SERVICES & FACILITIES ANNUAL REPORT - FY April 2000 to March 2001

SERVICE	FUNDING /AGREEMENT	ESTABLISHED as S&F	TERM
NERC Mesosphere-Stratosphere-Troposphere Radar (MSTR) Facility	SLA	1997	5 years to March 2005

TYPE OF SERVICE PROVIDED:

The Mission of the NERC Mesosphere-Stratosphere-Troposphere Radar (MSTR) Facility is to provide high quality atmospheric data products in near real-time to the UK and international scientific community in support of environmental research. The Facility also provides training and promotes good practice in the use of the data by the user community and increases the awareness, value and application of MST radar data through its web pages. For projects which require the Radar to be operated in a specific mode, it operates review procedures to enable accredited access thereby ensuring only the best science is supported.

In order to achieve its Mission the NERC MSTR Facility:-

- operates and maintains the MST Radar system at Capel Dewi, Aberystwyth and associated data systems at the Rutherford Appleton Laboratory (RAL)
- monitors and investigates the quality of the radar data output
- routinely archives the MSTR data products with the NERC British Atmospheric Data Centre (BADC) thereby providing access to the data through the BADC website: www.badc.rl.ac.uk
- provides appropriate scientific and technical support to the user community including the acquisition of additional related data at the radar site
- executes commissioned work with the UK Met Office to supplement the annual budget.

The NERC MST Radar is an active high-power, high-resolution radar facility unique in the UK for the measurement of both small-scale and meso-scale atmospheric structure and dynamics. It operates at a frequency of 46.5 MHz and is based on a field-array of antennas with dimensions of 100m x 100m. It is capable of measuring vertical profiles of echo power, winds and turbulence with a time resolution of 12 minutes and height resolution of 150 metres.

Central to the scientific exploitation of the MST Radar data is the continuous operation of the Facility in a standard operating mode which satisfies the needs of the majority of users. This generates high-quality, rigorously calibrated and uninterrupted datasets ideal for both detailed case studies and long-term statistical analyses. In fact, virtually continuous 12-minute average data have been acquired for more than 10 years.

A further unique feature of the UK MST Radar, compared to others of its kind world-wide, is the comprehensive provision to users of derived data products via the British Atmospheric Data Centre(BADC) website. Processing of the acquired raw data occurs in real-time and the atmospheric products, together with associated meteorological data recorded at the radar site, are available soon afterwards at the BADC.

SCORES AT LAST REVIEW (each out of 5) **(Date: January 1999)**

Need	Uniqueness	Quality of Service	Quality of Science & Training	Average
4.5	5.0	5.0	4.5	4.75

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status			Next Review (January)	Contract Ends (31 March)
80%	Project Manager:	Dr Stuart White	50% Established	2004	2005
	Project Engineer:	Mr Ken Slater	100% Established		
	Site Manager:	Mr Tony Olewicz	100% Fixed-Term		

FINANCIAL DETAILS: CURRENT FY

Recurrent Allocation £k	Unit Cost £k						Capital Expend £k	Revenue £k	Full cash cost £k
	Data Provision	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6			
130.3	7,007						10.0	32.0	133.1

FINANCIAL COMMITMENT (by year until end of current agreement)

2001/02	2002/03	2003/04	2004/05
£134k	£139k	£143k	£147k

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NERC Atmospheric Radar Facilities Steering Committee	5 (Chair: Prof Chris Collier University of Salford)	2	Chilbolton Radar Facility

APPLICATIONS: DISTRIBUTION OF GRADES (Current FY) ** A registration system has now been established at the BADC website for MSTR data users – this will allow peer review of projects using either standard data or "specific mode" projects, and hence the provision of comprehensive review grade statistics in future years. Only "specific mode" projects have been peer reviewed previously and are presented below.

	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects		1						
Other academic								
Students								
Pilot								
TOTAL								

APPLICATIONS: DISTRIBUTION OF GRADES (per annum average last 3 years)

	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects	2							
Other Academic	1		1					
Students								
Pilot								
TOTAL								

PROJECTS COMPLETED (Current FY)

	α5	α4	α3	α2	α1	β	R*/Pilot
NERC Grant projects		1					
Other Academic							
Students							
Pilot							

USER PROFILE (current FY) **combined non-Thematic and Thematic*

Grand Total	PAYG					Infrastructure				
	NERC Grant *	Student		NERC C/S	Other	supplement to NERC Grant*	Student		NERC C/S	Other
		Total	NERC				Total	NERC		
19						1	1	2	1	14

USER PROFILE (per annum average last 3 years)

Grand Total	PAYG					Infrastructure				
	NERC Grant *	Student		NERC C/S	Other	Supplement to NERC Grant*	Student		NERC C/S	Other
		Total	NERC				Total	NERC		

USER PROFILE (current FY)

Academic	Centre/Survey	NERC Fellows	PhD	Commercial
15	1	1	2	1

USER PROFILE (per annum average last 3 years)** See above

Academic	Centre/Survey	NERC Fellows	PhD	Commercial

OUTPUT & PERFORMANCE MEASURES (current FY)

Publications (by science area & type)

SBA	ES	MS	AS	TFS	EO	Polar	Refereed	Non-Ref/ Conf Proc	PhD Theses	Grand Total
			6				3	3		6

Distribution of Projects (by science areas)

SBA	ES	MS	AS	TFS	EO	Polar
			100%			

OUTPUT & PERFORMANCE MEASURES (per annum average last 3 years)

Publications (by science area & type)

SBA	ES	MS	AS	TFS	EO	Polar	Refereed	Non-Ref/ Conf Proc	PhD Theses	Grand Total
			9.0				6.0	3.0		9.0

Distribution of Projects (by science areas)

SBA	ES	MS	AS	TFS	EO	Polar
			100%			

OVERVIEW & ACTIVITIES IN FINANCIAL YEAR:

The MST Radar Facility acquired data on behalf of the scientific community for a total period of 8368 hours in 2000/01 which represents 95.5% of the projected availability during the year. These data are compiled in appropriate formats on the BADC website and are available to the user community on the following day.
In addition to the provision of data for the scientific community, quasi real-time data were supplied every 3 hours under a commercial contract to the UK Met Office – both for operational forecasting and scientific application.
Surface wind data from nearby Frongoch were also collected continuously – one minute averages – and similarly recorded on the BADC website for the user community. These data are now also updated on a daily basis and the annual recovery rate was 97.8%.
Following the installation of a surface meteorological station at Capel Dewi in July these average data – rainfall, temperature, pressure, humidity and down-welling solar radiation – were recorded every 10 minutes from 24 July onwards; 100% data recovery was achieved for the following 250 days of the reporting year. These data are routinely archived on the BADC website for access by accredited users.
Additionally, the Lower Atmosphere Profiler (LAP) - owned and operated by the UK Met Office – is now providing ½ hour average data of wind profiles which are stored at the BADC website; during the past year there has been 99.2% data capture by this system.
All MST Radar data and associated data products are archived in near real-time on the BADC website and it is from here that customers and visitors acquire data and information on the Facility to meet their scientific objectives.

For the NERC MST Radar Facility, the previous year has witnessed the culmination of the major re-design and new construction of the operational control and data recording system. This has been achieved at low cost - approximate capital cost £8k funded by the Facility – and the project was entirely carried out by the Project Engineer for the MST Radar Facility. Virtually no downtime in system availability was experienced during either the commissioning phase or the subsequent operation of the new hardware and software and the overall system is proving to be faster and more reliable than the old one.
In essence, the old PDP11 operating control computer and software together with the Vax data processing computer and software have been replaced with a new operating/data acquisition system which runs on a PC under Windows NT4. During the development of the new system it became apparent that the new 500MHz PC with 20Gbyte hard disc had sufficient speed/capacity to be able to execute all the data processing - previously carried out by the Vax - at the same time as managing the radar signal operational system – in the past managed by the PDP11. Full operational redundancy is now also provided at the radar site by the incorporation of a parallel PC operating system. The completely modernised system – including improved graphical displays of IQ, Doppler and vector wind data - now provides enhanced data capture and processing which is already providing significant benefits for the UK atmospheric science community.

The relay controller unit of the radar system has also been upgraded by Project staff which has resulted in the reduction of cabling to the antenna field array, significantly reducing the likelihood of damage from lightning strikes. In the same context, electrical isolators have been incorporated in the operational system to further improve continuity of operations during electrical storms which have occasionally caused difficulties previously. The RAL annual visit and report on Health & Safety issues for the MSTR site found no outstanding problems.

Following a successful capital bid, a new surface meteorological system was purchased and installed at Capel Dewi and the associated met data, together with the surface wind data from nearby Frongoch, are routinely recorded at the radar site before archiving – along with the LAP wind profiles - on the BADC website.

A new staff member – Dr David Hooper – was appointed as Project Scientist at the beginning of March and will replace Ken Slater who retires at the end of April. Dr Hooper will provide a stronger link with the UK and international research community to ensure that the Facility increasingly meets the data requirements which are needed to fulfil the community's scientific objectives.

SCIENCE SUPPORTED IN FY:

The highlight of the year has been the Aberystwyth Egrett Experiment, an international project conducted during May and June 2000 to study filamentation and mixing in the tropopause region. This made use of the MST radar, the co-located University of Wales lidar facility, and a variety of instruments on-board the Egrett high-altitude aircraft; 15 successful flights were made many of which passed over the radar/lidar site. The campaign was very productive and the data are continuing to be analysed by a number of different groups. Already the following 2 scientific highlights have been identified: (a) observation of gravity waves evolving into turbulence, and (b) observation of a subtropical intrusion by radar and lidar in which the Egrett was able to measure filamentary structures traceable back to small-scale breaking Rossby waves. The optimum timing and flight-paths of the aircraft were determined from a numerical gravity wave forecast model which itself has been developed using previous data from the MST radar for validation purposes. The flawless operation of the radar during the campaign benefited from the recent upgrade to a PC based control and data acquisition system; this has proved to be faster and more reliable than the old system. Moreover, use was made of the new capability for storage of 'raw' radar data which are currently being analysed in order to develop more sophisticated signal processing techniques (see next section). In particular attention is being focussed on a comparison of aircraft and radar observations in order to ascertain whether quantitative turbulence information can be reliably extracted from the radar spectral width data.

The high time and altitude resolutions of the radar data, and the continuous nature of the observations, continue to be invaluable for case studies of particular meteorological events. Data from the MST radar and a weather radar, satellite imagery and output from

limited-area and mesoscale versions of the Met Office Unified Model have been synthesized to depict the mesoscale structure of a polar low with strong upper-level forcing. Dry air descending within the circulation from near the tropopause region, predicted by the models, was found to give a striking signature in the MST radar return signal strength. Moreover, the radar data suggest that thin tongues of this air were continuing to penetrate slantwise down a further few hundred metres above the shallow cloud constituting the southern end of an archetypal cloud head. A second study focussed on the mesoscale structure of a cold comma cloud system that produced an area of heavy rain and locally severe weather. Again data from the MST radar were used in conjunction with observations from microwave and UHF research Doppler radars, a routinely available radar network, satellite, in-situ instruments and the output from a mesoscale model. The rain, generated in the exit region of an upper-level jet characterised by velocity perturbations, was organised into bands which may have been related to the multi-layered atmospheric structure upwind. The operational Met Office model, with its 12 km grid, was shown to resolve many but not all of the key features resolved by the radars. It has been suggested that further improvements in very-short-range forecasting of important local detail could be achieved by further increasing the resolution and assimilating more mesoscale observational data.

In addition to being used for these highly specific studies, radar data are being utilised in research projects of a broader based or more general nature. The topics of interest include the vertical propagation of mountain lee waves, the possible influence of gravity waves on ozone lamination, stratosphere-troposphere exchange and the effects of humidity on radar return signal strength; studies of the mesospheric altitude region will be referred to in the next section. Data from the radar are also being used for undergraduate teaching purposes.

“Throughout 2000 the Met Office has continued to regard the MST wind profiler radar at Aberystwyth as a significant component of the UK upper-air observing network. Throughout the year MSTR data has been assimilated in the UK Numerical Weather Prediction (NWP) models. Statistics of differences between the wind observations and the model demonstrate that the Aberystwyth MST radar is one of the best in Europe and is the only 50MHz system whose wind data is routinely assimilated in NWP forecast models.
The Met Office also considers the MST radar site as a significant platform for research and remote sensing instrument development. It presently has a LAP3000 boundary layer wind profiler installed alongside the MST radar. This system is used for software/hardware development projects prior to operational release into the network. In addition it is demonstrating the potential benefits of co-locating wind profilers with different operating frequencies whilst also providing near continuous measurements for research activities.”

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

It is intended that future use of the radar should be determined by users’ requirements rather than by historical constraints. The following proposals will therefore be implemented taking users' views into account.

As mentioned previously, analysis of data resulting from the Egrett Experiment will be instrumental in development of the signal processing; a comparison of different techniques has already identified the scope for improvements. In particular it is intended to update those aspects relying on simplifying assumptions which were essential under the limited speed and storage capacity of the original computer system. The use of more explicit techniques will principally lead to a greater confidence in the data rather than necessarily to better accuracy. A proposed modification to the data product files is the addition of a spectral reliability flag to indicate the meaningfulness of associated values.

The radar world-wide-web pages are to be significantly enhanced to include background information concerning MST radar principles, radar return mechanisms and specific details relating to the Aberystwyth facility.

A priority will also be given to adapting the radar control software to anticipated future requirements. In the early days of the facility, the radar tended to be run for a few days at a time in one of a number of specific modes which were of limited interest. In more recent years the radar has typically been run continuously in a single, lower-atmospheric mode which is of potential use to a broader range of atmospheric scientists. Although it is anticipated that, for the most part, the radar will continue to be run in a general mode, it would be useful to be able to interlace these observations with user-specific formats thereby avoiding long data gaps. For example, interest has been shown in using the radar to observe the sporadically occurring echoes from mesospheric altitudes and above. Anomalously strong radar returns from the mesopause region occasionally observed from Aberystwyth during mid-summer months are similar in nature to the so-called polar mesophere summer echoes (PMSEs) observed at higher latitudes. The occurrence of PMSEs is known to be associated with the extremely cold mesopause temperatures that also give rise to noctilucent clouds (NLCs). Speculation that a reduction in summer mesopause temperatures may be an indicator of global change has, in part, fuelled the growing interest in PMSEs and NLCs in recent years.

As highlighted in the previous section, observations made with the MST radar have proved to be of greatest value when combined with those from other instruments and the outputs from atmospheric models. During the last year the potential of the facility has been significantly improved by the installation of a new surface met station and the Met Office’s 915 MHz LAP radar; data from both are now available on the BADC. One of the projects for the forthcoming year is to utilise these in addition to the new JIF-funded UHF radar for joint studies of frontal passages with the MST radar. Plans are additionally underway to provide MST radar data in a more commonly used file format, consistent with those of other data sets stored on the BADC, in order to facilitate easier inter-comparisons.

It is also planned for the British Atmospheric Data Centre to provide more substantial statistics on the MST Radar customer profile and specific scientific applications supported by the Radar during the reporting year.