WP6- NA6: WP "Integration, outreach, and sustainability"

Deliverable D6.10: Report on synergy effects in a European network integrating ACTRIS and national stations

Report on synergy effects in a European network integrating ACTRIS and national stations

The largest uncertainties in our current knowledge on climate change and the related impact on air quality are associated with the complex feedback mechanisms in the climate system like the amplification of the CO2-induced greenhouse effect by water vapour or the effects of aerosols on cloud formation and cloud properties. Furthermore, the global distribution of involved climate-active trace species is strongly influenced by anthropogenic emissions, by atmospheric long-range transport, and by subsequent feedback mechanisms like enhanced evaporation of water vapour in a warming climate, or by the impending release of methane from melting marine clathrates. Understanding the global distribution patterns and reducing the uncertainty of climate predictions crucially requires data from an integrated system of long-term observation infrastructures, both as boundary conditions and for the evaluation and improvement of model parameterizations. The pressing scientific issues require an integration of existing infrastructures to constrain feedback mechanisms by detailed trace gas and aerosol observations, and to evaluate products from global chemistry-climate models.

Research infrastructures and infrastructure initiatives have developed in-depth expertise on their different fields of research but an integration of research activities across the boundaries of applied scientific approaches is still missing. Particular topics for required coordination are joint scientific issues, co-location of sites and network density, instrument and system development, and data management and sharing.

Integration amongst research infrastructures and the need for cross-topic integration can be addressed at different levels: 1) the atmospheric component only and 2) the larger Environmental system. ACTRIS partners in WP6 have addressed both levels in their strategy in response to the increasing complexity of required research on climate change and air quality.

1) Towards a network of research infrastructures for atmospheric observations

The existing infrastructure for atmospheric observation in Europe is highly developed in the different atmospheric domains (boundary layer, troposphere, upper troposphere and lowermost stratosphere) and topics (changing atmospheric composition, air quality, carbon, nitrogen and water cycles, greenhouse gases), while an over-arching structure for higher-level integration is missing. The establishment of a network of European Infrastructures dedicated to observation of atmospheric composition with the long-term goal of implementing a European Integrated Atmospheric Observations component of GEOS must be initiated rapidly. It should combine at first existing European Research Infrastructures of the atmospheric domain IAGOS (In-service Aircraft for a Global Observing System) and ICOS (Integrated Carbon Observation System), the Integrated Infrastructures Initiative ACTRIS (Aerosols, Clouds, and Trace Gases Research Infrastructure Network), and the Integrating Activity InGOS (Integrated Non-CO2 Greenhouse Gas Observing System).

Without a clear top-down initiative, this absolutely requires continuation of the involved infrastructures (ESFRI) and infrastructure initiatives (I3) that can remain independent entities managing their own

scientific objectives, research plans and budgets. The first objective is to further develop their capabilities for addressing complex topics in atmospheric research and to foster integration of the existing European capabilities in long-term atmospheric observation into a future European observing system for atmospheric composition change and air quality survey.

Research infrastructures and I3s address routine atmospheric observations of greenhouse gases, reactive trace gases, volatile organic compounds (VOC), aerosols and clouds by in-situ networks (ACTRIS, ICOS, InGOS) including the use of tall towers and flux towers, by remote sensing networks (active and passive) for profiling (ACTRIS, InGOS), and by instruments operated on board of in-service aircraft (IAGOS). Ground-based networks operate more than 50 stations in the framework of ACTRIS, including in-situ aerosol, trace gases, lidar, and cloud-radar. Greenhouse gas monitoring infrastructures operate more than 100 stations for the observation of carbon-cycle components (ICOS) and non-CO2 greenhouse gases (InGOS). The airborne segment will consist of 10-20 aircraft equipped with autonomous instrumentation and one aircraft equipped with extensive scientific payload installed in a cargo container.

An over-arching project can initiate joint work amongst these infrastructures and infrastructure initiatives to favour the construction of a single integrated observing system providing high-quality data for ground level, vertical profile and column and upper troposphere/lowermost stratosphere (UTLS) levels. This would address the requirements for establishing the integrated system that will combine monitoring of key atmospheric regions like (i) the boundary layer (BL) which is impacted largest by anthropogenic activities and natural emissions from surface, (ii) the entire (or integrated) depth of the troposphere relevant for atmospheric transport, and (iii) the UTLS as the interface between troposphere and stratosphere which is highly sensitive to climate change.

Clearly, such coordination would foster links and engage in the proper level of coordination and joint conduction of scientific activities amongst research infrastructures related to atmospheric research and addressing topics on climate change and air quality. A number of issues regarding atmospheric research infrastructures require decisions more efficiently taken at a higher level of integration than at the single infrastructure. The network would at first integrate activities of independent entities (ACTRIS, IAGOS, ICOS, InGOS) on specific areas as monitoring atmospheric composition, investigation of 4D atmospheric processes like atmospheric long-range transport and transformation of gases and particles, joint development of instrumentation, joint definition of quality assurance and quality control, and coordinated modelling activities (taking advantage of the developments/validation studies performed in the frame of GMES, MACC, and MACC-II).

The proposed topic aims at filling this gap and at developing an observing system that is in the position of responding to the full complexity of atmospheric processes including their feedbacks, and climate change research. Benefits from this integration would be:

- Harmonized quality assurance for atmospheric observation data.
- Joint development of new instrumentation which may be applicable to all platforms used by the involved infrastructures.
- Creation of harmonized 4D dataset of atmospheric composition over Europe (IAGOS, ICOS, ACTRIS, InGOS) and on a global scale (only IAGOS) for long-term trends data analysis and model studies on climate change and air quality.
- Support to national and international research projects in the field of air quality and climate change, e.g. GEOSS, GAW and GCOS.
- Strengthen the EU leadership in this research area or at least a key role by providing long-term records of atmospheric composition over Europe and on global scale.

ACTRIS responded to the EU consultation to promote this strategy.

2) ACTRIS contribution to ENVRI

At the larger scale in the whole Environmental Science domain, ACTRIS has been active in the EU-FP-7 ENVRI project "Common Operations of Environmental Research infrastructures". The ENVRI project gathers six ESFRI environmental projects to develop, with the support from ICT experts, common data and software components and services for their facilities. The ENVRI project aims to minimize the heterogeneity among environmental data infrastructures to offer common best practices and to provide technical tools to help ESFRI RIs to better fulfil their scientific remit. ACTRIS WP6 representatives have participated in the EU-FP-7.ENVRI "project meetings: H. Lappalainen (Univ.Helsinki), ENVRI meeting in Rome, Nov 2012 and P. Laj (CNRS), ENVRI meetings in Vienna Apr 2012 and Edinburg Sep 2102. The ACTRIS co-cordinator (Dr. Paolo Laj) is currently holding a position in a ESFRI Stakeholder Advisory Board member and has participated as an observer in the ENVRI meetings.

The ENVRI meeting, 23-13 November 2011, in Rome, was the kick off meeting for organization the work.

In the ENVRI meeting, 11-13 April 2012, in Vienna, it was discussed about:

- Training on Open Distributed Process (ODP); Understanding ESFRI ENV common problems (EISCAT-3D, EMSO, EPOS, Euro-Argo, LifeWatch); OpenSearch for data discovery; Ecosystem approach to virtualization ; EUDAT Data infrastructures project; Linked Open Data and data integration (Marx, UvA)

In the ENVRI meeting, 11-13 September 2012, in Edinburgh, it was discussed about:

- Achieving preliminary agreements on common requirements of the RIs, gaining a clearer picture of the overall ODP model (particularly its Enterprise, Information, and Computational viewpoints) and evaluating the overall model against at least one real RI model (ICOS)
- Gaining a clearer picture of data holdings and processing needs of the different RIs
- Achieving preliminary agreements on the tools to be developed in the context of the Icelandic Volcano use case
- Analysis of common requirements: look at overall functions according to proposed categories: data acquisition, data hosting, data integration, data aggregation, data presentation, embedded computation, supporting user investigations.
- Try to find high level roles and behaviours common to several RIs.
- For each Research Infra identify:
  - available data holdings, and catalogue services
  - metadata needed for data discovery
  - processing needs
- Overall ODP framework – Examine ICOS model
- Identify data needed in the context of the Icelandic Volcano use case
- Reviewing interaction with ESFRIs, what is needed from Coordination, Management, Liaison and Dissemination/Training: how to plan next steps?
- Data integration and Linked Data - initial ideas and progress
- Identify scientific SW tools/algorithms needed in the context of the Icelandic Volcano use case