HARMONIA CA21119

Virtual Mobility Grant

Extended final report

Graphic analysis of aerosol field campaigns, long-term measurements and permanent observatories

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1. Introduction

In the framework of the HARMONIA COST Action, Virtual Mobility (VM) allows the establishment and growth of international collaborations, carrying out coordinated studies and facilitating the exchange of information, allowing the objectives of the COST Action to be achieved quickly and efficiently.

The main objective of this VM is the graphical analysis of the information, collected during the first year of HARMONIA, about permanent stations, long-term measurements and field campaigns conducted in recent years with the involvement of at least a photometer (sun, lunar or stellar) or a skycamera co-located. Data obtained during the first year of activity of HARMONIA were analysed cataloguing and graphically summarizing the information available.

The activities carried out in this VM were performed under the supervision and coordination of Dr. Monica Campanelli (Italian National Research Council at Rome) and Dr. Victor Estelles (University of Valencia), co-leaders of HARMONIA WG2. The results were integrated in the report of the HARMONIA Deliverable D2.1 "Report on synergistic approaches towards better quality products".

The activities, discussed in what follows, were:

1) creation of a Google Earth project for quick visualization of the locations involved in permanent observatories, long-term measurements and field campaigns;

2) graphic summary of the instruments co-located in permanent stations in which HARMONIA WG1 and WG2 members attended or had contact for data access. For each of the 42 stations identified, the presence/absence of the following instruments was classified and graphed: CIMEL solar/lunar, PREDE solar/lunar, PFR, Stellar photometer, All-sky camera, LIDAR, Ceilometer, Pandora, BREWER or other instrument for O3, Spectral radiometer (direct/global), Pyranometer/pyrheoliometer, Low cost;

3) graphic summary of the temporal coverage of the long-term measurements and field campaigns, according to the survey conducted during the first year of HARMONIA. 13 long-term measurements (from 1994 to today) and 24 field-

campaigns (from 2014 to today) were identified. The graphs also show the duration of each event and whether the measured data is/is not published;

4) graphic summary of the instruments involved in the field campaigns and long-term measurements identified. For the sake of brevity, for each event the instruments/products was as follows: PREDE - AOD, PREDE - Aer_prod, PFR - AOD, CIMEL were AOD, CIMEL - Aer_prod, Middleton - AOD, MFRSR - AOD, Stellar - AOD, Allsky camera - AOD, Microtops - AOD, SP1A - AOD, LIDAR/Ceilometer/CLIDAR - LIDAR_prod, Wind LIDAR - Wind_prof, MWR - Moist_prof, Radiosoundings - Profiles, UAV - Aer_car, Aircrafts - Wind_prof/Aer_prod, In-situ - Aer_car, In-situ - Meteo, BREWER - AOD, BREWER - Gas, Spectrometers - Gas, Pyranometer/Pyrheliometer - Irradiance. The data was classified according to day/night/continuous measures and processed/not processed products.

2. Current status of aerosol observations

2.1 Campaigns and long-term measurements

To draw a picture of the status, the following information was asked:

Name
Campaign/Long-term
Purpose
Start and end period
Location
Instruments involved
Range of wavelengths
Day/Night/Continuous
How are instruments calibrated?
Where raw data are available?
Are data processed/analysed?
Where processed data are available?
List of processed products
List of products to be processed
Are data cloud-screened? (if necessary)
Are results published? Where?
Ancillary measurements (use of laboratory and/or models analysis)

Contacts

24 field campaigns were recorded in the census, ranging from 2014 up to September 2023, but many others are supposed to be collected during the next years of HARMONIA. Most of the campaigns have been performed in the European continent, 1 in South America and 3 in Africa (Figure 2.1). The duration (Figure 2.2) varies from 9 to 35 days, but longer campaigns as QUATRAM 2 and 3 (87 and 152 days, respectively), Montevideo 2 (67 days), Biosure (503 days) and Cycare (521 days) were listed. An increase in the numbers of field campaigns can be observed from 2021. The instruments involved (shown in Figure 2.3) can be grouped in: i) photometers or similar (PREDE, PFR, CIMEL, MIDDLETON, MFRSR, STELLAR, Sky CAMERAS, MICROTOPS, SP1) providing AOD and other aerosol properties as SSA, refractive index and size distribution; ii) lidars or similar (LIDAR, CELIOMETER, CLIDAR) providing aerosol vertical profiles; iii) wind, moisture and temperature profilers (WIND LIDAR, MWR, Radiosounding); iv) on board measurements (unmanned aerial vehicle/UAV, AIRCRAFTS); v) in situ measurements (aerosol samplers, and meteo stations); vi) spectrometers (BREWERS, other spectrometers as Pandora, and PSR) proving gas concentrations and AOD, vii) radiation meters (PYRANOMETERS, PYRHELIOMETERS). The most commonly deployed photometer is the CIMEL, as expected since they are part of the AERONET network. In many campaigns lidars are co-located and, in a smaller amount, also microwave radiometers. 13 long-term measurements sites were recorded, some of them became long-term by taking advantage of the instruments previously involved in field campaigns. The start date for each site is shown in Figure 2.4. In comparison to the campaigns list, the involved equipment (Figure 2.5) includes more observations from Sky cameras, Microptops, AOD from Brewer (which is the longest series), in situ aerosol sampling and meteorological observations.

Figure 2.1: Deployment of the campaigns (yellow markers) and long-term measurements (red markers). The yellow line in the upper panel refers to a shipboard campaign from Vigo (Spain) to Abu Dhabi (UAE).

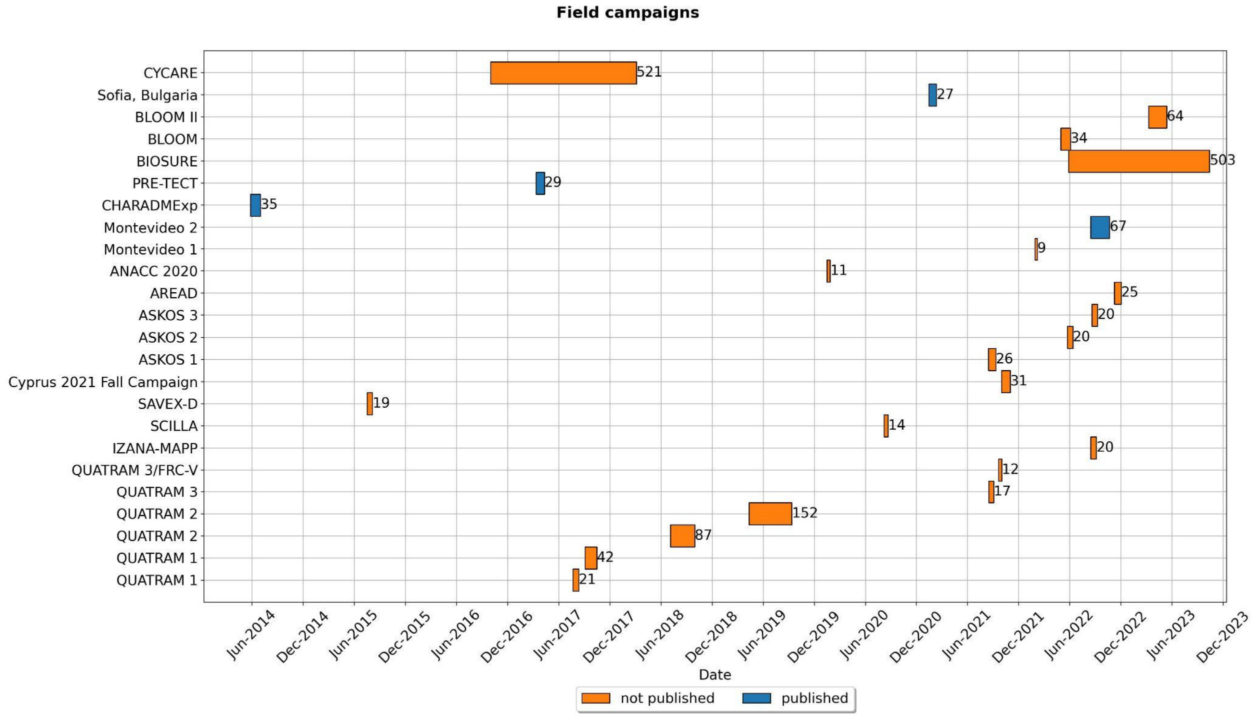

Figure 2.2: Temporal duration of the campaigns. The numbers indicate their duration (days), the colours refer to published and unpublished results, as detailed in the legend.

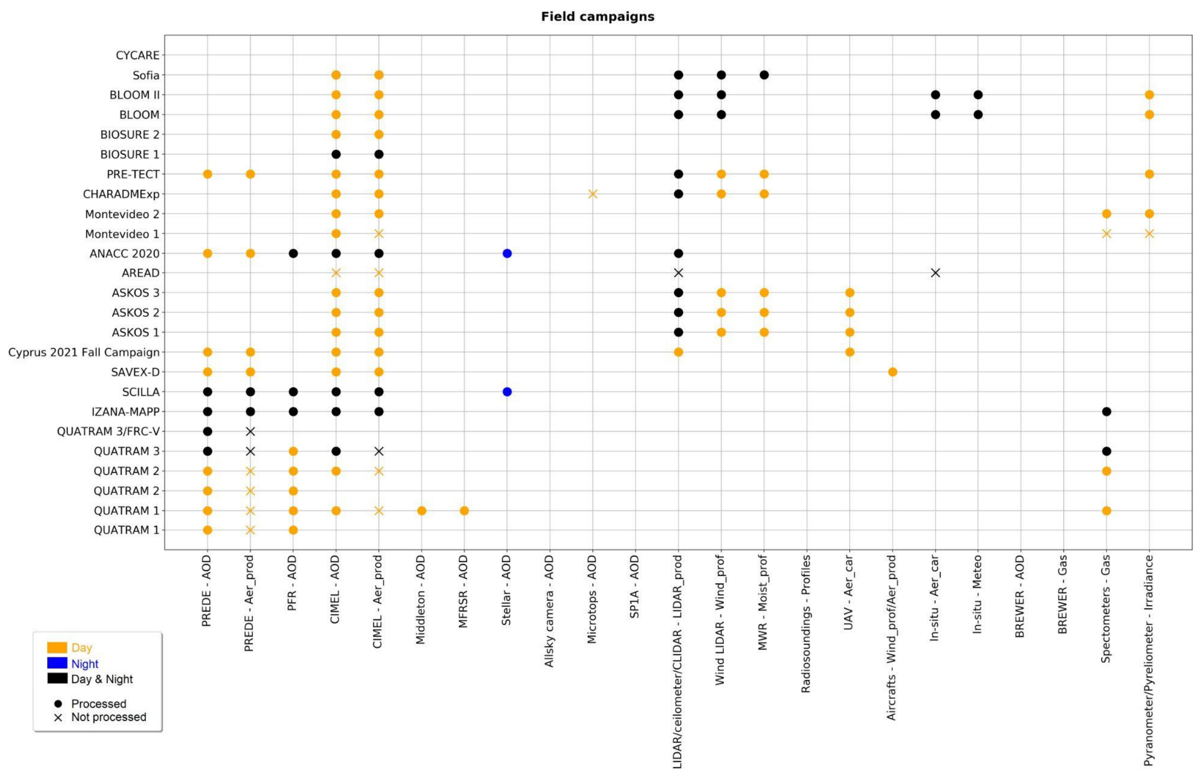

Figure 2.3: Instruments involved in each field campaign.

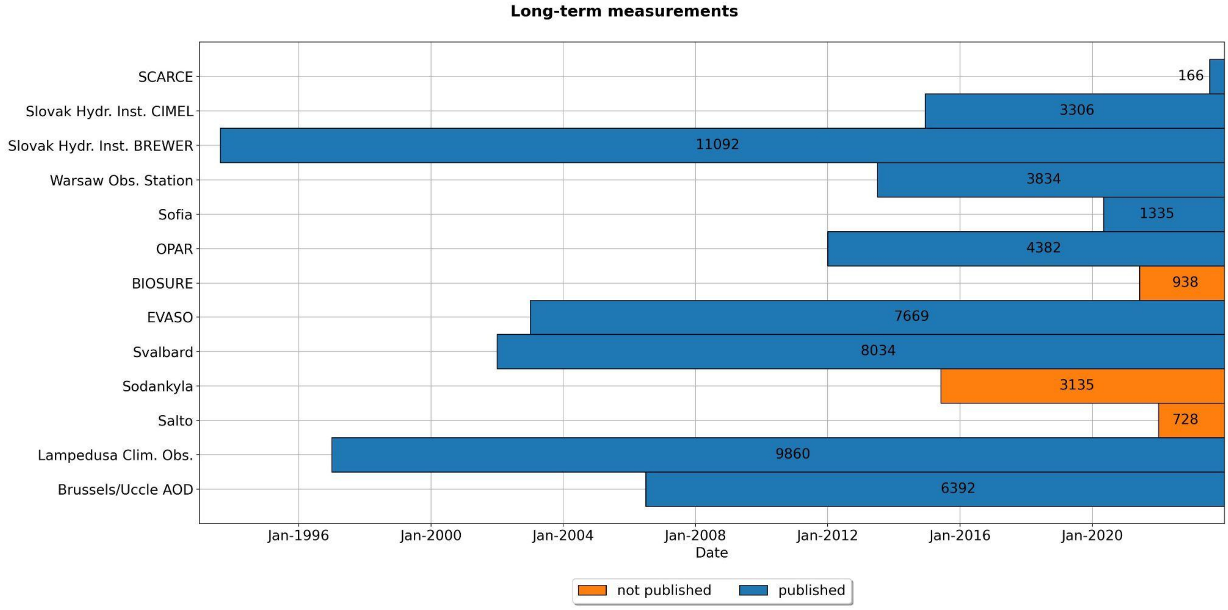

Figure 2.4: Temporal duration of the long-term measurements. The numbers indicate their duration (days), the colours refer to published and unpublished results, as described in the legend.

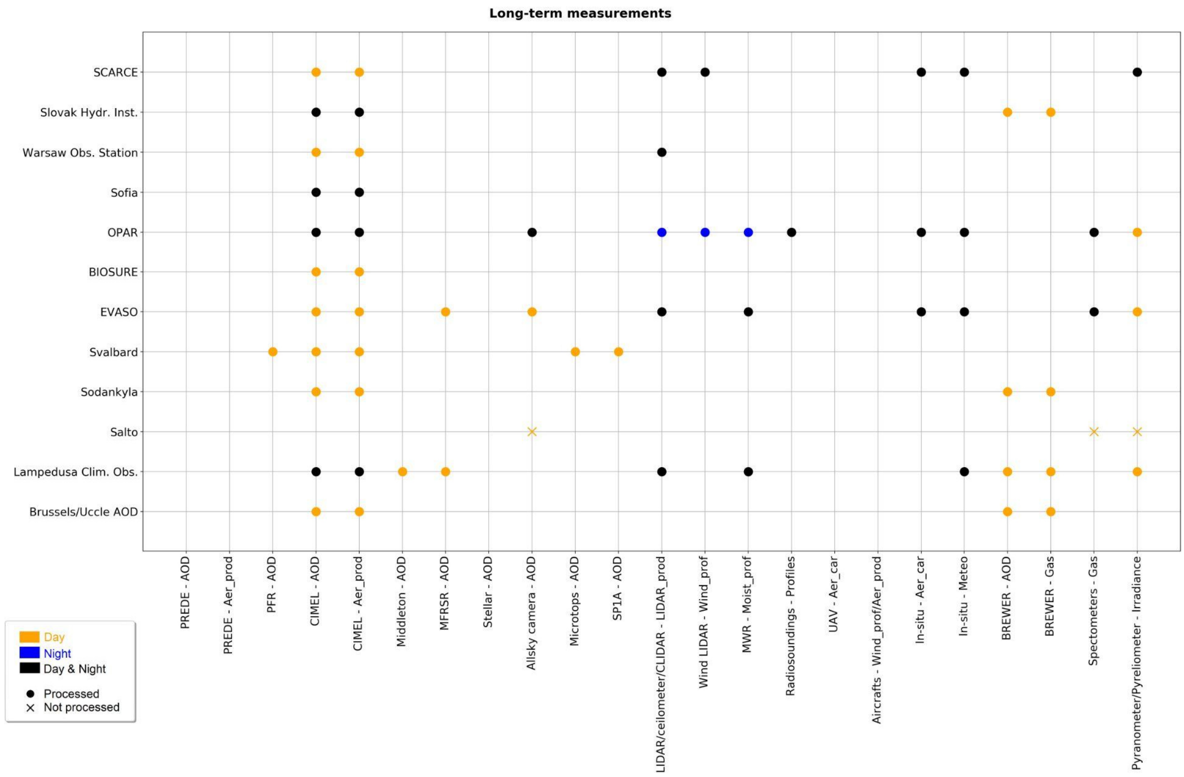

Figure 2.5: Instrument involved in the long-term measurements.

2.2 Permanent stations

Permanent observatories are important for several reasons. In fact, they allow to perform good quality long-term measurements thanks to the presence of the personnel which continuously check the status of the equipment. Moreover, they build large datasets of different instruments taking simultaneous measurements. These observations are important for climate models validation and models assimilation (Rubin et al., 2017; Randles et al., 2017; Benedetti et al., 2018; Gueymard and Yang, 2020; Mortier et al., 2020 ;Torres et al., 2021), satellite validation (Omar et al., 2013; Gupta et al., 2018; Sogacheva et al., 2020; Levy et al., 2018), climatological and trend studies (Holben et al., 2001; Che et al., 2018; Raptis et all., 2020; Barreto et al., 2022), and environmental effects (Kazadzis et al., 2016; Amiridis et al., 2009). Figure 2.6 shows the location of the surveyed permanent observatories, while the instruments operating are depicted in Figure 2.7. Observatories are quite homogeneously distributed in Europe, but also in this case it is expected to add more sites in the next years of HARMONIA. Low-cost instruments, PREDE sun and lunar photometers and stellar photometers are the equipment less deployed in the listed laboratories, whereas lidars/ceilometers and spectrometers are the most common.

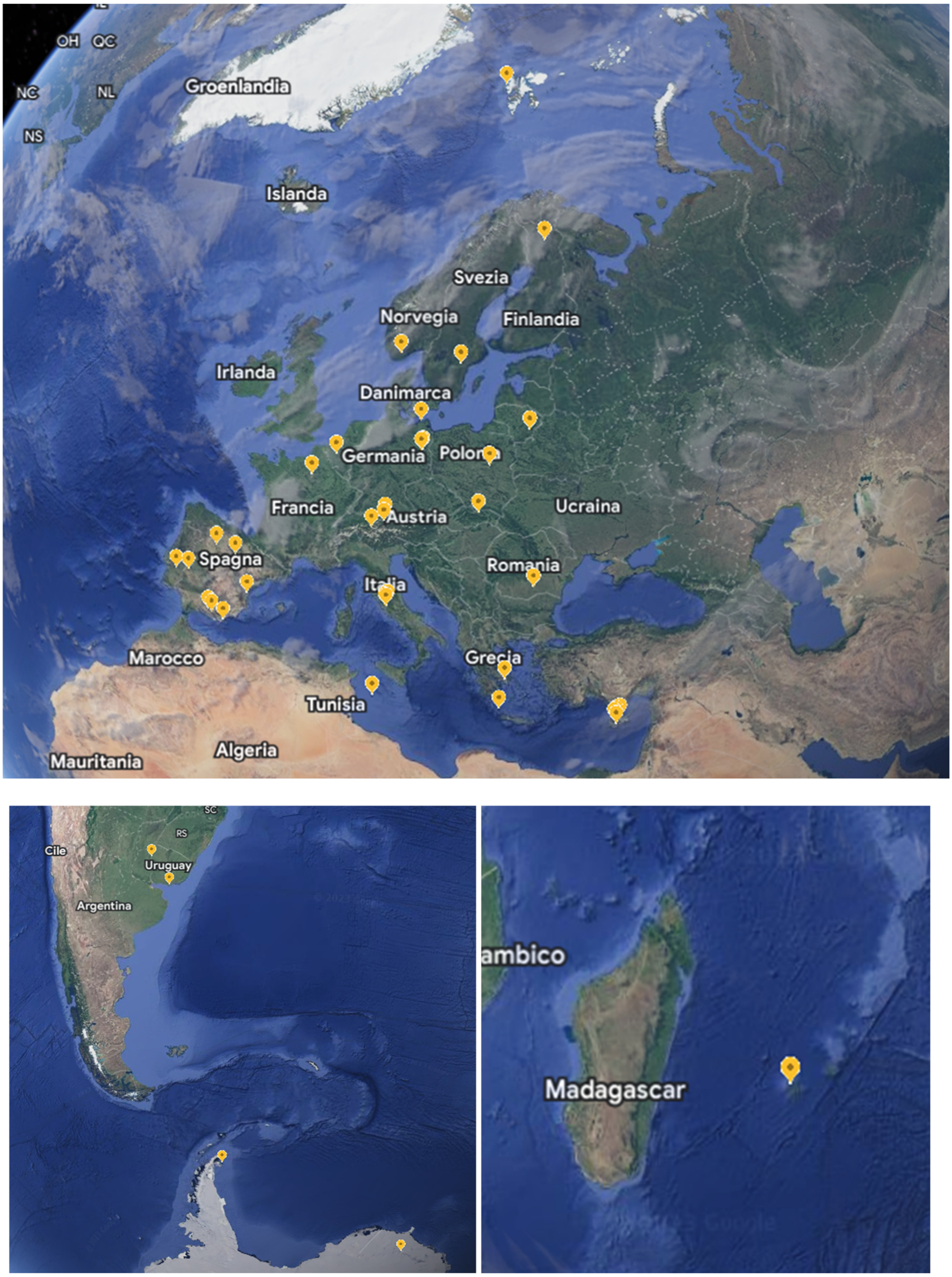

Figure 2.6: Deployment of the permanent observatories.

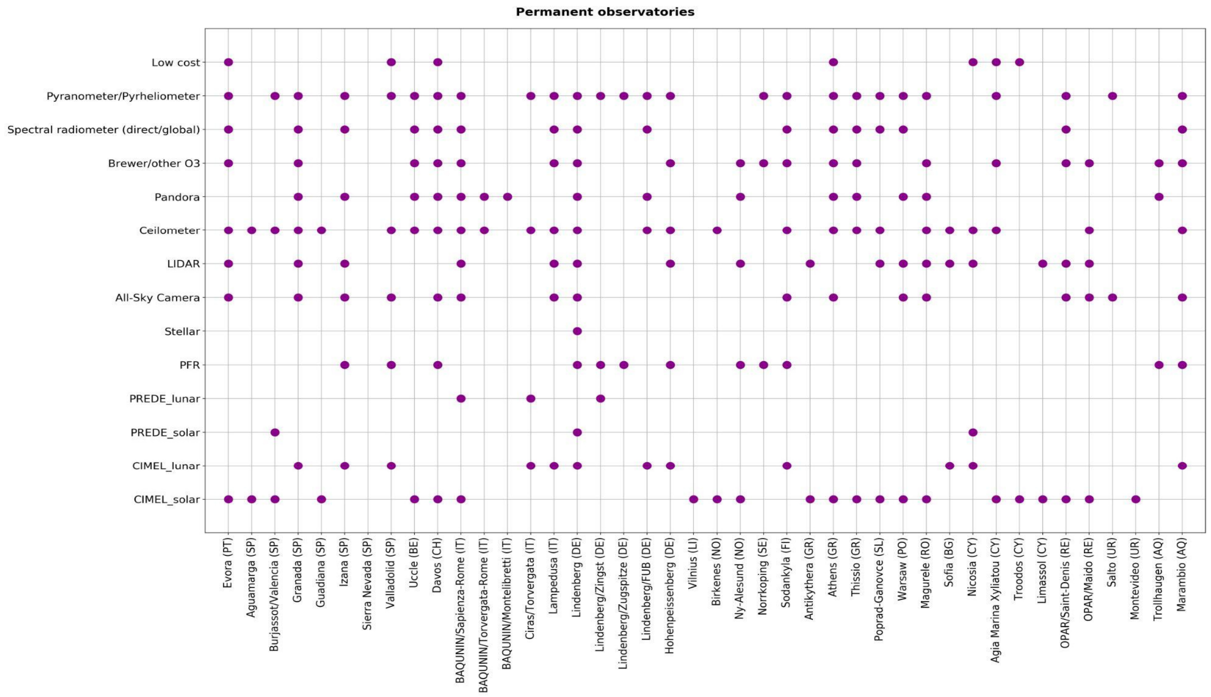

Figure 2.7: Instrument deployed in the permanent observatories.

3. Summary

The graphs created in this VM made it possible to summarize the information collected in the first year of HARMONIA and to provide an overall look of the location of the permanent observatories, the long-term measurements and field campaigns conducted in Europe and not only in recent years. These analyses also show scientific, geographical and temporal gaps in the study of the optical properties of aerosols and the synergistic use of remote sensing instruments and will also allow us to drive the tailored design of measurement campaigns in conjunction with interesting atmospheric events or in places not yet covered by previous studies.

4. References

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