ACTRIS Aerosol Remote Sensing data processing: Single Calculus Chain Overview

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Ministero dell'Università e della Ricerca

Italiadomani

What is SCC?

- SCC stands for ACTRIS/EARLINET Single Calculus Chain
- Centralized and automatic tool to process raw lidar data
- Developed within EARLINET community (multi-years projects – since 2006)
- Core service of ACTRIS Aerosol Remote Sensing Node (ARES)
- Standard tool to process ACTRIS(ARES)/EARLINET measurements
- Open-source project coordinated by CNR-IMAA
- Current development team: 13 members from 7 different scientific institutions
- Extensively tested on ARES/EARLINET data
- Freely accessible via Web/API → https://scc.imaa.cnr.it

D'Amico et al.: EARLINET Single Calculus Chain – overview on methodology and strategy, Atmos. Meas. Tech., 8, 4891-4916, https://doi.org/10.5194/amt-8-4891-2015, 2015

Main requests for a modern and efficient RI

- Standardization
- Full traceability
- Quality control
- Unique data access point
- NRT data provision
- FAIR compliance

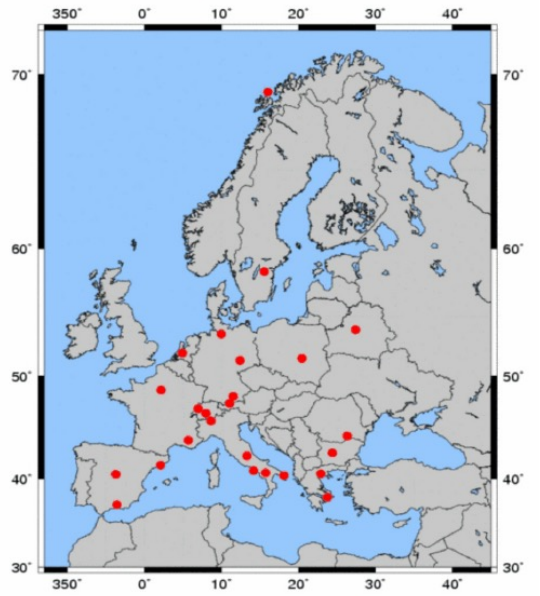
  https://www.force11.org/group/fairgroup/fairprinciples

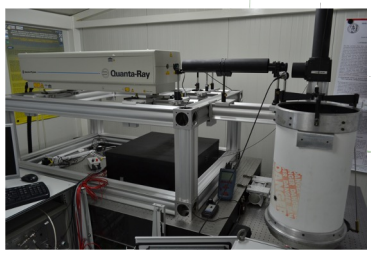
These are mandatory requirements to provide operative monitor services like for example CAMS or to participate in satellite validation plans.

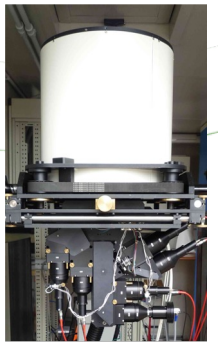
→ Submission of raw data to centralized processing chain

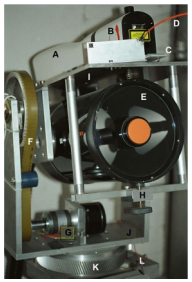
ACTRIS ARS Products Standardization

- Standardization of ACTRIS/EARLINET products is difficult
- EARLINET was born as Research Lidar Network
- lidar systems as often highly customized or fully home made
- differences in laser sources, telescopes, detection and acquisition systems







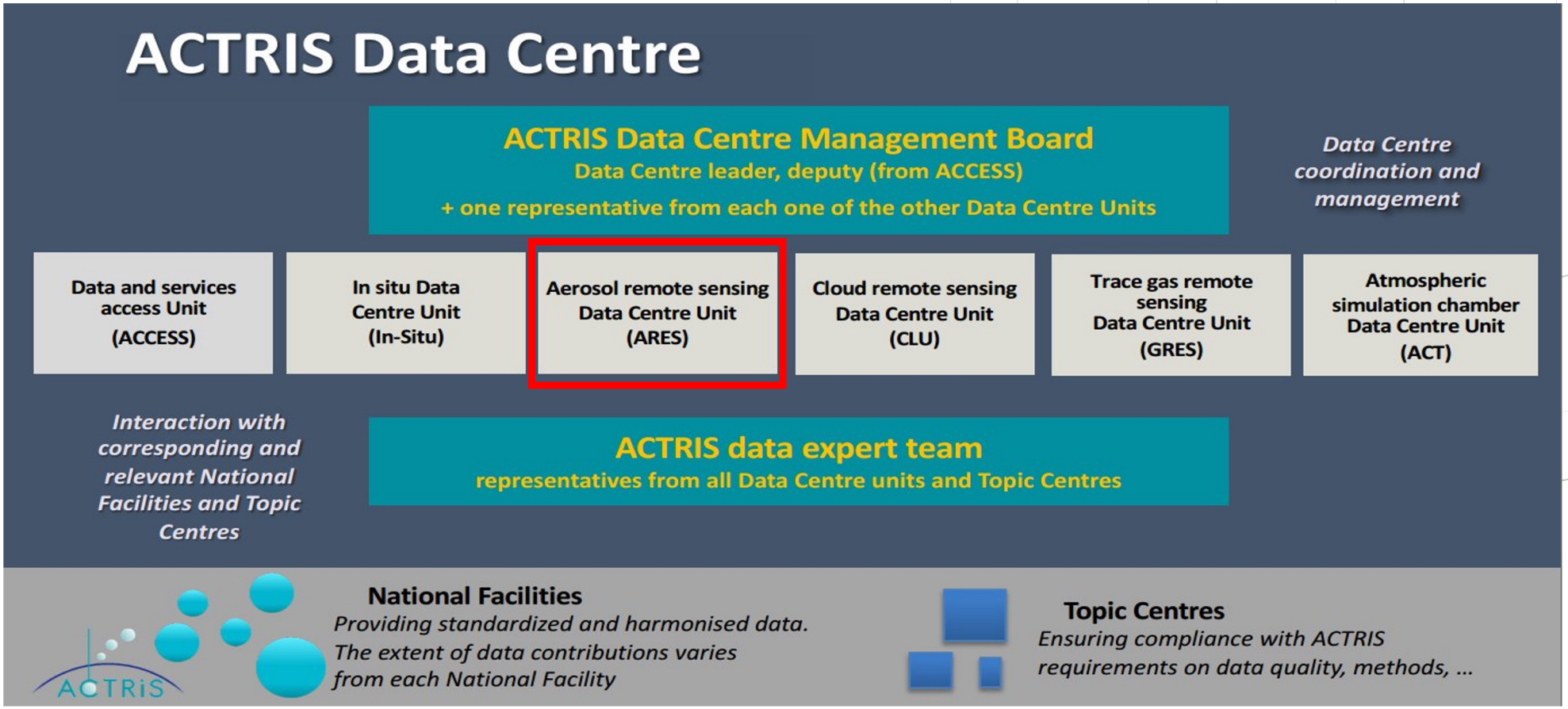


ACTRIS ARS Standardization Approach

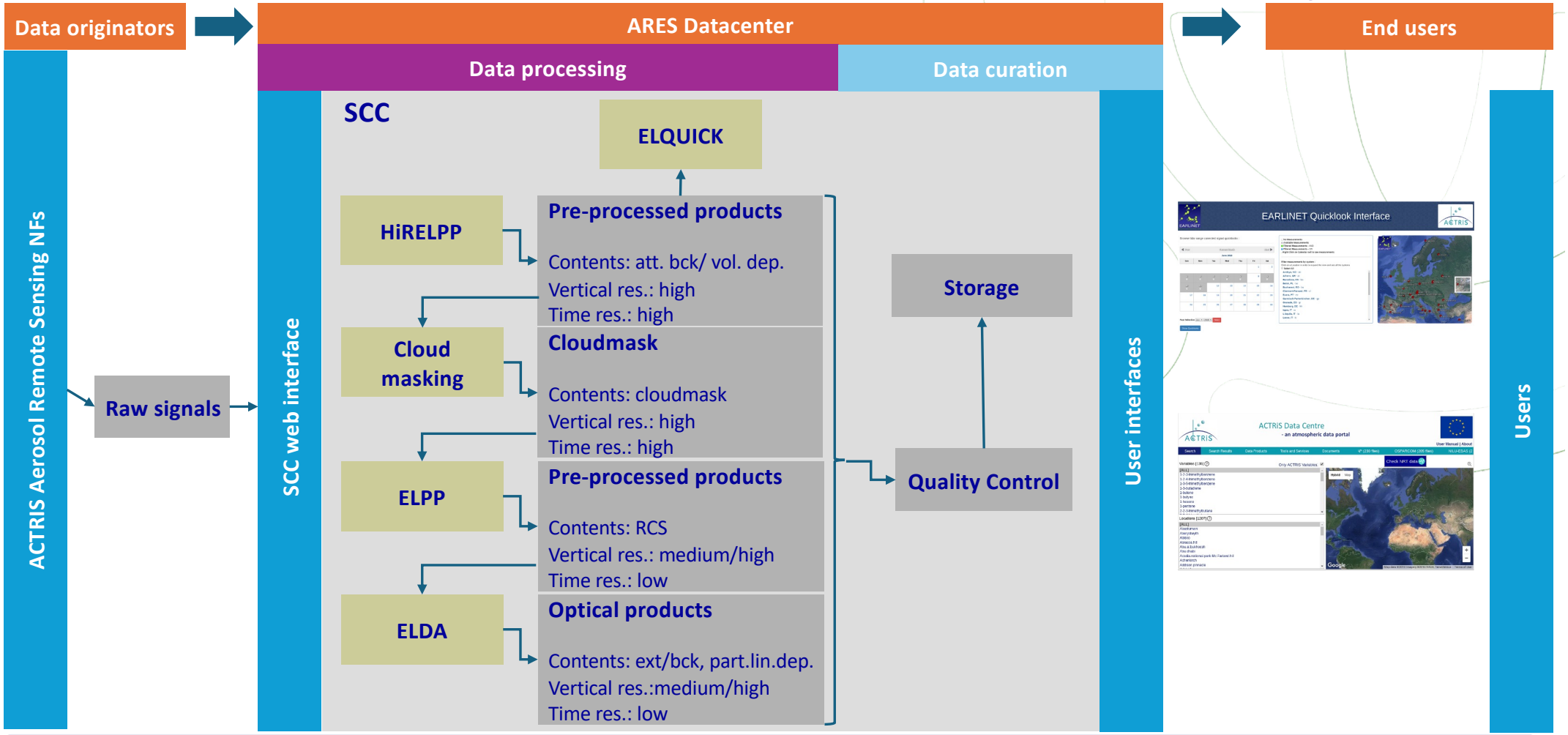
- Define quality control procedures to be applied on both hardware and software levels
- Several inter-comparison campaigns
- Definition of a standard format for all the data products including raw data (NetCDF, CF compliance)
- Development of an automatic and centralized processing chain (Single Calculus Chain - SCC)
- Storage of all the processing parameters in persistent way

- Long process: started on 2006 (EARLINET-ASOS) and still in progress in the framework of ACTRIS

SCC and ACTRIS Datacenter



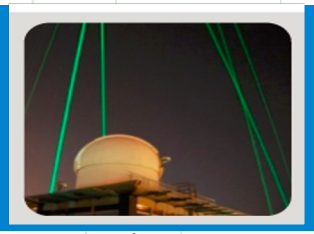
ACTRIS: ARES Datacenter Workflow



SCC and ACTRIS Datacenter

ACTRIS National Facilities

- Raman + depolarization lidars
- photometer



ARES (Data Centre)

- Data Curation and Standardization
- Quality Control
- Centralized Processing (SCC)

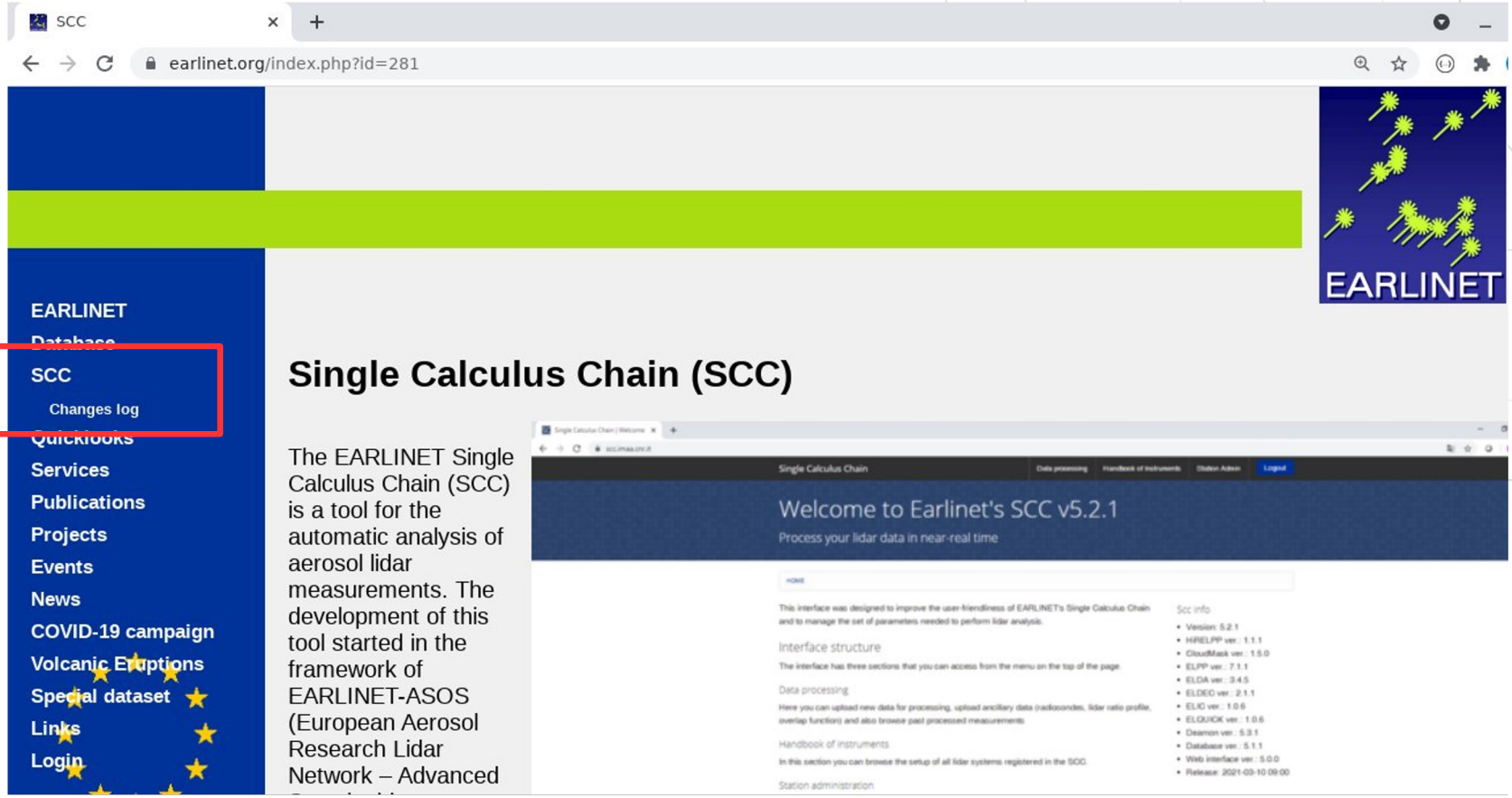
CARS (Topic Centre)

- Calibration
- Quality Assurance Tests
- Instrumental Characterization

End-Users / Stakeholders

Where to get info?

- EARLINET web site: https://www.earlinet.org



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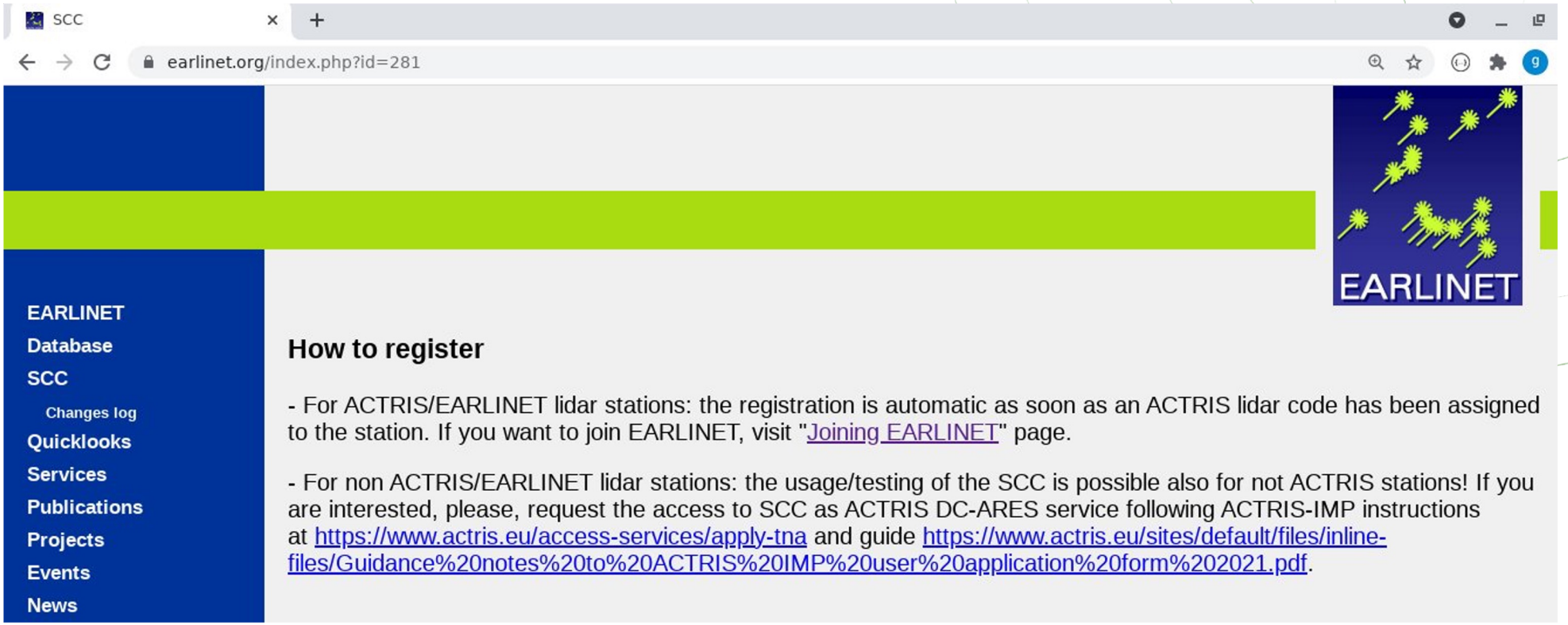

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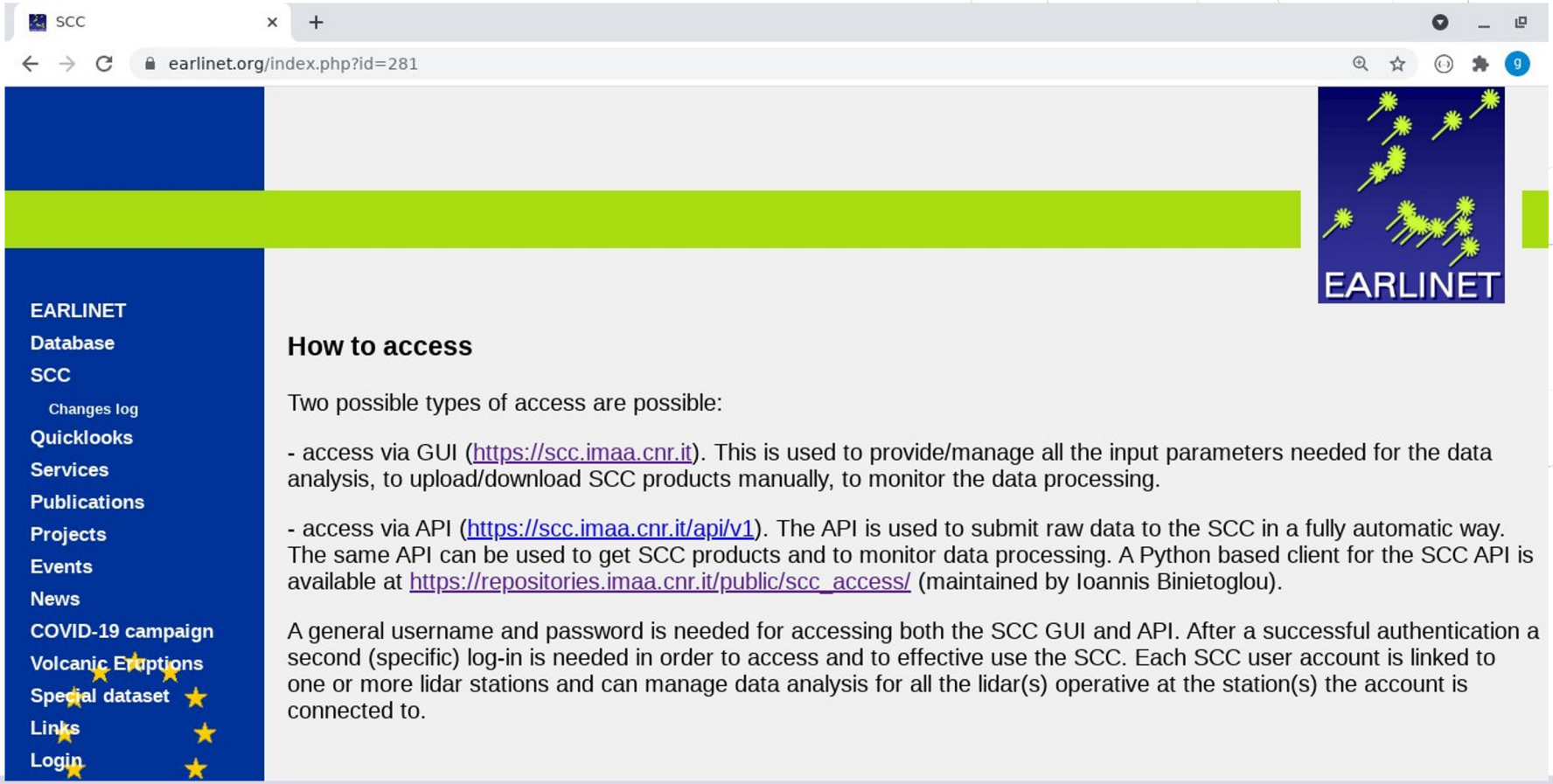
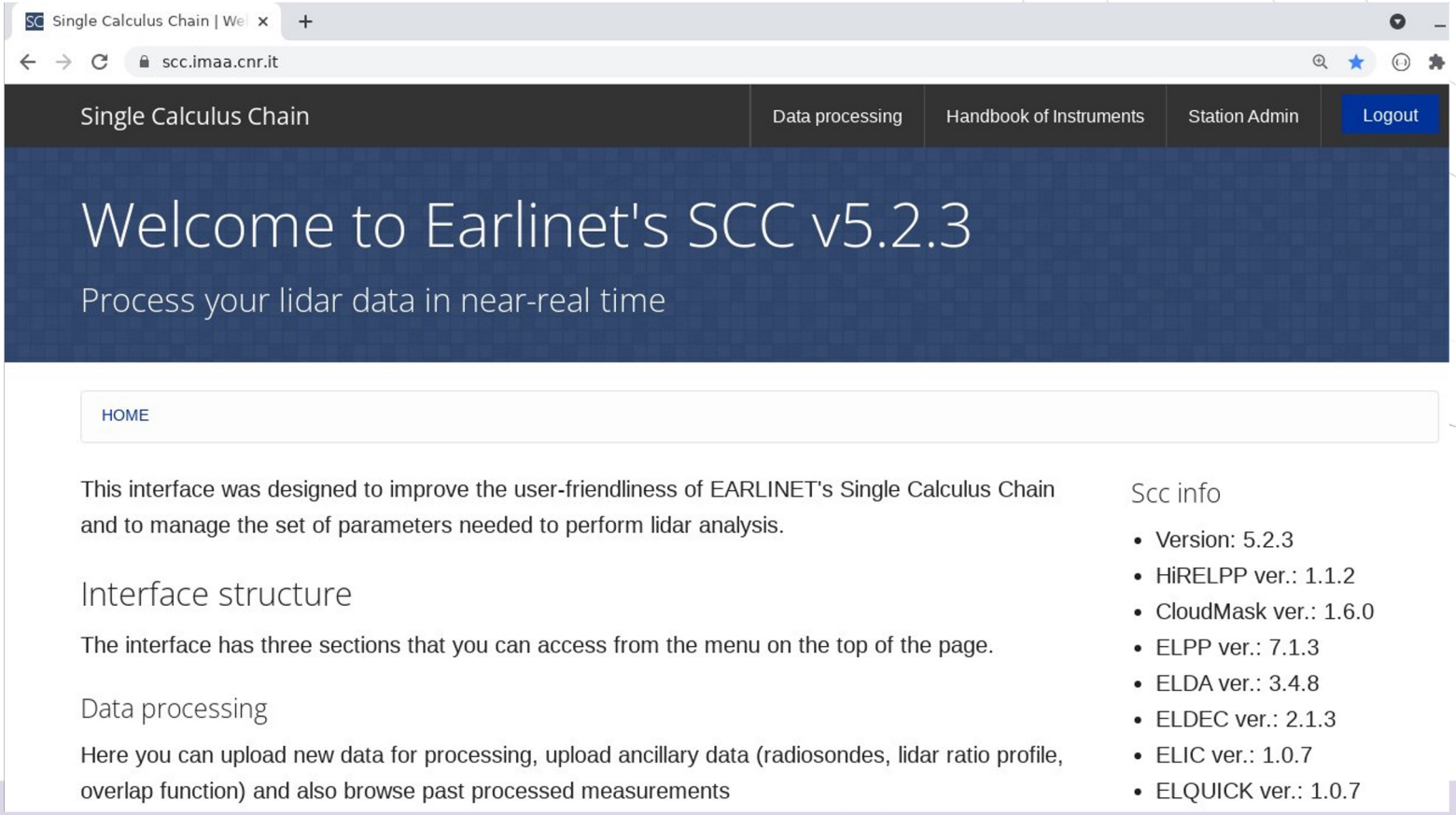


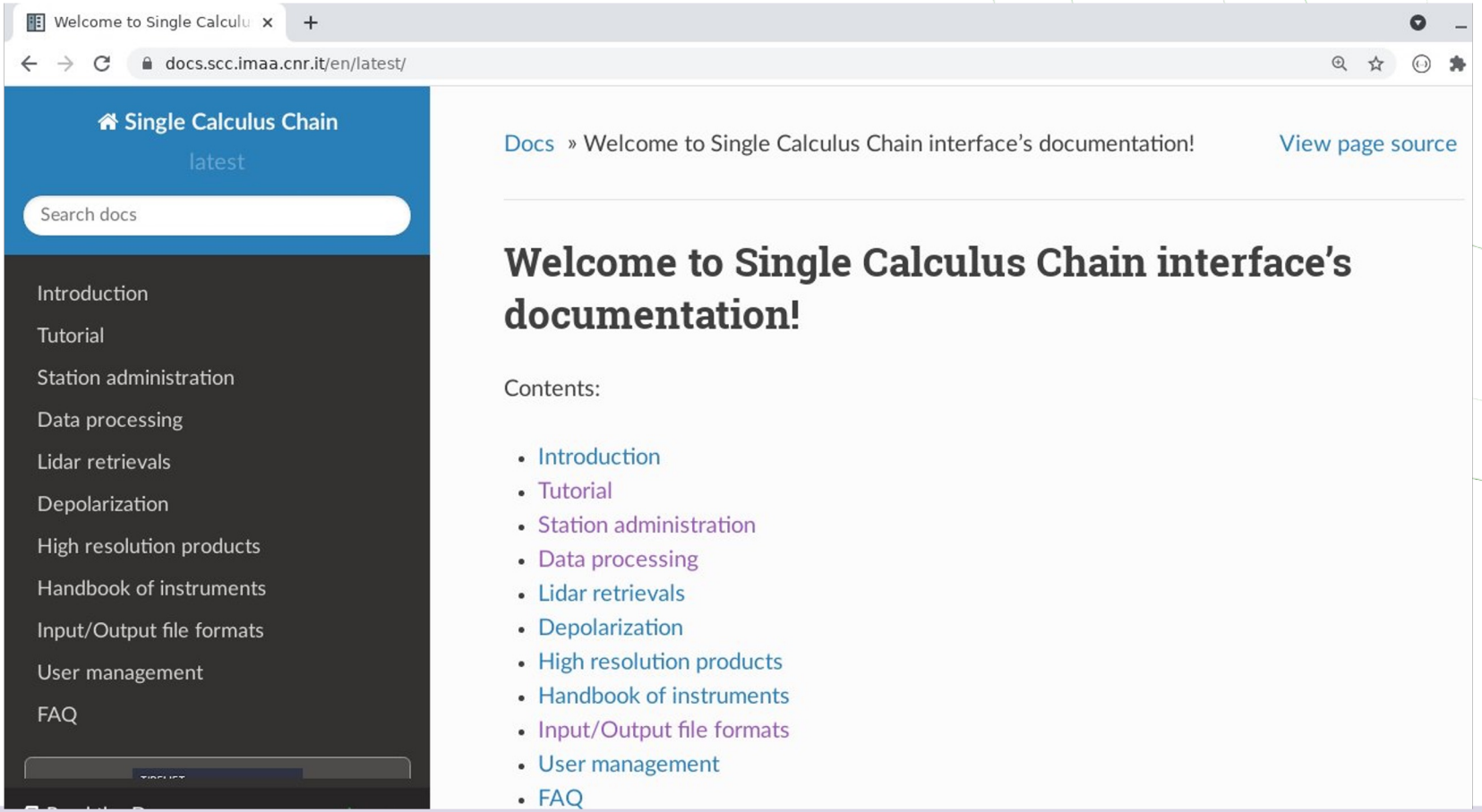
SCC access

- https://scc.imaa.cnr.it



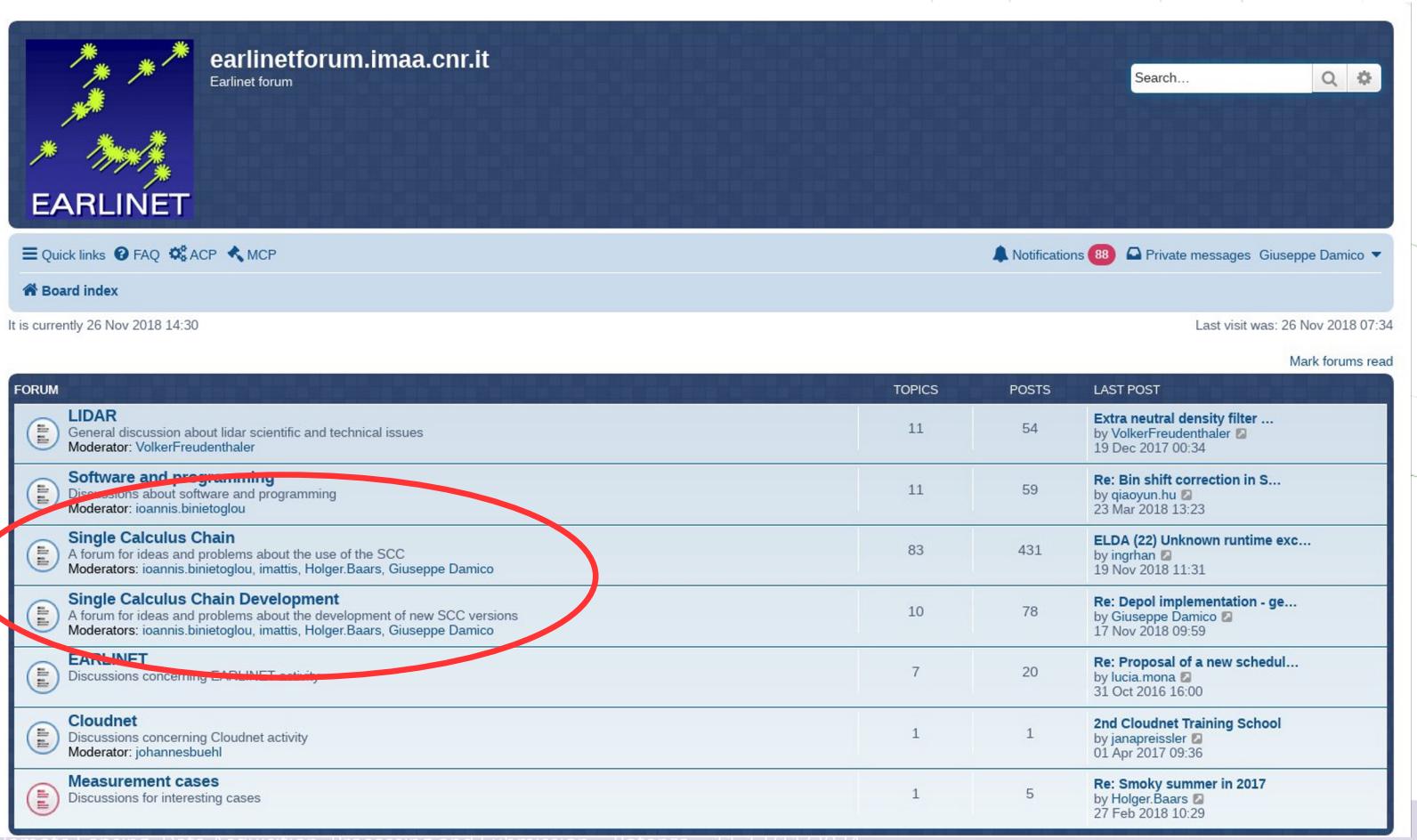
SCC documentation

- https://docs.scc.imaa.cnr.it



EARLINET forum

- https://earlinetforum.imaa.cnr.it



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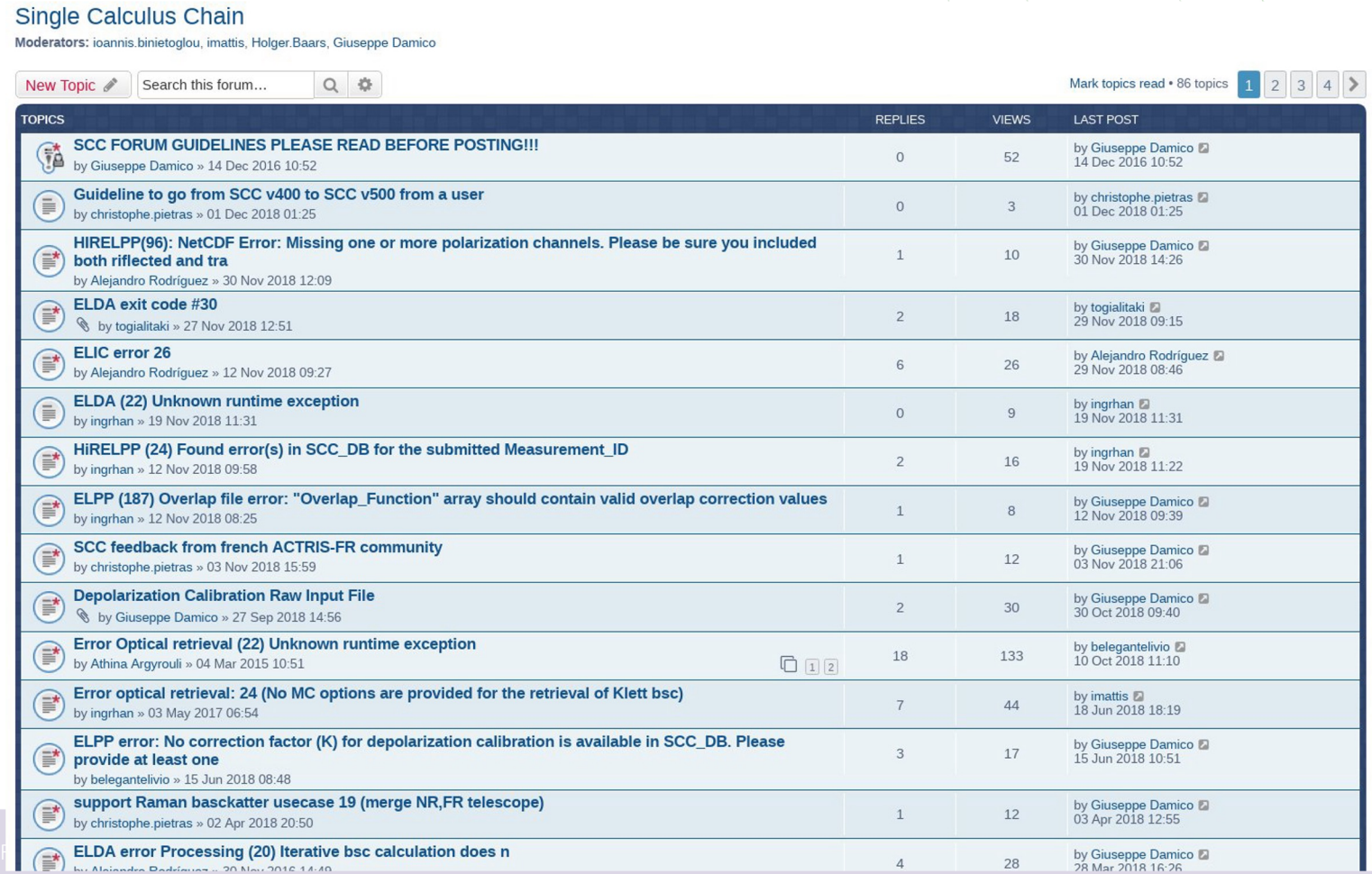

Single Calculus Chain

Moderators: ioannis.binietoglou, imattis, Holger.Baars, Giuseppe Damico

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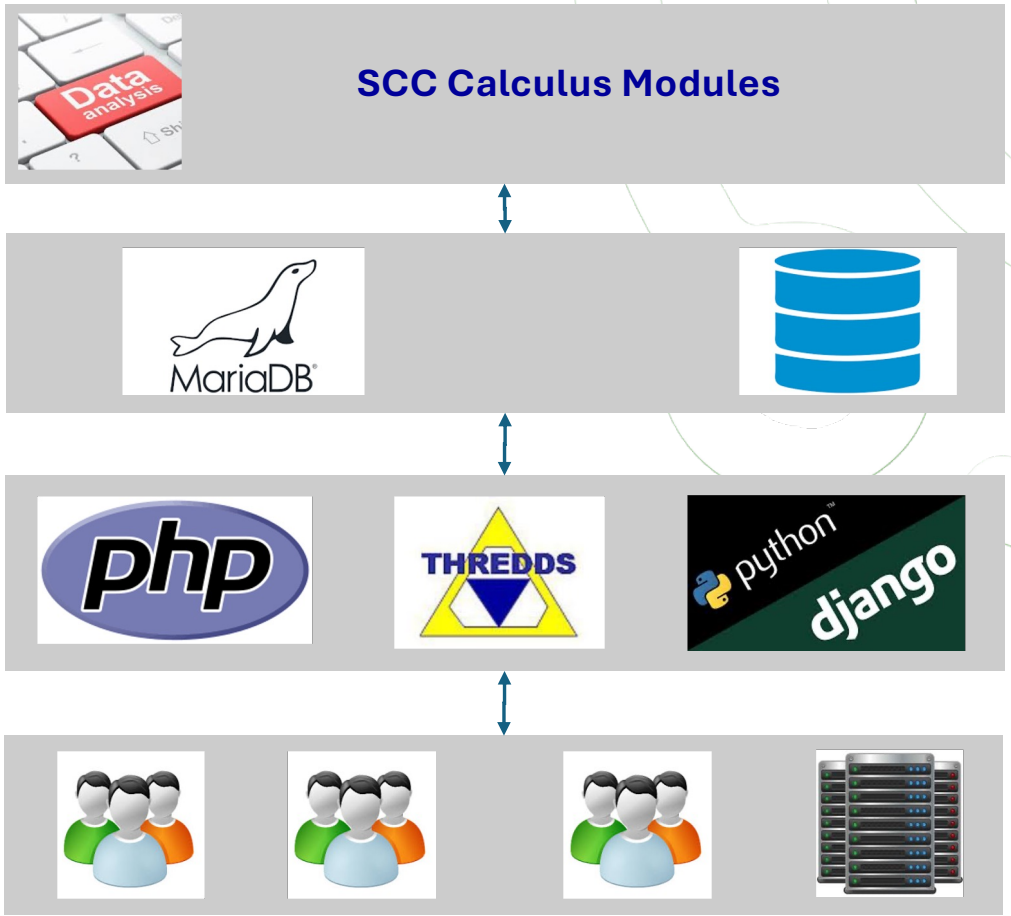
TOPICS	REPLIES	VIEWS	LAST POST
SCC FORUM GUIDELINES PLEASE READ BEFORE POSTING!!! by Giuseppe Damico » 14 Dec 2016 10:52	0	52	by Giuseppe Damico 14 Dec 2016 10:52
Guideline to go from SCC v400 to SCC v500 from a user by christophe.pietras » 01 Dec 2018 01:25	0	3	by christophe.pietras 01 Dec 2018 01:25
HIRELPP(96): NetCDF Error: Missing one or more polarization channels. Please be sure you included both riflected and tra by Alejandro Rodríguez » 30 Nov 2018 12:09	1	10	by Giuseppe Damico 30 Nov 2018 14:26
ELDA exit code #30 by togialitaki » 27 Nov 2018 12:51	2	18	by togialitaki 29 Nov 2018 09:15
ELIC error 26 by Alejandro Rodríguez » 12 Nov 2018 09:27	6	26	by Alejandro Rodríguez 29 Nov 2018 08:46
ELDA (22) Unknown runtime exception by ingrhan » 19 Nov 2018 11:31	0	9	by ingrhan 19 Nov 2018 11:31
HiRELPP (24) Found error(s) in SCC_DB for the submitted Measurement_ID by ingrhan » 12 Nov 2018 09:58	2	16	by ingrhan 19 Nov 2018 11:22
ELPP (187) Overlap file error: "Overlap_Function" array should contain valid overlap correction values by ingrhan » 12 Nov 2018 08:25	1	8	by Giuseppe Damico 12 Nov 2018 09:39
SCC feedback from french ACTRIS-FR community by christophe.pietras » 03 Nov 2018 15:59	1	12	by Giuseppe Damico 03 Nov 2018 21:06
Depolarization Calibration Raw Input File by Giuseppe Damico » 27 Sep 2018 14:56	2	30	by Giuseppe Damico 30 Oct 2018 09:40
Error Optical retrieval (22) Unknown runtime exception by Athina Argyrouli » 04 Mar 2015 10:51 1 2	18	133	by belegantelivio 10 Oct 2018 11:10
Error optical retrieval: 24 (No MC options are provided for the retrieval of Klett bsc) by ingrhan » 03 May 2017 06:54	7	44	by imattis 18 Jun 2018 18:19
ELPP error: No correction factor (K) for depolarization calibration is available in SCC_DB. Please provide at least one by belegantelivio » 15 Jun 2018 08:48	3	17	by Giuseppe Damico 15 Jun 2018 10:51
support Raman basckatter usecase 19 (merge NR,FR telescope) by christophe.pietras » 02 Apr 2018 20:50	1	12	by Giuseppe Damico 03 Apr 2018 12:55
ELDA error Processing (20) Iterative bsc calculation does n	4	28	by Giuseppe Damico 28 Mar 2018 16:26

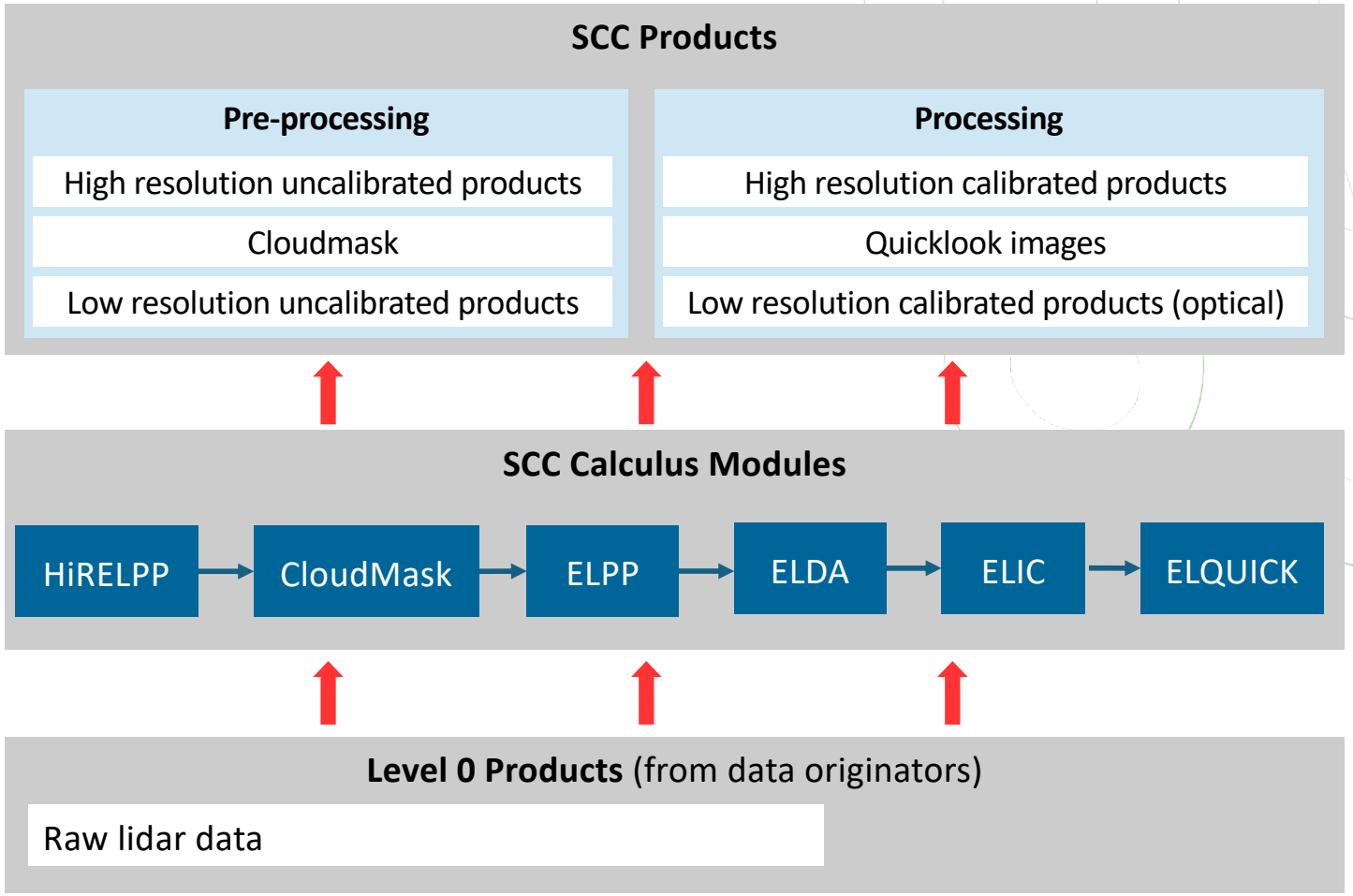
Bug reporting system

- https://bugzilla.imaa.cnr.it

SCC main structure



SCC main structure



Latest SCC release

SCC v5.2.9

- Released on 4th June 2024
- ELPP v7.1.3 — Earlinet Lidar Pre-Processor
- ELDEC v2.1.4 — Earlinet Lidar DEpolarization Calibrator
- ELDA v3.4.8.1 — Earlinet Lidar Data Analyzer
- SCC web interface v5.1.1
- HiRELPP v1.1.5 — High Resolution ELPP
- CloudMask v1.6.0
- ELIC v1.0.8 — Earlinet LIdar Calibrator
- ELQUICK v1.0.7 — Earlinet Lidar QUICKlook

SCC: contact points

- New station registration request
- New SCC accounts request
- Support for any technical problems (for example permission or log-in issues,…)

  earlinetdb@actris.imaa.cnr.it

- Do you want to collaborate on SCC project (as developer and/or tester)

  giuseppe.damico@imaa.cnr.it

SCC: steps to go!

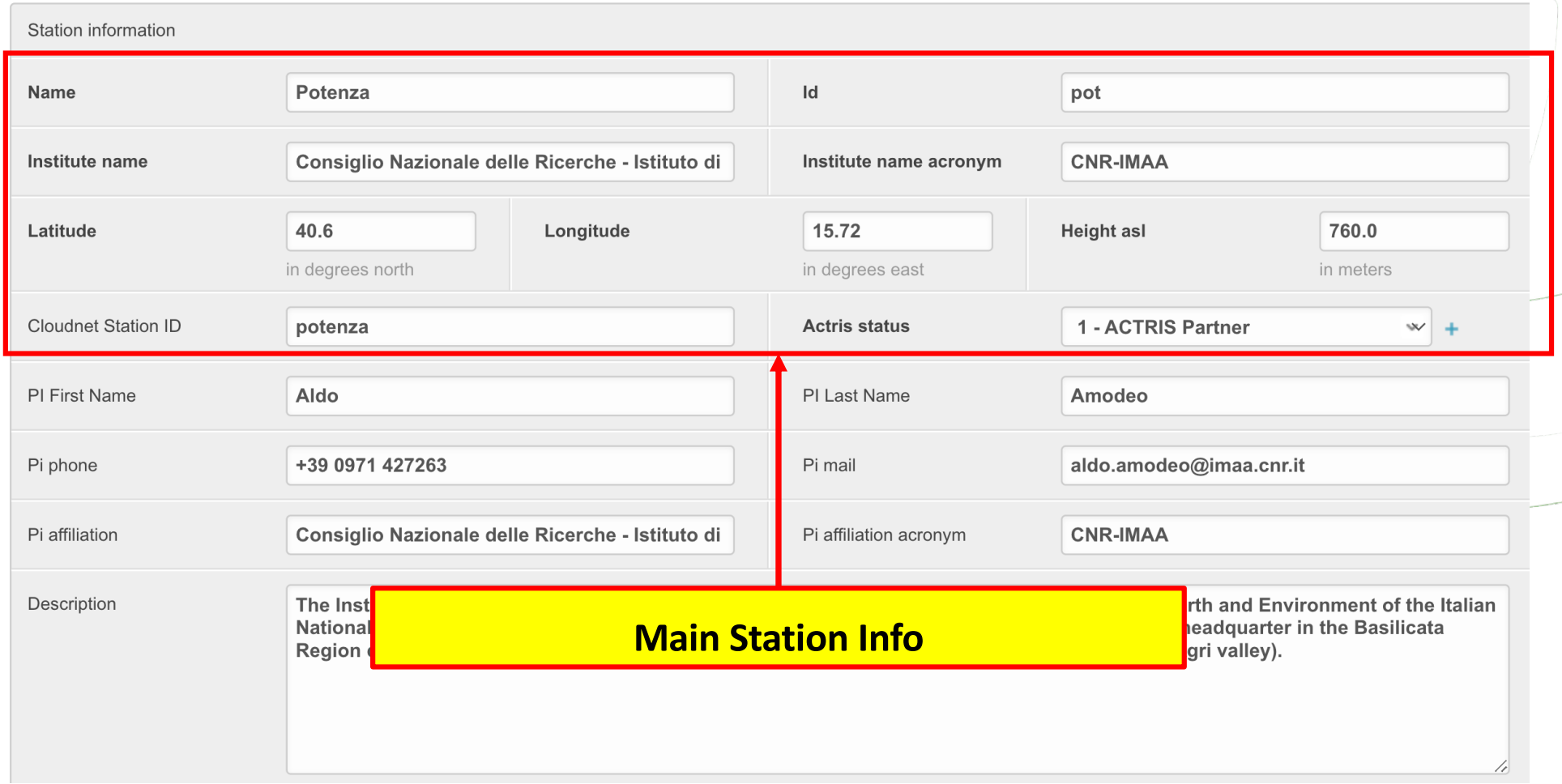
1. Station registration
2. SCC account(s)
3. Log in
4. Lidar(s) registration
5. Convert raw data in SCC format
6. Submit raw data
7. Get calculated products

SCC: Station registration (Step 1/7)

Station information

Name	Potenza	**Id**	pot		
Institute name	Consiglio Nazionale delle Ricerche - Istituto di	**Institute name acronym**	CNR-IMAA		
Latitude	40.6 in degrees north	**Longitude**	15.72 in degrees east	**Height asl**	760.0 in meters
Cloudnet Station ID	potenza	**Actris status**	1 - ACTRIS Partner +		
PI First Name	Aldo	PI Last Name	Amodeo		
Pi phone	+39 0971 427263	Pi mail	aldo.amodeo@imaa.cnr.it		
Pi affiliation	Consiglio Nazionale delle Ricerche - Istituto di	Pi affiliation acronym	CNR-IMAA		
Description	The Institute of Methodologies for Environmental Analysis (IMAA) is part of the Department of Earth and Environment of the Italian National Research Council (CNR). To-date IMAA is the only institute of the CNR network with its headquarter in the Basilicata Region consisting of aResearch Area in Potenza and a Research Laboratory in Marsico Nuovo, Agri valley).				

SCC: Station registration (Step 1/7)



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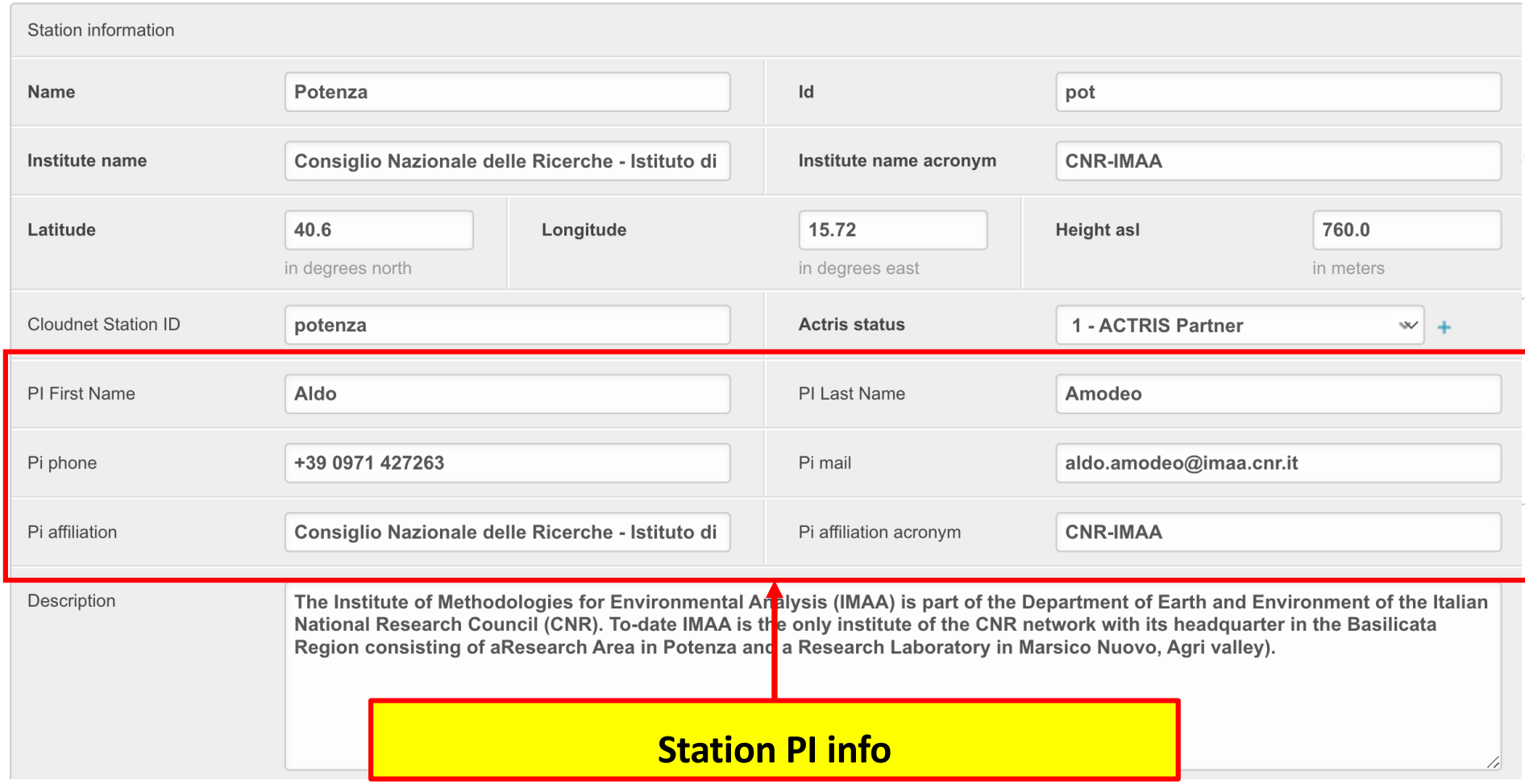
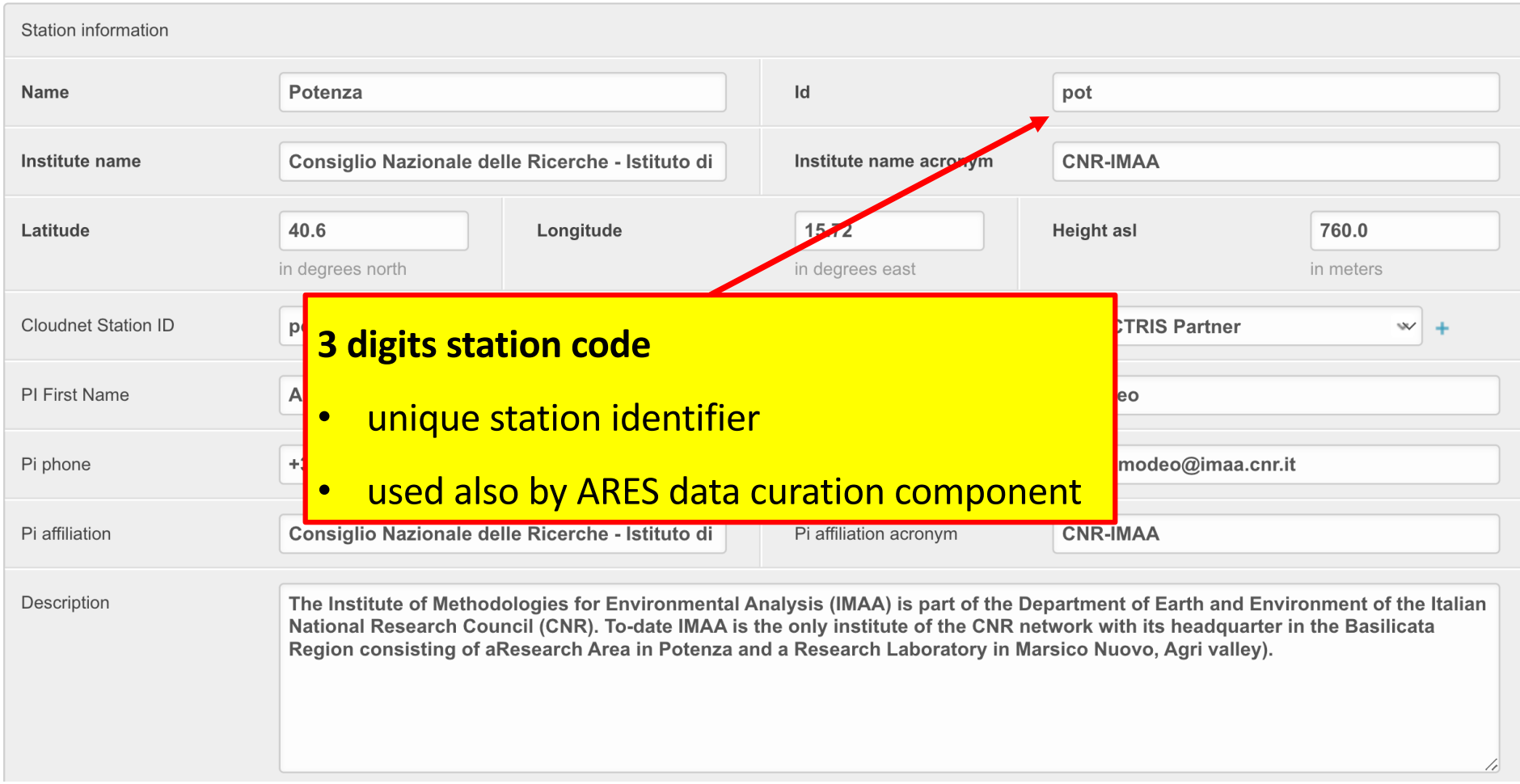


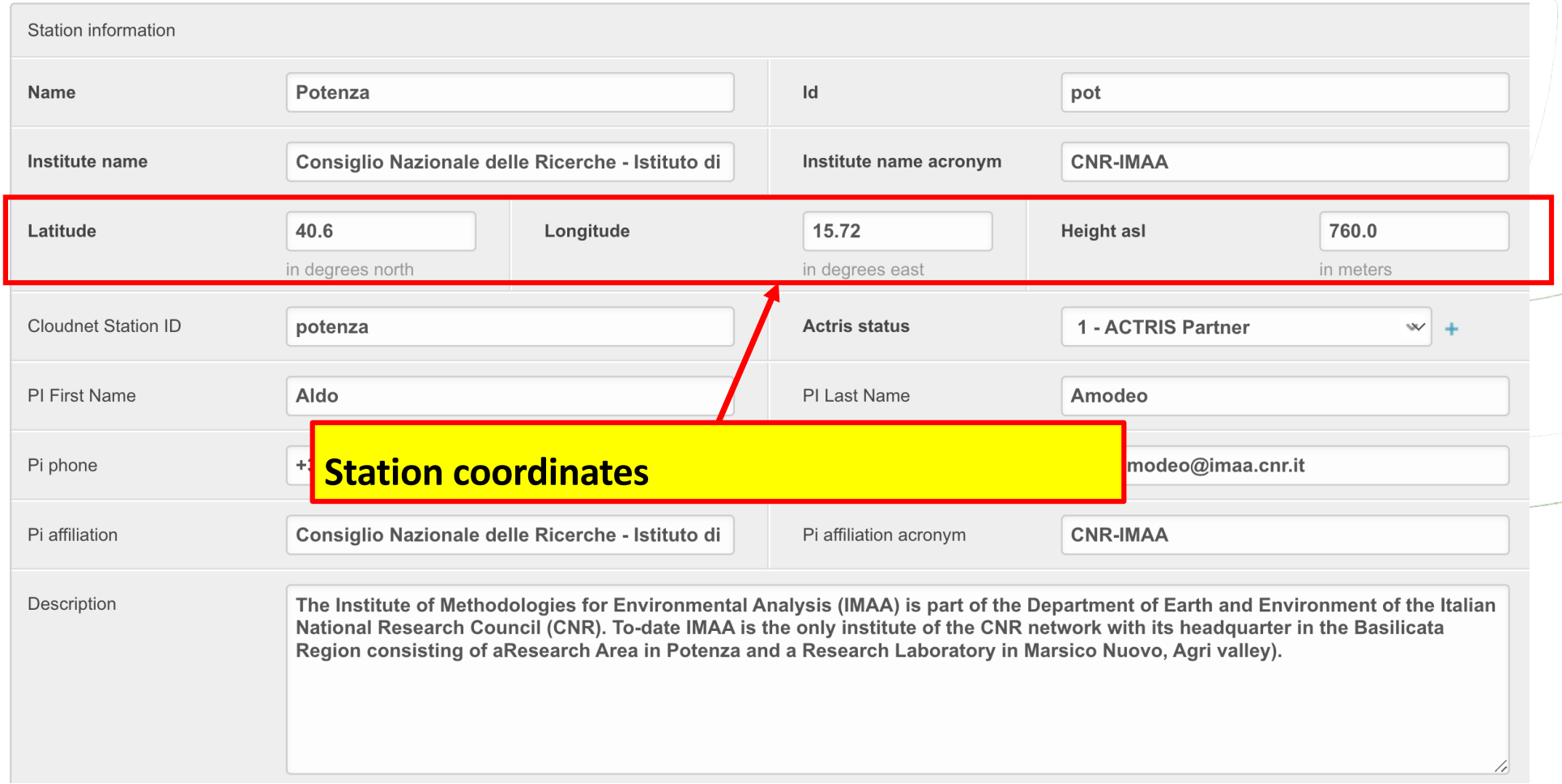
SCC: Station registration (Step 1/7)



3 digits station code

- unique station identifier
- used also by ARES data curation component

SCC: Station registration (Step 1/7)



SCC: Station registration (Step 1/7)

How to request station registration (for ACTRIS NFs only)?

- Station PI (or a deputy) should send a request by e-mail (preferably by her/his institutional mail address) to:

  earlinetdb@actris.imaa.cnr.it

- Once the request has been processed the PI will be contacted and asked to provide the info needed for the registration
- Finally, the PI will be notified (by e-mail) when the station registration is concluded

SCC: Account registration (Step 2/7)

Username	**test_user** Required. 150 characters or fewer. Letters, digits and @/./+/-/_ only.
Password	**algorithm**: pbkdf2_sha256 **iterations**: 30000 **salt**: rpIgeO****** **hash**: on+UO/********** Raw passwords are not stored, so there is no way to see this user's password, but you can change the password using this form.

Personal info

First name	
Last name	
Email address	

Permissions

	☑ Active Designates whether this user should be treated as active. Unselect this instead of deleting accounts.
	☑ Staff status Designates whether the user can log into this admin site.

SCC: Account registration (Step 2/7)

How to request new SCC account?

- Station PI (or a deputy) should send a request (specifying the his/her station code) by e-mail to:

  earlinetdb@actris.imaa.cnr.it

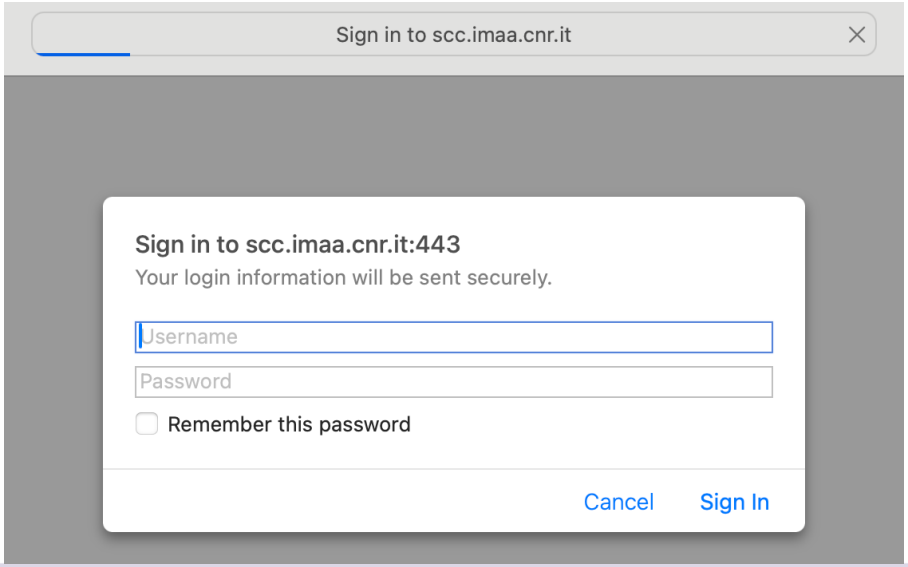
- Once the request has been processed the PI will be contacted and asked to provide the info needed for the registration
- Finally, the account owner will be notified (by e-mail) when the new account has been created

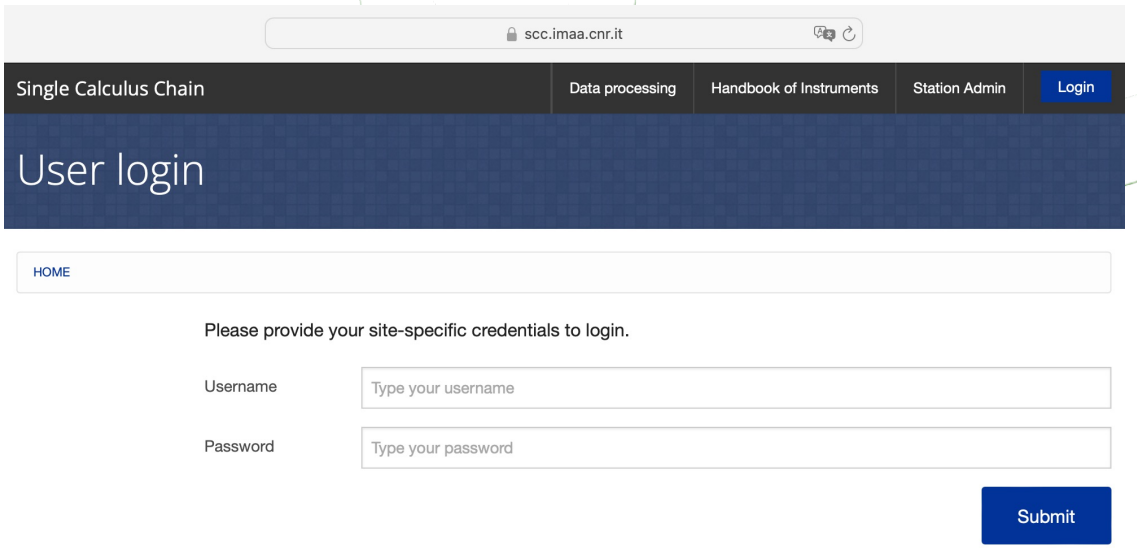
SCC: Log in (Step 3/7)

Entry point: https://scc.imaa.cnr.it

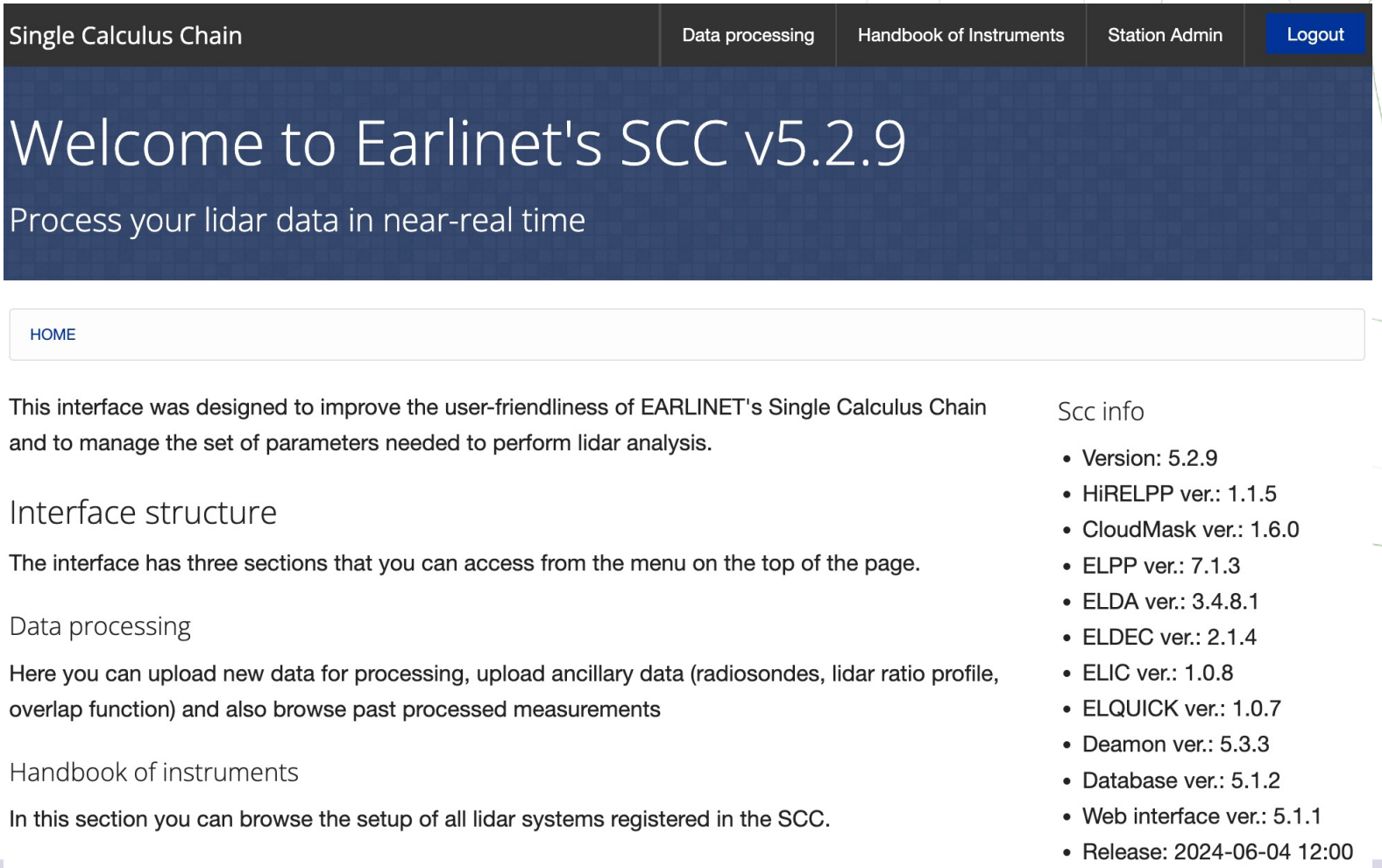
Two levels authentication

1. Https authentication
2. Web interface authentication

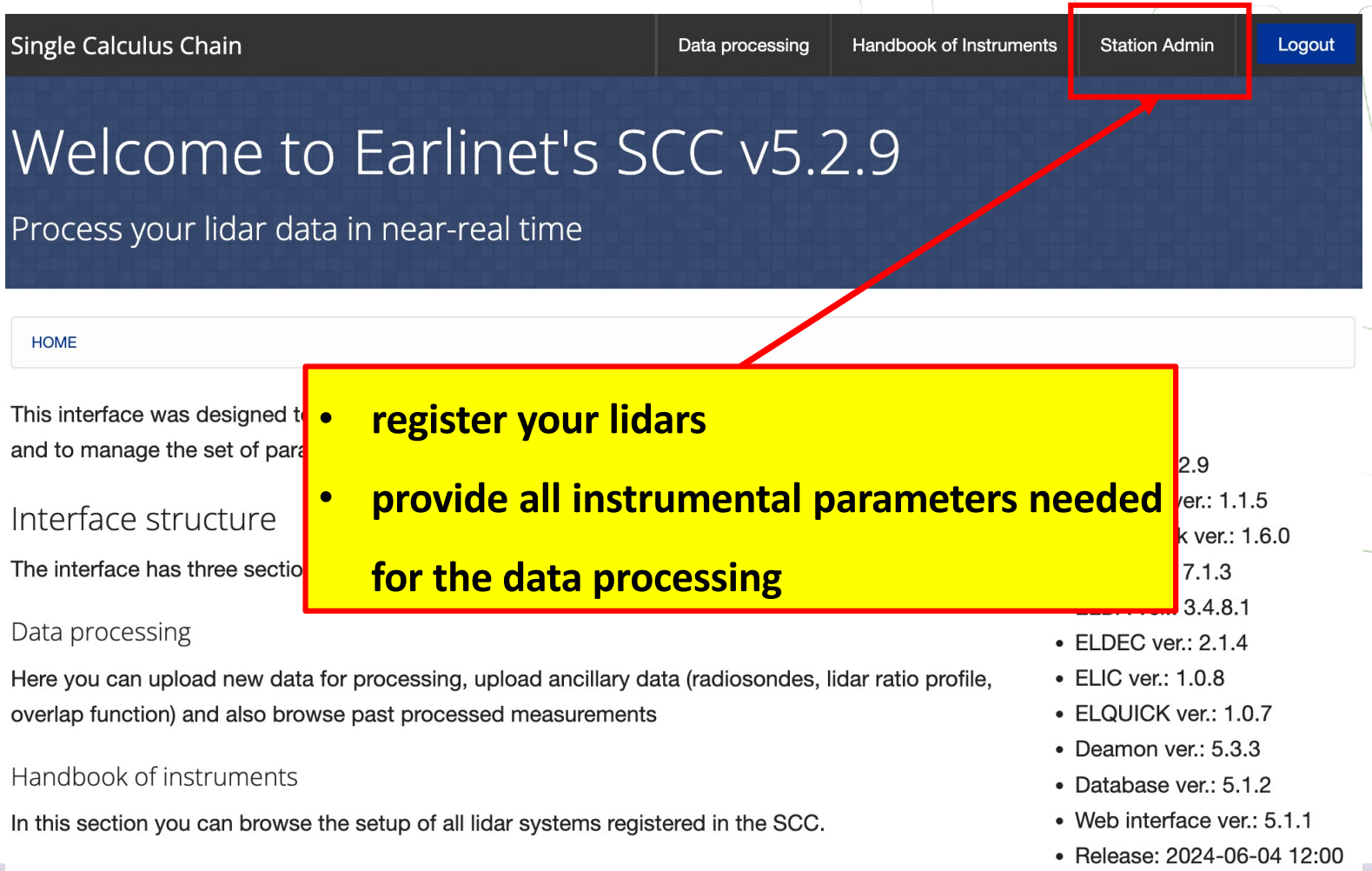




SCC: Log in (Step 3/7)

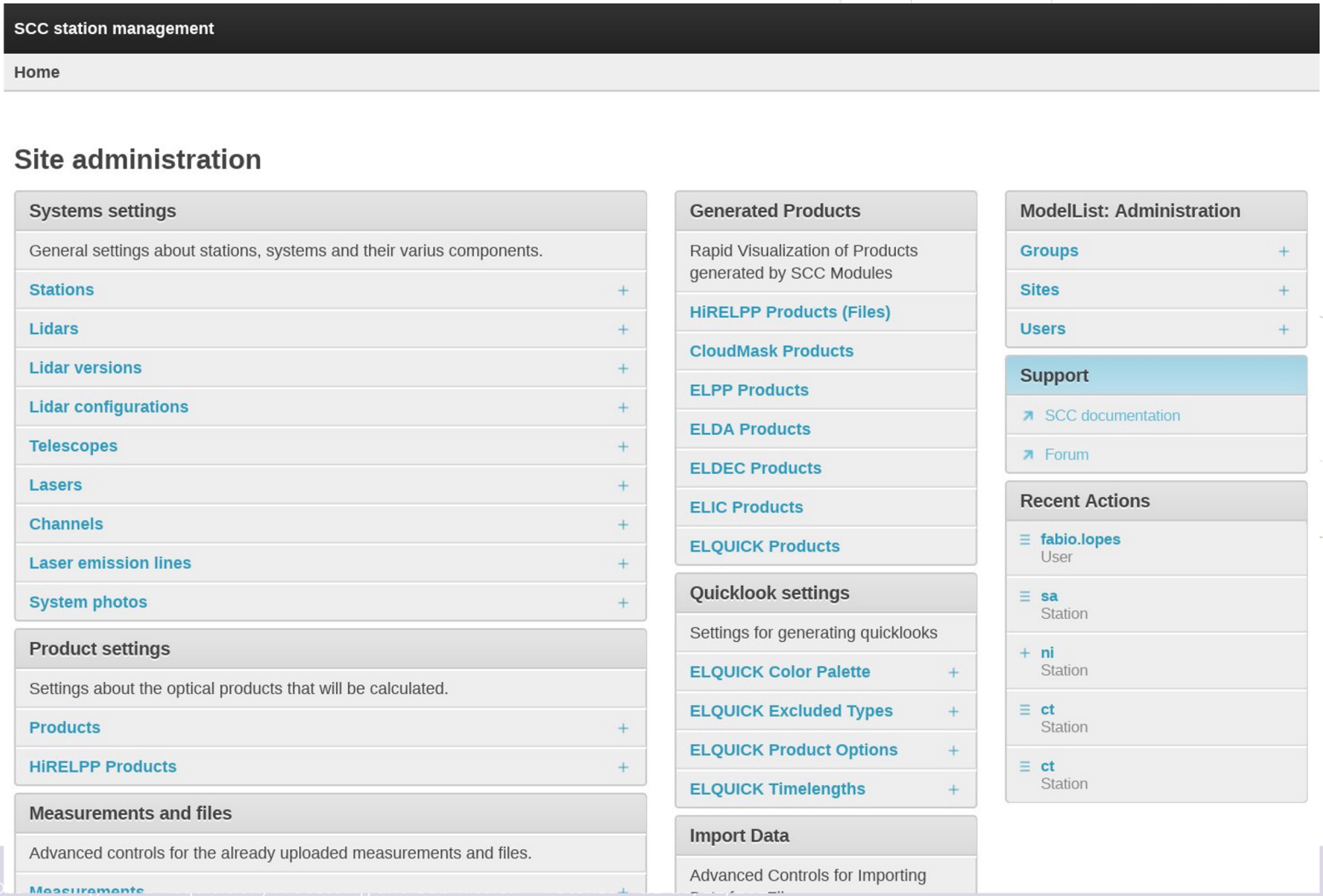


SCC: Lidar(s) registration (Step 4/7)



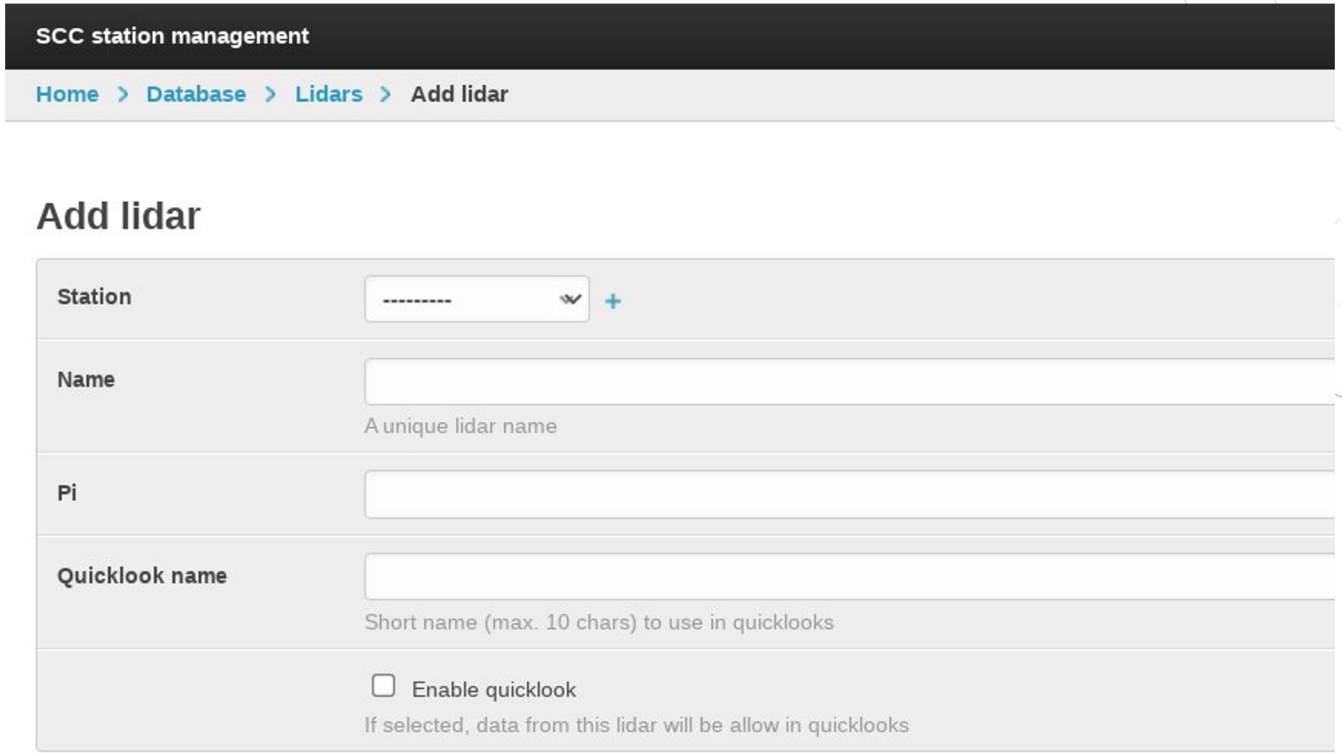
- **register your lidars**
- **provide all instrumental parameters needed for the data processing**

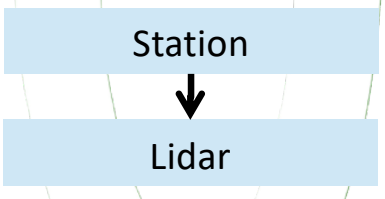
SCC: Lidar(s) registration (Step 4/7)



SCC: Lidar(s) registration (Step 4/7)

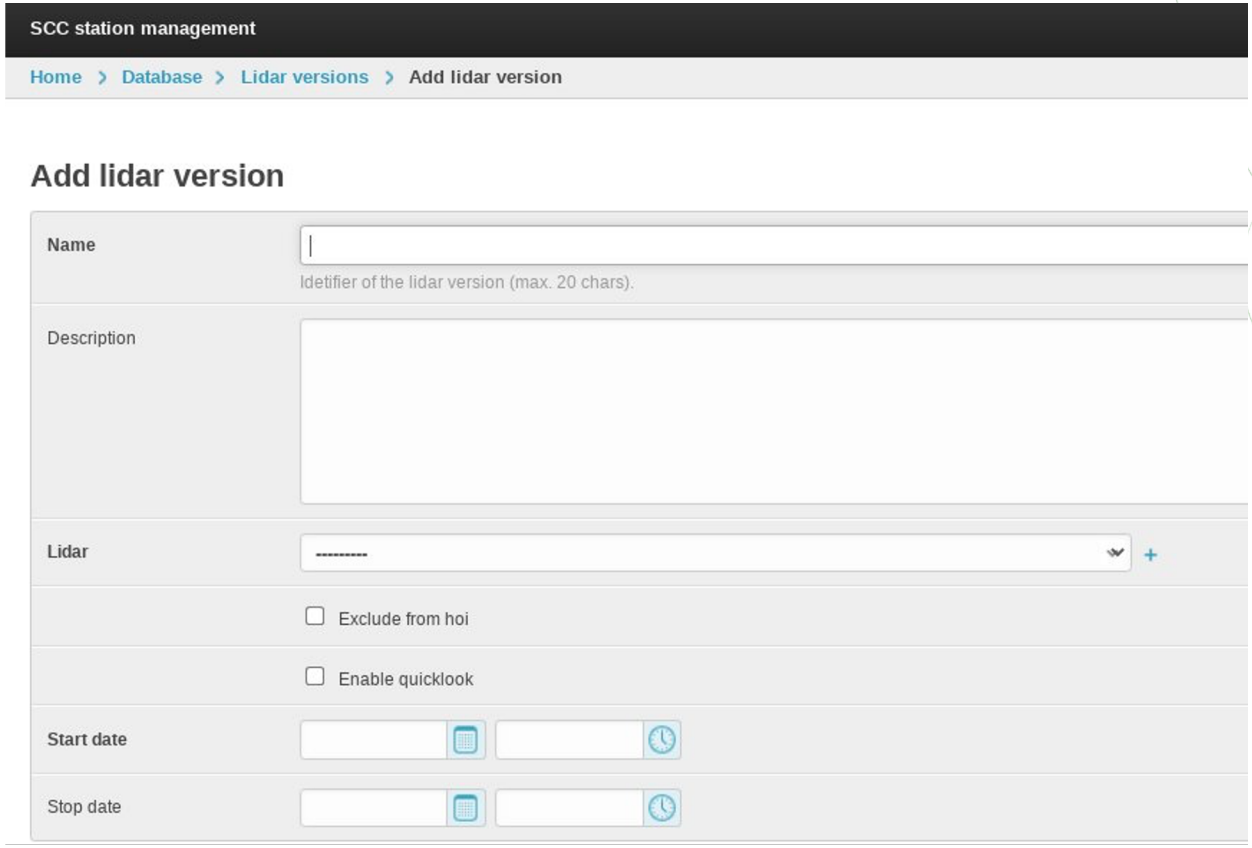
1) Lidar definition

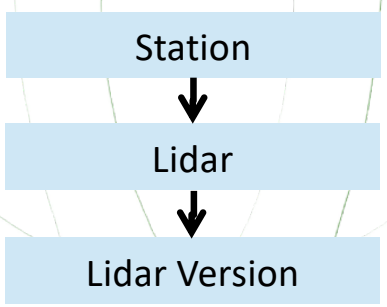




SCC: Lidar(s) registration (Step 4/7)

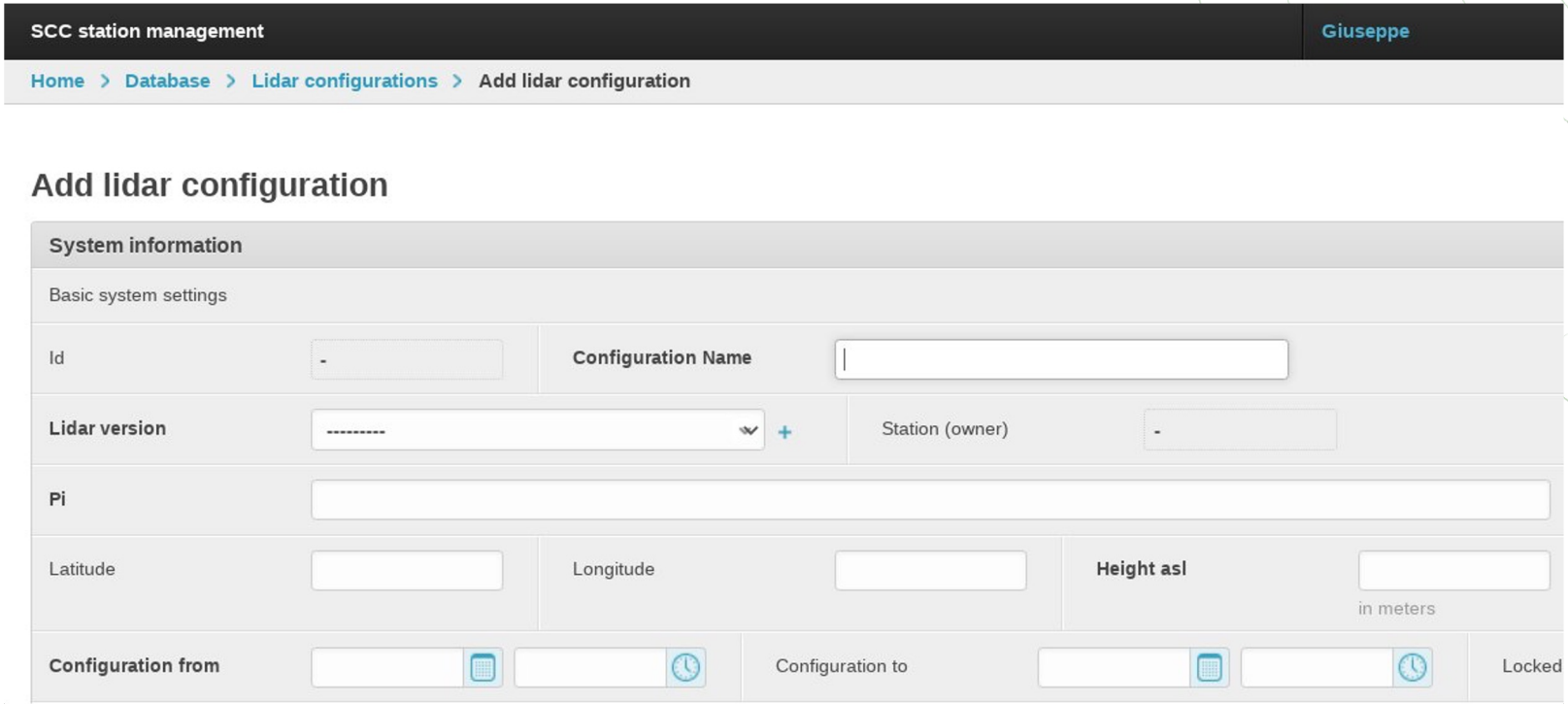
2) Lidar Version definition

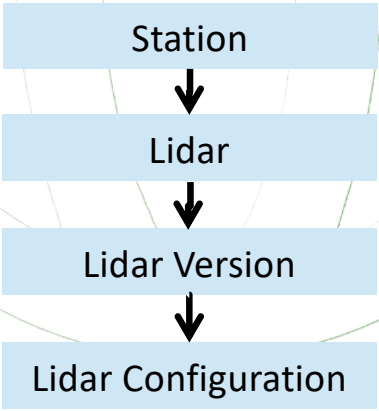




SCC: Lidar(s) registration (Step 4/7)

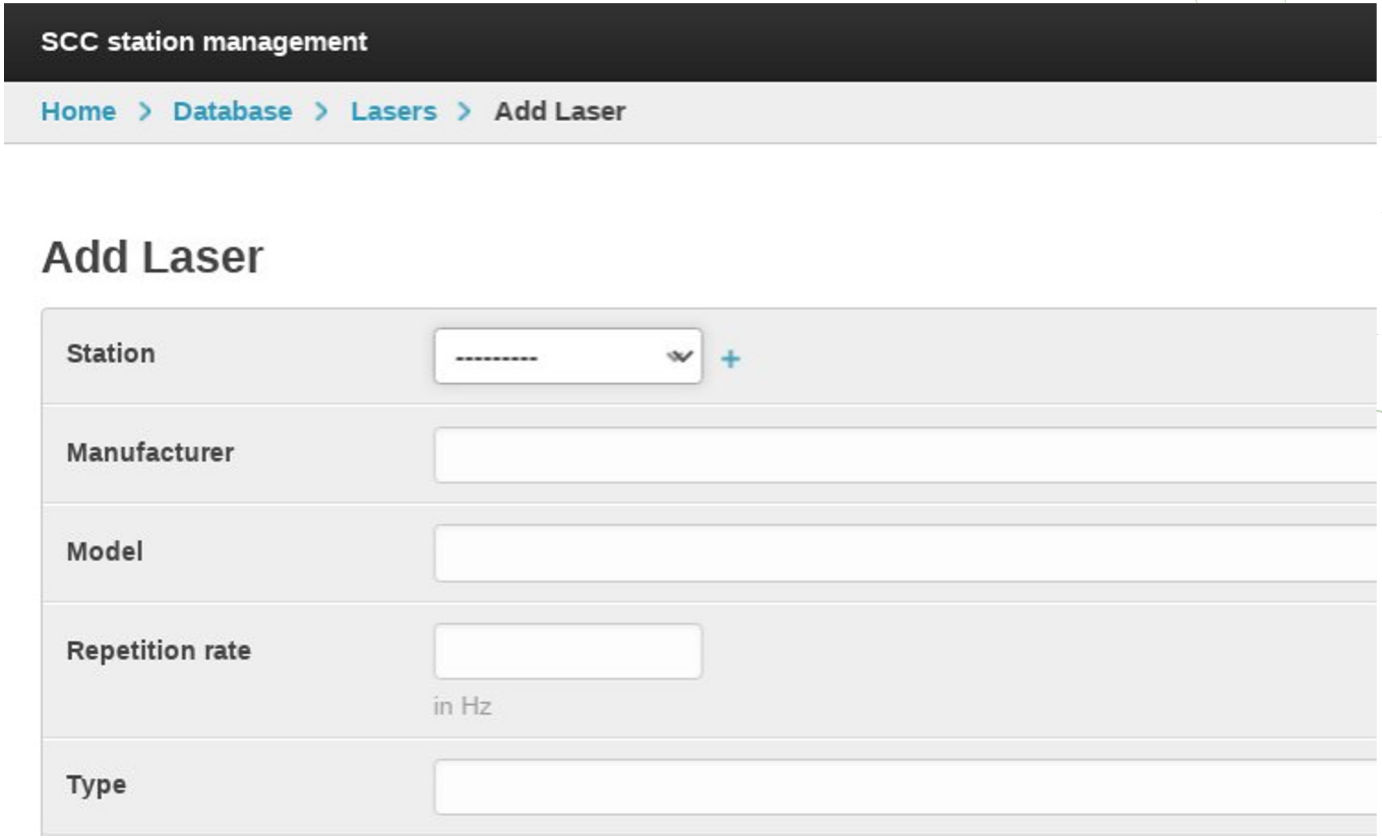
3) Lidar Configuration definition

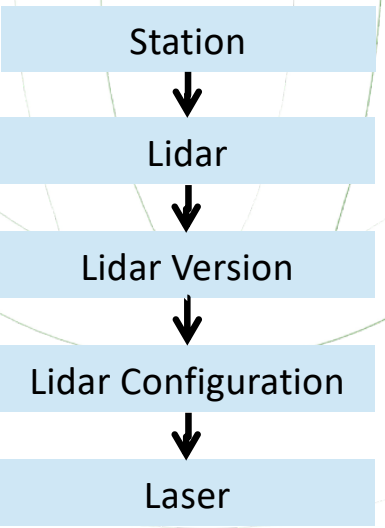




SCC: Lidar(s) registration (Step 4/7)

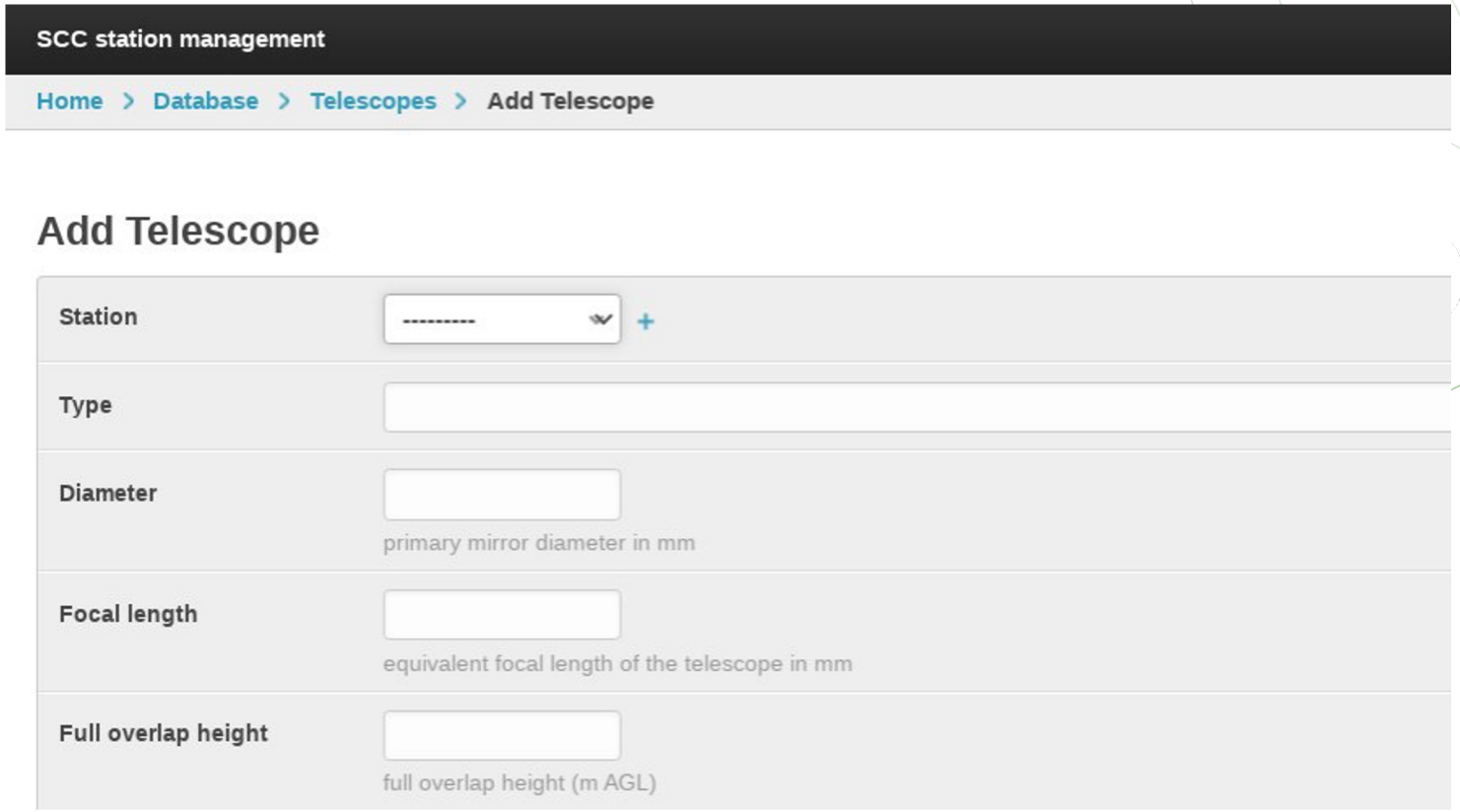
4) Laser(s) definition





SCC: Lidar(s) registration (Step 4/7)

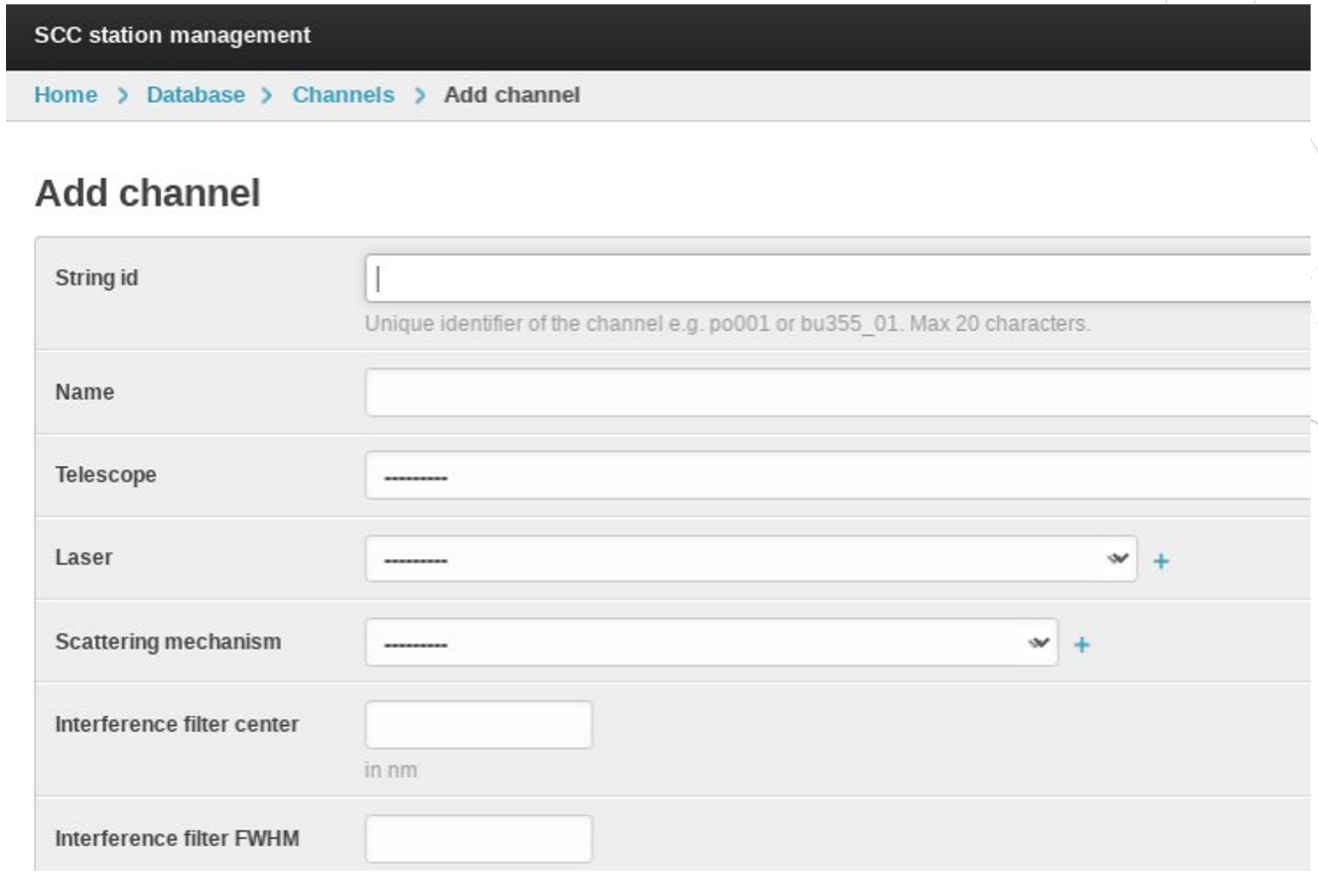
5) Telescope(s) definition



Station
↓
Lidar
↓
Lidar Version
↓
Lidar Configuration
↓
Laser
Telescope

SCC: Lidar(s) registration (Step 4/7)

6) Lidar Channels definition



Station
↓
Lidar
↓
Lidar Version
↓
Lidar Configuration
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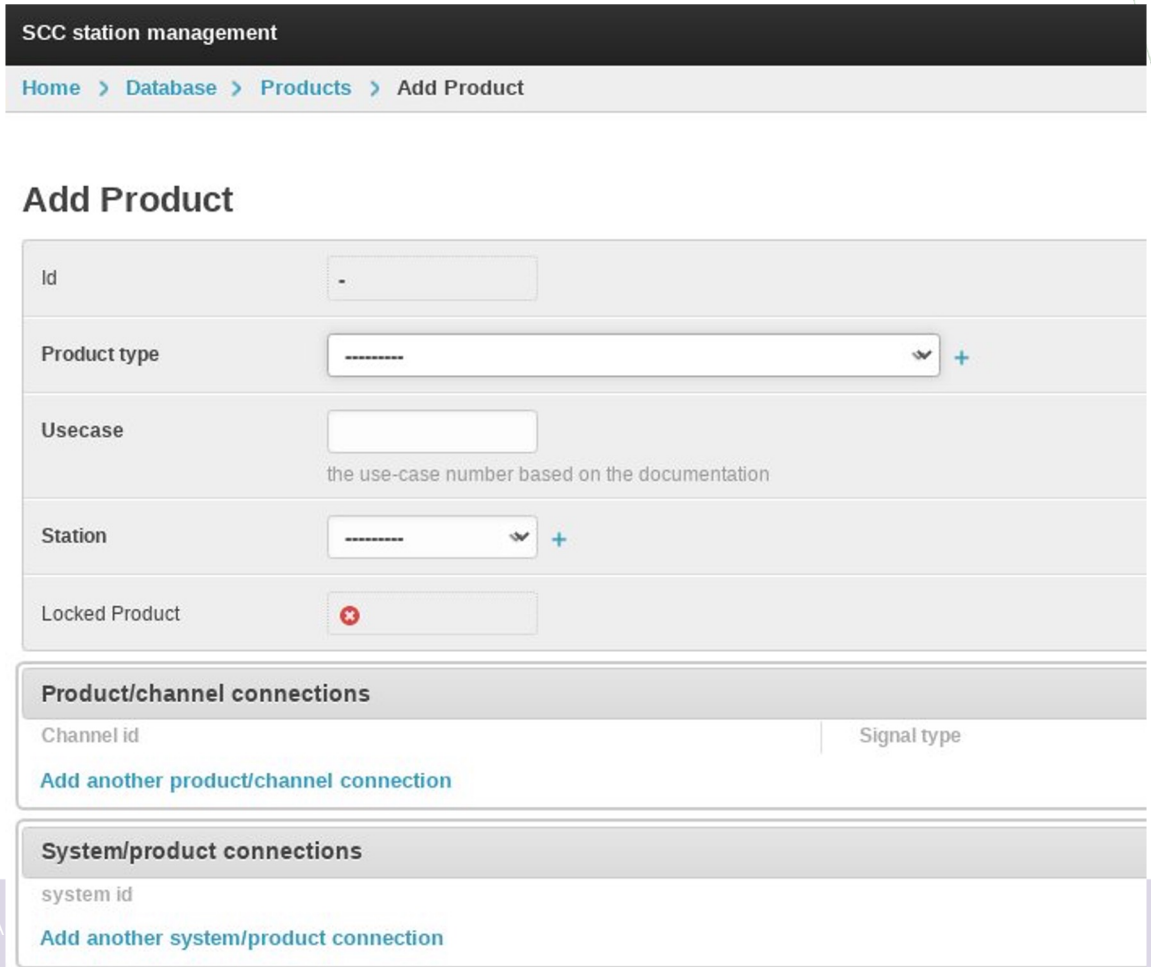
Laser
Telescope
Channels

SCC: Lidar(s) registration (Step 4/7)

7.a) Optical Products definition



Station
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Lidar
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Lidar Version
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Lidar Configuration
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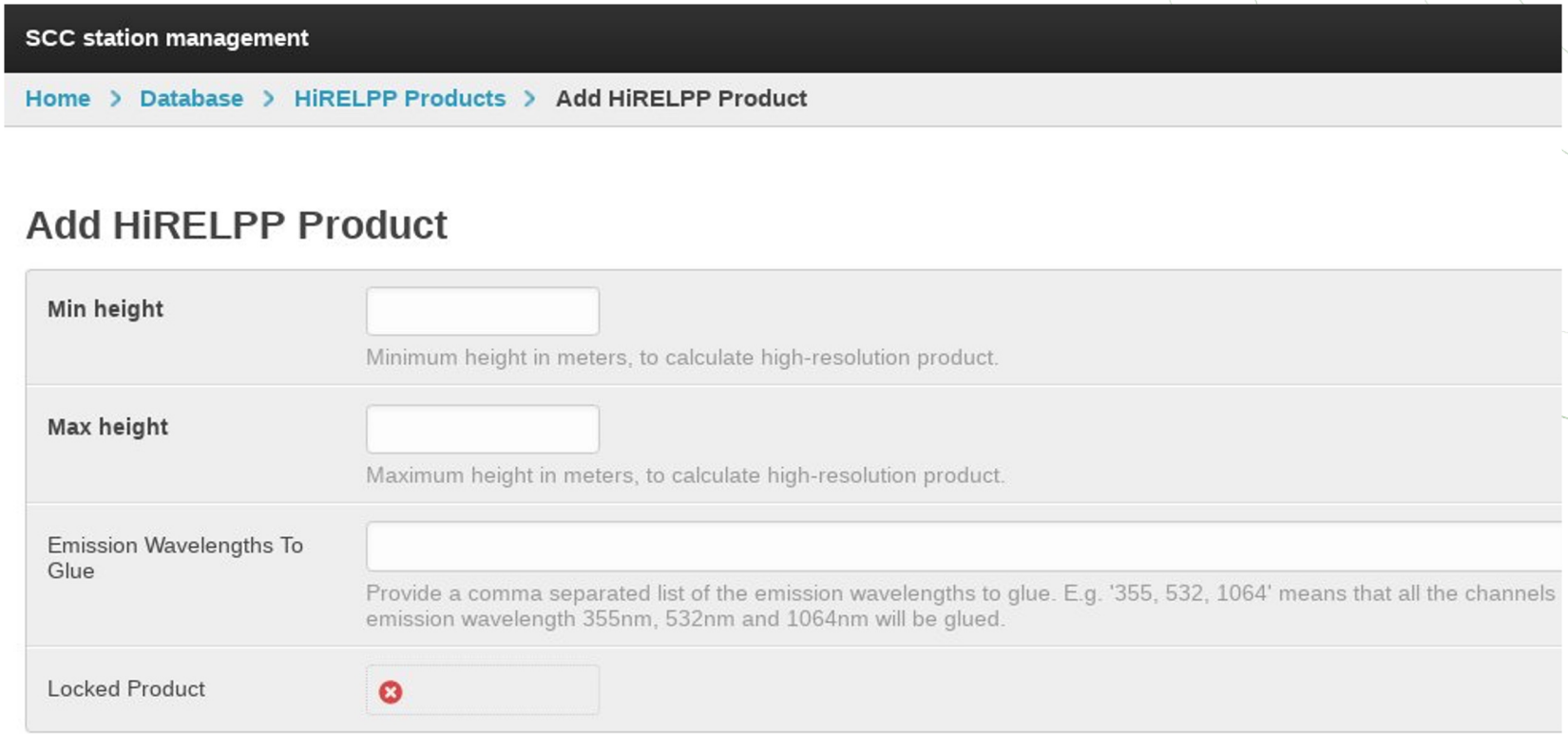
Laser
Telescope
Channels
Products

SCC: Lidar(s) registration (Step 4/7)

7.b) High Resolution Products definition



Station
↓
Lidar
↓
Lidar Version
↓
Lidar Configuration
↓
Laser
Telescope
Channels
Products

SCC: Convert raw data into SCC format (Step 5/7)

In order to use the SCC raw lidar data need to be converted from native format to SCC input NetCDF format

- the conversion is under station responsibility
- detailed description of SCC input NetCDF data file is available in SCC documentation

(https://docs.scc.imaa.cnr.it/en/latest/file_formats/netcdf_file.html)

- ARES can provide support to the stations
- tools available for commonly used data acquisition subsystem (like for example Licel TR)
- more info in Pilar presentation

Warning: During the conversion no operation/correction should be applied to the raw data!

SCC: Convert raw data into SCC format (Step 5/7)

Available tools:

atmospheric-lidar

author: Iannis Binietoglou

language: Python

link: https://repositories.imaa.cnr.it/public/atmospheric_lidar/

description: licel2scc, licel2scc-depol (convert Licel binary files to the EARLINET's Single Calculus Chain NetCDF format)

SCC: Convert raw data into SCC format (Step 5/7)

Available tools:

SCC netcdf checker

author: Iannis Binietoglou

language: Python

link: https://repositories.imaa.cnr.it/public/scc-netcdf-checker/

description: The aim of this script is to check if a netcdf file has the correct format to be used with the EARLINET's Single Calculus Chain

SCC: Convert raw data into SCC format (Step 5/7)

Available tools:

SCC access

author: Iannis Binietoglou

languange: Python

link: https://repositories.imaa.cnr.it/public/scc_access/

description: tool for interacting with the Single Calculus Chain through the command line. Specifically, with the script you can upload a file to the SCC for processing, download the processed files and graphs, delete an existing measurement from the SCC

SCC: Convert raw data into SCC format (Step 5/7)

Measurements (raw input files) are identified unique ID (**MeasurementID**)

MeasurementID format:

YYYYMMDDcccHHMM (for example 20181204pot0830, 20181204pot0115,...)

YYYYMMDD	→	start date of the measurement
ccc	→	station code (unique)
HHMM	→	start time of the measurement

SCC: Convert raw data into SCC format (Step 5/7)

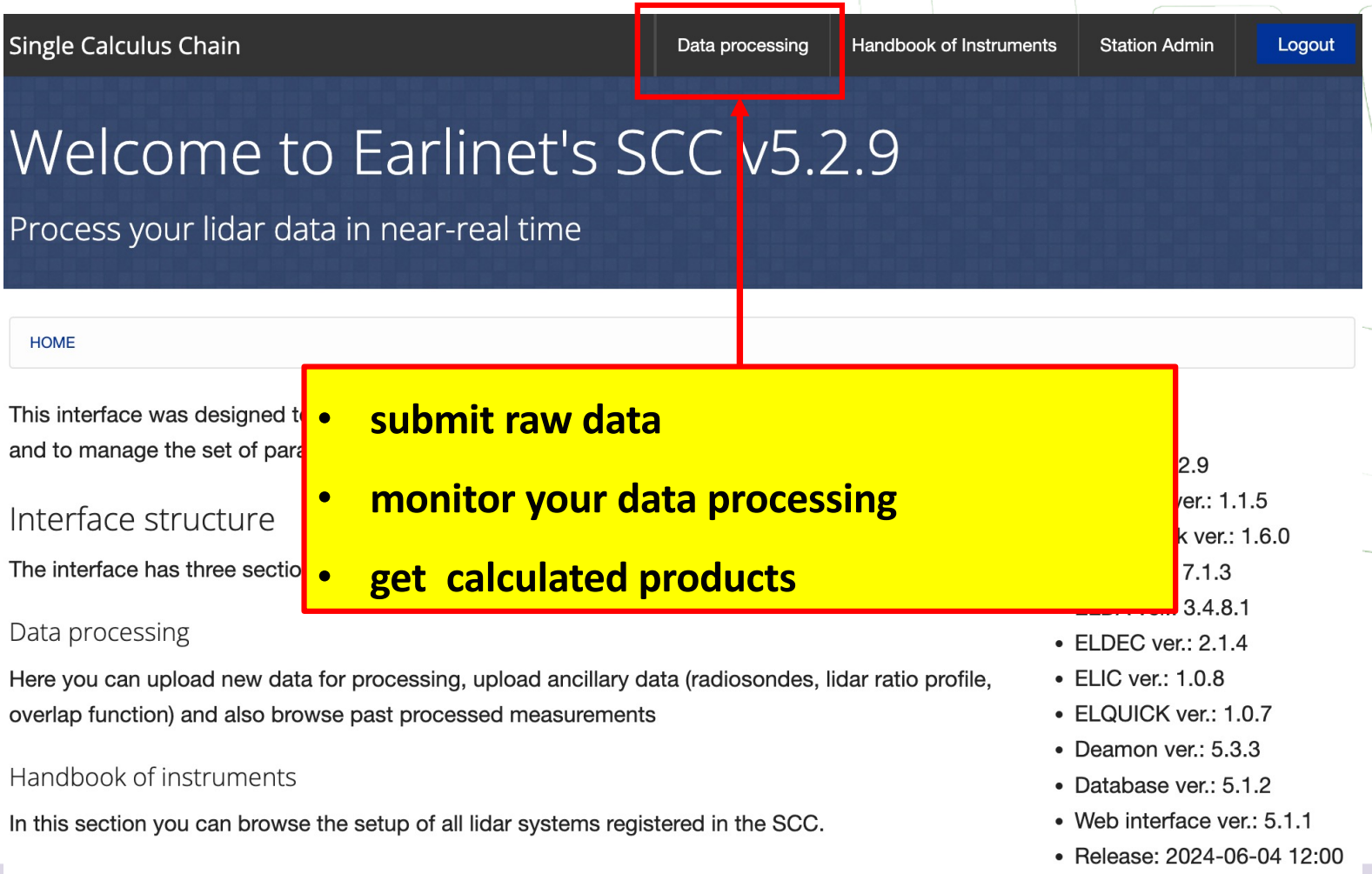
Measurements (raw input files) are identified unique ID (**MeasurementID**)

- **Warning**: do not include too many hours in the same MeasurementID.

  Too large input files are difficult to handle. 1-3 hours raw input files are recommended.

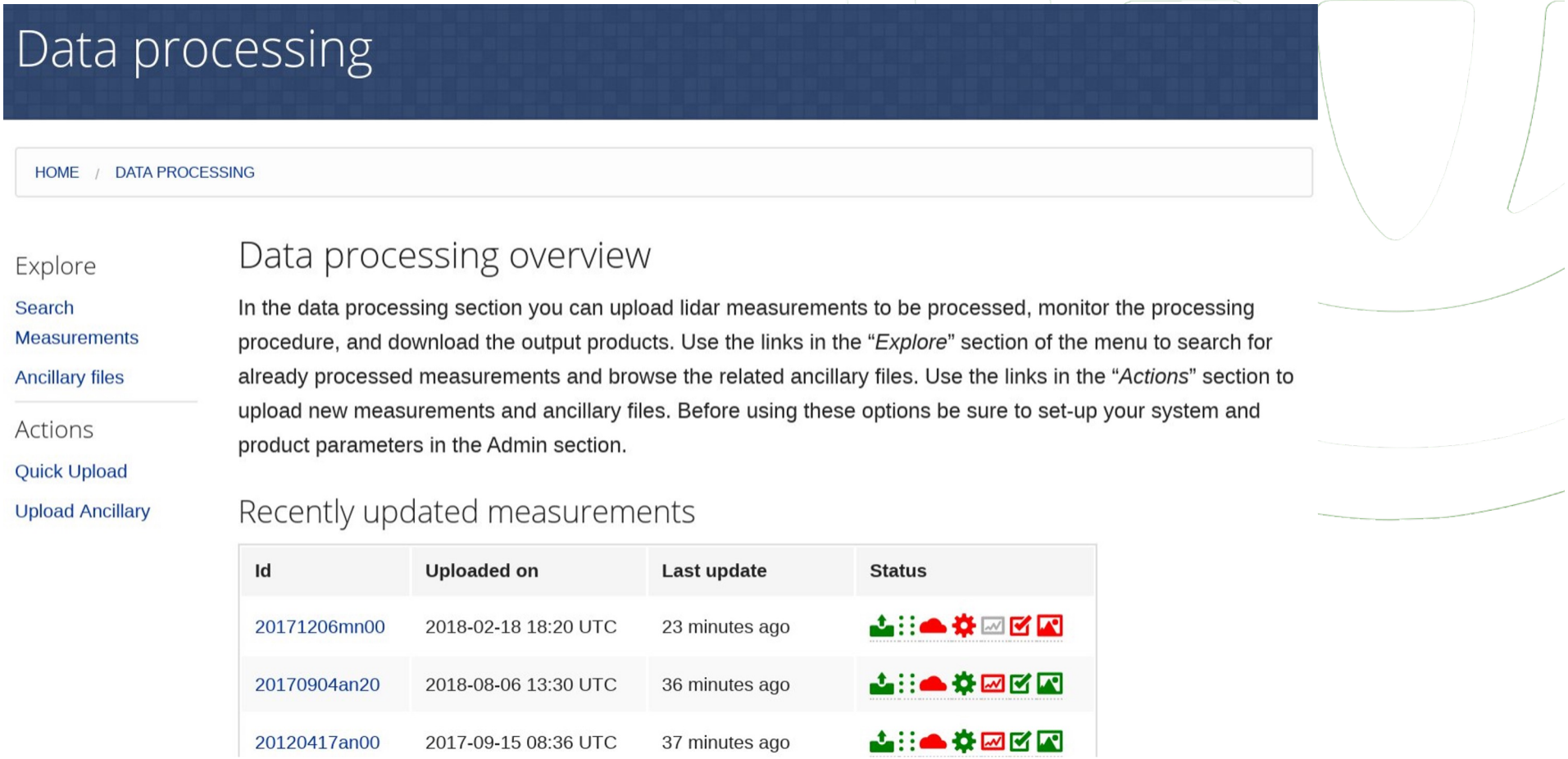
- NetCDF4 format is strongly suggested!
- The measurement ID is linked to a specific lidar configuration (during the submission phase)
- Processing is made according to parameters and the products defined for the corresponding lidar configuration

SCC: Raw data submission (Step 6/7)

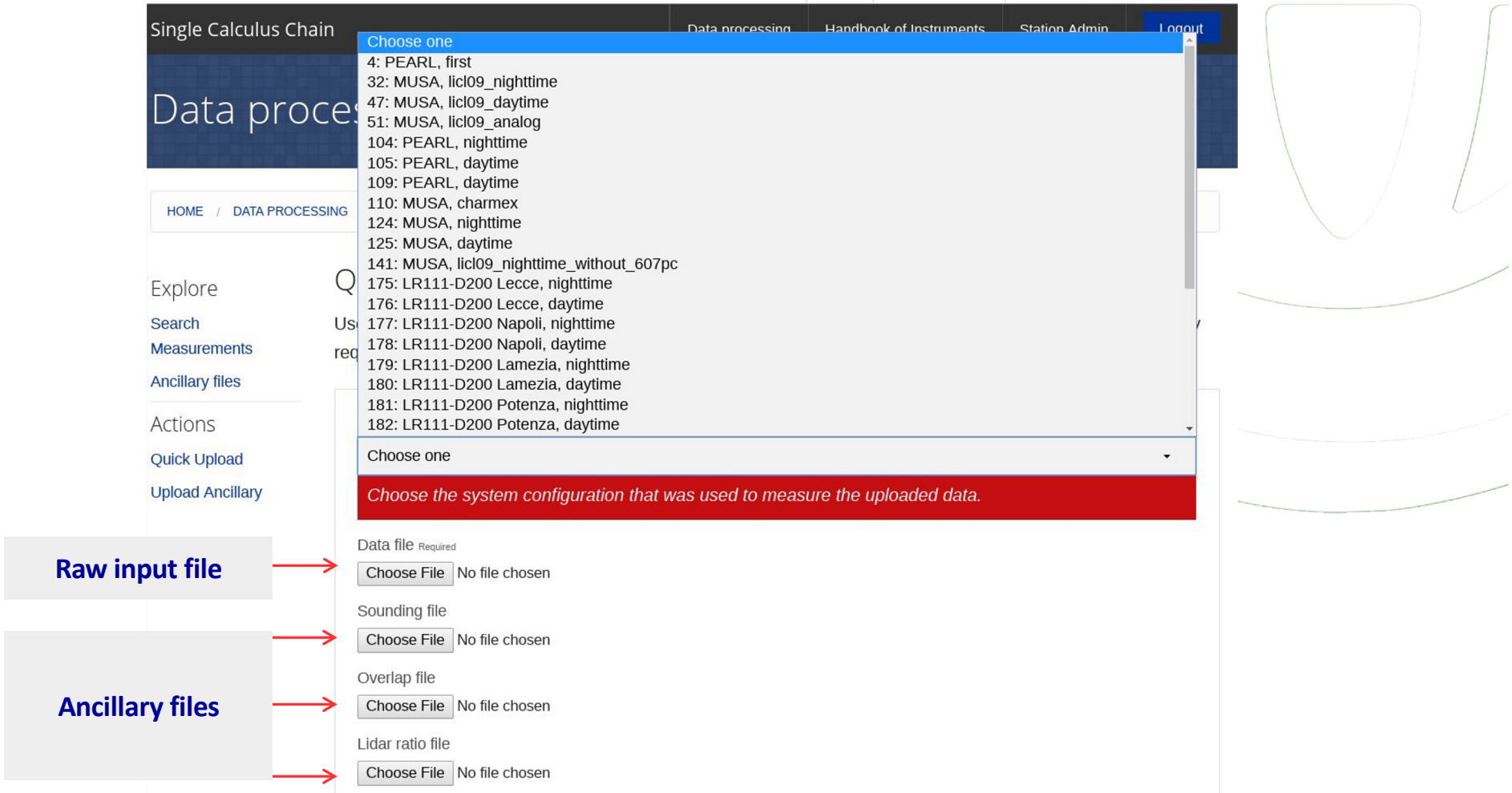


- **submit raw data**
- **monitor your data processing**
- **get calculated products**

SCC: Raw data submission (Step 6/7)



SCC: Raw data submission (Step 6/7)



SCC: Get SCC products (Step 7/7)

Measurement 20180505le18 (Finished)

The measurement parameters, processing status, and possible outputs are shown bellow. You can edit the system used in the processing and the categories in the “Admin” section.

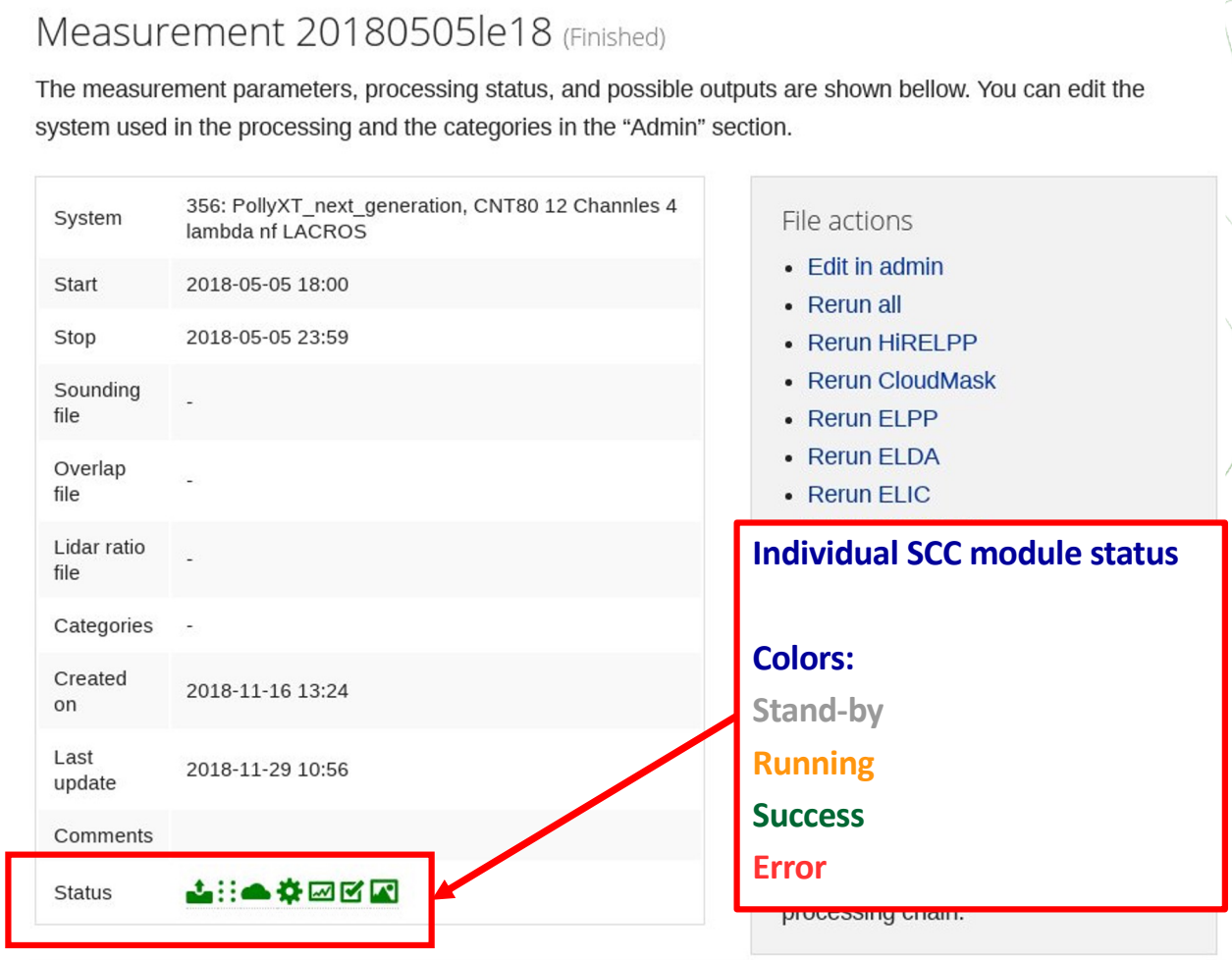
System	356: PollyXT_next_generation, CNT80 12 Channles 4 lambda nf LACROS
Start	2018-05-05 18:00
Stop	2018-05-05 23:59
Sounding file	-
Overlap file	-
Lidar ratio file	-
Categories	-
Created on	2018-11-16 13:24
Last update	2018-11-29 10:56
Comments	
Status	

File actions

- Edit in admin
- Rerun all
- Rerun HiRELPP
- Rerun CloudMask
- Rerun ELPP
- Rerun ELDA
- Rerun ELIC
- Rerun ELQUICK
- Download HiRELPP products
- Download CloudMask products
- Download ELPP files
- Download ELDA products
- Download plots
- Download ELIC products

N.B. = If products have not been obtained with the latest version of SCC, rerunning an intermidiate module will automatically restart all the processing chain.

SCC: Get SCC products (Step 7/7)



SCC: Get SCC products (Step 7/7)

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- Download ELIC products

N.B. = If products have not been obtained with the latest version of SCC, rerunning an intermidiate module will automatically restart all the processing chain.

Re-processing section

SCC: Get SCC products (Step 7/7)

Measurement 20180505le18 (Finished)

The measurement parameters, processing status, and possible outputs are shown bellow. You can edit the system used in the processing and the categories in the “Admin” section.

System	356: PollyXT_next_generation, CNT80 12 Channles 4 lambda nf LACROS
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Sounding file	-
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Last update	2018-11-29 10:56
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Status	

File actions

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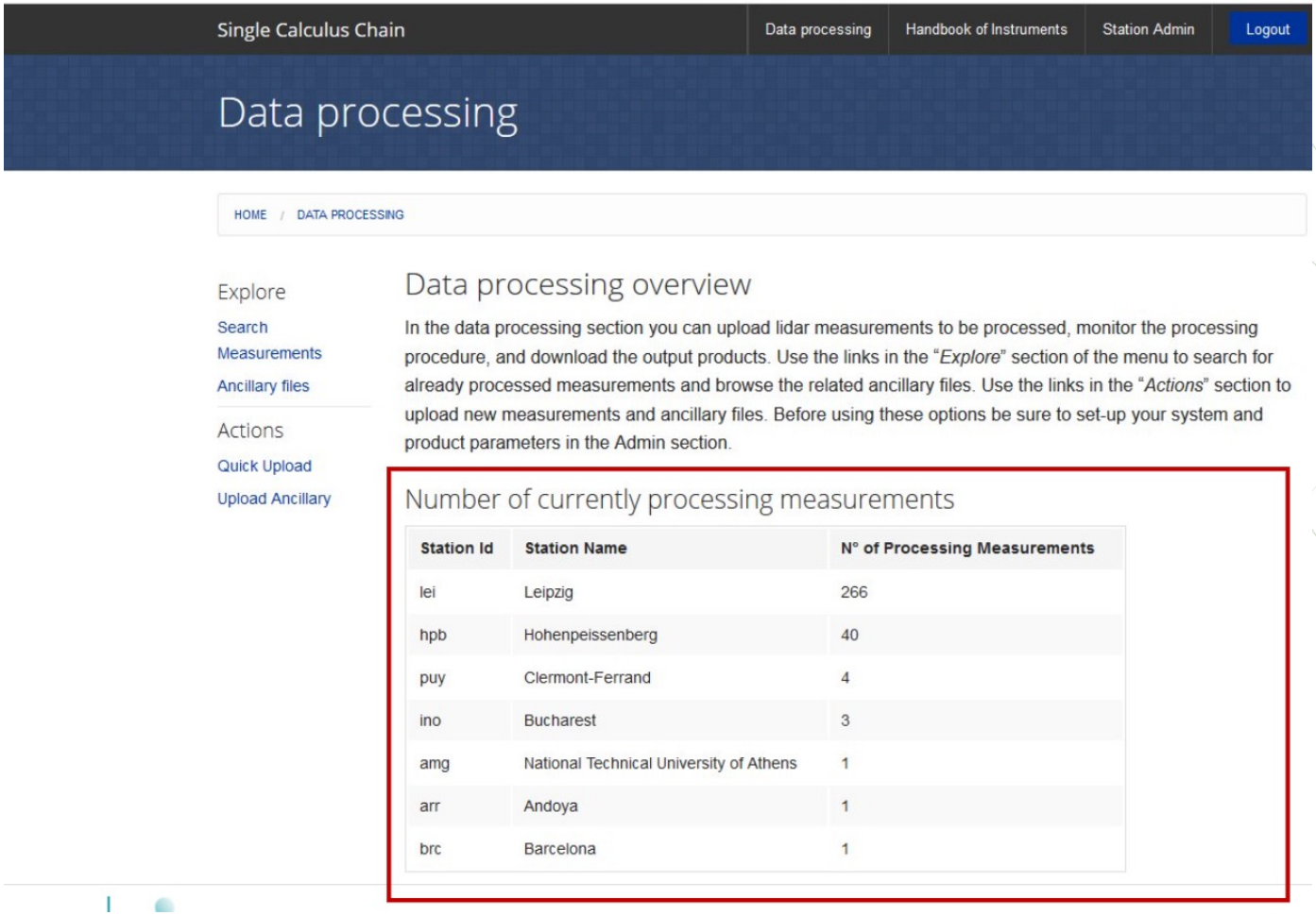
- Rerun HiRELPP
- Rerun CloudMask
- Rerun ELPP
- Rerun ELDA
- Rerun ELIC
- Rerun ELQUICK
- Download HiRELPP products
- Download CloudMask products
- Download ELPP files
- Download ELDA products
- Download plots
- Download ELIC products

N.B. = If products have not been obtained with the latest version of SCC, rerunning an intermidiate module will automatically restart all the processing chain.

Download section

SCC: Data processing monitoring



SCC: Data processing monitoring

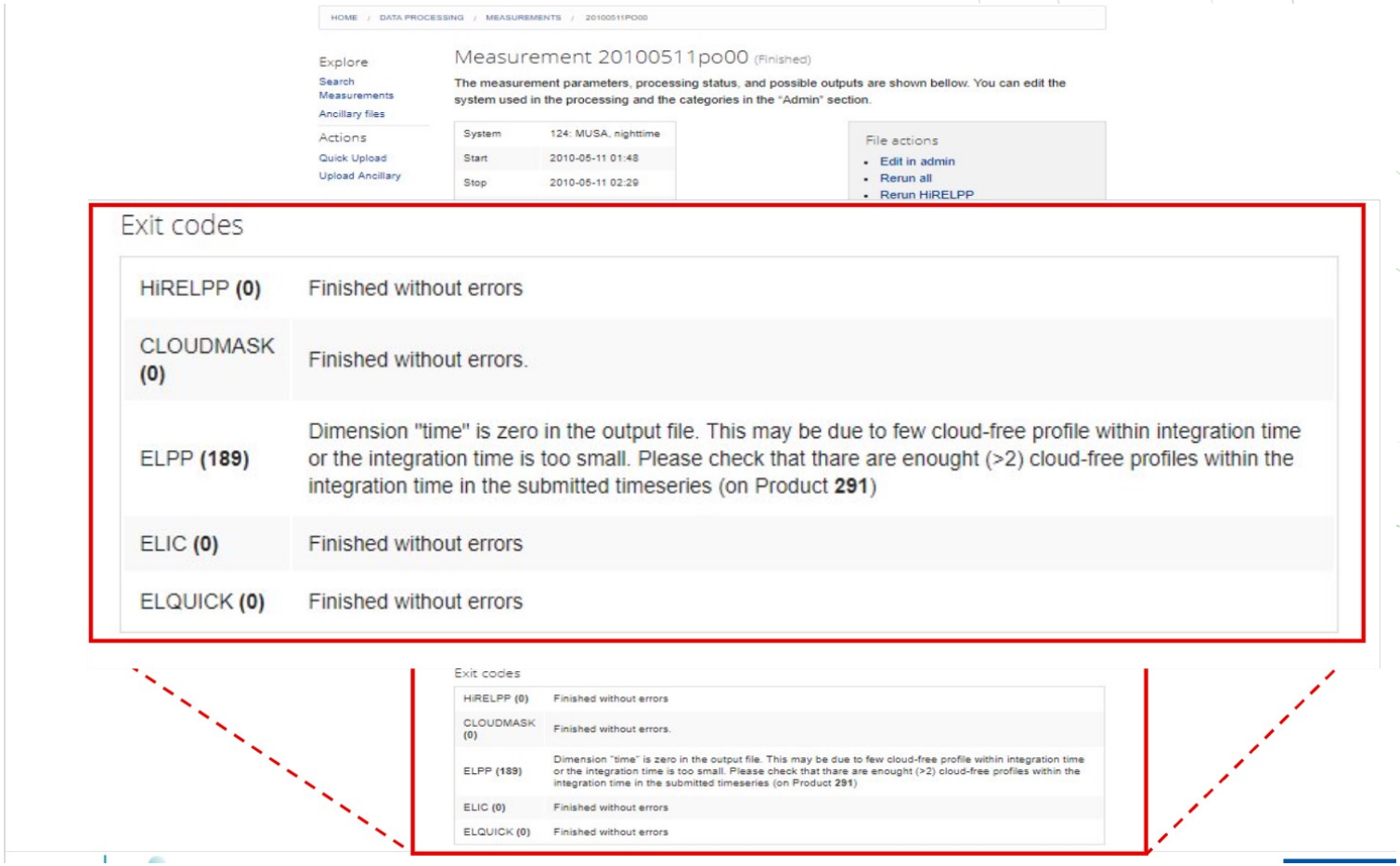
Number of queued measurements

Station Id	Station Name	Processing Priority	N° of Queued Measurements
rzc	Rzecin	Low	15
arr	Andoya	Low	3
aky	Antikythera	Low	2
lle	Lille	Low	2
sma	Servizio Meteorològico Nacional Argentina	Low	1
spl	Saint Petersburg	Low	1

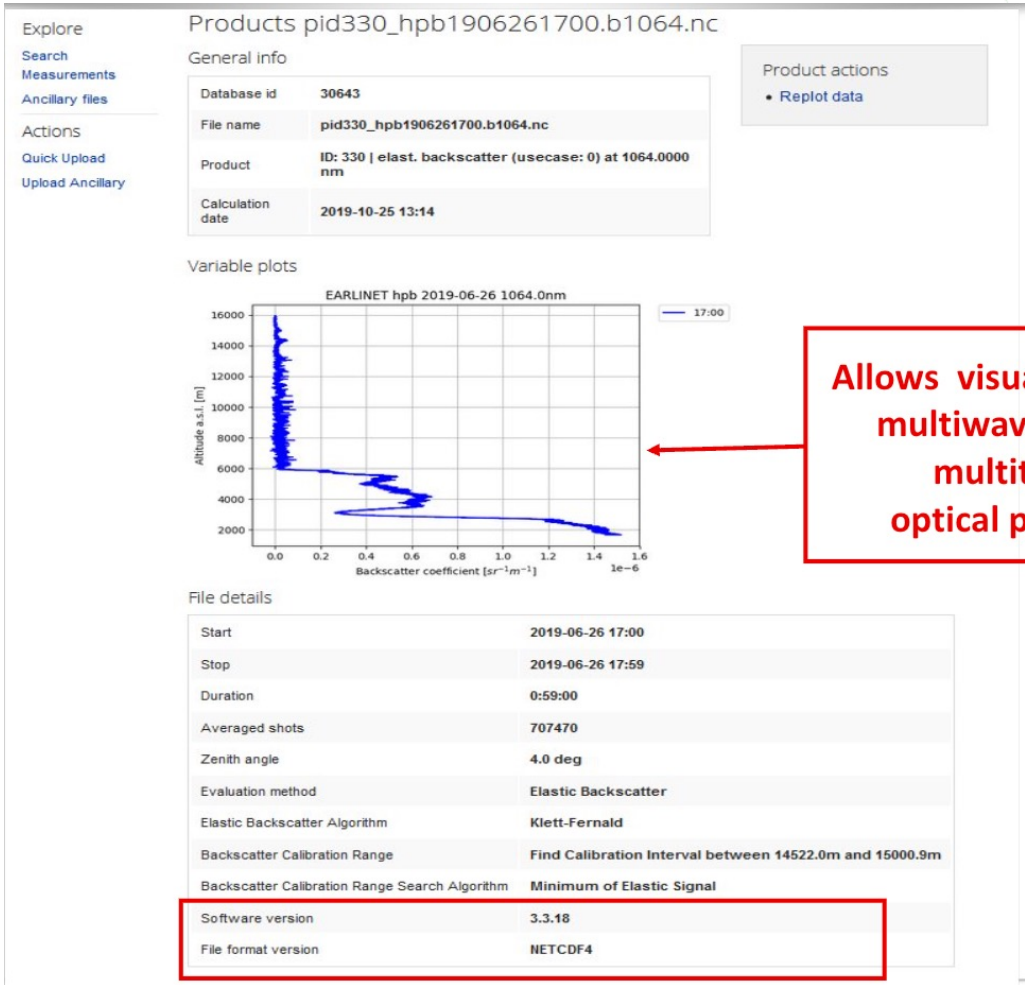
Recently updated measurements

Id	Uploaded on	Last update	Status
20241108cvo1400	2024-11-08 15:44 UTC	11 minutes ago	
20241108kuo1400	2024-11-08 15:33 UTC	22 minutes ago	

SCC: Data processing monitoring



SCC: Data processing monitoring



Allows visualization of multiwavelengths multitimes optical products

SCC Product Types

Calibration products

- Product type: “**Linear polarization calibration**”
- Only for lidars equipped with polarization channels
- Require the submission of a raw polarization calibration timeseries (+/-45 degrees measurements)
- Provides the polarization channels gain ratio used to:
  - Compute the volume depolarization ratio
  - Combine polarization channels

SCC Product Types

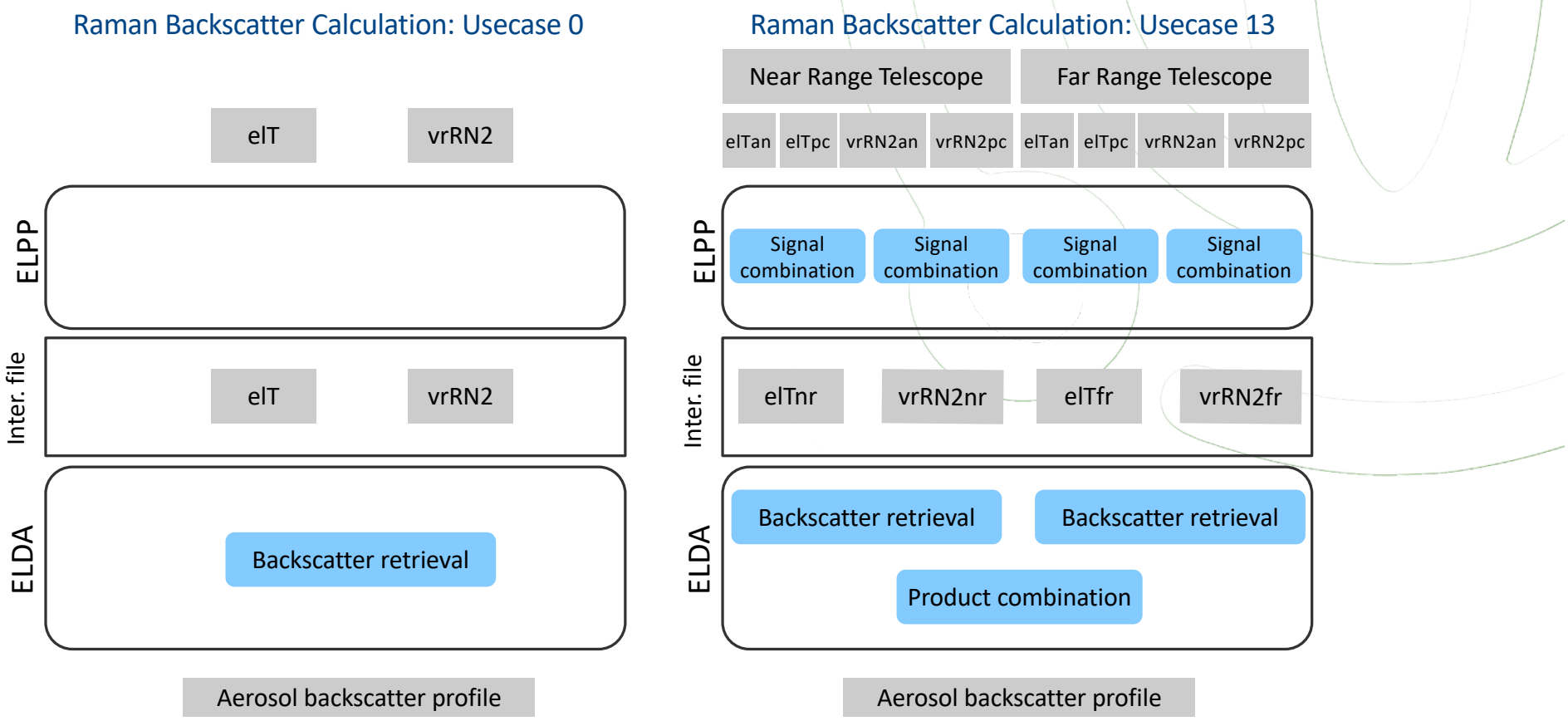
Low resolution optical products

- “**Extinction only**”
- “**Raman backscatter**”
- “**Elastic backscatter**”
- “**Lidar ratio**”
  - requires the definition of “**Extinction only**” and “**Raman backscatter**” products
- “**Raman backscatter and Linear Depolarization Ratio**”
  - requires the definition of “**Raman backscatter**” product
- “**Elastic backscatter and Linear Depolarization Ratio**”
  - requires the definition of “**Elastic backscatter**” product

SCC Product Types

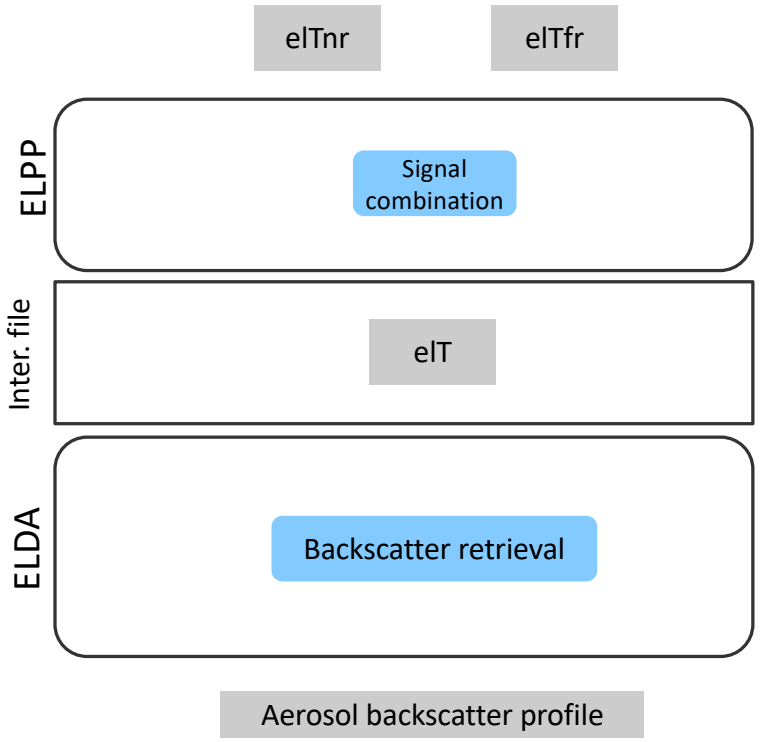
	RCS	Cloudmask	Attenuated backscatter	Particle backscatter	Particle extinction	VLDR	PLDR
HiRELPP products	✓					✓	
Cloudmask products		✓					
ELIC products			✓			✓	
ELPP products	✓	✓					
Elastic backscatter		✓		✓			
Raman backscatter		✓		✓			
Elastic backscatter + depol		✓		✓		✓	✓
Raman backscatter + depol		✓		✓		✓	✓
Extinction only		✓			✓		
Lidar ratio		✓		✓	✓		

SCC processing flexibility: Usecase concept

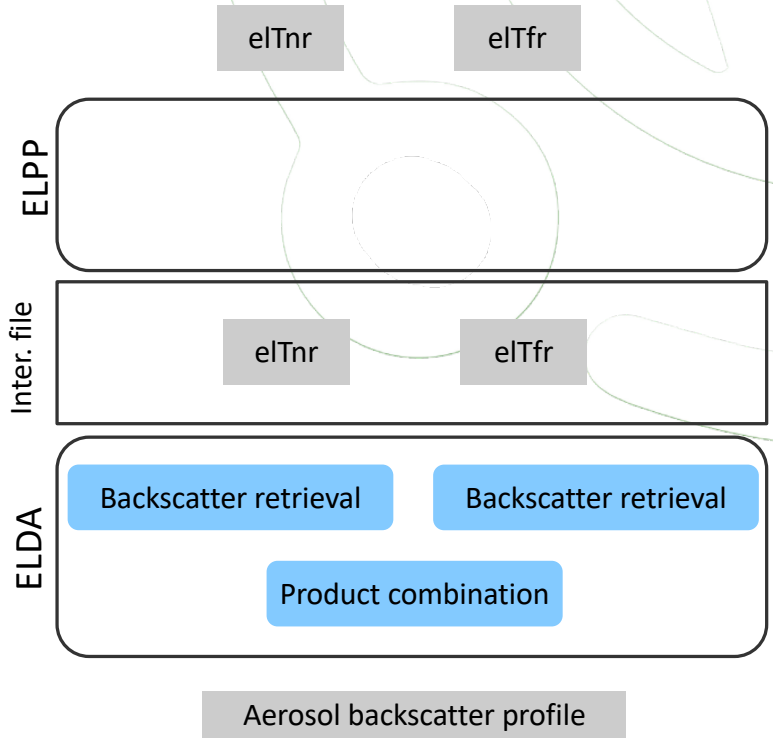


SCC processing flexibility: Usecase concept

Elastic Backscatter Calculation: Usecase 1



Elastic Backscatter Calculation: Usecase 2

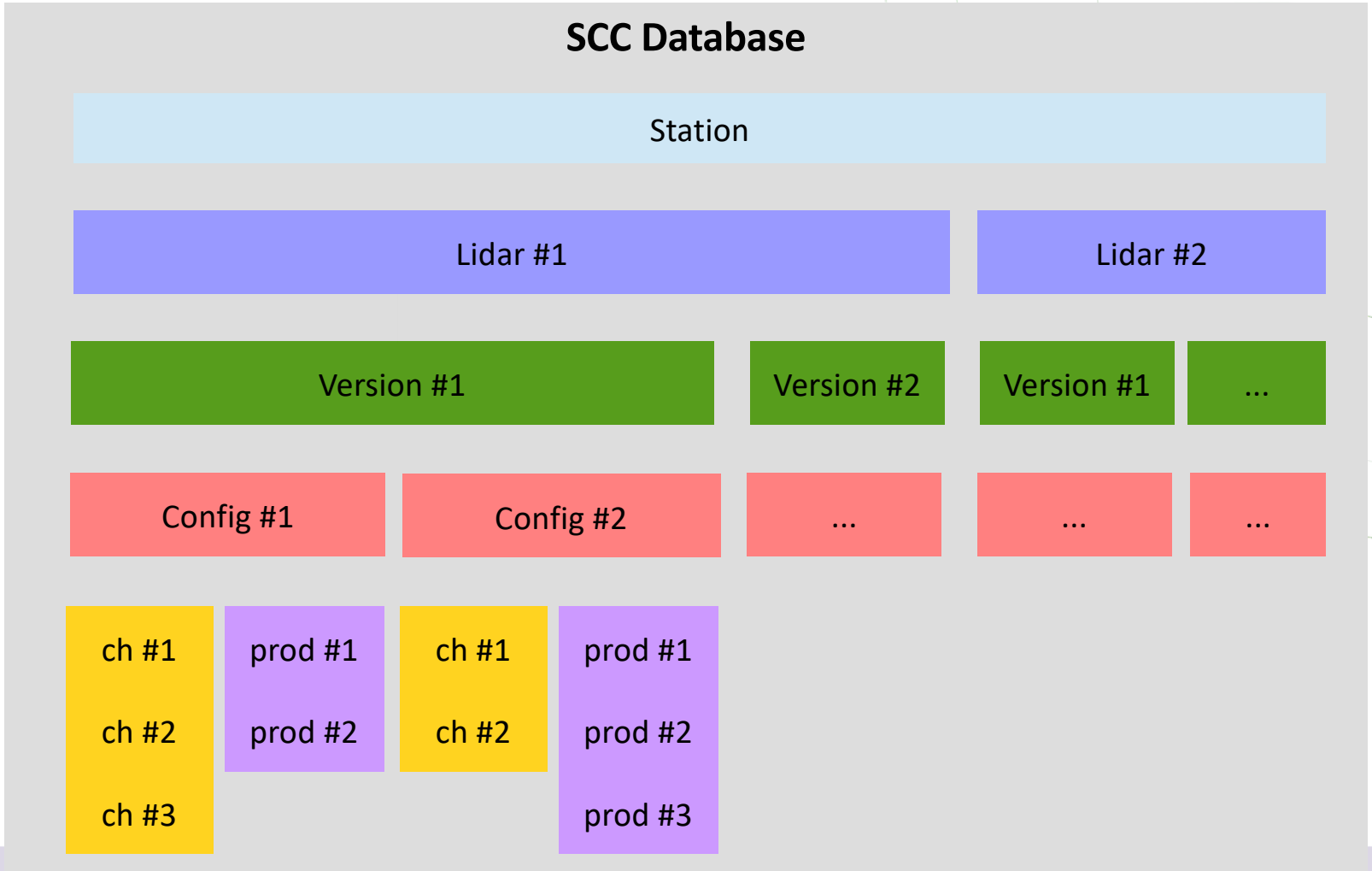


SCC processing flexibility: Usecase concept

Many analysis scenarios for optical products (usecases)

- Raman backscatter (and Lidar ratio)
  - Number of usecaseses: 19
- Elastic backscatter
  - Number of usecaseses: 9
- Elastic backscatter + depol
  - Number of usecaseses: 14
- Raman backscatter + depol
  - Number of usecaseses: 24
- Extinction only
  - Number of usecaseses: 5
- Linear polarization calibration
  - Number of usecaseses: 11

SCC processing traceability



SCC processing traceability

Unique ID for each channel

All the channels' characteristics used in the data processing are collected

- Trigger delay
- Pre-trigger region
- Dead time
- Dead time correction method
- Gluing options
- Raw resolution
- Wavelength
- ...

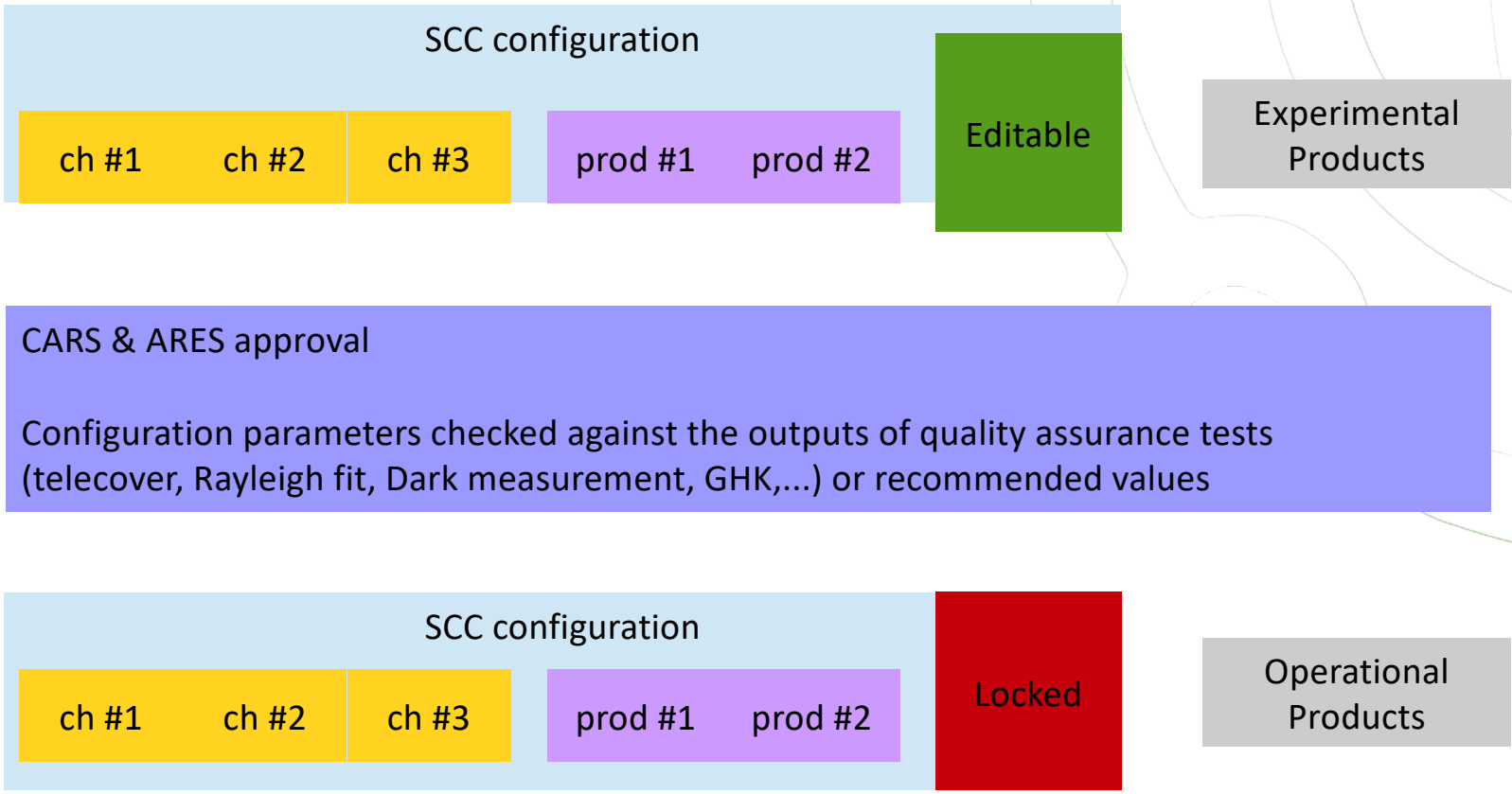
SCC processing traceability

Unique ID for each product

All the product characteristics used in the data processing are collected

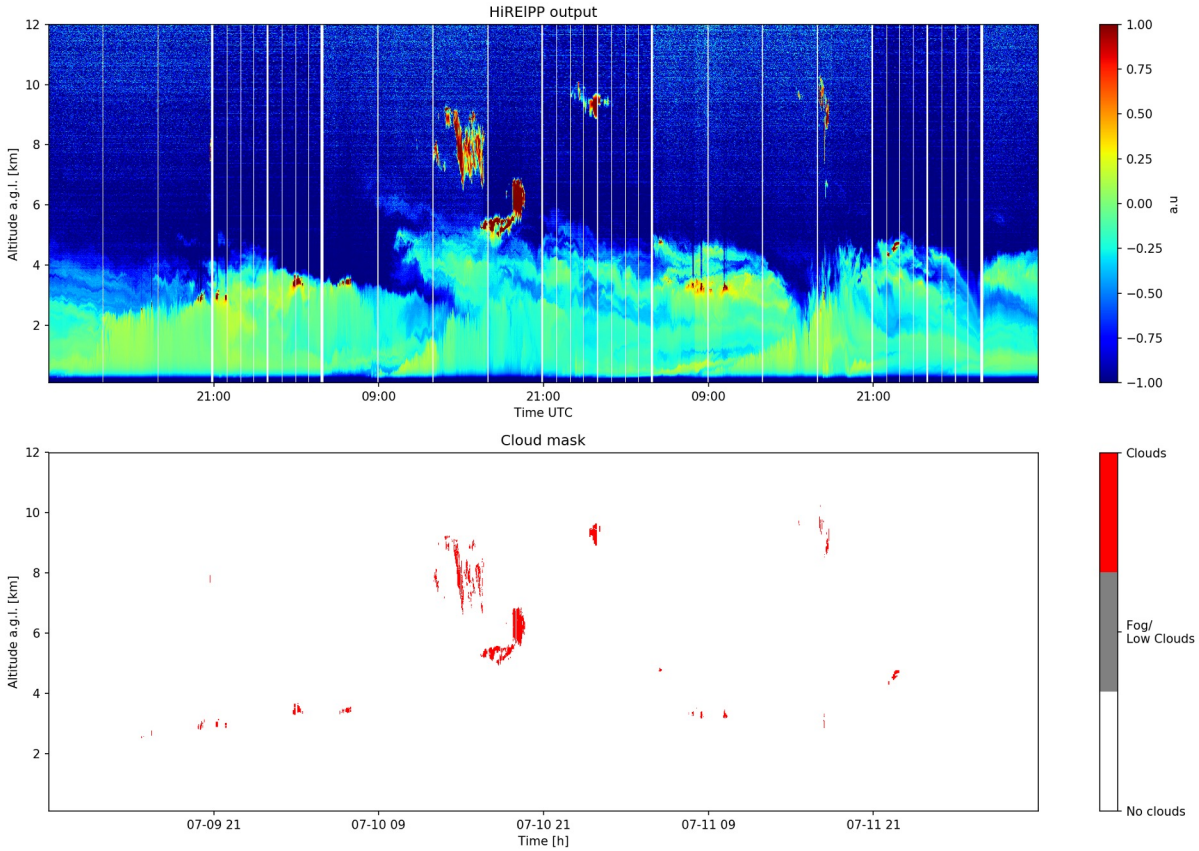
- Type (extinction, backscatter, depolarization ratio,...)
- Retrieval method
- Calibration options
- Minimum and maximum valid heights
- Error propagation method
- Maximum allowable statistical uncertainties
- ...

SCC: Connections with CARS instrumental QC



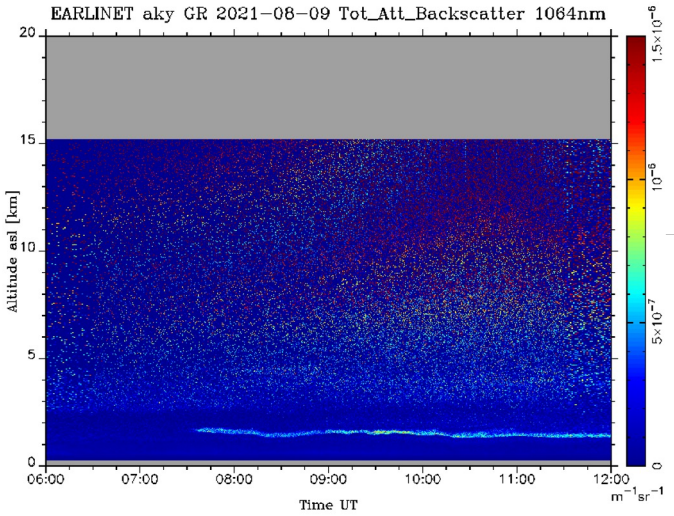
SCC: Example of retrieved products

Cloudmask



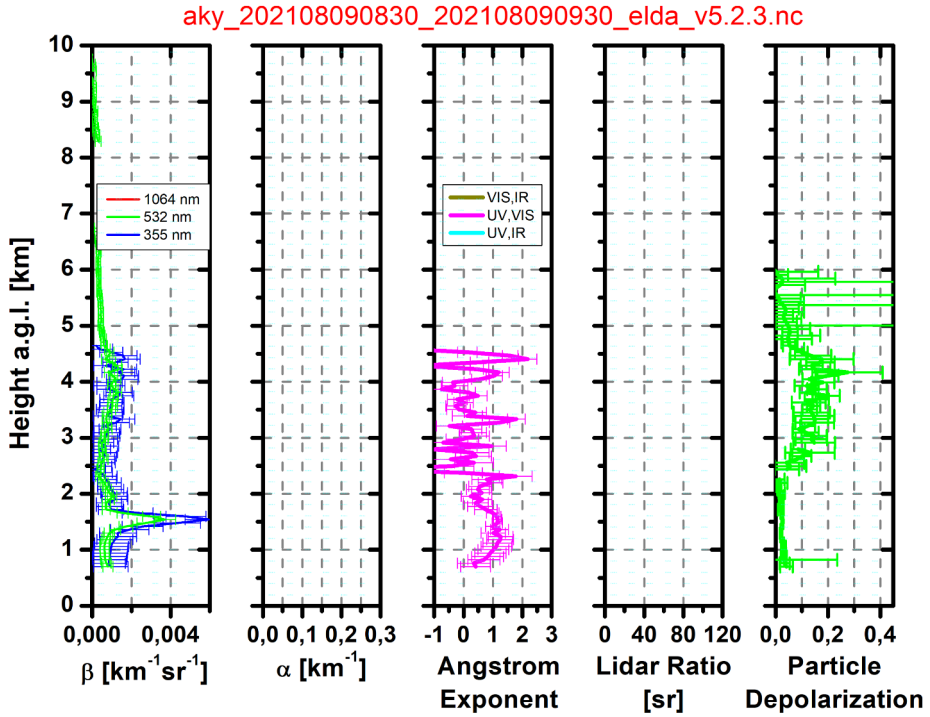
SCC: Example of retrieved products

Optical product #1



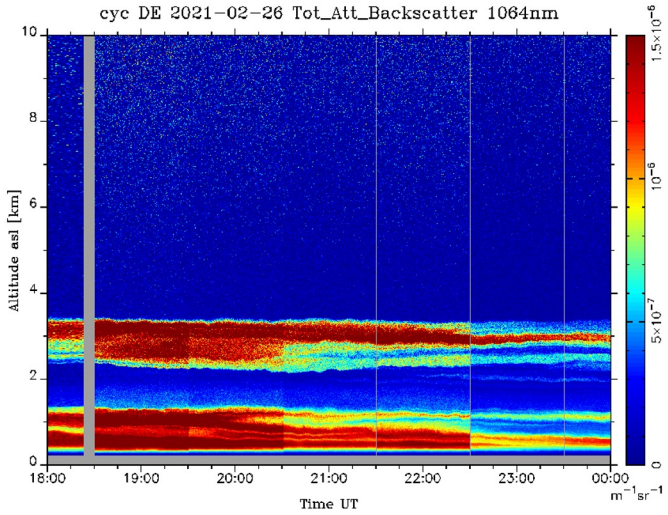
Smoke case (daytime)

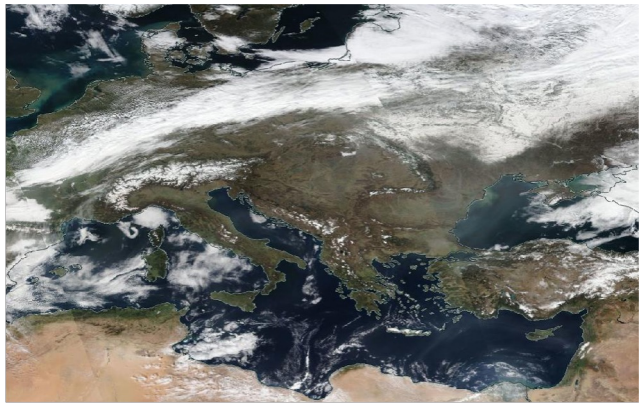
9 Aug 2021



SCC: Example of retrieved products

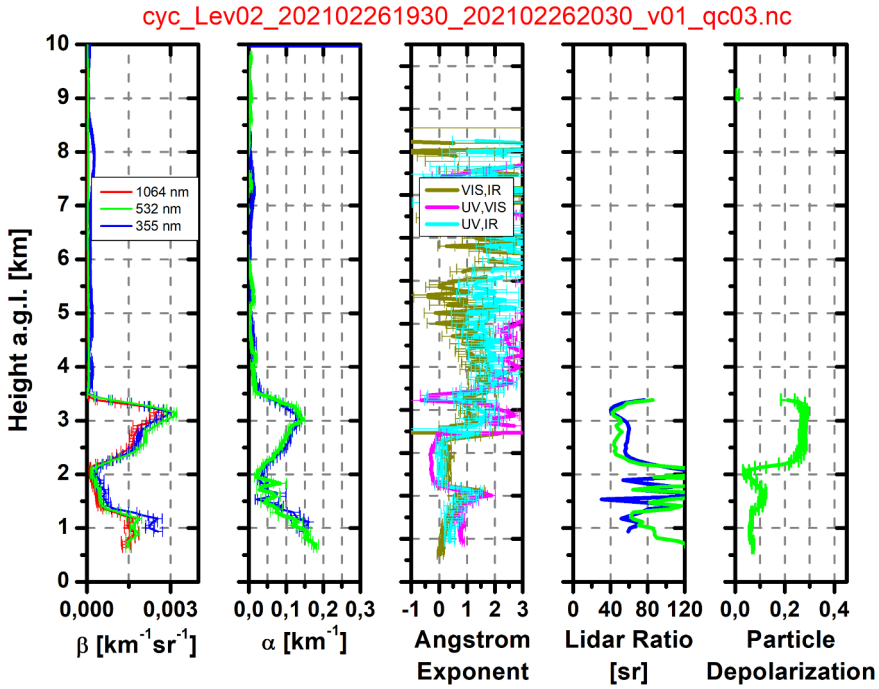
Optical product #2





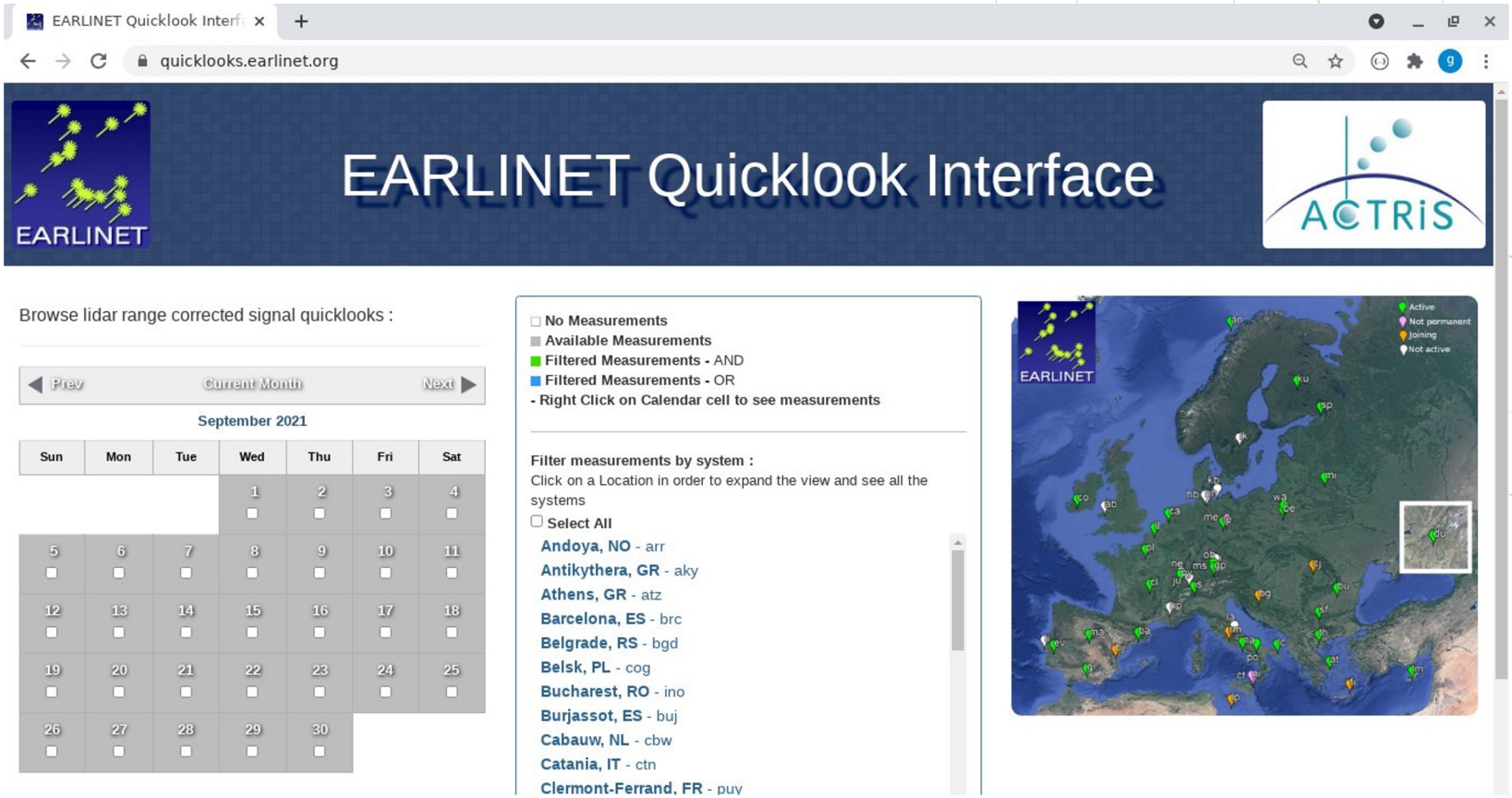
Dust case (nighttime)

26 Feb 2021



SCC: Example of retrieved products

Quicklooks (https://quicklooks.earlinet.org)



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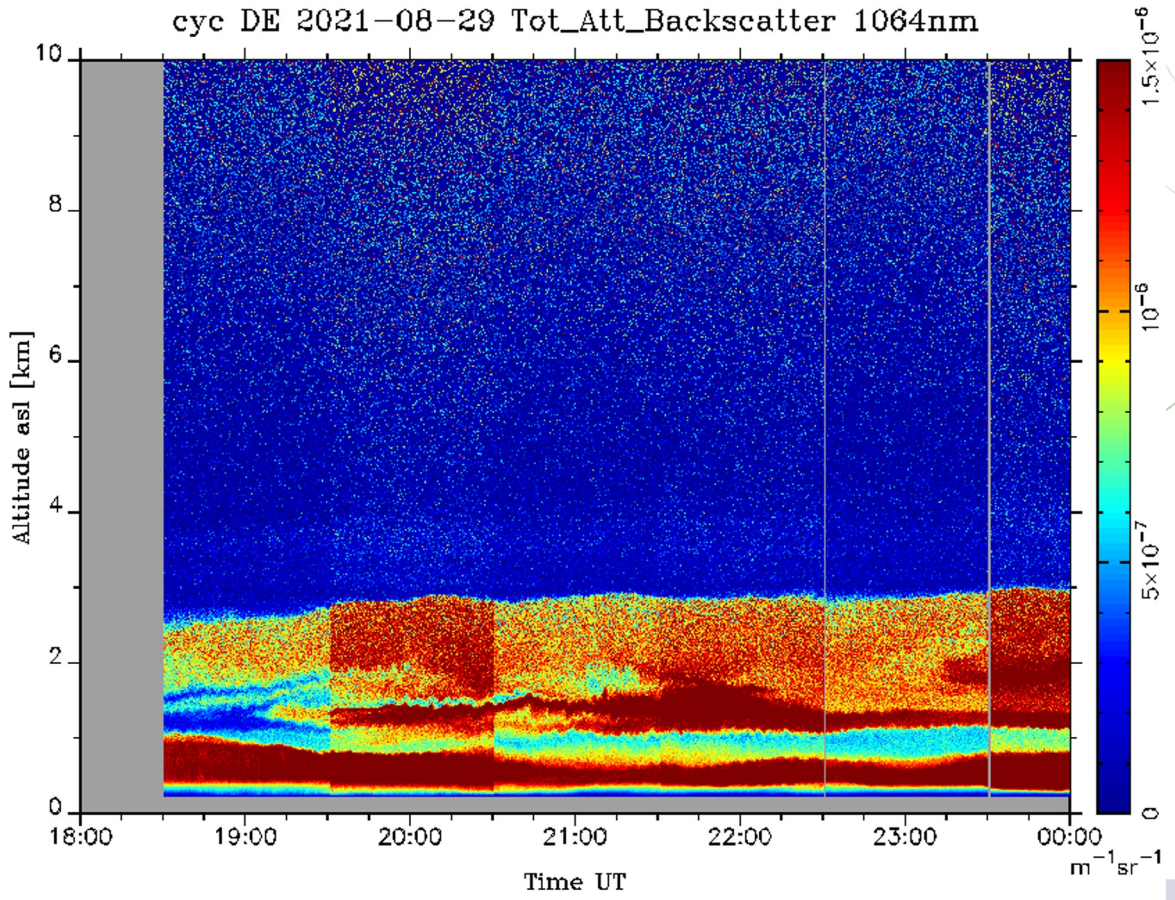

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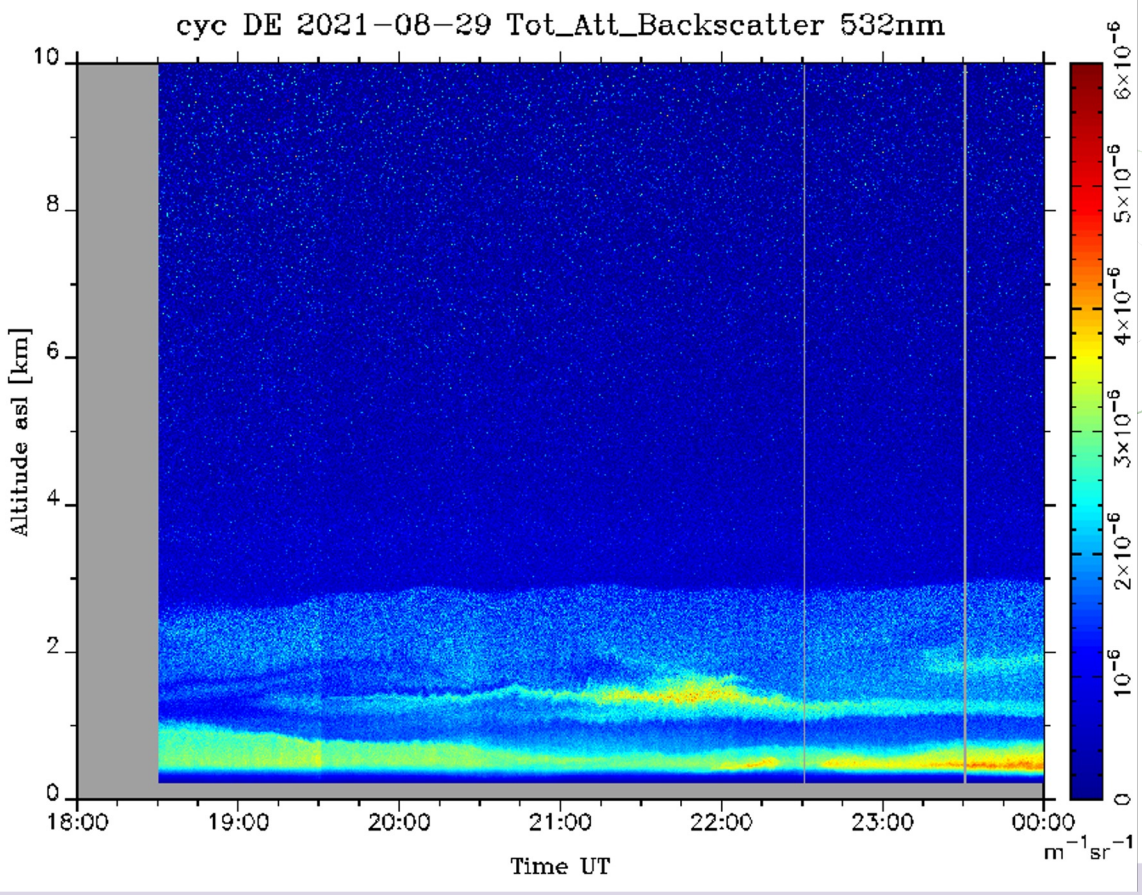

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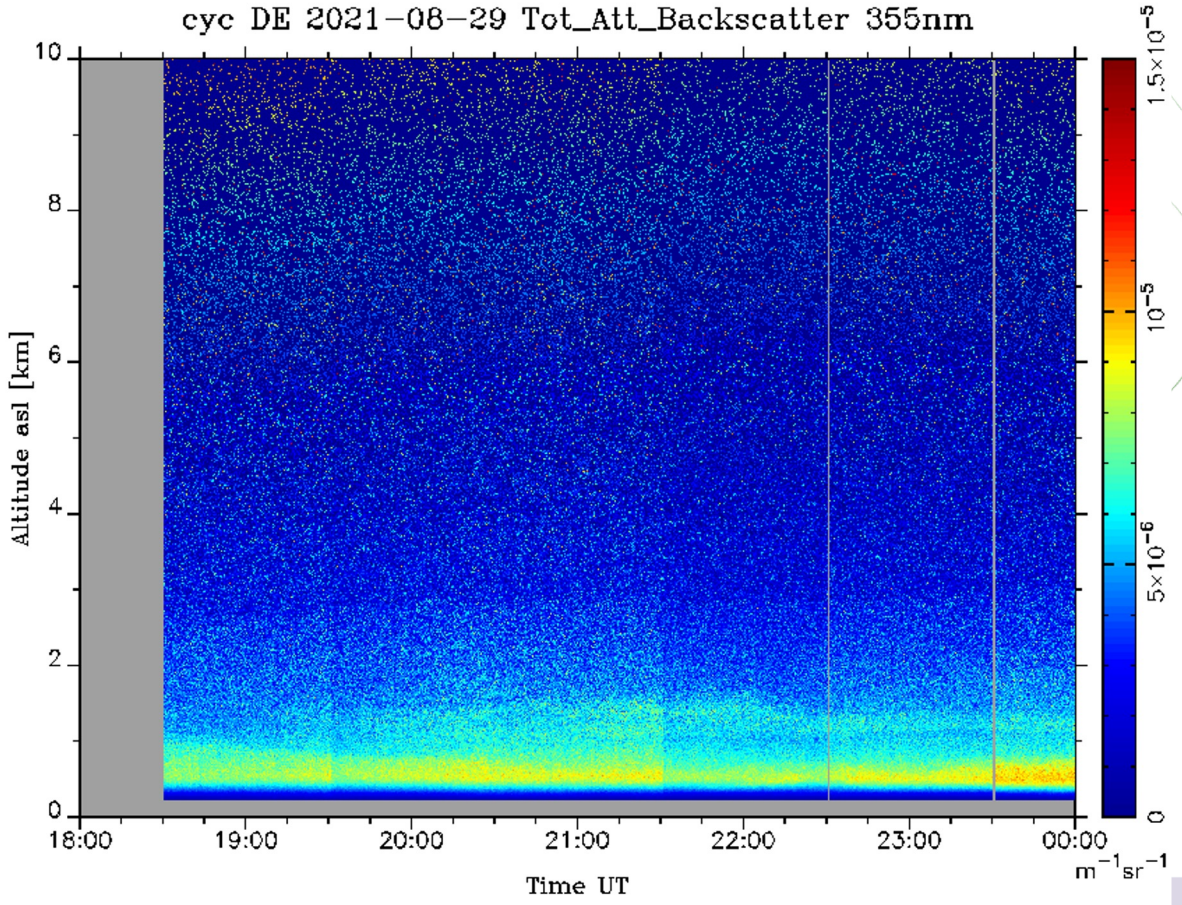

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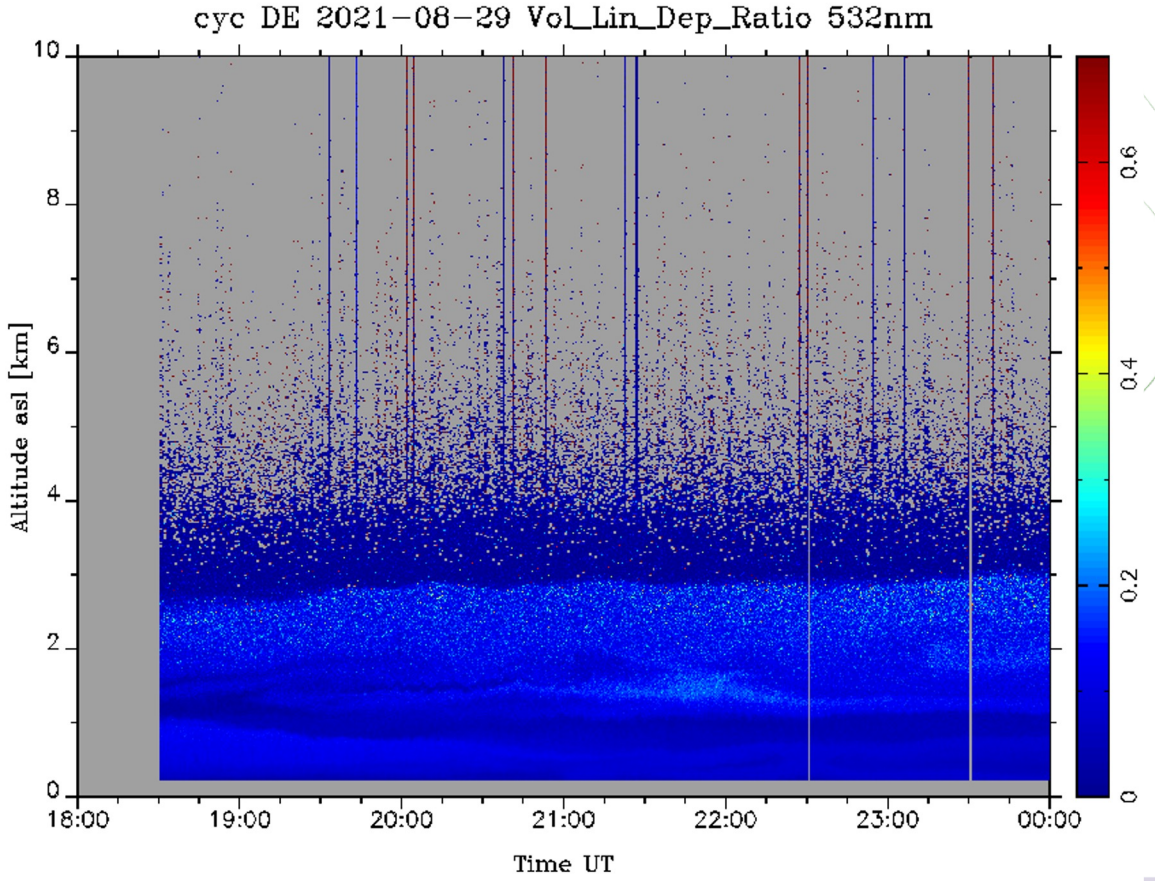

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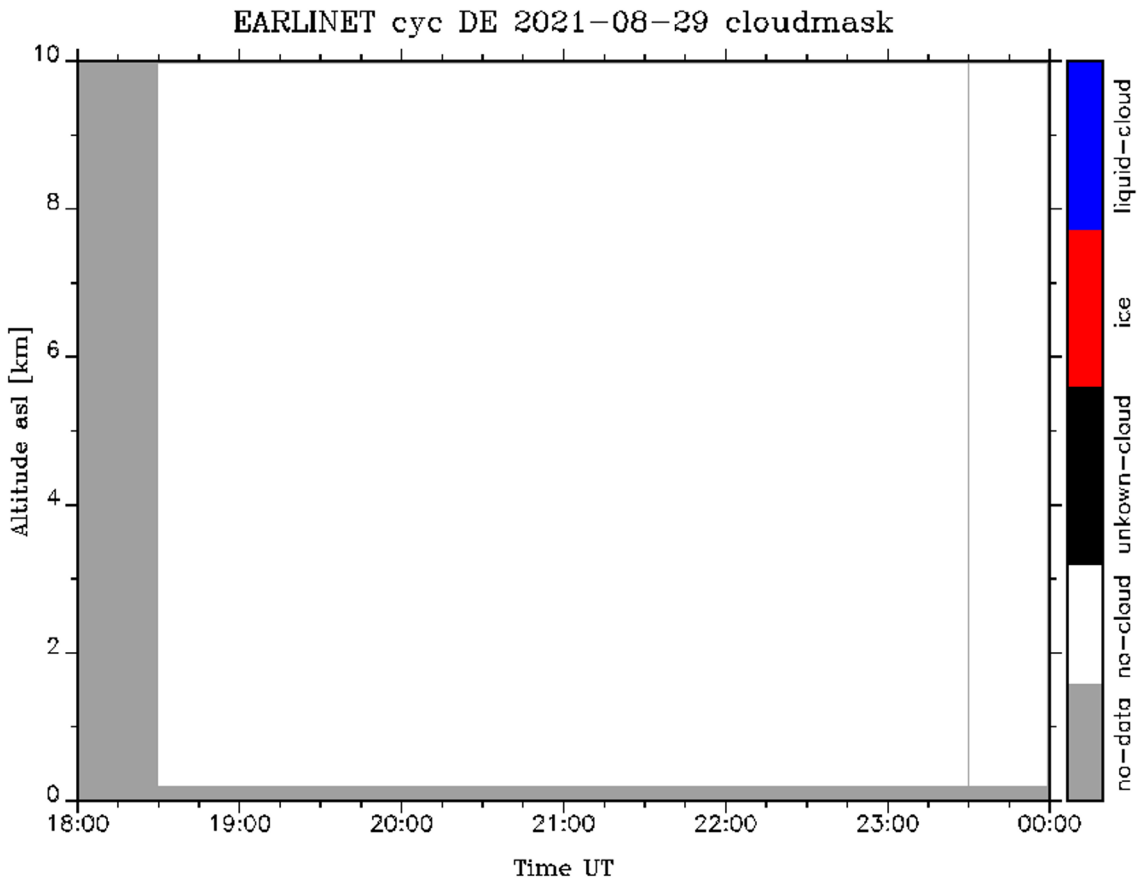
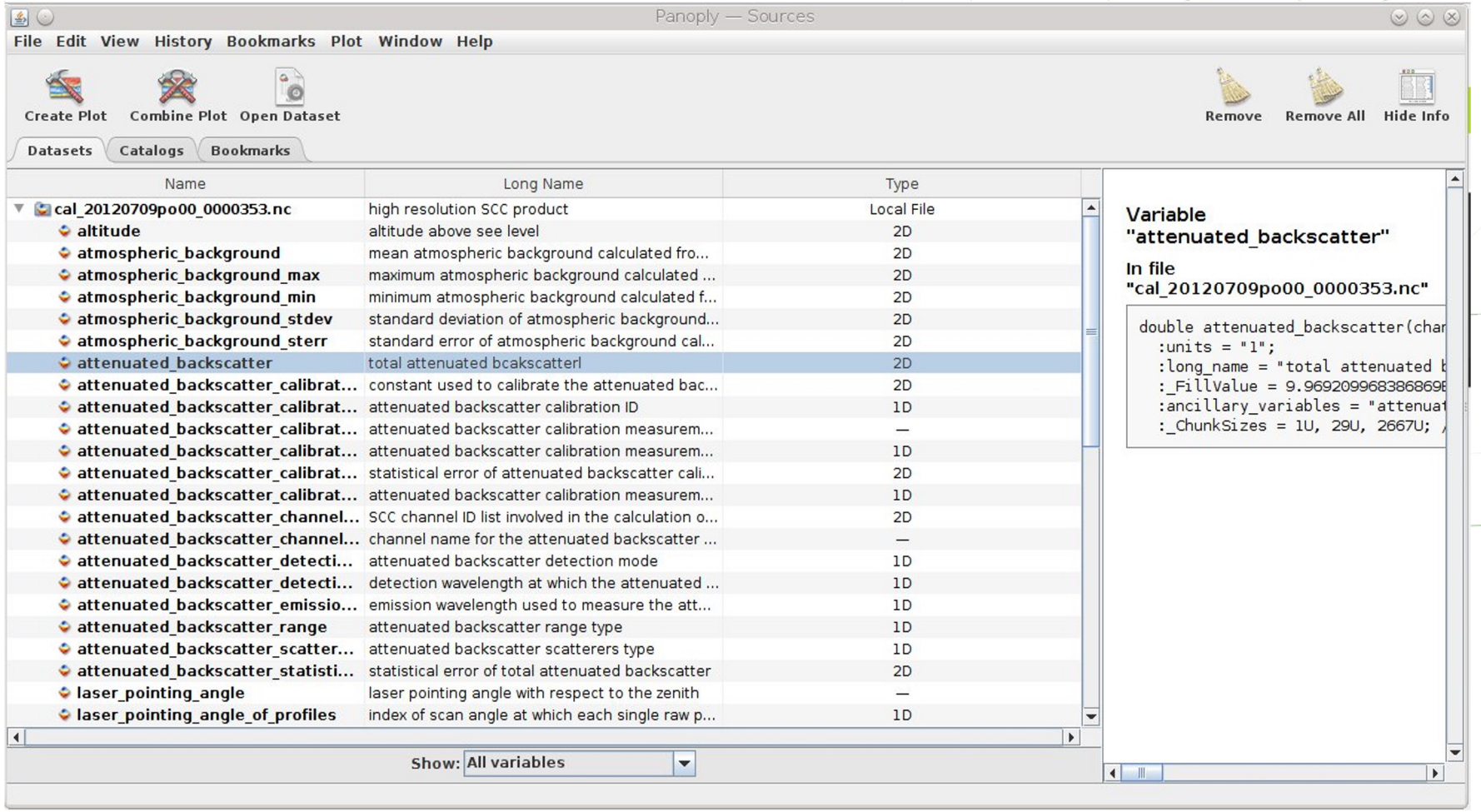


SCC Products format

- NetCDF4 (→ you need recent version of NetCDF libs to open it)
- CF compliant (version 1.7)
- Auto-descriptive
- Homogenized through all product types
- Calibrated and uncalibrated prods → same structure
- Low and high resolution prods → very similar structure
- Optical products → fully compatible with ARES db
- Rich metadata improve traceability
- All the SCC products are compatible with the NASA tool Panoply (https://www.giss.nasa.gov/tools/panoply/) - Use it to evaluate your data!!!
- More info on SCC official documentation:

  https://docs.scc.imaa.cnr.it/en/latest/file_formats/scc_product_format.html

SCC: Products plotting (via Panoply)



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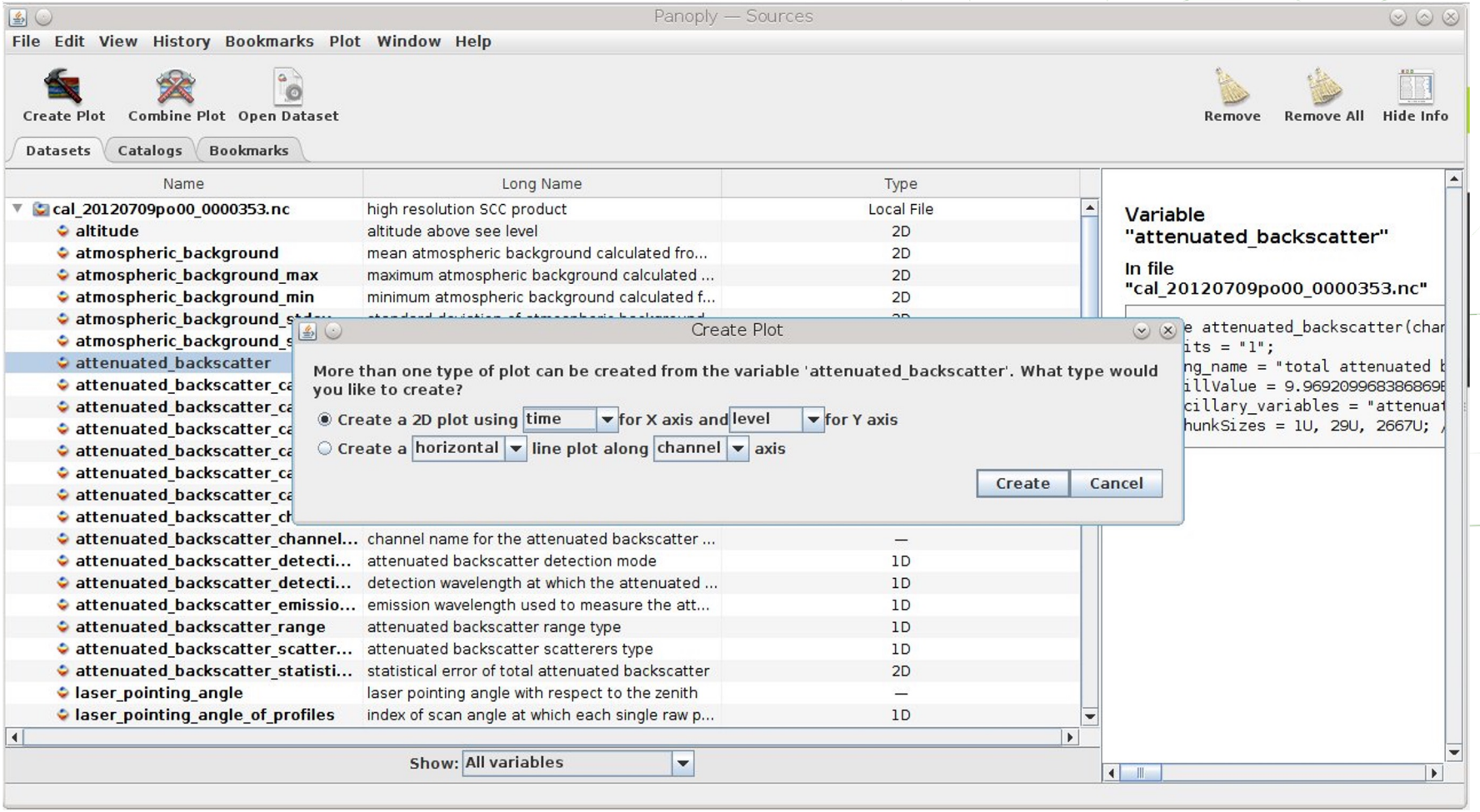

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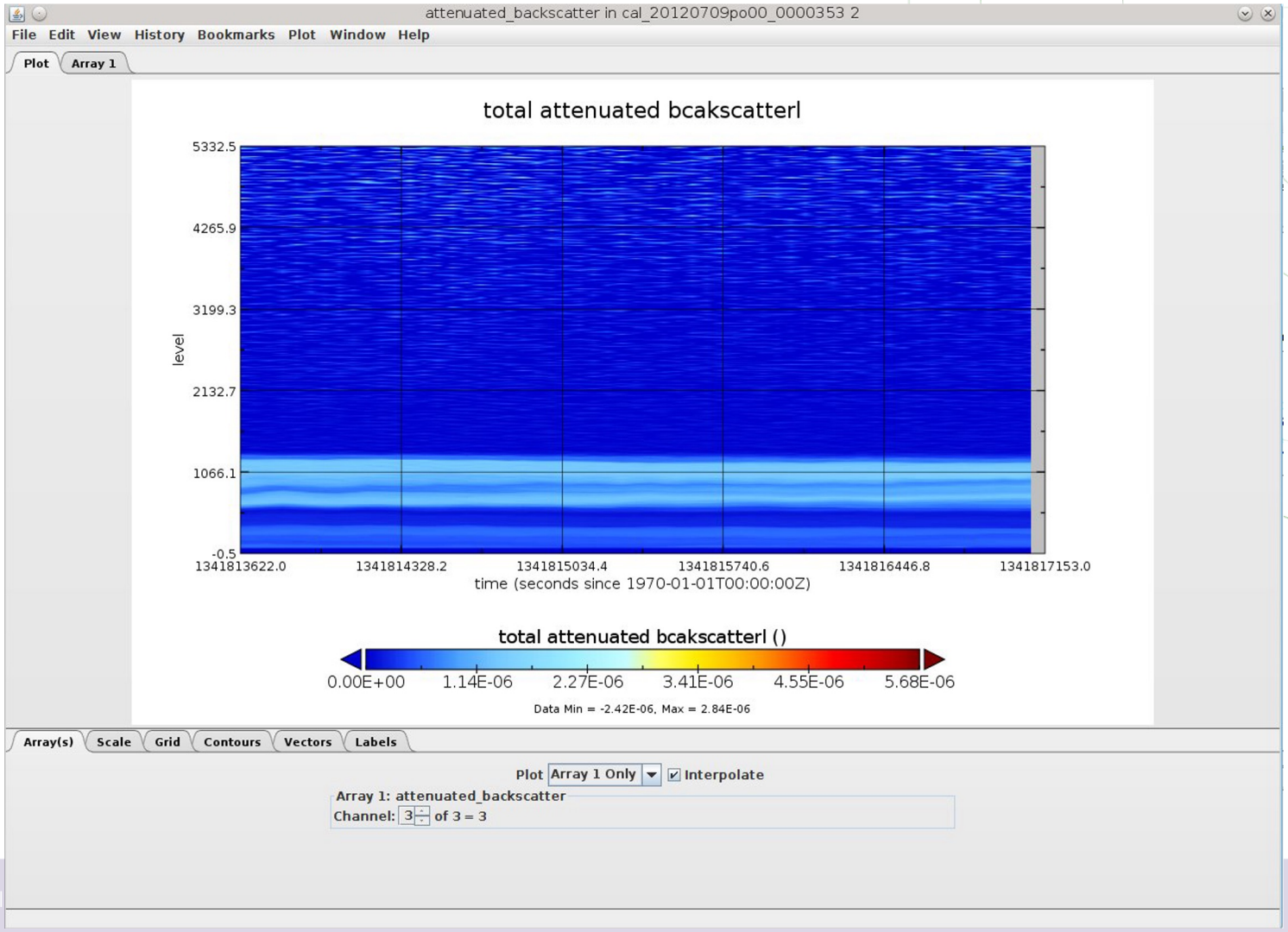

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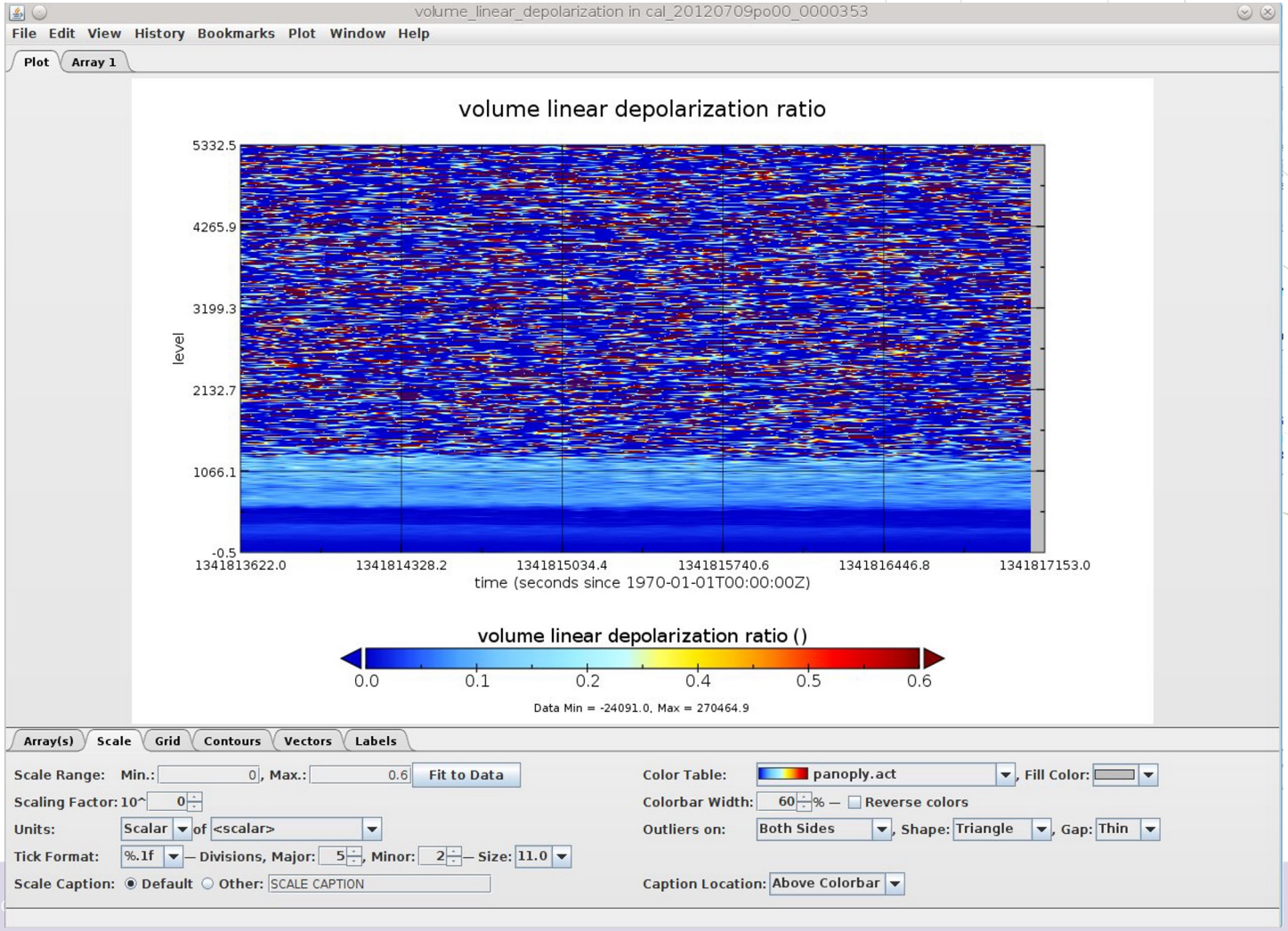

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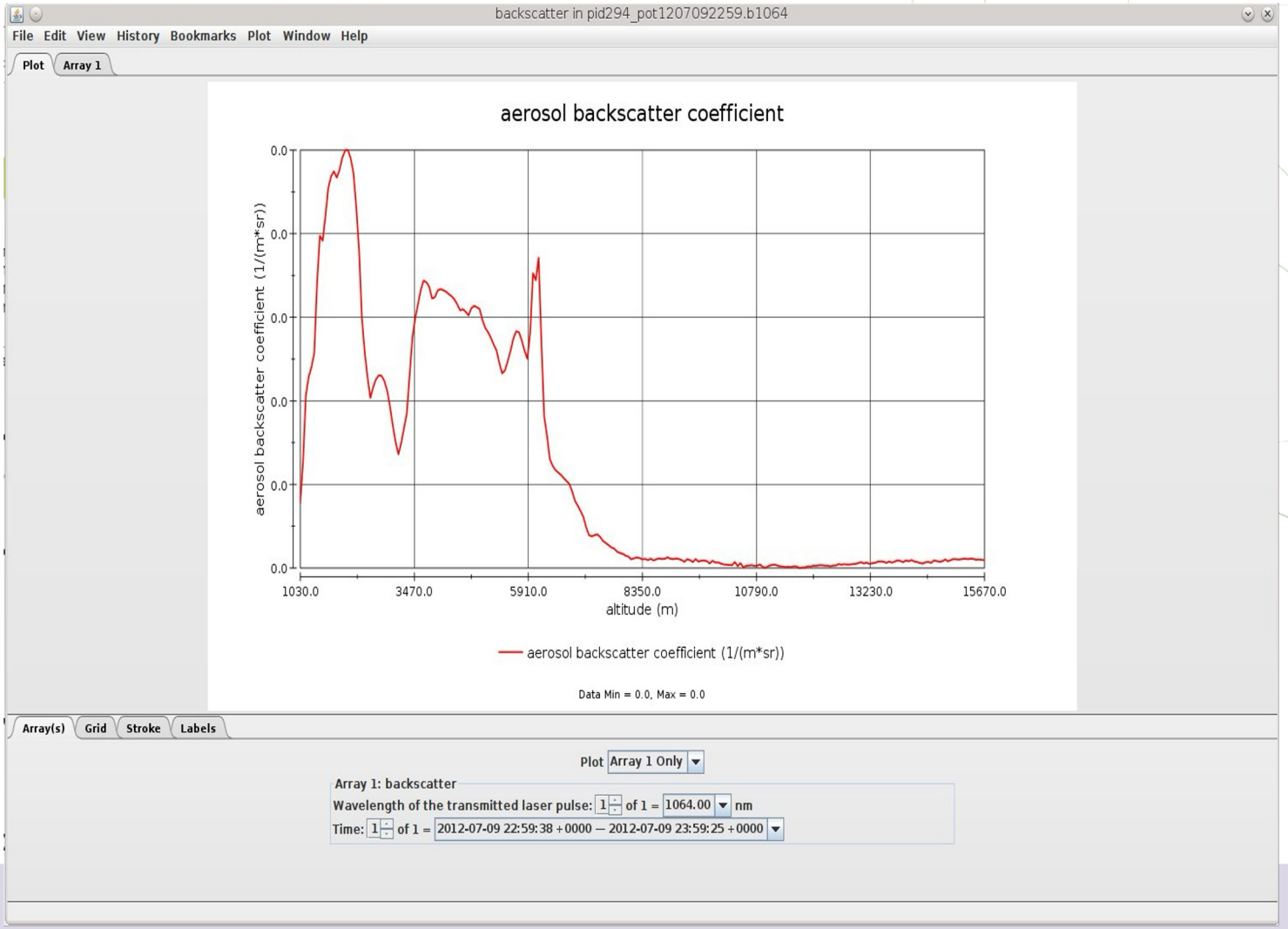

SCC: Requirements

Who can use the SCC?

- In principle any station running one or more lidar systems.
- Many types of lidars are supported:
  - Single wavelength elastic lidar
  - Single wavelength Raman lidar
  - Multi-wavelength Raman lidar
  - Single and multi-wavelength depolarization Raman lidar
  - Multiple telescope lidars (partially)

Not (yet!) supported systems:

- Ceilometer
- MPL
- HSRL
- Water vapour

SCC: Requirements

- “open” lidar systems!
- Access to all the info about the lidar (laser, telescope, acquisition)
- Access to raw data: all the correction should be applied by SCC (traceability)
    - Pure counts for photon-counting signals
    - Volts detected by ADC for analog signals
- Station registered into the SCC
- SCC account
- Insert all the lidar info into the SCC
- Produce an input file compliant with SCC format

THANKS!

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