Deliverable 9.1: Progress Report on the position of ACTRIS in the European Innovation Ecosystem

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Work package no	WP9
Deliverable no.	D9.1
Lead beneficiary	MUI
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	M18
Actual delivery date	29/12/2023, initially submitted 30/06/2021
Version	Final
Reviewed by	Ulla Wandinger, Niku Kivekäs
Accepted by	Eija Juurola
Comments	

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1. Introduction

The document has been prepared in the context of the activities of the ACTRIS IMP project (Aerosol, Clouds and Trace Gases Research Infrastructure Implementation Project), which aims at taking ACTRIS into a new level of maturity supporting the implementation of the organizational, operational, and strategic frameworks of the Research Infrastructure (RI). In particular, Work Package 9, coordinated by CNR, deals with the positioning of ACTRIS in the European Innovation Ecosystems with the primary aim to increase the interest of the private sector in ACTRIS as an innovation platform and to identify strategies and recommendations that may be adopted to nourish industrial innovation and to promote actions for effective technology and knowledge transfer. In fact, although the primary mission of RIs is to provide resources and services for conducting research, they also have significant innovation potential for providing new technological solutions, methodologies and services, and supporting instrumentation development for private sector users. In this regard, the white paper from European Strategy Forum on Research Infrastructures (ESFRI, 2021), recognizes the potential of RIs as knowledge and innovation hubs and acknowledges the strategic importance of strengthening the interactions with their surrounding economic and industrial environment to boost innovation and sustainable development.

This report focuses on the assessment of the current positioning and role of ACTRIS in the European Innovation Ecosystem, with evidence of best collaborative practices with the private sector. The report investigates ACTRIS collaboration with industry through a desk analysis and direct engagement with the business community through empirical surveys, dedicated innovation workshops and other initiatives such as newsletter, mailing list, etc.

The desk analysis has been carried out on previous and ongoing projects (ACTRIS-2, EUROCHAMP 2020, ACTRIS PPP, ACTRIS IMP and ATMO-ACCESS), in which the scientific ACTRIS community has succeeded in involving industry in different ways as supplier, co-developer, and user. It also benefited from ACTRIS IMP milestone *MS52 Identification of collaboration models between ACTRIS and the private sector*, which gives an overview of the different types of collaboration between ACTRIS and the private sector to provide a conceptual framework for sound interactions with industry in all possible models for technology and knowledge transfer. In detail, the analysis focused on Trans-National Access (TNA), collaborative research projects in the different ACTRIS Topical Centres (TCs), and the scientific collaboration between the ACTRIS community and industry. Concerning this last point, a bibliometric analysis on ACTRIS scientific productivity has been carried out including publications from 2020 until August 2023, extracting papers with co-authorship with industry partners.

The report is structured as follows: Section 2 provides an overview of the main typologies of collaborative relationships between ACTRIS and industry and includes some examples of best practice. Section 3 presents results from the empirical analysis of the collaborative relationships between ACTRIS and industry. Finally, in Section 4, some recommendations are provided for identifying and sharing future collaborative strategies to unlock the innovation potential of ACTRIS and for promoting effective technology and knowledge transfer to industry.

2. ACTRIS and industry collaboration: typologies and best practices

Collaboration and potential interactions between companies and Research Infrastructures (RIs) may arise in several areas, ranging from those which are more commonly associated with research activity such as new knowledge creation and dissemination, to those that are more commonly linked with technology transfer, such as:

- industrial supplies to RIs;
- usage of the RI facilities and knowledge by the private sector;
- co-development and co-design of innovative products and solutions.

However, the interaction between the companies - especially those of small and medium size - and RIs is not systematic and is often characterized by the resistance to be engaged in complex RI technology co-development processes, leading to innovative products and solutions. This calls for collaborative strategies based on understanding industry needs to ensure effective technology and knowledge transfer services leading to innovation.

Starting from an overview of the companies collaborating with ACTRIS, the main domains of collaboration are explored, specifically: Trans-National Access (TNA); collaborative research projects involving ACTRIS TCs; and, finally, scientific collaboration between the ACTRIS community and industry.

2.1 Overview of the companies collaborating with ACTRIS

In August 2023, the number of companies that collaborated with ACTRIS as suppliers, users, or partners in collaborative research initiatives was estimated to be 260. The complete list is provided in Annex A, where company websites and country of origin are also provided. Information about the business size, NACE code, and the relevant ACTRIS component have been collected but are not explicitly reported in Annex A.

Figure 1 shows a geographical representation of the countries of origin of companies connected to ACTRIS. These are mainly located in ACTRIS ERIC or ACTRIS IMP member countries. However, among other countries outside Europe, the USA plays an important role with 49 companies as partners/suppliers.

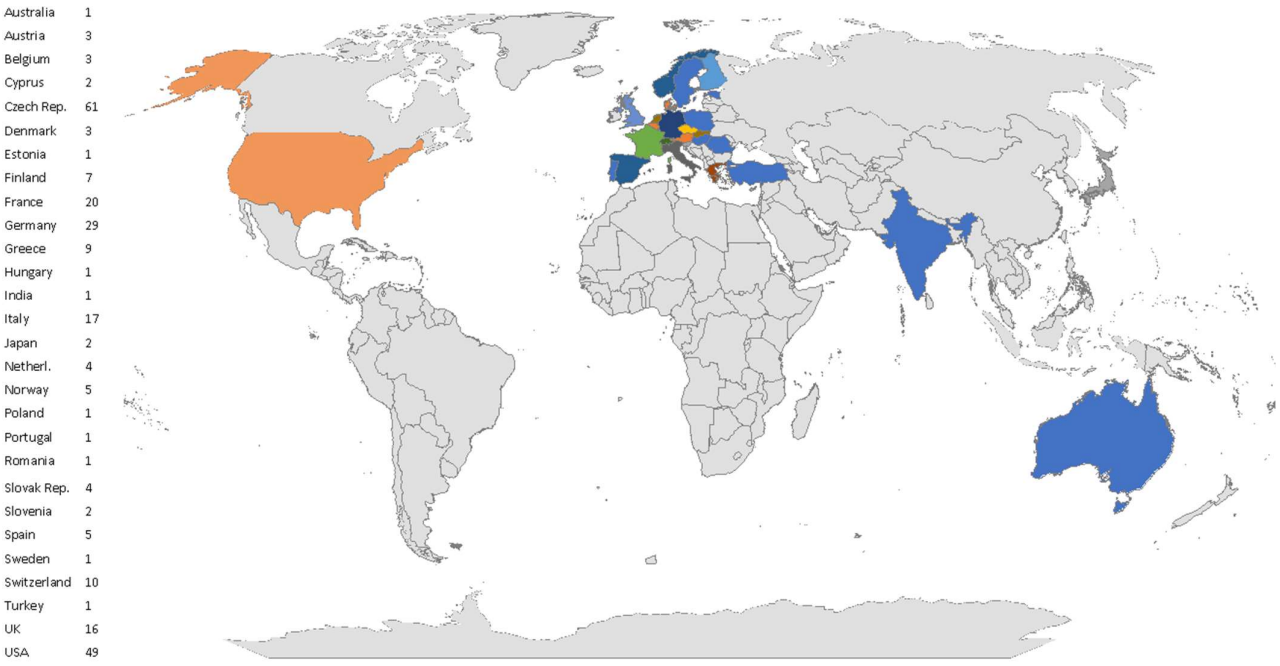

***Figure 1**: Companies collaborating with ACTRIS: countries of origin.*

Based on the EU definition[1] of business size, more than 50% are small-sized companies (less than 50 employees), 14% are medium-sized companies (from 50 to 250 employees), and around 10% are large-sized companies (more than 250 employees). However, 26% of collaborating businesses did have not provide information about their size (NA).

[1] https://single-market-economy.ec.europa.eu/smes/sme-definition_en

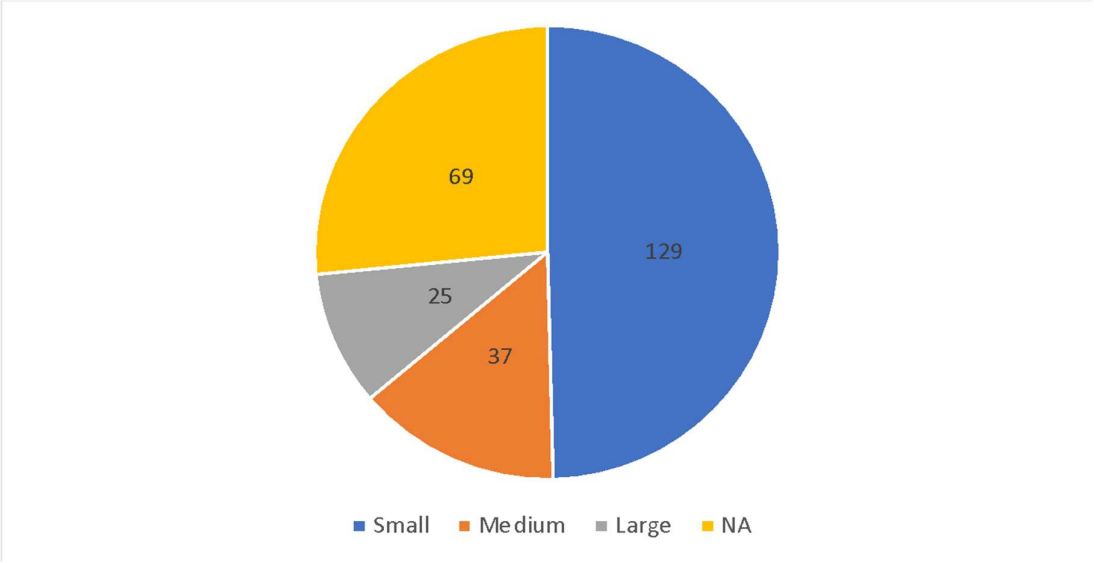

***Figure 2**: Number of companies collaborating with ACTRIS according to business size: Small-sized companies (Small), medium-sized companies (Medium), large-sized companies (Large) and no available information (NA).*

2.2 Trans-National Access (TNA)

One of the intrinsic features of RIs is providing access to data, facilities and services, serving a large number of diverse users (researchers, academia, public authorities, international networks and private sector).

Private sector companies need access to cutting-edge technologies and to new knowledge benefitting from research for testing innovative products/solutions to be placed in the market, and for training their own personnel.

As the majority of the companies collaborating with ACTRIS are small and medium-sized enterprises (SMEs), the costs associated with the access activities (travel, accommodation, shipping of samples or prototypes) are often prohibitive, resulting in difficulties in securing knowledge transfer or training activities without appropriate funding sources.

In most cases, the TNA programme allows free-of-charge physical, remote, and virtual access to ACTRIS facilities and services for private companies while guaranteeing, at least partially, the financial support for travel and subsistence.

There have been many collaborative projects with private companies in the past, supported by the European Commission within the ACTRIS-2 and EUROCHAMP-2020 TNA programs. Table 1 provides the list of the main companies and countries of origin.

***Table 1**: Private companies that accessed ACTRIS facilities via TNA in the framework of the ACTRIS-2 and EUROCHAMP-2020 projects.*

ACTRIS-2		**EUROCHAMP-2020**	
Company	***Country***	***Company***	***Country***
Aerodyne Researh Inc.	USA	Aerodyne Research	USA
ADDAIR	France	Blue Industry and Science	France
Aerosol d.o.o.	Slovenia	Catalytic Instruments GmbH	Germany
Airclip Service GmbH	Germany	ENI	Italy
Andøya Space Center	Norway	ENOVEO	France
Brechtel	USA	Haze Instruments	Slovenia
Campbell Scientific Ltd.	UK / France	Ionicon Analytik GmbH	Austria
CIMEL Electronique S.A.S	France	Optind Solutions Ltd	India
Droplet measurement technologies	USA	PM_TEN	Italy
EKO Instruments EUROPE BV	The Netherlands	U-Earth Biotech Ltd	Italy / UK
Envricontrol SA	Belgium		
GRASP S.A.S	France		
INOESY	Romania		
IONICON Analytik	Austria		
Lufft Mess-und Regeltechnik GmbH	Germany		
Palas GmbH	Germany		
Raymetrics SA	Greece		
Sigma Space Corporation	USA		
Sunset Laboratory Inc.	The Netherlands		
TENUM	France		
TOFWERK AG	Switzerland		
TSI Inc.	USA/Germany		
VAISALA	Finland		

Through the TNA schemes in the ongoing projects ACTRIS IMP (2020-2023) and ATMO-ACCESS (2021-2025), the European Commission continues to support collaborative research, by offering unique opportunities to private sector users.

The ACTRIS IMP TNA programme offers physical, remote, and virtual access to 11 facilities for testing access to specific services, assessing and improving the reliability of the overall ACTRIS service provision, increasing user trust, and expanding the user base. The facilities available for access via TNA were chosen to be representative of the diversity of facilities involved in ACTRIS and comprise some

of the TCs, the Data Centre (DC), National Facilities (NFs), or combined ACTRIS Facilities (NF-TC), located in 10 different European countries.

Three calls have been organized in the framework of ACTRIS-IMP WP7 "Piloting trans-national access for supporting the implementation of ACTRIS services".

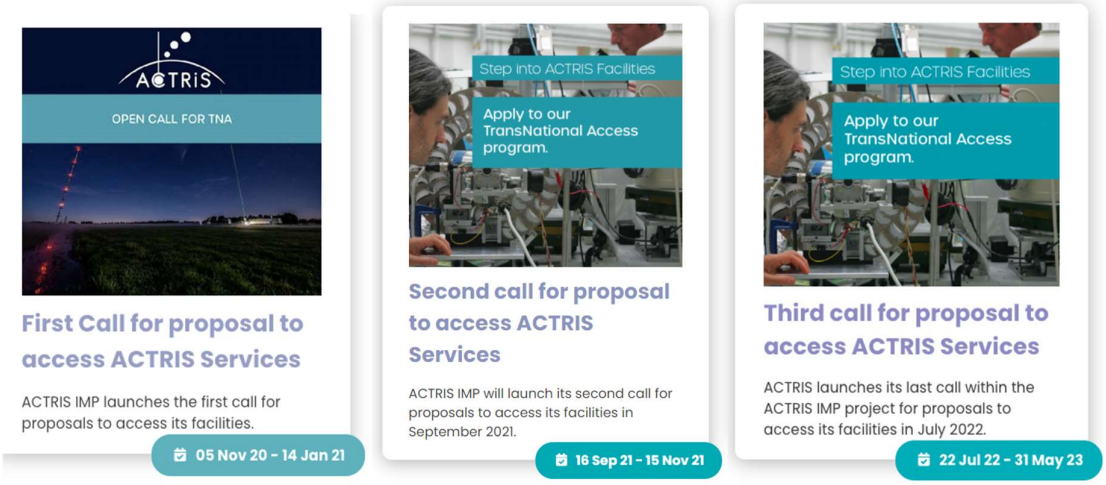

Figure 3: Advertisement of ACTRIS-IMP TNA calls on ACTRIS website (2020-2023).

An independent panel of experts evaluates access applications from the private sector by evaluating innovation and market-driven aspects of the proposed collaboration, possible technological developments and impacts on the economy.

Three private companies accessed ACTRIS facilities via the ACTRIS IMP TNA programme: MIRO Analytical AG, Aerosol doo and Tofwerk (Table 2).

***Table 2**: Private companies that accessed ACTRIS facilities via the ACTRIS-IMP TNA programme.*

Private Company	**Project Title & Acronym**	**Host Facility / Facilities**
MIRO Analytical AG	BEMIGA Benchmarking of MIRO Gas Analyzer	SMEAR II
Aerosol doo	Carbon balance field campaign in free troposphere with intermittent planetary boundary layer influence	JFJ
Tofwerk	STRUCTURE Structural characterization and quantitation of isoprene-derived oxidation products using a newly developed mass spectrometer	ACD-C/OGTAC-CC

In the framework of the ATMO-ACCESS project, five recurrent TNA calls have also been organized since the beginning of the project, and two more are foreseen by the end of the project, plus a dedicated

call for training at Central Laboratories. In addition, one specific call is continuously open for private sector requests, as detailed below. The ATMO-ACCESS recurrent calls schedule and topic are summarized in Figure 4.

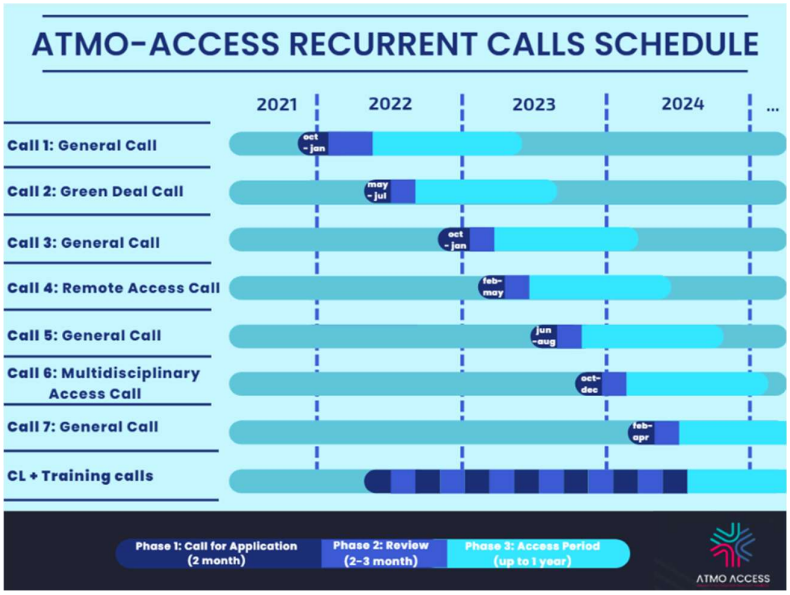

Figure 4: *ATMO-ACCESS recurrent calls schedule and topic 2021-2025.*

The ATMO-ACCESS project aims at delivering a series of recommendations for establishing a comprehensive and sustainable framework for access to distributed atmospheric RIs, ensuring integrated access to, and optimized use of, the services they provide.

Thanks to the joint efforts of the three atmospheric RIs participating, ACTRIS, ICOS, and IAGOS, the ATMO-ACCESS TNA programme offers physical and remote access to 52 operational atmospheric research facilities all over Europe, including ground-based observation stations, mobile facilities, central laboratories, and simulation chambers.

So far, 15 private companies have gained access through ATMO-ACCESS TNA calls. An overview of the companies, project titles and hosting facilities is given in Table 3.

Table 3: Overview of private sector TNA projects within *ATMO-ACCESS recurrent calls*

Private Company	Project Title & Acronym	Host Facility / Facilities
Aerosol d.o.o. (Slovenia)	ACAA:TC-BC 9λ Advanced carbonaceous aerosol apportionment using Total Carbon Analyzer and newly developed Aethalometer prototype with extended wavelength range	Station for Measuring Ecosystem – Atmosphere Relations II - (SMEAR II) Finland & European PHOtoreactor, Atmospheric Simulation Chamber - (EUPHORE) Spain
	Long-term and high-time-resolution validation of advanced total carbon–black carbon (TC-BC(λ)) method for apportionment of primary and secondary carbonaceous aerosols in the western Mediterranean basin (WMB: TC-BC(λ))	Barcelona Cluster (BCN) Spain
Airyx GmbH (Germany)	Delhi-OX The oxidizing capacity of the Delhi atmosphere	Simulation of Atmospheric Photochemistry in a Large Reaction Chamber (SAPHIR) Germany
CERES International (Portugal)	ATMO-SOC ATMospheric Observations and Soil Organic Carbon	Monte Cimone - Pò Valley Observatory (CMN-PV) Italy
CIMEL Electronique (France)	COALITION Characterization Of AerosoLs In The subtropIcal nOrth atlaNtic	Izana Subtropical Access Facility (ISAF) Spain
	EVOLUTION EValuation of aerOsol LUnar measuremets at the saTellIte cOmmunication chaNnels .	Izana Subtropical Access Facility (ISAF) Spain
GRASP SAS (France)	CALVANeph calibration and validation activities of nephelometers using ground-based instruments and their synergy	Andalusian Global ObseRvatory of the Atmosphere (AGORA) Spain Izana Subtropical Access Facility (ISAF) Spain World Calibration Center for Aerosol Physics (WCCAP) Germany
JB Hyperspectral Devices GmbH (Germany)	HAVAR-SIF Hyperspectral Assessment of Vertical Atmospheric Reabsorption of Sun Induced Chlorophyll Fluorescence	Cabauw Experimental Site for Atmospheric Research (CESAR) The Netherlands

Private Company	Project Title & Acronym	Host Facility / Facilities
Kärsa Oy (Finland)	TD-MION-MS Thermo Desorption – Multischeme chemical IONization inlet – Mass Spectrometer for atmospheric aerosol precursor and security research – proof of concept	Cyprus Atmospheric Observatory (CAO) Cyprus
Menapia Ltd (United Kingdom)	MTV MetSprite Tower Verification	Cabauw Experimental Site for Atmospheric Research (CESAR) The Netherlands
Origins.Earth (France)	UAS-GHG-T Unmanned Aerial System – GreenHouse Gas Tracker	Unmanned Systems Research Laboratory (USRL) Cyprus
Palas GmbH (Germany)	CDA Cloud Droplet Analyzer	Sonnblick Observatory (SBO) Austria
Stûv S.A (Belgium)	GO40VOC Catalytic solutions for the cleansing of wood stove emissions: a physical chemical characterization of effluents generated by wood combustion and their maturation in the atmosphere	PSI Atmospheric Chemistry Simulation Chambers (PACS-C2) Switzerland
Sunset Laboratory (The Netherland)	DUCATO DUal Carbon Analyzer with Thermal Optical method. Prototype field analyzer application for simultaneous real-time measurements of Organic Elemental	Barcelona Cluster (BCN) Spain
	DETONATE DetErminaTion of brown carboN using a duAl wavelength laser sEt-up	ATMOS, GR (OBS) PANGEA, GR (OBS)
Terra Modus Consultants Limited (United Kingdom)	MEVOC Medusa Enhanced Volatile Organic Compounds	Monte Cimone - Pò Valley Observatory (CMN-PV) Italy
TOFWERK AG (Switzerland)	TEDIMS-ASC TEsting of a Dual Ionization MS prototype by coupling with an Atmospheric Simulation Chamber	Quartz Reactor (QUAREC) Germany
Vaisala Oy (Finland)	CL61-4UrbanABL Testing the added-value of novel CL61 automatic ceilometer measurements for atmospheric boundary layer profiling in an urban environment.	Site Instrumental de Recherche par Télédétection Atmosphérique (SIRTA) France

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A dedicated continuous TNA call for private sector users was launched in May 2023. The call is open to all topics, and applications are evaluated outside of the standard schedule and process for selection to allow easy and fast-track access.

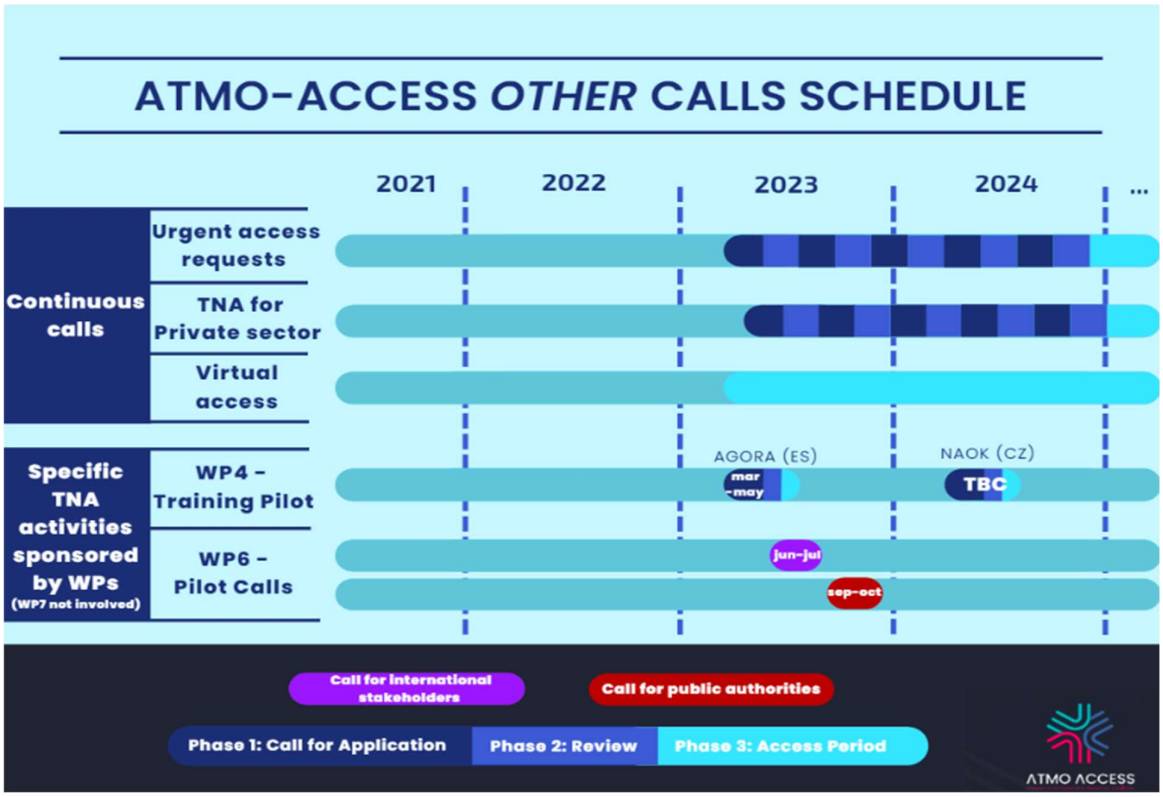

Figure 5: *ATMO-ACCESS other calls schedule, including private sector continuous call.*

The accelerated access procedure includes spontaneous application from the private sector without following any specific call schedule and a shortened evaluation period: the proposals are processed as quickly as possible, with an assessment being made by an independent review panel within 2-3 weeks from the proposal submission.

So far, three TNA proposals have been accepted following an application under the dedicated private sector open call. An overview of the involved companies, project title and hosting facilities is provided in Table 4.

Table 4: Private sector projects supported within the *ATMO-ACCESS dedicated TNA call for the private sector.*

Private Company	**Project Title & Acronym**	**Host Facility / Facilities**
LEN s.r.l. (Italy)	EvalDBAP Evaluation of Dual Beam Absorption Photometer	World Calibration Center for Aerosol Physics (WCCAP) Germany
Licel GmbH (Germany)	AGLP APD Ground Loop Prevention	Warsaw Observatory Station (WOS) Poland
Aerosol d.o.o. (Slovenia)	Inter-AE36 Intercomparison of optical absorption measurements using newly developed Aethalometer AE36 and AE36s with extended wavelength range (9-wavelengths)	World Calibration Center for Aerosol Physics (WCCAP) Germany

Another 15 proposals are in draft mode on the access proposal management platform, and, according to the trend, many others are expected to be submitted by the end of the ATMO-ACCESS project.

As in the past, the TNA scheme has proven to be effective in facilitating collaboration with the private sector, creating room for continuous knowledge transfer and chances for the companies to test their products and ideas.

However, as already highlighted in previous reports[2], TNA statistics provide only a partial picture of the "use" of ACTRIS by the private sector since many companies have accessed ACTRIS facilities outside the TNA scheme through an extensive range of formal and informal research collaborations.

Furthermore, there is a strong tendency for SMEs to access national research facilities, partly for convenience, but in many cases, because there is an existing relationship between the company and research facility. However, information on these national collaborations is often fragmented and yet to be systematically collected or provided.

2.3 Collaborative projects under different ACTRIS components

This subsection describes the innovative potential of ACTRIS based on best practice and examples of successful projects, which have already been completed or are still ongoing. Examples are selected with the aim of showing the diversity of ACTRIS components embedded in the six ACTRIS TCs:

- Centre for Aerosol In-Situ Measurements (CAIS-ECAC);
- Centre for Aerosol Remote Sensing (CARS);
- Centre for Cloud In-Situ Measurements (CIS);
- Centre for Cloud Remote Sensing (CCRES);
- Centre for Reactive Trace Gases In-Situ Measurements (CiGas);
- Centre for Reactive Trace Gases Remote Sensing (CREGARS).

[2] *Milestone MS52 Identification of collaboration models between ACTRIS and the private sector*

The ACTRIS TCs support the operation of National Facilities[3] and are responsible for:

1. defining procedures and tools for quality assurance and quality control of ACTRIS measurements and data;
2. performing quality assurance and quality control of ACTRIS instruments and measurements;
3. ensuring training and transfer of knowledge to ACTRIS operators and users, and;
4. improving measurement methodologies for aerosol, clouds, and reactive trace gases.

TCs are required to respond to the scientific and technical needs of ACTRIS, each focusing on remote sensing (from the ground) or in situ (near-surface) measurement techniques.

Figure 6 provides the number of collaborating companies for each TC.

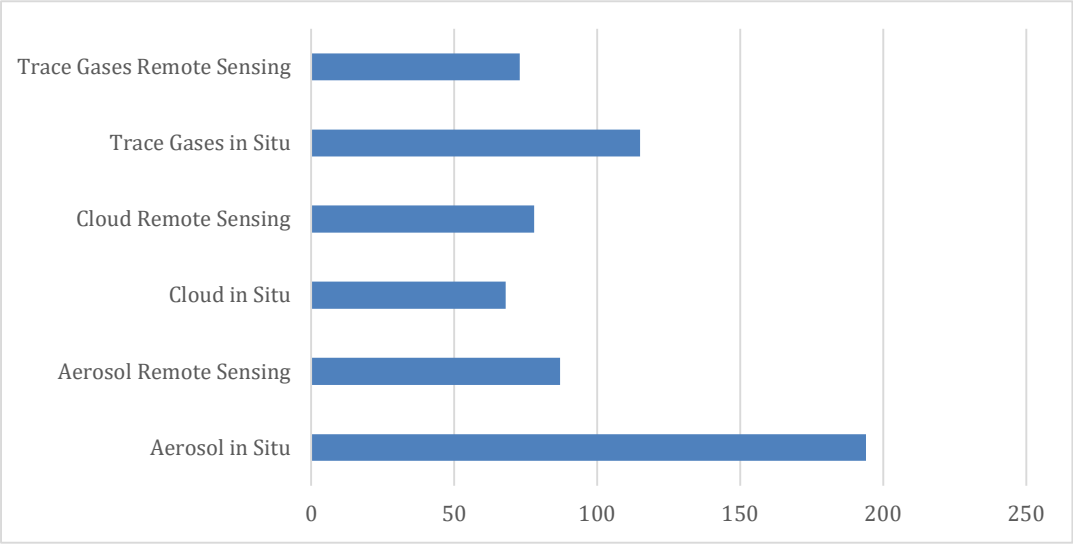

Figure 6: *Number of collaborating companies sorted by ACTRIS components.*

During the COVID-19 pandemic crisis, the Centre for Aerosol In-Situ Measurements (CAIS-ECAC) was used to test more than 350 types of respirators and face masks produced by over 50 small-sized companies.

Furthermore, it is worth noting that for several companies and related projects, a unique attribution to a TC is not always possible; indeed, companies can develop instruments and tools which are used in more than one TC. For instance, a single instrument can be used to measure trace gases and aerosol properties simultaneously. Another example is the development of a retrieval scheme that can serve to analyze both cloud in-situ and aerosol in-situ properties. Finally, there are cases where companies have used all TCs, and are counted for each of them in the figure.

[3] For more info about the ACTRIS National Facilities, please visit the ACTRIS website

2.3.1 Centre for Aerosol In-Situ Measurements (CAIS-ECAC)

The European Center for Aerosol Calibration and Characterization (ECAC) aims to act as the ACTRIS Centre for Aerosol In-Situ Measurements (CAIS). The mission of CAIS-ECAC is to offer operational support for quality assured and controlled physical and chemical aerosol in situ measurements and sampling, to conduct traceable instrument calibration, and to perform laboratory analysis of aerosol samples. CAIS-ECAC offers specialized services, measurements, and data tools to different users coming from research institutes, academia, public services and the private sector.

CAIS-ECAC is a consortium composed of seven units:

- *ACMCC* (Aerosol Chemical Monitor Calibration Center) operated by a consortium of French laboratories, including CNRS (Centre national de la recherche scientifique) and INERIS (Institut National de l'EnviRonnement InduStriel et des risques);
- *CCC* (Cluster Calibration Center) operated by INAR (INstitute for Atmospheric and earth system Research of the University of Helsinki), Finland;
- *EMC2* (Element Mass Calibration Center) managed by the INFN LABEC facility, which is operated by INFN (National Institute for Nuclear Physics) and the University of Florence, Italy;
- *OGTAC-CC* (Organic Tracer and Aerosol Constituents - Calibration Center) operated by TROPOS (Leibniz Institute for Tropospheric Research) in Germany, and JRC;
- *PACC* (Prague Aerosol Calibration Center) operated by the ICPF-CAS (Institute of Chemical Process Fundamentals of the Czech Academy of Sciences);
- *WCCAP* (World Calibration Center for Aerosol Physics) operated by TROPOS, Germany.

CAIS-ECAC had several collaborations with different private sector companies (TSI, PALAS, Grimm, Airmodus, Brechtel, Aerodyne) for activities related to quality control, standardization and development of new technology and prototypes.

The collaboration with some companies (e.g., TSI, GRIMM) is not entirely project-oriented but more focused on standardization activities. CAIS-ECAC[4] developed standards for in-situ aerosol measurements and techniques for ACTRIS National Facilities across Europe and, in some cases, worldwide, that are in line with WMO and GAW standards. The collaboration between ACTRIS and these companies has often been aimed at upgrading their instrumentation according to CEN and ISO standards. An example is the collaboration between TSI, CAIS-ECAC, and most of the ACTRIS NFs that widely use the TSI aerosol particle counters and sizers to calibrate different TSI instruments and particularly to verify, test, and calibrate their new ultrafine Condensation Particle Counter 3772-CEN. This instrument complies with the Technical Specification CEN/TS 16976, drafted by the European Committee for Standardization, for harmonizing the measurement and sampling of ultrafine particles. The testing and development of TSI technology at ECAC ensures reliable data is collected by the thousands of installed TSI instruments worldwide.

[4] For more info please visit https://www.actris-ecac.eu/actris-gaw-recommendation-documents.html

The WCCAP facility has collaborated with companies specializing in aerosol measurement technology to improve existing instrumentation and develop new instruments.

Other examples of good collaborative practices can be taken from industrial research projects carried out thanks to the support of CAIS-ECAC. Green City Solutions GmbH has developed movable moss walls, so-called “CityTrees” with the aim of improving air quality.

Figure 7: CityTrees developed by Green City Solutions GmbH.

Ambient air is flowed through the moss wall, which acts as a filter for fine and ultrafine dust particles and is also humidified and cooled. A measurement campaign lasting several days was organized in Germany to determine the efficiency of the filter and test it within the CAIS-ECAC facility managed by TROPOS.

In another project, LoCo-PM[5], ACTRIS has been collaborating with a Leipzig-based company manufacturing low-cost PM sensors. Quality checks of their sensors against reference instruments both in the laboratory and in the field have been performed.

Another example of a private sector collaboration on in situ aerosol measurement techniques is the work conducted by Lund University within the EU project called CLIMB-FOREST. The project involved several ACTRIS in-situ stations (Hyltemossa, Norunda, Hyytiälä, Melpitz, Košetice and Barcelona) and companies (Fritzøe, Neroj, Biskupství královéhradecké, CRPF, AMUFOR, Bergene Holm Sawmill, Swiss Krono Group, wood panel industries, etc.) working together to quantify the direct and indirect climate effects of terpenoids and aerosols.

ACTRIS support has been fundamental to gathering data and enhancing process understanding of carbon uptake, sinks, and other factors impacting climate at intensively researched forest field site infrastructures (Figure 8). Collected data allowed for performing pan-European modelling of scenarios, and the environmental and climate impact of alternative pathways for European forestry and to ensure

[5] More info at https://www.tropos.de/aktuelles/pressemitteilungen/details/neues-messnetz-untersucht-feinstaub-im-leipziger-westen (in German)

adaptation to new management strategies and forest preservation in geographically representative locations in Europe.

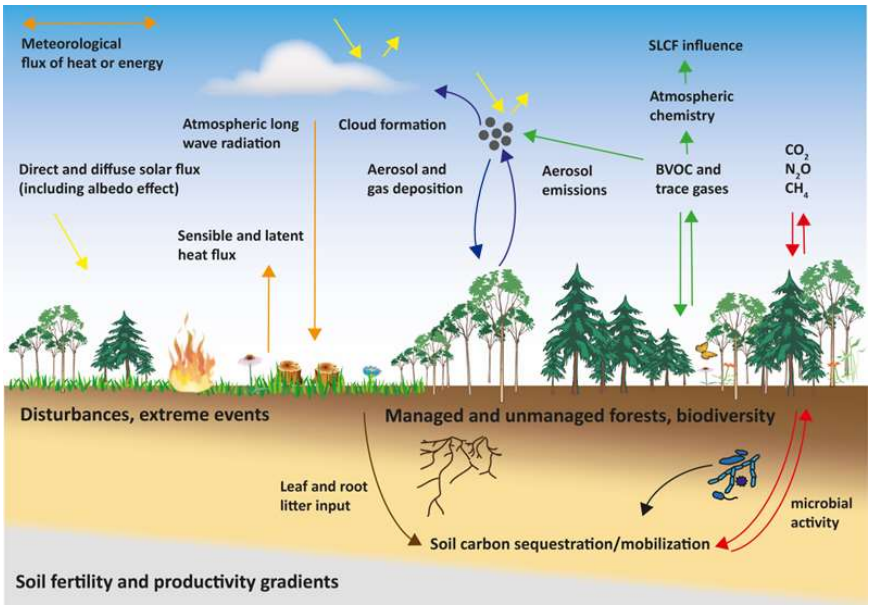

Figure 8: *Scheme of the forest-climate interactions.*

Another collaboration, led by the *PACC* during the COVID-19 pandemic, involved testing of respirators and face masks produced by over 50 manufacturers. The increased demand for highly efficient personal protective equipment and the urgent need to draft regulations for producing appropriate filters in a very short time frame required dedicated facilities to test products and provide extensive high-quality measurements of the filter effect of different materials. The PACC was very well suited for this, although the research focus was on hygroscopic behavior and growth of cloud condensation nuclei activity of aerosols (Figure 9).

For about one year, several tests were performed on more than 350 types of respirators and face masks. The companies are listed in ANNEX A. This example also illustrates that ACTRIS can react to social challenges arising at short notice. Furthermore, it shows that infrastructures used for research in the field of aerosol science are also suitable for fulfilling application-related tasks.

Figure 9: Left *Differential Mobility Particle Sizer (DMPS), Right Condensation Particle Counter (CPC) at the Department of Aerosol Chemistry and Physics at the Institute of Chemical Process Fundamentals of the Czech Academy of Sciences (CAS).*

CAIS-ECAC has also been involved in collaborative projects with networks and public authorities. An example of best practice is the collaboration with the GCOS Upper-Air network (GUAN) for the development and installation of a new measurement network for ultrafine dust. The project has been running since 2008, and the measurement data are currently used for descriptive atmospheric studies and to validate dispersion and forecast models. The data produced within this project also represents a reference for possible regulation of ultrafine particles as part of the revisions to the EU Air Quality Directive.

The CAIS-ECAC also collaborates with meteorological services and national environmental agencies. For instance, the WCCAP has agreements with DWD (German Weather Service) and UBA (German National Environmental Agency) to ensure the quality of their instruments through bi-yearly workshops in Leipzig and on-site audits.

2.3.2 Centre for Aerosol Remote Sensing (CARS)

The Centre for Aerosol Remote Sensing (CARS) is a consortium composed of eight units:

- Aerosol High-power Lidar unit operated by the National Institute for Research and Development in Optoelectronics (INOE), Romania;
- Aerosol High-power Lidar unit operated by the Meteorological Institute of the Ludwig-Maximilians-University (LMU), Germany;
- Aerosol High-power Lidar unit operated by the Institute of Methodologies for Environmental Analysis of the National Research Council of Italy (CNR-IMAA);
- Automatic low-power Lidar & Ceilometer unit operated by DWD, Germany;
- Automatic low-power Lidar & Ceilometer unit operated by LMU, Germany;
- Automatic Sun/sky/lunar Photometer unit operated by CNRS, France;

- Automatic Sun/sky/lunar Photometer unit operated by the University of Valladolid (UVA), Spain;
- Automatic Sun/sky/lunar Photometer unit operated by the State Meteorological Agency of Spain (AEMET) at the Izaña Atmospheric Research Center (IARC), Spain.

The mission of CARS is to offer operational support for aerosol remote sensing instrumentation such as aerosol high-power aerosol lidars, automatic low-power lidars and ceilometers, and automatic sun/sky/polarised/lunar photometers. CARS offers specialized services for these instruments to multiple users from research institutes, academia, public services, and the private sector:

- training at CARS workshops and technical webinars;
- consultancy for new/upgraded facilities and instruments;
- access to guidelines, standard operation procedures, standard quality assurance procedures, quality assurance and quality control tools;
- calibration of field photometers (automatic sun/sky/polarized/lunar photometer);
- laboratory characterization of instruments and blocks (aerosol high-power aerosol lidars, automatic low-power lidars, and ceilometers).

CARS has long-standing collaborations with the leading companies that produce instruments for measuring aerosol properties using remote sensing techniques. One example of best practice is the collaboration with the Greek company Raymetrics S.A. to develop a reference lidar system to validate the ESA Aeolus satellite mission.

Figure 10: *The* eVe lidar system developed by Raymetrics for the validation of Aeolus.

The Enhancement and Validation of ESA products (eVe) is a depolarization lidar system developed for the European Space Agency (ESA) by Raymetrics S.A. in collaboration with National Observatory of Athens (NOA) and LMU CARS Unit.

The eVe lidar is a surface-based remote sensor that deploys lidar techniques to detect and characterize atmospheric aerosols and clouds, aiming at providing the ESA Aeolus mission with a flexible, mobile reference ground-based lidar system capable of delivering well-characterized fiducial reference measurements of aerosol optical properties, such as the detection of optical activity originating in biogenic aerosols, the alignment of non-spherical particles such as dust, smoke, and volcanic ash, and the aerosol multiple scattering effects. Aeolus was the first satellite mission to acquire profiles of Earth's wind on a global scale, providing at the same time information on aerosols and clouds. These observations are being used to improve weather forecasts and climate models.

The new lidar system has been deployed in the Cape Verde islands along with other ground-based and airborne instrumentation of ACTRIS, to conduct the Joint Aeolus Tropical Atlantic Campaign (JATAC) ESA experiment to validate Aeolus. Furthermore, datasets will be used for the upcoming EarthCARE ESA mission and future satellite concepts (such as the Earth Explorer 11 Wivern candidate mission).[6]

Another example of best practice is the collaboration between the French company CIMEL Electronique and CNR-IMAA CARS Unit in Italy. CIMEL is a world-leading manufacturer of automatic meteorological instrumentation with expertise in meteorology, atmosphere optics, design of integrated systems, software solution development, and production control.

The collaboration with the CNR-IMAA Atmospheric Observatory led to different comparison exercises and the participation of CIMEL in the INTERACT II (Intercomparison of aerosol and Cloud Tracking) measurement campaign to study the atmosphere through the use and integration of its different active and passive remote sensing techniques, in order to evaluate and test the potential use of such automated instrumentation for monitoring of aerosols produced by different sources (both natural and anthropogenic, such as desert dust, typically observed in the Mediterranean area during the summer, fires present in Eastern Europe and North America). CIMEL has also been in charge of operating the automated CE370/CE376 Lidar, of data acquisition and analysis of data measured in combination with a CE318-T photometer, and the comparative analysis with CIMEL iAAMS software. CNR-IMAA has also been supportive of CIMEL Lidar performance for aerosol and cloud measurements, and to evaluate the stability, sensitivity, and uncertainties of automated lidars and ceilometers in terms of instrumental sensitivity and uncertainties, and to put these into context by simultaneously assessing the performance of a high specification research lidar. These activities represent first-time inter-comparison tests of commercial ceilometers and lidars; and future tests and collaborations are foreseen.

CNR-IMAA also collaborated with an Italian company, Meteorological and Environmental Earth Observation - MEEO s.r.l., to develop integrated data visualization tools, including ACTRIS aerosol remote sensing data, satellite and model data. MEEO is a consolidated partner of the European Space

[6] For more info, please visit https://evelidar.eu. For more technical insights, please look at Paschou P. et al.: "The eVe reference polarisation lidar system for the calibration and validation of the Aeolus L2A product", Atmos. Meas. Tech., 15, 2299–2323, 2022

Agency (ESA) and, since 2011, an affiliated partner of the Climate-KIC association. The collaboration with this company is ongoing on other topics related to climate data services, image information mining tools, satellite and ground data integration, multi-source/multi-temporal analysis, WebGIS applications, standardization of processes and data storage, and others.

2.3.3 Centre for Cloud In-Situ Measurements (CIS)

The key mission of the Centre for Cloud In Situ Measurements (CIS) is to offer support to ACTRIS NFs operating instrumentation for continuous long-term measurements of cloud occurrence, cloud water content, and cloud droplet effective diameter at observational platforms or for episodic measurements of cloud particle size distributions, chemical cloud water composition, and ice nucleating particles during dedicated laboratory and field campaigns.

While the main activities focus on the ACTRIS community, specialized services are offered to different users from research institutes, academia, public services, and the private sector.

CIS aims to develop and adapt its procedures and performance to future needs, continuously responding to new research and development projects, focusing on the operation of existing instruments and methods, and developing and implementing improved and new methods.

CIS is a consortium organized in 4 units, each specialized to a method for in-situ cloud characterization:

- Centre for Cloud Ice Nucleation (CCIce) operated by the Karlsruhe Institute of Technology (KIT), Germany. Here, the large atmospheric simulation chamber AIDA (Aerosol Interaction and Dynamics in the Atmosphere) is employed for cloud studies, instrument inter-comparison, or calibration.
- Centre for Cloud Water Chemistry (CCWaC) operated by TROPOS, Germany. It is composed of several laboratories, where a range of analytical instrumentation is used to develop and implement methods for studying the chemical composition of cloud water samples, including inorganic ions by ion chromatography, dissolved organic carbon by total organic carbon analysers, and – in synergy with the CAIS-ECAC OGTAC CC unit – organic marker compounds using liquid chromatography mass spectrometry or related techniques.
- European Centre for Cloud Ambient Intercomparison (ECCINT) operated by the GeoSphere Austria Sonnblick Observatorium located at Mt. Hoher Sonnblick, Austria (3.106 m asl). This Centre is located on an exposed alpine ridge and is almost emission-free. ECCINT is responsible for the mandatory integrated cloud probes to analyze cloud liquid water content and cloud droplet effective radius. In collaboration with several research institutions and scientists, it provides access to state-of-the-art cloud research and aerosols-cloud-climate interaction analysis. It also provides services to other user communities from private sector companies and public services for developing instruments, standards, and the monitoring program.
- The Centre for Cloud Particle Properties (CCPar) is currently in need of a new host RPO that is willing to implement and service the measurement of cloud droplet and cloud ice particle size distribution and number concentration.

One example of best practice is the collaboration of the ECCINT Unit with Palas GmbH for a pilot high altitude cloud ambient measurement performance study. The study was performed in 2022 at Sonnblick Observatory where 24 dedicated instruments were used to determine a wide range of cloud parameters, such as liquid water content, size and composition of the droplets and ice crystals, and the chemical composition of cloud water.

Figure 11: *Left: Sonnblick Observatory; right: measurement platform at Sonnblick Observatory.*

Among the instruments tested, was the Cloud Droplet Analyzer from Palas GmbH, a precise aerosol spectrometer which measures the size of dust particles and, under appropriate conditions, fog droplets and determines the water content of the air. It also measures the distribution of Saharan dust, which is transported from the desert across the Alps to Central Europe. At the same location, a condensation particle counter (ENVI-CPC) for measuring ultrafine particles and a scattered-light aerosol spectrometer (promo® 3000) have been used for years. The results of this study are made available to the scientific community through the Global Atmosphere Watch (GAW) programme for the evaluation of climate studies worldwide.

Another example of best practice is the collaboration between Bilfinger Noell GmbH and CCIce operated by KIT. A new dynamic cloud chamber, AIDA-2, has been developed thanks to this collaboration. The chamber has a unique and innovative engineering design in order to perform cloud simulation experiments at constant cooling rates of up to 10 K min^{-1} over a temperature range from 30°C to -55°C.

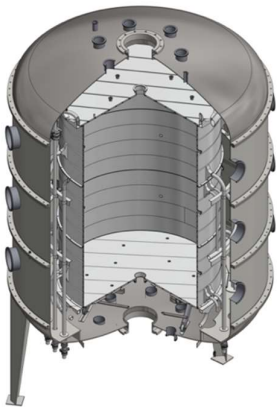

Figure 12: *Structure of the AIDA-2 cloud chamber.*

The CCIce support has also been fundamental for the co-development of a new and innovative mobile instrument for atmospheric measurements of ice nucleating particle (INP) concentrations and laboratory studies of ice nucleation processes. This new instrument called PINE (Portable Ice Nucleation Experiment) is the first instrument of its kind for fully-automated long- term INP measurements at high sensitivity and time resolution. Prototype versions were successfully tested at CCIce, and a commercial version has been available on the market since 2019.

2.3.4 Centre for Cloud Remote Sensing (CCRES)

The Centre for Cloud Remote Sensing (CCRES) provides access to continuous long-term vertical profiles of cloud fraction and water and ice cloud properties. These measurements require the synergistic use of several remote sensing instruments:

- Doppler Cloud Radars providing vertical profiles of reflectivity and Doppler velocity of hydrometeors;
- Doppler lidars for wind profiling;
- Low-power lidars and ceilometers for cloud profiling purposes;
- Microwave radiometers for temperature and humidity profiling;
- Disdrometers for measuring the size distribution and falling speed of precipitation at the surface.

The CCRES is a consortium composed of five units:

- CCRES-FR hosted at SIRTA and operated by CNRS, Ecole Polytechnique, and Université de Versailles Saint-Quentin-en-Yvelines, France;
- CCRES-NL operated by the Delft University of Technology (TUD), at Ruisdael Observatory in Cabauw, the Netherlands;
- CCRES-DE hosted at the JOYCE Observatory (Jülich Observatory for Cloud Evolution) and operated by the University of Cologne (UCol), Germany;
- CCRES-UK hosted at the National Centre for Atmospheric Science (NCAS), a distributed research centre of the Natural Environment Research Council (NERC) which is part of the UK Research and Innovation (UKRI), United Kingdom;
- CCRES-FI operated by the Finnish Meteorological Institute (FMI), Finland.

All five units have been involved for many years in operating multi-instrumented atmospheric observatories that include cloud remote sensing instruments. CCRES offers access to more than 15 years of experience in sensor development, cloud monitoring using remote sensing techniques, calibration of instruments and quality control, development of retrieval algorithms, and scientific studies of cloud processes, meteorology, and climate sensitivity to clouds, serving large and diverse user communities.

CCRES has long-standing collaborations with several companies producing instruments for remote sensing of cloud and wind properties. One example concerns collaborations with VAISALA, a manufacturer of automatic lidars and ceilometers and of Doppler Lidars. Collaborations with CCRES

resulted in enhancing the information provided by VAISALA to users about the operation and internal data processing of automatic lidars and ceilometers. A discussion is also on-going about implementing a fog alert algorithm developed by the CCRES-FR team in VAISALA software package.

CCRES-DE is working in close collaboration with the manufacturer Radiometer Physics GmbH (RPG) to improve data processing as well as the calibration procedures that NFs must implement. CCRES-NL and CCRES-FR also work with Radiometer Physics GmbH on calibration of Doppler Cloud Radar. CCRES-FR and CCRES-UK have a cooperation with METEK GmbH for radar data processing and housekeeping data monitoring. CCRES-FR works with the company BOWEN to support the development of a reference compact Doppler Cloud Radar that will be able to travel to NFs for direct intercomparisons.

2.3.5 Centre for Reactive Trace Gases In-Situ Measurements (CiGas)

The Centre for Reactive Trace Gases In Situ Measurements (CiGas) operates and supports instrumentation and observations for the in-situ measurement of reactive trace gases.

It is composed of six units in five countries:

- CiGas-FZJV and CiGas-FZJN operated by the Forschungszentrum Jülich GmbH (FZJ), Germany;
- CiGas-EMPA operated by Swiss Federal Laboratories for Materials Science and Technology (EMPA), Switzerland;
- CiGas-IMT NE operated by the Institut Mines Télécom Nord Europe (IMT NE), France;
- CiGas-DWD operated by the German Weather Service (DWD), Germany;
- CiGas-UHEL operated by the University of Helsinki (UHEL), Finland.

CiGas offers state-of-the-art operational support for continuous long-term measurements of volatile organic compounds (VOCs) and condensable vapors and nitrogen oxides (NOx) in the atmosphere. These activities include developing, testing, and implementing advanced measurement technologies and data evaluation algorithms, testing prototypes of gas analytical devices, and enhancing the competence of the operative personnel by training.

Tailored services have been implemented for users from the Global Atmospheric Watch (GAW) Network and other atmospheric observation networks, academia, private sector, and public services.

In-situ measurements of reactive trace gases are crucial for several market applications:

- Air Quality Monitoring, for assessing air quality in urban areas and industrial zones. Monitoring pollutants like nitrogen oxides (NO_x), ozone (O_3), and VOCs helps to identify pollution sources and formulate effective air quality management strategies.
- Atmospheric and Climate Research. Reactive trace gases play a pivotal role in atmospheric chemistry, influencing climate change, the formation of secondary air pollutants and aerosols.
- Industrial Emission Control: Industries emitting reactive trace gases, such as VOCs, need to monitor their emissions to comply with environmental regulations. In-situ measurements help industries optimize processes, reduce emissions, and maintain regulatory compliance.

- Environmental Monitoring, for tracking changes in natural ecosystems, studying emissions from wildfires, and assessing the impact of agricultural practices on reactive trace gas emissions.
- Health Studies. Some reactive trace gases, such as ozone and nitrogen dioxide, have implications for human health. In-situ measurements contribute to understanding exposure levels and potential health risks associated with these gases.
- Remote Sensing and Space Missions. In-situ measurements of reactive trace gases on Earth help validate remote sensing observations.

CiGas-UHEL collaborates with mass spectrometry instrument manufacturers producing instrumentation for condensable vapour measurements. The collaborative industrial partners are: Tofwerk, Aerodyne and Karsa, a spin-off company created by the University of Helsinki which developed the chemical ionization inlet (The Multi-scheme chemical IONization inlet, MION - patent application WO2018050962). The collaboration with the industrial partners and University of Helsinki started many years ago. All the industrial partners have shown interest in participating in the ACTRIS intercomparison workshops and supporting the calibration method development. An instrument-users meeting has been organized by CiGas-UHEL and Aerodyne and another instrument-users meeting will be organized together with Karsa within the next 6 months. These meetings benefit both users and instrument developers by fostering a supportive community, improving instrument performance, and promoting the advancement of research and applications in different fields.

CiGas-FZJN has been collaborating with Airyx GmbH and MIRO Analytical AG for several years in the application and development of NOx instrumentation based on innovative technologies. Both companies developed from research institutions in Germany (University of Heidelberg) and Switzerland (EMPA) with whom CiGas has maintained cooperation for decades. Airyx also took part in the ACTRIS-IMP TNA at the simulation chamber SAPHIR, in which instruments measuring NO_2 were compared as part of the quality assurance by CiGas. In addition to instruments measuring at NF observational platforms, Airyx provided an instrument making use of a new method, the CE-DOAS method that could be validated by measurements of CiGas reference instruments. CE-DOAS instruments have the potential to be deployed at observational platforms in the future.

CiGas-IMT collaborates with Chromatotec on the data quality assessment of formaldehyde monitors like the airmo HCHO, an autoGC using a FID detector dedicated to formaldehyde monitoring. The collaboration originated from a site visit of company representatives to CiGas-IMT and from their participation in events organized by ACTRIS.

2.3.6 Centre for Reactive Trace Gases Remote Sensing (CREGARS)

The mission of the Centre for Reactive Trace Gases Remote Sensing (CREGARS) is to facilitate the generation of the highest-standard reference data of several key trace gases using ground-based remote sensing techniques.

It also provides operation support and specialized services for instrument setting and development and related variable analysis to different user communities (academia, research organizations, private sector, and public services).

CREGARS is organized in different units, which are grouped in three clusters, one cluster for each measurement technique covered by the Centre:

- CREGARS FTIR - Fourier Transform Infrared spectrometer units in Belgium (operated by the Royal Belgian Institute for Space Aeronomy - BIRA-IASB and the University of Liège), and Germany (operated by the University of Bremen);
- CREGARS UV-VIS - UV-visible differential absorption spectrometer units in Belgium (operated by BIRA-ISAB), Austria (operated by the Medical University of Innsbruck), France (operated by the CNRS), and the Netherlands (operated by the Royal Netherlands Meteorological Institute, KNMI);
- CREGARS LIDAR - O_3 differential absorption lidar unit in France (operated by CNRS).

One example of best practice between the private sector and CREGARS is the long-standing collaboration with the German company Bruker, for long-term development of Fourier Transform Infrared (FTIR) spectrometers. The FTIR spectrometer model from Bruker is used for dedicated spectroscopy measurements, delivering spectroscopic reference data of the type that are needed for atmospheric research.
Recently, the Bruker instruments became the standard in the Network for the Detection of Atmospheric Composition Change (NDACC) and in ACTRIS. The long-standing cooperation brought continuous development and modifications to match the standards and needs of these communities.

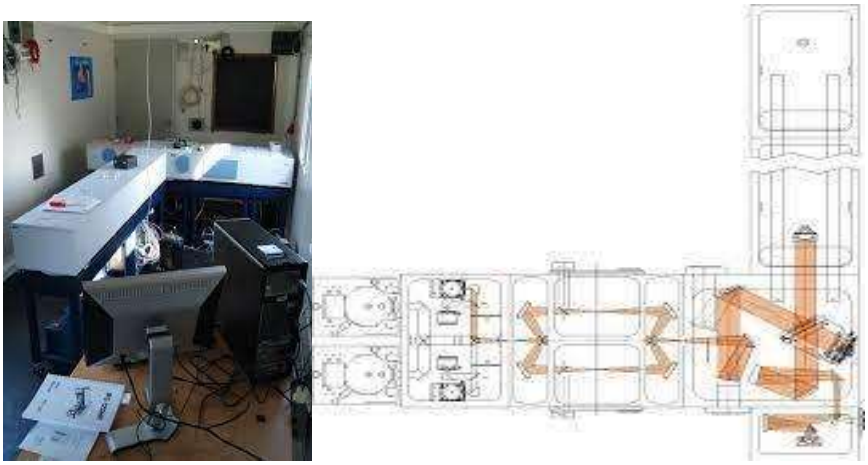

Figure 13: *Left: Bruker IFS 125HR ultra-high resolving spectrometer with its interferometer design ensuring beam integrity; right: schematic of the light path in the spectrometer* - Copyright © Brukeroptics.

Bruker also produced a compact mobile FTIR instrument, which was built and developed based on long-lasting discussions within the different user communities, particularly with KIT research groups. The company continues to be a regular user of ACTRIS facilities to test new developments.

2.4 Scientific collaboration between ACTRIS community and the industry

Research infrastructures are commonly used by scientific and industrial communities to conduct research and experiments which translate in the creation of new knowledge. This knowledge may generate different outcomes (e.g., publications, patents) and find applications in different sectors and domains, ultimately triggering innovation developments.

In order to analyze the scientific collaboration between the ACTRIS community and the industry, a bibliometric analysis was carried out on data gathered from the search engine Web of Science (WoS). The open-source software called Biblioshiny[7] has been used to perform the analysis.

In general, the ACTRIS community published 423 documents on Indexed Sources (such as journals, books and conference proceedings) from 2020 to August 2023. The main document types are articles published in ISI journals (372), followed by conference proceedings (37). *ACTRIS Scientific outputs* are synthetically reported in the following Table.

***Table 5**: ACTRIS scientific outputs from 2020 to August 2023 (Source: Web of Science).*

Description	Results
Timespan	2020-2023
Sources (Journals, Books, etc)	93
Documents	423
Average citations per doc	7.979
References	18.129
Authors	2.435
Authors of single-authored docs	1
Co-Authors per Doc	12
International co-authorships %	66.43
DOCUMENT TYPES	
Article	372
article; book chapter	1
article; data paper	2
article; early access	4
Correction	1
editorial material	1
proceedings paper	37
Review	5

With reference to co-authorship of research publications, which provides a measure of collaboration in science, there are 2.435 authors. On average, 12 authors contributed to each document. Multinational co-authorship, i.e., collaboration between researchers in different countries, accounts for 66.4% of the total scientific output. Researchers are thus increasingly networked across national and institutional borders.

[7] https://www.bibliometrix.org/home/index.php/layout/biblioshiny

The next figure provides an effective picture of the ACTRIS scientific collaboration world map. It is evident that main collaborations originate from and involve European countries; however, there are also a high number of co-authors from the USA. This interesting insight emerged also with reference to the countries of origin of companies collaborating with ACTRIS.

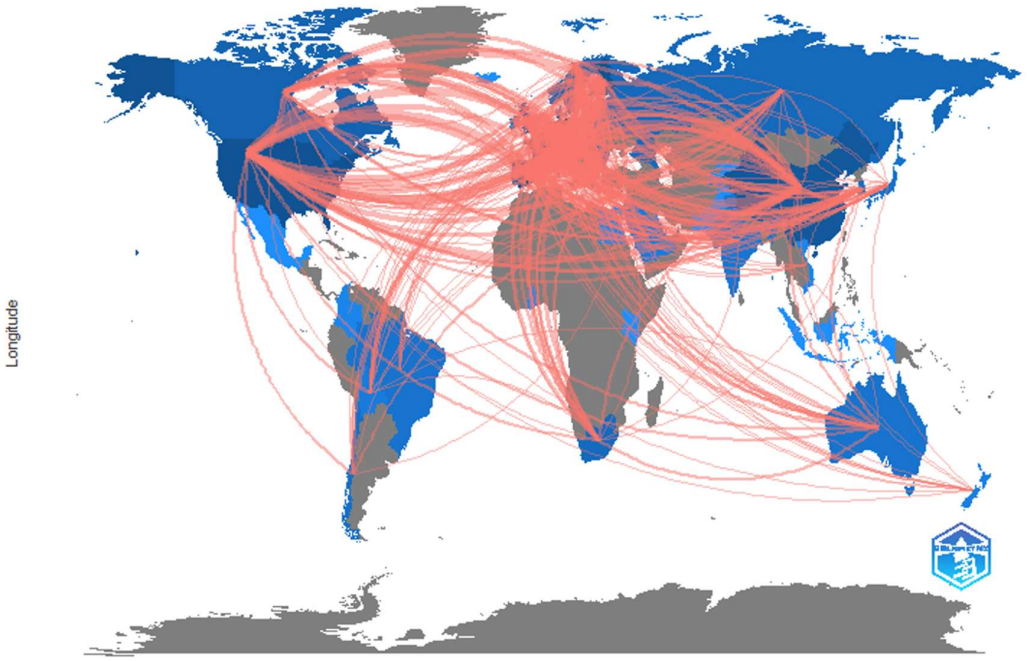

Figure 14: ACTRIS scientific collaboration World Map.

It is interesting to note that main keywords used in publications refer to: optical properties, aerosol impact, source apportionment, black carbon, particulate matter, chemical composition, Saharan dust, transport, emissions, and variability (Figure 15).

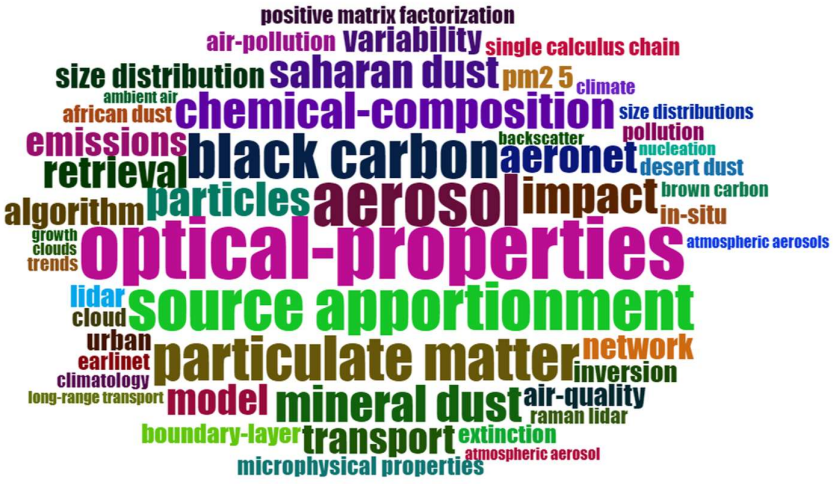

Figure 15: *Word cloud based on keywords of ACTRIS scientific publications.*

With reference to the scientific collaboration between the ACTRIS community and the industry, there are 36 documents as shown in Table 6.

Table 6: *ACTRIS co-authorship with industry collaborators from 2020 to August 2023 (Source: Web of Science).*

First Author	N° of auth.	Title	Journal	Year	Citation	Industry co-authorship
Wolf, Martin J.	20	A biogenic secondary organic aerosol source of cirrus ice nucleating particles	NATURE COMMUNICATIONS	2020	108	Aerodyne, TOFWERK, Droplet Meas. Tech.
Atabakhsh, S.	6	A 1-year aerosol chemical speciation monitor (ACSM) source analysis of organic aerosol particle contributions from anthropogenic sources after long-range transport at the TROPOS research station Melpitz	ATMOSPHERIC CHEMISTRY AND PHYSICS	2020	75	Datalystica
Laj, P.	125	A global analysis of climate-relevant aerosol properties retrieved from the network of Global Atmosphere Watch (GAW) near-surface observatories	ATMOSPHERIC MEASUREMENT TECHNIQUES	2020	98	Aerosol doo
Languille, B.	10	A methodology for the characterization of portable sensors for air quality measure with the goal of deployment in citizen science	SCIENCE OF THE TOTAL ENVIRONMENT	2020	53	Airparif, Cerema
Yus-Diez, J.	11	Absorption enhancement of black carbon particles in a Mediterranean city and countryside: effect of particulate matter chemistry, ageing and trend analysis	ATMOSPHERIC CHEMISTRY AND PHYSICS	2022	70	Aerosol doo
Barreto, A.	10	Aerosol characterisation in the subtropical eastern North Atlantic region using long-term AERONET measurements	ATMOSPHERIC CHEMISTRY AND PHYSICS	2022	59	Cimel Electronic
Garcia-Cabrera,RD.	7	Aerosol retrievals from the EKO MS-711 spectral direct irradiance measurements and corrections of the circumsolar radiation	ATMOSPHERIC MEASUREMENT TECHNIQUES	2020	85	Cimel Electronic, EKO instr. Europe
Affolter, S.	9	Assessing local CO2 contamination revealed by two near-by high altitude records at Jungfraujoch, Switzerland	ENVIRONMENTAL RESEARCH LETTERS	2021	37	Picarro
Yukhymchuk, Y.	9	Atmospheric Aerosol Outbreak over Nicosia, Cyprus, in April 2019: Case Study	ATMOSPHERE	2022	56	Cimel Electronic
Bianchi, F.	29	Biogenic particles formed in the Himalaya as an important source of free tropospheric aerosols	NATURE GEOSCIENCE	2021	38	Aerodyne, TOFWERK
Salgueiro, V.	31	Characterization of Tajogaite volcanic plumes detected over the Iberian Peninsula from a set of satellite and ground-based remote sensing instrumentation	REMOTE SENSING OF ENVIRONMENT	2023	86	Grasp

Dupont, JC.	6	Characterization and Corrections of Relative Humidity Measurement from Meteo-modem M10 Radiosondes at Midlatitude Stations	JOURNAL OF ATMOSPHERIC AND OCEANIC TECHNOLOGY	2020	18	Metemodem
Almansa, AF.	15	Column Integrated Water Vapor and Aerosol Load Characterization with the New ZEN-R52 Radiometer	REMOTE SENSING	2020	53	Cimel Electronic
Veselovskii, I.	8	Combined use of Mie-Raman and fluorescence lidar observations for improving aerosol characterization: feasibility experiment	ATMOSPHERIC MEASUREMENT TECHNIQUES	2020	33	Grasp
Ferrero, L.	16	Consistent determination of the heating rate of light-absorbing aerosol using wavelength- and time-dependent Aethalometer multiple-scattering correction	SCIENCE OF THE TOTAL ENVIRONMENT	2021	92	Aerosol doo
Roman, R.	10	Correction of a lunar-irradiance model for aerosol optical depth retrieval and comparison with a star photometer	ATMOSPHERIC MEASUREMENT TECHNIQUES	2020	81	Cimel Electronic
Graeffe, F.	14	Detecting and Characterizing Particulate Organic Nitrates with an Aerodyne Long-ToF Aerosol Mass Spectrometer	ACS EARTH AND SPACE CHEMISTRY	2022	58	Aerodyne
Bernardoni, V.	14	Determination of Aethalometer multiple-scattering enhancement parameters and impact on source apportionment during the winter 2017/18 EMEP/ACTRIS/COLOSSAL campaign in Milan	ATMOSPHERIC MEASUREMENT TECHNIQUES	2021	62	Aerosol doo
Yus-Diez, J.	14	Determination of the multiple-scattering correction factor and its cross-sensitivity to scattering and wavelength dependence for different AE33 Aethalometer filter tapes: a multi-instrumental approach	ATMOSPHERIC MEASUREMENT TECHNIQUES	2021	114	Aerosol doo
Tham, YJ.	40	Direct field evidence of autocatalytic iodine release from atmospheric aerosol	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF USA	2021	59	Aerodyne
Drosoglou, T.	12	Evaluating the effects of columnar NO2 on the accuracy of aerosol optical properties retrievals	ATMOSPHERIC MEASUREMENT TECHNIQUES	2023	112	Grasp
Fischer, L.	10	First eddy covariance flux measurements of semi-volatile organic compounds with the PTR3-TOF-MS	ATMOSPHERIC MEASUREMENT TECHNIQUES	2021	71	Ionicon
Milford, C.	21	Impact of the 2021 La Palma volcanic eruption on air quality: Insights from a multidisciplinary approach	SCIENCE OF THE TOTAL ENVIRONMENT	2023	90	Palas Gmbh, TRAGSATEC
Tirpitz, JL.	64	Intercomparison of MAX-DOAS vertical profile retrieval algorithms: studies on field data from the CINDI-2 campaign	ATMOSPHERIC MEASUREMENT TECHNIQUES	2021	60	LuftBlick OG

Piel, F.	5	Introducing the extended volatility range proton-transfer-reaction mass spectrometer (EVR PTR-MS)	ATMOSPHERIC MEASUREMENT TECHNIQUES	2021	27	Ionicon
Sicard, M	15	Long-term characterisation of the vertical structure of the Saharan Air Layer over the Canary Islands using lidar and radiosonde profiles: implications for radiative and cloud processes over the subtropical Atlantic Ocean	ATMOSPHERIC CHEMISTRY AND PHYSICS	2022	123	TRAGSATEC
Bouillon, L	12	NO2, BC and PM Exposure of Participants in the Polluscope Autumn 2019 Campaign in the Paris Region	TOXICS	2023	53	Cerema
Favez, O	35	Overview of the French Operational Network for In Situ Observation of PM Chemical Composition and Sources in Urban Environments (CARA Program)	ATMOSPHERE	2021	108	Air Breizh, Airparif
He, XC.	104	Role of iodine oxoacids in atmospheric aerosol nucleation	SCIENCE	2021	80	Ionicon
Garcia, RD.	9	Spectral Aerosol Radiative Forcing and Efficiency of the La Palma Volcanic Plume over the Izana Observatory	REMOTE SENSING	2023	94	EKO instr. Europe, TRAGSATEC
Bianchi, F.	42	The SALTENA Experiment Comprehensive Observations of Aerosol Sources, Formation, and Processes in the South American Andes	BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY	2022	53	Ionicon
Simon, L.	9	Two years of volatile organic compound online in situ measurements at the Site Instrumental de Recherche par Teledetection Atmospherique (Paris region, France) using proton-transfer-reaction mass spectrometry	EARTH SYSTEM SCIENCE DATA	2023	65	Airparif
Garcia, RD.	10	Water Vapor Retrievals from Spectral Direct Irradiance Measured with an EKO MS-711 Spectroradiometer-Intercomparison with Other Techniques	REMOTE SENSING	2021	67	Cimel Electronic, EKO instr. Europe
Sipila, M.	16	Volcanic Eruption of Cumbre Vieja, La Palma, Spain: A First Insight to the Particulate Matter Injected in the Troposphere	REMOTE SENSING	2022	31	TRAGSATEC
Sipila, M.	20	Wintertime subarctic new particle formation from Kola Peninsula sulfur emissions	ATMOSPHERIC CHEMISTRY AND PHYSICS	2021	44	Aerodyne
Languille, B	19	Wood burning: A major source of Volatile Organic Compounds during wintertime in the Paris region	SCIENCE OF THE TOTAL ENVIRONMENT	2020	74	Airparif, Cerema

The companies involved in the ACTRIS publications are mainly small-sized businesses located in Europe or in the USA, working with and interested in different ACTRIS components, as indicated in Table 7.

Table 7: *Companies as co-author in ACTRIS publications.*

Company	**Country**	**Size**	**ACTRIS Components**
Aerodyne Research, Inc.	USA	Small	Aerosol in situ
Aerosol d.o.o.	Slovenia	Small	Trace Gases in situ/Aerosol in situ
CIMEL Electronique	France	Medium	Aerosol remote sensing
Datalystica	Switzerland	Not specified	Trace Gases in situ/Aerosol in situ
Droplet Measuring Technologies	USA	Small	Cloud in situ
EKO Instruments EUROPE BV	Netherlands	Not specified	Aerosol remote sensing
GRASP SAS	France	Small	Aerosol remote sensing
Ionicon	Austria	Small	Trace Gases in situ
LuftBlick OG	Austria	Small	Trace Gases remote sensing
Meteomodem	France	Small	Trace Gases in situ/Aerosol in situ
Palas GmbH	Germany	Medium	Aerosol in situ
Picarro	USA	Small	Trace Gases in situ/Aerosol in situ
TOFWERK AG	Switzerland	Medium	Aerosol in situ

3. ACTRIS business engagement actions

There has been a long-term ACTRIS industry liaison based initially on personal contacts and then reinforced by significant efforts made within previous projects like ACTRIS-2 and EUROCHAMP to bring the private sector community together and involve them in the advancements and opportunities in ACTRIS. The Associated Partnership programme within the previous projects informed many private sector companies about day-to-day business in ACTRIS and kept them updated on its progress. Many of these companies are instrument manufacturers interested in testing and improving their instrumentation to keep up to date with the latest advances in technology and achieve the standards that ACTRIS requires.

However, the database of companies that was developed within WP9 and the examples of best practice presented in this report show that many private stakeholders strongly relate to ACTRIS in other sectors such as health, forestry, and filter manufacturing.

To foster the collaboration between ACTRIS and industry and to attract new private sector partners on a broader spectrum of scientific domains, ACTRIS has pursued several different business engagement actions, including:

- Empirical surveys;
- Innovation workshops;
- Mailing lists and newsletters;
- Continuous liaison through the established ACTRIS organizational units;
- ACTRIS participation in broader initiatives.

3.1. Empirical surveys

The analysis of industry needs has been carried out through two empirical surveys. The first survey is part of ACTRIS IMP WP6 “Implementation of the user access to ACTRIS services”. The main objective of WP6 is to connect the access management system of the Service and Access Management Unit (SAMU) with the DC, TCs, and NFs by offering physical and remote access and to set up the access services following a user-centric approach coherent with the ACTRIS technical capability and mission.

Although the number of answers received from companies participating in this first survey was small – only 14 companies participated in the survey – the results may offer some valuable insights on the services provided by ACTRIS TCs, companies’ interest, and willingness to keep the collaboration. The companies participating in the first survey are listed in Table 8.

Twelve respondents had an existing collaboration with a research organization in ACTRIS or used the Central Facilities, while only two, Engineering Ingegneria Informatica (Italy) and INOESY SRL (Romania), are new users.

Table 8: *Companies participating in the first empirical survey.*

Company	Country	Size	ACTRIS Components
Aerodyne Research, Inc.	USA	Small	Aerosol in situ
Aerosol d.o.o.	Slovenia	Small	Trace Gases in situ/Aerosol in situ
CIMEL Electronique	France	Medium	Aerosol remote sensing
CNC Solutions	Greece	NS	All
EKO Instruments EUROPE BV	Netherlands	Small	Aerosol remote sensing
Engineering Ingegneria Informatica	Italy	Large	New user
INOESY SRL	Romania	Micro	New user
Ionicon	Austria	Small	Trace Gases in situ
Licel GmbH Germany	Germany	Small	Aerosol remote sensing
Meteomodem	France	Small	Trace Gases in situ/Aerosol in situ
Raymetrics SA	Greece	Small	Aerosol remote sensing
RPG Radiometer Physics GmbH	Germany	Small	Cloud remote sensing
Sunset Laboratory Inc	Netherlands	Small	Aerosol in situ
TSI	USA	Large	Aerosol in situ

The majority are small and medium-sized companies, while only two - Engineering Ingegneria Informatica (Italy) and TSI (USA) - are large-sized companies with more than 250 employees. Furthermore, with reference to the market segment, almost a majority belongs to the instrument manufacturers or sensor industry, and just a few of them to distributors of instrument manufacturers and ICT services / products companies. The expertise of the companies participating in the survey is quite broad and can give some preliminary insights into the nature of industry collaborations with the ACTRIS community (Figure 16).

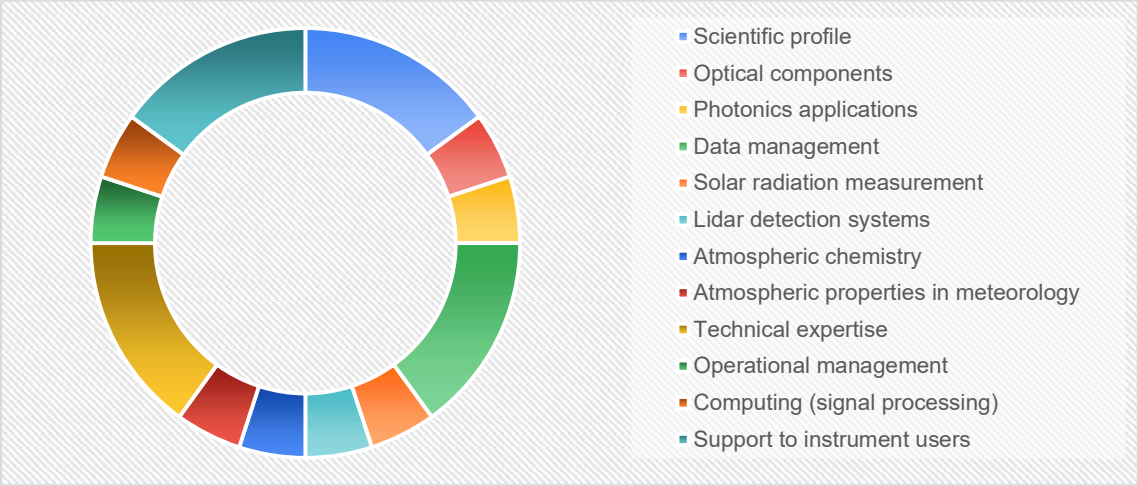

Figure 16: *Expertise of the companies involved in the first survey.*

All the companies answered specific questions to describe the nature of their collaboration with ACTRIS. In particular, companies classified their experience with ACTRIS as a partnership, with around 50% identifying as suppliers and 50% as users of the ACTRIS services. The collaborations were defined

as either systematic long-term relationships, one-off impromptu collaborations and other types of cooperation.

A mix of the different ACTRIS services have been accessed by the nine respondents (see Figure 17). The companies received a combination of support or services at different stages of the research, development, and innovation process: six companies got support or services from an ACTRIS RPO at commercialization stage, four at proof of concept / demonstration stage, three for pre-competitive research, and two for feasibility studies. Only two companies indicated that they had participated in an active programme of joint technology innovation pilots.

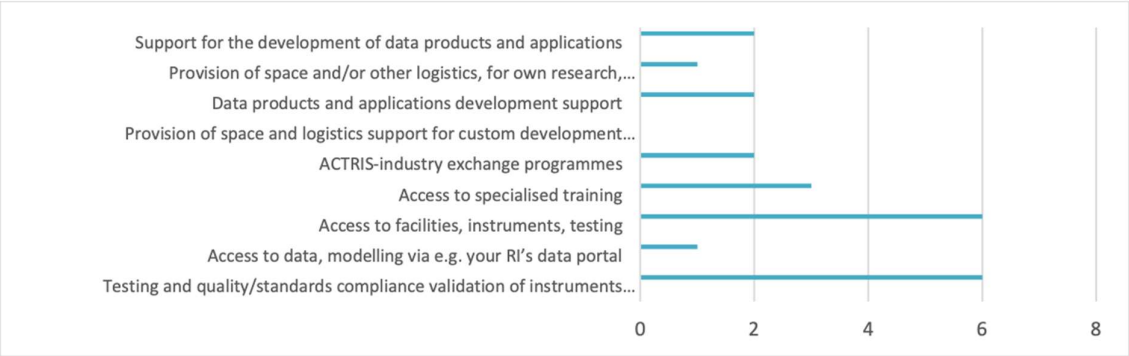

Figure 17: *Which of the following ACTRIS services did your company use?*

According to the majority of the companies, EU/publicly funded projects, industry training programs and financial subsidies from ACTRIS represent the main tools to sustain and support collaborations between ACTRIS and industry. Research needs seem to be focused on the access to ground-based observational platforms and exploratory platforms, with physical and remote access being the most popular types of access.

With reference to their willingness to collaborate in the near future, the new users expressed interest in a wide range of services, specifically: testing and quality/standards compliance, validation of instruments and processes and access to facilities and instruments. There was particular interest in a collaboration at the proof of concept and demonstration stages.

Regarding the measures that could be beneficial to develop collaborations between ACTRIS and industry, the most popular answer was through financial subsidies from ACTRIS, then EU or publicly funded projects and industry training programs.

Finally, some companies provided comments on the future role of ACTRIS:

- "As Instrument suppliers we supply equipment but work also as partners with ACTRIS facilities and take part as users in workshops, conferences etc."
- "ACTRIS represents an opportunity for the entire Europe. Together with other research infrastructures should be exploited in an integrated, well-supported manner in the interest of the European population".
- "We would like to be informed about next inter-comparison workshops for the filter photometers and OC/EC analysis".

To obtain further input from the companies collaborating with ACTRIS, a second empirical survey was administered using the SLIDO tool during the *Workshop on Innovation in Atmospheric Measurement Techniques* organized by ACTRIS and the Cyprus Institute in June 2022, in which about 100 private companies participated.

Three questions from the polls are most relevant for this report:

- *Which kind of services or collaboration did your company already use or are your company interested in?*
- *What are your current and prospective interests with ACTRIS?*
- *How can ACTRIS foster innovation and support the private sector?*

The following kinds of services or collaboration have been already used or requested by the companies (top – frequently mentioned, bottom – rarely mentioned):

- Testing and quality/standards compliance validation of instruments and processes;
- Support for the development of data products and applications;
- Data products and applications development support;
- Access to facilities, instruments, testing;
- RI-industry exchange programs;
- Access to data, modelling via, e.g., your RI's data portal;
- Access to specialized training;
- Space and/or other logistics, for own research, development and trials.

The current and prospective interests of the companies according to the survey are:

- Testing and quality/standards compliance validation of instruments and processes;
- Access to facilities, instruments, testing;
- Access to specialized training;
- Access to basic training on atmospheric sciences;
- Data products and applications development support.

Ideas from the private sector to foster innovation in ACTRIS and support the private sector are here summarized:

- Low entry requirements to get new technology operated at ACTRIS sites;
- Provide access;
- Provide reference instruments and technologies;
- Platform for communication between users and private [sector];
- Access to facilities via TNA;
- Offer more workshops like the InnovATMO.

3.2 Innovation Workshops

Three workshops have been organized online by the Cyprus Institute within the framework of ACTRIS and the Eastern Mediterranean and Middle East Climate and Atmosphere Research Center (EMME-CARE). The workshops were organized as Partner Events of the EU Green Weeks and were each

attended by over 300 participants from more than 30 countries. Representatives of ACTRIS, ICOS, and IAGOS actively participated in the workshops and around one third of the participants came from the private sector:

- Workshop on Innovation in Atmospheric Sciences, 18 May 2021;
- Innovation in Atmospheric Measurement Techniques, 2nd edition, 2 June 2022;
- Innovation in Atmospheric Measurement Techniques, 3rd edition, 8 June 2023.

These online workshops aimed to bring atmospheric science communities together to share and discuss the latest innovations, including new technologies, products, and services in atmospheric measurement techniques and modeling. Participants also had the opportunity to network and enhance national, regional, and local collaboration.

The first Workshop on Innovation in Atmospheric Measurement Techniques occurred in the spring of 2021 and became an annual event, here briefly described in numbers:

1st Online Innovation in Atmospheric Sciences Workshop

- 18 May 2021;
- EU Green Week 2021 Partner Event;
- >350 participations from 45 countries, 35 from the private sector;
- 30 oral presentations and 23 vPICOs;
- Co-hosted by ACTRIS and EMME-CARE.

2nd Annual Online Workshop on Innovation in Atmospheric Measurement Techniques

- 2 June 2022;
- EU Green Week 2022 Partner Event;
- > 300 participants from 30 countries, about 100 of which from the private sector;
- 38 presentations, half from the private sector;
- Co-hosted by ACTRIS, ICOS, IAGOS, and EMME-CARE.

3rd Annual Online Workshop on Innovation in Atmospheric Measurement Techniques

- 8 June 2023;
- EU Green Week 2023 Partner Event;
- > 300 participants from 44 different countries attended the workshop, including researchers, and industry professionals in the atmospheric sciences, 46 participants from the private sector;
- 33 presentations delivered by speakers from 13 countries, 16 of which from the private sector;
- Co-hosted by ACTRIS, ICOS, IAGOS, and EMME-CARE.

All material (e.g., recording, book of abstracts etc.) from past workshops is available through the EMME-CARE Open Education portal.

Different technical workshops are also organized in the framework of different CFs in order to keep the private sector updated on the latest technological advancements and to build and reinforce collaboration. Workshops and meetings organized by ACTRIS have also been used to collect ideas to foster and improve future collaboration; some of them have been taken up and they will be soon initiated.

This confirms that ACTRIS is a lively innovation system and ACTRIS events are appreciated by industry stakeholders. It also shows that ACTRIS can help deliver technical developments to speed up the enhancement of the Technology Readiness Level (TRL).

3.3 Mailing list and Newsletter

An ad-hoc mailing list has been used since the ACTRIS PPP to promote events and opportunities and to distribute the ACTRIS Newsletter to the broad ACTRIS Community, which includes the private sector. Within ACTRIS IMP, a dedicated mailing list has been created specifically to facilitate tailored communication with the private sector and promote news and upcoming events related to innovation in atmospheric sciences.

ACTRIS has published 21 newsletters since June 2018, one every quarter of the year. The archive can be found at the Outreach section of the ACTRIS website.

3.4 Continuous liaison through the established ACTRIS organisational units

During the implementation phase, it became clear that the National Contact Persons (NCPs) and Central Facility (CF) leaders are vital for maintaining and strengthening cooperation with the private sector, having direct contacts with companies and the surrounding innovation environment.

On the one hand, company contacts already reported by the NCPs are beneficial to facilitate Europe-wide networking within ACTRIS and to track national innovation environments. On the other hand, ACTRIS service offers can be communicated even more appropriately and effectively in this way.

Furthermore, liaisons between the CF leaders and the private sector enable effective communication on very technical topics. ACTRIS is a very diverse research infrastructure, and although the ACTRIS administrative staff often have scientific background and expertise on some of the components, direct contacts with CF leaders and staff members enables them to rapidly clarify technical issues.

Establishing an ACTRIS liaison office would ensure the coordination and consolidation of these efforts by offering centralized innovation-related services in close collaboration with all the ACTRIS Units and serving as a bridge between national research communities, RI governing/decision bodies, and international stakeholders.

The ACTRIS liaison office has not been officially established yet, but a set of recommendations for its operation have been given within ACTRIS IMP[8]. In particular, the ACTRIS liaison office would be in charge of:

- establishing and coordinating the innovation ecosystems around RI national nodes;

[8] For more details please look at ACTRIS IMP Deliverable D9.2: Means and recommendations for the operation of the ACTRIS liaison office.

- defining and implementing an overall ACTRIS innovation strategy;
- setting up of an action plan for periodic updates on innovation opportunities;
- providing the conceptual and legal framework for sound interactions with industries;
- building strategic relationships and cross-collaboration on innovation;
- organizing and participating in dedicated events to strengthen collaboration with industries.

3.5 ACTRIS participation in broader initiatives

ACTRIS has actively participated in broader initiatives in the context of cluster projects and networks for the coordination of innovation-related aspects, the sharing of good practice, and the implementation of guidelines.

Within the ENVRIplus project (2015-2019) an Innovation Roadmap was published in 2019, with the aim of offering a set of guidelines to help the ENVRI cluster of RIs to develop closer links with the private sector and to demonstrate their relevance in promoting innovation and economic benefits for RI Member countries and Europe as a whole. The roadmap suggests a set of basic measures and actions to be adopted and undertaken in order to organize and position ENVRI RIs more effectively in identifying and communicating with prospective private sector partners. ACTRIS RPOs participating in ENVRIplus as project beneficiaries actively participated in the roadmap concept and drafting, and the ACTRIS scientific chair was in charge of reviewing the report.

Within the ENVRI-FAIR project (2019-2023), Task 3.4: "Fostering ENVRI data-driven innovation, innovative products, and services developed by ENVRI", RIs have been analyzed to stimulate and better communicate those services towards industrial partners. ACTRIS actively participated in ENVRI-FAIR WP3 with different ACTRIS RPOs as project beneficiaries and responsible for deliverables[9]. As part of these activities:

- a comprehensive private sector uptake strategy was developed for promoting effective and continuous communication and liaison with industry, including leading industry associations, technology clusters and interest groups, in line with the ENVRIplus Innovation Preparedness Roadmap;
- a workshop - co-organised by ACTRIS and the European Multidisciplinary Seafloor and water column Observatory (EMSO) - with industrial stakeholders was held in 2021 to discuss how to unlock and exploit the innovation potential of ENVRI RIs as providers of advanced services and how to boost cooperation with industry as procurers of leading-edge technologies and partners in the development of new data-driven products and applications;
- a dedicated catalogue of services was developed to address ENVRI private sector partners and to promote industry uptake of ENVRI services in compliance with FAIR principles.

ACTRIS also participated as an associate partner in the ENRIITC project, the European Network of Research Infrastructures, and Industry for Collaboration.

[9] For more information and to consult the deliverables released within WP3 in ENVRI-FAIR, please visit the website https://envri.eu/deliverables/.

Examples of best practice were shared among RIs and industrial stakeholders through a series of webinars aimed at:

- raising industry awareness of collaboration opportunities at RIs;
- helping RIs better liaise with industry and;
- fully demonstrating the overall impact of these collaborations.

ENRIITC proposed the establishment of an Industrial Liaison and Contact Officers hub as a long-term initiative, which has been positively received by ACTRIS and other ENVRI RIs. The ENRIITC project also promoted ACTRIS opportunities for the private sector (TNA calls, workshops, etc.) within its extensive network of RIs and industrial contacts.

4. Conclusions

The positioning of ACTRIS in the European innovation ecosystem is a measure of how ACTRIS can contribute to the European Policy on European Innovation Ecosystems (EIE), the European Innovation Council (EIC), and the European Institute of Innovation and Technology (EIT) by supporting innovative activities across Horizon Europe and other EU funding programs to improve the overall ecosystem for innovation in Europe.

The EU strategies aim to create more connected and efficient innovation ecosystems to support the scaling of companies, encourage innovation and stimulate cooperation among national, regional, and local innovation actors.

This report has analyzed the different areas in which ACTRIS collaborates with industry and presents a set of best collaborative practices for each of the 6 TCs. It also highlights the existence of collaborations in scientific outputs and well-established relationships between some companies and the ACTRIS scientific community. The analysis identifies a very broad and rich area of interactions between ACTRIS and industry, which can be improved even further from the following recommendations to improve collaboration with the private sector.

A first consideration concerns, in general, the importance of formulating an overall strategy for industry engagement toward innovation starting by the Deliverable 3.1: Draft Innovation Strategy and foreseeing a continuous update in collaboration with the various TCs, NCPs and other relevant bodies such as the ACTRIS RI committee.

The analysis of current needs of the companies already collaborating with ACTRIS is clearly important for improving knowledge transfer services and consolidating collaboration into the future. However, it is necessary to broaden the base of potential industry suppliers, users, co-developers, and/or technology-transfer partners so that ACTRIS can strengthen its position in the European Innovation Ecosystems. In this regard, in addition to the tools described in this report, periodic meetings with local companies or with trade associations can be useful for testing new initiatives and methods of interaction with industry. Representatives of trade associations can provide in-depth knowledge about SME needs and identify the companies that are more open to innovative approaches. Moreover, it is important to define relevant KPIs for industry collaboration, so that progress may be monitored and actions improved.

Some recommendations for ACTRIS can also be derived from the answers collected in the surveys. They refer to those aspects and issues that go beyond the strict assessment of previous and current collaboration between ACTRIS and the private sector, in particular to increase dissemination and knowledge of the ACTRIS services and the potential for cooperation with the private sector. Long-term relationships and use of ACTRIS services beyond the partnerships at local and national levels are already realized in ACTRIS. The established mailing lists, newsletters, the evolving website https://www.actris.eu/, and the involvement of the ACTRIS structures (TCs, NFs, NCPs) already shows positive results. The new structures ensure that existing contacts are brought from the informal to the formal level and, in addition, that new companies become aware of the opportunities in collaborating with ACTRIS.

The ACTRIS Liaison Office at the ACTRIS TCs will improve communication with private companies. Simplified procedures and requirements should be put in place for setting up the partnerships and ensuring that the market-driven access to ACTRIS resources is fully implemented.

All of these favorable conditions also depend on the financial measures and availability of resources that could be beneficial to develop the collaboration: ACTRIS should ensure that the required resources, including experienced researchers and technicians, are dedicated to develop and serve the requirements of the private sector.

5. References

Publications

- ESFRI WORKING GROUP REPORT Monitoring of Research Infrastructures Performance
- ESFRI White Paper (2020) MAKING SCIENCE HAPPEN. A new ambition for Research Infrastructures in the European Research Area

Projects

- ACTRIS-2 - Aerosol, Clouds, and Trace gases Research Infrastructure project, EC H2020, G.A. n. 654109 (2015-2019)
- ACTRIS-PPP - ACTRIS Preparatory Phase Project, EC H2020, G.A. n. 739530 (2017-2019)
- ACTRIS-IMP - ACTRIS Implementation Project, EC H2020, G.A. n. 871115 – (2020-2023)
- ATMO-ACCESS - Solutions for Sustainable Access to Atmospheric Research Facilities, EC H2020, G.A. n. 101008004 (2021-2025)
- ENRIITC - European Network of Research Infrastructures and Industry for Collaboration, EC H2020, G.A. n. 871112 (2020-2022)
- ENVRI-FAIR - ENVironmental Research Infrastructures building Fair services Accessible for society, Innovation and Research, EC H2020, G.A. n. 824068 (2019-2023)
- ENVRIplus - Environmental Research Infrastructures Providing Shared Solutions for Science and Society, EC H2020, G.A. n. 654182 (2015-2019)
- EUROCHAMP-2020 - Integration of European Simulation Chambers for Investigating Atmospheric Processes – Towards 2020 and beyond, EC H2020, G.A. n. 730997 (2016-2021)

Project related Deliverables and Milestones used for reference

ACTRIS-2

- Deliverable D4.4: Final report on innovation
- Milestone MS4.5: Final report on the use of ACTRIS facilities and calibration centres for testing novel instruments

ACTRIS-IMP

- Deliverable 3.1: Draft Innovation Strategy
- Deliverable D4.3: Revised CF implementation plans
- Deliverable D6.2 Report on the ACTRIS User support system
- Deliverable D9.2: Means and recommendations for the operation of the ACTRIS liaison office
- Deliverable 10.2: Creation of dedicated communication portfolio
- Milestone MS30 ACTRIS User experience map
- Milestone MS35 Updated analysis of user needs

- Milestone MS52 Identification of collaboration models between ACTRIS and the private sector

EUROCHAMP-2020

- Deliverable D4.6: Final report on engagement with the private sector

ENVRIPLUS

- Deliverable D18.5: RI Innovation and Industry Liaison Preparedness Roadmap

ANNEX A: List of companies

Company	Website	Country
Abacus Laser GmbH	https://abacus-laser.com/	Germany
Ace glass	https://www.aceglass.com/	USA
Acoem GmbH	https://www.acoem.com/	France
ADDAIR	http://www.addair.fr/	France
Adient Strakonice s.r.o.	https://www.adient.com/czech-republic/	Czech Republic
ADLER Czech,a.s. Ústí nad Labem	https://www.zlatestranky.cz/profil/H67981	Czech Republic
Advanced Instruments	https://www.aicompanies.com/	USA
Aerodyne Research, Inc.	https://www.aerodyne.com/	USA
ASM Aerosol Service AG		Switzerland
Aerosol d.o.o.	http://www.aerosol.si/	Slovenia
Aerosol Devices Inc	https://aerosoldevices.com/	USA
Aersense LTD		Cyprus
AethLabs	https://aethlabs.com/	USA
Ahlstrom-Munksjö Falun AB	https://www.ahlstrom.com/	Finland
Air Quality Design Inc	http://noxwerx.com/	USA
Air Techniques Inc	https://www.airtechniques.com	USA
AIRCLIP SERVICE GmbH & Co. KG	https://www.airclip.de/	Germany
Airel Ltd	https://www.airel.ee/	Estonia
Airmodus Oy	https://airmodus.com/	Finland
Airscape	https://airlabs.com/	Denmark
Airyx GmbH	https://airyx.de/	Germany
ALDP association of forestry and wood processing companies	https://www.aldp.cz/	Czech Republic
Alnor Inc	http://www.alnor-usa.com	USA
Alpes Lasers S.A	http://www.alpeslasers.ch/	Switzerland
Alphasense	https://www.alphasense.com/	UK
AMUFOR association of forest municipalities & owners	https://amufor.es/	Spain
Andøya Space Center	https://www.andoyaspace.no/	Norway
Ansys fluent	https://www.ansys.com/	USA
Auto Štěpánek, a.s. Praha	http://www.auto-stepanek.cz/	Czech Republic
AutoNaut Ltd	https://www.autonautusv.com/	UK
Avet cz, s.r.o., Praha	https://www.avetcz.eu/	Czech Republic
Baldwin Environmental, Inc	https://www.sbir.gov/sbc/baldwin-environmental-inc	USA
BASF	https://www.basf.com/global/en.html	Germany
Beckham Coulter	https://www.beckmancoulter.com/	USA
Belfort Instrument	http://belfortinstrument.com/	USA
Bergene Holm Sawmill	https://www.bergeneholm.no/en	Norway
Bilfinger	http://www.noell.bilfinger.com/en/	Germany

Biowell	https://www.biowell.sk/	Slovak Republic
Biotest	https://www.biotest.com/	Germany
Biral	https://www.biral.eu/en/	Switzerland
Blue Industry and Science	https://www.blueindustryandscience.com/	France
BMMCR, s.r.o., Praha	https://bmmcr.cz/	Czech Republic
Brechtel	https://www.brechtel.com/	USA
Brookhaven Instruments	https://www.brookhaveninstruments.com/	USA
Bruker company	https://www.bruker.com/content/bruker/int/en.html	Germany
BTL Medical Technologies, s.r.o., Praha	https://www.btl.cz/	Czech Republic
Buck Inc	https://www.apbuck.com/	USA
Burkard Manufacturing Co Ltd	http://burkard.co.uk/	UK
Cambustion	https://www.cambustion.com/	UK
Campbell Scientific Ltd.	https://www.campbellsci.eu/	UK
Casella Solutions	https://www.casellasolutions.com/	UK
Catalytic Instruments	http://catalytic-instruments.com/	Germany
CAVAZZA ANNA Sas	https://www.easyspt.com/	Italy
CERES International	https://www.ceresinternational.org/	Portugal
CH Technologies	https://chtechusa.com/	USA
CHARLEROI CONSULT, s.r.o., Praha		Czech Republic
Chimera Technologies	http://www.chimeratech.com/	USA
Chromatotec	www.chromatotec.com/	France
Chromatotec	http://www.chromatotec.com/	France
Cilas Laser and beyond	https://cilas.ariane.group/en/	France
CIMEL Electronique	https://www.cimel.fr/?lang=en	France
CityZen, s.r.o. Chrudim	https://www.cityzenwear.cz/	Czech Republic
Climet Instruments	https://www.climet.com/	USA
CNC Solutions	https://www.cncsolutions.com/en/	Greece
Comde-Derenda	https://www.comde-derenda.com/	Germany
CONITECH Ltd	http://www.coniwater.com/en/Index.html	Romania
CON.TEC Engineering srl	http://www.conteng.it/	Italy
Contipro, a.s., Dolní Dobrouč	https://www.contipro.cz/	Czech Republic
Cooper Environmental	http://cooperenvironmental.com/	USA
Copley	https://www.copleyscientific.com/	UK
CPG LAB s.r.l.	https://www.cpglab.it/	Italy
CRPF private forestry association	https://www.cnpf.fr/	France
ČVUT v Praze	http://utopm.fsid.cvut.cz/	Czech Republic
Cytiva	https://www.cytivalifesciences.com/	UK
Dado Lab	https://www.dadolab.com/it/	Italy
DAHLHAUSEN CZ, spol. s r.o.	https://www.dahlhausen.cz/	Czech Republic
Dantec Dynamics A/S	https://www.dantecdynamics.com/	Denmark

Datalystica	https://datalystica.com/	Switzerland
Dekati Oy Finland	https://www.dekati.com/	Finland
Digitel	http://www.digitel-ag.com/	Switzerland
DITRITON CZ a.s., Praha		Czech Republic
Droplet Measuring Technologies	http://www.dropletmeasurement.com	USA
Drylock Technologies	https://drylocktechnologies.com/	Belgium
ECM ECO MONITORING	https://www.ecomonitoring.com/en/home/	Slovak Republic
Ecomesure	https://ecomesure.com	France
Ecophysics	https://www.ecophysics.com/	Switzerland
Ecotech Pty Ltd	https://www.ecotech.com/	Australia
EKO Instruments EUROPE BV	https://eko-eu.com/	Netherlands
EMBIO Diagnostics	https://embiodiagnostics.eu/	Cyprus
ENCO	http://www.enco.gr/	Greece
ENERG-SERVIS, a.s. Brno	https://www.energservis.cz/index.html	Czech Republic
ENI	https://www.eni.com/en-IT/home.html	Italy
ENOVEO	https://enoveo.com/	France
ENVEA Environnement S.A	http://www.environnement-sa.com/	France
Envicontrol	https://envicontrol.com/	Belgium
Envilyse	https://envilyse.de/	Germany
Enviropol, s.r.o. Praha	http://www.enviropol.cz/cs/	Czech Republic
Envirosys	https://enviro-sys.gr/	Greece
ENVItech Bohemia s.r.o.	https://www.envitech-bohemia.cz/	Czech Republic
Eurelettronica Icas SRL	http://www.eurelettronicaicas.com/	Italy
Eva české prádlo, Ostrava	https://www.eva-pradlo.cz/	Czech Republic
Fai Instruments srl	https://www.fai-instruments.com/it/home-it/	Italy
Fasmatech	http://fasmatech.com/	Greece
FCBA forest/wood sector association	https://www.fcba.fr/en/secteurs/forest/	France
FEVAMA federation of wood and furniture enterprises in Valencia	http://fevama.es/	Spain
Fritzøe Skoger	https://www.fritzoeskoger.no/	Norway
Gala, a.s. Prostějov	https://www.gala.cz/	Czech Republic
Grade Medical, s.r.o. Praha	https://www.grademed.cz/	Czech Republic
GRASP SAS	https://www.grasp-sas.com/	France
Green Technologies Slovakia, s.r.o., Brezová pod Bradlom, SK	https://www.finstat.sk/46101381	Slovak Republic
Grimm	https://www.grimm-aerosol.com/	Germany
GWU-Umwelttechnik GmbH	https://www.gwu-group.de/	Germany
Halo Phototonics	http://www.halo-photonics.com/	UK
Haze Instruments d.o.o.	https://haze.si/	Slovenia
Helmut Hund GmbH	https://www.hund.de/	Germany
Hilase	https://www.hilase.hu/	Hungary

Hosokawa Micron Cooperation	https://www.hosokawamicron.co.jp/	Japan
In Iustitia, o.p.s	https://in-ius.cz/	Czech Republic
ING MEDICAL, s.r.o. Praha	https://ingmed.cz/	Czech Republic
Ing. Petr Gross s.r.o.	https://www.ipg.cz/	Czech Republic
Inhalation sciences	https://www.inhalation.se/	Sweden
Innova IT	https://www.innovait.dk/	Denmark
Innovery srl	https://innovery.net/	Italy
Intelsol, s.r.o., Praha	https://intelsol.cz/	Czech Republic
Intertek	https://www.intertekintl.com/	Turkey
Ioner	https://ioner.eu/	Spain
Ionicon	https://www.ionicon.com/	Austria
JB Hyperspectral Devices GmbH	https://www.jb-hyperspectral.com/	Germany
Jiří Zezula	http://www.modnisperky.com/	Czech Republic
Kaiser servis,spol. s r.o._TRN	https://www.kaiserservis.cz/	Czech Republic
KANOMAX	https://kanomax-usa.com/	USA
Kärsa Oy	https://www.katsa.fi/	Finland
Kayrros	https://www.kayrros.com/	USA
KVANT spol. s r.o., Bratislava, Slovensko	https://www.kvant.sk/	Czech Republic
L+H Vakuumtechnik	http://lhvakuum.at/	Austria
Laseroptik GmbH	https://www.laseroptik.com/	Germany
LECKEL GmbH	https://www.leckel.de	Germany
LEN s.r.l.	https://www.lensrl.it/	Italy
LEOSPHERE	https://www.leosphere.com/	France
Licel GmbH Germany	https://licel.com/	Germany
LiCOR	https://www.licor.com/	USA
Loopshore Oy	https://loopshore.com/	Finland
Los Gatos/ABB	http://www.lgrinc.com/	USA
Lufft GmbH	https://www.lufft.com/	Germany
LuftBlick OG	http://luftblick.at/	Austria
Magee Scientific	https://mageesci.com/	USA
Malina – Safety s.r.o. Jablonec and Nisou	https://www.malina-safety.cz/	Czech Republic
Malvern Panalytical	https://www.malvernpanalytical.com	UK
Materion	https://materion.com/about	USA
Math2Market	https://www.math2market.de/	Germany
MEEO S.r.l	www.meeo.it	Italy
Menapia Ltd.	https://www.menapia.tech/	UK
Merck Millipore	https://www.merckmillipore.com/	Germany
Mesalabs	https://mesalabs.com/	USA
Met one Instruments	https://metone.com/	USA
METEK GmbH	https://metek.de/	Germany

Meteomodem	http://www.meteomodem.com/	France
Metrohm Applikon	https://www.metrohm.com	Netherlands
Mirion Technoilogies	https://www.mirion.com/	USA
MIRO Analytical AG	https://miro-analytical.com/	Switzerland
msensis	https://msensis.com/en/	Greece
MVB Opava CZ s.r.o	https://www.mvb.cz/	Czech Republic
NAFIGATE Park, s.r.o., Praha	https://www.nafigatepark.cz/	Czech Republic
Naneos	https://www.naneos.ch/	Switzerland
Nano Medical, s.r.o	https://nanomedical.cz/	Czech Republic
Nanopromedical s.r.o.	https://www.nanopromedical.cz/	Czech Republic
Nanothinx	http://www.nanothinx.com/	Greece
NanoTrade, s.r.o., Olomouc	http://www.nanotrade.cz/	Czech Republic
NH Hospital Nemocnice Hořovice	https://www.nemocnice-horovice.cz/	Czech Republic
Nicarnica Aviation	https://nicarnica.com/	Norway
NUVIA a.s	https://nuvia.com/cz/	Czech Republic
OCM Research	https://qcmresearch.com/	USA
OLMAN SERVICE, s.r.o., Brno	https://olman.cz/	Czech Republic
Optind Solutions Ltd	https://www.optind.in/	India
Origins.Earth	https://www.origins.earth/	France
Orion srl	https://www.orion-srl.it/	Italy
Oxility	https://www.oxility.com/	Netherlands
Palas GmbH	https://www.palas.de/en	Germany
Pall	https://www.pall.com/	USA
Pardam N4F Factory, Roudnice n/L	https://www.nano4fibers.com/cs	Czech Republic
Particle Measuring Systems	https://www.pmeasuring.com	USA
Perkin Elmer	https://www.perkinelmer.com/	USA
Perma pure	https://www.permapure.com/	UK
Pfeiffer Vacuum	https://www.pfeiffer-vacuum.com/	Germany
PFNonwovens Czech, s.r.o., Znojmo		Czech Republic
Photonion	https://www.photonion.de/	Germany
Picarro	https://www.picarro.com/	USA
Pikto Digital, a.s	https://www.pikto.digital/cz	Czech Republic
PLUMELABS	https://plumelabs.com/en/	France
Plzeňský Prazdroj, a.s., Plzeň	https://www.prazdroj.cz/	Czech Republic
PM TEN SRL	http://www.pm10-ambiente.com/	Italy
Pollution srl		Italy
Prádelna Kyselý, Vlašim	http://www.pradelna.cz/	Czech Republic
Purcon	https://www.purcon.gr/	Greece
Quantum Infinity, s.r.o.	http://www.quantum-infinity.cz/	Czech Republic
Raymetrics SA	https://www.raymetrics.com/	Greece

Redkoh Industries		USA
Remote Sensing Consultants Limited	http://www.rsacl.co.uk/	UK
Respilon Group, s.r.o. Brno	https://www.respilon.com/	Czech Republic
Ricardo-AEA Ltd.	https://ee.ricardo.com/	UK
Ricca IT SRL	https://www.ricca-it.com	Italy
ROLSIT, s.r.o. Brno	https://www.rolsit.cz/	Czech Republic
ROYAX	https://royax.eu/	Czech Republic
RPG Radiometer Physics GmbH	https://www.radiometer-physics.de/	Germany
RS DESIGN s.r.o.	https://www.rs-design.cz/	Czech Republic
Sailbri Cooper Incorporated (SCI)	https://sci-monitoring.com/	USA
Schaefer	https://schaefer-tec.com/	Germany
schnaiTEC GmbH	https://www.schnaitec.com/	Germany
Scientific aviation	https://www.scientificaviation.com/	USA
Sciglob	https://sciglob.com/	USA
SCIMED Biotechnologies s. r.o.,	https://www.scimed.cz/	Czech Republic
SEADM	https://www.seadm.com/	Spain
Selvik Bruk forest owner	https://www.selvikbruk.no/	Norway
SENSE Vital Air s.r.o., Praha	https://sense.cz/	Czech Republic
SHG Health Care Europe Ltd		Czech Republic
Shimadzu	https://www.shimadzu.it/	Japan
Sigma Space Corporation	http://www.sigmaspace.com/	USA
SINTEX,a.s. Česká Třebová	http://www.sintex.cz/	Czech Republic
SKC	https://www.skcinc.com/	USA
SMRC Automotive Solutions, s.r.o.	https://www.smrc-automotive.com/	Czech Republic
Sokol's Power Visual, s.r.o., Praha	http://www.spv.cz/	Czech Republic
Sono-Tek	https://www.sono-tek.com/	USA
Spektra SRL	https://www.spektra.it/	Italy
SPUR,a.s. Zlín	https://www.spur.cz/	Czech Republic
Stilvi, s.r.o. Praha	https://stilvi.cz/	Czech Republic
Stûv S.A	https://www.stuv.com/en/company	Netherlands
Sunset Laboratory Inc	http://www.sunlab.com/	Belgium
Swisens	https://swisens.ch/	Switzerland
Swiss Krono Group, wood panel industry	https://www.swisskrono.com/ch-de/#/	Poland
Tangensis, s.r.o., Rožnov pod Radhoštěm	http://www.tangensis.cz/	Czech Republic
Tecora	https://www.tecora.com/	France
TELAB, s.r.o., Praha	http://www.telab-corp.com/cz/	Czech Republic
Teledyne Api CLD	http://www.teledyne-api.com/	USA
Teleportuj Europe s.r.o.	https://urly.it/3xdnx	Czech Republic
Tenum	http://www.tenumshop.com/en/	France

Tera Environnement France Consultancy services	https://groupe-tera.com/	France
Terra Modus Consultants Limited	https://terramodus.co.uk/	UK
Textronik	https://www.tek.com/	USA
Thermo Electronics: Thermo Fisher CLD	www.thermofisher.com	USA
Thermofischer Scientific	https://www.thermofisher.com	USA
Thorlabs	https://www.thorlabs.com/	USA
Thrace Plastics	https://www.thracegroup.com/	Greece
Tisch Environmental	https://tisch-env.com/	USA
Tiskárna Kolbe	https://eurosetkolbe.cz/	Czech Republic
TOFWERK AG	https://www.tofwerk.com/	Switzerland
Topas GmbH	https://www.topas-gmbh.de/	Germany
TRAGSA	https://www.tragsa.es/	Spain
TSI	https://www.tsi.com/home/	USA
U-Earth Biotech	https://it.u-earth.eu/	UK
ULTIMATE-GEMS s.r.o., Králův Dvůr	https://respirator-shop.cz/	Czech Republic
URG better air. better lives	http://www.urgcorp.com/	USA
VAISALA	https://www.vaisala.com/en	Finland
Venacontra	http://www.venacontra.com/	Finland
VitalCare CZ, s.r.o.	https://urly.it/3xdnz	Czech Republic
Vitrocell Systems GmbH	https://www.vitrocell.com/	Germany
Výskumný ústav chemických vlákien, a.s., Svit, Slovensko	http://vuchv.sk/	Slovak Republic
Výzkumný ústav potravinářský Praha, v.v.i.	https://www.vupp.cz/cs/	Czech Republic
Workpress Aviation s.r.o., Plzeň	https://www.workpressaviation.com/	Czech Republic
XEARPRO	https://xearpro.it/	Italy