Version 21/04/2016

COST Action ES1309
(25/04/2014– 24/04/2018)

Innovative optical Tools for proximal sensing of ecophysiological processes (OPTIMISE)

PROGRESS REPORT AT MONTH 30

This report is submitted by the MC Chair on behalf of the Management Committee.

Confidentiality: This report, other than section II.D, is non-confidential. Section II.D is confidential to the Management Committee and the COST Association (including the Committee of Senior Officials, Scientific Committee and Administration).

Executive summary of the Progress Report:

Good progress has been made towards achieving the main Aims of this Action: a spectral data and information storage and sharing system (SPECCHIO) has been modified and trialled during OPTIMISE training courses. However, further development work to enable 3D data sets (geo-referenced images) to be indexed and the benefits of configurations for ecosystem-specific applications remain to be assessed; trial flights of one multispectral imaging system and further trials of two imaging/UAV systems and were successfully conducted. However, one other innovative and high quality spectrometer systems remain to be tested on UAVs. This system has been ground-tested and offers a significant technological advancement over other 'beam' spectrometer UAV systems. The same design of spectrometer can also be used for fixed-point logging applications and is currently deployed at the U. of Helsinki Hyytiälä research site. This system will offer a significant improvement in data quality and flexibility of application. A wireless communication system has been tested locally but is still to be deployed and tested in the field. More progress has been made with the reflectance and fluorescence aspects of the Action, themed workshops held and a number of international journal articles have been published and others are currently under review. ESRs have been actively encouraged to participate in the Action management, five of the eleven core group members are ESRs, and an ESR (Dr Helge Aassen) has organised and led one of the WG themed workshops in an 'inclusiveness country'. Each working group has held a themed workshop and dissemination activities have progressed: additional content has recently been included (STSM Report and Training School Science Reports) on the OPTIMISE website and the second OPTIMISE Newsletter has been published and the third OPTIMISE Newsletter is in preparation. A major success for the OPTIMISE network has been the announcement by the European Space Agency that the Fluorescence Explorer (FLEX) concept has been selected as the next Earth Explorer mission, with a launch scheduled for 2022. The work of COST Action ES1309 'OPTIMISE' was explicatively cited in the report submitted to ESA (ESA, 2015). Many of the OPTIMISE network are actively involved in FLEX and in the establishment of a ground validation network for the space-based observations of photosynthesis fluorescence, a more direct measure of vegetation health and primary productivity. Four OPTIMISE MC members are members of the FLEX Mission Advisory Group and OPTIMISE has provided ESA with a list and capabilities ot its network of Earth Observation calibration and validation and research sites. During STSMs and practical workshops the next generation of environmental scientists (PhD students and ESRs) are being specifically trained to build future capacity to utilise this exciting development in Earth observation for global monitoring and environment and security (GMES). Inclusiveness countries: Cyprus; Czech Republic; Estonia, Croatia; Hungary; Portugal; Bulgaria; Turkey; and Estonia have joined the Action and actively participate in workshops and meetings. In fact the OPTIMISE 2016/17 annual workshop and MC meeting will be held in Cyprus..

I. Progress Report

I.A. COST Action Profile

Objective/ Aim

The aim of the Action is to promote reflectance and fluorescence measurements of ecosystems as ground validation networks for Earth system models and global satellite observations, using innovative spectrometer and UAV platforms, and develop automated wireless communication systems with on-line spectral information storage, quality assurance and data product sharing portals

Details

MoU:
056/13
Start of Action:
25/04/2014
CSO approval date:
15/11/2013
End of Action:
24/04/2018

COST Member Countries and Cooperating State having accepted the MoU

Austria, Croatia, Estonia, Greece, Italy, Poland, Sweden, Belgium, Cyprus, Finland, Hungary, Latvia, Portugal, Bosnia and Herzegovina, Czech Republic, France, Ireland, Netherlands, Romania, Turkey, Bulgaria, Denmark, Germany, Israel, Norway, Spain, Switzerland, United Kingdom.
Intentions to Accept the MoU
Copy section from Action fact sheet here or enter "0"

Other participants:

Institution Name	Country
Scientific Centre for Aerospace Research of the Earth, Institute of Geological Science, NASU	Ukraine
University of Wisconsin-Madison	USA
University of Alberta	Canada
European Space Agency	Europe
University of Tasmania	Australia

Contacts

Chair/ Vice Chair

Position	Name	Contact details	Country	Date of PhD:	Gender
Chair:	Dr Alasdair Mac Arthur	University of Edinburgh Grant Institute, Kings Buildings, University of EdinburghEH9 3JW Edinburgh United Kingdom alasdair.macarthur@ed.ac.uk	UK	2012	M
Vice Chair:	Dr Micol Rossini	Remote Sensing of Environmental Dynamics Laboratory, DISAT, Universit degli Studi Milano-Bicocca piazza della Scienza, 120126 Milano Italy. micol.rossini@unimib.it	Italy	2006	F

Working Group Leaders

WG#	WG Title	WG Leader	Country	Date of PhD:	Gender	Number of participants
1	WG1 – Spectral Information System	Dr Andrea Hueni	Switzerland	2011	M	37
2	WG2 – Unmanned Aerial Vehicles	Dr Enrico Tomelleri	Germany	2007	M	44

3	WG3 – Reflectance and Fluorescence	Prof. Christiaan van der Tol	Netherlands	2007	M	46

Other positions if applicable (STSM Coordinator, WG Vice Leader, Task Force Leader…)

Position	Name	Country	Date of PhD:	Gender
Training Leader	Dr Radosław Juszczak	Poland	2004	M
Dissemination Leader	Dr Albert Porcar	Finland	2008	M
MEG Leader	Dr Loris Vescovo	Italy	2004	M
WG 1 co-coordinator	Dr Helge Aasen	Germany	2016d	M
WG 2 co-coordinator	Dr Andreas Burkart	Germany	2015	M
WG 3 co-coordinator	Dr Maria-Pilar Cendrero	Germany	2014	F

Action website:
http://optimise.dcs.aber.ac.uk/

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COST Association
Avenue Louise 149 I 1050 Brussels, Belgium
t: +32 (0)2 533 3800 I f: +32 (0)2 533 3890
office@cost.eu I www.cost.eu

I.B. Progress with MoU objectives and deliverables and additional outputs

MoU objectives

MoU objective	Achieved Yes/ Partially/ No	Evidence of (partial) achievement including hyperlink to enable assessment of the achievement[1]. Justification if full achievement is not foreseen
Support the ICOS network, bringing together EC scientists and the proximal sensing community, in order to enhance and enlarge the global spectral sampling network	Partly	**PR1** Prof. Christiaan van der Tol gave a OPTIMISE presentation in ICOS Finland during 2014 where (Werner Kutsch, ICOS Director, was also present). Link: http://www.icos-infrastructure.fi/?q=node/20 An ICOS-OPTIMISE discussion was held during the workshop in Madrid March 2015. See agenda http://optimise.dcs.aber.ac.uk/workshops-meetings/madrid-workshops-mc-meeting-2015/ **PR2** Two ICPOS members have been invited to the OPTIMISE 2016/17 annual workshop and MC meeting to be held in Cyprus
Harmonize instruments and measurement protocols to be adopted, across different ecosystems	Party	**PR2** The OPTIMISE Best practice in UAV Sampling (OPTIMISE BUS) was outlined by Mac Arthur et al at ESA LP16 in Prague and Co-ordinated by Dr P. Martin OPTIMISE members from SpecLab-CSIC (Spain), Max Planck Institute of Biochemistry (Germany), University of Milano Biccoca (Italy) and Forschungszentrum Jülich (Germany) collaborated in a field campaign in Majadas in June 2016 (see www.lineas.cchs.csic.es/fluxpec/node/71). The campaign was partly dedicated to the cross-calibration and testing of different hyperspectral sensors (an automated spectroradiometric system and an imager) as well as radiation sources dedicated to estimation and validation of sun induced fluorescence retrievals. In addition, UAV-borne spectroradiometric measurements over vegetation canopy were carried out in a showcase fashion, this transfer of knowledge has contributed to the implementation of a similar UAV system in SpecLab-CSIC. Work by Dr A. Hueni (WG1 leader) resulted in the publication Hueni, A., Damm, A., Kneubuehler, M., Schläpfer, D. and Schaepman, M. (2016). "Field and Airborne Spectroscopy Cross-Validation - Some Considerations." IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing PP(99): 1 – 19. which highlights the need to harmonize instruments and measurement protocols
Promote the use of a common 'smart' on-line spectral information system to share standardized	Partly	**PR1** Open floor discussion held during WG1 workshop Madrid, March 2015. See agenda

[1] The links to the outputs and deliverables will be used by the Action Rapporteur in assessing the progress.

proximal sensing data and products with other scientific communities (FLUXNET, ICOS, FLEX)		http://optimise.dcs.aber.ac.uk/workshops-meetings/madrid-workshops-mc-meeting-2015/
Develop a framework in the on-line system for consolidated metadata for specific ecosystem types and applications	Partly	**PR2** A practical workshop was held in Dubrovnik to start to address this issue See http://optimise.dcs.aber.ac.uk/working-groups/wg1-spectral-information-system/events/
Bridge the gap between in-situ measurements and satellite sensor data by promoting the development and use of UAV-based observation and their integration with modelling approaches for monitoring and investigating ecosystem functioning across differing temporal and spatial scales, leading to the better exploitation of satellite data	Partly	**PR1** Trial during SWAMP training school Poland July, 2015 See Group Reports http://optimise.dcs.aber.ac.uk/training-schools/the-6th-eufar-optimise-training-course-on-spectrometry-of-a-wetland-and-modelling-of-photosynthesis-with-hyperspectral-airborne-reflectance-and-fluorescence/ **PR2** Flux tower footprint modelling tol workshop planned for Feb 2017. (See WG2 objectives below)
Support the RS activities focused on steady-state fluorescence and the Fluorescence Explorer (FLEX) mission, promoting, coordinating, and disseminating the results of validation and calibrations campaigns	Partly	**PR1** Trials and field work conducted during SWAMP training school Poland July, 2015 and data sets made available via SPECCIO spectral information system. http://specchio.ch/campaign_overview.php **PR2** Mac arthur et al presentation at ESA Living Planet Prague 2016 (http://lps16.esa.int/page_session125.php#1972p)

MoU deliverables

MoU deliverable	Level of progress[1]	Evidence of (partial) delivery achievement including hyperlink to enable assessment of the delivery[1]. Justification if full achievement is not foreseen
WG1:		
Definition of a mandatory metadata set, aligned with current international efforts in the spectroscopy community	Party	**PR2** Metadata set has been coordinated with the NASA funded EcoSIS project (https://ecosis.org). Efforts are ongoing, inluding collaboration with SpecNet (http://specnet.info).
Develop an on-line instance of a spectral information database to serve as demonstration and testing platform for data sharing and information building	Partly	**PR1** Data sets from SWAMP training school Poland July, 2015 made available via SPECCIO spectral information system. http://specchio.ch/campaign_overview.php **PR2** Both ABEL and SWAMP training school data are available online (http://specchio.ch/campaign_overview.php) . A new web-based data portal is currently under development.
Develop a wireless automated dataflow from in-situ and UAV	Partly	**PR1** Field trials of prototype system initiated

sensor for the database system		**PR2** Wireless spectrometer control software with data upload to web based storage is currently under development. Prototype to be presented at EARSeL Special Interest Group Imaging Spectroscopy (SIG-IS) Workshop (Zurich, 19-21 April 2017): ASD Spectroradiometer Tablet Control. R. Bolliger, A. Luescher, M. Gwerder, University of Applied Sciences and Arts Northwestern Switzerland A. Hueni, RSL, University of Zurich, Zurich, Switzerland SPECY open source spectroscopy system, www.specy.de A prototype for URL based transfer of spectral data to the SPECCHIO database is currently under development and testing. Burkart, IBG-2 Research Center Jülich, Germany (See http://www.fz-juelich.de/ibg/ibg-2/EN/methods/specy/specy_node.html)
Definition and implementation of data pre-processing and metadata augmentation algorithms and routines including quality checks and flagging and data assimilation	Partly	**PR1** Trial data sets developed during SWAMP training school Poland July, 2015 made available via SPECCIO spectral information system. http://specchio.ch/campaign_overview.php **PR2** Two pre-processing tools with direct SPECCHIO database connetivity are currently under development: SALSA++: Unispec spectrometer data pre-processing with time-series support (http://www.geo.uzh.ch/en/units/rsl/news/2013/130218/, https://github.com/ahueni/SALSA-PlusPlus). In collaboration with SpecNet. RSL reflectance processing tool: intelligent processing of radiance data to reflectance including quality checks in the framework of the APEX airborne imaging spectrometer project (apex-esa.org). To be presented at EARSeL Special Interest Group Imaging Spectroscopy (SIG-IS) Workshop (Zurich, 19-21 April 2017): Applied Spectral Databases - APEX Spectral Ground Control Point Handling S. Bertschi, A. Hueni, RSL, University of Zurich, Zurich, Switzerland Dr A. Hueni collaboration with DLR, where SPECCHIO is used to build a spectral library. Spectral Database session at ISSI (Presented by Uta Heiden): http://www.issibern.ch/workshops/earthecosystem/wp-content/uploads/2016/11/ISSI_Workshop_Imaging-Spectroscopy_Program_final-3.pdf
Definition and implementation of system interfaces and algorithms for data retrieval allowing the building of products using sources such as biogeochemical modelling, flux data specialisation and space-sensed data	Yes	**PR1** Trial data sets developed during SWAMP training school Poland July, 2015 made available via SPECCIO spectral information system. http://specchio.ch/campaign_overview.php **PR2** Coupling of SPECCHIO and higher level programming languages (Matlab, R and Python). The API is available online (http://www.specchio.ch/doc/index.html) and training material as well (http://specchio.ch/programming_course.php). A example of an integration has been done for the Fluspect model: (http://specchio.ch/programming_course.php). The code of the GUI is available via Matlab Central:

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Avenue Louise 149 I 1050 Brussels, Belgium
t: +32 (0)2 533 3800 I f: +32 (0)2 533 3890
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		http://uk.mathworks.com/matlabcentral/fileexchange/60451-specchio-fluspect-gui
WG2		
Review and report on the challenges for optical sensing in up-scaling biophysical properties of vegetation and test different UAV platform/measurement instruments setups	Partly	**PR1** Approaches for linking ground and remote sensing approaches are being explored. Imaging spectrometer acquisitions have been used for retrieving biophysical parameters through inversion of RTM models. The ARTMO toolbox (Verelst et al. http://ipl.uv.es/artmo/) has been tested for this purpose during the SWAMP summer school. See Group Reports http://optimise.dcs.aber.ac.uk/training-schools/the-6th-eufar-optimise-training-course-on-spectrometry-of-a-wetland-and-modelling-of-photosynthesis-with-hyperspectral-airborne-reflectance-and-fluorescence/ **PR2** Extensive discussion on instruments traceability and UAV spectral data processing has been conducted during the Tartu Workshop. http://optimise.dcs.aber.ac.uk/workshops-meetings/esr-think-tank-tartu-obsveratory-estonia/ Challenges of UAV spatial sampling workshop Bolzano, 17-20 October 2016 See report at http://optimise.dcs.aber.ac.uk/workshops-meetings/workshops-meetingschallenges-of-uav-spatial-sampling/
Development of a footprint tool for optimal placement of fixed spectrometers and for combination of EC measurements with UAV-based spectral data	Not yet	**PR1** Currently the footprint must be characterized. At the moment no specific tool is available. **PR2** An experts workshop has been planned for integrating the footprint tool by Prof. N. Kljun with Remote Sensing data (http://footprint.kljun.net) Feb 2017
Liaise with industry representatives to improve accuracy of GPS	Partly	**PR1** The advantage of combining GPS and GLONASS has been tested in cooperation with UAV producers (e.g. www.soleon.it). An online system for real-time GPS correction is not being tested. We tested that differential correction of ground control points is necessary for matching time series of UAV borne measurements. **PR2** During the Bozen UAV workshop, tests for comparing multiple on-board GPS instruments have been executed. http://optimise.dcs.aber.ac.uk/workshops-meetings/workshops-meetingschallenges-of-uav-spatial-sampling/. Tests for making use of REACH RTK (www.emlid.com) have been conducted during Michal Chlinski STSM. See http://optimise.dcs.aber.ac.uk/stsms/approved-stsms/
Definition of new methods for scaling up functional relationships between optical properties and ecosystem processes from in-situ to landscape scale by	Partly	**PR1** An imaging spectrometer and a hyperspectral camera have been used for characterizing the footprint area of test sites in the North Eastern Alps and in Poland from UAV. i) Thermal data are currently being used for ET modelling and ii) hyperspectral data for retrieving biophysical parameters. The preliminary results of i) will be presented to AGU 2016 (Castelli et al.) and preliminary results of ii) have been presented to EARSEL 2015 (Tomelleri et al. 2014

means of UAVs, including identification of adequate radiative transfer models to be coupled with biogeochemical models for linking biogeophysical properties of vegetation with its optical properties		http://www.earsel2015.com/fileadmin/user_upload/Program_short.pdf). Further developments will be presented to the next ESA living planet conference. **PR2** a contribution to the ESA Living planet conference has been presented (Multi-Scale estimates of ecosystem traits: a meta-model approach by Tomelleri et al.)
WG3		
Review and report on the methods and instruments used to estimate the solar-induced fluorescence from passive remote measurements	Partly	**PR1** A questionnaire has been carried out among the working group members out the methods that are currently used. https://drive.google.com/file/d/0B3SaimDgRZM1MWd6eFNTbnVxMW8 Measurement protocols have been practised at the training schools. This will result in defined best practise protocols in the final stage of the project (see next deliverable). **PR2** As a follow up to the questionnaire in in the community, a workshop has been organized to address all 4 objectives for WG3 in depth (41 participants of which 23 from OPTIMISE). A research article on (i) and (ii) is in preparation now, and the outcome of the workshop has been published on http://optimise.dcs.aber.ac.uk/workshops-meetings/wg1-wg3-combined-workshop-twente/ Dr Albert Porcar-Castell received funding for "Cost-effective methods for tracking large scale vegetation physiology: Participatory phase and pilot experiments", is a two year project (Oct 2016 – Sep 2018) funded by the Academy of Finland under the key Funding Call. The goal of the project is to to evaluate the feasibility and potential of SIF and PRI for tracking large scale vegetation physiology, and to identify novel and cost-effective methods to optimize vegetation management in real-case scenarios. See http://blogs.helsinki.fi/optics-of-photosynthesis/keyproject/ Dr Albert Porcar-Castell also received funding for FLUOSYNTHESIS, a 5 year project Funded by the Academy of Finland, 1MEur. Goal: to obtain novel mechanistic understanding of the processes that control the dynamics of chlorophyll fluorescence signal across time, space and species. Novel methods, protocols, and process-based mathematical models will be developed and for VIHREAVALO (=GREENLIGHT), a 2 year project funded by the Academy of Finland, 0.3 MEur, (PI Porcar-Castell). Goal: to assess the potential of new optical indices such as chlorophyll fluorescence or the photochemical reflectance index for pre-visual stress detection and online vegetation management in real-case scenarios co-designed with key stakeholders. The methods will be assessed both at the leaf level as well as using hyperspectral imaging cameras mounted on UAVs. Dr Mac Arthur (with PI Prof. M. Williams) have had a 4 year 'precision agriculture' project (ATEC) funded by two UK research councils (BBSRC and NERC). This project will use knowledge gained through

		the OPTIMISE network to use UAVs for spatial sampling, reflectance and fluorescence as measurements and the SPECCHIO spectral information storage system as an archive and initial analysis portal Dr Micol Rossini H2020/Marie Curie The TRuStEE project. The TRuStEE idea was born in the context of two EU COST actions: ES0903 "Spectral Sampling Tools for Vegetation Biophysical Parameters and Flux Measurements in Europe" (EUROSPEC, 2009-2013) and ES1309 "Innovative optical Tools for proximal sensing of ecophysiological processes" (OPTIMISE, 2014-2017) where most of the participants involved (UNIMIB, UNEXE, CSIC, Jülich, UT, FEM, NERC) met.
Definition of the technical requirements and acquisition protocols for reflectance and fluorescence measurements from UAV and ground-based instruments	Partly	**PR2** Extensive discussion on instruments traceability and UAV spectral data processing has been conducted during the Tartu Workshop. http://optimise.dcs.aber.ac.uk/workshops-meetings/esr-think-tank-tartu-obsveratory-estonia/ A proposal for a national grant has been submitted to the Romanian Space Agency concerning the upgrade of the existing infrastructure in order to develop procedures for field instruments calibration for fluorescence measurements to support ESA FLEX. OPTIMISE MC member D. Sporea led this bid with OPTIMISE Chair A. Mac Arthur providing additional expertise.
Database of reflectance, fluorescence and productivity data for later use in models and applications	Completed	**PR2** The database of the SWAMP summer training school has been included in the SPECCHIO software. The data are not yet easily accessible for the general public outside the network.
Integration of ground and UAV measurements with biochemical model outputs to better understand the links between photosynthesis, plant stress, growth and physiology with the temporal dynamics of reflectance and fluorescence	Partly	**PR1** Two training schools in which both datasets have been collected: http://optimise.dcs.aber.ac.uk/wp-content/uploads/OPTIMISE-Newsletter1.pdf One online course on model-data integration for reflectance and transmittance: https://canvas.instructure.com/courses/993194/assignments/syllabus **PR2** See Dimitri Dauwe and Marco Celeste STSMs at U. of Twente http://optimise.dcs.aber.ac.uk/stsms/approved-stsms/

Co-authored publications and FP7/ H2020 proposals
The co-authored publications and FP7/ H2020 proposals/ projects resulting from the Action are listed on the page following the "Additional outputs and achievements" section

Additional outputs and achievements

Please describe any other outputs and achievements that have resulted or are in progress, focusing in particular on those that contribute to the COST mission of "COST enables break-through scientific developments leading to new concepts and products and thereby contributes to strengthen Europe's research and innovation capacities."
PR1 • A prototype of a hyperspectral sunphotometer for the validation of Sentinel-2 and 3 and FLEX observations have been developed and will be field trialled during a STSM in March 2016. This work will be presented at the ESA Living Planet workshop in Prague 2016.

- Collaborations with DLR for the calibration and validation of Sentinel-2 observations has been initiated. This project will uniquely use ground reflectances, as well as atmospheric soundings to validate Sentinel-2 observations.
- OPTIMISE members: Moreno; Rascher; Rossini; van der Tol; Damm; Magnani; Alonso; Cendrero-Mateo; Sabate; Verrelst; and Mac Arthur participated in the FLEX-Bridge project. FLEX is the ESA EE8 mission to measure photosynthesis fluorescence from space recently approved by the ESA board and with the intention to launce in 2022. The goal of the FLEX Bridge Study was to optimize approaches for SIF retrievals and applications in the assessment of photosynthesis and stress status in terrestrial vegetation, including the development of a calibration/validation strategy for FLEX products. See http://www.flex-photosyn.ca/FB_AboutFB.htm. This work directly furthers the aims of OPTIMISE

PR2

- ESA Earth Explorer 8 mission FLEX mission has been approved with a launch date scheduled for 2022. Dr Mac Arthur has provided details of the OPTMISE research site network which are being proposed as cal/val sites and research sites for FLEX. OPTIMISE member Prof. Jose Moreno is chair of the FLEX Mission Advisory group (FLEX MAG) and OPTIMISE MC members Prof. C. van der Tol, Dr Yves Goulas and Prof. U. Rascher are also members of the FLEX MAG
- Establishment of a Europe-wide network of EO cal/val and research site with a specific interest in vegetation fluorescence as a measure of primary productivity, stress limitations and health (See http://optimise.dcs.aber.ac.uk/dissemination/supporting-materials/)
- The FLUOSYNTHESIS project “From Chlorophyll fluorescence to photosynthesis: upscaling the link” funded by the Academy of Finland (2015-2020) project led by Dr Albert Porcar-Castell of U. of Helsinki investigates the role of physical, ecological and methodological factors in controlling the fluorescence signal. A multiscale campaign will be organized during 2017 as part of FLUOSYNTHESIS project. The goal of the campaign is to co-register the optical signals generated by the spring recovery of photosynthesis of a boreal forest at multiple scales, combining leaf, canopy and UAV measurements in an attempt to quantify the impact that physical, physiological and methodological factors exert on the interpretation of fluorescence data. The campaign is a joint effort of more than 20 research groups, most of them involved in OPTIMISE, and closely aligned with OPTIMISE goals. The results will serve to test and validate our current understanding and hopefully improve it. (See http://blogs.helsinki.fi/optics-of-photosynthesis/hyytiala-2017-campaign-materials-and-updates/)

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COST Association
Avenue Louise 149 I 1050 Brussels, Belgium
t: +32 (0)2 533 3800 I f: +32 (0)2 533 3890
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Co-authored publications and FP7/ H2020 proposals

Co-authored publications

Enter in the table below only publications on the topic of the Action, co-authored by at least two Action participants from two different countries participating in the Action and for which the Action networking added value. A maximum of ten publications may be entered. If the Action has more than ten such publications the Core Group should select the ten most significant ones to include in the table below.

NO.	Bibliographic data (including: Title, Authors, Title of the periodical or the series, Issue number or volume, Publisher, Year of publication, Relevant pages)	Main author	Number of authors	Action participants listed among the authors (Name, country and role[2])	WGs involved in publication	Date of submission (must be after Action start date)	Expected date of publication (if not already published)	Persistent link to publicly available version of the paper (if available) or the abstract	Is/Will open access[3] provided to this publication?	Is/ will COST be cited/ acknowledged in the publication?	Are/ will COST funds (be) implicated in this publication	Relevance to H2020 Societal Challenges[4]?	Is it peer-reviewed?	Was the added value of the Action Networking necessary for the publication	Impact Factor (if applicable)
1	***PR1*** A. Porcar-Castell, A. Mac Arthur, M. Rossini, L. Eklundh, J. Pacheco-Labrador, K. Anderson, M. Balzarolo, M.P. Martin, H. Jin, E. Tomelleri, S. Cerasoli, K. Sakowska, A. Hueni, T. Julitta, C.J. Nichol, L. Vescovo (2015) EUROSPEC: at the interface between remote-sensing and ecosystem CO2 flux measurements in Europe	*A Porcar-Castell*	*16*	*Primary authors A. Porcar-Castell A Mac Arthur (All co-authors in OPTIMISE and contributed to the writing and editing of this review paper)*	*G1 WG2 WG3*	*3rd June 2015*	*Published*	*http://www.biogeosciences.net/12/6103/2015/bg-12-6103-2015.html*	*yes/no*	*YES. OPTIMISE is introduced in the review*	*Indirectly YES. The work was planned during OPTIMISE meetings*	*es*	*yes*	*yes*	3.98
2	***PR1*** Cendrero-Mateo, M.P., Moran. S., Papuga, S., Thorp, K., Alonso, L., Moreno, J., Ponce-Campos, G., Rascher, U., and Wang, G. (2015b) Plant chlorophyll fluorescence: active and passive measurements at canopy and leaf scales with different nitrogen treatments. Journal of Experimental Botany, doi:10.1093/jxb/erv456	*Cendrero-Mateo, M.P.,*	*9*	*1st author Cendrero-Mateo, M.P.,* Technical contribution Alonso, L., science contribution Moreno, J., & Rascher, U	*WG1, WG2 WG3*	*25th April 2015*	*Published*	*http://jxb.oxfordjournals.org/content/early/2015/10/18/jxb.erv456.full.pdf*	*yes*	*no*	*no*	*yes*	*yes*	*yes*	*5.364*
3	***PR1*** *Cendrero-Mateo, M.P., Carmo-Silva AE, Porcar-Castell A, Hamerlynck EP, Papuga SA, Moran MS. (2015a). Dynamic response of plant chlorophyll fluorescence to light, water and nutrient availability. Functional Plant Biology 42, 746–757.*	*Cendrero-Mateo, M.P.,*	*2*	*1st author Cendrero-Mateo, M.P., Contributing author Porcar-Castell A,*	*WG2 WG3*	*8th Jan. 2015*	*Published*	*http://dx.doi.org/10.1071/FP15002*	*yes*	*no*	*no*	*yes*	*yes*	*yes*	*5.364*
4	***PR1*** *Burkart A., Schickling A.; Pilar Cendrero Mateo M., Wrobel T.; Rossini M., Cogliati S., Julitta T. & Rascher, U. (2015) A method for uncertainty assessment of passive sun-induced chlorophyll fluorescence retrieval by using an infrared reference light. IEEE Sensors, 15, 4603-4611.*	*Burkart A.,*	*6*	*1st author Burkart A., contributing authors Cendrero Mateo M.P,; Rossini M., Cogliati S.,*	*WG2 WG3*	*Aug. 2015*	*Published*	*http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7086007*	*yes*	*no*	*no*	*yes*	*yes*	*yes*	*1.852*

[2] MC Member/ MC Substitute/ MC Observer/ WG Member/ Training School Trainee/ STSM Recipient/ Other Action Participant

[3] Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

[4] H2020 Societal Challenges are “Health, demographic change and wellbeing”; “Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy”; “Secure, clean and efficient energy”; “Smart, green and integrated transport”; “Climate action, environment, resource efficiency and raw materials”; “Europe in a changing world - inclusive, innovative and reflective societies”; “Secure societies - protecting freedom and security of Europe and its citizens”

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Avenue Louise 149 I 1050 Brussels, Belgium
t: +32 (0)2 533 3800 I f: +32 (0)2 533 3890
office@cost.eu I www.cost.eu

				Julitta T. & Rascher, U											
5	**PR1** Cogliati S., Rossini M. Julitta T.; Meroni, M. Schickling A., Burkart A., Pinto F., Rascher U. & Colombo R. (2015) Continuous and long-term measurements of reflectance and sun-induced chlorophyll fluorescence by using novel automated field spectroscopy systems. Remote Sensing of Environment, 164, 270-281.	Cogliati S.,		Contributing authors Rossini M. Julitta T.; A., Burkart Rascher U.	WG3			http://www.sciencedirect.com/science/article/pii/S0034425715001248	no	no	no	yes	yes	yes	
6	**PR1** Rascher U., Alonso L., Burkart A., Cilia C., Cogliati S., Colombo R., Damm A., Drusch M., Guanter L., Hanus J., Hyvärinen T., Julitta T., Jussila J., Kataja K., Kokkalis P., Kraft S., Kraska T., Matveeva M., Moreno J., Muller O., Panigada C., Pikl M., Pinto F., Prey L., Pude R., Rossini M., Schickling A., Schurr U., Schüttemeyer D., Verrelst J. & Zemek F. (2015) Sun-induced fluorescence - a new probe of photosynthesis: First maps from the imaging spectrometer HyPlant. Global Change Biology; doi: 10.1111/gcb.13017.	Rascher U.	8	1st author Rascher U., Contributing authors Alonso L., Burkart A., Damm A.,., Julitta T.,., Moreno J., Rossini M., Verrelst J..	WG2 WG3	23rd Sept. 2015		http://onlinelibrary.wiley.com/doi/10.1111/gcb.13017/full	no		no	yes	yes	yes	8.044
7	**PR2** van der Tol, C., Rossini, M., Cogliati, S., Verhoef, W., Colombo, R., Rascher, U., & Mohammed, G. (2016). A model and measurement comparison of diurnal cycles of sun-induced chlorophyll fluorescence of crops. Remote Sensing of Environment, 186, 663-677.	van der Tol, C	7	van der Tol, C., Rossini, M., Cogliati, Rascher, U.	WG3	7th Oct 2016		http://www.sciencedirect.com/science/article/pii/S0034425716303649							
8	Häusler, M., J. M. N. Silva, S. Cerasoli, G. López-Saldaña and J. M. C. Pereira (2016). Modelling spectral reflectance of open cork oak woodlands: a simulation analysis of the effects of vegetation structure and background. International Journal of Remote Sensing, 37(3): 492-515, DOI: 10.1080/01431161.2015.1134847	Häusler, M.	5	J. M. N. Silva and S. Cerasoli (Portugal) contributed to writing and editing; J. M. N. Silva coordinated the study.	WG3	4 Jun 2015	Published	http://www.tandfonline.com/doi/full/10.1080/01431161.2015.1134847	yes	no	no	yes	yes	yes	
9	**PR2** Cerasoli, S., F. C. Silva and J. M. N. Silva (2016). Temporal dynamics of spectral bioindicators evidence biological and ecological differences among functional types in a cork oak open woodland. International Journal of Biometeorology, 60(6): 813-825, DOI: 10.1007/s00484-015-1075-x	Cerasoli, S.	3	J. M. N. Silva and S. Cerasoli (Portugal) designed and conducted the research.	WG3	2 Jul 2014	Published	http://link.springer.com/article/10.1007/s00484-015-1075-x	yes	no	no	yes	yes	Yes	
10	Inoue, Y., Guerif, M, Baret, F., Skidmore, A., Gitelson, A., Schlerf, M., Olioso, A. (2016). Simple and robust methods for remote sensing of canopy chlorophyll content: a comparative analysis of hyperspectral data for different types of vegetation, Plant, Cell and Environment, doi:10.1111/pce.12815	Inoue, Y.	7	Gitelson, A	WG3		Published	doi:10.1111/pce.12815	no	no	no	yes	yes	Yes	
	Hueni, A., Damm, A., Kneubuehler, M., Schläpfer, D. and Schaepman, M. (2016). "Field and Airborne Spectroscopy Cross-Validation - Some Considerations." IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing PP(99): 1 - 19.	Hueni, A	5	Hueni, A.	WG!			http://ieeexplore.ieee.org/document/7582439/	no	no	no	yes	yes	Yes	

11	*Gitelson, A. A., Peng, Y., Vina, A., Arkebauer, T., Schepers, J. S. (2016). Efficiency of chlorophyll in gross primary productivity: A proof of concept and application in crops. Journal of Plant Physiology, 201, 101–110, http://dx.doi.org/10.1016/j.jplph.2016.05.019*	*Gitelson, A.*	*5*	*Gitelson, A.*	*WG3*		*Published*	*ttp://dx.doi.org/10.1016/j.jplph.2016.05.019*	*no*	*no*	*no*	*yes*	*yes*	*Yes*	

FP7/ H2020 Proposals and projects

This table contains FP7/ H2020 proposals/ projects spinning off from Action activities and including in the proposing consortium at least three Action participants from at least three different countries participating in the Action.

NO.	Title	Name and country of main proposer	Number of proposers	Action participants listed among the proposers (Name, country, role[3] in the Action)	Funding agency submitted to	Date submitted	Date results expected	Result	Call identifier	Relevance to H2020 Societal Challenges[4]?	Was the added value of the Action Networking necessary for the proposal / project?
Projects											
1	Marie Curie training network TRuStEE project	Italy	7	Rossini, Italy; Anderson, UK; Mac Arthur, UK; Rascher, Germany; van der Tol, Netherlands, Vescov, Italy;	H2020/Marie Curie	Jan 2016	May/2016	funded			Yes it brought the group together
2											
Proposals											
	List FP7/ H2020 proposals submitted as a result of the Action in this section of the table	None yet									

I.C. Networking

Added value of the Networking
This Action has brought together a diverse range of scientists who are not collaborating and developing proposals and received for funding for science activities from national governments Poland (funding received) and Romania (proposal in review) in particular. Proposals are also in preparation for submission to ESA. None of these activities would have occurred without OPTIMISE
Extent of the networking
The network operates well and a diverse range of both MC and WG members attend themed workshops. ESR are actively encouraged to participate and lead activities (i.e. See ESR organised 'think tank' (http://optimise.dcs.aber.ac.uk/workshops-meetings/esr-think-tank-tartu-obsveratory-estonia/) Activities are held in inclusiveness countries where possible i.e. the 2017 annual workshop and MC meeting will be held in Cyprus and the ESR organised workshop refered to above was held in Estonia Collaborative work between U. of Edinburgh, U. of Life Science, Poznan and DLR to establish a Sentinel-2 mission cal/val field site in Poland

I.D. Impacts

The impacts that have resulted, or might result from the Action are described in the following table.

Description of the impact	Type of impact[5]	Timing of impact[6]
Enter one impact per line, and specify the type and timing of the impact.		
The possible establishment of a calibration and validation network of field research sites to support ESA FLEX mission and vegetation fluorescence science	Scientific	Foreseen within 2 years
Development of common procedures for laboratory calibration and characterisation of near-ground spectrometers for reflectance and fluorescence measurement in support of FLEX	Scientific	Foreseen within 2 years
Deployment and field trials of spectrometer system developed within OPTIMISE for fixed-point logging	Technical	Foreseen within 2 years
Establishment of a Sentinel-2 calibration and validation site in collaboration with DLR in Poland	Scientific	Achieved
Development of a Sentinel-2 calibration and validation site in collaboration with DLR and ESA in Poland	Scientific	Foreseen within 2 years
Deployment and field trials of spectrometer system developed within OPTIMISE for fixed-point logging	Technical	Achieved

I.E Dissemination and exploitation of Action results

Describe the Action's dissemination and exploitation approach as well as all activities undertaken to ensure dissemination and exploitation of Action results and the effectiveness of these activities.

Add description here

Item/ activity	Target audience	Result	Hyperlink
Newsletter1	OPTIMISE community	Wider dissemination of OPTIMISE activities	http://optimise.dcs.aber.ac.uk/wp-content/uploads/OPTIMISE-Newsletter1.pdf
Newsletter2	OPTIMISE community	Wider dissemination of OPTIMISE activities	http://optimise.dcs.aber.ac.uk/wp-content/uploads/OPTIMISE-Newsletter2.pdf

5 Scientific/ technological, Economic, Societal

6 Achieved/ Foreseen within 2 years/ Foreseen 2-5 years/ Foreseen 5-10 years/ Foreseen 10+ years

I.F. Action success(es)

COST regularly communicates the successes of Actions. At this point in time what aspect(s) (outcomes and/ or impacts, rather than activities) of this Action is/ are the most suitable for communication?

	Dimension of the success ■ Breakthrough: scientific, technological or socioeconomic ■ Policy implementation (specify which policy) ■ Capacity building

II. Management Report

II.A. Overview of expenditure

Insert below in the yellow cells the summary of figures from the Yearly Financial Reports (YFRs) of completed Grant Periods and an IFR of any incomplete Grant Period – the Totals (non-yellow cells) will automatically sum.

	Grant Period 1	Grant Period 2	Grant Period 3
GP start and end dates	01/06/2014-31/05/2015	01/06/2015-30/04/2016	01/05/2016-30/04/2017
Grant Holder institution	Aberystwyth University (GB)	Aberystwyth University (GB)	Aberystwyth University (GB)
Meetings	EUR 55,001.19	EUR 40,970.53	EUR 94,568.91
Training Schools	EUR 30,755.02	EUR 50,900.97	EUR -
STSMs	EUR 5,540.00	EUR 8,440.00	EUR 19,280.00
Dissemination	EUR 4,398.00	EUR 1,500.00	EUR -
OERSA[1]	EUR -	EUR -	EUR -
Total Scientific Expenditure	EUR 95,694.21	EUR 101,811.50	EUR 113,848.91

[1] OERSA = Other Expenses Related to Scientific Expenditure (e.g. bank charges)
[2] FSAC = Amount received by Grant Holder for Financial Scientific and Administrative Coordination

II.B. Budget and Participation management

II.B.1 Budget spent in relation to individuals/ institutions outside participating COST countries					
STSMs from or to institutions from countries other than Participating COST countries					
The table below describes the added value STSMs to approved institutions in IPC or NNC or Specific Organisations and any STSMs from an approved institution in an NNC to a participating COST country.					
Grantee		Host		Date	Topic and value added to the Action
Institution	Country	Institution	Country		
None					
Invited Speakers					
The table below highlights the added value of Invited Speakers from COST countries that have not accepted the MoU and/ or non-participating NNC, IPC or Specific Organisations whose participation at a meeting or Training School was reimbursed by the Action.					
Participant name	Institution	Country	Event date	Topic and added value to the Action	
None					
Dissemination meetings					
The table below highlights the added value of Dissemination Meetings financed from Action funds.					
Participant name	Role	Country	Date	Location	Topic and added value to the Action
None					

II.C. Participants

Management Committee		
Name	Country	Email address
Dr Alasdair Macarthur	UK	alasdair.macarthur@ed.ac.uk
Dr Micol Rossini	IT	micol.rossini@unimib.it
Dr Georg Wohlfarht	AT	georg.wohlfahrt@uibk.ac.at
Dr Hannes Kleindienst	AT	kleindienst@grid-it.at
Dr Kyriacos Themistocleous	CY	Kt33@cytanet.com.cy
Dr Daniel Kovac	CZ	Kovac.d@czechglobe.cz
Mr Andreas Burkart	DE	An.burkart@fz-jeulich.de
Prof Ranus Fensholt	DK	rf@ign.ku.di
Dr Monica Garcia	DK	mgarc@env.dtu.dk
Dr Pilar Martin	ES	Mpilar.martin@cchs.csic.es
Prof Jose Moreno	ES	Moreno.uv@gmail.com
Dr Lea Hallik	EE	Lea.hallik@to.ee
Mr Joel Kuusk	EE	joel@to.ee
Dr Jean-louis Roujean	FR	jlroujean@gmail.com
Dr Yves Goulas	FR	Yves.goulas@lmd.polytechnique.fr
Dr Albert Porcar-Castell	FI	Joan.porcar@helsinki.fi
Dr Tea Thum	FI	Tea.thum@fmi.fi
Dr Mark Neal	UK	mjn@aber.ac.uk
Dr Karen Anderson	UK	Karen.anderson@exeter.ac.uk
Dr Leonidas Toulios	EL	ltoulios@nagref.gr

COST is supported by the EU Framework Programme Horizon 2020

COST Association
Avenue Louise 149 I 1050 Brussels, Belgium
t: +32 (0)2 533 3800 I f: +32 (0)2 533 3890
office@cost.eu I www.cost.eu

Mr Antonis Kavvadis	EL	akavvadias@enagris.gr
Dr Zoltan Nagy	HU	Nagy.zoltan@mkk.szie.hu
Prof Branimir K.Hackenberger	HR	hack@biologija.unios.hr
Dr Micol Rossini	IT	Micol.rossini@unimib.it
Dr Loris Vescovo	IT	Loris.vescovo@fmach.it
Dr Anatoly Gitelson	IL	Agitelson2@uni.edu
Dr Connor Cahalane	IE	Conor.cahalane@nuim.ie
Dr John Connolly	IE	John.b.connolly@dcu.ie
Dr Dainis Jakovels	LV	Dainis.jakovels@gmail.com
Dr Hans Tommervik	NO	Hans.tommervik@nina.no
Dr Rune Storvold	NO	Rune.storvold@norut.no
Dr Christiaan van der Tol	NL	c.vandertol@utwente.nl
Dr Joao Silva	PT	joaonevessilva@gmail.com
Dr Jan Keizer	PT	jjkeizer@ua.pt
Dr Jaroslaw Chormanski	PL	j.chormanski@levis.sggw.pl
Prof Janusz Olejnik	PL	olejnikj@up.poznan.pl
Dr Dan Sporea	RO	Dan.sporea@inflpr.ro
Dr Gheorghe Stancalie	RO	Gheorghe.stancalie@meteoromania.ro
Prof Lars Eklundh	SE	Lars.eklundh@nateko.lu.se
Dr Manuela Balzarolo	BE	Manuela.balzarolo@uantwerpen.be
Prof Frank Veroustraete	BE	Frank.veroustraete@uantwerpe.be
Dr Srdjan Keren	BA	Keren_bl@hotmail.com
Prof Rumiana Vatseva	BG	rvatseva@gmail.com
Dr Andreas Hueni	CH	Andreas.hueni@geo.uzh.ch
Dr Mathias Kneubuehler	CH	Kneub@geo.uzh.ch
Dr Georgos Papadavid	CY	papadavid@ari.gov.cy
Dr Matthias Peichl	SE	Matthias.peichl@slu.se
Prof Eyup Koksal	TR	eselimk@yahoo.com

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COST Association
Avenue Louise 149 I 1050 Brussels, Belgium
t: +32 (0)2 533 3800 I f: +32 (0)2 533 3890
office@cost.eu I www.cost.eu

Annex 1

Definitions:

COST Action Challenge (main aim)	"The research question addressed by the COST Action targeting scientific, technological, and / or socioeconomic problems"
COST Action Innovation	"The creation and / or development of new or improved concepts, products, processes, services, and / or technologies that are made available to markets, governments and society"
COST Action objectives	"COST Action objectives are the results that an Action needs to achieve in order to respond to meet its challenge. These are SMART (Specific, Measurable, Achievable, Relevant, Timely) and twofold: research coordination objectives and capacity building objectives."
COST Action research coordination objectives	"Achieving these objectives turns COST Actions from initially scattered teams into one transnational team and leverages the existing funded research. These objectives entail the distribution of tasks, sharing of knowledge and know-how, and the creation of synergies among Action participants to achieve specific outputs."
COST Action capacity building objectives	"Achieving these objectives entail building critical mass to drive scientific progress, thereby strengthening the European Research Area. They can be achieved by the delivery of specific outputs and / or through network features or types and levels of participation."
COST Action networking activities	"any activities organised by the COST Action (whether or not directly funded by COST) in order to achieve research coordination and capacity building objectives."
COST Action networking tools	"instruments through which eligible activities can be funded"
COST Action outputs	"direct results from the COST Action activities. These can be codified knowledge, tacit knowledge, technology, and societal applications."
COST Action impact	"the short- to long-term scientific, technological, and / or socioeconomic changes produced by a COST Action, directly or indirectly, intended or unintended."
COST Action deliverable	"a distinct, expected and tangible output of the Action, meaningful in terms of the Action's overall objectives such as a report, a document, a technical diagram, a software etc. Action deliverables are used to measure its progress and success."
COST Action milestones	"Control points in the Action that help to chart progress. They are also needed at intermediary points so that, if problems have arisen, corrective measures can be taken. A milestone may be a critical decision point in the Action where, for example, the MC must decide which of several technologies to adopt for further development (e.g. core group and MC meetings, mid-term reviews)"
Inclusiveness Target Country (ITC):	Current COST Member Countries targeted by the COST inclusiveness Policy ("Inclusiveness Target Countries" (ITC)): EU 13 (Bulgaria, Cyprus, Czech Republic, Estonia, Croatia, Hungary, Lithuania, Latvia, Malta, Poland, Romania, Slovenia, Slovakia), EU candidate countries (the former Yugoslav Republic of Macedonia, Montenegro, Republic of Serbia, Turkey) and potential EU candidate countries (Bosnia and Herzegovina). In addition, to comply with the EC criteria for 'Spreading Excellence and Widening Participation', Portugal and Luxemburg are included.

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COST Association
Avenue Louise 149 I 1050 Brussels, Belgium
t: +32 (0)2 533 3800 I f: +32 (0)2 533 3890
office@cost.eu I www.cost.eu