

SERVICES & FACILITIES ANNUAL REPORT - FY April 2007 to March 2008

SERVICE Field Spectroscopy Facility	FUNDING Block	AGREEMENT Contract	ESTABLISHED as S&F 1988	TERM 3
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TYPE OF SERVICE PROVIDED:

The NERC Field Spectroscopy Facility is a unique world class facility supporting high quality Earth Systems science through the loan of high resolution, calibrated, and well maintained optical sensing equipment including high quality modern field spectroradiometers, sun photometers, an FTIR spectrometer and equipment for the measurement of underwater inherent optical properties. The Facility operates out of the School of GeoSciences, University of Edinburgh where it currently employs two personnel (Operations and Equipment managers at 0.75 FTE each) and exploits synergies with the Geophysical Equipment Facility. FSF represents a financially and operationally efficient means of providing users with well maintained and calibrated instrumentation and with the training to use the instruments to best effect.

Strategically, FSF underpins a wide swath of NERC science programmes, including Thematic and non-Thematic research programmes, and a broad range of NERC's Strategic Priority areas. It contributes to the training of PhD students and new academics and supports the NERC Centre for Earth Observation (NCEO), including EO Centres of Excellence, notably CTCD. FSF also vitally supports the NERC Airborne Research and Survey Facility and other airborne sensor operations (e.g. FAAM).

Calibration plays a key role in the Facility's operation and is critical to the compilation of reliable long-term data sets for studying the effects of climate change and the fluxes of carbon to and from the oceans and land where sustained observation is a key component of national capability. Emphasis is thus placed on the provision to users of calibrated equipment traceable to standards held by the National Physical Laboratory. This is key to minimising uncertainty if we are to reliably attribute detected changes observed in satellite and aircraft data to real environmental changes occurring at ground level, where the issues associated with the calibration of the space-borne sensors used to detect these changes is receiving increasing attention.

All new users are trained on a one to one basis in the use of Facility equipment. Additionally, an extended, highly rated, two and a half day *Introduction to Field Spectroscopy* training course is annually offered. 11 projects this year were associated with postgraduate PhD research including a significant number of NERC research studentships, frequently extending over two summer seasons.

Access to FSF resources is available free of charge to the UK research community, subject to expert peer review by the FSF Steering Committee. ~ 20 applications are received each year and the total requested loan time typically exceeds available capacity by ~10–20%. The science supported by the Facility is diverse and of high quality; this year papers were published in international journals such as *Atmospheric Environment*, *Estuarine and Coastal Shelf Science*, *Remote Sensing of Environment*, *Proceedings of the Royal Society* and the *International Journal of Remote Sensing*.

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

- Diversification of the user community achieved through: completion of FTIR instrument development project covering 2-15 um; enhancement of the underwater AC-S instrument suite with underwater spectroradiometers and backscatter instrument.
- Highly successful FTIR workshop held June 6th and 7th 2007 in London attracting 45 experienced and new users, to raise awareness and share expertise in the technique as well as to introduce the equipment developed by FSF.
- Continued broad-base training in optical field measurement and analysis methods through a two and a half day 'Introduction to Field Spectroscopy' training course for 8 PhD students and one researcher held in April/May 2008;
- Continuation of well maintained and calibrated instrumentation through an emphasis on QA and calibration procedures.
- Profile of the Facility raised through 10 presentations at national and international meetings highlighting new developments at the Facility and issues associated with fields-of-view of spectroradiometric instrumentation.
- Purchase of two replacement full wavelength spectroradiometers with improvements to field measurement, and fields-of-view.
- Initiation of VNIR/SWIR project to improve instrumentation to better support field measurement.
- Trends towards higher graded loan applications supporting a wide range of NERC Science priorities, longer loans on instrumentation, and increased publication outputs.

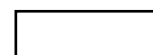
SCORES AT LAST REVIEW (each out of 5)			Date of Last Review:		2006
Need 5	Uniqueness 5	Quality of Service 5	Quality of Science & Training 5	Average 5	

CAPACITY of HOST ENTITY FUNDED by S&F 100%	Staff & Status 1 x Director – 100% U of Edinburgh 1 x Operations Manager – 75% NERC 1 x Equipment Manager – 75% NERC	Next Review (January) 2009	Contract Ends (31 March) 2010
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FINANCIAL DETAILS: CURRENT FY (* introduction of FEC, included maternity leave provision, + not loaned yet)											
Total Resource Allocation £k	Unit Cost £k								Capital Expend £k	Income £k	Full Cash Cost £k
	ASD FSPPro £283	GER 3700 £202	GER 1500 (D) £256	GER 1500 (S) £127	CIMEL £55	Micro-Tops £32	FTIR na ⁺	ASD £256			

FINANCIAL COMMITMENT (by year until end of current agreement) £k									
2007-08	£164*	2008-09	£183	2009-10	£168	2010-2011	na	2011-2012	na

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
FSFSC	4	1	None



APPLICATIONS: DISTRIBUTION OF GRADES (Current FY — 2007/08)								
	$\alpha 5$	$\alpha 4$	$\alpha 3$	$\alpha 2$	$\alpha 1$	β	R*/Pilot	Reject
NERC Grant projects		2						
Other academic	3	7	1				1	1
Students(NERC)		6(2)						
Pilot							1	
TOTAL	3	15	1	0	0	0	2	1

APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 years —2004/2005, 2005/2006 & 2006/2007)								
	$\alpha 5$	$\alpha 4$	$\alpha 3$	$\alpha 2$	$\alpha 1$	β	R*/Pilot	Reject
NERC Grant projects	3.7	2.3					0.3	
Other Academic	2.0	5.7	2.0	0.3				0.3
Students	1.3	6.3	0.7				0.3	
Pilot							0.3	
TOTAL	7	14.3	2.7	0.3			1	0.3

PROJECTS COMPLETED (Current FY) - 17 projects completed								
	$\alpha 5$	$\alpha 4$	$\alpha 3$	$\alpha 2$	$\alpha 1$	β	R*/Pilot	Reject
NERC Grant projects	4							
Other Academic		4	1					
Students		5	1					
Pilot		1						1

USER PROFILE (current FY) Note each loan can have multiple users *Combined non-Directed and Directed										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	Student		NERC C/S	Other	NERC Grant*	Student		NERC C/S	Other
		NERC	Other				NERC	Other		
29	1	7	5	6	10	0	0	0	0	0

USER PROFILE (per annum average previous 3 years) *Combined non-Directed and Directed										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	Student		NERC C/S	Other	NERC Grant*	Student		NERC C/S	Other
		NERC	Other				NERC	Other		
30.33	8.33	4.33	3.67	2.00	10.67	0.00	0.00	0.00	0.00	1.33

USER PROFILE (current FY) Note each loan can have multiple users				
Academic	Centre/Survey	NERC Fellows	PhD	Commercial
11	6	0	11	1

USER PROFILE (per annum average previous 3 years)				
Academic	Centre/Survey	NERC Fellows	PhD	Commercial
20.33	2.33	0.67	5.67	0.67

OUTPUT & PERFORMANCE MEASURES (current FY)										
Publications (by science area & type)										
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
0	2	.5	4	10	19.5	1	37	10	25	2

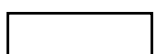
Distribution of Projects (by science areas)						
SBA	ES	MS	AS	TFS	EO	Polar
0	2	3	2	1.5	8	2.5

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)										
Publications (by science area & type)										
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
0	1.33	1.67	2.67	8.33	5.33	0	22	6.33	13	2.67

Distribution of Projects (by science areas)						
SBA	ES	MS	AS	TFS	EO	Polar
0.87	2.13	2.53	3.43	13.87	4.1	.63

Distribution of Projects (by old NERC strategic priority) (as whole or part of whole number NOT as a %)				
Note does not sum to 19 as 1 project was commercial and 1 project was instrument intercalibration with Chilbolton				
Earth's life support systems	Climate Change	Sustainable Economies	Underpinning Science	Specific Research
8.33	2.33	3	2.33	1

Distribution of Projects (by new NERC strategic priority) (as whole or part of whole number NOT as a %)						
Climate System	Biodiversity	Earth System Science	Sustainable Use of Natural Resources	Natural Hazards	Environment, Pollution & Human Health	Technologies
2.33	8.33	1.66	1.5	1.66	1.5	YES



OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2007/08):

Loans, user training and support

- 19 loans of equipment were supported. During the summer months the schedule was close to full with most instruments on loan throughout. This year two of these supported NERC ARSF campaigns, notably during their Ethiopian campaign in 2007.
- One-to-one training of 8 new users in the use of our instrumentation. Responses to the training received have been highly favourable. Telephone support has quickly resolved problems encountered in the field.
- Third successful running of 'Introduction to Field Spectroscopy' training course held 30th April to 2nd May 2008. The course addresses methods in field spectroscopy not addressed when users attend for training in specific instrument use. Attended by 8 PhD students and one academic, with highly favourable feedback received.
- Continued development of User Guides to support users in their research.



Introduction to FS training course

Publicity

- Poster and oral presentations made by FSF staff at IGARSS07, Barcelona, 23-27 July 2007; RSPSoc Annual Meeting, University of Newcastle, 11-14 September 2007; British Ecological Society Annual Meeting, University of Glasgow, 10-12 September 2007, RSPSoc Student meeting, University of Edinburgh, 29-30 March 2007, CEH/University of Edinburgh joint collaboration meeting, 16 January 2008, Division of Land and Water, CSIRO, Canberra, and to GeoScience Australia in Canberra in February/March 2008. These publicised planned developments and research issues.

Quality Assurance and calibration

- Continued development of in-house QA and calibration equipment, procedures and software to increase rigor and efficiency with which these are undertaken. Purchase of new integrating sphere to improve reference panel calibration procedures.
- FSF is key to the calibration of NERC ARSF airborne optical instrumentation, notably the AISA Eagle/Hawk sensor.

Instrumentation

- AC-S underwater instrument suite augmented with BB-3 backscatter meter and 3 SATlantic underwater spectroradiometers.
- Successful acceptance testing and delivery of new SVC HR-1024 full wavelength (400 – 2500 nm) spectroradiometer as replacement for aging GER 3700 instrument.
- Successful capital equipment bid to replace aging full wavelength ASD spectroradiometer; an ASD FieldSpec 3 instrument was delivered in March 2007.
- Initiation of VNIR/SWIR research and development project.
- Successful capital equipment bid for new integrating sphere to improve the calibration of Spectralon reference panels.
- Opinions of users sought on future equipment purchases. These show positive responses for the purchase of a ground-based imaging hyperspectral instrument and a thermal camera.

Research and development

- The FTIR instrument development project completed, supported by first ever UK FTIR workshop held at Kings College London on June 6th and 7th 2007. Attracted strong interest from both experienced and new users. The workshop raised awareness of the technique, shared expertise, and introduced the FSF equipment. The innovative design features of the new instrument (e.g. reduced size, weight and smaller input optics), has led to several groups owning such kit to request repackaging of their own instruments and optics.
- The GRASS gonio-spectroradiometer instrument, under development at NPL, will be completed and field tested during 2008; will be available for loans in 2009.
- Research into fields-of-view of GER 3700 and ASD instruments completed, revealing they are far from uniform. Presentations on the topic around the world have attracted a high degree of interest and concern. As an indication of the influence FSF has with the principal instrument manufacturers, subsequent modifications have been made to improve the fields-of-view in new instrumentation (see OPMs).
- New instrument development project initiated to explore novel designs to reduce uncertainties in measurement in the VNIR/SWIR region.



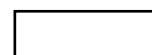
FTIR instrument in field trial

Other activities

- Completion of FSF activities in HYRESSA 'Hyperspectral Remote Sensing in Europe - Specific Support Actions' EU FP6 project. This saw HYRESSA members visit FSF on 8th November 2007. An application for full Research Infrastructure status for hyperspectral imaging has been made under the auspices of the EUFAR RI programme.
- Discussions with Prof Alan O'Neill of the NCEO, established on 1 April 2008, aimed at more closely aligning FSF's development activities with wider EO research activities.
- Provision to a wider range of users of third party processing software, Microtops Inverse, for retrieval of columnar aerosol optical thickness, concentrated in plumes, from Microtops II measurements.

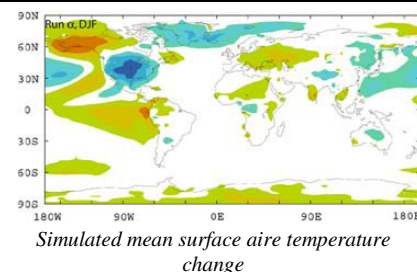
SCIENCE HIGHLIGHTS:

- Atmospheric chemistry above snowpacks is strongly influenced by UV-mediated reactions between hydroxyl radical, OH and impurities in the snowpack. With inputs from FSF GER1500 sensors, radiative-transfer modelling, of depth-integrated production rates of hydroxyl radical from the photolysis of H₂O₂ and NO₃⁻ demonstrates the importance of hydrogen peroxide photolysis over nitrate photolysis in different snowpacks, ozone column and snowpack depths accounting for 91–99% of all production with a solar zenith angle of 60°. (*France et al. 2007, Hydroxyl (OH) radical production rates in snowpacks from photolysis of hydrogen peroxide (H₂O₂) and nitrate (NO₃⁻). Atmos. Env. 41:5502-5509 – I.F. 2.549*)



SCIENCE HIGHLIGHTS:

- FSF spectroradiometers were used to measure the reflectivity of dry volcanic ash and other materials to understand the climatic impact of supervolcanic ash blankets. Dry volcanic ash albedos values can be as high as those for snow, implying that the effects on long-term climate change of an ash blanket erupted from supervolcanoes could be severe, and may be linked to previous ‘bottlenecks’ in human and animal populations. GCM modelling to simulate the effect of an ash blanket covering much of North America showed major disturbances to the climate, particularly to oscillatory patterns (e.g. ENSO). Such disruptions would continue for decades due to extended ash blanket longevity, though this is only one of several impacts associated with a super-eruption which may induce long-term climatic change. (Jones et al. 2007, *The climatic impact of supervolcanic ash blankets. Climate Dynamics*, 29, 553-564 - I.F. 3.961).
- The Buncefield oil depot explosion in Dec 2005 afforded study of the atmospheric consequences of a major oil fire at close range. Using FSF sunphotometer equipment and other ground-based instruments, near-source measurements suggested that plume particles were approximately 50% black carbon, effective radius of 0.45–0.85 μm and mass loading approximately 2000 mg m^{-3} . 50 km downwind, black carbon content increased (up to 75%) as did effective radius but mass loading decreased three-fold. Near-source trace gas concentrations of SO_2 , NO_2 , HONO, HCHO and CS_2 were elevated. Overall, effects were manifest in reduced solar flux reaching the surface, but little effect on atmospheric potential gradient. Results were consistent the 1991 Kuwaiti oil-fire plumes with differences reflecting contrasts in combustion efficiency and source composition leading to important potential differences in atmospheric impacts. (Mather et al. 2007, *Observations of the plume generated by the December 2005 oil depot explosions and prolonged fire at Buncefield (Hertfordshire, UK) and associated atmospheric changes. Proc. R. Soc. A - I.F. 1.523*)
- Biomass burning has major impacts on Earth's atmospheric chemistry and radiative budget. Africa is the largest source of biomass burning emissions, but the absolute magnitude of the emissions of trace gases and aerosols is uncertain. Accurate maps of the area burned per day, week or month, are necessary to improve emissions estimates and reduce uncertainty. FSF's GER3700 spectroradiometer was used to collect in situ spectral reflectance data to evaluate methods used to discriminate burned and unburned surfaces in coarse spatial resolution satellite imagery (MODIS) and in high spatial resolution imagery (Landsat ETM+ and IKONOS) commonly used as the reference datasets in accuracy assessments of such classifications. In the coarse scale data, the Mid-Infrared Bispectral Index (MIRBI) burned area discrimination method performed most effectively. Spectral mixture modelling was the best method for the production of reference datasets – using Landsat ETM+ data the burned area was mapped to within 2% of that from the higher resolution IKONOS imagery. (Smith et al. 2007, *Production of Landsat ETM+ reference imagery of burned areas within Southern African savannahs: comparison of methods and application to MODIS Int. J. Rem. Sens.*, 28:2753-2775 - I.F. 0.987).
- Field spectroscopic measurements will make increasingly important contributions to EO-based global observations, specifically through assimilation into numerical models. High quality data with stated levels of accuracy and uncertainty are required as are standardised terminologies and refinements in field measurement methodologies. FSF supported research has shown that; field generated instrument inter-calibration functions (ICFs) of dual-beam sensor pairs, obtained close in time and space to real field measurements, are superior to laboratory based generated functions. (Milton et al. 2007, *Progress in Field Spectroscopy Rem. Sens. Environ*, doi: 10.1016/j.rse.2007.08.001. - I.F. 3.013; Anderson et al. 2007, *Calibration of dual-beam spectroradiometric data. Int. J. Rem. Sens.* 27:975-986 - I.F. 0.987).



Landsat ETM burned areas, Zambia, August 2000

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

New science areas supported

- Support to marine and freshwater sciences enhanced with loans of the full underwater optics instrument suite. Development of user guides and data processing tools. First full loans of FTIR equipment by users during summer 2008.

Planned hardware developments to support science areas

- Continuation of VNIR/SWIR instrumentation research project to improve field reflectance measurement.
- Proposed purchase of imaging hyperspectral camera for ground-based use and high resolution thermal camera.

Other developments planned to meet mission objectives

- International journal paper on field-of-view measurement issues.
- Continued profile raising through FSF's key role in 2008 RSPSoc meeting, joint meeting with MSF planned for 2009, and presentations at other national and international meetings.
- Opportunities for closer integration of FSF activities with wider EO research activities through closer ties with the NCEO.
- Continue to: a) grow the user base through supporting wider areas of NERC science outlined above; b) emphasise training with repeat of introductory training course; c) further developments in QA and calibration procedures; d) develop website.

Non-Mandatory Facility-specific OPMs: utilisation, allocation of capacity etc

- Further OPMs are highlighted in Annex 10.
- Visitors of HYRESSA project team and others to FSF highlights the uniqueness of the Facility (Annex 7).
- Development of 'Scrambler' by ASD to overcome FieldSpec field-of-view issues is based on FSF suggestion and demonstrates our influence on manufacturers (Annex 7).
- Loan feedback forms demonstrate very high levels of user satisfaction for instrument performance, value of data collected and quality of service and training (Annex 7).
- Calibration services performed for three other organizations.

