Deliverable 8.4: Summary report on international ACTRIS training courses

Authors: Paolo Laj, Giulia Saponaro

Work package no	WP8
Deliverable no.	D8.4
Lead beneficiary	CNRS
Deliverable type	X R (Document, report) ☐ DEC (Websites, patent filings, videos, etc.) ☐ OTHER: please specify .....
Dissemination level	X PU (public) ☐ CO (confidential, only for members of the Consortium, incl. Commission)
Estimated delivery date	M40
Actual delivery date	16/05/2023
Version	Final
Reviewed by	Doina Nicolae
Accepted by	Eija Juurola
Comments	

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Contents

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

1. Background and purpose of this document

One of the transversal ambition of ACTRIS IMP is to provide a continuous availability of training both internally and to potential users. ACTRIS is science- and technology-based and, as such, operates at the leading edge of scientific and technological feasibility. It must ensure that all users and operators of the RI have access to the proper level of information to operate instruments as required by ACTRIS standards, produce data with the expected quality, have sufficient information to take full benefits of ACTRIS services. The term "training" in this document must, thus, be understood in the broader context of the transfer of expertise and the dissemination of good practices and of the ACTRIS standards, this transfer not being always unidirectional.

Training is essential, and targets both ACTRIS staff and ACTRIS users to ensure knowledge-sharing and best practice. Training of staff addresses both experimental issues (how to make measurements compliant with ACTRIS standards) and data management issues (how to make data compliant with ACTRIS standards). The training of staff is also part of the ACTRIS international strategy to prepare high-level managers for engaging in building ACTRIS-related infrastructure in other regions of the world. Training of users is aimed at enhancing the use of both ACTRIS instrumentation and methods as well as ACTRIS products by a larger community, and is offered by ACTRIS NFs, TCs, and the DC. Training is essentially targeted to early career scientists, students and new users, but Lifelong Learning for more experienced scientists and managers is not excluded. Training on the use of data and data products is provided via in-situ and hands-on sessions, the new e-ACTRIS environment is developing advanced, state-of-the-art course materials and webinars, where appropriate in close cooperation with the RI members, and made available on e-Training Platforms, to deepen and extend or adapt already existing materials whenever possible. It is critical for the RI that, at all levels, it ensures the high-level training of its users, necessary for the successful operation and long-term sustainability of research infrastructures.

WP8 also targets the international dimension of training in ACTRIS, i.e. how do we make sure that our training offer is open and available beyond the strict ACTRIS community. It is key for ACTRIS to ensure that recommended operations are shared by an international community.

In ACTRIS, training and capacity building in human resources are supported by both ACTRIS DC and ACTRIS CFs.the ACTRIS CFs (HO, DC and TCs). A list of training activities by TCs is provided in table 1.

As part of the internal support, each TC and DC is providing training actions during ACTRIS operations, specifically targeting operators at National Facilities.

Training in ACTRIS is not only targeting operators of the National Facilities but must engage in wider education actions, i.e. targeting not only operators within NFs. ACTRIS training activities must target all personnel either employed by RPOs for running the RI, but also a full dimension of ACTRIS users. ACTRIS IMP therefore develops a plan for training users beyond the current partnership, providing many technical capacity-building opportunities. D8.4 in WP8 therefore summarizes the training efforts.

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Table 1. List of training activities integrated in the TC activity plans.

TC	Specific tasks
ECAC/CAIS	• Building training courses for NF scientists and instrument operators • Generating intensive aerosol courses (physics and chemistry)
CARS	• Organization of CARS training events • Organization of CARS webinars • Consultancy to associated NFs • Consultancy to stakeholders, users and private companies
CIS	• Training of staff • Training of NF instrument operators and/or technicians • Consultancy for potential new observational sites • Consultancy to stakeholders, users and private companies
CCRES	• Training of CCRES staff • Training of NF instrument operators and technicians • Webinars • Consultancy for setting up observation sites • Consultancy to stakeholders, users and private companies
CiGas	• Training for NF instrument operators and/or technicians • Consultancy to users, stakeholders and private companies • Yearly data QA/QC workshops • Provision of online tools for data QA/QC
CREGARS	• Training of FTIR operators • Training of MAX-DOAS operators and scientists • Training of SAOZ operators and scientists • Training of ACTRIS Pandora operators and scientists • Training of O3DIAL operators

2. A training plan impacted by COVID travel restrictions

It is obvious that the original plan regarding training has been modified considerably due to travel restrictions over the COVID pandemia, which lasted from the beginning of the project in March 2020 till mid-2021. This unusual situation drove a massive shut down of universities across Europe and imposed travel restrictions, which entered into force during the first quarter of the 2020. These measures were kept in place, with short relaxation periods, until August 2021. ACTRIS IMP turned remote in its training activities as early as possible but clearly, a number of scheduled training events had to be cancelled in 2020.

Not only COVID changed the expected organization of training events, but also engaged all partners in ACTRIS to adapt the training contents to a new situation. Some courses based on hands-on training (at Central Facilities) or on student interactions and group work had to be adapted to a remote organisation using web-tools such as Zoom, Webex, MS Teams, Big blue button etc. Clearly, COVID created a new paradigm in training bringing positive and negative aspects, with the more negative aspects less tangible to evaluate (how to evaluate benefits of person-to-person interactions? How to evaluate efficiency of teaching on-line?).

On the positive side, remote training can be offered without restrictions with respect to the number of students, with training sessions that were offered to many more international students as previously imagined. In addition, many courses have been recorded and the recordings were made available for the

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

students over a longer period of time. The hybrid format for training is also a way to engage more international participants.

Online training was consistently offered for free in ACTRIS, with simple registration. Because turning into remote training was not anticipated, we have not asked organizers to monitor neither the number of international students attending online nor any information regarding parity. Eventually, and upon demand, this can be extracted from our data bases.

3. Summary report on international ACTRIS training courses

A list of training activities organized in ACTRIS since the start of ACTRIS IMP and until the first reporting period is available in Table 2 below. It is important to note that training activities have continued over the second reporting period and will continue until the end of the project.

The target indicators mentioned in the project are the following:

- #1Plan for human capital development in ACTRIS established
- #2Quantity of user access training organized;
- #3No. of participants from ACTRIS NFs and CFs in training sessions;
- #4No. of external training sessions organised.

Additional target indicators can be added

- #5No. of international participants
- #6No. of female participants

From the Table, we can extract the following informations:

- 35 different training courses were offered in the period from 1/3/2020 to 30/09/2022 responding to target indicator #2
- All TCs have offered at least one training sessions over the period, with often, a specific training session organized by the relevant units of ACTRIS DC, responding to target indicator #3
- More than 1500 people attended the ACTRIS training courses, mostly engineers and technicians involved at NFs, and PhD students and young scientists
- Most training courses were offered on-line, with in-person resuming by the second half of 2021
- Most training courses were offered also externally to ACTRIS, involving attendees from outside the community, responding to target indicator #4.
- ACTRIS staff in the TC, DC and HO units were involved in several of the training sessions.
- A number of training sessions were organized jointly with Universities (U. Koln, U. Helsinki), also offering ECTS.
- A number of training sessions were organized by third parties with ACTRIS staff involved to explain ACTRIS role and services to a wider audience (EUMETSAT training courses, GAWTEC training course)

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

- Training courses were offered both as virtual and in-person. This is partially due to COVID, in particular in 2020 till mid-2021, but gradually became a norm. Offering online training bears some advantages in terms of costs, logistics involved and number of attendees
- ACTRIS also offered managerial training upon demand from different National ACTRIS organisations and other ESFRI RIs.
- The training offer targeting the Atmospheric Simulation chambers is not integrated in ACTRIS IMP but remained in the EUROCHAMP-2020 project.
- Specific innovation training sessions (not included in the Table) were proposed by ACTRIS as part of the RI innovation workshop of EMME-CARE project, in 2021 and 2022
- Some statistical information are missing from this document, related to the exact number of international participants (target#5), to participants not linked to RPOs involved in ACTRIS, and to female participants (target#6). If necessary, we may provide precise numbers on this participation.

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Table 2. List of ACTRIS training sessions held during the period from 1/6/2020 to 30/9/2022.

Activity title	Type	Involved ACTRIS people	No. of students/participants	Explain impact for ACTRIS (Max. 10 lines/1 short paragraph)
Training school: Atmospheric observations of aerosols, clouds and trace gases 2-13.5.2022, virtual	Virtual	Coordinated by University of Helsinki, Finland, Lectures given by top-level experts from the ACTRIS science community and central facilities (in the form of tutorials as listed below)	32	This is an introductory course focusing on in-situ measurements and ground-based remote sensing techniques of atmospheric aerosols, reactive trace gases and clouds. Good opportunity to introduce ACTRIS operations and activies to advanced master students, doctoral students, young scientists (e.g., post docs), and personnel from aerosol measuring stations and research institutes involved in ACTRIS, CRAICC, GAW, GUAN, and EMEP.
Improvement of VOC measurement methods: challenges and best practices (Thérèse Salameh, IMT Nord Europe)	Virtual	CiGas – IMT Nord Eruope unit	72	MetClimVOC Month 18 workshop, open to the whole measurement and metrological community. Good opportunity to share information on ACTRIS - CiGas mission, technologies, instruments improvements, and impact of our activities
Importance of data quality for modellers and end users (Stefan Reimann, Empa)	Virtual	CiGas - EMPA unit	72	MetClimVOC Month 18 workshop, open to the whole measurement and metrological community. Good opportunity to share information on ACTRIS - CiGas mission, technologies, instruments improvements, and impact of our activities

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Atmospheric measurements of volatile organic compounds at monitoring stations (Rainer Steinbrecher, KIT)	Virtual	CiGas - KIT	95	MetClimVOC Month 10 workshop, open to the whole measurement and metrological community. Good opportunity to share information on ACTRIS - CiGas mission, technologies, instruments improvements, and impact of our activities
Hands-on training for photometer operators	In-person	CARS-ASP-AEMET, CARS-ASP-UVA	6	SIte managers are crucial in weekly maintenance and troubleshooting of photometers that prevent data loss and improve the overall quality of the datasets.
GAWTEC & YESS Webinar Series Reactive Gases: Continuous measurements of reactive trace gases over 20 years at the GAW station Hohenpeissenberg (Dagmar Kubistin, DWD) on 30th Nov 2021	Virtual	CiGas – DWD unit	50	Part of GAWTEC webinar series on Reactive Gases, Scientifc guidance and instructions to station personnel from atmospheric monitoring stations (e.g. ACTRIS, GAW), capacity building, promote best practice measurement guidelines from ACTRIS, open to ACTRIS community and other interested persons
GAWTEC Course on Reactive Gases, September 2022 (Robert Holla, Anja Claude, Dagmar Kubistin – DWD)	In-person	CiGas – DWD unit	12	Part of GAWTEC course on Reactive Gases, Scientifc guidance and instructions to GAW station personnel, capacity building, promote best practice measurement guidelines from ACTRIS/GAW

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Aerosol remote sensing webinar (6th July 2021)	Virtual	CARS & ARES	45	Part of a series of technical webinars organized for the aerosol remote sensing National Facilities. The topics cover mostly issues related with aerosol high-power lidar (instrument and data products). The webinars are open to users and are announced on the ACTRIS website. Subjects are proposed by the community and discussions are moderated by CARS and ARES. The main goal is to share experiences, propagate specific operation and quality assurance procedures as well as good practices. Specific topics of this webinar: 1. Backscatter calibration (examples & discussions); 2. Best resolution and full range optimization
Aerosol remote sensing webinar (14th September 2021)	Virtual	CARS & ARES	42	Part of a series of technical webinars organized for the aerosol remote sensing National Facilities. The topics cover mostly issues related with aerosol high-power lidar (instrument and data products). The webinars are open to users and are announced on the ACTRIS website. Subjects are proposed by the community and discussions are moderated by CARS and ARES. The main goal is to share experiences, propagate specific operation and quality assurance procedures as well as good practices. Specific topics of this webinar: 1. Lidar Inversions with Pure-Rotational Raman channels as an alternative to Vibro-Rotational channels

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Aerosol remote sensing webinar (14th December 2021)	Virtual	CARS & ARES	47	Part of a series of technical webinars organized for the aerosol remote sensing National Facilities. The topics cover mostly issues related with aerosol high-power lidar (instrument and data products). The webinars are open to users and are announced on the ACTRIS website. Subjects are proposed by the community and discussions are moderated by CARS and ARES. The main goal is to share experiences, propagate specific operation and quality assurance procedures as well as good practices. Specific topics of this webinar: 1. Solutions for overlap correction 2. An empirical method to correct for temperature-dependent variations in the overlap function of CHM15k ceilometers
Aerosol remote sensing webinar (8th February 2022)	Virtual	CARS & ARES	45	Part of a series of technical webinars organized for the aerosol remote sensing National Facilities. The topics cover mostly issues related with aerosol high-power lidar (instrument and data products). The webinars are open to users and are announced on the ACTRIS website. Subjects are proposed by the community and discussions are moderated by CARS and ARES. The main goal is to share experiences, propagate specific operation and quality assurance procedures as well as good practices. Specific topics of this webinar: Rotational Raman Lines (RRL) and interference filters (IFF)

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Aerosol remote sensing webinar (12th April 2022)	Virtual	CARS & ARES	51	Part of a series of technical webinars organized for the aerosol remote sensing National Facilities. The topics cover mostly issues related with aerosol high-power lidar (instrument and data products). The webinars are open to users and are announced on the ACTRIS website. Subjects are proposed by the community and discussions are moderated by CARS and ARES. The main goal is to share experiences, propagate specific operation and quality assurance procedures as well as good practices. Specific topics of this webinar: 1. Moving a lidar in a new infrastructure: challenge and relevant steps
Aerosol remote sensing webinar (10th May 2022)	Virtual	CARS & ARES	49	Part of a series of technical webinars organized for the aerosol remote sensing National Facilities. The topics cover mostly issues related with aerosol high-power lidar (instrument and data products). The webinars are open to users and are announced on the ACTRIS website. Subjects are proposed by the community and discussions are moderated by CARS and ARES. The main goal is to share experiences, propagate specific operation and quality assurance procedures as well as good practices. Specific topics of this webinar: 1. Some suggestions on SCC interface & more; 2. Automatic data management sustained by ACTRIS-FR & AERIS : implementation for french NFs

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Aerosol remote sensing webinar (20th September 2021)	Virtual	CARS & ARES	55	Part of a series of technical webinars organized for the aerosol remote sensing National Facilities. The topics cover mostly issues related with aerosol high-power lidar (instrument and data products). The webinars are open to users and are announced on the ACTRIS website. Subjects are proposed by the community and discussions are moderated by CARS and ARES. The main goal is to share experiences, propagate specific operation and quality assurance procedures as well as good practices. Specific topics of this webinar: 1. OBIWAN = the software tool for automatic submission to, and retrieaval of SCC products (Licel); 2. ATLAS = the software tool for QA/QC tests analysis – scope and structure
Aerosol remote sensing workshop (13-14th October 2021)	Virtual	CARS & ARES	72	The focus of the workshop is to present and discuss the Guidelines for ACTRIS aerosol remote sensing National Facility, and the requirements applicable during the labelling Step1a (initial acceptance). The workshop was open to ACTRIS National Facilities and users (https://www.actris.eu/topical-centre/cars/announcements-resources/actris-aerosol-remote-sensing-workshop)
Aerosol remote sensing workshop (27th October 2022)	Hybrid	CARS & ARES	152	The focus of the workshop is to present the new developments at CARS and ARES, and to discuss the current status of the aerosol remote sensing instruments and data products, in view of the upcoming NF labeling. The workhop addresses the PIs of the future aerosol remote sensing National Facilities and their teams, as well as to the external aerosol remote sensing community (https://www.actris.eu/topical-centre/cars/announcements-resources/actris-aerosol-remote-sensing-workshop-2022)

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Cloud remote sensing workshop (21 Sept 2021)	Virtual	CCRES	74	Presentation of CCRES's national facilities. Data processing, calibration strategy, Data transfer activities and quality assurance strategy were subjects of this workshop. Planning ACTRIS week, and the objectives of CCRES at this meeting
Cloud remote sensing workshop (3 and 5 May 2022)	Virtual	CCRES	65	This CCRES workshop focused on the labelling process: the CCRES requirements needed in order to achieve Step 1A, the CCRES labelling pilots, CCRES quality control that will take place as part of the labelling process.
Cloud remote sensing workshop (14-15 Nov 2022)	Hybrid	CCRES	41	One of the focus of the workshop was to present and discuss the Guidelines for ACTRIS labelling, for cloud remote sensing National Facilities, and the requirements needed for labelling Step1a (initial acceptance), explain the process. An update on technical highlights, scientific highlights was made. ALC preprocessing for CARS and CCRES products, presentations of boundary layer characterization and detection were discussed. The workshop was open to ACTRIS National Facilities and users.
Training school: Microwave radiometer workshop (31 Aug-02 Sept 2022)	In-person	CCRES	14	The workshop started with some background in microwave radiometry theory, applications, and retrieval development. On the first afternoon, a visit from a representative of the main radiometer manufacturing company (Radiometer Physics GmbH). The second day was dedicated to practical experiences, (follow calibrations using liquid nitrogen as well as the exchange of a radome). This workshop was wrapped up with some information on radiometer operation in ACTRIS and new data processing software tools.

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Training session on Disdrometer operation implementation (15 Nov. 2022 during CCRES workshop)	Hybrid	CCRES	30	The focus of this training was on the Disdrometer and the monotoring of stability of DCR reflectivity using disdrometers. The instrumental, technical set-up, the configuration rules and the calibration are subjects that were discussed during this training.
Staff exchange from CARS to the HO (23-27 January 2023)	In-person	Head Office	2	Staff exchange visit from CARS to learn the HO managemet processes and workmodes
Cross RI workshop with eLTER (24 August 2022)	In-person	Head Office	10	A workshop to share experiences and best practices
ACTRIS In Situ Data Centre intensive support period for aerosol data submission (18 – 21 May 2021)	Virtual	DC In Situ	10	A period of intensive online support for submitters of ACTRIS In Situ data, right before the reporting deadline.
Data curation in ACTRIS In Situ, part of Hyytiälä Training Courses (5 May 2021)	Virtual	DC In Situ	25	Graduate course for techniques of observing properties of atmospheric aerosol particles at surface in situ stations, lecture on data handling, management, reporting, and analysis.
Data curation in ACTRIS In Situ / GAW aerosol / EBAS, part of Hyytiälä Training Courses (5 May 2022)	Virtual	DC In Situ	25	Graduate course for techniques of observing properties of atmospheric aerosol particles at surface in situ stations, lecture on data handling, management, reporting, and analysis.

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

CiGas data QC workshop: ACTRIS and the EBAS data archive (27-28 April 2021)	Virtual	DC In Situ	40	Data management and reporting aspects for reactive trace gases in ACTRIS
CiGas community workshop: CiGas data provision (08 February 2022)	Virtual	DC In Situ	40	Data management and reporting aspects for reactive trace gases in ACTRIS
CiGas data QC workshop: ACTRIS and the EBAS data archive (28 April 2022)	Virtual	DC In Situ	40	Data management and reporting aspects for reactive trace gases in ACTRIS
RI-URBANS data submission workshop (16 November 2022)	Virtual	DC In Situ	40	Reporting of data on atmospheric properties from urban air quality networks and associated measurement campaigns
ACTRIS aerosol in situ community meeting: Data Reporting for Aethalometers (27 January 2022)	Virtual	DC In Situ	60	Introduction to data reporting procedures for aethalometers for observing the particle absorption coefficient
ACTRIS aerosol in situ community meeting: Annual data reporting, news and updates (25 January 2023)	Virtual	DC In Situ	60	Annual reminder of data reporting procedureds and deadlines.
CCIce workshop on QA/QC of INP measurements (15.-16.11.2022)	Virtual	CIS	38	status and discussion of CCIce techical requirements and standard operation procedures

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

CCIce workshop on QA/QC of INP measurements (21.09.2021)	Virtual	CIS	19	status and discussion of CCIce techical requirements and standard operation procedures
ECCINT and CCWaC workshop "pilot intercomparison" at SBO (21.11.-05.12.2022)	Hybrid	CIS	38	Pilot intercomparison and testing of in-situ cloud instruments and cloud water samplers. The goal is to carefully activate the operational use of ECCINT, to establish contact with the NFs and to gain details on the instrumentation. This is the basis for further workshops.
ECCINT internal training workshop for SBO staff	In-person	CIS	10	Presentation of ECCINT, including introduction of the organization, planning of the pilot intercomparison, handling of CIS instrumentation. The goal is to carefully implement the operational use of ECCINT and to test trainings for the NFs with the SBO staff.

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

4. International dimension of training in ACTRIS

Capacity development is not, *per se*, an objective within ACTRIS although it is clearly the basis for supporting the sound provision of data and services across the entire value cycle, from operation and maintenance of observations to data processing, data sharing, modelling, data assimilation and dissemination. With the ambition of developing as a Global Research Infrastructure ACTRIS must, to that respect, promote the use of its services at global scale. Global interoperability also means that ACTRIS would promote its choices in relation to technology used for monitoring, standard operating procedures, data managements, including formats, etc… beyond its strict community of users. The international dimension of training must therefore be considered in ACTRIS strategy.

The communication strategy in ACTRIS reaches communities that are beyond ACTRIS member and observer countries. In fact, most training events listed in Table 2 have attracted students from Regional Partners (countries not yet in ACTRIS) and from outside Europe. The exact number of international students participating to ACTRIS training events is not available in this deliverable but can be presented if required. Clearly, the switch from on-site to remote training, originally motivated by travel restrictions due to COVID, have proven essential to increase the number of trainee, and of international trainees in particular. Clearly, modern communication systems offer very interesting features for training. The only restriction to an even wider participation is obviously linked to time differences.

ACTRIS international training can either consist of attracting more international participants by widening its communication or by getting officially engaged in capacity development activities organized by thirsd parties. For example, Global Atmosphere Watch Training and Education Centre (GAWTEC) regularly organize topical and specialized workshops dedicated to training of GAW station personnel in the scientific and technical perimeter of ACTRIS. It is important that, when relevant, the technical solutions proposed during the GAWTEC sessions are aligned with ACTRIS. ACTRIS must pursue a close collaboration with GAWTEC in the future to ensure that ACTRIS-compatible messages are given to participants. Because ACTRIS is also operating World Calibration Centers and World Data Centers for GAW, official engagement of ACTRIS in GAWTEC would make sense. Twinning partnerships with other non-European institutions for training could be further developed in the future.

5. Plan for human capital development: offering a structured and coherent training offer in ACTRIS

ACTRIS-IMP realized the objectives of offering technical training for ACTRIS assuring high-level technical competences within the NF operators and engaging in active training of users of ACTRIS, with all elements involved (TC, DC and HO). Training in ACTRIS also was extended to the larger environmental domain with

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

developing the FAIR approach in ACTRIS DC, and the associated training sessions organized within the ENVRI-FAIR projects.

One of the target indicator proposed in the project (#1) was to establish a plan for human capital development in ACTRIS. The plan must have two principal objectives: 1) to offer training sessions to all categories of personnel, from inside ACTRIS (NF operators) to outside (the community of users) and 2) to be well structured (easily understood by potential attendees) and sustainable (from both the attendees side – registration costs – and the organizers side – organisation costs -).

5.1 Offering a well-structured training offer to ACTRIS communities

The overall aim of ACTRIS is to provide open and easy access to resources and services to a broad user community world-wide to conduct excellent research, foster innovation and provide high-quality information for society to tackle societal challenges related to air quality, climate change and health. ACTRIS is one of the rare distributed RI in the environmental domain that provides virtual, remote and physical access, to its advanced research facilities.

As such, ACTRIS develops a user strategy serving its users at the centre of operations and strategic development. The user strategy guarantees that the value proposition offered to the identified user communities remains current and continues to fit user needs. Training is an important pillar of this strategy which is with the goel to get new users on board, to familiarise potential users with ACTRIS services and to favor their uptake for contributing to excellent science. The user engagement strategy through training must be addressed in the long-term by targeting young scientists, post-docs and PhD students, establishing familiarity with ACTRIS services and collecting feedbacks so that users have a real influence over the services that are relevant for their research. In parallel, ACTRIS training offer shall also be organized in the short-to-medium term by developing capacity at the NFs to implement the tools defined by the various TCs and DC to support ACTRIS operations (defining procedures and tools for quality assurance and quality control of measurements and data, performing quality assurance and quality control of instruments and measurements). Generally organized by TCs and DC, instrumentation- and measurement-related training courses target operators at the NFs ensuring training and transfer of knowledge to ACTRIS operators. Obviously, because ACTRIS aims at becoming a Global Research Infrastructure, TC and DC related training must be opened to a wider community than the strict NF staff.

Finally, training activities can be addressed at managerial level. ACTRIS is a large research infrastructure, operating in 19 different countries. Over the years, the ACTRIS Head Office and some National ACTRIS offices have developed very specific competencies to meet the needs of Research Infrastructures in the planning, construction and operation phases. ACTRIS managerial training offer considers the need to develop the new generation of executives in national ACTRIS, but also to share ACTRIS managerial experience with other RIs, in the field of Environment or beyond.

Overal, our training offer targets 3 levels of users:

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

Table 1. List of training activities integrated in the TC activity plans.

Targeted users	Objectives of training	Main Content of training	Organizers
Personnel in charge of operating instrument at NFs and delivering data to ACTRIS Personnel operating instruments at facilities	To ensure ACTRIS procedures are well implemented at NFs and at associated sites, in Europe and Worlwide.	Understanding instrument functioning, Hands-on training on instruments, explaining implementation of SOPs, training on data reduction procedures.	Topical Centers experts
Community using ACTRIS services including academic research but also the international community of users and, for specific cases, the private sector	Facilitate and promote the use of ACTRIS by the scientific community. Provide ECTS for participants in their PhD program	Overview of the complex Earth system. Need for integrated approaches connecting Aerosol, clouds and reactive gases. Hand-on training on data and data products	ACTRIS expert scientists (NF scientific and Technical forum)
National ACTRIS managers and staff	Ensure implementation of ACTRIS policies in the various ACTRIS countries. Support establishment of new RIs in the European landscape	Governance and organisation of RIs, funding model, ethical and legal frameworks, management of organisational structures, IP regulations, data policies	ACTRIS Head Office (and advanced National ACTRIS offices)

5.2 Sustainability of training offer in ACTRIS

In addition to targeting the proper users, the ACTRIS training offer must be sustainable. Sustainability means

- The offer must be repeated over time (annual, bi-annual, etc..) so that participation can be planned in advance, possibly over identical time slots (ACTRIS level2 spring course)
- The offer must be clearly targeting a specific audience : engineers, technicians, managers, PhD students, Post-docs, young scientists.
- The offer must be attractive to participants, avoiding duplication with existing training offers, in ACTRIS and beyond ACTRIS.
- ACTRIS courses must be recognized for the quality of training and its uniqueness
- The offer must be affordable, limiting costs to participants, and avoiding a situation where training sessions would address the same target users over the same time period.
- The offer must be complementary avoiding duplication of contents and target users. It is important internal support offered as part of the TC and DC operations (see Table 1) is well-

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

differentiated or well-integrated in the training/education offer of ACTRIS, keeping in mind the ACTRIS economic model

- The modalities for training (virtual, in-person or hybrid) must be addressed in terms of efficacy, number of attendees and costs. Each CF has a specific modality to organise the training, either as data workshops, instrument workshops, courses or webinars, depending on the envisaged subjects and also on the preferences of the associated community.
- The offer must be easy to read for potential users, and well disseminated in ACTRIS and outside.

6. Conclusions

While ACTRIS IMP succeded in its objectives to offer a series of scientific, technical and managerial training for ACTRIS operators, users and managers, and for a larger community of potential users, we cannot consider that a well-structured and sustainable training offer is yet in place in ACTRIS.

It is certainly a recommendation to maintain a high degree of subsidiarity at CF level to respond to the identified training needs and to give TCs, DC and HO the agility to propose regular training opportunities. This however, must be organized within a framework that will be rapidly understood by potential users. In D8.4, we can make a series of recommendation that will lead to a better organized and sustainable training strategy

- Make sure the ACTRIS training offer is clearly defined, and clearly adding-value to existing training and education initiatives. Consider that the ACTRIS training offer may also be integrated in other training courses, ensuring that the ACTRIS dimension remains visible to users, and coherent with respect to the overall training offer
- Implement recommendations listed in section 4 for a well-structured and sustainable training offer in ACTRIS.
- Make sure the ACTRIS training offer is well visible in https://www.actris.eu. At present, training is listed in “Event and News” under “Training Events”. It is advertised through the ACTRIS newsletter and emails, but diffusion outside the ACTRIS community is not monitored. Evaluate whether the training offer shouldn’t also be appearing in the catalog of services.
- Evaluate how the different forms of training are used and labelled: training courses, webinars, schools, etc…
- While the training offer by the different TCs can take different formats, it is important that this is clearly compiled and explained in the ACTRIS web pages, and easily found. It is important that users can organize their participation in advance.
- Ensure proper distinction is made between internal support offered by TC/DC and training sessions when targeting NF operators.
- Consider the use of SAMU as unique registration portal for all ACTRIS training sessions (excluding internal support), and ensure the right information is collected for future statistical use (gender, provenance, role in the organization, etc..) registration
- Ensure proper dissemination of information by the ACTRIS communication officer in the Head Office

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115

- Define the specific training offer for the Atmospheric Simulation Chamber communities, if needed
- Define the specific training offer for partners in the private sector.
- Make sure the ACTRIS training offer continues to address all dimensions of ACTRIS users (See table 3)
- Address the capacity of ACTRIS to transfer good practices and standards at policy-making level
- Promote the international dimension of training by using modern communication technologies – such as streaming and subsequent online publication of training sessions, webinars, or video conferences – to reach out to a broader audience.
- Promote the cooperation with GAWTEC for courses relevant to ACTRIS instrumental perimeter.

ACTRIS IMP (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRADEV-2019-2, Grant Agreement number: 871115