

## D5.5 – Final report on ACTRIS training and education programme

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<b>Work package no</b>	<b>WP5</b>
<b>Deliverable no.</b>	<b>D5.5</b>
<b>Lead beneficiary</b>	<b>UHEL</b>
<b>Deliverable type</b>	<input checked="" type="checkbox"/> R (Document, report) <input type="checkbox"/> DEC (Websites, patent fillings, videos, etc.) <input type="checkbox"/> OTHER: please specify .....
<b>Dissemination level</b>	<input checked="" type="checkbox"/> PU (public) <input type="checkbox"/> CO (confidential, only for members of the Consortium, incl Commission)
<b>Estimated delivery date</b>	<b>Month 42</b>
<b>Actual delivery date</b>	<b>15/06/2019</b>
<b>Version</b>	
<b>Comments</b>	

## 1. Strategies for ACTRIS courses and main outcome

Efficient use of ACTRIS Research Infrastructure platforms requires both knowledge of the scientific relevance of observations and skills to optimize use of instruments and data sources within the experimental framework. ACTRIS provides a continuous availability of training and capacity building both internally and to its users, in Europe and beyond. Training in human resources is supported at different levels in ACTRIS by ACTRIS CF activities, TNA actions and through specific courses. WP5 targets these specific courses to maintain its unique cross-border training courses that have made the reputation of the RI. The aim in WP5 is to offer opportunities within and outside the ACTRIS consortium to train new users on the ACTRIS products and tools. Different training courses have been offered corresponding to different user typologies.

- Courses dedicated towards developing internal operations in ACTRIS (i.e. implementation of SOPs, quality control/quality analysis and data submission procedures, specific training on newly developed ACTRIS tools and products. Internal tutorial workshops are also organized in co-location with Central Facilities to improve knowledge transfer among ACTRIS-2 partners and associated
- Courses dedicated towards enhancing the uptake of ACTRIS products targeting users in the academics, in the private sector or by public authorities. Training activities also include dedicated ACTRIS courses targeting users outside Europe to international associated partners. Online MOOC (Massive Open Online Course) directed towards new operators of ACTRIS platforms may be included in the catalogue of training activities in the future.

Overall, courses were regularly offered during the course of the project. Courses targeting internal operations are mostly organized within the framework of both WP2 (remote sensing / vertical column) and WP3 (in-situ). Courses targeting users are organized in a larger framework, that allow clear opening to international users. Altogether, in ACTRIS-2, besides the specific training activities performed at the Central Facilities, 12 advanced and basic courses were offered to more than 250 attendees, from both inside and outside the project. Beneficiaries belong to universities and research performing organizations. Courses were provided to a whole range of attendees from technicians operating stations, to scientists using data or access to the RI to disseminate a culture of open data, from data provider to data users.

Through these courses, ACTRIS consolidated the European position as a leader in several international atmospheric networks and a leading actor globally. ACTRIS transfer of knowledge activities supported international networks such as the Global Atmosphere Watch of WMO, and indirectly, favoured adoption of standard operating procedures for measurement, calibration and data curation developed in ACTRIS. ACTRIS courses are part of a strategic and efficient communication practices to strengthen the link with the user communities, and to educate the next generation of ACTRIS scientists and operators.

At all times, ACTRIS courses were aimed a providing a good balance between internal and external users, ensuring balanced human capital development in ACTRIS following the

European Charter for Researchers and giving special attention for engaging early or mid-career scientists and promoting gender equality within attendees but also within lecturers. International courses were also always organized to promote regional initiatives connected to ACTRIS.

It should be noted that, parallel to the ACTRIS-2 courses, a number of national initiatives were organized, both in Europe and outside, involving ACTRIS lecturers and often organized using the ACTRIS “course format”. This national ACTRIS courses are not listed as part of WP5 activities but are clearly supporting the development of Regional Partner Facilities together with the integration of ACTRIS in the national research infrastructure landscape. The success of ACTRIS is tightly connected to effectively functioning National ACTRIS consortia that provide support to the implementation and operation of NFs and CFs.

As a general strategy, the development of specific skills for data stewardships and the specific training of research infrastructure staff have been delegated as part of the ENVRIPLUS project, and now, as part of the ENVRI FAIR project. However, specific training sessions for ACTRIS data management were regularly offered, often integrated in the courses. Extensive training and dissemination of data policies is the most efficient way to ensure adoption of best practices in ACTRIS, by all providers.

Training material for ACTRIS courses is often directly gathered at Central Facilities, with CF facility leaders often involved in the courses. This was very efficient to promote state of the art methodologies, directly related to the services offered by the RI and simultaneously expanding and updating best practices in the consortium. All training materials - including documents, tutorials, and some instructional videos – are provided in Open Access.

## 2. Courses targeting WP3 Aerosol and trace gases in-situ communities

Several courses to deeper train students and young scientists have been organized at the Hyytiälä station in Finland throughout the project gathering around 30 participants per training.



*Group picture at aerosol course at Hyytiälä May 2018*

The content of the courses are described below:

- [12<sup>th</sup> Summer School on Atmospheric Aerosol Physics, Measurement, and Sampling](#), 20-27 May 2016

The training course was intended for summer school is intended for Ph.D students, young scientist, and personnel from aerosol measuring stations to get training on aspects related to atmospheric aerosol measurements: Physical, mechanical, and electrical properties, sampling losses, particle filters, impactors, mobility and aerodynamic size spectrometers, particle counters, integrating nephelometer, absorption photometers, online mass measurements, aerosol mass spectrometer, artefact-free sampling, and aerosol dryers.

- [13th School on Atmospheric Aerosol Physics, Measurement, and Sampling](#), 5-12 May 2017

This summer school was an advanced course for deeper training of aspects related to atmospheric aerosol measurements. The very important dimension linked to data management was an addition to the course, highlighting the need for end-to-end approach in atmospheric measurements, from observations to usage.

- [14th School on Atmospheric Aerosol Physics, Measurement, and Sampling](#), 11-18 May 2018

This summer school was an advanced course for deeper training of aspects related to atmospheric aerosol measurements. The content of the course was similar to the summer schools described above.

### **3. Courses targeting WP2 remote sensing of Cloud, and aerosol communities**

Training and education actions are also regularly held during activities at Central facilities leading the 2 different Remote Sensing CFs. The courses and trainings are described below:

- [1st LiCalTrain workshop](#), Bucharest, Romania, 23-27 May 2016

The hands-on training was hosted by the LiCalTrain facility in Bucharest during 23-27 May 2016. The workshop was dedicated to un-experienced users that are unfamiliar with instrument operation and need to implement measurement and QA procedures available within the network. The main focus of the workshop aimed the basics of the instrument, common instrument problems and solutions, ACTRIS-EARLINET QA tests, good practices in operation and maintenance of the lidar, problem identification for individual cases and introduction to data check-up procedures.

- [2nd LiCalTrain workshop](#), Bucharest, Romania, 27 February - 3 March 2017

The second workshop focused on data processing with emphasis on depolarization measurements and their calibration. The specific topics covered will include: a) Pre-processing and optical processing of lidar signals b) Correction of polarization effect on lidar signals c) Calibration of depolarization measurements d) Use of SCC to automatically perform these tasks.

- [Data training Workshop on Data Submission to EBAS](#), Kjeller, Norway, 26-28 October 2016

A training course for data formatting and submission, including use of the EBAS tool was organized by NILU in October 2016. It focused on data quality and data reporting.

- [Cloudnet Training School](#), Limassol, Cyprus, 27-31 March 2017

TROPOS and Cyprus University of Technology hosted the first Cloudnet Training School at Limassol, Cyprus in March 2017. The one-week course introduced new users to the concept of Cloudnet and enable more experienced users of Cloudnet to deepen their understanding and/or implement new methods.

- [2nd Cloudnet Training school](#), Munich, Germany, 11-15 March 2019

The training school included basic lectures about cloud radar, lidar and microwave radiometers as well as an introduction to the newly developed python3-Cloudnet code. The current state and application of new forward operators for numerical models and forward-iterating microphysical retrievals was also part of the Training School. Four workshops dealt with cloud radar spectral processing, data evaluation, moving platforms and application of the VARCLOUD algorithm to Cloudnet data.

- [SCC Winter School](#), Potenza, Italy, 4-6 December 2018

The school focused on the usage of the new version of the SCC which was released in the end of October 2018. This version will contain several new features like the generation of new products (high resolution pre-processed products, cloudmask, quicklooks,..). Such new features were described during morning sessions and in the afternoon hands-on sessions were organised where all the participants can really test what has been described in the morning sessions. 25 people participated in this course.

#### 4. Courses developing Multidisciplinary Approaches

- [Winter school on Atmospheric Processes and Feedbacks and Atmosphere-Biosphere Interactions](#), Hyytiala, 7-18 March 2016

The winter school is an advanced course intended for PhD students in atmospheric and biospheric sciences and advanced MSc students. This course in particular has the following main topics: quantification of the CRAICC feedback loop and quantification of the

- [Autumn School Hyytiälä](#), Hyytiälä, 5-16 October 2015

The intensive course "Physics, Chemistry and Biology of Air Pollution and their Effects" was held at the Hyytiälä Forestry Field Station. This course in particular had the following main topics: 1) Biogenic Aerosols – Effects on Clouds and Climate (in relation to the BA ECC campaign in 2014); 2) Ecosystem-atmosphere exchange of greenhouse gases and trace gases (= COS, VOCs, CO, O<sub>3</sub> etc.) and 3) Feedback loops related to atmosphere-biosphere interactions BACCHUS/COBACC feedback loop.

- [Hyytiälä Winter School on the observation and modeling of high-latitude and Arctic clouds](#), Hyytiälä, 19-25 March 2017

The winter school is an advanced course intended for graduate students and researchers who want to receive up-to-date knowledge on the observation and modeling of clouds and precipitation, with a specific focus on Arctic and high-latitude clouds. The course is structured around a combination of lectures and hands-on experience using data from research-grade radars (US DOE ARM and ACTRIS), in situ sensors and state-of-the-art models.

- [Hyytiälä Winter School 2018 - Advanced Analysis of Atmosphere-Surface Interactions and Feedbacks](#), 5-16 March 2018

The course focused on ACTRIS integration of observations, COBACC feedback loop from in-situ to remote sensing, new particle formation in pristine and megacity surroundings. Some of the transferable skills the course strived to improve: statistical analysis and use of MATLAB, multidisciplinary approach, project management, collaborative learning, broadening of the personal comfort zone and introduction to SMEAR II measurement station.

- [Hyytiälä Winter School 2019 - Advanced Analysis of Atmosphere-Surface Interactions and Feedbacks](#), 4-19 March 2019

Similar to INAR annual Autumn/Winter Schools, the course was based on intensive work in small groups, with MATLAB being the main tool for statistical analysis. This course in particular had the following main topic: Boundary layer dynamics – from boreal forest to mountain top.

## 5. Time series analysis in environmental science and applications to climate change

ACTRIS-2 actively participated in the second and third training school and conference on "*Time series analysis*" organized within the ENVRIplus framework in [November 2016](#) and [January 2019](#). The concept of this event was to gather scientists from a large range of disciplines in Earth Sciences based on regular and constant in-situ measurements, and provide a discussion forum in the field of time series analysis and forecasting. Based on in-situ and remote data analysis and modelling, the conference gathered senior and young researchers (post-doctoral, doctoral and master students)

to share their experience in time series interpretation across several scientific fields. Both events gathered around 50 PhD students, post doc and researchers.

- [2<sup>nd</sup> Time series analysis in environmental science and applications to climate change](#), Tromsø, Norway, 8-11 November 2016, Organised by Ifremer and ENVRIplus

The conference focused on the implication of climate change on the environment, including land, sea and atmosphere. The training part consisted in a plenary session including all students, followed by group sessions for a better interaction between students and teachers.

- [3<sup>rd</sup> "Time series analysis" conference and training school](#)

The third training school and conference on "Time series analysis" was held in Tromsø (Norway) from 28.-30.01.2019 with focus on environmental science and applications to climate change, with a particular focus on atmospheric composition and time series measurements.



*Group picture, 2nd Time series analysis training school, November 2016*

## 6. Courses offered in the international context

[The School of Atmospheric Measurement in Latin America and the Caribbean SAMLAC](#), Puerto Rico

The proposed training school is part of the International Global Atmospheric Chemistry Project Americas Working Group (IGAC-AWG), which aims to build a cohesive network

and foster the next generation of atmospheric scientists, with the ultimate goal of contributing to development of a scientific community focused on building collective knowledge in/for the Americas, with a focus on Latin America and the Caribbean (Andrade et al. BAMS, 2016). Goals are to Improve regional capacity and stimulate the development of aerosol and reactive gases monitoring programs (regional and national) that can contribute with their data to regional and international projects and networks, to Foster the building of a community of atmospheric scientists in the Latin America and the Caribbean (LAC) region in order to provide expertise on topics related to atmospheric composition and its relation to anthropogenic emissions and natural variability to government agencies and international research, and 3) Educate early career scientists from the Latin America and the Caribbean region on global and regional aspects of atmospheric composition change and atmospheric composition monitoring.

[Latin American and Caribbean Aerosol Measurements School: from measurements technologies to applications](#) June 22-27, 2015. Universidad Mayor de San Andrés, La Paz, Bolivia.

Monitoring atmospheric composition has always been an important task within atmospheric sciences. This has become even more important in recent years due to observed changes in gas and aerosols concentrations. The rapid advances in technology and the increased scientific interest in measuring atmospheric composition have created the need to train scientists in measurement techniques. As discussed in the last meeting of the Americas Working Group of the International Global Atmospheric Chemistry Project (IGAC-AWG for short) August 2014, measurement technique training is particularly important in the Latin America and Caribbean (LAC) region. It was decided at the IGAC-AWG meeting there was a need to promote specialized training in atmospheric measurements, especially focused on aerosols with an emphasis on black carbon. The main goal of this course is to improve the knowledge and skills in issues related to atmospheric measurements focusing on aerosols and black carbon for LAC scientists and graduate students who are close to finishing their MS or PhDs.

[GAW TEC](#) Global Atmosphere Watch - Training & Education Centre

GAWTEC provides scientific guidance and instructions to GAW station personnel from worldwide global and regional stations. Basis ACTRIS aerosol courses (1,5 days) were co-organized with [WMO- GAWTEC](#) and were held at the Environmental Research Station Schneefernerhaus in [October 2015](#), [April 2016](#), [September 2017](#) and [April 2019](#). The course was directed towards operators of ACTRIS and GAW stations. This course provided basic training on specific aerosol instruments and critical to the long-term success of the program as it also addressed personnel operating GAW/ACTRIS stations outside Europe, where ACTRIS wants to develop awareness on the need for high quality measurements. The ACTRIS GAWTEC is part of the capacity building strategy of the project. The course covered measurement techniques, lab courses, theoretical background of atmospheric physics and chemistry and data handling and interpretation.





*GAWTEC 33, 33th training session, September 17th - 30th, 2017*

Additional training sessions were organized jointly with GAW and directed towards station operators and young scientists outside Europe. It is fundamental that ACTRIS takes the leadership to provide the right level of skills to operate aerosol measurements not only within Europe but also outside Europe political borders. Training courses were organized in Bolivia, India and South Korea, each time addressing more than 50 students, engineers, and young scientists. A very important issue is that courses were always integrating at similar levels the technical dimension (how to operate specific instruments) the quality dimension (how to ensure that data respond to quality objectives) and data-policy dimension (how to ensure proper usage of measurements). ACTRIS is promoting the open-data policy in atmospheric science worldwide, starting with education of young scientists. Feedbacks from participants to those courses were extremely positive.