Wildfire Research @ Manchester

MANCHESTER 1824
The University of Manchester

Who we are: Wildfire research at The University of Manchester spans two Faculties and four Schools: School of Environment, Education and Development (SEED) and Manchester Business School (MBS) in the Faculty of Humanities; School of Mathematics and School of Earth, Atmospheric and Environmental Sciences (SEAES) in the Faculty of Engineering and Physical Sciences. We also work with other institutions such as Manchester Metropolitan University (MMU), Salford University, Kings College London (KCL) , and stakeholders such as the Fire Service and land managers.

Atmospheric Aerosol Group Centre for Atmospheric Science

Contacts: Professor Hugh Coe hugh.coe@manchester.ac.uk
Professor Gordon McFiggans *gordon.mcfiggans@manchester.ac.uk*
School of Earth, Atmospheric and Environmental Sciences

Activities

- Measurements of deforestation fires, wildfires and domestic solid fuel emissions and their associated effects on air quality & climate.
- Modelling of fire emissions in atmospheric models studying regional air quality & climate.
- Investigation and modelling of the morphological and optical properties of soot particles, with relevance to climate.
- Laboratory characterisation of wildfire emissions

Capabilities

- Comprehensive suite of state-of-the-art aerosol instrumentation, covering composition, size, optical properties and water uptake, suitable for field, lab and aircraft use and highly
- Experienced staff who have developed their own analysis methodologies.
- Access to and experience using the Facility for Airborne Atmospheric Measurements (FAAM).
- Use of the WRF-Chem regional atmospheric model with dedicated HPC resources.

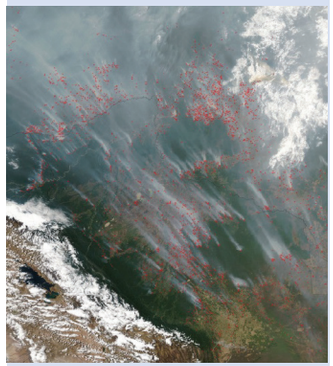
Recent publications

Regional modelling over Brazil - doi:10.5194/gmd-8-549-2015

UK domestic solid fuel burning - doi:10.5194/acp-15-2429-2015, doi:10.5194/acp-14-10061-2014, doi:10.1002/2014GL062443

North American wildfires - doi:10.5194/acp-14-13755-2014, doi:10.5194/acp-15-3077-2015

Global synthesis of emission ratios – doi:10.1021/es302386v



Fires in Amazonia, Brazil, September 2005, detected by the MODIS sensor on Aqua satellite. Red dots are active fires (hotspots) detected by MODIS thermal channels. Smoke plumes seen on this colour composite.

Fire physics and fire behaviour

Emeritus Professor John Dold john.dold@manchester.ac.uk
Mathematics

Top: attached buoyant flow causing fire eruption up a slope in Palasca, Corsica (Sept 2000, 2 killed). Bottom: fire growth in a horizontal attached buoyant layer with multiple fireline interactions

Active research areas

- Eruptive fire growth;
- Fire spread and simulation;
- Fire-atmosphere interactions;
- Resilience of deep smouldering;
- Spotfires & ember-driven spread;
- Unsteady spread dynamics and mechanisms;
- Buoyant flow associated with large area fires;
- Radiative and convective heating, pyrolysis and combustion

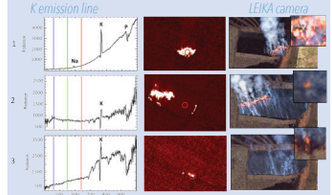
Hyperspectral detection of biomass burning

Dr Stefania Amici stefania.amici@manchester.ac.uk, *SEED & Istituto Nazionale di Geofisica e Vulcanologia, Italy*

Fire research interests:

- Hyperspectral indices to distinguish flaming from smouldering combustion in active fires; application to peat moorland fires
- Delineation of moorland wildfires burn scars from optical images

(i) Spectra with K emission line *(ii) AKBD image* *(iii) Super-resolution LEIKA camera*



(i) Eagle spectra , radiance at wavelengths 400 -1000 nm and potassium (K), Na and P emission lines; (ii) Advanced K band difference index image – lighter areas show flames, red circles mark location of sampled spectra; (iii) Super-resolution LEIKA camera photo for validation. (1) Flaming combustion produces very strong K emission peak at 766.5 and 769.9 nm and weak Na and P peaks; (2) and (3): smouldering and weaker flaming phases, resulting in weak but distinctive K peak, especially for (3). Eagle SPECIM courtesy of NERC, & Prof Martin Wooster, KCL. Field burns organised by Prof John Dold.

Relevant publication

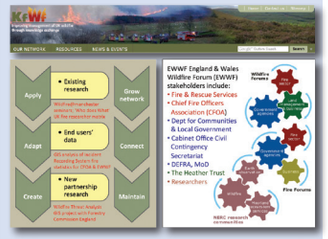
S. Amici, M.J. Wooster, A. Piscini (2011). Multi-Resolution Spectral Analysis of Wildfire Potassium Emission Signatures, Remote Sensing of Environment, 115:1811–1823 doi:10.1016/j.rse.2011.02.022

Knowledge exchange (KE)

Julia McMorrow julia.mcmorrow@manchester.ac.uk, *SEED*
Dr Ioanna (Jo) Tantanasi, *SEED*
Dr Gareth Clay, *SEED*
Jonathan Aylen, *MBS*

Fire KE projects

- Fire Interdisciplinary Research on Ecosystem Services (FIRES) ES-RC-NERC seminar series, 2007-2009. www.fires-seminars.org.uk
- Knowledge for Wildfire (KfWf): Improving management of UK wildfire through knowledge exchange, NERC KE Fellowship project, 2012-16, www.kfwf.org.uk



Top: KfWf website; left, types of KfWf activity; right, who we work with

Relevant publications

FIRES seminar series policy brief http://www.fires-seminars.org.uk/downloads/FIRES_Policy_Brief_final.pdf

Wildfire risk management case study: Recognising and improving management of UK Wildfire risk through action research & knowledge exchange http://documents.manchester.ac.uk/display.aspx?DocID=24477

Carbon biogeochemistry & fire

Dr Gareth Clay gareth.clay@manchester.ac.uk, *SEED*

Fire research interests:

How fire affects the carbon dynamics of ecosystems, especially peatlands, including:

- Conversion of biomass to charcoal in fires
- Long-term ecosystem responses such as impacts on CO_2 emissions and water quality.

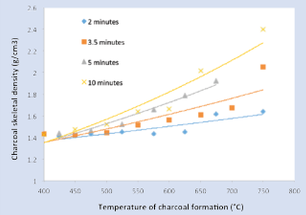


Figure Calluna vulgaris charcoal density with varying burn temperature and duration from lab-based burns. These simulations used typical temperatures and durations of moorland management burns. Changes in the physical properties of the charcoal could have implications for post-fire transport and degradation of the charcoal.

Relevant publications:

Clay, GD, Worrall, F (2011) Charcoal production in a UK moorland wildfire - how important is it? J Environmental Management, 92(3): 675-681.

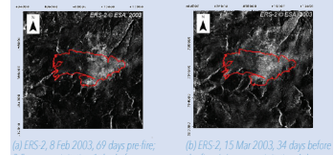
Clay, G.D., Worrall, F., Aebischer, N.J., 2015. Carbon stocks and carbon fluxes from a 10-year prescribed burning chronosequence on a UK blanket peat. Soil Use and Management, 31(1): 39-51.

Radar monitoring of peat moorland burn scars

Gail Millin-Chalabi gail.millin-chalabi@manchester.ac.uk
Julia McMorrow, Prof. Clive Agnew, *SEED*

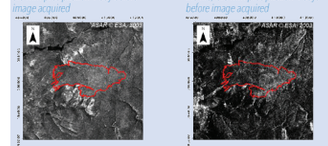
Fire research interests

- Use of Synthetic Aperture Radar (SAR) satellite images to detect and monitor the persistence of peat moorland burn scars
- Synergy of SAR and optical images for assessing burn severity
- Development of Spatial Data Infrastructures (SDI) to access and share geospatial data on wildfire



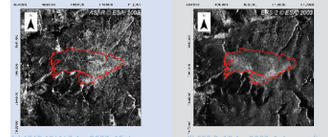
(a) ERS-2, 8 Feb 2003, 69 days pre-fire; 3.5 mm precipitation 1 day before image acquired

(b) ERS 2, 15 Mar 2003, 34 days before the fire; 6.6 mm precipitation 4 days before image acquired



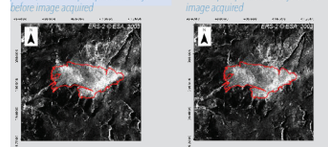
(c) ASAR IM, 22 Mar 2003, 27 days pre-fire; 6.6 mm precipitation 11 days before image acquired

(d) ASAR AP HH, 3 Apr 2003, 15 days pre-fire; 15.2 mm precipitation 2 days before image acquired



(e) ASAR AP VV, 3 Apr 2003, 15 days pre-fire; 15.2 mm precipitation 2 days before image acquired

(f) ERS 2, 19 Apr 2003, 1 day post-fire; 0.4 mm precipitation 15 days before image acquired



(g) ERS-2, 24 May 2003, 36 days post-fire; 20.6 mm precipitation 3 days before image acquired

(h) ERS 2, 28 Jun 2003, 71 days post-fire; 13.8 mm precipitation 2 days before image acquired

Post-fire

Time series of SAR intensity images for Bleaklow Head, Peak District National Park, with outline of 18 April 2003 burn scar in red; (a) – (e) pre-fire; (f) – (h) post-fire. Brighter where fire has exposed the peat surface, especially after precipitation in images (g) and (h). Lighter area at eastern area of future burn scar in images (a)- (e) is exposed peat from an earlier fire. Precipitation and fire history therefore enhance the burn signal. Unlike optical sensors, active SAR can image through cloud and at night.

Relevant publication

Millin-Chalabi, G., McMorrow, J. and Agnew, C (2014) Detecting a moorland wildfire scar in the Peak District, UK, using synthetic aperture radar from ERS-2 and Envisat ASAR. Int. J Remote Sensing, 35 (1): 54-69. DOI: 10.1080/01431161.2013.860658

Geospatial analysis of wildfire risk

Julia McMorrow julia.mcmorrow@manchester.ac.uk, *SEED*

Fire research interests

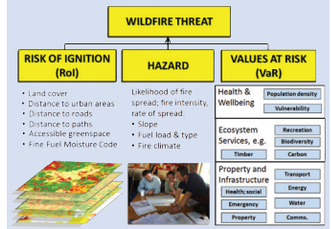
GIS modelling of wildfire risk using multi-criteria evaluation, e.g.

- Risk of ignition map for Peak District National Park; with Gina Cavan (Manchester Metropolitan), Sarah Lindley (SEED)
- Wildfire Threat Analysis for Forestry Commission; with Jonathan Aylen (Manchester Business School), Aleks Kazmierczak (Cardiff)

Analysis of Fire Service's Incident Recording System (IRS) data e.g

- Discriminating wildfires from other vegetation fires and mapping UK fire regime; with CFOA Wildfire Group
- Validating MODIS hotspot data

Hyperspectral remote sensing for monitoring restoration of peat moorland burn scars; with Beth Cole (Leicester)



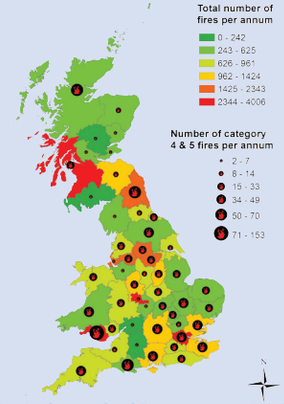
Wildfire Threat Analysis framework: three GIS modules, each made up of map layers; three sub-modules for Values at Risk. Scores within layers derived from IRS data and stakeholder consultation. Relative weighting of layers also derived from stakeholder consultation.

Relevant publications

McMorrow (2013) MODIS-detected fire regime in GB: potential and challenges of validating against national fire incident data. EARSeL Forest Fires Special Interest Group workshop. eScholarID:237306

McMorrow & Cavan (2011) Mapping the spring 2011 wildfires in England. Wildfire 2011 conference, Buxton. eScholarID:132299

Cole, McMorrow, Evans (2014) Empirical Modelling of Vegetation Abundance from Airborne Hyperspectral Data for Upland Peatland Restoration Monitoring. Rem.Sens. 6: 716-739 DOI:10.3390/rs6010716



Total number of vegetation fires of all sizes per annum attended by Fire and Rescue Services (FRS); Incident Recording System data, financial years 2009-13, courtesy of Dept. Communities and Local Government and Forestry Commission. Proportional circles show significant (category 4 and 5); i.e. ≥ 1ha, or ≥ 6 hrs attendance or ≥ 4 FRS vehicles.

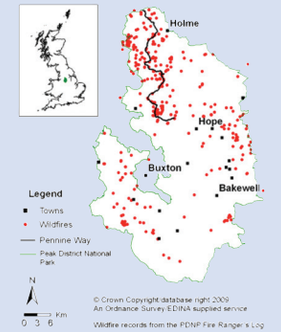
Forecasting and Costing wildfire

Jonathan Aylen jonathan.aylen@manchester.ac.uk, *MBS*
Julia McMorrow, *SEED*
Gina Cavan & Kevin Albertson, *MMU*

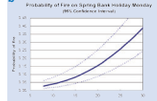
Fire research interests

- Forecasting fire occurrence using daily weather data and Probit statistical modelling
- Impact of climate change on wildfires in the Peak District
- Simulation of future wildfire from climate change models
- Costing of wildfire incidents

a



b



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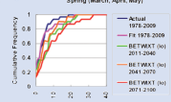

d

(a) Peak District wildfires 1976 – 2006; (b) Probit model probability of a fire on a Spring Bank Holiday, predicted from daily maximum temperature; (c) Observed and projected future cumulative distribution of wildfire frequency under a low emissions climate change scenario in Spring; (d) Interactive forecasting wildfire risk display for Peak District visitors in Moorland Centre, Edale, combining Probit forecast model, spatial risk of ignition model and real-time weather data.

Relevant publications

Albertson A, Aylen J, Cavan G and McMorrow J (2010) Climate change and the occurrence of moorland wildfires in the Peak District of the UK, Climate Research, 45: 105-118

Albertson A, Aylen J, Cavan G and McMorrow J (2009), Forecasting the outbreak of moorland wildfires in the English Peak District, J Environmental Management, 90: 2642-2651.

Produced at the Graphics Support Workshop, Media Services, The University of Manchester