Detailed descriptions

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Principal Investigator: Rui Paulo Vasco Salgado
Principal Contractor:: Universidade de Évora (UE)
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1. Introduction

As stated in the proposal, the aim of the project was to perform an observational Experiment in Alqueva (ALEX 2014), including measurements in the water and in the air columns, and over the water-atmosphere interface.

The team undertook an integrated field campaign with measurements of chemical, physical and biological parameters. Through the campaign, we took advantage of existing scientific, especially those belonging to the CGE, including new equipment acquired under the Inalentejo/QREN project "Laboratory Sciences and Technologies of Earth, Atmosphere and Energy".

In addition to the proposal team members, other researchers from different institutions, Portuguese and foreign, has joined the ALEX2014 field campaign, offering their resources and sharing knowledge and data. So, the ALEX2014 Experiment. benefited form qualified participation of researchers from the Portuguese Institute of the Sea and the Atmosphere (IPMA), the Commission for Coordination and Regional Development of Alentejo (CCDR-A), The Dom Luís Institute (IDL/UL), the Space & Earth Geodetic Analysis Laboratory (SEGAL/UBI), The Polytechnic of Porto (IPP, the University of Reading (UK) and the Instituto Nacional de Técnica Aerospacial (INTA, Spain).

The involvement of many researchers was the project's success key. Thus, it was possible to carry out a campaign with a number of measurements and objectives that far exceeded the initial objectives and what may be possible with the limited budget of the EXPL/GEO-MET/1422/2013 project.

The observations result in a inter-disciplinary database useful for the researchers working on Alqueva, not only for the team members, but also for the national scientific community. This database will included in addition to the measurements made by the experimental apparatus specifically set up for this purpose, others arising from other observations made continuously by other organizations such as the IPMA, the CGE/ICT, the EDIA and the APA (former INAG).

The ALEX2014 project and field campaign were accompanied by training and outreach activities. So it includes a summer school: "ALEX 2014 Workshop on Observations in Atmospheric and Water sciences, Alqueva" held in Alqueva during the Intensive Observation Period (IOP) and a public debate, which also took place in the Alqueva village, entitled "the Alqueva reservoir and the Climate".

In the course of the project, the research unit, Centro de Geofísica (CG/UE) merged with two other units, Earth Sciences Centre – U. Minho, Geology Centre – U. Porto, giving rise to the Institute of Earth Sciences (Instituto de Ciências da Terra, ICT), a new research unit hosted by 3 universities: Évora, Minho and Porto. Hereafter, references to ICT or CGE always refer to the project research unit.

In addition to the aforementioned enlargement of the working team, the realization of the campaign counted on very significant support: firstly EDIA, project partner, which involved more than what stated in the proposal, supporting many operating costs, particularly related to boat displacements, second the University of Évora, whose various schools, departments, laboratories and services rendered different types of support; Thirdly a large list of entities: IPMA, APA, CCDR-Alentejo, EDP, the Board parishes of the Union of Amieira and Alqueva, the Amieira Hostel, the Amieira Marina, The Beja Airbase, The "Comando distrital de operações de socorro de Beja" and the landowners of the "herdades" and "montes" of Cid Almeida, Barbosa, Alcarias, Areias, Avestruz, Catapral, Rola, Pata, Torrejona, Ferragial do Soto, Vaquinha.

With the support of FCT through project EXPL/GEO-MET/1422/2013 co-funded by FEDER (ref. COMPETE: FCOMP-01-0124-FEDER-041840), with an extraordinary team, with the students who came to participate in, and the support of all of the mentioned entities, it was possible to perform, between June and September 2014, an hydro-meteorological campaign in Alqueva, whose data allow and will continue to allow undertake studies and drawing conclusions on the lake- atmosphere interaction in Mediterranean climate conditions.

2. TASK1

2.1. Planing

This task has included all the planning and the design of the ALEX 2014 experiment, namely the selection of measurements sites, equipments and sensors, sampling and recording frequency. The schedule of experiment was established at this stage
This task also included the test and the calibration of some the scientific equipment used in the field campaign. Special attention was given to the calibration of solar radiation sensors and to test the new irgason eddy covariance system.
We took advantage of this phase to calibrate sensors and carry out recovery operations at the ICT meteorological stations of Évora, Mitra and Portel. These tasks have had so an interest that lasts beyond the end of the project, allowing to increase the confidence of the ICT database.
At this stage, several colleagues and other institutions were invited and have joined the ALEX 2014 team. On March 28, 2014, a meeting of the project team was carried out in the village of Alqueva, where the field experiment were planned. The conclusions of the meeting correspond to the milestone 1, however the campaign planning tasks, including the selection of sites, continued until the start of the campaign, as foreseen in the project. Regarding to the Intensive Observation Period (IOP) the planing continued until it starts on July 22.

i) Meeting – 28 / 03 / 2014 – 1st milestone

As a result of the calls made to colleagues who were not in the starting team and following several previous discussions, the planning meeting held on March 28 at the premises of the Alqueva Parish Council. With the participation of 21 researchers and technicians (see Figure 2.1 and the meeting synopsis) from UE, EDIA, FCUL and UBI, the meeting discuss the objectives of the different groups and made a first schedule of the field experiment. The presentations showed at the Alqueva meeting may be download from:
http://www.alex2014.cge.uevora.pt/wp-content/uploads/2014/05/ALEX20140328b.pdf.
The journey has included a visit to some of the potential experimental sites and facilities:

- The warehouses of Edia, near to the dam (Figure 2.2, Figure 2.3, Figure 2.4 and Figure 2.5). This location was selected to be the central point of the intensive campaign, based on the following reasons: belongs to EDIA, easy access, energy supply, security, near the dam, downwind from the reservoir (dominant winds). It was also decided to install here an continuous experimental site with measurements of: meteorological parameters, radiation, atmospheric electricity and air quality.
- Installations of the Firefighters Special Force "os Canarinhos" (Figure 2.6 and Figure 2.7), also near the Alqueva dam. It was decided to put here one GPS station
- The EDIA meteorological station placed on an Alqueva island (Figure 2.8 and Figure 2.9), near to the Dam: The Alquilha station. It were discussed the works to be done to integrate this station in the ALEX 2014 network
- The floating platform known as Alqueva montante (Figure 2.10). The state of the station was analyzed, and it was decided to make this platform the focal point for observations on water and water-atmosphere interface.
- The infrastructure on the top of the dam (Figure 2.11), in order to study whether they could be used for the installation of equipment.

Figure 2.1 28/03/2014 Meeting and visit to experimental sites.

Local: Alqueva Parish Council room (meeting); Dam and nearby sites (visit)
Agenda:

1. Presentation and discussion of the various components.
    - Overview and map of the existing structures: EDIA and APA
    - Meteorological measurements and fluxes
    - Water Quality / biological component
    - Attenuation of radiation in water
    - Composition of the atmosphere, aerosols and gases; air quality
    - water vapor mapping with GPS
    - radiosondes
    - Atmospheric electricity
    - Water Balance of Albufeira
    - solar resource
2. Possibility of holding a summer school in Alqueva, associated with the campaign, in collaboration with the IDL (University of Lisbon)
3. Experiment Planning
4. Technical and financial aspects

Participants: Rui Salgado, Miguel Potes, Maria João Costa, Paulo Canhoto, Hugo Silva, Daniele Bortoli, Pavan Kulkarni, Rui Mendes, Vanda Salgueiro, Marta Melgão, Samuel Bárias, Carlos Miranda, Manuela Morais, Helena Novais and António Serafim (UE), Ana Ilhéu, Martinho Murteira e Valter Rico (EDIA), Pedro Soares (FCUL), André Sá and João Apolinário (CEGAL/UBI)

Figure 2.2EDIA boat

Figure 2.3 Edia warehouse

Figure 2.4EDIA warehouse (interior)

Figure 2.5 Terrace on the EDIA warehouse

Figure 2.6 Installations of the Firefighters Special Force "os Canarinhos" near Alqueva

Figure 2.7 View from the site of the Firefighters Special Force "os Canarinhos".

Figure 2.8 Boat travel to ALquilha and floating platform

Figure 2.9 Visit to the Alquilha Meteorological station

Figure 2.10Visit to the the floating Platform Alqueva Montante

Figure 2.11 Visit to the Dam

The first milestone "Conclusion of the experiment planning"" was reached on 28 March, with the meeting in which it was carried out the overall planning of the campaign. although the more detailed programming have continued until the beginning of the field experiment.

2.2. Collaborations

As indicated in the proposal, "In addition to the team members, other researchers will be challenged to participate in the observation campaign, offering their resources and sharing data" and "this database [result from the project] will include in addition to the measurements made by the experimental apparatus specifically set up for this purpose, others arising from other observations made continuously by other organizations such as the APA (former INAG), the IPMA and the CGE, as well as information from remote sensing satellite." So, the planning phase included the invitation to other groups (some who participated in the meeting referred to in the previous section) and contacts with the institutions that collect data, in particular the IPMA and the APA.

It was also necessary to contact and request permission and support for the installation of equipment on private properties.

i) University of Évora

Despite being the Principal Contractor of the project, some colleagues and groups of the university, not included in the proposal were invited to participate in the field campaign.
From the CGE / ICT:

- The group of the LAE (Laboratory of Atmospheric Electricity), namely Hugo Silva and Marta Melgão join the ALEX2014 team and added an interesting component not foreseen initially: The study of the impact of the reservoir on the atmospheric electrical field. Thus, in addition to the equipment installed specifically for this purpose, the data collected in the existing station placed in the Beja Airbase facility, (38.07 N, 7.93 W) were integrated in the ALEX 2014 database.
- Daniele Bortoli and Pavan Kulkarni joined the project, being responsibles for the participation of the ICT air quality nobile unit and by displacing the SPACTRAM to Alqueva
- Sérgio Pereira joined the project in order to measure aerosol concentrations.
- Mouhaydine Tlemçani and André Albino have joined ALEX2014, developing a system for measuring the oscillation of the instrumented raft and a data acquisition system for the vaisala Weather Transmitter WXT520.
- The CGE/ICT technician Samuel Bárias was crucial in the planning, testing, installation, maintenance, data archiving, and uninstall all equipment. The computer engineer Joel Barrenho gave computer support, including being responsible for the ALEX2014 webpage (http://www.alex2014.cge.uevora.pt)
- The director of the Center, António Heitor Reis, gave support to the campaign and participated in IOP activities.
- The team from the Water Laboratory has been enriched with the participation of Joana Rosado (sampling of Chironomid pupal exuviae), Amely Zavattieri (molecular studies of cyamobacteria), Alexandra Penha e Susana Nunes (laboratory analysis)

The CGE/ICT provided financial and logistical support to the field experiment, including partially backing the missions of the researchers Giles Harrison, Keri Nicoll and Maria Parrondo.

Carlos Miranda Rodrigues, hydrologist, member of ICAAM joined the ALEX2014 in order to enhance the hydrological component of the project and was essential in the design and carrying out the hydrological field experiment.

The School of Science and Technology (ECT), particularly the Department of Physics, gave some support, namely:

- The technicians of the Physics Department, Josué Figueira and Sérgio Aranha, gave a valuable assistance in assembling ALEX2014.
- The ECT gave logistic support to the realization of the ALEX2014 Workshop
- The Doctoral Program on Earth and Space Sciences participates in the ALEX2014 Workshop

ii) Empresa de Desenvolvimento e Infra-estruturas do Alqueva, SA (EDIA)

The involvement of EDIA in the ALEX project was much higher than anticipated at the application stage. In the project planning phase, the Administration and the Department of Environment and Spatial

Planning, decided to increase the participation, namelly through:

- Martinho Murteira and Valter Rico joined the ALEX2014 team
- The weather station installed on a island close to the dam, known by Alquilha (Figure 2.9), was included in the list of ALEX stations.
- Providing a boat and also supporting the costs of several boat travels
- Providing space next to the EDIA solar park for the installation of scientific equipment and offering electric power. The Solar Park was the principal land site of the ALEX2014 experiment.
- Offering the warehouse to be the headquarters of the ALEX2014 IOP staff. It was here that the computers and the radiosonde ground base were placed, as other equipment and the material needed to launch the meteorological balloons, including the helium bottles.
- Guiding (Martinho Murteira) a graduate thesis of a student, who used the ALEX2014 data.
- Participation of Ana Ilheu, with a lecture, in the ALEX 2014 Workshop.

iii) Portuguese Institute of the sea and the atmosphere (IPMA)

The IPMA, the national authority in the fields of meteorology and climate, is an essential partner for a field experience like ALEX2014. Meetings with Pedro Viterbo, director of the Department of Meteorology and Geophysics and Fátima Coelho, head of the division of Climate and Climate change, has ensured the following supports from IPMA:

- Access and transfer of the raw data of all the surface Automatic Weather Stations belonging to the IPMA and located in South Portugal (see map on Figure 2.14) during the ALEX 2014 period (June - September)
- Access and transfer of the raw data of the radiosondes carried out in Lisbona during the ALEX 2014
- The IPMA launched an additional radiosonde from Lisbon every day at 00 UTC during the ALEX2014 IOP
- The IPMA provides a Vaisala Sounding receiver system to be used during the ALEX2014 IOP
- The meteorologists Victor Prior and Jorge Marques joined the ALEX2014 team

iv) Agência Portuguesa do Ambiente (APA)

Authorization for using the Alqueva floating platforms belonging to the APA
Make efforts to recover the existing meteorological stations on this rafts, which were not working.
Access to the data
Participation, with a lecture, in the ALEX2014 workshop,
The main difficulty resulted from the state of the stations, which were inactive as a result of interruption of the maintenance contract. A joint visit was organized including APA (Claudia Brandão, Manuela Saramago and colleagues), EDIA and CGE/ICT in order to check the status of the stations and try to find solutions.

Figure 2.12 Joint visit to check the status of the APA floating platforms existing in Alqueva. Participation of EDIA, APA and the ALEX team.

After a few weeks of work, it was possible to bring into operation the weather station of the Alqueva Mourão platform, in which new water temperature captures were placed.

v) Commission for Coordination and Regional Development of Alentejo (CCDR Alentejo)

The CCDR-A is the entity managing entity for the air quality in Alentejo region, disposing of five fixed stations, integrated into the air quality national network and a mobile unit. The stations follow the criteria of EMEP networks and EUROAIRNET and data is accessible in qualar.apambiente.pt. The handset is equipped with last generation equipment using methodology in accordance with European standards for each of the parameters involved.
Following previous collaborations involving Dr. Pavan Kulkarni, we proposed to CCDR-A to participate and we had a meeting with Maria José Santana, the directress of the Environmental Services of CCDR-A. As a result, CCDR-A offered the following support:

- providing an air-quality mobile unit to be conveyed and stationed in the Alqueva region during the period of the campaign.
- Ensure the maintenance of equipment and collect the data
- Eng. Paulo Beliche joined the ALEX2014 team

The mobile unit was installed in the Amieira Marina.

vi) Instituto Dom Luiz (IDL/UL)

The IDL decided to participate in the ALEX2014 activities, through:

- Joint organization of a summer course / ALEX2014 Workshop on Observations in atmospheric and water sciences, in Alqueva, during the ALEX2014 IOP, intended for graduate students
- Support the displacement “Lisbon Doctoral School on Earth System Science” PhD students to the workshop
- Perform measurements of radon (Susana Barbosa and Franciso Lopes)
- Pedro Miranda, Pedro Soares, Susana Barbosa and Franciso Lopes joined the ALEX2014 team and participated in the IOP
- Make an model inter-comparison study for ALEX 2014 IOP.

vii) Space & Earth Geodetic Analysis Laboratory (SEGAL/UBI)

The SEGAL decided to participate in the ALEX2014 activities, through:

- instaling a network of GNSS receivers in order to determine the water vapor distribution within the troposphere by tomographic techniques.
- participate, with a lecture, in the Workshop
- André Sá, João Apolinário and Rui Fernandes joined the ALEX2014 team

viii) EDP

As a result of contacts with André Silva, head of the Alqueva Hydro Power Plants and Carlos Rosário, Director of the "Centro de Produção Tejo-Mondego" the "EDP, Gestão da Produção de Energia, S.A.", supports the ALEX 2014 trough:

- providing the following data:
  - Quota of the Alqueva reservoir, measured close to the dam.
  - Quota of the Pedrogão reservoir, measured immediately downstream of the Alqueva dam.
  - Volume stored on the Alqueva reservoir.
  - Average influent flow.
  - Average flow discharged.
  - Average flow turbocharged and pumped in Alqueva I and Alqueva II Hydro Power Plants.
- Guided visit to the Alqueva Hydro Power Plant with a Talk about the Electro-Mechanical Components of the Alqueva Hydro Power (during the ALEX2014 IOP and Workshop) .
- Offering the Hydro Power auditorium for the workshop lectures. (It was not used)

ix) University of Reading

Through the Atmospheric Electricity Laboratory, a collaboration was established with the Department of Meteorology of the Reading University, UK, with the aim of study the atmospheric electrical field, measuring the atmospheric ionization profile, lauching geigersondes coupled to the meteorological radiosondes. The collaboration includes:

- Keri Nicol and Giles Harison joined the ALEX team, as consultants and participated in the ALEX IOP. Giles Harison became formally consultant of the project, and his scientific visit was funded by the project.
- The University of Reading provides the Geigersondes and the digital interfaces to connect to the Vaisala RS92 radiosondes
- The data obtained will be explored together

x) Beja Airbase

Carlos Policarpo, meteorologist and air force officer, responsible for the meteorology at the Beja Airbase join the team and participate in the IOP field campaign, giving valid advices on short term weather forecast, given its vast experience in operational meteorology in the region. Carlos Policarpo participate also on the exploration of the ALEX2014 data and in atmospheric modeling.
As indicated in section 2.2.i) the measurements of the atmospheric electrical potential gradient made at Beja Airbase are included in the ALEX2014 database.

xi) Polytechnic of Porto IPP

Raul Lima, from the School of Allied Health Sciences of Polytechnic of Porto and Center for Geophysics of the University of Coimbra/Astronomical Observatory of the University of Coimbra

joined the ALEX2014 field campaign, adding a new research topic: The evaluation of the brightness of the night sky in the Alqueva region due to the presence of Artificial Light At Night (ALAN).
The ALEX2014 IOP period coincided with nights plenty of moonless, which is a requisite for the study of the quality of the night sky regarding brightness. The realization of these measurements during the IOP, in which the structure and dynamics of the atmosphere is well documented, allows improving the knowledge about the influence of environmental conditions on the night brightness of the sky. The local evaluation of this quantity is important because the region was the first Starlight Tourism Destination in the world, classified in December 2011 by the UNWTO and the Starlight Foundation (Starlight, 2007).

xii) Instituto Nacional de Técnica Aeroespacial - INTA (Maria Parrondo)

Maria Parrondo from the Atmospheric Research and Instrumentation Branch, Área de Investigación e Instrumentación Atmosférica do Instituto Nacional de Técnica Aeroespacial – INTA, joined the ALEX2014 project in order to participate in the IOP, supporting the launch of radiosondes and post processing of the data, giving advice and collaborate on the study of the atmospheric boundary layer and precipitable water vapor.
The INTA provides a Vaisala RS92 Digicora system with a SPS311 receiver, the respective antennas and a GC25 ground check unit (MW31).
This last minute collaboration was of crucial importance, as we concluded that the the IPMA receiver system could not support the electric field devices coming from Reading Univ, U.K.. The collaboration was established less than a week before the start of IOP in response to a desperate appeal. The ALEX2014 team is very grateful to the INTA and in particular to Maria Parrondo, for her willingness.
The displacement of Maria Parrondo was financially supported by the CGE/ICT.

xiii) Parish of Amieira e Alqueva

The ALEX2014 sought the support of the parish council for two reasons: (1) the need of logistical supports; (2) the desire of involving local people, as a social duty of the ALEX2014 researchers. The council parish of Amieira e Alqueva (Junta da União das Freguesias da Amieira e Alqueva) decided to support the ALEX2014 activities, through:

- Availability of the Alqueva parish council meeting room for ALEX2014 meetings (as the planing meeting, shown in Figure 2.1)
- Availability of the Alqueva social room. It was used for the debate shown in Figure 2.19 and for the ALEX Workshop social dinner
- Co-organization of the open debate about “the Alqueva reservoir and the Climate” (Figure 9.1)
- Support to the displacement of researchers and students from the village to the experimental sites during the ALEX2014 IOP.
- Help in contact with people and local entities.

xiv) Landowners

To install the equipment in the field it was necessary to apply for permission to the owners of the sites. In addition to the EDIA, in whose land was installed one of the major sites, the following entities were contacted.

- **Amieira Marina**
  It was the second ALEX2014 land site, with observations of meteorology, air-quality (CCDR mobile unit), atmospheric electricity, radon and GSNN. The administration of the Amieria Marina decided to support the ALEX2014 activities, through:

- providing space for parking the air quality caravan and the installation of the equipment
- providing access to electricity.
- providing some technical support
- performing a short guided tour during the IOP

- **Herdade Cid Almeida**: Bogaris
  Permission to install a meteorological station and a gps receptor
- **Herdade da Barbosa**: Soc. Agricola da Barbosa
  Permission to install a meteorological station and a gps
- **Comandante distrital de operações de socorro de Beja**
  Permission to install a gps receptor in the facilities of the "Força Especial de Bombeiros Canarinhos"
- **Herdade das Alcarias**
  Permission to install a gps receptor
- **Monte das Areias**
  Permission to install a gps receptor
- **Quinta da Avestruz**
  Permission to install a gps receptor
- **Monte do Catapral**
  Permission to install a gps receptor
- **Monte da Rola**
  Permission to install a gps receptor
- **Monte da Pata**
  Permission to install a gps receptor
- **Monte da Torrejona**
  Permission to install a gps receptor
- **Monte do Ferragial do Soto**
  Permission to install a gps receptor
- **Monte da Vaquinha**
  Permission to install a gps receptor

xv) Alqueva Hostel

The new Alqueva Hostel was fully booked (37 beds) for the accommodation of researchers and students during the ALEX2014 IOP. The Hostel living room was used for the ALEX2014 Workshop

2.3. Experimental Sites

Following the meeting of March 28, 2014, there were some field trips to decide the location of the experimental sites. Based on the findings of these missions and on contacts reported in the section2.2, the sites identified in the Figure 2.13 were chosen.

i) Experimental sites in Alqueva backwater

The map of the Figure 2.13 shows the location of the sites in and near Alqueva. It don't includes the stations belonging to the CGE/ICT and to the IPMA. Also not shown are the locations where the night brightness measurements were made and where samples were collected along the banks.
In summary:

- there are **7 sites with meteorological measurements**: 2 Platforms (Montante and Mourão); the permanent weather station in the island (Alquilha), 2 dedicated weather stations in (Barbosa and Cid Almeida), two compact weather stations in the Solar Park and Amieira.
- **4 floating platforms** where water quality and biological sampling were done: Montante, Mourão, Captação and Alcarrache;
- **2 Air quality mobile units**: Amieira and Solar Park
- **3 Atmospheric Electricity stations**: Amieira, Solar Park and Beja (not shown in the map)
- **1 Radon measurements**: Amieira
- **1 radiometric station**: Solar Park
- **15 GSNN stations** (during the IOP)

More detailed information about each experimental site is given in section3.1 and 3.3.i).

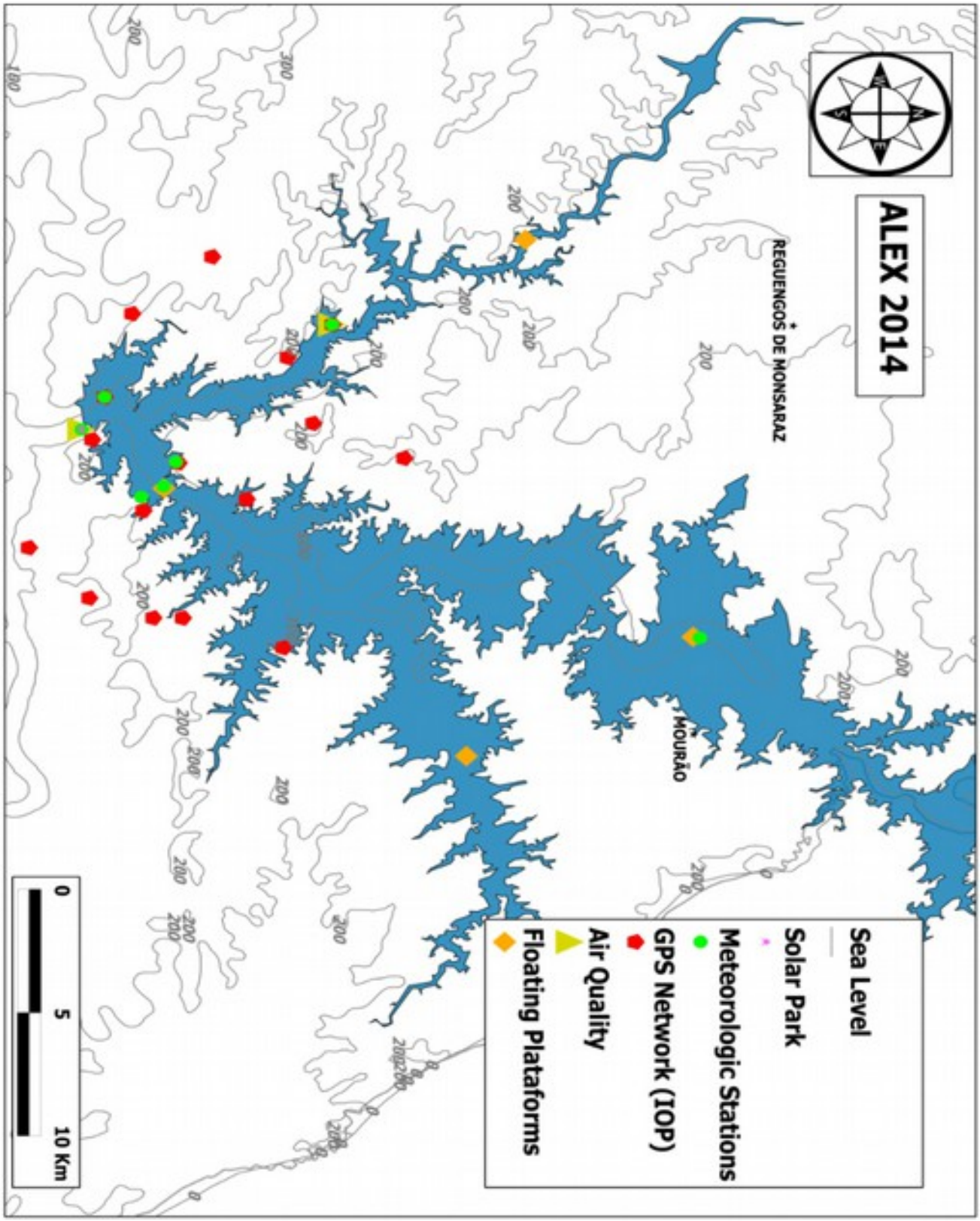
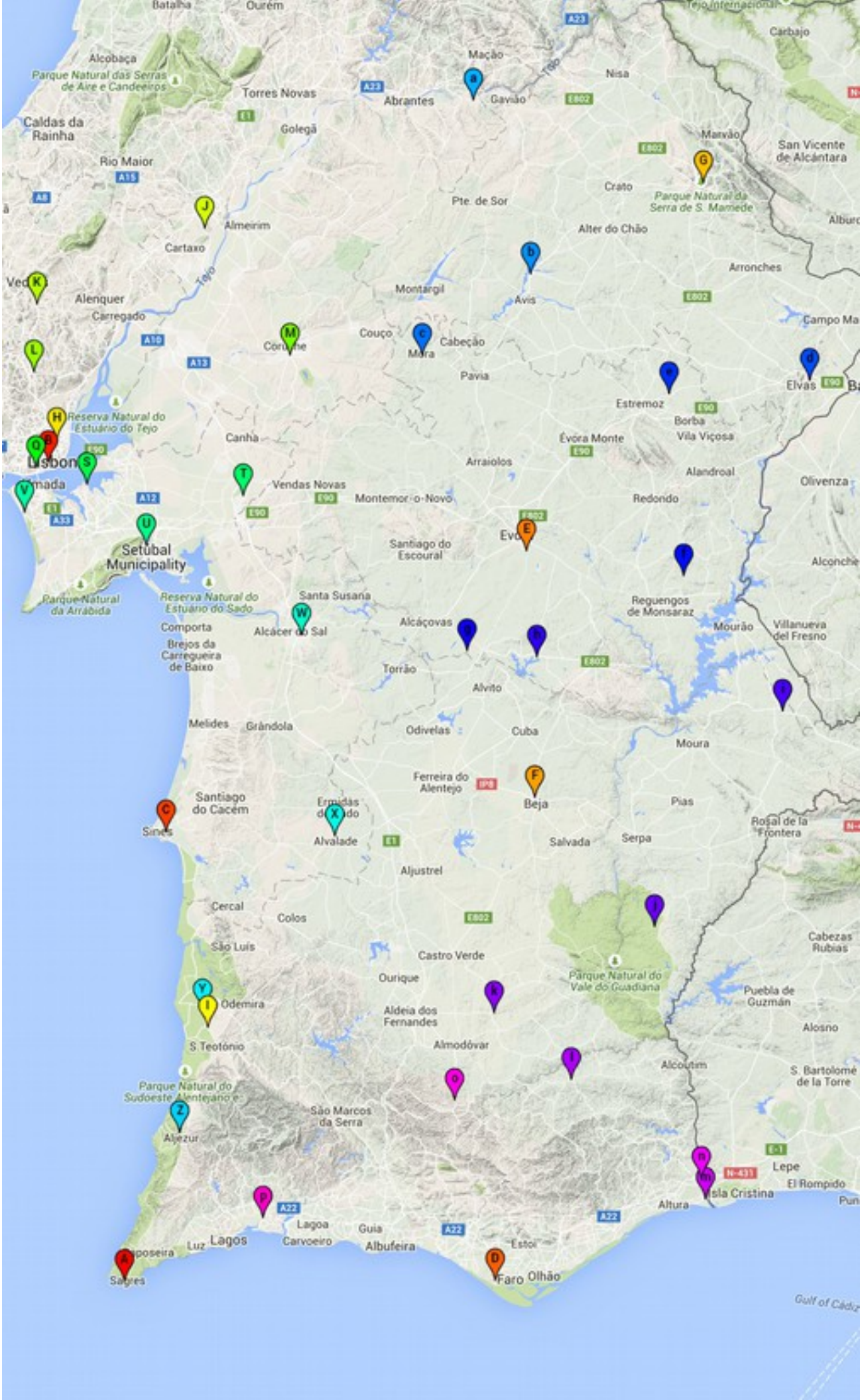


Figure 2.13 ALEX2014 experimental sites and the Alqueva reservoir

ii) IPMA Meteorological network

The figure list the IPMA meteorological stations, whose data in the period 01/06/ to 30/09 2014 are integrated into ALEX database.

Figure 2.14 IPMA automatic meteorological stations in Southern Portugal (map in the next page)


Batalha
Ourém
Alcobaça
Parque Natural das Serras de Aire e Candeeiros
Torres Novas
Abrantes
Mação
Gavião
Tejo Internacional
Carbajo
Nisa
Caldas da Rainha
Golegã
Rio Maior
A15
A8
A23
E1
E802
Marvão
San Vicente de Alcántara
Crato
Parque Natural da Serra de S. Mamede
Pte. de Sor
Alter do Chão
Almeirim
Cartaxo
Tejo
Montargil
Avis
Arronches
Alenquer
Carregado
A10
A13
Couço
Cabeção
Mora
Coruche
Pavia
Campo Ma
Elvas
E90
Estremoz
Borba
Vila Viçosa
Évora Monte
Arraiolos
Alandroal
Olivenza
Reserva Natural do Estuário do Tejo
Canha
Lisbon
Almada
Vendas Novas
Montemor-o-Novo
Redondo
A12
A33
Setúbal Municipality
Santiago do Escoural
Alconchel
Parque Natural da Arrábida
Reserva Natural do Estuário do Sado
Santa Susana
Alcácer do Sal
Reguengos de Monsaraz
Mourão
Villanueva del Fresno
Comporta
Brejos da Carregueira de Baixo
Alcáçovas
Torrão
Alvito
Melides
Grândola
Odivelas
Cuba
Moura
Ferreira do Alentejo
IP8
Beja
Santiago do Cacém
Sines
Ermidas do Sado
Alvalade
Salvada
Serpa
Pias
Rosal de la Frontera
Aljustrel
Cercal
Colos
São Luís
Castro Verde
Ourique
Parque Natural do Vale do Guadiana
Cabezas Rubias
Puebla de Guzmán
Odemira
Aldeia dos Fernandes
Almodôvar
Alosno
S Teotónio
Alcoutim
S. Bartolomé de la Torre
Parque Natural do Sudoeste Alentejano e
São Marcos da Serra
Aljezur
Lepe
El Rompido
Isla Cristina
N-431
Altura
Lagoa
Carvoeiro
Guia
Albufeira
Lagos
Luz
Estoi
Sagres
Faro
Olhão
A22
Gulf of Cádiz

2.4. Calibration / test

Several equipments, recently acquired by the CGE, were calibrated and tested before the beginning of the field Campaign. This phase lasted until the beginning of the campaign, June 1, 2014.
The second milestone "test and calibration of the equipment" was reached on 31 May.
However, tests were conducted in any equipment after this date.

i) Test of the IRGASON Eddy-covariance system

The new IRGASON Integrated Open-Path CO2 /H2O Gas Analyzer and 3D Sonic Anemometer is the equipment used to access the fluxes of CO_2, H_2O, energy and momentum between the lake and the atmosphere, a focal point of the ALEX project. Acquired under the Inalentejo/QREN project "Laboratory Sciences and Technologies of Earth, Atmosphere and Energy", it was first tested in the physics laboratory at the University of Évora. A demonstration of the potentialities of the IRGASON eddy-covariance system and a presentation of the ALEX project was given 7th March at the Évora Mechatronics Seminars, by Rui Salgado and Miguel Potes. The seminar title was "Eddy-covariance measurements of momentum, heat and mass fluxes in the air using the new Campbell Scientific's IRGASON Integrated Open-Path CO2 /H2O Gas Analyzer and 3D Sonic Anemometer" and the slides are available in the ALEX2014 webpage

Figure 2.15 S eminar given at the Évora Mechatronics Seminars, March 7, 2014.

In April 10, the eddy-covariance system, together with radiative captures, was mounted (Figure 2.16) at the Regional Meteorological Center of Évora (IPMA), located near the aerodrome, to perform tests in a field environment. The local was covered with grass. The system has been operating for a month, and it was useful to test and improve the data acquisition program and to measure the power consummation.

Figure 2.16 Installation of the IRGASON system in the Évora Regional Center of Meteorology

As an example, the results show positive CO_2 flux during night and negative during daytime (Figure 2.17). As seen, over grass in spring, the flux is correlated with the concentration.

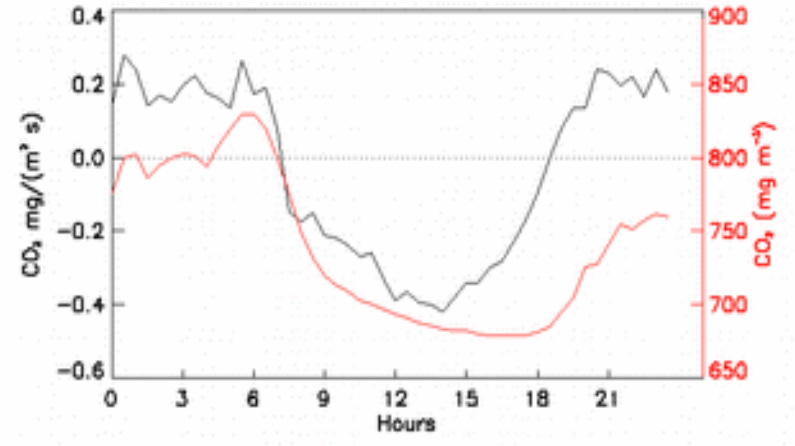


Figure 2.17 Average daily cycle of CO2 concentration (black) and flux (red) measured in April 2014 over grass near the city of Évora

ii) Dimensioning of autonomous solar energy system for the equipment installed at the floating platform

The dimensioning of an autonomous solar energy system to supply power to equipment that was installed on the floating platform was carried out by Tiago Lopes, an undergraduate student of Engineering of Renewable Energy, as part of their degree thesis (Lopes, 2014, in Portuguese). The system has been designed to support the following equipment: 1 IRGASON eddy-covariance system and 1 CR3000 Campbell datalogger connected to 9 temperature probes (PT100), 1 albedometer and 1 pyrradiomter. The simulations with the software PVSyst (version 6.23) indicates that two solar panels

with the characteristics indicated in the Table 1, mounted with an inclination of 30° and an azimuth of 90°, linked to a current controller and a 12V battery of 100 Ah, ensures autonomy for all year. The panels, the current controller and the battery, mounted on the floating platform, are shown in Figure 2.18

Manufacturer / model	BP Solar / BP380
Power / nominal voltage	80 W / 12 V
efficiency	12.6%
area	0.65 m^2

Table 1

Figure 2.18 PV modules, charge controller and battery mounted in the floating Platform Alqueva montante

iii) Calibration of Radiometers and test of the Sun Tracker

The radiation monitoring station comprised a sun tracker (K&Z Solys2), a new equipment acquired under the Inalentejo/QREN project "Laboratory Sciences and Technologies of Earth, Atmosphere and Energy", and the following sensors: pyrheliometer (K&Z CHP1); two pyranometers (K&Z CM6B) and a pyrgeometer (Eppley PIR).

Before installed in ALEX, the Solys2 tracker were tested in the Verney radiometric station at the University of Évora (Figure 2.19). The second-class pyranometers (two K&Z CM6B) were calibrated through the Alternating Sun-and-Shade Method using the new first class pyrheliometer (K&Z CHP1) as reference according to the ISO 9846:1993 standard procedure. A second pyrheliometer model Eppley NIP was also calibrated against the new K&Z CHP1 pyrheliometer according to the ISO 9059:1990 standard. The pyrgeometer was calibrated in the laboratory facilities using a reference cavity with known surface emissivity and temperature.

Figure 2.19 Test of the sun tracker and pyranometers calibration (17/05/2014)

iv) Testing the Underwater Solar Irradiance Profiler

The Underwater Solar Irradiance Profiler prototype was first tested in a five-meter deep pool from the municipal swimming complex of Évora (Figure 2.20 and Figure 2.21). This test allowed for calibration with pure water through comparison with results from Smith and Baker (1981). After the test sessions, the prototype was used to perform measurements in Alqueva reservoirs in the summer during the ALEX2014 field campaign.

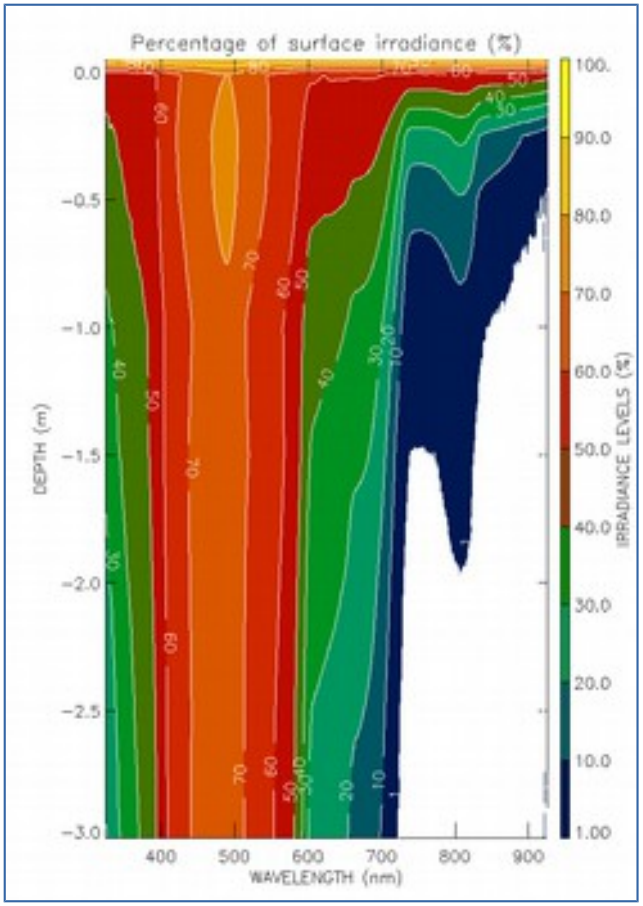


Figure 2.20 Spectral Profiles of underwater downwelling spectral irradiance in municipal swimming complex of Évora.

Figure 2.21 Prototype during tests in municipal swimming complex of Évora.

v) Air quality

The analyzers from the CCDR-A mobile unit, that have been placed in Amieira, were calibrated, before the field campaign, with certified gases and according to standard methodology for each parameter.

The caravan acquired by the CGE/ICT under the Inalentejo/QREN project "Laboratory Sciences and Technologies of Earth, Atmosphere and Energy" (see Figure 2.22) was received at the University of Evora only in June 2014. It was then necessary to install the analyzers and assemble the whole mobile unit, technical work carried out by the selling company, which also has trained technicians and researchers of the CGE/ICT.
The mobile unit was moved to Alqueva on 20 July, just in time to participate in the IOP. Then, it stood stationed there until the end of the ALEX2014 field campaign.

Figure 2.22 ICT Air quality mobile unit

vi) Floating platform recovering

In collaboration with the Portuguese Environmental Agency (APA), in particular thanks to the qualified intervention of Claudia Brandão and Manuel Saramago (from APA) and Carlos Miranda Rodrigues (ICAAM / UE) it was possible to recover the meteorological station installed on the Alqueva/Mourão platform, which, so, has been working during the ALEX campaign.

vii) Water temperature sensors

The company Bruno & Lopes – Engenheiros Civis Associados, Lda. (http://www.bl.com.pt/) kindly lent six temperature sensors, with different cable length, to be used in order to measure the water temperature profile under the floating station Alqueva/Mourão.
The sensors were recalibrate in the ICT laboratory of the University of Évora before assembled to the station.

viii) Regeneration of hygrometers

The Hygro-thermo-transmitter from Thies Clima, used at Cid Almeida and Barbosa were calibrated following a standard procedure indicates by the manufacturer. As known, in the course of time, the measuring elements used to measure humidity dry out and degenerate. Degeneration can be reversed by exposing the measuring elements to saturated air (regeneration). The way we made this was to wrap the immersion stem of the Hygro-transmitters for about 60 minutes in a damp cloth which has been dipped in lukewarm water and then correct the indicator, setting the relative humidity to 95%.

ix) Data acquisition system, based on Galileo, for Vaisala WXT520

A Vaisala Weather Transmitter WXT520, acquired under the Inalentejo/QREN project “Laboratory Sciences and Technologies of Earth, Atmosphere and Energy”, was available to use in ALEX 2014. Weather Transmitter WXT520 is a small and lightweight transmitter that offers six weather parameters in one compact package. WXT520 measures wind speed and direction, precipitation, atmospheric pressure, temperature and relative humidity.
Due to budget constraints, this equipment was purchased without options or software. For use in the field it was therefore necessary to build an economic and low consumption data acquisition system. This was done by a master student, André Albino, as part of his thesis. The prototype is described in

section 7.2 and was build and tested in the Geophysics Laboratory during April and May 2014.

x) Accelerometer

As indicated in the proposal, one of the objectives of the project is to access the energy, mass and momentum fluxes at the water-air. The turbulent fluxes were measured by the IRGASON system mounted on a raft. In order to calculate what may be the errors introduced by the oscillation of the raft in the vertical wind speed measurements and therefore in the fluxes calculations, we tried to measure the vertical velocity of the sensor. For this purpose a Libelium Waspmote board with a built-in accelerometer was used. The board is connect to a data logger where the three components of acceleration are archived at the same time sampling defined for the IRGASON measurements (20 Hz). The acceleration data are integrated, using a trapezoidal method, in order to estimate the vertical velocity of the sensor. This velocity was compared to the air vertical speed measured by IRGASON sonic anemometer and may be used to correct the wind and flux measurements.
As seen in the Figure 2.23, the Libelium Waspmote board, inside an environmental enclosure, was attached to the the arm holding the IRGASON.

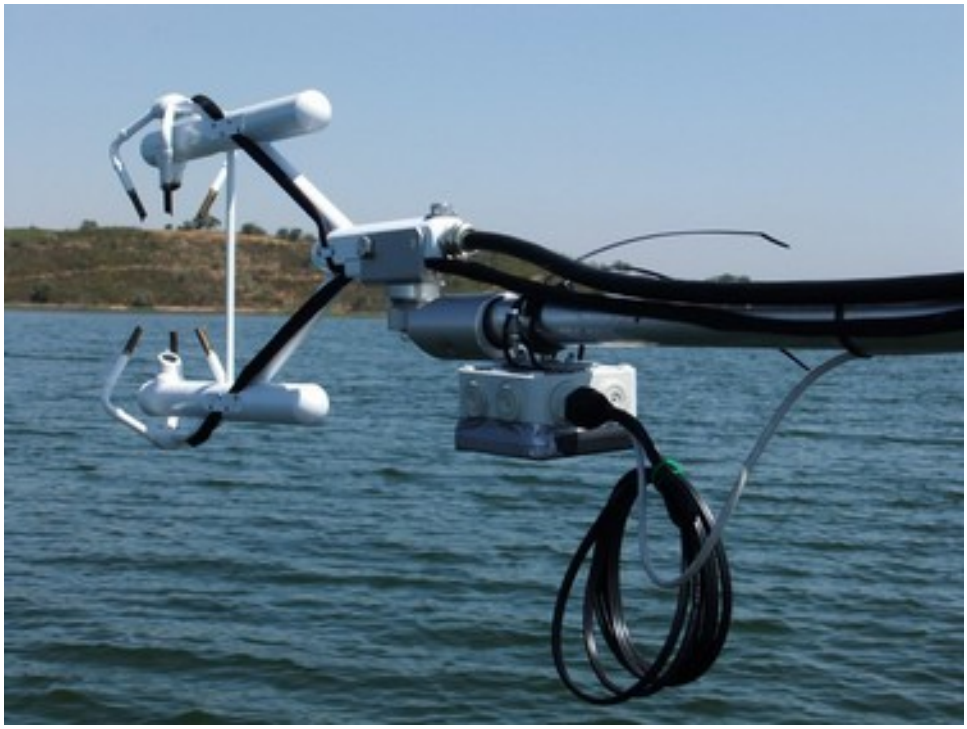


Figure 2.23 Case containing the accelerometer attached to IRGASSON system mounted on a raft.

xi) Mitra and Portel

Mitra and Portel are meteorological stations belonging to the actual ICT. The Mitra station is operating since 1994 and Portel station since 1997. As assumed in the proposal, the two stations were integrated in the ALEX 2014 field experiment. It was decided to proceed with a complete renovation of the Mitra station before the beginning of the experiment.

Figure 2.24 Renovation of the Mitra meteorological station, belonging to the ICT (Évora Pole).

Mitra Renewal operations took place on 15 and 16 May and are documented in Figure 2.24. A tower of 10 meters was installed (replacing the old 6m) and several sensors were replaced. The measurements made, and the sensors used, in the new Mitra station, which data are available at www.cge.uevora.pt, are shown in the Table 3.

In the case of Portel, the station has been subject to minor changes.

xii) Maintenance of Alquilha

The EDIA company has carried out maintenance operations on the station, including clearing in the neighborhood.

3. Task 2

This was the core task of the project: the ALEX 2014 Experiment. The Hydro-meteorological campaign of observations formally began on 2 June and ended on 1 October.

3.1. Equipments installed for continuous measurements (June – September)

i) EDIA Solar Park

The radiation monitoring station was installed in the EDIA Solar Park, near the Alqueva dam, in mid-May 2014 and data began to be collected in May 26.
The radiation station comprised the following components: (i) a sun tracker (K&Z Solys2); (ii) a pyrheliometer (K&Z CHP1) for measurement of direct normal solar radiation; (iii) two pyranometers (K&Z CM6B) for global and diffuse radiation; a (iv) pyrgeometer (Eppley PIR) for measurement of down-welling infrared radiation, and (v) a datalogger (Campbell Sci. model CR1000). The sun tracker was equipped with two shading spheres for obstructing direct solar radiation to one of the pyranometers (diffuse radiation) and to the pyrgeometer, and is capable of tracking the sun with a precision of 0.1 degrees through an integrated sun sensor.
Ambient air temperature was also measured together with radiation values. The data acquisition system

was programmed to measure and store 1-minute average, maximum, minimum and standard deviation of all variables, thus accomplishing the guidelines and requirements for the BSRN (Baseline Surface Radiation Network) stations. Rawdata files with the original signal outputs of sensors were also stored for backup and data quality assurance. All sensors and sun tracker were periodically cleaned and its alignment checked in order to keep a proper functioning. The datalogger clock was also periodically checked to ensure a correct data recording time.

Figure 3.1 Setup of the radiation monitoring station at the Solar Park site (26/05/3014)

At the same Solar Park site, it was also installed equipment to continuously monitor the local atmospheric electric field, through precise measurements of the in-situ potential gradient (PG) using an Electrostatic Fieldmeter JCI 131F (fast response version) from Chilworth, UK. The sensor has measurement sensitivities in the range of 2, 20, 200 and 2000 kV/m, being provided with high precision (< 1.5%), low noise and a stable zero. The sensor was installed at ~ 2 m height and was recently calibrated (December 2013).

Figure 3.2 Instalation of an Electrostatic Fieldmeter at Solar Park experimental site

A datalogger from Campell Scientific (USA) model CR1000 were used to record data from the radiative and potential gradient and meteorological sensors operating at the site.
A Vaisala Weather Transmitter WXT520 (http://www.vaisala.com/en/products/multiweathersensors/Pages/WXT520.aspx) was used to measure barometric pressure, humidity, precipitation, temperature, and wind speed and direction. The data were acquired and recorded by an Arduino Intel Galileo, using the prototype build during the project and described in the respective section:

ii) Amieira Site

Atmospheric Electricity and and Radon measurements

Continuous monitoring of radon (^{222}Rn) concentration was performed using an NaI(TI) scintillation sensor of 3'' x 3'' (Scionix, Holland) that allows measuring gamma radiation in the range 475 KeV to 3000 KeV. The sensor measures the gamma radiation originated from the decay series of radon which results in radioactive isotopes such as Pb-214 and Bi-214, as well as the background contribution from U-238, Th-232 and K-40. Due to the sensor high sensitivity, the temporal variability of the gamma radiation measured reflects directly the temporal variability of radon above a constant background, since only radon, as a gas, is able to be transported by diffusion and advection. The radon sensor is placed in a shallow borehole at ~50 cm from soil surface, inside a polyvinyl chloride (PVC) tube completely sealed for protection against exterior influences (e.g., soil humidity, temperature).
The local atmospheric electric field is continuously monitored through precise measurements of the in-situ potential gradient (PG) using an Electrostatic Fieldmeter JCI 131F (fast response version) from Chilworth, UK. The sensor has measurement sensitivities in the range of 2, 20, 200 and 2000 kV/m, being provided with high precision (< 1.5%), low noise and a stable zero. The sensor was installed at ~ 2 m height and was recently calibrated (December 2013).
A datalogger from Campell Scientific (USA) model CR800 recorded PG and gamma radiation every minute.
As indicated in the sections 2.2.ix) and 2.2.x), the potential gradient is also measured in Beja Airbase (BA, 38.07 N, 7.93 W), approximately 40 km away from the Alqueva reservoir, in the outskirts of the city of Beja. The sensor installed in BA is of the same model, was calibrated at the same time and was set for measurements with the same sensitivity.

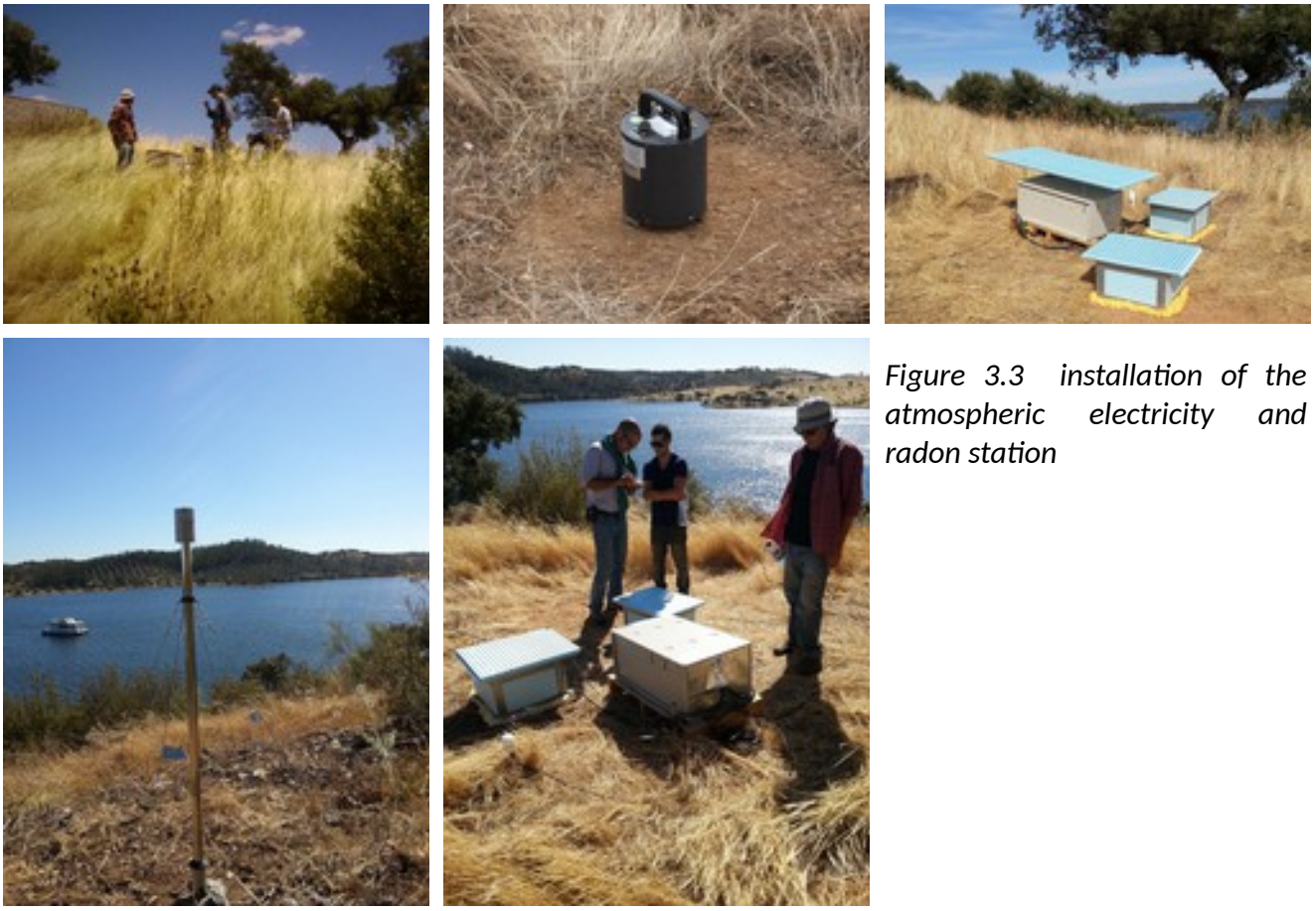


Figure 3.3 installation of the atmospheric electricity and radon station

Air Quality Mobile Unity

Figure 3.4 Installation of the air quality mobile unit in the boat park of the Amieira Marina. June 3, 2014.

To study the relationship between the air quality, meteorology and the electric field of the atmosphere, the Commission for Coordination and Regional Development of Alentejo (CCDR-A) provided a

mobile unit with analyzers of a set of gases. The mobile unit follow the criteria of EMEP networks and EUROAIRNET and is equipped with last generation equipment using methodology in accordance with European standards for each of the parameters involved.
The mobile station was installed on 03/06/2014 in the boat park of the Amieira Marina (Figure 3.4) and was operating continuously until 03/10/2014. The parameters recorded are indicated in Table 2, together with the norms and methodologies of the respective analyzers. The average values were recorded every 15 minutes.

Table 2 Norms and Methodologies used in air quality measurements

Parameter	European Norm	Methodology
Sulfur dioxide– SO_2	EN 14212:2005	Ambient air quality — Standard method for the measurement of the concentration of sulphur dioxide by ultraviolet fluorescence
Nitrogen oxides – NO; NO_2; NO_x	EN 14211:2005	Ambient air quality — Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence
Carbon monoxide - CO	EN 14626:2005	Ambient air quality — Standard method for the measurement of the concentration of carbon monoxide by non -dispersive infrared spectroscopy
Ozone - O_3	EN 14625:2005	Ambient air quality — Standard method for the measurement of the concentration of ozone by ultraviolet photometry
Benzene - C_6H_6	EN 14662:2005	Standard method for measurement of benzene concentrations

The mobile unite includes a weather station, allowing the measurements of in-situ meteorological parameters such as precipitation, air temperature, relative humidity, atmospheric pressure, solar radiation, wind speed and direction. In addition to its intrinsic interest, these weather unit provide support for the stations of air quality stations and atmospheric electricity operating in the Amieira Marina.

iii) Floating Platforms

The floating platform known as Alqueva-montante, was the principal ALEX2014 experimental site inside the reservoir. The following equipments were installed, 2 June 2014 (Figure 3.5 and Figure 3.6):

- The Irgason eddy-covarience system (Integrated Open-Path CO2 /H2O Gas Analyzer and 3D Sonic Anemometer, Figure 3.7 and Figure 3.11), which measures directly:
  - pressure
  - temperature
  - water vapor concentration
  - CO_2 concentration
  - 3D wind components

  and computes, among other quantities related to turbulence:

    - Momentum flux
    - Sensible and latent heat fluxes
    - CO2 fluxes
    - evaporation
- One albedometer and one pirradiometer (Figure 3.12) in order to measure, up and down, short and total, radiative fluxes
- 9 thermistors to measure the water temperature at different levels (Figure 3.10).

Figure 3.5: Assembly of equipment aboard the raft. 2 June 2014

Figure 3.6: partial view of the instrumented raft.

Figure 3.7: Mounting the eddy correlation system

Figure 3.8: Assembling the accelerometer

Figure 3.9: Albedometer and pirradiometer

Figure 3.10: cables in which the water temperature sensors are attached

Figure 3.11: View of the eddy correlation system

Meteorological measurement and sensors used in all the meteorological stations installed in the framework of ALEX 2014 are listed in Table 3

On the same day, June 2, a collecting system for sampling diatoms in depth was placed, as described in the section 3.2.

The accelerometer described in section 2.4.x) was attached, 23 July, to the the arm holding the IRGASON (Figure 3.8). The acceleration was monitored in the period from July 23 to October 1 using the

iv) Meteorological stations (Cid Almeida and Barbosa)

One meteorological station were mounted, May 26, close to the water in the homestead “herdade Cid Almeida”. The local is in the downwind margin of the reservoir (dominant wind).

Figure 3.12 Installation of the meteorological station in the Herdade of Cid Almeida

Figure 3.13 Installation of the meteorological station in the Herdade of Barbosa

Table 3 Meteorological Measurements in ALEX 2014 and ICT weather stations

Measurements	type	company	model
Alqueva Montante Platform			
Solar radiation Up/Down	Albedometer	Kipp Zonen	CM7B
Total radiation Up/Down	Pyrradiometer	Philipp Schenk	8111
Water temperature several levels	Thermistor	Campbell Scientific	107
Turbulent fluxes at 2 meters	Sonic	Campbell Scientific	IRGASON
Barbosa			
Wind speed and direction at 2.5 meters	Wind Sonic	Gill Instruments	Option 1 – 1405-PK-021
Temperature and relative humidity at 2 meters	Thermo-Hygrometer	Campbell Scientific	CS 215
Precipitation	Udometer	Institute of Hydrology	ARG 100 STD
Cid Almeida			
Wind speed at 2.5 meters	Switching Anemometer	Vector Instruments	A100R
wind direction at 2.5 meters	Potentiometer Wind Vane	Vector Instruments	W200P
Temperature and relative humidity at 2 meters	Thermo-Hygrometer	Thies Clima	1.1005.51.512
Precipitation	Udometer	Campbell Scientific	ARG 100
Parque Solar			
Temperature, relative humidity, wind speed and direction , precipitation	Weather transmitter	Vaisala	WXT520

Measurements	type	company	model
Portel			
Wind speed at 2.5 meters	Switching Anemometer	Vector Instruments	A100R
wind direction at 2.5 meters	Potentiometer Wind Vane	Vector Instruments	W200P
Temperature and relative humidity at 2 meters	Thermo-Hygrometer	Thies Clima	1.1005.5X.XXX
Precipitation	Udometer	Campbell Scientific	ARG 100
Solar radiation Up/Down	Albedometer	Kipp Zonen	CM7B
Mitra			
Wind speed and direction at 10 meters	Wind Sonic	Gill Instruments	Option 1 – 1405-PK-021
Temperature and relative humidity at 2 meters	Thermo-Hygrometer	Thies Clima	1.1005.5X.XXX
Precipitation	Udometer	Young	52203
Solar radiation Up/Down	Albedometer	Kipp Zonen	CMA6
Verney (UE)			
Wind speed at 2 meters	Switching Anemometer	Vector Instruments	A100R
wind direction at 2 meters	Potentiometer Wind Vane	Vector Instruments	W200P
Temperature and relative humidity at 2 meters	Thermo-Hygrometer	Thies Clima	1.1005.5X.XXX
Precipitation	Udometer	Campbell Scientific	ARG 100
Global Radiation	pyranometer	Eppley	8-48

3.2. Monthly Sampling

During the ALEX campaign, the team of the Water Laboratory from the University of Évora investigated biological quality indicators of the Alqueva water, namely Chironomid Pupal Exuvia, benthic diatoms and phytoplankton. A special attention was given to the presence of cyanobacteria.
In situ measurements, water samples and biological elements were monthly collected from the three fixed floating platforms (Alcarrache, Alqueva-Montante and Alqueva-Mourão) and from selected sites in the margins. An additional campaign for cyanobacteria was performed in October 6 due to a bloom situation.
At the beginning of the field campaign, June 2, a collecting system for sampling diatoms in depth was placed (Figure 3.14), in each platform. This comprises a rope with a weight at one end to keep the rope vertically, and at different depths a total of 9 bricks (7.5cm x 5cm) were placed (superficial, 2m, 5m, 10m, 20m, and every 10m until reaching the bottom), in order to permit the collection of 3 bricks at each depth in the further visits.

Figure 3.14 Placement of the bricks system for diatoms sampling

Each field trip includes sampling and measurements of physico-chemical, biological and radiative parameters. The field campaigns were realized on:

- 2 June
- 10 July
- 23 and 24 July (during IOP)
- 27 August
- 25 September
- 6 October (cyanobacteria)

i) Physico-chemical parameters

From each platform, in each campaign, vertical profiles of temperature, dissolved oxygen (mg DO L-1 and %), pH, oxidation-reduction potential, and turbidity were taken, using a in situ TROLL 9500 PROFILER XP multi parametric probe (Figure 3.15 left).

Figure 3.15 The TROLL 9500 multi parametric probe (left). Collection of water samples with the Van Dorn bottle.

Simultaneously, water samples were collected (Figure 3.15 right)at three depths (surface, methalinean and bottom) using a Van Dorn bottle (3L capacity) for nutrient determination [nitrates (µg NO_3^-–N l^{-1}), nitrites (µg NO_2^-–Nl^{-1}), ammonia (µg NH_4^+ –N l^{-1}), total nitrogen (µg N l^{-1}), total phosphorus (µg P l^{-1}) and soluble reactive phosphorus (µg PO_4^{3-}–P l^{-1}]. The samples were kept cool and in the dark until laboratory processing.

ii) Biological parameters

In each campaign, Diatoms were collected from the artificial substrates (Figure 3.16) placed in the platforms at discrete depths (see section 3.1.iii) and from stones in three sites in the margins in front of each platform, following the European norms for sampling lakes (King et al., 2006).

Figure 3.16 Collection of diatoms from the artificial substrates placed in the platform Alqueva-Montante (left and center). Measuring the Secchi disc depth (right)

Chironomid pupal exuviae were sampled (Figure 3.17) from two selected sites on the reservoir margins, considering human presence (Marina of Amieira and Alqueva quay).

Figure 3.17 Sampling Chironomid pupal exuviae

An integrated sample, representative of the euphotic zone, was collected from each platform, for phytoplankton and Chl *a* determinations. The integrated sample was obtained by collecting equal volumes of water, from the surface until the limit of the euphotic zone (determined by the use of a Secchi disc). Water samples were kept cool and in the dark until laboratory processing.

The surface cyanobacteria were collected (Figure 3.18) with a plankton net (15 µm mesh) in July, September and, extraordinarily, in October, in two different locations in Alqueva reservoir (marginal area and from the Alqueva-montante platform in the middle of the lacustrine zone of the reservoir). Each sample was immediately separated in two sub-samples (100 ml each): one for microscopic identification and isolation of cyanobacteria species and the other for molecular studies (kept on ice until laboratory arrival).

Figure 3.18 Collection of samples of cyanobacteria.

iii) underwater irradiation profiles

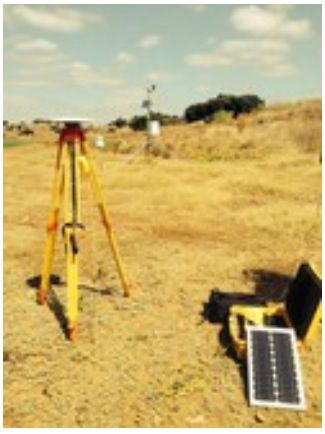
The in-water radiation fluxes at different levels were measured with the underwater solar irradiance profiler prototype built under the project and described in section 7.1. The measurements were performed taking advantage of the laboratory water displacement (see previous section) in the following days:

- 10 July
- 23 July (IOP)
- 30 July
- 27 August
- 25 September

3.3. IOP (22 to 25 July)

i) GPS network

A network of 15 GNSS receptors were mounted. The network was operating from 15th July to 1st August.

Herdade das Alcarias: *ALCI* Trimble NetR9 TRM57971.00 N 38º14'53.70710" W 07º26'54.75052" alt: 221.0106		**Monte das Areias**: *AREI* Trimble NetR9 TRM57971.00 N 38º13'45.11891" W 07º23'56.16558' alt: 253.8164	
Avestruz: *AVES* Trimble NetR9 TRM57971.00 N 38º14'21.47621" W 07º33'54.45896" alt: 288.9205		**Barbosa**: *BOSA* Trimble NetR9 TRM57971.00 N 38º13'38.82508" W 07º28'14.56778" alt: 210.5045	
Canarinhos: CANR Trimble NetR9 TRM57971.00 N 38º12'04.63993" W 07º28'53.34208" alt: 236.9138		**Catapral**: *CAPR* Trimble NetR9 TRM57971.00 N 38º17'59.84745" W07º28'18.07947" alt: 265.3251	

Cid Almeida: *CIDA* Trimble NetR9 TRM57971.00 N 38º13´01.48090´´ W 07º26´54.88619" alt: 223.8453		**Alquilha**: *IALQ* Trimble NetR9 TRM57971.00 N 38º12'17.90164" W 07º30'03.98502" alt: 213.2144	
Marina da Amieira: *MRNA* Trimble NetR9 TRM57971.00 N 38º16'38,63" W 07º32'01,58" alt: 158		**Monte da Rola**: *ROLA* | N 38º10'50.57874" W 07º25'55.08572" alt: 224.8373	
Monte da Pata: *MOPA* Trimble NetR9 TRM57971.00 N 38º15'40.12025" E 07º23'04.99595" alt: 217.6978		**Torrejona**: *TORJ* Trimble NetR9 TRM57971.00 N 38º15'48.04678" W 07º31'07.06141" alt: 224.5084	
TTeresinha Serpa: *SERP* Topcon GR3 N 37º56'41.24745" W 07º35'40.77296" alt: 265.8855		**Amieira**: *PRES* TRIMBLE NETR9 TRM57971.00 N 38º17'31.86611" | W 07º33'22.75737 | 249.3253	

Vaquinha:
VACA
TRIMBLE NETR9
TRM57971.00

N 38º12'01.70432"
W07º24'27.00929"
alt: 266.8580

ii) Radiosondes

The final plan of the launch of radiosondes was made at a brainstorm in Alqueva, on July 21, with the presence of the ALEX consultants, Patrick Le Moigne, Giles Harrison and Maria Parrondo, the colleagues from the University of Lisbon, Pedro Soares and Pedro Miranda, and the Meteorologist Carlos Policarpo. Given the weather forecast, it was decided to start the launch program on July 22 at 12 UTC.
The schedule of the radiosondes is shown in Table 4. In total, 18 radiosondes have been launched. Several have been launched from a boat (Figure 3.19, Figure 3.20) over the Alqueva reservoir (Lake in the Table 4) and the others from the Terrace over the EDIA warehouse (Land in the Table 4, Figure 3.22). In 8 cases (sond type = meteo + ion), Geigersondes (Harrison et al., 2012) were coupled to the

meteorological radiosondes (Figure 3.22, Figure 3.24) in order to obtain the atmospheric ionization profile.
The atmospheric profiles of Temperature, humidity and pressure were obtained with the Vaisala Radiosondes model RS92-SGP(Figure 3.23):
(http://www.vaisala.com/Vaisala%20Documents/Brochures%20and%20Datasheets/RS92SGP-Datasheet-B210358EN-F-LOW.pdf). TOTEX meteorological balloons (600 gr) were used.

Table 4 list of ALEX IOP radiosondes

day	hour (UT)	launch local	sond type
Tueday -22	12:00	Lake	meteo + ion
	18:00	Lake	meteo
	21:00	land	meteo + ion
Wednesday - 23	00:00	lake	meteo
	03:00	land	meteo + ion
	06:00	lake	meteo
	09:00	land	meteo + ion
	12:00	land	meteo + ion
	15:00	land	meteo + ion
	18:00	land	meteo + ion
	21:00	land	meteo
Thurday - 24	00:00	land	meteo
	03:00	land	meteo + ion
	06:00	land	meteo
	09:00	land	meteo
	12:00	land	meteo
	15:00	land	meteo
	18:00	land	meteo

The geigersondes are based on two miniature Geiger tubes (Figure 3.24). They are coupled to the RS92-SGP radiosondes (Figure 3.22) through a digital interface so that the radiosonde transmits all the data (GPS, meteorological and ionization of the atmosphere).

Figure 3.19

Figure 3.20

Figure 3.21

Figure 3.22

Figure 3.23

Figure 3.24

The radiosonde and GPS signals were received by Vaisala Sounding Processing Subsystem SPS311, using a SDR receiver and local antennas (Figure 3.23). The SPS311 decodes the data and relays it to

the sounding workstation for processing and archiving.

Lisbon Radiosondes

During the IOP, the IPMA launched two radiosondes every day from the Gaco Coutinho Observatory in Lisbon at 00 (additional for ALEX 2014) and at 12 UTC. So, in addition to the routine program, the following radiosondes were performed in Lisbon (launch time):

- 21/07/2014 23:13
- 22/07/2014 23:27
- 23/07/2014 23:12
- 24/07/2014 23:04

iii) Biological sampling and Underwater profiles

The IOP includes one field trip of sampling and measurement of physico-chemical, biological and radiative parameters, as described in section 3.2. The graduate students of the ALEX2014 workshop participated in this field works, as documented in Figure 3.34, 3.35 and 3.36.

iv) Second Air quality unit and characterization of the boundary layer

The VAISALA Ceilometer CL31, installed and operating since the beginning of May 2006 in the Observatory of the Évora Geophysics Centre (CGE), was dislocated to Alqueva during the IOP of the ALEX 2014 and mounted in the Solar Park site. The ceilometer measures the cloud base height up to three simultaneous layers, as well as the atmospheric backscattering. It employs a pulsed diode laser LIDAR (light detection and ranging) technology, where short, powerful laser pulses are sent out in a vertical or near vertical direction. The reflection of light (backscatter) caused by clouds, precipitation or other obscuration is analyzed and used to determine the cloud base height (http://www.vaisala.com).
The CL31Vaisala ceilometer uses a single lens design such that the centre of the lens is used for collimating the outgoing laser beam, whereas the outer part of the lens is used for focusing the backscattered light onto the receiver. The separation between transmitting and receiving areas is provided by an inclined mirror with a hole in the centre. In this way a very good performance is achieved, even at the lowest heights. The ceilometer has a measurement range from 0 to 7.5 km, maximum resolution of 5 m and programmable measurement cycle (from 2 to 120 s). It uses an eye-safe laser InGaAs diode at 910 nm.
The ceilometers measurements were used during the IOP to determine and characterize the boundary layer evolution. Since the period of study was mainly characterized by clear sky conditions, the ceilometer backscattering obtained was mainly due to aerosols. Assuming that these particles are mostly concentrated in the mixing layer, a sharp decrease of the backscatter signal at the top of the mixing layer is therefore expected. The ceilometer backscatter coefficient profile is then analyzed in order to detect profile trend changes in correspondence of the mixing layer top height.
In addition to the in situ measurements, the Vertical distribution of O3 and NO2 were obtained by the Spectrometer for Atmospheric Tracers Measurements

Figure 3.25 Ceilometer and the ICT Air-quality mobile unit installed at the Solar Park Site (up left); The optical particle sizer (OPS) TSI-Model 3330; the Spectrometer for Atmospheric Tracers Measurements (SPATRAM) mounted in the top of the van (Bottom left);View of Edia Solar Park during the IOP of ALEX 2014.

The second air quality caravan, belonging to the ICT, were placed in the Solar Park site, just in time to participate in the IOP. This mobile unit includes also a weather station. The parameters measured are indicated on the Table 5. In addition to the in situ measurements, the vertical distribution of O3 and NO2 were obtained by the Spectrometer for Atmospheric Tracers Measurements (SPATRAM).

Instrument	Parameter measured	Start Date	End Date
Gas analyser (*in situ*)	NO2 concentration	19/07/2014	26/09/2014
	O3 concentration		
	SO2 concentration		
Remote Sensing with Zenith-SKY DOAS and MultiAxis DOAS (MAX-DOAS)	NO2 concentration		
	O3 concentration		
	SO2 concentration		
Meteorological station	Pressure, temperature, humidity, wind vector		
Pyranometer	Global radiation		
Ceilometer	Backscattering profiles and cloud base height	19/07/2014	25/07/2014

Table 5 Instruments and Measurements at the ICT air-quality Mobile Unit

AEROSSOLS

The concentration of aerosols were measured in the Solar Park site, during the IOP (21-25 July 2014) with a light, portable Optical Particle Sizer (OPS, Figure 3.25). This unit, whose characteristics are detailed in the Table 6, provides fast and accurate measurement of particle concentration and particle size distribution using single particle counting.

Table 6 Characteristics of the optical particle sizer measurements

Instrument	Optical particle sizer (OPS) TSI-Model 3330
Measurements	particle concentration and particle size distribution, size range 0.3 – 10 μm)
sampling rate	5 min
Measurement period	21-25 July 2014

v) Night luminosity

The evaluation of the brightness of the night sky in the region of Alqueva due to the presence of ALAN (Artificial Light At Night) was an objective added to the ALEX2014. The ALEX2014 campaign coincided with nights plenty of moonless periods, a requisite for the study of the quality of the night sky regarding brightness.

For the measurements of the sky brightness on the nights of July 24 and 25, 2014, an Unihedron Sky Quality Meter–L (SQM-L hereafter) was used. The SQM-L uses a TAOS TSL237 high-sensitivity light-to-frequency converter that «combines a silicon photodiode with a current-to-frequency converter

on a single monolithic CMOS integrated circuit» (see http://unihedron.com/). An HOYA CM-500 filter covers the sensor to remove the infrared region of the spectra (wavelengths above ~700 nm).

Figure 3.26 Unihedron Sky Quality Meter–L

The SQM-L has a FWHM of 20° and is factory calibrated to a precision of ±0,10 mag/arcsec2. All measurements were obtained pointing the device to the zenith, handheld, during astronomical night (Sun 18° or more below the horizon). The geographic coordinates were obtained with the Fullpower Technologies Inc.'s MotionX-GPS app installed on an Apple iPhone smartphone (model 5s).
The measurements were made in 44 places inside the Dark Sky® Alqueva Reserve, covering the municipalities of Portel, Moura, Mourão, Alandroal and Reguengos de Monsaraz.

vi) Workshop

In parallel with the intensive period, a Workshop on Observations in Atmospheric and Water Sciences took place in Alqueva. taking advantage of the participation of several experts in the campaign. The Woekshop The program and other details about the ALEX 2014 workshop, intended for graduate students, are given in section 8.1.
In addition to participating in the field experiment (see for example Figure 3.34), the students had the opportunity to attend several lectures. Example images from the lectures are shown in Figure 3.27 to Figure 3.31. The Workshop included study visits to the Solar Park site (Figure 3.33 and Figure 3.37), to the Amieira Marina site (Figure 3.32, 3.38 and 3.39), and to the Alqueva Montante floating Platform (Figure 3.35 and 3.36). In the last workshop day the participants visit the EDIA interpretation Center, where Ana Ilhéu gives a talk about the Environmental Management of the Alqueva-Pedrogão System, and the he Alqueva Hydro Power Plant (Figure 3.40 3.41), where André Silva give the talk: "Electro-Mechanical Components of the Alqueva Hydro Power Plant".
The participants in the ALEX2104 workshop and field experiment were lodged at the Alqueva Hostel, in whose living room (Figure 3.27) the lectures were given. A group photo in front of the hostel is

shown in Figure 3.43. The movement of the students to the experimental activities were supported by the parish council. A social dinner were organized also with the help of the parish council (Figure 3.42).

Figure 3.27 ALEX2014 Workshop: Welcome Session by Miguel Potes "Introduction to ALEX 2014 Experiment and Workshop. Organization of work groups"

Figure 3.28 Giles Harrison

Figure 3.29 Keri Nicoll

Figure 3.30 Susana Barbosa

Figure 3.31 Pedro Miranda

Figure 3.32 Visit to the air quality mobile unit at Amieria Marina, guided by Paulo Beliche (not in the photo)

Figure 3.33Visit to the Solar Park site. Maria João Costa explaining the ceilometer

Figure 3.34 collection of water samples and biological material with Manuela Morais

Figure 3.35 Visit to the floating Platform: Measurement of chemical/biological parameters.

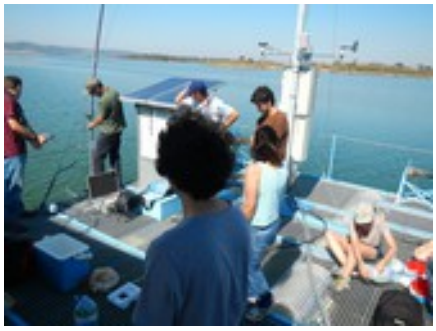


Figure 3.36 Visit to the floating Platform: measurements of underwater radiance

Figure 3.37 Visit to the Solar Park site: Paulo Canhoto shows the Sun-tracker and solar radiation, global and DNI.

Figure 3.38 Visit to the Amieira Marina: GPS for meteorological purposes.

Figure 3.39 Visit to the Amieira Marina: Atmospheric electricity and radon measurements, presented by Hugo Silva.

Figure 3.40Visit to the Alqueva Hydro Power Plant, guided by André Silva.

Figure 3.41Visit to the Alqueva Hydro Power Plant

Figure 3.42 ALEX 2014 social dinner in Alqueva with “cante alentejano" by the group "Almovreves da Amieira"

Figure 3.43Workshop group photo at the Alqueva Hostel

vii) Debate about Alqueva and Climate

Taking advantage of the stay of researchers and graduate students in the small village of Alqueva, the ALEX2014 IOP included a debate with the local population entitled "A Albufeira de Alqueva e o Clima" (the Alqueva reservoir and the Climate). This outreach activity, co-organized with the parish council, took place on July 22, 21 H, in the parish living hall and is described in section 9.1.

3.4. Maintenance and data collection

i) fortnightly routine operations

The meteorological stations were checked every fortnight. These maintenance tasks included cleaning the sensors and data download.

ii) Daily remote data checking and emergency repairs

The stations that had a remote access system were monitored on a daily basis. Sometimes it was necessary to make emergency visits.

3.5. End of field Experiment- 3th milestone

The third milestone "end of the field campaign" was reached on 30 September, as planned. The equipment was dismounted on 1 and 2 October.
Due to a bloom situation, an additional sampling campaign for cyanobacteria was performed in October 6. This was the last ALEX2014 field measurement activity.

4. Task 3

4.1. Database

The data collected during ALEX2014 are summarized in the the Tables 7 (Continuos field campaign), 8 (IOP) and 9 (Sampling).

Continuum Measurements		Meteo	Radiation	Elect.	Air Qual.	Sism.	Radon	Radiosond	Hidrol.
Local									
Platform Alqueva		x	x						
Platform Mourão		x	x						
Solar Park		x	x	x	x				
Amieira Marina		x		x	x	x	x		
Herdade da Barbosa		x							
Herdade de Cid Almeida		x							
Alquilha		x	x						
Beja				x					
44 IPMA Stations		x	x						
3 ICT Stations		x							
Lisboa								x	
Hydro-electric Central EDP									x

Table 7: ALEX2014 Continuum Measurements (June - September 2014)

IOP Measurements	Water T. Profiles	Radiation Profiles	Water Qual.	GPS	Meteo	Ceilom	TSI (aeros.)	Radio sond	Lum.
local									
Solar Park						x	x	x	
Platform Alqueva	x	x	x						
Platform Mourão	x	x	x						
Platform Alcarrache	x	x	x						
Amieira Marina			x	x					
Herdade Barbosa				x					
Herd. Cid Almeida				x					
Amieira Village				x					
Monte das Areias				x					
Rest. Avestruz				x	x				
Canarinhos				x					
Herdade Catapral				x					
Herdade Alcarias				x					
Alquilha				x					
Monte da Pata				x	x				
Monte da Rola				x					
Quinta Vaquinha				x					
Serpa				x					
Herdade Torrejona				x					
44 locals in region									x

Table 8 Measurements made during the ALEX2014 Intensive Observation Period (IOP)

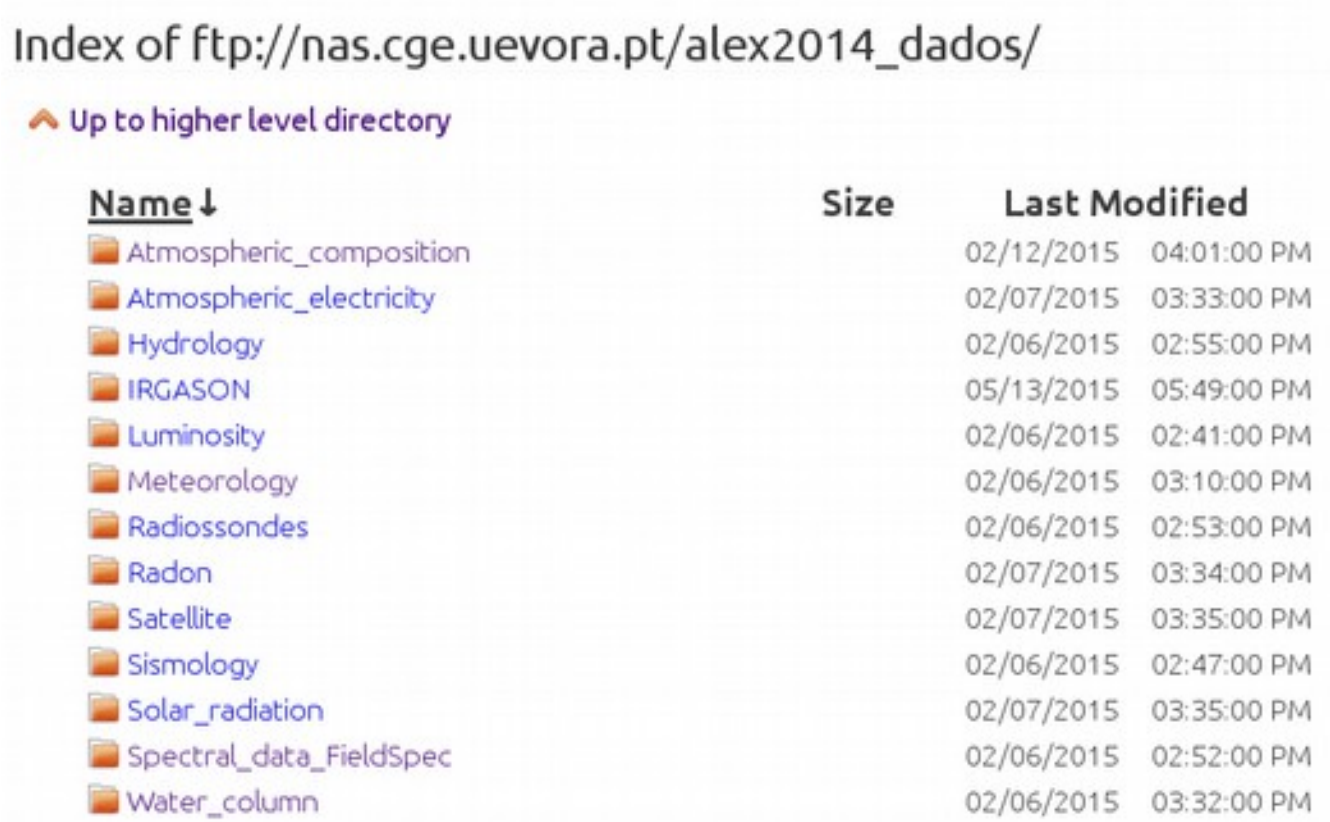
Measurements	Water quality profiles	Irradiative Profiles	Collection of water samples
local			
Platform Alqueva	X	X	X
Platform Mourão	X	X	X
Platform Alcarrache	X	X	X
Amieira			X

Table 9 Measurements made on the montly scientific trips

The data are stored in a database accessible to the scientific community. For the moment, the data are archived in the network-attached storage (NAS) of the CGE/ICT: nas.cge.uevora.pt. and may be accessed trough the ftp protocol.

i) ftp server

As stated above, the data can be downloaded from the ftp server:
ftp://nas.cge.uevora.pt in the folder “alex2014_dados”
Authentication is done by password. An username and a password should be required to project coordinator through the ALEX2014 webpage.
The data are stored in the following folders:



Each folder may contain severel sub-folders. As an example, the next print screen show the content of the Meterology folder:

This folder contains one sub-folder per ALEX2014 station, more two, one for all the CGE/ICT stations and 1 for the IPMA stations. In the last level the sub-folder “Herdade de Cid Almeida”, for example, contains files with the data and a README file with metadata.

ii) webpage

The webpage: http://www.alex2014.cge.uevora.pt, contains information and documents about the ALEX2014 project and campaign. It includes instructions for those who want to use the ALEX2014 data.

4.2. Data processing

In this section a not exhaustive list of data processing tasks performed under the project is present. The processing of data and its exploitation continues beyond the formal end of the project.

i) evaporation

A study on the calculation of the evaporation of the reservoir was carried out by the undergraduate student Rafael Serrano. Rafael Serrano was a student of engineering of renewable energies and performed his degree thesis at EDIA, under the project ALEX and the supervision of Carlos Miranda Rodrigues and Martinho Murteira. The results, based on data measured at Alquilha, may be found in Serrano (2015). Briefly, the values measured on the class A evaporation pan at the Alquilha weather station were confronted with the evaporation computed by the Brutsaert expression (Brutsaert, 2005). This allows to calibrate the Brutsaert method and use it to estimate evaporation even in the absence of pan data.

ii) flux calculations

The computation of momentum, energy (latent and sensible) and mass (water vapor and carbon dioxide) fluxes were made based on the archived raw data and using a code written for that purpose in IDL (the Interactive Data Language), as explained in section 6.1.
The acceleration of the floating platform, measured, from July 23 to October 1, with the built-in accelerometer attached to the eddy-covariance system (see section 2.4.x), are integrated, using a

trapezoidal method, in order to estimate the vertical velocity of the sensor. This velocity were used to correct the vertical component of the wind and therefor the turbulent fluxes. The comparison between the fluxes with and without the correction for the platform motion shows that differences are negligible. So it may be concluded that it is not necessary to take in account the raft motion and that float oscillation does not contaminate the flux calculations.
The IRGASON gas-analyzer were recalibrated after the experiment, using the zero-and-span procedure as indicated in the instruction manual of IRGASON® Integrated CO2/H2O Open-Path Gas Analyzer and 3D Sonic Anemometer (Revision: 6/14). This allows the CO_2 and H_2O gain factors to be calculated and used to correct past measurements for drift. The zero-and-span procedure also adjusts internal processing parameters to be used in future measurements with the sensor.

iii) Radiation

Data quality was verified by comparison with its physically possible limits and by determining the difference between the calculated and measured global radiation. This calculation was based on the measured values of direct and diffuse radiation, thus allowing checking the correctness and consistency of sensors calibration as well as the sun tracker alignment. Again, this quality indicator followed and was compared with the limits required by the BSRN stations guidelines. The radiation data and rawdata files were stored in a suitable storage medium and were made accessible through a database.

iv) Laboratory Analysis

One of the goals of this research are the determination of the reservoir trophic status, the analysis of the physical-chemical and biological vertical dynamics and the ecological status assessment based on the ensemble of several biological elements, including phytoplankton, cyanobacteria (and toxic genes), diatoms and CPE. The samples collected in the field campaign were analyzed at the Water laboratory of the Évora University (http://www.labagua.uevora.pt/)

The following **nutrients** were determined in laboratory: nitrates (µg NO_3^-–N l^{-1}), nitrites (µg NO_2^-–N l^{-1}), ammonia (µg NH_4^+ –N l^{-1}), total nitrogen (µg N l^{-1}), total phosphorus (µg P l^{-1}) and soluble reactive phosphorus (µg PO_4^{3-}–P l^{-1}), following standard methods for water chemical analyses (APHA, 1995).

Diatom samples were treated, identified and quantified following standard protocols (CEN 14407: European Committee for Standardization 2004; INAG 2008).

Chironomid pupal exuviae (CPE) analysis and identification was carried out according to Wilson & Bright, 1973; Wilson & Ruse, 2005; EN 15196: 2006)

In laboratory, the integrated ***phytoplankton samples***, representative of the euphotic zone, were preserved, identified and quantified according to recent literature and appropriate protocols (e.g. CEN/TC 230: European Committee for Standardization, 2004; INAG, 2009).

DNA extraction: The molecular technique, polymerase chain reaction (PCR) was used to corroborate microscopic identification and to verify the presence of toxic genes associated with cyanobacteria.
Cells used to extract DNA for PCR analysis were collected by filtering 100 ml of the sample onto 0,2 µm pore size polycarbonate membrane filters (Millipore), and immediately frozen in Eppendorfs (-20ºC) until processing. Extraction of DNA was latter perform using a modification of the protocol described by Rinta-Kanto et al., 2005. Conventional PCR was performed for cyanobacterial reference strains and bloom samples to check the presence of toxin genes; and second, to check the specificity of

the PCR primers to amplify single genes. The PCR protocol consisted of an initial denaturation step at 94 °C for 3 min, 35 cycles at 94 °C for 45 s, primer annealing at 50 °C for 30 s, primer elongation at 72 °C for 1 min, and a final single step at 72 °C for 7 min.

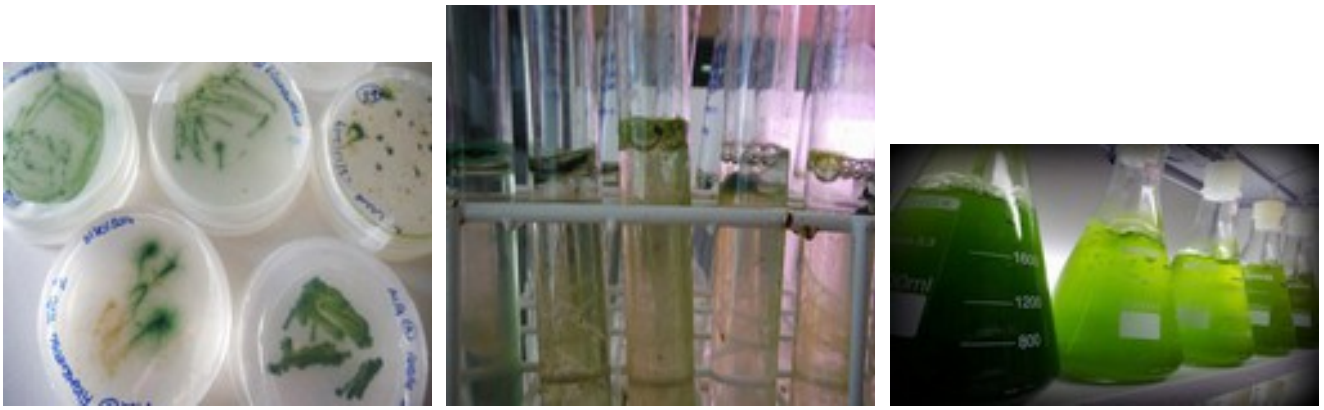


Figure 4.1 Different phases of in vitro culture. Isolated cyanobacteria on solid BG-11 medium (left); liquid medium without antibiotic (center). Liquid, non axenic cultures (right). Photos: Alexandra Penha & Amely Zavattieri

5. Publications

5.1. Papers in international journals

i) Submited

- F. Lopes, H.G. Silva, K.A. Nicoll, M. Potes, S.N. Pereira, R. Salgado, A.H. Reis, R.G. Harrison: **Negative space-charge density over the Alqueva reservoir (Portugal) calculated from atmospheric electrical measurements.** Submitted for publication in Journal of Geophysical Research - Atmospheres (manuscript 2015JD023804).

ii) in preparation

- Salgado, R., Potes, M., Albino, A., Apolinário, J., Barbosa, S., Bárias, S., Beliche, P., Bortoli, D., Canhoto, P., Costa, M. J., Fernandes, R.M., Harrison, G., Ilhéu, A., Le Moigne, P., Lima, R., Lopes, F., Lopes, T., Marques, J., Melgão, M., Miranda, P. M., Morais, M., Murteira, M., Nicoll, K., Novais, M. H., Nunes, S., Parrondo, M. C., Penha, A., Pereira, S., Policarpo, C., Prior, V., Rodrigues, C. M., Rosado, J., Sá, A., Serafim, A., Silva, H., Soares, P. M. M., Tlemçani, M., Zavattieri, A., 2015: **ALEX 2014: An integrated field experiment on Lake-Atmosphere Interactions in Alqueva (South Portugal)**
- Potes, M., R. Salgado, M.J. Costa, D. Bortoli, A. Albino and M. Morais: **Determination of mass and energy flux in lake-atmosphere interface and inwater solar spectral attenuation coefficient**
- Morais, M. Maria Helena Novais, Susana Nunes, Alexandra Penha, Joana Rosado, Amely Zavattieri, Miguel Potes and Rui Salgado: **Complementary approaches for the ecological assessment of a large reservoir (Alqueva, Southern Portugal)**

5.2. Communications in national meetings

Costa, M.J, Daniele Bortoli and Sérgio Pereira, 2014: Characterization of the atmosphere using remote sensing techniques. Workshop on Observations in Atmospheric and Water science, Alqueva 22-25 July 2014.

Morais, M., M. H. Novais, 2014: Measuring vertical profiles in reservoirs: physical and chemical variables. Workshop on Observations in Atmospheric and Water science, Alqueva 22-25 July 2014.

Morais, M., Zavattieri, A:, 2015: Remediation strategies in South Portugal reservoirs. Workshop on Observations in Atmospheric and Water science, Alqueva 22-25 July 2014.

Morais, M., Maria Helena Novais, António Serafim, Susana Nunes, Joana Rosado, Alexandra Penha, Amely Zavattieri, Miguel Potes, Rui Salgado, 2015: Alqueva hydro-meteorological experiment (ALEX): first results of aquatic ecological assessment. 9º simpósio de meteorologia e geofísica da APMG, 16-18 March 2015. Tavira, Portugal.

Potes, M., M. J. Costa, R. Salgado, 2015: Interacções lago-atmosfera na albufeira de Alqueva. 9º Simpósio de meteorologia e geofísica da APMG, 16-18 March 2015. Tavira, Portugal.

Salgado, Rui and Miguel Potes, 2014: "Eddy-covariance measurements of momentum, heat and mass fluxes in the air using the new Campbell Scientific's IRGASON Integrated Open-Path CO2 /H2O Gas Analyzer and 3D Sonic Anemometer". Évora Mechatronics Seminars, March 7, 2014, University of Évora.

Salgado, R., Potes, M., Albino, A., Apolinário, J., Barbosa, S., Bárias, S., Beliche, P., Bortoli, D., Canhoto, P., Costa, M. J., Fernandes, R.M., Harrison, G., Ilhéu, A., Le Moigne, P., Lima, R., Lopes, F., Lopes, T., Marques, J., Melgão, M., Miranda, P. M., Morais, M., Murteira, M., Nicoll, K., Novais, M. H., Nunes, S., Parrondo, M. C., Penha, A., Pereira, S., Policarpo, C., Prior, V., Rodrigues, C. M., Rosado, J., Sá, A., Serafim, A., Silva, H., Soares, P. M. M., Tlemçani, M., Zavattieri, A., 2015: ALEX2014: Campanha de observações hidro-meteorológicas em alqueva. 9º simpósio de meteorologia e geofísica da APMG, 16-18 March 2015. Tavira, Portugal.

5.3. Communications in International Meetings

Ilhéu, A. and Martinho, M., 2015: Environmental Management of the Alqueva-Pedrogão System. 4th Workshop on Workshop on "Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling, 07-09 May 2015, Évora, Portugal.

Lopes, F., Hugo G. Silva, K. Nicoll, M. Potes, S. N. Pereira, R. Salgado, A. H. Reis, R.G. Harrison, 2015: Negative space-charge density over Alqueva reservoir (Portugal) retrieved from atmospheric electric field measurements.

Morais, Manuela; Novais, Maria Helena; Rosado, Joana; Penha, Maria Alexandra; Nunes, Susana; Zavattieri, Amely; Salgado, Rui; Potes, Miguel, 2015: Complementary approaches for the ecological assessment of a large reservoir (Alqueva, Southern Portugal). 17th IWA International Conference on Diffuse Pollution and Eutrophication, 13–18 SEPTEMBER 2015, Berlin, Germany (accepted)

Morais, Manuela, Maria Helena Novais, Susana Nunes, Joana Rosado, Alexandra Penha, Amely Zavattieri, Miguel Potes & Rui Salgado, 2015: Ecological assessment of Mediterranean reservoirs: Alqueva reservoir as a case study (Alentejo, Southern Portugal). LAKE2015: 4th Workshop on Workshop on "Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling, 07-09 May 2015, Évora, Portugal.

Potes, M., M.J. Costa e R. Salgado, 2014: **Measurements of Lake-Atmosphere interactions at Alqueva reservoir**. European Meteorological Society Anual Meeting, Prague, Czech Republic. Vol. 11, EMS2014-498

Potes, M., R. Salgado and M. J. Costa, 2015: **How lakes influence the local atmospheric circulation**. Young Scientist Award Lecture in 15th EMS Annual Meeting & 12th European Conference on Applications of Meteorology (ECAM), 07 – 11 September 2015, Sofia, Bulgaria (accepted and ***selected to receive the 2015 EMS Young Scientist Award***).

Potes, M., R. Salgado and M. J. Costa, 2015: Exchanges of energy and mass between the atmosphere and lake, case study of Alqueva reservoir, Portugal. 2015 ASLO Aquatic Sciences Meeting, 22-27 February 2015, Granada, Spain.

Potes, M., R. Salgado, M. J. Costa and ALEX2014 team, 2015: Eddy covariance flux measurements at alqueva reservoir. LAKE2015: 4th Workshop on Workshop on "Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling, 07-09 May 2015, Évora, Portugal.

Salgado, R., M. Potes, A. Albino, C. M. Rodrigues and ALEX 2014 Scientific, 2014: Eddy covariance flux measurements over a man made lake during the ALEX 2014 field campaign in South Portugal, 2014 AGU Fall Meeting, San Francisco, USA, December 2014.

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Sá, André, Rui M.S. Fernandes, Fábio Bento, João Apolinário, Machiel Bos: GNSS as a tool for tropospheric water vapor monitoring. Alqueva lake Case-Study. 4th Workshop on Workshop on "Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling, 07-09 May 2015, Évora, Portugal.

Zavattier A.; Nunes S.; Penha A.; Caldeira A.T., Martins M. R.; Novais M. H.; Morais M.; Rosado J., Salgado R., 2015: Monitoring cyanobacteria and cyanotoxins in Alqueva Reservoir, Portugal. 4º

Congresso Ibérico Cianotoxinas, Lisboa, 8-10 de Julho, 2015 (accepted)

5.4. Master Thesis

André Filipe Rendeiro Albino: *Radiação solar: estudo e criação de plataforma de apoio à conceção de um sensor de radiação solar.* Universidade de Évora. November 2014 (supervisors: Mouhaydine Tlemçani and Rui Salgado)

5.5. Degree Thesis

Tiago Lopes, "Dimensionamento de sistemas PV e calibração de sensores de radiação solar", Relatório Final da Licenciatura em Engenharia de Energias Renováveis, Universidade de Évora, Setembro de 2014 (orientação: Paulo Canhoto - UE)

Filipe Gonçalves, "Medição e caracterização do vento na estação meteorológica da Mitra", Relatório Final da Licenciatura em Engenharia de Energias Renováveis, Universidade de Évora, Janeiro de 2015 (orientação: Rui Salgado - UE)

Rafael Serrano, "Quantificação das perdas por evaporação na albufeira de Alqueva como determinante do balanço de massa e do potencial hidroelétrico do reservatório", Relatório Final da Licenciatura em Engenharia de Energias Renováveis, Universidade de Évora, Janeiro de 2015 (orientação: Carlos Miranda Rodrigues - UE, Martinho Murteira . EDIA)

5.6. Reports

i) Reports of the fellows of the project

- Miguel Joaquim Fernandes Potes, 28 de Julho de 2014: *Relatório relativo ao período 18 de Março 2014 a 18 de Setembro 2014*
- Miguel Joaquim Fernandes Potes, 20 de Outubro de 2014: *Relatório relativo ao período 19 de Setembro 2014 a 30 de Novembro 2014*
- Maria Helena Batista da Costa Guerreiro de Novais, 26 de Maio de 2015: *Relatório relativo ao período 01 de Dezembro 2014 a 22 de Março 2015*

ii) Other Reports

- Salgado, R. et al., 2015: ***ALEX 2014 (Project EXPL/GEO-MET/1422/2013) detailed description***. This report
- Beliche, P. et al., 2015: ***ALEX2014: Notas sobre as medições de qualidade do ar medida pela CCDR Alentejo***

6. Software

6.1. Software for eddy covariance fluxes calculation

The software developed allows mass and energy fluxes calculations from raw data of IRGASON

(Integrated Open-Path CO_2/H_2O Gas Analyser and 3D Sonic Anemometer). It was developed in the programming Interactive Data language (IDL).
Eddy Covariance (EC) is the most common technique to access turbulent fluxes in surface-layer. This technique uses high frequency measurements, typically 20 Hz, and 30 minutes averaged fluxes. Depending on the equipment some corrections need to be done in order to have accurate fluxes. In this case, three corrections are necessary due to instrument surface heating/cooling: first the three dimensional coordinate rotations, which result in zero vertical and transverse mean wind speeds, are applied to the covariances; second the correction of density fluctuations for thermal expansion and water vapor dilution according Webb et al. (1980), and third the sonic temperature is corrected for water vapor according Kaimal and Gaynor (1991).

Input variables (high frequency, typically: 20 Hz):
u – X component of wind speed (m s^{-1})
v – Y component of wind speed (m s^{-1})
w – Z component of wind speed (m s^{-1})
Ts – Sonic Temperature (ºC)
ρ_w – Water Vapor density (g m^{-3})
ρ_c – Dioxide Carbon density (mg m^{-3})
T – Ambient Temperature (ºC)
p – Barometric Pressure (kPa)

Output fluxes each 30 minutes:
τ – Momentum Flux (Kg m^{-1} s^{-2})
H_c – Sensible Heat Flux (W m^{-2})
F_{LE} – Latent Heat Flux (W m^{-2})
F_C – Carbon Dioxide Flux (mg m^{-2} s^{-1})
For coordinate rotations the following equation were established:
The angles θ and φ are defined:

$$\theta = \arctan\left(\frac{\bar{v}}{\bar{u}}\right);\ \varphi = \arctan\left(\frac{\bar{w}}{\sqrt{\bar{u}^2+\bar{v}^2}}\right)$$

The rotated covariances are defined:

$$\overline{\hat{u}'\hat{w}'} = \overline{u'w'}cos\theta\left(\cos^2\varphi-\sin^2\varphi\right)+\overline{v'w'}sin\theta\left(\cos^2\varphi-\sin^2\varphi\right)$$
$$-2\overline{u'v'}csin\theta cos\theta sin\varphi cos\varphi-\sigma_u^2\cos^2\theta sin\varphi cos\varphi$$
$$-\sigma_v^2\sin^2\theta sin\varphi cos\varphi+\sigma_w^2 sin\varphi cos\varphi$$

$$\overline{\hat{u}'\hat{v}'} = \overline{u'v'}\cos\varphi\left(\cos^2\theta-\sin^2\theta\right)+\overline{v'w'}cos\theta sin\varphi-\overline{u'w'}sin\theta sin\varphi+\left(\sigma_v^2-\sigma_u^2\right)sin\theta cos\theta sin\varphi$$

$$\overline{\hat{v}'\hat{w}'} = \overline{v'w'}cos\theta cos\varphi-\overline{u'w'}sin\theta cos\varphi-\overline{u'v'}sin\varphi\left(\cos^2\theta-\sin^2\theta\right)+\left(\sigma_u^2-\sigma_v^2\right)sin\theta cos\theta sin\varphi$$

and

$$\overline{\hat{w}'s'} = \overline{w's'}cos\varphi-\overline{u's'}cos\theta sin\varphi-\overline{v's'}sin\theta sin\varphi$$

Where σ^2 are variances and s is any scalar quantity, in this case temperature, water vapor density or carbon dioxide density.
Momentum flux:

$$\tau = -\rho_a\overline{\hat{u}'\hat{w}'}$$

Where $\rho_a = \rho_{a,dry}+\rho_w$ is air density ; $\rho_{a,dry} = \frac{P}{R_d T_c}-\left(\rho_w\frac{M_{a,dry}}{M_w}\right)$ is density of dry air ; where $\frac{M_{a,dry}}{M_w}$ is the ratio of the molecular weight of dry air to water vapor and T_c is the temperature

corrected for water vapour: $T_c = T_s\left(1 + 0.32\frac{e}{p}\right)$; e is vapour pressure of water in air and p is absolute pressure.

Sensible heat flux:

$H_c = \rho_a C_p \overline{\hat{w}'\hat{T}_c'}$

C_p is specific heat of air (1003.5 J Kg^{-1} K^{-1})

Latent heat flux:

$$F_{LE} = \overline{\hat{w}'\hat{\rho}_w'} + \left(\frac{M_a}{M_w}\frac{\overline{\rho_w}}{\rho_{a,dry}}\right)\overline{\hat{w}'\hat{\rho}_w'} + \left(1 + \frac{M_a}{M_w}\frac{\overline{\rho_w}}{\rho_{a,dry}}\right)\frac{\overline{\rho_w}}{\overline{T}_c}\overline{\hat{w}'\hat{T}_c'}$$

The second term for water vapor dilution and the third for thermal expansion (both correction of density fluctuations for water vapor), where M_a molecular mass of air.

Carbon dioxide flux:

$$F_C = \overline{\hat{w}'\hat{\rho}_c'} + \left(\frac{M_a}{M_w}\frac{\overline{\rho_c}}{\rho_{a,dry}}\right)\overline{\hat{w}'\hat{\rho}_w'} + \left(1 + \frac{M_a}{M_w}\frac{\overline{\rho_w}}{\rho_{a,dry}}\right)\frac{\overline{\rho_c}}{\overline{T}}\overline{\hat{w}'\hat{T}_c'}$$

Again, the second term for water vapor dilution and the third for thermal expansion (both correction of density fluctuations for water vapor).

7. Prototypes

7.1. Underwater Solar Irradiance Profiler

The prototype developed intent to be a portable tool to measure spectral downwelling solar irradiance inwater. This prototype is an upgrade version of a device developed in 2012 (Potes et al., 2013) with the major difference in the field-of-view (FOV) which now allows for measurements of hemispherical radiance (180º of FOV) instead of a 25º of FOV.

The prototype is composed by a portable spectroradiometer linked to an optical fiber bundle driven by a customized frame to protect the optical cable with an optical receiver in the tip. See Figure 7.1 and Figure 7.2 for details.

The portable FieldSpec UV/VNIR Spectroradiometer from Analytical Spectral Devices Inc. (Boulder, CO, USA) was used to record the spectral downwelling zenith irradiance (hemispheric radiance) measured across the spectral range 325-1075 nm with a spectral resolution ranging from 1 to 3 nm for the UV and NIR spectral regions respectively. The optical cable was chosen to meet the optical features of the spectroradiometer. In order to maximize the signal reaching the spectrometer, the interspacing of the optical fibres in the bundle is minimized using fibres of two different diameters (0.22 and 0.11 mm).

The frame was developed to guarantee the verticality and horizontality of the optical receiver, which has to point upwards to the zenith in order to collect the downwelling zenith irradiance at several levels below the water surface. The profiles obtained from surface to three meters depth allow the calculation of spectral attenuation coefficient of light inwater.

The attenuation coefficients are relevant in the water surface layer energy budget, which is important for many applications, namely for the representation of lakes in numerical weather prediction models. In particular, results from Potes et al. (2012) in Alqueva reservoir (southeast Portugal) show that the two layer bulk lake model, FLake model (Mironov et al., 2010), currently coupled to some weather forecast models (see for example Balsamo et al., 2012) is very sensitive to the attenuation coefficient. In particular, this coefficient is important in the computation of the water surface temperature, which is a key parameter in heat and moisture transfers between the reservoirs and the atmosphere.

Figure 7.1 Schematic representation of the Underwater Solar Irradiance Profiler

Figure 7.2 Multi-layers frame developed to protect the optical cable (not visible here) and the optical receiver with a field-of-view (FOV) of 180°

In Figure 7.3 the team is starting the collection of one profile during ALEX2014 field campaign in Alqueva reservoir.

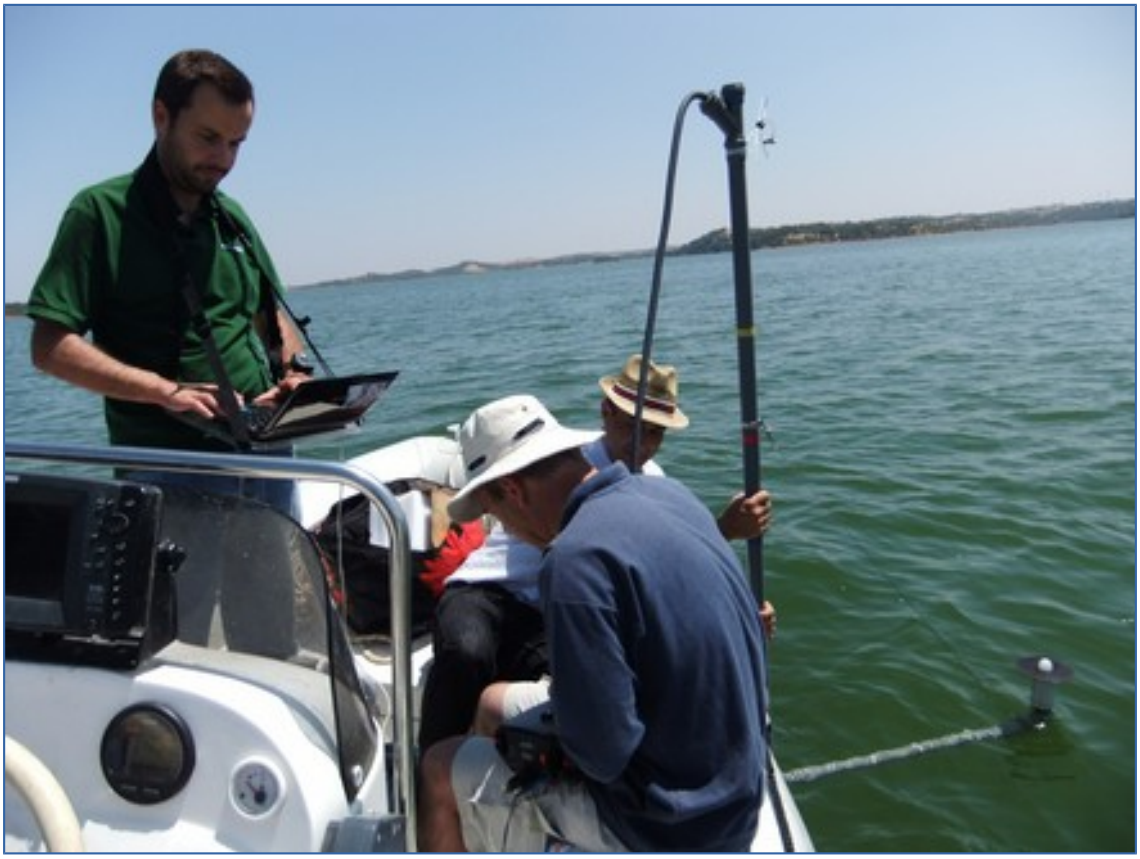

Figure 7.3 Measurements with the prototype during ALEX2014 field campaign in Alqueva reservoir.

7.2. Low power consumption acquisition system for the Vaisala WXT520

A low power consumption data logger device, using an Intel Galileo Arduino was developed. For the effect, the following tasks were done:

- built a physical interface to invert the tension signal.
- develop software for the Galileo to read the data and write it in an micro SD card.

This device is connected to the Vaisala WXT520 using the SDI-12 protocol.
This data logger can read, save and send information, and allows some real time data processing calculations. In the future, more functions will be added, namely to improve data communication.
Galileo is a microcontroller board based on the Intel® Quark SoC X1000 Application Processor, a 32-bit Intel Pentium-class system on a chip. It's a board based on Intel® architecture designed to be hardware and software pin-compatible with Arduino shields designed for the Uno R3.

Figure 7.4: Galileo microcomputer

8. Workshops

8.1. ALEX 2014 Workshop on Observations in Atmospheric and Water sciences, Alqueva, 22 – 25 July 2014

As indicated above, It was organized a summer school, a workshop on Observations in Atmospheric and Water sciences in parallel with the intensive period, taking advantage of the participation of several experts in the campaign.

i) Organization

- ALEX project,
- Lisbon Doctoral School on Earth System Science
- Geophysics Centre of Évora (University of Évora)
- Doctoral Program on Earth and Space Sciences (University of Évora)

ii) Organizing Committee

Rui Salgado, Pedro Miranda, Pedro Soares, Manuela Morais, Maria João Costa and Miguel Potes

iii) Local and Date

Alqueva Hostel in the Alqueva Village, 22 – 25 July 2014

iv) webpage

http://www.alex2014.cge.uevora.pt/

v) Program

Workshop on Observations in Atmospheric and Water sciences

AGENDA (Draft)	*ALEX2014 Workshop on Observations in Atmospheric and Water Sciences*
22 July	

AGENDA (Draft)	***ALEX2014 Workshop on Observations in Atmospheric and Water Sciences***
10:00 - 10:30	Rui Salgado and Miguel Potes Welcome Session: Introduction to ALEX 2014 Experiment and Workshop. Organization of work groups
10:30 - 13:00	Participation in the Field campaign activities Visit to the ALEX site in the EDIA Solar Park: • **Measurements of solar radiation, including DNI with a solar tracker.** Paulo Canhoto • **Radiação e Caracterização de Constituintes Atmosféricos.** Maria João Costa, Daniele Bortoli e Sérgio Pereira • **Launch of the first ALEX meteorological Balloon.**
13:00 - 15:00	Lunch and Siesta
15:00 - 15:45	Pedro Miranda ***From the regional climate impact of the Alqueva reservoir to global change***
16:00 - 17:45	Giles Harrison and Keri Nicoll ***Instrumentation for fair weather atmospheric electricity***
18:00 - 18:45	Susana Barbosa ***Geophysical radon monitoring***
19:00 - 21:00	Dinner time
21:00	Debate with the population of Alqueva and Amieira villages about the climate effects of the Alqueva reservoir (in Portuguese) / ***Debate com a população da Freguesia de Amieira e Alqueva sobre os efeitos da albufeira no clima*** com Rui Salgado (CGE / U. Évora), Pedro Miranda (IDL / U. Lisboa), Ana Ilhéu (EDIA), Carlos Miranda Rodrigues (ICAAM / UE), Carlos Policarpo (BASE Aérea nº11 de Beja) e Mauro Henriques (Presidente da União de Freguesias de Amieira e Alqueva)
23 July	
00:00 - 8:00	Launch of meteorological balloons: ONLY for volunteers

AGENDA (Draft)	***ALEX2014 Workshop on Observations in Atmospheric and Water Sciences***
Morning	***Field campaign activities*** Biological team. Visit to the floating platform: sample collection, vertical profiles of physical, chemical and biological parameters. Manuela Morais, Helena Novais e António Serafim. Eddy correlation system for flux measurements. Rui Salgado e Miguel Potes; Spectral measurements of underwater downwelling radiance. Miguel Potes
12:30 - 15:00	Lunch and siesta
15:00 - 16:30	Manuela Morais and Helena Novais ***Measuring vertical profiles in reservoirs: physical and chemical variables***
16:45 - 17:45	Cláudia Brandão ***Hydro-meteorological in extreme situations***
18:00 - 19:30	Manuela Morais and Amely Zavattieri ***Remediation strategies in South Portugal reservoirs***
24 July	
00:00 - 8:00	Launch of meteorological balloons: ONLY for volunteers
Morning	***Field campaign activities*** Visit to Amieira Marina ALEX site: Air Quality. Paulo Beliche Radon measurements. Susana Barbosa e Francisco Lopes Atmospheric electricity. Hugo Silva GPS site. André Sá e João Apolinário Automatic Weather Station. Rui Salgado
13:00 - 15:00	Lunch and Siesta
15:00 - 16:00	David Faiman ***Challenges to employing photovoltaics on a very large scale***
16:30 - 18:00	Patrick Le Moigne ***Surface - Atmosphere interactions: measurements and modelling***
20:00	Workshop Dinner and social event
25 July	
00:00 - 8:00	Launch of meteorological balloons: ONLY for volunteers

AGENDA (Draft)	*ALEX2014 Workshop on Observations in Atmospheric and Water Sciences*
10:00 - 11:30	Ana Ilhéu and Martinho Murteira Visit to the EDIA interpretation Center; Talk: ***Environmental Management of the Alqueva-Pedrogão System***
11:30 - 13:00	André Silva Visit to the Alqueva Hydro Power Plant; Talk: ***Electro-Mechanical Components of the Alqueva Hydro Power Plant***
13:00 - 15:00	Lunch and siesta
15:00 - 16:00	Maria João Costa, Daniele Bortoli and Sérgio Pereira ***Characterization of the atmosphere using remote sensing techniques***
16:00 - 17:00	André Sá ***The role of GNSS data for meteorological purposes***
17:00	Bye Session

vi) Participants

From Lisbon Doctoral School on Earth System Science:

- Sofia Nunes Lorena Ermida
- Daniela Catarina André Lima
- Virgílio Alexandre Bento
- Maria João Chinita
- Vânia Lima
- Diogo Martins
- Joana Ribeiro
- Andreia Filipa da Silva Pereira
- Mariana Santinho Vieira dos Santos
- Catarina Gonçalves Toronjo Guerreiro
- Pedro Ricardo Silva gomes Almeida

From Doctoral Program on Earth and Space Sciences (University of Évora)

- Marta Melgão
- Vanda Salgueiro
- Flavio Couto

Other undergraduate and graduate Students

- Emanuel Fidalgo
- André Albino
- Rui Mendes
- Victor Carrasco
- José Ventura
- Rafael Serrano

- Tiago Lopes

Researchers

- Rui Salgado
- Carlos Policarpo
- Miguel Potes
- Carlos Miranda
- Hugo Silva
- Maria João Costa
- Daniele Bortoli
- Paulo Canhoto
- Sérgio Pereira
- Manuela Morais
- Joana Rosado
- António Serafim
- Amely Zavattieri
- Pedro Miranda
- Pedro Soares
- Patrick Le Moigne
- María Concepción Parrondo
- Keri Nicoll
- Giles Harrison

8.2. 4th Workshop on "Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling" (LAKE 2015)

The 4th workshop on "Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling" took place in the University of Évora in May 2015. The Évora workshop continued the lake-parameterization workshop series, following the previous workshops held in Zelenogorsk (Russia) in 2008, Norrköping (Sweden) in 2010, and Helsinki (Finland) in 2012.

The Lake2015 was organized locally by ALEX team members (Rui Salgado, Miguel Potes and Maria João Costa), co-organized by the COST Action ES1404 "A European network for a harmonised monitoring of snow for the benefit of climate change scenarios, hydrology and numerical weather prediction" and had the support of the University of Évora and the of the Institute of Earth Sciences.

Figure 8.1 LAKE2015: Opening session

Figure 8.2 Welcome by the Rector of the University.

Figure 8.3 Lake2015: Group Photo

Figure 8.4 LAKE2015: Session at University of Évora

Figure 8.5 LAKE2015: Session in Alqueva

Figure 8.6 LAKE2015: Sociaol Dinner with "Cante Alentejano"

i) Comittee

Rui Salgado, University of Évora
Miguel Potes, University of Évora
Maria João Costa, University of Évora
M. José Monteiro, Portuguese Inst. for the Ocean and Atmosphere
Pedro Viterbo, Portuguese Institute for the Ocean and Atmosphere
Ekaterina Kourzeneva, Finnish Meteorological Institute
Laura Rontu, Finnish Meteorological Institute
Dmitrii Mironov, German Weather Service

ii) Local and Date

University of Évora. Portugal, May 07-09, 2015

iii) Web Page

http://www.lake15.cge.uevora.pt/

iv) Program

Thursday the 7th of May 2015 Universidade de Évora Colégio do Espírito Santo, Auditório 131	
9:00 9:30	Registration
9:30 – 10:00	Welcome session
10:00 11:00	**Inaugural Session** Chairperson: Laura Rontu Klaus Joehnk and Victor Stepanenko

	Integrated modelling of lakes in the climate system – a summary
11:00 11:30	Coffee break
11:30 – 13.00	**2nd Session: Lakes and Climate** Chairperson: Gabriel Rooney Patrick Le Moigne *FLake model at global scale: offline settings and evaluation of the impacts when coupled to the global circulation model CNRM-CM5* Rui Salgado *Interactions lake-atmosphere: The ALEX 2014 field campaign and numerical simulations* Pedro Soares *The Planetary Boundary Layer in the Alqueva Lake Region: observations and modelling results* Elena Shevnina *Water and thermal balances of Antarctic Lakes*
13:00 – 14:30	Lunch
14:30 – 16:00	**3º Session Lake parametrisations in NWP models** Chairperson: Maria Monteiro Gabriel Rooney *Lakes and lake effects in the Met Office Unified Model* Dmitrii Mironov *Lake Parameterization Scheme FLake in NWP Models COSMO and ICON: Status and Plans* Gianpaolo Balsamo *Interactive lakes in the ECMWF Integrated Forecasting System* Attila Nagy *Some aspects of the numerical weather prediction at Lake Balaton: application of a simple numerical wave parametrization scheme and experiments with the lake parametrization in WRF*
16:00 – 16:20	Coffee break
16:20 – 18:30	**4º Session Lake observations** Chairperson: Arkady Terzhevik

	Miguel Potes *Eddy covariance flux measurements at Alqueva reservoir* Ivan Mammarella *Benefits and challenges of long-term eddy covariance measurements over lakes* Victor Stepanenko *Numerical modeling of internal mixing and greenhouse gas dynamics in a boreal lake*
17:20 – 17:30	Pause
	Manuela Morais *Ecological assessment of Mediterranean reservoirs: Alqueva reservoir as a case study (Alentejo, Southern Portugal)* Lijuan Wen *Study of unstable atmosphere in early Summer over Ngoring lake in the Tibetan Plateau* Francisco Lopes *Negative space charge density over Alqueva reservoir (Portugal) retrieved from atmospheric electric field measurements*
18:30	Wine Tasting
	8th of May 2015 Colégio do Espírito Santo Auditório 131
8:30 – 9:45	**COST ES1404 Work Group technical meeting** **(For COST ES1404 members)**
10:00 12:30	**Special Cold Lake Session / COST ES1404 WG3 Meeting** **Chairperson: Jürgen Helmert** Jürgen Helmert *Objectives and tasks of the working group 3 (WG3) on snow data assimilation andvalidation methods for NWP and hydrological models in the COST action* ES1404 Laura Rontu *Lessons of the EU NPP programme "Snow and avalanche applications* Bin Cheng *Analyses snow and ice thickness from high resolution thermistor temperature profiles*

11:10 11:20	Coffee Break
	Homa Kheyrollah Pour *Winter-time Remotely-sensed Monitoring of Lake Ice- "North hydrology" European Space Agency Science Support Project* Arkady Terzhevik *Snow and ice cover on a shallow boreal lake: The effect on in-water processes* Sergey Golosov *Snow and ice cover on a shallow boreal lake: The effect on in-water processes*
12:30	Lunch
13:30	Excursion to Alqueva Bus From University of Évora to Alqueva
14:30 – 15:30	Visit to the Lake
	Social Center of the village of Alqueva
15:30 – 16:45	**5th Session: Warm lakes** Chairperson: Pedro Viterbo Ana Ilhéu *Environmental Management of the Alqueva-Pedrogão System* Wim Thierry *Present and future impact of the African Great Lakes on the regional climate* Maria Grechushnikova *Estimate of possible hydrological regime change of Tsimlyansk reservoir in conditions of the climate warming* André Sá *GNSS as a tool for tropospheric water vapor monitoring. Alqueva lake Case-Study.*
16:45 – 17:15	Coffee Break
17:15 – 18:00	**6th Session: Databases and Assimilation** Chairperson: Gianpaolo Balsamo Ekaterina Kurzeneva *Data assimilation with EKF for FLake: problems and perspectives* Margarita Choulga

	Status and progress in Global Lake Database developments
18:00 – 19:30	***Discussion on Lake Databases and Assimilation issues*** Moderator: Ekaterina Kurzeneva
20:00 – 22:00	Social Dinner
22:00	Bus back to Évora
	9th of May 2015 Colégio do Espírito Santo Auditório 131
9:00 – 10:30	***Final Discussion*** Moderators: Laura Rontu and Dmitrii Mironov
10:30 – 12:00	Guided visit to the Historic Centre of Évora (UNESCO World Heritage)
12:00 – 13:00	Visit to Wine Museum and Wine Tasting
14:00 – 17:00	Open Room for further discussions and meetings

v) Participants (35)

- Ana Ilhéu, EDIA – Portugal,
- André Sá, IPG – Portugal,
- Arkady Terzhevik, Russian Academy of Sciences – Russia
- Attlia Nagy, Hungarian Meteorologic Service – Hungary
- Bin Cheng, FMI – Finland
- Carlos Rodrigues, ICAAM – Portugal
- Dmitrii Mironov, German Weather Service – Germany
- Ekaterina Kurzeneva, FMI – Finland
- Elena Shevnina, FMI/Russian State Hydrometeorological University – Russia
- Francisco Lopes, ICT/IDL – Portugal
- Gabriel Rooney, Met Office – UK
- Gianpaolo Balsamo, ECMWF – UK
- Homa Kheyrollah Pour, University of Waterloo – Canada
- Hugo Silva, ICT/LAE – Portugal
- Ivan Mammarella, University of Helsinki – Finland
- João Rio, IPMA – Portugal
- Juergen Helmert, German Weather Service – Germany
- Klaus Joehnk, CSIRO – Australia

- Kukka-Maaria Erkkila, University of Helsinki – Finland
- Laura Rontu, FMI – Finland
- Lijuan Wen, Chinese Academy of Sciences – China
- Manuela Morais, ICT – Portugal
- Margarita Choulga, Russian State Hydrometeorological University – Russia
- Maria Grechushnikova, Moscow State University – Russia
- Maria João Costa, ICT – Portugal
- Maria Monteiro, IPMA – Portugal
- Miguel Potes, ICT – Portugal
- Patrick Le Moigne, CNRM/GAME – France
- Pedro Soares, IPMA – Portugal
- Pedro Viterbo, IPMA – Portugal
- Rui Salgado, ICT – Portugal
- Sergey Golosov, Institute of Limnology in St. Petersburg – Russia
- Vanda Salgueiro, ICT – Evora
- Victor Stepanenko, Lomonosov Moscow State University – Russia,
- Wim Thiery, KU Leuven – Belgium

8.3. Participation in the 9th APMG symposium

Rui Salgado and Maria João Costa participated in the Scientific Committee (http://www.apmg.pt/?page_id=632) of the APMG 2015: 9º Simpósio de Meteorologia e Geofísica da APMG e 16º Encontro Luso-Espanhol de Meteorologia, Tavira, 1 to 16 de March de 2015. The team members present several talks and posters (see sectuion 5.2).

9. Outreach Activities

9.1. Debate: the Alqueva reservoir and the Climate

Figure 9.1 Invitation to the population of Alqueva (Showbill of the debate)

Taking advantage of the stay of many researchers in Alqueva, a public debate was promoted in collaboration with the Parish of Amieira and Alqueva (*União de Freguesias de Amieira e Alqueva*), about "the Alqueva reservoir and the Climate", in July 22, at the Alqueva sociable lounge. The invitation to the people of the village, in Portuguese, is shown in Figure 9.1.

The invited speakers were: António Heitor Reis (UE, Director of the ICT), Carlos Miranda (UE, Hydrology), Pedro Miranda (IDL/FCUL, Meteorology, Responsible, in 1994, by the study of the climate impact of Alqueva), Ana Ilhéu (Head of the Environmental Department of EDIA), Carlos Policarpo (Base Aérea de Beja, Meteorology) and Mauro Henriques, President of the parish council. The population took part in the debate (Figure 9.2), reporting personal experiences about climate, but also concerns about the region's economic and social development, and particularly about employment.

Figure 9.2 Debate "Alqueva and the climate", Alqueva Village, 22nd July 2014.

9.2. Press

The ALEX 2014 experiment had some echo in the local and national media. In particular, it was the subject of two TV reports, issued in the main news of RTP1 (Figure 9.4, https://www.youtube.com/watch?feature=player_embedded&v=yXqR7F1Ua2k) and TVI (Figure 9.3, https://www.youtube.com/watch?feature=player_embedded&v=ZZGxoVnRJ3o).

Figure 9.3: The report carried out by TVI and first issued on July 28, 2014. The report can be seen at:
https://www.youtube.com/watch?feature=player_embedded&v=ZZGxoVnRJ3o

Figure 9.4: The report carried out by RTP1 and first issued on July 25, 2014. The report can be seen at:
https://www.youtube.com/watch?feature=player_embedded&v=yXqR7F1Ua2k

The following is a non-exhaustive list of ALEX2014 news available on the internet:

- http://diariodigital.sapo.pt/news.asp?id_news=719810
- http://jornale.pt/cientistas-estudam-alqueva/
- http://www.cmjornal.xl.pt/cm_ao_minuto/detalhe/observacoes-da-agua-e-da-atmosfera-do-alqueva-para-avaliar-efeitos-no-clima.html
- http://www.vozdaplanicie.pt/index.php?go=noticias&id=3627
- http://www.localvisao.tv/index.php/alentejo/1990-alqueva-recebe-programa-alex-2014
- http://videos.sapo.pt/wRPryiCzu0vQq0gQKFoH
- http://radionovaantena.com/index.php?option=com_content&view=article&id=15140:cientistas-e-estudantes-em-observacoes-hidro-metereologicas-no-alqueva&catid=1:regional&Itemid=25
- http://www.dianafm.com/index.php?option=com_content&view=article&id=31760:alqueva-arranca-campanha-de-observacoes-da-agua-e-da-atmosfera&catid=19:alentejo&Itemid=44
- http://www.radiocampanario.com/r/index.php/regional/3396-agua-da-barragem-de-alqueva-alvo-de-estudo-por-dezenas-de-cientistas-e-estudantes-c-som
- http://www.radioplanicie.com/gestao/noticias/index_noticias.php?noticia=10177
- http://da.ambaal.pt/noticias/?id=6036
- http://lifestyle.sapo.pt/saude/noticias-saude/artigos/dezenas-de-cientistas-observam-agua-e-atmosfera-do-alqueva-para-avaliar-efeitos-no-clima?artigo-completo=sim
- https://www.metalentejo.pt/portugal/tag/Alqueva
- http://www.confagri.pt/Noticias/Pages/noticia49623.aspx
- https://www.evoracity.net/alentejo/924-observacoes-da-agua-e-da-atmosfera-do-alqueva-para-avaliar-efeitos-no-clima
- http://maisevora.blogspot.pt/2014/07/alex-2014-campanha-de-observacoes-hidro.html
- http://www.ueline.uevora.pt/Canais/academia/(item)/14055

10. Supports / Sponsors

Instituto Dom Luís / Universidade de Lisboa

Junta de freguesia de Amieira e Alqueva:

Soc. Agricola da Barbosa

11. List of participants

As mentioned above, many colleagues joint the ALEX2014 field experiment. Here the full list of the participants. The researchers that formally belong to the team of the project EXPL/GEO-MET/1422/2013 are identified by an *.

Rui Salgado, CGE – PI, Investigador Responsável *
Miguel Potes, CGE – GS, Secretário Geral *
Samuel Bárias, CGE – TC, Coordenação Técnica

CGE/UE – Atmosfera e qualidade do ar

Maria João Costa *
Daniele Bortoli
Ana Maria Silva
Pavan Kulkarani
Sérgio Pereira
Vanda Salgueiro
Rui Mendes
Mouhaydine Tlemçani
André Albino
Flávio Couto

CGE / UE – Laboratório da Água

Manuela Morais *
Helena Novais *
António Serafim *
Amely Zavattieri
Joana Rosado

CGE /UE – Energia Solar

Paulo Canhoto *
Tiago Lopes

CGE /UE – Laboratório de Electricidade Atmosférica

Hugo Silva *
Marta Melgão

CGE / DFIS / UE – Apoio técnico

Josué Figueira
Sérgio Aranha
Joel Barrenho

ICAAM/UE – Hidrologia

Carlos Miranda Rodrigues *

EDIA

Ana Ilhéu *
Martinho Murteira

Valter Rico

IPMA

Victor Prior *
Jorge Marques *

CCDR-A – Qualidade do ar

Maria José Santana
Paulo Beliche

IDL / ULisboa

Pedro Miranda
Pedro Soares *
Susana Barbosa
Francisco Lopes

Beja Airbase

Carlos Policarpo

UBI – Rede GNSS

Rui Fernandes
André Sá *
João Apolinário *

Allied Health Sciences of Polytechnic of Porto and Center for Geophysics of the University of Coimbra

Raul Lima

CNRM / Météo France

Patrick Le Moigne *

University of Reading

Giles Harrison *
Keri Nicoll

Instituto Nacional de Técnica Aerospacial – INTA

Maria Concepción Parrondo

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