WGISS
AVHRR & Heritage Data Recovery

Committee on Earth Observation Satellites

WGClimate-22 & GHG-TT-5
Agenda Item 2.6
11 February 2025
M. Albani, ESA

WGISS Organizational Structure

WGISS Principals

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CAS/NRSCC: Chuang Liu
CNES: Pierre-Marie Brunet
CONAE: Homero Lozza
CSA: Paul Briand
CSIRO: Matt Paget
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JAXA: Makoto Natsuisaka
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NSO: Raymond Sluiter
ROSCOSMOS: Tamara Ganina
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USGS: Tom Sohre
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Chair Tom Sohre, USGS
Vice-Chair Nitant Dube, ISRO
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Data Preservation and Stewardship Interest Group: Mirko Albani, ESA

Data Interoperability and Use Interest Group: Nitant Dube, ISRO

Data Discovery and Access Interest Group: Damiano Guerrucci, ESA

- **IDN** Michael Morahan, NASA
- **FedEO** Damiano Guerrucci, ESA
- **CWIC** Minnie Wong, NASA

Technology Exploration Interest Group:
Yousuke Ikehata, JAXA
Maral Bayaraa, UKSA

https://ceos.org/ourwork/workinggroups/wgiss/

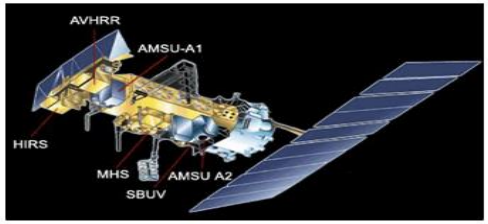
DSIG - Heritage Data Recovery

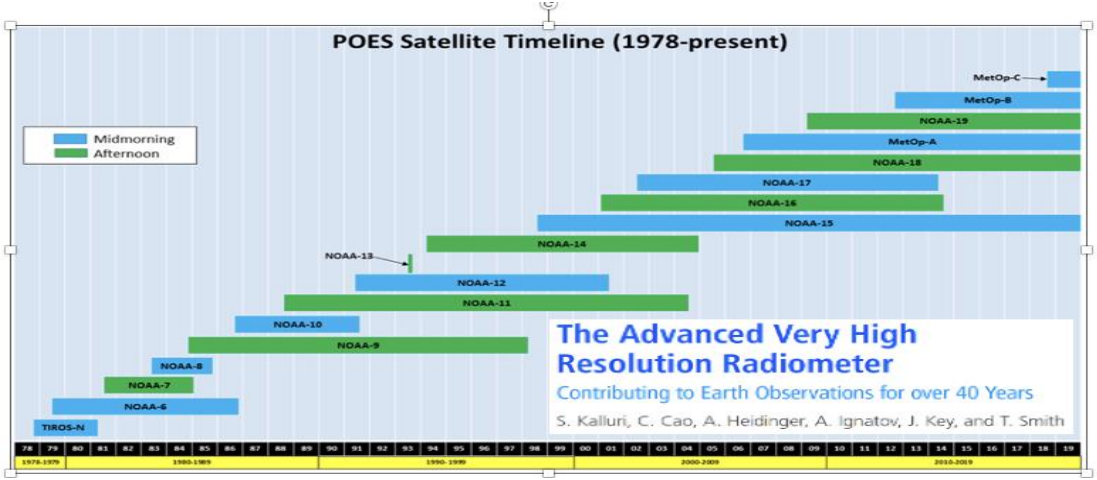
Climate related applications require to extend observations back in time through the use of heritage (historical) datasets.

Objective: identify historical/heritage datasets currently not accessible to users and trigger potential joint actions to **RECOVER AND MAKE THEM EASILY ACCESSIBLE OPEN AND FREE**

Inform us if you are aware of heritage datasets not accessible or usable that might be of interest for climate and other applications: Mission, instrument, owner, location, coverage, timespan, etc

Example: Advanced Very High Resolution Radiometer (AVHRR)



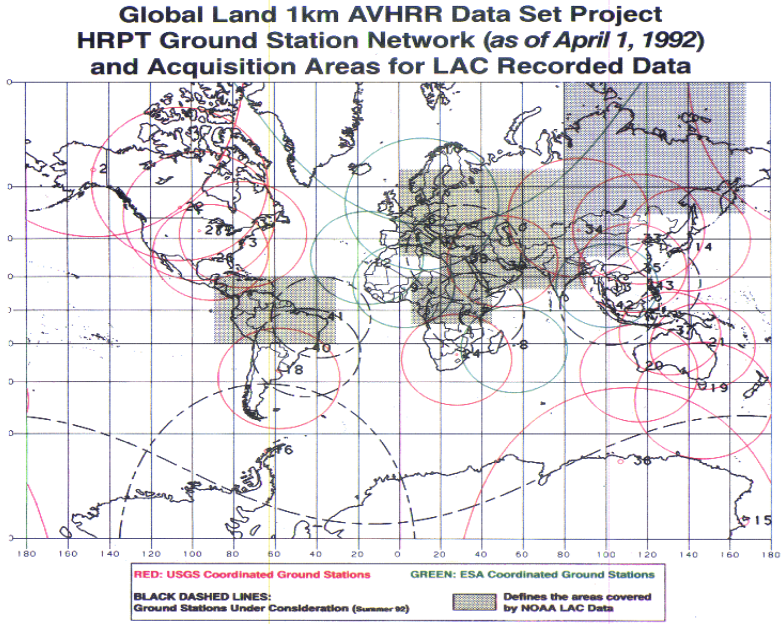


GAC DATASETS (4 km): NOAA POES AVHRR GAC global archive: 1978 onwards

LAC DATASETS (1 km)

- EUMETSAT MetOp AVHRR 1km FRAC global archive: March 2008 onwards
- Global Land 1-km AVHRR data set covering the period 1992-99 *"1Km project"*
- Many national / regional data archives of LAC data around the world covering a longer period with high value for the retrieval of ECVs. Some of them accessible to users, others not due to unknown accessibility, responsibility, data format and structure.

Global 1km AVHRR dataset 1992-1999



AVHRR receiving stations contributing to global land 1km AVHRR data set. (https://lta.cr.usgs.gov/1km/hrpt_image)

Products Number*				
	L0	L1A	L1B	L1C
1Km-Project (out of Europe)		3901	3901	2991

* No L0 available.

Two different global Land 1-km AVHRR datasets covering the period 1992-1999 are available at ESA :

1. **Data acquired at ESA network stations** (Terranova, Nairobi, Manila, etc..) were processed up to L1C and are disseminated via ESA systems open and free.
2. **Data in stitched format (.arch files) from USGS network stations** not accessible at USGS/NOAA and not processable at ESA due to unknown data format.

1. Recently digitised old documentation retrieved at ESA with description of stitched product format (.arch files). Stitched product reader tool also retrieved at ESA.
2. Software converter from stitched format to HRPT files is under development.
3. Next Steps: conversion, full processing into Level-1B and Level-1C, open access to users via ESA systems.

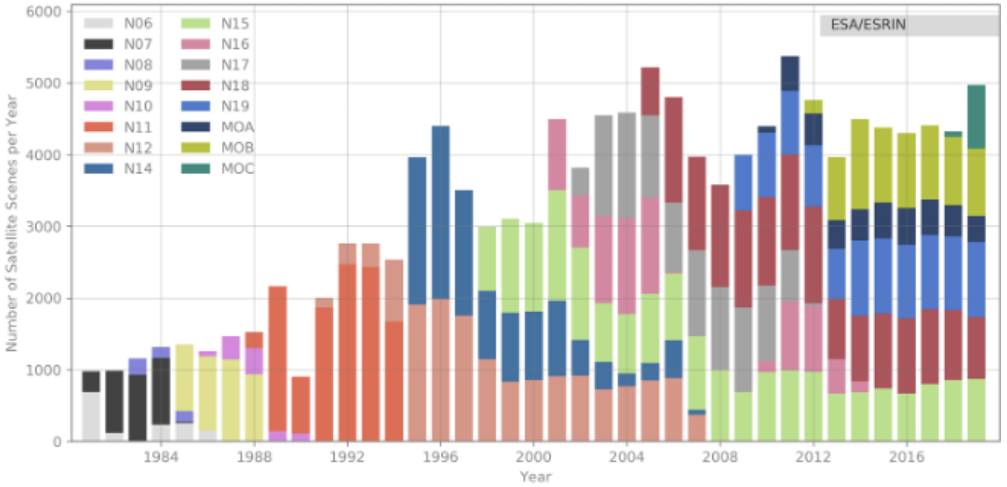
Europe – ESA & University of Bern

- **Long time series (1981–2020) of AVHRR data over Europe** from different platforms (POES, MetOp)
- Unique source to retrieve Essential Climate Variables (ECV) to investigate climate change over last 40 years.

Products Number*				
	L0	**L1A**	**L1B**	**L1C**
Europe	145231	259747	260060	259164

*The L0, L1A and L1B input data are scattered.

- European dataset includes data from University of Bern, Dundee Station and ESA holdings: **260.000 products. harmonized** and **consolidated** through a dedicated ESA project (Heritage Space Programme).
- All **data accessible free** of charge via ESA dissemination services and safely archived at ESA**.**
- **Processing to Level-1c completed,** data **opened to users in Oct'24**.



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

https://doi.org/10.5270/AVH-f1i8784

ESA LAC Data format

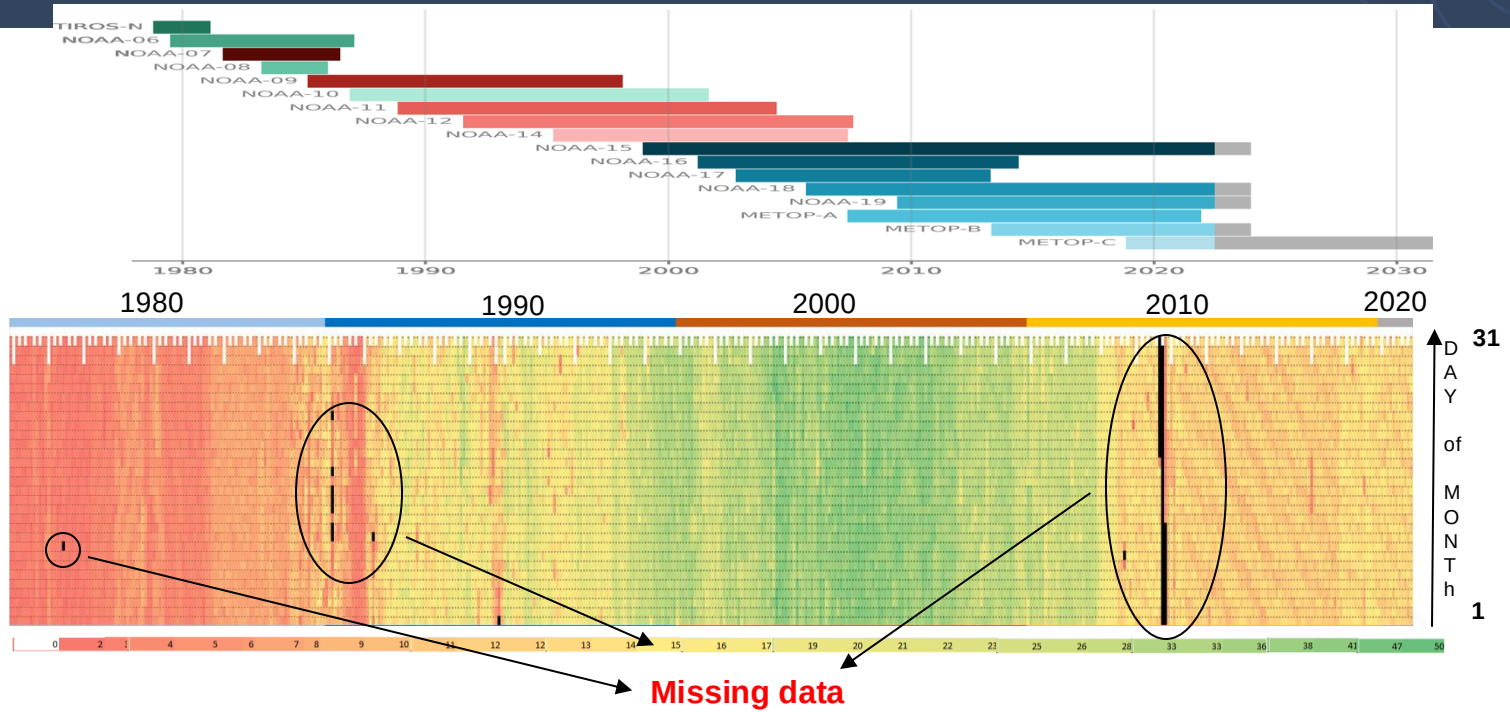
LAC L1b products: *NOAA format*

Description: 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.

LAC L1c products: *netCDF format*

Description: Counts to reflectance for the visible and near-infrared channels 1, 2, 3A, and to brightness temperatures for the infrared channels 3B, 4, 5. The infrared calibration uses on-board calibration data and it is satellite specific without cross-calibration between satellites. For the visible channels calculated coefficients from the CIMSS PATMOS-X project, version 2017r1, were used for the visible calibration aiming to minimize spectral differences among the various AVHRR sensors. Geocoding of the data is improved adding a time-correction based on coastline detection

Europe - ESA Data temporal coverage

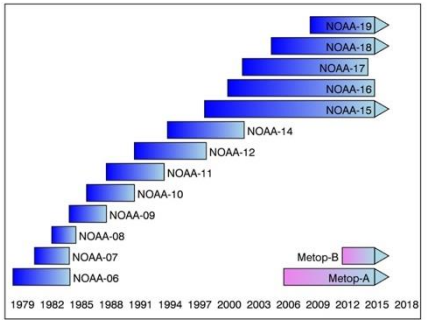


- **Heat chart** on data acquisition frequency per day: min value: 1, max value: 50, missing data: **black**
- Data gap will be closed getting missing products from other sources
- Data from other sources also being retrieved to extend European coverage towards Russia and Greenland

FDR for Advanced Very-High-Resolution Radiometer instrument (FDR4AVHRR) – ESA project

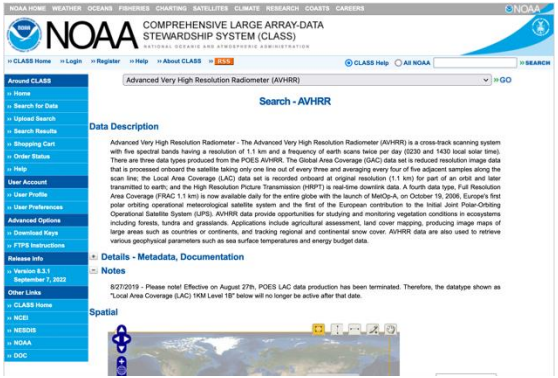
New project started at ESA in **Q1 2024:**

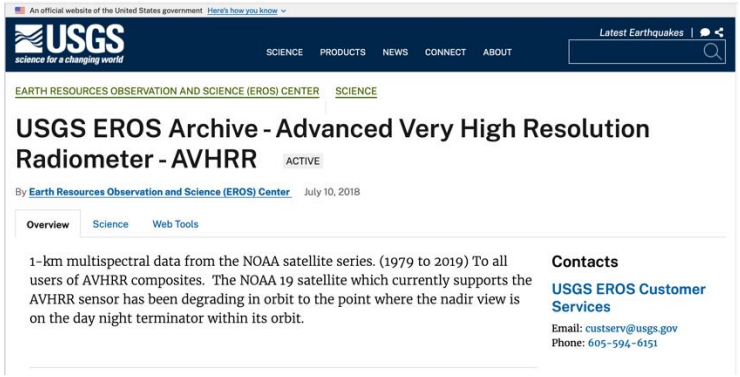
- New reprocessing of AVHRR series LAC products **40+ years of length** → climate record
- **FDRs for TIR and VNIR channels** mainly over Europe +
- **Cross-mission calibrated** AVHRR FDR dataset at 1km spatial resolution for all channels
- Generating dataset including **new modules** for improved **geocoding / orthorectification, error propagation** and **accurate uncertainty estimates** in the calibration module **with related documentation**
- Extending ESA 2020 AVHRR European Data Set: 1) with **data beyond 2020** over Europe; 2) adding data covering Greenland and northers areas; 3) adding selected regions across the world (**Argentina, Kenya, South Africa, etc…)**



UNIVERSITÄT BERN · SMHI · University of Reading · NPL National Physical Laboratory

North America – NOAA & USGS





LAC (North America and other areas) data from 1978 sometimes scattered in time/coverage

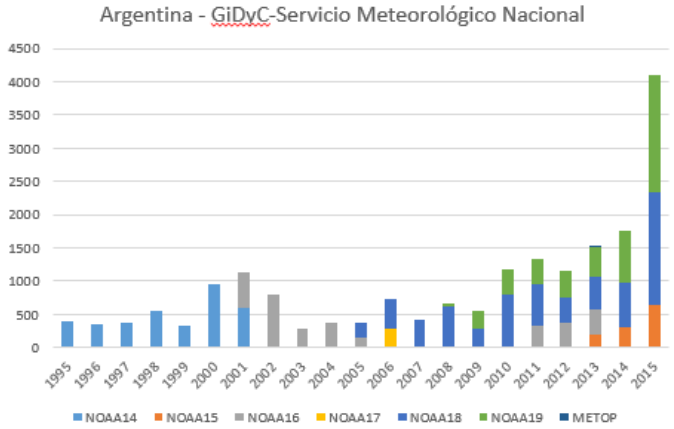
Receiving Station

- ☐ Cape Ferguson, Australia
- ☐ Dundee, Scotland, UK
- ☐ Ewa Beach, HI
- ☐ Ford Island, HI
- ☐ Gilmore Creek, AK
- ☐ Honolulu, HI
- ☐ Miami, FL
- ☐ McMurdo Antarctic Data Acquisition
- ☐ Monterey, CA
- ☐ Sioux Falls, SD
- ☐ NOAA Svalbard Antennae
- ☐ SOCC
- ☐ Svalbard
- ☐ Western Europe
- ☐ Wallops Island, VA

Argentina - GiDyC-Servicio Meteorológico Nacional

Initial products Metadata

- Source: Jefa Departamento Teledetección Y Aplicaciones Ambientales, GiDyC-Servicio Meteorológico Nacional, Buenos Aires, Argentina
- Number of products: 19360
- Volume size: 740GB
- Satellites: N14, N15, N16, N17, N18, MetopA/B
- Time Period: 1995 – 2015
- Extent: roughly Lat=[-30,15] Lon=[-60,-15]
- Format: QUO (HRPT)



Downloaded products metadata*:

- Number of products: **25504**
- Volume size: **1.02 TB**
- Time Period: **1995-2017**
- Format: **.rar, .quo, .WI**

- Data transfer to ESA is on-going.
- Next steps: complete transfer, full processing into Level-1B and Level-1C, open access to users via ESA systems.

Brazil - INPE

- Satellites: METOP-A, METOP-B, N12, N14, N15, N16, N17, N18, N19,
- Number of L0/L1A : 287325
- Volume size < 18TB
- Time Period: 1998 - 2024
- Extent: Brazil
- Format: HRPT and others

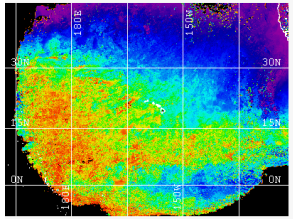
METOP-B	May 2013-Ma-2024	HRPT	29237
METOP-C	Dec 2019-Mar 2024	HRPT	7924
NOAA_12	Aug 1998-Aug 2007	HRPT	16333
NOAA_14	Aug 1998-Jun 2007	HRPT	10976
NOAA_15	Jul 2001-Aug 2019	HRPT	36816
NOAA_16	Aug 2001-Dec 2014	HRPT	20692
NOAA_17	Jan 2003 - Mar 2013	HRPT	24575
NOAA_18	May 2005 – Mar 2024	HRPT	52626
NOAA_19	Jan 2012 - Mar 2024	HRPT	39791
S1*	---	Unknown	48355

- Data transfer to ESA completed.
- Next Steps: full processing into Level-1B and Level-1C, open access to users via ESA systems.

** The S1* files are under investigation because they could be single data/calibration for channel.*

Hawaii – University of Hawaii

An AVHRR dataset was acquired at the Hawaii University between 1990 and 2000. Data are still on Exabyte tapes, some were extracted covering the islands but not accessible.



NOAA-AVHRR images data & processing

Time series:

9300 images from NOAA-AVHRR 11,12 & 14
July 10, 1991 to Dec. 31, 1999

Data received at the SeaSpace HRTP station of the University of Hawaii

Processing:

- internal calibration
- manual navigation to 1-km accuracy
- cloud detection (daytime ch 2; night-time ch 3 – ch 4)
- remapping to a common grid (1.25 km pixel)
- domain of 1250 x 1250 km²
- estimation of multi-channel SST using NOAA coefficients
- estimation of vegetation index (ch 2 - ch 1 / ch 2 + ch1)

HI HRPT wiki

Topics
Action items?
Blog
Technical issues
HI Catalog
HI Data
HI Analysis
Exabyte info
Pictures
Contractors
HI proposal?

wiki help

edit

Main /
University of Hawaii HRPT data rescue wiki

Objectives

From 1990 to 2000, the University of Hawaii operated a receiving station for the NOAA polar orbiter satellites, under joint NASA/ONR/NSF funding, to receive the High Resolution Picture Tran
resolution of 1 km for the Advanced Very High Resolution Radiometer (AVHRR).

This station was shutdown in 2000 due to lack of funding to upgrade the SeaSpace software to fix the year-2000 bug in the satellite orbit computation libraries.

About 500 Exabyte tapes holding close to 10,000 satellite passes have been archived and last read in 2002 to extract a subset covering the Hawaii islands.

It is proposed to rescue these data and transfer them to HDD for distribution and copy to National Centers. This involves delicate handling of potentially decaying media and tape drives, requiring specific expertise.

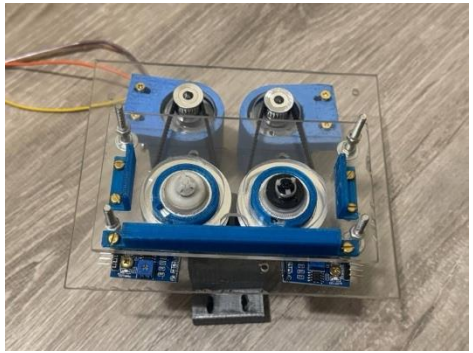
Scientific justification

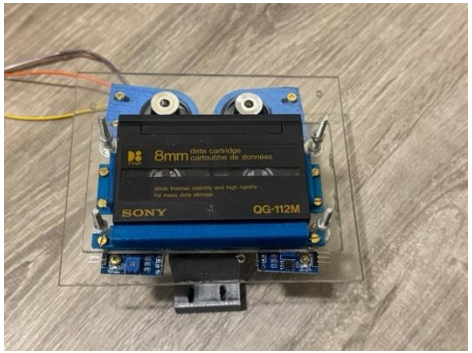
Metadata from the website

- All exabyte tapes and hardware were shipped to ESA/ESRIN.
- Transcription chain is being assembled.
- The ESRIN laboratory is manufacturing a special device to roll/unroll the tapes at very slow speed and clean the tape surface from moisture.
- Next steps: transcription, full processing into Level-1B and Level-1C, open access to users via ESA systems.

Heritage Exabyte tapes wrapper

Built at ESA ESRIN laboratory to clean and wrap exabyte tapes avoiding damaging both the cassette and the internal tape. Mandatory step for these old media before transcription.



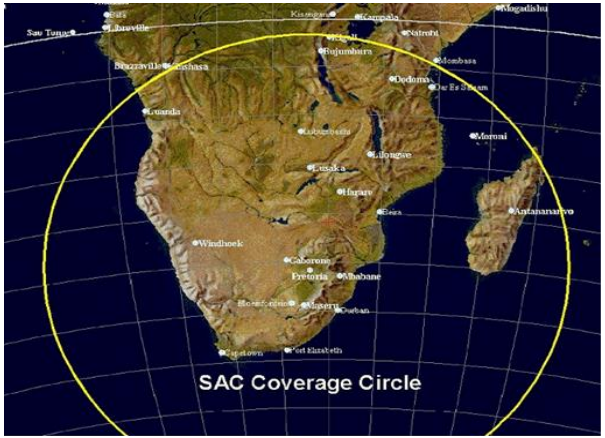


South Africa - SANSA

1km NOAA AVHRR data received at Hartebeesthoek, South Africa (25° 53' S 027° 42' E) and maintained by SAC/SANSA – South African National Space Agency

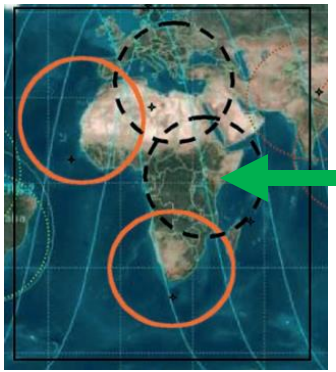
NOAA 9	1985-1987
NOAA 11	1989-1993
NOAA 14	1995-2001
NOAA 16	2001-2005
NOAA 17	2005-2010
NOAA 18	2005-2009

- Number of products: 7684
- Volume size: 464GB



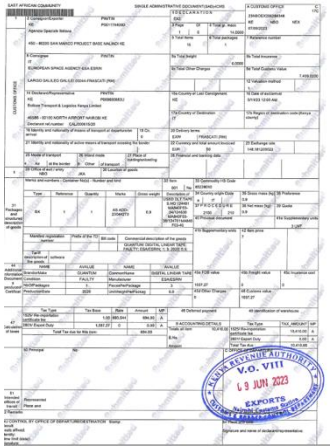
- Data transfer to ESA completed.
- Next steps: full processing into Level-1B and Level-1C, open access to users via ESA systems.

Central Africa (Kenya) - ASI/UniRoma



Data acquired at the Malindi station in Kenya from **2001** to **2009** and stored on **44 DLT** tapes.

- **8452 products** in L1B sharp format.
- Volume: **614 GB**

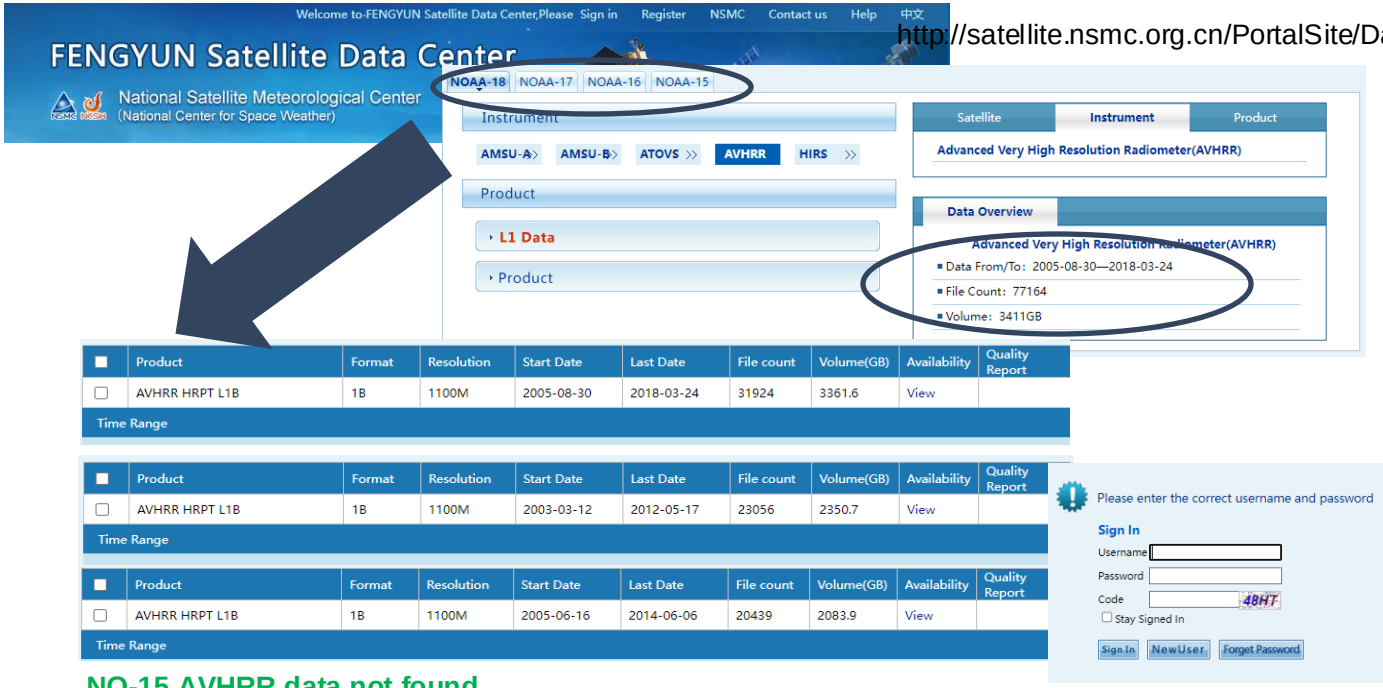


- ESA transcribed the DLTs content successfully.
- Next steps: full processing into Level-1B and Level-1C, open access to users via ESA systems.

China – CMA/NSMC

- AVHRR-receiving stations for global 1km land product (coordinated by USGS): Beijing, Urumqi, Guanzhou
- AVHRR 1-km data covering Himalaya-Hindukush of the period 1981 – 1992 would be of exceptional value

http://satellite.nsmc.org.cn/PortalSite/Data/Satellite.aspx



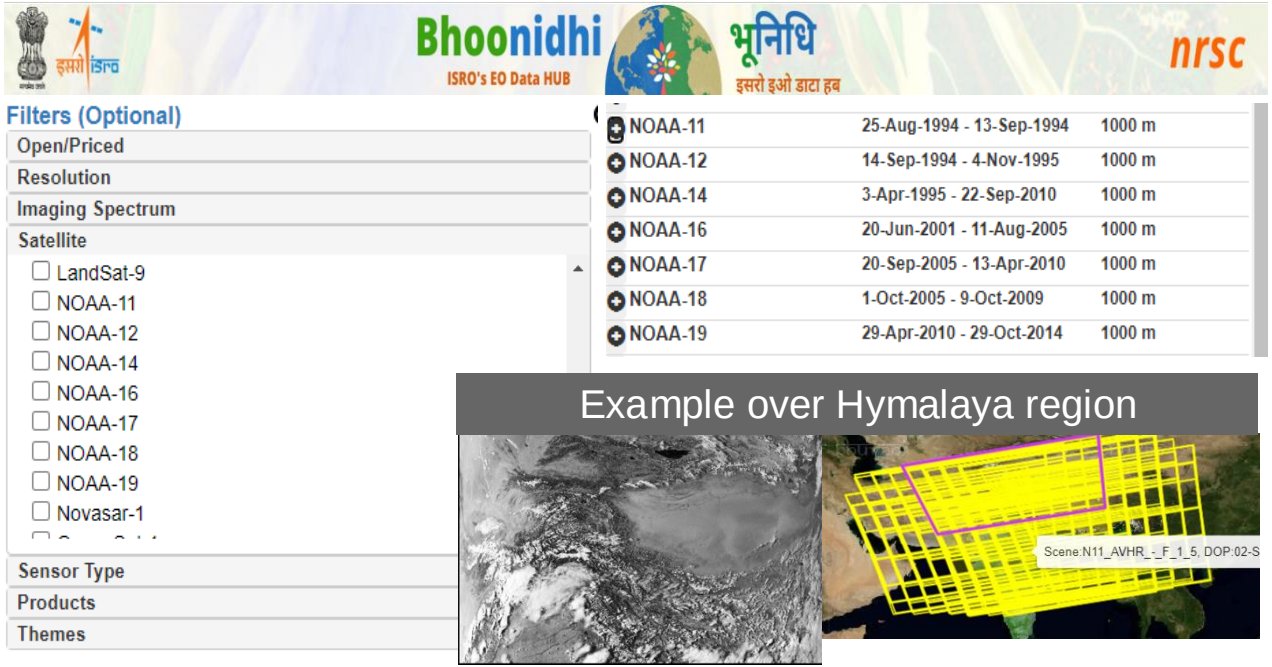
Sent request for accessing the data download area.

Next steps: CMA will be contacted to get information on data volume and status of accessibility

NO-15 AVHRR data not found

India - ISRO

https://bhoonidhi.nrsc.gov.in/bhoonidhi/index.html



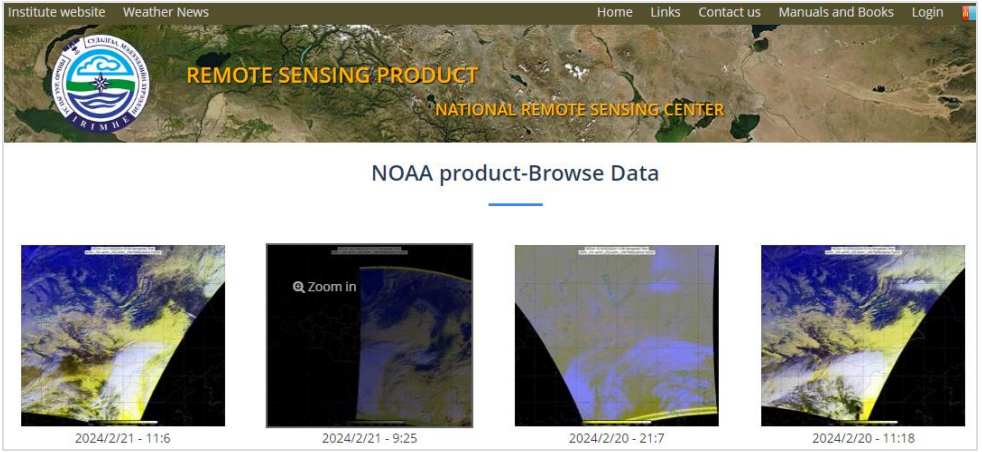
ISRO planning to reprocess data into L1A, then ESA processor provided to ISRO will be used to reprocess data into Level-1b and Level-1c. Afterwards dissemination via ISRO.

NOAA products are *open-data* and, after user registration, the products are downloadable.
No products number or volume can be extracted from the web site.

Mongolia - Remote Sensing Department, Information and Research Institute of Meteorology, Hydrology and Environment

From UniBern

- AVHRR UBM data
- Source: Remote Sensing Department, Information and Research Institute of Meteorology, Hydrology and Environment, Ulaanbatar, Mongolia
- Number of Scenes: 5.016
- Satellites: N09, N11, N12, N14, N15
- Time Period: 1993 – 1999
- Extent: roughly Lat=[20,70] Lon=[80,120]
- Format: hmf (origin: dat, grid, lut)
- Further info:- UBMx station data were included in the Global Land 1km AVHRR Data Project



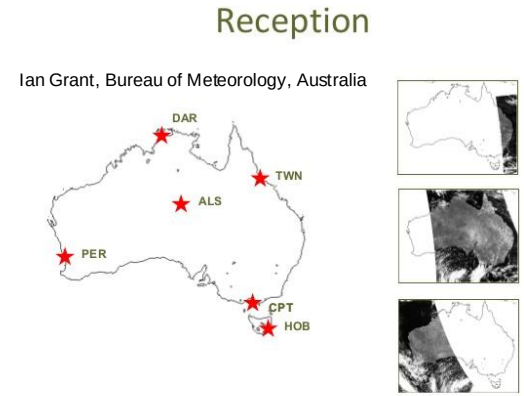
Browsing the NOAA data, the acquisitions are from 01/01/2017 up to now. Available data (raw,L1b,L1c) to download from 10/12/2023 (http://119.40.97.75:8080/thredds/catalog.html)

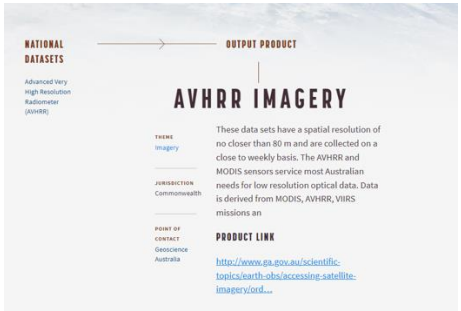
Next steps: The institute will be contacted to get information on data volume and status of accessibility

Australia – CSIRO

- AVHRR reception based on 6 stations for continuous 1-km data set. Since the early 1990s CSIRO has been merging these separate local data sets to produce a stitched archive which makes use of the redundancy arising from overlap between reception stations to produce a higher quality and consistently formatted data set with national coverage. The assembly and consolidation of this data set continues within CSIRO today.
- Data availability: 1981 (NOAA-7) onwards covering essentially the greater Australasian region and NZ.

- CSIRO planning to reprocess all data into higher levels and provide access.
- Coordination and cooperation with ESA ongoing (exchange of info and SW) to facilitate reprocessing and harmonization of datasets.





https://link.fsdf.org.au/dataset/avhrr-imagery

Other organizations

- Inventory of existing national/regional HRPT and LAC data archives Version 3 has been produced in Q1 2024 and will be updated in 2025
- List of Met offices and other organizations around the world who might have AVHRR LAC data being compiled at ESA
- ESA will perform a worldwide AVHRR LAC data gap analysis extending the one done for Europe
- ESA will contact additional organizations who might have AVHRR LAC data to investigate possibility to fill identified gaps

AVHRR 1 Km data on media - transcriptions

Several hundred heritage media (optical disks, DLTs, Exabytes) with potentially unique AVHRR LAC data were identified:

- ESA (Optical Disks)
- University of Reading (Optical Disks)
- University of Rome / ASI (DLTs)
- University of Hawaii (Exabytes)

LM 1200 optical Disk 2.4GB

300 CLV DISKS

100 ATG GM-9001/5 DISKS

Exabyte tapes

Next Steps

1. Continue ongoing transcription activities, coordination and projects and contact additional organizations with potentially unique AVHRR LAC data

2. Provide AVHRR points of contact and stakeholders with information and sw to facilitate reprocessing and harmonization of the respective datasets

3. Check status of discoverability of AVHRR datasets worldwide and pursue common entry point through WGISS data discovery and access infrastructure

4. **Start recovery activities on other datasets (feedback from WGClimate highly appreciated)**

THANK YOU !!! Mirko.Albani@esa.int