medium resolution satellite data
- > Data Usage:
 - Provide Access-Ready-Data (ARD) for user, climate modelling community (CMUG)
 - Climate Observations and Monitoring for Policy Action Support from Space;
 - Contribute with Heritage Mission data to Digital Twin Earth (DTE) and Climate-Space
- > Bring the user to the data: continue with the next level of DIAS to offer an European processing facility to analyze all ESA data incl. heritage mission data.