SERVICES & FACILITIES ANNUAL REPORT - FY April 2008 to March 2009

SERVICE	FUNDING BLOCK	AGREEMENT SLA	ESTABLISHED as S&F 1996	TERM 5 years
The NERC MST Radar Facility at Aberystwyth http://mst.nerc.ac.uk				

TYPE OF SERVICE PROVIDED:

The Mesosphere-Stratosphere-Troposphere (MST) Radar at Aberystwyth is the UK's most powerful and versatile wind-profiling instrument. It is unique in being able to provide continuous measurements of the three-dimensional wind vector over the altitude range 2-20 km at high resolution (typically 300 m in altitude and a few minutes in time). It can also provide information about atmospheric stability, turbulence, humidity and rainfall. It is therefore ideally suited for studying everything from small-scale atmospheric phenomena through to large-scale weather systems. Wind-profile data are supplied to the Met Office, for numerical weather prediction purposes, through a commercial contract. Developments in the signal processing have lead to measurable increases in data quality over the past few years.

The Facility operates and hosts additional instruments whose observations complement those made by the MST radar. The Met Office operates a GPS water vapour receiver at the site, and has previously operated a boundary-layer wind-profiler there. The NERC Facility for Ground based Atmospheric Measurements (FGAM – formerly UFAM) boundary-layer wind-profiler and ozone lidar are often operated at the site in-between campaigns. During the past year, FGAM equipment for tracking radiosondes (i.e. instrumented meteorological balloons) has been installed, thereby increasing the usefulness of the site for supporting field campaigns. During the past year the Facility has supported two NERC-funded field campaigns.

The mission of the Facility is:

- To operate the radar on behalf of the UK atmospheric science community
- To operate, and host, instruments whose observations complement those made by the MST radar
- To facilitate the analysis and interpretation of the data
- To promote the data products and thereby to increase the number of users

The Facility is currently supporting 9 PhD students, who cover a range of disciplines and who are based at a variety of institutions. The projects supported by the Facility cover the NERC priority themes of Climate Change, Sustainable Use of Natural Resources, and Natural Hazards.

The MST Radar has maintained operations for 99.0% of the available time, exceeding its target of 98.0%.

SCORES AT LAST REVIEW (each out of 5)			Date of Last Review:	2009
Need	Uniqueness	Quality of Service	Quality of Science & Training	Average
4.5	5.0	4.5	4.0	4.5

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (March)	Contract Ends (31 March)
72%	Project Manager: Mr Charles Wrench- 10% Project Scientist: Dr David Hooper – 100% Site Manager: Mr Tony Olewicz – 30%	2014	2015

FINANCIAL DETAILS: CURRENT FY						
Total Resource Allocation £k	Unit Cost £k			Capital Expend £k	Income £k	Full Cash Cost £k
	Unit 1	Unit 2	Unit 3			
110.0	General User Support £1.1k	Guest-instrument/ campaign support £15.0k		4.3	43.7	148.0

FINANCIAL COMMITMENT (by year until end of current agreement) £k				
2008-09 110.0	2009-10 137.1	2010-11 135.4	2011-12 140.0	2012-2013 144.8

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NARFSC	6	1	CFARR

APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2008/09)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*		3						
Other academic		1						
Students (non PhD)								
Pilot	**1** (applications in this category are graded as Pilot)							
TOTAL		4					1	

APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 financial years —2005/2006, 2006/2007 & 2007/2008)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*		1.67						
Other Academic		2.33	1.0					
Students (non PhD)	**1.33** (applications in this category are graded as Pilot)							
Pilot	**1.67** (applications in this category are graded as Pilot)							
TOTAL		4.00	1.00				3.0	

PROJECTS COMPLETED (current FY – 2008/09)							
	α5	α4	α3	α2	α1	β	R*/Pilot
NERC Grant projects*							
Other Academic		2	1				
Students							
Pilot							

USER PROFILE - funding type (current FY – 2008/09)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	Student		NERC C/S	Other	NERC Grant*	Student		NERC C/S	Other
		NERC	Other				NERC	Other		
18	5	3	6		3	Supply of data to the Met Office (counts as 1 user) under a commercial contract				

USER PROFILE - funding type (per annum average previous 3 financial years - 2005/2006, 2006/2007 & 2007/2008)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	Student		NERC C/S	Other	NERC Grant*	Student		NERC C/S	Other
		NERC	Other				NERC	Other		
24.00	6.33	3.0	4.33		9.33	Supply of data to the Met Office (counts as 1 user) under a commercial contract				

USER PROFILE – user type (current FY – 2008/09)				
Academic	Centre/Survey	NERC Fellows	PhD	Commercial
9			8	1
USER PROFILE - user type (per annum average previous 3 financial years - 2005/2006, 2006/2007 & 2007/2008)				
Academic	Centre/Survey	NERC Fellows	PhD	Commercial
18.67			4.33	1.0

OUTPUT & PERFORMANCE MEASURES (current year)										
Publications (by science area & type) (calendar year 2008)										
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
			5.5		0.5		6	4	2	

Distribution of Projects (by science areas) (FY 2008/09)						
SBA	ES	MS	AS	TFS	EO	Polar
			17.0		1.0	

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)										
Publications (by science area & type) (Calendar years 2005, 2006 &2007)										
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
			7.0				7.00	3.00	3.33	0.67

Distribution of Projects (by science areas) (FY 2005/2006, 2006/2007 & 2007/2008)						
SBA	ES	MS	AS	TFS	EO	Polar
			24.0			

Distribution of Projects by NERC strategic priority (current FY 2008/09)						
Climate System	Biodiversity	Earth System Science	Sustainable Use of Natural Resources	Natural Hazards	Environment, Pollution & Human Health	Technologies
9.33			1.00	2.83		4.83

**Combined Responsive Mode and Directed Programme grants*

OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2008/09):

Optimisation of the delivery of data to the Met Office. The Facility supplies near-real-time wind-profile data to the Met Office for the use in numerical weather prediction. Over the past few years, the quality of the data has been significantly improved through developments in the radar signal processing. During the last year the relative timings of the different stages of the processing have been optimised in order to minimise the delay in the data becoming available. This has resulted in a reduction of over 10 minutes in the supply chain.

Improved Automation. The Facility has conducted a programme of increased automation over the past few years. This has, in part, been in preparation for the retirement of the site manager, who has worked only part time since 2007 and who fully retired at the end of March 2009. A measure of success of this programme is given by the fact that last year's accumulated downtime of just 1.0% is significantly lower than has been achieved in recent years (the Facility has a target of keeping the downtime to less than 2.0%). A local, part-time site technician has taken over many of the tasks which were previously undertaken by the site manager. Other tasks will be taken over by staff from the Chilbolton radar facility.

Data Management. The Facility continues to improve the way in which it records data, thereby ensuring that they will remain scientifically-useful in the longer term. This principally requires that appropriate metadata, i.e. information about the data, are stored together in the same files. Although such information is available to current data users through the Facility's website, there is no guarantee that the website will continue to exist in the longer term. During the past year, a new dataset (of ground-level meteorological parameters) was made available using the latest file format and metadata standards recommended by the British Atmospheric Data Centre. Moreover, a paper describing the characteristics of the MST radar wind-profile data was published in the refereed literature, thereby ensuring that the information will remain available to data users in the longer term.

(left) The western side of the site bungalow in July 2008, before any vegetation was cleared; (middle) the same view after the intermediate removal of all vegetation within 2 m of the bungalow; (right) a view of the bungalow from the south in late March 2009 after virtually all vegetation had been removed.

Site Maintenance. During March 2009, the radar site received its first ever major programme of maintenance work, courtesy of NERC Services and Facilities. As can be seen from the images above, the site bungalow had become almost overtaken by the undergrowth by July 2008, when (as an intermediate step) all vegetation within 2 m of it was cleared. The rest of the vegetation was cleared during the main phase of the work in 2009. Other improvements include the replacement of the main gate, resurfacing of the track, and redecoration of the site bungalow. The site hasn't looked this good since construction of the radar was completed in 1990.

Service Review Group (SRG) 2009. The Facility submitted an application for the renewal of funding in January 2009. This was received favourably by the NERC SRG and funding will be extended for the period 2010 – 2015. It is anticipated that capital investment will be made available, thus allowing a much-needed hardware refurbishment to be implemented (see "Future Developments" section overleaf).

Prof Geraint Vaughan (right) being interviewed by the BBC film crew in front of the MST Radar antenna array.

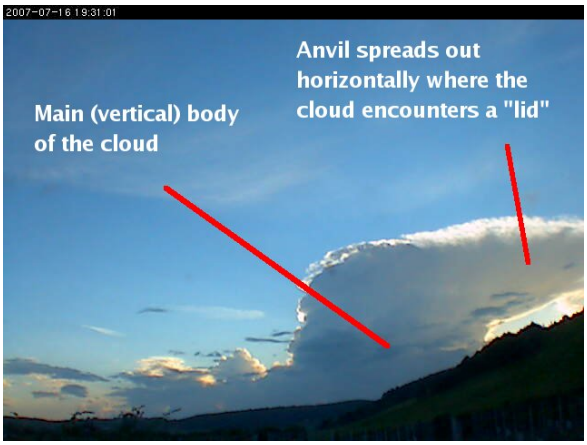
MSTRF on the BBC. A BBC crew filmed an interview with Prof Geraint Vaughan (University of Manchester) at the MST Radar site on 8th August 2008. This interview, together with footage of the radar, featured prominently in a programme entitled "Wind" - the third of a three part series on the weather. The programmes were first broadcast on BBC4 between 13th and 27th April 2009. They were repeated on BBC2 between 29th April and 13th May 2009.

SCIENCE HIGHLIGHTS:

Research students launching a radiosonde from the MST Radar site during the turbulence field campaign.

The 2009 Turbulence Field Campaign. Atmospheric turbulence can be a hazard to aircraft in addition to playing an important role in the transport of chemical species through the atmosphere. Consequently it can be of considerable significance to members of the flying public as well as to scientists and engineers. However, at present there is no unambiguous technique for detecting it using routinely-operated instruments. The aim of this March/April 2009 field campaign was to evaluate the potential of wind-profiling radars, such as the MST radar and the NERC FGAM boundary-layer wind-profiler (which was operated at the MST radar site during the campaign), for this purpose. This involved making measurements above the radar site from the NERC ARSF aircraft, which was equipped with a turbulence probe. Radiosondes (i.e. instrumented meteorological balloons) were simultaneously launched from the radar site in order to make complementary measurements. This latter capability would not have been possible without a recently-constructed NERC-funded work-shed, which provided an invaluable sheltered location for inflating the balloons prior to launch. As can be seen from the picture above, strong gust winds (which deform the nominally spherical balloon) were common during the campaign and the balloons could not have been inflated outside. This work is being undertaken in collaboration with the Met Office.

Convection studies. Convective activity, which is characterised by vigorous vertical motion, can lead to intense and localised rainfall, to thunder storms, and even to tornadoes. Nevertheless the location and timing of such events have proved to be difficult to predict accurately. This situation is beginning to improve thanks, on the one hand, to increases in available computing power and, on the other hand, to a series of observational campaigns such as the NERC-funded Convective Storm Initiation Project (CSIP). In connection with the latter, MST radar observations have been used to study the upper-level factors which affect the development of convection, which is typically initiated in the lower part of the atmosphere. In particular it has been found that stable layers can act as “lids” which inhibit the vertical development of the convection. This is illustrated by the sky-camera image to the right which shows an “anvil” spreading horizontally from the top of a convectively-generated cloud where it encounters such a lid.



An example of the vertical development of a convectively-generated cloud being inhibited by the presence of an atmospheric “lid”. Image taken from the Facility’s” sky-camera”.

The details of 4 key publications which made use of the Facility’s data during 2008:

1) J. M. Chagnon and S. L. Gray. Analysis of convectively-generated gravity waves in mesoscale model simulations and wind profiler observations. *Q. J. R. Meteorol. Soc.*, 134(632):663-676, 2008.
2) A. Russell, G. Vaughan, E. G. Norton, C. J. Morcrette, K. A. Browning, and A. M. Blyth. Convective inhibition beneath an upper-level PV anomaly. *Q. J. R. Meteorol. Soc.*, 134(631):371-383, 2008.
3) D. A. Hooper, J. Nash, T. Oakley, and M. Turp. Validation of a new signal processing scheme for the MST radar at Aberystwyth. *Ann. Geophys.*, 26(11):3253-3268, 2008.
4) Guglielmo S. Aglietti, Stefano Redi, Adrian R. Tatnall, and Thomas Markvart. High altitude electrical power generation. *WSEAS Transactions on Environment and Development*, 4(12):1067-1077, 2008.

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

The radar hardware has remained virtually unchanged since operations began in 1990. The maximum useful altitude for wind-profiling purposes has reduced from around 20 km in 1999 to nearer 15 km in 2009. Although this change had initially been attributed to a degradation in transmitter performance, this is not now thought to be the case. Two detailed studies of the entire radar system were conducted during the latter part of 2008. These revealed that the limiting factor lay in the radar beam-steering components, which are vital for allowing the radar to measure the full three-dimensional wind. The electro-mechanical relay units perform over a million switching operations per year and so are understandably prone to malfunction. They have been repeatedly re-conditioned over a period of almost 20 years and are now in urgent need of replacement. Anticipated capital investment from NERC for this purpose should restore the performance of the radar and extend its life for at least another 5 or 10 years.