Deliverable D4.2: Progress report on the use of ACTRIS facilities and calibration centres for testing novel instruments.

Sabine Philippin, Mylène Ndisi (CNRS)

Work package no	**WP4**
Deliverable no.	**D4.2**
Lead beneficiary	
Deliverable type	☑ R (Document, report) ☐ DEC (Websites, patent fillings, videos, etc.) ☐ OTHER: please specify**.....**
Dissemination level	☑ PU (public) ☐ CO (confidential, only for members of the Consortium, incl Commission)
Estimated delivery date	**Month 22**
Actual delivery date	**02/05/2017**
Version	**1**
Comments	

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

1. Introduction

The objective of this document is to report on the use of ACTRIS facilities and calibration centres for testing novel instruments. These ACTRIS facilities are an opportunity for access especially to SMEs and science-based companies to test and develop new innovative products that are relevant to ACTRIS observations and to promote sharing knowledge and collaboration with the private sector.

2. Opportunities of access to ACTRIS-2 facilities for instrument calibration, testing, and development

For SMEs and industrial companies, innovation and development of innovation capabilities through technology transfer and knowledge-sharing activities depends on dedicated facilities for testing, quality assurance, and calibration. Such centres are often very costly. Within ACTRIS-2, a number of dedicated calibration centres and observational facilities are accessible free-of-charge to different kind of users beyond the academic communities such as the private sector, particularly SMEs, and operational networks. The ACTRIS-2 offers access to the following platforms:

- **Lidar Calibration Centre (LiCal)** for testing, calibration, and maintenance, and optimization of lidars and ceilometers (operated by partners CNR, INOE, LMU);
- **AERONET-Europe calibration facility** with outdoor/indoor platforms for sun/moon/sky photometer calibration of AERONET-Cimel photometers (CNRS, Lille1, UVA, AEMET);
- **European Centre of Aerosol Calibration (ECAC)** for calibration, QA, capacity building related to high-quality measurements of physical, optical, and chemical in-situ aerosol parameters (TROPOS, CNRS, JRC);
- **18 advanced observational stations** at different geographical locations and altitudes in Europe equipped with state-of-the-art instrumentation for measurements of aerosols, trace gases, and aerosol-cloud interaction, for instrument testing and inter-comparisons under real conditions (CNR, CNRS, UHEL, FMI, PSI, KNMI, TROPOS, NOA, CHMI, AEMET, UGR, CSIC, ULUND, CYI, NUIG).

ACTRIS has a history of joint collaborations with the private sector for calibrating commercial instruments, testing new instrumentation, and developing novel methods and equipment, as it provides a platform for exchange between those marketing the products and software related to ACTRIS and its leading experts. The most relevant activities are summarized below.

3. Use of ACTRIS-2 facilities by SMEs

Since the beginning of the project, various SMEs have used ACTRIS-2 facilities for calibration of commercial instruments, testing/calibration of new instruments, and instrument development (including performance testing, software updates, hardware improvement).

The most relevant results related to ACTRIS-2 partnerships with SMEs are listed below.

Use of Lidar Calibration Centre (LiCal) by SMEs

- Sigma Space Corporation (USA)

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

Sigma Space Corp. an aerospace engineering company that participated in an intercomparison campaign (InterACT II, July 2016) held at the LICAL facility in Potenza to study the performances of the SIGMA micro-pulse mini lidar system (MiniMPL) under different atmospheric conditions. The commercial MiniMPL is a small, compact device, which has been launched by the SME in 2010 and is intended for field deployment (e.g., Atmospheric Boundary Layer measurements up to 10 km). The intercomparison took place in a period characterized by Saharan outbreaks over the Mediterranean basin, complemented by the fire season in surrounding areas, in East Europe and North America, thus allowing to observe different sources of aerosol affecting the site. The intercomparison allowed the characterization of its system performance through quantitative assessment with the reference MUSA advanced research lidar system to evaluate its stability, sensitivity, uncertainties, and accuracy of products, including active collaboration and exchange of expertise between LICAL and the users. As Sigma micro-pulse Lidars have been used by the NASA global aerosol network "MPLNET" and for the DOE Atmospheric Radiation Measurement (ARM) program, the development of a reliable and cost-effective lidar system is under demand and expected to be deployed by the aerosol monitoring community.

- Campbell Scientific Ltd. (UK / France)

Campbell Scientific is an international group of companies with offices worldwide for scientific instrumentation and solutions, in particularly optical sensors for cloud height, visibility and present weather. Campbell participated in the intercomparison campaign InterACT II with its CS135 ceilometer in order to assess in details the aerosol sensitivity and boundary layer aerosol profiling capability of the instrument. The CS135 measures cloud height and vertical visibility for meteorological and aviation applications using lidar technology. It is a low-cost instrument that transmits fast, low-power laser pulses into the atmosphere and detects back-scattered returns from clouds and aerosols above the instrument. The intercomparison with a higher specification reference instrument such as the MUSA fixed lidar system is required to assess in great detail the sensitivity and stability of the ceilometer. Such detailed performance analysis and evaluation will allow deploying such instruments in aerosol networks.

- Lufft Mess- und Regeltechnik GmbH (Germany)

The Ceilometer CHM 15k "NIMBUS" is a cloud height sensor / lidar based ceilometer that was involved in the InterACT-II campaign. It is a simple, one-wavelength backscatter lidar to detect multiple cloud layers, cirrus clouds, and aerosol layers.

- VAISALA (Finland)

Two ceilometers have been deployed by VAISALA during the InterACT-II campaign: the VAISALA CL51 and an older VAISALA CT25K (latter no longer commercially available, replaced by CL31). These ceilometers are designed to measure high cirrus clouds and report backscatter profiling over full measurement range up to 15 km.

The above manufacturers have provided their support in the evaluation of the data resulting from the InterACT-II campaign.

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

Use of the AERONET-Europe calibration facility by SMEs

- CIMEL Electronique S.A.S (France)

CIMEL is a manufacturer automatic meteorological instrumentation with expertise in the field of meteorology, atmosphere optics, design of integrated systems, software solution development and production control. For over 25 years, CIMEL has developed specific instruments for atmospheric monitoring that are deployed by leading scientific organisations in the world. In particular, the CIMEL CE318 is a multiband photometer that is today the worldwide reference instrument for all aerosol observing networks, which is, deployed at most ACTRIS-2 remote sensing stations for AOD measurements, which required calibration by AERONET-Europe. Since recently, CIMEL sells the CIMEL CE318T, a new combined sun/sky/lunar-photometer having both sun and lunar capabilities. CE318T is the only commercially available photometer to perform moon measurements and to provide AOD also at nighttime. In collaboration with CIMEL, AERONET-Europe has developed a new retrieval software for the CE318T. All CIMEL instruments provide high quality measurements with field-proven reliability and very low maintenance requirements (CIMEL provides direct support for installation, training and maintenance for its instruments).

Figure 1. Calibration of Calitoo Instruments (TENUM) at AERONET-Europe (Izana, Spain)

During ACTRIS-2, the manufacturer CIMEL has requested access to use AERONET-EUROPE for calibration of 13 of its instruments (of which 10 were used to test the new CE318T). A number of ACTRIS-2 stations are deploying the new CIMEL318T and require calibration services by AERONET-EUROPE: Leipzig, Munich (Germany), Potenza, Napoli, Lecce (Italy), Magurele (Romania), Granada (Spain), Lille (France). Furthermore, the calibration of this instrument at AERONET-EUROPE has been required for various (ACTRIS and non-ACTRIS) field campaigns: (i) SLOPE (Sierra Nevada Lidar AerOsol Profiling Experiment) campaign in Granada, Spain; (ii) INTERACT II field campaign (Intercomparison of aerosol and Cloud Tracking), Italy, at CIAO, the CNR-IMAA Atmospheric Observatory for the study of the atmosphere through the use and integration of active and passive remote sensing techniques; (iii) calibration and loan of instruments for an Aerosol Absorption Campaign in Athens, Greece; (iv) calibration of a lunar

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

photometer for the SHADOW (Study of SaHAran Dust Over West Africa) campaign in Senegal. AERONET-Europe also provides training on the basics of the instrument, common problems and solutions, quality assurance tests (theory, tools, hands-on, analysis), and good practices in operation and maintenance.

- TENUM (France)

TENUM is a design office specialized for more than 20 years in telemetry and digital systems collaborating with, e.g., CNES, Airbus, DGAC, Eurocopter, ALCATEL, NASA. TENUM has developed "Calitoo", a series of small, hand-held and low-cost photometers. TENUM has used AERONET-EUROPE during five accesses for absolute calibration of Calitoo and intercalibration with the CIMEL photometer (see Figure 1). In mid-2016, close to 200 Calitoo handheld sun photometers have been manufactured by TENUM, sold and distributed in and outside Europe, and designed for teaching and for small budget research projects.

Use of the European Centre of Aerosol Calibration (ECAC) by SMEs

- TSI Inc. (US/Germany)

TSI Inc. is a company specialized in the design and production of precision measurement instruments for aerosol science, airflow, chemical analysis, indoor air quality, fluid dynamics, biohazard detection, and even scrap metal sorting and plastics identification. TSI collaborates with most ACTRIS-2 partners that widely use the TSI aerosol particle counters and sizers. During ACTRIS-2, TSI has been closely cooperating with the World Calibration Centre for Aerosol Physics (ECAC-WCCAP) at TROPOS: to calibrate a number of various TSI CPCs and particularly to verify, test, and calibrate their new ultrafine Condensation Particle Counter 3772-CEN. This newly developed instrument is compliant with the proposed Technical Specification CEN/TS 16976, drafted by the European Committee for Standardization, for harmonization of measurement and sampling of ultrafine particles. The testing and development of TSI technology at ECAC ensures reliable data in thousands of installed units around the world.

- Aerosol d.o.o (Slovenia)

Aerosol d.o.o is a SME that develops and manufactures Aethalometer® instruments that are used in air monitoring network stations for sampling and measurement of the mass concentration of black carbon particles. Aethalometers are widely used within ACTRIS-2 and Aerosol d.o.o. have closely been interacting with ECAC-WCCAP during the intercomparison workshops for scientific development work.

- Brechtel (USA)

Brechtel develops and manufacturers aerosol devices for sampling, particle counting and sizing, and absorption measurements and its products are widely deployed with ACTRIS-2. ECAC-WCCAP closely interacts with Brechtel for scientific development work on multi-wavelength absorption photometers.

- Aerodyne Research Inc. (USA)

Aerodyne Research Inc. is an instrument manufacturer that provides instrumentation and consulting for environmental air quality monitoring and measurements. The Aerodyne Aerosol Mass Spectrometer (AMS) has been deployed worldwide at fixed sites, and on mobile laboratory, ship and aircraft platforms to obtain quantitative size and chemical mass loading information in real-time for non-refractory sub-micron aerosol particles. The AMS couples size-resolved particle

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

sampling and mass spectrometric techniques into a single real-time measurement system. The more recent Aerodyne Aerosol Chemical Speciation Monitor (ACSM) is smaller, lower cost and more robust than the AMS and measures particle mass loading and chemical composition in real-time for non-refractory sub-micron aerosol particles. Although the ACSM is designed for long-term unattended deployment and routine monitoring applications, it regularly requires calibration. The ECAC-ACMCC is worldwide the only facility providing on-site calibration and intercomparison workshops with reference instruments and manufacturer support. Within ACTRIS-2, a first intercomparison has been organized by ECAC in spring 2016 in which Aerodyne participated to intercompare ACSM instruments used within the scientific community and to test/develop new inorganic calibration procedures for ACSM (Aerosol Chemical Speciation Monitor) and TOF (Time-of-Flight)-ACSM (figure 2). Three times more users of ACSM instruments have demanded access to the calibration facility than initially planned for calibration of their devices intended.

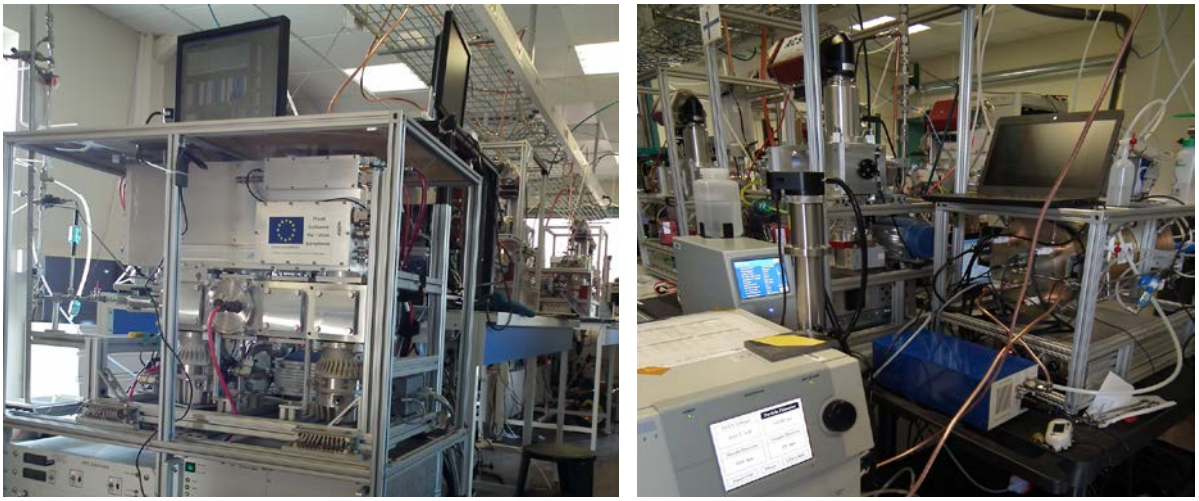

Figure 2. Aerodyne instruments during first ECAC-ACMCC intercomparison campaign (2016).

- TOFWERK AG (Switzerland)

TOFWERK is a provider of Time-Of-Flight Technology and offers custom instrumentation for research laboratories and high performance end-user instruments. TOFWERK has been involved ACTRIS ACSM intercomparison workshops to improve their ToF-ACSM through use of mass analyser with greater sensitivity and resolution, hardware development for measurement of atmospheric metals and black carbon, and software development for automated data reduction.

- ADDAIR (France)

ADDAIR is a distributor of high-quality monitoring for air quality and aerosol metrology (e.g., PALAS, Aerodyne). ADDAIR has participated in the inter-laboratory comparison workshops organized by ECAC-ACMCC for improvement and development of inorganic calibration methods for ACSM instruments.

Use of the advanced observational stations

- Sunset Laboratory Inc. (The Netherlands) @ CSIC Montseny (MSY, Spain)

Sunset Laboratory Inc. is a company specialized for manufacturing devices for organic carbon and elemental carbon (OC-EC) aerosol analysis and in the field of aviation, mining, marine, astronomy,

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

construction, and weather research. Their equipment is suitable for the laboratory or in the field, and ready for use with different methods, among others the EUSAAR2 protocol developed within the ACTRIS-1 predecessor EU project. Sunset Laboratory has developed the Sunset Semi-Continuous Field OCEC analyzer. To evaluate its performance with the EUSAAR2 protocol, Sunset Laboratory has used the ACTRIS-2 site MSY during a TNA project "SLOPE". The EUSAAR2 is a required protocols for the networks of all EU member states to measure EC and OC in particulate matter at background sites according to the Council Directive 2008/50/EC on ambient air quality and cleaner air for Europe. The European Committee of Standardization (CEN), has recently adopted EUSAAR2 as the reference temperature protocol to be used when performing the offline, thermal-optical/transmittance (TOT) Organic and Elemental Carbon analysis (OCEC) (CEN/TC 264/WG 35 prEN16909:2016). Sunset investigates the comparison of the online OCEC analysis method with the offline, reference method at a challenging rural environment, dominated by biogenic emissions, for their comparability and to evaluate the high-time resolution concentrations.

- Palas GmbH (Germany) @ Puy de Dome high altitude station (PUY, France)

Palas is a company specialized in particle measurement technology and the development and production of filter test systems and optical aerosol spectrometers. In October 2016, Palas participated in an intercomparison field campaign of cloud microphysical probes with two of its Fidas® 200 S instruments. Fidas® 200 S is a fine dust monitoring and ambient air measurement system for ambient air monitoring of fine dust for regulatory purposes. Goal of this campaign is to evaluate a new automatic instrumentation for clouds droplet real time analysis. The new Fidas® 200 analyzer supplies a particle size distribution (mass and/or number) between 0,4 and 40 µm, The aim is to study the interaction between droplets size and condensation nucleus with two analysers, installed side by side. One is configured to measure droplets size, the other to dry droplets and to evaluate condensation nucleus size. If successful, the low-cost and low-maintenance instrument could be an efficient solution for long-term measurement of cloud droplets at ACTRIS stations.

- Envicontrol SA (Belgium) @ CNR IMAA Atmospheric Observatory (CIAO, Italy)

Envicontrol is specialized in measuring equipment for gases, air and dust (sampling, analysis, calibration and generating of gases), as well as in acquisition and management systems for monitoring and warning networks. The SME has exclusive dealership for about 15 manufacturers in Benelux, France, and Africa. Envicontrol has participated in the measurement campaign INTERACT-II (INTERcomparison of Aerosol and Cloud Tracking) where a number of commercial instruments were involved: two multi-wavelength Raman lidars, a Raymetrics UV scanning Raman lidar, a VAISALA CT25K ceilometer, a VAISALA CL51 ceilometer, a JENOPTIK CHM15k ceilometer, a Campbell CS135s ceilometer, and a Sigma Space mini-Micro Pulse Lidar. Envicontrol has been in charge of operating the mini-MPL system to study the system performance for the measurements of aerosols and clouds, instrument stability, and accuracy of calibration. Envicontrol furthermore received training for advanced Raman lidar operation and use of calibration procedure for the lidar depolarization technique.

- CIMEL Electronique S.A.S (France) @ CNR IMAA Atmospheric Observatory (CIAO, Italy)

CIMEL is a manufacturer automatic meteorological instrumentation with expertise in the field of meteorology, atmosphere optics, design of integrated systems, software solution development and production control. For over 25 years, CIMEL has developed specific instruments for atmospheric monitoring that are deployed by leading scientific organisations in the world. CIMEL has

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

developed remote sensing instruments CE318 photometer and the CE370 Micro-Lidar. CIMEL has participated in the INTERACT II (Intercomparison of aerosol and Cloud Tracking) measurement campaign to study the atmosphere through the use and integration of its different active and passive remote sensing techniques in order to evaluate the potential use of such automated instrumentation for monitoring of aerosols produced by different source (both natural and anthropic, such as desert dust, typically observed in the Mediterranean area during the summer, fires present in Eastern Europe and North America). CIMEL has been in charge of operating the automated CE370/CE376 Lidar, of data acquisition and analysis of data measured in combination with a CE318-T photometer, and the comparative analysis with CIMEL iAAMS software. CIMEL further has been supportive for CIMEL Lidar performance for aerosol and cloud measurements, and to evaluate the stability, sensitivity, and uncertainties of automated lidars and ceilometers in terms of instrumental sensitivity and uncertainties, and to put these into context by simultaneously evaluating the performance of a high specification research lidar. This is a first-time intercomparison of commercial ceilometers, lidars, with advanced research systems available by ACTRIS-2.

- Aerodyne Research Inc. (USA) @ Monte Cimone/Po Valley facility (CMN, Italy)

Aerodyne Research Inc. is an instrument manufacturer that provides instrumentation and consulting for environmental air quality monitoring and measurements. The Aerodyne Center for Sensor Systems and Technology (CSST) designs and develops innovative sensors utilizing proprietary technology for its own use and for delivery to private, academic and government customers. It has built and marketed state-of-the-art monitors that employ cavity attenuated phase shift (CAPS) techniques. One of such CAPS monitors is the CAPS SSA, a single scattering albedo monitor for direct, combined measurements of both extinction and scattering in the same volume. Particle absorption can be obtained by subtraction of the two measured quantities (extinction minus scattering), with an uncertainty of 5-6%. Upcoming in July 2017, Aerodyne participates in an international field campaign at the Monte Cimone and Po Valley sites to assess the accuracy of aerosol absorption and black carbon measurements. The CAPS SSA is collocated with other instrumentation for aerosol measurements of optical, physical, and chemical properties: a nephelometer, an Aerosol Chemical Speciation Monitor, an optical particle counter. The presence of multiple techniques for measuring aerosol absorption (by difference with the CAPS SSA and on a filter) will allow measurement intercomparison and observe the changes in optical properties with changes in the chemical composition of the sub-micron aerosol as determined by the ACSM. In particular, the specific goal of the campaign is a comprehensive closure between absorption coefficient and BC concentration and an assessment of the reasons for the variability of the mass absorption efficiency using commercial instrumentation.

Other ACTRIS-2 partnerships with SMEs

ACTRIS-2 has active cooperation with other SMEs for testing of new instrumentation is in progress, for example with HALO Photonics, a manufacturer of Lidar based remote sensing instruments (UK) regarding the improvement of the Doppler lidar retrievals; with the Lidar company Raymetrics (Greece) for developing new lidar technical solutions in particular regarding the aerosol lidar polarization calibration; and with the manufacturer of high quality in-situ sensors and remote sensing profilers METEK for testing new polarimetric cloud radar systems. Overall, ACTRIS-2 actively collaborates with more than 40 SMEs for technological developments, continuous cooperation and exchange for hardware improvements and software updates and developments, and supply of instrumentation and components. A summary of collaborating SME partners is given in table 1.

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

Table 1. List of SME partners collaborating with ACTRIS-2

Organisation	**Country**
Abacus Laser	Germany
ADDAIR	France
Aerodyne Research, Inc.	USA
Aerosol Consulting ML SarL	Switzerland
Aerosol d.o.o	Slovenia
Airmodus Oy	Finland
Air Quality Design	USA
Brechtel	USA
Campbell Scientific Ltd.	UK, France
CIMEL Electronique	France
CNC Solutions	Greece
Cooper Environmental	USA
Dekati Oy Finland	Finland
Droplet Measuring Technologies	USA
Ecophysics: CLD	Germany
Ecotech Pty Ltd	Australia
EnviMeS: ICAD	Germany
Environnement S.A	France
GRASP-SAS	France
Halo Phototonics	UK
LEOSPHERE	France
Los Gatos: CAPS, CEAS	USA
Lufft GmbH	Germany
METEK GmhH	Germany
Meteomodem	France
Metrohm Applikon	The Netherlands
ML SaRL	France
Nicarnica Aviation	Norway
Palas GmbH	Germany
Perkin Elmer	USA
Raymetrics S.A.	Greece
Ricardo-AEA Ltd.	UK
RPG Radiometer Physics GmbH	Germany
Sigma Space Cooperation	USA
Teledyne Api CLD	USA
Tenum	France
Tera Environnement France Consultancy services	France

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

Thermo Electronics: Thermo Fisher CLD	USA
TOFWERK AG	Switzerland
TSI GmbH / TSI Inc.	Germany / USA

Conclusion

To date, 15 SMEs have used the ACTRIS facilities and calibration centres for testing, developing, calibrating, and intercomparison of commercial and new innovative products that are relevant to ACTRIS observations. Sigma Space and Campbell Scientific have participated with commercial automated remote sensing instrumentation at intercomparisons organized by LiCal to assess their performance for tropospheric profiling of aerosols and clouds in different environmental conditions. Both instruments are able to provide an extended spatial and temporal coverage for long-term observations in scientific and operational networks. The direct comparison with the reference lidar has been essential to assess in great detail the sensitivity and stability of these commercial instruments that are expected to be widely deployed by the aerosol measurement networks. The photometer manufacturer CIMEL regularly uses AERONET-Europe for calibration of its photometer, the world-wide reference instrument used in aerosol monitoring networks, and particularly for testing of the new CE318-T Sun Sky Lunar photometer available since very recently and increasingly deployed in atmospheric. AERONET-Europe has calibrated the small, low-cost photometer produced by TENUM, which is now widely marketed. ECAC has regularly been collaborating with several manufacturers and distributors of physical, chemical, and optical aerosol instruments that have participated during ACTRIS-2 in the calibrations and intercomparison workshops: for the improvement and S&T development of inorganic calibration methods for ACMS and ToF-ACSM (Aerodyne Research Inc., ADDAIR, TOFWERK AG), and testing and development of innovative aerosol particle counters and sizers and multi-wavelength absorption photometers (TSI Inc., Aerosol d.o.o, Brechtel). Five SMEs have used the ACTRIS-2 observational facilities to test and intercompare their commercial and new instrumentation in the field: an evaluation of the newly developed the Sunset Laboratory Semi-Continuous Field carbon analyzer with the EUSAAR2 protocol at a rural site in Spain; evaluation and testing of the Palas GmbH automatic instrumentation for clouds droplet real time analysis; an intercomparison of active and passive remote sensing commercial instrumentation including three commercial ceilometers (VAISALA, JENOPTIC, Campbell) and two commercial lidars (Sigma Space, CIMEL) with two advanced research systems from ACTRIS-2; and an upcoming intercomparison of an Aerodyne CAPS SSA with other physical and optical measurements of aerosol absorption and black carbon measurements to the accuracy of the commercial instrument and variability during field deployment at the Monte Cimone and Po Valley sites in Italy.

Furthermore, active cooperation with other SMEs for testing of new instrumentation is in progress (HALO Photonics, Raymetrics, METEK), and overall, ACTRIS-2 has active partnership with a large number of private sector partners for standardisation and deployment of long-term monitoring equipment for atmospheric observations in the field of aerosols, clouds, and trace gases.

In conclusion, the opportunities offered by ACTRIS-2 through its physical and remote access programme to ACTRIS-2 facilities are crucial to interaction with SMEs, allowing the participation of users from the industry and private sector for innovative research, new technological

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

knowledge, instrument testing and development. Although the use of ACTRIS-2 facilities by SME users is smaller than by public and academic users (up to 10% are used by SMEs), substantial efforts is devoted towards innovation and transfer of knowledge to SMEs, based on a long history of joint technological developments, continuous cooperation and exchange for hardware improvements and software updates and developments. The standardisation and establishment of reference standards is a key to promote the user of ACTRIS facilities by SMEs. The manufacturers suppliers of remote sensing and near-surface measurement equipment are actively involved within ACTRIS-2 to develop new algorithms and products as well as calibration standards. ACTRIS-2 offers the best facilities and expertise for supporting SMEs in the field in Europe.

ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 – Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109