13.10.2022

TOWARDS THE ACTRIS NATIONAL FACILITY STRATEGY

Short version for the basis of discussion in ACTRIS week, Prague 24-27.10.2022

Preface

This is a background document for facilitating the discussion within the ACTRIS community in the ACTRIS week 2022. The main topics include the scope of the NF strategy, the discussion on goals of ACTRIS in relation of the ACTRIS NF network and agreeing on the terminology and definitions used. In the end of the document, few more detailed dedicated questions are listed, where the feedback from the community is seen important.

After the ACTRIS Week, the NF Strategy will be further developed in the Research Infrastructure Committee based on the feedback received. The aim is to have an NF Strategy available for discussion and approval in the ACTRIS ERIC General Assembly towards the end of the implementation phase. The first ACTRIS NF Strategy is planned to extend over the first five year of operational phase, 2025-2030, and will be revisited regularly.

The work defining ACTRIS National Facility Strategy has started in the RI committee meeting 6/2020, but at that time there were too many open issues in the process towards the establishment of ACTRIS ERIC, that was considered as highest priority. The work has continued in RI committee meeting 1/2022, and from there on. The ACTRIS National Facility Strategy is becoming more and more important towards the end of ACTRIS implementation phase and in the operation phase. Thus, the foreseen deadline for the finalizing of the NF strategy is also at the end of ACTRIS implementation phase, around 2024-2025. The main principles of the NF strategy should be agreed upon much earlier.

Scope of the ACTRIS National Facility Strategy

The ACTRIS National Facility Strategy is a document towards optimizing the scientific impact of ACTRIS by describing what kind of National Facilities ACTRIS should have and where they should be located in order for ACTRIS to best reach its goals with manageable level of costs. These need to be considered from both scientific, technical, and geographical perspectives. The National Facility Strategy is a general guideline document concerning the National Facilities in ACTRIS, complementing the ACTRIS overall strategy, and expected to be approved by the ACTRIS ERIC General Assembly. The Central Facility issues and ACTRIS commitments to external organizations and networks are taken into account in the ACTRIS National Facility Strategy, but the main focus remains on the National Facilities.

Although implementation of the ACTRIS National Facility strategy is steered by the Head Office and the Director General, it is built through an open, iterative process where the voice of countries and national scientific communities is heard and taken into account. This is especially important as the countries and the national RPOs are the funders and operators of the NFs in ACTRIS. Thus, the strategy cannot be implemented without their support. Here the National Contact Persons are foreseen to play a key role.

The current ensemble of National Facilities in ACTRIS results from the proposals of the member and observer countries of ACTRIS ERIC. It is based on the countries' national decisions and taken into account in the membership fees of the countries. This is the starting point of the National Facility strategy, which is focusing on the development ACTRIS in the future. The National Facility Strategy is to give guidance on which new countries, new NFs and NF components, new observations and new experimental capacity ACTRIS shall try to attract in the future to shape its capabilities to meet the needs of the users, at the same time recognising the financial and political constraints. As ACTRIS is a long-term Research Infrastructure, the strategy must also be able to respond to emerging future needs.

ACTRIS National Facilities

ACTRIS National Facilities are the observational and exploratory platforms which provide data and/or physical or remote access to their premises. They are the main source of data within ACTRIS. The National Facilities are owned and operated by national research performing organizations (RPOs) and are connected to ACTRIS by a contractual relationship.

ACTRIS has not started from scratch. The scientific communities forming ACTRIS have worked together for decades through different projects and initiative, and the participating countries and institutions have invested a lot in building measurement sites and other facilities. Therefore, most of the facilities proposed to ACTRIS are pre-existing, and based on past and current national strategies and funding of scientific projects.

The initial list of National Facilities and their components proposed to ACTRIS is selected by each country individually, without common coordination. The countries have invested in their facilities and expressed their commitment for these proposed facilities, thus being an integral part of the NF network in ACTRIS. While countries have selected NFs independently, the overall choice of NFs reflects, to a large extent, networks of facilities operated within past EC projects (EUROCHAMP, EUSAAR, EARLINET, CLOUDNET) or international networks (GAW, EARLINET, EMEP, AERONET, …)

The initial ensemble of facilities is not to be questioned before the ACTRIS operations are running properly. At that stage we know much better whether the facilities have passed the labelling, how the data and services are provided and used, and how close we are to the capacity limits of the TCs. At that stage ACTRIS should take a more strategic role in the in the development of ACTRIS NF network.

The complete and updated list of ACTRIS NFs is available on the ACTRIS web site at https://www.actris.eu/facilities/national-facilities.

ACTRIS goals

The ACTRIS goals are defined in the vision, mission and services provision stated in the Technical and Scientific description (TSD) of ACTRIS ERIC. These will be revisited in 2023 when the ERIC is established, but no large changes are expected. Currently they are:

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.

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.

ACTRIS Services:

- Access to high quality, harmonized, and documented ACTRIS data from observational and exploratory NFs (data services)
- Access to services provided by the ACTRIS facilities (technical / research / innovation / training services)

The ***ACTRIS goals*** or main objectives are described in more detail also in the TSD as:

1. 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*.
2. To provide information and understanding on the *atmospheric processes driving the formation, transformation, and removal of short-lived atmospheric constituents*.
3. To provide *coordinated open physical and remote access to ACTRIS facilities* for effective scientific, technological, and innovative use of ACTRIS tools and services for a wide range of users, including the private sector.
4. To provide efficient open access to ACTRIS data and services and the means to effectively use ACTRIS products.
5. 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.
6. To promote training of operators and users and enhance the links between research, education, and innovation in the field of atmospheric science.

The above goals one to three are directly linked to National Facilities. The link to NFs from goals four to six is of secondary nature, and those goals are not analysed in this short version of the document. The means of reaching the goals one to three are analysed from ACTRIS NF perspective in the next chapter.

National Facility ensemble needed for reaching the goals

ACTRIS Technical and Scientific description, approved by the Interim ACTRIS Council as part of the STEP-2 submission to ERIC defines the ACTRIS National Facilities: *National Facilities consist of Observational and Exploratory Platforms, developed, managed and operated by national RPOs. Observational Platforms are fixed, ground-based stations located within Europe and at selected global sites. They acquire reliable high-quality data on the variability of aerosol, clouds and trace gases and their complex interactions by applying standardized remote-sensing and in- situ measurement techniques. Exploratory Platforms comprise atmospheric simulation chambers, laboratories, and mobile platforms. They perform dedicated experiments and provide quality-controlled data on atmospheric compounds, processes, events or regions of relevance by following common standards. Exploratory Platforms and selected Observational Platforms also provide physical and remote access to users, which is centrally managed via SAMU, following the ACTRIS Access and Service Policy*.

For the observational NFs, ACTRIS must in principle respond to a proper network design to answer to the first goal. Networks of observations ideally provide optimal sampling of parameters to be monitored for the scope of ACTRIS, i.e. to respond to scientific requirements (identification of sources, reliable estimates of radiative impacts, support to regional air quality and climate modelling, monitoring extreme events, etc…). Observation requirements obviously vary depending on applications. For application areas such as climate change, monitoring atmospheric composition changes, and modelling atmospheric composition, GCOS (Global Climate Observing System) and GAW/WMO (Global Atmosphere Watch) provide sets of observational requirements (timeliness, spatial and temporal sampling, etc…). Methods can be used to evaluate whether a specific network is suited for specific applications, and to optimally identify where new stations could be most effectively located. Adequacy of the current network of NFs can be tested against both the GCOS and GAW requirements whenever available. No requirements exist for parameters such as Cloud Liquid Water content as measured in CIS, for example. Clearly, GCOS or GAW/WMO type of requirements do not apply to experimentation facilities. A first goal in the ACTRIS NF strategy is therefore to ensure that the network of observational facilities is adequately organized to the various requirements

ACTRIS NF are also meant as research facilities offering access for short-term campaigns. Requirements are, in that case, formulated differently. For observational facilities, the overall suite of NFs must offer access to a variety of sites representing the diversity of environments in Europe and possibly beyond, reaching from Arctic to sub-tropical climate, from tundra and glaciers to Mediterranean vegetation, from 300 mm/a to 2500 mm/a precipitation, from sea level to almost 5 km altitude, from coast and islands to continental climate, from uninhabited to agricultural to urban landscape. In addition, observational NFs in ACTRIS should also offer capacity to study specific transient phenomena such as clouds. Similarly, experimental facilities must offer capacity to perform experiments under controlled atmosphere or natural atmosphere to generally provide in-depth knowledge building of processes driving the atmospheric environments and their impacts on climate, atmospheric composition, human and ecosystem health, etc… A second goal in ACTRIS NF strategy is therefore to ensure the existence of and availability of data from the most advanced facilities for atmospheric research in Europe.

The third goal requires ACTRIS to not only have the needed observational and exploratory facilities in the NF ensemble, but to also provide physical and remote access to the right facilities. This includes the experimental facilities, the most advanced observational facilities, and observational

facilities in unique or most interesting locations. There needs to be enough and right type of access-providing facilities to meet the user needs. Not all requested access needs to be granted, but enough to keep ACTRIS as an attractive access provider from the User perspective. There needs to be efficient access provision and management and data license systems in place enabling easy enough access and exploitation of the results.

As ACTRIS is a long-term research infrastructure, it also needs to adapt to future needs. This means that the goals and the means to reach those goals might change in the future, and this analysis as part of the strategy is always prepared for the certain timeframe. New instruments and new needs will emerge, and ACTRIS needs to be able to react to the changes. This includes both the processes for taking onboard or removing some instruments and services, but also the capacity to react to un-expected events such as volcanic eruptions in Europe.

Current gaps in the National Facility Ensemble

Goal 1. Responding to observation requirements (observational facilities only)

As highlighted in the previous section, testing adequacy of the NF network against requirements depends on application areas. As a case study, we tested the ACTRIS NF network against requirements for Essential Climate Variables as proposed by GCOS (climate observation application area). The network density of ACTRIS observational facilities (goal 1) is analysed here using the GCOS threshold and breakthrough values for aerosol in-situ measurements (500 km and 250 km representation distances) as reference. The real representativeness of a facility depends on the type of measurements, topography, and atmospheric conditions, but the distances used here give a first estimate on the coverage of the networks. The results were analysed separately for each component and discussed, considering the component-specific special characteristics, but here we present only the general picture.

The network-type coverage over Europe varies a lot between the components. Aerosol in-situ measurement facilities form the most comprehensive network, whereas for all other components there are significant coverage gaps in different parts of Europe. For cloud in-situ measurement and reactive trace gases remote sensing the number of facilities in Europe are so low that they cannot be considered as representative networks.

Common to all types, there are no facilities of any kind anywhere on the Atlantic or Barents Sea coast, and only a few facilities even within 250 km from the coast. This is clearly an underrepresented region of Europe. Another common gap is in the Northern Balkans. This is partly due to lack of member countries in that area, but also the location of facilities in those countries that are ACTRIS members. A third common feature is the very few remote sensing facilities of any kind in Northern Europe, whereas in Eastern Europe the remote sensing components are better represented than the in-situ ones. What is not yet analysed is the type of surroundings near the facilities. Most ACTRIS facilities are considered as rural or background measurements, whereas the urban dimension is largely lacking.

Generally, the suite of NF candidates gathers most expected facilities (and sometime provide an extension as respect to the historical network configuration), in particular for aerosol in-situ measurements, aerosol remote sensing and cloud remote sensing. This is not surprising since these three types of measurements have been core services in past projects since the early stages of ACTRIS. The trace gases in-situ facilities are still less numerous than the aerosol in-situ ones when a

purely scientific design of the network would naturally call for facilities to be responding to both components. The number of trace gases remote sensing NFs is still limited and clearly not reflecting the potential in Europe for monitoring trace gases with remote sensing techniques. Finally, the number of cloud in-situ facilities remains limited due to both its recent creation and to the fact that these variables can only be sampled at specific locations.

The facilities outside Europe have not been included in this analysis but they potentially could be far more numerous than what has been proposed now. An action must be undertaken in ACTRIS to better establish the international NFs.

Goal 2

The second goal requires measurements in controlled environments and in locations specific to the study. Also, of great importance here are the facilities where multiple types of measurements are performed at the same facility.

The controlled environments are available at the atmospheric simulation chambers (ASC) providing access to Users. The ASCs proposed by member and observer countries in the initial list of NFs cover almost all facilities operational in EUROCHAMP-2020. Missing ASCs with respect to EUROCHAMP-2020 are generally from countries not yet members of ACTRIS. A few additional ASCs are proposed within the NFs. Based on the EUROCHAMP-statistics the chambers are well in use and there are more requests than what access can be provided. The TNA program in EUROCHAMP-2020 was very successful demonstrating that the chambers proposed as ACTRIS NFs are well perceived by the Users. There might, however, be new markets available for the chambers, as there could be topical or technical gaps in the chamber service provision where there would be demand for access, but ACTRIS cannot yet provide it. New capacities recently implemented in NFs, in particular for studies with living organisms, may foster the requests for access to these facilities.

Only one NF falls under the category “laboratory” and this must be clarified providing a proposer definition for this category, either to increase the number of NFs under this concept or decide to cancel the category.

The other part of this goal is the multi-component facilities providing data on several ACTRIS components at the same time. Out of the 89 observational platforms proposed by the countries 66 contribute to only one or two components and only 23 to three or more components. The multi-component facilities are mostly concentrated in Central Europe, Italy, and Finland, with additional individual facilities in Spain, Greece, Cyprus and Romania.

Here one needs to keep in mind that the facilities nearby each other might not represent the same components of ACTRIS. As the threshold level for the multi-component category here is three components, two nearby facilities might even have no component in common. For this reason, the coverage within a specific radius and overlap are not important here, but whether there are multi-component facilities in all climate-, vegetation- and land use regions in Europe. From this perspective the Central Europe is overrepresented and there is a lack of multi-component facilities again in the Atlantic Coast, Scandinavia, and many parts of Eastern Europe.

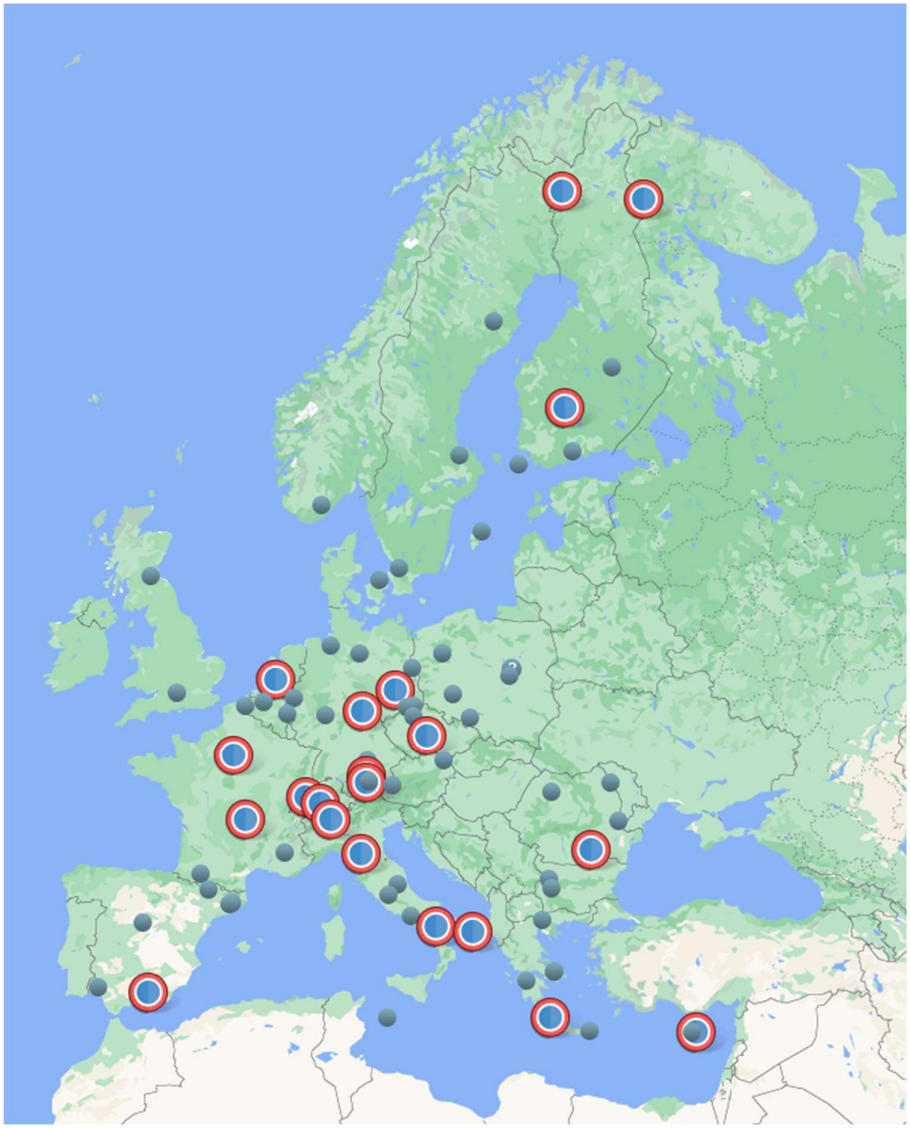

Figure 1. Proposed National Facilities contributing to 3 or more components of ACTRIS (circled dots) and those contributing to 1 or two components (simple dots).

Goal 3

For the third goal ACTRIS needs to have an access program providing Users with access to all exploratory and some observatory National Facilities. The observatory facilities participating in the access program are still to be defined but are likely to include at least those facilities that have provided TNA access in the past and current ACTRIS projects. We do have the access modalities prepared and tested, so we can claim that the access-related goal is reached. The funding for this access in the long run, however, is not solved., How well does the ACTRIS ensemble of access providing facilities match the User needs is to be found out. There might be technical or geographical gaps that have not been fully recognized. Do we know enough of the needs of potential Users to know whether our capacity and capability are sufficient to fully meet them?

Open questions

Besides the gaps analysed above there are a number of uncertainties and open questions related to the National Facilities and the operation support that they receive from the Topical Centres and Data Centre, that we wish to discuss during the dedicated session in ACTRIS Week.

1. An obvious question is the ensemble of member countries in ACTRIS. All 19 countries participating in the preparation of ACTRIS at ministry level are foreseen to become members or observers in ACTRIS ERIC, either as founding members or with a small delay. In addition, there are several countries that are already involved in ACTRIS community, and are engaged in many activities, but are not yet proceeding with the membership. New countries potentially joining in ACTRIS ERIC will bring new NFs filling some of the existing gaps. Another way of filling the gaps is for the current member and observer countries to bring in new facilities at strategic locations within Europe. What are the countries and facilities (and even facility components) that would bring most added value if being part of ACTRIS? In what ways can the ACTRIS community facilitate the engagement and joining of the new countries?

2. The second question concerns the potential services or operation support provided to facilities hosted by RPOs from countries that are not members or observers in ACTRIS ERIC. Within the ACTRIS member and observer countries there are also facilities and/or instruments that are not officially brought into ACTRIS by the hosting countries. Neither of these types of facilities are currently to be supported by ACTRIS. The role and status of such facilities and instruments in respect to ACTRIS needs to be defined. Scientifically it would be beneficial to have the facilities covered in ACTRIS one way or the other, but they cannot be free riders in the system, as the countries are paying to ACTRIS for the operation support ACTRIS provides. The service to these facilities can be provided upon a fee, but the fees would have to be such that there would always be an incentive for the country to join ACTRIS ERIC and / or to propose the facility as n National Facility. What would be the best way to treat these kinds of facilities within ACTRIS?

3. The third question is related to the definition of a National Facility. We have defined the technical minimum and optimum requirements for a National Facility of a component and platform type. We have also defined the contractual requirements for the facility. What has not been defined is the maximum requirements. How to treat duplicate instruments potentially going through the operation support provided by the TCs? This has an effect on the workload of the TCs. Also, if a facility has more than one measurement site, how far can they be from each other to be considered as a single NF. Whether it is one facility or separate facilities might affect the membership fee of the hosting country. These issues need to be solved in near future before the labelling and operation support for these facilities.

4. The fourth open question is what happens if some requirements are temporally or generally not met at a National Facility. What happens if everything else is fine, but one instrument measuring a mandatory parameter breaks down or fails the calibration and a replacement is not available. What exceptions on calibration schedule can be made for facilities and instruments located in very remote places, such as Greenland or Antarctica? There might also be other individual instruments bringing added value to measurements of some component, but technically belonging to another one. Eg. lidar data is needed at cloud remote sensing facilities, even though a lidar is an aerosol remote sensing instrument. How are these calibrations handled?

Proposed definitions and terminology to further define the ACTRIS facilities

There has been some unclarities and inconsistencies on the terminology related to the NFs and ACTRIS networks, and some terminology not fully defined. For moving forward in the process in building the ACTRIS NF Strategy, it is important that there is consensus on the definitions and terminology.

National Facility type (from TSD)

National Facilities can be either observational platforms, mobile platforms, atmospheric simulation chambers or laboratories.

ACTRIS component

The category of measurements performed at a National Facility and supported by a Topical Centre:

- aerosol in-situ measurements (supported by CAIS-ECAC)
- aerosol remote sensing (supported by CARS)
- cloud in-situ measurements (supported by CIS)
- cloud remote sensing (supported by CCRES)
- reactive trace gases in-situ measurements (supported by CiGas)
- reactive trace gases remote sensing (supported by CREGARS)

Please note that these components are called “NF observation types” in the Technical and Scientific Description of ACTRIS, provided to EC in the ACTRIS ERIC Step 2 proposal.

National Facility (NF)

From ACTRIS ERIC Statutes: “National Facility” means an observational or exploratory platform which has a contractual relationship with the ACTRIS ERIC and which provides data and/or physical access to its premises.

*From ACTRIS glossar*y: “an observational or exploratory platform which has a contractual relationship with ACTRIS ERIC, and which provides data and/or physical/remote access to its premises. National Facilities are developed, managed, and operated by national Research Performing Organisations.”

In this document we propose that a National Facility may include more than one measurement site / platform if the platforms are close enough to represent the same location and if there are scientific reasons to treat them as one entity. The operation support provided to one facility of a given component would cover one set of instruments limited to the optimum requirements, but no duplicates unless specified otherwise.

National Facility candidate (NF candidate)

As a National Facility is defined partly by its contractual relationship with ACTRIS ERIC, a facility can only be defined as an NF at the end of the labelling process (Step 1c). It is, however, officially

recognized by ACTRIS ERIC and receives operation support by the Topical Centres and Data Centre during the entire labelling process.

Here we propose to call such a facility a National Facility candidate, starting from the point when it is proposed by the hosting country, and until it is either labelled as a National Facility, or is removed from the labelling process due to withdrawal during or after the defined 5-year maximum duration of the process.

Regional Partner Facility (RPF)

According to the ESFRI definition regional partner facilities are facilities outside the RI (ACTRIS ERIC), being of regional or national importance, providing services meeting RI-standards and being recognized by the RI.

Here we propose for reasons of clarity and simplicity that in ACTRIS Regional Partner Facilities would be facilities at a country *not being a member or permanent observer of ACTRIS ERIC*, but the facility filling or in the process to fill all other requirements of ACTRIS NFs (measured parameters, data provision, instrument QA/QC procedures, and RPO commitment for funding). This way the data from contributing facilities would be of the same quality as other ACTRIS data, and the facility could even be labelled, if we so decide. The facility would pay a pre-defined fee for the operations support. This could also be a way for getting new countries into ACTRIS ERIC if the fee is properly defined.

Contributing Facility (CoF)

The term “contributing facility” has been mentioned several times in the process of establishing ACTRIS but has never been properly defined. One option is to use the term for facilities in ACTRIS ERIC member countries, that are not yet ready to start the labelling process. In such case it needs to be defined how the facility would contribute and what services the facility would receive from ACTRIS, as the operation support starts from the initial acceptance in the labelling process. The term Contributing Facility also be left unused.

References:

GCOS IP plan: https://library.wmo.int/doc_num.php?explnum_id=11317, https://library.wmo.int/index.php?lvl=notice_display&id=22135

OSCAR-surface : https://space.oscar.wmo.int/applicationareas/view/monitoring_atmospheric_composition