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CAPTOR

Collective Awareness Platform for Tropospheric Ozone Pollution

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RMSE Root Mean Square Error

Executive Summary

Description of the work

The aim of deliverable D3.2b is to report on the initial testing of sensor nodes during the summer 2017 monitoring campaign. This deliverable presents a review of the nodes deployed during the campaign and the periods of time during which they were operational. Deliverable 3.3b will report on data validation and quality.

Objectives

The main objective of the deliverable is to assess the results from the initial testing of the sensor nodes in preparation of the 2017 summer campaign. It also aims to quantify the data availability throughout the campaign, i.e., to assess the performance of the nodes in terms of data generation (not data quality).

1. Introduction

The previous deliverables D3.2a and 3.3a, submitted to the European Commission in 2017, presented the results from the summer ozone monitoring campaign in 2016, which was the first to be carried out in the framework of CAPTOR. As shown in D3.3a, the results from the 2016 campaign were not as positive as expected and this was mainly due to technical failures linked to the hardware and software of the CAPTOR nodes. In addition, during the 2016 campaign only CAPTOR (and not RAPTOR) nodes were systematically deployed, and data were only collected in Spain (and not in Italy and Austria).

Between October 2016 and April 2017 significant efforts were made by the project partners to address all of these issues, and subsequently aim for a robust 2017 summer campaign. The main changes implemented were:

- improvement of the hardware in the CAPTOR nodes, to prevent shifting of the inside components which resulted in data losses,
- software improvement in the CAPTOR data collection platform,
- call for and selection of volunteers in Italy and Austria, and
- finalisation of the RAPTOR nodes and data platform.

As a result of these improvements the 2017 campaign provided significantly better results, as is described in the following section. Because data availability was improved, new tools for data processing and node calibration were implemented and are described in D3.3b.

2. Results

2.1 Data collection

During 2017, data collection for the CAPTOR nodes was modified with respect to the first year of the project with regard to 2 main issues:

- Data transfer: in 2016 the CAPTOR nodes were connected via WiFi, using the hosts' home connections. This proved to be unreliable and as a result in 2017 the nodes were improved with an integrated 3G card. The cards used were Emnify, which allowed web access to monitor data transfer. This was seen as a major asset given that it allowed us to verify the proper installation of each node. Once the nodes were operational, this remote access also allowed for the real-time monitoring of the nodes.
- Access to the data: in parallel to the Commsensum platform developed for the 2016 campaign, in 2017 a new system was used where the data were directly converted to a .csv file after reception, and the .csv files were accessible to the CAPTOR partners in an internal server. This improved the processing speed, as all the sensors in each node were accessible in the same .csv file (as opposed to having to download each sensor individually).

The RAPTOR data were available systematically for the first time in 2017. The raw data were downloadable directly from an internal server from LIMOS, and the data calibrated by LIMOS were available through http://edss.isima.fr/capteur/upcspain01user/api/v1/upcspain01/Raptor_3G_01/0001000018671537/items4upc?period=100080&format=csv

2.2 *Data availability*

The number of CAPTOR nodes was increased in 2017 with regard to 2016, and in addition, RAPTOR nodes were also deployed systematically (as opposed to as a test, in 2016). In addition, nodes were deployed systematically for the first time in Austria and Italy. **Table 1** summarises the number of nodes deployed in each testbed (**Figure 1**).

Table 1. Number of CAPTOR and RAPTOR nodes deployed in each testbed in 2017.

Nr. nodes	CAPTOR	RAPTOR
Spain	25	1
Italy	10	10
Austria	0	15
Total	*35*	*26*

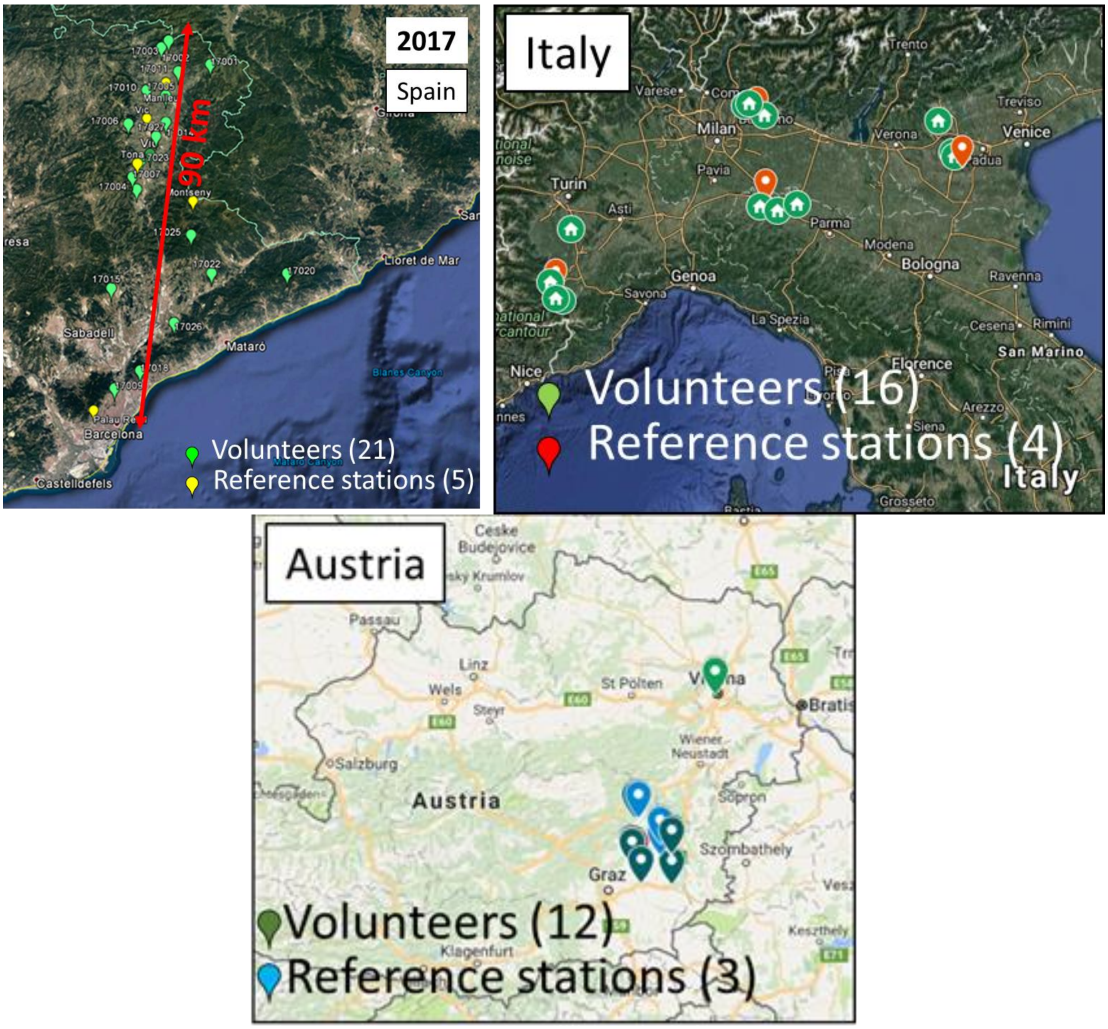


Figure 1. Maps of the 3 testbeds where the CAPTOR and RAPTOR nodes were deployed.

The performance of the CAPTOR and RAPTOR nodes with regard to data generation may be described as follows:

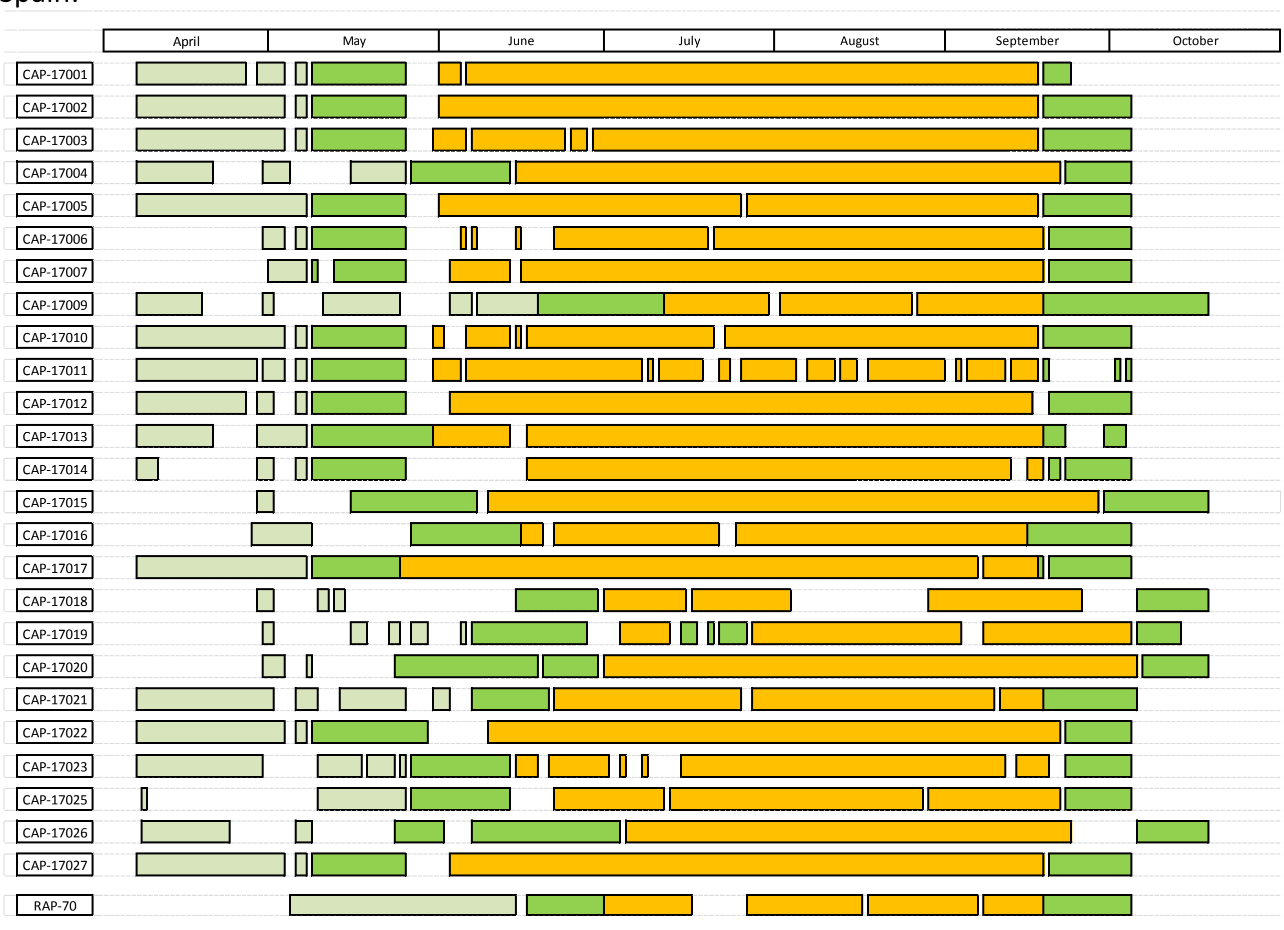
- 22/35 CAPTORS and 16/26 RAPTORS reported full datasets for the entire period (calibrations and campaign) and the data are reliable.

- 10/35 CAPTORS reported data during calibrations and the campaign, but at some point the scale of the sensor signal changed (what we described as "re-basing", or jumps in the time series, in D3.3a) and data from this moment on are not reliable.
- 1/35 CAPTOR and 2/26 RAPTORS reported data during calibrations and the campaign but the data are not reliable.
- 1/35 CAPTOR reported data during calibrations and the campaign but the temperature and humidity failed and it could not be calibrated.
- 1/35 CAPTOR and 1/26 RAPTOR did not submit any data.
- 7/26 RAPTORS reported data, but the datasets are incomplete.

Graphically, data availability may be summarised as shown in **Figure 2**: each bar in the graph represents an individual CAPTOR or RAPTOR node (identified as "CAP" or "RAP"), with the calibration periods marked in green and the campaign period, in orange. Gaps in the bar of an individual node imply lack of data, which results from some sort of technical failure (hardware or software). Gaps between the green and orange segments indicate that the nodes were stopped intentionally, to transport them to the reference stations or the hosts.

Figure 2 evidences the improved performance of the CAPTOR and RAPTOR nodes in 2017 in terms of data generation, as the gaps identified are few and mainly linked to transport of the nodes to and from the hosts' homes. The gaps in the RAPTOR nodes in Austria were originated by failures in data transfer and/or storage, mainly due to server issues.

Spain:



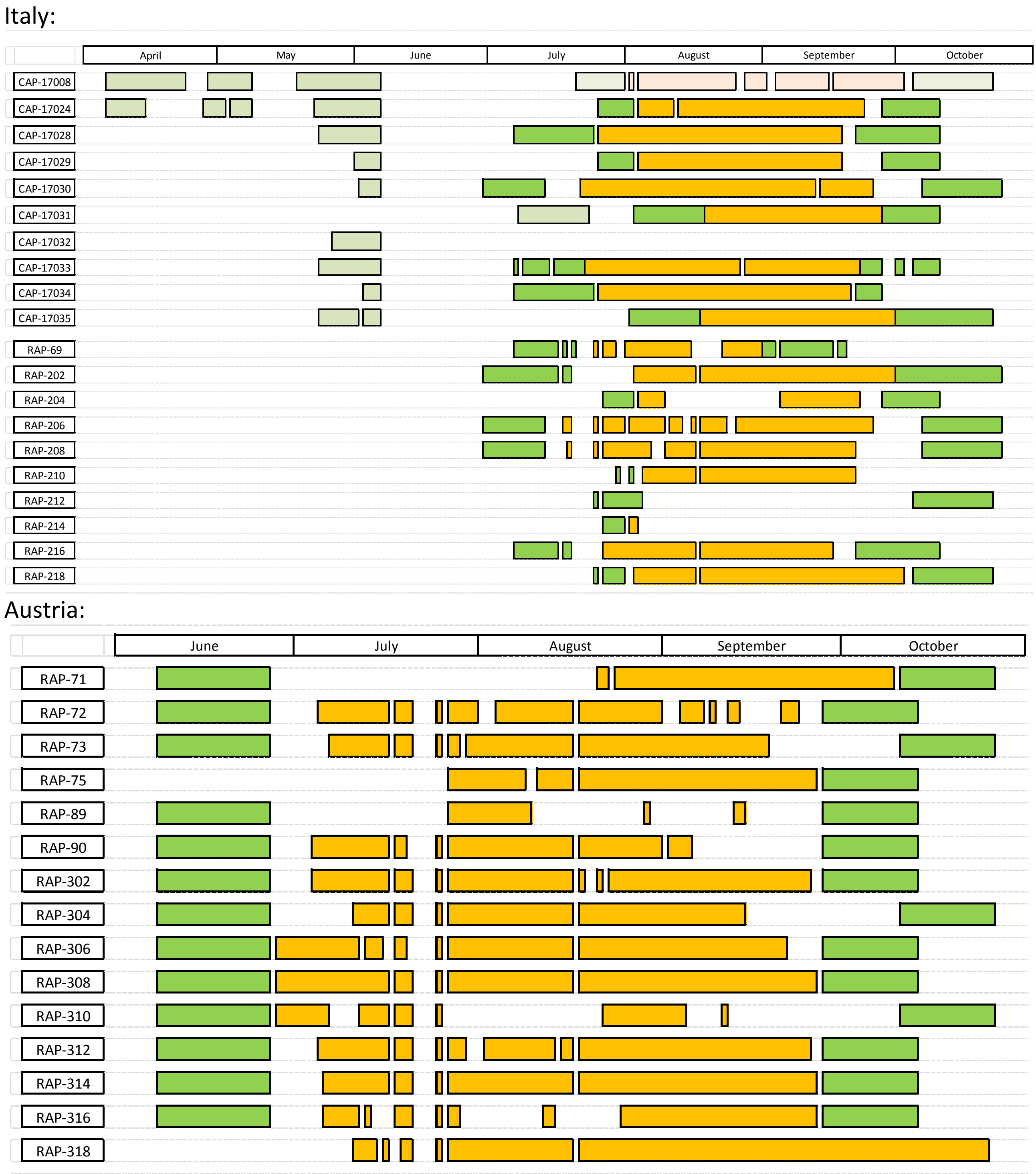


Figure 2. Graphical representation of data availability for the CAPTOR nodes. Orange bars: campaign period. Green bars: calibration periods. Light green bars: initial testing of the nodes to identify and replace under-performing sensors.

2.3 Technical issues

As discussed, aside from transport of the nodes the gaps in **Figure 2** indicate breaks in the time series caused by technical failures. In comparison to 2016 the number of failures decreased significantly in 2017 (**Figure 3**), with the only exception of CAPTOR 17018.

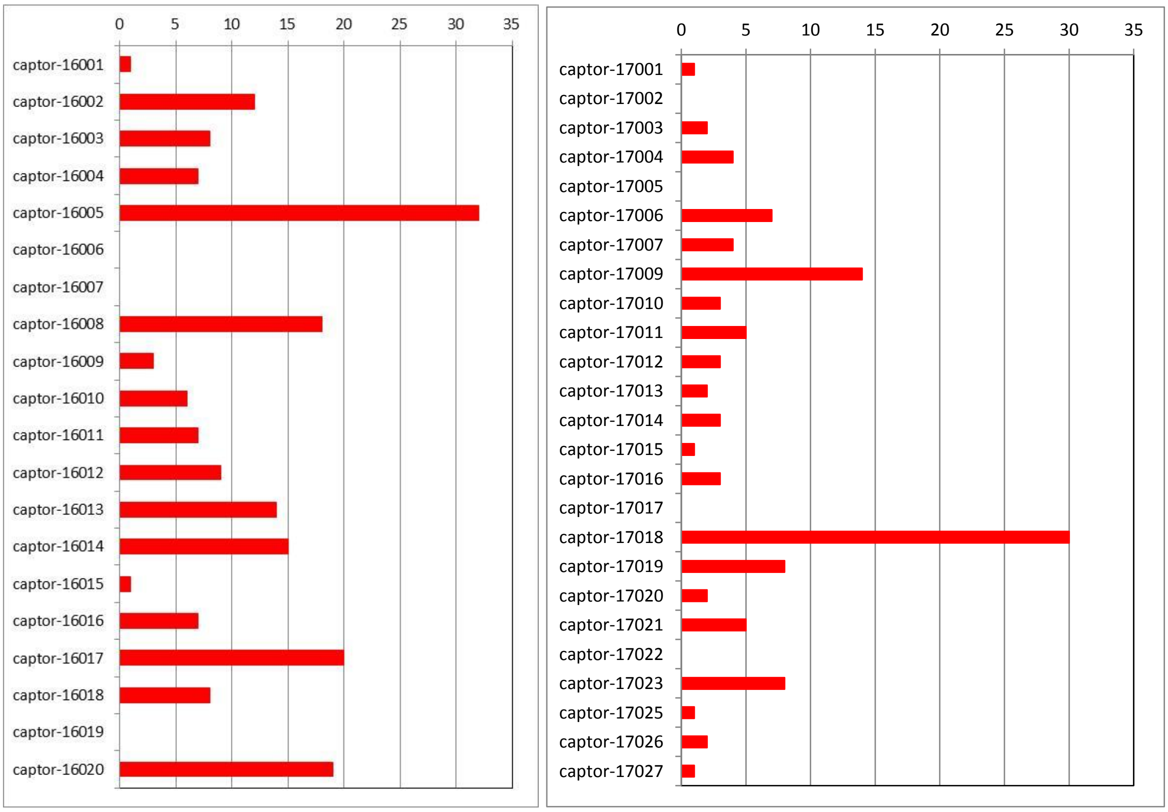


Figure 3. Number of times the CAPTOR nodes reported technical failures, per node: left, summer 2016; right, summer 2017.

The sources of failure detected were also analysed, and they are summarised in **Figure 4**. As shown, the main issue detected was lack of internet connectivity (issues with the 3G card), and data losses due to either lack of data generation (the node was not operational) or storage issues. Some hardware aspects still remain, such as the unintentional ejection of the SIM card during transport, which will have to be addressed in view of the 2018 campaign.

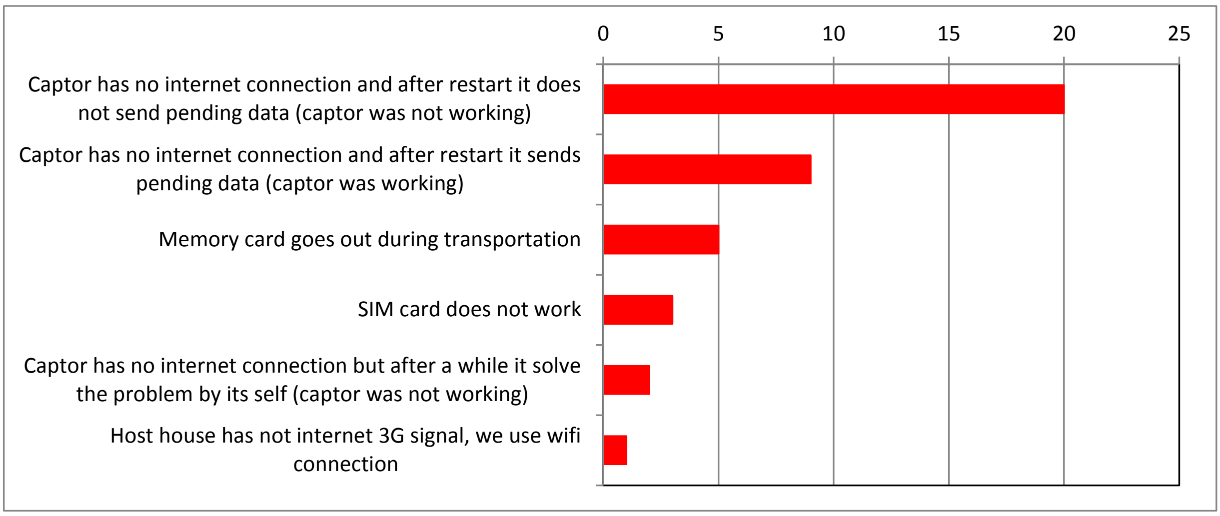


Figure 4. Sources of failure of the CAPTOR nodes in 2017.

3. Conclusions

The performance of the CAPTOR and RAPTOR nodes during summer 2017 was assessed and compared to that of the previous year (2016). It may be concluded that the performance of the nodes improved significantly, and as a result, sufficient data are available from 2017 for a robust analysis (presented in D3.3b). A total of 35 CAPTOR and 26 RAPTOR nodes were systematically deployed in the 3 testbeds, which was a significant increase with regard to 2016 (20 CAPTOR nodes, only 1 testbed). Hardware and software improvements were implemented, resulting in 22/35 CAPTORS and 16/26 RAPTORS reporting full datasets for the entire period (2 calibrations + summer campaign). Technical issues (both hardware and software) were still detected, even in with a much lower frequency than in 2016, and will be addressed for the upcoming 2018 summer campaign. From the point of view of volunteer engagement this campaign was considered a success given that sufficient volunteers were recruited for all testbeds.