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

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

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.

A major renovation of the radar was undertaken in March 2011. This lead to a significant improvement in overall performance.

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 previously operated a boundary-layer wind-profiler. 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.

The mission of the Facility is:

- To operate the MST radar on behalf of the UK atmospheric science community
- To operate, and host, instruments whose observations complement those made by the MST radar
- To participate in appropriate NERC supported field campaigns
- To support facility users with analysis and interpretation of the data

The projects supported by the Facility cover the NERC priority themes of Climate System, Sustainable Use of Natural Resources, and Natural Hazards, Technologies..

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

The MST Radar has maintained was operated for 98.7% of the available time, exceeding the target of 98.0%.

SCORES AT LAST REVIEW (each out of 5)		Date of Last Review:		March 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)
69%	Project Manager: Mr Charles Wrench- 10% Project Scientist: Dr David Hooper – 100% Site Technician: Mr Les Dean – 29%	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			
141.8	General user support 2.0814	Guest instrument/ campaign support 10.0	n.a.	330.4	63.0	209.4

FINANCIAL COMMITMENT (by year until end of current agreement) £k				
2010-11 141.8	2011-12 130.3	2012-13 133.5	2013-2014 136.9	2014-2015 140.3

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NARFSC	9	1	CFARR, EISCAT

APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2010/11)												
	10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**Pilot**
NERC Grant projects*			**1**									
Other academic												
Students					**1**	**1**						
Pilot												
TOTAL			**1**		**1**	**1**						

PROJECTS COMPLETED (current FY – 2010/11)							
	α5	**α4**	**α3**	**α2**	**α1**	**β**	**R*/Pilot**
NERC Grant projects*		**2**					
Other Academic		**2**					
Students							
Pilot	**1** (Applications in this category are not graded)						

Project Funding Type (current FY – 2010/11) (select one category for each project)										
Grand Total	**Infrastructure**					**PAYG**				
	Supplement to NERC Grant *	**PhD Students NERC**	**PhD Students Other**	**NERC C/S**	**Other**	**NERC Grant***	**PhD Students NERC**	**PhD Students Other**	**NERC C/S**	**Other**
15	**1**	**3**	**2**		**7**					**2**
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**	**PhD Students Other**	**NERC C/S**	**Other**	**NERC Grant***	**PhD Student NERC**	**PhD Student Other**	**NERC C/S**	**Other**
19.0	**4.0**	**3.0**	**5.67**		**5.33**					**1.0**

User type (current FY – 2010/11) (include each person named on application form)				
Academic	**NERC Centre/Survey**	**NERC Fellows**	**PhD Students**	**Commercial**
8			**5**	**2**
User type (per annum average previous 3 financial years - 2007/2008, 2008/2009 & 2009/2010)				
Academic	**NERC Centre/Survey**	**NERC Fellows**	**PhD Students**	**Commercial**
11.0			**7.0**	**1.0**

OUTPUT & PERFORMANCE MEASURES (current year)										
Publications (by science area & type) (calendar year 2010)										
SBA	**ES**	**MS**	**AS**	**TFS**	**EO**	**Polar**	**Grand Total**	**Refereed**	**Non-Ref/ Conf Proc**	**PhD Theses**
			11				**11**	**3**	**8**	

Distribution of Projects (by science areas) (FY 2010/11)							
Grand Total	**SBA**	**ES**	**MS**	**AS**	**TFS**	**EO**	**Polar**
15				**15**			

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)										
Publications (by science area & type) (Calendar years 2007, 2008 &2009)										
SBA	**ES**	**MS**	**AS**	**TFS**	**EO**	**Polar**	**Grand Total**	**Refereed**	**Non-Ref/ Conf Proc**	**PhD Theses**
							7.33	**3.67**	**2.00**	**1.67**

Distribution of Projects (by science areas) (FY 2007/2008, 2008/2009 & 2009/2010)							
Grand Total	**SBA**	**ES**	**MS**	**AS**	**TFS**	**EO**	**Polar**
19.00				**19.00**			

Distribution of Projects by NERC strategic priority (current FY 2010/11)							
Grand Total	**Climate System**	**Biodiversity**	**Earth System Science**	**Sustainable Use of Natural Resources**	**Natural Hazards**	**Environment, Pollution & Human Health**	**Technologies**
15	**5.33**			**2.00**	**2.83**		**4.83**

**Combined Responsive Mode and Directed Programme grants*

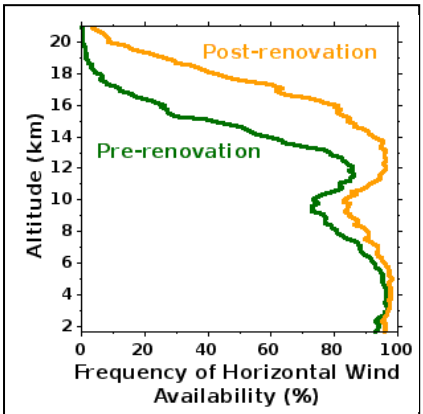
NOTE: All metrics should be presented as whole or part of whole number NOT as a %

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

Renovation of the MST Radar

The outstanding activity undertaken by the Facility over the past year was carrying out the first major renovation of the MST Radar in its 20 year lifetime. This was made possible by a £0.5M investment from NERC. A statistical analysis of the pre and post renovation data has confirmed that the overall useful coverage made by the radar has increased by 29% - an excellent outcome. Initial results also suggest a significant improvement in data quality.

ATRAD engineers installing replacement components for the MST Radar.



Statistical analysis of useful radar coverage for pre and post renovation data..

The primary focus of the renovation work was on replacing the components which allow the radar's beam to be steered to point in different directions. The new components were designed, manufactured and installed by ATRAD - one of the few companies which specialise in this type of radar. Consequently the Facility was able to benefit from tried and tested technological improvements rather than simply relying on a like-for-like replacement. The new components offer greater flexibility of operation, increased longevity, and superior diagnostic capabilities. This latter feature has also proved to be of value for monitoring pre-existing hardware components. For example, one of the five radar transmitters recently malfunctioned in such a way that this was not apparent from its own display panel. Nevertheless, unusual readings associated with the new components alerted Facility staff to the fact that something was not quite right and the problem was soon resolved.

SCIENCE HIGHLIGHTS:

Reducing the impact of aircraft

Improved airport approach procedures can significantly reduce fuel burn and aircraft emissions.

A recent aeronautical project, which made use of MST radar wind data, culminated in flight trials being undertaken at Nottingham East Midlands Airport to test improved airport approach procedures. The primary aim of this project was to reduce the noise of the aircraft (at ground level) as they came in to land. The flight trials demonstrated a reduction of around 50% in acoustic energy. A secondary, and welcome, effect was a reduction of around 10% in fuel burn, and therefore in aircraft emissions, along the airport approach section of the flight path. This represents considerable savings for the airlines involved and so these “Continuous Descent Approach” procedures are understandably being adopted on an ever-increasing basis. This was the first time that a methodical study was carried out to test the suitability of the procedures for all possible weather conditions at a UK airport – a prerequisite for allowing flight trials to be undertaken. NERC published an article about the study on their ``*Planet Earth*'' website - http://planetearth.nerc.ac.uk/news/story.aspx?id=820 - in September 2010.

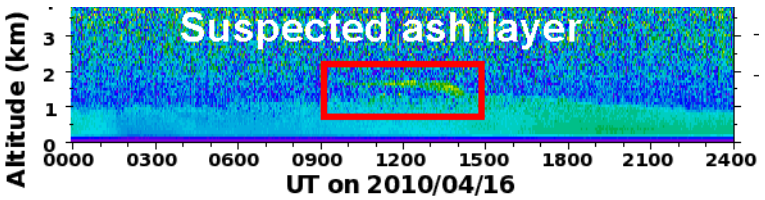
Convective activity (indicated here by the cumulus clouds) seen by the MST Radar was used as the basis for a computer modelling study.

Testing the validity of computer simulations

Two studies published during the last year made use of MST Radar observations in order to test the ability of computer models to realistically represent atmospheric phenomena. One was concerned with a destructive, ground-level wind phenomenon known as a Sting Jet. The other looked at the rapid transport of air between different heights in the atmosphere through convective activity. In both cases, the models had to be run at unusually high resolutions before they were capable of giving anything close to a realistic representation. Advances such as these are vital for the continued improvement of the weather forecast, which will increasingly rely on being able to represent high-impact and small-scale phenomena.

Detecting Volcanic Ash

Members of the NERC atmospheric science community, including the MST Radar Facility, played a key role in assisting the Met Office to detect signs of the ash cloud after the Icelandic Eyjafjallajökull volcano began to erupt on 14th April 2010. Volcanic ash is known to have a potentially-catastrophic effect on jet engines and so aircraft are redirected away from areas which are affected by the plume. The Met Office have the responsibility for advising international aviation on the location and movement of volcanic clouds originating in the north-east Atlantic sector, which covers Iceland. Owing to the unprecedented scale of the airspace closure and its associated economic impact, the Met Office were under considerable pressure to verify that their predictions of the ash cloud's location were correct. One way to do this was to use ground-based lidars, i.e. laser radars, which can detect the presence of atmospheric aerosols, i.e. very small particles such as ash, dust, and sand. The NERC community operate a variety of such instruments and they assisted the Met Office by making special observations, by sometimes making special deployments of equipment, and by sharing their data



Raw backscatter data recorded by the Facility's Vaisala LD40 laser ceilometer for the single day on which it detected a layer of volcanic ash.

The MST Radar Facility operates a Vaisala LD40 laser ceilometer. These instruments are designed primarily for determining the altitudes of cloud layers. Consequently they ignore the signals returned from the aerosol-rich layer which is habitually found in the lowest 1 – 2 km of the atmosphere. Nevertheless, it is possible to access the raw backscatter data and the Facility made these available to the community through quick-look plots, which were automatically-updated every half hour. Evidence of a volcanic ash layer was seen on only one day – on 16th April 2010. However, the more-powerful, research-class lidar systems operated by the University of Manchester at the MST Radar site were able to detect the ash layer on a much larger number of days. This was a useful result as it demonstrated that the LD40 ceilometer, which is comparable to the main models used in the Met Office's observational network, was not suitable for detecting volcanic ash on a routine basis. The Met Office have subsequently enhanced their network with a number of more-powerful lidar systems.

As a post-script to this story, the observations confirmed that the Met Office's predictions gave an accurate picture of the ash dispersal. Moreover, a recent study - see e.g. http://www.newscientist.com/article/mg21028104.000-europe-was-right-to-halt-flights-after-volcano.html - has confirmed that the nature of the ash would have made it particularly dangerous for any aircraft flying through it.

Details of 3 publications from 2010 which made use of data from the Facility.

1. Jeffrey M. Chagnon and Suzanne L. Gray. A comparison of stratosphere-troposphere transport in convection-permitting and convection-parameterizing simulations of three mesoscale convective systems. J. Geophys. Res., 115(632):663-676, 2010. (Impact factor 3.30)
2. Oscar Martínez-Alvarado, Florian Weidle, and Suzanne L. Gray. Sting jets in simulations of a real cyclone by two mesoscale models. Mon. Wea. Rev., 138(11):4054-4075, 2010. (Impact factor 2.35)
3. Graham Parton, Anthony Dore, and Geraint Vaughan. A climatology of mid-tropospheric mesoscale strong wind events as observed by the MST radar, Aberystwyth. Meteorol. Apps., 17:340-354, 2010. (Impact factor 1.40)

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

During the 2010-2011 year, the Facility was involved in a paper study of the MST radar's potential for detecting near-Earth objects in space. The ultimate aim of such work is to be able to detect objects which could be hazardous for manned-spacecraft and satellites. As a stepping stone towards such a goal, the Facility plans to make observations of the International Space Station (ISS) during the forthcoming year. Although the standard mode of radar operation is poorly-optimised for observing such a target (the ISS is travelling much faster and at a considerably greater distance from the radar than the usual atmospheric targets), a successful outcome will justify the effort required to adapt the observations to the requirements.

Two NERC-funded atmospheric science projects (TROSIAD and DIAMET), which have overlapping objectives, will hold a joint field campaign during the autumn of 2011. The MST radar will play a central role.