9th EARSeL Forest Fire Special Interest Group Workshop on
'Quantifying the environmental impact of forest fires'

Hosted by the University of Leicester, UK
Held at Coombe Abbey Hotel, Binley, Warwickshire, CV3 2AB, UK
Monday 14 October to Thursday 17 October 2013

Workshop Programme

Version 2 created 10 September 2013
(contents are subject to change)
Monday 14 October

15.00-19.00: Check-in and registration
17.00-17.00: Tea/coffee and cake served
19.00-19.30: Welcome drink
19.30-close: Dinner

Tuesday 15 October

08.00-09.00: Registration
09.00-09.15: Coffee
09.15-09.30: Welcome address and workshop objectives
09.30-10.30: KEYNOTE SPEAKER

Fire Monitoring from Space: Past accomplishments, recent developments and future directions
Chris Justice, University of Maryland, USA

With a warming world, extreme weather events and an increasing global population, fire regimes are changing, posing increasing challenges to local communities and fire and natural resource management agencies around the World. Costs of wildfire management are growing and communities and the associated infrastructure in fire prone systems are often at risk. Large conflagrations are commonly reported by the media and appear to be on the increase and the impact of reduced air quality from fires is creating local to regional concerns. Over the past two decades significant progress has been made in monitoring global fires from Space. The NASA MODIS instruments and the associated derived products and services have set a standard for delivery of global satellite-based fire information. The need for routine fire observations is now becoming accepted by the operational space agencies and new fire observation capabilities are available or planned. For example, the S-NPP VIIRS instrument is now producing data which provides dynamic continuity with the MODIS fire observations. We are also seeing improved fire monitoring capabilities from the Geostationary sensing systems. Fire records are of becoming of sufficient length to start to develop fire climate data records needed for studying trends in global fire occurrence, timing and extent and understanding the role of fire in our changing planet. The satellite record shows that fire occurrence is increasing in many parts of the World.

Challenges for the fire remote sensing community include furthering fire science and enhancing applications using satellite observations of fire, securing data continuity, determining the accuracy of available products, developing well-characterized long term-data records, creating new and improved products and data services from the new satellite observing systems, and the associated outreach to both science and applications user communities. The GOFC-GOLD program is continuing to provide a forum for international cooperation on fire remote sensing to explore how to better respond to these challenges.

10.30-11.00: Coffee
11.00-12.30:  Session 1 - Megafires and their impact on the environment

Monitoring of areas affected by forest megafires
Maria Isabel Cruz Lopez, CONABIO, Mexico
• Evaluating the impact of forest fire on vegetation.
• Monitoring vegetation recovery after mega-fires using two sensors with high
temporal and high spatial resolution.
• Assessment of the vulnerability of vegetation to fire.

Mapping the daily progression of large wildland fires using MODIS active fire
data
Sander Veraverbeke, Jet Propulsion Laboratory, Pasadena, USA
• Fire emission models need daily attribution of burned area to reduce
uncertainties.
• We used the timing and location of the MODIS active fire data in a kriging
interpolation as a new approach to estimate the daily progression of large
wildland fires.
• The resulting daily progression outperformed the temporal reporting accuracy
of the standard MODIS burned area products (MCD45A1 and MCD64A1)

Preparedness for Megafires – An example of pre-burn and combusted biomass
Heiko Balzter, University of Leicester, UK
• Pre-burn savanna biomass estimated from net primary productivity (NPP)
explains >50% of burned biomass estimated from fire radiative energy (FRE)
in southern African savannas.
• Multi-annual biomass accumulation (positive) and herbivory (negative) effects
on the residuals from the line are hypothesised to partially explain any residual
variation.
• Uncertainties in NPP-based pre-burn biomass estimation and FRE-based
burned biomass estimation also contribute to the residuals.

Forest fires on Mount Kenya
Abigail R. Mutambu, PASCO and RCMRD, Kenya
• To be provided

12.30-14.00: Lunch
14.00-15.00:  Session 2 – Are we closer to quantifying fire severity from space?

Burn severity assessment of a heathland fire in Belgium using APEX hyperspectral indices
Pieter Kempeneers, VITO TAP, Belgium
- We developed burn severity indices based on hyperspectral sensors
- We applied them to new APEX hyperspectral sensor for heathland burn severity assessment.
- We monitored natural habitats using hyperspectral remote sensing

Fire severity information from active fire detections in high northern latitude ecosystems
Kirsten Barrett, University of Leicester, UK
- Fire severity in high northern latitude ecosystems is defined primarily by the amount of surface organic material removed by combustion, which cannot be measured remotely but can be inferred through the incorporation of spectral and non-spectral remotely sensed data such as active fire detection data products.
- The combustion of surface organic material in high northern latitude ecosystems occurs primarily during smouldering combustion, and is associated with active fire detections that persist over multiple days and exhibit lower fire intensity.
- The date of burn from active fire data products can be used to inform analyses of fire severity by identifying late season fires, which are generally more severe, and by incorporation with weather station data to map variations in fire weather indices.

PREFER: space-based information support for prevention and recovery of forest fires
Giovanni Laneve, University of Rome La Sapienza, Italy
- The paper presents results from the FP7 project PREFER.
- PREFER aims at reducing fires incidence by developing a software capable of determining where and when the prescribed fire practice is applicable and by introducing a daily hazard index suitable for Mediterranean areas.
- PREFER aims to develop a fire damage severity index and at providing an automatic system for an accurate estimate of burned areas;

15.00-16.30:  Session 3 – Methods of quantifying post-fire recovery of the environment

Modelling vegetation succession in fire affected areas in the Mediterranean
Marco Lima, CIMA Research Foundation, Italy
- To be provided

Drought impact on post fire vegetation recovery in Greece during 2007
Célia Gouveia, University of Lisbon, Portugal
- To be provided
Burn impact assessment using NDVI and EVI MODIS data
Aurélio Azevedo Barreto-Neto, Federal Centre of Technological Education of State of Espírito Santo, Brazil

• To be provided

16.30-17.00: Tea

17.00-18.30: Poster session - see list at the end of the programme

18.30: Close of session
19.00-19.30: Pre-dinner drinks
19.30-close: Dinner
Wednesday 16 October

09.00-10.00: **KEYNOTE SPEAKER**

**Building a global fire climate record: The challenge of meeting the Essential Climate Variable requirements**  
Luigi Boschetti, University of Idaho, USA

Fire is a major ecosystem disturbance and a widely-used land management tool. It plays an important role in global change, for example by contributing to regional trace gas emissions and impacting air quality. Fire is an agent of land cover change and a land use change indicator. Satellite derived burned area and active fire datasets have been identified by the Global Climate Observing System (GCOS) as one of the Essential Climate Variables (ECVs) needed in support of the UN-FCCC. The nature of fire as a non-permanent land cover change pose unique technical challenges with respect to the development of fire detection and mapping algorithms, and in the development of validation techniques and datasets: as a result, only in recent years it has been possible to assess quantitatively the accuracy of global fire products. The use of fire datasets as ECVs is subject to strict requirements in terms of accuracy, precision and temporal stability, and will require the adoption of standard protocol for the systematic validation of the products, both in space (globally) and in time (evaluating the accuracy over time). The recent developments in intercomparison, quality assessment and validation of global fire products will be reviewed, showing how the recent changes in data policy for moderate resolution (~30m) data, with free access and systematic acquisition, allow for the implementation of a global, multiyear, validation strategy which meets the ECV requirements.

10.00-10.30: Coffee

10.30-12.30: **Session 4 – State-of-the-art in burnt area mapping techniques**

**Global mapping of burned areas from European satellites**  
Emilio Chuvieco, University of Alcala, Spain
- The current developments in the ESA fire_cci project are described.  
- This project aims to generate a long-term global burned area from VGT, ATSR and MERIS sensors.  
- The project includes extensive validation and is closely linked to the needs of climate modellers.

**Edge-preserving data assimilation and a simple linear spectral model for burned area detection**  
Jose Gomez-Dans, University College London, UK
- The application of data assimilation ideas to signal tracking where discontinuities such as fire are present. Benefits of this approach lie in its resilience to few observations and also in its ability to use different sensors.  
- The development and use of a spectral model of burned scenes can be used to interpret the effect of fire on vegetation.  
- We combine the previous two points in an burned area algorithm.

**National scale burn scar mapping in Greece.**  
Charalmpos Kontoes, National Observatory of Athens, Greece  
- We mapped burned areas across the country of Greece.  
- We undertook diachronic fire mapping and damage assessment.  
- We used high to very high resolution EO data to undertake this mapping.
Validation of a burned area product at global scale
Marc Padilla, University of Alcala, Spain
- Probability sampling was used to infer the accuracy of MCD45 for the globe and the main biomes.
- Accuracy measures chosen were guided by user requirements.
- The globally averaged Dice coefficient is 0.36 and the relative bias is -0.45.

Prototype Global Burnt Area Algorithm Using a Multi-Sensor Approach
Gerardo López Saldaña, Technical University of Lisbon, Portugal
- Identification of areas affected by fire using remotely-sensing data relies on a single-sensor observation, the approach that we present will allow the use of multiple sensors.
- There is no long-term data record of burned areas which comprises more than 30 years, this research will make use of the longest surface reflectance data record derived from the AVHRR to produce an Albedo time series that will be used as the main input of the burned area algorithm.
- The main goal of this research is to developed a prototype algorithm to create a long-term burnt area map database at 0.05° spatial resolution for every 8-day time period within a calendar year using multiple sensors.

12.30-13.30: Lunch
Remote Sensing of fire and fire effects in tundra ecosystems of North America
Nancy French, Michigan Tech Research Institute, USA

- Fire in tundra ecosystems can be better characterized with remote sensing in both the visible-IR spectrum and with active SAR imaging sensors. We review three activities to use these technologies.
- Fire occurrence information in North American tundra is lacking, so we have developed a method to monitor fires using a semi-automated approach with Landsat TM/ETM+. Since fire in this biome may be increasing, development of these approaches is valuable.
- We have investigated the utility of Synthetic Aperture Radar for characterizing tundra ecosystems and fire. This is a tool that could have great value due to its all-weather and day/night capabilities.

Using optical and radar remote sensing data to understand the effects of fire history and severity in tropical peat swamp forests
Matthew Waldram, University of Leicester, UK

- Temporal L-band radar profiles of areas of tropical peat swamp forest affected by fire do not conform to expected biomass/radar relationships.
- Temporal radar variation due to fire can be less than that due to changes in the peat land water table.
- Despite optical data being affected by clouds, it can be used to map fire severity in peat swamp forests and to help separate patterns of variation in the temporal radar signal caused by fires and other environmental drivers.

Integration of optical and radar remotely sensed data for mapping forest fires in Mediterranean regions
Daniela Stroppiana, CNR-IREA Milano, Italy

- We integrated radar and optical data for fire monitoring and burn mapping.
- Separability between burned and unburned surfaces in SAR backscatter is analysed
- Using both radar and optical data improved accuracy.

Monitoring tropical forests affected by recurrent fires using ALOS PALSAR data and object-based image analysis
Haron Xaud, EMBRAPA, Brazil

- Texture images derived from PALSAR FBS (HH polarization) were very useful to improve the separability between classes of fire impacts in a tropical forest region.
- Object-Based Image Analysis (OBIA) and the feature space optimization proved to be a powerful tool to evaluate and classify fire scars from PALSAR data.
- Based on forest inventories and ALOS PALSAR images, we classified 5 levels of fire impacts in a complex mosaic of vegetation cover found in the northern Amazon study area.
Quantifying wildfire fuel combustion using active fire observations
Gareth Roberts, University of Southampton, UK

Biomass burning is a key Earth system process which impacts the Earth’s surface through the removal of vegetation and organic matter and is a significant source of atmospheric trace gases and aerosols. The spatial significance of biomass burning is highlighted by recent estimates that, on average, ~3.4% of the Earth’s vegetated land surface is affected by fire. Burned area estimates play a key role in quantifying the spatial extent of biomass burning and the amount of biomass consumed. The latter is often estimated using Earth Observation (EO) datasets, including burned area measurements, and biogeochemical models (termed the ‘bottom-up’ approach). Thermal EO measurements of actively burning fires are also widely used to characterise the spatio-temporal variation of biomass burning. They are also able to quantify the radiative energy emitted during wildfires, the Fire Radiative Power (FRP). Measurements of the radiant energy released during combustion have been shown to be related to the quantity of fuel consumed and this relationship has been exploited using EO data to derive fuel consumption estimates at regional and global scales. Recent developments in polar and geostationary active fire characterisation algorithms attempt to improve the detection of small/low intensity fires which are, in particular, an issue for coarse spatial resolution geostationary observations. An example of one such algorithm is a prototype temporal fire detection algorithm which has been applied to one month of Meteosat SEVIRI observations over Africa. During this time, the temporal algorithm detected 2.6 million fire affected observations and a large proportion of these were low intensity fires (<30MW). However, whilst the FRE-derived fuel consumption estimate increased by ~20% compared to a contextual algorithm, it remains significantly underestimated compared to fuel consumption estimates derived via other means. In parallel with active fire algorithm developments have been improvements in Fire Radiative Energy (FRE) and fuel consumption datasets. One example is the development of methods to derive FRE from polar-orbiting instruments which account for the spatio-temporal sampling constraints imposed by the satellite orbit. Another approach is the integration of burned area and geostationary active fire datasets to account for the omission of small/low intensity fires. Merging SEVIRI FRP and MODIS burned area measurements increased the annual (2004) fuel consumption estimate for Africa by ~750Tg compared the ‘raw’ FRE-derived fuel consumption estimate alone. Due to the benefits of FRP, these data are now being applied in areas such as characterising the emissions source in atmospheric transport models, to improving our understanding of the spatial and temporal variation of fire activity and behaviour.
16.30-18.00:  Session 6 – Advances in the use of thermal observations

Retrieving the power law distribution parameters of forest fire radiative power
José-Luis Casanova, University of Valladolid, Spain
- By analysing a large number of MODIS hot spots in China we have confirmed FRE follows a power law distribution.
- The analysis of FRE power law distribution allows us to estimate the capacity of MODIS to detect forest fires.
- As a result, we conclude that FRE depends of five parameters: two could be estimated from the FRE distribution analysis; in addition, we suggest some ways to estimate the other three.

Remotely Sensed Fire Type Classification of the Brazilian Tropical Moist Forest Biome
David Roy, South Dakota State University, USA
- A validated methodology is presented to classify the fire type of MODIS active fire detections.
- The spatial and temporal patterns of classified MODIS active fire types are graphically presented and quantitatively summarized for 8 years over the 3.9 million km² of the Brazilian Tropical Moist Forest Biome (BTMF).
- The results are expected to be useful for fire occurrence and emissions modeling in the BTMF.

What we have learned about FRP & FRE from 6 years of study in the Canadian Boreal Forest
Martin Wooster, Kings College London, UK
- To be provided

18.00: Close of session
19.00-close: Workshop event – Medieval Banquet
Thursday 17 October

09.00-10.00:  KEYNOTE SPEAKER

Global fire emissions and potential fire-related climate mitigation options
Guido van der Werf, VU University Amsterdam, The Netherlands

Understanding the role of fire in the Earth system requires a proper quantification of global fire emissions. We present preliminary emissions estimates from the fourth generation of the Global Fire Emissions Database (GFED4) based on satellite-derived burned area and a biogeochemical model driven by satellite vegetation data. Major improvements over earlier version include accounting for fires that are too small to be detected by the burned area algorithms but seen by active fire algorithms and a more rigorous validation of modelled fuel consumption against ground-based measurements. We then focus on the African continent which accounts for about 70% of global burned area and 50% of carbon emissions to 1) understand the contrasting trends in fire activity observed over the past decade with a steady decrease in emissions in northern hemisphere Africa while fire activity in southern hemisphere Africa increased, and 2) quantify potential greenhouse gas emission savings and potential carbon sequestration that can be achieved by lowering fire activity. We show that a combination of climatic and human factors drives the observed trends in Africa and that future fire activity on this continent is likely to decline despite climate change, and that a world without fires would only look different from a carbon stock perspective in the African regions without strong rainfall seasonality. Although the latter indicates that success of so called 'carbon farming' initiatives is highly dependent on climatic conditions, we found that the total carbon sequestration potential is still large enough to offset African fossil fuel emissions.

10.00-10.30:  Coffee
10.30-13.00: Session 7 – Modelling the environmental impact of fires

Development of a global fuel map using FCCS: Mapping fuel characteristics to obtain fire potentials
M. Lucrecia Pettinari, University of Alcala, Spain
- The Fuel Characteristic Classification System was used for the first time to develop a global map of fuelbeds.
- Fire potentials under benchmark environmental conditions were calculated and mapped, which allowed comparing the different fuelbeds based solely on their fuel characteristics.
- This map could provide valuable information in regions that do not have a fire risk assessment system, and could be also used to obtain emissions estimations when incorporated into specific fire emissions algorithms.

Estimating carbon losses from fires for REDD in tropical peatlands
Agata Hoscilo, Institute of Geodesy and Cartography, Poland
- To be provided

Monitoring canopy structure and moisture content with dual-wavelength terrestrial laser scanning
Rachel Gaulton, Newcastle University
- Dual-wavelength laser scanning has potential to provide detailed information on both canopy structure and biochemistry.
- Leaf equivalent water thickness can be retrieved from data acquired by the Salford Advanced Laser Canopy Analyser in experimental trials.
- Such data is of value to provide information at plot scales on the vertical and spatial distribution of live and dead fuels and fuel moisture content for fire modelling.

Development and validation of new EFFIS probabilistic products utilising an ensemble prediction methodology
Thomas I. Petrioliagkis, Joint Research Centre (Ispra), Italy
- We investigate the applicability of extending EFFIS (European Forest Fire Information System) products to cover the global scale.
- We utilise ensemble forecasting methodology to develop and validate new EFFIS probabilistic products covering the globe.
- We further investigate the possibility of extending the forecast horizon of EFFIS products by utilising Monthly and Seasonal NWP (Numerical Weather Prediction) model fields.

Meteorological controls on biomass burning during Santa Ana events in southern California
Sander Veraverbeke, Jet Propulsion Laboratory, Pasadena, USA
- Regional-scale fire weather severity and fire activity are strongly correlated during Santa Ana fires in southern California.
- The growth of many Santa Ana fires was limited due to fuel limitations, the size of fires unlimited in fuels was controlled by ignition timing and location.
- Post-fire severity was not related to fire weather severity, but we found higher intensity fires in the main wind corridors.
A satellite hyperspectral remote sensing approach for detailed fuel type mapping in a Mediterranean study site

Ioannis Gitas, Aristotle University of Thessaloniki, Greece

- We obtained 72.4% overall accuracy for 6 forest fuel types.
- Moderate spatial resolution are less sensitive to discriminate mixed forest from 'pure' forest in this fragmented landscape.
- We consider a combination of high spatial and high spectral resolution imagery.

13.00-14.00: Lunch
14.00: Close of workshop and taxis
POSTERS

Posters will be mounted for the duration of the workshop. There is a dedicated poster viewing session on Tuesday 17.30-18.30.

Forest fire severity assessment using LiDAR data in a Mediterranean environment
Antonio Montealegre, University of Zaragoza, Spain
- LiDAR statistics derived from plot-level distributions of pulse return heights provide initial support for quantifying severity caused by fire in a Mediterranean ecosystem.
- Height related variables, as Skewness, Kurtosis and mean elevation, present the highest Spearman correlation coefficient with the CBI values measured in field and are the most significant in the analysis of the differences between high and low severity values.
- Although the logistic regression equation derived allows to infer burn severity, it is necessary to increase the field sample data to improve the robustness of the analysis, and develop more reliable burn severity mapping.

The use of very high spatial resolution SPOT imagery for fire risk characterization
Ioannis Gitas, Aristotle University of Thessaloniki, Greece
- A fire risk map was produced based on fuel type and burned area mapping using very high spatial resolution SPOT imagery.
- The forest fuel type map was produced with an overall accuracy of 88%, and a perfect matching of the fire-affected area to the classified burned area was observed.
- Overall, a total of four fire risk classes namely, ‘very high risk’, ‘high risk’, ‘medium risk’ and ‘low risk’ were produced.

Use of MERIS to map burned areas on a global scale
Emilio Chuvieco, University of Alcala, Spain
- To be provided

A new supervised burned area software in ArcGIS environment
Aitor Bastarrika, University of the Basque Country UPV/EHU, Spain
- A supervised burned area mapping tool in ArcGIS environment for Glovis Landsat data.
- High spatial agreement in comparison to visual analysis external reference data for different ecosystems.
- High time-efficient methodology with less than 15 minutes required for the mapping of the burned areas in each scene.
Analysis of the spatio-temporal relationship between land surface temperature (LST) and wildfire severity in a series of Landsat images
Lidia Vlassova, University of Zaragoza, Spain & Technical State University of Quevedo, Ecuador
- Spatio-temporal variations of Land Surface Temperature (LST) and fire severity levels in a 2009-2011 sequence of Landsat images following the pine forest burn in Central Spain were analyzed.
- Statistically significant differences between LSTs of any pair of severity levels were registered on all the dates.
- Spatial patterns of the relationship between LST and burn severity can be used to predict natural dynamics of burned areas

Assessing the integration of the fire danger index using sensitivity analysis
Aitor Bastarrika, University of the Basque Country UPV/EHU, Spain
- To be provided

Assessment of the fire-affected communities’ regrowth paths: methodological approach by means of Tasseled Cap time series and the FNI3
Marcos Rodrigues Míngue, University of Zaragoza, Spain
- Vegetation species groups go through regrowth stages which differ in terms of wetness and brightness.
- Obligate re-sprouters reproduce with similar pre-fire conditions 5 years after fire.
- The regrowth path for Pine forest is strongly influenced by sub-shrub species which often replace the pre-fire species.

The cartography of burned area on Borneo Island with ERS 2 and ENVISAT images between 2004 and 2009
Emilio Chuvieco, University of Alcalá, Spain
- This study has assessed a set of data layers derived from SAR data using a statistical technique. The cross-polarization images and image ratios between two dates reveal the best separability.
- A group of classification algorithms were evaluated for burned area detection. The image thresholding method and the support vector machine algorithm show the best performance.
- A visual analysis of the results reveal low omission errors in comparison with commissions, especially in agricultural land cover and seasonally flooded areas, where the SAR amplitude value vary widely.

Using active fire products to detect fires across vegetation types in Poland
Agata Hoscilo, Institute of Geodesy and Cartography, Poland
- To be provided
MODIS-detected fire regime in Great Britain: Potential and challenges of validating against national incident data
Julia McMorrow, University of Manchester, UK

- Comparison against 19 days of national Incident Recording System (IRS) fire statistics for England in spring 2011, showed that MODIS Rapid Response hotspot data missed 92% of significant vegetation fires attended by Fire Services due to a combination of cloud, smoke, small fire size and short duration.
- Despite this, MODIS provides a near-real time, if partial, national picture of the geography of large fires in Great Britain (GB) for operational fire managers, which is currently not available from IRS. They require faster, spatially-specific delivery of IRS data on wildfires (and an agreed definition of ‘wildfire’ using IRS data fields).
- IRS is limited as a validation source for remote sensing because fire location is recorded as a single point with estimated burned area. Standardising this point and/or recording fire perimeter would assist validation of remote sensing fire products and facilitate spatial analysis of GB’s fire regime.

Early exploration of quadcopter-type UAV’s for fire emissions assessment
Martin Wooster, Kings College London, UK

- To be provided

Simulating infrared Earth observation imagery of wildfires using the Prometheus Fire Growth model
Joshua Johnston, Canadian Forest Service, Canada

- This simulator translates spatial fire behavior predictions from a fire growth model into radiance maps using a series of models to describe flame front structure, geometry and temperature, as well as burn scar cooling.
- Research has been conducted to provide methods for compensating for flame emissivity, as well as for forest canopy interception of subcanopy flame radiance.
- This tool is designed for planning purposes and can be used to evaluate proposed sensors, overpass times, extraction algorithms.

Development of a Mobile App for fire prediction, detection and monitoring
Philip Frost, CSIR – Meraka Institute, South Africa

- We have developed a AFIS mobile app.
- Mobile fire information is collected and displayed.
- Geo tagged photos are vital information.
Application of GIS and remote sensing techniques for active fire detection and mapping in Smolyan District to support forest decision makers
Ivan Ivanov, University of Sofia “St. Kliment Ohridski”, Sofia, Bulgaria.

- We use 15 towers providing meteorological measure devices and PTZ cameras and near real time calculation of the Canadian Fire Weather Index with data from the towers with fire detection (hotspot) based on MODIS to provide long-term fire risk assessment.
- We utilise a number of GIS layers, useful for fire fighters (settlements, rivers, lake, roads, land cover etc).
- We use an online GIS platform that integrates all data.