

## ***OPTIMISE COST ACTION, NEWSLETTER 3***

### **Editorial:**

Welcome to the third Newsletter of the Optimise Cost Action ES1309, “Innovative optical Tools for proximal sensing of ecophysiological processes”. The goal of the Newsletter series is to regularly compile and disseminate the main results accomplished during the Optimise Cost Action. Printed versions of the Newsletter will be distributed at major Optimise events, and other conferences and both current and previous Newsletters will be available online for download on the Action website <http://optimise.dcs.aber.ac.uk>.

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### **The Editors:**

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**We hope you enjoy it!**

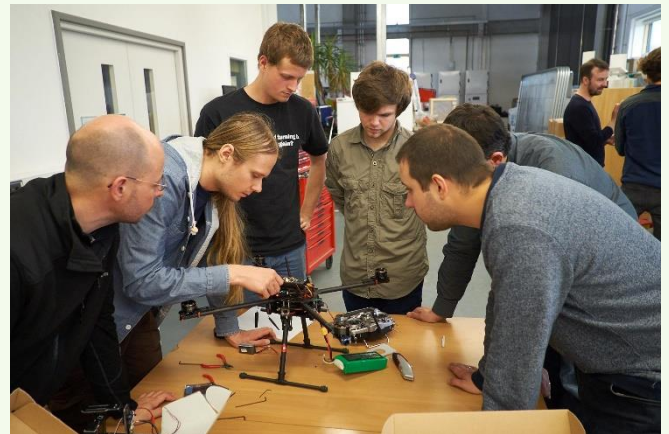
## DroneLab Training Course

The COST Action Optimise ES1309 WG2 DroneLab Training Course was open to early researchers interested in “Safe operations and Health and Safety in deployment of unpiloted aerial vehicles (UAVs) for environmental science”. The course took place between 30<sup>th</sup> March and 6<sup>th</sup> April 2016 at the Environment and Sustainability Institute of University of Exeter, UK. This 7.5-days training gave the participants an opportunity to discover the drone world and how drone-based remote sensing data can be used in a variety of science areas and settings. The training team (Dr. Karen Anderson and Mr. Leon Debell from University of Exeter, UK; Dr. Enrico Tomelleri from EURAC, Italy, and Dr. Andreas Burkart from Jülich Research Centre, Germany) gave special emphasis to provide training through a process of “doing”. For this purpose, 10 course participants received teaching and training in three different ways: i) lectures and delivered material from expert trainers; ii) hands-on activities including building their own drone in a team and learning to fly it safely, and iii) hands-on data processing using operational tools. Students had a chance: to learn about the major electronics components of most light weight drone systems and how to assemble and test them; to practice building and repairing a basic multirotor system and planning an operational flight using open-source state-of-the-art software; to develop flight skills in lightweight multirotor aircraft in both indoor and outdoor settings; to discover the range of sensors that can be included in drone-based remote sensing systems; to learn about key issues of spatial and radiometric data quality with drone systems; and to learn from experts in drone and aircraft flight safety at the Royal Navy Culdrose centre about operational flight planning and safety.

Below we quote some of the students’ opinions:  
*“It has helped us to make many things right in*

*our UAS projects in Helsinki, Finland. Thanks to you we build our UAS ourselves. We saved money. We learned more. The course help us to fly our fleet more safely.”* - Lari Kaukonen from Finnish Environment Institute in Helsinki.

*“The course was planned and executed professionally by people both passionate and being experts in the taught domains. The course agenda was well diversified with focus on both drone oriented topics and research networking between participants.”* - Mikołaj Dobski from Poznan Supercomputing and Networking Center in Poland.



*Students learning about the major electronics components of most lightweight drone systems.*



*Dr. Andreas Burkart demonstrating to students one of his drones.*

## **Spectroscopy as an indicator of biochemical processes in plants**

A combined WG1 and WG3 workshop on sampling, data processing and retrieval of biophysical parameters from field and airborne hyperspectral vegetation data took place at the University of Twente, Netherlands on 29<sup>th</sup> and 30<sup>th</sup> September 2016. In total, 41 Optimise members and non-members attended this meeting. The main workshop objective was the development of protocols and terminology for hyperspectral remote sensing of vegetation. The meeting consisted of 10-minute presentations of key experts, followed by group work dedicated to three specific topics:

*Subgroup I:* Measurement products and fluorescence retrieval algorithms – led by Dr. Tommaso Julitta from University of Milano-Bicocca in Italy – focused on protocols for optical measurements at various scales (from leaf to canopy), state-of-the-art of different fluorescence retrievals methods, reliability of the retrieved products and application to UAV and HyPlant data.

*Subgroup II:* Links between retrieved products and biochemistry – led by Dr. Christiaan van der Tol from University of Twente and Prof. Anatoly Gitelson from Technion-Israel Institute of Technology – provided clear definitions of parameters and variables (such as aPAR, yield, LUE etc.) and discussed the dependence of top-of-canopy reflectance, fluorescence, and photosynthesis on canopy structure and the dependence of leaf fluorescence on leaf pigments and photochemistry, leaf nitrogen and stress. The members of this group determined also field measurements required as input for SCOPE model and the best sampling strategy to obtain these data.

*Subgroup III:* Scaling Up reflectance and fluorescence measurements (Bottom-Up approach) – led by Dr. Helge Aasen from ETH Zurich in Switzerland – focused mainly on

identification of issues related to upscaling from field to satellite level, and identification of crucial parameters for field campaigns using sensitivity analysis of models at leaf, canopy and satellite scale. The effects of vegetation heterogeneity on reflectance and fluorescence signal were also addressed by this group.

The output of the workshop were reports on discussed topics, concepts and definitions. These reports include: i) a list of existing fluorescence retrieval algorithms with their pros and cons, including quantification of their computational efficiency; ii) a list of procedures for uncertainty estimation; and iii) an evaluation of limitations and opportunities related to measurements in spatially heterogeneous areas. These are currently being worked out in the form of research articles prepared by the subgroups members.



*Subgroup members during discussion.*

Prior to the focused workshop, a one-day training on the use of SPECCHIO database, radiative transfer models (SAIL and SCOPE) and retrieval algorithms (ARTMO) was given to 21 Optimise members. The overall objective was to develop skills to acquire, store and use hyperspectral data for retrieval of biophysical parameters. The course consisted of 30-minute introductions to each software package and breakout sessions with hands-on in a software package of choice.



*Trainees discovering the potential of SPECCHIO, SAIL and SCOPE packages.*

### **Challenges of UAV spatial sampling**

Another successful Optimise workshop was organized by Dr. Enrico Tomelleri (EURAC, Bolzano, Italy) and was hosted by the Free University of Bozen (Italy) between 17<sup>th</sup> and 20<sup>th</sup> October 2016. The workshop brought together twelve experts on both beam and imaging spectrometers for ecological analyses. The purpose of the workshop was to discuss the pros and cons of these two different approaches and to perform field experiments verifying hypothesis on optimal sampling designs. All scheduled experiments were held in the Jenesien area (covering a mixed ecosystem with predominant grassland cover and sparse larch trees), located about 4 kilometres northwest of the city of Bolzano. The topics covered by the experiments included: i) the BRDF effect from hyperspectral imagers, ii) estimates of spatial variability with increasing spectral information, iii) comparison of multispectral and hyperspectral cameras (MAIA and Rikola, respectively) with onboard spectrometers (Ocean Optics USB2000+ and STS), and iv) repeatability of GPS flight plans (the reproducibility of flight paths flown on workshop day 1 and day 2 was investigated, and different GPS systems mounted on the same UAV platform were compared).

This 2.5-days workshop reserved to Optimise members, was followed by a 2-day event opened to public (1<sup>st</sup> day) and graduate students (2<sup>nd</sup> day), with a series of invited talks on UAVs for precision agriculture and land management.



*Workshop participants in preparation for flying an UAV.*



*An RGB image providing an overview over the experimental area.*

## **OPTIMISE-BUS - The ESR Think Tank on best practice UAV spectral sampling**

The ESR Think Tank was held between 22<sup>nd</sup> and 24<sup>th</sup> November 2016 at the Tartu Observatory in Estonia and was attended by 13 participants. During this meeting, the Optimise members had an opportunity to exchange their opinions on the state-of-the-art of spectral sampling from UAVs and to discuss potential actions towards its improvement. The topic of the meeting concerned data quality issues, including proper calibration and characterization of instruments, as well as environmental impacts on data quality. After the first day of joint debates, the group was split in two subgroups. The first of them worked on laboratory calibration procedures for spectral UAV sensors, while the second subgroup focused on defining the best practice for UAV spectral sampling in the field. These included flight planning, calibration activities before the flight and sensor preparations, radiometric calibration before and during the flight and data post-processing.



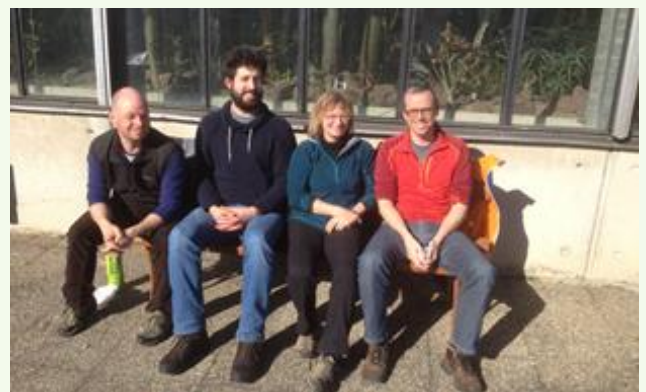
*OPTIMISE-BUS workshop participants.*

It was agreed by the workshop participants that a document should be assembled as guidelines for other researchers on the best practices on UAV spectral sampling. Additionally, a questionnaire should be designed to capture the

state-of-the-art in the UAV-based remote sensing community. The session on the last day was dedicated to planning how to proceed with these activities.

## **Footprint Modeling Expert Workshop**

The Footprint Modeling Expert Workshop was organized between 13<sup>th</sup> and 16<sup>th</sup> of February 2017 at the University of Innsbruck in Austria. The aim of this focused workshop was the development of a footprint tool for optimal placement of fixed spectrometers and for combination of eddy covariance (EC) measurements with UAV-based spectral data. The workshop participants (Prof. Natascha Kljun from Swansea University in UK, Dr. Enrico Tomelleri from EURAC in Italy, Prof. Georg Wohlfahrt from University of Innsbruck in Austria and Dr. Tarek El-Madany from Max Planck Institute for Biogeochemistry in Jena, Germany) are researchers with expertise in EC footprint modeling, coding and bayesian statistics.



*Footprint Modeling Workshop participants, from left to right: Enrico Tomelleri, Tarek El-Madany, Natascha Kljun, and Georg Wohlfahrt.*

During three days of an extensive work, the experts managed to test the adopted approach, that merges information about the EC footprint with unsupervised land cover classification based on remote sensing data (Sentinel-2 or RGB data

from Bing.maps) for flux towers in a grassland ecosystem in Austria, a Mediterranean savannah in Spain and a coniferous forest in Sweden. The web-based tool, which is currently being further developed, will allow a graphical visualisation of land cover type which contributes most to the measured fluxes and thus to determine the pixels for optimal proximal sensing instruments placement. Once extensively tested, this online tool will be broadly advertised and circulated among the Optimise members and the entire remote sensing, flux tower and modeling communities.

### Annual Workshop and MC Meeting

The Annual Optimise Action Workshop took place between 22<sup>nd</sup> and 23<sup>th</sup> February 2017 in Limassol, Cyprus. The event was hosted by Dr. Kyriacos Themistocleous from the Cyprus University of Technology in Limassol. After the introductory presentation of the Action Chair, the conference opened with the keynote speech of Dr. Dirk Schuettemeyer from ESA, dedicated to FLEX & Sentinel 2/3 Mission Development & Validation. The following focused sessions covered the topics of: i) Spatial Sampling, ii) Modelling, iii) Protocols, Procedures and Spectral database, iv) Understanding reflectance & fluorescence and ecophysiological & biophysical state variables, and v) Platforms, instruments and imagers. Moreover, a report on the Action performance and an overview of the current status of the OPTIMISE-BUS were presented by the Management & Evaluation Group Leader, and the Working Group 2 Coordinator, respectively. The meeting finished with an open floor discussion for development of plan for final year of the Optimise Action. In total, 4 keynote talks and 26 oral contributions were presented during this 2-day event. More than 40 Action members attended the meeting and shared great moments of intellectual stimuli and social venue.



*Action Chair, Dr. Alasdair Mac Arthur, introducing one of the meeting key speakers, Dr. Dirk Schuettemeyer from ESA.*



*Dr. Andreas Hueni giving a talk about SPECCHIO database and ecosystem specific metadata.*

The Annual MC meeting of the Optimise Action was held on February 24<sup>th</sup> 2017, following the Annual Workshop. During this half-day event the Action Chair presented Action financial report & future budget plan and proposed a couple of changes in the core group structure. All of these were unanimously agreed by the MC. Also, based on the report on the Action performance, the Action deliverables specified in the MoU were reviewed and future strategies on the last year of activities were planned.

## Update on Short-Term Scientific Missions (STSMs)

Until the end of March, 17 STSMs have been approved and more applications are being received. In the period between July 2016 and November 2016 (call 4) 6 STSMs were successfully carried out by early stage researchers from different European countries. Their great experiences are briefly presented below.

### Ms Karolina Sakowska

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Karolina visited the Forschungszentrum Jülich (Institute of Bio- and Geosciences, IBG-2: Plant Sciences) in Germany at the beginning of July 2016. The purpose of her one-month-long STSM was to continue the work carried out during FLEX field campaigns focused on understanding the link between sun-induced chlorophyll fluorescence (SIF) and plants photosynthesis. In the first part of her mission, Karolina was trained in *in-situ* measurements of SIF at leaf and canopy scales and in laboratory calibration of an hyperspectral HyScreen imaging system. After the training phase, she took part in a field campaign aiming at analyzing the photosynthetic capacity, SIF, optical and biophysical properties of the chlorophyll-deficient mutant leaves and canopies in comparison with a green soybean accession.

### Ms Chiara Torresan

Italian National Research Council  
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50145 Firenze, Italy

The main goal of Chiara's STSM was to quantify and characterize the vertical profile of chlorophyll fluorescence in maize canopies in order to improve the understanding of the crop

physiology, productivity and radiation use efficiency resulting from the interplant competition. To reach this purpose she visited the Forschungszentrum Jülich, Germany (Institute of Bio- and Geosciences, IBG-2: Plant Sciences) between 01 and 12 of July 2016, where she participated in the field measurements of active and passive fluorescence at different canopy layers performed on maize plants sown at two different inter-row spacings.



*Karolina and her STSM Host - Dr. MaPi Cendrero - performing Fluowat measurements of top MinnGold leaves.*



*Chiara's experimental setup. On the left: Moni-PAM units sampling maize leaves located at different canopy layers. On the right: Fluowat measurements of bottom maize leaves.*

**Mr Michał Chyliński**

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Faculty of Physics,  
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Michał visited EURAC in Bolzano, Italy in September 2016 and was hosted by Dr. Enrico Tomelleri for two weeks. His STSM was dedicated to development of small unmanned aerial systems and measurement protocols for measuring light absorption within tree canopies. During the first part of his STSM, the technical aspects of the integration of remote sensing sensors with drones were investigated and a low-cost Real Time Kinematics GPS was tested. Selected sensors were then integrated with a flying platform with custom made holders on 3D printer and laser cutter, and a dedicated software was written and installed on Raspberry Pi micro-computer. In the second part of the STSM, the optimal measurement protocols were discussed and verified during field test flights. Results from these initial measurements carried out over grassland ecosystems located nearby Bolzano city proved satisfactory reliability of the developed solution and gave ideas for further improvement.



*Michał performing the last check off before the drone takeoff.*

**Ms Bruna Oliveira**

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Bruna Oliveira visited the Max Planck Institute for Biogeochemistry in Jena, Germany in September 2016. During the two-week stay at the Host institution she worked with Dr. Mirco Migliavacca on simulating ecosystem respiration using proximal sensing data and meteorological measurements. Her aim was also to answer whether basal respiration is more related to structural spectral vegetation indices (such as, e.g. NDVI, MTCI, ND, EVI) or physiological activity indices (Fy760 or PRI). To reach the STSM objectives, she worked with hyperspectral and CO<sub>2</sub> flux data collected in a Mediterranean savannah in Spain within the SMANIE project focusing on the effects of N and P fertilization on ecosystem level C and water fluxes, plant traits, hyperspectral vegetation indices (VIs) and solar induced fluorescence (SIF).

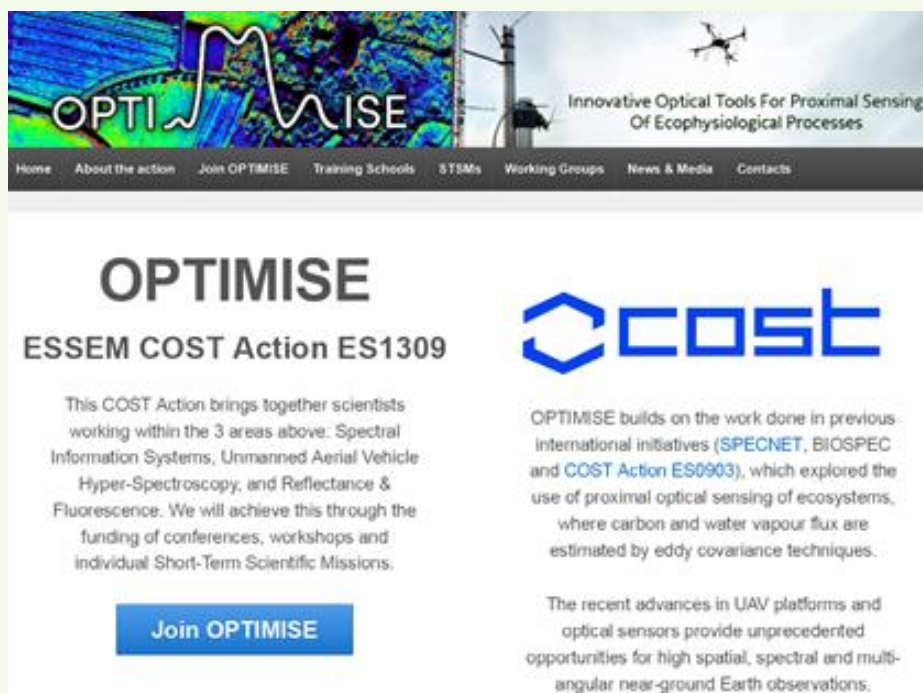
**Ms Laura Mihai**

Photonic Investigations Laboratory,  
CETAL, National Institute for Laser,  
Plasma and Radiation Physics  
Atomistilor Street, Magurele, Romania

In November 2016, Laura had a great research experience at the NERC facility, University of Edinburgh. The main objective of her mission was to develop laboratory-based calibration and characterization procedures for spectrometers across the spectral range of the FLEX fluorescence imager, at sampling interval and bandwidths which will enable measurements of the solar flux in the telluric oxygen A and B absorption bands reaching the Earth's surface. A Piccolo dual-field-of-view fiber optic-based spectrometer system (with irradiance and radiance measuring capabilities, and optical



benches capable of measuring across the 400 nm to 950 nm (VNIR) range at 2048 sampling intervals, and from 640 nm to 800 nm in 1044 sampling intervals) was characterized and calibrated using different calibration systems. A spectral resolution better than 0.15 nm was obtained. These procedures should enable calibrations to be replicated at various facilities.



**OPTIMISE**  
ESSEM COST Action ES1309

This COST Action brings together scientists working within the 3 areas above: Spectral Information Systems, Unmanned Aerial Vehicle Hyper-Spectroscopy, and Reflectance & Fluorescence. We will achieve this through the funding of conferences, workshops and individual Short-Term Scientific Missions.

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**cost**

OPTIMISE builds on the work done in previous international initiatives (SPECNET, BIOSPEC and COST Action ES0903), which explored the use of proximal optical sensing of ecosystems, where carbon and water vapour flux are estimated by eddy covariance techniques.

The recent advances in UAV platforms and optical sensors provide unprecedented opportunities for high spatial, spectral and multi-angular near-ground Earth observations.

**Remember to keep an eye on our website for updates, information and instructions on how to join our Action!**

## UPDATE OF OPTIMISE ACTIVITIES AND FUTURE PLANS BY THE CHAIR

Work and Budget Plan update. At the MC meeting in Limassol a draft W&BP for the 4<sup>th</sup> and final year of OPTIMISE was presented. This plan was then revised to reflect the MC discussion and recommendations. The W&BP funding request was then submitted to COST and has been approved. A budget of €138,650.00 has been assigned for the final year of OPTIMISE. The contract between COST and the U. of Aberystwyth will now be agreed and signed off. I would like to once again thank Sallie Jones (OPTIMISE Action Manager), Deniz Karaca (COST Action ES1309 Science Officer), and Christophe Peeters (COST ACTION ES1309 Administrative Officer) for processing this so promptly and efficiently.

We can therefore start to plan our activities for 2017/18. A schedule of activities will be posted on the OPTIMISE website over the next few weeks. However, I would like to highlight that our Action Final Conference will be hosted by Professor Rumiana Vatsheva (the Local Organiser) at the Bulgarian Academy of Sciences in Sofia, Bulgaria from 28<sup>th</sup> February to 2<sup>nd</sup> March 2018 and organised on behalf of OPTIMISE by Dr. Micol Rossini. Further details will follow.

EARSel 2017: Dr. Laura Mihai and I had the privilege of giving presentations on our work and a profile of OPTIMISE at the EARSel 2017 Imaging Spectroscopy workshop held at the University of Zurich, Switzerland from 19<sup>th</sup> to 21<sup>st</sup> April. An OPTIMISE network dissemination poster was also displayed. In addition, Dr. Helge Aassen -one of the EARSel 2017 local organisers- presented OPTIMISE BUS at the workshop and distributed leaflets requesting completion of the on-line State-of-the-art in UAV remote sensing survey questionnaire. See <http://optimise.dcs.aber.ac.uk/uav-survey/>. Please assist us by completing this survey which should only take 10 to 15 minutes of your time.

We are also very happy to mention that the results presented by few OPTIMISE members to this event were recognized through best scientific, outreach and the most catching presentation awards, as following: 1<sup>st</sup> rank for best scientific presentation obtained by Dr. Zbynek Malenovsky for his contribution on “Multi-angular and diurnal modelling of solar-induced chlorophyll fluorescence in structurally explicit three-dimensional plant canopies using DART”, 1<sup>st</sup> rank on outreach paper to Dr. Jochem Verrelst – “Emulation of Radiative Transfer Models: New Opportunities for Spectroscopy Data Processing”, 1<sup>st</sup> rank for the most catching presentation to Dr. Helge Aassen for paper “Spectral UAS sensing systems – Current sensor technology and their application in vegetation monitoring” and a 2<sup>nd</sup> rank at the best scientific paper category for Dr. Laura Mihai for her contribution on “Optimized spectrometers characterization procedure for near ground support of ESA FLEX observations” paper.

I would like to take this opportunity to thank you all, core group, MC and working group members alike for your support and efforts over the last three year to help make OPTIMISE the success it is and an Action highly regarded by COST. Finally, I would like to highlight the effort that Drs. MaPi Cendrero, Helge Aassen, Javier Pacheco, Karolina Sakowska and Laura Mihai have put in over the last year to meet the objective we set out to achieve in Dubrovnik and to help plan and lead activities for the final year’s activities of OPTIMISE. I look forward to seeing you in Sofia, if not before!

**Dr. Alasdair MacArthur** (OPTIMISE Chair)