

SERVICES & FACILITIES ANNUAL REPORT - FY April 2010 to March 2011

SERVICE Field Spectroscopy Facility	FUNDING Block	AGREEMENT Contract	ESTABLISHED as S&F 1988	TERM 5
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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 and apparent optical properties. The Facility is based in the School of GeoSciences, The University of Edinburgh where it currently employs two personnel (Operations and Equipment managers at 0.75 FTE each) and exploits synergies with the NERC Geophysical Equipment Facility. FSF represents a financially and operationally efficient means of providing users with well maintained, quality assured 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). FSF also vitally supports the NERC Airborne Research and Survey Facility, providing a calibration and technical support services for the hyperspectral imaging sensors.

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.

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 to 25 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 or in press in international journals such as Remote Sensing, of Environment Impact Factor:3.6; Catena, Impact Factor: 2.4; Quaternary International: 2.1; and the European Journal of Soil Science, Impact Factor:2.4

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

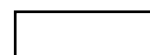
- Diversification of the user community achieved through: increasing number of ecologists and environmental scientists using field spectroscopy for the first time. A total of 5 new users have been trained during 2010/11
- Profile of the Facility raised through presentations at UK and international conferences.
- Continued to deliver broad-base training in field spectroscopy techniques and analysis methods through a two and a half day 'Introduction to Field Spectroscopy' training course for 9 PhD students, post-docs and academics held in March 2011.
- Continuation to supply well maintained and calibrated instruments through emphasis on QA and calibration procedures.
- Operational deployment and successful use of the FSF/NPL GRASS/VSWIR directional reflectance measurement instrument.
- Completion of VNIR/SWIR project to develop 2 state-of-the-art 400nm to 1,750nm field spectroradiometers for inclusion in the Facility loan equipment pool.
- Continued support of a wide range of NERC Science priorities, longer instrument loans and increased publication outputs.

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

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (March)	Contract Ends (31 March)
100%	1 x Director – 20% U of Edinburgh 1 x Operations Manager – 100% NERC 1 x Equipment Manager – 100% NERC 1 x ARSF support – 17% NERC	2014	2015

FINANCIAL DETAILS: CURRENT FY									
Total Resource Allocation £k	Unit Cost £k					Capital Expend £k	Income £k	Full Cash Cost £k	
	FTIR/GRASS	Full wvl spectro-radiometers	CIMEL/ OCRs & flurometer	Micro-tops	GER 1500s				
£212.12	£260	£130	£60	£20	£40	£82.93	£0.0	£320.6	
FINANCIAL COMMITMENT (by year until end of current agreement) £k									
2010-11	£256.380	2011-12	£265.198	2012-13	£272.97	2013-2014	£272.88	2014-2015	£280.179

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



APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2010/11)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*	2	2						
Other academic	4	5	2					
Students	1	2						
Pilot								
TOTAL	7	10	2					

APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 financial years — 2007/2008, 2008/2009 & 2009/2010)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*	1.67	2.67					0.33	
Other Academic	2.33	5.67	0.33				1.33	0.67
Students	0.33	6.00	0.33					
Pilot								
TOTAL	4.33	14.33	0.67	0.00	0.00	0.00	1.67	0.67

PROJECTS COMPLETED (current FY – 2010/11)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*	3	2						
Other Academic	5	8						
Students	3	7	1					
Pilot								1

Project Funding Type (current FY – 2010/11) (select one category for each project)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students		NERC	Other	NERC Grant*	PhD Students		NERC C/S	Other
		NERC	Other				NERC	Other		
30	1	7	5	4	13	0	0	0	0	0

Project Funding Type (per annum average previous 3 financial years - 2007/2008, 2008/2009 & 2009/2010)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students		NERC	Other	NERC Grant*	PhD Student		NERC C/S	Other
		NERC	Other				NERC	Other		
28	4.5	4.4	4.7	3.3	8.7	0	0	0	0	0

User type (current FY – 2010/11) (include each person named on application form)				
Academic 13	NERC Centre/Survey 4	NERC Fellows 1	PhD Students 12	Commercial 0
User type (per annum average previous 3 financial years - 2007/2008, 2008/2009 & 2009/2010)				
Academic 13.1	NERC Centre/Survey 3.7	NERC Fellows 0.2	PhD Students 10.7	Commercial 0.3

OUTPUT & PERFORMANCE MEASURES (current year)										
Publications (by science area & type) (calendar year 2010)										
SBA 3	ES 16	MS 3	AS 6	TFS 5	EO 10	Polar 2	Grand Total 45	Refereed 6	Non-Ref/ Conf Proc 35	PhD Theses 4
Distribution of Projects (by science areas) (FY 2010/11)										
Grand Total 30	SBA 1	ES 5	MS 1	AS 8	TFS 3	EO 8	Polar 4			

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)										
Publications (by science area & type) (Calendar years 2007, 2008 & 2009)										
SBA 0	ES 4.08	MS 2.67	AS 4.83	TFS 7.83	EO 25.42	Polar 2.17	Grand Total 47	Refereed 10.33	Non-Ref/ Conf Proc 32.67	PhD Theses 4
Distribution of Projects (by science areas) (FY 2007/2008, 2008/2009 & 2009/2010)										
Grand Total 27.52	SBA 0.46	ES 5.63	MS 1.43	AS 3.56	TFS 5.87	EO 9.70	Polar 0.88			

Distribution of Projects by NERC strategic priority (current FY 2010/11)							
Grand Total 30	Climate System 8.85	Biodiversity 3.25	Earth System Science 9.65	Sustainable Use of Natural Resources 1.25	Natural Hazards 2	Environment, Pollution & Human Health 1	Technologies 4

*Combined Responsive Mode and Directed Programme grants

NOTE: All metrics should be presented as whole or part of whole number NOT as a %



OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2010/11):

Loans, user training and support

- The Facility supported 30 projects during 2010/11, with a wide global distribution, and provided on user support, normally in real time, to all Facility users.
- One-to-one training of 5 new users of FSF instrumentation was carried out and 3 days training in the use of GRASS/VSWIR given to researchers from Royal Holloway, University of London.
- The 6th 'Introduction to Field Spectroscopy' course was held on 28th to 30th March 2011 and attended by 9 academics from diverse backgrounds. Feedback received was again highly complimentary.
- Supported the national scientific effort to monitor the Icelandic volcanic ash plume event with loans of sunphotometers to academic and Met Office scientists.

Publicity

- Facility staff gave a presentation on the services provided to the UK research community by NERC FSF to a group of 30 researcher at a EU COST ES0903 workshop held in Trento, Italy during April 2010
- Facility staff gave a presentation on the Facility's underwater optical measurement suite and the science it supports at the Marine Measurement Forum in Farnborough during November 2010.
- FSF staff participated in the open day at NPL Teddington during May, 2010 and demonstrated GRASS/VSWIR and gave talks on environmental remote sensing to the visiting public.

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. The "use once and recalibrate" reference panel procedure continues.
- Continued work with ARSF, PML-DAN and Dr R. Choi to create a factory calibration procedure with data processing for two Eagle & Hawk calibrations Nov. 2010 & Jan 2011.

Instrumentation

- Problems with the control software of the GRASS instrument have now been resolved and the instrument deployed to Antarctica over winter 2010. A bespoke VSWIR spectroradiometer was developed for GRASS using additional funds made available by NERC S&F. Some analysis software issues remain and a modification to the hardware is required before redeployment to Antarctica over winter 2011.
- The design and construction of the laboratory instrument to measure the directional response function of spectroradiometers and target surfaces has been completed and software control is being finalised.
- The V-SWIR spectroradiometer integrated in to GRASS instrument and deployed to Antarctica
- The jointly owned NERC FSF/NERC Diving Facility underwater spectrometers and fluorometer have been deployed under the Arctic ice during summer 2010.

Research and development

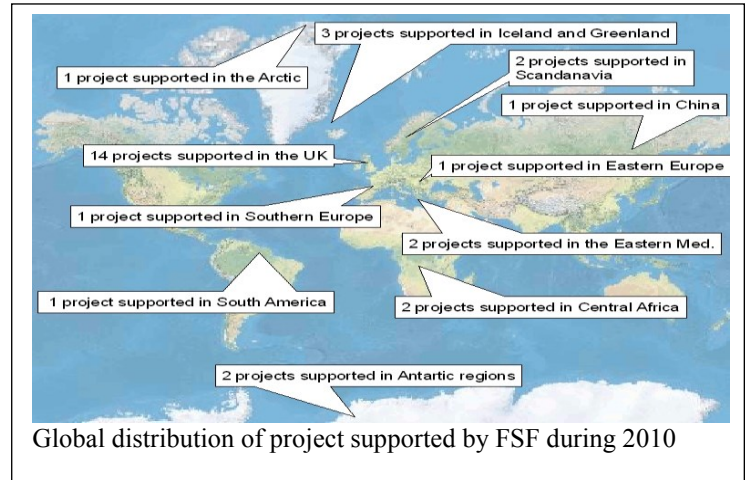
- The Bluetooth interface for the SVC HR-1024 spectroradiometer has now been completed and this will allow continuation of the small sensor suite project for the HR-1024.
- NPL requested that FSF cost the project management and production of two GRASS instruments for possible resale to 3rd parties. This has now been completed and the 3rd parties are awaiting the outcome of capital bids to the EU.

Other activities

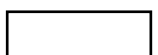
- The School of Geosciences contract renewed to host the NERC FSF from 2010-2015 with the staffing increased to 2 FTE and an additional 0.17 FTE for continuation of NERC ARSF support..
- Continued the development of FSF User Group web pages with the FSF Matlab Toolbox now available.
- Planning for the scientific and commercial programme of the EARSel 2011 imaging spectroscopy conference being held at the University of Edinburgh during April 2011 and hosted jointly by FSF and CSIRO, Australia has continued.

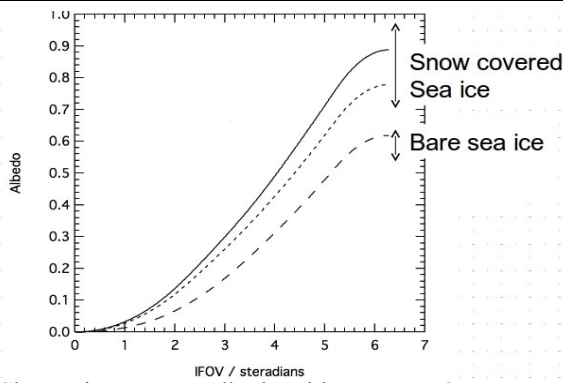
Science Highlights

BRDF and albedo of snow and ice in the Antarctic (Reay, King, Mac Arthur, Fox and Italian colleagues) Satellite observations have wide application in marine, land and snow/ice related climate and albedo studies. However, the reflectance of natural surfaces is not isotropic. As a result, the knowledge of bidirectional spectral reflectance of natural surfaces observed from space is a pre-requisite for a correct interpretation and use of satellite data.



Penguins taking an interest in the FSF GRASS Antarctic winter 2010 deployed by Ms H. Reay (PhD student) and Italian colleagues.





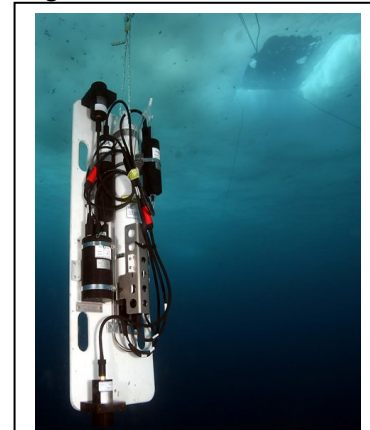
Change in apparent albedo with sensor IFOV

SCIENCE HIGHLIGHTS: cont. The requirement is even more stringent for long-term investigations (e.g., climate studies) that might require data from different space platforms and thus characterized by different spectral and spatial resolutions, and also different overpass time that might significantly change the illumination and viewing geometry. All satellite observations need a common reference to allow comparison and areas of the Antarctic ice sheets and snow fields may provide this. Since the early 2000s, the need for improving satellite observations for climate investigations in Polar Regions has become the rationale for focused studies on the bi-directional reflectance of snow surfaces (Six et al. 2004; Hudson et al. 2006). A study has been carried out by UK and Italian scientists during 2010 at Tethys Bay, Antarctica by making directional measurements of snow and ice reflectances using the

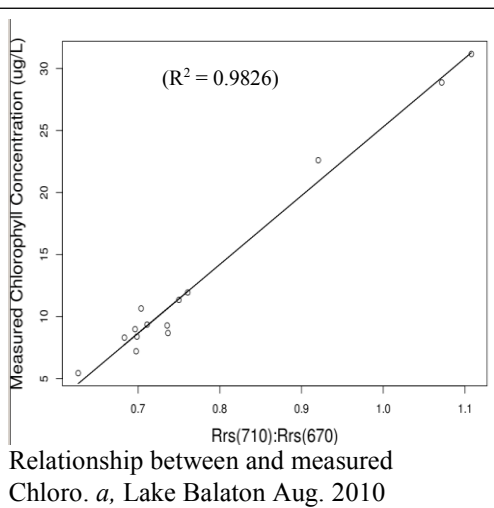
GRASS/VSWIR instrument developed by NPL and FSF. Initial results are promising as the albedo calculated from the GRASS/VSWIR measurements can be related to the instantaneous field of view of satellite sensors and offers greater spatial and directional resolution measurements than those previously reported. Building on the success of this project a field campaign to Dome-C for 2011/12 is currently being finalised by Dr King, Italian colleagues from JRC, ISAC-CNR and OGS-CNR with PNRA, NPL and FSF.

NERC RSS James Clark Ross Arctic cruise summer 2010 (Leaky, Bowman, Dumont, Griffiths, SAMS diving team & Mac Arthur). As the Arctic peatlands have warmed there has been an increase of carbon being washed into the Arctic ocean. Previously this carbon was transported to by thermohaline circulation to deep Atlantic ocean. As the Arctic waters have warmed this carbon is being utilised causing phytoplankton bloom in these water. In addition, as the Arctic ice sheet has thinned phytoplankton blooms are also occurring under the sea ice. A significant ecosystem and carbon cycle change. FSF terrestrial and underwater spectroradiometers were deployed in the Arctic during of 2010 to try to quantify primary productivity by optical methods.

Remote sensing and bio-optical properties of phytoplankton blooms in Lake Balaton, Hungary (Lyman, Hunter, Groom, Vicente, Kovács., Preston, Présing) Mass populations of cyanobacteria are an increasingly global phenomenon because of eutrophication and climate change, and can have serious ecological and socioeconomic consequences in freshwaters. There is much recent interest in the use of satellite remote sensing for routine, near real-time monitoring of cyanobacterial blooms in lakes, but currently standard algorithms for the



FSF/SDF instruments deployed under Arctic ice



Relationship between and measured Chloro. *a*, Lake Balaton Aug. 2010

retrieval of phytoplankton pigments lack the robustness needed for operational use. The development of analytically-based inversion algorithms should greatly improve uncertainties in pigment retrievals, but this approach requires detailed knowledge of the inherent and apparent optical properties (IOPs/AOPs) of lake waters. Lake Balaton presents an ideal arena for such work because of the range and complexity in its bio-optical properties. IOP and AOP measurements, concomitant with NERC ARSF (AISA Eagle and Hawk) and MERIS image acquisition, were made at a total of 38 stations using the FSF WetLabs AC-S/HyperOCRs instrument suite. The IOPs of the lake were found to vary significantly across its four basins in response to a marked trophic gradient Preliminary work also shows that the band ratio $[R_{rs}(710):R_{rs}(670)]$ demonstrates a very strong linear relationship with measured chlorophyll *a*. Calculation of specific IOPs of the optically active constituents to parameterize radiative transfer models will be carried out in the future, generating a synthetic database of water-leaving spectra to develop robust inversion algorithms for constituent retrieval in Case 2 waters.

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

- Measurement of the directional response function of the Facility's spectroradiometers will begin during 2011/12.
- The FSF Edinburgh based CIMEL will be mounted on the roof of BGS, Murchison House, and incorporated into NASA AERONET during 2011/12
- FSF in collaboration with UCL investigating the feasibility of updating the LOPEX experiment to include directional reflectance and total transmission measurements.
- Investigation into the spectral dependencies of the FWHM resolution of field spectroradiometers and the creation of Spectral Libraries in ENVI User Guide will begin.
- Mr Mac Arthur has been invited to participate in a field spectroscopy metadata knowledge exchange workshop being planned by CSIRO, Australia during 2011/12 and funding is being sought.

