

Deliverable 1.6: ACTRIS Business Plan

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Executive Summary

The Aerosol, Clouds and Trace Gases Research Infrastructure (ACTRIS) is a pan-European research infrastructure (RI) producing high-quality data and information on short-lived atmospheric constituents and on the processes leading to the variability of these constituents in natural and controlled atmospheres.

The atmosphere is a highly complex system driven by countless chemical and physical processes. The atmospheric environment is continuously changing, linked to growth of the human population and the associated mobility demand for people and goods, to the increasing energy demands and the expanding industrial activities in some regions of the World, to the intensification of agricultural activities worldwide and the associated changes in land use, to changes affecting some very vulnerable regions like the Arctic, to changes affecting the global cycle of pollutants. The ability to predict the future behaviour of the atmosphere over a wide range of time scales (hours to decades) brings great benefits to society and economy. Examples span from short-term hazardous weather and health warnings to long-term evaluation of climate change and policy effectiveness. Atmospheric process understanding, and predictions of all kinds, use complex models that are underpinned by observations. Without high quality observation data to constrain predictive models, any forecast of the atmosphere is highly unreliable.

The atmospheric environment is also shaped by the effectiveness of environmental policies for reducing emission of pollutants, which mitigate climate change and improve air quality. The nature of research will also evolve, from process understanding to providing atmosphere-related services liable to respond to societal demands and offering customised products such as projections on future changes, advice on best practices, and any other initiative that support adaptation, mitigation and disaster risk management.

ACTRIS is key to supporting scientific advances in the field of atmospheric research: fundamental understanding of atmospheric physical and chemical processes together with advances in theory, modelling, and observations is vital in narrowing gaps in the predictive capability of simulation models from the local to the global scale. ACTRIS activities contribute to reducing uncertainties in emission sources, to understanding deposition processes that remove short-lived constituents from the atmosphere, and to quantifying their potential impacts on ecosystems.

ACTRIS helps responding to the grand-challenges faced by our society by enabling a deeper understanding on atmospheric processes, improving our resiliency to climate change, and air quality, contributing to reduce the effects of air pollution on public health and ecosystems.

ACTRIS integrates, harmonizes, and distributes datasets, activities, and services provided by the Central Facilities (CFs) and National Facilities (NFs), located in 22 European countries. The National Facilities, which include Observational and Exploratory Platforms both within Europe and at selected global sites, are responsible for the acquisition of high quality, reliable and accurate data to document the 4-D distribution and variability of aerosol, clouds and trace gases and their complex interactions. ACTRIS includes eight Central Facilities (CFs) - six Topical Centres (TCs), the Data Centre (DC) and the Head Office (HO) - that are essential to ensure compliance of the measurements with standard operation procedures and data analysis. After many years of community building, design and preparatory phase, ACTRIS will enter in a five-year implementation phase (2020-2024) dedicated to constructing and upgrading the National Facilities and Central Facilities, setting up the user access and service provision as well as the governance and management structures. Additionally, efforts will be made to connect

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with new users and attract new member countries, develop further strategies within ACTRIS and for international collaboration and partnerships, and integrate ACTRIS at different strategic levels (national, European and internationally). Following the implementation phase, ACTRIS will be operational and will become a reference for short-lived atmospheric constituents, offering a unique portfolio of services including open access to data and physical and remote access to CFs and NFs services.

1. ACTRIS Overview - Objectives, Strategy and Structure

Vision & Mission

ACTRIS Vision

ACTRIS is the fundamental European Research Infrastructure for short-lived atmospheric constituents, increasing the excellence in Earth system observation and research and providing information and knowledge for developing sustainable solutions to societal needs.

ACTRIS Mission

ACTRIS shall establish, operate, and develop a pan-European distributed research infrastructure for short-lived atmospheric constituents. ACTRIS shall provide effective access for a wide user community to its resources and services in order to facilitate high-quality Earth system research.

Objectives of ACTRIS

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

The main objectives of ACTRIS are:

- to provide information on the 4D-composition and variability and of the physical, optical and chemical properties of short-lived atmospheric constituents, from the surface throughout the troposphere to the stratosphere, with the required level of precision, coherence and integration;
- to provide efficient open access to ACTRIS data and services and the means to effectively use the ACTRIS products;
- to promote the training of operators and users and enhance the linkage between research, education and innovation in the field of atmospheric science;
- to ensure and raise the quality of data and use of up-to-date technology used in the RI and the quality of services offered to the community of users, involving partners from the private sector.

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Scientific challenges and gaps addressed

The atmosphere is a highly complex system driven by countless chemical and physical processes. The ability to predict the future behaviour of the atmosphere over a wide range of time scales (hours to decades) brings great benefits to society and the economy. Examples span from short-term hazardous weather and health warnings to long-term evaluation of climate change and policy effectiveness. Atmospheric process understanding and predictions use complex models that are underpinned by observations. Without high-quality observation data to constrain predictive models, any forecast of the atmosphere is highly unreliable.

Short-lived atmospheric constituents, aerosols, clouds and trace gases, have residence times in the atmosphere ranging from seconds to a few weeks, which make their concentrations highly variable in time and space. Their properties, such as concentration as well as physical and chemical properties, affect:

- the Earth's radiation balance through absorption, scattering and indirect cloud-related processes, a major source of uncertainty in future climate predictions;
- extreme weather, by contributing to a changing energy balance at the ground and in the atmospheric column;
- public health, trough long- and short- term exposure by deteriorating lung and heart functions and causing respiratory infections and heart diseases.

ACTRIS helps responding to the grand-challenges faced nowadays by our society: ACTRIS enables a deeper understanding on atmospheric processes, improving our resiliency to climate change, and air quality, contributing to reduce the effects of air pollution on public health and ecosystems

ACTRIS is key to supporting scientific advances in the field of atmospheric research: fundamental understanding of atmospheric physical and chemical processes together with advances in theory, modelling, and observations is vital in narrowing gaps in the predictive capability of simulation models from the local to the global scale. ACTRIS activities contribute to reducing uncertainties in emission sources, to understanding deposition processes that remove short-lived constituents from the atmosphere and to quantify their potential impacts on ecosystems. More generally, ACTRIS brings essential information for understanding global biogeochemical interactions between the atmosphere and ecosystems, and how climate-ecosystem feedback loops may change atmospheric composition in the future. Air pollution is still a major problem for public health in Europe and many other countries in the world. ACTRIS supports the development of the required level of understanding of sources of the air pollutants that negatively affect human health. Finally, ACTRIS observations are an important component complementing Earth Observations from space, providing unique ground-truthing of remote sensing information collected by current and future satellite missions.

ACTRIS is a long-term activity with more than 100 European partners engaged in building a single, pan-European, sustainable and distributed research infrastructure, to cover both the 4-dimensional (4-D) observations (latitude, longitude, height, time) and process understanding for short-lived atmospheric constituents. ACTRIS is unique in its architecture and disciplinary coverage within atmospheric and climate science. ACTRIS integrates, harmonizes and distributes the high-quality observations provided by first-class facilities for atmospheric research currently located in 22 European countries and other locations globally, and operates the pan-European distributed

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research infrastructure providing open and effective access to unique resources and services to a wide user community of Earth system research.

Added Value

ACTRIS enables free-access to high-class long-term atmospheric data from a single entry point as well as access to the best research environments and expertise at Topical Centres and at selected National Facilities, promoting opportunities for world-class research ad international collaborations. ACTRIS develops new technologies and algorithms for monitoring activities relevant for climate and air quality models, satellite retrievals and forecast systems, serving a vast community of users working in research, space agencies, operational services, public and private sectors. ACTRIS facilitates the integration of the community around common strategic objectives, which will bring the economy of scale and harmonious development of the Infrastructure, including the user's needs. ACTRIS final goal is to generate the necessary conditions to enable a sustainable framework for ACTRIS long-term operations.

- ACTRIS offers a single point of access to users for services and data supporting the use of different platforms and facilities, which will increase access to the facilities by the users and potentially reduce the operational cost.
- ACTRIS simplifies the access to comprehensive and harmonised data collections.
- ACTRIS has a central repository and networked resources.
- ACTRIS facilitates the interoperability between RIs and promotes inter- and multidisciplinary research to tackle challenges in science and society.
- ACTRIS will have several operational services at the end of the implementation phase, making ACTRIS more attractive and accessible to external users.
- By the end of the implementation phase, ACTRIS will have integrated workflows between all the ACTRIS components, which can be further developed by the user ACTRIS community.
- ACTRIS offers tailored trainings to the NFs operators and external users based on their needs.
- ACTRIS strives to generate and foster attractive work environments to enable new opportunities, including novel outreach and technology-transfer activities, between ACTRIS facilities and users from the public and private sector.

Scenario	Without ACTRIS	With ACTRIS		
Infrastructure	Lower level of organizations. Higher complexity for a user to find and access a suitable service. Under-utilized.	Centralized single-point access. Pooling of infrastructure resources and tools.		
Costs	Under-utilised platforms leading to higher unit of access cost.	Increased use of platforms, likely reducing unit of access cost. Optimization of investments.		
Data collection	According to local practices.	Standardization of harmonised data collection and quality practices.		

Table 1. Added value of the ACTRIS.

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Fragmentation of repository. Low likelihood of fulfilment of FAIR principles.Single data repository. Data fulfilling FAIR principles.Data access fragmented datasets. Non-open datasets (unavailable datasets)Centralized single-point access to service and data.Service provision industrial liaisonsAccording to local practices.Integrated workflows. Established efficient and effective access facilitated to users.Innovation and industrial liaisonsFragmented and limited abilities responses to industry needsTrained and networked staff. Established strategy for innovation and industry.Scientific impactScattered and non-connected local research teams. Non-coordinated activities and possible duplication of work. Low dissemination impact and knowledge transfer.Joint resources and shared capabilities. Cross-domain knowledge transfer.InternationalisationNarrower international network. Fewer opportunities for cooperation and starff exchange.Largely enhanced visibility trough outreach activities coordinated by the HO. Established strategy for cooperation and support for staff exchange.				
Low likelihood of fulfilment of FAIR principles.Data fulfilling FAIR principles.Data accessMultiple and complex procedures to access fragmented datasets.Centralized single-point access to service and data.Data accessMon-open datasets (unavailable datasets)Open access datasets.Non-open datasets (unavailable datasets)Open access datasets.Service provisionAccording to local practices.Integrated workflows.Innovation and industrial liaisonsFragmented and limited abilities responses to industry needsTrained and networked staff.Scientific impactScattered and non-connected local research duplication of work.Joint resources and shared capabilities.Low dissemination impact and knowledge transfer.Joint resources and shared capabilities.InternationalisationNarrower international network. Fewer opportunities for cooperation and staff exchange.Largely enhanced visibility trough outreach activities coordinated by the HO.InternationalisationNarrower international network. Fewer opportunities for cooperation and staff exchange.Largely enhanced visibility trough outreach activities coordinated by the HO.InternationalisationNarrower international network. Fewer opportunities for cooperation and staff exchange.Largely enhanced visibility trough outreach activities coordinated by the HO.		Fragmentation of repository.	Single data repository.	
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Service provisionEstablished efficient and effective access facilitated to users.Innovation and industrial liaisonsFragmented and limited abilities responses to industry needsTrained and networked staff. Established strategy for innovation and industry. Wider ability to connect with industry.Scentific impactScattered and non-connected local research teams. Non-coordinated activities and possible duplication of work. Low dissemination impact and knowledge transfer.Joint resources and shared capabilities. Cross-domain knowledge transfer. High potential for outreach to a broader social impact. Low dissemination impact and knowledge transfer.InternationalisationNarrower international network. Fewer opportunities for cooperation and staff exchange.Largely enhanced visibility trough outreach activities coordinated by the HO. Established strategy for cooperation and support for staff exchange.		According to local practices.	Integrated workflows.	
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Scientific impactScattered and non-connected local research teams.Joint resources and shared capabilities. Cross-domain knowledge transfer.Non-coordinated activities and possible duplication of work.High potential for outreach to a broader 			Wider ability to connect with industry.	
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Low dissemination impact and knowledge transfer.Largely enhanced visibility trough outreach activities coordinated by the HO.InternationalisationPewer opportunities for cooperation and staff exchange.Largely enhanced visibility trough outreach activities coordinated by the HO.	Scientific impact	duplication of work.	High potential for outreach to a broader social impact.	
InternationalisationNarrower international network.Largely enhanced visibility trough outreach activities coordinated by the HO.InternationalisationFewer opportunities for cooperation and staff exchange.Established strategy for cooperation and support for staff exchange.		Low dissemination impact and knowledge transfer.		
Internationalisation Fewer opportunities for cooperation and staff activities coordinated by the HO. Exchange. Established strategy for cooperation and support for staff exchange.		Narrower international network.	Largely enhanced visibility trough outreach	
exchange. Established strategy for cooperation and support for staff exchange.	Internationalisation	Fewer opportunities for cooperation and staff	activities coordinated by the HU.	
		exchange.	support for staff exchange.	

Landscape

The importance of ACTRIS in the European atmospheric RI landscape has been acknowledged as part of European Strategy Forum for Research Infrastructures (ESFRI) Roadmap 2018 (<u>http://roadmap2018.esfri.eu/</u>) by the ESFRI Landscape analysis. ACTRIS build on previous efforts, such as EARLINET, EUSAAR/CREATE and CLOUDNET (Acronym list in Appendix 2), thus integrates several atmospheric science communities in Europe into one coherent RI, making ACTRIS the biggest atmospheric RI in size, covering most of the atmospheric observations and experiments, and providing the broadest set of atmospheric variables in the atmospheric RI domain.

ACTRIS is fully integrated into the European landscape of atmospheric research infrastructures together with EUROCHAMP¹, IAGOS-AISBL, EISCAT-3D and the atmospheric component of ICOS, and cooperation with other RIs is part of the ACTRIS overall strategy. More specifically (Fig.1):

^{*} All Acronyms can be found in Annex III.

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- ACTRIS collaborates towards common scientific goals by including atmospheric simulation chambers which have been operated for many years within the EUROCHAMP project.
- ACTRIS complements the area of the atmospheric component of ICOS (long-lived climate forcers) with the provision of information on short-lived climate forcers.
- ACTRIS completes information provided by IAGOS-AISBL (passenger aircraft measurements) both temporally, by adding the required continuity of the time series, and spatially, by offering 4-D information across Europe on parameters measured by both RIs.
- ACTRIS investigates the atmosphere from the surface to the stratosphere and therefore complements the EISCAT-3D, mostly focusing on upper atmosphere dynamics, a region and a domain not covered in ACTRIS.



Figure 1. ACTRIS in the atmospheric subdomain of the ESFRI RI landscape (Reference to Strategy Report on Research Infrastructures ROADMAP 2018, Part 2 Landscape Analysis)

ACTRIS is seeking synergies and collaboration opportunities with other (environmental) RIs, wherever it is feasible and reasonable. The motivation for collaboration derives from the fact that by increasing data interoperability, co-locating RI facilities and widening the access beyond RI specific user communities, unprecedented scientific breakthroughs can be achieved. Therefore, collaboration and synergies are a central activity of ACTRIS operations. To this end, ACTRIS joined and actively participated in several thematic activities related to technology development, FAIR data, access, training on knowledge transfer as well as communication and collaboration organized within the projects **ENVRI community** and **ENVRI plus** and will continue within the ongoing **ENVRI FAIR.** The participation in the ENVRI community (Fig.2) has been fundamental in boosting the engagement with users and stakeholders as well as promoting networking and cross-disciplinary activities. Furthermore, ACTRIS is actively involved in different European projects that will support the activities related to the implementation phase (Table 1,2).

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Additionally, there are other projects, which are currently funded under the European Commission Horizon 2020 Research Infrastructure Programme by the European Commission, that relate to the atmospheric domain of ENVRI:

• ARISE2: a design study aimed at monitoring the dynamics of the middle and upper atmosphere. ACTRIS will build upon ARISE as part of its National Facilities.

• HEMERA: a newly funded project dealing with atmospheric sounding technologies. HEMERA is a starting community and connections have not been established yet.



Figure 2. The cluster of European environmental RIs ENVRI gathers 26 research infrastructures, which are either working in single domain (atmosphere, marine, solid Earth or Terrestrial ecosystem/biodiversity) or in a multi-domain approach. Image credit: ENVRI Plus.

Domain	Project	ACTRIS Contribution		
	<u>ENVRIplus</u> (2015-2019)	ACTRIS directly benefits from guidelines developed in the ENVRIPlus project related to technologies, data management, access provision, ethical and training issues and management of distributed RIs.		
Multi-domain	<u>ENVRI-FAIR</u> (2019-2023)	ACTRIS leads the development of the e-environment towards FAIR for RIs in the atmospheric domain. The strategy for defining the correct level of liaison with European Open Science Cloud (EOSC) (and EOSC-hub – 2018-2022 – in particular) will be based on the outcome of ENVRI-FAIR.		
	<u>COOP+</u> (2017-2019)	ACTRIS uses COOP+ outcome to strengthen the links and coordination of ACTRIS with international counterparts.		
	EOSC-hub	EOSC-hub brings together multiple service providers to create a single		

Table 1. On-going EU-granted project that are synergic to ACTRIS implementation.

	(2018-2020)	contact point for access, use and reuse of a broad spectrum of resources for advanced data-driven research. ACTRIS will evaluate the need for
		connecting some services to EOSC-hub.
	ENRIITC (under evaluation),	ACTRIS is associated with the pending project that will help to define the ACTRIS innovation strategy and Network of Research Infrastructure Industrial Liaison and Contact Officers. (INFRAINNOV-2-2019)
	<u>RISCAPE</u> (2017-2019)	ACTRIS contributes to the landscape analysis that will directly benefit the European Union strategic RI development and policy.
	<u>ERA-PLANET</u> (2016-2020)	ACTRIS partners are involved in several H2020 GEO-related projects such as ERA-PLANET (2016-2020). Connection with GEO projects will facilitate integration of ACTRIS activities into a GEO initiative.
Environment	<u>NEXT-GEOSS</u> (2016-2020)	ACTRIS DC is a partner in the NEXT-GEOSS project that will be used for evaluating strategies addressing the downstream segment of ACTRIS.
	<u>E-SHAPE</u> (2020-2024)	ACTRIS benefits from the experience developed in E-SHAPE (formerly EUROGEOSS) to evaluate and develop its downstream applications.
	FORCeS (2019-2023)	ACTRIS contributes via comprehensive observations to provide constrained aerosol forcing pertinent for improved climate projections.
	EUROCHAMP-2020 (2017-2020)	ACTRIS IMP project will actively involve the science community of EUROCHAMP-2020 that are developing the required procedures to be implemented by ACTRIS CFs and NFs involving atmospheric simulation chambers.
	ACTRIS IMP (2020-2024)	The main objective of ACTRIS IMP is to support the ACTRIS implementation by establishing a long-term research infrastructure with demonstrated and well-functioning operations and services.
Atmosphere	ACTRIS CAMS (2019-)	The ACTRIS-CAMS are pilot projects aim at establishing the conditions for fully traceable and quality-controlled NRT data provision to ECMWF/Copernicus on aerosol in-situ (CAMS 21a) and aerosol vertical (CAMS 21b) components.
	<u>COST COLOSSAL</u> (2017-2021)	ACTRIS will benefit from the establishment of a well-defined user- community connected to the Topical Centre for Aerosol in-Situ measurements organized in COLOSSAL.
	EMPIR - EURAMET	ACTRIS partners, together with National Metrological Institutes in Europe, are involved in a series of projects – Black-Carbon (2017-2020), KEY-NOx-2 (2017-2020), MetClimVOC (submitted) – funded under the EURAMET program to develop the necessary standard procedures that will be used in ACTRIS.
	<u>E-PROFILE</u> - EUMETNET	ACTRIS facilitates the provision of services from the relevant TCs to the E- PROFILE EUMETNET network.

Table 2. Examples of possible future multi cross disciplinary co-operations between ACTRIS and other RIs.

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Domain Example RI		ACTRIS contribution	
Physical science and	Cherenkov Telescope	Provision of atmospheric transmittivity data	
engineering	Allay (CTA)		
	<u>EPOS</u>	Studying the evolution of a volcanic ash cloud after an eruption	
Environment	Euro-Argo ERIC	Coupling the atmosphere-marine coupling for climate	
	EMSO ERIC	and environmental research.	
Health and food	Anaee	ACTRIS data and technology are relevant for both	
ficaliti and food	Andee	health and agriculture	
Social and cultural	<u>E-RIHS</u>	Impact on cultural heritage	
innovation	ESS ERIC	Impact on life	
IIIIOvation	SHARE-ERIC	inipact on life	
	ECCSEL ERIC	ACTRIS data and technology are relevant for both energy supply and consumption	
Energy	EU-SOLARIS		
	<u>WindScanner</u>		

Societal benefits and Horizon 2020 funding strategy

ACTRIS has a positive impact on the service provision for generating and disseminating knowledge, on boosting science and technological development, creating human capital, jobs and welfare for the benefit of society, and addressing environmental and societal challenges following the European Research Area (ERA) principles of optimal transnational cooperation and competition.

The development, construction, operation and maintenance of ACTRIS offers important opportunities for strengthening human capital creation, through supporting educational activities, facilitating scientific cooperation, and creating employment opportunities in specialised and high-level positions. During the period 2008-2016, around 950 Master and PhD students performed part of their research in ACTRIS, and more than 2,200 graduates received training at ACTRIS facilities. In addition, hundreds of students and researchers have been able to develop their skills, ranging from technical and scientific abilities, to personal competencies such as learning new transferable skills on communication, managerial, negotiating and organisational capabilities, by participating in meetings, seminars, workshops, conferences and other events offered by ACTRIS partners. As an outcome, ACTRIS has built a robust community of scientists, managers and engineers involved in using Earth Observation both for research and for policy-making applications. Currently, more than 800 specialised research and technical staff are working in association with ACTRIS, either under full-time or part-time employment status. ACTRIS enhances the exchange of expertise, mobility and networking of researchers. For example, one in four trainees, researchers or technicians working in ACTRIS contributes to building a community of knowledge that will respond to rising societal demand for expertise in environmental and climate science.

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ACTRIS is at the heart of grand challenges that society is facing: air pollution, climate change and human health.

Data and data products provided by ACTRIS partners have already led to improved predictions for weather, climate and air quality as well as enhancing awareness of the environmental challenges. The information provided by ACTRIS will contribute to defining mitigation and adaptation strategies and supporting international conventions and protocols. The ACTRIS community has been instrumental in delivering key information to civil aviation authorities and is regularly used to identify causes for high-level of particulate matter in European cities, and early-warning of atmospheric hazards such as dust or forest fire episodes.

Contribution to European policies and priorities

ACTRIS supports policy-driven monitoring networks such as those established to respond to EU-directives (local and European air-quality networks), to the Convention on Long-Range Trans-Boundary Air Pollution (CLRTAP) of the United Nations Economic Commission for Europe (UNECE) and to the recent recommendation of Civil Aviation Authorities to improve the monitoring system for atmospheric hazards management, thus responding to several societal needs and challenges. Furthermore, ACTRIS provides coordinated and committed European contributions to NDACC, AERONET and WMO-GAW networks, enabling better recognized and evaluated globally representative data products.

ACTRIS has close connections to ESA, EUMETSAT, ECMWF, AeroCom, WMO-Global Climate Observing System (WMO-GCOS). Moreover, ACTRIS provides access to expert services for the development and testing of novel technologies and products. Also, ACTRIS contributes to Copernicus services by providing data products to CAMS for near-real-time model validation. CAMS monitor air-quality in Europe and provides a forecast of air-quality for European cities. ACTRIS has well-established links with other RIs, not only in the atmospheric domain (IAGOS, ICOS, SIOS, EISCAT-3D) but also in a broader environmental domain (such as in ENVRI) and with the e-infrastructures operating the EOSC (Fig.3).



Figure 3. ACTRIS involvement with European and Global initiatives.

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Organisational structure

The core components of ACTRIS are the Central Facilities (CFs) and National Facilities (NFs) as shown in Fig. 4. ACTRIS CFs **[1]** perform ACTRIS operations at European level and consists of six Topical Centre, the Data Centre and the Head Office, the latter comprising the Service and Access Management Unit (SAMU) as shown in Table 4.



Figure 4. ACTRIS structure (right) and countries involved in ACTRIS (left).

The 8 Central Facilities, operated by their respective hosting multinational consortia, were approved by the Interim ACTRIS Council (IAC, the highest decision-making body of ACTRIS) in December 2018 after an independent selection process taking into consideration their capacity, expertise and commitment for implementing the required operation support and services. Each Central Facility consists of several Units hosted by a responsible ACTRIS Research Performing Organisation (RPO) of an ACTRIS member country. Detailed information about the Units and Hosting institutions within each CF are presented in Table 4. CFs participate to ACTRIS governance and management and provide services to the users accordingly to the user access policy as well as operation support to the NFs.

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Table 3. List of ACTRIS CFs and their Units, Host institutions and brief descriptions.

CF	Units	Host Institutions	Description
	RI operations unit (OPU)	FMI, UHEL (prior ERIC)	
Head Office	Development and Relations Unit (DEVU)	FMI, UHEL (prior ERIC)	ACTRIS Head Office (HO) is in charge of the strategic development and planning of ACTRIS services for users to solve important scientific questions and in promoting technology development and innovations. HO also manages and oversees the future cooperation with RIs from other domains. HO manages the ACTRIS scientific and technological development project portfolio and ensures that these collaborations lead to benefits for ACTRIS users, such as
(HO)	• ERIC Management Unit (EMU)	FMI, UHEL (prior ERIC)	developments in services and operations, in line with the ACTRIS strategy. HO shall coordinate and promote ACTRIS services, handle internal and external communication, operate the legal entity, and ensure the strategic development and sustainability of ACTRIS. The HO coordinates the RI at the European level, in close cooperation with the national ACTRIS consortia, the NFs, and the other CFs.
	Service and Access Management Unit (SAMU)	CNR (prior ERIC)	
	ACTRIS data and services access unit (ACCESS)	NILU, BSC, CNRS, MetNo,	ACTRIS Data Centre (DC) is responsible for handling the ACTRIS data. The primary role of ACTRIS DC is to compile, archive and provide access to well documented and traceable ACTRIS measurement data and data products.
Data Centre (DC)	Aerosol remote sensing data centre unit (ARES)	CNR, CNRS	including digital tools for visualisations, data analysis and research. As a tool for science, the highest priorities for ACTRIS DC is to maintain and increase the availability of ACTRIS data and data products relevant to climate and air quality research for all interested users. All primary measurement data and produced data products are made available to the users via the ACTRIS data portal. ACTRIS DC will provide scientists and other user groups with free and open access to all ACTRIS data in accordance with the Access policy, and ACTRIS follows the open research data
	ACTRIS Atmospheric simulation chamber data centre unit (ASC)	CNRS	initiative of the Commission. ACTRIS DC provides access to all measurements, both quality-assured data and near- real-time data, archived in interoperable topical data repositories handling very diverse type of data.

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• Cloi Sensir	FMI
ACTRI remote cei	CNRS
• ACTRI cer	NILU

CF		Units	Host Institutions	Description	ACTRIS variables
	• Aei	rosol High-power Lidar	CNR-IMAA, INOE, LMU	he mission of this TC is to offer operational support to ACTRIS ational Facilities operating aerosol remote sensing istrumentation: profile and column observations. Relevant ata include higher-level aerosol variables such as daytime xtinction, backscatter, absorption and mass concentration otal, fine, coarse) and aerosol microphysical properties. The entre includes AERONET-Europe calibration facility for	 Attenuated backscatter profile Volume depolarization profile Particle backscatter coefficient profile Particle extinction coefficient profile
Centre for Aerosol Remote Sensing (CARS)	tre for Aerosol note Sensing • Automatic low-power lidar / ceilometer DWD, LMU • Centre includes AERONET-Europe calibration photometers which complements the AERO calibration facility in the USA. There is also a close Centre for Cloud Remote Sensing because auto power lidars and ceilometers belong to the minimu instrumentation of NFs for cloud remote sensing. The Centre are partially operational and provide tra access in ACTRIS-2. • Automatic Sun/Sky/Lunar Photometers AEMET, UVA	Centre includes AERONET-Europe calibration facility for photometers which complements the AERONET-NASA calibration facility in the USA. There is also a close link to the Centre for Cloud Remote Sensing because automatic low- power lidars and ceilometers belong to the minimum required instrumentation of NFs for cloud remote sensing. The Units of	 Lidar ratio profile Ångström exponent profile Backscatter-related Ångström exponent profile Bacticle dependerization ratio profile 		
		the Centre are partially operational and provide trans-national access in ACTRIS-2.	 Particle layer geometrical properties (height and thickness) Particle layer optical properties (extinction, backscatter, lidar ratio, Ångström exponent, depolarization ratio, optical depth) 		

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				Column integrated extinction
				Planetary boundary layer height
				Spectral Downward Sky Radiances
				Direct Sun/Moon Extinction
				Aerosol Optical Depth (column)
	Doppler Cloud Radar – France CNRS, UVSQ		Cloud/aerosol target classification	
		CNRS, UVSQ	The mission of this TC is to offer operation support to ACTRIS National Facilities operating cloud remote sensing instrumentation. The Centre is elemental in developing calibration methods for cloud radars, microwave radiometry and Doppler Wind Lidars to be implemented on site (e.g. using calibration equipment or self-consistency techniques) and through mobile services (e.g. reference instruments or drone- based calibration). The Units of the Centre are in preparation.	Drizzle drop size distribution
Centre for Cloud Remote Sensing (CCRES)	• Doppler Cloud Radar – Netherlands	TUD, KNMI		Drizzle water content
		UKRI		• Drizzle water flux
	Doppler Cloud Radar – UK			Ice water content
	Microwave Radiometer	UCol		Liquid water content
	• Doppler Lidar - Finland	FMI		• Liquid water path
				Temperature profile
				Relative humidity profile
				Integrated water vapor path
	• FTIR Belgian Unit	BIRA-IASB, Uliege	The mission of the Centre is to offer operation support to	Ozone profile
Centre for Reactive Trace Gases Remote Sensing(CREGARS)	• FTIR German Unit	UBremen	ACTRIS National Facilities operating reactive trace gases remote sensing instrumentation. The Centre deals with different trace gas remote sensing techniques: Fourier-	Ozone partial columns
	Ozone-DIAL	CNRS		• Ozone column
			absorption spectrometry in the UV-visible range (UVVIS) and	Formaldehyde column
	UVVIS Austrian Unit	MUI	ozone LIDAR or O3 DIAL (differential absorption lidar). The	Formaldehyde lower tropospheric profile
	• UVVIS Belgian Unit	BIRA-IASB	Centre provides essential knowledge about the observation techniques (measurement and retrieval) that may be applied in future applications (e.g., new satellite sensors, progress in air quality modelling etc.) to species that are currently not addressed. The Units of the Centre are in preparation.	• NO2 column
	UVVIS French Unit	CNRS		NO2 lower tropospheric profile
		KNINAL		• NH3 column
	OVVIS Dutch Unit	KINIVII		• C2H6 column

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CF	Units	Host Institutions	Description	ACTRIS variables
Centre for Aerosol In Situ Measurements	Aerosol Chemical Monitor Calibration Centre	CEA, CNRS, INERIS	The mission of this TC is fundamental to improve the quality of the ACTRIS in situ aerosol data, by offering operation support to NFs, operating instruments for the physical or chemical in situ characterization of atmospheric aerosol particles as well as for particle sampling and subsequent laboratory analysis of these particles. The Units of the Centre are partially operational and provide trans-national access in ACTRIS-2.	• Particle number size distribution – mobility diameter (10 - 800 nm)
	Cluster Calibration Centre	UHEL		• Multi-wavelengths particle light scattering & backscattering coefficient
	Elemental Mass Composition Centre	INFN		Particle light absorption coefficient & equivalent black carbon
	Organic Tracers			 Mass concentration of particulate organic and elemental carbon
	and Aerosol Constituents Calibration Centre	JRC, TROPOS		 Particle number size distribution – optical and aerodynamic diameter (0.7 - 10 μm)
	Prague Aerosol Calibration Centre	ICPF		• Particle number concentration (> 10 nm)
(CAIS)				Mass concentration of particulate elements
	• World Calibration Centre for Aerosol Physics	TROPOS		Mass concentration of particulate organic tracers
				 Cloud condensation nuclei number concentration
				 Mass concentration of non-refractory particulate organics and inorganics
				Nanoparticle number concentration (< 10 nm)
				• Nanoparticle number size distribution (1 - 20 nm)
Centre for Cloud In Situ Measurements (CIS)	• CCDIP	UMAN, ZAMG	The mission of this TC is to offer operation support to ACTRIS National Facilities performing cloud in situ measurements. The Centre will offer services for instrument calibration, provide training and knowledge transfer opportunities, and support instrument improvements and new technological	Liquid Water Content
				Droplet effective diameter
				Droplet number concentration

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	• CCice	KIT, ZAMG	developments for the relevant ACTRIS variables and measurement techniques. The units of the Centre are partly operational and provide services as part of the EUROCHAMP- 2020 project.	 Droplet size distribution Ice particle number concentration Ice particle size distribution
	• CCWaC	TROPOS		 INP (ice nucleating particle) concentration Cloud residuals number concentration Cloud residuals composition Total inlet aerosol number concentration Total inlet aerosol size distribution Interstitial inlet aerosol number concentration Interstitial inlet aerosol size distribution Bulk cloud water chemical composition Temperature Relative humidity
Centre for Reactive Trace Gases In Situ Measurements (CiGas)	• CiGas-CH	EMPA	The mission of the TC is to provide operation support to NFs measuring key trace gases (non-methane hydrocarbons	
	• CiGas-DWD	DWD	(NMHC), oxidized volatile organic compounds (OVOC), biogenic volatile organic compounds (BVOC), specific direct aerosol precursors, NO, and NO2) in order to produce traceable, reliable and quality controlled datasets with known compatibility. Additionally, the Centre develops and tests innovative gas analytical technologies and data evaluation algorithms and enhances the competence of operative personnel by intensive training courses. The Units of the Centre are in preparation.	
	• CiGas-FZJ	FZJ		• Terpenes
	• CiGas-KIT	КІТ		• NO
	• CiGas-IMT	IMT-LD		• NO2
	• CiGas-UHEL	UHEL		Condensable vapours

The National Facilities (NFs) comprise Observational and Exploratory Platforms, both within Europe and at selected global sites. Exploratory Platforms and selected Observational Platforms provide users physical access to state-of-the-art, well-characterised and versatile facilities.

Observational Platforms [2] are fixed ground-based stations that deliver long-term data based on a regular measurement schedule and common operation standards, including quality assurance and quality control (QA/QC). These Platforms perform measurements of aerosol, clouds, and reactive trace gases from the Earth surface throughout the troposphere up to the stratosphere by applying state-of-the-art remote-sensing and in situ measurement techniques with harmonized, standardised, and quality-controlled instrumentation, operation procedures and data retrieval schemes.

The sites are strategically located in diverse climatic regimes both within and outside Europe, and many of them contribute to one or several European and international networks, such as EMEP, NDACC, or GAW, and are possibly partly shared with other environmental infrastructures, such as ICOS, SIOS, ANAEE or eLTER.

Exploratory Platforms [3] are atmospheric simulation chambers, laboratory platforms and mobile platforms that perform dedicated experiments and contribute data on atmospheric constituents, processes, events or regions following common ACTRIS standards. Atmospheric simulation chambers and laboratories are highly instrumented facilities for the determination of parameters needed for understanding the chemical, physical, or biological processes and for controlled simulation experiments under near-realistic environmental conditions. Mobile platforms comprise land-based, shipborne and airborne facilities, and thus, allow investigations of various processes under specific meteorological, climatic, or topographic conditions in different environments and ecosystems.

NFs are responsible for the acquisition of reliable and high-quality data to document the 4-D variability of aerosol, clouds and trace gases and their complex interactions. Additionally, ACTRIS NFs provide physical or remote access to selected platforms that will be centrally managed by ACTRIS Head Office (SAMU).

ACTRIS consists of 77 existing candidate NFs (expected to rise to more than 100 at the end of the implementation phase). The principles for the selection and labelling of the NFs in ACTRIS have been agreed by the Interim ACTRIS Council (IAC), and the NF labelling process will commence immediately after the establishment of ACTRIS ERIC (European Research Infrastructure Consortium) as a legal entity (foreseen in 2021).

Outline of ACTRIS Business model

The overarching objective of ACTRIS in the implementation phase is to coordinate and accomplish the actions required for implementing a globally-recognized long-term sustainable research infrastructure with well-functioning operations and services.

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Table 4. Elements that are fundamental for ACTRIS sustainability

ACTRIS' elements of sustainability		
Demonstrated scientific leadership		
Long-term financial commitment by member countries		
Coordinated and balanced governance and operations		
Permanence of highly qualified staff		
Strong connection with EU policy framework		
Internationalization		

The sustainability of ACTRIS business model is based on the expectation that the values generated by ACTRIS will counterpart or exceed the investment sustained by the countries participating in ACTRIS ERIC as Members or Observers.

The business model, illustrated in Fig. 5, is based on three elements: the inputs (or resources), the process (or strategy) and the outcome (or evaluation).

I. The input (assets or key resources)

Physical resources

- The Central and National Facilities with their local RPO infrastructures, instruments and platforms are the core of ACTRIS.
- Regular national investments by participating countries ensure that the RI installations and equipment are maintained in state-of-the-art conditions.

Human resources

• Scientists, technicians, engineers and managers involved in the NFs and CFs are among the topclass atmospheric research organizations are renown in Europe and worldwide. The RPOs are responsible of providing expert staff to maintain the operability of ACTRIS facilities.

Financial resources

- Public funding is invested by Members and Observers to support ACTRIS activities
- Public national and regional funds are invested to support national Consortia and ensure the maintenance and upgrade of world-class level facilities.
- Collaborations and partnerships with private stakeholders, such as SME, are sought after, in line with the strategic positioning in the research and Innovation Landscape.

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II. The process (or key activities)

Governance and Management

 ACTRIS governance and management is designed to enable the high level ACTRIS operations and services.

Operation and Workflows

- Operational support
- Data provision
- Data products
- Development of QA/QC methodologies
- NFs labelling
- NFs and CFs operation
- Coordination of operations
- Communication

User interaction

- Maintenance and operation of Catalogue of services
- User-oriented services
- Science and User forum
- Joint technological development
- Strategic liaisons and engagement

III. The output (or services)

Data and access provision

- High-quality & long-term data
- Data for operational response, neat real-time data and early warning services
- Physical access to selected NFs and CFs.
- Remote access
- Virtual access to computing resources
- Interoperability: Shared procedures, methods and standards will facilitate the shared use of outputs (data, processes, procedures...) and increase the durability of ACTRIS products.
- New Services: access to new services will be offered to the private and public sector, fostering innovation.

Training and expertise

• Training programs designed based on user needs from industry and academia for continuous training of their HR, to develop specific skills along with public and private innovation requests.

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- Instrumented platforms for scientific experiments, instrument-specific calibrations, and QA/QC procedures and tools.
- ACTRIS will participate in the education and training of the next generation of atmospheric scientists, in academia and industry.
- Knowledge Transfer (publications, seminars...) activities will strengthen the knowledge-based economy and put atmospheric sciences at the forefront of the European research and innovation agenda.
- Consulting services and products will be tailored to public and private sector.
- Certification of prototypes.
- New technology development through collaboration with external users.

Outreach

- Catalogue of Services
- Scientific breakthrough, publications and seminars will contribute to the advancement of science through publication and scientific networking.
- Dissemination: ACTRIS will strive to outreach to the general public and especially youth to explain in simple terms the importance of the atmospheric constituents.



Figure 5. ACTRIS Business model is based on the physical, human and financial resources which generate ACTRIS services through key processes. Users (i.e. researchers), key contributors (i.e. ACTRIS countries, RPOs) and key partners (i.e. WMO) access to ACTRIS services via the ACTRIS web interface, where the Catalogue of Services provide a complete overview of ACTRIS services. Users, key contributors and partners will successively interact with SAMU (for service requiring physical and remote access) or be provided with virtual access to the Data Centre (DATA ACCESS). The SAMU feeds into the key processes, notably user interaction by providing user feedbacks. ACTRIS Revenue streams are fundamental in supporting the Business model by covering the costs linked to ACTRIS resources. They consist of countries and membership contributions, project

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funding, grants, sponsorships (including donations) and other payments. The latter includes user fees due to on-demand services or customized products.

Implementation strategy

ACTRIS was included in the ESFRI roadmap in 2016. The expertise and maturity of the ACTRIS community resulted into a successful sequence of consecutive achievements. In December 2018, the IAC approved the framework and the main implementation actions planned for the ACTRIS implementation phase (2020-2024). ACTRIS set an ambitious target of becoming a long-term sustainable research infrastructure with demonstrated well-functioning operation and services by 2025 and obtaining the ESFRI landmark status during the next ESFRI assessment process.

The prime target of ACTRIS is to become a long-term sustainable research infrastructure by 2025. To this end, these activities are fundamental:

- producing high-quality integrated datasets in the area of atmospheric sciences and provide services, including access to instrumented platforms, tailored for scientific and technological usage;
- providing the governance of the distributed research infrastructure ACTRIS. ACTRIS ERIC establishes and operates the research infrastructure and coordinates the strategic and financial development and eventual long-term operation of ACTRIS;
- coordinating and monitoring adequate provision of data from the National Facilities;
- coordinating and monitoring activities at the Central Facilities and their service development strategies;
- ensuring open and timely access to ACTRIS data and data products through the Data Centre;
- operating a physical and remote access program to the Topical Centres, Data Centre and National Facilities;
- promoting ACTRIS to science communities, private sector and the general public;
- harmonizing the ACTRIS implementation with national priorities and strategies;
- promoting the resources of ACTRIS for education and training purposes and fostering training, outreach and international cooperation;
- enhancing the innovation and technology development potential of ACTRIS to maximize private-user uptake of ACTRIS services and renewal of ACTRIS technologies;
- promoting knowledge transfer to industry and policy makers;
- collaborating and interoperating with other research infrastructures in related and complementary fields;

2. ACTRIS user strategy

ACTRIS aims to place its serving users (public research organisations, universities and higher education organisations, international organisation; public services; private companies and businesses) at the centre of ACTRIS operations and strategic development.

The user strategy (Fig. 6) is the provision of value in terms of services, assistance, knowledge, know-how etc., which ACTRIS can offer to users in response to their needs, based on the technical capabilities of the Central and National Facilities and in line with the overall ACTRIS mission.

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Figure 6. Elements constituting the ACTRIS user strategy.

As a living strategy, it is developed as result of a cyclic process meant to find a proper combination and composition of the evolving user needs and the evolving ACTRIS capabilities, thanks to the establishment of a systematic and consistent approach to involve user, ascertain their needs, receive their feedback and provide clear and practical recommendations to ensure that service development/improvement efforts meet user expectations and fulfil their needs, and will continue to do so over the RI's lifespan.

The user strategy is a complex and made up of different components that have overall cohesion and consistency:

- 1. Service development strategy: services developed in response to user needs, as resulting from the user requirements analysis
- 2. User engagement strategy: the strategy on how to establish a close relation between ACTRIS, its facilities and the users and how to shape, nurture and maintain ongoing interactions between ACTRIS and the users, working co-operatively with the users so that they have a real influence over the services that are relevant for their research. It's about earning trust of users;
- 3. User experience strategy: on how to ensure that the overall experience of ACTRIS (services, interactions, support, whatever) is positive, satisfactory, without pain points for users.
- 4. User acquisition strategy, which deals with the selection and adoption of the suitable approach to get new users on-board, mainly through communication, defining messages and using means to getting new users to know ACTRIS services and decide to use them for their excellent science.

The ACTRIS user strategy aims at considering the user dimension and identifying the potential gaps between the user needs (current and future) and the services offered within the limits of the facilities' capacities. ACTRIS promotes the provision of access to a large variety of high-quality services offered by ACTRIS facilities, to a wide range of users and needs, for scientific, technological and innovation-oriented usage. The ACTRIS access strategy enables an efficient and effective access process to respond to and integrate the evolving user requirements.

The guidelines and general principles for access and use of ACTRIS data and services are defined in the **ACTRIS** data policy [4] and **ACTRIS access and service policy** [5], and the management, detailed rules, procedures and

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workflows are described in the ACTRIS Data Management Plan [6] and the ACTRIS Access Management Plan [7]. ACTRIS has an open access policy available for all users. ACTRIS ERIC shall respect and comply with any European and national legislation as applicable regarding the protection of personal data and privacy, environmental science data as well as health and safety at work. Ethical guidelines [8] approved by the ACTRIS ERIC General Assembly for ACTRIS shall be applied to the ACTRIS data and access policy [9].

Outreach, communication, and tailored representation of ACTRIS for various user communities, stakeholders, and interest groups is also part of an integrated user strategy oriented to the user engagement.

To improve the visibility of available ACTRIS services to users, ACTRIS will develop a **Catalogue of Services** that allows users to easily find all relevant information about the available services and access details (location availability, modalities, costs, etc.). The Catalogue of Services should be on-line, interactive and regularly updated, and help guiding the users in their quest for the needed services.

The Catalogue of Services will comprehensively inform about the following ACTRIS services:

Data Services related to ACTRIS data, data products, and data tools provided by ACTRIS Data Centre (DC) and include:

- Compilation and quality control of ACTRIS measurements data from both observational and exploratory platforms;
- Long-term archiving and preservation of ACTRIS data, comprising raw data, calibrated and qualityassured data up to fully quality controlled data and elaborated data products;
- Access to ACTRIS data, data products, and digital tools through a single-entry point;
- Documentation of data and data flow;
- Citation service, and data attribution, including version control, and data traceability;
- Data curation for campaigns and dedicated research projects and initiatives, external or internal to ACTRIS.

Technical Services related to ACTRIS technology provided by ACTRIS Topical Centres (TCs) and National Facilities (NFs) and include:

- Provision of measurement quality assurance and quality control procedures and tools;
- Instrument-specific calibration, testing, and intercomparison;
- Improvement of measurement and retrieval methodologies for aerosol, clouds, and reactive trace gases.

Research Services provided by the ACTRIS facilities provided by the ACTRIS National Facilities (NFs) and include:

- Physical access to instrumented observational and exploratory platforms for realisation of scientific experiments under ambient or controlled conditions;
- Use of state-of-the-art instrument and equipment supporting scientific excellence.

Innovation Services related to technological innovation provided by ACTRIS Topical Centres (TCs) and ACTRIS National Facilities (NFs) and include:

- Development of new observation techniques for aerosol, clouds, and reactive trace gases;
- Improvement of measurement and retrieval methodologies for aerosol, clouds, and reactive trace gases;

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• Exploration of instrument synergies and novel innovative research capabilities.

Training Services are provided at all ACTRIS facilities and include:

- Best practice, knowledge sharing with and knowledge transfer internally and to ACTRIS users;
- Training of instrument operators and data managers to ensure compliancy with ACTRIS standards;
- Training of users of ACTRIS data, products and tools and training of young scientists and users from new regions world-wide;

ACTRIS Services, in general, are coordinated, managed and provided through the ACTRIS Head Office (HO) with single-access point.

A specific access management platform will be studied, designed and tested during the ACTRIS implementation phase to organize and optimize the central management of the access for the entire RI. It will provide a single interface and unique entry point from which users can access multiple applications, such as Catalogue of Services, Helpdesk, Science and User Forum, and all actors involved in the service provision will be connected (Fig.7).

The SAMU manages the access to services for which ACTRIS facilities' resources are limited (as compared to services for access to ACTRIS data, data products, and digital tools that are directly accessible via the ACTRIS DC, or TC, without SAMU interaction). The platform will guide and control each step of the access and service provision process (application, management, review and selection, approval, support to access and monitoring/reporting) as well as optimized management of facility availability. Furthermore, a mechanism for user feedback will be implemented by SAMU to regularly collect information from the user on the range and quality of the ACTRIS services and to properly tailor them according to evolving user needs.

The collection of user feedback is an essential part of the *user-oriented approach* affirmed in the **ACTRIS user strategy**.



Figure 7. SAMU – Service and Access Management Unit - and its functions.

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Access types

ACTRIS ERIC shall provide Physical access, Remote access and Virtual access to resources and Data services, Research services, Technical services, Innovation services, Training services and General services.

- Virtual access means free access to users provided through communication networks; the available services or resources are directly available through a single access point and can be simultaneously used by an unlimited number of users and the users are not selected. Virtual access within ACTRIS concerns access to ACTRIS data and digital tools or other ACTRIS tools offered by the ACTRIS facilities. Examples for Virtual access: data, products, software, computing resources, other digital tools and services provided by the ACTRIS DC; digital tools for data and instrument operation (e.g., data processing tools) provided by an ACTRIS TC.
- Physical access is "hands-on" access when users physically visit an infrastructure/facility/equipment and
 access to services offered by an ACTRIS CF or NF. The available services or resources are not unlimited and a
 competitive process to manage the access is required following a defined procedure and criteria for selection
 of users. Physical access within ACTRIS may concern access to ACTRIS TC, DC, observational and exploratory
 NF. Examples for Physical access: realisation of scientific experiments on fixed and mobile instrumented
 platforms (ground-based observation stations, atmospheric simulation chambers, mobile experimental
 facilities), education and training activities, expert support, station audits, or other services or tools provided
 by the ACTRIS CF and ACTRIS NF.
- **Remote access** is access to resources and services offered by an ACTRIS CF or NF without users physically visiting the infrastructure/facility. Similar to Physical access, the services or resources are not unlimited, and a competitive selection is required. Remote access within ACTRIS may concern access to ACTRIS CF or NF. Examples for Remote access: sample distribution, instrument calibration, QA/QC services, analytical services, provision of specific digital tools and products, computing, other services provided by the ACTRIS CF.

Virtual, Physical and Remote access to the Central Facilities and National Facilities are centrally coordinated by the ACTRIS ERIC. Users will access the ACTRIS services through a single-entry point. Virtual access to ACTRIS data and digital tools is free, in compliance with the **ACTRIS data policy [4]** and does not require a selection process. Competitive access regulates physical or remote access to the ACTRIS Facilities, including access to specific services offered by the Data Centre and shall be managed by the SAMU through a selection process (Fig.7). Competitive access to ACTRIS services is made on user demand and might involve user fees. Detailed guidelines shall be given in the **ACTRIS Access Management Plan [7]**.

All Topical Centres and the Data Centre shall provide either Physical or Remote access or both, although the level of services may vary. National Facilities may also provide Physical access. ACTRIS internal rules shall apply to access services. This access and service policy acknowledges the ongoing work of the European Commission to foster the FAIR principles for data access, sharing and use. This access policy also acknowledges the relevant international initiatives for the observation of the Earth System (e.g. GEOSS) and national policies and legislations with the aim of full and open exchange of data and metadata and providing access to elaborated data products with minimum time delay and at possible no costs.

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Access to Central Facility services concern access to both Topical Centres and to the Data Centre and covers:

- Virtual access to ACTRIS data and digital tools generated with high-quality assurance and quality control standards;
- Physical and remote access to technical services, innovation services, training, and user-specific tailored services.

Access to National Facility services concern access to both Observational Platforms and Exploratory Platforms and covers:

- Physical and remote access to instrumented platforms;
- Physical and remote access to training services and capacity building;
- Physical and remote access to user-specific tailored services.

Access modes

The process for selecting users to ACTRIS services is based on access modes. The access mode regulates the conditions for the selection of users. Access modes are part of the ACTRIS-internal access process and are not discernible to users. Access modes may differ as a function of the service requested, and may depend on possible contractual and legal obligations, capacities, resources, membership, etc.

Within ACTRIS, the following access modes apply:

• Excellence-driven access: the access depends on scientific excellence, originality, quality and technical and ethical feasibility of an application. The access is competitive and requires a user selection based on the ACTRIS access process and modalities: the request is evaluated through peer-review conducted by a review panel. Upon selection, users get access to the ACTRIS facilities, resources or services available. This access mode is intended to enable collaborative research, knowledge transfer, training and best practice, and technological development efforts across geographical and disciplinary boundaries. Examples for Excellence-driven access: Physical and Remote access to services provided by ACTRIS NF (observational, exploratory platforms).

• **Technical need-driven access:** access to ACTRIS services depends on technical needs to ensure instrument quality, high performance measurements, and dissemination of good practices. The access is competitive and requires a review process and evaluation. Examples for Need-driven access: Physical and Remote access to services provided by ACTRIS CF.

• Market-driven access: access to ACTRIS services is defined through an agreement between ACTRIS ERIC and the user; the access may be tailored to the user needs and may lead to an access fee that may remain confidential. This access is considered competitive access but may not necessarily involve a peer-review. Example for Market-driven access: Remote access to digital services provided by the ACTRIS DC.

ACTRIS aims at providing free access for users, where possible. Virtual access is free of charge and aiming at broad user groups. Competitive access to ACTRIS services provided by an ACTRIS CF or NF is made on user demand and might involve user fees. The costs of CF and NF services are calculated according to the ACTRIS financial rules and may be adjusted on a regular basis. The potential user fee may vary according to principles

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established by ACTRIS ERIC, for example as a function of a specific service, user (e.g., academic vs commercial user), user origin (ACTRIS member country or not), or availability of funding (ERIC contribution, national funding, EU funding, etc.).



Figure 8. Access for Users to ACTRIS services as a function of access type (Virtual, Physical, Remote) and access mode (Excellence-driven, Technical need-driven, Market-driven), and of the ACTRIS policy concerned. Free access means that ACTRIS services are provided free-of-charge. Wide access aims at maximizing the access and uptake to ACTRIS data and digital tools and is open and free access, not involving any selection process. Competitive access requires a selection process via SAMU.

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Example 1: Competitive access selection process workflow

Figure 9. Exemplificatory ACTRIS physical access selection process workflow. In order to be granted access to ACTRIS services, users shall apply through the SAMU (01), which centralize and manage both physical remote access and provides and represents the interface between the users and the services offered by ACTRIS. The selection process may involve multiple stages. Applications shall be (02) validated by the SAMU for eligibility, (03) validated by the access providers to check availability of services the existing capacity, as well as the feasibility and timing of the access request, (04) selected according to defined criteria and access modes (Excellence-driven access mode, Technical need-driven access mode, and Market-driven access mode). In case of peer-review, a specific panel will be set up for scientific and technical evaluation. The composition and the functioning of the panel are based on principles of transparency, fairness and impartiality. SAMU shall inform the applicants on the acceptance or rejection of their request, as well as any revisions that may be needed to the applications. After the application has been approved (05), SAMU shall assist the users to have access to the applied services. SAMU collects feedbacks from users and provides information about the results and publications to all interested.

Example 2: Wide access process workflow





The value proposition for the user communities

ACTRIS Value Proposition for researchers

- enhancement of research performance due to centralized access to ACTRIS data and specific services;
- quality-assured and open-access ACTRIS data;
- standardized operating procedures;
- instrument and procedure inter-comparisons;
- access to research platforms for conducting excellent research and creating new scientific knowledge;
- increased possibilities for international collaboration, large-scale research projects and training opportunities;
- training and technical support from CFs and on-site support from NFs.

ACTRIS Value Proposition for educators

- trainings and best practices;
- exchange programmes
- knowledge transfer, e.g. basic and advanced international courses on atmospheric composition and processes for Master and PhD students;
- providing educational material (e.g, on-line courses, webinars, e-training platforms, documentation);
- offering expertise (e.g. expert visitors to schools of all levels).

ACTRIS Value Proposition for the private sector

- open-access data;
- expert services;

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- physical and remote access to the infrastructure for innovative research and for the development of novel technologies and products and as a testbed for new technologies and instruments;
- development of quality assurance standards to support the technological development;
- novel public-private collaborations leading to the establishment of spin-off and start-up companies.

ACTRIS Value Proposition for policy makers

- support for policy-driven networks established under EU-directives (local and European air-quality networks);
- development of new policies by provision of novel tools for validating the impact of regulation strategies and emission abatement policies through direct evaluation of atmospheric trends at regional / European scale;
- decision-making regarding environmental issues by provision of high-quality and long-term data for predicting climate scenarios from local and regional up to national and international level;
- atmospheric hazard (e.g. volcanic eruptions) management and risk mitigation via the knowledge base of ACTRIS expert teams and monitoring of extreme atmospheric events;
- enhancing job creation indirectly (expert jobs, new business opportunities).

ACTRIS Value Proposition for ministries and funding organizations

- optimization of national investments in research infrastructures;
- providing better value for money via the pan-European dimension and coordinated access to data and services;
- establishment of a unique research infrastructure for atmospheric sciences within Europe to improve efficiency of operation and coordination among the European research institutions avoiding the duplication and fragmentation of research efforts;
- internationalization of local areas in which NFs are located increasing their attractiveness being part of pan-European RI;
- added value for research, innovation, and society through efficient use of the RI resources.

ACTRIS benefits to Society (e.g. general public, national and international media)

- improved weather, climate and air quality predictions and services due to novel scientific findings resulting from ACTRIS;
- enhanced awareness on the environmental challenges that society is facing, e.g., climate change and air quality issues; and promotion of dialogue between researchers and society to translate scientific knowledge into practical applications

ACTRIS benefits to Europe

- support in cutting edge research and excellence in European Research Area;
- cross-border collaboration;
- contribution to further development of the European Research Area;
- enhancing European leadership in global level

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ACTRIS as a platform for high-quality research

ACTRIS is the European contributor to global networks through data and service provision for short-lived atmospheric constituents. ACTRIS profile is unique in its scope and service portfolio, filling a scientific and service gap in the RI landscape. During the implementation phase, ACTRIS will foster the development and harmonisation of QA/QC and data quality requirements in global programs and legislation-based monitoring networks. Furthermore, ACTRIS will develop multiple high-quality operations presented in an extensive Catalogue of Services that are available to all user groups. By establishing the ACTRIS Catalogue of Services, ACTRIS will facilitate the uptake of high-quality, reliable data by a broad scientific community and will respond to the needs in other regions of the world.

ACTRIS ambition is to strengthen its position and leadership in ERA within the discipline of atmospheric research by providing unique information, services, tools and reference methodologies that will be used and applied by a wide community both within and outside of Europe.

Having already established during the preparation phase close connections to the satellite and modelling communities, during the implementation phase ACTRIS foreseen to boost the cooperation with organisations such as ESA, EUMETSAT, ECMWF and AeroCom.

ACTRIS as a platform for innovation

Services offered by ACTRIS to support innovation are meant to foster knowledge transfer, which aims in the medium to long term to create both technological and societal breakthroughs and impact. Such services can include training on demand or targeting specific users' groups; the design and co-design of instrumentation, equipment or procedures, joint research activities and joint instruments testing.

ACTRIS will continue to contribute to the Framework conditions that are the main drivers of EU innovation performance external to the firm: Human resources, Attractive research system, specifically in atmospheric and environmental science, as well as Innovation-friendly environment **[10]**.

During the implementation phase, ACTRIS will continue to contribute to innovation working on technology development, and, more in general, on knowledge transfer, including promoting cooperation with the private sector, policy makers and the general public. The main tasks to be implemented are:

- Identifying the development areas and services for private sector collaboration;
- Promoting of co-development opportunities for technology development and new services;
- Promoting ACTRIS as an innovation platform;
- Enhancing the use of ACTRIS data products and digital tools for market-oriented applications and decisionmaking processes; and
- Enhancing the use of ACTRIS exploratory and observational platforms for market-oriented applications by providing access to the private sector.

During the implementation project, ACTRIS will work for providing a sound platform and tools to stimulate a more open Technology Transfer approach within ACTRIS, for disseminating relevant research outputs on

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atmospheric science to the private sector and for enhancing the collaboration between NFs and CFs operators and private sector.

3. Stakeholder engagement strategy and communication

ACTRIS Stakeholders

Stakeholder management begins by identifying who is affected by ACTRIS activities. To identify a comprehensive list of stakeholders, ACTRIS evaluates individuals or groups who contribute to or receive value from the service offered ACTRIS and, even more generally, the existence of a RI such as ACTRIS.

The identified ACTRIS stakeholders originates from academia, public and private sector and citizen, ACTRIS member countries as well as from countries which are not ACTRIS members, inside and outside Europe. These groups comprise researchers in atmospheric sciences, environmental sciences and other neighbouring fields (hydro-marine, bio-ecosystem, geosciences, space physics, energy, health, and food domain); operational and climate services, national weather services, space agencies, national and regional air quality monitoring networks, environmental protection agencies, instrument manufacturers and sensor industries, policymakers and local, regional, and national authorities.

User influence and importance

Stakeholders' perspectives, involvement and ability to interact with ACTRIS may change with time. Periodically, ACTRIS HO shall revisit the stakeholder analysis, which will help guide tactical decisions for engaging key stakeholders to support ACTRIS mission. A recurring stakeholder analysis helps to identify the right approach and tools to effective stakeholder communication, risk mitigation and engagement.

To assess each stakeholder group, the stakeholder groups are rated as high, medium or low based on their influence and involvement in ACTRIS activities and these ratings are plotted on a 2×2 Influence-versus -Interest grid. Stakeholder ratings support the development and management of an effective communication plan, which recognizes that each group may have different information needs, allowing a better understanding about where to invest for maximizing the engagement and dissemination activities.

In the scenario of ACTRIS, the role of Policy Makers is fundamental to support the uptake of ACTRIS at European level. At the same time the group Research & Academia can have a huge influence to gain trust around the RI. General Public can boost the uptake as well with their endorsement and can help to fund the next steps of the projects and push them to Policy makers. Engagement of industry and clusters are key to ensure sustainability notably at regional and national levels.
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Figure 8. The key stakeholders are visually mapped to an influence vs. interested grid for the current situation (a) and future perspective (b).

In the implementation phase ACTRIS strives at boosting the engagement with all the stakeholders prioritizing the European Commission and Funding Agencies together with Policy Maker and Ministries as ACTRIS IMP project aims at developing new policies to build an efficient, long-term and sustainable research environment, followed by Industry and Clusters and then to Civil Society, lastly, research and academia that could participate in the further exploitation (and development) of the different devices even after the project completion (Fig. 11 and Fig.12). Table 5 maps the stakeholder groups with most of the appropriate communication channels to use to create the greatest impact.

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Figure 12. The key stakeholders are visually mapped to present the needs of each stakeholder in terms of geographical dissemination for the current situation (a) and future perspective (b).

	European Commission	Funding agencies	Policy makers	Ministries	Industry & Clusters	Research & Academia	Civil society
Demos					•		•
Videos	•				•	•	•
Website	•	٠	٠	٠	•	•	
Blogs			•				•
Newsletters	•	•	•	•	•	•	•
Social: Twitter					•	•	•
Social: LinkedIn	•	•	•	•	•	•	
Press Releases	•	٠	•	٠	٠	•	•
Media kit	•				٠	•	•
Flyers, posters, banners	•	•	٠	٠	•	•	•
Event & Workshops	•	•	•	•	•	•	•
Presentations	•	•	٠	•	•		
Infographics	•	•	•	•	•	•	•
Datasets & insights		٠	•	•	•	٠	
Policy briefs	•	•					

Table 5. Examples of on-going and planned dissemination channels tailored in function of ACTRIS stakeholder groups.

ACTRIS outreach strategy

The activities on outreach and external relations includes all the strategic and technical tasks and means to communicate and promote services, relevance, added value and impact of ACTRIS externally. In addition the strategy is advocating ACTRIS and its community in various fora, ensuring the representation of ACTRIS in different relevant bodies in Europe and globally, acquiring and managing new member- and partnerships through stakeholder liaisons, managing country level communication, and connecting potential ACTRIS National Facilities with RPOs as well as building and maintaining the connections to user communities, the development of services and products, the promotion of the usage of ACTRIS facilities and data. Continuous stakeholder engagement is an important part of this activity.

HO also manages and oversees the future cooperation with RIs from other domains. HO manages the ACTRIS scientific and technological development project portfolio and ensures that these collaborations lead to benefits for ACTRIS users, such as developments in services and operations, in line with the ACTRIS strategy. In addition to collaboration with other RIs, HO shall conclude mutual agreements with other organizations, either to facilitate the production of services or to ensure that a specific service is provided and ensuring that the role of ACTRIS is clearly established.

The HO coordinates and supports ACTRIS communication and dissemination, including the regular update on the communication and outreach strategy, executing coordinated external RI communications and outreach activities, and management of ACTRIS brand and visual outlook using multiple means and tools to increase the awareness of ACTRIS.

The development of ACTRIS relies on close connections to the ACTRIS science community and engaging new users. Thus, continuous development of community engagement activities is an important part of this activity and will enable enrolling of new members and observers for ACTRIS ERIC.

The organisation of scientific workshops and conferences, incl. Science conferences and technical development meetings, as well as community events and activities in non-ACTRIS countries, are an essential part of this activity. The main tasks of the activity are:

- Periodic updates of the ACTRIS communication and dissemination strategy
- Perform and monitor all the needed liaison tasks according to ACTRIS liaison strategy
- Facilitation of ACTRIS representation in relevant programmes and external bodies
- Represent ACTRIS in different meetings and fora
- Promote the engagement of new members and stakeholders to ACTRIS
- Building and maintaining the connection with new user communities
- Keep ACTRIS website and various social media activities to outreach and disseminate information and knowledge on ACTRIS and enhancing the visibility of ACTRIS
- Create different documents and presentations to promote ACTRIS activities
- Organise scientific meetings as well as community events in communities where ACTRIS is not well known

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This activity includes resources reserved for operating webpages, organising meetings and design and print out outreach and dissemination materials.

ACTRIS ERIC shall use various channels to reach the target audiences, including web portal, social media, newsletters, workshops, participation to conferences, articles in magazines and daily newspapers (Fig. 13).



Figure 13. On-going and planned channels for ACTRIS Communication, Dissemination and Exploitation activities.

Being ACTRIS products and services designed to benefit the ACTRIS communities identified in the previous section, ACTRIS engages in ad-hoc exploitation and dissemination activities to complement ACTRIS services and operations (Fig.13). A successful exploitation and dissemination of ACTRIS outcomes will rely on effective management and execution of engagement as well as communication activities with ACTRIS users and other target groups.

ACTRIS Branding

The ACTRIS brandbook describes the clean, professional yet simple visual style and outlook designed for the ACTRIS brand. All visual material, both outreach material and documentation, follow the same guidelines to ensure a cohesive and professional branding. The guidelines present recommendations on the use of the ACTRIS logos and motto, typography, ACTRIS colors and colorpalettes (Fig.14).





The ACTRIS visual material bank provides multiple readymade infographics, images, videos and templates for documents, presentations and posters (Fig. 15).



Figure 15. Example of one of ACTRIS Roll-up and template for slide presentations.

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4. ACTRIS ERIC governance and structure

ACTRIS ERIC legal entity

ACTRIS ERIC's task is to establish and operate a distributed RI, including long term agreements with ACTRIS CFs, and management of the service provision for wide user communities. ACTRIS ERIC will provide the coordination, integration, development, monitoring, and governance of ACTRIS, and will oversee the strategic and financial development as well as the long-term operation and sustainability of ACTRIS. The tasks and activities of ACTRIS ERIC and ACTRIS are defined in the **ACTRIS statutes [11]**.

ACTRIS ERIC will include at least the Head Office (HO). The HO provides Infrastructure coordination and leadership. The statutory seat will be in Finland with one unit located in Italy. The ACTRIS ERIC also coordinates and facilitates ACTRIS interaction with stakeholders, global and regional initiatives, and oversees the strategic development of the whole infrastructure.

ACTRIS ERIC governance

ACTRIS ERIC will include the highest decision-making body, the General Assembly (GA), which is advised by an external Scientific and Innovation Advisory Board (called during the implementation phase the Scientific and Implementation Advisory Board) and by an Ethical Advisory Board. ACTRIS ERIC is also supported by a Financial Committee. The decisions of the GA are implemented by the Director General (DG). The DG is the legal representative of the ACTRIS ERIC. In addition to the bodies mentioned above, ACTRIS will have other advisory and support bodies, such as the Research Infrastructure Committee and the National Facility Assembly. The Research Infrastructure Committee advises the DG on matters related to the research infrastructure to ensure the state-of-the-art development, consistency, coherence and sustainability of the operations of the research infrastructure.

• General Assembly (GA):

The General Assembly shall be the governing body of the ACTRIS ERIC and shall be composed of delegates of the member and the observer countries.

• Director General (DG):

 The Director General shall be the legal representative of the ACTRIS ERIC. The Director General shall be responsible for the implementation of the decisions by the General Assembly, and ensure the scientific and strategic development of ACTRIS, to meet the expectations on socio-economic impact, technology development and innovation, actively contribute to community building, and fostering external relations and strategic partnerships as well as overseeing and coordinating the ACTRIS activities.

• Science and Innovation Advisory Board (SIAB):

- $\circ~$ The General Assembly shall establish an independent external Science and Innovation Advisory Board.
- o The Science and Innovation Advisory Board shall

- Monitor scientific and operative quality of the ACTRIS ERIC and the research infrastructure activities
- Give feedback and make recommendations to develop the ACTRIS ERIC and the research infrastructure activities
- Meet and give recommendations at least annually to the General Assembly.

• Ethical Advisory Board:

- o The General Assembly shall establish an independent external Ethical Advisory Board.
- The Ethical Advisory Board shall
 - Give feedback and make recommendations to develop the ethical aspects of the ACTRIS ERIC and the research infrastructure activities.
 - Meet and give recommendations when needed to the General Assembly and the Director General/Board of Directors.

• Research Infrastructure Committee:

- The General Assembly shall establish a Research Infrastructure Committee.
- The role of the Research Infrastructure Committee is to advise the Director General on matters related to the research infrastructure to ensure consistency, coherence and sustainability of the operations of the research infrastructure.

• National Facilities Assembly:

 The National Facilities Assembly is the platform for the principal investigators and technicians from the ACTRIS National Facilities to exchange experiences and interact with each other and with the ACTRIS Central Facilities to develop the RI and to ensure the connection of the scientific expertise and technological development.

The ACTRIS RI Committee will have representatives from the ACTRIS CFs and NFs. The NF Assembly represents the bottom-up element in the ACTRIS governance structure and consists of the experts working in the NFs. The NF Assembly is a highly technical and operative platform to develop the RI and ensure the connection of the scientific expertise and technological development. Their feedback is important for the development and sustainability of the RI.

All countries participating in the implementation of ACTRIS have a substantial community involved in ACTRIS and numerous RPOs, and NFs contribute to the ACTRIS operations in their countries. Therefore, it is important that the ACTRIS NFs and RPOs at the national level are organised in a national ACTRIS consortium. National consortia should have a formal collaboration agreement and a clear governance/management structure. They should nominate a national ACTRIS contact person to act as link between the national consortium in the European level ACTRIS.

ACTRIS transition phase: from preparatory phase to ACTRIS ERIC

These lifecycle phases are supported and coordinated by the governance structures related to frameworks of the 1) a project (Preparatory Phase Project), 2) interim transition and 3) ACTRIS ERIC legal entity, as shown in Fig.

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16. During the lifecycle, the governance and management structures evolve, and the establishment of the governing bodies is dependent on the decisions and selections made during the previous phase.

ACTRIS lifecycle phases						Implementatio	m phase			Ор	erational	phase
Framework	Pr	oject-based		transitio	on 🛛	Legal entity - ACTRIS ERIC						
Support EC project	3	ACTRIS PPP			ACTRIS IMP							
Year	2017	2018	2019	2020	2021	1 2022	2023 2	2024 2	025	2026	2027	2028
De dite bele	Interim ACTRIS Council			ıncil								
Decision body							E	RIC Gei	neral	Assem	bly	
Internal body of GA								Financi	al Cor	nmitte	e	
	PP	P Coordinato	r i	Interim ACTRI	S Leader							
Body responsible for implementation				Interim Scienti	ific Chair							
Year Decision body Internal body of GA Body responsible for implementation Internal RI bodies supporting implementation External advisory								Direc	tor G	eneral		
Internal RI bodies	PPP I	Executive Boa	ird	Interim RI Con	nmittee			Rio	omm	ittee		
implementation				Interim NF A	ssebly			NF	Assei	nbly		
External advisory								Eth	ical B	oard		
bodies			Scientific	and Implement	tation Advi	isory Board						
On an alatterar				en				-		Scienti	fic & Innc	vation AB
open platforms						Science and User Forum						

Figure 9. Foreseen appointment year and duration of internal and external ACTRIS bodies during the ACTRIS lifecycle phases. As can be seen, several interim bodies will evolve into operative internal and external bodies.

ACTRIS ERIC linkages to the Central Facilities and National Facilities

The relation of ACTRIS ERIC to Topical Centres and Data Centre is still under iteration. The final decisions on the ACTRIS ERIC perimeter will be done spring 2020. In the case that Topical Centres and Data Centre are not directly under the ACTRIS ERIC, the links are established agreements. The agreements between the ERIC and the CFs shall define the contributions of the CFs towards ACTRIS ERIC and regulate the obligations and rights between the organisations hosting the CFs and the ERIC. These agreements shall also define how close the link between the respective CF and the ERIC shall be.

ACTRIS ERIC shall facilitate the activities including:

- collection of annual work plans and reports and financial plans and reports from each CF;
- allocation of the membership contributions to the GA decision and financial rules to each CF;

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- Providing information on developments of NF networks to the CFs to enable the planning of work and resources;
- collection of Key Performing Indicators from CFs;
- overseeing the ethical issues;
- managing the overall operations access process and interaction with the NF and CF (labelling, capacity/feasibility check, organise calls, evaluation, selection, implementing the user access, reporting) for the CF and NF services (SAMU).

The organisations operating CFs will need to establish a consortium agreement for defining the operations of the CFs, task sharing and the rights and obligations of each participating host organisation in charge of the CF Units.

The National Facilities will be linked to the ACTRIS ERIC by agreements to be made with the responsible Research Performing Organisations. The contract will define the expected operations and services from the NFs as part of the RI. It will define the obligations of the various NFs owners (e.g., the research performing organisations). The obligations are:

- to produce data and, if relevant, to provide access in accordance with the ACTRIS standards, and
- comply with the access policy and data policy that regulates the provision of access to ACTRIS services and data.

The rights are:

- to vote in the NF assembly;
- to access ACTRIS services (i.e. Training services, Technical services).

The fundamental interaction among the ACTRIS ERIC, the CFs and NFs is related to the periodical reporting obligations, coordination, monitoring and governance of ACTRIS activities. Another fundamental interaction is related to the access and service management that have clearly defined policies and process description (workflows).

ACTRIS Members and Observers

The following entities may become Members of ACTRIS ERIC with voting rights or may become Observers, or Permanent Observers, without voting rights of ACTRIS ERIC:

- Member States of the European Union;
- associated countries to the European Union;
- o third countries other than associated countries;
- o intergovernmental organizations.

An Observer that foresees a lasting participation in the consortium but is not in a position to become a member may be granted the status of a Permanent Observer based on the General Assembly approval. Permanent Observers have the same rights and obligations as members as stated in article 16.1, 16.2 and 25.2 **[11]**, except the right to vote at the General Assembly.

Both Members and Observers (incl. Permanent Observers) pay an annual contribution fee, but they face different rights and obligations (Table 7). Detailed information on ACTRIS Membership and Observership can be found in

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the **ACTRIS statutes [11]**. Any Member or Observer may be represented in the GA by one or more public entities. At the moment it is agreed that each Member shall have one vote that shall be supplemented with one additional vote for a Member hosting at least one ACTRIS CF unit and with one further vote for contributing to at least three ACTRIS CFs. Observers may attend the General Assembly meetings without the right to vote.

Table 6. Summarizing table of rights and obligations of Members, Observers and Permanent Observers. More detailed information can be found in ACTRIS statutes [11].

		Member	Observer	Permanent Observer
	Voting rights at the GA.	٠	•	
	Participation in ACTRIS ERIC events and activities.	•	•	•
Rights	Support from ACTRIS ERIC in developing relevant systems, processes and services.	•	٠	•
	Participate, as a voter and candidate, to the election for governance bodies.	•		
	Hosting a CF unit and leading a CF.	•		
	Purchase goods and services to be provided in kind for the official and exclusive non-economic use of ACTRIS ERIC.	•		
	Annual contribution.	•	•	•
	Empower its representatives with the full authority to vote on all issues raised during a meeting of the GA.	•		
Obligations	Commitment towards ACTRIS ERIC tasks and activities.	•	٠	•
	Promotion of the uptake of ACTRIS standards within the corresponding ACTRIS scientific communities.		•	•
	Provision of necessary technical infrastructure for enabling access.		•	•
	Adequate maintenance and update of NFs.	•		

ACTRIS members are (status: ACTRIS ERIC Step 1, March 2019):

Republic of Austria, Kingdom of Belgium, Republic of Bulgaria, Republic of Cyprus, Czech Republic, Republic of Finland, French Republic, Hellenic Republic, Italian Republic, Kingdom of the Netherlands, Kingdom of Norway, Republic of Poland, Romania, Kingdom of Spain.

ACTRIS observers are (status: ACTRIS ERIC Step 1, March 2019): Federal Republic of Germany and Swiss Confederation.

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5. Management and human resources

The ACTRIS management

ACTRIS is coordinated and managed through its legal entity, ACTRIS ERIC. As ACTRIS is a highly distributed RI, efficient leadership and management are essential. To succeed, ACTRIS needs to develop a management structure that optimally supports personnel in fulfilling their tasks. Efficient management can be established trough clearly defined roles for ACTRIS key personnel. A good set-up for the ACTRIS management line will enable ACTRIS to fulfil the expectations of the ACTRIS community, build social engagement, and steer the organisation in the right direction.

ACTRIS ERIC is responsible for planning, improving and securing all aspects related to the sustainability of the whole RI: scientific excellence, successful user strategy, efficient governance and management (incl. human resources), financial sustainability, technological development and upgrading of the RI, innovation, measuring the socio-economic impacts, and accounting for risks.

• Director General

Director General (DG) is the legal representative of the ACTRIS ERIC. According to the statutes, the DG is responsible for the implementation of the decisions by the General Assembly. He/she will ensure that the scientific and strategic development of ACTRIS meets the expectations on socio-economic impact, technology development and innovation. The DG will actively contribute to community building and fostering external relations and strategic partnerships as well as overseeing and coordinating the ACTRIS activities.

• Central Facility leader

The Central Facility leaders have a key role in the leadership and management of the distributed research infrastructure. They coordinate and manage the activities in the CFs, but they should also act as an interface between the Central Facility units and staff and the DG. Furthermore, together with the DG they represent ACTRIS and support the DG in their field of expertise.

Both the DG and the Central Facilities leaders have an important role in leading and managing together the research infrastructure in a management committee which role shall be defined in internal rules.

• Central Facility Head of Unit

Heads of Units will lead and manage the different units of the CFs. The Heads of Units act as an interface with the community and users taking care that ACTRIS activities are run according to ACTRIS rules. In addition to the operative tasks, they support the Central Facility leader, e.g. in annual planning and reporting.

• National Facility PI

National Facility PIs have an official role in ACTRIS, taking care of ACTRIS observational and experimental platforms. Thus, concerning the responsibilities towards ACTRIS they are not acting only as the PI of their host institution. Similarly, as the Heads of Units, they act as interface towards the ACTRIS community and to the users. The PI acts as a link between the platform and the CFs and represents the facility in the National Facility Assembly. The PIs need to secure that the data is produced according to ACTRIS rules.

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• National Contact Person

The National Contact Person (NCP) is acting as a key interface between the national ACTRIS consortia and the European level ACTRIS. NCP is expected to be responsible for organizing the coordination of ACTRIS community at the national level. Furthermore, the NCP should be responsible for ensuring proper dissemination and information flow from European level ACTRIS activities to the national science communities and to the relevant national shareholders.

Along with the new roles in ACTRIS as a distributed infrastructure, new kind of personnel skills and profiles are required. Hence, ACTRIS cannot purely rely on scientific expertise. Figure 17 summaries the foreseen skills for the personnel required in the different RI sections.

Director General

- Renowned scientist in a field related to the goals of ACTRIS
- Have extensive experience on leadership
- Excellent organisation skills
- Communication and management skills
- Familiar with research infrastructures at a senior level

Head Office

- Executive directorship
- Management of SAMU
- Officers and assistants to coordinate and oversee interlinkage with other parts of the RI
- Access management
- Evaluation
- User services as well as running and managing the every-day life the ERIC

Data Centre and Topical Centre

- CF leader should have:
 - Strong scientific and technical background
 - Good managerial and communication skills
 - Well connected with the Scientific community also outside ACTRIS
- CF experts should be:
 - Data scientists
 - System engineers
 - Management and administrative assistant
 - Have scientific and technical background

National Facilities PIs

- The NFs are operated nationally and many of them already have an operative structure in place.
- The NFs will not necessarily need new administrative skills but understanding of being a part of a distributed research infrastructure.
- As official ACTRIS representatives in the national level, skills for acting as a representative in the National Facilities assembly are needed.
- The same way as DC and TCs the NF need people with scientific and technician background.

Figure 10. ACTRIS experts' foreseen skills in the different RI sections

Premises and facilities

As Finland will host ACTRIS ERIC Statutory seat, part of the ACTRIS ERIC HO will locate in Helsinki, Finland at the Kumpula Campus, in proximity with the Headquarters of other top-performing research organisations such as Institute for Atmospheric and Earth System Research (INAR) and ICOS ERIC and the Finnish Meteorological Institute. ACTRIS HO premises, both in Finland and in Italy, are configured in a contemporary modern multifunctional office space offering several modern meeting rooms of different sizes supporting face-to-face and virtual meetings as well as large conference rooms.

Business practice and responsibilities

The HO premises as well as the managerial processes will be set up during 2020-2021 and the developed business practises as well as financial management and control systems will be included in ACTRIS Financial Plan.

Financial management and control systems

The main activities of these tasks include ACTRIS annual financial planning and budgeting, executing and monitoring money transactions, long term financial planning, financial reporting and auditing, financial management of the external projects, monitoring the working hours of the personnel and the management of travel costs, management of the tax exemption process and support the seeking of new financial possibilities. Additionally, the contract portfolio is managed, and all the agreement negotiations coordinated, including NFs, CFs and third parties (partnerships), as well as the procurement in the ACTRIS ERIC.

Insurance and Liability

As per standard business practices, the ACTRIS will be covered by all mandatory insurances.

ACTRIS ERIC shall be liable for its debts and shall take appropriate insurance to cover the risks specific to the construction and operation of ACTRIS ERIC. The Members' and Observers' (incl. Permanent Observers) financial liability for the debts of ACTRIS ERIC are defined in the ACTRIS ERIC statutes and shall be limited to their respective contributions provided to ACTRIS ERIC.

Human resource management

ACTRIS Human Resource (HR) strategy describes the aims and goals of ACTRIS HR management [12].

Employment regulations

ACTRIS developed its staff policy according to ACTRIS values and principles. **ACTRIS Staff Policy [15]** shall be followed when people are working or recruited to work for ACTRIS. The ACTRIS Staff Policy sets the guidelines for the persons contributing to ACTRIS activities to be ethically aware and socially responsible, and to comply with the expectations of stakeholders and the RI management.

Most of the ACTRIS personnel will be working directly for RPOs, thus not ACTRIS ERIC governance, which will have its own staff policy.

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One of the key goals of recruitment should be the long-term sustainable research infrastructure with motivated and committed personnel. Thus, there should be a balance between senior and junior staff so that in case of a change, expertise and knowledge is not lost but transferred. Organisations are also encouraged to provide contracts that are valid indefinitely as much as possible in order to provide security for employees and to offer competitive salaries in order to be able to hire the best possible expertise to ACTRIS.

Equal treatment and gender balance

ACTRIS recognises the need and importance of promoting gender balance and equality transversely throughout the RI to stand out as an excellent example of a well-balanced working community. Therefore, equal treatment is one of the key principles of the Staff policy and any discrimination based on for example gender should be prohibited according to the policy.

ACTRIS is located in several countries so it is by nature international, consisting of people from several nationalities. Diversity of nationalities should not rest, however, only on the fact that ACTRIS locates in different countries, but it is the interest of ACTRIS to facilitate also mobility so that people can choose their working place based on their expertise. The requirements for any positions should be set so that they are available for everyone equally regardless of nationality.

In addition, ACTRIS will actively work for building up physical access schemes to its Observational and Exploratory Platforms that allow equal participation of genders. It is important that the services built around the platforms enable users and managers in all life situations to be able to work at these prestige platforms. ACTRIS will also actively support gender-balanced technical training of ACTRIS NF operators, managers and users.

Specific attention will be given to the gender-dimension aspect when defining the user requirements, identifying and working with user groups and coordinating internal and external collaborative actions. ACTRIS is aiming to act as a role model in atmospheric research and in the research infrastructure area and to facilitate mentoring and networking opportunities for both genders.

Talent attraction, performance management and staff training

Within ACTRIS, examples of needed skills are financial and operational management, technical skills, data management, data curation, and computing with big research data. There is an increasing need for education in the emerging professions, e.g. infrastructure operators, research technologists with computational skills, and data scientists.

ACTRIS aims to recruit the best RI professionals to provide the best services for its users. ACTRIS needs to provide training possibilities and competitive career opportunities for those who want to specialise in managing and operating a world class RI. During the transition phase towards the operational research infrastructure, ACTRIS should aim specially to identify the urgent training needs.

Developing staff exchange programmes

ACTRIS shall provide opportunities to learn new skills and support the professional growth of people by periodically organising and managing staff exchange programmes. Through an exchange program personnel can

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gain wide knowledge on ACTRIS activities, plan their future and career paths and train themselves as professional research infrastructure experts.

Supporting career development

ACTRIS shall investigate ways for fostering career development and should identify the specific needs for support. To support the career development of the personnel, ACTRIS should work towards the recognition of the research infrastructure work at institute level. It should also advocate the importance of the RI roles toward the RPOs and support the recognition of RI related positions at national level.

Management of the RI operations

RI workflows

Efficient RI workflows support ACTRIS governance such as the General Assembly, Scientific and Innovation Advisory Board, Ethical Advisory Board and the RI Committee and any other committee or task force. Importantly, managerial tools and other support, facilitating the coordination and development of the whole RI, is provided to the other Central Facilities and the National consortia.

Capacity and integration management

ACTRIS is a multi-layered distributed RI with 8 Central Facilities operated in more than 40 units in different countries and operated by a staff consisting of technicians, engineers, scientists and managers. The national ACTRIS activities include more than 100 National Facilities. Thus, good coordination and integration of the large community is essential for the long-term success of ACTRIS.

ACTRIS brings together several scientific fields and in this activity, the scientific, technical and operational integrative activities are coordinated and facilitated. An important part of this activity is to facilitate the National Facility Assembly. The RI Operation Unit of the HO will participate in the community meetings to share information and foster the community building.

This activity includes also the coordination and integration of the annual work plans and reports of the CFs, and production of progress reports or other periodic reports, such as stakeholder handbook. The HO ensures that clear and agreed work plans for executing this strategy are put in place to guide optimum decision-making in ACTRIS.

Ethical and regulatory aspects

Everyone in ACTRIS should work in a socially ethical way keeping the integrity and fairness and maintaining high level of trust and respect among the people working in ACTRIS and with the users and other stakeholders. One should always consider that the mission of ACTRIS is to provide effective access for a wide user community to its resources and services, in order to facilitate high-quality Earth system research, to increase the excellence in Earth system research, and to provide information and knowledge on developing sustainable solutions to societal challenges.

Managing ethical issues

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Following the principle of subsidiarity, ACTRIS activities-related misconducts are handled locally according to the local regulations. However, the information of the misconducts and the local process on the matters involving staff within the ACTRIS activities should also be transferred to the Ethical Advisory Board. The ACTRIS Ethical Advisory Board shall advise both the ACTRIS ERIC, its advisory bodies, and its contractual ACTRIS partners in all ethical issues. Anyone from these organisations can contact the Director General or the members or observers of the General Assembly and raise an ethical issue to be discussed and handled.

Conflict of interest

Since ACTRIS involves several organisations and countries, conflicts of interest may arise if the same organisations or their staff are present in several places in the ACTRIS governance or operations. A conflict of interest may arise when a person or a legal entity is involved in multiple activities related to, for example financial, scientific, management, or other aspects, or a person has a secondary occupation, which may affect his/her motivation and personal or organisational interest. All persons involved in the ACTRIS activities should conduct their affairs avoiding or minimizing conflicts of interest. However, if a conflict of interest cannot be avoided, this person should declare it openly and disqualify him/herself if needed. Disqualifying oneself ensures that decisions are not influenced by competing interests and will solely be made for the benefit of ACTRIS. When a person is disqualified, he/she shall not participate in the consideration of a matter or be present during such consideration. Conflict of interest shall be resolved on personal, financial and institutional levels.

Ethical principles in ACTRIS activities

Data production

ACTRIS shall follow the rules of good scientific practice in research and data production.

The basic principles of good scientific practice and production of data are:

- highest professional standards in designing and conducting investigations,
- a critical, open-minded approach in conducting research and scholarship,
- frankness and fairness regarding the contributions of partners, involvement of scientists, and predecessors, and
- integrity at all stages in scientific enquiry, data quality assurance and quality control.

Data production procedures and protocols should be written in clear and unambiguous terms. They should include specific details of the aim, materials, methods, time schedules and analytical approaches to be used. It is essential that all participants in the research infrastructure comply with the Data Management Plan where specific procedures are described. Particular attention should be paid to the completeness, integrity and security of the data records and connected metadata.

Data management

Preserving primary data, managing data in a good and correct way, storing and documenting all relevant data and processing data adequately are of highest priority and should always follow good scientific practice. The technical requirements for ACTRIS are given in the ACTRIS Central Facility concept and National Facility

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requirement descriptions and will be further described in the Data Management Plan. Individual parties of ACTRIS should develop mechanisms, appropriate to their particular task, discipline and situation, for ensuring compliance with good practice for compliance monitoring. Responsibility for compliance monitoring should be assigned to an experienced member of each unit.

Data access and access to facilities

ACTRIS data policy defines the principles for using ACTRIS data. In order to guarantee fair scientific competition no user should be privileged. The administration connected to requesting and granting data access or access to ACTRIS facilities shall be kept to a minimum. The users shall be provided with instructions in order to have effective and efficient access. Users shall provide their data resulting from the available access in accordance with the Findable, Accessible, Interoperable and Reusable (FAIR) principles, including specifications of the data format, and the users should respect ethical principles defined in these guidelines.

Acknowledging contribution

Users of ACTRIS data or ACTRIS facilities are encouraged to disseminate the results from the work done through the provided access in peer-reviewed publications, and they shall acknowledge the contribution and support provided by ACTRIS. In accordance with good scientific practice, users are encouraged to offer co-authorship to those persons working at ACTRIS facilities who have made genuine scientific contributions to their work. Users are encouraged to make their publications available through open access repositories. The persons and organisations, which have originally generated ACTRIS data or digital tools or produced different levels of ACTRIS data, shall be given appropriate acknowledgement and attribution. Authors of publications shall be given acknowledgment in accordance with applicable copyright legislation and scientific custom.

Use of animals

Use of animals shall be conducted according to the Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes.

6. ACTRIS Financial framework

The ACTRIS financial framework gives the picture of the overall infrastructure's implementation and operational financial needs, assesses funding models best suited for delivering the construction and operational needs of ACTRIS, develops policy recommendations on financial principles, and establishes the ACTRIS 5-year financial plan for ACTRIS.

The **ACTRIS long-term sustainability** will be ensured by the long-term Members' and Permanent Observer commitment, as well as the commitment of more than 100 RPOs distributed over 22 Countries in Europe operating the National Facilities.

The Countries hosting the ACTRIS CFs shall be responsible for financing 100% of the construction of the CFs hosted in their own country. The resources to construct and operate the NFs are organized nationally.

ACTRIS is about to enter the **implementation phase in 2020**. During the implementation phase, the focus is on the construction and upgrading the ACTRIS CFs and NFs to meet the ACTRIS requirements and set up all the

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necessary work flows, activities for internal support and service provision. The EC-funded ACTRIS implementation project, ACTRIS IMP, will take ACTRIS into a new level of maturity and will set the needed structures for the implementation actions, both at the national and European level. ACTRIS IMP builds on three main pillars: securing the long-term sustainability, implementing of ACTRIS functionalities, and positioning ACTRIS in the national, European and international science and innovation landscape. ACTRIS IMP will ensure the needed EU resources to integrate the national resources to support ACTRIS in the implementation phase towards the operations.

Members' commitments to **ACTRIS operation** are established in the 5-year financial plan, which summarizes, for each budgetary cycle, the ACTRIS ERIC expenditures and revenues for the considered years and provides ACTRIS with medium-term funding continuity to support the operations planned for the financial period.

The expenditures of ACTRIS (ERIC) are the outgoing flows and mainly consist of:

- Operation Costs of the Central Facilities as part of the ACTRIS ERIC
- ERIC contribution to support the operations of the Central Facilities not part of the ACTRIS ERIC
- Other costs related to operating ACTRIS ERIC.

The revenues of ACTRIS ERIC are the incoming flows and mainly consist of:

- Host Premium Contribution from the Member and Permanent Observer countries hosting the Central Facilities as part of ACTRIS ERIC
- Host Contribution from the Member countries hosting the Central Facilities not part of ACTRIS ERIC
- Annual Membership Contribution from ACTRIS ERIC Members and Observers
- Third party contributions and grants
- Any other income.

Cost Book

The ACTRIS Cost Book summarizes the RI financial requirements providing a clear identification, definition and realistic planning of the overall infrastructure costs for the entire ACTRIS RI lifetime.

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* Phases named after the Esfri Roadmap 2018 Guide

Figure 11. the Cost Book summarizes the costs for each phase of the RI starting from the implementation phase, through the Operations Phase and Decommissioning Phase.

The Cost Book is a reference document that serves:

- to support the stakeholders' engagement by providing information on the value of the investment needed to realize the RI or one of its Central and/or National Facilities starting from scratch
- to assess the necessary information to evaluate the long-term sustainability of ACTRIS in the Financial Plan
- to provide comprehensive information for the ESFRI monitoring and evaluation activities.

CENTRAL FACILITY	TOTAL COST OF IMPLEMENTATION PHASE (M€)	AVG. ANNUAL COST OF OPERATION PHASE (M€)	TOTAL COST OF DECOMMISSIONING PHASE (M€)
ACTRIS Head Office	6,97	1,55	0,90
ACTRIS Data Centre	21,48	3,68	0,42
Centre for Aerosol In Situ Measurements	14,45	1,94	1,67
Centre for Aerosol Remote Sensing	20,04	2,88	0,58
Centre for Cloud In Situ Measurements	7,01	0,95	0,29
Centre for Cloud Remote Sensing	9,23	1,29	0,24
Centre for Reactive Trace Gases In Situ Measurements	15,12	2,15	0,57
Centre for Reactive Trace Gases Remote Sensing	13,25	1,90	0,95
Grand Total Cost	107,56	16,34	5,62

Error! Reference source not found. includes all costs to construct the Facilities from the ground up, following the technical documents adopted for them (Implementation Costs – green bar), the annual average costs to operate the Facilities performing the activities planned in the technical documents (Operations Costs

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occurring in the Operation Phase – orange bar), and includes the estimate costs for dismantling the Facilities (Decommissioning Costs occurring in the Termination Phase). The cost estimate is based on a standardized item list for every life cycle phase considering personnel, equipment and Other Costs (building & construction, consumables, travel, external services, utilities other costs).

A complete cost analysis for Central Facilities and for each National Facility type is presented in the **ACTRIS Cost Book** [10].

ACTRIS internal financial rules

The Internal Financial Rules (IFR) detail the principles for funding the whole ACTRIS and for calculating the contributions from Member, permanent Observer and Observer States to ACTRIS ERIC. The IFR lay down all other arrangements relating to ACTRIS ERIC finances, budget and accounting standards, including details regarding preparation, filing, auditing and publication of accounts.

The IFR go hand in hand with the ACTRIS ERIC statutes [8] financial articles and Annex II.

Contributions from Countries

Membership contributions, Host Premium and Host contributions are an important part of the ACTRIS ERIC revenue streams (Fig. 5).

The operations of the CFs as part of the ACTRIS ERIC are partially funded by the Central Facility Hosting Countries and partially by ACTRIS ERIC through the cash contributions of the ACTRIS ERIC Members and Observers. The operations of the CFs not part of the ACTRIS ERIC are partially funded by the Central Facility Hosting Countries and partially by ACTRIS ERIC through reallocation of cash contributions.

Host Premium Contribution is the support provided by ACTRIS ERIC Members and Observers for the functioning of the CF Units as a part of the ACTRIS ERIC. The Host contribution can be provided cash or in-kind. The level of Host Contributions for each Central Facility is a relevant quota, and should account for not less than 70% of its annual operation costs **Host Contribution** is the support provided by ACTRIS ERIC Members and Observers for the functioning of the CF Units not included in the ACTRIS ERIC and hosted in their own country. The Host contribution can be provided cash or in-kind.

The level of Host Contributions for each Central Facility is a relevant quota, and should account for not less than 70% of its annual operation costs.

The **Membership contribution** is the amount of money a country pays in order to join ACTRIS ERIC as Members or Observers. The Membership contributions are used by the ACTRIS ERIC to fund the quota of each CF's annual operation cost that is not covered by Host Premium or Host Contributions.

Contributions of Members and Observers shall be calculated in accordance with the basic rules and principles laid down in the **ACTRIS statutes [8]**, which are further detailed in the ACTRIS ERIC internal financial rules. Any change to the contributions must be approved by the Member(s) or Observer(s) affected by the change before it can be approved by the GA.

Membership contributions

The Membership Contribution will provide a contribution for general support to sustain the operations of the Head Office and the Data Centre, for the part not covered by the Host Contribution or Host Premium Contribution, and a contribution for specific/technical support to sustain the operations of the Topical Centres, for the part not covered by the Host Contribution or Host Premium Contribution.

According to the ACTRIS Statutes, the annual Membership contribution is based on the main principles of the *inclusiveness* of ACTRIS and shall reflect the support provided by ACTRIS to its Members, Permanent Observers and Observers.

ACTRIS 5-year financial plan

The 5-year ACTRIS Financial Plan establishes the general framework for the detailed annual budget of the ACTRIS ERIC, based on the work programs and related financial plans provided by each CF. The 5-year financial plan shall set the level of the Host premium contributions and Host contributions that the Hosting Countries agree to provide as well as the level of Membership contributions that the Members, permanent Observers and Observers agree to pay.

The initial 5-year Financial Plan for the ACTRIS ERIC for the years 2020 – 2024 summarizes the ACTRIS ERIC expenditures and revenues for the considered years (**Error! Reference source not found.**). Data and figures reported in the following tables are taken from the draft ACTRIS 5-year Financial Plan that was prepared for the ERIC Step 1 application.

ACTRIS ERIC EXPENDITURES	2020	2021	2022	2023	2024
HEAD OFFICE	1 215 000	1 215 000	1 261 000	1 291 000	1 352 000
DATA CENTER	614 000	716 000	819 000	921 000	1 024 000
AEROSOL IN SITU	339 000	422 000	488 000	592 000	613 000
AEROSOL REMOTE SENSING	579 000	662 000	744 000	827 000	827 000
CLOUD IN SITU	135 000	162 000	189 000	216 000	243 000
CLOUD REMOTE SENSING	200 000	240 000	281 000	321 000	361 000
REACTIVE TRACE GASES IN SITU	314 000	376 000	439 000	502 000	565 000
REACTIVE TRACE GASES REMOTE	78 000	156 000	312 000	364 000	468 000
TOTAL	3 474 000	3 949 000	4 533 000	5 034 000	5 453 000

Table 7. The plan for ACTRIS ERIC revenue and expenditure for the first 5 years (source: ERIC Step 1 application).

ACTRIS ERIC REVENUES	2020	2021	2022	2023	2024
Membership Contribution	2 679 400	3 132 400	3 646 400	4 102 400	4 447 400
Host Contribution for Head Office	851 000	851 000	883 000	904 000	946 000
TOTAL	3 530 400	3 983 400	4 529 400	5 006 400	5 393 400

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Country	Contribution	2020	2021	2022	2023	2024
country	Memberchin Contribution	76.000	86.000	97.000	102.000	117,000
AUSTRIA	Hert Contribution	120.000	184 000	272.000	214 000	270.000
	Mombership Contribution	116 000	116 000	272 000	116 000	116 000
BELGIUM		110 000	105 000	210,000	245.000	215 000
	Host Contribution	53 000	105 000	210 000	245 000	315 000
BULGARIA	Membership Contribution	42 000	47 000	52 000	58 000	62 000
	Host Contribution	-	-	-	-	-
CYPRUS		52 000	60 000	68 000	// 000	82 000
	Host Contribution	- 67 400	- 67 400	- 67 400	- 67 400	- 67 400
CZECH REPUBLIC	Membership Contribution					
	Host Contribution	51 000	64 000	74 000	89 000	93 000
EU-JRC	Membership Contribution	66 000	75 000	84 000	93 000	100 000
	Host Contribution	26 000	32 000	37 000	45 000	47 000
	Membership Contribution	243 000	287 000	330 000	379 000	410 000
FINLAND	Host Contribution	495 000	590 000	680 000	783 000	858 000
	Host Contribution for Head Office	700 000	700 000	700 000	700 000	700 000
FRANCE	Membership Contribution	242 000	284 000	329 000	372 000	404 000
	Host Contribution	1 153 000	1 389 000	1 645 000	1 882 000	2 060 000
GERMANY	Membership Contribution	513 000	633 000	795 000	904 000	1 012 000
-	Host Contribution	1 425 000	1 728 000	2 048 000	2 360 000	2 559 000
GREECE	Membership Contribution	141 000	168 000	198 000	226 000	242 000
	Host Contribution	-	-	-	-	-
	Membership Contribution	272 000	320 000	371 000	419 000	450 000
ITALY	Host Contribution	594 000	693 000	788 000	892 000	935 000
	Host Contribution for Head Office	151 000	151 000	183 000	204 000	246 000
	Membership Contribution	105 000	124 000	147 000	165 000	182 000
NETHERLANDS	Host Contribution	199 000	265 000	363 000	418 000	494 000
	Membership Contribution	76 000	87 000	98 000	110 000	118 000
NORWAT	Host Contribution	529 000	618 000	706 000	794 000	882 000
	Membership Contribution	127 000	146 000	164 000	184 000	194 000
POLAND	Host Contribution	-	-	-	-	-
	Membership Contribution	123 000	143 000	163 000	184 000	196 000
ROMANIA	Host Contribution	213 000	243 000	273 000	304 000	304 000
	Membership Contribution	185 000	223 000	268 000	306 000	334 000
SPAIN	Host Contribution	259 000	296 000	333 000	371 000	374 000
	Manakanakin Canatrikati	05.000	07.000	100.000	100.000	122.000
SWITZERLAND		85 000	97 000	109 000	122 000	132 000
	Host Contribution	48 000	58 000	67 000	77 000	86 000

Table 9. Estimated annual contributions for the first five years for the assumed participating Countries, that have signed the Letter of Intent and will be revised based on the final membership by the first GA (*source: ERIC Step 1 application*).

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Membership Contribution	148 000	169 000	190 000	212 000	229 000
Host Contribution	98 000	118 000	138 000	157 000	177 000
Membership Contribution total	2 679 400	3 132 400	3 646 400	4 102 400	4 447 400
Host Contribution total	5 273 000	6 383 000	7 634 000	8 731 000	9 563 000
Host Contribution for Head Office	851 000	851 000	883 000	904 000	946 000

7. Implementation

The ACTRIS implementation phase will be a five-year period (2020-2024) dedicated to the construction and upgrading of the NFs and CFs, setting-up the user access and service provision, work on the governance and management tasks, increase the connection with new users and member countries, further develop strategies within ACTRIS and for international collaboration and partnerships, and integrate ACTRIS at different strategic levels (national, European and internationally).



Figure 12. Timeline of ACTRIS lifecycle.

The target of the ACTRIS implementation phase is to ensure the long-term operations and sustainability of ACTRIS. The objectives of the implementation phase are:

- Construct and upgrade the ACTRIS Central Facilities and National Facilities;
- Kick-off and carry out the NF labelling process to grant ACTRIS status for NFs to be included in ACTRIS;
- Validate the ACTRIS internal support actions for the Operational Phase
- Validate the ACTRIS services for the Operational Phase;
- Design a Catalogue of Services targeted for the broad market of ACTRIS users;
- Enable the smooth and easy access to ACTRIS data by setting up workflows for data processing and data provision
- Provide pilot services to the users, as physical, remote and virtual access to the CFs and selected NFs, and create new services depending on the users' needs by implementing the Services Access Management Unit (SAMU;
- Ensure well-managed ACTRIS ERIC governance and legal entity operations to guarantee the long-term sustainability of the RI;
- Ensure the connections between national ACTRIS consortia and ACTRIS ERIC;
- Guarantee long-term financial commitment from ACTRIS ERIC members;

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- Engage potential new members and observers;
- Generate new interactions with ESFRI research infrastructures and international programmes and initiatives where ACTRIS can contribute (e.g., health, agriculture, the European contribution to global activities);

The ACTRIS implementation phase will be supported by the 5-year EC funded project ACTRIS IMP kickstarting in January2020. The ACTRIS IMP project will be devoted to establishing ACTRIS as a long-term RI with demonstrated well-functioning operations and services.

ACTRIS 5-year activity plan

Nine main activities for the next five years have been identified in the 5-year implementation plan (Table 10). More details will be given in the ACTRIS Implementation plan that is currently under development.

Table 10. Main activities of the ACTRIS Implementation Plan.

	Strategic activities	Description	Implementation actions
1	RI operations	Many of the CFs and NFs will become gradually operational, depending on the maturity of the CF or NF and the ability of ACTRIS ERIC members to access national and European Structural funding.	CF constructions and implementation of operation support. Constructions and upgrades of NFs to meet ACTRIS NF requirements. ACTRIS NF labelling process for granting the inclusion of NFs into ACTRIS. Developing the workflows among NFs, TCs, DC, and HO to streamline the RI operations. Validation of the operation support actions (technical, sustainable, financial, legal validations). Prioritization of the operation support actions (first set of pre-operational support actions). Piloting the selected operation support actions.
2	Service development	Establishment of service validation as part of the service development. Set-up of user access and feedback mechanisms as part of a quality assurance system for continuous improvement of access and services.	Establishment of the ACTRIS Catalogue of Services. Validation of services (technical, sustainable, financial, legal validations) Prioritization of service provision (first set of services provided)

			Continuous engagement with the user community.
3	Piloting access and service provision	The first set of services will be piloted and tested, and user feedback gathered. This requires identifying a set of access services and gathering the test group for piloting the access service.	Identification of the virtual, remote and physical access pilot services. Testing the provision of pilot services (including implementation of user interface, access management, and review process). Establishment of the user forum to collect user feedbacks
л	Covernance	The Head Office continues to set up and	Teedbacks.
4	and coordinated management	facilitate the ACTRIS governing bodies and ensure the long-term sustainability of the RI. After ACTRIS ERIC is established, ERIC starts working with contractual agreements with NFs, CFs and third parties (partnerships). Among many management tasks, ACTRIS ERIC will set up quality management systems to monitor the RI performance.	Provide regular updates of the Financial Plan Conclude the CF and NF agreements. Communicate with national ACTRIS consortia and ensure their connection to ACTRIS ERIC. Operate the quality management system for performance monitoring. Respond to external assessments.
5	Community	ACTRIS continuously engages with the	Set up community engagement activities, incl. science
	engagement and attraction of new Members	ACTRIS science community and support community building in regions that are not yet connected to ACTRIS. These community-building and engagement actions will, in the end, enable enrolling of new members and observers for ACTRIS ERIC.	conferences and technical development meetings. Enhance European coverage by community events and activities in non-ACTRIS countries. Ensure wide memberships for ERIC STEP2 and beyond with targeted support actions.
6	International cooperation	ACTRIS is a key player in the field of environmental RIs but is also an	Participation in global and regional collaboration and partnerships.
		important part of the regional and global atmospheric networks. ACTRIS will continue to participate in international initiatives actively and collaborate with strategic liaison partners. The ACTRIS HO will be the central point of contact for these liaison and partnership activities	Seeking new opportunities for collaboration and liaisons at national, regional and international level. Positioning and collaborating in the RI landscape, both within the environmental domain and with other domains.
7	Outreach and	The community building and	Developing the communication strategy
	communication	engagement of various stakeholder groups are important ongoing tasks. ACTRIS will strive to outreach to its users and stakeholders but also to the general public to explain the effects that short- lived atmospheric constituents have in our life.	Promoting the awareness and visibility of ACTRIS Creating targeted outreach activities and materials for different user groups and stakeholders. Facilitating the internal and external communications.
8	Innovation and	Services offered by ACTRIS to support	Identifying the development areas and
	technology development activities	innovation are meant to foster knowledge transfer, which aims in the medium to long term to create new technological and societal breakthroughs	services for private sector collaboration.

		and impact. Such services can include training on-demand or targeting specific user groups; the design and co-design of instrumentation, equipment or procedures; joint research activities and joint instruments testing. ACTRIS participates in the knowledge production on societal challenges and to the mitigation of the impacts of climate change and air quality. Within the implementation phase, ACTRIS will start working towards technology development and innovation activities, including promoting cooperation with the private sector, policymakers and the general public;	 Promoting of co-development opportunities for technology development and new services Promoting ACTRIS as an innovation platform. Enhancing use of ACTRIS data products and digital tools for market-oriented applications and for decision-making processes. Enhancing use of ACTRIS exploratory and observational platforms for market-oriented applications by providing access to the private sector.
9	Socio-economic impacts	The first socio-economic impact study was carried out during ACTRIS Preparatory Phase. It clearly demonstrated the societal benefits and contributions to several dimensions of regional, national and European development. The second round of the socio-economic analyses (direct, indirect) will be carried out during the implementation phase.	Establish a methodology for analysing and measuring socio-economic impact for largely distributed RIs as in the case of ACTRIS.

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Milestones

The planned Milestones for the foreseen activities undergoing during the 5-year implementation plan are presented in Table 11.

Task Nama										
Таяк Name	01-20	07-20	01-21	07-21	01-22	07-22	01-23	07-23	01-24	07-24
RI operations										
CF constructions and implementation of operational										
support										
Constructions and upgrades of NFs to meet ACTRIS NF										
requirements										
ACTRIS NF labelling										
Developing the workflows among NFs, TCs, DC, and HO										
Validation of the operational support actions										
Prioritisation of the operation support actions										
Piloting the selected operation suppot actions										
Service development										
Catalogue of services										
Validation of services										
Prioritisation of service provision (1st set of services)										
Engagement of the user community										
Piloting access and service provision										
Set of pilot services										
Testing user services										
User feedbacks										

Table 11. Milestones for the implementation phase of ACTRIS, 2020-2024.

Table 11. (Continuing) Milestones for the implementation phase of ACTRIS, 2020-2024.



Task Name	01-20	07-20	01-21	07-21	01-22	07-22	01-23	07-23	01-24	07-24
Outreach and Communication								it i		
Development of communication strategy										
Development of communication strategy			-							
Promoting the awareness and visibility of ACTRIS										
Creating targeted outreach activities and materials for different user groups and stakeholders										
Facilitating the internal and external communications										
Innovation and Technology Development Activities										
Identifying the development areas and services for private sector collaboration										
Promoting co-development for technology development and new services										
Promoting ACTRIS as an innovation platform										
Enhancing use of data and data products for market- oriented applications and for decision-making processes										
Enhancing use of ACTRIS exloratory and observational platforms for market-oriented applications by providing access to the privat sector										
ACTRIS Socio-economic impact										
Establish a methodology for analysing and measuring the socio-economic impact										
Establish a methodology for analysing and measuring the socio-economic impact										
Establish a methodology for analysing and measuring the socio-economic impact										
Enhancing use of ACTRIS exploratory and observational platforms for market-oriented applications by providing access to the privat sector										
ACTRIS Socio-economic impact								1		
Establish a methodology for analysing and measuring the socio-economic impact										
Establish a methodology for analysing and measuring the socio-economic impact										
Establish a methodology for analysing and measuring the socio-economic impact										

Table 8. (Continuing) Milestones for the implementation phase of ACTRIS, 2020-2024.

Monitoring of performance

Key performance indicators

The HO is responsible for organising self-assessment and consultation, monitoring KPIs and risks, providing guidance on quality management to CFs and NFs, and employing benchmarking and best practices to support the planning and development of quality management. The HO performance shall be evaluated annually against a set of KPIs. The specific KPIs for HO are connected to the HO core mission and functions and reflect the efficiency and quality of the main HO tasks.

Table 9. First planned se	of KPIs for ACTRIS fo	or the implementation	phase (2020 - 2024).
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Index	Comment	Type of data	Frequency		
RI operations					
Number of CF units operational	Measure of success in implementation. Expect increasing value in first two years.	Numerical	Twice a year		
Number of ACTRIS NFs labelled	Measure of success in implementation. According to the labelling process and plan.	Numerical	Yearly		
Number of internal support actions validated	Measure of success in implementation. Expect increasing value throughout the years according to the primary service catalogue.	Numerical	Yearly		
	Service development and provision				
Number of validated services in pre-operational service provision	Measure of success in implementation. Expect increasing value throughout the years according to the primary service catalogue.	Numerical	Yearly		
Number of European and non-European users (virtual, physical and remote access) served during ramp-up period	Measure of success of implementation of access management and monitoring systems. Expect increasing number throughout the years.	Numerical	Twice a year		
	Governance and coordinated managemen	nt			
Number of CF and NF agreements concluded	Measure of well-coordinated management. Expect increasing value throughout the years.	Numerical	Yearly		
Number of new members and observers in ACTRIS ERIC	Measure of attractiveness for countries to join. Expect increasing value throughout the years.	Numerical	Yearly		
Deviation from the annual ACTRIS ERIC budget	Measure of financial planning and management. Expect minimal absolute value.	Numerical	Yearly		
Common meetings organised among NF assembly, TCs, DC and HO.	Measure of strengthening the interactions of staff among TCs, DC, HO to build common work community and culture.	Numerical	Yearly		
ACTRIS staff satisfaction	Measure of ACTRIS attractiveness as a working place. Expect steady high numbers. Workplace questionnaire to be developed.	Semi- quantitative	Every second year		
Index	Comment	Type of data	Frequency		

Collaboration and Communication					
Number of agreements concluded with critical partnerships (liaisons)	Based on critical partnerships identified at the beginning of the implementation period. Measure of the attractiveness of ACTRIS service. Expect increasing value throughout the years.	Numerical	Every second year		
Number of participants that are part of the User Forum activities (representing various types of users and stakeholders)	Measure of success of implementation of access management and monitoring systems. Expect increasing value throughout the years.	Numerical	Yearly		
Number of dissemination and outreach activities on ACTRIS	Measure of ACTRIS visibility and outreach. Expect steady high numbers.	Numerical	Yearly		
	Impact (innovation and socio-economic)				
Number of development projects together with private sector actors	Based on national and European level co- development activities. Measure of the attractiveness of ACTRIS services. Expect increasing value throughout the years.	Numerical	Every second year		

External assessment

Furthermore, according to the ACTRIS draft statutes, the services, operations and management of ACTRIS shall be evaluated at least every 5 years by independent external evaluators, appointed by and reporting to the General Assembly. These processes are coordinated and managed in this activity. In addition, evaluations requested by ESFRI, or any other evaluations, are managed in this activity.

EMU has the overall responsibility of this activity, OPU contributes to the operational part of the assessments, and the DEVU and SAMU support the processes with the operational steps of the evaluations, and access monitoring and evaluation.

Risk Management Plan

The risk management in ACTRIS is important – as in any research infrastructure (RI), organisation, business, or project - the risks are the main source of uncertainty and potential threats to ACTRIS operation, outcome and success. Risks can originate from external and internal sources and be of different nature: e.g., operational, organisational, financial, legal, or strategic. Risk management is the process of identifying, addressing, prioritising, and eliminating potential sources of malfunctioning of the RI and the possible difficulties to achieve the objectives of the ACTRIS implementation phase. The risk assessment should be an integral and systematic part of the governance, management, planning and reporting processes and culture of ACTRIS. There is a link between quality management and risk management. All the ACTRIS bodies have a role in the risk management by identifying, monitoring or reporting the risks. As a rule, especially legally, the decision to act on the risk mitigation plan or adaptation plan is taken by the national host institutions for National Facilities and Central Facility Units, and the Director General and the General Assembly for the ACTRIS ERIC.

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ACTRIS Risk management principles

ACTRIS is proposing the following risk management principles as a general guideline:

Risk management principle 1: The risks need to be taken in the regular management and decision-making procedure, and they are assessed and monitored regularly. ACTRIS considers risk management as an integral part of the organisational process.

Risk management principle 2: ACTRIS shall apply all the necessary measurements and tools to mitigate the impact of the potential risks and prepare for contingencies.

Risk management principle 3: High likelihood risks with high consequences must be taken seriously. Everybody in ACTRIS is responsible for preventing the risks and reporting those to the Central Facility director, national ACTRIS Consortium coordinator and the HO and the Director General.

Risk management principle 4: ACTRIS maintains a Risk Register (RR), which is the basis for the European level Risk Management. The Risk Register (RR) identifies the potential risks for ACTRIS (Table 13).

ACTRIS risk assessment

The first edition of the **ACTRIS Risk Management Plan [11]** is elaborated by the ACTRIS HO in collaboration with the ACTRIS community within the ACTRIS PPP project. This current document is a living document available for partners to access and contribute to the development of risk identification, their probabilities, define the mitigation, adaptation and contingency measures, identify responsibilities.

For the identification of risks in ACTRIS and defining the impacts of each risks, all the ACTRIS partners are invited to participate, especially National ACTRIS Consortia, CFs and NFs together with HO should work on the risk assessment.

For the implementation phase, ACTRIS is using following risk categories that are reflecting the main activity categories and objectives of ACTRIS implementation. The risks are categorised in relation to:

- RI operations;
- Services development and provision;
- Governance and coordinated management;
- Community and country engagement;
- Collaboration and communication; and
- ACTRIS impact

In addition to the ACTRIS Risk Management Plan, a detail risks assessment related to the implementation of the specific CF will be prepared for each CF and they are based on CFs' internal activities and the requirement from the hosting organisations.

Risk treatment in ACTRIS

For the risk treatment ACTRIS has drafted the first version of the RR that includes identification of main mitigation actions. Moreover, ACTRIS will work on the contingency principles, procedures and preparation of ACTRIS contingency plans for main risks.

Risk treatment related to the resources and funding of ACTRIS strengthen the sustainability of the RI. Showing that ACTRIS can manage the risks related to the resources gives credibility to the stakeholders and the funding agencies increasing the possibilities of the RI to succeed in attracting funding and partners.

Regarding the identification and communication on the risks related to the resources, it is useful to follow the reporting rules for financial reporting. Since the CFs deliver their financial reports and work plans to the HO, they could also assess and report the financial risks as part of reporting tasks.

The HO together with the DG identifies and communicates the financial risks related to ACTRIS and ACTRIS ERIC to Interim ACTRIS Council, before the establishment of ACTRIS ERIC, and to the General Assembly, once ACTROIS ERIC is in place. Major changes in the financial plans require similar contingency procedures than the deviations in the main activities and operations. In the case of ACTRIS ERIC, the General Assembly makes decisions related to any financial mitigation or contingency actions. Risk mitigation and contingency actions on the financial risks related to the CF units and NFs are under the responsibility of the RPO, and should be handled by the national host organisation. The National ACTRIS Consortium can manage the financial mitigation or contingency actions of the ACTRIS NFs together with hosting RPO at the national level.

The development and implementation of different CFs will be done at different times. The HO will be operational when the ERIC is established. Also, some of the CF units are already mature enough to start with their operation, supporting the existing community needs and the NFs labelling process and in the near future to be able to provide operational support to the foreseen NFs and to provide services to external users. The different maturity levels of the CF units need to be taken into account when planning risk treatment actions.

Highly educated and committed personnel is a key asset for ACTRIS, and managing the risks related to the stability and performance of the key personnel are important for the successful implementation of ACTRIS. **ACTRIS Human Resources strategy [9]** and **Staff policy [12]** define actions for ensuring the positive development and maintenance of ACTRIS personnel

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Table 10. ACTRIS risk registry for the implementation phase and contingency plan.

Description of Risk	Likelihood (high/medium/low)	Potential Impact (high/medium/low)	Mitigation/Risk reduction/Planned response
RI operations			
CFs consortia have difficulties in setting up CF activities for internal support and service provision	Medium	High	Ensure support from the RPOs and countries hosting CF units to have enough resources for the CF implementation.
The TCs do not have enough capacity to provide the required operational support to NFs	Low	Medium	Establish a well-planned ramp-up process with clear RI support schedule and plan for gathering the capacity.
Less than half of the foreseen NFs are submitted for labelling process	Medium	High	Ensure support from the RPOs operating NFs to have enough resources for upgrading and maintaining NFs operative. Ensure that the cost of memberships for ERIC is not hindering the NF.
Inefficient data work flow due to the difficulties in implementation of CFs and NFs	Low	High	Ensure the coherent development and implementation of ACTRIS Data Centre according to ACTRIS Data Centre concept and data management plan. Ensure proper RI operation management with all necessary ACTRIS components (HO, DC, TCs and NFs).

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Service development and provision			
SAMU is not able to provide services to users due to the low level of TC and NF commitments or capacity on the provision of access to external users	Low	High	Work together with TC units, NF operators, hosting RPOs and countries to ensure the commitments for service provision. Communicate the benefits for NFs and TCs.
The user's interface is not efficient enough to process all the data and service requests from the users	Low	High	Establish a long-term plan for the SAMU and DC to be able to increase the capacity and resources if needed.
Users are not aware of the ACTRIS services or the cost per service is to high resulting too few requests for access to ACTRIS Facilities via SAMU	Low	High	Formulate a clear user strategy during the implementation phase in consultation with the experts and user communities. The awareness with efficient dissemination and promotion activities.
Governance and coordinated management			
Not enough countries as members of the ACTRIS ERIC	Medium	High	Present a clear ACTRIS concept and activity plan to the country delegates. Ensure the high quality and timely management and implementation of activities. Promote ACTRIS with the different stakeholders in each country and communicate the benefits of ACTRIS for countries.
ACTRIS ERIC not established in 2021	High	Low/Medium	Feed high-quality support material for decision making of the Interim ACTRIS

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			Council and national decision-making processes. Engage and support IAC for constructive development of ACTRIS ERIC and ACTRIS.
Not enough CF agreements concluded	Medium	High	Define a clear plan for negotiation and signing the agreements with the RPOs hosting CFs units and NFs.
Not enough agreements sign with the NFs	Medium	High	Communicate the benefits of ACTRIS. Secure enough members for ACTRIS ERIC. Integrate the process with the CFs contract agreement when the RPO have both facilities; define a clear plan of negotiation for the rest of the RPOs
National ACTRIS consortia and national stakeholders are not interactive with ACTRIS ERIC	Low	Medium	Program NF assembly and national consortia events with ACTRIS ERIC to keep the communication flow.
Underestimation of the expertise and human resources to build ACTRIS or not enough staff provided by the RPOs to work on ACTRIS implementation	Medium	High	Guarantee the allocation of necessary human resources and available skills, efficient HR management and realistic progress assessment toward operation, training of staff. Communicate the importance of good HR and management to funders. Have a clear, updated strategy for human resources.
Over-dependence on key individuals	High	High	Ensure the engagement on ACTRIS goals and strategic issues. Communicate with RPOs on their crucial role for providing
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			good work conditions and environment to ACTRIS staff. Create and maintain a supportive and attractive working environment. Monitor the well-being of staff. Adopt a management plan feasible for the complexity of the enterprise. Train new HR capacity and decrease dependence on single persons. Adopt good documentation and archiving system. Have a clear, updated strategy for human resources.
Underestimation of real implementation costs	Medium	High	Update and revise the implementation and business plan regularly. Revise the cost assessment, some of the services may not be implemented due to cost. Analyze expenditures, actively seek for cost efficiency in, e.g. procurements and operations RI-wide and with other environmental RIs.
Delay in implementing the RI in ten years since getting to the Roadmap	Low	High	Efficiently set up of the governance and get formal commitments from countries for ACTRIS ERIC; solid and concrete implementation plan written for CF and NFs; monitoring.
Community and country engagement			
Difficulties to engage countries, disagreements on the contribution principles.	Medium	High	Engage key countries and funders early in the negotiations. Keep everyone

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			informed. Prepare (the decisive) meetings well with realistic financial plans. Build up trust and transparency in the working culture. National ACTRIS Consortia play an important role at the national level
Countries do not have strong and well-organized ACTRIS science communities.	Low	Low	Establish open and well-communicated events for science communities. Support the establishment of National Consortia.
Collaboration and communication			
Not enough collaboration agreements concluded with key partnerships (liaisons)	Medium	Low	Participate actively in the international arena, i.e. seeking partnerships and creating concreted means for collaborations and identifying service provision.
Not enough visibility among targeted user groups. ACTRIS does not reach new user communities	Low	Medium	Establish communication tasks working on targeting outreach activities and create different tools and materials to the user groups and stakeholders and facilitate internal and external communications.
The relevance and impact of ACTRIS not sufficiently communicated and promoted	Medium	Medium	Update the ACTRIS science case in dialogue with the users. Ensure that users have a proper way to acknowledge ACTRIS by request the users to cite ACTRIS datasets within the text of the

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			publication and include a reference to them in the reference list. References to the dataset shall be detail enough that the reader of the paper or document shall be able to obtain the datasets from ACTRIS.
Impact (innovation and socio-economic)			
Not enough interest from the private sector to co- develop new services with ACTRIS	Medium	Low	Promote ACTRIS platforms for private sector users. Participate actively in technology and innovation events. Develop partnerships with private companies in the ACTRIS framework.
ACTRIS does not have enough socio-economic impacts	Low	Medium	Verify and strengthen communication and dissemination strategy and activities. Guarantee the full exploitation of ACTRIS results. Formulate a clear scientific strategy and align it to the needs of the user communities. Ensure the needed resources and competence for promoting, analyzing and communicating impacts.

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8. Annexes

Appendix 1: ACTRIS Glossary

- **Access** the legitimate and authorised physical, remote and virtual admission to, interactions with and use of Research Infrastructures and to services offered by Research Infrastructures to users.
- **ACTRIS** Aerosol, Clouds and Trace Gases Research Infrastructure, which produces high-quality data documenting short-lived atmospheric constituents and processes leading to their variability in natural and controlled atmospheres and integrates, harmonizes and distributes datasets, activities and services provided by Central Facilities and National Facilities.
- **ACTRIS data** data from observational National Facilities and exploratory National Facilities complying with the procedures established within ACTRIS.
 - o ACTRIS level 0 data: Raw sensor output. Native resolution, metadata necessary for next level.
 - o ACTRIS level 1 data: Calibrated and quality assured data with minimum level of quality control.
 - ACTRIS level 2 data: Approved and fully quality controlled ACTRIS data product or geophysical variable.
 - ACTRIS level 3 data: Elaborated ACTRIS data products derived by post-processing of ACTRIS Level 0 -1 -2 data, and data from other sources. The data can be gridded or not.
- ACTRIS Data Centre (DC) the Central Facility responsible for ACTRIS data curation, preservation, and distribution of data, value-added products and tools, and hosting the ACTRIS data portal.
- ACTRIS data originator entity operating instruments at a National Facility or Topical Centre, resulting in ACTRIS data and delivering ACTRIS data to the Data Centre.
- **ACTRIS data provider** the Data Centre offering the ACTRIS data and value-added data products and tools to users.
- **ACTRIS digital tools** tailored codes and software for processing and visualization of ACTRIS data, production of ACTRIS data products, and for data analysis and research.
- ACTRIS ERIC ACTRIS set up as a European Research Infrastructure Consortium (ERIC) under Regulation (EC) No 723/20092. ACTRIS ERIC provides the governance of the distributed research infrastructure ACTRIS and coordinates the strategic and financial development and long-term operation of ACTRIS.
- **ACTRIS exploratory platform** ACTRIS National Facility; atmospheric simulation chambers, laboratory platforms and mobile platforms that perform dedicated experiments and contribute data on atmospheric constituents, processes, events or regions by following common ACTRIS standards.
- ACTRIS General Assembly (GA) a council of ministry- and funding organization representatives of ACTRIS members after ACTRIS legal entity has been established, superior decision-making body of ACTRIS.
- ACTRIS Head Office (HO) a Central Facility coordinating and representing ACTRIS, and holding the statutory seat.

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ACTRIS label - earmarks a data set or a measurement site as ACTRIS data or ACTRIS National Facility.

- **ACTRIS observational platform** ACTRIS National Facility; a fixed ground-based station that delivers long-term data based on a regular measurement schedule and common operation standards.
- **ACTRIS Risk Register** A document containing all risks identified for the ACTRIS implementation phase, their risk rating and the planned mitigation measures to reduce their likeliness of occurrence.
- **ACTRIS synthesis product** Data products not under direct ACTRIS responsibility from e.g. research activities, citizen science, for which ACTRIS offers repository and access.
- ACTRIS Topical Centres (TCs) a Central Facility offering services and operation support for QA/QC of measurements and data (including training, calibration, QA/QC tools, and development of standard operation and evaluation procedures)
- ACTRIS variables the measured atmospheric variables as described in <u>ACTRIS Data Centre Concept</u> <u>document</u>.
- **AeroCom** an open international initiative of scientists interested in the advancement of the understanding of global aerosol properties and aerosol impacts on climate, weather, and air quality. A central goal is to more strongly tie and constrain modelling efforts to observational data from satellite, ground-based, and aircraft observations.
- **Central Facility (CF)** a European level ACTRIS component that offers ACTRIS data or other ACTRIS services to users as well as operation support to ACTRIS National Facilities.
- **Central Facility Unit** part of a Central Facility and operated by a research performing organization (RPO) or by ACTRIS ERIC.
- CF Director the person responsible for the coordination and representation of a Central Facility.
- **CF Unit Head** the person responsible for the coordination and representation of a Central Facility Unit.
- **CF Management Board** consists of the CF Unit Heads and the CF Director; this board manages the Central Facility.
- **Competitive access** means access to the ACTRIS Central Facility and National Facility services through a selection process via SAMU.
- **Data curation** the activity that stores, manages and ensures access to all persistent data sets produced within the infrastructure.
- **Data traceability** an unbroken chain of uniquely identified process steps leading from raw data to any kind of processed data, where identification of process steps follows the data.
- **Director General (DG)** is the leader of the ACTRIS (research infrastructure) and the legal representative of the ACTRIS ERIC. The main duty of the DG is to implement the GA decisions and ensure the scientific and strategic development of ACTRIS.
- **ERIC Management board** If a Central Facility is a part of ACTRIS ERIC (ACTRIS Head Office is a part of ERIC per default), the director of the given CF can be a member of the internal ERIC management board that ensures the coordinated development, management, and implementation of ACTRIS ERIC activities.

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- **Ethical Advisory Board** consists of independent external members appointed by the GA; the board provides feedback and recommendations to develop the ethical aspects of the ACTRIS ERIC and the research infrastructure activities.
- FAIR principles Findable, Accessible, Interoperable and Reusable principles
- **Financial Committee** consists of members appointed by the GA; the committee supports the GA on matters related to the management of financial planning as an internal body of GA.
- Free access means free-of-charge access for users.
- Host Country the country where the Central Facility unit is located and operated.
- Host Contributions support provided by members or permanent observers for the functioning of
- the Central Facility unit or units hosted in their own country.
- **In situ measurements** measured or sampled air and instrument are at the same location and in physical contact. In the context of ACTRIS, in situ measurements of aerosol, cloud, and reactive-tracegas properties are performed at observational sites near the Earth surface, on mobile surface-based or airborne platforms, and in atmospheric simulation chambers and laboratories.
- **Interim ACTRIS Council** a council of ministry- and funding organization representatives of ACTRIS members before ACTRIS legal entity has been established (during the ACTRIS Preparation and Transition Phase), superior decision-making body of ACTRIS.
- **Measurement traceability** an unbroken chain of comparisons relating an instrument's measurements to a known standard, in the ideal case SI units.
- Membership contribution the amount of money the countries pay in order to join ACTRIS ERIC

as members, permanent observers or observers.

- **National Facility (NF)** an observational or exploratory platform providing data and/or physical access to the platform within ACTRIS.
- **National Facilities Assembly** is the platform for the principal investigators and technicians from the ACTRIS NF to exchange experiences and interact with each other and with the ACTRIS CFs; the assembly develops the RI and ensure the connection between the scientific expertise and technological development.
- **Physical access** physical access of users to the services of an ACTRIS Central Facility or National Facility.
- **Quality assurance and control**: Quality assurance is process oriented and focuses on defect prevention; quality control is product oriented and focuses on defect identification:
 - **Quality Assurance (QA):** The process or set of processes used to ensure the quality of a product (e.g. data series, instrument, sample, measured value of a variable, etc.),
 - **Quality Control (QC):** The process and activities of ensuring products and services meet the expectations.

Remote access - access to an ACTRIS Central Facility or National Facility without users physically visiting the facility.

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- **Remote sensing** measured air and instrument are not at the same location and not in physical contact. In the context of ACTRIS, active and passive atmospheric remote-sensing techniques for the observation of aerosol, clouds and trace gases are applied at observational sites and on mobile surface-based or airborne platforms.
- **RI committee** is established by the GA; the committee advices the DG on matters related to the RI to ensure consistency, coherence, and sustainability of the operations of the RI. Each CF director from those CFs that are not part of ACTRIS ERIC has a seat in the Research Infrastructure Committee. Also, representatives of the National Facilities Assembly shall be members of the Research Infrastructure Committee.
- **Science and Innovation Advisory Board** consists of independent external members appointed by the GA; the board monitors and advices on the scientific and operative quality of the ACTRIS ERIC and the research infrastructure activities.
- **Science and User Forum** an open platform for users to interact with ACTRIS. To be established during the implementation phase of ACTRIS.
- **Scientific and Implementation Advisory Board (SIAB)** The SIAB advises and supports the Interim ACTRIS IAC and the ACTRIS PPP in their implementation work to obtain the objectives of ACTRIS.
- Service and Access Management Unit (SAMU) a part of ACTRIS Head Office facilitating the access to ACTRIS services.
- Topical Centre a Central Facility, which is either included in ACTRIS ERIC or has a contractual

relationship with ACTRIS ERIC, offering services and operation support for quality assurance/quality

control of measurements and data (including training, calibration, quality assurance/quality control tools, and development of standard operation and evaluation procedures).

- User a person, a team, or an institution making use of ACTRIS data or other ACTRIS services, including access to ACTRIS facilities.
- Virtual access free access provided through communication networks.

Appendix 2: List of Acronyms

ACMCC Aerosol Chemical Monitor Calibration Center

ACTRIS Aerosol, Clouds and Trace Gases Research Infrastructure

ACTRIS HO ACTRIS Head Office

ACTRIS DC ACTRIS Data Centre

ACTRIS CF ACTRIS Central Facility

ACTRIS TC ACTRIS Topical Centre

ACTRIS NF ACTRIS National Facility

ACTRIS SAMU ACTRIS Service and Access Management Unit

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ACTRIS GA ACTRIS General Assembly

ACTRIS-I3 EU FP7 Aerosol, Clouds and Trace gases Research InfraStructure Network, grant agreement No 262254 (2011-2015)

ACTRIS-2 Aerosol, Clouds and Trace gases Research InfraStructure Integrated Activity (IA) project is funded by EU Horizon 2020 Research and Innovation programme (grant agreement No 654109). ACTRIS-2 started on 1 May 2015 for a period of 4 years.

ACTRIS PPP, Aerosol, Clouds and Trace gases Research InfraStructure Preparatory Phase Project is a EU Horizon 2020 Coordination and Support Action (grant agreement No 739530). ACTRIS PPP started on 1 January 2017 for a period of 3 years.

AERONET Aerosol Robotic NETwork

AISBL Association without lucrative purpose

AMAP Arctic Monitoring and Assessment Programme

ANAEE European research infrastructure on Analysis and Experimentation on Ecosystems

AOD Aerosol optical depth

ARISE2 Atmospheric dynamics Research InfraStructure in Europe Design Study (DS) is a collaborative infrastructure project (2015-2018) funded by the H2020 European Commission.

BVOC Biogenic Volatile Organic Carbon

CAIS Center for aerosol in-situ measurements

CAMS Copernicus Atmosphere Monitoring Service

CAPS Cavity Attenuated Phase Shift Spectroscopy

CI-APi-ToF Chemical Ionization Time-Of-Flight mass spectrometer

CiGas Centre of trace gases in-situ measurements

CLD Chemiluminescence detection

CLRTAP Convention on Long-Range Trans-Boundary Air Pollution

CLOUDNET EU FP5 Development of a European pilot network of stations for observing cloud profiles (2001-2005)

COPERNICUS The European Earth Observation Programme

CREATE Establishment, use and delivery of an European aerosol database

CTA Cherenkov Telescope Array

DIAL Differential Absorption Lidar

DOI Digital Object Identifier

EARLINET EU FP5 European Aerosol Research Lidar Network to establish an aerosol climatology

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EARLINET-ASOS EU FP6 European Aerosol Research Lidar Network - Advanced Sustainable Observation System

EBAS Database EMEP framework Observation database of atmospheric chemical composition and physical properties

ECMWF European Centre for Medium-Range Weather Forecasts

EISCAT-3D The Next Generation Radar for Atmospheric and Geospace Science

eLTER Long-Term Ecosystem Research in Europe

EMEP Co-operative programme for monitoring and evaluation of the long range transmission of air pollutants in Europe

EMSO ERIC European Multidisciplinary Seafloor and water-column Observatory

ENRTIIC European Network of Research Infrastructures & Industry for Collaboration

ENVRIplus Horizon 2020 cluster project on Environmental Research Infrastructures (ENVRI) Providing Shared Solutions for Science and Society

EPOS European Plate Observing system

ERA-PLANET The European network for observing our changing planet

ERIC European Research Infrastructure Consortium

E-RIHS European Research Infrastructure for Heritage Science

ESA European Space Agency

ESFRI European Strategy Forum on Research Infrastructures

ESS ERIC European Social Survey

EUMETSAT European Organisation for the Exploitation of Meteorological Satellites

Euro-Argo ERIC European infrastructure for Argo program that aims at sustaining 1/4 of the global network and enhance coverage in European seas.

EUROCHAMP-2020 Integration of European Simulation Chambers for Investigating Atmospheric Processes - Towards 2020 and beyond project is funded from the European Union's Horizon 2020 research and innovation programme (grant agreement No 730997, 12/2016-11/2020).

EUSAAR EU FP6 European Supersites for Atmospheric Aerosol Research Grant Agreement n°026140 (2006-2011)

FAIR Findable, Accessible, Interoperable and Reusable

FID Gas chromatographic methods with flame ionization

FTIR Fourier-transform infrared spectrometry

Future Earth Global change research program coordinated by the International Council for Science (ICSU)

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GAW WMO Global Atmosphere Watch GAW-WDCA WMO World Data Centre for Aerosols GAW-WDCRG WMO World Data Centre for Reactive Gases GC-MS Gas chromatography mass spectrometry HEMERA EU H2020 project dedicated to balloon-based observations of Earth and space HPLC-MS High performance liquid chromatography mass spectrometry IAC Interim ACTRIS Council IAGOS-AISBL European Research Infrastructure on In-service Aircraft for a Global Observing System IC Ion chromatography ICOS ERIC Integrated Carbon Observation System Research Infrastructure iLEAPS Integrated Land Ecosystem-Atmosphere Processes Study, Global Research Project of Future Earth INP Ice nucleating particle 13 European Commission's Integrated Infrastructure Initiative of EU FP7 or design study LC-MS Liquid chromatography mass spectrometry LIDAR Light detection and ranging MoU Memorandum of Understanding **MS Mass Spectrometry** NASA The National Aeronautics and Space Administration NDACC International Network for the Detection of Atmospheric Composition Change NMHC Non-methane hydrocarbon NOAA National Oceanic and Atmospheric Administration, U.S. Department of Commerce OVOC Oxidized Volatile Organic Carbon **PEEX Pan-Eurasian Experiment** PTR-MS Proton-transfer-reaction mass spectrometry **RECETOX Research Centre for Toxic Compounds in the Environment RI Research Infrastructure RPO Research performing organization** SHARE ERIC The Survey of Health, Ageing and Retirement in Europe SIOS Svalbard Integrated Earth Observing System SME Small and Medium-sized Enterprise

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UAV Unmanned Aerial Vehicle

UNECE United Nations Economic Commission for Europe

UNEP United Nations Environment Programme

UVVIS Differential optical absorption spectrometry in the ultraviolet-visible range

VOC Volatile Organic Compound

WCC GAW World Calibration Center

WCC-VOC GAW World Calibration Center for Volatile Organic Compounds

WDC GAW World Data Center

WHO World Health Organization

WMO World Meteorological Organization

WMO-GAW The Global Atmosphere Watch (GAW) programme of WMO

WMO-GCOS Global Climate Observing System Programme of WMO

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Reference documents

- 1. <u>ACTRIS PPP Deliverable 4.1: Concept document on ACTRIS Central Facilities structure</u> <u>and services</u>
- 2. <u>ACTRIS PPP Deliverable 5.1: Documentation on technical concepts and requirements</u> for ACTRIS observational platforms
- 3. <u>ACTRIS PPP Deliverable 5.2: Documentation on technical concepts and requirements</u> <u>for ACTRIS exploratory platforms</u>
- 4. ACTRIS PPP Deliverable D2.3: Data policy
- 5. ACTRIS PPP Deliverable D2.6: Access and service policy
- 6. ACTRIS PPP Deliverable D4.2: ACTRIS Data Management Plan
- 7. ACTRIS PPP Deliverable 6.4: ACTRIS Access Management Plan
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- 9. ACTRIS PPP Deliverable D2.6: Access and service policy
- 10. European Innovation Scoreboard 2019, doi: 10.2873/877069
- 11. <u>ACTRIS PPP Deliverable D2.4</u>: Document defining the founding articles for the legal <u>entity</u>
- 12. ACTRIS PPP Deliverable D1.4: Strategy for Human resources
- 13. ACTRIS PPP Deliverable D3.1 Cost Book
- 14. Deliverable D1.2: ACTRIS Risk Management Plan for the Implementation Phase
- 15. ACTRIS PPP Deliverable D2.7: ACTRIS staff policy