SERVICES & FACILITIES ANNUAL REPORT - FY April 2006 to March 2007

SERVICE	FUNDING BLOCK	AGREEMENT SLA	ESTABLISHED as S&F 1996	TERM 5 Years (to March 2010)
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 precipitation. 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. Upper-air input from the Aberystwyth area has been found to have a significant impact on improving longer range forecasts.

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 Universities' Facility for Atmospheric Measurement (UFAM) boundary-layer wind-profiler and ozone lidar are operated at the site in-between 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

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

1. **Target:** To have the new MST radar wind-profile data stream accepted by the Met Office for operational purposes by September 2006.
   Progress: This was completed on 16th August 2006.
2. **Target:** To renovate the remaining original site shed and to erect a car port in place of the recently-removed (dilapidated) site shed by October 2006.
   Progress: Completion was delayed until May 2007 owing to planning permission issues..
3. **Target:** To operate the MST Radar in a special ST-mode, for which observations are made at both 6° and 12° off-vertical, for at least 1 month continuously by November 2006.
   Progress: This action has been delayed into the 2007-2008 financial year.
4. **Target:** To operate the MST radar for a minimum of 98% of the available time.
   Progress: The radar was operated for 99.0% of the available time.

SCORES AT LAST REVIEW (each out of 5)		Date of Last Review: January 2004		
Need	Uniqueness	Quality of Service	Quality of Science & Training	Average
5.0	5.0	4.5	4.5	4.75

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (January)	Contract Ends (31 March)
76%	Project Manager: Dr Sam Pepler - 10% Project Scientist: Dr David Hooper – 100% Site Manager: Mr Tony Olewicz – 100%	2009	2010

FINANCIAL DETAILS: CURRENT FY							
Total Resource Allocation £k	Unit Cost £k				Capital Expend £k	Income £k	Full Cash Cost £k
	Unit 1 Priority Project	Unit 2 Secondary Project	Unit 3 Pilot Project	Unit 4 Guest Instrument Support			
123	9.8	4.9	0.9	19.6	7	38	150.6

FINANCIAL COMMITMENT (by year until end of current agreement) £k				
2006-07 123	2007-08 121	2008-09 128	2009-10 136	2010-2011 -

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NARFSC	7	1	CFARR

APPLICATIONS: DISTRIBUTION OF GRADES (Current FY — 2006/07)

	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects		2						
Other academic		3	1					
Students (non PhD)	3 (Applications in this category are not graded – the totals are shown in the Pilot column)							
Pilot	1 (Applications in this category are not graded – the totals are shown in the Pilot column)							
TOTAL		5	1				4	

APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 years —2003/2004, 2004/2005 & 2005/2006)

	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects		1.67	0.33					
Other Academic		1.33						
Students (non PhD)	1.00 (Applications in this category are not graded – the totals are shown in the Pilot column)							
Pilot	1.67 (Applications in this category are not graded – the totals are shown in the Pilot column)							
TOTAL		3.0	0.33				2.67	

PROJECTS COMPLETED (Current FY)

	α5	α4	α3	α2	α1	β	R*/Pilot
NERC Grant projects							
Other Academic							
Students (non PhD)	4 (Applications in this category are not graded)						
Pilot	2 (Applications in this category are not graded)						

USER PROFILE (current FY) **Combined non-Directed and Directed*

Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	Student Total	Student NERC	NERC C/S	Other	NERC Grant*	Student Total	Student NERC	NERC C/S	Other
24	7	6	3		10	Supply of data to the Met Office (counts as 1 user) under a commercial contract				

USER PROFILE (per annum average previous 3 years) **Combined non-Directed and Directed*

Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	Student Total	Student NERC	NERC C/S	Other	NERC Grant*	Student Total	Student NERC	NERC C/S	Other
23.00	7.33	4.33	3.00		10.33	Supply of data to the Met Office (counts as 1 user) under a commercial contract				

USER PROFILE (current FY)

Academic	Centre/Survey	NERC Fellows	PhD	Commercial
20			3	1.0

USER PROFILE (per annum average previous 3 years)

Academic	Centre/Survey	NERC Fellows	PhD	Commercial
19.33			2.33	1.0

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
			7				7	3	4	

Distribution of Projects (by science areas)

SBA	ES	MS	AS	TFS	EO	Polar
			100%			

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
			7.33				7.33	4.00	3.00	0.33

Distribution of Projects (by science areas)

SBA	ES	MS	AS	TFS	EO	Polar
			100%			

Distribution of Projects (by NERC strategic priority)

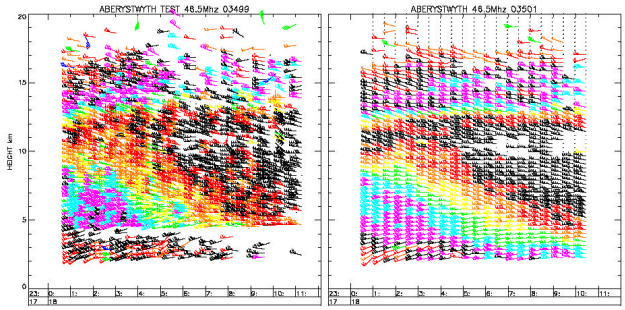
Earth's life support systems	Climate Change	Sustainable Economies	Underpinning Science	Specific Research
	9	7	2	6

OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2006/07):

Acceptance of a new MST Radar signal processing scheme for Numerical Weather Prediction purposes

During the past year the Facility has been collaborating with the Met Office to validate a new MST Radar signal processing scheme. The signal processing software was written by the Facility's Project Scientist whilst the Met Office generated wind-profile data quality statistics for the new (v3) and for an old (v0) scheme in parallel. The validation process was conducted over a period of 12 months to ensure that the new scheme was reliable under all weather conditions. The Met Office had been assimilating data from the old scheme for a number of years, for Numerical Weather Prediction purposes, and so they had a high confidence in the quality of the data. In the words of the Met Office's wind-profiling data hub manager: "*The v3 algorithm has proved to be superior to v0 consistently over the test period so we no longer have a need to process the old v0 data*."

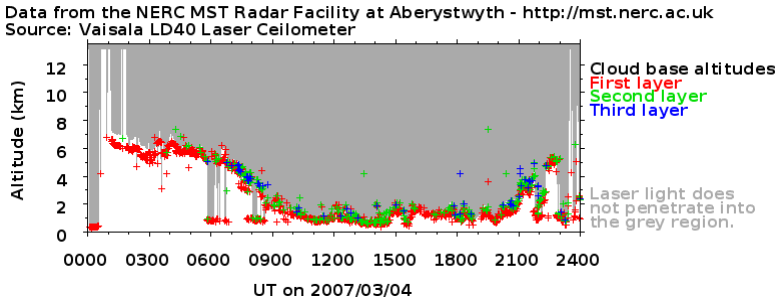
Wind-profile data from the old (left) and new (right) signal processing schemes for 18th January 2007 – a day on which 9 people were killed by gales sweeping across the UK. The new scheme clearly gives more complete and more reliable cover. Images courtesy of the Met Office.



Increasing the reliability of equipment at the MST Radar site

The MST radar site is located a few kilometres outside Aberystwyth, where the mains power supply is not always as reliable as it could be. Blackouts are rare, but the mains voltage is prone to frequent fluctuations which can damage the transmitters and cause computers to shut down unexpectedly. One of the measures undertaken during the last year to improve the reliability of equipment is the installation of Uninterrupted Power Supply (UPS) units. During the 2005-2006 year, over 120 hours of radar downtime resulted from just 5 mains disruption events. One incident alone accounted for 68 hours of downtime simply because it occurred on a Friday evening. No observations were made until the following Monday morning when the site manager manually restarted the equipment. Another important step has been the switch-over to a new radar control and data acquisition system for operational purposes (this switch-over could only take place once the Met Office had accepted v3 signal processing for operational assimilation). The previous system was based around a WindowsNT computer, which needed to be rebooted on a weekly basis to prevent it from crashing. The new system has been running faultlessly for 4 months without the need for a single reboot. A third measure has been the installation of a broadband internet connection to supersede the original link (which had a speed equivalent to that of a dial-up modem connection). Not only has this increased the capacity for data transfer (which is becoming increasingly important as more instruments are operated at the site), and the ability to remotely-connect to site computers, but it has allowed considerably more-effective security measures to be implemented (though use of the router's firewall facility). In previous years numerous hours of staff effort have been wasted dealing with computer viruses. There have been no such problems since the transfer to the new system.

Example of one of the automatically-created daily quick-look plots which are available through the British Atmospheric Data Centre.



Increasing the accessibility of data recorded by the Facility

During the past year the Facility has achieved the important milestone of ensuring that all current data products are being made available (automatically) in recognised-format files. Prior to June 2003, all data were written in basic (non-standard format) files. Although most of these were relatively simple to understand, they contained virtually no explanatory material and so could not be used without reference to external documentation. A key feature of all the files currently being created is the inclusion of descriptions of the instruments being used, of the measurement techniques and of the ways in which the data are processed. The aim is that these files should remain scientifically useful long after the people responsible for collecting the data are available for comment. Daily quick-look plots, which are available through the British Atmospheric Data Centre, are also now being produced automatically for each instrument. These further increase the accessibility of the data by allowing potential users to quickly establish which subsets of the data are likely to be of use for their research.

SCIENCE HIGHLIGHTS:

Improvements to aircraft flight patterns

Improved airport approach procedures can significantly reduce fuel burn and emissions. Image courtesy of David Hooper

A unique ability of the MST Radar is to provide continuous wind-profile measurements at intervals of just a few minutes. Alternative techniques at best provide measurements at intervals of several hours. Consequently use of the data has spread beyond the Facility's designated atmospheric science community. A number of projects in recent years have been concerned with aeronautical applications. One such project has developed noise abatement procedures for use by aircraft on their approach to airports. MST radar observations were required to provide realistic winds for a flight simulator program. The response of different aircraft types was tested for a variety of approach procedures. As a result of this work, the Civil Aviation Authority approved a trial programme, for flights approaching Nottingham East Midlands Airport, which has been ongoing since the summer of 2006. To date, over 100 flights by Boeing 757 and MD11 aircraft have made use of an improved approach procedure. Environmental analyses indicate that, on average, they are 3-6 dBA quieter than non-trial flights (at distances of 10 - 30 nautical miles from the airport), whilst reductions in fuel burn and in emissions of approximately 10% are being achieved for those sections of the flight paths below 10,000 feet.

Modelling of small-scale atmospheric phenomena

Buoyancy wave activity apparent above a convectively-active cloud. Image courtesy of David Hooper.

Convective activity within the atmosphere, which is characterised by strong updrafts and heavy rainfall, tends to be localised within small geographical regions at any one time. Nevertheless small-scale ripples of motion (known as gravity or buoyancy waves), which are generated where the updrafts impact on stable layers aloft, can influence the behaviour of the atmosphere at large distances from their source. One current study is using MST radar observations of these ripples to test the ability of atmospheric models to accurately reproduce convective events. As atmospheric models become ever more advanced, their ability to reproduce such small scale phenomena becomes increasingly important for improving their accuracy. MST Radars are the only routinely-available source of information needed for this type of study.

The Bow Street Twister.

One of the buildings damaged by the Bow Street Twister. Image courtesy of Tony Olewicz.

According to bbc.co.uk: *A small tornado hit the village of Bow Street, near Aberystwyth during the early hours of 28 November [2006]. Although no one was injured more than 20 houses were damaged, trees were uprooted and electricity cables were brought down. ``There was an amazing bang at about 1.15am - it was like a train running out of control." - Villager Gwynfor Davies*. Unsurprisingly, this event, which occurred just 3 km from the MST radar site, was the subject of a great deal of interest for the Facility's user scientists (including those at the Met Office). It is a good example of a small-scale but high-impact weather event which is not typically captured by the Met Office's current operational observing systems (although they did capture the broader meteorological feature within which the tornado occurred). Both the MST Radar and the UFAM (Universities' Facility for Atmospheric Measurement) boundary-layer wind-profiler (which happened to be in operation at the MST Radar site at the time) are specifically designed to observe small-scale atmospheric phenomena. They were able to offer a more detailed picture. Although they did not observe the tornado directly, this is probably just as well. Had the tornado (a phenomenon of destructive ferocity) passed directly over the MST Radar site, this would almost certainly have been the last thing that the instruments ever saw!

Three refereed publications from 2006:

1. Y. G. Choi, S. C. Lee, A. J. McDonald, and D. A. Hooper. Wind-profiler observations of gravity waves produced by convection at mid-latitudes. *Atmos. Chem. and Phys.*, 6:2825-2836, 2006.
2. A. J. McDonald, K. P. Monahan, D. A. Hooper, and C. T. Gaffard. VHF signal power suppression in stratiform and convective precipitation. *Ann. Geophys.*, 24:23-35, 2006.
3. R. M. Worthington. Diurnal variation of mountain waves. *Ann. Geophys.*, 24:2891-2900, 2006.

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

- **Documentation:** Produce documentation describing the v3 signal processing scheme.
- **Automation:** Install a new air-conditioning unit in the radar control room (since the radar receiver is known to operate unstably under conditions high temperatures)
- **Promotion**: Give seminars and conference presentations in order to attract new users.